ORNITHOLOGY HABITATS REGULATIONS APPRAISAL

Table of Contents

SUMMARY: ORNITHOLOGY HABITATS REGULATIONS APPRAISAL (HRA) ADDENDUM

This ornithology HRA Addendum provides an update to that originally provided with the Seagreen 2018 Environmental Impact Assessment Report.

It has assessed the operational effects over 25 years of the optimised Seagreen Project namely Project Alpha, Project Bravo and Project Alpha and Project Bravo combined against a restricted suite of five qualifying species at three Special Protection Areas (SPA) and one proposed SPA (pSPA) as agreed with Marine Scotland and Scottish Natural Heritage in January 2019.

Included in the assessment were: Forth Islands SPA, Fowlsheugh SPA, St Abb's Head to Fast Castle SPA and the Outer Firth of Forth and St Andrews Bay Complex pSPA. The species assessed were gannet, kittiwake, guillemot, razorbill and puffin at each SPA where they were qualifying features and the SPA/pSPA was within foraging range of the optimised Seagreen Project. Species were assessed for both the breeding and non-breeding season.

The optimised Seagreen project has been assessed alone and cumulatively, according to the scenarios advised in the 2017 Scoping Opinion, with other projects in the Forth and Tay and, in the case of gannet and kittiwake, the wider North Sea including Channel for gannet only.

The HRA Addendum finds that, in all cases, the effects from the optimised Seagreen Project both alone and including the worst case cumulative scenario would be well below those estimated for the projects as consented in 2014. PVA modelling indicates that the size of the impacted populations will be generally similar to those of the un-impacted populations with a high ratio of around 90% or above. Similar predictions are made in terms of the population growth rate where the ratios are generally above 99%. On this basis, it is concluded that the populations of these species at each SPA would be maintained in the long term.

In conclusion, and particularly considering the reduced effects when compared to the projects as consented in 2014, this HRA finds that there would be no adverse effects on the integrity of:

Forth Islands SPA;

Fowlsheugh SPA;

St Abb's Head to Fast Castle SPA; and

Outer Firth of Forth and St Andrews Bay Complex pSPA.

1. Introduction

1. This chapter of the Addendum (the 'HRA Addendum') provides an update to the Habitats Regulations Appraisal (HRA) included as Chapter 16 of the Seagreen 2018 Environmental Impact Assessment Report (the '2018 EIAR'). As agreed with the Marine Scotland Licensing and Operations Team (MSLOT), it covers effects during the operational period only, all other effects having been screened out, and includes a restricted number of bird species and European sites compared to the 2018 EIAR as described in the scope which follows. The overview of the HRA process provided in the 2018 EIAR Chapter 16 (paragraphs 16.86 to 16.171) is not repeated here.

2. Consultation

2. This HRA Addendum has been produced following detailed post-submission consultation with Scottish Natural Heritage (SNH) and Marine Scotland (MS) which is summarised in Tables 2.1 to 2.3 of Section 1, the Introduction to this Addendum. As noted previously, references to Marine Scotland include both Marine Scotland Licensing and Operations Team (MSLOT) and Marine Scotland Science (MSS). Where only one of these organisations was involved, they are referred to separately.

3. Scope of the Habitats Regulations Appraisal (HRA)

3. This HRA Addendum is provided for five species at the three Special Protection Areas (SPA) and one proposed (p)SPA shown in Table 3.1.

4. Connectivity with each SPA was assumed if the Seagreen sites were within the mean-maximum foraging range (mmfr) (Thaxter et al. 2012) of a species from its respective SPA as advised in the Scoping Opinion (MS 2017), hereafter referred to as the 2017 Scoping Opinion.

Table 3-1 SPAs and species considered in this HRA Addendum

SPA/pSPA	Species
Forth Islands SPA	Gannet, kittiwake, guillemot, razorbill and puffin
Fowlsheugh SPA	Kittiwake, guillemot and razorbill
St Abb's Head to Fast Castle SPA	Kittiwake and guillemot
Outer Firth of Forth and St Andrews Bay Complex pSPA	Gannet, kittiwake, guillemot, razorbill and puffin

5. There was discussion as to whether the kittiwake and razorbill features of the St Abb's Head to Fast Castle SPA should be assessed as the Seagreen sites lie beyond the mmfr of these species from the SPA. Following consultation with SNH, it was concluded that kittiwake should be included on the basis that the Seagreen site, at approximately 68 km distant, is only 8 km beyond the limit of the species' mmfr (60 km). However, razorbill was excluded because the Seagreen sites lie well beyond the mmfr although they are within the mmfr plus one Standard Deviation (SD) (43.5 +/- 35 km) (Thaxter et al. 2012) (Tables 3.2 & 3.3).

6. The issue arose because tracking suggests that, for some species, mmfr may be under-estimated and that values currently in use from Thaxter et al. (2012), which underpin the apportioning of birds to SPAs, may be revised based on new evidence. However, based on current methods of apportioning, the majority of Seagreen's effect on razorbill would be assigned to Forth Islands and Fowlsheugh SPAs with a much smaller proportion assigned to St Abb's Head to Fast Castle SPA (0.051 as advised by SNH). Given the density of razorbill within the Seagreen sites, this would represent a very small number of individuals and minimal effects. SNH therefore concluded that razorbill at this SPA could be excluded from the assessment (letter of 26 February 2019 – see Annex 5). This is in line with the 2017 Scoping Opinion and the HRA approach of the other Forth and Tay developers (IC 2018, NNG 2018). It should be noted that the previous Seagreen approach used mmfr + 1 SD to assign connectivity owing to the inclusion at that time of the Buchan Ness to Collieston Coast SPA which, it has now been agreed, can be excluded from this revised HRA (see paragraphs 11 and 12). As a result, apportioning values in this HRA Addendum differ from those in the 2018 EIAR.

7. Herring gull is also omitted from the HRA because it was assessed in full in the 2018 HRA and the assessment remains unchanged. The species is a feature of Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle SPAs and the Outer Firth of Forth and St Andrew's Bay Complex pSPA. The Seagreen 2018 HRA concluded that the maximum additional herring gull mortality caused by collision at any of the Seagreen sites and any SPA was 0.6 individual per annum. This was due to the effects of Project Alpha and Project Bravo combined at St Abb's Head to Fast Castle SPA. The mortality of less than one bird at any SPA would be indistinguishable from natural variation in baseline mortality and would not contribute significantly to in-combination effects. It was therefore concluded that there would be no adverse effects on the integrity of any SPA arising from effects on herring gull either from the Seagreen sites alone or in combination. SNH concurred with this conclusion in their letter of 2nd November 2018.

8. The Outer Firth of Forth and St Andrew's Bay pSPA is included in this HRA Addendum in the context required by the 2017 Scoping Opinion i.e. for five species: gannet, kittiwake, guillemot, razorbill and puffin. The assessment follows the advice of the Scottish Ministers and SNH in that the 'assessment carried out for these species at the breeding colony SPAs …should also be used for the assessment of the pSPA' and that 'for 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'.

9. Although the export cables pass through the pSPA over a length of 9.4 km, potentially affecting an area of 9.42 km^2 i.e. approximately 0.3% of the total pSPA area of 2720.68 km^2 (SNH 2019), they give rise only to potential construction and decommissioning effects with no potential effects during operation. As this HRA Addendum only considers operational effects, as confirmed with SNH and Marine Scotland on 13th December 2018, the export cables were screened out of this assessment.

10. A detailed assessment of the construction and decommissioning effects of the Offshore Transmission Asset (OfTA) was provided in the Seagreen 2012 Environmental Statement (ES). Annex 6 supplies cross references to the location of this information which includes, amongst other things, cable lengths, corridor widths and cable laying rates. Its effects were considered in the 2018 HRA on a cumulative basis with other projects but, as in this case, screened out of further assessment during the operational period (2018 EIAR Table 16.5).

11. Buchan Ness to Collieston Coast SPA is screened out of further assessment in this HRA Addendum as it was assessed in full in Chapter 16: HRA of the 2018 EIAR for species within mmfr + 1 SD of the optimised Seagreen sites including herring gull and guillemot. The maximum annual collision mortality for herring gull at this SPA was 0.1 individuals. For guillemot, the additional mortality predicted from displacement was between three and four birds depending on whether July 2017 data were included or not. Scaling the effects on guillemot to accommodate a discrepancy identified in the 2018 displacement data (see EIA chapter for explanation), effects would potentially increase to a maximum of seven birds. The breeding population of guillemot at this SPA was estimated to be 45,067 in 2017. Using an adult survival rate of 0.939 and background mortality of 0.061, natural annual mortality equates to 2,749. Additional mortality of seven birds represents an increase of 0.03% and would be indistinguishable from natural variation in baseline mortality allowing the conclusion of no adverse effects on the integrity of the SPA arising from effects on either herring gull or guillemot species. SNH concurred with this conclusion for the Seagreen sites alone and in combination in their letter of 2nd November 2018. This SPA is therefore not considered further. Kittiwake was excluded from the 2018 EIAR assessment because the SPA, at 82 km distant from the Seagreen sites, is at the limits of the species' foraging range based on mmfr + 1 SD (Table 3.2) and therefore no effects were anticipated.

12. No likely significant transboundary effects were identified with regards to European sites (Seagreen 2018). However, other offshore wind projects located outside Scottish waters in the UK North Sea and Channel have potential non-breeding season effects on the Scottish SPAs scoped in to this assessment. These other projects are considered, specifically for gannet and kittiwake, in the cumulative assessment.

3.1 SPA information

13. Full descriptions of each SPA can be found in the 2018 EIAR: Chapter 16, paragraphs 16.211 to 16.240 and are not repeated here. The distances of each SPA/pSPA from the edge of the optimised Seagreen Project (i.e. the closest point not including any site buffers) are given in Table 3.3. For purposes of the apportioning calculations, distances are measured from the Seagreen site centroid to the closest point of the SPA.

Table 3-2 Mean maximum foraging range of species considered in this Addendum (Thaxter et al. 2012)

Species	Mean-maximum foraging range + 1 SD (km)
Gannet	229.4 +/- 124.3
Kittiwake	60 +/- 23.3
Guillemot	84 +/- 50.1
Razorbill	48.5 +/- 35
Puffin	200 +/- 105.6

Table 3-3 Distances of each SPA from the edge of the Seagreen site

SPA / pSPA	Distance from the edge of the Seagreen site (km)
Fowlsheugh SPA	30
Forth Islands SPA	53
St Abb's Head to Fast Castle SPA	68
Outer Firth of Forth and St Andrew's Bay Complex pSPA	17

14. The conservation objectives of the three SPAs are the same as for all designated SPAs in Scotland and are:

- To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:

- population of the species as a viable component of the site;
- distribution of the species within the sites;
- distribution and extent of habitat supporting the species;
- structure, function and supporting processes of habitats supporting the species; and
- no significant disturbance of the species.

15. The footprint of the optimised Seagreen Project and 2 km buffer (excluding the cable corridor) does not overlap the designated SPAs considered here. For this reason it will not directly disturb or affect the distribution of the species within the SPAs nor alter the distribution, extent, structure, function and supporting processes of the habitat within them. The HRA therefore focuses on the objective of maintaining the 'population of the species as a viable component of the site' as advised in the 2017 Scoping Opinion and as evidenced by collision and disturbance effects potentially arising from the operation of the optimised Seagreen Project.

16. The conservation objectives of the pSPA are still in draft but differ from those above. They are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, subject to natural change, thus ensuring that the integrity of the site is maintained in the long-term and it continues to make an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species.
- This contribution will be achieved through delivering the following objectives for each of the site's qualifying features:

  - Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term;
  - To maintain the habitats and food resources of the qualifying features in favourable condition.

17. The optimised Seagreen Project is a minimum of 17 kilometres from the pSPA and therefore will not directly disturb or affect the distribution of species or habitats within it. However, effects on its features (Table 3.1) will be considered in the context of their breeding colony SPAs as required by the 2017 Scoping Opinion, focussing on the same conservation objective as described for the SPA. Excepting razorbill, these pSPA features are all designated for the breeding season with kittiwake, guillemot and razorbill also designated for the non-breeding season (SNH 2016b).

18. In relation to the conservation objective to 'maintain the habitats and food resources of the qualifying features in favourable condition', the 2017 Scoping Opinion records that SNH are 'satisfied that the previous assessments adequately address cable impacts for each of the Forth & Tay wind farms' and have 'consider(ed) potential loss or damage to supporting habitat and prey species within the pSPA, arising from cable installation, as well as any disturbance to pSPA bird interests'. They concluded that cable would not give rise to 'any significant amount of permanent habitat loss' and that 'habitats or prey disturbed during the cable laying should not take long to recover' i.e. no likely significant effects are anticipated.

4. HRA methodology

19. In line with the 2018 EIAR, this HRA Addendum only considers effects during the operational period, all other potential effects having been screened out. This approach was confirmed with SNH and Marine Scotland on 13th December 2018.

20. The effects considered are collision mortality and displacement with the worst case scenario (WCS) differing between the two. The WCS described in the 2018 EIAR at Chapter 16, Table 16.11 remains unchanged. It is repeated in the ornithology EIA chapter of this Addendum at section 2.5 for displacement and section 2.7 for collision.

21. Based on the impact predictions in the ornithology EIA chapter of this Addendum, effects on each species have been apportioned to the three breeding seabird SPAs as described below. Effects are expressed as a change in adult survival rate and further explored by Population Viability Analysis (PVA) as required by the 2017 Scoping Opinion. Where a change in adult survival rate is referenced it has been calculated as shown in the example below.

EXAMPLE 1 : Calculation of change in survival rate

Population size of Forth Islands kittiwake = 9,326 adult individuals

Adult survival rate (from PVA model) = 0.854

Annual natural adult survival = adult population size x survival rate = 9,326 X 0.854 = 7,964

Additional annual mortality is, for example, 20 birds

Revised annual survival = natural survival - additional mortality = 7,964 – 20 = 7,944

Revised annual survival rate = 7,944/9,326 =0.852

Change in survival rate = 0.854 - 0.852 = 0.002 (or 0.2%)

4.1 Apportioning and assessment of cumulative effects

22. The apportioning methodology described in the 2018 EIAR Appendix 16B has been revised in order to address discrepancies identified during the data review for this Addendum. The main revisions are to:

- stage II of the process whereby the SPA proportion of the regional population based on Seabird 2000 data is re-calculated based on current SPA counts; and
- the weighting of Fowlsheugh SPA to which additional colonies had been attributed.

The previous Appendix 16B on apportioning (Seagreen 2018) is therefore superseded by the information in this HRA Addendum and the apportioning tables provided in Annex 4. However, it should be noted that most values are similar to those in the original documents (e.g. Seagreen 2018 EIAR, Chapter 16: HRA Table 16.21).

4.1.1 Seasons for assessment as advised in the Scoping Opinion (MS 2017)

23. Seasons for assessment are shown in Table 4.1. For gannet and kittiwake the non-breeding season has been further divided into post-breeding (autumn passage) and pre-breeding (spring passage) as in the 2018 EIAR. This is to enable comparison with similar seasons used to define the reference populations for the assessment of non-breeding season effects (Furness 2015).

4.1.2 Breeding season

24. Mortality during the breeding season was apportioned to each European site following the SNH (2016a) methodology as advised by the 2017 Scoping Opinion whilst noting that the methodology has since been updated (SNH 2018). However, the update would not affect the conclusions reached in this Addendum.

Table 4-1 Seasons for assessment

Species	Breeding	Non-breeding	Post-breeding	Pre-breeding
Gannet	mid-March - September	October - mid-March	Oct - Nov	Dec – mid Mar
Kittiwake	mid-April - August	September - mid-April	Sep – Dec	Jan – mid Apr
Guillemot	April - mid-August	mid-August – March	N/A	N/A
Razorbill	April - mid-August	mid-August – March	N/A	N/A
Puffin	April - mid-August	mid-August – March	N/A	N/A

25. The SNH (2016a) methodology was retained to enable a fair comparison between Seagreen's optimised Project and its 2014 consented projects which used similar methods, and to keep common currency with the 2018 Neart na Gaoithe consent and the 2018 Inch Cape application both of which were based on 2016 or earlier guidance. The Marine Scotland apportionment tool recommended in the 2017 Scoping Opinion was unavailable at the time of the original application and, for consistency, has not been used here.

26. Apportioning followed a two-step approach:

- Stage I used a Geographical Information System (GIS) to identify all breeding colonies within mean-maximum foraging range of the edge of the optimised Seagreen Project as the closest point. Colony size was determined using Seabird 2000 data as this was the last year in which a contemporaneous count of all colonies was available. Each colony was weighted according to its distance from the geometric centre of the site (as a representative distance for the whole site) and the proportion of sea available within foraging range using the formula shown below. From this, the proportion of SPA to non-SPA colonies was established.
- Stage II took the SPA proportion derived in Stage I and reapportioned it to the relevant SPA colonies using the latest population counts provided by SNH.

27. The weighting value (W) was calculated for each colony population as:

$$W = (N / \text{Sum of } N) * (\text{Sum of } (D^2) / D) * ((1\text{-Psea}) / (\text{Sum of } (1\text{-Psea}))$$

where N is the population size of each colony, D is the distance (km) from each colony to the geometric centre of the site and Psea is the proportion of open sea within the foraging range of each colony. Apportioning tables are provided in Annex 4.

28. Note that, unless specified, all population counts used in this HRA Addendum are individual birds rather than pairs.

29. The number of individuals apportioned to each SPA during the breeding season was sub-divided into adults and sub-adults based on the proportions observed at sea for gannet and kittiwake or, for auks, using age classes based on the PVA stable age structure (Table 4.2). In this instance, juveniles /young of the year were not separated from other sub-adults as this information was not available for all sites included in the cumulative assessment. For the other Forth and Tay projects, the proportion of adults observed at sea was taken from their respective EIARs.

30. During the breeding season some adult birds were assumed to be 'sabbatical' i.e. taking a break from breeding, according to the rates advised in the 2017 Scoping Opinion and were removed from mortality estimates before the assessment was made. The sabbatical rates advised were:

- Gannet and kittiwake - 0.1 (10%)
- Auks – 0.07 (7%)

Table 4-2 Apportioning[1] of non-SPA and SPA adult birds to the Seagreen sites during the breeding and non-breeding seasons

Species	Season	Non SPA	Forth Islands SPA	Fowlsheugh SPA	St Abb's Head to Fast Castle SPA
Gannet	Breeding	0.004	0.996	N/A	N/A
	Post-breeding	N/A	0.31	N/A	N/A
	Pre-breeding	N/A	0.62	N/A	N/A
Kittiwake	Breeding	0.44	0.092	0.419	0.044
	Post-breeding	N/A	0.007	0.014	0.005
	Pre-breeding	N/A	0.009	0.018	0.006
Guillemot	Breeding	0.10	0.176	0.586	0.135
	Non-breeding	0.10	0.176	0.586	0.135
Razorbill	Breeding	0.31	0.22	0.467	N/A
	Non-breeding	0.31	0.22	0.467	N/A
Puffin	Breeding	0.19	0.807	N/A	N/A

[1] Numbers taken from Annex 4

Table 4-3 Proportions of adult and sub-adult age classes at the Seagreen sites during the breeding season

Species	Season	Adult	Sub adult
Gannet[2]	Breeding	0.976	0.024
	Post-breeding	0.934	0.066
	Pre-breeding	0.982	0.018
Kittiwake[1]	Breeding	0.914	0.086
	Post-breeding	0.663	0.337
	Pre-breeding	0.798	0.202
Guillemot[3]	Breeding	0.55	0.45
	Non-breeding	0.55	0.45
Razorbill[2]	Breeding	0.6	0.4
	Non-breeding	0.6	0.4
Puffin[2]	Breeding	0.53	0.47

4.1.3 Non-breeding season

31. Methods of apportioning effects to SPAs during the non-breeding season differ between species.

32. For gannet and kittiwake in the non-breeding season, the 2017 Scoping Opinion required cumulative collision effects to be calculated from other offshore wind farms in the North Sea (and Channel for gannet only). The apportioning of effects was therefore based on the Biologically Defined Minimum Population Scale (BDMPS) described by Furness (2015) with some methodological updates, particularly for gannet.

4.1.3.1 Gannet

33. Gannets are migratory and, during autumn and spring passage, the Forth Islands SPA population forms part of a larger regional BDMPS population (Furness 2015). In order to assess cumulative effects during passage periods the proportion of Forth Islands (or other) SPA birds in the BDMPS population must therefore be calculated and this proportion applied to the estimated effects from each offshore wind farm.

[2] Proportions observed in 'at-sea' surveys

[3] Proportions taken from the stable-age class structure as applied in the PVA

Seagreen 2018 approach

34. In the Seagreen (2018) EIAR the proportion for each season was derived simply by taking the number of birds from the SPA of interest from tables in Furness (2015) and expressing it as a proportion of the total BDMPS population in the region taken from the same table. This number was then used to apportion wind farm effects.

35. For example, the post-breeding adult population of adult Forth Islands SPA gannets in the BDMPS is given as 110,964 and the total post-breeding population as 456,299, therefore the proportion of the Forth Islands SPA gannets in the post-breeding (autumn) passage population was 110,964/456,299 = 0.243. For the pre-breeding season, the respective numbers were 77,675 and 248,385 giving a proportion of 0.313. These proportions were then applied to the seasonal collision estimates for the Seagreen projects and all other wind farms in the cumulative assessment. Therefore, if 100 birds were predicted to collide during the post-breeding season, the number assumed to have to come from Forth Islands SPA was 100*0.243 = 24.3.

36. In the 2018 EIAR, the list of wind farms for inclusion in the cumulative assessment was agreed with MS/SNH and based on information originally used for Hornsea Project Two (SMart Wind 2015).

HRA Addendum approach

37. The above methods have been updated in this HRA Addendum because, since the publication of Furness (2015), the original BDMPS populations have been updated with:

- more recent colony counts; and
- new information on the proportions of birds migrating south or north from each colony based on tracking data (MacArthur Green 2015a).

38. This has led to changes in:

- the proportions of birds with connectivity to Forth Islands (or other) SPA in each season; and
- the total BDMPS population in each season as it relates to specific offshore wind farms in the region depending on their location in the North Sea.

39. These updated numbers were first used for the cumulative assessment of gannet collision risk from all wind farms in the UK North Sea and Channel at East Anglia THREE (RHDHV 2015, MacArthur Green 2015a). At that time, collision estimates were based on the consented capacity of each wind farm.

40. Subsequently, a method was developed to update the estimated collisions based on the wind farms' 'as built' rather than consented capacity (MacArthur Green 2017). In the majority of cases 'as built' capacity is lower than the consented capacity meaning that collision estimates are reduced. These updated collision numbers have been used to revise cumulative effects and were partitioned into adult and sub-adult age classes according to the proportions used by Furness (2015).

41. The collision numbers derived in this way are based on slightly different seasons for assessment than those recommended by SNH therefore the final step was to apply an adjustment factor to align them.

42. The revised methodology briefly described above was the subject of discussion between SNH and Inch Cape in the context of the SNH (2017) advice note on non-breeding season assessment. As a result, the information in the advice note was superseded as outlined in SNH/MS correspondence with Inch Cape (emails from MS of 1/11/2017, 8/11/2017 and 30/11/2017).

43. This HRA Addendum follows the revised methods agreed between Inch Cape (2018) and SNH/MS and, in line with similar methods used for Norfolk Vanguard (RHDHV 2018 Table 6.6), includes three further wind farms in the cumulative assessment of gannet. These are: Beatrice Demonstrator, Thanet Extension and Hornsea Three. All offshore wind farms included in this assessment are shown in Table 4.4. The data tables supporting this assessment are reproduced in Annex 4 and an example of the process provided below (Example 2).

44. Despite the more complex, updated methods used in this HRA Addendum it should be noted that the numbers derived by the approach used in the 2018 EIAR are very similar, providing increased confidence in the current outputs.

4.1.3.2 Kittiwake

45. The approach to apportioning kittiwake effects to the three relevant SPAs: Forth Islands SPA, Fowlsheugh SPA and St Abb's Head to Fast Castle SPA, is similar to the Seagreen 2018 approach described for gannet above. It was initially developed for the cumulative assessment of kittiwake at East Anglia THREE (MacArthur Green 2015b, RHDHV 2015) with similar methods used at Hornsea Project Two (SMart Wind 2015), Norfolk Vanguard (RHDHV 2018) and Inch Cape (2018). Steps in the process are described below.

- Step 1: The proportion of birds (adults and sub-adults) from the SPA of interest either passing through or remaining in the North Sea BDMPS is extracted from Furness (2015) for each part of the non-breeding season, noting that numbers may differ between autumn and spring passage (MacArthur Green 2015b).
- Step 2: the adult population of the SPA is multiplied by this proportion to find the number of SPA birds remaining in or passing through the North Sea in the appropriate season.

- Step 3: The total North Sea BDMPS population at this time, including adults and sub adults, is taken from Furness (2015).
- Step 4: The final proportion of SPA birds in the BDMPS is found by dividing the SPA number of adults by the BDMPS population of adults and sub-adults combined. This is then repeated for sub-adults. This proportion can then be used to assign the effects of specific windfarms.

46. As with gannet, updated seasonal collision estimates for other wind farms in the North Sea (Table 4.4) were calculated according to the 'as built' as opposed to consented scenarios using wind farm specific factors from The Crown Estate 'Headroom' report (MacArthur Green 2017).

47. Finally, where the SNH season for assessment differed from that defined in the original documents (Furness 2015) a further seasonal adjustment factor was applied to the collision estimate. Numbers were then summed to calculate cumulative collision effects in each season for the other projects in the North Sea (Table 4.4). Seasonal adjustments were not applied to the Forth and Tay projects as the seasons were already aligned with the SNH requirements.

