THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA OFFSHORE WIND FARM - PROJECT TWO APPLICATION

International Mainstream Renewable Power Limited and Siemens Project Ventures for:

The construction and operation of Hornsea Offshore Wind Farm Project Two, a 1,800 MW with up to 360 turbines wind farm located approximately 89km off the East Riding of Yorkshire coast, and 50km from the median line between UK and Dutch waters.

Planning Inspectorate Reference: EN010053

WRITTEN SUBMISSION FOR DEADLINE 4

Dated 20th October 2015

INTRODUCTION

1.1 This submission consists of 4 parts:

a. Section A– Natural England’s response to the Examining Authority’s second round of written questions

b. Section B – Natural England’s detailed response to the Examining Authority’s written question EOO16

c. Section C – Natural England’s detailed response to the Examining Authority’s written question EOO19

d. Section D - References

SECTION A – Natural England's response to the Examining Authority's second round of written questions

	Question to:	Question:	Natural England Response:
EOO	**Ecology offshore: ornithology**		
EOO15	applicant, NE	Please provide an update on the position reached on the Ornithology Road Map, including the Clarification Notes, as mapped out in Appendix Y to Deadline 3.	Since the submission of its response at Deadline 3 Natural England has continued to engage with the Applicant to resolve outstanding matters wherever possible. As set out in their Deadline 3 Offshore Ornithology Roadmap, the Applicant intends to submit various documents at Deadline 4. Natural England will review the respective Clarification Notes and will provide an update at Deadline 5 and, where possible, at the issue specific hearings (scheduled for 27th October 2015).
EOO16	applicant, NE, RSPB	Please provide an update on the positions reached in the most recent SoCG on the effects of Hornsea Project 2 on Special Protection Areas (SPA) populations of kittiwake, gannet, guillemot, razorbill and puffin, for the project alone and in combination. Relevant data should be presented in tabular form. This should include in particular the issues around kittiwake, including Flamborough Head Bempton Cliff and Flamborough and Filey Coast (FHBC/FFC) population trends, and additional clarification on kittiwake apportioning.	Natural England provided details in our submission at Deadline 3 (Appendices 2-7), in tabular form, of its position on the effects of Hornsea Project 2 on Special Protection Area (SPA) populations of kittiwake, gannet, guillemot, razorbill and puffin, for the project alone and in combination. Please note that Natural England continues to discuss the predicted impacts of the project on kittiwake with the applicant, and an update on progress will be provided at the Issue Specific Hearings. Information on kittiwake population trends and apportioning for Flamborough Head and Bempton Cliffs SPA and Flamborough and Filey Coast pSPA is set out in detail in Section B of this submission.

	Question to:	Question:	Natural England Response:
EOO17	applicant, NE, RSPB	Please provide an update on the positions reached in SoCG on the effects of Hornsea Project 2 on EIA species (including lesser black backed gull, and greater black backed gull). Relevant data should be presented in tabular form.	Natural England met with the applicant on 14 October 2015 to discuss the EIA positions for the relevant species including lesser black-backed gull and great black-backed gull. Natural England understands that the applicant will submit updated EIA tables at Deadline 4. Natural England will provide an update on any positions reached for EIA species including lesser black-backed gull and great black-backed gull at Deadline 5.
EOO18	applicant, NE	Please provide an update on discussions between the applicant and NE on migratory bird collision risk.	Natural England met with the applicant on 14 October 2015 to discuss the migratory collision risk assessment for seabirds. Natural England understands that the Applicant will submit an updated migratory bird collsion risk assessment for the 5 seabird species (great skua, Arctic skua, little gull, Arctic tern and common tern) at Deadline 4. Natural England will provide an update on any positions reached at Deadline 5.
EOO19	applicant, NE and RSPB	Given the paucity of recent data on Offshore Windfarm (OWF) ornithological impacts, and the importance noted in NPS EN-3 of improving the evidence base, can the applicant please: a) set out the Project approach to the monitoring of offshore ornithological impacts (not limited to the pre- and post- construction surveys); and	Although this question is directed to Natural England, along with the Applicant and RSPB, we think the Applicant is better placed to respond. Natural England understands that conditions 10(2)(k) and 15(2)(b) in the DMLs commits the Applicant to undertake monitoring in accordance with the Ornithological Monitoring Plan (OMP), details of which will be decided post consent. However, the OMP condition should be read in conjunction with the In-Principle monitoring Plan (IPMP) which sets out the key

	Question to:	Question:	Natural England Response:
		b) indicate where the approach will be secured in the DCO/DMLs.	species which should be monitored and what approaches could be adopted (e.g. site specific, colony specific or strategic).
EOO20	NE, MMO and RSPB	Further to the submission of 'Notes of NE/RCUK Post Consent Monitoring Seminar (March 2015)' to Deadline 3 (REP3-032), can NE, MMO and RSPB please advise on potential good practice for project specific, and strategic, ornithological impacts monitoring?	Natural England's response to question EOO20 is set out in Section C of this submission.
EOMM	**Ecology offshore: marine mammals**		
EOMM27	NE	What is the basis in international law for extending the Wash pSPA beyond the limit of the territorial sea?	Natural England understands that this question is in relation to the draft Greater Wash SPA, in which the current draft boundary extends beyond the UK's territorial sea limit (i.e. beyond the 12nm limit). Natural England's remit as regards to the designation of European sites does not extend beyond 12nm (at 12nm JNCC becomes the relevant SNCB). Information on how the requirements of the Birds and Habitats Regulations are applied beyond territorial waters can be found on the JNCC website at: http://jncc.defra.gov.uk/page-4550. If further detail is required, Natural England recommends that the Examining Authority contact John Clorley (Head of MPA Management and International Marine Biodiversity Team) at Defra.
EL	**Ecology – onshore and intertidal**		

	Question to:	Question:	Natural England Response:
EL21	applicant, NE	Please provide in tabular form the NE/applicant conclusions about the effects of Hornsea Project 2, (i) alone and (ii) in combination, on features of: a) the Humber Estuary SPA; b) the Humber Estuary Ramsar site; and c) the Humber Estuary SAC.	Please refer to the Applicant's response to question EL21, which is effectively a joint statement regarding our positions on the effects of the project, alone and in-combination, on the features of the Humber Estuary SAC, SPA and Ramsar site.
CL	**Construction – onshore and inter-tidal**		
CL25	applicant, NE, RSPB	With regard to the Intertidal Access Management Plan, please advise on: a) progress made; and b) how the plan is secured?	Natural England welcomes the Applicant's commitment to prepare and submit an Intertidal Access Management (IAMP) post consent that will be agreed with the relevant local authorities and Natural England. The plan will set out specific details in relation to access over the lifetime of the project (i.e. during construction and operational phase of the project) to ensure impacts are no greater than those assessed in the environmental Statement. Natural England looks forward to seeing an updated version of the draft DCO/DMLs incorporating the requirement for an IAMP.
CL26	RSPB, NE	Are the RSPB and NE satisfied with the scope of contents of the Code of Construction Practice (CoCP), including how	Natural England is satisfied with the scope of contents of the CoCP. We understand that the CoCP sets out the management measures that will be required for all of Hornsea Project Two

	Question to:	Question:	Natural England Response:
		the role of the Ecological Clerk of Works (ECOW) is secured?	construction activities and will incorporate a suite of documents/plans, some of which will be required to be produced and agreed with Natural England (e.g. EMP, Construction Method Statement, etc.). Natural England understands that all ecology works described in the CoCP will be carried out under the guidance of ECoW. The role of the ECoW will be set out in the EMP and Project Environmental Management and Monitoring Plan (PEMMP).
CS	**Construction – offshore**		
CS17	applicant, MMO and NE	Please provide an update on the progress between the applicant and the MMO/NE in resolving issues relating to the 'In Principle Monitoring Plan', including inclusion in the draft DCO.	The inclusion of the IPMP in the draft DCO is still a matter of on-going discussion between Natural England and the Applicant. Natural England maintains its position that the IPMP is an important document and would welcome its inclusion in the DCO.
DC	**Draft Development Consent Order (DCO)**		
DC31	MMO	Is the MMO now satisfied with the latest version of the DMLs? If not, what further amendments do they require?	Although this question is not directed at Natural England, we have provided some comments below to aid the Examiners' understanding of outstanding concerns that we believe need to be addressed in the draft DCO/DMLs. In our written representation (para 6.6.36) Natural England raised concerns of potential disturbance to overwintering birds due to scheduled inspections during the operational and maintenance phase of the project. During a meeting on 15th

	Question to:	Question:	Natural England Response:
			October the Applicant has advised they will update the draft DMLs with an overwintering restriction during the operation & maintenance phase of the project, the text of which has been agreed with Natural England. The inclusion of a 6.5m CD tidal restriction on construction activities taking place in the intertidal area is still a matter of discussion between the Applicant and Natural England.
DC33	NE, MMO and local authorities	a) Do NE, MMO and the local authorities consider that they have sufficient information on the principles and parameters to be used in drafting the Ecological Management Plan (EMP) to be confident that the submitted plan will be capable of approval? b) Do they consider that they have or will have sufficient information and assurances about monitoring to be confident that the submitted EMP will be monitored adequately? c) Do they consider that they will have sufficient information to be confident about the enforcement of the EMP?	a) Natural England is satisfied that the outline EMP submitted by the Applicant has considered the appropriate habitats and species of nature conservation importance. Additionally, Natural England notes that the EMP will be submitted for approval by the local authorities in consultation with Natural England, at least 4 months prior to commencement of construction activities. b) Natural England notes that monitoring will be conducted in accordance with Natural England's licensing guidelines, where appropriate. In addition we note that the scope of monitoring surveys (e.g. intertidal habitats, sand dunes and *Salicornia* and other annuals colonising mud) will be produced and agreed with Natural England. Therefore, Natural England is satisfied that the EMP will ensure adequate pre, and post, construction monitoring is carried out. However, we have highlighted with the Applicant that a requirement to secure intertidal monitoring for operational and maintenance activities over the lifetime of the project is needed. The Applicant has identified that the In-Principle Monitoring Plan

	Question to:	Question:	Natural England Response:
			relates to the DML activities only, so it wouldn't be an appropriate place to secure such a requirement, but noted the EMP could consider this. Therefore, Natural England welcomes further discussions with the Applicant on how intertidal monitoring over the lifetime of the project can be secured as part of the consenting process, recognising the detail of monitoring would be included in the either the EMP, IAMP or IPMP and dealt with post consent/prior to construction as required. c) Enforcement of DCO/ DML conditions is a matter for the consideration of the regulators i.e. MMO and Local Authorities
DC34	NE, MMO and local authorities	a) Do NE, MMO and the local authorities consider that they have sufficient information on the principles and parameters to be used in drafting the CoCP to be confident that the submitted code will be capable of approval? b) Do they consider that they have or will have sufficient information and assurances about monitoring to be confident that the submitted CoCP will be monitored adequately? c) Do they consider that they will have sufficient information to be confident	a) Natural England does not have any outstanding concerns regarding the CoCP. We understand that the CoCP sets out the management measures that will be required for all of Hornsea Project Two construction activities and will incorporate a suite of documents/plans, some of which will be required to be produced and agreed with Natural England (e.g. EMP, Construction Method Statement, etc.). b) Natural England is satisfied that the pre-construction plans, surveys and documentation that will be incorporated into the CoCP will ensure adequate monitoring will be carried out. In addition, these will plans and documents will be produced and agreed with Natural England. c) Enforcement of DCO/ DML conditions is a matter for the

	Question to:	Question:	Natural England Response:
		about the enforcement of the CoCP?	consideration of the regulators i.e. MMO and Local Authorities

SECTION B – Natural England's detailed response to the Examining Authority's written question EOO16

EOO16: Please provide an update on the positions reached in the most recent SoCG on the effects of Hornsea Project 2 on Special Protection Areas (SPA) populations of kittiwake, gannet, guillemot, razorbill and puffin, for the project alone and in combination. Relevant data should be presented in tabular form. This should include in particular the issues around kittiwake, including Flamborough Head Bempton Cliff and Flamborough and Filey Coast (FHBC/FFC) population trends, and additional clarification on kittiwake apportioning.

Natural England provided details in our submission at Deadline 3 (Appendices 2-7), in tabular form, of its position on the effects of Hornsea Project 2 on Special Protection Area (SPA) populations of kittiwake, gannet, guillemot, razorbill and puffin, for the project alone and in combination. Please note that Natural England continues to discuss the predicted impacts of the project on kittiwake with the applicant, and an update on progress will be provided at the Issue Specific Hearings.

Below, Natural England provides information on kittiwake population trends for Flamborough Head and Bempton Cliffs SPA and Flamborough and Filey Coast pSPA in the context of national and regional trends based on data from JNCC (2014), as well as clarification of kittiwake apportioning.

<u>**Kittiwake Population Trends**</u>

Information from UK Seabird Population Censuses: 1969-2002.

Three complete censuses of seabirds at their breeding colonies in Britain and Ireland have been carried out: Operation Seafarer (1969-70); the Seabird Colony Register (SCR) Census (1985-1988); and Seabird 2000 (1998-2002). These censuses of colonies across Britain and Ireland allow calculation of population change between the census periods as a percentage change in breeding numbers (Table 1).

Table 1. Population changes in kittiwake numbers (Apparently Occupied Nests (AON)) at a UK, England and Scotland scale between the national census periods.

	Population change 1969-70 – 1985-88 (between Operation Seafarer and SCR)	Population change 1985-88 – 1998-2002 (between SCR and Seabird 2000)
Kittiwake UK scale	+24%	-25%
Kittiwake England Scale	+153%	-39%
Kittiwake Scotland Scale	+4%	-21%
Kittiwake Wales Scale	+27%	-20%

The overall UK trend was an increase in numbers between 1969/70 and 1985-88, followed by a decline between 1985-88 and 1998-2002. The percentage population increase between 1969/70 to 1985-88 was greatest in England although this does reflect the starting population being much lower in England than in Scotland. The kittiwake population in England in 1969/70 was 49,676 AON, compared to 346,097 AON in Scotland (and 6,891 AON in Wales). While the largest increase in numbers between 1969/70 and 1985-88 was in England, there were also substantial increases at a number of Scottish colonies, particularly in the south-east of Scotland, and similarly increases in kittiwake numbers at English sites occurred not only in Humberside (where Bempton Cliffs and Flamborough Head SPA colony is located) but also at colonies in Northumberland, Cleveland and North Yorkshire (Mitchell et al. 2004).

The percentage change in breeding numbers between censuses can also be calculated for individual colonies. Table 2 below shows population changes for the most important kittiwake colonies in Britain in the period between the two most recent seabird censuses. This shows that the majority of large kittiwake colonies in Britain experienced declines over the period 1985/88 – 1998/2002, including the Bempton Cliffs (including North Flamborough Head) colony. The average population change over this period for the major colonies was a decline of 21% or a 2.35% decline per annum. Individual colonies show per annum rates for change that varied from an 8.2% per annum decline to a 4.5% per annum increase. The Bempton Cliffs (including North Flamborough Head) colony covers kittiwake that are within the original Flamborough Head and Bempton Cliffs SPA. This site supports one of the largest kittiwake colonies in the UK and the only colony that qualifies as an SPA for kittiwake as a feature in England. Between the two census periods the population declined by 50%, which equates to a 5.2% decline per annum.

Table 2. Changes in the number of breeding kittiwakes (AON) at major colonies in Britain between the SCR Census (1985–88) and Seabird 2000 (1998–2002). Major colonies are those that contained the top 50% of the national populations of Great Britain during the SCR Census. Pink shading indicates colonies where numbers have declined, green shading colonies that have shown increases between the two census periods. Data from Mitchell et al. (2004).

Colony	Location	SCR Census 1985-88	Seabird 2000 1998-2002	% population change between censuses	Annual %change between censuses
Bempton Cliffs (incl.N. Flamborough Head)	NE England	85,095	42,659	-50%	-5.2%
West Westray (SSSI)	Scotland (Orkney)	31,085	34,864	12%	1.0%
Fowlsheugh (SSSI)	Scotland (east coast)	22,051	19,842	-10%	-0.8%
St Abb's Head to Fast Castle head SSSI	Scotland (east coast)	20,132	16,223	-19%	-1.6%
Fair Isle	Scotland (Shetland)	19,072	8,204	-57%	-5.5%
Berriedale Cliffs (SSSI)	Scotland (east coast)	13,847	24,427	76%	4.5%
Handa	Scotland (west)	10,732	7,013	-35%	-3.5%
Copinsay	Scotland (Orkney)	9,550	4,364	-54%	-5.9%
Noss	Scotland (Shetland)	9,438	2,395	-75%	-8.2%
Clo Mor	Scotland (north coast)	9,020	9,475	5%	0.4%
Isle of May	Scotland (east coast)	6,765	3,639	-46%	-4.3%
Lion's Head	Scotland (east coast)	6,653	5,431	-18%	-1.3%
Farne Islands	NE England	5,915	5,096	-14%	-1.1%
Turturra Heughs	Scotland (east coast)	5,674	3,098	-45%	-4.5%
Colonsay: NW Cliffs	Scotland (west)	5,646	6,485	15%	1.0%
Marwick Head (SSSI)	Scotland (Orkney)	5,509	5,573	1%	0.1%
Berneray	Scotland (west)	5,114	2,613	-49%	-5.0%

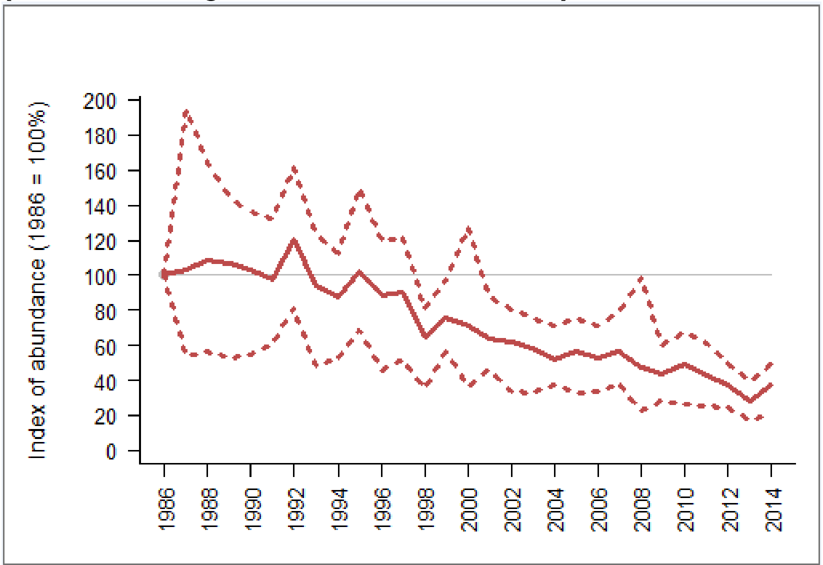
Information from UK Seabird Monitoring Programme: 1986-present.
In 1986 an annual monitoring programme - the Seabird Monitoring Programme (SMP) – was established in the UK by a partnership of organisations coordinated by JNCC. The SMP

aims to monitor 26 species of seabird, including kittiwake, at a sample of breeding colonies throughout the UK and Ireland on a regular basis.

However, because not every colony is counted annually, and different combinations of colonies may be counted in different years, it is not possible to sum actual colony counts to calculate national or regional trends. Instead population trends are assessed using annual indices of abundance which are calculated by modelling the counts for individual sites using site and year effect parameters. This is a methodology that is widely applied to ornithological monitoring data where a large number of sites are counted but not all sites are counted in all years in the time series (e.g. see Mountford 1982, Thomas 1993, Underhill & Prys-Jones 1994 and Pannekoek & van Strien 1996). The index model generates “imputed” counts for site and year combinations where count coverage is missing, which allows assessment of population trends over the whole time period. Bootstrap sampling across the sample of sites is used to generate confidence intervals (Thomas 1993). In the case of the SMP data this allows trends to be generated for the period since 1986.

Seabird Monitoring Programme (SMP) UK Population Trends

Figure 1. UK Population indices for kittiwake 1986-2014 with 95% confidence intervals (JNCC indexing data from SMP colonies)



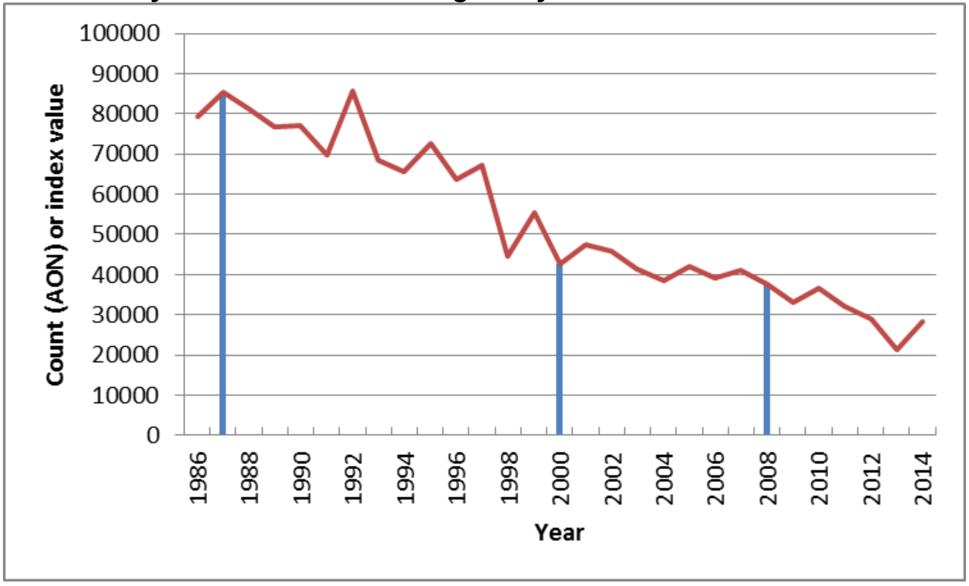
The population index produced by JNCC from SMP data shows that the UK kittiwake population has declined by 4.4% per annum over the period 1986-2014. This index model includes count data from around 240 SMP count units including Flamborough and Filey Coast pSPA. As there are not complete counts for all sites in all years, some of the numbers for individual sites within the index will be represented by imputed counts for the site.

Therefore, since the last seabird colony census in 2000-2002 (Seabird 2000), there is evidence of a continued decline in kittiwake numbers at a UK scale and this is also evident at an individual country level. In Scotland the index shows a steady decline since the late 1980s with the 2013 index level at 23% of the 1986 baseline, a per annum decline of 5.1% (JNCC 2014). In England the index has not fallen to the same extent as in Scotland, but the 2013 index was at 42% of the 1986 baseline, a per annum decline of 3.1% (JNCC 2014). The index for Wales shows a similar pattern to England with a slow decline since the mid-1990s and a 2013 index level at 43% of the 1986 baseline, a decline of 3% per annum (JNCC 2014).

Flamborough Head and Bempton Cliffs SPA trend

There are a number of SMP colony sites that fall within the Flamborough Head and Bempton Cliffs SPA and the larger Flamborough and Filey Coast pSPA. For the purposes of producing indices, JNCC combines data from count units within the original SPA to give a Flamborough Head and Bempton Cliffs SPA figure. There are three counts for the original Flamborough Head and Bempton Cliffs SPA in the SMP database (Table 3) from 1987, 2000 and 2008. Based on these counts there has been a 56% decline in numbers or 4.1% per annum at the SPA.

Figure 2. Colony Counts (AON) for Flamborough Head and Bempton Cliffs SPA, Humberside taken from SMP online database http://jncc.defra.gov.uk/smp. Blue bars represent the actual colony counts and red line the index values. For years where count data is missing for the SPA, index values are modelled counts for the site based on a site factor and a year factor that reflects the trend across all UK colonies included by JNCC in the indexing analysis.



Flamborough and Filey Coast pSPA - Additional counts for areas within the Filey coast terrestrial extension.

For the Flamborough and Filey Coast pSPA there are additionally three SMP count units that fall within the proposed terrestrial extension area to the north of Flamborough Head: Filey 1; Filey 2; and Filey 3 (Figure 3). However, as coverage of the Flamborough and Bempton Cliffs SPA and the Filey count units is incomplete for the period 1986-2014, with no overlaps, there have been no counts for the Filey coast extension that coincide with original SPA counts (Table 3). It is, therefore, not possible to sum the actual counts across the whole pSPA site for surveyed years due to the missing coverage. However, it should be noted that Flamborough Head and Bempton Cliffs SPA and the three Filey colonies on the coastal cliffs between Filey Brigg and Cunstone Nab that comprise the terrestrial pSPA extension are considered as one population separated by a sandy coastal stretch in Filey Bay, which does not provide suitable breeding habitat.

Figure 3. Map showing existing Flamborough Head and Bempton Cliffs SPA and proposed terrestrial extension areas for the Flamborough and Filey Coast pSPA that include the Filey 1, Filey 2 and Filey 3 SMP colonies. From FFC pSPA Departmental Brief:

http://webarchive.nationalarchives.gov.uk/20140605090108/http://www.naturalengland.org.uk/Images/Flamborough-departmental-brief_tcm6-37219.pdf

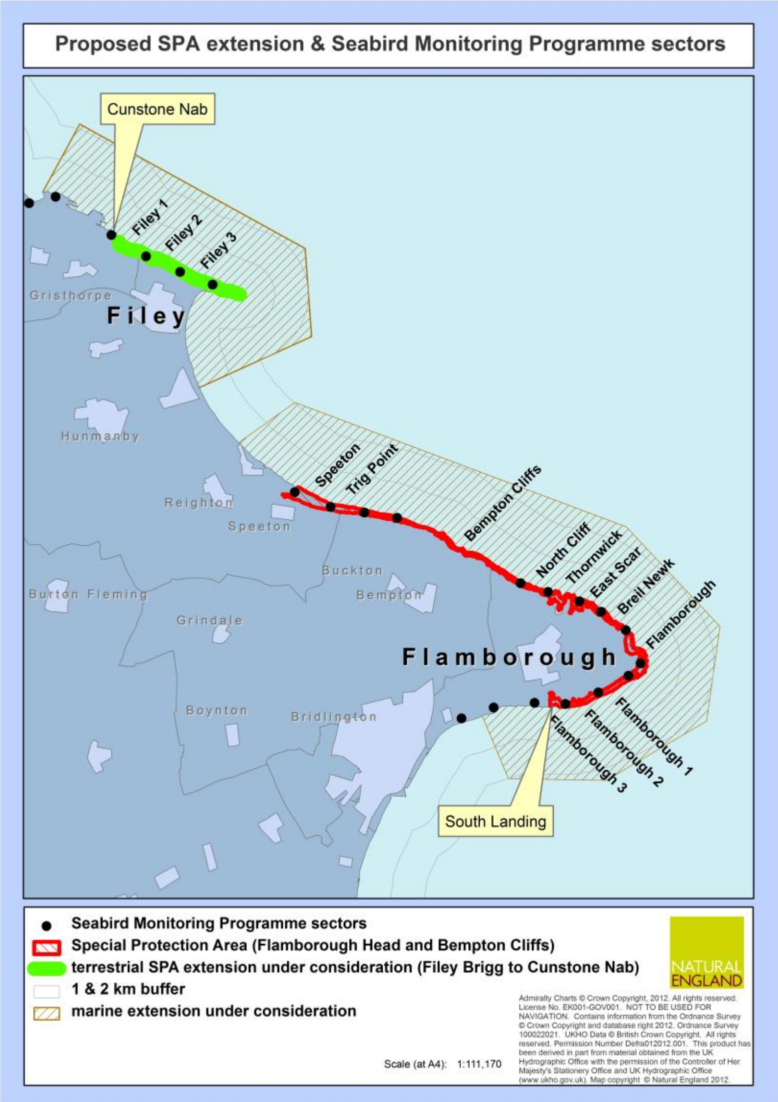
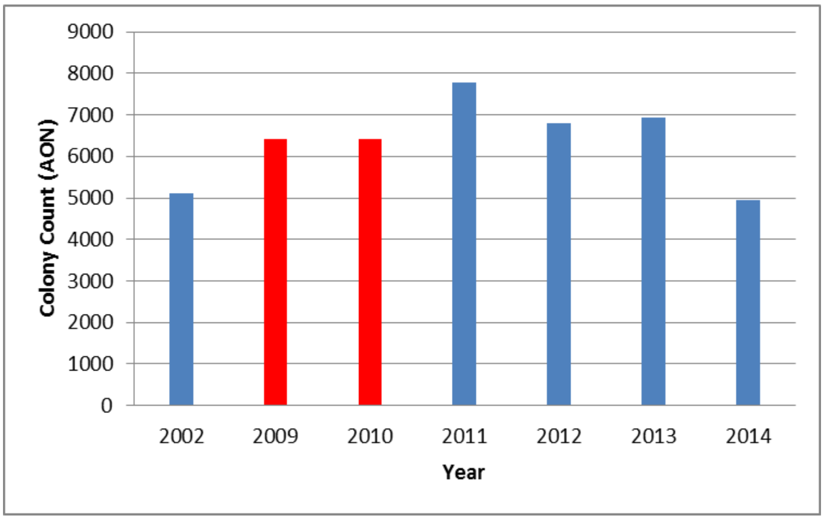


Table 3. Summary of counts made at the different component colonies of FFC pSPA that are in the SMP database.

Count Unit	Years with abundance records in SMP
Flamborough and Bempton Cliffs SPA	1987, 2000, 2008
Filey 1	2002, 2011, 2012, 2013, 2014
Filey 2	2002, 2011, 2012, 2013, 2014
Filey 3	2002, 2011, 2012, 2013, 2014

Additionally, the RSPB undertook counts of the Filey coast extension area (covering Filey 1, Filey 2 and Filey 3 count units) in 2009, 2010.

Figure 4. Counts of kittiwake (AON) in the Filey extension area of the pSPA. Blue bars represent SMP counts summed across the Filey 1, Filey 2 and Filey 3 SMP count units. Red bars represent additional RSPB counts for the Filey extenension area.



Note the non consecutive count years (2002, 2011-14). 2002 count marked as an “estimate” in SMP database, other counts as “accurate”.

The kittiwake count for FFC pSPA in the pSPA departmental brief has been calculated using the 2008 SMP count for Bempton Cliffs and Flamborough Head SPA (37,617 pairs) and the mean count for the Filey coast area in the terrestrial extension counts for 2009, 2010 and 2011 (6,903 pairs). On this basis the addition of the Filey coast kittiwake adds around 7,000 pairs to the original SPA total. The counts indicate that the number of birds using this part of the pSPA have fluctuated between around 5000 and 8000 pairs over the last six years, however it is not clear whether the same pattern has occurred during this period across the larger pSPA area (including the original Flamborough Head and Bempton Cliffs SPA).

Table 4. Summary of figures used to derive a population estimate for kittiwake at FFC pSPA. Numbers are AON which is considered to reflect breeding pairs.

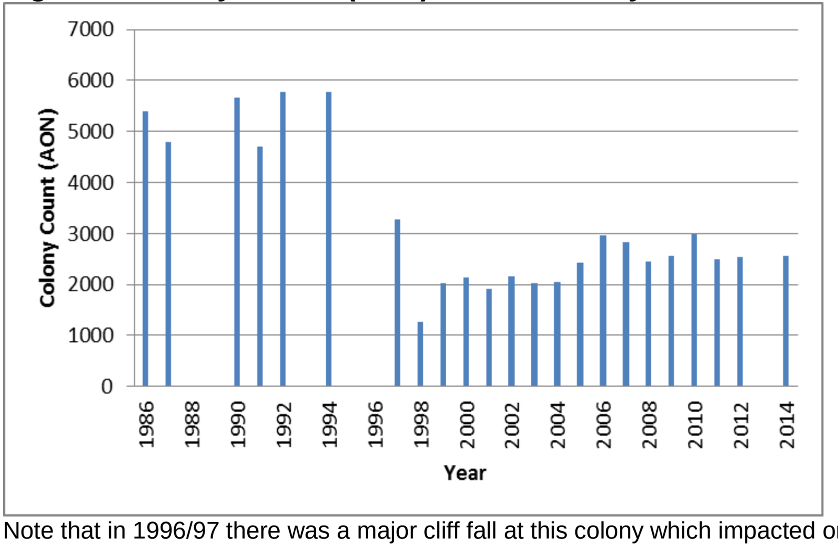
Year	Flamborough head and Bempton Cliffs SPA	Filey Coast	pSPA population (2008-2011)
2008	37,617	-	
2009	-	6,413	
2010	-	6,420	
2011	-	7,877[1]	
Population	**37,617**	**6,903**	**44,520**

Population trends at other colonies in North East England

Below (Figure 5-9) are the colony counts for larger colonies (those which have recorded more than 1,000 AON at some point between 1986 and 2014) in the north east of England, and which have a more complete set of counts than FFC pSPA (for some sites there have been counts in every year 1986-2014). The trends on these sites suggest that for several of the larger regional colonies there have been declines in kittiwake numbers since the mid 1980’s, reflecting the trend at the Flamborough Head and Bempton Cliffs SPA site. For some sites there have been continuing declines over the last few years, while at other colonies recent numbers have been more stable.

[1] Note that the SMP count for 2011 for Filey 1, Filey 2 and Filey 3 is 7,777 AON. Natural England are currently investigating this small discrepancy.

Figure 5. Colony counts (AON) at Marsden, Tyne & Wear, 1986-2014.



Note that in 1996/97 there was a major cliff fall at this colony which impacted on the colony, therefore the changes in numbers of kittiwake at the colony before and after 1996 may reflect these physical changes at the site.

Figure 6. Colony counts (AON) at the Farne Islands, Northumberland, 1986-2014.

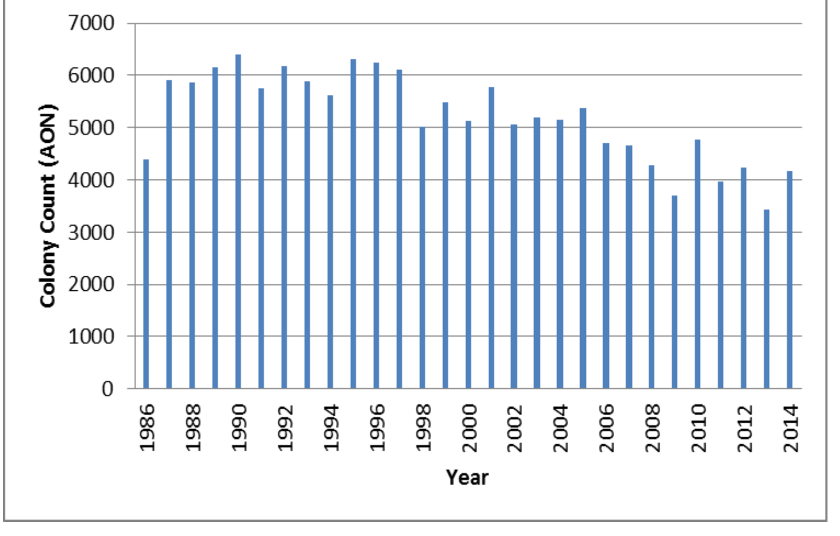


Figure 7. Colony counts (AON) at Saltburn Cliffs to Huntcliff, Cleveland, 1987-2014.

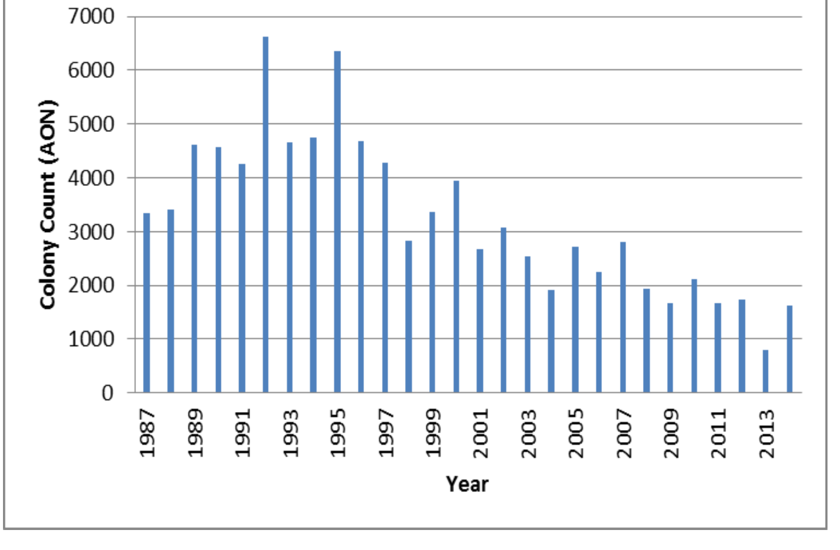


Figure 8. Boulby Cliffs (AON) colony counts, Cleveland, 1987-2014.

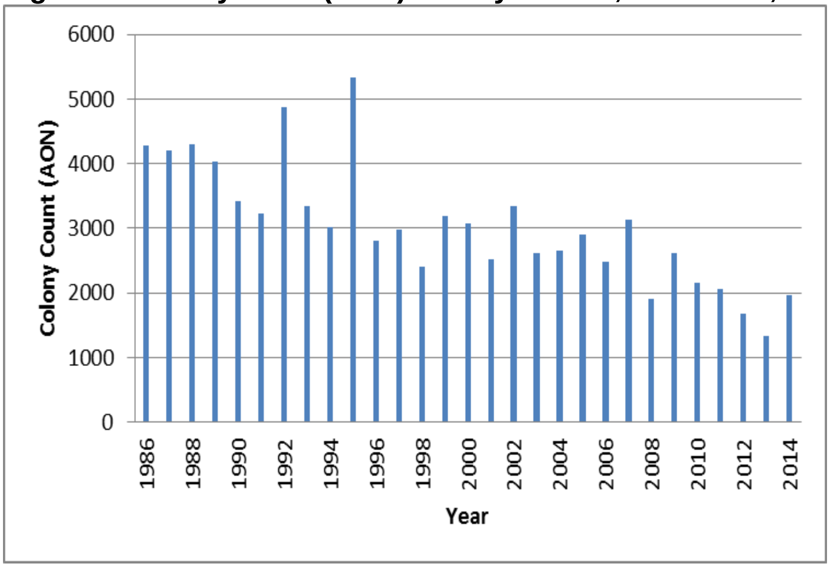
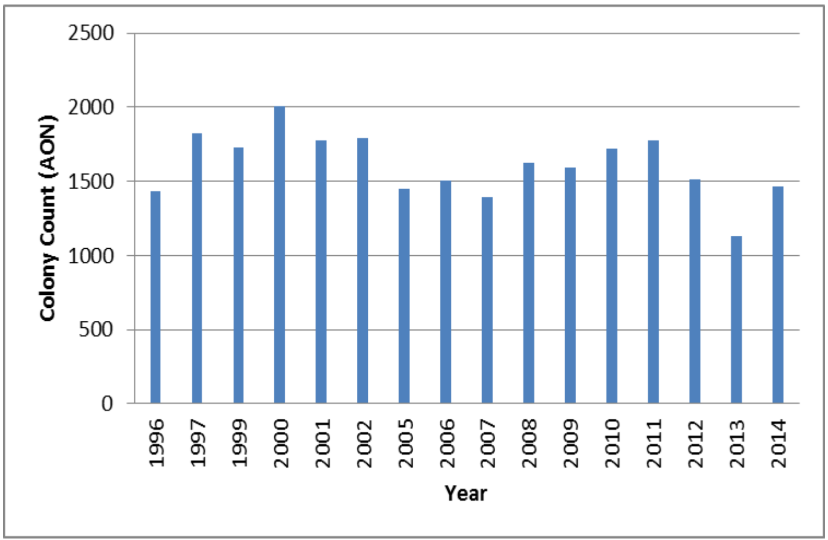


Figure 9. Castle Headland (AON) colony counts, Cleveland, 1996-2014.



Conclusions

- Based on count data from Flamborough Head and Bempton Cliffs SPA the kittiwake population has declined by 56% or 4.1% per annum over the period 1986 to 2008;
- This trend mirrors the national population trend for kittiwake as well as the trend on many of the larger kittiwake colonies in the UK;
- Since 2009 numbers of kittiwake in the terrestrial extension areas for the FFC pSPA have been relatively stable;
- There have been no whole colony count data for the larger, original Flamborough Head and Bempton Cliff SPA since 2008 so we do not know the population trend for this site over recent years;
- Population indices calculated across all UK sites for the period 2008-2013 indicate that kittiwake numbers nationally have continued to decline with the 2013 index value being 31% lower than the 2008 value.

- Based on counts for other colonies in the region as well as counts of the terrestrial extension areas of the FFC pSPA and national indices calculated by JNCC, there is no evidence to suggest that the population across the pSPA as a whole has increased since 2008 and, therefore, we consider that the current trend is most likely to be either stable or a continued decline in line with the national trend;
- Given the strong evidence for a decline in the colony size since the original SPA designation in 1993, and the March 2015 condition assessment of the SSSI putting the site as "unfavourable declining" (https://designatedsites.naturalengland.org.uk/ReportUnitCondition.aspx?SiteCode=S1002289&ReportTitle=FLAMBOROUGH HEAD), when conservation objectives for kittiwake at the FFC pSPA are set they are likely to be to restore the populationto a higher level than the current population size.

Kittiwake Apportioning Clarification

The predicted impact figures for kittiwake collsions apportioned to FFC pSPA in Appendix 2 of Natural England's deadline 3 submission for the Project alone are based on the apportioning assumptions detailed below.

Breeding season

For the purposes of asessing potential impacts Natural England defines the breeding season as all times of year when seabirds are present at their colonies and constrained in their foraging movements. Although this will predominantly refer to birds provisioning young, it is also considered to include birds sitting on eggs, courting, nest building, etc i.e. when there is a strong behavioural attachment to the colony site. These periods will be colony and species-specific. Natural England defines the breeding season for kittiwake at FFC pSPA as being April to July. This is based on information provided by colony managers at RSPB Bempton Cliffs Reserve, who have indicated that birds start to return to the colony in mid March and that large numbers are present from April. This is consistent with the published literature that indicates that birds re-occupy colonies from February, with modal return in March (Pennington et al. 2004; Brown and Grice 2005; Forrester et al. 2007). Similarly, a study of geolocator data from individuals from 18 colonies across the North Atlantic range of kittiwake showed that most birds were back in the vicinity of their colonies by the equinox period in April (Fredericksen et al. 2012). Birds breeding in colonies further south in the range return to colonies earlier and peak migration through English waters as recorded at Trektellen seawatching sites in the UK (mosly located in southern and eastern England) was in March (see Furness 2015).

Foraging ranges

Thaxter et al. (2012) recently summarised knowledge of seabird foraging ranges based on evidence from tracking studies, colony studies and other methods of estimating range. Several metrics can be derived from this approach, including the mean and maximum foraging ranges. Natural England advises (JNCC & NE 2013) that the 'mean maximum' range (i.e. the mean of maxima for all studies per species) from Thaxter et al (2012) is a useful guide for identifying SPA colonies that need to be considered for HRA assessments during the breeding season. However, this should be considered as a coarse screening method and, the values in Thaxter et al. (2012) should not be viewed as the only source of available information on foraging ranges and likely connectivity between colonies and project areas.

Following the intial screening process, Natural England/JNCC advice is to then:

"Assess all available colony-specific evidence to examine if connectivity between SPA colonies and the OWF is supported or not. This assessment should be carried out for relevant SPAs within and beyond the relevant mean maximum foraging range. Relevant SPAs are those supporting breeding seabird qualifying features (QFs), which may be commuting to offshore foraging areas; these areas may be coincident with the development site, or commuting trips may pass through the development site. Those SPAs beyond the mean maximum foraging range should include, for example, those within maximum known foraging range or within upper confidence limits around the mean maximum range (Thaxter et al. 2012), where this exceeds the maximum (including any recent unpublished studies that may update this knowledge). Colony-specific data can include tracking research and also field data on behaviour or flight orientation (for example, fish-carrying behaviour at the OWF site implies provisioning chicks at a breeding site; orientation of birds at sea may indicate directional preferences associated with coastal colonies)." (JNCC & Natural England 2013)

Assessments should always be based upon the best and most up to date evidence available. In some situations, it may be justified to consider screening in SPAs beyond published mean maximum foraging range of the qualifying features. For example, new tracking data may suggest that previous maximum ranges for a species were underestimated; thus, it may be appropriate to derive new maximum and mean maximum ranges. Alternatively, behavioural data from development sites such as offshore wind farms (OWFs) might indicate connectivity to a SPA within maximum, rather than mean maximum, foraging range. Finally, mean maximum values in Thaxter et al. (2012) are presented with standard deviations, and each estimate of foraging range is rated in terms of confidence in its derivation. It may be appropriate to consider the full variability around mean maximum ranges, especially where estimates are made with comparatively low confidence.

Hornsea Project 2 lies between the mean maximum (60km) and maximum foraging ranges (120km) calculated for kittiwake in Thaxter et al (2012). These foraging ranges were based on data from seven colonies but the majority of these were in Alaska and only two UK sites were included the analysis with no data from the Flamborough Head and Bempton Cliffs colony available to be included. Site specific evidence indicates that birds from FFC pSPA do forage within Hornsea P2 areas during the breeding season. This includes data from tracking studies undertaken by the RSPB which shows that tracked birds were foraging within the Hornsea Project 2 windfarm area, and calculations of mean maximum foraging ranges for birds ranged from 55.7km (SD, +/- 31.9km) to 156.4 km (SD, +/- 28.2km) in different study years, some of which were coincident with the baseline survey data collected for Hornsea P2.

Further evidence to support connectivity between Hornsea Project 2 and FFC pSPA during the breeding season comes from the Project baseline survey data collected over the whole Hornsea survey area (Figure 10) where "*Flight direction was recorded for 26,625 kittiwakes during baseline surveys in the breeding season, and 9,756 kittiwakes in the non-breeding season. In the breeding season, just under half (47.6%) of all birds recorded were flying west, in the general direction of the breeding colony at Flamborough and Filey Coast pSPA. In the non-breeding season, the pattern was less clear, with birds seen flying in every direction fairly equally, with perhaps a slight bias towards flights heading in a southerly direction." (*SMartWind 2015*).*

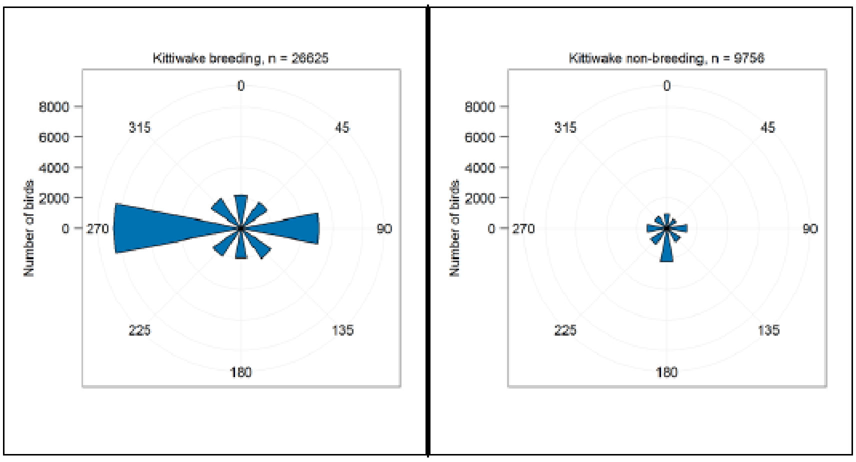


Figure 10. Flight direction of kittiwake in the Horsea Project area in years 1 and 2 of the basline surveys (SMartWind 2015a).

Additionally, peak numbers of kittiwake at Hornsea Project 2 were recorded in the breeding season (peak densities of birds in flight were in July in both survey years) and similarly overall estimates of birds on the water and in the air also peaked in July in both survey years with a high proportion (>85%) of adult birds also recorded during the breeding season months (see Table 6.28 of SMartWind 2015a). This suggests that the Hornsea Project 2 area is important for kittiwake during the breeding season relative to other seasons.

On the basis of the evidence outlined above, Natural England consider that there is a high probability that kittiwake present in the Hornsea Project 2 area during April to July will have connectivity with the FFC pSPA colony. The Applicant's data shows that 94.6% of birds present in the breeding season were adult birds and, therefore, Natural England has assumed that 95% of the birds recorded in the Project area during the breeding season are FFC pSPA adults. Natural England accepts that this assessment may overestimate the proportion of adult birds on the project site, since it is difficult to distinguish older immature birds from adults in the field.

During the non-breeding periods, August-December and January-March, Natural England has based its apportionning assumptions on the non-breeding season population scales defined in Furness (2015). Furness (2015) provides an assessment of the numbers and origins of both adult and immature birds present in North Sea UK waters during the non breeding seasons, including birds from overseas colonies. Based on the figures in Furness (2015), 5.4% of birds in the period August to December and 7.2% of birds in January to March are predicted to be adult birds from FFC pSPA.

Natural England met with the applicant on 14 October 2015 to discuss potential refinements to the apportioning approaches for the breeding season, and will update on progress regarding this matter at the Issue Specific Hearings.

For the in-combination assessment of kitiwake collisions for FFC pSPA presented in Appendix 2 of our submission at deadline 3, Natural England used the collision figures presented by the Applicant in Table 1.7 of SMartWind (2015b) with some adjustments as outlined below in Table 5 and associated notes. Please note that Natural England met with the applicant on 14 October 2015 to discuss potential refinements to the in-combination apportioning approach, and will update on progress regarding this matter at the Issue Specific Hearings.

Table 5. In-combination collision totals for kittiwake population of Flamborough and Filey Coast pSPA (based on data presented by the Applicant in Table 1.7 of SMartWind (2015b)), which Natural England used to calculate the annual in-combination collision total apportioned to FFC pSPA of around 500 kittiwake presented in Natural England's Deadline 3 submission (Appendix 2 – HRA kittiwake collision impacts on FFC pSPA).

Offshore wind farm	Band Model	Option	Avoidance rate (%)	Annual, unapportioned, collisions	Breeding	% Apportioning	pSPA breeding collisions	Post-breeding	% Apportioning	pSPA post breeding collisions	Pre-breeding	% apportioning	pSPA pre breeding collisions
Aberdeen European Offshore Wind Deployment Centre	Band (2012)	2	98.9	18.70				5.8	5.4	0.31	1.1	7.2	0.08
Beatrice	Band (2012)	1	98.9	57.86				4.3	5.4	0.23	15.9	7.2	1.14
Beatrice Demonstrator	Band (2000)	1	99.2	4.95				2.1	5.4	0.11	1.7	7.2	0.12
Blyth Demonstration Project	Band (2011)	1	98.9	5.39	1.8	100.0	1.8	2.3	5.4	0.12	1.4	7.2	0.10
Dogger Bank Creyke Beck Projects A and B	Band (2012)	2	98.9	718.85	288.0	19.3	55.6	135.0	5.4	7.3	295	7.2	21.2
Dogger Bank Teesside Projects A and B	Band (2012)	2	98.9	444.40	136.9	19.3	26.4	90.7	5.4	4.9	216.9	7.2	15.6
Dudgeon	Band (2000)	1	98.9	0.00	0.0	100.0	0.0	0.0	5.4	0.0	0.0	7.2	0.0
East Anglia One	Band (2012)	1	98.9	429				295	5.4	15.9	104.6	7.2	7.53
Galloper	Band et al. (2007)	1	98.9	65.89				27.8	5.4	1.5	31.8	7.2	2.29
Greater Gabbard	Band (2000)	1	98.9	27.50				15.0	5.4	0.81	11.4	7.2	0.82
Hornsea Project One	Band (2012)	1	98.9	122.00	47.9	100.0	47.9	55.9	5.4	2.9	20.9	7.2	1.50
Hornsea Project Two	Band (2012)	2	98.9	230.00	136.0	95.0	129.2	72.0	5.4	3.9	23	7.2	1.66
Humber Gateway	Not available	1	98.9	7.70	2.55	100.0	2.55	3.19	5.4	0.17	1.9	7.2	0.14
Inch Cape	Band (2012)	1	98.9	301.42				224.8	5.4	12.1	63.5	7.2	4.57
Kentish Flats	Band (2012)	1	98.9	2.20				0.9	5.4	0.05	0.7	7.2	0.05
Lincs	Band (2000)	1	98.9	2.75	0.92	100.0	0.92	1.16	5.4	0.06	0.69	7.2	0.05
London Array	Band (2000)	1	98.9	5.50				2.3	5.4	0.12	1.8	7.2	0.13
Moray Firth Project One (MORL)	Band (2012)	1	98.9	45.4				2.0	5.4	0.11	19.3	7.2	1.39
Neart na Gaoithe	Band (2012)	1	98.9	93.39				56.1	5.4	3.0	4.4	7.2	0.32
Race Bank	Band (2000)	1	98.9	31.35	1.86	100.0	1.86	23.9	5.4	1.3	5.59	7.2	0.40

Seagreen Alpha	Band (2012)	1	98.9	371.25				171.1	5.4	9.2	133.8	7.2	9.63
Seagreen Bravo	Band (2012)	1	98.9	343.20				142.4	5.4	7.7	114.0	7.2	8.21
Teesside	Band (2000)	1	98.9	77.08	50.8	100.0	50.8	24.0	5.4	1.3	2.5	7.2	0.18
Thanet	Band (2000)	1	98.9	1.10				0.5	5.4	0.03	0.4	7.2	0.03
Triton Knoll	Band (2000)	1	98.9	209.00	24.6	100.0	24.6	139.0	5.4	7.5	45.4	7.2	3.27
Westermost Rough	Band et al. (2007)	1	98.9	0.55	0.176	100.0	0.176	0.22	5.4	0.01	0.132	7.2	0.01
TOTAL				**3616.4**			**341.8**			**80.8**			**80.5**

Collisions in Table 1 are based on those presented by the Applicant in Table 1.7 of *Apportioning and assessment of predicted kittiwake mortality of the Flamborough and Filey Coast pSPA population* submitted at Deadline IIa (SMartWind 2015b). Natural England has adjusted some of the figures as explained below to reflect its position regarding seasonality, Band Model Options and apportioning. Additionally Natural England has used seasonal collision figures for Dogger Bank Teesside A&B from Table 2.3 of Forewind's Dogger Bank Teesside A&B Deadline VI *Final HRA ornithology in-combination tables*, as Forewind's figures differed from those presented by the Applicant for that project.

Basic Band Model Option 1 outputs with 98.9 AR are used except for Dogger Bank Creyke Beck and Dogger Bank Teesside, where Natural England agreed use of Option 2 with Forewind due to methodological queries regarding the site specific flight height data. For Hornsea Project 2, Natural England has advised use of Option 2 due to methodological issues around the site specific flight height data. Note that for Hornsea Project One, Natural England considered Option 2 outputs alongside Option 1 outputs for the same reasons, but have retained the Option 1 figures in this table as Option 1 figures were used in the in-combination assessment at Hornsea Project One. The Option 2 annual collision figure would be 257 birds for Hornsea Project One.

Natural England is unclear why the AR for Beatrice Demonstrator is 99.2% in table 1.7 or why Option 2 is cited for EOWDC when Option 1 outputs were presented for the project; however Natural England has not adjusted figures for these two projects.

Apportioning percentages to FFC pSPA during the breeding season are the same as those presented by the Applicant in Table 1.7 of *Apportioning and assessment of predicted kittiwake mortality of the Flamborough and Filey Coast pSPA population* submitted at Deadline IIa, apart from Natural England has calculated breeding season collisions for April to July rather than May to July as calculated by the Applicant.

Apportioning percentages during the non-breeding season are derived from Furness (2015) for the North Sea BDMPS scale for kittiwake during the Spring and Autumn migration periods.

Section C – Natural England's detailed response to the Examining Authority's written question EOO20

EOO20: Further to the submission of 'Notes of NE/RCUK Post Consent Monitoring Seminar (March 2015)' to Deadline 3 (REP3-032), can NE, MMO and RSPB please advise on potential good practice for project specific, and strategic, ornithological impacts monitoring?

In 2014 the MMO published an updated review of OWF monitoring data to inform recommendations on improving future license-related monitoring strategies. The report was independently commissioned and overseen by an expert steering group including Cefas, the Crown Estate, The Department of Energy & Climate Change, Defra, MMO, Marine Scotland, Natural England, Natural Resources Wales, and representatives from industry:

MMO (2014). Review of post-consent offshore wind farm monitoring data associated with licence conditions. A report produced for the Marine Management Organisation, pp 194. MMO Project No: 1031. ISBN: 978-1-909452-24-4. Report

The review includes recommendations for post-consent monitoring aims, objectives, licence conditions and best practice methodologies for site specific and strategic monitoring of ornithology impacts.

Recommendations relating to good practice for project specific and strategic ornithological monitoring include:

- Ensuring licence conditions are clearly linked to the monitoring of impacts predicted in the ESs (and supporting technical reports), with species specific objectives focussing on impacts which are predicted to have high significance, or the resolution of uncertainty in potential impacts (e.g. those assessed more qualitatively or which are dependent on particular assumptions e.g. bird densities, flight height behaviour, avoidance rates etc).

- Monitoring should not necessarily only focus on the development site, but should also consider monitoring impacts of effects at protected sites if this would reduce the uncertainty in predictions. For example, understanding the relative connectivity between qualifying bird features of SPAs and the development is a fundamental part of the HRA process. The deployment of tracking devices on birds to inform on the foraging areas of birds from specific colonies, within or outside the breeding season and the relative overlap with the development site may provide important information that reduces the uncertainty in impact predictions. Similarly, the collection of colony counts or demographic information for colonies may improve the accuracy of predictions where such information is lacking or out-of-date.

- Survey design and methodology - ensuring that data on the numbers of birds using the site (and, depending on survey design, wider areas around this or control sites) are collected in a manner that allows adequate statistical comparisons to be made between baseline, during construction and post-construction periods including:

  - Providing details of monitoring protocols and ensuring details regarding the analyses to be undertaken are determined at the outset of the study;

- Using power analysis to help determine the most appropriate survey design in order to be able to detect changes in numbers. The power to detect change from survey data alone is related to the frequency of surveys, their temporal extent and spatial coverage. Data need to be collected over a sufficient number of years to enable detection of changes accounting for year-to-year variability in numbers. Sufficient within year data needs to be collected to cover the key months for receptor species at the site and to account for changes in seasonal phenology. To adequately characterise the baseline numbers of seabirds, at least three years of pre-construction monitoring are required in order to account for inter-annual variation. Post-construction monitoring should be undertaken annually. With respect to displacement, evaluation on an annual basis will also enable the potential for displacement effects to reduce through habituation to be explored. Collection of additional environmental covariate data could improve the power of the surveys to detect changes and should be considered.

- Ensuring that spatial extent of survey area is sufficient to detect changes based on proposed analyses - this may require surveying an area much larger than the OWF footprint - buffers of 4km may be too small for some survey designs;

- Due to difficulties in identifying reference sites which are truly comparable in terms of their environmental conditions, the use of Before and After Control Impact (BACI) survey designs for monitoring the displacement of seabirds has recently been questioned. Use of alternatives such a Before-After-Gradient (BAG) approach, in conjunction with the use of density surface modelling techniques is recommended;

- The use of density surface modelling techniques enables environmental correlates to be accounted for, such that changes in densities that might be a result of the construction or operation of the wind farm may be better evaluated. The inclusion of temporally varying covariates rather than solely static covariates (ideally environmental data that is collected simultaneously to the bird surveys) is desirable.

- Strategic monitoring – Co-ordinated regional monitoring studies should be encouraged where practicable (e.g. for wind farms developed in close proximity to each other; where the ornithological features of concern and the monitoring objectives are similar or are linked to the same colonies; where monitoring is required on a different spatial scale to a single project to test hypotheses).

- Incorporating existing data from sites nearby to inform baselines, ESs and licence conditions where appropriate will improve understanding of the site prior to construction – for example, if ecological conditions are similar, impacts are also likely to be similar.

Further details on good practice for project specific, and strategic, ornithological impacts monitoring can be found in the report.

Section D – References

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

JNCC & Natural England (2013). JNCC & NE interim advice on breeding season HRA screening for seabirds.

JNCC (2014) Seabird Population Trends and Causes of Change: 1986-2013 Report (http://www.jncc.defra.gov.uk/page-3201). Joint Nature Conservation Committee. Updated August 2014. (Accessed 15 October 2015).

Mitchell, P, Ian, Stephen F. Newton, Norman Ratcliffe and Timothy E. Dunn (Eds.). (2004). Seabird Populations of Britain and Ireland: results of the Seabird 2000 census (1998-2002). Published by T and A.D. Poyser, London.

MMO (2014). Review of post-consent offshore wind farm monitoring data associated with licence conditions. A report produced for the Marine Management Organisation, pp 194. MMO Project No: 1031. ISBN: 978-1-909452-24-4.

Mountford, M.D., (1982). Estimation of population fluctuations with application to the common birds census. Applied Statistics 31, 135–143.

Pannekoek, J. & van Strien, A. (1996) TRIM (TRends and Indices for Monitoring data). Research paper 9634. Statistics Netherlands, Voorburg.

SMartWind (2015a). Hornsea Offshore Wind Farm Project Two Environmental Statement Volume 5 - Offshore Annexes Chapter 5.5.1 Ornithology Technical Report. Part 1. PINS Document Reference: 7.5.5.1 APFP Regulation 5(2)(a), January 2015.

SMartWind (2015b). Hornsea Offshore Wind Farm Project Two. Clarification Note – Apportioning of predicted kittiwake mortality to the Flamborough and Filey Coast pSPA population Appendix P to the Response submitted for Deadline IIA Application Reference: EN010053.

Thomas, G.E. (1993) Estimating annual total heron population counts. Applied Statistics 42: 473–486.

Underhill, L.G., Prys-Jones, R., (1994). Index numbers for waterbird populations. I. Review and methodology. Journal of Applied Ecology 31, 463–480.

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES

2010

Hornsea Project Three Offshore Wind Farm

Relevant Representations of Natural England

For:

The construction and operation of Hornsea Project Three Offshore Wind Farm, a 2,400 MW with up to 300 turbines wind farm located 121 km off the Norfolk coast and 160 km off the Yorkshire coast, covering an area of approximately 696 km^2.

Planning Inspectorate Reference: EN010080

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20 July 2018

NATURAL ENGLAND'S RELEVANT REPRESENTATIONS IN RESPECT OF HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

1. Introduction

1.1. Natural England is a non-departmental public body established under the Natural Environment and Rural Communities Act 2006 ('NERC Act'). Natural England is the statutory advisor to Government on nature conservation in England and promotes the conservation of England's wildlife and natural features[1]. Natural England's remit extends to the territorial sea adjacent to England, up to the 12 nautical mile limit from the coastline[2].

1.2. Natural England is a statutory consultee:

1.2.1. in respect of environmental information submitted pursuant to the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 ('the EIA Regs')[3];

1.2.2. in respect of plans or projects that are subject to the requirements of the Conservation of Habitats and Species Regulations 2017 (the 'Habitats Regulations') which are likely to have a significant effect on European protected sites – that is, sites designated as Special Areas of Conservation ('SACs') and Special Protection Areas ('SPAs') for the purposes of the EU Habitats and Birds Directives[4];

1.2.3. in respect of proposals likely to damage any of the flora, fauna or geological or physiological features for which a Site of Special Scientific Interest ('SSSI') has been notified pursuant to the Wildlife and Countryside Act 1981 (the '1981 Act')[5]; and

1.2.4. in respect of all applications for consent for Nationally Significant Infrastructure Projects which are likely to affect land in England[6].

1.2.5. Pursuant to the Conservation of Offshore Marine Habitats and Species Regulations 2017 (the '2017 Regulations') under regulation 28(4)(a) of the 2017 Regulations, where the assessment relates to a European offshore marine site, the competent authority must consult the Joint Nature Conservation Committee (JNCC). Where the assessment relates to a

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[1] NERC Act ss. 1(2), (2) and 4
[2] NERC Act, s.1(3)
[3] Regs. 2(1), 8(6), 9(1), 13(2)(b), 17(3)(g), 18(3)(f), 19(3)(e) of the EIA Regs
[4] Regulation 61 of the Habitats Regulations
[5] Section 281 of the 1981 Act
[6] Planning Act s.42; Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009, reg. 3 and sch. 1.

European site (including a European marine site), then the competent authority must consult Natural England, in accordance with regulation 25(3) (b) of the 2007 Regulations.

1.3. It is also the Government's policy to consult Natural England in respect of sites listed for the purposes of the Convention on Wetlands of International Importance especially as Waterfowl Habitat signed at Ramsar on 2 January 1971 ('Ramsar sites') as if they were European protected sites[7].

1.4. The Examining Authority should note that pursuant to an authorisation made on 9 December 2013 by the JNCC under paragraph 17(c) of Schedule 4 to the Natural Environment and Rural Communities Act 2006, Natural England is authorised to exercise the JNCC's functions as a statutory consultee in respect of applications for offshore renewable energy installations in offshore waters (0-200 nm) adjacent to England. This application was included in that authorisation and, therefore, Natural England will be providing statutory advice in respect of that delegated authority. However, JNCC retains responsibility as the statutory advisors for European offshore marine sites that are located outside the territorial sea and UK internal waters (i.e. more than 12 nm offshore) and continues to provide Natural England advice on the significance of any potential impacts on interest features of those sites.

1.5. In determining this application, the Secretary of State will be acting as the competent authority for the purposes of the Habitats Regulations and the 2007 Regulations. The Secretary of State is also a section 28G authority with specific duties under the 1981 Wildlife and Countryside Act in respect of SSSIs.

1.6. Natural England's advice in these Relevant Representations is based on information submitted by Ørsted Hornsea Project Three (UK) Ltd., on behalf of Ørsted Power (UK) Ltd., in support of its application for a Development Consent Order ('DCO') in relation to the Hornsea Project Three Offshore Wind Farm ('the project'). The project refers to the construction and operation of an offshore wind farm of up to 2,400 MW with up to 300 turbines located 121 km off the north Norfolk coast and 160 km off the Yorkshire coast, covering an area of approximately 696 km^2. The export cable makes landfall at Weybourne in Norfolk, and the grid connection at the existing National Grid substation to the south of Norwich in Norfolk.

1.7. Natural England has been working with Ørsted Hornsea Project Three (UK) Ltd. and other interested parties to provide advice and guidance on the

[7] National Planning Policy Framework (March, 2012), para 118; PINS Advice Note 10: Habitats Regulation Assessment for nationally Significant infrastructure projects, p.4.

Hornsea Project Three Offshore Wind Farm (further referred to as ‘Hornsea Project Three) since 2016.

1.8. These Relevant Representations contain a summary of what Natural England considers the main nature conservation, landscape and related issues to be in relation to the DCO application, as well as the Deemed Marine Licences (DMLs) contained therein, and indicate the principal submissions that it wishes to make at this point. Natural England will develop these points further as appropriate during the examination process. Natural England may have further, or additional, points to make, particularly if more information about the project becomes available.

1.9. These Relevant Representations provide an overview of the issues and a summary of Natural England’s advice. Section 2 of these representations identifies the natural features for which there may be impacts by this application. Section 3 summarises Natural England’s overall view of the application. Section 4 sets out Natural England’s overarching concerns with this application. Section 5 provides high level comments on topic specific matters, which Natural England considers need to be addressed. Section 6 is intended to identify those issues that should be dealt with by way of DCO requirements and the DMLs. Natural England has also provided an appendix covering more detailed comments on the DCO/DML conditions in recognition that a DCO hearing may occur prior to the submission of written representations.

1.10. It should be noted that Natural England is very concerned about the number of outstanding substantive issues in this case. Natural England intends, if possible, to continue discussions with Ørsted Hornsea Project Three (UK) Ltd. and seek to resolve concerns through the provision of further evidence and assessment, which can then lead to the agreement of the outstanding issues in statements of common ground. Failing satisfactory agreement, Natural England advises that the matters set out in sections 3 to 5 of these Relevant Representations, will require consideration by the Examining Authority as part of the examination process.

1.11. The Examining Authority may wish to ensure that the matters set out in these relevant representations are addressed as part of the Examining Authority’s first set of questions, to ensure the provision of information early in the examination process.

2. The natural features potentially affected by this application

2.1. The project affects the marine environment and the countryside between the onshore substation near Norwich and the landfall at Weybourne, North Norfolk, with the wind farm array located in the southern North Sea.

2.2. The designated sites relevant to this application are:

2.2.1. Special Protection Areas (SPAs) – The following sites and interest features are those for which Natural England has outstanding concerns:

Site Name	**Distance from project site (indicative)**	**Features for which outstanding concerns remain**
Flamborough Head and Bempton Cliffs SPA	149 km	Black-legged kittiwake (*Rissa tridacyla)* – as an individual feature and as part of the overall assemblage; Common guillemot (*Uria aalge)* – as part of the overall assemblage; Razorbill (*Alca torda)* **–** as part of the overall assemblage; and Atlantic puffin (*Fratercula artica*) – as part of the overall assemblage.
Flamborough and Filey Coast pSPA	149 km	Northern gannet (Morus bassanus) – as an individual feature and as part of the overall assemblage; Black-legged kittiwake (*Rissa tridacyla*) – as an individual feature and as part of the overall assemblage; Common guillemot (*Uria aalge*) – as an individual feature and as part of the overall assemblage; Razorbill (*Alca torda*) – as an individual feature and as part of the overall assemblage; Fulmar (*Fulmarus glacialis*) –as part of the overall assemblage; Atlantic puffin (*Fratercula artica*) – as part of the overall assemblage; Herring gull (*Larus argentatus*) – as part of the overall assemblage; Cormorant (*Phalacrocorax carbo*) **–** as part of the overall assemblage; and Shag (*Phalacrocorax aristotelis*) – as part of the overall assemblage.
Forth Islands SPA	384 km	Fulmar (*Fulmarus glacialis*) – as part of the overall assemblage (please note that this is a Scottish SPA and representations will be required from Scottish Natural Heritage)

The Greater Wash SPA	0 km (the proposed export cable route overlaps with the site)	Red-throated diver (*Gavia stellata*); Sandwich tern (*Thalasseus sandvicensis*); Common tern (*Sterna hirundo*); Little tern (*Sternula albifrons*); and Common scoter (*Sterna hirundo*).
The Wash and North Norfolk Coast SPA	<0.5 km from the proposed cable route	Sandwich tern (*Thalasseus sandvicensis*); Common tern (*Sterna hirundo*), and Little tern (*Sternula albifrons*).

2.2.2. Special Areas of Conservation (SACs) – The following sites and interest features are those for which Natural England has outstanding concerns:

Site Name	**Distance from project site (indicative)**	**Features for which outstanding concerns remain**
Southern North Sea cSAC/SCI	0 km (the proposed export cable route overlaps with the site)	Harbour porpoise (*Phocoena phocoena*)
North Norfolk Sandbanks and Saturn Reef SAC	0 km (the proposed export cable route overlaps with the site)	Sandbanks which are slightly covered by seawater all the time (Annex I sandbanks) and Reefs
The Wash and North Norfolk Coast SAC	0 km (the proposed export cable route overlaps with the site)	Sandbanks which are slightly covered by seawater all the time (Annex I sandbanks) and Reefs
Norfolk Valley Fens SAC	<0.5 km from the proposed cable route	All qualifying features
River Wensum SAC	0 km (the proposed export cable route overlaps with the site)	All qualifying features

2.2.3. Ramsar sites - The following sites and interest features are those for which Natural England has outstanding concerns:

Site Name	**Distance from project site (indicative)**	**Features for which outstanding concerns remain**
North Norfolk Coast Ramsar	<0.5 km from the proposed cable route	Pink-footed goose (*Anser brachyrhynchus*)

2.2.4. Sites of Special Scientific Interest (SSSI) – The following notified features are those for which Natural England have outstanding concerns:

Site Name	**Distance from project site (indicative)**	**Features for which outstanding concerns remain**
Flamborough Head SSSI	149 km	Internationally important colonies of breeding seabirds, including: black-legged kittiwake (*Rissa tridacyla*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), Atlantic puffin (*Fratercula artica*) and fulmar (*Fulmarus glacialis*).
North Norfolk Coast SSSI	<0.5 km from the proposed cable route	Pink-footed goose (*Anser brachyrhynchus*)
Booton Common SSSI	<0.5 km from the proposed cable route	All qualifying features
Alderford Common SSSI	0 km (the proposed export cable route lies adjacent to the site)	Bats (hibernation and roosting sites are identified on the SSSI citation)

2.2.5. Marine Conservation Zones (MCZ) – The following designated features are those for which Natural England have outstanding concerns:

Site Name	**Distance from project site (indicative)**	**Features for which outstanding concerns remain**
Cromer Shoal Chalk Beds MCZ	0 km (the proposed export cable route overlaps with the site)	Subtidal mixed sediment; and Subtidal chalk.
Markham's Triangle pMCZ	0 km	Subtidal coarse sediment; Subtidal sand; and Subtidal mixed sediment.

2.3. European Protected Species (EPS) – The following marine and terrestrial European protected species may be affected by the proposed project:

- Harbour porpoise
- Great crested newt
- Bats

2.4 Protected Landscapes – The Hornsea Project Three export cable corridor is within the setting of the Norfolk Coast Area of Outstanding Natural Beauty

(AONB) designated for its key special quality of ‘Exceptionally Important, Varied and Distinctive Biodiversity, based on Locally Distinctive Habitats’.

3. The overall position of Natural England

3.1. Natural England does not consider the documents presented to the Planning Inspectorate to support the application for Development Consent Order (DCO) for Hornsea Project Three to be of sufficient quality and detail to enable a thorough assessment of the impacts on nature conservation issues in line with; the Marine Works (Environmental Impacts Assessment) Regulations 2007 (as amended), the Town and Country Planning (Environmental Impact Assessment) Regulations 2011 (as amended), Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017.

3.2. Natural England provided a detailed response to the Applicant’s Preliminary Environmental Information report (PEIr) in September 2017 raising a number of substantive concerns. With the exception of the baseline data deficiencies Natural England felt the majority of issues were capable of resolution prior to the Applicant’s final submission. Despite further engagement through the expert working group process, only a limited number of concerns raised during the pre-application phase of this project have been addressed to Natural England’s satisfaction in the final application.

3.3. Given the timescales for the submission of Relevant Representations and the extensive number of documents to review, Natural England is unable to provide detailed comments covering the full range of our concerns in relation to this application at this stage. We have therefore sought to provide high-level comments, covering our fundamental issues and main concerns and consequently this representation should not be considered to be an exhaustive documentation of our comments. Further detail will be provided upon the Examining Authority’s request and within our written representations.

4. Overarching concerns.

4.1. Natural England has a number of **fundamental** overarching concerns in relation to this application which are summarised below. These issues need to be addressed in order for a robust assessment to be undertaken. If these issues are not addressed Natural England will be unable to exclude beyond all reasonable scientific doubt that there will be no adverse effect on site integrity for the relevant SACs and SPAs, or that the conservation objectives of the relevant MCZs will not be hindered.

4.2. Evidence

4.2.1. Natural England has considerable issues with the standard of evidence provided in support of this application.

4.2.2. Natural England views the provision of project specific information to be fundamental to any assessment of a project at this scale. The project specific survey data sets within this application are limited for some designated site features (see points 5.2.6 and 5.4.7, for example) and although additional information has been used to inform conclusions (i.e. historic data, data collected outside the development zone), Natural England does not feel that this is sufficient to characterise the development site in order to fully understand the impacts of this project.

4.2.3. Consequently Natural England does not consider this level of information to be sufficient in the context of the Environmental Impact Assessment (EIA) and Habitat Regulations Assessment (HRA).

4.2.4. It is also unclear if the best available evidence is being used throughout the application when determining the likely nature and extent of impacts, with a reliance on the modelling used in historic applications rather than the available post-construction monitoring information. Recent experience from offshore energy projects entering the pre-construction and construction phase has brought to light fundamental flaws in the consent documents which we advise are rectified in future applications including Hornsea Project Three. For example, modelled data from the Environmental Statements of recently constructed projects have been relied upon for Hornsea Project Three, but Natural England is aware that the construction impacts for those projects have been significantly greater than those predicted. Therefore it is imperative that the modelled data is validated using post-consent/construction information before being further relied upon in this process.

4.2.5. There are also a number of instances where data is either not presented or incomplete (e.g. see points 5.2.1 and 5.4.13), which is preventing Natural England from being able to understand or comment on the significance of the assessment that the Applicant has undertaken.

4.2.6. Natural England has found the information presented is not sufficiently clear and is inconsistent and ambiguous in many places. Consequently it is extremely difficult to understand, assess its significance or arrive at clear conclusions. It is vitally important the information provided in support of the application (and each aspect thereof) is to be accurate and clearly presented in a way that can be easily understood and taken forwards into the construction phase without any ambiguity.

4.3. **Project Proposals**

4.3.1. Natural England recognises that the Applicant wishes to use a Rochdale Envelope approach in order to retain flexibility in the consent that is granted. Consequently we advise that the project parameters are clearly defined and that a realistic worst case scenario (WCS) is used to enable the impacts of a development to be fully assessed (noting that the actual impacts will probably lie within a range of values).

4.3.2. The wording of the project description associated with this application is confusing and the description of activities provided in subsequent chapters does not always tally with the overarching project description chapter and figures presented within the Development Consent Order (DCO) and/or Deemed Marine Licences (DMLs). This lack of clarity around the parameters of the project means that the activities that are to be undertaken are undoubtedly open to interpretation. Given this level of uncertainty, Natural England is unable to advise appropriately on the significance of the nature conservation and landscape impacts.

4.3.3. In order to allow for a realistic assessment of WCS it is important that as much information as possible is provided to enable the assessment to fully consider the impacts. Natural England's view is that evidence should be drawn from the construction of other projects (see point 4.2.4).

4.3.4. Throughout the chapters the descriptions are limited in detail in relation to the scale of the proposals included in particular for the marine environment, e.g. boulder clearance, sandwave levelling, cable protection. It is often unclear as to how the WCS has been derived, and consequently it is unclear if the WCS has in fact been presented.

4.3.5. For example, there is an assumption that 10% of the cable length will require protection as a WCS. It is unclear how the Applicant arrived at this percentage figure and the extent to which evidence of the ground conditions and previous experience of cable installation in similar areas/designated sites have been a factor in this assumption. Consequently, this figure seems arbitrary.

4.3.6. Whilst a percentage assumption offers flexibility to the Applicant, it does not enable a meaningful assessment of the ecological impacts of the installing, maintaining and decommissioning of the cables due to a lack of information on the impacts of cable protection on specific sensitive habitats and species present along the route. Therefore, based on the current level of information, Natural England is unable to advise on the specific nature of the impacts of this activity both within and outside of Marine Protected Areas (MPAs).

4.3.7. We therefore cannot agree with the conclusions of this application, nor can we rule out the potential for adverse effect on site integrity of European designated sites and significant impacts to nationally designated sites.

4.4. **Assessment of Impacts**

4.4.1. It is Natural England's view that the data and predicted impacts should be presented in a way that allows the full range of uncertainty (e.g. around input data, analysis, methodology) to be understood and evaluated. It is necessary to have a good understanding of these uncertainties to be able to make an informed assessment of the significance of potential impacts.

4.4.2. Natural England does not feel that sufficient precaution has been built into the analysis to address the uncertainties arising from the lack of site specific data and detailed proposals. However, building in sufficient precaution/mitigation measures to allow for the uncertainties is likely to change the proposal and therefore may affect the viability of this project and/or subsequent projects when considered in-combination.

4.4.3. Taking the cable protection example, the absence of site specific data and the use of an arbitrary percentage figure would mean that a WCS assessment would need to assume that all of the 10% is installed on each of the most sensitive features within the MPA or cable corridor. This would involve running a number of different feature based scenarios. Where a scenario has the potential to hinder the conservation objectives of an MPA, consideration of options to minimise the impacts to an acceptable level is required. Again there would need to be a number of different options presented to enable adverse effect on integrity to be fully ruled out. Without sufficient supporting evidence however, it is unclear if following this approach would ultimately provide sufficient certainty for Natural England to rule out the potential for adverse effect on integrity beyond reasonable scientific doubt.

4.4.4. Furthermore, Natural England does not agree with the methodology used for the analysis in a number of cases (e.g. see points 5.2.2 and 5.4.14 for further details). This provides a further layer of uncertainty to any conclusions drawn and compounds any errors in modelling data used in the analysis.

4.4.5. Additionally, Natural England does not agree with the approach taken to the assessment of impacts over the lifetime of the project. The Applicant has assessed the impacts of the project in three phases – construction, operation and maintenance and decommissioning and has considered each phase in isolation, thereby failing to consider cumulative impacts over time. The implications of a 'phased build' over a number of years have not been fully considered and is also unclear whether any particular impact is considered to be temporary or long term/persistent. Consequently Natural England cannot agree with the conclusions made in these assessments and we strongly suggest that these assessment sections are rewritten to comprehensively and satisfactorily assess the impacts throughout the lifetime of the project.

4.5. **Cumulative/ in-combination assessment**

The level of uncertainty arising as a result of the issues raised above (see 4.3 – 4.4) means that the cumulative and in-combination assessments are compounding errors. Therefore, it is not feasible to reach a conclusion on the significance of the effects of the project alone and in-combination. As well as the uncertainty this provides in relation to Hornsea Project Three, it will also impact on the in combination assessment for other plans and projects seeking consent.

5. Issues requiring further consideration

This section summarises the principal issues that Natural England has with the application. The issues set out below require further work, or clarification, to enable a complete and robust assessment to be undertaken. If the issues are not resolved Natural England will not be able to exclude beyond all reasonable scientific doubt that there will be no adverse effect on site integrity for the relevant designated sites.

In order to indicate the relative significance of our comments we have colour-coded our points, using red to denote our major concerns and amber for moderate comments.

As highlighted above (Section 3) this should not be considered to be an exhaustive list of Natural England’s concerns and comments. Further detail will be provided upon the Examining Authority’s request, and within Natural England’s written representations.

5.1. **DCO and DML**

The application is the first opportunity Natural England has had to review the proposed Development Consent Order (DCO) and Deemed Marine Licences (DMLs). Given there are several significant unprecedented proposals/ conditions included within the DCO and DMLs, we advise that DCO/DMLs should have been provided prior to application to allow for discussion and consideration within the pre-application process. This is in keeping with the principles of the Planning Act 2009 and the front loaded process that was envisioned.

Point	Summary of comments
5.1.1. Document sign-off condition	Natural England notes that the Applicant has included a condition in both DMLs that requires all post-consent documentation to be signed off within 8 weeks of a report being submitted. It is our view, that such condition is extremely restrictive and leaves no room for potential discussions that may be required post-consent. The DMLs also state that failure to reply on time could lead to the developer submitting the matter to arbitration.
5.1.2. Arbitration provision	With regard to the arbitration provision in the DCO, arbitration conditions in the DMLs and the arbitration rules schedule, Natural England does not believe the provision made for arbitration within this DCO is appropriate. Natural England's expert advice is given pursuant to its statutory duties. It cannot be bound by the findings of another organisation or individual if that contradicts its expert opinion. Natural England is, therefore, unable to agree to a mechanism which compels it to abide by an outcome which it does not believe is appropriate in its expert opinion. .
5.1.3. Arbitration costs	It is also noted that, within this provision, an award of costs may be made against Natural England. While it is acknowledged that the wording used is reasonably standard for arbitration agreements, Natural England considers that it is inappropriate for a Statutory Body to be subject to additional outside costs while performing its statutory function.
5.1.4. Confidentiality clause	In relation to the confidentiality clause of the arbitration schedule: Natural England is subject to the requirements of the Freedom of Information Act 2000 ('FOIA') and the Environmental Information Regulations 2004 ('EIR'). Therefore Natural England may be obliged to release documents in response to an FOIA or EIR request including any file notes. In respect of any FOIA or EIR request, Natural England is responsible for determining at its absolute discretion whether any information it holds, whether commercially sensitive information or otherwise, is exempt from disclosure in accordance with the provisions of the FOIA or the EIR or is to be disclosed in response to a request for information. Natural England cannot therefore guarantee confidentiality or agree to be bound by such a requirement.
5.1.5. Offshore preparation works	Additional to the concerns on arbitration, Natural England cannot agree to the definition of 'offshore preparation works' as currently provided within the draft DCO and DMLs. The definition allows works such as sandwave levelling and boulder clearance to be conducted without any regulatory oversight or control of the methodology. These works form a significant part of the impact of the project, including a significant part of the impact to designated sites, and must be subject to appropriate regulatory review and sign off prior to any works commencing.

Natural England has provided further detailed comments on our concerns regarding the draft DCO and DML within Annex A.

5.2. **Offshore ornithology**

The table below provides a summary of Natural England's key concerns.

Point	Summary of comments
Ornithological baseline and impact assessment methodology	
5.2.1. Baseline data collection	Due to the potential for considerable variability of seabird numbers and distribution in the offshore environment, characterising the use of a project area by a species requires multiple years of data. Natural England therefore consistently advises across all offshore wind farm projects that a minimum of two years of site specific baseline survey data (covering two complete 'bird seasons') should be used. The site-specific baseline survey data to inform the offshore ornithology assessments within this application comprise 20 months of data. Having less than two years of data will increase the uncertainty around the offshore ornithology impact assessment and will increase the risk that Natural England will not be able to agree with the impact assessment conclusions presented by the Applicant. Furthermore, the Applicant has chosen to only partially analyse their Digital Aerial Survey data from their 2016-17 surveys, giving them a 10% coverage of the area rather than a potential 20%. Given that the full two years of data are not available for this application, Natural England queries why only 10% of aerial data has been analysed while up to 20% could potentially have been analysed? Natural England does not agree with the Applicant that this is sufficient for baseline characterisation.
5.2.2. Existing baseline data analysis methodology	The Applicant has sought to address the evidence gap by incorporating historical boat-based survey data collected at various spatial and temporal scales across the Hornsea Zone. However, it is Natural England's view that the Applicant's hierarchical data selection method for integrating densities/ numbers of species derived from digital aerial and boat-based survey data is flawed, and consequently has limited confidence in its application.
5.2.3. Collision Risk Modelling (CRM)	The Applicant has used Option 3 of the Extended Band Model (Band 2012) to assess the predicted impacts on gannet, kittiwake, lesser black-backed gull and great black-backed gull from collisions with turbines in the Hornsea Project Three Study Area. The SNCBs have outstanding concerns regarding the Extended Band Model's (Option 3) sensitivity to flight height distribution data and the uncertainty this component introduces to variation in estimates of collision (JNCC et *al*., 2014). Therefore, Natural England advises that the Basic Band Model Option 2 should be used for the CRM for all species. Natural England also does not agree with the way that nocturnal activity factors have been used in the CRM for some species. As this has not been done in the present application, Natural England is unable to provide advice on the current CRM.
5.2.4. Displacement	Natural England has the following main points to note: • Natural England does not agree with seasonal definitions for several species, in particular gannet and puffin, relevant to the displacement assessment. The SNCB recommended approach to

	displacement assessment is to use the mean seasonal peak. Natural England disagrees with the mean seasonal peaks used by the Applicant to calculate displacement for gannet and puffin. • As previously advised in the Natural England's Section 42 response, the Joint SNCB guidance on assessing displacement (MIG-Birds, 2017) recommends that displacement impacts calculated for individual seasons should be summed across seasons to allow assessment of the annual impact on the population of a species. As this has not been done in the present application, Natural England is unable to provide advice on any of the species identified for displacement assessment.	
5.2.5. Accounting for uncertainty and variability	There is uncertainty around the predicted impacts in the assessments presented in the Applicant's Environmental Statement and the Report to Inform Appropriate Assessment (RIAA). Some of this comes from natural variability and uncertainty in the input data (e.g. densities of birds at Hornsea Project Three, flight heights etc.) and some of which is due to imperfect understanding of how systems work (e.g. avoidance rates and collision models, effects of displacement on mortality of birds etc.). In order to be able to make an assessment of the significance of potential impacts on populations it is necessary to understand and, where possible, take account of this uncertainty. Natural England advises that the assessments of displacement and collision mortality should both use the information on uncertainty and variability in the input parameters (e.g. bird densities, flight heights, avoidance rates) to allow consideration of the range of values predicted impacts may fall within, and to allow an assessment of confidence in the conclusions made regarding adverse effects on site integrity and significance of impacts for populations.	
5.2.6. Definition of the breeding season	Natural England has consistently advised that for species where breeding birds are predicted to be present in the project area, that the breeding season months follow those presented in Furness (2015) under 'breeding season' and not the 'migration-free breeding season', except where colony or site specific information suggests that a different set of months is appropriate for defining colony attendance. Natural England place considerably higher confidence and emphasis on the use of colony specific data to inform colony specific breeding seasons, while Hornsea Project Three focused substantially on using at sea abundance data (from a variety of offshore wind farms in the area) to define seasons. As such, and as previously advised, Natural England do not agree with the seasonal definitions for gannet, kittiwake and puffin.	
5.2.7. Assessment of cumulative and in-combination effects	Cumulative and in-combination impacts and the *approach* to impact assessment are a key area of concern for Natural England. The key concerns are summarised below: • Use of Extended Band Model collision figures for gannet and kittiwake for some project figures; • Application of Extended Band Model options to certain projects in the cumulative assessment for lesser black-backed gull and great	

	black-backed gull (e.g. Option 4 applied to Hornsea Project One and Hornsea Project Two; Option 3 for Hornsea Project Three); • Retrospective application of correction factors to existing collision figures for projects as a proxy for lower nocturnal activity levels than used in the original CRM; • Retrospective 'proportional' changes to collision figures for projects based on assumptions that consented turbine configurations represent a lower collision risk than the Rochdale Envelope defined during the consenting process for a project; • Use of MacArthur Green (2017) ratio correction factors to adjust collision figures for projects based on 'as built' versus consented turbine layouts; • Exclusion of impacts from Tier 3 projects in the CEA (Tier 3 includes Norfolk Vanguard and Thanet Extension); • Conducting qualitative rather than quantitative in-combination displacement assessments for certain species • The proportions of birds that have been apportioned to Flamborough and Filey Coast (FFC) pSPA during the breeding season from the different North Sea projects; • Cumulative assessment of impacts under Environmental Impact Assessment (EIA) does not incorporate impacts across the whole annual cycle for a species at an appropriate scale. • The assessment of EIA impacts on a season by season basis, at varying population scales, and therefore with varying project impacts included. Natural England advise that assessment of impacts should be undertaken at an appropriate scale (e.g. North Sea) across the whole year for each relevant species.	
5.2.8. Population modelling approaches and population impacts	The Applicant has considered the significance of the predicted in-combination mortality impacts on FFC pSPA by reference to population modelling work undertaken by MacArthur Green (2015b) for Hornsea Project Two. The Applicant has used outputs from these population viability analysis (PVA) models for gannet, kittiwake and guillemot populations. Natural England does not consider that the PVA models produced for Hornsea Project Two are suitable to inform the assessments for Hornsea Project Three.	
Habitats Regulations Assessment (HRA)		
5.2.9. Apportioning	Natural England has outstanding concerns regarding the approach Hornsea Project Three has taken to apportioning, and we do not agree with the figures presented for gannet, kittiwake and puffin. Consequently we are unable to agree with the conclusions of the HRA for FFC pSPA.	
5.2.10. Age class data	Natural England previously requested (NE Discretionary Advice Service (DAS) dated December, 2017) that Hornsea Project Three provides age class data month by month for the full breeding seasons as defined by Natural England due to a lack of agreement. We also requested that proportions of unaged birds are specifically presented (month by month) for each relevant data set for both boat based and (where appropriate) aerial survey data. This information is required for Natural England to	

	establish suitable apportioning figures. To date these data have not been provided.	
5.2.11. HRA screening and LSE conclusions	Natural England commented on the Applicant's HRA screening methodology on a number of occasions (NE DAS dated February, 2017, and Section 42 response). The Likely Significant Effect (LSE) test is a 'coarse filter', identifying potential effect pathways that warrant further consideration through Appropriate Assessment. Generally, a feature should not be screened out unless it can be clearly demonstrated that there is no impact alone or in-combination. The structure of the HRA screening document means that those plans or projects that could contribute to in-combination effects are only considered after the test of LSE has been applied. This potentially misses interactions, that whilst not LSE on their own, might be an LSE in-combination when considered in tandem with other developments.	
5.2.12. HRA conclusions	The issues and uncertainties raised above mean that, on the basis of the information presented by the Applicant, Natural England cannot conclude beyond reasonable scientific doubt the absence of an adverse effect on the integrity on the SPAs and pSPAs assessed by the Applicant. Further, Natural England considers there are additional SPAs and associated features that are missing from the HRA.	

5.3. Marine processes

The table below provides a summary of Natural England's key concerns.

Point	**Summary of comments**	
Impacts on marine physical processes		
5.3.1. Sandwave clearance	Natural England notes that the Applicant considers the impacts of sandwave clearance during construction to be of minor significance in Environmental Impact Assessment (EIA) terms on the basis that they are of local spatial extent, of short to medium term duration and high reversibility. However, it is our view that limited empirical evidence is presented to support the assumptions made in relation to the scale of impacts including duration and recoverability and therefore we have low confidence in conclusions drawn. The conclusions appear to be based on a scenario whereby dredge disposal takes place within close proximity and is retained in the sediment system, but there is no modelling provided to demonstrate this. There is also reference to the fact that as worst case it could take 'months to years' for a new equilibrium to be established. There is also reference to a worst case scenario (WCS) whereby sediment is disposed further way and therefore 'lost from the system'. Again limited data is provided in relation to this scenario and the justification is based on the scale of loss in relation to the North Norfolk Sandbanks and Saturn Reef (NNSSR) SAC. It should be noted that the removal of approximately 1,804,434 tonnes of material thought the project area is significantly greater than the average	

	annual aggregates licence with allows removal of around 250,000 to 400,000 tonnes, of which the vast majority occurs outside of any protected sites and not directly on Annex I features. Therefore, the sandwave clearance proposals alone are on a greater scale and extent than other marine industry activities We acknowledge the sandwave clearance data provided by the Applicant from Race Bank offshore wind farm indicated a partial recovery after a 4 month period, but it is unclear from this study if a full recovery will occur. Furthermore, no indication is provided as to the scale over which sandwave clearance occurred at Race Bank so Natural England are unable to draw a direct comparison. Natural England considers it important to adequately quantify and assess the associated impacts. However, based on the evidence presented the conclusions are subjective and it is Natural England's view that with such a large amount of material being removed from a protected site, there needs to be higher confidence in the potential impact before significant impacts can be ruled out.	
5.3.2. Cable and scour protection.	The draft DML indicates that up to 2.4 km^2 of cable protection for the array and another 3 km^2 for the cables, meaning that a potential 5.4km2 area could be covered in rock by the project. For context, the width of a motorway is on average 55 m, so 3 km^2 will be the same as a 55 km stretch. It is therefore essential that potential impacts are fully understood in order to determine the potential significance in EIA terms. The array/offshore cable corridor area is characterised by sandwaves and mega ripples. As a result of this highly mobile environment and these large bedform features it is essential that export and array cables will be positioned correctly as to avoid excessive scour. Any rock protection should be considered a last resort and needs to consider the level of sediment transport in the area, and the orientation of the rock protection compared to the local sediment transport direction/ ripple field. Natural England remains concerned about the impacts from cable protection on sediment transport and coastal processes in relation to the north Norfolk coast where the proposed cable route runs parallel to the coast. In Natural England's experience, standard cable burial techniques such as using a plough have resulted in trenches being formed that are taking longer than anticipated to infill. The probably of this occurring should be considered further as well as the recoverability of both the sediment levels and associated communities. This is especially true if a mass flow excavator is used as currently there is not empirical data presented to support its' use in the Greater Wash and southern North Sea.	
5.3.3. Wave height	There is uncertainty in relation to the frequency at which the maximum reduction in magnitude of the wave height by 28% will occur, Natural England does not believe that this level of reduction is insignificant and questions what the potential associated impacts are likely to be.	
Habitats Regulations Assessment (HRA)		
5.3.4. Sandwave clearance impacts NNSSR SAC	The proposed amount of sandwave clearance both within the NNSSR SAC and in the offshore export cable corridor overall is of great concern to Natural England and JNCC. Although the assessment states that < 0.2 % of the SAC will be impacted, there is no real indication of what these	

	impacts will be, particularly on a biological level (no linkages to the benthic chapter) and how any impacts may propagate across the site. Natural England advises if any sandwave clearance does take place, the material that is to be disposed of should remain within the overall sandbank system, and deposited upstream of the tidal currents and be 'intelligently' placed so that it quickly infills the excavated depressions. Disposal should also avoid sensitive habitats such as *Sabellaria spinulosa* reef. JNCC's recent conservation advice package for the SAC highlights a restore objective for the Annex 1 sandbank feature that the site is designated for (JNCC, 2017). The Applicant must therefore demonstrate that their proposals will not contribute to the further deterioration of the features of the site, through the provision of a robust project plan and by defining clear project parameters.	
5.3.5. Sandwave clearance impacts on W&NNC SAC	Natural England notes the potential for sandwave clearance within the Wash and North Norfolk Coast (W&NNC) SAC spanning an area of approximately 9000 m^2, and dredge disposal of approximately 265,474 m^2 of material. Natural England does not consider this to be insignificant. As there are no baseline data for this part of the cable route we are unable to advise on the nature and scale of any associated impacts or potential mitigation that may be required.	
5.3.6. Cable protection in W&NNC & NNSSR SACs	It is indicated that up to 10% of the cable route within designated sites may require some form of cable protection as a WCS. As indicated above, it is unclear how this figure has been derived, and as such it is unclear if this in-fact represents the worst case in terms of the potential amount of protection required. In order for Natural England to advise on the potential impacts of cable protection in designated sites in the context of marine processes we would require further information on the potential locations of cable protection and the local seabed and sea state conditions. Related to potential changes to marine processes is cumulative impact that this may have on benthic habitats and communities Consequently there is insufficient information to rule out adverse effect on integrity at this time.	

5.4. **Benthic ecology**

The table below provides a summary of Natural England's key concerns.

Point	**Summary of comments**	
North Norfolk Sandbanks and Saturn Reef (NNSSR) SAC		
5.4.1. Impact assessment conclusions	We do not believe that the Applicant has either provided enough evidence for, or assessment of, impact to protected features or site integrity for the NNSSR SAC. As such, we cannot agree that the project is unlikely to have any significant effect on features or site.	

	JNCC's latest view on condition is that the sandbank and reefs features are in unfavourable condition and should be restored to favourable condition. Restoration of the features require an overall reduction, or removal, of pressures associated with human activities that cause impacts to biological and physical feature characteristics. As such, any human activities which causes pressures resulting in changes to these may present a risk to the site's restoration. We note that there is no expectation that the Applicant should demonstrate recovery of the site. Recovery is an objective for all sectors placing pressure on the site. We do, however, expect the Applicant to demonstrate the risk levels that they believe their proposed operations will present to the restoration of the extent and distribution of the sandbank and reef features.	
5.4.2. Sandbanks covered by seawater all the time	Based on the information presented on the proposals, the SNCBs (Natural England & JNCC) cannot currently provide an evidence-based opinion on the scale of the potential impacts to the Annex I Sandbanks feature of the NNSSR SAC. We cannot currently exclude adverse effect on integrity.	
5.4.3. *Sabellaria spinulosa*	Based on the information presented on the proposals and flawed methods used for assessment, the SNCBs cannot currently provide an evidence-based opinion on the scale of the potential impacts to the Annex I *Sabellaria spinulosa* reef feature of the NNSSR SAC. It is our view that the impacts to Annex I Reef have been potentially underestimated and therefore the proposed mitigation measures to avoid reef are not fit for purpose. Therefore, we cannot exclude adverse effect on integrity. We strongly suggest re-analysis using the approach that all other industries take when operating in areas of offshore *Sabellaria* reef, and that is the use of the JNCC reef layer with 500m buffers added to allow for change in reef extent and distribution. JNCC has continued to update their Annex I Reef layer, and the Applicant should be aware that one further *Sabellaria* data point and further area to be managed as reef has been added within the cable corridor since we last provided them with the data layer. This can be made available to the Applicant on request.	
5.4.4. Core reef approach	It is Natural England's view that the core reef approach used to assess impacts on Annex I Reef within NNSSR SAC does not follow Natural England's guidance and therefore is not fit for purpose.	
The Wash and North Norfolk Coast SAC (W&NNC)		
5.4.5. Consideration of alternatives	Although it is acknowledged at early stages of route refinement that Hornsea Project Three aimed to avoid impacts on the W&NNC SAC, Natural England questions why W&NNC SAC is not mentioned any further in the 'refinements' sections, even though the Preliminary Environmental Information report (PEIr) export cable route version and the boundary had overlap with the site.	
5.4.6. Impact of the nearshore part	Whilst Natural England acknowledges that in taking forwards the alternative route the Applicant has reduced the known impacts to designated sites i.e. by relocating cable crossing outside of designated	

of the cable route	sites which would require cable protection, he total impacts from all associated activities on each designated site and/or feature still need to be thoroughly considered in the assessment. It is Natural England's view that insufficient project specific data and/or information has been provided with regards to the near-shore alternative route and its interactions with the designated sites to agree with either assessments and/or the conclusions of no significant impact.	
5.4.7. Impact assessment	Natural England has the following concerns with the impact assessment: i) Consideration of sub-features of The W&NNC SAC Natural England would like to note that for The Wash and North Norfolk Coast SAC Annex I feature 'Sandbanks which are slightly covered by seawater all the time' has a number of sub-features associated with it. It is our understanding that the Applicant refers to those sub-features as 'supporting habitat', which is inaccurate. In the case of this SAC the sub-features are components of the Annex I feature and should therefore be assessed as such. ii) Extent of Annex I features in The W&NNC SAC We are pleased to note that the Applicant assumed 100% overlap of the cable route with the site features for the purpose of defining the magnitude of impact. However, without project specific data we can't determine the extent of each feature to inform any mitigation measures and rule out other Annex I habitats being present along the cable route. iii) Ability to install cables We question how much weight has been given to the sub-features in the overall assessment not only for ecological impacts purposes, but also the ability to install cables. Data from other offshore windfarm projects within the same designated site, is showing that cables have been sub-optimally buried within the same features which may lead to further remedial works that would have significant impacts to the site. Therefore, we disagree with the interpretation to inform the worst case scenario (WCS). And there is still a high risk of significant impacts to designated features from cable installation and associated activities. Especially given that data was presented to the expert working group on 3 December 2017 that showed that there is shallow bed rock between 20 cm and 3 m below the seabed which would mean that the cables would be sub-optimally buried across a large proportion of the designated sites	
Marine Conservation Zones (MCZs)		
5.4.8. MCZ Assessment	It is Natural England's view that the relevant authority will need to carry out a full MCZ Assessment to determine whether the project has a potential to hinder the conservation objectives of the sites. For Cromer Shoal Chalk Beds MCZ conservation advice, including conservation objectives, operational advice and sensitivity assessment is now available on Natural England's Designated Sites System[8] and these should be used to inform the assessment.	

[8] https://designatedsites.naturalengland.org.uk/SiteSearch.aspx

5.4.9. Cromer Shoal Chalk Beds MCZ – nearshore works	It should not be assumed that excavated material form the Horizontal Directional Drilling (HDD) and cable laying activities would be allowed to be stored within the Cromer Shoal MCZ. Regardless of avoiding sensitive protected features, there is potential for material to be transported and deposited on sensitive designated features, such as subtidal chalk reef. Whilst Natural England recognises that the Applicant has included options with the Rochdale envelope to potentially reduce the impacts to the MCZ such as HDD Natural England remains concerned about the potential impacts of HDD exit pits and associated activities on the protected features of the MCZ. It is our view that the WCS has not been fully assessed for the nearshore works.
5.4.10. Markham's Triangle	Please note, that the site is now considered a *proposed* MCZ (pMCZ) after it was included in Tranche Three of MCZ consultation, which was announced on 8 July 2018.
5.4.11. Markham's Triangle pMCZ evidence	We do not consider that the benthic analyses is appropriate for characterising Markham's Triangle pMCZ, or that Markham's Triangle survey evidence has been used appropriately. We request the Applicant to clarify, why: • The Cefas/Defra evidence for Markham's Triangle was not used in the characterisation of the Hornsea Project Three array area. • The biotopes provided in JNCC Report 608 (Sotheran et *al*., 2017) were not used in the analyses, instead considering only suggested biotopes for the survey points within the pMCZ; • Suggested biotopes for the Cefas / Defra data are quite dissimilar to the biotopes within JNCC Report 608.
5.4.12 Markham's Triangle pMCZ impact assessment	We do not believe that the scale and magnitude of the impacts from the offshore wind farm installation activities have been adequately assessed, therefore we cannot agree that the project is unlikely to have any significant effect on the designated features of the Markham's Triangle pMCZ. It is the SNCB view that the features should be assessed separately and instead of using one feature as proxy for the whole site (unless shown to be applicable). This is equally relevant for the Marine Processes assessment of the pMCZ.
Evidence analysis and impact assessment	
5.4.13. Evidence analysis	Natural England has considerable amount of questions for the Applicant on their analysis and interpretation of benthic survey results. We had the opportunity through the Benthic Expert Working Group to provide initial comments to the Applicant on the quality of their benthic analysis. Where the Applicant has provided a response, we remain uncertain that the analyses have been undertaken to the standards that we would expect in a development of this nature. Some of the concerns include: • Survey data and evidence used needs to be the most up to date and be presented to support statements; • We have outstanding questions on how the survey data have be analysed and interpreted as we have found errors in results and

	determining significance of impacts especially in relation to biotopes and Valued Ecological Receptors (VERs).	
5.4.14. Impact assessment methodology	Natural England disagrees with how the impact assessment has been carried out due to the lack of explanation and detail around the proposed activities and assessment of significance. It is our view that: • More clarity is required on cable burial activities to fully understand the impacts; • Elements of phased build approach that have not been fully explored in the WCS for cable installation as it only considers it to be a one-off activity; • Based on knowledge from built projects, it is Natural England's view that realistic WCSs are not being presented in the ES, especially with regards to cable protection in designated sites; • Full and total impact assessment through the lifetime of the project has not been provided.	
5.4.15. Operation and Maintenance (O&M) impacts	It is not clear, why it is assumed that the 25% WCS of additional cable protection will only be added to the areas already impacted by cable protection at the construction phase. We note that the dynamic nature of the seabed in the project area could mean that cables may get exposed in areas where they were initially buried into mobile sediments. Could the Applicant clarify, whether their assumption means that the 10% cable protection WCS at construction is still applicable to the O&M phase of the project?	
5.4.16. Impact significance	We note that the use of matrices to determine significance is not precautionary as 'minor' significance is used when 'moderate-minor' impact is shown in a matrix. Natural England notes that choosing to conclude 'minor' impact may result in downplaying the potential impact on sensitive habitats. In addition, on a number of occasions in the Benthic Ecology Chapter the magnitude of impact is defined as 'minor' where the impact is 'of local extent, long term, continuous and irreversible during the lifetime of Hornsea Three'. It is not clear how this definition relates to the magnitude categories presented in Table 5.3 of Ch. 5 (EIA Methodology). It is our view that this inconsistency may result in underestimation of the impacts on benthic receptors.	
Mitigation measures		
5.4.17. Sensitive cable and scour protection	The Applicant has not provided any evidence to support the statement that 'sensitive scour and cable protection' actually works. Unless it can be shown that such methods allow a decrease in the overall cable laying impacts, these measures cannot currently be viewed as viable mitigation. For example: Table 2.31 in the Benthic Ecology chapter includes a proposed O&M monitoring commitment to 'to determine the effectiveness of the designed-in mitigation measures proposed for sensitive cable protection within designated sites.' Natural England questions the validity of the mitigation measures proposed for the project, and associated impact assessment, if the Applicant is not confident in the effectiveness of these measures at this time.	

5.5. **Marine mammals**

The table below provides a summary of Natural England's key concerns.

Point	Summary of comments	
5.5.1. Noise mitigation at source	We note that no consideration has been given to at-source noise mitigation of piling noise, such as bubble curtains or isolation casing. It is recognised that some of the mitigation measures are not necessarily suited to all environmental conditions. However, the current industry knowledge outlines the wave height limit for bubble curtain operation to be 3 m, and for survival 5 m; wind speeds up to 30 m/s and currents up to around 1.5 m/s (K. Kloske, pers. comm). Figures from the Marine Processes chapter suggest that the conditions within the Hornsea Project Three array area are within the operating limits of existing bubble curtain solutions therefore these options should be explored.	
5.5.2. Maximum hammer energy inclusion on the DCO/DML	The maximum hammer energy assessed in the Environmental Statement (ES) should be detailed within the design parameters on the Development Consent Order (DCO) and/or Deemed Marine Licences (DMLs). This is the best available metric to ensure the noise generated from piling does not exceed that assessed within the project envelope. Given the discussions and amendments that have been requested on other projects, this needs to be included on the face of the consent to ensure this important maximum parameter is only amended through an appropriate variation process.	
5.5.3. Mitigation for harbour porpoise	The DMLs have proposed the inclusion of a mitigation condition for harbour porpoise in the Southern North Sea cSAC/SCI similar to that included in Hornsea Project Two. Natural England notes that a Marine Mammal Mitigation Protocol will be provided to remove the risk of potential death and/or injury to marine mammals. In addition, the Project should have a Site Integrity Plan – a live document, which needs to be updated prior to construction to inform the relevant authority's Appropriate Assessment of disturbance to harbour porpoise.	
5.5.4. UXO detonations worst case scenario (WCS)	Could the Applicant clarify if the numbers in Table 4.51 of the Marine Mammals chapter are the total number of animals injured from multiple UXO detonations? The total number will impact the magnitude scoring for each species and possibly the overall significance of the effect. Natural England also questions why the lower SCANS III densities have been used, which would result in smaller numbers of animals affected.	
5.5.5. Operational noise	Paragraph 4.11.2.7 of the Marine Mammal Chapter states that 'operational noise is predominantly low frequency and as such, the impacts on MF [medium frequency] and HF [high frequency] marine mammals will be reduced as the majority of the noise may be outside of their hearing range', however there is no reference to low frequency (LF) cetaceans (minke whale). This requires further consideration.	
5.5.6. Magnitude of disturbance	The conclusion for Tier 1 and 2 combined assessment states: moderate for the duration of the piling (~12 yrs) but minor in terms of long term population level effects, therefore not an issue in terms of the Environmental Impact Assessment (EIA). Natural England does not agree with this conclusion. There will be changes to the local abundance and	

	distribution of the population for the duration of the piling, and there is currently no understanding as to how an individual or the population will respond to long term piling (for the lifetime of an animal) in a site that is of importance to them and whether long term displacement could occur. In addition, there is no assessment of Tier 3, which would further increase the potential number of porpoises affected.	
5.5.7. Cumulative effects assessment	We note that the Cumulative Effects Assessment has assessed Hornsea Project Three with other wind farms, as well as Hornsea Project Three with seismic surveys, but not all noisy activities together (e.g. wind, seismic and UXO detonation combined).	
Habitats Regulations Assessment		
5.5.8. Conclusions of the RIAA	While Natural England agrees with the assessment that the Hornsea Project Three windfarm alone will not adversely affect site integrity given the relatively small disturbance footprint within the site, Natural England does not agree with the conclusions of the in-combination assessment, as presented in the Report to Inform Appropriate Assessment (RIAA). Various scenarios (sequential and concurrent piling), including minimum and median in combination spatial overlaps, total over 20% of the cSAC/SCI area. These total numbers do not take into account seismic or UXO detonations within the tables. In addition to that, there are two wind farm project that are at the Preliminary Environmental Information report (PEIr) stage, but are on overlapping construction timeframes with Hornsea Project Three, that have not been included within the assessment. It cannot be shown at the present time that there will not be an adverse effect on site integrity from the projects that are in development. This is not an issue unique to Hornsea Project Three and work will need to be undertaken to reduce the noise levels of multiple wind farms potentially developing at the same time, nevertheless, this should be reflected in the ES.	
5.5.9. Screening out cable and pipeline installations	Natural England does not agree that cables and pipeline installations should be screened out of the CEA (6.6.1.7). Such projects may also have to carry out UXO detonations within the cSAC/SCI and therefore should be assessed in combination with other noisy activities. In addition, the RIAA does not assess the combined impact of the project alone in terms of disturbance from various noisy activities arising just from Hornsea Project Three, such as piling and UXO clearance.	
5.5.10. Averaging piling across seasons	Natural England does not agree with the proposed approach to average the piling days across all seasons (see section 6.5.2.66 of the RIAA). Based on our experience, more work is likely to happen in summer months and developers would normally want to finish the works as early as possible. Therefore, we question whether averaging the piling across the whole year presents a realistic WCS. It is our view that a realistic worst case would be to start on the first day of the summer season and look the maximum number of piles that could feasibly be installed in that season.	
5.5.11. Projects scoped in	Even though Norfolk Boreas and East Anglia Two and One North have not submitted their PEIrs at the present time, they have submitted scoping reports and should be acknowledged qualitatively as potentially overlapping with the Hornsea Project Three construction schedule, especially since the MORL Western development area is also at a	

	scoping stage (4.13.1.79). Natural England also notes the RIAA chapter where all projects that have submitted a scoping report are included within Tier 2. Natural England supports the definitions within the RIAA. i.e. any project that has submitted a scoping report is included within Tier 2. However, the definition of the tiers also changes in section 6.6.1.13 of the RIAA. Please can clarification be provided for the differences between (and within) the two chapters.

