Department for
Business, Energy
& Industrial Strategy

Review of Consents for Major Infrastructure Projects and Special Protection Areas (Draft)

Regulation 65 of the Conservation of Habitats and Species Regulations 2017, and Regulation 33 of the Conservation of Offshore Marine Habitats and Species Regulations 2017

Version: Draft for Consultation

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Contents

1 Introduction

1.1 Background

This is a record of the Habitats Regulations Assessment ("HRA") that the Secretary of State for Business, Energy and Industrial Strategy (BEIS) has undertaken under the Conservation of Habitats and Species Regulations 2017 ("the Habitats Regulations") in respect of relevant consents for projects onshore or in the territorial sea and the Conservation of Offshore Marine Habitats Species Regulations 2017 ("the Offshore Habitats Regulations") for projects in the UK Continental Shelf in respect of existing consents granted under the Planning Act 2008 (as amended)[1], the Electricity Act 1989 (as amended), or the Transport and Works Act 1992 (as amended), in relation to certain Special Protection Areas (SPAs). These consents are subject to review under regulations 85 and 89 of the Habitats Regulations, and regulation 33 of the Offshore Habitats Regulations.

Under regulation 65 of the Habitats Regulations, and 33 of the Offshore Habitats Regulations, the competent authority (in this case the Secretary of State for Business, Energy and Industrial Strategy) is required to review decisions made regarding consents, permissions or other authorisations for all relevant plans or projects which are likely to have a significant effect on Special Protection Areas (SPAs) or Special Areas of Conservation (SACs), either alone or in combination with other plans or projects, which are not directly connected with or necessary to the management of that site. Where a competent authority reviews a decision, consent, permission, or other authorisation under these Regulations, in the form of an Appropriate Assessment ("AA")[2] it must affirm, modify or revoke it. It should be noted that nothing in these Regulations affects anything done in pursuance of the decision, or the consent, permission, or other authorisation, before the date on which a relevant site (as identified in this HRA screening), became a protected site. As such, the range of potential sources of effect for relevant projects varies depending on their stage of implementation.

Under regulations 85 and 89 of the Habitats Regulations, the review provisions apply to a consent unless the works to which the consent relates have been completed before the "relevant date", that being the date on which the site became a European Site or European Offshore Marine Site, or, if consent conditions were for works to commence within a period of time and the works have not begun before the period expired. The development/works are to be treated as "completed" based on the following definitions, as set out in the Habitats Regulations:

- For consents under Electricity Act 1989; when the generating station is first operated, which may be prior to the completion of the works in their entirety; or

[1] The Welsh Ministers are now responsible for section 36 consents and Development Consent Orders (DCOs) up to and including 350MW in Welsh waters, except for those consented before 1st April 2018. BEIS is responsible for all other consents under these Acts.
[2] As per regulation 63(2) to (4) and (8) and regulation 65(1) of the Habitats Regulations, and regulations 28 and 33 of the Offshore Habitats Regulations.

- For consents under the Planning Act 2008 and the Transport and Works Act 1992[3]; when the development is completed (i.e., fully built out)

The review cannot affect anything done in pursuance of the consent before the relevant date. This is also the case for reviews carried out under regulation 33 of the Offshore Habitats Regulations for those projects on the UK Continental Shelf, but note that for the latter, all are subject to the review provisions even if completed.

A HRA screening assessment for LSE has already been undertaken[4] which identified the potential for likely significant effects in relation to certain relevant consents, for several SPAs (Table 1.1, also see Figure 2.1 and Figure 2.2).

This report documents the second stage of the HRA, the AA (Section 1.2) being undertaken by the Secretary of State and, therefore, considers the potential for adverse effects on those SPAs which were classified following the authorisation of those consents identified at the screening stage, but prior to the completion of a project, for those projects in territorial seas and onshore, or for all projects in the offshore marine area. The assessment also considers the potential for in-combination effects with other plans or projects.

Table 1.1: European sites for which significant effects were not excluded alone or in combination with other plans or projects, at the screening stage

Site	Species	Associated Consent(s)
Copeland Islands SPA	Manx shearwater	Walney, West of Duddon Sands, Ormonde, Gwynt y Môr
Skomer, Skokholm and the Seas off Pembrokeshire SPA	Manx shearwater	Burbo Bank Extension, Walney Extension
Irish Sea Front SPA	Manx shearwater	Walney Extension
Dee Estuary (extension) SPA	Wintering waterbirds (teal, grey plover, dunlin, black-tailed godwit and curlew)	Walney, West of Duddon Sands, Ormonde
	Sandwich tern, common tern, wintering waterbirds (teal, grey plover, dunlin, black-tailed godwit and curlew)	Gwynt y Môr
Liverpool Bay SPA	Red-throated diver, common tern, little tern, little gull, cormorant, red-breasted merganser	Walney Extension, Preesall Saltfield Underground Gas Storage
	Red-throated diver	Gwynt y Môr
Mersey Narrows and Wirral Foreshore SPA	Breeding/non-breeding common tern. Wintering bar-tailed godwit and knot. Waterbird assemblage.	Gwynt y Môr
Anglesey Terns SPA	Sandwich tern	Burbo Bank Extension
Morecambe Bay and Duddon Estuary SPA	Black-tailed godwit, whooper swan, little egret, Mediterranean gull, lesser	Burbo Bank Extension

[3] Certain energy projects have been consented under the *Transport and Works Act 1992*, and are included in this review as the power to make an Order under Section 3 of the Act is the responsibility of the Secretary of State.
[4] https://www.gov.uk/government/consultations/review-of-consents-for-major-energy-infrastructure-projects-and-special-protection-areas

Site	Species	Associated Consent(s)
	black-backed gull and ruff, Sandwich tern	
	Black-tailed godwit, whooper swan, little egret, Mediterranean gull, lesser black-backed gull and ruff, Sandwich tern, common tern	Walney Extension
	Black-tailed godwit, whooper swan, little egret, Mediterranean gull, lesser black-backed gull, ruff, Sandwich tern, common tern, little tern	Preesall Saltfield Underground Gas Storage
Coquet Island SPA	Puffin (assemblage feature)	Dogger Bank A & B, Dogger Bank C, Sofia offshore wind farm, Hornsea Project One, Hornsea Project Two, Triton Knoll
Farne Islands SPA	Puffin, kittiwake (assemblage features)	Dogger Bank A & B, Sofia offshore wind farm
	Kittiwake (assemblage feature)	Dogger Bank C, Hornsea Project One, Triton Knoll, Race Bank, Hornsea Project Two
Northumberland Marine SPA	Puffin, kittiwake (assemblage feature)	Dogger Bank A & B, Dogger Bank C, Sofia offshore wind farm, Hornsea Project One, Hornsea Project Two, Triton Knoll, Race Bank
	Kittiwake	Dudgeon
Flamborough and Filey Coast SPA	Northern gannet, guillemot, razorbill, puffin (assemblage feature).	Dudgeon, Race Bank
	Northern gannet	Greater Gabbard
Greater Wash SPA	Red-throated diver, common scoter, little tern, Sandwich tern, common tern, little gull	Dogger Bank A&B (export cable), Race Bank
	Sandwich tern	Dudgeon, East Anglia One, East Anglia Three
Humber Estuary SPA	Avocet, black-tailed godwit, knot, dunlin, redshank and ruff	Lynn, Inner Dowsing
Outer Thames Estuary SPA	Common tern	Galloper, Greater Gabbard
Stour and Orwell Estuaries (extension) SPA	Avocet, knot, pintail, waterbird assemblage	Gunfleet Sands I
Dungeness, Romney Marsh & Rye Bay SPA	Avocet, bittern, ruff, golden plover, Sandwich tern	Rampion

Source: BEIS (2021)

1.2 Habitats Regulations Assessment (HRA)

The Habitats Regulations and the Offshore Habitats Regulations aim to ensure the long-term conservation of certain species and habitats by protecting them from possible adverse effects of plans and projects.

In the UK, the Habitats Regulations apply as far as the 12 nautical miles (nm) limit of territorial waters. Beyond territorial waters, the Offshore Habitats Regulations serve the same function for the UK's offshore marine area. Following the UK's departure from the European Union, these domestic regulations continue to apply. The review covers areas within and outside the 12nm limit, so both sets of Regulations apply.

The Habitats Regulations, and Offshore Habitats Regulations[5], provide for the designation of sites for the protection of habitats and species of international importance. These sites are called Special Areas of Conservation ("SACs"). These Regulations also provide for the classification of sites the protection of rare and vulnerable birds and for regularly occurring migratory species within the UK and internationally. These are called Special Protection Areas ("SPAs"). SACs and SPAs together, referred to as European sites in legislation, form part of the UK's national site network.

As noted in Section 1.1, regulations 63(2) to (4) and (8) of the Habitats Regulations (and similar provisions in regulation 28 of the Offshore Habitats Regulations as appropriate) are relevant to this review of consents, and provides that:

(2) 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 or to enable it to determine whether an appropriate assessment is required.

(3) The competent authority must for the purposes of the assessment consult the appropriate nature conservation body and have regard to any representations made by that body within such reasonable time as the authority specifies.

(4) It must also, if it considers it appropriate, take the opinion of the general public, and if it does so, it must take such steps for that purpose as it considers appropriate.

(8) Where a plan or project requires an appropriate assessment both under this regulation and under the Offshore Marine Conservation Regulations, the assessment required by this regulation need not identify those effects of the plan or project that are specifically attributable to that part of it that is to be carried out in the United Kingdom, provided that an assessment made for the purpose of this regulation and the Offshore Marine Conservation Regulations assesses the effects of the plan or project as a whole.

[5] These Regulations, which transpose the requirements of Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora ("the Habitats Directive") and Council Directive 2009/147/EC on the conservation of wild birds ("the Birds Directive"), aim to ensure the long-term conservation of certain species and habitats by protecting them from possible adverse effects of plans and projects. Note that the *European Union (Withdrawal) Act 2018* confirms that the body of EU law transposed into UK legislation at the time that the UK exits the EU has been retained, such that it will continue to have effect in domestic law after the end of the Implementation Period as defined in the *European Union (Withdrawal) Act 2018*.

The assessment has been undertaken in accordance with the European Commission Guidance (EC 2021) and with reference to other guidance, reports and policy, including the Habitats Regulations Guidance Notes (Defra 2021, SEERAD 2000), SNH (2015), the National Planning Policy Framework (MHCLG 2019), the Marine Policy Statement (HM Government 2011), English Nature report No. 704 (Hoskin & Tyldesley 2006) and Natural England report NECR205 (Chapman & Tyldesley 2016).

This report was compiled using evidence from the project-specific documents which are available on the Planning Inspectorate's Nationally Significant Infrastructure Project web pages[6], previous HRAs for relevant projects undertaken as part of the original development consent order process, or subsequently as part of application for non-material changes. Key information from these documents is referenced in this report.

1.3 Consultation

Under the Habitats Regulations and the Offshore Habitat Regulations the competent authority must, for the purposes of an AA, consult the appropriate nature conservation bodies and have regard to any representation made by those bodies within such reasonable time as the authority specifies.

Natural England is the Statutory Nature Conservation Body ("SNCB") for England and for English waters within the 12 nm limit. Natural Resources Wales is the SNCB for Welsh waters within the 12 nm limit. The Joint Nature Conservation Committee ("JNCC") is the SNCB beyond 12 nm, but this duty has been discharged by Natural England following the 2013 Triennial Review of both organisations (Defra 2013). However, JNCC retains responsibility as the statutory advisor for protected sites that are located outside the territorial sea and UK internal waters (i.e. more than 12 nautical miles offshore) and as such, continues to provide advice to Natural England on the significance of any potential effects on interest features of such sites.

A virtual workshop was held early in the AA process with the relevant consent holders and SNCBs. The workshops covered the proposed approach to the AA, including the sources of information that would be used to inform the assessment, and an outcome of a review of modelling associated with the relevant consents. A note covering the proposed source of information to underpin the assessment was shared with the workshop group prior to formal public consultation. Feedback received from workshop participants has been considered and incorporated into this draft AA.

This draft AA is being subject to public consultation for a period of four weeks ending on 31st January 2023, now extended to 14 February 2023. Feedback received during the public consultation will be reviewed and amendments made to the AA, as appropriate.

[6] https://infrastructure.planninginspectorate.gov.uk/ and https://webarchive.nationalarchives.gov.uk/ukgwa/*/https://infrastructure.planninginspectorate.gov.uk/

2 Relevant projects and SPAs

2.1 Introduction

The relevant projects and related SPAs for which a LSE could not be excluded were identified at the screening stage (see BEIS 2021). As noted in the screening, the identification of SPA sites and projects relevant to the review relied on an understanding of the consenting and completion (where this has occurred) timelines of relevant projects, particularly for those which were onshore or within territorial seas, and the classification date of relevant SPAs. The determination of LSE for the relevant SPAs in relation to those consents within the remit of the review followed that outlined in Section 3 of the screening report and will not be repeated here.

The following section provides a summary of information relating to each of the projects, the consents of which are subject to this review, based on the outcome of the screening stage. The information is based on that presented in the Development Consent Orders (DCOs), Section 36 Consents, Marine Licences and orders made under the Transport and Works Act 1992, along with any subsequent variations. Information from documents submitted to the Planning Inspectorate, BEIS (or its predecessors) or the MMO as part of the relevant applications has also been used. The figures shown for each project include their location relative to those SPAs for which a LSE could not be excluded. Summaries of those SPAs are given in Section 2.3.

2.2 Information sources

Project-specific information has been collected from the recent decisions on applications contained on the BEIS (and formerly DECC) Energy Infrastructure webpages, the National Infrastructure Planning website, and the archived versions of these websites[7] with the date of capture for these websites selected as appropriate. Information, for example, on as-built elements of projects including turbine models and numbers was collected from developer websites, turbine manufacturer websites, the 4coffshore wind farm database, the BEIS Renewable Energy Planning Database[8], or directly from operators/developers where relevant information could not be found publicly. SPA data has been collated from the JNCC, Natural England and NRW websites.

2.3 Relevant Projects

An overview of the projects relevant to the Review of Consents (RoC) AA is provided in Table 2.1 (Irish Sea) and Table 2.2 (southern North Sea and Channel). The summary information includes the nature of the consents and links to these and their amendments (e.g., through non-material changes), an overview of the consented project and, where relevant, information on the as-built project.

[7] As available through UK Government web archive: http://www.nationalarchives.gov.uk/webarchive/
[8] https://www.gov.uk/government/collections/renewable-energy-planning-data

Table 2.1: Overview of the projects subject to review: Irish Sea

Type of consent, status and current operator	Relevant dates[9]	Location	Short description of consented project	Short description of as-built project
Gwynt y Môr: Figure 2.3				
Electricity Act (S36); Active/In Operation; RWE	Consent: 03/12/2008 Completion: 30/08/2013	Irish Sea, territorial sea; 12km from the North Wales coast	Up to 750MW, comprising 250 wind turbines, four offshore sub-stations, up to four meteorological masts and inter-array cabling.	The constructed project has an installed capacity of 576MW from 160, 3.6MW turbines (Siemens Wind Power SWT-3.6-107).
Ormonde: Figure 2.4				
Electricity Act (S36); Active/In Operation; Vattenfall	Consent: 04/09/2008 Completion: 18/08/2011[1]	Irish Sea, territorial sea; 10km west of Barrow	Up to 108MW (consent dated 9th February 2007), comprising 30 wind turbines, a sub-station, meteorological mast and inter-array cabling, subsequently modified to have a capacity of 150MW in 2008.	The constructed project is equal to that consented, using 5MW turbines (Repower 5M).
West of Duddon Sands: Figure 2.4				
Electricity Act (S36); Active/In Operation; Scottish Power Renewables & Ørsted	Consent: 04/09/2008 Completion: 28/01/2014	Irish Sea, territorial sea; 14km west of Barrow	Up to 500MW, comprising 139 wind turbines, two offshore sub-stations, up to two meteorological masts and inter-array cabling.	The constructed project has an installed capacity of 389MW from 108, 3.6MW turbines (Siemens Wind Power SWT-3.6-120).
Walney: Figure 2.4				
Electricity Act (S36); Active/In Operation; Ørsted	Consent: 07/11/2007 Completion: 13/01/2011 (phase 1), 01/11/2011 (phase 2)[1]	Irish Sea, territorial sea; ~15km west of Barrow	Up to 600MW, comprising 150 turbines, 2 sub-stations and 2 meteorological masts. The distance between turbines should not be less than 550m, and not less than 650m between rows.	The Walney wind farm has 102, 3.5MW turbines, with an overall capacity of 367MW (using an equal combination of the SWT-3.6-107 and the SWT-3.6-120).

[9] Refer to Section 1.2 for the meaning and relevance of these dates in relation to which projects and SPAs are subject to this review; also see BEIS (2021).

Type of consent, status and current operator	Relevant dates[9]	Location	Short description of consented project	Short description of as-built project
Burbo Bank Extension: Figure 2.5				
Planning Act 2008; Active/In Operation; Ørsted	Consent: 26/09/2014 Completion: 27/04/2017[2]	Irish Sea, territorial sea; ~6.5km north of The Wirral	Up to 259MW, comprising 69 wind turbines, one offshore sub-station, and inter-array and export cabling.	The constructed project has an installed capacity of 258MW from 32 turbines (MHI-Vestas V164 8MW)
Walney Extension: Figure 2.6				
Planning Act 2008; Active/In Operation; Ørsted	Consent: 28/11/2014 Completion: 13/09/2018[2]	Irish Sea, partly in territorial sea and the offshore marine area; 20km west of the Isle of Walney	Up to 750MW, comprising 207 wind turbines, up to three offshore sub-stations, and inter-array and export cabling.	The constructed project has an installed capacity of 659MW from 87 turbines (40 MHI-Vestas V164 8.25MW and 47 Siemens Gamesa 154 7MW).
Preesall: Figure 2.7				
Planning Act 2008; Consented; Halite Energy Group Limited	Consent: 07/08/2015 Completion: n/a	The project is primarily terrestrial. The works of relevance relate to the brine discharge pipeline and diffuser.	Specifically of relevance is the brine discharge pipeline, which reached from approximately mean low water mark (off Rossall Promenade) to the pipeline's termination at a single two-port diffuser. The works include a pressure pipeline laid in a backfilled trench beneath the seabed from a vessel; all to be constructed no less than 1m below the seabed and no more than 10m below the seabed.	n/a, not completed.

Notes: [1]Taken as the date of first electricity generation as noted on 4coffshore; [2]Completion date as noted in the BEIS Renewable Energy Planning Database

Table 2.2: Overview of the projects subject to review: southern North Sea and eastern Channel

Type of consent, status and current operator	Relevant dates	Location	Short description of consented project	Short description of as-built project
Rampion: Figure 2.17				
Planning Act 2008; Active/In Operation; RWE	Consent: 06/08/2014 Completion: 30/11/2018[1]	Eastern Channel, within territorial sea; 13km off the Sussex coast.	Up to 700MW, comprising 175 wind turbines, up to two offshore sub-stations, and inter-array and export cabling.	The constructed project has an installed capacity of 400MW from 116 turbines (Vestas V112 3.45MW).
Galloper: Figure 2.9				
Planning Act 2008; Active/In Operation; RWE	Consent: 15/06/2013 Completion: 30/03/2018[2]	Southern North Sea, offshore marine area	Up to 500MW, comprising 140 wind turbines, up to one offshore sub-station, three meteorological masts, and inter-array and export cabling.	The constructed project has an installed capacity of 353MW from 56 turbines (Siemens Gamesa SWT-6.0-154 up to 6.3MW).
Greater Gabbard: Figure 2.8				
Electricity Act (S36); Active/In Operation; SSE Renewables	Consent: 19/02/2007 Completion: 14/01/2011[3]	Southern North Sea, partly in territorial and offshore marine area	Up to 500MW, comprising 140 wind turbines, up to four offshore sub-stations, six meteorological masts, and inter-array and export cabling.	The constructed project has an installed capacity of 504MW from 140 turbines (Siemens SWT-3.6-107).
Dudgeon: Figure 2.10				
Electricity Act (S36); Active/In Operation; Equinor	Consent: 06/07/2012 Completion: 07/02/2017[4]	Southern North Sea, offshore marine area	Up to 560MW, number of turbines not specified (but not exceeding 190m to blade tip from MHWS, with a rotor diameter not greater than 160m and a clearance of not less than 22m between MHWS and the lowest point of the rotating blade). Note that the number and type of wind turbines were left to the discretion of the developer, subject to written approval, but must not result an expected collision risk of more than 28 Sandwich terns per year – refer to Annex A of the consent. Project to also include up to three offshore	The constructed project has an installed capacity of 402MW from 67 turbines (Siemens SWT-6.0-154 6MW).