4.1.3.3 Auks

48. As advised in the 2017 Scoping Opinion, non-breeding season effects for guillemot and razorbill were apportioned to SPAs in the same way as for the breeding season. This is because these species are not thought to disperse widely and in the Firth of Forth guillemots, in particular, may return to the region of their breeding colonies as early as October (Harris et al. 2006, Forrester et al. 2007). This apportioning approach is acknowledged to be conservative, however the use of the wider BDMPS population could underestimate effects.

49. Puffin was not assessed in the non-breeding season as advised in the 2017 Scoping Opinion.

50. For all auk species, cumulative effects were assessed for the Forth and Tay projects only, as advised by the 2017 Scoping Opinion, other projects in the wider North Sea having been scoped out.

Table 4-4 Offshore wind farm projects included in the cumulative assessment of gannet and kittiwake

Wind Farm Name		
Beatrice	**Gunfleet Sands**	**Rampion**
Beatrice Demonstrator[4]	Hornsea One	Scroby Sands
Blyth Demonstrator	Hornsea Two	Sheringham Shoal
Creyke Beck A	Hornsea Three[4]	Teesside
Creyke Beck B	Humber Gateway	Teesside A
Dudgeon	Kentish Flats Extension	Teesside B (Sofia)
East Anglia ONE	Lincs	Thanet
East Anglia THREE[4]	London Array	Thanet Extension[4]
EOWDC	Lynn and Inner Dowsing	Triton Knoll
Galloper	Moray Firth	Westermost Rough
Greater Gabbard	Race Bank	

[4] Data available for gannet only

EXAMPLE 2: Calculating the proportion of gannets from Forth Islands SPA at the Seagreen projects during autumn passage

NOTE: numbers are taken direct from MacArthur Green (2015a) Table 2.2 and cannot be reproduced exactly due to rounding protocols in Excel. See Annex 4 for tables.

Step 1: Number of Forth Islands SPA gannet in the autumn passage BDMPS

The adult population of Forth Islands SPA (Bass Rock) is 150,518 birds.

During the non-breeding season Furness (2015) estimates the proportion of adults as 0.55 and sub-adults as 0.45.

The total population of birds from Bass Rock post-breeding (adults and sub adults) is therefore:

150,518 + 121,920 = 272,438 individuals.

Of these birds, 63% are assumed to migrate south through the North Sea and Channel and 37% north around the north of Scotland and down the west coast.

Therefore, the number of birds from Forth Islands SPA in the BDMPS of the North Sea and Channel during autumn passage is:

272,438 * 0.63 = 171,636 individuals flying south and 272,438 * 0.37 = 100,802 flying north.

Step 2: Total autumn passage population at the Seagreen sites

The total BDMPS number of gannets from all colonies flying south in the autumn is estimated at 395,934. However, because the Seagreen projects lie north of colonies at: Helgoland, Flamborough Head and Filey Coast and also Bass Rock, the passage population will not include the birds flying south from these colonies, but will include the birds flying north (Annex 4 Table 1.8).

To recalculate the autumn passage population the south-flying birds must be subtracted from the total number and the north-flying birds added:

395,934 – 2,375 – 30,031 - 171,636 + 0 + 10,010 + 100,802 = 302,704 individuals.

Step 3: Apportioning proportion of effect to Forth Islands SPA

To find the proportion of adult breeding gannet from the Forth Islands SPA in the south-flying autumn passage population, the total number of Forth Island individuals (171,636 from Step 1) must be multiplied by the proportion of adults (0.55) and then calculated as a proportion of the total population.

Number of Forth Islands SPA adults: 171,636 * 0.55 = 94,400

Forth Islands SPA proportion in the autumn passage population =

94,400/302,704 = 0.31

Step 4: Apportioning collisions

The above proportion is then applied to Seagreen's total estimated post breeding (autumn passage) collisions to identify the number which can be attributed to the Forth Islands SPA gannet population.

EXAMPLE 3: Calculating the proportion of adult kittiwakes from Forth Islands SPA in the autumn passage BDMPS of the North Sea (based on MacArthur Green (2015b))

The proportion of adult kittiwakes from Forth Islands SPA estimated to pass through or remain in the North Sea during autumn is 0.6.

The adult population of kittiwake at Forth Islands SPA used in this assessment is 9,326 individuals.

The number of Forth Islands SPA adult birds remaining in the North Sea during autumn is therefore

9,326*0.6 = 5,596 adults

The total BDMPS population at this time = 480,815 adults + 349,028 sub-adults = 829,843 birds

Proportion of Forth Islands SPA kittiwakes (adult) in the autumn passage BDMPS =

5,596/829,843 = 0.007 (or 0.7%)

4.2 Population Viability Analysis (PVA)

51. In order to understand the effects of additional mortality on the SPA population of each species, PVA was carried out. The methodology remains the same as in the 2018 EIAR. However, demographic rates were reviewed to obtain colony- or region-specific information for each species. Where this was unavailable rates were taken from Horswill and Robinson (2015) as advised in the 2017 Scoping Opinion. Full details are provided in the revised PVA Annex 3.

52. In summary, for each of the five species at the relevant SPAs, age-structured, Leslie matrix population models were constructed to simulate population trends over a 25 year period as agreed at a meeting with MS and SNH on 30 April 2018. Models were stochastic and density-independent as advised by the 2017 Scoping Opinion. Models were run initially with no additional wind farm mortality, then using mortality increments appropriate to the total cumulative mortality estimated for the species at that SPA (Table 4.5). Specific mortality was then modelled in the same way according to the predicted additional mortality expressed as a change in adult survival for each Seagreen site alone and for the in-combination scenarios described in each species account. As the specific predicted mortality was calculated at an early stage, in some cases, the PVA mortality modelled differs from the final effect calculated by a small number of individuals.

53. The approach assumes windfarm impacts start in the same year as the latest population counts rather than letting the un-impacted model run for a number of years (a 'burn in' period) before applying the impact. As the levels of impacts are specified in proportion to the latest population count, the results in terms of stable age distributions, growth rates and counterfactuals will be identical to those obtained using a 'burn in' approach, the exception being the end population sizes because the length of projection will differ (i.e. 25 years as opposed to the 'burn in' period plus 25 years). Given the levels of uncertainty surrounding some of the demographic parameters, this approach is considered the most appropriate.

Table 4-5 Incremental mortality used in the PVA model for each species at each SPA

Species	Forth Islands SPA		Fowlsheugh SPA		St Abb's Head to Fast Castle SPA	
	Increment	Total mortality	Increment	Total mortality	Increment	Total mortality
Gannet	25	0 - 1500				
Kittiwake	20	0 - 160	20	0 - 300	10	0 - 50
Guillemot	10	0 - 60	10	0 -100	10	0 - 40
Razorbill	10	0 -100	10	0 -100		
Puffin	10	0 -100				

54. The incremental modelling assumed that additional mortality would occur not only to adults but also to sub- adults in proportion to their presence in the population i.e. additional mortality of 25 adult gannets was assumed to be accompanied by additional mortality to 18 sub-adults; 50 adults was accompanied by 36 sub-adults etc. based on their proportion in the stable age structure of the PVA. Given that for gannet and kittiwake in particular, sub-adults may not return to the region of their breeding colonies for several years and so are unlikely to be in the population affected by these wind farms, this assumption is conservative.

55. For each specific run i.e. additional mortality based on the actual number of adults and sub-adults predicted to be affected, the following PVA metrics were produced as required by the 2017 Scoping Opinion:

- the ratio (counterfactual) of the median impacted to un-impacted population size after 25 years;
- the ratio (counterfactual) of the median impacted to un-impacted annual growth rate after 25 years; and
- the centile for the un-impacted population that matches the 50th centile for the impacted population after 25 years.

4.3 Cumulative assessment

56. Cumulative assessments were made for each species at the relevant SPAs following the scenarios laid out in the ornithology EIA chapter of this Addendum, section 1.2.

57. In each case, Project Alpha and Project Bravo combined represented the worst case Seagreen scenario so this was taken forward for assessment with other projects in the Forth and Tay and the wider region where required. In terms of collision, option 2 results with a 98.9% avoidance rate were used in all cases and for displacement, all site populations were calculated including a 2 km buffer as required by the 2017 Scoping Opinion. The Seagreen data for kittiwake, guillemot and razorbill were adjusted, as agreed with MS/SNH, to acknowledge the unusual foraging event recorded during the July 2017 surveys (see the EIA chapter of this Addendum, section 2.6).

58. Collision and displacement estimates for other projects in the Forth and Tay (2018) were taken from the relevant EIAR (IC 2018, NNG 2018). Estimates for the 2014 collision scenarios for Inch Cape were taken from Annex 2: CRM, with the non-breeding season estimates divided into post and pre-breeding season in proportion to the length of each season. For Neart na Gaoithe, where a discrepancy was identified in the Annex 2 CRM calculations, numbers were taken from Band CRM spreadsheets provided by Marine Scotland. It should be noted that the displacement estimated for Neart na Gaoithe and Inch Cape did not differ between 2014 and 2018 because the site populations and areas did not change between the two assessments.

59. Effects from Inch Cape and Neart na Gaoithe during the breeding season were apportioned to SPAs based on two different data sources. For Inch Cape they were taken from the Developer's Apportioning Appendix, Table 11B.3 (IC 2018). For Neart na Gaoithe, they were taken from spreadsheets provided to inform the Appropriate Assessment for kittiwake and razorbill (SNH 2018b). Apportioning values for gannet, guillemot and puffin were derived from the project's HRA (NNG 2018). The values used are given in the tables below.

60. The apportioning values for these projects in the non-breeding season were the same as those used by Seagreen and given in Table 4.2.

Table 4-6 Apportioning values for the breeding season used for Inch Cape and Neart na Gaoithe

Species	Forth islands SPA		Fowlsheugh SPA		St Abb's Head to Fast Castle SPA	
	Inch Cape[5]	Neart na Gaoithe[6]	Inch Cape	Neart na Gaoithe	Inch Cape	Neart na Gaoithe
Gannet	0.996	0.999*	N/A	N/A	N/A	N/A
Kittiwake	0.210	0.654	0.287	.074	0.056	0.092
Guillemot	0.350	0.62*	0.377	.087*	0.153	0.22*
Razorbill	0.319	0.79	0.314	0.05	N/A	N/A
Puffin	0.900	0.935*	N/A	N/A	N/A	N/A

* Derived from NNG (2018) HRA

61. Where the assessment for the non-breeding season required consideration of projects in the wider North Sea i.e. for gannet and kittiwake, collision mortality was taken from estimates provided in the HRA assessment for East Anglia THREE (RHDHV 2015; Macarthur Green 2015a, b) and updated using the methods described above and in Annex 4. All were underpinned by the BDMPS methodology of Furness (2015).

4.4 Other notes

62. The number of decimal points used in this HRA varies according to the value cited and is a maximum of three for values such as apportioning or PVA metrics where small changes in value may have significant implications. One decimal point is shown where numbers are derived through calculation, are less than one or where they have been taken from the documents of other developers. Final effects estimates are given as 'whole birds' rounded up where the decimal point exceeds 0.5.

63. For ease of reading, references to the 2018 EIAR, including the Appendices, of other Forth and Tay offshore wind farm developers have been abbreviated as follows: Inch Cape is IC 2018; Neart na Gaoithe is NNG 2018.

5 From (IC 2018) Apportioning Appendix, Table 11B.3

6 From SNH (2018b) spreadsheets

5. Forth Islands SPA assessment

64. The Forth Islands SPA is assessed for the five species shown in Table 5.1. The table provides the most recent population count as advised by SNH (counts converted to individual birds) together with the population size at designation and the site condition of the species.

Table 5-1 Qualifying and assemblage features of the Forth Islands SPA assessed in this HRA

Species	Season	Site condition	Cited population – individuals[7]	Current population – individuals (year)
Gannet	Breeding	Favourable maintained	43,200	150,518 (2014)
Kittiwake	Breeding	Unfavourable declining	16,800	9,326 (2017)
Guillemot	Breeding	Favourable maintained	32,000	38,573[8]
Razorbill	Breeding	Favourable maintained	2,800	7,792[9]
Puffin	Breeding	Favourable maintained	28,000	90,010 (2009-2017)

5.1 Gannet – Forth Islands SPA

65. The gannet colony on Bass Rock, Forth Islands SPA has grown rapidly since the site was designated and is now the largest colony in the world with 150,518 individuals as at 2014 (Murray et al. 2014). As most available space is occupied, it is likely that the site is close to capacity, especially given that, since 2016, birds have attempted to nest and finally nested successfully at the nearby St Abb's Head to Fast Castle SPA (NTS 2017) and may represent 'overspill' from the Bass Rock colony.

66. Predicted collision mortality for gannet at the proposed Seagreen site was apportioned to Forth Islands SPA as shown below (Table 4.2) and a sabbatical rate of 0.1 (10%) applied to adult breeding birds:

- Breeding season 0.996 (99.6%)
- Post-breeding 0.31 (31%)
- Pre-breeding 0.62 (62%)

7 Data from SNH Sitelink at https://sitelink.nature.scot/site/8500
8 'Latest count' information received from SNH by email of 21/05/2018
9 'Latest count' information received from SNH by email of 21/05/2018

67. Results for Project Alpha, Project Bravo and Project Alpha and Project Bravo combined for each season are shown in Table 5.2 with option 1 and option 2 shown for comparison. A 98.9% avoidance rate was used for both options as advised by the 2017 Scoping Opinion and described in the CRM methodology (see EIA 2.7 of this Addendum).

68. The annual survival rate of adult gannet is 0.916. That is 137,874 adults from the Forth Island population of 150,518 birds would survive each year in an un-impacted population. The change to adult survival caused by additional collision mortality varied according to the Seagreen site and CRM option used (Table 5.2) but the maximum of 334 adult birds in all seasons based on option 1 collision estimates at Project Alpha and Project Bravo combined represents a proportional change of 0.002 or 0.2% in adult survival.

69. Collision estimates are influenced mainly by the percentage of birds at collision height (PCH) but also by bird density. At the Seagreen sites, the flight heights used in option 1 were observed at sea and verified using optical rangefinders (Harwood et al. 2018) with separate PCH estimates made for each site and season (EIA chapter of this Addendum, Table 2.10). In Project Bravo, the PCH used in option 1 was estimated to be higher than that derived from the generic flight heights used in option 2 (Johnston et al. 2014). Hence, option 1 predicted more collisions. For Project Alpha and Project Bravo combined, the greater influence of Project Bravo in terms of the densities of birds at PCH meant that, as in Project Bravo alone, option 1 estimated greater mortality, although the greater area of the site and hence, number of birds meant that option 2 collision estimates were also high.

Table 5-2 Collision mortality attributed to Forth Islands SPA gannet from the Seagreen projects alone

Gannet			**Estimated collision mortality**	
Project	**CRM option**	**Season**	**Adult[10]**	**Sub-adult**
Alpha	Option 2	Breeding	168	5
		Post-breeding	3	0.2
		Pre-breeding	5	0.0
	Option 1	Breeding	70	2
		Post-breeding	2	0.1
		Pre-breeding	3	0.0

[10] Adults adjusted for sabbaticals

Gannet			Estimated collision mortality	
Bravo	Option 2	Breeding	119	3
		Post-breeding	3	0.2
		Pre-breeding	6	0.0
	Option 1	Breeding	219	6
		Post-breeding	8	0.5
		Pre-breeding	16	0
Alpha + Bravo combined	Option 2	Breeding	245	7
		Post-breeding	5	0.3
		Pre-breeding	10	0
	Option 1	Breeding	310	9
		Post-breeding	8	0.5
		Pre-breeding	16	0

70. Differences in PCH may reflect different ecological uses of the sites by gannet as the flight height of birds commuting to and from foraging areas has been shown to be lower than that used by actively foraging birds (Cleasby et al. 2015).

71. Owing to the differences in flight heights observed at the individual sites, there is no consistent trend between option 1 and option 2 collision estimates for the Seagreen projects. However, option 2 results were taken forward for cumulative assessment and PVA as required by the 2017 Scoping Opinion.

5.1.1 Cumulative collision assessment of gannet at Forth Island SPA - Forth and Tay projects

72. For cumulative assessment, Project Alpha and Project Bravo combined was assessed with the other Forth and Tay projects using the results of Band CRM option 2 and a 98.9% avoidance rate for all projects under two cumulative scenarios:

- Scenario 1: with Neart na Gaoithe as consented in 2018 and Inch Cape as proposed in 2018;
- Scenario 2: with Neart na Gaoithe and Inch Cape as consented in 2014.

73. For scenario 1, breeding season collision estimates for other projects were taken from the relevant EIAR (IC 2018, NNG 2018) and were apportioned to Forth Islands SPA as shown below:

- Inch Cape 99.6%
- Neart na Gaoithe 99%

74. For Inch Cape, numbers were taken for each part of the non-breeding season from the Inch Cape EIAR (IC 2018). However, in the case of Neart na Gaoithe, where numbers were not divided this way, total non-breeding season numbers were split between post- and pre-breeding periods according to the season's length in months (Table 4.1) and apportioned to Forth Islands SPA using the Seagreen proportions of 0.31 post-breeding and 0.62 pre-breeding (Table 4.2).

75. For scenario 2, Project Alpha and Project Bravo combined plus Neart na Gaoithe and Inch Cape as consented in 2014, collision estimates for Inch Cape were taken from Annex 2: CRM. Numbers for Neart na Gaoithe were taken from original spreadsheets supplied by SNH/MS. Calculations for both developments used the updated nocturnal activity rate for gannet of 1 (equivalent to zero nocturnal activity) and the revised flight height distributions of Johnston et al. (corrected) (2014).

76. For the other Forth and Tay projects, the proportion of adults was taken from each Developers' EIAR (IC 2018, NNG 2018):

- Inch Cape: 97.1% adults in breeding season; 94% adults during non-breeding season
- Neart na Gaoithe: 97.5% adults in breeding season; 96.4% adults during non-breeding season.

77. Scenario 1 results predicted a total additional mortality of 421 adult breeding birds with a further 26 adults during the non-breeding seasons (Table 5.3). This level of additional mortality across all seasons would give rise to a change in adult survival rate of 0.003 (0.3%). Mortality of sub-adults was predicted to be an additional 12 birds during the breeding season and one bird during the non-breeding season. The low number of sub-adults reflects their infrequent occurrence in the population observed at sea in the Firth of Forth owing to the fact that juvenile and immature birds may not return to their breeding colonies until they approach breeding age at around five years old (Wanless et al. 2006, Forrester et al. 2007).

Table 5-3 Cumulative collision estimates for gannet at Forth Islands SPA from Forth and Tay projects 2018 and 2014 scenarios (Option 2 and 98.9% avoidance rate)

Forth Islands SPA	**Gannet**	**Estimated collision mortality**	
Scenario/Project	**Season**	**Adults**[11]	**Sub-adults**
Scenario 1: Alpha + Bravo combined 2018	Breeding	245	7
	Post-breeding	5	0.3
	Pre-breeding	10	0
Inch Cape 2018[12]	Breeding	94	3
	Post-breeding	1.6	0.1
	Pre-breeding	2.4	0.1
Neart na Gaoithe 2018[13]	Breeding	82	2
	Post-breeding	1.6	0.1
	Pre-breeding	5.5	0.4
Scenario 1: Seasonal totals – all projects	Breeding	421	12
	Post-breeding	8	0.5
	Pre-breeding	18	0.5
Scenario 1: Cumulative total	**All seasons**	**447**	**13**
Scenario 2: Alpha + Bravo combined 2018	Breeding	245	7
	Post-breeding	5	0.3
	Pre-breeding	10	0
Inch Cape 2014[14]	Breeding	334	11
	Post-breeding	3	0.2
	Pre-breeding	11	0.7
Neart na Gaoithe 2014[15]	Breeding	197	6
	Post-breeding	5	0.4
	Pre-breeding	5	0.3
Scenario 2: Seasonal totals – all projects	Breeding	776	24
	Post-breeding	13	0.9
	Pre-breeding	25	1
Scenario 2: Cumulative total	**All seasons**	**815**	**26**

11 Breeding adults adjusted for sabbaticals.
12 Data from IC (2018) HRA Table 4.2
13 Adjusted data from NNG (2018) Table 2.9
14 Data from Seagreen Addendum (2019) Annex 2 Table 16
15 Data from spreadsheet 2014 04 23 - FTOWDG - CRM MLS - GX.xlsm

78. Scenario 2 represented the worst case for the Forth and Tay projects, estimating a cumulative total of 776 adult collisions during the breeding season and a further 38 adults during the non-breeding season i.e. 815 adult birds in all seasons. The additional adult mortality would give rise to a change in adult survival of 0.005 (0.5%). Sub-adult mortality was estimated at 24 birds during the breeding season and two during the non-breeding season.

79. The 2017 Scoping Opinion requires qualitative consideration of potential collision effects from smaller offshore windfarms in the Forth and Tay region which are within mean-maximum foraging range of the Bass Rock colony (Forth Islands SPA). These projects include the European Offshore Wind Deployment Centre (EOWDC), Hywind, Kincardine and the ORE Catapult turbine at Levenmouth, all in operation, and the consented Forthwind site. These projects may contribute a small number of additional collisions during the breeding season. However, based on gannets' general avoidance of offshore wind farms and that any quantitative collision estimates from these projects will be based on higher nocturnal activity factors than advised in the 2017 Scoping Opinion and collisions thus over-estimated, their effects are considered unlikely to make a material difference to the Forth Islands SPA population.

80. Larger offshore wind projects in the Moray Firth are also technically within range of breeding gannets from Bass Rock but are considered unlikely to contribute to the mortality of its birds. This is due to the spatial partitioning of foraging areas by gannets from different breeding colonies suggesting that these projects are more likely to affect the colony at Troup Head or colonies further north (Wakefield et al. 2013).

81. In summary, breeding season effects from these other offshore wind farms are considered unlikely to make a material difference to overall collision estimates. However, non-breeding season effects from all other projects where collision estimates were available have been included in the non-breeding season assessment which follows.

5.1.2 Cumulative collision assessment of gannet at Forth Island SPA - Forth and Tay plus non-breeding season effects from other UK North Sea and Channel projects

82. The cumulative collision effects of the WCS of the Forth and Tay projects i.e. Project Alpha and Project Bravo combined (2018 application) and Neart na Gaoithe and Inch Cape as consented in 2014, were combined with the predicted collision effects on gannet from other wind farms in the UK North Sea and Channel during the non-breeding season (Table 5.4). Tables showing how these numbers were derived are provided in Annex 4.

83. Additional mortality from wind farms in the UK North Sea and Channel was estimated at 83 adults (57 during the post-breeding season and 26 during the pre-breeding season) plus 68 sub-adults (47 post-breeding and 21 pre-breeding) in addition to the mortality estimated for the Forth and Tay projects. In total, this would be 897 adults and 94 sub-adults from the Forth Islands SPA gannet population. This would be equivalent to a change in adult survival from 0.916 to 0.910 i.e. 0.006 (0.6%).

84. It is noted that these numbers are not dissimilar to those in the 2018 EIAR which estimated a total additional mortality of 768 adult birds during the breeding season and an overall total of 951 adult birds in all seasons compared to the 776 and 897 estimated in Table 5.4

85. Care should be taken in the interpretation of the above numbers owing to the assumptions underpinning the cumulative calculations which, whilst based on best available information, may be subject to revision e.g. due to changes in methodology, and because some of the consented wind farms in the wider North Sea are submitting revised planning applications which would reduce impacts or, alternately, may not build out to full capacity which would revise collision estimates downwards.

Table 5-4 Cumulative collision estimates for gannet at Forth Islands SPA from Forth and Tay projects plus non-breeding season impacts from wind farms in the UK North Sea and Channel

Project/Scenario	**Season**	**Estimated collision mortality**	
		Adults	**Sub-adults**
Cumulative: Seagreen Alpha + Bravo combined 2018 and other Forth and Tay projects 2014	Breeding	776	24
	Post-breeding	13	1
	Pre-breeding	25	1
Other UK North Sea offshore wind farms[16]	Post-breeding	57	47
	Pre-breeding	26	21
Seasonal totals	Breeding	776	24
	Post-breeding	70	48
	Pre-breeding	51	22
Cumulative total	**All seasons**	**897**	**94**

.

[16] See Annex 4 for calculations

5.1.3 Gannet - Forth Islands SPA - PVA and discussion

86. Results for the gannet PVAs are laid out in Table 5.5. They show that under all scenarios the gannet population of the Forth Islands SPA is predicted to increase above its current size. Each of the Seagreen projects alone makes a relatively small difference to the end population size after 25 years (worst case counterfactual of 0.966 or 97%) and a very small change to growth rate (counterfactual of 0.999 or 99%).

87. When considering cumulative additional mortality based on the 2018 scenario for all Forth and Tay projects the population size after 25 years is predicted to be 95% of that of the un-impacted population.

88. Based on the worst case scenario of Project Alpha and Project Bravo combined using 2018 parameters and the other Forth and Tay projects as consented in 2014, the population size would be 90% of the un-impacted population after 25 years. In both scenarios, the growth rate is maintained at above 99% of the un-impacted population. The centile of the un-impacted population matching the 50th centile of the impacted population however shows greater deviation and changes from 11% to 9%.

89. When considering the worst case Forth and Tay scenario with additional non-breeding season collision mortality from other OWFs in the UK North Sea and Channel, the counterfactual of population size drops slightly below 90% (counterfactual of 0.881) although the growth rate still remains above 99% of the un-impacted population (counterfactual of 0.995) and the predicted end population size after 25 years is approximately 26,000 birds higher than at present.

