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Abbreviations and Acronyms

BDMPS	Biologically Defined Minimum Population Scales
CEH	Centre for Ecology and Hydrology
CIA	Cumulative Impact Assessment
CIV	Cable Installation Vessel
COWRIE	Collaborative Offshore Wind Research into the Environment
CRM	Collision Risk Model/Modelling
ECoW	Ecological Clerk of Works
EIA	Environmental Impact Assessment
FAME	Future of the Marine Environment
FTRAG-O	Forth and Tay Regional Advisory Group – ornithology sub-group
HRA	Habitats Regulations Appraisal
ICOL	Inch Cape Offshore Limited
MHWS	Mean High Water Springs
MS-LOT	Marine Scotland Licensing Operations Team
MSS	Marine Scotland Science
OfTW	Offshore Transmission Works
OnTW	Onshore Transmission Works
OSP	Offshore Substation Platform
PSG	Project Steering Group
pSPA	Proposed Special Protection Area
PVA	Population Viability Analysis
RSPB	Royal Society for the Protection of Birds
SD	Standard deviation
SNCB	Statutory Nature Conservation Bodies
SNH	Scottish Natural Heritage
SPA	Special Protection Area
STAR	Seabird Tracking and Research
WTG	Wind Turbine Generator

11 Ornithology

11.1 Introduction

1 This chapter presents the assessment of potential impacts on birds predicted to arise from the construction, operation and maintenance, and decommissioning of the Inch Cape Wind Farm and associated Offshore Transmission Works (OfTW) (the Development).

2 The following chapters and appendices should be read in conjunction with this chapter, the introductory chapters (1-8) and the ornithology section of the Inch Cape Wind Farm and Offshore Transmission Works Habitats Regulations Appraisal (HRA):

- *Appendix 11A: Offshore Ornithology Baseline Survey Report*
- *Appendix 11B: Apportioning Effects to Special Protection Area (SPA) Colonies During the Breeding and Non-Breeding Seasons*
- *Appendix 11C: Estimation of the Development Alone and Cumulative Collision Risk*
- *Appendix 11D: Estimation of the Development Alone and Cumulative Effects from Displacement and Barrier Effects*
- *Appendix 11E: Population Viability Analyses*
- *Chapter 9: Natural Fish and Shellfish; and*
- *Chapter 18: Summary of Effects.*

11.2 Consultation

11.2.1 Scoping

3 An Environmental Impact Assessment (EIA) Scoping Report for the Development was issued in April 2017. This Scoping Report contained the HRA screening report for the Development.

4 Prior to issuing the formal Scoping Opinion, a meeting was held by Marine Scotland Licensing Operations Team (MS-LOT) on 26 May 2017, involving Marine Scotland Science (MSS), Scottish Natural Heritage (SNH), the Royal Society for the Protection of Birds (RSPB) and Inch Cape Offshore Limited (ICOL), to facilitate early engagement and structured discussion between these stakeholders and ICOL. Discussions at this meeting covered a range of topics including the following:

- Baseline survey data;
- Proposed operational period for the Inch Cape Wind Farm;
- Foraging range data to be used to define regional seabird populations and connectivity with SPAs;
- Approaches for inclusion of the Forth and Tay projects in the Cumulative Impact Assessment (CIA) (specifically in relation to whether the consented or revised designs should be used); and

- Recent updates to modelling methodologies.

5 The formal Scoping Opinion from MS-LOT was received on the 28 July 2017 covering all receptors other than marine mammals and ornithology. Separate addendums to cover marine mammals and ornithology were issued on the 3 and 10 August 2017 respectively. The MS-LOT Scoping Opinion for ornithology included the scoping advice from SNH and RSPB, as well as a summary of discussions between MSS, SNH and RSPB on the issues pertaining to the scope of the assessment.

6 Following receipt of the ornithology addendum, received on the 10 August 2017, further correspondence with MS-LOT was undertaken to seek clarification on several points, as well as a small number of further, new queries that emerged during the course of undertaking the assessment. This correspondence comprised letters of clarification from ICOL to MS-LOT sent on 29 August 2017, 19 September 2017, 11 October 2017 (dated 06 October 2017), 26 October 2017, with associated responses received on 8 and 29 September 2017, 17 October 2017, and 3 November 2017, respectively. Additional to these letters, there was associated email correspondence. This concerned; (i) the colony count data provided by SNH in their scoping advice (with emails sent from ICOL to MS-LOT on 28 September 2017, 17 October 2017, 28 November 2017, and 5 and 11 December 2017 and respective responses received on 29 September 2017, 19 October 2017, 30 November 2017, 8 and 18 December 2017); (ii) the methods for calculating non-breeding season effects (with emails from MS-LOT to ICOL on 1, 8 and 30 November 2017, and from ICOL to MS-LOT on 8 and 28 November 2017); and (iii) the development and availability of the MS-LOT Apportioning Tool (email from MS-LOT to ICOL of 7 November 2017)[1]. The ornithology addendum and subsequent clarifications are referred to as the Scoping Opinion. A summary of the final outcome of this correspondence is provided below (Table 11.1).

Table 11.1: Scoping responses and actions

Consultee	Scoping Response	ICOL's Response
SNH	Recommend that pre-application dialogue should continue after scoping to address points of clarification and confirm final methodological details. This should be co-ordinated, as far as is possible given uncertain re-submission timescales, with all three Forth and Tay developers.	Within the constraints of having to meet a tight deadline for production and submission of the application, efforts were made to continue dialogue on the key elements of the assessment beyond the Scoping Opinion. This included a stakeholder's workshop on 7 March 2018, which was attended by SNH, RSPB, MSS and MS-LOT.
SNH	Scoping advice is limited to the time frame of the expected application in early 2018. Advice may be updated if the application is significantly delayed.	This has been noted. MS-LOT confirmed the Scoping Opinion would be valid for 12 months, unless otherwise agreed.

[1] At the time of writing, all correspondence is available at http://www.gov.scot/Topics/marine/Licensing/marine/scoping/ICOLRevised-2017/OrnithologyQ-092017.[Accessed:02/08/18]

<table>
<tr><th>Consultee</th><th>Scoping Response</th><th>ICOL’s Response</th></tr>
<tr><td>SNH</td><td>Noted that no further baseline survey is required (as per SNH advice note of 2 February 2017), but this advice may change if the application is delayed.</td><td>The assessment is based upon the existing two years of boat-based survey data (spanning the period September 2010 to September 2012), which the Scoping Opinion states to remain valid for the application provided that the application is received within 12 months of the issue of the Scoping Opinion (after which time this position could be subject to review). An extension to the validity of the Scoping Opinion was granted and the application submitted within this time. The existing two years of boat-based survey data is therefore considered to remain valid.</td></tr>
<tr><td>SNH</td><td>SNH does not require any assessment against the regional populations of the seabird species of concern. The SNH focus is on the individual breeding colonies, particularly SPAs.

The key species and SPAs for assessment are:

• Gannet – Forth Islands
• Kittiwake – Forth Islands, Fowlsheugh
• Herring gull – Forth Islands, Fowlsheugh
• Puffin – Forth Islands
• Guillemot – Forth Islands, Fowlsheugh
• Razorbill – Forth Islands, Fowlsheugh

Inclusion of St Abb’s Head to Fast Castle SPA and Buchan Ness to Collieston Coast SPA populations of kittiwake, herring gull, guillemot and razorbill will depend upon review of the updated apportionment calculations.

SNH do not consider that the Inch Cape Project (either alone or in-combination with the other Forth and Tay proposals) will give rise to significant population level impacts to lesser black-backed gull, fulmar, common tern and Arctic tern at any of the identified SPAs.</td><td>This advice from SNH is reflected in the focus of the assessment. The impacts to each of the SPA populations identified for inclusion by SNH (and which were identified to have connectivity with the Development Area and 2 km buffer) have been assessed, with conclusions reached regarding whether these impacts represent adverse effects on the respective SPAs. The following key species and SPAs were assessed:

• Gannet – Forth Islands
• Kittiwake – Forth Islands, Fowlsheugh, St Abb’s Head to Fast Castle
• Herring gull – Forth Islands, Fowlsheugh, St Abb’s Head to Fast Castle
• Puffin – Forth Islands
• Guillemot – Forth Islands, Fowlsheugh, St Abb’s Head to Fast Castle, Buchan Ness to Collieston Coast
• Razorbill – Forth Islands, Fowlsheugh

The Buchan Ness to Collieston Coast SPA kittiwake and herring gull populations, and the St Abb’s Head to Fast Castle SPA razorbill population were determined not to have connectivity to the Development Area and buffer.

Consideration has also been given to the regional populations of the identified seabird species of concern.</td></tr>
<tr><td>SNH</td><td>In relation to the Outer Firth of Forth and St Andrews Bay Complex proposed SPA (pSPA), the Inch Cape Wind Farm lies</td><td>The assessment has adopted the approach advised by SNH in relation to the qualifying features of the Outer Firth of Forth and St</td></tr>
</table>

Consultee	Scoping Response	ICOL's Response
	approximately 10 km from the boundary and is unlikely to cause disturbance to, or displacement of, seabirds foraging within the pSPA. Outwith the pSPA, it is considered that impacts on individuals can only meaningfully be assessed in relation to these birds as members of a breeding population. It is advised that six key pSPA interests should be scoped in for assessment – i.e. gannet, kittiwake, herring gull, guillemot, razorbill and puffin. The advice provided on these species in relation to the SPA breeding colonies also covers the pSPA requirements. Further advice provided to MS-LOT on 07 September 2017 stated that insufficient information is currently available on the extent of the activities associated with the installation, operational maintenance and decommissioning of the Offshore Export Cable within the Outer Firth of Forth and St Andrews Bay Complex pSPA to enable this to be scoped out of the assessment (see below)[1]. With this exception, it is advised that other seabird qualifying features (or named components of assemblage features) of the pSPA can be scoped out of the assessment.	Andrews Bay Complex pSPA which are identified for inclusion in the assessment. In line with SNH advice, the other qualifying features have been scoped out of the assessment other than in relation to the installation, maintenance and decommissioning of the Offshore Export Cable. This is considered in the HRA (ICOL, 2018a), but also in relation to the wider regional populations of the relevant species.
SNH	It is considered that all other bird interests (i.e. non-seabirds) were fully considered and addressed in pre-application dialogue and in final assessments for the previous application. The key possible impact from the Forth and Tay wind farms on these interests relates to the collision risk that turbines may present to birds on migration. In this regard, MS-LOT commissioned a strategic 'worst case' collision risk assessment for all wind farms proposed in Scottish waters at the time (WWT Consulting, 2014). It is considered that current offshore wind proposals in Scottish waters do not present significant risk to any other bird interests and SNH do not require any individual developer to submit further information in this regard.	This advice has been noted and the assessment has scoped out all non-seabird interests.
SNH	Inch Cape only presents a risk to seabirds when they're outwith SPA or pSPA boundaries. Therefore, as previously advised, any potential wind farm impacts should be considered in relation to the conservation objective for 'population of	In relation to the SPA qualifying features that are considered in the assessment, the focus of the assessment is in relation to the conservation objective for 'population of the bird species as a viable component

Consultee	Scoping Response	ICOL's Response
	the bird species as a viable component of the SPA'. This means that the significance of any collision mortality, disturbance or displacement of individual birds at sea is considered in relation to the consequent effects on SPA breeding populations. SNH do not require any assessment against regional populations nor a separate assessment for the pSPA.	of the SPA'. As noted above, consideration has also been given to the regional populations of the identified seabird species of concern, whilst an assessment in relation to the installation, maintenance and decommissioning of the Offshore Export Cable is also presented for both the pSPA and regional populations of the relevant species.
SNH	The CIA should include non-breeding season effects, as follows: • Kittiwake: All UK wind farms in the North Sea[1]. • Gannet: All UK wind farms in the North Sea and English Channel[1]. • Herring gull: If project alone collisions are significant, CIA for non-breeding season effects to encompass the Forth and Tay wind farms[1]. • Guillemot and razorbill: The same wind farms as included for the breeding season effects. • Puffin: No assessment of non-breeding season effects is required[1].	The assessment has followed SNH advice on the inclusion of non-breeding season effects within the CIA.
SNH	No need to consider displacement effects on kittiwake, as available post-construction monitoring indicates no significant avoidance by this species.	Contrary to SNH advice, displacement effects on kittiwake have been assessed, following advice from MS-LOT. In line with the advice from MS-LOT, quantitative assessment of displacement is limited to the breeding period and only a qualitative assessment for the SPA populations is undertaken for the non-breeding periods.
SNH	For the purposes of assessing displacement using the Statutory Nature Conservation Bodies (SNCB) matrix approach, assumed mortality rates amongst displaced birds should be 2% for puffin and 1% for other species.	The mortality rates advised by SNH have been used to inform the SNCB matrix approach for assessment of displacement effects (except in the case of kittiwake for which displacement effects were assessed although SNH did not consider this necessary - see above).
SNH	Displacement impacts should be undertaken for the three auk species. It is considered that the updated Centre for Ecology and Hydrology (CEH) displacement model (SeabORD) should be the preferred approach to assessing breeding season	The SeabORD model was not published at the time of undertaking the assessment but CEH were commissioned by ICOL to run the model using the latest unpublished version. The resulting outputs have been used to estimate the effects of

Consultee	Scoping Response	ICOL's Response
	displacement effects.	displacement and barrier effects during the breeding season on SPA populations of the three auk species and kittiwake, and consideration has been given within the assessment to the resulting outputs. However, in line with the advice provided by MS-LOT in the Scoping Opinion the SNCB matrix approach provides the basis for assessing breeding season displacement and barrier effects on these species, and provides the displacement-related inputs to the Population Viability Analyses (PVAs)[5].
SNH	Displacement effects in the non-breeding season should only be assessed for guillemot and razorbill because puffins disperse from the Forth and Tay region in winter. Non-breeding displacement of these two species should be assessed using the SNCB matrix approach (SNCBs 2017). It is advised that a 60% displacement rate and 1% rate of mortality are assumed for this.	Non-breeding season displacement effects have been assessed quantitatively for guillemot and razorbill only. Qualitative assessment of kittiwake displacement during the non-breeding season has also been undertaken (following advice from MS-LOT). The displacement and mortality rates used in this exercise are as advised by SNH.
SNH	It was advised that a 2 km buffer should be assumed for use with the SeabORD model (as advised for the SNCB matrix approach), although it was recognised that previous modelling outputs for estimating displacement and barrier effects had assumed a 1 km buffer[2].	A two kilometre buffer has been assumed for both the SNCB matrix approach and the SeabORD models, whilst the outputs from Searle *et al.* (2014) are presented as estimated using a one kilometre buffer. Bird densities and population-sizes within the two kilometre buffer were extrapolated from the existing density estimates for the four kilometre buffer (the original analyses to estimate densities within the buffer having been undertaken on the four kilometre buffer). This approach was confirmed as acceptable by MS-LOT and SNH[4].
SNH	Based on the discussions at the ornithology meeting attended by MS-LOT, SNH, RSPB and MSS on 19 July 2017 (but not stated within the SNH Scoping Advice), collision risk models (CRMs) should use monthly maximum densities of birds in flight as opposed to monthly mean densities, because this would capture uncertainty in the survey data.	Contrary to the SNH advice, the mean monthly densities of birds in flight have been used as the inputs to the CRMs. As detailed in the Scoping Opinion, this is consistent with what has been advised for, and undertaken by, other assessments of offshore wind farms. A measure of the statistical uncertainty about these mean values is presented through calculation of the standard deviations (SDs) for the mean monthly densities.

Consultee	Scoping Response	ICOL's Response
SNH	Nocturnal activity scores should be 2 (i.e. 25%) for herring gull and kittiwake and 1 (i.e. 0%) for gannet.	The SNH advice on nocturnal activity scores to use in the CRMs has been followed.
SNH	For gannet and kittiwake, CRM outputs should be presented for model options 1 and 2 using Johnston *et al.* flight heights and a 98.9% (+/- 2 SD) avoidance rate. For herring gull, CRM outputs should be presented for model options 1, 2 and 3 using a 99.5% (+/- 2 SD) avoidance rate and Johnston *et al.* flight heights.	CRMs for kittiwake and gannet have been undertaken using the options and avoidance rates advised by SNH. For herring gull, options 1, 2 and 3 have been undertaken (as advised by SNH). It has been assumed that the SNH advice on avoidance rates to use for herring gull is an unintentional error (as it differs from the conclusions of the SNCB advice document – SNCB 2014). Therefore, in line with the MS-LOT advice (and SNCBs (2014)), avoidance rates of 99.5% have been used for options 1 and 2, and the more precautionary 99.0% for option 3.
SNH	Recommended periods to define breeding and non-breeding seasons are provided for each of the key seabird species. These should be used to apportion impacts between seasons.	The advised seasonal periods have been used in the assessment.
SNH	All birds recorded as adults during the at-sea surveys should be considered to be breeding adults. This is a precautionary assumption and it may be possible to refine it with further discussion.	The advised approach to determining the proportion of breeding adults within the on-site population has been followed. However, as advised by MS-LOT, a proportion of the birds classed as adults from at-sea survey data are assumed to be sabbatical birds. For the three auk species the at-sea survey data do not provide information on age distributions and their age distributions are estimated from the stable age distributions of the associated population models that have been produced to inform the assessment (as advised by MS-LOT).
SNH	Apportioning breeding season impacts between colony populations should be undertaken following the SNH guidance (SNH 2016). It is recommended that this should be done according to the following two-step process: • apportioning between SPA and non-SPA colonies using Seabird 2000 data • impacts apportioned to the SPA component should use most recent colony counts to apportion to the	The assessment uses the approach advised by SNH to apportion breeding season impacts between colony populations.

Consultee	Scoping Response	ICOL's Response
	individual SPA populations	
SNH	Assessment of collision mortality in the non-breeding season for herring gull, kittiwake and gannet can use the approach agreed for herring gull during the Moray Firth determinations. While many herring gulls remain locally in the Forth and Tay over-winter, there is also an influx of wintering birds from elsewhere. Any collisions which might occur at the wind farm will therefore need to be apportioned between the local SPA breeders and these other wintering birds. We consider that a similar method can be worked up for kittiwake and gannet: defining the overall wintering population in the Forth and Tay and determining what proportion of this comprises birds from the relevant SPA breeding colonies. Updated advice from SNH for gannet and kittiwake was to use the Biologically Defined Minimum Population Scales (BDMPS) approach (Furness, 2015), with further correspondence between SNH, MS-LOT and ICOL leading to agreement that this should be adapted in line with what was undertaken (by the same authors) for the more recent East Anglia THREE assessment (Royal HaskoningDHV *et al*. 2015, MacArthur Green 2015 a, b)[6].	The estimated collision impacts to herring gulls were considered to be sufficiently small that the approach outlined by SNH for assessing non-breeding period effects was not necessary. Instead a more precautionary approach of assessing against the regional population as defined in the breeding period was undertaken for the SPA populations. In line with the MS-LOT advice, and following correspondence with SNH (including updated advice) and MS-LOT on the details of the approach to be used[6], the assessment of non-breeding collision mortality to kittiwake and gannet SPA populations has been undertaken using the BDMPS approach, as modified in the East Anglia THREE assessment (Royal HaskoningDHV *et al*. 2015, MacArthur Green 2015 a, b) and using collision estimates as revised in MacArthur Green (2017).
SNH	SNH do not require any assessment of the potential impacts on seabird prey species from piling (underwater noise) impacts during construction. Any such impacts are relatively short-term and SNH consider these to be offset by the greatly reduced long-term impacts from having fewer turbines.	In accordance with the SNH advice, potential impacts on seabird prey species from piling have been scoped out of the assessment.
SNH	The interpretation of the PVA outputs should be undertaken using the following metrics: • median of the ratio of impacted to unimpacted annual growth rate • median of the ratio of impacted to unimpacted population size	The two metrics advised by SNH for use in interpreting PVA outputs have been applied in the assessment. However, as advised by MS-LOT, a third metric has also been applied in the interpretation of PVA outputs (i.e. the centile for unimpacted population that matches the 50th centile for impacted population).
SNH	Advised that PVAs were not required for either the Buchan Ness to Collieston Coast	PVAs were undertaken for all SPA populations of the identified key seabird

Consultee	Scoping Response	ICOL's Response
	SPA populations or the St Abb's to Fast Castle SPA populations. Final advice on the requirement for PVAs for the relevant SPA populations is dependent on the outputs of the CRMs and displacement modelling.	species which were considered to have connectivity to the Development Area and two kilometre buffer, except for the herring gull SPA populations. Impacts to herring gulls were considered to be sufficiently small to negate the need for PVAs.
SNH	As a minimum, any PVAs that are required should be based upon deterministic, density independent, Leslie Matrix population models.	The assessment uses density independent, stochastic PVAs with those for species other than gannet undertaken using a state-space modelling framework (Freeman *et al.* 2014). Stochastic PVAs are likely to be more precautionary than deterministic PVAs (Cook and Robinson, 2015), whilst the approach adopted follows the advice of the Scoping Opinion. The specific PVA used for gannet was as agreed in the Scoping Opinion[1].
SNH	Where population modelling and PVAs are required, this should be undertaken over both 25 and 50 year time periods.	PVAs have been based upon both 25 and 50 year projections.
SNH	SNH have considered the proposed transmission works in relation to the relevant qualifying interests of the Outer Firth of Forth and St Andrews Bay Complex pSPA, in order to confirm that in their view there are no outstanding matters requiring further assessment. Potential impacts from the transmission works on seabird species were fully considered for the relevant marine licence. SNH do not consider there will be any significant disturbance to these seabirds (including pSPA qualifiers) arising from the proposed cable-laying activity in the export corridor. Subsequent clarification states that although SNH remains of the opinion that the effects arising from the cabling works can be managed to reduce impacts, they realise that there may be insufficient details to inform any appropriate assessments required[1]. Therefore, it is recommended that the following information should be provided in relation to the cabling works: • Extent and route of export cable corridors and number of cables. • Duration and method of cable	The SNH advice on the information that should be provided in relation to the cabling works has been followed, and is presented in the HRA (ICOL, 2018a) and also (for regional populations) in the EIA chapter.

Consultee	Scoping Response	ICOL's Response
	deployment including start and finish dates. • Type and number of vessels involved in cable laying operations • Habitat mapping within cable corridor and the likely prey species of pSPA interests where the cable route crosses the pSPA. • Use of any cable protection materials – type, location and method of deployment. • Schedule of operational maintenance checks, types of vessels, duration and timing. • Any proposed mitigation and inclusion of draft cable laying plan and cable maintenance plan.	
RSPB	Note that a proposed operating time of 50 years presents challenges to the environmental assessment, particularly in relation to the degree of uncertainty in predicting population scale effects on protected seabird colonies. Confidence in projected population model outputs decreases as time increases. This increasing lack of confidence extending to 25 years and beyond has a direct effect on the decision-makers' ability to reach an ecologically robust conclusion on the potential adverse effects to the Natura network and its protected species. RSPB would welcome further discussion on this topic as mechanisms for addressing the issue may exist.	As detailed in the assessment, impacts have been assessed over both 25 and 50 year timescales as requested in the Scoping Opinion. It is considered that sufficient information is available on the potential impacts and their potential effects to enable sufficiently precautionary conclusions to be made.
RSPB	Noted that the dedicated two year ornithology site survey data is now 5-7 years old. An updated survey was not requested, but the spatial and temporal variability of seabird distributions was highlighted. As a consequence, the survey data may not represent an accurate account of seabird usage and this element of uncertainty will have to be taken into account within the assessment.	The assessment is based upon the existing two years of boat-based survey data (spanning the period September 2010 to September 2012 inclusive), which were considered in the Scoping Opinion to be suitable for the purposes of the assessment. These surveys were undertaken using the recommended approach and methodology (Camphuysen *et al.* 2004) and are therefore no less reliable and representative than analogous surveys for other offshore wind farm projects. Uncertainty has been accounted for within the assessment by using a range of

Consultee	Scoping Response	ICOL's Response
		precautionary assumptions and by undertaking the assessment in relation to worst-case scenarios.
RSPB	There is a need to establish a worst-case scenario in relation to the Forth and Tay wind farms. RSPB suggests that this is likely to be the Inch Cape Wind Farm plus the Neart na Gaoithe and Seagreen Alpha and Bravo 2014 consented designs. Verification will be required to confirm that the 2014 consented designs for these projects represent a worst-case compared to new, alternative, designs that are submitted for these projects.	The cumulative/in-combination assessment has considered two different scenarios with respect to the inclusion of the other Forth and Tay wind farm projects. This followed the MS-LOT advice on this matter, with the scenarios being: 1. The worst case for each species from (i) Neart na Gaoithe (2014 as consented) or Neart na Gaoithe (2017 Scoping Report) and (ii) Seagreen Alpha and Bravo (2014 as consented) or Seagreen (2017 Scoping Report); and 2. Neart na Gaoithe (2017 Scoping Report) and Seagreen (2017 Scoping Report).
RSPB	The RSPB holds the results of an extensive seabird tracking programme. The information could provide additional evidence of seabird foraging distances, which can be used to identify reference populations for assessment purposes. RSPB has raised the potential of providing analysed information on foraging ranges to support the assessment. We will seek to provide this in due course.	ICOL submitted a request to RSPB for the seabird tracking data on 1 September 2017. Tracking data were provided to ICOL on 13 September 2017. However, the tracking data that were provided represented a subset of the full tracking data from UK colonies held by RSPB from the Future of the Marine Environment (FAME) and Seabird Tracking and Research (STAR) projects. This subset was the data that were owned solely by RSPB. It was considered that the subset of data provided to ICOL could not be assumed to be representative of the full data set. Further advice on this matter from MS-LOT advised that if the MS-LOT Apportioning Tool was not available in time for use in the assessment, it would be appropriate to determine colony connectivity using the Thaxter *et al.* (2012) foraging range data[2]. Subsequently, MS-LOT informed ICOL of a delay to the finalisation and publication of the MS-LOT Apportioning Tool due to an error in some of the underpinning analyses of Wakefield *et al*. (2017)[7]. As such, the RSPB tracking data were not used in place of the existing Thaxter *et al.* (2012) data on seabird foraging ranges.
RSPB	In addition to the SNH advice on the inclusion of non-breeding season effects in	The non-breeding season collisions to gannet and kittiwake have been

Consultee	Scoping Response	ICOL's Response
	the CIA, to consider collision impacts to kittiwake and gannet from non-UK wind farms in a qualitative way.	considered quantitatively for UK North Sea and (for gannet) Channel wind farms, as advised in the Scoping Opinion. Non-UK wind farms have not been included as this was not advised by the Scoping Opinion.
RSPB	In relation to SPA assemblage features, both the assemblage and the named individual species populations within it need to be considered as part of the HRA. The two are not mutually exclusive.	The assessment has treated named individual species populations within the SPA assemblage features as a full part of the HRA (ICOL, 2018a). The assemblage features have also been assessed in their own right.
RSPB	The species and sites to be included in the assessment should be as per the SNH and MS-LOT advice except that great black-backed gull and lesser black-backed gull should also be included in the EIA.	Following the advice from SNH, MSS and MS-LOT, both great black-backed gull and lesser black-backed gull were scoped out of the assessment. This was on the basis that the previous assessments by all three Forth and Tay developers had demonstrated that effects on these species would be negligible.
RSPB	All conservation objectives of the protected sites should be taken into account in order to review whether they can be discounted.	Following the advice from MS-LOT, the conservation objective relating to the "*population of the species as a viable component of the site*" is the focus of the assessment presented in the HRA (ICOL, 2018a). However, consideration is given to all the conservation objectives of the protected sites in the assessment to review whether they can be discounted and, where relevant, to provide justification as to why the other conservation objectives are less relevant than, or are addressed via, the conservation objective relating to the "*population of the species as a viable component of the site*".
RSPB	Evidence relating to the avoidance behaviour of kittiwakes during the breeding season is lacking. Therefore, displacement effects should be considered for kittiwake, with a 50% displacement rate proposed.	The advice from MSS and MS-LOT has been followed, with kittiwake displacement effects considered on the basis of a 30% displacement rate, which takes account of the contrasting advice from SNH and RSPB. SNH advised that the available evidence for kittiwake from post-construction monitoring indicated no significant avoidance of wind farms and, as such, displacement did not need to be assessed.
RSPB	For the purposes of assessing displacement using the SNCB matrix approach, assumed mortality rates amongst displaced birds	The mortality rates advised by MS-LOT have been used in the assessment of displacement effects by the SNCB matrix

Consultee	Scoping Response	ICOL's Response
	should be 2% for all species.	approach. Thus, mortality rates of 2% are assumed amongst displaced birds for puffin and kittiwake, and of 1% for guillemot and razorbill. This also follows the advice of SNH, with the exception of kittiwake (for which SNH advised displacement did not need to be assessed).
RSPB	For apportioning of effects to non-adult age classes, the preference should be to use age structures as derived from the site survey data for gannet and kittiwake, as opposed to those from PVA-derived stable age structures.	Age structures have been derived from the survey data for kittiwake and gannet for the purposes of apportioning effects.
RSPB	Recommend using the Band (2012) collision model, with model options and avoidance rates to be used for each species as advised by SNH, except that an avoidance rate of 98.0% for gannet during the breeding season is advised. This is because the evidence presented by Cook *et al.* (2014) to justify the 98.9% avoidance rate for gannet was based largely non-breeding birds.	The assessment uses the Band (2012) collision model, with model options and avoidance rates for each species as advised by SNH. An avoidance rate of 98.9%, as opposed to 98.0%, is used for gannet during the breeding season. This is as advised by SNH, MSS and MS-LOT on the basis of the conclusions of Cook *et al.* (2014) and the SNCBs (2014).
RSPB	Based on the discussions at the ornithology meeting attended by MS-LOT, SNH, RSPB and MSS on 19 July 2017 (but not stated within the RSPB Scoping Advice), CRMs should use monthly maximum densities of birds in flight as opposed to monthly mean densities, because this would capture uncertainty in the survey data.	Contrary to the RSPB advice, the mean monthly densities of birds in flight have been used as the inputs to the CRMs. As detailed in the Scoping Opinion, this is consistent with what has been advised for, and undertaken by, other assessments of offshore wind farms. A measure of the statistical uncertainty about these mean values is presented through calculation of the SDs for the mean monthly densities.
RSPB	The nocturnal activity score for gannet should be 2 (i.e. 25%) because at-sea surveys may omit dawn and dusk, when gannet activity may be greatest.	The nocturnal activity scores used in the CRMs follow the advice of SNH, MSS and MS-LOT. Therefore, a score of 1 (i.e. 0%) has been used for gannet. MSS considered that the rationale proposed by RSPB for using a higher nocturnal activity score conflated colony attendance, foraging activity and the timing of at-sea surveys.
RSPB	Comparison should be made of site specific and generic data and associated confidence intervals using Proportion at Collision Height ("PCH") as defined by survey height bands of both data sets. This should also include discussion of any significant differences.	This comparison has been undertaken and is presented within the assessment, and the differences between the site-specific and generic flight heights are discussed.