Type of consent, status and current operator	Relevant dates	Location	Short description of consented project	Short description of as-built project
			sub-stations, four meteorological masts, and inter-array and export cabling.	
Race Bank: Figure 2.11				
Electricity Act (S36); Active/In Operation; Ørsted	Consent: 06/07/2012 Completion: 18/05/2017[5]	Southern North Sea, offshore marine area	Up to 580MW, with two offshore sub-stations[10], one meteorological mast, and inter-array and export cabling. No. of turbines were not stated, but restricted due to limits on Sandwich tern mortality in the range 82-101 turbines depending on final selection.	The constructed project has an installed capacity of 573MW from 91 turbines (Siemens SWT-6.3-154 6MW).
Triton Knoll: Figure 2.15				
Planning Act 2008; Under construction; RWE	Consent: 12/07/2013 Completion: under construction	Southern North Sea, offshore marine area	Up to 900MW, comprising, 90 wind turbines, up to two offshore collector sub-stations, four meteorological masts, and inter-array and export cabling[11].	The project includes 90 turbines providing an installed capacity of 857MW (MHI Vestas v164-9.5MW).
Lynn: Figure 2.12				
Transport and Works Act 1992; Active/In Operation; Green Investment Bank	Consent: 19/11/2003[12] Completion: 01/03/2009[1]	Southern North Sea, territorial sea	Up to 30 wind turbines (hub height up to 100m above chart datum, blades with a diameter of up to 120m), and inter-array and export cabling.	The constructed project has an installed capacity of 97.2MW from 27 turbines (Siemens SWT-3.6-107 3.6MW).
Inner Dowsing: Figure 2.12				
Transport and Works Act 1992; Active/In Operation; Green Investment Bank	Consent: 19/11/2003 Completion: 01/03/2009	Southern North Sea, territorial sea	Up to 30 wind turbines (blade tip up to 87m above high water and blades with a diameter	The constructed project has an installed capacity of 97.2MW from 27 turbines (Siemens SWT-3.6-107 3.6MW).

[10] As varied in the consent of 25th March 2015
[11] As amended by The Triton Knoll Offshore Wind Farm (Amendment) Order 2018
[12] The Orders for Lynn and Inner Dowsing made under the Transport and Works Act 1992 (as amended) were varied under The Lynn and Inner Dowsing Offshore Wind Farms (Amendment) Order 2011 allowing the construction and maintenance of cabling relating to three specific wind turbines relevant to each project.

Type of consent, status and current operator	Relevant dates	Location	Short description of consented project	Short description of as-built project
			of up to 120m), and inter-array and export cabling.	
Gunfleet Sands I: Figure 2.13				
Transport and Works Act 1992; Active/In Operation; Ørsted	Consent: 16/04/2004 Completion: 15/06/2010[1]	Southern North Sea, territorial sea	Up to 30 wind turbines (blade tip up to 130.5m above high water and blades with a diameter of up to 110m), and inter-array and export cabling, and substation.	The constructed project has an installed capacity of 108MW from 30 turbines (Siemens SWT-3.6-107 3.6MW).
Dogger Bank A & B: Figure 2.14				
Planning Act 2008; Consented; SSE Renewables, Equinor and ENI	Consent: 11/03/2015 Completion: n/a	Southern North Sea, offshore marine area	Each project with up to 200 wind turbines (with rotor diameter not exceeding 280m[13] or a height of 315m from HAT), inter-array and export cabling. Up to seven offshore platforms (collector and converter stations, and accommodation/helicopter platforms) and five meteorological masts.	The project has not been constructed. It is anticipated that each wind farm will use 190 General Electric Haliade-X 13MW turbines.
Dogger Bank C (formerly Dogger Bank Teesside A)[14]: Figure 2.15				
Planning Act 2008; Consented; SSE Renewables, Equinor	Consent: 26/08/2015 Completion: n/a	Southern North Sea, offshore marine area	Up to 200 wind turbines (with rotor diameter not exceeding 280m[15]), inter-array and export cabling. Up to seven offshore platforms	The project has not been constructed. It is anticipated that the wind farm will

[13] As modified through a non-material change, coming into force 10th April 2019 under The Dogger Bank Creyke Beck Offshore Wind Farm (Amendment) Order 2019. The maximum installed capacity of the projects (formerly 1,200MW) was removed under The Dogger Bank Creyke Beck Offshore Wind Farm (Amendment) Order 2020, coming into force 23rd March 2020. The Order also specified that the total rotor-swept area for each Work No. of the project would not exceed 4.35 square kilometres, as per the original Order.

[14] Note that Dogger Bank C and Sophia (formerly the Dogger Bank Teesside A and B wind farms) have been reconfigured since their original consent and are now separate projects. Changes made under The Dogger Bank Teesside A and B Offshore Wind Farm (Amendment) (No. 2) Order 2020, coming into force 1st December 2020, allow the project to be considered separately, and for the discharge and enforcement of the relevant requirements on a project specific basis.

[15] The rotor diameter was increased through a non-material change which came into force on 12th August 2020 under The Dogger Bank Teesside A and B Offshore Wind Farm (Amendment) Order 2020. The Dogger Bank Teesside A and B Offshore Wind Farm (Amendment) Order 2019. The same order removed

Type of consent, status and current operator	Relevant dates	Location	Short description of consented project	Short description of as-built project
			(collector and converter stations, and accommodation/helicopter platforms) and five meteorological masts.	use 190 General Electric Haliade-X 14MW turbines[16].
Sofia (formerly Dogger Bank Teesside B): Figure 2.15				
Planning Act 2008; Consented; RWE	Consent: 26/08/2015 Completion: n/a	Southern North Sea, offshore marine area	Up to 200 wind turbines (with rotor diameter not exceeding 280m), inter-array and export cabling. Up to seven offshore platforms (collector and converter stations, and accommodation/helicopter platforms) and five meteorological masts.	The project has not been constructed. It is anticipated that the wind farm will use 100 Siemens Gamesa SG 14-222 DD 14MW turbines.
Hornsea Project One: Figure 2.15				
Planning Act 2008; Active/In Operation; Ørsted	Consent: 31/12/2014 Completion: 02/06/2020	Southern North Sea, offshore marine area	Originally consented as two or three wind farms with a combined capacity of 1,218MW[17], each having up to 80 turbines for three wind farms, or each having 120 turbines for two wind farms (with rotor diameter not exceeding 178m, exceed a height of 200 metres from MHWS to the upper tip of the vertical blade and with less than 22m from MHWS to the lowest point of the rotating blade). A network of subsea inter-array cabling and up to five offshore HVAC collector substations (and an offshore reactive compensation substation if HVAC chosen) and, in the event that the mode of transmission is HVDC, up to two offshore HVDC converter stations together with a	The constructed project has an installed capacity of 1,218MW from 174 turbines (Siemens SWT-7.0-154 7MW).

the maximum wind farm capacity of 1,400MW. Subsequent non material changes made under The Dogger Bank Teesside A and B Offshore Wind Farm (Amendment) Order 2021 and The Dogger Bank Teesside A and B Offshore Wind Farm (Amendment) (No. 2) Order 2021 relate to piling hammer energies and aspects of array and export cabling.

[16] https://doggerbank.com/press-releases/ges-haliade-x-14mw-turbine-to-debut-at-dogger-bank-c/

[17] As amended under The Hornsea One Offshore Wind Farm (Amendment) Order 2017, commencing 24th March 2017.

Type of consent, status and current operator	Relevant dates	Location	Short description of consented project	Short description of as-built project
			network of electrical circuits. Four or two export cables to shore for HVAC and HVDC respectively.	
Hornsea Project Two: Figure 2.15				
Planning Act 2008; Under construction; Ørsted	Consent: 07/09/2016 Completion: n/a, under construction	Southern North Sea, offshore marine area	Originally consented as two wind farms with a combined capacity of 1,800MW, with a combined total of up to 300 turbines (with rotor diameter not exceeding 241.03m, exceed a height of 276 metres from LAT to the upper tip of the vertical blade and with less than 34.97m from LAT to the lowest point of the rotating blade). A network of subsea inter-array cabling and up to three offshore HVAC collector substations[18] (and up to two offshore reactive compensation substations if HVAC chosen) and, in the event that the mode of transmission is HVDC, up to two offshore HVDC converter stations together with a network of electrical circuits. Not exceeding eight or two export cables to shore for HVAC and HVDC respectively.	The project is under construction. It is anticipated that the wind farm will use 165 Siemens Gamesa SG 8.4-167 DD 8.4MW turbines.
East Anglia One: Figure 2.16				
Planning Act 2008; Active/In Operation; Scottish Power Renewables	Consent: 10/07/2014 Completion: 28/07/2020	Southern North Sea, offshore marine area	Depending on the selection of HVAC or HVCD, a wind farm with a capacity of up to 750MW and 150 turbines, or one with a capacity of 1,200MW, from up to 240 turbines, respectively[19] (with rotor diameter not exceeding 170m, not exceeding a height of 200m from LAT to blade tip and with not less than 22m from MHWS to the lowest point of	The constructed project has an installed capacity of 714MW from 102 turbines (Siemens SWT-7.0-154 7MW).

[18] As amended by The Hornsea Two Offshore Wind Farm (Amendment) (No. 2) Order 2018
[19] As indicated in The East Anglia ONE Offshore Wind Farm (Corrections and Amendments) Order 2016, coming into force 25th March 2016

Type of consent, status and current operator	Relevant dates	Location	Short description of consented project	Short description of as-built project
			the rotating blade). For the HVAC option, up to two offshore HVAC collector substations, or for the HVDC option, up to three offshore HVAC collector substations and two HVDC offshore converter stations. A network of subsea inter-array cabling and four HVDC export cables for the HVDC option, or up to two HVAC export cables for the HVAC option.	
East Anglia Three: Figure 2.16				
Planning Act 2008; Consented; Scottish Power Renewables	Consent: 29/08/2017 Completion: n/a	Southern North Sea, offshore marine area	An offshore wind farm of capacity up to 1,400MW[20] comprising up to 121 turbines (with rotor diameter not exceeding 230m, not exceeding a height of 262m from LAT to blade tip and with not less than 24m from MHWS to the lowest point of the rotating blade)[21], up to one accommodation platform, one offshore electrical station, a network of subsea inter-array cables and up to four export cables[22].	The project has not been constructed and final turbine selection is not known.

Notes: [1]date of the project having been fully built out taken to be the date the project was fully commissioned, 4coffshore; [2]completion date as noted in the BEIS Renewable Energy Planning Database; [3]note that while this date represents the first time electricity was generated, consistent with the definition of "completed" for Electricity Act consents, under the Habitats Regulations any project fully or partly in the offshore marine area may be reviewed for any SPA classified since consent was granted, irrespective of the completion date; [4]Project location in the offshore marine area renders the completion date not relevant for the purposes of review; [5]taken as the date of first electricity generation as noted on 4coffshore.

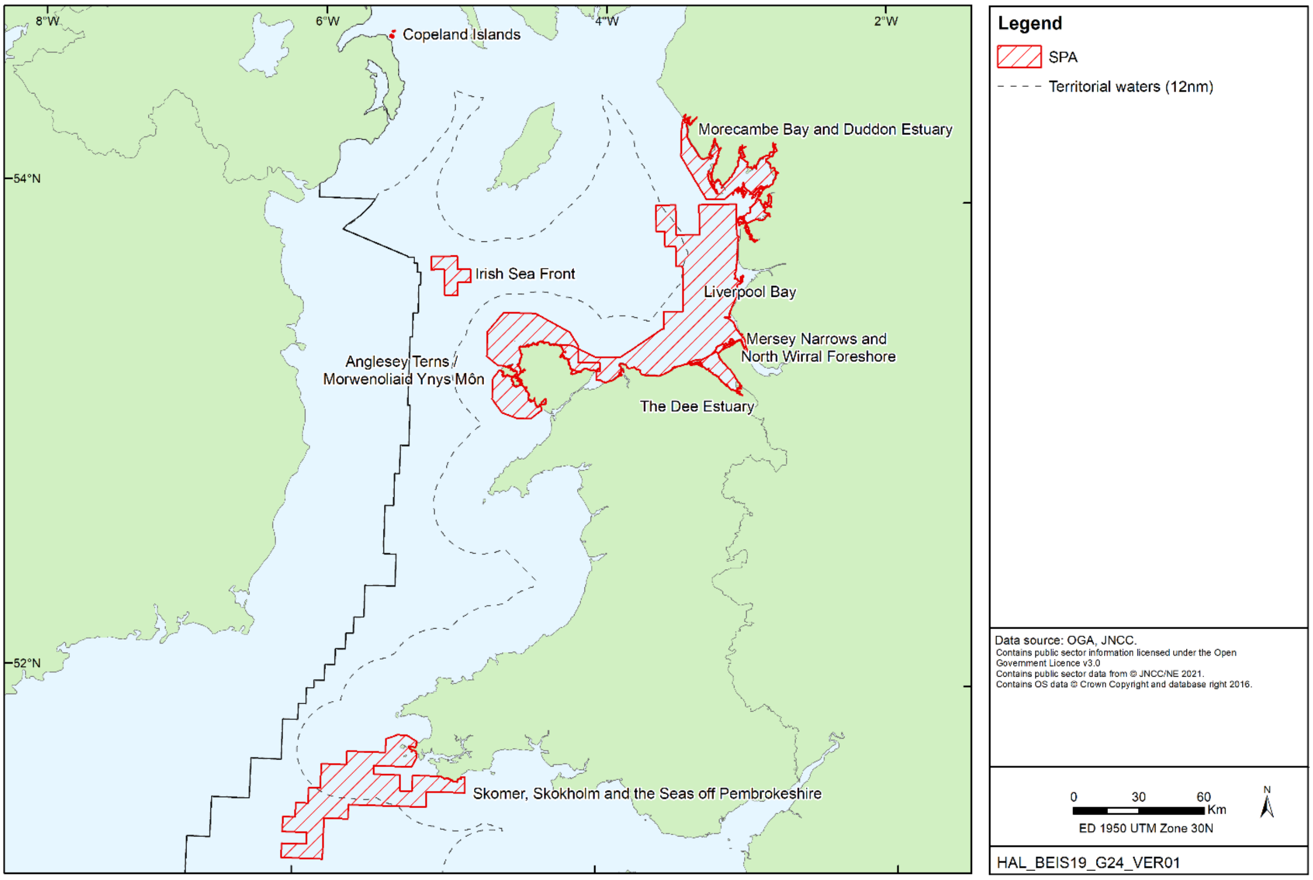
[20] As amended in The East Anglia THREE Offshore Wind Farm (Amendment) Order 2019, coming into force 7th June 2019
[21] As amended in The East Anglia THREE Offshore Wind Farm (Amendment) Order 2021, coming into force 16th April 2021
[22] Note that a non-material change is presently being progressed which makes further proposed amendments which are, to reduce the number of turbines to up to 100, an increase in the maximum rotor diameter to 250m and height from LAT to blade tip to 282m, and the removal of the capacity limit of 1,400MW.

2.4 Relevant SPAs

This section summarises the SPAs and related qualifying interests which are subject to this AA. Not all the qualifying features of each relevant site are subject to assessment, as their selection for inclusion in the AA has been based on various criteria provided in BEIS (2021) including, site classification dates relative to relevant project consent and completion dates (subject to location), and the migratory routes and foraging ranges of relevant qualifying interests relative to the location and nature of the consents being reviewed. All qualifying features of the relevant sites are listed for context, but tabulations of species populations[23] only include those features which are subject to assessment.

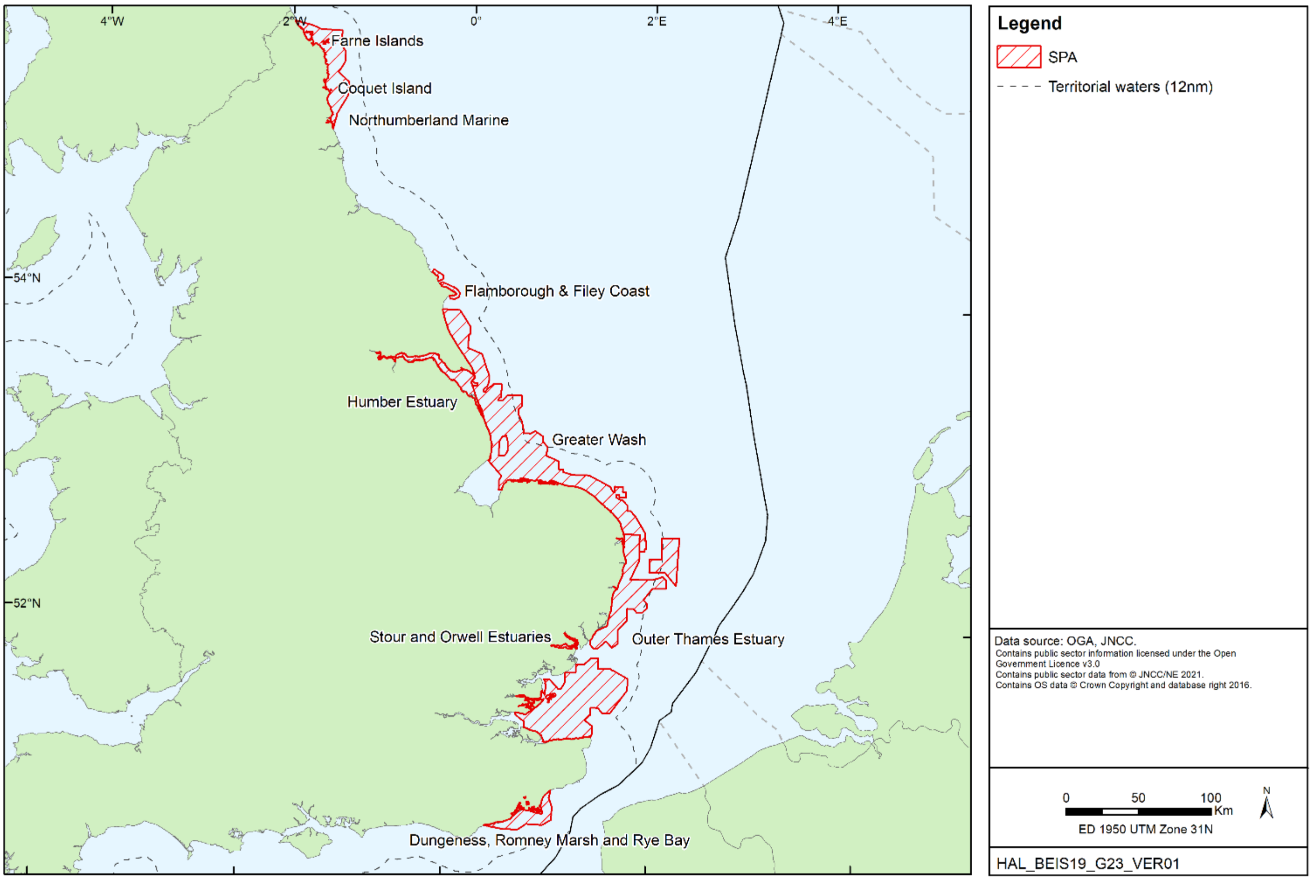
The location of the SPAs subject to assessment are shown in Figure 2.1 (Irish Sea) and Figure 2.2 (southern North Sea and Channel) below.

Figure 2.1: SPAs relevant to the Review of Consents AA (Irish Sea)



[23] Population values contain Wetland Bird Survey (WeBS) data from Waterbirds in the UK 2019/20 © copyright and database right 2021. WeBS is a partnership jointly funded by the BTO, RSPB and JNCC, in association with WWT, with fieldwork conducted by volunteers.

Figure 2.2: SPAs relevant to the Review of Consents AA (southern North Sea and Channel)



2.4.1 Copeland Islands SPA

Qualifying features: breeding Arctic tern *Sterna paradisaea* and breeding Manx shearwater *Puffinus puffinus*

The Copeland Islands SPA was classified on 29th September 2009. The site is in the territorial sea of Northern Ireland, close to the mouth of Belfast Lough, approximately 1.5km off the County Down coastline. The site comprises three islands (Copeland Island (Big Copeland), Lighthouse Island and Mew Island) and associated islets, covering an area of 201.52ha.

Table 2.3: Copeland Island SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Manx shearwater	Total 4,800 pairs Lighthouse Island (surveyed 2000) and Big Copeland – (surveyed 2002 and 2003)[1]	Total 4,850 pairs (Lighthouse and Big Copeland, both 2007)[2]

Source: [1]Copeland Islands SPA Citation and Conservation Objectives, [2]Seabird Monitoring Programme

Conservation objectives[24]:

To maintain each feature in favourable condition. Component objectives are:

- Manx Shearwater breeding population: No significant decrease in population against national trends, fledging success sufficient to maintain or enhance population
- Habitat extent: To maintain or enhance the area of natural and semi-natural habitats used or potentially usable by Feature bird species, (breeding areas 201ha) subject to natural processes; maintain the extent of main habitat components subject to natural processes

2.4.2 Skomer, Skokholm and the Seas off Pembrokeshire SPA

Qualifying features: breeding Manx shearwater *Puffinus puffinus*, storm petrel *Hydrobates pelagicus*, lesser black-backed gull *Larus fuscus*, Atlantic puffin *Fratercula arctica*

Skomer, Skokholm and the Seas off Pembrokeshire SPA is located off the extreme south-west tip of Pembrokeshire in Welsh territorial and the offshore marine area. It includes the islands of Skomer and Skokholm which hold the largest concentration of breeding seabirds in England and Wales. Especially notable is the population of Manx shearwater which represents the largest breeding colony in the world.