90. At this level of impact, the centile matching the 50th centile of the impacted population is 5% suggesting a low overlap between the impacted and un-impacted population distributions. In this context it is important to note that the centile metric, unlike the counterfactuals, expresses the uncertainty around the demographic rates driving the population models and is also sensitive to population trends (Cook & Robinson 2016). In the case of gannet, the coefficient of variation is low compared to the other species modelled by PVA (4.6% compared to 36.4% for kittiwake at Forth Islands SPA (DMP Statistics Pers. Comm.)) and, as a result, projections of both un-impacted and impacted population size have narrower distributions and are therefore less likely to overlap. This is therefore an unreliable metric to use for comparison between species and needs to be carefully interpreted.

91. The counterfactual of end population size calculated for gannet in the 2014 AA (MS 2014) was 79% compared to 88% for the worst case cumulative scenario in the current assessment meaning that current effects are reduced from 2014. This is due to project modifications using fewer, larger turbines and increased rotor tip clearance. Reductions occur in spite of the fact that some elements of the 2018 assessment are more conservative e.g. the inclusion of effects from projects in the wider North Sea and Channel.

92. The 2014 AA also included a threshold below which it was determined that the Forth Islands SPA gannet population would be unlikely to decline below current levels. MSS and the Statutory Nature Conservation Bodies (SNCB) agreed that this was a decline of 1.17%, equivalent to 1,300 adult birds. Since then, the gannet population has been revised upwards to 150,518 individuals (Murray et al 2014). Using the same percentage of 1.17%, the threshold number would now be equivalent to 1,761 adult birds. The current worst case estimate of additional mortality of 897 adult birds is well below this.

93. This level of additional mortality may be an overestimate for a number of reasons. For example, a revised application for the Neart na Gaoithe project as consented in 2014 was submitted in 2018 and achieved consent. Should Neart na Gaoithe be built out to the revised scenario then approximately 100 fewer adult collisions are predicted than in 2014 (Table 5.3).

94. With regard to other North Sea and Channel wind farms, effects may also be overestimated because, although collisions have been adjusted for the 'as built' rather than consented developments following the methods of The Crown Estate's 'headroom' report, many of the projects included are currently submitting revised applications for fewer, larger turbines which would reduce these collision estimates further (e.g. Creyke Beck Non-Material Change Application consented in April 2019). In addition, the estimates used in this example have not been adjusted for reductions to the nocturnal activity factor (from 25% to 0% of day time activity) excepting collisions from the three projects added from the Norfolk Vanguard assessment which were based on stochastic simulations including a range of nocturnal activity factors between 0% and 25% (NV 2018). This would also result in fewer predicted collisions.

Table 5-5 PVA outputs for Forth Islands SPA gannet

Project / Scenario	Additional mortality[17]		Starting population	Median end population after 25 years	Counterfactual of population size (impacted / unimpacted)	Counterfactual of population growth rate (impacted / unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	150,518	200,706	1.000	1.000	50
Alpha	176	5	150,518	195,974	0.977	0.999	30
Bravo	128	3	150,518	197,264	0.983	0.999	34
Alpha + Bravo combined	260	7	150,518	193,761	0.966	0.999	22
Alpha + Bravo combined with other Forth and Tay projects 2018	423 (447)	12 (13)	150,518	189,518	0.945	0.998	11
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014	822 (815)	25 (26)	150,518	179,490	0.895	0.996	9
Alpha + Bravo combined (2018) with other Forth and Tay projects as consented in 2014 plus non-breeding season effects from other wind farms in the UK North Sea and Channel[18]	904 (897)	93 (94)	150,518	176,539	0.881	0.995	5

[17] Additional mortality is the specific mortality modelled. Where final mortality estimates differ, they are given in brackets

[18] See Annex 4 for calculations

95. Other factors which may mean the current assessment is conservative relate to the avoidance rate of 98.9% advised by the 2017 Scoping Opinion. As noted previously, Bowgen and Cook (2018) have recently reviewed the empirical data collected during the ORJIP project and concluded that gannet avoidance rates could be raised to 99.5% to reflect high levels of macro-avoidance. This would more than halve the number of collisions predicted here. Whilst the 99.5% rate does not currently represent SNCB guidance, and there are concerns that these estimates are based on non-breeding birds, it seems a more realistic rate given that gannets appear to be very sensitive to displacement and demonstrate strong avoidance of windfarms (Vanermen & Stienen 2019). Another way of considering this issue is that if post-construction monitoring were to confirm that gannets avoid windfarms, revised CRM using current methods and avoidance rates would be based on significantly reduced gannet densities. CRM using these reduced density values would have the same effect as increasing the avoidance rate i.e. theoretical collisions would be reduced.

5.1.4 Gannet - Forth Islands SPA - Summary

96. The gannet population of Forth Islands SPA has increased rapidly since designation and its conservation status is 'favourable maintained'. The current assessment indicates that, at the predicted levels of impact, the population is likely to continue to increase, albeit at a slightly slower rate than the un-impacted population and is therefore unlikely to fall below its current level. The cumulative effects estimated here by a more conservative assessment than in 2014, and in line with current SNCB guidance, are well below those predicted for the Forth and Tay projects as consented in 2014. Based on this, it is concluded that the Forth Islands SPA gannet population would be maintained in the long term. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on the Forth Islands SPA arising from effects on this species.

5.2 Kittiwake – Forth Islands SPA

97. Kittiwake is the most numerous gull in the world (Coulson 2011) however some populations have recently undergone rapid decline. At Forth Islands SPA the population appears to have increased to a maximum in the late 1990s, then slowly declined until 2013 both the increase and decline replicating widespread trends. Since then the population appears to have been stabilising or increasing slowly but remains below that at designation (Seagreen 2018, Table 16.27).

98. Kittiwake is assessed separately for collision and displacement and both effects combined. Seagreen effects are presented in two ways:

- with all data including the very high values recorded in July 2017; and
- with adjusted data i.e. where the July 2017 density data were replaced by the median July value recorded over the three survey years. This applies to breeding season

mortality estimates for both collision and displacement and is indicated in the results tables as 'Breeding (adj)'. In all cases, adjusted estimates were taken forward for the cumulative assessment as agreed with SNH and MS. Further details are provided in the EIA chapter of this Addendum, section 2.6 and Annex 5.

99. It should be noted that the high values observed in the July 2017 data have been incorporated into the overall assessment through the use of all 2017 data to calculate scaling factors which were applied to Seagreen's 2009 – 2011 densities. These generally increased densities were used to calculate the population of the site and 2 km buffer required for the assessment of displacement.

100. Predicted mortality for kittiwake at the proposed Seagreen sites was apportioned to Forth Islands SPA as shown below (and Table 4.2) and a sabbatical rate of 0.1 (10%) applied to adult breeding birds:

- Breeding season 0.092 (9.2%)
- Post-breeding 0.007 (0.7%)
- Pre-breeding 0.009 (0.9%)

5.2.1 Kittiwake – Forth Islands SPA - Collision

101. Predicted kittiwake collision mortality at Project Alpha, Project Bravo and Project Alpha and Project Bravo combined at Forth Islands SPA in each season is shown in Table 5.6 with option 1 and option 2 and 98.9% avoidance rate results shown for comparison.

102. Adjusted data (EIA chapter of this Addendum, section 2.6) are shown only for Project Alpha and Project Alpha and Project Bravo combined. This is because for Project Bravo, the median density of birds in flight was represented by the July 2017 data and therefore no adjustment was needed.

103. The annual survival rate of adult kittiwake is 0.854. That is 7,964 adults from the Forth Island kittiwake population of 9,326 birds would survive each year in an un-impacted population. For all sites and any option of the CRM, the maximum predicted change in adult survival was 0.001 (0.1%). This low level of effect is likely due to the location of the Seagreen site in relation to this SPA which, at 53 km distant, is towards the mean-maximum foraging range of the species (60 km). In addition, the spatial partitioning of foraging areas by breeding kittiwake from different colonies, as demonstrated by specific data on Forth Islands SPA birds (Wakefield et al. 2017) suggests that the Seagreen sites are more likely to be used by breeding birds from Fowlsheugh SPA.

Table 5-6 Collision estimates attributed to Forth Islands SPA kittiwake from the Seagreen projects alone

Forth Islands SPA Kittiwake			Estimated collision mortality	
Project	**CRM option**	**Season**	**Adult[19]**	**Sub-adult**
Alpha	Option 2	Breeding	8	0.8
		Breeding (adj)[20]	6	0.6
		Post-breeding	0.3	0.1
		Pre-breeding	0.2	0
	Option 1	Breeding	9	0.9
		Breeding (adj)	6	0.7
		Post-breeding	0.3	0.1
		Pre-breeding	0.2	0
Bravo	Option 2	Breeding	5	0.5
		Post-breeding	0.2	0.1
		Pre-breeding	0.2	0.1
	Option 1	Breeding	3	0.4
		Post-breeding	0.1	0
		Pre-breeding	0.1	0
Alpha + Bravo combined	Option 2	Breeding	11	1
		Breeding (adj)	8	0.9
		Post-breeding	0.4	0.2
		Pre-breeding	0.3	0.1
	Option 1	Breeding	10	1
		Breeding (adj)	9	1
		Post-breeding	0.3	0.1
		Pre-breeding	0.2	0.1

[19] Breeding adults adjusted for sabbaticals

[20] (Adj) Data adjusted by substituting the median July density recorded over the three years for the maximum recorded in July 2017

5.2.2 Cumulative collision assessment of kittiwake at Forth Island SPA - Forth and Tay projects

104. For cumulative assessment, Project Alpha and Project Bravo combined using adjusted data was assessed with the other Forth and Tay projects using the results of Band CRM option 2 and a 98.9% avoidance rate for all projects under two scenarios:

- Scenario 1: with Neart na Gaoithe as consented in 2018 and Inch Cape as proposed in 2018;
- Scenario 2: with Neart na Gaoithe and Inch Cape as consented in 2014.

105. For scenario 1, based on data from each Developer's EIAR (IC 2018, NNG 2018), a total additional mortality of 21 adult birds was predicted during the breeding season and approximately one adult bird during the non-breeding season. This additional adult mortality across all seasons would give rise to a change in adult survival of 0.002 (0.2%). Mortality of sub-adults was predicted to be an additional 2 birds during the breeding season and one bird during the non-breeding season. This low number of sub-adults reflects their relatively infrequent occurrence in the population observed at sea in the Forth and Tay.

106. For scenario 2, collision estimates for Inch Cape as consented in 2014 were taken from Annex 2: CRM and for Neart na Gaoithe from developer's spreadsheets provided by Marine Scotland. Breeding birds were adjusted for sabbaticals at a rate of 10% and collisions apportioned to Forth Islands SPA at the rates shown below:

- Inch Cape 21 % (breeding) (IC 2018, Appendix 11B);
- Neart na Gaoithe 65.4% (breeding) (SNH 2018b).

107. For the breeding and non-breeding season, numbers were adjusted for the proportion of adults observed at sea as given in the projects' ornithology technical reports i.e.

- Inch Cape: 97.1% breeding season; 59.4% autumn passage, 83.4% on spring passage;
- Neart na Gaoithe: 93.2% breeding season, 51.8% autumn passage, 71.4% on spring passage.

108. Totals for the non-breeding season were divided into post-breeding and pre-breeding birds in proportion to the length of each season. The non-breeding season proportions attributed Forth Islands were as used by Seagreen (Table 4-2).

109. Scenario 2 predicted higher level of mortality than Scenario 1 with a total of 46 adults during the breeding season and a further 1 during the non-breeding season. This total of 48 adults would equate to a change in adult survival of 0.005 (0.5%). In addition, a total of 2.7 sub-adult birds were predicted to collide during the breeding season and less than one sub-adult in the non-breeding season (Table 5.7).

Table 5-7 Cumulative collision estimates for kittiwake at Forth Islands SPA from Forth and Tay projects 2018 and 2014 scenarios (Option 2 and 98.9% avoidance rate)

Forth Islands SPA Kittiwake		Estimated collision mortality	
Project/Scenario	**Season**	**Adults**	**Sub-adults**
Scenario 1: Alpha + Bravo combined 2018	Breeding (adj)[21]	8.4	0.9
	Post-breeding	0.4	0.2
	Pre-breeding	0.3	0.1
Inch Cape 2018[22]	Breeding	7	1
	Post-breeding	0.1	0.1
	Pre-breeding	0.1	0.1
Neart na Gaoithe 2018[23]	Breeding	6	0
	Post-breeding	0.1	0.1
	Pre-breeding	0.1	0.1
Scenario 1: Seasonal totals	Breeding	21	2
	Post-breeding	0.6	0.4
	Pre-breeding	0.5	0.3
Scenario 1: Cumulative total	**All seasons**	**22**	**3**
Scenario 2: Alpha + Bravo combined 2018	Breeding (adj)	8	0.9
	Post-breeding	0.4	0.2
	Pre-breeding	0.3	0.1
Inch Cape 2014[24]	Breeding	26	1
	Post-breeding	0.2	0.2
	Pre-breeding	0.3	0.1
Neart na Gaoithe 2014[25]	Breeding	12	1
	Post-breeding	0.1	0.1
	Pre-breeding	0.0	0.0
Scenario 2: Seasonal totals	Breeding	46	2.7
	Post-breeding	0.7	0.4
	Pre-breeding	0.7	0.2
Scenario 2: Cumulative total	**All seasons**	**48**	**3**

21 Adj = Data adjusted by substituting the median July density recorded over the three years for the maximum recorded in July 2017

22 Data from IC (2018) HRA Table 4.6.

23 NNG (2018) HRA Tables 2.16 and 2.17 and SNH 2018b

24 Data from Seagreen (2019) Annex 2: CRM

25 Data from NNG spreadsheet 2014 04 23 - FTOWDG - Offshore Wind - Cumulative Impacts - Kitti.xlsm

110. There are a number of smaller offshore windfarms in the Forth and Tay region within mean-maximum foraging range of breeding kittiwake from the Forth Islands SPA. These projects include the coastal sites of Forthwind (as consented) and the ORE Catapult turbine at Levenmouth which is in operation. The AA of the consented Forthwind project did not consider kittiwake to be at risk. In general, the low levels of collision impacts on kittiwake predicted from these projects are considered unlikely to make a material difference to the Forth Islands SPA population. However, impacts on the SPA from all projects where collision estimates are available were incorporated in to the assessment of cumulative effects during the non-breeding season when the population disperses away from the colony. The projects are listed in Table 4.4.

5.2.3 Cumulative collision assessment of kittiwake at Forth Island SPA - Forth and Tay and UK North Sea

111. The cumulative collision effects of the worst case combination of the Forth and Tay projects i.e. Project Alpha and Project Bravo combined using adjusted values (2018 application) and Neart na Gaoithe and Inch Cape as consented in 2014 were added to the predicted non-breeding season effects on kittiwake from other wind farms in the UK North Sea (Tables 4.4 and 5.8).

112. The additional mortality from other projects in the North Sea was estimated as 8.8 adults (3.2 during the post-breeding season and 5.6 during the pre-breeding season) plus 4.3 sub-adults (1.8 post-breeding and 2.5 pre-breeding). With the worst case estimates from the Forth and Tay projects this totalled 56 adults and 7 sub-adults from the Forth Islands SPA kittiwake population and would be equivalent to a change in adult survival from 0.854 to 0.848 i.e. a change of 0.006 (0.6%). However, results from the calculation of cumulative effects of this scale should be treated with caution given the number of extrapolations involved, the potential for changes in methodology, and because some of the consented wind farms in the wider North Sea are submitting revised planning applications which would reduce impacts or, alternately, may not build out to full capacity which would revise collision estimates downwards. These points are considered in more detail in the section PVA and discussion at 5.2.9.

Table 5-8 Cumulative collision estimates for kittiwake at Forth Islands SPA from Forth and Tay projects and non-breeding impacts from other wind farms in UK North Sea (Option 2 and 98.9% avoidance rate)

Project	Season	Estimated collision mortality	
		Adults	Sub-adults
Cumulative: Seagreen Alpha + Bravo combined 2018 and other Forth and Tay projects 2014	Breeding	46	2.4
	Post-breeding	0.7	0.4
	Pre-breeding	0.7	0.2
Other UK North Sea offshore wind farms[26]	Post-breeding	3.2	1.8
	Pre-breeding	5.6	2.5
Seasonal totals	Breeding	46	2.4
	Post-breeding	3.9	2.2
	Pre-breeding	6.3	2.7.
Cumulative total	**All seasons**	**56**	**7**

5.2.4 Kittiwake – Forth Islands SPA - Displacement

113. Displacement effects on kittiwake at each Seagreen project alone are shown in Table 5.9. A displacement rate of 30% and consequent mortality of 2% was used with results presented for the breeding season only as required by the 2017 Scoping Opinion. Seagreen effects are presented in two ways:

- With all data including the very high values recorded in July 2017; and
- With adjusted (adj) data where the peak July 2017 density data were replaced by the median July value recorded over the three survey years as agreed with SNH/MS. The mean peak breeding population between April and August was then derived in the normal way (EIA chapter of this Addendum, section 2.6).

[26] See Annex 4 for calculations.

114. The greatest effect is predicted at Project Alpha and Project Bravo combined with a maximum mortality of five adult birds using all data or three adult birds using adjusted data. For sub-adults, additional mortality of 0.5 or 0.3 birds is predicted for the same project using unadjusted and adjusted data respectively. This level of effect is calculated to make no change to the adult survival rate.

5.3 Cumulative displacement assessment of Forth Island SPA kittiwake - Forth and Tay projects

115. For cumulative assessment, the breeding season effects of displacement on kittiwake from Project Alpha and Project Bravo combined using adjusted data were assessed with the other Forth and Tay projects (Table 5.9). It should be noted that displacement effects for Neart na Gaoithe and Inch Cape do not change between 2014 and 2018 because the site population and the area of the sites and buffer remained unchanged from the original assessments

116. Displacement estimates for the other Forth and Tay projects were taken from their respective EIARs as were the proportion of adult birds. For Inch Cape, the proportion from Forth Islands SPA was taken from the EIAR (IC 2018); for Neart na Gaoithe, it was as supplied by SNH (2018b). Sabbaticals were applied to breeding adults at a rate of 10%.

117. The cumulative effect of displacement on kittiwake at Forth Islands from Project Alpha and Project Bravo combined together with Inch Cape and Neart na Gaoithe was estimated as 16.4 or 13.9 adults using adjusted Seagreen data. Sub-adult mortality was an additional 1.5 or 1.2 individuals using unadjusted and adjusted Seagreen data respectively. In both cases this would represent a change in adult survival from 0.854 to 0.852 i.e. 0.002 (0.2%).

118. No further cumulative assessment was made of the effect of displacement on kittiwake at the wider scale because displacement is considered most likely to affect breeding birds and other projects in the North Sea are beyond foraging range of the SPA colony. The assessment was therefore not required by the 2017 Scoping Opinion.

Table 5-9 Displacement estimates attributed to Forth Islands SPA kittiwake from the Seagreen projects alone (30% displacement rate and 2% mortality) and cumulatively with Neart na Gaoithe and Inch Cape

Kittiwake	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub adults
Alpha	Breeding	8265	0.914	7554	711	6799	41	4	0.092	3.8	0.4
	Breeding (adj)[27]	3935	0.914	3597	338	3237	19	2	0.092	1.8	0.2
Bravo	Breeding	5147	0.914	4704	443	4234	25	3	0.092	2.3	0.2
	Breeding (adj)	3146	0.914	2875	271	2588	16	2	0.092	1.4	0.1
Alpha + Bravo	Breeding	11405	0.914	10424	981	9382	56	6	0.092	5.2	0.5
	Breeding (adj)	5962	0.914	5449	513	4904	29	3	0.092	2.7	0.3
Inch Cape[28]	Breeding	3,866	0.93	3595	271	3236	19	2	0.21	4.1	0.3
Neart na Gaoithe[29]	Breeding	2,164	0.93	2013	151	1811	11	1	0.65	7.1	0.6
				Estimated cumulative mortality – all Forth and Tay projects						**16.4**	**1.5**
				Estimated cumulative mortality all Forth and Tay projects with Seagreen adjusted						**13.9**	**1.2**

[27] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of the mean peak population in the normal way. Unadjusted populations based on all data.

[28] Data from Inch Cape (2018) HRA Table 4.10.

[29] Data for Neart na Gaoithe (2018) HRA Table 2.16, Appendix 9.2 Ornithology baseline report and apportioned according to SNH (2018b).

Table 5-10 Cumulative effects of collision plus displacement on kittiwake from Forth islands SPA from Seagreen projects (2018) and other Forth and Tay wind farms as consented 2014.

Kittiwake			**Estimated additional mortality**	
			Adults[30]	**Sub-adults**
Alpha	Collision	Breeding (adj)[31]	5.6	0.6
		Post-breeding	0.3	0.1
		Pre-breeding	0.2	0
	Displacement	Breeding (adj)	1.8	0.2
		Total	**7.9**	**0.9**
Bravo	Collision	Breeding (adj)	4.9	0.5
		Post-breeding	0.2	0.1
		Pre-breeding	0.2	0.1
	Displacement	Breeding (adj)	1.4	0.1
		Total	**6.7**	**0.8**
Alpha + Bravo combined	Collision	Breeding (adj)	8.4	0.9
		Post-breeding	0.4	0.2
		Pre-breeding	0.3	0.1
	Displacement	Breeding (adj)	2.7	0.3
		Total	**11.8**	**1.5**
Inch Cape (2014 as consented)	Collision[32]	Breeding	26	1
		Post-breeding	0.2	0.2
		Pre-breeding	0.3	0.1
	Displacement	Breeding	4.1	0.3
		Total	**31**	**2**
Neart na Gaoithe (2014 as consented)	Collision[33]	Breeding	12	1
		Post-breeding	0.1	0.1
		Pre-breeding	0.0	0.0
	Displacement	Breeding	7.1	0.6
		Total	**19**	**1.7**
Cumulative total: Forth & Tay projects (WCS)			**62**	**5**

30 Breeding adults adjusted for sabbaticals.

31 (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way. Unadjusted populations based on all data.

32 Collision data from Annex 2 CRM.

33 Data from NNG spreadsheet 2014 04 23 - FTOWDG - Offshore Wind - Cumulative Impacts - Kitti.xlsm.

5.4 Collision and displacement effects on kittiwake at Forth Island SPA - Seagreen projects

119. The combined effects of collision (all seasons) and displacement (breeding season only) both based on adjusted July data, are shown for the Seagreen projects in Table 5.10.

120. The maximum effect was from Project Alpha and Project Bravo combined with an estimated mortality of 12 adults and 2 sub-adult birds. This would be equivalent to a change from 0.854 to 0.853 (0.1%) in adult survival.

5.4.1 Cumulative collision and displacement effects on kittiwake at Forth Island SPA – Forth and Tay projects

121. The effects of collision and displacement from Project Alpha and Project Bravo combined with the other Forth and Tay developments as consented in 2014 are also shown in Table 5.10.

122. This predicts a total mortality of 62 adults and five sub-adults. This would be equivalent to a change in adult survival from 0.854 to 0.847 i.e. 0.007 (0.7%).

5.4.2 Cumulative collision plus displacement assessment of kittiwake at Forth Island SPA – Forth and Tay plus other UK North Sea wind farms

123. The combined effects of collision and displacement from the Forth and Tay projects in all seasons were added to the non-breeding season effects of collision from other UK North Sea wind farms (Table 5.11). The cumulative total was predicted to be 71 adult birds and nine sub-adults in all seasons and would represent a change in adult survival of 0.008 (0.8%).

124. Combined collision and displacement effects should be treated with caution as they are 'currently considered to be mutually exclusive impacts' as noted by SNH in the 2017 Scoping Opinion. The inclusion of effects from other UK North Sea wind farms, whilst adding a small numbers of collisions, increases the level of uncertainty owing to the fact that many of them are currently submitting planning applications for revised projects with fewer, larger turbines or, alternately, may not build out to their consented capacity, both of which would reduce collision effects, making this assessment conservative.

Table 5-11 Cumulative effects of collision plus displacement on kittiwake from Forth Islands SPA from worst case scenario Forth and Tay projects and UK North Sea wind farms

Wind farm	Effect	Season	Adult	Sub-adult
Forth and Tay WCS (Seagreen Alpha + Bravo combined 2018 plus Neart na Gaoithe and Inch Cape as consented in 2014)	Collision	Breeding	46.7	2.7
		Post-breeding	0.7	0.4
		Pre-breeding	0.7	0.2
	Displacement	Breeding	13.9	1.2
	Collision + displacement	Breeding	60.6	3.9
		Post-breeding	0.7	0.4
		Pre-breeding	0.7	0.2
Other UK North Sea windfarms[34]	Collision	Post-breeding	3.2	1.8
		Pre-breeding	5.6	2.5
Seasonal totals: Forth and Tay WCS plus non-breeding season collisions from other UK North Sea wind farms	Collision + displacement	Breeding	60.6	3.9
		Post-breeding	3.9	2.2
		Pre-breeding	6.3	2.7
Cumulative total			**71**	**9**

5.4.3 Kittiwake - Forth Islands SPA – PVA and discussion

125. PVA outputs indicate that the Seagreen projects alone have a relatively small effect on kittiwake at Forth Islands SPA either when considering collision alone or collision and displacement combined. In all cases the population is predicted to grow above current levels at a slightly slower rate than at present (worst case counterfactual of 99%) (Tables 5.12 and 5.13) although it remains below the population at citation. The centile matching the 50th centile of the impacted population is 48% showing good overlap between the two population distributions. These metrics are consistent with the small changes to the adult survival rate (0.1%) predicted to arise from collision and displacement.

[34] See Annex 4 for calculations.

126. When considering cumulative collision effects with other projects in the Forth and Tay and 2018 scenarios, the population trend remains positive and is higher than the starting population after 25 years at 95% of the un-impacted population size (counterfactual of population size 0.953), and with a growth rate counterfactual of 0.998 (99.8%). The centile matching the 50th centile of the impacted population is 44, showing good overlap between the two population distributions. These metrics are also consistent with the relatively small predicted change in adult survival rate of 0.2%.

