Table of Contents

SUMMARY: ORNITHOLOGY ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ADDENDUM

This ornithology EIA Addendum provides an update to the original assessment given in the Seagreen (2018) Environmental Impact Assessment Report.

It provides clarification on the methodology used plus a revised assessment for a restricted suite of five species over the 25 year operational life time of the proposed Seagreen project. This approach was agreed with Marine Scotland and Scottish Natural Heritage in January 2019. The species considered are gannet, kittiwake, guillemot, razorbill and puffin. The impacts considered are collision and displacement and the assessment follows the advice and methods provided in Marine Scotland's 2017 Scoping Opinion.

In each case, the impacts of the optimised Seagreen Project including Project Alpha, Project Bravo and Project Alpha and Project Bravo combined have been assessed against the regional populations of the five species listed above. The impacts have also been assessed cumulatively with other projects in the Forth and Tay during the breeding and non-breeding seasons. Non-breeding season collision impacts on gannet and kittiwake from other offshore wind projects in the wider North Sea are considered in detail in the Habitats Regulations Appraisal (Section 3).

The EIA predicts that, in all cases, the likely effects from the optimised Seagreen projects both alone and cumulatively with other projects in the Forth and Tay, specifically Neart na Gaoithe and Inch Cape plus other smaller offshore windfarms, are not significant. In addition they are well below those estimated for the Seagreen projects as consented in 2014.

ORNITHOLOGY ENVIRONMENTAL IMPACT ASSESSMENT

1. Introduction and scope of the ornithology Environmental Impact Assessment (EIA) Addendum

1. The scope of the updated EIA included in this Addendum was agreed based on the post-submission consultation responses from MSLOT, MSS, SNH and RSPB to the 2018 application for the optimised Seagreen Project, and subsequent teleconferences and correspondence documented in Tables 1.1 to 1.3 of Section 1: Introduction and consultation

1.1 Species and impacts included in the revised assessment

2. The Addendum provides a revised EIA for five species compared to the six species in the 2018 EIAR as agreed with MS and SNH on 14th February 2018:

- Northern gannet, hereafter gannet, *Morus bassanus;*
- Black-legged kittiwake, hereafter kittiwake, *Rissa tridactyla;*
- Common guillemot, hereafter guillemot, *Uria aalge;*
- Razorbill *Alca torda;* and
- Atlantic Puffin, hereafter puffin, *Fratercula arctica*.

3. Herring gull *Larus argentatus* was not included in the revised assessment because the predicted collision effects on the species at the Seagreen sites remained unchanged from the 2018 EIAR. Collision estimates were predicted to be very low with an increase in the baseline mortality of the regional population of between 0.03 and 0.08 percentage points during the breeding season and 0.01 and 0.02 during the non-breeding season, depending on whether Project Alpha and Project Bravo were being assessed individually or combined and whether option 2 or option 3[1] of the Band collision risk model was used. This information is summarised in the 2018 EIAR, Chapter 8, Tables 8.23, 8.27 and 8.31. As a result, SNH confirmed in their letter to MSLOT of 28 November 2018 that there would be no significant effects on the regional breeding population and in HRA terms, no adverse effects on the integrity of any SPA where herring gull is a qualifying species or feature of the assemblage either from the optimised Seagreen Project alone or in combination with other Forth and Tay offshore wind farms.

4. The updated assessment is for the operational period only because impacts on these species during the construction and decommissioning of the wind farms both alone and in-combination were predicted in the 2018 EIAR to be not significant and these conclusions would be unchanged by information in this Addendum. This approach was agreed with SNH during a teleconference on 13 December 2018 and mirrors that of the 2018 EIAR. The location in the 2018 EIAR of assessments for the construction and decommissioning periods is provided in Annex 6 of this Addendum.

[1] Option 3 was advised in the 2017 Scoping Opinion for herring gull only

5. The impacts to be assessed were collision and displacement.

6. The five species listed above were assessed as summarised in Table 1.1 in line with the 2017 Scoping Opinion. It is noted that for kittiwake and puffin, displacement effects are to be assessed for the breeding season only. This is because for kittiwake there is limited evidence for displacement from offshore wind farms (e.g. Welcker & Nehls 2016) and for puffin, which disperse widely during the non-breeding period (e.g. Harris et al. 2010, Harris & Wanless 2011), individuals present in the Forth and Tay at this time are likely to comprise a large proportion of birds from breeding colonies outside the region.

Table 1-1 Species and impacts for assessment

Species	Collision	Displacement	Collision and displacement combined
Gannet	x		
Kittiwake	x	x breeding season only	x
Guillemot		x	
Razorbill		x	
Puffin		x breeding season only	

7. Impacts are calculated by season with additional mortality broken down into adult and sub-adult (including juvenile) age classes. However, the EIA focuses on the assessment of additional adult mortality on the regional breeding population. This is defined as the sum of all breeding adults within mean-maximum foraging range of the site based on colony counts in the breeding season. Changes are expressed as a percentage point change in baseline mortality.

8. Whilst sub-adult mortality during the breeding season is calculated, it is not presented as a percentage point change in mortality rate because it is generally not possible to census the immature component of seabird populations (Furness 2015) and, for gannet and kittiwake in particular, sub-adults generally spend time away from the colonies, returning only when approaching breeding age (e.g. Forrester et al. 2007). The population present in the Firth of Forth during the breeding season does not, therefore, reflect the stable age structure used in PVA models.

9. The exceptions to this are guillemot and razorbill as advised by the 2017 Scoping Opinion because immature birds are assumed to stay in the region of the colony and the sub-adult regional population during the breeding season can therefore be calculated from the stable age structure provided by the PVA and an average sub-adult baseline mortality calculated.

10. During the non-breeding season, when gannet and kittiwake migrate or disperse away from the breeding colonies (Frederiksen et al. 2011), the relevant regional population is defined at a species-specific scale known as the Biologically Defined Minimum Population Scale (BDMPS) (Furness 2015). For gannet, this encompasses the North Sea and Channel and for kittiwake the North Sea only. In this EIA, the total additional mortality of all birds is simply given as a proportion of the BDMPS and changes to baseline mortality are not estimated for these populations of mixed age class birds. However, a detailed non-breeding season assessment based on the BDMPS is carried out in the HRA section of this Addendum for gannet and kittiwake at each relevant SPA.

11. For guillemot and razorbill the non-breeding season population is considered to be the same as in the breeding season as these species are assumed to remain in the Forth and Tay over winter (MS 2017). Changes in baseline mortality are provided for adult birds in all assessments, with sub-adults included in the cumulative assessments.

12. The 2017 Scoping Opinion did not require the assessment of puffin during the non-breeding season as it disperses widely away from the region.

1.2 Cumulative assessment

13. Each species is assessed for different cumulative scenarios as advised by the 2017 Scoping Opinion. The assessment is made for the effect of Project Alpha and Project Bravo combined with other Forth and Tay projects as originally presented in the 2018 EIAR. This is because combining the effects of Project Alpha alone with Project Bravo alone would double-count effects owing to the 4 km overlap of the buffer used for displacement assessment and because the optimised project contains fewer turbines (120 compared to 140) therefore collision effects would be overestimated. It is noted that where cumulative assessments have been undertaken by other Forth and Tay offshore wind projects and the effects of Project Alpha and Project Bravo have been added together as two separate projects, the effects will have been overestimated compared to those of Project Alpha and Project Bravo combined.

14. The assessment of cumulative impacts for EIA focuses on the regional breeding population as before except in the case of guillemot and razorbill where, the 2017 Scoping Opinion advises, the breeding and non-breeding population are considered to be the same. The scenarios listed below are as required by the 2017 Scoping Opinion.

15. For gannet, collision effects were assessed for Project Alpha and Project Bravo combined:

- cumulatively with Inch Cape (2018 as submitted) and Neart na Gaoithe (2018 as consented);
- cumulatively with Inch Cape (2014 as consented) and Neart na Gaoithe (2014 as consented);

- cumulatively with the worst case scenario of the above plus non-breeding season effects from other offshore wind farms in the UK North Sea and Channel (HRA only).

16. For kittiwake, collision effects were assessed for Project Alpha and Project Bravo combined:
    - cumulatively with Inch Cape (2018 as submitted) and Neart na Gaoithe (2018 as consented);
    - cumulatively with Inch Cape (2014 as consented) and Neart na Gaoithe (2014 as consented);
    - cumulatively with the worst case scenario of the above plus non-breeding season effects from other offshore wind farms in the UK North Sea (HRA only).

17. For kittiwake, displacement effects were assessed for Project Alpha and Project Bravo combined:
    - cumulatively with Inch Cape (2018 as submitted) and Neart na Gaoithe (2018 as consented);
    - cumulatively with Inch Cape (2014 as consented) and Neart na Gaoithe (2014 as consented).

18. For kittiwake, collision plus displacement effects were assessed for Project Alpha and Project Bravo combined:
    - cumulatively with Inch Cape (2018 as submitted) and Neart na Gaoithe (2018 as consented);
    - cumulatively with Inch Cape (2014 as consented) and Neart na Gaoithe (2014 as consented);
    - cumulatively with the worst case scenario of the above plus non-breeding season effects from other offshore wind farms in the UK North Sea (HRA only).

19. For the three auk species: guillemot, razorbill and puffin, displacement effects were assessed for Project Alpha and Project Bravo combined:
    - cumulatively with Inch Cape (2018 as submitted) and Neart na Gaoithe (2018 as consented);
    - cumulatively with Inch Cape (2014 as consented) and Neart na Gaoithe (2014 as consented).

2. EIA Methodology

2.1 Study area, data collection and analysis

20. The study area, data collection including baseline survey methodology and data analysis are as described in the 2018 EIAR, Chapter 8: Ornithology paragraphs 8.52 to 8.73 and in the 2018 EIAR Appendix 8A: Ornithology Technical Report, reproduced here as Annex 1. This EIA Addendum provides clarification on the methods used for calculating site density and population. The area of each site and buffer is shown in Table 2.1 and a map is provided in Figure 1.

Table 2-1 The area of the optimised Seagreen Project

Site	Area of site alone (km^2)	Area of site +2 km buffer (km^2)
Project Alpha	197.2	356.2
Project Bravo	193.7	348.9
Project Alpha and Project Bravo combined	390.9	595.4

2.2 Site density and population

21. The density of birds on each site was calculated by adding the density of birds on the water to the density of birds in flight. However, a number of adjustments were first made to the component populations.

22. To account for the fact that birds on the water may be harder to detect the further they are from the boat, a species-specific distance correction factor was applied to the species count using Distance software (Thomas et al. 2010). A distance correction factor was applied to kittiwake, guillemot, razorbill and puffin i.e. all species except gannet which is more easily detected at distance owing to its size. The process is described in full in Annex 1: Ornithology Technical Report, paragraphs 3.2.9 - 3.2.15. (was 2018 EIAR Appendix 8A).

23. For densities of birds in flight it was agreed with MSS and SNH at a meeting on 6 March 2018 that a correction factor of 0.783 could be applied to the Seagreen data. This was in acknowledgement of the different methodology used by Seagreen to survey birds in flight (the 'radial' method). This observes birds in flight over a smaller 'snapshot' area of 0.141 km^2 when surveying both sides of the boat compared to that used by other Forth and Tay developers (the 'box' method) with a survey area of 0.18 km^2. As surveying the larger area has been shown not to capture observations of any additional birds, the radial method delivers higher density estimates. To establish parity between all Forth and Tay developments a correction factor of 0.783 was therefore applied to the Seagreen data. The full detail and reasoning behind this adjustment is described in Annex 1, paragraphs 3.1.31 - 3.1.38.

24. The population size for each site was then estimated by combining the adjusted densities of birds on the water and birds in flight and multiplying by the total site area.

25. Where the density of birds in the site and 2 km buffer was required for displacement assessment, further adjustments were made to the densities of birds on the water as agreed with MS and SNH at a meeting on 6 March 2018 as explained below.

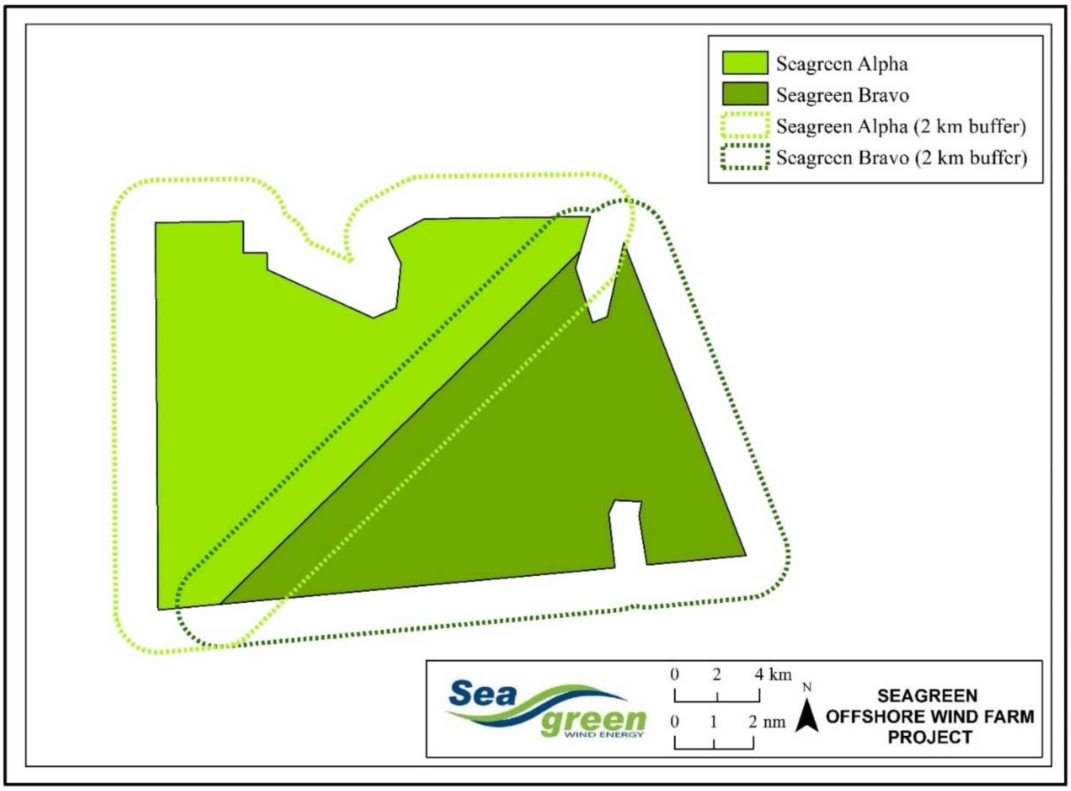

Figure 1 Project Alpha and Project Bravo and the 2 km buffer areas of each site relative to the 2 km buffer around Project Alpha and Project Bravo combined