The SPA was first classified in 1982 as the Skokholm and Skomer SPA and was subsequently extended in 2014. The site was reclassified with a marine extension in January 2017 for species included in the original citation, Manx shearwater and Atlantic puffin, and the site renamed to Skomer, Skokholm and the Seas off Pembrokeshire SPA, and now covering an area 166,800ha. It is this latter extension to the site (and species relevant to this extension) which is relevant to the review of consents.

Table 2.4: Skomer, Skokholm and the Seas off Pembrokeshire SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Manx shearwater	150,968 pairs[1]	349,663 pairs[2]

Source: [1]Skomer, Skokholm and the Seas off Pembrokeshire SPA draft conservation objectives and departmental brief, count data after Stroud *et al.* (2001). [2]Perrins *et al.* (2012) and Perrins *et al.* (2018) estimated a Manx shearwater breeding population of 316,070 pairs and 349,663 pairs respectively.

Conservation objectives[25]:

The size of the population should be stable or increasing, allowing for natural variability, and sustainable in the long term: The breeding population of Manx shearwater should be stable or increasing with no measured decrease in numbers (based on a population count of 150,968), based on annual study plots.

[24] https://www.daera-ni.gov.uk/publications/special-protection-area-copeland-islands
[25] https://jncc.gov.uk/our-work/skomer-skokholm-and-the-seas-off-pembrokeshire-mpa/

The distribution of the population should be being maintained, or where appropriate increasing: The distribution of this species within the site should not be constrained by anthropogenic factors, including disturbance of nesting sites by the public and activities leading to possible loss of suitable nesting sites.

There should be sufficient habitat, of sufficient quality, to support the population in the long term: The breeding and foraging habitat of this species should be stable or increasing in terms of its area, and its quality should remain unaffected by anthropogenic factors.

Factors affecting the population or its habitat should be under appropriate control: Rafting birds should remain unaffected by boat use and other anthropogenic factors; appropriate codes of conduct must be followed by all visitors and craft surrounding the islands. Factors affecting the species within the site should be under control.

2.4.3 Irish Sea Front SPA

Qualifying features: breeding Manx shearwater *Puffinus puffinus*

The site (classified October 2017) is located ~36km to the northwest of Anglesey, covers 180km² of the offshore marine area, and is the third largest offshore aggregation of Manx shearwater in the UK (Kober *et al.* 2012), being a foraging location for a large number of breeding birds from colonies likely in Wales, Northern Ireland and Devon. About 15km to the west of the site, a large channel up to 150m deep stretches from North to South. To the southwest of the Isle of Man, a dome of thermally stratified waters forms over this channel during spring due to the seasonal warming of the surface waters. South of the Isle of Man, the sea is shallower and tidal currents are strong enough to mix the water column, thereby preventing stratification. Between these two bodies of stratified and mixed waters, a tidal-mixing front appears known as the western Irish Sea Front (ISF). In spring, this front forms mainly south and east of the stratified waters; it establishes over the summer and disintegrates again in late summer when the air temperature cools down (Simpson and Hunter 1974).

The site was identified as a hotspot of seabirds based on data from the European Seabirds At Sea database (ESAS) – note other data informing the site selection included that from the Irish Sea Zone Appraisal Planning report, tracking data from Manx shearwater colonies on Copeland, Skomer and Lundy, and seabird census/SMP data from related colonies. The analysis of ESAS data estimated a modelled population of over 12,000 Manx shearwaters within the Irish Sea Front SPA during the breeding season. While not exceeding the 1% threshold of the biogeographic population on a regular basis, the site was considered under 1.4 of the SPA selection guidelines and it was concluded that it held a sufficient number of Manx shearwaters (0.68% of the biogeographic population, and greater than the 0.5% threshold under Stage 2) to justify proposing the site as an SPA.

Table 2.5: Irish Sea Front SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Manx shearwater	12,039 birds[1]	None available

Source: [1]Irish Sea Front SPA departmental brief. Note that the population figure is based on spatial interpolation and taken from modelled output. The figure should be taken as an indication of the scale of the population rather than interpreted as a precise number. The modelled population was based on 26 years of ESAS data.

Conservation objectives[26]:

The most recently available conservation objectives for the site (July 2016) are marked as draft. The objectives and related supplementary advice is provided below.

To avoid significant deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, subject to natural change, thus ensuring that the integrity of the site is maintained in the long term and makes an appropriate contribution to achieving the aims of the Birds Directive[27] for each of the qualifying species.

This contribution would be achieved through delivering the following objectives for each of the sites qualifying features:

- Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term.

  The site area has been identified as an aggregation hotspot for Manx shearwater, see Kober *et al.* (2010, 2012).

- Maintain the habitats and food resources of the qualifying features in favourable condition.

The ISF encompasses the site. The ISF is a highly productive shallow sea tidal mixing front that forms seasonally from May to September. The SPA, as delineated, is thought to be used by Manx Shearwater for foraging during the breeding season (which overlaps in time with the formation of the ISF).

The high productivity within the ISF can affect availability of prey to seabirds such as shearwaters, and as such is likely to provide important and predictable foraging habitat.

Manx shearwaters have been observed to forage mainly on small shoaling fish such as sandeels, sprat and herring and cephalopod species such as squid (Thompson 1987). There is some evidence that Manx Shearwaters from Welsh breeding colonies feed heavily on fish of the clupeid family (herrings, shads, sardines) (Brooke 1990).

All these prey species are likely to contribute to Manx shearwater diet in this area.

The Irish Sea Front SPA overlaps low intensity spawning grounds for sandeel (Ellis *et al.* 2012). Sandeels are reliant on favourable sandy benthic habitats and have been shown to prefer sandy seabeds with high proportion of coarse and medium sand particles (Greenstreet *et al.* 2010, Holland *et al.* 2005). Sandeels are highly resident and non-migratory, with large-scale dispersal only possible during larval phase and this is generally to a limited extent (Proctor *et al.* 1998; Christensen *et al.* 2008; Christensen *et al.* 2009, van Deurs 2010). Therefore, sandeel seabed habitats in or linked to the Irish Sea Front SPA should be conserved.

- Ensure access to the site from linked breeding colonies. Manx shearwaters have large foraging ranges and there are several Manx shearwater colonies within foraging range of the Irish Sea Front SPA (see Appendix I of the conservation objectives document for more information). Although the Manx shearwaters from existing SPA colonies receive

[26] https://jncc.gov.uk/our-work/irish-sea-front-spa/
[27] Any reference to all or part of a European Directive in this document is only made to provide context to retained EU law. The conservation objectives are reproduced here as they appear in relevant documents and webpages of the SNCBs which still refer to the Directives which were transposed into UK law through the Habitats and Offshore Habitats Directives.

some level of protection, via the current HRA process, whilst at sea, this objective should seek to ensure that Manx shearwater can continue to access the site without being subject to significant additional energetic costs whilst commuting to/from the site from linked colonies.

2.4.4 Dee Estuary (extension) SPA

Qualifying features: wintering northern pintail *Anas acuta*, Eurasian teal *Anas crecca*, dunlin *Calidris alpina*, red knot *Calidris canutus*, Eurasian oystercatcher *Haematopus ostralegus*, bar-tailed godwit *Limosa lapponica*, black-tailed godwit *Limosa limosa islandica*, Eurasian curlew *Numenius arquata*, grey plover *Pluvialis squatarola*, common shelduck *Tadorna tadorna*, common redshank *Tringa totanus,* breeding little tern *Sternula albifrons*, common tern *Sterna hirundo*, on passage Sandwich tern *Thalasseus sandvicensis*, wintering waterbird assemblage

The Dee Estuary was first classified in July 1985, and the boundaries and site features were revised in December 2009. It is the latter revision which is relevant to this review of consents, and therefore only those species subject to that revision are considered in this assessment. The 2009 classification included the addition of breeding little tern, common tern and Sandwich tern, and wintering teal, grey plover, dunlin, black-tailed godwit and curlew.

The Dee Estuary lies on the border between England and Wales on the north-west coast of Britain, covering an area of 14,292ha. It is a large, funnel-shaped, sheltered estuary, which supports extensive areas of intertidal sand and mudflats and saltmarsh. Where agricultural reclamation has not occurred, the saltmarshes grade into transitional brackish and swamp vegetation on the upper shore. The site is of major importance for waterbirds; during the winter the intertidal flats, saltmarshes and fringing habitats including coastal grazing marsh/fields, provide feeding and roosting sites for internationally important numbers of ducks and waders; in summer the site supports nationally important breeding colonies of two species of tern. The site is also important during migration periods, particularly for wader populations moving along the west coast of Britain and for Sandwich terns post-breeding.

Common terns, little terns and Sandwich terns exploit food resources provided within the estuary. The estuary also provides a staging post for Sandwich terns beginning their autumn migration.

Table 2.6: Dee Estuary extension SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Common tern	392 breeding pairs (5 year mean 1995-1999)[1]	355 breeding pairs (6 year mean 2014-2020)[3]
Sandwich tern	957 individuals-autumn passage (5 year mean 1995-1999)[1]	1,623 individuals-autumn passage (5 year mean 2015/16-2019/20)[4]
Teal	5,251 wintering individuals (5 year mean 1994/95-1998/99)[1]	6,062 wintering individuals (5 year mean 2015/16-2019/20)[4]
Grey plover	1,643 wintering individuals (5 year mean 1994/95-1998/99[1]	910 wintering individuals (5 year mean 2015/16-2019/20)[4]
Dunlin	27,769 wintering individuals (5 year mean 1994/95-1998/99)[1]	16,922 wintering individuals (5 year mean 2015/16-2019/20)[4]
Black-tailed godwit	1,747 wintering individuals (5 year mean 1994/95-1998/99)[1]	6,206 wintering individuals (5 year mean 2015/16-2019/20)[4]

Species	Population at time of designation	Most recent population counts
Curlew	3,899 wintering individuals (5 year mean 1994/95-1998/99)[1]	5,118 wintering individuals (5 year mean 2015/16-2019/20)[4]

Source: [1]Dee Estuary SPA citation; [2]JNCC website - Little tern; [3]Seabird Monitoring Programme; [4]WeBS count data (Frost *et al.* 2021)

Conservation objectives[28]:

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- The extent and distribution of the habitats of the qualifying features
- The structure and function of the habitats of the qualifying features
- The supporting processes on which the habitats of the qualifying features rely
- The population of each of the qualifying features, and,
- The distribution of the qualifying features within the site.

2.4.5 Liverpool Bay SPA

Qualifying features: non-breeding red-throated diver *Gavia stellata*, little gull *Hydrocoloeus minutus*, common scoter *Melanitta nigra*, breeding little tern *Sternula albifrons*, common tern *Sterna hirundo*, non-breeding waterbird assemblage

The site is located in the south-eastern region of the northern part of the Irish Sea, bordering north-west England and north Wales up to the mean low water mark, and forming a broad arc from approximately Morecambe Bay to the east coast of Anglesey, covering an area of some 252,758ha.

The site was originally classified in 2010 for red-throated diver and common scoter and a non-breeding waterbird assemblage. It was subsequently extended in 2017, the extension was for little tern, common tern and little gull, and assemblage features of cormorant and red-breasted merganser, and not for red-throated divers. The updated seaward boundary resulting from the 2017 classification is a combination of that relating to important areas for red-throated diver and common scoter as part of the original site, with the addition of important areas for little gull (Lawson *et al.* 2016a), little tern (Parsons *et al.* 2015) and common tern (Wilson *et al.* 2014). Much of the seaward extension relates important areas for non-breeding little gull defined by kernel density estimates and maximum curvature (see Lawson *et al.* 2016a).

The little tern foraging area is mostly contained within either the extended Liverpool Bay SPA boundary or the abutting intertidal area of the Dee Estuary SPA (see above). The Liverpool Bay SPA was extended such that the entire expected foraging range for little tern was covered by SPA designations for which it is a qualifying feature.

[28] http://publications.naturalengland.org.uk/publication/6557770283220992

Breeding common terns are qualifying features of Mersey Narrows & North Wirral Foreshore SPA (see below) and the Ribble and Alt Estuaries SPA[29]. Generic models of common tern foraging behaviour, along with maximum curvature, were used to generate boundaries containing the most important foraging areas around the SPA colony. The predictor variables used in this model were: i) distance to colony, ii) distance to shore, and iii) bathymetry. These variables predicted highest usage around the colony, generally decreasing with increasing distance from it. This means that for the common terns nesting within the Mersey Narrows and North Wirral Foreshore SPA, the predicted foraging area extends north approximately to Formby, west along most of the Wirral foreshore, and into the mouth of the Mersey Estuary approximately to Rock Ferry[30].

Table 2.7: Liverpool Bay SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Red-throated diver	1,171 non-breeding individuals (MoP 2004/05-2010/11)[1]	None available
Common tern	360 breeding individuals (2011-2015)[1]	347 breeding individuals (2018-2019)[2]
Little tern	260 breeding individuals (2010-2014)[1]	286 breeding individuals (3 year average 2014-2018)[4]
Little gull	319 non-breeding individuals (2004/05-2010/11)[1]	None available
Cormorant[3]	826 non-breeding individuals (2004/05-2010/11)[5]	None available
Red-breasted merganser[3]	160 non-breeding individuals (2004/05-2010/11)[5]	None available

Source:[1]Liverpool Bay SPA citation, [2] recent common tern counts based on apparently occupied nests at Seaforth Nature Reserve from Seabird Monitoring Programme, [3]assemblage feature; [4]JNCC website - Little tern, based on the Gronant Beach colony; [5]Liverpool Bay SPA Departmental Brief

Conservation objectives[31]:

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- The extent and distribution of the habitats of the qualifying features
- The structure and function of the habitats of the qualifying features
- The supporting processes on which the habitats of the qualifying features rely
- The population of each of the qualifying features, and,

[29] http://publications.naturalengland.org.uk/publication/4868920422957056
[30] See the Liverpool Bay SPA departmental brief for more information on the predicted habitat use of the extension species.
[31] https://jncc.gov.uk/our-work/liverpool-bay-spa/

- The distribution of the qualifying features within the site.

2.4.6 Mersey Narrows and North Wirral Foreshore SPA

Qualifying features: breeding and non-breeding common tern *Sterna hirundo*, non-breeding bar-tailed godwit *Limosa lapponica*, knot *Calidris canutus*, little gull *Hydrocoloeus minutus*, waterbird assemblage

The site was classified in 2013 for waterbird species and breeding/non-breeding common tern, and non-breeding little gull. The site includes extensive intertidal mud and sandflats, distinct areas of rocky shore and small areas of saltmarsh, covering an area of 2,078ha. The intertidal areas provide important feeding areas, and the site includes the Seaforth Nature Reserve which is a high tide roost site, nesting site for common terns, and a feeding area for little gull. Common tern have also been known to nest outside of the site at Langton Dock and Birkenhead docks.

Table 2.8: Mersey Narrows and North Wirral Foreshore SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Bar-tailed Godwit	3,344 non-breeding individuals (2008/09)[1]	1,408 non-breeding individuals (2010/11-2014/15)
Common tern	177 breeding pairs (2005-2009); 1,475 non-breeding individuals (2004-2008)[1]	174 breeding pairs (2018-2019)[2]
Little gull	213 non-breeding individuals (2004/05-2008/09)[1]	53 non-breeding individuals (2012/13-2016/17)
Knot	10,655 non-breeding individuals (2004/05-2008/09)[1]	11,107 non-breeding individuals (2012/13-2016/17)

Source: [1]Mersey Narrows and North Wirral Foreshore SPA citation; [2] recent common tern counts based on apparently occupied nests at Seaforth Nature Reserve from Seabird Monitoring Programme

In the non-breeding season, the area regularly supports 32,366 individual waterbirds (5 year peak mean 2004/05-2008/09), including: cormorant, oystercatcher, grey plover, sanderling, knot, dunlin, bar-tailed godwit and redshank. More recently, the 5-year peak mean is 31,989 individuals (2012/13-2016/17).

Conservation objectives[32]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely

[32] http://publications.naturalengland.org.uk/publication/6521906232557568

- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives (SACO)[33] for the site has also been consulted.

There is evidence that the waterbird assemblage and breeding common tern abundance, and their connectivity with supporting habitats are in a good condition and/or are currently unimpacted by anthropogenic activities, though recreational disturbance to the non-breeding assemblage is noted as a potential issue. The abundance of non-breeding little gull and bar-tailed godwit are both considered to be in a poor condition or impacted by anthropogenic activities. A target is set to restore the non-breeding populations of bar-tailed godwit and little gull to 3,344 and 213, from recent counts of 1,408 and 53 individuals, respectively. Many other targets lack a specific status as they lack evidence to demonstrate whether there are impacts. The SACO does not identify the types of project subject to this review as specifically impacting the status of the features of the site.

The SACO notes that the common tern use habitats beyond the site boundaries which should be regarded as functionally linked to the site, and so should be considered in HRA. This HRA process has reflected this in considering impacts to the features based on the mean maximum (+1SD) foraging range.

2.4.7 Anglesey Terns SPA

Qualifying features: breeding common tern *Sterna hirundo*, Arctic tern *Sterna paradisea*, roseate tern *Sterna dougalli*, Sandwich tern *Thalasseus sandvicensis*

The site was originally classified in 1992 as Ynys Feurig, Cemlyn Bay and The Skerries SPA, and was extended in January 2017 to cover the foraging areas of tern species associated with the SPA, with the site covering 101,931ha. The tern colonies are located on Ynys Feurig, a series of small islets off the west coast of Anglesey (mostly Arctic terns and some common terns), The Skerries, a group of sparsely vegetated rocky islets, lying ~3km off the north western coast of Anglesey (mostly Arctic terns and some common terns), and, Cemlyn Bay on the north coast of Anglesey (mainly Sandwich terns with some common and Arctic terns). The site boundary was defined using maximum curvature for each of the species and related colonies (see Wilson *et al.* 2014).

Table 2.9: Anglesey Terns SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Sandwich tern	460 breeding pairs (5 year mean 1993-1997)[1]	1,819 pairs (5 year mean 2015-2020)[2]

Source: [1]after Stroud *et al.* 2001, see Anglesey Terns SPA departmental brief, [2]apparently occupied nests at Cemlyn Lagoons, Seabird Monitoring Programme.

33 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9020287&SiteName=&SiteNameDisplay=Mersey+Narrows+and+North+Wirral+Foreshore+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=5

Conservation objectives[34]:

For Sandwich tern:

- The size of the population should be stable or increasing, allowing for natural variability, and sustainable in the long term.

  The breeding population of Sandwich tern should be stable or increasing. The site was designated for 460 pairs across the SPA.

- The distribution of the population should be being maintained, or where appropriate increasing.

  The range and distribution of terns within the SPA and beyond is not constrained or hindered.

- There should be sufficient habitat, of sufficient quality, to support the population in the long term.

  The extent of supporting habitats used by terns is stable or increasing. Supporting habitats are of sufficient quality to support the requirements of terns. There are appropriate and sufficient food sources for terns within access of the SPA.

- Factors affecting the population or its habitat should be under appropriate control.

  The number of chicks successfully fledged in the SPA and beyond is sufficient to help sustain the population. Actions or events likely to impinge on the sustainability of the population are under control. There should be no mammalian land predators present in the SPA, and control measures should be in place to ensure that accidental introduction does not take place.