Table 5-12 PVA outputs for kittiwake at Forth Islands SPA – collision

Project / Scenario	Additional mortality[35]		Starting population	End population after 25 years	Counterfactual of end population size (impacted / unimpacted)	Counterfactual of population growth rate (impacted / unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	9,326	10,136	1.000	1.000	50
Alpha	6	1	9,326	9,988	0.986	0.999	48
Bravo	5	1	9,326	10,010	0.988	1.000	48
Alpha + Bravo combined	9	1	9,326	9,923	0.979	0.999	47
Alpha + Bravo combined with other Forth and Tay projects 2018	20 (22)	3	9,326	9,658	0.953	0.998	44
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014	49 (47)	4 (3)	9,326	9,046	0.893	0.996	37
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014 plus non-breeding season collisions effects from wind farms in the UK North Sea[36]	57 (56)	7	9,326	8,849	0.874	0.995	35

35 Additional mortality is the specific mortality modelled. Where final mortality estimates differ, they are given in brackets.

36 See Annex 4 for calculations.

Table 5-13 PVA outputs for kittiwake at Forth Islands SPA – collision and displacement

Project / Scenario	Additional mortality[37]		Starting population	End population after 25 years	Counterfactual of end population size (impacted / unimpacted)	Counterfactual of population growth rate (impacted / unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	9,326	10,136	1.000	1.000	50
Alpha	8	1	9,326	9,945	0.981	0.999	48
Bravo	7	1	9,326	9,966	0.983	0.999	48
Alpha + Bravo combined	12	2	9,326	9,843	0.971	0.999	46
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014	64 (62)	5	9,326	8,737	0.863	0.994	34
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014 plus non-breeding season collisions from wind farms in the UK North Sea[38]	70 (71)	8 (9)	9,326	8,585	0.848	0.993	33

[37] Additional mortality is the specific mortality modelled. Where final mortality estimates differ, they are given in brackets.

[38] See Annex 4 for calculations.

127. When considering Project Alpha and Project Bravo combined 2018 with the other Forth and Tay developments as consented in 2014 for collision alone, PVA suggests that the population after 25 years would be below the starting population at 89% of the un-impacted population size (counterfactual of population size 0.893) with a relatively high growth rate counterfactual of 0.996 (99.6%). When combined with displacement, the end population is predicted to be further below the starting population although growth rate is maintained at above 99% of the un-impacted population (counterfactual of 0.994). The centile matching the 50th centile of the impacted population is 37% still showing good overlap between the two population distributions.

128. Considering only collision, the cumulative effects from the Forth and Tay projects (WCS) and those in the wider North Sea are predicted to cause a small decline below the current population after 25 years with a counterfactual of population size of 0.874 although the counterfactual of the growth rate remains above 99% (counterfactual of 99.5%). The centile matching the 50th centile of the impacted population is 35% still showing relatively good overlap between the two population distributions.

129. Combined collision and displacement exaggerate these effects (Table 5.13), with the counterfactual of population size decreasing to 0.863 (86.3%) for the Forth and Tay projects alone and 0.848 (84.8%) when including all projects in the wider North Sea. However, the counterfactual of growth rate still remains strong at 0.994 (99.4%) and 0.993 (99.3%) respectively. These results should be treated with caution as noted by SNH in the 2017 Scoping Opinion, where collision and displacement are described as 'mutually exclusive' impacts.

130. Displacement effects should also be considered in the following context. There is little empirical evidence that kittiwake are displaced from constructed offshore wind farms (Leopold 2018, Vanermen & Stienen 2019) and therefore an assumption of 30% displacement and 2% mortality is conservative. In addition, during the breeding season, seabird behaviour suggests that if resources become critical for example due to changes in food supply which could, potentially, arise from displacement, effects on productivity are perhaps more likely than on adult survival e.g. Hamer et al. (1993). Whilst effects on productivity are not taken into account in the matrix method of displacement assessment, effects on both survival and productivity were modelled for the 2014 AA.

131. Searle et al (2014) investigated the effects of displacement on the adult survival and breeding success of kittiwake assuming a slightly greater displacement rate of 40% compared to the 30% used in this assessment but with a reduced wind farm buffer of 1 km. For kittiwake, the model assumed that productivity was reduced to 'moderate' in all years owing to reduced prey availability over the lifetime of the Forth and Tay wind farms. Demographic rates were based on those used in the population models of Freeman et al. (2014). The model estimated a potential decline in kittiwake population size of more than 0.5% from the effects of the Forth and Tay wind farms, although effects from the wider North Sea were not considered. This is significantly greater than the 0.2% change in adult survival estimated here using the methods recommended by the 2017 Scoping Opinion and indicates that the developments as currently proposed would result in reduced displacement effects.

132. Tracking data collected by Centre for Ecology and Hydrology (CEH) from breeding kittiwakes on the Isle of May (Forth Islands SPA) and specifically commissioned by the Forth and Tay offshore wind projects (Daunt et al. 2011a,b) also suggested that birds from this colony made relatively limited use of the Seagreen sites. Collated tracking data published in Wakefield et al. (2017) which included the CEH data and additional RSPB data reinforced this suggestion. In this case, any modelling based on tracking data, for example tools recently developed on behalf of MS for apportioning and displacement, such as the SeabORD model, would be likely to lead to lower effects estimates than those based on the current methods.

133. With regard to collision, a number of moderating factors should be considered which may point to the scale of this effect being exaggerated. The flight speed currently applied to kittiwake is 13.1 m/s based on a small sample size (n= 2) (Alerstam et al. 2007). However, the recent ORJIP study undertaken at Thanet noted that flight speeds were considerably below this at between 6.7 m/s and 8.6 m/s based on a much more representative sample size (n= 287) (Skov et al. 2018). Revised CRM using this lower flight speed for kittiwake reduces collision effects by almost 20% (Annex 2: CRM, Table 14).

134. Avoidance rates for kittiwake have also been re-calculated by Skov et al. (2018) based on empirical evidence and reviewed by Bowgen & Cook (2018) on behalf of the Joint Nature Conservation Committee (JNCC). The final recommendation from the latter paper is that avoidance rate could be increased from the 98.9% used here to 99%. This seemingly small change of 0.1% would also result in a reduction in estimated collisions.

135. As noted previously, the CRM undertaken for the Seagreen projects uses the worst case WTG envelope with a rotor speed for a 164 m diameter rotor. It is also possible that a 220 m diameter rotor could be deployed in which case the rotor speed is likely to be lower and would reduce collision estimates. For modelling of an indicative scenario, please see Annex 2, Table 14.

136. In relation to cumulative assessment with the other Forth and Tay projects, as with gannet, the worst case scenario here may be unrealistic in the sense that, for example, Neart na Gaoithe has recently been consented for a project that would have reduced impacts from that consented in 2014. Also, in the wider North Sea, several projects are in the process of submitting revised planning applications to use fewer, larger turbines and other developments may not be built out to their consented capacity, both of which would reduce collision effects. As an example, if Neart na Gaoithe was built out to its 2018 consent this would reduce its kittiwake collision estimates to a level which would, in large part, offset the cumulative effects of other North Sea projects.

137. The 2014 AA suggested that the cumulative effects of the Forth and Tay projects from collision and displacement during the breeding season would reduce adult survival by 1.8%, equivalent to 135 individuals. The current assessment estimates a worst case mortality of 71 adults and nine sub- adults (Table 5.11) based on the combined effects of collision and displacement from Project Alpha and Project Bravo combined (2018) and the other Forth and Tay projects as consented in 2014 plus non-breeding season collision effects from other UK North Sea windfarms. This is approximately half of the 2014 mortality estimate.

138. The kittiwake population at Forth Islands SPA is currently below that at designation and classed as 'unfavourable declining'. This is consistent with a more widespread decline in kittiwake populations, particularly in the northern part of their range (JNCC 2016) following a period of rapid expansion in the 1990s (Coulson 2011). This decline has been attributed in part to climate change, specifically ocean warming, affecting prey availability (Frederiksen et al. 2004, Sandvik et al. 2014, MCCIP 2018).

139. Kittiwakes feed preferentially on sandeels (Coulson 2011) and in the late 1990s, it was noted that sandeel abundance in the Forth and Tay, particularly on the Wee Bankie, was depressed, most likely due to overfishing. The sandeel fishery was therefore closed in 2000 and sandeel numbers initially appeared to recover although subsequently continued to decline (Greenstreet et al. 2010). In parallel, the kittiwake population made a small recovery, including an increase in productivity (Daunt et al. 2008), but this was not maintained, presumably owing to the continuing downward trend of the sandeel population i.e. its main prey resource. However, since a low point in 2013 of 4,900 individuals (Seagreen 2018, Chapter 16, Table 16.27), the kittiwake population of Forth Islands SPA has almost doubled to 9,326 individuals in 2015 (SNH 2017). Referring to the fishery closure, Greenstreet et al. (2010), describing kittiwake as a top predator, concluded that 'simply closing offshore areas close to top predator colonies may not be sufficient to guarantee the long term prospects of predators at these locations'. This suggests there are larger factors driving the present widespread decline in kittiwake numbers, as there were when the population increased in 1990, and the additional mortality predicted here is unlikely to influence the background trend. In terms of ameliorating climate change, the move to decarbonising electricity production is a Scottish Government commitment with offshore wind farms named as an important strategic component (Scottish Government 2018).

5.4.4 Kittiwake - Forth Islands SPA – Summary

140. The kittiwake population of Forth Islands SPA is currently classed as unfavourable declining and is below that at designation. This status is thought to be due to wider issues causing seabird declines such as climate change and associated sea temperature warming with consequent changes in seabird food supply. This assessment demonstrates that collision and displacement effects from the Seagreen projects alone would have minimal effects on the population. When assessed cumulatively with other projects in the Forth and Tay and the wider UK North Sea, PVA demonstrates that taking a more realistic case in terms of the likelihood of collision and displacement occurring simultaneously, the specifications of the projects that will finally be built and potential adjustments to CRM methodology, the kittiwake population of the Forth Islands SPA is likely to be maintained around its current level. In addition, the effects estimated here are considerably lower than those for the Forth and Tay projects as consented in 2014. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on the integrity of the Forth Islands SPA arising from effects on kittiwake.

5.5 Guillemot - Forth Islands SPA

5.5.1 Guillemot – Forth Islands SPA - Displacement

141. Displacement effects on guillemot at each Seagreen project alone are shown in Table 5.14. A displacement rate of 60% and consequent mortality of 1% were used in the assessment. Results are presented for the breeding and non-breeding season as required by the 2017 Scoping Opinion. The Seagreen displacement estimates are presented in two formats:

- with all data; and
- without the July 2017 data when very high densities of birds were observed. This was agreed with SNH/MS and was consistent with the advice given to other offshore wind projects in the region where surveys undertaken in late July recorded high densities owing to the occurrence of large numbers of adults accompanying dependent young (SNH email to MSLOT of 11/01/2019).

142. It should be noted that the high values observed in the July 2017 data have been incorporated into the overall assessment through the use of all 2017 data to calculate scaling factors which were applied to Seagreen's 2009 – 2011 densities. These generally increased densities were used to calculate the population of the site and 2 km buffer for the assessment of displacement.

143. Predicted mortality for guillemot at the proposed Seagreen site was apportioned to Forth Islands SPA at a rate of 0.176 (17.6%) for both the breeding and non-breeding season (Table 4.2) and a sabbatical rate of 0.07 (7%) was applied to adult breeding birds. The proportion of adults was based on the stable age structure of the population used in the PVA.

144. The greatest effect is predicted at Project Alpha and Project Bravo combined with a maximum mortality for both breeding and non-breeding season together of 23 adult birds using all data or 19 adult birds using adjusted data. For sub-adults, additional mortality of 19 or 16 birds is predicted for the same project with and without the July data respectively. The population of Forth Islands SPA guillemot is 38,573 individuals with an adult survival rate of 0.939. This means that in one year 36,220 adult birds would survive naturally. The estimated level of additional mortality is calculated to make a change of less than 0.001 (0.1%) to the adult survival rate.

5.5.1 Cumulative displacement assessment of guillemot at Forth Island SPA - Forth and Tay projects

145. Displacement data for Neart na Gaoithe and Inch Cape were taken from their respective EIARs and apportioned to Forth Islands SPA at a rate of 62% and 35% respectively. Sabbaticals were applied to adult breeding birds at a rate of 0.07 (7%).

146. The cumulative effects of Project Alpha and Project Bravo combined minus July 2017 data together with Neart na Gaoithe and Inch Cape are predicted to cause additional mortality of 27 adults during the breeding season and 26 adults during the non-breeding season plus 28 and 25 sub-adults for the same seasons respectively (Table 5.15). This would be equivalent to a change of 0.001 (0.1%) in adult survival.

Table 5-14 Displacement estimates attributed to Forth Islands SPA guillemot from the Seagreen projects alone (60% displacement rate and 1% mortality)

Project		Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub-adults
Alpha	Breeding	18,730	0.55	10,301	8,428	9,580	57	51	0.176	10	9
	Breeding (adj)[39]	14,253	0.55	7,839	6,414	7,290	44	38	0.176	8	7
	Non-breeding	8,469	0.55	4,658	3,811		28	23	0.176	4	4
Bravo	Breeding	14,729	0.55	8,101	6,628	7,534	45	40	0.176	8	7
	Breeding (adj)	10,421	0.55	5,732	4,690	5,330	32	28	0.176	6	5
	Non-breeding	7,410	0.55	4,075	3,334		24	20	0.176	4	4
Alpha + Bravo combined	Breeding	27,783	0.55	15,281	12,502	14,211	85	75	0.176	15	13
	Breeding (adj)	20,813	0.55	11,447	9,366	10,646	64	56	0.176	11	10
	Non-breeding	13,634	0.55	7,499	6,135		45	37	0.176	8	6

[39] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way. Unadjusted populations based on all data.

Table 5-15 Displacement estimates attributed to Forth Islands SPA guillemot from all Forth and Tay projects (60% displacement rate and 1% mortality)

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub-adults
Alpha + Bravo combined	Breeding (adj)[40]	20813	0.55	11447	9366	10646	64	56	0.176	11	10
	Non-breeding	13634	0.55	7499	6135		45	37	0.176	8	6
Inch Cape[41]	Breeding	8184	0.437	3576	4608	3326	20	28	0.35	7	10
	Non-breeding	3912	0.437	1710	2202		10	13	0.35	4	5
Neart na [42] Gaoithe	Breeding	4893	0.51	2495	2398	2321	14	14	0.62	9	9
	Non-breeding	7618	0.51	3885	3733		23	22	0.62	14	14
								Breeding		**27**	**28**
								Non-breeding		**26**	**25**
								Cumulative total		**53**	**53**

[40] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of seasonal mean peak population in the normal way. Unadjusted populations based on all data.

[41] Data from IC (2018) HRA Table 4.18.

[42] Neart na Gaoithe (2018) from Tables 2.58-2.63 and paras 266 et seq.

Table 5-16 PVA outputs for Forth Island SPA guillemot - displacement

Project / Scenario	Additional mortality[43]		Starting population	End population after 25 years	Counterfactual of end population size	Counterfactual of population growth rate	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	38,573	92,300	1.000	1.000	50
Alpha	11 (12)	10 (11)	38,573	91,539	0.992	1.000	47
Bravo	9 (10)	7 (9)	38,573	91,709	0.994	1.000	47
Alpha + Bravo combined	17 (19)	15 (16)	38,573	91,139	0.987	0.999	45
Alpha + Bravo 2018 combined with other Forth and Tay projects	46 (53)	53	38,573	88,862	0.962	0.998	35

[43] Additional mortality is the specific mortality modelled. Where the final mortality estimates differ they are given in brackets

5.5.1 Guillemot – Forth Islands SPA - PVA and discussion

147. PVA outputs (Table 5.16) indicate that displacement from any Seagreen project alone has an almost negligible effect on guillemot at Forth Islands SPA. In all cases the population is predicted to grow strongly above current levels (growth rate counterfactual of 1.0) and for the population after 25 years to be 99% of that predicted for the un-impacted population (population size counterfactual of 0.987). The centile matching the 50th centile of the impacted population is 45% indicating good overlap of the two populations. These results are consistent with the very small changes to the adult survival rate (< 0.1%) predicted to arise from displacement. In addition, tracking studies on breeding guillemots from the Isle of May suggested that the Seagreen sites do not form part of the species' core foraging range (Annex 1, Figure 40) with the 90% usage contour well to the west/south west of the sites (Daunt et al. 2011a).

148. When considering cumulative displacement effects with other projects in the Forth and Tay, noting that the displacement estimates for these projects do not change between 2014 and 2018 because the site footprint and buffer remain the same, the population trend remains positive and is considerably higher than the starting population after 25 years at 96% of the un-impacted population size (counterfactual of population size 0.962) and with a strong growth rate counterfactual of 0.998 (99.8%). The centile matching the 50th centile of the impacted population is 35% showing relatively good overlap between the impacted and un-impacted populations. These findings are consistent with the relatively small predicted change in adult survival rate of 0.1%.

149. The results are also consistent with the 2014 AA which predicted a decline in adult survival of 0.1% (MS 2014, Appendix 7 Table A) and a counterfactual of end population size after 25 years of 99%. With this level of effect, the population was predicted to continue to increase above baseline (Freeman et al. 2014).

150. The guillemot population of Forth Islands SPA is classed as favourable maintained and is currently higher than the cited population (38,573 compared to 32,000 individuals). Whilst the population has been higher in the past, reaching a peak in 2001, it has fluctuated since but shown a general increase since 2013 (Seagreen 2018, Chapter 16: HRA Table 16.28). Whilst some studies have shown that guillemot are displaced from wind farms (Vanermen et al. 2015), UK studies at Robin Rigg (Vallejo et al. 2017) and Thanet (Percival 2013) and at other European offshore wind farms have suggested that the species is indifferent to them or only weakly displaced and that other factors are the key drivers of guillemot distribution (Leopold 2018). This difference in response may be due to the fact that behaviour may vary e.g. for breeding birds, which are constrained as central place foragers. In this case displacement rates may be lower than for non-breeders birds which are not constrained in the same way (Vallejo et al. 2017). Wind farm configuration may also play a part in that lower turbine densities, such as Seagreen's, may make the site more permeable to birds. Nonetheless, empirical evidence linking displacement and mortality has yet to be demonstrated.

5.5.2 Guillemot - Forth Islands SPA - Summary

151. The guillemot population of Forth Islands SPA is currently classed as favourable maintained. This assessment indicates that displacement effects from the Seagreen projects alone would have minimal effects on the population, which is predicted to continue to increase in size. When assessed cumulatively with other projects in the Forth and Tay, PVA indicates that this increase is likely continue and that after 25 years the population would be maintained at well above its current levels. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on the integrity of the Forth Islands SPA arising from displacement effects on guillemot.

5.6 Razorbill - Forth Islands SPA

5.6.1 Razorbill - Forth Islands SPA - Displacement

152. Displacement effects on razorbill at each Seagreen project alone are shown in Table 5.17. A displacement rate of 60% and consequent mortality of 1% was used in the assessment and results are presented for the breeding and non-breeding season as required by the 2017 Scoping Opinion. Seagreen results are presented in two ways:

- including all data; and
- without the July 2017 data when very high densities of birds were observed. This was agreed with SNH/MS and was consistent with the advice given to other offshore wind projects in the region where surveys undertaken in late July recorded high densities owing to the occurrence of large numbers of adults accompanying dependent young (SNH email to MSLOT of 11/01/2019).

153. It should be noted that the high values observed in the July 2017 data have been incorporated into the overall assessment through the use of all 2017 data to calculate scaling factors which were applied to Seagreen's 2009 – 2011 densities. These generally increased densities were used to calculate the population of the site and 2 km buffer.

154. Predicted mortality for razorbill at the proposed Seagreen site was apportioned to Forth Islands SPA at a rate of 0.22 (22%) for both the breeding and non-breeding season (Table 4.2) and a sabbatical rate of 0.07 (7%) was applied to adult breeding birds. The proportion of adults was based on the stable age structure of the population used in the PVA.

155. The greatest effect is predicted at Project Alpha and Project Bravo combined with a maximum mortality for both seasons combined of 10 adult birds using all data or 7 adult birds using adjusted data. For sub-adults, additional mortality of 7 or 5 birds is predicted for the same project with and without the July data respectively. The population of Forth Islands SPA razorbill is 7,792 individuals with an adult survival rate of 0. 90. This means that in one year 7,013 adult birds would survive naturally. The estimated level of additional mortality is calculated to make a change of approximately 0.001 (0.1%) to the adult survival rate.

5.6.2 Cumulative displacement assessment of razorbill at Forth Island SPA - Forth and Tay projects

156. Displacement data for Neart na Gaoithe and Inch Cape were taken from their respective EIARs and apportioned to Forth Islands SPA at a rate of 79% and 32% respectively. Sabbaticals were applied to adult breeding birds at a rate of 0.07 (7%).

157. The cumulative displacement effects of Project Alpha and Project Bravo combined minus July 2017 data together with Neart na Gaoithe and Inch Cape are predicted to be 11 adults during the breeding season and 15 adults during the non-breeding season and 10 and 13 sub-adults for the same seasons respectively (Table 5.18). This would be equivalent to a change of less than 0.003 (0.3%) in adult survival.

Table 5-17 Displacement estimates attributed to Forth Islands SPA razorbill from the Seagreen projects alone (60% displacement rate and 1% mortality)

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub-adults
Alpha	Breeding	7184	0.6	4310	2874	4009	24	17	0.22	5	4
	Breeding (adj)[44]	4529	0.6	2717	1812	2527	15	11	0.22	3	2
	Non-breeding	1812	0.6	1087	725		7	4	0.22	1	1
Bravo	Breeding	4087	0.6	2452	1635	2281	14	10	0.22	3	2
	Breeding (adj)	1831	0.6	1099	732	1022	6	4	0.22	1	1
	Non-breeding	2292	0.6	1375	917		8	5	0.22	2	1
Alpha + Bravo combined	Breeding	9380	0.6	5628	3752	5234	31	23	0.22	7	5
	Breeding (adj)	5338	0.6	3203	2135	2979	18	13	0.22	4	3
	Non-breeding	3207	0.6	1924	1283		12	8	0.22	3	2

[44] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of seasonal mean peak population in the normal way. Unadjusted populations based on all data

Table 5-18 Displacement estimates attributed to Forth Islands SPA razorbill from all Forth and Tay projects (60% displacement rate and 1% mortality)

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub-adults
Alpha + Bravo combined	Breeding (adj)[45]	5338	0.6	3203	2135	2979	18	13	0.22	4	3
	Non-breeding	3207	0.6	1924	1283		12	8	0.22	3	2
Inch Cape[46]	Breeding	4671	0.484	2261	2410	2103	13	14	0.319	4	5
	Non-breeding	4905	0.484	2374	2531		14	15	0.319	5	5
Neart na Gaoithe[47]	Breeding	1248	0.564	704	544	655	4	3	0.79	3	3
	Non-breeding	3101	0.564	1749	1352		10	8	0.79	8	6
								Total breeding		**11**	**10**
								Total non-breeding		**15**	**13**
								Cumulative total		**26**	**23**

[45] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of seasonal mean peak population in the normal way. Unadjusted populations based on all data.

[46] [2]Inch Cape data taken from IC 2018 Table 4.23.

[47] [3]Neart na Gaoithe data derived from NNG (2018) HRA Tables 2.45 to 2.48. Displacement rate from SNH 2018b

Table 5-19 PVA for Forth Island SPA razorbill - displacement

Project / Scenario	Additional mortality[48]		Starting population	End population after 25 years	Counterfactual of end population size (impacted / un-impacted)	Counterfactual of population growth rate (impacted / un-impacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	7,792	14,081	1.000	1.000	50
Alpha	4	3	7,792	13,876	0.985	0.999	47
Bravo	3	2	7,792	13,933	0.989	1.000	48
Alpha + Bravo combined	7	5	7,792	13,730	0.975	0.999	46
Alpha + Bravo combined (2018) with other Forth and Tay projects	26	25 (23)	7,792	12,684	0.900	0.996	32

[48] Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets

5.6.3 Razorbill – Forth Islands SPA - PVA and discussion

158. The Forth Islands SPA razorbill population is classed as favourable maintained and is currently higher than the cited population (7,792 compared to 2,800 individuals). Whilst the population increased from designation until 2004, it has fluctuated since. However, it is currently at its highest recorded level (Seagreen 2018 HRA Table 16.28) and PVA predicts that it will continue to increase.

159. PVA outputs indicate that displacement from the Seagreen projects alone has a small effect on razorbill at Forth Islands SPA. In all cases the population is predicted to grow above current levels and for the population after 25 years to be 98% of that predicted for the un-impacted population based on the effects of Project Alpha and Project Bravo combined (counterfactual of 0.975). This is consistent with the small change to the adult survival rate (< 0.1%) predicted to arise from displacement. The centile matching the 50th centile of the impacted population is 46% indicating close overlap between the projected populations.

160. When considering cumulative displacement effects with other projects in the Forth and Tay, noting that the displacement estimates for these projects do not change between 2014 and 2018 because the site footprint and buffer remain the same, the population trend remains positive and higher than the starting population after 25 years at 90% of the un-impacted population size (counterfactual of population size 0.900), and with a growth rate of 99.6% of the un-impacted population (counterfactual 0.996). The centile matching the 50th centile of the impacted population is 32% indicating reasonable overlap between the impacted and un-impacted populations. These metrics suggest relatively low levels of change consistent with the relatively small predicted change in adult survival rate of 0.3% and with the foraging distribution of breeding razorbills tracked from the Isle of May (Forth Islands SPA) where the 90% contour of the kernel density distribution did not overlap any of the Forth and Tay projects (Daunt et al. 2011a).