5.6. Onshore ecology

The table below provides a summary of Natural England's key concerns.

Point	Summary of comments
Impacts on designated sites	
5.6.1. Norfolk Valley Fens SAC	We do not consider that there is sufficient information on groundwater impacts from Hornsea Project Three for us to provide a comment on the impact assessment of the project alone. Therefore, we are not able to comment on any likely in-combination effects with Norfolk Vanguard Offshore Wind Farm cable route. Natural England advises that impacts, which may arise in combination on the internationally designated features via changes to groundwater supply, should be considered and mitigation measures put in place to minimise any likely significant effects. Currently, the ES only considers the in-combination effects on narrow-mouthed and Desmoulin's whorl snail.
5.6.2. Booton Common SSSI	It is Natural England's view that the Environmental Impact Assessment (EIA) does not have sufficient detail around the potential impact on groundwater flows for us to provide detailed comments at this stage. The proposal is to carry out Horizontal Directional Drilling (HDD) very close to the designated site in terms of potential hydrological connectivity (about 360 m). Therefore, we request further detailed information and impact assessment. The proposal to HDD under the Blackwater Drain which feeds into Booton Common SSSI will avoid surface water quality impacts on the interest features, provided there is no accidental pollution from HDD operations. However, there may be a risk from water-borne pollution arising from chemical spills, leakages etc. during construction.
5.6.3. North Norfolk Coast SPA/Ramsar	North Norfolk Coast SPA/Ramsar site will not be directly impacted by the proposal. However, pink-footed geese which are a feature of the internationally designated sites use neighbouring fields in the winter to forage (known as functionally-linked land) and may be affected during the construction of the cable route. If construction works take place September-April, then some loss of feeding habitat and/or displacement of birds may take place depending on the location of sugar beet fields. We note the Applicant proposes to submit a pink-footed goose mitigation plan to Natural England in the 12 months prior to construction if works are proposed for the period November to January. We are not able to comment on the likely effectiveness of this plan without further detail. Our recommendation is that avoidance measures, such as timing or crop

	rotation should be considered first, as outlined in best practice of mitigation hierarchy. We advise that sugar beet is not planted in the season prior to construction in those fields within a 500 m radius of the landfall and the cable route in areas known to be used by pink-footed geese. It is not clear whether this approach has been considered, and if so, why the Applicant does not propose to implement it.	
5.6.4. Kelling Heath SSSI	Natural England notes that the cable will be installed by HDD immediately adjacent to the Kelling Heath SSSI. We advise there must be no incursion of surface water run-off and temporary construction works, including fencing, vehicles, storage of materials etc. onto the Kelling Heath SSSI during construction, operation or decommissioning. If mitigation measures for any species (e.g. for reptiles), are proposed within the SSSI, assent will be required from Natural England. We advise that light spill onto the SSSI should be kept to a minimum.	
5.6.5. Alderford Common SSSI	Natural England expresses concern that no bats are shown as present on Alderford Common SSSI. It is our understanding that they are present with a well-established roost, hibernaculum and a feeding area. Not identifying this site is a potentially significant omission in the surveys (and questions the adequacy of other ecological surveys). Measures to avoid disturbance will need to be implemented here.	
Other potential impacts on nature conservation		
5.6.6. Pollution and runoff	Surface water run-off from the full width of the working corridor is not clearly or consistently addressed, nor are the potential impacts, which are underestimated as being short or medium term and reversible. The outline Code of Construction Practice (CoCP) is the only place in the documents runoff and its control is actually addressed. Effective design and implementation in the context of local conditions of all pollution control measures is imperative to mitigate pollution and invasive non-native species/disease risks. Ongoing consultation with Environment Agency and Natural England will be vital to ensure pollution and run off control measures are effective and appropriate for local conditions. Without it the measures and claims in other chapters cannot be considered robust.	
5.6.7. Geology and ground conditions	The Applicant proposes to ‘minimise production of silt and contaminated water where practicable’. It is our view that minimising run off from exposed ground and stockpiles will be vital and we require more clarity over the mitigation measures that will be used and their effectiveness is required to have confidence in assessments of effects. Complying with Ciria guidance is an appropriate starting point but actual measures need to be effective within the local context (topography, soils, rainfall, pathways, receptors etc.). Note: Ciria C692 has been superseded by Ciria C741.	
5.6.8. Hydrology and flood risk	Natural England notes that a single flood event that would overwhelm protection measures could deposit large amounts of sediment into watercourses. This situation would not readily reversible nor would the impacts be of short term duration. Recent rainfall data show of the 11 intense rainfall events (>31 mm/day) in the last 26 years 9 have been in the last 10 years. Therefore, run off control measures should be designed to cope with this type of event as a minimum.	
5.6.9. Soils	Natural England agrees with the conclusions of a moderate-adverse significant effect of the permanent loss of best and most versatile (BMV)	

	soils between 23.66-50 ha. We question why the outline CoCP does not address management of BMV soils when it has been identified as a significant effect. We advise the Applicant that detailed guidance is available in Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[9] and we recommend that this is followed.	
Protected species		
5.6.10. Protected species licencing	No draft licences had been submitted to Natural England prior to the application submission. However the Applicant states that 'there are no known issues that would prevent a European Protected Species (EPS) license being granted'. The Applicant needs to have obtained a Letter of No Impediment (LONI) for each EPS, otherwise the Examining Authority can have no certainty that a licence will be granted.	

5.7. **Seascape and Landscape**

The table below provides a summary of Natural England's key concerns.

5.7.1. Norfolk Coast AONB	It is Natural England's view that there is insufficient information in the application to determine impact from the onshore cable corridor on special qualities of the Norfolk Coast Area of Outstanding Natural Beauty (AONB). A key special quality of the Norfolk Coast AONB is 'Exceptionally Important, Varied and Distinctive Biodiversity, based on Locally Distinctive Habitats'. A key characteristic of the landscape character type Coastal Towns and Villages, CTV1: Weybourne to Sheringham within Norfolk Coast AONB is 'Small fields, hedgerows and woodland, which provide an enclosed structure for this intimately scaled rural landscape'. Natural England would expect to see a detailed analysis of the impacts on key landscape elements within the AONB which contribute to biodiversity and landscape character, such as hedgerows and woodland and other semi-natural habitats. At this present time the ES does not include information about where there will be a long term/persistent loss of key landscape features, such as veteran trees and important hedgerows within the AONB, and there is no detail provided of the steps that have been taken to minimise the loss. We understand that following completion of construction, there would be a period of a minimum of five years for the new hedgerow planting to fully mature. This means that the time for the landscape to recover is temporary long term. In addition to the impact of the cable route, the construction impacts of any joint bays, link boxes, compounds etc. within the AONB should be assessed in full.	
5.7.2. National Trails	There is likely to be a significant impact on the visual amenity of users of the national trails from the cable landfall, particularly during construction and decommissioning.	

[9] https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites

	Section 4.11.1.26 of the Landscape and Visual Resources chapter states that construction activities would potentially require temporary closure or diversion of these routes. The offshore activity associated with the landfall and works in the intertidal zone would be visible from the national trails. We agree that the sensitivity of users is very high and we consider that the effect on them would be significant for the duration of the construction. There are no details of what measures might be taken to mitigate for any adverse visual impacts and whether any footpath improvements might be required for the diversion.
5.7.3. Offshore HVAC lighting	There is no mention of whether the Offshore HVAC Booster Station will be lit and visible at night. The representative visualisations should include night time views if the station will be lit.

5.8. **In Principle Monitoring Plan (IPMP)**

5.8.1. IPMP	Natural England believes that the hypotheses to be answered as part of the offshore wind farm monitoring plan need to be clearly set out in the IPMP and should be based on the conservation objectives for the designated sites and the key concerns relating to the HRA. In addition the IPMP does not allow for the consideration of residuals concerns that the SNCBs currently have in relation to the impacts of this project and remain concerned that the monitoring will not support any industry learning in relation to impacts and recovery and/or inform the undertaking of any required remedial/restoration works that may be required. Natural England looks forward to further discussion with the Applicant and the other interested partied on this matter.

6. Matters that must be secured by requirements in the Development Consent Order (DCO)

6.1. In light of the fundamental concerns we have highlighted with this application, Natural England does not feel able to advise on matters to be secured through the DCO at this time.

7. References

Joint Nature Conservation Committee (JNCC), (2017). Supplementary Advice on Conservation Objectives for North Norfolk Sandbanks and Saturn Reef Special Area of Conservation. http://jncc.defra.gov.uk/pdf/NNSSR_SACO_v1_0.pdf

Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resource Wales (NRW), Northern Ireland Environment Agency (NIEA), Scottish Natural Heritage (SNH), (2014). Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review. 25 November 2014.

MIG-Birds 2017. Joint SNCB Interim Displacement Advice Note: Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments. January 2017.

Natural England (2017). Natural England's advice on the Section 42 and the Preliminary Environmental Information report (PEIr) consultation for Hornsea Project Three. Ref: 10827/221825, 20 September 2017.

Sotheran, I., Benson, A. & Johnston, C.M., (2017), Marine Conservation Zone Benthic Community Analysis, JNCC Report 608, ISSN 0963-8901. Available: http://jncc.defra.gov.uk/pdf/Report_608_web.pdf

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Ørsted Power (UK) Ltd.

for:

The construction and operation of Hornsea Project Three Offshore Wind Farm, a 2,400 MW with up to 300 turbines wind farm located 121 km off the Norfolk coast and 160 km off the Yorkshire coast, covering an area of approximately 696 km^2.

Planning Inspectorate Reference: EN10080

WRITTEN REPRESENTATIONS OF NATURAL ENGLAND

7 November 2018

Table of Contents

1. INTRODUCTION

1.1. Purpose and structure of these representations

1.1.1. These Written Representations are submitted in pursuance of rule 10(1) of the Infrastructure Planning (Examination Procedure) Rules 2010 ('ExPR') in relation to an application under the Planning Act 2008 for a Development Consent Order ('DCO') for the construction and operation of an offshore wind farm called Hornsea Project Three Offshore Wind Farm and associated infrastructure ('the Project') submitted by Ørsted Hornsea Project Three (UK) Ltd., on behalf of Ørsted Power (UK) Ltd., ('the Applicant') to the Secretary of State. The project refers to the construction and operation of an offshore wind farm of up to 2,400 MW with up to 300 turbines located 121 km to the north from the north Norfolk coast and 160 km to the east from the East Riding of Yorkshire, covering an area of approximately 696 km^2. The export cable makes landfall at Weybourne in Norfolk, with the onshore cable route of approx. 53 km crossing north Norfolk to a proposed onshore substation in the vicinity of the existing Norwich Main substation.

1.1.2. Natural England has already provided its principal concerns in its Relevant Representations, submitted to the Planning Inspectorate on 20 July 2018. This document comprises a further detailed statement of Natural England's views, as they have developed in view of the common ground discussions that have taken place with the Applicant to date. The document is structured as follows:

- Section 2 introduces the status and functions of Natural England.
- Section 3 is an account of the legislative framework.
- Section 4 is an account of the policy framework.
- Section 5 describes the statutory nature conservation and landscape designations, features and interests that may be affected by the Project and need to be considered.
- Section 6 comprises Natural England's submissions in respect of the issues that concern it. This submission cross-refers to, and is supported by, the evidence contained in the Annexes.
- Annex A provides Natural England's responses to the first round of Examining Authority's written questions
- Annexes B-E contain Natural England's detailed comments on various nature conservation topics
- Annex F provides a list of additional documents supplied by the Applicant after submission of the Relevant Representations
- Annex G contains the summary of Natural England's Relevant Representations
- Annex H summarises Natural England's comments on the Relevant Representations submitted by other partied
- Annex I contains the summary of Natural England's Written Representations.

1.1.3. In its letter of 9 October 2018 the Examining Authority asked the parties, including Natural England, a number of first written questions. The answers to those questions are contained within these Written Representations Annex A.

2. STATUS AND FUNCTIONS OF NATURAL ENGLAND AND JNCC

2.1. Natural England

2.1.1. Natural England is a statutory body established under the Natural Environment and Rural Communities Act 2006 ('NERC Act'). Natural England is the statutory advisor to Government on nature conservation in England and promotes the conservation of England's wildlife and natural features. It is financed by the Department for Environment, Food and Rural Affairs ('Defra') but is a Non-Departmental Public Body, which forms its own views based on the best scientific evidence available.

2.1.2. Natural England works for people, places and nature, to enhance biodiversity, landscapes and wildlife in rural, urban, coastal and marine areas; promoting access, recreation and public well-being, and contributing to the way natural resources are managed so that they can be enjoyed now and by future generations.

2.1.3. Section 2 of the NERC Act provides that Natural England's general statutory purpose is:

> *'…to ensure that the natural environment is conserved, enhanced and managed for the benefit of present and future generations, thereby contributing to sustainable development.'*

2.1.4. Section 2(2) states that Natural England's general purpose includes

a. promoting nature conservation and protecting biodiversity;

b. conserving and enhancing the landscape;

c. securing the provision and improvement of facilities for the study, understanding and enjoyment of the natural environment;

d. promoting access to the countryside and open spaces and encouraging open-air recreation; and

e. contributing, in other ways, to social and economic well-being through management of the natural environment.

2.1.5. Natural England is required to keep under review all matters relating to its general purpose,[1] and to provide public authorities with advice where they request this.[2] Natural England's remit extends to the territorial sea adjacent to England, up to the 12 nautical mile limit from the coastline.[3]

2.1.6. Natural England is a statutory consultee in respect of (amongst other matters):

a. all applications for consent for Nationally Significant Infrastructure Projects which are likely to affect land in England;[4] and

b. the environmental information submitted pursuant to the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 ('the EIA Regs').[5]

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[1] NERC Act, s.3(1).

[2] NERC Act, s.4(1).

[3] NERC Act, s.1(3).

[4] Planning Act s.42; Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009, reg. 3 and sched.1

[5] Regs. 2(1), 8(6), 9(1), 13(2)(b), 17(3)(g), 18(3)(f), 19(3)(e) of the EIA Regs.

c. plans or projects that are subject to the requirements of the Conservation of Habitats and Species Regulations 2017 (the 'Habitats Regulations') or the Conservation of Offshore Marine Habitats and Species Regulations 2017 ('Offshore Regulations') which are likely to have a significant effect on European protected sites – that is, sites designated as Special Areas of Conservation ('SACs') (and candidate SACs ('cSACs'))[6] and Special Protection Areas ('SPAs') and potential SPAs ('pSPAs')[7].

d. proposals likely to damage any of the flora, fauna or geological or physiographical features for which a Site of Special Scientific Interest ('SSSI') has been notified pursuant to the Wildlife and Countryside Act 1981 (as amended) ('WCA 1981');[8]

e. proposals relating to the English territorial sea capable of affecting, other than insignificantly, any of the protected features of a Marine Conservation Zone ('MCZ') or any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependent, where the Examining Authority believes that there is or may be a significant risk of the act hindering the achievement of the conservation objectives stated for the MCZ.[9]

2.1.7. It is also the Government's policy to consult Natural England in respect of sites listed for the purposes of the Convention on Wetlands of International Importance especially as Waterfowl Habitat signed at Ramsar on 2 February 1971 ('Ramsar sites'), as if they were European protected sites.[10]

2.1.8. In addition, Natural England performs duties relating to SSSIs under the WCA 1981, and in relation to European protected sites and species under the Habitats Regulations.

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[6] As a matter of law cSACs are protected as they are included within the definition of 'European site' set out at regulation 8 of the Habitats Regulations. A cSAC is the term given to sites which Member States have decided are Sites of Community Importance ('SCI') within their borders containing either species prescribed in Annex II of the Habitats Directive or which have Annex I habitat types. Sites containing priority habitats or species must be listed as SCIs and then designated as SACs. These sites are known as cSACs until such time as those sites are confirmed as SACs or a decision is taken that they should not be SACs.

[7] As a matter of policy, the Government expects public authorities to treat pSPAs as if they are fully designated European Sites, for the purpose of considering development proposals that may affect them. A potential SPA is a site on which Government has initiated public consultation on the scientific case for its classification. Revised National Planning Policy Framework (July 2018), para 176; PINS Advice Note 10: Habitats Regulation Assessment for nationally significant infrastructure projects, p.4.

[8] Section 28I of the 1981 Act.

[9] Marine and Coastal Access Act 2009, ss.126(2) and 147(1). The first MCZs are anticipated to be designated in the course of 2013. It is submitted that where an expanse of sea is under consideration for designation as an MCZ this is a material consideration.

[10] Revised National Planning Policy Framework (July 2018), para 176 PINS Advice Note 10: Habitats Regulation Assessment for nationally significant infrastructure projects, p.4.

2.2. Authorisation to delegate

2.2.1. The Examination Authority should note that pursuant to an authorisation made on the 9th December 2013 by the JNCC under paragraph 17(c) of Schedule 4 to the Natural Environment and Rural Communities Act 2006, Natural England is authorised to exercise the JNCC's functions as a statutory consultee in respect of applications for offshore renewable energy installations in offshore waters (0-200nm) adjacent to England. This application was included in that authorisation and therefore Natural England will be providing statutory advice in respect of that delegated authority.

3. LEGISLATIVE FRAMEWORK

3.1. Environmental Impact Assessment

3.1.1. The Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 ('EIA Regs') transposed Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment (as amended). That directive and its amending instruments have since been repealed and replaced by consolidated Council Directive 2011/92/EU ('the EIAD'). Development consent cannot lawfully be granted for EIA development unless there has been substantial compliance with the EIA Regs.[11]

3.1.2. The descriptions in the schedules apply broadly, and are not to be interpreted as mutually exclusive 'pigeonholes'.[12] In assessing whether a development is likely to have a significant effect on the environment, the Planning Inspectorate must have regard to criteria in Schedule 3 of the EIA Regs.[13]

3.1.3. Where the Examining Authority is considering adopting a scoping opinion in which it specifies what information should be required in the environmental statement, it must consult Natural England in respect of proposed applications likely to affect land in England and the marine environment.[14].

3.1.4. The environmental statement must meet the requirements of Schedule 4 to the EIA Regulations. These include providing:

a. an outline of the main alternatives studied by the applicant and an indication of the main reasons for the applicant's choice, taking into account the environmental effects;

b. a description of the development, its construction and operation phases, its production processes, and an estimate by type and quantity of its emissions and residues;

c. a description of the aspects of the environment likely to be significantly affected by the development including air, water, soil, fauna and flora, and landscape;

d. a description of the likely significant effects of the development on the environment, including direct, indirect, secondary, cumulative, long- and short-term, temporary and permanent effects;

e. a description of the measures envisaged in order to prevent/avoid, reduce and remedy/offset the significant adverse effects on the environment;

f. the data required to identify and assess the main effects which the development is likely to have on the environment.

3.1.5. Regulation 3(2) of the EIA Regs provides that a DCO must not be made unless environmental information has been taken into consideration. 'Environmental information' means the required environmental statement, including any further

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[11] *Berkeley v SSE* [2001] 2 AC 603, HL which also concerned the materially identical Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999..

[12] *R(Warley) v Wealden DC* [2011] EWHC 2083 (Admin) at [41]-[44] and [63]-[64] per Singh J, in relation to the materially identical Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999.

[13] EIA Regs, reg 7(1).

[14] Regulation 8(6) of the EIA Regs.

information requested, any other relevant information, and any duly made representations made about the environmental effects of the development and of any associated development.[15] The environmental statement must meet the required standard before consent may be granted.[16] Consideration of the environmental information must be done conscientiously. Where the development qualifies as EIA Development consent will be unlawful if the decision ignores issues relating to the significance of environmental impacts or the effectiveness of mitigation.[17]

3.2. Duty to conserve biodiversity

3.2.1. Section 40 of the NERC Act imposes a '*duty to conserve biodiversity*' on public authorities, including members of the Examining Authority and the Secretary of State. In pursuance of this, section 40(1) states:

> *'Every public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity.'*

3.2.2. For the purposes of the NERC Act, conservation includes restoring or enhancing a habitat or population of organisms.[18] The Secretary of State must in particular have regard to the Convention on Biological Diversity when performing his duty.[19]

3.2.3. Section 41 of the NERC Act requires the Secretary of State to publish a list of the living organisms and types of habitat which in the Secretary of State's opinion are of principal importance for the purpose of conserving biodiversity in England. Section 41(3) states:

> 'the Secretary of State must–
>
> (a) take such steps as appear to the Secretary of State to be reasonably practicable to further the conservation of the living organisms and types of habitat included in any list published under this section, or
>
> (b) promote the taking by others of such steps.'

3.3. European Sites

3.3.1. The Secretary of State and the individual members of the Examining Authority are each a 'competent authority' for the purposes of the Habitats Regulations, with a duty to have regard to the requirements of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora ('the Habitats Directive') and Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds ('Wild Birds Directive').[20] So far as lies within their powers, a competent authority in exercising any function in or in relation to the United Kingdom must use all reasonable endeavours to avoid any pollution or deterioration of habitats of wild birds.[21]

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15 EIA Regs, reg. 2(1).

16 *R v Cornwall CC, ex p Hardy* [2001] Env LR 25.

17 *Smith v SSETR* [2003] EWCA Civ 262.

18 NERC Act, s.40(3).

19 NERC Act, s.40(2).

20 Habitats Regu;ations, regs 7(1)(a), 3(1), and 9(3). Directive 2009/147/EC replaced Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds.

21 Habitats Regulations, reg.9A(8).

3.3.2. The Secretary of State is also the 'appropriate authority' for the purposes of the Habitats Regulations.[22] He must accordingly exercise his functions which are relevant to nature conservation so as to secure compliance with the requirements of the Habitats Directive and Wild Birds Directive.[23] He must furthermore take such steps as he considers appropriate to secure the objective of the preservation, maintenance and re-establishment of a sufficient diversity and area of habitat for wild birds in the United Kingdom, including by means of the upkeep, management and creation of such habitat, as appropriate, having regard to the requirements of article 2 of the Wild Birds Directive.[24]

3.3.3. The Wild Birds Directive applies to all species of naturally occurring birds in the wild state in the European territory of the UK, including their nests, eggs and habitats.[25] Article 2 of the Wild Birds Directive requires populations of wild birds to be maintained 'at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements'.[26] Article 3 requires Member States, in the light of Article 2, to 'take the requisite measures to preserve, maintain or re-establish a sufficient diversity and area of habitats'. Article 5 requires Member States to take the requisite measures to establish a general system of protection for all their wild birds, prohibiting the deliberate killing or capture, deliberate destruction or removal of nests and eggs, and deliberate disturbance of the birds insofar as this is significant having regard to the objectives of the Directive. Article 4 requires SPAs to be established in respect of particular species, in order to ensure the survival and reproduction of these species in their area of distribution. In respect of SPAs, Article 4 requires that the Member States 'shall take appropriate steps to avoid pollution or deterioration of habitats or any disturbances affecting the birds, in so far as these would be significant having regard to the objectives of this Article'. It requires that '[o]utside these protection areas, Member States shall also strive to avoid pollution or deterioration of habitats.' Article 13 provides that application of measures taken pursuant to the Directive may not lead to a deterioration in the present situation as regards the conservation of wild birds.

3.3.4. The Habitats Directive aims to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora. It provides that measures taken pursuant to the Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of community interest.[27] Member States, in consultation with the European Commission, must select and designate areas for protection as SACs pursuant to articles 3 and 4 of the Habitats Directive. Together with SPAs, these sites make up the Natura 2000 ecological network, which is supposed to be a coherent ecological European network that enables 'the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range'.[28]

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[22] Habitats Regulations, reg.3(1).

[23] Habitats Regulations, reg. 9(1) and (2).

[24] Habitats Regulations, reg 9A(1), (3)

[25] Wild Birds Directive, art.1.

[26] Wild Birds Directive, article 2.

[27] Habitats Directive, art.2.

[28] Habitats Directive, art.3(1).

3.3.5. Article 6 of the Habitats Directive applies both to SACs and to SPAs.[29] Article 6(2) requires that Member States shall take appropriate steps to avoid, in the European sites, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of the Habitats Directive. Article 6(3) requires that any project not directly connected with or necessary to the management of the European site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site the competent national authorities shall agree to the project only after having ascertained that it will not adversely affect the integrity of the site concerned, unless it meets the enumerated criteria for derogation.

3.3.6. If an adverse effect on the integrity of the site cannot be ruled out, then the effect of Article 6(4) is that the project may only be carried out where (i) there are no alternative solutions, (ii) it must go ahead for imperative reasons of overriding public interest, including reasons of a social or economic nature; and (iii) all compensatory measures necessary to protect the overall coherence of the Natura 2000 network are taken. Where the site concerned hosts a priority natural habitat type and/or a priority species (as defined in Annex I of the Habitats Directive), the only considerations which may be raised as 'imperative reasons of overriding public importance' are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or such other matters contained in an opinion of the European Commission.[30]

3.3.7. SACs and SPAs are protected as European sites in inshore waters off England (up to 12 nm) by the Habitats Regulations and in offshore waters (i.e. outside 12 nm) by the Offshore Regulations, which transpose the relevant parts of the Habitats Directive into domestic law. The provisions of Article 6 of the Habitats Directive which are noted above are found at regulations 63, 64 and 68 of the Habitats Regulations and regulations 28, 29 and 36 of the Offshore Regulations. In determining these applications, the Secretary of State will be acting as a competent authority for the purposes of those Regulations.

3.3.8. The Regulations describe a sequence of steps to be taken by the competent authority in respect of a European site when deciding whether to authorise a plan or project. Those steps are:

Step 1 Consider whether the project is directly connected with or necessary to the management of the site?[31] If not—

Step 2 Consider[32] whether the project is likely to have a significant effect on the site, either alone or in combination with other plans or projects. If such an effect cannot be excluded –

Step 3 Make an appropriate assessment of the implications for the site in view of its current conservation objectives.[33] In so doing, it is mandatory to

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[29] Habitats Directive, art. 6 applies to SACs and art.7 applies it to SPAs designated under the Wild Birds Directive.

[30] Regulations 64 and 68 of the Habitats Regulations, transposing Article 6(4) of the Habitats Directive.

[31] Under regulation 63(1)(b) of the Habitats Regulations or reg. 28(1)(c) of the Offshore Regulations.

[32] Under regulation 63(1)(a) of the Habitats Regulations or reg.28(1)(b) of the Offshore Regulations.

[33] Under regulations 63(1) of the Habitats Regulations.or 28(1) of the Offshore Regulations.

consult Natural England[34] and have regard to its representations, and optional to obtain the opinion of the general public.[35] The competent authority is empowered to require the Applicant to provide information for the purposes of the appropriate assessment, or to enable the authority to determine whether such an assessment is required.[36]

Step 4 Consider[37] whether the project will adversely affect the integrity of the site, having regard to the manner in which it is proposed to be carried out, and any conditions or restrictions subject to which that authorisation might be given (the 'Integrity Test').

Step 5 Reject the project, unless it is ascertained that the project will not adversely affect the integrity of the site.[38]

Step 6 If the project fails the Integrity Test in respect of the site, consider, whether one is satisfied that there is no alternative solution.[39] If not so satisfied, reject the project; but if so satisfied, proceed to steps 7 and 8.

Step 7 Consider whether one is satisfied that the project must be carried out for imperative reasons of overriding public interest.[40] If not, reject the application. If so, proceed to Step 8.

Step 8 Consider whether one can secure that compensatory measures are taken which would be necessary to secure that the overall coherence of Natura 2000 is protected. If not, reject the application; if so, accept the application subject to requirements securing that the necessary compensatory measures will be implemented in the appropriate timeframe.[41]

3.3.9. The Directives are both to be construed purposively in the light of Article 191 of the Treaty on the Functioning of the European Union ('TFEU'). Article 191(1) TFEU provides that 'Union policy on the environment shall contribute to the pursuit of the…objectives [of] preserving, protecting and improving the quality of the environment'; and Article 191(2) provides that Union policy on the environment shall aim at a high level of protection, and shall be based on the precautionary principle and on the principle that preventive action should be taken.

3.3.10. The case law of the Court of Justice of the European Union has established the following points:

a. Articles 6(2) and 6(3) are aimed at achieving the same level of protection. The Habitats Directive therefore requires that Member States take systematic and effective measures pursuant to Article 6(3) which guarantee the avoidance in fact of significant deterioration of the habitats or

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[34] under regulations 63(3) of the Habitats Regulations or 28(3)(b) of the Offshore Regulations.

[35] under regulation 63(4) of the Habitats Regulations or 28(3)(f) of the Offshore Regulations.

[36] By regulation 63(2) of the Habitats Regulations or 28(2) of the Offshore Regulations.

[37] Pursuant to regulation 63(5) and (6) of the Habitats Regulations or 28(4) and (5) of the Offshore Regulations.

[38] Applying regulation 63(5) of the Habitats Regulations, subject to regulation 64, or reg 28(4) of the Offshore Regulations subject to reg.26.

[39] in accordance with regulation 64(1) of the Habitats Regulations or 29(1) of the Offshore Regulations.

[40] in accordance with regulation 64(1) of the Habitats Regulations or 29(1) of the Offshore Regulations.

[41] As required by regulation 68 of the Habitats Regulations or 36 of the Offshore Regulations.

disturbance of the species for which SPAs and SACs have been designated.[42]

b. 'Article 6(3) of [the] Directive makes the requirement for an appropriate assessment of the implications of a plan or project conditional on there being a probability or a risk that that plan or project will have a significant effect on the site concerned. In the light, in particular, of the precautionary principle, such a risk exists if it cannot be excluded on the basis of objective information that the plan or project will have a significant effect on the site concerned... It follows that the Habitats Directive requires that any plan or project undergo an appropriate assessment of its implications if it cannot be excluded on the basis of objective information that that plan or project will have a significant effect on the site concerned'.[43]

c. Under Article 6(3) of the Habitats Directive, 'an appropriate assessment of the implications for the site concerned of the plan or project implies that, prior to its approval, all aspects of the plan or project which can, by themselves or in combination with other plans or projects, affect the site's conservation objectives must be identified in the light of the best scientific knowledge in the field'.[44]

d. 'An assessment made under Article 6(3) of the Habitats Directive cannot be regarded as appropriate if it contains gaps and lacks complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the works proposed on the SPA concerned'.[45]

e. In the context of priority habitats within SACs, 'a plan or project not directly connected with or necessary to the management of a site will adversely affect the integrity of that site if it is liable to prevent the lasting preservation of the constitutive characteristics of the site that are connected to the presence of a priority natural habitat whose conservation was the objective justifying the designation of the site in the list of SCIs, in accordance with the directive. The precautionary principle should be applied for the purposes of that appraisal'.[46]

f. In order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site[47].

[42] CJEU, Case C-241/08 *Commission v France* at paras 30-36; Case C-535/07 *Commission v Austria* at paras 57-58.

[43] CJEU Case C-418/04 *Commission v Ireland* at paras 226 to 227; Case C-127/02, *Landelijke Vereniging tot Behoud van de Waddenzee v Staatsecretaris van Landbouw, Natuurbeheer en Visserij* at paras 43-45

[44] CJEU Case C-127/02 *Waddenzee* at para 61.

[45] CJEU Case C-404/09 *Commission v Spain* at para 100; cf case C-304/05 *Commission* v *Italy* [2007] ECR I-7495, paras 58-59, 67-70.

[46] CJEU Case C-258/11 *Peter Sweetman and Others v An Bord Pleanála* [2013] ECR-000, para 48.

[47] CJEU Case C-323-17 *People Over Wind and Sweetman vs Coillte Teoranta,* para 40.

3.4. Ramsar Convention

3.4.1. The UK is a party to the 1971 Convention on Wetlands of International Importance, done at Ramsar, Iran ('the Ramsar Convention').

3.4.2. Article 2(1) of the Convention provides that 'Each Contracting Party shall designate suitable wetlands within its territory for inclusion in a List of Wetlands of International Importance'.

3.4.3. Article 4 of the Convention provides:

a. Each Contracting Party shall promote the conservation of wetlands and waterfowl by establishing nature reserves on wetlands, whether they are included in the List or not, and provide adequately for their wardening.

b. Where a Contracting Party in its urgent national interest, deletes or restricts the boundaries of a wetland included in the List, it should as far as possible compensate for any loss of wetland resources, and in particular it should create additional nature reserves for waterfowl and for the protection, either in the same area or elsewhere, of an adequate portion of the original habitat.

c. The Contracting Parties shall encourage research and the exchange of data and publications regarding wetlands and their flora and fauna.

d. The Contracting Parties shall endeavour through management to increase waterfowl populations on appropriate wetlands.'

3.4.4. The Government designates Ramsar sites in accordance with the criteria set out in the Convention, in recognition of the international importance of these sites as a wetland wildlife habitat.

3.4.5. In accordance with Government Circular: Biodiversity and Geological Conservation Statutory Obligations and their Impact within the Planning System (ODPM 06/2005), and the revised National Planning Policy Framework (2018), paragraph 176, Ramsar sites are subject to the same procedures described in the preceding section (in relation to European sites) as a matter of UK Government Policy, in order to assist the Government in fully meeting its obligations under the Ramsar Convention.

3.5. Sites of Special Scientific Interest (SSSIs)

3.5.1. SSSIs are designated as such by Natural England under section 28 of the WCA 1981, where we are of the opinion that land is of special interest by reason of any of its flora, fauna, or geological or physiographical features.

3.5.2. Section 28G of the WCA 1981 places legal obligations on public authorities in relation to SSSIs. These authorities are known as 'section 28G authorities', and the definition given at s.28G(3) embraces all public office-holders including the Secretary of State and the Examining Authority.

3.5.3. An authority to whom section 28G applies has a duty in exercising its functions so far as their exercise is likely to affect the flora, fauna or geological or physiographical features by reason of which a SSSI is of special interest to:

> *'take reasonable steps, consistent with the proper exercise of the authority's functions, to further the conservation and enhancement of the flora, fauna or geological or physiographical features by reason of which the site is of special scientific interest.'*

3.5.4. In addition, where the permission of a section 28G authority is needed before proposed operations may be carried out, the section 28G authority must, in accordance with section 28I(5) of the WCA 1981, take any advice received from Natural England into account:

a. in deciding whether or not to permit the proposed operations; and

b. if it does decide to do so, in deciding what (if any) conditions are to be attached to the permission.

3.5.5. 'Permission' is defined so as to include any kind of consent or authorisation.[48] As the Applicant requires development consent from the Secretary of State in order to proceed with its proposals, and as the Secretary of State is a section 28G authority, the duties under section 28I(5) apply to the Secretary of State.[49]

3.5.6. Section 35 of the WCA 1981 empowers Natural England to declare as a 'National Nature Reserve' ('NNR') any land which is managed as a nature reserve and is of national importance. There is no additional protection for these over and above SSSI, European or Ramsar site status.

3.6. European Protected Species

3.6.1. Regulation 9(5) of the Habitats Regulations, headed 'Exercise of functions in accordance with the Habitats Directive', stipulates that:

> *'a competent authority, in the exercising of any of their functions, must have regard to the requirements of the Habitats Directive so far as they may be affected by the exercise of those functions'.*

The Examining Authority and Secretary of State are both 'competent authorities' by virtue of reg.7(1), which includes any person holding a public office.

3.6.2. In relation to species of animals and plants listed in Annex IV of the Habitats Directive, article 12 of the Directive provides that the UK must take the requisite measures to ensure that they are subject to a system of strict protection.

3.6.3. In relation to the animal species, the system must in particular prevent the deliberate capture or killing of specimens of these species in the wild; deliberate disturbance of these species; deliberate destruction or taking of eggs from the wild; and deterioration or destruction of breeding sites or resting places. Disturbance or destruction may be indirect, for instance through noise or light pollution, or loss of habitat.[50]

3.6.4. The plant species must be protected in particular from deliberate picking, collecting, cutting, uprooting or destruction in their natural range in the wild.

3.6.5. Article 16 of the Habitats Directive provides that this strict protection may be derogated from only where (i) there is no satisfactory alternative, (ii) the derogation is not detrimental to the maintenance of the populations of the species concerned at a favourable conservation status in their natural range, and (iii) the purpose is (a) protecting wild fauna and flora and conserving natural habitats; (b) preventing serious damage to crops, livestock, forests, fisheries and water and other types of property; (c) public health and safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial

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[48] WCA 1981, s.28I(7).

[49] Natural England accepts that the notice requirements of section 28I(2) to (4) have been satisfied for the purposes of the Secretary of State's determination of the planning applications at issue here.

[50] CJEU Case C-103/00, *Commission v Greece*, judgment para 34 and Opinion of Léger AG delivered on 25 October 2001, paras 46, 56 and 57; *R(Morge) v Hampshire CC* [2010] EWCA Civ 608 at [49]. [2011] UKSC 2 at [19].

consequences of primary importance for the environment; (d) research, education, and repopulating and re-introducing these species; or (e) to allow, under strictly supervised conditions, on a selective basis and to a limited extent, the taking or keeping of certain specimens of the species listed in Annex IV in limited numbers specified by the competent national authorities.

3.6.6. Regulation 43 of the Habitats Regulations and the provisions of the WCA 1981 make it a criminal offence to engage in the behaviour prohibited by the Habitats Directive. However, prohibitions enforced by penalties for infractions are not in themselves adequate to implement the Directive if they will not prevent significant destruction or disturbance taking place in fact: 'such protection requires that individuals be prevented in advance from engaging in potentially harmful activities'.[51]

3.6.7. The Court of Justice of the European Union has accordingly ruled that Member States must not only adopt a comprehensive legislative framework but also to implement concrete and specific protection measures that are coherent, co-ordinated and preventive in nature.[52] Such a system of strict protection must enable the effective avoidance of deterioration or destruction of breeding sites or resting places caused by development.[53] Strict protection must be enforced even if the population of the species is not declining.[54]

3.6.8. The Secretary of State should follow the guidance in paragraphs 99 and 116 of Circular 06/2005, and take care to ensure that any disturbance of protected species, including harm to their habitats, food-sources, resting-places or breeding sites, is avoided unless he considers that the derogation criteria are likely to be met, in which case he should require any necessary licence to be obtained before development commences.[55]

3.7. Nationally Protected Species

3.7.1. Certain birds, other animals and plants which are listed in the schedules to the WCA 1981 are protected from disturbance, injury and capture or taking by the provisions of Part 1 that Act, which makes it a criminal offence to disturb, injure, capture or take them.

3.7.2. Under section 16 of the WCA 1981, licences may be issued to authorise these activities, provided that certain enumerated conditions are met. The enumerated conditions do **not** include derogation for the purpose of facilitating development, nor for general social or economic purposes.

3.7.3. Badgers and their setts are also protected under the Protection of Badgers Act 1992, which makes it illegal to kill, injure or take badgers or to interfere with a badger sett.

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[51] CJEU, Case C-418/04 *Commission v Ireland* at para 208.

[52] CJEU Case C-183/05, *Commission v Ireland*, paras 29-30.

[53] CJEU Case C-383/09 *Commission v France,* opinion of Advocate-General Kokott *at* para 89; judgment at paras 21, 35, 37.

[54] CJEU Case C-103/00 *Commission v Greece* para 31; CJEU Case C-518/04 *Commission v Greece*, para 21.

[55] That was the approach endorsed by the High Court in *R(Woolley) v East Cheshire DC* [2010] Env. L.R. 5 at [27]-[28]. In *Morge v Hampshire CC*, the Supreme Court appears to have thought that it would not be unlawful to grant permission for a development unconditionally, unless it were thought unlikely that the criteria would be met. This was on the premise that it was sufficient for the prohibited conduct to be subject to criminal penalties if no species licence were obtained. However, the CJEU authorities cited above – which the Supreme Court did not consider in that case – make it clear that a preventive approach must be taken by the planning authority. It would be unsafe for the Secretary of State to grant consent without ensuring, so far as he can, that the requirements of the Directive would be met.

There is provision within the legislation for Natural England to permit activities affecting badgers or their setts where there is suitable justification and the problem cannot be resolved by alternative means.

3.8. Areas of Outstanding Natural Beauty (‘AONBs’)

3.8.1. Section 85(1) of the Countryside and Rights of Way Act 2000 (‘CRWA 2000’) requires all persons holding public office, public bodies and Ministers of the Crown, when exercising or performing any functions so as to affect land in an AONB to ‘have regard to the purpose of conserving and enhancing the natural beauty of the area of outstanding natural beauty’. By section 92(2) of the CRWA 2000, this includes having regard for conserving its fauna, flora and geological and physiographical features.

4. POLICY FRAMEWORK

4.1. Introduction

4.1.1. The documents referred to below are statements of overarching policy which are central and applicable to planning decisions affecting biodiversity, such that it is presumed that the Examining Authority has copies of them, and it has not been thought necessary to include them as Annexes to these Written Representations.

4.2. National Policy Statements

4.2.1. EN-1: Overarching National Policy Statement for Energy & EN-3 National Policy Statement for Renewable Energy Infrastructure.

This section summarises the provisions of EN-1 and EN-3 that are most relevant to Natural England's case in relation to particular topics[56]. Bracketed references are made to the corresponding sections of each NPS.

Environmental Statement

4.2.2. When considering an application for a DCO, the Secretary of State and the Examining Authority should satisfy itself that likely significant effects, including any significant residual effects taking account of any proposed mitigation measures or any adverse effects of those measures, have been adequately assessed [EN-1 at 4.24]. Where necessary, the Secretary of State and the Examining Authority should request further information where necessary to ensure compliance with the EIA Directive [EN-1 at 4.24].

Habitats and Species Regulations

4.2.3. Prior to granting a DCO, the Secretary of State must, under the Habitats Regulations, consider whether the project may have a significant effect on a European site (including Ramsar sites), either alone or in combination with other plans or projects [EN-1 at 4.3.1].

4.2.4. The Applicant should seek the advice of Natural England and provide the Examining Authority, with such information as it may reasonably require, to determine whether an Appropriate Assessment is required [EN-1 at 4.3.1]. In the event that an Appropriate Assessment is required, the Applicant must provide the Examining Authority with such information as may be reasonably be required to enable it to conduct the Appropriate Assessment [EN-1 at 4.3.1].

National designations

4.2.5. In sites with nationally recognised designations (including Sites of Special Scientific Interest and National Parks) consent for renewable energy projects should only be granted where it can be demonstrated that the objectives of designation of the area will not be compromised by the development, and any significant adverse effects on the qualities for which the area has been designated are clearly outweighed by the environmental, social and economic benefits [EN-3 at 2.5.33].

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[56] References to EN-1 and EN-3 are combined for purposes of this section for purposes of organising the section by topic. This is consistent with, eg, EN-1.3.1, which requires EN-1 to be read "in conjunction" with EN-3. The exact wording of any provision may have been modified in order to remove outdated or irrelevant references (e.g., "IPC" is replaced with "Secretary of State" or "Examining Authority" where relevant, or references to designations that are irrelevant to the facts of this case, such as AoNBs have been removed) in order to adapt these provisions to the circumstances of this case for the purposes of these Written Representations.

Impacts on Biodiversity and Geological Conservation

4.2.6. Where the development is subject to EIA, the Applicant should ensure that the environmental statement clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity [EN-1 at 5.3.3]. The Applicant should also show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests [EN-1 at 5.3.3].

4.2.7. As a general principle, development should aim to avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives. Where significant harm cannot be avoided, compensation measures should be sought [EN-1 at 5.3.7].

4.2.8. In taking decisions, the Secretary of State should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment [EN-1 at 5.3.8].

4.2.9. Where a development proposal is located outside of a SSSI and is likely to have an adverse effect on the SSSI (either individually or in combination with other developments), development should not normally be granted. Where an adverse effect, after mitigation, on the SSSI's notified special interest features is likely, an exception should only be made where the benefits (including need) clearly outweigh both the impacts that it is likely to have on the features of the site that make it of special scientific interest and any broader impacts on the national network of SSSIs [EN-1 at 5.3.11]. The Secretary of State should use requirements and/or planning obligations to mitigate the harmful aspects of the development and, where possible, to ensure the conservation and enhancement of the site's biodiversity or geological interest [EN-1 at 5.3.11].

4.2.10. For species and habitats that have been identified as being of principal importance for the conservation of biodiversity in England, the Secretary of State should ensure that these are protected from the adverse effects of development by using requirements or planning obligations [EN-1 at 5.3.17]. The Secretary of State should refuse consent where harm to the habitats or species would result, unless the benefits (including need) of the development outweigh that harm [EN-1 at 5.3.17]. In this context the Secretary of State should give substantial weight to any such harm to the detriment of biodiversity features of national or regional importance which it considers may result from the proposed development [EN-1 at 5.3.17].

4.2.11. The applicant should include appropriate mitigation measures as an integral part of the development. These include measures that will minimise harm to species or habitats during the construction of the operation and, where practicable, restore habitats after construction work have finished [EN-1 at 5.3.18]. Where the applicant cannot demonstrate this, the Secretary of State (and the Examining Authority) should consider what appropriate requirements should be attached to any consent and/or planning obligations entered into [EN-1 at 5.3.19].

4.2.12. The Secretary of State (and the Examining Authority) will need to take account of what mitigation measures may have been agreed between Natural England or the Marine Management Organisation, and whether these bodies have granted or refused or intends to grant or refuse, any relevant licences, including protected species mitigation licences [EN1 at 5.3.20].

4.2.13. The following provisions of EN-3 are of particular relevant to Natural England's case in relation to the topic of Biodiversity and Geological Conservation:

Impacts on Birds

4.2.14. The Secretary of State (and the Examining Authority) will want to be satisfied that the collision risk assessment has been conducted to a satisfactory standard having had regard to the advice from the relevant statutory advisor [EN-3 at 2.6.104].

4.2.15. Subject to other constraints, wind turbines should be laid out within a site, in a way that minimises collision risk, where the collision risk assessment shows there is a significant risk of collision [EN-3 at 2.6.108].

Impacts on Marine Mammals

4.2.16. If piling associated with an offshore windfarm is likely to lead to the commission of an offence (which would include deliberately disturbing, killing or capturing a European Protected Species), an application may have to be made for a wildlife licence (to the MMO) to allow the activity to take place [EN-3 at 2.6.91].

4.2.17. Where assessment shows that noise from offshore piling may reach noise levels likely to lead to such an offence, the applicant should look at possible alternatives or appropriate mitigation before applying for a licence [EN-3 at 2.6.93].

4.2.18. The Secretary of State (and the Examining Authority) should be satisfied that the preferred methods of construction, in particular the construction method needed for the proposed foundations and the preferred foundation type, where known at the time of application, are designed so as to reasonably minimise effects on marine mammals [EN-3 at 2.6.94]. Unless suitable noise mitigation measures can be imposed by requirements to any development consent the Secretary of State may refuse the application [EN-3 at 2.6.94].

Impacts on Fish, Intertidal and Subtidal Habitats

4.2.19. The applicant's assessment should include relevant information about the impacts of development activities (including cabling) on the likely receptors, including the potential loss of habitats [EN-3 at 2.6.74, 2.6.81 and 2.6.113].

4.2.20. The Secretary of State (and the Examining Authority) should be satisfied that activities during the construction, operational and decommissioning phases (including cabling) have been appropriately designed, including in relation to the mitigation of adverse effects on fish and intertidal and subtidal habitats, to avoid or minimise harm to those features wherever possible in accordance with the relevant NPS policies on biodiversity [EN-3 at 2.6.72 to 2.6.89 and 2.6.111 to 2.6.119; see also EN-1 at 5.3.7 & 5.3.8]. Any consent that is granted by the Secretary of State should be flexible to allow for necessary micrositing of elements of the proposed wind farm during its construction [EN-3 at 2.6.194].

Impacts on Physical Environment

4.2.21. The assessment should include predictions of the physical effect that will result from the construction and operation of the required infrastructure and include effects such as the scouring that may result from the proposed development [EN-3 at 2.6.194].

4.2.22. The Secretary of State (and the Examining Authority) should be satisfied that the methods of construction, including use of materials, are such as to reasonably minimise the potential for impact on the physical environment [EN-3 at 2.6.196].

4.2.23. Mitigation measures which the Secretary of State (and the Examining Authority) should expect, include the burying of cables to a necessary depth and using scour protection techniques around offshore structures to prevent scour effects around them, and applicants should consult the statutory consultees appropriate mitigation [EN-3 at 2.6.197].

Future Monitoring of Environmental Impacts

4.2.24. The Secretary of State (and the Examining Authority) should consider whether the applicant should be required to undertake monitoring prior to and during the development's construction, and during its operation, in order to measure and document the effects of the development. This enables an assessment of the accuracy of the original predictions and may inform the scope of future EIAs [EN-3 at 2.6.5.1].

4.2.25. The above ecological monitoring is also required so that, where appropriate, residual concerns can addressed, and should unpredicted adverse effects be identified these can then be mitigated and enable further useful information to be published relevant to future projects [EN-3 at 2.6.71].

4.3. National planning policy and guidance on protected sites and species

National Planning Policy Framework ("NPPF")

4.3.1. Although the NPPF does not contain specific policies for NSIPs, and defers to the NPSs in this respect, it is submitted that the provisions of the NPPF, including those relevant to the conservation and enhancement of the natural environment, are both important and relevant considerations, and should be taken into account by the Secretary of State and the Examining Authority for purposes of assessing this DCO application[57].

4.3.2. NPPF makes it clear that setting is an important consideration in relation to heritage assets. It notes that the significance of a heritage asset derives not only from its physical presence, but also from its setting (para 132 and 137).

Government Circular: Biodiversity and Geological Conservation – Statutory Obligations and their Impact within the Planning System (ODPM 06/2005)

4.3.3. This Circular is relevant here, as indicated in EN-1 at, *e.g.*, 5.3.2. Reference to certain provisions of that Circular has already been made in relation to Section 3 of these Written Representations (the Legislative Framework).

4.3.4. In addition, Natural England refers to the following provisions of the Circular that are relevant to Natural England's case for the purposes of this examination.

4.3.5. *European sites*. In relation to Step 2 of paragraph 3.3.8, *supra* (the 'likely significant effect' determination under the Habitats Regulations Assessment steps), the Circular provides:

4.3.6. 'The decision on whether an appropriate assessment is necessary should be made on a precautionary basis. An appropriate assessment is required where there is a probability or a risk that the plan or project will have significant effects on the site. This is in line with the ruling of the European Court of Justice in Case C-127/02 (the Waddenzee Judgement) which said '*any plan or project not directly connected with or necessary to the management of the site is to be subject to an appropriate assessment of its implications for the site in view of the site's conservation objectives if it cannot be excluded, on the basis of objective information, that it will have a significant effect on that site, either individually or in combination with other plans or project'*[58].

4.3.7. If an appropriate assessment is required, '[it] is for the decision-taker to consider the likely and reasonably foreseeable effects and <u>to ascertain that the proposal will not</u>

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[57] See NPPF at paragraph 4.

[58] Circular 06/2005 at paragraph 13.

have an adverse effect on the integrity of the site before it may grant permission. If the proposal would adversely affect integrity, or the effects on integrity are uncertain, but could be significant the decision-taker should not grant permission, subject to the provisions of regulations' 64 and 68 of the Habitats Regulations (or regulations 28 and 36 of the Offshore Regulations).[59]

4.3.8. 'In the Waddenzee judgement, the European Court of Justice ruled that a plan or project may be authorised only if a competent authority has made **certain** that the plan or project will not adversely affect the integrity of the site. 'That is the case where *no reasonable scientific doubt* remains as to the absence of such effects.' Competent national authorities must be '***convinced***' that that there will not be an adverse effect.'[60]

4.3.9. *Protected Species*. With respect to wild plant and animal species (including all species of wild bird) protected under the 1981 Act or the Habitats Regulations:

4.3.10. 'It is essential that the presence [of] protected species, and the extent that they may be affected by the proposed development, is established before the planning permission is granted, otherwise all relevant material considerations may not have been addressed in making the decision.'[61]

Advice note ten: Habitats Regulations Assessment

4.3.11. The Examining Authority is also reminded of the Planning Inspectorate's own Advice note ten: Habitats Regulations Assessment (April 2012).

4.4. European Commission guidance

4.4.1. The European Commission has produced guidance on the protected sites and species procedures. This includes the following relevant guidance:

- Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (2000);
- EC (2001) Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6 (3) and (4) of the Habitats Directive 92/43/EEC (November 2001);
- Guidance document on Article 6(4) of the Habitats Directive 92/43/EEC (2007);
- The implementation of the Birds and Habitats Directives in estuaries and coastal zones (2011);
- Wind energy developments and Natura 2000 (October 2010);
- Non-energy mineral extraction and Natura 2000 (July 2010); and
- Guidance document on the strict protection of animal species of Community interest under the Habitats Directive 92/43/EEC (final version February 2007).

[59] *Id* at paragraph 20; references to the Habitats Regulations and Offshore Regulations are as amended.
[60] *Id* at paragraph 21.
[61] *Id* at paragraph 99.

5. CONSERVATION DESIGNATIONS, FEATURES AND INTERESTS THAT COULD BE AFFECTED BY THE PROPOSED PROJECT

5.1. International Conservation Designations

5.1.1. Natural England has previously raised concerns around the staged approach to Likely Significant Effect (LSE) screening adopted within this application, whereby interactions that are deemed to be no LSE alone are not carried forward into an in-combination assessment.

Natural England is not in a position to undertake our own screening exercise, but based on our concerns around this approach, we are unable to confirm that section 5 provides a complete list of features and European sites that require consideration within the HRA.

Special Protection Areas (SPAs)

5.1.2. **Flamborough Head and Bempton Cliffs SPA**

a. The Flamborough Head and Bempton Cliffs SPA was classified by the UK Government as an SPA under the provisions of the Birds Directive in 1993.

b. Flamborough Head and Bempton Cliffs SPA covers an area of 212.17 ha.

c. Flamborough Head and Bempton Cliffs SPA is located 149 km from the project site.

d. Flamborough Head is located on the central Yorkshire coast of eastern England. The cliffs project into the North Sea, rising to 135 m at Bempton Cliffs, and exposing a wide section of chalk strata. The cliff-top vegetation comprises maritime grassland vegetation growing alongside species more typical of chalk grassland. The site supports large numbers of breeding seabirds including Kittiwake Rissa tridactyla and auks, as well as the only mainland-breeding colony of Gannet Morus bassanus in the UK. The seabirds feed and raft in the waters around the cliffs, outside the SPA, as well as feeding more distantly in the North Sea. The intertidal chalk platforms are also used as roosting sites, particularly at low water and notably by juvenile Kittiwakes.

e. This site qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:

  i. During the breeding season; black-legged kittiwake *Rissa tridactyla*, 83,370 pairs representing at least 2.6% of the breeding Eastern Atlantic - Breeding population (Count, as at 1987).

  ii. Assemblage qualification: A seabird assemblage of international importance. The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 seabirds. During the breeding season, the area regularly supports 305,784 individual seabirds including: puffin *Fratercula arctica*, razorbill *Alca torda*, guillemot *Uria aalge*, herring gull *Larus argentatus*, gannet *Morus bassanus*, black-legged kittiwake *Rissa tridactyla*.

f. The citation for the Flamborough Head and Bempton Cliffs SPA and other relevant documents can be found by following the link to the public consultation documents here:

http://publications.naturalengland.org.uk/publication/5400434877399040?category=5758332488908800

g. Features for which outstanding concerns remain:

- Black-legged kittiwake (*Rissa tridacyla)*

5.1.3. **Flamborough and Filey Coast pSPA**

a. The Flamborough and Filey Coast pSPA is currently in the process of being classified as an SPA under the provisions of the Birds Directive. The public consultation concluded in April 2014 and the minister publically noted the intention to classify the site as a SPA in summer 2018. Natural England and JNCC are currently going through required steps for formal notification regarding which includes EC registration.

b. The pSPA covers 8039.60 ha across areas in East Riding of Yorkshire, North Yorkshire and Scarborough of which the marine extension covers 7471.78 hectares.

c. Flamborough and Filey Coast pSPA is located 149 km from the project site.

d. The pSPA is proposed to be classified under Article 4.2 of the Birds Directive by regularly supporting populations of the following species:

i. On Migration: black-legged kittiwake *Rissa tridactyla,* northern gannet *Morus bassanus,* common guillemot *Uria aalge,* razorbill *Alca torda.*

ii. In the breeding season: 215,750 seabirds (5 year peak mean 2008 to 2012), including*:* black-legged kittiwake, northern gannet, common guillemot, razorbill, northern fulmar.

e. The citation and draft conservation advice for the Flamborough and Filey Coast pSPA can be found by following the link to the public consultation documents here:

http://publications.naturalengland.org.uk/publication/5511099672690688

f. Features for which outstanding concerns remain:

- Black-legged kittiwake (Rissa tridacyla)
- Northern gannet (*Morus bassanus*)
  - Razorbill (*Alca torda*) – as an individual feature and as part of the overall assemblage.
  - Fulmar (*Fulmarus glacialis*) – as part of the overall assemblage;
  - Atlantic puffin (*Fratercula artica*) – as part of the overall assemblage;
  - Herring gull (*Larus argentatus*) – as part of the overall assemblage;
  - Cormorant (*Phalacrocorax carbo*) – as part of the overall assemblage;
  - Shag (*Phalacrocorax aristotelis*) – as part of the overall assemblage.

(N.B. Cormorant and Shag are included here due to Natural England's overall concerns with the Applicant's approach to LSE screening, although we anticipate that they can be screened out of this assessment.)

5.1.4. **The Greater Wash SPA**

a. The Greater Wash SPA was classified in 2018 and Natural England and JNCC are currently going through required steps for formal notification regarding which includes EC registration.

b. The Greater Wash SPA lies along the east coast of England, predominantly in the coastal waters of the mid-southern North Sea between the counties of Yorkshire to the north and Suffolk to the south. It covers an area of c. 3,536 km^2.

c. The proposed Hornsea Project Three export cable route overlaps with the SPA.

d. Water depth within the site ranges from mean high water to about 90m depth within the Wash approach channel; however, most of the site is in less than 30 m water depth.

e. The Greater Wash SPA is classified for the protection of red-throated diver *(Gavia stellata),* common scoter *(Melanitta nigra),* and little gull (*Hydrocoloeus minutus*) during the non-breeding season, and for breeding Sandwich tern (*Sterna sandvicensis*), common tern (*Sterna hirundo*) and little tern (*Sternula albifrons*).

f. This site protects important foraging areas for the largest breeding populations of little tern in the UK marine SPA network (798 pairs), and important areas used by the second largest non-breeding populations of red-throated diver (1,407 individuals) and little gull (1,255 individuals) within the UK SPA network. The boundary of the Greater Wash SPA extends beyond 12 nautical miles; hence it is a site for which both Natural England and JNCC have responsibility to provide statutory advice.

g. The citation and Conservation Objectives Summary are provided by the following links detailed below.

http://publications.naturalengland.org.uk/publication/4597871528116224

h. Features for which outstanding concerns remain for the Hornsea Project Three are:

- Red-throated diver (*Gavia stellata*);
- Sandwich tern (*Thalasseus sandvicen*sis);
- Common tern (*Sterna hirundo*);
- Little tern (*Sternula albifrons*); and
- Common scoter (*Sterna hirundo*).

5.1.5. **North Norfolk Coast SPA**

a. The North Norfolk Coast SPA was designated in 1996. It is located east of The Wash on the northern coastline of Norfolk, eastern England. The SPA covers 7886.79 ha and extends 40 km from Holme to Weybourne and includes a great variety of coastal habitats; intertidal mudflats and sandflats, coastal waters, saltmarshes, shingle, sand dunes, freshwater grazing marshes and reedbeds.

b. The site qualifies under Article 4.1 by supporting up to 4500 pairs of sandwich terns *Sterna sandvicensis* (12% of the EC breeding population and one-third of the British breeding population), up to 1000 pairs of common terns *Sterna hirundo* (3% of the EC and 9% of the British breeding populations) and up to 400 pairs of little terns *Sterna albifrons* (9% of the, EC and 20% of the British breeding populations). The site qualifies also under Article 4(l) by supporting nationally important numbers of bitterns *Botaurus stellaris* (about 10% of the British breeding population), marsh harriers *Circus aeruginosus* (about 30%), Montagu's harrier Circus pygargus, and avocets *Recurvirostra avosetta* (about. 30%). Smaller proportions of the national breeding populations of other species listed on Annex 1 of the Directive, arctic tern *Sterna paradisaea*, kingfisher *Algedo atthis* and short-eared owl *Asio flammeus* are also supported.

c. The site qualifies under Article 4.2 as an internationally important wetland, regularly supporting, in winter, over 10,000 wildfowl (average over 20,000) and internationally important numbers of the following waterfowl species: 9000 dark-bellied Brent geese *Branta bernicla bernicla* (7% of the European wintering population), 6000 pink-footed-geese *Anser brachyrhynchus* (6%), 6000 knot Calidris canutus (2%) and 5600 wigeon *Anas penelope* (1%). Nationally important wintering numbers of the following species are also supported: 270 European white-fronted geese *Anser albifrons albifrons* (4% of the British wintering population), 450 pintails *Anas acuta* (2%), 2600 shelducks *Tadorna tadorna* (1%.), 500 grey plovers *Pluvialis squatarola* (2%), 400 ringed plovers *Charadrius hiaticula* (2%), 5000 oyster catchers *Haematopus ostralegus* (2%) and 800 redshanks *Tringa totanus* (1%). In addition, many of the huge wader flocks which feed in The Wash regularly use the western parts of this site as a safe high-water roost. The site supports also nationally important breeding populations of rare species, including gadwall *Anas strepera*, shoveler *Anas clypeata*, garganey *Anas querauedula*, black-tailed godwit *Limosa limosa*, bearded tit *Panurus biarmicus* and parrot crossbill *Loxia pytyopsittacus*.

d. Link to information on the North Norfolk Coast SPA conservation Advice, standard data form and citation: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9009031&SiteName=northnorfolk&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

e. The proposed export cable route is less than 0.5 km from the SPA.

f. Features for which outstanding concerns remain:

- Sandwich tern (*Thalasseus sandvicensis*);
- Common tern (*Sterna hirundo*), and
- Little tern (*Sternula albifrons*).

5.1.6. Forth Islands SPA

a. Forth Island SPA covers an area of 9,797.01 ha and was classified on 25 April 1990. The classification was extended on 16 February 2004, marine extension classified on 25 September 2009. An amended citation adopted on 25 May 2018.

b. Forth Islands SPA consists of a series of islands supporting the main seabird colonies in the Firth of Forth. The islands of Inchmickery, Isle of May, Fidra, The Lamb, Craigleith and Bass Rock were classified on 25 April 1990. The extension to the site, classified on the 16 February 2004 consists of the island of Long Craig, which supports the largest colony of roseate tern in Scotland. It is the most northerly of only six regular British colonies. The seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface.

c. The boundary of the SPA overlaps with the boundaries of the following Sites of Special Scientific Interest: Long Craig, Inchmickery, Forth Islands, Bass Rock and the Isle of May. A small overlap also occurs with the Firth of Forth SPA.

d. Qualifying Interest N.B All figures relate to numbers at the time of classification except where amended by the 2001 SPA Review and or subsequent surveys (roseate tern and common tern):

e. Forth Islands SPA qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex 1 species: Arctic tern *Sterna paradisaea* (mean between 1992 and 1996 of 540 pairs, 1.2% of the UK population); roseate tern *Sterna dougallii* (mean between 1997 and 2001 of 8 pairs, 13% of the UK population); common tern *Sterna hirundo* (mean between 1997 and 2001 of 334 pairs, 3% of the UK population) and sandwich tern *Sterna sandvicensis* (an average of 440 pairs, 3% of the GB population).

f. Forth Islands SPA further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species: northern gannet *Morus bassanus* (21,600 pairs, 8.2% of the world biogeographic population); European shag *Phalacrocorax aristotelis* (2,400 pairs, 1.9% of the North Europe biogeographic population); lesser black-backed gull *Larus fuscus* (1,500 pairs, 1.2% of total *L.f. graellsii* biogeographic population) and Atlantic puffin *Fratercula arctica* (14,000 pairs, 1.5% of the total *F. a. grabae* biogeographic population).

g. Forth Islands SPA also qualifies under Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. The site regularly supports 90,000 seabirds (three year mean, 1986 – 1988) including nationally important populations of the following species: razorbill *Alca torda* (1,400 pairs, 1.4% of the UK population); common guillemot *Uria aalge* (16,000 pairs, 2.2% of the UK population); black-legged kittiwake *Rissa tridactyla* (8,400 pairs, 1.7% of the UK population); herring gull *Larus argentatus* (6,600 pairs, 4.1% of the UK population); great cormorant *Phalacrocorax carbo* (200 pairs, 2.8% of the UK population); northern gannet (21,600 pairs,13.6% of the UK population); lesser black-backed gull (1,500 pairs, 1.8% of the GB population); European shag (2,400 pairs, 6.6% of the GB population); Atlantic puffin (14,000 pairs, 3.1% of the UK population); Arctic tern (540 pairs); common tern (334 pairs); roseate tern (8 pairs), and sandwich tern (440 pairs).

h. The citation, Standard Data Form, Conservation Objectives Summary, and boundary map of the SPA are provided by the following link: https://sitelink.nature.scot/site/8500

i. Distance the SPA is from the project site is (indicative) 384 km.

j. Features for which outstanding concerns remain Fulmar (*Fulmarus glacialis*) – as part of the overall assemblage.

k. Please note that this is a Scottish SPA and as such representations may be required from Scottish Natural Heritage.

Wetlands of international importance designated under the Ramsar Convention (Ramsar sites)

5.1.7. **North Norfolk Coast Ramsar site**

a. The North Norfolk coast Ramsar was designated in 1976 and covers 7862.4 ha and lies approximately 45 km north-west of Norwich.

b. This site is less than 0.5 km from the proposed cable route.

c. This low-lying barrier coast site extends for 40 km from Holme to Weybourne and encompasses a variety of habitats including intertidal sands and muds, saltmarshes, shingle and sand dunes, together with areas of land-claimed freshwater grazing marsh and reedbed, which is developed in front of rising land. Both freshwater and marine habitats support internationally important numbers of wildfowl in winter and several nationally rare breeding birds. The sandflats, sand dune, saltmarsh, shingle and saline lagoons habitats are of international importance for their fauna, flora and geomorphology.

d. The site is listed for the following criteria:

Ramsar criterion 1

The site is one of the largest expanses of undeveloped coastal habitat of its type in Europe. It is a particularly good example of a marshland coast with intertidal sand and mud, saltmarshes, shingle banks and sand dunes. There are a series of brackish-water lagoons and extensive areas of freshwater grazing marsh and reed beds.

Ramsar criterion 2

Supports at least three British Red Data Book and nine nationally scarce vascular plants, one British Red Data Book lichen and 38 British Red Data Book invertebrates.

Ramsar criterion 5

Assemblages of international importance: Species with peak counts in winter: 98462 waterfowl (5 year peak mean 1998/99-2002/2003).

Ramsar criterion 6

Species/populations occurring at levels of international importance. Qualifying Species/populations (as identified at designation):

Species regularly supported during the breeding season: Sandwich tern, *Sterna sandvicensis sandvicensis*, West Europe 4275 apparently occupied nests, representing an average of 7.7% of the breeding population (Seabird 2000 Census) Common tern, *Sterna hirundo hirundo*, North and East Europe 408 apparently occupied nests, representing an average of 4% of the UK population (Seabird 2000 Census) Little tern, *Sterna albifrons albifrons*, West Europe 291 apparently occupied nests, representing an average of 2.5% of the breeding population (Seabird 2000 Census).

Species with peak counts in spring/autumn: Red knot, *Calidris canutus islandica*, West & Southern Africa (wintering) 30781 individuals, representing an average of 6.8% of the population (5 year peak mean1998/9-2002/3)

Species with peak counts in winter: Pink-footed goose, *Anser brachyrhynchus*, Greenland, Iceland/UK 16787 individuals, representing an average of 6.9% of the population (5 year peak mean 1998/9-2002/3) Dark-bellied brent goose, *Branta bernicla bernicla*, 8690 individuals, representing an average of 4% of the population (5 year peak mean 1998/9-2002/3) Eurasian wigeon , *Anas penelope*, Northwest Europe 17940 individuals, representing an average of 1.1% of the population (5 year peak mean 1998/9-2002/3) Northern pintail, *Anas acuta*, Northwest Europe 1148 individuals, representing an average of 1.9% of the population (5 year peak mean 1998/9-2002/3).

Species/populations identified subsequent to designation for possible future consideration under criterion 6.

Species with peak counts in spring/autumn:

Ringed plover, *Charadrius hiaticula,* Europe/Northwest Africa,1740 individuals, representing an average of 2.3% of the population (5 year peak mean 1998/9-2002/3) Sanderling, *Calidris alba*, Eastern Atlantic 1303 individuals, representing an average of 1% of the population (5 year peak mean 1998/9-2002/3) Bar-tailed godwit, *Limosa lapponica lapponica*, West Palearctic 3933 individuals, representing an average of 3.2% of the population (5 year peak mean 1998/9-2002/3).

e. Contemporary data and information on waterbird trends at this site and their regional (sub-national) and national contexts can be found in the Wetland Bird Survey report, which is updated annually. See www.bto.org/survey/webs/webs-alerts-index.htm.

f. The Information Sheet on Ramsar Wetlands (RIS) and the Regulation 33 document are provided by the following links detailed below.

Information Sheet on Ramsar Wetlands (RIS):

http://jncc.defra.gov.uk/pdf/RIS/UK11048.pdf

Link to webpage containing Regulation 33 document and other relevant information:
http://publications.naturalengland.org.uk/publication/3244315

g. Features for which outstanding concerns remain: Pink-footed goose (*Anser brachyrhynchus*).

Special Areas of Conservation (SAC)

5.1.8. **The Wash and North Norfolk Coast SAC**

a. The Wash and North Norfolk Coast SAC was first classified by the UK Government as an SAC under the provisions of the EC Directive 92/43 on the Conservation of Natural Habitats and of Wild Fauna and Flora in 2005.

b. The SAC covers 107761.28 ha in the counties of Lincolnshire and Norfolk.

c. The proposed offshore wind farm’s cable route overlaps with the site.

d. The reasons for Notification:

The site is designated under article 4.4 of the Directive (92/43/EEC) as it hosts the following habitats listed in Annex I:

i. Sandbanks which are slightly covered by sea water all the time;

ii. Mudflats and sandflats not covered by seawater at low tide;

iii. Coastal lagoons;

iv. Large shallow inlets and bays;

v. Reefs;

vi. *Salicornia* and other annuals colonising mud and sand;

vii. Spartina swards (Spartinion maritimae);

viii. Atlantic salt meadows (Glauco-Puccinellietalia maritimae);

ix. Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruit*).

e. The site is designated under article 4.4 of the Directive (92/43/EEC) as it hosts the following species listed in Annex II:

i. Common Otter, *Lutra lutra*

ii. Common or Harbour Seal, *Phoca vitulina*

f. The Standard Data Form, Conservation Objectives Summary and Regulation 33 document of the SAC are provided by the following links detailed below.

Standard Data Form:

http://jncc.defra.gov.uk/protectedsites/sacselection/n2kforms/UK0017075.pdf

Natural England Conservation Advice for the site:

https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0017075&SiteName=wash and north norfolk&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

g. Features for which outstanding concerns remain:

- Shallow Inlets and Bays
- Sandbanks which are slightly covered by seawater all the time (Annex I sandbanks); and
- Reefs.

5.1.9. **North Norfolk Sandbanks and Saturn Reef SAC**

a. The North Norfolk Sandbanks and Saturn Reef SAC was designated as an SAC in 2017.

b. The SAC covers 360,341 ha in UK offshore waters.

c. The proposed offshore cable route overlaps with the site

d. The reasons for Notification:

The site is proposed for designation under article 4.4 of the Directive (92/43/EEC) as it hosts the following habitats listed in Annex I:

- Sandbanks which are slightly covered by sea water all the time
- Reefs

e. More detailed information, including conservation advice, in relation to the SAC is provided through the following link:

http://jncc.defra.gov.uk/page-6537

The boundary map of the SAC can be found here:

http://jncc.defra.gov.uk/default.aspx?page=5201&LAYERS=World%2CUKCS%2CReef%2CSandyRange%2CTwelveTS%2CSAC&zoom=8&Y=53.36211&X=2.16407

f. Features for which outstanding concerns remain:

- Sandbanks which are slightly covered by seawater all the time (Annex I sandbanks); and
- Reefs.

5.1.10. **Southern North Sea candidate SAC (cSAC) / Site of Community Importance (SCI)**

a. The Southern North Sea cSAC/SCI was submitted to the European Commission to become designated as a SAC. While it is in a process of being designated as a SAC, under the provisions of the EC Directive 92/43 on the Conservation of Natural Habitats and of Wild Fauna and Flora in 2009, the cSAC is legally afforded the same protection as a SAC.

b. The cSAC covers an area of 36,958 km^2 stretching from the central North Sea north of the Dogger Bank southwards to the Strait of Dover.

c. The proposed offshore wind farm is located within the Southern North Sea cSAC.

d. The qualifying feature of the site is the Habitats Directive Annex II species:

- harbour porpoise (*Phocoena phocoena*)

e. The draft conservation objectives for the site are:

To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for the UK harbour porpoise *(Phocoena phocoena)*. To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term:

1. The species is a viable component of the site.
2. There is no significant disturbance of the species.
3. The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.

f. Links to further information on site selection, Standard Data Form, Draft Advice on Activities and Management Options Paper for the Southern North Sea cSAC can be found here:

http://jncc.defra.gov.uk/page-7243

g. Features for which outstanding concerns remain: Harbour porpoise (*Phocoena phocoena*).

5.1.11. **Norfolk Valley Fens SAC**

a. The Norfolk Valley Fen SAC was designated in 2005 and covers an area of 616.21 ha.

b. Norfolk Valley Fens SAC is less than 0.5 km from the proposed cable route.

c. Qualifying habitats: The site is designated under article 4.4 of the Directive (92/43/EEC) as it hosts the following habitats listed in Annex I:

- Alkaline fens. (Calcium-rich springwater-fed fens);

- Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae). (Alder woodland on floodplains)*;
- Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*. (Calcium-rich fen dominated by great fen sedge (saw sedge))*;
- European dry heaths;
- Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (Purple moor-grass meadows);
- Northern Atlantic wet heaths with *Erica tetralix* (Wet heathland with cross-leaved heath);
- Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) (Dry grasslands and scrublands on chalk or limestone).

Annex I priority habitats are denoted by an asterisk (*).

d. Qualifying species: The site is designated under article 4(4) of the Directive (92/43/EEC) as it hosts the following species listed in Annex II:

- Narrow-mouthed whorl snail *Vertigo angustior;*
- Desmoulin's whorl snail *Vertigo moulinsiana*

e. Links to further information on the SAC, including the citation document and the conservation objectives, are provided by the following links detailed below. http://publications.naturalengland.org.uk/publication/6684666086031360

f. Features for which outstanding concerns remain: All qualifying features.

5.1.12. **River Wensum SAC**

a. The River Wensum SAC was designated in 2005 and covers an area of 381.74 ha.

b. The proposed offshore wind farm's cable route overlaps with the site.

c. Qualifying habitats. The site is designated under article 4.4 of the Directive (92/43/EEC) as it hosts the following habitat listed in Annex I:

- Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. (Rivers with floating vegetation often dominated by water-crowfoot).

d. Qualifying species. The site is designated under article 4.4 of the Directive (92/43/EEC) as it hosts the following species listed in Annex II:

- White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes*;
- Bullhead *Cottus gobio*;
- Brook lamprey *Lampetra planeri*;
- Desmoulin's whorl snail *Vertigo moulinsiana*.

e. Links to further information on the SAC, including the citation document and the conservation objectives, are provided by the following links detailed below.

http://publications.naturalengland.org.uk/publication/6039440396910592

f. Features for which outstanding concerns remain: All qualifying features.

5.2. European Protected Species

Bats

5.2.1. There is considerable evidence that all species of bat in Britain declined significantly during the last Century, particularly since the 1960s.The reasons for the decline include: loss of suitable roost sites, loss of feeding habitat, reduced availability of insect prey through pesticide use and mortality resulting from the use of highly toxic timber treatment chemicals in house roosts.

5.2.2. All bats and their roosts are strictly protected under the Wildlife and Countryside Act 1981 (as amended) and the Habitats Regulations. Deliberately capturing, disturbing, injuring and killing bats is prohibited, as is damaging or destroying their breeding sites and resting places (roosts). All bats are European protected species; Bechstein's bat and the barbastelle are Annex II species, for which Natura 2000 sites (SACs) have been declared.

Great crested newt

5.2.3. Great crested newts underwent a huge decline in the last century, and are threatened by a wide range of land uses, including agriculture, forestry and development. It is an offence for anyone intentionally to kill, injure or disturb a great crested newt, to possess one (whether live or dead), or sell or offer for sale without a licence. It is also an offence to damage, destroy or obstruct access to any place used by great crested newt for shelter.

Harbour porpoise

5.2.4. The harbour porpoise is a small, highly mobile species of cetacean that is common to all UK waters. Due to threats from pressures such as incidental fisheries by-catch, the species has been assessed as under threat / in decline in the Greater North Sea and Celtic Sea, resulting in its recognition as a species of conservation importance under several directives and conventions. This includes Annexes II and IV of the Habitats Directive, Appendix II of the Bonn Convention and the UK Biodiversity Action Plan. Protection under Annexes II and IV of the Habitats Directive gives Harbour Porpoise the status of a European marine protected species.

5.2.5. The Habitat Regulations (Habitats Regulations) for England and Wales (as amended) and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2017 make it an offence to kill, injure or disturb European marine protected species.

5.2.6. In the second UK report on implementation of the Habitats Directive, the conservation status of harbour porpoise in UK waters was assessed as favourable with medium confidence, and the species is expected to survive and prosper under the current conservation approach.

5.3. National conservation designations

Sites of Special Scientific Interest (SSSI)

5.3.1. Flamborough Head SSSI

a. The Flamborough Head SSSI was first notified in 1952 and amended in 1986 under Section 28C of the Wildlife and Countryside Act 1981, as inserted by Schedule 9 to the Countryside & Rights of Way Act 2000.

b. The Flamborough Head SSSI covers 315.2 ha in the counties Humberside and North Yorkshire.

c. The Flamborough Head SSSI is located 149 km from the proposed offshore wind farm.

c. The Reasons for Notification:

The site comprises the coastal cliffs of Flamborough Head between Reighton and Sewerby, composed of chalk and softer sedimentary rocks. The cliff line exposes a variety of geological features and the chalk, which reaches 130 m at Bempton, has been eroded to form impressive stacks and caves between North Cliff and Castlemere Hole. These rock exposures are also of interest in supporting important breeding bird colonies, whilst the cliff tops support interesting plant communities.

d. The Flamborough Head SSSI citation and other relevant information can be found here:

Citation:

https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1002289.pdf

Designated sites:

https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1002289&SiteName=flamborough&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

f. Features for which outstanding concerns remain: Internationally important colonies of breeding seabirds, including: black-legged kittiwake (*Rissa tridacyla*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), Atlantic puffin (*Fratercula artica*) and fulmar (*Fulmarus glacialis*).

5.3.2. North Norfolk Coast SSSI

a. Site of Special Scientific Interest (SSSI) notified in 1986 under Section 28 of the Wildlife and Countryside Act 1981 as amended.

b. The North Norfolk Coast SSSI is comprised of 7,700 ha.

c. The North Norfolk Coast SSSI is located less than 0.5 km from the proposed export cable route.

d. Reasons for Notification:

i. The site comprises of The North Norfolk marshland with a wide range of coastal plant communities. There are also extensive intertidal areas are present along the entire coast. Intertidal flats mostly consist of sand or mud and shingle and are unvegetated. There is also mature saltmarsh, sand dune and lagoons that are important in their own right and supporting habitats for birds.

ii. The whole coast is of great ornithological interest with nationally and internationally important breeding colonies of several species. The geographical position of the North Norfolk Coast and its range of habitats make it especially valuable for migratory birds and wintering waterfowl, particularly brent and pink-footed geese.

e. Links to the citation, standard data form and further information on the designated sites web page are as follows:

Citation:

https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1001342.pdf

Standard Data Form

http://jncc.defra.gov.uk/protectedsites/sacselection/n2kforms/UK0019838.pdf

Designated Sites Information:

https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1001342&SiteName=northnorfolk&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

f. Features for which outstanding concerns remain: Pink-footed goose (*Anser brachyrhynchus*).

5.3.3. Booton Common SSSI

a. Site of Special Scientific Interest (SSSI) notified in 1984 under Section 28 of the Wildlife and Countryside Act 1981 as amended.

b. Booton Common SSSI covers an area of 8.2 ha.

c. Booton Common SSSI is located less than 0.5 km from the proposed offshore cable route.

d. Reasons for Notification:

i. Booton Common lies in the valley of a tributary of the River Wensum, about 1 mile east of Reepham. The principal interest of the site is associated with a mosaic of wet calcareous fen grassland and acid heath communities which have developed due to the naturally undulating ground. Areas of tall fen and a strip of valley alder woodland occupy the lower ground adjacent to the stream.

ii. The wet hollows are floristically rich and support abundant Bog-rush *Schoenus nigricans* and Blunt-flowered Rush *Juncus subnodulosus*. Notable associated species include Grass of Parnassus *Parnassia palustris*, Common Cotton-grass *Eriophorum angustifolium*, Common Butterwort *Pinguicula vulgaris*, Marsh Helleborine *Epipactis palustris*, Fragrant Orchid *Gymnadenia conopsea*, Adder's Tongue Fern *Ophioglossum vulgatum* and the rare Marsh Fern *Thelypteris thelypteroides*.

iii. The ridges between the hollows support a type of wet heathland with Heather *Calluna vulgaris* and Purple Moor-grass *Molinia caerulea* as the principal species. Gorse *Ulex europaeus* and Tormentil *Potentilla erecta* are also present. Reed *Phragmites australis* dominates the tall fen vegetation and typical associates include Hemp Agrimony *Eupatorium cannabinum*, Marsh Pennywort *Hydrocotyle vulgaris*, Yellow Iris *Iris pseudacorus* and Marsh Marigold *Caltha palustris*.

iv. Additional interest is provided by the alder woodland. This contains some Ash with a ground flora of Yellow Iris, Bittersweet *Solanum dulcamara* and nettles.

v. A variety of breeding birds are present including Snipe, Woodcock, Grasshopper Warbler and Lesser Whitethroat.

e. Links to the citation and further information on the designated sites web page are as follows:

Citation: https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1000657.pdf

Designated Sites Link:

https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1000657&SiteName=bootoncommon&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

f. Features for which outstanding concerns remain: All qualifying features.

5.3.4. **Alderford Common SSSI**

a. Site of Special Scientific Interest (SSSI) notified in 1986 under Section 28 of the Wildlife and Countryside Act 1981 as amended.

b. Alderford Common SSSI covers an area of 16.8 ha.

c. The proposed offshore wind farm cable route lies adjacent to the site.

d. Reasons for Notification:

i. Alderford Common is situated on gently undulating ground and supports a wide range of habitats developed in response to variations in soils and topography. A thin layer of glacial sands and gravels cover the underlying chalk which is exposed in abandoned marl workings. A diverse chalk flora has developed in the old pits and the site forms the only remaining example of species-rich chalk grassland in East Norfolk. A bat roost and an outstanding assemblage of breeding birds provide additional interest. The habitats represented include scrub, woodland, bracken heath, marshy grassland and ponds.

ii. Chalk grassland occurs in the bottom of the marl-pits and is dominated by Red Fescue *Festuca rubra*, Crested Hair-grass *Koelaria macrantha* and False Brome *Brachypodium sylvaticum*. Many herb-species are associated with the grassland and include Wild Basil *Clinopodium vulgare*, Burnet Saxifrage *Pimpinella saxifraga*, Dwarf thistle *Cirsium acaule*, Larger Wild Thyme *Thymus pulegoides*, Dropwort *Filipendula vulgaris* and Common Spotted Orchid *Dactylorhiza fuchsii*. Damp holloes, on low-lying ground, have a characteristic flora which includes Water Mint *Mentha aquatica*, Pennywort *Hydrocotyle vulgaris* and a large population of Adder's Tongue *Ophioglossum vulgatum*.

iii. Secondary woodland dominated by Silver Birch *Betula pendula* and Pedunculate Oak *Quercus robur*, open Bracken heath and dense scrub surround the marl workings. Two ponds are also present and a small marshy area has developed around one with abundant Meadowseet *Filipendula ulmaria*.

iv. The thick Blackthorn *Prunus spinosa* and Hawthorn *Crataegus monogyna* scrub provides suitable nesting sites for a wide range of breeding birds including the largest population of Nightingales in East Norfolk. Other notable breeding birds are Lesser Whitethroat, Whitethroat, Turtle Dove, Woodcock and Hawfinch.

v. The ponds are used as breeding sites by several species of amphibians including a small population of the scarce Warty Newt *Triturus cristatus*.

vi. An old lime-kiln is used by bats both as a winter hibernating site and as a daytime roost during the summer months.

e. Links to the citation and further information on the designated sites web page are as follows:

Citation:

https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1000483.pdf

Designated Sites:

https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S1000483&SiteName=alderfordcommon&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

f. Features for which outstanding concerns remain: Bats (hibernation and roosting sites are identified on the SSSI citation)

Marine Conservation Zones (MCZ)

5.3.5. **Cromer Shoal Chalk Beds MCZ**

a. This site was designated a Marine Conservation Zone (MCZ) in January 2016. Cromer Shoal Chalk Beds MCZ is an inshore site 200 metres off the North Norfolk Coast. It begins just west of Weybourne and ends at Happisborough, extending around 10 km out to sea and covering an area of 321 km^2.

b. The proposed export cable route overlaps with the site.

c. The site protects seaweed-dominated infralittoral rock, which does not yet receive enough protection in this region. These rocks in shallow water are an important habitat, providing a home for a variety of small creatures which shelter and feed amongst seaweeds.

d. Within a wider area that is predominantly sandy, the chalk beds provide stable surfaces for seaweeds and static animals to settle on and grow. The beds are nursery areas for juvenile species as well as being important in the food chain for animals such as the fish, tompot blenny and the small-spotted catshark. The chalk beds are home to lobsters and crabs which settle within the crevices and holes. The area supports the small-scale crab and lobster fishery vital to the character and economy of the area. Other common species include sea squirts, hermit crabs and pipefish, a relative of the seahorse. The site has a maximum depth of about 20 metres.

e. Protected features of the site are:

- Moderate energy infralittoral rock;
- High energy infralittoral rock;
- Moderate energy circalittoral rock;
- High energy circalittoral rock;
- Subtidal chalk;
- Subtidal coarse sediment;
- Subtidal mixed sediments;
- Subtidal sand;
- Peat and clay exposures;
- North Norfolk Coast (subtidal) (Geological feature).

f. Link to information on the site including the conservation advice and objective: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0031&SiteName=cromer&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=#hlco

Designation Order:

http://www.legislation.gov.uk/ukmo/2016/4/pdfs/ukmo_20160004_en.pdf

g. Features for which outstanding concerns remain: all features.

5.3.6. **Markham's Triangle pMCZ**

a. Markham's Triangle proposed Marine Conservation Zone (pMCZ) is an offshore site covering an area of around 200 km^2. The site is located in the Southern North Sea approximately 137 km from the Humberside coastline in the East of England. The site is bordered by a Dutch Special Area of Conservation known as Cleaver Bank.

b. Markham's Triangle pMCZ overlaps with the proposed offshore array area.

c. Markham's Triangle is composed of a mix of subtidal coarse sediment, subtidal sand, subtidal mud and subtidal mixed sediments. The varied nature of the seabed within this site means that it supports a wide range of animals such as polychaete worms, bivalves, starfish, and sea urchins. These species provide prey for crabs and flat fish on the surface of the sediment.

d. The site is proposed for designation for to protect the following features:

- Subtidal coarse sediment
- Subtidal sand
- Subtidal mud
- Subtidal mixed sediments

e. Links to information regarding Markham's Triangle pMCZ:

Markham's Triangle pMCZ Factsheet:

https://consult.defra.gov.uk/marine/consultation-on-the-third-tranche-of-marine-conser/supporting_documents/Markhams%20Triangle%20factsheet.pdf

Natural England Information on pMCZ:

http://publications.naturalengland.org.uk/publication/6079955233931264

Site assessment for Markham's Triangle pMCZ:

http://jncc.defra.gov.uk/pdf/JNCC_T3PreConsultationAdviceOnPossibleOffshoreMCZs_v3.0.pdf

f. Features for which outstanding concerns remain:

- Subtidal coarse sediment;
- Subtidal sand; and
- Subtidal mixed sediment.

Areas of Outstanding Natural Beauty (AONB)

5.3.7. **Norfolk Coast AONB**

a. The Norfolk Coast Area of Outstanding Natural Beauty was designated in 1968 under the National Parks and Access to the Countryside Act, 1949. The AONB was designated for its key special quality of 'Exceptionally important, varied and distinctive biodiversity, based on locally distinctive habitats'. The final area of 453 km^2 confirmed in 1990s includes the greater part of the remaining unspoiled coastal areas between the Wash and Great Yarmouth. Though there are minor instances where boundary features have changed or disappeared, the statutory boundary remains as originally designated.

b. The western outlier, coming within two miles of King's Lynn, takes in part of Sandringham Estate including Sandringham House, and also about six miles of the south-eastern corner of the Wash. The holiday resort of Hunstanton, and the coast immediately to the south of it, is not included, but from nearby Old Hunstanton a continuous coastal strip, varying in depth between three to five miles (five to eight kilometres), extends eastwards to a point near Bacton, excluding the built-up areas of the resorts of Sheringham, Cromer, Overstrand and Mundesley. The eastern outlier stretches from Sea Palling to Winterton, including the magnificent dune system of Winterton Dunes.

c. Statutory purpose of designation:

The statutory purpose of designating an area of land as an Area of Outstanding Natural Beauty is to conserve and enhance the natural beauty of the area. This comprises the area's distinctive landscape character, biodiversity and geodiversity, historic and cultural environment.

d. Two secondary non-statutory purposes of AONBs are also recognised:

- To take account of the needs of agriculture, forestry, fishing and other local rural industries and of the economic and social needs of local communities, paying particular regard to promoting sustainable forms of social and economic development that in themselves conserve and enhance the area's natural beauty; and

- To seek to meet the demand for recreation so far as this is consistent with the statutory purpose of conserving and enhancing the area's natural beauty – and which preferably supports this purpose by increasing understanding, valuation and care for the area - and is also consistent with the needs of rural industries.

e. Link to Norfolk Coast AONB Management Plan

http://www.norfolkcoastaonb.org.uk/mediaps/pdfuploads/pd001159.pdf

f. The Hornsea Project Three export cable corridor is within the setting of the Norfolk Coast AONB.

5.4. Nationally Protected Species

5.4.1. The applicant has determined that no Nationally Protected Species (NPS) will be impacted from the project. However should any NPS be detected from pre-construction surveys which could be impacted from the project a licence may be required.

6. NATURAL ENGLAND'S CONCERNS AND ADVICE

6.1. Introduction

6.1.1. In this section Natural England will set out its concerns and advice regarding the Project at the time of submission of these Representations. In some instances more detailed advice is provided in the Annexes.

6.2. The principal issues

6.2.1. Natural England highlighted the following overarching issues in our relevant representations which were submitted to PINS on 20th July 2018.

6.2.2. Evidence

Natural England raised considerable concerns with the standard of evidence provided in support of the application. Natural England is not satisfied that there was insufficient project specific information / evidence presented to characterise the development site in order to fully understand the impacts of this project, or that the best available evidence is being used throughout the application to determine the nature of impacts. Consequently Natural England is unable to reach conclusions beyond reasonable scientific doubt in a number of areas.

6.2.3. Project Proposals

Natural England is not satisfied that the project parameters have been clearly defined to enable the impacts of a development to be fully assessed against a realistic Worst Case Scenario (WCS). Consequently Natural England is unable to agree with a number of the conclusions outlined.

6.2.4. Assessment of Impacts

Natural England is not satisfied that sufficient precaution has been built into the analysis to address the uncertainties arising from a lack of site specific data and detailed proposals.

Natural England does not agree with the approach taken for the assessment of the impacts over the lifetime of the project and do not consider that the implications of a 'phased build' scenario had been fully considered.

6.2.5. Cumulative / in-combination assessment

Natural England is not able to reach a conclusion on the significance of effects of the project alone and in-combination as a result of the uncertainties arising from the lack of site specific data and approach to data analysis.

6.2.6. As a result of the fundamental concerns raised above, Natural England is unable to state beyond reasonable scientific doubt that there will be no adverse effect on site integrity for the relevant SPAs and SACs, or that the conservation objectives of the relevant MCZs will not be hindered.

6.2.7. Natural England has also set out a number of additional issues within our relevant representation which are explored further within this representation in the sections below and within the annexes. As many of Natural England concerns are fundamental in nature, much of our advice remains at a high level. Consequently we have not been able to identify every element of the application and the ES that we may disagree with within this representation. Therefore, a lack of reference to a specific point or issue should not necessarily be taken to indicate agreement from Natural England.

6.3. Progress since the Relevant Representations

6.3.1. Since the Relevant Representations were submitted to PINs on 20th July 2018 Natural England has had further communications with the Applicant to discuss our submission and outstanding points of concern. During this period Natural England has also engaged with the Applicant to set out matters of agreement and disagreement on topics other than offshore ornithology and benthic ecology. The full details of these matters are set out in the draft All Other Matters Statements of Common Ground (SoCG) which are to be submitted by the Applicant at Deadline 1. The topics, where agreement in-principle has been reached, include: fish and shellfish ecology and seascape and visual resources

6.3.2. A schedule of meetings that took place after the Relevant Representations is provided below:

- 25th July 2018 – A teleconference call to clarify points included in Natural England's relevant Representations;
- 6th Septemeber 2018 – A call to discuss further engagement on drafting the SoCGs;
- 2nd October 2018 – A meeting, where the Applicant provided an update on the information included in the additional documents prepared on the topics of: marine mammals, benthic ecology and offshore ornithology;
- 25th October 2018 – A teleconference call on the contents of the All Other Matters SoCG (with a focus on marine mammals);
- 26th October 2018 - A teleconference call on the contents of the All Other Matters SoCG (with a focus on onshore ecology).

6.3.3. During these discussions, the Applicant has supplied a number of 'clarification notes.' Natural England and the full list of documents provided is included in Annex F. It is Natural England's view that the contents of some of those documents is far more technical than just a 'clarification note' and it is our view that a major part of that information should have been submitted as part of the DCO Application to support the ES.

6.3.4. Natural England has made every effort to review the additional documents and incorporate the information into the Written Representations. However, this has not been possible for all the topics due to when the documents have been received and the volume and content of the documents supplied. Relevant sections and Annexes of the Written Representations clearly state whether new information has been taken into account in formulating our comments. Natural England encourages the Applicant to submit these additional documents to PINS as part of the examination.

6.4. Development Consent Order and Deemed Marine Licenses

6.4.1. While there has been significant progress on some of the issues raised in our relevant representation, a number of Natural England's concerns on the Development Consent Order (DCO) and Deemed Marine Licenses (DMLs) still remain.

6.4.2. It is our view that significant changes are still required to ensure that the DCO and DMLs are fit for purpose and acceptable. The main outstanding areas of concern are:

- The arbitration articles, related dML conditions and Schedule 13.
- The outstanding discrepancies between project values in the DCO, DML and ES Project description.

- The timing for pre-construction document submission.

6.4.3. In addition, we have requested additional changes and further clarifications subsequent to our Relevant Representations. Natural England's detailed comments on the DCO and DML can be found in Annex B.

6.5. Ornithology

6.5.1. Natural England does not consider that the data provided in support of this application are sufficient to adequately characterise bird abundance and density in the Hornsea Three Project Area and are consequently unable to form any conclusions about the significance of the impacts presented by the applicant that are dependent on these data.

6.5.2. Natural England also has a number of concerns with the approach to various different aspects of the analyses of impacts, which further reduces the confidence in the applicant's conclusions.

6.5.3. Consequently, Natural England is unable to conclude beyond reasonable scientific doubt that the conservation objectives of designated sites will not be hindered as a result of the proposals outlined in this application.

6.5.4. The main areas of concern relate to:

- Baseline Data Collection and Analysis Methodology;
- Collision Risk Modelling (CRM);
- Assessment of Displacement Impacts;
- Assessment of Cumulative and In-combination Effects;
- Population Modelling Approaches and Population Impacts;
- Phenology, Population Scales and Apportioning to individual SPAs;
- HRA Screening and LSE conclusions;
- Habitats Regulations Assessment (HRA);
- Environmental Impact Assessment (EIA);
- Inaccurate and missing information and data presentation in Application documentation;
- The need to present data and predicted impacts in a way that allows the full range of uncertainty (e.g. around input data, analysis, methodology) to be understood and evaluated;
- Migratory Bird Analysis.

6.5.5. Detailed comments on all of these areas can be found in Annex C.

6.6. Benthic ecology and protected sites

6.6.1. Natural England continues to disagree with the conclusions of the Habitats Regulations and Marine Conservation Zone assessments for North Norfolk Sandbanks and Saturn Reef SAC, The Wash and North Norfolk Coast SAC, Cromer Shoal Chalk Beds MCZ and Markham's Triangle pMCZ.

6.6.2. It is our view that there is sufficient uncertainty (reasonable scientific doubt) in relation to the impact assessments on the features, and recoverability of the features, to have limited confidence in HRA conclusions and the Stage 1 conclusion. It is our view that there is a risk of Hornsea Project Three hindering the achievement of the conservation objectives for the designated sites.

6.6.3. The main areas of concern relate to:

- Evidence presented to support cables being buried to the appropriate burial depth;
- Cable protection – including (but not exclusively) the ability to use 'sensitive' cable protection, the ability to remove at the time of decommissioning and therefore the assessment that the impacts will be 'temporary long term';
- Cable installation proposals such as cofferdams and the associated impacts within the Cromer Shoal MCZ;
- Habitat classification and recognition that not just reef features are Annex I/ Sensitive Ecological important habitats;
- The recoverability of Annex I sandbanks and associated subfeatures;
- Ability to micro-route cables around Annex I *Sabellaria spinulosa* Reef.

6.6.4. The detailed comments can be found in the following annexes:

- Annex D1: Natural England's comments on The Wash and North Norfolk Coast SAC additional clarification note.
- Annex D2: Natural England and JNCC's advice on cable protection additional clarification note.
- Annex D3: Natural England and JNCC's advice on sandwave levelling clarification note and other relevant documents.
- Annex D4: Natural England and JNCC's detailed advice on offshore benthic ecology.
- Annex D5: Natural England and JNCC's detailed advice on benthic sections of the HRA.
- Annex D6: Natural England and JNCC's detailed comments on the Hornsea Three Vol. 5 Annex 2.3 – MCZ assessment.
- Annex D7: Natural England advice on the benthic characterisation of the nearshore section of the cable corridor.

6.7. Marine processes

6.7.1. At the Relevant Representations stage Natural England raised several overarching issues regarding marine processes, these comments remain valid.

6.7.2. Please note that there is further reference to marine processes in the context of designated sites within Annexes D1-D7 of this Written Representation.

6.8. Marine mammals

6.8.1. At the Relevant Representations stage Natural England raised a number of issues regarding potential impacts to marine mammals. We have since had discussions with the Applicant regarding some of those points. Areas of agreement between Natural England and the Applicant are included in the draft All Other Matters SoCG provided by the Applicant.

6.8.2. For any points not agreed in the SoCG, the submissions made in the Relevant Representations are still valid and should be considered as outstanding points of concern. These relate to:

- Cumulative effect assessment of all noisy activities (inc. unexploded ordnance clearance);

- Southern North Sea cSAC/SCI HRA assessment in combination with other plans or projects;
- Natural England currently cannot agree that the Site Integrity Plan (SIP) is the appropriate control measure to manage concerns relating to in-combination disturbance effects on marine mammals. It is our view that agreement on the HRA conclusions needs to be achieved in the first instance, as those are carried over into the SIP.

6.8.3. Additional minor comments on the ES Vol. 2 Ch. 4 – Marine Mammals, that were not included in the Relevant Representations, are provided in Annex E.

6.8.4. Natural England has received three additional documents from the Applicant since submission of the Relevant Representations and will review them in due course.

- In-Principle Southern North Sea SCI Site Integrity Plan
- In-Principle Monitoring Plan
- A review of precaution in the marine mammal assessment – Clarification Note

We suggest the Applicant submits these documents as part of the examination.

6.8.5. A European Protected Species (EPS) license will be required to cover the risk of disturbance to all cetacean species identified as likely to be in the area under the Offshore Regulations 2017. Natural England can confirm that we have received a draft EPS licence provided by the Applicant and we do not have any further comments to make.

6.9. Onshore ecology

6.9.1. At the Relevant Representations stage Natural England raised a number of issues regarding potential impacts to onshore ecology. We have since had discussions with the Applicant regarding some of those points. Areas of agreement between Natural England and the Applicant are included in the draft All Other Matters SoCG provided by the Applicant.

6.9.2. For any points not agreed in the SoCG, the submissions made in the Relevant Representations are still valid and should be considered as outstanding points of concern. These relate to:

- Potential impacts on pink-footed goose associated with the North Norfolk Coast SPA – Natural England would like to be consulted on the mitigation plan issued at least 12 months in advance of any construction activities;
- Potential impacts on groundwater flows and hydroecology from the onshore cable – Natural England would like to be consulted on pre-construction site-specific cable installation method statements post consent, should a DCO be granted;
- Protected species licensing – no draft licences for any terrestrial species had been submitted to Natural England prior to the application submission. We note that other OWF NSIP Applicants have obtained a Letter of No Impediment (LONI) to reassure the Examining Authority that a licence will be granted.

6.10. Landscape and visual impact assessment

6.10.1. Natural England raised several issues regarding potential impacts to landscape and visual resources. We have since had discussions with the Applicant regarding some of those points. Areas of agreement between Natural England and the Applicant are included in the draft All Other Matters SoCG provided by the Applicant.

6.10.2. Outstanding points of concerns relate to:

- Potential visual impacts of the cable route on the setting of the Norfolk Coast AONB;
- Potential effects on the users of the England Coast Path near Weybourne during construction works at landfall.

6.11. Decommissioning

6.11.1. Natural England acknowledges that a decommissioning plan will be required post consent and that this will be agreed at the relevant time under the provisions of the Energy Act 2004. The decommissioning plan should include an assessment on whether in-combination decommissioning impacts have been assessed fully and, if not, request additional information on the impact assessment. Natural England would welcome a discussion with the Applicant on the potential for in-combination impacts at that time.

6.11.2. Furthermore, Natural England recommends that removal of scour protection and cables where scour is severe is essential in order for the seabed to return to its natural state as required under OSPAR. These matters should be subject to consideration at the time of decommissioning.

7. REFERENCES

Aitken, D., Babcock, M., Barratt, A., Clarkson, K.C., Prettyman, S. 2017. *Flamborough and Filey Coast pSPA Seabird Monitoring Programme 2017 Report.* RSPB. http://publications.naturalengland.org.uk/file/5574008674451456

Babcock, M., Aitken, D., Kite, K., Clarkson, K.C. *Flamborough and Filey Coast pSPA Seabird Monitoring Programme 2016 Report.* RSPB http://publications.naturalengland.org.uk/file/6297001121808384

Band, W. (2012). Using a collision risk model to assess bird collision risks for offshore wind farms. Report to The Crown Estate Strategic Ornithological Support Services (SOSS), SOSS-02. http://www.bto.org/science/wetland-and-marine/soss/projects

Bradbury G, Trinder M, Furness B, Banks AN, Caldow RWG, Hume D (2014) Mapping Seabird Sensitivity to Offshore Wind Farms. PLoS ONE 9(9): e106366 doi: 10.1371/journal.pone.0106366

Benson, A., Foster-Smith, B., Gubbay, S. and Hendrick, V. (2013). Background document on Sabellaria spinulosa reefs. Biodiversity Series [online]. Available at: http://www.ospar.org/documents/dbase/publications/p00614/p00614_sabellaria.pdf

Buckland, S.T. Burt, M. L., Rexstad, E.A. Mellor, M., Williams, A.E. and Woodward, R. (2012). Aerial surveys of seabirds: the advent of digital methods. Journal of Applied Ecology 2012, 49, 960–967

Busch, M., and Garthe, S., (2018). Looking at the bigger picture: the importance of considering annual cycles in impact assessments illustrated in a migratory seabird species. – ICES Journal of Marine Science, 75: 690–700. doi:10.1093/icesjms/fsx170

Chapman, C. & Tyldesley, D. 2016. *Small-scale effects: How the scale of effects has been considered in respect of plans and projects affecting European sites - a review of authoritative decisions*. Natural England Commissioned Reports, Number205.

Cook, A.S.C.P. and Robinson, R.A. (2017). Towards a framework for quantifying the population-level consequences of anthropogenic pressures on the environment: The case of seabirds and windfarms. Journal of Environmental Management 190, 113-121.

Coolen, J. W. P (2017) *North Sea Reefs. Benthic biodiversity of artificial and rocky reefs in the southern North Sea*. PhD thesis, Wageningen University and Research, Wageningen, NL (2017).

Forsythe, W.C., Rykiel Jr., E.J., Stahl, R.S., Wu, H. and Schoolfield, R.M. (1995). A model comparison for daylength as a function of latitude and day of year. Ecological Modelling 80, 87-95.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

Furness, R.W., Garthe, S., Trinder, M., Matthiopoulos, J., Wanless, S. and Jeglinski, J. (2018). Nocturnal flight activity of northern gannets *Morus bassanus* and implications for modelling collision risk at offshore wind farms. Environmental Impact Assessment Review 73 (2018) 1–6.Garthe, S. and Hüppop, O. (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology, 41, 724- 734.

Hendrick, V. J. (2007). An appraisal of Sabellaria spinulosa reefs in relation to their management and conservation. PhD thesis, School of Marine Science and Technology, University of Newcastle Upon Tyne [online]. Available at: http://ethos.bl.uk/OrderDetails.do?uin=uk.bl.ethos.485604

Jitlal, M., Burthe, S., Freeman, S. and Daunt, F. (2017). Testing and Validating Metrics of Change Produced by Population Viability Analysis (PVA). Scottish Marine and Freshwater Science Vol 8 No 23. Marine Scotland Science.

Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resource Wales (NRW), Northern Ireland Environment Agency (NIEA), Scottish Natural Heritage (SNH). (2014). Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review. 25th November 2014.

Johnston, A., Cook, A. S. C. P., Wright, L. J., Humphreys, E. M. and Burton, N.H.K. (2014a). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. Journal of Applied Ecology 51, 31–41 doi: 10.1111/1365-2664.12191

Johnston, A., Cook, A. S. C. P., Wright, L. J., Humphreys, E. M. and Burton, N.H.K. (2014b). Corrigendum. Journal of Applied Ecology 2014, 51, 1126–1130 doi: 10.1111/1365-2664.12260

Johnston, A. and Cook, A.S.C.P. (2016). How high do birds fly? Development of methods and analysis of digital aerial data of seabird flight heights. BTO Research Report Number 676.

King, S., Maclean, I.M.D., Norman, T., and Prior, A. (2009). Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE.

Langston, R.H.W., Teuten, E. & Butler, A. (2013). Foraging ranges of northern gannets Morus bassanus in relation to proposed offshore wind farms in the UK: 2010-2012. The Royal Society for the Protection of Birds, Sandy, Bedfordshire SG19 2DL. RSPB Report to DECC, December 2013

MacArthur Green (2015). East Anglia THREE. Ornithology Evidence Plan Expert Topic Group Meeting 6. Appendix 7- Sensitivity analysis of collision mortality in relation to nocturnal activity factors and wind farm latitude. In: East Anglia THREE Appendix.13.1. Offshore Ornithology Evidence Plan. Volume 3 [doc. ref. 6.3.13(1)]

MacArthur Green, (2015b). MacArthur Green Seabird PBA Report. https://infrastructure.planninginspectorate.gov.uk/projects/yorkshire-and-the-humber/hornsea-offshore-wind-farm-zone-4-project-two

MacArthur Green (2017). Estimates of Ornithological Headroom in Offshore Wind Farm Collision Mortality. The Crown Estate.

MacArthur Green (2018). Norfolk Vanguard Offshore Wind Farm Appendix 13.1 Offshore Ornithology Technical Appendix. [Online]. Available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-001547-Appendix%2013.01%20Ornithology%20Technical%20Appendix.pdf (Accessed October 2018).

Masden, E. (2015). Developing an avian collision risk model to incorporate variability and uncertainty. Scottish Marine and Freshwater Science Vol 6 No 14. Published by Marine Scotland Science. DOI: 10.7489/1659-1

Mather, J.R. (1986). *The Birds of Yorkshire,* Croom Helm, Kent.