Consultee	Scoping Response	ICOL's Response
RSPB	The interpretation of the PVA outputs should be undertaken using the median of the ratio of impacted to unimpacted population size	The metric advised by RSPB for use in interpreting PVA outputs has been applied in the assessment. However, as advised by MS-LOT, two other metrics have also been applied in the interpretation of PVA outputs (i.e. the median of the ratio of impacted to unimpacted annual growth rate and the centile for unimpacted population that matches the 50th centile for impacted population).
RSPB	Population modelling should be undertaken for the SPA populations with connectivity to the Development Area, including those for Buchan Ness to Collieston Coast SPA and St Abb's Head to Fast Castle SPA.	Population modelling has been undertaken in relation to the Buchan Ness to Collieston Coast SPA and the St Abb's Head to Fast Castle SPA for the SPA populations considered to have connectivity to these SPAs, except in the case of herring gull where the predicted impacts were considered to be sufficiently small to negate need for any PVAs.
RSPB	Firth of Forth and St Andrew's Bay Complex pSPA requires inclusion in the assessment. The supporting habitats within this pSPA are especially relevant to the cabling corridor. Such development could lead to habitat disturbance or loss within the pSPA. The relative importance of the cable corridor in terms of the quality of habitat and how its structure and function could be affected.	The predicted impacts of the cable corridor on the supporting habitats within the pSPA have been considered within the assessment for both the pSPA populations (ICOL, 2018a) and the wider regional populations.
MSS	The CIA breeding season effects should consider effects from projects within mean maximum foraging range of the relevant SPA colony. Effects should be considered quantitatively for the Forth and Tay wind farms, and qualitatively for other wind farms.	The CIA considers effects from projects within the mean maximum foraging range of the relevant SPA colony and assesses these effects quantitatively for the Forth and Tay wind farms and qualitatively for other wind farms.
MSS	In relation to the inclusion of non-breeding season effects in the CIA, agreed with SNH's advice for herring gull, guillemot, razorbill and puffin but considered that it will be challenging to identify gannet, kittiwake and herring gull collision estimates from other UK offshore wind farms that have used consistent approaches. MSS advised that the cumulative collision estimates for these species should be treated with extreme caution (as should the PVA outputs that are derived from consideration of these	The advice regarding cumulative collision estimates from the non-breeding season has been noted, and for gannet and kittiwake the in-combination assessment is undertaken in relation to the Forth and Tay wind farms only as well as for all UK North Sea and (for gannet) Channel wind farms.

Consultee	Scoping Response	ICOL's Response
	effects).	
MSS	Displacement should be included in the kittiwake assessment. Macro avoidance/ displacement has been observed at some wind farms, and whilst displacement and collision effects may be mutually exclusive for individuals, this may not be the case at the population level. Proposed a 30% displacement rate, based on taking account of the differing SNH and RSPB advice on this issue, as well the approach taken in the original Forth and Tay assessments and the reduced number of Wind Turbine Generators (WTGs) compared to the previous designs.	Displacement and barrier effects have been estimated for kittiwake using the SNCB matrix approach, with reference also made to the estimates produced using the SeabORD and earlier Searle *et al.* (2014) models. In line with the advice from MS-LOT, the assessment is based upon the SNCB matrix approach, with the SeabORD model not yet published at the time of undertaking the assessment.
MSS	Supported the SNH advice with regard to assumed mortality rates for use with the SNCB matrix approach.	The mortality rates advised by SNH for use with the SNCB matrix approach for estimating displacement effects have been adopted.
MSS	The use of monthly maximum densities of birds in flight for the CRMs ignores uncertainty and is overly precautionary. The use of monthly maximum densities is highly likely to estimate effects that are unrealistically high. The mean monthly densities of birds in flight should be used in the CRMs, with 95% confidence limits presented for the mean values.	CRMs are based upon the mean monthly densities of birds in flight, with the SDs for the mean monthly densities also presented.
MSS	Nocturnal activity scores should be 2 (i.e. 25%) for herring gull and kittiwake and 1 (i.e. 0%) for gannet. The justification from RSPB to use different scores for gannet appears to conflate nocturnal activity with colony attendance, foraging activity and timing of at-sea surveys and lacks an adequate empirical basis.	The nocturnal activity scores advised by MSS and SNH have been used.
MSS	Avoidance rates for use in CRMs should be as detailed in the joint SNCB document on avoidance rates (SNCBs 2014). There is no evidence to support going against the advice provided in this document.	The avoidance rates used in the CRMs are as advised by MSS and SNH.
MSS	The interpretation of the PVA outputs should be undertaken using the following metrics: • median of the ratio of impacted to unimpacted annual growth rate	All three of the metrics recommended by MSS have been applied to the PVA outputs in the assessment.

Consultee	Scoping Response	ICOL's Response
	• median of the ratio of impacted to unimpacted population size • centile for unimpacted population that matches the 50th centile for impacted population	
MSS	Recommended the use of stochastic, density independent, population models to provide the basis for the PVAs, because they are more precautionary than deterministic models and they provide the option of a greater range of outputs.	The PVAs used in the assessment have been based upon stochastic, density independent, population models.
MS-LOT	Based upon the information and rationale presented in the Scoping Report, it is agreed that the EIA should only concentrate on those receptors which may be subject to significant effects from the proposed development.	As set out in the Scoping Opinion, the EIA assessment encompasses the following impacts and species, with the focus being on populations from protected sites: • Gannet – collisions; • Kittiwake – collisions and displacement/barrier effects; • Herring gull – collisions; • Guillemot – displacement/barrier effects; • Razorbill – displacement/barrier effects; and • Puffin – displacement/barrier effects.
MS-LOT	Consider that the existing boat-based survey data remain suitable for providing the baseline survey data for the EIA but advise ICOL that if their application is delayed this advice may change. Advise that this Scoping Opinion has a shelf life of 12 months from the date of issue.	The assessment is based upon the existing two years of boat-based survey data (spanning the period September 2010 to September 2012 inclusive).
MS-LOT	Consider that the near-shore and intertidal survey data remain suitable for describing the baseline characteristics in the areas around the landfall site.	In the event of any assessment of the landfall site and its surrounds being required the near-shore and intertidal survey data will be used. However, effects on bird populations in the near-shore and intertidal habitats within the vicinity of the landfall site have been scoped out for the assessment of the Development following the advice of SNH. These effects are addressed in *Chapter 6: Ecology* of the Inch Cape Onshore Transmission Works EIA report (ICOL, 2018b).
MS-LOT	For the CIA the following two scenarios should be considered in relation to incorporating the effects from the other	This advice regarding the incorporation of predicted effects from the other Forth and Tay projects has been followed within the

Consultee	Scoping Response	ICOL's Response
	Forth and Tay wind farms: 1. The worst case for each species of (i) Neart na Gaoithe (2014 as consented) or Neart na Gaoithe (2017 Scoping Report) and (ii) Seagreen Alpha and Bravo (2014 as consented) or Seagreen Alpha and Bravo (2017 Scoping Report). 2. Neart na Gaoithe (2017 Scoping Report) and Seagreen Alpha and Bravo (2017 Scoping Report) should be considered the other Forth and Tay projects.	assessment.
MS-LOT	Further advice provided by MS-LOT indicated that estimation of non-breeding season collisions to gannet and kittiwake should be based on the up-to-date information on wind farm parameters provided in the recently produced spreadsheets from The Crown Estate[2].	The up-to-date information on non-breeding season collision estimates for gannet and kittiwake have been used in the assessment. The detail of the approach that has been adopted was agreed following correspondence with SNH and MS-LOT[6].
MS-LOT	Species that are listed as named components of SPA and pSPA assemblage features should be assessed in the HRA.	Named components of SPA and pSPA assemblage features have been assessed in the HRA (ICOL, 2018a).
MS-LOT	In relation to the estimation of collision risk, if the stochastic CRM is available in time (due December 2017) to use for the production of the EIA then it should be used as it would represent the best available method.	It has not been possible to use the stochastic CRM within the assessment because it was not available when the CRMs were being undertaken for the assessment.
MS-LOT	If required, population models (and resultant PVAs) for breeding populations of kittiwake, guillemot and razorbill should be based upon those developed by Freeman *et al.* (2014), but it is not realistic to necessarily expect such complex models to be developed for other species or populations. Existing matrix-based population models for Forth Islands gannet and puffin populations would still be considered suitable for use in the EIA and HRA.	Kittiwake, herring gull, guillemot, razorbill and puffin population models are based upon those developed by Freeman *et al.* (2014). As agreed in the Scoping Opinion[1], the existing Forth Islands gannet population model has been used, with it being adapted to incorporate the 2014 population estimate for the SPA, with the resultant PVA using the at-sea survey estimates of age distribution (in accordance with the Scoping Opinion).
MS-LOT	The assessment must include the following SPAs/pSPA qualifying features: • Forth Islands SPA – gannet, kittiwake, herring gull, puffin, guillemot, razorbill • Fowlsheugh SPA – kittiwake, herring gull, guillemot, razorbill	All of the SPA and pSPA qualifying features identified by MS-LOT have been scoped into the assessment. Information has also been provided on the scale of the cable laying works and the longevity of effects on supporting habitats, with the predicted consequent effects on

Consultee	Scoping Response	ICOL's Response
	• Buchan Ness to Collieston Coast SPA and St Abb's Head to Fast Castle SPA should be scoped in due to connectivity. PVAs for these SPAs are required unless the cumulative effects from the Forth and Tay projects are estimated to be less than a reduction in annual adult survival of 0.2%. • Firth of Forth and St Andrews Bay Complex pSPA - gannet, kittiwake, herring gull, puffin, guillemot, razorbill. The assessment carried out for these species at the breeding colony SPAs listed above should also be used for the assessment of the pSPA species. Subsequent clarification advises that the further SNH advice from 7 September 2017 should be followed with regard to providing information on the scale of the cable laying works and the longevity of effect on supporting habitats to enable MS-LOT to undertake an Appropriate Assessment of the cable laying within the pSPA[1]. With this exception, there is no requirement for qualifying features of the pSPA other than those listed above to be assessed.	the pSPA assessed (ICOL, 2018a).
MS-LOT	For the existing colony SPAs the conservation objective relating to the population of the species as a viable component of the site should be the focus of the assessment, although justification should be provided within the EIA/HRA Report as to why the other conservation objectives are less relevant or are addressed via this conservation objective.	The conservation objective relating to the "*population of the species as a viable component of the site*" is the focus of the assessment presented in the HRA (ICOL, 2018a). Consideration is also given to all the conservation objectives of the protected sites to review whether they can be discounted and, where relevant, to provide justification as to why the other conservation objectives are less relevant than, or are addressed via, the conservation objective relating to the "*population of the species as a viable component of the site*".
MS-LOT	SPA reference population sizes should be as provided in the SNH advice.	Clarifications to this advice, indicated that more recent count data were available from CEH, whilst there were discrepancies in some count data for the St Abb's Head to Fast Castle SPA guillemot population[3,4]. SNH provided finalised colony counts for SPAs on 8 December 2017[8]. The SPA reference populations used to inform the assessment and PVAs are as advised by SNH and MS-LOT on the basis of

Consultee	Scoping Response	ICOL's Response
		the information provided by SNH in their advice. Details of the colony counts used as reference population sizes and as model inputs are provided in the assessment, with justification given for any differences from the reference populations advised by SNH.
MS-LOT	Seasonal periods for seabird species are to be as detailed by SNH advice.	The assessment uses the seasonal periods as advised in the SNH scoping response.
MS-LOT	For breeding season populations, the SNH apportioning approach should be used, following the two-step process outlined in the SNH scoping response. In addition, the Apportionment Tool currently being developed by MS-LOT should also be used if it is available in time.	Apportioning of impacts between breeding colonies has been undertaken using the SNH apportioning approach and following the two-step process outlined in the SNH scoping response. Finalisation of the Apportionment Tool was delayed, so that it was not available in time to inform the assessment[7], so that the apportioning of impacts between breeding colonies was based solely on the SNH advised approach (as above).

Consultee	Scoping Response	ICOL's Response
MS-LOT	Displacement should be assessed for SPA populations of puffin, guillemot, razorbill and kittiwake. Three different methods for assessing displacement and barrier effects were outlined in the Scoping Opinion – i.e. the SNCB matrix, the SeabORD model and the Searle *et al.* (2014) model. The SNCB matrix approach should be used to assess breeding season effects, with the Searle *et al.* 2014 model output used to provide context if SeabORD is not available[5]. Non-breeding season effects should be estimated for guillemot and razorbill using the SNCB matrix approach. The non-breeding assessment for kittiwake should be qualitative, whilst it is not required for puffin[1]. For the SNCB matrix approach bird densities should be mean seasonal peaks from the wind farm plus 2 km buffer, and based on all birds (in flight and on the water). The following displacement rates should be used: • Auk species – 60% • Kittiwake – 30% For the SNCB matrix approach a mortality rate from displacement of 2% should be assumed for puffin and kittiwake during the breeding season, and 1% for guillemot and razorbill (in both breeding and non-breeding seasons). Effects should be apportioned between age classes according to the 'at-sea' survey data for kittiwake and the proportions from the stable age structure, as derived from PVA, for the auk species. For guillemot and razorbill, all non-breeding season effects should be assigned to relevant SPAs as per breeding season, and should be based on the total SPA population, with impacts apportioned to age classes according to the stable age structure from population models.	Displacement/barrier effects have been assessed for puffin, guillemot, razorbill and kittiwake. The approaches used for this have followed the advice provided by MS-LOT in the Scoping Opinion[5]. Thus, the SNCB matrix approach provides the basis for assessing breeding season displacement and barrier effects on these species, as well as the non-breeding season effects for guillemot and razorbill. The rates of displacement and of mortality amongst displaced birds assumed for the matrix approach were as advised by the Scoping Opinion. The estimated effects were apportioned to age classes according to the 'at-sea' survey data for kittiwake and the stable age structure from the respective population models for the three auk species. A qualitative assessment was undertaken for the kittiwake SPA populations in the non-breeding period (ICOL, 2018a). The Scoping Opinion noted that the SeabORD model and the way that CEH advise that it should be used has changed considerably since the draft version was circulated to the Project Steering Group (PSG), and that the model was still to be reviewed by the PSG with feedback not due until end November 2017[5]. However, although the SeabORD model was not yet published at the time of undertaking the assessment, ICOL commissioned CEH to run the model for kittiwake and the three auk species, with the resulting outputs presented for comparison with those produced by the SNCB matrix and the earlier Searle *et al.* (2014) modelling. Both the SNCB matrix and the SeabORD modelling assumed a two kilometre buffer for the Wind Farm (as well as for the other Forth and Tay wind farms for the CIA and in-combination assessment). For the SNCB matrix, bird densities and population-sizes within the two kilometre buffer for the Development Area were extrapolated from the existing density estimates for the four kilometre buffer (the original analyses having been undertaken on the four kilometre buffer). This approach was confirmed as acceptable by MS-LOT and SNH[4].

Consultee	Scoping Response	ICOL's Response
MS-LOT	For apportioning non-breeding season impacts from collisions to gannet and kittiwake populations the BDMPS should be used (Furness, 2015). For herring gull, an appropriate non-breeding season regional population should be defined, with impacts apportioned according to either the BDMPS proportion and/ or an analogous approach to that used for the assessment of impacts to non-breeding herring gulls in the Moray Firth[1].	The approach used in the assessment for the apportioning of non-breeding season impacts from collisions to gannet and kittiwake populations follows the advice provided by MS-LOT in the Scoping Opinion, and following further correspondence between MS-LOT, SNH and ICOL to agree the details of this[6]. For herring gull, the estimated collisions were considered to be sufficiently small that a more precautionary approach of assessing against the regional population as defined in the breeding period was undertaken.
MS-LOT	For breeding season gannet and kittiwake, effects should be apportioned to age classes using proportions derived from site survey data. This approach should also be followed for non-breeding season populations of these species if the survey data are available, otherwise the proportions from the PVA-derived stable age structure should be used.	Effects from the Wind Farm on gannet, kittiwake and herring gulls have been apportioned to age classes using the proportions derived from the site survey data. This approach is used for both the breeding and non-breeding seasons. For the CIA, effects from the other Forth and Tay projects are also apportioned to age classes according to site survey data (for all seasonal periods), but the approaches used (and agreed) for estimating impacts from other wind farms in the UK North Sea and Channel do rely (to varying extents) upon PVA-derived stable age structure to apportion effects.
MS-LOT	Collision risk assessments should be undertaken for gannet, herring gull and kittiwake. For this, nocturnal activity scores should be 2 (i.e. 25%) for herring gull and kittiwake and 1 (i.e. 0%) for gannet. For collision modelling, mean monthly densities of birds in flight should be used, without any correction for potential boat-based bias. Densities should have 95% confidence limits presented. Option 2 of the collision model should be used for gannet and kittiwake (flight height data according to Johnston *et al.* (2014a,b) with corrigendum). The Option 2 estimates should be used for PVAs. Option 1 estimates should also be presented if sufficient site-specific flight height data are available. Comparison should be made of the site-specific and generic flight height data	Collision risk has been assessed for gannet, kittiwake and herring gull. The approaches used for the CRMs (e.g. model options and avoidance rates) follow the advice provided by MS-LOT in the Scoping Opinion. Mean monthly densities of birds in flight have been used in the CRMs and have been presented with 95% confidence limits. Comparisons of site-specific and generic flight heights have been undertaken for gannet, kittiwake and herring gull. Uncertainty in collision estimates has been presented based upon ± 2SD of the avoidance rate.

Consultee	Scoping Response	ICOL's Response
	(Johnston *et al.* (2014a, b) with corrigendum). For herring gull, Options 2 and 3 of the collision model should be presented, and if sufficient data are available, Options 1 and 4 also. Any PVA that is required should use the Option 3 outputs[1]. The recommended avoidance rates (with SD) are: • Gannet – 98.9% (± 0.002) • Kittiwake – 98.9% (± 0.002) • Herring gull – 99.5% (± 0.001) for Option 2 and 99.0% (± 0.002) for Option 3. Uncertainty in collision estimates should be presented as ± 2SD.	
MS-LOT	PVA outputs are required for SPA colonies where the assessed effects exceed a change to the adult annual survival rate of 0.2 %. Considered it likely that PVAs would need to be produced for the estimated effects from: • For guillemot, razorbill, puffin, gannet and kittiwake, the windfarm in isolation (effects throughout the year and on all age classes) • For guillemot, razorbill, puffin, gannet and kittiwake, the wind farm in combination with the other three Forth and Tay windfarms (effects throughout the year and on all age classes) • For gannet and kittiwake the breeding season effects from the Forth and Tay wind farms combined with the non-breeding season effects from the offshore wind farms in UK waters For kittiwake, the PVAs should be undertaken to consider effects from collisions only and to consider the combined effects of collision and breeding season displacement / barrier effects. 'Worst case scenario' estimated effects, as outlined above, should be assessed using PVAs but subsequent clarification advises that there is no requirement to assess	PVA outputs have been produced for all SPA populations considered to have connectivity with the Development Area and two kilometre buffer, except for the SPA herring gull populations. Impacts to herring gulls were considered sufficiently small to negate the need for PVAs, and justification for this is provided in the assessment. PVAs were undertaken for the Development alone effects as well as the CIA. 'Worst case scenario' estimated effects were determined following the approaches advised by MS-LOT in the Scoping Opinion.

Consultee	Scoping Response	ICOL's Response
	effects that are ± 10% of the 'worst case scenario' estimated effects[1].	
MS-LOT	Advise the use of stochastic, density independent, PVA models which include all age classes and use baseline demographic rates based on site specific information where available, or alternatively as presented in Horswill and Robinson (2015). Effects should be assessed over both 25 and 50 year timescales with no recovery period. Any extended construction period that is planned should be considered within the PVAs. PVAs should assume the following proportions of sabbatical birds amongst the breeding adult age class: • Herring gull – 35% • Kittiwake – 10% • Guillemot, razorbill, puffin – 7% • Gannet – 10%	The PVAs used in the assessment were based upon stochastic, density independent, population models. PVAs used all age classes, with baseline demographic rates based entirely upon site-specific information for the Forth Islands SPA populations, other than gannet. For gannet, the demographic rates were as for the existing matrix-based population model for the Forth Islands (considered by MS-LOT to be suitable for use in the assessment – see above), and essentially as presented in Horswill and Robinson (2015). The PVAs for the SPA populations for Fowlsheugh SPA, Buchan Ness to Collieston SPA and St Abb's Head to Fast Castle SPA used site-specific colony count data but also relied upon data from the nearby Forth Islands populations to inform the demographic rates. This followed the methodology of Freeman *et al.* (2014), as advised by MS-LOT in the Scoping Opinion (see above). For purposes of determining impacts, it was assumed that a proportion of the affected birds within the breeding adult age class were 'sabbaticals', with the assumed proportions as per the advice provided by MS-LOT in the Scoping Opinion. 'Sabbaticals' were not assumed amongst the passage period collision estimates for gannet and kittiwake due to the different approach used for apportioning these estimates to different colony populations. PVAs for all species other than gannet were run for three years before introducing the Wind Farm effects, to take account of potential changes to baseline populations before these effects manifest. This 'lag' was not incorporated in the gannet PVA, but the projected high growth rate for the Forth Islands SPA gannet population will mean that the outputs are more precautionary without its inclusion.
MS-LOT	The interpretation of the PVA outputs should be undertaken using the following	The three metrics advised by MS-LOT for use in interpreting PVA outputs have been

Consultee	Scoping Response	ICOL's Response
	metrics: • median of the ratio of impacted to unimpacted annual growth rate • median of the ratio of impacted to unimpacted population size • centile for unimpacted population that matches the 50th centile for impacted population	applied in the assessment.
East Lothian Council (ELC)	HRA The previous assessment considered impacts on the Firth of Forth SPA and Forth Islands SPA, both of which are partly within East Lothian. This Council is content to leave comment on this and other ornithological aspects of the assessment to SNH, who have particular expertise and responsibilities in this area.	Noted
1. Letter of 8 September 2017 from MS-LOT to ICOL. 2. Letter of 29 September 2017 from MS-LOT to ICOL. 3. Email of 29 September 2017 from SNH to MS-LOT. 4. Letter of 17 October 2017 from MS-LOT to ICOL. 5. Letter of 3 November 2017 from MS-LOT to ICOL. 6. Emails of 1 November 2017 from MS-LOT to ICOL providing the SNH illustrative example for calculation of non-breeding season collisions for gannet and subsequent emails of 08 November 2017 from ICOL to MS-LOT, and from MS-LOT to ICOL. 7. Email of 7 November 2017 from MS-LOT to ICOL. 8. Email of 8 December 2017 from MS-LOT to ICOL, with commentary on colony counts from SNH and attached table of the SPA colony counts as provided by SNH.		

11.2.2 Stakeholder Engagement on the Approach and Findings of the Assessment

7 A workshop was held on 7 March 2018, at which ICOL presented the details of the approach and methods used in the assessment, together with the main findings from the assessment. This workshop was attended by MS-LOT, MSS, SNH and RSPB.

11.3 Scope of Assessment

8 As part of this application ICOL have drawn on the detail presented in the Scoping Report, MS LOT's Scoping Opinion and subsequent correspondence refining the finer detail on the scope of assessment. Therefore, this chapter focusses on those impacts on ornithology, and uses methodologies and assessments that have been agreed throughout this process and which are summarised in Table 11.2. ICOL considers that the level of time and effort

invested in agreeing the scope, approach and methodologies will ensure that the ornithological assessment carried out is robust and when the application, and associated assessment, is submitted the key stakeholders will know exactly what has been agreed and the underlying rationale.

9 For clarity, those impacts that have been agreed to be scoped out of the EIA are listed in Table 11.3 below. For further information, reference should be made to the Scoping Report and the Scoping Opinion[2].

10 The assessment focuses on the key impacts and the key species agreed at scoping. With the exception of the installation (and decommissioning) of the Offshore Export Cable, the potential impacts due to construction (and decommissioning) were scoped out as being short term (Table 11.3).

11 In relation to the Offshore Export Cable, the potential effects of decommissioning are considered to be equivalent to, and potentially lower than, the worst case effects assessed for the construction phase (with the approach to decommissioning described *in Chapter 7: Description of Development, Section 7.12*). However, with the above exception, potential impacts during construction and decommissioning are not considered further here.

12 The other impacts being assessed all occur only during the operation and maintenance phase of the Wind Farm and focus on additional mortality due to collisions of seabirds in flight, and the effects of displacement and barrier effects on species using the Wind Farm and surrounding areas of sea.

[2] At the time of writing this can be accessed at:
http://www.gov.scot/Topics/marine/Licensing/marine/scoping/ICOLRevised-2017 [Accessed: 02/08/18]

Table 11.2: Scope of assessment covered in this Chapter

Potential Impact	Scope of Assessment	Reason
Operation and Maintenance Phase - Development Area		
Displacement and Barrier effects	The impacts resulting from displacement and barrier effects are predicted using a matrix approach, following SNCB guidance (SNCB 2017). This combines the assumed proportion of birds displaced with the assumed additional mortality amongst those displaced birds. These calculations are undertaken separately for the breeding and non-breeding seasons (where relevant). Additionally, reference has been made to estimates produced using energetics-based modelling approaches (focussing on the SeabORD model, which at the time of writing is still unpublished) but also to the earlier Searle *et al.* 2014 model). These modelling approaches predict the mortality and productivity effects of displacement and barrier effects on SPA populations of seabirds during the breeding season.	Displacement and barrier effects have the potential to result in detrimental effects on seabird foraging success and/or impose increased energetic costs to seabirds. As such, there is the potential for population-level impacts. The approach to assessing impacts from displacement and barrier effects is based on the advice received from MS-LOT in the Scoping Opinion. This advice also identifies the receptors that may be subject to significant impacts from displacement and barrier effects, and which are considered in the assessment (see *Section 11.8).* The assessment focusses on the outputs from the SNCB matrix approach for predicting the impacts to populations during the breeding and non-breeding seasons. For those receptors which remain within the Forth and Tay region to a large extent during the non-breeding season, the predicted breeding season impacts are combined with the non-breeding season impacts. Predicted breeding season impacts from the SeabORD model and from the previous Searle *et al.* (2014) modelling are considered to provide further context.
Collision risk	Collision Risk Modelling (Band 2012) used to determine the potential mortality to seabirds.	Collisions are a potential source of direct mortality, with the potential to give rise to population-level impacts. The advice received from MS-LOT in the Scoping Opinion follows the standard method for offshore wind farm impact assessment. This advice also identifies the receptors that may be subject to significant impacts from collisions, and which are considered in the assessment (see *Section 11.8*).

