Habitats Regulations Appraisal Report

Pelagica Environmental Consultancy Ltd.

Cork Ecology

March 2018

Table of Contents

Table of Figures

Table of Tables

1 Habitats Regulations Appraisal

1.1 Introduction

1. This document is referred to as a Habitats Regulations Appraisal (HRA) and its purpose is to provide the information required by the competent authority, in this case Marine Scotland, to undertake an Appropriate Assessment as required under the Habitats Regulations. This document has been prepared on behalf of Neart na Gaoithe Offshore Wind Limited (NnGOWL) by Pelagica Environmental Consultancy Ltd (Pelagica) with significant input from Cork Ecology. Acknowledgement is also made to Genesis for undertaking noise and iPCoD modelling and Bureau Waardenburg for undertaking collision rate modelling and population viability analysis, the results of which have been used extensively in this assessment.
2. The scope of this document is based on the advice received and the information requested by the Scottish Ministers in the Scoping Opinion (Marine Scotland 2017a).
3. This document presents information on potential impacts on sites of nature conservation importance as a result of the construction, operation and maintenance and decommissioning of the proposed Neart na Gaoithe offshore wind farm (the Project) alone and in-combination with other plans or projects and provides the necessary information to inform an Appropriate Assessment of whether, in view of the relevant European site's conservation objectives, the Project would have an adverse effect (or risk of adverse effect) on the integrity of a European site.
4. This HRA provides the relevant supporting information to help inform the competent authority when undertaking the assessment. Further details of the Project and the environmental impacts of the Project on habitats and species can be found within the following Chapters and associated Appendices of the EIA*:*
    - Chapter 4: Project Description;
    - Chapter 7: Fish Ecology;
    - Chapter 8 Marine Mammals (and associated technical appendices); and
    - Chapter 9: Ornithology (and associated technical appendices).
5. The information presented determines whether the Project, either alone or in-combination with other plans and projects, will likely have a significant effect on the qualifying species of the European sites identified by the Scottish Ministers.

1.2 Guidance and Legislation

6. Within the EU the international legislative measures requiring the protection of rare and at-risk habitats and species are the Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds) and the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, as amended). These Directives are intended to fulfil the EU's commitment to international conventions and provide a framework for the designation of a network of protected sites for species and features across all EU member states, known as the 'Natura 2000 network'.
7. Species of nature conservation interest not necessarily benefitting from protection within the Natura 2000 network but listed within Annex IV of the Habitats Directive receive a different level of protection; these are known as European Protected Species (EPS).

8. Within Scottish Territorial Waters (STW) the transposing legislation for the Habitats and Birds Directives are the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), the Conservation of Habitats and Species Regulations 2017 (together "the Habitats Regulations"), the Wildlife and Countryside Act 1981 (as amended) and the Nature Conservation (Scotland) Act 2004.

9. The Habitats Regulations allow for the designation of Natura 2000 areas: Special Areas of Conservation (SACs) which act to protect ecologically vulnerable or valuable habitats and Special Protection Areas (SPAs) for sites which are considered important for bird populations.

10. Candidate SACs (cSACs) are afforded the same level of statutory protection as sites that have already been designated and as a matter of policy, for the purpose of considering development proposals, potential SPAs (pSPAs) and possible SACs (pSACs) (i.e. sites which have been approved by Scottish Ministers for formal consultation but which have not yet been designated) and sites designated under the Ramsar Convention are to be considered in the same way as if they had already been designated. Draft sites, i.e. those that have not been subject to any formal consultation (dSPAs), are not subject to the Appropriate Assessment process.

11. The Habitats Regulations implement the Habitats Directive in STW. The Regulations require the competent authority to carry out an Appropriate Assessment (AA) where a plan or project, either alone or in-combination with other plans or projects, is likely to have a significant effect on a Natura 2000 site. The AA is required to assess the implications for the site in view of the site's conservation objectives and whether the project will adversely affect the integrity of the site. If the AA finds that such an adverse effect on the integrity of the site is likely to arise then consent for such a project must, other than in certain circumstances, be refused.

12. The Habitats Regulations require the competent authority to:

    - Determine whether the proposal is directly connected with or necessary to the management of the site;
    - Determine whether the proposal is likely to have a significant effect on the site either individually or in combination with other plans or projects;
    - If so, then make an AA of the implications (of the proposal) for the site in view of that site's conservation objectives.

13. Scottish Ministers have advised that information to inform an AA, an HRA report, is to be submitted along with the EIA Report (Marine Scotland, 2017).

14. The Habitats Regulations state that '*A person applying for any such consent, permission or other authorisation must provide such information as the competent authority may reasonably require for the purposes of the assessment*'. The purpose of this document is to provide the necessary information to allow the competent authority to undertake such an assessment.

15. In undertaking the assessment, the following guidance documents have been used to inform the HRA:

    - Scottish Natural Heritage (SNH) guidance on Habitats Regulation Appraisal (Tyldesley and Associates, 2010); and
    - SNH Habitats regulations appraisal of plans. Guidance for plan-making bodies in Scotland (SNH, 2015).

1.3 Habitats Regulations Process

16. The Habitats Regulations set out the procedure for the assessment of the implications of plans and projects on European sites. If the proposed development is not directly connected with or necessary to the management of a European site and is likely to significantly affect the site, the competent authority must undertake an Appropriate Assessment of the implications for that site in view of that site's conservation objectives. The assessment is undertaken as a four stage process:

- Stage 1 Screening - Test of Likely Significance: Determining whether the plan or project "*either alone or in-combination with other plans and projects*" is likely to have a significant effect on a European site(s);
- Stage 2 Appropriate Assessment: Where likely significant effects are identified during screening, determining whether, in view of the European site's conservation objectives, the plan or project would have an adverse effect on the integrity of the site. If not, the plan can proceed;
- Stage 3 Alternatives and Compensation: Where the plan or project cannot be shown to avoid an adverse effect on the integrity of a site, there should be an examination of compensation measures and alternative solutions; and
- Stage 4 Assessment of "*imperative reasons of overriding public interest*" (IROPI): If it is not possible to identify mitigation and alternatives that would avoid an adverse effect, it would be necessary to establish IROPI. This is not considered a standard part of the process and will only be carried out in exceptional circumstances.

17. This appraisal is undertaken to provide information for Stage 1 and Stage 2 of the HRA process. Relevant information for Stage 3 and Stage 4 of the HRA are outwith the scope of this appraisal.

1.4 Relevant Consultations

18. As part of the EIA process, NnGOWL has undertaken a number of consultations with various statutory and non-statutory stakeholders.

- An initial kick-off meeting was held in Aberdeen on 20th January 2017 between MS-LOT and NnGOWL, regarding the approach to scoping and the EIA process.
- A pre-scoping meeting was held in Battleby on 3rd April 2017 between MS-LOT, MSS, SNH and NnGOWL regarding the approach to scoping and the EIA process, including modelling.
- A scoping meeting was held in Aberdeen on 13th June 2017 to discuss the NnGOWL Scoping Report and to agree the approach for the EIA Report and HRA. Present at the meeting were MS-LOT, MSS, SNH, RSPB and NnGOWL.
- A formal scoping opinion was requested from MS-LOT, supported by the NnGOWL Scoping Report. In response to NnGOWL's request, MS-LOT issued a Scoping Opinion on 8th September 2017, identifying a number of issues that could not be scoped out of the assessment at this stage following review of the Scoping Report.

19. Ongoing consultation with stakeholders continued post-scoping and responses have been used to develop an appropriate methodology and parameters for assessment.

20. From consultation and advice received the following designated sites and qualifying features were identified as requiring an HRA assessment:

- Forth Islands SPA – gannet, kittiwake, herring gull, puffin, guillemot, razorbill.
- Fowlsheugh SPA – kittiwake, herring gull, guillemot, razorbill.
- Buchan Ness to Collieston Coast SPA – (kittiwake, herring gull, guillemot).
- St Abb's Head to Fast Castle SPA – (kittiwake, herring gull, razorbill, guillemot).
- Outer Firth of Forth and St Andrews Bay Complex pSPA – gannet, kittiwake, herring gull, puffin, guillemot, razorbill, little gull, common gull, black-headed gull.
- Moray Firth SAC – bottlenose dolphin.
- Firth of Forth and Eden Estuary SAC – harbour seal.
- Isle of May SAC – grey seal.
- Berwickshire and North Northumberland coast SAC – grey seal.

21. No qualifying species for the Buchan Ness to Collieston Coast SPA and St Abb's Head to Fast Castle SPA were identified in the Scoping Opinion. For the purposes of this is assessment kittiwake, herring gull and guillemot were considered for the Buchan Ness to Collieston Coast SPA and kittiwake, herring gull, razorbill and guillemot were considered for the St Abb's Head to Fast Castle SPA. These species were considered to have the potential for some connectivity with the Project either during the breeding or non-breeding season.

1.5 The Proposed Development

22. Details of the proposed development are presented in Chapter 4: *Project Description*. The following summarises the proposed development.

1.5.1 Project Location

23. The proposed Neart na Gaoithe Offshore Wind Farm (NnG) is located in the outer Firth of Forth, approximately 15.5 km from Fife Ness and 16 km from the Isle of May. The Wind Farm Area is approximately 105 km^2. The offshore export cables run south-southwest from the Wind Farm Area to Thorntonloch just south of Torness Power Station approximately 29 km away from the Wind Farm Area boundary (Figure 1-1). The site lies in water depths of between 40 m and 60 m.

Figure 1-1: Neart na Gaoithe Offshore Wind Farm site and export cable route.

1.5.2 Project Overview

24. Installation of the offshore infrastructure including cable installation and hook up of the turbines are predicted to be undertaken between Q1 2021 and Q3 2022, with first power generation in Q2 2022 (Figure 1-2).

25. Following commissioning of the wind farm in Q2-Q3 2022 the wind farm is planned to be operational for up to 50 years.

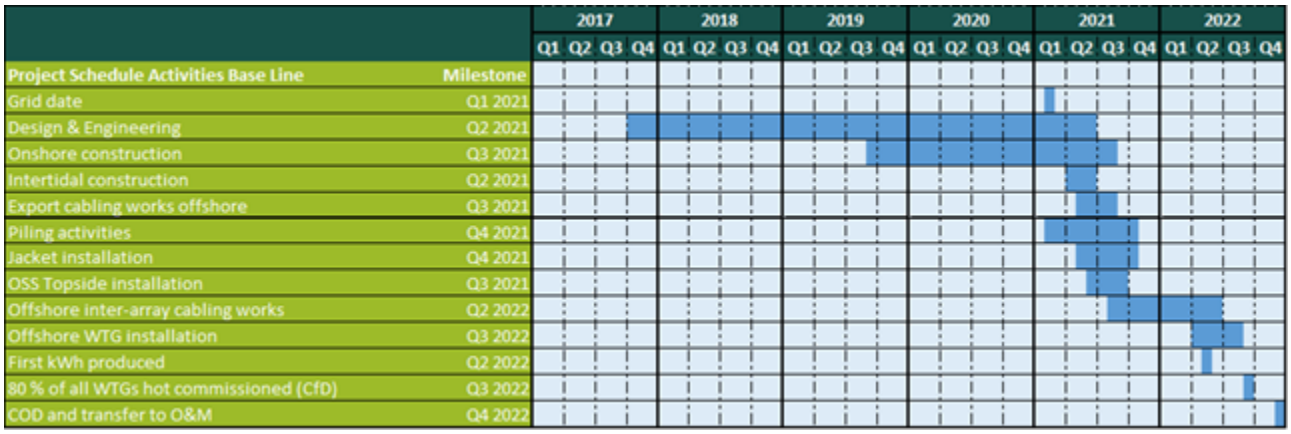

Figure 1-2: Indicative project schedule

26. The wind farm will comprise a maximum of 54 wind turbines, up to two Offshore Substation Platforms (OSPs) and a meteorological mast, along with approximately 140 km of inter-array cabling.

1.5.2.1 Wind Turbines

27. Each turbine will have a maximum hub height of 126 m above the lowest astronomical tide (LAT) and maximum rotor tip height of 208 m LAT. The rotor diameter will be a maximum of 167 m and the minimum air gap between the blade tip and lowest astronomical tide will be 35 m above Lowest Astronomical Tide (LAT). The minimum spacing between any turbines will be 800 m.

28. Once the foundations are installed the wind turbine will be lifted onto the foundations using one or more vessels.

1.5.2.2 Foundations

29. The turbine foundations will be steel lattice structures known as jackets, anchored onto the seabed by a maximum of six piles, each up to 3.5 m in diameter. The maximum overall footprint of each jacket on the seabed, including scour protection will be approximately 1,200 m^2. Between 90% and 100% of the piles can be installed using one or both of 'drive-drill-drive' method or the drill only method. Where drill only is adopted, a sacrificial casing is expected to be driven to an average length of 30% of the pile length, and piles will be 'grouted in place' to provide fixity to the bedrock. It will take between 62 and 180 hours to fully install all six piles using the 'drive-drill-drive' or drill only scenario. Depending on the seabed conditions it is estimated that no more than 10% of the piles may be installed without any drilling, the 'drive-only' scenario and will take between an estimated 6 to 18 hrs to install all six piles. Pile-driving for all piles will use a hammer with a maximum energy of no greater than 1,635 kJ.

30. Prior to each turbine foundation being installed, the seabed may need to be prepared by levelling and by removing any debris, such as boulders, that could interfere. The foundations will be installed using either a jack-up barge or a vessel that uses dynamic positioning to ensure it remains stable for the installation works. In the event a jack-up barge is selected, at each wind turbine location, the jack-up barge will be anchored using up to eight anchors with up to 1,200 m of mooring chain. Each of the four legs of the jack-up will impact on up to 106 m^2 of seabed, i.e. up to 424 m^2 of seabed may be impacted by the legs from the jack-up barge. Depending on the spacing of the piles more than one jack-up movement may be required at each wind turbine location.

31. The design parameters for the wind turbines are summarised in Table 1-1.

1.5.2.3 Meteorological mast

32. A single meteorological mast (met mast) will be installed within the Wind Farm area. It will be installed on a similar steel lattice jacket foundation as the wind turbines.

1.5.2.4 Offshore Substation Platforms (OSPs)

33. Up to two offshore OSPs may be placed within the Wind Farm Area. Between three and eight piles will be required for each jacket, depending on the final design selected. Each pile will be up to 3.5 m in diameter. The total area of the OSP footprint will be up to 1,200 m^2 including scour protection. The installation of the OSP foundations will be similar to the wind turbine foundations. Once the foundations are in place a heavy lift vessel will transport the topsides onto location and lift them onto the foundations.

Table 1-1: Project design parameters

Parameter	Maximum Design Envelope
Wind Farm Area	105 km^2
Number of turbines	54
Number of OSPs	2
Number of Met masts	1
Maximum rotor height tip	208 m
Minimum air gap (LAT)	35 m
Foundation Type	Jacket
Number of piles for wind turbine	6
Number of piles per OSP	8
Pile diameter	3.5 m
Seabed area per turbine, including scour protection	1,200 m^2
Seabed area per OSP, including scour protection	1,200 m^2
Maximum hammer capacity	1,800 kJ
Maximum hammer energy usage	1,635 kJ (90% of maximum hammer energy)
Foundation installation time	6 – 20 hrs ('drive-only') 62 – 180 hrs ('Drive-drill-drive' or 'Drill Only')
Seabed area - jack-up barge legs x4	424 m^2
Jack-up barge anchors	8

1.5.2.5 Inter-array cables

34. Up to 140 km of inter-array cables will be installed within the Wind Farm Area. Where seabed conditions allow, the cables will be trenched and buried up to 3 m deep. Where the seabed conditions do not allow the cables to be buried to a suitable depth the cables will be protected by rock, mattresses or grout bags. Trenching will be undertaken using either ploughing or jetting.

35. In the event that two OSP's are installed, up to four additional interconnector cables between the two OSP's will be installed

36. The design parameters for the inter-array cables are summarised in Table 1-2.

Table 1-2: Inter-array cable design parameters

Parameter	Maximum Design Envelope
Number of inter-array cables	14
Length of cables	140 km
Burial depth	3 m
Width of seabed impact	10 m
Area of physical impact (cable)	1.4 km^2
cable protection	20% of inter-array cable
Length of cable protection	28 km
Area of physical impact (protection)	0.28 km^2

1.5.2.6 Export cables

37. Two export cables, each up to 43 km long, will be installed in separate trenches between the Wind Farm Area and Thorntonloch. Where seabed conditions allow, the cables will be trenched using either ploughing or jetting techniques and the cables buried up to 3 m deep. It is estimated that seabed conditions for an estimated 15% of the cable route are not suitable for burial of the cables at the required depth and will therefore require additional protection by the placement of rock, mattresses or grout bags above the cable route. The installation of the cables will require a single cable laying vessel and the support of up to three additional vessels.

38. The design parameters for the export cable(s) are summarised in Table 1-3.

Table 1-3: export cable design parameters

Parameter	Maximum Design Envelope
Number of export cables	2
Length of each cable	43 km
Burial depth	3 m
Width of seabed impact	10 m
Area of physical impact (2 x cables)	0.86 km^2
cable protection	15% of export cable
Length of cable protection (2 x cables)	12.9 km
Area of physical impact (protection)	0.13 km^2

1.5.2.7 Landfall

39. At landfall the export cables will either be brought ashore through an open cut trench or through a conduit made by horizontal directional drilling (HDD).

40. In the event that open cut trenches are used to bring the cables across the inter-tidal zone, trenches at least 1 m deep will be excavated across the foreshore, within which a duct is laid, through which the cable will be pulled ashore to transition pits located beyond any sea defences.

41. The trench will be cut using an excavator which may be mounted onto a barge when excavating below the tide line. Once completed the trench will be back-filled.

42. HDD will require the use of a drilling rig to drill a duct beneath the beach to allow the export cable(s) to be pulled through to a transition pit. An estimated length of 1 km will be drilled. The drill rig will be located in a construction area of approximately 30 m by 40 m and the pipes stored in an area of approximately 20 m by 20 m.

1.5.2.8 Operations and maintenance

43. Once operational, regular inspections, servicing and maintenance will be required throughout its lifetime. This will require vessel movements to and from the site. The vessel activity will vary depending on the maintenance activity but will include frequent routine inspections where a maintenance crew does a local visual inspection. It is estimated that there will be up to 10 such visits per turbine per year. Less frequent visits will be made for changing out consumables and worn parts as part of a preventative maintenance regime. It is anticipated that two such visits per year per turbine will be required. Lubricants, hydraulic oils and any other hazardous liquids and materials will be disposed of through licensed recycling contractors onshore. Non routine visits will be necessary to replace major components, requiring the use of a jack-up or similar large vessel on site. These major visits are typically infrequent and have a likelihood of occurrence of up to three times per annum across the full Wind Farm. Activities might involve disassembly and replacement of components, such as, for example, blades, gearboxes etc. The use of helicopters to and from the Wind Farm Area will be required and an estimated 80 round trips per annum are predicted. The use of a helicopter is envisaged for troubleshooting, particularly when performing wind turbine resets and addressing minor defects, or to facilitate access by technicians at times when sea states do not permit access by vessels.

1.5.2.9 Decommissioning

44. At the end of the operational lifetime of the Project the wind farm may be re-powered or decommissioned. It is predicted that decommissioning activities will likely be the reverse of those used during construction with the use of heavy lift vessels and cutting equipment.

1.6 Potential Impacts on qualifying features

45. The following section identifies the potential impacts that may arise on qualifying species or habitats from the proposed development based on the activities described in the previous section.

1.6.1 Potential Impacts on Birds

46. Potential impacts on birds that could cause a likely significant effect include:

- Mortality as a result of direct collision with turbines during the operational phase of the development;
- Displacement and disturbance resulting in effective habitat loss from an area around turbines and other offshore (e.g. vessels) activities during the construction, operational and decommissioning phases of the project;
- Barrier effects caused by the physical presence of turbines; and
- Direct habitat loss during construction, operation and decommissioning.

1.6.1.1 Collision Mortality to birds

47. It is widely recognised that there is the potential for flying birds to collide with operating wind turbines. The risk of collision with wind turbines depends on a number of variables, in particular, the size and number of turbines, species-specific flight heights, turbine rotor heights, bird avoidance behaviour and the frequency of bird movements in or near to the turbines. Weather conditions and time of year may also affect the risk of collisions occurring.

48. Collisions only occur during the operational phase of the wind farm.

1.6.1.2 Displacement and disturbance of birds

49. Displacement impacts can occur during all phases of a project. Vessel activities during construction, operation and decommissioning may cause relatively localised and temporally short-term displacement effects. During the operational phase seabirds may avoid operating wind turbines and

therefore effectively be displaced to a lesser or greater extent from suitable habitat (e.g. Diersche and Garthe, 2006). The level of displacement is very species-specific and the extent of displacement varies across species with some species showing no evidence of any displacement and others showing levels of displacement out to 2 km (Furness, 2016). Displacement caused by the presence of the turbines during the operational phase may occur over a wider area and for a longer duration than displacement that may occur during the construction and decommissioning phases.

50. Disturbance and displacement have the potential to cause birds to relocate to sites that might be less optimal and therefore cause increased energetic or behavioural demands to the birds and risk increasing mortality or reducing breeding success.

51. Evidence from existing wind farms and other marine activities suggest that there is potentially a significant effect from displacement to Divers (e.g. red-throated diver (*Gavia stellata*); Norman and Ellis, 2005) and seaduck (e.g. common scoter (*Melanitta nigra*); Kaiser, 2002).

52. Key species recorded within the Wind Farm Area that may be affected by displacement or disturbance are the Auks (guillemot, razorbill and puffin).

1.6.1.3 Barrier effects to birds

53. Birds may avoid flying through wind farms and in doing so detour around a constructed wind farm causing a bird to fly further than it may have otherwise done and expend additional energy. This incremental increase in energy expenditure, if great enough, could cause increase risk of mortality or reduced productivity. This is of particular concern should there be regular, daily, movements around an offshore wind farm (i.e. from a breeding colony to and from foraging or roosting areas).

54. Barrier effects only occur once the turbines have been constructed and are therefore present for the duration of the operational period.

55. Displacement and barrier effects have been considered together in this assessment, as recommended by the SNCBs (SNCB 2017).

1.6.1.4 Direct habitat loss

56. The loss of seabed habitat due to installation and operational presence of the wind turbine foundations, OSP foundations and associated infrastructure (e.g. cables), could cause a negative impact on birds if they require the seabed and associated fauna for prey. This may, for example, be the case for seaduck feeding on bivalves (e.g. common scoter; Kaiser *et al.* 2006).

1.6.1.5 Habitat formation

57. The proposed Project has the potential to create habitat suitable for resting or roosting birds on the turbine and OSPs. It is predicted they will form a suitable site for birds and could increase their numbers within the area. Similarly, species that were either not recorded, or were only infrequently recorded during baseline surveys, e.g. shags (*Phalacrocorax aristotelis*) and cormorants (*Phalacrocorax carbo*) may start occurring more frequently, e.g. Krijgsveld *et al*. 2010.

1.6.1.6 Impacts on bird prey

58. Potential impact on prey species can have an indirect effect on qualifying species. The main impacts on potential prey species arise from either direct physical impacts causing the loss of individuals or suitable habitat and the displacement of prey, usually associated with noise impacts on fish.

59. The scale of the proposed project is such that there will be very little loss of suitable habitat for prey species and therefore this is not considered a concern for the project. Noise impacts on prey can arise during the construction, operational and decommissioning phases of the project. The most significant effects usually arise during the construction phase, particularly if there is pile driving. Vessel noise could have a very localised and temporary effect on possible prey species.

60. Further information and details of potential impacts on birds are provided within the EIA Report Chapter 9: Ornithology.

1.6.2 Potential Impacts on Marine Mammals

61. Potential impacts on marine mammals that could cause a likely significant effect include:

- Mortality or physical injury as a result of noise;
- Displacement or disturbance as a result of noise;
- Physical impact from vessels; and
- Secondary impacts on prey.

1.6.2.1 Mortality or physical injury to marine mammals from noise impacts

62. If the sound source peak pressure levels are high enough there is the potential for a lethal effect from noise on marine mammals. Studies suggest that potentially lethal effects can occur when the peak pressure level is greater than 240 dB re. 1 µPa (Parvin *et al*. 2007). Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 µPa.

63. Underwater sound has the potential to cause hearing damage in marine mammals, either permanently or temporarily. The potential for either of these conditions to occur is dependent on the hearing bandwidth of the animal, the duty cycle of the sound source and duration of the exposure (Southall *et al*. 2007, OSPAR 2009).

64. Physical injury is described as either a permanent loss of hearing range (permanent threshold shift (PTS)) or temporary loss of hearing range (temporary threshold shift (TTS)).

65. Sound exposure levels considered capable of causing the onset of either PTS or TTS do not mean that such physical impacts will always occur. The probability of developing PTS or TTS will follow a dose response curve, with increasing risk of physical injury as exposure increases. Studies undertaken on bottlenose dolphin indicate that only between 18% and 19% of bottlenose dolphins exposed to sound exposure levels of 195 dB re 1 µPa2.s-1, actually resulted in the onset of TTS (Finneran *et al*. 2005).

66. A temporary threshold shift may not significantly affect the hearing ability of the impacted individual. Studies on harbour porpoise exposed to piling sounds indicate that the main impacts on hearing thresholds occurred at frequencies of between 4 kHz and 8 kHz, which are below the sound frequencies used by harbour porpoise for echolocation (Kastelein *et al.* 2012). Consequently, a change in hearing threshold may not affect the ability of a harbour porpoise to communicate or locate prey.

67. Although PTS is a permanent physical injury impairing the marine mammal's ability to hear, TTS is not and impacts are relatively short-lived. Studies undertaken on harbour porpoise indicate that, depending on the exposure level and duration, hearing ability returns between 4 and 96 minutes after the sound causing the impact has ceased (Kastelein *et al.* 2012).

1.6.2.2 Displacement or disturbance of marine mammals from noise impacts

68. Changes in behaviour arising from noise impacts may be easily detectable, e.g. a significant displacement from an area. Other effects caused by changes in behaviour, e.g. energetic stress, may be more difficult to detect and go unnoticed (OSPAR, 2009).

69. Potential changes in behaviour may occur depending on the sound source levels and the species' and individuals' sensitivities. Behavioural changes can include changes in swimming direction, diving duration, reduced communication and avoidance of an area (e.g. Sivle *et al*. 2015).

70. The displacement of marine mammals could cause them to relocate to sub-optimal locations where there is lower prey availability or increased inter and intra-specific competition. If permanent or over a long period, this could cause lower fecundity or increased mortality (Harwood and King, 2014).

71. Masking effects may also cause changes in the behaviour of marine mammals as the level of sound may impair their directional hearing, their ability to adjust vocalisation amplitude and frequency and consequently their ability to detect echolocation clicks and other sounds that species use to communicate or detect prey, thus causing them to alter their behaviour (David 2006).

1.6.2.3 Physical impact on marine mammals from vessels

72. Marine mammals are at risk of physical injury and mortality due to impacts with vessels. Post-mortems undertaken on stranded cetaceans in UK waters have indicated that of those for which the cause of death could be established, up to 4% of harbour porpoises and 15% of minke whales were killed by vessel strikes (Deaville and Jepson 2011; Evans *et al*. 2011).

1.6.2.4 Impacts on marine mammal prey

73. There is potential for impacts on prey species to affect harbour porpoise, in particular possible impacts of noise on fish species. The potential effects on fish in the form of physical injury and displacement are predicted to be similar to those for marine mammals, although their sensitivity to sound will differ.

74. Further information and details of potential impacts on marine mammals are provided within the EIA Report Chapter 8: Marine mammals.

1.6.3 Potential Impacts on Fish

75. Potential impacts on fish that could cause a likely significant effect include:

- Mortality or physical injury as a result of noise;
- Displacement or disturbance as a result of noise;
- Behavioural impacts from Electromagnetic fields (EMF) emitted by inter-array and export cables.

1.6.3.1 Mortality or physical injury to fish from noise impacts

76. Underwater sound has the potential to cause hearing damage to fish, either permanently or temporarily. The potential for either of these conditions to occur is dependent on the hearing ability of the fish. Fish hearing is based on detecting particle motion directly stimulating the inner ear. However, those with swim bladders are also able to detect pressure waves and can detect a wider range of frequencies and sounds of lower intensity than fish without swim bladders (Popper, 2003). Fish with swim bladders, e.g. herring (*clupea harengus*), are recognised to be hearing specialists and those without, e.g. sandeels (*Ammodytes* Spp.) have limited hearing capability.

77. Sound levels at a SEL of 207 dB re 1 µPa are thought to cause the onset of physical injury in hearing specialists and 219 dB re 1 µPa in non-hearing specialists (Popper *et al*. 2014).

78. The onset of TTS is predicted to occur in all species at a SEL of 186 dB re 1 µPa.

1.6.3.2 Displacement or disturbance of fish from noise impacts

79. As with marine mammals, fish may be disturbed or displaced by noise impacts causing them to relocate to other less impacted areas.

1.6.3.3 Behavioural impacts from Electromagnetic Fields

80. Some species of fish are able to detect electromagnetic fields (EMF) through either specialist receptor cells or through magnetically sensitive material located within their skeletal structure. Atlantic salmon (*Salmo salar*) may use EMF for navigational purposes and the effect of EMF emitted by cables could result in avoidance behaviour (Gill *et al*. 2012)

81. Further information and details of potential impacts on fish are provided within the EIA Report Chapter 7: Fish and Shellfish.

1.6.4 In-combination Impacts

82. Under the Habitats Regulations, it is necessary to consider the in-combination effects of development proposals on European Sites. These refer to effects, which may or may not interact with each other, but which could affect the same receptor or interest feature (i.e. a habitat or species for which a European Site is designated).

83. The in-combination assessment includes developments that are:

- Under construction,
- Permitted application(s), but not yet implemented,
- Submitted application(s) not yet determined,
- Projects identified in the relevant Development Plan (and emerging Development Plans),
- Sites identified in other policy documents, as development reasonably likely to come forward.

84. For the purposes of this assessment, on-going impacts from current activities have not been included within the in-combination assessment where the influence of the projects upon a receptor, that may also be predicted to be significantly affected by the development, is considered to be captured within the baseline. For some on-going activities, e.g. fishing and shipping it is technically not possible to determine what the baseline conditions would be without the influence the impacts from these activities have on the current seabird and marine mammal populations. For example, many seabird species obtain a significant proportion of their food from fish discards from the fishing industry, e.g. kittiwake, gannet and fulmar (Bicknell *et al*. 2013). The impact that this activity has on the seabird populations is not measurable but is likely to have allowed for greater adult survival and fecundity and the impacts from the fishing industry may have inflated the natural populations for some species (Bicknell *et al*. 2013). In addition to this, although the relationship between predators and prey are complex, the increase in sandeel stocks (from which seabird populations have benefited during most of the 20th century) may be due to the impacts the fishing industry has had on other fish species that would otherwise predate sandeels (Englehard *et al.* 2014). Consequently, the 'natural baseline' populations for seabirds and marine mammals are unknown and it is not possible to assess the impacts historic and current activities have had, nor is it possible to assess what future impacts any changes in policy will have on these populations.

85. Following advice from Marine Scotland (Marine Scotland 2017), the following projects have been considered as having potential for an in-combination effect with the proposed Project with respect to birds:

- Inch Cape Offshore Wind Farm (consented development),
- Seagreen A Offshore Wind Farm (consented development),
- Seagreen B Offshore Wind Farm (consented development),
- Inch Cape Offshore Wind Farm (revised application),
- Seagreen Phase 1 (revised application),
- Kincardine Offshore Wind Farm (consented development),
- Forthwind Demonstration Project (2 turbines) consented development),
- Forthwind Offshore Wind Demonstrator ((Up to 7 turbines) Pre-application),
- Hywind (consented development),
- All constructed offshore wind farms in the North Sea and English Channel for gannet (in North Sea only for kittiwake).

86. It should be noted that based on the outputs from the collision rate modelling, the worst-case scenario with respect to collision impacts with projects in the Firths of Forth and Tay occurs with the existing

consented developments (Inch Cape, Seagreen A and Seagreen B). Consequently, the in-combination assessment is based on the potential impacts from these developments.

87. Following advice from Marine Scotland (Marine Scotland 2017), the following projects have been considered as having potential for an in-combination effect with the proposed Project with respect to marine mammals:

- Inch Cape (consented development),
- Seagreen Alpha (consented development),
- Seagreen Bravo (consented development),
- Inch Cape (revised application),
- Seagreen Phase 1 (revised application)
- Moray East (consented / revised development),
- Moray West Pre-application),
- Beatrice (consented development),
- Aberdeen Harbour Expansion (consented development).

88. It should be noted that based on the outputs from the noise modelling, the worst-case scenario with respect to impacts from noise on marine mammals with projects in the Firths of Forth and Tay occurs with the proposed revised projects (Inch Cape, Seagreen Phase 1). Consequently, the in-combination assessment is based on the potential impacts from these developments. There is the potential that Seagreen Phase 1 may comprise two developments and both these have been considered in the assessment.

1.7 Likely Significant Effect Screening

89. A likely significant effect (LSE) is any effect that may be reasonably predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the European site was designated, but excluding trivial or inconsequential effects.

90. In order to determine the designated sites and associated qualifying features on which a project alone and in-combination with other plans or projects could have a likely significant effect, a LSE screening assessment is undertaken. A LSE screening assessment identifies all the sites and qualifying features that could be affected by a project and considers whether it can be objectively concluded that these effects will not be significant (EC 2001).

91. The Scoping Opinion provided by Marine Scotland includes advice on the designated sites and associated qualifying features on which the proposed Project may have a likely significant effect and should therefore be considered further under the requirements of the Habitats Regulations (Marine Scotland 2017). Scottish Natural Heritage (SNH) and the Royal Society for the Protection of Birds (RSPB) largely agree with the advice pertaining to both the designated sites and the qualifying features. The RSPB have advised that great-black-backed gull and lesser black-backed gull should also be considered as part of the HRA. However, the advice from Scottish Ministers is that they are not required to be included in the assessment (Marine Scotland 2017).

92. Based on the advice received, the SPA sites and the relevant qualifying features considered further are presented in Table 1-4 and those for SAC are presented in Table 1-5. All qualifying sites and features identified as requiring information to inform an AA and therefore requiring additional assessment have previously been assessed in the Original application and the Appropriate Assessment undertaken for the Original Project (NnGOWL 2012, 2013, Marine Scotland, 2014).

Table 1-4: SPA/pSPAs and qualifying features identified as being at risk of a likely significant effect from the proposed Neart na Gaoithe Offshore Wind Farm (Source Marine Scotland 2017).

Designated site SPA/pSPA	Qualifying features to be assessed in Project HRA [1]	Assessed in Original HRA [2]	Assessed in Addendum of Supplementary information [3]	Assessed in Appropriate Assessment for Originally Consented Project [4]
Forth Islands	Gannet, Kittiwake, Herring gull, Puffin, Guillemot, Razorbill.	Yes, plus fulmar and lesser black-backed gull.		Yes
Fowlsheugh	Kittiwake, Herring gull, Guillemot, Razorbill.	Yes, plus fulmar, kittiwake and guillemot.		Yes
Buchan Ness to Collieston Coast	Herring gull, Kittiwake, Guillemot	Yes, plus shag and fulmar	Yes, plus fulmar	Yes
St Abb's Head to Fast Castle	Herring gull, Kittiwake, Guillemot, Razorbill	Yes, plus shag	Yes	Yes
Outer Firth of Forth and St Andrews Bay Complex	Gannet, Kittiwake, Herring gull, Puffin, Guillemot, Razorbill, Little gull, Common gull, Black-headed gull.	No. Site was not designated as pSPA at the time previous assessments were undertaken.		
1: Marine Scotland 2017, 2: Mainstream 2012, 3: Mainstream 2013, 4: Marine Scotland 2014				

Table 1-5: SACs and qualifying features identified as being at risk of a likely significant effect from the proposed Project (Source Marine Scotland 2017)

Designated site SAC	Qualifying features to be assessed in Project HRA [1]	Assessed in Original HRA [2]	Assessed in Addendum of Supplementary information [3]	Assessed in Appropriate Assessment [4]
Moray Firth	Bottlenose dolphin	Yes	Yes	Yes
Firth of Tay and Eden Estuary	Harbour seal	Yes	Yes	Yes
Berwickshire and North Northumberland Coast	Grey seal	Yes	Yes	Yes
Isle of May	Grey seal	Yes	Yes	Yes
1: Marine Scotland 2017, 2: Mainstream 2012, 3: Mainstream 2013, 4: Marine Scotland 2014				

93. Within the Scoping Opinion SNH have advised that on the basis of previous assessments and the conditions to be attached to any possible consent that diadromous fish (e.g. salmon (*Salmo salar*)) and other qualifying interests of designated rivers can be scoped out of any additional assessment. Marine Scotland Science (MSS) have advised that due to new information having become available since the Original project was consented a new assessment on salmon is required and if shown to change the outcomes from the previous assessment further assessment should be undertaken (Marine Scotland 2017). The impacts on fish, including salmon, are assessed in Chapter 7: Fish and Shellfish Ecology and Appendix 7.2: Appraisal of Original EIA. The assessment has shown that the outcomes from the previous assessment have not been changed and that no further assessment is required.

1.8 Conservation Objectives

94. Conservation objectives outline the desired state for any European site, in terms of the features for which it has been designated. If these features are being managed in a way, which maintains their nature conservation value, they are assessed as being in a 'favourable condition'. An adverse effect on the integrity of a site is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of its designation.

95. The purpose of an HRA is to determine whether a plan or project adversely affects a site's integrity. The critical consideration in relation to site integrity is whether the plan or project affecting a site, either individually or in combination, affects the site's ability to achieve its conservation objectives and favourable conservation status.

96. Each qualifying site has its own conservation objective. However, for the majority of designated sites in Scotland the conservation objectives for SACs (for marine mammals) and SPAs (for birds) are generic.

97. For the SPA sites considered in this HRA the conservation objectives are common to all breeding seabird SPAs. These are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

98. For the SAC sites considered in the HRA the conservation objectives are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

99. The conservation objectives for the Outer Firth of Forth and St Andrews Bay Complex pSPA are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species; and
- To ensure for the qualifying species that, subject to natural change, the following attributes are maintained in the long term:
  - The species as a viable component of the site;
  - No significant disturbance of the species or significant reduction in ability of the species to utilise important parts of the site;

- Distribution and extent of habitats and the structure, function and supporting processes of the habitats supporting the qualifying species and their prey are maintained.

100. The potential impacts on the qualifying species are outwith the boundaries of the SPAs, (with the exception of Outer Firth of Forth and St Andrews Bay Complex pSPA) and therefore there will be no effect on the distribution of species within the SPAs. The distribution and extent of habitats will not be significantly affected by wind farms and the assessment on the potential impacts on the prey of seabirds has shown no significant effect on the distribution of the prey. There will be no significant disturbance to seabirds outwith the SPA. Consequently, the conservation objective relating to maintaining the population of the species as a viable component of the site either captures the other conservation objectives or they are not relevant for this assessment. Similarly, the impacts on marine mammals are focussed on ensuring the species remain a viable component of the site. This was advice received in the Scoping Opinion (Marine Scotland 2017).

1.8.1 Site Integrity

101. In order to meet the conservation objectives of a site, the integrity of the site must be maintained. The integrity of the site is the coherence of its ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified. The integrity of the site can therefore be considered to be the structure and the functioning of its ecological systems, the features for which the site is designated (habitats and/or species) and the ability of the site to meet its conservation objectives. An adverse effect is defined as something that impacts the site features, either directly or indirectly, and results in disruption or harm to the ecological structure and functioning of the site and/or affects the ability of the site to meet its conservation objectives across all parts of the site.

2 Special Protection Areas (SPA/pSPA)

2.1 Baseline Information - Birds

102. The following section provides a summary of the relevant baseline information on birds relevant to this assessment. Further information can be found in the EIA Report Chapter 9: Ornithology and the associated Appendices.

2.1.1 Gannet

103. Gannets breed in a few, typically very large, colonies around the UK. The current UK breeding population is 293,200 pairs (JNCC, 2016) and the largest UK colony is at the Bass Rock, in the outer Firth of Forth, with an estimated breeding population of 75,259 nests in 2014 (Murray, Harris and Wanless 2015).

104. The breeding season for gannet has been defined as mid-March to September (SNH 2017a). During the breeding season birds from the Bass Rock colony range widely across the North Sea, at times travelling as far as the Norwegian coast (Hamer *et al.* 2007). Regular feeding movements occur to the north-east of the colony with concentrations of feeding locations off North-east Scotland (Hamer *et al.* 2011). Outwith the breeding season, gannets disperse widely across the North Sea and move southward with birds wintering in the Bay of Biscay and off West Africa.

105. Gannets feed by plunge diving for fish, typically from around 25 to 40 m above the surface (Robinson 2017).

106. Gannet was the most frequently recorded seabird during the three years of monthly baseline surveys in the study area. Highest numbers occurred during the breeding season (mid-March to September). The peak mean number of gannets recorded during the breeding season and non-breeding (October to mid-March) season are presented in Table 2-1.

Table 2-1: Three-year mean peak estimated numbers of gannets in the offshore site (plus 1 and 2 km buffer)

Data	Survey area	Breeding mid-March – September	Non-breeding October – mid-March
3 year peak mean	Wind Farm Area	1,152	302
	Wind Farm Area + 1 km	1,560	425
	Wind Farm Area + 2 km	1,987	635

107. Tagging studies undertaken at the Bass Rock gannet colony within the Forth Islands SPA indicate that when feeding chicks, gannets from the SPA may forage widely across the North Sea, covering an area greater than 200,000 km^2 and extending as far as Bergen/Viking Bank (SW Norway) in the north and the Frisian Islands (NW Netherlands) in the south (Hamer *et al.* 2011). During the winter gannets occur widely across their winter range. In recent years, increasing numbers of adult gannet winter further south than historically, with an increasing availability of discards from fishing vessels further south and a decreasing availability of discards in the North Sea (Garthe *et al*. 2012). Maps of breeding adult gannets tracked from the Bass Rock in the breeding season in 2010, 2011, 2012 and 2015 are presented in the EIA Chapter 9: Appendix 9.7.

108. Evidence from existing offshore wind farms (e.g. Egmond aan Zee), indicates that gannets avoid flying through wind farms with birds changing flight direction 500 m or more away from the turbines. Those that do not change flight direction have been reported to reduce flight height to be below rotor height

and therefore are at very low risk of collision (Leopold *et al.* 2011). This avoidance behaviour reduces the risk of potential collision and it is predicted that avoidance behaviour for gannet is significantly greater than 98% and an avoidance behaviour of 99% has been used for the basis of the assessment here, although impacts based on a 98% avoidance behaviour are presented for comparison. The significant far field avoidance rates reported indicate low risk of collision but a potentially larger risk of displacement from the constructed wind farm (Cook *et al.* 2012; 2014; Walls *et al.* 2013a).

109. One SPA for breeding gannets (Forth Islands SPA) was highlighted in the Scoping Opinion as being of possible risk of collision impact arising from the Project (Marine Scotland, 2017). This SPA held 21,600 pairs of gannets on the Bass Rock at the time of designation, and at the last census (2014), the breeding population was estimated to be 75,259 pairs, the largest colony in the UK (Table 2-7).

110. The distance between the Wind Farm Area and the Bass Rock colony is approximately 27 km, which is within the mean maximum foraging range of 229.4 ± 124.3 km (Thaxter *et al.* 2012). The next closest SPA for breeding gannet is Flamborough Head and Bempton Cliffs SPA, which is approximately 259 km from the Wind Farm Area (Figure 2-1).

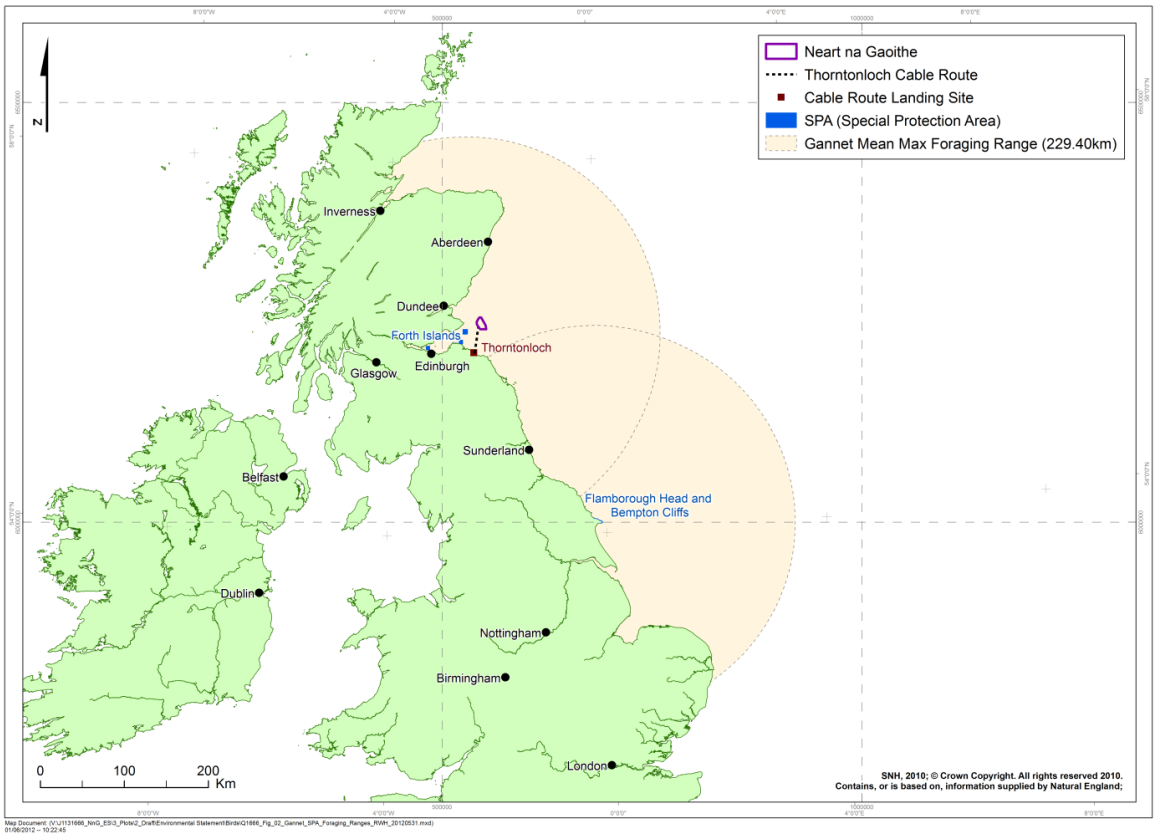

Figure 2-1: SPAs for breeding Gannets within mean maximum foraging range of the Project

111. In addition to the SPA breeding colonies, the Scottish Government is currently considering the designation of a new suite of marine SPAs. This includes the Outer Firth of Forth & St Andrews Bay Complex pSPA. Gannet is listed as a qualifying interest for this pSPA in the breeding season (SNH 2016).

2.1.2 Kittiwake

112. Kittiwakes are one of the commonest seabird species in the UK, breeding in large colonies on suitable coastal cliff habitat. Largest numbers occur on the east coast, and 366,835 breeding pairs were recorded in Britain during Seabird 2000 (Mitchell *et al.* 2004). However, the population has undergone a significant decline since many of the sites have been designated.

113. The closest large colonies to the NnG are the Isle of May, St Abb's Head and Fowlsheugh. Kittiwakes mostly prey on small fish species such as lesser sandeels and clupeids, as well as fishery discards (Forrester *et al.* 2007).