McGregor, R.M., King, S., Donovan, C.R., Caneco, B. and Webb, A. (2018). A Stochastic Collision Risk Model for Seabirds in Flight. Marine Scotland Report.

MIG-Birds (2017). Joint SNCB Interim Displacement Advice Note: Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments. January 2017.

Natural England (2015). Hornsea Offshore Wind Farm (Zone 4) - Project Two Written Representations of Natural England. Planning Inspectorate Reference: EN010053. 15 July 2015.

Natural England (2017). Discretionary Advice Service (Charged Advice) on Hornsea Project Three offshore windfarm RE: Habitat Regulations Assessment (HRA) screening report. Ref: DAS2229/205871, 3 February 2017.

Natural England (2017). Natural England's advice on the Section 42 and the Preliminary Environmental Information report (PEIr) consultation for Hornsea Project Three. Ref: 10827/221825, 20 September 2017.

Pidduck, E., Jones, R., Daglish, P., Farley, A., Morley, N., Page, A. and Soubies, H. (2017). *Identifying the possible impacts of rock dump from oil and gas decommissioning on Annex I mobile sandbanks*. JNCC Report No. 603. JNCC, Peterborough.

Roberts, G., Edwards, N., Neachtain, A., Richardson, H. & Watt, C. 2016. Core reef approach to *Sabellaria spinulosa* reef management in The Wash and North Norfolk Coast SAC and The Wash approaches. *Natural England Research Reports, Number 065.*

Robertson, G.S., Bolton, M., Grecian, W.J. and Monaghan, P., (2014). Inter- and intra-year variation in foraging areas of breeding kittiwakes (*Rissa tridactyla*). *Marine Biology,* 161: 1973-1986. DOI 10.1007/s00227-014-2477-8

SMartWind (2015). Collision Risk Modelling; Addressing Uncertainty Clarification Note. Appendix J to the Response submitted for Deadline I. Application Reference: EN010053. 15 July 2015

Thaxter, C.B. & Burton, N.H.K. (2009) High Definition Imagery for Surveying Seabirds and Marine Mammals: A Review of Recent Trials and Development of Protocols. British Trust for Ornithology Report Commissioned by Cowrie Ltd.

Votier, S.G., Grecian, W.J, Patrick, S., Newton, J. (2010) Inter-colony movements, at-sea behaviour and foraging in an immature seabird: results from GPS-PPT tracking, radio-tracking and stable isotope analysis. Marine Biology 158:355-362 DOI 10.1007/s00227-010-1563-9

8. EXECUTIVE SUMMARY

(Also available separately as Annex I)

1. Summary

1.1. Natural England's (NE) Written Representations provide NE's statutory advice in respect of the potential impacts of the proposed development on the natural environment. NE's Written Representations expand upon the issues outlined in NE's Relevant Representations, in view of statement of common ground discussions that have taken place with the Applicant to date and the information that has been submitted by the Applicant to address certain issues.

1.2. In its letter of 9th October 2018 the Examining Authority asked the parties, including NE, a number of written questions. The answers to those questions are contained within a separate document submitted alongside our Written Representations.

2. Overview of the sections of Natural England's Written Representations

2.1. Section one sets out the introduction and background sections of the Written Representations.

2.2. Section 2 sets out the status and functions of NE.

2.3. Section 3 provides information on the legislative framework which applies in this case, with reference to the relevant pieces of environmental law and policy.

2.4. Section 4 provides an account of the policy framework that can provide assistance to competent authorities when considering the legal steps sets out in section 3 in respect of European sites and SSSIs.

2.5. Section 5 introduces the statutory nature conservation designations and interests in the area of the proposed development. It provides links to designation citations and boundary maps. The relevant protected sites potentially affected by the proposed development are as follows:

- The Flamborough Head and Bempton Cliffs Special Protection Area (SPA).
- The Flamborough and Filey Coast proposed SPA.
- The Greater Wash SPA.
- North Norfolk Coast SPA
- Forth Island SPA
- North Norfolk Coast Ramsar site
- The Wash and North Norfolk Coast Special Area of Conseravtion (SAC)
- North Norfolk Sandbanks and Saturn Reef SAC
- Southern North Sea candidate SAC (cSAC)
- North Valley Fens SAC
- River Wensum SAC
- Flamborough Head Sites of Special Scientific Interest (SSSI)
- North Norfolk Coast SSSI
- Booton Common SSSI
- Alderford Common SSSI

- Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ)
- Markham's Triangle proposed MCZ
- North Norfolk Coast Area of Outstanding Natural Beauty (AONB)

2.6. Section 5 also introduces the relevant European Protected Species :

- Bats
- Great Crested Newt
- Harbour Porpoise.

2.7. Section 6 contains the statutory advice of NE with regard to the issues of concern arising as a result of the proposed development. In its Relevant Representations, NE identified the main principle issues of concern which are dealt with in the Written Representation. Detailed comments on all principle issues are supplied in supporting annexes.

3. Principal Issues

3.1. Evidence

NE has considerable concerns with the standard of evidence provided in support of this application. Natural England is not satisfied that there was insufficient project specific information / evidence presented to characterise the development site in order to fully understand the impacts of this project, or that the best available evidence is being used throughout the application to determine the nature of impacts.

3.2. Project Proposals

Natural England is not satisfied that the project parameters have been clearly defined to enable the impacts of a development to be fully assessed against a realistic Worst Case Scenario (WCS).

3.3. Assessment of Impacts

NE's view is that that sufficient precaution has *not* been built into the analysis to address the uncertainties arising from a lack of site specific data and detailed proposals.

Additionally, we do not agree with the approach taken for the assessment of impacts over the lifetime of the project. The Applicant has considered each phase of the project (construction, operation and maintenance and decommissioning) in isolation, thereby failing to consider cumulative impacts over time. The implications of a 'phased build' over a number of years have not been fully considered and it is also unclear whether any particular impact is considered to be temporary or long term / persistent.

3.4. Cumulative / in-combination assessment

Currently it is not feasible to reach a conclusion on the significance of effects of the project alone and in-combination as a result of the uncertainties arising from the lack of site specific data.

3.5. Habitats Regulation Assessment/ Report to Inform Appropriate Assessment

NE is unable to agree with the conclusions set out in the HRA/RIAA due to the reasons set out within the written representations.

3.6. Progress since the Relevant Representations

Since the submission of our relevant Representations NE has engaged with the applicant. This has included through meetings and work on a joint Statement of Common Ground (SoCG), which will be submitted by the Applicant at Deadline 1. This section outlines those meetings and notes that the Applicant has provided updated information and documents, some of which NE has not has sufficient time to review to provide comment within the Written Representation and will provide response later.

3.7. **DCO and DML**

Significant progress has been made on several of the issues raised within our relevant reps. However, there are still several outstanding issues of principle concern:

- The arbitration articles, related dML conditions and Schedule 13.
- The outstanding discrepancies between project values in the DCO, DML and ES Project description.
- The timing for pre-construction document submission.

3.8. **Ornithology**

NE does not consider that the data provided in support of this application are sufficient to adequately characterise bird abundance and density in the Hornsea Three Project Area and are consequently unable to form any conclusions about the significance of the impacts presented by the applicant that are dependent on these data.

NE also has a number of concerns with the approach to various different aspects of the analyses of impacts, which further reduces the confidence in the applicant's conclusions.

NE is unable to conclude beyond reasonable scientific doubt that the conservation objectives of designated sites will not be hindered as a result of the proposals outlined in this application.

3.9. **Benthic ecology and protected sites**

NE are concerned with the potential impacts upon designated sites, which are either adjacent to or within the red line boundary of the proposed development. These include:

- North Norfolk Sandbanks and Saturn Reef (NNSSR) SAC;
- The Wash and North Norfolk Coast SAC (W&NNC);
- Cromer Shoal Chalk Beds MCZ and
- Markham's Triangle pMCz.

3.10. **Marine processes**

At the Relevant Representations stage NE raised several overarching issues regarding marine processes, these comments remain unresolved.

3.11. **Marine mammals**

At the Relevant Representations stage NE raised a number of issues regarding potential impacts to marine mammals. We have since had discussions with the Applicant regarding some of those points. Areas of agreement between NE and the Applicant are included in the draft All Other Matters SoCG provided by the Applicant

The matters not agreed largely relate to matters raised in NE's relevant representation. However, some new minor issues have been raised and are summarised in Annex E. The outstanding points of concern relate to:

- Cumulative effect assessment of all noisy activities (inc. unexploded ordnance clearance);
- Southern North Sea cSAC/SCI HRA assessment in combination with other plans or projects;

- NE cannot agree to the Site Integrity Plan (SIP) until agreement is reached on HRA conclusions.

NE confirmed receipt of several additional support documents. A draft SIP, an updated In-Principle Monitoring Plan and a clarification note reviewing precaution in the marine mammal assessment. Which we will review and advise on any change of position.

3.12. **Onshore ecology**

Within our relevant representations NE raised a number of issues related to onshore ecology. Significant progress has been made with the applicant and some issues resolved. Those resolved issues are outlined in the agreed SoCG with the applicant.

Outstanding points of concern are;

- NE need to be consulted on a mitigation plan for pink-footed goose 12 months prior to any construction;
- NE need to be consulted on site specific cable installation methods to ensure impacts to groundwater flows and hydroecology is appropriately protected; and
- NE has not received any draft applications for terrestrial protected species. This prevents the granting of a Letter of No Impediment.

3.13. **Landscape and visual impact assessment**

Within our relevant representations NE raised several issues regarding potential impacts to landscape and visual resources. Agreement on some areas have been made as detailed in the agreed SoCG. The outstanding points of concern relate to:

- Visual impacts to the Norfolk Coast AONB from the cable; and
- Potential effects on users of the England Coast Path near Weybourne during construction works.

3.14. **Decommissioning**

NE acknowledges that a decommissioning programme will be required post consent and that this will be agreed at the relevant time under the provisions of the Energy Act 2004. The decommissioning plan should include an assessment on whether in-combination decommissioning impacts have been assessed fully and, if not, request additional information on the impact assessment. NE would welcome a discussion with the Applicant on the potential for in-combination impacts at that time.

Furthermore, NE advises that scour prevention and cable protection is removed at the time of decommissioning in order for the seabed to return to its natural state as required under OSPAR.

9. LIST OF ANNEXES

Annex A – Schedule of Natural England's responses to Examining Authority's first round of written questions.

Annex B – Natural England's detailed comments on the Development Consent Order and Deemed Marine Licenses

Annex C – Natural England's detailed advice on ornithology

Annex D – Benthic ecology annexes

Annex D1 – Natural England advice on The Wash and North Norfolk Coast SAC Clarification Note

Annex D2 – Natural England and the JNCC advice on the cable protection clarification note

Annex D3 - NE and JNCC advice on Sandwave Clearance Clarification Note and other relevant documentation on sandwave levelling

Annex D4 - JNCC and Natural England advice on offshore benthic ecology

Annex D5 - NE and JNCC comments on the Benthic sections of the HRA revised in light of further information

Annex D6 - NE and JNCC detailed comments on Vol. 5 Annex 2.3 - MCZ Assessment

Annex D7 - Natural England detailed comments on ES benthic characterisation of the nearshore cable corridor

Annex E - Natural England's additional detailed comments on marine mammals

Annex F - Documentation submitted by the Applicant to Natural England post submission of the Relevant Representation

Annex G - Summary of Natural England Relevant Representations

Annex H - Natural England's Response to Relevant Representations submitted by other parties

Annex I - Summary of NE Written Representations

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN10080

Annex C: Natural England detailed advice on ornithology

7 November 2018

Table of contents

1. Introduction

1.7. In this appendix Natural England has set out what we consider to be the main issues in relation to the assessment of offshore ornithology for Hornsea Three. These are organised under the following sections:

- Baseline Data Collection and Analysis Methodology;
- Collision Risk Modelling (CRM);
- Assessment of Displacement Impacts;
- Assessment of Cumulative and In-combination Effects;
- Population Modelling Approaches and Population Impacts;
- Phenology, Population Scales and Apportioning to individual SPAs;
- HRA Screening and LSE conclusions;
- Habitats Regulations Assessment (HRA);
- Environmental Impact Assessment (EIA);
- Inaccurate and missing information and data presentation in Application documentation;
- The need to present data and predicted impacts in a way that allows the full range of uncertainty (e.g. around input data, analysis, methodology) to be understood and evaluated;
- Migratory Bird Analysis.

1.8. This response draws on information provided by the Applicant in the following Hornsea Three Offshore Windfarm documents submitted to PINs in May 2018:

- Environmental Statement: Volume 2, Chapter 5 - Offshore Ornithology. PINS Document Reference: A6.2.5 (hereafter referred to as the Environmental Statement Report).
- Environmental Statement: Volume 5, Annex 5.1 - Baseline Characterisation Report. PINS Document Reference: A6.5.5.1.
- Environmental Statement: Volume 5, Annex 5.2 - Analysis of Displacement Impacts on Seabirds. PINS Document Reference: A6.5.5.2
- Environmental Statement: Volume 5, Annex 5.3 - Collision Risk Modelling. PINS Document Reference: A6.5.5.3
- Environmental Statement: Volume 5, Annex 5.4 – Data Hierarchy Report. PINS Document Reference: A6.5.5.4
- Habitats Regulations Assessment. Report to Inform Appropriate Assessment. PINS Document Reference: A5.2 (hereafter referred to as the HRA Report)
- Report to Inform Appropriate Assessment: Annex 1 – HRA Screening Report. PINS Document Reference: A5.2.1
- Report to Inform Appropriate Assessment: Annex 2 - Additional Special Protection Areas Screening Exercise. PINS Document Reference: A5.2.2
- Report to Inform Appropriate Assessment. Annex 3 - Phenology, connectivity and apportioning for features of FFC pSPA. PINS Document Reference: A5.2.3
- Environmental Statement: Chapter 3: Project Description. PINS Document Reference: A6.1.3

1.9. Natural England has significant concerns with a number of aspects of this application in relation to ornithology. Given that our main concerns are fundamental in nature, much of our advice remains at a high level. Consequently we have not been able to identify every element of the application and the ES that we may disagree with within this representation. Therefore, a lack of reference to a specific point or issue should not necessarily be taken to indicate agreement from Natural England.

1.10. Furthermore, it should be noted that our collective understanding of offshore ornithological impacts and associated assessment methods is constantly evolving and at a relatively fast pace. Natural England's advice on any given project is always based on our understanding at that time, and therefore may be subject to change as new scientific evidence becomes available or based on our growing experience of consented and constructed projects. As such, our advice on this project may have evolved from that provided on projects in the past, and may be subject to further refinement in relation to projects in the future.

2. Baseline Data Collection and Analysis Methodology.

2.1. **As a result of the fundamental issues associated with the collection, analysis and use of the survey data outlined in this section, Natural England is unable to form any conclusions about the significance of the impacts presented by the Applicant that are dependent on these data.**

2.2. **The comments in the following sections are therefore caveated on the basis that Natural England consider that there are issues with the derivation of the baseline bird density data that underpin all the analyses that need resolving. However, we have provided comments regarding other methodological aspects of the assessment below where these are not dependent on the baseline survey data.** The aim of the baseline surveys is to produce the most reliable, precise and accurate estimates possible of bird numbers at the Hornsea Three project site. These estimates need to have some measure of the degree of variability around them, which reflects both the degree of natural variation in numbers (e.g. from year to year) as well as uncertainty in the estimates e.g. from sampling or measurement errors. In order to capture the variability and uncertainty in numbers at the site it is necessary to sample across the full range of natural variation in numbers and to ensure that the sample design is such that the sample size and distribution of sampling minimises sampling and measurement errors.

2.3. Achieving all of the above is made difficult by the inherent variability in almost every aspect of seabird ecology and the wide range of temporal and spatial scales over which variability occurs. For example, considering temporal variability, evidence from at sea survey data has shown that the number of birds recorded can vary substantially within years (even within months/seasons), and between years. That raises the problem of capturing real-world variation through sampling that is invariably limited to a degree in terms of the total number of surveys, extent of the area surveyed, time-periods surveyed, etc. All this natural variation needs to be quantified and captured in assessments, while at the same time minimising sampling error.

2.4. If this variability is not adequately quantified the resulting assessment for a species may significantly under or over-estimate the potential impact of a development. If insufficient data are collected it will not be possible to make reliable conclusions regarding the key ornithological questions that the surveys seeks to address. Natural England advises that a **minimum** of two years of survey data are collected to inform the Environmental Statement.

2.5. The Applicant has collected data to characterise the baseline environment for bird abundance and density in the Hornsea Three Study Area using digital aerial surveys conducted monthly over the period April 2016 to November 2017. As a result the baseline survey data to inform the offshore ornithology assessments only comprise 20 months of data. While there are two years of baseline data from the months April to November for key species, there are only one year of data for the December-March period, in other words, the December to March period has not been adequately characterised.

2.6. This has a number of implications for the offshore ornithology impact assessments. At a practical level, the lack of data presents methodological issues, for example, the collision risk modelling requires density estimates for each month of the year which have sampled the range of variability in bird numbers present in the project area across years, and the displacement assessments require data from all months within a season in order to be able to select a peak abundance figure for the season, neither of which are possible if some months are missing. In terms of assessing the significance of predicted impacts, large numbers of birds of the key species were recorded in the months December to March of the 2016/17 survey year – including the peak annual count of guillemot (December 2016) – therefore the December to March period represents a period of significant site usage by the key species.

2.7. Natural England considers that having less than two years of data will substantially increase the scientific uncertainty around the offshore ornithology impact assessment and will limit confidence in any conclusions reached.

2.8. Throughout the Evidence Plan process, Natural England advised the Applicant that two years of baseline survey data (covering two complete "bird seasons" for each species and season) are the minimum requirement in order to characterise the baseline environment and to enable the assessment of potential impacts.

2.9. The Applicant has sought to address the issue of insufficient baseline data, by incorporating information from historical boat-based survey data collected at various spatial and temporal scales across the Hornsea Zone Study Area over the period 2010 to 2013.

2.10. Natural England has provided advice to the Applicant regarding the validity of both the historical datasets used, and the Applicant's method for incorporating elements of these boat-based datasets into the 2016/17 digital aerial survey baseline for the purposes of the environmental impact assessment. In particular there are issues around the integration of the datasets due to the different survey platforms used (boat based versus digital aerial), the spatial and temporal coverage of the historical datasets (and the effect this has on the sample size of data available), and the age of the boat based data. These issues are compounded further by the method that the Applicant has used to integrate data from the boat and digital aerial surveys to generate densities and abundances of bird species to use in the subsequent impact assessment which are covered in the section below.

Hierarchical Data Selection Method and integration of boat-based and aerial datasets

2.11. The Applicant undertook a review of historical datasets of boat-based data collected across the Hornsea Zone (which included some overlap with Hornsea Three), including survey data from the Hornsea One and Two project sites, to determine if existing data (2010-2013) could be used to inform the baseline for Hornsea Three.

2.12. A particular issue that was not resolved in this meta-analysis was whether the digital aerial data are comparable with boat based data. This was difficult to test because the Applicant was comparing boat-based data collected in different years from the digital aerial data so that any platform differences were confounded by variability in bird abundances between years. The Applicant's comparison between boat-based data and digital aerial data therefore focussed on comparing modelled boat data extrapolated to 2016/17 with 'real' digital aerial from 2016/17. Densities predicted for Hornsea Three for 2016/17 using boat data did not match the 2016/17 aerial data well for many species (and the comparisons based on the predictions from the models using Hornsea Three overlap data only were less robust than the models that use all the Hornsea Zone data). As a result it was not clear how much of the difference between the modelled boat survey estimates for 2016/17 and the digital aerial estimates for 2016/17 was a platform effect, and how much was due to the failure of the boat-based data models to predict densities in Hornsea Three in 2016/17 accurately. As a result, Natural England's view is that it was not possible to conclude that densities and associated confidence intervals generated from the historical boat-based data are comparable with densities and associated confidence intervals (CIs) generated from the digital aerial data.

2.13. Therefore there are problems in trying to compare and integrate data from the boat-based surveys with the data from the digital aerial surveys generally – and in particular Natural England does not agree with the way the Applicant has chosen to incorporate the historical boat-based data into the baseline data for Hornsea Three for their displacement and collision risk assessments.

2.14. The Applicant has not used the modelled data in their impact assessments, however they have used historical density data derived from boat-based surveys (that in some instances cover the whole Hornsea Zone and in others just the Hornsea Three overlap data) in their ES assessments of collision and displacement risk. Their hierarchical method for selecting which data to use for a given month (December - March) is based on the degree of overlap between the confidence intervals around densities and abundances from the 2010-2013 boat-based data and the 2016/17 digital aerial survey (DAS) data. The method used by the Applicant means that, depending on the species, the impact assessments are based in some months on two years of DAS data (April – November), in some months on only one year of DAS data, in some months on a combination of Hornsea Three boat and DAS data and in some months on a combination of Hornsea Zone and DAS data. For example the collision risk modelling for lesser black-backed gull and great black-backed gull is based on just one year of data for the months December to March and the same applies to the displacement assessment for guillemot and puffin. In contrast, for gannet the collision risk figures for December use both DAS and 2010 Hornsea Three boat data, for February they use DAS data and Hornsea Zone boat data from three years 2011-2013 and for January and March the collision figures are derived from just one year of DAS data (2017).

2.15. Natural England does not consider this to be a valid methodology. Firstly, one purpose of having multiple years of survey data is so the ecological variability in bird numbers across years is captured and reflected in both the mean and the CIs of the estimates. If just a single DAS estimate with CIs is taken forward for the impact assessment (as is the case for some months/species combinations) the natural variability between years is not captured at all as the mean DAS density and CIs for a single month has not sampled the inter-annual variation in numbers. Secondly, the densities and CIs for the boat based data have been generated using a different methodology and in the case of the data from just Hornsea Three overlap areas are based on low sample sizes and coverage. The meta-analysis work undertaken by the Applicant does not provide any evidence that the estimates and associated confidence intervals are comparable across survey platforms and in a number of cases the CIs around the boat-based estimates are larger than those associated with the DAS estimates, yet the Applicant's methodology for deciding whether or not to use the historical boat-based data is to compare whether the CIs for estimates from the different platforms overlap. Natural England does not consider that it appropriate to compare these, and in the situation whereby the mean estimates from boat based and DAS surveys are combined for use in the impact assessments, Natural England do not consider that it is not valid to do so. The Applicant has not indicated the reasons why the confidence intervals calculated for the boat based data seem larger than those calculated for the DAS data, but they could be a function of the different data sampling or collection methods, or due to real differences in the variability of the samples. For example, Natural England notes that the coefficient of variation (which is a measure of the variability of a sample, and therefore precision) around the densities of gannet in flight for the DAS data for January 2017 is 90% compared to a coefficient of variation of between 200% and 245% for the Hornsea Three boat-based data and between 114% and 125% for the full Hornsea Zone boat-based data equivalent. From this it is clear that there is considerably more variability around the boat-based density estimates compared to the DAS estimates, and this will have an impact on the Applicant's method which is based on comparing the overlap in the variability between boat-based and DAS estimates.

2.16. Based on the evidence provided by the Applicant, and the meta-analysis undertaken, Natural England does not consider it possible to conclude that the digital aerial survey data collected over one winter season (i.e. one year rather than two) adequately reflects the inter-annual variability in densities across that would be expected at Hornsea Three, or that the densities derived from digital aerial data are comparable to boat based data and therefore can be integrated in the way that the Applicant has done.

2.17. Natural England's position is that:

- The subset of the historical boat survey data that overlaps spatially with Hornsea Three, which the Applicant has selected to use in the environmental impact assessment for Hornsea Three is not robust or appropriate for generating species densities and abundance estimates for Hornsea Three;
- The Applicant's method for integrating densities/numbers of birds derived from digital aerial and boat-based survey data, and deriving confidence limits around these combined estimates is not robust or appropriate;
- Natural England does not agree with the Applicant's hierarchical data selection method to derive densities for use in collision risk modelling, which results in density estimates for April to November being generated from two years of digital aerial data, but estimates for December to March in some instances being based on a single year of digital aerial data, in other instances on one year of digital aerial data combined with multiple years of Hornsea Survey Area boat data, and in other instances on one year of digital aerial data combined with one year of boat based data from Hornsea Three transects surveyed in 2010. The exact datasets used varies for month and species concerned.
- Natural England does not agree with the Applicant's hierarchical data selection method to generate population estimates for the displacement assessment, which results in peak counts for some species/season combinations being based on selecting a peak count for a season from an incomplete set of monthly counts.

2.18. **Therefore Natural England does not agree that the historical boat-based data can be used to inform the impact assessment for Hornsea Three as presented by the Applicant. This includes integration of either the Hornsea Three boat survey data or the wider Hornsea Zone boat survey data with the DAS data collected in 2016/17.**

Adequacy of the Digital Aerial Survey (DAS) data collected in 2016/17

2.19. Natural England considers that the data analysed from the 2016/17 digital aerial surveys are not sufficient to adequately characterise the baseline. Surveys were undertaken using an aircraft equipped with four cameras. Each camera sampled a strip of 125 m width, separated from the next camera by ~25 m, thus providing a combined sampled width of 500 m within a 575 m overall strip. There were 20 transects surveyed across the Hornsea Three array area plus a 4 km buffer. If all data collected had been analysed to generate density and population estimates for species there would have been coverage of approximately 20% of the survey area. However the analyses were conducted utilising data from only two of the four cameras, representing 10% coverage of this area, with "*this level of coverage deemed to be sufficient for baseline characterisation based on the results of previous surveys*" by the Applicant (Annex 5.1: Baseline Characterisation Report).

2.20. Natural England does not agree that this level of coverage can be considered to be sufficient for baseline characterisation "*based on the results of previous surveys*" as it will depend on the nature of the area being surveyed and the abundance and distribution of receptors across the area. Further, if a narrower transect width is used for surveys (e.g. a 250m transect width rather than a 500m width) then it is likely that a larger number of transects will be needed to achieve the same level of precision as would be derived from a sample of wider transects (Buckland et al. 2012, Thaxter and Burton 2009). No information is presented to show that an analysis was undertaken to look at the level of precision that could be achieved by analysing the full dataset collected (from four cameras) versus the reduced coverage selected by the Applicant. However, Natural England note that during the Evidence Working Group process the Applicant indicated that the proposed coverage of 10% would be sufficient for achieving a CV of 16% or better for abundance estimates. Natural England has not seen information on the precision of the estimates for the full digital aerial survey dataset as the Applicant has not presented these data in the Application documents, but the levels of precision achieved for the population estimates that Natural England have seen via Evidence Working Group reports have typically been considerably lower, with CVs greater than 16% (and in many cases much higher). In discussions with the Applicant during the Evidence Working Group process, Natural England queried whether 10% survey coverage was sufficient to achieve the desired level of precision and whether the Applicant could look back at the boat based survey data to check 10% coverage was sufficient. Natural England remains unsure of the reasons why the Applicant did not analyse the full four-camera dataset given that the levels of precision around the estimates did not achieve the expected levels of precision.

Method for calculating confidence intervals around mean density estimates

2.21. A further issue that predominantly affects the Applicant's collision risk modelling assessment concerns the methodology used for generating a density estimate with confidence intervals for each month, to use in the collision risk model. The Applicant has analysed the survey data for each survey year separately to generate a density estimate with confidence intervals for each of the 20 months of the year where survey data were collected. In the months where the Applicant has two years of DAS data (April-Nov) they have therefore generated two density estimates per month (one for year 1 and one for year 2) each with their own associated confidence intervals. In order to derive a single density estimate for a particular month e.g. April, to use in the collision risk model the Applicant has simply calculated the mean of the year 1 and year 2 density values for a given month (e.g. April). Generating confidence intervals around this mean value is more complicated and the Applicant has used a method outlined in Section 2.7 of Annex 5.4 of the ES. Natural England queried the validity of this approach during the Evidence Working Group process and in particular, the method for deriving the pooled confidence intervals around the average mean densities by month, and we do not consider that the confidence intervals that have been generated by this method are adequately capturing the uncertainty and variability in densities of birds present in Hornsea Three across years. This will affect the upper and lower confidence intervals of the collision risk figures calculated from the density data and will potentially underestimate the collision risk.

2.22. **As a result of the fundamental issues associated with the collection, analysis and use of the survey data, as outlined in this section, Natural England is unable to form any conclusions about the significance of the impacts presented by the Applicant that are dependent on these data.**

2.23. **The comments in the following sections are therefore caveated on the basis that Natural England consider that there are issues with the derivation of the baseline bird density data that underpin all the analyses that need resolving. However, we have provided comments regarding other methodological aspects of the assessment below where these are not dependent on the baseline survey data.**

3. Collision Risk Modelling (CRM)

3.1. The Applicant has undertaken collision risk modelling (CRM) for four species of seabird recorded in the Hornsea Three Study Area (gannet, kittiwake, lesser black-backed gull and great black-backed gull). Additionally they have undertaken migratory CRM on five species of seabird that are present in Hornsea Three Study Area predominantly during passage and also twelve migratory waterbird species.

Seabird CRM Model Options – gannet, kittiwake, lesser black-backed gull and great black-backed gull

3.2. The Applicant has used Option 3 of the Extended Band Model (Band 2012) to assess the predicted impacts on gannet, kittiwake, lesser black-backed gull and great black-backed gull from collisions with turbines in the Hornsea Three Study Area. The predicted collisions for Hornsea Three that are used in the cumulative assessment of impacts use Option 3 CRM outputs for all four species.

3.3. Natural England do not agree with the Applicant's use of Option 3 for the assessment of collision impacts at Hornsea Three for the following reasons:

3.3.1. The SNCB position is that 'it is not appropriate to use the Extended Band model in predicting collisions for northern gannet or black-legged kittiwake, at the current time' (JNCC et al., 2014).

3.3.2. While the current SNCB position is that the Extended Band Model (Option 3) can be used for lesser black-backed gull and great black-backed gull with an avoidance rate of 98.9% (+/- 0.002), JNCC et al. (2014) further notes that concerns remain over the use of the Extended Band Model, in particular regarding the Extended Band Model's (Option 3) sensitivity to flight height distribution data and the uncertainty this component introduces to variation in estimates of collision. This is of particular relevance for the Hornsea Three CRM, as the Applicant has used generic flight height information derived by Johnston et al. (2014a,b), which comes predominantly from boat-based surveys (with no data on flight heights from digital aerial surveys included). This means that the Applicant has used flight height distribution data derived from boat based surveys with site-specific bird density data derived from digital aerial surveys. Where the extended Band model is used, flight height distributions derived from boat based data (such as presented in Johnston et al., 2014a,b) may not be transferable to flight height density data derived from digital aerial survey (Johnston and Cook, 2016). This is because while the flight height distributions derived from boat and digital aerial surveys have been shown to result in similar predictions of the proportion of birds flying at collision risk height and so appear to be transferable across platform for the purposes of calculating a PCH value for use in the basic Band Model, the different underlying shapes of the flight height distributions derived from the different platforms, coupled with platform differences in density estimates for birds in flight, may lead to significant differences in the number of collisions predicted when using an extended version of the Band model to carry out CRM (Johnston and Cook, 2016). For this reason, given that the CRM will be using flight height data derived from boat surveys but densities of birds in flight derived from digital aerial surveys, Natural England does not recommend that the extended Band Model Options are used for the lesser black-backed gull or great black-backed gull CRM for Hornsea Three.

3.4. Therefore **Natural England's position is that the Basic Band Model should be used for the CRM for all species at Hornsea Three**.

3.5. There are two options within the Basic Band Model, both of which require calculation of the proportion of birds at risk height. Option 1 uses site-specific flight height data, and Option 2 uses generic flight height data to derive the proportion of birds at risk height.

3.6. The Applicant is unable to utilise the flight height information generated from the Hornsea Three digital aerial surveys (due to a methodological problem that became apparent during the collection of the digital aerial survey data at Hornsea Three), so Option 1 cannot be used with these data.

3.7. The Applicant has, however presented Option 1 outputs, by deriving a Hornsea Three site-specific proportion of birds at risk height (PCH value) from the historical boat based data. Natural England do not consider that the data or methodology used by the Applicant to generate PCH values for use with Option 1 are appropriate for a number of reasons including:

- While there is a considerable amount of flight height data collected from boat surveys across the Hornsea Survey Area for the period 2010-2013, the Applicant has calculated PCH values using only those survey records that occurred within Hornsea Three plus a 4 km buffer. This considerably reduces the amount of data on flight heights available and introduces significant biases into the dataset based on the limited spatial and temporal coverage of Hornsea Three during the Hornsea Survey Area surveys.

- Natural England did not agree with the methodology applied to derive PCH values from the boat based data as presented by Hornsea Two (which is the same method applied by Hornsea Three). A particular concern was the assertion by Hornsea Two, that observers on boats were able to accurately assign birds to five metre height bands defined as 32.5-37.5 m, for example, but we also raised concerns about the post collection processing of birds in flight data to calculate PCH values coincident with the rotor height.

3.8. Therefore Natural England does not consider it is appropriate to use Option 1 of the Band Model for the Hornsea Three seabird CRM and advises that Option 2 outputs should be used to assess impacts for all species.

Nocturnal Activity Factors in CRM

3.9. The Applicant has used nocturnal activity factors (NAF) of 3 for lesser black-backed gull and great black-backed gull, 2 for kittiwake and 1 for gannet in the CRM. The nocturnal activity factor input parameter used in the Band Model calculation of collision risk is a ranking score from 1 to 5, derived from an assessment of nocturnal activity in different species in Garthe and Hüppop (2004) (where 1 denotes "*hardly any flight activity at night*" and 5 "*much flight activity at night*"), and not a 'nocturnal activity rate' *per se*. The Band model converts these factors to a percentage: 0% (factor 1), 25% (2); 50% (3), 75% (4) and 100% (factor 5) that is applied to the densities of birds in flight collected from surveys during daylight hours to correct for a different pattern of flight behaviour (typically reduced) occurring during the night. Under this broad classification Garthe and Hüppop (2004) assigned a factor of 2 to gannet (i.e. densities of birds in flight at night are assumed be 25% of the densities of birds in flight recorded during day), and kittiwake, Herring gull and lesser black-backed gull a factor of 3 (King et al., 2009, adds great black-backed gull as factor 3) and these are the levels that Band (2012) advises should be used in the absence of night-time survey data or other empirical evidence of nocturnal activity levels for a species.

3.10. The Applicant has used evidence from studies that have deployed loggers on seabirds that provide empirical data on activity levels at different times of the day and night for kittiwake and gannet. The Applicant has used this empirical evidence of nocturnal behaviour and made a set of assumptions about how this might relate to a NAF for use in the Band Model. Natural England's position is that we currently do not have any agreed 'empirically derived' nocturnal activity factors that can be used with the Band model. We recognise from recent evidence presented e.g. by MacArthur Green (2015) and Furness et al. (2018), that nocturnal activity levels relative to daytime levels for some species may be lower than the levels that equate to the nocturnal activity factors currently used in CRM. However we also note that there is uncertainty and variability about the empirical activity levels derived from tracking studies, uncertainty around the models that are used to derive daylight hours and how day-length is defined (Forsythe et al. 1995), and uncertainty about how these might translate into nocturnal factors applicable to the Band model. For example, there will be variability in nocturnal activity levels with time of year, location, dependent on levels of ambient lighting e.g. from offshore structures etc. Further, the Band model calculation defines day-length as the time period between sunrise and sunset, using the US government definition of sunrise and sunset of when the top of the sun is "apparently" even with the horizon (see Forsythe et al.(1995) for other definitions of sunrise and sunset). As a result the Band model calculation of night-time includes periods of twilight (e.g. civil twilight, nautical twilight or astronomical twilight) which include periods when light levels can be relatively high and where there are likely to be higher levels of seabird foraging activity compared to true night-time.

3.11. Additionally, the tagging studies cited by the Applicant calculate flight activity during night relative to daytime flight activity derived from those same tracking studies. However, daytime flight activity in the Hornsea Three area which come from the at sea surveys data may not match the levels of daytime flight activity that are the basis of the calculations in the empirical tagging studies. For example, the percentage of birds recorded as flying in the Hornsea Three surveys ranged from 7% to 76% for gannet and 17% to 90% for kittiwake, depending on the survey year and month. The tagging examples, cited by the Applicant in Table D1 of Annex 5.3 of the ES calculated nocturnal activity relative to daytime activity where daytime activity levels ranged from 10-50% for gannet and 15-42% for kittiwake. It is therefore not clear whether it is appropriate to apply the proportional nocturnal activity data from the tagging studies to the Hornsea Three daytime activity level data in this way since the nocturnal flight activity percentage as a proportion of daytime activity from the tracking studies is assumed to apply to a daytime activity level ranging from 7% in some months and 90% in other months. Therefore, while use of the nocturnal activity factors in Garthe and Hüppop (2004) may overestimate flight activity during hours of total darkness, it is equally not clear what an appropriate empirically based figure should be for use with Hornsea Three flight activity data. The emerging evidence on nocturnal activity levels from analysis of tagging work has itself generated conflicting recommendations. The MacArthur Green (2015) paper which the Applicant cites as the evidence to support the use of a 1 as a nocturnal activity factor for gannet, recommends use of 0% nocturnal activity during the breeding season and 2% nocturnal activity for gannet in the non-breeding season. However, in a subsequent analysis Furness et al. (2018) calculated average activity rates for gannet from several studies and recommended use of a "precautionary" 8% of daylight activity in the breeding season and 3% in the non-breeding season applied to the period sunset to sunrise. A submission as part of the Norfolk Vanguard project application (MacArthur Green 2018) recommends use of 4.3% in the breeding season and 2.3% in the non-breeding season. While these analyses differ in terms of suggested levels of nocturnal activity, none of these papers provide evidence to support the use of a nocturnal activity factor of 1 (no activity) during the nocturnal period, as used by the Applicant in their CRM for gannet.

3.12. Likewise, for kittiwake, the Applicant uses MacArthur Green (2015) figures of 0% nocturnal activity in the breeding season and 12% in the non-breeding season as evidence to support use of a NAF of 2 in the Band model. However, MacArthur Green (2018) reports evidence to suggest use of a nocturnal activity rate of 20% of daytime activity in the breeding season and 17% in the non-breeding season, with variability around these mean levels.

3.13. Given the uncertainty as well as variability in the data on activity levels (both during the daytime and during night), Natural England advises that collision risk outputs covering a range of nocturnal activity factors are considered to account for the uncertainty/variability (in the same way as has been recommended for bird densities, avoidance rates and flight heights). The suggested range of nocturnal flight activities to be considered within the Band model CRM are:

- Gannet: 1-2 (equating to 0-25% nocturnal activity)
- Kittiwake: 2-3 (equating to 25-50% nocturnal activity)
- Large gulls: 2-3 (equating to 25-50% nocturnal activity)

Bird Densities used in Collision Risk Modelling (CRM)

3.14. As set out in section 1 above, Natural England does not agree with the methodology the Applicant has used to generate monthly estimates of density and associated confidence intervals for use in the CRM.

3.15. Given these issues, Natural England advises that monthly density estimates and confidence intervals for the CRM assessments should:

- Be derived using only data collected from the digital aerial surveys of Hornsea Three;
- Improve the precision of the population by analysing the data collected from all four cameras, rather than the data from just two cameras;

3.16. Applying this approach will result in density estimates for December, January, February and March being based on a single year of survey data. These density estimates will not capture any of the inter-annual variability in bird numbers at Hornsea Three and therefore there will be additional uncertainty associated with these estimates that cannot be quantified. While it is not possible to fully address this additional uncertainty (see paragraphs 3.17-3.25 below), Natural England advises that it would be precautionary to place greater weight on using the upper confidence intervals of the density estimates for these months, in order to try and reduce the likelihood that impacts are underestimated.

Presenting Uncertainty in Collision Risk Predictions

3.17. The assessment of collision risk needs to take account of the effect that uncertainty and variability in input parameters have on the predictions of collisions. Some of the uncertainty comes from natural variability in the input data (e.g. monthly densities of birds, flight heights etc), some due to uncertainty in the data (e.g. sampling error, uncertainty in windfarm design parameters), and some of which is due to imperfect understanding of how systems work (e.g. avoidance rates and collision models). It is well documented that there is considerable uncertainty in the input parameters used in the Band Model and in the model itself and in order to be able to make a robust assessment of potential collision impacts on populations it is necessary to understand and, where possible, take account of the uncertainty (Band 2012, Masden 2015, Natural England 2015, SMartWind (2015), McGregor et al. 2018).

3.18. The Band (2012) collision risk model is a deterministic model. It is not possible to incorporate variability and uncertainty in the various input parameters of the model and to incorporate these into calculations of variability and uncertainty in the outputs of collision prediction from the model. However, Band (2012) did emphasise the need to be explicit about the uncertainty in the collision risk estimate outputs, "*by indicating, in addition to a 'best estimate', a range of confidence around that estimate*".

3.19. Therefore, Natural England advises that assessments of collision risk undertaken with the Band Model need to consider the effect that variability in key input parameters to the model have on the predicted number of collisions. Key parameters where variability and uncertainty needs to be considered are the monthly densities of birds in the project area, the flight heights of birds and avoidance rates. Nocturnal activity factors are another parameter where variability could be considered as outlined in sections 3.9-3.13 above.

3.20. However, there is no way of combining uncertainty across the different parameters in the Band (2012), so the effect of the uncertainty can only be considered on an individual parameter basis. This does give some indication of which parameters might have most influence on the prediction of collision risk, but individually these will not reflect the effect of uncertainty across all parameters.

3.21. Natural England advises that the Applicant presents collision outputs for each species that reflect the variability and uncertainty around densities, flight heights and avoidance rates as a minimum.

3.22. This includes presentation of collisions calculated using the relevant mean avoidance rate and ± 2SD of the mean avoidance rate as given in JNCC et al (2014); presentation of collisions using mean, upper and lower 95% confidence intervals around the mean flight density data by month (noting Natural England's comments above regarding methods for generating density estimates and associated confidence intervals); presentation of collisions using mean, upper and lower flight height distribution data from Johnston et al., 2014b, and presentation of collisions that reflect variability in NAFs for species where relevant.

3.23. The Applicant has provided a range of collision outputs in Annex 5.3 of the ES that consider variability in bird densities, avoidance rates and flight heights. However, as outlined in Section 2 above Natural England does not agree with methods used to derive bird density data and associated confidence intervals, in particular the densities for December, January, February and March where only one year of digital aerial survey data are available.

3.24. Additionally all the collision estimates presented for kittiwake and gannet have been generated using nocturnal activity factors applied to the Band (2012) model that Natural England do not agree with.

3.25. Further the Applicant's assessment of impacts in the ES (and RIAA) is based on a single central value for the density, flight height and avoidance rate inputs and the variability around these estimates is only considered in a general, qualitative way for each species with the conclusion for all species that "*The degree of variability associated with the density data, flight height data and avoidance rates used in collision risk modelling…is considered to represent a negligible change in resulting collision risk estimates in terms of the effect on the regional … population*". Natural England do not agree with these conclusions as consideration of the variability in the collision risk outputs using the Applicant's figures results in changes in the levels of predicted mortality that result in 1% of baseline mortality being exceeded for some species and populations in the assessments, which Natural England do not consider to be a negligible change. Natural England advises that consideration of the effects of variability in input parameters on predicted impacts should be a quantitative assessment using the collision predictions calculated using the range of variability used in the CRM (e.g. as presented in Volume 5, Annex 5.3 of the ES (Collision Risk Modelling).

Avoidance Rates

3.26. The Applicant has presented collision risk predictions using a range of avoidance rates for each species in Annex 5.3 of their ES. However, in the main ES chapter, collision impacts are presented for species based on a single avoidance rate value for each species and Band model option. For kittiwake the Applicant has used an avoidance rate of 99.2% for the Basic Band model options. Natural England do not agree with the use of this avoidance rate and advise that an avoidance rate of 98.9% should be used for kittiwake with the Basic Band model options as set out in JNCC et al. (2014).

4. Assessment of Displacement Impacts

Population estimates

4.1. As a result of the issues Natural England has highlighted, associated with the collection and analysis of the survey data (see Section 2) , Natural England is unable to form any conclusions about the significance of the displacement impacts presented by the Applicant that are dependent on these data.

4.2. As set out in Section 2 above, Natural England does not agree with the methodology the Applicant has used to generate monthly estimates of abundance and associated confidence intervals for use in the displacement assessment

4.3. Natural England advises that monthly abundance estimates and confidence intervals for use in the displacement assessments should:

- be derived using only data collected from the digital aerial surveys of Hornsea Three;
- be presented as population estimates of the Hornsea Three footprint and a 2km buffer (total birds in flight and on the water, after correcting for survey effort and availability bias) on a month by month basis for all 20 months individually with associated upper and lower confidence intervals
- improve the precision of the population estimates by analysing the data collected from all four cameras, rather than the data from just two cameras.

4.4. This approach will result in population estimates for December, January, February and March being presented for a single survey year alone. Displacement effects require the calculation of seasonal mean of peaks – the peak abundance is selected from the monthly population estimates within a season (per year). In the case of Hornsea three, there are four missing months, which will lead to some seasons having a number of missing months (this will vary depending on the season/species). As such, the calculation of mean of peaks will not fully capture the inter-annual variability in bird numbers at Hornsea Three and therefore there will be additional uncertainty associated with these estimates that cannot be quantified. While it is not possible to fully address this additional uncertainty, Natural England advises that it would be precautionary to place greater weight on using the upper confidence intervals of the density estimates for these months, in order to try and reduce the likelihood that impacts are underestimated.

Seasonal definitions

4.5. Furthermore, Natural England disagrees with Hornsea Three in regards the seasonal definitions for several species, in particular those for gannet and puffin are relevant to the displacement assessment (see Section 7).The SNCB recommended (MIG-Birds 2017) approach to displacement assessment is to use the mean seasonal peak, therefore for gannet and puffin (where Natural England recommend different seasons) we do not agree with the mean seasonal peaks used to calculate displacement.

Apportioning

4.6. In regard HRA for Flamborough and Filey Coast potential SPA (FFC pSPA), as previously advised Natural England have a number of concerns regarding the approach Hornsea Three have taken to apportioning (see Section 7), and do not agree with the apportioning of breeding adults presented for gannet, kittiwake and puffin, furthermore we have concerns regarding the lack of apportioning of immature/non-breeding guillemot and razorbill in the breeding season to FFC pSPA.

Combination of seasonal impacts - RIAA

4.7. Furthermore as advised previously (NE PEIr response dated 20.09.17) joint SNCB guidance on assessing displacement (MIG-Birds, 2017) advises that displacement impacts calculated for individual seasons should be summed across seasons to allow assessment of the annual impact on the population. Throughout the HRA Report displacement sections (both alone and in-combination) the impacts per season have been presented separately. The aim of an assessment of impacts to an SPA population is to consider all impacts the population may experience throughout year (from all projects in the case of an in-combination assessment). A key reason for developing the BDMPS (Furness 2015) was to inform apportioning of impacts in the non-breeding season to facilitate the combining of both breeding and non-breeding season impacts. The assessment should therefore be presented as total annual impact to the population under consideration. Again we advise that (as per SNCB guidance, MIG-Birds, 2017) mortality and displacement rates should remain constant across the year. Therefore matrices should be presented of the combined breeding and non-breeding seasons.

Combination of seasonal impacts - EIA

4.8. The same requirement to sum seasonal impacts to present an annual impact applies to EIA assessments. However, in the context of EIA, the annual impact needs to be assessed at an appropriate population scale. NE advises that the appropriate population scale to assess a predicted annual impact should be the largest population under consideration at any point in the annual cycle. This does not preclude consideration of impacts for each season being assessed against a smaller population size to provide contextual information about the relative impacts across seasons and colonies.

Lack of confidence intervals

4.9. Natural England require that the variability and uncertainty in the underlying population estimates is presented (in the form of appropriately calculated upper and lower confidence intervals), so that the full range of potential scenarios can be explored. For the purposes of displacement assessment, confidence intervals should be presented around monthly total abundance estimates for all birds (in flight and on the water), after correcting for availability bias for the site and a 2km buffer. These have not been presented within the application and Natural England's requests that they are provided by the Applicant.

Mortality/Displacement levels

4.10. As previously advised, while it may be the case that displacement levels and mortality do vary at different times of the year for different species, there is no empirical evidence to suggest what these levels might be for different seasons, or even what the relative differences might be. For this reason SNCB advice (MIG-Birds, 2017) is that given there is currently no empirical evidence on the seasonal variation of displacement in seabirds, the SNCBs do not view it as appropriate at this time to apply varying mortality and displacement levels per season, however we do recommend the presentation of a range of displacement and mortality rates for the annual and seasonal assessments to reflect the uncertainty.

Inclusion of immature impacts

4.11. In relation to the HRA Report, we note that in the case of puffin, guillemot and razorbill apportioning figures are presented for adult birds, however Annex 3 (Phenology, Connectivity and Apportioning for features of the FFC pSPA) presents apportioning figures for immatures in the non-breeding seasons as well. Natural England query why this impact to immatures associated with FFC pSPA has not been presented within the assessment and why no attempt to quantitatively apportion immatures in the breeding season has been made. As noted above, a matrix should be presented that combines all displacement impacts to the FFC pSPA population across the year (including immatures). Please see paragraphs 4.7-4.8 for further comments on this.

The exclusion or qualitative assessment of species for in-combination assessments

4.12. Natural England note that the in-combination displacement impact for a number of species (e.g. for FFC pSPA: fulmar, puffin and razorbill) has been qualitatively, rather than quantitatively assessed. The developer has presented several reasons for this approach.

4.13. Firstly, if a 'negligible impact' for the project alone has been concluded by the Applicant. Natural England advises that as a result of the issues Natural England has highlighted, associated with the collection and analysis of the survey data, seasonal definitions, apportioning and displacement assessments, we are unable to form any conclusions about the significance of the displacement impacts presented by the Applicant and therefore cannot agree with the conclusion that the impacts are 'negligible' for the project alone at this stage.

4.14. Secondly, a lack of quantitative data from other wind farm projects has been presented as a barrier to conducting quantitative in-combination assessments. However, the calculation of a displacement effect requires only a population estimate for the wind farm in question at a suitable temporal scale (i.e. seasons). Indeed the Applicant notes they can use two data sources to determine the potential levels of displacement and mortality from wind farms included in the in-combination assessment: population data held in individual wind farm project Environmental Statements and Habitats Regulations Assessments consisting of population estimates for individual project areas rather than raw survey data; and density data provided in the Natural England seabird Sensitivity Mapping for English Territorial Waters (Bradbury et. al., 2014) (see HRA Report 7.6.2.8).

Data for Cumulative and in-combination assessments from other projects for auk species

4.15. The applicant presents tables showing mortality as a result of displacement for auk species for cumulative (guillemot and razorbill) and in-combination (guillemot) assessments which include "0" mortality against several projects in the non-breeding season (e.g. Table 7.40 RIAA. Table 5.41 & Table 5.42 Ch 5, Kincardine, Seagreen A&B projects). This implies there were no birds present in these project areas during the non-breeding season, but Natural England's understanding is that there were large numbers of birds present in these particular project areas and therefore the "0" values in the table may indicate that the Applicant has not obtained the data, rather than that there were no birds/impacts present.

4.16. If this is the case there is a high likelihood that the cumulative and in-combination assessments are underestimated for guillemot and razorbill. The applicant should seek to populate the cumulative/in combination assessment with appropriate data for these wind farms. As noted above (see points 4.12-4.14) the calculation of a displacement effect requires only a population estimate for the wind farm in question at a suitable temporal scale (i.e. seasons).

Combining effects to assess the overall impact to a population

4.17. Natural England advises that in cases where a population may be exposed to multiple effects (for example gannet is assessed for both collision risk and displacement effects) the combined impact to the relevant population should be assessed. This applies to both HRA and EIA assessments alone and in-combination/cumulatively.

5. Assessment of Cumulative and In-combination Effects

5.1. Cumulative and in-combination impacts are a key area of concern in relation to predicted impact levels for Natural England. They are also an area where Natural England has significant concerns about the assessment approach presented by the Applicant.

5.2. The key concerns are summarised below:

- use of Extended Band Model collision figures for gannet and kittiwake for some individual project figures including those of Hornsea Three;
- application of Extended Band Model options that Natural England do not consider appropriate to certain projects in the cumulative assessment for lesser black-backed gull and great black-backed gull (e.g. Option 4 applied to Hornsea One and Hornsea Two; Option 3 for Hornsea Three);
- retrospective application of correction factors to existing collision figures for projects as a proxy for lower nocturnal activity levels than used in the original CRM for a project;
- retrospective "proportional" changes to collision figures for projects based on assumptions that consented turbine configurations represent a lower collision risk than the Rochdale Envelope defined during the consenting process for a project and that the reduction is a simple function of the change in turbine number;
- use of MacArthur Green (2017) ratio correction factors to adjust collision figures for projects based on "as built" versus consented turbine layouts;
- exclusion of impacts from Tier 3 and some Tier 2 projects in the CEA (including Norfolk Vanguard, Thanet Extension, Moray West and Norfolk Boreas);
- conducting qualitative rather than quantitative in-combination displacement assessments for certain species (see detailed comments in points 4.12-4.14).
- the proportions of birds that have been apportioned to FFC pSPA during the breeding season from the different North Sea projects;

- cumulative assessment of impacts under EIA that does not incorporate impacts across the whole annual cycle for a species at an appropriate scale.
- the assessment of EIA impacts on a season-by-season basis, at varying population scales, and therefore with varying project impacts included. Natural England advises that assessment of impacts should be undertaken at an appropriate scale (e.g. North Sea) across the whole year for each relevant species. For example, if the population scale for the cumulative EIA is a North Sea scale, then breeding season impacts on all birds within this scale, from all projects within this scale in the breeding season need to be accounted for and considered together with predicted impacts at a North Sea scale for birds in the non-breeding seasons.

6. Population Modelling Approaches and Population Impacts

6.1. The Applicant has considered the significance of the predicted in-combination mortality impacts on the Flamborough and Filey Coast pSPA (FFC pSPA) by reference to population modelling work undertaken by MacArthur Green (2015b) for Hornsea Two. The Applicant has used outputs from these population viability analysis (PVA) models for gannet, kittiwake and guillemot populations at FFC pSPA.

6.2. Natural England discussed the MacArthur Green (2015b) PVA models with the Applicant during the Evidence Working Group process and indicated that Natural England does not consider the PVA models produced for Hornsea Project Two are adequate to inform the assessments for Hornsea Three for the following reasons:

- The PVA models for Hornsea Two were run over a period of 25 years and not the 35 years that represent the operational phase of Hornsea Three. The counterfactual of population size and counterfactual of growth rate metrics should be calculated at the end of the impact period – which for Hornsea Three should be 35 years – however as the Hornsea Two PVA models were only run for a 25 year period the model metrics are only available for impacts projected over 25 years of windfarm operation and not 35 years. The Applicant has made assumptions about what effect these ten additional years would have on the metrics, but does not have the actual metric value which would vary depending on various model assumptions and parameters;
- The Applicant has considered two PVA model output metrics in order to assess the significance of the predicted impact level on the population - change in median population growth rate and counterfactual of population size. Natural England agree with the use of the counterfactual of population size, but we also recommend using the counterfactual of population growth rate to quantify the relative changes in a population in response to anthropogenic impacts. The change in median growth rate metric that the Applicant has used is not the same as the counterfactual of growth rate that Natural England advises, as it has not been calculated from the growth rate at the end of the duration of the projection, e.g. at 35 years if the model is projected across a 35 year licence period. The Applicant has calculated the growth rate averaged across years five to 25 of the model simulations and compared the median value of the average growth rate between impacted and unimpacted scenarios;
- The stochastic simulations for the Hornsea Project Two models were not run as matched pairs. Where stochastic PVA models are used, it is important to use a ‘matched-runs’ approach where a metric is derived for each matched pair of baseline and impacted simulations. Stochasticity is included in the population model, but the survival and productivity rates used for a ‘pair’ of

impacted and un-impacted populations at each time step are kept the same. This means that the effect that is measured with the metric can be more clearly attributed to the impact, than to model uncertainties such as the variability in the demographic parameters that have been sampled or to observation errors. Cook and Robinson (2017) tested the effect of using unmatched compared to matched runs in PVA models and demonstrated that the median values of several evaluation metrics (e.g. counterfactual of population size) were greater when a matched runs approach was used compared to when the simulations were unmatched and the uncertainty around the metrics was much greater in the unmatched scenario. Models were run with 1000 iterations. It may be the case that the median values of the matched versus unmatched runs approach will converge if a larger number of simulations (e.g. 5000) are used, however the confidence limits are still expected to vary between the two approaches. Natural England therefore advises that one amendment required to the Hornsea Project Two PVA models is to run the simulations using matched-pairs as recommended in Cook and Robinson (2017) and Jital et al. (2017).

- Natural England has also had discussions with the Applicant regarding the way that the additional windfarm mortality is incorporated into the PVA. The PVA models for Hornsea Two required additional windfarm mortality to be added to the models as adult mortality, with the assumption that mortality of the other age classes present in the project area would occur at a level proportional to the model stable age structure. Although there are a number of assumptions inherent in this approach, it can be applied where project impacts are presented in terms of an “adult currency” as they were for Hornsea Two. However, in situations where for example zero mortality is predicted for the adult age class, but where there is predicted mortality for other classes of birds in the population, as is the case for some species at Hornsea Three, it is not possible to derive a metric of population impact from the existing models. The Applicant acknowledges this point (e.g. in section 1.4.1.2 of Annex 3 of the HRA Report), but does not present a method for accounting for this issue. Natural England advise that if mortality is predicted for birds from a particular population that does not include any predicted adult mortality, or where predicted mortality is not distributed across age classes in a manner that reflects the stable age structure within the population model, then an alternative method (to only applying adult mortality impacts to the model) for including the predicted mortality into the population models needs to be used. Natural England considers that the proportions of birds recorded in different age classes present in the Hornsea Three project site from the offshore surveys is the best evidence available for adding mortality to different age classes in the model. In the non-breeding season months, if information on the age classes of birds in offshore projects areas is not available, the proportion of adult and immature birds present in offshore areas that are expected to originate from different colonies can be derived from Furness (2015) and applied to the population models.
- A further issue with deriving the metrics from the Hornsea Two population model is that the Applicant has had to select impact levels from those published for Hornsea Two. This means that the Applicant can only derive metric values from a pre-populated set of impact levels and cannot calculate a metric that is specific to the impact level that they have calculated for Hornsea Three.

6.3. Natural England understands that the Applicant has subsequently produced updated PVA models for some FFC pSPA species that use matched-runs and a 35 year projection and that these will be submitted at Deadline I. Natural England requests that the Applicant provides tables that show the population size at year 35 of the projection based on a full range of additional mortality added to the model, that spans the full range of predicted impacts (and not just the impact value selected by the Applicant), including zero impact. For the stochastic versions of the model the final population sizes at year 35 should include the median value and upper and lower 95% CIs. Additionally, Natural England requests that the Applicant provides the same outputs as above but for the population growth rate in the final year of the simulation.

6.4. Natural England also requests that PVA outputs are provided for the following species that are either qualifying features or are part of the assemblage at FFC pSPA: kittiwake, gannet, guillemot, razorbill and puffin.

6.5. For HRA, Natural England recommends interpreting the metrics from population modelling against a framework of considerations including the Conservation Objectives for the SPA population, SPA and wider population status, threats and pressures acting on the population and policies which may change the wider population status. Natural England notes that, based on the level of kittiwake mortality predicted to arise from Hornsea Three in-combination with other projects, the Applicant has concluded that there is no indication that, the population is likely to decline, over a period of 35 years, to an extent that would mean that the breeding kittiwake population of the FFC pSPA would no longer be considered to be in favourable condition. The Applicant’s conclusion is based on a prediction that additional mortality from Hornsea Three in-combination with other plans or projects would not result in the population declining below the cited population of 44,520 pairs.

6.6. The population size on the citation for Flamborough Head and Bempton Cliffs SPA is 83,700 pairs of kittiwake. The citation for the Flamborough and Filey Coast pSPA (which includes the original SPA) is 44,520 pairs based on counts from the period 2008 to 2011. The latest colony census counted 51,535 pairs across the FFC pSPA in 2017 (JNCC 2018). The current population is therefore below the level in the original citation for the SPA and the kittiwake feature of the site is, therefore, in unfavourable condition.

6.7. Therefore any assessment of the significance of a predicted impact or whether it would affect the status of the species at the site or result in an Adverse Effect on Site Integrity needs to be considered against the Conservation Objectives for the site and not necessarily against the current or citation population for a site.

7. Phenology, Population Scales and Apportioning to individual SPAs

Data used to inform definition of the breeding season

7.1. Natural England have consistently advised that for species where breeding birds are predicted to be present in the Hornsea project area, the breeding season months follow those presented in Furness (2015) under “breeding season” and not the “migration-free breeding season”, except in cases where relevant colony or site specific information suggests that a different set of months is appropriate for defining colony attendance.

7.2. Natural England have noted throughout the Evidence Working Group process that the interpretation of at sea, project specific abundance data can be extremely challenging. Natural England place considerably higher confidence and emphasis on the use of colony specific data to inform colony specific breeding seasons, while Hornsea Three have focussed substantially on the use of at sea abundance data (from a variety of offshore wind farms in the area) to define seasons. As such, and as previously advised, Natural England do not agree with the seasonal definitions for gannet, kittiwake and puffin.

7.3. Natural England advise that when undertaking an assessment in relation to a specific colony (e.g. for HRA) it is important, where possible, to use colony specific breeding seasons for the assessment (i.e. to apportion birds at the project site to the colony at an appropriate rate during those months associated with breeding at the colony in question).

7.4. Of the evidence sources available to establish colony specific breeding seasons, Natural England place higher confidence in observations made at the colony, as opposed to at sea observations. Colony specific observations (e.g. colony attendance, egg laying, chick fledging, colony desertion dates) give a clear indication of when birds are present at the colony and the assumption that birds observed are part of the colony in question is a reasonable one. Indeed, Busch and Garthe (2018) in their paper on the need to consider annual cycles within cumulative assessments, use kittiwake as an example and recommend the use of a 'colony attendance' season based on colony specific data.

7.5. The alternative option of interpreting at-sea data gathered as part of the baseline characterisation surveys of the wind farm site (e.g. abundance peaks) is challenging and introduces considerably uncertainty. In the case of Hornsea Three and the FFC pSPA, for the species where connectivity in the breeding season has been established at FFC pSPA (kittiwake, gannet and puffin) a peak in bird numbers can variously be interpreted as birds on passage passing through the project site to colonies further afield, breeding birds from FFC pSPA using the project site in higher numbers during a period in the breeding season when central place foraging constraints are relaxed and/or when both birds of a pair can forage (e.g. Robertson et al 2014), immature birds returning to the colony they intend to recruit into (e.g. Votier 2010), or failed/non-breeders associated with FFC pSPA. In reality the birds observed at Hornsea Three are likely to be a combination of all these categories, and it is important to note that the last three categories (breeding birds, immatures, non-breeders) are all components of the FFC pSPA population to some extent. Natural England accepts that during the FFC pSPA breeding season, a proportion of the birds present at the project site will be 'non-FFC' birds, but that this should be addressed in the approach to apportioning and not in the definition of the FFC pSPA breeding season.

7.6. In terms of defining the length of the breeding season at a colony, using observations from the colony in question is more defensible and provides greater certainty that attempting to interpret at-sea data. At-sea data (e.g. abundance peaks, flight direction, fish carrying behaviour) combined with other evidence sources (e.g. tracking data, ringing recoveries) can however help build a picture of how birds are using the project site throughout the breeding season.

7.7. Natural England have referred to a number of evidence sources to determine the appropriate breeding length definitions for FFC pSPA (summarised below in Table 1). It should be noted that data on colony attendance and breeding observations are found predominantly in the grey literature (in monitoring reports and observer records) and are not commonly peer-reviewed. In the case of FFC pSPA it is closely managed and monitored by the RSPB, and as such, the RSPB reserve managers are best placed to advise on breeding colony attendance periods (these are included as *pers comms* and by reference to monitoring reports (e.g. Aitken et al 2017, Babcock et al 2016) in the table).

7.8. The use of colony observations to define the length of the breeding season for kittiwake, gannet and puffin results in breeding seasons at FFC pSPA that are closely aligned to the breeding seasons described in Furness (2015) for the UK.

The interpretation provided by the applicant of at-sea data to define the breeding seasons for these species results in reduced breeding seasons (see Table 1).

Table 7.1 – Summary of evidence sources to inform breeding season definition at FFC pSPA for the purpose of HRA for gannet, kittiwake and puffin, and seasons advised by Natural England and proposed by the applicant.

Species	FFC pSPA specific evidence sources	NE proposed breeding season for FFC pSPA	Applicant's proposed breeding season
Gannet	RSPB reserve managers advise that numbers of gannet inshore start to increase from mid-January, with birds prospecting on the cliffs from February onwards, with the majority returning by late March. A high proportion of birds have departed the colony by the end of September, though some presence on the cliffs is expected throughout October and into November. The last juveniles on the cliffs are usually in early November. (K Clarkson, A Barratt, M Babcock *pers comm*) Langston et al (2013) conducted tracking studies at FFC pSPA between 2010 and 2012. They noted that in 2012 gannets started to return in mid-January, with most birds back at their nest during March. In 2010 peak fledging occurred late August/early Sept, in 2011 it was the first 3 weeks of August (with most fledged by the end of Sept) and in 2012 it was late August (with the last few fledging by the end of Sept). They further noted that: 'Many adults remain at Bempton Cliffs for a while after their chicks have fledged. Tracking studies indicated that most adults departed Bempton Cliffs during the second half of September in 2011 and all adults had left by early October. Productivity monitoring at Bempton Cliffs takes place between late April and October (Aitken et al, 2017)	March – Sept	April - August
Kittiwake	RSPB reserve managers advise that: Birds usually start to return to the colony from mid-February, but irregularly, with significant numbers not expected until late March and egg-laying not generally occurring until May. Early August finds the colony still well occupied, but numbers decline during the month and the colony is usually deserted come September. (K Clarkson, A Barratt, M Babcock *pers comm*) RSPB analysed data from twenty-two kittiwake plots across the colony in 2016 and 2017, comprising of 713 apparently occupied nests (AON) in 2016, and 749 AON in 2017 to calculate estimated laying and hatching dates. The plots were visited at 7 day intervals, and so the resulting	March - August	April - July

	dates could be up to 7 days earlier (but not later). The modal lay dates were 24th May & 9th May and hatch dates were 28th June and 13th June (2016 and 2017 respectively). In regards defining the end of the breeding season, the latest hatch dates were at the end of July in both years (30th and 25th July respectively for 2016 and 2017). (RSPB, unpublished data) RSPB productivity monitoring takes place between May and August (Aitken et al, 2017).		
Puffin	RSPB managers advise that: Productivity monitoring at Bempton Cliffs is not possible, due to puffin nesting in inaccessible clefts in the cliffs. (K Clarkson, A Barratt, M Babcock *pers comm*). From 2016 onwards a snapshot of colony numbers was estimated by recording numbers of birds aggregating on the sea below the colony prior to breeding. The first reports of large numbers of puffin on the sea were in the morning of 22nd March in 2016 (Babcock et al, 2016). In 2017, the equivalent date was 24th March (Aitken et al, 2017). In 2018, this assembly did not occur until early April, reflecting the lateness of the breeding season (Mike Babcock *pers comm*). The breeding season ends later than the other auks, although the majority have departed by mid-August. (K Clarkson, A Barratt, M Babcock *pers comm*). Mather (1986) notes that puffin arrives on the breeding cliffs of the Yorkshire coast in April, though no specific information is given to support this.	April – July (NB wider evidence presented in Furness (2015) suggests early August however in the colony specific case of FFC pSPA NE consider inclusion of July to be sufficient.	May-July

Breeding season definitions and apportioning

7.9. As the previous section outlines, there continues to be a lack of agreement between the Applicant and Natural England in regards the appropriate definition of the breeding season for certain key species both at FFC pSPA and at wider population scales. Natural England consider that controversies arise because there is a conflation between the definition of the breeding season and the approach to apportioning.

7.10. In Natural England's view breeding seasons should be defined by the breeding population under consideration, and largely informed by colony-specific data (e.g. if the population of interest is the UK breeding population then the appropriate breeding season should encompass the full extent of time that breeding activities are underway within the UK for that species). In the case of FFC pSPA, the appropriate breeding season should be defined by when birds are present at the FFC pSPA breeding site engaged in breeding behaviours (see comments above).

7.11. Developers and SNCBs regularly refer to the Natural England commissioned report on 'Non-breeding season populations of seabirds in UK waters' (Furness 2015).

The aim of this project was to review and define species-specific non-breeding season seabird populations at biologically defined minimum population scales (BDMPS) to enable the apportioning of potential impacts of marine renewable developments during the non-breeding season. The apportioning rates derived using BDMPS in the non-breeding seasons assume a totally homogenous mixing of birds within the spatial region defined (e.g. North Sea), and therefore reflect an average probability of encountering a bird from a specific colony across the BDMPS region. In reality the probability of encountering a bird from a particular colony will vary both temporally and spatially within the season and within the BDMPS region under consideration. For example, it would be expected that there is a higher chance of encountering a kittiwake from the Flamborough and Filey Coast SPA colony at the Hornsea Three site in the first few weeks after the breeding season, than encountering a kittiwake originating from the Flamborough and Filey Coast SPA colony in waters around Shetland at this time. Similarly while the BDMPS assumes that 25% of kittiwake in the North Sea BDMPS in spring are from Norwegian colonies, it might be expected that the proportion of Norwegian birds in northern Scottish waters might be higher than this and the in southern North Sea waters lower – particularly during the tails of the season.

7.12. Hornsea Three argue that in some months (early or late in the breeding season) there may be adult birds from colonies further afield present at the project site (i.e. in transit to or from their breeding grounds), and use this to support excluding these months from the breeding season (as they do not consider apportioning the majority of birds to FFC pSPA is appropriate), and instead apportion them at a non-breeding season rate.

7.13. Natural England agree that the probability of an adult bird observed at a project site being part of the FFC pSPA breeding population will vary over the full breeding season (although finding suitable evidence sources to quantify this is challenging). However excluding these months, and using the non-breeding apportioning figures (derived from Furness 2015) is likely to considerably under-estimate the number of adults apportioned to the colony[1]. During these early/late breeding season months the likelihood of encountering a bird from the Flamborough colony is higher, than encountering a bird from a breeding colony much further afield (e.g. Norway).

7.14. The current approach to apportioning is to keep the percentage of adults apportioned to a colony constant across the season, however this should reflect the average probability across that period of time (i.e. the apportioning rate used for the full breeding season should reflect our understanding where possible of the variability in proportions of birds connected to the colony in different months of the breeding season).

7.15. As such, Natural England continue to advise that breeding seasons should be defined by the colony in question (e.g. FFC pSPA), and that any debate should focus on agreeing an appropriate apportioning rate to use that encompasses the

[1] To use Gannet as an example, Natural England advise that a breeding season of March – Sept is defined for FFC pSPA while Hornsea Three have selected April – August (see below). The apportioning rates defined by Hornsea Three for gannet are: 40.4% in breeding season, 4.8% in post breeding and 6.2% pre-breeding. This would mean that in March (when breeding gannets are in attendance at FFC pSPA) only 6.2% of birds observed at the project site are considered likely to be part of the nearest breeding colony. Likewise in September (when gannets are still breeding at FFC pSPA) only 4.8% of birds recorded at the project site would be apportioned to FFC pSPA.

variability in the proportions of FFC pSPA birds present at the project site during the breeding season.

Age Class data

7.16. Hornsea Three have presented an apportioning approach for gannet, kittiwake and puffin based on at-sea age class data. As previously requested (EWG meeting, 23.11.17) a detailed breakdown of age class data from boat and digital aerial data sets should be provided in order for Natural England to assess suitability of the two data sets and help to establish suitable apportioning figures.

7.17. Natural England understands that the applicant intends to submit these data at Deadline 1. We would like to take the opportunity to re-iterate the data requirements for this, and note that as per Section 11 below we also request these data for guillemot and razorbill.

- Species list: Puffin, Gannet, Kittiwake, Guillemot, Razorbill
- Digital aerial data:

  All species. All age class data should be provided (including the un-aged class) for every survey month (2016 and 2017 should be presented separately), and at all survey scales (site footprint, 2km buffer, 4km buffer);

- Boat based data:

  All species. All age class data should be provided (including the un-aged class) for every survey month (years presented separately) of the sub-set of data that applies to Hornsea Three. Or in the cases where there is insufficient data at the HOW3 level, (e.g. puffin) then from the entire Hornsea zone.

Survey platform and coverage issues to inform age class

7.18. Hornsea Three present age class data derived from both boat based survey data and digital aerial survey data. As a general comment on the suitability of the two data sets it is of note that the boat based data is now several years old (2010-2013), and the transects covering the Hornsea Three project site were spaced at 6km and resulted in a maximum coverage of 5%. This compares to the digital aerial data that were from surveys designed specifically for the Hornsea Three project site, cover the 2016 and 2017 breeding seasons, and results in a consistent coverage of 10% of the project site. Furthermore, Natural England note that the digital aerial data collected to inform the Hornsea Three application was collected using four cameras, yet only two cameras have been analysed, and presented within the application, resulting in half the data collected not being presented within the application. Natural England would recommend that that these survey data are analysed and presented, this would increase the sample size (and hence decrease uncertainty) for age class data derived from these surveys, and result in 20% coverage of the project site.

Approach to apportioning for kittiwake and puffin

7.19. Hornsea Three present an approach to apportioning for kittiwake and puffin that utilises age class data (for first year birds alone) and immature survival rates. As previously advised through the Evidence Plan process (NE DAS letters to Ørsted, dated 24.03.17 and 15.12.17), Natural England does not consider this approach is warranted given that it is entirely dependent on the accuracy of the numbers of first year birds recorded on survey and survival rates estimated for immature age classes, both of which are subject to considerable uncertainty (and variability in the case of age class proportions). Furthermore, it assumes that sub-adult age classes are present at the project site in proportions related to the numbers of first year birds, which, as various sections within Annex 3 of the HRA Report argue (see 1.4.3.11 and 1.4.3.12 kittiwake and 1.4.4.9 and 1.4.3.11 puffin) is not likely to be the case. Natural England's preference is to use the age class data from the offshore surveys to estimate the proportions of 'adult type' birds that are present at the project site and to use this to inform a range of adult apportioning values.

Apportioning immature impacts within the breeding season - RIAA

7.20. The applicant states that in relation to razorbill and guillemot at Hornsea Three it is likely that a large proportion of the immature population present at Hornsea Three in the breeding season will originate from those breeding colonies that are closest to it (Annex 3 of HRA Report). The applicant identifies the colonies listed below and notes that as a result, only a proportion of the mortality of immature birds predicted will be attributable to the Flamborough and Filey Coast SPA.

7.21. In the case of razorbill, the Applicant identifies: 'FFC pSPA (10,570 pairs), the Farne islands (491 occupied sites in 2016), St Abb's to Fast Castle SPA (1,385 pairs in 2016) and the Firth of Forth (3,597 equivalent pairs in 2015)'. In the case of guillemot: 'FFC pSPA (the Farne Islands (32,855 pairs in 2016), St Abb's to Fast Castle SPA (24,258 pairs in 2016) and the Firth of Forth (21,181 pairs in 2015).'

7.22. Natural England welcomes the acknowledgement that a proportion of the birds present at Hornsea Three will exhibit connectivity with FFC pSPA but query how the 'nearest colonies' presented in this annex have been determined and why these can't be used to inform a likely apportioning figure. Furthermore we request age class data (including observations of juveniles with attendant adults) are provided for guillemot and razorbill from both digital aerial and boat based data sets (see points 7.16-7.17 above).

8. HRA Screening and LSE Conclusions

8.1. Natural England commented on the Applicant's LSE methodology in our response to the Hornsea Three Habitat Regulations Assessment Screening Report (NE DAS letter to Ørsted dated 03.02.17, and NE PEIr response dated 20.09.17). The LSE test is a 'coarse filter', identifying potential effect pathways that warrant further consideration through Appropriate Assessment. The LSE test requires competent authorities to consider whether there is an LSE alone or in-combination with other plans and projects. Generally, a feature should not be screened out unless it can be clearly demonstrated that there is no impact alone or in-combination. The structure of the HRA screening document means that those plans or projects that could contribute to in-combination effects are only considered after the test of LSE has been applied. This potentially misses interactions, that whilst not LSE on their own, might be an LSE in-combination when considered in conjunction with other developments.

8.2. Additionally, given that Natural England has queries regarding the sufficiency of the baseline survey data for Hornsea Three, the way that the data have been analysed and insufficient consideration of variability and uncertainty in the data and assumptions underpinning the assessments, it is Natural England's view that it is not possible to conclude no LSE for a number of sites and associated features, which will therefore need to be captured within the appropriate assessment.

8.3. In particular, Natural England do not agree with the methodology used by the Applicant whereby they have assumed there is a potential for LSE only where a predicted impact amounts to 1% or more of the baseline mortality level for a feature of an SPA. This is firstly, because calculating the predicted level of mortality for a feature depends on analysis and interpretation of a considerable amount of information, with assumptions and uncertainties in the process, and so determining with certainty that a predicted impact is above or below 1% of baseline mortality is not clear-cut. Secondly, while a predicted impact from an individual development may not exceed 1% of baseline mortality for a given population, when considered in-combination with other plans or projects there may be a significant impact.

9. Habitats Regulations Assessment (HRA)

9.1. The issues and uncertainties raised in the preceding sections of this report mean that, on the basis of the information presented by the Applicant, Natural England cannot conclude beyond reasonable scientific doubt the absence of an adverse effect on the integrity on the SPAs and pSPAs assessed by the Applicant. Further, Natural England consider there are additional SPAs and associated features that are missing from the HRA.

9.2. Once these concerns are addressed, and the assessment of impacts is updated, we will need to consider the scale and significance of the predicted impacts from the project alone, and in combination with other plans and projects, in terms of the conservation objectives relevant to the feature populations for the SPAs concerned.

10. Environmental Impact Assessment (EIA)

10.1. The Applicant has used a set of criteria for identifying which species are "Valued Ornithological Receptors" (VORs). Those species not identified as VORs are not included in the EIA assessment process. One of the criteria used to define a VOR is that the population estimate for the species in Hornsea Three plus a 4 km buffer needs to reach 1% of the regional population for a species in a given season. The Applicant further considers "*that any impacts on species occurring in numbers of less than 1% of the relevant regional population will not be significant*".

10.2. Natural England does not agree with this criterion for identifying VORs. Seabirds distributed across an offshore marine area at a scale defined by a windfarm agreement for lease area, such as Hornsea Three, are not expected to reach 1% of a wider population level, when that regional population may be several hundred thousand birds. However, this does not mean that impacts on birds within that area could not be significant when considered cumulatively with other plans or projects, or at different population scales.

10.3. Of particular concern for Natural England is the exclusion of Herring gull as a VOR and therefore from any consideration of cumulative impacts under EIA.

10.4. Natural England also require further clarification regarding the regional, national and international population scales and "importance levels" for species included in the assessment (as presented in Table 1.5 of the Applicant's Annex 5.1: Baseline Characterisation Report).

10.5. The Applicant's approach to determining the significance of impacts based on combining receptor sensitivity and magnitude of impact is confusing and difficult to follow. To determine the significance of an impact, a sequence of criteria are evaluated against each species, each season and each impact. The criteria include receptor sensitivity; magnitude of impact; and significance. Within these criteria there are a number of sub-criteria, for example, receptor sensitivity is made up of conservation value, vulnerability, recoverability.

10.6. This matrix approach involves multiple layers of categorisation for each species and in a number of cases the assessment against a particular criterion has not been done consistently across species and subjective decisions are then multiplied across a number of different criteria. Further, the assessment of EIA significance has been undertaken separately for each potential impact that could affect a species, for each phase of the windfarm, and also separately for each season (Table 5.56 of Environmental Statement Report) which makes it difficult to determine whether there could be an overall significant effect on a particular species.

10.7. The assessment of magnitude of impacts (as set out in Table 5.14 of Environmental Statement Report) is based on factors such as spatial extent, duration, frequency and reversibility of the impact. On the other hand, for some impacts, such as collisions and displacement, a quantitative assessment of impact is made and the Applicant has assessed whether this predicted additional mortality exceeds 1% relative to baseline mortality. However it is not clear how this threshold has been factored into the assessment of magnitude or significance of the impact. Natural England advises that predicted mortalities that exceed 1% of baseline mortality for a population require further investigation as to the likelihood of significant impact.

10.8. Additionally, the Applicant has assessed the significance of the impact mortality separately for each season with no attempt to consider the significance of the mortality across the whole annual cycle at an appropriate scale for each species. As a result, while predicted mortality may not exceed 1% of baseline mortality for an individual season, when considered across the whole annual cycle and an appropriate population scale, the predicted impact could exceed 1% of baseline mortality and potentially be significant.

10.9. In assessing the significance of EIA impacts, the Applicant has determined that anything categorised below ‘moderate’ in the matrix (Table 5.15 in Environmental Statement Report) is not significant. However Natural England considers that excluding any impacts categorised as below moderate could lead to errors in assessing cumulative effects properly as limited impacts when taken cumulatively can become significant.

10.10. Natural England requests that the Applicant sets out a transparent methodology which explains the EIA assessment approach, and that they then demonstrably apply that methodology to the assessment.

10.11. Given the uncertainty surrounding a number of crucial elements to the Hornsea Three Environmental Impact Assessment (EIA), Natural England is unable to conclude at this stage that the project, either alone or cumulatively with other plans or projects, would not have a significant effect on a number of seabird species.

11. Data Presentation Issues: Inaccurate and missing information in the Application documentation

11.1. It is important that the information provided by the Applicant is accurate and clearly presented in a way that can be easily understood, and that all the information to support each aspect of the assessment is provided. This is not always the case in the documentation provided by the Applicant. In some instances there are discrepancies and errors in the information and data presented across the documentation.

11.2. For example, in the Project Description and Collision Risk Annex a 300 turbine scenario is described where the turbine diameter is given as 195m. However, in the Offshore Ornithology chapter the turbine diameter is cited as 185m.

11.3. Another example of inconsistency across the documentation is the list of SPAs and features that have been screened into the HRA. Table 3.7 of the HRA Report lists *European Sites designated for ornithological features for which LSE has been identified or could not be discounted during HRA screening* but does not list fulmar under FFC pSPA. Likewise fulmar does not feature in Table 7.1 *European sites and features for which LSE have been identified – offshore birds,* although it is identified in Table 7.8: *Results of the screening process with respect to the FFC pSPA.*

11.4. Another example where the presentation is unclear and misleading is in the cumulative and in-combination collision mortality tables. For example, Table 5.47 in the Environmental Statement Report presents a column of data headed "*Uncorrected collision risk estimate*", however the totals do appear to include some corrections to collision totals for certain projects on the basis of assumptions about changes to a projects' collision figures based on differences between the assessed project layout and the consented one (as documented in Table 5.48).

11.5. There are also a number of instances where data is either not presented at all or where incomplete data is presented that prevents Natural England from being able to understand or comment on the assessment that the Applicant has undertaken. For example, the Applicant presents tables showing cumulative mortality as a result of displacement for auk species which includes "0" mortality against several projects in the non-breeding season. This implies that there were no birds present in these project areas during the non-breeding season, but Natural England's understanding is that there were large numbers of birds present in these particular project areas and therefore the "0" values in the table may indicate that the Applicant has not been able to obtain the data, rather than that there were no birds/impacts present. If this is the case, the Applicant should indicate this clearly in the information provided, rather than substitute "no information" for a zero value. Furthermore the applicant should seek to populate the cumulative/in combination assessment for these wind farms with appropriate data. As noted above (see paragraphs 4.12-4.16) the calculation of a displacement effect requires only a population estimate for the wind farm in question at a suitable temporal scale (i.e. seasons). Indeed the Applicant notes they can use two data sources to determine the potential levels of displacement mortality from wind farms included in the in-combination assessment: population data held in individual wind farm project Environmental Statements and Habitats Regulations Assessments consisting of population estimates for individual project areas rather than raw survey data; and density data provided in the Natural England seabird Sensitivity Mapping for English Territorial Waters (Bradbury et. al., 2014) (see HRA Report section 7.6.2.8).

11.6. In order to provide transparency and a clear audit trail for the competent authority to undertake a full assessment of the proposed project, Natural England requests that the Applicant provides the following information relevant to the assessment for the relevant species:

- Band Model spread-sheets populated with all the project, turbine and bird parameters and data used for CRM for each species (gannet, kittiwake, lesser black-backed gull, great black-backed gull and Herring gull);

- Raw digital aerial survey data giving the number of birds of each species recorded on each survey day and each transect, with birds in flight and birds on the water presented separately.
- Tables of raw numbers of birds recorded in each year and month of the baseline surveys – presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. With numbers presented separately for birds in flight and birds on the water.
- Tables of population estimates for birds in each year and month of the baseline surveys – presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. With numbers presented separately for birds in flight and birds on the water (availability bias corrected) and upper and lower 95% confidence intervals around each population estimate provided.
- Tables of population estimates with 95% confidence intervals, generated by bootstrapping all the transect data for a given month and year (ie 2 separate monthly estimates where there are data from 2 years) calculated for birds on the water (with availability bias correction) and birds in flight combined. Presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. Standard deviations and coefficients of variation should also be presented for each population estimate.
- Tables of density estimates for birds in flight for each year and month of the baseline surveys - presented for Hornsea Three, Hornsea Three plus 2km buffer and Hornsea Three plus 4 km buffer. With upper and lower 95% confidence intervals around each density estimate provided. Standard deviations and coefficients of variation should also be presented for each population estimate.
- Age class data provided month by month, and include the 'unaged' proportions (per month) for each data set of both digital and boat based data (see points 7.16-7.17).
- All of the above data presented from analysis of the full 4 camera survey strips within each transect;
- PVA Tables with median, L95% CI and U95%CL of un-impacted population size in each year of the simulation n=0…35
- PVA Tables with median, L95% CI and U95%CL of impacted population size for each year of the simulation n=0…35, and the equivalent for impact levels equating to adult mortality at 5 bird increments e.g. 5, 10, 15, 20 …
- PVA Tables with median, L95% CI and U95%CL of un-impacted population growth rate in each year of the simulation n=0…35
- PVA Tables with median, L95% CI and U95%CL of impacted population growth rate for each year of the simulation n=0…35, and for impact levels equating to adult mortality at 5 bird increments e.g. 5, 10, 15, 20 …
- PVA outputs for 10-13 above provided for gannet, kittiwake, guillemot, razorbill and puffin for FFC pSPA.
- Information on demographic parameters used in PVA models for each species;
- Information on the stable age structure of the PVA models for each species;
- Cumulative and in-combination project tables for the relevant species that contain all available data by month (ideally) or season with no changes applied to the figures derived from the relevant project Environmental Statement (or

whatever source the data were derived from). The precise source of the data presented should also be clearly referenced.

12. Treatment of uncertainty in the impact assessments.

12.7. There is uncertainty around the predicted impacts in the assessments presented in the Applicant's Environmental Statement Report and HRA Report. Some of this comes from natural variability and uncertainty in the input data (e.g. densities of birds at Hornsea Three, flight heights, sampling and measurement errors etc.) and some of which is due to imperfect understanding of how systems work (e.g. avoidance rates and collision models, effects of displacement on mortality of birds etc.). In order to be able to make an assessment of the significance of potential impacts on populations it is necessary to understand and, where possible, take account of this uncertainty.

12.8. The Applicant has presented predicted impacts that take account of some of the uncertainties in flight heights, avoidance rates and densities (noting that Natural England does not agree with the method used to derive some of these parameters) in the Collision Risk Modelling Annex, but this range of collision predictions have not been used by the Applicant to inform the Appropriate Assessment or EIA. Further, the Applicant has not considered uncertainty around the population estimates in the assessment of displacement impacts.

12.9. Natural England advises that the assessments of displacement and collision mortality should both use the information on uncertainty and variability in the input parameters (e.g. bird densities, flight heights, avoidance rates) to allow consideration of the range of values predicted impacts may fall within, and to allow an assessment of confidence in the conclusions made regarding adverse effects on site integrity and significance of impacts for populations.

13. Migratory Bird Analysis.

13.1. Natural England has made several comments in relation to the approach to migratory bird collision risk analysis which we have detailed in paragraphs 13.3-13.7below. Whilst Natural England does not agree with all aspects of the Applicant's methodology or approach, we do not believe that the methodology and approach adopted has resulted in fundamentally different conclusions to the assessment in the specific cases assessed. However, there remains a lack of clarity regarding: the criteria on which migratory waterbird species were selected for this analysis; the suite of SPAs with which those species may be associated; those species/SPAs close to the Hornsea Zone but not considered in this analysis, and the magnitude of potential cumulative and in-combination impacts for migratory species. While we do not consider it very likely that this additional information will identify further species/sites for which a significant effect might arise from collision mortality during migration for Hornsea Three alone or in combination with other plans or projects, the information requested will confirm whether these assumptions are correct, and will provide greater certainty to all parties that this is not the case.

13.2. It is worth bearing in mind that when considering the impact pathway for migratory birds, the likelihood of a significant effect arising on a given population is most likely to arise from cumulative and in-combination effects across multiple developments, even if the effects from each individual development appear insignificant. Thus, there is benefit in the environmental impact assessment of every development considering a wider suite of species than might otherwise be considered most important in each case. This additional information can inform future cumulative and in-combination impact assessments such as might for example be conducted in forthcoming plan-level impact assessments.

Seabirds – skuas, terns, little gull

13.3. Natural England notes that the Applicant has used a migratory front approach for the migratory seabird CRM given that the offshore digital aerial baseline surveys will not be appropriate for characterisation of the interaction of these migratory species with the Hornsea Three project area. Natural England agrees that this is an appropriate approach in these cases.

13.4. The migratory seabird CRM approach requires definition of an interacting population size, and for the skua and tern species the Applicant has defined an interacting population size based on information in Furness (2015).

13.5. Natural England notes that the Furness (2015) population numbers may not be the most biologically appropriate numbers to use as an 'interacting' population size for a migration collision analysis as they were derived to provide an estimate of the number (and origins) of birds in a geographically defined area (generally smaller than a flyway or biogeographic population scale) during the non-breeding season. Natural England has not reviewed the use of the population estimates from Furness (2015) in the context of a migration front CRM assessment or compared the results derived using the numbers in Furness (2015) with those using other interacting population sizes so cannot say whether they would produce comparable results.

Waterbirds

13.6. Natural England is unsure about the rationale for selecting the 12 species that have been included in the migratory waterbird collision risk modelling. The text states that selection was '*consistent with the suite of species incorporated into similar modelling undertaken for other offshore wind farms in the vicinity of Hornsea Three (i.e. Hornsea Project One and Hornsea Project Two)*. *This list represents those species recorded during boat-based surveys at Hornsea Project One in addition to migrant species that may potentially cross the former Hornsea Zone with species ultimately selected through consultation with Natural England and JNCC based on a relatively high proportion of birds occurring within the SPAs close to the former Hornsea Zone*.'

13.7. However, Natural England considers that there are other species with a relatively high proportion of UK SPA birds occurring in SPAs close to the Hornsea zone and where a large proportion of the population is predicted to migrate through UK waters including areas that would overlap with the Hornsea Zone. These include redshank, gadwall, teal, pintail, shoveler and turnstone. Further, the Applicant has not set out how the predicted collisions have been assigned to the relevant SPAs, and has made no attempt to consider in-combination impacts across all plans and projects. Therefore, Natural England requests that the Applicant presents 1) the criteria for identifying the selection of waterbird species to include in the migratory collision risk modelling; 2) information about the SPA sites that the species included are connected to and how predicted collisions have been assigned to these SPAs; 3) the list of SPA qualifying feature species for SPAs close to the Hornsea Zone that have so far been omitted from the analysis; 4) include in-combination assessment totals for the species and SPAs that are in scope.

References

Aitken, D., Babcock, M., Barratt, A., Clarkson, K.C., Prettyman, S. 2017. *Flamborough and Filey Coast pSPA Seabird Monitoring Programme 2017 Report.* RSPB. http://publications.naturalengland.org.uk/file/5574008674451456

Babcock, M., Aitken, D., Kite, K., Clarkson, K.C. *Flamborough and Filey Coast pSPA Seabird Monitoring Programme 2016 Report.* RSPB http://publications.naturalengland.org.uk/file/6297001121808384

Band, W. (2012). Using a collision risk model to assess bird collision risks for offshore wind farms. Report to The Crown Estate Strategic Ornithological Support Services (SOSS), SOSS-02. http://www.bto.org/science/wetland-and-marine/soss/projects

Bradbury G, Trinder M, Furness B, Banks AN, Caldow RWG, Hume D (2014) Mapping Seabird Sensitivity to Offshore Wind Farms. PLoS ONE 9(9): e106366 doi: 10.1371/journal.pone.0106366

Buckland, S.T. Burt, M. L., Rexstad, E.A. Mellor, M., Williams, A.E. and Woodward, R. (2012). Aerial surveys of seabirds: the advent of digital methods. Journal of Applied Ecology 2012, 49, 960–967

Busch, M., and Garthe, S., (2018). Looking at the bigger picture: the importance of considering annual cycles in impact assessments illustrated in a migratory seabird species. – ICES Journal of Marine Science, 75: 690–700. doi:10.1093/icesjms/fsx170

Cook, A.S.C.P. and Robinson, R.A. (2017). Towards a framework for quantifying the population-level consequences of anthropogenic pressures on the environment: The case of seabirds and windfarms. Journal of Environmental Management 190, 113-121.

Forsythe, W.C., Rykiel Jr., E.J., Stahl, R.S., Wu, H. and Schoolfield, R.M. (1995). A model comparison for daylength as a function of latitude and day of year. Ecological Modelling 80, 87-95.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

Furness, R.W., Garthe, S., Trinder, M., Matthiopoulos, J., Wanless, S. and Jeglinski, J. (2018). Nocturnal flight activity of northern gannets *Morus bassanus* and implications for modelling collision risk at offshore wind farms. Environmental Impact Assessment Review 73 (2018) 1–6.Garthe, S. and Hüppop, O. (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology, 41, 724- 734.

Jitlal, M., Burthe, S., Freeman, S. and Daunt, F. (2017). Testing and Validating Metrics of Change Produced by Population Viability Analysis (PVA). Scottish Marine and Freshwater Science Vol 8 No 23. Marine Scotland Science.

Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resource Wales (NRW), Northern Ireland Environment Agency (NIEA), Scottish Natural Heritage

(SNH). (2014). Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review. 25th November 2014.

Johnston, A., Cook, A. S. C. P., Wright, L. J., Humphreys, E. M. and Burton, N.H.K. (2014a). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. Journal of Applied Ecology 51, 31–41 doi: 10.1111/1365-2664.12191

Johnston, A., Cook, A. S. C. P., Wright, L. J., Humphreys, E. M. and Burton, N.H.K. (2014b). Corrigendum. Journal of Applied Ecology 2014, 51, 1126–1130 doi: 10.1111/1365-2664.12260

Johnston, A. and Cook, A.S.C.P. (2016). How high do birds fly? Development of methods and analysis of digital aerial data of seabird flight heights. BTO Research Report Number 676.

King, S., Maclean, I.M.D., Norman, T., and Prior, A. (2009). Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE.

Langston, R.H.W., Teuten, E. & Butler, A. (2013). Foraging ranges of northern gannets Morus bassanus in relation to proposed offshore wind farms in the UK: 2010-2012. The Royal Society for the Protection of Birds, Sandy, Bedfordshire SG19 2DL. RSPB Report to DECC, December 2013

MacArthur Green (2015). East Anglia THREE. Ornithology Evidence Plan Expert Topic Group Meeting 6. Appendix 7- Sensitivity analysis of collision mortality in relation to nocturnal activity factors and wind farm latitude. In: East Anglia THREE Appendix.13.1. Offshore Ornithology Evidence Plan. Volume 3 [doc. ref. 6.3.13(1)]

MacArthur Green, (2015b). MacArthur Green Seabird PBA Report. https://infrastructure.planninginspectorate.gov.uk/projects/yorkshire-and-the-humber/hornsea-offshore-wind-farm-zone-4-project-two

MacArthur Green (2017). Estimates of Ornithological Headroom in Offshore Wind Farm Collision Mortality. The Crown Estate.

MacArthur Green (2018). Norfolk Vanguard Offshore Wind Farm Appendix 13.1 Offshore Ornithology Technical Appendix. [Online]. Available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-001547-Appendix%2013.01%20Ornithology%20Technical%20Appendix.pdf (Accessed October 2018).

Masden, E. (2015). Developing an avian collision risk model to incorporate variability and uncertainty. Scottish Marine and Freshwater Science Vol 6 No 14. Published by Marine Scotland Science. DOI: 10.7489/1659-1

Mather, J.R. (1986). *The Birds of Yorkshire,* Croom Helm, Kent.

McGregor, R.M., King, S., Donovan, C.R., Caneco, B. and Webb, A. (2018). A Stochastic Collision Risk Model for Seabirds in Flight. Marine Scotland Report.

MIG-Birds (2017). Joint SNCB Interim Displacement Advice Note: Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments. January 2017.

Natural England (2015). Hornsea Offshore Wind Farm (Zone 4) - Project Two Written Representations of Natural England. Planning Inspectorate Reference: EN010053. 15 July 2015.

Natural England (2017). Discretionary Advice Service (Charged Advice) on Hornsea Project Three offshore windfarm RE: Habitat Regulations Assessment (HRA) screening report. Ref: DAS2229/205871, 3 February 2017.

Natural England (2017). Natural England's advice on the Section 42 and the Preliminary Environmental Information report (PEIr) consultation for Hornsea Project Three. Ref: 10827/221825, 20 September 2017.

Robertson, G.S., Bolton, M., Grecian, W.J. and Monaghan, P., (2014). Inter- and intra-year variation in foraging areas of breeding kittiwakes (*Rissa tridactyla*). *Marine Biology,* 161: 1973-1986. DOI 10.1007/s00227-014-2477-8

SMartWind (2015). Collision Risk Modelling; Addressing Uncertainty Clarification Note. Appendix J to the Response submitted for Deadline I. Application Reference: EN010053. 15 July 2015

Thaxter, C.B. & Burton, N.H.K. (2009) High Definition Imagery for Surveying Seabirds and Marine Mammals: A Review of Recent Trials and Development of Protocols. British Trust for Ornithology Report Commissioned by Cowrie Ltd.

Votier, S.G., Grecian, W.J, Patrick, S., Newton, J. (2010) Inter-colony movements, at-sea behaviour and foraging in an immature seabird: results from GPS-PPT tracking, radio-tracking and stable isotope analysis. Marine Biology 158:355-362 DOI 10.1007/s00227-010-1563-9

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

NATURAL ENGLAND

WRITTEN SUBMISSION FOR DEADLINE 6

Written Submission of Natural England's Representations at Issue Specific Hearing 5

Offshore Ecology

Dated 7th February 2019

Hornsea Project Three

ISH 5: OFFSHORE ECOLOGY 29th January 2019

Written Summary of Natural England's Representations.

1. Natural England highlighted that there are now a huge number of documents associated with this application. The applicant has provided a number of annexes at each deadline, some of which include revised analyses, and in some cases there are subsequent revisions to revisions. As such it is no longer clear what the applicant's current position is, and how far this departs from their original ES. Natural England stressed that point is not only important for this examination, but will also be important for current and future applications which need to take account of this one in their cumulative and in-combination assessments. [NB: It would also aid clarity on requirements of post consent/pre construction design parameters and commitment]. Natural England therefore requested clarification of the applicants' current position, with signposting to the relevant supporting documentation.

2. The applicant queried if this was specific to ornithology or wider issues and stated that they would like feedback from Natural England on the documents that had been submitted.

3. Natural England clarified that it is primarily the ornithology subject they wish to seek clarification on, but also some benthic issues. It is a challenge to keep track of the revisions and how these relate to the applicants overall position and how this might affect the decisions makers Appropriate Assessment. Natural England agreed to highlight these areas throughout the Hearing.

4. The Examiner referred to Natural England's Deadline 5 response [i.e. that Natural England were unable to consider the volume of documents submitted in line with the deadline].There followed a conversation about which documents the ExA had questions on and whether or not these had been assessed by NE.

    - Appendix 4 - Second Issue Specific Hearing clarifications in relation to offshore ornithology. REP5 – 012. (Ornithologists later confirmed they had reviewed this document)

    - Trenching Assessment REP 5- 010 – Not reviewed by NE prior to ISH.

    - Revised Collision Risk Modelling – REP 4-049. Reviewed

    - RSPB response. REP 4 – 137. Reviewed

- Bowgen and Cook Appendix 14. Rep 4-035. Reviewed

- Additional HRA Screening REP4-081. (Ornithologists later confirmed they had reviewed this document).

- Revised Population Assessment – REP4 – 092. (Ornithologists later confirmed they reviewed this document).

- Biotope Classification REP4-097. NE had forwarded to JNCC – Awaiting their comment.

- Response to interested parties. Rep 5-007. Reviewed.

- Applicant's response to other interested parties responses to the ExA. REP 5-008. Not reviewed by NE Prior to ISH

- Immature Auk Apportioning. 5-014. (Ornithologists later confirmed they reviewed this document).

[NB: With the exception of the Biotope Classification document, which was with JNCC for comment, the only documents highlighted that NE had not reviewed were submitted at deadline 5 and only available on the PINS website on Thursday 24th January -i.e. less than 2 working days prior to the hearing.]

5. The Examiner then called for a 25 minute adjournment so that the Applicant could run through the benthic documents that Natural England had not yet reviewed. It should be noted that during this time the Applicant summarised REP5-010, REP4-97 and Appendix 3 - Outline Cable Specification and Installation Plan REP5-011 which was not included in the above list.

Post adjournment discussion

6. Natural England stated that given the short amount of time available to discuss key documents [submitted at Deadline 5] the views expressed during the hearing would be preliminary and provided without prejudice to any formal response provided through the written responses.
7. The Examiner queried with the applicant if the matters raised by NE were a surprise in relation to the baseline characterisation and Applicant stated that they were a surprise, but that they felt these points have been dealt with.
8. Natural England stated that although there were discussions on the original cable route and survey methodology an alternative cable route was submitted in December 2017. Natural England also highlighted that throughout the Evidence Plan Process only snap shots of data were presentment and the

applicant's complete benthic data set along the export cable was only available with the finalised application.

9. The applicant clarified that the baseline characterisation of the Wash and North Norfolk Coast was not as much of a surprise. The surprise was around other areas.

10. Natural England stated that they raised concerns regarding the PEIR at the end of summer 2017 in relation to how the assessments were to be undertaken and there were comments regarding the baseline included as well.

    [For clarity, the point here is that snapshots of information were provided within Expert working Group Meetings, so it was not possible to consider and advise on detail such as biotope classification at that time. As this detail has become available within the application and supplementary information provided through the course of the examination, Natural England (in consultation with JNCC) have advised accordingly.]

11. The Examiner queried why Natural England were unable to submit documents subject to copyright, when other parties had been able to do so. Natural England clarifi that the advice from their legal and access to information teams was that Natural England should not be submitting documents under copyright and that Natural England would need to get permission from the author [or authors] of the copyright document in order to do so.

12. The Examiner asked if the applicant could provide the papers and the applicant agreed. ExA give a list of the relevant documents to the applicant and NE, advising NE to speak to the applicant if there are any documents missing from the list that are required.

AGENDA 3: BENTHIC ECOLOGY

AGENDA 3a Additional Commitments

13. The Examiner referred to the additional commitments proposed by the applicant at deadline 4 and their Deadline 5 provision of a cable specification and installation plan (REP5 – 011) and trenching document (REP5- -010) and asked for Natural England's views.

14. Natural England explained that the applicant had rapidly explained the cable and specification and installation plan and the trenching document and need to consider these more fully. But that they were able to present an initial view on the decommissioning commitment, and the use of an Ecological Clerk of works.

15. Whilst Natural England welcomes the applicant's commitment to remove cable protection at the time of decommissioning, and would welcome the inclusion of this commitment in the conditions of the DCO/DMLs, it is important note that this should be subject to there being the available technology to do so without further causing further damage to designated sites.

16. Although the removal of the cable protection has been considered to be feasible mitigation in the past (for example Dogger Bank) there are now concerns about the feasibility of achieving this without causing further damage to site. Consequently Natural England no longer consider this commitment to constitute mitigation.

17. For example at Race Bank the option proposed for removal effectively involves ‘dredging’ the areas of cable protection. This would likely impact surrounding areas of the feature and potentially involve removing the underlying feature beneath the cable protection.

18. Natural England also notes that attempts to remove cable protection at Thanet OWF have failed and resulted in additional cable protection to that envisaged at the time of the original consent and having to install a replacement section of cable around the existing protection.

19. Therefore, it is based on information received from across the industry/s on the inability to remove cable protection that we have significant concerns about this and have therefore revised our original position on this option.

20. The examiner asked if this could result in the permanent loss of the feature.

21. Natural England confirmed that the dredging involved in removing infrastructure and the ensuing dredging of the feature would likely result in a permanent loss of the feature.

22. The Applicant pointed out that they had submitted a response at deadline 4 and will provide further information at deadline 6. The applicant went on to highlight that decommissioning will be 35 years in the future. The decommissioning tools may remove sediment now, but in the future these may well be improved to reduce the impact on the interest feature. The applicant suggested that the sand and gravel of the interest feature will recover.

23. Natural England stated that it acknowledges the possibility that the technology for decommissioning may have improved in 35 years’ time, but that this does not allay Natural England’s concerns as there is no guarantee there will be improvements to the decommissioning methods.

24. Natural England referred to the Wadden Sea ECJ case of 2004 and the reference to requirement for certainty beyond reasonable scientific doubt. Natural England advised that it was not say beyond reasonable scientific doubt that the interest features will recover. Whilst NE recognise that there is a possibility of recovery of the site and communities there is no guarantee that the same Annex 1 communities would be found in areas previously beneath the rock armour after the decommissioning stage.

25. The Examiner requested the applicant to respond to the Wadden Sea view, and the view that recovery could not be guaranteed in 35 years' time.

26. The applicant suggested that there were suitable techniques to remove rock armour [beyond those NE referred to] and that they would provide further detail in their deadline 6 submission. The applicant also advised that their positon was that even without the removal of cable protection it was possible to conclude that there will be no AEoI.

27. Natural England stated that they recognise the applicant's point on rock armour placement, but disagree on the significance of the impact.

Agenda 3. B Cable Protection:

28. The Examiner queried whether the replenishment rate would hinder recovery at the decommissioning phase.

29. The applicant explained that the 25% replenishment rate was considered within the RIAAA along with the long term habitat loss assessment. The Applicant advised that the cable specification and installation plan document sets out to clarify the footprint of the cable protection plan and the replenishment of rock protection and can be incorporated into the DML.

30. Natural England requested clarification on the 25% replenishment plan for rock protection and queried where the justification for 25% replenishment came from.

31. Applicant said they would take this query away and respond at deadline 6. The applicant went on to say it was a developing issue which has arisen in some of their other projects and 25% was the amount that was considered adequate.

32. Natural England referred to the impact assessment in the HRA and questioned whether the 25% related to 25% of the amount of cable protection specified in the DCO/DMLs or 25% of the amount of cable protection actually installed.

33. The applicant stated that the cable protection placed at the construction phase is not 100% of the cable protection, and that some of the 10% cable protection would be added throughout the operational lifetime of the project. They indicated that the 25% replenishment relates to additional rock that would be placed where the protection had winnowed away. The 25% relates to the maximum design scenario. 10% of the cable length is subject to rock protection, and 25% of that is what is assessed.

34. Natural England sought to clarify their understanding that 10% of the entire cable would require cable protection over the lifetime of the project. 25% of that 10% may require replenishment over the lifetime of the project. Natural England then questioned why the 25% had been separated out rather than added to the 10% figure to provide an overarching volume of rock, albeit without a definite location for its use. Natural England highlighted that the rock armour figures in the DCO are not based on area, they are based on volume.

Natural England went on to highlight that the Applicant needed to clarify the details of the 25%, to ensure it is dealt with appropriately within the HRA and that the volume and location of the cable protection needs to be more defined within the DCO/DML.

35. The MMO stated that the timings and quantities needed to be clarified in the DML.

36. Natural England's further highlighted a further concern that the scenario described by the applicant [within the hearing] appears to be different to the scenario described in the HRA.

37. The applicant stated that they had described the scenario from HRA, and suggested that any discussions on the DCO/DML conditions would be better placed at the DCO/DML hearing.

38. The applicant confirmed that a maximum of 10% of the cable within a designated site would require rock protection. Therefore of the total 1km of cable within the Cromer Shoal MCZ, a maximum of 10% of this may require rock protection. The MCZ and RIAA assessment are clear on these assumptions.

39. The Examiner commented that to summarise; the length of cable protection within an MPA will never be more than 10% of the length. And the replenishment would be within this 10% area and that is the maximum design scenario within MPAs.

40. Natural England: Natural England queried if the amount of cable protection permitted would decrease if there were fewer cables (e.g. With the HVDC scenario)

41. The applicant stated that the HVAC option needs to be kept open, and that is the scenario being requested to be considered for the DCO, so have considered worst case scenario (WCS) for this option.

42. Natural England accepted the applicant's comments regarding HVDC highlighted that it should be recognised that at the time of construction there will need to be regulatory control over the amount of cable protection. Should the applicant use HVDC infrastructure there should be a commitment that the cable protection is reduced equally.

43. The Examiner stated that this is a matter for draft DCO, so can be picked up in the DCO hearing.

[Natural England is unclear if this issue was fully addressed within the DCO/DML hearing]

44. The Examiner noted that in the applicant's response to ExA questions they had commented that Sheringham Shoal and Dudgeon more comparable to Hornsea Three than Race Bank

45. Natural England stated that if it could be demonstrated that Dudgeon and Sheringham Shoal were shown to have similar habitat to Hornsea 3 then this can be considered. However, the DDV video snapshots that had been presented as part of The Wash and North Norfolk Clarification note showed that consolidated mixed sediment was present that was comparable to Race Bank. Natural England highlighted concerns about the location, quantity and quality of the Dudgeon and Sheringham Shoal pre-construction survey data. [In addition NE would also highlight that different installation tools where used for these projects with Sheringham cutting into chalk.].

46. The Examiner noted that within Natural England's Deadline 4 submission they had highlighted that unexpected issues arose at Race Bank even with a post consent geotechnical survey and that this created impacts that were significantly greater than what was assessed in the appropriate assessment. The Examiner went on to ask Natural England how it would be possible to fully assess the WCS to enable consent and to deliver mitigation for this project.