Potential Impact	Scope of Assessment	Reason
Construction (and Decommissioning) Phase - Offshore Export Cable Corridor		
Direct disturbance/ displacement	Disturbance/ displacement of ornithological receptors (qualifying species of the Outer Firth of Forth and St Andrews Bay Complex pSPA) from construction (cable-laying) activities in the Export Cable Corridor between the Development Area and Mean High Water Springs (MHWS) at the cable landfall at Cockenzie.	Potential effects of disturbance on the ornithology receptors and on the maintenance and extent of supporting habitats and processes, following advice received from MS-LOT further to the Scoping Opinion (letter of 8 September 2017 from MS-LOT to ICOL, and referring to correspondence with RSPB and SNH).
Indirect disturbance of habitats/prey	Potential indirect effects via disturbance of habitats and prey species, on ornithological receptors (qualifying species of the Outer Firth of Forth and St Andrews Bay Complex pSPA) from construction (cable-laying) activities in the Export Cable Corridor between the Development Area and MHWS at the cable landfall at Cockenzie.	
Operation and Maintenance Phase - Offshore Export Cable Corridor-		
Direct disturbance/ displacement	Disturbance/ displacement of ornithological receptors (qualifying species of the Outer Firth of forth and St Andrews Bay pSPA) from maintenance (cable repair and reburial) activities in the Export Cable Corridor between the Development Area and MHWS at the cable landfall at Cockenzie.	Potential effects of disturbance and habitat loss on the ornithology receptors and on the maintenance and extent of supporting habitats and processes, following advice received from MS-LOT further to the Scoping Opinion (letter of 8 September 2017 from MS-LOT to ICOL, and referring to correspondence with RSPB and SNH).
Indirect disturbance of habitats/prey	Potential indirect effects via disturbance of habitats and prey species, on ornithological receptors (qualifying species of the Outer Firth of forth and St Andrews Bay pSPA) from maintenance (cable repair and reburial) activities in the Export Cable Corridor between the Development Area and MHWS at the cable landfall at Cockenzie.	

Potential Impact	Scope of Assessment	Reason
Permanent habitat loss	Potential indirect effects on ornithological receptors due to loss of benthic habitats within the Export Cable Corridor. This impact is considered for the operational phase only, as habitat loss during construction is considered above as part of the disturbance to habitats during cable laying activities (construction habitat disturbance would include temporary disturbance of habitats that subsequently recover, as well as disturbance resulting in permanent loss of habitats which do not recover to their former state	

Table 11.3: Impacts Scoped Out of this Chapter

Potential Impact	Justification for Scoping out of the EIA
Construction (and Decommissioning) Phase	
Direct habitat loss from disturbance to seabed (possibly causing indirect impacts via effects on prey).	Agreed by MS-LOT in their Scoping Opinion[1] that assessment of this potential impact not required except in relation to the installation (and decommissioning) of the Offshore Export Cable due to overlap with the Outer Firth of Forth and St Andrews Bay Complex pSPA. This impact is unlikely to lead to a significant effect and (with the exception noted above) sufficient information was considered to be available to enable this conclusion. Therefore, in line with the 2017 EIA Regulations it does not require assessment, other than in relation to the Offshore Export Cable.
Direct disturbance.	Agreed by MS-LOT in their Scoping Opinion[1] that assessment of this potential impact not required except in relation to the installation (and decommissioning) of the Offshore Export Cable due to overlap with the Outer Firth of Forth and St Andrews Bay Complex pSPA. Any disturbance effects would be temporary and short-term only. This impact is unlikely to lead to a significant effect and (with the exception noted above) sufficient information was considered to be available to enable this conclusion. Therefore, in line with the 2017 EIA Regulations it does not require assessment, other than in relation to the Offshore Export Cable.

Potential Impact	Justification for Scoping out of the EIA
Indirect impacts on birds via noise impacts from piling on prey species	Agreed by MS-LOT in their Scoping Opinion[1] that assessment of this potential impact not required. This impact is unlikely to lead to a significant effect and (with the exception noted above) sufficient information was considered to be available to enable this conclusion. Therefore, in line with the 2017 EIA Regulations it does not require assessment.
Operation and Maintenance Phase	
Direct habitat loss	Agreed by MS-LOT in their Scoping Opinion[1] that assessment of this potential impact not required, except in relation to the maintenance of the Offshore Export Cable due to overlap with the Outer Firth of Forth and St Andrews Bay Complex pSPA. This impact is unlikely to lead to a significant effect and, therefore, in line with the 2017 EIA Regulations it does not require assessment, other than in relation to the Offshore Export Cable.
Direct disturbance	Agreed by MS-LOT in their Scoping Opinion[1] that assessment of this potential impact not required except in relation to the maintenance of the Offshore Export Cable due to overlap with the Outer Firth of Forth and St Andrews Bay Complex pSPA. This impact is unlikely to lead to a significant effect and (with the exception noted above) sufficient information was considered to be available to enable this conclusion. Therefore, in line with the 2017 EIA Regulations it does not require assessment, other than in relation to the Offshore Export Cable.
Indirect impacts on birds via prey species	Agreed by MS-LOT in their Scoping Opinion[1] that EIA not required, except in relation to the maintenance of the Offshore Export Cable due to its overlap with the Outer Firth of Forth and St Andrews Bay Complex pSPA. This impact is unlikely to lead to a significant effect and (with the exception noted above) sufficient information was considered to be available to enable this conclusion. Therefore, in line with the 2017 EIA Regulations it does not require assessment, other than in relation to the Offshore Export Cable.
1. Letter of 8 September 2017 from MS-LOT to ICOL.	

11.4 Regulation and Guidance

11.4.1 EIA Regulations

13 As the Scoping Report for this application was submitted on 28 April 2017, the 2017 EIA Regulations therefore now apply under the transitional arrangements (please see the MS-LOT Scoping Opinion for further details). Therefore, the scope of the assessment falls under the following regulations:

- *The Marine Works (Environmental Impact Assessment) Regulations 2007*; and
- *The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000* (as amended).

14 The 2017 EIA Regulations will apply for processes such as consultation and publicity requirements, additional information provisions and decision notices. Therefore, the updated EIA regulations have been considered, and are as follows:

- *The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017; and*
- *The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017*

15 For the purposes of this chapter reference is made to 'the EIA regulations' which refers to the 2007 and 2000 (as amended) regulations.

16 In addition, the following legislation has been considered as part of the ornithological assessment process:

- *European Directive 2009/147/EC on the conservation of wild birds (EU Birds Directive);*
- *European Directive 1992/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (EU Habitats Directive);*
- *Ramsar Convention on Wetlands of International Importance 1971;*
- *Bonn Convention on the Conservation of Migratory Species of Wild Animals 1979, as amended;*
- *The Nature Conservation (Scotland) Act 2004 (as amended);*
- *Conservation (Natural Habitats, etc.) Regulations 1994 (as amended);*
- *Conservation of Habitats and Species Regulations 2010;*
- *Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended);*
- *Conservation of Offshore Marine Habitats and Species Regulations 2017;*
- *Conservation of Habitats and Species Regulations 2017;* and
- *Wildlife and Countryside Act 1981*, as amended.

17 Guidance on general ecological and ornithological assessments for offshore wind farms was derived from:

- European Union (2011). *EU Guidance on wind energy development in accordance with the EU nature legislation.* European Union, Luxembourg;
- IEEM (2010) *Ecological Impact Assessment Guidelines for Marine and Coastal Projects*;
- Maclean *et al*. (2009) *A review of assessment methodologies for offshore wind farms*; and
- King *et al*. (2009) *Developing guidance on ornithological cumulative impact assessment for offshore wind farm developers*.

18 Specific advice and guidance on impacts or species, and on the approaches to undertaking and interpreting the assessment, are referenced and discussed in the relevant sections.

11.5 Design Envelope and Embedded Mitigation

11.5.1 Design Envelope

19 As the design of the Wind Farm is not fixed and flexibility in the design envelope is required, the following key parameters, detailed in Table 11.4 and Table 11.5, represent the worst case scenario for impacts on ornithology in relation to the Development Area and the Offshore Export Cable Corridor. For the Development Area it is considered that the worst case scenario is represented by the design which gives highest collision estimates, as displacement and barrier effects are unaffected by the number of Wind Turbine Generators (WTGs) and the total rotor swept area (as estimated by the methods used in the assessment). For the Offshore Export Cable Corridor the design parameters are detailed in *Chapter 7*. These scenarios have been carried through into the assessment, leading to a conservative approach such that any design taken forward is considered within the assessment.

Table 11.4: Worst Case Scenario Definition - Development Area

Potential Impact	Design Envelope Scenario Assessed
Operational Phase	
Displacement and Barrier effect.	For both displacement and barrier effects the assessment is based upon a maximum extent of the Development Area (150 km^2) plus a two kilometre buffer. The methods used to determine impacts from displacement and barrier effects are not influenced by WTG density or by the dimensions of the WTGs. WTGs will have markings, foghorns and lighting as per agreement with navigation and aviation stakeholders.
Collision risk.	Assessment based on a maximum extent of the Development Area (150 km^2). Two scenarios for the array have been considered, each giving a maximum rotor swept area below 50 m above mean sea level of 87,000 m^2: 1. 72 WTGs, with a maximum mean hub height above LAT of 119 m and a maximum rotor diameter of 167 m. 2. 40 WTGs, with a maximum mean hub height above LAT of 155.5 m and a maximum rotor diameter of 250 m. Of these, the 40 WTG design represented the worst case for two of the three receptors for which collision risk impacts were considered to have the potential to cause significant effects (i.e. gannet and kittiwake). The slightly higher gannet and kittiwake collision estimate for the 40 WTG design was due to the fact that the lower blade tip height was less than for the 72 WTG design. In the case of herring gull, the design representing worst-case varied according to the CRM option used (but with the 72 WTG design being worst-case for the CRM option 3 estimates on which the assessment for this species is mainly based). However, in all

Potential Impact	Design Envelope Scenario Assessed
	model options for herring gull the two designs differed by a single collision only (*Appendix 11C*). WTGs will have markings, foghorns and lighting as per agreement with navigation and aviation stakeholders.

Table 11.5: Worst Case Scenario Definition – Offshore Export Cable Corridor

Potential Impact	Design Envelope Scenario Assessed
Construction (and Decommissioning) Phase	
Direct disturbance/ displacement Disturbance of habitats and prey	• A maximum of two (AC) Export cables which will run from the Offshore Substation Platforms (OSPs) to landfall. • Maximum length for each cable is approximately 83 km. • Each cable installed in a separate trench (maximum of two trenches). Due to technical and practical constraints around access to cables and local conditions, cable separation is generally four times the water depth with a minimum separation of 50 metres (reducing as cables enter the landfall) • Maximum Offshore Export Cable Route Corridor approximately 20.75 kilometres squared (based on two cables, each 83 kilometres long, 200 metres separation between cables and 25 metres distance from the centreline of each cable to the outer extremity of the corridor). • Subtidal area of seabird disturbed across export cable corridor during cable installation is approximately 2.5 kilometres squared. • Export cable installation (excluding intertidal) - nine months, start and finish dates to be confirmed.
Operational Phase	
Direct disturbance/ displacement Temporary habitat disturbance from Operation and Maintenance activities Habitat loss	• A small number of vessel movements associated with inspections and monitoring to identify if the Offshore Export Cable becomes exposed over time and take appropriate remedial action. • Annual disturbance from Offshore Export Cable reburial is 0.0025 kilometres squared. This results from a maximum predicted reburial of 10 per cent of the 83 kilometre Offshore Export Cable length for each of the two cables during the operational phase. • Total area of original habitat loss is 0.2 kilometres squared resulting from: o Protection of 20 per cent of each of the 83 kilometre long Offshore Export Cables; and o Protection material 6.0 metres wide • Protection will be either mattresses (small concrete blocks connected by polypropylene rope), sand/grout bags or rock placement

11.5.2 Embedded Mitigation

20 The assessment of effects of ornithology has taken into account the following embedded mitigation measures:

- Development design has taken into account minimising the rotor swept area below 50 metres above mean sea level to reduce collision risk for birds; and
- A suitably qualified Ecological Clerk of Works (ECoW) will be appointed to the Development during construction. This will ensure compliance with mitigation and best practice is followed relating to disturbance of birds (notably qualifying features from the SPAs with connectivity to the Development).

11.5.3 Consent Conditions Including Monitoring Plans

21 As well as the embedded mitigation measures, ICOL proposes to commit to the purpose of the relevant consent conditions granted for the 2014 Inch Cape Consent, as they are still relevant to this application. This will provide reassurance to stakeholders that the relevant issues will be addressed and secured by way of appropriate conditions.

22 ICOL recognises that the wording and detail of the consent conditions will be at the discretion of the Scottish Ministers. For ornithology interests, ICOL propose that the consent conditions address matters surrounding, but not limited to, the following;

- Production of a Construction Method Statement;
- Production of a Construction Programme;
- Production of an Operations and Maintenance Plan;
- Production of a Project Environmental Management Plan;
- Production of an Environmental Monitoring Programme; and
- Appointment of an ECoW.

23 Further to this, should the Scottish Ministers continue the Forth and Tay Regional Advisory Group (FTRAG) and establish a Scottish Strategic Marine Environment Group (SSMEG), ICOL will continue to participate as required.

11.6 Baseline Environment

11.6.1 Study Area

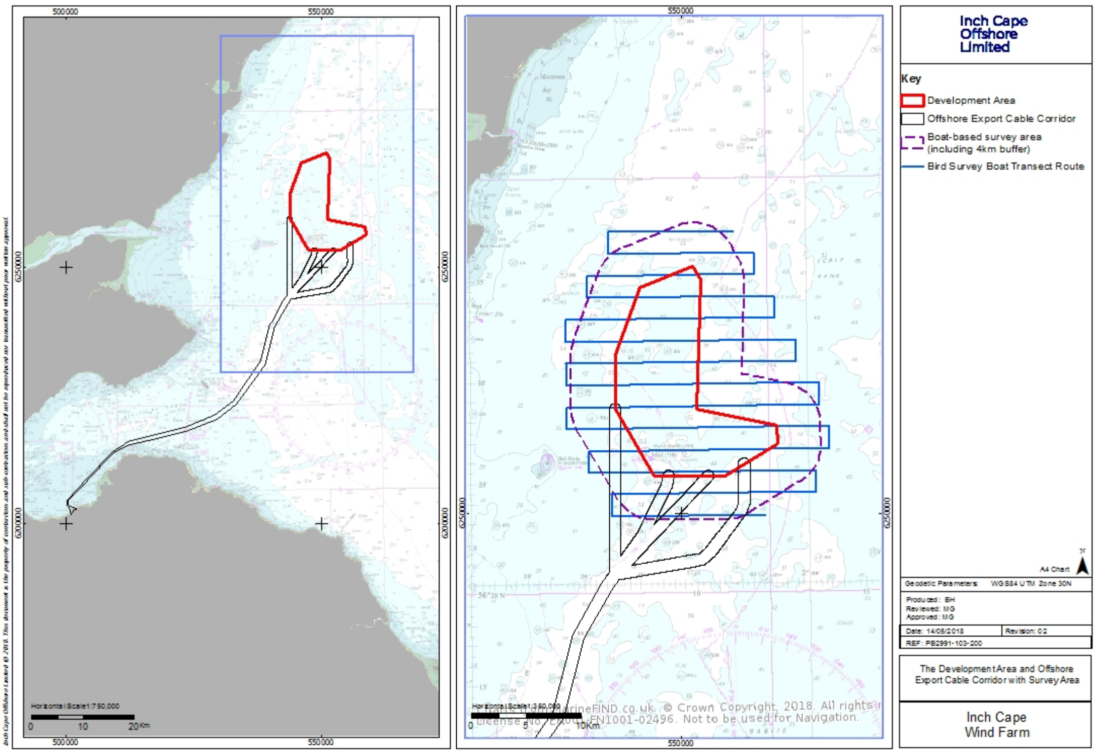
24 The Study Area covers the entire Development Area, a two kilometre buffer around this and the Offshore Export Cable Corridor (Figure 11.1). The habitat in this area, as it is used by fish-eating seabirds, is fully described in *Chapter 9* of this EIA Report and *Chapter 12: Benthic Ecology* of the 2013 Inch Cape Environmental Statement (ICOL, 2013). From the perspective of the key seabird species in this assessment, the habitat has several key characteristics:

- It supports key prey species of the correct age or size for either adult foraging needs, or for chick provisioning;

- It is shallow enough to allow diving species to reach suitable depths (either in the water column or to the sea bed) to reach key prey species; and
- For aerial and surface feeding species, key prey species occur regularly enough at the sea surface to provide foraging opportunities.

For many of the seabirds recorded in the Study Area, the habitat is simply the air volume used as birds pass through it. This is particularly relevant for birds that pass through the Development Area and Offshore Export Cable Corridor without making use of any prey resources.

Figure 11.1: Development Area and Offshore Export Cable Corridor with Survey Area.



11.6.2 Designated Sites

25 The Scottish Ministers stated in their Scoping Opinion that the following European Designated sites should be considered in the EIA and HRA Reports:

- Forth Islands SPA;
- Fowlsheugh SPA;
- Buchan Ness to Collieston Coast SPA;
- St Abb’s Head to Fast Castle SPA; and,
- Outer Firth of Forth and St Andrews Bay Complex pSPA.

26 The information regarding the qualifying features and conservation objectives of these designated sites is provided in the associated HRA report (ICOL, 2018a). This includes citation population sizes and site condition status.

11.6.3 Data Sources

Desk-based assessment

27 The desk-based assessment has drawn on a wide range of published literature (encompassing both peer reviewed scientific publications and the 'grey literature' - e.g. wind farm project submissions and reports), and other sources of data (e.g. as held on Statutory Nature Conservation Bodies (SNCB) websites or provided by the RSPB). These sources include information on seabird ecology and distribution and on the potential impacts of wind farms on birds. The key topics to which this information relates are:

- Potential impacts of wind farms (e.g. Garthe and Hüppop 2004, Drewitt and Langston 2006, Langston 2010, Band 2012, Furness and Wade 2012, Furness *et al.* 2013, Cook *et al*. 2014, Cook and Robinson 2015, Freeman *et al.* 2014, Johnston *et al.* 2014a, b, MacArthur Green 2014, MacArthur Green 2017, Royal Haskoning *et al.* 2015, Searle *et al.* 2014, SNCBs 2014, 2017, Dierschke *et al.* 2016, Vallejo *et al.* 2017);
- Seabird population sizes, distributions and seasonal movements (MacArthur Green 2015a, b, Mitchell *et al.* 2004, Furness 2015, JNCC 2017a);
- Seabird breeding ecology (Snow and Perrins 1998); and
- Seabird foraging ranges and foraging behaviour (Daunt *et al.* 2011a,b,c, Hamer *et al.* 2011, Thaxter *et al.* 2012, Wakefield *et al.* 2013, 2017, Cleasby *et al.* 2015).

28 Also, in contrast to the Development Area (see below), no specific bird surveys were commissioned to encompass the area around the Offshore Export Cable Corridor, except within the inter-tidal and near-shore habitats in the vicinity of the Landfall (see *Appendix 6C: Intertidal and Near-shore Bird Surveys* of the Inch Cape Onshore Transmission Works EIA report (ICOL,2018b)). This was because of the limited scale of works required in relation to the Offshore Export Cable, and therefore the assessment makes use of published sources of data and information on the abundance and distribution of birds in this area. In particular, the assessment for the Offshore Export Cable relies upon the Departmental Brief for the Outer Firth of Forth and St Andrews Bay Complex pSPA (SNH and JNCC, 2016), which overlaps with the Offshore Export Cable for the vast majority of its length.

Site-specific surveys

29 To assess the abundance and distribution of birds within the Development Area and surrounding waters, and the associated spatial and temporal variation in these attributes, monthly boat-based surveys were undertaken between September 2010 and September 2012. These surveys encompassed the Development Area and a four kilometre buffer, extending across a total area of 430 km^2 (subsequently referred to as the Survey Area) (Figure 11.1). Survey methods were based upon the guidelines for Collaborative Offshore Wind Research into the Environment (COWRIE) (Camphuysen *et al.* 2004, Maclean *et al.*

2009), with full details of the survey methods given in *Appendix 11A*. In addition to the data on abundance and distribution, these surveys also provided data on flight heights and behaviour within the Survey Area.

30 It should be noted that the SNH advice prior to the commencement of boat-based surveys was to undertake surveys in the Development Area and a four kilometre buffer, and subsequent analyses were undertaken at this resolution (providing bird density and population-size estimates for the Survey Area). However, the Scoping Opinion advised that the impact assessment should be focussed on the Development Area and a two kilometre buffer. As such, population sizes for the two kilometre buffer were derived by extrapolation from the estimated densities within the four kilometre buffer (as agreed with MS-LOT and SNH; Table 11.1).

31 Thus, for the purposes of the assessment, bird densities and population sizes are presented at the resolution of the Development Area and two kilometre buffer, despite the surveys encompassing a wider area (*Appendix 11A*). The extent of any differences in bird densities between the two buffer areas (and hence the potential for any bias from the extrapolations) was assessed qualitatively on the basis of distribution maps, both for the overall survey data (Annex 11A.1, *Appendix 11A*), as well as for the specific surveys which produced the seasonal peak counts on which displacement estimates were based (Annex 11D.1, *Appendix 11D*). Little, or no, bias as a result of the extrapolation was apparent from these examinations.

11.6.4 Overview of Baseline

32 The baseline conditions were determined through a combination of the existing information from the desk-based study detailed above and the results from the boat-based surveys. From this information, it was possible to provide the Scottish Minsters with suitable information for identifying the receptors requiring impact assessment.

33 The survey information from the Development Area and two kilometre buffer provided clear information that potentially important numbers of protected bird species were using this part of the sea. During the breeding season, many of these birds likely originate from breeding colonies on the coast that are within foraging range. Many of these colonies are designated as SPAs, showing that they are of international importance.

34 As stated above (*Section 11.6.3*), information on the importance of the Offshore Export Cable Corridor for birds was derived in particular from the Departmental Brief for the Outer Firth of Forth and St Andrews Bay Complex pSPA (SNH and JNCC, 2016). This includes maps of relative density for the key bird species and populations within the pSPA.

11.6.5 Receptors

Development Area

35 For the purposes of the EIA, it is the regional populations of the key receptors that are the focus of the assessment. Based on the results of the boat-based surveys, the desk-based

assessment and the Scoping Opinion, the species for assessment in the Development Area and two kilometre buffer are:

- Gannet;
- Puffin*;*
- Razorbill*;*
- Guillemot*;*
- Kittiwake*;* and
- Herring gull*.*

36 In relation to the potential impacts associated with the Development Area and two kilometre buffer, it is the breeding populations of the above six species that that have been scoped into the assessment, although the assessment also considers the potential impacts to these populations during the non-breeding season where relevant. The impacts considered for each species are summarised in Table 11.6 below, based on the Scoping Opinion. Displacement and barrier effects are not considered for gannet or herring gull. This is because the particularly large foraging range of gannet during the breeding season (Thaxter *et al.* 2012, Wakefield *et al.* 2013) means that the resulting impacts are of little significance (Searle *et al.* 2014), whilst for herring gull there is little evidence for the occurrence of displacement and barrier effects (Cook *et al.* 2014, Dierschke *et al.* 2016). Collision impacts are not considered for the three auk species because of their low flight heights, meaning that almost all flights are well below the rotor swept area (Cook *et al.* 2014, Johnston *et al.* 2014a, b, *Appendix 11A*). Following consultation with Scottish Ministers, their advisors and key stakeholders, all other bird species have been scoped out of the assessment of impacts related to the Wind Farm.

37 For the purposes of the assessment, the regional population of each of these key species during the breeding period is defined on the basis of the mean of the maximum breeding season foraging range (Thaxter *et al.* 2012). Thus, the regional populations comprise the breeding colonies within this distance of the Development Area and two kilometre buffer (*Appendix 11A*). The areas encompassing the regional populations for each species are shown in Figures 11.2 to 11.7, together with the SPAs which are identified in the Scoping Opinion and for which the species is a qualifying feature. A summary of the occurrence and sensitivity of these key species and the impacts assessed in relation to the Wind Farm is provided in Table 11.6 below.

Figure 11.2: Special Protection Areas for Gannet within Mean Maximum Foraging Range of the Development Area and Two Kilometre Buffer

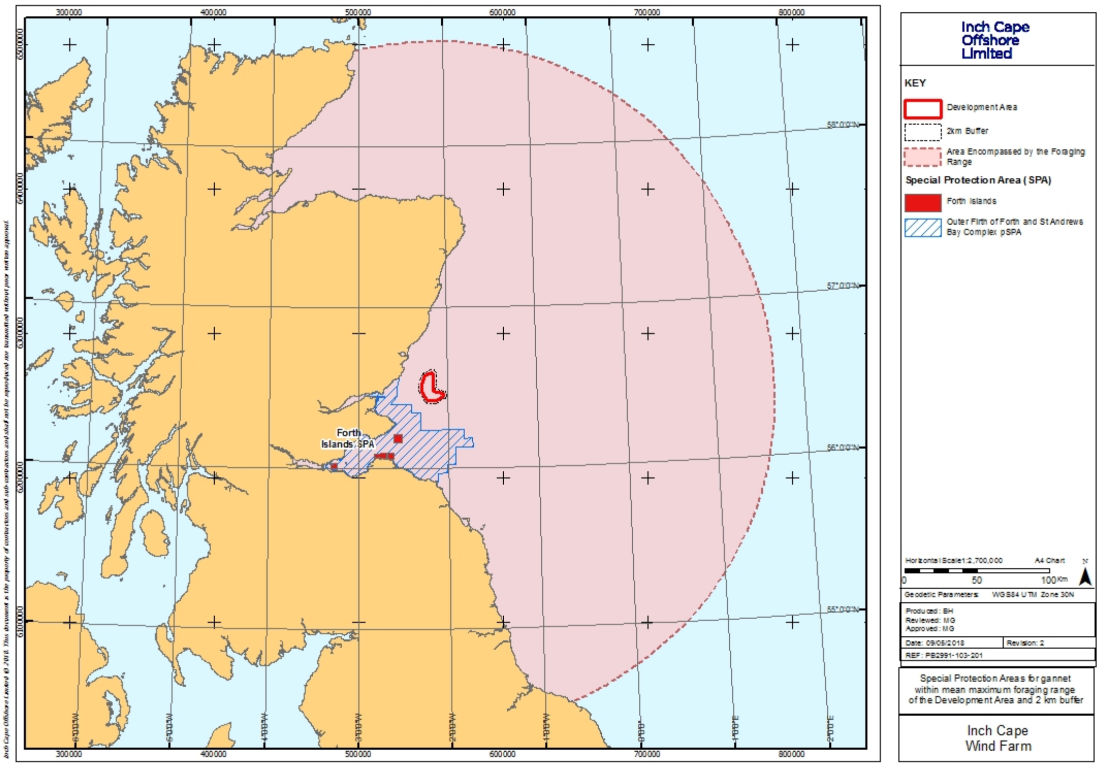


Figure 11.3: Special Protection Areas for Kittiwake within Mean Maximum Foraging Range of the Development Area and Two Kilometre Buffer

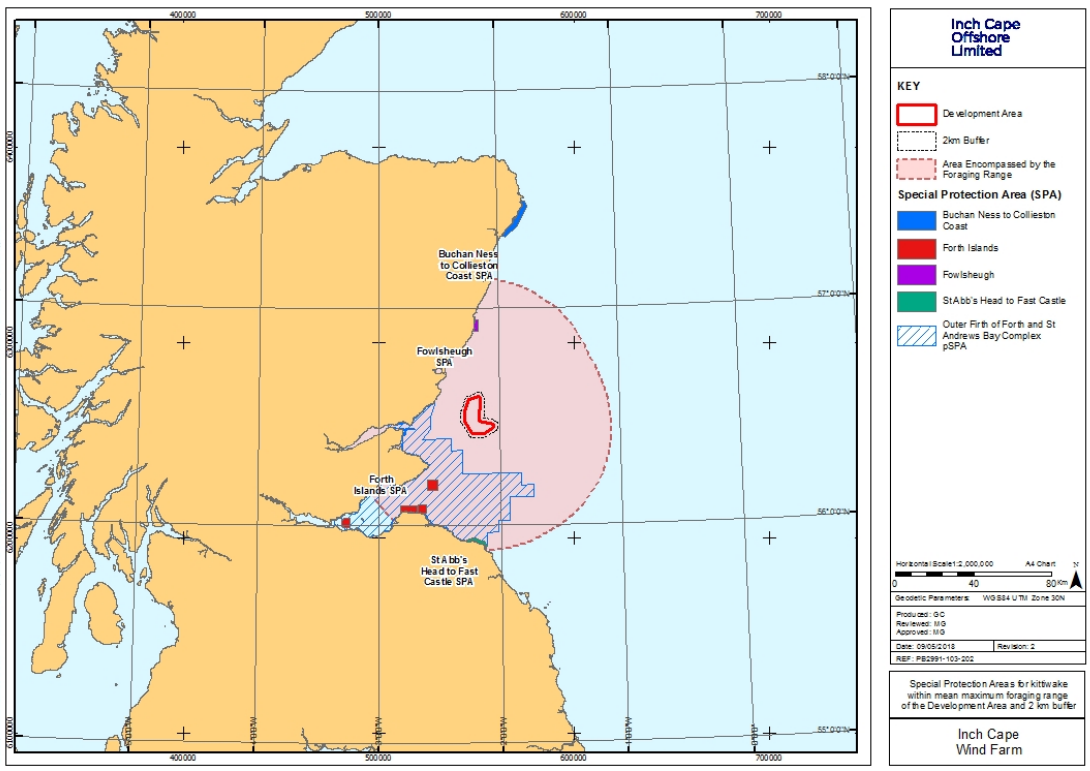


Figure 11.4: Special Protection Areas for Herring Gull within Mean Maximum Foraging Range of the Development Area and Two Kilometre Buffer