161. These results are similar to the 2014 AA which predicted a counterfactual of population size of 88% compared to 90% in this assessment. However, the predicted decline in adult survival was 0.9% or 45 birds compared to the reduced number of 27 adult birds estimated in this assessment.

162. Empirical evidence generally confirms that razorbill are likely to be displaced from wind farms to some degree (Vanermen & Stienen 2019) although studies at Egmond aan Zee (Leopold et al. 2013) and Robin Rigg could not demonstrate this with birds at Robin Rigg showing some level of post-construction habituation (Nelson et al. 2015). However, as with guillemot, where foraging areas are constrained e.g. for breeding birds, it is possible that displacement effects may be reduced. Site-specific influences may also play a part with wind farm size, WTG spacing and configuration potentially increasing site permeability to birds where turbine densities are lower. Furness et al. (2013) ranked razorbill as at medium risk of displacement (score 3 out of a maximum of 5) with Wade et

al. (2016) ranking this as 'low uncertainty' which may support the high displacement rate used here although empirical evidence linking displacement and mortality has yet to be demonstrated. On the other hand, tracking data from breeding razorbills from the Forth Islands SPA colony on the Isle of May (n=18) suggested that the use of Forth and Tay wind farm footprints was limited, tending to be more inshore suggesting that displacement estimates for this species could be overestimated (Annex 1, Figure 52).

5.6.4 Razorbill - Forth Islands SPA - Summary

163. The razorbill population of Forth Islands SPA is currently classed as favourable maintained. This assessment indicates that displacement effects from the Seagreen projects alone would have minimal effects on the population, which is predicted to continue to increase in size. When assessed cumulatively with other projects in the Forth and Tay, PVAs indicate that this increase is likely continue and that after 25 years the population would be maintained above its current levels. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on the Forth Islands SPA arising from displacement effects on razorbill.

5.7 Puffin - Forth Islands SPA

5.7.1 Puffin – Forth Islands SPA - Displacement

164. Predicted mortality for puffin at the proposed Seagreen site was apportioned to Forth Islands SPA at a rate of 81 % for both the breeding and non-breeding season (Table 4.2) and a sabbatical rate of 0.07 (7%) was applied to adult breeding birds. The proportion of adults was based on the stable age structure of the population used in the PVA.

165. Displacement effects on puffin at each of the Seagreen projects alone are shown in Table 5.20. A displacement rate of 60% and consequent mortality of 2% were used in the assessment. Results are presented for the breeding season only as required by the 2017 Scoping Opinion. Puffin was unaffected by the July 2017 foraging event in the Seagreen sites as it was not a significant part of the foraging association. Puffin displacement estimates are therefore based on all survey data.

166. The greatest effect is predicted at Project Alpha and Project Bravo combined with a maximum mortality of 37 adult birds and 36 sub-adults. The puffin population of Forth Islands SPA is 90,010 individuals with an adult survival rate of 0.919. The number of adult puffins that would survive naturally in one year is 82,719. This level of additional mortality is calculated to make a change of less than 0.001 (< 0.1%) to the adult survival rate.

5.7.2 Cumulative displacement assessment of puffin at Forth Island SPA - Forth and Tay projects

167. Displacement data for Neart na Gaoithe and Inch Cape were taken from their respective EIARs and apportioned to Forth Islands SPA puffin at a rate of 94% and 90% respectively. Sabbaticals were applied to adult breeding birds at a rate of 0.07 (7%).

168. The cumulative displacement effects of Project Alpha and Project Bravo combined together with Neart na Gaoithe and Inch Cape are predicted to be 91 adults and 108 sub-adults during the breeding season (Table 5.20). This would be equivalent to a change of 0.001 (0.1%) in adult survival.

5.7.3 Puffin – Forth Islands SPA - PVA and discussion

169. PVA outputs indicate that displacement from the Seagreen projects alone has a small effect on puffin at Forth Islands SPA. In all cases the population is predicted to grow significantly above current levels and for the population after 25 years to be 99% (worst case counterfactual of 0.988) of that predicted for the un-impacted population based on the effects of Project Alpha and Project Bravo combined. This is consistent with the very small changes to the adult survival rate (< 0.1%) predicted to arise from displacement. The centile matching the 50th centile of the impacted population is 44% indicating good overlap between the impacted and un-impacted population distributions.

170. When considering cumulative collision effects with other projects in the Forth and Tay, noting that the displacement estimates for these projects do not change between 2014 and 2018 because the site footprint and buffer remain the same, the population trend remains positive and higher than the starting population after 25 years at 96% of the un-impacted population size (counterfactual of population size 0.957), and with a growth rate of more than 99% of the un-impacted population (counterfactual 0.998). This is consistent with the relatively small predicted change in adult survival rate of 0.1%. The centile matching the 50th centile of the impacted population is 34% indicating relatively good overlap between the impacted and un-impacted populations.

171. The current results are more optimistic than the 2014 AA which predicted a counterfactual of population size of 75% after 25 years, compared to 96% in this assessment, and a decline in adult survival of 2% compared to 0.1%.

172. The puffin population of Forth Islands SPA is classed as favourable maintained and is currently higher than the cited population (90,010 compared to 28,000 individuals). Whilst the population increased after designation until 2003, it subsequently declined then recovered to reach its highest point since designation (Seagreen 2018 HRA Table 16.28). These counts should be considered in the context that puffin is a difficult species to census because of its burrow-nesting habit, however, PVA predicts that numbers will continue to increase under all scenarios.

173. There is little evidence concerning the effects of offshore wind farms on puffin as very few operational wind farms lie within foraging range of puffin breeding colonies and in the winter the birds tend to disperse widely (Harris et al. 2009). This means that an empirical displacement rate has yet to be demonstrated as has the link between displacement and mortality. Furness et al. (2014) estimated that the species was at relatively low risk of disturbance and displacement (score 2 out of a maximum of 5) although the uncertainty around this score was estimated at moderate (Wade et al. 2016). Further evidence of their spatial distribution in the Firth of Forth has also been more difficult to acquire than for other auk species as early attempts to tag breeding birds from the Isle of May met with limited success, with the species appearing to be more sensitive to the tracking devices than other auks (Daunt Unpubl). The species may show some avoidance of wind farm sites consistent with guillemot and razorbill but, once again, this may depend on wind farm configuration. In addition, the greater foraging range of puffin may mean that they are less susceptible to displacement impacts.

5.7.4 Puffin - Forth Islands SPA – Summary

174. The puffin population of Forth Islands SPA is currently classed as favourable maintained. This assessment indicates that displacement effects from the Seagreen projects alone would have minimal effects on the population, which is predicted to continue to increase in size. When assessed cumulatively with other projects in the Forth and Tay, PVAs indicate that this increase is likely to continue and that after 25 years the population would be maintained at well above its current levels. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on the integrity of the Forth Islands SPA arising from displacement effects on puffin.

Table 5-20 Displacement estimates attributed to Forth Islands SPA puffin from all Forth and Tay projects (60% displacement rate and 2% mortality)

Puffin	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub-adults
Alpha	Breeding	3876	0.526	2,039	1,837	1,896	23	22	0.807	18	18
Bravo		5576	0.526	2,933	2,643	2,727	33	32	0.807	26	26
Alpha + Bravo combined		7744	0.526	4,073	3,670	3,788	45	44	0.807	37	36
Inch Cape[49]		5678	0.381	2,163	3,515	2,012	24	42	0.9	22	38
Neart na Gaoithe[50]		6173	0.494	3,124	3,049	2905	35	37	0.94	33	34
									Cumulative total	**92**	**108**

[49] Data for Inch Cape from IC (2018) HRA Table 4.27.

[50] Data from Neart na Gaoithe from NNG (2018) HRA Para 230 Table 2.41 and 2.43.

Table 5-21 PVA outputs for Forth Islands SPA puffin from all Forth and Tay projects (60% displacement rate and 2% mortality)

Project / Scenario	Additional mortality[51]		Starting population	End population after 25 years	Counterfactual of end population size (impacted /unimpacted)	Counterfactual of population growth rate (impacted /unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	90,010	306,831	1.000	1.000	50
Alpha	18	18	90,010	305,069	0.994	1.000	47
Bravo	26	26	90,010	304,289	0.992	1.000	46
Alpha + Bravo combined	37	36	90,010	303,252	0.988	1.000	44
Alpha + Bravo combined with other Forth and Tay projects	127 (92)	158 (108)	90,010	293,628	0.957	0.998	34

1

51 Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets

6. Fowlsheugh SPA

176. Fowlsheugh SPA is the closest SPA to the Seagreen sites and is assessed for the three species shown in Table 6.1. The table provides the most recent population count as advised by SNH, with counts converted to individual birds, together with the population size at designation and the site condition of the species.

177. As with the Forth Islands SPA assessments, all effects are expressed as individual birds for comparison with the current SPA population.

Table 6-1 Qualifying and assemblage features of the Fowlsheugh SPA assessed in this HRA

Species	Season	Site condition	Cited population – individuals[52]	Current population – individuals (year)
Kittiwake	Breeding	Favourable maintained[1]	73,300	19,310 (2015)
Guillemot	Breeding	Favourable maintained	56,450	74,379[53]
Razorbill	Breeding	Favourable maintained	5,800	9,950[54]

6.1 Kittiwake – Fowlsheugh SPA

178. The Fowlsheugh SPA kittiwake population has followed a similar trajectory to that of the Forth Islands SPA, in that it appears to have increased to a maximum in the early 1990s (population in 1992 of over 34,000 birds) then slowly declined to its lowest level in 2009. It now appears to be stabilising or increasing slightly although it remains below its population at citation (Seagreen EIAR 2018 Chapter 16, Table 16.29). Tracking data collected from breeding kittiwakes (Daunt et al. 2011b, Wakefield et al. 2017) indicate that birds from Fowlsheugh SPA make use of the Seagreen sites.

179. Kittiwake is assessed separately for collision and displacement and both effects combined. Seagreen effects are presented in two ways:

- with all data including the very high values recorded in July 2017; and
- with adjusted data i.e. where the July 2017 density data were replaced by the median July value recorded over the three survey years. This applies to breeding season mortality estimates for both collision and displacement and is indicated in the results tables as 'Breeding (adj)'. In all cases, adjusted estimates were taken forward for the cumulative assessment as agreed with SNH and MS. Further details are provided in the EIA chapter of this Addendum, section 2.6 and Annex 5.

52 Data from SNH Sitelink at https://sitelink.nature.scot/site/8505.
53 'Latest populations' as advised by SNH on 21/05/2018
54 'Latest populations' as advised by SNH on 21/05/2018

180. It should be noted that the high values observed in the July 2017 data have been incorporated into the overall assessment through the use of all 2017 data to calculate scaling factors which were applied to Seagreen's 2009 – 2011 densities. These generally increased densities were used to calculate the population of the site and 2 km buffer for the assessment of displacement.

181. Predicted mortality for kittiwake at the proposed Seagreen site was apportioned to Fowlsheugh SPA as shown below (Table 4.2) and a sabbatical rate of 0.1 (10%) applied to adult breeding birds:

- Breeding season 0.419 (41.9%)
- Post-breeding 0.014 (1.4%)
- Pre-breeding 0.018 (1.8%)

6.1.1 Kittiwake – Fowlsheugh SPA - Collision

182. Predicted additional kittiwake mortality from collision at Project Alpha, Project Bravo and Project Alpha and Project Bravo combined at Fowlsheugh SPA for each season is shown in Table 6.2 with option 1 and option 2 results at 98.9% avoidance rate shown for comparison.

183. Adjusted data (See EIA chapter of this Addendum, section 2.6) are shown only for Project Alpha and Project Alpha and Project Bravo combined. This is because, for Project Bravo, the median density of birds in flight was represented by the July 2017 data and therefore no adjustment was needed.

184. The annual survival rate of adult kittiwake is 0.854. That is, 16,491 adults from the Fowlsheugh kittiwake population of 19,310 birds would survive each year in the natural, un-impacted population. For Project Alpha a maximum change in adult survival of 0.002 (0.2%) was predicted regardless of the CRM option used. For Project Bravo a 0.001 (0.1%) change in adult survival was predicted and from Project Alpha and Project Bravo combined a 0.003 or 0.002 (0.3% or 0.2%) change in adult survival using option 2 and 1 respectively and using unadjusted data. With data adjusted for July 2017, effects were equivalent to a change of 0.002 (.2%) in both cases.

6.1.1.1 Cumulative collision assessment of Fowlsheugh SPA kittiwake – Forth and Tay projects

185. For cumulative assessment of the Forth and Tay projects, Project Alpha and Project Bravo combined using option 2, a 98.9% avoidance rate and adjusted collision data was assessed with Inch Cape for all seasons. This is because, at 62 km from this SPA, Neart na Gaoithe is just beyond the mean-maximum foraging range of breeding kittiwakes from Fowlsheugh. SNH (2018b) calculated an apportioning rate of 0.074 for the project meaning that less than a single collision would be attributed to it during the breeding season (NNG 2018 HRA Table 2-28). It is therefore excluded from the breeding season assessment. However, non-breeding season collisions were included and are taken from Neart na Gaoithe (2018) HRA Table 2-33 and apportioned as described previously.

186. Cumulative effects were assessed under two scenarios

- with all relevant Forth and Tay projects as proposed in 2018; and
- Seagreen as proposed in 2018 and other Forth and Tay projects as consented in 2014.

187. The 2018 collision estimates for Inch Cape were taken from the EIAR (IC 2018). The 2014 values were taken from Annex 2: CRM with the proportions of adults and the proportion attributed to Fowlsheugh from the IC EIAR (2018). Non-breeding season effects were divided according to the length of the post-and pre-breeding seasons and apportioned as for the Seagreen projects (Table 4.2).

Table 6-2 Collision mortality attributed to Fowlsheugh SPA kittiwake from the Seagreen projects alone

Project	CRM option	Season	Estimated collision mortality	
			Adult[55]	Sub-adult
Alpha	Option 2	Breeding	34	4
		Breeding (adj)[56]	26	3
		Post-breeding	0.9	0.4
		Pre-breeding	0.5	0.1
	Option 1	Breeding	39	4
		Breeding (adj)	29	3
		Post-breeding	0.8	0.4
		Pre-breeding	0.5	0.1
Bravo	Option 2	Breeding	23	2
		Post-breeding	0.5	0.2
		Pre-breeding	0.6	0.2
	Option 1	Breeding	16	2
		Post-breeding	0.2	0.1
		Pre-breeding	0.3	0.1
Alpha + Bravo combined	Option 2	Breeding	49	5
		Breeding (adj)	38	4
		Post-breeding	1	0.6
		Pre-breeding	1	0.3
	Option 1	Breeding	45	5
		Breeding (adj)	42	4
		Post-breeding	0.8	0.4
		Pre-breeding	0.7	0.2

55 Breeding adults adjusted for sabbaticals.

56 (adj) indicates data adjusted by using the median rather than the mean July data for CRM.

Table 6-3 Cumulative collision estimates for kittiwake at Fowlsheugh SPA from Forth and Tay projects 2018 and 2014 scenarios (Option 2 and 98.9% avoidance rate)

Project/Scenario	Season	Estimated collision mortality	
		Adult[57]	**Sub-adult**
Scenario 1: Alpha + Bravo combined 2018	Breeding (adj)[58]	38	4.0
	Post-breeding	1.1	0.6
	Pre-breeding	1.0	0.3
Inch Cape 2018[59]	Breeding	10.0	1.0
	Post-breeding	0.4	0.2
	Pre-breeding	0.1	< 0.1
Neart na Gaoithe 2018[60]	Post-breeding	0.2	< 0.1
	Pre-breeding	0.1	0.1
Scenario 1: Seasonal totals	Breeding	48.3	5.0
	Pre-breeding	1.7	0.9
	Post-breeding	1.2	0.5
Scenario 1: Cumulative total	**All seasons**	**51**	**6**
Scenario 2: Alpha + Bravo combined 2018	Breeding (adj)[61]	38	4.0
	Post-breeding	1.1	0.6
	Pre-breeding	1.0	0.3
Inch Cape 2014[62]	Breeding	35.9	1.2
	Post-breeding	0.4	0.3
	Pre-breeding	0.7	0.1
Neart na Gaoithe 2014	Post-breeding	0.2	0.2
	Pre-breeding	0.1	0.0
Scenario 2: Seasonal totals	Breeding	74	5
	Pre-breeding	2	1
	Post-breeding	2	0.4
Scenario 2: Cumulative total	**All seasons**	**78**	**6**

57 Breeding adults adjusted for sabbaticals.
58 (Adj) Adjusted data using the median rather than the mean July data for CRM
59 Data from Inch Cape (2018) HRA Table 4.30
60 Data from NNG (2018) HRA Table 2-28 and 2.33
61 Data from Seagreen (2019) Annex 2 CRM.
62 Data from spreadsheet 2014 04 23 - FTOWDG - Offshore Wind - Cumulative Impacts - Kitti. Xlsm

188. Scenario 1, considering all Forth and Tay projects consented or applied for in 2018, predicted a cumulative collision total of 48 adults and five sub-adults during the breeding season and a total of 51 adults and six sub-adults for all seasons combined based on 2018 scenarios. This would be equivalent to a change in adult survival of 0.003 (0.3%).

189. Scenario 2, considering the Seagreen project 2018 and other Forth and Tay developments as consented in 2014, estimated a total collision mortality of 78 adults and six sub-adults during all seasons. This would be equivalent to a change in adult survival of 0.004 (0.4%).

190. There are a number of smaller operational offshore windfarms within mean- maximum foraging range of breeding kittiwake from Fowlsheugh SPA. These projects include the EOWDC, Hywind Scotland Pilot Park and Kincardine Offshore Wind Farm. In general, the low levels of collision impacts on kittiwake predicted from these projects during the breeding season are considered unlikely to make a material difference to the Fowlsheugh population. In addition, the more northerly location of these projects in relation to kittiwake tracking data from Fowlsheugh suggests that any effects may be more likely to be felt by breeding birds from Buchan Ness to Collieston Coast SPA (Wakefield et al. 2017). However, impacts on the SPA from all smaller projects where collision estimates are available are incorporated in to the assessment of cumulative effects during the non-breeding season when the population disperses away from the colony.

6.1.2 Cumulative collision assessment of kittiwake at Fowlsheugh SPA – Forth and Tay and UK North Sea wind farms

191. When considering breeding season effects from the Forth and Tay projects plus non-breeding season effects from other UK North Sea wind farms (Table 4.4), a total additional mortality of 95 adults and 15 sub- adults was estimated in all seasons. This would be equivalent to a change in adult survival from 0.854 to 0.849 i.e. a 0.005 (0.5%) change (Table 6.4).

Table 6-4 Cumulative collision estimates for kittiwake at Fowlsheugh SPA from Forth and Tay projects worst case scenario and non-breeding impacts from other offshore wind farms in UK North Sea (Option 2 and 98.9% avoidance rate)

Project	Season	Estimated collision mortality	
		Adults	Sub-adults
Cumulative: Seagreen 2018 and other Forth and Tay projects 2014	Breeding	74.2	5.2
	Post-breeding	1.8	1.1
	Pre-breeding	1.7	0.4
Other UK North Sea offshore wind farms[63]	Post-breeding	6.5	3.7
	Pre-breeding	11.3	5
Seasonal totals	Breeding	74	5
	Post-breeding	8.3	4.8
	Pre-breeding	13.0	5.4
Cumulative total	**All seasons**	**95**	**15**

[63] See Annex 4 for calculations

Table 6-5 Displacement estimates attributed to Fowlsheugh SPA kittiwake from the Seagreen projects alone (30% displacement rate and 2% mortality) and cumulatively with Inch Cape

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub adults
Alpha	Breeding	8265	0.914	7554	711	6799	41	4	0.419	17	2
	Breeding (adj)	3935	0.914	3597	338	3237	19	2	0.419	8	1
Bravo	Breeding	5147	0.914	4704	443	4234	25	3	0.419	11	1
	Breeding (adj)	3146	0.914	2875	271	2588	16	2	0.419	7	1
Alpha + Bravo combined	Breeding	11405	0.914	10424	981	9382	56	6	0.419	24	2
	Breeding (adj)	5962	0.914	5449	513	4904	29	3	0.419	12	1
Inch Cape[64]	Breeding	3,866	0.93	3595	271	3236	19	2	0.287	6	0.5
									Cumulative total[2]	**18**	**2**

[64] Data from Inch Cape (2018) HRA Table 4.34. [2] Cumulative total is based on Project Alpha + Project Bravo combined using adjusted July data plus Inch Cape.

6.1.3 Kittiwake – Fowlsheugh SPA - Displacement

192. Displacement of kittiwake at Fowlsheugh was assessed for the breeding season only assuming a displacement rate of 30% and consequent mortality of 2%. Estimates were made for each Seagreen project:

- With adjusted (adj) data;
- With data where the July 2017 density data were replaced by the median July value recorded over the three survey years as agreed with SNH/MS. The mean peak breeding population between April and August was then derived in the normal way (EIA chapter of this Addendum, section 2.6).

193. The maximum mortality was predicted from Project Alpha and Project Bravo combined with a total of 24 adults and two sub- adults using unadjusted data and 12 adults and one sub adult using adjusted data. This represents a maximum change of 0.001 (0.1%) in the adult survival rate.

6.1.4 Cumulative displacement assessment of kittiwake at Fowlsheugh SPA – Forth and Tay projects

194. For the cumulative assessment of displacement, Project Alpha and Project Bravo combined was assessed with Inch Cape alone as Neart na Gaoithe is beyond the mean-maximum foraging range of breeding kittiwakes from Fowlsheugh. As the displacement assessment for Inch Cape remains the same between 2014 and 2018 only a single scenario was modelled.

195. The cumulative mortality estimated from Project Alpha and Project Bravo combined, using adjusted data, together with Inch Cape was a total of 18 adults and two sub- adults. This represents a change of approximately 0.001 (0.1%) in the adult survival rate (Table 6.5).

6.1.5 Collision plus displacement assessment of kittiwake at Fowlsheugh SPA -Seagreen projects

196. The combined effects of collision and displacement are shown for the Seagreen projects alone in Table 6.6. As expected, the worst case in terms of Seagreen is for Project Alpha and Project Bravo combined. This predicts a total mortality of 52 adults and six sub-adults. This would be equivalent to a change in adult survival from the background rate of 0.854 to 0.851 i.e. 0.003 (0.3%).

6.1.6 Cumulative collision plus displacement assessment of kittiwake at Fowlsheugh SPA -Forth and Tay projects

197. Project Alpha and Project Bravo combined is taken forward as the worst case scenario to estimate cumulative collision and displacement mortality for the Forth and Tay projects. In the case of Inch Cape this is for the 2014 projects as consented for collision and displacement, the latter remaining the same between 2014 and 2018. For Neart na Gaoithe effects are considered for the non-breeding season only, hence 2014 non-breeding season collision only, as this project is beyond the mean-maximum foraging range of breeding birds from Fowlsheugh.

Table 6-6 Cumulative effects of collision plus displacement on kittiwake from Fowlsheugh SPA from Seagreen projects (2018) and other Forth and Tay wind farms as consented 2014.

Project	Effect	Season	Estimated additional mortality	
			Adult	Sub-adult
Alpha	Collision	Breeding (adj)[65]	26	3
		Post-breeding	0.9	0.4
		Pre-breeding	0.5	0.1
	Displacement	Breeding (adj)	8	1
		Total	**36**	**4**
Bravo	Collision	Breeding	23	2
		Post-breeding	0.5	0.2
		Pre-breeding	0.6	0.2
	Displacement	Breeding (adj)	7	1
		Total	**31**	**3**
Alpha + Bravo	Collision	Breeding (adj)	38	4
		Post-breeding	1	0.6
		Pre-breeding	1	0.3
	Displacement	Breeding (adj)	12	1
		Total	**52**	**6**
Inch Cape (as consented 2014)[66]	Collision	Breeding	35.9	1.2
		Post-breeding	0.4	0.3
		Pre-breeding	0.7	0.1
	Displacement[67]		6.0	0.5
		Total	**43**	**2**
Neart na Gaoithe (as consented 2014)[68]	Collision	Post-breeding	0.2	0.2
		Pre-breeding	0.1	0.0
		Total	**0.3**	**0.2**
		Cumulative total[69]	**95.7**	**6.7**

65 (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way. Unadjusted populations based on all data.

66 Collision data from Seagreen (2019) Annex 2 and displacement from Inch Cape (2018) HRA Table 4.34

67 The cumulative effects of the Forth and Tay projects for collision and displacement combined is predicted to affect 96 adults and 7 sub-adults (Table 6.6). This would be equivalent to a change in adult survival of 0.005 (0.5%).

68 Data from Neart na Gaoithe (2018) and spreadsheet 2014 04 23 - FTOWDG - Offshore Wind - Cumulative Impacts - Kitti. Xlsm

69 Cumulative total is Project Alpha and Project Bravo combined with Neart na Gaoithe and Inch Cape.

198. When considered with the additional non-breeding season mortality from other projects in the North Sea a further 18 adults and nine sub-adults would be affected taking the overall total including Forth and Tay effects to 114 adults and 17 sub-adults (Table 6.7). This would increase the change in adult survival to 0.006 (0.6%).