47. Natural England stated that it was unlikely to be possible to assess the full extent of the WCS up front as there will always be unforeseen issues. However, Natural England stressed that it was important to be able to characterise interest features the site and associated ground conditions to gain an understanding of the likely scenarios up front to give as much certainty as possible and information suitably mitigation measures to minimise the impacts. There is inherent uncertainty in the Rochdale Envelope approach and the applicant is seeking a lot of flexibility in their approach to cable protection and sand wave levelling, which means that the impacts on designated site features are difficult to ascertain. Natural England has previously stated that there needs to be a cable burial risk assessment provided in support of the application, the aim of which should be to reduce variables to reduce AEoI., At the moment there is a high risk of AEoI due to lack of knowledge. The CSIP and trenching documents may allay concerns, but Natural England need to review it. The need for certainty beyond reasonable scientific doubt in relation to the Habitat Regulations as highlighted in case law remains an outstanding concern.

48. The Examiner requested that Natural England review the CSIP and report their conclusions.

49. Natural England stated that there are no such examples as most projects have encountered issues post consent.

50. Natural England stated that the Race Bank project that was assessed as part of the original application was so different to what was built the appropriate assessment (AA) was no longer fit for purpose. Additional AAs have been undertaken for further work however these have also not been fit for purpose because of 'unknown unknowns' that occurred during the installation.

51. In hindsight, based on the lessons learnt at Race Bank Natural England would approach the decision making process and the project as a whole very differently.

52. The Examiner asked if Natural England was on a learning curve with these projects.

53. Natural England confirmed that it was developing its knowledge of how to deal with these projects.

54. Natural England stated that their overarching position was that there is insufficient evidence to enable the applicant to demonstrate that the impacts on designated site features can reduced to an acceptable level. In the case of both the Wash and North Norfolk Coast and North Norfolk Sand Banks and Saturn Reef the sites are all annex 1 feature [i.e. there is no site fabric] with a mosaic of designated features. Whilst it is possible to identify potential mitigation options for an individual feature (e.g. avoiding reef features) may impact on other features.

55. In response the applicant stated that there were lessons learned from previous projects and that these have been incorporated within their design envelope. The applicant stated that they would need to undertake an additional assessment should they step outside of their consented envelope, and therefore requested that Natural England's comment pertain solely to their application.

56. Natural England explained that it was assessing the current design envelope and that the concern is around if the worst case scenario assessed for this project is appropriate. Previous projects have had worse outcomes than their worst case scenario had concluded, even with more data available to them at the time of application upon which to base their assessments on.

57. The Wildlife Trust commented that cabling in a designated site is an issue, particularly where the site was in unfavourable condition. The latest condition assessment for W&NNC means that the applicant needs to demonstrate that there would not be further deterioration of the site. Increased cable protection required post-consent need to be reviewed as well as the reasons for cable protection failure.

58. Natural England highlighted that the Wash and North Norfolk Coast SAC condition assessment has been published the previous day and confirmed that this was considered to be largely as a result of pressures associated with cabling and fisheries. Race Bank and Lincs OWF cables are a contributing factor. Natural England stated that subtidal mixed sediment, subtidal coarse sediment and intertidal mud and Intertidal sand and muddy sand were affected by OWF cable installation.

59. The applicant highlighted that they had not seen this information as it was just published yesterday. The reasons for Race Bank cable protection failure has been submitted in evidence.

60. Natural England stated that when parameters change significantly post consent the applicant, MMO and Natural England need to consider the impacts, potentially undertake appropriate assessments and address the possibilities of AEoI. This creates delays for the applicant and potentially incurs costs, the SNCBs have to invest a substantial proportion of limited resource and time to help resolve the issues which has implication for other OWF projects. Natural England therefore requests that the documents submitted by the applicant are fit for purpose and ensure that the need to rely on amendments post consent are minimised in order to allay further delays or costs for the developers. The variability of designated sites features/conditions make them difficult to assess. Natural England hope to finalise initial reviews of Race Bank which details these concerns before end of the examination for Hornsea 3, but cannot guarantee it.

61. The Examiner queried whether Natural England's advice was based on the applicant's cable burial assessment [Submitted at Deadline 5]

62. Natural England's understanding from discussions during the adjournment was that there is an assessment available, but they highlighted that they did not feel this would be sufficient to address concerns relating to the lack of information.

63. Natural England highlighted that they understood that there were two documents to consider. The Trenching document referred to the burial risks. The CSIP document sets how the cable will be e installed including control measures for doing so.

AGENDA 3c: Special Areas of Conservation.

64. The Examiner asked Natural England if there were any comprehensive surveys of Natura 2000 sites, that could be made available to the applicant.

65. Natural England explained that surveys undertaken by SNCBs are broad scale mapping surveys, undertaken with the aim of assessing site condition. The type of survey required in support of an application is different to the aforementioned surveys. There may be information available in relation to other development in the site such as oil and gas, but as the applicant is seeking avoid existing pipelines as far as possible it is unlikely that there will be significant overlap.

66. The Examiner asked how likely it would be that a suitable survey could be completed by April 2019?

67. Natural England stated that it was very unlikely that a suitable survey could be done by April 2019. Even if survey work were to commence immediately it would be unlikely that data could be analysed in time.

68. The Examiner asked Natural England to clarify their position.

69. Natural England advised that based on the information cannot currently rule out AEoI. Alternatives need to be considered.

70. The Examiner asked what Natural England advised their decision should be if adverse Effect of Integrity could not be ruled out.

71. Natural England stated that it was not their remit to reach a decision on behalf of the competent authority. Natural England are advising on whether AEoI can be ruled out beyond reasonable scientific doubt, which currently it cannot.

72. The Examiner stated that in their response to ExQs the applicant highlights that NE have stated that they are satisfied with the survey for the WNNC SAC.

73. Natural England stated that their previous response needed to be clarified as it was poorly worded. Under the terms of the EIA they are satisfied, however under the terms of the HRA they are not satisfied. [i.e. if the development area did not overlap any SACs or MCZs the level of coverage would be considered to be adequate].

74. The Examiner asked if Natural England's position also pertained to North Norfolk sandbanks and Saturn Reef SAC.

75. Natural England stated that additional documents had been submitted at deadline 4 with the intention of clarifying Natural England and JNCCs concerns and that Natural England intension is to respond regarding these surveys at deadline 6.

76. The Examiner highlighted that the infrastructure within Markham's Triangle has been reduced from 24% to 10% and asked what difference this would make to the array and in turn what impact has this on the Environmental Statement and how has it been assessed.

77. The applicant said they will respond to this point at deadline 6.

78. The Examiner asked Natural England if they agree that the reduction in use of Markham's Triangle and proposal to decommission will reduce the impact to the designated site.

79. Natural England suggested that they would request the relevant information from the applicant to discuss with JNCC, with a view to providing a response at deadline 6.

80. The Examiner asked for Natural England's thoughts on Applicant's suggested MEEB provided at deadline 4

81. Natural England suggested that they would also discuss this with JNCC with a view to responding at Deadline 6. However, Natural England highlighted that as there remains uncertainty in relation to the scale of the impacts it would be difficult to fully assess the suitability of any MEEB proped. In addition it should be noted that case would be a precedent for MEEB and currently there is no guidance.

82. The applicant stated that it was not necessary to use MEEB unless Natural England found MEEB appropriate. The applicant suggested that in eventuality they would require Natural England's Advice.

AGENDA 3d: Marine Conservation Zones

83. The Examiner highlighted that Natural England's deadline 4 response stated that the applicant has not conducted an MCZ assessment to clearly understand the impacts, and asked what the applicant would need to do in order to achieve this.

84. Natural England again suggested that this was a matter they would take away and discuss with JNCC with a view to provide further comment at Deadline 6.

AGENDA 3e: Cumulative Effects

85. The Examiner asked if Natural England accept that it phased build has been considered.

86. Natural England explained that there are repetitive impacts over the different installation stages and then there is phase build. .

87. Natural England questioned whether certain actions would happen multiple times to the same feature (sand bank) delaying recoverability.

88. Natural England stated that the impacts may be greater resulting from this. It is not clear from the application that it has been considered.

89. The Examiner commented that the Applicant had stated at deadline 1 that this has been considered.

90. Natural England: Natural England stated that there were different aspects to the examiners' written question under consideration and that these appeared to have been conflated. Natural England's response to the question therefore sought to clarify this confusion, rather than state a position. As there potential for further confusion, Natural England will take this away and will clarify this for deadline 6.

91. The Examiner referred to the GIS data submitted by Natural England at deadline 4. The Examiner could not access the GIS files, and queries whether there had been any additional information to accompany this.

92. Natural England explained that their submission within their email submission GIS files there were also two additional documents provided that should provide this information. It was Natural England's intention that these would be added to the PINS website together, however, one of the PDF documents had corrupted resulting in the three document being saved separately with the revised copy of the corrupted file being uploaded as a late submission.

93. The Examiner stated that he will look at the document over lunch and advise if the documents need resubmitting.

    [This was not raised again after lunch, but NE are happy to resubmit this information if required]

94. The applicant stated that they had looked at the updated reef layers. To resolve some of Natural England's concerns the cables will avoid sensitive

areas in those layers. The applicant mentioned a DCO amendment for identifying areas for temporary work.

95. Natural England stated that it is important to recognise that this reef layer is intended to highlight the areas that JNCC and DEFRA have identified to be managed as reef in response to the feature's unfavourable condition.

AGENDA 4. MARINE MAMMALS

[AGENDA 4a - No comment from Natural England]

4b: Site Integrity Plan

96. Examiner referred to the fact Natural England has highlighted that JNCC piling protocol is outdated, flagged alternative such as the European approach and asked if it was reasonable to expect the Applicant to review alternatives.

97. Natural England stated that there was no marine mammal specialist present, therefore would answer as far as possible or respond at deadline 6.

98. In relation to the question, Natural England suggested that a range of possible mitigation measures would need to be considered in the draft SIP, highlighting any options that would be unsuitable in the specific context of the project, whilst leaving it open for new mitigation to be considered and added as the technology develops. It is important that the SIP is a robust document, but that it also viewed as a live document. Natural England is waiting for guidance on SIPs from BEIS and the MMO as part of the RoC, and expect that this will set a template for what should and shouldn't be included.

99. The applicant clarified the difference between the SIP and the MMMP. [The latter being more prescriptive].

100. The Examiner queried if everyone was in agreement with the SoCG.

101. The applicant stated that they were in agreement with the MMO and NE, except for some regulatory matters. The MMO will finalise the regulatory process.

102. Natural England stated they were largely in agreement with the SoCG. There are a few minor to moderate issues to be resolved, but the main concern is the in-combination impacts. The intention is that these will be dealt with through the SIP process, but Natural England has some outstanding procedural concerns in relation to the mechanism to enable regulators to consider the impact of multiple SIPs occurring over varying timescales.

103. The Examiner question whether this issue was outside of the scope of this hearing.

104. Natural England stated that as this stood an adverse effect on site integrity in combination could not be ruled out, should a number of noisy activities occur in the site concurrently. Therefore procedural elements need to

be in place to ensure noisy activity does not happen at once. The SIP alone does not provide this certainty.

105. The Examiner asked Natural England if it was likely or possible that all noisy activities would occur at once

106. Natural England clarified that it would not necessarily need *all* noisy activities to take place at once and that particular combinations of the existing consented activities could take us beyond the SNCB threshold.

107. The Examiner asked if Natural England are content with the MMMP conditions.

108. Natural England said they did not have specific notes on it from their marine mammal specialist, which suggested they are content, however, this would be made clear in the updated SoCG provided at deadline 6.

AGENDA 5 OFFSHORE ONRITHOLOGY

109. NE highlighted that the views expressed on deadline 4 and 5 submissions are preliminary and will confirm their position. Once they have had the opportunity to fully review the documents.

AGENDA 5 a. Road map

110. The applicant has updated the roadmap in response to Natural England's feedback.

111. Natural England stated that they did not have the opportunity to review and comment on the Roadmap prior to its submission at deadline 3.

112. Natural England have provided a list of outstanding key information to the applicant which we also submitted in an Annex to REP4-130 (which was originally provided in our written rep). This list represents key information that Natural England would expect to be provided as an audit trail in support of an application, and is important to allow us to provide advice, to enable the competent authority to undertake their assessments in line with our advice, and for future projects to be able to take account of this project in cumulative and in combination assessments.

113. Natural England therefore think that it is important that this Roadmap incorporates this list and signposts to where this information can be found within the applicants submissions.

114. The applicant stated that they maintain their position of no AEOI. The applicant has now provided an additional analysis which exclude boat based data based on Natural England's advice, and they have also considered Natural England's points on apportioning, flight speeds etc within this additional analysis. Data is displayed in the tables in Appendix 28 (of their deadline 4 submission [REP4-049]. The applicant requested feedback from NE

on this additional analysis and sought clarification regarding Natural England's position regarding AEOI. Should NE reach a conclusion of AEOI, the applicant requested that NE provide an indication of the level of mitigation required.

115. Natural England stated that it made its position clear at the last hearing and in written submissions. Natural England cannot rule out an adverse effect on integrity (AEOI) in particular for the Flamborough and Filey Coast SPA and potentially for other designated sites given Natural England's previous comments on the Applicant's LSE screening.

116. Natural England went on to highlight that the decision regarding the acceptability of the baseline data ultimately rests with the SoS as advised by the Examining Authority. Therefore in acknowledgement for this, Natural England has sought to be helpful by providing detailed advice on the methods, parameters and analysis to ensure the approach was in line with current SNCB guidance (notwithstanding the baseline concerns) .

117. Natural England cannot ascertain no AEOI due to lack of information. Natural England cannot advise on the level of mitigation required for an unquantified impact.

118. Natural England stated that they have fully engaged throughout the process and will continue to provide advice. Natural England always look to be constructive in their engagement and advice.

119. Natural England stated that they will engage in the roadmap process [in order to ensure that information is presented to allow the competent Authority to undertake an analysis in line with SNCB advice]. Natural England can advise on the outputs of the applicant's revised analysis and their implications, however Natural England cannot quantify the collision numbers or displacement effects with any certainty. To do so would be irrational given Natural England's position regarding baseline data. Based on experience, where Natural England has provided advice on estimates using data it considers unsatisfactory it is likely to be quoted as Natural England's position by developers and used in future project applications. Therefore Natural England do not believe it is possible for them to provide any form of quantification on a without prejudice basis.

120. Natural England will engage in a roadmap process with the Applicant, to ensure that assessments are undertaken in line with SNCB guidance. Natural England did highlight that an incomplete baseline was a risk during the evidence plan process, and that Natural England may not be able to conclude no AEOI

Agenda Item 5 B Collision Risk Modelling.

Agenda Item 5 b i: General issues

121. Natural England: Natural England stated that in the Applicant's document (appendix 28 deadline 4) figures are given on the key species subject to collision risk. Appendix 28 contains an "alternative analysis" which

the Applicant states “presents updated risk assessments using the most precautionary assumptions proposed by Natural England”. Natural England does not agree that this “alternative analysis” accurately reflects Natural England’s advice on the collision risk modelling. For example, Natural England advised that Option 2 of the Band Model should be used in the collision risk model assessment, however the tables provided also contain figures from Band Model Options 1 and 3 in the “alternative analysis”. It is not clear what evidence aligns to Natural England advice within the document. The applicant has presented collision risk modelling figures that follow Natural England advice within the document, but it is not clear to the reader where that information is presented.

122. Natural England: Natural England confirmed the applicant has included a column in the Tables in Appendix 28 that is the applicant’s position, which for the project alone figures is the RIAA (APP-051) ,. However, the applicant has submitted a number of additional papers since submission of their ES and RIAA which modify the assessment compared to that outlined in their ES, so their overall position regarding the assessment is no longer clear.

123. Natural England stated that whilst some of the information within the tables would be in line with SNCB advice, some for the parameters were not, for example, the tables also include Band Model options that are not in line with SNCB advice, Avoidance rates that are not in line with SNCB advice etc.

124. Overall, it is possible for an NE Ornithologist to pick out information that would relate to SNCB advice, but for most people this would be very difficult to find.

125. The Examiner highlighted that he has previously asked for the data to be presented as per NE’s advice. Therefore the Examiner requested that the Applicants position and Natural England’s positon are presented as a side by side analysis.

126. The applicant committed to provide this at deadline 6.

127. The Examiner requested that Natural England and the applicant come together to discuss how to define the rows and columns of a revised table or set of tables. [N.B. Action completed in the break].

128. Natural England stated that it is possible to use the confidence intervals with the collision risk data tables. [Discussed in the break].

129. The Examiner queried why NE advice on flight speed appeared to be different to Scottish Natural Heritage (SNH).

130. Natural England stated that cannot comment directly on Scottish Natural Heritage (SNH) cases.

131. Natural England’s understanding is that SNH have not formally advised the use of flight speed data from Skov et al (2018) for use in collision risk modelling, and that in the particular case being referred to, SNH also

considered collision risk predictions that used flight speed data from Pennycuik (1987,1997)/Alerstam et al. (2007) which is the source of flight speed information typically used by OWF developers in Scotland

132. Natural England accepts that there are now lots of reports available which include information on flight speeds and that a review is needed of appropriate flight speeds to use for Collision Risk Modelling, but this needs to be based on all of the available information, and not just a single study or set of outputs. There is no evidence that any single published set of figures is more appropriate than the current set,

133. The examiner asked a question about migratory species and the array, and whether this had included consideration of all relevant species.

134. The applicant advised that this was dealt with at the pre-application stage.

135. Natural England advised that they have commented on the suite of migratory species, stating that it does not appear to be a comprehensive list and asking for more information regarding how it was derived. Whilst we acknowledge that the figures for additional species may be very low for this project alone, this information is still needed to calculate the cumulative effects. There will be species that are subject to collision impacts elsewhere and this project could add to the cumulative or in-combination total. . Natural England had queried where the applicant had sourced their list, as it is a more restrictive list than has been generated for other projects.

136. The applicant confirmed that their list was based on previous projects e.g. Hornsea 2, and that they were satisfied that they had included all species that would be affected.

AGENDA 5 b ii: Flight Height

137. The Examiner asked Natural England to confirm if they agree with the applicant that Johnston et al. 2014 et al. is the accepted paper on flight height.

138. Natural England confirmed that they agree that Johnston et al. 2014, the corrected version, is the accepted paper on flight height.

139. The Examiner highlighted that Skov et a.l noted flight height of gannets below the rotor height of the array and that kittiwakes and large gulls were noted to fly at rotor height. Flight height higher than previous studies. The Examiner asked why this had not been used by the applicant.

140. The Applicant stated that the ORJIP bird collision and avoidance study [Skov et al] was looking at avoidance behaviour of birds. It wasn’t trying to obtain flight height distribution for use in collision risk analysis. We don’t know how to convert to use for analysis and is a behavioural study rather than quantification.

141. Natural England stated that this paper highlights the variability between sites.

142. Natural England stated that knowledge on parameters that affect variability in collision predictions has influenced the development of the stochastic model. This includes parameters such as flight height and speed of turbines.

143. The Examiner asked Natural England which factor has the greatest influence on a stochastic model.

144. Natural England stated that there are differences between the Basic and Extended versions of the Band Model with respect to sensitivity to input parameters:

145. The Band Model - density of birds, flight speed and flight height have the greatest influence.

146. The Extended Band Model - flight height, hub height, bird density and turbine rotor speed have the greatest influence.

147. The Examiner highlighted that Band suggests that site specific flight height information should be used over generic flight height information. Does NE's position mean you disagree?

148. Natural England advises that where there is appropriate site specific information on flight height behaviour this should be used for CRM, however at Hornsea Three the flight height data come from earlier Hornsea Zone boat based surveys and Natural England have previously raised issues with the methodology used to derive flight height statistics from these data. Additionally, Johnston and Cook (2016) suggest it is not appropriate to use the Extended Band Model when combining boat based flight height data and Digital Aerial Surveys (DAS) density data. Natural England advocate using Johnston et al. (2014) generic flight height data with Option 2 of the Basic Band Model for the Hornsea Three CRM.

149. The Examiner referred to the LIDAR data provided by the Applicant.

150. Natural England stared that they welcome new data and papers that provide evidence to inform collision risk modelling. Using LIDAR is a novel approach to assess height information. It was a pilot trial to test a system. Most were not identified to species level, therefore it is difficult to draw conclusions on flight heights at a species level. Neither the method, nor the data derived by the Applicant has been reviewed in detail in terms of robustness.

151. The Applicant stated that their position is it is good data. They clarifies that they were not relying on LIDAR data per se. but that it was presented as further evidence of the applicability of the data they do rely on.

152. The Examiner highlighted that the guidance says that generic flight height data should not take precedence over site specific data and questioned whether Natural England's advice was contrary to this.

153. Natural England stated the approach is not contrary to guidance. If there is robust site specific information on flight height then this should be used. However, the applicant is using flight height data from previous boat surveys of the Hornsea Zone. Natural England raised a number of issues with the methodology used to collect and analyse these data and made a number of submissions in the Hornsea Two examination. Hornsea 3 data on flight heights it is not as extensive and not contemporary with the bird density data which was collected using a digital aerial platform.

154. When it was found that the DAS data could not be used to derive flight height information, Natural England advised that option 2 would need to be used.

155. Applicant stated that NE considered the information adequate to use Band option 1 for Hornsea 2.

156. [Whilst Natural England did not comment on this point in the hearing, we would urge caution in consideration of the outcomes of other examinations without full sight of the context]

157. Natural England confirmed their positon that Band option 2 should be used for collision risk modelling.

158. Natural England: Natural England does not believe that the LIDAR methodology has been validated so it would be a leap for the applicant to state that this validates the boat based .There have only been a few studies with LIDAR data. Until recently we had a widely accepted methodology for using DAS to derive flight height which has now been shown to be invalid, so this demonstrates the need to fully evaluate methodologies prior to accepting them.

159. The Applicant clarified that they were not seeking to present the LIDAR data in place of the data used in their ES, but for use in support of the data.

AGENDA 5 b iii Flight Speed

160. The Examiner asked Natural England if they accept that Skov et al is more representative than Pennycuick because they measured a considerably larger sample size.

161. Natural England stated that they do not accept that Skov et al. is more representative just because it has more data points. This does not necessarily mean a higher number of birds sampled, it is not clear what the sample sizes for the flight speed data are in Skov et al (2018), but it appears that there data were derived from rangefinder track positions that may relate to nodes on the same bird, such that the same birds may have been sampled multiple times.. Natural England also highlighted that there were a large number of variables that had not necessarily been considered in Skov et al (2018) such as weather conditions, time of year etc, Natural England therefore does not consider it appropriate to derive flight speeds solely from Skov et al (2018).

162. The examiner questioned if the study NE recommends was representative as NE stated the study has a sample size of 18 birds.

163. Natural England stated that there are issues with all data. Natural England accepts that there are now a number of sources of empirical data on flight speeds available and that these show that there is high variability in flight speeds and that it is probably more appropriate to present this information as a range. There is a recognised need for a review of the evidence on flight speeds and also to use the stochastic CRM model, which would allow parameters like flight speed to be inputted as ranges.

164. The flight speed information from Pennycuick/Alerstam has been used in previous OWF project collision risk models to date There is certainly a need for a review to derive more robust flight speed parameters, but this should be based on a review of all of the information available, not just a single study.

165. Natural England highlighted that Skov et al. (2018) does not represent a correction for species flight speeds. It is a separate data set. The information come from a study that was not designed to measure flight speed information for seabirds. It does not provide clear information about the number of birds sampled, or whether the birds were recorded in the breeding or non-breeding season etc. It is not an SNCB position to recommend the Skov et al. (2018) flight speed data for collision risk modelling.

AGENDA 5 b iv: Avoidance rates

166. The Examiner asked for Natural England's views on Bowgen and Cook as mentioned in Q2.2.19.

167. Natural England pointed out that in REP1-088 the applicant said that Skov et al. (2018) Empirical Avoidance Rates could be used in Band (2012) collision risk models. Subsequently in Rep5-008 the applicant said this is incorrect.

168. Natural England stated that Bowgen and Cook (2018) is an externally commissioned evidence report by the JNCC. It was commissioned in order to explore whether avoidance rates could be derived from the work presented in Skov et al (2018) that were compatible with collision risk models such as the Band (2012) Model. JNCC and the SNCB's are in the process of reviewing this report and the implications it has for SNCB advice on collision risk modelling.

169. The applicant stated that their position is they used the ORJIP study and that they believe that Bowgen and Cook is the best available evidence for avoidance.

170. The Examiner asked the Applicant: NE said you used higher avoidance rates in CRM. Is this true and have you also used in the RIAA?

171. Applicant stated that the 98.9% avoidance rate was used. The 99.2% value was better than 99.8%. THE ES and RIAA used 99.8 and 99.2 in the CRM.

172. Natural England stated that it wasn't clear in the RIAA what avoidance rate was used.

173. [Table 7.17 in the RIAA which gives the collision impacts for kittiwake at FFC SPA only lists figures for a 99.2% AR for the Basic Band Model and then 98% for Option 3. So there is no value given for an 98.9% AR which is the SNCB position for use with the Basic Band Model]

174. The Examiner highlighted the RSPB query on the 98.9 associated with large gulls. (RSPB were not in attendance at the hearing).

175. Natural England stated that there was some debate about which was the most appropriate avoidance rate to use for kittiwake based on the Cook et al (2014) work. Cook et al (2014) were not able to derive a species specific avoidance rate for kittiwake so they suggested using an avoidance rate calculated for "small gulls" (mostly black-headed gull and common gull). Cook et al (2014) also calculated avoidance rates for the grouping "large gulls" and for a combined "all gull" category. The SNCBs reviewed the evidence and given the lack of species specific information available for kittiwake advise that the pooled "all gull" avoidance rate (98.9%) is used for kittiwake.

AGENDA 5 b v: Nocturnal Activity Factor

176. Natural England stated that bird activity was highest during the mornings and evenings. Surveys on bird activity are usually carried out during the middle of the day therefore generally miss the times of higher activity levels for species. As nocturnal activity is calculated relative to day time activity, this bias in the daytime survey data will also affect the calculation of nocturnal activity levels.

177. The Examiner cited a number of papers that state different levels of nocturnal activity, stating that there is no consistency.

178. The Applicant stated that there is variation in bird behaviour so it stands to reason that there would be variation in different studies. However there is no massive variation in the studies stated level of nocturnal bird activity listed, suggesting that ultimately they are correct.

179. Natural England stated that in the applicants environmental statement they made the assumption that gannet nocturnal activity is zero, which is not correct as the evidence shows gannets can be active between sunset and sunrise.

180. Applicant stated that Natural England advised NAFs are presented in Appendix 28.

Agenda c: Cumulative Assessment:

181. ExA Q: Correction factors – headroom issue. Applicant noted that that headroom is not an issue for windfarms which are already constructed.

182. Natural England stated that is not sufficient for the Applicant to base their assessments on a 'most likely scenario' and that where they seek to redefine project parameters they should provide evidence that options they are assessing are legally secure and that further changes are no longer possible. The approach to making revised assessments for these projects would also need to be agreed.

183. Applicant stated that Appendix 4 (Rep 1.148) at Deadline 1 covers this issue.

184. Natural England highlighted that within this appendix, the applicant was making a series of assumptions regarding other projects and revising the parameters in accordance with these assumptions. Natural England advise that confirmation is needed from regulators (MMO and BEIS) that these assumptions were in line with their understanding.

185. The Applicant highlighted that there was no means to obtain confirmation from regulators.

186. Natural England pointed to the Applicants REP1-148 assumptions and said the MMO would need to agree that the parameters that the applicant were seeking to define for other projects were legally secured for projects in English waters (and MS-LOT for Scottish projects).

187. Without proof from the relevant regulator Natural England stated that it cannot make an assessment on changes that they cannot confirm are legally secure. The regulator needs to define the worst case scenario (WCS), or the default is to go with what has been consented.

188. [N.B. For clarity, once receiving confirmation of the legally secured project parameters, any subsequent CRM/Displacement analysis would need to be agreed]

189. Natural England stated that it is common for a developer to seek a change to their consent, for example to enable them to use a smaller number of larger turbines. These requests to date have been considered to fit within the existing Rochdale envelope so an additional assessment has not been required. It is important to note at this stage, the developer is not taking options off the table, therefore the worst case scenario has not actually changed. It is important not to confuse likely scenarios with the WCS that is legally permitted through the consent.

190. Additionally Natural England highlighted that whilst other projects had made small adjustments to the collision figures presented by other projects, the Applicant was seeking to make extensive revisions to multiple projects.

191. Natural England highlighted that this discussion exemplified why Natural England does not want to present figures, as advice given on a without prejudice basis seems to be taken as our acceptance. In the case of Hornsea 2 it is important to note that the consent was scaled back significantly during the examination process.

192. [For clarity, it should be noted that in past cases, project parameters have been known to change significantly through the course of an examination. Given time constraints, it has not always been possible to address all aspects of the SNCBs advice in the context of those revised proposals. In these kinds of situations, Natural England may have not agreed with the applicant's approach to their assessment, but may have considered that the overall outcome would not be substantially changed by following the SNCBs advice in that particular instance. However, Natural England are now finding that this approach, whilst intended to be helpful, can lead or has led to unforeseen issues both in terms of how those outcomes are interpreted by other applicants, as well as challenges they may present when assessment are updated post consent in relation to condition discharge or licence/consent variation.]

193. Natural England: Natural England stated that there needs to be clarity and consistency around how the revised parameters are assessed. If the number of turbines are halved it does not mean that the collision risk is halved as typically a larger turbine is used. This is an over-simplification.

194. The applicant argues that if you plan for 100 turbines and build 50 turbines the model will predict half the effect. Projects that are currently operational have not been built to WCS.

195. Natural England stated that there are not many cases where there has simply been a reduction in turbine numbers. Often the capacity of the Windfarm remains the same despite the reduction in turbine number, and there are other factors to consider such as the change in rotor swept area.. You cannot simply take collision figure data from the environmental statement and scale it based on numeric reductions in turbine numbers.

196. The Examiner requested that Natural England comment on the Applicant's comments on Q2.2.38 of their Deadline 4 Submission at deadline 6.

AGENDA 5 d Biological Seasons.

197. The applicant response to Q2.2.25 lists additional information that the applicant is requesting in relation to Biological Seasons.

198. Natural England feel they have responded adequately already to Q2.2.25, but will review this again and comment at Deadline 6.

199. Natural England stated that the difference in evidence sources (between NE and the applicant) used to define breeding seasons arise due to a divergence in what constitutes a 'breeding season'. NE advises that a full breeding season (at the colony in question) should be defined, while the applicant seeks to identify a 'core' breeding season that defines months where only adults from the colony will be present at the project site.

200. The Examiner highlighted that Applicant's approach to define core breeding seasons and asked for Natural England's view

201. Natural England understands the applicant's logic however Natural England does not agree with this approach. Limiting the period to a 'core' breeding season results in the apportioning rates being considerably lower.

202. A different apportioning rate may be needed for the 'shoulder' months extending beyond the core breeding season to avoid over-estimating the effects.

203. Natural England has not been given information on the 'shoulder' months concept.

204. Applicant stated that the 'shoulder' month's concept was not discussed because it was rejected.

205. The Examiner commented that the tracking data showed that there was a small number of kittiwakes in array area. 25 individuals in a 9 year period.

206. Natural England noted that this was an RSPB submission at deadline 5, and as such had not been fully reviewed by Natural England. Natural England noted that it is a large colony of kittiwakes, with a small number of tracked birds. This means that tracking just demonstrates how far they can forage and that they do use the Hornsea 3 area. There is no indication of the amount of use of the array area.

207. The Examiner asked why LSE was not de-minimus.

208. Natural England explained that we do not know what proportion of the FFC population use Hornsea 3 area. For large sections of the colony we have no data, such as there is no tagging from considerable sections of the colony

209. The Examiner queried whether tracking different parts of the colony would reveal different behaviours.

210. Natural England explained there was 3 issues:

a. Temporal: Ideally birds would be tracked throughout the breeding season, from pre-egg laying to post fledging.

b. Spatial: good spatial representation of the colony is needed, including tagging from the centre of the colony.

c. Presence only: Tagging only gives you positional data on presence, it doesn't tell you where birds are absent

211. The Applicant argued that this is the best available evidence. This is a long data set and can infer level of importance.

212. ExA Q for Applicant: Displacement mortality – NE requested this in December 2017.

213. Natural England stated that as previously advised, the baseline data that informs the displacement assessment presented in the ES is inadequate.

The applicant has presented an ‘alternative baseline’ Appendix 28 at Deadline 4, which is based on an incorrect interpretation of our advice. Natural England in their written representation advised that we would place ‘greater emphasis’ on the upper confidence limits of the population estimate data, whereas the applicant has combined UCL and mean data to present the ‘alternative baseline’.

214. Annex 4 Rep 4.1.30 specify what we require for the displacement data. (Requested in Annex 2 as part of that representation.)

215. ExA: Q2.2.24 definition of biological seasons may influence collision risk. Can you confirm collision risk would increase if seasons defined by Furness or Natural England were used to inform apportioning

216. Applicant accepts that change in season would change the collision risk.

AGENDA 5 e Apportioning rates

217. The Examiner asked if Natural England have any comment on the applicant’s submission on the Apportioning of immature Auks.

218. Natural England noted that the apportioning approach was requested by the RSPB, but can present comments for deadline 6.

219. The Examiner asked for Natural England’s opinion on the applicant’s age class data.

220. Natural England highlighted a number of points on this subject:

221. Data used to inform age classes. DAS data for Hornsea 3 is the preferable data set. We welcome age class data from DAS.

222. In reference to initial apportioning rates used by the applicant, there are issues around puffin and kittiwake. Natural England does not agree with the use of first year survival rates to backward calculate survival rates.

223. Ages class data from DAS – Rep 4 Annex 2 natural England has a query on apparent discrepancies in the DAS age class data

224. The applicant explained that the approach to apportioning used for kittiwake and puffin in the RIAA was accepted by Natural England at Hornsea 2.

225. Natural England highlighted that whilst they accepted a reduction in the apportioning value for kittiwake at Hornsea 2. We did not necessarily accept the approach used to reach that conclusion.

226. Natural England’s preference would be to see age class DAS for razorbill and guillemot.

227. Natural England stated that they had previously seen DAS data suggesting auks had been aged but cannot comment further.

228. The Examiner referred back to the comments made earlier in the meeting in relation to apportioning and the applicant said that NE discounted the shoulder months for the breeding season.

229. Natural England stated that this was mentioned in an evidence working group meeting– However we can't find evidence in the meeting minutes or our notes that this was followed up by the applicant.

AGENDA 5 f Population viability analysis

230. The Examiner asked for NE's view on the revised PVA

231. Natural England stated that the applicant submitted an update in REP4-092

- Natural England requested information on the demographic rates used in the models – The applicant has done this.
- Natural England had queried why the Applicant had not been able to undertake a matched-runs approach with the density dependent version of the models when other publications have presented matched pairs for density dependent models.
- Natural England were surprised that the number of simulations in the stochastic population viability analysis (PVA) model versions done by the applicant were quite low. Natural England consider that a larger number of simulations would potentially be needed to generate reliable results.
- Natural England had asked the applicant to recalculate the counterfactual metrics using a matched-runs approach. The Applicant had argued that their previous analysis showed no difference between matched and unmatched runs which was unexpected as other work suggests that there should be a difference The applicant has now presented the counterfactual metrics and associated confidence intervals for matched and unmatched runs for the density independent models and these do show differing results. As far as Natural England can tell this analysis is satisfactory for the density independent models.

232. The Examiner asked what Natural England's outstanding issues were and if more simulations needed to be done.

233. Natural England confirmed that they would like more simulations to be carried out to demonstrate the reliability of the output. The demographic data has not been updated and this needs updating.

234. The Applicant stated that it is not essential for them to update the data.

235. Natural England confirmed that they did not use the density dependant models for kittiwake and gannet in previous assessments.

236. Natural England stated that after the last round of ISH there was an updated Statement of Common Ground (SoCG). The applicant has sent Natural England a draft of the SoCG which will assist in closing down these issues.

237. The applicant highlighted that Natural England's view appears to be contradictory. On the one hand asking for more information in line with their advice, and on the other complaining that there is too much information to review.

238. Natural England stated that they want to engage to ensure that the competent authority can consider Natural England's advice when undertaking their HRA and that is why we are asking for the additional information. Natural England is now receiving the additional information which has been requested throughout the process [i.e initially requested in the Evidence Plan process] but in addition to that this is a large amount of new information (that we have not requested) that we are being asked to evaluate.

239. The applicant stated that meaningful engagement with Natural England in meetings would be best rather than communicating during hearings.

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

NATURAL ENGLAND
WRITTEN SUBMISSION FOR DEADLINE 6

ISH5 Annex A: Natural England's Comments on REP 4 097 Biotope Clarification paper as requested at ISH 5.

Dated 7th February 2019

Natural England's Comments on REP 4 097 Biotope Clarification paper as requested at ISH 5.

Natural England have reviewed this clarification paper in consultation with JNCC, and we do not consider that it sufficiently addresses our concerns.

The issue remains that SNCBs (NE & JNCC) do not consider that the processes the applicant took to reach their biotope results to be scientifically rigorous. Whilst we accept that the conclusions appear consistent with the JNCC/Cefas biotopes, this does not necessarily indicate that they are correct.

For example, JNCC could have found ApriBatPo, and the Applicant could have found the same in a similar area. To get these results, there could be several things happening:

1) Both sets of survey methodologies and accuracies allowed analyses to show the same conclusion
2) One set of survey methodologies and accuracies was as above, and the other set could show the same result, albeit artefactually from incorrect analyses or poor evidence

Within our submissions to date, we've maintained that we can't tell which situation is occurring. The Applicant's habitat mapping could be correct, but because the processes through which they analysed their data is somewhat different to the standard set of analyses undertaken with survey evidence we are unable to establish this.

Consequently, as per our response to The Examiner's Question in ISH 5, we are unable to confirm that the assessment of the baseline for North Norfolk Sandbanks and Saturn Reef SAC is appropriate.

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

NATURAL ENGLAND

WRITTEN SUBMISSION FOR DEADLINE 6

ISH 5 Annex B: Natural England's comments on REP5 – 010 Preliminary Trenching Assessment (PTA)

Dated 7th February 2019

Natural England's comments on REP5 – 010: Preliminary Trenching Assessment (PTA)

Summary

1. Whilst these comments are provided in the spirit of trying to find common ground; it should be noted, that it may not be possible, even with the potential provision of further information, to satisfactorily address all of our nature conservation concerns and thus change our advice/position as set out in our Written Representations at Deadline 1. However, this is not to say that any further information and/or revisions wouldn't help inform any risk based decisions made by the competent authorities.

2. Natural England is in the process of seeking further advice from our geologist on the ground modelling outputs, but thought it would be helpful in the interim to provide our initial comments.

3. We believe that this document provides some of the necessary information to determine the likelihood of achieving cable burial, but as it stands it falls short of being able to change our position, as the burial assessment does not go far enough in considering the potential burial risks.

4. The document states there are various cable tools that could work in each soil type, but does not give an indication of what % change of burial it thinks this will lead to given the options. If would be helpful to gain a better understanding of this.

5. Whilst we think the lessons learnt are good; but they haven't been translated across sufficiently to look at analogous soil types in each section and whether the lessons learnt and proposed solutions (which are scant aside from gathering more data) will reduce risk of cables not being buried and by how much.

6. What we would like to see included is:
   - the % chance of burial evidenced in each section of the route through the MPAs using the geotechnical information and experience from other projects;
   - where the Applicant has high confidence that cables can be sufficiently buried evidenced and where it is realistically lower ;
   - Agreed, High, Med, Low risk of burial across sections of the cable route; and
   - The sections broken down into the sediment/habitat types/characteristics.

7. In addition there is no discussion on how the Applicant will ensure that the successful contractor will be able to deliver on the ground what is set out in this document– this is needs to also be considered in both the Cable Specification and Installation Plan (CSIP).

Detailed Comments

8. Section 1.2: This assessment is based on the Applicant's knowledge of the site, but because some of the geophysical data has not been available to Natural England we are unable to agree with all of the conclusions. Therefore we are still considering the confidence level of evidence presented and survey intensity and will provide further comments in due course.

9. Section 3.1: It should be noted that the whole of the MPAs are designated features and therefore we query why are only parts of the designated sites being considered?

10. Section 4.1: This section makes assumptions in relation to our concerns and doesn't acknowledge mixed sediment. With further input from our geologist we hope that we might be able to be clearer on where we think there may be more of an issue.

11. Section 4.1: Ground modelling – we are still in the process of considering how much confidence we have in the modelling. But it would be helpful to understand how similar it is to modelling undertaken for other projects that have already constructed. At 4.3 it is stated that ground modelling is iterative and is effectively only as good as the data available which then begs the question - how much more is needed to ensure the conclusions are sufficiently robust.

12. Section 4.1: Whilst we welcome the further work The Applicant has undertaken we will need further information before we will be able to provide clear advice if it is sufficient to allay our concerns or not.

13. Table 4.1: We haven't seen the detailed output from the geotechnical surveys undertaken in 2018 within The W&NNC.

14. Figure 4.1: There seems to be more focus on geotechnical investigations along the dog leg outside of The W&NNC SAC/ Cromer Shoal MCZ and question whether there is a reason for this. We note that the geotechnical surveys are away from the near shore and where EIFCA found suspected cobble reef, which is more likely to be a challenging area for cable burial.

15. Table 4.2: JNCC is not aware of Edmond Ground being referenced in NNSSR. It would be good to get confirmation as to whether the Applicant would expect to encounter that formation either (a) on the surface (presumably not) or (b) when clearing sand waves, i.e. is there any way in which that formation will end up on the surface? We advise that Botney Cut and Bolders Bank are much more familiar and their description seem consistent with everything else previously noted for the site.

16. Bolders Bank is the still till that would be the most difficult to trench through. JNCC is currently checking to see if they have further information on the formations and their stiffness / trench-ability. We believe that the Bolders Bank formation is about 5-10m down, so that would suggest there may be some interaction.

17. Figure 4.2: We are concerned about the consolidated mixed sediment/geogenic

reef that we saw on the DDV data within the NNS SAC (close to the Dalek arm). That area could potentially be a more difficult area to install cables and one where rock armouring would be a concern.

18. Section 4.4: It would be helpful if the geophysical survey data for W&NNC were presented

19. Section 4.5: In the Applicant‘s opinion, how would the structure-less chalk likely behave when trenching occurs? If it is structure-less, but still consolidated like mixed sediment we would highlight that this particular substrate is likely to be difficult to install cables in.

20. Section 4.8: There is an issue about visibility of base layer in the geophys. layer which adds uncertainty, but it is unclear how much. Could the Applicant provide more clarity?

21. Section 4.33: It would be useful to understand how this chalk differs from parameters for Thanet chalk where inter-array cables could not be buried. Is the applicant’s view that it is softer?

22. Section 5.1: A cable burial risk assessment would also take into account the risk posed to the cables if insufficiently buried. This will be different depending on the sediment type and the activities occurring in particular areas. For instance there may be limited activities so lower risk, or lower likelihood of bigger vessel with larger anchors in shallow water due to limited vessel draft.

23. Section 6.2: We would welcome evidence that Sheringham and Dudgeon cables are in similar sediment/ geology types. Statements in this section are not supported by evidence. Also Sheringham used a cutting tool to cut a grove in the chalk which provided natural protection around the cables. Exit pits seem to be a problem on several projects and it would be useful to understand why, and if something can be done to minimise the impacts and need to protect. Also for Sheringham and Dudgeon there is limited survey data prior to construction and afterwards to compare against as there wasn’t an MCZ at the time of agreement on the scope of monitoring and the pre-construction survey data for Sheringham was considered unusable by Natural England.

24. Race bank lessons learnt: This section is very useful and characterises the issues encountered, but does not state how they will be resolved or increase chances of burial for Hornsea Project 3 cable aside from gathering more information. We need to understand whether gathering more information will just yield more understanding of where burial is likely to be a problem pre installation, or whether it will increase the chances of burial because something can be changed or done differently. It also doesn’t evidence how analogous soil types on Hornsea Project 3 cable route are compared to Race Bank.

25. Section 6.4: Natural England queries if there is a solution. Would a different tool have achieved burial, or is there always likely to be less burial in this sediment type? What is bearing capacity and what effect does it have? More detail is

required in this section.

26. Section 6.5: As above – understanding is good, but will this actually increase chances of burial or are burial chances reduced in this soil type?

27. Section 6.6: How do we make sure that there is sufficient slack in the cables to ensure there is contingency to avoid cable protection in designated sites?

28. Rampion lessons learnt: This gives some confidence that Rampion found tools which sufficiently buried their cables in harder chalk rock. However, it should be noted that there has been no monitoring of the impacts of cable installation in chalk. Natural England's assumption would be that there is scarring along the cable corridor the width of the plough track in chalk unless it is covered with mobile surface sediments.

29. Section 8.3 '…*this does not mean that cable burial can be guaranteed and negate the requirement for remedial burial and/or protection. External factors outside the applicant's control should be considered such as adverse weather conditions, unforeseen round conditions and mechanical breakdown*' As this is a cover-all statement can the Applicant provide a realistic worst case scenario or is it a case that the position remains unchanged in relation 10% cable protection?

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HORNSEA PROJECT THREE OFFSHORE WIND FARM

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NATURAL ENGLAND
WRITTEN SUBMISSION FOR DEADLINE 6

ISH 5 Appendix C: Natural England Comments on REP5 – 011: Appendix 3 Cable Specification Installation Plan (CSIP)

Dated 7th February 2019

Natural England Comments on REP5 – 011: Appendix 3 Cable Specification Installation Plan (CSIP)

Summary

1. Whilst these comments are provided in the spirit of trying to find common ground; it should be noted that it may not be possible, even with the potential provision of further information, to satisfactorily address all of our nature conservation concerns and thus change our advice/position as set out in our Written Representations at Deadline 1. However, this is not to say that any further information and/or revisions wouldn't help inform any risk based decisions made by the competent authorities.

2. Overall we believe a CSIP is useful document and consider it to be best practice to provide such a plan for installation activities within designated sites.

3. However, the CSIP only ensures compliance with the consent. As Natural England has outstanding concerns with the Applicant's proposals and/or do not have sufficient information and evidence to advise on the impacts of those proposals; this document does not change our position in consenting terms.

4. In addition this document largely concerns the installation phase and based on the discussions within ISH 5, Natural England's current understanding is that the Applicant would like to place the 10% cable protection anytime over the lifetime of the project. We therefore believe that there are unlikely to be the same level of controls beyond the initial installation to minimise impacts to the designated features and would therefore question the overall value of this document without an amendment to a DCO/DML condition to ensure that the requirements of the CSIP are also adhered to during any subsequent operation phase when the condition requirements are likely to be transferred to an Offshore Transmission Organisation (OFTO). NB: Section 1.4 Schedule 11 wording only relates to construction.

Detailed Comments

5. Section 2: Any further iterations/versions of the CSIP post consent would need additional/amended text to be included in a dialogue box for ease of clarity and review.

6. Section 3.1: Whilst NE understands and welcomes the Applicant's view that cable protection is to be a last resort; there is no definite commitment to limit the amount of cable protection to a specified amount and/or locations during/ post construction. Therefore the assessment remains for the 10% plus additional 25%.

7. Section 3.2: Whilst it is noted later on in the document that engineers may attend some meetings we request that this is the norm rather than the exception as it avoids understandings and helps find appropriate solutions.

8. Section 3.3: We would welcome input into contractor tendering and pre

installation consultation.

9. Section 3.4: The provision of these docs is best practice in designated sites and is not considered as mitigation.

10. Section 4.1: We welcome the inclusion of the following text *'robust project plan should be provided, defining clear project parameters for Hornsea Three sandwave clearance activities within the North Norfolk Sandbanks and Saturn Reef SAC.*' Which will demonstrate compliance. However, there is not enough information provided now to be sufficiently clear on the impacts so that whilst this is welcomed should consent be granted it does not address the examination issues of not having a full enough understanding of the impacts through the EIA/HRA process to advise on level of impacts in designated sites.

11. The CSIP should help to ensure that impacts are no bigger than predicted/ consented and as stated in 4.2 will help with evidence base going forwards. We agree with this comment. But it effectively means we are all stuck post consent with the consented parameters and very difficult to change them e.g. Race Bank

12. Section 4.3: We would welcome the clarification now on what is the maximum design scenarios. Our understanding is that the text as it stands wouldn't take into account any modifications the Applicant has or may do to minimise the impacts during the examination process

13. Section 4.4: This section should also consider deposition of disposal material in areas of similar grain size to further enable the recovery of benthic communities over time. Again as per 4.3 as much information on the level of risk (low, med, high) etc. should be provided upfront prior to consent.

14. Section 5: Natural England queries what happens if once more site specific data is available we advise that there is an AEoI? How can the MMO be certain that AEoI will/can be avoided?

15. Section 5.10: We would like to see this mapped as well as presented. This license condition used at IFA2 interconnector is consider appropriate:

    Within 3 months of completion of licensed activities, an 'as built' plan displaying the location of the cable as laid with specific details of the locations of buried and surface-laid cables, the placed location and quantity of rock placement or rock mattressing used in these works must be submitted to the MMO.

16. Section 5.10: Natural England queries how impacts to surrounding areas as noted for sandwave levelling at Race Bank will be taken into account?

17. Section 5.11 as 5.9: The monitoring should also focus on impacts on benthic habitat of habitat loss/ change and whether cable protection remains exposed or becomes covered in sediment, not just sediment transport and colonisation. It is about form and function and fully understanding impacts and recoverability. Scope for surveys should be agreed in consultation with the SNCBs to address residual concerns.

18. Section 5.14: Whilst we agree with the text is should be caveated by previous comments.

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ISH 5 Annex D: Natural England Comments on REP4-012 pg 43 onwards Applicants response to ExA Q2.2.46 in relation to MEEB.

Dated 7th February 2019

Natural England's comments on REP4-012 pg 43 onwards: Applicants response to ExA Q2.2.46 in relation to MEEB.

Natural England has reviewed this document in consultation with JNCC and we welcome the Applicant's comments regarding MEEB.

As we have previously highlighted, there is currently no Government guidance in relation to Measures of Equivalent Environmental Benefit (MEEB) and to date there have been no other cases that have reached this stage. Therefore, should the Secretary of State conclude that MEEB are required, this case would be precedent setting.

In the absence of guidance/experience to draw upon, we would recommend that discussions relating to MEEB, and the requirements thereof, include input from the SNCBs, Regulatory Agencies (i.e. MMO and BEIS) and Defra.

Consequently, Natural England are not in a position to comment more specifically on the suitability and acceptability of the Applicant's suggestions at this time, but consider the Applicant's suggestions would be a useful starting point for discussion, should the need arise.

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ISH 5 Annex E: Natural England's comments on REP3 – 024 Appendix 15

The Wash and North Norfolk Coast (W&NNC) SAC In-combination Assessment

Dated 07th February 2019

Natural England's comments on REP3 – 024 Appendix 15 - The Wash and North Norfolk Coast (W&NNC) SAC In-combination Assessment

1) Revised Assessment: Firstly for audit trial purposes and for the audience of doubt please could the Applicant confirm that the assessment in Section 2.12 of Vol 2, Chapter 2 is no longer the current position and that the revised in-combination assessment provided at REP3-024 for W&NNC SAC is to be used for any further assessment undertaken by the regulators.

2) Completeness of Assessment: Natural England has reviewed REP3 – 024 and we still consider this to be an incomplete assessment as MLA/2017/00277/4 in relation to cable protection for Race Bank has not been considered in the assessment.

3) Fundamental concerns with the baseline: In relation to the appropriateness of the assessment, Natural England continues to have fundamental concerns in relation to the baseline information which have been used to determine the features (and subfeatures) that may be present along the HP3 cable route. Therefore we do not agree that the assessment is pre-cautionary and consider that there is a degree of uncertainty in relation to the percentage impacts on each feature provided.

4) Consideration of Large Shallow Inlet and Bay: The Large Shallow Inlet and Bay interest feature has not be considered and whilst a snapshot from the Magic.defra.gov.uk website has been provided by the Applicant to NE defining a boundary, the current conservation advice packages including conservation objectives do not explicitly define the parameters of the Shallow Inlet and Bay as only being only 'The Wash'. Therefore it is not appropriate to exclude this feature and subfeatures from the assessment.

5) Natural England currently considers the impacts from cable protection to be permanent which is not explicit in the document.

6) There remains some doubt in relation to the 25% additional cable protection included as replenishment and how that has been incorporated in the in-combination assessment

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ISH5 Annex F: Natural England's Response to the Applicant's response to ExA Q2.2.25

[Ornithology: SPA Breeding Seasons]

Dated 07th February 2019

Natural England's Response to Applicants response to ExA Q 2.2.25 as requested at ISH5

Natural England note that at the first Issue Specific Hearing it was requested that we provide details of the Personal Communication (pers comm) from RSPB and the Phenology Report (authored by Mike Babcock, RSPB) evidenced to support the definition of seasonal extents for the species presented in Table 7.1 of Natural England's Written Representation, and we confirmed that we were able to submit the pers comm from RSPB but that the 'Phenology report' would need to be supplied by RSPB. (REP3-101)

Natural England submitted an email chain pertaining to the pers comm from RSPB colony managers regarding Flamborough and Filey Coast SPA breeding seasons that informed NE's advised breeding seasons (Appendix 3, REP3-075). Natural England apologise that the embedded attachment within the email correspondence was accessible Appendix 3 (REP3-075). This contained a summary of the pers comm from a telecall held on July 8th 2018. This was submitted at deadline 5 and we hope this addresses the majority of the applicant's outstanding queries on this subject.

It should be noted that the email chain and associated attachment is the written summary of the pers. comm between NE and RSPB which occurred on a telecall (dated July 8th 2018).

The applicant has also requested the following information (in their response to Q 2.2.25 Deadline 4),

- How the information for gannet presented in Appendix 3 of Natural England's Deadline 3 submission was interpreted to provide seasonal definitions;
- Information in relation to the seasonal definitions defined in Natural England's Written Representation's for kittiwake and how this information was interpreted to define seasonal extents;
- Information in relation to the seasonal definitions defined in Natural England's Written Representation's for guillemot and how this information was interpreted to define seasonal extents;
- Information in relation to the seasonal definitions defined in Natural England's Written Representation's for razorbill and how this information was interpreted to define seasonal extents;
- Information in relation to the seasonal definitions defined in Natural England's Written Representation's for puffin and how this information was interpreted to define seasonal extents; and
- How does all of the information relate to Hornsea Three especially when considering the limited connectivity suggested by the foraging range of certain species.

NE advise that this information has been supplied (for gannet, kittiwake and puffin) in Table 7.1 of Natural England's Written Representation (REP1-211) and within Appendix 3 (REP3-075), and associated attachment (REP5-026).

Natural England have not challenged the seasonal definitions used by the applicant (and matching Furness 2015) for Guillemot and Razorbill and hence have not supplied any further information on seasonal definitions for these species.

Natural England is uncertain how to address the Applicant's query of 'how does all the information relate to Hornsea Three, especially when considering the limited connectivity suggested by the foraging range'. The applicant has concluded (APP-054, 5.2.3 RIAA Annex 3 - Phenology, Connectivity and Apportioning) that there is connectivity between Hornsea Project 3 and breeding gannets, kittiwakes and puffins at FFC SPA. We have provided a full response within our written representation and response to the examiners first round of questions (REP1-211, Section 7 Annex C: Natural England Detailed Advice on Ornithology and REP1-212, Q1.2.51 regarding our approach to defining breeding seasons at FFC SPA, which is a necessary step to inform the HRA process required for these species at FFC SPA.

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WRITTEN SUBMISSION FOR DEADLINE 6

ISH5 Annex G: Natural England's Comments on the Applicant's response to ExA Q2.2.38.

[Ornithology, Cumulative and in-combination Assessment]

Dated 07th February 2019

Natural England's comments on the Applicant's response to ExA Q 2.2.38

Within ISH 5, Natural England were asked to provide comments on the Applicant's response to ExA Q.2.2.38. These comments are presented in the table below.

However, Natural England consider it important to make the overarching point The Crown Estate commissioned the Trinder 2017 report in order to better understand the potential level of 'headroom' for their own purposes (i.e. potentially to inform their decisions on future leasing rounds) and that it was not the intention that the figures from this report, or the methods outlined within in it, were used to revise the in-combination assessments of current and future applications.

Given this, whilst Natural England is happy to answer ExA Questions on this paper and provide the additional comments below, we consider it important to take this opportunity to clarify our position more broadly in relation to the assessment of cumulative and in-combination impacts within the Hornsea Three Application.

Natural England's comments on cumulative and in-combination assessment.

The standard approach to cumulative and in-combination assessments, is to use the consented parameters of the project and to refer to the WCS assessed within the Environmental statement, taking account of any updated assessments provided throughout the examination process.

As highlighted within REP1-148, because Offshore Windfarms are consented based on the Rochdale Envelope approach, the worst case scenarios assessed within the Environmental Statements are often different to the potential 'as-built' impacts. Consequently, as the applicant maintains, the use of collision risk estimates calculated based on assumptions at application or decision, may lead to a potential over-estimate of the total cumulative or in combination assessments in terms of both EIA and HRA.

Within their ES and the additional annex [REP1-148], the applicant is seeking to reassess/redefine collision risk for consented projects where they consider that the predicted 'as-built' scenario for that project is, or is likely to be, different to the WCS that was originally assessed.

*Whilst this is recognised as an issue, it is highly complex, and **it is important to note that there is not yet an agreed and legally tested way to address this matter** at present. As such, applicants have largely continued to use the standard approach of referring back to the original assessments in the Environmental Statement.*

Natural England Advises that is not sufficient for the Applicant to base their assessments on a 'most likely scenario' and that where they seek to redefine project parameters they should provide evidence that options they are assessing are legally secure and that further changes are no longer possible.

*Where the applicant is able to demonstrate that the revisions to the Rochdale Envelope of a particular plan or project **are** legally secure, Natural England would expect that a revised collision risk assessment/displacement be undertaken in line with the revised envelope, with the parameters of such assessment agreed with the regulators (as advised by the appropriate SNCB).*

Natural England recognises that this would be challenging for an individual applicant to achieve, would likely require a nationally co-ordinated approach.

ExA Q 2.2.38 NE has highlighted a number of issues relating to Trinder 2017 in its submission at Deadline 3 [REP3-075]. Please comment on the matters raised.	
Applicant Comment	Natural England Response
The Applicant welcomes the statement by Natural England that the approach applied in Trinder (2017) and subsequently by the Applicant in Volume 2, Chapter 5: Offshore Ornithology (APP-065), the RIAA (APP-051) and Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148) is valid.	Natural England reiterate the comment made at Deadline 3 [REP3-075] that Natural England has not checked the details of the calculation for scaling collisions as set out in MacArthur Green (2017), but in principle the calculation method is valid. However there are a number of issues which mean that the results obtained will not always be accurate and we do not advise that it is used as a method for altering the collision figures of planned and consented projects.

In response to the individual comments: 1. The Applicant has provided references to where turbine specifications have been obtained (Appendix A of Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148)) for relevant projects. Where parameters are unavailable, expert judgement has been applied utilising parameters from projects using comparable turbines or information from turbine manufacturers to provide as accurate an appraisal of collision risk as possible. This is considered to represent a suitably precautionary approach that is unlikely to provide collision risk estimates that are significantly different to those that would be obtained if actual turbine parameters were available. This issue is not considered to have any significant effect on the conclusions reached in Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148);	As highlighted within REP1-148, because Offshore Windfarms are consented based on the Rochdale Envelope approach, the worst case scenarios assessed within the Environmental Statements are often different from the planned or actual 'as-built' layouts. Consequently, as the Applicant maintains, the use of collision risk estimates calculated based on assumptions at application or decision, may lead to a potential over-estimate of the total cumulative or in combination assessments in terms of both EIA and HRA (although under-estimates are also possible at a project level e.g. collision estimates at Lincs OWF increase after application of the correction factor). Whilst this is recognised as an issue, it is highly complex, and it is important to note that there is not yet an agreed and legally tested way to address this matter at present. As such, developers have largely continued to use the standard approach of referring back to the original collision assessments in the Environmental Statement for consented projects (and any subsequent updates to collision predictions that were agreed during the Examination for a project). 1. Natural England does not agree that the references provided by the Applicant provide a suitable audit trail for the turbine and bird parameters that were a) used to derive the collision figures used in the original project consent and b) the worst case scenario of the legally secured final build layout. As an example of this, the Applicant has calculated their own correction factor for Greater Gabbard as they say that the turbine parameters used by MacArthur Green (2017) were not correct.

2. The Applicant has ensured that the turbine parameters used in Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148) were those used to calculate the collision risk estimates for relevant projects. This resulted in the use of Approach 3 in Appendix 4 to the Applicant submission at Deadline 1 (REP1-135), which updates the parameters in MacArthur Green (2017) due to this very issue. This issue therefore does not affect the conclusions in Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148); 3. The Applicant has ensured that the number of turbines used is consistent with the modelling used to calculate collision risk estimates for each project. This issue therefore does not affect the conclusions in Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148);	This fact underlines the reason why Natural England do not consider there to be robust evidence available for these corrections. The Applicant cites Banks et al (2006) as the source of the original turbine parameter information to calculate a correction factor for Greater Gabbard (noting that the turbine information in the Applicant's Table 1.29 does not appear to match that given in Banks et al 2006). However the collision risk modelling assessment in Banks et al (2006) is not based on the Band (2012) model, did not include calculations for kittiwake and gannet, and it is not clear whether the P.Collision figures cited in Banks et al (2006) for lesser black backed gull and great black-backed gull have been used to calculate the correction factor or whether the Applicant has calculated alternative P.Collision values using Band (2012). It is also therefore unclear what collision totals for each species the Applicant has used to apply their correction factor to. In relation to the "as built" layout for projects, the Applicant has simply referenced manufacturer information for particular turbine models as evidence of the "as built" layout, for the majority of projects. While these may reflect the actual built turbine parameters, it is not a sufficient audit trail with respect to individual projects. Natural England also does not agree that it is appropriate to use "expert judgement" as a means of determining the turbine parameters to use in an updated collision risk assessment for a consented project. Natural England do not agree with the Applicant's statement that this is a "suitably precautionary approach" or that it would not have any significant effect on the conclusions. The Applicant has not demonstrated that either of these statements are true. 2. It is not clear to Natural England that the turbine parameters in REP1-148 were those used to calculate the collision risk estimates for the relevant projects. Natural England have not been able to find this information in the references provided by

4. The Applicant has not assumed that all turbine parameters presented in Trinder (2017) are legally secured and has provided consideration of this in Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148). This issue therefore does not affect the conclusions in Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148); 5. The Applicant would welcome further clarification on Natural England in relation to this point with this identifying those parameters that Natural England believe do not have sufficient confidence. The Applicant considers that this does not affect the conclusions reached in Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148) as it was not assumed that the parameter	the Applicant in REP1-148 to support this statement (some examples of this are given below in relation to the information the Applicant has presented in Table 1.29). 3. Natural England have not been able to find this information in the references provided by the Applicant in REP1-148 (see below for examples). 4. While the Applicant acknowledges that they haven't assumed all the turbine parameters in MacArthur Green (2017) are legally secured, the Applicant has presented collision figures for modified turbine parameters for such projects in REP1-148. Further, for those projects where the Applicant has assumed the updated turbine parameters are legally secured they have not provided evidence from the appropriate regulator that this is the case for the turbine parameters they used to calculate the correction factors. 5. As a first stage Natural England considers that the relevant regulator would need to provide confirmation that a modified turbine design envelope is 1) legally secured with no further change possible and 2) represents a worst case scenario in relation to collision predictions. This information would need to include details on number of turbines, rotor radius, blade pitch, max blade width (chord) and average RPM. Natural England suggest that additional advice is sought from the regulators on this matter. For projects where revisions to the turbine design parameters can be used to update CRM figures (i.e. there is evidence from the appropriate regulator of a legally secured new design envelope), Natural England would need to agree updated collision risk

The Applicant would draw Natural England's attention to Table 1.29 in Appendix A of Appendix 4 to the Applicant's submission at Deadline 1 (REP1-148) which provides the turbine parameters and associated sources for those projects for which turbine parameters were updated from Trinder (2017).	modelling figures – including bird parameters used in the CRM, which CRM model/option to be used; Our advice is that CRM should be re-run to generate updated collision figures. Where this is not possible for a project because original bird density data cannot be obtained, we would need to agree whether correction ratios can be calculated (e.g. following MacArthur Green (2017) approach) and see the full calculation details for these correction factors. This will be dependent on whether there is information available on the turbine and bird parameters used to generate the original collision figures. The information on the as-built turbine scenarios in Table 1.29 cites the source reference as manufacturer technical information on turbine specifications for five of the six projects listed. These references do not provide any information that is specific to the project in question, and therefore provide no information or audit trail regarding the turbines that have been or are planned to be constructed at the relevant project site. Further, there is no information regarding the source of information on the number of turbines in the as-built scenario. The information regarding the assessed turbine scenario also does not provide a clear audit trail to the relevant information. For example, the assessed turbine scenario for Greater Gabbard cites Banks et al (2006), but this reference gives a rotor speed of 14rpm and not 97 rpm as listed in Table 1.29. Banks et al (2006) also cites a pitch of 24 degrees and not 2 degrees as listed in Table 1.29 and a max blade width of 2m not 14m as listed in Table 1.29. It is also not clear whether Banks et al (2006) contains the collision figures that were assessed for the project consent (and therefore what turbine parameters, bird parameters and models were used to derive the collision figures used in the consenting process as there do not appear to be figures presented for some species (e.g. kittiwake and gannet). For Triton Knoll, the Applicant cites RWE npower renewables (2011) as the source of information on the assessed turbine

	scenario, but Table 1.29 says the assessed number of turbines was 288 with a rotor speed of 9.47 rpm and max blade width of 5.45m. However, RWE npower renewables (2011) states that the collision risk modelling was undertaken based on 333 turbines, that rotor speed varied according the month used (from 8.2 rpm to 10.6 rpm depending on the month) and max blade width (chord) was 4.2m. These examples highlight the reason why Natural England do not consider that there is a clear audit trail regarding the turbine and bird parameters used for the original collision risk modelling for consented projects, or the turbine parameters for the configurations that have or are planned to be built, or clear evidence that the collision totals that the Applicant has applied correction factors to were derived using the parameters that the Applicant cites.

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ISH 5 Annex H: Natural England's Response to REP5-014

[Apportioning immature Auks to colonies]

Dated 07th February 2019

Natural England's Response to REP5-014.

Appendix 6 to deadline 5 submission – Apportioning immature auks to colonies.

The approach presented within this appendix was suggested by RPSB as a method to apportion immature auks present at Hornsea Project 3 in the breeding season to breeding colonies.

It is based on a method developed by SNH in order to apportion BETWEEN breeding colonies when foraging ranges from multiple colonies overlap a development site.

Natural England welcome the presentation of this approach and consider that it helps to provide context around the likely proportion of immature auks present at the project site that will recruit into the breeding population at FFC SPA.

The apportioning approach requires that a 'foraging range' or in the case of immature birds perhaps a 'dispersal range' is defined to identify which colonies the immatures are likely to be connected to (the applicant treats this as a requirement to identify which colonies immatures originate from, but perhaps the more appropriate factor is where immatures will ultimately recruit into).

As the applicant notes, evidence on the origin, distribution and movements of immature birds is limited, however the applicant defines the range as 470km (based on including North Sea colonies up to and including the firth of forth). In the absence of evidence to suggest otherwise, this range seems a reasonable one, and the resulting apportioning rates are informative (guillemot – 64%, razorbill – 82%, puffin - 8% of birds apportioned to FFC SPA).

However we would note that the precautionary assumption regarding the apportioning of immature auks in the breeding season would be to assume 100% of immature birds are apportioned to FFC SPA.

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Planning Inspectorate Reference: EN010080

NATURAL ENGLAND

Written Submission for Deadline 7

Natural England's comments on the Report on the Implications for European Sites (RIES)

Dated 14th March 2019

1. Documents used to inform the RIES – Applicant's position

1.1. Natural England notes that the RIES is based on the conclusions presented in the Applicant's RIAA (Report to Inform an Appropriate Assessment), which was submitted with their application [APP-051] and the accompanying annexes. However, we note that the Applicant has made a number of subsequent submissions throughout the examination, some of which indicate a change in their position.

1.2. This is particularly the case for their assessment of ornithological impacts, where (for example) they have made multiple submissions based on revised parameters of their collision risk modelling (and in some cases there are revisions to revisions).

1.3. Natural England notes that in some cases, updated versions of assessments are referred to in the supporting notes, but not always. Consequently it is not always clear if the planning inspectorate are considering the applicant's position in the RIAA, or a subsequent position in their analysis.

1.4. In previous submissions, Natural England has highlighted that it is no longer clear what the applicant's current position is, and how far this departs from their original ES and RIAA.

1.5. It is important to note that clarity on this point is not only important for this examination, but will also be important for current and future applications which need to take account of this one in their cumulative and in-combination assessments.

2. Likely Significant Effects – Screening

2.1. As highlighted in our Written Representation [REP1-213] para 5.1.1, Natural England does not consider the Applicant's approach to identifying LSE is robust and may have/has led to sites and their features not being considered fully.

2.2. The 'significance test' is a coarse filter intended to identify which proposed plans and projects require further assessment. It is the first stage of the process, and is distinct from the appropriate assessment of 'adverse effect on integrity' that follows. Unless the impact can be considered to be trivial or inconsequential, it should be screened in to the appropriate assessment.

2.3. Consequently, Natural England has advised that where there is an impact pathway between a designated site feature and the proposed activity/activities, the feature should be screened in to the appropriate assessment.

2.4. In a number of cases throughout their screening, the applicant has screened out feature on basis that they consider the level of impact to be of minor or/low significance alone. These terms are more applicable to an EIA assessment and do not always translate to a conclusion of no Likely Significant Effect.

2.5. Although these potential impacts may be considered to be of minor or low impact to the designated site alone, the potential significance of their impact in combination has not been considered.

2.6. Natural England has provided detailed comments in the tables below to indicate where we consider that additional features of the identified sites should be carried through to the appropriate assessment.

2.7. However, we also consider that there may be additional Special Protection Areas with features that have connectivity to the development Zone that have not been captured. We note that the applicant has focussed their considerations on connectivity in the breeding season. However, there may be an impact pathway for a number of species in the non-breeding season. To establish this, an assessment should be conducted using the Biologically Defined Minimum Population Scales BDMPS [a copy of this submitted at Deadline 7] of the species present at the project site in the season under-consideration.

3. Detailed comments

	Section	Comment
3.1	3.0.9	Natural England reiterates our concerns that LSE was ruled out on the basis of less than 1% baseline mortality alone. Firstly, reaching this conclusion requires a level of analysis and is therefore better captured within an appropriate assessment. Secondly, the impacts on these features have not been considered in-combination. [N.B. Natural England advise that features are screened in to the Appropriate Assessment where there is an impact pathway, but the level of assessment undertaken at that stage should be proportionate. For example, where it is concluded that the impact is less than 1% of baseline mortality, it may not be necessary to undertake a Population Viability Analysis, but the totals should be included in the in combination assessment.
3.2	3.1.1	Natural England's concerns in relation to the Applicant's approach to LSE are three-fold: • Firstly, we have concerns that the applicants approach to LSE screening has resulted in features being screened out on the basis of low level of impact 'alone', without consideration of that impact in-combination. • Secondly, with respect to Marine SPAs, we do not consider that that the impact pathways within the non-breeding season have been adequately assessed. • Thirdly, where baseline data is incomplete, a more precautionary approach should be taken to LSE screening. (i.e. numbers of birds present in the array area in the winter period, features present along the cable route in W&NNC SPA etc.).

	Section	Comment
		Natural England highlights that alongside the conclusions disputed on 6 sites, there are also likely to be addition sites/features that have not been included on this list.
3.3	4.1.1	As highlighted, Natural England does not consider that the Applicant has undertaken a comprehensive screening exercise. Therefore the conservation advice provided in REP1-213 does not cover all sites for which we may have concerns. (In section 5.1.1 of REP1 -213 it is made clear that the information provided should not be considered 'complete' due to our concerns regarding the screening).
3.4	4.2	It should also be noted that Adverse Effect on Site integrity cannot be ruled out for harbour porpoise in the Southern North Sea SCI/SAC in combination. We are able to conclude in this instance that there are mitigation/avoidance measures available that are capable of mitigating these impacts, but as the exact timing and scale of construction is not known it is not possible to establish a mitigation plan at this stage. This will be achieved prior to construction through the production of a Site Integrity Plan (SIP) which will require sign off prior to construction. In order for the SIP to be signed off, it must be demonstrated that there will be no Adverse Effect on Site Integrity from the project alone and in-combination.
3.5	4.5.2	Natural England would highlight that there has not yet been a discussion regarding alternatives.

4. Comments on Table 3.1: Sites/features for which the Applicant has identified likely significant effects

	Comment:
4.1	Overarching comment : As highlighted in our Written Representation [REP1-213] para 5.1.1, Natural England does not consider the Applicant's approach to identifying LSE is robust and may have led to sites and their features not being considered fully.
4.2	Coquet Island SPA: Natural England expected that consideration would be given to the potential impact pathway for other features of the SPA (including the assemblage).
4.3	Farne Islands SPA :

	Comment:
	Natural England expected that consideration would be given to the potential impact pathway for other features of the SPA (including the assemblage).
4.4	Fourth Islands SPA: Natural England expected that consideration would be given to the potential impact pathway for other features of the SPA (including the assemblage).
4.5	Flamborough and Filey Coast SPA : Fulmar are part of the assemblage feature, but are missing from this table. Natural England queries why this is the case when fulmar have been considered in the context of other sites (Coquet, Farnes, Fourth). Natural England note that fulmar at Flamborough have been considered in Annex 1.
4.6	Greater Wash SPA: Little tern and little gull should also be screened in. Potential impact pathways on these SPA features include displacement and disturbance impacts, as well as indirect effects on prey availability associated with construction/laying of the cable.
4.7	The Wash and North Norfolk Coast SAC: Large Shallow Inlet and Bays should also be considered.

5. Comments on Table 4.1: The Applicant's shadow appropriate assessment and degree of agreement with Interested Parties

	Comment:
5.1	Natural England would consider that there may be other sites that should be under consideration (see comments above). The comments provided on this table are in relation to the **sites** listed.
5.2	Natural England notes that the conclusions on AEoI are based on the Applicant's ES, and the level of agreement has been established based on Reponses from IPs at RR and Deadline 1&2. In a number of cases the applicant has presented additional versions of their assessments at different deadlines, which alter their assessments (if not their conclusions)
5.3	Natural England would consider that the areas of disagreement have been captured for the features/sites listed in the table. (Please see comments on table 3.1 and on the annexes for more information in relation to missing sites and features).
5.4	Southern North Sea SCI: There is no reference to a stage 2 matrix in the table, but note

	that one is presented in the Annex. (Stage 2 Matrix 2)

6. Comments on Annex 3: Stage 1 Matrices: Screening for Likely Significant Effect

	Section	Comment
	General	
6.1	"Assemblage during the breeding season"	It is unclear why this terminology is used throughout. Consideration of impacts on a breeding seabird assemblage may also include impacts outside of the breeding season.
6.2	Disturbance/Displacement of SPA features	It is unclear how disturbance and displacement have been defined within these tables, and we question why disturbance only seems to be a consideration at construction and decommissioning and displacement is only a consideration during the operational phase. Displacement of birds from an area could start to arise in the construction phase and feasibly persist until operation. Likewise disturbance from e.g. vessel movements could occur throughout the operational phase as well as at construction and decommissioning
	Stage 1 Matrix 1: Coquet Island SPA	
6.3	Table: Effects on integrity	There should be consideration of the impact on prey availability
6.4	Table: Collision and Assemblage Supporting note c	We are unclear about the commentary in supporting note c. Generally, Natural England considers that there would be no collision risk for Auk species and fulmar, but there may be a pathway for other assemblage species such as kittiwake and herring gull and lesser black backed gull. These species should be considered in the appropriate assessment.
6.5	Barrier effects	Reiterating Natural England's advice in relation to the test of Likely Significant Effect being a coarse filter (see section 2 above), Natural England would recommend that barrier effects were carried through to appropriate assessment
6.6	Displacement	Natural England agrees with the conclusion that there is LSE in relation to the Assemblage feature, but would suggest that this is not limited to Fulmar and would also include Auk species, particularly in the non-breeding season. Therefore we would like note B updating to reflect our concerns in relation to Auks.
6.7	In combination	Natural England agrees with the conclusion that there is LSE in relation to the Assemblage feature, but would suggest that this is not limited to Fulmar and would also include Auk species, particularly in the non-breeding season

	Section	Comment
		(displacement) as well as kittiwake and herring gull (collision risk). Therefore we would like note B updating to reflect NE's concerns in relation to Auks and displacement, as well as kittiwakes and herring gull and collision risk.
	Stage 1 Matrix 2: Farnes Island SPA	
6.8	Table: Effects on integrity	There should be consideration of the impact on prey availability
6.9	Table: Collision and Assemblage Supporting note B	Generally, Natural England considers that there would be no collision risk for Auk species and fulmar, but there may be a pathway for other assemblage species such as kittiwake. These species should be considered in the appropriate assessment.
6.10	Barrier effects	Reiterating Natural England's advice in relation to the test of Likely Significant Effect being a coarse filter (see section 2), Natural England would recommend that barrier effects were carried through to appropriate assessment
6.11	Displacement	Natural England agrees with the conclusion that there is LSE in relation to the Assemblage feature, but would suggest that this is not limited to Fulmar and would also include Auk species, particularly in the non-breeding season. Therefore we would like note B updating to reflect NE's concerns in relation to Auks.
6.12	In combination	Natural England agrees with the conclusion that there is LSE in relation to the Assemblage feature, but would suggest that this is not limited to Fulmar and would also include Auk species, particularly in the non-breeding season (displacement) as well as kittiwake and (collision risk). Therefore we would like note B updating to reflect NE's concerns in relation to Auks and displacement, as well as kittiwake collision risk.
	Stage 1 Matrix 3: Flamborough and Filey Coast SPA	
6.13	Disturbance	It is not clear what aspects of disturbance have been considered here, and why there has been no consideration of impacts such as increased lighting, during the operational phase. It should be noted that in relation to supporting note b 'low sensitivity' is not the same as 'not sensitive'. This would indicate that the impact should be further explored within an appropriate assessment.
6.14	Collision Risk: Kittiwake (& In Combination)	It should also be noted that based on the in-combination totals for plans and projects that already have consent, we are unable to rule out an Adverse Effect on Integrity of Kittiwake at Flamborough and Filey Coast SPA. Therefore any contribution from this project would effectively constitute an Adverse effect.

	Section	Comment
		Ref. to table 5.1 in APP-052 showing limited connectivity – Connectivity of FFC SPA Kittiwake and the development zone has been established
6.15	Collision Risk: Herring Gull (& In combination)	Natural England maintains that consideration must be given to the impact on site features in the non-breeding season, as well as in the breeding season.
6.16	Barrier effects	Reiterating Natural England's advice in relation to the test of Likely Significant Effect being a coarse filter (see para XX), Natural England would recommend that barrier effects were carried through to appropriate assessment and that supporting note i is more appropriate at that stage.
6.17	In combination	Natural England dispute the conclusion of '× Likely significant effect can be excluded' for all species.
	Stage 1 Matrix 4: Greater Wash SPA	
6.18	Common, Sandwich and little tern	Natural England would consider that there is an impact pathway for each of these species regarding prey availability, disturbance and displacement and consequently in- combination impacts. Therefore we agree that all three species should be considered within the appropriate assessment.
6.19	Little gull	"NE has also raised concerns about the appropriateness of the population size used in the migratory seabird assessment for little gull [**REP1-211**]. The Applicant has provided an additional screening document at deadline 4 in response to these concerns [**REP4-081**]." The applicant has clearly identified an impact pathway to undertake this analysis. Natural England therefore considers that little gull should be screened in to the AA.
	Stage 1 Matrix 7: Wash and North Norfolk Coast SAC	
6.20	Large Shallow Inlet and Bays	As captured in the table, Natural England would consider there to be an impact pathway for LSIB and that this should be considered further in the appropriate assessment. In relation to supporting note f, it was not agreed that there was no impact pathway for Large Shallow Inlets and Bays within the expert working groups.
6.21	Supporting note e	This supporting note is a little difficult to follow and it is not clear if this relates to The Wash and North Norfolk Coast SAC given it refers to a minimal overlap with the array.

7. Comments on Annex 4: Stage 2 Matrices: Adverse Effect On Integrity

	Section	Comment
	Stage 2 Matrix 1: North Norfolk Sandbanks and Saturn Reef SAC	
7.1	Table: Changes to water quality (incl. Supporting note i)	It seems from the supporting note that only accidental pollution has been considered as part of the assessment of potential changes to water quality. Natural England would highlight that there may be other potential impacts on water quality as a result of the activities proposed within the site such as increased levels of suspended sediment which should be considered within this assessment for completeness.
7.2	Table: Changes to physical processes (incl. Supporting note j)	There may be localised changes to physical process at the point of construction (i.e. removal of sandwaves/sandbanks) which should also be considered, as well as the potential for changes as a result of construction and operation to persist at and beyond decommissioning. For example, refer to comments on supporting note **a** (sandwave levelling – which may have implications at the time of construction) and **b** (the implications of rock protection which could result in a persistent impact on physical processes beyond the operational phase).
7.3	Supporting note **a**	Cable burial Sandwave clearance works have only been proposed and carried out relatively recently and as such there is currently no evidence on how well this technique works, whether cables remain buried thus avoiding the need for additional cable protection, and very limited evidence on how quickly dredged areas recover. Projects should fully assess the impacts of any likely sandwave clearance **at the time of application** and not at post-consent stage. Full consideration needs to be given to the volumes to be dredged, orientation of dredge to the sandbank, areas for disposal of dredged material and impacts on the benthos and sediment transport. Until further evidence is available on its efficacy as a technique and the timescales for recovery, there remains significant

	Section	Comment
		uncertainties in relation to the impacts of sandwave clearance on the interest features of Marine Protected Areas Impact of Sandwave Clearance in NNS SR SAC Sandwave levelling/sandwave clearance within NNS SR SAC, would involve the removal/levelling of part of an SAC feature. Natural England accept that the evidence provided by the applicant shows that the feature ***could*** recover. However, this is not the same as having evidence to demonstrate that it ***will*** recover. The Race Bank Study referred to here, only demonstrates that areas that have been subject to sandwave clearance had begun to show signs of recovery. Furthermore, it is not clear how applicable the Race Bank example may be to significantly greater Hornsea Project Three proposals and- the recoverability of larger, deeper sandbank features found further offshore, such as the North Norfolk Sandbanks. In addition, as the applicant highlights, the potential for the recovery of the feature is likely to be aided by retaining the dredged sediment within the sandbank system 'where possible'. Whilst conclusions around the significance of the impact appear to be predicated on this being a possibility, the potential disposal locations are not discussed. It is therefore not possible to be certain that the sediment will be retained. (Additionally, without further information on the location of the potential disposal sites it is not possible to understand the potential impacts of disposal on site features). As highlighted above, there is limited evidence to demonstrate the efficacy sandwave clearance in terms of avoiding the need for cable protection. The addition of cable protection into the site would constitute a loss or change to the feature (depending on the feature impacted), and as there is limited evidence that cable protection can be successfully decommissioned without removing part of the feature, this impact on the site is considered to be persistent/permanent depending on feature and/or whether it is left in situ. It should be noted that the sandbank feature is currently in unfavourable condition. Therefore, the competent authority has a responsibility under the habitat's regulations to ensure that any further plans or projects will not hinder the recovery of the feature. Fundamentally, NE/JNCC's view, is that there is not yet sufficient evidence to demonstrate beyond reasonable scientific doubt that the sandbank feature within the site is

	Section	Comment
		capable of full recovery, and therefore we cannot agree with the Applicant's conclusions. To address this, NE/JNCC would advise that a level of precaution is built in to the assessment to account for these areas of uncertainty and to consider the ways in which the potential impacts may be avoided/mitigated/reduced. As with North Vanguard a Site Integrity plan (SIP) one stage up from the Cable Installation Plan that considers all impacts to the site collectively would be most appropriate
7.4	Supporting note b.	Reef is an ephemeral feature and it is widely accepted that areas identified in a pre-application survey may have changed or moved prior to construction and that equally areas previously identified as having no reef present may have been colonised. In recognition of this issue the UK SNCBs have developed and keep updated, the 'Reef Layer'. In simple terms, this dataset is based on the best available evidence of known reef locations and extent, and includes a buffer to account for the ephemerality of the feature. These buffers represent the areas that the SNCBs consider should be managed for reef, and therefore where operations which are likely to damage reef should be avoided. This method is of avoiding damage to features is widely accepted across industries (aggregates, oil and gas, cables, renewables) and underlies Defra fisheries management plans in designated sites. Please see "Marine Buffers Doc." submitted at Deadline 7. <u>Assessment of impacts to reef in NNS SR SAC</u> As the reef feature within NNS SR SAC has a restore conservation objective, plans and projects capable of impacting on the site must demonstrate that they will not further hinder the conservation objectives of that site. Natural England/JNCC would consider that the areas identified within the reef layer should be treated as reef within the appropriate assessment, in order to ensure that a worst case scenario has been considered and that appropriate measures to avoid/reduce/mitigate the impacts have been identified. <u>Micro-siting as mitigation within designated sites</u> Micro-siting to avoid areas of reef could in theory act as mitigation. However, for this to be considered as acceptable mitigation to reach a conclusion of no AEoI, there must be absolute certainty beyond reasonable scientific doubt that this could be achieved within the development area. Demonstrating that micro-siting is achievable may be relatively straight forward for the installation of one or two cables within the cable corridor, but would become

	Section	Comment
		increasingly difficult with each additional cable, bearing in mind that the applicant's maximum design scenario includes the installation of up to 6 cables with a cable corridor covering 50% of the Saturn Reef management area. It should also be considered that micro-siting to avoid one feature may have implications for another. It should also be considered that the applicant is committing to micro-siting 'where possible', which again does not give certainty. NE/JNCC accept that in this instance demonstrating the required level of certainty to rely on micro-siting as acceptable mitigation to remove impacts on reef completely is likely to be challenging given the ephemeral nature of the feature and the data limitations, and therefore we do not consider this a suitable mitigation measure to address impacts that this site. We therefore reiterate our advice regarding the use of the SNCB Reef Layer. **[N.B. It is really important to note that seeking to minimise an impact does not offer certainty that an AEOI can be ruled out.]**
7.5	Supporting note c	The applicant has not provided information on the proposed disposal location of the material that will be removed through sandwave levelling. Therefore it is not clear how a conclusion on the potential significance of this impact could be reached.
7.6	Supporting note d	See above
7.7	Supporting note f	<u>Conservation Objective</u> It should be noted that the conservation objectives for both features (sandbanks and reef) are to **recover** to favourable condition. <u>Cable protection</u> NE/JNNC advise there is currently little or no evidence to provide certainty beyond reasonable scientific doubt that cable protection can be removed without causing a further impacts on designated site features, based on the technology that is currently available. [See Annex C and D to NE's D7 Submission] It is recognised that new technologies may develop over the operational lifetime of the project and we would welcome the commitment to explore the feasibility of removal at decommissioning, but for the purposes of the HRA, the impact of the cable protection remaining in situ permanently should be assessed. Cable protection would therefore represent the permanent

	Section	Comment
		loss of reef feature in this context. <u>Cable protection requirement</u> The applicant has set out a maximum design parameter for cable protection within designated sites, which equates to cable protection across 10% of the total length of cable within the site. This is presented in the draft DCO as an overall volume of cable protection to potentially be used within the designated site. It is the applicant's intention that this total volume of cable protection will be 'available' throughout the operational lifetime of the project. The applicant is also seeking an additional 25% on top of the volume of cable protection requested for use within the site for replenishment. NE/JNCC's points are as follows: - The impacts are completely on site feature - The volume/extent of cable protection sought within the site is not an insignificant amount. - The use of cable protection would result in a permanent loss/change to the feature. - We acknowledge that based on previous cable installations (requiring c6% of their cable lengths to be protected) the Applicant has presented reasonable justification for the WCS of 10% along the **entire** export cable length requiring cable protection and this could meet EIA requirements. Given that the applicant has presented this as a conservative estimate, and based over a calculation over a much wider area, it is unclear whether this assumption is directly applicable to this site. This is important because cable protection will have a permanent impact on the site and the volume required can make a big difference in relation to the outcome of an appropriate assessment. - The 10% figure has been represented as a volume within the draft DCO, and it appears that this volume would remain the permitted volume regardless of the length of cable that is actually installed. Impacts on designated sites should always be avoided/reduced/ mitigated as far as possible. - Whilst NE/JNCC consider that the requirement for additional cable protection across the lifetime of the project should be considered within the ES, we agree with the MMOs position that the implications of the impact on designated site features over the life time of the project can't be assessed with sufficient certainty. Therefore we also agree that the volume of cable protection permitted in the DCO

	Section	Comment
		should relate only to the amount required at construction and that any additional requirement should be dealt with through a separate marine licence. Please see ANNEX C of our D7 submission for further discussion <u>Potential for reef to colonise artificial habitats.</u> NE/JNCC's current position is that reef occurring on artificial habitats would not qualify as Annex I feature. (Although we recognise this view may be subject to change in the future as more evidence becomes available). Please see ANNEX B of our D7 submission for further discussion <u>Sensitive Cable and Scour Protection</u> NE/JNCC welcome the applicant's proposal to trail the use of 'sensitive scour protection' within the designated site. However, this would still require the deposition of material from outside the site so will continue to represent permanent loss/change to the feature. It is also noted in [REP1 -216] that the size of the sensitive protection, may not be similar to the surrounding habitat as it more likely to winnow away and doesn't provide adequate protection
7.8	Supporting note k	"*NE queried whether the assessment adequately considers the combined effects of the different phases of the Proposed Development as they are not convinced that features would recover completely before the next impact occurs [RR-97, REP1-212, REP1-217, REP4-130 and REP6-055].*" This comment applies more widely than the in combination assessment. <u>In combination assessment</u> As highlighted in the comments above (in particular comments made in relation to supporting notes **a** and **b**), Natural England & JNCC do not consider that the evidence provided provides certainty that there will be no residual impacts on site features. Therefore the appropriate assessment must seek to quantify these impacts and establish if they are likely to cause an adverse effect on site integrity alone or in combination. <u>Exclusion of Reef from in combination assessment</u> Please refer to the comment on supporting note b above

	Section	Comment
		regarding the use of the SNCB Reef Layer, and the fact that this feature is currently in unfavourable condition. Please also note NE/JNCC position regarding the feasibility of micro-siting within the cable corridor as mitigation and the consideration of the colonisation of *Sabellaria spinulosa* on artificial substrates Consequently, NE/JNCC do not agree with the applicants conclusion that reef will not be affected and that any impacts that arise would be mitigated. We would therefore expect in-combination impacts to be considered for this feature.
	Stage 2 Matrix 2: Southern North Sea SCI	
7.9	Supporting note a	For clarity, Natural England considers that the soft start procedure is an appropriate form of mitigation to reduce the risk of PTS. Natural England's comments in relation to the JNCC guidance being out of date were in reference to SIP, and the fact that there are now a much wider range of mitigation options available than outlined in the JNCC guidance which should be considered/included within the outline SIP.
7.10	Supporting note b	*"NE agrees with the Applicant's position that effects from the Proposed Development alone would not lead to adverse effects on the integrity of the SCI [**RR-097** and **REP1-213**]"* N.B this is subject to the agreed mitigation being in place.
7.11	Supporting note f	Natural England has concerns that six months is not sufficient time for the SIP to be agreed and provisions to be in place if significant impacts are concluded in the in-combination assessment.
	Stage 2 Matrix 3: The Wash and North Norfolk Coast SAC	
7.12	Table: Features	Large Shallow Inlet and Bays should also be considered in the assessment.
7.13	Table: Changes to physical processes.	As highlighted in relation to NNS SR SAC above, there may be localised changes to physical process at the point of construction (i.e. removal of sandwaves/sandbanks) which should also be considered, as well as the potential for changes as a result of construction and operation to persist at and beyond decommissioning. For example, refer to comments on supporting note **a** (sandwave levelling – which may have implications at the time of construction) and **b** (the implications of rock protection which could result in a persistent impact on physical processes beyond the operational phase).

	Section	Comment
7.14	Notes:	Adequacy of the baseline In the Applicant's original proposals, the cable route did not cross through the W&NNC SAC. Consequently their survey campaign did not include this site and they relied on extrapolated data from outside of the site and historic data from within the site (not within the development zone) in order to characterise the cable corridor. In response to feedback, the Applicant collected drop down video footage at six locations along the cable corridor. Natural England considers that whilst this provides information on the habitats present at the survey locations, without supporting geotechnical and geophysical information, it is not possible to stablish the likely extent of features within the cable corridor. Therefore NE does not consider that the baseline has been adequately characterised at this site. Feature condition Please note that the following Annex I features are in unfavourable condition : sandbanks slightly covered by water all of the time, mudflats, reefs, LSIB.s Including (but not exclusively) circalittoral rock which is one of the subfeatures of reef and mixed sediment which is one of the subfeatures of sandbanks. Therefore, recovery of these features should not be hindered by the current development [Clarification: Natural England's advice is that the assessment should be made in relation to the site features against their conservation objectives.]
7.15	Supporting note a	Sandwave clearance As per the comments made above in relation to the evidence available to support the applicant's conclusions regarding the recoverability of areas of feature impacted by sandwave clearance, Natural England would reiterate that the evidence from the Race Bank project only demonstrates that the areas have begun to show signs of recovery and not that the area has fully recovered. It is therefore not possible to conclude with certainty beyond reasonable scientific doubt that the feature will recover. As with the assessment of NNS SR, the Applicant's assumptions in relation to the recoverability of the feature are predicated on the assumption that the dredged/cleared material will be retained within the sandbank system. As with NNS SR the potential disposal locations have not been identified within the ES. It is therefore not possible to be certain that the sediment

	Section	Comment
		will be retained. Additionally, without sufficient information to characterise the baseline of the site and further information on the location of the potential disposal sites it is not possible to understand the potential impacts of disposal on site features (NB: All of the Wash and North Norfolk Coast SAC is Annex I habitat). As highlighted above in the context of NNS SR, there is limited evidence to demonstrate the efficacy of sandwave clearance in terms of avoiding the need for cable protection. The addition of cable protection into the site would constitute a loss or change to the feature (depending on the feature impacted), and as there is limited evidence that cable protection can be successfully decommissioned without removing part of the feature, this impact on the site would be permanent.. Consequently, it is Natural England's view, is that there is not yet sufficient evidence to demonstrate beyond reasonable scientific doubt that the sandbank feature within the site is capable of full recovery, and therefore we cannot agree with the Applicant's conclusions. To address this, NE/JNCC would advise that a level of precaution is built in to the assessment to account for these areas of uncertainty and to consider the ways in which the potential impacts may be avoided/mitigated/reduced. Please see ANNEX C of our D7 response for further comments. It is likely that a site integrity plan is also required as proposed by Norfolk Vanguard for impacts to SACs Cable protection As highlighted in relation to NNS SR above, the Applicant's calculation of the amount of cable protection they require is based on previous cable installations (requiring c6% of their cable lengths to be protected), rather than from direct evidence from the site. As highlighted in the comments above, Natural England does not consider that there is sufficient evidence to demonstrate that cable protection can be removed at decommissioning without further impacting the features, and consequently consider the impact to be permanent. As a result the amount of cable protection placed within the designated site would have a significant bearing on the conclusions of an appropriate assessment As highlighted in the supporting notes, the experience of cable installation from other offshore windfarms within the site, has demonstrated that the ground conditions can be problematic, and that remedial works have been required. Natural England has requested a cable burial risk

	Section	Comment
		assessment (CBRA) prior to consent in order to provide sufficient certainty regarding the conclusions of the HRA. However, the information provided by the applicant has been unable to address that uncertainty. (See XXX for further comments on the PTA and cable protection)).
7.16	Supporting note b	Please also see comments in relation to Micro-siting as mitigation, the potential for *Sabellaria spinulosa* reef to colonise cable protection, and the use of ‘sensitive’ cable protection, which are also applicable here. Overall, Natural England consider that there is insufficient certainty that the potential impacts on the reef feature can be mitigated to support a conclusion of no Adverse Effect on Integrity beyond reasonable scientific doubt.
7.17	Supporting note c	The applicant has not provided information on the proposed disposal location of the material that will be removed through sandwave levelling. Therefore it is not clear how a conclusion on the potential significance of this impact could be reached.
7.18	Supporting note d	See above
7.19	Supporting note f	The comments made in relation to supporting note f would appear to be equally applicable to reef. Conclusion in relation to 10% cable protection The applicant’s clarification note [**REP1-138**] provided a rationale for their calculation, but this did not allay Natural England’s concerns in relation to the assessment of impacts on designated features. As highlighted in relation to supporting note a, the Applicant’s assessment of their cable protection requirement has not been based on site level considerations. As cable protection represents a permanent impact on the designated site, it is important that its use is minimised. Potential for reef to colonise artificial habitats. NE/JNCC’s current position is that reef occurring on artificial habitats would not qualify as Annex I feature. (Although we recognise this view may be subject to change in the future as more becomes available). Sensitive Cable and Scour Protection NE/JNCC welcome the applicant’s proposal to trail the use of ‘sensitive scour protection’ within the designated site. However, this would still require the deposition of material from outside the site so will continue to represent

	Section	Comment
		permanent loss/change to the feature. It is also noted in [REP1 -216] that the size of the sensitive protection, may not be similar to the surrounding habitat as it more likely to winnow away and doesn't provide adequate protection
	Stage 2 Matrix 4: Coquet Island SPA	
7.20	Table: Features	See comments on Stage 1 Matrix 1. Natural England is unclear why only fulmar have been included in the assessment when a number of the assemblage species are likely to have connectivity with the development zone. We would therefore consider this table to be incomplete.
7.21	Table: Disturbance/Displacement	Please note Natural England's overarching comment regarding consideration of disturbance and displacement activities across all stages of the project.
7.22	Table: Barrier Effects	Natural England considers that barrier effects should be considered at the Appropriate Assessment phase .
	Stage 2 Matrix 5: Farne Islands SPA	
7.23	Table: Features	See comments on Stage 1 Matrix 2. Natural England is unclear why only fulmar have been included in the assessment when a number of the assemblage species are likely to have connectivity with the development zone. We would therefore consider this table to be incomplete
7.24	Table: Disturbance/Displacement	Please note Natural England's overarching comment regarding consideration of disturbance and displacement activities across all stages of the project.
7.25	Table: Barrier Effects	Natural England considers that barrier effects should be considered at the Appropriate Assessment phase .
	Stage 2 Matrix 6: Flamborough and Filey Coast SPA	
7.26	Kittiwake In combination impacts	It is Natural England's position that and Adverse Effect on Integrity on Kittiwake at Flamborough and Filey Coast SPA cannot be ruled out based on the in-combination totals of consented plans and projects. Consequently, any additional impact on this feature would be considered to constitute an Adverse Effect on Site Integrity in combination.
7.27	Notes:	For clarity, Natural England's concerns in relation to the baseline data ***are*** applicable to all of the features of the SPA. The implication of this is that there would not be certainty beyond reasonable scientific doubt to support the

	Section	Comment
		applicant's conclusions. "*The Applicant has maintained its position on the basis that the Proposed Development is located 150 km from the SPA and that extending the breeding season to cover the period advised by NE and the RSPB could lead to inclusion of immature/non-breeding birds that are not associated with the SPA breeding colonies."* Natural England has explained that the converse of this is that excluding these months will substantially under-estimate the impacts apportioned to the colony. <u>Applicant's 'Preferred Approach'</u> The applicant has revised a number of their assessments (some more than once) since their original application. It is unclear to Natural England what the status of these revised/preferred approaches are and whether they are considered to supersede the information set out in the ES and RIAA. For example: REP4-049 presents an "alternative approach" to the ES, but it is not clear whether the Applicant is saying that this should supersede the approach set out in their ES/RIAA. Natural England advice on the alternative approaches is often different to our advice on the ES, so this lack clarity of makes it particularly difficult for to provide comments on this REIS. For example, the flight speeds that the applicant has used within their original ES accord with the SNCBs advice [APP-051], but the applicant has subsequently changed their flight speeds and introduced new avoidance rates at deadline 1 [REP1-188]. *"At deadline 6, in response to a request from the ExA, the Applicant provided a summary of CRM based on its preferred parameters [**REP6-042**] and inputs and one based on those advised by NE [**REP6-043**]."* The parameters in REP6-043 are not the parameters that the Applicant has used in their ES and RIAA. Does this mean that the ES and RIAA are now inaccurate and should be ignored? To clarify, REP6-043 is the applicant's document and not a Natural England document. It presents CRM figures using parameters that we have advised the Applicant to use except crucially we advised that the Applicant should use densities estimated from 2 years of baseline survey data.REP6-043 does not include CRM outputs that are based on 2 years of survey data.

	Section	Comment
7.28	Supporting note a	*"It should also be noted that the predicted collision rates are considered precautionary due to the likely presence of a significant number of non-breeding adult birds in the observed population in the array area "* Non-breeding adult birds can still be part of the SPA feature. This is only one aspect of the uncertainty and variability in predictions of collision mortality of FFC SPA birds. Uncertainty can operate in both directions. It is not representative of the full range of uncertainty in the estimates to just mention one factor here. Natural England and RSPB disagree with the values of Nocturnal Activity Factors (NAF) used, rather than the use of NAF. It is not clear if Natural England and the applicant are in agreement on flight speeds. Natural England agrees with the flight speeds used in the ES, but does not accept the Applicant's alternative approach presented at a subsequent deadline [REP1-188] which has been used in all of their subsequent revisions of their CRM. *"see [**REP1-211**], [**REP1-212**], [**REP3075**], [**REP4-130**] and [**REP6-055**]"* Some of these references refer to subsequent iterations of the Applicant's assessment and not necessarily relevant to APP-051 – this is confusing. *"The Applicant has maintained its position regarding the parameters and choice of Band model"* This statement is not correct as for example the Applicant has introduced different NAFS (REP1-188), different ARs (twice) (REP1-188 and REP6-042) and different flight speed (REP1-188) parameters during the Examination – these are not the same as those in the Applicant's ES and RIAA or in the PEiR docs. *"The Applicant has maintained the position that its analysis does take account of the degree of uncertainty associated with the modelling outputs [**REP1-122**, **REP3-004** and **REP5-008**]."* As the applicant has revised their analysis/aspects of their analysis multiple times through the examination, it would be helpful to understand which particular analysis is being referred to here.

	Section	Comment
7.29	Supporting note b	It is unclear if the view present at the start of this note is that of the Applicant or the Planning Inspectorate. The Applicant revised their PVA figures at REP4-092. Based on Natural England's assessment of these, we do not agree with the statement that " levels of in combination mortality predicted in Table 7.39 of [**APP-051**] would not be sufficient for the population to decline below the SPA citation numbers for this species". Natural England would reiterate that and Adverse Effect on Integrity on Kittiwake at Flamborough and Filey Coast SPA cannot be ruled out based on the in-combination totals of consented plans and projects. It is also unclear which citation levels are being referred to and it should also be noted that the Conservation Objectives for kittiwake at FFC SPA remains to restore to the original citation population figure for Flamborough Head and Bempton Cliffs SPA. The PVA modelling within APP-051 does include some adjustment for "as built scenarios". It also includes NAF, but these are not figures that Natural England is in agreement with for Hornsea 3. "The Applicant submitted a revised PVA at deadline 1 [**REP1-135**] but this did not allay ours concerns [**REP3-075**]" The revised PVA [REP1-135] did not address Natural England's Advice. Natural England remain concerned that there is potential for AEoI. It should also be noted that the Applicant has submitted an updated version of their PVA [REP4-092]. <u>The Applicant's Revised In combination Assessment</u> As an increasing number of projects are consented, the risk of in combination/cumulative impacts reaching significant levels has increased. (As highlighted above, Adverse Effect on Integrity on Kittiwake at Flamborough and Filey Coast SPA cannot be ruled out based on the in-combination totals of consented plans and projects, so projects that contribute to this total would be considered to be contributing AEoI irrespective of the scale.) Most offshore windfarms are consented using a Rochdale Envelope Approach, and the assessments of impact are based on their maximum design scenario, to represent a worst case scenario in terms of impact. It is therefore

	Section	Comment
		possible that the "as built" impacts will be different to those assessed. The Applicant has presented an in combination assessment which revises the figures presented by other projects to reduce them to what they consider to be a more realistic reflection of the "As built scenario". Natural England has provided more detailed comment on the Applicants approach at deadline 6 [REP6-053]. However in the context of the HRA, Natural England would make the following overarching points: - **The principle of revising the figures from other projects:** Within this assessment represents a set of assumptions from the applicant in relation what they consider to be a **most likely scenario** within the Maximum Design Parameters. Whilst we acknowledge that these assumptions are informed by their expertise of the industry, Natural England's view is that unless these parameters are legally secure (i.e. the MMO/Marine Scotland Licensing) can confirm/give certainty the project **would not be able to** build out to their Maximum), then the figures from their original assessment should be used. - **The Applicant's approach to revising the figures of other projects:** Natural England made detailed comments on the applicant's approach to revising the collision and displacement figures of consented plans and projects in our deadline 6 response [REP6-053]. Consequently Natural England does not consider that the Applicant's in-combination assessment is valid, and consider that it has the potential to significantly under-estimate the in-combination impact. …."and also applies a NAF (Table 7.35, [**APP-051**]" It's unclear what this relates to as CRM always apply a NAF. Natural England did not agree with the NAF presented in the ES. The applicant has since presented figures using alternative NAF, but these do not accord with Natural England's advice.
7.30	Supporting note c	**Razorbill:** This is based on the figures provided in the application. Natural England has provided considerable comment on the applicants approach to displacement (as summarised in o below) – the applicant has presented an approach that is more aligned with NE advice in Appendix 28 Annex C at deadline 4. Please refer to table 1.17 p28

	Section	Comment
		Mortality impacts ranges from 0 – 63 for razorbill at FFC SPA (including immatures in the breeding season) (19 being adults in the non-breeding season)
7.31	Supporting note d	NE do not agree that the predicted impact is 'negligible'.
7.32	Supporting note e	**Guillemot:** As above please refer to table 1.13 Appendix 28 Annex C at deadline 4 range is 3 – 995. 3-59 adults in the non-breeding season.
7.33	Supporting note f	Natural England do not agree that the predicted impact is 'negligible'. "*No indication that, at the level of mortality predicted to arise from the Proposed Development in combination with other projects, the population is likely to decline over a period of 35 years such that the feature would no longer be considered in favourable condition (paragraphs 7.7.2.41 – 58, [**APP-051**])"* This refers to a PVA analysis that has subsequently been updated by the applicant.
7.34	Supporting note g	*"Due to the low percentage of the SPA population affected by collision and the small increase in background mortality it is assessed that there is no adverse effect on integrity of the feature population of the SPA (paragraphs 7.5.2.32 - 35, [**APP051**])."* It should be made clear that this is 'in the applicant's view'.
7.35	Supporting note h	**Gannet:** As above Table 1.9 (Appendix 28, annex c, deadline 4) – displacement figures = 0-76 adults at FFC SPA (including 8 in the non-breeding seasons)
7.36	Supporting note i	"*The Proposed Development contributes to less than 3% of the in combination collision risk total for gannet at the SPA (section 7.7, [APP-051]).*" - It should be made clear that this is the Applicant's view Based on NE's assessment of the Applicant's figures would indicated that the contribution of HOW3 is considerably higher than 3%. "PVA modelling indicates that the resulting levels of in combination mortality predicted in Table 7.36 of APP-051 would be insufficient for the population to decline below the SPA citation numbers for this species."

	Section	Comment
		Again, this is the Applicant's view- NE do not agree. It is unclear which citation numbers are being referred to. The conservation objective for FFC SPA is to recover the Kittiwake population to the citation numbers for Flamborough head and Bempton Cliffs SPA. Please also see NE's comments on NAF and 'as built scenarios' under supporting note b above.
7.37	Supporting note j	*"An in combination displacement impact of 14 birds for gannet would not adversely affect the integrity of the SPA."* NE don't agree with this figure and as stated previously, this is based on a PVA modelling that has since been superseded by revisions submitted by the applicant.
7.38	Supporting note o	This paragraph is a little unclear and would benefit from re working. NE is unsure what is meant by "*particularly the monthly estimates of abundance" and "the inclusion of immature individuals.* Natural England would also highlight that our key concern is in relation to the months of missing data.
	Stage 2 Matrix 7: Greater Wash SPA	
7.39	Table: Features	As highlighted in stage 1 comments – NE is of the view that all tern species and little gull should have been considered within the appropriate assessment
7.40	Table: Disturbance/Displacement	Please note NE's overarching comment regarding consideration of disturbance and displacement activities across all stages of the project.
7.41	Table: Barrier Effects	NE consider that barrier effects should be considered at the Appropriate Assessment phase.
	Stage 2 Matrix 8: North Norfolk Coast SPA	
7.42	Marsh Harrier	Natural England agree with the applicant's conclusions in relation to marsh harrier. However, we would highlight that should nesting sites be discovered during pre-construction surveys, or prior to construction, further assessment would

	Section	Comment
		be needed and appropriate mitigation agreed.
7.43	Pink Footed Geese	Pink footed geese are NE's only outstanding concern in relation to this site. It is likely that the potential impacts can be mitigated, but discussions with the Applicant on the mitigation plan are ongoing.
7.44	Supporting note c.	*"NE agree that 12 months is acceptable but wishes to be consulted 12 months prior to construction commencing to ensure that mitigation is sufficient and can be implemented effectively [**REP1-207** and **REP1213**]. It is within their remit to sign off such mitigation plans relating to SPA features before mitigation can be implemented [**REP3-074**]."* As clarified in our deadline 6 response, the LPA would be responsible for the sign off of the mitigation plan in consultation with Natural England.