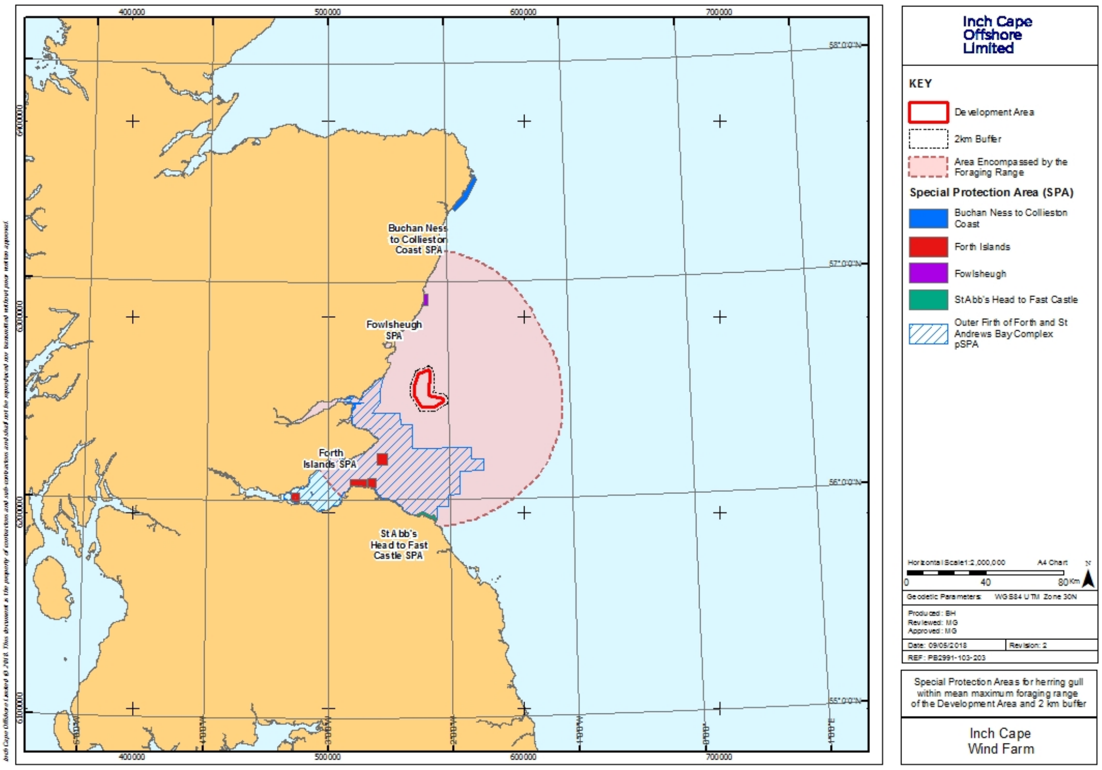


Figure 11.5: Special Protection Areas for Guillemot within Mean Maximum Foraging Range of the Development Area and Two Kilometre Buffer

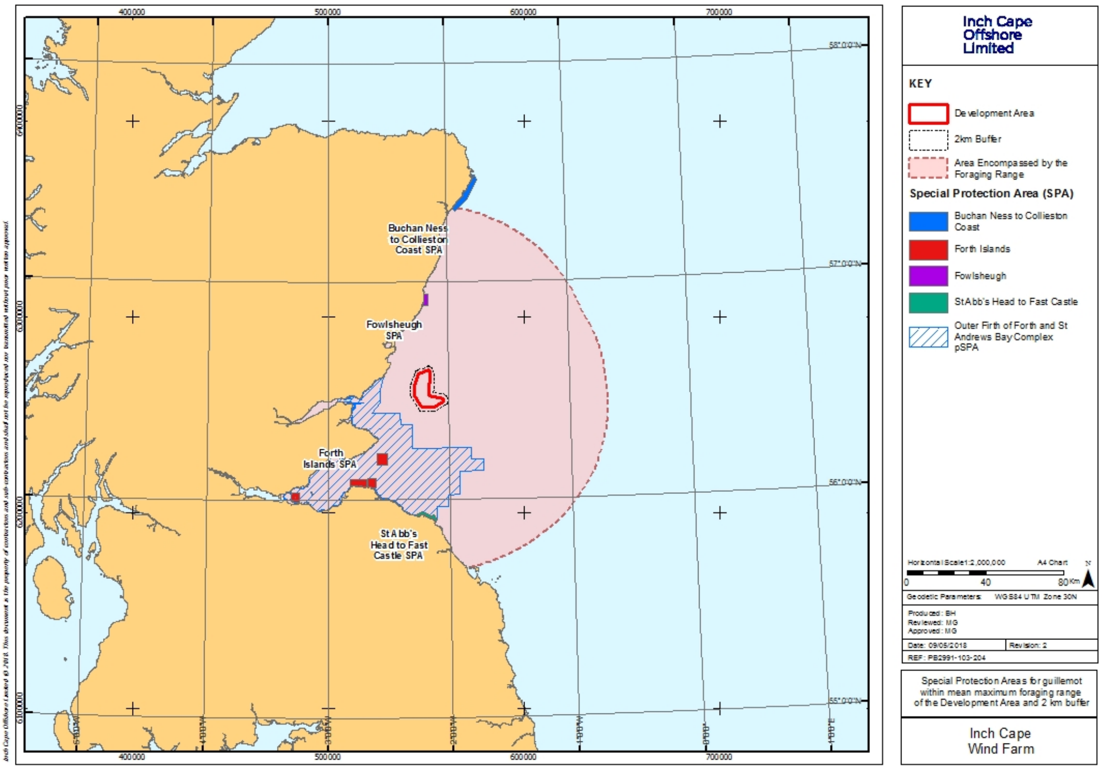


Figure 11.6: Special Protection Areas for Razorbill within Mean Maximum Foraging Range of the Development Area and Two Kilometre Buffer

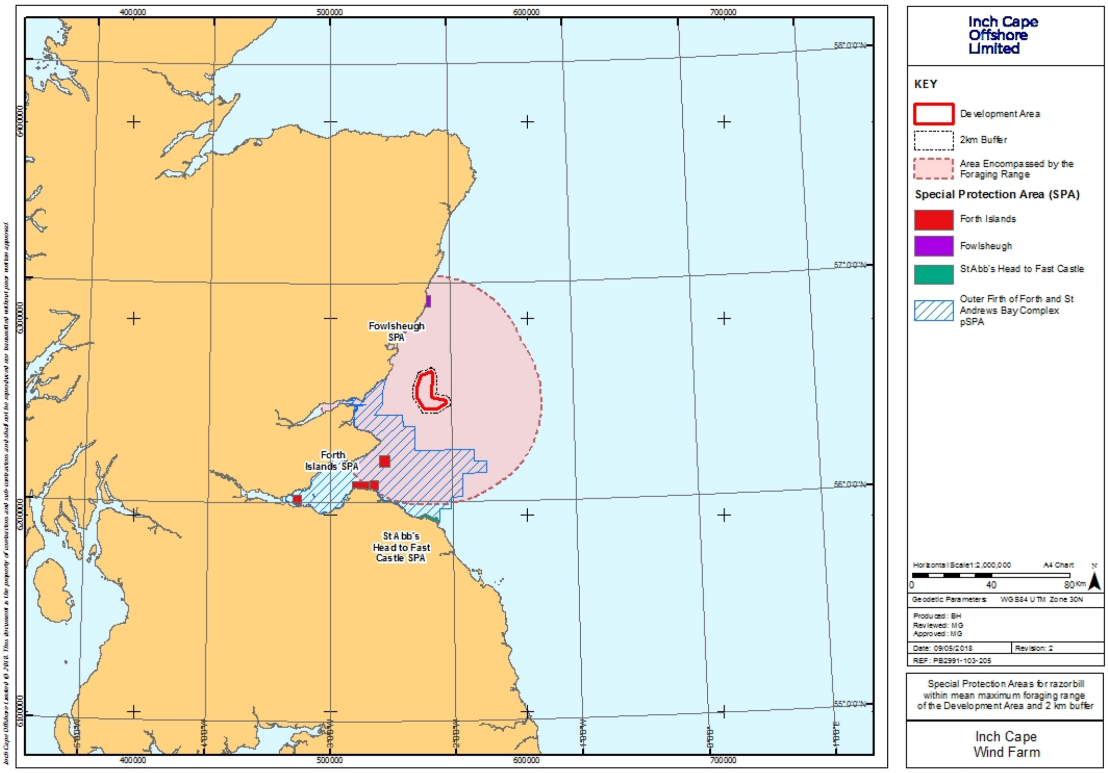


Figure 11.7: Special Protection Areas for Puffin within Mean Maximum Foraging Range of the Development Area and Two Kilometre Buffer

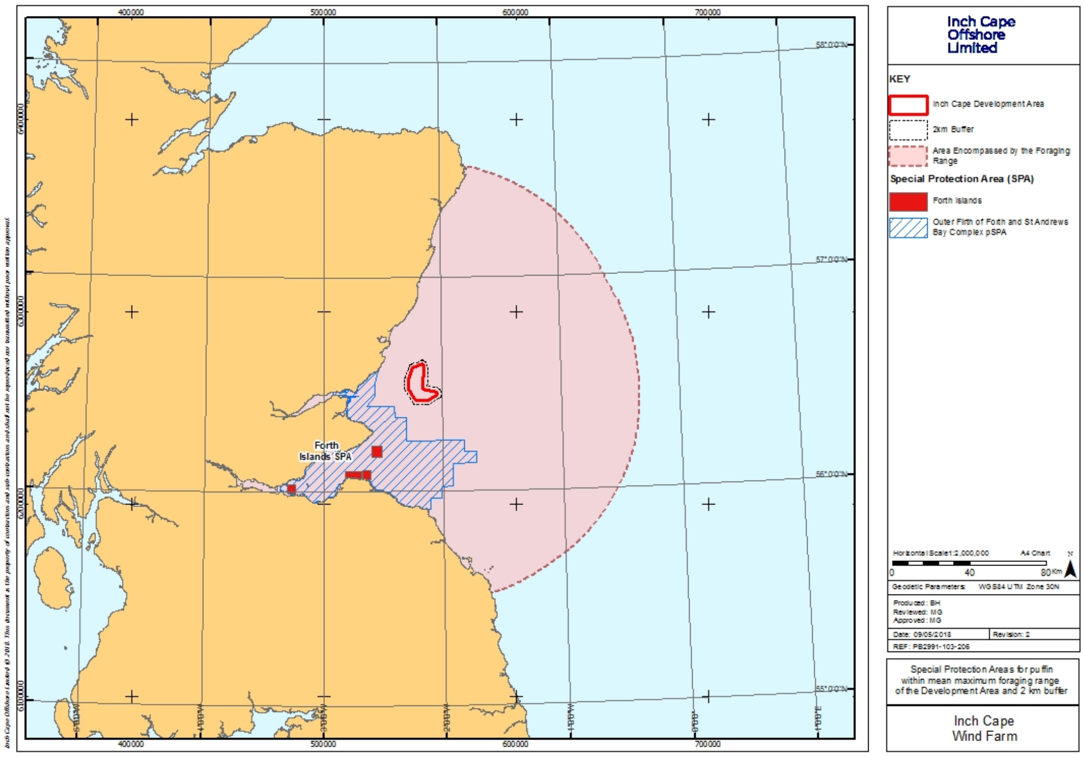


Table 11.6: Summary of occurrence and sensitivity of key species for the assessment of impacts associated with the Wind Farm.

Species	Summary of boat-based survey findings	Populations of relevance	Sensitivity[1]	Rationale	Impacts assessed		
					Displacement (operation)	Barrier (operation)	Collision (operation)
Gannet	Recorded in all months of the year and in every survey. One of the most abundant species recorded.	Breeding[2]	High	Qualifying feature of the Forth Islands SPA and the Outer Firth of Forth and St Andrews Bay Complex pSPA, occurring within foraging range.	X	X	✓
Puffin	Recorded in all months of the year and in all but one survey. One of the most abundant species recorded.	Breeding	High	Qualifying feature of the Forth Islands SPA and the Outer Firth of Forth and St Andrews Bay Complex pSPA occurring within foraging range.	✓	✓	X
Razorbill	Recorded in all months of the year and in all but one survey. One of the most abundant species recorded.	Breeding[2]	High	Qualifying feature of the Forth Islands and Fowlsheugh SPAs and the Outer Firth of Forth and St Andrews Bay Complex pSPA occurring within foraging range.	✓	✓	X
Guillemot	Recorded in all months of the year and in all but one survey. One of the most abundant species recorded.	Breeding[2]	High	Qualifying feature of the Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle and Buchan Ness to Collieston Coast SPAs and the Outer Firth of Forth and St Andrews Bay Complex pSPA occurring within foraging range.	✓	✓	X

Species	Summary of boat-based survey findings	Populations of relevance	Sensitivity[1]	Rationale	Impacts assessed		
					Displacement (operation)	Barrier (operation)	Collision (operation)
Kittiwake	Recorded in all months of the year and in all but one survey. One of the most abundant species recorded.	Breeding[2]	High	Qualifying feature of the Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle SPAs and the Outer Firth of Forth and St Andrews Bay Complex pSPA occurring within foraging range.	✓	✓	✓
Herring gull	Recorded in all months of the year and in 18 (of 24) boat-based surveys. Abundance largest in winter.	Breeding[2]	High	Qualifying feature of the Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle and the Outer Firth of Forth and St Andrews Bay Complex pSPA occurring within foraging range.	X	X	✓

1. Species sensitivity to offshore wind farms is based on Furness *et al*. (2013) and the connectivity between the Development Area and SPAs.

2. Although it is the breeding populations of these species that have connectivity with the Development Area that have been scoped in to the assessment, the assessment also considers the potential impacts to these populations during the non-breeding seasons.

Offshore Export Cable Corridor

38 The assessment of the Offshore Export Cable considers the Offshore Export Cable Corridor between MHWS at the landfall and the (OSPs of the Development, a distance of approximately 83 kilometres. As the site-specific baseline data for the Offshore Export Cable Corridor is limited to the inter-tidal and near-shore habitats, on a precautionary basis the bird species scoped in for this assessment are those identified as qualifying species of the Outer Firth of Forth and St Andrews Bay Complex pSPA. These species are listed in Table 3.10 of the HRA (ICOL, 2018a).

11.6.6 Development Baseline

Development Area

39 Existing information and data from boat-based surveys indicate that the Development Area and two kilometre buffer is regularly used by seabirds throughout the year, but particularly during the breeding period (the breeding period for each species as advised in the Scoping Opinion is summarised in Table 11.7). During this time of year, the Development Area and two kilometre buffer lies within the foraging range of several seabird breeding colonies on the east coast of Scotland, including colonies designated as SPAs (Figures 11.2 – 11.7). Adult seabirds with active nests are constrained in the distances that they can travel to forage, as they need to acquire sufficient energy to meet their own needs as well as the requirements of incubating eggs and feeding nestlings (Enstipp *et al.* 2006). Immediately after the breeding season, aggregations of post-breeding birds were recorded within the Development Area and two kilometre buffer, including guillemot, razorbill and kittiwake. Outside the breeding season the Development Area and two kilometre buffer is also used for foraging and resting/roosting by seabirds, although at this time of year birds can potentially range and forage over larger areas of sea, and individuals of many species present during the breeding season migrate to wintering areas elsewhere in the North Sea, Atlantic Ocean or Mediterranean Sea (Furness 2015).

40 Details of the temporal and spatial variation in the abundance of each of the key species in the Development Area and two kilometre buffer are presented in *Appendix 11A*.

Table 11.7: SNH recommended seasons for key species

Species	Breeding season	Non-breeding season
Gannet	Mid-March to September	October to mid-March[1]
Puffin	April to mid-August	Mid-August to March
Razorbill	April to mid-August	Mid-August to March
Guillemot	April to mid-August	Mid-August to March

Species	Breeding season	Non-breeding season
Kittiwake	Mid-April to August	September to mid-April[2]
Herring gull	April to August	September to March
[1]For the purposes of the assessment, the non-breeding season is further divided into the autumn (October to November) and spring (December to mid-March) passage periods. [2]For the purposes of the assessment, the non-breeding season is further divided into the autumn (September to December) and spring (January to mid-April) passage periods.		

<u>**Offshore Export Cable Corridor**</u>

41 As stated above, the assessment for the Offshore Export Cable uses published data sources on the presence of birds, in particular the Departmental Brief for the Outer Firth of Forth and St Andrews Bay Complex pSPA (SNH and JNCC, 2016), which includes information on seasonal occurrence and maps of relative density for the pSPA qualifying species within the pSPA boundary.

11.6.7 Baseline without the Development

42 In the absence of the operational Development, the numbers of seabirds occurring within the Study Area, over the operational period of the project, would likely reflect changes in populations resulting from multiple pressures. Recent population change in the seabirds of interest, and possible future causes of change, are described below.

43 Most species of seabird have undergone large changes in abundance and distribution in Europe, and Scotland, from the late 19th Century to present. Causes of change have included the increased availability of fisheries discards resulting in population increases for some species, changes in mortality from hunting for food (eggs, nestlings and adults) resulting in large reductions and then increases follow legal protection and societal change, or killing for other purposes (including “sport” and population management) (Mitchell *et al.* 2004). In the late 20th and early 21st Centuries, many seabird populations have generally declined, including in Scotland (SNH, 2012). Such declines are hypothesised to be the result of a number of non-mutually exclusive factors, including:

- Increasing sea temperatures (e.g. Frederiksen *et al.* 2007), which can affect the distribution and abundance of prey species (Burthe *et al.* 2012);
- Reduced prey abundance or availability through human fishing activities (e.g. Tasker *et al.* 2000). Breeding failure of seabird colonies in the east of Scotland was linked to reduced availability of small shoaling fish, particularly sandeels (Frederiksen *et al.* 2004);
- Predation of eggs, chicks or adults at breeding colonies by introduced non-native predators, such as mink (e.g. Craik, 1997), or native predators such as rats, accidentally introduced to island breeding colonies (e.g. McDonald *et al.* 1997);

- Exploitation by humans in wintering areas (e.g. Gremillet *et al.* 2015); and
- Proposed changes in fisheries policy to reduce or eliminate discards of unsuitable catches (Bicknell *et al.* 2013).

44 If the Development was not progressed, no change in the baseline conditions in the Development Area are predicted, beyond those resulting from the drivers referred to above: climatic factors (such as temperature change and subsequent impacts on species' ranges), or anthropogenic activities such as changes in fishing activities indirectly affecting seabird communities. This assumes that no other developments occurred within this area.

11.7 Assessment Methodology

11.7.1 Assessment of Effects

45 The assessment considers the Design Envelope, embedded mitigation and conditions as described in *Section 11.5.*

46 The impacts and receptors which are the subject of the ornithology assessment are identified in *Section 11.6* above, having been determined from the boat-based survey data for the Development Area and two kilometre buffer the findings of the desk based assessment, and agreed through the Scoping Opinion. All receptors scoped into the assessment are classified as being of high sensitivity due to their likely sensitivity to offshore wind farms (Furness *et al.* 2013), and their status as qualifying features of SPAs and/or pSPAs with connectivity to the Development Area and two kilometre buffer.

47 In relation to the Development Area, the impacts that are scoped into the assessment are limited to the operation and maintenance phase of the Wind Farm and comprise displacement, barrier effects and collisions. As outlined in Table 11.2, a range of modelling approaches and other methods are used to estimate the potential increase in mortality and reduction in productivity that could occur as a result of these impacts. Apportioning of the effects according to population age-classes and breeding colonies is undertaken (*Appendices 11B and 11C*), with population-level impacts predicted using Population Viability Analyses (PVAs) for five of the six key species. The methods used to estimate these effects and predict the subsequent population-level impacts are detailed in *Appendices 11A to 11E*.

48 The approach to determining the significance of the different impacts that are considered in the assessment follows that outlined in *Chapter 4: Process and Methodology*. Thus, the magnitude of impact arising from the Development is categorised according to the criteria in Table 11.8, with the magnitude of impact determined for each receptor then combined with its identified sensitivity (Table 11.6) to establish the significance of the effects (Table 11.9).

Table 11.8: Magnitude of Impact

Magnitude	Definition
High	Total loss or major alteration to key elements/features of the baseline conditions
Moderate	Partial loss or alteration to one or more key elements/features of the baseline conditions
Low	Minor shift away from the baseline conditions
Negligible	Very slight change from baseline conditions

Table 11.9: Significance of Effects

Magnitude of Impact	Sensitivity of receptor		
	Low	**Moderate**	**High**
Negligible	Negligible/Minor	Minor	Minor/Moderate
Low	Minor	Minor/Moderate	Moderate
Moderate	Minor/Moderate	Moderate	Moderate/Major
High	Moderate	Moderate/Major	Major

49 The assessment of significance of each potential effect has therefore been based on the sensitivity of receptors and the magnitude of impacts. In this process, the magnitude of impact and definitions of receptor sensitivity have been used as a framework to guide the assessment process, rather than as a prescriptive formula following IEEM (2010). Expert judgement, informed by available scientific information on the ecology and behaviour of each species, has been applied to interpret the assessment of likelihood and ecological significance of a predicted impact.

50 For the purposes of this assessment those residual positive and negative effects indicated as major and moderate/major are considered significant. This is also subject to expert judgement, bearing in mind the available definitions of ecological significance. IEEM (2010) guidance states that an ecologically significant impact is: 'an impact that has a negative, or positive, effect on the integrity of a site or ecosystem and/or the conservation objectives for habitats or species populations within a given geographical area. In this way significant impacts are distinguished from other, lesser (and, in the context of EIA, unimportant) effects'.

11.7.2 Cumulative Impact Assessment

Development and Onshore Transmission Works (OnTW)

51 This section considers whether the Wind Farm, OfTW and OnTW may have cumulative or combined impacts on ornithological receptors.

Cumulative with other projects

Development Area and buffer

52 For the purposes of the EIA, the CIA considers the impacts on the regional breeding populations (as for the Development-alone assessment), as defined using the mean maximum foraging range (Thaxter *et al.* 2012) and as detailed in *Appendix 11A*. The cumulative impacts during the breeding period are considered quantitatively for the Development together with the three other proposed Forth and Tay wind farms (i.e. Neart na Gaoithe, Seagreen Alpha and Seagreen Bravo), whilst breeding season effects from other wind farms are considered qualitatively (as advised in the Scoping Opinion).

53 For guillemot, razorbill and herring gull, many of the adult birds are known to remain close to the breeding areas for at least part of the non-breeding period (Furness, 2015), so that the CIA (again as for the Development-alone assessment) considers the potential impacts to regional populations of these species during the non-breeding period, as well as the breeding period. Non-breeding season effects on the SPA populations of these species are also considered within the in-combination assessment of the HRA (ICOL, 2018a).

54 Both gannet and kittiwake are migratory, and birds from the regional breeding populations are generally absent from the Forth and Tay region for much of the non-breeding period (Furness, 2015). These birds may pass through other offshore wind farms during their autumn and spring passage. The Scoping Opinion advised that, for the purposes of the CIA, the potential passage period collision mortality should be considered quantitatively both in relation to the Forth and Tay wind farms and in relation to the UK North Sea and (for gannet) Channel wind farms. This aspect of the assessment is considered fully within the in-combination assessment of the HRA for the gannet and kittiwake SPA populations with connectivity to the Development and two kilometre buffer (ICOL, 2018a).

55 The approaches used to estimate the non-breeding season effects on gannet and kittiwake are specific to SPA populations (see *Appendix 11B*) and are less suited to estimating effects at the broader level of the regional populations, which may comprise multiple colonies across a wide geographical area. Consequently, the presentation of collision estimates within the CIA for the gannet and kittiwake regional breeding populations is limited to those for the breeding period, and estimates of passage period collisions are not presented. However, the PVAs used to support the assessment of these regional populations are based upon SPA populations. As such, these PVAs include consideration of the passage period collision impacts, so that the CIA does take account of this source of impact in relation to the Development and the other Forth and Tay wind farms. Consideration of passage period collisions from the other UK North Sea and (for gannet) Channel wind farms is limited to the

in-combination assessment for the SPA populations, which is presented in the HRA (ICOL, 2018a).

56 As advised in the Scoping Opinion, no assessment of non-breeding season effects is undertaken for puffin. This is on the basis that puffins migrate rapidly from their UK breeding areas (leaving the seas immediately adjacent to their colonies by late August – Wernham *et al*., 2002, Harris and Wanless, 2011), whilst they are not considered vulnerable to collision mortality. Therefore, the CIA for this species does not extend beyond those sites considered in relation to breeding period.

Offshore Export Cable Corridor

57 As detailed in Table 11.1 above, the Scoping Opinion advised that further information to inform an assessment of the Offshore Export Cable was required because this passes through the Outer Firth of Forth and St Andrews Bay Complex pSPA. Therefore, the pSPA and associated ornithological receptors (i.e. the qualifying species of the pSPA) have been scoped in to the EIA, and consideration is also given to the potential for cumulative effects of the Offshore Export Cable Corridor with those from other projects.

58 The CIA section also considers the potential for cumulative effects between the Development Area and other plans and projects and the Offshore Export Cable.

11.8 Impact Assessment – Development Area

11.8.1 Operation and maintenance

Collision

59 Collision risk for offshore wind farms is assessed by modelling the predicted number of collisions for key bird species based on data on flight densities from baseline surveys. For the Wind Farm, Collision Risk Modelling (CRM) was undertaken for key species as per the Scoping Opinion (Table 11.6) based on the industry standard approach for offshore wind farms (Band 2012). Full details are given in *Appendix 11C*. The avoidance rates applied to the CRMs for each species and CRM option were as advised in the Scoping Opinion (and following the SNCBs guidance note (2014), whilst the collision estimates are also presented with the range based upon the avoidance rate plus or minus two standard deviations (SDs), as advised in the Scoping Opinion.

60 The estimated impacts from collisions were assessed for gannet and kittiwake for the Wind Farm design of 40 WTGs with rotor diameter 250 m, which represents the worst-case for these species. For herring gull, the estimated impacts from collisions were assessed for the 72 WTG design with rotor diameter 167 m, which was the worst case for the option 2 and 3 estimates for this species (Table 11.4*, Appendix 11C*). Details of the wind farm parameters comprising both of the designs that were considered are given in *Appendix 11C*.

61 For gannet and kittiwake, the assessment uses CRM options 1 and 2, which assume a uniform flight height distribution within the rotor swept heights and use the site-specific

flight heights and generic flight heights (Johnston *et al.* 2014a, b), respectively. For herring gull, the assessment uses CRM options 1, 2 and 3, with option 3 assuming a modelled flight height distribution within the rotor swept heights, based on the generic flight heights. The different CRM options used for each species followed the advice of the Scoping Opinion (with further explanation and justification provided in *Appendix 11C*). The avoidance rates applied to the different species and CRM options are detailed in *Appendix 11C*, and again followed the advice of the Scoping Opinion.

Gannet

62 The estimated seasonal collision mortality of adult and sub-adult gannets and the percentage increases in mortality rates of reference populations are shown in Table 11.10. These assume that collision mortality is additional to other mortality factors.

63 Collision estimates were higher for the option 2 CRMs than for the option 1 CRMs, which was due to the lower estimated flight heights for the site-specific data than for the generic data, resulting in fewer birds estimated to be at potential collision height (PCH) using option 1 (*Appendices 11A and 11C*). However, the collision estimates represented small increases in the annual mortality rates of the regional breeding population, irrespective of the CRM option used.

64 For sub-adult birds, the percentage increase in the annual mortality rate is estimated to be, at most, 0.01 per cent (Table 11.10), which would not materially affect the background mortality of the population and would be undetectable in terms of population-level effects. Predicted collisions of adult birds during the breeding season represent a larger increase in the annual mortality rate, although the estimates (from both CRM options 1 and 2) represent an increase of less than one per cent in the annual mortality rates of the breeding adults (Table 11.10).

65 To further investigate the predicted impacts of collision mortality on the regional breeding population, PVA was undertaken using a population model for the Forth Islands SPA gannet population (*Appendix 11E*). The Forth Islands SPA population represents over 90 per cent of the regional breeding population, with an estimated 150,518 gannets breeding on the Bass Rock (Murray *et al.* 2015, *Appendix 11A*). Thus, it is reasonable to apply the PVA outputs from this model to the regional breeding population.

66 The Forth Islands SPA population has undergone a long-term increase, and although further increase in numbers on the Bass Rock (where almost all of this SPA population nest) is likely to be limited by a lack of available space, the recent colonisation of St Abb's Head[3] by the species could indicate the potential for continued growth of the regional population through occupation of new areas (*Appendix 11A*).

67 The gannet population model used was a stochastic, density independent, matrix model, developed from previous population models for the UK and Bass Rock gannet populations

[3]https://www.nts.org.uk/stories/first-gannet-chick-hatched-at-st-abbs-head [Accessed: 02/08/18]

(WWT Consulting 2012, MacArthur Green 2014). Further details of the model are provided in *Appendix 11E*. Predicted population trends under baseline conditions were projected over both 25 and 50 year timescales. Additional mortality was incorporated at intervals of 25 individuals up to a maximum of 1,500 (and in such a way that the additional mortality remains proportional to population-size as this changes through the course of the projection), with 97 per cent of the additional mortality attributed to the breeding adult age class and three per cent to the sub-adult age classes (on the basis of the age distribution as determined from the at-sea survey data – *Appendix 11A*).