2.4.8 Morecambe Bay and Duddon Estuary SPA

Qualifying features: bar-tailed godwit *Limosa lapponica*, black-tailed godwit *Limosa limosa islandica*, common tern *Sterna hirundo*, curlew *Numenius arquata*, dunlin *Calidris alpina alpina*, golden plover *Pluvialis apricaria*, grey plover *Pluvialis squatarola*, herring gull *Larus argentatus*, knot *Calidris canutus*, lesser black-backed gull *Larus fuscus*, little egret *Egretta garzetta*, little tern *Sternula albifrons*, Mediterranean gull *Ichthyaetus melanocephalus*, oystercatcher *Haematopus ostralegus*, pink-footed goose *Anser brachyrhynchus*, pintail *Anas acuta*, redshank *Tringa totanus*, ringed plover *Charadrius hiaticula*, ruff *Calidris pugnax*, sanderling *Calidris alba*, Sandwich tern *Thalasseus sandvicensis*, shelduck *Tadorna tadorna*, turnstone *Arenaria interpres*, whooper swan *Cygnus cygnus*, waterbird assemblage, seabird assemblage

The Morecambe Bay and Duddon Estuary SPA is situated along the coast of northern Lancashire and southern Cumbria and includes the second largest embayment in Britain after The Wash. The site represents the largest continuous area of intertidal mudflats and sandflats in the UK, covering an area of 66,900ha, and includes several major estuaries where the river Wyre, Lune, Kent, Leven and Duddon enter the Irish Sea. The SPA is a highly dynamic coastal and estuarine system which creates continually shifting channels, creeks and pools and the total extent, distribution and character of most subtidal and intertidal habitats are therefore subject to high levels of change over both short and long periods of time. High numbers of various polychaete worms, bivalve molluscs, crustaceans and other invertebrates

[34] https://naturalresources.wales/guidance-and-advice/environmental-topics/consultations/our-own-consultations/our-own-consultations-closed/closed-2016/new-marine-sac/anglesey-terns/?lang=en

are present and contribute significantly to the diet of many bird species in the SPA. Areas of coarse sediment, boulders and cobbles create intertidal reefs, known locally as ‘skears’, which provide a hard substrate for dense beds of mussel that can cover large areas. The parts of the SPA away from the coast are sandy and shallow, mostly less than 15m deep.

The Morecambe Bay and Duddon Estuary SPA is an amalgamation of two previously separate SPAs. The amalgamated site was classified in February 2017 and it is this latter classification which is the subject of this review. The re-classification included the addition of an extension approximately 7km north along the Cumbrian coast to afford protection to foraging tern species, and also the following additional qualifying interests; non-breeding black-tailed godwit, whooper swan, little egret, Mediterranean gull, lesser black-backed gull and ruff.

The common tern feature of Morecambe Bay and Duddon Estuary SPA was retained in the 2017 classification as a matter of Defra policy, as the population had declined to be below the selection criteria for the species. Birds were absent from the Foulney Island and South Walney colonies by 2014 (note one AON was observed in 2017), with the latest available counts for common tern at Hodbarrow (average 2015-2019) being 86 individuals, which is considerably lower than the 570 individuals formerly cited in the 1991 Morecambe Bay SPA and which has been retained to date on the SPA citation.

Table 2.10: Morecambe Bay and Duddon Estuary SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Lesser black-backed gull	9,720 breeding individuals (2011-2015); 9,450 non-breeding individuals (2009/10-2013/14)[1]	3,139 breeding individuals (average 2016-2020)[2]
Mediterranean gull	18 non-breeding individuals (2009/10-2013/14)[1]	19 non-breeding individuals (5 year mean 2015/16-2019/20)[4]
Black-tailed godwit	2,413 non-breeding individuals (2009/10-2013/14)[1]	3,726 non-breeding individuals (5 year mean 2015/16-2019/20)[4]
Whooper swan	113 non-breeding individuals (2009/10-2013/14)[1]	199 non-breeding individuals (5 year mean 2015/16-2019/20)[4]
Little egret	134 non-breeding individuals (2009/10-2013/14)[1]	356 non-breeding individuals (5 year mean 2015/16-2019/20)[4]
Ruff	8 non-breeding individuals (2009/10-2013/14)[1]	8 non-breeding individuals (5 year mean 2015/16-2019/20)[4]
Sandwich tern	1,608 breeding individuals (1988-1992)[1]	2,203 breeding individuals (average 2017-2019)[2]
Common tern	570 breeding individuals (Morecambe Bay SPA citation value 1991)[1]	Breeding (average 89 individuals 2015-2019)[2]
Little tern	84 breeding individuals (2010-2014)[1]	No data

Source: [1]Morecambe Bay and Duddon Estuary SPA citation which note sources as the Seabird Monitoring Programme database, RSPB and Cumbria Wildlife Trust; [2]Seabird Monitoring Programme; [4]WeBS count data (Frost *et al.* 2021)

Conservation objectives[35]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[36] for the site has also been consulted.

The SACO notes that there are restore targets set for the breeding lesser black-backed gull and common tern, which have declined more than 50% and 80% respectively from the original 1991 classification. A similar target has been set for Sandwich tern, with the SACO noting a current total of only 40 pairs, however this differs markedly from the numbers noted above from the Seabird Monitoring Programme. For terns, predation is considered one of the main factors affecting tern nesting range, and though measures are in place, these are labour intensive.

The habitats the species rely on are generally in good condition, however, a lack of suitable breeding habitat for terns and lesser black-backed gull is noted. The status of other aspects of the site features are mostly judged to be in good condition, or with a lack of evidence to indicate a level of impact, such that targets are set to maintain the attributes of the site (e.g. the extent, distribution and availability of suitable habitat in the site).

The only reference to any of the project types relevant to this HRA in the SACO is for the breeding lesser black-backed gull and its connectivity with supporting habitats. The advice noted that there is some evidence that birds fly out to wind farms, however there is no evidence that they pose a barrier to movement.

2.4.9 Flamborough and Filey Coast SPA

Qualifying features: gannet *Morus bassanus*, guillemot *Uria aalge*, kittiwake *Rissa tridactyla*, razorbill *Alca torda*, Seabird assemblage

The site was originally classified as Flamborough Head and Bempton Cliffs SPA in August 1998 and was extended in August 2018 to include the north cliffs of Filey and inshore waters to 2km. This extension also included the addition of gannet, guillemot and razorbill as qualifying features. It is the extension to this site, and related features, which is relevant to this review (BEIS 2021). The SPA is in two sections: the southern section extends north from South

35 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020326&HasCA=1&NumMarineSeasonality=25&SiteNameDisplay=Morecambe%20Bay%20and%20Duddon%20Estuary%20SPA#hlco

36 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9020326&SiteName=Morecambe%20Bay%20and%20Duddon%20Estuary%20&SiteNameDisplay=Morecambe+Bay+and+Duddon+Estuary+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=25,25

Landing around Flamborough Head to Speeton; the northern section covers the peninsula of Filey Brigg before extending north west to Cunstone Nab. The seaward boundary extends 2km throughout the two sections of the site into the marine environment, running parallel to the landward boundaries to include the adjacent coastal waters; overall the SPA covers an area of 7,858ha.

The cliffs of Flamborough Head rise to 135 metres and are composed of chalk and other sedimentary rocks. These soft cliffs have been eroded into a series of bays, arches, pinnacles and gullies with an extensive system of caves at sea-level. The numerous ledges, crevices and caves provide ideal nesting and roosting sites for seabirds, supporting a colony of national and international importance, and currently the largest mainland seabird colony in England. The SPA supports the only mainland gannetry in England, the largest kittiwake colony in the UK and the largest guillemot and razorbill colonies in England. The colonies are situated along the cliffs on the southern and northern sides of Filey Bay and the north and south sides of Flamborough Head. They support over 200,000 seabirds during the breeding season, many of which are extremely limited in breeding range throughout the UK.

The waters adjacent to the colonies are used by large numbers of seabirds for a wide range of activities, including bathing, preening, displaying, loafing and local foraging. The proximity to the productive Flamborough Front also provides rich feeding ground for birds related to the SPA.

Table 2.11 Flamborough and Filey Coast SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Northern gannet	16,938 breeding adults (2008-2012)[1]	26,784 breeding adults (2017)[2]
Guillemot	83,214 breeding adults (2008-2011)[1]	84,647 individuals (2017)[2]
Razorbill	21,140 breeding adults (2008-2011)[1]	27,967 individuals (2017)[2]
Puffin[3]	1,960 breeding adults (2008-2011)[4]	3,579 (average on sea 2017-2018)[2]

Source: [1]Flamborough and Filey Coast SPA citation; [2]Seabird Monitoring Programme data as noted in the site SACO; [3]assemblage feature; [4]originally derived from SMP data for “individuals on land”, this was regarded as an underestimation, such that a doubling of this figure was, on balance, considered appropriate to reflect the population at the site – see Natural England’s consultation outcome for the site.

Conservation objectives[37]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

37 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9006101&HasCA=1&NumMarineSeasonality=4&SiteNameDisplay=Flamborough%20and%20Filey%20Coast%20SPA#hlco

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[38] for the site has also been consulted.

The SACO notes that the razorbill feature of the site is performing well against its target population, with a 2017 colony count of 20,253 breeding pairs compared with a target of 10,570 pairs; it is the only feature specifically noted to be in a good condition and/or currently un-impacted by anthropogenic activities, though note that status is not attributed to any other features of the site in the SACO. The gannet colony is similarly expanding, with a census recording 12,494 Apparently Occupied Nests (AON) in 2015 and 13,392 AON in 2017. The SACO notes that gannet tagging studies at Bempton cliffs shown there is an overlap between foraging ranges and wind farms and that gannets fly at and plunge dive from elevations within the rotor swept area; displacement from wind farms is also noted as a potential impact.

For guillemot and razorbill, it is noted that collision risk is low due to their flight heights. It is noted that for all features, other disturbance including, but not limited to, human presence, fast moving motorised watercraft, non-powered craft in close proximity to the nesting site, low-flying aircraft and noise/vibration from construction work, could cause disturbance. There are some management measures including a bylaw in Filey Bay which helps limit bycatch, sanctions that limit use of personal watercraft and voluntary measures to reduce impact of recreational activities.

2.4.10 Greater Wash SPA

Qualifying features: red-throated diver *Gavia stellata*, little gull *Hydrocoloeus minutus*, common scoter *Melanitta nigra*, little tern *Sternula albifrons*, common tern *Sterna hirundo*, Sandwich tern *Thalasseus sandvicensis*

The landward boundary of the SPA covers the coastline from Bridlington Bay in the north (at the village of Barmston), to the existing boundary of the Outer Thames Estuary SPA in the south. The site is classified for the protection of red-throated diver, common scoter, and little gull during the non-breeding season, and for breeding sandwich tern, common tern and little tern. The seaward boundary is defined by the area of importance to red-throated diver, and by the foraging area of sandwich tern off the north Norfolk Coast. Red-throated diver are distributed throughout the SPA, with higher densities of birds were recorded close inshore, particularly in the area outside The Wash SPA, north of the Humber Estuary, along the eastern part of North Norfolk Coast and in the south of the site where it abuts the Outer Thames Estuary SPA (Lawson *et al.* 2016a). Highest densities of common scoter are observed in the area outside The Wash SPA and along the North Norfolk Coast SPA.

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38 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9006101&SiteName=&SiteNameDisplay=Flamborough+and+Filey+Coast+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=4

Common and Sandwich are associated with the Scott Head and Blakeney Point colonies (i.e. associated with the North Norfolk SPA). The Greater Wash SPA, along with the Outer Thames Estuary SPA, covers marine areas used by common terns related to the colony associated with the Breydon Water SPA (Lawson *et al.* 2016a). Marine areas associated with little tern colonies from the Humber Estuary SPA, Gibraltar Point SPA, North Norfolk Coast SPA and the Great Yarmouth North Denes SPA, are also covered by the Greater Wash SPA.

Table 2.12 Greater Wash SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Red-throated diver	1,407 non-breeding individuals (MoP 2002/03-2005/06)[1]	No update available
Common scoter	3,449 non-breeding individuals (MoP 2002/03-2007/08)[1]	No update available
Little tern	798 breeding pairs (5 year MoP 2009-2013)[1]	No update available
Sandwich tern	3,852 breeding pairs (5 year MoP 2010-14)[1]	Average 2,431 AON (average 2015-2020)[2]
Common tern	510 breeding pairs (5 year MoP 2010-2014)[1]	Average 311 AON (average 2015-2020)[2]
Little gull	1,255 non-breeding individuals (MoP 2004/05-2005/06)[1]	No update available

Source: [1] Greater Wash SPA citation, [2]Seabird Monitoring Programme (based on relevant colonies including those of Titchwell Marsh, Holkham, Blakeney Point, Scolt Head and Breydon Water), MoP = Mean of Peak for non-breeding populations, breeding populations taken from various sources and are summed across the relevant site-specific population estimates.

Conservation objectives[39]:

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- The extent and distribution of the habitats of the qualifying features
- The structure and function of the habitats of the qualifying features
- The supporting processes on which the habitats of the qualifying features rely
- The population of each of the qualifying features, and,
- The distribution of the qualifying features within the site.

2.4.11 Outer Thames Estuary SPA

Qualifying features: common tern *Sterna hirundo*, little tern *Sternula albifrons*, red-throated diver *Gavia stellata*

[39] http://publications.naturalengland.org.uk/file/4597105251581952

The Outer Thames Estuary SPA is located on the southeast coast of England, stretching from Caister-on-Sea in Norfolk down the Suffolk coast to Sheerness on the Kent coastline, and reaching as far as Canvey Island into the Thames Estuary, covering some 392,452ha. The site was first classified in August 2010 and subsequently extended in November 2017 to include common tern and little tern. It is the latter extension which is relevant to the review, and a likely significant effect was only determined for common tern (BEIS 2021).

Common tern breed on the dynamic Scroby Sands intertidal sandbank, located 6km offshore from Great Yarmouth, and within this SPA. The Outer Thames Estuary SPA protects important at-sea foraging waters for common tern which breed at six adjacent SPAs: Great Yarmouth North Denes; Benacre to Easton Bavents; Breydon Water; Minsmere-Walberswick; Alde-Ore Estuary; Foulness; and Thanet Coast and Sandwich Bay SPAs. The coastal waters of the SPA are used for foraging, as well as a wide range of maintenance activities, such as bathing and loafing. Terns nesting on the Scroby Sands sandbank and nearby Great Yarmouth North Denes SPA may also forage within the adjacent Greater Wash SPA, suggesting there is a degree of connectivity between the sites.

Table 2.13 Outer Thames Estuary SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Common tern	532 breeding individuals (2011-2015)[1]	520 breeding individuals (2016-2017/2019)[2]

Source: [1]Outer Thames Estuary SPA citation; [2]Seabird Monitoring Programme for Scroby Sands and Breydon Water SPA

Conservation objectives[40]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

40 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020309&SiteName=outer%20thames&countyCode=&responsiblePerson=&unitId=&SeaArea=&IFCAArea=&NumMarineSeasonality=&SiteNameDisplay=Outer%20Thames%20Estuary%20SPA&HasCA=1&NumMarineSeasonality=3&SiteNameDisplay=Outer%20Thames%20Estuary%20SPA#hlco

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[41] for the site has also been consulted.

The SACO for common tern notes that birds which forage in the Outer Thames Estuary breed at adjacent colonies including those at Foulness SPA and Breydon Water SPA, and note that a large colony breed on Scroby Sands. A target has been set to maintain the colony at 532 breeding individuals, though the SACO notes that the target would be reassessed once sufficient time had passed to draw an appropriate comparison. It is noted that the terns are subject to pressures including disturbance and predation. There is also a target to maintain passage between nesting and foraging areas, and in particular, the potential effect from constructing and operating wind farms is noted, which could act as a barrier to tern movements. Additional pressures come from aggregate extraction and pile driving associated with construction, and the SACO indicated a precautionary approach to the timing of activities should be taken due to the sensitivity of terns, and their prey which includes herring. With regards to the latter, appropriate management of fisheries is also noted as a means to ensure the availability of key prey species within the site.

2.4.12 Stour and Orwell Estuaries (extension) SPA

Qualifying features: avocet *Recurvirostra avosetta*, black-tailed godwit *Limosa limosa islandica*, dark-bellied brent goose *Branta bernicla bernicla*, dunlin *Calidris alpina alpina*, grey plover *Pluvialis squatarola*, knot *Calidris canutus*, pintail *Anas acuta*, redshank *Tringa totanus*, waterbird assemblage

The Stour and Orwell estuaries straddle the eastern part of the Essex/Suffolk border in eastern England. The site was classified on 13 July 1994. On 19 May 2005 the site underwent boundary extensions at Bathside Bay and part of Copperas Bay, now covering some 3,323ha. These extensions to the SPA were added as compensation for loss of habitat as part of the Bathside Bay development. The following were added as qualifying features in 2005: avocet (breeding), knot (breeding), pintail (non-breeding) and waterbird assemblage, in addition to the areas of compensatory habitat associated with the proposed Bathside Bay port development.

The estuaries include extensive mud-flats, low cliffs, saltmarsh and small areas of vegetated shingle on the lower reaches. The mud-flats hold Enteromorpha, Zostera and Salicornia spp. The site also includes areas of low-lying grazing marsh at Shotley Marshes on the south side of the Orwell and at Cattawade Marshes at the head of the Stour. Trimley Marshes on the north side of the Orwell includes several shallow freshwater pools, as well as areas of grazing marsh, and is managed as a nature reserve by the Suffolk Wildlife Trust. In summer, the site supports important numbers of breeding avocet *Recurvirostra avosetta*, while in winter it holds major concentrations of waterbirds, especially geese, ducks and waders. The geese also feed, and some waders roost, in surrounding areas of agricultural land outside the SPA. The site has close ecological links with the Hamford Water and Mid-Essex Coast SPAs, lying to the south.

41 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9020309&SiteName=outer+thames&SiteNameDisplay=Outer+Thames+Estuary+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=%2c3

Table 2.14 Stour and Orwell Estuaries (extension) SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Avocet	21 breeding pairs (5 year peak mean 1996-2000)[1]	-
Knot	5,970 non-breeding individuals (5 year peak mean 1995/96-1999/2000)[1]	10,900 non-breeding individuals (5 year peak mean 2015/16-2019/2020)[2]
Pintail	741 non-breeding individuals (5 year peak mean 1995/96-1999/2000)[1]	364 non-breeding individuals (5 year peak mean 2015/16-2019/2020)[2]

Source: [1] Stour and Orwell Estuaries SPA citation; [2]WeBS count data (Frost *et al.* 2021)

In the non-breeding season, the area regularly supports 63,017 individual waterbirds (5 year peak mean 1993/94-1997/98, or 63,508 for 2015/16-2019/20), including great crested grebe, cormorant*, dark-bellied brent goose, shelduck, wigeon*, gadwall*, pintail, goldeneye*, ringed plover, grey plover, lapwing*, knot, dunlin, black-tailed godwit, curlew*, redshank and turnstone (*assemblage feature added in 2005 classification).

Conservation objectives[42]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[43] for the site has also been consulted.

The SACO notes an 11.9% decline in breeding avocet since classification, though the target for population remains to maintain a level above 21 pairs while the cause of the decline is investigated. The knot population is noted to have increased, with a target to maintain

42 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9009121&SiteName=stour&countyCode=&responsiblePerson=&unitId=&SeaArea=&IFCAArea=&NumMarineSeasonality=&SiteNameDisplay=Stour%20and%20Orwell%20Estuaries%20SPA&HasCA=1&NumMarineSeasonality=8&SiteNameDisplay=Stour%20and%20Orwell%20Estuaries%20SPA#hlco

43 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9009121&SiteName=stour&SiteNameDisplay=Stour+and+Orwell+Estuaries+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=,8

numbers above 5,970 individuals, and conversely the population of pintail has declined, with an objective to restore the population to above 741 individuals. Recreational disturbance at the site, and in particular in the Orwell estuary, is considered to be high and includes walkers, sailing boats, jet-skis, and less frequently but with a greater level of disturbance, bait digging, shooting, motorboats and light aircraft. Wildfowling occurs over the winter period (September to February) and can cause significant disturbance to bird populations, as well as reducing their abundance. Additionally, port and harbour activity may generate disturbance with some resulting in high traffic levels. Felixstowe, Harwich and Ipswich ports have especially high levels of commercial activity.

2.4.13 Humber Estuary SPA

Qualifying features: avocet *Recurvirostra avosetta*, bar-tailed godwit *Limosa lapponica*, bittern *Botaurus stellaris*, black-tailed godwit *Limosa limosa islandica*, dunlin *Calidris alpina alpina*, golden plover *Pluvialis apricaria*, hen harrier *Circus cyaneus*, knot *Calidris canutus*, little tern *Sternula albifrons*, marsh harrier *Circus aeruginosus*, redshank *Tringa totanus*, ruff *Calidris pugnax*, shelduck *Tadorna tadorna*, waterbird assemblage

The Humber Estuary is a large macro-tidal coastal plain estuary with high suspended sediment loads, which feed a dynamic and rapidly changing system of accreting and eroding intertidal and subtidal mudflats, sandflats, saltmarsh and reedbeds. The range of habitats on the Estuary (detailed in the feature descriptions) support a variety of non-breeding, passage and breeding birds, including internationally important populations of a number of species. At high tide essential roost sites are at a premium due to the combined effects of extensive historical land claim, coastal squeeze and the acute lack of grazing marsh and grassland. A number of developing managed realignment sites are contributing to the variety of habitats available to the birds.

The site was formerly named the Humber Flats, Marshes and Coast SPA, classified in July 1994, which was the first of two planned phases of classification for the Humber estuary. The second phase of designation was not taken forward, and instead the Humber Flats, Marshes and Coast SPA was subsumed into the wider Humber Estuary SPA, classified in August 2007. Citation information for the Humber Flats, Marshes and Coast SPA, indicate that the additional species now classified for the site are avocet (breeding and non-breeding), black-tailed godwit (passage and non-breeding), bittern (breeding; already classified as non-breeding), knot, dunlin and redshank (all passage), and ruff (on passage).