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

NATURAL ENGLAND

Written Submission for Deadline 7

Natural England's Response to Rule 17 Questions

14 March 2019

Statements of Common Ground		
F2.1	Written questions Q2.2.1 and Q2.2.37 requested the submission of agreed Statements of Common Ground for benthic ecology and offshore ornithology by D6. Please submit these statements using the required headings noting any areas where there will be no agreement.	Natural England provided updated comments to the applicant on both Benthic and Ornithology Statements of comment Ground prior to Deadline 6. We have also held discussions with the Applicant and provided subsequent comments since this time In Natural England's view there have been versions of these documents that could have been submitted at each deadline as an indication of our progress, however, as these documents are owned by the Applicant, it is for them to submit to Examining authority. The Applicant is seeking to provide SoCGs that are clear and well-structured in line with the ExA's requests.
General Benthic Issues		
F2.2	You submitted geographical data at D4 [REP4-131, REP4-132] and an associated report by Vanstaen & Whomersley (2015) [REP4-140]. Please submit a text document that contains the justification for assigning a 500m buffer to the reef layer.	Please see "Marine Buffers" doc submitted as part of our D7 submission.
Cable Specification Installation Plan		
F2.3	In your D6 submission [REP6-049] you state that the rock protection within MPAs would be 10% plus 25%. The ExA understands that 25% is the replenishment rate of the maximum design scenario where up to 10% of the cable route within MPAs would require protection during the lifetime of the project. If this is correct, how do you arrive at a figure of 35%? In paragraph 12 of your submission you seek clarification on the maximum design scenarios, can you explain your concerns more fully?	[For clarification the 35% figure was a query, and we received subsequent information from the applicant to clarify this point.] We have considered the issue of 10% vs 25% further in ANNEX C Natural England's Deadline 7 Submission. Please note that both Natural England and the MMO believe that the 10% of cable protection should be restricted to the construction phase only. There are also some outstanding concerns/considerations in relation to the quantities relating to the 25%. Therefore, we request that should the SoS of state be minded to permit the application as is (i.e. considers there to be no AEoI) the parameters of the both the 10%

		and the 25% in both Volume, Area and length are secured in the DCO/DML so that the necessary restrictions are in place.
Cable Trenching Assessment		
F2.4	Please explain why you think that the trenching assessment [REP6-026] should consider more than the direct areas of overlap between the MPAs and the cable corridor as stated in paragraph 9 of your D6 submission [REP6-048].	Natural England has reviewed our previous comment and can confirm that there was an error on our part and we are content with the sections considered by PTA.
F2.5	In paragraph 7 of your D6 submission [REP6-048] you raised questions about how the insights from the trenching assessment would be implemented and incorporated into the Cable Specification and Installation Plan (CSIP). However, the Applicant appears to have set out how this would occur through liaison with an Ecological Clerk of Works and ongoing dialogue. Please explain why you do not think that this would be adequate. What specific measures do you suggest?	Natural England recognises that the Applicant is making upfront assumptions in relation to contractor installation capabilities, before they have a contractor on board. It is recognised that not all contractors will be able to deliver all requirements. Therefore we are seeking assurances on how the applicant will ensure the contractor can deliver on the ground what they are committing to now i.e. is the applicant committing themselves to have a contract tender/s for the work that specifies any particular requirements/tools to achieve desired outcomes.
F2.6	You note in paragraph 10 of your D6 submission [REP6-048] that the Applicant hasn't considered mixed sediments. The ExA notes that they are not listed in table 4.2. Do you have any further clarification from your geologist to be able to elaborate on this point? Do you have any further comments on the adequacy of the ground model?	Please refer to ANNEX A of our D7 submission where we have provided further advice on REP5 - 10. Our Stratigrapher has raised some concerns in relation to the adequacy the ground model particulary in relation to coverage, lithologies, and Ground models (section 3), but is unfortunately without more evidence from the Applicant we are unable to provide further advice in relation to mixed sediment. As a sub feature of Annex I sandbanks it is highly probable that this features will be regularly found along the cable route. Mixed sediment have proven to be challenging for cable installation for other projects and therefore It would be helpful for the Applicant to consider this further.
F2.7	Please explain how seeing the detail of the geotechnical surveys undertaken in 2018 within the Wash and North Norfolk Coast Special Area of Conservation, as set out in paragraph 13 of your D6 submission [REP6-048], would inform your views and help the examination at this stage?	As with other thematic areas such as Ornithology having sight of the survey data can often help us formulate our own views on what the data shows and enable us to have a better understanding on what the applicant has based their assessment on. It would hopefully provide a greater degree of confidence in the findings of the PTA.

F2.8	Please elaborate on the point you made about Edmond Ground in paragraph 15 of your D6 submission [REP6-048]. How does this relate to potential impacts on site integrity.	Please see sections 1 and 3 of ANNEX A of Natural Deadline 7 submission.
F2.9	You have suggested in paragraph 16 of your D6 submission [REP6-048] that the Applicant might not be able to trench through Boulder's Bank because of the stiff clay. This contradicts the applicant's tool assessment which highlights two viable trenching options. What technical evidence or direct engineering experience have you drawn upon to suggest that either mechanical trenchers or cable ploughs would be unsuitable under these circumstances? What are JNCCs views and how are they informed by direct engineering knowledge of the equipment that would be used? If cable trenching has been unsuccessful elsewhere was the trenching equipment the same in all respects as the equipment that would be used in this project?	Please see Further comments on REP5-010 submitted at Deadline 7. (Annex A) Please note that the Applicant themselves have identified that outcropping stiff clay is particularly challenging to install cable through, citing one advantage of the alternative route through The Wash and Norfolk Coast SAC away from Cromer Shoal Chalk Beds MCZ is avoiding known outcropping clay within the MCZ. Whilst Natural England's Stratigrapher has also highlighted the challenges of this sediment, we do not have sufficient engineering knowledge of the specific equipment and or evidence presented in the PTA to comment on the unsuitability of the equipment. Whilst both Natural England and JNCC are aware that stiff clay was a challenge this awareness is derived from industry who have cited challenges with stiff clay as justification to progress alternative installation options which avoid those areas. We are also aware that both Sheringham Shoal and Humber Gateway OWFs have cut through stiff clay in the near shore area some of which is part of the boulder bank formation there is no evidence to demonstrate how analogous that is to stiff clay formations in the offshore environment. And whilst we know that cutting tools where required for those two projects, we do not have sufficient information on the schematics of the tools to make an direct comparison of the equipment presented in the PTA and/or evidence of the impacts of using said tools on designated site features as either outside of a site or monitoring not undertaken. In addition as set out in question F.2.5 The PTA sets out known tools on the market that could undertake the work to the desired outcome. But as with all equipment some manufactures and models are better than others at achieving the desired outcome.

F2.10	You queried the consistency of the chalk in paragraphs 19 and 21 of your D6 submission [REP6-048]. What, if anything, do you infer from the fact that all of the sample cores readily penetrated the chalk up to a depth of 6m? If there was no impedance why would a mechanical trencher not work under these circumstances?	Please see "NE's Further Advice on PTA" section 2 submitted at deadline 7 in relation to the chalk. Natural England acknowledges that a trencher could work in these habitats as Sheringham Shoal used similar. However, the scale of the impact remains unknown. But we remain cautious because similar CPT tests where undertaken prior to construction for other projects only for the installation tool to fail in burying to the optimum depth. Is this because the wrong tool was chosen/used for the job? Or is it a compromise between repeatedly switching between tools and potential requirement for cable protection therefore choosing a suboptimal tool for one particular habitat in favour for one that is more of a generalist that can install in most habitats
Cable Protection Decomissioning		
F2.11	The Rock Protection Decommissioning Report submitted at D6 [REP6-018] states that rock protection measures could be removed either with a Trailing Suction Hopper or a Backhoe Dredger. If up to 30cm of seabed was removed, would you still conclude that the removal of the rock protection would lead to the permanent loss of interest features? Would this conclusion apply equally to all features or would some have a greater potential for recovery? If so, which ones? Do you have any other comments to make regarding this report?	Please see section 7 ANNEX C of our D7 submission which provides our advice on the limitations of REP6 – 018. Natural England remains of the view that removal of 30cm of Annex I feature below the rock armouring would be a permanent habitat loss. The Annex I habitat that has the greatest potential for recovery is Annex I Sandbanks, but not where there are mixed and coarse sediment sub features. Natural England is of a view that for all other features an AEoI can't be ruled out.
F2.12	The Applicant has highlighted the fact that some studies suggest a greater frequency of rocky habitats previously occurred in the North Sea and that significant infaunal and epifaunal communities, including sabbelariid reefs, can develop on rock berms [REP1-138]. What are your views? Could the rock protection lead to 'no net loss' of biodiversity in its broader sense? What would be the consequences of removing rock protection under those circumstances?	Please ANNEX B of our D7 submission in which Natural England presents our advice on colonisation of Sabellaria spinulosa on rock armouring. Please note that whilst we don't disagree that the North Sea may have looked very different in the past. The habitats Regulations requirements is to protect the interest features of the sites at the time of designation. Therefore, our advice remains unchanged.
F2.13	In your D6 response [REP6-055] you state that you would welcome the inclusion of a commitment to remove rock protection in the dDCO but you then go on to state that it no longer	Natural England welcomes any commitment to minimise the impacts the impacts of a project. Natural England has previously considered the removal of cable protection as mitigation as the

	provides mitigation and that you have significant concerns over its effectiveness. Why would a condition be justified if it would not provide the necessary mitigation?	impacts would be 'long lasting, but temporary' (Dogger Bank Creyke Beck 2014 and Dogger Bank Teesside 2015). However as set out in our Deadline 1 response we no longer have the confidence that decommissioning can occur and if it can that there wouldn't be wider impacts to the features as a result i.e. permanent removal of the interest feature.
North Norfolk Sandbanks and Saturn Reef Special Area of Conservation		
F2.14	You referred to a 'standard set of analyses' in your D6 response [REP6-47] to a D4 submission [REP4-097]. Please indicate where this standard has been established, whether it has been subject to peer review in an academic journal and the extent to which benthic researchers apply the analysis you favour in the peer reviewed literature. If there is more than one accepted way to analyse benthic data why is the approach used by the Applicant unacceptable?	The SNCBs advice to all developers and marine industries on best practice/standard set of analyses are based on our *ongoing* consideration of casework and assessment that have been undertaken and all relevant peer reviewed guidance that is out there (best available evidence). And yes these are subject to change as knowledge and understanding evolves. Therefore we are not necessarily saying the applicant is incorrect in their approach, but we are trying to ensure that the competent authorities can undertake an equitable in-combination assessment i.e. comparing apples with apples and the only way to do this is to undertake standard analysis to provide a common currency. The applicant figures could then be used by the competent authority (if considered appropriate) to inform the level of confidence or risk around standard analysis figures.
F2.15	In your D6 response [REP6-47] you stated that the methodology used by the Applicant, which includes the techniques highlighted in Jenkins et al. (2015), was not 'scientifically rigorous'. Could you explain why you consider this to be the case and whether this was related to the sampling strategy, sample processing, measurements or the processing of the resulting data? In your view, what should have been done differently and why?	Natural England has provided the Examiner at D7 with a copy of a JNCC report on undertaking surveys within MPAs. This is provided to help demonstrate the expected survey design and effort required when trying to determine the scale of the impacts and possible mitigation measures required for sustainable development in SACs. Short of doing further surveys, it is our opinion there is nothing that the Applicant can do at this time to address the survey shortfall and therefore their remains scientific doubt. And whilst any pre-construction survey could provide that rigour it doesn't address our current uncertainties
The Wash and North Norfolk Coast		
F2.16	You raised a number of concerns in your D6 submission [REP6-051] in relation to the revised in combination assessment for this site [REP3-024]. You noted that the assessment did not include Race Bank or explicitly consider permanent loss from cable protection. Please explain these comments in more detail bearing in mind, among other things, the content of section 3 and	The details behind the figures included in table 3.1 have not explicitly been included, therefore we are unable to collaborate any figures presented here. Please also note that discussions in relation to Race Bank cable protection are ongoing and currently we are unable to advise that an adverse effect on integrity could be ruled out alone.

	table 3-1 of [REP3-024]. You have also noted a failure to consider the 'Large Shallow Inlet and Bay' feature. What did your own data from the MAGIC website show? If there was no overlap with the cable export corridor why should it be considered in the assessment?	Whilst MAGIC provide a boundary for the Large Shallow Inlet and Bay Feature the conservation advise packages and objectives for The Wash and North Norfolk Coast doesn't make the same distinction. Therefore we don't believe that it was appropriate to screen this feature out at the tLSE stage, but recognise that an argument could be put forward to demonstrate why there is unlikely to be an AEoI.
Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ)		
F2.17	In your D6 submission [REP6-050] you recommend further discussions with relevant parties over Measures of Equivalent Environmental Benefit (MEEB). Section 126(5) of the Marine & Coastal Access Act (2009) states that authorisation should not be granted where harm might be caused unless three tests are met which includes arrangements for MEEB. Section 126(9) requires an authority to attach conditions to an authorisation in order to secure MEEB. As a consequence, and given your unresolved concerns, is it the case that consent cannot be granted for the proposal unless MEEB are secured through the dDCO? If this is the case then what would be your advice to the SoS?	If the SoS were to conclude that the impacts on the MCZ were significant and that MEEB are required, we would recommend that further Advice is sought from Defra on the status of the designation (noting that we do not yet have a timetable for the decision on tranche 3 sites) and for further guidance in relation to MEEB. As highlighted in our D6 [REP6-050], there is currently no formal guidance on MEEB, consequently we would we would recommend that discussions relating to MEEB (should the need arise) include input from the SNCBs, Regulatory Agencies (i.e. MMO and BEIS) and Defra. [It should be noted that the applicant has concluded that the impacts are not significant]. The Applicant has not provided information in their application or additional submissions that allows Natural England to understand and advise the potential significance of impacts to the designated features at this stage. Natural England hopes to explore this matter with the applicant over the coming week, with a view to informing our SoCG with the Applicant."
Markham's Triangle pMCZ		
F2.18	Do you consider that the proposed reduction in the maximum design envelope within Markham's Triangle and removal of cable/scour protection would reduce the risk of hindering the conservation objectives to an acceptable level at this site? If this is not the case, do you also advise that MEEB should be secured for this site?	Natural England's understanding is that the commitment to reduce the Maximum Design scenario from 24% overlap with the pMCZ to 10.5% is secured within the dDCO/DML. Obviously, the reduction of infrastructure in the site would intuitively reduce the overall footprint of impact within the site. However, as explained further in NE's Deadline 7 Submission "Summary of Advice on Markham's Triangle pMCZ" NE/JNCC

		would require further information before we could comment on the likely significance of the impact on each feature of the site. It should also be noted that NE would consider cable/scour protection would constitute a permanent impact on the site
F2.20	If Markham's Triangle is designated as an MCZ before the SoS determines the application, is it the case that consent cannot be granted for the proposal unless MEEB are secured through the dDCO? If this is the case then what would be your advice to the SoS?	As Markham's Triangle is a pMCZ it is a material consideration and therefore should be treated in the same way as a designated MCZ.
F2.21	In your D4 response [REP1-131] you raised concerns over inconsistencies in biotope classification compared to Sotheran et al. (2017). Given that the majority of samples were in the eastern part of Markham's Triangle, away from the array area, how can this survey be considered representative and why do the inconsistencies matter? Whilst some samples indicated a different biotope in the western area, the Applicant considers that there would be no significant difference in recoverability given the similarity to what was identified in their own analysis [REP5-008]. How do you respond? Sotheran et al. (2017) states that 'biotope allocation can be subjective and dependent on the opinion of the analyst'. If there is no objective method of assigning biotopes could the differences not simply be the result of subjective similarity thresholds that were used in the cluster analysis?	Whilst NE and JNCC would be happy to answer this question in detail, we would first direct the ExA to consider NE's Deadline 7 Submission: Summary of Advice on Markham's Triangle pMCZ. Should the ExA have any further Questions we would be happy to provide further comment.
F2.22	In your D4 response [REP1-131] you stated that the applicant has not undertaken MCZ assessments in a way that allows the best scientific understanding of the potential impacts. Can you be more specific about what, in your view, needs to be done to enable	Please note, Natural England has provided a summary of our position on Markham's Triangle pMCZ, and Cromer Shoal Chalk Beds MCZ with our Deadline 7 submission.

	the impacts to be more clearly understood for both Markham's Triangle and Cromer Shoal Chalk Beds?	Natural England hopes to explore this matter with the applicant over the coming week, with a view to informing our SoCG with the Applicant.
Cumulative Benthic Effects		
F2.23	In your D4 response [REP4-130] you stated that repetitive impacts on the same benthic footprints had not been adequately considered between different stages of installation and under a phased scenario. The Applicant disputes your position and has stated that no recovery was assumed between different phases of installation [REP1-178] and that the approach to assessing cumulative impacts was no different to other projects [ERP4-012]. In the light of these comments what are your outstanding concerns and are they sufficient to conclude that the cumulative impact assessments are flawed? If so, please suggest how this should be remedied..	Natural England notes that in [REP - 178] the applicant has not an anticipated that recovery will happen between both the different construction stages and the phased builds. Therefore any Appropriate Assessment would need to take into account both the spatial and temporal impact to the interest feature/s of the site. As there could 13 years of impact before the site would start to recover and up to 18 before full recovery could occur unless cable protection was used when we believe there would be a permanent habitat change. Therefore we can confirm that we do not believe the cumulative impact is flawed, it is more a recognition of the temporal scale of the impacts
Marine Mammal Site Integrity Plan		
F2.24	You stated at ISH5 [REP6-055] that you were awaiting general guidance on Site Integrity Plans (SIP) from BEIS and the MMO as part of the Review of Consents. Do you have any further information?	BEIS/MMO conducted a second consultation on what the SIP will include. Natural England have responded, but still have concerns that there is no mechanism for the review and oversight of multiple SIPs.
F2.25	You stated at ISH5 [REP6-055] that you required a mechanism to enable regulators to consider the impact of multiple SIPs occurring over varying timescales and that procedural elements need to be in place to ensure noise generating activities do not happen at once. Do you have any suggestions about how this could be achieved bearing in mind the legal scope of the dDCO?	Natural England consider that the current requirement within the dDCO for a SIP to be produced and signed off by the MMO (in consultation with the SNCBs) prior to construction commencing, would be sufficient to address the AEoI issue. The point Natural England seeking to raise is that in order for the SIP to be signed off, it would need to be demonstrated that there would not be an adverse effect on site integrity in combination. This would require consideration of multiple SIPs over different timescales, and as yet there is no mechanism in place for this which would presents a potential risk to the project (rather than the harbour porpoise) down the line.
Ornithological Collision Risk Model		

F2.26	The Applicant submitted a revised Collision Risk Model (CRM) analysis at D6 that includes your recommended parameters [REP6-043]. Leaving aside the baseline data issue, please can you indicate precisely which aspects of this analysis accord with your original recommendation and how any relevant results would alter the baseline mortality estimates for gannet and kittiwake, as set out in tables 7.13 and 7.17 of [APP-051] and tables 5.26 and 5.27 of [APP-065]. Please address whether the apportioning outside the core breeding season is realistic and give a reasoned justification for your conclusion. In your D1 submission [REP1-211] you recommend the use of Option 2 but do not specify which generic height data should be used. Please indicate your preferred choice. Please also submit a table showing what CRM parameters you feel should be applied to each species and the publications that justify each of your choices, these should include: proportion flying at risk height, windfarm latitude, nocturnal activity factor, flight speed (m/sec), wing span (m), bird length (m), flight style, proportion of upwind flights, avoidance rate for the basic model and avoidance rate for the extended model.	*Applicant's revised collision risk modelling* Natural England has provided precise information on the aspects of REP6-043 that accord with our advice in the Table 1 below and in ANNEX E of our D7 submission, including how these affect the annual mortality relative to the baseline mortality for gannet and kittiwake for comparison with information presented by the Applicant as set out in tables 7.13 and 7.17 of [APP-051] and tables 5.26 and 5.27 of [APP-065] and associated text. *Apportioning outside the core breeding season.* Birds are apportioned to individual SPAs throughout the year – outside the breeding season the standard approach is to refer to Furness (2015 - REP4-036) and derive proportions from this. The approach set out in Furness (2015) defines seasonal 'biologically defined minimum population sizes – (BDMPS), and calculates what proportion a particular SPA population constitutes of this BDMPS. (e.g. 4.8% of the total gannet population estimated to be in the North Sea in the post breeding season are estimated to be adults that breed at FFC SPA) During the breeding season the approach in the past (if only one breeding colony is within foraging range) has been to assume either that 100% of birds are apportioned or that 100% of adults are connected (and hence apportioned) to the colony in question. As NE have explained in our response to the first Ex A (REP1-212 Q1.2.51) and in our written representation (REP1-211, Section 7.9-7.15), the outcome of defining a 'core' breeding season (i.e. excluding 'non-core' early/late breeding season months) is that a very low number of birds are apportioned to the colony in the 'non-core' breeding season months .As an example, in the case of Gannet the applicant has defined the 'core' breeding season as April – August. In August somewhere between 40-60+% of birds are apportioned to FFC SPA (depending on the data set used to inform the % of adults observed – in the case of Gannets adults can be aged, so there is no reason to think that immatures are included in this figure). In September, FFC SPA reserve managers/researchers observe substantial numbers of birds to still be present at the breeding colony,(RSPB, pers com, Langston et al 2012) however only 4.8% of birds observed at the project site would be apportioned to FFC. We do not consider this approach to apportioning in the 'non-

		core' breeding months to be a realistic, and more specifically we consider this approach to lead to an underestimation of impact at the SPA in question (FFC) which is contrary to the precautionary principle. The most data driven approach is to assume that all adults observed during the full breeding season ('core and non 'core) are apportioned to FFC SPA based on the proportion of adults at the project site (admittedly, for kittiwake and puffin this is 'adult-type' birds which will contain an unknown proportion of pre-adult birds). We do not have specific data that will inform the proportion of birds that are non-FFC birds, or the proportion of immatures (in the case of puffin and kittiwake). If this approach is employed it is the case that an unknown proportion of birds will be incorrectly apportioned to FFC SPA, i.e. the impact may be over-estimated. The two approaches then, 'core' vs 'full' breeding season apportioning lead to inaccuracies – either under or over estimating the impact (respectively). However, of the two approaches, NE consider the latter is more appropriate and justifiable, it makes no assumptions in regards when the 'core' months might be (an aspect open to considerable debate) and establishes a precautionary baseline that can be examined via presentation of a range of lower apportioning rates. NE suggested presenting a range of apportioning values (in much the same way that a range of displacement and mortality effects are presented for displacement) acknowledging that there is likely to be a proportion of non-breeding adult FFC birds present, and the applicant has followed this advice and presented such a range in REP4-049 (e.g. Table 1.28 Annex C). *Generic height data for use with Option 2 of the Band Model.* See below table for information on the generic flight height data that Natural England advises should be used with Option 2 of the Band (2012) collision model and other CRM parameter information requested.
F2.27	In your D1 response [REP1-211] you use Johnston and Cook (2016) as one of the reasons for rejecting the use of boat-based observations of flight height from earlier Hornsea projects when used in conjunction with digital aerial survey	The issue that Natural England raised in our [REP1-211] response related specifically to the use of flight height distributions generated from boat-based observations with density data derived from digital aerial data when the Extended Band Model is used. The Extended Band model does not use a

	data. Why does this matter when: a) the same study shows that there was only a significant overall difference in height estimation between the two methods for gannet and Sandwich tern; and b) a supplementary aerial survey [REP2-017] indicates that the flight heights recorded during boat-based surveys are representative of flight behaviour of birds in the array area when recorded by more accurate means.	simple percentage of birds at collision height (PCH) measure, but uses detailed information on flight height distributions in one metre height intervals. Johnston and Cook (2016) found that for most species, the fitted distributions generated from digital aerial survey data differed from distributions previously estimated with boat survey data. The reasons for these differences were not clear and may have included different observation processes and data collection processes resulting in for example, differences in the accuracy of the different survey methods, analytical differences, site-specific differences, survey times in different seasons or times of day, behavioural patterns affected by the presence of boats or planes (Johnston and Cook 2016). So although Johnston and Cook (2016) found that the estimated proportion at potential collision height for the distributions derived from boat survey data and digital aerial data was similar for 5 out of 7 species, the fitted distributions that are needed for the Extended Band Model were not. In other words it is possible to have a similar value for PCH but for the fine scale distribution of flight heights to be different between datasets. As a result Johnston and Cook (2016) concluded that "*if the extended Band model is used, the flight height distributions may not be transferable across platforms, i.e. distributions derived from digital aerial survey data should not be used with densities derived from boat-based surveys and vice versa.*" Natural England do not agree that the supplementary aerial survey [REP2-017] provides evidence to prove that the flight heights recorded during boat-based surveys are representative of flight behaviour of birds in the array area. The Applicant did not test whether the flight heights from the LiDAR data were statistically comparable with the historical boat based data used in the Applicant's collision risk modelling. The LiDAR data collected by the Applicant was limited to July and August 2017. Flight heights of species are known to vary by season, so any comparison with historical flight height data would need to account for this. The study did not use a LiDAR scanner synchronised with digital still cameras to measure the flight height of identified seabirds (eg. as in Cook et al 2018), instead the Applicant used the LiDAR data to indicate where in a separate image database to find an image subset, and from there make a manual visual interpretation of

		species. No review of the robustness of this method has been undertaken. Using this method the Applicant was not able to identify all birds to species level in their study – for example the Applicant states that "*Thirty-four birds were identified as probable Kittiwake across HOW03. However, it was also considered likely that the majority of birds identified as grey backed gull species from the images (91 birds) were also Kittiwake"*. Given that there are differences in the flight height behaviour of the different gull species, being able to accurately identify birds to a species level is important. The Applicant also states that "*The findings of this study found a markedly lower proportion of birds at potential collision height than the baseline characterisation surveys at HOW03 (HiDef pers comm.)*", however it is not clear whether this statement refers to the digital aerial baseline data or the historical boat based data. The Applicant states that "*In combination with those birds identified as probable Kittiwake (34 birds), only 2.4% (3) of grey backed gulls flying were at potential collision risk. This is markedly lower than the proportion of Kittiwakes baseline characterisation surveys at HOW03 have identified as being at collision risk…*". This statement is confusing as the Applicant has used a PCH value of 0.78% for kittiwake in collision risk modelling at Hornsea Project Three (Table 1.6 [REP-109]) which the Applicant apparently derived from the boat based survey data for Hornsea Project Three. Further, this statement does not seem to indicate that the LiDAR data demonstrate that "*flight heights recorded during boat-based surveys are representative of flight behaviour of birds in the array area when recorded by more accurate means"* as stated in part b of question F2.27. Using LIDAR is a novel approach to assess height information. The Applicant has stated that the work presented in [REP2-017] was a pilot trial to test a system. Most birds were not identified to species level, therefore it is difficult to draw conclusions on flight heights at a species level. Neither the method, nor the data derived by the Applicant has been reviewed in detail in terms of robustness. Natural England does not believe that the LIDAR methodology has been validated so it would be a leap for the applicant to state that this validates the boat based data in any way.There have only

		been a few studies with LIDAR data. Until recently there was a widely accepted methodology for using digital aerial survey data to derive flight height which has now been shown to be invalid, so this demonstrates the need to fully evaluate methodologies prior to accepting them.
F2.28	In your D3 response [REP3-075] you state that the flight height data in Skov et al. (2018) are not more widely applicable because the results relate to a single site outside the breeding season. Figure 3.4 of Skov et al. (2018) seems to suggest otherwise. Please explain the basis for your view that flight height measurements in this study did not occur during the breeding season. Given that Pennycuick 1987 relates to a single site why is it more acceptable to use this as the basis for gannet flight speed estimation in a CRM rather than Skov et al. (2018) which has a larger sample size? What evidence do you have to suggest that flight speed varies in a statistically significant manner between spatially distinct seabird populations?	Our comments regarding the ORJIP study were in relation to the flight speed data not flight height data, as the Applicant has proposed use of the Skov et al (2018) data presented on flight speeds but not the data collected for flight heights. Figure 3.4 of Skov et al (2018) shows the fieldwork effort from 1 July 2014 - 14 April 2016 for the ORJIP study. This does include survey effort in months that represent the breeding season for seabird species, but does not indicate if birds were recorded in those months. In the case of kittiwake the majority of rangefinder track samples (which were the platform used to derive flight speed data) came from the non-breeding season months (~84% of rangefinder tracks were from the months September to February), and of those ~16% of tracks that were recorded between March and August, 86% were in March. Further, there are no colonies within foraging range of Thanet for kittiwake (or gannet) so Natural England's view is that any flight speed records from breeding season months for these species will not relate to birds that are engaged in breeding activity in that season. This is the basis for our view that flight behaviour measurements relate to a single site (Thanet OWF) and the data are derived from birds that were not breeding birds with foraging connectivity to a colony, and further were birds that were recorded predominantly in non-breeding season months. Bird flight speeds are highly variable depending on environmental factors, notably wind speed and direction as well as behavioural state e.g. migrating, foraging, and also at different stages of breeding season (e.g. incubation versus chick rearing) e.g. Elliott and Gaston 2005, Pennycuik 1987, Spear and Ainley 2008), all of which have a spatial as well as temporal component. For example, GPS logger data from studies of great black-backed gulls at two sites – one in Swedish Baltic Sea and the other in Danish Kattegat showed a similar distribution of flight speeds, but the mean flight speed for the Swedish data was 45.1 km/hr

		compared to 38.8 km/hr for the Danish offshore data (Gyimesi et al. 2017). Seabird flight speed data for use in CRM with the Band Model have typically been taken from Pennycuik 1987,1997 for gannet and Pennycuik 1987,1997 and Alerstam et al 2007 for kittiwake. The Pennycuik data are based on observations at Foula, Shetland. Foula is an SPA for breeding seabirds including kittiwake. Natural England accepts that there are now additional sources of data available which include information on flight speeds (e.g. from seabird tracking studies) and that a review is needed of appropriate flight speeds and variability around these to use for Collision Risk Modelling. However this needs to be based on all of the available information, and not just a single study or set of outputs. There is no evidence that any single published set of figures is more appropriate than the current set, irrespective of sample sizes and what those “samples” represent (e.g. number of birds, number of tracks, number of segments within tracks, length of tracks etc). There are a number of factors that need to be considered including weather conditions at the time of the studies, methods used to measure flights speeds (e.g. rangefinders, data from tagged birds etc) and methods used to analyse the data and derive flight speed statistics (e.g. how data have been processed for analysis and how flight speed data have been calculated from the recorded information), as well as time of year and location of studies. A further consideration is that the appropriate avoidance rates (ARs) to use in CRM are dependent on other model parameters and flight speed is one of these. The avoidance rates that Natural England advise are used for CRM with Band (2012) were calculated using the flight speed data from Pennycuik/Alerstam et al. and are based on the work in Cook et al (2014) which derived ARs using flight speeds from Pennycuik/Alterstam et al. These ARs are not transferable for use in CRM with the flight speed data from Skov et al. (2018). Natural England note that projects that have generated collision risk figures that use Pennycuik (1987) and Alerstam et al (2007) flight speed data include East Anglia 1, Burbo Bank Extension, Hornsea Project One, Hornsea Project Two, Dogger Bank Creyke Beck, Dogger Bank Teesside, East Anglia 3, Beatrice, Moray East, Nearte na Gaoithe,

		Norfolk Vanguard, Thanet Extension (noting that the Skov et al (2018) study was based at Thanet OWF) and Hornsea Project Three in their original ES and RIAA, amongst others. Given that the majority of projects that have recently been consented or are in the planning system have used Pennycuik/Alterstam et al. figures and that the ARs that are recommended by the SNCBs for the key species were derived using the Pennycuik/Alterstam et al. flight speed data, Natural England advise that these figures should be used until a full review of all evidence sources has been undertaken.
F2.29	In your D6 submission [REP6-055] you stated that you were in the process of reviewing Bowgen and Cook (2018) and the implications it has for SNCB advice on collision risk modelling parameterisation. Please provide a summary of your conclusions in relation to this study. If the recommendations in JNCC (2014) have changed then please include any revised Apportioning Rate (AR) and flight height values and provide a view on the implications this has for the CRM analysis that informed the ES and RIAA.	The recommendations in JNCC et al (2014) have not changed. As stated in F2.29, the SNCB's are currently reviewing the evidence on avoidance rates presented in the recently published Bowgen and Cook (2018), and its implications for SNCB advice on CRM parameterisation, including avoidance rates (AR). This work is ongoing and will not be completed before the end of the Hornsea Project Three examination. Therefore Natural England's position remains that the appropriate avoidance rates to use with Band (2012) model are those set out in the SNCB guidance note JNCC et al (2014) as provided in advice to Hornsea Three through the Evidence Working Group process, Scoping and PEiR stages of the Application as well as to other projects currently in the planning system.
F2.30	The following publication does not appear to be present in the examination library: JNCC et al. (2014) Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review, 25th November 2014. Please submit a copy.	A copy of this report is provided with our Deadline 7 Submission.

Table 1. CRM Parameter information requested by ExA.

Parameter	Ref	Gannet	Kittiwake	Lesser BBG	Great BBG	Herring Gull
Proportion flying at risk	PCH is not a relevant parameter as NE advise use of Band Model Option 2. This uses the flight height distributions available as a spreadsheet from the authors of					

height (PCH)	Johnston et al (2014a,b) to calculate PCH values within the Band Model. Summaries of these data are available in the corrigendum of Johnston et al (2014a,b).					
Windfarm Latitude	This is not something that Natural England can provide. The developer has specified a latitude for the windfarm in Table 1.4 of Annex 5.3 of their ES [APP-109]					
Nocturnal Activity Factor (NAF)	Natural England Annex C [REP1-211]	1-2	2-3	2-3	2-3	2-3
Flight Speed	Speed data taken from Pennycuick (1987,1997) and Alerstam et al. (2007) and used in Cook et al. (2014). Copied here for reference for ExA. In m/sec	14.9	13.1	13.1	13.7	12.8
Wingspan	Approach is to follow guidance in Band (2012) "*these should be drawn from standard reference works, eg Cramp & Simmons (1983) or from BTO Bird Facts*". The Applicant has used "Robinson 2017" which is the BTO Bird Facts data. See Table 1.3 of Annex 5.3 of the ES. These are the same data used in Cook et al 2014. NE accepts the use of these parameters for CRM.					
Bird length	Follow guidance in Band (2012) "*these should be drawn from standard reference works, eg Cramp & Simmons (1983) or from BTO Bird Facts*". The Applicant has used Robinson 2017 which is the BTO Bird Facts data. See Table 1.3 of Annex 5.3 of the ES [APP-109]. These are the same data used in Cook et al 2014. NE accepts the use of these parameters for CRM.					
Flight style	Applicant has used F (Flapping) for all species. Cook et al (2014) used G (Gliding) for GX, and F (Flapping) for all other species that are relevant to Hornsea Project Three. The Applicant states that use of Flapping rather than Gliding is more precautionary. Natural England have not tested this.					
Proportion upwind flights	Band (2012) advises "*This should be set to 50% unless survey indicates a predominant direction relative to wind, eg for large-scale migration flights*." Applicant has used 50%. Natural England accepted these assumptions for the HOW3 CRM					
Avoidance rate (AR) Basic Band Model	JNCC (2014)	98.9 (98.7-99.1)	98.9 (98.7-99.1)	99.5 (99.4-99.6	99.5 (99.4-99.6	99.5 (99.4-99.6
Avoidance Rates (AR) Extended Band Model	JNCC (2014) and Natural England Annex C [REP1-211]	none	none	none	none	none

References

Alerstam, T., Rosén, M., Bäckman, J., Ericson, P.G.P., Hellgren, O. (2007) Flight speeds among bird species: allometric and phylogenetic effects. PLoS Biology 5(8): 1656-1662.

Band, W. (2012). Using a collision risk model to assess bird collision risks for offshore wind farms. Report to The Crown Estate Strategic Ornithological Support Services (SOSS), SOSS-02. http://www.bto.org/science/wetland-and-marine/soss/projects.

Bowgen, K. & Cook, A. (2018). Bird Collision Avoidance: Empirical evidence and impact assessments. JNCC Report No. 614, JNCC, Peterborough, ISSN 0963-8091.

Cook, A.S.C.P., Humphries, E.M., Masden, E.A., and Burton, N.H.K. 2014. The avoidance rates of collision between birds and offshore turbines. BTO research Report No 656 to Marine Scotland Science.

Elliott, K.H. and Gaston, A.J. (2005) Flight speeds of two seabirds: a test of Norberg's hypothesis. Ibis 147, pp 783–789.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

Gyimesi, A., T.J. Evans, J.F. Linnebjerg, J.W. de Jong, M.P. Collier, R.C. Fijn (2017). Review and analysis of tracking data to delineate flight characteristics and migration routes of birds over the Southern North Sea. Bureau Waardenburg bv / Rijkswaterstaat report commissioned by: Rijkswaterstaat WVL.

Joint Nature Conservation Committee (JNCC), Natural England (NE), Natural Resource Wales (NRW), Northern Ireland Environment Agency (NIEA), Scottish Natural Heritage (SNH). (2014). Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review. 25th November 2014.

Johnston, A., Cook, A. S. C. P., Wright, L. J., Humphreys, E. M. and Burton, N.H.K. (2014a). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. Journal of Applied Ecology 51, 31–41 doi: 10.1111/1365-2664.12191

Johnston, A., Cook, A. S. C. P., Wright, L. J., Humphreys, E. M. and Burton, N.H.K. (2014b). Corrigendum. Journal of Applied Ecology 2014, 51, 1126–1130 doi: 10.1111/1365-2664.12260

Johnston, A. and Cook, A.S.C.P. (2016). How high do birds fly? Development of methods and analysis of digital aerial data of seabird flight heights. BTO Research Report Number 676.

Pennycuick, C.J. (1987). Flight Of Auks (Alcidae) And Other Northern Seabirds Compared With Southern Procellariiformes: Ornithodolite Observations. J. exp. Biol. 128, 335-347.

Pennycuick, C.J. (1997) Actual and 'optimum' flight speeds: field data reassessed. The Journal of Experimental Biology 200: 2355-2361.

Skov, H., Heinänen, S., Norman, T., Ward, R.M., Méndez-Roldán, S. & Ellis, I. (2018). ORJIP Bird Collision and Avoidance Study. Final report – April 2018. The Carbon Trust. United Kingdom. 247 pp.

Spear, L.B. and Ainley, B.G. (2008) Flight speed of seabirds in relation to wind speed and direction. Ibis 139: 234-251.

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

NATURAL ENGLAND

Written Submission for Deadline 7

Summary of Natural England's Advice on The Wash and North Norfolk Coast SAC

14 March 2019

Features of concern		Large Shallow Inlet and Bay, Sandbanks, Reef,	
1.1	Feature condition		A recent condition assessment on 25th January 2019 has identified the listed features relevant to this application and some of their sub features are now in unfavourable condition as a result of fisheries and OWF cable installation. The mechanism that is currently in place to ensure recovery is currently the identification and implementation of fisheries byelaw areas and natural processes for OWFs.
2.1	Survey Data	Project specific incl. Survey effort	NE considered that the post application submission survey effort was sufficient to provide a basic consent characterisation of the development area, and that this level of information with support desk based evidence remains suitable at an EIA scale. Please see Annex D1 [REP1 – 210] and Annex D7 [REP – 217] However, Natural England highlights that the levels of information/evidence/data required to understand the potential scale of the impacts of a proposal on designated site features often go beyond those that would be required to characterise the development area. Especially where an Adverse Effect on Integrity can't be ruled out and/or consideration is required in relation to the suitability of any proposed mitigation measures to minimise the impacts to an acceptable level. This is particularly true for this site where the survey data doesn't allow for the extent of the features to be determine due to the lack of Geophysical data and also limited near shore survey data. Often, the tools and techniques required to undertake a development activity, such as cable installation, can vary significantly depending on the ground conditions, and consequently the impacts arising from the installation can also vary. In some cases, the requirements in a particular location may be easily determined from a fairly basic level of site characterisation. For example, where exposed bedrock is identified it may be relatively easy to confirm the techniques required for installation and to consider the impacts on that feature. However, in a sediment habitat, the techniques required may depend not only on the surface substrate/biotope, but also on the underlying geology, and therefore further investigative work may be required in order to establish the likely installation method before the impacts could be considered and/or mitigated. We note that no geotechnical survey data for the near shore area of the Wash and North Norfolk Coast SAC was not included in the Potential Trenching Assessment [REP5 – 010] document. Therefore this adds decreased certainty.

			It would have been beneficial if a more complete PEIr had been provided during the pre-application phase and during this phase sufficient time was allowed for issues and potential evidence gaps to be addressed. However, the lack of additional evidence to reduce the uncertainty in relation to scale of the impacts and possible mitigation measures is unlikely to resolved within the examination phase and remains an outstanding concern. The significance of which means we are unable to advise that an adverse effect on integrity can be ruled out.
2.2		SNCB site management	As part of management of designated sites, the SNCBs will periodically commission designated site surveys. However, due to the size of the marine sites it is unlikely that the whole site will be surveyed at any one time. These surveys are broad scale mapping surveys to inform site management measures and therefore are not of sufficient resolution and/or scale to be used to determine impacts to designated features from sustainable development. As noted at ISH 2 EIFCA has data for the near shore area adjacent to the proposed cable corridor which has identified possible cobble reef which is a more stable habitat that the Applicant has set out in it RIAA. This area is under consideration for a revised fisheries byelaw area.
2.3		Desked based Study	It is prudent to use all available data sets to support project specific data and/or fil any evidence gaps. However, as set out In Annex DI and Annex D7 [REP- 201 and REP217] it is not appropriate to rely on point surveys 10s KM from the cable corridor and outwith the designated site. Therefore there remains considerable uncertainty in the interest features present; the under lying geology and the implications this may have on cable burial; the need for remediation works and what they may be; and the scale of any further impacts to the designated site features.
3.1	Characterisation	Biotopes	Again Natural England highlights the importance of the use of a 'common currency' approach to facilitate in combination and cumulative assessments, not just for this project, but for future plans and projects that may need to take account of Hornsea 3 in their assessments.
3.2		Site Features	Whilst the applicant has extrapolated from project specific data in the MCZ, we believe from the drop down video survey that it is not just Annex I sandbanks along the Hornsea Project three cable route. The more consolidated sediments and epifauna within the video stills could be representative of Reef features Annex D1 [REP – 210]

4.1	Consideration of impacts to site features and significance	Site Preparation work (none sandwave levelling)	In the Applicants RIAA [APP - 051] Benthic impacts from the cable route prep. were not included such as grapnel run, UXO clearance, boulder clearance and sandwave clearance. Therefore further consideration should be given to the cumulative impacts to the site features.
4.2		Sandwave levelling	Location of impact: Natural England advises that the proposed sandwave levelling within W&NNC SAC is levelling/changing of Annex I habitats i.e. mobile part of Annex I sandbanks and wholly within designated feature. Recovery: Sandwave clearance activities have only been proposed and undertaken relatively recently and consequently there is limited evidence on how well this approach works, whether cables remain buried thus avoiding the need for additional cable protection, and very limited evidence on how quickly dredged areas recover. The applicant has provided additional information in REP-020 outlining their experience at one of their other projects, Race Bank Offshore Windfarm. As set out in Natural England Deadline 1 Annex D3 response [REP – 215] This report provides some evidence to support the potential for recovery of affected features after sandwave levelling has occurred. However, at this stage there is not sufficient information available to determine if full recovery to pre impact condition can be achieved or to determine a potential timescale for recovery, and it is also unclear if the findings at Race Bank (nearshore project) would be relatable to all sandwave/sandbank features, including the much larger examples found further offshore. The main factors that are considered to influence the recovery potential (i.e. the mechanism and speed of recovery) of the levelled sandwaves are: • The dimensions of the dredged area, particularly the width and depth of the dredged channel relative to the overall sandwave height, and the alignment of the dredged channel relative to the crest axis; and

			• The degree of sediment mobility at the dredge location, which is in turn controlled by the environmental forcing conditions and water depth. In addition no consideration has been given to potential remediation plan using proven techniques Scale of Impacts: The scale of the proposed sandwave levelling is not considered as de minimus even if the sediment can be retained within the system (see Mitigation below). The project is likely to impact on the variables that help define the extent and distribution of a sandbank, namely sediment composition and biological assemblages.
4.3		Deposition of sediment	As yet the deposal location/s has/have not been agreed. Therefore there is no guarantee that the sediment will remain within the system. A loss of Annex I sediment is considered to be Likely Significant effect, The quantities proposed in the Application is not considered to be deminimis and/or in consequential. Therefore we advise that an adverse effect on integrity can't be excluded. It should be noted that there is a difference in the particle size of the Annex I sandbank sub features. Therefore there is the potential for a significant difference in particle size between the removal and disposal locations resulting in a change in the extent of Annex I habitats; the temporal scale of which is unknown for sandwave levelling and within this site. Without further restrictions on disposal locations there is also the potential for Annex I reef to be significantly impacted. We would therefore advise that there are disposal conditions included within the DML: identify the disposal locations; the locations ensure that sediment remains within the Annex I sandbanks system; the particle size as the disposal locations is 95% similar that of the removal location and Annex I reef and areas being managed as such (Plus buffer) are avoided All Areas of Annex I Reef and areas managed as reef should be excluded for direct disposition and mechanisms should be put in place to ensure indirect impacts through

			sedimentation is limited to an acceptable level; including those areas to be managed as reef.
4.4		Cable Protection	Natural England's advice remains unchanged from our Deadline 1 Written Reps. Having considered the RIAA, and further documents submitted by the applicant during examination including the measures proposed to mitigate for any adverse effects, it is the advice of Natural England that it is not possible to ascertain that the proposal will not result in adverse effects on the integrity of the site in question either alone or in-combination. Further assessment and consideration of mitigation options are required, and Natural England provides the following advice on the additional assessment work required; NE remains concerned that evidence presented by the applicant does not sufficiently show that there will be no permanent, long-lasting and adverse loss of SAC habitat as a result of the proposed cable protection; in coming to this view we advise the following; - The predicted impacts will directly affect the SAC feature. - We are not satisfied that the likely impacts can be considered to be of a temporary nature. Natural England remains concerned about the decommissioning of rock protection that is proposed to make good any impact. We do not believe that this has been satisfactorily addressed by Annex 2 JdN 'Technical note for decommissioning Race Bank Export Cable rock protection' we have the following comments: See Deadline 7 Cable protection Annex - The predicted Impacts are only considered by Applicant to be significant if impacting on existing Annex I Sabellaria spinulosa reef (priority habitat). And therefore that impact of that feature is small. However, this feature is in unfavourable condition due to anthropogenic activities. The placement of rock armour within the area for the management of reef would in our view hinder the restoration of this feature. We consider that the establishment of Sabellaria spinulosa on artificial substrate does not form part of the SAC feature and is not ""counting"" towards its conservation objectives, in so much as if reef grows back over rock armouring then it's still

			unfavourable condition, as it is not the biotope set out in conservation advice i.e. it is not a replacement for Sabellaria spinulosa reef on natural site sediment habitat.
4.5		Phased Build	Natural England notes that in [REP - 178] the applicant has not an anticipated that recovery will happen between both the different construction stages and the phased builds. Therefore any Appropriate Assessment would need to take into account both the spatial and temporal impact to the interest feature/s of the site. As there could 13 years of impact before the site would start to recover and up to 18 before full recovery could occur unless cable protection was used when we believe there would be a permanent habitat change. Therefore we can confirm that we do not believe the cumulative impact is flawed, it is more a recognition of the temporal scale of the impacts
4.6		Operation and Maintenance	See Natural England advice on cable protection Deadline 7 Annex
5.1	Mitigation		Annex I sandbanks: Whilst at Para 11. of Annex D4 [REP1- 217] we suggested some mitigation that has been used for other industries. The only mitigation that has been presented to reduce the impacts has been one of potential removal at the time of decommissioning. As set in our response to Deadline 6 the Cable Installation Plan and the conditions with that including the use of an ECOW may ensure the real time compliance with the requirements of the DML condition documents, but it doesn't address the current LSE sufficiently to exclude an adverse effect on integrity and meet the requirements of the habitats directives i.e. the presence/use of a ECOW s not mitigation. Annex I reef: Micrositing around reef where possible. When undertaking Pre construction Annex I reef surveys in an area with the same side scan sonar a ‘reef’ return is identified and the extent of that habitat is mapped. That potential reef area is then ground truthed using grab samples and drop down video to determine the reefiness qualities i.e. elevation, abundance and patchiness.

			The micro siting condition is to avoid areas of reef no matter what the quality. Therefore the suggestion to avoid reef where possible is outside the proposed mitigation. In addition to this if cable protection is installed then there will be a permanent change to the habitat and therefore we believe that there will be a loss of feature extent and the management measures for the site would be hindered. Accordingly consideration of the most appropriate installation technique/tool would is required
6.1	Recovery		We note the Applicant's conclusion of "high confidence that the seabed will recover to a new natural equilibrium state within a timescale of months to years." We would suggest that approaching a new equilibrium may not be in accord with restoration of the site, if that new equilibrium is out with the sediment composition or biological communities expected from the designated feature. Natural England agrees The applicant has cited that Sabellaria spinulosa reef can establish on rock amour and therefore the Annex I habitat can recover. However, it is the SNCB advice that the establishment of Sabellaria spinulosa on artificial substrate doesn't "count" towards favourable condition, in so much as if reef grows back over rock armouring then it's still unfavourable condition, as it is not the biotope set out in conservation advice i.e. it is not a replacement for Sabellaria spinulosa reef on natural site sediment habitat.
7.1	Restoration		No consideration has been given to any remediation plan using proven techniques for any Annex I habitat. Natural England doesn't believe that there is any remediation and/or restoration that can be undertaken to restore Reef feature to any pre impact state.

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

NATURAL ENGLAND

Written Submission for Deadline 7

Summary of Natural England's Advice on North Norfolk Sand Banks and Saturn Reef SAC

14 March 2019

	Features	Consideration	Annex I Sandbanks	Annex I Reef
1.1	Feature condition		Our latest view on condition is that the sandbank feature is in unfavourable condition and needs to be restored to favourable condition. Restoration of the feature requires an overall reduction, or removal, of pressures associated with human activities that cause impacts to the sandbanks' extent and distribution, delineated by both substratum and biological communities. As such, any human activities which can cause pressures resulting in changes to substratum or biological communities to the sandbank feature may present a risk to the site's restoration. We note that there is no expectation that The Applicant should demonstrate recovery of the site. Recovery is an objective for all sectors placing pressure on the site, including oil and gas, renewables, aggregates and fisheries. We do, however, expect The Applicant to demonstrate the risk levels that they believe their proposed operations will present to the restoration of the extent and distribution of the sandbank feature. We note that The Applicant may find our discussion of mitigation below helpful in this. As a minimum, this would be to demonstrate that proposed activities will be mitigated to not impede restoration, i.e. that activities will not increase the site's	Our latest view on condition is that the reef feature is in unfavourable condition and needs to be restored to favourable condition. Installation and/or removal of infrastructure may have a continuing effect on extent and distribution of the reef within the site. Restoration of the feature requires an overall reduction, or removal, of pressures associated with human activities that cause impacts to the reefs' extent and distribution, delineated by both substratum and biological communities. As such, any human activities which can cause pressures resulting in changes to substratum or biological communities to the reef feature may present a risk to the site's restoration. Activities must look to minimise, as far as is practicable, damaging the established, i.e. high confidence, reef within the site.

			exposure to damaging pressures, particularly in regard to changes in extent and distribution of substratum and biological communities.	
2.1	Survey Data	Project specific incl. Survey effort	NE considered that the initial survey effort was sufficient to provide a basic consent characterisation of the development area, and that this level of information remains suitable at an EIA scale. Recognising that further surveys will be required should consent be granted. However, Natural England highlights that the levels of information/evidence/data required to understand the potential scale of the impacts of a proposal on designated site features often go beyond those that would be required to characterise the development area. Especially where an Adverse Effect on Integrity can't be ruled out and/or consideration is required in relation to the suitability of any proposed mitigation measures to minimise the impacts to an acceptable level. Often, the tools and techniques required to undertake a development activity, such as cable installation, can vary significantly depending on the ground conditions, and consequently the impacts arising from the installation can also vary. In some cases, the requirements in a particular location may be easily determined from a fairly basic level of site characterisation. For example, where exposed bedrock is identified it may be relatively easy to confirm the techniques required for installation and to consider the impacts on that feature. However, in a sediment habitat, the techniques required may depend not only on the surface substrate/biotope, but also on the underlying geology, and therefore further investigative work may be required in order to establish the likely installation method before the impacts could be considered and/or mitigated. It would have been beneficial if a more complete PEIr had been provided during the pre-application phase and during this phase sufficient time was allowed for issues and potential evidence gaps to be addressed. However, the lack of additional evidence to reduce the uncertainty in relation to scale of the impacts and possible mitigation	

			measures is unlikely to resolved within the examination phase and remains an outstanding concern.	
2.2		SNCB site management	As part of management of designated sites, the SNCBs will periodically commission designated site surveys. However, due to the size of the offshore sites it is unlikely that the whole site will be surveyed at any one time. These surveys are broad scale mapping surveys to inform site management measures and therefore are not of sufficient resolution and/or scale to be used to determine impacts to designated features from sustainable development. As set out at Deadline 6 in relation to management measures for the restoration for Saturn Reef, the SNCBs have to use the best available information, determine confidence levels and then apply appropriate precaution to ensure a site favourable condition	
2.3		Desked based Study	It is prudent to use all available data sets to support project specific data and/or fil any evidence gaps. During the evidence plan process JNCC highlighted the data sets held by the oil and gas companies within this site. These data sets helped informed alteration of the route near the Darlek arm.	
3.1	Characterisation	Biotopes	Whilst we recognise that the biotopes used by the applicant are more precautionary than alternative ones. The approach taken to biotope classification does not follow the standard approach. Whilst this may present varying levels of risk in understanding the impacts of this application to features at an EIA level and within designated sites (which will be detailed below), Natural England would also highlight the importance of the use of a 'common currency' approach to facilitate in combination and cumulative assessments, not just for this project, but for future plans and projects that may need to take account of Hornsea 3 in their assessments.	N/A

3.2		Site Features	JNCC considers that the site boundary delineates the sandbank feature, supported by the original Site Assessment Document (JNCC, 2010) and further validated by recent biological community analysis (Parry et al., 2015). Therefore there is no site fabric and any or all impacts with the site will be on Annex I features	See point above about management measures for Saturn Reef.
4.1	Consideration of impacts to site features and significance	Site Preparation work (none sandwave levelling)	In the Applicants RIAA [APP - 051] Benthic impacts from the cable route prep. were not included such as grapnel run, UXO clearance, boulder clearance and sandwave clearance. Therefore further consideration should be given to the cumulative impacts to the site features.	
4.2		Sandwave levelling	Location of impact: Natural England advises that the proposed sandwave levelling within NNS SAC is levelling/changing of Annex I habitats i.e. mobile part of Annex I sandbanks and wholly within designated feature. Recovery: Sandwave clearance activities have only been proposed and undertaken relatively recently and consequently there is limited evidence on how well this approach works, whether cables remain buried thus avoiding the need for additional cable protection, and very limited evidence on how quickly dredged areas recover. The applicant has provided additional information in REP-020 outlining their	N/A

			experience at one of their other projects, Race Bank Offshore Windfarm. This report provides some evidence to support the potential for recovery of affected features after sandwave levelling has occurred. However, at this stage there is not sufficient information available to determine if full recovery to pre impact condition can be achieved or to determine a potential timescale for recovery, and it is also unclear if the findings at Race Bank (nearshore project) would be relatable to all sandwave/sandbank features, including the much larger examples found further offshore. The main factors that are considered to influence the recovery potential (i.e. the mechanism and speed of recovery) of the levelled sandwaves are: • The dimensions of the dredged area, particularly the width and depth of the dredged channel relative to the overall sandwave height, and the alignment of the dredged channel relative to the crest axis; and • The degree of sediment mobility at the dredge location, which is in turn controlled by the environmental forcing conditions and water depth. It would therefore be useful to ensure any assessment of the offshore sites take this	

			into consideration and we believe that the relevant site information is available to undertake such an assessment. Understanding these factors would also inform assessment of hydrological process impact within site integrity tests. In addition no consideration has been given to potential remediation plan using proven techniques Scale of Impacts: The scale of the proposed sandwave levelling with North Norfolk Sandbanks is X which is a considerable volume of material and can't be considered as de minimus even if the sediment can be retained within the system (see Mitigation below). It would be good to know how the proposed sandwave levelling will impact on Ower and Leman sandbanks and how that will effect their contribution to site feature. Based on our current understanding, JNCC do not consider it likely that human activities taking place within the site have the potential to permanently impact on the large-scale topography of the North Norfolk sandbanks. They could, however, have an impact on the other variables that help define the extent and distribution of a sandbank, namely sediment composition and biological assemblages.	

			Of note for the industrial activities taking place within the site are operations associated with the deposition of material (e.g. rock dump), or other alteration of surface sediment (e.g. drill cuttings and cabling operations), that are likely to lead to a persistent change to substrate which is not suitable habitat for sandbank communities. As such, some of the sandbank's extent and distribution is lost, in that there are areas present within the site that no longer represent sandbank feature, as defined by sediment composition and/or biological communities, because the substrate has been changed. We believe that there has been physical change in sediment composition as a result of industrial activity in the site, but it is unclear what impact this may have on overall sediment composition and distribution. Furthermore, due to lack of evidence about deposits present within the site (i.e. not based on anticipated worst case scenario estimates), it is currently not possible to quantify the loss of extent.	
4.3		Deposition of sediment	As yet the deposal location/s has/have not been agreed. Therefore there is no guarantee that the sediment will remain within the system. A loss of Annex I sediment is considered to be Likely Significant effect, The quantities proposed	All Areas of Annex I Reef and areas managed as reef should be excluded for direct disposition and mechanisms should be put in place to ensure indirect impacts through sedimentation is limited

			(X m^3) in the Application this is not considered to be *de minimus* and/or in consequential. Therefore we advise that an adverse effect on integrity can't be excluded. It should be noted that there is a difference in the particle size of the Annex I sandbank sub features. Therefore there is the potential for a significant difference in particle size between the removal and disposal locations resulting in a change in the extent of Annex I habitats; the temporal scale of which is unknown for sandwave levelling and within this site. Without further restrictions on disposal locations there is also the potential for Annex I reef to be significantly impacted. We would therefore advise that there are disposal conditions included within the DML: identify the disposal locations; the locations ensure that sediment remains within the Annex I sandbanks system; the particle size as the disposal locations is 95% similar that of the removal location and Annex I reef and areas being managed as such (Plus buffer) are avoided	to an acceptable level; including those areas to be managed as reef.
4.4		Cable Protection		Natural England's advice remains unchanged from our Deadline 1 Written Reps. Having considered the RIAA, and further documents submitted by the applicant during examination including the measures proposed to mitigate for any adverse effects. It is the advice of

				Natural England that it is not possible to ascertain that the proposal will not result in adverse effects on the integrity of the site in question either alone or in-combination. Further assessment and consideration of mitigation options is required, and Natural England provides the following advice on the additional assessment work required; NE remains concerned that evidence presented by the applicant does not sufficiently show that there will be no permanent, long-lasting and adverse loss of SAC habitat as a result of the proposed cable protection; in coming to this view we advise the following; - The predicted impacts will directly affect the SAC feature. - We are not satisfied that the likely impacts can be considered to be of a temporary nature. Natural England remains concerned about the decommissioning of rock protection that is proposed to make good any impact. We do not believe that this has been satisfactorily addressed by Annex 2 JdN 'Technical note for decommissioning Race Bank Export Cable rock protection'

				we have the following comments: See Annex C of D7 response. - The predicted Impacts are only considered by Applicant to be significant if impacting on existing Annex I *Sabellaria spinulosa* reef (priority habitat). And therefore that impact of that feature is small. However, this feature is in unfavourable condition due to anthropogenic activities. The placement of rock armour within the area for the management of reef would in our view hinder the restoration of this feature. We consider that the establishment of *Sabellaria spinulosa* on artificial substrate does not form part of the SAC feature and is not ""counting"" towards its conservation objectives, in so much as if reef grows back over rock armouring then it's still unfavourable condition, as it is not the biotope set out in conservation advice i.e. it is not a replacement for *Sabellaria spinulosa* reef on natural site sediment habitat.
4.5		Phased Build	Natural England notes that in [REP - 178] the applicant has not an anticipated that recovery will happen between both the different construction stages and the phased builds. Therefore any Appropriate Assessment would need to take into account both the spatial and temporal impact to the interest feature/s of the site. As there could 13 years of impact before the site would start to recover and up to 18 before full recovery could occur unless cable protection was used when we believe there would be a permanent habitat change.	

			Therefore we can confirm that we do not believe the cumulative impact is flawed, it is more a recognition of the temporal scale of the impacts	
4.6		Operation and Maintenance	See Natural England advice on cable protection (ANNEX C @ D7)	See Natural England advice on cable protection (ANNEX C @ D7)
5.1	Mitigation		Whilst at Para 11. of Annex D4 [REP1- 217] we suggested some mitigation that has been used for other industries. The only mitigation that has been presented to reduce the impacts has been one of potential removal at the time of decommissioning. As set in our response to Deadline 6 the Cable Installation Plan and the conditions with that including the use of an ECOW may ensure the real time compliance with the requirements of the DML condition documents, but it doesn't address the current LSE sufficiently to exclude an adverse effect on integrity and meet the requirements of the habitats directives i.e. the presence/use of a ECOW s not mitigation."	Based on JNCC reef layer data provided at Deadline 5 NE and JNCC advise that the *Sabellaria spinulosa* area to be managed as reef straddles the Saturn reef area of the cable route. {Put in RB advice about byelaw]. Therefore, we advise that this management area is avoided. If as anticipated the removal of anthropogenic activities enables the recovery of Annex I reef and cabling is permitted within this area there is a high probability that there will be sufficient space to micro-route around the reef features. Therefore, whilst we continue to advocate that the standard mitigation measure/marine licence conditioned to avoid reef features is included in the Projects DML it may not be feasible to do so. To address this the Applicant has included the caveat ‘where possible’, but NE and JNCC have concerns about the increased level of risk to the integrity of the site such a caveat would endorse as there are no parameters to assess and agree what is “possible”.

				We do not consider the applicant's consideration of routing through 'lower quality' reef to be acceptable, because in terms of restoration of conservation objectives the 'lower quality' reef mentioned by the applicant is still contained within area to be managed as reef, with the protection provided by Annex I status. Furthermore whether reef is avoided or not during installation there does remain a risk during O&M cable remediation activities that reef could establish across the cable corridor or nearby areas where remediation activities needed to occur. Accordingly, every effort should be made, with input from the MMO and NE, to minimise the impacts at the time of undertaking the works.
6.1	Recovery		We note the Applicant's conclusion of "high confidence that the seabed will recover to a new natural equilibrium state within a timescale of months to years." We would suggest that approaching a new equilibrium may not be in accord with restoration of the site, if that new equilibrium is out with the sediment composition or biological communities expected from the designated feature.	Natural England agrees The applicant has cited that *Sabellaria spinulosa* reef can establish on rock amour and therefore the Annex I habitat can recover. However, it is the SNCB advice that the establishment of *Sabellaria spinulosa* on artificial substrate doesn't "count" towards favourable condition, in so much as if reef grows back over rock armouring then it's still unfavourable condition, as it is not the biotope set out in conservation advice i.e. it is not a

				replacement for *Sabellaria spinulosa* reef on natural site sediment habitat.
7.1	Restoration		No consideration have been given to any remediation plan using proven techniques	Natural England doesn't believe that there is any remediation and/or restoration that can be undertaken to restore this feature to any pre impact state.

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

NATURAL ENGLAND

Written Submission for Deadline 7

Summary of Natural England's Advice on Markham's Triangle pMCZ

14 March 2019

	Features	Subitdal Coarse Sediment	Subtidal Mixed Sediment	Subtidal Sand	Subtidal Mud
1.1	**Site Status**	Markham's Triangle was included in the third tranche of MCZ consultation and is now a proposed MCZ or 'pMCZ' which means that it is a material consideration. Defra's Tranche 3 consultation was held over Summer 2018. The outcome of this consultation and the decision regarding the designation of this site is yet to be announced. At the moment there is no indication of a likely timeframe for this announcement. NE/ JNCC note that the Tranche 3 consultation was announced after the Applicant had submitted the Application, and therefore we welcome that the site was assessed.			
1.2	**Feature Condition**	As the site is yet to be designated, there is no conservation advice package available. The Conservation Objectives of the site are yet to be determined, but it should be noted that the consultation document indicated a General Management Approach of 'Restore' for all features. This should be taken into account when considering the significance of impacts on the site. Extents of the features within the site are as follows: Coarse Sediment 145.56km^2, Sand 26.35 km^2, mud 1.49km^2, Mixed sediment 27.54km^2			
2.1	**Baseline Characterisation**	The applicant has undertaken their own survey work, which has provided a good level of coverage across the site. NE/JNCC have highlighted that the Applicant has taken a non-standard approach to their assessment procedure and in particular the allocation of biotopes and that this makes it difficult to make comparisons across datasets and to draw conclusions with the highest level of certainty at the biotope level. However, we note that the applicant's conclusions align with additional surveys - (Defra Cefas & JNCC), and therefore consider that there is sufficient information to characterise the broadscale habitats within the site (i.e. the site features) in order to facilitate a WCS assessment of the potential impacts on the site. This can then be refined when further pre-construction monitoring becomes available.			
2.2					Subtidal Mud: NE/JNCC note that subtidal mud was not identified within the development area,

			therefore we are happy for this to be removed from further consideration.
3.1	**Assessment of Impacts**	At deadline 3, the Applicant Submitted a pMCZ Lifetime Effects Assessment [REP3-023] within which they committed to reducing the proportion of the array within the pMCZ from 24% to 10.5%, and that this will be secured within the DCO/DML and therefore supersedes the positon set out in the ES. Natural England and JNCC welcome this reduction of infrastructure within the site. Assessment of a potential operation in any protected area focuses on understanding how the conservation objectives are affected. In practice this mainly relates to understanding how the potential operations affect the designated features. For Markham's Triangle, all features have a general management approach to "restore" to favourable condition. As such, a critical piece of information needed for assessment is the amount of operations expected to occur in each feature. The Applicant has presented figures of the area of each feature within the MCZ which they consider will be impacted by the operations on both a temporary and permanent basis in Table 1.1 of REP3-023. However, it is not clear to NE how these figures were calculated, specifically with regard to how the potential overlap with each feature was considered. Therefore we do not feel able to comment on these conclusions. Within REP3-023, the Applicant has provided a detailed breakdown of the potential area of broadscale habitat impacted as a result of each project element at each phase (construction O&M and decommissioning). This information has then been used to inform assumptions around the likely areas of habitat permanently and temporarily affected at each stage. NE/JNCC's advice on impacts to the features of this site would align with our advice on other designated sites. Therefore there are some project elements that have been considered to be temporary, that we would consider to be persistent and/or permanent depending on the feature- for example cable protection.	

4.1	**Significance**	The applicant has calculated that the level of temporary habitat loss would equate to 2% of the overall site, with a permanent habitat loss of 0.12% of the entire site [N.B NE/JNCC suggests that these figures would require an adjustment to take account of our advice on impacts]. Whilst this relates to a fairly sizable area in km2, NE/JNCC accept that this is relatively small in the context of the entire site. However, the level of impact and impacts of significance need to be understood at a feature level before any conclusions regarding the significance can be drawn. The Subtidal Coarse Sediment feature dominates the site, and therefore impacts on the scale described in REP2-023 may prove to be relatively small in the context of the feature. However, sand and mixed sediment are present in much smaller amounts within the site and therefore impacts on these features may be significant.	
5.1	**Measures of Equivalent Environmental Benefit**	As highlighted above, Natural England currently unable to provide definitive advice on the significance of the impact on the features of the designated site. There is currently no formal guidance in relation to Measures of Equivalent Environmental Benefit (MEEB) and there and there have been no other cases that have reached this stage. Therefore, should the SoS conclude that MEEB are required, this case would be precedent setting. In the absence of guidance/experience to draw upon, we would recommend that discussions relating to MEEB include input from the SNCBs, Regulatory Agencies (i.e. MMO and BEIS) and Defra.	
6.1	**Summary**	Natural England hopes to have further discussions with the applicant to try to address some of the issues highlighted above prior to the close of the examination.	

THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

HORNSEA PROJECT THREE OFFSHORE WIND FARM

Planning Inspectorate Reference: EN010080

NATURAL ENGLAND

Written Submission for Deadline 7

Summary of Natural England's Advice on Cromer Shoal Chalk Beds MCZ

14 March 2019

	Features	Subtidal Coarse Sediment	Subtidal Mixed Sediment	Subtidal Sand	Subtidal Chalk	Peat and Clay Exposures	North Norfolk Coast (Subtidal)	Moderate Energy Infralittoral Rock	Moderate Energy circalittorial rock	High Energy infralittoral rock	High Energy circalittoral rock
1.1	**Site Status**	Cromer Shoal Chalk Beds MCZ is a designated tranche 2 MCZ									
1.2	**Feature Condition**	Whilst the site has a conservation advice package, there has been no condition assessment undertaken for the site. Evidence is being collected in 2019/20 to inform the condition assessment currently planned for 2020/21. However, it is noted that the conservation advice package and advice on operations has identified that the cable installation for Sheringham Shoal and Dudgeon OWFs will have impacted the site. There is however, no empirical data to inform the scale and significance of the impacts on the favourable condition of the site. https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0031&SiteName=MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=									
2.1	**Baseline Characterisation**	The applicant has undertaken their own survey work, which has provided a good level of coverage across the site. Therefore we consider that there is sufficient information to characterise the broadscale habitats within the site (i.e. the site features) in order to facilitate a WCS assessment of the potential impacts on the site. This can then be refined when further pre-construction monitoring becomes available.									
3.1	**Assessment of Impacts and significance**	The current assessment assumes that a WCS would involve trenching through the MCZ. However, Natural England considers that whilst the impacts from HDD may be smaller in area, they may also be significant depending on the recoverability of the features. (i.e Both impacts have the potential to impact different features in different ways). This will be dependent on the scale of the impact and not just extent and permanency of the associated activities including cable and scour protection. Assessment of a potential operation in any protected area focuses on understanding how the conservation objectives are affected. In practice this mainly relates to understanding how the potential operations affect the designated features. For Cromer Shoal, all features have a general management approach to 'maintain' favourable condition. As such, a critical piece of information needed for assessment is the amount of operations expected to occur in each feature.									

		The Applicant has presented figures of the area of each feature within the MCZ which they consider will be impacted by the operations, however there is still some uncertainty about the depth of the layer of sand at the exit pit locations and the potential for other features to be present and/or impacted from the disposal activities; especially in relation to the cofferdams Just because it is small scale impact doesn't mean it is not insignificant. But currently the evidence in relation to this and the amount of cable protection required in the site which would potentially result in a permanent change in habitat is uncertain. The disposal locations have also not been assessed. Issues raised in relation to the RIES are also pertinent for the MCZ in relation to colonisation of cable protection, decommission of cable protection, sand wave levelling and understanding the significance of the impacts in terms of temporary/permanency and recoverability of the site. With a predicted 191200 m2 temporary impact to the MCZ. However, this is not fully linked the conservation objectives of the site and the vulnerability of the features.
4.1	**Measures of Equivalent Environmental Benefit**	As highlighted above, Natural England currently unable to provide definitive advice on the significance of the impact on the features of the designated site. There is currently no formal guidance in relation to Measures of Equivalent Environmental Benefit (MEEB) and there and there have been no other cases that have reached this stage. Therefore, should the SoS conclude that MEEB are required, this case would be precedent setting. In the absence of guidance/experience to draw upon, we would recommend that discussions relating to MEEB include input from the SNCBs, Regulatory Agencies (i.e. MMO and BEIS) and Defra.
5.1	**Summary**	Natural England questions the conclusions of the MCZ assessment for the Cromer Shoal Chalk beds and believes there is sufficient uncertainty in relation to the impacts to the features and coastal processes, and recoverability of the features, to have limited confidence in the Stage 1 conclusion that there will be no significant risk of HOW03, hindering the achievement of the conservation objectives for the Cromer Shoal MCZ.

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NATURAL ENGLAND

Written Submission for Deadline 7

ANNEX A: Further Advice on REP5 -010 Preliminary Trenching Assessment (PTA)

14 March 2019

1. Introduction

1.1. Further to the interim advice provided by Natural England for Deadline 6 [REP – 048] England's Stratigrapher has subsequently considered the evidence presented by the Applicant.

2. Summary

2.1. Having reviewed the report the stratigrapher has confirmed our initial comments that there is a clear issue regarding the current extent of the geophysical and geotechnical data available to inform the design and execution of the cable burial along parts of the cable route within the protected areas. This might be critical if (for example) the Egmond Ground Formation is present within the range of the trench depth.

2.2. Whilst we agree that there is inevitably an iterative process in the acquisition of this data; the comments set out at point 3 (below) indicates that an improvement in understanding of these particular sectors is a priority in relation in relation to achieving confidence in the trenching methodology.

2.3. NB: The advice provided below should be considered alongside our previous advice provided at Deadline 6 [REP – 048].

3. Coverage

3.1. Currently there are some substantial sections along the cable route that are within marine SACs or MCZs that have not been intrusively sampled and/or lack shallow seismic data because of the presence of strong surface or near-surface reflectors.

3.2. Given that some of these gaps could be interpreted as being underlain by the Egmond Ground Formation, and given that this may be cogent to the tooling assessment, a greater degree of certainty is needed in order to be confident of successful cable burial in these zones.

4. Lithologies

4.1. Chalk: In terms of a geotechnical material, the Chalk has been treated as weathered and structureless, as is also suggested by the cone penetration tests. Nevertheless, where exposed on the foreshore between Weybourne and West Runton there is evidence of hard grounds, as well as horizons containing frequent large flints. These suggest that conditions could be quite variable and are hardly structureless. It may be that the foreshore exposures were originally overlain by glacially tectonised and weathered chalk that has been removed by wave action. But remain uncertain that the Chalk will be in a weathered condition wherever it is encountered on the cable route. The lessons gained from the Rampion Project indicate that cabling could be installed successfully in trenches cut in unweathered chalk which (given the location and route) would have encountered hardgrounds and nodular chalks where the unconfined shear strengths of the rock are in the range of 10s of MPa as opposed to the maximum 500kPa indicated for the Hornsea route.

4.2. No comments on other lithologies.

5. Transects and assumptions regarding the underlying geology.

5.1. The limitations in the ground models have been noted. While it is clear that further investigations will improve the ground models, some comment should be made about the assumptions made along parts of these transects where the data remains limited.

i) *Figure 4.3.* Shows the Bolders Bank Formation abutting the coast. One would therefore expect there to be an onshore correlate (Holkham Till Formation?) which might help to characterise this unit given its extensive distribution along the cable route.

ii) *Figure 4.6.* Seems reasonable to infer the presence of the Bolders Bank Formation at the northern end of the section.

iii) *Figure 4.8.* If it is the Egmond Ground Formation underlying the Bolders Bank Formation, then it appears that it would intersected by the trench and needs to be considered in the trenching feasibility assessments (tables 5.2 - 5.4). At present this unit does not appear to have been considered and since it is reported to have different properties to the Botney Cut and Bolders Bank formations (table 4.3), this may be cogent when considering the appropriate tooling for the work.

iv) *Figure 4.9.* We don’t believe that the interpretation makes sense. If the missing layer is the lower part of the Botney Cut Formation and it extends the full length of this sector, then it is underlying the Bolders Bank Formation – which would be a paradox – as everywhere else the Botney Cut Formation rests unconfomably on the Bolders Bank and older formations. One possibility is that the missing layer is represented by the Egmond Ground Formation. If this were to be the case, then this would need to be addressed in table 4.3).

v) *Figure 4.11.* Agreed – likely to be Egmond Ground Formation. Given that it is very shallow in places it again needs to be addressed in table 4.3.

vi) *Figure 4.18.* On the basis of figure 4.20 could be Botney Cut or Bolders Bank formations, while the presence of the Egmond Ground Formation cannot be ruled out on the available evidence. Clearly needs physical sampling.

vii) *Figure 4.19.* Comments as for figure 4.18 (above).

6. Remarks

6.1. We would recommend that geotechnical, geophysical and geological data acquired though these surveys is deposited with the British Geological Survey where it would supplement other North Sea data and contribute to a much improved knowledge of the geology of the Quartenary and Holocene sediment of the North Sea. As this data accumulates, it will provide a much more reliable evidence base on which to judge risk and inform management of development and infrastructure in the North Sea.

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Annex B: Statutory Nature Conservation Bodies (SNCB's) advice in relation to colonisation of *Sabellaria spinulosa* reef on artificial substrate being considered as Annex I reef and contributing to the favourable condition status as reef

14 March 2019

1. Introduction

1.1. This note provides SNCB's advice in relation to colonisation of *Sabellaria spinulosa* reef on artificial substrate being considered as Annex I reef and contributing to the favourable condition status of Annex I reef.

1.2. Please note should further evidence be presented then this position may change.

2. Increase in *Sabellaria spinulosa* reef feature vs. loss of another Annex I habitat

2.1. Areas of Annex I features within Marine Protected Areas (MPAs) are delineated as much as possible at the time of designation with reference to any supporting habitats/sediments and/or sub features. All Annex I habitats have equitable protection, therefore it is not appropriate to trade one habitat in a site for another. For example, if the site is designated for both sandbanks and reef and rock protection is placed on the sandbank feature and then *Sabellaria* reef colonises this rock protection it cannot be considered as a benefit to the site that you have taken one feature in the site and swapped it for another.

2.2. Furthermore, possible gain of *Sabellaria spinulosa* reef and definite loss of sandbank feature is not acceptable mitigation under recent ECJ ruling. Please see Briels judgement: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:62012CC0521&from=EN.

3. Establishment of *Sabellaria spinulosa* reef on artificial substrata over laying suitable habitat for reef development

3.1. In theory this shouldn't happen as there is the standard marine licence mitigation condition to avoid reef or areas to be managed as reef at the time of construction. The developers first choice is also to use the appropriate tools to install the cable to the optimum cable burial depth so that further cabling activities i.e. reburial and protection are not required.

3.2. However, Natural England's 'Cables' paper (Natural England, 2018) which summarises our experience of cable installation over the last 10 years is demonstrating that cable installation is more challenging than predicted with the need for cable protection therefore on the increase to protect the developers assets.

3.3. Offshore windfarm developers are stating in their applications that rock protection can be colonised by *Sabellaria spinulosa* reef and therefore doesn't preclude the recovery of the reef features. Whilst Natural England (and other SNCBs) agree that *Sabellaria spinulosa* could colonise rock protection we consider the establishment of *Sabellaria spinulosa* reef on artificial substrate as not "counting" towards favourable condition of the feature and/or site. This is because it is not a replacement for Annex I *Sabellaria spinulosa* reef on natural site sediment as set out at the time of designation and within the conservation advice package for the site.

4. Consideration of possible mitigation

4.1. The fact that new areas of habitat may be created elsewhere in the same site does not appear to be relevant, even if a net beneficial effect is predicted. There is still a possible adverse – even irreparable – effect on the existing natural habitat, and thus on the integrity of the site. The new habitat will be, to some extent, artificially created and cannot become a true natural habitat for some, possibly quite considerable, time.

4.2. As was pointed out by counsel for the Stichting hearing, there can be no certainty that steps to create a new area of a particular habitat will in fact ever achieve the desired outcome and, in application of the precautionary principle, absence of uncertainty is a condition for approval in the context of Article 6(3) of the Habitats Directive. Outcomes cannot be guaranteed in heavily- managed agriculture; it is all the more difficult to guarantee them when seeking to encourage nature to take its course. The Court has stated that there must be no remaining scientific doubt before it can be concluded that there are no lasting adverse effects on the integrity of a site. The same standard must in Natural England's view be applied to predictions of success for planned new areas of created 'natural' habitat.

4.3. NB: Whilst this case law is primarily in relation to mitigation vs compensation when avoiding adverse effect on integrity; it still serves as underpinning the general principal of not considering the possible creation of new habitat as in some way reducing the consideration of habitat loss elsewhere.

5. Decommissioning

5.1. Offshore windfarm developers have suggested that views on the acceptability of colonisation of rock armouring may have changed by the time of decommissioning, including a potential argument to retain the rock armouring in situ within designated sites. Whilst, Natural England acknowledges this may be the case, we can't foresee what will happen over the next 20 - 30 years and a further assessment would need to be made at that time. **Therefore, based on best available evidence our advice remains unchanged that Sabellaria spinulosa on artificial substrate is not Annex I reef.**

5.2. It should also be noted that should decommissioning happen there are still no guarantees that site/features will be returned to pre impact states, thus further hindering the recovery of Annex I reef features.

6. References

Natural England (2018) Natural England Offshore wind cabling: ten years experience and recommendations.

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Annex C : Cable Protection Advice Note

14 March 2019

1. Standard advice

1.1. Natural England advises against the use of cable protection within designated sites as the addition of hard substrata is often incompatible with the conservation objectives for Annex I sandbanks and reef features.

2. The use of 10% Worst Case Scenario (WCS)

2.1. We acknowledge that based on previous cable installations (requiring c.6% of their cable lengths to be protected) the developer has presented reasonable justification for the WCS of 10% along the entire export cable length requiring cable protection and this could potentially meet EIA requirements . However, it doesn't take into account the localised diversity of sediment types and structure, which would result in cable protection being concentrated in particular areas/habitats rather than a uniform distribution. Therefore assessing WCS of 10% of the cable length within an SAC requiring protection, based on evidence from entire export cable routes measuring 10s of kilometres, with multiple sediments types, is not appropriate for HRAs.

2.2. It therefore remains unclear whether this assumption is directly applicable to the individual designated sites, This is important because cable protection will have a permanent impact on the designated site and the volume/area/length can make a big difference in relation to the outcome of an appropriate assessment

3. Habitat Features

3.1. The ability to bury cables and thus the need for cable protection should be based on project specific information on the habitats/features present and the underlying substrata and allow for sufficient contingency around changing installation tools and/or technical hiccups. Please see Natural England advice submitted for Deadline 6 [REP6 - 048] and Deadline 7 on the Preliminary Trenching Assessment [REP5 – 010].

4. Temporary vs. permanent loss

4.1. Natural England advises that the placement of cable protection is a permanent impact and that to date no empirical evidence has been presented to demonstrate the successful decommissioning / removal of cable protection where the habitat is returned to its pre impact state.

5. During construction vs. over the lifetime of the project:

5.1. During the discussion at ISH 4 the Applicant said that 10% of cable protection was to be placed over the life time of the project, not just during the construction phase. If the Applicant would like flexibility to place rock armouring in new areas over the life time of the project then there needs to be an agreed approach on how impacts to priority habitats and/or interest features will be avoided and/or minimised during subsequent cable protection placement and this should be assessed as part of the consenting process. We advise that a Site Integrity plan should be submitted which goes one step further than the Cable Installation Plan to ensure that these HRA concerns are addressed. NB: this is something that Vattenfall is already undertaking for Norfolk Vanguard NSIP.

5.2. Natural England highlights that the MMO has highlighted other projects which have required substantially more cable protection [REP1-095 and REP3-092]. Therefore, the MMO has advised that if the volume of cable protection detailed in the DMLs is not used during construction then they would expect to see a separate marine licence application for remedial cable protection during the operational phase. The MMO does not feel it is possible to fully assess the impacts on designated sites over the lifetime of the Proposed Development [REP6-073].

5.3. Therefore, Natural England is in agreement with the MMO that the figure provided for cable protection should only be assessed and restricted to the construction phase. Any further request for cable protection over the life time of the project should be dealt with through a separate marine licence. Please also see our comments on the RIES submitted at deadline 7.

6. Use of 25% WCS for O&M:

6.1. As discussed during ISH 4 and within our response to ExA question Q2.2.60 the Applicants HRA includes a figure of 25% for the replacement of rock protection during the operation phase of the project. However, it is considered by the Applicant to not increase the significance of the impact as it will be located on areas previously protected. Natural England queried several assumptions during the ISH and this is now our understanding of this proposal:

i) Where did this figure come from?

6.2. No information has been provided to support this

ii) Is it 25% of the area/volume of cable protection placed during construction to protect the cables, or 25% of the original figure applied for cable protection in the application? N.B. There could be a significant difference between the two and would need to be outline which in the DCO/DML

6.3. Our understanding is that 10% cable protection was not intended by the Applicant to be limited to the construction phase, therefore the 25% is of the full <u>volume </u>of cable protection applied for within the application.

iii) If only in areas where cable protection has been previously place then there should be a restriction in the DCO/DML on this.

6.4. However, if 10% cable protection is permitted beyond the construction phase, there is still a question of how the Developer will differentiate between placing a proportion of the 10% over the lifetime of the project and that of the 25% of the replenishment amount? For example how will the regulator be certain that 10%

of the length of the cable corridor within a designated site hasn't been exceeded? And that either 25% of the existing cable protection length and/or 25% of the volume hasn't been exceeded? If the Secretary of State is minded consent the project, and noting the point above about concentration of cable protection on particular habitats/features, further DCO/DML restrictions would be appropriate.

6.5. Natural England suggests that the DCO/DML clearly sets out what the maximum volume, area and length of cable protection permitted in each designated site would be, with the 25% replenishment of the cable protection set as a volume only. It would also be helpful to set out what the combined volume of cable protection would be to make it clear to all parties what the thresholds are.

iv) If not in new areas, why will there be a need for replenishment? This needs to be restricted in the DCO/DML: For example:

- *Replacing damaged cables – If so, evidence from Thanet suggests that a new cable located around the damaged area would be required; which we believe would be a new area of impact and extension of cable protection and therefore a marine licence variation request would be required as area impact not length.*
- *The protection has moved/winnowed - If so, then the area footprint of the cable protection has already expanded outwards, potentially beyond the parameters assessed. We understand that the Applicant has taken this into consideration in their assessment. However, this is not clear from the HRA.*

6.6. Please note that this should not be 25% of the total amount of rock protection applied for across the project including that requested for scour protection and that this point should be made clear in the DCO/DML.

7. Decommissioning

7.1. Natural England notes that the Applicant has submitted [REP6 - 018] JdN 'Technical note for decommissioning Race Bank Export Cable rock protection'

7.2. Please note that NE this document has been produced in support of a live application that is yet to be determined by the MMO (MLA/2017/00277/4 Race Bank marine licence application.).

7.3. As the Applicant is the same developer as for Race Bank and our interim advice is in the public domain we set out below our advice to the MMO in relation to this document alone: -

i) Whilst the document demonstrates that dredging of rock is possible. However, that is very different to sensitively decommissioning rock armour within designated sites.

ii) The examples provided give no details of why they were dredging rock? Where they were and overarching sediment type? What was required? What was achieved? What did the seabed look like before and after and compared to surrounding habitat? Did the dredging in itself have any wider impacts?

iii) There is no assessment of how analogous these examples are to what is required for Race Bank [and thus Hornsea Project 3].

iv) Section 2.6.5 the drag Head vertical accuracy to 30cm means that it is unlikely that the seabed will be returned to it's previous state. For instance a remaining layer of 30cm of Norwegian granite in areas in less mobile sediment as proposed in The Wash means a permanent change in the habitat. Similarly the same is true if dredging is undertaken to 30cm below the seabed as habitat will be permanently removed and as with the existing trenches is unlikely to recover.

7.4. Therefore Natural England is unable to agree with the applicant that successful decommissioning, which ensure that the seabed/site features are returned to their previous condition.

8. Summary

8.1. Presently there is insufficient data for Natural England to agree:

a) that the WCS is appropriate for designated sites;

b) that there would be no adverse effect on integrity; and

c) any mitigation/compensation measures.

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Written Response for Deadline 7

ANNEX D: Advice note regarding consideration of small scale habitat loss within Special Areas of Conservation (SACs) in relation to cable protection

14 March 2019

In relation to consideration of small scale habitat loss within Special Areas of Conservation (SACs) in relation to cable protection Natural England provides the following advice:

1.1. Natural England will usually consider permanent, long-lasting and irreversible loss to be an adverse effect unless it can be clearly demonstrated otherwise.

1.2. The following points should be considered (but not exclusively) when providing evidence to underpin an assessment of whether an impact is likely to be an adverse effect:

- Location of the predicted loss in terms of whether it sits on a designated or supporting feature of the site;
- Duration of the loss – for loss to be considered temporary it must be clearly time-limited to the point where the impact is predicted to return to the same pre-impact condition and must include a detailed remediation plan using proven techniques as part of the licence;
- Scale of the loss in relation to the feature / sub feature of the site including consideration of the quality and rarity of the affected area;
- Impact on structure, functioning or supporting processes of the habitat;
- Feature condition; and
- Existing habitat loss within the same site/ feature/ sub feature.

1.3. Whilst there are no hard and fast rules or thresholds, in order for Natural England to advise that there is no likelihood of an adverse effect the project would need to demonstrate the following:

1) That the loss is not on the priority habitat/feature/ sub feature/ supporting habitat and/or
2) That the loss is temporarily and reversible (within guidelines above) and/or
3) That the scale of loss is so small as to be de minimus alone and/ or
4) That the scale of loss is inconsequential including other impacts on the site/ feature/ sub feature

1.4. It is noted that Applicant's will argue that they have provided the above information and provided the necessary assessment and evidence. However, as set out in (C-294/17 Cooperatie Mobilisation for the Environment UA and Others v College van gedeputeerde staten van Limburg and Others) and other case law relating to People over Wind (2018) for a plan/project to be consented within a designated site there needs to be sufficient certainty in the evidence presented and the recoverability of the features and/or absolute certainty that any proposed mitigation measures will remove an adverse effect on integrity.

1.5. As set out in our Deadline 7 response for Hornsea Project 3 there is low confidence in the evidence presented to support the Application and considerable uncertainty about the temporal and spatial scale of the impacts due to lack of supporting empirical evidence, project specific data and confidence in the presented Worst Case Scenario.

1.6. Therefore, we welcome any further work the applicant can do to provide more certainty in relation to the Worst Case Scenario presented and/or minimise the impacts as much as possible.

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Annex E: Offshore Ornithology Comments for Deadline 7, including information requested by ExA question F2.26

14 March 2019

1. This paper presents a synthesis of the Applicant's assessment of predicted collision and displacement impacts based on parameter values that are most closely aligned with the approach advised by Natural England. The figures have been taken from those presented by the Applicant in REP6-043 for collision risk modelling, REP4-049 for displacement and REP4-092 for Population Viability Analysis.

2. Natural England have highlighted throughout our written and oral submissions that the lack of complete baseline information for the Hornsea Three Zone (i.e. the array area) means that there is not certainty beyond reasonable scientific doubt to support the Applicant's conclusions. Consequently Natural England does not consider that it is possible to rule out Adverse Effect of Integrity for multiple features across multiple sites. This position remains unchanged.

3. Recognising that Natural England is an adviser and not the decision maker in this process, we have provided detailed and consistent project specific advice to the Applicant and the Examining Authority on the parameters and analyses that should be used in order to reduce uncertainty in the assessments as far as possible.

4. The Applicant has provided several updates of their analysis, and have revised their choice of parameters in several instances, but they have not followed the advice of the Statutory Nature Conservation Body (SNCB) ie. Natural England, in their assessments of impact and AEoSI. Therefore we do not consider that the level of uncertainty (and thereby the level of risk) associated with the Applicant's conclusions has reduced.

5. At the Examiner's request, the applicant has provided collision and displacement figures that are more in line with Natural England's Advice (notably [REP6-043] and [REP4-092]], though there are outstanding issues.

6. Our assessment of these figures clearly demonstrates that the choice of parameters can make a considerable difference to the predicted impacts of the proposed development, and make a vast difference to the conclusions relation to AEoSI and significance at an EIA scale. Natural England have provided a worked example to demonstrate this for the kittiwake feature of FFC SPA.

7. Natural England would therefore highlight that whilst the incomplete baseline information represents a key consenting risk, further consenting risks are also apparent from the data that *has* been supplied.

1. Collision Data

1.1. KITTWAKE

Table 1. Summary Figures for Kittiwake Predicted Annual Collisions

Kittiwake	EIA North Sea (individuals)		FFC SPA (adults)	
	Project Alone	Cumulative	Project Alone	In-combination
East Anglia 3[1]	n/a	3447	n/a	319
Hornsea Project Three based on Applicant's project figures closest to NE advice on methods	297 (127-503)[2]	4247 (3737-5073)[3]	181 (81-304)[4]	533 (407-704)[5]

Table 2. Percentage of baseline mortality for kittiwake impact levels predicted by Applicant in REP6-043. Baseline mortality calculated using Applicant's population size figures from APP-051 and APP-065.

[1] Figures taken from EA3 as most recently consented southern North Sea OWF as starting point for the cumulative and in-combination totals. These figures have uncertainty associated with them – Natural England do not necessary agree with all the assumptions that underpin the figure. https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/EN010056-001644-EA3%20-%20Revised%20CRM.pdf

[2] See Tables below for details of figures.

[3] East Anglia Three cumulative total plus 800 (290-1626) birds added from Hornsea Project Three, Norfolk Vanguard, Thanet Extension and Moray West OWFs. Moray West figures derived from http://marine.gov.scot/sites/default/files/00538033.pdf ,Table 10.8.13. Norfolk Vanguard figures from Vanguard CRM Link Table A4.2 Appendix 3.2. Thanet Extension figures taken from Taken from: Table 3 and associated text from: Vattenfall Wind Power Ltd. Thanet Extension Offshore Wind Farm. Appendix 39 to Deadline 3 Submission: Clarification Note on Collision Risk Modelling Parameters and Thanet Extension's Contribution to Cumulative and In-Combination Totals. No mean value given so taken as central point of range.

[4] See Tables below for details of figures.

[5] East Anglia Three in-combination total plus 214 (88-384) birds added from Hornsea Project Three, Norfolk Vanguard, Thanet Extension and Moray West OWFs. Data sources as above.

	Impact level. Collisions per annum. Central estimate indicated in green.	% of baseline mortality using Applicant's figures for population size at FFC SPA (44,520 pairs for FFC SPA) as used in APP-051, Table 7.17, and 839,456[6] individuals for largest North Sea Population scale (from Furness 2015) as used by Applicant in Table 5.27 of APP-065 for the Post-breeding season. Baseline mortality taken from survival rates in Horswill and Robinson (2015)
Project Alone	127	0.104
	297	0.242
	503	0.410
Cumulative	3737	3.05
	4247	3.47
	5073	4.14
FFC SPA Project alone	81	0.623
	181	1.38
	304	2.34
FFC in-combination	407	3.13
	533	4.10
	704	5.42

8. Details of the collision figures extracted from the Applicant's REP6-043 that are most closely aligned with Natural England's advice are set out below. Natural England notes that these figures from the Applicant do not address the issue of the incomplete baseline.

9. These figures are based on the following collision risk modelling parameters for kittiwake: Band Model (2012) Option 2, Nocturnal Activity Factor (NAF) 2-3,

[6] Note that for the EIA population scales Natural England have used the annual total collisions and assessed these against the largest population size present in the North Sea UK waters for the population (i.e. the largest population size used in Table 5.27 in APP-065) rather than broken down into separate seasons as the Applicant has done.

Avoidance Rates (AR) 98.9% (98.7-99.1), flight speeds from Pennycuik (1987)/Alerstam et al (2007).

10. Numbers in Tables 3-6 are total annual collisions with no apportioning to colonies. Green cells indicate the central and range of values for a given set of parameters. Numbers taken from Tables 3.7 and 3.8 of Applicant's REP6-043.

Table 3. NAF2. Variability in density and AR. Maximum likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	183	296	423
98.9	155	251	358
99.1	127	205	293

Table 4. NAF3. Variability in density and AR. Maximum likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	217	351	503
98.9	184	297	426
99.1	150	243	348

Table 5. NAF 2. Flight height and AR variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
98.7	194	296	388
98.9	164	251	328
99.1	134	205	269

Table 6. NAF 3. Flight height and AR variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
98.7	230	351	460
98.9	195	297	389

99.1	159	243	318

11. The mean estimate is 297 birds per annum (NAF 3) or 251 birds per annum (NAF 2). The range of estimates is 127-503, noting that variability across all parameters cannot be estimated statistically by this approach.

HRA numbers: FFC SPA mortality estimates (adult birds) – project alone.

12. Tables 7-10 are annual predicted collisions of adult kittiwake from FFC SPA using the Applicant's figures from REP6-043 taken from Tables 3.9 to 3.12.

13. Apportioning assumptions: Breeding season March – August 93.1%[7] birds apportioned to FFC SPA; Post-breeding migration season Sept- December 5.4%; Pre breeding spring migration season January - February 7.2%.

Table 7. FFC SPA predicted annual collisions (adults). NAF2. Variability in density (mean density and 95% confidence intervals) and Avoidance Rate (AR). Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	117	188	266
98.9	99	159	225
99.1	81	144	184

Table 8. FFC SPA predicted annual collisions NAF3 (adults). Variability in density. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	133	214	304
98.9	112	181	257
99.1	92	164	210

Table 9. FFC SPA predicted annual collisions NAF2 (adults). Flight height and AR variation, using mean density.

[7] Breeding season Apportioning rate presented is proportion of all 'adult-type' birds recorded during March – August in the digital aerial data set. This will incorporate an unknown proportion of older immatures birds and potentially non-FFC SPA adults.

AR/PCH	LCL	Mean PCH	UCL
98.7	123	188	246
98.9	104	159	208
99.1	85	144	170

Table 10. FFC SPA predicted annual collisions NAF3 (adults). Flight height and AR variation, using mean density.

AR/PCH	LCL	Mean PCH	UCL
98.7	140	214	280
98.9	118	181	237
99.1	97	164	194

Pink cells are impact levels that exceed 1% of baseline mortality for the colony.

Table 11. Predicted population impacts on the kittiwake population of FFC SPA for the range of mortality impacts predicted for Hornsea Project Three alone and in-combination with other plans and projects. PVA Impact Metrics are as provided by the Applicant in REP4-092. The range of predicted Project alone figures are indicated in pink, in-combination in purple. The darker shaded cells represent the level of impact closest to the central value of the predictions in Tables 8 and 10 above.

Kittiwake	FFC SPA		
ADDITIONAL MORTALITY	% Baseline Mortality using Applicant's population sizes[8]	Counterfactual of Final Population Size (CPS)[9]	Counterfactual of Growth Rate (CGR)[10]
50	0.38	0.981 (0.981-0.981)	0.999

[8] Note that Applicant uses 89040 adults as FFC SPA population estimate (44,520 pairs) in APP-051 which gives 1% BM as 130 birds. Natural note that using the mean of 2016-17 census data (102,536 adults) 1% BM is 150 birds.

[9] Kittiwake, demographic rate set 2, counterfactuals of population size after 35 years, estimated using a matched runs method, from 1000 density independent simulations. Table A2_7.1. REP4-092.

[10] Kittiwake, demographic rate set 2, counterfactuals of population growth rate after 35 years, estimated using a matched runs method, from 1000 density independent simulations. No CLs given as they are the same as the median values. Table A2_7.3. REP4-092.

100	0.78	0.962 (0.962-0.963)	0.999
150	1.15	0.944 (0.944-0.945)	0.998
200	1.54	0.926 (0.926-0.927)	0.998
250	1.92	0.909 (0.908-0.909)	0.997
300	2.31	0.892 (0.891-0.892)	0.997
350	2.69	0.875 (0.874-0.876)	0.996
400	3.08	0.858 (0.857-0.859)	0.996
450	3.46	0.842 (0.840-0.843)	0.995
500	3.85	0.826 (0.824-0.827)	0.994
550	4.23	0.810 (0.809-0.811)	0.994
600	4.62	0.794 (0.793-0.796)	0.993
650	5.0	0.779 (0.778-0.781)	0.993
700	5.38	0.765 (0.763-0.766)	0.992

14. Predicted impacts for the kittiwake feature of FFC SPA are **181 (81-304)** adults per annum for Hornsea Project Three alone and **533 (407-703)** adults per annum in-combination with other plans and projects.

15. If the additional mortality from the windfarm is **550 adults per annum** (closest PVA output to 533 birds in [REP4-092]) then the population of FFC SPA after 35 years will be 19% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.6%.

16. If it is assumed that the population is stable then this would mean that the population would be 19% lower than the current population size. This would be counter to the restore conservation objective and would be AEoSI.

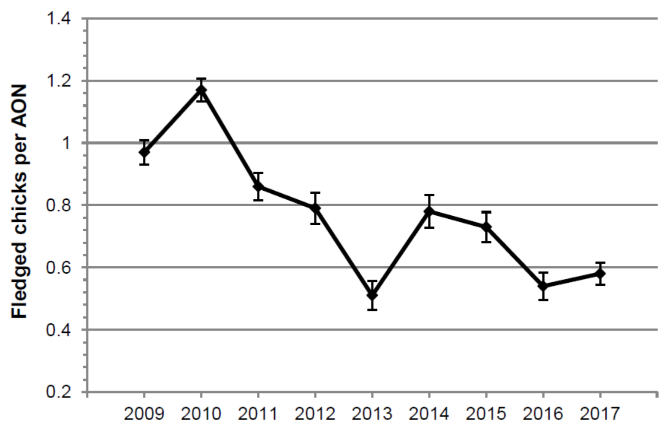
17. If the additional mortality from the windfarm is **200 adult birds** per annum (closest PVA output to 181 birds in [REP4-092]) then the population of FFC SPA after 35 years will be 7.4% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.2%.

18. If it is assumed that the population is stable then this would mean that the population would be 7.4% lower than the current population size. This would be counter to the restore conservation objective and would be AEoSI.

19. It is not known what the growth rate of the colony will be over the next 35 years. There has been a 2.2% per annum decline in numbers for Flamborough Head and Bempton Cliffs colony between 1987 and 2017 (a growth rate of 0.979 per annum). Over the period 2000 to 2017 the population has shown a 0.37% per annum increase in numbers (a growth rate of 1.0037 per annum) based on census counts in the JNCC Seabird Monitoring Programme Database[11].

20. There is no evidence to suggest that the future population trend will be significantly different from the current trend, for example productivity at the colony has not been increasing in recent years (see Figure 1) (Aitken et al. 2017)

Figure 1. Flamborough/Bempton Black-legged kittiwake productivity 2009-2017, mean of plot results +/- SE. From Aitken et al. (2017). Note this does not include productivity data for Filey, where productivity is lower (e.g. in 2017 mean productivity for kittiwake at Filey was 0.39 (SE ± 0.0742) chicks per AON).



21. Between the SCR Census (1985–88) and Seabird 2000 (1998–2002) for major colonies in Britain, no sites showed a per annum increase that exceeded 4.5% (see Natural England Deadline 4 submission for Hornsea Project Two). The growth rate of the colony at Bempton/Flamborough between 2008 and 2017 was 0.37% per annum, following declines from 1987. So the evidence suggests that the FFC SPA colony has a growth rate of <1% p.a.

22. If we assume a 1% per annum growth rate for the next 35 years then 150-200 additional mortalities per annum would result in the population being approximately 9,700 birds lower than without the additional mortality after 35 years and it would

11 JNCC. 2016. Seabird Population Trends and Causes of Change: 1986-2015 Report (http://jncc.defra.gov.uk/page-3201). Joint Nature Conservation Committee. Updated September 2016. Accessed 12 March 2019. And http://jncc.defra.gov.uk/smp/

take an additional 12 years to reach the target population compared to the no windfarm mortality scenario (note that this additional number of years is with a reduced growth rate operating for a period exceeding 35 years).

23. If we assume a 1% per annum growth rate for the next 35 years then 550 additional mortalities per annum would result in the population being approximately 27,000 birds lower than without the additional mortality after 35 years and it would take an additional 74 years to reach the target population compared to the no windfarm mortality scenario (note that this additional number of years is with a reduced growth rate operating for a period exceeding 35 years).

1.2 GANNET

Table 12. Summary Figures for Gannet Predicted Annual Collisions

	EIA North Sea		FFC SPA	
	Project Alone	Cumulative	Project Alone	In-combination
EA3	n/a	2875	n/a	173
Hornsea Project Three based on Applicant's project figures closest to NE advice on methods	49 (10-128)[12]	3168 (2940-3563)[13]	18 (4-46)[14]	250 (180-379)[15]

Table 13. Percentage of baseline mortality for impact levels for gannet predicted by Applicant in REP6-043. Baseline mortality calculated using Applicant's population size figures.

[12] See Tables below for details of figures
[13] East Anglia Three cumulative total plus 293 (65-688) birds added from Hornsea Project Three, Norfolk Vanguard, Thanet Extension and Moray West OWFs. Moray West figures derived from http://marine.gov.scot/sites/default/files/00538033.pdf ,Table 10.8.10. Norfolk Vanguard figures from Vanguard CRM Link Table A4.1 Appendix 3.2. Thanet Extension figures taken from Taken from: Table 3 and associated text from: Vattenfall Wind Power Ltd. Thanet Extension Offshore Wind Farm. Appendix 39 to Deadline 3 Submission: Clarification Note on Collision Risk Modelling Parameters and Thanet Extension's Contribution to Cumulative and In-Combination Totals. No mean value given so taken as central point of range.
[14] See Tables below for details of figures
[15] East Anglia Three in-combination total plus 77 (7-206) birds added from Hornsea Project Three, Norfolk Vanguard, Thanet Extension and Moray West OWFs. Data sources as above.

	Impact level. Collisions per annum	% of baseline mortality using Applicant's figures for population size at FFC SPA (8,469 pairs for FFC SPA) as used in APP-051 Table 7.13, and 456,299[16] individuals for largest North Sea Population scale (from Furness 2015) as used by Applicant in Table 5.26 of APP-065 for the Post-breeding season. Baseline mortality based on survival rates from Horswill and Robinson 2015)
Project Alone	10	0.027
	49	0.133
	128	0.346
Cumulative	2940	7.95
	3168	8.57
	3563	9.64
FFC SPA Project alone	4	0.292
	18	1.31
	46	3.35
FFC in-combination	180	13.1
	250	18.2
	379	27.6

24. Details of the collision figures extracted from the Applicant's REP6-043 that are most closely aligned with Natural England's advice are set out below. Natural England notes that these figures from the Applicant do not address the issue of the incomplete baseline.

[16] Note that for the EIA population scales Natural England have used the annual total collisions and assessed these against the largest population size present in the North Sea UK waters for the population (i.e. the largest population size used in Table 5.26 in APP-065) rather than broken down into separate seasons as the Applicant has done.

25. These figures are based on the following collision risk modelling parameters for gannet: Band Model (2012) Option 2, Nocturnal Activity Factor (NAF) 1-2, Avoidance Rates (AR) 98.9% (98.7-99.1), flight speed Pennycuik (1987).

26. Numbers in Tables 14-17 show total annual collisions with no apportioning to colonies. Green cells indicate the range of values for a given set of parameters. Numbers taken from Tables 3.1 and 3.2 of Applicant's REP6-043.

Table 14. NAF1. Variability in density and Avoidance Rate. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	27	45	64
98.9	23	38	54
99.1	19	31	44

Table 15. NAF2. Variability in density and Avoidance Rate. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	35	58	81
98.9	29	49	69
99.1	24	40	56

Table 16. NAF 1. Flight height and Avoidance Rate variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
98.7	14	45	100
98.9	12	38	85
99.1	10	31	69

Table 17. NAF 2. Flight height and Avoidance Rate variation, using mean density

AR/PCH	LCL	Mean PCH	UCL

98.7	18	58	128
98.9	15	49	108
99.1	12	40	88

27. The mean estimate is 49 birds per annum (NAF 2) or 38 birds per annum (NAF 1). The range of estimates is 10-128, noting that variability across all parameters cannot be estimated statistically by this method.

HRA numbers: FFC SPA mortality estimates (adult birds) – project alone.

28. Tables 18-21 show annual predicted collisions of adult gannet from FFC SPA using the Applicant's figures from REP6-043 taken from Tables 3.3-3.5.

29. Apportioning: Breeding season March – September 63.3%[17]; Post-breeding migration season October-November 4.8%; Pre breeding spring migration season December-February 6.2%.

Table 18. FFC SPA predicted annual collisions NAF1. Variability in density and Avoidance Rates. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	10	18	25
98.9	9	15	22
99.1	7	12	18

Table 19. FFC SPA predicted annual collisions NAF2. Variability in density and Avoidance Rates. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	12	21	30
98.9	10	18	25
99.1	8	14	21

[17] Breeding season apportioning rate presented is proportion of all adult birds recorded during March – Sept from the digital aerial data set. This may incorporate an unknown proportion of non-FFC SPA adults.

Table 20. FFC SPA predicted annual collisions NAF1. Flight height and Avoidance Rate variation, using mean density.

AR/PCH	LCL	Mean PCH	UCL
98.7	5	18	39
98.9	5	15	33
99.1	4	12	27

Table 21. FFC SPA predicted annual collisions NAF2. Flight height and Avoidance Rate variation, using mean density.

AR/PCH	LCL	Mean PCH	UCL
98.7	6	21	46
98.9	5	18	39
99.1	4	14	32

Table 22. Predicted Population impacts on the gannet population of FFC SPA for the range of mortality impacts predicted for Hornsea Project Three alone and in-combination with other plans and projects. PVA Impact Metrics are as provided by the Applicant in REP4-092. The range of predicted Project alone figures are indicated in pink, in-combination in purple. The darker shaded cells represent the level of impact closest to the central value of the predictions in Tables 19 and 21 above.

GANNET	FFC SPA		
ADDITIONAL MORTALITY	%Baseline Mortality using Applicant's population sizes[18]	Counterfactual of Final Population Size (CPS)[19]	Counterfactual of Growth rate (CGR)[20]
5	0.36	No value available	No value available

[18] Using Applicant's population size of 8,469 pairs (16,938 adults) from APP-051, 1% BM is 14 adults. Note that using the mean of 2012, 2015 and 2017 census counts of 24,594 adults, the 1% BM is 20 adults.
[19] Gannet, demographic rate set 2, counterfactuals of population size after 35 years, estimated using a matched runs method, from 1000 density independent simulations. See Table A2_3.1 in REP4-092.
[20] Gannet, demographic rate set 2, counterfactuals of population growth rate after 35 years, estimated using a matched runs method, from 1000 density independent simulations. See Table A2_3.3 in REP4-092

10	0.71	No value available	No value available
20	1.43	No value available	No value available
25	1.79	0.962 (0.962-0.963)	0.999
30	2.14	No value available	No value available
40	2.86	No value available	No value available
50	3.57	0.926 (0.925-0.927)	0.998
150	10.7	0.793 (0.792-0.795)	0.993
175	12.5	0.763 (0.761-0.765)	0.992
200	14.3	0.734 (0.732-0.737)	0.991
225	16.1	0.706 (0.704-0.709)	0.990
250	17.9	0.679 (0.677-0.682)	0.989
300	21.9	0.629 (0.626-0.632)	0.987
350	25.5	0.581 (0.578-0.585)	0.984
375	23.3	0.559 (0.555-0.563)	0.983

30. Predicted impacts for the gannet feature of FFC SPA are **18 (4-46)** adults per annum for Hornsea Project Three alone and **250 (180-379)** adults per annum in-combination with other plans and projects.

31. If the additional mortality from the windfarm is 25 adults per annum (closest PVA outputs available in REP4-092 to predicted 18 adult mortalities) then the population of FFC SPA after 35 years will be 3.8% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 0.1%.

32. If the additional mortality from the windfarm is 250 adults per annum then the population of FFC SPA after 35 years will be 32% lower than it would have been in the absence of the additional mortality. The population growth rate would be reduced by 1.1 %.