Table 6-7 Cumulative effects of collision plus displacement on kittiwake from Fowlsheugh SPA from Forth and Tay projects and UK North Sea wind farms

Wind farm	Effect	Season	Adult	Sub-adult
Forth and Tay WCS (Seagreen Alpha + Bravo combined 2018 plus Neart na Gaoithe and Inch Cape as consented in 2014)	Collision	Breeding	74.2	5.2
		Post-breeding	1.8	1.1
		Pre-breeding	1.7	0.4
	Displacement	Breeding	18.0	1.5
	Collision + displacement	Breeding	92.2	6.7
		Post-breeding	1.8	1.1
		Pre-breeding	1.7	0.4
Other UK North Sea windfarms[70]	Collision	Post-breeding	6.5	3.7
		Pre-breeding	11.3	5
Seasonal totals: Forth and Tay WCS plus non-breeding season collisions from other UK North Sea wind farms	Collision + displacement	Breeding	92.2	6.7
		Post-breeding	8.3	4.8
		Pre-breeding	13.0	5.4
Cumulative total			**113.5**	**16.9**

[70] See Annex 4 for calculations

6.1.7 Kittiwake – Fowlsheugh SPA - PVA and discussion

199. PVA outputs indicate that collision at the Seagreen projects alone has a relatively small effect on kittiwake at Fowlsheugh SPA (Table 6.8) and, as to be expected, a slightly larger effect when considering collision and displacement combined (Table 6.9). The worst case is Project Alpha and Project Bravo combined considering collision and displacement together. In this case the PVA predicts that the population would be 95% of the un-impacted population size after 25 years (counterfactual of 0.945) but maintain a growth rate of 99.8% compared to the un-impacted population (counterfactual of 0.998). The centile of the un-impacted population matching the 50th centile of the impacted population is 43% showing good overlap between both populations. In all cases the population is predicted to grow above current levels although at a slightly slower rate than at present. This is consistent with the relatively small change to the adult survival rate (worst case scenario 0.2%) predicted to arise from collision and displacement from any of the Seagreen projects alone.

200. For cumulative collision effects from Seagreen and other Forth and Tay projects using 2018 scenarios, the population trend remains positive and is higher than the starting population after 25 years at 95% of the un-impacted population size (counterfactual of population size 0.946) and a growth rate counterfactual of 0.998 (99.8%).

201. When considering the worst case scenario of Project Alpha and Project Bravo combined 2018 with the other Forth and Tay developments as consented in 2014 for collision alone, PVA suggests that the population after 25 years would be maintained above the starting population with the end population equivalent to 92% (counterfactual 0.916) of the un-impacted population. The growth rate remains above 99% (counterfactual of 0.997). When combined with displacement, the impacted end population is predicted to be 90% of the un-impacted population after 25 years although the counterfactual of growth rate still remains high at 0.996 (99.6%).

202. Considering cumulative collision effects from the Forth and Tay projects (worst case scenario) and those in the UK North Sea, PVA predicts the end population after 25 years to be 90% of the un-impacted population although the growth rate remains high (counterfactual of 0.996 (99.6%)).

    As expected, combined collision and displacement exaggerate these effects slightly by reducing the counterfactual of end population size to 88% (counterfactual of 0.877) and the growth rate counterfactual to 0.995 (99.5%) (Table 6.7). However, the scale of these combined cumulative effects should be treated with caution because collision and displacement are '*currently considered to be mutually exclusive impacts*' as noted by SNH in the 2017 Scoping Opinion. A full discussion of the issues concerning the combined effects of kittiwake displacement and collision is provided in the section on Forth Islands SPA kittiwake and is not repeated here.

Table 6-8 PVA outputs for Fowlsheugh SPA kittiwake - collision

Project / Scenario	Additional mortality[71]		Starting population	End population after 25 years	Counterfactual of end population size (impacted / unimpacted)	Counterfactual of population growth rate (impacted / unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	19,310	33,680	1.000	1.000	50
Alpha	28 (27)	3	19,310	32,660	0.970	0.999	46
Bravo	24	2	19,310	32,816	0.975	0.999	47
Alpha + Bravo combined	40	5	19,310	32,218	0.957	0.998	45
Alpha + Bravo combined with other Forth and Tay projects 2018	51	6	19,310	31,835	0.946	0.998	43
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014	80 (78)	9 (6)	19,310	30,838	0.916	0.997	41
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014 plus non-breeding season effects from wind farms in the North Sea and Channel	98 (95)	17 (15)	19,310	30,116	0.895	0.996	38

[71] Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets

Table 6-9 PVA outputs Fowlsheugh SPA kittiwake – collision and displacement

Project / Scenario	Additional mortality[72]		Starting population	End population after 25 years	Counterfactual of end population size (impacted / unimpacted)	Counterfactual of population growth rate (impacted / unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	19,310	33,680	1.000	1.000	50
Alpha	36	4	19,310	32,372	0.961	0.998	45
Bravo	31	3	19,310	32,560	0.967	0.999	46
Alpha + Bravo combined	52	6	19,310	31,802	0.945	0.998	43
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014	98 (96)	10 (7)	19,310	30,251	0.899	0.996	39
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014 plus non-breeding season effects from other wind farms in the UK North Sea	116 (114)	19 (17)	19,310	29,523	0.877	0.995	37

[72] Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets

203. As with many other kittiwake colonies, the Fowlsheugh colony underwent a rapid expansion in the 1990s to around its highest point at citation in 1992 after which the population dropped until 2009 (Seagreen 2018 HRA, Table 16.29). Since then it has appeared to be stabilising or increasing. It should be noted that the recommended method of PVA modelling (Leslie matrix) is unable to replicate these fluctuations and, based on the data available, which have been carefully reviewed, predicts that the population will now start to rise (Annex 3: PVA) even though it has fallen until recently. Such PVA models are sensitive to very small changes in the input parameters and outputs should be viewed in this context. Further discussion on kittiwake population trends is provided in the section on Forth Islands SPA kittiwake and is not repeated here.

204. The 2014 AA suggested that the cumulative effects of the Forth and Tay projects from collision and displacement during the breeding season would reduce adult survival at Fowlsheugh by 1.1%, equivalent to 212 individuals. The current assessment estimates a worst case mortality of 114 adults and 17 sub- adults (Table 6.7) based on the combined effects of collision and displacement from the worst case Forth and Tay scenario plus non-breeding season collision effects from other UK North Sea windfarms. This is approximately half of the 2014 mortality estimate.

6.1.8 Kittiwake - Fowlsheugh SPA - Summary

205. The kittiwake population of Fowlsheugh SPA is classed as favourable maintained although this assessment was made in 1999 (SNH Sitelink) and currently the population is lower than at designation. This is thought to be due to wider issues causing recent seabird declines such as climate change and associated sea temperature warming with consequent changes in seabird food supply. This assessment demonstrates that collision and displacement effects from the Seagreen projects alone would have a relatively small effect on the population and would be unlikely to affect its trajectory. When assessed cumulatively with other projects in the Forth and Tay and the wider North Sea, PVA predicts that the SPA population would be maintained at or above its current levels with small declines in population size and growth rate compared to the un-impacted population. In addition, the effects assessed in this HRA Addendum are predicted to be considerably lower than those for the Forth and Tay projects as consented in 2014. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on Fowlsheugh SPA arising from effects on kittiwake.

6.2 Guillemot – Fowlsheugh SPA

6.2.1 Guillemot – Fowlsheugh SPA - Displacement

206. Displacement effects on guillemot at each Seagreen project alone are shown in Table 6.10. A displacement rate of 60% and consequent mortality of 1% were used in the assessment and results are presented for the breeding and non-breeding season as required by the 2017 Scoping Opinion. The Seagreen displacement estimates are presented in two formats:

- with all data; and
- without the July 2017 data when very high densities of birds were observed. This was agreed with SNH/MS and was consistent with the advice given to other offshore wind projects in the region where surveys undertaken in late July recorded high densities owing to the occurrence of large numbers of adults accompanying dependent young (SNH email to MSLOT of 11/01/2019).

207. It should be noted that the high values observed in the July 2017 data have been incorporated into the overall assessment through the use of all 2017 data to calculate scaling factors which were applied to Seagreen's 2009 – 2011 densities. These generally increased densities were used to calculate the population of the site and 2 km buffer for the assessment of displacement.

208. Predicted mortality for guillemot at the proposed Seagreen site was apportioned to Fowlsheugh SPA at a rate of 0.586 (58.6 %) for both the breeding and non-breeding season (Table 4.2) and a sabbatical rate of 0.07 (7%) was applied to adult breeding birds. The proportion of adults was based on the stable age structure of the population used in the PVA.

209. The population of guillemot at Fowlsheugh is 74,379 individuals with an adult survival rate of 0.939. That is, in any one year a total of 69,842 adult individuals would survive in the natural, un-impacted population. The greatest effect caused by Seagreen at Fowlsheugh SPA is predicted at Project Alpha and Project Bravo combined with a maximum guillemot mortality for both seasons combined of 76 adult birds using all data or 63 without the July 2017 data. For sub-adults, additional mortality of 66 or 55 birds is predicted for the same project with and without the July data respectively (Table 6.10). This level of effect is calculated to make a maximum change of 0.001 (0.1%) to the adult survival rate.

6.2.2 Cumulative displacement assessment of guillemot at Fowlsheugh SPA - Forth and Tay projects

210. Displacement data for Neart na Gaoithe and Inch Cape were taken from their respective EIARs and apportioned to Fowlsheugh at a rate of 8.7% and 37.7% respectively. Sabbaticals were applied to adult breeding birds at a rate of 0.07 (7%).

211. The cumulative effect of displacement on Fowlsheugh guillemot from Project Alpha and Project Bravo combined, using adjusted data, together with Neart na Gaoithe and Inch Cape is predicted to be a total of 78 adult birds, 46 during the breeding season and 32 during the non-breeding season. This would change the adult survival rate from 0.939 to 0.938 i.e. by 0.001 (0.1%). In addition, mortality of 73 sub-adults is predicted, 44 during the breeding season and 29 during the non-breeding season (Table 6.11).

212. This level of effect has been further investigated using PVA as reported below. However, as noted earlier, attributing all non-breeding season effects to the SPA colony in the same proportions as the breeding season is likely to be conservative in the sense that not all birds will remain close to the colonies during the non-breeding period.

Table 6-10 Displacement estimates attributed to Fowlsheugh SPA guillemot from Seagreen projects alone (60% displacement rate and 1% mortality)

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub adults
Alpha	Breeding	18,730	0.55	10,301	8,428	9,580	57	51	0.586	34	30
	Breeding (adj)[73]	14,253	0.55	7,839	6,414	7,290	44	38	0.586	26	23
	Non-breeding	8,469	0.55	4,658	3,811		28	23	0.586	16	13
Bravo	Breeding	14,729	0.55	8,101	6,628	7,534	45	40	0.586	26	23
	Breeding (adj)	10,421	0.55	5,732	4,690	5,330	32	28	0.586	19	16
	Non-breeding	7,410	0.55	4,075	3,334		24	20	0.586	14	12
Alpha + Bravo combined	Breeding	27,783	0.55	15,281	12,502	14,211	85	75	0.586	50	44
	Breeding (adj)	20,813	0.55	11,447	9,366	10,646	64	56	0.586	37	33
	Non-breeding	13,634	0.55	7,499	6,135		45	37	0.586	26	22

[73] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way. Unadjusted populations based on all data

Table 6-11 Cumulative displacement estimates attributed to Fowlsheugh SPA guillemot from all Forth and Tay projects (60% displacement rate and 1% mortality)

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub adults
Alpha + Bravo combined	Breeding (adj)[74]	20,813	0.55	11,447	9,366	10,646	64	56	0.586	37	33
	Non-breeding	13,634	0.55	7,499	6,135		45	37	0.586	26	22
Inch Cape[75]	Breeding	8184	0.452	3699	4485	3440	22	27	0.377	8	10
	Non-breeding	3912	0.452	1768	2144		11	13	0.377	4	5
Neart na Gaoithe[76]	Breeding	4893	0.51	2495	2398	2321	15	14	0.087	1	1
	Non-breeding	7618	0.51	3885	3733		23	22	0.087	2	2
							Cumulative total			**78**	**73**

[74] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way.

[75] Data from Inch Cape (2018) HRA Table 4.42.

[76] Data from Neart na Gaoithe (2018) HRA Tables 2.58 - 2.63 and paras 266 et seq.

Table 6-12 PVA outputs for Fowlsheugh SPA guillemot - displacement

Project / Scenario	Additional mortality[77]		Starting population	End population after 25 years	Counterfactual of end population size	Counterfactual of population growth rate	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	74,379	177,421	1.000	1.000	50
Alpha	38 (42)	32 (33)	74,379	174,883	0.986	0.999	45
Bravo	30 (33)	26 (28)	74,379	175,394	0.988	1.000	46
Alpha + Bravo combined	58 (63)	49 (55)	74,379	173,556	0.978	0.999	41
Alpha + Bravo combined with other Forth and Tay projects	89 (78)	88 (73)	74,379	171,184	0.964	0.999	37

[77] Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets.

6.2.3 Guillemot – Fowlsheugh SPA - PVA and discussion

213. PVA outputs indicate that displacement from any of the Seagreen projects alone has an almost negligible effect on guillemot at Fowlsheugh SPA (Table 6.12). In all cases the population is predicted to grow strongly above current levels (growth rate counterfactual of 0.999) and for the population size after 25 years to be 98% (counterfactual of 0.978) of that predicted for the un-impacted population. The centile matching the 50th centile of the impacted population is 41% indicating good overlap between the impacted and un-impacted populations.

214. When considering cumulative collision effects with other projects in the Forth and Tay, noting that the displacement estimates for these projects do not change between 2014 and 2018 because the site footprint and buffer remain the same, the population trend remains positive and is considerably higher than the starting population after 25 years at 96% of the un-impacted population size (counterfactual of population size 0.964), owing to a strong growth rate of 99.9% compared to the un-impacted population (counterfactual 0.999). This is consistent with the relatively small predicted change in adult survival rate of 0.1%. The centile matching the 50th centile of the impacted population is 37% indicating good overlap between the impacted and un-impacted populations.

215. These results are consistent with the 2014 AA which predicted no decline in adult survival of guillemot at Fowlsheugh SPA and a counterfactual of population size of 100% meaning that the impacted and un-impacted population would be the same after 25 years.

216. The guillemot population Fowlsheugh SPA is classed as favourable maintained and is currently higher than the cited population (74,379 compared to 56,450 individuals). PVA predicts that the impacted population will continue to grow, although at a slightly lower rate than the un-impacted population. As described in more detail for Forth Islands SPA guillemots, whilst some studies have shown that guillemot are displaced from wind farms (Vanermen et al. 2015), UK studies at Robin Rigg (Vallejo et al. 2017) and Thanet (Percival 2013) have suggested that the species is indifferent to them. For a more detailed discussion of the issues please see the section on guillemot at Forth Islands SPA. It should be noted that empirical evidence linking displacement and mortality has yet to be demonstrated.

6.2.4 Guillemot - Fowlsheugh SPA - Summary

217. The guillemot population of Fowlsheugh SPA is currently classed as favourable maintained. This assessment indicates that displacement effects from the Seagreen projects alone would have minimal effects on the population, which is predicted to continue to increase. When assessed cumulatively with other projects in the Forth and Tay, PVAs indicate that this increase is likely to continue and that after 25 years the population would be maintained well above its current levels. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on the integrity of the Fowlsheugh SPA arising from displacement effects on guillemot. Razorbill – Fowlsheugh SPA

6.3 Razorbill – Fowlsheugh SPA - Displacement

218. Displacement effects on razorbill at each Seagreen project alone are shown in Table 6.13. A displacement rate of 60% and consequent mortality of 1% was used in the assessment and results are presented for the breeding and non-breeding season as required by the 2017 Scoping Opinion. Seagreen results are presented in two ways:

- including all data; and
- without the July 2017 data when very high densities of birds were observed. This was agreed with SNH/MS and was consistent with the advice given to other offshore wind projects in the region where surveys undertaken in late July recorded high densities owing to the occurrence of large numbers of adults accompanying dependent young (SNH email to MSLOT of 11/01/2019).

219. It should be noted that the high values observed in the July 2017 data have been incorporated into the overall assessment through the use of all 2017 data to calculate scaling factors which were applied to Seagreen's 2009 – 2011 densities. These generally increased densities were used to calculate the population of the site and 2 km buffer for the assessment of displacement.

220. Predicted mortality for razorbill at the proposed Seagreen site was apportioned to Fowlsheugh SPA at a rate of 0.467 (46.7 %) for both the breeding and non-breeding season (Table 4.2) and a sabbatical rate of 0.07 (7%) was applied to adult breeding birds. The proportion of adults was based on the stable age structure of the population used in the PVA.

221. The population of razorbill at Fowlsheugh is 9,950 individuals with an adult survival rate of 0.9, that is, in any one year a total of 8,955 adult individuals would survive in the natural, un-impacted population. The greatest effect on razorbill at Fowlsheugh SPA is predicted at Project Alpha and Project Bravo combined with a maximum mortality for both seasons combined of 20 adult birds using all data or 13 without the July 2017 data. For sub-adults, additional mortality of 15 or 10 birds is predicted for the same project with and without the July data respectively. This level of effect is calculated to make a change of 0.002 (0.2%) to the adult survival rate using all data or 0.001 (0.1%) minus July data.

6.3.1 Cumulative displacement assessment of Fowlsheugh SPA razorbill - Forth and Tay projects

222. The cumulative effect of displacement on Fowlsheugh SPA razorbill during the breeding season includes only Project Alpha and Project Bravo combined and Inch Cape. This is because Neart na Gaoithe is beyond the foraging range of razorbill from Fowlsheugh and estimated that less than one bird would be affected during the breeding season (NNG 2018).

223. Displacement data for Inch Cape were taken from the EIAR (IC 2018) and apportioned to Fowlsheugh at a rate of 31.4%. Sabbaticals were applied to adult breeding birds at a rate of 0.07 (7%).

224. The combined effects of Project Alpha and Project Bravo combined and Inch Cape are predicted to be a total of 22 adults and 19 sub adult birds from both seasons combined. This would be equivalent to a change in 0.002 (0.2%) in adult survival.

Table 6-13 Displacement effects on razorbill at Fowlsheugh SPA – Forth and Tay

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub adults
Alpha	Breeding	7184	0.600	4310	2874	4009	24	17	0.467	11	8
	Breeding (adj)[78]	4529	0.600	2717	1812	2527	15	11	0.467	7	5
	Non-breeding	1812	0.600	1087	725		7	4	0.467	3	2
Bravo	Breeding	4087	0.600	2452	1635	2281	14	10	0.467	6	5
	Breeding (adj)	1831	0.600	1099	732	1022	6	4	0.467	3	2
	Non-breeding	2292	0.600	1375	917		8	5	0.467	4	3
Alpha + Bravo combined	Breeding	9380	0.600	5628	3752	5234	31	23	0.467	15	11
	Breeding (adj)	5338	0.600	3203	2135	2979	18	13	0.467	8	6
	Non-breeding	3207	0.600	1924	1283		12	8	0.467	5	4
Inch Cape[79]	Breeding	4671	0.492	2298	2373	2137	13	14	0.314	4	4
	Non-breeding	4905	0.492	2413	2492		14	15	0.314	5	5
								Cumulative Total[80]		**22**	**19**

[78] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way

[79] Data from Inch Cape (2018) HRA Table 4.47.

[80] Total is calculated based on Alpha and Bravo combined adjusted values with those of Inch Cape

Table 6-14 PVA outputs for Fowlsheugh SPA razorbill - displacement

Project / Scenario	Additional mortality[81]		Starting population	End population after 25 years	Counterfactual of end population size	Counterfactual of population growth rate	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	9,950	9064	1.000	1.000	50
Alpha	10	7	9,950	8797	0.971	0.999	47
Bravo	7	5	9,950	8875	0.979	0.999	48
Alpha + Bravo combined	13	10	9,950	8709	0.961	0.998	46
Alpha + Bravo combined with other Forth and Tay projects	22	19	9,950	8449	0.931	0.997	43

[81] Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets

6.3.2 Razorbill – Fowlsheugh SPA - PVA and discussion

225. PVA outputs predict that the un-impacted razorbill population at Fowlsheugh will undergo a slow decline over the next 25 years. Displacement from the Seagreen projects alone has a small effect on this, predicting that, after 25 years, the impacted population would be 96% of the un-impacted population size due to a small change in growth rate (counterfactual of 0.998 or 99.8%). This level of change is consistent with the small change to the adult survival rate (0.1%) predicted to arise from displacement. The centile matching the 50th centile of the impacted population after 25 years is 46% indicating good overlap between the impacted and un-impacted populations.

226. When considering cumulative collision effects with Inch Cape, noting that the displacement estimates for this project do not change between 2014 and 2018 because the site footprint and buffer remain the same, the impacted population size is predicted to be 93% of the un-impacted population (counterfactual of population size 0.931), and the growth rate 99.7% of the un-impacted population after 25 years (counterfactual 0.997). This is consistent with the relatively small predicted change in adult survival rate of 0.2%. The centile matching the 50th centile of the impacted population after 25 years is predicted to be 43% indicating good overlap between the impacted and un-impacted populations.

227. This result differs from the 2014 AA which did not anticipate any effects on the Fowlsheugh razorbill population. However, it defined a threshold for additional mortality of 1.2%. This would be 85 birds based on the Fowlsheugh razorbill population of 7,048 individuals used in the assessment. The maximum additional adult mortality predicted in this HRA Addendum is 22 adults and 19 sub adults. These numbers are based on the conservative assumption that effects during the non-breeding season can be attributed to the SPA colony in the same proportion as those during the breeding season. This is unlikely to be the case given that some wintering razorbills from the east coast of Scotland are known to disperse east into the North Sea and others further south including as far as the Bay of Biscay (Forrester et al. 2007).

228. Tracking studies suggest that razorbill may not partition their foraging areas so that they are spatially segregated to the same extent as other species such as kittiwake (Wakefield et al. 2017). This suggests that their habitat usage may be more flexible, potentially reducing the risk caused by displacement.

229. The Fowlsheugh SPA razorbill population is classed as favourable maintained, although this assessment has not been revised since 1999. However, it is currently higher than the cited population (9,950 compared to 5,800 individuals). Whilst empirical evidence generally suggests that razorbill are likely to be displaced from wind farms (Vanermen & Stienen 2019), not all studies e.g. at Egmond aan Zee (Leopold et al. 2013) and Robin Rigg (Nelson et al. 2015) demonstrate this. Further discussion of razorbill displacement is provided in the section on Forth Islands SPA razorbill.

6.3.3 Razorbill - Fowlsheugh SPA - Summary

230. The razorbill population of Fowlsheugh SPA is currently classed as favourable maintained and the population is higher than that at designation. Whilst PVA predicts that the un-impacted population may undergo a slow decline, the additional effects of any Seagreen project alone or in combination with other projects in the Forth and Tay would have a very small effect on the population's trajectory and growth rate and it would remain at levels above those at citation. The impacts predicted here are also well below the acceptable threshold defined in the 2014 AA. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on the integrity of Fowlsheugh SPA arising from displacement effects on razorbill.

7. St Abb's Head to Fast Castle SPA

231. St Abb's Head to Fast Castle SPA is assessed for the two species shown in Table 7.1. The table provides the most recent population count as advised by SNH with counts presented as individual birds, together with the population size at designation and the site condition of the species.

Table 7-1 Qualifying and assemblage features of the St Abb's Head to Fast Castle SPA assessed in this HRA

Species	Season	Site condition	Cited population – individuals[82]	Current population – individuals (year)
Kittiwake	Breeding	Unfavourable declining (2014)	42,340	6,668 (2016)
Guillemot	Breeding	Favourable maintained (2013)	31,750	48,516[83]

7.1 Kittiwake – St Abb's Head to Fast Castle SPA

232. Kittiwake at St Abb's Head to Fast Castle SPA is assessed separately for collision and displacement and both effects combined. Seagreen effects are calculated in two ways:

- with all data including the very high values recorded in July 2017; and
- with adjusted data i.e. where the July 2017 density data were replaced by the median July value recorded over the three survey years. This applies to breeding season mortality estimates for both collision and displacement and is indicated in the results tables as 'Breeding (adj)'. In all cases, adjusted estimates were taken forward for the cumulative assessment as agreed with SNH and MS. Further details are provided in the EIA chapter of this Addendum, section 2.6 and Annex 5.

82 Data from SNH SiteLink https://sitelink.nature.scot/site/8579
83 Data from MS/SNH email of 21/05/2018 giving 'latest count'

233. It should be noted that the high values observed in the July 2017 data have been incorporated into the overall assessment through the use of all 2017 data to calculate scaling factors which were applied to Seagreen's 2009 – 2011 densities. These generally increased densities were used to calculate the population of the site and 2 km buffer for the assessment of displacement.

234. Predicted mortality for kittiwake at the proposed Seagreen site was apportioned St Abb's Head to Fast Castle SPA as shown below (Table 4.2) and a sabbatical rate of 0.1 (10%) applied to adult breeding birds:

- Breeding season 0.044 (4.4%)
- Post-breeding 0.005 (0.5%)
- Pre-breeding 0.006 (0.6%)

7.1.1 Kittiwake - St Abb's Head to Fast Castle SPA - Collision

235. Predicted kittiwake mortality from collision at Project Alpha, Project Bravo and Project Alpha and Project Bravo combined is shown in Table 7.2 with option 1 and option 2 and a 98.9% avoidance rate shown for comparison.

236. Adjusted data (see EIA chapter of this Addendum, section 2.6) are shown only for Project Alpha and Project Alpha and Project Bravo combined. This is because for Project Bravo, the median density of birds in flight was represented by the July 2017 density data and therefore no adjustment was needed.

237. The annual survival rate of adult kittiwake is 0.854. That is, 5,694 adults from the St Abb's Head to Fast Castle SPA kittiwake population of 6,668 birds would survive each year in the natural, un-impacted population. For Project Alpha, the maximum change in adult survival caused by additional mortality of 4 adults was equivalent to 0.001 (0.1%) based on CRM option 2 using unadjusted data and option 1 using either adjusted or unadjusted data. For Project Bravo no detectable change in adult survival was predicted using any option or dataset. At Project Alpha and Project Bravo combined additional mortality of a maximum of five breeding adults from either option was predicted to cause a change of 0.001 (0.1%) in adult survival.