114. The offshore distribution of kittiwakes breeding within the Forth Islands SPA has been studied via the use of tracking devices for a period of four years between 1999 and 2003 and again in 2010. The results indicate that kittiwakes forage in St Andrew's Bay and in offshore waters with maximum foraging range recorded of c. 120 km (Daunt *et al.* 2011b). Although there is seasonal and inter-annual variation with maximum foraging ranges during most years being less than 100 km (Daunt *et al.* 2010; 2011a). Data from studies undertaken in 2010 reported a foraging area of 3,993 km^2 (Daunt *et al.* 2011b).

115. The overlap in foraging range with NnG varies across years. In 2010 there was a very small overlap in both the core foraging area (based on 50% kernel distribution) and the wider area (based on 90% kernel distribution). This contrasts with data collected in 2002 where a third of the core area activity overlapped with NnG.

116. Tagging studies undertaken in 2011 on kittiwakes at St Abb's Head and Fast Castle SPA and Fowlsheugh SPA, two colonies adjacent to the Forth Islands SPA recorded no kittiwakes from either of these colonies at Neart na Gaoithe. This suggests that there is relatively little overlap between the foraging ranges of birds from these colonies and NnG. Maps showing tracked adult kittiwakes from the 2010 and 2011 breeding season are shown in the EIA Report in the EIA Chapter 9: Appendix 9.6.

117. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (17 tagged birds), 2013 (22 tagged birds) and 2014 (11 tagged birds). In the 2012 breeding season, the majority of recorded activity was south-west of the Wind Farm Area, to the north and east of the Isle of May, although some birds travelled through and well beyond the Wind Farm Area (Chapter 9: Appendix 9.6). Kittiwakes were less widespread in the 2013 breeding season, based on the recorded track data, but again, most tagged birds travelled north and east of the Isle of May colony (Chapter 9: Appendix 9.6). Activity within the Wind Farm Area was not higher than elsewhere within the tracking activity. In the 2014 breeding season, fewer tagged birds were recorded in the Wind Farm Area, although the sample size of tagged birds was slightly lower than previous years (11 tagged birds) (Chapter 9: Appendix 9.6).

118. Evidence from existing offshore wind farms (e.g. Egmond aan Zee, Horns Rev, Arklow Bank, Robin Rigg), indicates that kittiwakes are not displaced from offshore wind farms and do not avoid flying through wind farms, with some sites showing no significant attraction or displacement and others indicating a potential for attraction (Leopold *et al.* 2011; Diersche and Garthe, 2006; Barton *et al.* 2009; Nelson *et al.* 2015).

119. A study conducted at the operational Westermost Rough Wind Farm in July 2017 found that mean densities calculated for the entire wind farm and its surrounding 8 km buffer zone indicated that there was no clear evidence of displacement for kittiwakes. There were variations in kittiwake densities between buffers but this was not statistically significant, potentially due in part to the large between-survey variability in kittiwake densities (APEM 2017). Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding kittiwakes from this colony. A copy of this report is provided in Appendix 9.5 of the EIA Report.

120. Kittiwakes were frequently recorded during the three years of monthly baseline surveys undertaken in the study area. Highest numbers occurred during the breeding season (mid-April to August). The peak mean number of kittiwakes recorded during the breeding and non-breeding (September to mid-April) seasons are presented in Table 2-2.

Table 2-2: Three-year mean peak estimated numbers of kittiwakes in the offshore site (plus 1 and 2 km buffer)

Data	Survey area	Breeding mid-April – August	Non-breeding September – mid April
3 year peak mean	Wind Farm Area	1,772	1,065
	Wind Farm Area + 1 km	1,984	1,195
	Wind Farm Area + 2 km	2,164	2,016

121. Three SPAs for kittiwakes (Forth Islands SPA, St Abb's Head to Fast Castle SPA and Fowlsheugh SPA) were highlighted in the Scoping Opinion as being of possible risk of impact arising from the Project during the breeding season (Marine Scotland, 2017)(Figure 2-2). The Buchan Ness to Collieston Coast SPA is beyond the mean maximum foraging range (+1 SD) for breeding kittiwakes. However, it is recognised that birds from this SPA may occur in the Wind Farm Area during the non-breeding season.

122. In addition to the SPA breeding colonies, the Scottish Government is currently considering the designation of a new suite of marine SPAs. This includes the Outer Firth of Forth & St Andrews Bay Complex pSPA. Kittiwake is listed as a qualifying interest for this pSPA in the breeding and non-breeding seasons (SNH 2016).

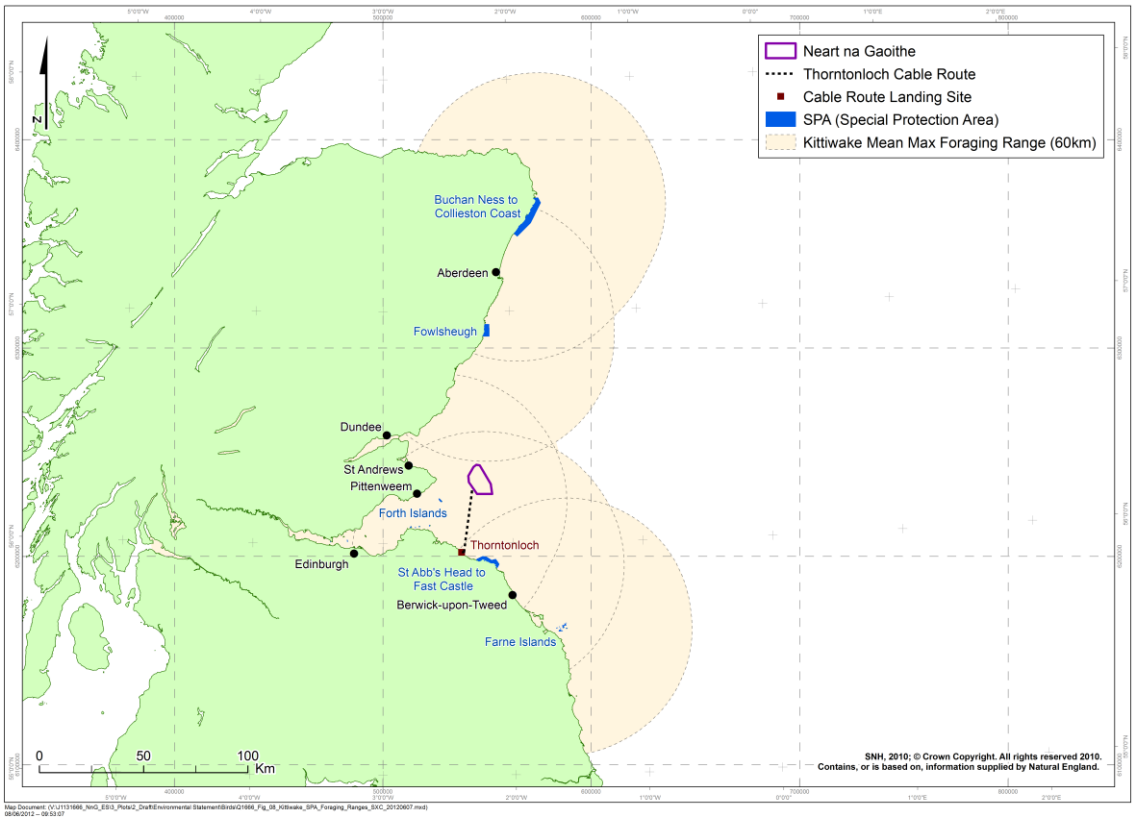

Figure 2-2: SPAs for breeding Kittiwakes within mean maximum foraging range of the Project

2.1.3 Herring gull

123. Herring gulls are resident, common and widespread, breeding in colonies in coastal and inland locations. The closest large breeding colonies to NnG are on the islands in the Firth of Forth and the Isle of May. Herring gulls exploit a wide range of food sources, including scraps and offal from trawlers, as well as on land at refuse dumps and farm land (Forrester *et al.* 2007).

124. Results from site specific monitoring indicate that herring gulls occur in the Wind Farm Area throughout the year. Peak numbers occurred within the offshore site and a 2 km buffer during the

winter and early spring periods with an estimated 784 during January in Year 1 surveys, 116 in January in Year 2 and 252 in March during Year 3.

125. During the breeding season from April to August numbers were generally lower than the rest of the year. In Year 1 the peak count was of an estimated 28 herring gulls in June, in Year 2 of 146 birds in April and 82 in June during Year 3. The three year mean peak during the breeding season within the Wind Farm Area was 40 herring gulls, this increased to 85 birds when including a 2 km buffer area (Table 2-3).

Table 2-3: Three-year mean peak estimated numbers of herring gulls in the offshore site (plus 1 and 2 km buffer)

Data	Survey area	Breeding April – August	Non-breeding September - March
3 year peak mean	Wind Farm Area	40	31
	Wind Farm Area + 1 km	40	279
	Wind Farm Area + 2 km	85	384

126. Evidence from existing offshore wind farms indicate that herring gulls are not displaced by offshore wind farms (e.g. Leopold *et al.* 2011) although they are at potential risk of collision mortality (e.g. Everaert and Kuijken, 2007; Diersche and Garthe, 2006).

127. Three SPAs for breeding herring gulls (Forth Islands SPA, St Abb's Head to Fast Castle SPA and Fowlsheugh SPA) were highlighted in the Scoping Opinion as being of possible risk of impact arising from the Project during the breeding season (Marine Scotland, 2017) (Figure 2-3). Buchan Ness to Collieston Coast SPA is beyond the mean maximum foraging range during the breeding season but it is recognised that birds from this SPA could occur in the Wind Farm Area during the non-breeding season.

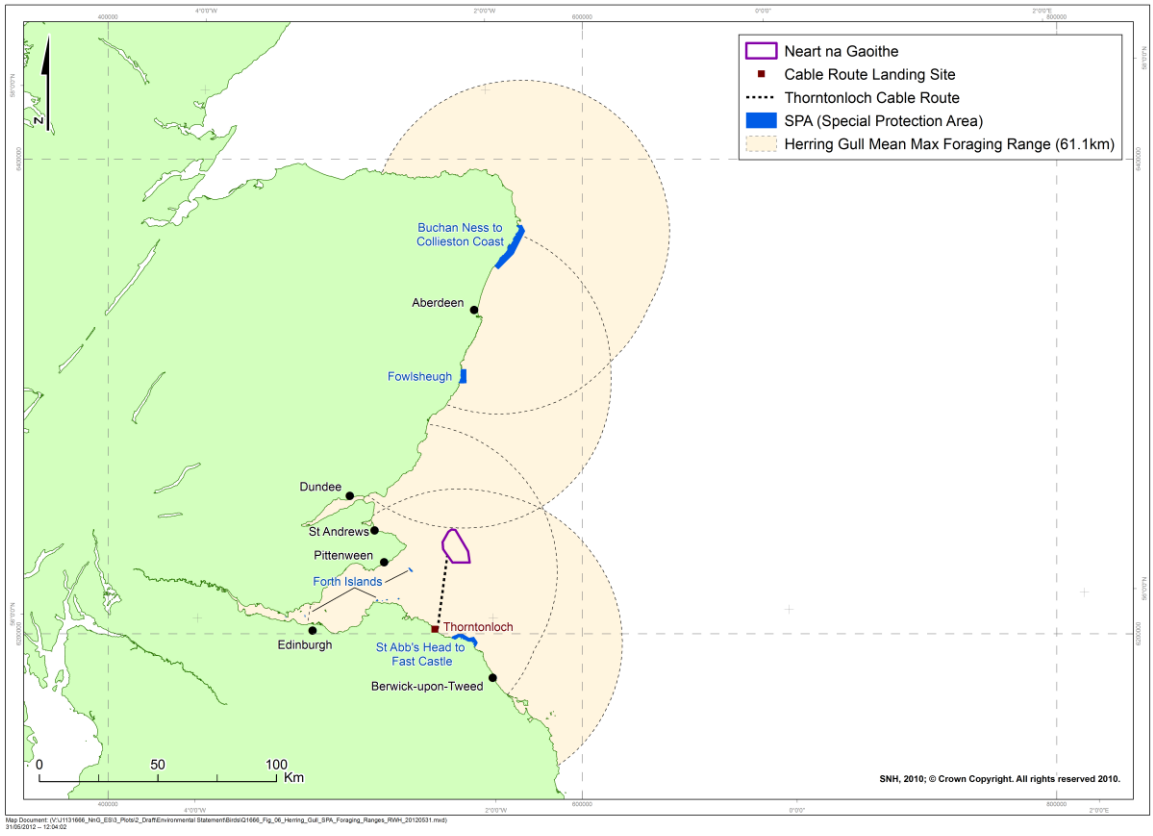

Figure 2-3: SPAs for breeding Herring gull within mean maximum foraging range of the Project

2.1.4 Guillemot

128. Guillemots are one of the commonest seabird species in Britain, breeding in large colonies on suitable coastal cliff habitat. There are several large colonies on the east coast, and Seabird 2000 recorded 1,322,830 individuals at breeding colonies in Britain (Mitchell *et al.* 2004). The closest large colonies to the Wind Farm Area are the Isle of May, St Abb's Head and Fowlsheugh. Guillemots mostly prey on small fish species such as lesser sandeels, sprat and gadoid fish (Mitchell *et al.* 2004).

129. The three year mean peak during the breeding season within the Wind Farm Area was 2,202 guillemots, this increased to 4,894 birds when including a 2 km buffer area (Table 2-4). During the non-breeding season (mid-August to March) the three year peak mean within the Wind Farm Area was 3,890 birds and 7,618 birds when including a 2 km buffer.

Table 2-4: Three-year mean peak estimated numbers of guillemots in the Wind Farm Area (plus 1 and 2 km buffer)

Data	Survey area	Breeding April – mid-August	Non-breeding mid-August - March
3 year peak mean	Wind Farm Area	2,202	3,890
	Wind Farm Area + 1 km	2,696	5,592
	Wind Farm Area + 2 km	4,894	7,618

130. Tracking studies on guillemots breeding on the Isle of May, Fowlsheugh and St Abb's Head undertaken by CEH in 2010 at the request of FTOWDG indicate that guillemots from the Isle of May use both coastal and offshore areas, with a mean maximum range of 18 km and a maximum of 61 km (Daunt *et al.* 2011b). Based on tracked birds, guillemots breeding at Fowlsheugh had a mean maximum range of 12 km, while guillemots at St Abb's Head had a mean maximum range of 16 km. The maximum range for the latter two colonies for guillemot was 55 km (Daunt *et al.* 2011b). Maps showing tracked adult guillemots from the 2010 breeding season are shown in the EIA Chapter 9: Appendix 9.6.

131. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (20 tagged birds), 2013 (20 tagged birds) and 2014 (11 tagged birds). In the 2012 breeding season, the majority of recorded activity was again west of the Wind Farm Area, to the north and south of the Isle of May (Chapter 9: Appendix 9.6). Guillemots were more widespread in the 2013 breeding season, based on the recorded track data (Chapter 9: Appendix 9.6). Activity within the Wind Farm Area was not higher than elsewhere within the tracking activity. In the 2014 breeding season, no tagged birds were recorded in the Wind Farm Area, although the sample size of tagged birds was slightly lower (12 tagged birds) (EIA Chapter 9: Appendix 9.6).

132. Four SPAs for breeding guillemots (Forth Islands SPA, St Abb's Head to Fast Castle SPA, Fowlsheugh SPA and Buchan Ness to Collieston Coast SPA) were highlighted in the Scoping Opinion as being of possible risk of displacement impact arising from the Project (Marine Scotland, 2017) (Figure 2-4).

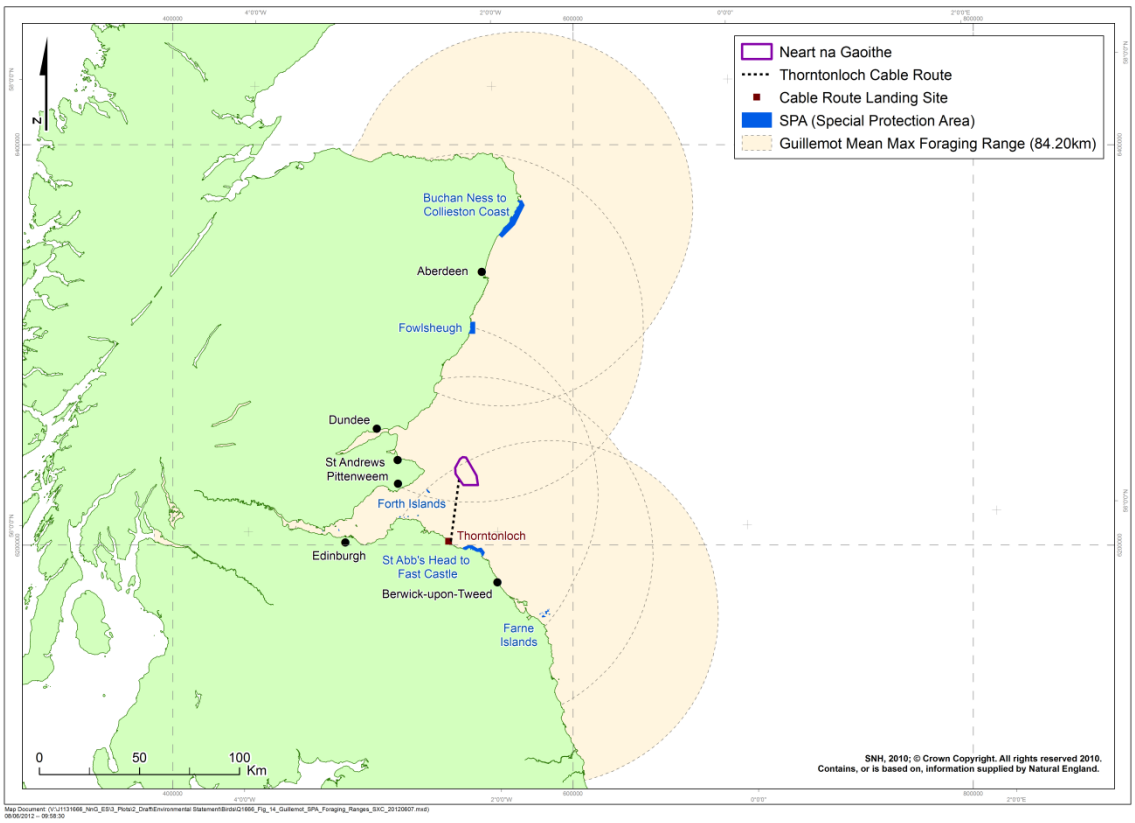

Figure 2-4: SPAs for breeding guillemots within mean maximum foraging range of the Project

133. In addition to the SPA breeding colonies, the Scottish Government is currently considering the designation of a new suite of marine SPAs. This includes the Outer Firth of Forth and St Andrews Bay Complex pSPA. Guillemot is listed as a qualifying interest for this pSPA in the breeding and non-breeding seasons (SNH 2016).

2.1.5 Razorbill

134. Razorbills breeding in large colonies of other seabirds on suitable coastal cliff habitat. There are several large colonies on the east coast, and Seabird 2000 recorded 164,557 individuals breeding in Britain (Mitchell *et al.* 2004). The closest large colonies to the Wind Farm Area and 8 km buffer area are at the Isle of May, St Abb's Head and Fowlsheugh.

135. Razorbills prey on sandeels and other small fish species (Snow & Perrins 1998). A study in the Netherlands concluded that razorbills are probably more dependent on a specialised diet of small schooling fish such as herring, sprat or sandeels than guillemots, which have a much broader diet (Ouwehand *et al.* 2004).

136. The three year mean peak during the breeding season within the Wind Farm Area was 613 razorbills, this increased to 1,248 birds when including a 2 km buffer area (Table 2-5). During the non-breeding season (mid-August to March) the three year peak mean within the Wind Farm Area was 1,404 birds and 3,101 birds when including a 2 km buffer.

137. Tracking studies on 18 razorbills breeding on the Isle of May in 2010 indicate that razorbills from the Isle of May use both coastal and offshore areas, with a mean maximum range of 14 km and a maximum of 69 km, although they avoided the deeper water between the Isle of May and the Wee Bankie. In addition, the ranges recorded during this study for razorbill were intermediate when compared with historical data. The study also indicated that razorbills did not use the Wind Farm Area for non-flight activities such as foraging or resting (Daunt *et al.* 2011a). Maps showing tracked adult razorbills from the 2010 breeding season are shown in the EIA Report in EIA Chapter 9 Appendix 9.6.

Table 2-5: Three-year mean peak estimated numbers of razorbills in the Wind Farm Area (plus 1 and 2 km buffer)

Data	Survey area	Breeding April – mid-August	Non-breeding mid-August - March
3 year peak mean	Wind Farm Area	613	1,404
	Wind Farm Area + 1 km	956	2,118
	Wind Farm Area + 2 km	1,248	3,101

138. Similar tracking studies were repeated by CEH in the breeding seasons of 2012 (16 tagged birds), 2013 (seven tagged birds) and 2014 (five tagged birds). In the 2012 breeding season, the majority of recorded activity was again west of the Wind Farm Area, to the east and west of the Isle of May (Chapter 9: Appendix 9.6). In the 2013 breeding season, there was little activity of tagged birds recorded within the Wind Farm Area, although the sample size of tagged birds was smaller than in 2010 or 2012 (Chapter 9: Appendix 9.6). Similarly, in the 2014 breeding season, there was little activity of tagged birds recorded in the Wind Farm Area, although the sample size of tagged birds was low (EIA Chapter 9: Appendix 9.6).

139. Three SPAs for breeding razorbills (Forth Islands SPA, Fowlsheugh SPA and St Abb's Head to Fast Castle SPA) were highlighted in the Scoping Opinion as being of possible risk of displacement impact arising from the Project (Marine Scotland, 2017) (Figure 2-5).

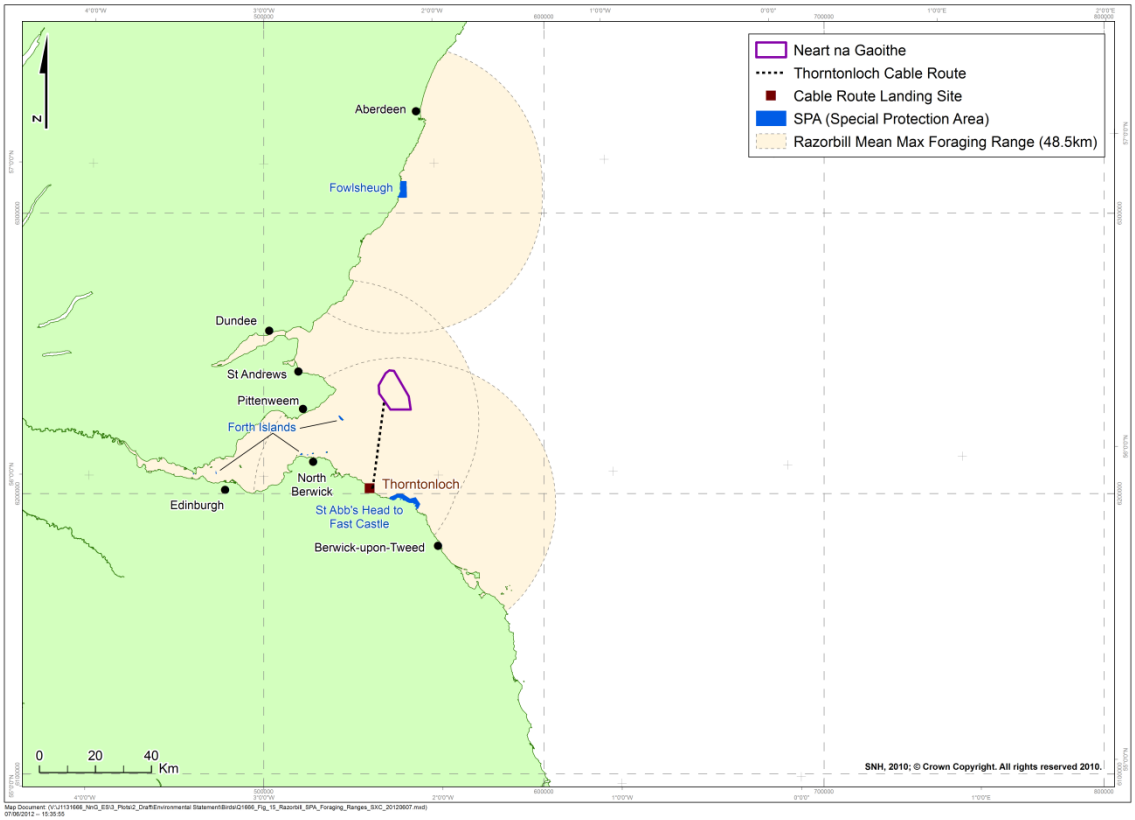

Figure 2-5: SPAs for breeding razorbills within mean maximum foraging range of the Project

140. In addition to the SPA breeding colonies, the Scottish Government is currently considering the designation of a new suite of marine SPAs. This includes the Outer Firth of Forth and St Andrews Bay Complex pSPA. Razorbill is listed as a qualifying interest for this pSPA in the non-breeding season (SNH 2016).

2.1.6 Puffin

141. The closest large puffin colony to the Wind Farm Area is the Isle of May, with an estimated population of 46,200 pairs in 2013 (SMP, 2017). Lesser sandeel (*Ammodytes tobianus*) is the commonest prey item for puffins, but they also eat sprat, herring and a wide range of young gadoid fish (Harris 1984).

142. Puffin was one of the most frequently recorded seabirds on baseline surveys in the NnG study area. Peak numbers occurred during April, July and August with estimated three year peak means of 2,404 (April), 2,185 (July) and 1,509 (August) within the Wind Farm Area. Across the wider study area peak numbers occurred in August.

143. The three year mean peak during the breeding season within the Wind Farm Area was 2,682 puffins, which increased to 6,173 birds when including a 2 km buffer area (Table 2-6). During the non-breeding season (mid-August to March) the three year peak mean within the Wind Farm Area was 1,538 birds and 3,656 birds when including a 2 km buffer.

Table 2-6: Three-year mean peak estimated numbers of puffins in the Wind Farm Area (plus 1 and 2 km buffer)

Data	Survey area	Breeding April – mid-August	Non-breeding mid-August - March
3 year peak mean	Wind Farm Area	2,682	1,538
	Wind Farm Area + 1 km	3,888	2,552
	Wind Farm Area + 2 km	6,173	3,656

144. One SPA for breeding puffins (Forth Islands SPA) was highlighted in the Scoping Opinion as being of possible risk of impact arising from the Project (Marine Scotland, 2017) (Figure 2-6). The locations of Farne Islands SPA and Coquet Island SPA are also shown.

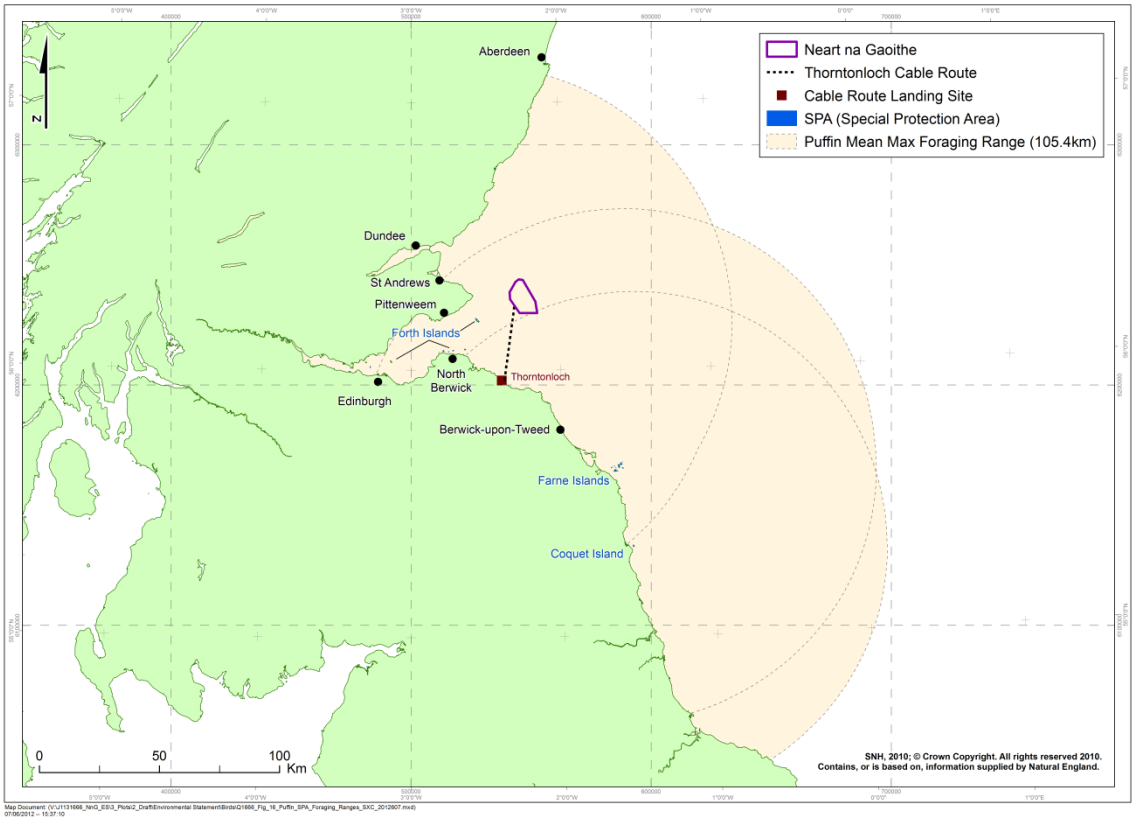

Figure 2-6: SPAs for breeding puffins within mean maximum foraging range of the Project

145. In addition to the SPA breeding colonies, the Scottish Government is currently considering the designation of a new suite of marine SPAs. This includes the Outer Firth of Forth and St Andrews Bay Complex pSPA. Puffin is listed as a qualifying interest for this pSPA in the breeding season (SNH 2016).

2.1.7 Seabird reference populations

146. Most recent population counts for the seabirds and breeding colony SPAs of relevance to this assessment have been taken from Appendix A(ii) of SNH guidance, as provided in the Scoping Opinion (Marine Scotland, 2017) (Table 2-7). For the breeding and non-breeding seasons, those SPAs within mean maximum foraging range (+1 SD) for each species, based on Thaxter *et al.,*(2012) were used in the assessment.

Table 2-7: Most recent population counts for the key seabirds and breeding colony SPAs of relevance to this assessment, as provided in Scoping Opinion and subsequent amendments (Marine Scotland, 2017).

Species	SPAs and distance from NNG	SPA Citation population	Most recent counts & year
Gannet	Forth Islands (16 km)	21,600 pairs	75,259 pairs (2014)
Kittiwake	Buchan Ness/Collieston Coast (113 km) Forth Islands (16 km) Fowlsheugh (62 km) St Abb's Head to Fast Castle (31 km) **Total**	30,452 pairs 8,400 pairs 36,350 pairs 21,170 pairs **96,372 pairs**	11,482 pairs (2016-17) 4,663 pairs (2017) 9,655 pairs (2015) 3,334 pairs (2016) **29,134 pairs**
Herring gull	Buchan Ness/Collieston Coast (113 km) Forth Islands (16 km) Fowlsheugh (62 km) St Abb's Head to Fast Castle (31 km) **Total**	4,292 pairs 6,600 pairs 3,190 pairs 1,160 pairs **15,242 pairs**	3,115 pairs (2016-17) 6,580 pairs (2014-16) 125 pairs (2015) 325 pairs (2016) **10,145 pairs**
Puffin	Forth Islands (16 km)	14,000 pairs	45,005 pairs (2009-2017)
Guillemot	Buchan Ness/Collieston Coast (113 km) Forth Islands (16 km) Fowlsheugh (62 km) St Abb's Head to Fast Castle (31 km) **Total**	17,280 birds 8,000 birds 56,450 birds 31,750 birds **113,480 birds**	33,632 birds (2016-17) 28,786 birds (2017) 55,507 birds (2015) 36,206 birds (2016) **154,131 birds**
Razorbill	Forth Islands (16 km) Fowlsheugh (62 km) St Abb's Head to Fast Castle (31km) **Total**	2,800 birds 5,800 birds 2,180 birds **10,780 birds**	5,815 birds (2017) 7,426 birds (2015) 2,067 birds (2016) **15,308 birds**

2.2 In-combination Impacts

147. In-combination impacts refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term 'projects' is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

2.2.1 In-combination Collision Impacts

148. For the in-combination collision assessment, two scenarios have been assessed to take into account the new and consented design envelopes for the Inch Cape and the Seagreen Phase 1 Offshore Wind Farms. Scenario One incorporates the worst case design envelopes for the proposed Inch Cape and Seagreen projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario Two incorporates the consented design envelopes as detailed in the existing 2014 consents. Scenario Two is considered to be extremely unlikely to be realised due to advances in turbine technology and the considerably greater costs associated with using a larger number of turbines. However, the results from the modelling indicate that this is the worst-case scenario and therefore has been considered in this assessment. In addition to the wind farms in the Firths of Forth and Tay additional wind farms within the region, namely: Hywind, Kincardine and Forthwind were

included in the assessment of impacts during the breeding season. During the non-breeding season an additional 25 wind farm developments within the North Sea were considered. These were:

East Anglia 3
East Anglia 1
Hornsea 3
Blyth Demonstrator
Dogger Creke Beck A&B
Dogger Teeside A&B
Dudgeon
Hornsea 1
Hornsea 2
Humber Gateway
Lincs
Race Bank
Sheringham Shoal
Teeside
Triton Knoll
Westermost Rough
Aberdeen demonstrator
Beatrice
Galloper
Greater Gabbard
Kentish Flats
London Array
Moray Firth 1
Thanet
Rampion

149. For the in-combination displacement assessment, one scenario has been assessed, as Wind Farm Area population estimates for the existing 2014 consents did not change for the 2017 proposed projects. This assessment is based on displacement and mortality rates that were recommended in the Scoping Opinion (Marine Scotland, 2017).

150. Table 2-8 sets out the potential in-combination impacts and the worst case in-combination design envelope scenario considered within the in-combination impact assessment.

Table 2-8: In-combination worst-case design envelope scenarios.

Impact	Worst Case Design Scenario	Justification
In-combination collision impacts	In the breeding season, the Project and other Forth and Tay wind farms (both scenarios) along with Hywind, Kincardine and Forthwind were included. In the non-breeding season, in addition to the Forth & Tay projects, more distant wind farm projects in the UK North Sea were included for kittiwake, and UK North Sea and English Channel for gannet.	Species from breeding SPA colonies are within mean maximum foraging range of Forth and Tay wind farms but not more distant projects. This approach was recommended in the Scoping Opinion (Marine Scotland, 2017).
In-combination impacts arising from displacement	In the breeding season, the Project and other Forth and Tay wind farms were included. In the non-breeding season, for guillemot and razorbill, displacement effects from Inch Cape & Seagreen A & B were included.	Displacement and mortality rates followed guidance in Scoping Opinion. This approach was recommended in the Scoping Opinion (Marine Scotland, 2017).

2.2.2 In-combination Displacement Assessment

151. The assessment for the Project on its own has considered displacement impacts for four species in the breeding season (kittiwake, guillemot, razorbill and puffin). These four species are also considered for in-combination displacement impacts.

152. As recommended in the Scoping Opinion, the assessment should consider effects from projects within mean maximum foraging range of the colony SPA under consideration. All four species have a similar mean maximum foraging range and therefore, the same SPAs: Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle and Buchan Ness to Collieston Coast, are considered applicable for these species.

153. The following projects were considered in the assessment of in-combination displacement impacts for these species:

- Inch Cape Offshore Wind Farm (Consented),
- Seagreen A Offshore Wind Farm (Consented),
- Seagreen B Offshore Wind Farm (Consented),
- Kincardine Offshore Wind Farm (Consented),
- Forthwind Demonstration Project ((2 turbines) Consented),
- Forthwind Offshore Wind Demonstrator ((Up to 7 turbines) Pre-application),
- Hywind (Consented).

154. The site boundaries for the consented Inch Cape and Seagreen A and B developments are the same as those projects at the pre-application stage and planned in same area.

2.3 Estimated Magnitude of Effect (SPAs)

155. The following section summarises the information used to estimate the magnitude of the potential impacts on the relevant qualifying species of the SPA sites. The aim of this section is not duplicate all the detailed analysis undertaken and presented within the EIA but to present a succinct summary of the key data used to inform the HRA. Further more detailed analysis of the information used can be found in the relevant chapters and associated appendices within the EIA, i.e. Marine Mammals Chapter 8 and Ornithology Chapter 9.

2.3.1 Gannet

156. The gannet is a qualifying feature for the Forth Islands SPA.

157. Advice provided in the Scoping Opinion is that the only impact from the proposed Project alone and in-combination that could have a likely significant effect on gannet is from collisions with the turbines (Marine Scotland 2017).

158. Details of all the collision rate modelling undertaken can be found in Appendix 9.3 of the EIA Report.

159. Collision rate modelling has been undertaken to estimate the number of potential gannet collisions per season based on the maximum design envelope of 54 turbines. The minimum height for the turbine blades above the sea surface for both designs is 32.0 m at mean sea level (MSL) (35 m LAT).

160. A study of avoidance rates by the BTO recommended that for gannet, an avoidance rate of 98.9% should be used with the basic Band Model, (which includes Option 2, as used here) (Cook *et al.* 2014). This was also the avoidance rate recommended for gannet in the Scoping Opinion (Marine Scotland, 2017). Based on these recommendations, an avoidance rate of 98.9% has been used in this assessment.

161. The results from the collision rate modelling based on an avoidance rate of 98.9% and using Band Option 2, are presented in Table 2-9.

162. Based on the worst case design scenario (54 turbines), a total of 93 gannets (91 adults and two immature birds) are estimated to be impacted during the breeding season and 15 gannets (14 adults and one immature bird) were estimated for the non-breeding season (October to mid-March).

Table 2-9: Estimated number of gannet and kittiwake collisions based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD.

98.9% AR (± 2 SD)	Gannet	Kittiwake
Collisions in breeding season, all ages	93 ± 16.9	9 ± 1.6
Collisions in breeding season, adults birds	91	8
Collisions in breeding season, immature birds	2	1
Collisions in non-breeding season, all ages	15 ± 2.7	19 ± 3.5
Collisions in non-breeding season, adults birds	14	12
Collisions in non-breeding season, immature birds	1	7
Total collisions per year, all ages	108 ± 19.6	28 ± 5.0
Collision scenario - 54 turbines, 98.9% AR (± 2 SD). Band Option 2		

163. A recent review estimated species-specific non-breeding season seabird populations at biologically defined minimum population scales (BDMPS) to enable the apportioning of potential impacts of marine renewable developments during the non-breeding season (Furness, 2015). This review also included estimates of the numbers of adult and immature birds originating from each individual UK SPA population in the non-breeding season split between 'spring' and 'autumn' periods. Where appropriate, this information has been reproduced here and used to inform the assessment.

164. The estimated number of breeding adult gannets from the Forth Islands SPA in the North Sea is 150,518 birds and in the autumn period of the non-breeding season it is 110,964 individuals (Furness, 2015). In addition to this, there is an estimated 80,893 immature birds from the Forth Islands SPA in the North Sea in the autumn period of the non-breeding season. The total population of adult and immature gannets from the Forth Islands SPA in the North Sea in the autumn period of the non-breeding season is therefore estimated to be 191,857 individuals. During the spring period of the non-breeding season, it is estimated that 77,675 adult gannets from the Forth Islands SPA winter in the North Sea along with 35,952 immatures. The total number of gannets from the Forth Islands SPA in the North Sea during the spring period of the non-breeding season is estimated to be 113,627 birds (Furness, 2015).

165. The estimated proportions of the SPA gannet population impacted are presented in Table 2-10. It is estimated that 0.06% of the Forth Island's SPA gannet breeding population may be impacted during the breeding season and 0.07% of the population during the non-breeding season.

Table 2-10: Estimated number of gannet collisions based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD.

Gannet	54 turbines 98.9% AR (± 2 SD) Band Option 2	SPA Gannet population (individuals)	Proportion of population impacted (%)
Collisions in breeding season, adults birds	91	150,518	0.06%
Total collisions non-breeding season, all ages	15	113,627	0.07

2.3.1.1 Gannet – In-combination

166. The Scoping Opinion (Marine Scotland 2017) stated that for gannet and kittiwake, the CIA should estimate breeding and non-breeding season collision effects from the Forth and Tay wind farms (Inch Cape and Seagreen) in isolation and for the non-breeding season in-combination with other relevant UK wind farms.

167. There are two scenarios considered for the in-combination collision rate modelling. Scenario One incorporates the design envelopes for the proposed Inch Cape and Seagreen Phase 1 projects as detailed in the Scoping Reports submitted to MS-LOT (ICOL, 2017; Seagreen, 2017). Scenario Two incorporates the consented 2014 design envelopes as detailed in the respective project consents (See EIA Chapter 9: Ornithology for detailed information on methods and approaches used).

168. Predicted in-combination gannet mortality in the breeding season (mid-March to September) for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape and Seagreen Phase 1 (Scenario One) is shown in Table 2-11. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%.

Table 2-11: Estimated in-combination number of gannet collisions in the breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

Project	Band Option 2 all birds	Band Option 2 adults
NnG (2017)	93 ± 16.9	91
Inch Cape (2017)	115 ± 20.9	112
Seagreen Phase 1 (2017)	326 ± 59.4	317
Total	534 ± 97.2	520

169. Based on Scenario One, there will be an estimated 534 gannet collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario.

170. During the breeding season, for NnG, 97.5% of aged gannets were adults, for Inch Cape (2014 consented), 97.1% of aged gannets were adults, for Seagreen A (2014 consented), the proportion of adults from aged birds in the breeding season was 96.7%, while for Seagreen B (2014 consented), the proportion of adults in the breeding season was 97.8%. This gives an average ratio of 97.3% for both Seagreen projects. These proportions have been used for the Scenario One developments. The total number of adult gannets for each of the projects is presented in Table 2-11.

171. Based on Scenario Two, there will be an estimated 1,166 gannet collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario, of which 1,135 birds will be adults (Table 2-12).

Table 2-12: Estimated in-combination number of gannet collisions in the breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on Band Model Option 2 and an avoidance rate of 98.9%

Project	Band Option 2 all birds	Band Option 2 adults
NnG (2017)	93 ± 16.9	91
Inch Cape (2014)	384	375
Seagreen A (2014)	423	409
Seagreen B (2014)	266	260
Total	1,166	1,135

172. During the non-breeding season an estimated 63 gannets (adult and immature) will be impacted based on Scenario One and 75 under Scenario Two (Table 2-13). The combined total number of gannets (breeding season adults and non-breeding season all birds) estimated to be impacted from collisions is 583 under Scenario One and 1,210 under Scenario Two (Table 2-14).

Table 2-13: Estimated in-combination number of gannet collisions in the non-breeding season for Scenario One and Scenario Two based on Band Model Option 2 and an avoidance rate of 98.9%

Project	Scenario One	Scenario Two
NnG (2017)	14 ± 2.6	14 ± 2.6
Inch Cape (2017)	10 ± 2.1	
Seagreen Phase 1 (2017)	39 ± 7.0	-
Inch Cape (2014)		26
Seagreen A (2014)	-	23
Seagreen B (2014)	-	12
Total	63 ± 11.7	75

Table 2-14: Estimated annual in-combination number of gannet collisions for Scenario One and Scenario Two based on Band Model Option 2 and an avoidance rate of 98.9%

Project	Scenario One	Scenario Two
NnG (2017)	105	105
Inch Cape (2017)	122	-
Seagreen Phase 1 (2017)	356	-
Inch Cape 2014		401
Seagreen A (2014)	-	432
Seagreen B (2014)	-	272
Total	583	1,210

173. The estimated number of gannets predicted to be impacted from all offshore wind farms in the North Sea and English Channel during the non-breeding season have been estimated, as recommended in the Scoping Opinion (Marine Scotland, 2017). Details on the approach undertaken are presented in the EIA Chapter 9: Ornithology. Table 2-15 presents the results of the detailed assessment work carried out in-order for an HRA to be undertaken.

174. Based on the figures presented in Table 2-15 an estimated 193 gannets from the Forth Islands SPA may be impacted during the non-breeding period by all currently consented offshore wind farms in the North Sea and English Channel.

Table 2-15: Estimated in-combination number of gannets from the Forth Islands SPA involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea and English Channel Wind Farms in the autumn and spring periods of the non-breeding season

Project	Number of adults from Forth Islands SPA in autumn period	Number of immature birds from Forth Islands in autumn period	Number of adults from Forth Islands SPA in spring period	Number of immature birds from Forth Islands in spring period	Total number of birds in non-breeding season
NnG (2017)	1	1	1	1	4
Inch Cape (2014)	3	2	3	1	10
Seagreen A (2014)	2	1	2	1	6
Seagreen B (2014)	1	1	1	1	4
Other UK OWFs in North Sea & English Channel	71	46	32	21	170
Total	**78**	**51**	**39**	**25**	**193**

2.3.2 Kittiwake

175. Within the mean maximum foraging range of 60.0 ± 23.3 km, kittiwake is a qualifying species for the Forth Islands SPA, Fowlsheugh SPA and St Abb's Head to Fast Castle SPA. The Buchan Ness to Collieston Coast SPA lies 125 km to the north of the Wind Farm Area and birds from this SPA may occur in the Wind Farm Area during the non-breeding season. Consequently, potential impacts on kittiwakes from this SPA have been considered during non-breeding season only.

176. Advice provided in the Scoping Opinion is that impacts from collision and displacement effects arising from the proposed Project alone and in-combination could have a likely significant effect on kittiwake (Marine Scotland 2017).

2.3.2.1 Kittiwake collision impacts

177. Collision rate modelling has been undertaken to estimate the number of potential kittiwake collisions per season based on the maximum number of 54 turbines.

178. The results from the collision rate modelling based on an avoidance rate of 98.9% and using Band Option 2, as recommended in the Scoping Opinion (Marine Scotland, 2017) are presented in Table 2-9.

Kittiwake collision rate – Breeding season (mid-April to August)

179. Based on the maximum design scenario of 54 turbines, a total of 8 adult kittiwakes and one immature kittiwake are estimated to be impacted during the breeding season (Table 2-16).

180. Following the recommended approach to apportioning impacts (SNH 2014), the potential impacts on all non-SPA breeding colonies and across all SPA colonies within the mean maximum foraging range

60.0 ± 23.3 km (Thaxter *et al.* 2012) for which kittiwake is a qualifying feature of the site during the breeding season have been apportioned (Table 2-16)[1].

Table 2-16: Estimated number of kittiwake collisions during breeding season across SPA colonies and all colonies within mean maximum foraging range.

Kittiwake	Breeding season adults	
	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle)	All colonies Mean maximum foraging range (60.0 ± 23.3 km)
Forth Islands	5.69	3.06
Fowlsheugh	1.12	0.79
St Abb's Head to Fast Castle	1.19	2.49
Other colonies	0	1.66

181. Results from tagging studies indicate that kittiwakes from Fowlsheugh and St Abb's Head to Fast Castle SPA do not regularly occur in the Wind Farm Area (See EIA Appendix 9.6 in Ornithology Chapter). The worst-case scenario presumes that all kittiwakes at risk of being impacted during the breeding season originate from the Forth Islands SPA.

182. The current kittiwake breeding population in Forth Islands SPA is 4,663 pairs (Table 2-7). Assuming that all kittiwakes impacted during the breeding season are from the Forth Islands SPA, it is estimated that 0.08% of the adult kittiwake population will be impacted.