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Table 11.10: Collision estimates for gannet during the breeding period for the 40 WTG design, with the associated increase in annual mortality rates for the regional breeding population.

Seasonal period	Number of collisions (individuals per season)			Regional population, adults[2] (individuals)	Regional population, sub-adults[2] (individuals)	Mortality rate, adults[3]	Mortality rate, sub-adults[3]	Collisions as % increase in mortality, adults	Collisions as % increase in mortality, sub-adults
	Total	Adults[1]	Sub-adults[1]						
Option 1 (Basic model, site specific flight height data, 98.9% avoidance (± 2 SD applied to the total collision estimate))									
Breeding	46 (38 – 54)	40	1	163,430	107,149	0.081	0.346	0.3 %	<0.01 %
Option 2 (Basic model, generic flight height data, 98.9% avoidance (± 2 SD applied to the total collision estimate))									
Breeding	108 (88 – 128)	94	3	163,430	107,149	0.081	0.346	0.7 %	0.01 %

1. Apportioning of collisions to age classes is based upon age distributions from site survey data (*Appendix 11A*), with the number of adult collisions reduced by 10 % to account an assumed 10 % sabbatical rate amongst the adults in the breeding period (as per the Scoping Opinion). The immature and juvenile age categories are combined as sub-adults to simplify presentation.

2. After Murray *et al*. (2015) for Bass Rock and Troup Head (*Appendix 11A*); sub-adult component is estimated from the stable age distribution of the Forth Islands SPA gannet population model used for the current assessment (*Appendices 11A and 11E*).

3. Baseline annual mortality rates after WWT Consulting (2012) and Horswill and Robinson (2015). The value for sub-adults is calculated as the mean mortality rate of the different sub-adult age classes (0 – 4 years), weighted by their proportional occurrence as estimated from the stable age distribution of the Forth Islands SPA gannet population model (*Appendices 11A and 11E*).

68 The PVA assumed that impacts began at the start of the projection period (i.e. essentially 2014, as the year of the estimate on which the starting population-size is based) and did not allow for any intervening period to account for the likely timing of the start of the Development operation period. However, this is likely to lead to precautionary conclusions, given that the model predicted continued growth of the population (see below).

69 Impacts were assessed according to the Forth Islands SPA population and the collisions apportioned to this SPA population (both during the breeding period and during the autumn and spring passage periods – *Appendices 11B and 11E*). This is precautionary with respect to assessing impacts on the regional breeding population because the Forth Islands SPA population is estimated to contribute a disproportionately high number of birds to the population within the Development Area (*Appendix 11B*), and hence will be subject to a disproportionately high number of the overall collisions. For the purposes of assessing population-level impacts from the Development-alone collisions, the CRM option 2 estimates were used (as advised in the Scoping Opinion), with the collision estimate being matched to the closest higher additional mortality value considered in the PVA (because the additional mortality was considered at intervals of 25 individuals). The breeding period collision estimates apportioned to the adult age class also accounted for an assumed 10 per cent of sabbatical birds (as advised in the Scoping Opinion).

70 Outputs from the PVA were summarised according to the median predicted population-sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which have been shown to have relatively low sensitivity to factors such as varying population status and the mis-specification of the demographic rates underpinning the population model (Cook and Robinson 2015, Jitlal *et al*. 2017). These metrics are:

- The counterfactual of population size – the median of the ratio of the end-point size of the impacted to un-impacted (or baseline) population, expressed as a proportion.
- The counterfactual of population growth rate - the median of the ratio of the annual growth rate of the impacted to un-impacted population, expressed as a proportion (with this metric being unaffected by the projection period).
- The centile of the unimpacted population that matches the median (i.e. 50th centile) of the impacted population (based upon the distribution of the end-point population sizes generated by the multiple replications of the model runs, the value should always be less than 50 because the median for the impacted population is not expected to exceed that for the unimpacted population).

71 The PVA outputs predict continued growth of the gannet population, under both the baseline conditions and with the Development-alone collisions taken into account (Table 11.11). As indicated above, it is unclear how realistic such a scenario is (given that the Bass Rock is likely to be close to capacity), but nonetheless the metrics suggest minimal population-level effects from the Development-alone collisions, with:

- Virtually no decrease in annual population growth rate (as indicated by a counterfactual value of 0.999)
- Small reductions in end-point population-sizes (the impacted population predicted to be 97 per cent of the size of the unimpacted population after 50 years)
- Centile values of 41 and 37 for the 25- and 50-year projections, respectively, which indicate a considerable overlap between the distributions of the impacted and unimpacted populations, suggesting a reasonable likelihood of the impacted population being similar in size to the unimpacted population after 50 years.

72 The above metrics derive from a PVA based upon the option 2 collision estimates, which are more than twice as high as those generated by the option 1 CRM. As outlined in *Appendix 11C* there are good reasons for considering the site-specific flight heights (and hence the option 1 collision estimates) to be representative of gannet flights within the Development Area and two kilometre buffer. Therefore, the collision estimates used in the PVA are likely to be highly precautionary, leading to an overestimation of the impact magnitude.

73 Even with these precautionary assumptions, collision mortality from the Development-alone is evaluated as a low magnitude impact (Table 11.8) for gannet, reflecting the predicted small effect on the regional population. Application of the impact matrix (Table 11.9) indicates that this equates to a moderate and ecologically non-significant impact for a receptor of high sensitivity.

74 Based on the relatively small percentage increases in annual mortality rates for the adult and, particularly, sub-adult ages classes, and the outcome of the PVA, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of collision risk on gannet. It is considered that this impact is more appropriately categorised as minor and ecologically non-significant.

Table 11.11 Outputs from the Forth Islands SPA gannet PVA in relation to Development-alone collision estimates for 25-year and 50-year projections

Additional mortality scenario	Median number of breeding adults at end of projection (2.5 – 97.5 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	172,530 (148,172 – 199,825)	199,491 (160,083 – 245,839)	1.000	1.000	1.000	50	50
Development-alone collisions (assumes starting-point additional mortality of 125 individuals)[1]	169,653 (145,724 – 196,717)	192,824 (154,739 – 240,072)	0.983	0.967	0.999	41	37

1. Collisions are apportioned in ratio of 97:3 breeding adults to sub-adults (based on at-sea survey data from the Survey Area).
2. The value of this metric does not vary according to the length of the projection period.

<u>*Kittiwake*</u>

75 The estimated seasonal collision mortality of adult and sub-adult kittiwakes and the percentage increases in mortality rates of reference populations are shown in Table 11.12. These assume that collision mortality is additional to other mortality factors.

76 Collision estimates were substantially higher for the option 2 CRMs than for the option 1 CRMs, with only a single collision estimated during the breeding period by option 1. As for gannet, this was due to the lower estimated flight heights for the site-specific data than for the generic data, resulting in fewer birds estimated to be at potential collision height (PCH) using option 1 (*Appendices 11A and 11C*). However, the collision estimates represented small increases in the annual mortality rates of the regional breeding population, irrespective of the CRM option used.

77 For sub-adult birds, the percentage increase in the annual mortality rates is estimated to be, at most, 0.03 per cent (Table 11.12), which would not materially affect the background mortality of the population and would be undetectable in terms of population-level effects. Predicted collisions of adult birds during the breeding season represent a larger increase in the annual mortality rate on the basis of the option 2 estimates, although the increase associated with the option 2 collision estimates remains below one per cent (Table 11.12).

78 To further investigate the predicted impacts of collision mortality on the regional breeding population, PVA was undertaken using a population model which was based upon demographic and population trend data from the three kittiwake SPA populations which are considered to have connectivity to the Development Area and two kilometre buffer (*Appendix 11E*). These SPA populations are estimated to account for 68 per cent of the regional breeding population, but only 55 per cent of the estimated collisions for the Development-alone (as determined by the apportioning calculations - *Appendix 11B*). On this basis, the PVA will underestimate the impacts to the regional population by a small amount.

79 The regional breeding population is estimated at 51,786 breeding adults, as derived from recent counts of the SPA populations (as provided in the SNH scoping advice), combined with Seabird 2000 census (Mitchell *et al.* 2004) counts for non-SPA colonies with correction factors applied from the trend recorded at SPA colonies since the Seabird 2000 census (*Appendices 11A and 11B*). In common with other areas in eastern Scotland, the regional breeding population has undergone a marked decline over the past few decades (Freeman *et al.* 2014, *Appendix 11E*). This large-scale decline is related to declines in the abundance of sandeel prey (JNCC 2017b), and provides important context for the impact assessment of this species.

80 The regional-SPA kittiwake population model was based on a Bayesian state-space modelling framework, and was adapted from the existing kittiwake population models developed for the SPA populations in this region (Freeman *et al.* 2014, Jitlal *et al.* 2017). The regional-SPA model was produced by summing the projections for the population models for the three kittiwake SPA populations. Further details are provided in *Appendix 11E*. Predicted population trends under baseline conditions were projected over both 28 and 53 year

timescales. Additional mortality within the PVA was not incorporated until after year three of the projection (giving 25 and 50-year impact periods), to provide a more realistic representation of the likely population status at the time when potential collisions impacts will begin to arise.

81 The additional mortality was incorporated into the PVAs for each of the three SPA populations on the basis of the percentage point change to the annual mortality represented by the option 2 collision estimates (accounting for both the breeding period collisions and the passage period collisions apportioned to these SPA populations – *Appendices 11B and 11E*). This additional mortality was apportioned to age classes according to the age distributions as determined from the at-sea survey data (classifying 93 per cent as adults during the breeding period – *Appendix 11A*) but with the breeding period collisions also accounting for an assumed 10 per cent of sabbatical birds (as advised in the Scoping Opinion).

82 Outputs from the PVA were summarised according to the median predicted population-sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in the section on gannet.

83 The PVA outputs predict a continued steep decline in the regional breeding population of kittiwakes under baseline conditions, with the median number of breeding pairs by the model predictions declining from 16,550 at the start of the projection to 7,150 after 25 years of the operational period and 3,700 after 50 years of the operational period (Table 11.13 and *Appendix 11E*). The population-level effects of the Development-alone collisions are considered to be minimal, with:

- Virtually no detectable decrease in annual population growth rate (as indicated by a counterfactual value of 0.999)
- Small reductions in end-point population sizes (the impacted population predicted to 97 per cent of the size of the unimpacted population after 50 years)
- Centile values of 49 which indicate a considerable overlap between the distributions of the impacted and unimpacted populations, suggesting a high likelihood of the impacted population being a similar size to the unimpacted population after 50 years.

84 The above metrics derive from a PVA based upon the option 2 collision estimates, which are an order of magnitude higher than those generated by the option 1 CRM. As outlined in *Appendix 11C* there are good reasons for considering the site-specific flight heights (and hence the option 1 collision estimates) to be representative of kittiwake flights within the Development Area and two kilometre buffer. Therefore, the collision estimates used in the PVA are likely to be highly precautionary, leading to an overestimation of the impact magnitude.

Table 11.12: Collision estimates for kittiwake during the breeding period for the 40 WTG design, with the associated increase in annual mortality rates for the regional breeding population.

Season	Number of collisions (individuals per season)			Regional population, adults[2] (individuals)	Regional population, sub-adults[2] (individuals)	Mortality rate, adults[3]	Mortality rate, sub-adults[3]	Collisions as % increase in mortality, adults	Collisions as % increase in mortality, sub-adults
	Total	Adults[1]	Sub-adults[1]						
Option 1 (Basic model, site-specific flight height data, 98.9% avoidance (± 2 SD applied to the total collision estimate))									
Breeding	1 (0.8 – 1.2)	1	<1	51,786	41,113	0.143	0.210	0.01 %	<0.01 %
Option 2 (Basic model, generic flight height data, 98.9% avoidance (± 2 SD applied to the total collision estimate))									
Breeding	40 (33 – 47)	33	3	51,786	41,113	0.143	0.210	0.45 %	0.03 %

1. Apportioning of collisions to age classes is based upon age distributions from site survey data (*Appendix 11A*), with the number of adult collisions reduced by 10 % to account for an assumed 10 % sabbatical rate amongst the adults in the breeding period (as per the Scoping Opinion).

2. Adult breeding population based on Seabird 2000 database (http://jncc.defra.gov.uk/page-4460) and more recent estimates for SPA breeding populations provided by SNH, with counts for non-SPA colonies corrected based on the SPA trends. The sub-adult component of the breeding population is estimated from the stable age distribution of the SPA population models (*Appendices 11A and 11E*).

3. Baseline annual mortality rates are as used for the SPA kittiwake population models (*Appendix 11E*) for adults, and after Horswill and Robinson (2015) for sub-adults.

Table 11.13 Outputs from the regional-SPA kittiwake PVA in relation to Development-alone collision estimates for 25-year and 50-year projections

Additional mortality scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	7,150 (3,200 – 18,000)	3,700 (900 – 19,100)	1.000	1.000	1.000	50	50
Development-alone collisions (based upon the percentage point increases to the annual mortality of adult and sub-adult age classes in each of the individual kittiwake SPA PVAs)[1]	7,100 (3,150 – 17,800)	3,600 (900 – 18,700)	0.987	0.975	0.999	49	49

1. Details of the individual kittiwake SPA PVAs are presented in *Appendix 11E*. The ratio of adult to sub-adult additional mortality in each of these PVAs is based on the age distribution as determined from at-sea survey data from the Survey Area (*Appendix 11A*), and also accounts for an assumed 10 % sabbatical rate amongst the adults during the breeding period (as per the Scoping Opinion).
2. The value of this metric does not vary according to the length of the projection period.

85 Even with these precautionary assumptions, collision mortality from the Development-alone is evaluated as a low magnitude impact (Table 11.8) for kittiwake, reflecting the predicted small effect on the regional population. Application of the impact matrix (Table 11.9) indicates that this equates to a moderate and ecologically non-significant impact for a receptor of high sensitivity. This assessment is in the context of a regional population undergoing a long-term decline which is predicted to continue during the operational life of the Inch Cape Wind Farm. However, the evidence indicates that the small levels of predicted mortality due to the Development-alone collisions will effectively not contribute to accelerating the rate, or increasing the magnitude, of this ongoing decline. Collisions with the Inch Cape Wind Farm are also not predicted to impede population recovery, should environmental conditions become more favourable for kittiwakes.

86 Based on the small percentage increases in annual mortality rates for the adult and, particularly, sub-adult ages classes, and the outcome of the PVA, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of collision risk on kittiwake. Applying scientific judgement to the evidence and assessment process, it is considered that this impact is more appropriately categorised as minor and ecologically non-significant.

Herring gull

87 The assessment for herring gull considers results for CRM options 1, 2 and 3 (*Appendix 11C*) for the Inch Cape Wind Farm design of 72 WTGs of rotor diameter 167 m (Table 11.14), although it is the option 3 estimates that are regarded as the main outputs (as these were to be used in any PVAs required for the assessment, as confirmed in letter of 8 September 2017 from MS-LOT to ICOL). For herring gull the option 3 collision estimates for the 72 WTG design were higher than those for the 40 WTG design (by a single collision), but equivalent to the option 2 estimates for the 40 WTG design (*Appendix 11C*). Thus, for the purposes of consistency across the different species (and because the assessment also relies on the option 2 estimates – see below), the assessment for herring gull is undertaken in relation to the 40 WTG design.

88 Under all three CRM options the predicted collision estimates for herring gull are very low, with a maximum of one collision estimated for the breeding period and at most three collisions estimated for the non-breeding period (Table 11.14). For adult and sub-adult birds in both seasons, the estimated percentage increases in the annual mortality rates are very small (0.01 per cent or less). It is considered that these small magnitudes of increase in mortality would not materially alter the background mortality of the population and would be undetectable in terms of population effects. Given the low levels of estimated collision mortality, PVAs were not considered to be required for this species. For all age classes of herring gull, collision mortality for the Development-alone is considered to be an effect of negligible magnitude on the regional breeding and non-breeding populations.

89 Collision risk from the Development-alone is evaluated as a negligible magnitude impact (Table 11.8) for herring gull. Application of the impact matrix (Table 11.9) indicates that this equates to a minor/moderate and ecologically non-significant impact for a receptor of high sensitivity.

90 Based on the very small percentage increase in population mortality rates for all seasons and age classes, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of collision risk on herring gull. It is considered that this impact is more appropriately categorised as negligible and ecologically non-significant.

Table 11.14: Seasonal collision estimates for herring gull for the 72 WTG design, with the associated increase in annual mortality rates for the regional populations.

Season	Number of collisions (individuals)			Regional population, adults[2] (individuals)	Regional population, sub-adults[2] (individuals)	Mortality rate, adults[3]	Mortality rate, sub-adults[3]	Collisions as % increase in mortality, adults	Collisions as % increase in mortality, sub-adults
	Total	Adults[1]	Sub-adults[1]						
Option 1 (Basic model, site-specific flight height data, 99.5% avoidance (± 2 SD applied to the total collision estimate))									
Breeding	0 (0 - 0)	0	0	24,248	36,372	0.166	0.202	0 %	0 %
Non-breeding	1 (0.8 – 1.2)	<1	<1	210,298	256,222	0.166	0.202	<0.01 %	<0.01 %
Option 2 (Basic model, generic flight height data, 99.5% avoidance (± 2 SD applied to the total collision estimate))									
Breeding	1 (0.8 – 1.2)	<1	<1	24,248	36,372	0.166	0.202	0.01 %	<0.01 %
Non-breeding	3 (2 – 4)	1	1	210,298	256,222	0.166	0.202	<0.01 %	<0.01 %
Option 3 (Extended model, generic flight height data, 99% avoidance (± 2 SD applied to the total collision estimate))									
Breeding	1 (0.8 – 1.2)	<1	<1	24,248	36,372	0.166	0.202	0.01 %	<0.01 %
Non-breeding	2 (1.6 – 2.4)	1	<1	210,298	256,222	0.166	0.202	<0.01 %	<0.01 %

Season	Number of collisions (individuals)			Regional population, adults[2] (individuals)	Regional population, sub-adults[2] (individuals)	Mortality rate, adults[3]	Mortality rate, sub-adults[3]	Collisions as % increase in mortality, adults	Collisions as % increase in mortality, sub-adults
	Total	Adults[1]	Sub-adults[1]						

1. Apportioning of collisions to age classes is based upon age distributions from site survey data (*Appendix 11A*), with the number of adult collisions reduced by 35 % to account for an assumed 35 % sabbatical rate amongst the adults (as per the Scoping Opinion).

2. Adult breeding population based on Seabird 2000 database (http://jncc.defra.gov.uk/page-4460) and more recent estimates for SPA breeding populations provided by SNH, with counts for non-SPA colonies corrected based on SPA trends. The sub-adult component of breeding population is estimated from the stable age distribution of a population model for the Forth Islands SPA herring gull population (*Appendix 11E*). The non-breeding population (for each age class) is taken as the UK North Sea and Channel Waters from Furness (2015), see *Appendix 11A*.

3. Baseline mortality rates after Horswill and Robinson (2015).

Displacement and barrier effects

Definitions and approach to assessing the effects

91 Displacement is defined as 'a reduced number of birds occurring within or immediately adjacent to an offshore wind farm' (Furness *et al.* 2013) and involves birds present in the air and on the water (SNCB 2017). Birds that do not intend to utilise a wind farm area but would have previously flown through the area on the way to a feeding, resting or nesting area, and which either stop short or detour around a development, are subject to barrier effects (SNCB, 2017). For the purposes of assessment, however, it is usually not possible to distinguish between displacement and barrier effects (for example to define where individual birds may have intended to travel to, or beyond an offshore wind farm, even when tracking data are available). Therefore, in this assessment the effects of displacement and barrier effects on the key seabird species are considered together.

92 There remains limited robust empirical evidence on the extent of displacement and barrier effects from offshore wind farms on seabirds of different species, particularly in relation to breeding populations. However, the number of available studies of post-construction monitoring is increasing, and indicates variation between species and sites, and variation within species at different sites and/or in different seasons (e.g. JNCC 2015, Dierschke *et al.* 2016, Vallejo *et al.* 2017).

93 There is also no empirical evidence that birds displaced from wind farms, or exposed to barrier effects, suffer increased mortality, but modelling of the energetic costs incurred by breeding seabirds as a result of these impacts predicts effects to both adult survival rates and breeding productivity (Searle *et al.* 2014). Any mortality due to displacement would most likely be a result of increased densities of foraging birds in locations outside the affected area, resulting in increased competition for food. Barrier effects to breeding seabirds may occur as a consequence of the additional energetic costs incurred by adopting flight routes around (as opposed to through) wind farms which may lie between the breeding colony and foraging locations (Masden *et al.* 2010). Impacts of displacement and barrier effects are also likely to be dependent on other environmental factors such as food supply, and are expected to be greater in years of low prey availability (e.g. as could result from unsustainably high fisheries pressures or effects of climatic changes on fish populations).

94 In the current assessment, the impacts from displacement and barrier effects were assessed quantitatively for guillemot and razorbill in both the breeding and non-breeding periods and for kittiwake and puffin in the breeding period only (*Appendix 11D*). For the reasons given in *Section 11.7.2* above, displacement and barrier effects are not assessed for the regional breeding kittiwake population during the non-breeding period, although (as advised in the Scoping Opinion) a qualitative assessment of these impacts during the non-breeding period is undertaken for the kittiwake SPA populations which have connectivity to the Development Area and two kilometre buffer (with this assessment presented in the HRA (ICOL, 2018a)).

95 The SNCB matrix approach was used to assess the impacts from displacement and barrier effects (as advised in the Scoping Opinion[4]). This approach used the peak seasonal population estimates averaged across the two years of baseline survey for the Development Area and two kilometre buffer (combining birds on the water and in flight). The species-specific displacement rates advised in the Scoping Opinion were applied to these mean peak population estimates, along with the assumed mortality rates for displaced birds (again as advised in the Scoping Opinion), to estimate the total breeding season and (in the case of guillemot and razorbill) non-breeding season mortality from displacement and barrier effects (Table 11.1, *Appendix 11D*). The mortality estimated using the matrix approach was apportioned to population age classes based upon either the proportion of birds identified as being in adult plumage from at-sea survey data (for kittiwake) or from the stable age distributions of population models (for guillemot, razorbill and puffin – see species accounts below for details).

Alternative approaches to estimating effects

96 The Scoping Opinion also advised that the effects of displacement and barrier effects as estimated by individual-based modelling approaches should be used to provide context to the estimates produced by the SNCB matrix approach. At the time of undertaking the work for the current assessment the recently developed SeabORD model had not been published. To provide this context, ICOL commissioned the CEH to run the latest unpublished version of the SeabORD model for the wind farm alone and cumulatively with the other three Forth and Tay wind farms. Additionally, consideration was given to the estimates from the existing Searle *et al.* (2014) model.

97 The basic approach used by these modelling methods is outlined below, together with a summary of the comparisons between the estimates produced by the different methods. This is based upon the detailed consideration presented in *Appendix 11D*.

98 Both of the SeabORD and the existing Searle *et al*. (2014) modelling approaches simulate the behaviour and energetics of individual birds from breeding seabird populations under baseline conditions (i.e. with no wind farm present) and compare the resulting demographic estimates to model runs undertaken in scenarios which have the wind farm(s) of interest present (so that birds undertaking foraging trips from the colony have the potential to incur energetic costs from barrier effects and of increased intra-specific competition for food if they are displaced). In both the SeabORD and Searle *et al.* (2014) models, these effects are estimated in terms of changes to adult and chick mortality, with the outputs relating to specific individual SPA populations (as opposed to the wider regional populations). The estimated mortality to adult birds relates only to the breeding period.

99 For the SeabORD modelling undertaken to inform the current assessment, the percentage of birds within each SPA population assumed to be susceptible to displacement and barrier effects matched the displacement rates assumed by the SNCB matrix approach, whilst a two

[4] Letter of 03 November 2017 from MS-LOT to ICOL.

kilometre buffer was assumed for the Development Area (also for the other three Forth and Tay wind farms, when considering in-combination effects). However, the earlier Searle *et al.* (2014) modelling assumed that 40 per cent of kittiwakes were susceptible to displacement and barrier effects (as opposed to 30 per cent for the SNCB matrix), whilst a one kilometre buffer was used for each site.

100 Comparisons between the estimates produced by the two individual-based modelling approaches indicated varying degrees of agreement, but with little overall consistency between the respective estimates. Approximately half of the estimated effects from Searle *et al.* (2014) were within the 95 per cent prediction intervals of the corresponding SeabORD estimate, despite these intervals encompassing a wide range. Variation in the predicted effects on the Forth Islands SPA puffin population was particularly marked, both according to the different models and, for the Searle *et al.* (2014) model, the assumptions made in relation to prey distribution.

101 Comparisons between the estimates from the SeabORD model and the SNCB matrix indicated that agreement between the two methods was often poor, with the estimates produced by the matrix being within the 95 per cent prediction intervals of the SeabORD estimates for six and seven of the 10 SPA populations for the Development-alone and in-combination scenarios, respectively (Table 11D.18*, Appendix 11D*). The estimates from the SeabORD model were invariably greater than those from the matrix for the Forth Islands SPA populations for both the Development-alone and in-combination (by an order of magnitude in most cases), with this difference particularly marked for guillemot and puffin. This pattern was not consistent across the other SPA populations and was associated with the SeabORD model predicting considerably greater effects on the populations from the Forth islands SPA than on those from other SPAs (even though the Fowlsheugh SPA is a similar distance to the Development Area, and closer to the Seagreen sites but further from the Neart na Gaoithe site).

102 Extrapolations from the adult mortality estimates produced by the SeabORD model suggested that for some populations (particularly from the Forth Islands SPA) unrealistically high rates of displacement (often in excess of 100 per cent) and/or of mortality amongst displaced birds (up to approximately 12 to 50 per cent in some cases) would be required for these estimates to match the population sizes (as determined by the mean peak counts) recorded on the Development Area and two kilometre buffer, and on the other Forth and Tay wind farm sites. Similarly, extrapolations based on the advised rates of displacement and of mortality amongst displaced birds suggested that the use of the Development Area and two kilometre buffer and of the other Forth and Tay wind farms would have to be unrealistically high amongst some SPA populations to match the adult mortality predicted by SeabORD (with these extrapolations suggesting that more than 100 per cent of the Forth Islands SPA kittiwake, guillemot and puffin populations occurred on at least one of the Forth and Tay wind farms).

103 These comparisons suggest a high level of variability in the predicted effects from the individual-based modelling approaches, and an overestimation of adult mortality in some SPA populations by the SeabORD model (at least as it has been used in the current

assessment). The level of knowledge and understanding of the biology underpinning the effects of displacement and barrier effects on breeding seabird populations, at the current time, may be insufficient to enable the reliable prediction of impacts using these sophisticated modelling approaches. In contrast to the SeabORD model, the matrix approach relies upon qualitative consideration of what is likely to be biologically plausible in terms of rates of displacement and of mortality amongst displaced birds, with there being broad consensus on these rates amongst the range of expertise on which the Scoping Opinion relied. This information is combined with (precautionary) estimates of bird abundance from the actual sites of interest. Given this, it is considered that the matrix approach remains a more suitable method for estimating impacts from displacement and barrier effects at the current time.

Puffin

104 The advised displacement rate for puffin during the breeding period is 60 per cent, with an assumed two per cent mortality rate amongst the displaced birds. Applying these rates to the regional breeding population gives predicted mortality levels from displacement (and barrier effects) which represent a very small increase in the annual mortality rates of both adult and sub-adult birds (0.15 % and 0.06%, respectively – Table 11.15). These small-scale changes suggest that the effect from displacement and barrier effects as a result of the Development -alone is of low magnitude for puffin during the breeding season.

105 To further investigate the predicted impacts of displacement and barrier effects on the regional puffin breeding population, PVA was undertaken using a population model for the Forth Islands SPA puffin population (*Appendix 11E*). The Forth Islands SPA population is estimated to represent 51 per cent of the regional breeding population, although 90 per cent of the impacts from displacement and barrier effects for the Development-alone are apportioned to this population (*Appendix 11B*). Therefore, the PVA will overestimate the impacts to the regional breeding population.

106 The regional breeding population is currently estimated at 87,647 pairs (Table 11.15, *Appendix 11A*), as derived from recent counts of the SPA populations (as provided in the SNH scoping advice, and as obtained from the Seabird Monitoring Programme database[5]), combined with Seabird 2000 census (Mitchell *et al.* 2004) counts for non-SPA colonies with correction factors applied from the trend recorded at the SPA colonies since the Seabird 2000 census (*Appendices 11A and 11B*). The respective population estimates suggest a decline since the Seabird 2000 census (*Appendix 11B*), although the species can be difficult to census accurately and there can be marked fluctuations in counts (e.g. Freeman *et al.* 2014) so that some caution should be applied in interpreting a change based upon counts from only two points in time.