Table 2.15 Humber Estuary SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Avocet	59 non-breeding individuals (5 year peak mean 1996/97-2000/01), 64 breeding pairs (5 year mean 1998-2002)[1]	2,479 non-breeding individuals (5 year mean 2015/16-2019/20)[2]
Black-tailed godwit	1,113 non-breeding individuals (5 year peak mean 1996/97-2000/01)[1]	4,545 non-breeding individuals (5 year mean 2015/16-2019/20)[2]
Knot	28,165 non-breeding individuals (5 year peak mean 1996/97-2000/01); 18,500 individuals on passage (5 year peak mean 1996-2000)[1]	22,500 non-breeding individuals (5 year mean 2015/16-2019/20)[2]
Dunlin	22,222 non-breeding individuals (5 year peak mean 1996/97-2000/01)[1]	15,954 non-breeding individuals (5 year mean 2015/16-2019/20)[2]

Species	Population at time of designation	Most recent population counts
Redshank	4,632 non-breeding individuals (5 year peak mean 1996/97-2000/01)[1]	2,881 non-breeding individuals (5 year mean 2015/16-2019/20)[2]
Ruff	128 individuals on passage (5 year peak mean 1996-2000)[1]	80 non-breeding individuals (5 year mean 2015/16-2019/20)[2]

Source: [1]Humber Estuary SPA citation; [2]WeBS count data (Frost *et al.* 2021)

Conservation objectives[44]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[45] for the site has also been consulted.

There is an objective to maintain the population of knot at above 18,500 individuals on passage and 28,165 non-breeding individuals, and to restore the dunlin non-breeding population to above 22,222 (the 5 year mean peak 2013/14-2017/18 was 15,607 individuals). There is also evidence of a significant and ongoing decline in both winter and passage redshank populations on the site over both short- and medium-term periods, therefore, there is an objective to restore the population to a level above 4,632 non-breeding individuals and 7,462 individuals during passage. There is a loss of extent to the related SAC mudflat and sand flat feature, and of the Atlantic salt meadow feature, with a predicted long-term loss to this habitat based on modelling of future coastal squeeze, such that there is an objective to restore the extent, distribution and availability of suitable habitat (either within or outside the site boundary). The population of ruff has declined by over 50% since classification and has an objective to restore the non-breeding population to above 128 individuals, though the target has been set with low confidence due to limited information on wider trends in passage populations. The SACO notes that recreational disturbance at the site is at levels which would

44 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9006111&HasCA=1&NumMarineSeasonality=15&SiteNameDisplay=Humber%20Estuary%20SPA#hlco

45 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9006111&SiteName=&SiteNameDisplay=Humber+Estuary+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=15

influence waterbird usage, in particular from dog walking, such that there is a target to reduce such disturbance to roosting, foraging, feeding, moulting and/or loafing birds.

2.4.14 Dungeness, Romney Marsh and Rye Bay SPA

Qualifying features: Non-breeding aquatic warbler *Acrocephalus paludicola*, Bewick's swan *Cygnus columbianus bewickii*, bittern *Botaurus stellaris*, golden plover *Pluvialis apricaria*, hen harrier *Circus cyaneus*, ruff *Calidris pugnax*, shoveler *Spatula clypeata*, Waterbird assemblage; breeding avocet *Recurvirostra avosetta*, common tern *Sterna hirundo*, little tern *Sternula albifrons*, marsh harrier *Circus aeruginosus*, Mediterranean gull *Ichthyaetus melanocephalus*, Sandwich tern *Thalasseus sandvicensis*

The site is located on the south coast of England between Hythe in Kent crossing the county border of East Sussex to Norman's Bay. Coastal processes have shaped this landscape, forming a barrier of extensive coastal shingle beaches and sand dunes across an area of intertidal mud and sand flats. The extensive network of open water, including flooded gravel pits, canal, reservoirs and lowland ditch system are all important supporting habitats for the SPA birds, as are other terrestrial habitats including damp grassland, grazing marsh, reedbeds and the adjoining cultivated fields. Saltmarsh, saline lagoons and other intertidal habitats are also important supporting habitats.

The original Dungeness to Pett Level SPA was classified on 2 August 1999 for common tern, little tern, Mediterranean gull, aquatic warbler, Bewick's swan and shoveler. The site was subsequently extended in March 2016 and renamed as Dungeness, Romney Marsh and Rye Bay SPA. The 2016 extension included a number of additional features (Marsh harrier, avocet, Sandwich tern, bittern, hen harrier, golden plover and ruff), and the addition of a waterbird assemblage. The site was again extended in 2017 for foraging terns (Sandwich tern, common tern, little tern) and now covers an area of 42,418ha.

The principal location within the SPA which has held all of the Sandwich tern nests in the last two decades has been Rye Harbour (Lewis Yates 2014). Predictions of relative usage of marine areas by foraging Sandwich terns around Rye Bay were made in relation to Sandwich terns originating from this location using a generic model, generated from pooled data obtained from surveys at Sandwich tern colonies across the UK. The model generated predictions of relative usage by Sandwich tern originating from Rye Harbour, and the areas in which predicted usage exceeded the threshold identified by application of the maximum curvature approach. The 2017 site extension boundary is based on generic model predictions of usage by Sandwich and common terns from their source colonies within the SPA, and application of the maximum curvature technique, a composite boundary to the important foraging areas of the birds.

Table 2.16 Dungeness, Romney Marsh and Rye Bay SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Sandwich tern	420 breeding pairs (5 year mean 2011-2015)[1]	315 breeding pairs (4 year mean 2016-2019)[2]

Source: [1] Dungeness, Romney Marsh and Rye Bay SPA citation; [2]Seabird Monitoring Programme; the number of individuals on the site has declined since classification and so a restore target has been set.

Conservation objectives[46]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[47] for the site has also been consulted.

A target has been set in the SACO to restore the population of Sandwich terns to above 420 breeding pairs. Disturbance to breeding birds from recreational activities at the site is a potential issue, as well as predation from mammalian and avian predators. The erection of mammal proof anti-predator fencing has reduced the mammal predator threat on Rye Harbour Local Nature Reserve but the chicks are still susceptible to avian predators. Management efforts for Sandwich tern have focused on providing suitable nesting areas free from disturbance and predation and ensuring there is sufficient food available for raising chicks.

2.4.15 Coquet Island SPA

Qualifying features: breeding Arctic tern *Sterna paradisaea*, common tern *Sterna hirundo*, roseate tern *Sterna dougallii*, Sandwich tern *Thalasseus sandvicensis*, Seabird assemblage

Coquet Island is a small, flat topped island located 1km off the coast of Northumberland in north-east England. The island has a rocky upper shore and intertidal area covering some 15ha when fully exposed, with the designated site area covering 19.9ha. The SPA was first classified in 1985 for breeding seabirds and was subsequently amended in 2017 to implement recommendations of the 2001 SPA Review. The site was formally designated for breeding tern species and a seabird assemblage of international importance, including both the qualifying tern species, puffin and black-headed gull. The island is surrounded by the Northumberland Marine SPA (see below), which protects the foraging areas for the tern species and the breeding seabird assemblage. The site shares features with the nearby Northumbria Coast SPA, Lindisfarne SPA and the Farne Islands SPA.

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[46] http://publications.naturalengland.org.uk/publication/5208885390475264

[47] https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9012091&SiteName=&SiteNameDisplay=Dungeness%2c+Romney+Marsh+and+Rye+Bay+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=13

Table 2.17 Coquet Island SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Puffin (assemblage feature)	15,843 pairs (average 2008, 2009 and 2013 censuses)[1]	28,669 pairs (average 2018 and 2019)[2]

Source: [1]Coquet Island Special Protection Area (SPA) – site amendment Departmental brief; [2]Seabird Monitoring Programme

Conservation objectives[48]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[49] for the site has also been consulted.

There are no specific objectives in relation to puffin within the SACO for the site, but for the wider assemblage, there are objectives to maintain its overall abundance above 47,662 individual breeding seabirds, and to maintain the diversity of species within the assemblage. It is noted that evidence from surveys or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities. The site is managed by the RSPB, which undertake measures to limit predation and disturbance from visitors.

2.4.16 Farne Islands SPA

Qualifying features: Breeding Arctic tern *Sterna paradisaea*, common tern *Sterna hirundo*, guillemot *Uria aalge*, roseate tern *Sterna dougallii*, Sandwich tern *Thalasseus sandvicensis*, Seabird assemblage

The Farne Islands are a group of low-lying islands 2-6km off the coast of Northumberland in north-east England, covering 101ha. The islands are important as nesting areas for seabirds birds, especially terns, gulls and auks. The SPA was first classified in 1985 for breeding seabirds and was subsequently amended in 2017 to implement recommendations of the 2001

48 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9006031&HasCA=1&NumMarineSeasonality=4&SiteNameDisplay=Coquet%20Island%20SPA#hlco

49 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9006031&SiteName=&SiteNameDisplay=Coquet+Island+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=4

SPA Review. The site was formally designated for breeding tern species and guillemot, and a seabird assemblage of international importance including both the qualifying tern species, puffin, cormorant, shag and kittiwake. The area surrounding the Farne Islands is protected by the Northumberland Marine SPA (see below), which has been classified to protect the foraging areas of tern species and other breeding seabirds.

Table 2.18 Farne Islands SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Puffin (assemblage feature)	76,798 breeding adults (2008 and 2013 censuses)[1]	87,708 breeding adults (2018 and 2019)[2]
Kittiwake (assemblage feature)	8,241 breeding adults (2010-2014)	8,804 breeding adults (2019)[2]

Source: [1] Farne Islands SPA citation; [2] Seabird Monitoring Programme

Conservation objectives[50]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[51] for the site has also been consulted.

There are no specific objectives in relation to puffin within the SACO for the site, but for the wider assemblage, there are objectives to maintain its overall abundance above 163,819 individual breeding seabirds, and to maintain the diversity of species within the assemblage. It is noted that evidence from surveys or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities. The National Trust works with Natural England to produce The Farne Islands Management Plan which sets out steps to

50 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9006021&HasCA=1&NumMarineSeasonality=5&SiteNameDisplay=Farne%20Islands%20SPA#hlco

51 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9006021&SiteName=&SiteNameDisplay=Farne+Islands+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=5

reduce disturbance such as limiting visitor numbers, and a management plan is also in place to limit the effects of predation.

2.4.17 Northumberland Marine SPA

Qualifying features: Breeding Arctic tern *Sterna paradisaea*, common tern *Sterna hirundo*, guillemot *Uria aalge,* little tern *Sternula albifrons*, puffin *Fratercula arctica*, roseate tern *Sterna dougallii*, Sandwich tern *Thalasseus sandvicensis*, seabird assemblage

Northumberland Marine SPA is located on the Northumberland coast between Blyth and Berwick-Upon-Tweed. The coastal parts of the site consist of sandy bays separated by rocky headlands backed by dunes or soft and hard cliffs. The site was classified in 2017 and protect waters used by seabird and auk features of the Farne Islands SPA, Coquet Island SPA (see both above), Lindisfarne SPA and Northumbria Coast SPA used for foraging, bathing and preening, and covers some 88,498ha.

Table 2.19 Northumberland Marine SPA interests relevant to the review and their populations

Species	Population at time of designation	Most recent population counts
Puffin	108,484 individuals (2008-2013)[1]	145,046 individuals (2018-2019)[2]
Kittiwake (assemblage feature)	8,667 breeding adults (2010-2014)[1]	8,675 breeding adults (2015-2019)[2]

Source: [1]Northumberland Marine SPA citation, Seabirds that undertake maintenance and/or foraging behaviour within Northumberland Marine SPA include those that breed at existing SPAs in Northumberland. Specifically these are; Lindisfarne, Northumbria Coast, Farne Islands and Coquet Island SPAs. Accordingly the numbers listed in the table above are summed across the relevant site specific population estimates; [2]Seabird Monitoring Programme

Conservation objectives[52]:

Ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

In addition to the above high level conservation objectives, the supplementary advice on the conservation objectives[53] for the site has also been consulted.

[52] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020325&HasCA=1&NumMarineSeasonality=7&SiteNameDisplay=Northumberland%20Marine%20SPA#hlco

[53] supplementary advice on the conservation objectives

The SACO has an objective to maintain the population of puffins at a level above 108,484 individuals, and notes that there is evidence from surveys or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities. There are no specific objectives in relation to kittiwake within the SACO for the site, but for the wider assemblage, there are objectives to maintain its overall abundance above 214,669 individual breeding seabirds, and to maintain the diversity of species within the assemblage. It is noted that evidence from surveys or monitoring that shows the feature to be in a good condition and/or currently un-impacted by anthropogenic activities.

2.5 Project and SPA site combinations for further assessment

The screening outcome identified the potential for LSE in relation to the above sites for certain consents (Table 1.1). The justification for which sites are relevant to each consent and the approach to screening is contained in BEIS (2021) and is not repeated here. The following maps (Figure 2.3 to Figure 2.15) indicate the location of each relevant SPA in relation to those consents they are being assessed against.

Figure 2.3: Location of Gwynt y Môr offshore wind farm and relevant SPAs

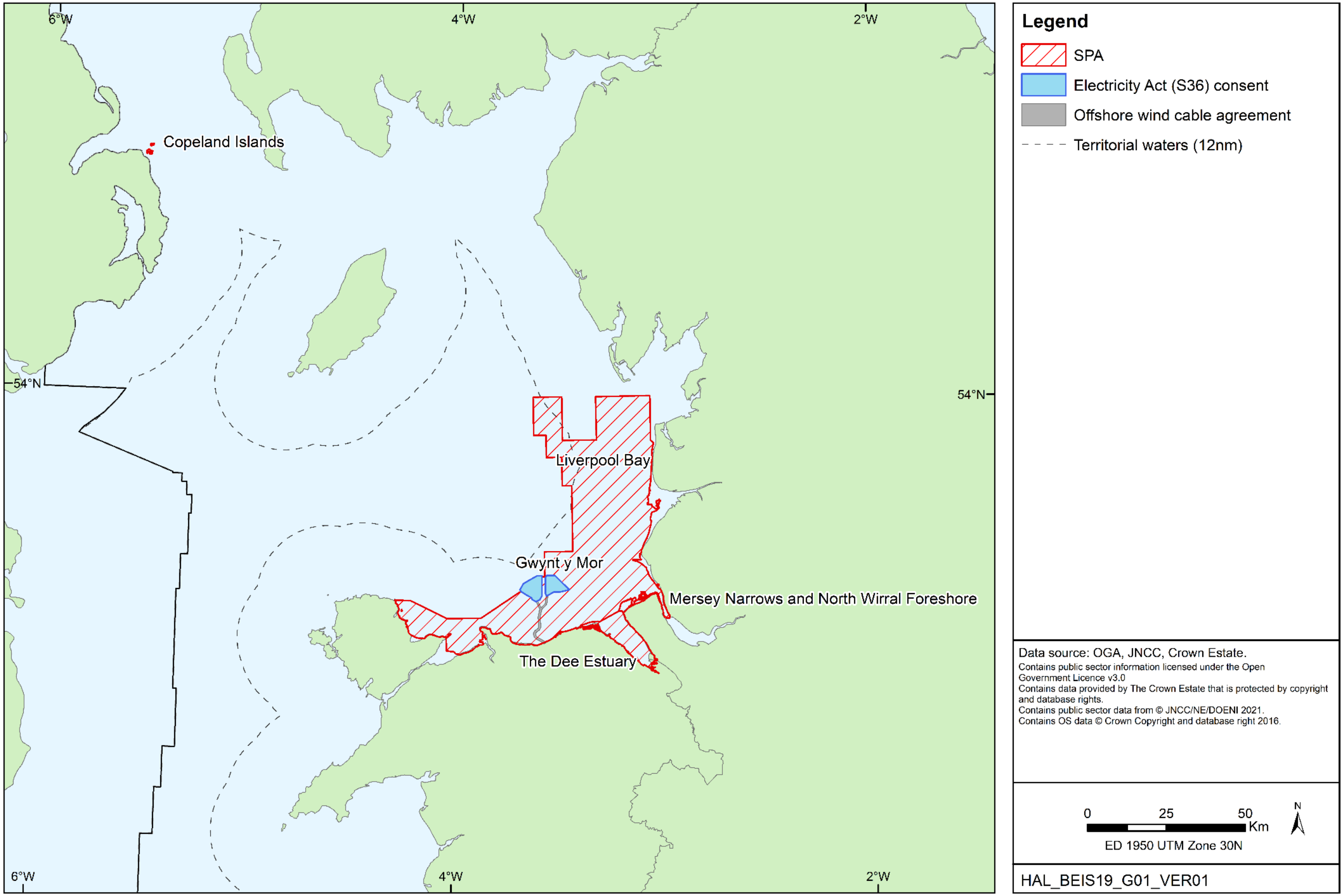


Figure 2.4: Location of Ormonde, West of Duddon Sands, Walney and relevant SPAs

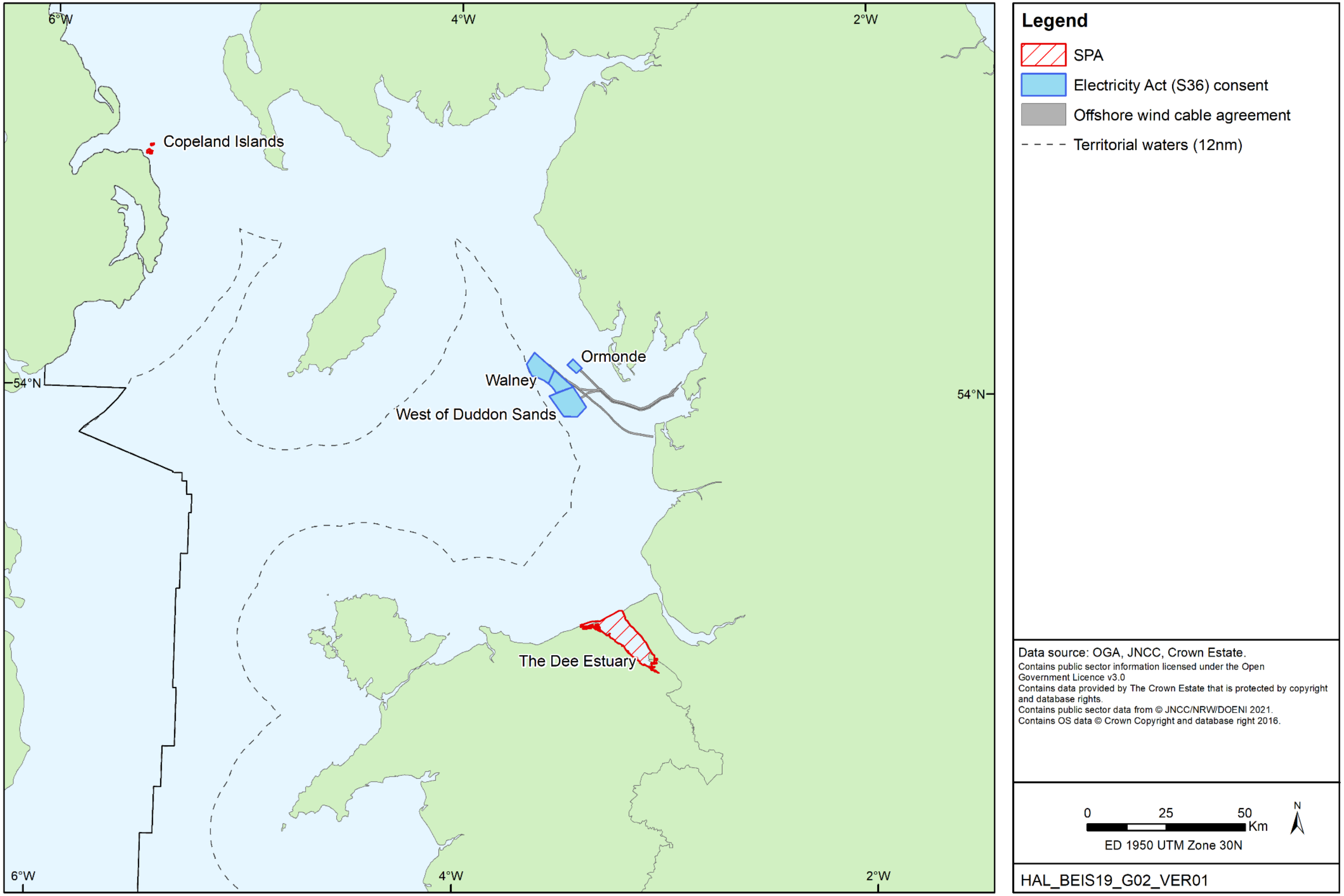


Figure 2.5: Location of Burbo Bank extension offshore wind farm and relevant SPAs