183. Recognising that there is potential for kittiwakes from other SPAs within the mean maximum foraging range to occur within the Wind Farm Area during the breeding season and apportioning the potential impacts only across the SPA designated colonies, it is estimated that six of the kittiwakes impacted may be from the Forth Islands SPA with singles from St Abb's Head to Fast Castle SPA and Fowlsheugh SPA (Table 2-16).

184. Apportioning the potential impacts across all kittiwake colonies within the mean maximum foraging range reduces the impacts on the Forth Islands SPA to three birds, with two from St Abb's Head to Fast Castle SPA and one from Fowlsheugh SPA; approximately two kittiwakes will be from other non-SPA colonies (Table 2-16).

Kittiwake collision rate – Non-breeding season (September to mid April)

185. A total of 28 kittiwake collisions were predicted to occur throughout the year, with nine collisions (adults and immatures) occurring in the breeding season. A total of 19 collisions (12 adults and seven immature birds) were therefore predicted for the non-breeding season (Table 2-9).

186. A total of 43.1% of kittiwakes aged during baseline surveys between September and December were immature and 20.8% of birds between January and mid-April were immature (EIA Chapter 9: Appendix 9.2). These proportions have been applied in order to estimate the number of collisions for the autumn and spring periods of the non-breeding season to provide the total estimated number of collisions for adult and immature kittiwakes (Table 2-17).

[1] It should be noted that Scoping Opinion has advised that when apportioning potential impacts across SPA colonies the latest SPA colony counts, as presented in Table 2-7, should be used. However, when apportioning potential impacts across all colonies then only data from Seabird 2000 should be used. This can result in the proportion of birds associated with SPA colonies to differ between the SPA only assessment and the SPA plus all colonies assessment, depending on the relative changes in the SPA populations that have occurred since the Seabird 2000 colony counts were undertaken.

Table 2-17: Estimated number of kittiwake collisions in the autumn (September to December) and spring (January to mid-April) periods of the non-breeding season (September to December), based on 54 turbines, Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD

54 turbines	Band Option 2 98.9% AR (± 2 SD)	
	Autumn	Spring
Collisions in non-breeding season, all ages	17 ± 3.1	2 ± 0.3
Collisions in non-breeding season, adults birds	10	2
Collisions in non-breeding season, immature birds	7	0

187. Assuming that the 19 kittiwakes at risk of collision mortality during the whole of the non-breeding season are all from SPAs within the mean maximum foraging range of the Wind Farm Area plus Buchan Ness to Collieston Coast SPA, a total of 11 kittiwakes from the Forth Islands SPA may be impacted, three from Fowlsheugh SPA, four from St Abb's Head to Fast Castle SPA and one from Buchan Ness to Collieston Coast SPA (Table 2-18).

188. If the collision impacts during the non-breeding season affect all kittiwake colonies within the mean maximum foraging range then an estimated seven kittiwakes from the Forth Islands SPA may be impacted, two from Fowlsheugh SPA and two from St Abb's Head to Fast Castle SPA. Assuming that all 19 kittiwakes estimated to be at risk of an impact during the non-breeding season are from colonies within the mean maximum foraging range an estimated seven birds will be from the Forth Islands SPA, two from Fowlsheugh SPA, two from St Abb's Head to Fast Castle SPA and one from Buchan Ness to Collieston Coast SPA may be impacted (Table 2-18).

Table 2-18: Estimated kittiwake collision mortality during non-breeding season across SPA colonies and all colonies within mean maximum foraging range

Kittiwake	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle, Buchan Ness to Collieston Coast)		All colonies Mean maximum foraging range (60.0 ± 23.3 km)	
	Autumn	Spring	Autumn	Spring
Forth Islands	10.22	1.20	6.49	0.73
Fowlsheugh	2.44	0.29	1.55	0.17
St Abb's Head to Fast Castle	3.26	0.38	2.07	0.23
Buchan Ness to Collieston Coast	1.08	0.13	0.69	0.08
Other colonies	0	0	8.20	0.78

2.3.2.2 Kittiwake displacement

189. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it is assumed that there will be 30% displacement of kittiwakes from the Wind Farm Area (and buffer areas) in the breeding and non-breeding seasons.

Kittiwake displacement – Breeding season (mid-April to August)

190. Assuming 30% of all kittiwakes are displaced from the Wind Farm Area during the breeding season, this would affect an estimated 532 birds, increasing to 649 birds when including a 2 km buffer (Table 2-19).

Table 2-19: Summary of kittiwake displacement for Offshore Wind Farm Area and surrounding buffer areas in the breeding season

Displacement	Breeding adults	Immature birds	Total number of birds
Wind Farm Area	496	36	532
Wind Farm Area + 2 km	605	44	649

191. Based on advice received on mortality rates in the Scoping Opinion (Marine Scotland, 2017), it is assumed that 2% of all kittiwakes displaced from the Wind Farm Area (10 adults and one immature bird) and the Wind Farm Area 2 km buffer (12 adults and one immature bird) during the breeding season would die as a result (Table 2-20). The matrices presenting the full range of potential impacts are presented in EIA Appendix 9.4.

Table 2-20: Estimated kittiwake mortality arising from displacement effects from the proposed Project during the breeding season

Displacement mortality	Breeding adults	Immature birds	Total number of birds
Wind Farm Area	10	1	11
Wind Farm Area + 2 km	12	1	13

192. Assuming that all impacts from displacement only affect birds from the Forth Islands SPA during the breeding season the potential mortality of 12 adult kittiwakes corresponds to 0.13% of the Forth Islands SPA population, for the Wind Farm Area and 2 km buffer.

193. Apportioning the potential worst-case impacts during the breeding season across all SPA colonies within the mean maximum foraging range 60.0 +23.3 km it is estimated that nine kittiwakes from the Forth Islands SPA, and two kittiwakes from Fowlsheugh and St Abb's Head to Fast Castle SPAs will be impacted. If apportioned across all colonies five kittiwakes from the Forth Islands SPA, four from St Abb's Head to Fast Castle and approximately one kittiwake from Fowlsheugh SPA may be affected (Table 2-21).

Table 2-21: Estimated adult kittiwake displacement mortality during breeding season across SPA colonies and all colonies within mean maximum foraging range.

Kittiwake	Breeding season adults	
	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle)	All colonies Mean maximum foraging range (60.0 ± 23.3 km)
Forth Islands	8.54	4.60
Fowlsheugh	1.68	1.18
St Abb's Head to Fast Castle	1.78	3.74
Other colonies	0	2.49

Kittiwake displacement – Non-breeding season (September to mid April)

194. The non-breeding season from between September to mid-April is spilt into two separate periods: autumn (September to December) and spring (January to mid-April) (Marine Scotland, 2017). To assess potential impacts during the non-breeding season the estimated number of birds displaced during each of the non-breeding periods have been calculated for within the Wind Farm Area and and

2 km buffer areas. Based on the advice received during Scoping it is assumed that 30% of the kittiwakes will be displaced and that this will cause a 2% rate in mortality. The number of immatures within the population has been estimated based on site specific data obtained during the non-breeding season when 43.1% were immature birds between September to December and 20.8% of birds between January and April were immature.

195. The estimated numbers of kittiwakes displaced for each of the two non-breeding season periods are presented in Table 2-22 and Table 2-23 and the estimated levels of mortality for each of the two non-breeding periods are presented in Table 2-24 and Table 2-25.

Table 2-22: Summary of kittiwake displacement for the Wind Farm Area and surrounding buffer areas in the Autumn period of the non-breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	182	138	320
Wind Farm Area + 2 km	344	261	605

Table 2-23: Summary of kittiwake displacement for the Wind Farm Area and surrounding buffer areas in the Spring period of the non-breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	21	6	27
Wind Farm Area + 2 km	33	9	42

Table 2-24: Summary of kittiwake displacement mortality for the Wind Farm Area and surrounding buffer areas in the autumn period of the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds
Wind Farm Area	3	3	6
Wind Farm Area + 2 km	7	5	12

Table 2-25: Summary of kittiwake displacement mortality for the Wind Farm Area and surrounding buffer areas in the spring period of the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds
Wind Farm Area	1	0	1
Wind Farm Area + 2 km	1	0	1

196. Based on a worst-case scenario of displacement effects occurring within 2 km of the Wind Farm Area it is estimated that a total of 13 kittiwakes (8 adults and 5 immatures) may not survive due to the effects of displacement during the non-breeding season.

197. The estimated number of adult and immature kittiwakes within the UK waters of the North Sea during each of the non-breeding periods are presented in Table 2-26 (Furness, 2015).

Table 2-26: Estimated numbers of adult and immature kittiwakes from the four SPAs in the UK waters of the North Sea in the non-breeding season (Furness, 2015)

SPA	Autumn			Spring		
	Adult	Immature	Total	Adult	Immature	Total
Fowlsheugh	11,204	6,573	17,778	11,204	4,930	16,134
Forth Islands	3,720	2,182	5,902	3,720	1,637	5,357
St Abb's Head to Fast Castle	4,084	2,396	6,479	4,084	1,797	5,881
Buchan Ness to Collieston Coast	15,050	8,830	23,880	15,050	6,622	21,673
Combined total	34,058	19,981	54,039	34,058	14,986	49,045

198. Assuming that the 13 kittiwakes at risk of mortality during the whole of the non-breeding season are all from SPAs within the mean maximum foraging range of the Wind Farm Area a total of eight kittiwakes from the Forth Islands SPA may be impacted, two from Fowlsheugh SPA, two from St Abb's Head to Fast Castle SPA and one from Buchan Ness to Collieston Coast SPA.

199. If the impacts during the non-breeding season affect all kittiwake colonies within the mean maximum foraging range then an estimated six kittiwakes from the Forth Islands SPA may be impacted, one from Fowlsheugh SPA and two from St Abb's Head to Fast Castle SPA and one from Buchan Ness to Collieston Coast SPA. Less than one kittiwake may be from a non-SPA colony (Table 2-27).

Table 2-27: Estimated kittiwake displacement mortality during non-breeding season across SPA colonies and all colonies within mean maximum foraging range

Kittiwake	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle)		All colonies Mean maximum foraging range (60.0 +23.3 km)	
	Autumn	Spring	Autumn	Spring
Forth Islands	7.21	0.60	5.57	0.45
Fowlsheugh	1.72	0.14	1.33	0.11
St Abb's Head to Fast Castle	2.3	0.19	1.78	0.14
Buchan Ness to Collieston Coast	0.77	0.06	0.59	0.05
Other colonies	0	0	2.73	0.30

200. Table 2-28 presents the estimated level of collision and displacement impact on kittiwakes from SPAs within the mean maximum foraging range + 1.s.d of 83.3 km. This is the most realistic scenario with all birds impacted originating from all colonies within the 83.3 km foraging range of the Wind Farm Area. It is still precautionary in assuming that birds from colonies beyond 83.3 km do not occur in the Wind Farm Area during the non-breeding season.

Table 2-28: Total estimated kittiwake mortality assuming that impacts are on kittiwakes from all colonies within the mean maximum foraging range.

Kittiwake All colonies	Collision Rate		Displacement		Total
	Breeding	Non-breeding	Breeding	Non-breeding	
Forth Islands	3	7	5	6	21
Fowlsheugh	1	2	1	1	5
St Abb's Head to Fast Castle	3	2	4	2	11
Buchan Ness to Collieston Coast	-	1	-	1	2
Other colonies	2	5	2	3	12

2.3.2.3 Kittiwake In-combination

2.3.2.3.1 Kittiwake in-combination collision impacts

201. Predicted in-combination kittiwake mortality in the breeding season (mid-April to August) for the Project and additional collisions based on 2017 proposed turbine figures for Inch Cape, Seagreen Phase 1 (Scenario One) is shown in Table 2-29. This is based on the Project worst case scenario (54 turbines), Band Model Option 2 and an avoidance rate of 98.9%. Estimated collision numbers for NnG were previously presented in Table 2-30. Estimated collision numbers for Inch Cape and the Seagreen projects are presented in the EIA Appendix 8.3.

Table 2-29: Estimated in-combination number of kittiwake collisions in the breeding season for Scenario One: NnG (2017 design) and proposed Forth and Tay Wind Farms (2017 design), based on Band Model Option 2 and an avoidance rate of 98.9%

Project	Band Option 2 all birds	Band Option 2 adults
NnG (2017)	9 ± 1.6	8
Inch Cape (2017)	43 ± 7.9	39
Seagreen Phase 1 (2017)	119 ± 21.7	116
Total	171 ± 31.2	163

Table 2-30: Estimated in-combination number of kittiwake collisions in the breeding season for Scenario Two: NnG (2017 design) and previously consented Forth and Tay Wind Farms (2014 design), based on Band Model Option 2 and an avoidance rate of 98.9% ± 2 SD

Project	Band Option 2 all birds	Band Option 2 adults
NnG (2017)	9 ± 1.6	8
Inch Cape (2014)	149	136
Seagreen A (2014)	126	122
Seagreen B (2014)	135	131
Total	419	397

202. It is estimated that up to 171 and 419 kittiwakes may be impacted each breeding season from the Project and Inch Cape and Seagreen projects depending on the in-combination Scenario, of which 163 and 397 birds will be adults..

203. Apportioning the potential impacts from each of the Projects across the relevant SPAs it is estimated that based on the worst case scenario, i.e. Scenario Two, that of the 397 adult kittiwakes estimated to be impacted during the breeding season, 26 will be from the Forth Islands SPA, 176 will be from Fowlsheugh, 38 will be St Abb's Head to Fast Castle SPA, 21 from Buchan Ness to Collieston Coast SPA and 136 will be from other non-SPA colonies.

Table 2-31: Estimated number of adult kittiwakes impacted by collision during the breeding season based on worst-case scenario (Scenario 2).

Project	Forth Islands	Fowlsheugh	St Abb's Head to Fast Castle	Buchan Ness to Collieston Coast	Other Colonies
NnG (2017)	2.99	0.77	2.43	0.19	1.62
Inch Cape (2014)	12.6	47.1	14.9	5.83	55.4
Seagreen A (2014)	4.80	61.8	9.79	7.22	38.3
Seagreen B (2014)	5.16	66.4	10.5	7.75	41.4
Total	25.6	176.2	37.7	21.0	136.4

204. During the non-breeding season an estimated 286 kittiwakes (adult and immature) will be impacted based on Scenario One and 639 under Scenario Two (Table 2-32).

Table 2-32: Estimated in-combination number of kittiwake collisions in the non-breeding season for Scenario One and Scenario Two based on Band Model Option 2 and an avoidance rate of 98.9%

Project	Scenario One	Scenario Two
NnG (2017)	19 ± 3.4	19 ± 3.4
Inch Cape (2017)	36 ± 6.7	98
Seagreen Phase 1 (2017)	231 ± 41.9	-
Seagreen A (2014)	-	295
Seagreen B (2014)	-	227
Total	286 ± 52.0	639

205. The estimated number of kittiwakes predicted to be impacted from all offshore wind farms in the North Sea during the non-breeding season have been estimated. Details on the approach undertaken in order to calculate the number of kittiwakes at risk of collision from the four SPAs relevant to this assessment during the non-breeding season are presented in the EIA Report Chapter 9: Ornithology. Table 2-33 below presents the results of the detailed assessment work carried out in-order for an HRA to be undertaken.

Table 2-33: Estimated in-combination number of kittiwakes (all ages) from SPAs involved in collisions at NnG (2017 design), proposed Forth and Tay Wind Farms (2014 design), and other UK North Sea Wind Farms in the autumn and spring periods of the non-breeding season

Project	Forth Islands	Fowlsheugh	St Abb's Head to Fast Castle	Buchan Ness to Collieston Coast
NnG (2017)	0.11	0.3	0.11	0.45
Inch Cape (2014)	0.53	1.53	0.56	2.27
Seagreen A (2014)	1.58	4.55	1.68	6.71
Seagreen B (2014)	1.16	3.39	1.23	4.96
Other UK OWFs in North Sea & English Channel	10.61	31.55	11.30	45.59
Total	13.99	41.32	14.88	59.98

2.3.2.3.2 Kittiwake in-combination Displacement impacts

206. Based on advice received in the Scoping Opinion it is assumed that in-combination displacement impacts on adult kittiwakes that could cause a likely significant effect only arise during the breeding season (Marine Scotland 2017).

207. The four SPAs considered for kittiwake for the cumulative assessment were Buchan Ness to Collieston Coast SPA, Fowlsheugh SPA, Forth Islands SPA and St Abb's Head to Fast Castle SPA. Based on SNH figures, the most recent total combined breeding population estimate for these SPAs is 29,134 pairs (Table 2-7).

208. In order to assess in-combination impacts on kittiwakes it is assumed that there will be 30% displacement effect that will cause 2% mortality for all projects considered in the assessment based on the peak mean number of kittiwakes recorded at each project during the breeding season. The estimated number of adult kittiwakes at each project is obtained from site specific information. The number of adult kittiwakes impacted by displacement from each of the projects based on the worst-case Scenario are presented in Table 2-34.

Table 2-34: Estimated adult kittiwake mortality from displacement impacts from wind farms in the breeding season

Project	No of adults	
	Wind Farm Area	Wind Farm Area + 2 km buffer
NnG	10	12
Inch Cape	12	22
Seagreen A	9	9
Seagreen B	10	10
Kincardine OWF	1	1
Forthwind (2 turbines)	1	1
Hywind	1	1
Total	44	56

209. The results from apportioning the potential impacts across the four SPAs that are within the mean maximum foraging range of breeding kittiwakes, i.e. Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle and Buchan Ness to Collieston Coast are presented in Table 2-35. Due to the low numbers

estimated to be impacted (a total of three birds) by Kincardine OWF, Forthwind (2 turbines) and Hywind these have not been apportioned across colonies as they will make only a negligible difference to any outputs.

Table 2-35: Estimated number of adult kittiwakes at risk of displacement level impacts

Project	Forth Islands	Fowlsheugh	St Abb's to Fast Castle	Buchan Ness to Collieston Coast
NnG	4.49	1.15	3.65	0.00
Inch Cape	2.05	7.63	2.42	0.94
Seagreen A	0.35	4.56	0.72	0.53
Seagreen B	0.39	5.97	0.80	0.59
Other wind farm	<1	<1	<1	<1
Total	7.28	18.41	7.59	2.35

210. The results indicate that during the breeding season an in-combination displacement impact could cause the loss of seven birds at the Forth Islands SPA, 18 birds at Fowlsheugh SPA, 8 birds at St Abb's head to Fast Castle SPA and two birds at Buchan Ness to Collieston Coast SPA.

211. The total number of kittiwakes estimated to be impacted by in-combination impacts during the breeding and non-breeding seasons across these four SPAs is presented in Table 2-36.

Table 2-36: Total number of kittiwakes estimated to be impacted at each of the SPAs during breeding and non-breeding seasons

Project	Forth Islands	Fowlsheugh	St Abb's to Fast Castle	Buchan Ness to Collieston Coast
Collision Impacts (Breeding)	25.6	176.2	37.7	21.0
Collision Impacts (non-breeding)	13.99	41.32	14.88	59.98
Displacement effect (Breeding	7.28	18.41	7.59	2.35
Total	46.8	235.9	60.2	83.3

2.3.3 Herring gull

212. Herring gull is a qualifying species for the Forth Islands SPA, Fowlsheugh SPA, St Abb's Head to Fast Castle and Buchan Ness to Collieston Coast SPA.

213. Advice provided in the Scoping Opinion is that impacts from collision arising from the proposed Project alone and in-combination could have a likely significant effect on herring gulls (Marine Scotland 2017).

2.3.3.1 Herring gull collision impacts

214. Collision rate modelling has been undertaken to estimate the number of potential herring gull collisions per season based on the maximum number of 54 turbines.

215. Estimated herring gull collisions for the worst-case design scenario (54 turbines) using an avoidance rate of 99.5% (± 0.001) with Band Option 1 and 2, and 99.0% (± 0.002) with Band Option 3, as recommended in the Scoping Opinion (Marine Scotland, 2017) are shown in Table 2-37. Three sets of figures are presented: Band Model Option 1, Band Model Option 2 and Band Model Option 3, for the breeding and non-breeding seasons.

Table 2-37: Estimated number of herring gull collisions based on 54 turbines, an avoidance rate of 99.5% (± 1SD) with Band Option 1 and 2, and 99.0% (± 2SD) with Band Option 3

54 turbines	Band Option 1 99.5% AR ± 1 SD	Band Option 2 99.5% AR ± 1 SD	Band Option 3 99.0% AR ± 2SD
Collisions in breeding season, all ages	1 ± 0.3	2 ± 0.4	1 ± 0.3
Collisions in breeding season, adults birds	1	2	1
Collisions in breeding season, immature birds	0	0	0
Collisions in non-breeding season, all ages	3 ± 0.5	4 ± 0.7	3 ± 0.6
Collisions in non-breeding season, adults birds	2	3	2
Collisions in non-breeding season, immature birds	1	1	1
Total collisions per year, all ages	4 ± 0.8	6 ± 1.1	4 ± 0.8

216. Based on the maximum design scenario of 54 turbines and the worst-case collision modelling output (Band Option 2 with 99.5% AR (± 0.001)), a total of two adult herring gulls and no immatures are estimated to be impacted during the breeding season and three adults and one immature herring gull are estimated to be impacted during the non-breeding season.

Herring gull collision rate – Breeding season (April to August)

217. In the breeding season, the mean maximum foraging range of breeding herring gulls is 61.1 ± 44 km, based on a sample size of two birds (Thaxter *et al.* 2012). Based on this, three SPAs for breeding herring gulls (Forth Islands, Fowlsheugh and St Abb's Head to Fast Castle) are within mean maximum foraging range + 1 SD of the Project. Herring gulls from other breeding colonies that may not be SPAs will occur within the Wind Farm Area and therefore may also be at risk of collision impacts. Following the recommended approach to apportioning impacts (SNH 2014), the potential impacts on all non-SPA breeding colonies and across all SPA colonies within the mean maximum foraging range for which herring gull is a qualifying feature of the site during the breeding season have been apportioned (Table 2-16).

Table 2-38: Estimated number of herring collisions during breeding season across SPA colonies and all colonies within mean maximum foraging range.

Herring gull	Breeding season adults	
	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle)	All colonies Mean maximum foraging range (105.1 km)
Forth Islands	1.95	1.67
Fowlsheugh	0.01	0.00
St Abb's Head to Fast Castle	0.04	0.04
Other colonies	0	0.29

218. Based on the results from the collision rate modelling and apportioning the estimated impacts across SPA and non-SPA colonies it is predicted that two herring gulls from the Forth Islands SPA may be impacted during the breeding season and there will, in effect, be no impacts on herring gulls from other SPA colonies.

Herring gull collision rate – Non-breeding season (September to March)

219. A total of six herring gull collisions are predicted to occur throughout the year, with two collisions occurring in the breeding season. A total of four collisions are therefore predicted to occur during the non-breeding season, of which one will be an immature bird.

220. The total number of herring gulls (adults and immature birds) estimated to occur in the UK waters of the North Sea and English Channel in the non-breeding season (September to February) is 466,511 birds (Furness, 2015). Of this population, an estimated 331,381 herring gulls (adults and immature birds) are considered to be from UK breeding colonies.

221. Estimated numbers of adult and immature herring gulls from the four SPAs for herring gulls considered in this assessment in the UK waters of the North Sea in the non-breeding season (September to March) are shown in Table 2-39 (Furness, 2015).

Table 2-39: Estimated numbers of adult and immature herring gulls from the four key SPAs in the UK waters of the North Sea and English Channel in the non-breeding season (Furness, 2015)

SPA	Non-breeding season North Sea		
	Adult	Immature	Total
Fowlsheugh	513	536	1,049
Forth Islands	5,597	5,855	11,452
St Abb's Head to Fast Castle	473	495	968
Buchan Ness to Collieston Coast	6,166	6,449	12,615
Combined total	12,749	13,335	26,084

222. If all four collisions impacted on herring gulls from the Forth Islands SPA, this would represent 0.03% of the Forth Islands SPA population in the UK waters of the North Sea in the non-breeding season.

223. However, this is an unrealistic assumption as during the non-breeding season herring gulls will forage widely across their wintering areas and many of the birds at risk of being impacted during the non-breeding season will be from other colonies. Assuming that all four herring gulls estimated to be at risk of an impact during the non-breeding season are from colonies within the mean maximum foraging range an estimated three birds will be from the Forth Islands SPA and one from a non-SPA colony (Table 2-40).

Table 2-40: Estimated number of herring gull collisions during non- breeding season across SPA colonies and all colonies within mean maximum foraging range

Herring gull	Non-breeding season (all ages)	
	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle)	All colonies Mean maximum foraging range (105.1 km)
Forth Islands	3.75	3.24
Fowlsheugh	0.03	0.03
St Abb's Head to Fast Castle	0.13	0.12
Buchan Ness to Collieston	0.08	0.07
Other colonies	0	0.54

224. The results from the assessment above indicates that two herring gulls during the breeding season and three during the non-breeding season be from the Forth Islands SPA. There is a very low risk of any herring gulls from other SPAs or other colonies being impacted.

225. Due to the very low level of impact on herring gulls from the Project alone, no in-combination assessment has been undertaken.

2.3.4 Puffin

226. Within the mean maximum foraging range of 105.4 ± 46.0 km, puffin is a qualifying species for the Forth Islands, Farne Islands and Coquet Island SPAs. Advice provided in the Scoping Opinion is that only the Forth Islands SPA should be considered in the assessment.

227. Advice provided in the Scoping Opinion is that impacts from displacement arising from the proposed Project alone and in-combination could have a likely significant effect on puffins during the breeding season. No significant effects are predicted to occur during the non-breeding season (Marine Scotland, 2017).

228. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it is assumed that there will be 60% displacement of puffins from the Wind Farm Area (and buffer areas).

Puffin displacement - Breeding season (April to mid - August)

229. Assuming 60% of all puffins are displaced from the Wind Farm Area during the breeding season, this would affect an estimated 1,609 birds, increasing to 3,704 birds including the 2 km buffer (Table 2-41). The matrices presenting the full range of potential displacement impacts on puffins are presented in EIA Report Appendix 9.4

230. Using the approach recommended in the Scoping Opinion of estimating the number of immature birds by the PVA stable age structure it is estimated that 49.4% of the population present are immature or non-breeding birds. Consequently, an estimated 795 puffins that may be displaced from the Wind Farm Area during the breeding season would be immature or non-breeding adults and that the number of displaced breeding adult birds would be 814 birds. Similarly, an estimated 1,830 puffins displaced from the Wind Farm Area and 2 km buffer during the breeding season would be immature or non-breeding adults, with 1,874 displaced breeding adult birds (Table 2-41).

Table 2-41: Summary of puffin displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	814	795	1,609
Wind Farm Area + 2 km	1,874	1,830	3,704

231. Using the 2% mortality rate as advised in the Scoping Opinion, it is estimated that up to 37 adult and 37 immature puffins could suffer mortality if displacement impacts occur up to 2 km from Wind Farm Area during the breeding season (Table 2-42).

Table 2-42: Summary of puffin displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement mortality	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	16	16	32
Wind Farm Area + 2 km	37	37	74

232. Based on advice received during Scoping the only SPA for which puffin is a qualifying species that is to be considered in the HRA is the Forth Islands SPA. A displacement mortality of 37 adults during the breeding season in the Wind Farm Area and 2 km buffer corresponds to 0.04% of the Forth Islands SPA adult breeding population.

233. If the potential impacts are apportioned across all colonies that are within the mean maximum foraging range then it is estimated that 35 puffins from the Forth Islands SPA may be impacted and two from other colonies within the mean maximum foraging range (Table 2-43).

Table 2-43: Estimated adult puffin displacement mortality during breeding season across SPA colonies and all colonies within mean maximum foraging range.

Puffin	Breeding season adults	
	SPAs only (Forth Islands)	All colonies Mean maximum foraging range (105.4 ± 46.0 km)
Forth Islands	37	34.6
Other colonies	0	2.4

234. The loss of 35 adult puffins from the SPA during the breeding season corresponds to 0.04% of the breeding population.

Puffin displacement - Non-breeding season (mid-August to March)

235. Advice in the Scoping Opinion is that puffins during the non-breeding season from mid-August to March are not required to be assessed in the HRA. Following breeding, puffins disperse widely and are not present in the Firths of Forth and Tay in any significant numbers. Consequently, no assessment has been undertaken for the purposes of this HRA.

2.3.4.1 Puffin In-combination

236. In-combination impacts on puffins relate to potential displacement impacts during the breeding season only.

2.3.4.1.1 Puffin in-combination displacement impacts

237. In order to assess in-combination impacts on puffins it is assumed that there will be 60% displacement effect that will cause 2% mortality for all projects considered in the assessment based on the peak mean number of puffins recorded at each project during the breeding season. The estimated number of adult puffins is estimated from a PVA stable age structure. The number of adult puffins impacted by displacement from each of the projects based on the worst-case Scenario are presented in Table 2-44.

Table 2-44: Estimated adult puffin mortality from displacement impacts from Forth and Tay Wind Farms in the breeding season

Project	No of adults	
	Wind Farm Area	Wind Farm Area + 2 km buffer
NnG	16	37
Inch Cape	25	46
Seagreen A	21	21
Seagreen B	27	27
Kincardine OWF	0	0
Forthwind (2 turbines)	1	1
Hywind	2	2
Total	92	134

238. There is only one SPA for which puffin is a qualifying feature in the area of potential effect, although there are relatively smaller numbers of puffins nesting at other colonies within the mean maximum

foraging range, the majority of puffins will from the Forth Islands SPA and it is presumed for the purposes of this in-combination assessment that all impacted birds will be from this SPA.

2.3.5 Razorbill

239. Within the mean maximum foraging range of 48.5 ± 35.0 km, razorbill is a qualifying species for the Forth Islands SPA, St Abb's Head to Fast Castle SPA and Fowlsheugh SPA.

240. Advice provided in the Scoping Opinion is that impacts from displacement arising from the proposed Project alone and in-combination could have a likely significant effect on razorbills (Marine Scotland, 2017).

241. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it is assumed that there will be 60% displacement of razorbills from the Wind Farm Area (and buffer areas) in the breeding and non-breeding seasons.

Razorbill displacement - Breeding season (April to mid - August)

242. Assuming 60% of all razorbills are displaced from the Wind Farm Area during the breeding season, this would affect an estimated 368 birds and 749 birds including the 2 km buffer (Table 2-45). The matrices presenting the full range of potential displacement are presented in EIA Appendix 8.4

243. This estimate includes non-breeding immature birds, as well as breeding adults. Using the approach recommended in the Scoping Opinion of estimating the number of immature birds by the PVA stable age structure it is estimated that 43.6% of the population present are immature or non-breeding birds. Consequently, an estimated 160 razorbills displaced from the Wind Farm Area during the breeding season would be immature or non-breeding adults and that the number of displaced breeding adult birds would be 208 birds. Similarly, an estimated 327 razorbills displaced from the Wind Farm Area and 2 km buffer during the breeding season would be immature or non-breeding adults, with 422 displaced breeding adult birds (Table 2-45).

Table 2-45: Summary of razorbill displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	208	160	368
Wind Farm Area + 2 km	422	327	749

244. Using the 1% mortality rate as advised in the Scoping Opinion, it is estimated that up to four adult and three immature razorbills could suffer mortality if displacement impacts occur up to 2 km from the Wind Farm Area (Table 2-46).

Table 2-46: Summary of razorbill displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season.

Displacement mortality	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	2	2	4
Wind Farm Area + 2 km	4	3	7

245. Apportioning the potential worst-case impacts during the breeding season only across the SPA colonies within the mean maximum foraging range +1 SD of 83.5 km, it is estimated that three razorbills from the Forth Islands SPA, and less than one razorbill from the other SPAs may be impacted. If apportioned across all colonies that are within the mean maximum foraging range an estimated

four[2] razorbills from the Forth Islands SPA and less than one from each of the other SPAs and non-SPA colonies may be affected (Table 2-47).

Table 2-47: Estimated adult razorbill displacement mortality during breeding season across SPA colonies and all colonies within mean maximum foraging range.

Razorbill	Breeding season adults	
	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle)	All colonies Mean maximum foraging range (48.5 ± 35 km)
Forth Islands	3.32	3.10
Fowlsheugh	0.34	0.31
St Abb's Head to Fast Castle	0.34	0.32
Other colonies	0	0.27

Razorbill displacement - Non-breeding season (mid-August to March)

246. The non-breeding season is between mid-August and March. As defined in the Scoping Opinion (Marine Scotland, 2017) Based on the advice received during Scoping it is assumed that during this season 60% of the razorbills will be displaced and that this will cause a mortality rate of 1%. The number of immatures within the population has been estimated through the use of PVA stable age structures.

247. The estimated numbers of razorbill displaced during the non-breeding season is presented in Table 2-48 and the estimated mortality based on the number of birds displaced within the Wind Farm Area and a 2 km radius is presented in Table 2.49.

Table 2-48: Summary of razorbill displacement for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	511	331	842
Wind Farm Area + 2 km	1,130	731	1,861

Table 2-49: Summary of razorbill displacement mortality for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds
Wind Farm Area	5	3	8
Wind Farm Area + 2 km	11	8	19

248. Based on a worst-case scenario of displacement effects occurring within 2 km of the Wind Farm Area, it is estimated that a total of 19 razorbills (11 adults and 8 immatures) may not survive due to the effects of displacement during the non-breeding season.

249. To apportion out the potential impacts of both adult and immature razorbills across the SPA colonies during the non-breeding season the estimated number of adult and immature razorbills within the UK

[2] Note the apportioned total of razorbills during the breeding season predicts three razorbills from the Forth Island SPA to be impacted and less than one for other SPAs. For the purposes of this assessment the impacts on the Forth Islands population has been rounded up to ensure that the total number of razorbills predicted to be impacted is equal to un-apportioned total of four birds.

waters of the North Sea and English Channel during each of the non-breeding seasons have been used and presented in Table 2-50 (Furness, 2015).

Table 2-50: Estimated numbers of adult and immature razorbills from the three SPAs in the UK waters of the North Sea and English Channel in the non-breeding season (Furness, 2015)

SPA	Non-breeding season		
	Adult	Immature	Total
Fowlsheugh	7,048	4,757	11,805
Forth Islands	5,250	3,544	8,794
St Abb's Head to Fast Castle	2,438	1,646	4,084
Combined total	14,736	9,947	24,683

250. Assuming that all 19 razorbills at risk of mortality are all from SPAs that are within the breeding season mean maximum foraging range, a total of 15 razorbills are predicted to come from the Forth Islands SPA, two from Fowlsheugh SPA and two from St Abb's Head to Fast Castle SPA (Table 2-51).

251. If the impacts during the non-breeding season affect all razorbill colonies within the mean maximum foraging range then an estimated 15 razorbills from the Forth Islands may be impacted, two from Fowlsheugh, two from St Abb's Head to Fast Castle and one from a non-SPA colony[3].

Table 2-51: Estimated razorbill displacement mortality during non-breeding season across SPA colonies and all colonies within mean maximum foraging range

Razorbill	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle)	All colonies Mean maximum foraging range (48.5 ± 35 km)
	Non-breeding Season	Non-breeding Season
Forth Islands	15.31	14.62
Fowlsheugh	1.63	1.55
St Abb's Head to Fast Castle	2.06	1.97
Other colonies	0	0.85

252. The total number of razorbills estimated to be impacted during the breeding and non-breeding seasons, assuming impacts are on all colonies within the mean maximum foraging range, is presented in Table 2-52.

Table 2-52: Estimated razorbill displacement mortality during breeding and non-breeding seasons across all SPA colonies

Razorbill	Breeding season (Adults)	Non – breeding season (all ages)	Total number of birds
Forth Islands	4	15	19
Fowlsheugh	0	2	2
St Abb's Head to Fast Castle	0	2	2
Other colonies	0	1	1

[3] Note that the number of razorbills at each of the colonies has been rounded up or down, as appropriate.

2.3.5.1 Razorbill In-combination

253. In-combination impacts on razorbills relate to potential displacement impacts during the breeding and non-breeding seasons.

2.3.5.1.1 Razorbill in-combination displacement impacts

254. In order to assess in-combination impacts on razorbill it is assumed that there will be 60% displacement effect that will cause 1% mortality for all projects considered in the assessment based on the peak mean number of razorbills recorded at each project during the breeding season. The estimated number of adult razorbills is estimated from a PVA stable age structure. The number of adult razorbills impacted by displacement from each of the projects during the breeding season and based on the worst-case Scenario are presented in Table 2-53.

Table 2-53: Estimated adult razorbill mortality from in-combination impacts from Forth and Tay Wind Farms in the breeding season

Project	No of adults	
	Wind Farm Area	Wind Farm Area + 2 km buffer
NnG	2	4
Inch Cape	11	20
Seagreen A	7	7
Seagreen B	2	2
Kincardine OWF [1]	0	0
Forthwind (2 turbines)	0	0
Hywind	0	0
Total	22	33

255. The results from apportioning the potential impacts across the three SPAs that are within the mean maximum foraging range of breeding razorbills, i.e. Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle are presented in Table 2-54.

Table 2-54: Estimated number of adult razorbills at risk of displacement level impacts during breeding season

Project	Forth Islands	Fowlsheugh	St Abb's Head to Fast Castle
NnG	2.83	0.31	0.55
Inch Cape	4.77	7.47	1.35
Seagreen A	0.73	3.95	0.55
Seagreen B	0.21	1.13	0.10
Total	8.54	12.86	2.55

256. The results indicate that during the breeding season an in-combination displacement impact could cause the loss of nine birds at the Forth Islands SPA, 13 birds at Fowlsheugh SPA and 3 birds at St Abb's Head to Fast Castle SPA.

257. During the non-breeding season there is potential for an in-combination displacement impact on razorbills from the Project and Inch Cape and Seagreen wind farms (Marine Scotland 2017).

258. The estimated number of razorbills predicted to be impacted based on a 60% avoidance rate and 1% mortality are presented in Table 2-55.

Table 2-55: Estimated razorbill mortality from displacement impacts from Forth and Tay Wind Farms in the non-breeding season

Project	No of birds	
	Wind Farm Area	Wind Farm Area + 2 km buffer
NnG	8	19
Inch Cape	13	29
Seagreen A	5	5
Seagreen B	7	7
Total	33	60

259. The results from apportioning the potential impact on 60 birds across the three SPAs that are within the mean maximum foraging range of breeding razorbills, i.e. Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle are presented in Table 2-56.

Table 2-56: Estimated number of adult razorbills at risk of displacement level impacts during non-breeding season

Project	Forth Islands	Fowlsheugh	St Abb's to Fast Castle
NnG	14.6	1.55	1.97
Inch Cape	8.39	12.93	1.64
Seagreen A	0.62	3.29	0.21
Seagreen B	0.86	4.60	0.29
Total	23.61	22.37	4.11

260. The results indicate that during the non-breeding season an in-combination displacement impact could cause the loss of 24 birds in the Forth Islands SPA, 23 birds at Fowlsheugh SPA and four birds at St Abb's Head to Fast Castle SPA.

261. The total number of razorbills estimated to be impacted by in-combination impacts during the breeding and non-breeding seasons across these three SPAs is presented in Table 2-57.

Table 2-57: Total number of razorbills estimated to be impacted at each of the SPAs during breeding and non-breeding seasons

Project	Forth Islands	Fowlsheugh	St Abb's Head to Fast Castle
Displacement effect (Breeding)	8.54	12.86	2.55
Displacement effect (Non-breeding)	23.61	22.37	4.11
Total	32.15	35.23	6.66

262. An estimated total of 32 razorbills from the Forth Islands SPA, 35 from Fowlsheugh SPA and seven from St Abb's Head to Fast Castle SPA may be impacted each year.

2.3.6 Guillemot

263. Guillemot is a qualifying species for the Forth Islands SPA, St Abb's Head to Fast Castle SPA, Fowlsheugh SPA and Buchan Ness to Collieston Coast SPA. It is also a qualifying species for the Farne Islands SPA which lies 72 km from the Wind Farm Area and is therefore within the mean maximum foraging range of 84.2 ± 50.1 km for guillemot during the breeding season. Advice received in the

Scoping Opinion is that only the four SPAs listed above need to be considered for HRA and therefore the Farne Islands SPA is not included in this assessment (Marine Scotland, 2017).

264. Advice provided in the Scoping Opinion is that impacts from displacement arising from the proposed Project alone and in-combination could have a likely significant effect on guillemots (Marine Scotland, 2017).

265. Based on advice received in the Scoping Opinion (Marine Scotland, 2017), it is assumed that there will be 60% displacement of guillemots from the Wind Farm Area (and buffer areas) in the breeding and non-breeding seasons.

Guillemot displacement - Breeding season (April to mid - August)

266. Assuming 60% of all guillemots are displaced from the Wind Farm Area during the breeding season, this would affect an estimated 1,321 birds, increasing to 2,936 birds including the 2 km buffer (Table 2-58). The matrices presenting the full range of potential displacement are presented in EIA Appendix 8.4.

267. This estimate includes non-breeding immature birds, as well as breeding adults. Studies have shown that for several seabird species, in addition to breeding birds, colonies are also attended by many immature individuals and a smaller number of non-breeding adults (e.g. Wanless *et al.* 1998). There is little information on the breakdown of immature and non-breeding adults present at a colony. Using the approach recommended in the Scopining Opinion of estimating the number of immature birds by the PVA stable age structure it is estimated that 48.9% of the population present are immature or non-breeding birds. Consequently, an estimated 646 guillemots displaced from the Wind Farm Area during the breeding season would be immature or non-breeding adults and the number of displaced breeding adult birds would be 675 birds. Similarly, an estimated 1,500 guillemots that may be displaced from the Wind Farm Area plus a 2 km radius during the breeding season would be immature or non-breeding adults, with 1,436 displaced breeding adult birds (Table 2-58).

Table 2-58: Summary of guillemot displacement for the Wind Farm Area and surrounding buffer areas in the breeding season

Displacement	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	675	646	1,321
Wind Farm Area + 2 km	1,436	1,500	2,936

268. Using the 1% mortality rate advised by the Scoping Opinion (Marine Scotland, 2017), it is estimated that up to 15 adults and 14 immature or non-breeding guillemots could suffer mortality if displacement impacts occur up to 2 km from Wind Farm Area (Table 2-59).

Table 2-59: Summary of guillemot displacement mortality for the Wind Farm Area and surrounding buffer areas in the breeding season.

Displacement mortality	Breeding adults	Immature or non-breeding adults	Total number of birds
Wind Farm Area	7	6	13
Wind Farm Area + 1 km	8	8	16
Wind Farm Area + 2 km	15	14	29

269. Apportioning the potential worst-case impacts during the breeding season across the SPA colonies considered within this HRA, it is estimated that ten guillemots from the Forth Islands SPA, three from St Abb's Head to Fast Castle SPA, two from Fowlsheugh SPA and less than one from Buchan Ness to Collieston Coast SPA may be impacted. If apportioned across all colonies that are within the mean maximum foraging range, nine guillemots from the Forth Islands SPA, four from St Abb's Head to Fast Castle SPA, one from Fowlsheugh SPA and one from a non-SPA may be affected (Table 2-60). Less

than one guillemot from the Buchan Ness to Collieston Coast SPA is estimated to be impacted by the offshore wind farm.

Table 2-60: Estimated adult guillemot displacement mortality during breeding season across SPA colonies and all colonies within mean maximum foraging range.

Guillemot	Breeding season adults	
	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle, Buchan Ness to Collieston Coast)	All colonies Mean maximum foraging range (84.2 ± 50.1 km)
Buchan Ness to Collieston Coast	0.30	0.20
Forth Islands	9.85	9.40
Fowlsheugh	1.50	1.28
St Abb's Head to Fast Castle	3.34	3.59
Other colonies	0	0.84

Guillemot displacement - Non-breeding season (mid-August March)

270. Assuming 60% of all guillemots were displaced from the Wind Farm Area during the non-breeding season (mid-August to March), this would affect an estimated 2,334 birds, increasing to 4,571 birds with a 2 km buffer (Table 2-61). Of these, it is estimated through the use of PVA stable age structures, that 45.1% of the population are immature birds.

Table 2-61: Summary of guillemot displacement for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement	Adults	Immature birds	Total number of birds
Wind Farm Area	1,281	1,053	2,334
Wind Farm Area + 2 km	2,509	2,062	4,571

271. Using the 1% mortality rate advised by the Scoping Opinion (Marine Scotland, 2017), it is estimated that 46 guillemots (25 adults and 21 immature birds) displaced from the Wind Farm Area plus a 2 km buffer, during the non-breeding season would suffer mortality as a result (Table 2-62).

Table 2-62: Summary of guillemot displacement mortality for the Wind Farm Area and surrounding buffer areas in the non-breeding season

Displacement mortality	Adults	Immature birds	Total number of birds
Wind Farm Area	13	10	23
Wind Farm Area + 2 km	25	21	46

272. Estimated numbers of adult and immature guillemots from the four SPAs for guillemots considered in this assessment in the UK waters of the North Sea and English Channel in the non-breeding season are presented in Table 2.63 (Furness, 2015).

Table 2-63: Estimated numbers of adult and immature guillemots from the four key SPAs in the UK waters of the North Sea in the non-breeding season (Furness, 2015)

SPA	Non-breeding Season North Sea and English Channel		
	Adult	Immature	Total
Buchan Ness to Collieston Coast	20,685	13,393	34,078
Fowlsheugh	48,160	31,184	79,344
Forth Islands	26,413	17,374	43,787
St Abb's Head to Fast Castle	39,785	26,170	65,955
Combined total	135,043	88,121	223,164

273. Assuming that all 46 guillemots at risk of mortality are from SPAs a total of 30 will be from the Forth Islands SPA, 12 from St Abb's Head to Fast Castle SPA, four from Fowlsheugh SPA and less than one from Buchan Ness to Collieston Coast SPA.

274. If the impacts during the non-breeding season affect all guillemot colonies within the mean maximum foraging range then an estimated 29 guillemots from the Forth Islands SPA may be impacted, ten from St Abb's Head to Fast Castle SPA, four from Fowlsheugh SPA, three from non-SPA colonies and none from Buchan Ness to Collieston Coast SPA.

Table 2-64: Estimated guillemot displacement mortality during non-breeding season across SPA colonies and all colonies within mean maximum foraging range

Guillemot	Non-breeding season (all ages)	
	SPAs only (Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle, Buchan Ness to Collieston Coast)	All colonies Mean maximum foraging range (84.2 ± 50.1 km)
Buchan Ness to Collieston Coast	0.55	0.49
Forth Islands	29.87	28.84
Fowlsheugh	3.87	3.91
St Abb's Head to Fast Castle	11.73	10.08
Other colonies	0	2.56

275. The total number of guillemots estimated to be impacted during the breeding and non-breeding seasons, assuming impacts are on all colonies within the mean maximum foraging range, is presented in Table 2-65.

Table 2-65: Estimated guillemot displacement mortality during breeding and non-breeding seasons across all SPA colonies

Guillemot	Breeding season (Adults)	Non – breeding season (all ages)	Total number of birds
Forth Islands	9	29	38
Fowlsheugh	1	4	5
St Abb's Head to Fast Castle	4	10	14
Buchan Ness to Collieston Coast	0	0	0

Guillemot	Breeding season (Adults)	Non – breeding season (all ages)	Total number of birds
Other colonies	1	3	4

2.3.6.1 Guillemot In-combination

276. In-combination impacts on guillemots relate to potential displacement impacts during the breeding and non-breeding seasons.

2.3.6.1.1 Guillemot in-combination displacement impacts

277. In order to assess in-combination impacts on guillemot it is assumed that there will be 60% displacement effect that will cause 1% mortality for all projects considered in the assessment based on the peak mean number of guillemots recorded at each project during the breeding season. The estimated number of adult guillemots is estimated from a PVA stable age structure. The number of adult guillemots impacted by displacement from each of the projects during the breeding season are presented in Table 2-66. For the purposes of this assessment due to the very small numbers of birds impacted by Kincardine OWF, Forthwind and Hywind these have not been apportioned across the SPAs as the numbers impacted at each site will be negligible.