[5] http://jncc.defra.gov.uk/smp/ [Accessed: 02/08/18]

Table 11.15: Predicted impacts from displacement and barrier effects on the key seabird species as estimated using the SNCB matrix approach, with the associated increase in annual mortality rates for the regional populations

Species	Season	Additional mortality (individuals)[1]			Regional population adults (individuals)[3]	Regional population sub-adults (individuals)[3]	Mortality rate		Displacement as % increase in adult mortality	Displacement as % increase in sub-adult mortality
		Total	Adults[2]	Sub-adults[2]			Adults[4]	Sub-adults[4]		
Puffin	Breeding	68	24	42	175,294	285,255	0.094	0.242	0.15 %	0.06 %
Razorbill	Breeding	28	13	14	23,728	24,696	0.091	0.370	0.59 %	0.16 %
	Non-breeding	29	13	15	23,728	24,696	0.091	0.370	0.62 %	0.16 %
Guillemot	Breeding	49	20	28	218,352	280,667	0.074	0.244	0.12 %	0.04 %
	Non-breeding	23	10	13	218,352	280,667	0.074	0.244	0.06 %	0.02 %
Kittiwake	Breeding	23	19	2	51,786	41,113	0.143	0.210	0.26 %	0.02 %

Species	Season	Additional mortality (individuals)[1]			Regional population adults (individuals)[3]	Regional population sub-adults (individuals)[3]	Mortality rate		Displacement as % increase in adult mortality	Displacement as % increase in sub-adult mortality
		Total	Adults[2]	Sub-adults[2]			Adults[4]	Sub-adults[4]		

1. Additional mortality calculated using displacement rates of 60 % for puffin, razorbill and guillemot and 30% for kittiwake, with the mortality rate of displaced birds being 1% for guillemot and razorbill and 2% for puffin and kittiwake.

2. Apportioning of additional mortality to age classes is based on the stable age distribution from population models for guillemot, razorbill and puffin, and on-site survey data for kittiwake. The mortality to adult guillemots, razorbills and puffins is reduced by 7 % and to adult kittiwakes by 10 % to account for the assumed sabbatical rates (as per the Scoping Opinion).

3. Adult breeding populations based on Seabird 2000 database (http://jncc.defra.gov.uk/page-4460) and more recent estimates for the SPA populations provided by SNH, with counts for non-SPA colonies corrected based on the SPA trend. The sub-adult component of the breeding population is estimated from the stable age distribution of a population model. For guillemot and razorbill the regional population is assumed to be unaffected by seasonal period (as advised in the Scoping Opinion).

4. Annual mortality rates are from the appropriate population model for each species (as detailed in *Appendix 11E*) for adults, and after Horswill and Robinson (2015) for sub-adults.

107 The Forth Islands SPA population model used a Bayesian state-space modelling framework, and was adapted from the existing puffin population model developed for the Forth Islands SPA (Freeman *et al.* 2014) but with the underpinning data augmented by further count and productivity estimates collected since 2013. Further details of the model are provided in *Appendix 11E*. Predicted population trends under baseline conditions were projected over both 28 and 53 year timescales. Additional mortality within the PVA was not incorporated until after year three of the projection (giving 25- and 50-year impact periods), to provide a more realistic representation of the likely population status at the time when potential displacement and barrier effect impacts will begin to arise.

108 The additional mortality from displacement and barrier effects was incorporated on the basis of the percentage point change to the annual mortality that this represented (Table 11.16). This additional mortality was apportioned to population age classes according to the stable age distribution from the population model, as adults and sub-adults are not distinguishable during at-sea surveys (*Appendices 11A and 11E*). Thus, 38 per cent of birds were classed as adults but with account also made for an assumed seven per cent of sabbatical birds amongst the adult age class (as advised in the Scoping Opinion).

109 Outputs from the PVA were summarised according to the median predicted population-sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in the section on gannet collision impacts (within the current *Section 11.8.1*).

110 The PVA outputs predict a steeply increasing population under baseline conditions, which would number nearly 290,000 pairs after 25 years of the operational period and over one million pairs after 50 years of the operational period (Table 11.16). An increase of this magnitude is unrealistic and other factors would likely act to limit the growth of the Forth Islands SPA puffin population before it reached such levels (e.g. sufficient suitable areas for nesting burrows). Accepting the limited reliability of the overall projection, the PVA nevertheless indicates minimal population-level effects of the Development-alone displacement and barrier effects, with:

- Virtually no detectable decrease in annual population growth rate (as indicated by a counterfactual value of 1, as taken to three decimal places)
- Virtually no reduction in end-point population-sizes (the impacted population predicted to be 99 per cent of the size of the unimpacted population after 50 years)
- Centile values of 49 which indicate a considerable overlap between the distributions of the impacted and unimpacted populations, suggesting a high likelihood of the impacted population being a similar size to the unimpacted population after 50 years.

Table 11.16: Outputs from the Forth Islands SPA puffin PVA in relation to the estimated additional mortality resulting from Development-alone displacement and barrier effects

Additional mortality scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	286,950 (106,850 – 614,550)	1,002,250 (225,050 – 3,043,050)	1.000	1.000	1.000	50	50
Development-alone displacement/barrier effects (based upon percentage point increases of 0.024 and 0.026 to the annual mortality of the adult and sub-adult age classes, respectively)[1]	285,100 (106,150 – 610,550)	989,450 (221,700 – 2,999,650)	0.993	0.986	1.000	50	49

1. Ratio of adult to sub-adult additional mortality is based on the stable age distribution of the Forth Islands SPA population model (*Appendix 11E*), and also accounts for an assumed 7 % sabbatical rate amongst the adults (as per the Scoping Opinion).
2. The value of this metric does not vary according to the length of the projection period.

111 The PVA for puffin predicts that the impacts from the Development-alone breeding season displacement and barrier effects under the scenario set out in the Scoping Opinion (60 per cent displacement and two per cent mortality of displaced birds) will have virtually no effect on the population growth rate and population-size over 25 and 50 year timescales, with the population predicted to continue to increase irrespective of the Development-alone impacts (*Appendix 11E*).

112 Based upon these predictions, the assessment considers a negligible magnitude displacement impact on a high sensitivity receptor. The impact is therefore evaluated as minor/moderate and ecologically non-significant (Table 11.9).

113 Applying scientific judgement in relation to the very small percentage increase in annual mortality rates for all age classes during the breeding season, and the outcome of the population model, the impact is considered to be most appropriately categorised as minor and ecologically non-significant.

Razorbill

114 Displacement and barrier effects are assumed to affect the regional breeding population of razorbills during both the breeding and non-breeding periods, which follows the advice of the Scoping Opinion. For both seasonal periods, the advised displacement rate for razorbill during the breeding period is 60 per cent, with an assumed one per cent mortality rate amongst the displaced birds. It is also assumed that the regional population against which the impacts are assessed during the non-breeding period is as for the breeding period (following the advice of the Scoping Opinion). Available information indicates that birds from UK colonies tend to remain close to their colonies in late summer and early autumn and then move southwards. However, too few birds have been ringed from east Britain to indicate their movement pattern in detail, but it is likely that the wintering population will be augmented by birds from more northern breeding colonies (Furness 2015, *Appendix 11B*). Therefore, the assessment of impacts during the non-breeding period is precautionary in this respect.

115 The mean peak population estimates for razorbill were similar between the two seasonal periods (at 4,671 and 4,905 for the breeding and non-breeding periods, respectively – *Appendix 11D*), resulting in similar estimates of the additional mortality in each season (Table 11.15). These predicted mortality levels from displacement (and barrier effects) represent a small increase in the annual mortality rates of both adult and sub-adult birds during each of the two seasonal periods.

116 For sub-adults, the estimated percentage increase in the annual mortality rate is 0.16 per cent for each seasonal period, so that over the full annual period there is an estimated increase of 0.32 per cent (Table 11.15). The estimated increase to the annual mortality rate of the adults is 0.59 and 0.62 per cent for the breeding and non-breeding periods, respectively, so that over the full annual period the increase is in excess of one per cent (Table 11.15).

117 To further investigate the predicted impacts of displacement and barrier effects on the regional razorbill breeding population, PVA was undertaken using a population model which was based upon the demographic and population trend data from the two razorbill SPA populations which are considered to have connectivity to the Development Area and two kilometre buffer (*Appendix 11E*). These SPA populations are estimated to represent 75 per cent of the regional breeding population, although only 63 per cent of the impacts from displacement and barrier effects for the Development-alone are apportioned to these populations (*Appendix 11B*). On this basis, the PVA will underestimate the impacts from the Development-alone to the regional population by a small amount.

118 The regional breeding population is currently estimated at 11,864 pairs (Table 11.15, *Appendix 11A*), as derived from recent counts of the SPA populations (as provided in the SNH scoping advice), combined with Seabird 2000 census (Mitchell *et al.* 2004) counts for non-SPA colonies with correction factors applied from the trend recorded at the SPA colonies since the Seabird 2000 census (*Appendices 11A and 11B*). The respective population estimates for the SPA colonies suggest a 20 per cent increase in numbers since the Seabird 2000 census (*Appendix 11B*).

119 The regional SPA razorbill population model was based on a Bayesian state-space modelling framework, and was adapted from the existing razorbill population models developed for the SPA populations in this region (Freeman *et al.* 2014, Jitlal *et al.* 2017). The regional SPA model was produced by summing the projections for the population models for the two razorbill SPA populations. Further details are provided in *Appendix 11E*. Predicted population trends under baseline conditions were projected over both 28 and 53 year timescales. Additional mortality within the PVA was not incorporated until after year three of the projection (giving 25 and 50-year impact periods), to provide a more realistic representation of the likely population status at the time when potential displacement and barrier effect impacts will begin to arise.

120 The additional mortality from displacement and barrier effects was incorporated into the PVAs for each of the two SPA populations on the basis of the percentage point change to the annual mortality that this represented. This additional mortality was apportioned to population age classes according to the stable age distribution from the population model, as adults and sub-adults are not distinguishable during at-sea surveys (*Appendices 11A and 11E*). Thus, 49 per cent of birds were classed as adults but with account also made for an assumed seven per cent of sabbatical birds amongst the adult age class (as advised in the Scoping Opinion).

121 Outputs from the PVA were summarised according to the median predicted population-sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in the section on gannet collision impacts (within the current *Section 11.8.1*).

122 The PVA outputs predict an increasing population under baseline conditions, which (from an initial predicted starting population of 8,500 pairs) would number 15,600 pairs after 25 years of the operational period and 28,450 pairs after 50 years of the operational period (Table

11.17). The population is also predicted to increase with the impacts from the Development-alone displacement and barrier effects incorporated, and the PVA indicates small population-level effects, with:

- Virtually no detectable decrease in annual population growth rate (as indicated by a counterfactual value of 0.999)
- Small reductions in end-point population sizes (the impacted population predicted to be 94 per cent of the size of the unimpacted population after 50 years)
- Centile values of 46 and 45 for the 25- and 50-year projections, respectively, which indicate a considerable overlap between the distributions of the impacted and unimpacted populations, suggesting a reasonable likelihood of the impacted population being similar in size to the unimpacted population after 50 years.

123 Although the assessment of displacement suggests that there would be an increase of more than one percent in the annual mortality rate of the regional breeding population, the PVA predicts that the impacts from the Development-alone displacement and barrier effects under the scenario set out in the Scoping Opinion (60% displacement and 1% mortality of displaced birds) will have a very small effect on the population growth rate and population size over periods of 25 and 50 years, with the population predicted to increase irrespective of the Development-alone impacts (*Appendix 11E*).

124 Based upon these predictions, the assessment indicates that the magnitude of the displacement impact on a high sensitivity receptor is low. The impact of displacement throughout the year on razorbill is therefore evaluated as moderate and ecologically non-significant (Table 11.9).

125 Based on the small changes between the impacted and unimpacted population as indicated by the PVA outputs, it is considered that the impact is more appropriately evaluated as minor and ecologically non-significant.

Table 11.17: Outputs from the regional-SPA razorbill PVA in relation to the estimated additional mortality resulting from Development-alone displacement and barrier effects

Additional mortality scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	15,600 (9,950 – 24,250)	28,450 (13,400 – 61,950)	1.000	1.000	1.000	50	50
Development-alone displacement/barrier effects (based upon percentage point increases to the annual mortality of the adult and sub-adult age classes in each of the individual razorbill SPA PVAs)[1]	15,200 (9,700 – 23,600)	26,700 (12,750 – 58,050)	0.972	0.945	0.999	46	45

1. Details of the individual razorbill SPA PVAs are presented in *Appendix 11E*. The ratio of adult to sub-adult additional mortality is based on the stable age distribution of the regional-SPA population model (*Appendix 11E*), and also accounts for an assumed 7 % sabbatical rate amongst the adults (as per the Scoping Opinion).
2. The value of this metric does not vary according to the length of the projection period.

Guillemot

126 As for razorbill, displacement and barrier effects are assumed to affect the regional breeding population of guillemots during both the breeding and non-breeding periods, which follows the advice of the Scoping Opinion. For both seasonal periods, the advised displacement rate for guillemot during the breeding period is 60 per cent, with an assumed one per cent mortality rate amongst the displaced birds. It is also assumed that the regional population against which the impacts are assessed during the non-breeding period is as for the breeding period (following the advice of the Scoping Opinion). However, some birds from the regional breeding population are likely to spend at least part of the winter further afield in the North Sea, whilst it is also likely that the wintering population will be augmented by birds from more northern breeding colonies (Furness 2015, *Appendix 11B*). Therefore, the assessment of impacts during the non-breeding period is precautionary in this respect.

127 The mean peak population estimates for guillemot were higher in the breeding period (at 8,184 birds compared with 3,912 for the non-breeding period – *Appendix 11D*), resulting in higher estimates of additional mortality during the breeding period (Table 11.15). These predicted mortality levels from displacement (and barrier effects) represent small increases in the annual mortality rates of both adult and sub-adult birds during each of the two seasonal periods.

128 For sub-adults, the estimated percentage increase in the annual mortality rate is 0.04 per cent or less for each seasonal period, with the estimated increase over the full annual period being 0.06 per cent (Table 11.15). The estimated increase to the annual mortality rate of the adults is 0.12 and 0.06 per cent for the breeding and non-breeding periods, respectively, so that over the full annual period the increase is well below 0.5 per cent (Table 11.15).

129 To further investigate the predicted impacts of displacement and barrier effects on the regional guillemot breeding population, PVA was undertaken using a population model which was based upon the demographic and population trend data from the four guillemot SPA populations which are considered to have connectivity to the Development Area and two kilometre buffer (*Appendix 11E*). These SPA populations are estimated to represent 95 per cent of the regional breeding population, with 91 per cent of the impacts from displacement and barrier effects for the Development-alone apportioned to these populations (*Appendix 11B*). Therefore, this PVA effectively represents the entire regional breeding population.

130 The regional breeding population is currently estimated at 109,176 pairs (Table 11.15, *Appendix 11A*), as derived from recent counts of the SPA populations (as provided in the SNH scoping advice), combined with Seabird 2000 census (Mitchell *et al.* 2004) counts for non-SPA colonies with correction factors applied from the trend recorded at the SPA colonies since the Seabird 2000 census (*Appendices 11A and 11B*). The respective population estimates for the SPA colonies suggest a 13 per cent decline in numbers since the Seabird 2000 census (*Appendix 11B*).

131 The regional SPA guillemot population model was based on a Bayesian state-space modelling framework, and was adapted from the existing guillemot population models developed for the SPA populations in this region (Freeman *et al.* 2014, Jitlal *et al.* 2017). The regional SPA model was produced by summing the projections for the population models for the four guillemot SPA populations. Further details are provided in *Appendix 11E*. Predicted population trends under baseline conditions were projected over both 28 and 53 year timescales. Additional mortality within the PVA was not incorporated until after year three of the projection (giving 25 and 50-year impact periods), to provide a more realistic representation of the likely population status at the time when potential displacement and barrier effect impacts will begin to arise.

132 The additional mortality from displacement and barrier effects was incorporated into the PVAs for each of the four SPA populations on the basis of the percentage point change to the annual mortality that this represented. This additional mortality was apportioned to population age classes according to the stable age distribution from the population model, as adults and sub-adults are not distinguishable during at-sea surveys (*Appendices 11A and 11E*). Thus, 44 per cent of birds were classed as adults but with account also made for an assumed seven per cent of sabbatical birds amongst the adult age class (as advised in the Scoping Opinion).

133 Outputs from the PVA were summarised according to the median predicted population-sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in the section on gannet collision impacts (within the current *Section 11.8.1*).

134 Despite the decline in numbers recorded since the Seabird 2000 census, the longer-term trend in the region has been for a slight increase in numbers overall, which is reflected in the model projections of an increasing population under baseline conditions (*Appendix 11E*). Thus, from an initial predicted starting population of 115,950 pairs, the projection is for 163,200 pairs after 25 years of the operational period and 243,650 pairs after 50 years of the operational period (Table 11.18). The population is also predicted to increase with the impacts from the Development-alone displacement and barrier effects incorporated, and the PVA indicates very small population-level effects, with:

- Virtually no detectable decrease in annual population growth rate (as indicated by a counterfactual value of 1.000, as taken to three decimal places)
- Virtually no reduction in end-point population sizes (the impacted population predicted to be 99 per cent of the size of the unimpacted population after 50 years)
- Centile values of 49 which indicate a considerable overlap between the distributions of the impacted and unimpacted populations, suggesting a high likelihood of the impacted population being similar in size to the unimpacted population after 50 years.

135 Based on predicted changes to mortality rates and the outputs from the regional-SPA population model, the PVA predicts that impacts from the Development-alone displacement and barrier effects under the scenario set out in the Scoping Opinion (60% displacement and

1% mortality of displaced birds) will have virtually no effect on the population growth rate and population size over 25- and 50-year timescales, with the population predicted to continue to increase irrespective of the Development-alone impacts (*Appendix 11E*).

136 Based upon these predictions, the assessment indicates that the magnitude of the displacement impact on a high sensitivity receptor is low. The impact is therefore evaluated as moderate and ecologically non-significant (Table 11.9).

137 Based on the very small predicted changes in annual mortality rates of all age classes, and very small predicted differences between the impacted and unimpacted populations, it is considered that the impact is more appropriately evaluated as minor and ecologically non-significant.

Table 11.18: Outputs from the regional-SPA guillemot PVA in relation to the estimated additional mortality resulting from Development-alone displacement and barrier effects

Additional mortality scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	163,200 (129,150 – 205,550)	243,650 (163,400 – 369,700)	1.000	1.000	1.000	50	50
Development-alone displacement/barrier effects (based upon percentage point increases to the annual mortality of the adult and sub-adult age classes in each of the individual guillemot SPA PVAs)[1]	162,800 (128,100 – 204,650)	241,900 (162,750 – 365,100)	0.996	0.994	1.000	49	49

1. Details of the individual guillemot SPA PVAs are presented in *Appendix 11E*. The ratio of adult to sub-adult additional mortality is based on the stable age distribution of the regional-SPA population model (*Appendix 11E*), and also accounts for an assumed 7 % sabbatical rate amongst the adults (as per the Scoping Opinion).
2. The value of this metric does not vary according to the length of the projection period.

Kittiwake

138 The advised displacement rate for kittiwake during the breeding period is 30 per cent, with an assumed two per cent mortality rate amongst the displaced birds. Applying these rates to the regional breeding population gives predicted mortality levels from displacement (and barrier effects) which represent small increases to the annual mortality rates of both the adult and sub-adult birds (0.26 per cent and 0.02 per cent, respectively – Table 11.15). Changes of this magnitude suggest that the impact from the Development-alone displacement and barrier effects is of low magnitude for kittiwake.

139 No PVA was undertaken to investigate the population-level impacts from the Development-alone displacement and barrier effects. However, the additional mortality predicted from the Development-alone displacement and barrier effects is lower than for Development-alone collisions, for which the estimated increase in the annual mortality rate of adults was 0.45 per cent (at least as determined by option 2 of the CRM - Table 11.12). As detailed above, the outputs from the PVA investigating the impacts from Development-alone collision mortality on the regional breeding kittiwake population found the effects to be small. Collision mortality from the Development-alone was evaluated as a low magnitude impact, and on this basis the same conclusion is applied to the Development-alone displacement and barrier effects.

140 Thus, based upon these predictions, the very small increases in adult and sub-adult mortality rates from displacement and barrier effects from the Inch Cape Wind Farm, and by comparison with a PVA which predicted small population-level impacts for collision mortality (for which estimated adult mortality was higher than from displacement/barrier effects), displacement and barrier effects are considered to be a low magnitude impact for kittiwake and evaluated as a moderate impact on the regional population (Table 11.9). Given the small predicted changes to mortality rates and population trajectory, the impact is concluded to be minor and ecologically non-significant.

141 This assessment is in the context of a regional population undergoing a long-term decline which is predicted to continue during the operational life of the Inch Cape Wind Farm. However, the evidence indicates that the small levels of predicted mortality due to displacement and barrier effects from the Wind Farm will effectively not contribute to accelerating the rate, or increasing the magnitude, of this ongoing decline. Displacement and barrier effects from the Inch Cape Wind Farm would also not be predicted to impede population recovery, should environmental conditions become more favourable for kittiwakes.

Combined impacts from collisions and displacement/barrier effects

Kittiwake

142 Of the key receptors for the assessment, kittiwake is the one species potentially affected by both displacement/barrier effects and collision risk (Table 11.6). The potential for combined effects is considered below.

143 The combined effects of collisions and displacement (and barrier effects) were considered, on the assumption that these effects are additive (although, in reality, displaced birds will not be subject to collisions). The effects of each of these impacts on the baseline annual mortality rates of both the adult and sub-adult age classes are shown in Tables 11.12 and 11.156 above, and when combined the increase to the mortality rate remains below one per cent for the adults (and is an order of magnitude lower for the sub-adults).

144 The regional SPA PVA for kittiwakes (see Collisions section of *Section 11.8.1* for kittiwake) was used to further investigate the combined Development-alone impacts from collisions and displacement/barrier effects. As before, this assumed the option 2 collision estimates for the design of 40 WTGs with rotor diameter 250 metres, and a scenario in which 30 per cent of kittiwakes were displaced during the breeding period with a two per cent mortality rate amongst these displaced birds. As outlined above, the three SPA populations on which the PVA is based are estimated to account for 68 per cent of the regional breeding population but only 61 per cent of the estimated additional mortality from the impacts is apportioned to these populations (*Appendix 11B*). Therefore, the PVA will underestimate the impacts to the regional population by a small amount.

145 Outputs from the PVA were summarised (at timescales of 25 and 50 years of operation) according to the median predicted population sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in the section on Development-alone gannet collision impacts (within the current *Section 11.8.1*).

146 As detailed above, the PVA outputs predict a continued steep decline in the regional breeding population of kittiwakes under baseline conditions (Table 11.19, *Appendix 11E*), but the combined impacts of the Development-alone collisions and displacement/barrier effects are considered to be minimal, with:

- Virtually no detectable decrease in annual population growth rate (as indicated by a counterfactual value of 0.999);
- Small reductions in end-point population sizes (the impacted population predicted to 96 per cent of the size of the unimpacted population after 50 years); and
- Centile values of 48 which indicate a considerable overlap between the distributions of the impacted and unimpacted populations, suggesting a high likelihood of the impacted population being a similar size to the unimpacted population after 50 years.

147 For the reasons outlined earlier in relation to the assessment for collision impacts, the collision estimates used in the PVA are likely to be highly precautionary (being based upon the option 2 CRM). However, even using these precautionary collision estimates, the combined collision and displacement mortality from the Development-alone is evaluated as a low magnitude impact (Table 11.8) for kittiwake, reflecting the predicted small effect on the regional population. Application of the impact matrix (Table 11.9) indicates that this equates to a moderate and ecologically non-significant impact for a receptor of high sensitivity. This assessment is in the context of a regional population undergoing a long-term

decline which is predicted to continue during the operational life of the Development. However, the evidence indicates that the small levels of predicted mortality due to the Development-alone collisions and displacement/barrier effects will effectively not contribute to accelerating the rate, or increasing the magnitude, of this ongoing decline. Collisions with the Inch Cape Wind Farm are also not predicted to impede population recovery, should environmental conditions become more favourable for kittiwakes.

148 Based on the outcome of the PVA, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of collision risk on kittiwake. Applying scientific judgement to the evidence and assessment process, it is considered that this impact is more appropriately categorised as minor and ecologically non-significant.

Table 11.19: Outputs from the regional-SPA kittiwake PVA in relation to estimated additional mortality resulting from the combined Development-alone impacts of collisions and displacement and barrier effects for 25-year and 50-year projections

Additional mortality Scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	7,150 (3,150 – 18,000)	3,700 (900 – 19,100)	1.000	1.000	1.000	50	50
Development-alone combined collisions and displacement (based upon the percentage point increases to the annual mortality of the adult and sub-adult age classes in each of the individual kittiwake SPA PVAs)[1]	7,000 (3,100 – 17,650)	3,550 (900 – 18,400)	0.980	0.961	0.999	48	48

1. Details of the individual kittiwake SPA PVAs are presented in *Appendix 11E*. The ratio of adult to sub-adult additional mortality is based on the age distribution as determined from at-sea survey data from the Survey Area (*Appendix 11A*), and also accounts for an assumed 10 % sabbatical rate amongst the adults during the breeding period (as per the Scoping Opinion).

2. The value of this metric does not vary according to the length of the projection period.

11.9 Impact Assessment - Offshore Export Cable Corridor

11.9.1 Construction (and decommissioning)

Direct disturbance/displacement

149 Under the worst-case scenario (Table 11.5) two (AC) Export Cables will be laid in separate trenches through the sub-tidal areas between the OSPs and MHWS at the landfall site at Cockenzie, over a total distance of about 83 kilometres. Details of separation distances and the width of the affected area are given in Table 11.5, with the total area within which the works will occur over the nine-month construction period being approximately 20.75 kilometres squared under the worst-case scenario.

150 Export cables will be installed using floating Cable Installation Vessels (CIV), with the worst case involving one vessel and 24-hour operations. These are usually self-propelled but may be towed or assisted. These vessels store and transport the cables and feed them to the lay system which lowers the cable onto the seabed in a controlled manner. There would be an estimated 30 vessel movements per cable during the installation period.

151 The predicted construction period of nine months means that disturbance will be short-term, although works will overlap with both the breeding and non-breeding seasons for birds. Disturbance would not take place simultaneously over the entire length of the Offshore Export Cable Corridor, but at any one time would be limited to the vicinity of activities around CIVs. These would move slowly as cable installation takes place and remain static for long periods. Their presence would represent only a fractional increase in existing shipping traffic levels (*Chapter 15: Shipping and Navigation*). Cable laying activities emit low levels of noise, both above and below water. Visual disturbance above the sea surface would be limited to vessels and activities on board, and below water to areas in close proximity to the cable-laying tools and the cable itself.

152 Bird species differ in their responses to anthropogenic disturbance. A detailed consideration of the sensitivity of each ornithological receptor (i.e. each qualifying species of the Outer Firth of Forth and At Andrews Bay Complex pSPA) to disturbance from boat movements and associated activities during the laying of the export cables is included in the HRA (ICOL, 2018a). This considers information in the scientific literature and expert opinion (in particular, reviews by Furness *et al.* 2013, Furness and Wade, 2012 and Garthe and Hüppop, 2004). For all pSPA qualifying species, even those which are considered most sensitive to disturbance, the short-term presence of a slow moving CIV and associated activities is considered a very small effect, which would result only in the displacement of birds from the near vicinity of the vessel. In the context of wider shipping activities in the outer Firth of Forth, the increase in disturbance is predicted to be so small as to be undetectable. Therefore, disturbance is identified as an impact of negligible magnitude (Table 11.8) on ornithological receptors of high sensitivity, resulting in a minor/moderate (Table 11.9) and non-significant impact.

Indirect disturbance of habitats/prey

153 During the laying of the Offshore Export Cable there would be disturbance to subtidal habitats along the length of the cable corridor, associated with the digging and backfill of trenches on the sea floor for the cables (using various techniques and equipment, including ploughs, jetting and/or cutting, as detailed in *Chapter 7*). Cable protection would be required in some areas (estimated as up to 20 per cent of each 83 kilometre cable length - Table 11.5), involving the use of rock placement, concrete mattresses and/or sand/grout bags for cable protection.

154 Disturbance to sub-tidal habitats could affect foraging habitat and the availability and abundance of prey for ornithological receptors. The total sub-tidal area of seabed that will be disturbed during the installation of the Offshore Export Cable is estimated at 2.5 kilometres squared (Table 11.5). This is a very small area relative to the area of the outer Forth Estuary (and equivalent to less than 0.1 per cent of the area of the Outer Firth of Forth and St Andrews Bay Complex pSPA). Furthermore, such disturbance would not affect the whole area at once. Rather, at any given time during the nine-month construction period it would be limited to the area where cable laying works are ongoing, and recovery of habitats would be expected to begin as soon as cable laying was completed.

155 Cable laying operations would likely result in disturbance, displacement and mortality of benthic species living on and in sediments in the areas where the cable is laid. Such species would include bivalve molluscs (shellfish), annelid worms, and other marine invertebrates, which are prey species for several of the ornithological receptors. However, as described above, the areas affected would be very small in relation to the available seabed habitat, and any losses of benthic prey species are likely to be so small as to be undetectable in relation to the sizes of local populations. Fish are expected to be able to swim away from cable laying activities and areas of seabed disturbed during cable-laying operations, and the small-scale disturbance of habitat would not be expected to cause any detectable changes in the abundance and distribution of fish in the vicinity of the Offshore Export Cable Corridor. Thus, no detectable changes are predicted in the prey availability for birds in this area.