EXAMPLE 1: Steps in calculation of Seagreen site densities and populations
At sea surveys

STEP 1

Count birds in flight (BIF) Snapshot counts over 300 m radius arc on both sides of boat		**Count birds on water (BOW)** Continuous count over 300 m strip on both sides of boat

STEP 2

Radial adjustment Apply radial adjustment factor to make Seagreen 'radial' counts over area of 0.141 km² comparable with other developers' 'box' counts over area of 0.18 km² 0.141/0.18 = 0.783 Adjusted count (BIF) = snapshot count X 0.783		**Distance correction** Apply Distance correction software to adjust for decline in detection of birds with distance from boat and sea state Adjusted count (BOW) = original count with Distance correction

STEP 3

Calculate density (BIF) Density (adj) = adjusted count (BIF) divided by total survey area This value used in Collision Risk Modelling		**Calculate density (BOW)** Density (adj) = adjusted count BOW divided by total survey area

STEP 4

Calculate population of site
Population of site = (Density (adj) BIF + Density (adj) BOW) x area of site

STEP 5

Calculate population of site + 2 km buffer
Apply buffer adjustment factor derived from all 2017 data to 2010 and 2011 densities in order to acknowledge different densities recorded in buffer. The adjustment factor includes the July 2017 survey data when very high densities of kittiwake, guillemot and razorbill were observed Population of site + 2 km buffer = ((Density (adj) BIF + Density (adj) BOW) x buffer adjustment factor) x area of site and 2 km buffer This value is used in the displacement assessment

26. During the 2017 breeding period (April to August), both the site and buffer were surveyed and densities for the whole area were calculated as described above. However, because no buffer was surveyed in 2010 and 2011 it was agreed with Marine Scotland that a scaling factor derived from all 2017 data should be applied to the original densities. In general, because 2017 densities were higher than those recorded previously, the scaling factor had the effect of increasing densities. It should be noted that all 2017 data were used to derive these factors including the very high densities recorded in July 2017 which are further discussed below. The scaling factors applied to the 2009 - 2011 data are shown in Table 2.2. A full description of the process is given in Annex 1: Ornithology Technical Report, paragraphs 3.2.19 - 3.2.23. During the review of data for this Addendum a discrepancy in the calculation of the population the site + 2 km buffer was established, meaning that numbers in the 2018 EIAR were underestimated. The revised site + 2 km buffer population estimates are included in Appendix 2 of Annex 1 and constitute the only changes to this technical report.

Table 2-2 Density scaling factors (+/- 1 SD) used for each project

Species	Alpha	Bravo	Alpha + Bravo
Puffin	1.004 (0.099)	1.068 (0.347)	1.023 (0.122)
Razorbill	1.339 (0.437)	1.125 (0.649)	1.228 (0.509)
Guillemot	1.214 (0.286)	0.959 (0.180)	1.098 (0.235)
Kittiwake	1.489 (0.620)	1.126 (0.234)	1.381 (0.377)
Gannet	1.007 (0.213)	0.967 (0.126)	0.963 (0.165)

27. The largest scaling factors were derived for kittiwake, razorbill and guillemot particularly in Project Alpha (and consequently Project Alpha and Project Bravo combined). This is primarily owing to the buffer on the west side of the site incorporating an area near Scalp Bank which frequently has higher densities of birds in what is thought to be good foraging habitat (Figure 2 and Annex 1: Ornithology Technical Report Paragraph 5.3.15).

2.3 Seasons for assessment

28. The seasons for assessment were as advised in the 2017 Scoping Opinion. They are reproduced below for the relevant species. Where half months were included, the way density and population data were calculated is described in the assessment methodology for that specific impact.

29. For gannet and kittiwake, the non-breeding season was further split into post-breeding and pre-breeding seasons, equivalent to autumn passage and spring passage, to enable comparison with the BDMPS population sizes for those periods given in Furness (2015).

Table 2-3 Seasons for assessment as advised in the 2017 Scoping Opinion

Species	Breeding	Non-breeding
Gannet	mid-March – September	October - mid-March
Kittiwake	mid-April – August	September - mid-April
Guillemot	April - mid-August	mid-August – March
Razorbill	April - mid-August	mid-August – March
Puffin	April - mid-August	mid-August – March

2.4 Regional population size and SPAs

30. The regional breeding population size for each species was calculated by summing the population counts for each colony within mean maximum foraging range of the perimeter of the Seagreen Phase 1 area e.g. for kittiwake, the number of breeding individuals at all colonies within 60 km was summed. The counts were based on Seabird 2000 data ensuring that they were contemporaneous for all species. In acknowledgement of the fact that seabird populations may have changed significantly since that time, the regional breeding populations were then trend adjusted by applying a simple formula based on the change in SPA colony size between Seabird 2000 and recent counts. The trends were sense-checked by comparison with JNCC seabird trend data for each species. The exception was for gannet where recent counts were available for both regional colonies from 2014. Calculations are shown in Annex 4.

31. The region contains three Special Protection Areas (SPA) and one proposed SPA (pSPA) within mean maximum foraging range of the Seagreen sites. The closest is Fowlsheugh SPA at approximately 30 km, followed by Forth Islands SPA at approximately 53 km and St Abb's Head to Fast Castle SPA at approximately 68 km. As the Scoping Opinion required kittiwake at the latter SPA to be included in the Habitats Regulations Appraisal (HRA) although it lies beyond the species' mean-maximum foraging range, the SPA population was simply added to the regional population within the 60 km range without including other, non-SPA sites in the total. This means that the regional kittiwake population within 68 km of the Seagreen sites may be slightly underestimated meaning that effects will be slightly overestimated, making the assessment more precautionary. The Outer Firth of Forth and St Andrew's Bay pSPA lies at a minimum distance of 16.6 km. All distances are measured from the edge of the Seagreen Phase 1 area to the nearest point of the SPA.

32. This EIA Addendum discusses the regional population as a whole without specific reference to the populations of individual SPAs to avoid repetition of information in the following HRA section where effects on the relevant species of each SPA/pSPA are discussed in detail.

2.5 Displacement methodology

33. The presence of wind turbines and their associated operations and maintenance activities has the potential to directly disturb and hence displace birds from within and around offshore windfarms. An overview of displacement effects, the spatial scales at which they may operate and the way different species may be affected is discussed in the Seagreen 2018 EIAR, Chapter 8: Ornithology, paragraphs 8.77 - 8.112.

34. The worst case scenario for displacement represents assessment over the site area plus a 2 km buffer. It should be noted that the Appropriate Assessment (AA) of the Seagreen projects consented in 2014 (MS 2014) reached its conclusions based on displacement from the site plus a 1 km buffer (Searle et al. 2014). The EIA and HRA displacement assessments submitted by Seagreen at this time considered the site footprint alone i.e. without a buffer. This approach had been agreed with MS and SNH because the turbine densities within the Seagreen sites were considerably lower than those within the neighbouring Forth and Tay projects of Neart na Gaoithe and Inch Cape and it is possible that displacement effects are reduced where turbine densities are lower and hence separation distances are greater (Table 2.4) potentially allowing greater permeability for foraging birds. As this remains the case, the assessment presented here (using a 2 km buffer) represents an extreme worst case. It should be noted that the impact of Project Alpha and Project Bravo combined was calculated based on a single buffer round the combined sites (i.e. discounting the overlapping buffers of the individual sites where they abut one another).

Table 2-4 Comparative turbine densities in the Forth and Tay projects

Project	Turbine number (maximum)	Site area (km^2)	Turbine density (per km^2)
Projects Alpha/Bravo	70	197.2 and 193.7	0.35 and 0.36
Project Alpha and Project Bravo combined	120	390.9	0.31
Neart na Gaoithe[2]	54	105	0.51
Inch Cape[3]	72	150	0.48

2 Neart na Gaoithe EIAR (NNG 2018)

3 Inch Cape EIAR worst case (IC 2018)

35. The species assessed for displacement in this Addendum are kittiwake, guillemot, razorbill and puffin as agreed with MS and SNH (23/01/2019 and 14/02/2019). As advised by the 2017 Scoping Opinion, the assessment of displacement effects on gannet is not required because, although the species may be displaced from wind farm footprints, its foraging range is great enough for the proportion of that range occupied by wind farms to be relatively small in terms of the total foraging area available. In addition, modelling of displacement and barrier effects for gannet in the Firths of Forth and Tay (Searle et al. 2014) concluded that the effects of the proposed wind farms would be negligible.

36. The methodology for the assessment of displacement is unchanged from the 2018 EIAR Chapter 8: Ornithology, Appendix 8C and follows the method recommended by SNCB (2017) guidance.

37. The populations for displacement supersede those in the 2018 EIAR owing to a discrepancy noted in the original data and discussed with MS and SNH on 14 February 2018.

38. The mean peak population of each species in each season, based on adjusted counts of birds on the water and birds in flight, was estimated for the relevant Seagreen site plus a 2 km buffer. Where the season included a half-month (Table 2.3), the survey data for that month were included in the derivation of the mean peak population regardless of when in the month the survey was conducted. The population was then multiplied by the appropriate displacement and mortality rates for each species as advised in the 2017 Scoping Opinion (Table 2.5). The 2018 EIAR Appendix 8C presented this information in the form of matrix tables for each species and season. For purposes of brevity, the revised displacement calculations have been tabulated in the text of this document and the matrix tables are not reproduced.

Table 2-5 Displacement and mortality rates as advised in the 2017 Scoping Opinion

Species	Displacement rate (%)	Mortality rate (%)
Kittiwake	30	2
Guillemot and razorbill	60	1
Puffin	60	2

39. The estimated mortality was then apportioned to adult and sub-adult (including juvenile) age classes. For kittiwake this was based on the proportions observed during at-sea surveys in the appropriate season, with the non-breeding season being split into post-breeding and pre-breeding. For auk species, where age class is more difficult to differentiate at sea, the proportions were based on the stable age class structure of the populations as described in Annex 3: Population Viability Analysis (PVA) (revised). The age classes applied are given in Table 2.6.

40. The mortality of the adult age class was finally reduced by the sabbatical factor of 10% for kittiwake and 7% for auk species as advised in the 2017 Scoping Opinion.

Table 2-6 The proportion of adult to sub-adult age classes applied in the displacement assessment

Species	Breeding period	Non-breeding period
Kittiwake	91 : 9	66 : 34 (post) 80 : 20 (pre)
Guillemot	55 : 45	55 : 45
Razorbill	60 : 40	60 : 40
Puffin	53 : 47	53 : 47

41. The impact was assessed by comparing the estimated additional mortality of adult breeding birds with the background mortality of the regional breeding population. The background mortality rate was based on figures taken from Annex 3: PVA. An impact was classed as of negligible magnitude where it represented a very slight change in baseline mortality which would be undiscernible from natural background variation (Table 2.15).

42. Assessment of displacement effects on kittiwake during the non-breeding season was not required by the 2017 Scoping Opinion.

43. During the non-breeding season for guillemot and razorbill, the regional population size of adult birds was assumed to be the same as during the breeding season as advised in the 2017 Scoping Opinion and the impacts of additional displacement mortality on the populations of adult birds are discussed accordingly.

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

2.6 Treatment of July 2017 data

45. During the breeding season 2017, Seagreen undertook additional boat-based surveys of the Phase 1 area including the Project Alpha and Project Bravo sites and a 2 km buffer. This was to supplement and update the December 2009 to November 2011 data. The 2017 data were used in their entirety to derive a scaling factor for the 2009 to 2011 data which were originally calculated without a buffer.

46. As noted previously, bird densities in 2017 were generally higher than those recorded during 2010 and 2011, particularly to the west of the sites in the area of Scalp Bank and, within the sites, in three specific areas, one of which, in the north part of Project Alpha is in deep water, unsuitable for turbine deployment (Figure 2). In particular, during the surveys of 24 and 25th July 2017, exceptionally high numbers of some species were recorded including in part of the buffer area to the west of Project Alpha. These included what appeared to be a multi-species foraging association (MSFA) when large numbers of kittiwakes, guillemots, razorbills as well as marine mammal species were observed. This event is described fully in the Ornithology Technical Report (Annex 1) paragraph 5.3.32. This inflated the densities of key species to numbers well in excess of those recorded previously in the area (Table 2.7).

47. Whilst comparable density data (e.g. Skov et al. 1995, Stone et al. 1995) cover a larger geographic area, they represent a period when regional populations e.g. for kittiwake, were significantly higher than at present. Since then, there have been documented declines in kittiwake colony size although some appear to have stabilised and may be increasing. However, it might be expected that current densities at sea during the breeding season might be reduced from when the populations were at their peak rather than increased. This suggests that the densities recorded by Seagreen in July 2017 represented an unusual event.

48. It was therefore agreed with MSS (letter of 23rd January 2019) and SNH (letter of 11th January 2019) that displacement data for guillemot and razorbill could be presented with and without the July 2017 data for comparison. Also, that numbers taken forward for PVA and HRA should exclude the July 2017 data because numbers in late summer may be elevated by the presence of adults accompanying dependent young. This advice was in line with that previously provided to Scottish east coast floating wind farm developments (e.g. Kincardine and Hywind) where similar effects had been noted in late July.