33. The gannet population of FFC SPA increased at 11.1% per annum (between 2003/4 and 2015, JNCC Seabird Monitoring Programme data[21]). Using FFC SPA census data 2002-2017 the growth rate was 9.4% per annum.

34. Note that these figures are for predicted collision mortalities only. Adding predicted displacement mortality would add 3-67 adults per annum to FFC SPA for Hornsea Project Three alone and 10-243 birds (all ages) to the cumulative total.

[21] JNCC. 2016. Seabird Population Trends and Causes of Change: 1986-2015 Report (http://jncc.defra.gov.uk/page-3201). Joint Nature Conservation Committee. Updated September 2016. Accessed 12 March 2019.

2. Displacement data – general notes

2.1 Summary data:

35. Figures are annual predicted mortality (i.e. summed across seasons) from displacement. This is based on data presented by the applicant at REP4-049 (Annex C, Appendix 28), summed to get annual totals. It uses displacement presented as the 'alternative analysis' within REP4-049.

36. **It should be noted that:**

1) The seasons in the 'alternative analysis' (REP4-049) are defined in accordance with NEs advice
2) The calculation of seasonal mean of peaks is NOT NEs recommended approach.

- It is a combination of 20 months of DAS and 4 months using the Upper Confidence Limits (from the DAS data) for the previous year for the missing months (Dec-March).
- No upper or lower confidence limits have been provided for the other months, so it is not possible to explore the variability around the mean in these data. The use of the UCL of the mean from year 1 to fill the data gaps in year 2 may lead to an under or over estimation of the mean seasonal peaks.

3) The apportioning rates presented in the alternative analysis for the non-breeding seasons are in accordance with NE advice.
4) In the case of Guillemot and Razorbill no immatures have been included in the totals for FFC SPA in the breeding season.
5) Natural England has apportioned 50% of Puffin in the breeding season, while the applicant has apportioned 0%
6) Cumulative and In-combination totals are based on an incomplete data set. The following wind farm projects are missing from the assessment : Beatrice Demo, Gunfleet 2, Hywind, Inner Dowsing, Kentish flats, Kentish Flats Ext, Kincardine, Lynn, Methil, Moray west, Rampion, Scroby Sands, Seagreen A&B (non-breeding seasons).
7) This missing data reduces confidence in the assessment and can only result in an under-estimation of the cumulative and in-combination assessments.

2.2 GUILLEMOT

Table 23. Summary of range of potential displacement impacts at EIA North Sea Scale and FFC SPA scale for the project alone and cumulatively/in-combination.. Lower displacement mortality represents 30% displacement and 1% mortality; upper displacement mortality represents 70% displacement and 10% mortality. Data is summed from that presented in Tables 1.12 and 1.13 in REP4-049

Guillemot	EIA North Sea (all birds)	FFC SPA (adults only)

	Project Alone	Cumulative	Project Alone	In-combination
EA3[22]		529 - 12354		61-1425
Hornsea 3[23]	98 - 2278	655 - 15277	3-59	64-1499

Table 24. Percentage of baseline mortality for displacement levels for guillemot calculated using Applicant's population size figures.

<u>Guillemot</u>	Impact level. Displacement per annum. Lower figure represents 30% displacement and 1% mortality and upper figure represents 70% displacement and 10% mortality	% of baseline mortality using figures for largest North Sea Population scale, 2,045,078 individuals (from Furness 2015) and the population size at FFC SPA (41,607 pairs for FFC SPA) as used in APP-051. Baseline mortality taken from Horswill and Robinson 2015)
Project Alone	98	0.07
	2278	1.82
Cumulative	655	0.52
	15277	12.25
FFC SPA Project alone	3	0.07
	59	1.31
FFC in-combination	64	1.42
	1499	33.36

[22] Figures presented are from EA3 as most recently consented southern North Sea OWF as starting point for the cumulative and in-combination totals.

[23] Figures include EA3 cumulative/in-combo total and in addition – Norfolk Vanguard, Thanet ext (as presented in Norfolk Vanguard Environmental statememt, Table 13.73 https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-001501-Chapter%2013%20Offshore%20Ornithology%20Norfolk%20Vanguard%20ES.pdf

2.3 RAZORBILL

Table 25. Summary of range of potential displacement impacts at EIA North Sea Scale and FFC SPA scale for the project alone and cumulatively/in-combination. Lower displacement mortality represents 30% displacement and 1% mortality; upper displacement mortality represents 70% displacement and 10% mortality. Data is summed from that presented in Tables 1.16 and 1.17 in REP4-049

Razorbill	EIA North Sea (all birds)		FFC SPA (adults only)	
	Project Alone	Cumulative	Project Alone	In-combination
EA3[24]		252		16-369
HOW3[25]	26-660	289-6785	0-19	17-393

Table 26. Percentage of baseline mortality for displacement levels for razorbill calculated using Applicant's population size figures.

Razorbill	Impact level. Displacement per annum. Lower figure represents 30% displacement and 1% mortality and upper figure represents 70% displacement and 10% mortality	% of baseline mortality using figures for largest North Sea Population scale, 591,874 individuals (from Furness 2015) and the population size at FFC SPA (10,570 pairs for FFC SPA) as used in APP-051. Baseline mortality taken from Horswill and Robinson 2015)
Project Alone	26	0.05
	660	1.06
Cumulative	291	0.47

[24] Figures presented are from EA3 as most recently consented southern North Sea OWF as starting point for the cumulative and in-combination totals.
[25] Figures include EA3 cumulative/in-combo total and in addition – Norfolk Vanguard, Thanet ext (as presented in Norfolk Vanguard Environmental statememt, Table 13.71 https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-001501-Chapter%2013%20Offshore%20Ornithology%20Norfolk%20Vanguard%20ES.pdf

	675	10.93
FFC SPA Project alone	1	0.05
	19	0.90
FFC in-combination	17	0.80
	393	18.59

2.4 PUFFIN

Table 27. Summary of range of potential displacement impacts at EIA North Sea Scale and FFC SPA scale for the project alone and cumulatively/in-combination. Lower displacement mortality represents 30% displacement and 1% mortality; upper displacement mortality represents 70% displacement and 10% mortality. Data is summed from that presented in Tables 1.20 and 1.21 in REP4-049.

Puffin	EIA North Sea (all birds)		FFC SPA (adults only)[26]	
	Project Alone	Cumulative	Project Alone	In-combination
EA3[27]		119-2772		3-59
HOW3[28]	1-23	120-2802	0 -9	3 -67

Table 28. Percentage of baseline mortality for displacement levels for puffin calculated using Applicant's population size figures.

Puffin	Impact level. Displacement per annum. Lower figure represents 30% displacement and 1% mortality and upper figure represents 70%	% of baseline mortality using figures for largest North Sea Population scale, 868,689 individuals (from Furness 2015) and the population size at FFC SPA (980 pairs for FFC SPA) as used in APP-051. Baseline mortality taken from Horswill and Robinson 2015)

[26] 50% of birds have been apportioned as adults in the breeding season to FFC SPA
[27] Figures presented are from EA3 as most recently consented southern North Sea OWF as starting point for the cumulative and in-combination totals.
[28] Figures include EA3 cumulative/in-combo total and in addition – Norfolk Vanguard, Thanet ext (as presented in Norfolk Vanguard Environmental statement, Table 13.69 https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-001501-Chapter%2013%20Offshore%20Ornithology%20Norfolk%20Vanguard%20ES.pdf

	displacement and 10% mortality	
Project Alone	1	0.00
	23	0.03
Cumulative	120	0.15
	2803	3.43
FFC SPA Project alone	0	0
	9	6.56
FFC in-combination	3	2.19
	67	48.83

2.5 GANNET

Table 29. Summary of range of potential displacement impacts at EIA North Sea Scale and FFC SPA scale for the project alone. Lower displacement mortality represents 30% displacement and 1% mortality; upper displacement mortality represents 70% displacement and 10% mortality. Data is summed from that presented in Tables 1.8 and 1.9 in REP4-049

Gannet	EIA North Sea (all birds)	FFC SPA (adults only)[29]
	Project Alone	Project Alone
HOW3	10-243	3-67

2.6 EIA

37. Natural England have presented a summary table below (Table 30) of potential EIA impacts, based on data presented by the applicant and identified by Natural England to be the most closely aligned to our advice (see tables 1, 12, 23, 25, 27, 31, 36 and 41 for information about the source of these figures).

[29] 63.3% of birds have been apportioned as adults in the breeding season to FFC SPA

Table. 30. EIA Summary for all Species. Predicted collisions at North Sea Scale from Hornsea Project Three alone and cumulatively with other plans and projects in the North Sea. In the case of Guillemot, Razorbill, Puffin and Gannet (displacement) the range indicates lower displacement mortality represents 30% displacement and 1% mortality; upper displacement mortality represents 70% displacement and 10% mortality. For gannet, kittiwake, lesser black-backed gull, great black-backed gull and Herring gull (collisions) the range indicates the range associated with variability around density, avoidance rate, NAF and flight height estimates. Pink shaded cells indicate increasing level of concern regarding impact to the North Sea population.

	Population scale for assessment (North Sea) from Furness (2015)	Project Alone Impact (all individuals)		Cumulative Impact (all individuals)	
		Impact	% Baseline Mortality[30]	Impact	% Baseline Mortality[31]
Gannet	456,299	49 (10-128)[32]	0.13 (0.027-0.35)	3168 (2940-3563)[33]	8.57 (7.95-9.64)
Kittiwake	839,456[34]	297 (127-503)	0.242 (0.104-0.41)	4247 (3737-5073)	3.47 (3.05-4.14)
Lesser Black-backed Gull	209,007	17 (4-44)	0.071 (0.017-0.183)	540 (483-650)	2.25 (2.01-2.7)
Great Black-backed Gull	91,399	66 (12-137)	1.03 (0.188-2.14)	1069 (887-1438)	16.7 (13.86-22.5)
Herring Gull	173,299	9 (1-23)	0.031(0.003-0.08)	784 (727-927)	2.73 (2.53-3.22)
Guillemot	2,045,078	98-2278	0.07-1.82	655-15277	0.52-12.25
Razorbill	591,874	28-660	0.05 - 1.06	291-6785	0.47-10.93
Puffin	868,689	1-23	0.00-0.03	120-2803	0.15-3.43

2.7 LESSER BLACK-BACKED GULL

[30] Calculated from Horswill & Robinson 2015
[31] Calculated from Horswill & Robinson 2015
[32] Gannet is predicted to experience an additional impact from displacement from Hornsea 3 alone of 10 – 243 birds, this would increase the % baseline mortality range to be 0.05-1.00%
[33] Gannet is predicted to experience an additional impact from displacement from Hornsea 3 alone of 10 – 243 birds, no cumulative displacement figures have been provided to calculate the additional impact of displacement from other OWFs, this will result in an under-estimation of cumulative impact to Gannet
[34] Population estimate for all UK colonies within North Sea BDMPS scale (from Furness 2015)

Table 31. Summary Figures for Lesser Black-backed Gull Predicted Annual Collisions

LBBG – collisions per annum	EIA North Sea (all birds)	
	Project Alone	Cumulatively
East Anglia Three[35]	n/a	475
Hornsea Project Three based on Applicant's project figures closest to NE advice on methods	17 (4-44)[36]	540 83-650)[37]

38. Details of the collision figures extracted from the Applicant's REP6-043 that are most closely aligned with Natural England's advice are set out below. Natural England notes that these figures from the Applicant do not address the issue of the incomplete baseline.

39. These figures are based on the following collision risk modelling parameters for lesser black-backed gull: Band Model (2012) Option 2, Nocturnal Activity Factor (NAF) 2-3, Avoidance Rates (AR) 99.5% (99.4-99.6), flight speeds from Pennycuik1987/Alerstam et al 2007.

40. Numbers in Tables 32-35 are total annual collisions with no apportioning to colonies. Green cells indicate the central and range of values for a given set of parameters. Numbers taken from Tables 3.13 and 3.14 of Applicant's REP6-043.

Table 32. NAF2. Variability in density and AR. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL

[35] Figures taken from EA3 as most recently consented southern North Sea OWF as starting point for the cumulative totals. These figures have uncertainty associated with them – Natural England do not necessary agree with all the assumptions that underpin the figure. https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/EN010056-001644-EA3%20-%20Revised%20CRM.pdf

[36] See Tables below for details of figures

[37] East Anglia Three cumulative total plus 65 (6-175) birds added from Hornsea Project Three, Norfolk Vanguard, Thanet Extension. No LBBG impacted at Moray West OWFs (http://marine.gov.scot/sites/default/files/00538033.pdf). Norfolk Vanguard figures from Vanguard CRM Link Table A4.8 Appendix 3.2. Thanet Extension figures taken from Taken from: Table 3 and associated text from: Vattenfall Wind Power Ltd. Thanet Extension Offshore Wind Farm. Appendix 39 to Deadline 3 Submission: Clarification Note on Collision Risk Modelling Parameters and Thanet Extension's Contribution to Cumulative and In-Combination Totals. No mean value given so taken as central point of range.

99.4	6	19	32
99.5	5	16	27
99.6	4	13	22

Table 33. NAF3. Variability in density and AR. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
99.4	6	21	36
99.5	5	17	30
99.6	4	14	24

Table 34. NAF 2. Flight height and AR variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
99.4	10	19	40
99.5	8	16	33
99.6	6	13	27

Table 35. NAF 3. Flight height and AR variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
99.4	11	21	44
99.5	9	17	37
99.6	7	14	29

2.8 GREAT BLACK-BACKED GULL

Table 36. Summary Figures for Great Black-backed Gull Predicted Annual Collisions

GBBG – collisions per annum	EIA North Sea (all birds)	
	Project Alone	Cumulatively
East Anglia Three[38]	n/a	840
Hornsea Project Three based on Applicant's project figures closest to NE advice on methods	66 (12-137)[39]	1069 7-1438)[40]

41. Details of the collision figures extracted from the Applicant's REP6-043 that are most closely aligned with Natural England's advice are set out below. Natural England notes that these figures from the Applicant do not address the issue of the incomplete baseline.

42. These figures are based on the following collision risk modelling parameters for great black-backed gull: Band Model (2012) Option 2, Nocturnal Activity Factor (NAF) 2-3, Avoidance Rates (AR) 99.5% (99.4-99.6), flight speeds from Pennycuik1987/Alerstam et al 2007.

43. Numbers in Tables 37-40 are total annual collisions with no apportioning to colonies. Green cells indicate the central and range of values for a given set of parameters. Numbers taken from Tables 3.17 and 3.18 of Applicant's REP6-043.

Table 37. NAF2. Variability in density and AR. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
99.4	18	64	110

[38] Figures taken from EA3 as most recently consented southern North Sea OWF as starting point for the cumulative totals. These figures have uncertainty associated with them – Natural England do not necessary agree with all the assumptions that underpin the figure. https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/EN010056-001644-EA3%20-%20Revised%20CRM.pdf

[39] See Tables below for details of figures

[40] East Anglia Three cumulative total plus 229 (47-598) birds added from Hornsea Project Three, Norfolk Vanguard, Thanet Extension and Moray West OWFs. Moray West figures derived from http://marine.gov.scot/sites/default/files/00538033.pdf ,Table 10.8.19. Norfolk Vanguard figures from Vanguard CRM Link Table A4.5 Appendix 3.2. Thanet Extension figures taken from Taken from: Table 3 and associated text from: Vattenfall Wind Power Ltd. Thanet Extension Offshore Wind Farm. Appendix 39 to Deadline 3 Submission: Clarification Note on Collision Risk Modelling Parameters and Thanet Extension's Contribution to Cumulative and In-Combination Totals. No mean value given so taken as central point of range.

99.5	15	53	92
99.6	12	42	73

Table 38. NAF3. Variability in density and AR. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
99.4	24	79	136
99.5	20	66	113
99.6	16	53	91

Table 39. NAF 2. Flight height and AR variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
99.4	50	64	110
99.5	42	53	92
99.6	33	42	73

Table 40. NAF 3. Flight height and AR variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
99.4	62	79	137
99.5	52	66	114
99.6	42	53	91

2.9 HERRING GULL

Table 41. Summary Figures for Herring Gull Predicted Annual Collisions

HG – collisions per annum	EIA North Sea (all birds)

	Project Alone	Cumulatively
East Anglia Three[41]	n/a	701
Hornsea Project Three based on Applicant's project figures closest to NE advice on methods	9 (1-23)[42]	784 27-927)[43]

44. Details of the collision figures extracted from the Applicant's REP6-043 that are most closely aligned with Natural England's advice are set out below. Natural England notes that these figures from the Applicant do not address the issue of the incomplete baseline.

45. These figures are based on the following collision risk modelling parameters for Herring gull: Band Model (2012) Option 2, Nocturnal Activity Factor (NAF) 2-3, Avoidance Rates (AR) 99.5% (99.4-99.6), flight speeds from Pennycuik1987/Alerstam et al 2007.

46. Numbers in Tables 42-45 are total annual collisions with no apportioning to colonies. Green cells indicate the central and range of values for a given set of parameters. Numbers taken from Tables 3.15 and 3.16 of Applicant's REP6-043. Natural England note that there may be errors in the Table 3.15 (indicated in brackets in the table below).

Table 42. NAF2. Variability in density and AR. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	1	9	12 (19)

[41] Figures taken from EA3 as most recently consented southern North Sea OWF as starting point for the cumulative totals. These figures have uncertainty associated with them – Natural England do not necessary agree with all the assumptions that underpin the figure. https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/EN010056-001644-EA3%20-%20Revised%20CRM.pdf

[42] See Tables below for details of figures

[43] East Anglia Three cumulative total plus 83 (26-226) birds added from Hornsea Project Three, Norfolk Vanguard, Thanet Extension and Moray West OWFs. Moray West figures derived from http://marine.gov.scot/sites/default/files/00538033.pdf ,Table 10.8.16. Norfolk Vanguard figures from Vanguard CRM Link Table A4.4 Appendix 3.2. Thanet Extension figures taken from Taken from: Table 3 and associated text from: Vattenfall Wind Power Ltd. Thanet Extension Offshore Wind Farm. Appendix 39 to Deadline 3 Submission: Clarification Note on Collision Risk Modelling Parameters and Thanet Extension's Contribution to Cumulative and In-Combination Totals. No mean value given so taken as central point of range.

98.9	1	7	10 (16)
99.1	1	6	8 (13)

Table 43. NAF3. Variability in density and AR. Maximum Likelihood Flight height.

AR/density	LCL	Mean density	UCL
98.7	1	11	23
98.9	1	9	20
99.1	1	7	16

Table 44. NAF 2. Flight height and AR variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
98.7	6	9	15
98.9	5	7	12
99.1	4	6	10

Table 45. NAF 3. Flight height and AR variation, using mean density

AR/PCH	LCL	Mean PCH	UCL
98.7	7	11	19
98.9	6	9	16
99.1	5	7	13

REFERENCES

Aitken, D., Babcock, M., Barratt, A., Clarkson, K.C., Prettyman, S. 2017. Flamborough and Filey Coast pSPA Seabird Monitoring Programme 2017 Report. RSPB. http://publications.naturalengland.org.uk/file/5574008674451456

Alerstam, T., Rosén, M., Bäckman, J., Ericson, P.G.P., Hellgren, O. (2007) Flight speeds among bird species: allometric and phylogenetic effects. PLoS Biology 5(8): 1656-1662.

Band, W. (2012). Using a collision risk model to assess bird collision risks for offshore wind farms. Report to The Crown Estate Strategic Ornithological Support Services (SOSS), SOSS-02. http://www.bto.org/science/wetland-and-marine/soss/projects.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

Horswill, C. & Robinson R. A. (2015). Review of seabird demographic rates and density dependence. JNCC Report No. 552. Joint Nature Conservation Committee, Peterborough.

Pennycuick, C.J. (1987). Flight Of Auks (Alcidae) And Other Northern Seabirds Compared With Southern Procellariiformes: Ornithodolite Observations. J. exp. Biol. 128, 335-347.

From:	Dominika Phillips
To:	Hornsea Project Three; KJ Johansson; Kay Sully
Cc:	Andrew Guyton; Stuart Livesey
Subject:	Hornsea Project Three (UK) Ltd response to Deadline 4 (Part 15)
Date:	15 January 2019 23:24:05
Attachments:	image001.png D4_HOW03_Appendix 69_NV_Ornithology.pdf D4_HOW03_Appendix 70_Inch Cape_Ornithology.pdf D4_HOW03_Appendix 71_NE_HOW02_DL5.pdf D4_HOW03_Appendix 72_Aviation Team.pdf D4_HOW03_Appendix 73_Q2.2.30_Q2.2.39.pdf

Dear Kay, K-J

Please find attached the 15th instalment of documents.

Best regards,
Dr Dominika Chalder PIEMA
Environment and Consent Manager

[redacted]

Environmental Management UK | Wind Power
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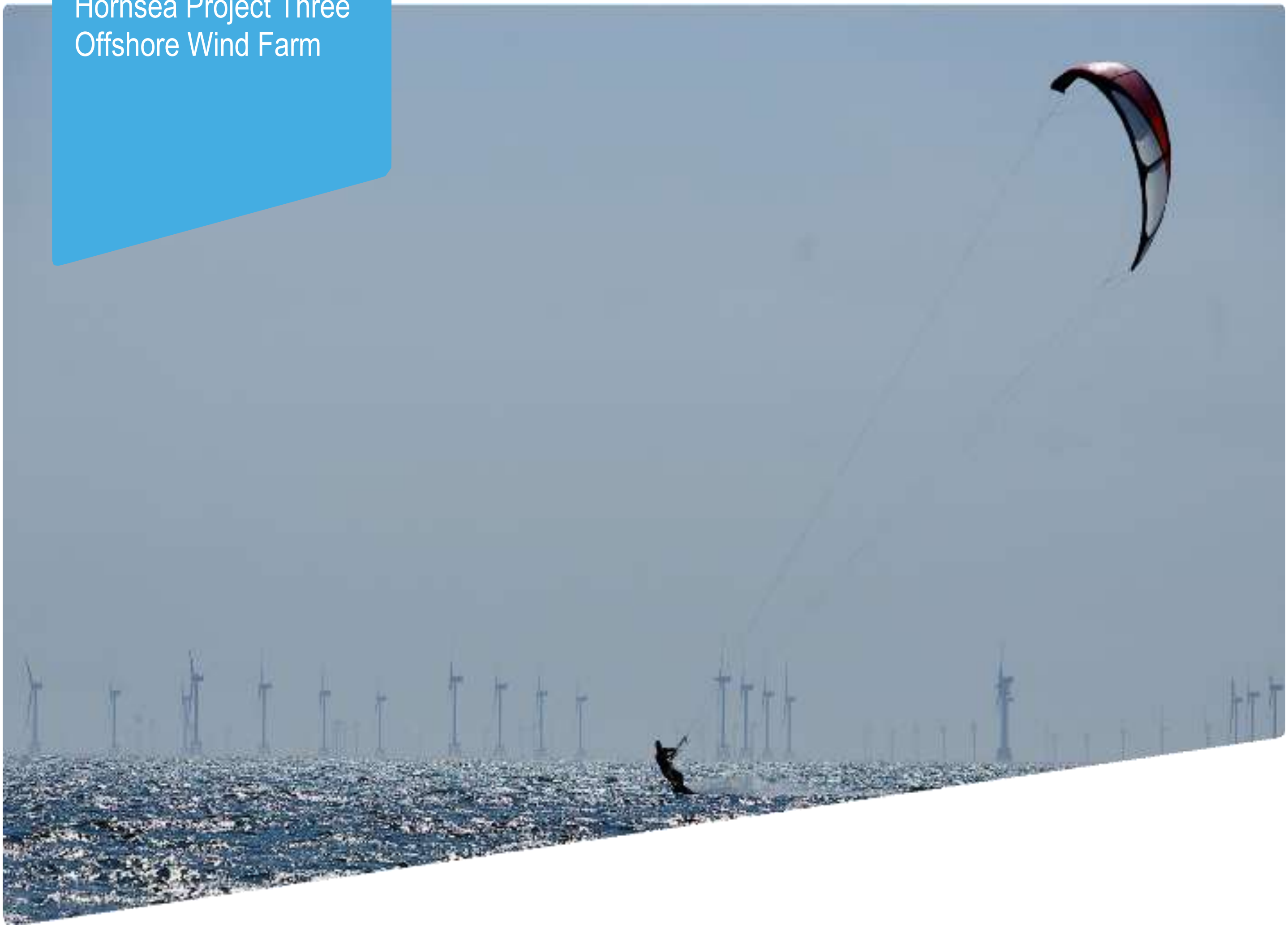

Hornsea Project Three

Offshore Wind Farm

Appendix 73 to Deadline 4 Submission – Detailed response to the ExA Q2.2.30 and Q2.2.39: PVA information

Date: 15th January 2019

Hornsea 3
Offshore Wind Farm

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Document Control	
Document Properties	
Organisation	Ørsted Hornsea Project Three
Author	MacArthur Green
Checked by	Felicity Browner
Approved by	Andrew Guyton
Title	Appendix 73 to Deadline 4 Submission – Detailed response to the ExA Q2.2.30 and Q2.2.39: PVA information
PINS Document Number	n/a

Version History

Date	Version	Status	Description / Changes
15/01/2019	A	Final	Submitted at Deadline 4 (15/01/2019)

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Table of Contents

1. Intorduction

1.1 This Appendix provides the Applicant's response to Ex.A second written questions ("SWQ") 2.2.30 and 2.2.39, which are as follows:

No.	Question
2.2.30	*NE has provided a response to your population viability assessment in Appendix 2 of its Deadline 3 submission [REP3-075].* *Please comment on the points raised. Please provide copies of any publications you wish to rely upon in evidence that have not already been supplied.*
2.2.39	*In its submission at Deadline 3 [REP3-075], NE notes that Rate Set 2 will relate to Flamborough/ Bempton productivity for 2009-2014 and that there will be more up to date productivity data available which may be more appropriate to use for colony population viability assessment. NE highlights the fact that you have applied the original model because you have assumed that none of the key model parameters have changed.* *Please explain why you have not used the most recent demographic rates in this model.* *Why you have not accepted that the model should be re-run in your Deadline 3 response to the RSPB comments?*

1.2 A detailed response to each of the points raised by Natural England in Appendix 2 of its Deadline 3 submission (REP3-075) is provided in the table below. The Applicant's response to the first item raised by Natural England also addresses the issue in relation to the use of demographic rate set 2 that is the subject of Question 2.2.39.

2. Responses to specific points raised by Natural England in Appendix 2 (REP3-075)

NE comment	Applicant's Response
Natural England understand that the models have been parameterised using the same two demographic "rate sets" (Rate Set 1 and Rate Set 2) that were used for the original (MacArthur Green (2015)) PVA models. Rate Set 1 uses demographic parameters from Horwsill and Robinson (2015); Rate Set 2 uses productivity data from Aitken et al (2014) where available (selected for the period 2009-2014) and data from Horswill and Robinson (2015). Based on the understanding that the Applicant has retained these two rate sets in the updated PVAs, Rate Set 2 will relate to Flamborough/Bempton productivity for 2009-2014, however there will be more up to date productivity data available which may be more appropriate to use for colony PVA models now. In section 1.2 of the main Appendix the Applicant states "As none of the assumed values for all key model input parameters (including population size, survival rates and productivity) have changed since that Original PVA Model was produced and examined, it was considered appropriate to use it for the assessment of Hornsea Three". Although the use of counterfactual metrics should reduce the sensitivity of the model outputs to misspecification of demographic rates, Natural England advise that it would be best practice to use the most accurate estimates of demographic rates in the models.	The PVA work that was submitted by the Applicant at Deadline 1 (REP1-135) was commissioned to demonstrate the continuing utility of the predictions presented in MacArthur Green (2015), specifically in relation to a comparison of outputs obtained with matched pairs of simulations with unmatched outputs. Therefore it was not considered necessary for this purpose (nor was it suggested by NE in discussions prior to the work being undertaken) to update the demographic rates. As NE also point out, the use of counterfactuals means that any differences in output due to changes in productivity will likely be small, indeed this is one of the key characteristics of counterfactual outputs cited for their use in impact assessments. In addition, productivity rates in long-lived species such as seabirds have a relatively small effect on population growth rates compared with survival rates, further reducing the likelihood that revisions to this rate would have any material effect on the conclusions of the PVA. The more recent productivity estimates are described by NE as 'more accurate' however it is not apparent why this should be the case. Moreover, the key feature of rates used in the model should be how representative they are for future predictions.
Natural England also requests that all the information on parameters used in the models is presented in the document for clarity, rather than referring to previous reports submitted to PINs for other projects.	The demographic rates are provided in Table 1 below.
There is no information about starting population sizes used in the models or what the growth rates of the projected populations in the different models were. Natural England requests that these are presented.	The initial population sizes are provided in Table 2 below.
For the density dependent stochastic models (where density dependence is applied to productivity and not survival rates) the Applicant could not match reproductive rates between impacted and un-impacted runs so only survival rates were matched	As Natural England note, the Cook et al. (2016) and Jitlal et al. (2017) papers do not provide details of how the demographic rates were matched in density dependent formulations. Therefore it is not possible to determine if those

NE comment	Applicant's Response
between the impacted and un-impacted pairs. This issue was not raised in the Cook et al (2016) report where the metrics were calculated using a matched pairs approach for density dependent stochastic versions of the models. Natural England therefore requests clarification on this issue – in particular if it is possible to configure the models such that matched pairs can be run for the stochastic density dependent models and whether the Applicant's models have been parameterised in a different way from those in Cook et al (2016) and Jitlal et al (2017) where matched pairs were run for the stochastic density dependent models.	authors used different methods from those applied in the current PVA. However, there is a fundamental reason why a pair of density dependent simulations, one with an additional impact and one without, cannot be parameterised using the same (i.e. matched) demographic rates: the mechanism by which the population predictions are linked to population size is to use a relationship between population size and one or more demographic rates (in this case productivity) to adjust that rate. Thus, if this is a negative relationship, as the population increases in size the productivity rate declines, and vice versa. In this manner the population size is restricted. Because the two population projections in a matched pair are subject to different impacts (one has additional mortality applied, the other does not) the population sizes differ, and therefore the productivity rate for each, derived using the density dependent relationship, will also differ. Any attempt to modify the demographic rates in order to achieve equivalence (i.e. to 'match' the productivity rates for the impacted and non-impacted simulations) would therefore be modifying the effective density dependent relationship applied in the model, and the magnitude of this modification would increase as the difference in the population size of the two simulations increases. This does not affect density independent simulations since these models have no linkage between population size and demographic rates, therefore identical values can be applied to both pairs.
Please can the Applicant confirm that the density independent versions of the models have been run with both the survival and reproductive rates matched between the impacted and un-impacted pairs in each stochastic simulation.	Yes, this is the case.
The previous PVAs (MacArthur Green 2015) used 5000 simulations for the stochastic models whereas the PVA models presented in Annex 2 have used	A comparison of kittiwake model outputs for matched and non-matched runs obtained with 10, 1000 and 5000 simulations was provided to

NE comment	Applicant's Response
1000 simulations. Natural England requests that the Applicant demonstrates that using 1000 simulations does not affect the outputs of the models compared to the previous use of 5000 simulations, as it is possible that more than 1000 simulations might be needed to generate reliable results.	Natural England during the EWG process (APP-035). This clearly demonstrated that the difference in outputs for 1,000 simulations and 5,000 simulations was small, and most importantly there was no bias in the outputs.
Annex A presents tables that give metrics across a range of impact levels as requested by Natural England in our Written Reps. However the impacts are presented in 50 bird increments. In our Written Reps we requested a higher resolution of impact levels were presented (we suggested 5 bird increments) and we consider that increments less than 50 birds would be more informative when considering alternative predictions of impact levels.	Further work would be required to re-run the models at a finer scale of impact increment. However, given the linear nature of the counterfactual outputs it is clear that intermediate predictions can simply be obtained by interpolation between the values provided.
Both the Counterfactual of Growth Rate (CGR) and Counterfactual of Population Size (CPS) Metrics should be presented as a median value of the metric with 95% confidence intervals. The CPS metrics tables do not provide any confidence intervals. The CGR tables do give 95% confidence intervals for the metric. Natural England request that the 95% confidence intervals for the counterfactual of final population size metrics are also presented	Updated tables have been produced which provide the median and confidence intervals for both the counterfactuals of population size (CPS) and population growth rate (CPGR). See Annex A to this note.
It is not clear how the median and confidence intervals around the counterfactual of growth rate metrics have been calculated for both the matched runs and the unmatched runs approach (see below for more details). Although there are no confidence intervals presented for the counterfactual of final population size metrics the same query applies to this metric. Natural England requests that the Applicant sets out how they have calculated the metrics for the matched and un-matched runs approaches. A worked example would be useful.	The method for calculating the confidence intervals has been modified as per Natural England's suggested method, as per the following descriptions. At each level of modelled impact (i.e. additional mortality applied), for each matched pair of simulations, the impacted population size (at 5 year intervals) has been divided by the corresponding unimpacted population size. This yielded 1,000 values (as each run comprised 1,000 repeat simulations), from which the median and 95% confidence intervals were calculated. For the matched run CPGR, the population growth rate was calculated across the period from year 5 to year 35 for each population, yielding 1,000 impacted and 1,000 nonimpacted values. The impacted rates were divided by their matched nonimpacted rates to obtain 1,000 values of

NE comment	Applicant's Response
	CPGR, from which the median and confidence intervals were calculated. This is a slightly different method than that used in the original reporting and therefore generates slightly different values (but not materially so). Note that calculating the population growth rate over a long period as here (from year 5 to year 35) ensures that the estimates reflect the long term trend, rather than chance effects which may influence the population projections within shorter periods (e.g. if the rate is calculated for only the last few years of the simulation). This is considered a more robust approach for calculating growth. For the nonmatched calculations the same methods were used, however each impacted run was compared with the initial (baseline) run of the model when additional mortality was set to zero.
Natural England advises that with a matched pairs method the metric should be calculated for each of the individual matched pairs and then (given there are 1000 simulations in the Applicant's models) there will be 1000 metric calculations from which a median value of the metric and the 95% CIs can be derived.	See above response.
Natural England also requests details of how the counterfactual metrics have been calculated for the un-matched pairs runs. A worked example would be useful.	See above response.
Natural England note that the models still add mortality impacts in adult currency which remains an unresolved issue if impacts are assumed to occur on non-adult component of the population only.	This comment is noted, however the purpose of the modelling was to update the previous versions using matched runs and a 35 year projection period, and provide comparative outputs. Therefore the question of which age class to apply impacts to was not revisited. It is also important to note that although outputs are reported in relation to additional adult mortality, mortality within the model is applied to all age classes in proportion to their presence in the population.

Table 1. Initial population sizes used in the modelling. The figures and sources were provided by Natural England. Note that the guillemot and razorbill populations have been adjusted as per Harris (1989) to convert from individuals on land to breeding pairs.

Species	Initial population size (breeding individuals)	Year	Source
Gannet	22122	2012	Census of breeding adults, Seabird Monitoring Programme (SMP)
Kittiwake	89041	2008	Breeding adults for original SPA (SMP) plus RSPB counts for terrestrial extension of SPA (2009-2011), unpublished.
Guillemot	83214	2008	Breeding adults for original SPA (SMP) plus RSPB counts for terrestrial extension of SPA (2009-2011), unpublished.
Razorbill	21140	2008	Breeding adults for original SPA (SMP) plus RSPB counts for terrestrial extension of SPA (2009-2011), unpublished.
Puffin	1960	2008	Breeding adults for original SPA (SMP) plus RSPB counts for terrestrial extension of SPA (2009-2011), unpublished.

Table 2. Demographic rates used in the population models

Model		Survival						Reproduction	
		0-1	1-2	2-3	3-4	4-5	Adult	Fledged young per pair	Age first breeding
GX1	Mean	0.42	0.829	0.891	0.895	-	0.919	0.77	5
	SD	0.078	0.031	0.031	0.031	-	0.012	0.035	
GX2	Mean	0.42	0.829	0.891	0.895	-	0.919	0.828*	5
	SD	0.078	0.031	0.031	0.031	-	0.012	0.028	
KI1	Mean	0.79	0.85	0.87	-	-	0.882	0.672	4
	SD	0.035	0.035	0.035	-	-	0.035	0.3	
KI2	Mean	0.790	0.854	0.854	-	-	0.854	0.847*	4
	SD	0.051	0.051	0.051	-	-	0.051	0.219	
GU1	Mean	0.56	0.792	0.917	0.938	-	0.965	0.68	5

Model		Survival						Reproduction	
		0-1	1-2	2-3	3-4	4-5	Adult	Fledged young per pair	Age first breeding
	SD	0.014	0.030	0.017	0.017	-	0.010	0.113	
GU2	Mean	0.56	0.792	0.917	0.939	0.939	0.939	0.775*	6
	SD	0.014	0.030	0.017	0.015	0.015	0.015	0.026	
RA1	Mean	0.9	0.9	0.9	-	-	0.9	0.63	4
	SD	0.028	0.028	0.028	-	-	0.028	0.085	
RA2	Mean	0.63	0.63	0.895	0.895	-	0.895	0.683*	5
	SD	0.209	0.209	0.067	0.067	-	0.067	0.056	
PU1	Mean	0.924	0.924	0.924	0.924	-	0.924	0.67	5
	SD	0.010	0.010	0.010	0.010	-	0.010	0.156	
PU2	Mean	0.709	0.709	0.760	0.805	-	0.906	0.617	5
	SD	0.083	0.083	0.083	0.083	-	0.083	0.151	

3. Annex A

Table A2_1.1. Gannet, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	Lower 95%	0.995	0.990	0.984	0.978	0.973	0.967	0.962
	Median	**0.995**	**0.990**	**0.984**	**0.979**	**0.973**	**0.968**	**0.962**
	Upper 95%	0.996	0.990	0.985	0.979	0.974	0.968	0.963
50	Lower 95%	0.991	0.979	0.968	0.957	0.946	0.936	0.925
	Median	**0.991**	**0.980**	**0.969**	**0.958**	**0.947**	**0.936**	**0.926**
	Upper 95%	0.991	0.980	0.969	0.958	0.948	0.937	0.927
75	Lower 95%	0.986	0.969	0.953	0.937	0.921	0.905	0.890
	Median	**0.987**	**0.970**	**0.954**	**0.938**	**0.922**	**0.906**	**0.891**
	Upper 95%	0.987	0.971	0.954	0.938	0.923	0.907	0.892
100	Lower 95%	0.982	0.959	0.938	0.916	0.896	0.876	0.856
	Median	**0.982**	**0.960**	**0.939**	**0.917**	**0.897**	**0.877**	**0.857**
	Upper 95%	0.983	0.961	0.940	0.919	0.898	0.878	0.859
125	Lower 95%	0.977	0.949	0.923	0.897	0.871	0.847	0.823
	Median	**0.978**	**0.950**	**0.924**	**0.898**	**0.873**	**0.848**	**0.825**
	Upper 95%	0.978	0.951	0.925	0.899	0.874	0.850	0.826
150	Lower 95%	0.972	0.939	0.908	0.877	0.848	0.819	0.792
	Median	**0.973**	**0.941**	**0.909**	**0.879**	**0.849**	**0.821**	**0.793**
	Upper 95%	0.974	0.942	0.911	0.880	0.851	0.823	0.795
175	Lower 95%	0.968	0.930	0.893	0.858	0.824	0.792	0.761

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.969**	**0.931**	**0.895**	**0.860**	**0.827**	**0.794**	**0.763**
	Upper 95%	0.970	0.932	0.896	0.862	0.828	0.796	0.766
200	Lower 95%	0.963	0.920	0.879	0.839	0.802	0.766	0.732
	Median	**0.964**	**0.922**	**0.881**	**0.842**	**0.804**	**0.768**	**0.734**
	Upper 95%	0.965	0.923	0.882	0.844	0.806	0.771	0.737
225	Lower 95%	0.959	0.910	0.865	0.821	0.780	0.741	0.704
	Median	**0.960**	**0.912**	**0.867**	**0.823**	**0.782**	**0.743**	**0.706**
	Upper 95%	0.961	0.914	0.869	0.826	0.785	0.746	0.709
250	Lower 95%	0.954	0.901	0.851	0.803	0.759	0.717	0.677
	Median	**0.956**	**0.903**	**0.853**	**0.806**	**0.761**	**0.719**	**0.679**
	Upper 95%	0.957	0.905	0.855	0.808	0.764	0.722	0.682
275	Lower 95%	0.950	0.892	0.837	0.786	0.738	0.693	0.651
	Median	**0.951**	**0.894**	**0.839**	**0.788**	**0.741**	**0.696**	**0.653**
	Upper 95%	0.953	0.896	0.842	0.791	0.743	0.698	0.656
300	Lower 95%	0.945	0.882	0.824	0.769	0.718	0.670	0.626
	Median	**0.947**	**0.884**	**0.826**	**0.771**	**0.721**	**0.673**	**0.629**
	Upper 95%	0.949	0.887	0.829	0.774	0.723	0.676	0.631
325	Lower 95%	0.941	0.873	0.810	0.752	0.698	0.648	0.602
	Median	**0.943**	**0.875**	**0.813**	**0.755**	**0.701**	**0.651**	**0.605**
	Upper 95%	0.944	0.878	0.815	0.758	0.704	0.654	0.608
350	Lower 95%	0.936	0.864	0.797	0.736	0.679	0.626	0.578
	Median	**0.938**	**0.866**	**0.800**	**0.739**	**0.682**	**0.630**	**0.581**
	Upper 95%	0.940	0.869	0.803	0.742	0.685	0.633	0.584
375	Lower 95%	0.932	0.855	0.784	0.719	0.660	0.606	0.556
	Median	**0.934**	**0.857**	**0.787**	**0.723**	**0.663**	**0.609**	**0.559**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.936	0.860	0.790	0.726	0.667	0.613	0.563
400	Lower 95%	0.927	0.846	0.771	0.704	0.642	0.586	0.534
	Median	**0.930**	**0.848**	**0.775**	**0.707**	**0.645**	**0.589**	**0.538**
	Upper 95%	0.932	0.851	0.778	0.710	0.649	0.592	0.541
425	Lower 95%	0.923	0.837	0.759	0.688	0.624	0.566	0.513
	Median	**0.925**	**0.840**	**0.762**	**0.692**	**0.628**	**0.570**	**0.517**
	Upper 95%	0.927	0.843	0.765	0.695	0.631	0.573	0.521
450	Lower 95%	0.919	0.828	0.746	0.673	0.607	0.548	0.494
	Median	**0.921**	**0.831**	**0.750**	**0.677**	**0.611**	**0.551**	**0.497**
	Upper 95%	0.923	0.834	0.753	0.680	0.614	0.554	0.501
475	Lower 95%	0.914	0.819	0.734	0.658	0.590	0.529	0.475
	Median	**0.917**	**0.823**	**0.738**	**0.662**	**0.594**	**0.533**	**0.478**
	Upper 95%	0.919	0.826	0.742	0.666	0.598	0.537	0.482
500	Lower 95%	0.910	0.810	0.722	0.644	0.574	0.511	0.456
	Median	**0.913**	**0.814**	**0.726**	**0.648**	**0.578**	**0.515**	**0.459**
	Upper 95%	0.915	0.818	0.730	0.651	0.582	0.519	0.463

Table A2_1.2. Gannet, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	Lower 95%	0.913	0.876	0.834	0.809	0.788	0.773	0.740
	Median	**0.996**	**0.990**	**0.985**	**0.980**	**0.981**	**0.971**	**0.963**
	Upper 95%	1.080	1.130	1.163	1.203	1.231	1.232	1.245
50	Lower 95%	0.908	0.857	0.822	0.790	0.765	0.738	0.710
	Median	**0.991**	**0.979**	**0.966**	**0.960**	**0.954**	**0.943**	**0.933**
	Upper 95%	1.083	1.117	1.147	1.151	1.185	1.195	1.203
75	Lower 95%	0.900	0.843	0.803	0.762	0.731	0.701	0.687
	Median	**0.986**	**0.967**	**0.945**	**0.938**	**0.926**	**0.907**	**0.891**
	Upper 95%	1.076	1.106	1.124	1.141	1.154	1.151	1.150
100	Lower 95%	0.898	0.840	0.801	0.763	0.724	0.694	0.664
	Median	**0.983**	**0.963**	**0.941**	**0.921**	**0.904**	**0.882**	**0.863**
	Upper 95%	1.073	1.096	1.120	1.102	1.116	1.114	1.102
125	Lower 95%	0.895	0.831	0.776	0.739	0.702	0.665	0.634
	Median	**0.980**	**0.952**	**0.923**	**0.902**	**0.878**	**0.850**	**0.824**
	Upper 95%	1.068	1.086	1.082	1.091	1.099	1.101	1.073
150	Lower 95%	0.891	0.825	0.770	0.734	0.696	0.649	0.612
	Median	**0.973**	**0.937**	**0.907**	**0.879**	**0.849**	**0.826**	**0.798**
	Upper 95%	1.065	1.074	1.065	1.062	1.048	1.047	1.020
175	Lower 95%	0.884	0.812	0.750	0.712	0.669	0.625	0.587
	Median	**0.968**	**0.929**	**0.890**	**0.860**	**0.829**	**0.795**	**0.762**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.055	1.066	1.058	1.044	1.033	1.021	1.004
200	Lower 95%	0.879	0.810	0.748	0.684	0.640	0.609	0.571
	Median	**0.963**	**0.919**	**0.880**	**0.842**	**0.809**	**0.772**	**0.735**
	Upper 95%	1.055	1.052	1.031	1.026	1.009	0.971	0.958
225	Lower 95%	0.883	0.800	0.735	0.665	0.627	0.585	0.536
	Median	**0.961**	**0.912**	**0.864**	**0.825**	**0.783**	**0.744**	**0.705**
	Upper 95%	1.047	1.039	1.030	0.999	0.972	0.955	0.922
250	Lower 95%	0.871	0.789	0.715	0.668	0.609	0.568	0.523
	Median	**0.957**	**0.905**	**0.853**	**0.806**	**0.764**	**0.722**	**0.680**
	Upper 95%	1.045	1.036	1.017	0.995	0.963	0.940	0.903
275	Lower 95%	0.870	0.781	0.714	0.654	0.592	0.548	0.513
	Median	**0.951**	**0.894**	**0.838**	**0.792**	**0.742**	**0.698**	**0.655**
	Upper 95%	1.041	1.020	0.994	0.948	0.930	0.892	0.847
300	Lower 95%	0.865	0.775	0.693	0.624	0.580	0.529	0.489
	Median	**0.948**	**0.884**	**0.825**	**0.774**	**0.724**	**0.677**	**0.632**
	Upper 95%	1.034	1.003	0.976	0.943	0.902	0.864	0.823
325	Lower 95%	0.858	0.753	0.675	0.608	0.556	0.510	0.467
	Median	**0.945**	**0.879**	**0.811**	**0.756**	**0.708**	**0.656**	**0.608**
	Upper 95%	1.031	1.007	0.969	0.934	0.883	0.829	0.792
350	Lower 95%	0.860	0.746	0.668	0.601	0.543	0.492	0.449
	Median	**0.941**	**0.867**	**0.799**	**0.739**	**0.685**	**0.631**	**0.584**
	Upper 95%	1.027	0.995	0.939	0.898	0.852	0.813	0.757
375	Lower 95%	0.854	0.750	0.664	0.592	0.531	0.475	0.430
	Median	**0.933**	**0.855**	**0.786**	**0.723**	**0.666**	**0.613**	**0.561**
	Upper 95%	1.019	0.971	0.933	0.877	0.825	0.781	0.724

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
400	Lower 95%	0.849	0.746	0.656	0.581	0.524	0.471	0.419
	Median	**0.930**	**0.853**	**0.776**	**0.711**	**0.651**	**0.594**	**0.544**
	Upper 95%	1.018	0.967	0.915	0.861	0.794	0.748	0.694
425	Lower 95%	0.845	0.737	0.653	0.571	0.509	0.458	0.407
	Median	**0.925**	**0.840**	**0.762**	**0.694**	**0.632**	**0.574**	**0.514**
	Upper 95%	1.012	0.964	0.893	0.844	0.790	0.734	0.675
450	Lower 95%	0.847	0.729	0.632	0.554	0.491	0.435	0.387
	Median	**0.920**	**0.829**	**0.747**	**0.677**	**0.610**	**0.552**	**0.498**
	Upper 95%	1.003	0.949	0.882	0.819	0.764	0.700	0.644
475	Lower 95%	0.839	0.721	0.627	0.545	0.477	0.422	0.366
	Median	**0.917**	**0.820**	**0.734**	**0.663**	**0.597**	**0.534**	**0.477**
	Upper 95%	1.003	0.942	0.878	0.809	0.745	0.674	0.617
500	Lower 95%	0.839	0.708	0.617	0.541	0.467	0.407	0.358
	Median	**0.913**	**0.814**	**0.729**	**0.654**	**0.582**	**0.519**	**0.462**
	Upper 95%	1.001	0.936	0.858	0.795	0.728	0.659	0.596

Table A2_1.3. Gannet, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	**Lower 95%**	**Median**	**Upper 95%**
0	1.000	1.000	1.000
25	0.999	0.999	0.999
50	0.998	0.998	0.998
75	0.997	0.997	0.997
100	0.995	0.995	0.996
125	0.994	0.994	0.994
150	0.993	0.993	0.993
175	0.992	0.992	0.992
200	0.991	0.991	0.991
225	0.990	0.990	0.990
250	0.989	0.989	0.989
275	0.987	0.988	0.988
300	0.986	0.986	0.987
325	0.985	0.985	0.985
350	0.984	0.984	0.984
375	0.983	0.983	0.983
400	0.982	0.982	0.982
425	0.981	0.981	0.981
450	0.979	0.980	0.980
475	0.978	0.979	0.979
500	0.977	0.977	0.978

Table A2_1.4. Gannet, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
25	0.991	0.999	1.007
50	0.990	0.998	1.006
75	0.988	0.997	1.005
100	0.988	0.996	1.003
125	0.986	0.994	1.003
150	0.985	0.993	1.001
175	0.984	0.992	1.001
200	0.983	0.991	0.999
225	0.981	0.990	0.998
250	0.981	0.989	0.997
275	0.980	0.988	0.996
300	0.979	0.987	0.995
325	0.978	0.985	0.994
350	0.976	0.984	0.992
375	0.975	0.983	0.991
400	0.974	0.982	0.990
425	0.973	0.981	0.989
450	0.972	0.980	0.987
475	0.970	0.979	0.986
500	0.970	0.978	0.986

Table A2_2.1. Gannet, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	Lower 95%	0.996	0.991	0.987	0.983	0.980	0.977	0.975
	Median	**0.996**	**0.991**	**0.987**	**0.984**	**0.981**	**0.978**	**0.976**
	Upper 95%	0.996	0.992	0.988	0.984	0.982	0.979	0.977
50	Lower 95%	0.991	0.982	0.974	0.967	0.961	0.955	0.950
	Median	**0.992**	**0.983**	**0.975**	**0.968**	**0.962**	**0.957**	**0.952**
	Upper 95%	0.992	0.983	0.975	0.969	0.964	0.959	0.955
75	Lower 95%	0.987	0.974	0.962	0.951	0.942	0.933	0.926
	Median	**0.988**	**0.974**	**0.963**	**0.952**	**0.944**	**0.936**	**0.929**
	Upper 95%	0.988	0.975	0.963	0.954	0.946	0.938	0.932
100	Lower 95%	0.983	0.965	0.949	0.935	0.923	0.912	0.902
	Median	**0.984**	**0.966**	**0.950**	**0.937**	**0.925**	**0.915**	**0.906**
	Upper 95%	0.984	0.966	0.951	0.939	0.928	0.918	0.910
125	Lower 95%	0.979	0.957	0.937	0.920	0.904	0.890	0.878
	Median	**0.979**	**0.957**	**0.938**	**0.922**	**0.907**	**0.894**	**0.883**
	Upper 95%	0.980	0.958	0.939	0.923	0.910	0.898	0.888
150	Lower 95%	0.975	0.948	0.925	0.904	0.886	0.869	0.855
	Median	**0.975**	**0.949**	**0.926**	**0.906**	**0.889**	**0.874**	**0.861**
	Upper 95%	0.976	0.950	0.927	0.909	0.892	0.879	0.867
175	Lower 95%	0.970	0.940	0.913	0.889	0.867	0.848	0.831
	Median	**0.971**	**0.940**	**0.914**	**0.891**	**0.871**	**0.854**	**0.838**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.972	0.941	0.915	0.894	0.875	0.859	0.845
	Lower 95%	0.966	0.931	0.900	0.874	0.849	0.828	0.809
200	**Median**	**0.967**	**0.932**	**0.902**	**0.876**	**0.854**	**0.834**	**0.817**
	Upper 95%	0.968	0.933	0.904	0.879	0.858	0.840	0.823
	Lower 95%	0.962	0.923	0.888	0.858	0.831	0.807	0.786
225	**Median**	**0.963**	**0.924**	**0.890**	**0.861**	**0.836**	**0.814**	**0.795**
	Upper 95%	0.964	0.925	0.892	0.864	0.841	0.820	0.803
	Lower 95%	0.958	0.914	0.877	0.844	0.814	0.788	0.765
250	**Median**	**0.959**	**0.916**	**0.879**	**0.847**	**0.819**	**0.795**	**0.774**
	Upper 95%	0.960	0.917	0.881	0.850	0.824	0.802	0.783
	Lower 95%	0.954	0.906	0.865	0.829	0.797	0.769	0.744
275	**Median**	**0.955**	**0.908**	**0.867**	**0.832**	**0.802**	**0.776**	**0.753**
	Upper 95%	0.956	0.909	0.869	0.836	0.808	0.783	0.762
	Lower 95%	0.950	0.898	0.853	0.814	0.779	0.749	0.722
300	**Median**	**0.951**	**0.899**	**0.856**	**0.818**	**0.785**	**0.757**	**0.732**
	Upper 95%	0.952	0.901	0.858	0.822	0.791	0.765	0.742
	Lower 95%	0.946	0.890	0.842	0.800	0.763	0.731	0.702
325	**Median**	**0.947**	**0.891**	**0.844**	**0.804**	**0.769**	**0.739**	**0.712**
	Upper 95%	0.948	0.893	0.847	0.808	0.776	0.747	0.723
	Lower 95%	0.941	0.882	0.830	0.785	0.746	0.711	0.681
350	**Median**	**0.943**	**0.883**	**0.833**	**0.790**	**0.753**	**0.720**	**0.692**
	Upper 95%	0.944	0.885	0.836	0.795	0.760	0.730	0.703
	Lower 95%	0.937	0.874	0.819	0.771	0.729	0.693	0.660
375	**Median**	**0.939**	**0.875**	**0.822**	**0.776**	**0.736**	**0.702**	**0.672**
	Upper 95%	0.940	0.877	0.824	0.781	0.743	0.711	0.683

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
400	Lower 95%	0.933	0.865	0.807	0.757	0.713	0.675	0.641
	Median	**0.935**	**0.867**	**0.811**	**0.762**	**0.721**	**0.685**	**0.653**
	Upper 95%	0.937	0.869	0.813	0.767	0.727	0.693	0.664
425	Lower 95%	0.929	0.858	0.796	0.744	0.698	0.657	0.621
	Median	**0.931**	**0.860**	**0.800**	**0.749**	**0.705**	**0.667**	**0.634**
	Upper 95%	0.933	0.861	0.803	0.754	0.713	0.677	0.647
450	Lower 95%	0.925	0.850	0.785	0.730	0.682	0.640	0.603
	Median	**0.927**	**0.852**	**0.789**	**0.735**	**0.689**	**0.650**	**0.615**
	Upper 95%	0.929	0.854	0.792	0.741	0.697	0.660	0.628
475	Lower 95%	0.921	0.842	0.775	0.717	0.666	0.622	0.583
	Median	**0.923**	**0.844**	**0.778**	**0.722**	**0.674**	**0.633**	**0.597**
	Upper 95%	0.925	0.846	0.781	0.727	0.682	0.643	0.609
500	Lower 95%	0.917	0.834	0.764	0.703	0.651	0.605	0.566
	Median	**0.919**	**0.836**	**0.767**	**0.709**	**0.659**	**0.616**	**0.578**
	Upper 95%	0.921	0.838	0.770	0.715	0.667	0.626	0.591

Table A2_2.2. Gannet, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	Lower 95%	0.919	0.892	0.870	0.860	0.847	0.839	0.835
	Median	**0.992**	**0.991**	**0.985**	**0.981**	**0.981**	**0.975**	**0.979**
	Upper 95%	1.068	1.094	1.120	1.122	1.132	1.130	1.134
50	Lower 95%	0.915	0.877	0.860	0.833	0.827	0.817	0.806
	Median	**0.991**	**0.982**	**0.972**	**0.965**	**0.964**	**0.960**	**0.955**
	Upper 95%	1.069	1.093	1.113	1.117	1.114	1.126	1.130
75	Lower 95%	0.916	0.883	0.846	0.836	0.821	0.805	0.789
	Median	**0.987**	**0.973**	**0.961**	**0.949**	**0.943**	**0.937**	**0.933**
	Upper 95%	1.067	1.078	1.087	1.094	1.101	1.096	1.094
100	Lower 95%	0.908	0.865	0.836	0.811	0.792	0.787	0.770
	Median	**0.982**	**0.963**	**0.949**	**0.940**	**0.926**	**0.916**	**0.913**
	Upper 95%	1.065	1.077	1.083	1.076	1.077	1.073	1.068
125	Lower 95%	0.907	0.858	0.823	0.801	0.784	0.767	0.756
	Median	**0.978**	**0.955**	**0.939**	**0.925**	**0.913**	**0.900**	**0.890**
	Upper 95%	1.053	1.059	1.063	1.051	1.048	1.054	1.039
150	Lower 95%	0.908	0.854	0.816	0.793	0.769	0.750	0.734
	Median	**0.975**	**0.948**	**0.926**	**0.906**	**0.890**	**0.874**	**0.861**
	Upper 95%	1.045	1.053	1.047	1.040	1.024	1.022	1.011
175	Lower 95%	0.898	0.838	0.807	0.774	0.749	0.734	0.712
	Median	**0.972**	**0.942**	**0.912**	**0.888**	**0.871**	**0.851**	**0.835**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.049	1.044	1.044	1.028	1.019	1.010	0.986
200	Lower 95%	0.901	0.839	0.796	0.759	0.730	0.714	0.699
	Median	**0.967**	**0.932**	**0.904**	**0.877**	**0.856**	**0.836**	**0.817**
	Upper 95%	1.042	1.034	1.030	1.008	0.998	0.979	0.968
225	Lower 95%	0.891	0.831	0.782	0.745	0.719	0.691	0.669
	Median	**0.959**	**0.921**	**0.888**	**0.859**	**0.834**	**0.814**	**0.791**
	Upper 95%	1.041	1.028	1.007	0.978	0.963	0.959	0.948
250	Lower 95%	0.886	0.814	0.771	0.733	0.702	0.681	0.654
	Median	**0.953**	**0.913**	**0.876**	**0.848**	**0.818**	**0.797**	**0.775**
	Upper 95%	1.040	1.019	0.997	0.973	0.964	0.953	0.924
275	Lower 95%	0.881	0.817	0.763	0.724	0.699	0.668	0.636
	Median	**0.953**	**0.905**	**0.868**	**0.833**	**0.805**	**0.777**	**0.753**
	Upper 95%	1.030	1.009	0.979	0.957	0.932	0.909	0.885
300	Lower 95%	0.883	0.807	0.751	0.700	0.675	0.643	0.620
	Median	**0.949**	**0.899**	**0.852**	**0.817**	**0.783**	**0.756**	**0.730**
	Upper 95%	1.023	0.997	0.975	0.940	0.916	0.889	0.861
325	Lower 95%	0.878	0.804	0.749	0.699	0.667	0.638	0.602
	Median	**0.946**	**0.892**	**0.846**	**0.803**	**0.771**	**0.742**	**0.715**
	Upper 95%	1.018	0.986	0.953	0.918	0.899	0.863	0.845
350	Lower 95%	0.877	0.792	0.732	0.682	0.641	0.621	0.582
	Median	**0.942**	**0.881**	**0.832**	**0.789**	**0.753**	**0.721**	**0.691**
	Upper 95%	1.018	0.989	0.954	0.913	0.889	0.855	0.820
375	Lower 95%	0.869	0.789	0.721	0.668	0.633	0.597	0.572
	Median	**0.937**	**0.871**	**0.819**	**0.774**	**0.736**	**0.704**	**0.672**
	Upper 95%	1.016	0.966	0.931	0.888	0.849	0.820	0.786

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
400	Lower 95%	0.863	0.777	0.713	0.658	0.617	0.584	0.555
	Median	**0.933**	**0.865**	**0.806**	**0.761**	**0.723**	**0.686**	**0.654**
	Upper 95%	1.003	0.960	0.924	0.875	0.848	0.808	0.770
425	Lower 95%	0.862	0.773	0.700	0.646	0.612	0.574	0.535
	Median	**0.930**	**0.861**	**0.800**	**0.748**	**0.707**	**0.666**	**0.636**
	Upper 95%	1.004	0.950	0.913	0.876	0.833	0.793	0.751
450	Lower 95%	0.860	0.764	0.692	0.634	0.592	0.557	0.519
	Median	**0.925**	**0.850**	**0.786**	**0.735**	**0.692**	**0.650**	**0.617**
	Upper 95%	0.997	0.943	0.898	0.853	0.808	0.772	0.736
475	Lower 95%	0.852	0.757	0.687	0.623	0.576	0.536	0.503
	Median	**0.922**	**0.841**	**0.777**	**0.722**	**0.675**	**0.634**	**0.599**
	Upper 95%	0.992	0.933	0.883	0.828	0.782	0.745	0.708
500	Lower 95%	0.849	0.744	0.665	0.612	0.557	0.521	0.487
	Median	**0.917**	**0.834**	**0.766**	**0.708**	**0.659**	**0.616**	**0.580**
	Upper 95%	0.993	0.924	0.869	0.812	0.769	0.721	0.684

Table A2_2.3. Gannet, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	**Lower 95%**	**Median**	**Upper 95%**
0	1.000	1.000	1.000
25	0.999	0.999	0.999
50	0.999	0.999	0.999
75	0.998	0.998	0.998
100	0.997	0.997	0.997
125	0.996	0.997	0.997
150	0.996	0.996	0.996
175	0.995	0.995	0.995
200	0.994	0.994	0.995
225	0.993	0.994	0.994
250	0.992	0.993	0.993
275	0.992	0.992	0.993
300	0.991	0.991	0.992
325	0.990	0.991	0.991
350	0.989	0.990	0.990
375	0.988	0.989	0.989
400	0.987	0.988	0.989
425	0.987	0.987	0.988
450	0.986	0.986	0.987
475	0.985	0.986	0.986
500	0.984	0.985	0.985

Table A2_2.4. Gannet, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	**Lower 95%**	**Median**	**Upper 95%**
0	1.000	1.000	1.000
25	0.994	0.999	1.005
50	0.993	0.999	1.004
75	0.993	0.998	1.003
100	0.992	0.997	1.003
125	0.991	0.997	1.002
150	0.991	0.996	1.001
175	0.989	0.995	1.001
200	0.989	0.994	1.000
225	0.988	0.994	0.999
250	0.988	0.993	0.999
275	0.986	0.992	0.997
300	0.986	0.991	0.997
325	0.985	0.991	0.996
350	0.984	0.990	0.996
375	0.984	0.989	0.994
400	0.982	0.988	0.994
425	0.982	0.987	0.993
450	0.981	0.987	0.992
475	0.980	0.986	0.991
500	0.979	0.985	0.990

Table A2_3.1. Gannet, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	Lower 95%	0.995	0.990	0.984	0.978	0.973	0.967	0.962
	Median	**0.995**	**0.990**	**0.984**	**0.979**	**0.973**	**0.968**	**0.962**
	Upper 95%	0.996	0.990	0.985	0.979	0.974	0.968	0.963
50	Lower 95%	0.991	0.979	0.968	0.957	0.946	0.936	0.925
	Median	**0.991**	**0.980**	**0.969**	**0.958**	**0.947**	**0.936**	**0.926**
	Upper 95%	0.991	0.980	0.969	0.959	0.948	0.937	0.927
75	Lower 95%	0.986	0.969	0.953	0.937	0.921	0.905	0.890
	Median	**0.987**	**0.970**	**0.954**	**0.937**	**0.922**	**0.906**	**0.891**
	Upper 95%	0.987	0.970	0.954	0.938	0.923	0.907	0.892
100	Lower 95%	0.981	0.959	0.938	0.916	0.896	0.876	0.856
	Median	**0.982**	**0.960**	**0.939**	**0.917**	**0.897**	**0.877**	**0.857**
	Upper 95%	0.983	0.961	0.940	0.919	0.898	0.878	0.858
125	Lower 95%	0.977	0.949	0.922	0.896	0.871	0.847	0.823
	Median	**0.978**	**0.950**	**0.924**	**0.898**	**0.873**	**0.848**	**0.825**
	Upper 95%	0.978	0.951	0.925	0.899	0.874	0.850	0.826
150	Lower 95%	0.972	0.939	0.908	0.877	0.848	0.819	0.792
	Median	**0.973**	**0.941**	**0.909**	**0.879**	**0.849**	**0.821**	**0.793**
	Upper 95%	0.974	0.942	0.910	0.880	0.851	0.823	0.795
175	Lower 95%	0.968	0.930	0.893	0.858	0.824	0.792	0.761
	Median	**0.969**	**0.931**	**0.895**	**0.860**	**0.826**	**0.794**	**0.763**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.970	0.932	0.896	0.862	0.828	0.796	0.765
200	Lower 95%	0.963	0.920	0.879	0.839	0.802	0.766	0.732
	Median	**0.964**	**0.922**	**0.881**	**0.841**	**0.804**	**0.768**	**0.734**
	Upper 95%	0.965	0.923	0.882	0.844	0.806	0.771	0.737
225	Lower 95%	0.959	0.910	0.865	0.821	0.780	0.741	0.704
	Median	**0.960**	**0.912**	**0.867**	**0.823**	**0.782**	**0.743**	**0.706**
	Upper 95%	0.961	0.914	0.869	0.826	0.785	0.746	0.709
250	Lower 95%	0.954	0.901	0.851	0.803	0.759	0.716	0.677
	Median	**0.956**	**0.903**	**0.853**	**0.806**	**0.761**	**0.719**	**0.679**
	Upper 95%	0.957	0.905	0.855	0.808	0.764	0.722	0.682
275	Lower 95%	0.950	0.891	0.837	0.786	0.738	0.693	0.651
	Median	**0.951**	**0.893**	**0.839**	**0.788**	**0.741**	**0.696**	**0.654**
	Upper 95%	0.953	0.896	0.842	0.791	0.743	0.698	0.656
300	Lower 95%	0.945	0.882	0.823	0.769	0.718	0.670	0.626
	Median	**0.947**	**0.884**	**0.826**	**0.771**	**0.721**	**0.673**	**0.629**
	Upper 95%	0.948	0.887	0.829	0.774	0.723	0.676	0.632
325	Lower 95%	0.941	0.873	0.810	0.752	0.698	0.648	0.602
	Median	**0.943**	**0.875**	**0.813**	**0.755**	**0.701**	**0.651**	**0.605**
	Upper 95%	0.944	0.878	0.815	0.758	0.704	0.654	0.608
350	Lower 95%	0.936	0.864	0.797	0.736	0.679	0.627	0.578
	Median	**0.938**	**0.866**	**0.800**	**0.739**	**0.682**	**0.630**	**0.581**
	Upper 95%	0.940	0.869	0.803	0.742	0.685	0.633	0.585
375	Lower 95%	0.932	0.855	0.784	0.719	0.660	0.605	0.555
	Median	**0.934**	**0.857**	**0.787**	**0.723**	**0.663**	**0.609**	**0.559**
	Upper 95%	0.936	0.860	0.790	0.726	0.667	0.613	0.563

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
400	Lower 95%	0.927	0.846	0.771	0.704	0.642	0.586	0.534
	Median	**0.930**	**0.848**	**0.774**	**0.707**	**0.645**	**0.589**	**0.538**
	Upper 95%	0.932	0.851	0.778	0.710	0.649	0.593	0.541
425	Lower 95%	0.923	0.837	0.759	0.688	0.624	0.566	0.513
	Median	**0.925**	**0.840**	**0.762**	**0.691**	**0.628**	**0.570**	**0.517**
	Upper 95%	0.928	0.843	0.765	0.695	0.631	0.573	0.520
450	Lower 95%	0.919	0.828	0.746	0.673	0.607	0.547	0.494
	Median	**0.921**	**0.831**	**0.750**	**0.677**	**0.611**	**0.551**	**0.497**
	Upper 95%	0.924	0.834	0.753	0.680	0.614	0.555	0.501
475	Lower 95%	0.914	0.819	0.734	0.658	0.590	0.529	0.474
	Median	**0.917**	**0.822**	**0.738**	**0.662**	**0.594**	**0.533**	**0.478**
	Upper 95%	0.919	0.826	0.742	0.666	0.598	0.537	0.482
500	Lower 95%	0.910	0.811	0.723	0.644	0.574	0.511	0.456
	Median	**0.913**	**0.814**	**0.726**	**0.648**	**0.578**	**0.515**	**0.460**
	Upper 95%	0.915	0.817	0.729	0.652	0.581	0.519	0.463

Table A2_3.2. Gannet, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	Lower 95%	0.910	0.866	0.827	0.805	0.783	0.762	0.740
	Median	**0.994**	**0.992**	**0.983**	**0.982**	**0.974**	**0.971**	**0.964**
	Upper 95%	1.093	1.134	1.171	1.197	1.214	1.242	1.257
50	Lower 95%	0.907	0.846	0.807	0.786	0.766	0.733	0.714
	Median	**0.989**	**0.980**	**0.962**	**0.957**	**0.951**	**0.937**	**0.928**
	Upper 95%	1.089	1.127	1.146	1.177	1.198	1.214	1.211
75	Lower 95%	0.904	0.854	0.807	0.767	0.739	0.707	0.685
	Median	**0.988**	**0.973**	**0.955**	**0.939**	**0.929**	**0.911**	**0.895**
	Upper 95%	1.082	1.109	1.123	1.142	1.132	1.152	1.166
100	Lower 95%	0.894	0.835	0.802	0.756	0.714	0.685	0.656
	Median	**0.982**	**0.962**	**0.935**	**0.924**	**0.905**	**0.888**	**0.866**
	Upper 95%	1.079	1.105	1.120	1.132	1.141	1.136	1.122
125	Lower 95%	0.888	0.822	0.780	0.740	0.712	0.665	0.628
	Median	**0.979**	**0.951**	**0.924**	**0.902**	**0.879**	**0.854**	**0.836**
	Upper 95%	1.079	1.098	1.088	1.103	1.100	1.111	1.107
150	Lower 95%	0.890	0.824	0.768	0.719	0.682	0.645	0.614
	Median	**0.977**	**0.946**	**0.910**	**0.885**	**0.856**	**0.825**	**0.803**
	Upper 95%	1.073	1.087	1.067	1.070	1.054	1.042	1.022
175	Lower 95%	0.882	0.809	0.755	0.708	0.655	0.621	0.588
	Median	**0.969**	**0.933**	**0.896**	**0.865**	**0.830**	**0.796**	**0.764**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.068	1.067	1.066	1.052	1.036	1.025	0.997
200	Lower 95%	0.876	0.801	0.745	0.697	0.654	0.612	0.569
	Median	**0.968**	**0.922**	**0.880**	**0.841**	**0.808**	**0.774**	**0.737**
	Upper 95%	1.062	1.064	1.053	1.030	0.998	0.986	0.968
225	Lower 95%	0.873	0.795	0.742	0.684	0.635	0.588	0.552
	Median	**0.962**	**0.914**	**0.863**	**0.824**	**0.785**	**0.749**	**0.707**
	Upper 95%	1.058	1.046	1.027	1.003	0.967	0.941	0.914
250	Lower 95%	0.871	0.786	0.719	0.664	0.612	0.562	0.520
	Median	**0.954**	**0.904**	**0.853**	**0.806**	**0.765**	**0.722**	**0.682**
	Upper 95%	1.047	1.045	1.005	0.975	0.955	0.943	0.904
275	Lower 95%	0.863	0.779	0.709	0.643	0.593	0.545	0.501
	Median	**0.953**	**0.896**	**0.840**	**0.789**	**0.742**	**0.696**	**0.653**
	Upper 95%	1.047	1.026	0.994	0.973	0.928	0.879	0.843
300	Lower 95%	0.863	0.778	0.699	0.642	0.585	0.536	0.487
	Median	**0.949**	**0.888**	**0.825**	**0.773**	**0.723**	**0.679**	**0.629**
	Upper 95%	1.045	1.019	0.979	0.936	0.894	0.872	0.830
325	Lower 95%	0.861	0.768	0.689	0.624	0.568	0.507	0.466
	Median	**0.942**	**0.876**	**0.813**	**0.757**	**0.705**	**0.653**	**0.606**
	Upper 95%	1.033	1.014	0.968	0.926	0.897	0.833	0.798
350	Lower 95%	0.856	0.757	0.679	0.606	0.550	0.493	0.443
	Median	**0.943**	**0.871**	**0.801**	**0.743**	**0.685**	**0.635**	**0.586**
	Upper 95%	1.032	1.002	0.950	0.904	0.844	0.801	0.747
375	Lower 95%	0.851	0.745	0.667	0.596	0.536	0.479	0.427
	Median	**0.934**	**0.859**	**0.787**	**0.724**	**0.662**	**0.612**	**0.562**
	Upper 95%	1.023	0.987	0.939	0.876	0.829	0.796	0.734

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
400	Lower 95%	0.849	0.736	0.655	0.584	0.521	0.465	0.415
	Median	**0.931**	**0.851**	**0.774**	**0.707**	**0.644**	**0.585**	**0.532**
	Upper 95%	1.022	0.980	0.924	0.861	0.812	0.761	0.707
425	Lower 95%	0.847	0.728	0.647	0.573	0.502	0.445	0.397
	Median	**0.928**	**0.845**	**0.766**	**0.696**	**0.632**	**0.576**	**0.521**
	Upper 95%	1.020	0.975	0.912	0.857	0.797	0.744	0.682
450	Lower 95%	0.834	0.727	0.633	0.552	0.488	0.430	0.384
	Median	**0.923**	**0.836**	**0.751**	**0.680**	**0.614**	**0.555**	**0.499**
	Upper 95%	1.005	0.951	0.879	0.820	0.766	0.708	0.650
475	Lower 95%	0.834	0.723	0.621	0.546	0.480	0.423	0.367
	Median	**0.918**	**0.826**	**0.740**	**0.665**	**0.597**	**0.537**	**0.482**
	Upper 95%	1.010	0.947	0.873	0.804	0.736	0.673	0.611
500	Lower 95%	0.833	0.716	0.619	0.539	0.473	0.407	0.357
	Median	**0.912**	**0.816**	**0.728**	**0.649**	**0.582**	**0.519**	**0.462**
	Upper 95%	1.010	0.935	0.853	0.788	0.717	0.661	0.601

Table A2_3.3. Gannet, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
25	0.999	0.999	0.999
50	0.998	0.998	0.998
75	0.997	0.997	0.997
100	0.995	0.995	0.996
125	0.994	0.994	0.994
150	0.993	0.993	0.993
175	0.992	0.992	0.992
200	0.991	0.991	0.991
225	0.990	0.990	0.990
250	0.989	0.989	0.989
275	0.987	0.988	0.988
300	0.986	0.986	0.987
325	0.985	0.985	0.985
350	0.984	0.984	0.984
375	0.983	0.983	0.983
400	0.982	0.982	0.982
425	0.981	0.981	0.981
450	0.979	0.980	0.980
475	0.978	0.979	0.979
500	0.977	0.977	0.978

Table A2_3.4. Gannet, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
25	0.991	0.999	1.007
50	0.990	0.998	1.007
75	0.988	0.997	1.005
100	0.986	0.996	1.004
125	0.986	0.995	1.003
150	0.985	0.993	1.001
175	0.984	0.992	1.000
200	0.983	0.991	1.000
225	0.982	0.990	0.998
250	0.980	0.989	0.997
275	0.980	0.988	0.995
300	0.979	0.986	0.995
325	0.977	0.985	0.993
350	0.976	0.984	0.992
375	0.975	0.983	0.991
400	0.974	0.982	0.990
425	0.973	0.981	0.989
450	0.972	0.980	0.987
475	0.970	0.979	0.986
500	0.969	0.978	0.985

Table A2_4.1. Gannet, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	Lower 95%	0.996	0.991	0.987	0.984	0.980	0.978	0.975
	Median	**0.996**	**0.991**	**0.987**	**0.984**	**0.981**	**0.978**	**0.976**
	Upper 95%	0.996	0.992	0.988	0.985	0.982	0.979	0.977
50	Lower 95%	0.991	0.982	0.974	0.967	0.961	0.955	0.950
	Median	**0.992**	**0.983**	**0.975**	**0.968**	**0.962**	**0.957**	**0.952**
	Upper 95%	0.992	0.983	0.975	0.969	0.963	0.959	0.955
75	Lower 95%	0.987	0.974	0.962	0.951	0.942	0.933	0.926
	Median	**0.988**	**0.974**	**0.962**	**0.952**	**0.943**	**0.936**	**0.929**
	Upper 95%	0.988	0.975	0.963	0.954	0.945	0.938	0.932
100	Lower 95%	0.983	0.965	0.949	0.935	0.923	0.912	0.902
	Median	**0.983**	**0.966**	**0.950**	**0.937**	**0.925**	**0.915**	**0.906**
	Upper 95%	0.984	0.966	0.951	0.938	0.927	0.918	0.910
125	Lower 95%	0.979	0.957	0.937	0.919	0.904	0.890	0.878
	Median	**0.979**	**0.957**	**0.938**	**0.921**	**0.907**	**0.894**	**0.883**
	Upper 95%	0.980	0.958	0.939	0.923	0.910	0.898	0.888
150	Lower 95%	0.975	0.948	0.925	0.904	0.885	0.869	0.854
	Median	**0.975**	**0.949**	**0.926**	**0.906**	**0.889**	**0.874**	**0.861**
	Upper 95%	0.976	0.949	0.927	0.909	0.892	0.878	0.866
175	Lower 95%	0.970	0.940	0.912	0.888	0.867	0.848	0.831
	Median	**0.971**	**0.940**	**0.914**	**0.891**	**0.871**	**0.853**	**0.838**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.972	0.941	0.915	0.893	0.875	0.859	0.844
200	Lower 95%	0.966	0.931	0.900	0.873	0.849	0.828	0.809
	Median	**0.967**	**0.932**	**0.902**	**0.876**	**0.853**	**0.834**	**0.816**
	Upper 95%	0.968	0.933	0.904	0.879	0.857	0.839	0.823
225	Lower 95%	0.962	0.923	0.888	0.858	0.831	0.807	0.786
	Median	**0.963**	**0.924**	**0.890**	**0.861**	**0.836**	**0.814**	**0.794**
	Upper 95%	0.964	0.925	0.892	0.864	0.841	0.821	0.803
250	Lower 95%	0.958	0.914	0.876	0.843	0.813	0.787	0.764
	Median	**0.959**	**0.916**	**0.878**	**0.847**	**0.819**	**0.795**	**0.773**
	Upper 95%	0.960	0.917	0.880	0.850	0.824	0.802	0.783
275	Lower 95%	0.954	0.906	0.865	0.828	0.796	0.768	0.742
	Median	**0.955**	**0.907**	**0.867**	**0.832**	**0.802**	**0.775**	**0.752**
	Upper 95%	0.956	0.909	0.869	0.836	0.807	0.783	0.761
300	Lower 95%	0.950	0.898	0.853	0.813	0.779	0.748	0.721
	Median	**0.951**	**0.899**	**0.855**	**0.818**	**0.785**	**0.757**	**0.732**
	Upper 95%	0.952	0.900	0.858	0.822	0.791	0.764	0.741
325	Lower 95%	0.946	0.890	0.842	0.799	0.762	0.729	0.701
	Median	**0.947**	**0.891**	**0.844**	**0.803**	**0.768**	**0.738**	**0.711**
	Upper 95%	0.948	0.893	0.846	0.808	0.775	0.747	0.722
350	Lower 95%	0.941	0.882	0.830	0.785	0.746	0.711	0.680
	Median	**0.943**	**0.883**	**0.833**	**0.790**	**0.752**	**0.720**	**0.691**
	Upper 95%	0.944	0.884	0.835	0.794	0.758	0.728	0.702
375	Lower 95%	0.937	0.873	0.818	0.771	0.729	0.692	0.659
	Median	**0.939**	**0.875**	**0.821**	**0.776**	**0.736**	**0.702**	**0.672**
	Upper 95%	0.941	0.877	0.824	0.780	0.743	0.710	0.683

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
400	Lower 95%	0.933	0.865	0.807	0.757	0.713	0.674	0.640
	Median	**0.935**	**0.867**	**0.810**	**0.762**	**0.720**	**0.684**	**0.652**
	Upper 95%	0.937	0.869	0.813	0.767	0.728	0.694	0.665
425	Lower 95%	0.929	0.857	0.796	0.743	0.697	0.656	0.621
	Median	**0.931**	**0.859**	**0.799**	**0.748**	**0.704**	**0.666**	**0.633**
	Upper 95%	0.933	0.861	0.802	0.754	0.713	0.677	0.646
450	Lower 95%	0.925	0.850	0.785	0.730	0.682	0.640	0.602
	Median	**0.927**	**0.851**	**0.788**	**0.735**	**0.689**	**0.649**	**0.614**
	Upper 95%	0.929	0.853	0.792	0.740	0.697	0.659	0.626
475	Lower 95%	0.921	0.842	0.774	0.716	0.666	0.622	0.584
	Median	**0.923**	**0.844**	**0.777**	**0.721**	**0.673**	**0.632**	**0.596**
	Upper 95%	0.925	0.845	0.781	0.727	0.682	0.643	0.610
500	Lower 95%	0.917	0.834	0.763	0.703	0.650	0.605	0.566
	Median	**0.919**	**0.836**	**0.767**	**0.708**	**0.659**	**0.615**	**0.578**
	Upper 95%	0.921	0.838	0.770	0.714	0.667	0.626	0.591

Table A2_4.2. Gannet, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
25	Lower 95%	0.920	0.890	0.874	0.857	0.850	0.842	0.833
	Median	**0.994**	**0.993**	**0.984**	**0.983**	**0.978**	**0.974**	**0.975**
	Upper 95%	1.068	1.108	1.118	1.122	1.130	1.142	1.145
50	Lower 95%	0.917	0.887	0.862	0.845	0.825	0.813	0.808
	Median	**0.991**	**0.981**	**0.971**	**0.970**	**0.959**	**0.957**	**0.950**
	Upper 95%	1.070	1.091	1.104	1.108	1.106	1.111	1.107
75	Lower 95%	0.920	0.879	0.852	0.832	0.807	0.795	0.802
	Median	**0.984**	**0.972**	**0.957**	**0.949**	**0.940**	**0.933**	**0.927**
	Upper 95%	1.060	1.083	1.087	1.090	1.092	1.085	1.086
100	Lower 95%	0.908	0.867	0.838	0.812	0.799	0.789	0.784
	Median	**0.981**	**0.968**	**0.949**	**0.937**	**0.922**	**0.909**	**0.904**
	Upper 95%	1.060	1.072	1.071	1.069	1.058	1.057	1.058
125	Lower 95%	0.910	0.862	0.828	0.810	0.783	0.766	0.754
	Median	**0.976**	**0.956**	**0.939**	**0.923**	**0.906**	**0.894**	**0.881**
	Upper 95%	1.057	1.065	1.061	1.049	1.045	1.035	1.027
150	Lower 95%	0.903	0.846	0.817	0.787	0.770	0.749	0.727
	Median	**0.973**	**0.949**	**0.925**	**0.906**	**0.883**	**0.871**	**0.861**
	Upper 95%	1.047	1.055	1.052	1.045	1.035	1.016	1.009
175	Lower 95%	0.897	0.845	0.806	0.770	0.751	0.722	0.709
	Median	**0.968**	**0.937**	**0.913**	**0.891**	**0.870**	**0.849**	**0.834**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.042	1.040	1.030	1.009	1.002	0.998	0.975
200	Lower 95%	0.898	0.837	0.799	0.761	0.737	0.705	0.692
	Median	**0.967**	**0.930**	**0.899**	**0.875**	**0.850**	**0.834**	**0.815**
	Upper 95%	1.039	1.031	1.013	0.996	0.976	0.968	0.954
225	Lower 95%	0.889	0.828	0.786	0.748	0.714	0.689	0.678
	Median	**0.964**	**0.925**	**0.889**	**0.862**	**0.834**	**0.810**	**0.792**
	Upper 95%	1.037	1.032	1.013	0.985	0.971	0.953	0.934
250	Lower 95%	0.888	0.822	0.772	0.735	0.706	0.680	0.659
	Median	**0.959**	**0.919**	**0.879**	**0.847**	**0.816**	**0.795**	**0.774**
	Upper 95%	1.034	1.017	0.991	0.976	0.955	0.934	0.914
275	Lower 95%	0.885	0.812	0.758	0.716	0.688	0.657	0.640
	Median	**0.954**	**0.907**	**0.865**	**0.829**	**0.799**	**0.770**	**0.749**
	Upper 95%	1.024	1.008	0.985	0.957	0.931	0.903	0.882
300	Lower 95%	0.884	0.808	0.744	0.711	0.677	0.647	0.620
	Median	**0.950**	**0.902**	**0.856**	**0.818**	**0.783**	**0.755**	**0.733**
	Upper 95%	1.028	1.006	0.972	0.944	0.917	0.886	0.856
325	Lower 95%	0.875	0.804	0.746	0.703	0.661	0.619	0.595
	Median	**0.948**	**0.891**	**0.842**	**0.805**	**0.767**	**0.736**	**0.711**
	Upper 95%	1.014	0.996	0.957	0.915	0.892	0.862	0.832
350	Lower 95%	0.874	0.797	0.741	0.693	0.646	0.619	0.584
	Median	**0.944**	**0.885**	**0.833**	**0.791**	**0.753**	**0.719**	**0.689**
	Upper 95%	1.014	0.986	0.944	0.899	0.878	0.847	0.813
375	Lower 95%	0.872	0.783	0.717	0.668	0.630	0.590	0.565
	Median	**0.939**	**0.875**	**0.821**	**0.777**	**0.738**	**0.705**	**0.672**
	Upper 95%	1.009	0.976	0.937	0.884	0.853	0.816	0.788

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
400	Lower 95%	0.861	0.772	0.709	0.658	0.615	0.585	0.554
	Median	**0.933**	**0.868**	**0.807**	**0.760**	**0.719**	**0.684**	**0.650**
	Upper 95%	1.002	0.970	0.923	0.873	0.834	0.804	0.764
425	Lower 95%	0.865	0.774	0.705	0.653	0.603	0.564	0.530
	Median	**0.928**	**0.859**	**0.797**	**0.748**	**0.703**	**0.664**	**0.633**
	Upper 95%	1.007	0.960	0.907	0.863	0.824	0.786	0.754
450	Lower 95%	0.859	0.761	0.694	0.641	0.592	0.550	0.525
	Median	**0.925**	**0.852**	**0.785**	**0.734**	**0.685**	**0.647**	**0.611**
	Upper 95%	0.997	0.956	0.902	0.840	0.808	0.763	0.734
475	Lower 95%	0.854	0.754	0.687	0.621	0.572	0.535	0.505
	Median	**0.921**	**0.842**	**0.773**	**0.718**	**0.670**	**0.628**	**0.594**
	Upper 95%	0.994	0.940	0.882	0.833	0.782	0.738	0.699
500	Lower 95%	0.852	0.754	0.674	0.611	0.562	0.522	0.491
	Median	**0.919**	**0.835**	**0.763**	**0.707**	**0.657**	**0.613**	**0.574**
	Upper 95%	0.990	0.928	0.861	0.812	0.766	0.726	0.685

Table A2_4.3. Gannet, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
25	0.999	0.999	0.999
50	0.999	0.999	0.999
75	0.998	0.998	0.998
100	0.997	0.997	0.997
125	0.996	0.997	0.997
150	0.996	0.996	0.996
175	0.995	0.995	0.995
200	0.994	0.994	0.995
225	0.993	0.994	0.994
250	0.992	0.993	0.993
275	0.992	0.992	0.992
300	0.991	0.991	0.992
325	0.990	0.990	0.991
350	0.989	0.990	0.990
375	0.988	0.989	0.989
400	0.987	0.988	0.989
425	0.987	0.987	0.988
450	0.986	0.986	0.987
475	0.985	0.986	0.986
500	0.984	0.985	0.985

Table A2_4.4. Gannet, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
25	0.994	0.999	1.004
50	0.993	0.999	1.004
75	0.992	0.998	1.004
100	0.992	0.997	1.002
125	0.991	0.997	1.002
150	0.990	0.996	1.001
175	0.990	0.995	1.000
200	0.989	0.994	1.000
225	0.988	0.994	0.999
250	0.987	0.993	0.998
275	0.987	0.992	0.998
300	0.986	0.991	0.997
325	0.985	0.990	0.996
350	0.984	0.990	0.995
375	0.984	0.989	0.994
400	0.982	0.988	0.994
425	0.982	0.987	0.993
450	0.981	0.986	0.992
475	0.980	0.985	0.991
500	0.979	0.985	0.990

Table A2_5.1. Kittiwake, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	Estimate	yr.5	yr.10	yr.15	yr.20	yr.25	yr.30	yr.35
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.998	0.995	0.992	0.989	0.986	0.984	0.981
	Median	**0.998**	**0.995**	**0.992**	**0.989**	**0.987**	**0.984**	**0.981**
	Upper 95%	0.998	0.995	0.992	0.990	0.987	0.984	0.981
100	Lower 95%	0.995	0.990	0.984	0.978	0.973	0.967	0.962
	Median	**0.996**	**0.990**	**0.984**	**0.979**	**0.973**	**0.968**	**0.962**
	Upper 95%	0.996	0.990	0.985	0.979	0.974	0.968	0.963
150	Lower 95%	0.993	0.984	0.976	0.968	0.960	0.951	0.943
	Median	**0.993**	**0.985**	**0.977**	**0.968**	**0.960**	**0.952**	**0.944**
	Upper 95%	0.994	0.985	0.977	0.969	0.961	0.953	0.945
200	Lower 95%	0.991	0.979	0.968	0.957	0.947	0.936	0.925
	Median	**0.991**	**0.980**	**0.969**	**0.958**	**0.947**	**0.937**	**0.926**
	Upper 95%	0.991	0.981	0.970	0.959	0.948	0.938	0.927
250	Lower 95%	0.988	0.974	0.960	0.947	0.934	0.920	0.907
	Median	**0.989**	**0.975**	**0.961**	**0.948**	**0.935**	**0.922**	**0.909**
	Upper 95%	0.989	0.976	0.962	0.949	0.936	0.923	0.910
300	Lower 95%	0.986	0.969	0.953	0.937	0.921	0.905	0.890
	Median	**0.987**	**0.970**	**0.954**	**0.938**	**0.922**	**0.907**	**0.892**
	Upper 95%	0.987	0.971	0.955	0.939	0.923	0.908	0.893
350	Lower 95%	0.984	0.964	0.945	0.926	0.908	0.890	0.873
	Median	**0.984**	**0.965**	**0.946**	**0.928**	**0.910**	**0.892**	**0.875**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.985	0.966	0.948	0.929	0.911	0.894	0.876
400	Lower 95%	0.981	0.959	0.937	0.916	0.896	0.876	0.856
	Median	**0.982**	**0.960**	**0.939**	**0.918**	**0.898**	**0.878**	**0.858**
	Upper 95%	0.983	0.961	0.940	0.920	0.899	0.879	0.860
450	Lower 95%	0.979	0.954	0.930	0.907	0.884	0.861	0.840
	Median	**0.980**	**0.955**	**0.932**	**0.908**	**0.885**	**0.863**	**0.842**
	Upper 95%	0.981	0.957	0.933	0.910	0.887	0.865	0.844
500	Lower 95%	0.977	0.949	0.922	0.897	0.871	0.847	0.823
	Median	**0.978**	**0.951**	**0.924**	**0.899**	**0.874**	**0.849**	**0.826**
	Upper 95%	0.979	0.952	0.926	0.900	0.876	0.852	0.828
550	Lower 95%	0.974	0.944	0.915	0.887	0.859	0.833	0.807
	Median	**0.975**	**0.946**	**0.917**	**0.889**	**0.862**	**0.835**	**0.810**
	Upper 95%	0.977	0.947	0.919	0.891	0.864	0.838	0.813
600	Lower 95%	0.972	0.939	0.908	0.877	0.848	0.819	0.792
	Median	**0.973**	**0.941**	**0.910**	**0.879**	**0.850**	**0.822**	**0.795**
	Upper 95%	0.974	0.943	0.912	0.882	0.853	0.825	0.797
650	Lower 95%	0.970	0.934	0.900	0.868	0.836	0.806	0.776
	Median	**0.971**	**0.936**	**0.902**	**0.870**	**0.839**	**0.808**	**0.779**
	Upper 95%	0.972	0.938	0.905	0.872	0.841	0.811	0.783
700	Lower 95%	0.968	0.930	0.893	0.858	0.825	0.793	0.762
	Median	**0.969**	**0.931**	**0.895**	**0.861**	**0.827**	**0.795**	**0.765**
	Upper 95%	0.970	0.933	0.898	0.864	0.830	0.798	0.768
750	Lower 95%	0.965	0.925	0.886	0.849	0.813	0.779	0.747
	Median	**0.967**	**0.927**	**0.888**	**0.851**	**0.816**	**0.782**	**0.750**
	Upper 95%	0.968	0.929	0.891	0.854	0.819	0.786	0.753

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.963	0.920	0.879	0.839	0.802	0.766	0.732
	Median	**0.965**	**0.922**	**0.881**	**0.842**	**0.805**	**0.770**	**0.736**
	Upper 95%	0.966	0.924	0.884	0.845	0.808	0.773	0.739
850	Lower 95%	0.961	0.915	0.872	0.830	0.791	0.754	0.718
	Median	**0.962**	**0.917**	**0.874**	**0.833**	**0.794**	**0.757**	**0.722**
	Upper 95%	0.964	0.920	0.877	0.837	0.798	0.760	0.725
900	Lower 95%	0.958	0.910	0.865	0.821	0.780	0.741	0.704
	Median	**0.960**	**0.913**	**0.867**	**0.824**	**0.783**	**0.745**	**0.708**
	Upper 95%	0.962	0.915	0.870	0.828	0.787	0.748	0.711
950	Lower 95%	0.956	0.906	0.858	0.812	0.769	0.729	0.691
	Median	**0.958**	**0.908**	**0.861**	**0.816**	**0.773**	**0.733**	**0.694**
	Upper 95%	0.960	0.911	0.864	0.819	0.777	0.736	0.698
1000	Lower 95%	0.954	0.901	0.851	0.803	0.759	0.717	0.677
	Median	**0.956**	**0.903**	**0.854**	**0.807**	**0.762**	**0.721**	**0.681**
	Upper 95%	0.958	0.906	0.857	0.810	0.766	0.724	0.685
1050	Lower 95%	0.952	0.896	0.844	0.795	0.748	0.705	0.664
	Median	**0.954**	**0.899**	**0.847**	**0.798**	**0.752**	**0.709**	**0.668**
	Upper 95%	0.956	0.902	0.850	0.802	0.756	0.713	0.673
1100	Lower 95%	0.949	0.891	0.837	0.786	0.738	0.693	0.651
	Median	**0.951**	**0.894**	**0.840**	**0.790**	**0.742**	**0.697**	**0.655**
	Upper 95%	0.954	0.897	0.844	0.793	0.746	0.701	0.659
1150	Lower 95%	0.947	0.887	0.830	0.777	0.728	0.682	0.638
	Median	**0.949**	**0.890**	**0.833**	**0.781**	**0.732**	**0.686**	**0.643**
	Upper 95%	0.951	0.892	0.837	0.785	0.736	0.690	0.647
1200	Lower 95%	0.945	0.882	0.823	0.769	0.718	0.671	0.626

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.947**	**0.885**	**0.827**	**0.773**	**0.722**	**0.675**	**0.630**
	Upper 95%	0.949	0.888	0.831	0.777	0.726	0.679	0.635
1250	Lower 95%	0.943	0.877	0.817	0.760	0.708	0.659	0.614
	Median	**0.945**	**0.880**	**0.820**	**0.764**	**0.712**	**0.664**	**0.618**
	Upper 95%	0.947	0.884	0.824	0.768	0.716	0.668	0.623
1300	Lower 95%	0.940	0.873	0.810	0.752	0.698	0.648	0.602
	Median	**0.943**	**0.876**	**0.814**	**0.756**	**0.702**	**0.653**	**0.606**
	Upper 95%	0.945	0.879	0.818	0.761	0.707	0.658	0.611
1350	Lower 95%	0.938	0.868	0.803	0.744	0.689	0.637	0.590
	Median	**0.941**	**0.871**	**0.807**	**0.748**	**0.693**	**0.642**	**0.595**
	Upper 95%	0.943	0.875	0.811	0.752	0.697	0.646	0.600
1400	Lower 95%	0.936	0.863	0.797	0.736	0.679	0.627	0.579
	Median	**0.939**	**0.867**	**0.801**	**0.740**	**0.684**	**0.631**	**0.583**
	Upper 95%	0.941	0.871	0.805	0.744	0.688	0.636	0.588
1450	Lower 95%	0.934	0.859	0.790	0.727	0.669	0.616	0.567
	Median	**0.936**	**0.862**	**0.795**	**0.732**	**0.674**	**0.621**	**0.572**
	Upper 95%	0.939	0.866	0.799	0.737	0.679	0.626	0.577
1500	Lower 95%	0.931	0.854	0.784	0.720	0.660	0.606	0.557
	Median	**0.934**	**0.858**	**0.788**	**0.724**	**0.665**	**0.611**	**0.561**
	Upper 95%	0.937	0.862	0.793	0.729	0.670	0.616	0.566
1550	Lower 95%	0.929	0.850	0.778	0.711	0.651	0.596	0.545
	Median	**0.932**	**0.854**	**0.782**	**0.716**	**0.656**	**0.601**	**0.550**
	Upper 95%	0.935	0.858	0.786	0.721	0.660	0.605	0.555
1600	Lower 95%	0.927	0.845	0.771	0.704	0.642	0.586	0.535
	Median	**0.930**	**0.849**	**0.776**	**0.708**	**0.647**	**0.591**	**0.540**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.933	0.853	0.780	0.714	0.652	0.596	0.545

Table A2_5.2. Kittiwake, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.838	0.753	0.692	0.673	0.650	0.621	0.599
	Median	**1.000**	**0.999**	**0.986**	**0.984**	**0.984**	**0.987**	**0.988**
	Upper 95%	1.207	1.294	1.375	1.427	1.549	1.580	1.693
100	Lower 95%	0.820	0.754	0.697	0.666	0.629	0.603	0.587
	Median	**0.991**	**0.983**	**0.981**	**0.980**	**0.971**	**0.962**	**0.955**
	Upper 95%	1.212	1.292	1.384	1.440	1.498	1.537	1.616
150	Lower 95%	0.831	0.745	0.685	0.664	0.633	0.592	0.567
	Median	**0.992**	**0.987**	**0.980**	**0.966**	**0.956**	**0.943**	**0.936**
	Upper 95%	1.194	1.279	1.364	1.432	1.500	1.518	1.568
200	Lower 95%	0.830	0.748	0.680	0.641	0.598	0.569	0.544
	Median	**0.990**	**0.983**	**0.971**	**0.964**	**0.944**	**0.940**	**0.936**
	Upper 95%	1.181	1.286	1.330	1.385	1.445	1.453	1.477
250	Lower 95%	0.828	0.746	0.687	0.634	0.616	0.577	0.541
	Median	**0.986**	**0.978**	**0.962**	**0.948**	**0.940**	**0.939**	**0.927**
	Upper 95%	1.180	1.281	1.312	1.391	1.429	1.464	1.514
300	Lower 95%	0.820	0.748	0.668	0.638	0.590	0.566	0.529
	Median	**0.994**	**0.969**	**0.966**	**0.950**	**0.925**	**0.911**	**0.893**
	Upper 95%	1.176	1.243	1.326	1.392	1.416	1.443	1.489
350	Lower 95%	0.814	0.755	0.681	0.630	0.594	0.543	0.521
	Median	**0.982**	**0.960**	**0.945**	**0.931**	**0.914**	**0.895**	**0.878**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.173	1.239	1.323	1.389	1.408	1.448	1.499
400	Lower 95%	0.811	0.716	0.664	0.616	0.587	0.548	0.520
	Median	**0.982**	**0.957**	**0.927**	**0.908**	**0.890**	**0.873**	**0.854**
	Upper 95%	1.192	1.254	1.315	1.338	1.442	1.423	1.433
450	Lower 95%	0.813	0.711	0.655	0.610	0.569	0.533	0.495
	Median	**0.978**	**0.949**	**0.935**	**0.910**	**0.885**	**0.865**	**0.842**
	Upper 95%	1.182	1.263	1.303	1.354	1.358	1.418	1.412
500	Lower 95%	0.814	0.727	0.663	0.614	0.572	0.527	0.504
	Median	**0.970**	**0.941**	**0.920**	**0.890**	**0.863**	**0.836**	**0.814**
	Upper 95%	1.165	1.223	1.289	1.307	1.302	1.350	1.352
550	Lower 95%	0.814	0.720	0.645	0.589	0.557	0.491	0.460
	Median	**0.977**	**0.948**	**0.925**	**0.890**	**0.866**	**0.835**	**0.814**
	Upper 95%	1.173	1.235	1.283	1.357	1.350	1.343	1.387
600	Lower 95%	0.812	0.718	0.645	0.595	0.554	0.509	0.461
	Median	**0.970**	**0.941**	**0.918**	**0.879**	**0.853**	**0.823**	**0.809**
	Upper 95%	1.169	1.241	1.262	1.316	1.289	1.324	1.331
650	Lower 95%	0.817	0.718	0.640	0.574	0.543	0.490	0.444
	Median	**0.972**	**0.938**	**0.908**	**0.872**	**0.840**	**0.807**	**0.780**
	Upper 95%	1.174	1.228	1.275	1.328	1.317	1.294	1.340
700	Lower 95%	0.815	0.715	0.628	0.575	0.543	0.494	0.457
	Median	**0.969**	**0.932**	**0.899**	**0.855**	**0.823**	**0.803**	**0.775**
	Upper 95%	1.168	1.211	1.269	1.253	1.275	1.251	1.225
750	Lower 95%	0.802	0.717	0.632	0.584	0.527	0.491	0.445
	Median	**0.965**	**0.927**	**0.885**	**0.854**	**0.810**	**0.780**	**0.743**
	Upper 95%	1.169	1.211	1.257	1.258	1.251	1.257	1.294

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.807	0.698	0.617	0.545	0.502	0.465	0.431
	Median	**0.964**	**0.919**	**0.877**	**0.839**	**0.796**	**0.768**	**0.738**
	Upper 95%	1.163	1.193	1.225	1.255	1.234	1.224	1.225
850	Lower 95%	0.799	0.693	0.608	0.561	0.512	0.454	0.418
	Median	**0.962**	**0.913**	**0.873**	**0.835**	**0.794**	**0.751**	**0.723**
	Upper 95%	1.158	1.197	1.256	1.247	1.230	1.204	1.288
900	Lower 95%	0.800	0.685	0.609	0.562	0.501	0.454	0.424
	Median	**0.959**	**0.912**	**0.870**	**0.822**	**0.781**	**0.745**	**0.715**
	Upper 95%	1.149	1.184	1.210	1.240	1.194	1.187	1.190
950	Lower 95%	0.794	0.689	0.620	0.552	0.503	0.456	0.402
	Median	**0.954**	**0.904**	**0.848**	**0.808**	**0.773**	**0.728**	**0.694**
	Upper 95%	1.150	1.164	1.186	1.182	1.192	1.196	1.175
1000	Lower 95%	0.800	0.688	0.599	0.533	0.483	0.448	0.404
	Median	**0.955**	**0.894**	**0.850**	**0.813**	**0.764**	**0.725**	**0.689**
	Upper 95%	1.134	1.197	1.216	1.244	1.185	1.151	1.166
1050	Lower 95%	0.798	0.687	0.613	0.550	0.487	0.433	0.394
	Median	**0.954**	**0.897**	**0.845**	**0.792**	**0.750**	**0.708**	**0.672**
	Upper 95%	1.134	1.137	1.159	1.187	1.130	1.143	1.108
1100	Lower 95%	0.780	0.678	0.593	0.530	0.486	0.433	0.378
	Median	**0.949**	**0.892**	**0.840**	**0.793**	**0.739**	**0.696**	**0.649**
	Upper 95%	1.149	1.170	1.191	1.181	1.187	1.142	1.115
1150	Lower 95%	0.792	0.685	0.593	0.521	0.474	0.426	0.395
	Median	**0.944**	**0.889**	**0.827**	**0.779**	**0.727**	**0.680**	**0.642**
	Upper 95%	1.140	1.158	1.158	1.164	1.137	1.109	1.051
1200	Lower 95%	0.779	0.660	0.572	0.521	0.448	0.414	0.360

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.945**	**0.877**	**0.823**	**0.765**	**0.715**	**0.667**	**0.630**
	Upper 95%	1.140	1.140	1.148	1.141	1.084	1.052	1.049
1250	Lower 95%	0.784	0.668	0.582	0.513	0.460	0.407	0.369
	Median	**0.948**	**0.879**	**0.830**	**0.768**	**0.714**	**0.661**	**0.626**
	Upper 95%	1.139	1.155	1.172	1.132	1.119	1.081	1.056
1300	Lower 95%	0.786	0.664	0.568	0.498	0.438	0.396	0.343
	Median	**0.941**	**0.872**	**0.810**	**0.746**	**0.688**	**0.638**	**0.598**
	Upper 95%	1.119	1.142	1.133	1.134	1.087	1.056	1.021
1350	Lower 95%	0.788	0.660	0.585	0.507	0.443	0.400	0.357
	Median	**0.942**	**0.873**	**0.806**	**0.747**	**0.695**	**0.641**	**0.594**
	Upper 95%	1.119	1.124	1.109	1.104	1.064	1.025	0.940
1400	Lower 95%	0.782	0.662	0.562	0.491	0.438	0.392	0.350
	Median	**0.932**	**0.864**	**0.801**	**0.735**	**0.679**	**0.632**	**0.585**
	Upper 95%	1.128	1.145	1.117	1.089	1.081	1.044	1.003
1450	Lower 95%	0.780	0.651	0.540	0.476	0.425	0.379	0.339
	Median	**0.931**	**0.854**	**0.791**	**0.727**	**0.671**	**0.614**	**0.565**
	Upper 95%	1.124	1.126	1.104	1.065	1.029	0.992	0.952
1500	Lower 95%	0.771	0.636	0.549	0.483	0.423	0.380	0.330
	Median	**0.935**	**0.860**	**0.788**	**0.719**	**0.661**	**0.611**	**0.561**
	Upper 95%	1.113	1.093	1.110	1.053	1.015	0.984	0.922
1550	Lower 95%	0.774	0.648	0.553	0.498	0.435	0.388	0.333
	Median	**0.926**	**0.852**	**0.779**	**0.715**	**0.655**	**0.596**	**0.551**
	Upper 95%	1.106	1.108	1.076	1.044	1.006	0.973	0.923
1600	Lower 95%	0.774	0.647	0.544	0.472	0.416	0.368	0.321
	Median	**0.926**	**0.845**	**0.773**	**0.706**	**0.646**	**0.595**	**0.544**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.098	1.097	1.077	1.041	0.998	0.982	0.934

Table A2_5.3. Kittiwake, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.999	0.999	0.999
100	0.999	0.999	0.999
150	0.998	0.998	0.998
200	0.998	0.998	0.998
250	0.997	0.997	0.997
300	0.997	0.997	0.997
350	0.996	0.996	0.996
400	0.995	0.996	0.996
450	0.995	0.995	0.995
500	0.994	0.994	0.994
550	0.994	0.994	0.994
600	0.993	0.993	0.993
650	0.993	0.993	0.993
700	0.992	0.992	0.992
750	0.991	0.992	0.992
800	0.991	0.991	0.991
850	0.990	0.990	0.991
900	0.990	0.990	0.990
950	0.989	0.989	0.989
1000	0.989	0.989	0.989
1050	0.988	0.988	0.988
1100	0.987	0.988	0.988
1150	0.987	0.987	0.987

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.986	0.987	0.987
1250	0.986	0.986	0.986
1300	0.985	0.985	0.986
1350	0.985	0.985	0.985
1400	0.984	0.984	0.985
1450	0.983	0.984	0.984
1500	0.983	0.983	0.983
1550	0.982	0.983	0.983
1600	0.982	0.982	0.982

Table A2_5.4. Kittiwake, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.985	1.000	1.017
100	0.983	0.999	1.015
150	0.983	0.998	1.015
200	0.982	0.997	1.012
250	0.981	0.997	1.012
300	0.981	0.997	1.014
350	0.980	0.996	1.013
400	0.980	0.996	1.012
450	0.979	0.995	1.011
500	0.979	0.994	1.010
550	0.977	0.994	1.010
600	0.977	0.994	1.009
650	0.976	0.993	1.009
700	0.977	0.993	1.007
750	0.976	0.991	1.008
800	0.975	0.991	1.006
850	0.974	0.990	1.008
900	0.974	0.990	1.006
950	0.973	0.989	1.005
1000	0.973	0.989	1.006
1050	0.972	0.989	1.005
1100	0.971	0.988	1.004
1150	0.972	0.987	1.003

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.970	0.987	1.002
1250	0.971	0.986	1.003
1300	0.969	0.985	1.001
1350	0.970	0.985	0.999
1400	0.969	0.984	1.000
1450	0.968	0.984	1.000
1500	0.967	0.983	0.998
1550	0.967	0.983	0.999
1600	0.967	0.982	0.999