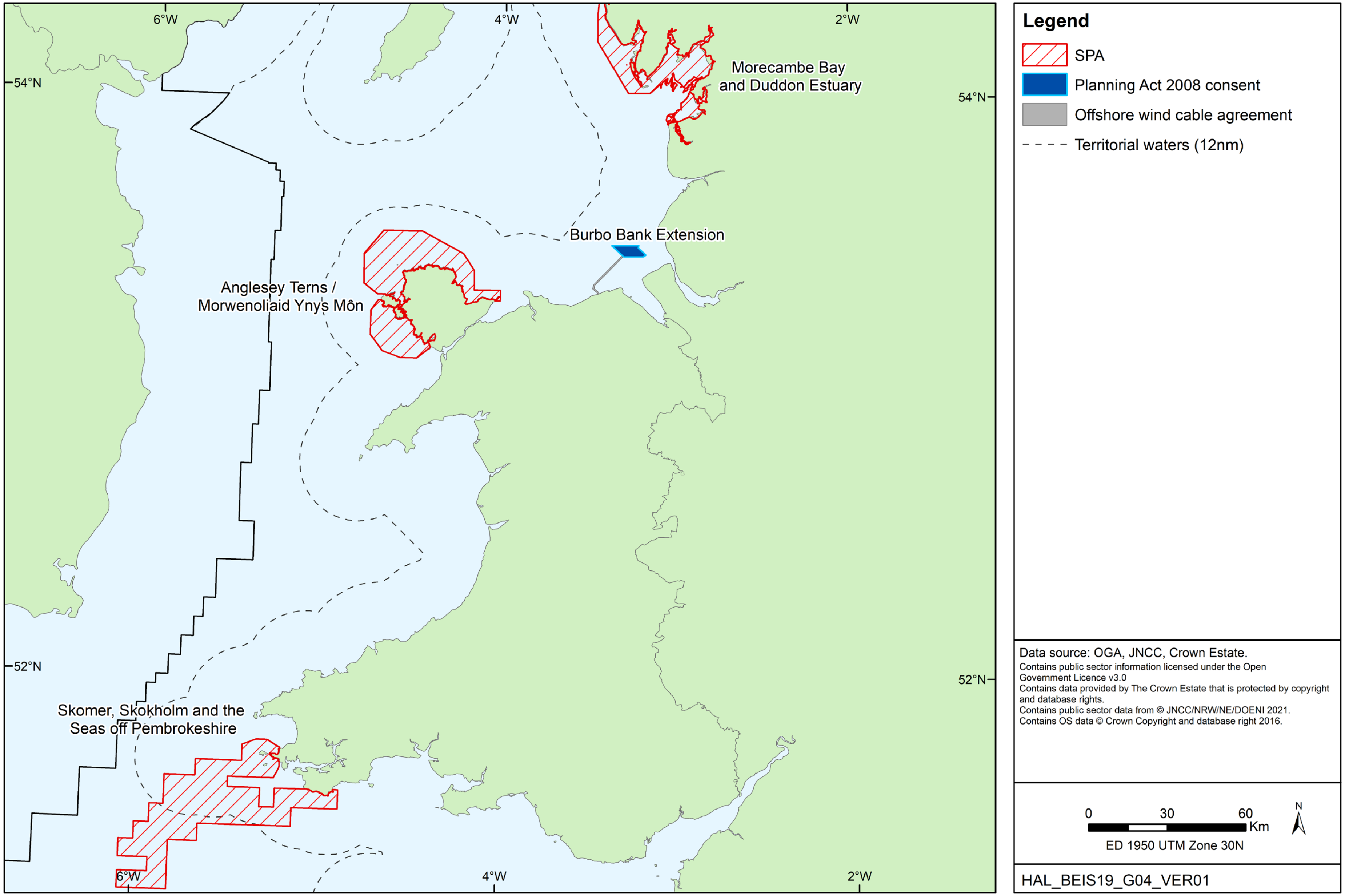


Figure 2.6: Location of Walney Extension offshore wind farm and relevant SPAs

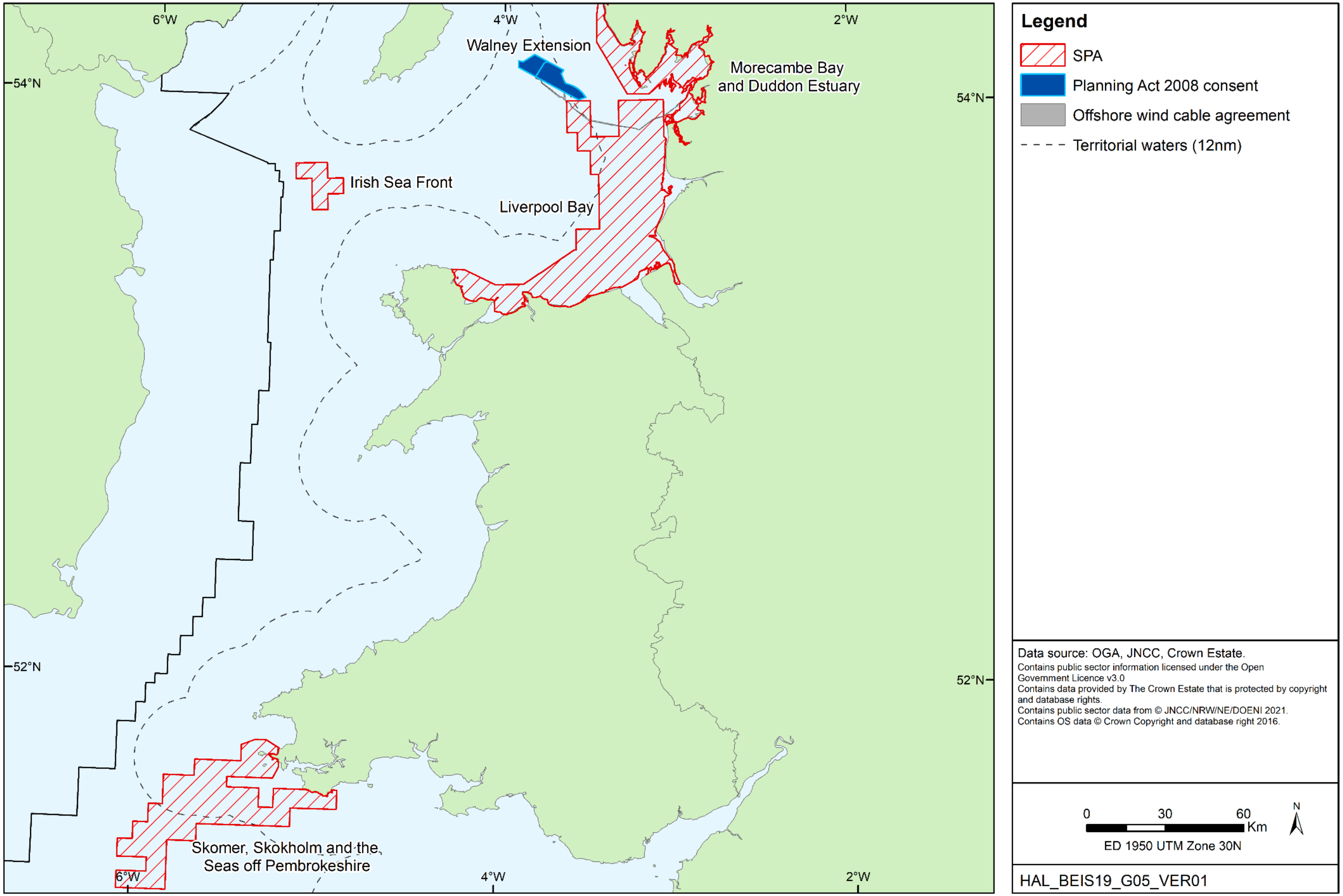


Figure 2.7: Location of Preesall Gas Storage and relevant SPAs

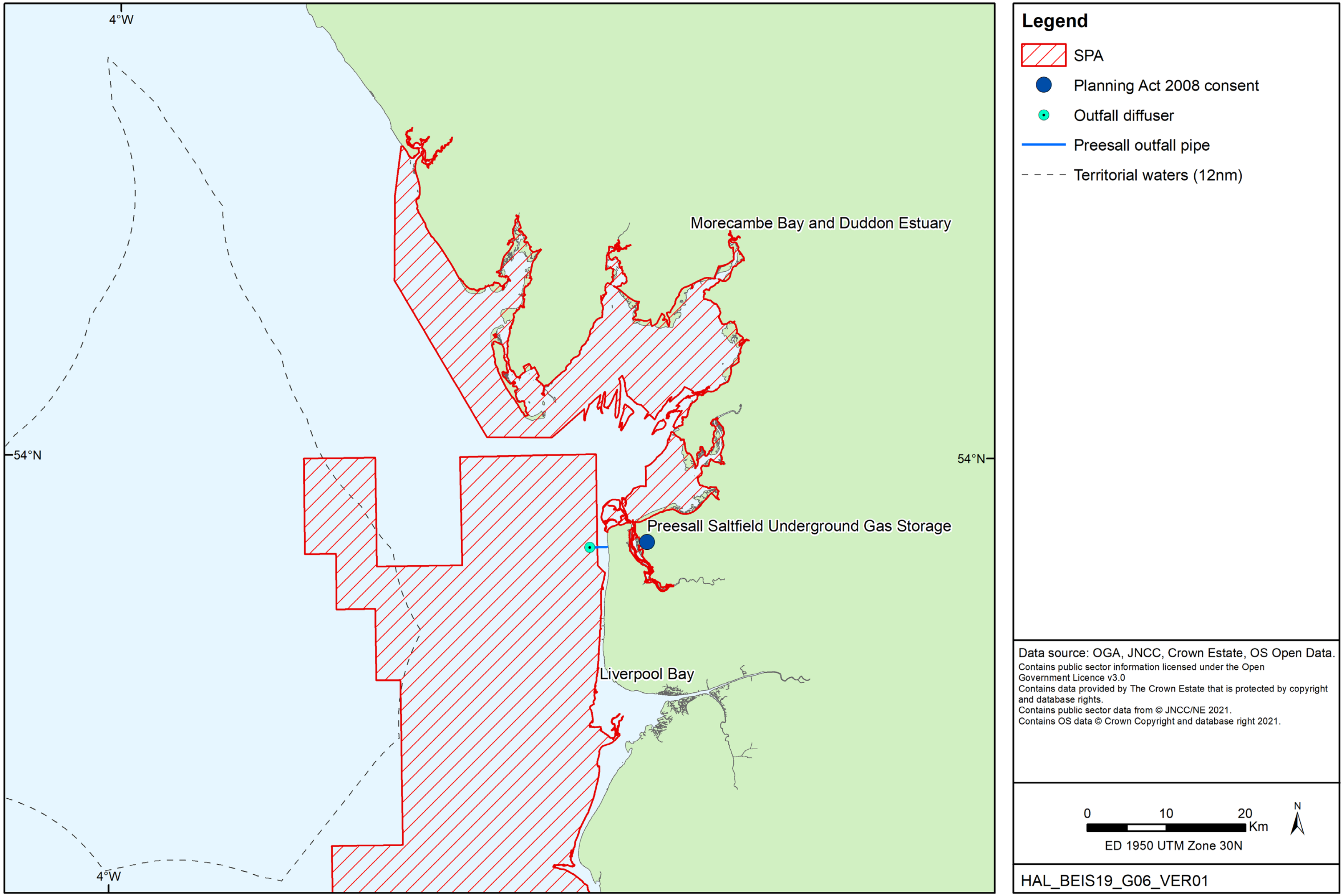


Figure 2.8: Location of Greater Gabbard and relevant SPAs

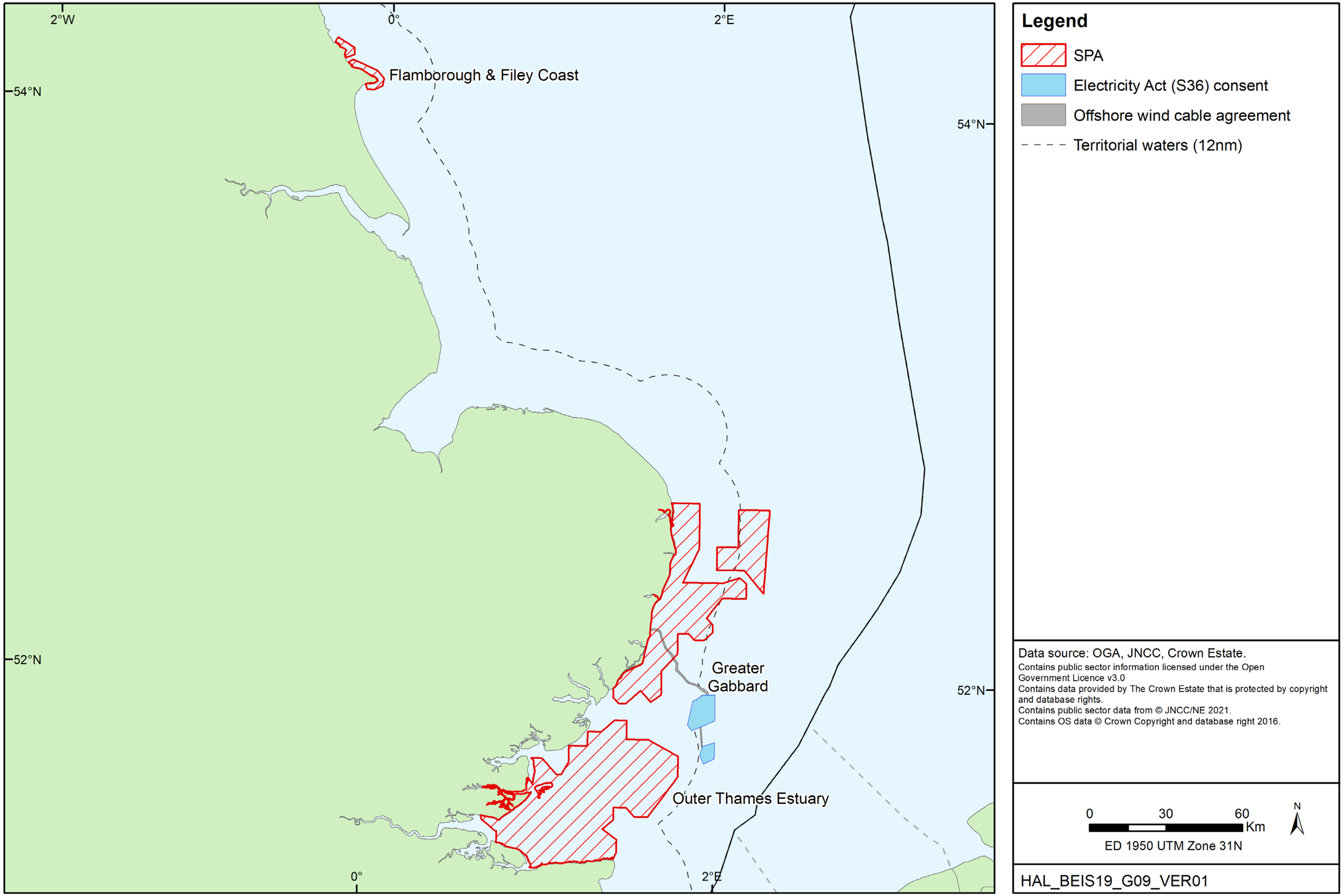


Figure 2.9: Location of Galloper and relevant SPAs

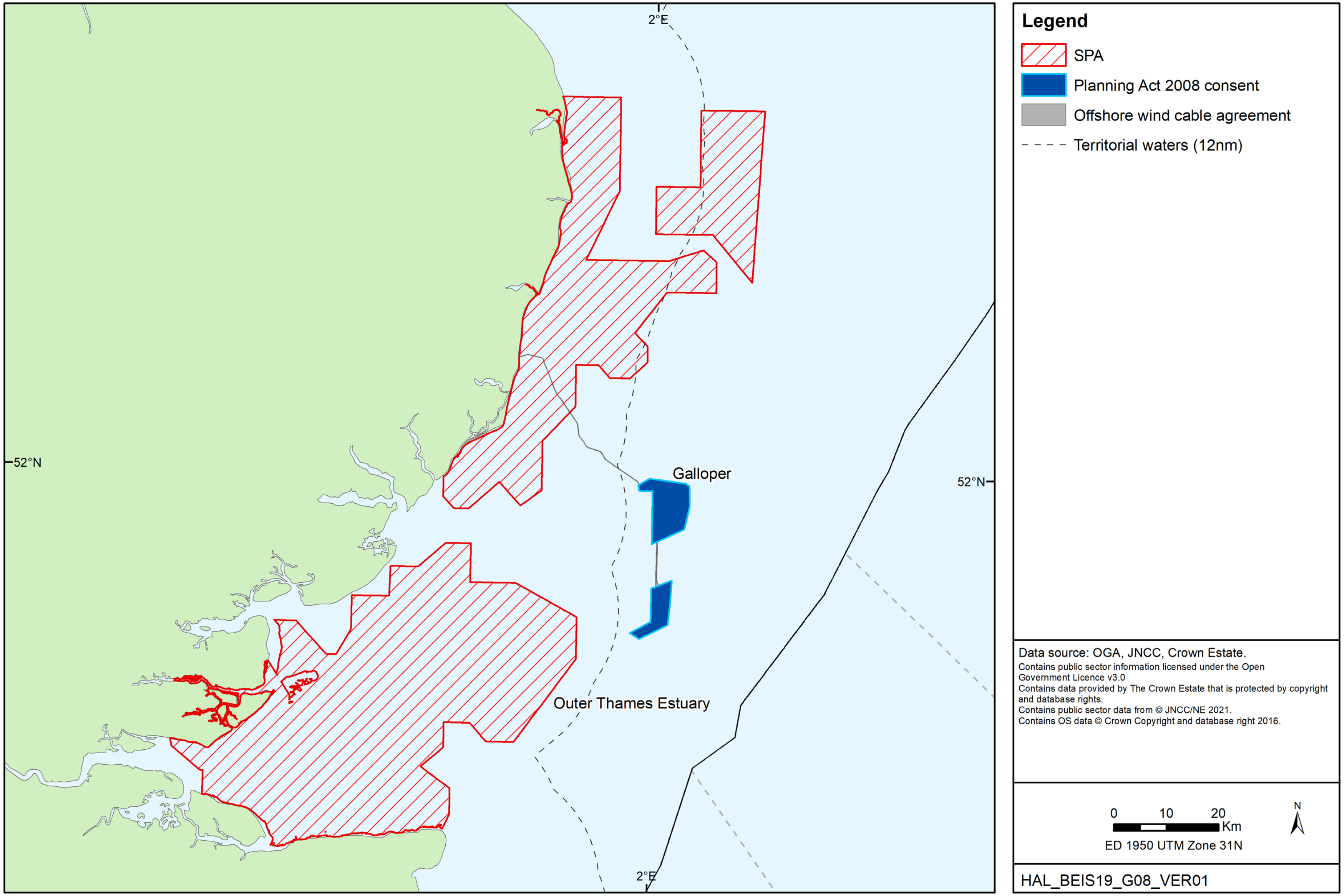


Figure 2.10: Location of Dudgeon and relevant SPAs

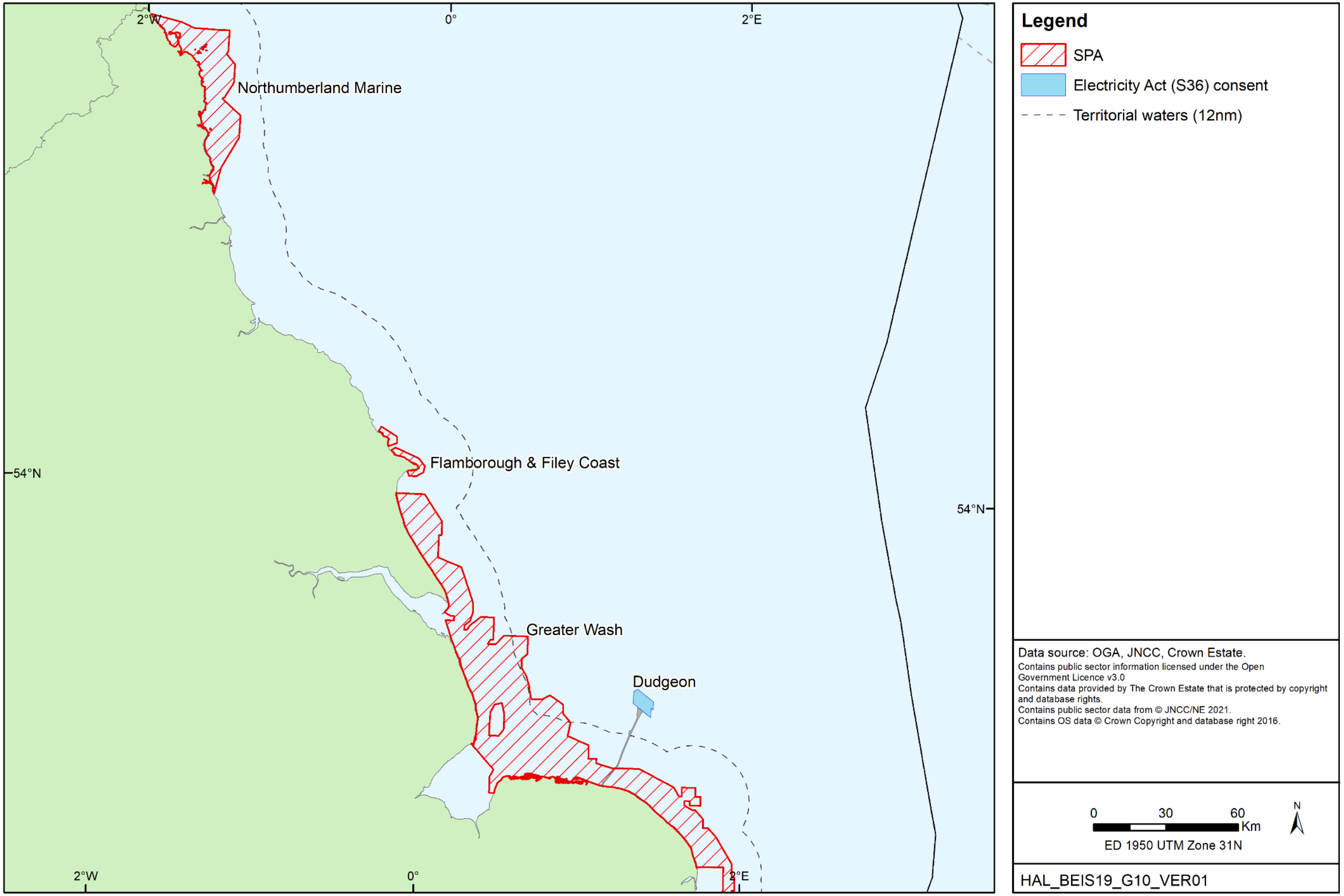