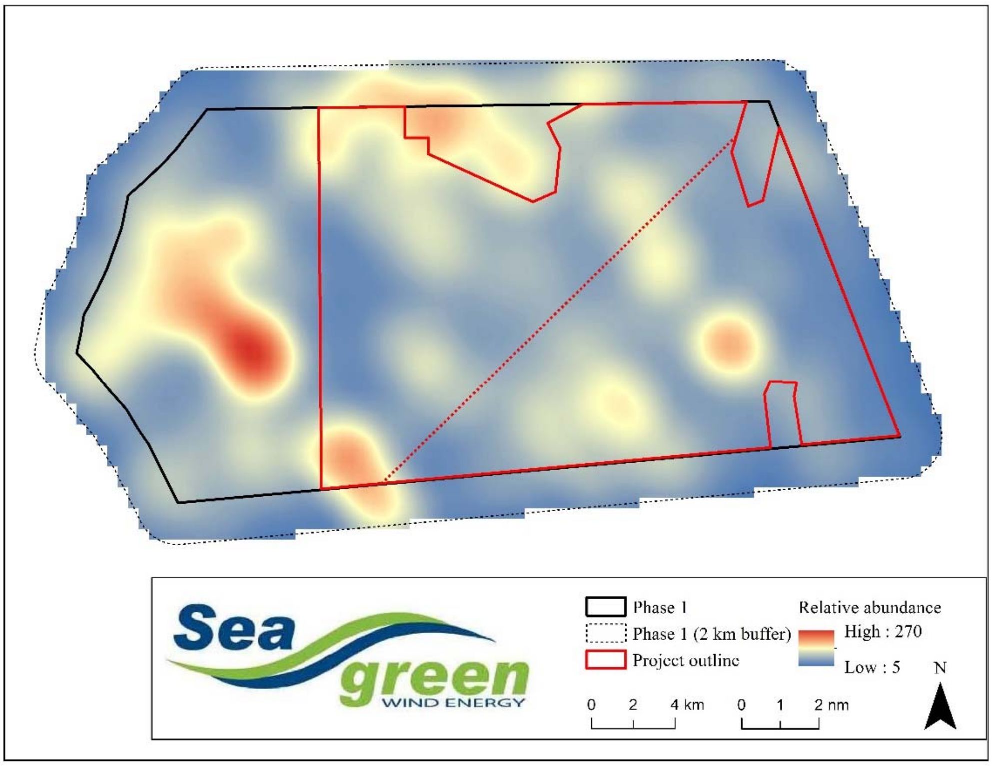

Figure 2 Relative abundance surface derived using Kernel Density Estimation applied to density distribution of all birds in 2017 (combined flying and sitting on the water) Source: Annex 1, Figure 16b. Note: This figure shows the 2 km buffer around the whole of Phase 1 whereas this assessment is based on the red line boundaries of the sites + 2 km buffers (Figure 2).

49. For kittiwake it was advised that the median July density observed over the three survey years was substituted for the July 2017 data. The peak seasonal population in each year was then derived in the same way as before and averaged over the three years to provide the mean peak value.

Table 2-7 Densities of kittiwake and razorbill recorded on the Seagreen sites compared to density values estimated by other authors

	Seagreen					Stone et al.	Skov et al.		Camphuysen
Species	2010-2011		2010-2011 + 2017			1995	1995		2005
	Alpha	Bravo	Alpha	Bravo	Alpha + Bravo combined	Western North Sea	Aberdeen Bank including Firth of Forth	Scalp Bank	Firth of Forth
Kittiwake	3.2	2.2	20.7	10.7	15.26	0.41 - 4.54	12.1		
Razorbill	6	2.9	17.3	11.3	14.2	1		7.1	2 - 10+

Summary of differences in the displacement assessment from the 2018 EIAR

- Site populations recalculated to correctly incorporate area of site + 2 km buffer;
- For kittiwake, breeding season displacement impacts presented:
  - using all data; and
  - with the mean peak population calculated substituting the median July value for the July 2017 value;
- For guillemot and razorbill, breeding season displacement impacts presented with and without July 2017 data; and
- Results presented by season and age class.

2.7 Collision risk modelling (CRM) methodology

50. Operational wind farms may pose a risk to some seabirds due to direct collision with the turbine blades. An overview of this topic can be found in the Seagreen 2018 EIAR, Chapter 8: Ornithology, paragraphs 8.115 and 8.144. Full details of the CRM process are described in Annex 2 and remain unchanged. They are summarised below.

51. The species for collision assessment in this Addendum include gannet and kittiwake as agreed with MS and SNH by letter of 23 January 2019. Herring gull is excluded as discussed in paragraph 3. Collision assessment is not required for auk species as advised in the 2017 Scoping Opinion as their flight height is generally below the lower tip height of the turbine rotor blades.

52. Collision risk modelling was based on a wind turbine generator (WTG) design envelope with parameter limits identified as 'worst case', rather than modelling a specific turbine. The modelled WTG parameters are defined in the 2018 EIAR Chapter 5: Project Description, Table 5.2. In summary, the worst case scenario for modelling collision risk comprises up to 70 WTG at either Project Alpha or Project Bravo in isolation, or up to 120 WTG for Project Alpha and Project Bravo combined. A maximum rotor diameter of 220 m was assumed with a maximum blade width of 7.5 m. Hub height was calculated based on an assumed minimum blade tip clearance of 30.18 m above mean sea level (amsl), equivalent to 32.5 m above lowest astronomical tide (LAT). This is an increase of 2.7 m relative to the specified blade tip clearance used in the 2014 AA conducted by Marine Scotland. As a worst case, the rotation speed applied was equivalent to that of a smaller rotor of 164 m diameter.

2.7.1 Bird Parameters

53. Mean monthly densities for gannet and kittiwake for the Seagreen sites are presented in Table 2.8 with the standard deviation (SD) being omitted for clarity. These densities have not been adjusted using the 'radial' adjustment factor which is applied at a later stage. All data including SDs can be found in Annex 2, Table 1. Bird morphological parameters are shown in Table 2.9.

Table 2-8 Unadjusted mean monthly densities (ind. / km^2) of gannet and kittiwake in the optimised Seagreen sites. Grey cells = breeding season, blue cells = latter half of month to be included in breeding season. n = number of surveys

Species	Project	Value	Jan (n=2)	Feb (n=1)	Mar (n=2)	Apr (n=2)	May (n=4)	Jun (n=3)	Jul (n=3)	Aug (n=3)	Sept (n=2)	Oct (n=2)	Nov (n=2)	Dec (n=2)
Kittiwake	Alpha	Mean	1.397	0.591	2.696	2.187	2.687	2.382	5.431	1.455	3.602	2.467	10.230	0.617
	Bravo	Mean	2.434	2.133	2.560	1.413	3.271	2.449	1.273	0.904	0.402	1.523	6.961	0.715
	Alpha + Bravo	Mean	1.911	1.355	2.629	1.804	2.947	2.409	3.414	1.167	2.017	1.999	8.610	0.666
Gannet	Alpha	Mean	0.297	0.430	2.028	1.189	6.808	9.172	1.807	3.786	2.492	1.231	0.459	0.084
	Bravo	Mean	0.322	0.800	1.770	1.118	3.242	6.189	2.449	3.018	1.897	1.437	0.607	0.082
	Alpha + Bravo	Mean	0.309	0.613	1.900	1.154	4.986	7.612	2.116	3.403	2.197	1.333	0.532	0.083

Table 2-9 Bird morphological parameters

Species	Body length (m)	Wingspan (m)	Flight speed (m/s)	Nocturnal activity factor	Flight type
Gannet	0.94	1.72	14.9	1	Flap
Kittiwake	0.39	1.08	13.1	2	Flap

54. The flight speeds used here are the rates currently applied in CRM although based on very small sample sizes e.g. for kittiwake, the sample size (n) = 2 (Alerstam et al. 2007) and recent work suggests that they may be overestimated (Skov et al. 2018, Bowgen & Cook 2018). Examples of CRM modelling using flight speeds based on larger sample sizes e.g for kittiwake n = 287 (Skov et al. 2018) are included in Annex 2.

55. The percentage of birds at collision height (PCH) is shown in Table 2.10 (from Annex 1, Tables 5 and 7. These data were derived as explained below.

56. The ability of surveyors to reliably estimate the percentage of birds at collision risk height has been the subject of discussion and, in the past, birds in flight were often assigned to broad height bands. For example, in Seagreen surveys during 2010 and 2011, all birds flying at >20 m above sea level were recorded as 'potentially at risk'. However, this information was not appropriate for the use of option 1 of the Band CRM in the 2012 application as the lowest tip height (and therefore the true 'at risk' height) was much higher than the modelled 'at risk' height at 27.5 m above mean sea level. As most bird flight heights are strongly skewed towards the sea surface, the use of all birds above 20 m in the model would have produced highly conservative and unrealistic collision estimates. For this reason the AA (MS 2014) relied on estimates from the Band CRM option 2 which uses generic flight height data in 1 m bands above sea level from Johnston et al. (2014), allowing the correct tip clearance to be modelled.

57. During 2017, Seagreen surveyors recorded flight heights in 5 m bands and their reliability was assessed using an optical laser rangefinder as described in Annex 2, paragraphs 2.1.12 to 2.1.16. This generally found good agreement between the two estimates (Harwood et al. 2018). This allowed the derivation of an adjustment factor for the 2009 to 2011 flight height data to estimate site and species-specific proportions at collision height across each season (Table 2.10) and permitted the use of Band option 1 in the current assessment. Values for option 2 were also calculated and were used for input into the PVA models as required by the 2017 Scoping Opinion.

58. It should be noted that the flight height trends for each species are slightly different, for example the proportions of gannet flight heights at >30 m are slightly higher in the non-breeding season and for kittiwake slightly lower. Proportions also differ between sites perhaps indicating different behaviours. For example gannet flight heights appear to be lower in Project Alpha than Project Bravo and vice versa for kittiwake. The averaging of flight heights for Project Alpha and Project Bravo combined gives intermediate values as would be expected. The incorporation of these site and season-specific flight heights into the Band option 1 CRM means that comparison with option 2 results which use standard flight height distributions from Johnston et al. (2014) is not straightforward as the trend between one option and another is not consistent. This should be borne in mind in the interpretation of outputs, noting that it is option 2 that is taken forward for PVA and cumulative impact assessment.

Table 2-10 Percentage of gannet and kittiwake at collision height (PCH) (>30 m) in each project during the breeding and non-breeding season

Species	Project	Breeding	Non-breeding
Gannet	Alpha	1.77	2.52
	Bravo	7.78	11.12
	Alpha + Bravo combined	5.37	6.97
Kittiwake	Alpha	6.30	5.19
	Bravo	3.80	2.88
	Alpha + Bravo combined	5.04	3.81

2.7.2 Wind farm parameters

59. The wind farm parameters are unchanged from those in the 2018 EIAR. Project Alpha and Project Bravo each contain 70 turbines. Project Alpha and Project Bravo combined contain 120.

60. The latitude of the Seagreen site was set at 56.37 decimal degrees for all projects.

61. Turbine parameters are shown in Table 2.11.

Table 2-11 Turbine Parameters

Blades (no.)	Pitch(degrees)	Rotor radius (m)	Hub ht. to msl (m)	Blade width (m)
3	10	110	140.2	7.5

62. Monthly estimates of rotor speeds were modelled by the Seagreen engineers and the averages for the breeding and non-breeding seasons for each species are shown in Table 2.12. For example, the breeding season for kittiwake as advised in the 2017 Scoping Opinion is mid-April to August therefore the mean rotor speed for each month was averaged for this period. It should be noted that these rotor speeds were based on a smaller rotor (164 m diameter) and represent the worst case. This is because the actual rotor speed for the worst case 220 m rotor diameter modelled is likely to be slower, which would reduce collisions. The use of the rotor speeds in Table 2.12 means that the collision estimates are conservative. The implications of this are discussed and modelled examples provided in Annex 2.

63. Operational time was set at an average of 89% across all months from Vortex Hindcast modelling undertaken by Seagreen (Annex 2).

Table 2-12 Mean estimated rotor speed used for the breeding and non-breeding season of gannet and kittiwake (rpm)

Species	Breeding season rotor speed (rpm)[4]	Non-breeding season rotor speed (rpm)
Kittiwake	8.39	9.90
Gannet	8.67	10.19

2.7.3 Avoidance rates

64. For both gannet and kittiwake avoidance rates were set at 98.9% (± 0.2%) as recommended by the 2017 Scoping Opinion and current SNCB (2014) guidance. However, it is noted that Bowgen and Cook (2018) have recently reviewed and re-estimated the avoidance rates to be used for these species based on the evidence presented by Skov et al. (2018). For gannet, the report suggests that the recommended avoidance rate, currently 98.9%, is too precautionary and could rise to 99.5% and for kittiwake to 99%. For kittiwake a 98% avoidance rate is also recommended for use with option 3 of the Band model (as used by MS in the 2014 AA) which would reduce collision estimates by as much as 50%. Should these new values be approved by the SNCBs, including SNH, it would mean that any collision estimates based on the values recommended in the 2017 Scoping Opinion would be precautionary.

4 Data source for rotor speeds Annex 2: CRM Tables 3 and 4

2.7.4 Collision estimates

65. Collision mortality was estimated using the Band (2012) CRM options 1 and 2 as shown in Annex 2. It should be noted that this Annex utilises unadjusted bird in flight densities therefore the collision estimates presented in this Addendum (and in the 2018 EIAR) are lower than those in Annex 2. This is because the radial adjustment factor (0.783) was applied retrospectively once the collision risk calculations had been completed. Checks confirmed that the same collision numbers are achieved whether the adjustment factor is applied to the raw densities or the final collision estimates. A worked example is shown below and further examples in Table 2.13.

EXAMPLE 2: Applying 'radial adjustment factor' to collision estimates

Collisions estimate using unadjusted densities = 145

Final collisions = original estimate x radial adjustment factor = 145 x 0.783

Final collisions = 114 (rounded to whole birds).

Table 2-13 Example of Option 1 and 2 collision estimates for kittiwake during the breeding season showing the effect of the radial adjustment factor (0.783) (unadjusted data from Annex 2, Table 13)

Project	CRM Option 1	CRM Option 2
Alpha	145	127
Alpha adjusted by 0.783	114	99
Bravo	57	83
Bravo adjusted by 0.783	45	65
Alpha + Bravo combined	165	180
Alpha + Bravo combined adjusted by 0.783	129	141

66. All results are taken direct from Annex 2 with the exception of those for Neart na Gaoithe (2014). These have been recalculated to include a tidal offset as used in the original spreadsheets but are not revised in Annex 2.

67. Additional modelling using both option 1 and 2 was also carried out for kittiwake at the optimised Seagreen sites substituting the median July density observed in the three survey years for the maximum observed in July 2017. Both adjusted and unadjusted values are presented.