7.1.1.1 Cumulative collision assessment of kittiwake at St Abb's Head to Fast Castle SPA - Forth and Tay projects

238. When considering Scenario 1, all Forth and Tay projects based on 2018 scenarios, a cumulative additional mortality of eight adults and less than one sub-adult was predicted during the breeding season and the total of 10 adults and one sub-adult for all seasons combined (Table 7.3). This would be a change in adult survival of 0.001 (0.1%).

239. For Scenario 2, the worst case scenario of Project Alpha and Project Bravo combined 2018 plus the other Forth and Tay projects as consented in 2014 additional mortality of 14 adults and one sub- adult was predicted in all seasons. This would be equivalent to a change in background mortality of 0.002 (0.2%).

240. There are a number of smaller offshore windfarms in the Forth and Tay region within mean- maximum foraging range of breeding kittiwake from the St Abb's Head to Fast Castle SPA. These projects include the operational coastal sites of the ORE Catapult turbine at Levenmouth and the consented but not yet constructed Forthwind project. The AA of the Forthwind project did not consider kittiwake to be at risk and also, these projects are more likely to be within the foraging range of kittiwake from Forth Islands SPA. In general, the low levels of collision impacts on kittiwake predicted from these projects are considered unlikely to make a material difference to the St Abb's Head to Fast Castle SPA. However, impacts on the SPA from all smaller projects where collision estimates are available are incorporated in to the assessment of cumulative effects during the non-breeding season when the population disperses away from the colony.

7.1.1.2 Cumulative collision assessment of kittiwake at St Abb's Head to Fast Castle SPA – Forth and Tay plus UK North Sea

241. When considering effects during all seasons from the Forth and Tay projects and non-breeding season effects from other UK North Sea wind farms, a very small number of additional collisions from wind farms in the wider North Sea were attributed to this SPA totalling 6.1 adults and 3.3 sub-adults (Table 7.4).

Table 7-2 Collision mortality attributed to St Abb's Head to Fast Castle SPA kittiwake from the Seagreen projects alone

Project	CRM option	Season	Estimated collision mortality	
			Adult[84]	Sub-adult
Alpha	Option 2	Breeding	3.6	0.4
		Breeding (adj)[85]	2.7	0.3
		Post-breeding	0.3	0.2
		Pre-breeding	0.2	0.0
	Option 1	Breeding	4.1	0.4
		Breeding (adj)	3.1	0.3
		Post-breeding	0.3	0.1
		Pre-breeding	0.2	0.0
Bravo	Option 2	Breeding	2.4	0.2
		Post-breeding	0.2	0.1
		Pre-breeding	0.2	0.1
	Option 1	Breeding	1.6	0.2
		Post-breeding	0.1	0.0
		Pre-breeding	0.1	0.0
Alpha + Bravo combined	Option 2	Breeding	5.1	0.5
		Breeding (adj)	4.0	0.4
		Post-breeding	0.4	0.2
		Pre-breeding	0.4	0.1
	Option 1	Breeding	4.7	0.5
		Breeding (adj)	4.0	0.4
		Post-breeding	0.3	0.1
		Pre-breeding	0.3	0.1

[84] Breeding adults adjusted for sabbaticals

[85] (adj) indicates data adjusted by using the median rather than the mean July data for CRM

Table 7-3 Cumulative collision estimates for kittiwake at St Abb's Head to Fast Castle SPA from Forth and Tay projects 2018 and 2014 scenarios (Option 2 and 98.9% avoidance rate)

Project/Scenario	Season	Estimated collision mortality	
		Adult[86]	Sub-adult
Scenario 1: Alpha + Bravo combined 2018	Breeding (adj)[87]	4.0	0.4
	Post-breeding	0.4	0.2
	Pre-breeding	0.4	0.1
Inch Cape 2018[88]	Breeding	2	0
	Post-breeding	0.1	0.1
	Pre-breeding	0.1	0.1
Neart na Gaoithe 2018[89]	Breeding	2.5	0
	Post-breeding	0.1	0
	Pre-breeding	0	0
Scenario 1: Seasonal totals	Breeding	8.5	0.4
	Post-breeding	0.6	0.3
	Pre-breeding	0.5	0.2
Cumulative total	**All seasons**	**10**	**1**
Scenario 2: Alpha + Bravo combined 2018	Breeding (adj)	4.0	0.4
	Post-breeding	0.4	0.2
	Pre-breeding	0.4	0.1
Inch Cape 2014[90]	Breeding	7	0.2
	Post-breeding	0.2	0.1
	Pre-breeding	0.1	0.0
Neart na Gaoithe 2014[91]	Breeding	1.7	0.1
	Post-breeding	0.1	0.1
	Pre-breeding	0	0
Scenario 2: Seasonal totals	Breeding	12.7	0.7
	Pre-breeding	0.7	0.4
	Post-breeding	0.5	0.1
Cumulative total	**All seasons**	**13.9**	**1.2**

86 Breeding adults adjusted for sabbaticals
87 (adj) indicates data adjusted by using the median rather than the mean July data for CRM
88 Inch Cape data from IC (2018) Table 4.50
89 NNG data derived from NNG (2018) HRA Tables 2.16 and 2.18
90 Derived from numbers in Seagreen (2019) Annex 2: CRM Table 15 and seasonal/SPA proportions from Developers' HRA
91 Derived from spreadsheet 2014 04 23 - FTOWDG - Offshore Wind - Cumulative Impacts - Kitti. Xlsm and seasonal/SPA proportions from SNH (2018b).

Table 7-4 Cumulative collision estimates for kittiwake at St Abb's Head to Fast Castle SPA from Forth and Tay projects worst case scenario and non-breeding impacts from other offshore wind farms in UK North Sea (Option 2 and 98.9% avoidance rate)

Project	Season	Estimated collision mortality	
		Adults	**Sub-adults**
Cumulative Seagreen 2018 and other projects 2014	Breeding	12.7	0.8
	Post-breeding	0.6	0.4
	Pre-breeding	0.6	0.1
Other UK North Sea offshore wind farms[92]	Post-breeding	2.3	1.4
	Pre-breeding	3.8	1.9
Seasonal totals	Breeding	13	1
	Post-breeding	3	2
	Pre-breeding	4	2
Cumulative total	**All seasons**	**20**	**5**

242. The total cumulative mortality incorporating other projects in the UK North Sea in all seasons was estimated to be 20 adults and five sub-adults. This would represent a change in adult survival rate from 0.854 to 0.851 i.e. a 0.003 (0.3%) change.

7.1.2 Kittiwake - St Abb's Head to Fast Castle SPA - Displacement

243. Displacement of kittiwake at St Abb's Head to Fast Castle SPA was assessed for the breeding season only assuming a displacement rate of 30% and consequent mortality of 2%. Seagreen effects are calculated in two ways:

- With all data;
- With data where the July 2017 density data were replaced by the median July value recorded over the three survey years as agreed with SNH/MS. The mean peak breeding population between April and August was then derived in the normal way (EIA chapter of this Addendum, section 2.6).

244. The maximum mortality was predicted from Project Alpha and Project Bravo combined with a total of 2.5 adults and 0.3 sub-adults using unadjusted data and 1.3 adults and 0.1 sub-adult using adjusted data (Table 7.5). This very small change in adult survival would make a negligible change to the background survival rate.

[92] See Annex 4 for calculations

7.1.2.1 Cumulative displacement assessment of kittiwake at St Abb's Head to Fast Castle SPA – Forth and Tay projects

245. For cumulative assessment, Project Alpha and Project Bravo combined (adjusted data) was assessed with Inch Cape and Neart na Gaoithe. As the displacement assessment for both projects remained the same between 2014 and 2018, only a single scenario was modelled. The assessment estimated additional mortality of 3.4 adult birds and 0.3 sub-adults from displacement. This level of mortality would result in a change of less than 0.001 (< 0.1%) in adult background mortality.

Table 7-5 Estimated displacement effects for kittiwake at St Abb's Head to Fast Castle SPA - Forth and Tay projects

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub adults
Alpha	Breeding	8265	0.914	7554	711	6799	41	4	0.044	1.8	0.2
	Breeding (adj)[93]	3935	0.914	3597	338	3237	19	2	0.044	0.9	0.1
Bravo	Breeding	5147	0.914	4704	443	4234	25	3	0.044	1.1	0.1
	Breeding (adj)	3146	0.914	2875	271	2588	16	2	0.044	0.7	0.1
Alpha + Bravo combined	Breeding	11405	0.914	10424	981	9382	56	6	0.044	2.5	0.3
	Breeding (adj)	5962	0.914	5449	513	4904	29	3	0.044	1.3	0.1
Inch Cape[94]	Breeding	3,866	0.93	3595	271	3236	19	2	0.056	1.1	0.1
Neart na Gaoithe[95]	Breeding	2,164	0.93	2013	151	1811	11	1	0.092	1.0	0.1
							Cumulative total: Forth & Tay[96]			**3.4**	**0.3**

[93] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way. Unadjusted populations based on all data

[94] Data from the Inch Cape (2018) HRA Table 4.54

[95] Data for Neart na Gaoithe (2018) HRA derived from paragraph 175 et seq, Tables 2.19 to 2.28 and Appendix 9.2 Ornithology baseline report and SNH (2018b)

[96] Cumulative total is Project Alpha and Project Bravo combined using adjusted data with the other Forth and Tay projects

Table 7-6 Cumulative effects of collision plus displacement on kittiwake from St Abb's Head to Fast Castle SPA from Seagreen projects (2018) and other Forth and Tay wind farms as consented 2014.

Project	Effect	Season	Estimated additional mortality	
			Adult	**Sub-adult**
Alpha	Collision	Breeding (adj)[97]	2.7	0.3
		Post-breeding	0.3	0.2
		Pre-breeding	0.2	0.0
	Displacement	Breeding (adj)	0.9	0.1
		Total	**4.1**	**0.6**
Bravo	Collision	Breeding	2.4	0.2
		Post-breeding	0.2	0.1
		Pre-breeding	0.2	0.1
	Displacement	Breeding (adj)	0.7	0.1
		Total	**3.5**	**0.5**
Alpha + Bravo combined	Collision	Breeding (adj)	4.0	0.4
		Post-breeding	0.4	0.2
		Pre-breeding	0.4	0.1
	Displacement	Breeding (adj)	1.3	0.1
		Total	**6.1**	**0.8**
Inch Cape (as consented 2014)[98]	Collision	Breeding	7	0.2
		Post-breeding	0.2	0.1
		Pre-breeding	0.2	0.0
	Displacement	Breeding	1.1	0.1
		Total	**8.5**	**0.4**
Neart na Gaoithe (as consented 2014)[3]	Collision	Breeding	1.7	0.1
		Post-breeding	0.1	0.1
		Pre-breeding	0.0	0.0
	Displacement	Breeding	1	0.1
		Total	**2.8**	**0.3**
Cumulative total: Forth & Tay projects (WCS)			**17**	**2**

[97] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way. Unadjusted populations based on all data.

[98] Collision data from Annex 2: CRM. [3] Data from NNG spreadsheet 2014 04 23 - FTOWDG - Offshore Wind - Cumulative Impacts - Kitti.xlsm

7.1.1 Collision plus displacement assessment of kittiwake at St Abb's Head to Fast Castle SPA – Seagreen projects

246. The combined effects of collision and displacement are shown for the Seagreen projects alone and for other Forth and Tay projects in Table 7.6. As expected, the worst case in terms of Seagreen, is for Project Alpha and Project Bravo combined where an estimated additional mortality of 6 adults and 1 sub-adult was predicted. This would represent a change in adult survival of 0.001 (0.1%).

247. This value is taken forward as the worst case scenario to estimate cumulative values with the other Forth and Tay projects. In the case of Inch Cape and Neart na Gaoithe this is for the 2014 projects as consented for collision and displacement.

7.1.2 Collision plus displacement assessment of kittiwake at St Abb's Head to Fast Castle SPA – Forth and Tay projects

248. The cumulative effects of the Forth and Tay projects for collision and displacement combined are predicted to cause additional mortality of 17 adults and 2 sub-adults (Table 7.6). This would be equivalent to a change in adult survival of 0.003 (0.3%).

Table 7-7 Cumulative effects of collision plus displacement on kittiwake from St Abb's Head to Fast Castle SPA from worst case scenario Forth and Tay projects and other North Sea wind farms

Project	Effect	Season	Estimated additional mortality	
			Adult	**Sub-adult**
Cumulative: Seagreen 2018 and other Forth and Tay projects 2014	Collision	Breeding	12.7	0.7
		Post-breeding	0.7	0.4
		Pre-breeding	0.6	0.1
	Displacement	Breeding	3.4	0.3
Other UK North Sea wind farms[99]	Collision	Post-breeding	2.3	1.4
		Pre-breeding	3.8	1.9
Seasonal totals	Collision + displacement	Breeding	16	1.1
		Post-breeding	2.9	1.8
		Pre-breeding	4.4	2.0
Cumulative total		**All seasons**	**23**	**5**

[99] See Annex 4 for calculations

7.1.2.1 Collision plus displacement assessment of kittiwake at St Abb's Head to Fast Castle SPA – Forth and Tay and UK North Sea

249. When considered with the additional non-breeding season mortality from other projects in the North Sea, a further 6.1 adults and 3.3 sub- adults would be affected bringing the cumulative total to 23 adults and five sub-adults (Table 7.7). This would increase the change in adult survival to just under 0.004 (0.4%).

Table 7-8 PVA outputs for St Abb's Head to Fast Castle SPA kittiwake – collision

Project / Scenario	Additional mortality[100]		Starting population	End population after 25 years	Counterfactual of end population size (impacted / unimpacted)	Counterfactual of population growth rate (impacted / unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	6,668	6774	1.000	1.000	50
Alpha	3	1	6,668	6698	0.989	1.000	49
Bravo	3	0	6,668	6712	0.991	1.000	49
Alpha + Bravo combined	4 (5)	1	6,668	6677	0.986	0.999	48
Alpha + Bravo combined with other Forth and Tay projects 2018	8 (10)	1	6,668	6597	0.974	0.999	47
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014	16 (14)	3 (1)	6,668	6410	0.946	0.998	44
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014 plus non-breeding season effects from wind farms in the UK North Sea	21 (20)	6 (5)	6,668	6272	0.926	0.997	41

[100] Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets

Table 7-9 PVA outputs for St Abb's Head to Fast Castle SPA kittiwake – collision and displacement

Project / Scenario	Additional mortality[101]		Starting population	End population after 25 years	Counterfactual of end population size (impacted / unimpacted)	Counterfactual of population growth rate (impacted / unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	6,668	6774	1.000	1.000	50
Alpha	4	1	6,668	6677	0.986	0.999	48
Bravo	4	1	6,668	6677	0.986	0.999	48
Alpha + Bravo combined	6	1	6,668	6637	0.980	0.999	48
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014	19 (17)	2	6,668	6366	0.940	0.998	43
Alpha + Bravo combined with other Forth and Tay projects as consented in 2014 plus non-breeding season effects from other wind farms in the UK North Sea	25 (23)	6 (5)	6,668	6196	0.915	0.996	40

[101] Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets

7.1.3 Kittiwake - St Abb's Head to Fast Castle SPA - PVA and discussion

250. PVA outputs indicate that the Seagreen projects alone have a very small effect on kittiwake at St Abb's Head to Fast Castle SPA in terms of collision. The worst case is Project Alpha and Project Bravo combined which, after 25 years, is predicted to result in a population which is 99% of that of the un-impacted population (counterfactual of 0.986) with a growth rate of 99% of that of the un-impacted population (counterfactual of 0.999). The centile matching the 50th centile of the impacted population is 48% indicating good overlap between the impacted and un-impacted population.

251. As expected, a slightly greater effect is predicted when considering collision and displacement combined. Once again, the worst case is Project Alpha and Project Bravo combined and the PVA predicts that the population will be 98% of the un-impacted population size after 25 years (counterfactual of 0.980) with the growth rate maintained at 99.9% of that of the un-impacted population (counterfactual of 0.999). The population remains at approximately its current level which is consistent with the relatively small change to the adult survival rate (WCS 0.2%) predicted to arise from collision and displacement from any of the Seagreen projects alone.

252. When considering cumulative collision effects with other projects in the Forth and Tay using 2018 scenarios, the population remains similar to the starting population after 25 years at 97% of the un-impacted population size (counterfactual of population size 0.974) and the growth rates remain at 99.9% (counterfactual 0.999).

253. When considering the worst case scenario of Project Alpha and Project Bravo combined 2018 with the other Forth and Tay developments as consented in 2014 for collision alone, PVA suggests that the population after 25 years would be equivalent to 95% (counterfactual 0.946) of the un-impacted population and the growth rate would remain above 99% of that of the un-impacted population (counterfactual of 0.998).

254. Taking into account the cumulative collision effects from the Forth and Tay projects (WCS) and non-breeding season collisions from other offshore wind farms in the wider UK North Sea, the end population after 25 years is predicted to be 93% of what it would have been without impacts although the counterfactual of the growth rate still remains high (0.997). The population is predicted to be slightly lower than at present.

255. Whilst combined collision and displacement exaggerate these effects slightly by reducing the end population size to 92% of the un-impacted population after 25 years (counterfactual of 0.915) and the counterfactual of the growth rate to 0.996 (99.6%), the overlap between the populations remains high with the centile matching the 50th centile of the impacted population at 40%. Nonetheless, these results should be treated with caution as noted by SNH in the 2017 Scoping Opinion, where collision and displacement are described as 'mutually exclusive' impacts. It would therefore be more appropriate either to consider collision and displacement effects individually or, based on the limited evidence for displacement, consider collision alone.

256. St Abb's Head to Fast Castle SPA lies 68 km from the Seagreen sites and tracking data collected from breeding kittiwakes (Wakefield et al. 2017) indicate that birds from this SPA rarely venture as far as the Seagreen sites, suggesting that apportioning by the method represented in the 2017 Scoping Opinion is likely to be conservative. As with many other kittiwake colonies, the St Abb's, population increased until the late 1980s but has subsequently declined more rapidly than other Scottish and UK populations (Swann 2018). However, since 2012, there are indications that it may be stabilising or increasing in terms of both numbers and productivity (IC 2018, NTS 2018, Swann 2018). As stated previously, the recommended method of PVA modelling (Leslie matrix) is unable to replicate these fluctuations and, based on the data available, which have been carefully reviewed, predicts that the un-impacted population will now continue to rise (Annex 3: PVA). Such PVA models are sensitive to very small changes in the input parameters and outputs should be viewed in this context. Further discussion on kittiwake population trends is provided in the section on Forth Islands SPA kittiwake and is not repeated here.

257. The 2014 AA suggested that the cumulative effects of the Forth and Tay projects from collision and displacement during the breeding season would reduce adult survival at the SPA by 0.5%, equivalent to 60 individuals and predicted a counterfactual of end population size of 94% (MS 2014, Appendix 7). The current assessment estimates a worst case cumulative mortality of 27 adults and five sub- adults for collision and displacement from Project Alpha and Project Bravo combined (2018), other Forth and Tay projects as consented in 2014 plus non-breeding season collision effects from other UK North Sea windfarms. This assessment predicts less than half of the 2014 mortality estimate based on a more conservative scenario that, unlike the 2014 AA, includes effects from projects in the wider UK North Sea.

7.1.4 Kittiwake - St Abb's Head to Fast Castle SPA –- Summary

258. The kittiwake population of St Abb's Head to Fast Castle SPA is classed as unfavourable declining and currently the population is lower than at designation. This is thought to be due to wider issues causing recent seabird declines such as climate change and associated sea temperature warming with consequent changes in seabird food supply. This assessment demonstrates that collision and displacement effects from the Seagreen projects alone would have a very small effect on the population which would be unlikely

to affect its long term trajectory. When assessed cumulatively for collision and displacement effects with other projects in the Forth and Tay and the wider North Sea, PVA predicts that the kittiwake population of the SPA would potentially undergo a small decline in population size and growth rate compared to the un-impacted population. The effects in this HRA Addendum have been assessed on a conservative basis including collisions from offshore wind farms in the wider North Sea however they are predicted to be considerably lower than those for the Forth and Tay projects as consented in 2014. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on St Abb's Head to Fast Castle SPA arising from effects on kittiwake.

7.2 Guillemot – St Abb's Head to Fast Castle SPA

7.2.1 Guillemot - St Abb's Head to Fast Castle SPA - Displacement

259. Displacement of guillemot at St Abb's Head to Fast Castle SPA was assessed for both the breeding and non-breeding season assuming a displacement rate of 60% and consequent mortality of 1%. Estimates were made for each Seagreen project alone using:

- all survey data; and
- without the July 2017 data when very high densities of birds were observed. This was agreed with SNH/MS and was consistent with the advice given to other offshore wind projects in the region where surveys undertaken in late July recorded high densities owing to the occurrence of large numbers of adults accompanying dependent young (SNH email to MSLOT of 11/01/2019).

260. It should be noted that the high values observed in the July 2017 data have been incorporated into the overall assessment through the use of all 2017 data to calculate scaling factors which were applied to Seagreen's 2009 – 2011 densities. These generally increased densities were used to calculate the population of the site and 2 km buffer for assessment of displacement.

261. Predicted mortality for guillemot at the proposed Seagreen site was apportioned to St Abb's Head to Fast Castle SPA at a rate of 0.135 (13.5 %) for both the breeding and non-breeding season (Table 4.2) and a sabbatical rate of 0.07 (7%) was applied to adult breeding birds. The proportion of adults was based on the stable age structure of the population used in the PVA.

262. The population of guillemot at St Abb's Head to Fast Castle SPA is 48,516 individuals with an adult survival rate of 0.939. That is in any one year a total of 45,557 adult individuals would survive in the natural, un-impacted population. The maximum mortality at any proposed Seagreen site was predicted from Project Alpha and Project Bravo combined with a total of 18 adults and 15 sub-adults using unadjusted data and 15 adults and 13 sub-adults using adjusted data (Table 7.10). The additional mortality of adults at this scale would be indistinguishable from natural variation in background mortality and would make no change to adult survival rate.

7.2.2 Cumulative displacement assessment of guillemot at St Abb's Head to Fast Castle SPA - Forth and Tay projects

263. For cumulative assessment of the Forth and Tay projects, Project Alpha and Project Bravo combined (2018) using adjusted data was assessed with Neart na Gaoithe and Inch Cape.

264. Displacement data for Neart na Gaoithe and Inch Cape were taken from their respective EIARs and apportioned to at St Abb's Head to Fast Castle SPA at a rate of 22% and 15.3% respectively. Sabbaticals were applied to adult breeding birds at a rate of 0.07 (7%). As the displacement assessment for both these projects remained the same between 2014 and 2018, only a single cumulative scenario was modelled (Table 7.10).

265. The assessment estimated additional mortality of 13 adults during the breeding season and 11 during the non-breeding season together with 13 and 11 sub-adults during same seasons respectively. In total this amounted to 28 adults and 27 sub-adults. As for the Seagreen projects alone, this level of additional mortality would cause a change of less than 0.001 (< 0.1%) in adult survival rate.

Table 7-10 Estimated displacement effects for guillemot at St Abb's Head to Fast Castle SPA from each Seagreen site alone and in combination with other Forth and Tay projects (displacement rate of 60%, mortality 1%)

Project	Season	Mean peak population of site	Adult proportion	Breeding adults	Sub-adults	Breeding adults minus sabbaticals	Adult displacement mortality	Sub-adult displacement mortality	SPA proportion	Additional mortality adults	Additional mortality sub adults
Alpha	Breeding	18730	0.55	10301	8428	9580	57	51	0.135	8	7
	Breeding (adj)[102]	14253	0.55	7839	6414	7290	44	38	0.135	6	5
	Non-breeding	8469	0.55	4658	3811		28	23	0.135	4	3
Bravo	Breeding	14729	0.55	8101	6628	7534	45	40	0.135	6	5
	Breeding (adj)	10421	0.55	5732	4690	5330	32	28	0.135	4	4
	Non-breeding	7410	0.55	4075	3334		24	20	0.135	3	3
Alpha + Bravo combined	Breeding	27783	0.55	15281	12502	14211	85	75	0.135	12	10
	Breeding (adj)	20813	0.55	11447	9366	10646	64	56	0.135	9	8
	Non-breeding	13634	0.55	7499	6135		45	37	0.135	6	5
Inch Cape[103]	Breeding	8184	0.439	3593	4591	3341	22	28	0.153	3	4
	Non-breeding	3912	0.439	1717	2195	1597	10	13	0.153	2	2
Neart na Gaoithe[104]	Breeding	4893	0.51	2495	2398	2321	15	14	0.22	3	3
	Non-breeding	7618	0.51	3885	3733	3613	23	22	0.22	5	5

[102] (Adj) Adjusted data substitutes the median July density from all survey years for the maximum recorded in July 2017 before calculation of monthly collision or seasonal mean peak population in the normal way. Unadjusted populations based on all data

[103] Data from Inch Cape (2018) HRA Table 4.62

[104] Data from Neart na Gaoithe (2018) HRA Tables2.58 – 2.63 and paras 266 et seq

Table 7-11 PVA outputs St Abb's Head to Fast Castle SPA guillemot –displacement

Project / Scenario	Additional mortality[105]		Starting population	End population after 25 years	Counterfactual of end population size (impacted / unimpacted)	Counterfactual of population growth rate (impacted / unimpacted)	Centile of un-impacted population matching 50th centile of impacted
	Adult	Sub-adult	Adult	Adult			
Un-impacted population	0	0	48,516	115,528	1.000	1.000	50
Alpha	8 (10)	8	48,516	114,957	0.995	1.000	49
Bravo	7	5 (7)	48,516	115,083	0.996	1.000	49
Alpha + Bravo combined	13 (15)	11 (13)	48,516	114,656	0.992	1.000	47
Alpha + Bravo combined with other Forth and Tay projects	24 (28)	24 (27)	48,516	113,823	0.985	0.999	44

105 Additional mortality is the specific mortality modelled. Where final mortality estimates differ they are given in brackets

7.2.3 Guillemot - St Abb's Head to Fast Castle SPA - PVA and discussion

266. PVA outputs indicate that displacement effects from the Seagreen projects alone have a very small effect on guillemot at St Abb's Head to Fast Castle SPA. In all cases the population is predicted to be above 99% of the un-impacted population size after 25 years (WCS counterfactual of population size of 0.992) and the growth rate is unaffected by this level of effect (counterfactual of 1.000) (Table 7.11). In all cases the end population after 25 years is predicted to be well above current levels and those at citation. This is consistent with the finding that the displacement effect of any Seagreen project would be indistinguishable from natural variation in background mortality. The centile matching the 50th centile of the impacted population is 47% indicating good overlap between the impacted and un-impacted population distributions.