Table 2-66: Estimated adult guillemot mortality from displacement impacts from Forth and Tay Wind Farms during the breeding season

Project	No of adults	
	Wind Farm Area	Wind Farm Area + 2 km buffer
NnG	7	15
Inch Cape	16	33
Seagreen A	42	42
Seagreen B	32	32
Kincardine OWF	4	4
Forthwind (2 turbines)	2	2
Hywind	1	1
Total	104	129

278. The results from apportioning the potential impacts across the four SPAs that are within the mean maximum foraging range of breeding guillemots, i.e. Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle and Buchan Ness to Fast Castle are presented in Table 2-67.

Table 2-67: Estimated number of adult guillemots at risk of displacement level impacts during breeding season

Project	Forth Islands	Fowlsheugh	St Abb's Head to Fast Castle	Buchan Ness to Collieston Coast
NnG	9.77	1.33	3.4	0.21
Inch Cape	8.25	16.24	4.18	1.26
Seagreen A	4.19	28.56	3.67	2.1
Seagreen B	3.19	21.76	2.80	1.6
Total	25.41	67.87	14.07	5.16

279. The results indicate that during the breeding season an in-combination displacement impact could cause the loss of 25 birds at the Forth Islands SPA, 68 birds at Fowlsheugh SPA 14 birds at St Abb's Head to Fast Castle SPA and five from Buchan Ness to Collieston Coast SPA.

280. During the non-breeding season there is potential for an in-combination displacement impact on guillemots from the the Project and Inch Cape and Seagreen wind farms (Marine Scotland 2017).

281. The estimated number of guillemots predicted to be impacted based on a 60% avoidance rate and 1% mortality are presented in Table 2-68.

Table 2-68: Estimated guillemot mortality from displacement impacts from Forth and Tay Wind Farms in the non-breeding season

Project	No of birds	
	Wind Farm Area	Wind Farm Area + 2 km buffer
NnG	23	46
Inch Cape	12	23
Seagreen A	24	24
Seagreen B	27	27
Total	86	120

282. The results from apportioning the potential impact on 120 birds across the four SPAs i.e. Forth Islands, Fowlsheugh, St Abb's Head to Fast Castle and Buchan Ness to Collieston Coast are presented in Table 2-69.

Table 2-69: Estimated number of adult guillemots at risk of displacement level impacts during non-breeding season

Project	Forth Islands	Fowlsheugh	St Abb's Head to Fast Castle	Buchan Ness to Fast Castle
NnG	28.29	4.0	12.38	0.58
Inch Cape	5.51	11.47	3.50	0.81
Seagreen A	2.29	16.51	2.52	1.10
Seagreen B	2.58	18.57	2.83	1.24
Total	38.67	50.55	21.23	3.73

283. The results indicate that during the non-breeding season an in-combination displacement impact could cause the loss of 39 birds in the Forth Islands SPA, 51 birds at Fowlsheugh SPA 21 birds at St Abb's head to Fast Castle SPA and 4 birds at Buchan Ness to Collieston Coast SPA. An estimated six birds will be from non-SPA colonies.

284. The total number of guillemots estimated to be impacted by in-combination impacts during the breeding and non-breeding seasons across these four SPAs is presented in Table 2-57.

Table 2-70: Total number of guillemots estimated to be impacted at each of the SPAs during breeding and non-breeding seasons

Project	Forth Islands	Fowlsheugh	St Abb's Head to Fast Castle	Buchan Ness to Collieston Coast
Displacement effect (Breeding)	25.41	67.87	14.07	5.16
Displacement effect (Non-breeding)	38.67	50.55	21.23	3.73
Total	64.08	118.42	35.30	8.89

285. An estimated total of 64 guillemots from the Forth Islands SPA, 118 from Fowlsheugh SPA, 35 from St Abb's Head to Fast Castle SPA and nine from Buchan Ness to Collieston Coast SPA may be impacted each year.

2.4 Estimated Magnitude of Effect (pSPAs)

286. The following section provides the information relating to the potential estimated impacts on the relevant qualifying species for the Firth of Forth and St Andrews Bay Complex pSPA. Details on the methods used and approaches taken are presented in the EIA Report Chapter 9: Ornithology.

287. Based on advice received during Scoping, the qualifying species and the potential impacts to be assessed are presented in Table 2-71.

Table 2-71: Qualifying Interest species for the Outer Firth of Forth and St Andrews Bay Complex pSPA included in the assessment of displacement and collision impacts

Qualifying interest	Displacement	Collision impacts
Gannet	x	Collision impacts in breeding season
Kittiwake	Displacement impacts in breeding and non-breeding seasons	Collision impacts in breeding and non-breeding seasons
Herring gull	x	Collision impacts in breeding and non-breeding seasons
Guillemot	Displacement impacts in breeding and non-breeding seasons	x
Razorbill	Displacement impacts in non-breeding season	x
Puffin	Displacement impacts in breeding season	x
Little gull	Displacement impacts in non-breeding season	Collision impacts in non-breeding season
Common gull	Displacement impacts in non-breeding season	Collision impacts in non-breeding season
Black-headed gull	Displacement impacts in non-breeding season	Collision impacts in non-breeding season

288. For the following assessment, it is assumed that for each species considered, the pSPA population is spread evenly across the pSPA. For breeding season impacts, the reference pSPA population was taken as the most recent available counts of the breeding populations of the terrestrial SPA breeding colonies that border the pSPA. This approach was agreed at a meeting between NnG, Marine Scotland, SNH and JNCC to discuss the pSPA designation in October 2016, on the basis that the population estimates presented for the pSPA during the pSPA consulation process (SNH 2016), were the minimum number of birds that occurred regularly within the pSPA boundary that could be used to build the case for designation. Counts from the adjacent terrestrial SPA breeding colonies bordering the pSPA were considered more representative of the numbers of birds likely to occur within the pSPA in the breeding season.

289. Impacts in the non-breeding season within the pSPA are based on the populations given in the pSPA site selection document (SNH 2016). However, it should be noted that the populations presented in the pSPA site selection document were intended for designation purposes only and are effectively the minimum numbers likely to be present.

290. Collision Impacts and the effects from displacement will only affect birds within the pSPA. Consequently, not all the estimated impacts from the Project will affect birds within the pSPA as the whole of the Project does not overlap with the pSPA. Although it is recognised that in-

combination impacts could occur with projects outwith the SPA, these in-combination impacts have already been assessed against the relevant terrestrial SPA populations which make up the reference pSPA population. Therefore, no additional in-combination assessment has been undertaken for the pSPA.

2.4.1 Gannet

291. For gannet, the Forth Islands SPA borders the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season is estimated at 75,259 pairs (Table 2-7).

292. As details of the number of turbines likely to be placed within the part of the Wind Farm Area that overlaps with the pSPA are not yet available, the area of the Wind Farm within the pSPA has been applied to results from Collision Rate Modelling, to allow the proportionate affected number of birds of each species to be estimated. Approximately 32% of the Wind Farm Area overlaps with the pSPA.

293. For the worst-case design scenario (54 turbines), a total of 93 gannet collisions (91 adults and two immature birds) were estimated for the breeding season (Table 2-14). Assuming that all gannets recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all breeding season collisions will occur in the overlapping Wind Farm Area; an estimated total of 30 birds.

2.4.2 Kittiwake

294. For kittiwake, both the Forth Islands SPA (4,663 pairs), and St. Abb's Head to Fast Castle SPA (3,334 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 7,997 pairs (Table 2-7).

295. For the worst case design scenario (54 turbines), nine kittiwake collisions (eight adults and one immature bird) have been estimated for the breeding season (Table 2-16). Assuming that all kittiwakes recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all breeding season collisions would occur in the overlapping Wind Farm Area; an estimated total of three birds.

296. During the non-breeding season, the estimated population for the pSPA is 3,191 birds (SNH 2016). Approximately 32% of the Wind Farm Area overlaps with the pSPA.

297. A total of 19 kittiwake collisions (12 adults and seven immature bird) are estimated to be impacted during the non-breeding season (Table 2-17). Assuming that all kittiwakes recorded in the Wind Farm Area during baseline surveys are evenly distributed, then 32% of all non-breeding season collisions could occur in the overlapping Wind Farm Area; an estimated total of six birds.

298. Based on Project specific information the three-year peak mean population of kittiwakes recorded in the Wind Farm Area and 2 km buffer in the breeding season was 2,164 birds. The area of overlap with the pSPA with a 2 km buffer is 46%. Therefore, 46% of the 3-year peak mean population of 2,164 kittiwakes recorded in the Wind Farm Area and 2 km buffer on baseline surveys could be displaced, which equates to 995 individuals. Assuming that there is a 30% displacement rate and 2% mortality it is estimated that a total of six adult kittiwakes may suffer mortality due to displacement effects in the breeding season.

299. During the non-breeding season, the pSPA kittiwake estimated population is 3,191 birds (SNH 2016). The three-year peak mean population of kittiwakes recorded in the Wind Farm Area and 2 km buffer during the non-breeding season was 2,016 birds. The area of overlap with the pSPA is 46% and therefore 46% of the 3-year peak mean population of 2,016 kittiwakes could be displaced in the breeding season, which equates to 927 individuals. Assuming that there is a 30% displacement rate and 2% mortality then an estimated six birds (3 adults and 3 immature or non-breeding adults) may be impacted during the non-breeding season.

300. The total number of kittiwakes at risk of mortality from the effects of displacement across the year is estimated to be 12 birds.

2.4.3 Puffin

301. For puffin the Forth Islands SPA borders the pSPA and therefore, for the purposes of this assessment, the pSPA puffin population during the breeding season is estimated at 45,005 pairs (Table 2-7).

302. The three-year peak mean population of puffins recorded in the Wind Farm Area and 2 km buffer during the breeding season was 6,173 birds. The area of overlap with the pSPA is 46% and therefore 46% of the 3-year peak mean population of 6,173 puffins could be displaced in the breeding season, which equates to 2,840 individuals. Assuming that there is a 60% displacement rate and 2% mortality then an estimated 34 birds (17 adults and 17 immature or non-breeding adults) may be impacted during the breeding season.

2.4.4 Razorbill

303. During the non-breeding season the estimated pSPA razorbill population is 5,481 birds (SNH 2016).

304. The three-year peak mean population of razorbills recorded in the Wind Farm Area and 2 km buffer during the non-breeding season was 2,536 birds. The area of overlap with the pSPA is 46% and therefore 46% of the 3-year peak mean population of 2,536 razorbills could be displaced in the non-breeding season, which equates to 1,167 individuals. Assuming that there is a 60% displacement rate and 1% mortality then an estimated seven birds (four adults and three immature) may be impacted during the non-breeding season.

2.4.5 Guillemot

305. For guillemot, both the Forth Islands SPA (28,786 birds), and St. Abb's Head to Fast Castle SPA (36,206 birds) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 64,992 birds (Table 2-7).

306. The three-year peak mean population of guillemots recorded in the Wind Farm Area and 2 km buffer during the breeding season was 4,894 birds. The area of overlap with the pSPA is 46% and therefore 46% of the 3-year peak mean population of 4,894 guillemots could be displaced in the breeding season, which equates to 2,251 individuals. Assuming that there is a 60% displacement rate and 1% mortality then an estimated 14 birds (seven adults and seven immature or non-breeding adults) may be impacted during the breeding season.

307. During the non-breeding season, the estimated pSPA guillemot population is 21,968 birds (SNH 2016).

308. The three-year peak mean population of guillemots recorded in the Wind Farm Area and 2 km buffer during the non-breeding season was 7,618 birds. The area of overlap with the pSPA is 46% and therefore 46% of the 3-year peak mean population of 7,618 puffins could be displaced in the non-breeding season, which equates to 3,504 individuals. Assuming that there is a 60% displacement rate and 1% mortality then an estimated 21 birds (12 adults and 9 immature) may be impacted during the non-breeding season.

2.4.6 Herring gull

309. For herring gull, both the Forth Islands SPA (6,580 pairs), and St. Abb's Head to Fast Castle SPA (325 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 6,905 pairs (Table 2-7).

310. For the worst-case design scenario (54 turbines), a total of two herring gull collisions (both adults) were estimated for the breeding season (Table 2-38), Assuming that all herring gulls recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32%

of all breeding season collisions, could occur in the overlapping Wind Farm Area and therefore less than one bird is predicted to be impacted during the breeding season.

311. For herring gull, the estimated population for the pSPA in the non-breeding season is given as 12,313 birds (SNH 2016).

312. An estimated four herring gulls are predicted to be impacted during the non-breeding season (Table 2-40) Assuming that all herring gulls recorded in the Wind Farm Area during baseline surveys were evenly distributed across the Wind Farm Area, then 32% of all non-breeding season collisions could occur in the overlapping Wind Farm Area. An estimated one herring gull may be impacted during the non-breeding season.

2.4.7 Little gull

313. For little gull, the estimated population for the pSPA in the non-breeding season is given as 126 birds (SNH 2016). However, the size of the regional autumn passage population of little gulls is unknown and this presents a constraint in undertaking the assessment. Analysis of ESAS data by Skov *et al*. (1995) identifies a geographically discrete autumn passage concentration in the outer Firth of Forth and Firth of Tay (referred to as Tay Bay by Skov *et al*.). There is uncertainty regarding the current size of this population as the number estimated by Skov *et al*. (450 birds) is far lower than the typical total of about 1,000 birds seen at coastal roost counts in Fife and Lothian (Forrester *et al.* 2007). Furthermore, survey work commissioned in recent years to inform the proposed offshore wind farms in the Firth of Forth area has shown that this species is more common than previously appreciated (or numbers have increased), with peak estimates for the NnG Wind Farm Area and 8 km buffer area of 1,756 birds in October of Year 1, 1,352 birds in October of Year 2 and 3,841 birds in September of Year 3 (Appendix 9.2: Table 16), which gives a three-year peak seasonal mean of 2,316 little gulls. The upper limit of 3,000 birds from Forrester *et al.*'s (2007) estimate of 1,500 - 3,000 individuals present between June and November in the Forth and Tay area has been used in this assessment as the best available pSPA population size during autumn passage.

314. Based on the outputs from Collision Rate Modelling there will be no impacts on little gulls from collisions.

315. The three-year peak mean population of little gulls recorded in the Wind Farm Area and 2 km buffer during the breeding season was 495 birds. The area of overlap with the pSPA is 46% and therefore 46% of the 3-year peak mean population of 495 little gulls could be displaced in the non-breeding season, which equates to 228 individuals. Assuming that there is a 30% displacement rate and 2% mortality then an estimated 1 bird may be impacted during the non-breeding season.

2.4.8 Black-headed gull

316. Based on the outputs from Collision Rate Modelling there will be no impacts on black-headed gulls from collisions.

317. During the non-breeding season the estimated pSPA black-headed gull population is 26,835 birds (SNH 2016). The three-year peak mean population of black-headed gulls recorded in the Wind Farm Area and 2 km buffer during the breeding season was 912 birds. The area of overlap with the pSPA is 46% and therefore 46% of the 3-year peak mean population of 912 black-headed gulls could be displaced in the non-breeding season, which equates to 228 individuals. Assuming that there is a 30% displacement rate and 2% mortality then an estimated 6 birds may be impacted during the non-breeding season.

2.4.9 Common gull

318. Based on the outputs from Collision Rate Modelling there will be no impacts on common gulls from collisions

319. During the non-breeding season, the estimated pSPA common gull population is 14,647 birds (SNH 2016). The three-year peak mean population of common gulls recorded in the Wind Farm Area and 2 km buffer during the breeding season was 498 birds. The area of overlap with the pSPA is 46% and therefore 46% of the 3-year peak mean population of 498 common gulls could be displaced in the non-breeding season, which equates to 149 individuals. Assuming that there is a 30% displacement rate and 2% mortality then an estimated 3 birds may be impacted during the non-breeding season.

2.5 Habitats Regulations Appraisal SPA

320. The following section assesses the potential impacts on the relevant qualifying species within the SPAs as advised in the Scoping Opinion.

2.5.1 Forth Islands SPA

321. Site overview information for the Forth Islands SPA is provided in Table 2-72 below.

Table 2-72: Site overview for Forth Islands SPA

Site Information	Details
Site overview	The Forth Islands SPA lies approximately 16 km to the west of the proposed Project. The site comprises a series of islands supporting the main seabird colonies in the Firth of Forth including the Isle of May, Bass Rock, Craigleith, Inchmickery, Fidra and The Lamb.
Site designation – qualifying species and features (* indicates assemblage qualifier only)	▪ Arctic tern *Sterna paradisaea*; ▪ Common tern *Sterna hirundo*; ▪ Cormorant *Phalacrocorax carbo**; ▪ Fulmar *Fulmarus glacialis**; ▪ Gannet *Morus bassanus*; ▪ Guillemot *Uria aalge**; ▪ Herring gull *Larus argentatus**; ▪ Kittiwake *Rissa tridactyla**; ▪ Lesser black-backed gull *Larus fuscus*; ▪ Puffin *Fratercula arctica*; ▪ Razorbill *Alca torda**; ▪ Roseate tern *Sterna dougallii*; ▪ Sandwich tern *Sterna sandvicensis*; ▪ Shag *Phalacrocorax aristotelis*; and ▪ Seabird assemblage.
Site Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: ▪ Population of the species as a viable component of the site; ▪ Distribution of the species within site; ▪ Distribution and extent of habitats supporting the species; ▪ Structure, function and supporting processes of habitats supporting the species; and ▪ No significant disturbance of the species.

322. The potential effects of the proposed development, as identified, occur outside the SPA itself. Advice received in the Scoping Opinion is that, the conservation objective "Population of the species as a viable component of the site" captures all of the other conservation objectives for the existing colony SPAs (Marine Scotland 2017). This is also the advice received by MS-LOT from the Statutory Nature

Conservation Bodies when undertaking an Appropriate Assessment for the Original Project (Marine Scotland, 2014)

323. The Scoping Opinion advised that the following qualifying species should be considered as being at risk of a likely significant effect:

- Gannet,
- Kittiwake,
- Herring gull,
- Puffin,
- Guillemot,
- Razorbill.

324. Other qualifying species are scoped out of this assessment.

2.5.1.1 Gannet

325. Based on the advice received there will be a likely significant effect on gannets from the Forth Islands SPA due to collision mortality with Neart na Gaoithe offshore wind farm on its own and in-combination with other offshore wind farms.

2.5.1.1.1 Gannet: Project alone

326. Results from collision rate modelling indicate that 108 (± 19.6) gannets of all ages may be impacted by collisions across the year (Table 2-9). During the breeding season an estimated 91 adults will be impacted and a further 15 (± 2.7) of all ages will be impacted during the non-breeding season. For the purposes of this assessment it has been assumed that all gannets impacted will be from the Forth Islands SPA. However, during the non-breeding season it is likely that gannets from other colonies could occur in the area and therefore not all birds estimated to be impacted will be from this SPA.

327. Tagging studies undertaken at the Bass Rock gannet colony within the Forth Islands SPA indicate that when feeding chicks, gannets from the SPA may forage widely across the North Sea, covering an area greater than 200,000 km^2 and extending as far as Bergen/Viking Bank (SW Norway) in the north and the Frisian Islands (NW Netherlands) in the south (Hamer *et al.* 2011). During the winter gannets occur widely across their winter range. In recent years, increasing numbers of adult gannets winter further south than historically, with an increasing availability of discards from fishing vessels further south and a decreasing availability of discards in the North Sea (Garthe *et al*. 2012). The mean maximum distances recorded from tagged gannets from the Bass Rock varies between years, depending on food availability, but ranges from between 170 km and 363 km (Hamer *et al.* 2011)

328. Gannets from the Bass Rock frequently forage over distinct bathymetric features including Buchan Deep and Halibut Bank to the north-east of the colony and to the area between Farne Deep, Outer Silver Pit and Dogger Bank to the south-east of the colony (Hamer *et al.* 2011). A significant amount of foraging occurs over a tidal mixing front approximately 50 km offshore. However, there are also large inter-annual variations linked with the availability of food with significant differences in the maximum recorded foraging distance between years. EIA Appendix 9.7 contains maps of breeding adult gannets from the Bass Rock between 2010 and 2012, and in 2015.

329. Population Viability Analysis has been undertaken for gannets breeding in the Forth Islands SPA over 25 year and 50 year seasons. Details of the PVA undertaken are presented in the EIA Report Appendix 9.8 and results are summarised here.

330. The results from the PVA indicate that with the estimated level of impact arising from the Project alone the population of gannets within the SPA will continue to increase, although at a reduced rate. After 25 years it is predicted that the breeding population will have increased from the current population of 75,259 pairs to 132,394 pairs and continue to increase to 203,046 pairs after 50 years (Table 2-73).

331. After 25 years, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of -1.23%. Alternatively, the counterfactual population size is 98.77% of that for the scenario with no wind farm constructed.

332. After 50 years, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of -2.88%. Alternatively, the counterfactual of population size (CPS) is 97.12% of that for the scenario with no wind farm constructed (Table 2-73).

Table 2-73: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the Project over 25 and 50 years

Gannet	SPA & start Population	Baseline population (pairs) (no wind farm)	Population (pairs) with NnG (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
25 years	Forth Islands 75,259 pairs	132,394	130,761	-1.23	98.77%
50 years		203,046	197,206	-2.88	97.12%

333. The potential loss of up to 91 adult gannets from collision impacts during the breeding season and a further 15 birds in the non-breeding season (108 individuals in total per year, all ages), is significantly below the predicted levels of impact the population will be able to withstand before a decline on the SPA gannet population occurs. Population Viability Analysis has indicated that the SPA population will continue to increase. Overall, PVA results indicate that collision impacts from NnG alone on the breeding gannet population at Forth Islands SPA over the lifetime of the Project are not likely to be significant.

334. Gannets at the Forth Islands SPA are reported to be in favourable condition (SNH, 2017b) and based on the results from PVA analysis, gannets will remain a viable component of the site. The loss of up to 108 additional gannets across the year will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.1.1.2 Gannet: in-combination

335. Based on the worst-case in-combination scenario (Scenario Two: NnG, 2014 Inch Cape and Seagreen A and B), there will be an estimated 1,166 gannet collisions (adults and immatures) each breeding season, assuming all four Forth and Tay projects are built to this scenario. This corresponds to 0.9% of the breeding population of the Forth Islands SPA. Considering only adult gannets, there will be an estimated 1,135 collisions each breeding season, this corresponds to 0.75% of the breeding SPA population.

336. Population Viability Analysis has been undertaken for gannets breeding in the Forth Islands SPA over 25 year and 50 year seasons with in-combination impacts arising from Scenario Two. Details of the PVA undertaken are presented in the EIA Report Chapter 9: Ornithology: Appendix 9.8 and results are summarised here.

337. The results from the PVA indicate that with the estimated level of impact arising from the Project in-combination with other consented developments the population of gannets within the SPA will continue to increase, although at a reduced rate (Table 2-74). After 25 years it is predicted that the breeding population may have increased from the current population of 75,259 pairs to 112,892 pairs and continue to increase to 148,150 pairs after 50 years.

338. After 25 years, the percentage change in the median final population size is -14.73%, and the CPS value is 85.27%of the scenario with no wind farms built. After 50 years, the percentage change in the median final population size when comparing the baseline (no wind farms) with Scenario Two present is a decrease of -27.04%. The CPS value for Scenario Two after 50 years is 72.96%of the scenario with no wind farms.

Table 2-74: Change in predicted population size for gannets breeding at the Forth Islands SPA (Bass Rock) with and without the NnG and 2014 Forth and Tay projects over 25 and 50 years

Gannet	SPA & start Population	Baseline population (Pairs) (no wind farm)	Population (Pairs) with NnG & F&T projects (collisions all year)	Percentage change in median final population size compared to baseline	Counterfactual of Population Size (CPS)
25 years	Forth Islands 75,259 pairs	132,394	112,892	-14.73	85.27%
50 years		203,046	148,150	-27.04	72.96%

339. During the non-breeding season gannets from the Forth Islands SPA may be impacted by other wind farms across the North Sea. It is estimated that a total of 193 gannets from the Forth Islands SPA may be impacted during the non-breeding season by NnG, the 2014 Forth & Tay project and other UK wind farms in the North Sea and English Channel (Table 2-15). Population Viability Analysis analysis for all collision impacts throughout the year from this scenario has been undertaken and the results indicate that the gannet population within the Forth Islands SPA will continue to increase over 25 and 50 years, albeit at a slower rate than if there were no wind farms present.

340. The results from the collision rate modelling undertaken and the assessment of potential in-combination impacts across wind farms in the Firths of Forth and Tay during the breeding season and across all UK North Sea and English Channel wind farms during the non-breeding season indicate that the population of gannets will continue to increase within the SPA, although at a lower rate than is predicted to occur when no wind farms are present. However, the predicted growth rate indicates that the gannet population will remain a viable component of the site. It is therefore concluded that the in-combination impacts will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.1.2 Kittiwake

341. Based on the advice received there will be a likely significant effect on kittiwakes from the Forth Islands SPA due to collision and displacement mortality with the Project on its own and in-combination with other offshore wind farms.

2.5.1.2.1 Kittiwake: Project alone

342. The kittiwake population at the Forth Islands SPA is in an unfavourable and declining condition (SNH, 2017b) having declined from 9,380 pairs at the time of SPA review undertaken in 2001 (Stroud *et al.* 2001). This is an annual decline of 631 breeding adults per year over a 16 year period and a decline of 50% since the SPA review.

343. Results from collision rate modelling indicate that 21 kittiwakes from the Forth Islands SPA may be impacted by combined collision and displacement impacts across the year (Table 2-28). During the breeding season an estimated eight adults may be impacted and a further 13 of all ages will be impacted during the non-breeding season.

344. The total number of adult kittiwakes from the Forth Islands SPA estimated to occur in the UK waters of the North Sea during the autumn and spring periods of the non-breeding season is 3,720 birds (Furness, 2015). In addition, a further 2,182 immature kittiwakes from the Forth Islands SPA are estimated to occur in the UK waters of the North Sea in the autumn period of the non-breeding season, with 1,637 immature birds from the Forth Islands SPA estimated to occur in the UK waters of the North Sea in the spring period of the non-breeding season.

345. PVA undertaken on kittiwakes breeding in the Forth Islands SPA indicate that for both the baseline and built scenarios, the kittiwake breeding population is predicted to increase over 25 years, although there is a slightly lower rate of increase when NnG is present. Over 25 years it is predicted to have

increased from its current population of 4,663 pairs to 6,118 pairs with no wind farm present (Table 2-75). With NnG present, the kittiwake breeding population is predicted to be very slightly lower after 25 years with an estimated end population of 6,059 pairs, for annual collisions and breeding season displacement combined. Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a maximum decrease of -0.97% for the Forth Islands SPA, for annual collisions and breeding season displacement. Alternatively, the CPS value is 99.03% of that for the scenario with no wind farm constructed.

346. Over 50 years the Forth Islands SPA kittiwake population is predicted to increase from 4,663 pairs to 7,665 pairs with no wind farm present. With NnG present, the kittiwake breeding population is predicted to be very slightly lower than the baseline after 50 years, with an estimated end population of 7,458 pairs, for annual collisions and breeding season displacement combined. Overall, the percentage change in the median final population size when comparing the baseline (no wind farm) with NnG is a maximum decrease of -2.70%, for annual collisions and breeding season displacement. Alternatively, the CPS value is 97.30%of that for the scenario with no wind farm constructed

347. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA with and without NnG over 25 years and 50 years are presented in Table 2-75.

Table 2-75: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA with and without the Project over 25 and 50 years

Kittiwake	SPA & start Population	Baseline population (Pairs) (no wind farm)	Population with NnG (Pairs)		Percentage change in median final population size compared to baseline		Counterfactual Population Size (%)	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
25 years	Forth Islands 4,663 pairs	6,118	6,034	6,059	-1.37	-0.97	98.63%	99.03%
50 years		7,665	7,515	7,458	-1.95	-2.70	98.05%	97.30%

348. Available evidence from existing operational projects indicates that kittiwake displacement is not likely to occur and as such it is considered that a displacement rate of 30% represents a highly precautionary assumption.

349. Results from monitoring at operational offshore wind farms indicate that kittiwakes are not likely to be displaced. Typically, studies at existing offshore wind farms show either no significant change or small increases in kittiwake numbers compared to pre-construction numbers. For example, analysis of five years of post-construction monitoring data at the Robin Rigg OWF suggested that there was no change in kittiwake flight behaviour in response to the presence of the turbines. (Walls *et al.* 2013a, 2013b). Post construction monitoring of kittiwakes at the OWEZ wind farm showed statistically significant attraction to the offshore wind farm during one survey with non-significant results (neither attraction or avoidance) for a further four surveys (Leopold *et al.* 2011). At Horns Rev, Denmark, selectivity indices were significantly higher for the wind farm area during operation compared with the baseline period (Diersche and Garthe, 2006). Post-construction monitoring at Arklow Bank, Ireland reported an increase in kittiwake numbers compared to baseline numbers, concentrated within *c.* 10 km of the turbine array (Barton et al. 2009). A review of avoidance behaviour recorded at operational wind farm projects in Denmark, Germany, the Netherlands, Belgium and the UK by Krijgsveld (2014), reported that three out of five studies reported kittiwakes as being indifferent to offshore wind farms, and readily entering them (OWEZ, PAWP, Blighbank). At Thorntonbank (B), results indicated that kittiwakes were positively attracted to the wind farm (Vanermen *et al*. 2013). Only one project (Alpha Ventus), where kittiwakes were numerous, reported a strong decline in numbers, suggesting possible avoidance (Mendel *et al*. 2014).

350. A recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated the degree of displacement for kittiwakes and auks within the wind farm (APEM 2017). This report is presented in EIA Appendix 9.5. The study concluded that mean densities calculated for the entire wind farm and its surrounding 8 km buffer zone indicated that there was no evidence of displacement for kittiwakes. There were variations in kittiwake densities between buffers but this was not statistically significant, potentially due in part to the large between-survey variability in kittiwake densities.

351. The advice provided by SNH in the Scoping Opinion (Marine Scotland, 2017) was that kittiwake did not need to be considered for displacement effects, as the data available from post construction monitoring indicates no significant avoidance behaviour by this species. It was also considered that 2% mortality following displacement was a precautionary estimate, and that the actual mortality rate as a direct result of displacement would be lower than this.

352. Consequently, on the basis of the evidence available it is unlikely that kittiwakes will be displaced from the Wind Farm Area and that mortality will occur.

353. For kittiwake, the PVA considered collision effects in isolation and in combination with displacement effects. Over both 25 and 50 years, the Forth Islands SPA population modelled showed an increase in the baseline scenario. For the modelled wind farm scenarios, these increases remained evident although were slightly lower than the baseline (no wind farm) scenario. Overall, results indicate that collision and displacement impacts from NnG alone on the breeding kittiwake population at Forth Islands SPA over the lifetime of the Project are likely to be small and have relatively little influence on the resulting population size.

354. Based on the relatively small reduction in increase on the population predicted to occur over both a 25 year and 50 year period, it is concluded that this level of impact will not significantly alter the future status of the species as a viable component of the site and therefore not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.1.2.2 Kittiwake: In-combination

355. Based on the worst-case in-combination scenario (Scenario Two: NnG, and the 2014 Inch Cape and Seagreen A and B design scenarios), there will be an estimated 26 adult kittiwakes from the Forth Islands SPA during the breeding season impacted by collisions and seven from displacement effects. A further 14 birds (adult and immature) may be impacted by collisions during the non-breeding season. Consequently, it is estimated that a total of 47 kittiwakes from the Forth Islands SPA could be impacted each year from in-combination impacts (Table 2-36).

356. PVA undertaken on kittiwakes breeding in the Forth Islands SPA indicate that the kittiwake population will increase if no wind farms are constructed. Over 25 years it is predicted to have increased from its current population of 4,663 pairs to 6,118 pairs for the no build situation. The predicted end population after 25 years with NnG and the 2014 Forth and Tay projects is 4,059 pairs for combined annual collision and breeding season displacement (Table 2-76). Overall, the change in the median final population size after 25 years when comparing the baseline (no wind farm) with NnG and the 2014 Forth and Tay projects is a maximum decrease of -33.66% for the Forth Islands SPA, for combined annual collisions and breeding season displacement. This gives a CPS value of 66.34% of the scenario with no wind farm.

357. Over 50 years the Forth Islands SPA is predicted to have increased from its current population of 4,663 pairs to 7,665 pairs for the no build situation. The predicted end population after 50 years with NnG and the 2014 Forth and Tay projects is 3,458 pairs, for combined annual collision and breeding season displacement. Overall, the change in the median final population size after 50 years when comparing the baseline (no wind farm) with NnG and the 2014 Forth and Tay projects is a maximum decrease of -54.88% for the Forth Islands SPA, for collisions and displacement throughout the year. This gives a CPS value of 45.12% of the scenario with no wind farm.

358. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA with and without in-combination effects over 25 years and 50 years are presented in Table 2-76.

Table 2-76: Change in predicted population size for kittiwakes breeding at the Forth Islands SPA with and without the Project and the 2014 Forth and Tay projects over 25 and 50 years

Kittiwake	SPA & start Population	Baseline population (pairs) (no wind farm)	Population (pairs) with in-combination impacts		Percentage change in median final population size compared to baseline		Counterfactual Population Size (%)	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
25 years	Forth Islands 4,663 pairs	6,118	4,19	4,059	-31.36	-33.66	68.64%	66.34%
50 years		7,665	3,644	3,458	-52.46	-54.88	47.54%	45.12%
Coll = Collision impacts, Disp = Displacement impacts, (y) = All year, (br) = Breeding season only								

359. For kittiwake, the Forth Islands SPA population modelled showed an increase in the baseline scenario. For the modelled wind farm scenarios, the end populations were predicted to be lower than the start population after both 25 and 50 years. As would be expected, the population growth rate was lowest for NnG and the 2014 Forth and Tay projects, as this scenario involves the highest number of turbines, and consequently a higher predicted number of collisions, with all of these collisions being assigned to the local breeding populations.

360. It is predicted that there will be a measurable decrease in the future kittiwake population due to in-combination impacts from estimated collision and displacement effects and that after 25 years these in-combination impacts could cause a decrease in the kittiwake breeding population of 33.66%, based on the worst-case scenario, which is unlikely to be built. It should be noted that it is considered highly unlikely that Inch Cape and Seagreen A & B will be built to the maximum extent of their 2014 consented envelopes, therefore the outcome of this assessment is considered to be highly precautionary and unrealistic. Based on the more realistic and most likely 2017 turbine scenarios for NnG, Inch Cape & Seagreen Phase 1, the PVA modelling predicted that after 25 and 50 years, the end population would be higher than the current start population, with these wind farms present (See Chapter 9: Ornithology).

361. Consequently, the estimated in-combination impacts will not affect the conservation objective to ensure the qualifying species remain a viable component of the site in the long term as other factors are influencing this objective. It is therefore concluded that the in-combination impacts will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.1.3 Herring gull

362. Based on the advice received there will be a likely significant effect on herring gulls from the Forth Islands SPA due to collision mortality with the Project on its own and in-combination with other offshore wind farms.

2.5.1.3.1 Herring gull: Project alone

363. The herring gull population has decreased slightly since the time of designation but is in a maintained and favourable condition (SNH, 2017b).

364. Results from collision rate modelling indicate that a total of two adult herring gulls and no immatures may be impacted during the breeding season and three adults and one immature herring gull may be

impacted during the non-breeding season. Of these six birds, five will be from the Forth Islands SPA and one from a non-SPA colony.

365. The herring gull breeding population in the Forth Islands SPA is 6,580 pairs (13,160 adults). The potential loss of up to five herring gulls per year is 0.04% of the SPA breeding population.

366. An increase in breeding herring gull mortality of less than 0.04% is a very small increase and will not impact on maintaining the population of the species as a viable component of the site adversely and not affect the integrity of the Forth Islands SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.1.3.2 Herring gull: In-combination

367. It is recognised that there is potential for an in-combination impact. However, the number of herring gulls estimated to be impacted by the Project alone are so low that any potential contribution the Project may have in-combination with other projects will be negligible and therefore it is predicted that there will be no in-combination impact with the Project that will affect the integrity of the Forth Islands SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.1.4 Puffin

368. Based on the advice received there will be a likely significant effect on puffins from the Forth Islands SPA due to the effects from displacement arising from the Project on its own and in-combination with other offshore wind farms in the breeding season only.

2.5.1.4.1 Puffin: Project alone

369. The puffin population is in a favourable maintained condition with an increase in population from 14,000 pairs at the time of site designation to 45,005 pairs between 2009 and 2017(SNH, 2017b) (Table 2-7).

370. The impacts from displacement during the breeding season based on 60% rate of displacement and 2% mortality during the breeding season indicates a total of 74 puffins may suffer mortality due to the effects from displacement, of which 37 may be breeding adults. The loss of 37 adults is 0.04% of the breeding population.

371. PVA undertaken on puffins during the breeding season in the Forth Islands SPA indicate that the puffin population will continue to increase. Over 25 years it is predicted that the population will have increased from its current level of 45,005 pairs to 174,231 pairs, with no wind farms present. The additional estimated mortality arising from displacement effects from the proposed wind farm may cause a reduced level of population increase with the future population predicted to be 172,875 pairs; an overall population difference of -0.78%. Alternatively, the counterfactual population size is 99.22% of that for the scenario with no wind farm constructed. Over a 50 year season the population is predicted to increase further to 531,902 pairs without the wind farm compared to 525,558 pairs with the wind farm; an overall population difference of -1.19%. Alternatively, the counterfactual population size is 98.81% of that for the scenario with no wind farm constructed.

372. Changes in the predicted population size for puffins breeding at the Forth Islands SPA with and without NnG over 25 years and 50 years are presented in Table 2-77.

Table 2-77: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without the Project over 25 and 50 years

Puffin	SPA & start Population	Baseline population (pairs) (no wind farm)	Population (pairs) with NnG	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Forth Islands 45,005 pairs	174,231 pairs	172,875 pairs	-0.78	99.22%
50 years		531,902 pairs	525,558 pairs	-1.19	98.81%

373. There is little published evidence from monitoring studies as to how puffins will respond to offshore wind farms as few wind farms are operating in areas where puffins regularly occur. However, a recent study conducted at the operational Westermost Rough Offshore Wind Farm in July 2017, investigated the degree of displacement for auks, including puffins within the operating wind farm (APEM 2017). This report is presented in Appendix 9.5 of the EIA Report. Westermost Rough is approximately 35 km from the Flamborough Head and Bempton Cliffs SPA, and is therefore within mean maximum foraging range of breeding puffins from this colony. The study recorded a high variability in overall mean densities of Auks, including puffins, calculated for the entire offshore wind farm and the surrounding buffer zone suggesting no evidence of displacement. There were variations in mean densities of Auks across the buffer zone but these differences were not statistically significant.

374. The population modelling undertaken indicates that at the levels of displacement and mortality used in this assessment, there will not be any decrease in the current population; with a continued significant increase in the breeding puffin population over the next 25 and 50 years. However, the effect from displacement may be to reduce the future population by 1.0 % over 25 years and 2.1% over 50 years from what it otherwise would be without any wind farm.

375. Based on the very low number of birds predicted to be affected and the results from population modelling that predict a continued increase in the SPA puffin population it is concluded that displacement effects on puffins during the breeding season will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.1.4.2 Puffin: In-combination

376. For the purposes of this assessment it is presumed that all puffins at risk of being impacted from the effects of displacement are from this SPA. This is precautionary as there are other small colonies within the mean maximum foraging range of this species that could occur in the area.

377. Based on a displacement of 60% and a 2% mortality, it is estimated that 134 puffins could suffer mortality due to in-combination displacement impacts, assuming displacement effects out to 2 km around the wind farms (Table 2-44). This is 0.15% of the current breeding population.

378. PVA analysis indicates that the puffin population within the SPA will increase significantly over the next 25 and 50 years without any impacts (Table 2-78). After 25 years, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of -2.56%. Alternatively, the counterfactual population size is 97.44% of that for the scenario with no wind farm constructed.

379. After 50 years, the change in the median final population size when comparing the baseline (no wind farm) with the built scenario is a decrease of -4.03%. Alternatively, the counterfactual of population size (CPS) is 95.97% of that for the scenario with no wind farm constructed.

Table 2-78: Change in predicted population size for puffins breeding at the Forth Islands SPA with and without in-combination impacts over 25 and 50 years

Puffin	SPA & start Population	Baseline population(pairs) (no wind farm)	Population (pairs) with NnG & F&T projects (displacement)	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Forth Islands 45,005 pairs	174,231	169,773	-2.56	97.44%
50 years		531,902	510,482	-4.03	95.97%

380. Based on the number of birds predicted to be affected and the results from population modelling that predict a continued increase in the SPA puffin population it is concluded that in-combination impacts of displacement on puffins during the breeding season will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.1.5 Razorbill

381. Based on the advice received there will be a likely significant effect on razorbills from the Forth Islands SPA due to the effects from displacement arising from the Project on its own and in-combination with other offshore wind farms.

2.5.1.5.1 Razorbill: Project alone

382. The razorbill population is in a favourable maintained condition with an increase in population from 2,800 birds at the time of site designation to 5,815 birds in 2017(SNH, 2017b) (Table 2-7).

383. The impacts from displacement during the breeding season based on 60% rate of displacement and 1% mortality during the breeding season indicates a total of four adult razorbills may suffer mortality due to the effects from displacement and further 15 birds of all ages may be impacted during the non-breeding season (Table 2-52). The potential loss of 19 razorbills across the year is 0.3% of the breeding population.

384. PVA undertaken on razorbills during the breeding season in the Forth Islands SPA indicate that the razorbill population will continue to increase with no wind farm present, although the rate of increase is predicted to be low. With NnG present, the end population after both 25 and 50 years is predicted to be slightly higher than the start population. Over 25 years it is predicted that the population will have increased from its current level of 7,792 pairs to 7,862 pairs, with no wind farm present (Table 2-79). With the proposed wind farm present, the population level is predicted to be similar, with the future population predicted to be 7,870 pairs; an overall population difference of +0.10%. Alternatively, the counterfactual population size is 110.10%% of that for the scenario with no wind farm constructed.

385. Over a 50 year period the population is predicted to increase further to 8,063 pairs without the wind farm compared to 7,749 pairs with the wind farm; an overall population difference of -3.89%. Alternatively, the counterfactual population size is 96.11% of that for the scenario with no wind farm constructed.

386. Changes in the predicted population size for razorbills breeding at the Forth Islands SPA with and without NnG over 25 years and 50 years are presented in Table 2-79.

Table 2-79: Change in predicted population size for razorbills breeding at the Forth Islands SPA with and without the Project over 25 and 50 years

Razorbill	SPA & start Population	Baseline population (pairs) (no wind farm)	Population with NnG & F&T projects (pairs) (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Forth Islands 7,792 pairs	7,862	7,870	+0.10	100.10%
50 years		8,063	7,749	-3.89	96.11%

387. There is some evidence from monitoring studies to suggest how razorbills may respond from the proposed wind farm. A review of avoidance behaviour recorded at operational wind farm projects in Denmark, Germany, the Netherlands, Belgium and the UK by Krijgsveld (2014) reported that strong avoidance by guillemots and razorbills was shown in eight out of 10 studies. Only at Thorntonbank in Belgium, results suggested that razorbills were attracted to and guillemots were indifferent to or avoided the wind farm, although these results were not significant. Similarly, at Blighbank both guillemots and razorbills avoided the wind farm (Vanermen *et al*. 2013). The level of displacement may vary depending on the spacing of the turbines with lower levels of displacement occurring in wind farms with wider spacing between turbines (Leopold *et al.* 2011). Five years of post-construction monitoring at Robin Rigg offshore wind farm indicated that razorbills were not displaced from the wind farm during the breeding season. Although they were recorded in lower densities these were not statistically significant (Nelson *et al.* 2015). A study conducted at the operational Westermost Rough Wind Farm in July 2017 recorded a high variability in overall mean densities of auks, including guillemots, calculated for the entire wind farm and its surrounding 1 km buffer zones suggesting no clear evidence of displacement. There were variations in mean densities of auks between buffers but these differences were not statistically significant (APEM 2017).

388. There is no clear pattern of displacement behaviour by razorbills, with some studies reporting displacement behaviour and others suggesting limited, if any, displacement. Therefore, by assuming that 60% of the razorbills may be displaced it is predicted to be precautionary and lower levels of displacement may occur, particularly during the breeding season, with two studies showing limited displacement of breeding razorbills during this period.

389. The population modelling undertaken indicates that at the levels of displacement and mortality used in this assessment, there will not be any significant decrease in the current population; with the razorbill population predicted to remain stable over the next 25 and 50 years. However, the effect from displacement may be to increase the future population by 0.10% over 25 years, with a decrease of 3.89% over 50 years from what it otherwise would be without any wind farm impacts.

390. Based on the very low number of birds predicted to be affected and the results from population modelling that predict continued stability in the SPA razorbill population, it is concluded that displacement effects on razorbills across the year will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.1.5.2 Razorbill: In-combination

391. Based on a displacement of 30% and a 1% mortality it is estimated that 32 razorbills could suffer mortality due to in-combination displacement impacts throughout the year (Table 2-57).

392. PVA undertaken on razorbills across the year in the Forth Islands SPA indicate that the razorbill population will continue to increase slightly with no wind farm present. The current population is estimated to be 7,792 pairs and the future population without any impacts may be 7,862 pairs after 25 years. The additional estimated mortality arising from in-combination displacement effects from the proposed wind farm may cause a reduced level of population increase with the future population

predicted to be 7,563 pairs; an overall population difference of -3.80%. Alternatively, the counterfactual population size is 96.20% of that for the scenario with no wind farm constructed (Table 2-80). Over a 50 year period the population is predicted to increase further to 8,063 pairs without the wind farm compared to 7,428 pairs with the wind farms present; an overall population difference of -7.88%. Alternatively, the counterfactual population size is 92.12% of that for the scenario with no wind farm constructed.

Table 2-80: Change in predicted population size for razorbills breeding at the Forth Islands SPA with and without in-combination impacts over 25 and 50 years

Razorbill	SPA & start Population	Baseline population (Pairs)	Population (pairs) with NnG & F&T projects (displacement)	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Forth Islands 7,792 pairs	7,862	7,563	-3.80	96.20%
50 years		8,063	7,428	-7.88	92.12%

393. Based on the number of birds predicted to be affected and the results from population modelling that predict continued stability in the SPA razorbill population, it is concluded that in-combination impacts of displacement on razorbills across the year will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.1.6 Guillemot

394. Based on the advice received there will be a likely significant effect on guillemots from the Forth Islands SPA due to the effects from displacement arising from the Project on its own and in-combination with other offshore wind farms.

2.5.1.6.1 Guillemot: Project alone

395. The guillemot population is in a favourable maintained condition with an increase in population from 8,000 birds at the time of site designation to 28,786 birds in 2017(SNH 2017b) (Table 2-7).

396. The impacts from displacement during the breeding season based on 60% rate of displacement and 1% mortality during the breeding season indicates a total of nine adult guillemots may suffer mortality due to the effects from displacement and further 29 birds of all ages may be impacted during the non-breeding season (Table 2-65). The potential loss of 28 guillemots across the year is 0.1% of the breeding population.

397. PVA undertaken on guillemots during the breeding season in the Forth Islands SPA indicate that the guillemot population will continue to increase. Over 25 years it is predicted that the population will have increased from its current level of 38,573 pairs to 67,234 pairs with no wind farm present (Table 2-81). The population modelling indicates that there will be little, if any impact on the guillemot population with a predicted increase in the population with the presence of the wind farm to 67,611 pairs; a 0.56% increase in the population. Alternatively, the counterfactual population size is 100.56% of that for the scenario with no wind farm constructed.