Table A2_6.1. Kittiwake, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.998	0.997	0.996	0.995	0.995	0.995	0.995
	Median	**0.998**	**0.997**	**0.996**	**0.996**	**0.996**	**0.995**	**0.995**
	Upper 95%	0.998	0.997	0.996	0.996	0.996	0.996	0.996
100	Lower 95%	0.996	0.993	0.992	0.991	0.990	0.990	0.990
	Median	**0.996**	**0.994**	**0.992**	**0.992**	**0.991**	**0.991**	**0.991**
	Upper 95%	0.997	0.994	0.993	0.992	0.992	0.991	0.991
150	Lower 95%	0.994	0.990	0.987	0.986	0.985	0.985	0.985
	Median	**0.995**	**0.991**	**0.989**	**0.987**	**0.987**	**0.986**	**0.986**
	Upper 95%	0.995	0.991	0.989	0.988	0.988	0.987	0.987
200	Lower 95%	0.992	0.987	0.983	0.982	0.980	0.980	0.979
	Median	**0.993**	**0.988**	**0.985**	**0.983**	**0.982**	**0.982**	**0.981**
	Upper 95%	0.993	0.989	0.986	0.984	0.983	0.983	0.983
250	Lower 95%	0.990	0.983	0.979	0.977	0.976	0.975	0.974
	Median	**0.991**	**0.985**	**0.981**	**0.979**	**0.978**	**0.977**	**0.977**
	Upper 95%	0.992	0.986	0.982	0.980	0.979	0.979	0.978
300	Lower 95%	0.988	0.980	0.975	0.972	0.971	0.970	0.969
	Median	**0.989**	**0.982**	**0.977**	**0.975**	**0.973**	**0.972**	**0.972**
	Upper 95%	0.990	0.983	0.979	0.977	0.975	0.975	0.974
350	Lower 95%	0.987	0.977	0.971	0.968	0.966	0.965	0.964
	Median	**0.988**	**0.978**	**0.973**	**0.970**	**0.969**	**0.968**	**0.967**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.988	0.980	0.975	0.973	0.971	0.970	0.970
400	Lower 95%	0.985	0.974	0.967	0.963	0.961	0.959	0.959
	Median	**0.986**	**0.975**	**0.969**	**0.966**	**0.964**	**0.963**	**0.962**
	Upper 95%	0.987	0.977	0.972	0.968	0.967	0.966	0.965
450	Lower 95%	0.983	0.970	0.963	0.959	0.956	0.955	0.954
	Median	**0.984**	**0.972**	**0.966**	**0.962**	**0.960**	**0.958**	**0.958**
	Upper 95%	0.985	0.974	0.968	0.965	0.963	0.962	0.961
500	Lower 95%	0.981	0.967	0.958	0.954	0.951	0.949	0.949
	Median	**0.982**	**0.969**	**0.962**	**0.958**	**0.955**	**0.954**	**0.953**
	Upper 95%	0.983	0.971	0.965	0.961	0.958	0.957	0.957
550	Lower 95%	0.979	0.963	0.954	0.949	0.946	0.944	0.944
	Median	**0.981**	**0.966**	**0.958**	**0.953**	**0.951**	**0.949**	**0.948**
	Upper 95%	0.982	0.968	0.961	0.957	0.954	0.953	0.952
600	Lower 95%	0.977	0.960	0.950	0.944	0.941	0.939	0.938
	Median	**0.979**	**0.963**	**0.954**	**0.949**	**0.946**	**0.944**	**0.943**
	Upper 95%	0.980	0.966	0.957	0.953	0.950	0.949	0.948
650	Lower 95%	0.975	0.957	0.946	0.940	0.936	0.934	0.933
	Median	**0.977**	**0.960**	**0.950**	**0.945**	**0.942**	**0.939**	**0.938**
	Upper 95%	0.978	0.963	0.954	0.949	0.946	0.944	0.943
700	Lower 95%	0.973	0.954	0.942	0.935	0.931	0.929	0.927
	Median	**0.975**	**0.957**	**0.947**	**0.940**	**0.937**	**0.935**	**0.934**
	Upper 95%	0.977	0.960	0.951	0.945	0.941	0.940	0.939
750	Lower 95%	0.971	0.950	0.938	0.931	0.926	0.923	0.922
	Median	**0.973**	**0.954**	**0.943**	**0.936**	**0.932**	**0.930**	**0.929**
	Upper 95%	0.975	0.957	0.947	0.941	0.938	0.936	0.934

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.969	0.947	0.933	0.925	0.922	0.918	0.917
	Median	**0.972**	**0.951**	**0.939**	**0.932**	**0.928**	**0.925**	**0.924**
	Upper 95%	0.974	0.954	0.944	0.937	0.933	0.931	0.930
850	Lower 95%	0.968	0.943	0.929	0.922	0.917	0.914	0.912
	Median	**0.970**	**0.948**	**0.935**	**0.928**	**0.923**	**0.921**	**0.919**
	Upper 95%	0.972	0.951	0.940	0.933	0.930	0.927	0.926
900	Lower 95%	0.966	0.940	0.926	0.917	0.911	0.908	0.907
	Median	**0.968**	**0.945**	**0.931**	**0.923**	**0.919**	**0.916**	**0.914**
	Upper 95%	0.970	0.948	0.936	0.929	0.925	0.922	0.921
950	Lower 95%	0.964	0.937	0.921	0.912	0.907	0.904	0.900
	Median	**0.967**	**0.942**	**0.927**	**0.919**	**0.914**	**0.912**	**0.910**
	Upper 95%	0.968	0.945	0.933	0.925	0.921	0.918	0.917
1000	Lower 95%	0.962	0.934	0.918	0.908	0.902	0.899	0.896
	Median	**0.965**	**0.939**	**0.924**	**0.915**	**0.910**	**0.906**	**0.905**
	Upper 95%	0.967	0.943	0.929	0.921	0.916	0.914	0.913
1050	Lower 95%	0.960	0.931	0.913	0.903	0.896	0.893	0.890
	Median	**0.963**	**0.936**	**0.920**	**0.911**	**0.905**	**0.902**	**0.900**
	Upper 95%	0.965	0.940	0.926	0.917	0.913	0.910	0.908
1100	Lower 95%	0.958	0.927	0.909	0.899	0.892	0.888	0.886
	Median	**0.961**	**0.933**	**0.916**	**0.907**	**0.901**	**0.897**	**0.895**
	Upper 95%	0.964	0.937	0.922	0.913	0.908	0.905	0.904
1150	Lower 95%	0.956	0.924	0.905	0.894	0.887	0.884	0.881
	Median	**0.959**	**0.930**	**0.913**	**0.902**	**0.896**	**0.893**	**0.890**
	Upper 95%	0.962	0.934	0.919	0.910	0.904	0.901	0.899
1200	Lower 95%	0.954	0.921	0.901	0.889	0.882	0.878	0.875

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.958**	**0.927**	**0.909**	**0.898**	**0.891**	**0.888**	**0.885**
	Upper 95%	0.960	0.931	0.915	0.905	0.899	0.896	0.894
1250	Lower 95%	0.952	0.917	0.897	0.885	0.877	0.873	0.871
	Median	**0.956**	**0.923**	**0.905**	**0.894**	**0.887**	**0.883**	**0.881**
	Upper 95%	0.959	0.928	0.912	0.902	0.896	0.892	0.890
1300	Lower 95%	0.951	0.915	0.892	0.880	0.872	0.867	0.865
	Median	**0.954**	**0.921**	**0.901**	**0.890**	**0.883**	**0.878**	**0.875**
	Upper 95%	0.957	0.926	0.908	0.897	0.891	0.888	0.885
1350	Lower 95%	0.949	0.911	0.888	0.875	0.867	0.862	0.859
	Median	**0.953**	**0.918**	**0.897**	**0.885**	**0.878**	**0.873**	**0.871**
	Upper 95%	0.955	0.923	0.904	0.894	0.887	0.883	0.882
1400	Lower 95%	0.946	0.908	0.885	0.871	0.862	0.857	0.855
	Median	**0.951**	**0.915**	**0.893**	**0.881**	**0.873**	**0.869**	**0.866**
	Upper 95%	0.954	0.920	0.901	0.889	0.882	0.879	0.876
1450	Lower 95%	0.945	0.905	0.882	0.867	0.858	0.852	0.849
	Median	**0.949**	**0.911**	**0.890**	**0.876**	**0.869**	**0.864**	**0.861**
	Upper 95%	0.952	0.918	0.897	0.886	0.879	0.874	0.872
1500	Lower 95%	0.943	0.901	0.876	0.861	0.852	0.846	0.843
	Median	**0.947**	**0.909**	**0.886**	**0.872**	**0.864**	**0.859**	**0.856**
	Upper 95%	0.951	0.914	0.894	0.882	0.874	0.870	0.867
1550	Lower 95%	0.941	0.899	0.873	0.856	0.847	0.841	0.838
	Median	**0.945**	**0.906**	**0.882**	**0.868**	**0.859**	**0.854**	**0.851**
	Upper 95%	0.949	0.911	0.890	0.878	0.870	0.865	0.862
1600	Lower 95%	0.939	0.895	0.869	0.852	0.842	0.837	0.833
	Median	**0.944**	**0.902**	**0.878**	**0.864**	**0.855**	**0.850**	**0.846**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.947	0.909	0.886	0.873	0.865	0.861	0.858

Table A2_6.2. Kittiwake, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.846	0.823	0.804	0.813	0.805	0.816	0.814
	Median	**1.001**	**0.994**	**0.990**	**0.992**	**0.992**	**1.005**	**1.003**
	Upper 95%	1.179	1.202	1.211	1.214	1.204	1.208	1.207
100	Lower 95%	0.853	0.829	0.809	0.824	0.814	0.819	0.820
	Median	**0.997**	**0.992**	**0.993**	**0.990**	**0.991**	**0.997**	**0.996**
	Upper 95%	1.167	1.197	1.207	1.208	1.226	1.218	1.201
150	Lower 95%	0.848	0.825	0.789	0.811	0.803	0.811	0.813
	Median	**0.999**	**0.993**	**0.988**	**0.989**	**0.987**	**0.990**	**0.985**
	Upper 95%	1.167	1.194	1.197	1.210	1.194	1.204	1.200
200	Lower 95%	0.860	0.823	0.802	0.802	0.790	0.805	0.799
	Median	**0.999**	**0.987**	**0.982**	**0.988**	**0.988**	**0.989**	**0.983**
	Upper 95%	1.169	1.200	1.194	1.192	1.192	1.200	1.204
250	Lower 95%	0.861	0.829	0.810	0.812	0.802	0.808	0.810
	Median	**0.992**	**0.986**	**0.982**	**0.981**	**0.975**	**0.982**	**0.978**
	Upper 95%	1.166	1.184	1.196	1.214	1.185	1.190	1.205
300	Lower 95%	0.848	0.810	0.800	0.808	0.801	0.804	0.790
	Median	**0.987**	**0.978**	**0.981**	**0.978**	**0.978**	**0.978**	**0.974**
	Upper 95%	1.168	1.169	1.192	1.205	1.191	1.174	1.191
350	Lower 95%	0.846	0.820	0.794	0.793	0.798	0.805	0.808
	Median	**0.984**	**0.978**	**0.976**	**0.972**	**0.970**	**0.976**	**0.973**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.169	1.181	1.173	1.182	1.182	1.182	1.200
400	Lower 95%	0.848	0.809	0.785	0.797	0.785	0.799	0.785
	Median	**0.986**	**0.975**	**0.971**	**0.964**	**0.967**	**0.966**	**0.967**
	Upper 95%	1.175	1.181	1.168	1.178	1.178	1.170	1.171
450	Lower 95%	0.838	0.809	0.795	0.790	0.806	0.801	0.785
	Median	**0.986**	**0.974**	**0.968**	**0.969**	**0.963**	**0.965**	**0.958**
	Upper 95%	1.149	1.156	1.169	1.174	1.159	1.164	1.165
500	Lower 95%	0.842	0.804	0.791	0.795	0.783	0.800	0.783
	Median	**0.986**	**0.967**	**0.963**	**0.963**	**0.959**	**0.959**	**0.953**
	Upper 95%	1.146	1.162	1.166	1.181	1.162	1.168	1.176
550	Lower 95%	0.841	0.812	0.783	0.795	0.782	0.787	0.784
	Median	**0.981**	**0.964**	**0.955**	**0.955**	**0.954**	**0.954**	**0.952**
	Upper 95%	1.155	1.151	1.159	1.165	1.155	1.158	1.167
600	Lower 95%	0.832	0.808	0.788	0.782	0.779	0.777	0.775
	Median	**0.980**	**0.957**	**0.953**	**0.948**	**0.951**	**0.951**	**0.944**
	Upper 95%	1.152	1.147	1.143	1.150	1.154	1.160	1.150
650	Lower 95%	0.840	0.802	0.771	0.777	0.772	0.778	0.780
	Median	**0.977**	**0.953**	**0.948**	**0.946**	**0.944**	**0.945**	**0.939**
	Upper 95%	1.158	1.172	1.145	1.149	1.149	1.145	1.138
700	Lower 95%	0.838	0.803	0.773	0.780	0.777	0.786	0.771
	Median	**0.974**	**0.953**	**0.941**	**0.949**	**0.944**	**0.943**	**0.938**
	Upper 95%	1.141	1.153	1.124	1.154	1.147	1.135	1.128
750	Lower 95%	0.840	0.800	0.776	0.772	0.772	0.771	0.762
	Median	**0.977**	**0.949**	**0.943**	**0.943**	**0.940**	**0.936**	**0.932**
	Upper 95%	1.147	1.143	1.145	1.134	1.132	1.124	1.138

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.833	0.792	0.771	0.770	0.772	0.779	0.770
	Median	**0.973**	**0.954**	**0.942**	**0.935**	**0.929**	**0.929**	**0.927**
	Upper 95%	1.143	1.151	1.139	1.137	1.127	1.144	1.140
850	Lower 95%	0.828	0.789	0.759	0.764	0.760	0.764	0.759
	Median	**0.971**	**0.945**	**0.936**	**0.928**	**0.926**	**0.925**	**0.923**
	Upper 95%	1.142	1.142	1.148	1.141	1.118	1.126	1.131
900	Lower 95%	0.825	0.784	0.768	0.764	0.752	0.757	0.747
	Median	**0.970**	**0.942**	**0.930**	**0.925**	**0.921**	**0.920**	**0.919**
	Upper 95%	1.138	1.131	1.123	1.108	1.121	1.112	1.116
950	Lower 95%	0.825	0.782	0.757	0.764	0.754	0.753	0.750
	Median	**0.966**	**0.941**	**0.928**	**0.923**	**0.918**	**0.911**	**0.916**
	Upper 95%	1.120	1.135	1.131	1.121	1.104	1.122	1.128
1000	Lower 95%	0.824	0.777	0.755	0.748	0.752	0.742	0.754
	Median	**0.963**	**0.940**	**0.921**	**0.915**	**0.910**	**0.912**	**0.905**
	Upper 95%	1.127	1.127	1.112	1.102	1.092	1.101	1.115
1050	Lower 95%	0.816	0.786	0.749	0.743	0.747	0.749	0.752
	Median	**0.966**	**0.931**	**0.921**	**0.917**	**0.908**	**0.902**	**0.898**
	Upper 95%	1.125	1.126	1.115	1.104	1.102	1.111	1.110
1100	Lower 95%	0.818	0.764	0.755	0.750	0.740	0.733	0.739
	Median	**0.963**	**0.930**	**0.915**	**0.909**	**0.902**	**0.905**	**0.897**
	Upper 95%	1.111	1.112	1.123	1.103	1.100	1.087	1.093
1150	Lower 95%	0.822	0.778	0.750	0.747	0.733	0.731	0.742
	Median	**0.954**	**0.928**	**0.910**	**0.902**	**0.899**	**0.893**	**0.886**
	Upper 95%	1.127	1.120	1.108	1.087	1.080	1.095	1.077
1200	Lower 95%	0.820	0.775	0.735	0.731	0.737	0.729	0.722

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.964**	**0.925**	**0.909**	**0.903**	**0.893**	**0.888**	**0.885**
	Upper 95%	1.128	1.115	1.117	1.095	1.082	1.084	1.074
1250	Lower 95%	0.810	0.772	0.746	0.732	0.719	0.733	0.729
	Median	**0.959**	**0.931**	**0.904**	**0.893**	**0.890**	**0.890**	**0.879**
	Upper 95%	1.107	1.107	1.089	1.095	1.091	1.067	1.072
1300	Lower 95%	0.814	0.767	0.741	0.729	0.724	0.731	0.720
	Median	**0.955**	**0.920**	**0.901**	**0.891**	**0.881**	**0.881**	**0.875**
	Upper 95%	1.129	1.116	1.095	1.085	1.075	1.063	1.063
1350	Lower 95%	0.817	0.758	0.731	0.729	0.732	0.728	0.731
	Median	**0.948**	**0.913**	**0.895**	**0.884**	**0.878**	**0.880**	**0.870**
	Upper 95%	1.124	1.098	1.089	1.082	1.057	1.071	1.058
1400	Lower 95%	0.811	0.762	0.726	0.723	0.713	0.713	0.704
	Median	**0.952**	**0.913**	**0.893**	**0.887**	**0.871**	**0.869**	**0.864**
	Upper 95%	1.120	1.097	1.083	1.058	1.070	1.067	1.052
1450	Lower 95%	0.804	0.750	0.730	0.727	0.717	0.716	0.715
	Median	**0.952**	**0.916**	**0.886**	**0.875**	**0.867**	**0.864**	**0.862**
	Upper 95%	1.109	1.097	1.077	1.069	1.060	1.060	1.047
1500	Lower 95%	0.813	0.762	0.728	0.715	0.711	0.718	0.704
	Median	**0.952**	**0.912**	**0.888**	**0.877**	**0.866**	**0.865**	**0.861**
	Upper 95%	1.124	1.085	1.071	1.043	1.047	1.051	1.054
1550	Lower 95%	0.813	0.743	0.723	0.707	0.708	0.703	0.710
	Median	**0.945**	**0.905**	**0.883**	**0.867**	**0.861**	**0.861**	**0.854**
	Upper 95%	1.108	1.077	1.067	1.053	1.044	1.040	1.042
1600	Lower 95%	0.808	0.757	0.716	0.714	0.704	0.697	0.693
	Median	**0.945**	**0.900**	**0.878**	**0.863**	**0.859**	**0.850**	**0.847**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.102	1.074	1.061	1.053	1.047	1.038	1.032

Table A2_6.3. Kittiwake, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	1.000	1.000	1.000
100	1.000	1.000	1.000
150	1.000	1.000	1.000
200	1.000	1.000	1.000
250	0.999	1.000	1.000
300	0.999	0.999	0.999
350	0.999	0.999	0.999
400	0.999	0.999	0.999
450	0.999	0.999	0.999
500	0.999	0.999	0.999
550	0.999	0.999	0.999
600	0.999	0.999	0.999
650	0.998	0.999	0.999
700	0.998	0.999	0.999
750	0.998	0.998	0.999
800	0.998	0.998	0.999
850	0.998	0.998	0.998
900	0.998	0.998	0.998
950	0.998	0.998	0.998
1000	0.998	0.998	0.998
1050	0.997	0.998	0.998
1100	0.997	0.998	0.998
1150	0.997	0.998	0.998

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.997	0.997	0.998
1250	0.997	0.997	0.998
1300	0.997	0.997	0.998
1350	0.997	0.997	0.997
1400	0.996	0.997	0.997
1450	0.996	0.997	0.997
1500	0.996	0.997	0.997
1550	0.996	0.996	0.997
1600	0.996	0.996	0.997

Table A2_6.4. Kittiwake, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.992	1.000	1.008
100	0.992	1.000	1.008
150	0.992	1.000	1.008
200	0.991	0.999	1.008
250	0.992	1.000	1.008
300	0.991	0.999	1.008
350	0.991	1.000	1.008
400	0.991	0.999	1.008
450	0.991	0.999	1.007
500	0.991	0.999	1.007
550	0.990	0.999	1.008
600	0.991	0.999	1.008
650	0.990	0.999	1.007
700	0.991	0.999	1.007
750	0.990	0.998	1.007
800	0.990	0.999	1.007
850	0.990	0.998	1.006
900	0.990	0.998	1.007
950	0.989	0.998	1.007
1000	0.990	0.998	1.007
1050	0.990	0.998	1.006
1100	0.990	0.998	1.006
1150	0.990	0.997	1.006

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.989	0.997	1.005
1250	0.990	0.997	1.005
1300	0.989	0.997	1.006
1350	0.989	0.997	1.006
1400	0.988	0.997	1.005
1450	0.988	0.997	1.005
1500	0.988	0.997	1.005
1550	0.988	0.997	1.005
1600	0.988	0.996	1.005

Table A2_7.1. Kittiwake, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.998	0.995	0.992	0.989	0.986	0.984	0.981
	Median	**0.998**	**0.995**	**0.992**	**0.989**	**0.987**	**0.984**	**0.981**
	Upper 95%	0.998	0.995	0.992	0.990	0.987	0.984	0.981
100	Lower 95%	0.995	0.990	0.984	0.979	0.973	0.968	0.962
	Median	**0.996**	**0.990**	**0.984**	**0.979**	**0.973**	**0.968**	**0.962**
	Upper 95%	0.996	0.990	0.985	0.979	0.974	0.968	0.963
150	Lower 95%	0.993	0.985	0.976	0.968	0.960	0.952	0.944
	Median	**0.993**	**0.985**	**0.977**	**0.968**	**0.960**	**0.952**	**0.944**
	Upper 95%	0.993	0.985	0.977	0.969	0.961	0.953	0.945
200	Lower 95%	0.991	0.980	0.969	0.958	0.947	0.936	0.926
	Median	**0.991**	**0.980**	**0.969**	**0.958**	**0.947**	**0.937**	**0.926**
	Upper 95%	0.991	0.980	0.969	0.959	0.948	0.937	0.927
250	Lower 95%	0.989	0.975	0.961	0.947	0.934	0.921	0.908
	Median	**0.989**	**0.975**	**0.961**	**0.948**	**0.935**	**0.922**	**0.909**
	Upper 95%	0.989	0.975	0.962	0.949	0.935	0.922	0.909
300	Lower 95%	0.986	0.970	0.953	0.937	0.921	0.906	0.891
	Median	**0.987**	**0.970**	**0.954**	**0.938**	**0.922**	**0.907**	**0.892**
	Upper 95%	0.987	0.971	0.954	0.939	0.923	0.908	0.892
350	Lower 95%	0.984	0.965	0.946	0.927	0.909	0.891	0.874
	Median	**0.984**	**0.965**	**0.946**	**0.928**	**0.910**	**0.892**	**0.875**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.985	0.966	0.947	0.929	0.911	0.893	0.876
400	Lower 95%	0.982	0.960	0.938	0.917	0.897	0.877	0.857
	Median	**0.982**	**0.960**	**0.939**	**0.918**	**0.898**	**0.878**	**0.858**
	Upper 95%	0.983	0.961	0.940	0.919	0.899	0.879	0.859
450	Lower 95%	0.979	0.955	0.931	0.907	0.884	0.862	0.840
	Median	**0.980**	**0.955**	**0.931**	**0.908**	**0.885**	**0.863**	**0.842**
	Upper 95%	0.980	0.956	0.932	0.909	0.887	0.865	0.843
500	Lower 95%	0.977	0.950	0.923	0.897	0.872	0.848	0.824
	Median	**0.978**	**0.951**	**0.924**	**0.899**	**0.874**	**0.849**	**0.826**
	Upper 95%	0.978	0.951	0.925	0.900	0.875	0.851	0.827
550	Lower 95%	0.975	0.945	0.916	0.888	0.860	0.834	0.809
	Median	**0.976**	**0.946**	**0.917**	**0.889**	**0.862**	**0.835**	**0.810**
	Upper 95%	0.976	0.947	0.918	0.890	0.863	0.837	0.811
600	Lower 95%	0.973	0.940	0.908	0.878	0.849	0.820	0.793
	Median	**0.973**	**0.941**	**0.910**	**0.879**	**0.850**	**0.822**	**0.794**
	Upper 95%	0.974	0.942	0.911	0.881	0.851	0.823	0.796
650	Lower 95%	0.970	0.935	0.901	0.869	0.837	0.807	0.778
	Median	**0.971**	**0.936**	**0.902**	**0.870**	**0.839**	**0.808**	**0.779**
	Upper 95%	0.972	0.937	0.904	0.871	0.840	0.810	0.781
700	Lower 95%	0.968	0.930	0.894	0.859	0.826	0.794	0.763
	Median	**0.969**	**0.931**	**0.895**	**0.861**	**0.827**	**0.795**	**0.765**
	Upper 95%	0.970	0.932	0.897	0.862	0.829	0.797	0.766
750	Lower 95%	0.966	0.926	0.887	0.850	0.815	0.781	0.748
	Median	**0.967**	**0.927**	**0.888**	**0.851**	**0.816**	**0.782**	**0.750**
	Upper 95%	0.968	0.928	0.890	0.853	0.818	0.784	0.752

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.964	0.921	0.880	0.841	0.803	0.768	0.734
	Median	**0.965**	**0.922**	**0.881**	**0.842**	**0.805**	**0.770**	**0.736**
	Upper 95%	0.965	0.923	0.883	0.844	0.807	0.771	0.737
850	Lower 95%	0.961	0.916	0.873	0.832	0.792	0.755	0.720
	Median	**0.962**	**0.917**	**0.874**	**0.833**	**0.794**	**0.757**	**0.722**
	Upper 95%	0.963	0.919	0.876	0.835	0.796	0.759	0.724
900	Lower 95%	0.959	0.911	0.866	0.823	0.782	0.743	0.706
	Median	**0.960**	**0.913**	**0.867**	**0.824**	**0.783**	**0.745**	**0.708**
	Upper 95%	0.961	0.914	0.869	0.826	0.785	0.747	0.710
950	Lower 95%	0.957	0.906	0.859	0.814	0.771	0.730	0.692
	Median	**0.958**	**0.908**	**0.860**	**0.815**	**0.773**	**0.732**	**0.694**
	Upper 95%	0.959	0.909	0.862	0.818	0.775	0.735	0.696
1000	Lower 95%	0.955	0.902	0.852	0.805	0.760	0.718	0.679
	Median	**0.956**	**0.903**	**0.854**	**0.807**	**0.762**	**0.721**	**0.681**
	Upper 95%	0.957	0.905	0.856	0.809	0.765	0.723	0.683
1050	Lower 95%	0.952	0.897	0.845	0.796	0.750	0.707	0.666
	Median	**0.954**	**0.899**	**0.847**	**0.798**	**0.752**	**0.709**	**0.668**
	Upper 95%	0.955	0.900	0.849	0.800	0.754	0.711	0.670
1100	Lower 95%	0.950	0.893	0.838	0.788	0.740	0.695	0.653
	Median	**0.951**	**0.894**	**0.840**	**0.790**	**0.742**	**0.697**	**0.655**
	Upper 95%	0.953	0.896	0.842	0.792	0.744	0.700	0.657
1150	Lower 95%	0.948	0.888	0.832	0.779	0.730	0.683	0.640
	Median	**0.949**	**0.890**	**0.834**	**0.781**	**0.732**	**0.686**	**0.643**
	Upper 95%	0.951	0.891	0.836	0.783	0.734	0.688	0.645
1200	Lower 95%	0.946	0.883	0.825	0.771	0.720	0.672	0.628

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.947**	**0.885**	**0.827**	**0.773**	**0.722**	**0.675**	**0.630**
	Upper 95%	0.949	0.887	0.829	0.775	0.724	0.677	0.633
1250	Lower 95%	0.944	0.879	0.818	0.762	0.710	0.661	0.616
	Median	**0.945**	**0.880**	**0.820**	**0.764**	**0.712**	**0.663**	**0.618**
	Upper 95%	0.946	0.882	0.823	0.767	0.715	0.666	0.621
1300	Lower 95%	0.941	0.874	0.812	0.754	0.700	0.650	0.604
	Median	**0.943**	**0.876**	**0.814**	**0.756**	**0.702**	**0.653**	**0.606**
	Upper 95%	0.944	0.878	0.816	0.759	0.705	0.655	0.609
1350	Lower 95%	0.939	0.869	0.805	0.745	0.690	0.639	0.592
	Median	**0.941**	**0.871**	**0.807**	**0.748**	**0.693**	**0.642**	**0.595**
	Upper 95%	0.942	0.873	0.810	0.750	0.696	0.644	0.597
1400	Lower 95%	0.937	0.865	0.799	0.737	0.681	0.629	0.581
	Median	**0.939**	**0.867**	**0.801**	**0.740**	**0.683**	**0.631**	**0.583**
	Upper 95%	0.940	0.869	0.803	0.742	0.686	0.634	0.586
1450	Lower 95%	0.935	0.860	0.792	0.729	0.671	0.618	0.569
	Median	**0.936**	**0.862**	**0.794**	**0.732**	**0.674**	**0.621**	**0.572**
	Upper 95%	0.938	0.865	0.797	0.734	0.677	0.624	0.575
1500	Lower 95%	0.933	0.856	0.786	0.721	0.662	0.608	0.558
	Median	**0.934**	**0.858**	**0.788**	**0.724**	**0.665**	**0.611**	**0.561**
	Upper 95%	0.936	0.860	0.791	0.727	0.668	0.613	0.564
1550	Lower 95%	0.931	0.852	0.780	0.714	0.653	0.598	0.548
	Median	**0.932**	**0.854**	**0.782**	**0.716**	**0.656**	**0.601**	**0.550**
	Upper 95%	0.934	0.856	0.785	0.719	0.659	0.604	0.553
1600	Lower 95%	0.928	0.847	0.773	0.705	0.644	0.588	0.537
	Median	**0.930**	**0.849**	**0.776**	**0.708**	**0.647**	**0.591**	**0.540**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.932	0.852	0.778	0.711	0.650	0.594	0.542

Table A2_7.2. Kittiwake, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.782	0.698	0.658	0.592	0.562	0.531	0.518
	Median	**0.998**	**0.969**	**0.979**	**0.974**	**0.965**	**0.959**	**0.952**
	Upper 95%	1.268	1.389	1.492	1.569	1.694	1.805	1.839
100	Lower 95%	0.799	0.712	0.623	0.590	0.543	0.511	0.476
	Median	**0.991**	**0.979**	**0.968**	**0.966**	**0.953**	**0.950**	**0.942**
	Upper 95%	1.262	1.383	1.474	1.633	1.667	1.764	1.815
150	Lower 95%	0.779	0.702	0.616	0.576	0.543	0.498	0.472
	Median	**0.996**	**0.975**	**0.974**	**0.961**	**0.944**	**0.930**	**0.924**
	Upper 95%	1.253	1.381	1.467	1.541	1.672	1.684	1.789
200	Lower 95%	0.771	0.687	0.612	0.574	0.539	0.492	0.457
	Median	**0.995**	**0.976**	**0.957**	**0.962**	**0.936**	**0.917**	**0.914**
	Upper 95%	1.249	1.405	1.441	1.547	1.604	1.700	1.794
250	Lower 95%	0.779	0.684	0.613	0.568	0.513	0.462	0.466
	Median	**0.987**	**0.979**	**0.973**	**0.954**	**0.939**	**0.917**	**0.904**
	Upper 95%	1.254	1.367	1.444	1.505	1.598	1.753	1.752
300	Lower 95%	0.767	0.682	0.596	0.556	0.522	0.481	0.441
	Median	**0.981**	**0.960**	**0.940**	**0.927**	**0.904**	**0.881**	**0.871**
	Upper 95%	1.217	1.371	1.484	1.565	1.634	1.697	1.696
350	Lower 95%	0.782	0.679	0.606	0.578	0.528	0.490	0.459
	Median	**0.981**	**0.973**	**0.938**	**0.927**	**0.905**	**0.869**	**0.868**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.222	1.340	1.436	1.484	1.496	1.594	1.636
400	Lower 95%	0.778	0.684	0.607	0.565	0.508	0.485	0.441
	Median	**0.982**	**0.945**	**0.938**	**0.920**	**0.888**	**0.856**	**0.831**
	Upper 95%	1.246	1.328	1.418	1.463	1.533	1.596	1.631
450	Lower 95%	0.777	0.697	0.625	0.566	0.519	0.476	0.414
	Median	**0.987**	**0.954**	**0.937**	**0.911**	**0.895**	**0.858**	**0.843**
	Upper 95%	1.252	1.356	1.414	1.479	1.560	1.606	1.685
500	Lower 95%	0.776	0.658	0.579	0.541	0.497	0.459	0.414
	Median	**0.984**	**0.943**	**0.923**	**0.891**	**0.863**	**0.835**	**0.802**
	Upper 95%	1.233	1.360	1.427	1.462	1.501	1.561	1.590
550	Lower 95%	0.775	0.673	0.617	0.542	0.491	0.448	0.414
	Median	**0.977**	**0.946**	**0.914**	**0.885**	**0.861**	**0.822**	**0.809**
	Upper 95%	1.232	1.349	1.378	1.485	1.534	1.538	1.543
600	Lower 95%	0.774	0.662	0.585	0.560	0.514	0.466	0.408
	Median	**0.966**	**0.925**	**0.894**	**0.866**	**0.813**	**0.799**	**0.788**
	Upper 95%	1.234	1.311	1.353	1.388	1.444	1.461	1.510
650	Lower 95%	0.767	0.658	0.578	0.529	0.471	0.420	0.389
	Median	**0.968**	**0.932**	**0.890**	**0.859**	**0.830**	**0.799**	**0.764**
	Upper 95%	1.211	1.330	1.327	1.378	1.417	1.446	1.493
700	Lower 95%	0.769	0.650	0.583	0.520	0.451	0.412	0.392
	Median	**0.967**	**0.929**	**0.883**	**0.852**	**0.814**	**0.785**	**0.765**
	Upper 95%	1.204	1.290	1.364	1.387	1.390	1.416	1.431
750	Lower 95%	0.783	0.660	0.567	0.513	0.449	0.417	0.382
	Median	**0.971**	**0.922**	**0.899**	**0.860**	**0.831**	**0.777**	**0.749**
	Upper 95%	1.217	1.317	1.360	1.369	1.410	1.428	1.418

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.768	0.661	0.570	0.499	0.443	0.407	0.375
	Median	**0.967**	**0.911**	**0.869**	**0.835**	**0.789**	**0.748**	**0.725**
	Upper 95%	1.208	1.319	1.336	1.389	1.372	1.370	1.411
850	Lower 95%	0.785	0.655	0.575	0.518	0.459	0.405	0.362
	Median	**0.959**	**0.906**	**0.868**	**0.831**	**0.784**	**0.744**	**0.713**
	Upper 95%	1.213	1.317	1.314	1.345	1.379	1.382	1.407
900	Lower 95%	0.763	0.640	0.544	0.497	0.458	0.401	0.353
	Median	**0.965**	**0.907**	**0.866**	**0.821**	**0.776**	**0.735**	**0.699**
	Upper 95%	1.202	1.278	1.309	1.310	1.326	1.391	1.420
950	Lower 95%	0.757	0.632	0.538	0.486	0.427	0.401	0.348
	Median	**0.957**	**0.915**	**0.862**	**0.811**	**0.776**	**0.728**	**0.701**
	Upper 95%	1.203	1.308	1.338	1.356	1.348	1.327	1.335
1000	Lower 95%	0.755	0.651	0.552	0.488	0.423	0.376	0.337
	Median	**0.954**	**0.891**	**0.850**	**0.806**	**0.763**	**0.719**	**0.685**
	Upper 95%	1.213	1.292	1.321	1.331	1.381	1.336	1.336
1050	Lower 95%	0.753	0.634	0.542	0.477	0.427	0.383	0.339
	Median	**0.962**	**0.901**	**0.830**	**0.788**	**0.735**	**0.686**	**0.648**
	Upper 95%	1.183	1.267	1.291	1.316	1.307	1.272	1.275
1100	Lower 95%	0.749	0.619	0.548	0.480	0.411	0.353	0.326
	Median	**0.950**	**0.891**	**0.826**	**0.785**	**0.737**	**0.682**	**0.636**
	Upper 95%	1.188	1.255	1.284	1.274	1.250	1.253	1.274
1150	Lower 95%	0.753	0.616	0.529	0.473	0.413	0.366	0.323
	Median	**0.947**	**0.888**	**0.829**	**0.777**	**0.727**	**0.682**	**0.636**
	Upper 95%	1.194	1.269	1.258	1.290	1.268	1.264	1.239
1200	Lower 95%	0.746	0.632	0.538	0.469	0.399	0.357	0.321

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.950**	**0.884**	**0.817**	**0.760**	**0.723**	**0.664**	**0.629**
	Upper 95%	1.201	1.252	1.267	1.275	1.260	1.236	1.262
1250	Lower 95%	0.737	0.609	0.537	0.452	0.399	0.351	0.302
	Median	**0.949**	**0.874**	**0.815**	**0.758**	**0.702**	**0.650**	**0.596**
	Upper 95%	1.185	1.227	1.241	1.259	1.275	1.218	1.148
1300	Lower 95%	0.748	0.628	0.529	0.446	0.391	0.334	0.296
	Median	**0.942**	**0.880**	**0.819**	**0.755**	**0.696**	**0.642**	**0.595**
	Upper 95%	1.183	1.240	1.243	1.198	1.175	1.149	1.163
1350	Lower 95%	0.746	0.618	0.520	0.451	0.394	0.347	0.313
	Median	**0.937**	**0.859**	**0.790**	**0.744**	**0.683**	**0.630**	**0.582**
	Upper 95%	1.187	1.213	1.237	1.244	1.202	1.143	1.160
1400	Lower 95%	0.742	0.612	0.513	0.452	0.384	0.342	0.298
	Median	**0.936**	**0.862**	**0.793**	**0.732**	**0.680**	**0.612**	**0.573**
	Upper 95%	1.194	1.247	1.212	1.212	1.172	1.181	1.162
1450	Lower 95%	0.737	0.617	0.518	0.455	0.388	0.334	0.291
	Median	**0.943**	**0.857**	**0.786**	**0.723**	**0.668**	**0.609**	**0.564**
	Upper 95%	1.173	1.212	1.204	1.220	1.195	1.146	1.113
1500	Lower 95%	0.744	0.598	0.502	0.427	0.382	0.328	0.282
	Median	**0.940**	**0.863**	**0.791**	**0.730**	**0.671**	**0.606**	**0.566**
	Upper 95%	1.168	1.203	1.178	1.173	1.131	1.140	1.099
1550	Lower 95%	0.736	0.611	0.516	0.441	0.383	0.327	0.282
	Median	**0.935**	**0.847**	**0.773**	**0.713**	**0.647**	**0.594**	**0.545**
	Upper 95%	1.178	1.192	1.175	1.172	1.144	1.101	1.080
1600	Lower 95%	0.716	0.600	0.487	0.426	0.367	0.320	0.270
	Median	**0.926**	**0.841**	**0.769**	**0.695**	**0.633**	**0.577**	**0.525**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.179	1.201	1.181	1.141	1.119	1.057	1.049

Table A2_7.3. Kittiwake, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.999	0.999	0.999
100	0.999	0.999	0.999
150	0.998	0.998	0.998
200	0.998	0.998	0.998
250	0.997	0.997	0.997
300	0.997	0.997	0.997
350	0.996	0.996	0.996
400	0.995	0.996	0.996
450	0.995	0.995	0.995
500	0.994	0.994	0.994
550	0.994	0.994	0.994
600	0.993	0.993	0.993
650	0.993	0.993	0.993
700	0.992	0.992	0.992
750	0.991	0.992	0.992
800	0.991	0.991	0.991
850	0.990	0.990	0.991
900	0.990	0.990	0.990
950	0.989	0.989	0.989
1000	0.989	0.989	0.989
1050	0.988	0.988	0.988
1100	0.988	0.988	0.988
1150	0.987	0.987	0.987

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.986	0.987	0.987
1250	0.986	0.986	0.986
1300	0.985	0.985	0.986
1350	0.985	0.985	0.985
1400	0.984	0.984	0.984
1450	0.984	0.984	0.984
1500	0.983	0.983	0.983
1550	0.982	0.983	0.983
1600	0.982	0.982	0.982

Table A2_7.4. Kittiwake, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.980	0.999	1.021
100	0.978	0.998	1.019
150	0.976	0.997	1.019
200	0.974	0.997	1.018
250	0.977	0.997	1.018
300	0.975	0.996	1.017
350	0.976	0.996	1.016
400	0.975	0.995	1.016
450	0.974	0.994	1.017
500	0.973	0.994	1.015
550	0.973	0.994	1.015
600	0.972	0.993	1.014
650	0.971	0.992	1.012
700	0.971	0.992	1.013
750	0.971	0.991	1.013
800	0.969	0.991	1.011
850	0.969	0.990	1.012
900	0.969	0.989	1.012
950	0.968	0.989	1.011
1000	0.967	0.988	1.010
1050	0.968	0.987	1.009
1100	0.967	0.987	1.008
1150	0.967	0.987	1.009

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.964	0.986	1.007
1250	0.965	0.985	1.007
1300	0.965	0.985	1.006
1350	0.963	0.985	1.006
1400	0.962	0.983	1.005
1450	0.963	0.983	1.004
1500	0.961	0.983	1.004
1550	0.963	0.982	1.003
1600	0.962	0.981	1.002

Table A2_8.1. Kittiwake, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.998	0.997	0.996	0.995	0.995	0.994	0.994
	Median	**0.998**	**0.997**	**0.996**	**0.996**	**0.995**	**0.995**	**0.995**
	Upper 95%	0.998	0.997	0.996	0.996	0.996	0.996	0.996
100	Lower 95%	0.996	0.993	0.991	0.990	0.989	0.989	0.989
	Median	**0.996**	**0.994**	**0.992**	**0.991**	**0.991**	**0.990**	**0.990**
	Upper 95%	0.997	0.994	0.993	0.992	0.991	0.991	0.991
150	Lower 95%	0.994	0.990	0.987	0.985	0.984	0.984	0.983
	Median	**0.995**	**0.990**	**0.988**	**0.987**	**0.986**	**0.985**	**0.985**
	Upper 95%	0.995	0.991	0.989	0.988	0.987	0.987	0.987
200	Lower 95%	0.992	0.986	0.982	0.980	0.979	0.978	0.977
	Median	**0.993**	**0.987**	**0.984**	**0.982**	**0.981**	**0.980**	**0.980**
	Upper 95%	0.993	0.988	0.985	0.984	0.983	0.982	0.982
250	Lower 95%	0.990	0.983	0.978	0.975	0.973	0.972	0.972
	Median	**0.991**	**0.984**	**0.980**	**0.978**	**0.976**	**0.975**	**0.975**
	Upper 95%	0.991	0.985	0.982	0.980	0.978	0.978	0.977
300	Lower 95%	0.988	0.979	0.974	0.970	0.968	0.967	0.966
	Median	**0.989**	**0.981**	**0.976**	**0.973**	**0.971**	**0.970**	**0.970**
	Upper 95%	0.990	0.982	0.978	0.976	0.974	0.973	0.973
350	Lower 95%	0.987	0.976	0.969	0.965	0.963	0.961	0.961
	Median	**0.987**	**0.978**	**0.972**	**0.969**	**0.967**	**0.965**	**0.965**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.988	0.979	0.974	0.971	0.970	0.969	0.968
400	Lower 95%	0.985	0.973	0.965	0.961	0.957	0.956	0.955
	Median	**0.986**	**0.975**	**0.968**	**0.964**	**0.962**	**0.960**	**0.960**
	Upper 95%	0.986	0.976	0.971	0.967	0.965	0.964	0.964
450	Lower 95%	0.983	0.969	0.960	0.955	0.952	0.950	0.949
	Median	**0.984**	**0.971**	**0.964**	**0.960**	**0.957**	**0.955**	**0.954**
	Upper 95%	0.985	0.973	0.967	0.963	0.961	0.960	0.959
500	Lower 95%	0.981	0.966	0.956	0.951	0.947	0.945	0.943
	Median	**0.982**	**0.968**	**0.960**	**0.955**	**0.952**	**0.951**	**0.949**
	Upper 95%	0.983	0.971	0.963	0.959	0.957	0.955	0.954
550	Lower 95%	0.979	0.962	0.952	0.946	0.941	0.939	0.938
	Median	**0.980**	**0.965**	**0.956**	**0.951**	**0.948**	**0.945**	**0.944**
	Upper 95%	0.981	0.968	0.960	0.955	0.952	0.951	0.950
600	Lower 95%	0.977	0.959	0.948	0.941	0.937	0.934	0.932
	Median	**0.978**	**0.962**	**0.952**	**0.946**	**0.943**	**0.940**	**0.939**
	Upper 95%	0.980	0.965	0.956	0.951	0.948	0.946	0.946
650	Lower 95%	0.975	0.956	0.943	0.936	0.931	0.928	0.926
	Median	**0.977**	**0.959**	**0.948**	**0.942**	**0.938**	**0.936**	**0.934**
	Upper 95%	0.978	0.962	0.953	0.947	0.944	0.942	0.940
700	Lower 95%	0.973	0.952	0.939	0.931	0.925	0.922	0.920
	Median	**0.975**	**0.956**	**0.944**	**0.937**	**0.933**	**0.930**	**0.929**
	Upper 95%	0.976	0.958	0.949	0.943	0.939	0.937	0.936
750	Lower 95%	0.971	0.949	0.935	0.926	0.920	0.917	0.915
	Median	**0.973**	**0.952**	**0.940**	**0.933**	**0.928**	**0.925**	**0.924**
	Upper 95%	0.974	0.956	0.945	0.939	0.935	0.933	0.932

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.969	0.945	0.930	0.921	0.915	0.911	0.909
	Median	**0.971**	**0.949**	**0.936**	**0.928**	**0.923**	**0.920**	**0.918**
	Upper 95%	0.973	0.953	0.942	0.935	0.931	0.928	0.926
850	Lower 95%	0.967	0.942	0.926	0.916	0.910	0.907	0.903
	Median	**0.970**	**0.946**	**0.932**	**0.924**	**0.919**	**0.915**	**0.913**
	Upper 95%	0.971	0.950	0.938	0.931	0.926	0.924	0.922
900	Lower 95%	0.966	0.939	0.921	0.911	0.903	0.898	0.897
	Median	**0.968**	**0.943**	**0.928**	**0.919**	**0.914**	**0.910**	**0.908**
	Upper 95%	0.969	0.947	0.934	0.927	0.922	0.919	0.918
950	Lower 95%	0.964	0.935	0.917	0.906	0.899	0.894	0.892
	Median	**0.966**	**0.940**	**0.924**	**0.915**	**0.909**	**0.905**	**0.903**
	Upper 95%	0.968	0.944	0.930	0.922	0.917	0.914	0.913
1000	Lower 95%	0.962	0.932	0.913	0.900	0.893	0.889	0.885
	Median	**0.964**	**0.937**	**0.920**	**0.911**	**0.905**	**0.901**	**0.898**
	Upper 95%	0.966	0.941	0.926	0.918	0.914	0.910	0.907
1050	Lower 95%	0.960	0.928	0.908	0.896	0.889	0.883	0.880
	Median	**0.962**	**0.934**	**0.916**	**0.906**	**0.899**	**0.895**	**0.893**
	Upper 95%	0.964	0.938	0.923	0.914	0.909	0.906	0.903
1100	Lower 95%	0.958	0.925	0.904	0.891	0.882	0.877	0.874
	Median	**0.960**	**0.930**	**0.912**	**0.901**	**0.895**	**0.890**	**0.887**
	Upper 95%	0.963	0.935	0.919	0.911	0.905	0.901	0.899
1150	Lower 95%	0.956	0.922	0.900	0.886	0.877	0.872	0.869
	Median	**0.959**	**0.927**	**0.908**	**0.897**	**0.890**	**0.886**	**0.883**
	Upper 95%	0.961	0.932	0.916	0.907	0.900	0.896	0.894
1200	Lower 95%	0.954	0.918	0.895	0.880	0.871	0.865	0.861

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.957**	**0.924**	**0.904**	**0.892**	**0.885**	**0.880**	**0.877**
	Upper 95%	0.959	0.929	0.912	0.902	0.896	0.892	0.889
1250	Lower 95%	0.952	0.915	0.892	0.876	0.867	0.861	0.857
	Median	**0.955**	**0.921**	**0.901**	**0.888**	**0.880**	**0.875**	**0.872**
	Upper 95%	0.957	0.926	0.909	0.898	0.891	0.887	0.885
1300	Lower 95%	0.950	0.912	0.887	0.871	0.861	0.855	0.851
	Median	**0.953**	**0.918**	**0.896**	**0.883**	**0.875**	**0.870**	**0.866**
	Upper 95%	0.956	0.924	0.904	0.893	0.886	0.883	0.881
1350	Lower 95%	0.949	0.908	0.882	0.867	0.855	0.848	0.843
	Median	**0.952**	**0.915**	**0.893**	**0.879**	**0.870**	**0.865**	**0.861**
	Upper 95%	0.954	0.921	0.901	0.889	0.883	0.878	0.875
1400	Lower 95%	0.947	0.905	0.879	0.863	0.850	0.844	0.840
	Median	**0.950**	**0.912**	**0.889**	**0.875**	**0.866**	**0.860**	**0.856**
	Upper 95%	0.952	0.917	0.898	0.885	0.877	0.873	0.869
1450	Lower 95%	0.945	0.901	0.874	0.856	0.845	0.838	0.834
	Median	**0.948**	**0.909**	**0.885**	**0.870**	**0.860**	**0.854**	**0.850**
	Upper 95%	0.951	0.915	0.894	0.881	0.873	0.869	0.866
1500	Lower 95%	0.943	0.898	0.870	0.852	0.840	0.832	0.828
	Median	**0.946**	**0.905**	**0.880**	**0.865**	**0.855**	**0.849**	**0.845**
	Upper 95%	0.949	0.912	0.890	0.877	0.869	0.863	0.860
1550	Lower 95%	0.941	0.895	0.866	0.847	0.835	0.825	0.821
	Median	**0.945**	**0.902**	**0.877**	**0.861**	**0.851**	**0.845**	**0.840**
	Upper 95%	0.947	0.909	0.887	0.873	0.865	0.860	0.856
1600	Lower 95%	0.939	0.891	0.861	0.842	0.828	0.820	0.816
	Median	**0.943**	**0.899**	**0.873**	**0.856**	**0.846**	**0.839**	**0.835**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.946	0.906	0.883	0.869	0.860	0.855	0.851

Table A2_8.2. Kittiwake, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.841	0.808	0.788	0.795	0.797	0.786	0.781
	Median	**0.999**	**1.004**	**1.003**	**0.996**	**0.992**	**0.997**	**0.993**
	Upper 95%	1.182	1.237	1.246	1.241	1.258	1.248	1.228
100	Lower 95%	0.846	0.810	0.802	0.796	0.782	0.790	0.789
	Median	**0.997**	**1.003**	**0.998**	**0.999**	**0.987**	**0.994**	**0.991**
	Upper 95%	1.202	1.230	1.269	1.257	1.249	1.257	1.237
150	Lower 95%	0.846	0.817	0.785	0.782	0.792	0.777	0.779
	Median	**1.000**	**0.998**	**0.993**	**0.996**	**0.989**	**0.985**	**0.976**
	Upper 95%	1.207	1.265	1.253	1.249	1.222	1.224	1.235
200	Lower 95%	0.831	0.803	0.798	0.794	0.786	0.770	0.775
	Median	**0.996**	**0.992**	**0.991**	**0.994**	**0.975**	**0.968**	**0.976**
	Upper 95%	1.190	1.205	1.219	1.234	1.219	1.230	1.218
250	Lower 95%	0.832	0.796	0.782	0.785	0.778	0.772	0.752
	Median	**0.988**	**0.995**	**0.988**	**0.985**	**0.979**	**0.968**	**0.966**
	Upper 95%	1.178	1.225	1.241	1.219	1.236	1.223	1.214
300	Lower 95%	0.824	0.783	0.776	0.775	0.769	0.756	0.762
	Median	**0.994**	**0.993**	**0.975**	**0.980**	**0.964**	**0.967**	**0.958**
	Upper 95%	1.188	1.219	1.236	1.229	1.220	1.218	1.247
350	Lower 95%	0.826	0.806	0.773	0.775	0.779	0.764	0.764
	Median	**0.992**	**0.983**	**0.974**	**0.971**	**0.965**	**0.964**	**0.959**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.183	1.220	1.224	1.227	1.199	1.218	1.197
400	Lower 95%	0.836	0.799	0.785	0.771	0.771	0.759	0.754
	Median	**0.990**	**0.986**	**0.966**	**0.970**	**0.961**	**0.958**	**0.956**
	Upper 95%	1.171	1.190	1.216	1.208	1.210	1.190	1.202
450	Lower 95%	0.823	0.785	0.771	0.761	0.769	0.761	0.746
	Median	**0.986**	**0.973**	**0.967**	**0.965**	**0.954**	**0.952**	**0.945**
	Upper 95%	1.174	1.199	1.197	1.206	1.204	1.182	1.180
500	Lower 95%	0.830	0.794	0.775	0.764	0.758	0.753	0.747
	Median	**0.986**	**0.974**	**0.965**	**0.962**	**0.948**	**0.947**	**0.949**
	Upper 95%	1.177	1.207	1.209	1.204	1.188	1.201	1.178
550	Lower 95%	0.822	0.780	0.755	0.765	0.760	0.737	0.746
	Median	**0.981**	**0.970**	**0.960**	**0.949**	**0.944**	**0.946**	**0.938**
	Upper 95%	1.164	1.194	1.198	1.206	1.191	1.182	1.183
600	Lower 95%	0.818	0.776	0.770	0.761	0.758	0.744	0.734
	Median	**0.987**	**0.968**	**0.960**	**0.952**	**0.942**	**0.937**	**0.931**
	Upper 95%	1.165	1.193	1.195	1.195	1.175	1.178	1.162
650	Lower 95%	0.819	0.787	0.755	0.752	0.752	0.743	0.736
	Median	**0.982**	**0.969**	**0.956**	**0.947**	**0.936**	**0.937**	**0.923**
	Upper 95%	1.166	1.179	1.194	1.194	1.171	1.156	1.176
700	Lower 95%	0.822	0.788	0.755	0.751	0.739	0.739	0.742
	Median	**0.976**	**0.963**	**0.948**	**0.940**	**0.922**	**0.925**	**0.925**
	Upper 95%	1.165	1.184	1.165	1.166	1.162	1.145	1.156
750	Lower 95%	0.826	0.786	0.755	0.741	0.735	0.733	0.714
	Median	**0.977**	**0.963**	**0.940**	**0.933**	**0.927**	**0.919**	**0.916**
	Upper 95%	1.155	1.180	1.197	1.170	1.162	1.141	1.167

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.815	0.778	0.758	0.750	0.741	0.741	0.734
	Median	**0.974**	**0.962**	**0.935**	**0.932**	**0.921**	**0.917**	**0.911**
	Upper 95%	1.162	1.186	1.157	1.165	1.143	1.133	1.127
850	Lower 95%	0.822	0.762	0.745	0.748	0.734	0.722	0.716
	Median	**0.978**	**0.954**	**0.934**	**0.927**	**0.912**	**0.908**	**0.909**
	Upper 95%	1.145	1.181	1.167	1.154	1.139	1.139	1.172
900	Lower 95%	0.809	0.773	0.755	0.737	0.723	0.712	0.712
	Median	**0.970**	**0.946**	**0.932**	**0.923**	**0.912**	**0.905**	**0.902**
	Upper 95%	1.153	1.173	1.149	1.161	1.141	1.145	1.135
950	Lower 95%	0.804	0.769	0.747	0.718	0.715	0.712	0.708
	Median	**0.969**	**0.948**	**0.930**	**0.921**	**0.906**	**0.901**	**0.893**
	Upper 95%	1.142	1.165	1.160	1.163	1.137	1.141	1.141
1000	Lower 95%	0.819	0.762	0.738	0.727	0.729	0.712	0.702
	Median	**0.967**	**0.944**	**0.926**	**0.927**	**0.901**	**0.899**	**0.890**
	Upper 95%	1.147	1.183	1.163	1.151	1.149	1.117	1.123
1050	Lower 95%	0.805	0.762	0.731	0.722	0.717	0.703	0.698
	Median	**0.963**	**0.940**	**0.918**	**0.913**	**0.903**	**0.887**	**0.890**
	Upper 95%	1.130	1.160	1.160	1.132	1.102	1.107	1.111
1100	Lower 95%	0.807	0.752	0.735	0.718	0.704	0.696	0.696
	Median	**0.957**	**0.933**	**0.918**	**0.905**	**0.892**	**0.888**	**0.877**
	Upper 95%	1.153	1.175	1.161	1.174	1.135	1.119	1.127
1150	Lower 95%	0.803	0.763	0.741	0.716	0.705	0.704	0.687
	Median	**0.962**	**0.935**	**0.916**	**0.906**	**0.888**	**0.886**	**0.877**
	Upper 95%	1.136	1.156	1.148	1.134	1.112	1.119	1.124
1200	Lower 95%	0.803	0.755	0.719	0.700	0.694	0.694	0.680

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.958**	**0.930**	**0.907**	**0.896**	**0.879**	**0.875**	**0.870**
	Upper 95%	1.138	1.143	1.139	1.127	1.102	1.109	1.133
1250	Lower 95%	0.809	0.759	0.716	0.717	0.705	0.685	0.696
	Median	**0.956**	**0.928**	**0.909**	**0.892**	**0.884**	**0.874**	**0.862**
	Upper 95%	1.139	1.141	1.121	1.114	1.104	1.097	1.072
1300	Lower 95%	0.785	0.733	0.715	0.706	0.693	0.689	0.665
	Median	**0.959**	**0.928**	**0.900**	**0.887**	**0.870**	**0.865**	**0.858**
	Upper 95%	1.139	1.127	1.127	1.113	1.101	1.100	1.093
1350	Lower 95%	0.792	0.750	0.712	0.697	0.684	0.671	0.677
	Median	**0.955**	**0.926**	**0.901**	**0.884**	**0.866**	**0.866**	**0.858**
	Upper 95%	1.129	1.118	1.121	1.113	1.101	1.071	1.077
1400	Lower 95%	0.796	0.748	0.714	0.699	0.694	0.681	0.666
	Median	**0.958**	**0.919**	**0.892**	**0.883**	**0.863**	**0.863**	**0.851**
	Upper 95%	1.128	1.125	1.113	1.098	1.104	1.067	1.066
1450	Lower 95%	0.792	0.729	0.710	0.687	0.675	0.677	0.665
	Median	**0.947**	**0.915**	**0.886**	**0.873**	**0.853**	**0.855**	**0.848**
	Upper 95%	1.135	1.121	1.113	1.101	1.101	1.082	1.068
1500	Lower 95%	0.794	0.737	0.698	0.683	0.670	0.666	0.669
	Median	**0.949**	**0.909**	**0.881**	**0.864**	**0.853**	**0.845**	**0.841**
	Upper 95%	1.117	1.122	1.127	1.076	1.069	1.075	1.060
1550	Lower 95%	0.791	0.742	0.713	0.684	0.667	0.660	0.664
	Median	**0.947**	**0.910**	**0.886**	**0.868**	**0.849**	**0.839**	**0.832**
	Upper 95%	1.127	1.112	1.123	1.092	1.061	1.062	1.059
1600	Lower 95%	0.795	0.729	0.699	0.677	0.668	0.665	0.657
	Median	**0.946**	**0.905**	**0.876**	**0.858**	**0.843**	**0.835**	**0.830**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.138	1.124	1.103	1.079	1.062	1.049	1.059

Table A2_8.3. Kittiwake, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	1.000	1.000	1.000
100	1.000	1.000	1.000
150	1.000	1.000	1.000
200	0.999	1.000	1.000
250	0.999	0.999	1.000
300	0.999	0.999	0.999
350	0.999	0.999	0.999
400	0.999	0.999	0.999
450	0.999	0.999	0.999
500	0.999	0.999	0.999
550	0.999	0.999	0.999
600	0.998	0.999	0.999
650	0.998	0.999	0.999
700	0.998	0.998	0.999
750	0.998	0.998	0.999
800	0.998	0.998	0.998
850	0.998	0.998	0.998
900	0.997	0.998	0.998
950	0.997	0.998	0.998
1000	0.997	0.998	0.998
1050	0.997	0.997	0.998
1100	0.997	0.997	0.998
1150	0.997	0.997	0.998

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.997	0.997	0.998
1250	0.996	0.997	0.997
1300	0.996	0.997	0.997
1350	0.996	0.997	0.997
1400	0.996	0.997	0.997
1450	0.996	0.996	0.997
1500	0.996	0.996	0.997
1550	0.995	0.996	0.997
1600	0.995	0.996	0.997

Table A2_8.4. Kittiwake, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.991	1.000	1.009
100	0.991	1.000	1.009
150	0.990	0.999	1.008
200	0.990	0.999	1.008
250	0.990	0.999	1.009
300	0.990	0.999	1.009
350	0.990	0.999	1.009
400	0.989	0.999	1.008
450	0.989	0.999	1.008
500	0.989	0.998	1.008
550	0.989	0.998	1.008
600	0.989	0.998	1.008
650	0.989	0.998	1.008
700	0.989	0.998	1.007
750	0.988	0.998	1.008
800	0.989	0.998	1.007
850	0.988	0.998	1.007
900	0.988	0.997	1.006
950	0.988	0.997	1.007
1000	0.987	0.997	1.007
1050	0.987	0.997	1.007
1100	0.988	0.997	1.007
1150	0.987	0.997	1.007

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.987	0.997	1.007
1250	0.987	0.996	1.006
1300	0.987	0.996	1.007
1350	0.987	0.996	1.006
1400	0.987	0.996	1.006
1450	0.987	0.996	1.006
1500	0.987	0.996	1.006
1550	0.986	0.996	1.006
1600	0.986	0.996	1.006

Table A2_9.1. Guillemot, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.998	0.995	0.992	0.989	0.986	0.983	0.980
	Median	**0.998**	**0.995**	**0.992**	**0.989**	**0.986**	**0.983**	**0.980**
	Upper 95%	0.998	0.995	0.992	0.989	0.986	0.983	0.980
100	Lower 95%	0.995	0.989	0.983	0.977	0.971	0.966	0.960
	Median	**0.995**	**0.989**	**0.983**	**0.977**	**0.972**	**0.966**	**0.960**
	Upper 95%	0.995	0.989	0.983	0.978	0.972	0.966	0.960
150	Lower 95%	0.993	0.984	0.975	0.966	0.957	0.949	0.940
	Median	**0.993**	**0.984**	**0.975**	**0.966**	**0.958**	**0.949**	**0.940**
	Upper 95%	0.993	0.984	0.975	0.966	0.958	0.949	0.941
200	Lower 95%	0.990	0.978	0.967	0.955	0.944	0.932	0.921
	Median	**0.990**	**0.979**	**0.967**	**0.955**	**0.944**	**0.933**	**0.921**
	Upper 95%	0.991	0.979	0.967	0.955	0.944	0.933	0.922
250	Lower 95%	0.988	0.973	0.959	0.944	0.930	0.916	0.902
	Median	**0.988**	**0.973**	**0.959**	**0.944**	**0.930**	**0.916**	**0.903**
	Upper 95%	0.988	0.973	0.959	0.945	0.931	0.917	0.903
300	Lower 95%	0.986	0.968	0.950	0.933	0.917	0.900	0.884
	Median	**0.986**	**0.968**	**0.951**	**0.934**	**0.917**	**0.901**	**0.884**
	Upper 95%	0.986	0.968	0.951	0.934	0.917	0.901	0.885
350	Lower 95%	0.983	0.963	0.942	0.923	0.903	0.885	0.866
	Median	**0.983**	**0.963**	**0.943**	**0.923**	**0.904**	**0.885**	**0.866**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.983	0.963	0.943	0.923	0.904	0.885	0.867
400	Lower 95%	0.981	0.957	0.934	0.912	0.890	0.869	0.848
	Median	**0.981**	**0.958**	**0.935**	**0.913**	**0.891**	**0.870**	**0.849**
	Upper 95%	0.981	0.958	0.935	0.913	0.891	0.870	0.849
450	Lower 95%	0.978	0.952	0.927	0.902	0.878	0.854	0.831
	Median	**0.979**	**0.952**	**0.927**	**0.902**	**0.878**	**0.854**	**0.832**
	Upper 95%	0.979	0.953	0.927	0.902	0.878	0.855	0.832
500	Lower 95%	0.976	0.947	0.919	0.891	0.865	0.839	0.814
	Median	**0.976**	**0.947**	**0.919**	**0.892**	**0.865**	**0.840**	**0.815**
	Upper 95%	0.976	0.947	0.919	0.892	0.866	0.840	0.815
550	Lower 95%	0.974	0.942	0.911	0.881	0.852	0.825	0.798
	Median	**0.974**	**0.942**	**0.911**	**0.882**	**0.853**	**0.825**	**0.798**
	Upper 95%	0.974	0.942	0.912	0.882	0.853	0.826	0.799
600	Lower 95%	0.971	0.937	0.903	0.871	0.840	0.810	0.781
	Median	**0.971**	**0.937**	**0.904**	**0.872**	**0.841**	**0.811**	**0.782**
	Upper 95%	0.972	0.937	0.904	0.872	0.841	0.811	0.782
650	Lower 95%	0.969	0.931	0.896	0.861	0.828	0.796	0.765
	Median	**0.969**	**0.932**	**0.896**	**0.862**	**0.828**	**0.797**	**0.766**
	Upper 95%	0.969	0.932	0.896	0.862	0.829	0.797	0.767
700	Lower 95%	0.966	0.926	0.888	0.851	0.816	0.782	0.750
	Median	**0.967**	**0.927**	**0.888**	**0.852**	**0.816**	**0.783**	**0.750**
	Upper 95%	0.967	0.927	0.889	0.852	0.817	0.783	0.751
750	Lower 95%	0.964	0.921	0.880	0.841	0.804	0.768	0.734
	Median	**0.964**	**0.922**	**0.881**	**0.842**	**0.805**	**0.769**	**0.735**
	Upper 95%	0.965	0.922	0.881	0.843	0.805	0.770	0.736

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.962	0.916	0.873	0.832	0.792	0.755	0.719
	Median	**0.962**	**0.917**	**0.873**	**0.832**	**0.793**	**0.756**	**0.720**
	Upper 95%	0.962	0.917	0.874	0.833	0.794	0.756	0.721
850	Lower 95%	0.959	0.911	0.866	0.822	0.781	0.742	0.705
	Median	**0.960**	**0.912**	**0.866**	**0.823**	**0.782**	**0.742**	**0.705**
	Upper 95%	0.960	0.912	0.867	0.823	0.782	0.743	0.706
900	Lower 95%	0.957	0.906	0.858	0.813	0.770	0.729	0.690
	Median	**0.957**	**0.907**	**0.859**	**0.813**	**0.770**	**0.730**	**0.691**
	Upper 95%	0.958	0.907	0.859	0.814	0.771	0.730	0.692
950	Lower 95%	0.955	0.901	0.851	0.803	0.758	0.716	0.676
	Median	**0.955**	**0.902**	**0.851**	**0.804**	**0.759**	**0.717**	**0.677**
	Upper 95%	0.955	0.902	0.852	0.805	0.760	0.718	0.678
1000	Lower 95%	0.952	0.896	0.844	0.794	0.747	0.703	0.662
	Median	**0.953**	**0.897**	**0.844**	**0.795**	**0.748**	**0.704**	**0.663**
	Upper 95%	0.953	0.897	0.845	0.796	0.749	0.705	0.664
1050	Lower 95%	0.950	0.891	0.836	0.785	0.736	0.691	0.649
	Median	**0.950**	**0.892**	**0.837**	**0.786**	**0.737**	**0.692**	**0.649**
	Upper 95%	0.951	0.893	0.838	0.786	0.738	0.693	0.650
1100	Lower 95%	0.948	0.887	0.829	0.776	0.726	0.679	0.635
	Median	**0.948**	**0.887**	**0.830**	**0.777**	**0.727**	**0.680**	**0.636**
	Upper 95%	0.949	0.888	0.831	0.777	0.727	0.681	0.637
1150	Lower 95%	0.945	0.882	0.822	0.767	0.715	0.667	0.622
	Median	**0.946**	**0.882**	**0.823**	**0.768**	**0.716**	**0.668**	**0.623**
	Upper 95%	0.946	0.883	0.824	0.768	0.717	0.669	0.624
1200	Lower 95%	0.943	0.877	0.815	0.758	0.705	0.655	0.609

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.944**	**0.877**	**0.816**	**0.759**	**0.706**	**0.656**	**0.610**
	Upper 95%	0.944	0.878	0.817	0.760	0.707	0.657	0.611
1250	Lower 95%	0.941	0.872	0.808	0.749	0.695	0.644	0.597
	Median	**0.941**	**0.873**	**0.809**	**0.750**	**0.695**	**0.645**	**0.598**
	Upper 95%	0.942	0.873	0.810	0.751	0.696	0.646	0.599
1300	Lower 95%	0.938	0.867	0.801	0.741	0.684	0.632	0.585
	Median	**0.939**	**0.868**	**0.802**	**0.741**	**0.685**	**0.633**	**0.585**
	Upper 95%	0.939	0.869	0.803	0.742	0.686	0.634	0.586
1350	Lower 95%	0.936	0.862	0.795	0.732	0.674	0.621	0.572
	Median	**0.937**	**0.863**	**0.795**	**0.733**	**0.675**	**0.622**	**0.573**
	Upper 95%	0.937	0.864	0.796	0.734	0.676	0.623	0.574
1400	Lower 95%	0.934	0.858	0.788	0.724	0.665	0.610	0.561
	Median	**0.934**	**0.858**	**0.789**	**0.724**	**0.665**	**0.611**	**0.562**
	Upper 95%	0.935	0.859	0.789	0.725	0.666	0.612	0.563
1450	Lower 95%	0.932	0.853	0.781	0.715	0.655	0.600	0.549
	Median	**0.932**	**0.854**	**0.782**	**0.716**	**0.656**	**0.601**	**0.550**
	Upper 95%	0.933	0.854	0.783	0.717	0.657	0.602	0.551
1500	Lower 95%	0.929	0.848	0.774	0.707	0.645	0.589	0.538
	Median	**0.930**	**0.849**	**0.775**	**0.708**	**0.646**	**0.590**	**0.539**
	Upper 95%	0.930	0.850	0.776	0.709	0.647	0.591	0.540
1550	Lower 95%	0.927	0.844	0.768	0.699	0.636	0.579	0.527
	Median	**0.928**	**0.844**	**0.769**	**0.700**	**0.637**	**0.580**	**0.528**
	Upper 95%	0.928	0.845	0.770	0.701	0.638	0.581	0.529
1600	Lower 95%	0.925	0.839	0.761	0.691	0.626	0.568	0.516
	Median	**0.925**	**0.840**	**0.762**	**0.691**	**0.628**	**0.569**	**0.517**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.926	0.841	0.763	0.693	0.629	0.571	0.518

Table A2_9.2. Guillemot, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.950	0.926	0.911	0.897	0.880	0.867	0.860
	Median	**0.997**	**0.996**	**0.992**	**0.987**	**0.986**	**0.982**	**0.980**
	Upper 95%	1.045	1.069	1.083	1.092	1.095	1.106	1.111
100	Lower 95%	0.947	0.919	0.900	0.886	0.868	0.849	0.837
	Median	**0.995**	**0.989**	**0.984**	**0.973**	**0.969**	**0.965**	**0.956**
	Upper 95%	1.038	1.064	1.072	1.077	1.077	1.087	1.089
150	Lower 95%	0.945	0.915	0.893	0.872	0.855	0.837	0.820
	Median	**0.993**	**0.983**	**0.975**	**0.965**	**0.956**	**0.947**	**0.941**
	Upper 95%	1.041	1.058	1.063	1.074	1.077	1.078	1.085
200	Lower 95%	0.944	0.907	0.884	0.861	0.834	0.811	0.793
	Median	**0.990**	**0.978**	**0.967**	**0.955**	**0.940**	**0.928**	**0.919**
	Upper 95%	1.037	1.049	1.056	1.056	1.056	1.052	1.051
250	Lower 95%	0.939	0.906	0.874	0.844	0.827	0.808	0.784
	Median	**0.987**	**0.971**	**0.955**	**0.940**	**0.923**	**0.908**	**0.897**
	Upper 95%	1.033	1.045	1.042	1.040	1.037	1.038	1.038
300	Lower 95%	0.940	0.899	0.865	0.843	0.817	0.790	0.771
	Median	**0.985**	**0.966**	**0.951**	**0.932**	**0.915**	**0.897**	**0.883**
	Upper 95%	1.035	1.041	1.039	1.032	1.030	1.024	1.015
350	Lower 95%	0.935	0.894	0.864	0.836	0.809	0.784	0.753
	Median	**0.983**	**0.962**	**0.943**	**0.922**	**0.901**	**0.883**	**0.865**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.029	1.034	1.032	1.024	1.010	0.993	0.986
400	Lower 95%	0.937	0.893	0.857	0.827	0.796	0.769	0.744
	Median	**0.982**	**0.957**	**0.935**	**0.911**	**0.888**	**0.867**	**0.848**
	Upper 95%	1.027	1.024	1.020	1.012	0.990	0.971	0.969
450	Lower 95%	0.931	0.886	0.850	0.811	0.780	0.749	0.721
	Median	**0.978**	**0.951**	**0.924**	**0.900**	**0.874**	**0.851**	**0.830**
	Upper 95%	1.028	1.024	1.023	1.003	0.992	0.972	0.946
500	Lower 95%	0.930	0.877	0.840	0.801	0.768	0.736	0.708
	Median	**0.975**	**0.945**	**0.918**	**0.891**	**0.863**	**0.838**	**0.815**
	Upper 95%	1.023	1.019	1.001	0.986	0.964	0.947	0.925
550	Lower 95%	0.927	0.875	0.839	0.792	0.760	0.732	0.701
	Median	**0.974**	**0.941**	**0.910**	**0.880**	**0.850**	**0.823**	**0.795**
	Upper 95%	1.022	1.011	0.992	0.971	0.948	0.920	0.908
600	Lower 95%	0.924	0.870	0.828	0.793	0.750	0.721	0.683
	Median	**0.972**	**0.937**	**0.902**	**0.869**	**0.842**	**0.812**	**0.781**
	Upper 95%	1.018	1.004	0.991	0.963	0.937	0.909	0.890
650	Lower 95%	0.921	0.869	0.821	0.772	0.734	0.700	0.672
	Median	**0.969**	**0.931**	**0.896**	**0.861**	**0.827**	**0.794**	**0.764**
	Upper 95%	1.017	1.004	0.982	0.956	0.929	0.909	0.879
700	Lower 95%	0.921	0.862	0.819	0.773	0.731	0.690	0.659
	Median	**0.967**	**0.926**	**0.889**	**0.851**	**0.815**	**0.781**	**0.750**
	Upper 95%	1.011	0.994	0.967	0.938	0.911	0.883	0.857
750	Lower 95%	0.919	0.859	0.809	0.763	0.721	0.679	0.646
	Median	**0.965**	**0.922**	**0.881**	**0.841**	**0.803**	**0.767**	**0.733**
	Upper 95%	1.007	0.988	0.961	0.927	0.903	0.867	0.836

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.917	0.854	0.801	0.754	0.713	0.668	0.630
	Median	**0.961**	**0.917**	**0.874**	**0.833**	**0.792**	**0.755**	**0.719**
	Upper 95%	1.005	0.984	0.952	0.922	0.889	0.852	0.817
850	Lower 95%	0.917	0.850	0.796	0.746	0.699	0.650	0.615
	Median	**0.960**	**0.910**	**0.866**	**0.821**	**0.781**	**0.741**	**0.705**
	Upper 95%	1.004	0.981	0.938	0.904	0.868	0.835	0.803
900	Lower 95%	0.912	0.842	0.786	0.731	0.690	0.645	0.603
	Median	**0.958**	**0.907**	**0.858**	**0.813**	**0.770**	**0.728**	**0.690**
	Upper 95%	1.005	0.973	0.940	0.897	0.863	0.823	0.788
950	Lower 95%	0.911	0.838	0.774	0.721	0.673	0.632	0.588
	Median	**0.956**	**0.902**	**0.853**	**0.807**	**0.758**	**0.716**	**0.676**
	Upper 95%	0.999	0.964	0.929	0.886	0.853	0.814	0.783
1000	Lower 95%	0.909	0.838	0.781	0.726	0.672	0.629	0.584
	Median	**0.952**	**0.897**	**0.845**	**0.794**	**0.746**	**0.703**	**0.662**
	Upper 95%	0.998	0.966	0.920	0.878	0.833	0.799	0.759
1050	Lower 95%	0.905	0.832	0.764	0.706	0.655	0.609	0.567
	Median	**0.950**	**0.892**	**0.838**	**0.785**	**0.737**	**0.692**	**0.650**
	Upper 95%	0.995	0.959	0.914	0.872	0.822	0.776	0.737
1100	Lower 95%	0.903	0.825	0.760	0.697	0.642	0.593	0.553
	Median	**0.948**	**0.886**	**0.828**	**0.774**	**0.723**	**0.678**	**0.634**
	Upper 95%	0.993	0.954	0.909	0.861	0.814	0.764	0.724
1150	Lower 95%	0.900	0.821	0.759	0.697	0.643	0.591	0.545
	Median	**0.945**	**0.882**	**0.824**	**0.766**	**0.716**	**0.666**	**0.620**
	Upper 95%	0.994	0.951	0.901	0.851	0.798	0.760	0.712
1200	Lower 95%	0.899	0.818	0.750	0.685	0.630	0.581	0.536

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.943**	**0.877**	**0.814**	**0.757**	**0.703**	**0.653**	**0.607**
	Upper 95%	0.991	0.942	0.884	0.835	0.782	0.737	0.690
1250	Lower 95%	0.897	0.811	0.738	0.673	0.616	0.573	0.521
	Median	**0.941**	**0.873**	**0.809**	**0.750**	**0.693**	**0.644**	**0.597**
	Upper 95%	0.987	0.936	0.883	0.827	0.771	0.722	0.676
1300	Lower 95%	0.893	0.807	0.736	0.668	0.610	0.559	0.511
	Median	**0.938**	**0.869**	**0.804**	**0.739**	**0.683**	**0.632**	**0.584**
	Upper 95%	0.985	0.936	0.876	0.821	0.768	0.717	0.671
1350	Lower 95%	0.891	0.802	0.727	0.662	0.604	0.549	0.499
	Median	**0.938**	**0.862**	**0.795**	**0.733**	**0.672**	**0.620**	**0.571**
	Upper 95%	0.982	0.927	0.867	0.812	0.756	0.703	0.655
1400	Lower 95%	0.890	0.795	0.717	0.651	0.595	0.538	0.486
	Median	**0.933**	**0.857**	**0.787**	**0.722**	**0.662**	**0.607**	**0.559**
	Upper 95%	0.979	0.916	0.859	0.795	0.736	0.686	0.635
1450	Lower 95%	0.888	0.798	0.717	0.646	0.586	0.533	0.485
	Median	**0.933**	**0.852**	**0.781**	**0.715**	**0.653**	**0.599**	**0.548**
	Upper 95%	0.980	0.922	0.855	0.793	0.731	0.686	0.627
1500	Lower 95%	0.885	0.790	0.712	0.642	0.581	0.524	0.471
	Median	**0.931**	**0.849**	**0.776**	**0.709**	**0.645**	**0.589**	**0.538**
	Upper 95%	0.974	0.911	0.848	0.784	0.723	0.669	0.619
1550	Lower 95%	0.883	0.785	0.709	0.639	0.569	0.513	0.461
	Median	**0.927**	**0.842**	**0.769**	**0.698**	**0.634**	**0.578**	**0.525**
	Upper 95%	0.971	0.907	0.837	0.769	0.710	0.654	0.602
1600	Lower 95%	0.880	0.781	0.697	0.626	0.559	0.504	0.452
	Median	**0.926**	**0.840**	**0.760**	**0.691**	**0.626**	**0.567**	**0.512**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.968	0.905	0.834	0.767	0.702	0.646	0.596

Table A2_9.3. Guillemot, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.999	0.999	0.999
100	0.999	0.999	0.999
150	0.998	0.998	0.998
200	0.998	0.998	0.998
250	0.997	0.997	0.997
300	0.996	0.996	0.996
350	0.996	0.996	0.996
400	0.995	0.995	0.995
450	0.995	0.995	0.995
500	0.994	0.994	0.994
550	0.993	0.993	0.993
600	0.993	0.993	0.993
650	0.992	0.992	0.992
700	0.992	0.992	0.992
750	0.991	0.991	0.991
800	0.990	0.990	0.990
850	0.990	0.990	0.990
900	0.989	0.989	0.989
950	0.989	0.989	0.989
1000	0.988	0.988	0.988
1050	0.987	0.987	0.987
1100	0.987	0.987	0.987
1150	0.986	0.986	0.986

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.986	0.986	0.986
1250	0.985	0.985	0.985
1300	0.984	0.984	0.984
1350	0.984	0.984	0.984
1400	0.983	0.983	0.983
1450	0.983	0.983	0.983
1500	0.982	0.982	0.982
1550	0.981	0.981	0.981
1600	0.981	0.981	0.981

Table A2_9.4. Guillemot, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.995	0.999	1.003
100	0.995	0.999	1.003
150	0.994	0.998	1.002
200	0.993	0.997	1.002
250	0.993	0.997	1.001
300	0.992	0.996	1.001
350	0.992	0.996	1.000
400	0.991	0.995	0.999
450	0.990	0.995	0.999
500	0.990	0.994	0.998
550	0.989	0.993	0.997
600	0.989	0.993	0.997
650	0.988	0.992	0.996
700	0.988	0.992	0.996
750	0.987	0.991	0.995
800	0.986	0.990	0.994
850	0.985	0.990	0.994
900	0.985	0.989	0.993
950	0.984	0.989	0.993
1000	0.984	0.988	0.992
1050	0.983	0.987	0.991
1100	0.982	0.987	0.991
1150	0.982	0.986	0.990

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.982	0.985	0.990
1250	0.981	0.985	0.989
1300	0.980	0.984	0.989
1350	0.980	0.984	0.988
1400	0.979	0.983	0.987
1450	0.979	0.982	0.987
1500	0.978	0.982	0.986
1550	0.977	0.981	0.985
1600	0.977	0.981	0.985

Table A2_10.1. Guillemot, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.998	0.996	0.994	0.993	0.992	0.992	0.991
	Median	**0.998**	**0.996**	**0.994**	**0.993**	**0.992**	**0.992**	**0.991**
	Upper 95%	0.998	0.996	0.995	0.993	0.993	0.992	0.991
100	Lower 95%	0.996	0.992	0.989	0.986	0.985	0.983	0.982
	Median	**0.996**	**0.992**	**0.989**	**0.987**	**0.985**	**0.983**	**0.982**
	Upper 95%	0.996	0.992	0.989	0.987	0.985	0.984	0.983
150	Lower 95%	0.994	0.988	0.983	0.980	0.977	0.975	0.973
	Median	**0.994**	**0.988**	**0.983**	**0.980**	**0.977**	**0.975**	**0.974**
	Upper 95%	0.994	0.988	0.984	0.980	0.978	0.976	0.974
200	Lower 95%	0.992	0.984	0.978	0.973	0.969	0.967	0.964
	Median	**0.992**	**0.984**	**0.978**	**0.973**	**0.970**	**0.967**	**0.965**
	Upper 95%	0.992	0.984	0.978	0.974	0.970	0.968	0.966
250	Lower 95%	0.990	0.980	0.972	0.966	0.962	0.958	0.956
	Median	**0.990**	**0.980**	**0.972**	**0.967**	**0.962**	**0.959**	**0.956**
	Upper 95%	0.990	0.980	0.973	0.967	0.963	0.960	0.957
300	Lower 95%	0.988	0.976	0.967	0.960	0.954	0.950	0.947
	Median	**0.988**	**0.976**	**0.967**	**0.960**	**0.955**	**0.951**	**0.948**
	Upper 95%	0.988	0.976	0.967	0.961	0.956	0.952	0.948
350	Lower 95%	0.985	0.972	0.961	0.953	0.947	0.942	0.938
	Median	**0.986**	**0.972**	**0.962**	**0.954**	**0.947**	**0.943**	**0.939**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.986	0.972	0.962	0.954	0.948	0.944	0.940
400	Lower 95%	0.983	0.968	0.956	0.946	0.939	0.934	0.929
	Median	**0.984**	**0.968**	**0.956**	**0.947**	**0.940**	**0.935**	**0.931**
	Upper 95%	0.984	0.968	0.957	0.948	0.941	0.936	0.932
450	Lower 95%	0.981	0.964	0.950	0.940	0.932	0.926	0.921
	Median	**0.982**	**0.964**	**0.951**	**0.941**	**0.933**	**0.927**	**0.922**
	Upper 95%	0.982	0.965	0.951	0.941	0.934	0.928	0.923
500	Lower 95%	0.979	0.960	0.945	0.933	0.924	0.917	0.912
	Median	**0.980**	**0.960**	**0.945**	**0.934**	**0.925**	**0.919**	**0.914**
	Upper 95%	0.980	0.961	0.946	0.935	0.927	0.920	0.915
550	Lower 95%	0.977	0.956	0.939	0.927	0.917	0.909	0.904
	Median	**0.978**	**0.956**	**0.940**	**0.928**	**0.918**	**0.911**	**0.905**
	Upper 95%	0.978	0.957	0.941	0.929	0.919	0.912	0.907
600	Lower 95%	0.975	0.952	0.934	0.920	0.909	0.901	0.895
	Median	**0.975**	**0.952**	**0.935**	**0.921**	**0.911**	**0.903**	**0.897**
	Upper 95%	0.976	0.953	0.936	0.922	0.912	0.904	0.898
650	Lower 95%	0.973	0.948	0.928	0.914	0.902	0.893	0.887
	Median	**0.973**	**0.948**	**0.929**	**0.915**	**0.904**	**0.895**	**0.888**
	Upper 95%	0.974	0.949	0.930	0.916	0.905	0.897	0.890
700	Lower 95%	0.971	0.944	0.923	0.907	0.895	0.886	0.878
	Median	**0.971**	**0.945**	**0.924**	**0.908**	**0.896**	**0.887**	**0.880**
	Upper 95%	0.972	0.945	0.925	0.910	0.898	0.889	0.882
750	Lower 95%	0.969	0.940	0.918	0.901	0.888	0.878	0.870
	Median	**0.969**	**0.941**	**0.919**	**0.902**	**0.889**	**0.879**	**0.872**
	Upper 95%	0.970	0.941	0.920	0.903	0.891	0.881	0.874

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.967	0.936	0.912	0.894	0.880	0.870	0.861
	Median	**0.967**	**0.937**	**0.914**	**0.896**	**0.882**	**0.872**	**0.863**
	Upper 95%	0.968	0.937	0.915	0.897	0.884	0.874	0.866
850	Lower 95%	0.965	0.932	0.907	0.888	0.873	0.862	0.853
	Median	**0.965**	**0.933**	**0.908**	**0.889**	**0.875**	**0.864**	**0.855**
	Upper 95%	0.966	0.934	0.909	0.891	0.877	0.866	0.857
900	Lower 95%	0.963	0.928	0.902	0.882	0.866	0.854	0.845
	Median	**0.963**	**0.929**	**0.903**	**0.883**	**0.868**	**0.856**	**0.847**
	Upper 95%	0.964	0.930	0.904	0.885	0.870	0.858	0.850
950	Lower 95%	0.961	0.924	0.896	0.875	0.859	0.846	0.836
	Median	**0.961**	**0.925**	**0.898**	**0.877**	**0.861**	**0.848**	**0.839**
	Upper 95%	0.962	0.926	0.899	0.879	0.863	0.851	0.841
1000	Lower 95%	0.959	0.920	0.891	0.869	0.852	0.838	0.828
	Median	**0.959**	**0.921**	**0.893**	**0.871**	**0.854**	**0.841**	**0.831**
	Upper 95%	0.960	0.922	0.894	0.872	0.856	0.843	0.833
1050	Lower 95%	0.957	0.916	0.886	0.863	0.845	0.831	0.820
	Median	**0.957**	**0.918**	**0.887**	**0.864**	**0.847**	**0.833**	**0.823**
	Upper 95%	0.958	0.918	0.889	0.866	0.849	0.836	0.825
1100	Lower 95%	0.955	0.913	0.881	0.856	0.838	0.823	0.812
	Median	**0.955**	**0.914**	**0.882**	**0.858**	**0.840**	**0.826**	**0.815**
	Upper 95%	0.956	0.915	0.884	0.860	0.842	0.828	0.817
1150	Lower 95%	0.953	0.909	0.876	0.850	0.831	0.815	0.804
	Median	**0.953**	**0.910**	**0.877**	**0.852**	**0.833**	**0.818**	**0.807**
	Upper 95%	0.954	0.911	0.879	0.854	0.835	0.821	0.810
1200	Lower 95%	0.951	0.905	0.870	0.844	0.824	0.808	0.795

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.951**	**0.906**	**0.872**	**0.846**	**0.826**	**0.811**	**0.799**
	Upper 95%	0.952	0.907	0.874	0.848	0.829	0.813	0.802
1250	Lower 95%	0.949	0.901	0.865	0.838	0.817	0.800	0.788
	Median	**0.949**	**0.902**	**0.867**	**0.840**	**0.819**	**0.803**	**0.791**
	Upper 95%	0.950	0.904	0.869	0.842	0.822	0.806	0.794
1300	Lower 95%	0.947	0.897	0.860	0.831	0.810	0.792	0.779
	Median	**0.947**	**0.899**	**0.862**	**0.834**	**0.812**	**0.796**	**0.783**
	Upper 95%	0.948	0.900	0.863	0.836	0.815	0.799	0.786
1350	Lower 95%	0.945	0.893	0.855	0.826	0.803	0.785	0.772
	Median	**0.945**	**0.895**	**0.857**	**0.828**	**0.805**	**0.788**	**0.775**
	Upper 95%	0.946	0.896	0.858	0.830	0.808	0.791	0.778
1400	Lower 95%	0.943	0.890	0.850	0.819	0.796	0.778	0.763
	Median	**0.943**	**0.891**	**0.852**	**0.822**	**0.799**	**0.781**	**0.767**
	Upper 95%	0.944	0.892	0.853	0.824	0.801	0.784	0.770
1450	Lower 95%	0.941	0.886	0.845	0.813	0.789	0.770	0.755
	Median	**0.941**	**0.887**	**0.847**	**0.816**	**0.792**	**0.773**	**0.759**
	Upper 95%	0.942	0.889	0.848	0.818	0.795	0.777	0.762
1500	Lower 95%	0.939	0.882	0.840	0.807	0.782	0.763	0.747
	Median	**0.939**	**0.883**	**0.842**	**0.810**	**0.785**	**0.766**	**0.751**
	Upper 95%	0.940	0.885	0.843	0.812	0.788	0.769	0.755
1550	Lower 95%	0.937	0.878	0.835	0.801	0.775	0.755	0.740
	Median	**0.937**	**0.880**	**0.837**	**0.804**	**0.779**	**0.759**	**0.744**
	Upper 95%	0.938	0.881	0.839	0.806	0.781	0.762	0.747
1600	Lower 95%	0.935	0.875	0.829	0.795	0.769	0.748	0.732
	Median	**0.935**	**0.876**	**0.831**	**0.798**	**0.772**	**0.751**	**0.736**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.936	0.877	0.833	0.800	0.775	0.755	0.740

Table A2_10.2. Guillemot, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.952	0.939	0.932	0.926	0.923	0.927	0.921
	Median	**0.998**	**0.995**	**0.994**	**0.994**	**0.993**	**0.992**	**0.991**
	Upper 95%	1.041	1.055	1.064	1.066	1.069	1.068	1.068
100	Lower 95%	0.949	0.936	0.928	0.920	0.918	0.915	0.915
	Median	**0.996**	**0.992**	**0.988**	**0.986**	**0.984**	**0.982**	**0.982**
	Upper 95%	1.044	1.053	1.061	1.062	1.062	1.058	1.058
150	Lower 95%	0.950	0.933	0.922	0.915	0.909	0.906	0.906
	Median	**0.994**	**0.987**	**0.984**	**0.979**	**0.976**	**0.977**	**0.976**
	Upper 95%	1.041	1.053	1.051	1.060	1.055	1.056	1.058
200	Lower 95%	0.948	0.933	0.920	0.906	0.904	0.905	0.898
	Median	**0.991**	**0.985**	**0.980**	**0.975**	**0.971**	**0.969**	**0.965**
	Upper 95%	1.038	1.043	1.045	1.047	1.047	1.046	1.042
250	Lower 95%	0.947	0.928	0.913	0.899	0.894	0.894	0.890
	Median	**0.990**	**0.980**	**0.973**	**0.968**	**0.964**	**0.960**	**0.957**
	Upper 95%	1.035	1.039	1.044	1.045	1.032	1.031	1.028
300	Lower 95%	0.942	0.920	0.906	0.895	0.888	0.888	0.883
	Median	**0.986**	**0.976**	**0.967**	**0.962**	**0.957**	**0.951**	**0.948**
	Upper 95%	1.033	1.036	1.034	1.034	1.027	1.020	1.023
350	Lower 95%	0.941	0.916	0.904	0.889	0.882	0.874	0.870
	Median	**0.985**	**0.971**	**0.960**	**0.954**	**0.947**	**0.943**	**0.940**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.029	1.032	1.028	1.024	1.019	1.020	1.017
400	Lower 95%	0.937	0.913	0.896	0.880	0.871	0.869	0.866
	Median	**0.984**	**0.967**	**0.956**	**0.948**	**0.942**	**0.936**	**0.933**
	Upper 95%	1.028	1.030	1.023	1.015	1.015	1.009	1.003
450	Lower 95%	0.935	0.905	0.888	0.879	0.869	0.863	0.855
	Median	**0.981**	**0.964**	**0.950**	**0.942**	**0.933**	**0.927**	**0.921**
	Upper 95%	1.024	1.018	1.015	1.014	1.006	0.998	0.994
500	Lower 95%	0.935	0.905	0.887	0.874	0.863	0.850	0.849
	Median	**0.980**	**0.959**	**0.944**	**0.933**	**0.926**	**0.919**	**0.912**
	Upper 95%	1.024	1.016	1.005	1.003	0.994	0.991	0.980
550	Lower 95%	0.933	0.908	0.883	0.869	0.854	0.847	0.841
	Median	**0.977**	**0.955**	**0.939**	**0.928**	**0.919**	**0.911**	**0.905**
	Upper 95%	1.023	1.011	1.001	0.994	0.986	0.982	0.970
600	Lower 95%	0.933	0.901	0.878	0.856	0.842	0.839	0.837
	Median	**0.975**	**0.953**	**0.937**	**0.922**	**0.914**	**0.903**	**0.897**
	Upper 95%	1.023	1.008	0.998	0.991	0.982	0.978	0.973
650	Lower 95%	0.930	0.899	0.877	0.851	0.840	0.830	0.828
	Median	**0.975**	**0.948**	**0.930**	**0.916**	**0.904**	**0.897**	**0.888**
	Upper 95%	1.017	1.006	0.991	0.985	0.972	0.967	0.956
700	Lower 95%	0.929	0.892	0.870	0.850	0.836	0.826	0.819
	Median	**0.972**	**0.945**	**0.925**	**0.910**	**0.899**	**0.889**	**0.881**
	Upper 95%	1.016	1.003	0.988	0.980	0.966	0.957	0.948
750	Lower 95%	0.928	0.890	0.862	0.840	0.826	0.820	0.814
	Median	**0.969**	**0.941**	**0.919**	**0.904**	**0.890**	**0.880**	**0.872**
	Upper 95%	1.015	1.000	0.987	0.967	0.956	0.948	0.938

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.923	0.885	0.860	0.836	0.820	0.810	0.803
	Median	**0.966**	**0.935**	**0.912**	**0.894**	**0.881**	**0.871**	**0.865**
	Upper 95%	1.014	0.993	0.976	0.964	0.947	0.939	0.929
850	Lower 95%	0.922	0.882	0.852	0.830	0.814	0.804	0.796
	Median	**0.965**	**0.932**	**0.909**	**0.889**	**0.875**	**0.864**	**0.855**
	Upper 95%	1.011	0.993	0.973	0.959	0.939	0.930	0.921
900	Lower 95%	0.921	0.878	0.848	0.824	0.810	0.797	0.785
	Median	**0.963**	**0.929**	**0.904**	**0.883**	**0.869**	**0.857**	**0.847**
	Upper 95%	1.008	0.989	0.967	0.951	0.934	0.922	0.915
950	Lower 95%	0.917	0.873	0.841	0.817	0.802	0.788	0.783
	Median	**0.961**	**0.925**	**0.897**	**0.877**	**0.862**	**0.849**	**0.838**
	Upper 95%	1.006	0.982	0.964	0.944	0.926	0.918	0.904
1000	Lower 95%	0.914	0.869	0.838	0.810	0.792	0.783	0.772
	Median	**0.959**	**0.921**	**0.891**	**0.868**	**0.855**	**0.841**	**0.830**
	Upper 95%	1.005	0.979	0.950	0.931	0.918	0.908	0.894
1050	Lower 95%	0.917	0.867	0.834	0.809	0.787	0.773	0.766
	Median	**0.956**	**0.919**	**0.887**	**0.865**	**0.849**	**0.835**	**0.823**
	Upper 95%	0.998	0.974	0.950	0.926	0.912	0.901	0.887
1100	Lower 95%	0.912	0.866	0.830	0.798	0.781	0.768	0.763
	Median	**0.954**	**0.913**	**0.882**	**0.859**	**0.839**	**0.825**	**0.814**
	Upper 95%	1.001	0.967	0.938	0.919	0.899	0.890	0.877
1150	Lower 95%	0.909	0.860	0.822	0.794	0.776	0.760	0.750
	Median	**0.953**	**0.909**	**0.877**	**0.852**	**0.833**	**0.819**	**0.807**
	Upper 95%	1.000	0.966	0.935	0.916	0.897	0.883	0.871
1200	Lower 95%	0.910	0.857	0.815	0.788	0.764	0.749	0.740

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.950**	**0.906**	**0.871**	**0.847**	**0.827**	**0.811**	**0.800**
	Upper 95%	0.997	0.964	0.930	0.911	0.888	0.875	0.864
1250	Lower 95%	0.908	0.854	0.812	0.780	0.760	0.750	0.734
	Median	**0.949**	**0.902**	**0.868**	**0.842**	**0.820**	**0.803**	**0.791**
	Upper 95%	0.994	0.960	0.929	0.903	0.881	0.868	0.852
1300	Lower 95%	0.902	0.849	0.806	0.773	0.752	0.736	0.726
	Median	**0.947**	**0.899**	**0.861**	**0.833**	**0.814**	**0.796**	**0.783**
	Upper 95%	0.989	0.957	0.922	0.897	0.873	0.858	0.842
1350	Lower 95%	0.906	0.846	0.804	0.773	0.747	0.730	0.721
	Median	**0.944**	**0.894**	**0.858**	**0.828**	**0.807**	**0.788**	**0.774**
	Upper 95%	0.990	0.951	0.919	0.891	0.875	0.855	0.834
1400	Lower 95%	0.904	0.843	0.800	0.767	0.741	0.725	0.710
	Median	**0.943**	**0.890**	**0.851**	**0.823**	**0.800**	**0.782**	**0.768**
	Upper 95%	0.985	0.949	0.916	0.889	0.862	0.841	0.826
1450	Lower 95%	0.900	0.840	0.796	0.761	0.734	0.718	0.706
	Median	**0.940**	**0.887**	**0.846**	**0.815**	**0.792**	**0.774**	**0.759**
	Upper 95%	0.984	0.941	0.903	0.874	0.850	0.833	0.817
1500	Lower 95%	0.899	0.835	0.792	0.756	0.732	0.712	0.698
	Median	**0.940**	**0.883**	**0.841**	**0.811**	**0.787**	**0.767**	**0.751**
	Upper 95%	0.982	0.934	0.900	0.874	0.845	0.825	0.807
1550	Lower 95%	0.893	0.829	0.782	0.749	0.723	0.707	0.691
	Median	**0.937**	**0.880**	**0.836**	**0.804**	**0.778**	**0.757**	**0.743**
	Upper 95%	0.981	0.931	0.892	0.861	0.839	0.824	0.801
1600	Lower 95%	0.895	0.828	0.779	0.747	0.722	0.704	0.689
	Median	**0.935**	**0.875**	**0.833**	**0.798**	**0.772**	**0.753**	**0.737**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.978	0.929	0.890	0.853	0.828	0.811	0.791

Table A2_10.3. Guillemot, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	1.000	1.000	1.000
100	1.000	1.000	1.000
150	0.999	0.999	0.999
200	0.999	0.999	0.999
250	0.999	0.999	0.999
300	0.999	0.999	0.999
350	0.998	0.998	0.998
400	0.998	0.998	0.998
450	0.998	0.998	0.998
500	0.998	0.998	0.998
550	0.997	0.997	0.997
600	0.997	0.997	0.997
650	0.997	0.997	0.997
700	0.997	0.997	0.997
750	0.996	0.996	0.997
800	0.996	0.996	0.996
850	0.996	0.996	0.996
900	0.996	0.996	0.996
950	0.995	0.995	0.996
1000	0.995	0.995	0.995
1050	0.995	0.995	0.995
1100	0.995	0.995	0.995
1150	0.994	0.994	0.995

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.994	0.994	0.994
1250	0.994	0.994	0.994
1300	0.994	0.994	0.994
1350	0.993	0.993	0.994
1400	0.993	0.993	0.993
1450	0.993	0.993	0.993
1500	0.992	0.993	0.993
1550	0.992	0.992	0.992
1600	0.992	0.992	0.992

Table A2_10.4. Guillemot, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.997	1.000	1.003
100	0.997	1.000	1.002
150	0.997	0.999	1.002
200	0.996	0.999	1.002
250	0.996	0.999	1.001
300	0.996	0.999	1.001
350	0.996	0.998	1.001
400	0.996	0.998	1.001
450	0.995	0.998	1.001
500	0.995	0.998	1.000
550	0.995	0.997	1.000
600	0.995	0.997	1.000
650	0.994	0.997	1.000
700	0.994	0.997	1.000
750	0.994	0.996	0.999
800	0.994	0.996	0.999
850	0.993	0.996	0.999
900	0.993	0.996	0.998
950	0.993	0.995	0.998
1000	0.993	0.995	0.998
1050	0.992	0.995	0.998
1100	0.992	0.995	0.997
1150	0.992	0.994	0.997

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.992	0.994	0.997
1250	0.991	0.994	0.997
1300	0.991	0.994	0.997
1350	0.991	0.993	0.996
1400	0.990	0.993	0.996
1450	0.990	0.993	0.996
1500	0.990	0.993	0.995
1550	0.990	0.992	0.995
1600	0.989	0.992	0.995

Table A2_11.1. Guillemot, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.998	0.995	0.992	0.989	0.986	0.983	0.980
	Median	**0.998**	**0.995**	**0.992**	**0.989**	**0.986**	**0.983**	**0.980**
	Upper 95%	0.998	0.995	0.992	0.989	0.986	0.983	0.980
100	Lower 95%	0.995	0.989	0.983	0.977	0.971	0.966	0.960
	Median	**0.995**	**0.989**	**0.983**	**0.977**	**0.972**	**0.966**	**0.960**
	Upper 95%	0.995	0.989	0.983	0.978	0.972	0.966	0.960
150	Lower 95%	0.993	0.984	0.975	0.966	0.957	0.949	0.940
	Median	**0.993**	**0.984**	**0.975**	**0.966**	**0.958**	**0.949**	**0.940**
	Upper 95%	0.993	0.984	0.975	0.966	0.958	0.949	0.941
200	Lower 95%	0.990	0.978	0.967	0.955	0.944	0.932	0.921
	Median	**0.990**	**0.979**	**0.967**	**0.955**	**0.944**	**0.933**	**0.921**
	Upper 95%	0.991	0.979	0.967	0.955	0.944	0.933	0.922
250	Lower 95%	0.988	0.973	0.959	0.944	0.930	0.916	0.902
	Median	**0.988**	**0.973**	**0.959**	**0.944**	**0.930**	**0.916**	**0.903**
	Upper 95%	0.988	0.973	0.959	0.945	0.931	0.917	0.903
300	Lower 95%	0.986	0.968	0.950	0.933	0.917	0.900	0.884
	Median	**0.986**	**0.968**	**0.951**	**0.934**	**0.917**	**0.901**	**0.884**
	Upper 95%	0.986	0.968	0.951	0.934	0.917	0.901	0.885
350	Lower 95%	0.983	0.963	0.942	0.923	0.903	0.885	0.866
	Median	**0.983**	**0.963**	**0.943**	**0.923**	**0.904**	**0.885**	**0.866**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.983	0.963	0.943	0.923	0.904	0.885	0.867
400	Lower 95%	0.981	0.957	0.934	0.912	0.890	0.869	0.848
	Median	**0.981**	**0.958**	**0.935**	**0.913**	**0.891**	**0.870**	**0.849**
	Upper 95%	0.981	0.958	0.935	0.913	0.891	0.870	0.849
450	Lower 95%	0.978	0.952	0.927	0.902	0.878	0.854	0.831
	Median	**0.979**	**0.952**	**0.927**	**0.902**	**0.878**	**0.854**	**0.832**
	Upper 95%	0.979	0.953	0.927	0.902	0.878	0.855	0.832
500	Lower 95%	0.976	0.947	0.919	0.891	0.865	0.839	0.814
	Median	**0.976**	**0.947**	**0.919**	**0.892**	**0.865**	**0.840**	**0.815**
	Upper 95%	0.976	0.947	0.919	0.892	0.866	0.840	0.815
550	Lower 95%	0.974	0.942	0.911	0.881	0.852	0.824	0.798
	Median	**0.974**	**0.942**	**0.911**	**0.882**	**0.853**	**0.825**	**0.798**
	Upper 95%	0.974	0.942	0.912	0.882	0.853	0.826	0.799
600	Lower 95%	0.971	0.937	0.903	0.871	0.840	0.810	0.781
	Median	**0.971**	**0.937**	**0.904**	**0.872**	**0.841**	**0.811**	**0.782**
	Upper 95%	0.972	0.937	0.904	0.872	0.841	0.811	0.782
650	Lower 95%	0.969	0.931	0.896	0.861	0.828	0.796	0.765
	Median	**0.969**	**0.932**	**0.896**	**0.862**	**0.828**	**0.797**	**0.766**
	Upper 95%	0.969	0.932	0.896	0.862	0.829	0.797	0.767
700	Lower 95%	0.966	0.926	0.888	0.851	0.816	0.782	0.750
	Median	**0.967**	**0.927**	**0.888**	**0.852**	**0.816**	**0.783**	**0.750**
	Upper 95%	0.967	0.927	0.889	0.852	0.817	0.783	0.751
750	Lower 95%	0.964	0.921	0.880	0.841	0.804	0.768	0.734
	Median	**0.964**	**0.922**	**0.881**	**0.842**	**0.805**	**0.769**	**0.735**
	Upper 95%	0.965	0.922	0.881	0.843	0.805	0.770	0.736

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.962	0.916	0.873	0.832	0.792	0.755	0.719
	Median	**0.962**	**0.917**	**0.873**	**0.832**	**0.793**	**0.756**	**0.720**
	Upper 95%	0.962	0.917	0.874	0.833	0.794	0.756	0.721
850	Lower 95%	0.959	0.911	0.865	0.822	0.781	0.742	0.705
	Median	**0.960**	**0.912**	**0.866**	**0.823**	**0.782**	**0.742**	**0.705**
	Upper 95%	0.960	0.912	0.867	0.823	0.782	0.743	0.706
900	Lower 95%	0.957	0.906	0.858	0.813	0.770	0.729	0.690
	Median	**0.957**	**0.907**	**0.859**	**0.813**	**0.770**	**0.730**	**0.691**
	Upper 95%	0.958	0.907	0.859	0.814	0.771	0.730	0.692
950	Lower 95%	0.955	0.901	0.851	0.803	0.758	0.716	0.676
	Median	**0.955**	**0.902**	**0.851**	**0.804**	**0.759**	**0.717**	**0.677**
	Upper 95%	0.956	0.902	0.852	0.805	0.760	0.718	0.678
1000	Lower 95%	0.952	0.896	0.844	0.794	0.747	0.703	0.662
	Median	**0.953**	**0.897**	**0.844**	**0.795**	**0.748**	**0.704**	**0.663**
	Upper 95%	0.953	0.897	0.845	0.795	0.749	0.705	0.664
1050	Lower 95%	0.950	0.891	0.836	0.785	0.737	0.691	0.649
	Median	**0.950**	**0.892**	**0.837**	**0.786**	**0.737**	**0.692**	**0.649**
	Upper 95%	0.951	0.893	0.838	0.786	0.738	0.693	0.650
1100	Lower 95%	0.948	0.886	0.829	0.776	0.726	0.679	0.635
	Median	**0.948**	**0.887**	**0.830**	**0.777**	**0.727**	**0.680**	**0.636**
	Upper 95%	0.949	0.888	0.831	0.777	0.727	0.681	0.637
1150	Lower 95%	0.945	0.882	0.822	0.767	0.715	0.667	0.622
	Median	**0.946**	**0.882**	**0.823**	**0.768**	**0.716**	**0.668**	**0.623**
	Upper 95%	0.946	0.883	0.824	0.768	0.717	0.669	0.624
1200	Lower 95%	0.943	0.877	0.815	0.758	0.705	0.655	0.609

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	Estimate	yr.5	yr.10	yr.15	yr.20	yr.25	yr.30	yr.35
	Median	**0.944**	**0.877**	**0.816**	**0.759**	**0.706**	**0.656**	**0.610**
	Upper 95%	0.944	0.878	0.817	0.760	0.707	0.657	0.611
1250	Lower 95%	0.941	0.872	0.808	0.749	0.695	0.644	0.597
	Median	**0.941**	**0.873**	**0.809**	**0.750**	**0.695**	**0.645**	**0.598**
	Upper 95%	0.942	0.873	0.810	0.751	0.696	0.646	0.599
1300	Lower 95%	0.938	0.867	0.801	0.740	0.684	0.632	0.584
	Median	**0.939**	**0.868**	**0.802**	**0.741**	**0.685**	**0.633**	**0.585**
	Upper 95%	0.939	0.869	0.803	0.742	0.686	0.634	0.586
1350	Lower 95%	0.936	0.862	0.794	0.732	0.674	0.621	0.572
	Median	**0.937**	**0.863**	**0.795**	**0.733**	**0.675**	**0.622**	**0.573**
	Upper 95%	0.937	0.864	0.796	0.734	0.676	0.623	0.574
1400	Lower 95%	0.934	0.858	0.788	0.723	0.664	0.610	0.561
	Median	**0.934**	**0.858**	**0.789**	**0.724**	**0.665**	**0.611**	**0.562**
	Upper 95%	0.935	0.859	0.789	0.725	0.666	0.612	0.563
1450	Lower 95%	0.931	0.853	0.781	0.715	0.655	0.600	0.549
	Median	**0.932**	**0.854**	**0.782**	**0.716**	**0.656**	**0.601**	**0.550**
	Upper 95%	0.933	0.855	0.783	0.717	0.657	0.602	0.551
1500	Lower 95%	0.929	0.848	0.774	0.707	0.645	0.589	0.538
	Median	**0.930**	**0.849**	**0.775**	**0.708**	**0.646**	**0.590**	**0.539**
	Upper 95%	0.930	0.850	0.776	0.709	0.647	0.591	0.540
1550	Lower 95%	0.927	0.843	0.768	0.699	0.636	0.579	0.527
	Median	**0.928**	**0.844**	**0.769**	**0.700**	**0.637**	**0.580**	**0.528**
	Upper 95%	0.928	0.845	0.769	0.701	0.638	0.581	0.529
1600	Lower 95%	0.925	0.839	0.761	0.690	0.626	0.568	0.516
	Median	**0.925**	**0.840**	**0.762**	**0.691**	**0.628**	**0.569**	**0.517**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.926	0.841	0.763	0.693	0.629	0.571	0.518