68. Estimated collision mortality was divided by season, and, where a season covered a half-month, the total collisions in that month were divided equally between the respective seasons.

69. The seasonal estimate was then split into adult and sub-adult (including juveniles) age classes. For both gannet and kittiwake this was based on the proportions of each age class observed during at sea surveys during breeding and non-breeding periods (Table 2.14).

70. The number of adults was then reduced by the sabbatical factor of 10% for both gannet and kittiwake as advised in the 2017 Scoping Opinion.

Table 2-14 Age classes observed at sea for species[5] used in CRM

Species	Season	Survey months	Adults (%)	Sub-adults (%)
Gannet	Breeding	March to September	97.6	2.4
	Post-breeding	October to December	93.4	6.6
	Pre-breeding	January to March	98.2	1.8
Kittiwake	Breeding	April - August	91.4	8.6
	Post-breeding	September to December	66.3	33.7
	Pre-breeding	January to March	79.8	20.2

71. The impact was assessed by comparing the estimated additional mortality of breeding adults with the background mortality of the regional breeding population. The background mortality rate was taken from Annex 3: PVA (revised). An impact was classed as of negligible magnitude where it represented a very slight change in baseline mortality which would be undiscernible from natural background variation (Table 2.15).

72. The regional BDMPS population during the non-breeding season is split into separate post-breeding (autumn migration) and pre-breeding (spring migration) seasons. The BDMPS seasons differ slightly in length from those prescribed by SNH and this is discussed further in the HRA section. For EIA purposes, the total mortality of gannet and kittiwake (all birds) in these seasons is discussed as a proportion of the total population rather than a percentage change in the background mortality of this mixed age population. This is given a more detailed consideration in the HRA section of this Addendum.

5 Data source: Annex 1: Ornithology Technical Report

Summary of differences in the collision assessment from the 2018 EIAR

- Recalculation of Neart na Gaoithe (2014) CRM using tidal offset;
- Option 1 and 2 results presented and discussed in full;
- For kittiwake, modelling carried out with and without adjusted (median) July 2017 densities;
- Mortality presented by season and age class;
- Option 2 results incorporated into the PVA.

2.8 Significance criteria

73. The sensitivity of each species and the magnitude and significance of the impact are based on criteria defined in the 2018 EIAR: Chapter 6 (EIA process) adapted for offshore ornithology as described in Chapter 8: Tables 8.9, 8.10, 8.12 and 8.13. Those relating to magnitude and significance are repeated below at Tables 2.15 and 2.16.

74. In a change from the 2018 EIAR, the sensitivity of all receptors considered in the Addendum is now classed as high owing to peak numbers of all species exceeding 1% of the national population within one or more of the Seagreen sites and because of their status as qualifying features of SPAs/pSPA with connectivity to the Seagreen project. Their sensitivity to particular impacts is discussed as part of the species assessment.

75. The application of a matrix to determine significance (Table 2.16) is consistent with the 2018 EIAR and, in line with this, impacts of minor or negligible significance are considered not significant in EIA terms (Table 2.17). However, current professional guidance (CIEEM 2018) discourages the use of the 'category' approach and recommends that a rationale for the predicted effect is explained in the text. This approach is taken here and conclusions are presented in the context of relevant research and best available evidence. Where empirical evidence is unavailable e.g. in terms of a species sensitivity to a particular effect, peer-reviewed papers based on expert judgement e.g. Furness et al. 2013, are referred to. For each species a summary analysis is contained in the relevant part of sections 4, 5 and 6 and a more detailed discussion is contained in section 7.

2.9 Population Viability Analysis (PVA)

76. Regional PVAs were not required by the 2017 Scoping Opinion and have not been carried out for EIA purposes however, reference is made to those carried out for the MS 2014 AA (Freeman et al. 2014). PVAs for each species at the relevant SPAs, as required by the 2017 Scoping Opinion, are presented in Section 3: HRA of this Addendum.

2.10 Presentation of results

77. This assessment is presented by species in taxonomic order for each of Seagreen's proposed wind farms: Project Alpha, Project Bravo and Project Alpha and Project Bravo combined plus cumulative impacts with other wind farms in the Forth and Tay region (Neart na Gaoithe and Inch Cape). As stated above, the detailed discussion of cumulative effects on gannet and kittiwake from other wind farms in the wider North Sea during the non-breeding season is considered in the HRA section at SPA rather than regional level.

78. To avoid repetition of information, results are initially presented simply by describing the magnitude of each impact as detailed in Table 2.15 and its significance for each site and species combination with a brief discussion. Where necessary, extended discussion is provided in section 7 – Cumulative effects. Also, note that in all cases collision and displacement impacts are classed as temporary, over the operating lifetime of the wind farm, although this text may not be repeated in each section.

79. Impacts on each species are generally rounded to 1 decimal place (dp) or to whole birds when calculating totals. Mortality and survival rates are given to 3 dp.

80. For brevity, where the EIARs of the other Forth and Tay developers are referenced they are abbreviated, for Inch Cape as IC 2018, for Neart na Gaoithe as NNG 2018.

Table 2-15: Criteria Used to Define the Magnitude of Impacts (source: EIAR, Ch.8, Table 8.12)

Magnitude	Criteria
High	Fundamental and permanent/irreversible changes to the sum of influences acting on the conservation status of the receptor concerned that may affect its abundance and distribution within a given geographical area.
Medium	Material and permanent/irreversible changes to the sum of influences acting on the conservation status of the receptor concerned that may affect its abundance and distribution within a given geographical area.
Low	Detectable and temporary (throughout project duration) change to the sum of influences acting on the conservation status of the receptor concerned that may affect its abundance and distribution within a given geographical area.
Negligible	Detectable and temporary (for part of the project duration) change, or barely discernible change for any length of time, to the sum of influences acting on the conservation status of the receptor concerned that may affect its abundance and distribution within a given geographical area.

Table 2-16 Criteria Used to Define the Significance of Impacts (source: EIAR, Ch.8, Table 8.13)

Value/Sensitivity	Magnitude			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

3. Baseline conditions

81. The baseline conditions for the five species considered in this Addendum, namely gannet, kittiwake, guillemot, razorbill and puffin are described in respect of the optimised Seagreen Project in the 2018 EIAR Chapter 8: Ornithology, between paragraphs 8.166 and 8.226 noting that population sizes have been updated in Annex 1 of this Addendum to address discrepancies noted in the 2018 EIAR. The text is not repeated here.

4. Impact assessment: Project Alpha

4.1 Project Alpha – Gannet - Collision

82. Collision estimates for gannet based on Band CRM option 1 and option 2 are shown in Table 4.1 with option 1 predicting fewer collisions. This option was based on flight heights estimated by surveyors within Project Alpha and verified using optical rangefinders (Harwood et al. 2018). As such, it is considered to represent a more accurate prediction than that derived from the generic flight heights used in option 2.

83. During the breeding season, collision mortality based on option 1 would represent a 0.51% change to the baseline mortality of adult breeding birds and option 2 a 1.22% change. At maximum, considering option 2 collision estimates, this would be equivalent to 0.1% of the regional population.

84. During the non-breeding season, the population of birds in the Forth and Tay region forms part of the wider BDMPS population of the North Sea and Channel (Furness 2015). Background mortality is not estimated for this population of mixed age class birds, however, the maximum predicted mortality would affect between 0.002 - 0.003% of the population and would be un-detectable at the population level.

85. This level of additional mortality represents a very slight change in baseline conditions which would be barely discernible from natural variation in background mortality over the lifetime of the wind farm and is classed as of negligible magnitude. This is equivalent to an effect of minor significance on this high sensitivity receptor. It would not materially affect the gannet population which, in the Forth and Tay region is continuing to undergo an increase in size and productivity (Murray et al. 2015, JNCC 2016). In EIA terms, the effects of collision on gannet at Project Alpha are classed as not significant. As required by the 2017 Scoping Opinion, the mortality estimates from option 2, which predicts a higher number of collisions, have been taken forward for cumulative assessment and PVA modelling.

4.2 Project Alpha – Kittiwake – Collision

86. Collision estimates for kittiwake based on option 1 and option 2 are shown in Table 4.2. In contrast to gannet, option 2 predicted fewer collisions for this species.

87. For the breeding season, estimates are provided in two ways, firstly based on the monthly densities of all kittiwakes observed in flight, and secondly using adjusted values for the July 2017 data when extremely high densities of birds were observed as part of what appeared to be a multi-species foraging aggregation. In this instance, the median July value from the three survey years was substituted for the July 2017 density before CRM was carried out as agreed with Marine Scotland (letter of 12 February 2019).

88. Based on the unadjusted values for the breeding season, additional mortality predicted by option 1 would increase kittiwake baseline mortality by 1.15%, for option 2 this would reduce to 1.01%. However, using adjusted density values, collision mortality estimated by option 1 would represent a 0.86% change to the baseline mortality of adult breeding birds and option 2 a 0.75% change representing approximately 0.1% of the regional population. This level of additional mortality over the lifetime of the wind farm is classed as of negligible magnitude as it would be indistinguishable from natural variation in background mortality.

89. During the non-breeding season, the population of birds in the Forth and Tay region forms part of the wider BDMPS population of the North Sea (Furness 2015). Background mortality is not estimated for this population of mixed age class birds, however, the maximum predicted mortality would affect between 0.005 - 0.01% of the population and would be un-detectable at the population level.

90. Based on the above, and using the adjusted breeding season estimates to acknowledge the anomalous July 2017 data as agreed with SNH/MS, the effects on kittiwake from collision at Project Alpha are assessed as of negligible magnitude, minor significance and therefore not significant in EIA terms. Option 2 results have been taken forward for cumulative assessment and PVA as required by the 2017 Scoping Opinion.

4.3 Project Alpha – Kittiwake – Displacement

91. The impact of displacement on kittiwake from the site + 2 km buffer is shown in Table 4.3. This assumes a displacement rate of 30% and a consequential mortality rate of 2% and is assessed for the breeding season only as advised by the 2017 Scoping Opinion. The results are presented in two ways as agreed with Marine Scotland (letter of 12 February 2019):

- including the July 2017 data when extremely high densities of birds were observed; and
- replacing the July 2017 value with the median July value recorded over the three survey years (as per collision risk modelling).

In both instances the seasonal mean peak population across the three survey years was calculated in the same way.

92. The additional kittiwake mortality caused by displacement is estimated to represent an increase in adult mortality of 0.5% notwithstanding the very high densities observed in July 2017. Where the July 2017 density is replaced with median July density from the three survey years this value drops to 0.24% which is equivalent to 0.03% of the regional population.

93. These impacts would represent a very slight change in baseline conditions which would be barely discernible from natural variations in background mortality and, as such, are assessed as of negligible magnitude and minor significance for this high sensitivity receptor. The effect of displacement mortality on kittiwake during the breeding season at Project Alpha is therefore assessed as not significant.

4.4 Project Alpha – Kittiwake – Displacement + Collision Combined

94. As required by the 2017 Scoping Opinion kittiwake is assessed for displacement (during the breeding season only) and collision (annual) combined. Using unadjusted data there would be a change to background mortality of between:

- 1.01 collision + 0.5 displacement = 1.51% combined based on option 2; and
- 1.15 collision + 0.5 displacement = 1.65% combined based on option 1.

95. Using adjusted density values these estimates would reduce to a change of:

- 0.75 collision + 0.24 displacement = 0.99% combined based on option 2; and
- 0.86 collision + 0.24 displacement = 1.1% combined based on option 1.

96. The combined effects of collision and displacement based on unadjusted data suggest a minor change to baseline conditions over the operational lifetime of the wind farm i.e. one of potentially low magnitude and moderate significance for this high sensitivity receptor. However, based on adjusted data, to acknowledge the July 2017 anomaly as agreed with SNH/MS, the impacts are predicted to bring about a change in background mortality of approximately 1% which would be of potentially negligible magnitude and minor significance. In addition, it is considered that combining these effects is overly precautionary because if birds are displaced from the wind farm they cannot collide with the turbines. In this sense, the effects are 'mutually exclusive' as noted by SNH in the 2017 Scoping Opinion.

97. Evidence for the species' displacement from wind farms is also limited. For example, an analysis of eight studies classed kittiwake as indifferent to constructed wind farms (Vanermen & Stienen 2019). Similarly, post-construction surveys at Westermost Rough could find no evidence of displacement from the offshore wind farm and an 8 km buffer (APEM 2017). In a situation where displacement effects are undiscernible, then there could not be any associated mortality. In this case, the theoretical displacement rate of 30% with mortality of 2% used here is likely to be precautionary yet it contributes between a quarter and a third of the effect size. Taking these points into consideration, the combined effects of collision and displacement on kittiwake at Project Alpha are assessed as not significant in EIA terms. For further, more detailed discussion, please see section 7.

4.5 Project Alpha – Auk species – Displacement

98. The three auk species, guillemot, razorbill and puffin were assessed for displacement assuming a displacement rate of 60% with consequent mortality of 1% for guillemot and razorbill and 2% for puffin as advised by the 2017 Scoping Opinion.

99. During the breeding season, guillemot and razorbill were assessed with and without the July 2017 data when very high numbers of birds were observed within the Project Alpha site. These high numbers were attributed in part to a multi-species foraging event but also, during late July, birds may be dispersing from their breeding colonies with attendant young, inflating count numbers. In line with similar advice given to the Hywind and Kincardine floating wind projects, SNH and Marine Scotland advised that the breeding season assessment should be carried out with and without these data (letter of 23rd January 2019).

100. For guillemot, the additional mortality was equivalent to a change in baseline mortality of 0.55% or 0.42% with and without the July 2017 data respectively. For razorbill this value was between 0.99% and 0.62% with and without the July 2017 data respectively. For puffin, which was not particularly associated with the feeding event, and was assessed using all data, a change in baseline mortality of 0.17% was estimated. For all three species the increase in adult mortality is classed as of negligible magnitude and minor significance for these high sensitivity receptors as it represents a very slight change in baseline conditions which would be barely discernible from natural variations in background mortality.

101. During the non-breeding season, when the effects on guillemot and razorbill are assessed against the same regional population as during the breeding season, changes to the adult background mortality were assessed as 0.27% for both species. This level of effect is assessed as of negligible magnitude.