156 Recovery of disturbed seabed areas would be expected to occur in the short to medium term (and based on a range of studies of dredged areas, this might be expected to begin within one to two months and take one to three years in an estuarine environment (UK Marine SACs Project, 2018).

157 Given the very small scale, and temporary, nature of works, and the expected recovery of habitats in the short term, disturbance of habitat and/or prey for ornithological receptors is identified as an impact of negligible magnitude (Table 11.8). It is assessed as a minor/moderate (Table 11.9) and non-significant impact.

11.9.2 Operation and maintenance

Direct disturbance/displacement

158 Based on predictions of very small-scale repair requirements for offshore cables (about 10% of the export cable length for each cable over the operational life of the Wind Farm), vessel and other activities associated with cable repairs and/or reburial would represent very infrequent, temporary and localised sources of disturbance.

159 In the context of wider shipping activities in the outer Firth of Forth, the potential disturbance or displacement to ornithological receptors from operation and maintenance of the Offshore Export Cable is considered to be trivial. The effect magnitude is considered to be negligible (Table 11.8), resulting in a minor/moderate (Table 11.9) and non-significant impact.

Indirect disturbance of habitats/prey

160 Temporary habitat disturbance from operation and maintenance of the Offshore Export Cable is estimated to affect a maximum of 0.0025 kilometre squared of seabed per year (Table 11.5). This is extremely small in relation to the area of the outer Forth Estuary (and equivalent to be less than 0.0001 per cent of the area of the Outer Firth of Forth and St Andrews Bay Complex pSPA). No detectable effects of loss of habitat for prey species or depletion of prey resource are predicted. This is identified as an impact of negligible magnitude (Table 11.8) resulting in a moderate/minor (Table 11.9) and non-significant impact on ornithological receptors of high sensitivity.

Habitat loss

161 This impact is considered for the operational phase only, as habitat loss during construction is considered above as part of the disturbance to habitats during cable laying activities (construction habitat disturbance would include temporary disturbance of habitats that subsequently recover, as well as disturbance resulting in permanent loss of habitats which do not recover to their former state).

162 The total area of original seabed habitat that will be lost due to the presence of the Offshore Export Cable is estimated in the worst-case as 0.2 kilometre squared (resulting from protection of areas six metres wide over 20 per cent of each 83-kilometre cable - Table 11.5). This is very small in relation to the area of the outer Forth Estuary (and equivalent to less than 0.01 per cent of the area of the Outer Firth of Forth and St Andrews Bay Complex pSPA). No detectable effects of loss of habitat for prey species or depletion of prey resource are predicted. This is identified as an impact of negligible magnitude (Table 11.8) resulting in a moderate/minor (Table 11.9) and non-significant impact on ornithological receptors of high sensitivity.

11.10 Impact Assessment - Development and Onshore Transmission Works

11.10.1 Cumulative effects of the Development and OnTW

163 This section considers whether different components of the Development and OnTW (i.e. the Wind Farm, OfTW and OnTW) may have cumulative or combined impacts on ornithological receptors. This could happen where activities occur in sufficiently close proximity to cause cumulative or combined impacts, where the Development Area joins the Offshore Export Cable Corridor, and where the latter joins the OnTW (combined impacts of activities at the Development Area and OnTW would not be expected due to the large distance between these two Development elements).

164 The potential for intra-project cumulative effects could occur during construction (and decommissioning) or operation and maintenance, in relation to disturbance/displacement, indirect effects from disturbance of habitats and prey, and habitat loss.

165 There is no scope for intra-project cumulative impacts of collision or displacement and barrier effects, which are associated with the Wind farm, because neither the OfTW nor the OnTW cause any such effects to ornithological receptors.

11.10.2 Construction (and decommissioning)

<u>Combined direct disturbance – Development Area and Offshore Export Cable Corridor</u>

166 Cumulative or combined direct disturbance impacts on ornithological receptors from construction activities within the Development Area and adjacent Offshore Export Cable Corridor are predicted to be of negligible magnitude (Table 11.8). This is because the spatial overlap between construction activities in the Development Area and the Offshore Export Cable Corridor is relatively small. It would extend to approximately two kilometres along the Offshore Export Cable Corridor at most (based on the maximum disturbance distance of about two kilometres for the most sensitive ornithological receptors, and no more than 500 metres for most bird species identified as ornithological receptors (see *Section 4.6* of the HRA – ICOL, 2018a). The presence of a CIV travelling at low speed and with relatively few associated vessel movements is not predicted to cause any detectable additional disturbance effects. In addition, the overlap of construction activities would be a short term and temporary effect, reducing as the cable laying progresses away from the Development Area (with cable laying rates expected to be 300 to 500 metres per hour).

167 The potential impact of combined disturbance from construction works in the Development Area and Offshore Export Cable Corridor is assessed as minor/moderate (a negligible impact on ornithological receptors of high sensitivity - Table 11.9) and non-significant.

<u>Combined direct disturbance –Offshore Export Cable Corridor and OnTW</u>

168 There is the potential for combined disturbance effects from the laying of the Offshore Export Cable in subtidal areas close to the landfall, and intertidal and onshore works associated with the OnTW at Cockenzie on the East Lothian coast. In terms of spatial

overlap, such combined effects would be likely only where the Offshore Export Cable is being installed within two kilometres of the coast, which is the maximum disturbance distance for the ornithological receptors most sensitive to disturbance from boats (see above, and as discussed in detail in *Section 4.6* of the HRA - ICOL, 2018a). At most, the overlap of activities would be temporary and short term, limited to the time required to lay the cables from about two kilometres from the shore to the landfall. The presence of a CIV travelling at low speed and with relatively few associated vessel movements is predicted to cause very little additional disturbance to ornithological receptors (qualifying species of the Outer Firth of Forth and St Andrews Bay pSPA) alongside the onshore works. Disturbance effects on ornithological receptors associated with the OnTW are themselves described as negligible (*Chapter 6: Ecology* – ICOL, 2018b).

169 The potential impact of combined disturbance from construction works in the Offshore Export Cable Corridor and the OnTW is assessed as minor/moderate (a negligible impact on ornithological receptors of high sensitivity, Table 11.9) and non-significant.

Combined indirect disturbance via habitats and prey– Development Area and Offshore Export Cable Corridor

170 Within the Offshore Export Cable Corridor, indirect disturbance of seabed habitats and prey species for ornithological receptors during construction has been identified as an impact of negligible magnitude (see *Section 11.8.2* above). For the Development Area, indirect impacts of habitat disturbance and piling via prey species have been scoped out of the assessment (Table 11.3). The potential for combined effects would apply only in areas of the Offshore Export Cable Corridor which are adjacent to the Development Area, and any combined effects would be temporary and localised. The combined indirect disturbance of habitats and prey is identified as a negligible magnitude (Table 11.8), giving a moderate/minor (Table 11.9) and non-significant impact.

Combined indirect disturbance via habitats and prey–Offshore Export Cable Corridor and OnTW

171 As above, within the Offshore Export Cable Corridor, indirect disturbance of seabed habitats and prey species for ornithological receptors during construction (extending from the Development Area to MHWS at the Offshore Export Cable landfall) has been identified as an impact of negligible magnitude (*Section 11.9*). For the OnTW, indirect impacts of habitat disturbance within the intertidal area (from Mean Low Water Springs to MHWS) have also been identified as negligible (*Chapter 6: Ecology* - ICOL, 2018b). The potential for combined effects would apply only in areas of the Offshore Export Cable Corridor which are adjacent to the OnTW, and any combined effects would be temporary and localised. The combined indirect disturbance of habitats and prey is identified as a negligible (Table 11.8), moderate/minor (Table 11.9) and non-significant impact on ornithological receptors.

11.10.3 Operation and maintenance

Combined direct disturbance – Development Area and Offshore Export Cable Corridor

172 Based on predictions of very small-scale repair requirements for offshore cables (about 10% of the export cable length for each cable over the operational life of the Wind Farm), vessel and other activities associated with cable repairs would represent very infrequent, temporary and localised sources of disturbance. For the Development Area, direct disturbance of ornithological receptors during operation and maintenance activities has been scoped out of the assessment (Table 11.3). The potential for combined effects would apply only in areas of the Offshore Export Cable Corridor which are adjacent to the Development Area. Given the low frequency of activities predicted for the maintenance of the export cables, the likelihood of simultaneous operation and maintenance activities in the Development Area and adjacent areas of the Offshore Export Cable Corridor is considered very low. Any combined activities would represent temporary and localised sources of disturbance. The combined impact is identified as a negligible magnitude (Table 11.8), giving moderate/minor (Table 11.9) and non-significant impact.

Combined direct disturbance – Development Area and OnTW

173 Temporary habitat disturbance from operation and maintenance of the export cables is estimated to affect a maximum of 0.0025 kilometres squared of seabed per year (Table 11.5). This is extremely small in relation to the area of the outer Forth Estuary (and equivalent to less than 0.0001 per cent of the area of the Outer Firth of Forth and St Andrews Bay Complex pSPA). Disturbance impacts associated with operation and maintenance of the OnTW are predicted to be occasional and identified as of negligible magnitude (*Chapter 6: Ecology* - ICOL, 2018b).

174 The potential for combined effects would apply only in areas of the Offshore Export Cable Corridor which are adjacent to the cable landfall and OnTW. Given the low frequency of activities predicted for the export cables and the OnTW, the likelihood of simultaneous operation and maintenance activities is considered very low. Any combined activities would represent temporary and localised sources of disturbance. The combined impact is identified as a negligible magnitude (Table 11.8), giving a moderate/minor (Table 11.9) and non-significant impact.

Combined habitat loss – Development Area, Offshore Export Cable Corridor and OnTW

175 This impact is considered for the operational phase only, as habitat loss during construction is considered as part of the disturbance to habitats during construction activities (construction habitat disturbance would include temporary disturbance of habitats that subsequently recover, as well as disturbance resulting in permanent loss of habitats which do not recover to their former state).

176 The total area of original seabed habitat that will be lost due to the presence of the Offshore Export Cable is estimated in the worst-case as 0.2 kilometres squared (resulting from protection of areas six metres wide over 20 per cent of each 83-kilometre cable - Table

11.5). This is very small in relation to the area of the outer Forth Estuary (and equivalent to less than 0.01 per cent of the area of the Outer Firth of Forth and St Andrews Bay Complex pSPA).

177 Direct loss of seabed habitats within the Development Area, due to the presence of the Inch Cape Wind Farm and OSPs, will also be extremely small, and has been scoped out of the ornithological assessment (Table 11.3).

178 There will be no subtidal habitat loss associated with the OnTW, and none of the intertidal habitat at the landfall of the Offshore Export Cable is expected to be permanently lost (*Chapter 6: Ecology* – ICOL, 2018b).

179 The combined effect of habitat loss due to different elements of the Development is considered an impact of negligible magnitude (Table 11.8), resulting in a moderate/minor (Table 11.9) and non-significant impact on ornithological receptors of high sensitivity

11.11 Cumulative Impact Assessment

11.11.1 Scope

180 This section considers the cumulative impacts of the Development together with other projects and proposed projects, which are within the mean maximum foraging range of the main colonies which contribute to the regional populations of the key ornithological receptors. In relation to the impacts from collisions and displacement and barrier effects, which are associated with the operation and maintenance phase, the scope of the assessment is summarised in Table 11.20 below.

181 Consideration has also been given to the potential for cumulative effects of the Inch Cape Offshore Export Cable with those arising from other projects. The construction (and decommissioning) and operation/maintenance of the Export Cable Corridor will not contribute to collision risk or displacement/barrier effects. All potential impacts on ornithological receptors associated with the Inch Cape Offshore Export Cable have been identified as of negligible magnitude, both when considered alone (*Section 11.9*) and cumulatively with other elements of the Development (*Section 11.10*). Given this, and in the context of current shipping and other ongoing activities in the Outer Firth of Forth, there is considered to be no potential for cumulative impacts of ecological significance with other existing and proposed developments in relation to direct disturbance/displacement, indirect disturbance of habitats/prey or habitat loss, during either the construction (and decommissioning) or the operation and maintenance phases of the Development. As outlined above, these conclusions also apply to the OnTW.

Table11.20: Scope of cumulative assessment for the regional breeding population of the six key seabird species in relation to impacts from collisions and displacement and barrier effects

Species	Impact	Seasonal period over which assessment undertaken	Scope
Gannet	Collision[1]	Breeding and autumn and spring passage periods[2]	Quantitative consideration of the other Forth and Tay wind farms (Neart na Gaoithe and Seagreen Alpha and Bravo), using the worst-case scenario from the 2014 and 2017 designs[3] (which produce different collision estimates). Qualitative consideration given to other wind farms within mean maximum foraging range of the main colonies contributing to the regional population.
Kittiwake	Collision[1] and displacement/ barrier effects	Breeding and autumn and spring passage periods[2]	
Herring gull	Collision[1]	Breeding and non-breeding	
Puffin	Displacement/ barrier effects	Breeding	Quantitative consideration of other Forth and Tay wind farms (Neart na Gaoithe and Seagreen Alpha and Bravo), plus qualitative consideration given to other wind farms within mean maximum foraging range of the main colonies contributing to the regional population. The 2014 and 2017 designs do not differ with respect to displacement and barrier effect estimates.
Razorbill	Displacement/ barrier effects	Breeding and non-breeding	
Guillemot	Displacement/ barrier effects	Breeding and non-breeding	

1. Collision estimates for the CIA are based upon options 2 or 3 (for herring gull) of the CRM only, because site-specific data are not readily available for the other Forth and Tay wind farms.
2. As outlined in *Section 11.7.2*, only the breeding period collision estimates are presented in the CIA but the PVAs incorporate both the breeding and passage period collisions. The potential effects during the autumn and spring passage periods are considered fully within the HRA for the SPA populations of these two species.
3. The 2014 designs for these wind farms are as consented, whilst the 2017 designs are based upon the information provided by the respective developers on the updated designs.

11.11.2 Gannet

182 The breeding period collisions for gannet for the Development and the other Forth and Tay wind farms, as estimated using option 2 of the CRM, are provided in Table 11.21. These are given for both the 2014 consented designs and 2017 designs for each of the other Forth and Tay wind farms. The estimates for the 2014 designs are based on the input parameters used for the CRMs on which the consent was based, with the only amendment being to the species-specific nocturnal activity scores (to reflect the advice of Scoping Opinion). The 2017 designs are based on information supplied by the respective developers. Details of the parameters used for each design are provided in *Appendix 11C.*

183 For all three of the other Forth and Tay wind farms, the 2014 designs give highest collision estimates (and represent the worst case), although differences are small (a single collision) for each of the two Seagreen sites (Table 11.21). Overall, the cumulative gannet collision estimates for the Development and the other Forth and Tay wind farms during the breeding period are estimated as 759 and 630 as based upon the 2014 and 2017 designs for the other Forth and Tay wind farms, respectively. Accounting for age distributions and sabbatical birds, the worst case (i.e. using the 2014 designs for each of the other Forth and Tay wind farms) gives 664 breeding adult and 21 sub-adult collisions. Assuming this mortality to be additive equates to an increase of five per cent and 0.06 percent in the annual mortality rates of adults and sub-adults, respectively (Table 11.21).

Table11.21: Cumulative gannet collision estimates for the Development with the other three Forth and Tay wind farms, for both the 2014 and 2017 designs for the other Forth and Tay wind farms

Wind farm	**Design**	**Collisions (based on 98.9 % avoidance rate with ± 2 SD applied to the total collisions)**		
		Total	**Breeding Adults[1]**	**Sub-adults[1]**
Inch Cape	2017	108 (88 – 128)	94	3
Neart na Gaoithe	2017	69 (56 – 82)	60	2
	2014	196 (160 – 232)	171	6
Seagreen Alpha	2017	278 (227 – 329)	243	8
	2014	279 (228 – 330)	244	8
Seagreen Bravo	2017	175 (143 – 207)	154	4
	2014	176 (144 – 208)	155	4
Forth and Tay Total[4]	2017 – all projects	630 (514 – 746)	552	17
	2014 with 2017 for the Development	759 (620 – 898)	664	21
Regional breeding populations (individuals)[2]			163,340	107,149
Increase in annual mortality rate[3]	2017 for all projects		4.2 %	0.05 %
	2014 with 2017 for the Development		5.0 %	0.06 %

Wind farm	Design	Collisions (based on 98.9 % avoidance rate with ± 2 SD applied to the total collisions)		
		Total	Breeding Adults[1]	Sub-adults[1]
1. Apportioning of collisions to age classes is based upon age distributions from site survey data for each wind farm (*Appendix 11C*), with the number of adult collisions reduced by 10 % to account for an assumed 10 % sabbatical rate amongst the adults in the breeding period (as per the Scoping Opinion). 2. After Murray *et al.* (2015) for Bass Rock and Troup Head (*Appendix 11A*); sub-adult component is estimated from the stable age distribution of the Forth Islands SPA gannet population model used for the current assessment (*Appendices 11A and 11E*). 3. Calculated from baseline annual mortality rates after WWT Consulting (2012) and Horswill and Robinson (2015), and as given in Table 11.10. 4. Totals for the adults and sub-adults may differ by a small amount from the summed numbers in the above table cells (and from the application of the age distribution and sabbatical proportion to the overall bird number) due to rounding errors.				

184 As for the Development-alone assessment, the Forth Islands SPA gannet PVA was used to further investigate the predicted impacts of the worst case cumulative collision mortality on the regional breeding population (*Appendix 11E*). Again, impacts were assessed according to the collisions apportioned to the Forth Islands SPA population (both during the breeding period and the autumn and spring passage periods – *Appendices 11B and 11E*), which is precautionary because a disproportionately high percentage of the collisions are apportioned to this SPA population.

185 Outputs from the PVA were summarised according to the median predicted population sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in *Section 11.8.1* on Development-alone gannet collision impacts.

186 The PVA outputs predict continued growth of the gannet population, under both the baseline conditions and with the Forth and Tay cumulative collisions taken into account (Table 11.22). As indicated above, it is unclear how realistic such a scenario is (given that the Bass Rock is likely to be close to capacity), but nonetheless the metrics suggest small population-level effects overall from the cumulative collisions, with:

- A small decrease in annual population growth rate (as indicated by a counterfactual value of 0.996, to three decimal places);
- Relatively small reductions in end-point population sizes (the impacted population predicted to be 91 per cent and 84 per cent of the size of the unimpacted population after 25 and 50 years, respectively); and
- Centile values of 12 and 5 for the 25- and 50-year projections, respectively, which indicate little overlap between the distributions of the impacted and unimpacted

populations, suggesting a high likelihood of the impacted population being smaller than the unimpacted population after 25 and 50 years.

Table 11.22: Outputs from the Forth Islands SPA gannet PVA in relation to cumulative collisions from the Forth and Tay wind farms for 25-year and 50-year projections

Additional mortality Scenario	Median number of breeding adults at end of projection (2.5 – 97.5 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	172,530 (148,172 – 199,825)	199,491 (160,083 – 245,839)	1.000	1.000	1.000	50	50
Cumulative collisions, Forth and Tay (assumes starting-point additional mortality of 725 individuals)[1]	157,743 (136,486 – 183,310)	166,484 (134,418 – 207,195)	0.914	0.835	0.996	12	5

1. Collisions are apportioned in ratio of 97:3 breeding adults to sub-adults (based on at-sea survey data from each wind farm).

2. The value of this metric does not vary according to the length of the projection period.

187 Thus, although the PVA outputs suggest that the cumulative impacts are highly likely to reduce the end-point population size, the scale of the reduction is predicted to be relatively small (at 16 per cent after 50 years) and the population is predicted to continue to increase irrespective of these impacts.

188 Also, as stated in relation to the Development-alone assessment, the above metrics derive from a PVA based upon the option 2 collision estimates, which for the Development at least are considered to be precautionary (as detailed in *Appendix 11C*).

189 In addition to the Development and the other three Forth and Tay wind farms, several other offshore wind farms occur within the mean maximum foraging range of gannets from the regional breeding population. These include the relatively large Beatrice and Moray Firth East developments in north-east Scotland, which due to their distance from the Bass Rock are unlikely to be in areas used by gannets from the Forth Islands SPA population (Thaxter *et al.* 2012, Wakefield *et al.* 2013) but are likely to be used by gannets from the Troup Head colony. However, the Troup Head colony accounts for only eight per cent of the regional breeding population, whilst the Beatrice and Moray East developments will also be used by gannets from larger colonies to the north. Thus, collisions attributable to this colony from these wind farms are unlikely to add significantly to effects on the regional population. Other developments are relatively small-scale (e.g. the Aberdeen Offshore Wind Farm, and the Kincardine Offshore Floating Wind Farm and Hywind Scotland Pilot Park) for which the number of breeding season collisions attributable to the regional breeding population will be relatively small and will not add significantly to the impacts as estimated in Tables 11.21 and 11.22.

190 Cumulative collision risk from the Forth and Tay wind farms, based on a worst case scenario of project design for Neart na Gaoithe and Seagreen Alpha and Bravo, is evaluated as a moderate magnitude impact (Table 11.8) for gannet, reflecting a small predicted change to population growth rate (by 0.4 per cent) and the 50-year population size (by 16 per cent) but continued increase of the impacted population (albeit with a high likelihood of a reduced population size after 25 and 50 years). Application of the impact matrix (Table 11.9) indicates that this equates to an ecologically significant moderate/major impact for a receptor of high sensitivity.

191 Based on the precautionary nature of the collision estimates, the very small reduction of the population growth rate for gannet, and the fact that the population model predicts a continued increase of regional breeding population over 25 and 50 years, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of cumulative collision risk on gannet. It is considered that this impact is more appropriately categorised as moderate and ecologically non-significant

11.11.3 Kittiwake

192 The cumulative assessment for the regional kittiwake breeding population considers the impacts from both collisions and displacement/barrier effects as a result of the Development and the other three Forth and Tay wind farms, with collisions as estimated

using the option 2 CRMs. Collision estimates are presented for the Development and for both the 2014 and 2017 designs of the other three Forth and Tay wind farms in Table 11.23, along with the estimated additional mortality resulting from displacement and barrier effects for each of these wind farms.

193 For the other three Forth and Tay wind farms, the additional mortality resulting from displacement and barrier effects was calculated by the SNCB matrix approach using mean peak seasonal abundance estimates for kittiwake provided by the respective developers (*Appendix 11D*). The at-sea baseline surveys for the two Seagreen sites encompassed the development areas only, and did not include surrounding buffer areas. Therefore, the peak seasonal abundances for the two Seagreen sites were adjusted by extrapolating the densities for each site across an assumed two kilometre buffer. The Seagreen sites are contiguous along their longest boundary, so that these assumed buffers did not extend out along the boundary between the two sites (i.e. each of the two sites was partially buffered to avoid including areas for which the bird abundance was already incorporated into the estimate for the neighbouring site). Further details of these data and of the extrapolated Seagreen 'buffer estimates' are provided in *Appendix 11D*.

Table 11.23: Cumulative estimated additional mortality from collisions and displacement / barrier effects for kittiwake in relation to the Development and the other three Forth and Tay wind farms, for both the 2014 and 2017 designs for the other Forth and Tay wind farms

Development	Impact	Design	Additional mortality (individuals)		
			Total	Breeding adults[1]	Sub-adults[1]
Inch Cape	Collision	2017	40 (33 – 47)	33	3
	Displacement/ barrier effects[2]	N/A	23	19	2
Neart na Gaoithe	Collision	2017	7 (6 – 8)	6	0
		2014	18 (15 – 21)	15	1
	Displacement/ barrier effects[2]	N/A	13	11	1
Seagreen Alpha	Collision	2017	74 (61 – 87)	62	5
		2014	78 (64 – 92)	65	5
	Displacement/ barrier effects[2]	N/A	13	11	1
Seagreen Bravo	Collisions	2017	80 (65 – 95)	68	4
		2014	84 (69 – 99)	72	4

Development	Impact	Design	Additional mortality (individuals)		
			Total	Breeding adults[1]	Sub-adults[1]
	Displacement/ barrier effects[2]	N/A	16	14	1
Forth and Tay total[5]		2017 – all projects	267	225	17
		2014 with 2017 for the Development	286	241	18
Regional populations (Individuals)[3]				51,786	41,113
Increase in mortality[4]	2017 for all projects			3.0 %	0.20 %
	2014 with 2017 for the Development			3.2 %	0.21 %

1. Apportioning of additional mortality to age classes is based upon age distributions from site survey data for each wind farm (*Appendix 11C*), with the adult mortality reduced by 10 % to account for an assumed 10 % sabbatical rate amongst the adults during the breeding period (as per the Scoping Opinion).
2. The estimated impacts from displacement and barrier effects are unaffected by the design changes. Mortality is calculated on basis of a 30 % displacement rate and 2 % mortality of displaced birds.
3. Adult breeding populations based on Seabird 2000 database (http://jncc.defra.gov.uk/page-4460) and more recent estimates for the SPA populations provided by SNH, with counts for non-SPA colonies corrected based on the SPA trend. The sub-adult component of the breeding population is estimated from the stable age distribution of the SPA population models (*Appendices 11A and 11E*).
4. Calculated from the baseline annual mortality rates, derived from the values used for the SPA kittiwake population models for adults (*Appendix 11E*) and after Horswill and Robinson (2015) for sub-adults, and as given in Table 11.12.
5. Totals for the adult and sub-adult categories may differ by a small amount from the summed numbers in the above table cells (and from the application of the age distribution and sabbatical proportion to the overall bird number) due to rounding errors.

194 For all three of the other Forth and Tay wind farms, the 2014 designs give highest collision estimates, although (as for gannet) the differences are small in the case of the two Seagreen sites (Table 11.23). The impacts from displacement and barrier effects are unaffected by the design, so that the 2014 design represents the worst case for each of the other Forth and Tay wind farms. Overall, the cumulative additional mortality to kittiwakes during the breeding period is estimated as 286 and 267 birds, based upon the 2014 and 2017 designs for the other Forth and Tay wind farms, respectively. Accounting for age distributions and

sabbatical birds, the worst case (i.e. using the 2014 designs for each of the other Forth and Tay wind farms) gives additional mortality of 241 adults and 18 sub-adults, equating to increases of approximately three per cent and 0.21 per cent in the annual mortality rates of adults and sub-adults, respectively (Table 11.23). Collisions account for over 75 per cent of the estimated additional mortality.

195 As for the Development-alone, the regional-SPA kittiwake PVA was used to further investigate the predicted population-level impacts of the worst case cumulative mortality on the regional breeding population, with the PVA incorporating the collisions apportioned to the SPA populations during both the breeding and passage periods (*Appendices 11B and 11E*). Again, this PVA is likely to underestimate the cumulative impacts to the regional population by a small amount because impacts to the non-SPA component of this population during the breeding period are disproportionately high (*Appendix 11B*).

196 Outputs from the PVA were summarised according to the median predicted population sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in *Section 11.8.1* on Development-alone gannet collision impacts.

197 The PVA outputs predict a continued steep decline in the regional breeding population of kittiwakes under both baseline conditions and with the Forth and Tay cumulative impacts taken into account (Table 11.24). The metrics summarising the predicted cumulative population-level impacts suggest relatively small effects overall, with:

- A small decrease in annual population growth rate (as indicated by a counterfactual value of 0.996);
- Modest reductions in end-point population sizes (the impacted population predicted to be 91 per cent and 82 per cent of the size of the unimpacted population after 25 and 50 years, respectively);
- Centile values of 42 for both the 25 and 50-year projections, respectively, which indicate a considerable overlap between the distributions of the impacted and unimpacted populations, suggesting a high likelihood of the impacted population being a similar size to the unimpacted population after 50 years.

198 Also, as stated in relation to the Development-alone, the above metrics derive from a PVA based upon the option 2 collision estimates, which for the Development at least are considered to be highly precautionary (as detailed in *Appendix 11C*).

199 In addition to the Development and the other three Forth and Tay wind farms, several other offshore wind farms occur within the area defined for the regional breeding population (e.g. Aberdeen Offshore Wind Farm, Kincardine Offshore Floating Wind Farm, Hywind Scotland Pilot Park and Forthwind Offshore Wind Demonstration Project). These are all small-scale developments comprising 11 or fewer WTGs. The collision estimates provided in the respective assessments (or from MacArthur Green 2017 in the case of Aberdeen Offshore Wind Farm) for these developments suggest a further 54 adult kittiwake collisions. Incorporating these into the estimates in Table 11.23 increases the estimated collisions of

adult kittiwake to 295 (equating to a four per cent, as opposed to a three per cent, increase to the annual adult mortality rate of the regional breeding population). If these additional collisions from these smaller wind farms were to be incorporated within the PVA it is expected that the values for the counterfactual of population growth rate and population-size (as detailed in Table 11.24) would be reduced by a small amount.

200 Therefore, the cumulative collision and displacement/barrier effect mortality from the Forth and Tay wind farms is evaluated as a moderate magnitude impact (Table 11.8) for kittiwake, reflecting the predicted change in the end-point population-size after 50 years of operation. Application of the impact matrix (Table 11.9) indicates that this equates to a moderate/major impact for a receptor of high sensitivity. This assessment is in the context of a regional population undergoing a long-term decline which is predicted to continue during the operational life of the Inch Cape Wind Farm. However, the evidence indicates that the cumulative mortality due to collisions and displacement result in only a small reduction in population growth rate and there is still a relatively high probability that the size of the impacted population after 50 years will be similar to that of the unimpacted population.