398. Over a 50 year period the population is predicted to increase further to 108,366 pairs without the wind farm compared to 107,270 pairs with the wind farm; a 1.01% difference in the population. Alternatively, the counterfactual population size is 98.99%% of that for the scenario with no wind farm constructed.

399. Changes in the predicted population size for guillemots breeding at the Forth Islands SPA with and without NnG over 25 years and 50 years are presented in Table 2-81.

Table 2-81: Change in predicted population size for guillemots breeding at the Forth Islands SPA with and without the Project over 25 and 50 years

Guillemot	SPA & start Population	Baseline population (pairs) (no wind farm)	Population (pairs) with NnG	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Forth Islands 38,573 pairs	67,234	67,611	+0.56	100.56%
50 years		108,366	107,270	-1.01	98.99%

400. Post-construction monitoring undertaken at Horns Rev offshore wind farm has indicated that displacement of guillemots can occur (Petersen *et al.* 2006). However, results from other operating wind farms have not shown a total displacement of guillemots. Compared to Horns Rev, the modelled results from OWEZ and the adjacent Princess Amalia wind farm did not conclusively show that guillemots were displaced from either of these wind farms (Leopold *et al.,*2011). Where guillemots were significantly displaced (2 out of 9 survey visits) this was not total, with birds recorded within both wind farms. However, the authors suggest that higher turbine density probably increased displacement of guillemots. The OWEZ study concluded that the magnitude of the displacement effect for guillemots was less than 50% (Leopold *et al.* 2011).

401. Guillemots have been recorded at the constructed Robin Rigg offshore wind farm, mean densities of birds on the sea declined during the construction phase, before returning to pre-constructions levels during operation (Nelson *et al.* 2015). Similarly, post-construction monitoring at Arklow Bank recorded no statistical difference in the number of guillemots recorded between pre and post construction, indicating no displacement of guillemots following construction (Barton *et al.* 2009).

402. There is no clear pattern of displacement behaviour by guillemots, with some studies reporting displacement behaviour and others suggesting limited, if any, displacement. Therefore, by assuming that 60% of the guillemots may be displaced it is predicted to be precautionary and lower levels of displacement are predicted to occur.

403. The population modelling undertaken indicates that at the levels of displacement and mortality used in this assessment, there will not be any decrease in the current population; with a continued increase in the guillemot population over the next 25 and 50 years. Furthermore, over a period of 25 and 50 years there is predicted to be effectively no population level effect. Over a period of 50 years the population may be reduced by approximately 1% from what it would have been if the wind farm was not present.

404. Based on the very low number of birds predicted to be affected and the results from population modelling, it is concluded that displacement effects will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.1.6.2 Guillemot: In-combination

405. Based on a displacement of 30% and a 1% mortality it is estimated that 64 guillemots could suffer mortality due to in-combination displacement impacts throughout the year (Table 2-70).

406. PVA undertaken on guillemots across the year in the Forth Islands SPA indicate that the guillemot population will continue to increase. The additional estimated mortality arising from in-combination displacement effects from the proposed wind farms is not predicted to affect the future population over a 25 year period with an overall population difference of -1.16%. Alternatively, the counterfactual population size is 98.84% of that for the scenario with no wind farm constructed (Table 2-82). Over a 50 year period the population is predicted to continue to increase with or without in-

combination displacement impacts, although there may be an overall population difference of -2.88%. Alternatively, the counterfactual population size is 97.12% of that for the scenario with no wind farm constructed.

Table 2-82: Change in predicted population size for guillemots breeding at the Forth Islands SPA with and without in-combination impacts over 25 and 50 years

Guillemot	SPA & start Population	Baseline population (pairs)	Population (pairs) with NnG & F&T projects (displacement)	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Forth Islands 38,573 pairs	67,234	66,454	-1.16	98.84%
50 years		108,366	105,244	-2.88	97.12%

407. Based on the number of birds predicted to be affected and the results from population modelling that predict a continued increase in the SPA guillemot population, it is concluded that in-combination impacts of displacement on guillemots across the year will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the Forth Islands SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.1.7 Forth Islands SPA - Conclusions

408. Based on the predicted level of potential impacts, it is concluded that there will be no adverse effects on the integrity of the Forth Islands SPA from the Project, either alone or in-combination with other plans or projects.

2.5.2 Fowlsheugh SPA

409. Site overview information for the Fowlsheugh SPA is provided in Table 2-83 below.

Table 2-83: Site overview for Fowlsheugh SPA

Site Information	Details
Site overview	Fowlsheugh SPA lies approximately 62 km to the north of Neart na Gaoithe. The site comprises of sheer cliffs, between 30 m and 60 m high, located 4 km south of Stonehaven on the east coast of Aberdeenshire in north-east Scotland.
Site designation – qualifying species and features (* indicates assemblage qualifier only)	▪ Fulmar (*Fulmarus glacialis*)*; ▪ Herring gull (*Larus argentatus*)*; ▪ Kittiwake (*Rissa tridactyla*)*; ▪ Guillemot (*Uria aalge*); ▪ Razorbill (*Alca torda*); and ▪ Seabird assemblage
Site Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: ▪ Population of the species as a viable component of the site; ▪ Distribution of the species within site; ▪ Distribution and extent of habitats supporting the species; ▪ Structure, function and supporting processes of habitats supporting the species; and ▪ No significant disturbance of the species

410. The potential effects of the proposed development, as identified, occur outside the SPA itself. Advice received in the Scoping Opinion is that, the conservation objective "Population of the species as a viable component of the site" captures all of the other conservation objectives for the existing colony SPAs (Marine Scotland, 2017). This is also the advice received by MS-LOT from the Statutory Nature Conservation Bodies when undertaking an Appropriate Assessment for the Original Project (Marine Scotland, 2014)

411. The Scoping Opinion advised that the following qualifying species should be considered as being at risk of a likely significant effect:

- Kittiwake,
- Herring gull,
- Razorbill,
- Guillemot.

412. On the basis of advice received other qualifying species and seabird assemblages are scoped out of this assessment.

2.5.2.1 Kittiwake

413. Based on the advice received there will be a likely significant effect on kittiwakes from the Fowlsheugh SPA due to collision and displacement mortality with the Project on its own and in-combination with other offshore wind farms.

2.5.2.1.1 Kittiwake: Project alone

414. The kittiwake population at the Fowlsheugh SPA is reported as in a favourable and maintained condition (SNH, 2017b). However, the kittiwake population has declined from 36,350 pairs at the time of site designation in 1992 to 9,655 pairs in 2015 (Table 2-7). This is an annual decline of over 2,300 breeding adults per year over a 23 year period and a decline of 73% since the SPA review. It is therefore considered unlikely to be in a favourable condition.

415. A total of five kittiwakes from the Fowlsheugh SPA may be impacted per year by combined collision and displacement impacts (Table 2-28). During the breeding season an estimated two adults may be impacted (one from collision and one from displacement effects), which equates to 0.01% of the current breeding population. A further three kittiwakes of all ages will be impacted during the non-breeding season.

416. PVA undertaken on kittiwakes breeding in the Fowlsheugh SPA indicate that the kittiwake population will continue to decline without any impacts from the proposed wind farm. Over 25 years it is predicted to have declined from its current population of 9,655 pairs to 4,629 pairs with no wind farm, and an estimated end population of 4,563 pairs, for annual collisions and breeding season displacement combined, with NnG present (Table 2-84). Overall, the change in the median final population size when comparing the baseline (no wind farm) with NnG is a maximum decrease of -1.42% for the Fowlsheugh SPA, for annual collisions and breeding season displacement. Alternatively, the CPS value is 98.58% of that for the scenario with no wind farm constructed.

417. Over 50 years the Fowlsheugh SPA kittiwake population is predicted to have declined from 9,655 pairs to 2,593 pairs with no wind farm present. With NnG present, the kittiwake breeding population is predicted to be very slightly lower than the baseline at the end of the 50 year period, with an estimated end population of 2,532 pairs, for annual collisions and breeding season displacement combined. Overall, the percentage change in the median final population size when comparing the baseline (no wind farm) with NnG is a maximum decrease of -2.34%, for annual collisions and breeding season displacement. Alternatively, the CPS value is 97.66% of that for the scenario with no wind farm constructed.

418. Changes in the predicted population size for kittiwakes breeding at the Fowlsheugh SPA with and without NnG over 25 years and 50 years are presented in Table 2-84.

Table 2-84: Change in predicted population size for kittiwakes breeding at the Fowlsheugh SPA with and without the Project over 25 and 50 years

Kittiwake	SPA & start Population	Baseline population (pairs) (no wind farm)	Population with NnG (pairs)		Percentage change in median final population size compared to baseline		Counterfactual Population Size (%)	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
25 years	Fowlsheugh 9,665 pairs	4,629	4,577	4,563	-1.12	-1.42	98.88%	98.58%
50 years		2,593	2,547	2,532	-1.76	-2.34	98.24%	97.66%
Coll = Collision impacts, Disp = Displacement impacts, (y) = All year, (br) = Breeding season only								

419. As previously discussed (See Section 2.5.1.2 Forth Islands Kittiwake) available evidence from existing operational projects indicates that kittiwake displacement is not likely to occur and as such it is considered that a displacement rate of 30% represents a highly precautionary assumption and it is unlikely that kittiwakes will be displaced from the Wind Farm Area and that mortality will occur.

420. For kittiwake, the PVA considered collision effects in isolation and in combination with displacement effects. The Fowlsheugh SPA population modelled showed a decline in the baseline scenario. For the modelled wind farm scenarios, these declines remained evident and were slightly enhanced. Overall, results indicate that collision and displacement impacts from NnG alone on the breeding kittiwake population at Fowlsheugh SPA over the lifetime of the Project are likely to be small and have relatively little influence on the resulting population size.

421. Based on the relatively small additional effect on the population predicted to occur over both a 25 year and 50 year period, it is concluded that this level of impact will not significantly alter the future status of the species as a viable component of the site and therefore not adversely affect the integrity of the Fowlsheugh SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.2.1.2 Kittiwake: In-combination

422. Based on the worst-case in-combination scenario (Scenario Two: NnG, and the 2014 Inch Cape and Seagreen A and B design scenarios), there will be an estimated 176 adult kittiwakes from the Fowlsheugh SPA during the breeding season impacted by collisions and 18 from displacement effects. A further 41 birds (adult and immature) may be impacted by collisions during the non-breeding season. Consequently, it is estimated that a total of 235 kittiwakes from the Fowlsheugh SPA could be impacted each year from in-combination impacts (Table 2-36). The Project is estimated to contribute no more than five kittiwakes to the total.

423. PVA undertaken on kittiwakes breeding in the Fowlsheugh SPA indicate that the kittiwake population will continue to decline if no wind farms are constructed. Over 25 years it is predicted to have declined from its current population of 9,655 pairs to 4,629 pairs for the no build situation (Table 2-85). The predicted end population after 25 years with NnG and the 2014 Forth and Tay projects is 3,367 pairs, for annual collisions and breeding season displacement. Overall, the change in the median final population size after 25 years when comparing the baseline (no wind farm) with NnG and the 2014 Forth and Tay projects is a maximum decrease of -27.27% for the Fowlsheugh SPA, for annual collisions and breeding season displacement. This gives a CPS value of 72.74% of the scenario with no wind farm.

424. Over 50 years the Fowlsheugh SPA is predicted to have declined from its current population of 9,655 pairs to 2,593 pairs for the no build situation. The predicted end population after 50 years with NnG and the 2014 Forth and Tay projects is 1,399 pairs for annual collisions and breeding season displacement. Overall, the change in the median final population size after 50 years when comparing the baseline (no wind farm) with NnG and the 2014 Forth and Tay projects is a maximum decrease of -46.07% for the Fowlsheugh SPA, for annual collisions and breeding season displacement. This gives a CPS value of 53.93% of the scenario with no wind farm.

425. Changes in the predicted population size for kittiwakes breeding at the Forth Islands SPA with and without in-combination effects over 25 years and 50 years are presented in Table 2-85.

Table 2-85: Change in predicted population size for kittiwakes breeding at the Fowlsheugh SPA with and without in-combination impacts over 25 and 50 years

Kittiwake	SPA & start Population	Baseline population (pairs) (no wind farm)	Population (pairs) with in-combination impacts		Percentage change in median final population size compared to baseline		Counterfactual Population Size (%)	
			Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)	Coll (y)	Coll (y) & Disp (br)
25 years	Fowlsheugh 9,665 pairs	4,629	3,454	3,367	-25.39	-27.27	74.61%	72.74%
50 years		2,593	1,462	1,399	-43.61	-46.07	56.39%	53.93%
Coll = Collision impacts, Disp = Displacement impacts, (y) = All year, (br) = Breeding season only								

426. For kittiwake, the Fowlsheugh SPA population modelled showed a decline in the baseline scenario. For the modelled wind farm scenarios, these declines remained evident and were slightly enhanced. As would be expected, the population growth rate was lowest for the Project and the 2014 Forth and Tay projects, as this scenario involves the highest number of turbines, and consequently a higher predicted number of collisions, with all of these collisions being assigned to the local breeding populations.

427. Overall, results indicate that in-combination collision and displacement impacts from the Project and the 2014 Forth and Tay projects on the breeding kittiwake population at Fowlsheugh SPA over the lifetime of the Project are likely to be small and have relatively little influence on the resulting population size.

428. It should be noted that it is considered highly unlikely that Inch Cape and Seagreen A & B will be built to the maximum extent of their 2014 consented envelopes, therefore the outcome of this assessment is considered to be highly precautionary and unrealistic.

429. It is predicted that there will be a measurable decrease in the future kittiwake population due to in-combination impacts from estimated collision and displacement effects and that after 25 years these in-combination impacts could cause a decrease in the kittiwake breeding population of 27.27%, based on the worst-case scenario, which is unlikely to be built. The additional impacts estimated from offshore wind farms will not alter the fact that the SPA population is, and will continue to decline for factors not related to offshore wind farms and that the absence of wind farms will not stop the decline from occurring. Consequently, the estimated in-combination impacts will not affect the conservation objective to ensure the qualifying species remain a viable component of the site in the long term as other factors are influencing this objective. It is therefore concluded that the in-combination impacts will not adversely affect the integrity of the Fowlsheugh SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.2.2 Herring gull

430. Based on the advice received there will be a likely significant effect on herring gulls from the Fowlsheugh SPA due to collision mortality with the Project on its own and in-combination with other offshore wind farms.

2.5.2.2.1 Herring gull Project alone and in-combination

431. The herring gull population has decreased significantly since the time of designation when the population was 3,190 pairs to the latest population estimate of 125 pairs (Table 2-7). The population is in an unfavourable and declining condition (SNH, 2017b).

432. Results from collision rate modelling indicate that no herring gulls will be impacted by the proposed Project during the breeding season and 0.03 herring gulls during the non-breeding season (Table 2-38 and Table 2-40).

433. Although, it is recognised that the herring gull population at the Fowlsheugh SPA has undergone significant decrease, the very small potential impact of 0.03 birds per year caused by collision impacts will not contribute to this decline either alone or in-combination with other offshore wind farms and will therefore not affect the maintaining of the population as a viable component of the site.

434. The predicted very low number of impacts will not adversely affect the integrity of the Fowlsheugh SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.2.3 Razorbill

435. Based on the advice received there will be a likely significant effect on razorbills from the Fowlsheugh SPA due to the effects from displacement arising from the Project on its own and in-combination with other offshore wind farms.

2.5.2.3.1 Razorbill: Project alone

436. The razorbill population is in a favourable maintained condition with an increase in population from 5,800 birds at the time of site designation to 7,426 birds in 2017 (SNH, 2017b) (Table 2-7).

437. The impacts from displacement during the breeding season based on 60% rate of displacement and 1% mortality indicates a total of <1 razorbill may suffer mortality due to the effects from displacement and two birds of all ages may be impacted during the non-breeding season (Table 2-52). The potential loss of two razorbills across the year is 0.02% of the current breeding population.

438. PVA undertaken on razorbills during the breeding season in the Fowlsheugh SPA indicate that the razorbill population will continue to increase. Over 25 years it is predicted that the population will have increased from its current level of 9,950 pairs to 13,491 pairs with no wind farm present (Table 2-86). The additional estimated mortality arising from displacement effects from the proposed wind farm may cause a reduced level of population increase with the future population predicted to be 13,324 pairs; an overall population difference of -1.23%. This gives a CPS value of 98.77% of the scenario with no wind farm.

439. Over a 50 year period the population is predicted to increase further to 16,932 pairs without the wind farm compared to 16,353 pairs with the wind farm; an overall population difference of -3.42% and a CPS value of 96.58%

440. Changes in the predicted population size for razorbills breeding at the Fowlsheugh SPA with and without NnG over 25 years and 50 years are presented in Table 2-86.

Table 2-86: Change in predicted population size for razorbills breeding at the Fowlsheugh SPA with and without the Project over 25 and 50 years

Razorbill	SPA & start Population	Baseline population (pairs) (no wind farm)	NnG Alone Population (pairs) (displacement all year)	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Fowlsheugh 9,950 pairs	13,491	13,324	-1.23	98.77%
50 years		16,932	16,353	-3.42	96.58%

441. As discussed in section 2.5.1.5 there is no clear pattern of displacement effects on razorbills from existing wind farms.

442. The population modelling undertaken indicates that at the levels of displacement and mortality used in this assessment, there will not be any decrease in the current population; with a continued increase in the razorbill population over the next 25 and 50 years. However, the effect from displacement may be to reduce the future population by 1.23 % over 25 years (CPS value of 99.77%) and 3.42% (CPS value of 96.58%) over 50 years from what it otherwise would be without any wind farm impacts.

443. Based on the very low number of birds predicted to be affected and the results from population modelling that predict a continued increase in the SPA razorbill population, it is concluded that displacement effects on razorbills across the year will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the Fowlsheugh SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.2.3.2 Razorbill: In-combination

444. Based on a displacement of 60% and a 1% mortality it is estimated that 35 razorbills from Fowlsheugh SPA could suffer mortality due to in-combination displacement impacts throughout the year (Table 2-57).

445. PVA undertaken on razorbills across the year in the Fowlsheugh SPA indicate that the razorbill population will continue to increase. The current population is estimated as 9,950 pairs and the future population without any impacts is predicted to be 13,491 pairs after 25 years. The additional estimated mortality arising from in-combination displacement effects from the proposed wind farm may cause a reduced level of population increase with the future population predicted to be 12,923 pairs; an overall population difference of -4.21%. Alternatively, the counterfactual population size is 95.79% of that for the scenario with no wind farm constructed (Table 2-87). Over a 50 year period the population is predicted to increase further with or without in-combination displacement impacts. Although there may be an overall end population difference of -6. 04%. Alternatively, the counterfactual population size is 93.96% of that for the scenario with no wind farm constructed.

Table 2-87: Change in predicted population size for razorbills breeding at the Fowlsheugh SPA with and without in-combination impacts over 25 and 50 years

Razorbill	SPA & start Population	Baseline population (Pairs)	Population (pairs) with NnG & F&T projects (displacement)	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Fowlsheugh 9,950 pairs	13,491	12,923	-4.21	95.79%
50 years		16,932	15,910	-6.04	93.96%

446. Based on the number of birds predicted to be affected and the results from population modelling that predict a continued increase in the Fowlsheugh SPA razorbill population, it is concluded that in-combination impacts of displacement on razorbills across the year will not impact on the species

remaining as a viable component of the site and will not adversely affect the integrity of the Fowlsheugh SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.2.4 Guillemot

447. Based on the advice received there will be a likely significant effect on guillemots from the Fowlsheugh SPA due to the effects from displacement arising from the Project on its own and in-combination with other offshore wind farms.

2.5.2.4.1 Guillemot: Project alone

448. The guillemot population is in a favourable maintained condition with a small decrease in population from 56,450 birds at the time of site designation to 55,507 birds in 2017 (SNH, 2017b) (Table 2-7).

449. The impacts from displacement during the breeding season based on 60% rate of displacement and 1% mortality during the breeding season indicates that one adult guillemot may suffer mortality due to the effects from displacement and a further four birds of all ages may be impacted during the non-breeding season (Table 2-65). The potential loss of five guillemots across the year is <0.001% of the current breeding population.

450. PVA undertaken on guillemots during the breeding season in the Fowlsheugh SPA indicate that the guillemot population will continue to significantly increase. The population modelling indicates that there will be little, if any impact on the guillemot population with a predicted decrease in the end population with the presence of the wind farm of 0.17%; a CPS value of 99.83% after 25 years (Table 2-88). Over a 50 year period the population is predicted to increase further, although with the wind farm present there may be a 1.10% reduction in the population; a CPS value of 98.90%.

451. Changes in the predicted population size for guillemots breeding at the Fowlsheugh SPA with and without NnG over 25 years and 50 years are presented in Table 2-88.

Table 2-88: Change in predicted population size for guillemots breeding at the Fowlsheugh SPA with and without the Project over 25 and 50 years

Guillemot	SPA & start Population	Baseline population (pairs) (no wind farm)	Population (pairs) with NnG	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Fowlsheugh 74,379 pairs	150,711	150,453	-0.17	99.83%
50 years		267,057	264,113	-1.10	98.90%

452. As discussed in Section 2.5.1.6 there is no clear pattern of displacement behaviour by guillemots, with some studies reporting displacement behaviour and others suggesting limited, if any, displacement.

453. The population modelling undertaken indicates that at the levels of displacement and mortality used in this assessment, there will not be any decrease in the current population; with a continued increase in the guillemot population over the next 25 and 50 years. Furthermore, over a period of 25 and 50 years there is predicted to be effectively no population level effect, with a maximum potential decrease of 1.10% between the population with and without a wind farm over a 50 year period; a CPS value of 98.90%.

454. Based on the very low number of birds predicted to be affected and the results from population modelling it is concluded that displacement effects will not impact on the guillemot remaining as a viable component of the site and will not adversely affect the integrity of the Fowlsheugh SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.2.4.2 Guillemot: In-combination

455. Based on a displacement of 60% and a 1% mortality it is estimated that 118 guillemots could suffer mortality due to in-combination displacement impacts throughout the year (Table 2-70).

456. PVA undertaken on guillemots across the year in the Fowlsheugh SPA indicate that the guillemot population will continue to increase. The additional estimated mortality arising from in-combination displacement effects from the proposed wind farms may cause a reduction in the future end population of -1.09% after 25 years. Alternatively, the counterfactual population size is 98.91% of that for the scenario with no wind farm constructed (Table 2-89). Over a 50 year period the population is predicted to continue to increase with or without in-combination displacement impacts, although there may be an overall end population difference of -1.93%; a CPS population size value of 98.07%.

Table 2-89: Change in predicted population size for guillemots breeding at the Fowlsheugh SPA with and without in-combination impacts over 25 and 50 years

Guillemot	SPA & start Population	Baseline population (pairs)	Population (pairs) with NnG & F&T projects (displacement)	Percentage change in median final population size compared to baseline	Counterfactual Population Size (%)
25 years	Fowlsheugh 74,379 pairs	150,711	149,071	-1.09	98.91%
50 years		267,057	261,912	-1.93	98.07%

457. Based on the number of birds predicted to be affected and the results from population modelling that predict a continued increase in the SPA guillemot population, it is concluded that in-combination impacts of displacement on guillemots across the year will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the Fowlsheugh SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.2.5 Fowlsheugh SPA - Conclusions

458. Based on the predicted level of potential impacts, it is concluded that there will be no adverse effects on the integrity of the Fowlsheugh SPA from the Project, either alone or in-combination with other plans or projects.

2.5.3 St Abb's Head to Fast Castle SPA

459. Site overview information for the St Abb's Head to Fast Castle SPA is provided in Table 2-90 below.

Site Information	Details
Site overview	St Abb's Head to Fast Castle SPA lies approximately 31 km to the south of Neart na Gaoithe. The site comprises an area of sea cliffs and coastal strip stretching over 10 km along the Berwickshire coast, north of St Abb's.
Site designation – qualifying species and features (* indicates assemblage qualifier only)	▪ Guillemot (*Uria aalge*)* ▪ Herring gull (*Larus argentatus*)* ▪ Kittiwake (*Rissa tridactyla*)* ▪ Razorbill (*Alca torda*)* ▪ Shag (*Phalacrocorax aristotelis*)* ▪ Seabird assemblage

Site Information	Details
Site Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: ▪ Population of the species as a viable component of the site; ▪ Distribution of the species within site; ▪ Distribution and extent of habitats supporting the species; ▪ Structure, function and supporting processes of habitats supporting the species; and ▪ No significant disturbance of the species

Table 2-90: Site overview for St Abb's Head to Fast Castle SPA

460. The potential effects of the proposed development, as identified, occur outside the SPA itself. Advice received in the Scoping Opinion is that, the conservation objective "Population of the species as a viable component of the site" captures all of the other conservation objectives for the existing colony SPAs (Marine Scotland 2017). This is also the advice received by MS-LOT from the SNCBs when undertaking an Appropriate Assessment for the Original Project (Marine Scotland, 2014).

461. The Scoping Opinion advised that St Abb's Head to Fast Castle SPA should be scoped in to the HRA due to connectivity (Marine Scotland 2017). However, no qualifying species from this SPA were identified for assessment in the Scoping Opinion. For the purposes of this assessment the qualifying species identified as being at risk of a likely significant effect from other SPAs considered within this assessment have been assessed.

462. The following qualifying species are considered as being at risk of a likely significant effect:

- Kittiwake,
- Herring gull,
- Razorbill,
- Guillemot.

2.5.3.1 Kittiwake

463. Based on the advice received there will be a likely significant effect on kittiwakes from the St Abb's Head to Fast Castle SPA due to collision and displacement mortality with the Project on its own and in-combination with other offshore wind farms.

464. The kittiwake population at the St Abb's Head to Fast Castle SPA is reported as in an unfavourable and declining condition (SNH, 2017b). The population has declined from 21,170 pairs at the time of site designation in 1992 to 3,334 pairs in 2016 (Table 2-7). This is an annual decline of over 1,486 breeding adults per year over a 24 year period and a decline of 84% since the SPA citation.

2.5.3.1.1 Kittiwake: Project alone

465. A total of 11 kittiwakes from the SPA may be impacted per year by combined collision and displacement impacts (Table 2-28). During the breeding season an estimated seven adults may be impacted (three from collision and four from displacement effects), which equates to 0.1% of the current breeding population. A further four kittiwakes of all ages may be impacted during the non-breeding season.

466. Advice received in the Scoping Opinion is that no population modelling is required on kittiwakes from this colony unless the predicted impacts during the breeding season reduce the annual adult survival by more than 0.2%. This is on the basis that effects greater than this would be more than expected based on the assessments undertaken for the Original Project (Marine Scotland, 2017). The models

that may be used to calculate this, e.g. SeaBORD, are not available for this assessment. However, kittiwake adult mortality is reported to be 11.8% (BTO 2017) and therefore an estimated 787 adult kittiwakes from the St Abb's Head to Fast Castle SPA die each year, based on the current breeding population of 3,324 pairs. An increase in adult mortality of 0.2% increases the level of adult mortality to 800 birds per year. The estimated additional mortality of 11 birds (including immatures during the non-breeding season) caused by displacement and collision impacts across the year increases the adult mortality by 0.1% and is therefore below the level at which an adverse effect is predicted to occur.

467. As previously discussed (See Section 2.5.1.2) available evidence from existing operational projects indicates that kittiwake displacement is not likely to occur and as such it is considered that a displacement rate of 30% represents a highly precautionary assumption and it is unlikely that kittiwakes will be displaced from the Wind Farm Area and that mortality will occur.

468. It is recognised that the kittiwake population of St Abb's Head to Fast Castle SPA has been and will likely continue to decline over the next 25 or more years. Collision modelling and displacement assessment indicates that 0.1% of the current population may be impacted across the year and that the impacts across the year may increase adult mortality by 0.1%. This additional loss over a period when the overall population is predicted to decline is not going to impact on maintaining the species as a viable component of the site and will not adversely affect the integrity of the St Abb's Head to Fast Castle SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.3.1.2 Kittiwake: In-combination

469. Based on the worst-case in-combination scenario (Scenario Two: NnG, and the 2014 Inch Cape and Seagreen A and B design scenarios), there will be an estimated 37 adult kittiwakes from the St Abb's head to Fast Castle SPA during the breeding season impacted by collisions and eight from displacement effects. A further 15 birds (adult and immature) may be impacted by collisions during the non-breeding season. Consequently, it is estimated that a total of 60 kittiwakes from the St Abb's Head to Fast Castle SPA could be impacted each year from in-combination impacts (Table 2-36). The Project is estimated to contribute no more than 11 kittiwakes to the total.

470. No PVA has been undertaken on the kittiwakes at St Abb's Head to Fast Castle SPA. The loss of 60 kittiwakes per year is 0.9% of the current breeding population. It is therefore likely that this level of in-combination impact could cause an increase in the on-going decline in the population. However, the additional loss of 60 birds per year is only 4% of the annual loss that has occurred over the last 24 years. It is therefore predicted that the population will continue to decline with or without any wind farm impacts.

471. It should be noted that it is considered highly unlikely that Inch Cape and Seagreen A and B will be built to the maximum extent of their 2014 consented envelopes, therefore the outcome of this assessment is considered to be highly precautionary and unrealistic.

472. It is predicted that there will be a measurable decrease in the future kittiwake population due to in-combination impacts from estimated collision and displacement effects and that after 25 years these in-combination impacts could cause a difference in the kittiwake breeding population. However, the additional impacts estimated from offshore wind farms will not alter the fact that the SPA population is, and will continue to decline for factors not related to offshore wind farms and that the absence of wind farms will not stop the decline from occurring. Consequently, the estimated in-combination impacts will not affect the conservation objective to ensure the qualifying species remains a viable component of the site in the long term as other factors are influencing this objective. It is therefore concluded that the in-combination impacts will not adversely affect the integrity of the St Abb's Head to Fast Castle SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.3.2 Herring gull

473. Based on the advice received there will be a likely significant effect on herring gulls from the St Abb's Head to Fast Castle SPA due to collision mortality with the Project on its own and in-combination with other offshore wind farms.

2.5.3.2.1 Herring gull: Project alone and in-combination

474. The herring gull population has decreased significantly since the time of designation when the population was 1,160 pairs to the latest population estimate of 325 pairs (Table 2-7). The population is in an unfavourable and declining condition (SNH, 2017b).

475. Results from collision rate modelling indicate that 0.04 herring gulls from the St Abb's Head to Fast Castle SPA may be impacted by the proposed Project each year during the breeding season and 0.12 herring gulls during the non-breeding season (Table 2-38 and Table 2-40). Therefore, less than one herring gull per year from this SPA may be impacted by the Project.

476. Although, it is recognised that the herring gull population at the St Abb's Head to Fast Castle SPA has undergone significant decrease, the very small additional potential impact of 0.16 birds per year caused by collision impacts will not contribute to this decline either alone or in-combination with other projects and will therefore not affect maintaining the population as a viable component of the site.

477. The predicted very low number of impacts will not adversely affect the integrity of the St Abb's Head to Fast Castle SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.3.3 Razorbill

478. Based on the advice received there will be a likely significant effect on razorbills from St Abb's Head to Fast Castle SPA due to the effects from displacement arising from the Project on its own and in-combination with other offshore wind farms.

2.5.3.3.1 Razorbill: Project alone

479. The razorbill population is in a favourable maintained condition with a small decrease in the population since the time of designation from 2,180 birds to 2,067 in 2016 (SNH, 2017b) (Table 2-7).

480. The impacts from displacement during the breeding season based on 60% rate of displacement and 1% mortality indicates that there will be no increase in mortality of razorbills from the SPA. During the non-breeding season it is estimated that two razorbills from the SPA could be affected (Table 2-52). The potential loss of two razorbills across the year is 0.09% of the current breeding population.

481. No PVA analysis has been undertaken on razorbills from this SPA. However, it is predicted that there will be no impacts that will cause increased mortality in razorbills during the breeding season. Population Viability Analysis modelling undertaken at the Forth Islands and Fowlsheugh SPAs predicted that low levels of impact would not cause population declines that would affect the future status of the species as a viable component of the site. It is predicted that the potential loss of two birds during the non-breeding season will not cause a population level effect.

482. Based on the very low number of birds predicted to be affected and the results from population modelling undertaken at adjacent colonies, it is concluded that displacement effects on razorbills across the year will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the St Abb's Head to Fast Castle SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.3.3.2 Razorbill: In-combination

483. Based on a displacement of 60% and a 1% mortality it is estimated that seven razorbills from St Abb's Head to Fast Castle SPA could suffer mortality due to in-combination displacement impacts throughout the year (Table 2-57). This is equivalent to 0.3% of the breeding population. However, only three

birds are estimated to be impacted from in-combination impacts during the breeding season and therefore the proportion of the population impacted is 0.14% of the population.

484. No PVA analysis has been undertaken for razorbills at St Abb's Head to Fast Castle SPA. However, this level of impact during breeding and non-breeding seasons is very low and based on PVA undertaken on razorbills for other colonies it is predicted that no significant population level effect that would impact on the species remaining a viable component of the site will occur.

485. Based on the very low number of birds predicted to be affected and the results from population modelling undertaken at adjacent colonies, it is concluded that displacement effects on razorbills across the year will not impact on the species remaining as a viable component of the site and will not adversely affect the integrity of the St Abb's Head to Fast Castle SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.3.4 Guillemot

486. Based on the advice received there will be a likely significant effect on guillemots from the St Abb's Head to Fast Castle SPA due to the effects from displacement arising from the Project on its own and in-combination with other offshore wind farms.

487. The guillemot population is in a favourable maintained condition with an increase in the population from 31,750 birds at the time of site designation to 36,206 birds in 2017 (SNH 2017b) (Table 2-7).

2.5.3.4.1 Guillemot: Project only

488. The impacts from displacement during the breeding season based on 60% rate of displacement and 1% mortality during the breeding season indicates that four adult guillemots may suffer mortality due to the effects from displacement and a further 10 birds of all ages may be impacted during the non-breeding season (Table 2-65). The potential loss of 14 guillemots across the year is <0.04% of the current breeding population.

489. No PVA analysis has been undertaken on guillemots from the SPA. However, the potential loss of 4 birds during the breeding season is 0.01% of the breeding population. This is a very small impact on a population that is increasing. Population Viability Analysis undertaken at other colonies indicate that this level of impact will not have a population level effect that would impact on maintaining the species as a viable component of the site.

490. On this basis it is concluded that displacement effects will not impact on the guillemot remaining as a viable component of the site and will not adversely affect the integrity of the St Abb's Head to Fast Castle SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.3.4.2 Guillemot: In-combination

491. Based on a displacement of 60% and a 1% mortality it is estimated that 35 guillemots could suffer mortality due to in-combination displacement impacts throughout the year, of which 14 will occur during the breeding season (Table 2-70).

492. No PVA has been undertaken for guillemots at St Abb's Head to Fast Castle SPA. The loss of an estimated 35 guillemots across the year due to in-combination impacts is 0.1% of the breeding population. The loss of an estimated 14 birds during the breeding season is 0.04% of the breeding population. Population Viability Analysis undertaken at adjacent colonies that are currently in a similar favourable condition have indicated that the loss of this proportion of birds from the population will not have a population level effect that will impact on maintaining the species as a viable component of the site Consequently, it is concluded that the in-combination impacts will not adversely affect the integrity of the St Abb's Head to Fast Castle SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.3.5 St Abb's Head to Fast Castle SPA - Conclusions

493. Based on the predicted level of potential impacts, it is concluded that there will be no adverse effects on the integrity of the St Abb's Head to Fast Castle SPA from the Project, either alone or in-combination with other plans or projects.

2.5.4 Buchan Ness to Collieston Coast SPA

494. Site overview information for the Buchan Ness to Collieston Coast SPA is provided in Table 2-91 below.

Table 2-91: Site overview for Buchan Ness to Collieston Coast SPA

Site Information	Details
Site overview	Buchan Ness to Collieston Coast SPA lies approximately 113 km to the north of Neart na Gaoithe. The site comprises an area of sea cliffs and coastal strip stretching along the Aberdeenshire coast, north of Collieston.
Site designation – qualifying species and features (* indicates assemblage qualifier only)	▪ Fulmar (*Fulmarus glacialis*) ▪ Herring gull (*Larus argentatus*)* ▪ Kittiwake (*Rissa tridactyla*)* ▪ Shag (*Phalacrocorax aristotelis*)* ▪ Guillemot (*Uria aalge*)* ▪ Seabird assemblage
Site Conservation Objectives	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: ▪ Population of the species as a viable component of the site; ▪ Distribution of the species within site; ▪ Distribution and extent of habitats supporting the species; ▪ Structure, function and supporting processes of habitats supporting the species; and ▪ No significant disturbance of the species

495. The potential effects of the proposed development, as identified, occur outside the SPA itself. Advice received in the Scoping Opinion is that, the conservation objective "Population of the species as a viable component of the site" captures all of the other conservation objectives for the existing colony SPAs (Marine Scotland 2017). This is also the advice received by MS-LOT from the SNCBs when undertaking an Appropriate Assessment for the Original Project (Marine Scotland, 2014)

496. The Scoping Opinion advised that Buchan Ness to Collieston Coast SPA should be scoped in to the HRA due to connectivity (Marine Scotland 2017). However, no qualifying species from this SPA were identified for assessment in the Scoping Opinion. For the purposes of this assessment the qualifying species identified as being at risk of a likely significant effect from other SPAs considered within this assessment have been assessed.

497. The following qualifying species are considered as being at risk of a likely significant effect:

- Kittiwake,
- Herring gull,
- Guillemot.

2.5.4.1 Kittiwake

498. Based on the advice received there will be a likely significant effect on kittiwakes from the Buchan Ness to Collieston Coast SPA due to collision and displacement mortality with the Project on its own and in-combination with other offshore wind farms.

2.5.4.1.1 Kittiwake: Project alone

499. The kittiwake population at the Buchan Ness to Collieston Coast SPA is reported as in an unfavourable (SNH, 2017b). The population has declined from 30,452 pairs at the time of site designation in 1998 to 11,482 pairs in 2016 (Table 2-7). This is an annual decline of over 3,993 breeding adults per year over a 19 year period and a decline of 62% since the SPA citation.

500. The Wind Farm Area lies 125 km to the south of this SPA and is beyond the mean maximum foraging range of breeding kittiwakes. There is therefore a very small risk of any adult breeding kittiwakes from the SPA occurring in the Wind Farm Area during the breeding season.

501. During the non-breeding season kittiwakes from the SPA will disperse and may occur within the Wind Farm Area. Results from collision rate modelling and displacement analysis indicate that a total of two kittiwakes from the colony may be impacted each year (Table 2-28). The loss of two kittiwakes per year is 0.008% of the current breeding population. For a 0.2% increase in adult mortality to occur it is estimated that an increase in the annual rate of mortality of 46 adult birds will be required. The loss of two birds per year is significantly below this.

502. It is recognised that the kittiwake population of Buchan Ness to Collieston SPA has been and will likely continue to decline. Collision modelling and displacement assessment indicates that 0.008% of the current population may be impacted across the year and that the impacts across the year will be less than a 0.2% increase in adult mortality. The potential additional loss over a period when the overall population is predicted to decline is not going to impact on maintaining the species as a viable component of the site and will not adversely affect the integrity of the Buchan ness to Collieston Coast SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.4.1.2 Kittiwake: Project in-combination

503. Based on the worst-case in-combination scenario (Scenario Two: NnG, and the 2014 Inch Cape and Seagreen A and B design scenarios), there will be an estimated 21 adult kittiwakes from the Buchan Ness to Collieston Coast SPA during the breeding season impacted by collisions and two from displacement effects. A further 60 birds (adult and immature) may be impacted by collisions during the non-breeding season. Consequently, it is estimated that a total of 83 kittiwakes from the Buchan Ness to Collieston Coast SPA could be impacted each year from in-combination impacts (Table 2-36). The Project is estimated to contribute to none of the breeding season impacts as it is beyond the mean maximum foraging range and only two impacts are estimated arise from the Project during the non-breeding season. The majority of impacts, are from wind farms outwith the Firths of Forth and Tay area.

504. It is predicted that the Project will not cause any impacts on the Buchan Ness to Collieston Coast SPA in the breeding season and therefore will not have an in-combination impact on the kittiwake population. The very small potential collision impact of two birds during the non-breeding season will not significantly contribute to the in-combination impacts which are predicted to occur largely outwith the region. Therefore, the Project will not have an in-combination impact on the kittiwake SPA population that will affect the population being maintained as a viable component of the site. It is therefore concluded that the Project's in-combination impact will not adversely affect the integrity of the Buchan Ness to Collieston Coast SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.4.2 Herring gull

2.5.4.2.1 Herring gull: Project alone and In-combination

505. Based on the advice received there will be a likely significant effect on herring gulls from the Buchan Ness to Collieston Coast SPA due to collision mortality with the Project on its own and in-combination with other offshore wind farms.

506. The herring gull population has decreased since the time of designation when the population was 4,292 pairs to the latest population estimate of 3,115 pairs (Table 2-7). The population is in an unfavourable condition (SNH, 2017b).

507. The Wind Farm Area is beyond the mean maximum foraging range of herring gulls from this SPA during the breeding season and therefore birds from this SPA will be unlikely to occur in the Wind Farm Area in the breeding season. During the non-breeding season it is estimated that 0.07 herring gulls from the SPA may be impacted each year (Table 2-40). This is a very small impact and less than 0.001% of the breeding population.

508. Although, it is recognised that the herring gull population at the Buchan Ness to Collieston Coast SPA has undergone decrease, the very small potential impact of 0.07 birds per year caused by collision impacts will not contribute to this decline, either alone or in-combination with other projects, and will therefore not affect maintaining the population as a viable component of the site.

509. The predicted very low impacts will not adversely affect the integrity of the Buchan Ness to Collieston Coast SPA, in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.4.3 Guillemot

510. Based on the advice received there will be a likely significant effect on guillemots from the Buchan Ness to Collieston Coast SPA due to the effects from displacement arising from the Project on its own and in-combination with other offshore wind farms.

511. The guillemot population is in a favourable maintained condition with an increase in the population from 17,280 birds at the time of site designation to 33,632 birds in 2017 (SNH, 2017b) (Table 2-7).

2.5.4.3.1 Guillemot: Project alone and in-combination

512. The impacts from displacement during the breeding season based on 60% rate of displacement and 1% mortality during the breeding season indicates that no guillemots from the Buchan Ness to Collieston Coast SPA are predicted to be impacted by the Project and therefore there will be no population level effects on guillemots from this SPA (Table 2-65).

513. On this basis it is concluded that displacement effects will not impact on the guillemot remaining as a viable component of the site and will not adversely affect the integrity of the Buchan Ness to Collieston Coast SPA, in light of the qualifying interest, their condition and the site's conservation objectives.

2.5.4.4 Buchan Ness to Collieston Coast SPA - Conclusions

514. Based on the predicted level of potential impacts, it is concluded that there will be no adverse effects on the integrity of the Buchan Ness to Collieston Coast SPA from the Project, either alone or in-combination with other plans or projects.

2.5.5 Outer Firth of Forth and St Andrews Bay Complex pSPA

515. Site overview information for the Outer Firth of Forth and St Andrews Bay Complex pSPA is provided in Table 2-92 below.

Table 2-92: Site overview for Outer Firth of Forth and St Andrews Bay Complex pSPA

Site Information	Details
Site overview	The Outer Firth of Forth and St Andrews Bay Complex pSPA partially overlaps with Wind Farm Area. The site comprises of marine and coastal habitat.
Site designation – qualifying species and features	• Arctic tern (*Sterna paradisaea*), • Black-headed gull (*Chroicocephalus ridibundus*), • Common gull (*Larus canus*), • Common scoter (*Melanitta nigra*), • Common tern)*Sterna hirundo*), • Eider (*Somateria mollissima*), • Gannet (*Morus bassanus*), • Goldeneye (*Bucephala clangula*), • Guillemot (*Uria aalge*), • Herring gull (*Larus argentatus*), • Kittiwake (*Rissa tridactyla*), • Little gull (*Hydrocoloeus minutus*), • Long-tailed duck (*Clangula hyemalis*), • Manx shearwater (*Puffinus puffinus*), • Puffin (*Fratercula arctica*); • Razorbill (*Alca torda*), • Red-breasted merganser (*Mergus serrator*), • Red-throated diver (*Gavia stellata*), • Shag (*Phalacrocorax aristotelis*), • Slavonian grebe (*Podiceps auritus*), • Velvet scoter (*Melanitta fusca*).
Site Conservation Objectives	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species; and To ensure for the qualifying species that, subject to natural change, the following attributes are maintained in the long term: • The species as a viable component of the site; • No significant disturbance of the species or significant reduction in ability of the species to utilise important parts of the site; • Distribution and extent of habitats and the structure, function and supporting processes of the habitats supporting the qualifying species and their prey are maintained.

516. The potential effects of the proposed development, as identified, occur both within and outside the SPA itself. Approximately 32% of the Wind Farm Area overlaps with the pSPA (Figure 2-7).

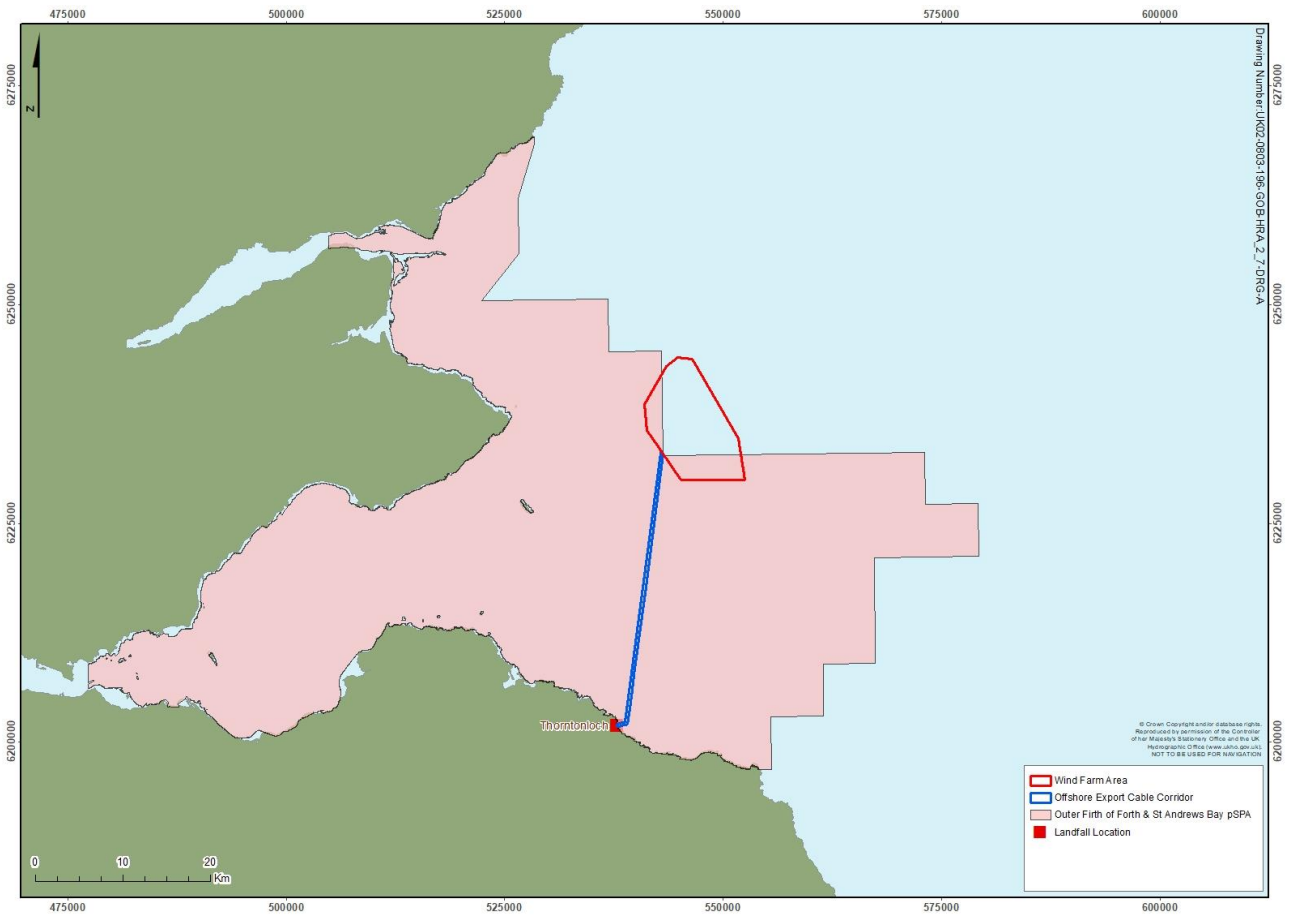

Figure 2-7: Outer Firth of Forth and St Andrews Bay Complex pSPA and Project location

517. The Scoping Opinion advised that the following qualifying species should be considered as being at risk of a likely significant effect:

- Gannet,
- Kittiwake,
- Herring gull,
- Puffin,
- Guillemot,
- Razorbill,
- Little gull,
- Common gull,
- Black-headed gull.