102. Following the advice of the 2017 Scoping Opinion, puffin was not assessed during the non-breeding season because it disperses widely and birds within the Firth of Forth are more likely to come from breeding colonies outside the region.

103. During the breeding season (and non-breeding season for guillemot and razorbill) the effects of displacement on auk species at Project Alpha are assessed as not significant in EIA terms.

Table 4-1 Project Alpha - Gannet – Collision estimates

Band Option	Season	Collision mortality			Regional population[6]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Collisions minus sabbaticals	Increase in baseline mortality (%)
		Total	Adults	Sub-adults		Adults	Adults	Adults	Adults	Adults
1	Breeding	80	78.1	1.9	163,430	0.084	13,728	137.3	70	0.51
	Post-breeding	5	4.7	0.3	456,298					
	Pre-breeding	5	4.9	0.1	248,385					
	Total	90	87.7	2.3						
2	Breeding	191	186.4	4.6	163,430	0.084	13,728	137.3	168	1.22
	Post-breeding	8	7.5	0.5	456,298					
	Pre-breeding	9	8.8	0.2	248,385					
	Total	209	202.7	6.3						

6 Regional population during the breeding season is adults only based on counts from Bass Rock (2014) and Troup Head and Pennan (2014). Non-breeding season estimates from Furness (2015) comprise adults and sub-adults.

Table 4-2 Project Alpha - Kittiwake – Collision estimates

Band Option	Season	Collision mortality			Regional population[7]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Collisions minus sabbaticals	Increase in baseline mortality (%)
		Total	Adults	Sub-adults		Adults	Adults	Adults	Adults	Adults
1	Breeding	114	104	10	55,944	0.146	8,168	82	94	1.15
	Breeding (adj)[8]	85	78	7	55,944	0.146	8,168	82	70	0.86
	Post-breeding	90	60	30	822,894					
	Pre-breeding	34	27	7	624,215					
	Total	238 (209)	191 (165)	47 (43)						
2	Breeding	100	91	9	55,944	0.146	8,168	82	82	1.01
	Breeding (adj)	74	68	6	55,944	0.146	8,168	82	61	0.75
	Post-breeding	96	64	32	822,894					
	Pre-breeding	36	29	7	624,215					
	Total[9]	231 (206)	184 (161)	47 (45)						

7 Regional population during the breeding season is adults only. Non-breeding season estimates from Furness (2015) comprise adults and sub-adults.

8 Adjusted (adj) mortality during the breeding season is based on adjusted July 2017 data as described in the methodology.

9 Totals in brackets calculated using adjusted data

Table 4-3 Project Alpha – Displacement mortality estimates for kittiwake and auk species

Species	Season	Regional population (adults)[10]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Site population	Displacement mortality				Overall change to adult baseline mortality (%)	
							Total	Adults	Adults minus sabbaticals	Sub - adults	Adults	Adults minus sabbaticals
Kittiwake	Breeding	55,944	0.146	8,168	82	8,265	50	45	41	4	0.55	0.50
	Breeding (adj)[11]	55,944	0.146	8,168	82	3,935	24	22	19	2	0.26	0.24
Guillemot	Breeding	170,922	0.061	10,426	104	18,730	112	63	57	51	0.59	0.55
	Breeding - minus July 2017 data	170,922	0.061	10,426	104	14,253	86	48	44	38	0.45	0.42
	Non-breeding	170,922	0.061	10,426	104	8,469	51	28	N/A	23	0.27	N/A
Razorbill	Breeding	24,391	0.1	2,439	24	7,184	43	26	24	17	1.06	0.99
	Breeding - minus July 2017 data	24,391	0.1	2,439	24	4,529	27	16	15	11	0.67	0.62
	Non-breeding	24,391	0.1	2,439	24	1,812	11	7	N/A	4	0.27	N/A
Puffin	Breeding	166,240	0.081	13,465	135	3,876	47	21	23	22	0.18	0.17

10 Regional populations comprise adult birds only. Non-breeding season populations for auks are assumed to be the same as breeding season as advised in the 2017 Scoping Opinion.

11 Adjusted (adj) mortality during the breeding season is based on adjusted July 2017 data as described in the methodology.

5. Impact assessment: Project Bravo

5.1 Project Bravo – Gannet - Collision

104. Collision estimates for gannet based on option 1 and option 2 are shown in Table 5.1. Unlike gannet in Project Alpha, option 2 predicted fewer collisions in Project Bravo. This is explained by the differences in flight heights observed at sea in the two projects, with the PCH in Bravo being more than four times greater than Alpha and potentially reflecting different usage of the site (Table 2.10).

105. During the breeding season, collision mortality based on option 1 would represent a 1.6% change to the baseline mortality of adult breeding birds and option 2 a change of 0.88%. At maximum, considering option 1 collision estimates, this would be equivalent to 0.13% of the regional population. This level of additional mortality would represent a minor change in baseline conditions i.e. an impact of low magnitude and moderate significance on this high sensitivity receptor. Option 2 would represent a slight change which would be barely discernible from natural variations in background mortality i.e. one of negligible magnitude and minor significance.

106. During the non-breeding season, the population of birds in the Forth and Tay region forms part of the wider BDMPS population of the North Sea and Channel (Furness 2015). Background mortality is not estimated for this population of mixed age class birds, however, the maximum predicted mortality (option 1) would affect between 0.005 to 0.01% of the population on either autumn or spring passage. This would be un-detectable at the population level.

107. Whilst Furness et al. (2013) suggested that gannet might be of high sensitivity to collision, the authors noted that this assessment was precautionary and would need to be reviewed as evidence emerged. Skov et al. (2018) have subsequently suggested that gannets exhibit macro-avoidance of wind farms and that their collision avoidance rate should be higher than the 98.9% currently recommended by the SNCBs (2014) and used in this assessment. A peer-review of the empirical evidence presented by Skov et al. (2018) suggests that the current avoidance rate for gannet is underestimated and should be raised to 99.5% (Bowgen & Cook 2018). This would reduce the collision impacts at Project Bravo by more than half. Based on these more appropriate criteria, the predicted impact of option 1 would represent a very slight change in baseline conditions which would be barely discernible from natural variations in background mortality. That is, the impact would be not significant in EIA terms. More detailed discussion of impacts on gannet is provided in section 7.

108. Based on this information, effects on gannet using either option 1 or 2 of the Band CRM at Project Alpha in the breeding and non-breeding season are predicted to be of minor significance for this high sensitivity receptor. They would not materially affect the gannet population which, in the Forth and Tay region, is continuing to undergo an increase in size and productivity (Murray et al. 2015, JNCC 2016). In EIA terms, the effects of collision on gannet at Project Bravo are classed as not significant. As required by the 2017 Scoping Opinion, the mortality estimates from option 2 have been taken forward for cumulative assessment and PVA modelling.

5.2 Project Bravo – Kittiwake – Collision

109. Collision estimates for kittiwake based on option 1 and option 2 are shown in Table 5.2. Option 1 estimates predict fewer collisions

110. In this instance, unlike Project Alpha, only a single breeding season estimate is provided. This is because densities of kittiwake in flight in Project Bravo during July 2017 were not inflated by the unusual foraging event, the effects of which were felt mainly in Project Alpha and, in particular, concentrated in its western buffer (Fig 2). In Project Bravo, the median July value of birds in flight recorded during the three survey years was that observed in July 2017 and therefore no alternative density estimate was required.

111. For the breeding season, collision mortality estimated by option 1 would represent a 0.45% change to the baseline mortality of adult breeding birds and option 2 a 0.65% change. At maximum this would represent 0.09% of the regional population.

112. During the non-breeding season, the population of birds in the Forth and Tay region forms part of the wider BDMPS population of the North Sea (Furness 2015). Background mortality is not estimated for this population of mixed age class birds. The maximum predicted option 2 mortality would affect between 0.006 -0.007% of the population and would be un-detectable at the population level.

113. Based on the above, estimated collisions would represent a very slight change to the regional kittiwake population and be indistinguishable from background regardless of the CRM option used. The impact on kittiwake from collision at Project Bravo is therefore assessed as of negligible magnitude and minor significance for this high sensitivity receptor and not significant in EIA terms. Option 2 results have been taken forward for cumulative assessment and PVA as required by the 2017 Scoping Opinion.

5.3 Project Bravo – Kittiwake – Displacement

114. The impact of displacement on kittiwake from the site + 2 km buffer is shown in Table 5.3. This assumes a displacement rate of 30% and a mortality rate of 2% and is assessed for the breeding season only as advised by the 2017 Scoping Opinion. Unlike birds in flight, there were increased numbers of birds on the water in Project Bravo during July 2017, apparently resting after the feeding event, therefore the results are presented in two ways as agreed with Marine Scotland (letter of 12 February 2019):

- including the July 2017 data when extremely high densities of birds were observed; and
- replacing the July 2017 value with the median July value recorded over the three survey years.

In both instances the seasonal mean peak population was then calculated in the same way.

115. The additional kittiwake mortality caused by displacement is estimated to be a maximum increase in adult mortality of 0.31% notwithstanding the higher densities observed in July 2017, although densities were lower than those in Project Alpha. Where the July maximum is replaced with the July median this value drops to 0.19%.

116. This level of predicted displacement mortality would represent a very slight change to the regional kittiwake population and would be indistinguishable from background variation. The impact on kittiwake from collision at Project Bravo is therefore assessed as of negligible magnitude and minor significance for this high sensitivity receptor and not significant in EIA terms.

5.4 Project Bravo – Kittiwake – Displacement + Collision Combined

117. As advised in the 2017 Scoping Opinion kittiwake is assessed for displacement during the breeding season and collision (all seasons) combined, although as also noted in the 2017 Scoping Opinion SNH consider the effects to be 'mutually exclusive'. Combining additional mortality from Tables 5.2 and 5.3 and including the July 2017 data for displacement, collisions plus displacement would lead to a change in background mortality of:

- 0.45 collision + 0.31 displacement = 0.76% combined using CRM option 1; and
- 0.65 collision + 0.31 displacement = 0.96% combined using CRM option 2.

When assessed using median July data for additional displacement mortality the combined values fall to:

- 0.45 collision + 0.19 displacement = 0.64% combined using CRM option 1; and
- 0.65 collision + 0.19 displacement = 0.84% combined using CRM option 2.

118. These combined values represent a very slight change in background mortality, are of negligible magnitude and minor significance for this high sensitivity receptor. The impact is therefore assessed as not significant in EIA terms.

5.5 Project Bravo – Auk species – Displacement

119. The three auk species, guillemot, razorbill and puffin were assessed for displacement assuming a displacement rate of 60% with consequent mortality of 1% for guillemot and razorbill and 2% for puffin.

120. During the breeding season, guillemot and razorbill were assessed for displacement with and without the July 2017 data as agreed with Marine Scotland and SNH. Although at this time, greater numbers of birds were seen than usual in Project Bravo, there were somewhat fewer than in the Project Alpha site. Results are shown in Table 5.3.

121. For guillemot, the additional mortality was equivalent to a change in baseline mortality of 0.43% or 0.31% with and without the July 2017 data respectively. For razorbill this value was between 0.56% and 0.25%. For puffin, which was not particularly associated with the feeding event, and was assessed using all data, a change in baseline mortality of 0.24% was estimated.

122. During the non-breeding season, when the effects on auks are assessed against the same regional population as during the breeding season, changes to the adult background mortality were assessed as 0.23% and 0.34% for guillemot and razorbill respectively.

123. For all three species the increase in baseline mortality represents a very slight change to the regional population which would be indistinguishable from variation in background mortality and is assessed as of negligible magnitude. The effect of displacement on guillemot, razorbill and puffin at Project Bravo during the breeding season and non-season breeding is therefore assessed as of minor significance on these high sensitivity receptors and not significant in EIA terms.

Table 5-1 Project Bravo - Gannet – Collision estimates

Band Option	Season	Collision mortality			Regional population[12]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Collisions minus sabbaticals	Increase in baseline mortality (%)
		Total	Adults	Sub-adults		Adults	Adults	Adults	Adults	Adults
1	Breeding	250	244	6	163,430	0.084	13,728	137.3	220	1.60
	Post-breeding	26	24	2	456,298					
	Pre-breeding	26	25	1	248,385					
	Total	302	293	9						
2	Breeding	137	134	3	163,430	0.084	13,728	137.3	120	0.88
	Post-breeding	10	9	3	456,298					
	Pre-breeding	10	10	<1	248,385					
	Total	157	153	7						

12 Regional population during the breeding season is adults only based on counts from Bass Rock (2014) and Troup Head and Pennan (2014). Non-breeding season estimates from Furness (2015) comprise adults and sub-adults.

Table 5-2 Project Bravo - Kittiwake – Collision estimates

Band Option	Season	Collision mortality			Regional population[13]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Collisions minus sabbaticals	Increase in baseline mortality (%)
		Total	Adults	Sub adults		Adults	Adults	Adults	Adults	Adults
1	Breeding	45	41	4	55,944	0.146	8,168	82	37	0.45
	Post-breeding	27	18	9	822,894					
	Pre-breeding	24	19	5	624,215					
	Total	96	78	18						
2	Breeding	65	59	6	55,944	0.146	8,168	82	53	0.65
	Post-breeding	52	34	18	822,894					
	Pre-breeding	46	37	9	624,215					
	Total	163	130	33						

1

13 Regional population during the breeding season is adults only. Non-breeding season estimates from Furness (2015) comprise adults and sub-adults.

Table 5-3 Project Bravo – Displacement mortality estimates for kittiwake and auk species

Species	Season	Regional population (adults) [14]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Site population	Displacement mortality				Overall change to adult baseline mortality (%)	
							Total	Adults	Adults minus sabbaticals	Sub-adults	Adults	Adults minus sabbaticals
Kittiwake	Breeding	55,944	0.146	8,168	82	5,147	31	28	25	3	0.35	0.31
	Breeding (adj)[15]	55,944	0.146	8,168	82	3,146	19	17	16	2	0.21	0.19
Guillemot	Breeding	170,922	0.061	10,426	104	14,729	88	49	45	40	0.47	0.43
	Breeding - minus July 2017 data	170,922	0.061	10,426	104	10,421	63	34	32	28	0.33	0.31
	Non-breeding	170,922	0.061	10,426	104	7,410	44	24	N/A	20	0.23	N/A
Razorbill	Breeding	24,391	0.1	2,439	24	4,087	25	15	14	10	0.60	0.56
	Breeding - minus July 2017 data	24,391	0.1	2,439	24	1,831	11	7	6	4	0.27	0.25
	Non-breeding	24,391	0.1	2,439	24	2,292	14	8	N/A	6	0.34	N/A
Puffin	Breeding	166,240	0.081	13,465	135	5,576	67	35	33	32	0.26	0.24

14 Regional populations comprise adult birds only. Non-breeding season populations for auks are assumed to be the same as breeding season as advised in the 2017 Scoping Opinion.