Table A2_11.2. Guillemot, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.936	0.899	0.880	0.858	0.846	0.838	0.818
	Median	**0.998**	**0.992**	**0.990**	**0.986**	**0.982**	**0.979**	**0.973**
	Upper 95%	1.065	1.087	1.106	1.136	1.154	1.155	1.168
100	Lower 95%	0.934	0.897	0.875	0.851	0.830	0.813	0.792
	Median	**0.994**	**0.988**	**0.980**	**0.975**	**0.972**	**0.963**	**0.957**
	Upper 95%	1.057	1.087	1.110	1.120	1.130	1.153	1.159
150	Lower 95%	0.928	0.891	0.864	0.837	0.814	0.800	0.781
	Median	**0.990**	**0.981**	**0.975**	**0.966**	**0.954**	**0.945**	**0.939**
	Upper 95%	1.059	1.085	1.101	1.109	1.126	1.129	1.130
200	Lower 95%	0.930	0.890	0.859	0.835	0.810	0.789	0.768
	Median	**0.990**	**0.977**	**0.965**	**0.955**	**0.946**	**0.931**	**0.920**
	Upper 95%	1.053	1.072	1.079	1.087	1.088	1.094	1.096
250	Lower 95%	0.926	0.884	0.852	0.827	0.807	0.774	0.760
	Median	**0.988**	**0.970**	**0.954**	**0.944**	**0.931**	**0.918**	**0.906**
	Upper 95%	1.057	1.067	1.086	1.080	1.088	1.091	1.091
300	Lower 95%	0.923	0.875	0.849	0.820	0.782	0.756	0.731
	Median	**0.983**	**0.965**	**0.946**	**0.934**	**0.921**	**0.900**	**0.885**
	Upper 95%	1.052	1.062	1.058	1.065	1.064	1.067	1.062
350	Lower 95%	0.925	0.872	0.834	0.800	0.767	0.743	0.721
	Median	**0.982**	**0.961**	**0.941**	**0.925**	**0.904**	**0.886**	**0.870**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.052	1.054	1.059	1.056	1.051	1.037	1.034
400	Lower 95%	0.921	0.872	0.831	0.791	0.758	0.722	0.702
	Median	**0.978**	**0.954**	**0.932**	**0.909**	**0.889**	**0.868**	**0.849**
	Upper 95%	1.043	1.047	1.048	1.050	1.034	1.020	1.015
450	Lower 95%	0.921	0.870	0.823	0.781	0.753	0.720	0.693
	Median	**0.976**	**0.949**	**0.925**	**0.901**	**0.875**	**0.849**	**0.829**
	Upper 95%	1.036	1.045	1.042	1.023	1.016	1.000	0.999
500	Lower 95%	0.920	0.857	0.814	0.781	0.741	0.702	0.670
	Median	**0.975**	**0.945**	**0.917**	**0.887**	**0.860**	**0.838**	**0.815**
	Upper 95%	1.046	1.041	1.032	1.022	1.015	0.991	0.978
550	Lower 95%	0.913	0.854	0.805	0.762	0.722	0.679	0.649
	Median	**0.972**	**0.935**	**0.905**	**0.880**	**0.849**	**0.824**	**0.796**
	Upper 95%	1.036	1.032	1.016	1.000	0.988	0.969	0.949
600	Lower 95%	0.913	0.851	0.800	0.761	0.726	0.689	0.654
	Median	**0.970**	**0.935**	**0.904**	**0.873**	**0.842**	**0.812**	**0.783**
	Upper 95%	1.031	1.026	1.012	1.000	0.983	0.956	0.937
650	Lower 95%	0.908	0.850	0.799	0.764	0.715	0.679	0.644
	Median	**0.970**	**0.928**	**0.891**	**0.858**	**0.823**	**0.793**	**0.763**
	Upper 95%	1.030	1.028	1.010	0.988	0.964	0.939	0.914
700	Lower 95%	0.906	0.845	0.791	0.734	0.703	0.659	0.616
	Median	**0.966**	**0.922**	**0.886**	**0.851**	**0.816**	**0.780**	**0.748**
	Upper 95%	1.025	1.019	0.993	0.973	0.948	0.926	0.904
750	Lower 95%	0.907	0.834	0.788	0.739	0.693	0.652	0.622
	Median	**0.962**	**0.920**	**0.883**	**0.844**	**0.806**	**0.772**	**0.736**
	Upper 95%	1.029	1.014	0.990	0.957	0.940	0.916	0.888

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.900	0.829	0.771	0.719	0.675	0.631	0.594
	Median	**0.959**	**0.912**	**0.868**	**0.828**	**0.789**	**0.754**	**0.715**
	Upper 95%	1.023	1.004	0.976	0.952	0.925	0.893	0.858
850	Lower 95%	0.901	0.831	0.767	0.718	0.670	0.619	0.582
	Median	**0.958**	**0.906**	**0.865**	**0.821**	**0.780**	**0.740**	**0.704**
	Upper 95%	1.023	1.003	0.976	0.943	0.915	0.882	0.853
900	Lower 95%	0.899	0.826	0.763	0.713	0.658	0.617	0.571
	Median	**0.957**	**0.905**	**0.858**	**0.814**	**0.771**	**0.733**	**0.692**
	Upper 95%	1.017	1.000	0.965	0.929	0.890	0.855	0.830
950	Lower 95%	0.897	0.820	0.760	0.704	0.649	0.607	0.561
	Median	**0.954**	**0.901**	**0.850**	**0.804**	**0.757**	**0.717**	**0.675**
	Upper 95%	1.020	0.997	0.958	0.917	0.878	0.847	0.807
1000	Lower 95%	0.897	0.820	0.750	0.698	0.637	0.594	0.546
	Median	**0.953**	**0.895**	**0.845**	**0.795**	**0.750**	**0.705**	**0.663**
	Upper 95%	1.017	0.992	0.954	0.913	0.876	0.833	0.793
1050	Lower 95%	0.891	0.811	0.741	0.684	0.633	0.584	0.540
	Median	**0.949**	**0.889**	**0.835**	**0.785**	**0.737**	**0.694**	**0.651**
	Upper 95%	1.014	0.980	0.944	0.895	0.857	0.825	0.780
1100	Lower 95%	0.894	0.804	0.736	0.671	0.621	0.570	0.523
	Median	**0.947**	**0.884**	**0.826**	**0.773**	**0.722**	**0.677**	**0.634**
	Upper 95%	1.007	0.974	0.934	0.890	0.843	0.799	0.755
1150	Lower 95%	0.887	0.800	0.733	0.674	0.613	0.558	0.517
	Median	**0.944**	**0.881**	**0.822**	**0.765**	**0.714**	**0.664**	**0.623**
	Upper 95%	1.003	0.968	0.920	0.876	0.832	0.790	0.744
1200	Lower 95%	0.885	0.793	0.723	0.660	0.601	0.554	0.509

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.942**	**0.872**	**0.812**	**0.757**	**0.705**	**0.655**	**0.605**
	Upper 95%	1.006	0.963	0.911	0.866	0.822	0.766	0.724
1250	Lower 95%	0.883	0.790	0.715	0.656	0.598	0.547	0.499
	Median	**0.942**	**0.870**	**0.806**	**0.748**	**0.693**	**0.643**	**0.598**
	Upper 95%	1.000	0.952	0.905	0.856	0.807	0.763	0.726
1300	Lower 95%	0.884	0.788	0.714	0.648	0.587	0.541	0.490
	Median	**0.936**	**0.865**	**0.799**	**0.740**	**0.685**	**0.633**	**0.586**
	Upper 95%	0.996	0.951	0.899	0.850	0.799	0.751	0.703
1350	Lower 95%	0.881	0.786	0.705	0.639	0.582	0.527	0.477
	Median	**0.936**	**0.862**	**0.792**	**0.730**	**0.671**	**0.621**	**0.571**
	Upper 95%	0.997	0.954	0.898	0.848	0.781	0.732	0.687
1400	Lower 95%	0.881	0.785	0.704	0.634	0.576	0.514	0.470
	Median	**0.934**	**0.856**	**0.786**	**0.724**	**0.663**	**0.611**	**0.561**
	Upper 95%	0.994	0.947	0.885	0.821	0.772	0.722	0.668
1450	Lower 95%	0.876	0.776	0.692	0.626	0.567	0.510	0.460
	Median	**0.931**	**0.853**	**0.782**	**0.716**	**0.656**	**0.601**	**0.551**
	Upper 95%	0.994	0.938	0.881	0.821	0.764	0.708	0.659
1500	Lower 95%	0.874	0.768	0.690	0.623	0.554	0.498	0.452
	Median	**0.930**	**0.847**	**0.775**	**0.705**	**0.645**	**0.588**	**0.537**
	Upper 95%	0.992	0.934	0.877	0.810	0.754	0.701	0.650
1550	Lower 95%	0.872	0.770	0.682	0.612	0.550	0.490	0.441
	Median	**0.926**	**0.843**	**0.766**	**0.702**	**0.636**	**0.579**	**0.527**
	Upper 95%	0.989	0.934	0.869	0.804	0.748	0.690	0.631
1600	Lower 95%	0.873	0.762	0.676	0.604	0.543	0.488	0.433
	Median	**0.924**	**0.837**	**0.760**	**0.690**	**0.625**	**0.567**	**0.516**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.986	0.924	0.854	0.793	0.728	0.673	0.622

Table A2_11.3. Guillemot, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.999	0.999	0.999
100	0.999	0.999	0.999
150	0.998	0.998	0.998
200	0.998	0.998	0.998
250	0.997	0.997	0.997
300	0.996	0.996	0.996
350	0.996	0.996	0.996
400	0.995	0.995	0.995
450	0.995	0.995	0.995
500	0.994	0.994	0.994
550	0.993	0.993	0.993
600	0.993	0.993	0.993
650	0.992	0.992	0.992
700	0.992	0.992	0.992
750	0.991	0.991	0.991
800	0.990	0.990	0.990
850	0.990	0.990	0.990
900	0.989	0.989	0.989
950	0.989	0.989	0.989
1000	0.988	0.988	0.988
1050	0.987	0.987	0.987
1100	0.987	0.987	0.987
1150	0.986	0.986	0.986

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.986	0.986	0.986
1250	0.985	0.985	0.985
1300	0.984	0.984	0.984
1350	0.984	0.984	0.984
1400	0.983	0.983	0.983
1450	0.983	0.983	0.983
1500	0.982	0.982	0.982
1550	0.981	0.981	0.981
1600	0.981	0.981	0.981

Table A2_11.4. Guillemot, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.994	0.999	1.005
100	0.993	0.999	1.004
150	0.993	0.998	1.004
200	0.992	0.998	1.003
250	0.992	0.997	1.003
300	0.990	0.996	1.002
350	0.990	0.996	1.002
400	0.990	0.995	1.001
450	0.989	0.995	1.000
500	0.988	0.994	0.999
550	0.987	0.993	0.999
600	0.987	0.993	0.998
650	0.987	0.992	0.998
700	0.986	0.992	0.997
750	0.986	0.991	0.997
800	0.985	0.990	0.996
850	0.984	0.990	0.995
900	0.983	0.989	0.995
950	0.983	0.989	0.994
1000	0.982	0.988	0.994
1050	0.982	0.987	0.993
1100	0.981	0.987	0.993
1150	0.980	0.986	0.992

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.980	0.985	0.991
1250	0.979	0.985	0.991
1300	0.979	0.984	0.990
1350	0.978	0.984	0.989
1400	0.977	0.983	0.989
1450	0.977	0.983	0.988
1500	0.977	0.982	0.988
1550	0.976	0.982	0.987
1600	0.975	0.981	0.986

Table A2_12.1. Guillemot, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.998	0.996	0.994	0.993	0.992	0.991	0.990
	Median	**0.998**	**0.996**	**0.994**	**0.993**	**0.992**	**0.991**	**0.991**
	Upper 95%	0.998	0.996	0.994	0.993	0.992	0.991	0.991
100	Lower 95%	0.996	0.992	0.988	0.986	0.983	0.982	0.981
	Median	**0.996**	**0.992**	**0.989**	**0.986**	**0.984**	**0.982**	**0.981**
	Upper 95%	0.996	0.992	0.989	0.986	0.984	0.983	0.982
150	Lower 95%	0.994	0.987	0.982	0.978	0.975	0.973	0.971
	Median	**0.994**	**0.988**	**0.983**	**0.979**	**0.976**	**0.974**	**0.972**
	Upper 95%	0.994	0.988	0.983	0.980	0.977	0.974	0.973
200	Lower 95%	0.992	0.983	0.977	0.971	0.967	0.964	0.961
	Median	**0.992**	**0.984**	**0.977**	**0.972**	**0.968**	**0.965**	**0.962**
	Upper 95%	0.992	0.984	0.978	0.973	0.969	0.966	0.964
250	Lower 95%	0.989	0.979	0.971	0.964	0.959	0.955	0.951
	Median	**0.990**	**0.979**	**0.971**	**0.965**	**0.960**	**0.956**	**0.953**
	Upper 95%	0.990	0.980	0.972	0.966	0.961	0.957	0.955
300	Lower 95%	0.987	0.975	0.965	0.957	0.951	0.946	0.942
	Median	**0.988**	**0.975**	**0.966**	**0.958**	**0.952**	**0.948**	**0.944**
	Upper 95%	0.988	0.976	0.967	0.959	0.954	0.949	0.945
350	Lower 95%	0.985	0.971	0.959	0.950	0.943	0.937	0.932
	Median	**0.985**	**0.971**	**0.960**	**0.951**	**0.944**	**0.939**	**0.934**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.986	0.972	0.961	0.953	0.946	0.941	0.936
400	Lower 95%	0.983	0.967	0.953	0.943	0.935	0.928	0.923
	Median	**0.983**	**0.967**	**0.954**	**0.944**	**0.936**	**0.930**	**0.925**
	Upper 95%	0.984	0.968	0.955	0.946	0.938	0.932	0.927
450	Lower 95%	0.981	0.962	0.948	0.936	0.926	0.919	0.913
	Median	**0.981**	**0.963**	**0.949**	**0.938**	**0.929**	**0.921**	**0.916**
	Upper 95%	0.982	0.964	0.950	0.939	0.930	0.924	0.918
500	Lower 95%	0.979	0.958	0.942	0.929	0.918	0.910	0.904
	Median	**0.979**	**0.959**	**0.943**	**0.931**	**0.921**	**0.913**	**0.907**
	Upper 95%	0.980	0.960	0.944	0.932	0.923	0.916	0.910
550	Lower 95%	0.977	0.954	0.936	0.922	0.910	0.901	0.894
	Median	**0.977**	**0.955**	**0.938**	**0.924**	**0.913**	**0.904**	**0.897**
	Upper 95%	0.977	0.956	0.939	0.926	0.915	0.907	0.900
600	Lower 95%	0.975	0.950	0.931	0.915	0.902	0.893	0.884
	Median	**0.975**	**0.951**	**0.932**	**0.917**	**0.905**	**0.896**	**0.888**
	Upper 95%	0.975	0.952	0.934	0.919	0.908	0.899	0.892
650	Lower 95%	0.973	0.946	0.925	0.908	0.894	0.884	0.875
	Median	**0.973**	**0.947**	**0.926**	**0.910**	**0.897**	**0.887**	**0.879**
	Upper 95%	0.973	0.948	0.928	0.912	0.900	0.890	0.882
700	Lower 95%	0.971	0.942	0.919	0.901	0.886	0.875	0.865
	Median	**0.971**	**0.943**	**0.921**	**0.904**	**0.890**	**0.879**	**0.870**
	Upper 95%	0.971	0.944	0.923	0.906	0.892	0.882	0.874
750	Lower 95%	0.969	0.938	0.914	0.894	0.879	0.866	0.856
	Median	**0.969**	**0.939**	**0.915**	**0.897**	**0.882**	**0.870**	**0.861**
	Upper 95%	0.969	0.940	0.917	0.899	0.885	0.874	0.865

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.966	0.934	0.908	0.887	0.870	0.857	0.846
	Median	**0.967**	**0.935**	**0.910**	**0.890**	**0.874**	**0.862**	**0.851**
	Upper 95%	0.967	0.936	0.912	0.893	0.878	0.865	0.856
850	Lower 95%	0.964	0.930	0.902	0.880	0.863	0.848	0.837
	Median	**0.965**	**0.931**	**0.904**	**0.883**	**0.867**	**0.853**	**0.842**
	Upper 95%	0.965	0.932	0.906	0.886	0.870	0.857	0.847
900	Lower 95%	0.962	0.926	0.897	0.873	0.855	0.840	0.828
	Median	**0.963**	**0.927**	**0.899**	**0.877**	**0.859**	**0.845**	**0.833**
	Upper 95%	0.963	0.928	0.901	0.880	0.863	0.849	0.838
950	Lower 95%	0.960	0.922	0.891	0.867	0.847	0.831	0.818
	Median	**0.961**	**0.923**	**0.893**	**0.870**	**0.851**	**0.836**	**0.824**
	Upper 95%	0.961	0.924	0.896	0.873	0.855	0.841	0.830
1000	Lower 95%	0.958	0.917	0.885	0.860	0.839	0.823	0.810
	Median	**0.959**	**0.919**	**0.888**	**0.863**	**0.844**	**0.828**	**0.815**
	Upper 95%	0.959	0.920	0.890	0.867	0.848	0.833	0.820
1050	Lower 95%	0.956	0.913	0.880	0.853	0.831	0.814	0.799
	Median	**0.957**	**0.915**	**0.882**	**0.857**	**0.836**	**0.819**	**0.806**
	Upper 95%	0.957	0.917	0.885	0.860	0.840	0.825	0.812
1100	Lower 95%	0.954	0.909	0.875	0.846	0.824	0.805	0.790
	Median	**0.955**	**0.911**	**0.877**	**0.850**	**0.828**	**0.811**	**0.797**
	Upper 95%	0.955	0.913	0.879	0.854	0.833	0.816	0.803
1150	Lower 95%	0.952	0.905	0.869	0.839	0.816	0.797	0.781
	Median	**0.953**	**0.907**	**0.872**	**0.844**	**0.821**	**0.803**	**0.788**
	Upper 95%	0.953	0.909	0.874	0.847	0.826	0.808	0.794
1200	Lower 95%	0.950	0.901	0.863	0.833	0.808	0.788	0.772

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.951**	**0.903**	**0.866**	**0.837**	**0.813**	**0.795**	**0.779**
	Upper 95%	0.951	0.905	0.869	0.841	0.818	0.800	0.785
1250	Lower 95%	0.948	0.897	0.858	0.826	0.801	0.780	0.763
	Median	**0.949**	**0.899**	**0.861**	**0.830**	**0.806**	**0.786**	**0.770**
	Upper 95%	0.949	0.901	0.864	0.834	0.811	0.792	0.777
1300	Lower 95%	0.946	0.893	0.852	0.819	0.793	0.771	0.753
	Median	**0.947**	**0.895**	**0.855**	**0.824**	**0.799**	**0.778**	**0.761**
	Upper 95%	0.947	0.897	0.858	0.828	0.803	0.784	0.768
1350	Lower 95%	0.944	0.889	0.847	0.813	0.785	0.763	0.744
	Median	**0.945**	**0.891**	**0.850**	**0.817**	**0.791**	**0.770**	**0.752**
	Upper 95%	0.945	0.893	0.853	0.821	0.797	0.776	0.760
1400	Lower 95%	0.942	0.885	0.841	0.806	0.778	0.754	0.735
	Median	**0.943**	**0.888**	**0.845**	**0.811**	**0.784**	**0.762**	**0.744**
	Upper 95%	0.943	0.890	0.848	0.815	0.789	0.768	0.752
1450	Lower 95%	0.940	0.881	0.836	0.799	0.770	0.746	0.726
	Median	**0.941**	**0.884**	**0.839**	**0.804**	**0.776**	**0.753**	**0.735**
	Upper 95%	0.941	0.885	0.843	0.809	0.782	0.760	0.743
1500	Lower 95%	0.938	0.878	0.830	0.793	0.762	0.738	0.717
	Median	**0.939**	**0.880**	**0.834**	**0.798**	**0.769**	**0.745**	**0.726**
	Upper 95%	0.939	0.882	0.837	0.802	0.775	0.752	0.734
1550	Lower 95%	0.936	0.874	0.825	0.786	0.754	0.729	0.708
	Median	**0.936**	**0.876**	**0.829**	**0.791**	**0.761**	**0.737**	**0.717**
	Upper 95%	0.937	0.878	0.832	0.796	0.767	0.744	0.725
1600	Lower 95%	0.933	0.870	0.820	0.780	0.747	0.721	0.699
	Median	**0.934**	**0.872**	**0.824**	**0.785**	**0.754**	**0.729**	**0.708**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.935	0.874	0.827	0.790	0.760	0.736	0.716

Table A2_12.2. Guillemot, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.944	0.923	0.917	0.909	0.901	0.906	0.900
	Median	**0.996**	**0.996**	**0.995**	**0.995**	**0.993**	**0.989**	**0.989**
	Upper 95%	1.052	1.071	1.082	1.084	1.082	1.086	1.088
100	Lower 95%	0.943	0.925	0.905	0.901	0.893	0.889	0.888
	Median	**0.997**	**0.993**	**0.989**	**0.988**	**0.983**	**0.982**	**0.981**
	Upper 95%	1.052	1.068	1.080	1.082	1.077	1.078	1.079
150	Lower 95%	0.941	0.917	0.905	0.898	0.892	0.883	0.881
	Median	**0.994**	**0.990**	**0.984**	**0.980**	**0.978**	**0.977**	**0.974**
	Upper 95%	1.051	1.064	1.069	1.071	1.073	1.077	1.069
200	Lower 95%	0.940	0.916	0.897	0.889	0.875	0.871	0.872
	Median	**0.993**	**0.984**	**0.977**	**0.974**	**0.969**	**0.966**	**0.963**
	Upper 95%	1.045	1.057	1.065	1.069	1.071	1.070	1.067
250	Lower 95%	0.937	0.912	0.887	0.877	0.872	0.866	0.865
	Median	**0.990**	**0.979**	**0.971**	**0.964**	**0.960**	**0.957**	**0.953**
	Upper 95%	1.046	1.053	1.057	1.057	1.051	1.049	1.045
300	Lower 95%	0.936	0.905	0.887	0.874	0.866	0.861	0.854
	Median	**0.989**	**0.976**	**0.965**	**0.961**	**0.954**	**0.947**	**0.943**
	Upper 95%	1.042	1.050	1.055	1.048	1.048	1.047	1.038
350	Lower 95%	0.932	0.901	0.883	0.867	0.859	0.851	0.848
	Median	**0.987**	**0.973**	**0.961**	**0.953**	**0.947**	**0.939**	**0.935**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.044	1.047	1.043	1.045	1.042	1.045	1.033
400	Lower 95%	0.930	0.897	0.876	0.859	0.849	0.844	0.836
	Median	**0.982**	**0.966**	**0.954**	**0.943**	**0.936**	**0.929**	**0.925**
	Upper 95%	1.042	1.044	1.043	1.035	1.029	1.026	1.022
450	Lower 95%	0.922	0.895	0.871	0.852	0.849	0.840	0.830
	Median	**0.982**	**0.964**	**0.948**	**0.938**	**0.930**	**0.920**	**0.916**
	Upper 95%	1.036	1.038	1.030	1.029	1.024	1.023	1.015
500	Lower 95%	0.925	0.893	0.865	0.851	0.838	0.826	0.818
	Median	**0.980**	**0.959**	**0.942**	**0.933**	**0.923**	**0.916**	**0.908**
	Upper 95%	1.037	1.036	1.031	1.017	1.016	1.017	1.005
550	Lower 95%	0.924	0.886	0.861	0.843	0.829	0.818	0.815
	Median	**0.977**	**0.955**	**0.938**	**0.924**	**0.912**	**0.904**	**0.898**
	Upper 95%	1.033	1.029	1.018	1.015	1.003	1.000	0.987
600	Lower 95%	0.921	0.886	0.854	0.834	0.818	0.810	0.801
	Median	**0.975**	**0.952**	**0.933**	**0.918**	**0.906**	**0.897**	**0.887**
	Upper 95%	1.032	1.028	1.012	1.006	0.996	0.989	0.983
650	Lower 95%	0.922	0.878	0.852	0.829	0.819	0.804	0.797
	Median	**0.972**	**0.948**	**0.926**	**0.911**	**0.898**	**0.889**	**0.881**
	Upper 95%	1.026	1.019	1.008	1.001	0.988	0.973	0.966
700	Lower 95%	0.915	0.870	0.843	0.824	0.807	0.795	0.785
	Median	**0.970**	**0.943**	**0.921**	**0.903**	**0.889**	**0.878**	**0.868**
	Upper 95%	1.025	1.016	1.003	0.992	0.980	0.971	0.966
750	Lower 95%	0.916	0.874	0.845	0.820	0.806	0.792	0.776
	Median	**0.969**	**0.943**	**0.918**	**0.900**	**0.885**	**0.872**	**0.863**
	Upper 95%	1.025	1.007	0.999	0.982	0.972	0.964	0.955

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.912	0.864	0.832	0.809	0.791	0.782	0.768
	Median	**0.966**	**0.935**	**0.912**	**0.891**	**0.875**	**0.860**	**0.851**
	Upper 95%	1.020	1.001	0.992	0.980	0.968	0.953	0.942
850	Lower 95%	0.911	0.861	0.835	0.803	0.784	0.774	0.763
	Median	**0.965**	**0.933**	**0.905**	**0.886**	**0.867**	**0.852**	**0.843**
	Upper 95%	1.014	1.002	0.985	0.973	0.958	0.941	0.932
900	Lower 95%	0.910	0.863	0.823	0.801	0.784	0.761	0.758
	Median	**0.963**	**0.931**	**0.900**	**0.878**	**0.860**	**0.847**	**0.836**
	Upper 95%	1.019	0.998	0.979	0.960	0.944	0.927	0.918
950	Lower 95%	0.910	0.861	0.820	0.793	0.774	0.761	0.742
	Median	**0.959**	**0.926**	**0.895**	**0.872**	**0.852**	**0.835**	**0.824**
	Upper 95%	1.015	0.997	0.977	0.959	0.939	0.925	0.914
1000	Lower 95%	0.910	0.851	0.813	0.786	0.772	0.756	0.736
	Median	**0.959**	**0.921**	**0.890**	**0.866**	**0.846**	**0.830**	**0.816**
	Upper 95%	1.015	0.988	0.970	0.946	0.925	0.911	0.899
1050	Lower 95%	0.906	0.850	0.808	0.778	0.761	0.741	0.724
	Median	**0.957**	**0.915**	**0.882**	**0.858**	**0.836**	**0.819**	**0.803**
	Upper 95%	1.012	0.987	0.959	0.944	0.925	0.907	0.886
1100	Lower 95%	0.900	0.845	0.804	0.778	0.751	0.734	0.722
	Median	**0.955**	**0.911**	**0.875**	**0.850**	**0.829**	**0.810**	**0.797**
	Upper 95%	1.011	0.986	0.961	0.935	0.909	0.895	0.883
1150	Lower 95%	0.901	0.845	0.795	0.766	0.744	0.728	0.710
	Median	**0.954**	**0.908**	**0.872**	**0.843**	**0.822**	**0.805**	**0.788**
	Upper 95%	1.009	0.977	0.952	0.925	0.903	0.880	0.868
1200	Lower 95%	0.901	0.842	0.796	0.766	0.734	0.717	0.705

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Median	**0.950**	**0.903**	**0.865**	**0.840**	**0.812**	**0.794**	**0.779**
	Upper 95%	1.002	0.976	0.947	0.920	0.898	0.879	0.862
1250	Lower 95%	0.898	0.837	0.789	0.753	0.728	0.710	0.693
	Median	**0.949**	**0.900**	**0.859**	**0.832**	**0.806**	**0.787**	**0.770**
	Upper 95%	1.001	0.967	0.942	0.917	0.891	0.875	0.857
1300	Lower 95%	0.893	0.832	0.786	0.750	0.723	0.704	0.687
	Median	**0.947**	**0.896**	**0.855**	**0.824**	**0.800**	**0.778**	**0.760**
	Upper 95%	1.002	0.974	0.935	0.910	0.883	0.870	0.850
1350	Lower 95%	0.895	0.827	0.783	0.741	0.717	0.699	0.675
	Median	**0.943**	**0.891**	**0.850**	**0.820**	**0.792**	**0.770**	**0.754**
	Upper 95%	0.996	0.960	0.927	0.902	0.872	0.851	0.835
1400	Lower 95%	0.895	0.821	0.774	0.737	0.707	0.686	0.669
	Median	**0.943**	**0.891**	**0.847**	**0.814**	**0.786**	**0.763**	**0.746**
	Upper 95%	0.996	0.962	0.922	0.890	0.865	0.845	0.827
1450	Lower 95%	0.891	0.820	0.769	0.731	0.702	0.681	0.666
	Median	**0.940**	**0.883**	**0.838**	**0.804**	**0.778**	**0.754**	**0.736**
	Upper 95%	0.995	0.956	0.917	0.888	0.859	0.838	0.818
1500	Lower 95%	0.885	0.813	0.762	0.724	0.692	0.669	0.651
	Median	**0.940**	**0.883**	**0.835**	**0.799**	**0.772**	**0.745**	**0.726**
	Upper 95%	0.991	0.946	0.906	0.879	0.849	0.822	0.802
1550	Lower 95%	0.886	0.818	0.761	0.725	0.690	0.668	0.645
	Median	**0.936**	**0.876**	**0.829**	**0.791**	**0.763**	**0.737**	**0.716**
	Upper 95%	0.990	0.945	0.905	0.871	0.839	0.816	0.798
1600	Lower 95%	0.886	0.810	0.755	0.713	0.680	0.659	0.639
	Median	**0.934**	**0.873**	**0.824**	**0.786**	**0.756**	**0.729**	**0.709**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.986	0.941	0.897	0.858	0.825	0.804	0.784

Table A2_12.3. Guillemot, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	1.000	1.000	1.000
100	0.999	1.000	1.000
150	0.999	0.999	0.999
200	0.999	0.999	0.999
250	0.999	0.999	0.999
300	0.998	0.998	0.999
350	0.998	0.998	0.998
400	0.998	0.998	0.998
450	0.998	0.998	0.998
500	0.997	0.997	0.998
550	0.997	0.997	0.997
600	0.997	0.997	0.997
650	0.996	0.997	0.997
700	0.996	0.996	0.996
750	0.996	0.996	0.996
800	0.996	0.996	0.996
850	0.995	0.995	0.996
900	0.995	0.995	0.995
950	0.995	0.995	0.995
1000	0.994	0.995	0.995
1050	0.994	0.994	0.995
1100	0.994	0.994	0.994
1150	0.993	0.994	0.994

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.993	0.993	0.994
1250	0.993	0.993	0.993
1300	0.992	0.993	0.993
1350	0.992	0.992	0.993
1400	0.992	0.992	0.992
1450	0.991	0.992	0.992
1500	0.991	0.991	0.992
1550	0.991	0.991	0.992
1600	0.990	0.991	0.991

Table A2_12.4. Guillemot, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.997	1.000	1.003
100	0.996	0.999	1.003
150	0.996	0.999	1.003
200	0.995	0.999	1.003
250	0.995	0.999	1.002
300	0.995	0.998	1.002
350	0.995	0.998	1.002
400	0.994	0.998	1.001
450	0.994	0.998	1.001
500	0.994	0.997	1.001
550	0.994	0.997	1.001
600	0.993	0.997	1.000
650	0.993	0.997	1.000
700	0.993	0.996	1.000
750	0.993	0.996	1.000
800	0.992	0.996	1.000
850	0.992	0.996	0.999
900	0.992	0.995	0.999
950	0.991	0.995	0.999
1000	0.991	0.995	0.998
1050	0.991	0.994	0.998
1100	0.990	0.994	0.998
1150	0.990	0.994	0.997

Additional adult mortality	Lower 95%	Median	Upper 95%
1200	0.990	0.993	0.997
1250	0.989	0.993	0.997
1300	0.989	0.993	0.996
1350	0.989	0.993	0.996
1400	0.989	0.992	0.996
1450	0.988	0.992	0.996
1500	0.988	0.991	0.995
1550	0.987	0.991	0.995
1600	0.987	0.991	0.994

Table A2_13.1. Razorbill, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.990	0.979	0.967	0.956	0.945	0.933	0.922
	Median	**0.991**	**0.979**	**0.967**	**0.956**	**0.945**	**0.934**	**0.923**
	Upper 95%	0.991	0.979	0.968	0.956	0.945	0.934	0.923
100	Lower 95%	0.981	0.958	0.935	0.914	0.892	0.871	0.851
	Median	**0.981**	**0.958**	**0.936**	**0.914**	**0.892**	**0.872**	**0.851**
	Upper 95%	0.981	0.958	0.936	0.914	0.893	0.872	0.852
150	Lower 95%	0.972	0.938	0.905	0.873	0.842	0.813	0.784
	Median	**0.972**	**0.938**	**0.905**	**0.873**	**0.843**	**0.813**	**0.785**
	Upper 95%	0.972	0.938	0.906	0.874	0.843	0.814	0.785
200	Lower 95%	0.962	0.918	0.875	0.834	0.795	0.758	0.723
	Median	**0.963**	**0.918**	**0.875**	**0.835**	**0.796**	**0.759**	**0.724**
	Upper 95%	0.963	0.918	0.876	0.835	0.797	0.760	0.724
250	Lower 95%	0.953	0.898	0.846	0.797	0.751	0.707	0.667
	Median	**0.953**	**0.898**	**0.847**	**0.798**	**0.752**	**0.708**	**0.667**
	Upper 95%	0.954	0.899	0.847	0.798	0.752	0.709	0.668
300	Lower 95%	0.944	0.879	0.818	0.761	0.709	0.660	0.614
	Median	**0.944**	**0.879**	**0.819**	**0.762**	**0.710**	**0.661**	**0.615**
	Upper 95%	0.945	0.880	0.819	0.763	0.710	0.661	0.616
350	Lower 95%	0.935	0.860	0.791	0.727	0.669	0.615	0.566
	Median	**0.935**	**0.860**	**0.792**	**0.728**	**0.670**	**0.616**	**0.567**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.936	0.861	0.792	0.729	0.671	0.617	0.568
400	Lower 95%	0.926	0.841	0.764	0.695	0.631	0.574	0.521
	Median	**0.926**	**0.842**	**0.765**	**0.696**	**0.632**	**0.575**	**0.522**
	Upper 95%	0.927	0.843	0.766	0.696	0.633	0.576	0.523
450	Lower 95%	0.917	0.823	0.739	0.663	0.596	0.535	0.480
	Median	**0.918**	**0.824**	**0.740**	**0.664**	**0.597**	**0.536**	**0.481**
	Upper 95%	0.918	0.825	0.741	0.665	0.598	0.537	0.482
500	Lower 95%	0.908	0.805	0.714	0.633	0.562	0.498	0.442
	Median	**0.909**	**0.806**	**0.715**	**0.635**	**0.563**	**0.499**	**0.443**
	Upper 95%	0.910	0.807	0.716	0.636	0.564	0.501	0.444
550	Lower 95%	0.899	0.788	0.690	0.605	0.530	0.464	0.407
	Median	**0.900**	**0.789**	**0.691**	**0.606**	**0.531**	**0.465**	**0.408**
	Upper 95%	0.901	0.790	0.692	0.607	0.532	0.467	0.409
600	Lower 95%	0.890	0.771	0.667	0.577	0.500	0.433	0.375
	Median	**0.891**	**0.772**	**0.668**	**0.579**	**0.501**	**0.434**	**0.376**
	Upper 95%	0.892	0.773	0.669	0.580	0.502	0.435	0.377
650	Lower 95%	0.882	0.754	0.644	0.551	0.471	0.403	0.345
	Median	**0.883**	**0.755**	**0.646**	**0.552**	**0.473**	**0.404**	**0.346**
	Upper 95%	0.884	0.756	0.647	0.554	0.474	0.405	0.347
700	Lower 95%	0.873	0.737	0.623	0.526	0.445	0.376	0.317
	Median	**0.874**	**0.739**	**0.624**	**0.527**	**0.446**	**0.377**	**0.318**
	Upper 95%	0.875	0.740	0.625	0.529	0.447	0.378	0.319
750	Lower 95%	0.864	0.721	0.602	0.502	0.419	0.350	0.292
	Median	**0.865**	**0.722**	**0.603**	**0.503**	**0.420**	**0.351**	**0.293**
	Upper 95%	0.867	0.724	0.604	0.505	0.421	0.352	0.294

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.856	0.705	0.581	0.479	0.395	0.326	0.268
	Median	**0.857**	**0.707**	**0.583**	**0.480**	**0.396**	**0.327**	**0.269**
	Upper 95%	0.858	0.708	0.584	0.482	0.397	0.328	0.270
850	Lower 95%	0.847	0.690	0.562	0.457	0.372	0.303	0.247
	Median	**0.849**	**0.691**	**0.563**	**0.458**	**0.373**	**0.304**	**0.248**
	Upper 95%	0.850	0.692	0.564	0.460	0.375	0.305	0.249
900	Lower 95%	0.839	0.674	0.542	0.436	0.351	0.282	0.227
	Median	**0.840**	**0.676**	**0.544**	**0.437**	**0.352**	**0.283**	**0.228**
	Upper 95%	0.842	0.677	0.545	0.439	0.353	0.284	0.229
950	Lower 95%	0.831	0.660	0.524	0.416	0.330	0.263	0.209
	Median	**0.832**	**0.661**	**0.525**	**0.417**	**0.332**	**0.264**	**0.209**
	Upper 95%	0.833	0.663	0.527	0.419	0.333	0.265	0.210
1000	Lower 95%	0.822	0.645	0.506	0.397	0.311	0.244	0.192
	Median	**0.824**	**0.647**	**0.507**	**0.398**	**0.312**	**0.245**	**0.192**
	Upper 95%	0.825	0.648	0.509	0.400	0.314	0.246	0.193

Table A2_13.2. Razorbill, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.879	0.811	0.771	0.731	0.700	0.662	0.632
	Median	**0.990**	**0.974**	**0.961**	**0.949**	**0.939**	**0.930**	**0.914**
	Upper 95%	1.113	1.172	1.202	1.242	1.267	1.296	1.309
100	Lower 95%	0.861	0.790	0.746	0.710	0.665	0.635	0.591
	Median	**0.980**	**0.964**	**0.937**	**0.910**	**0.890**	**0.875**	**0.848**
	Upper 95%	1.105	1.141	1.161	1.194	1.164	1.183	1.197
150	Lower 95%	0.855	0.773	0.721	0.669	0.630	0.583	0.555
	Median	**0.975**	**0.947**	**0.909**	**0.875**	**0.848**	**0.814**	**0.789**
	Upper 95%	1.099	1.123	1.132	1.132	1.138	1.144	1.127
200	Lower 95%	0.852	0.759	0.695	0.632	0.589	0.550	0.501
	Median	**0.964**	**0.920**	**0.876**	**0.833**	**0.796**	**0.759**	**0.721**
	Upper 95%	1.093	1.110	1.108	1.098	1.084	1.055	1.052
250	Lower 95%	0.843	0.746	0.682	0.618	0.558	0.505	0.468
	Median	**0.954**	**0.900**	**0.848**	**0.806**	**0.757**	**0.714**	**0.669**
	Upper 95%	1.082	1.085	1.083	1.042	1.022	0.975	0.955
300	Lower 95%	0.834	0.731	0.650	0.582	0.527	0.473	0.433
	Median	**0.944**	**0.881**	**0.819**	**0.764**	**0.715**	**0.666**	**0.620**
	Upper 95%	1.064	1.060	1.023	0.988	0.946	0.908	0.857
350	Lower 95%	0.828	0.713	0.634	0.569	0.501	0.447	0.400
	Median	**0.935**	**0.858**	**0.791**	**0.731**	**0.673**	**0.618**	**0.566**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.054	1.027	1.004	0.961	0.899	0.848	0.827
400	Lower 95%	0.819	0.707	0.614	0.542	0.470	0.424	0.370
	Median	**0.927**	**0.844**	**0.770**	**0.701**	**0.635**	**0.578**	**0.522**
	Upper 95%	1.045	1.009	0.957	0.907	0.849	0.807	0.753
450	Lower 95%	0.812	0.679	0.583	0.505	0.443	0.383	0.338
	Median	**0.918**	**0.821**	**0.747**	**0.671**	**0.602**	**0.538**	**0.483**
	Upper 95%	1.039	0.979	0.941	0.854	0.803	0.740	0.670
500	Lower 95%	0.804	0.679	0.565	0.494	0.423	0.356	0.301
	Median	**0.909**	**0.806**	**0.718**	**0.636**	**0.564**	**0.503**	**0.446**
	Upper 95%	1.027	0.969	0.903	0.835	0.781	0.698	0.635
550	Lower 95%	0.798	0.656	0.555	0.467	0.402	0.338	0.290
	Median	**0.901**	**0.793**	**0.693**	**0.609**	**0.534**	**0.469**	**0.410**
	Upper 95%	1.015	0.958	0.870	0.792	0.723	0.654	0.580
600	Lower 95%	0.789	0.645	0.538	0.443	0.379	0.312	0.267
	Median	**0.890**	**0.768**	**0.665**	**0.577**	**0.502**	**0.433**	**0.376**
	Upper 95%	0.993	0.924	0.847	0.767	0.672	0.591	0.536
650	Lower 95%	0.777	0.621	0.509	0.425	0.349	0.294	0.239
	Median	**0.881**	**0.754**	**0.644**	**0.553**	**0.473**	**0.407**	**0.345**
	Upper 95%	0.995	0.907	0.816	0.723	0.633	0.549	0.486
700	Lower 95%	0.768	0.612	0.493	0.400	0.325	0.267	0.222
	Median	**0.875**	**0.739**	**0.624**	**0.528**	**0.445**	**0.380**	**0.322**
	Upper 95%	0.982	0.877	0.783	0.682	0.592	0.515	0.448
750	Lower 95%	0.758	0.598	0.473	0.379	0.304	0.248	0.200
	Median	**0.868**	**0.724**	**0.600**	**0.505**	**0.423**	**0.354**	**0.294**
	Upper 95%	0.979	0.876	0.763	0.657	0.568	0.489	0.416

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.758	0.586	0.462	0.371	0.296	0.235	0.189
	Median	**0.858**	**0.705**	**0.581**	**0.481**	**0.395**	**0.325**	**0.271**
	Upper 95%	0.967	0.849	0.735	0.629	0.538	0.452	0.390
850	Lower 95%	0.751	0.580	0.450	0.353	0.279	0.218	0.175
	Median	**0.848**	**0.693**	**0.563**	**0.456**	**0.372**	**0.304**	**0.248**
	Upper 95%	0.955	0.826	0.705	0.601	0.506	0.429	0.359
900	Lower 95%	0.740	0.563	0.435	0.340	0.265	0.207	0.161
	Median	**0.841**	**0.676**	**0.544**	**0.437**	**0.351**	**0.284**	**0.229**
	Upper 95%	0.944	0.813	0.687	0.566	0.473	0.397	0.326
950	Lower 95%	0.740	0.554	0.428	0.323	0.247	0.197	0.155
	Median	**0.833**	**0.661**	**0.525**	**0.418**	**0.332**	**0.264**	**0.211**
	Upper 95%	0.946	0.792	0.655	0.537	0.446	0.363	0.295
1000	Lower 95%	0.729	0.541	0.404	0.308	0.235	0.178	0.137
	Median	**0.824**	**0.643**	**0.506**	**0.397**	**0.314**	**0.246**	**0.192**
	Upper 95%	0.932	0.786	0.642	0.528	0.432	0.344	0.272

Table A2_13.3. Razorbill, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.998	0.998	0.998
100	0.995	0.995	0.995
150	0.993	0.993	0.993
200	0.991	0.991	0.991
250	0.988	0.988	0.988
300	0.986	0.986	0.986
350	0.983	0.983	0.983
400	0.981	0.981	0.981
450	0.979	0.979	0.979
500	0.976	0.976	0.976
550	0.974	0.974	0.974
600	0.972	0.972	0.972
650	0.969	0.969	0.969
700	0.967	0.967	0.967
750	0.964	0.965	0.965
800	0.962	0.962	0.962
850	0.960	0.960	0.960
900	0.957	0.957	0.958
950	0.955	0.955	0.955
1000	0.953	0.953	0.953

Table A2_13.4. Razorbill, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.986	0.998	1.009
100	0.984	0.995	1.006
150	0.982	0.993	1.004
200	0.980	0.991	1.002
250	0.977	0.988	0.999
300	0.975	0.986	0.996
350	0.973	0.983	0.994
400	0.970	0.981	0.992
450	0.968	0.979	0.989
500	0.965	0.977	0.988
550	0.963	0.974	0.985
600	0.961	0.972	0.982
650	0.959	0.969	0.980
700	0.956	0.967	0.977
750	0.954	0.965	0.975
800	0.951	0.962	0.973
850	0.950	0.960	0.970
900	0.947	0.958	0.969
950	0.945	0.955	0.965
1000	0.943	0.953	0.963

Table A2_14.1. Razorbill, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.992	0.986	0.982	0.979	0.978	0.977	0.977
	Median	**0.992**	**0.986**	**0.983**	**0.980**	**0.979**	**0.978**	**0.978**
	Upper 95%	0.992	0.987	0.983	0.981	0.980	0.979	0.979
100	Lower 95%	0.984	0.971	0.964	0.959	0.956	0.955	0.953
	Median	**0.984**	**0.972**	**0.965**	**0.961**	**0.958**	**0.957**	**0.956**
	Upper 95%	0.985	0.973	0.967	0.962	0.960	0.958	0.958
150	Lower 95%	0.976	0.957	0.946	0.939	0.934	0.932	0.930
	Median	**0.977**	**0.959**	**0.948**	**0.941**	**0.937**	**0.935**	**0.933**
	Upper 95%	0.977	0.960	0.950	0.944	0.940	0.938	0.937
200	Lower 95%	0.968	0.943	0.928	0.918	0.913	0.909	0.907
	Median	**0.969**	**0.945**	**0.931**	**0.922**	**0.917**	**0.913**	**0.911**
	Upper 95%	0.969	0.947	0.933	0.925	0.920	0.917	0.915
250	Lower 95%	0.960	0.929	0.910	0.898	0.891	0.886	0.884
	Median	**0.961**	**0.931**	**0.914**	**0.903**	**0.896**	**0.892**	**0.889**
	Upper 95%	0.962	0.933	0.917	0.906	0.900	0.896	0.894
300	Lower 95%	0.952	0.915	0.892	0.878	0.869	0.863	0.860
	Median	**0.954**	**0.918**	**0.897**	**0.883**	**0.875**	**0.870**	**0.867**
	Upper 95%	0.954	0.920	0.900	0.888	0.880	0.875	0.873
350	Lower 95%	0.944	0.901	0.875	0.858	0.847	0.840	0.836
	Median	**0.946**	**0.905**	**0.880**	**0.864**	**0.855**	**0.848**	**0.844**

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	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.947	0.907	0.884	0.870	0.861	0.855	0.851
400	Lower 95%	0.937	0.887	0.857	0.838	0.825	0.818	0.813
	Median	**0.938**	**0.891**	**0.863**	**0.845**	**0.834**	**0.826**	**0.822**
	Upper 95%	0.939	0.894	0.868	0.851	0.841	0.834	0.830
450	Lower 95%	0.929	0.873	0.839	0.817	0.803	0.795	0.789
	Median	**0.931**	**0.878**	**0.846**	**0.826**	**0.813**	**0.805**	**0.799**
	Upper 95%	0.932	0.882	0.851	0.833	0.821	0.813	0.809
500	Lower 95%	0.921	0.860	0.823	0.799	0.782	0.772	0.766
	Median	**0.923**	**0.865**	**0.829**	**0.807**	**0.792**	**0.783**	**0.777**
	Upper 95%	0.924	0.869	0.836	0.815	0.801	0.793	0.787
550	Lower 95%	0.914	0.847	0.805	0.779	0.761	0.749	0.741
	Median	**0.916**	**0.852**	**0.812**	**0.788**	**0.771**	**0.761**	**0.754**
	Upper 95%	0.917	0.856	0.819	0.796	0.782	0.772	0.765
600	Lower 95%	0.906	0.833	0.788	0.758	0.740	0.727	0.718
	Median	**0.908**	**0.838**	**0.796**	**0.769**	**0.751**	**0.739**	**0.731**
	Upper 95%	0.910	0.843	0.803	0.777	0.761	0.750	0.743
650	Lower 95%	0.898	0.819	0.771	0.739	0.718	0.703	0.693
	Median	**0.901**	**0.825**	**0.779**	**0.750**	**0.730**	**0.718**	**0.708**
	Upper 95%	0.902	0.831	0.787	0.759	0.741	0.730	0.722
700	Lower 95%	0.890	0.806	0.753	0.720	0.697	0.681	0.670
	Median	**0.893**	**0.813**	**0.763**	**0.731**	**0.710**	**0.695**	**0.686**
	Upper 95%	0.895	0.818	0.771	0.742	0.722	0.709	0.700
750	Lower 95%	0.883	0.793	0.737	0.700	0.675	0.658	0.646
	Median	**0.886**	**0.800**	**0.747**	**0.712**	**0.689**	**0.673**	**0.663**
	Upper 95%	0.888	0.805	0.756	0.724	0.702	0.688	0.678

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.875	0.780	0.720	0.681	0.654	0.635	0.622
	Median	**0.878**	**0.787**	**0.730**	**0.694**	**0.669**	**0.652**	**0.640**
	Upper 95%	0.881	0.793	0.739	0.705	0.683	0.666	0.655
850	Lower 95%	0.868	0.767	0.704	0.662	0.634	0.614	0.599
	Median	**0.871**	**0.774**	**0.715**	**0.676**	**0.649**	**0.631**	**0.617**
	Upper 95%	0.873	0.781	0.725	0.687	0.662	0.646	0.633
900	Lower 95%	0.860	0.754	0.687	0.643	0.612	0.590	0.575
	Median	**0.864**	**0.762**	**0.699**	**0.657**	**0.628**	**0.609**	**0.594**
	Upper 95%	0.866	0.768	0.708	0.670	0.643	0.625	0.612
950	Lower 95%	0.853	0.741	0.671	0.626	0.591	0.568	0.552
	Median	**0.856**	**0.749**	**0.683**	**0.639**	**0.609**	**0.587**	**0.572**
	Upper 95%	0.859	0.757	0.693	0.652	0.623	0.604	0.590
1000	Lower 95%	0.845	0.729	0.654	0.605	0.571	0.547	0.527
	Median	**0.849**	**0.737**	**0.667**	**0.621**	**0.589**	**0.566**	**0.548**
	Upper 95%	0.852	0.744	0.678	0.635	0.605	0.584	0.568

Table A2_14.2. Razorbill, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.897	0.877	0.870	0.850	0.860	0.852	0.848
	Median	**0.992**	**0.986**	**0.983**	**0.980**	**0.982**	**0.981**	**0.978**
	Upper 95%	1.096	1.110	1.133	1.116	1.136	1.133	1.116
100	Lower 95%	0.894	0.859	0.845	0.835	0.839	0.835	0.827
	Median	**0.985**	**0.973**	**0.965**	**0.960**	**0.961**	**0.954**	**0.956**
	Upper 95%	1.095	1.092	1.111	1.090	1.088	1.092	1.095
150	Lower 95%	0.879	0.848	0.826	0.821	0.830	0.814	0.813
	Median	**0.975**	**0.954**	**0.944**	**0.936**	**0.933**	**0.934**	**0.931**
	Upper 95%	1.078	1.079	1.098	1.077	1.080	1.079	1.081
200	Lower 95%	0.877	0.831	0.814	0.795	0.791	0.799	0.794
	Median	**0.970**	**0.946**	**0.930**	**0.920**	**0.916**	**0.910**	**0.909**
	Upper 95%	1.072	1.058	1.061	1.061	1.056	1.050	1.047
250	Lower 95%	0.863	0.828	0.807	0.796	0.783	0.772	0.777
	Median	**0.963**	**0.936**	**0.916**	**0.903**	**0.900**	**0.891**	**0.885**
	Upper 95%	1.060	1.045	1.053	1.030	1.037	1.031	1.021
300	Lower 95%	0.859	0.812	0.786	0.769	0.762	0.758	0.752
	Median	**0.953**	**0.916**	**0.894**	**0.882**	**0.876**	**0.870**	**0.865**
	Upper 95%	1.053	1.044	1.022	1.012	1.002	1.007	0.992
350	Lower 95%	0.853	0.799	0.772	0.755	0.740	0.737	0.737
	Median	**0.946**	**0.907**	**0.881**	**0.862**	**0.856**	**0.846**	**0.843**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.045	1.030	1.007	0.998	0.993	0.977	0.975
400	Lower 95%	0.849	0.784	0.754	0.735	0.720	0.716	0.707
	Median	**0.939**	**0.891**	**0.861**	**0.842**	**0.835**	**0.826**	**0.819**
	Upper 95%	1.046	1.022	0.991	0.979	0.965	0.955	0.946
450	Lower 95%	0.835	0.768	0.734	0.713	0.709	0.702	0.693
	Median	**0.931**	**0.878**	**0.844**	**0.824**	**0.814**	**0.807**	**0.800**
	Upper 95%	1.032	0.992	0.964	0.952	0.944	0.925	0.922
500	Lower 95%	0.829	0.763	0.726	0.703	0.688	0.678	0.674
	Median	**0.922**	**0.865**	**0.830**	**0.804**	**0.795**	**0.781**	**0.778**
	Upper 95%	1.022	0.977	0.958	0.925	0.920	0.905	0.896
550	Lower 95%	0.833	0.752	0.710	0.680	0.668	0.657	0.649
	Median	**0.916**	**0.853**	**0.811**	**0.786**	**0.772**	**0.764**	**0.755**
	Upper 95%	1.010	0.959	0.935	0.901	0.891	0.881	0.864
600	Lower 95%	0.817	0.737	0.689	0.671	0.649	0.643	0.637
	Median	**0.907**	**0.838**	**0.795**	**0.768**	**0.753**	**0.741**	**0.730**
	Upper 95%	1.006	0.951	0.913	0.885	0.878	0.849	0.844
650	Lower 95%	0.804	0.729	0.680	0.649	0.636	0.616	0.611
	Median	**0.901**	**0.825**	**0.778**	**0.746**	**0.731**	**0.715**	**0.705**
	Upper 95%	1.002	0.923	0.897	0.862	0.843	0.828	0.811
700	Lower 95%	0.802	0.719	0.660	0.634	0.618	0.600	0.587
	Median	**0.892**	**0.812**	**0.761**	**0.731**	**0.712**	**0.698**	**0.685**
	Upper 95%	0.987	0.926	0.880	0.841	0.824	0.804	0.792
750	Lower 95%	0.800	0.702	0.655	0.614	0.595	0.580	0.574
	Median	**0.884**	**0.801**	**0.747**	**0.709**	**0.685**	**0.673**	**0.661**
	Upper 95%	0.983	0.898	0.851	0.816	0.796	0.789	0.771

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.791	0.692	0.639	0.600	0.575	0.557	0.543
	Median	**0.879**	**0.787**	**0.729**	**0.692**	**0.671**	**0.652**	**0.640**
	Upper 95%	0.969	0.885	0.833	0.804	0.777	0.753	0.735
850	Lower 95%	0.780	0.684	0.625	0.587	0.563	0.543	0.535
	Median	**0.870**	**0.775**	**0.714**	**0.673**	**0.651**	**0.631**	**0.616**
	Upper 95%	0.967	0.873	0.825	0.776	0.762	0.738	0.715
900	Lower 95%	0.779	0.675	0.610	0.569	0.546	0.525	0.509
	Median	**0.862**	**0.761**	**0.696**	**0.657**	**0.632**	**0.610**	**0.595**
	Upper 95%	0.957	0.863	0.799	0.753	0.732	0.716	0.688
950	Lower 95%	0.775	0.665	0.596	0.554	0.518	0.503	0.494
	Median	**0.857**	**0.750**	**0.684**	**0.639**	**0.612**	**0.590**	**0.571**
	Upper 95%	0.949	0.843	0.784	0.729	0.707	0.678	0.662
1000	Lower 95%	0.760	0.641	0.578	0.538	0.512	0.486	0.469
	Median	**0.848**	**0.736**	**0.669**	**0.621**	**0.590**	**0.564**	**0.551**
	Upper 95%	0.949	0.836	0.769	0.719	0.686	0.654	0.632

Table A2_14.3. Razorbill, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.999	1.000	1.000
100	0.999	0.999	0.999
150	0.998	0.998	0.999
200	0.998	0.998	0.998
250	0.997	0.997	0.998
300	0.997	0.997	0.997
350	0.996	0.996	0.996
400	0.995	0.996	0.996
450	0.995	0.995	0.995
500	0.994	0.994	0.995
550	0.993	0.994	0.994
600	0.992	0.993	0.993
650	0.991	0.992	0.993
700	0.990	0.991	0.992
750	0.990	0.990	0.991
800	0.989	0.990	0.990
850	0.988	0.989	0.989
900	0.987	0.988	0.989
950	0.985	0.987	0.988
1000	0.984	0.986	0.987

Table A2_14.4. Razorbill, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.994	0.999	1.005
100	0.993	0.999	1.005
150	0.993	0.998	1.005
200	0.992	0.998	1.003
250	0.992	0.997	1.003
300	0.991	0.997	1.003
350	0.991	0.996	1.002
400	0.989	0.995	1.001
450	0.989	0.995	1.001
500	0.989	0.994	1.000
550	0.988	0.994	0.999
600	0.988	0.993	0.999
650	0.986	0.992	0.997
700	0.985	0.991	0.997
750	0.985	0.990	0.997
800	0.983	0.989	0.995
850	0.983	0.989	0.995
900	0.982	0.988	0.994
950	0.981	0.987	0.993
1000	0.979	0.986	0.991

Table A2_15.1. Razorbill, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.990	0.978	0.966	0.955	0.943	0.932	0.921
	Median	**0.991**	**0.979**	**0.967**	**0.956**	**0.945**	**0.933**	**0.922**
	Upper 95%	0.991	0.980	0.969	0.957	0.946	0.935	0.924
100	Lower 95%	0.980	0.956	0.933	0.911	0.890	0.868	0.848
	Median	**0.981**	**0.958**	**0.936**	**0.914**	**0.892**	**0.871**	**0.851**
	Upper 95%	0.983	0.960	0.938	0.917	0.895	0.874	0.854
150	Lower 95%	0.970	0.935	0.902	0.870	0.839	0.809	0.780
	Median	**0.972**	**0.938**	**0.905**	**0.873**	**0.842**	**0.813**	**0.784**
	Upper 95%	0.974	0.941	0.908	0.877	0.847	0.817	0.789
200	Lower 95%	0.960	0.914	0.871	0.829	0.790	0.753	0.718
	Median	**0.963**	**0.918**	**0.875**	**0.834**	**0.795**	**0.758**	**0.723**
	Upper 95%	0.965	0.922	0.880	0.839	0.801	0.764	0.729
250	Lower 95%	0.950	0.894	0.841	0.792	0.745	0.701	0.660
	Median	**0.953**	**0.898**	**0.846**	**0.797**	**0.751**	**0.707**	**0.666**
	Upper 95%	0.957	0.903	0.852	0.803	0.757	0.714	0.673
300	Lower 95%	0.940	0.874	0.812	0.755	0.703	0.653	0.608
	Median	**0.944**	**0.879**	**0.818**	**0.762**	**0.709**	**0.660**	**0.614**
	Upper 95%	0.948	0.884	0.825	0.769	0.716	0.667	0.622
350	Lower 95%	0.931	0.854	0.785	0.721	0.662	0.608	0.558
	Median	**0.935**	**0.860**	**0.791**	**0.728**	**0.669**	**0.616**	**0.566**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.940	0.867	0.799	0.735	0.677	0.623	0.574
400	Lower 95%	0.921	0.835	0.757	0.687	0.624	0.566	0.514
	Median	**0.926**	**0.842**	**0.765**	**0.695**	**0.631**	**0.574**	**0.521**
	Upper 95%	0.931	0.848	0.772	0.703	0.640	0.583	0.530
450	Lower 95%	0.912	0.816	0.731	0.655	0.587	0.526	0.472
	Median	**0.918**	**0.824**	**0.740**	**0.664**	**0.596**	**0.535**	**0.480**
	Upper 95%	0.923	0.831	0.748	0.673	0.604	0.544	0.489
500	Lower 95%	0.902	0.798	0.706	0.625	0.553	0.489	0.434
	Median	**0.909**	**0.806**	**0.715**	**0.634**	**0.562**	**0.499**	**0.442**
	Upper 95%	0.915	0.814	0.724	0.644	0.571	0.508	0.451
550	Lower 95%	0.892	0.780	0.681	0.596	0.521	0.455	0.398
	Median	**0.900**	**0.788**	**0.691**	**0.605**	**0.530**	**0.465**	**0.407**
	Upper 95%	0.907	0.798	0.701	0.615	0.540	0.474	0.416
600	Lower 95%	0.884	0.761	0.658	0.568	0.490	0.423	0.366
	Median	**0.891**	**0.771**	**0.667**	**0.578**	**0.500**	**0.433**	**0.374**
	Upper 95%	0.898	0.781	0.679	0.589	0.511	0.442	0.384
650	Lower 95%	0.874	0.744	0.635	0.541	0.461	0.393	0.336
	Median	**0.882**	**0.754**	**0.645**	**0.551**	**0.471**	**0.403**	**0.345**
	Upper 95%	0.890	0.765	0.656	0.562	0.481	0.413	0.353
700	Lower 95%	0.865	0.728	0.613	0.516	0.436	0.367	0.310
	Median	**0.874**	**0.738**	**0.623**	**0.527**	**0.444**	**0.375**	**0.317**
	Upper 95%	0.883	0.749	0.635	0.537	0.456	0.386	0.326
750	Lower 95%	0.856	0.711	0.591	0.492	0.410	0.341	0.283
	Median	**0.865**	**0.722**	**0.602**	**0.503**	**0.419**	**0.350**	**0.292**
	Upper 95%	0.874	0.733	0.614	0.514	0.430	0.359	0.300

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.847	0.695	0.570	0.469	0.385	0.316	0.260
	Median	**0.857**	**0.706**	**0.582**	**0.479**	**0.395**	**0.326**	**0.268**
	Upper 95%	0.867	0.718	0.595	0.492	0.406	0.336	0.277
850	Lower 95%	0.837	0.679	0.550	0.446	0.362	0.294	0.239
	Median	**0.848**	**0.690**	**0.562**	**0.457**	**0.372**	**0.303**	**0.247**
	Upper 95%	0.858	0.702	0.573	0.469	0.383	0.312	0.255
900	Lower 95%	0.829	0.662	0.530	0.425	0.340	0.273	0.219
	Median	**0.840**	**0.675**	**0.543**	**0.436**	**0.351**	**0.282**	**0.227**
	Upper 95%	0.851	0.689	0.556	0.449	0.363	0.292	0.236
950	Lower 95%	0.820	0.648	0.512	0.404	0.320	0.254	0.201
	Median	**0.832**	**0.661**	**0.525**	**0.417**	**0.331**	**0.263**	**0.208**
	Upper 95%	0.844	0.674	0.538	0.429	0.341	0.272	0.216
1000	Lower 95%	0.812	0.632	0.494	0.386	0.301	0.235	0.184
	Median	**0.824**	**0.646**	**0.507**	**0.398**	**0.312**	**0.244**	**0.192**
	Upper 95%	0.836	0.660	0.520	0.410	0.323	0.254	0.200

Table A2_15.2. Razorbill, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.661	0.575	0.475	0.423	0.397	0.361	0.322
	Median	**0.991**	**0.981**	**0.978**	**0.964**	**0.951**	**0.954**	**0.969**
	Upper 95%	1.440	1.719	2.035	2.145	2.290	2.426	2.535
100	Lower 95%	0.659	0.505	0.458	0.391	0.334	0.305	0.278
	Median	**0.968**	**0.945**	**0.922**	**0.914**	**0.878**	**0.865**	**0.847**
	Upper 95%	1.391	1.671	1.840	2.041	2.154	2.321	2.521
150	Lower 95%	0.666	0.544	0.453	0.394	0.327	0.292	0.279
	Median	**0.968**	**0.942**	**0.917**	**0.892**	**0.855**	**0.827**	**0.832**
	Upper 95%	1.399	1.665	1.785	2.112	2.304	2.422	2.478
200	Lower 95%	0.668	0.517	0.437	0.388	0.333	0.292	0.266
	Median	**0.959**	**0.929**	**0.872**	**0.831**	**0.784**	**0.773**	**0.756**
	Upper 95%	1.369	1.566	1.736	1.824	1.962	2.084	2.198
250	Lower 95%	0.668	0.538	0.433	0.382	0.315	0.274	0.230
	Median	**0.952**	**0.894**	**0.855**	**0.805**	**0.757**	**0.729**	**0.707**
	Upper 95%	1.377	1.552	1.623	1.720	1.827	1.810	1.841
300	Lower 95%	0.650	0.510	0.410	0.346	0.274	0.241	0.213
	Median	**0.941**	**0.871**	**0.827**	**0.766**	**0.710**	**0.672**	**0.614**
	Upper 95%	1.361	1.578	1.689	1.766	1.875	1.860	1.826
350	Lower 95%	0.641	0.500	0.379	0.317	0.266	0.226	0.204
	Median	**0.930**	**0.849**	**0.782**	**0.729**	**0.660**	**0.638**	**0.579**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.356	1.529	1.586	1.550	1.665	1.722	1.674
400	Lower 95%	0.636	0.468	0.364	0.294	0.241	0.198	0.174
	Median	**0.926**	**0.845**	**0.776**	**0.705**	**0.627**	**0.588**	**0.548**
	Upper 95%	1.304	1.478	1.509	1.554	1.615	1.497	1.481
450	Lower 95%	0.635	0.476	0.381	0.289	0.233	0.193	0.165
	Median	**0.916**	**0.826**	**0.731**	**0.666**	**0.597**	**0.547**	**0.486**
	Upper 95%	1.277	1.438	1.474	1.389	1.464	1.401	1.395
500	Lower 95%	0.617	0.469	0.371	0.280	0.230	0.183	0.145
	Median	**0.903**	**0.802**	**0.708**	**0.627**	**0.567**	**0.515**	**0.459**
	Upper 95%	1.307	1.386	1.413	1.373	1.386	1.334	1.326
550	Lower 95%	0.612	0.442	0.344	0.260	0.211	0.173	0.143
	Median	**0.904**	**0.798**	**0.696**	**0.603**	**0.524**	**0.466**	**0.422**
	Upper 95%	1.316	1.423	1.369	1.365	1.288	1.204	1.175
600	Lower 95%	0.602	0.452	0.338	0.267	0.207	0.163	0.127
	Median	**0.890**	**0.767**	**0.661**	**0.574**	**0.493**	**0.437**	**0.390**
	Upper 95%	1.269	1.300	1.318	1.265	1.229	1.134	1.049
650	Lower 95%	0.609	0.446	0.335	0.260	0.193	0.153	0.117
	Median	**0.878**	**0.760**	**0.651**	**0.566**	**0.477**	**0.421**	**0.367**
	Upper 95%	1.265	1.275	1.253	1.158	1.129	1.062	0.967
700	Lower 95%	0.610	0.419	0.330	0.249	0.183	0.148	0.114
	Median	**0.881**	**0.748**	**0.641**	**0.541**	**0.460**	**0.390**	**0.328**
	Upper 95%	1.297	1.329	1.288	1.148	1.095	1.050	0.945
750	Lower 95%	0.617	0.421	0.296	0.232	0.162	0.128	0.094
	Median	**0.871**	**0.727**	**0.611**	**0.506**	**0.421**	**0.356**	**0.301**
	Upper 95%	1.238	1.237	1.189	1.111	1.057	0.931	0.853

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.582	0.403	0.287	0.219	0.152	0.123	0.091
	Median	**0.851**	**0.706**	**0.589**	**0.483**	**0.393**	**0.324**	**0.272**
	Upper 95%	1.257	1.241	1.166	1.028	0.945	0.868	0.760
850	Lower 95%	0.578	0.386	0.274	0.200	0.152	0.119	0.086
	Median	**0.842**	**0.685**	**0.556**	**0.453**	**0.378**	**0.307**	**0.254**
	Upper 95%	1.222	1.212	1.149	1.086	0.974	0.844	0.742
900	Lower 95%	0.587	0.381	0.275	0.198	0.139	0.106	0.075
	Median	**0.837**	**0.670**	**0.542**	**0.432**	**0.348**	**0.288**	**0.233**
	Upper 95%	1.192	1.186	1.093	0.980	0.862	0.794	0.657
950	Lower 95%	0.566	0.381	0.244	0.179	0.127	0.098	0.076
	Median	**0.827**	**0.657**	**0.519**	**0.411**	**0.333**	**0.263**	**0.209**
	Upper 95%	1.217	1.157	1.044	0.898	0.807	0.696	0.602
1000	Lower 95%	0.572	0.357	0.242	0.171	0.124	0.084	0.062
	Median	**0.829**	**0.646**	**0.515**	**0.399**	**0.311**	**0.247**	**0.195**
	Upper 95%	1.183	1.146	0.994	0.880	0.793	0.650	0.564

Table A2_15.3. Razorbill, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	**Lower 95%**	**Median**	**Upper 95%**
0	1.000	1.000	1.000
50	0.998	0.998	0.998
100	0.995	0.995	0.995
150	0.993	0.993	0.993
200	0.990	0.991	0.991
250	0.988	0.988	0.988
300	0.985	0.986	0.986
350	0.983	0.983	0.984
400	0.981	0.981	0.982
450	0.978	0.979	0.979
500	0.976	0.976	0.977
550	0.973	0.974	0.975
600	0.971	0.972	0.972
650	0.968	0.969	0.970
700	0.966	0.967	0.968
750	0.964	0.964	0.965
800	0.961	0.962	0.963
850	0.959	0.960	0.961
900	0.956	0.957	0.958
950	0.954	0.955	0.956
1000	0.951	0.953	0.954

Table A2_15.4. Razorbill, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.966	0.999	1.031
100	0.963	0.995	1.030
150	0.960	0.995	1.030
200	0.960	0.992	1.025
250	0.957	0.990	1.019
300	0.953	0.985	1.019
350	0.954	0.984	1.016
400	0.948	0.983	1.013
450	0.946	0.980	1.013
500	0.945	0.978	1.011
550	0.942	0.975	1.006
600	0.938	0.973	1.004
650	0.939	0.971	1.002
700	0.934	0.968	1.000
750	0.932	0.966	0.998
800	0.931	0.963	0.994
850	0.929	0.961	0.995
900	0.925	0.958	0.990
950	0.926	0.955	0.990
1000	0.920	0.953	0.985

Table A2_16.1. Razorbill, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.990	0.979	0.969	0.959	0.950	0.941	0.933
	Median	**0.991**	**0.981**	**0.971**	**0.963**	**0.955**	**0.949**	**0.943**
	Upper 95%	0.992	0.982	0.973	0.966	0.961	0.956	0.952
100	Lower 95%	0.980	0.958	0.939	0.920	0.902	0.886	0.870
	Median	**0.982**	**0.961**	**0.943**	**0.927**	**0.912**	**0.899**	**0.888**
	Upper 95%	0.983	0.964	0.947	0.934	0.923	0.912	0.904
150	Lower 95%	0.970	0.938	0.909	0.882	0.856	0.832	0.811
	Median	**0.973**	**0.943**	**0.916**	**0.892**	**0.871**	**0.851**	**0.834**
	Upper 95%	0.975	0.946	0.921	0.901	0.884	0.870	0.859
200	Lower 95%	0.960	0.918	0.880	0.845	0.812	0.782	0.753
	Median	**0.964**	**0.924**	**0.889**	**0.858**	**0.830**	**0.806**	**0.784**
	Upper 95%	0.967	0.928	0.896	0.871	0.849	0.830	0.814
250	Lower 95%	0.950	0.899	0.851	0.808	0.768	0.731	0.697
	Median	**0.955**	**0.906**	**0.863**	**0.825**	**0.791**	**0.761**	**0.734**
	Upper 95%	0.958	0.911	0.872	0.840	0.813	0.791	0.772
300	Lower 95%	0.941	0.880	0.824	0.774	0.728	0.686	0.649
	Median	**0.946**	**0.887**	**0.837**	**0.792**	**0.753**	**0.718**	**0.687**
	Upper 95%	0.950	0.894	0.848	0.810	0.778	0.749	0.725
350	Lower 95%	0.931	0.861	0.798	0.742	0.690	0.644	0.602
	Median	**0.937**	**0.870**	**0.812**	**0.761**	**0.717**	**0.678**	**0.643**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.942	0.877	0.823	0.780	0.743	0.714	0.687
400	Lower 95%	0.922	0.842	0.771	0.708	0.650	0.600	0.552
	Median	**0.929**	**0.852**	**0.786**	**0.729**	**0.679**	**0.635**	**0.596**
	Upper 95%	0.934	0.860	0.801	0.751	0.710	0.674	0.642
450	Lower 95%	0.912	0.823	0.745	0.677	0.617	0.563	0.514
	Median	**0.920**	**0.835**	**0.763**	**0.701**	**0.648**	**0.601**	**0.559**
	Upper 95%	0.926	0.844	0.778	0.724	0.679	0.642	0.607
500	Lower 95%	0.902	0.805	0.722	0.648	0.584	0.527	0.475
	Median	**0.911**	**0.818**	**0.739**	**0.673**	**0.615**	**0.565**	**0.521**
	Upper 95%	0.918	0.828	0.754	0.696	0.648	0.605	0.570
550	Lower 95%	0.893	0.788	0.699	0.619	0.551	0.493	0.439
	Median	**0.902**	**0.801**	**0.716**	**0.644**	**0.583**	**0.529**	**0.483**
	Upper 95%	0.910	0.811	0.731	0.667	0.614	0.571	0.534
600	Lower 95%	0.883	0.768	0.672	0.590	0.518	0.457	0.402
	Median	**0.894**	**0.784**	**0.693**	**0.616**	**0.551**	**0.495**	**0.446**
	Upper 95%	0.901	0.794	0.709	0.643	0.587	0.540	0.498
650	Lower 95%	0.876	0.752	0.651	0.564	0.491	0.428	0.372
	Median	**0.886**	**0.768**	**0.672**	**0.591**	**0.523**	**0.466**	**0.416**
	Upper 95%	0.894	0.780	0.690	0.618	0.560	0.511	0.470
700	Lower 95%	0.866	0.737	0.629	0.539	0.462	0.399	0.345
	Median	**0.877**	**0.752**	**0.650**	**0.566**	**0.496**	**0.436**	**0.385**
	Upper 95%	0.886	0.764	0.669	0.592	0.529	0.478	0.432
750	Lower 95%	0.856	0.720	0.607	0.514	0.436	0.371	0.316
	Median	**0.868**	**0.736**	**0.630**	**0.542**	**0.469**	**0.409**	**0.357**
	Upper 95%	0.878	0.749	0.649	0.570	0.507	0.454	0.407

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.847	0.703	0.586	0.490	0.410	0.343	0.288
	Median	**0.860**	**0.721**	**0.609**	**0.519**	**0.444**	**0.381**	**0.329**
	Upper 95%	0.870	0.734	0.629	0.547	0.481	0.424	0.377
850	Lower 95%	0.837	0.686	0.564	0.466	0.386	0.320	0.265
	Median	**0.852**	**0.705**	**0.589**	**0.495**	**0.418**	**0.355**	**0.303**
	Upper 95%	0.863	0.719	0.610	0.524	0.454	0.400	0.354
900	Lower 95%	0.831	0.672	0.548	0.446	0.364	0.296	0.241
	Median	**0.844**	**0.690**	**0.570**	**0.473**	**0.395**	**0.332**	**0.279**
	Upper 95%	0.855	0.705	0.590	0.502	0.433	0.375	0.332
950	Lower 95%	0.821	0.657	0.526	0.424	0.340	0.274	0.222
	Median	**0.836**	**0.675**	**0.552**	**0.453**	**0.374**	**0.310**	**0.258**
	Upper 95%	0.848	0.691	0.574	0.480	0.408	0.351	0.304
1000	Lower 95%	0.810	0.639	0.507	0.405	0.322	0.257	0.205
	Median	**0.827**	**0.661**	**0.532**	**0.431**	**0.352**	**0.288**	**0.237**
	Upper 95%	0.840	0.677	0.555	0.461	0.387	0.325	0.278

Table A2_16.2. Razorbill, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
50	Lower 95%	0.722	0.620	0.558	0.525	0.490	0.466	0.434
	Median	**0.990**	**0.979**	**0.972**	**0.952**	**0.952**	**0.952**	**0.936**
	Upper 95%	1.333	1.498	1.616	1.706	1.835	1.854	1.850
100	Lower 95%	0.714	0.599	0.558	0.516	0.471	0.455	0.449
	Median	**0.978**	**0.965**	**0.933**	**0.917**	**0.903**	**0.894**	**0.905**
	Upper 95%	1.321	1.483	1.559	1.637	1.755	1.837	1.782
150	Lower 95%	0.722	0.596	0.522	0.471	0.451	0.429	0.398
	Median	**0.973**	**0.935**	**0.894**	**0.897**	**0.882**	**0.846**	**0.848**
	Upper 95%	1.307	1.466	1.544	1.590	1.657	1.666	1.737
200	Lower 95%	0.694	0.584	0.499	0.446	0.447	0.416	0.374
	Median	**0.965**	**0.920**	**0.874**	**0.849**	**0.836**	**0.802**	**0.789**
	Upper 95%	1.298	1.439	1.554	1.571	1.598	1.585	1.546
250	Lower 95%	0.695	0.547	0.486	0.404	0.386	0.362	0.335
	Median	**0.954**	**0.903**	**0.852**	**0.831**	**0.793**	**0.761**	**0.752**
	Upper 95%	1.309	1.400	1.474	1.436	1.508	1.501	1.582
300	Lower 95%	0.699	0.559	0.492	0.440	0.400	0.353	0.336
	Median	**0.937**	**0.892**	**0.845**	**0.791**	**0.753**	**0.727**	**0.702**
	Upper 95%	1.280	1.370	1.433	1.451	1.473	1.425	1.386
350	Lower 95%	0.690	0.542	0.479	0.415	0.382	0.340	0.295
	Median	**0.940**	**0.881**	**0.820**	**0.766**	**0.729**	**0.694**	**0.656**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.292	1.369	1.431	1.359	1.418	1.361	1.345
400	Lower 95%	0.670	0.517	0.429	0.372	0.324	0.287	0.272
	Median	**0.926**	**0.836**	**0.787**	**0.726**	**0.675**	**0.637**	**0.608**
	Upper 95%	1.237	1.288	1.335	1.327	1.284	1.239	1.195
450	Lower 95%	0.662	0.527	0.431	0.374	0.327	0.287	0.265
	Median	**0.920**	**0.829**	**0.757**	**0.703**	**0.661**	**0.611**	**0.567**
	Upper 95%	1.262	1.293	1.324	1.302	1.320	1.265	1.230
500	Lower 95%	0.673	0.513	0.422	0.357	0.314	0.280	0.236
	Median	**0.913**	**0.821**	**0.743**	**0.664**	**0.613**	**0.574**	**0.527**
	Upper 95%	1.228	1.288	1.253	1.265	1.244	1.174	1.115
550	Lower 95%	0.664	0.513	0.413	0.339	0.284	0.250	0.221
	Median	**0.905**	**0.798**	**0.708**	**0.642**	**0.590**	**0.534**	**0.490**
	Upper 95%	1.215	1.249	1.191	1.164	1.135	1.065	1.007
600	Lower 95%	0.653	0.494	0.394	0.332	0.283	0.227	0.205
	Median	**0.884**	**0.776**	**0.680**	**0.601**	**0.545**	**0.491**	**0.438**
	Upper 95%	1.199	1.185	1.164	1.159	1.122	1.045	0.961
650	Lower 95%	0.645	0.492	0.389	0.329	0.265	0.224	0.181
	Median	**0.885**	**0.772**	**0.665**	**0.589**	**0.529**	**0.478**	**0.426**
	Upper 95%	1.199	1.201	1.178	1.107	1.085	0.990	0.945
700	Lower 95%	0.649	0.477	0.380	0.306	0.255	0.212	0.181
	Median	**0.889**	**0.743**	**0.659**	**0.568**	**0.504**	**0.440**	**0.387**
	Upper 95%	1.202	1.200	1.128	1.070	0.986	0.894	0.903
750	Lower 95%	0.639	0.463	0.353	0.287	0.240	0.189	0.161
	Median	**0.865**	**0.735**	**0.626**	**0.544**	**0.473**	**0.417**	**0.366**
	Upper 95%	1.220	1.185	1.092	0.995	0.962	0.889	0.798

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
800	Lower 95%	0.608	0.452	0.343	0.285	0.222	0.182	0.152
	Median	**0.862**	**0.720**	**0.605**	**0.513**	**0.434**	**0.372**	**0.323**
	Upper 95%	1.188	1.106	1.073	0.966	0.869	0.830	0.703
850	Lower 95%	0.623	0.430	0.322	0.258	0.201	0.166	0.139
	Median	**0.847**	**0.700**	**0.583**	**0.491**	**0.419**	**0.357**	**0.307**
	Upper 95%	1.140	1.086	1.001	0.908	0.831	0.764	0.633
900	Lower 95%	0.606	0.433	0.319	0.241	0.187	0.154	0.124
	Median	**0.847**	**0.687**	**0.561**	**0.465**	**0.391**	**0.323**	**0.273**
	Upper 95%	1.154	1.108	1.013	0.883	0.824	0.702	0.666
950	Lower 95%	0.619	0.417	0.321	0.229	0.175	0.140	0.113
	Median	**0.835**	**0.678**	**0.554**	**0.452**	**0.378**	**0.314**	**0.263**
	Upper 95%	1.136	1.037	0.984	0.880	0.796	0.649	0.572
1000	Lower 95%	0.585	0.416	0.307	0.230	0.181	0.138	0.109
	Median	**0.828**	**0.654**	**0.529**	**0.426**	**0.351**	**0.291**	**0.237**
	Upper 95%	1.127	1.039	0.917	0.837	0.710	0.610	0.518

Table A2_16.3. Razorbill, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.998	0.998	0.999
100	0.996	0.997	0.997
150	0.994	0.995	0.996
200	0.992	0.993	0.994
250	0.990	0.991	0.993
300	0.987	0.989	0.991
350	0.985	0.988	0.990
400	0.983	0.985	0.988
450	0.981	0.984	0.986
500	0.978	0.982	0.985
550	0.976	0.979	0.983
600	0.974	0.977	0.981
650	0.972	0.975	0.979
700	0.969	0.973	0.977
750	0.967	0.971	0.975
800	0.964	0.968	0.973
850	0.962	0.966	0.971
900	0.959	0.964	0.969
950	0.957	0.962	0.967
1000	0.955	0.959	0.964

Table A2_16.4. Razorbill, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
50	0.973	0.998	1.023
100	0.973	0.997	1.021
150	0.972	0.995	1.019
200	0.970	0.993	1.017
250	0.967	0.992	1.016
300	0.968	0.990	1.013
350	0.962	0.988	1.011
400	0.961	0.986	1.009
450	0.959	0.985	1.011
500	0.956	0.981	1.006
550	0.955	0.980	1.003
600	0.952	0.977	1.003
650	0.951	0.976	1.000
700	0.949	0.973	1.000
750	0.946	0.972	0.997
800	0.944	0.968	0.994
850	0.943	0.967	0.991
900	0.939	0.963	0.990
950	0.935	0.962	0.988
1000	0.936	0.959	0.984

Table A2_17.1. Puffin, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.989	0.977	0.964	0.952	0.940	0.928	0.916
	Median	**0.990**	**0.978**	**0.965**	**0.953**	**0.941**	**0.929**	**0.917**
	Upper 95%	0.991	0.979	0.967	0.954	0.942	0.930	0.919
10	Lower 95%	0.979	0.954	0.929	0.906	0.883	0.861	0.839
	Median	**0.980**	**0.955**	**0.931**	**0.907**	**0.884**	**0.862**	**0.840**
	Upper 95%	0.981	0.956	0.932	0.909	0.886	0.863	0.842
15	Lower 95%	0.969	0.932	0.897	0.863	0.830	0.799	0.769
	Median	**0.970**	**0.933**	**0.898**	**0.864**	**0.832**	**0.800**	**0.770**
	Upper 95%	0.971	0.935	0.900	0.866	0.833	0.802	0.772
20	Lower 95%	0.959	0.910	0.865	0.821	0.780	0.741	0.704
	Median	**0.960**	**0.912**	**0.866**	**0.823**	**0.782**	**0.743**	**0.706**
	Upper 95%	0.961	0.913	0.868	0.824	0.783	0.744	0.707
25	Lower 95%	0.949	0.889	0.834	0.782	0.733	0.688	0.645
	Median	**0.950**	**0.891**	**0.835**	**0.783**	**0.735**	**0.689**	**0.646**
	Upper 95%	0.951	0.892	0.837	0.785	0.736	0.691	0.648
30	Lower 95%	0.939	0.869	0.804	0.744	0.689	0.637	0.590
	Median	**0.940**	**0.870**	**0.806**	**0.746**	**0.691**	**0.639**	**0.592**
	Upper 95%	0.941	0.872	0.807	0.748	0.692	0.641	0.594
35	Lower 95%	0.929	0.849	0.775	0.708	0.647	0.591	0.540
	Median	**0.930**	**0.850**	**0.777**	**0.710**	**0.649**	**0.593**	**0.542**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.932	0.852	0.779	0.712	0.651	0.595	0.544
	Lower 95%	0.919	0.829	0.747	0.674	0.608	0.548	0.494
40	**Median**	**0.921**	**0.831**	**0.749**	**0.676**	**0.610**	**0.550**	**0.496**
	Upper 95%	0.922	0.832	0.751	0.678	0.612	0.552	0.498
	Lower 95%	0.910	0.809	0.720	0.641	0.571	0.508	0.452
45	**Median**	**0.911**	**0.811**	**0.722**	**0.643**	**0.573**	**0.510**	**0.454**
	Upper 95%	0.913	0.813	0.724	0.645	0.575	0.512	0.456
	Lower 95%	0.900	0.791	0.694	0.610	0.536	0.471	0.413
50	**Median**	**0.902**	**0.793**	**0.696**	**0.612**	**0.538**	**0.473**	**0.415**
	Upper 95%	0.903	0.794	0.698	0.614	0.540	0.475	0.417

Table A2_17.2. Puffin, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.945	0.913	0.890	0.869	0.846	0.826	0.811
	Median	**0.991**	**0.976**	**0.964**	**0.951**	**0.940**	**0.926**	**0.916**
	Upper 95%	1.039	1.048	1.051	1.050	1.049	1.041	1.041
10	Lower 95%	0.936	0.896	0.864	0.825	0.797	0.769	0.743
	Median	**0.979**	**0.953**	**0.929**	**0.906**	**0.881**	**0.858**	**0.836**
	Upper 95%	1.024	1.015	1.008	0.993	0.983	0.961	0.945
15	Lower 95%	0.926	0.876	0.830	0.785	0.748	0.715	0.682
	Median	**0.970**	**0.935**	**0.900**	**0.864**	**0.831**	**0.800**	**0.771**
	Upper 95%	1.011	0.997	0.975	0.955	0.930	0.906	0.878
20	Lower 95%	0.919	0.853	0.795	0.741	0.697	0.660	0.623
	Median	**0.959**	**0.912**	**0.868**	**0.823**	**0.783**	**0.743**	**0.705**
	Upper 95%	1.008	0.980	0.944	0.913	0.869	0.839	0.801
25	Lower 95%	0.909	0.835	0.769	0.710	0.657	0.609	0.565
	Median	**0.949**	**0.890**	**0.835**	**0.782**	**0.734**	**0.688**	**0.646**
	Upper 95%	0.999	0.955	0.905	0.863	0.819	0.771	0.733
30	Lower 95%	0.895	0.814	0.744	0.677	0.622	0.565	0.522
	Median	**0.939**	**0.870**	**0.804**	**0.745**	**0.689**	**0.637**	**0.590**
	Upper 95%	0.986	0.927	0.876	0.824	0.769	0.719	0.670
35	Lower 95%	0.889	0.794	0.718	0.649	0.587	0.529	0.479
	Median	**0.931**	**0.851**	**0.778**	**0.711**	**0.650**	**0.593**	**0.542**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.973	0.912	0.844	0.780	0.721	0.668	0.616
40	Lower 95%	0.881	0.780	0.695	0.619	0.554	0.494	0.439
	Median	**0.920**	**0.830**	**0.751**	**0.676**	**0.610**	**0.550**	**0.497**
	Upper 95%	0.966	0.886	0.815	0.740	0.680	0.622	0.566
45	Lower 95%	0.874	0.759	0.666	0.589	0.518	0.455	0.400
	Median	**0.911**	**0.811**	**0.723**	**0.645**	**0.574**	**0.511**	**0.455**
	Upper 95%	0.956	0.869	0.782	0.701	0.638	0.573	0.515
50	Lower 95%	0.861	0.743	0.644	0.562	0.485	0.420	0.366
	Median	**0.903**	**0.794**	**0.697**	**0.612**	**0.537**	**0.473**	**0.416**
	Upper 95%	0.943	0.846	0.756	0.670	0.595	0.528	0.466

Table A2_17.3. Puffin, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
5	0.997	0.997	0.997
10	0.995	0.995	0.995
15	0.992	0.992	0.992
20	0.990	0.990	0.990
25	0.987	0.987	0.987
30	0.985	0.985	0.985
35	0.982	0.982	0.982
40	0.979	0.980	0.980
45	0.977	0.977	0.977
50	0.974	0.974	0.975

Table A2_17.4. Puffin, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
5	0.993	0.997	1.001
10	0.991	0.995	0.999
15	0.989	0.992	0.996
20	0.986	0.990	0.994
25	0.983	0.987	0.991
30	0.981	0.985	0.989
35	0.978	0.982	0.986
40	0.976	0.980	0.984
45	0.973	0.977	0.981
50	0.971	0.975	0.978

Table A2_18.1. Puffin, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.991	0.984	0.980	0.977	0.975	0.974	0.973
	Median	**0.992**	**0.986**	**0.982**	**0.979**	**0.978**	**0.976**	**0.976**
	Upper 95%	0.993	0.987	0.983	0.981	0.980	0.979	0.978
10	Lower 95%	0.982	0.968	0.959	0.953	0.950	0.948	0.947
	Median	**0.983**	**0.969**	**0.961**	**0.955**	**0.952**	**0.950**	**0.949**
	Upper 95%	0.984	0.970	0.962	0.957	0.954	0.952	0.951
15	Lower 95%	0.974	0.953	0.941	0.933	0.928	0.925	0.923
	Median	**0.975**	**0.956**	**0.943**	**0.936**	**0.931**	**0.928**	**0.926**
	Upper 95%	0.977	0.958	0.946	0.939	0.934	0.931	0.929
20	Lower 95%	0.964	0.937	0.920	0.910	0.903	0.898	0.895
	Median	**0.966**	**0.939**	**0.923**	**0.912**	**0.906**	**0.902**	**0.899**
	Upper 95%	0.967	0.941	0.925	0.915	0.909	0.904	0.902
25	Lower 95%	0.956	0.922	0.902	0.888	0.880	0.874	0.870
	Median	**0.958**	**0.925**	**0.905**	**0.892**	**0.884**	**0.878**	**0.875**
	Upper 95%	0.960	0.928	0.908	0.895	0.887	0.882	0.879
30	Lower 95%	0.948	0.908	0.882	0.866	0.856	0.849	0.844
	Median	**0.950**	**0.910**	**0.886**	**0.870**	**0.860**	**0.853**	**0.849**
	Upper 95%	0.952	0.913	0.889	0.874	0.864	0.858	0.853
35	Lower 95%	0.939	0.892	0.863	0.844	0.832	0.824	0.819
	Median	**0.941**	**0.896**	**0.867**	**0.849**	**0.837**	**0.829**	**0.824**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.943	0.898	0.871	0.852	0.841	0.833	0.828
40	Lower 95%	0.931	0.878	0.844	0.823	0.808	0.799	0.792
	Median	**0.933**	**0.881**	**0.849**	**0.827**	**0.813**	**0.804**	**0.798**
	Upper 95%	0.935	0.885	0.852	0.832	0.819	0.809	0.803
45	Lower 95%	0.923	0.863	0.825	0.801	0.785	0.773	0.766
	Median	**0.925**	**0.867**	**0.830**	**0.806**	**0.790**	**0.780**	**0.772**
	Upper 95%	0.927	0.870	0.834	0.811	0.795	0.785	0.778
50	Lower 95%	0.915	0.848	0.806	0.779	0.761	0.749	0.740
	Median	**0.917**	**0.853**	**0.812**	**0.785**	**0.767**	**0.755**	**0.747**
	Upper 95%	0.919	0.856	0.816	0.790	0.773	0.761	0.753

Table A2_18.2. Puffin, demographic rate set 1, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.943	0.923	0.924	0.919	0.912	0.914	0.914
	Median	**0.992**	**0.985**	**0.981**	**0.981**	**0.976**	**0.978**	**0.975**
	Upper 95%	1.044	1.049	1.050	1.046	1.048	1.046	1.044
10	Lower 95%	0.933	0.912	0.902	0.895	0.895	0.890	0.886
	Median	**0.983**	**0.969**	**0.960**	**0.956**	**0.953**	**0.950**	**0.949**
	Upper 95%	1.033	1.034	1.026	1.022	1.018	1.016	1.013
15	Lower 95%	0.926	0.898	0.890	0.878	0.871	0.870	0.866
	Median	**0.975**	**0.957**	**0.944**	**0.935**	**0.931**	**0.929**	**0.925**
	Upper 95%	1.031	1.014	1.001	1.000	0.995	0.988	0.986
20	Lower 95%	0.916	0.885	0.866	0.855	0.852	0.843	0.844
	Median	**0.967**	**0.941**	**0.923**	**0.913**	**0.907**	**0.904**	**0.901**
	Upper 95%	1.021	0.997	0.985	0.972	0.967	0.966	0.959
25	Lower 95%	0.911	0.874	0.855	0.838	0.827	0.826	0.820
	Median	**0.959**	**0.926**	**0.905**	**0.892**	**0.882**	**0.878**	**0.875**
	Upper 95%	1.009	0.983	0.966	0.949	0.945	0.939	0.935
30	Lower 95%	0.902	0.858	0.832	0.817	0.809	0.797	0.797
	Median	**0.950**	**0.911**	**0.886**	**0.870**	**0.859**	**0.854**	**0.850**
	Upper 95%	1.000	0.969	0.942	0.927	0.916	0.909	0.908
35	Lower 95%	0.896	0.845	0.816	0.801	0.788	0.779	0.767
	Median	**0.941**	**0.895**	**0.867**	**0.850**	**0.836**	**0.828**	**0.824**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.990	0.949	0.922	0.903	0.894	0.886	0.878
40	Lower 95%	0.885	0.828	0.801	0.775	0.764	0.754	0.750
	Median	**0.933**	**0.880**	**0.849**	**0.826**	**0.812**	**0.805**	**0.801**
	Upper 95%	0.983	0.938	0.903	0.884	0.866	0.860	0.849
45	Lower 95%	0.880	0.818	0.778	0.754	0.746	0.731	0.723
	Median	**0.924**	**0.866**	**0.831**	**0.806**	**0.790**	**0.781**	**0.774**
	Upper 95%	0.976	0.925	0.888	0.864	0.845	0.836	0.826
50	Lower 95%	0.872	0.805	0.766	0.736	0.720	0.708	0.698
	Median	**0.917**	**0.853**	**0.811**	**0.787**	**0.768**	**0.757**	**0.748**
	Upper 95%	0.965	0.906	0.861	0.833	0.816	0.805	0.797

Table A2_18.3. Puffin, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	**Lower 95%**	**Median**	**Upper 95%**
0	1.000	1.000	1.000
5	0.999	0.999	1.000
10	0.999	0.999	0.999
15	0.998	0.998	0.998
20	0.997	0.998	0.998
25	0.997	0.997	0.997
30	0.996	0.996	0.996
35	0.995	0.996	0.996
40	0.995	0.995	0.995
45	0.994	0.994	0.994
50	0.993	0.993	0.993

Table A2_18.4. Puffin, demographic rate set 1, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
5	0.997	0.999	1.002
10	0.996	0.999	1.002
15	0.996	0.998	1.001
20	0.995	0.998	1.000
25	0.994	0.997	1.000
30	0.994	0.996	0.999
35	0.993	0.996	0.998
40	0.992	0.995	0.997
45	0.991	0.994	0.997
50	0.991	0.993	0.996

Table A2_19.1. Puffin, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.988	0.974	0.961	0.948	0.936	0.924	0.912
	Median	**0.990**	**0.977**	**0.964**	**0.952**	**0.940**	**0.928**	**0.917**
	Upper 95%	0.991	0.979	0.968	0.956	0.946	0.935	0.926
10	Lower 95%	0.978	0.952	0.927	0.903	0.879	0.856	0.834
	Median	**0.980**	**0.955**	**0.931**	**0.907**	**0.884**	**0.862**	**0.840**
	Upper 95%	0.981	0.957	0.933	0.910	0.888	0.866	0.844
15	Lower 95%	0.968	0.930	0.894	0.859	0.826	0.794	0.763
	Median	**0.970**	**0.933**	**0.898**	**0.864**	**0.831**	**0.800**	**0.769**
	Upper 95%	0.971	0.936	0.901	0.868	0.835	0.804	0.774
20	Lower 95%	0.957	0.908	0.862	0.818	0.776	0.736	0.698
	Median	**0.960**	**0.912**	**0.866**	**0.823**	**0.781**	**0.742**	**0.705**
	Upper 95%	0.962	0.915	0.869	0.826	0.785	0.747	0.709
25	Lower 95%	0.947	0.887	0.831	0.779	0.729	0.683	0.639
	Median	**0.950**	**0.891**	**0.835**	**0.783**	**0.734**	**0.689**	**0.646**
	Upper 95%	0.952	0.894	0.839	0.787	0.739	0.693	0.650
30	Lower 95%	0.937	0.866	0.801	0.740	0.684	0.633	0.585
	Median	**0.940**	**0.870**	**0.805**	**0.745**	**0.690**	**0.639**	**0.591**
	Upper 95%	0.943	0.873	0.810	0.750	0.695	0.644	0.596
35	Lower 95%	0.927	0.845	0.772	0.703	0.642	0.586	0.535
	Median	**0.930**	**0.850**	**0.777**	**0.710**	**0.648**	**0.592**	**0.541**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.933	0.854	0.781	0.714	0.654	0.597	0.546
40	Lower 95%	0.917	0.825	0.743	0.669	0.603	0.543	0.488
	Median	**0.921**	**0.830**	**0.749**	**0.675**	**0.609**	**0.549**	**0.495**
	Upper 95%	0.924	0.835	0.754	0.680	0.614	0.555	0.501
45	Lower 95%	0.907	0.806	0.716	0.636	0.565	0.502	0.446
	Median	**0.911**	**0.811**	**0.722**	**0.643**	**0.572**	**0.509**	**0.453**
	Upper 95%	0.915	0.816	0.727	0.648	0.577	0.514	0.458
50	Lower 95%	0.897	0.786	0.689	0.604	0.529	0.465	0.408
	Median	**0.902**	**0.792**	**0.696**	**0.611**	**0.537**	**0.472**	**0.414**
	Upper 95%	0.905	0.797	0.701	0.617	0.543	0.477	0.420

Table A2_19.2. Puffin, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density independent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.654	0.517	0.446	0.395	0.351	0.307	0.299
	Median	**0.983**	**0.999**	**0.989**	**0.984**	**0.959**	**0.948**	**0.943**
	Upper 95%	1.458	1.732	2.060	2.236	2.603	2.922	3.017
10	Lower 95%	0.610	0.506	0.422	0.357	0.332	0.288	0.263
	Median	**0.982**	**0.951**	**0.932**	**0.910**	**0.891**	**0.853**	**0.857**
	Upper 95%	1.447	1.728	2.118	2.263	2.421	2.611	2.935
15	Lower 95%	0.625	0.517	0.417	0.351	0.321	0.268	0.238
	Median	**0.964**	**0.927**	**0.919**	**0.863**	**0.846**	**0.803**	**0.770**
	Upper 95%	1.409	1.716	1.935	2.225	2.315	2.560	2.956
20	Lower 95%	0.646	0.510	0.391	0.316	0.287	0.241	0.206
	Median	**0.964**	**0.923**	**0.889**	**0.832**	**0.781**	**0.761**	**0.732**
	Upper 95%	1.410	1.679	1.829	1.897	2.038	2.249	2.453
25	Lower 95%	0.600	0.467	0.406	0.312	0.274	0.225	0.185
	Median	**0.940**	**0.896**	**0.843**	**0.780**	**0.739**	**0.688**	**0.649**
	Upper 95%	1.404	1.613	1.766	2.010	2.005	2.097	2.234
30	Lower 95%	0.608	0.450	0.380	0.321	0.254	0.227	0.184
	Median	**0.931**	**0.872**	**0.809**	**0.757**	**0.703**	**0.654**	**0.603**
	Upper 95%	1.426	1.608	1.727	1.818	1.936	2.055	1.975
35	Lower 95%	0.609	0.458	0.357	0.275	0.235	0.195	0.161
	Median	**0.923**	**0.851**	**0.787**	**0.713**	**0.644**	**0.587**	**0.540**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.363	1.560	1.664	1.640	1.661	1.738	1.824
	Lower 95%	0.600	0.443	0.355	0.280	0.214	0.174	0.148
40	**Median**	**0.915**	**0.859**	**0.756**	**0.683**	**0.610**	**0.562**	**0.510**
	Upper 95%	1.344	1.550	1.607	1.721	1.737	1.722	1.764
	Lower 95%	0.612	0.461	0.344	0.272	0.211	0.176	0.142
45	**Median**	**0.904**	**0.811**	**0.733**	**0.645**	**0.583**	**0.525**	**0.458**
	Upper 95%	1.347	1.469	1.551	1.602	1.659	1.630	1.611
	Lower 95%	0.590	0.441	0.334	0.259	0.209	0.162	0.121
50	**Median**	**0.888**	**0.781**	**0.699**	**0.608**	**0.541**	**0.481**	**0.426**
	Upper 95%	1.314	1.487	1.505	1.482	1.412	1.374	1.376

Table A2_19.3. Puffin, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density independent simulations.

Additional adult mortality	**Lower 95%**	**Median**	**Upper 95%**
0	1.000	1.000	1.000
5	0.997	0.997	0.998
10	0.995	0.995	0.995
15	0.992	0.992	0.993
20	0.989	0.990	0.990
25	0.987	0.987	0.987
30	0.984	0.985	0.985
35	0.982	0.982	0.982
40	0.979	0.980	0.980
45	0.977	0.977	0.977
50	0.974	0.974	0.975

Table A2_19.4. Puffin, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density independent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
5	0.963	0.999	1.037
10	0.959	0.996	1.035
15	0.958	0.993	1.035
20	0.951	0.991	1.029
25	0.953	0.988	1.027
30	0.950	0.986	1.026
35	0.946	0.983	1.020
40	0.945	0.981	1.019
45	0.939	0.978	1.015
50	0.940	0.975	1.012

Table A2_20.1. Puffin, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.988	0.976	0.965	0.956	0.946	0.939	0.930
	Median	**0.990**	**0.979**	**0.970**	**0.961**	**0.954**	**0.947**	**0.941**
	Upper 95%	0.991	0.981	0.973	0.966	0.960	0.955	0.951
10	Lower 95%	0.978	0.955	0.934	0.915	0.897	0.881	0.865
	Median	**0.981**	**0.960**	**0.942**	**0.926**	**0.912**	**0.899**	**0.888**
	Upper 95%	0.982	0.963	0.947	0.934	0.923	0.914	0.906
15	Lower 95%	0.967	0.933	0.902	0.874	0.848	0.824	0.801
	Median	**0.971**	**0.940**	**0.913**	**0.889**	**0.868**	**0.850**	**0.834**
	Upper 95%	0.973	0.944	0.921	0.902	0.886	0.872	0.861
20	Lower 95%	0.957	0.912	0.872	0.836	0.802	0.771	0.744
	Median	**0.962**	**0.921**	**0.885**	**0.855**	**0.828**	**0.804**	**0.782**
	Upper 95%	0.964	0.927	0.895	0.870	0.848	0.830	0.813
25	Lower 95%	0.947	0.891	0.841	0.797	0.757	0.719	0.686
	Median	**0.952**	**0.901**	**0.857**	**0.819**	**0.786**	**0.756**	**0.730**
	Upper 95%	0.955	0.908	0.870	0.840	0.813	0.793	0.773
30	Lower 95%	0.937	0.871	0.813	0.762	0.714	0.672	0.634
	Median	**0.943**	**0.882**	**0.831**	**0.786**	**0.748**	**0.714**	**0.683**
	Upper 95%	0.946	0.891	0.846	0.808	0.777	0.751	0.727
35	Lower 95%	0.926	0.850	0.783	0.722	0.670	0.624	0.581
	Median	**0.934**	**0.864**	**0.805**	**0.754**	**0.709**	**0.671**	**0.638**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	0.938	0.874	0.821	0.779	0.744	0.715	0.687
40	Lower 95%	0.916	0.830	0.756	0.690	0.633	0.580	0.535
	Median	**0.924**	**0.845**	**0.778**	**0.722**	**0.673**	**0.630**	**0.592**
	Upper 95%	0.929	0.856	0.798	0.746	0.706	0.672	0.642
45	Lower 95%	0.905	0.811	0.728	0.658	0.594	0.539	0.491
	Median	**0.915**	**0.827**	**0.753**	**0.691**	**0.637**	**0.591**	**0.550**
	Upper 95%	0.920	0.838	0.773	0.719	0.675	0.638	0.607
50	Lower 95%	0.895	0.789	0.701	0.625	0.559	0.502	0.450
	Median	**0.906**	**0.810**	**0.730**	**0.662**	**0.604**	**0.554**	**0.511**
	Upper 95%	0.911	0.822	0.751	0.691	0.645	0.607	0.571

Table A2_20.2. Puffin, demographic rate set 2, counterfactuals of population size after 5 to 35 years, estimated using a non-matched runs method, from 1000 density dependent simulations.

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
0	Lower 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Median	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
	Upper 95%	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	Lower 95%	0.716	0.612	0.559	0.525	0.501	0.490	0.455
	Median	**0.985**	**0.966**	**0.967**	**0.963**	**0.957**	**0.961**	**0.943**
	Upper 95%	1.420	1.628	1.711	1.734	1.861	1.901	1.942
10	Lower 95%	0.718	0.618	0.564	0.510	0.490	0.461	0.455
	Median	**0.986**	**0.963**	**0.961**	**0.944**	**0.917**	**0.909**	**0.913**
	Upper 95%	1.356	1.554	1.630	1.772	1.848	1.880	1.815
15	Lower 95%	0.683	0.581	0.512	0.480	0.444	0.424	0.398
	Median	**0.979**	**0.956**	**0.932**	**0.904**	**0.877**	**0.869**	**0.851**
	Upper 95%	1.331	1.478	1.633	1.611	1.682	1.765	1.740
20	Lower 95%	0.691	0.593	0.534	0.476	0.415	0.401	0.376
	Median	**0.968**	**0.934**	**0.909**	**0.870**	**0.835**	**0.810**	**0.799**
	Upper 95%	1.368	1.482	1.589	1.549	1.572	1.627	1.668
25	Lower 95%	0.685	0.550	0.497	0.439	0.410	0.369	0.335
	Median	**0.954**	**0.908**	**0.868**	**0.817**	**0.785**	**0.763**	**0.732**
	Upper 95%	1.337	1.455	1.462	1.499	1.554	1.542	1.541
30	Lower 95%	0.675	0.568	0.471	0.420	0.393	0.355	0.331
	Median	**0.937**	**0.882**	**0.840**	**0.795**	**0.753**	**0.726**	**0.691**
	Upper 95%	1.321	1.427	1.475	1.455	1.459	1.470	1.477
35	Lower 95%	0.665	0.532	0.433	0.379	0.350	0.314	0.293
	Median	**0.937**	**0.857**	**0.815**	**0.768**	**0.727**	**0.694**	**0.655**

	Counterfactual of population size at 5 year intervals							
Additional adult mortality	**Estimate**	**yr.5**	**yr.10**	**yr.15**	**yr.20**	**yr.25**	**yr.30**	**yr.35**
	Upper 95%	1.298	1.364	1.445	1.481	1.409	1.382	1.329
40	Lower 95%	0.671	0.518	0.446	0.396	0.338	0.309	0.276
	Median	**0.918**	**0.837**	**0.771**	**0.712**	**0.675**	**0.635**	**0.601**
	Upper 95%	1.312	1.378	1.404	1.406	1.349	1.281	1.231
45	Lower 95%	0.668	0.505	0.418	0.355	0.294	0.279	0.252
	Median	**0.913**	**0.832**	**0.766**	**0.703**	**0.644**	**0.600**	**0.558**
	Upper 95%	1.257	1.302	1.340	1.322	1.286	1.262	1.197
50	Lower 95%	0.654	0.497	0.403	0.341	0.292	0.262	0.223
	Median	**0.910**	**0.810**	**0.732**	**0.670**	**0.609**	**0.561**	**0.509**
	Upper 95%	1.272	1.330	1.295	1.258	1.189	1.174	1.122

Table A2_20.3. Puffin, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
5	0.998	0.998	0.999
10	0.996	0.997	0.997
15	0.994	0.995	0.996
20	0.991	0.993	0.994
25	0.989	0.991	0.993
30	0.987	0.989	0.991
35	0.985	0.987	0.990
40	0.982	0.985	0.988
45	0.980	0.983	0.986
50	0.977	0.981	0.985

Table A2_20.4. Puffin, demographic rate set 2, counterfactuals of population growth rate calculated between year 5 and year 35, using a non-matched runs method, from 1000 density dependent simulations.

Additional adult mortality	Lower 95%	Median	Upper 95%
0	1.000	1.000	1.000
5	0.975	0.998	1.022
10	0.975	0.997	1.021
15	0.971	0.995	1.018
20	0.969	0.994	1.018
25	0.967	0.991	1.015
30	0.966	0.990	1.016
35	0.962	0.988	1.011
40	0.961	0.986	1.009
45	0.958	0.984	1.009
50	0.957	0.981	1.006