267. When considering cumulative displacement effects with other projects in the Forth and Tay, noting that the displacement estimates for these projects do not change between 2014 and 2018 because the site footprint and buffer remain the same, the population trend remains positive and is considerably higher than the starting population after 25 years at 99% of the un-impacted population size (counterfactual of population size 0.985) owing to a strong growth rate of 99.9% of the un-impacted population (counterfactual 0.999) (Table 7.11). This is also consistent with the small predicted change in adult survival rate of less than 0.1%. The centile matching the 50th centile of the impacted population is 44% indicating good overlap between the population distributions. These results are consistent with the 2014 AA which predicted no decline in adult survival and a counterfactual of population size of 100% for guillemot at St Abb's Head to Fast Castle SPA i.e. the impacted and un-impacted population size would be the same after 25 years.

268. The St Abb's Head to Fast Castle SPA guillemot population is classed as favourable maintained and is currently higher than the cited population (48,516 compared to 31,750 individuals) having shown a steady increase since Seabird 2000 (Swann 2018). As noted previously, whilst some studies have shown that guillemot are displaced from wind farms (Vanermen et al. 2015), UK studies at Robin Rigg (Vallejo et al. 2017) and Thanet (Percival 2013) and other European offshore wind farms have suggested that the species is indifferent to them or shows only weak displacement (Leopold 2018). For a more detailed discussion of displacement effects see section on guillemot at Forth Islands SPA.

7.2.4 Guillemot - St Abb's Head to Fast Castle SPA - Summary

269. The guillemot population of St Abb's Head to Fast Castle SPA is currently classed as favourable maintained. This assessment indicates that displacement effects from the Seagreen projects alone would have minimal effects on the population, which is predicted to continue to increase. When assessed cumulatively with other projects in the Forth and Tay for both the breeding and non-breeding seasons, PVA indicates that this increase is likely continue and that, after 25 years, the population would be maintained in the long term well above its current levels. The evidence presented in this assessment should therefore enable the competent authority to conclude no adverse effect on St Abb's Head to Fast Castle SPA arising from displacement effects on guillemot.

8. Outer Firth of Forth and St Andrew's Bay Complex pSPA

270. The 2017 Scoping Opinion advised that assessment for the following qualifying features of the pSPA, namely: gannet kittiwake, guillemot, razorbill and puffin, 'should be carried out … at the breeding colony SPAs listed above', all other pSPA features having been screened out of assessment. For reference, gannet and puffin qualify at the pSPA for the breeding season only; kittiwake and guillemot for both breeding and non-breeding season and razorbill for the non-breeding season only.

271. In this context, the Scoping Opinion advises that 'the conservation objective relating to the population of the species as a viable component of the site should be the focus of the assessment' for the SPAs and that a separate assessment for the pSPA is not required (2017 Scoping Opinion Appendix A (i) page 106).

272. In each case this HRA has assessed the required pSPA species at the breeding colony SPAs of Forth Islands SPA, Fowlsheugh SPA and St Abb's Head to Fast Castle SPA as required by the 2017 Scoping Opinion. The assessment has been carried out in a conservative manner i.e. for all seasons, regardless of the season for which each pSPA feature is designated. On this basis, it has concluded that there would be no adverse effect for any of the species at any of their breeding colony SPAs focussing on the conservation objective to 'maintain the population of the species as a viable component of the site'. Following the advice of the 2017 Scoping Opinion, and the methodology of the Neart na Gaoithe Appropriate Assessment (MS 2019) these conclusions can therefore also be applied to the Outer Firth of Forth and St Andrews Bay Complex pSPA. This conclusion is drawn for each Seagreen project alone and cumulatively based on the worst case effects from other projects in the Forth and Tay and, including for gannet and kittiwake those in the wider UK North Sea (and Channel in the case of gannet).

273. As noted in paragraphs 8 and 9, the effects of the Offshore Transmission Asset (OfTA) on the pSPA have been screened out of this assessment as they do not exert effects during operation. Effects during construction and decommissioning were fully considered previously by Seagreen as detailed in Annex 6, noting SNH's statement in the 2017 Scoping Opinion 'that the previous assessment addressed all relevant bird interests' and that 'previously agreed mitigation measures and marine licence conditions can be relied upon'. However, Annex 6 also provides the further information requested by the RSPB via the 2017 Scoping Opinion on the maximum extent of the pSPA which would be affected, habitat mapping within the export cable corridor and the method of cable installation. More specific details and timings would be provided by the Cable Plan and the Operations and Maintenance Programme as required by the OfTA consent and marine licence conditions.

9. Conclusion and summary

274. This ornithology HRA Addendum has assessed the operational effects over 25 years of the optimised Seagreen Project: Project Alpha, Project Bravo and Project Alpha and Project Bravo combined, against a suite of five qualifying species at four SPA/pSPAs as agreed with Marine Scotland and Scottish Natural Heritage.

275. Included in the assessment were: Forth Islands SPA, Fowlsheugh SPA, St Abb's Head to Fast Castle SPA and the Outer Firth of Forth and St Andrews Bay Complex pSPA. The species assessed were gannet, kittiwake, guillemot, razorbill and puffin at each SPA where they were qualifying features and where the SPA was within mean-maximum foraging range of the optimised Seagreen Project.

276. The optimised Seagreen Projects have been assessed alone and cumulatively, according to the scenarios advised in the 2017 Scoping Opinion, with other projects in the Forth and Tay and, in the case of gannet and kittiwake, the wider UK North Sea (including Channel for gannet only).

277. A summary of the findings is tabulated below. For each species at each relevant SPA it outlines the estimated effects, provides the PVA ratios (counterfactuals) for the impacted versus the un-impacted population size and growth rate after 25 years of wind farm operation, and compares the current estimated level of effect with that of the projects as consented in 2014 as described in the Appropriate Assessment (MS 2014).

278. It finds that, in all cases, effects from the optimised Seagreen Project both alone and including the worst case cumulative scenario would be well below those estimated for the Forth and Tay projects as consented in 2014. PVA modelling indicates that the impacted populations will be generally similar to those of the un-impacted populations with a ratio of impacted to un-impacted population size of around 90% or above. Similar predictions are made in terms of the population growth rate where the ratio generally remains above 99%. On this basis, it is concluded that the populations of these species at each SPA would be maintained in the long term.

279. In conclusion, and particularly in the context of the projects as consented in 2014, this HRA finds that there would be no adverse effects on the integrity of:

- Forth Islands SPA;
- Fowlsheugh SPA; and
- St Abb's Head to Fast Castle SPA.

280. In relation to the Outer Firth of Forth and St Andrews Bay Complex pSPA, the effects of the optimised Seagreen Project have been assessed both alone and cumulatively with other projects in the Forth and Tay region and, where required, in the wider North Sea and Channel, in respect of both breeding and non-breeding season effects at the above named breeding colony SPAs as advised in the 2017 Scoping Opinion. Based on the conclusion of no adverse effect at the breeding colony SPAs, it is concluded that there would be no adverse effect on the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA.

Table 9-1 Summary of effects for Forth Islands SPA

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea (and Channel for gannet only)
Gannet	Collision[106]	Predicted mortality (adults): breeding season 168, non-breeding season 8. PVA predicts strong growth above baseline with ratio (counterfactual) of population size after 25 years of 97.7 and growth rate 99.9%. Estimated effects would be 15% of the total (1169 adults) predicted by the MS (2014) AA.[107]	Predicted mortality (adults): breeding season 119, non-breeding season 9. PVA predicts strong growth above baseline with ratio of population size after 25 years of 98.3% and growth rate 99.9%. Estimated effects would be 11% of the total (1169 adults) predicted by the MS (2014) AA.	Predicted mortality (adults): breeding season 245, non-breeding season 15. PVA predicts strong growth above baseline with ratio of population size after 25 years of 96.6% and growth rate 99.9%. Estimated effects would be 22% of the total (1169 adults) predicted by the MS (2014) AA.	Predicted mortality (adults): breeding season 421, non-breeding season 26. PVA predicts strong growth above baseline with ratio of population size after 25 years of 94.5% and growth rate 99.8%. Estimated effects would be 38% of the total (1169 adults) predicted by the MS (2014) AA.	Predicted mortality (adults): breeding season 776, non-breeding season 38. PVA predicts strong growth above baseline with ratio of population size after 25 years of 89.5% and growth rate 99.6%. Estimated effects would be 70% of the total (1169 adults) predicted by the MS (2014) AA.	Predicted mortality (adults): breeding season 776, non-breeding season 121. PVA predicts strong growth above baseline with ratio of population size after 25 years of 88.1% and growth rate 99.5%. Estimated effects would be 77% of the total (1169 adults) predicted by the MS (2014) AA

106 All collision numbers relate to option 2 and 98.9% avoidance rate..

107 All effects and thresholds predicted in 2014 are taken from the Appropriate Assessment Appendix 7, Table A (MS 2014). Thresholds in the AA table are expressed as a percentage of the SPA population of individuals at the time

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea (and Channel for gannet only)
Kittiwake	Collision	Predicted mortality (adults): breeding season 6, non-breeding season <1. PVA predicts growth above baseline with ratio (counterfactual) of population size after 25 years of 98.6 and growth rate 99.9%. Effects predicted to be 5% of the total (135) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 5, non-breeding season <1. PVA predicts growth above baseline with ratio of population size after 25 years of 98.8% and growth rate 100%. Effects predicted to be 4% of the total (135) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 8, non-breeding season <1. PVA predicts growth above baseline with ratio of population size after 25 years of 97.9% and growth rate 99.9%. Effects predicted to be 6% of the total (135) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 21, non-breeding season 1. PVA predicts stable ratio of population size after 25 years of 95.3% and growth rate 99.8%. Effects predicted to be 16% of the total (135) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 46, non-breeding season 1. PVA predicts similar population size to present with ratio of population size after 25 years of 89.3% and growth rate 99.6%. Effects predicted to be 35% of the total (135) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 46, non-breeding season 10. PVA predicts similar population size to present with ratio of population size after 25 years of 87.4% and growth rate 99.5%. Effects predicted to be 41% of the total (135) predicted by the MS 2014 AA.
	Displacement	Predicted mortality (adults): breeding season only 2. Effects negligible	Predicted mortality (adults): breeding season only <2. Effects negligible	Predicted mortality (adults): breeding season only <3. Effects negligible	Predicted mortality (adults): breeding season only 14. Effects predicted to be 10% of the total (135) predicted by the MS 2014.	N/A	N/A
	Collision + Displacement	Predicted mortality (adults): breeding season 7, non-	Predicted mortality (adults): breeding season 6,	Predicted mortality (adults): breeding season 11, non-	N/A	Predicted mortality (adults): breeding season 61, non-	Predicted mortality (adults): breeding season

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea (and Channel for gannet only)
		breeding season 1. PVA predicts (counterfactual) of population size after 25 years of 98.1 and growth rate 99.9%. Effects predicted to be 7% of the total (135) predicted by the MS 2014 AA.	non-breeding season 1. PVA ratio of population size after 25 years of 98.3% and growth rate 99.9%. Effects predicted to be 5% of the total (135) predicted by the MS 2014 AA.	breeding season 1. PVA ratio of population size after 25 years of 97.1% and growth rate 99.9%. Effects predicted to be 9% of the total (135) predicted by the MS 2014 AA.		breeding season 1. PVA predicts ratio of population size after 25 years of 86.3% and growth rate 99.4%. Effects predicted to be 46% of the total (135) predicted by the MS 2014 AA.	61, non-breeding season 10. PVA predicts ratio of population size after 25 years of 84.8% and growth rate 99.3%. Effects predicted to be 53% of the total (135) predicted by the MS 2014 AA.
Guillemot	Displacement	Predicted mortality (adults): breeding season 8, non-breeding season 4. PVA predicts strong growth above baseline with ratio (counterfactual) of population size after 25 years of 99.2 and growth rate 100%. Effects predicted to be 80% of the total (15) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 6, non-breeding season 4. PVA predicts strong growth above baseline with ratio of population size after 25 years of 99.4% and growth rate 100%. Effects predicted to be 67% of the total	Predicted mortality (adults): breeding season 11, non-breeding season 8. PVA predicts strong growth above baseline with ratio of population size after 25 years of 98.7% and growth rate 99.9. Effects predicted to slightly exceed the total (15) predicted by the MS 2014 AA but only reach 7% of the threshold (262 birds).	Predicted mortality (adults): breeding season 27, non-breeding season 26. PVA predicts strong growth above baseline with ratio of population size after 25 years of 96.2% and growth rate 99.8%. Effects predicted to exceed the total (15) predicted by the MS 2014 AA but	N/A	N/A

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea (and Channel for gannet only)
			(15) predicted by the MS 2014 AA.		only reach 20% of the threshold of 262 birds.		
Razorbill	Displacement	Predicted mortality (adults): breeding season 3, non-breeding season 1. PVA predicts growth above baseline with ratio (counterfactual) of population size after 25 years of 98.5 and growth rate 99.9%. Effects predicted to be 9% of the total (45) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 1, non-breeding season 2. PVA predicts growth above baseline with ratio of population size after 25 years of 98.9% and growth rate 100%. Effects predicted to be 7% of the total (45) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 4, non-breeding season 3. PVA predicts growth above baseline with ratio of population size after 25 years of 97.5% and growth rate 99.9%. Effects predicted to be 16% of the total (45) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 11, non-breeding season 15. PVA predicts growth above baseline with ratio of population size after 25 years of 90% and growth rate 99.6%. Effects predicted to be 58% of the total (45) predicted by the MS 2014 AA	N/A	N/A
Puffin	Displacement	Predicted mortality (adults): breeding season only - 18. PVA predicts strong growth above baseline with ratio (counterfactual) of	Predicted mortality (adults): breeding season only - 26. PVA predicts strong growth above baseline with	Predicted mortality (adults): breeding season only – 37. PVA predicts strong growth above baseline with ratio of population size after 25 years of 98.8%	Predicted mortality (adults): breeding season only -92. PVA predicts strong growth above baseline with ratio of	N/A	N/A

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea (and Channel for gannet only)
		population size after 25 years of 99.4 and growth rate 100%. Effects predicted to be 1% of the total (1251) predicted by the MS 2014 AA.	ratio of population size after 25 years of 99.2% and growth rate 100%. Effects predicted to be 2% of the total (1251) predicted by the MS 2014 AA.	and growth rate 100%. Effects predicted to be 3% of the total (1251) predicted by the MS 2014 AA.	population size after 25 years of 95.7% and growth rate 99.8%. Effects predicted to be 7% of the total (1251) predicted by the MS 2014 AA.		

Table 9-2 Summary of effects for Fowlsheugh SPA

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea
Kittiwake	Collision[108]	Predicted mortality (adults): breeding season 26, non-breeding season 1. PVA predicts growth above baseline with ratio (counterfactual) of population size after 25 years of 97% and growth rate 99.9%. Effects predicted to be 13% of the total (212) predicted by the MS 2014 AA[109].	Predicted mortality (adults): breeding season 23, non-breeding season 1. PVA predicts growth above baseline with ratio of population size after 25 years of 97.5% and growth rate 99.9%. Effects predicted to be 11% of the total (212) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 38, non-breeding season 2. PVA predicts growth above baseline with ratio of population size after 25 years of 95.7% and growth rate 99.8%. Effects predicted to be 19% of the total (212) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 48, non-breeding season 3. PVA predicts stable ratio of population size after 25 years of 94.6% and growth rate 99.8%. Effects predicted to be 24% of the total (212) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 74, non-breeding season 4. PVA predicts similar population size to present with ratio of population size after 25 years of 91.6% and growth rate 99.7%. Effects predicted to be 37% of the total (212) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 74, non-breeding season 21. PVA predicts similar population size to present with ratio of population size after 25 years of 89.5% and growth rate 99.6%. Effects predicted to be 45% of the total (212) predicted by the MS 2014 AA.

[108] All collision numbers relate to option 2 and 98.9% avoidance rate.

[109] All effects and thresholds predicted in 2014 are taken from the Appropriate Assessment Appendix 7, Table A (MS 2014). Thresholds in the AA table are expressed as a percentage of the SPA population of individuals at the time

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea
	Displacement	Predicted mortality (adults): breeding season only - 8. Effects predicted to be 4 % of the total (212) predicted by the MS 2014 AA	Predicted mortality (adults): breeding season only - 7. Effects predicted to be 3% of the total (212) predicted by the MS 2014 AA	Predicted mortality (adults): breeding season only - 12. Effects predicted to be 6 % of the total (212) predicted by the MS 2014 AA	Predicted mortality (adults): breeding season only - 18. Effects predicted to be 8% of the total (212) predicted by the MS 2014 AA	N/A	N/A
Kittiwake	Collision + Displacement	Predicted mortality (adults): breeding season 34, non-breeding season 2. PVA predicts (counterfactual) of population size after 25 years of 96.1 and growth rate 99.8%. Effects predicted to be 17% of the total (212) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 30, non-breeding season 1. PVA ratio of population size after 25 years of 96.7% and growth rate 99.9%. Effects predicted to be 15% of the total (212) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 50, non-breeding season 2. PVA ratio of population size after 25 years of 94.5% and growth rate 99.8%. Effects predicted to be 25% of the total (212) predicted by the MS 2014 AA.	N/A	Predicted mortality (adults): breeding season 92, non-breeding season 4. PVA predicts ratio of population size after 25 years of 89.9% and growth rate 99.6%. Effects predicted to be 45% of the total (212) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 92, non-breeding season 21. PVA predicts ratio of population size after 25 years of 87.7% and growth rate 99.5%. Effects predicted to be 53% of the total (212) predicted by the MS 2014 AA.

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea
Guillemot	Displacement	Predicted mortality (adults): breeding season 26, non-breeding season 16. PVA predicts growth above baseline with ratio (counterfactual) of population size after 25 years of 98.6 and growth rate 99.9%. Effects not predicted in 2014 but current assessment is 6% of 2014 AA threshold (1.1% - 662 birds).	Predicted mortality (adults): breeding season 19, non-breeding season 14. PVA predicts growth above baseline with ratio of population size after 25 years of 98.8% and growth rate 100%. Effects not predicted in 2014 but current assessment is 5% of 2014 AA threshold (1.1% - 662 birds).	Predicted mortality (adults): breeding season 37, non-breeding season 26. PVA predicts growth above baseline with ratio of population size after 25 years of 97.8% and growth rate 99.9. Effects not predicted in 2014 but current assessment is 10% of 2014 AA threshold (1.1% - 662 birds).	Predicted mortality (adults): breeding season 46, non-breeding season 32. PVA predicts growth above baseline with ratio of population size after 25 years of 96.4% and growth rate 99.9%. Effects not predicted in 2014 but current assessment is 12% of 2014 AA threshold (1.1% - 662 birds).	N/A	N/A
Razorbill	Displacement	Predicted mortality (adults): breeding season 7, non-breeding season 3. PVA predicts decline in the baseline but with ratio (counterfactual) of	Predicted mortality (adults): breeding season 3, non-breeding season 4. PVA predicts decline in the baseline with ratio of population size	Predicted mortality (adults): breeding season 8, non-breeding season 5. PVA predicts decline in the baseline with ratio of population size after 25 years of 96.1% and growth rate 99.8%.	Predicted mortality (adults): breeding season 12, non-breeding season 10. PVA predicts decline in the baseline with ratio of population size after 25 years of	N/A	N/A

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea
		population size after 25 years of 97.1 and growth rate 99.9%. Effects not predicted in 2014 but current assessment is 12% of 2014 AA threshold (1.2% - 85 birds).	after 25 years of 97.9% and growth rate 99.9%. Effects not predicted in 2014 but current assessment is 8% of 2014 AA threshold (1.2% - 85 birds).	Effects not predicted in 2014 but current assessment is 15% of 2014 AA threshold (1.2% - 85 birds).	93.1% and growth rate 99.7 %. Effects not predicted in 2014 but current assessment is 26% of 2014 AA threshold (1.2% - 85 birds).		

Table 9-3 Summary of effects for St Abb's Head to Fast Castle SPA

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea
Kittiwake	Collision[1]	Predicted mortality (adults): breeding season 3, non-breeding season <. PVA predicts growth above baseline with ratio (counterfactual) of population size after 25 years of 98.9 and growth rate 100%. Effects predicted to be 5% of the total (60) predicted by the MS 2014 AA[2].	Predicted mortality (adults): breeding season 2, non-breeding season <1. PVA predicts growth above baseline with ratio of population size after 25 years of 99.1% and growth rate 100%. Effects predicted to be 3% of the total (60) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 4, non-breeding season <1. PVA predicts growth above baseline with ratio of population size after 25 years of 98.6% and growth rate 99.9%. Effects predicted to be 7% of the total (60) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 9, non-breeding season 1. PVA predicts similar population size to present after 25 years of 97.4% and growth rate 99.9%. Effects predicted to be 17% of the total (60) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 13, non-breeding season 1. PVA predicts slight decline in population size to present but ratio of population size after 25 years of 94.6% and growth rate 99.8%. Effects predicted to be 23% of the total (60) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 13, non-breeding season 7. PVA predicts slight decline in population size but with ratio of population size after 25 years of 92.6% and growth rate 99.7%. Effects predicted to be 33% of the total (60) predicted by the MS 2014 AA.
	Displacement	Predicted mortality (adults): breeding season only, <1. Effects negligible	Predicted mortality (adults): breeding season only, <1. Effects negligible	Predicted mortality (adults): breeding season only, 1. Effects negligible	Predicted mortality (adults): breeding season only, 3. Effects predicted to be 5% of the total (60) predicted by the MS 2014 AA.	N/A	N/A

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea
Kittiwake	Collision + Displacement	Predicted mortality (adults): breeding season 4, non-breeding season <1. PVA predicts (counterfactual) of population size after 25 years of 98.6 and growth rate 99.9%. Effects predicted to be 7% of the total (60) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 3, non-breeding season <1. PVA ratio of population size after 25 years of 98.6% and growth rate 99.9%. Effects predicted to be 5% of the total (60) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 5, non-breeding season 1. PVA ratio of population size after 25 years of 98% and growth rate 99.9%. Effects predicted to be 10% of the total (60) predicted by the MS 2014 AA.	N/A	Predicted mortality (adults): breeding season 16, non-breeding season 1. PVA predicts ratio of population size after 25 years of 94% and growth rate 99.8%. Effects predicted to be 28% of the total (60) predicted by the MS 2014 AA.	Predicted mortality (adults): breeding season 16, non-breeding season 7. PVA predicts ratio of population size after 25 years of 91.5% and growth rate 99.6%. Effects predicted to be 38% of the total (60) predicted by the MS 2014 AA.
Guillemot	Displacement	Predicted mortality (adults): breeding season 6, non-breeding season 4. PVA predicts strong growth above baseline with ratio (counterfactual) of population size after 25 years of 99.5 and growth rate 100%. Effects not predicted	Predicted mortality (adults): breeding season 4, non-breeding season 3. PVA predicts strong growth above baseline with ratio of population size after 25 years of 99.6% and growth rate 100%. Effects not predicted in	Predicted mortality (adults): breeding season 9, non-breeding season 6. PVA predicts strong growth above baseline with ratio of population size after 25 years of 99.2% and growth rate 100%. Effects not predicted in 2014 but	Predicted mortality (adults): breeding season 15, non-breeding season 13. PVA predicts strong growth above baseline with ratio of population size after 25 years of 98.5% and growth rate 99.9%. Effects	N/A	N/A

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea
		in 2014 but current assessment is 1% of 2014 AA threshold (1.3% - 762 birds).	2014 but current assessment is <1% of 2014 AA threshold (1.3% - 762 birds).	current assessment is 2% of 2014 AA threshold (1.3% - 762 birds).	not predicted in 2014 but current assessment is 4% of 2014 AA threshold (1.3% - 762 birds).		

Table 9-4 Summary of effects for Outer Firth of Forth and St Andrew's Bay Complex pSPA

Species	Effect	Project Alpha	Project Bravo	Project Alpha + Project Bravo combined	Cumulative - All Forth and Tay projects 2018	Cumulative - Seagreen 2018, other Forth and Tay projects 2014 (Worst Case Scenario - WCS)	Cumulative - Forth and Tay WCS plus North Sea
Gannet Kittiwake Guillemot Razorbill Puffin	Collision: gannet and kittiwake. Displacement: kittiwake, guillemot, razorbill and puffin. Collision and displacement: kittiwake only.	The five species of the pSPA have been assessed in terms of both the breeding and non-breeding season effects during the operational period at the above named breeding colony SPAs for the optimised Seagreen Project alone and cumulatively as advised in the 2017 Scoping Opinion. Based on the conclusion of no adverse effect at the breeding colony SPAs, it is concluded that there would be no adverse effect on the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA.					