Figure 2.11: Location of Race Bank and relevant SPAs

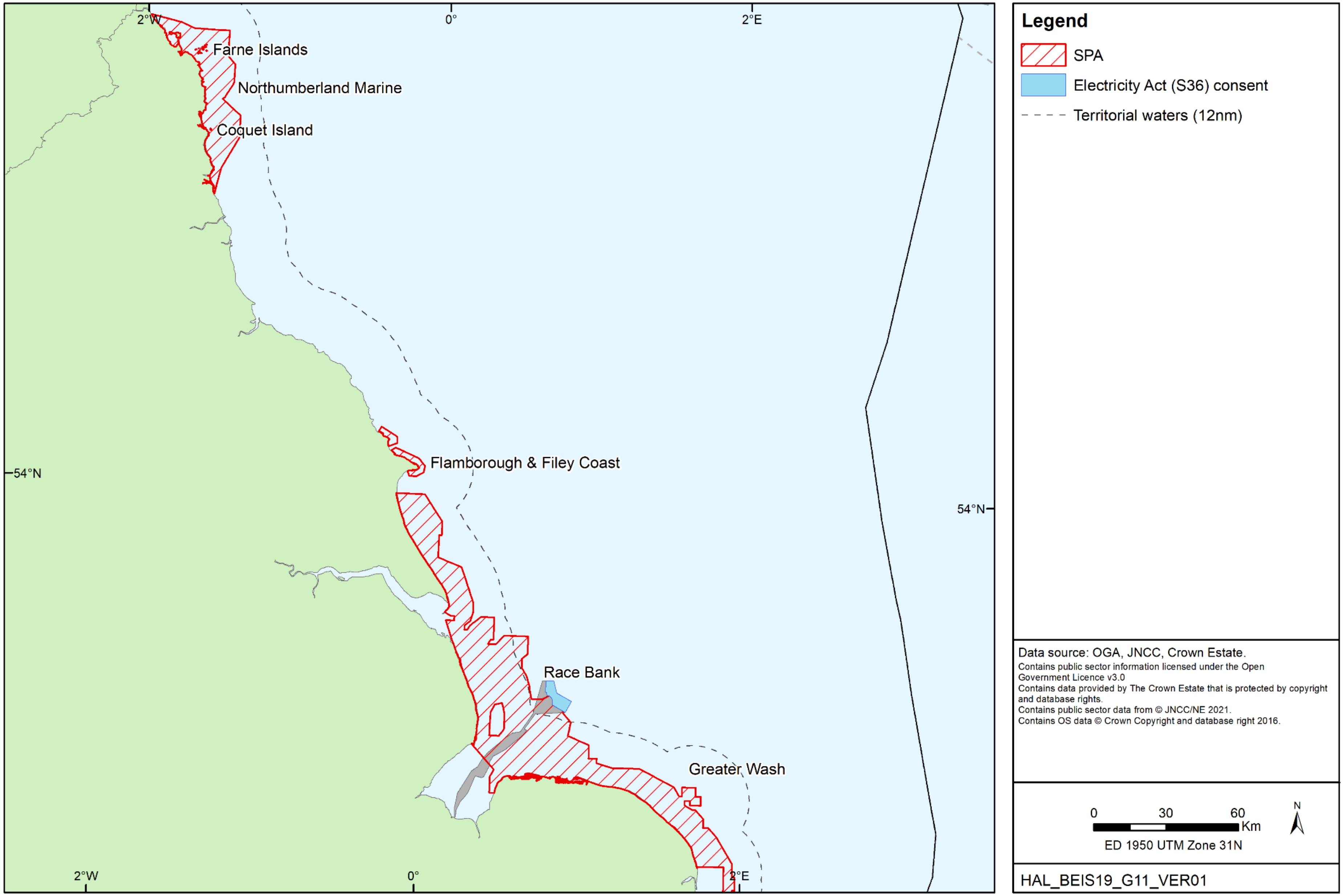


Figure 2.12: Location of Lynn, Inner Dowsing and relevant SPAs

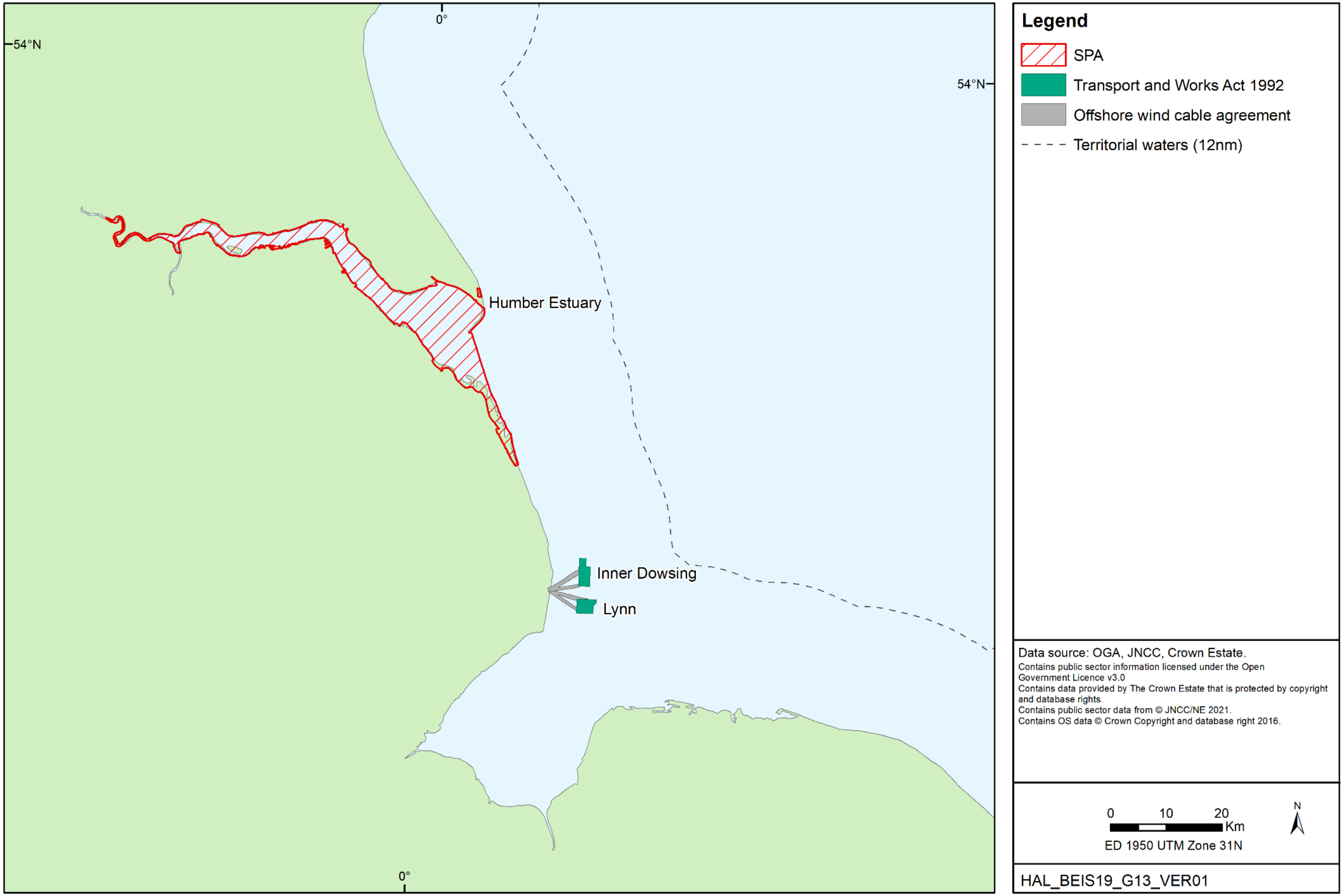


Figure 2.13: Location of Gunfleet Sands I and relevant SPAs

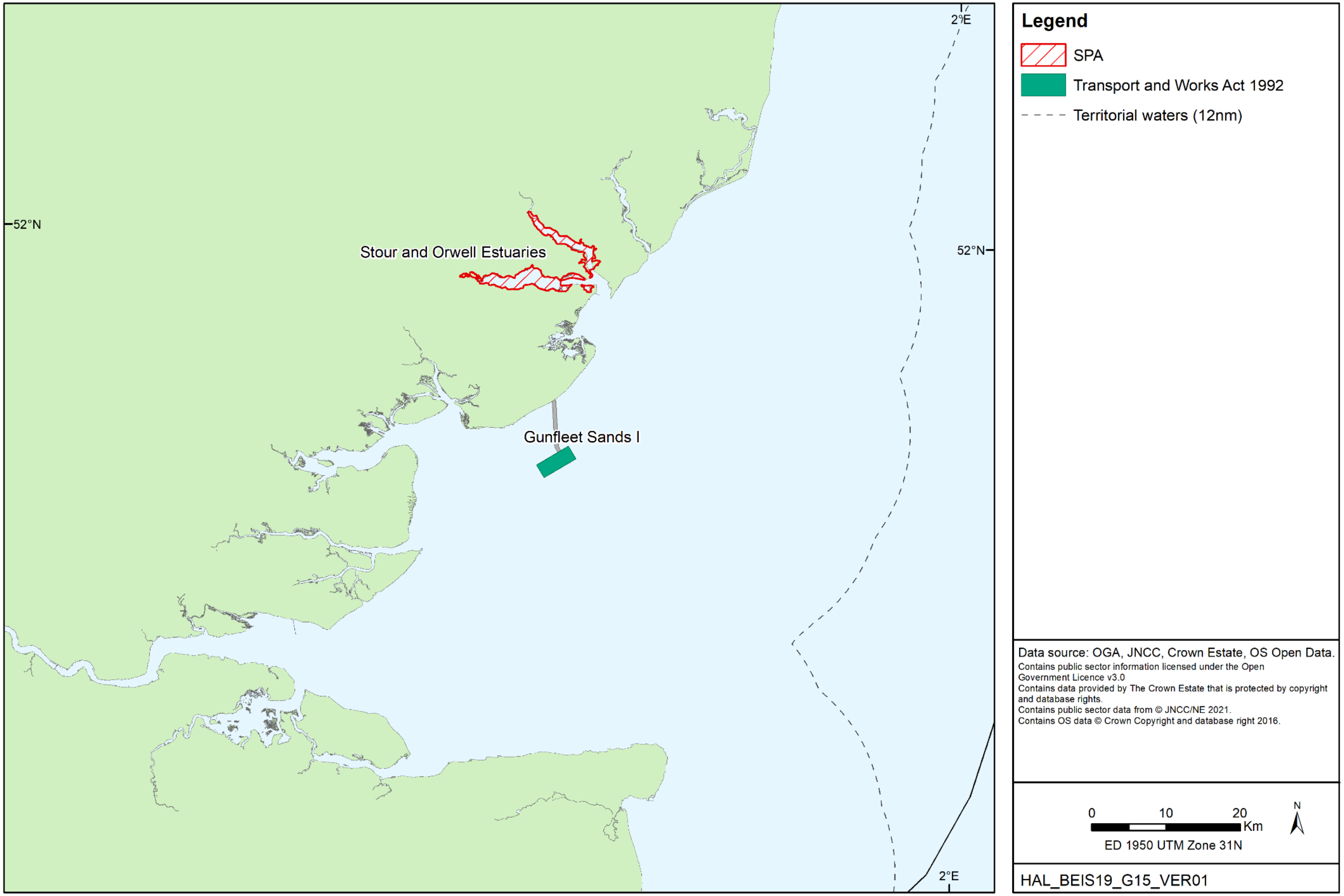


Figure 2.14: Location of Dogger Bank A & B and relevant SPAs

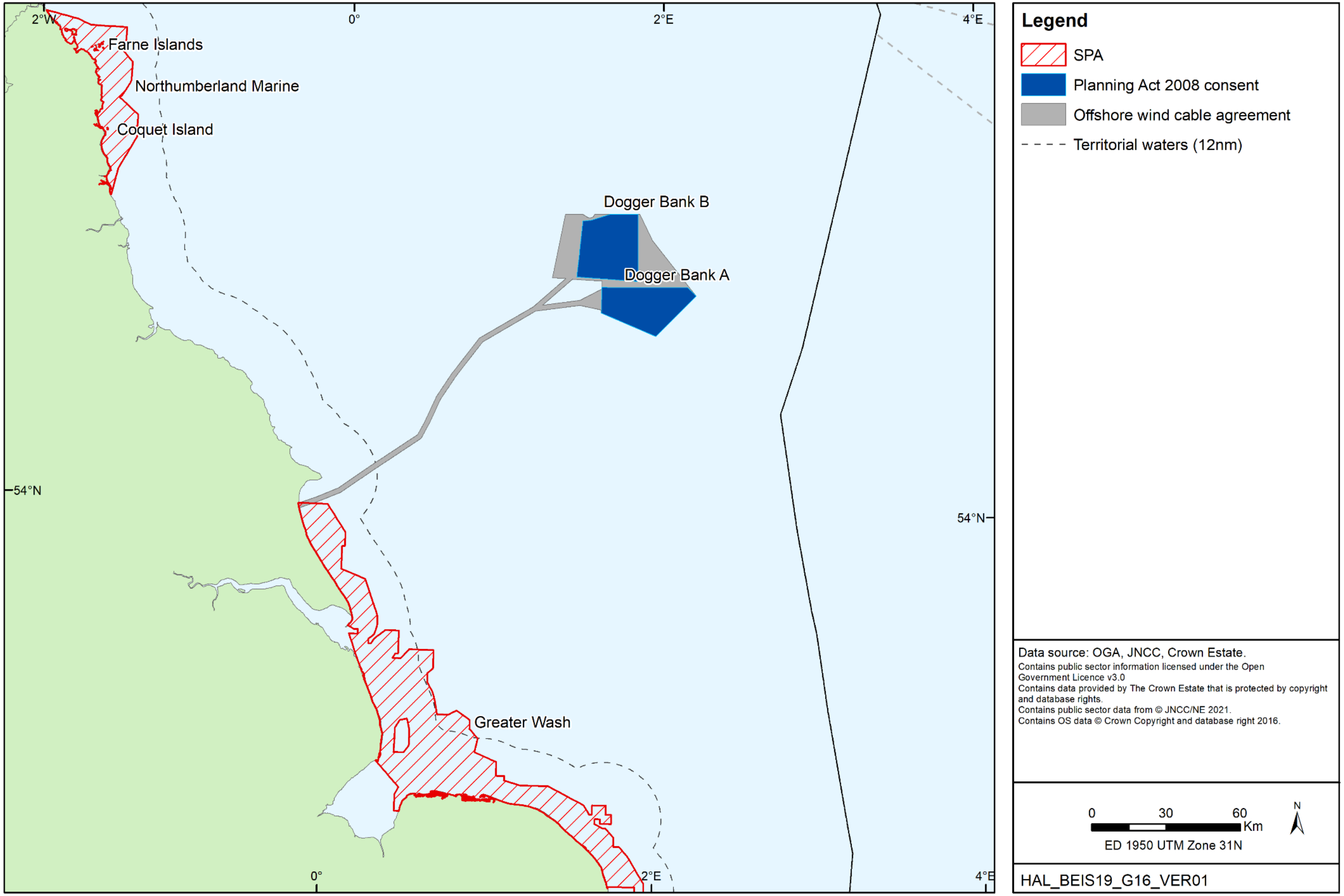


Figure 2.15: Location of Dogger Bank C, Sofia, Hornsea Project One, Hornsea Project Two, Triton Knoll and relevant SPAs