518. Other qualifying species are scoped out of this assessment (Marine Scotland 2017).

519. Once operational, the presence of the Project could potentially result in collision and displacement impacts on seabirds from the Outer Firth of Forth and St Andrews Bay Complex pSPA. It has not yet been determined how many turbines will lie within the pSPA boundary. However, based on the published current pSPA site boundary (SNH, 2016), the Project footprint will overlap the pSPA by a maximum of 34 km^2. This corresponds to approximately 1.3% of the overall area of the pSPA (2,720.68 km^2).

520. Direct habitat loss within the Outer Firth of Forth and St Andrews Bay Complex pSPA arising from the installation of the turbines and temporary impacts from cable laying could also affect a conservation objective (See Section 2.5.6.1).

521. The largest potential displacement effect is predicted to occur during the operational phase of the Project, caused by the physical presence of the turbines. For this reason, this assessment only considers displacement effects arising from the presence of the wind turbines. However, it is recognised that temporary displacement of seabirds within the Wind Farm Area may occur during the construction and decommissioning phases, due the physical presence of vessels. However, any such displacement effects, if they do occur, are considered a temporary, localised effect, and are therefore not considered significant.

2.5.5.1 Gannet

522. Advice received in the Scoping Opinion was that the impacts from collision during the breeding season could cause a likely significant effect on gannets (Marine Scotland 2017).

523. For breeding season impacts, the reference pSPA population is taken to be the most recent available counts of the breeding populations of the terrestrial SPA breeding colonies that border the pSPA. For gannet, the Forth Islands SPA borders the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season is estimated to 75,259 pairs (Table 2-7).

524. It is estimated that of the total of 93 gannets predicted to be impacted during the breeding season by the Project, 30 of them will be within the pSPA (Section 2.4.1).

525. PVA has been undertaken for gannets breeding in the Forth Islands SPA over 25 years and 50 year periods. The loss of an estimated 30 birds per year within the pSPA is below that which PVA modelling predicted to cause a decrease in the breeding gannet population (Table 2-73 and Table 2-74). Therefore, it is concluded that the loss of up to 30 gannets per year will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.5.2 Kittiwake

526. Advice received in the Scoping Opinion was that the impacts from collision and displacement during the breeding and non-breeding seasons could cause a likely significant effect on kittiwakes from the Outer Firth of Forth and St Andrew's Bay Complex pSPA (Marine Scotland 2017). The estimated kittiwake mortality during the breeding and non-breeding seasons from collision and displacement impacts are presented in Table 2-93.

Table 2-93: Estimated kittiwake mortality in the Outer Firth of Forth and St Andrews Bay Complex pSPA from displacement and collision impacts throughout the year

Season	Breeding		Non-breeding	
	No of birds	% of pSPA population (15,994 ind.)	No of birds (3,191 ind.)	% of pSPA population
Total displacement	6	0.04	6	0.18
Total collisions	3	0.02	6	0.18
Total	9	0.05	12	0.37

527. For kittiwake, both the Forth Islands SPA (4,663 pairs), and St. Abb's Head to Fast Castle SPA (3,334 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season is estimated at 7,997 pairs (Table 2-7).

528. An estimated three kittiwake collisions are estimated to occur during the breeding season within the pSPA (Section 2.4.2) and further six kittiwakes may be risk of mortality due to the effects from displacement. Therefore, an estimated total of nine kittiwakes may suffer mortality during the breeding season. This is equivalent to 0.05% of the breeding population at the two SPAs.

529. PVA undertaken on kittiwakes during the breeding season indicates that the additive effect that the loss of nine kittiwakes during the breeding season will have on the kittiwake population will not cause any measurable population effect (See Section 2.5.1.2).

530. During the non-breeding season an estimated six kittiwakes may be impacted by collisions and a further six from the effects of displacement; a total of 12 kittiwakes.

531. The estimated pSPA population for the non-breeding season is 3,191 individuals and therefore the loss of up to 12 kittiwakes during the non-breeding season is 0.4% of the population. This estimate is considered highly precautionary as it is based on the peak mean number of birds recorded during baseline surveys which indicate that the kittiwake population within the pSPA during the non-breeding season is higher than the population used in the citation. It is recognised that the numbers used to designate the pSPA are likely the minimum number of birds present within the pSPA. Furthermore, there is little, if any evidence that kittiwakes will be displaced by the wind farm and that, if they are displaced, that they will suffer 2% morality. On this basis it is considered highly unlikely that 0.4% of the population could be affected and the actual numbers at risk of being impacted will be considerably lower than predicted.

532. It is concluded that the loss of 0.05% of the kittiwake population during the breeding season and the highly precautionary potential loss of up to 0.4% of the kittiwake population during the non-breeding season will not affect the species remaining as a viable component to the site and therefore not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.5.3 Puffin

533. Advice received in the Scoping Opinion was that the impacts from displacement during the non-breeding season could cause a likely significant effect on puffins (Marine Scotland 2017).

534. For puffin the Forth Islands SPA border the pSPA and therefore, for the purposes of this assessment, the pSPA puffin population during the breeding season is estimated at 45,005 pairs (Table 2-7).

535. Based on the assessment presented in Section 2.4.3 an estimated 34 puffins, of which 17 may be breeding adults, could be impacted during the breeding season. The potential loss of up to 17 breeding adults out of a population of 90,010 individuals is 0.02% of the population.

536. PVA has been undertaken for puffins breeding in the Forth Islands SPA over 25 year and 50 year periods. The loss of an estimated 17 birds per year within the pSPA is below that which PVA modelling is predicted to cause a decrease in the breeding puffin population (Table 2-77). Therefore, it is concluded that the loss of up to 17 puffins per year will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.5.4 Herring gull

537. Advice received in the Scoping Opinion was that the impacts from collision mortality during the breeding and non-breeding season could cause a likely significant effect on herring gulls (Marine Scotland 2017).

538. For herring gull, both the Forth Islands SPA (6,580 pairs), and St. Abb's Head to Fast Castle SPA (325 pairs) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 6,905 pairs (Table 2-7).

539. Based on the assessment presented in Section 2.4.6 it is estimated that less than one herring gull may be impacted during the breeding season, equivalent to <0.01% of the breeding population. During the non-breeding season less than one herring gull is predicted to be impacted, equivalent to <0.01% of the non-breeding population.

540. The estimated impacts on herring gulls during both breeding and non-breeding seasons are very low and at levels that would not affect the species being a viable component of the site. Consequently, it is concluded that impacts from displacement will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.5.5 Little gull

541. Advice received in the Scoping Opinion was that the impacts from collision and displacement during the non- breeding season could cause a likely significant effect on little gulls (Marine Scotland 2017).

542. During the non-breeding season, the estimated pSPA little gull population is 126 birds (SNH, 2016). However, this is recognised to be low and for reasons presented in Section 2.4.7 a population of 3,000 individuals may be considered to be more realistic.

543. There are predicted to be no impacts from collision on little gulls from the Project. An estimated one bird may be impacted by displacement effects during the non-breeding season.

544. The potential loss of one little gull during the non-breeding season is equivalent to 0.8% of the cited SPA population. However, based on an estimated population of 3,000 individuals, 0.03% of the population may be impacted.

545. This level of impact on a non-breeding population is very low and will not affect the species being a viable component of the site. Consequently, it is concluded that impacts from displacement will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.5.6 Black-headed gull

546. Advice received in the Scoping Opinion was that the impacts from collision during the breeding season and displacement effects during the non-breeding season could cause a likely significant effect on black-headed gulls (Marine Scotland 2017).

547. During the non-breeding season, the estimated pSPA black-headed gull population is 26,835 birds (SNH, 2016).

548. Based on the outputs from Collision Rate Modelling there will be no impacts on black-headed gulls from collisions and six birds may be suffer mortality during the non-breeding season caused by displacement effects, if displacement occurs out to 2 km beyond the Wind Farm Area (Section 2.4.8). The loss of any black-headed gulls during the non-breeding season due to displacement is considered unlikely on the basis that evidence from wind farms on other species of Gull have shown, little, if any, displacement behaviour. However, should it occur, an estimated 0.02% of the pSPA population could be affected.

549. The estimated impacts on black-headed gulls during both breeding and non-breeding seasons are very low and at levels that would not affect the species being a viable component of the site. Consequently, it is concluded that impacts from displacement will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.5.7 Common gull

550. Advice received in the Scoping Opinion was that the impacts from collision during the breeding season and displacement effects during the non-breeding season could cause a likely significant effect on black-headed gulls (Marine Scotland, 2017).

551. During the non-breeding season, the estimated pSPA common gull population is 14,647 birds (SNH, 2016).

552. Based on the outputs from Collision Rate Modelling there will be no impacts on common gulls from collisions and three birds may be affected by impacts from displacement during the non-breeding season, if displacement occurs out to 2 km beyond the Wind Farm Area (Section 2.4.9).

553. The loss of any common gulls during the non-breeding season due to displacement is considered unlikely as evidence from existing wind farms indicate little, if any, displacement behaviour by Gulls towards operating wind farms. However, should it occur, an estimated 0.02% of the pSPA population could be affected.

554. The estimated impacts on common gulls during both breeding and non-breeding seasons are very low and at levels that would not affect the species being a viable component of the site. Consequently, it is concluded that impacts from displacement will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.5.8 Razorbill

555. Advice received in the Scoping Opinion was that the impacts from displacement during the non-breeding season could cause a likely significant effect on razorbills (Marine Scotland 2017).

556. During the non-breeding season the estimated pSPA razorbill population is 5,481 birds (SNH 2016).

557. Based on the assessment presented in Section 2.4.4 it is estimated that three razorbills may be affected by impacts from displacement. This is 0.02% of the wintering population. This is a very low level of impact and will not affect the species being a viable component of the site. Consequently, it is concluded that impacts from displacement will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.5.9 Guillemot

558. Advice received in the Scoping Opinion was that the impacts from displacement during the breeding season and non-breeding seasons could cause a likely significant effect on guillemots (Marine Scotland 2017).

559. For guillemot, both the Forth Islands SPA (28,786 birds), and St. Abb's Head to Fast Castle SPA (36,206 birds) border the pSPA, therefore, for the purposes of this assessment, the pSPA population during the breeding season was estimated at 64,992 birds (Table 2-7).

560. Based on the assessment presented in 2.4.5 it is estimated that 14 birds (seven adults and seven immature or non-breeding adults) may be impacted during the breeding season. Population Viability Analysis has been undertaken for guillemots breeding in the Forth Islands SPA over 25 year and 50 year periods. The loss of an estimated 14 birds per breeding season within the pSPA is below that which PVA modelling is predicted to cause a decrease in the breeding guillemot population (Table 2-81), which is forecast to increase over the next 25 to 50 years. Therefore, it is concluded that the loss of up to 14 guillemots each breeding season will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

561. During the non-breeding season the pSPA guillemot population is 21,968 birds (SNH 2016). It is estimated that up to 21 guillemots may suffer mortality during this season, if displacement occurs out to 2 km beyond the Wind Farm Area. This is 0.01% of the non-breeding population. The potential loss of 0.01% of the non-breeding population is very small and will not affect the species being a viable component of the site. Consequently, it is concluded that impacts from displacement will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives.

2.5.6 Indirect impacts on birds

2.5.6.1 Habitat Loss

562. During construction, there is the potential for indirect effects on bird communities resulting from impacts on prey availability to occur. Within the Wind Farm Area that overlaps with the pSPA site boundary, there is the potential for the loss of habitat arising from the physical presence of the turbines and cable protection. There may also be temporary impacts arising from disturbance to the seabed from cable laying during construction.

563. The possible loss of seabed habitat due to the physical presence of the turbines will occur on the seabed at each of the turbine locations. The scour protection around each turbine is estimated to be up to 1,200m^2. If each turbine foundation impacts an area of 1,200m^2 then, assuming all 54 turbines are within the pSPA (an unrealistic worst-case scenario), there is the potential for a maximum loss of 64,800m^2 (0.064 km^2) of seabed habitat. However, approximately 68% of the Wind Farm Area is outwith the pSPA and therefore approximately 68% of the turbines will occur outwith the pSPA boundary and have no physical impact on the pSPA. It is therefore assumed that the potential habitat lost from turbine installation will be 68% less than 64,800 m^2, which means that approximately 20,736 m^2 (0.0207 km^2) of seabed habitat could be lost due to wind turbine foundations.

564. In addition, there is the possibility that an Offshore Substation Platform will be situated within the pSPA, which would remove a further 2,400m^2 of seabed habitat.

565. The export cable route will pass through the pSPA (Figure 2-7). Two export cables will be trenched and buried in two separate trenches, each 43 km long; a total of 86 km. It is estimated that impacts from trenching and burying the cable will impact 5 m of seabed either side of the cable and therefore a total of 0.86 km^2 of seabed could be disturbed during the trenching and burying of the export cables. It is estimated that approximately 15% of the cable route may need protection, which would be a permanent loss of seabed. If this is the case, then an estimated 0.13 km^2 of seabed could be lost due to cable protection.

566. In total the potential area of seabed habitat lost due to wind turbine foundations, offshore substation foundations and cable protection could therefore be 0.1527 km^2. The potential loss of 0.1527 km^2 of seabed habitat out of a total pSPA area of 2,720.68 km^2 is 0.0056% of the physical habitat within the pSPA.

567. Cables will be trenched and buried using either mechanical ploughs or cutters or by high pressure jets depending on the ground conditions.. If cable protection is not required, the trenches will backfill naturally over time. The length of time it takes for the trenches to backfill is dependent on the local seabed conditions and currents. The predominant sediment type along the cable route is muddy sand with more extensive areas of bedrock near the coast. The dominant currents across the Offshore Wind Farm Area are semi-diurnal tidal currents that can peak during mean spring tides at 0.6 m/s (NnGOWL, 2012).

568. In areas of soft mud or sand natural infill is predicted to occur rapidly and studies have indicated that infill of trenches can occur at a rate of 0.2 and 0.5 m every six months and sediment communities returning to the area of disturbed sediment within 12 months of the cable laying having been undertaken (BERR, 2008; NnGOWL, 2012). Consequently, the potential impacts from trenching cables within the pSPA will be localised and temporary and not have a long-term impact on the habitat.

569. It is concluded that the very small area of seabed habitat lost within the pSPA as a result of turbine installation and cable protection will not cause a significant reduction in the extent, distribution or quality of habitats that support the qualifying species or their prey. The trenching of cables will cause a localised and temporary impact on the habitats within the pSPA.

570. Consequently, it is concluded that impacts from loss or disturbance of habitat within the pSPA will not adversely affect the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA in light of the qualifying interests, their condition and vulnerabilities and the conservation objectives

2.5.6.2 Impacts on prey

571. The impacts from noise during construction on the prey of seabirds, including those from the Outer Firth of Forth and St Andrews Bay pSPA are addressed in Section 3.4.4.

2.5.6.3 Outer Firth of Forth and St Andrews Bay Complex pSPA - Conclusions

572. Based on the predicted level of potential impacts, it is concluded that there will be no adverse effects on the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA from the Project, either alone or in-combination with other plans or projects.

3 Special Areas of Conservation

573. The following section presents the information required to undertake an HRA on the qualifying features of SACs identified in the Scoping Opinion as being at risk of a likely significant effect from the proposed Project alone and in-combination (Figure 3-1) (Marine Scotland 2017). The designated sites and qualifying species assessed are:

- Moray Firth SAC: Bottlenose dolphin,
- Firth of Tay and Eden Estuary SAC: Harbour seal,
- Isle of May: Grey seal,
- Berwickshire and Northumberland Coast SAC: Grey seal.

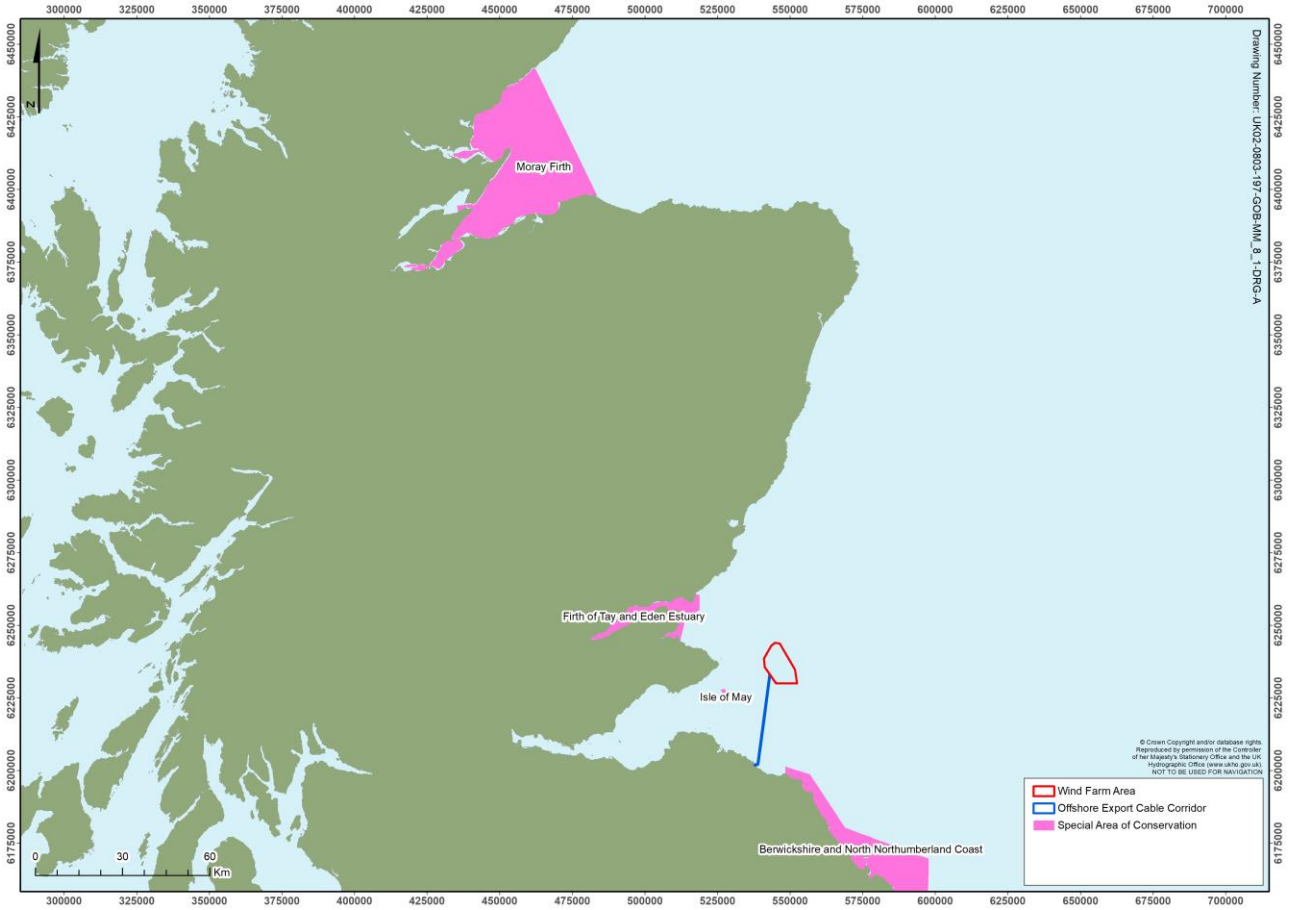

Figure 3-1: Special Areas of Conservation considered within this assessment

3.1 Baseline Information

574. The following section provides a summary of the relevant baseline information pertaining to the marine mammals relevant to this assessment.

3.1.1 Bottlenose dolphin

575. Bottlenose dolphin (*Tursiops truncatus*) occur widely in nearshore waters along the Moray Firth and the east coast of Scotland. Elsewhere in the UK they occur regularly in Cardigan Bay with smaller

numbers recorded elsewhere particularly around South-west England and North Uist (Reid *et al*. 2003). No bottlenose dolphins were recorded during three years of boat-based surveys within the Offshore Wind Farm Area and the 8 km buffer surrounding the site, i.e. no bottlenose dolphins have been recorded within 8 km of the proposed wind farm area.

576. In Scotland, bottlenose dolphins occur widely along the east coast between the Moray Firth and the Firth of Forth with recognised areas of regular usage in the Moray Firth, Aberdeen Bay and the Firth of (Anderwald and Evans, 2010; Quick *et al.* 2014). They are less frequently recorded between Montrose and Aberdeen or within the Firth of Forth (Quick *et al*. 2014).

577. The estimated population of bottlenose dolphins in the Moray Firth and the east coast of Scotland is 195 (95% HDPI 162 – 253) individuals of which, based on surveys undertaken in 2003, between 81 and 142 bottlenose dolphins might occur in the Tay area (Cheney *et al*. 2013; Quick and Cheney, 2011; Thompson *et al.* 2011). The proportion of the east coast bottlenose dolphin population estimated to occur within the Firth of Forth and Firth of Tay area varies across years with between 71 (95% CI 63 - 81) and 91 (95% CI 82 - 100) individuals occurring within the area between 2009 and 2013 and between 35% and 55% of the east coast population (Arso Civil, 2014; Quick *et al*. 2014).

578. Based on advice received during Scoping the density of bottlenose dolphins has been estimated on an assumption that, of the reference population of 195 bottlenose dolphins, 98 of them will be present along the east coast of Scotland at the time pile driving activities are undertaken. It is assumed that all bottlenose dolphins will be within the 20 m contour depth and that they are distributed evenly across their range as presented in Figure 3-2. Following this approach, a bottlenose dolphin density of 0.07 ind./km^2 is derived.

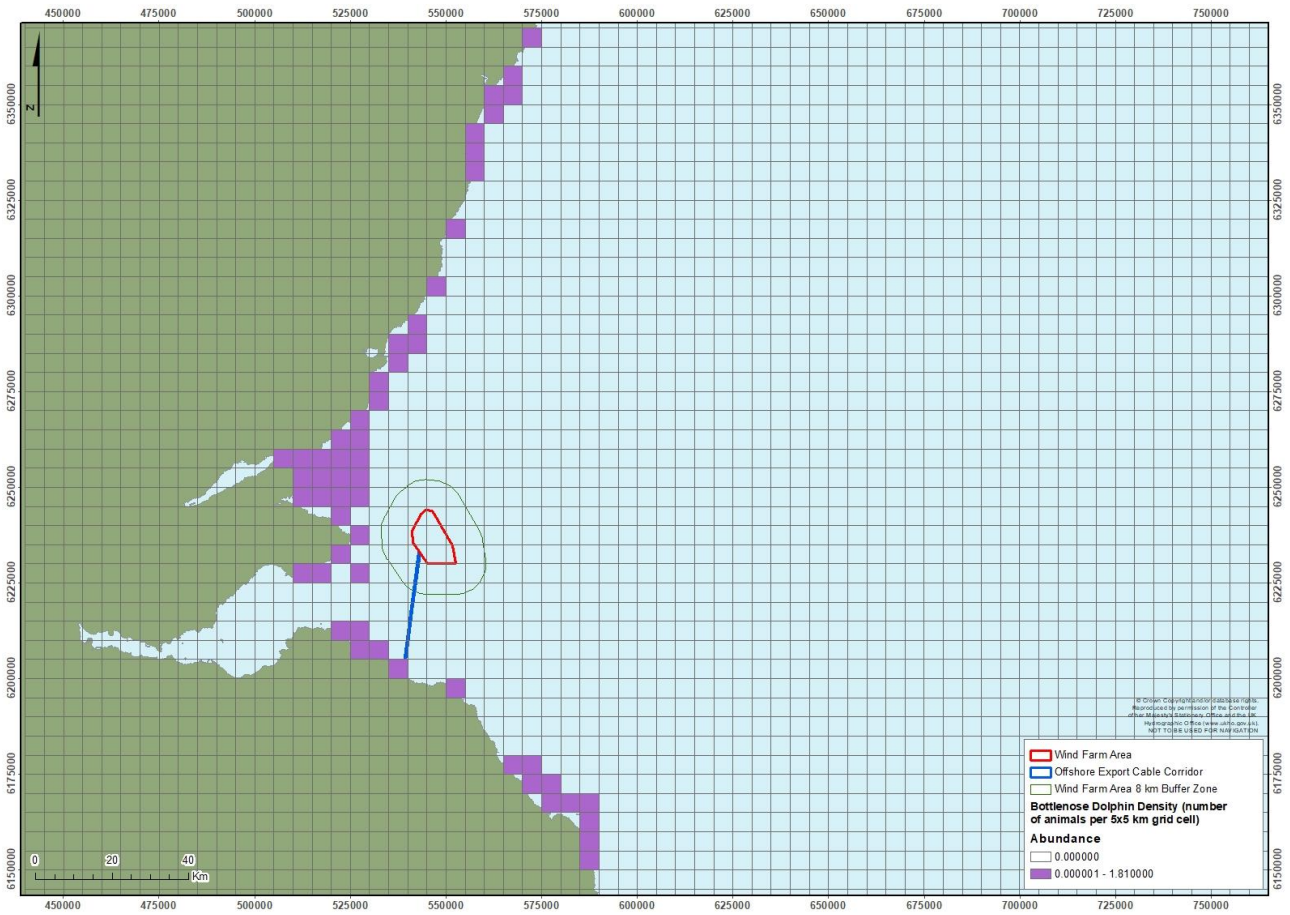

Figure 3-2: Distribution of coastal east Scotland bottlenose dolphins

579. Along the east coast of Scotland, bottlenose dolphins occur predominantly within 2 km of the coast and in water depths of less than 20 m. There are relatively very few records of bottlenose dolphins in waters beyond 2 km and in water depths of greater than 20 m (Quick *et al*. 2014).

580. Between 2013 and 2016 C-PODs that are able to detect bottlenose dolphins have been deployed between Cromarty and St Abb's Head, including at five locations between Cruden Bay and and St Abb's Head (Brookes, 2017). Bottlenose dolphins were recorded most frequently within 5 km of Cromarty, in the Moray Firth, with detections recorded on more than 89% of the days that C-PODs were present. Daily detection rates at C-PODS located within 5 km of St Andrews were no greater than 18%. Further offshore daily detection rates were lower with detections on less than 10% of the days at distances of between 10 km and 15 km (Figure 3-3).

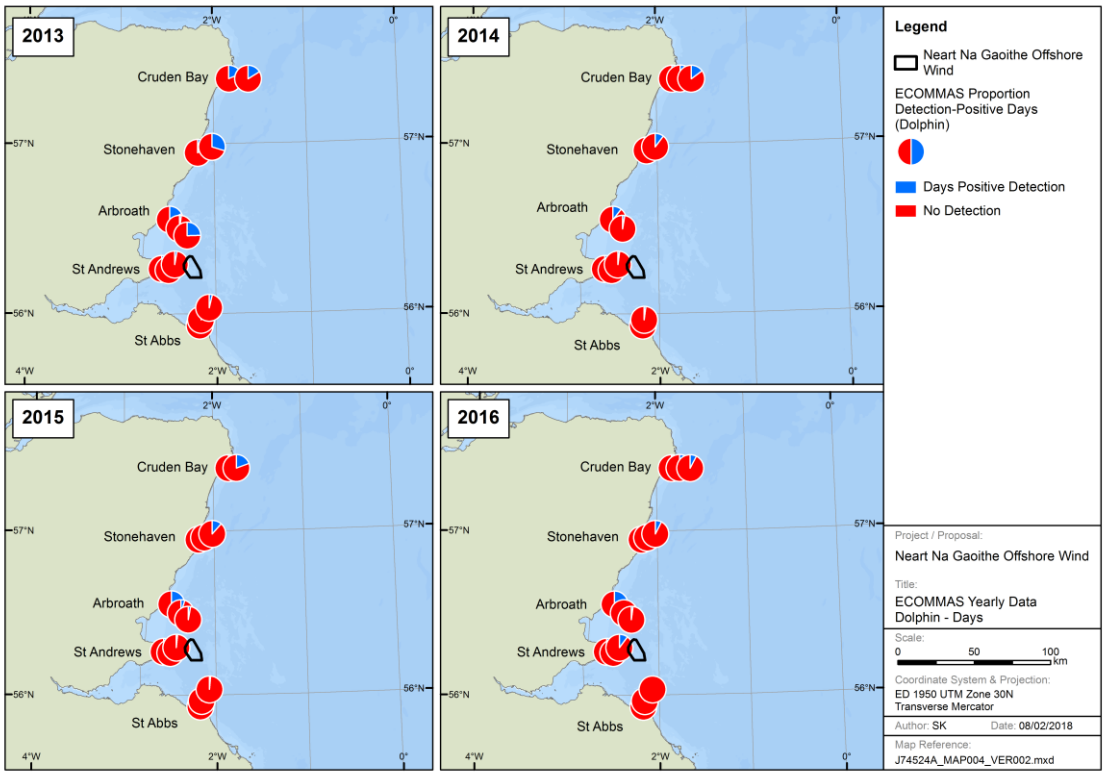

Figure 3-3: Bottlenose dolphin positive detection days at C-PODs located between Cruden Bay and St Abb's Head from 2013 to 2016 (Source Brookes, 2017)

581. The use of C-PODS to detect dolphins at five locations between Cruden Bay and St Abb's, including at Arbroath and St Andrews supports the evidence that the majority of dolphin activity along the east coast of Scotland occurs within 5 km of the coast (Brookes, 2017; Palmer *et al.* 2017).

582. Acoustic surveys undertaken at two locations between Arbroath and Fife Ness using T-Pods between 2006 and 2009 indicated that dolphins occur in the coastal waters throughout the year, although there may be seasonal variation with an increase in the number of detections at Fife Ness between May and October compared with the rest of the year. However, a similar seasonal variation was not observed at Arbroath where the number of detections across the year are relatively similar (Quick and Cheney, 2011).

583. Within the Firths of Forth and Tay area bottlenose dolphin occur predominantly in nearshore waters of the coast and in water depths of less than 20 m. Within the Firth of Tay bottlenose dolphin have been most frequently recorded along the north side of a sand bar to the south of a shipping lane (Quick and Cheney, 2011). However, complete survey coverage across the whole of the Firths of Forth and Tay has not been undertaken and therefore their distribution across the wider area is unclear.

584. Using photo identification techniques, it is recognised that many, if not all, of the bottlenose dolphins occurring in the Firth of Tay area are associated with those that occur to the north, along the east coast of Scotland and the Moray Firth including within the Moray Firth SAC. There is a relatively high level of movement of bottlenose dolphins between those in the Firth of Tay and elsewhere along the east coast of Scotland and, to a lesser extent, along the coasts of North-east England (Quick and Cheney, 2011).

585. Bottlenose dolphins first breed from the age of between 5 and 13 years of age and produce a single offspring which will remain with its mother from between 3 and 8 years. Inter-birth years, the time between calves, range from between 2 and 9 years, although 3 years is most frequent. Mortality rates in the first year vary from between 19 and 29%. Adult survival within the east coast of Scotland population is 94.7% (Quick *et al*. 2014).

586. Bottlenose dolphins feed on a wide range of prey species with main prey items for bottlenose dolphins in the Moray Firth reported to be cod, saithe (*Pollachius virens*) and whiting with some salmon (*Salmo salar*), haddock (*Melanogrammus aeglefinus*) and cephalopods (Santos *et al*. 2001).

587. The bottlenose dolphin is a qualifying species for the Moray Firth SAC, which is located approximately 165 km from the Wind Farm Area.

3.1.2 Harbour seal

588. During three years of boat-based surveys harbour seals were infrequently recorded within the wind farm and buffer area. A total of 41 harbour seals were recorded over the three years of surveys, of which five were within the Wind Farm Area. The majority of sightings were outwith the Wind Farm Area with most observations to the south-east of the site.

589. The UK population of harbour seal is estimated to be 43,300 individuals (95% CI: 35,500 - 59,000) of which 224 individuals occur within the East Coast Management Area (ECMA), which extends from Fraserburgh to the border with England. (Duck *et al.* 2016). However, as not all harbour seals are at haul-out sites at the same time the actual population will be greater than the number of seals counted. Based on a scalar of 1.39 (Sparling *et al.* 2012), the latest population estimate of harbour seals in the ECMA is 311 (95% CI 254 - 415) individuals.

590. Densities of harbour seals vary across the Firths of Forth and Tay region and those used in this assessment are based on the offshore usage presented in Figure 3-4.

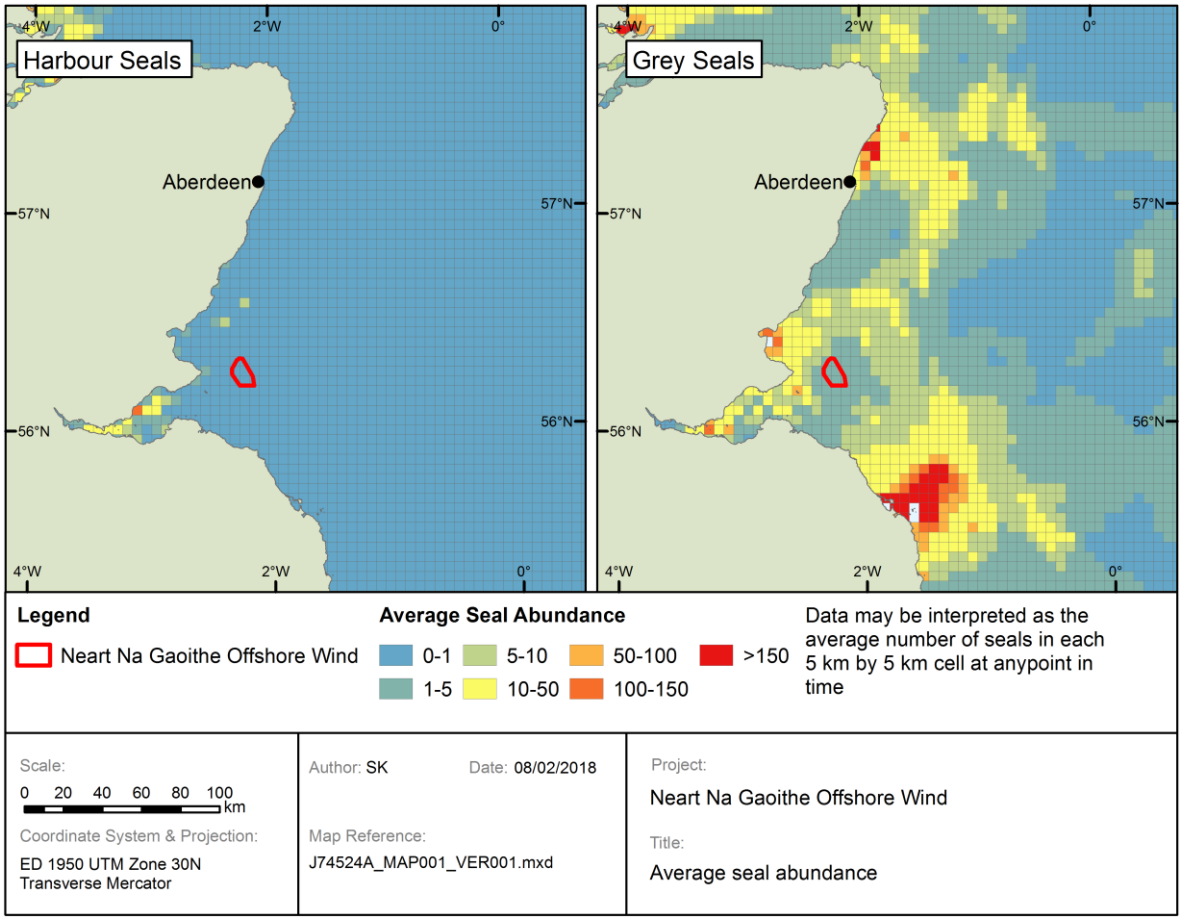

Figure 3-4: Estimated at sea distribution of grey and harbour seals off eastern Scotland (Source Marine Scotland 2017b)

591. For the purposes of this assessment the ECMA population has been used; a total regional population of 311 individuals. This is based on the most recent population estimates adjusted to account for animals not hauled out at the time counts were undertaken (Duck *et al*. 2016; Sparling *et al*. 2012).

592. Since 1997 there has been a wide-scale decline in the number of harbour seals across much of the UK with significant reductions at most haul out sites along the east coast of Scotland. The Firth of Tay and Eden Estuary SAC lies approximately 30 km from the proposed development and like most other east coast harbour seal sites has recorded a decrease in the number of harbour seals present, with a 90% decline in the harbour seal population since 2002 (SCOS, 2016). The latest harbour seal population estimate based on counts undertaken in 2015 is 60 individuals (Duck *et al*. 2016).

593. The cause of the decline in harbour seals is unknown but if the trend continues, based on the current rate of decline, the population of harbour seals within the Firth of Tay and Eden Estuary SAC may become effectively extinct by approximately 2030 (Figure 3-5).

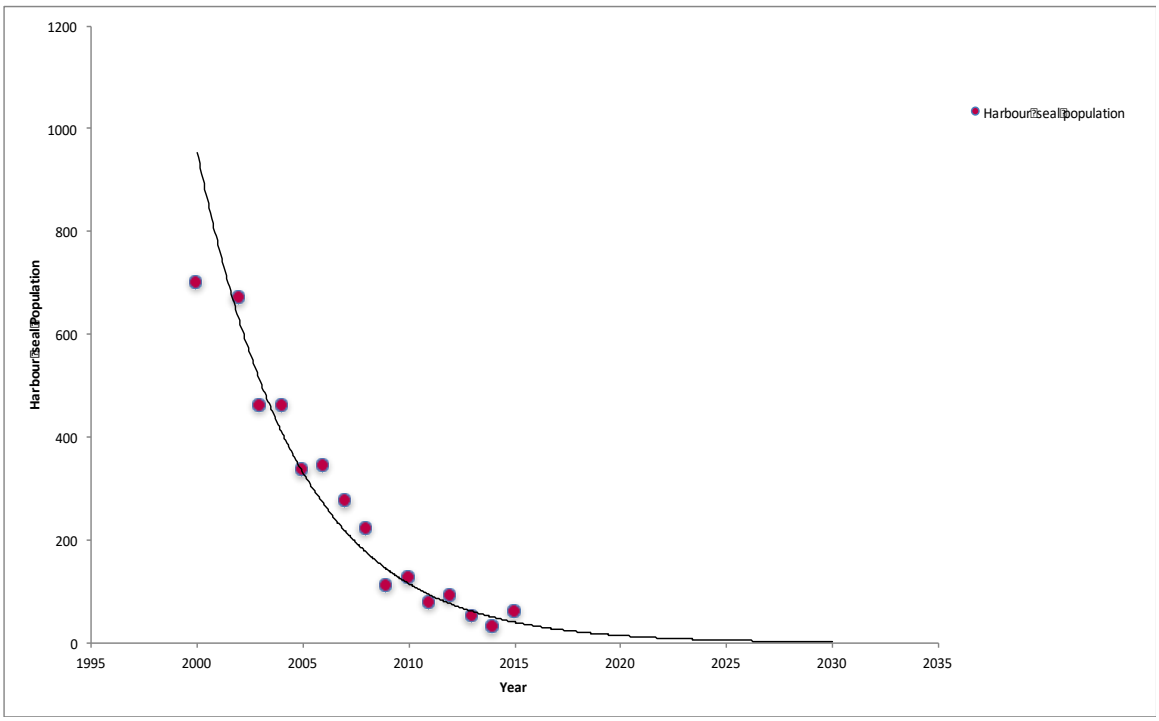

Figure 3-5: Harbour seal population in the Firth of Tay and Eden Estuary SAC from 2000 to 2015

594. Breeding in the region takes place between June and July and pups are nursed for a few weeks. Harbour seals undergo a moult during August during which time they spend a greater proportion of their time on shore (Brown and Pierce, 1997; SCOS, 2016).

595. Harbour seals are opportunistic feeders, feeding within 40-50 km around their haul out sites, and take a wide variety of prey including sandeels, cod, haddock, whiting, ling (*Molva molva*), herring and sprat, flatfish species, octopus and squid, with some seasonal and regional variation with sandeels, octopus, whiting, flounder (*Platichthys flesus*) and cod being eaten by harbour seals in North-east Scotland and sandeels and salmonids being significant prey items for harbour seals in the Tay Estuary (Sparling *et al.* 2012; SCOS, 2005; Tollit and Thompson, 1996).

596. The harbour seal is a qualifying species for the Forth and Tay and Eden estuary SAC and their haul out site within the SAC is protected under the Marine (Scotland) Act 2010.

3.1.3 Grey seal (*Halichoerus grypus*)

597. During three years of boat-based surveys grey seals were occasionally recorded within the Wind Farm Area and 8 km buffer area. The majority of sightings were outwith the Wind Farm Area with 125 of the 140 sightings occurring in the 8 km buffer area. Across years the total number of grey seals recorded was relatively constant with 43 in year 1, 58 in year 2 and 39 in Year 3.

598. Peak numbers occurred during March and October with a maximum of 16 grey seals recorded across the whole survey area in October 2011. Outwith these periods, grey seals were recorded infrequently.

599. The grey seal is the more abundant of the two species of seal that breed around the coast of the British Isles with a UK population of 139,800 (95% CI 116,500 - 167,100) individuals (SCOS, 2016). Approximately 88% of British grey seals breed in Scotland, mostly in the Outer Hebrides and Orkney. Elsewhere, they occur in Shetland and along the north and east coasts of the UK and in the southwest (SCOS, 2016).

600. Based on a scalar multiplier of 2.39 (Russell *et al*. 2016a), the latest population estimate of grey seals in the East Coast Management Area (ECMA) is 9,607 (95% CI 8,028 – 11,958) individuals (Duck *et al*. 2016).

601. Densities of grey seals vary across the Firths of Forth and Tay area with relatively higher occurrence in St Andrews Bay and around the Farne Islands and off North-east Scotland (Figure 3-4).

602. Prior to pupping there is a gradual increase in the numbers of grey seals occurring in nearshore waters adjacent to the haul-out beaches (SNH, 2006). Pupping occurs late October and late November and the pup is weaned after approximately 2 weeks, after which mating takes place (Duck, 2010). During this period grey seals remain largely onshore or in nearshore waters; outwith this period grey seals are more widespread occurring more frequently in offshore foraging areas. Following breeding, grey seals undergo a moult in January and February (SNH, 2006).

603. Grey seals forage in areas that are up to at least 100 m deep and that tend to have gravel/sand seabed sediments, which are the preferred burrowing habitat of their primary prey, sandeels. Grey seal foraging movements are on two geographical scales: long and distant trips from one haul-out site to another; and local repeated trips to specific offshore areas. Long-term telemetry studies show that grey seals occur regularly in the waters around the Neart na Gaoithe site (Hammond *et al.* 2004).

604. For the purposes of this assessment a total population comprising the ECMA population of 9,607 individuals and a density based on the at sea distributions.

605. Grey seals are qualifying species for the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC. Their haul out sites within these SACs are protected under the Marine (Scotland) Act 2010.

3.2 In-combination Impacts

606. The following section provides an outline of the potential in-combination impacts relevant to marine mammals.

607. In-combination impacts refer to effects upon receptors arising from the Project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context, the term 'projects' is considered to refer to any project, plan or programme with comparable effects and is not necessarily limited to offshore wind projects. Impacts from other projects identified as being most likely to have the potential to have an in-combination effect, in the context of the issues scoped into this HRA, are from other underwater sound sources.

Project and activities considered within the in-combination impact assessment are set out in Table 3-1 and are based on, and incorporate, the advice received during the formal Scoping consultation (Marine Scotland, 2017a). It is recognised that there may be plans or projects for which there is limited information and yet may be being undertaken at the same time as the planned construction period of NnG. It is also possible that activities arising from current projects that have been identified as having the potential to cause an in-combination impact may be completed prior to works commencing at NnG. There is, in some cases, also an element of uncertainty associated with the design envelope of other proposed projects. Therefore, a judgement is made on the confidence associated with the latest available design envelope.

Table 3-1: Projects for in-combination assessment

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Inch Cape Offshore Wind Farm	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Seagreen Alpha Offshore Wind Farm	Consented	High – Consented project details available.

Development Type	Project	Status	Data Confidence Assessment / Phase
Offshore Wind Farm	Seagreen Bravo Offshore Wind Farm	Consented	High – Consented project details available.
Offshore Wind Farm	Seagreen Phase 1 Wind Farm Project	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Beatrice Offshore Wind Farm	Consented	High – Consented project details available
Offshore Wind Farm	Moray East Offshore Wind Farm	Consented	High – Consented project details available
Offshore Wind Farm	Moray East Offshore Wind Farm – Alternative design	Proposed	High – Scoping report publicly available.
Offshore Wind Farm	Moray West Offshore Wind Farm	Proposed	High – Scoping report publicly available.
Harbour Expansion	Aberdeen Harbour Expansion Project	Consented	High – Consented project details available

608. It is anticipated that work arising from the Beatrice Offshore Wind Farm and the Aberdeen Harbour Expansion Project that could cause a potential in-combination impact on marine mammals will have been completed prior to any construction activities associated with the Project. However, it is recognised that impacts from these projects could cause population level effects that may continue beyond the end of the construction and therefore there is potential for an on-going in-combination impact.

609. The construction schedules for the other consented offshore wind farms located within the Firths of Forth and Tay, e.g. Inch Cape and Seagreen A and B, are based on the publicly available information but must be considered subject to change at this stage. It is considered unlikely that there will be any construction being undertaken at other planned wind farms within the Firths of Forth and Tay area at the same time as NnG is being constructed.

Table 3-2 sets out the worst-case cumulative design envelope scenario considered within the in-combination impact assessment.

Table 3-2: In-combination worst-case design envelope scenarios.