201 Thus, cumulative collisions and displacement mortality from the Forth and Tay wind farms, at levels advised in the Scoping Opinion, will effectively not contribute to accelerating the rate, of the ongoing decline of the regional kittiwake population, or the magnitude of the decline. These combined effects are also not predicted to impede population recovery, should environmental conditions become more favourable for kittiwakes. Based on the PVA predictions, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of collision risk on kittiwake and that this impact is more appropriately categorised as moderate and ecologically non-significant.

Table 11.24: Outputs from the regional-SPA kittiwake PVA in relation to the estimated additional mortality from the cumulative impacts from the Forth and Tay wind farms for 25-year and 50-year projections

Additional mortality Scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	7,150 (3,150 – 18,000)	3,700 (900 – 19,100)	1.000	1.000	1.000	50	50
Cumulative collisions and displacement (based upon the percentage point increases to the annual mortality of the adult and sub-adult age classes in each of the individual kittiwake SPA PVAs)[1]	6,500 (2,900 – 16,300)	3,050 (750 – 15,750)	0.908	0.825	0.996	42	42

1. Details of the individual kittiwake SPA PVAs are presented in *Appendix 11E*. The ratio of adult to sub-adult additional mortality is based on the age distribution as determined from at-sea survey data for each wind farm (*Appendix 11C*), and also accounts for an assumed 10 % sabbatical rate amongst the adults during the breeding period (as per the Scoping Opinion).

2. The value of this metric does not vary according to the length of the projection period.

11.11.4 Herring gull

202 The cumulative assessment for the regional herring gull breeding population considers the impacts from collisions (based on the option 3 CRM estimates) during both the breeding and non-breeding periods (as the species is resident in the region – Furness 2015). Collision estimates for the Development are presented together with those from both the 2014 consented designs and 2017 designs for the other three Forth and Tay wind farms (Table 11.25).

203 The 2014 design gives the highest collision estimates for Neart na Gaoithe, whilst the collision estimates do not differ between designs for either of the Seagreen sites. The worst-case estimates for herring gulls are for nine collisions during the breeding period and 16 during the non-breeding period (Table 11.25). Accounting for age distributions and sabbatical birds, the worst case gives collision estimates of four adults and two sub-adults during the breeding period and of nine adults and seven sub-adults during the non-breeding period. These potential losses equate to increases of 0.1 per cent or less in the annual mortality rates of adults during both the breeding and non-breeding periods and of less than 0.03 per cent for sub-adults during both periods (Table 11.25).

Table 11.25: Cumulative herring gull collision estimates for the Development and the other three Forth and Tay wind farm, for both the 2014 and 2017 designs for the other Forth and Tay wind farms

Development	Design	Season	Collisions by option 3 (based on 99 % avoidance rate with ± 2 SD applied to the total collisions)		
			Total	Adults[1]	Sub-adults[1]
Inch Cape	2017	Breeding	1 (0.8 – 1.2)	1	<1
		Non-breeding	2 (1.6 – 2.4)	1	<1
Neart na Gaoithe	2017	Breeding	1 (0.8 – 1.2)	1	<1
		Non-breeding	2 (1.6 – 2.4)	1	1
	2014	Breeding	3 (2 – 4)	2	1
		Non-breeding	5 (4 – 6)	2	2
Seagreen Alpha	2017	Breeding	3 (2 – 4)	1	1
		Non-breeding	5 (4 – 6)	2	3
	2014	Breeding	3 (2 – 4)	1	1

Development	Design	Season	Collisions by option 3 (based on 99 % avoidance rate with ± 2 SD applied to the total collisions)		
			Total	Adults[1]	Sub-adults[1]
		Non-breeding	5 (4 – 6)	2	3
Seagreen Bravo	2017	Breeding	2 (1.6 – 2.4)	1	<1
		Non-breeding	4 (3 – 5)	1	2
	2014	Breeding	2 (1.6 – 2.4)	1	<1
		Non-breeding	4 (3 – 5)	1	2
Forth and Tay total[4]	2017 – all projects	Breeding	7 (5 – 9)	3	2
		Non-breeding	13 (10.4 – 15.6)	4	6
	2014 with 2017 for the Development	Breeding	9 (6 – 12)	4	2
		Non-breeding	16 (12 – 18)	6	7
Regional population[2]		Breeding		24,248	36,372
		Non-breeding		210,298	256,222
Increase in mortality[3]	2017 for all projects	Breeding		0.08 %	0.03 %
		Non-breeding		0.02 %	0.01 %
	2014 with 2017 for the Development	Breeding		0.10 %	0.03 %
		Non-breeding		0.03 %	0.01 %

<table>
<tr><th rowspan="2">Development</th><th rowspan="2">Design</th><th rowspan="2">Season</th><th colspan="3">Collisions by option 3 (based on 99 % avoidance rate with ± 2 SD applied to the total collisions)</th></tr>
<tr><th>Total</th><th>Adults[1]</th><th>Sub-adults[1]</th></tr>
<tr><td colspan="6">1. Apportioning of collision estimates to age classes is based upon seasonal age distributions from site survey data at each wind farm (Appendix 11C), with the adult mortality reduced by 35 % to account for an assumed 35 % sabbatical rate amongst breeding adults (as per the Scoping Opinion).
2. Adult breeding populations based on Seabird 2000 database (http://jncc.defra.gov.uk/page-4460) and more recent estimates for the SPA populations provided by SNH, with counts for non-SPA colonies corrected based on the SPA trend. The sub-adult component of the breeding population is estimated from the stable age distribution of a population model for the Forth Islands SPA herring gull population (Appendix 11E). The non-breeding population for each age class is taken as the UK North Sea and Channel waters from Furness (2015), see Appendix 11A.
3. Calculated from the baseline annual mortality rates for adults and sub-adults, after Horswill and Robinson (2015) and as given in Table 11.14.
4. Totals for the adult and sub-adult categories may differ by a small amount from the summed numbers in above table cells (and from the application of the age distribution and sabbatical proportion to the overall bird number) due to rounding errors.</td></tr>
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204 The cumulative predicted collision estimates for herring gulls at the Forth and Tay wind farms is very low for adult and sub-adult birds in all seasons (0.1 per cent or less). It is considered that these small magnitudes of increase in mortality rates would not materially alter the background mortality of the population and would be undetectable in terms of population effects. As such, no population modelling and associated PVAs have been undertaken to further investigate the population-level effects.

205 Given the small numbers of total collisions estimated for the Development together with the other three Forth and Tay wind farms (and the resultant small predicted effects), it is considered that collisions from the other smaller wind farms that occur within the area defined for the regional population will not contribute significantly to the level of effect identified.

206 Application of the impact matrix (Table 11.9) indicates that the predicted impacts on herring gull equate to a minor/moderate and ecologically non-significant impact for a receptor of high sensitivity.

207 Based on the very small percentage increase in population mortality rates for all seasons and age classes, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of collision risk on herring gull, and this impact is more appropriately categorised as negligible and ecologically non-significant.

11.11.5 Puffin

208 The predicted level of additional mortality affecting the regional breeding puffin population as a result of displacement and barrier effects from the Development and the other three

Forth and Tay wind farms is presented in Table 11.26. As for kittiwake, the mortality predicted as a result of displacement and barrier effects at the other three Forth and Tay wind farms is based upon the mean peak seasonal abundances provided by the respective developers, with the estimates for Seagreen Alpha and Bravo adjusted to account for the absence of survey data from a surrounding two kilometre buffer (see *Section 11.11*.3 above and *Appendix 11D*).

209 These cumulative impacts from displacement and barrier effects are predicted to result in an additional mortality of approximately 250 birds per year. After accounting for age distributions and sabbatical birds, this level of additional mortality is estimated to result in an increase of considerably less than 1 per cent in annual mortality rates of both adults and sub-adults (Table 11.26).

Table 11.26: Predicted cumulative impacts from displacement and barrier effects for puffin in relation to the Development and the other three Forth and Tay wind farms

Wind farm[1]	Seasonal period	Additional mortality (individuals)[2]		
		Total	Adults[3]	Sub-adult[3]
Inch Cape	Breeding	68	24	42
Neart na Gaoithe	Breeding	74	26	46
Seagreen Alpha	Breeding	44	16	28
Seagreen Bravo	Breeding	64	23	40
Forth and Tay, total[6]	Breeding	251	89	155
Regional breeding population (individuals)[4]			175,294	285,255
Increase in annual mortality rate[5]			0.54 %	0.22 %

Wind farm[1]	Seasonal period	Additional mortality (individuals)[2]		
		Total	Adults[3]	Sub-adult[3]

1. Predicted impacts from displacement and barrier effects are unaffected by the design changes for the other Forth and Tay wind farms.
2. Additional mortality calculated using a displacement rate of 60 % and 2 % mortality of displaced birds.
3. Apportioning of the additional mortality to age classes is based on the stable age distribution from the Forth Islands SPA puffin population model (*Appendix 11E*). The mortality to adult puffins is reduced by 7 % to account for the assumed sabbatical rates (as per the Scoping Opinion).
4. Adult breeding populations based on Seabird 2000 database (http://jncc.defra.gov.uk/page-4460) and more recent estimates for the SPA populations provided by SNH, with counts for non-SPA colonies corrected based on the SPA trend. The sub-adult component of the breeding population is estimated from the stable age distribution of the Forth Islands SPA puffin population model.
5. Annual mortality rates are as used in the Forth Islands SPA puffin population model for adults (*Appendix 11E*) and after Horswill and Robinson (2015) for sub-adults.
6. Totals for the adult and sub-adult categories may differ by a small amount from the summed numbers in the above table cells (and from the application of the age distribution and sabbatical proportion to the overall bird number) due to rounding errors.

210 As for the Development-alone impacts, the Forth Islands SPA puffin PVA was used to further investigate the population-level impacts of the cumulative displacement and barrier effects on the regional breeding population (*Appendix 11E*). This PVA will overestimate the cumulative impacts to the regional population because a high percentage of the impacts from the Development and each of the other Forth and Tay wind farms are apportioned to the Forth Islands SPA population, although the SPA population accounts for only 51 per cent of the total regional population (*Appendix 11B*).

211 Outputs from the PVA were summarised according to the median predicted population sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs (Table 11.27) and which are defined above in *Section 11.8.1* on the Development-alone gannet collision impacts.

212 The PVA outputs predict a steeply increasing population under both baseline conditions and with the cumulative impacts from displacement and barrier effects included (although as noted in the Development-alone section on puffin, this level of population growth over such periods is unrealistic). The metrics from the PVA suggest minimal impacts from the cumulative displacement and barrier effects, with:

- Virtually no detectable decrease in annual population growth rate (as indicated by a counterfactual value of 0.999);
- Small reductions in end-point population sizes (the impacted population predicted to be 95 per cent of the size of the unimpacted population after 50 years); and

- Centile values of 48 which indicate a close overlap between the distributions of the impacted and unimpacted populations, suggesting a high likelihood of the impacted population being of a similar size to the unimpacted population after 50 years.

213 In relation to other offshore wind farms that occur within the area defined for the regional puffin breeding population, these are all relatively small-scale developments (comprising no more than 11 WTGs). As such, the resultant impacts from displacement and barrier effects will be small or non-existent, and are not expected to add significantly to the impacts determined for the Development together with the other three Forth and Tay wind farms.

214 On the basis of the PVA outputs (and assessment of additional mortality), the predicted cumulative impact from displacement and barrier effects arising from the Development together with the other Forth and Tay wind farms is evaluated as a low magnitude impact (Table 11.8) for puffin. Application of the impact matrix (Table 11.9) indicates that this equates to a moderate and ecologically non-significant impact for a receptor of high sensitivity.

215 Based on the very small reduction in population growth rate and high probability that the size of the impacted population will be similar to that of an unimpacted population over 50 years, and the predicted continued population growth over this period, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of cumulative displacement on puffin. It is considered that this impact is more appropriately categorised as minor and ecologically non-significant.

Table 11.27: Outputs from the Forth Islands SPA puffin PVA in relation to the estimated additional mortality resulting from the cumulative displacement and barrier effects from the Forth and Tay wind farms for 25-year and 50-year projections

Additional mortality Scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	286,950 (106,850 – 617,250)	1,002,250 (225,050 – 3,043,050)	1.000	1.000	1.000	50	50
Cumulative displacement (based upon percentage point increases of 0.086 and 0.092 to the annual mortality of the adult and sub-adult age classes)[1]	279,850 (104,300 – 599,450)	955,100 (213,350 – 2,894,500)	0.975	0.952	0.999	48	48

1. Ratio of adult to sub-adult additional mortality is based on the stable age distribution of the Forth Islands SPA population model (*Appendix 11E*), and also accounts for an assumed 7 % sabbatical rate amongst the adults (as per the Scoping Opinion).

2. The value of this metric does not vary according to the length of the projection period.

11.11.6 Razorbill

216 Displacement and barrier effects are assumed to affect the regional breeding population of razorbills during both the breeding and non-breeding periods, with the regional population against which the impacts are assessed being assumed to be the same over both seasonal periods (as advised in the Scoping Opinion).

217 The predicted level of additional mortality affecting the regional breeding razorbill population as a result of displacement and barrier effects from the Development and the other three Forth and Tay wind farms is presented in Table 11.28. As for kittiwake, the mortality predicted as a result of displacement and barrier effects at the other three Forth and Tay wind farms is based upon the mean peak seasonal abundances provided by the respective developers, with the estimates for Seagreen Alpha and Bravo adjusted to account for the absence of survey data from a surrounding two kilometre buffer (see *Section 11.11.3* above and *Appendix 11D*).

218 These cumulative impacts from displacement and barrier effects are predicted to result in an additional mortality of 124 birds per year (with an approximately even split between the two seasonal periods). After accounting for age distributions and sabbatical birds, this level of additional mortality is estimated to result in an increase of approximately 2.5 per cent in the annual mortality rate of adults and 0.7 per cent in the annual mortality rate of sub-adults (Table 11.28).

Table 11.28: Predicted cumulative impacts from displacement and barrier effects for razorbill in relation to the Development and the other three Forth and Tay wind farms

Wind farm[1]	Seasonal period	Additional mortality (individuals)[2]		
		Total	Adults[3]	Sub-adult[3]
Inch Cape	Breeding	28	13	14
	Non-breeding	29	13	15
Neart na Gaoithe	Breeding	7	3	4
	Non-breeding	19	8	9
Seagreen Alpha	Breeding	17	8	8
	Non-breeding	8	3	4
Seagreen Bravo	Breeding	6	3	3
	Non-breeding	10	5	5
Forth and Tay, total[6]	Breeding	58	26	30
	Non-breeding	66	30	34

Wind farm[1]	Seasonal period	Additional mortality (individuals)[2]		
		Total	Adults[3]	Sub-adult[3]
Regional population for both the breeding and non-breeding periods (individuals)[4]			23,728	24,696
Increase in annual mortality rate[5]	Breeding		1.20 %	0.33 %
	Non-breeding		1.39 %	0.37 %

1. Predicted impacts from displacement and barrier effects are unaffected by the design changes for the other Forth and Tay wind farms.
2. Additional mortality calculated using a displacement rate of 60 % and 1 % mortality of displaced birds.
3. Apportioning of the additional mortality to age classes is based on the stable age distribution from the regional-SPA razorbill population model (*Appendix 11E*). The mortality to adult razorbills is reduced by 7 % to account for the assumed sabbatical rates (as per the Scoping Opinion).
4. Adult breeding populations based on Seabird 2000 database (http://jncc.defra.gov.uk/page-4460) and more recent estimates for the SPA populations provided by SNH, with counts for non-SPA colonies corrected based on the SPA trend. The sub-adult component of the breeding population is estimated from the stable age distribution of the regional-SPA razorbill population model.
5. Annual mortality rates are as used in the regional-SPA razorbill population model for adults (*Appendix 11E*) and after Horswill and Robinson (2015) for sub-adults.
6. Totals for the adult and sub-adult categories may differ by a small amount from the summed numbers in the above table cells (and from the application of the age distribution and sabbatical proportion to the overall bird number) due to rounding errors.

219 As for the Development-alone impacts, the regional-SPA razorbill PVA was used to further investigate the population-level impacts of the cumulative displacement and barrier effects on the regional breeding population (*Appendix 11E*). This PVA is likely to underestimate the cumulative impacts to the regional breeding population by a small amount because the SPA populations comprise 75 per cent of the total regional breeding population, whilst the percentage of the impacts apportioned to these populations is lower for the Development and the two Seagreen sites (*Appendix 11B*).

220 Outputs from the PVA were summarised according to the median predicted population-sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in *Section 11.8.1* on the Development-alone gannet collision impacts.

221 The PVA outputs predict an increasing population under both baseline conditions and with the cumulative impacts from displacement and barrier effects included (Table 11.29). The metrics from the PVA suggest relatively small impacts from the cumulative displacement and barrier effects, with:

- A small no decrease in annual population growth rate (as indicated by a counterfactual value of 0.997);

- Small reductions in end-point population sizes (the impacted population predicted to be 94 per cent and 88 per cent of the size of the unimpacted population after 25 and 50 years, respectively); and
- Centile values of 40 and 39 for the 25 and 50-year projections, respectively, which indicate a moderate extent of overlap between the distributions of the impacted and unimpacted populations, suggesting a reasonable likelihood of the impacted population being of a similar size to the unimpacted population after 50 years.

222 In relation to other offshore wind farms that occur within the area defined for the regional razorbill breeding population, these are all relatively small-scale developments (comprising no more than 11 WTGs). As such, the resultant impacts from displacement and barrier effects will be small or non-existent, and are not expected to add significantly to the impacts determined for the Development together with the other three Forth and Tay wind farms.

223 On the basis of the PVA outputs (and assessment of additional mortality), the predicted cumulative impact from displacement and barrier effects arising from the Development together with the other Forth and Tay wind farms is evaluated as a moderate magnitude impact (Table 11.8) for razorbill. Application of the impact matrix (Table 11.9) indicates that this equates to an ecologically significant moderate/major impact for a receptor of high sensitivity.

224 Based on the small reduction in population growth rate and relatively high probability that the size of the impacted population will be similar to that of an unimpacted population over 50 years, and the predicted continued population growth over this period, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of cumulative displacement on razorbill. It is considered that this impact is more appropriately categorised as moderate/ minor and ecologically non-significant.

Table 11.29: Outputs from the regional-SPA razorbill PVA in relation to the estimated additional mortality resulting from the cumulative displacement and barrier effects from the Forth and Tay wind farms for 25-year and 50-year projections

Additional mortality Scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	15,600 (9,950 – 24,250)	28,450 (13,400 – 61,950)	1.000	1.000	1.000	50	50
Cumulative displacement (based upon the percentage point increases to the annual mortality of the adult and sub-adult age classes in each of the individual razorbill SPA PVAs)[1]	14,600 (9,300 – 22,800)	24,900 (11,750 – 54,100)	0.937	0.878	0.997	40	39

1. Details of the individual razorbill SPA PVAs are presented in *Appendix 11E*. The ratio of adult to sub-adult additional mortality is based on the stable age distribution of the regional-SPA razorbill population model (*Appendix 11E*), and also accounts for an assumed 7 % sabbatical rate amongst the adults (as per the Scoping Opinion).

2. The value of this metric does not vary according to the length of the projection period.

11.11.7 Guillemot

225 As for razorbill, displacement and barrier effects are assumed to affect the regional breeding population of guillemots during both the breeding and non-breeding periods, with the regional population against which the impacts are assessed being assumed to be the same over both seasonal periods (as advised in the Scoping Opinion).

226 The predicted level of additional mortality affecting the regional breeding guillemot population as a result of displacement and barrier effects from the Development and the other three Forth and Tay wind farms is presented in Table 11.30. As for kittiwake, the mortality predicted as a result of displacement and barrier effects at the other three Forth and Tay wind farms is based upon the mean peak seasonal abundances provided by the respective developers, with the estimates for Seagreen Alpha and Bravo adjusted to account for the absence of survey data from a surrounding two kilometre buffer (*see Section 11.11.3* above and *Appendix 11D*).

227 These cumulative impacts from displacement and barrier effects are predicted to result in an additional mortality of 353 birds per year, with this being highest during the breeding period. After accounting for age distributions and sabbatical birds, this level of additional mortality is estimated to result in an increase of less than one per cent in the annual mortality rates of adults and sub-adults (Table 11.30).

Table 11.30: Predicted cumulative impacts from displacement and barrier effects for guillemot in relation to the Development and the other three Forth and Tay wind farms

Wind farm[1]	Seasonal period	Additional mortality (individuals)[2]		
		Total	Adults[3]	Sub-adult[3]
Inch Cape	Breeding	49	20	28
	Non-breeding	23	10	13
Neart na Gaoithe	Breeding	20	8	11
	Non-breeding	46	19	26
Seagreen Alpha	Breeding	73	30	41
	Non-breeding	37	15	21
Seagreen Bravo	Breeding	65	26	36
	Non-breeding	41	17	23
Forth and Tay, total[6]	Breeding	206	84	116
	Non-breeding	147	60	83

Wind farm[1]	Seasonal period	Additional mortality (individuals)[2]		
		Total	Adults[3]	Sub-adult[3]
Regional population for both the breeding and non-breeding periods (individuals)[4]			218,352	280,667
Increase in annual mortality rate[5]	Breeding		0.52 %	0.17 %
	Non-breeding		0.37 %	0.12 %

1. Predicted impacts from displacement and barrier effects are unaffected by the design changes for the other Forth and Tay wind farms.
2. Additional mortality calculated using a displacement rate of 60 % and 1 % mortality of displaced birds.
3. Apportioning of the additional mortality to age classes is based on the stable age distribution from the regional-SPA razorbill population model (*Appendix 11E*). The mortality to adult guillemots is reduced by 7 % to account for the assumed sabbatical rates (as per the Scoping Opinion).
4. Adult breeding populations based on Seabird 2000 database (http://jncc.defra.gov.uk/page-4460) and more recent estimates for the SPA populations provided by SNH, with counts for non-SPA colonies corrected based on the SPA trend. The sub-adult component of the breeding population is estimated from the stable age distribution of the regional-SPA guillemot population model.
5. Annual mortality rates are as used in the regional-SPA guillemot population model for adults (*Appendix 11E*) and after Horswill and Robinson (2015) for sub-adults.
6. Totals for the adult and sub-adult categories may differ by a small amount from the summed numbers in the above table cells (and from the application of the age distribution and sabbatical proportion to the overall bird number) due to rounding errors.

228 As for the Development-alone impacts, the regional SPA guillemot PVA was used to further investigate the population-level impacts of the cumulative displacement and barrier effects on the regional breeding population (*Appendix 11E*). This PVA effectively represents the entire regional breeding population, with the SPA populations comprising 95 per cent of the regional population (*Appendix 11B*).

229 Outputs from the PVA were summarised according to the median predicted population-sizes at the end of the projection period, and the three metrics which the Scoping Opinion advised should be used for the interpretation of outputs and which are defined above in *Section11.8.1* on the Development-alone gannet collision impacts.

230 The PVA outputs predict an increasing population under both baseline conditions and with the cumulative impacts from displacement and barrier effects included (Table 11.31). The metrics from the PVA suggest small impacts from the cumulative displacement and barrier effects, with:

- Virtually no detectable decrease in annual population growth rate (as indicated by a counterfactual value of 0.999);
- Very small reductions in end-point population sizes (the impacted population predicted to be 97 per cent of the size of the unimpacted population after 50 years); and

- Centile values of 45 for both the 25- and 50-year projections, which indicate a considerable overlap between the distributions of the impacted and unimpacted populations, suggesting a high likelihood of the impacted population being of a similar size to the unimpacted population after 50 years.

231 In relation to other offshore wind farms that occur within the area defined for the regional guillemot breeding population, these are all relatively small-scale developments (comprising no more than 11 WTGs). As such, the resultant impacts from displacement and barrier effects will be small or non-existent, and are not expected to add significantly to the impacts determined for the Development together with the other three Forth and Tay wind farms.

232 On the basis of the PVA outputs (and assessment of additional mortality), the predicted cumulative impact from displacement and barrier effects arising from the Development together with the other Forth and Tay wind farms is evaluated as a low magnitude impact (Table 11.8) for guillemot. Application of the impact matrix (Table 11.9) indicates that this equates to an ecologically non-significant moderate impact for a receptor of high sensitivity.

233 Based on the very small reduction in population growth rate and end-point population-size, the high probability that the size of the impacted population will be similar to that of an unimpacted population over 50 years, and the predicted continued population growth over this period, it is considered that the impact matrix (Table 11.9) over-evaluates the effect of cumulative displacement on guillemot. It is considered that this impact is more appropriately categorised as moderate/minor and ecologically non-significant.

Table 11.31: Outputs from the regional-SPA guillemot PVA in relation to the estimated additional mortality resulting from the cumulative displacement and barrier effects from the Forth and Tay wind farms for 25-year and 50-year projections

Additional mortality Scenario	Median number of breeding pairs at end of projection (5 - 95 centiles)		Counterfactual of end-point population size		Counterfactual of population growth rate	Centile of baseline population matching the median of the impacted population	
	25 years	50 years	25 years	50 years	25 and 50 years[2]	25 years	50 years
Baseline (no additional mortality)	163,200 (129,150 – 205,550)	243,650 (163,400 – 369,700)	1.000	1.000	1.000	50	50
Cumulative displacement (based upon the percentage point increases to the annual mortality of the adult and sub-adult age classes in each of the individual guillemot SPA PVAs)[1]	160,600 (126,400 – 201,900)	236,000 (158,200 – 360,650)	0.982	0.970	0.999	45	45

1. Details of the individual guillemot SPA PVAs are presented in *Appendix 11E*. The ratio of adult to sub-adult additional mortality is based on the stable age distribution of the regional-SPA guillemot population model (*Appendix 11E*), and also accounts for an assumed 7 % sabbatical rate amongst the adults (as per the Scoping Opinion).

2. The value of this metric does not vary according to the length of the projection period.

11.12 Additional Mitigation

234 The ornithology assessment has assessed worst case scenario impacts of the Development, alone and cumulatively, and has taken into account the embedded mitigation measures listed in *Section 11.5.2*. The assessment concluded that residual effects for the Development-alone and cumulatively would be at most moderate and ecologically non-significant and no additional mitigation is proposed.

235 It is anticipated that pre-, during and post-construction monitoring will provide valuable data regarding the predicted and actual effects of the Development on bird species. Throughout the duration of the offshore wind farm lifecycle, ICOL will work with MS-LOT and other stakeholders (including through forums such as the Forth and Tay Regional Advisory Group – ornithology sub-group (FTRAG-O)) to develop effective post-consent monitoring programmes and share ornithology data, with a view to informing and further developing best practice measures.

11.13 Conclusion and Residual Effects

236 The assessment of impacts on bird species is summarised below.

237 No ecologically significant impacts on bird species are identified from either the OfTW or OnTW during the construction (and decommissioning), or operation and maintenance periods in relation to direct disturbance/displacement, indirect disturbance of habitats/prey or habitat loss.

238 The assessment of impacts on bird species from the Wind Farm is summarised in Table 11.32 below. All embedded mitigation identified in *Section 11.5.2* has been included within the assessments, and no further mitigation requirements have been identified. Therefore, there is no separation of pre- and post-mitigation effects in Table 11.32.

239 The assessment has identified no ecologically significant residual impacts for the Development, either alone or cumulatively, for any ornithological receptor (i.e. no moderate/major or major impacts were concluded).

Table 11.32: Summary of effects and mitigation on the six key ornithology receptors (defined as the regional breeding population of the species listed below)

Impacts	Receptor	Seasonal periods relevant to the assessment	Development-alone effect	Cumulative effect
Operation and Maintenance				
Collision	Gannet	Breeding and non-breeding	Minor and non-significant	Moderate and non-significant
Collision	Herring gull	Breeding and non-breeding	Negligible and non-significant	Negligible and non-significant

<table>
<tr><th>Impacts</th><th>Receptor</th><th>Seasonal periods relevant to the assessment</th><th>Development-alone effect</th><th>Cumulative effect</th></tr>
<tr><td>Displacement/ barrier</td><td>Kittiwake</td><td>Breeding</td><td>Minor and non-significant</td><td rowspan="3">Moderate and non-significant</td></tr>
<tr><td>Collision</td><td>Kittiwake</td><td>Breeding and non-breeding</td><td>Minor and non-significant</td></tr>
<tr><td>Displacement/ barrier and collision</td><td>Kittiwake</td><td>Breeding and non-breeding</td><td>Minor and non-significant</td></tr>
<tr><td>Displacement/ barrier</td><td>Puffin</td><td>Breeding</td><td>Minor and non-significant</td><td>Minor and non-significant</td></tr>
<tr><td>Displacement/ barrier</td><td>Razorbill</td><td>Breeding and non-breeding</td><td>Minor and non-significant</td><td>Moderate/minor and non-significant</td></tr>
<tr><td>Displacement/ barrier</td><td>Guillemot</td><td>Breeding and non-breeding</td><td>Minor and non-significant</td><td>Moderate/minor and non-significant</td></tr>
</table>

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