15 Adjusted (adj) mortality during the breeding season is based on adjusted July 2017 data as described in the methodology.

6. Impact assessment: Project Alpha and Project Bravo combined

6.1 Project Alpha and Project Bravo combined – Gannet - Collision

124. Collision estimates for gannet based on option 1 and option 2 are shown in Table 6.1 with option 2 predicting fewer collisions.

125. During the breeding season, collision mortality based on option 1 would represent a 2.27% change to the baseline mortality of adult breeding birds. Option 2 estimates are equivalent to a 1.79% increase in baseline mortality. These estimates would represent 0.19% and 0.15% of the regional population respectively. The predicted impacts from option 2 are taken forward for PVA modelling as required by the 2017 Scoping Opinion.

126. During the non-breeding season, the population of birds in the Forth and Tay region forms part of the wider BDMPS population of the North Sea and Channel (Furness 2015). Background mortality is not estimated for this population of mixed age-class birds, however, the maximum predicted mortality based on option 1 would affect between 0.005 and 0.01% of the population pre- and post-breeding birds and would be un-detectable at the population level.

127. The effects on gannet mortality at Project Alpha and Project Bravo combined during the breeding season are assessed as causing a minor shift in baseline conditions i.e. one of low magnitude throughout the operational lifetime of the project. They therefore have the potential to cause an impact of moderate significance on this high sensitivity receptor.

128. As discussed for Project Bravo, whilst Furness et al. (2013) suggested that gannet might be of high sensitivity to collision, the authors noted that this assessment was precautionary and would need to be reviewed as evidence emerged. Skov et al. (2018) have subsequently suggested that gannets exhibit macro-avoidance of wind farms and that their collision avoidance rate should be higher than the 98.9% currently recommended by the SNCBs (2014) and used in this assessment. A peer-review of the empirical evidence presented by Skov et al. (2018) suggests that the current avoidance rate for gannet is underestimated and should be raised to 99.5% (Bowgen & Cook 2018). This would reduce the collision impacts at Project Alpha and Project Bravo combined by more than half. In addition, there is evidence to suggest that the flight speeds used in this assessment are overestimates (Skov et al. 2018, Bowgen & Cook 2018). The use of a lower flight speed would also reduce collisions. Based on these more appropriate criteria, the predicted impact would represent a very slight change in baseline conditions which would be barely discernible from natural variations in background mortality. That is, the impact would be of minor significance and not significant in EIA terms. More detailed discussion of collision impacts on gannet is provided in section 7, in particular regarding the influence of flight speeds and flight height and the way the latter has been calculated for separate Seagreen projects.

6.2 Project Alpha and Project Bravo combined– Kittiwake – Collision

129. The impact of collision on kittiwake from the combined sites is shown in Table 6.2. When considering results including all July 2017 data, the additional mortality using option 1 is estimated to be a change in baseline mortality of 1.31% and using option 2, 1.43%. Incorporating the adjusted July data the mortality is reduced to 1.12% and 1.23% for options 1 and 2 respectively. The worst case, option 2 and unadjusted data would affect 0.2% of the regional population.

130. The changes in background mortality represented by the adjusted data would represent a very slight/minor shift in baseline which could represent a low magnitude impact of potentially moderate significance on this high sensitivity receptor. However, this should be considered in the context of recent recommendations (Bowgen & Cook 2018) that suggest that avoidance rates for kittiwake should be raised from 98.9% to 99% and that the kittiwake flight speed used in current CRM (13.1 m/sec) is likely to be overestimated and that a lower flight speed should be used. Both of these factors would reduce collision estimates, the latter by approximately 20% (see Annex 2). In this context, the more appropriate conclusion is that impacts are of minor significance and therefore not significant in EIA terms. Further discussion of these elements can be found in section 7.

6.3 Project Alpha and Project Bravo combined – Kittiwake – Displacement

131. The impact of displacement on kittiwake from the combined sites + 2 km buffer is shown in Table 6.3. This assumes a displacement rate of 30% and a mortality rate of 2% and is assessed for the breeding season only as advised by the 2017 Scoping Opinion. The results are presented in two ways as agreed with Marine Scotland (letter of 12 February 2019):

- including the July 2017 data when extremely high densities of birds were observed; and
- replacing the July 2017 value with the median July value recorded over the three survey years.

In both instances the seasonal mean peak population was calculated in the same way.

132. The additional kittiwake mortality caused by displacement using all data is estimated to be a maximum increase in adult mortality of 0.69%. Where the July maximum is replaced with the July median this value drops to 0.36%.

133. As these changes in background mortality are likely to be indistinguishable from natural variation in baseline mortality over the lifetime of the wind farm, they are assessed as of negligible magnitude and minor significance for this high sensitivity receptor. Overall, the effect of displacement mortality on kittiwake at Project Alpha and Project Bravo combined is assessed as not significant in EIA terms.

6.4 Project Alpha and Project Bravo combined – Kittiwake – Displacement + Collision Combined

134. As advised in the 2017 Scoping Opinion kittiwake is assessed for displacement during the breeding season and collision (all seasons) combined. Combining additional mortality from Tables 6.2 and 6.3 and including the July 2017 data, collisions plus displacement would lead to a change in background mortality of;

- 1.31 collision + 0.69 displacement = 2% combined based on option 1
- 1.43 collision + 0.69 displacement = 2.12% combined based on option 2

Using adjusted data for July 2017, these rates would be reduced to:

- 1.12 collision + 0.36 displacement = 1.48% combined based on option 1
- 1.23 collision + 0.36 displacement = 1.59% combined based on option 2.

135. These combined values represent a minor shift from baseline which would act over the operational lifetime of the wind farm. They are therefore potentially of low magnitude and moderate significance for this high sensitivity receptor. However, this assessment should be considered in the following context.

136. SNH note in the 2017 Scoping Opinion that collision and displacement are 'currently considered to be mutually exclusive impacts' as birds that are displaced cannot collide with the turbines i.e. the effects should not be combined. An extensive review of displacement effects (Vanermen & Stienen 2019) found no evidence for the consistent displacement of kittiwakes from offshore wind farms which was also confirmed at Westermost Rough (APEM 2017) therefore the displacement rate of 30% with a relatively high consequent mortality used in this assessment is also considered highly precautionary adding between one quarter and one third to the scale of the effect. Combined with the conservative approach to collision risk modelling discussed at 6.2 above, it is likely that combined effects are overestimated here. It is therefore concluded that a more appropriate assessment of the effect, based on adjusted data, is one of minor significance i.e. not significant in EIA terms. Further discussion of these factors is included in section 7.

6.5 Project Alpha and Project Bravo combined – Auk species – Displacement

137. The three auk species, guillemot, razorbill and puffin were assessed for displacement assuming a displacement rate of 60% with consequent mortality of 1% for guillemot and razorbill and 2% for puffin.

138. During the breeding season, guillemot and razorbill were assessed with and without the July 2017 data as described previously. For guillemot, the additional mortality was equivalent to a change in baseline mortality of 0.82% and 0.61% with and without the July 2017 data respectively. For razorbill this value was between 1.29% and 0.73%. For puffin, which was assessed using all data, a change in baseline mortality of 0.34% was estimated. For guillemot and razorbill, when excluding the July data, and for puffin when using all data, the increase in adult mortality represents a very slight change to baseline conditions and is therefore likely to be indistinguishable from natural variation in background mortality.

139. During the non-breeding season, the change in adult mortality was 0.43% and 0.47% for guillemot and razorbill respectively.

140. The effect of displacement on guillemot, razorbill and puffin at Project Alpha and Project Bravo combined during the breeding and non-breeding seasons is therefore assessed as of negligible magnitude and minor significance for these high sensitivity receptors. In EIA terms effects are assessed as not significant.

Table 6-1 Project Alpha and Project Bravo combined - Gannet – Collision estimates

Band Option	Season	Collision mortality			Regional population[16]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Collisions minus sabbaticals	Increase in baseline mortality (%)
		Total	Adults	Sub adults		Adults	Adults	Adults	Adults	Adults
1	Breeding	354	346	8	163,430	0.084	13,728	137.3	311	2.27
	Post-breeding	26	24	2	456298					
	Pre-breeding	26	25	1	248385					
	Total	406	395	11						
2	Breeding	280	273	7	163,430	0.084	13,728	137.3	246	1.79
	Post-breeding	16	15	1	456298					
	Pre-breeding	16	16	0	248385					
	Total	312	304	8						

16 Regional population during the breeding season is adults only based on counts from Bass Rock (2014) and Troup Head and Pennan (2014). Non-breeding season estimates from Furness (2015) comprise adults and sub-adults.

Table 6-2 Project Alpha and Project Bravo combined - Kittiwake – Collision estimates

Band Option	Season	Collision mortality			Regional population[17]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Collisions minus sabbaticals	Increase in baseline mortality (%)
		Total	Adults	Sub adults		Adults	Adults	Adults	Adults	Adults
1	Breeding	130	119	11	55,944	0.146	8,168	82	107	1.31
	Breeding (adj)[18]	111	101	10	55,944	0.146	8,168	82	91	1.12
	Post-breeding	88	58	30	822,894					
	Pre-breeding	48	38	10	624,215					
	Total[19]	266 (247)	215 (197)	51 (50)						
2	Breeding	142	130	12	55,944	0.146	8,168	82	117	1.43
	Breeding (adj)	122	112	10	55,944	0.146	8,168	82	101	1.23
	Post-breeding	127	84	43	822,894					
	Pre-breeding	70	56	14	624,215					
	Total	339 (319)	270 (252)	69 (67)						

17 Regional population during the breeding season is adults only. Non-breeding season estimates from Furness (2015) comprise adults and sub-adults

18 Adjusted (adj) mortality during the breeding season is based on adjusted July 2017 data as described in the methodology.

19 Totals in brackets calculated using adjusted data

Table 6-3 Project Alpha and Project Bravo combined – Displacement mortality estimates for kittiwake and auk species

Species	Season	Regional population (adults) [20]	Regional mortality rate	Regional baseline mortality	1% baseline mortality	Site population	Displacement mortality				Overall change to adult baseline mortality (%)	
							Total	Adults	Adults minus sabbaticals	Sub-adults	Adults	Adults minus sabbaticals
Kittiwake	Breeding	55,944	0.146	8,168	82	11,405	68	63	56	6	0.77	0.69
	Breeding (adj)[21]	55,944	0.146	8,168	82	5,962	36	33	29	3	0.4	0.36
Guillemot	Breeding	170,922	0.061	10,426	104	27,783	167	92	85	75	0.88	0.82
	Breeding - minus July 2017 data	170,922	0.061	10,426	104	20,813	125	69	64	56	0.66	0.61
	Non-breeding	170,922	0.061	10,426	104	13,634	82	45	N/A	37	0.43	N/A
Razorbill	Breeding	24,391	0.10	2,439	24	9,380	56	34	31	23	1.38	1.29
	Breeding - minus July 2017 data	24,391	0.10	2,439	24	5,338	32	19	18	13	0.79	0.73
	Non-breeding	24,391	0.10	2,439	24	3,207	19	12	N/A	8	0.47	N/A
Puffin	Breeding	166,240	0.081	13,465	135	7,744	93	49	45	44	0.36	0.34

20 Regional populations comprise adult birds only. Non-breeding season populations for auks are assumed to be the same as breeding season as advised in the 2017 Scoping Opinion.

21 Adjusted (adj) mortality during the breeding season is based on adjusted July 2017 data as described in the methodology

7. Cumulative impact assessment

141. Cumulative assessment was carried out for the operational period for each of the five species, impacts and scenarios described in part 1.2. Impacts on the regional population are assessed against the adult breeding population for the breeding season only except in the case of guillemot and razorbill. Non-breeding season impacts are quantified for auks as required by the 2017 Scoping Opinion because they are assumed to remain in the region of their local colonies within the Forth and Tay. Assessment of non-breeding season impacts on gannet from other offshore wind farms in the wider region of the North Sea and Channel and for kittiwake in the wider North Sea are assessed fully in the HRA section of this Addendum in relation to specific SPAs.

142. For all species the assessment was based on the impacts of Project Alpha and Project Bravo combined together with other projects in the Forth and Tay region using two scenarios as required by the 2017 Scoping Opinion.

- Scenario A: Project Alpha and Bravo Project combined plus Neart na Gaiothe as consented in 2018 and Inch Cape as applied for in 2018; and
- Scenario B: Project Alpha and Project Bravo combined plus Neart na Gaiothe and Inch Cape as consented in 2014.

143. Collision mortality estimates for the Forth and Tay developments as proposed in 2018 were taken from the relevant application documents (NNG 2018, IC 2018).

144. Collision mortality estimates for Inch Cape as consented in 2014 were taken from Annex 2. For Neart na Gaoithe, estimates were calculated from Excel workbooks provided to Seagreen by SNH/MS. Estimates were adjusted in line with methodology recommended in the 2017 Scoping Opinion i.e. based on Band option 2 and a 98.9% avoidance rate and, in the case of kittiwake, the nocturnal activity factor was adjusted from 3 to 2 (i.e. from 50% of daytime activity to 25%). Estimated mortality was split according to the proportions of each age class observed at sea by each developer with the number of adults reduced by 10% to account for sabbatical birds.

145. Other, smaller, offshore wind projects in the region were considered qualitatively in the cumulative context as recommended in the 2017 Scoping Opinion.

146. The mean peak populations for displacement for Inch Cape were taken from the Inch Cape EIAR (2018). For Neart na Gaoithe, populations were re-estimated based on numbers provided in the NNG EIAR (2018). The estimated impacts from displacement and barrier effects at these projects in 2014 and 2018 remain the same as they are unaffected by the design changes.