Impact	Project	Worst Case Design Scenario
Noise arising from hammering	Inch Cape Offshore Wind Farm (proposed)	Pile diameter - unknown Maximum hammer size 2400 kJ Total pile driving duration –4.2 hrs
	Inch Cape Offshore Wind Farm (consented)	Pile diameter - 2.43 m Maximum hammer size - 1200 kJ Total pile driving duration – 4.2 hrs
	Seagreen Alpha Offshore Wind Farm (consented)	Pile diameter – 3.0 m Maximum hammer size - 1800 kJ Total pile driving duration – 0.5 hrs
	Seagreen Bravo Offshore Wind Farm (consented)	Pile diameter – 3.0 m Maximum hammer size - 1800 kJ Total pile driving duration – 0.5 hrs
	Seagreen Phase 1 Wind Farm Project (proposed)	Pile diameter – 3.0 m Maximum hammer energy – 2,400 kJ Total pile driving duration – 2.1 hrs.
	Beatrice Offshore Wind Farm	Pile diameter – 2.4 m Maximum hammer size - 2300 kJ Total pile driving duration – 5 hrs

Impact	Project	Worst Case Design Scenario
	Moray East Offshore Wind Farm (consented)	Pile diameter – 2.5 m Maximum hammer size - 1200 kJ Total pile driving duration – 1.2 hrs
	Moray East Offshore Wind Farm (proposed)	Potential use of suction bucket foundations eliminating the requirement to pile. Pile driving as previously consented still an option.
	Moray West Offshore Wind Farm	Pile diameter – 4 - 12 m (depending on foundation type) Maximum hammer size - Unknown Total pile driving duration – Unknown
Noise arising from blasting	Aberdeen Harbour Expansion Project	Blasting – maximum of two blasts per day.

610. No other projects or plans have been identified as having the potential to cause an in-combination impact on marine mammals with respect to noise arising from construction (Marine Scotland 2017a).

3.2.1 In-combination Noise Modelling Results on Marine Mammals

611. To ensure a consistent approach is taken across all projects when identifying potential in-combination impacts and to allow a direct comparison to be made, noise modelling has been undertaken for all planned and consented offshore wind farms within the Firths of Forth and Tay (see Appendix 8.1: Noise modelling for further details on the noise modelling undertaken). The noise modelling is based on the design envelopes presented in Table 3-2. For existing consented developments within the Moray Firth, e.g. Beatrice and Moray East, information has been obtained from their Environmental Statements. In the absence of any project specific information for the Moray Firth projects that do not have consent the potential impacts on marine mammals from the proposed Moray East (alternative design) and the Moray West wind farms are considered to be equivalent to the consented Moray East Offshore Wind Farm.

612. The results from the noise modelling indicates that the revised Inch Cape and the Seagreen Phase 1 developments will have greater impacts on marine mammals than the previously consented projects. This is likely due to the proposed increases in hammer energies used to install the piles. Hammer energy has an important effect on the level of sound produced, with pile driving using higher hammer energies typically creating higher noise levels (Lepper *et al*. 2012). Other factors that could have an effect on the propagation of noise include water depth and seabed type. However, these are the same for the consented developments and new applications. Consequently, it is predicted that as one of the main factors that affects the level of noise produced, i.e. hammer energy, has increased in the new applications the cumulative impacts will be greatest with the revised Inch Cape and Seagreen Phase 1 developments, rather than their consented designs. The new designs are therefore included in the worst-case cumulative assessment scenario.

613. The estimated number of marine mammals predicted to be at risk from the onset of Permanent Threshold Shift (PTS) across all developments considered in the cumulative impact assessment is presented in Table 3-3 and for disturbance in Table 3-4. The results from modelling single pile driving and concurrent pile driving are presented for NnG. The estimates for developments in the Firths of Forth and Tay are from noise modelling undertaken based on the revised design parameters available at the time modelling was undertaken. Data for other developments have been obtained from their applications.

Table 3-3: Estimated number of marine mammals at risk of the onset of PTS from developments considered in the cumulative impacts

Wind farm	Bottlenose dolphin [1]		Grey seal [2,3]		Harbour seal [2,3]	
Neart na Gaoithe [5]	<1	<1	1	1	1	1
Inch Cape (revised project)	<1		1		1	
Seagreen Phase 1 (Location 1)	<1		1		1	
Seagreen Phase 1 (Location 2)	<1		1		1	
Beatrice	1		-		-	
Aberdeen Harbour Expansion Project	1		1		1	
Moray East	1		-		-	
Moray West [4]	1		-			

1 = The predicted area of PTS for wind farms in the Firths of Forth and Tay area did not overlap with the bottlenose dolphin management unit area.
2 = Number of seals that could potentially experience the onset of PTS has been estimated using seal distribution maps (SMRU and Marine Scotland, 2017). The number of seals that could experience PTS onset has been calculated by estimating the number of seals within the predicted PTS area using the latest seal distribution maps.
3 = It has been assumed that the Moray Firth projects will not impact the East Coast Scotland seal management unit area and therefore not applicable for this assessment.
4 = In the absence of any published information it is assumed that the number of individuals impacted by the Moray West development is the same as Moray East.
5 = NnG Single pile driving left cell, Concurrent pile driving right cell

Table 3-4: Estimated number of marine mammals at risk of disturbance from developments considered in the cumulative impacts

Wind farm	Bottlenose dolphin		Grey seal [2,3]		Harbour seal [2,3]	
Neart na Gaoithe [1,5]	2	2	821	1,357	8	10
Inch Cape (revised project)	1		925		10	
Seagreen Phase 1 (Location 1)	1		1,103		11	
Seagreen Phase 1 (Location 2)	1		1,087		4	
Beatrice	19		-		-	
Aberdeen Harbour Expansion Project	15		N/A		N/A	
Moray East	17		-		-	
Moray West [4]	17		-		-	

1 = For assessing potential cumulative impacts it is assumed that single pile driving will be undertaken at the time as this provides the greatest period of sequential pile driving.
2 = Number of seals that could potentially experience the onset of PTS has been estimated using seal distribution maps (SMRU and Marine Scotland, 2017). The number of seals that could experience PTS onset has been calculated by estimating the number of seals within the predicted PTS area using the seal distribution maps.
3 = It has been assumed that the Moray Firth projects will not impact the East Coast Scotland seal management unit area and is therefore zero.
4 = In the absence of any published information it is assumed that the number of individuals impacted by the Moray West development is the same as Moray East.
5 = NnG Single pile driving left cell, Concurrent pile driving right cell
N/A = Not available.

3.2.2 In-combination Population Modelling Results on Marine Mammals

614. Advice received during consultation is to use the interim Population Consequences of Disturbance (iPCoD) population model to predict potential population level effects from pile driving activities. Details of the population modelling undertaken and the results are presented in Appendix 8.2: Interim PCoD Modelling. The worst case in-combination scenario is predicted to arise when construction across all proposed wind farms occurs sequentially (Marine Scotland, 2017c).

615. The timing and duration of construction by the projects included within the in-combination impact assessment are known with a high degree of certainty for projects that have commenced construction. However, for projects that have not started construction or received consent there is a degree of uncertainty as to when construction may occur. For those projects which have been awarded Contracts for Difference (CfDs) i.e. NnG and Moray East, broad timescales can be estimated. For those without CfDs there is no certainty regarding timescales and a highly precautionary worst-case scenario has been applied for the in-combination assessment. This assumes that all construction activities occur sequentially and that there are no breaks in the in-combination construction period between 2019 and 2028 (Figure 3-6). Overall, impacts from pile driving will occur over a period of 11 years. This scenario will almost certainly not occur; therefore the assessment outputs are considered to be highly precautionary and unrealistic.

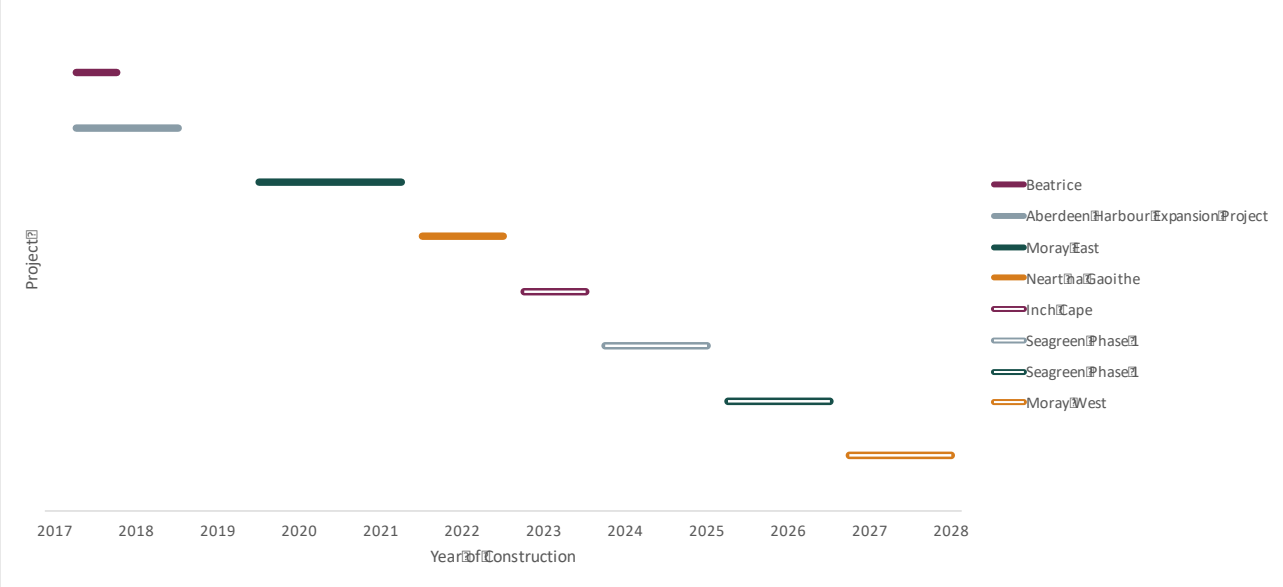

Figure 3-6: Estimated construction schedule used for in-combination population modelling

616. The HRA assesses the potential population level impacts on marine mammals from in-combination impacts arising from the construction of:

- Beatrice Offshore Wind Farm;
- Aberdeen Harbour Expansion Project;
- Moray East Offshore Wind Farm;
- Neart na Gaoithe Offshore Wind Farm;
- Inch Cape Offshore Wind Farm;
- Seagreen Phase 1;
- Moray West Offshore Wind Farm.

617. Note, that Seagreen Phase 1 may be two developments A and B. For the purposes of this assessment it is assumed that the worst-case scenario is that both developments could be constructed. For the purposes of the in-combination assessment it is assumed, based on a realistic worst-case scenario, that single pile driving will be undertaken at NnG. This produces a worst-case scenario as the overall duration of noise impacts occurs over a period of 15 months, as opposed to nine months if concurrent

pile driving occurs. The longer duration of pile driving is predicted to have a greater population level effect.

3.3 Estimated Magnitude of Effect (SACs)

618. The following section summarises the information used to estimate the magnitude of the potential impacts on the relevant qualifying species of the SAC sites. The aim of this section is not to duplicate the detailed analysis undertaken and presented within the EIA and associated Appendices but to present a succinct summary of the key data used to inform the HRA. Further, more detailed analysis of the information used can be found in the relevant chapters and associated appendices within the EIA, e.g. Marine Mammals Chapter 8, Appendix 8.1: Noise modelling, Appendix 8.2: Interim PCoD Modelling.

619. Sound arising from proposed construction activities has the potential to impact on marine mammals within or adjacent to the Wind Farm Area.

620. There is a substantial volume of literature describing the potential effects of sound on marine mammals, and summarised in e.g. Thomsen *et al.* (2006), Southall *et al.* (2007) and OSPAR (2009).

621. There are four main types of potential effect from noise that are recognised within the marine environment:

- *Fatal effects* caused by significant levels of noise in close proximity to the receptor.
- *Physical injury*, specifically hearing impairment, which can be permanent or temporary. These effects can impact on the ability of marine mammals to communicate, forage or avoid predators.
- *Behavioural effects* such as avoidance, resulting in displacement from suitable feeding or breeding areas, and changes in travelling routes.
- *Secondary impacts* caused by the direct effects of noise on potential prey causing a reduction in prey availability

622. The range at which marine mammals may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. Pinnipeds (seals) are potentially more sensitive to low frequency sounds than bottlenose dolphin or harbour porpoise. Other factors potentially affecting the potential impact of sound on marine mammals includes ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as weather and sea state and other existing sources of human produced sound, e.g. shipping, can also reduce the auditory range.

Fatal effects

623. If source peak pressure levels from the proposed operations are high enough there is the potential for a lethal effect on marine mammals. Studies suggest that potentially lethal effects can occur to marine mammals when the peak pressure level is greater than 246 or 252 dB re. 1 µPa (Parvin, Nedwell and Harland, 2007). Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 µPa. Sound levels arising from pile driving are not predicted to exceed levels capable of causing fatal effects beyond 1 m and therefore this potential impact is not assessed.

Physical injury

624. Underwater sound has the potential to cause hearing damage in marine mammals, either permanently or temporarily. The potential for either of these conditions to occur is dependent on the hearing bandwidth of the animal, the duty cycle of the sound source and duration of the exposure (Southall *et al*. 2007; OSPAR, 2009).

625. Physical injury is described as either a permanent loss of hearing range (permanent threshold shift (PTS)) or temporary loss of hearing range (temporary threshold shift (TTS)). Sound exposure levels considered capable of causing the onset of either PTS or TTS do not mean that such physical impacts will always occur. The probability of developing PTS or TTS will follow a dose response curve, with increasing risk of physical injury as exposure increases. Studies undertaken on bottlenose dolphin indicate that only between 18% and 19% of bottlenose dolphins exposed to sound exposure levels of 195 dB re 1 μPa^2.s-1, actually resulted in the onset of TTS (Finneran *et al*. 2005).

626. Although PTS is a permanent physical injury impairing the marine mammal's ability to hear, TTS is not and impacts are relatively short-lived. Studies undertaken on harbour porpoise indicate that, depending on the exposure level and duration, hearing ability returns between 4 and 96 minutes after the sound causing the impact has ceased (Kastelein *et al*. 2012). For this reason the assessment focusses on the impacts from PTS and disturbance.

627. To assess the risk of the onset of PTS to occur results from noise modelling based on an un-weighted SPL and weighted cumulative SELs have been used. The thresholds and auditory weightings used in the assessment are based on the latest evidence published in NMFS (2016), i.e. the 'NOAA thresholds'.

Behavioural Change

628. Potential changes in behaviour may occur depending on the sound source levels and the species' and individuals' sensitivities. Behavioural changes can vary from changes in swimming direction, diving duration, avoidance of an area and reduced communication from masking. The displacement of marine mammals could cause them to relocate to sub-optimal locations where there is lower prey availability or increased inter and intra-specific competition. If permanent or over a long period, this could cause lower fecundity or increased mortality.

629. Changes in behaviour arising from noise impacts may be easily detectable, e.g. a significant displacement from an area. Other effects caused by changes in behaviour, e.g. energetic stress, may be more difficult to detect and may go unnoticed (OSPAR, 2009).

630. Masking effects may also cause changes in the behaviour as the level of sound may impair the detection of echolocation clicks and other sounds that species use to communicate or detect prey thus causing them to alter their behaviour (David, 2006).

631. The area within which a marine mammal may be displaced or disturbed will vary depending on a number of factors including the level of sound received, the sensitivity of the species and individuals to noise and whether there are suitable areas to which they may move. In order to assess potential impacts from disturbance and displacement noise modelling undertaken within the Wind Farm Area predicts the extent sound from pile driving will propagate (Figure 3-7). From these figures, it is possible to estimate the area of impact at a range of SEL and the proportion of marine mammals that will be displaced.

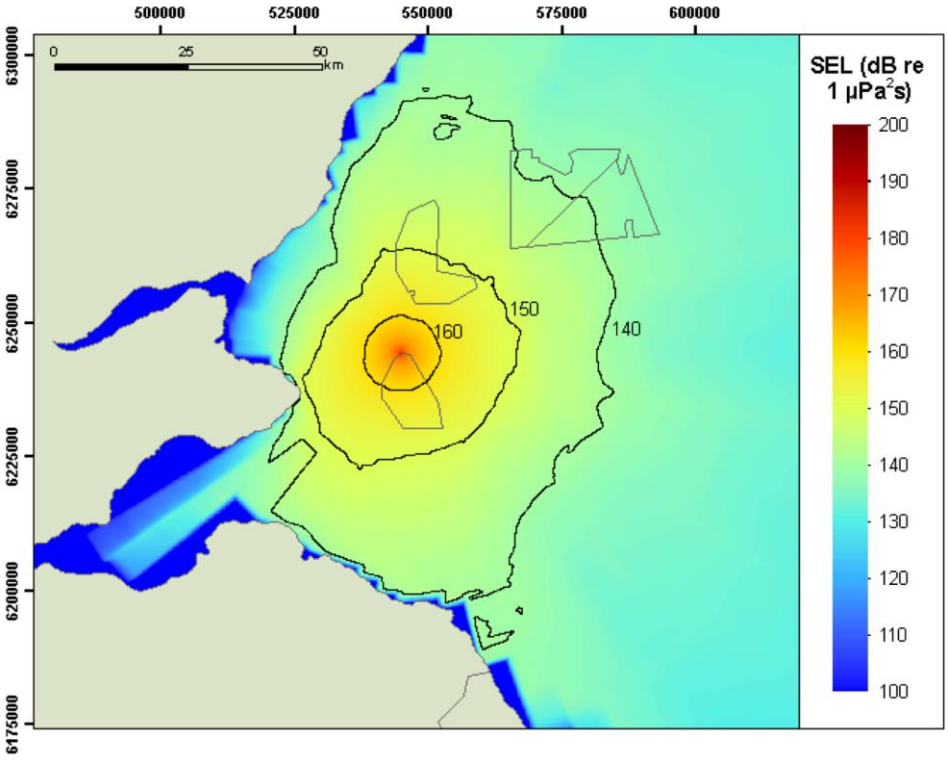

Figure 3-7: Predicted unweighted SEL during pile driving at Neart na Gaoithe with hammer operating at maximum energy

632. The extent of potential disturbance depends on the individuals' tolerance to noise and a wide range of other factors, e.g. the attractiveness of the area for the species/individual, the availability of alternative areas to relocate to. Studies on marine mammals during pile driving activities have demonstrated that higher levels of displacement or disturbance occur at higher received sound levels. The received sound level decreases with increasing distance from the sound source and there is a corresponding reduction in displacement or disturbance (e.g. Brandt *et al.* 2016). Based on these findings a dose-response curve has been developed from which it can be estimated the proportion of individuals displaced at any given received sound level (Figure 3-8). Details of the dose response curve are presented in the EIA Appendix 8.1: Noise Modelling.

633. Using this approach, the number of individuals at risk of disturbance can be estimated. This has been undertaken for bottlenose dolphin, harbour seal and grey seal in order to provide information for this assessment.

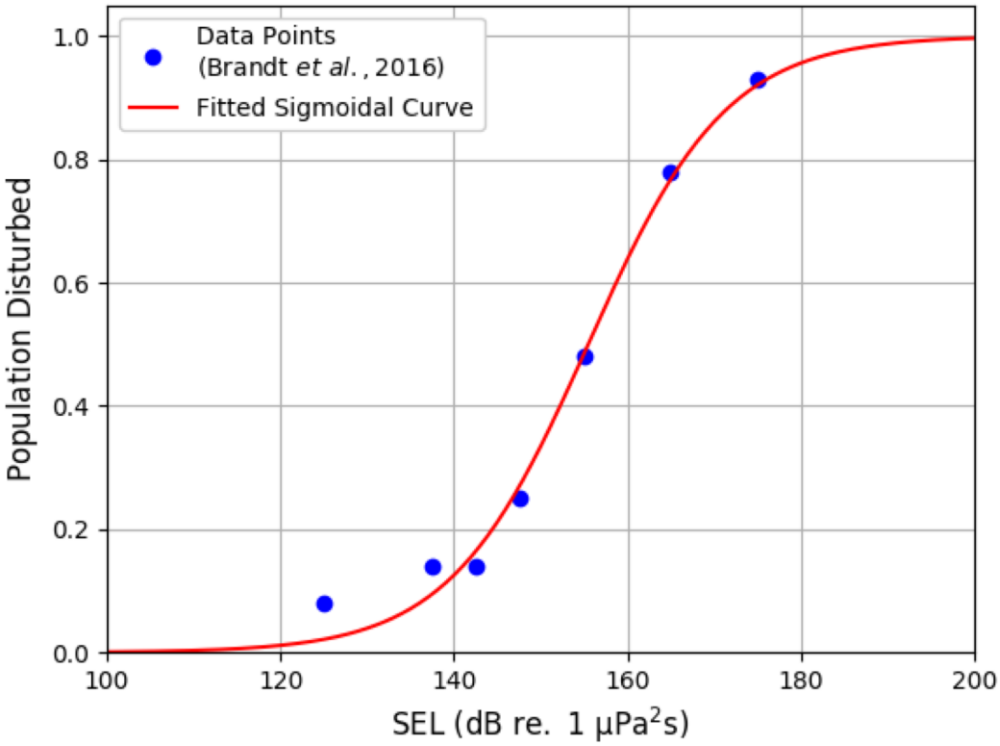

Figure 3-8: Behavioural response curve used for assessing potential behavioural disturbance to marine mammals.

Secondary Effects

634. There is potential for impacts on prey species to affect marine mammals and seabirds, in particular, possible impacts of noise on fish species. The impacts from noise on fish based on noise modelling results are assessed in Section 3.4.4.

3.3.1 Bottlenose dolphin

635. The bottlenose dolphin is a qualifying feature for the Moray Firth SAC.

636. Advice provided in the Scoping Opinion is that the only impacts from the proposed Project alone and in-combination that could have a likely significant effect on bottlenose dolphin are the impacts from noise arising from pile driving during construction (Marine Scotland 2017).

637. Details of all the noise modelling undertaken can be found in Appendix 8.1: Noise modelling, of the EIA.

3.3.1.1 Permanent Threshold Shift (Neart na Gaoithe)

638. The results from the noise modelling indicate that the average distances at which the onset of instantaneous PTS (un-weighted SPL) is predicted to occur on bottlenose dolphins from a single 1,635 kJ hammer strike is within 3 m from the pile driving and the onset of cumulative PTS occurs within 1 m (Table 3-5). In the event concurrent pile driving occurs within the Wind Farm Area the total area of impact within which the onset of PTS is predicted to occur is <0.001 km^2.

639. It is predicted that no bottlenose dolphins will receive levels of sound at which the onset of PTS are predicted to occur.

Table 3-5: Predicted distances and areas where NOAA thresholds for PTS in bottlenose dolphin are exceeded during pile driving at Neart na Gaoithe.

Bottlenose dolphin PTS	Distance to threshold exceedance (m)			Area (km^2)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 230 dB re 1 µPa	3	3	3	<0.001
Weighted cumulative SEL of 185 dB re 1 μPa^2s	1	1	1	<0.001

3.3.1.2 Disturbance (Neart na Gaoithe)

640. Based on a coastal bottlenose dolphin density of 0.07 ind/km^2, the results from the noise modelling undertaken (Figure 3-7) and the use of the dose response curve (Figure 3-8), it is estimated that two bottlenose dolphins may be disturbed from pile driving activities (See EIA Report Chapter 8: Appendix 8.2: Interim PCoD Modelling). In the event that concurrent pile driving occurs within the wind farm Area the number of bottlenose dolphins estimated to be impacted remains at two individuals.

3.3.1.3 In-combination

641. It is predicted that fewer than four bottlenose dolphins could receive levels of sound at which the onset of PTS are predicted to occur from the proposed wind farms within the Firths of Forth and Tay (Table 3-3). The number of individuals estimated to be disturbed is no more than 19 at any one development at any one time (Table 3-4).

3.3.2 Harbour seal and grey seal

642. The harbour seal is a qualifying species for the Forth of Tay and Eden Estuary SAC.

643. The grey seal is a qualifying species for the Isle of May SAC and the Berwickshire and Northumberland Coast SAC.

644. Advice provided in the Scoping Opinion is that the only impacts from the proposed Project alone and in-combination that could have a likely significant effect on seals are the impacts from noise arising from pile driving during construction (Marine Scotland 2017).

645. Details of all the noise modelling undertaken can be found in Appendix 8.1: Noise modelling, of the EIA.

3.3.2.1 Permanent Threshold Shift (Neart na Gaoithe)

646. The results from the noise modelling indicate that the average distances at which the onset of instantaneous PTS (un-weighted SPL) is predicted to occur on seals from a single 1,635 kJ hammer strike is within 18 m from the pile driving and the onset of cumulative PTS occurs within 472 m. The area within which the onset of PTS is predicted to occur is 0.706 km^2 (Table 3-5). In the event concurrent pile driving occurs within the Wind Farm Area, the total area of impact within which the onset of PTS is predicted to occur is 1.305 km^2.

647. It is predicted that one harbour seal and one grey seal may receive levels of sound at which the onset of PTS are predicted to occur (Table 3-3). In the event concurrent pile driving is undertaken the number of harbour seals and grey seals at risk remains the same.

Table 3-6: Predicted distances and areas where NOAA thresholds for PTS in pinniped are exceeded during pile driving at Neart na Gaoithe model location 2

Harbour seal and grey seal PTS	Distance to threshold exceedance (m)			Area (km^2)
	Minimum	Average	Maximum	
Unweighted single pulse peak SPL of 218 dB re 1 µPa	18	18	18	<0.001
Weighted cumulative SEL of 185 dB re 1 μPa^2s	337	472	553	0.706

3.3.2.2 Disturbance (Neart na Gaoithe)

648. Based on offshore densities (See Figure 3-4), the results from the noise modelling undertaken (Figure 3-7) and the use of the dose response curve (Figure 3-8), it is estimated that up to 8 harbour seals may be disturbed from pile driving activities (Table 3-4). In the event that concurrent pile driving occurs within the Wind Farm Area the number of harbour seals estimated to be impacted increases to 10 individuals. Similarly, the number of grey seals estimated to be impacted is 821 and in the event concurrent pile driving occurs this increases to 1,347 (Table 3-4).

3.3.2.3 In-combination

649. It is predicted that no more than one harbour seal will receive levels of sound at which the onset of PTS are predicted to occur at each of the planned or proposed wind farms (Table 3-3). A combined maximum total of eight harbour seals are estimated to receive levels of sound at which the onset of PTS are predicted to occur. The number of individuals estimated to be disturbed is no more than 11 at any one development and therefore at any one time (Table 3-4).

650. It is predicted that no more than one grey seal will receive levels of sound at which the onset of PTS are predicted to occur at each of the planned or proposed wind farms (Table 3-3). A combined total of eight grey seals are estimated to receive levels of sound at which the onset of PTS are predicted to occur. The maximum number of individuals estimated to be disturbed is no more than 1,103 at any one development and therefore at any one time (Table 3-4). Note, when assessing the potential in-combination impacts concurrent pile driving was not considered as this scenario reduced the overall duration of impacts.

3.4 Habitats Regulations Appraisal SACs

651. The following section assesses the potential impacts on the relevant qualifying species within the SACs as advised in the Scoping Opinion.

3.4.1 Moray Firth SAC

Site overview information for the Moray Firth SAC is provided in Table 3-7.

Table 3-7: Site overview for Forth Islands SPA

Site Information	Details
Site overview	The Moray Firth SAC lies approximately 170 km (in a direct line) to the north of Neart na Gaoithe. The site covers an area of 1,512 km^2 and is a marine site.
Site designation – qualifying species and features	▪ Bottlenose dolphin *Tursiops truncatus* ▪ Sandbanks which are slightly covered by sea water all the time (Subtidal sandbanks)

Site Information	Details
Site Conservation Objectives (for species)	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are established then maintained in the long term: ▪ Population of the species as a viable component of the site, ▪ Distribution of the species within site, ▪ Distribution and extent of habitats supporting the species, ▪ Structure, function and supporting processes of habitats supporting the species, ▪ No significant disturbance of the species.

652. The Scoping Opinion advised that the following qualifying species should be considered as being at risk of a likely significant effect:

- Bottlenose dolphin.

653. Based on the advice received in the Scoping Opinion other qualifying features are scoped out of this assessment (Marine Scotland 2017a).

3.4.1.1 Bottlenose dolphin (Neart na Gaoithe)

654. Based on the advice received there will be a likely significant effect on bottlenose dolphin from the Moray Firth SAC due to potential physical injury and disturbance arising from pile driving during construction with Neart na Gaoithe Offshore Wind Farm on its own and in-combination with other offshore wind farms.

655. The bottlenose dolphin population at the Moray Firth SAC is in a favourable and recovered condition (SNH, 2017b). The estimated SAC population is 195 (95% HDPI 162 – 253) individuals.

656. Results from the noise modelling undertaken indicates that no bottlenose dolphins will receive sound levels at which the onset of PTS is predicted to occur and two bottlenose dolphins may be disturbed or displaced during the pile driving at Neart na Gaoithe either with a single pile driving event undertaken over a period of 15 months or concurrent pile-driving undertaken over a period of nine months.

657. Based on the results from the iPCoD population model, the Moray Firth SAC bottlenose dolphin population is predicted to increase over the next 24 years (Figure 3-9 and Table 3-8). In the event that pile driving occurs over a period of 15 months, after 24 years the difference in the median impacted population compared with the unimpacted population is +6.25%. If concurrent pile driving over a period of nine months, the difference in the impacted population compared with the unimpacted population after 24 years is +5.76%.

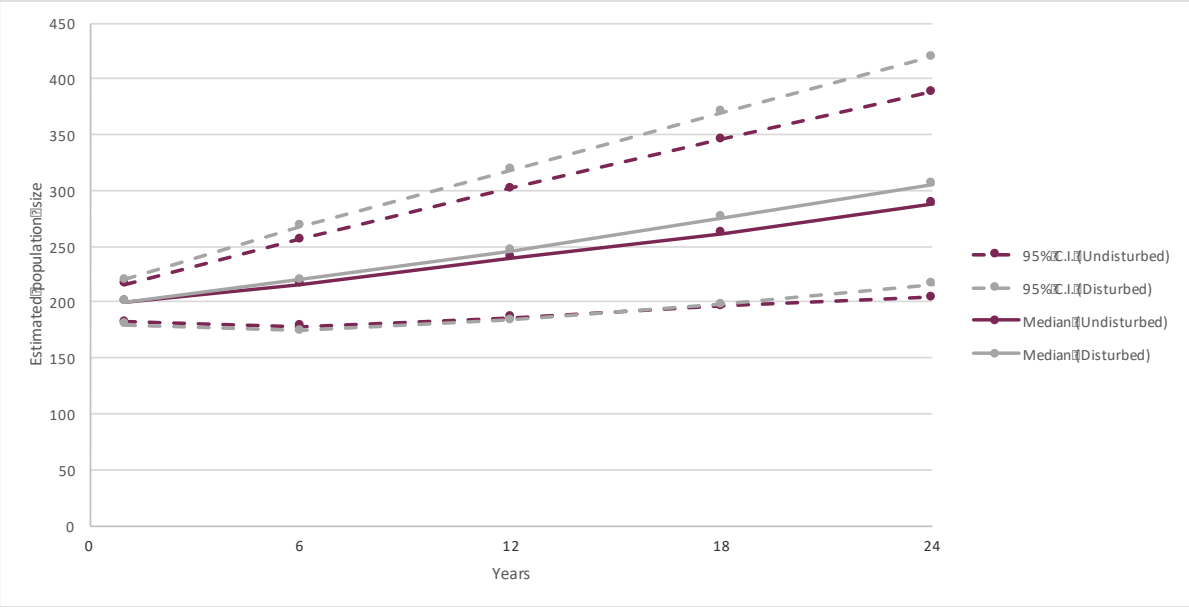

Figure 3-9: Estimated median (50th centile) and 95% C.I. for bottlenose dolphin Coastal East Scotland Management Unit population with (disturbed) and without (undisturbed) single pile driving over a period of 15 months

Table 3-8: Estimated change in predicted population size for bottlenose dolphins in the Moray Firth SAC with and without the Project alone or in-combination with other developments over 24 years

Bottlenose dolphin	SAC Population	Baseline population after 24 years (no wind farm)	Population with NnG after 24 years	Percentage difference in median final population size compared to baseline	Counterfactual Population Size (%)
Single pile driving	195	288	306	+6.25	106.3
Concurrent pile driving		278	294	+5.76	105.8
Cumulative pile driving		244	136	-47.7	53.5

658. There is the potential for some disturbance to bottlenose dolphins during the construction period. It is estimated that this will last for between 9 and 15 months depending on the construction scenario selected. Once pile driving has ceased there will be no disturbance to bottlenose dolphins, the impacts from disturbance are therefore temporary. There will be no disturbance to bottlenose dolphins within the site and their distribution within the site will not be affected. There will be no direct impacts on the distribution and extent of habitats supporting the species, although there may be an impact on their prey (See Section 3.4.4). Based on the results from the modelling undertaken it is predicted that the effects from disturbance will not have a population level effect and therefore not impact on the species remaining a viable component of the site in the long-term.

659. Consequently, it is concluded that the impacts from pile-driving noise during construction on bottlenose dolphin will not adversely affect the integrity of the Moray Firth SAC, in light of the qualifying interest, their condition and the sites conservation objectives.

3.4.1.2 Bottlenose dolphin (In-combination)

660. Results from the noise modelling undertaken indicates that no more than eight bottlenose dolphins might receive sound levels at which the onset of PTS is predicted to occur and no more than 19 bottlenose dolphins will be disturbed at any one time over a period of 11 years (Table 3-3 and Table 3-4).

661. Based on the results from the iPCoD population model, the Moray Firth SAC bottlenose dolphin population is predicted to increase over the next 24 years. In the event that pile driving occurs over a period of 11 years, the difference in the median impacted population compared with the unimpacted population is predicted to be -47.7% (Table 3-8 and Figure 3-10). This output from the population model is considered highly unlikely to occur and is based on a very much worst-case scenario.

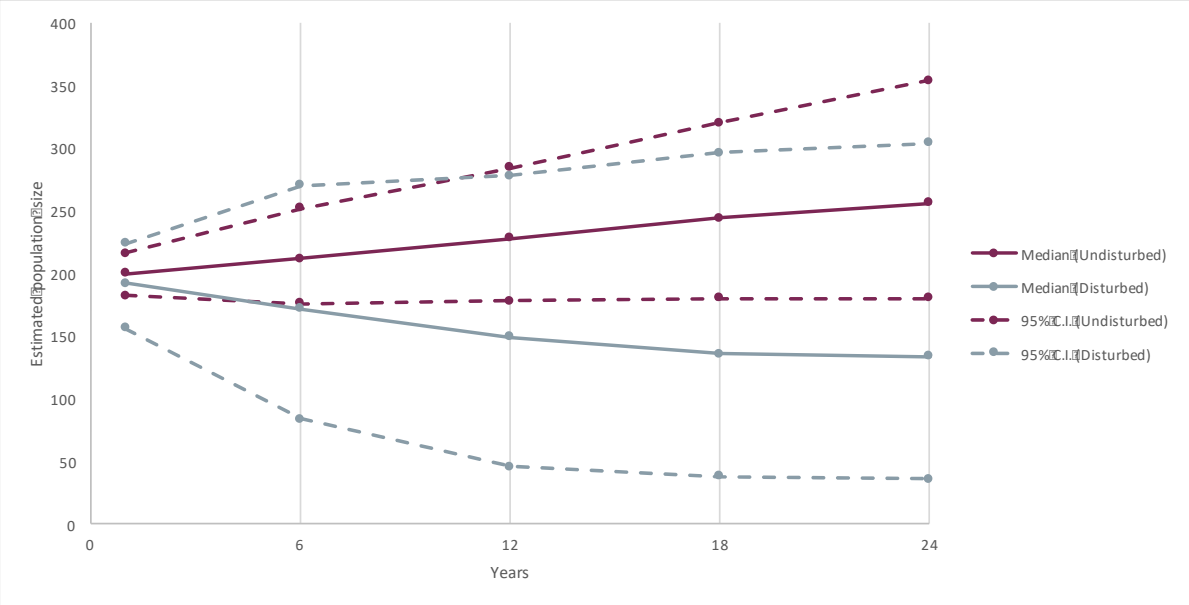

Figure 3-10: Estimated median (50th centile) and 95% C.I. for bottlenose dolphin Coastal East Scotland Management Unit population with (disturbed) and without (undisturbed) sequential pile driving over a period of 11 years

662. However, based on the results from the noise modelling NnG is predicted to cause disturbance impacts on no more than two bottlenose dolphins and the population modelling indicates that NnG on its own will not have a population level effect. Consequently, the Project will not cause any, in-combination impact on the bottlenose dolphin population. Although there is predicted to be a reduction in the population from cumulative impacts the Project does not contribute to this predicted impact.

663. It is noted that the estimated in-combination impacts are based on a worst-case scenario of all developments being constructed sequentially, without any breaks in pile driving from between 2019 and 2028 (Figure 3-6). This is considered very unlikely with a high potential for the construction of developments to be delayed and breaks in pile driving to occur. This reduces the risk on the population, providing years when there are likely to be no impacts from wind farm developments.

664. Based on the lack of any population level effect the Project alone has on the estimated decrease in the bottlenose dolphin population, it is concluded that there will be no in-combination impacts from pile-driving noise from the construction of the Project on bottlenose dolphin will therefore not adversely affect the integrity of the Moray Firth SAC, in light of the qualifying interest, their condition and the sites conservation objectives

3.4.1.3 Moray Firth SAC - Conclusions

665. Based on the predicted level of potential impacts, it is concluded that there will be no adverse effects on the integrity of the Moray Firth SAC from the Project, either alone or in-combination with other plans or projects.

3.4.2 Firth of Tay and Eden Estuary SAC

666. Site overview information for the Firth of Tay and Eden Estuary SAC is provided in Table 3-7 below.

Table 3-9: Site overview for Firth of Tay and Eden Estuary SAC

Site Information	Details
Site overview	The Firth of Tay and Eden Estuary SAC lies approximately 30 km to the west of the proposed Neart na Gaoithe Offshore Wind Farm. The site covers an area of 154 km^2 and is a coastal site comprising mainly of estuaries, tidal rivers, mud flats and sand flats.
Site designation – qualifying species and features	▪ Harbour seal *Phoca vitulina* ▪ Mudflats and sandflats not covered by seawater at low tide (Intertidal mudflats and sandflats) ▪ Sandbanks which are slightly covered by sea water all the time (Subtidal sandbanks)
Site Conservation Objectives (for species)	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are established then maintained in the long term: ▪ Population of the species as a viable component of the site, ▪ Distribution of the species within site, ▪ Distribution and extent of habitats supporting the species, ▪ Structure, function and supporting processes of habitats supporting the species, ▪ No significant disturbance of the species.

667. The Scoping Opinion advised that the following qualifying species should be considered as being at risk of a likely significant effect:

- Harbour seal.

668. Based on the advice received in the Scoping Opinion other qualifying features are scoped out of this assessment (Marine Scotland 2017a).

3.4.2.1 Harbour seal

669. Based on the advice received there will be a likely significant effect on harbour seals from the Firth of Tay and Eden Estuary SAC due to potential physical injury and disturbance arising from pile driving during construction with Neart na Gaoithe Offshore Wind Farm on its own and in-combination with other offshore wind farms (Marine Scotland 2017a).

670. The harbour seal population at the Firth of Tay and Eden estuary SAC is in an unfavourable and declining condition (SNH, 2017b). The latest harbour seal population estimate based on counts undertaken in 2015 is 60 individuals (Duck *et al*. 2016). The latest estimated number of harbour seals within the ECMA is 311 (95% CI 254 - 415) individuals. For the purposes of this assessment the ECMA is taken to be the SAC population (Marine Scotland 2017a).

671. The results from the noise modelling indicate that there is potential for the onset of PTS to occur within 472 m from pile driving and that one harbour seal may be impacted. In the event that concurrent pile driving occurs over a period of nine months this remains the same (Table 3-3)

672. The area across which disturbance or displacement may occur is presented in Figure 3-7. Based on the outputs from the noise modelling and the use of a dose response curve. It is estimated that up to 8 harbour seals may be displaced or disturbed from a single pile driving event and 10 from concurrent pile driving (Table 3-4).

673. Based on the results from the iPCoD population model, the harbour seal ECMA population is predicted to decrease over the next 24 years and there may not be any harbour seals present in the area after 18 years (Figure 3-11). In the event that pile driving occurs over a period of 15 months or concurrently over none months the modelling predicts a similar level of population decline over the same period of time. Under all scenarios the population in 24 years is predicted to be zero (Table 3-10).

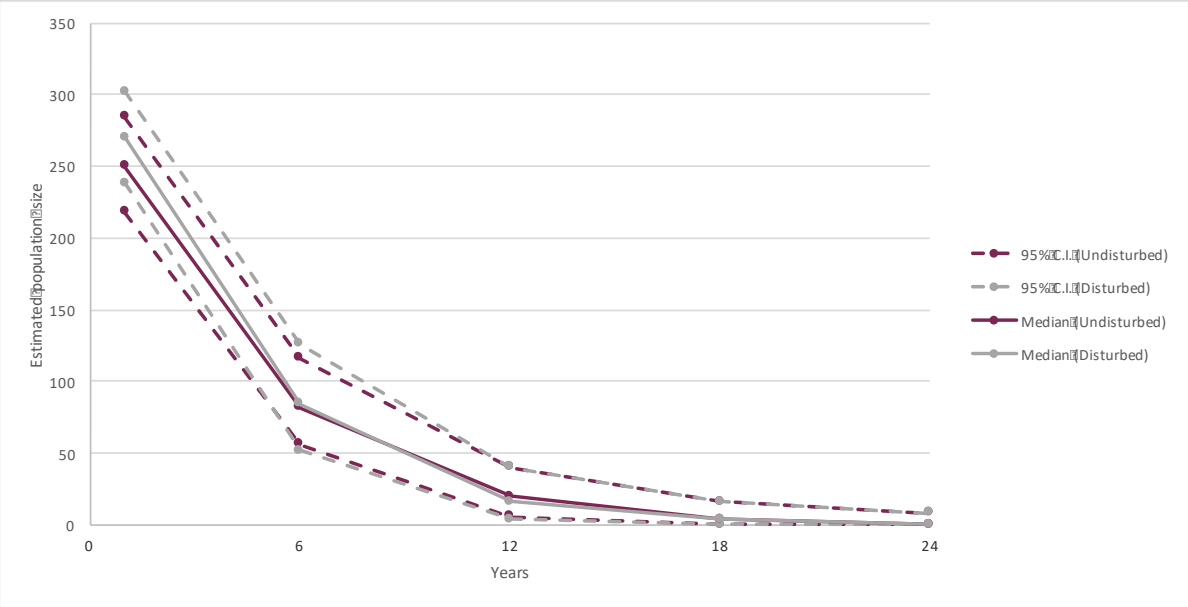

Figure 3-11: Estimated median (50th centile) and 95% C.I. for harbour seal ECMA population with (disturbed) and without (undisturbed) single pile driving over a period of 15 months

Table 3-10: Estimated change in predicted population size for Harbour seals in the ECMA (Firth of Forth and Eden estuary SAC) with and without the Project alone or in-combination with other developments over 24 years

Harbour seal	ECMA (SAC) Population	Baseline population after 24 years (no wind farm)	Population with NnG after 24 years	Percentage difference in median final population size compared to baseline	Counterfactual Population Size (%)
Single pile driving	311	0	0	0.0	1.00
Concurrent pile driving		0	0	0.0	1.00
Cumulative pile driving		0	0	0.0	1.00

674. Tagging data obtained during the construction of the Lincs Offshore wind farm indicated that displacement effects could occur out to 25 km from the sound source with a predicted maximum SPL of 235 dB re 1 $\mu Pa_{(p\text{-}p)}$ @ 1 m and a maximum SEL of 211 dB re 1 $\mu Pa^2 s^{-1}$. However, following cessation

of pile driving the distribution of harbour seals returned to the pre-pile driving scenarios (Russell *et al.* 2016b). Consequently, any potential displacement arising from pile driving are predicted to be temporary.

675. Studies undertaken at other offshore wind farms indicate that there is a low risk of any population level effect to harbour seals from construction activities. Following construction at Horns Rev offshore wind farm no changes in the abundance of harbour seals were recorded at haul-out sites (Teilmann *et al*. 2006) and at the Dutch Egmond aan Zee wind farm harbour seals avoided the wind farm area during construction but were recorded within the wind farm following the cessation of construction activities. However, due to the limited data it was not possible to conclusively conclude that there were no population effects (Brasseur *et al*. 2012).

676. Although there will be an impact on harbour seals arising from pile driving noise, the results from the population modelling indicate that there will be a very minor if any, additive effect on the harbour seal population from the pile driving.

677. There will be some disturbance to harbour seals during the construction period. It is estimated that this will last for a maximum of either 9 or 15 months depending on the construction scenario selected. Once pile driving has ceased there will be no disturbance to harbour seals, the impacts from disturbance are therefore temporary. There will be no direct impacts on the distribution and extent of habitats supporting the species, although there may be an impact on their prey (See Section 3.4.4). Based on the results from the modelling undertaken it is predicted that the effects from potential physical injury and disturbance will not have a population level effect and the predicted future population of harbour seals will not be affected by noise arising from pile driving from the proposed Neart na Gaoithe Offshore Wind Farm, when compared with a scenario where no wind farm is constructed.

678. Based on the results from the modelling undertaken it is predicted that the any impacts on harbour seals from pile driving will not have a significant population level effect. Consequently, it is concluded that the impacts from pile driving noise during construction on harbour seals will not adversely affect the integrity of the Firth of Tay and Eden Estuary SAC, in light of the qualifying interest, their condition and the site's conservation objectives.

3.4.2.2 Harbour seal (In-combination)

679. Results from the noise modelling undertaken indicates that no more than five harbour seals might receive sound levels at which the onset of PTS is predicted to occur and no more than 11 may be disturbed at any one time over a period of 11 years (Table 3-3 and Table 3-4).

680. The iPCoD model used in the population modelling does not run if the population upon which it is impacting is smaller than the number of days the impact occurs. Consequently, population modelling was not able to be used to assess potential in-combination impacts on harbour seal. However, the population modelling undertaken predicted a significant decline in the harbour seal population without any possible impacts from pile driving (Table 3-10) with the population becoming extinct within 24 years. The cumulative impacts from pile driving will not significantly alter the predicted on-going population decline and will make no material difference to the predicted population trend. Although, there is a possibility that the reduction in the population may be hastened in the event that in-combination impacts do occur.

681. The level of impacts predicted are similar to those assessed in the Appropriate Assessment undertaken for the consented developments, i.e. a continued population decline, which has previously been determined to have no measurable impact on site integrity in relation to the viability of the population (Marine Scotland, 2014).

682. Based on the predicted decline in the population over a period of 24 years and the negligible contribution the Project alone has on the estimated decrease in the population it is concluded that the

in-combination impacts from pile-driving noise during construction on harbour seal will not adversely affect the integrity of the Firth of Tay and Eden Estuary SAC, in light of the qualifying interest, their condition and the sites conservation objectives.

3.4.2.3 Firth of Tay and Eden Estuary SAC - Conclusions

683. Based on the predicted level of potential impacts, it is concluded that there will be no adverse effects on the integrity of the Firth of Tay and Eden Estuary SAC from the Project, either alone or in-combination with other plans or projects.

3.4.3 Isle of May SAC and Berwickshire and North Northumberland Coast SAC

684. Site overview information for the Isle of May SAC is provided in Table 3-7 below.

Table 3-11: Site overview for the Isle of May SAC

Site Information	Details
Site overview	The Isle of May SAC lies approximately 16 km to the west of the proposed Neart na Gaoithe Offshore Wind Farm. The site covers an area of 3.56 km^2 and is an island site comprising mainly of marine habitat.
Site designation – qualifying species and features	▪ Grey seal *Halichoerus gryous* ▪ Reefs
Site Conservation Objectives (for species)	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are established then maintained in the long term: ▪ Population of the species as a viable component of the site, ▪ Distribution of the species within site, ▪ Distribution and extent of habitats supporting the species, ▪ Structure, function and supporting processes of habitats supporting the species, ▪ No significant disturbance of the species.