7.1 Cumulative impacts – Gannet – Collision

147. For the purposes of cumulative impact assessment, the collision estimates for all Forth and Tay projects were taken forward using option 2 and a 98.9% avoidance rate as required in the 2017 Scoping Opinion. Table 7.1 provides breeding season mortality including adults, adjusted for sabbaticals at a rate of 10%, and sub-adults for both of the required scenarios.

148. Scenario A, using all projects as described in 2018, estimates a total mortality of 422 breeding adult birds plus 15 sub-adults. This would represent 0.26% of the regional population and increase background mortality by 3.07%.

149. Scenario B includes estimated collisions for Project Alpha and Project Bravo combined in 2018 and values for Neart na Gaoithe and Inch Cape as consented in 2014. For the 2014 CRMs, breeding season collisions at Inch Cape were estimated as 335 adult breeding birds plus 9 sub-adults and for Neart na Gaoithe, 198 breeding adults and five sub-adults. Combined with the 2018 estimates for the optimised Seagreen Project this would represent 0.4% of the regional population and increase baseline mortality by 5.67%.

150. The Seagreen 2018 EIAR also quantified further potential effects of smaller offshore windfarms in the Forth and Tay region and within mean-maximum foraging range of the Bass Rock colony. These projects, including European Offshore Wind Deployment Centre (EOWDC), Hywind, Kincardine and the ORE Catapult turbine at Levenmouth which are in operation and Forthwind, which is consented, may contribute a small number of additional collisions in both the breeding and non-breeding seasons. However, quantitative values are likely to have been overestimated due, for example, to the use of higher nocturnal activity factors than advised in the 2017 Scoping Opinion. The small scale of these effects is not considered likely to make a material difference to the magnitude of impacts on the regional population.

151. Larger offshore wind projects in the Moray Firth are also technically within range of birds from breeding colonies in the region but are considered unlikely to contribute to the mortality of birds from the main colony on Bass Rock (Forth Islands SPA) which comprises the majority of the Forth and Tay population. This is owing to the way that foraging areas of gannets from different breeding colonies are spatially partitioned suggesting that birds impacted by projects in the Moray Firth are more likely to come from the colony at Troup Head and Pennan or colonies further north (Wakefield et al. 2013).

152. These impacts represent a minor shift away from baseline mortality, temporary over the lifetime of the wind farms which would be of low magnitude and potentially moderate significance for this high sensitivity receptor. However, before reaching a conclusion on significance, the assessment should be considered in the following context.

Table 7-1 Gannet cumulative collision impacts (option 2 and 98.9% AR)

Scenario A: all projects 2018 applications/consents			
Project	All birds (breeding season)	Breeding adults[5]	Sub adults
Alpha + Bravo combined	280	246	9
Inch Cape[22]	108	94	3
Neart na Gaoithe[23]	94	82	3
Total	482	422	15
Regional breeding population			163,430
Mortality rate			0.084
Background mortality			13,728
Increase in background mortality (%)			3.07
Scenario B: Seagreen 2018 application + other projects 2014 consents			
Project	All birds (breeding season)	Breeding adults[24]	Sub adults
Alpha + Bravo combined	280	246	7
Inch Cape[25]	384	335	9
Neart na Gaoithe[26]	224	198	5
Total		779	21
Regional breeding population			163,430
Mortality rate			0.084
Background mortality			13,728
Increase in background mortality (%)			5.67

22 Inch Cape (2018) ES Vol 1 a Table 11.21
23 Neart na Gaoithe EIA (2018) Table 9.5
24 Adults adjusted for sabbatical birds
25 Data from Annex 2 adjusted as described above.
26 Data from Neart na Gaoithe workbook (2014 04 23 - FTOWDG - CRM MLS - GX.xlsm)

7.1.1 Impacts on gannet - discussion

153. Avoidance rates for gannet have recently been reviewed (Bowgen & Cook 2018) based on a re-analysis of data collected from Thanet offshore wind farm during the Offshore Renewables Joint Industry Programme (ORJIP) study (Skov et al. 2018); a long term study funded by industry and with a steering group including SNCBs and RSPB. The review recommended that the avoidance rates used with the Band CRM options 1 and 2 should be increased to 99.5%. As the current 98.9% rate was extrapolated from data related primarily to non-breeding birds, collected at onshore and coastal wind farms, the new rate, derived from evidence collected in an operational wind farm is likely to be more appropriate. The application of this rate would more than halve the mortality predicted in the scenarios modelled here i.e. for the worst case cumulative scenario (i.e. Project Alpha and Project Bravo combined as per the 2018 application and Neart na Gaoithe and Inch Cape as consented in 2014) predicted impacts would reduce from approximately 6% to a 3% change in background mortality.

154. There is also growing evidence that gannets avoid offshore windfarms at the macro-scale (e.g. Skov et al. 2018, Dierschke et al. 2016, Krijgsveld 2014) although this has yet to be quantified particularly for breeding birds. In addition, as displacement and collision are, by definition, mutually exclusive, the mortality estimates here are likely to be overly precautionary.

155. Further precaution is introduced by the use of option 2 estimates to assess cumulative effects from all projects. For both Scenario 1 and Scenario 2 at both Inch Cape and Neart na Gaoithe (IC 2018, NNG 2018), option 2 overestimates collisions because the generic proportion of birds at rotor height is greater than that actually observed on the sites, therefore option 1 would predict fewer collisions.

156. The CRM uses a flight speed for gannet of 14.9 m/sec which is higher than the average of 13.3 m/sec found in empirical studies at Thanet (Skov et al. 2018). Examples of how a reduction in flight speed would reduce collisions are given in Annex 2, Table 14. This indicates that, for gannet, the use of the reduced flight speed derived by the ORJIP study would reduce collision estimates by approximately 6%.

157. Finally, whilst the worst case scenario has been modelled as required by the Scoping Opinion it is likely that some of the projects at least, e.g. Neart na Gaoithe, will not be built out to the worst case presented here. It is also possible that the rotor speed modelled as part of the Seagreen worst case WTG envelope might be reduced. For modelling of an indicative scenario, please see Annex 2, Table 14. Such changes would also reduce the predicted number of collisions.

158. Although regional population modelling was not conducted for gannet, it was carried out for the gannet colony at Forth Islands SPA which represents a large part of the regional population. It shows that at the maximum predicted level of cumulative mortality in the Forth and Tay region, the population would continue to increase strongly above its current size. (Annex 3, Figure 2). Only when potential mortality exceeded approximately 1400 birds per annum did it stabilise at current levels, with higher levels of mortality causing a slow decline.

159. The AA completed for the Forth and Tay projects in 2014 predicted a cumulative mortality of 1169 breeding birds from Forth Islands SPA alone (MS 2014: Appendix 7, Table B). By contrast, the worst case estimated in Table 7-1 predicts a cumulative regional mortality of 779 breeding adults. On this basis, the worst case cumulative scenario modelled here predicts a substantial reduction in mortality compared to the 2014 consented projects.

160. In summary, the potentially moderate significance of collision impacts on gannet should be considered in the context of reductions in mortality estimates through the use of more appropriate avoidance rates and flight speeds and the predictions of the population model which indicate that the population will continue to increase. In addition, the previous AA concluded no adverse effects on the population of the Forth Islands SPA which contributes the majority of birds to the regional population and was based on a cumulative mortality greater that that modelled here. Based on this evidence, it is considered that cumulative collision impacts on gannet would be more appropriately assessed as of minor ecological significance. In EIA terms this would be not significant.

7.2 Cumulative impacts – Kittiwake – Collision

161. Cumulative impacts on the regional kittiwake breeding population were calculated for all projects using Band CRM option 2 and a 98.9% avoidance rate. Estimates taken forward for Project Alpha and Project Bravo combined are based on adjusted densities for July data as explained previously.

Table 7-2 Kittiwake cumulative collision impacts (option 2 and 98.9% AR)

Scenario A: all projects 2018 applications/consents			
Project	Total (breeding season)	Breeding adults[5]	Sub adults
Alpha + Bravo combined	122	100	10
Inch Cape[27]	40	33	3
Neart na Gaoithe[28]	9	7	1
Total	171	141	14
Regional breeding population			55,944
Mortality rate			0.146
1% background mortality			82
Increase in background mortality (%)			1.72
Scenario B: Seagreen 2018 application + other projects 2014 consents			
Project	All birds (breeding season)	Breeding Adults[29]	Sub adults
Alpha + Bravo combined	122	100	10
Inch Cape[30]	143	120	10
Neart na Gaoithe[31]	17	14	1
Total	282	234	21
Regional breeding population			55,944
Mortality rate			0.146
1% background mortality			82
Increase in background mortality (%)			2.87

27 Data from Inch Cape (2018) EIA Table 11.23
28 Data from Neart na Gaoithe (2018) EIA Table 9.60.
29 Adults adjusted for sabbatical birds
30 Data for Inch Cape from Annex 2 adjusted as described above
31 Data from Neart na Gaoithe workbook (2014 04 23 - FTOWDG - Offshore Wind - Cumulative Impacts - Kitti.xlsm)

162. For scenario A, based on the 2018 applications for all projects, modelling predicted additional mortality of 171 kittiwakes of which 141 are estimated to be breeding adults plus 14 sub-adults. This would represent a 1.72% increase in adult background mortality (Table 7.2).

163. Scenario B including Project Alpha and Project Bravo combined (2018) and 2014 estimates for Inch Cape and Neart na Gaoithe predicted total collisions of 282 birds of which 234 were breeding adults and 21 sub-adults. This would represent a 2.87% increase in adult background mortality affecting 0.4% of the regional population.

164. These impacts represent a minor shift away from baseline mortality, temporary over the lifetime of the wind farms i.e. an impact of low magnitude which would be of potentially moderate significance for this high sensitivity receptor. However any conclusion on significance needs to take into account the factors considered at section 7.3.1 below.

7.3 Cumulative impacts – Kittiwake – Displacement + Collision Combined

165. The cumulative effects of collision and displacement on the regional breeding population of kittiwake are presented in Table 7.3. All collision results are for the Band CRM option 2 and an avoidance rate of 98.9%. Displacement values for the optimised Seagreen Project are those calculated for the site plus a 2 km buffer and include adjusted July 2017 data; those for Neart na Gaoithe and Inch Cape were extracted from their respective EIARs (IC 2018, NNG 2018) and are effectively unchanged between 2014 and 2018 because the site boundaries remained unchanged and site populations were initially calculated with a 2 km buffer.

Table 7-3 Kittiwake cumulative collision and displacement impacts

Project	Impact	All birds (breeding season)	Breeding adults	Sub adults
Alpha + Bravo combined	Collision 2018	122	100	10
	Displacement	36	29	3
Inch Cape	Collision 2018	40	33	3
	Collision 2014	143	120	10
	Displacement	23	19	2
Neart na Gaoithe	Collision 2018	9	7	1
	Collision 2014	17	14	1
	Displacement	13	11	1
Total (all 2018 consents/applications)		243	199	20
Total (Seagreen 2018 NNG and IC 2014)		354	293	27
Regional breeding population				55,944
Mortality rate				0.146
1% background mortality				82
Increase in background mortality (%) - all projects 2018				2.44
Increase in background mortality (%) - Seagreen 2018 + NNG & IC 2014				3.59

166. The combined effects of collision and displacement on kittiwake from all Forth and Tay projects as currently proposed are predicted to cause an estimated mortality of 243 birds of which 199 are breeding adults which would increase the background mortality by 2.44%.

167. Considering Project Alpha and Project Bravo combined as in 2018 and Neart na Gaoithe and Inch Cape as consented in 2014 the impacts would affect 354 birds of which 293 are estimated to be breeding adults which would give rise to a potential increase in background mortality of 3.59 % representing 0.5% of the regional population.

168. There are a small number of smaller offshore windfarms in the Forth and Tay region within mean- maximum foraging range of regional breeding colonies. These projects include the coastal sites of Forthwind and the ORE Catapult turbine at Levenmouth. The AA of the consented Forthwind project did not consider kittiwake to be at risk and, in general, the low levels of collision impacts on kittiwake predicted from these projects are not considered likely to make a material difference to the impacts on the regional population. Kincardine Floating Wind Farm and EOWDC are at the limits of this species' range and are more likely to affects breeding colonies outside the region such as Buchan Ness to Collieston Coast SPA. This is borne out by tracking studies which indicate that, like gannet, the foraging areas of kittiwakes from specific colonies are spatially partitioned (Wakefield et al. 2017) and that kittiwakes from Buchan Ness to Collieston Coast SPA tend to track east rather than south east into the Forth and Tay region. For these reasons, no significant additional mortality is predicted from these smaller wind farms on the regional population of the Forth and Tay as defined in this Addendum.

169. Cumulative collision and displacement impacts represent a minor shift away from baseline mortality, temporary over the lifetime of the wind farms i.e. of low magnitude, which would be of potentially moderate significance for this high sensitivity receptor based on the matrix shown in Table 2.16. However, any conclusion on significance needs to take into account the following factors.

7.3.1 Impacts on kittiwake- discussion

170. Avoidance rates for kittiwake have recently been reviewed (Bowgen & Cook 2018) based on a re-analysis of data collected from Thanet operational wind farm during the ORJIP study (Skov et al. 2018). The review recommended that avoidance rates used with the Band CRM options 1 and 2 should be increased from 98.9% to 99%. For option 3, a 98% avoidance rate was calculated. Whilst option 3 has not been modelled in this Addendum, it formed the basis of the 2014 AA which concluded no adverse effects on SPA populations of kittiwakes within the region. The application of the increased avoidance rate or the use of option 3 would reduce collision estimates substantially below those reported here and potentially by as much as half.

171. Further precaution is introduced by the use of option 2 estimates to assess cumulative effects from all projects. In many cases, e.g. as stated by Inch Cape (IC 2018), this overestimates collisions because the generic proportion of birds at rotor height is greater than that actually observed on site, therefore option 1 would predict fewer collisions.