685. Site overview information for the Berwickshire and North Northumberland Coast SAC is provided in Table 3-12.

Table 3-12: Site overview for the Berwickshire and North Northumberland Coast SAC

Site Information	Details
Site overview	The Berwickshire and North Northumberland Coast SAC lies approximately 33 km to the south of the proposed Neart na Gaoithe Offshore Wind. The site covers an area of 652 km^2 and is a coastal and marine site comprising mainly of marine areas, tidal rivers, estuaries, mud flats, sand flats and lagoons.
Site designation – qualifying species and features	• Grey seal *Halichoerus grypus,* • Large shallow inlets and bays (Shallow inlets and bays), • Mudflats and sandflats not covered by seawater at low tide (Intertidal mudflats and sandflats), • Submerged or partially submerged sea caves (Sea caves), • Reefs

Site Information	Details
Site Conservation Objectives (for species)	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are established then maintained in the long term: • Population of the species as a viable component of the site, • Distribution of the species within site, • Distribution and extent of habitats supporting the species, • Structure, function and supporting processes of habitats supporting the species, • No significant disturbance of the species.

686. The Scoping Opinion advised that the following qualifying species for both the Isle of May SAC and Berwickshire and North Northumberland Coast SAC should be considered as being at risk of a likely significant effect:

- Grey seal

687. Based on the advice received in the Scoping Opinion other qualifying features for both SACs are scoped out of this assessment (Marine Scotland 2017a).

3.4.3.1 Grey seal

688. Based on the advice received there will be a likely significant effect on grey seals from the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC due to potential physical injury and disturbance arising from pile driving during construction with Neart na Gaoithe Offshore Wind Farm on its own and in-combination with other offshore wind farms (Marine Scotland 2017a).

689. The grey seal populations at the Isle of May SAC and the Berwickshire and North Northumberland Coast SAC are in a favourable and maintained condition (SNH, 2017b). Based on the latest population estimates and a scalar multiplier of 2.39 (Duck *et al*. 2016; Russell *et al*. 2016a), the latest population estimate of grey seals in the ECMA is 9,607 (95% CI 8,028 – 11,958). For the purposes of this assessment the ECMA is taken to be the population for both SACs (Marine Scotland 2017a).

690. The results from the noise modelling indicate that there is potential for the onset of PTS to occur within 472 m from pile driving and that one grey seal may be impacted. In the event that concurrent pile driving occurs over a period of nine months this remains at one individual (Table 3-3).

691. The area across which disturbance or displacement may occur is presented in Figure 3-7. Based on the outputs from the noise modelling and the use of a dose response curve, it is estimated that up to 821 grey seals may be displaced or disturbed from a single pile driving event and 1,357 from concurrent pile driving (Table 3-4).

692. Based on the results from the iPCoD population model, the ECMA grey seal population is predicted to increase over the next 24 years (Figure 3-12). In the event that pile driving occurs over a period of 15 months, after 24 years the difference in the median impacted population compared with the unimpacted population is -7.72%. If concurrent pile driving over a period of nine months, the difference in the impacted population compared with the unimpacted population after 24 years is -5.67% (Table 3-13). Although, there is a difference in the population between the impacted and impacted populations after 24 years, the population modelling predicts that under both pile driving scenarios the grey seal population will continue to increase and be higher than the current estimated population.

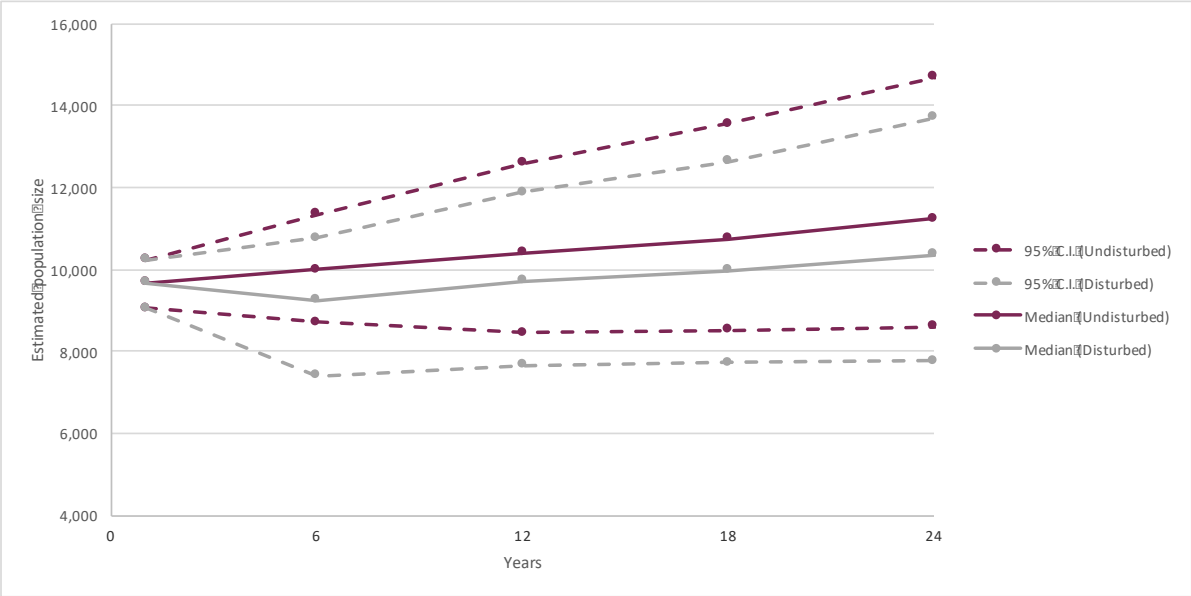

Figure 3-12: Estimated median (50th centile) and 95% C.I. for grey seal ECMA population with (disturbed) and without (undisturbed) single pile driving over a period of 15 months

Table 3-13: Estimated change in predicted population size for grey seals in the ECMA (Isle of May SAC and Berwickshire and North Northumberland Coast SAC) with and without the Project alone or in-combination with other developments over 24 years

Harbour seal	ECMA (SAC) Population	Baseline population after 24 years (no wind farm)	Population with NnG after 24 years	Percentage difference in median final population size compared to baseline	Counterfactual Population Size (%)
Single pile driving	9,607	11,224	10,357	-7.72	95.0
Concurrent pile driving		11,206	10,571	-5.67	97.3
Cumulative pile driving		11,260	7,793	-30.8	70.7

693. Studies undertaken at other offshore wind farms have not detected any declines in the population of grey seals following construction. At Scroby Sands Offshore wind farm the population of grey seals continued to increase following the construction of the wind farm (Skeate *et al.* 2012). Similarly, following construction of the Nysted offshore wind farm in Denmark, no long term effects on the number grey seals hauled at Rødsand as close as 4 km away were recorded (Edrén, *et al.* 2010). Consequently, it is predicted that there will not be any decrease in the ECMA grey seal population and the population may continue to increase as indicated by the population modelling.

694. There will be some disturbance to grey seals during the construction period. It is estimated that this will last for between 9 and 15 months depending on the construction scenario selected. Once pile driving has ceased there will be no disturbance to grey seals, the impacts from disturbance are therefore temporary. There will be no direct impacts on the distribution and extent of habitats supporting the species, although there may be an impact on their prey (See Section 3.4.4). Based on the results from the modelling undertaken it is predicted that the effects from potential physical injury and disturbance will not have a population level effect.

695. Based on there being no decrease in the grey seal population below the current levels after a period of 24 years it is concluded that the population of grey seals will remain a viable component at both sites

and the impacts from pile-driving noise during construction on grey seals will not adversely affect the integrity of the Isle of May SAC or the Berwickshire and North Northumberland Coast SAC, in light of their qualifying interests, their conditions and their conservation objectives.

3.4.3.2 Grey seal (In-combination)

696. Results from the noise modelling undertaken indicates that no more than 5 grey seals might receive sound levels at which the onset of PTS is predicted to occur and no more than 1,103 grey seals may be disturbed at any one time (Table 3-3 and Table 3-4).

697. Based on the results from the iPCoD population model, the ECMA grey seal population is predicted to increase over the next 24 years. In the event that pile driving occurs over a period of 11 years, the difference in the median impacted population compared with the unimpacted population is predicted to be -30.8% (Figure 3-13 and Table 3-13).

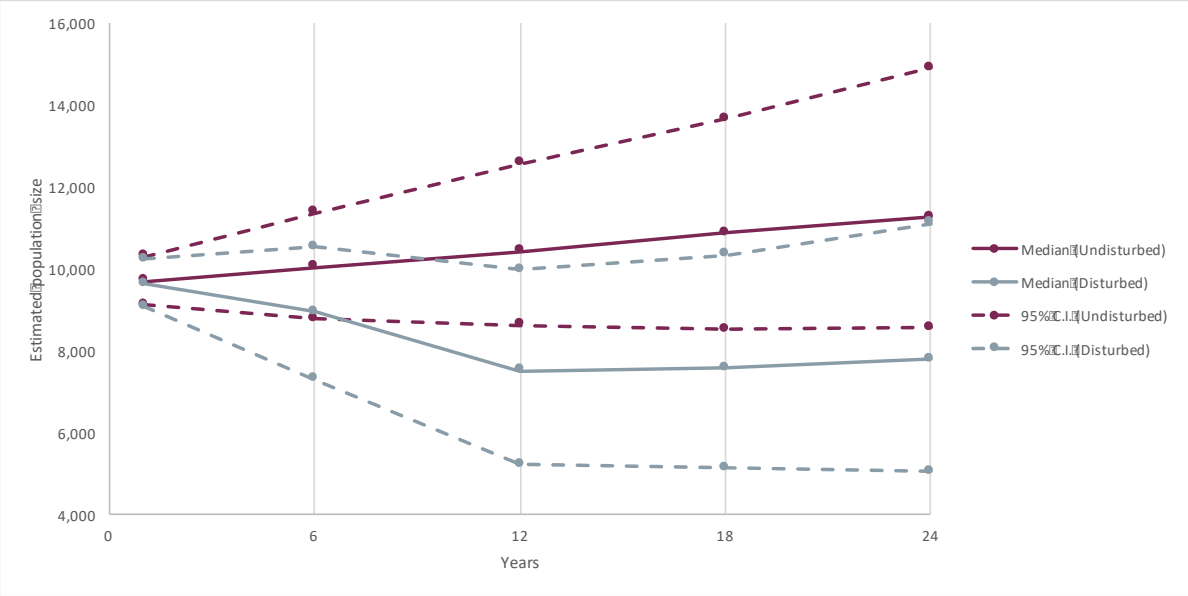

Figure 3-13: Probability of a decline in the population of grey seals within the East Coast and North-east England Management Areas over 24 years with and without cumulative pile driving events

698. It is recognised that the estimated in-combination impacts are based on a worst-case scenario of all developments being constructed sequentially, without any breaks in pile driving. This is considered very unlikely with a high potential for the construction of developments to be delayed and breaks in pile driving to occur. This reduces the risk on the population, providing years when there are likely to be no impacts from the construction of offshore wind farm developments.

699. The Project alone is not predicted to cause a population level effect, in that the population after 24 years is predicted to be higher than the current ECMA population. However, there is potential for an in-combination impact with other planned developments.

700. The grey seal population at both SACs are considered to be robust and increasing. Although there is a risk that the in-combination impacts may cause a reduction in the population size, the precautionary nature of the assessment and the population model used for this assessment suggests that there is significant uncertainty in these results. Should it occur then there is potential for an adverse effect on the grey seal population from potential cumulative impacts. However, it is considered highly unlikely to occur and that the population of grey seals will remain a viable component of both sites. It is therefore concluded that the in-combination impacts from pile-driving noise during construction on grey seals will not adversely affect the integrity of the Isle of May SAC or the Berwickshire and North Northumberland Coast SAC, in light of their qualifying interests, their condition and their conservation objectives.

3.4.3.3 Isle of May SAC and Berwickshire and North-Northumberland Coast SAC- Conclusions

701. Based on the predicted level of potential impacts and the precautionary nature of the assessment, it is concluded that there will be no adverse effects on the integrity of either the Isle of May SAC or the North Northumberland Coast SAC from the Project, either alone or in-combination with other plans or projects.

3.4.4 Impacts on Prey

702. Advice in the Scoping Opinion is that noise from pile driving may require consideration if it extends into the Firth of Forth and St Andrews Bay Complex pSPA (Marine Scotland 2017a). Impacts on fish may also affect the structure, function and supporting processes of habitats supporting the qualifying species. This section assesses the potential impacts on fish that are predominant prey items for both seabirds and marine mammals and could be affected by noise arising from the proposed pile driving.

703. Noise modelling has been undertaken to determine the extent potential impacts from pile driving may have on fish. The results are presented in detail in the EIA Appendix 8.1: Noise modelling.

704. The results from the noise modelling indicate that noise levels that have the potential to cause mortality to fish will be very localised and will not exceed 129 m from the pile driving. The distance within which the onset of TTS is predicted to occur is larger and is predicted to extend up to 10,157 m (Table 3-14 and Table 3-15).

Table 3-14: Predicted average distance at which thresholds for mortality and potential mortal injury are exceeded during pile-driving at Neart na Gaoithe for fish with swim bladders

Fish: swim bladder involved in hearing	Average distance to threshold exceedance (m)	Area (km^2)
Mortality and potential mortal injury (single pulse peak SPL of 207 dB re 1 µPa)	129	0.058
Mortality and potential mortal injury (unweighted cum. SEL of 207 dB re 1 μPa^2s)	2	<0.001
Recoverable injury (unweighted cum. SEL of 206 dB re 1 μPa^2s)	6	<0.001
TTS (unweighted cum. SEL of 186 dB re 1 μPa^2s)	10,157	337.2

Table 3-15: Predicted average distance at which thresholds for mortality and potential mortal injury are exceeded during pile-driving at Neart na Gaoithe for fish with no swim bladders.

Fish: swim bladder not involved in hearing	Average distance to threshold exceedance (m)	Area (km^2)
Mortality and potential mortal injury (single pulse peak SPL of 207 dB re 1 µPa)	46	0.006
Mortality and potential mortal injury (unweighted cum. SEL of 207 dB re 1 μPa^2s)	0	0.000
Recoverable injury (unweighted cum. SEL of 206 dB re 1 μPa^2s)	0	0.000
TTS (unweighted cum. SEL of 186 dB re 1 μPa^2s)	10,157	337.2

705. The area of impact within which physical injury could occur is therefore relatively very small. However, the area within which disturbance could occur may be significantly greater. There are no thresholds at which disturbance to fish may be predicted to occur (Popper *et al.* 2014). However, using the onset of TTS as a proxy measure of potential disturbance it is predicted that disturbance to

fish may occur out to approximately 10 km depending on the location and encompass an area up to 337 km^2 (and Table 3-15).

706. The main prey items for the majority of the seabirds and marine mammals recorded within the study area are fish, although some non-fish prey items such as cephalopods may also be taken, particularly by marine mammals. The main prey items recorded for seabirds and marine mammals in the region are presented in Table 3-16. However, it is recognised that many species are opportunistic feeders and will prey on a wide variety of species if available.

Table 3-16: Main prey items for marine mammals recorded within the study area

Species	Main prey
Seabirds	sandeel, sprat, herring
Bottlenose dolphin	cod, saithe, whiting and also salmon and haddock
Grey seal	sandeel, cod and haddock
Harbour seal	sandeel, whiting, flounder and cod

707. Sandeels are one of the main prey items for many of the seabirds and marine mammals recorded in the area. They are also an important prey species for predatory fish such as whiting, cod and haddock, all of which are also prey to other species (Greenstreet *et al*. 2006). Sandeels are not considered to have sensitive hearing (Popper *et al.* 2014). Studies undertaken using airguns indicate that sandeels have distinct but weak reactions to seismic airguns with initial startle responses reducing in frequency with on-going noise and no increased mortality detected (Hassel *et al.* 2004).

708. Results from studies on cod and sole indicate that pile-driving may cause fish to increase swimming speed and move away from the pile-driving noise (Mueller-Blenkle *et al.* 2010). Studies undertaken during 35 days of pile-driving in a wharf on two species of fish which possess swim-bladders: grey snapper (*Lutjanus griseus*) and sheepshead (*Archosargus probatocephalus*), indicated little displacement effects at received SPL of between 152±157 dB re 1 µPa (peak) (Lafrate *et al*. 2016).

709. Similarly, studies undertaken during seismic surveys have reported localised and temporary changes in behaviour, with fish swimming away from the area or into deeper water but fish populations returning to pre-survey levels shortly after the noise from seismic surveys had stopped (e.g. Wardle *et al*. 2001; Slotte *et al*. 2004; Løkkeborg *et al.* 2010; Peña *et al*. 2013).

710. Construction surveys from existing wind farms have indicated that fish numbers present within operating wind farms are at least similar to those prior to construction and may be higher (e.g. Jensen *et al.* 2006; Leonhard and Pederson, 2006; Lindeboom *et al.* 2011, Leonhard *et al.* 2011). Consequently, no long-term impacts on fish on which seabirds and marine mammals prey are predicted following cessation of construction activities.

711. Sound arising from pile-driving may have an effect on some prey species for seabirds and marine mammals. Although the level of impact is dependent on the level of the sound source and the species of fish, the results from the noise modelling indicate that there is a very low risk of injury to any fish species. Although there is potential for a wider area of displacement or disturbance, published studies indicate that the impacts will be localised and temporary, with fish populations returning to background levels following cessation of the noise.

It is therefore predicted that there may be a relatively localised effect on the distribution of prey species upon which seabirds and marine mammals prey. However, the potential impacts will localised and short-term, with fish population returning to normal background levels. Consequently, the distribution and extent of the species will be maintained in the long term. The predicted impacts on prey will not cause an adverse effect on the integrity of any of the designated sites considered in this assessment.

3.5 Mitigation

712. Embedded Mitigation measures to minimise the potential effects on marine mammals, are captured within the Project design envelope.

713. Pile driving will be undertaken using the lowest possible hammer energy to allow satisfactory pile installation. This will reduce the area of potential impact from noise on marine mammals and their prey. Pile driving will commence by using a lower hammer energy and slowly, over a period of time, ramp-up to a maximum hammer energy. This reduces the duration at which marine mammals will be impacted by potentially significant levels of noise and provides time for them to leave the area in order to avoid possible risk of physical injury

714. A number of conditions relating to marine mammals were attached to the Original Consents to manage the environmental risk associated with the Originally Consented Project. NnGOWL anticipates that any future consents issued to the Project may incorporate similar conditions to manage the risk to marine mammals commensurate with the Project design envelope where it remains necessary to do so. Table 3-17 sets out the conditions attached to the Original Consents which have relevance to the management of effects on marine mammals.

Table 3-17: Consent conditions for the Originally Consented Project relevant to marine mammals

Original Consent Requirement	Relevance to Marine Mammals
Piling Strategy	Setting out, for approval, the piling methods, in accordance with the Application and detailing associated mitigation incorporating data collected as part of pre-construction survey work to demonstrate how effects on bottlenose dolphin, harbour seal and grey seal will be adequately mitigated.
Noise registry	Prior to the commencement of piling activities the proposed date(s), location(s) and nature of the piling activities undertaken must be reported. In the event piling is to be carried out for more than 10 consecutive days, submit quarterly noise registry reports.
Vessel Management Plan	Requires details of the vessels to be used and working practices to reduce the use of ducted propellers.
Environmental Management Plan	Setting out, for approval, relevant environmental management and mitigation measures to be applied during the construction and operation of the Project.
Project Environmental Monitoring Plan	Setting out, for approval, the proposed environmental monitoring programme, to include the participation in surveys to be carried out in relation to marine mammals as set out in the Marine Mammal Monitoring Programme
Participation in the Scottish Strategic Marine Environmental Group (SSMEG)	Requires participation in the SSMEG with respect to research, monitoring and mitigation programmes for marine mammals.
Participation in the Forth and Tay Regional Advisory Group (FTRAG)	Participation in the FTRAG with respect to monitoring and mitigation for marine mammals.

3.6 References

- Anderwald, P., and Evans, P.G.H. (2010). *Cetaceans of the East Grampian Region.* Sea Watch Foundation, August 2010.
- APEM (2017). Mainstream Kittiwake and Auk Displacement Report. APEM Scientific Report P000001836. Neart na Gaoithe Offshore Wind Limited, 04/12/17, v2.0 Final, 55 pp.
- Arso Civil, M. (2014). Population Ecology of Bottlenose Dolphins (*Tursiops truncatus*) off the East Coast of Scotland. PhD Thesis. University of St Andrews
- Barton, C., Pollock, C. & Harding, N. (2009). *Arklow Bank seabird and marine mammal monitoring programme. Year 8*. A report to Airtricity.
- BERR (2008). *Review of cabling techniques and environmental effects applicable to the offshore wind farm industry*. Technical Report. January 2008.
- Bicknell, A.W.J., Oro, D., Camphuysen, C.J. and Votier, S.C. 2013. Potential consequences of discard 18 reform for seabird communities. *Journal of Applied Ecology*, 50: 649-658. Doi:10.1111/1365-2664.12072.
- Brookes, K. (2017). The East Coast Marine Mammal Acoustic Study data. doi: 10.7489/1969-1. https://data.marine.gov.scot/dataset/east-coast-marine-mammal-acoustic-study.
- Brown, E.G. and Pierce G.J. (1997). Diet of harbour seals at Mousa, Shetland during the third quarter of 1994. *Journal of Marine Biological Association* 77: 539-555.
- BTO (2017). Bird Facts. https://app.bto.org/birdfacts/results/bob6340.htm (Accessed December 2017).
- Cheney, B., Thompson, P.M., Ingram, S.N., Hammond, P.S., Stevick, P.T., Durban, J.W., Culloch, R.M., Elwen, S.H., Mandleberg, l., Janik, V.M., Quick, N.J., Islas-Villanueva, V., Robinson, K.P., Costa, M., Eisfeld, S.M., Walters, A., Phillips, C., Weir, C.R., Evans, P.G.H., Anderwald, P., Reid, R.J., Reid, J.B. and Wilson, B. (2013). Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins *Tursiops truncatus* in Scottish waters. *Mammal Review*, 43: 71-88.
- Cook, A,S,C.P, Johnstone, A., Wright, L.J. and Burton, N.H.K. (2012). *A review of methods to estimate the risk of bird collisions with offshore wind farms*. Strategic Ornithological Support Services. Project SOSS-02. BTO Report for The Crown Estate. December 2011.
- Cook, A.S.C.P., Humphreys, E.M., Masden, E.A. and Burton, N.H.K. (2014). *The avoidance rates of collision between birds and offshore turbines.* BTO Research Report No. 656.
- Daunt, F., Bogdanova, M., Newell, M., Harris, M. & Wanless, S. (2010). *Literature review of foraging distribution, foraging range and feeding behaviour of common guillemot, razorbill, Atlantic puffin, black-legged kittiwake and northern fulmar in the Forth/Tay region*. Report to FTOWDG 2011. Centre for Ecology & Hydrology. Edinburgh.
- Daunt, F., Bogdanova, M., Newell, M., Harris, M. & Wanless, S. (2011a). *GPS tracking of common guillemot, razorbill, black-legged kittiwake on the Isle of May Summer 2010*. Report for FTOWDG. Centre for Ecology and Hydrology, Edinburgh.
- Daunt, F., Bogdanova, M., Redman, P., Russell, S. & Wanless, S. (2011b). *GPS tracking of black-legged kittiwake and observations of trip durations and flight directions of common guillemot at Fowlsheugh and St Abb's Head, summer 2011*. Report to FTOWDG, Centre for Ecology and Hydrology, Edinburgh, UK: 70pp.
- David, J.A. (2006). Likely sensitivity of bottlenose dolphins to pile-driving noise. *Water and Environment Journal* 20: 48–54.
- Deaville, R. and Jepson, P.D. (compilers) (2011) *UK Cetacean Strandings Investigation Programme Final report for the period 1st January 2005-31st December 2010*.
- Diersche, V. & Garthe, S. (2006). *Literature review of offshore wind farms with regard to seabirds*. In: Zucco, C., Wende, W., Merck, T., Kochling, I. & Köppel, J. (eds.) Ecological

research of offshore wind farms: international exchange of experiences (Project No. 804 46 001), Part B: Literature review of the ecological impacts of offshore wind farms. Bonn, Germany: BfN-Skripten.

- Duck, C., Morris C. and Thompson, D. (2016). *The status of UK harbour seal populations in 2015, including summer counts of grey seals*. Briefing Papers for SCOS 16/04. In: Scientific Advice on Matters Related to the Management of Seal Populations: 2015. SCOS (Special Committee on Seals).
- Edrén, S., Andersen, S., Teilmann, J., Carstensen, J., Hardes, P.B., Dietz, R. and Millar, L.A. (2010). The effect of a large Danish Offshore wind farm on harbor and grey seal haul-out behavior. *Marine Mammal Science*, 26(3), 614-634.
- Englehard, G.H., Peck, M.A., Rindorf, A., Smout, S.C., van Deurs, M.,Raab, K., Andersen, K.H., Garthe, S., Lauerburg, R.A.M., Scott, F., Brunel, T., Aarts, G., van Kooten, T., and Dickey-Collas, M. (2014). Forage fish, their fisheries, and their predators: who drives whom? *ICES Journal of Marine Science* 71, 90–104.
- Evans, P. G., Mick E., Baines, and Pia Anderwald. (2011). *Risk Assessment of Potential Conflicts between Shipping and Cetaceans in the ASCOBANS Region. 18t*h ASCOBANS Advisory Committee Meeting AC18/Doc.6-04 (S) rev.1 UN Campus, Bonn, Germany, 4-6 May 2011 Dist. 2 May 2011.
- Everaert, J. & Kuijken, E (2007). Wind turbines and birds in Flanders (Belgium) Preliminary summary of the mortality research results.
- Finneran, J.J., Carder, D.A., Schlundt, C.E. and Ridgway, S.H. (2005). Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. *J. Acoust. Soc. Am.* 2005 Oct; 118(4): 2696-705.
- Forrester, R.W., Andrews, I.J., McInerny, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds) (2007). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.
- Furness, R.W. (2015). *Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS*). Natural England Commissioned Report Number 164. 389 pp.
- Furness R. (2016). *Qualifying impact assessments for selected seabird populations: A review of recent literature and understanding*. Report commissioned by Vattenfall, Statkraft and ScottishPower Renewables.
- Garthe, S., Ludynia, K., Huppop, O., Kubetzki, U., Meraz, J.F. and Furness, R.W. (2012). Energy budgets reveal equal benefits of varied migration strategies in northern gannets. *Marine Biology* 159:1907-1915.
- Gill A.B., Bartlett M., & Thomsen F. (2012). Potential interactions between diadromous teleosts of UK conservation importance and electromagnetic fields and subsea noise from marine renewable energy developments. *Journal of Fish Biology*, 81, 664–695.
- Greenstreet, S., Robertson, M., Fraser, H., Holland, G., Doyle K. and Li, R., (2006). *Variation in the abundance, distribution, diet and food consumption rates of gadoid predators in the Wee Bankie/Marr Bank region of the northwestern North Sea, and consequences for predator population dynamics*. IMPRESS Final Report Appendix 8. 65pp
- Hamer K.C., Humphreys E.M., Garthe S., Hennicke J., Peters G., Grémillet D., Phillips R.A., Harris M.P. & Wanless S. (2007). Annual variation in diets, feeding locations and foraging behaviour of Gannets in the North Sea: flexibility, consistency and constraint. *Marine Ecology Progress Series*, 338, 295-305.
- Hamer, K.C., Holt, N. & Wakefield, E. (2011*). The distribution and behaviour of northern gannets in the Firth of Forth and Tay area. A review on behalf of the Forth and Tay Offshore Wind Developers Group*. Institute of Integrative & Comparative Biology, University of Leeds.
- Harris, M.P. (1984). *The Puffin*. T & A.D. Poyser, Calton.

- Harwood, J. & King, SL. (2014). The Sensitivity of UK Marine Mammal Populations to Marine Renewables Developments. Report number SMRUL-NER-2012-027. Submitted to the Natural Environment Research Council (NERC) (unpublished).
- Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Løkkeborg, S., Misund, O. A., Østensen, Ø., Fonn, M., and Haugland, E. K., (2004). *Influence of seismic shooting on the lesser sandeel (Ammodytes marinus).* ICES Journal of Marine Science, 61: 1165e1173.
- ICOL. (2017). Inch Cape Wind Farm Offshore Scoping Report 2017. http://www.gov.scot/Topics/marine/Licensing/marine/scoping/InchCape/InchCapeScoping2017
- Jensen BS, Klaustrup M, and Skov H. (2006). *EIA Report Fish - Horns Rev 2 Offshore Wind Farm*, BioConsult A/S.
- JNCC. 2016. Online information on Gannets. http://jncc.defra.gov.uk/page-2875
- Kaiser, J.M. (2002). *Predicting the displacement of common scoter Melanitta nigra from benthic feeding areas due to offshore wind farms*. COWRIE – BEN – 03 – 2002. Centre for Applied Marine Sciences, School of Ocean Sciences, University of Wales, BANGOR Final report for Cowrie.
- Kaiser M.J, Galanidi M., Showler D.A., Elliot A.J., Caldow, R.W./G., Rees E.I.S., Stillman R.A. and Sutherland W.J. (2006). Distribution and behaviour of Common scoter *Melanitta nigra* relative to prey resources and environmental parameters. *Ibis* (2006) 148, pp 110-128.
- Kastelein, R. A., Gransier, R., Hoek, L. and Olthuis, J. (2012). Temporary threshold shifts and recovery in a harbor porpoise (*Phocoena phocoena*) after octave-band noise at 4 kHz. *Journal of the Acoustical Society of America.* 132(5): 3525–3537.
- Krijgsveld, K.L., Fijn, R.C., Heunks, C., van Horssen, P.W., de Fouw, J., Collier, M., Poot, M.J.M., Beuker, D. and Dirksen, S. (2010). *Effect Studies Offshore Wind Farm Egmond aan Zee: Progress report on fluxes and behaviour of flying birds covering 2007 & 2008*. Bureau Waardenburg, report for Noordzeewind.
- Krijgsveld, K.L., (2014). *Avoidance behaviour of birds around offshore wind farms - Overview of knowledge including effects of configuration*. A report by Bureau Waardenburg.
- Lafrate, J.D., Watwood, S.L., Reyier, E.A., Scheidt, D.M., Dossot, G.A. and Crocker, S.E. (2016) *Effects of Pile Driving on the Residency and Movement of Tagged Reef Fish*. PLoS ONE11(11): e0163638. https://doi.org/10.1371/journal.pone.0163638.
- Leonhard, S.B. and Pedersen, J. (2006). *Benthic communities at Horns Rev before, during and after Construction of Horns Rev Offshore Wind Farm*. Vattenfall Report number: Final Report/Annual report 2005, p 134.
- Leonhard, S.B., Stenberg, C. and Støttrup, J. (2011). Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities Follow-up Seven Years after Construction DTU Aqua Report No 246-2011.
- Leopold, M. F., Dijkman, E. M. & Teal, L. (2011). L*ocal Birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ)* (T-0 & T-1, 2002-2010). Texel, The Netherlands: Wageningen IMARES.
- Lepper P.A., Robinson S.P., Ainslie M.A., Theobald P.D., de Jong C.A.F. (2012). *Assessment of Cumulative Sound Exposure Levels for Marine Piling Events.* In: Popper A.N., Hawkins A. (eds) *The Effects of Noise on Aquatic Life. (*Advances in Experimental Medicine and Biology, vol 730. Springer, New York, NY).
- Lindeboom, H. J., Kouwenhoven, H. J., Bergman, M. J. N., Bouma, S., Brasseur, S., Daan, R., Fijn, R. C., de Haan, Dirksen S.D., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K.L., Leopold, M., and Scheidat. M. (2011). *Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation*. Environ. Res. Lett. 6 035101.

- Løkkeborg, S., Ona, E., Vold, A., Pena, H., Salthaug, A, Totland, B., Øvredal, J.T., Dalen, J. and Handegard, N.O. (2010). *Effects of seismic surveys on fish distribution and catch rates of gillnets and longlines in Vesterålen in summer 200*9. Institute of Marine Research. Bergen. Norway
- Marine Scotland, (2011a). *Blue Seas – Green Energy: a Sectoral Marine Plan for Offshore Wind Energy in Scottish territorial Waters*. Part B: Post Adoption Statement. Edinburgh, Marine Scotland.
- Marine Scotland, (2011b). *Blue Seas – Green Energy: a Sectoral Marine Plan for Offshore Wind Energy in Scottish territorial Waters*. Part A: The Plan. Edinburgh, Marine Scotland.
- Marine Scotland, (2011c). *Habitats Regulations Appraisal of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review*. Available online from: http://www.scotland.gov.uk/Topics/marine/marineenergy/wind.
- Marine Scotland. (2014) Application for consent under Section 36 of the Electricity Act 1989 And applications for Marine Licences under the Marine (Scotland) Act 2010 for the construction and operation of The NnG Offshore Windfarm. Marine Scotland's consideration of a proposal affecting designated Special Areas of Conservation ("SACs") or Special Protection Areas ("SPAs").
- Marine Scotland (2017). *Marine Scotland – Licensing Operations Team Scoping Opinion. Scoping opinion for the proposed Section 36 consent and associated marine licence application for the revised Neart na Gaoithe offshore wind farm and revised Neart na Gaoithe offshore transmission works*. Marine Scotland 8 September 2017.
- Marine Scotland (2017b). *Estimated at-sea distribution of grey and harbour seals. Updated maps 2017*. Marine Scotland. https://data.marine.gov.scot/dataset/estimated-sea-distribution-grey-and-harbour-seals-updated-maps-2017. (accessed February 2018).
- Mendel, B., J., Kotzerka, J., Sommerfeld, H., Schwemmer, N., Sonntag and Garthe, S. (2014). *Effects of the offshore test site Alpha Ventus on distribution patterns, behaviour and flight heights of seabirds*. Chapter in StUK-plus publication.
- Mitchell, P.I., Newton, S.F., Ratcliffe, N. and Dunn, T.E. (2004). *Seabird populations of Britain and Ireland.* T & AD Poyser, London.
- Murray, S., Harris, M.P. and Wanless, S. (2015). The status of the Gannet in Scotland in 2013–14. *Scottish Birds* 3-18.
- Mueller-Blenkle, C., McGregor, P. K., Gill, A. B., Andersson, M. H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D. T. and Thomsen, F. (2010). *Effects of Pile-driving Noise on the Behaviour of Marine Fish*. COWRIE Ref: Fish 06-08, Technical Report.
- Nelson, E., Caryl, F. & Vallejo, G. (2015). *Analysis of Marine Ecology Monitoring Plan Data – Robin Rigg Offshore Wind Farm Operational Year Five Technical Report – Ornithological Monitoring*. Natural Power report for E.ON Climate & Renewables.
- NMFS (2016). *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p. National Marine Fisheries Service.
- NnGOWL (2012). Neart na Gaoithe Offshore Wind Farm Environmental Statement.
- NnGOWL (2013) Neart na Gaoithe Offshore Wind Farm Addendum of Supplementary Environmental Information. Ornitholgy Appendix 3: Special Protection Areas. Habitats Regulation Appraisal – Information to inform Appropriate Assessment for Special Protection Areas. May 2013.
- Norman, T & Ellis, I. (2005). *Observations of the effects of disturbance by boat survey vessel on diver species at London Array*. Report for London Array Ltd.

- OSPAR (2009). Guidance on Environmental considerations for Offshore Wind Farm Development 2008-3. *Overview of the impacts of anthropogenic underwater sound in the marine environment*. OSPAR Biodiversity Series
- Ouwehand J., Leopold M.F. & Camphuysen C.J. (2004). A comparative study of the diet of Guillemots *Uria aalge* and Razorbills *Alca torda* killed during the Tricolor oil incident in the south-eastern North Sea in January 2003. *Atlantic Seabirds* (special issue) 6: 147-166.
- Palmer, K.J., Brookes, K. and Rendell, L. (2017). Categorizing click trains to increase taxonomic precision in echolocation click loggers. *Acoustical Society of America* 142: 863. http://asa.scitation.org/doi/full/10.1121/1.4996000.
- Parvin, S.J, Nedwell, J.R. and Harland. E. (2007). Lethal and physical injury of marine mammals and requirements for Passive Acoustic Monitoring. Subacoustech Report.
- Peña, H., Handegard, N.O. and Ona, E. (2013). Feeding herring schools do not react to seismic air gun surveys. *ICES Journal of Marine Science*.
- Petersen, I. K., Christensen, T. K., Kahlert, J., Desholm, M. & Fox, A. D. (2006). *Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark. National Environmental Research Institute*. Report to DONG energy and Vattenfall A/S.
- Popper, A.N. (2003). Effects of anthropogenic sounds on fishes. *Fisheries 28*(10): 24-31.
- Popper, A.N. (2012). *Fish hearing and sensitivity to acoustic impacts. Appendix j. Atlantic ocs proposed geological and geophysical activities, Mid-Atlantic and South Atlantic planning areas, draft programmatic environmental impact statement*. OCS EIS/EA BOEM 2012-005. March 2012. 2 vols.
- Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W. T., Gentry, R., Halvorsen, M. B., Lokkeborg, S., Rogers, P., Southall, B. L., Zeddies, D. G., Tavolga, W. N. (2014). Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report by ANSI-Accredited Standards Committee S3/SCI and registered with ANSI. Springer Briefs in Oceanography.
- Quick, N., and Cheney, B., (2011). *Cetacean baseline characterisation for the Firth of Tay based on existing data: bottlenose dolphins*. Report for Forth Tay Offshore Windfarm Developers Group (FTOWDG).
- Quick, N. J., Arso Civil, M., Cheney, B., Islas Villanueva, V., Janik, V., Thompson, P. and Hammond, P. S. (2014). *The east coast of Scotland bottlenose dolphin population: improving understanding of ecology outside the Moray Firth SAC*. (OESEA2 Supporting documents; No. 14D/086). Department of Energy and Climate Change.
- Reid, J.B., Evans, P.G.H. and Northridge, S.P. (2003). *Atlas of Cetacean distribution in northwest European waters*. Joint Nature Conservation Committee, Peterborough.
- Robinson, R.A. (2017) BirdFacts: profiles of birds occurring in Britain & Ireland (BTO Research Report 407). BTO, Thetford. https://blx1.bto.org/birdfacts/results/bob710.htm. (Accessed November 2017).
- Russell, D., Duck, D., Morris, C. and Thompson, D. (2016a). Independent estimates of grey seal population size: 2008 and 2014. Briefing Papers for SCOS 16/03. In: Scientific Advice on Matters Related to the Management of Seal Populations: 2015. SCOS (Special Committee on Seals).
- Russell, D. J.F., Hastie, G. D., Thompson, D., Janik, V. M., Hammond, P. S., Scott-Hayward, L. A.S., Matthiopoulos, J., Jones, E. L. and McConnell, B. J. (2016b). Avoidance of wind farms by harbour seals is limited to pile driving activities. *Journal of Applied Ecology* pp 1365-2664.
- Santos, M.B., Pierce, G.J., Reid, R.J., Patterson, I.A.P., Ross, H.M. and Mente, E. (2001). Stomach contents of bottlenose dolphins (*T. truncatus*) in Scottish waters. *Journal of the Marine Biological Association of the United Kingdom,* 81: 873-878.
- SCOS (2005). Scientific Advice on Matters Related to the Management of Seal Populations: 2005. Special Committee on Seals.

- SCOS (2016). *Scientific Advice on Matters Related to the Management of Seal Populations: 2016*. Special Committee on Seals. http://www.smru.st-andrews.ac.uk/files/2017/04/SCOS-2016.pdf. (Accessed August 2017).
- Seagreen. (2017). Seagreen Phase 1 Offshore Project Scoping Report Round 3: Firth of Forth. http://www.gov.scot/Topics/marine/Licensing/marine/scoping/SeagreenPhase1-2017/SeagreenPhase1-ScopingReport
- Sivle, L.D., Kvadsheim, P.H., Cure, C., Isojunno, S., Wensveen, P.J., Lam, F-PA., Visser, F., Kleivane, L., Tyack, P. L., Harris, C.M. and Miller, P. (2015). Severity of expert-identified behavioural responses of humpback whale, minke whale, and northern bottlenose whale to naval sonar *Aquatic Mammals*, Vol 41, no. 4, pp. 469-502.
- Skeate, E. R., Perrow, M.R. and Gilroy, J.J. (2012). Likely effects of construction of Scroby Sands offshore wind farm on a mixed population of harbour *Phoca vitulina* and grey *Halichoerus grypus* seals. *Marine pollution bulletin* 64(4): 872-81.
- Skov, H., Durinck, J., Leopold, M. & Tasker, M.L. (1995). *Important Bird Areas for Seabirds in the North Sea including the Channel and the Kattegat*. BirdLife international, Cambridge. 156 p
- Slotte, A., Hansen, K., Dalen, J. and One, E. (2004). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fish. Res.* 67: 143-150.
- SNCBs. (2017). *Joint SNCB Interim Displacement Advice Note: Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments*.
- SNH (Scottish Natural Heritage), 2010. Neart na Gaoithe – Proposed Offshore Windfarm: SNH and JNCC Advice on Habitats Regulation Appraisal. Letter to Marine Scotland 31 Aug 2010, Ref CNS REN OSWF NNG.
- SNH. (2014). *Interim Guidance On Apportioning Impacts From Marine Renewable Developments To Breeding Seabird Populations In Special Protection Areas.* http://www.snh.gov.uk/docs/A1355703.pdf.
- SNH (Scottish Natural Heritage). (2015). *Habitats Regulations Appraisal of plans: Guidance for plan-making bodies in Scotland*. Doc Ref. 1739. Version 3.0 January 2015.
- SNH. (2016). Outer Firth of Forth and St Andrews Bay Complex Proposed Special Protection Area (pSPA) NO. UK9020316. SPA Site Selection Document: Summary of the scientific case for site selection. Scottish Natural Heritage.
- SNH. (2017a). Seasonal Periods for Birds in the Scottish Marine Environment. http://www.snh.gov.uk/docs/A2200567.pdf
- SNH (2017b). Sitelinks. Scottish Natural Heritage. https://gateway.snh.gov.uk/sitelink/index.jsp (Accessed December 2017).
- Snow, D.W. & Perrins, C.M. (Eds). (1998). *The Birds of the Western Palearctic. Volume 1*. Concise Edition. Oxford University Press.
- Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, Ro., Greene Jr., C., Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J. and Tyack, P. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific recommendations. *Aquatic Mammals*. 33(4): 411-521.
- Sparling, C.E., Russell, D.F., Lane, E., Grellier, K., Lonergan, M.E., McConnell, B.J., Matthiopoulous, J. and Thompson, D. (2012). *Baseline seal information for the FTWODG area*. SMRUL-FDG-2012-0 to FTOWDG. May 2012 (unpublished).
- Stroud, DA, Chambers, D, Cook, S, Buxton, N, Fraser, B, Clement, P, Lewis, P, McLean, I, Baker, H and Whitehead, S (eds). (2001). *The UK SPA network: its scope and content*. JNCC, Peterborough.
- Teilmann, J., Tougaard, J., Carstensen, J., Dietz, R., Tougaard, S. (2006). *Summary on seal monitoring 1999-2005 around Nysted and Horns Rev Offshore Wind Farms*. Technical report to Energi E2 A/S and Vattenfall A/S.

- Thaxter, C.B., Lascelles, B., Sugar, K., Cook, A.S.C.P., Roos, S., Bolton, M. Langston, R.H.W. and Burton, N.H.K. (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. *Biological Conservation*.
- Thompson, P.M., Cheney, B., Ingram, S., Stvick, P., Wilson, B., and Hammond, P.S. (Eds). (2011). *Distribution, abundance and population structure of bottlenose dolphins in Scottish waters.* Scottish Natural Heritage Commissioned report.
- Thomsen, F., Ludemann, K., Kafemann, R. and Piper, W. (2006). *Effects of offshore wind farm noise on marine mammals and fish*. Biola, Hamburg, Germany on behalf of Cowrie Ltd.
- Tollit, D.J., and Thompson, P.M. (1996). Seasonal and between year variations in the diet of harbour seals in the inner Moray Firth, N.E. Scotland. *Canadian Journal of Zoology* 74: 1110-1121.
- Tyldesley, D., and Associates, (2010). *Guidance on Habitats Regulation Appraisal.* Report for Scottish Natural Heritage. Available online from: http://www.snh.gov.uk/docs/B698695.pdf.
- Vanermen N., E.W.M. Stienen, W. Courtens, T. Onkelinx, M. Van de walle and H. Verstraete (2013). *Bird monitoring at offshore wind farms in the Belgian part of the North Sea - Assessing seabird displacement effects*. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2013 (INBO.R.2013.755887). Instituut voor Natuur- en Bosonderzoek, Brussels, Belgium.
- Walls, R., Pendlebury, C., Lancaster, J., Lye, G., Canning, S., Malcom, F., Rutherford, V., Givens., L. & Walker, A. (2013a). *Analysis of Marine Environmental Monitoring Plan Data from the Robin Rigg Offshore Wind Farm, Scotland (Operational Year 2*). Natural Power report to E.ON Climate and Renewables.
- Walls, R., Pendlebury, C., Lancaster, J., Lye, G., Canning, S., Malcom, F., Rutherford, V., Givens., L. and Walker, A. (2013b). Analysis of Marine Environmental Monitoring Plan Data from the Robin Rigg Offshore Wind Farm, Scotland (Operational Year 2). Natural Power report to E.ON Climate and Renewables.
- Wanless, S., Harris, M.P. and Greenstreet, S.P.R. (1998). Summer sandeel consumption by seabirds breeding in the Firth of Forth, south-east Scotland. *ICES Journal of Marine Science*, 55: 1141–1151.
- Wardle, C.S., Carter, T.J., Urquart, G.G., Johnstone, A.D.F., Ziolkowski, A.M., Hampson, G. and Mackie, D. (2001). Effects of seismic airguns on marine fish. *Continental shelf research* 21: 1005 – 1027.

3.7 Acronyms

µPa	Micropascal
AA	Appropriate Assessment
AR	Avoidance Rate
dB	Decibel
c.	Circa
CEH	Centre for Ecology and Hydrology
CfD	Contracts for Difference
CL	Confidence Limits
dSAC	Draft Special Area of Conservation
ECMA	East Coast Management Area
EC	European Commission
EEC	European Economic Community
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EPS	European Protected Species
ES	Environmental Statement
EU	European Union
HRA	Habitats Regulations Appraisal
HDD	Horizontal Directional Drilling
HDPI	Highest Posterior Density Intervals
Hrs	Hours
iPCoD	Interim Population Consequences of Disturbance
IROPI	Imperative Reasons of Overriding Public Interest
JNCC	Joint Nature Conservation Committee
kJ	Kilojoule
Km	Kilometre
Km^2	Square kilometre
LAT	Lowest Astronomical Tide
LSE	Likely Significant Effect
m	Metre
MSL	Mean Sea Level
MSS	Marine Scotland Science
NnG	Neart na Gaoithe
NM	Nautical mile
NOAA	National Oceanic and Atmospheric Administration
OSP	Offshore Substation Platform
Pa	Pascal
pSAC	Possible Special Area of Conservation
pSPA	Potential Special Protection Area
PTS	Permanent Threshold Shift
PVA	Population Viability Analysis
RSPB	Royal Society for the Protection of Birds
Q	Quarter
SAC	Special Area of Conservation
SD	Standard Deviation
SEL	Sound Exposure Level
SMP	Seabird Monitoring programme

SNH	Scottish Natural Heritage
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
STW	Scottish Territorial Waters
TTS	Temporary Threshold Shift
UK	United Kingdom