172. The influence of the flight speed used in standard CRM (13.1 m/s) is more significant for kittiwake than for gannet in that kittiwake flight speeds recorded during empirical studies in UK waters were much lower than that used in this assessment. They ranged between 6.7 m/s straight line speed i.e. the direct distance between two points, and 8.6 m/s track speed i.e. the actual speed at which the bird is travelling along a sinuous route between two points (Skov et al. 2018). Lower flight speeds of between 9 and 11 m/s were also recorded by Elliott et al. (2014). The use of a reduced speed would reduce flux rate through the wind farm and hence collisions (noting that the Band model also uses flight speed to calculate the probability of collision and slower speeds may increase this risk, however this is outweighed by the change in flux rate). An example of how a reduction in flight speed would reduce collisions estimates is given in Annex 2, Table 14 and shows that, using the Skov et al. (2018) values, they could reduce by as much as 19%.

173. As mentioned previously, the CRM undertaken for the Seagreen projects also uses the worst case WTG envelope with a rotor speed representative of a 164 m diameter rotor. It is possible that the rotor speed modelled as part of the Seagreen worst case WTG envelope might be reduced, which would also reduce the predicted number of collisions. For modelling of an indicative scenario, please see Annex 2, Table 14.

174. Displacement and barrier effects were modelled on behalf of Marine Scotland (Searle et al. 2014) to inform the 2014 AA of the Forth and Tay projects (MS 2014). The model was based on tracked kittiwakes from three regional SPAs and used a slightly greater displacement rate of 40% (compared to the 30% used here) but a reduced wind farm buffer of 1 km to estimate effects.

175. Using information from the above model and CRMs, the 2014 AA estimated a cumulative mortality from displacement and collision of 407 breeding birds from the three SPAs within the region as defined by this Addendum, namely Forth Islands SPA, Fowlsheugh SPA and St Abb's Head to Fast Castle SPA (MS 2014: Appendix 7, Table B). Given that the regional population includes non-SPA colonies and so regional mortality could be expected to be higher than this, the current worst case cumulative mortality estimate of 293 adult breeding birds predicts (albeit by different methods) a substantial reduction in impact. Regional population modelling conducted by Freeman et al. (2014) predicted that the un-impacted kittiwake population was declining and would continue to do so. Worst case impacts predicted in this Addendum would reduce the rate of decline compared to that predicted by the 2014 consented projects.

176. In summary, the potentially moderate significance of combined collision and displacement impacts on kittiwake should be considered in the following context. In terms of collision, the compound effect of applying more realistic lower flight speeds, together with a small increase in avoidance rate from 98.9% to 99% would reduce collision estimates significantly. If option 3 and a 98% avoidance rate, as recommended by Bowgen & Cook (2018), were applied across all projects, in-combination cumulative collision estimates would be approximately halved. In addition, the use of option 2 for all cumulative assessment is precautionary in that option 1 results using site-based flight heights predict fewer collisions at all Forth and Tay projects. When combined with displacement effects which are not supported by empirical evidence (Vanermen & Stienen 2019), the mortality estimated by current methods is considered to be overly precautionary and, on this basis, an attribution of minor significance is considered appropriate. It is therefore concluded that the cumulative collision and displacement impacts on kittiwake are not significant in EIA terms. The fact that the 2014 AA was able to conclude no adverse effects on the populations of the three SPAs which contribute the majority of birds to the regional population supports this conclusion.

7.4 Cumulative impacts –Auks – Displacement

177. The cumulative impacts of displacement on the regional breeding populations of guillemot and razorbill are presented in Table 7.4. Displacement values for the Project Alpha and Project Bravo combined are those calculated for the site plus a 2 km buffer using adjusted July 2017 data; those for Neart na Gaoithe and Inch Cape were extracted from their respective EIARs (IC 2018, NNG 2018) and are effectively unchanged between 2014 and 2018 because the site boundaries of the respective projects have not changed and site populations were initially calculated with a 2 km buffer.

178. For guillemot, additional mortality from displacement during the breeding season is estimated as a change in baseline mortality of 0.88% for adults and 0.51% for sub-adults. During the non-breeding season these proportions reduced to 0.71% and 0.40% respectively. As all impacts represent a very slight change in baseline conditions which would be barely discernible from natural variations in background mortality they are classed as of negligible magnitude and minor significance for this high sensitivity receptor. For this reason the impact of cumulative displacement mortality on the regional guillemot population of the Forth and Tay is assessed as not significant in EIA terms.

179. For razorbill, the additional mortality of adults and sub-adults due to displacement during the breeding and non-breeding season was similar. For breeding adults it was equivalent to a 1.39% change in regional baseline mortality and for sub-adults population 1.16%. During the non-breeding season, additional adult mortality represented a slightly smaller change of approximately 1.35% with sub-adults at a similar rate to the breeding season of 1.2%. Impacts on razorbill are slightly higher than for those on guillemot but, at this level, still represent a very small change from baseline which is unlikely to be discernible. A precautionary assessment based on the matrix in Table 2.17 would be an effect of potentially low magnitude and moderate significance for this high sensitivity receptor.

180. However, the apportionment of all additional mortality in the non-breeding season to the regional population is likely to overestimate effects as birds within the region at this time are likely to include individuals from colonies further afield (Furness 2015). In this context, the additional mortality in terms of the regional population is more appropriately assessed as of minor significance and, in EIA terms not significant in either season.

181. Cumulative impacts on puffin are shown in Table 7.5. This species is assessed in the breeding season only as required in the 2017 Scoping Opinion. Additional mortality impacts on both adults (0.71%) and sub-adults birds (0.5%) represent a very slight change in baseline conditions which would be barely discernible from natural variations in background i.e. of negligible magnitude and minor significance for this high sensitivity receptor and is therefore assessed as not significant in EIA terms.

7.4.1 Impacts on auks - discussion

182. There is limited quantitative evidence on the displacement of auks from offshore windfarms. However, displacement and barrier effects on auks were modelled on behalf of Marine Scotland (Searle et al. 2014) to inform the 2014 AA of the Forth and Tay projects (MS 2014). The model was based on tracked birds and used a displacement rate of 60% plus a reduced wind farm buffer of 1 km. Modelling of the regional populations of both guillemot and razorbill suggested that they would continue to increase (although razorbill more slowly than guillemot) until impacts on adult survival and productivity exceeded between 1%/1% and 2%/5% respectively. However, there was no evidence of effects on adult survival of more than 0.5% for guillemot and razorbill at any of the regional SPAs. The specific mortality represented by this change was not given in the 2014 AA for guillemot but for razorbill it was estimated at 41 breeding birds at Forth Islands SPA. The cumulative regional mortality of 33 breeding razorbills estimated here is a reduction in that number.

183. The model predicted that displacement would cause a greater than 0.5% change in adult survival for puffin at Forth Islands SPA. As a large proportion of breeding puffins in the Forth and Tay region originate from this SPA, it could be taken as a proxy for the regional population. However, this was based on the assumption that prey distribution was homogeneous. When modelled for heterogeneous prey i.e. prey were assumed to be located relative to bird distribution, effects were well below the 0.5% threshold. However, for puffin, the very limited number of tracked individuals (n=7) and the apparent behavioural response of some of them which suggested that shorter foraging trips were under-represented, meant that the 'reliability' of the model was unclear (MS 2014) and it was advised that results should be treated with caution. An alternative approach using a 'common currency' methodology, estimated a potential cumulative change to adult survival of 2.01 % from the Forth and Tay projects (MS 2014, Table 9).

184. Regional population modelling conducted at this time (Freeman et al. 2014) found that, owing to data limitations, the un-impacted puffin population was predicted to show an unrealistic increase in size and was potentially unreliable. Alternatives methods of assessing the effects were considered including Potential Biological Removal (PBR) and a matrix-based PVA.

185. Considering all of the above, the 2014 AA concluded there would be no adverse effect on the puffin population of the Forth Islands SPA. This was based on predicted cumulative mortality of 1,251 breeding puffins (MS 2014: Appendix 7, Table B). As the worst case cumulative impact predicted in this Addendum, using the methods advised in the 2017 Scoping Opinion, is the additional mortality of 231 individuals of which 95 are breeding adults and which would increase background mortality by 0.71% the impacts are assessed as not significant.

Table 7-4 Cumulative displacement mortality for guillemot and razorbill

Guillemot	Season	Additional mortality		
Project		Total (all birds)	Breeding adults	Sub-adults
Alpha + Bravo combined	Breeding	125	64	56
	Non-breeding	82	45	37
Inch Cape	Breeding	48	20	28
	Non-breeding	23	10	13
Neart na Gaoithe	Breeding	19	8	11
	Non-breeding	45	19	26
Total	Breeding	192	92	95
	Non-breeding	150	74	76
Regional population			170,922	134,296
Mortality rate			0.061	0.14
Background mortality			10,426	18,801
1% background mortality			104	188
Increase in breeding season mortality (%)			0.88	0.51
Increase in non- breeding season mortality (%)			0.71	0.40

Razorbill	Season	Additional mortality		
Project		Total (all birds)	Breeding adults	Sub-adults
Alpha + Bravo combined	Breeding	32	18	13
	Non-breeding	20	12	8
Inch Cape	Breeding	27	13	14
	Non-breeding	28	13	15
Neart na Gaoithe	Breeding	7	3	4
	Non-breeding	17	8	9
Total	Breeding	66	34	31
	Non-breeding	64	33	32
Regional population			24,391	16,261
Mortality rate			0.10	0.164
Background mortality			2,439	2,667
1% background mortality			24	27
Increase in breeding season mortality (%)			1.39	1.16
Increase in non- breeding season mortality (%)			1.35	1.20

Table 7-5 Cumulative displacement mortality for puffin

Puffin	Season	Additional mortality		
Project		Total (all birds)	Breeding adults	Sub-adults
Alpha + Bravo combined	Breeding	93	45	44
Inch Cape	Breeding	66	24	42
Neart na Gaoithe	Breeding	72	26	46
Total		231	95	132
Regional breeding population			166,240	199,927
Mortality rate			0.081	0.133
Background mortality			13,465	26,590
1% background mortality			135	266
Increase in background mortality			0.71	0.50

8. Conclusions

186. This EIA Addendum has carried out a revised environmental impact assessment for each of the three Seagreen scenarios namely: Project Alpha, Project Bravo and Project Alpha and Project Bravo combined. The latter has been assessed cumulatively with other offshore wind projects in the Forth and Tay region including Neart na Gaoithe and Inch Cape offshore windfarms.

187. The assessment has been made in relation to impacts during the operational period on the regional breeding populations of five species: gannet, kittiwake, guillemot, razorbill and puffin, all of which are classed as of high sensitivity. For these species this EIA Addendum supersedes the assessment provided in the Seagreen EIAR (2018).

188. This assessment concludes that there would be no significant impacts on the regional populations of the above species arising from Project Alpha, Project Bravo and Project Alpha and Project Bravo combined either alone or cumulatively with other offshore wind projects in the Forth and Tay. This is because impacts are generally of negligible magnitude and minor significance and therefore not significant in EIA terms. Where an impact of potentially low magnitude and moderate significance is identified, a discussion of the ecological context is provided citing recent studies based on empirical data and ecological modelling. In each case this suggests that the more appropriate conclusion is that the effects are of minor significance and, once again, in EIA terms, not significant (Table 8.1).

189. When compared to the level of impact predicted by the 2014 AA (MS 2014), all impacts are reduced.

Table 8-1 Summary of impact significance for all sites and species

NOTE: (Adj) indicates the assessment was based on Seagreen data adjusted for July 2017 densities.

Species	Effect	CRM option	Alpha	Bravo	Project Alpha + Project Bravo combined	Cumulative All Forth and Tay projects 2018	Cumulative Seagreen 2018, other Forth and Tay projects 2014
Gannet	Collision	1	Minor and not significant	Potentially moderate with review of further factors - minor and not significant	Potentially moderate with review of further factors - minor and not significant		
		2	Minor and not significant	Minor and not significant	Potentially moderate with review of further factors - minor and not significant	Potentially moderate with review of further factors - minor and not significant	Potentially moderate with review of further factors - minor and not significant
Kittiwake	Collision	1	Minor and not significant	Minor and not significant	Potentially moderate with review of further factors - minor and not significant		
	Collision (adj)	1	Minor and not significant		Potentially moderate with review of further factors - minor and not significant		
	Collision	2	Minor and not significant	Minor and not significant	Potentially moderate with review of further factors - minor and not significant		
	Collision (adj)	2	Minor and not significant		Potentially moderate with review of further factors - minor and not significant	Potentially moderate with review of further factors - minor and not significant	Potentially moderate with review of further factors - minor and not significant
	Displacement		Minor and not significant	Minor and not significant	Minor and not significant		

Species	Effect	CRM option	Alpha	Bravo	Project Alpha + Project Bravo combined	Cumulative All Forth and Tay projects 2018	Cumulative Seagreen 2018, other Forth and Tay projects 2014
	Displacement (adj)		Minor and not significant	Minor and not significant	Minor and not significant		
	Collision + Displacement	1	Potentially moderate with review of further factors - minor and not significant	Minor and not significant	Potentially moderate with review of further factors - minor and not significant		
	Collision + Displacement	2	Potentially moderate with review of further factors - minor and not significant	Minor and not significant	Potentially moderate with review of further factors - minor and not significant		
	Collision + Displacement (adj)	1	Minor and not significant	Minor and not significant	Potentially moderate with review of further factors - minor and not significant		
	Collision + Displacement (adj)	2	Minor and not significant	Minor and not significant	Potentially moderate with review of further factors - minor and not significant	Potentially moderate with review of further factors - minor and not significant	Potentially moderate with review of further factors - minor and not significant
Guillemot	Displacement	-	Minor and not significant	Minor and not significant	Minor and not significant		
	Displacement minus July data	-	Minor and not significant	Minor and not significant	Minor and not significant	Minor and not significant	
Razorbill	Displacement	-	Minor and not significant	Minor and not significant	Potentially moderate with review of further factors - minor and not significant		
	Displacement minus July data	-	Minor and not significant	Minor and not significant	Minor and not significant	Potentially moderate with review of further	

Species	Effect	CRM option	Alpha	Bravo	Project Alpha + Project Bravo combined	Cumulative All Forth and Tay projects 2018	Cumulative Seagreen 2018, other Forth and Tay projects 2014
						factors - minor and not significant	
Puffin	Displacement	-	Minor and not significant	Minor and not significant	Minor and not significant	Minor and not significant	