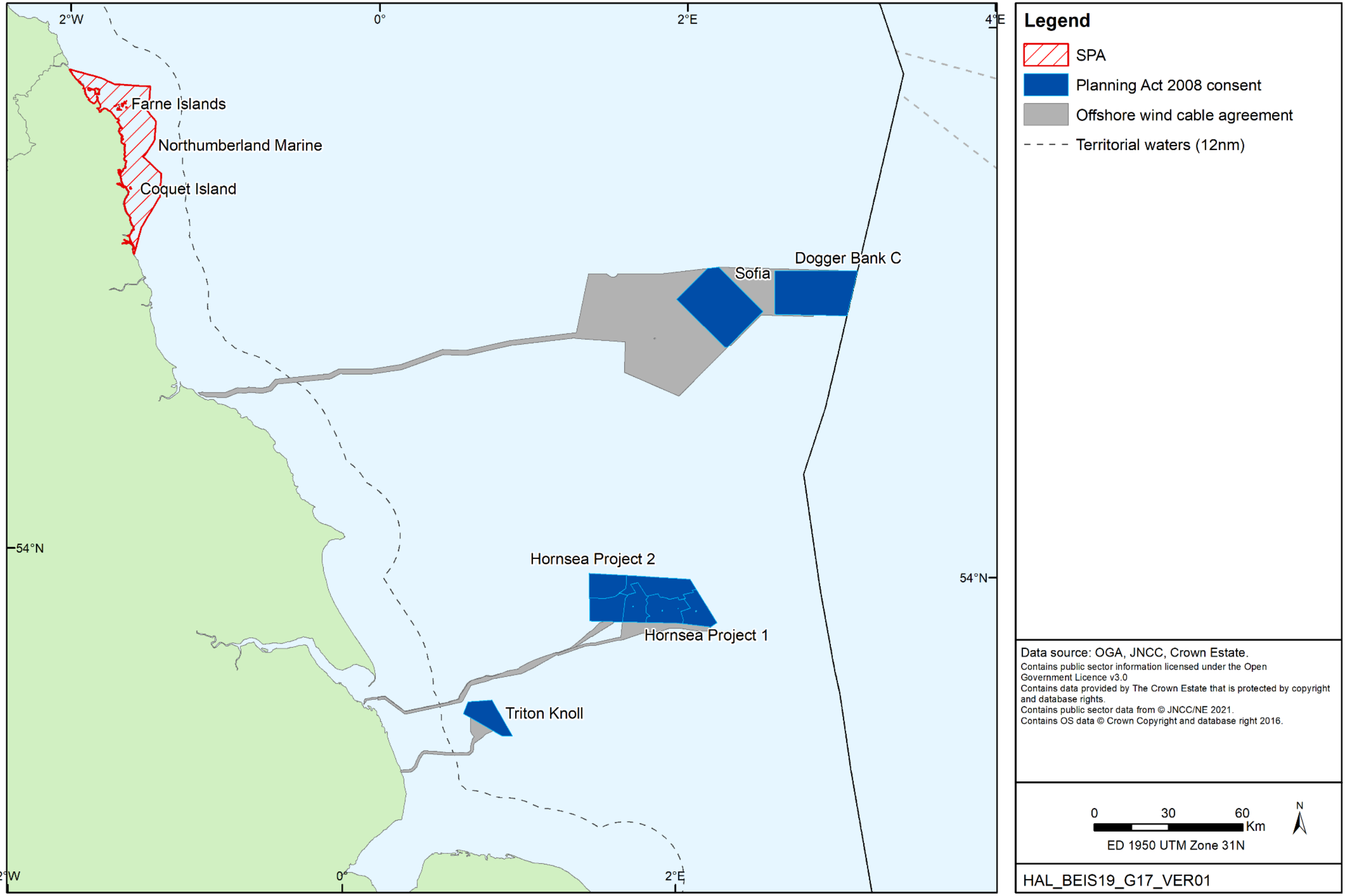


Figure 2.16: Location of East Anglia One, East Anglia Three and relevant SPAs

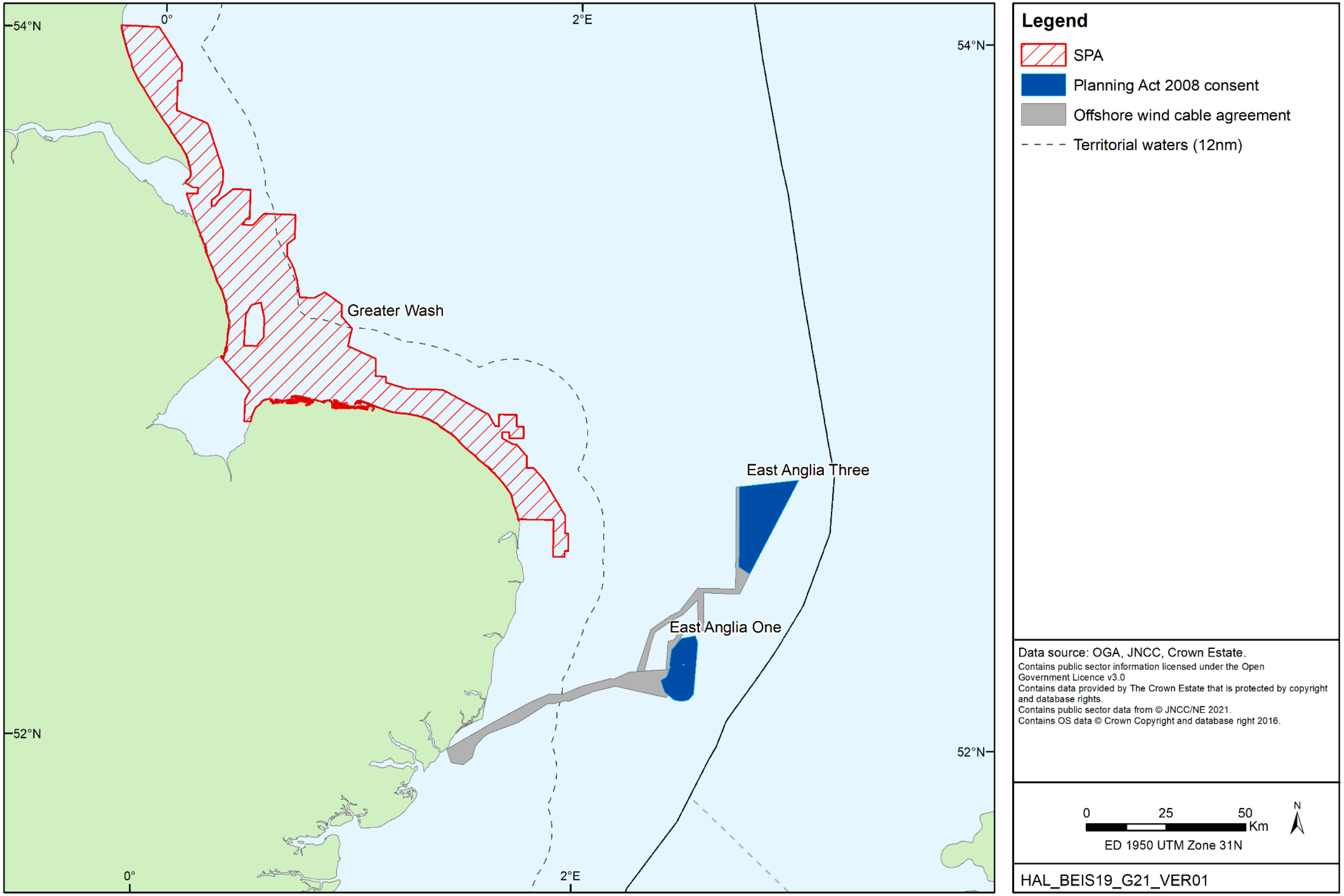
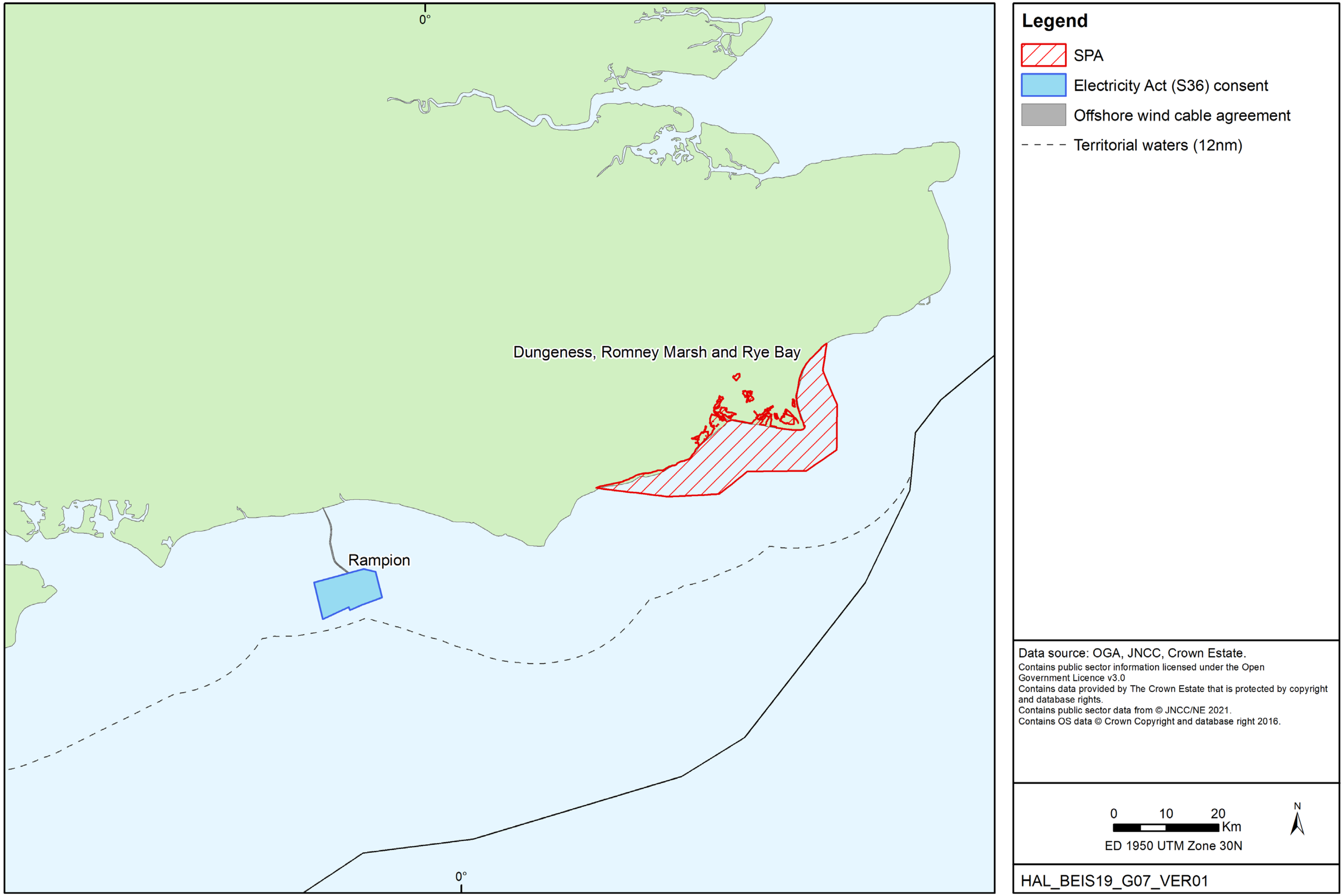


Figure 2.17: Location of Rampion and relevant SPAs



3 Approach to assessment

3.1 Overview of potential impacts and approaches to assessment

Of the 23 consented projects relevant to the RoC HRA, 22 are offshore wind farms; the only other type of project is the Preesall gas storage project, though the SPAs for which this project is being assessed against are largely marine in nature. Following on from those sources of effect that led to the identification of LSE for each of the projects, the impacts from the consented projects that are considered in the AA are:

- Disturbance and displacement,
- Barrier effects caused by the physical presence of a project (offshore wind turbines and ancillary structures),
- Mortality as a result of direct collision (with wind turbines),
- Indirect effects on prey or habitats (by alteration of water quality from discharges).

The evidence base for these sources of effect and the approaches to assessing them are expanded upon below. The parameters used in the assessment (e.g., avoidance rates, displacement and mortality rates), whether in new work completed as part of this assessment, or previous work used to inform this assessment, are provided in Section 4.

3.1.1 Disturbance and displacement

Background

Both disturbance/displacement and barrier effects are closely related to avoidance behaviour; the stronger the avoidance of the wind farms the larger the potential barrier and displacement effects of these wind farms. Most auks, terns, cormorant and shag show intermediate vulnerability to displacement/disturbance, with gulls, skuas, gannet and pelagic seabirds (i.e. petrels and shearwaters) considered among the least vulnerable (Garthe & Hüppop 2004, Furness *et al.* 2013; Bradbury *et al.* 2014, MMO 2018, Fliessbach *et al.* 2019).

Divers (red-throated, black-throated, great northern) are considered to be the most vulnerable to displacement/disturbance, closely followed by scoters and several other diving species (e.g. eider, goldeneye, certain grebes and black guillemot). The Joint SNCB interim displacement advice (JNCC 2017)[54] recommends a standard displacement buffer of 2km for most species with the exception of the species groups of divers and sea ducks. Divers and sea ducks have been assessed as being the most sensitive species groups to offshore development and associated boat and helicopter traffic. Therefore, for divers and sea ducks, a 4km displacement buffer is recommended. It should be noted that displacement effects for divers, and specifically red-throated divers, from wind farms have been detected at greater distances (e.g. 5-6km, Petersen *et al.* 2014; 5-7km, Webb 2016; 8km, HiDef 2017; 10-16.5km, Mendel *et*

[54] https://hub.jncc.gov.uk/assets/9aecb87c-80c5-4cfb-9102-39f0228dcc9a (accessed October 2021)

al. 2019, Heinänen *et al.* 2020, APEM 2021b), however, this is highly variable (see Table 3.1) and there are likely to be location-specific factors which do not necessarily make such effect distances universally applicable which may not be transferrable to other geographic areas (Vilela *et al.* 2020). Additionally, while significant displacement effects can be detected at some distance from the boundaries of wind farm arrays (Mendel *et al.* 2019, Heinänen *et al.* 2020), this does not result in complete displacement of the species from the array or its immediate vicinity (e.g. as noted in monitoring data for UK windfarms (e.g. Percival 2014, NIRAS 2016, HiDef 2017, APEM Ltd 2021b). Heinänen *et al.* (2020) also noted that displacement effects appeared greater at night, possibly in reaction to the navigation lighting of the turbines, though it is assumed that divers do not forage at night.

Table 3.1: Displacement distances and diver reduction within array areas (modified after Vattenfall 2019)

Windfarm	Distance from array over which diver density was significantly reduced (km)	Percentage reduction in diver density within array area	Reference
Thanet	0	82	Percival (2013)
Kentish Flats	1	-	Percival (2014)
Kentish Flats Extension	0.5	89	Percival & Ford (2018)
Gunfleet Sands	1	-	Barker (2011)
Greater Gabbard	<1	(75)[1]	Gill *et al.* (2018)
London Array	<1.5, 11[2]	<50, 55	APEM (2016), APEM (2021b)
Lincs	8	59	HiDef (2017)
North Hoyle	2.5	-	May (2008)
Alpha Ventus	1.5	90	Welcker & Nehls (2016)
Horns Rev 1	2	90	Petersen *et al.* (2006)
Horns Rev 2	5.5	50	Petersen *et al.* (2014)
Butendiek, Amrumbank, Nordsee Ost, Meerwind Süd/Ost, Dan Tysk	12	94	Mendel *et al.* (2019)
German Bight	10-15[3]	90[4]	Heinänen *et al.* (2020)
Burbo Bank Extension	4-18	-	HiDef Aerial Surveys Limited (2020)

Notes: [1]not statistically significant due to high variance in data, [2]the report notes that the greatest density of divers pre-construction occurred at the 9km distance from the wind farm. [3]authors noted the strongest effect at 5km, with significant effects detected at a distance band of 10-15km. [4]lower than a reference population >20km distant.

Despite some wind farms being present within UK SPAs for non-breeding red-throated diver for many years (e.g. London Array), there is no strong evidence of habitation of divers to their presence. Those studies indicated above provide consistent evidence for displacement of divers from offshore wind farms, but there is much less certainty over the level of effect displacement has on mortality (Dierschke *et al.* 2017), and there is an ongoing study (e.g. O'Brien *et al.* 2018, Duckworth *et al.* 2020) on red-throated diver energetics which may help to inform this. Dierschke *et al.* (2012, 2017) note that divers are unlikely to be in competition for resources during the non-breeding period, being present in low densities and with the ability to exploit a range of prey, and populations of non-breeding birds are therefore only likely to be affected by displacement if the available habitat is reduced extensively, bird density increases across such areas such that competition and prey depletion become a limiting factor, or where site fidelity is a limiting factor for some birds. Surveys of diver numbers tend to show relatively large inter-annual variation, and while displacement effects can still be demonstrated between survey years, the overall populations within an area, including an SPA, for any given year may be variable. While noting the potential differences that could be generated by variation in survey methods (e.g. see Goodship *et al.* 2015) visual aerial survey data was used to estimate a non-breeding population for the Outer Thames Estuary SPA of 6,466 individuals (O'Brien *et al.* 2008, as presently referred to in the SPA citation[55]), which contrasts with results from a digital still aerial survey for the winter of 2012/13 from which a peak estimate of 14,161 was made (Goodship *et al.* 2015), with a more recent digital video aerial survey in 2018 placing the population closer to 22,280 individuals (Irwin *et al.* 2019). While the purposes of these surveys has not been to monitor wind farm displacement effects, there does not appear to be a corresponding population response to the displacement of divers by windfarms for the Outer Thames Estuary SPA to date.

A range of other species are relevant to this AA, including cormorant, red-breasted merganser, bar-tailed godwit, black-tailed godwit, knot, whooper swan, little egret, teal, grey plover, golden plover, dunlin, avocet, redshank, ruff, pintail and curlew. Cormorant and red-breasted merganser are strongly and weakly attracted to offshore wind farms respectively (Dierschke *et al.* 2016). The former uses wind farm structures as outposts allowing foraging further offshore and both species may take advantage of enhanced foraging opportunity at these locations from higher fish abundance. Conversely, Garth & Hüppop (2004) identified cormorant as being moderately sensitive to offshore wind farms, scoring highly in relation to flight manoeuvrability, time spent flying, disturbance by shipping (also see Fliessbach *et al.* 2019) and population level, and are considered of moderate risk of displacement (Bradbury *et al.* 2014). Both cormorant and red-breasted merganser are judged to be at low risk of collision (Furness *et al.* 2013, Bradbury *et al.* 2013).

While seabird responses to approaching vessels are highly variable (e.g. Fliessbach *et al.* 2019), flushing disturbance would be expected to displace most diving seabirds from vessels associated with wind farm installation, particularly in or near SPAs established for shy species (e.g. common scoter, red-throated diver). Such disturbance can result in repeated disruption of bird feeding, loafing and roosting. For example, large flocks of common scoter were observed being put to flight at a distance of 2km from a 35m vessel, though smaller flocks were less sensitive and put to flight at a distance of 1km (Kaiser 2002, also see Schwemmer *et al*. 2011). Larger vessels would be expected to have an even greater disturbance distance (Kaiser *et al.* 2006), and Mendel *et al.* (2019) further note behavioural response in red-throated diver within 5km of ships.

Barrier effects of birds altering their migration flyways or local flight paths to avoid a wind farm are also a form of displacement (Drewitt & Langston 2006) and this effect is related to the possibility of increased energy expenditure when birds must fly further. In a review, Furness *et al.* (2013) defined displacement as a reduced number of birds occurring within or immediately adjacent to offshore wind farms and disturbance as birds spending extra time and/or energy to avoid structures or human activity associated with the wind farms. Using a sensitivity index incorporating disturbance, habitat specialisation and conservation importance elements,

[55] http://publications.naturalengland.org.uk/file/5459831745413120 (accessed October 2021)

Furness *et al.* (2013) identified populations of divers and common scoter as most vulnerable to population level impacts of displacement (see above). In terms of energy expenditure, the potential energetic costs to seabirds (migrants and residents) of commuting around offshore wind farms (barrier effects), were found to be trivial (e.g., depletion of <2% of available fat reserves even if birds had to travel an extra 30km), with greater potential costs to birds having to make regular deviations around a facility located between nesting/roosting sites and feeding areas (e.g., Speakman *et al.* 2009, Masden *et al.* 2010).

Approach to assessment

Current SNCB guidance (JNCC 2017) for red-throated diver indicates that a displacement rate of 100% of all birds within 4km of a wind farm should be used, and that mortality rates be presented at 10% increments other than between 0% and 5%, which should have a 1% increment. It is expected that this guidance will be updated to take account of more recent findings of greater displacement by offshore wind farms noted above, however, an equivalent 100% displacement rate at greater distance is unrealistic and is not consistent with wind farm monitoring within other areas used by red-throated divers (e.g., London Array), where complete displacement does not occur even within the array area. The approach taken by the Applicant in the assessments for East Anglia One North and East Anglia Two wind farms[56] assumed a level of displacement out to 12km, with 100% of birds being displaced within the array and out to 1km, with a linear decline in displacement to 0% at 12km. Comparisons of this approach and that of JNCC (2017) were made in drafting this AA report, and even with a declining rate of displacement at distance, a larger combined level of displacement for each project was estimated by using the proposed approach. For scoter and other relevant species, the standard 100% displacement within 2km of wind farm array areas has been assumed. In relation to cable installation activities, recent advice from Natural England has included a worst-case scenario of up to 100% displacement within 2km of works[57], though unlike the presence of wind turbines, works are transient. This has been adopted for all relevant species and for pipeline installation works. Mortality rates are presented from 1% to 100% and are discussed against qualifying interests of each relevant site in Section 4.

As noted in BEIS (2021), results and data from existing assessments have been used in preparing this HRA. Displacement matrices are, however, not available for the relevant consents for sites and features, including those for red-throated diver and common scoter. The density surfaces of Lawson *et al.* (2016a, b) have been used to inform the displacement of red-throated diver and scoter, augmented with site-specific survey data where available. GIS outputs have been combined with the above matrix approach to provide estimates of displacement.

For other species including gannet, kittiwake, guillemot, razorbill and puffin, the estimated number of birds present at each of the wind farms have been obtained from East Anglia One North/East Anglia Two and Norfolk Vanguard consenting applications[58] [59] [60], as these reflect

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[56] SPR (2022). East Anglia ONE North and East Anglia TWO Offshore Windfarms Applicants' Responses to the Secretary of State's Questions of 20th December 2021 (Item 5), 35pp + appendices.
[57] See Paragraph 6.7.110 of the Examining Authority's Report for Norfolk Vanguard
[58] Vattenfall (2019). Norfolk Vanguard Offshore Wind Farm Chapter 13 Offshore Ornithology Environmental Statement Volume 1 Norfolk Vanguard Limited Document Reference: 6.1.13.
[59] Vattenfall (2021). Norfolk Boreas Offshore Wind Farm Updated Population Viability Analysis: Flamborough and Filey Coast SPA. Norfolk Boreas Limited Document Reference: ExA.AS-2.D21.V1. 20 August 2021
[60] SPR (2021). East Anglia TWO and East Anglia ONE North Offshore Windfarms Deadline 13 Offshore Ornithology Cumulative and In-Combination Collision Risk and Displacement Update. EA1N_EA2-DWF-ENV-REP-IBR-001138. July 2021, 31pp

the most recently accepted figures that can be used to assess displacement covering all wind farms of relevance to this HRA, which also reflects the potential for in-combination effects. Where required, the SNH (2018) apportioning tool has been used so that the displacement and associated mortality of each species can be attributed to the sites being assessed[61].

3.1.2 Collision risk

Birds flying through wind turbine arrays have the potential to collide with turbine blades resulting in injury and possibly mortality. Collision risk has received considerable attention in relation to offshore wind farm development, with substantial effort expended both in empirical studies (e.g., Skov *et al.* 2018) and predictive modelling (e.g., Band 2000, 2012, McGregor *et al.* 2018). Direct mortality and lethal injury of birds as a result of collision with wind turbines (and associated infrastructure) is widely acknowledged but the empirical evidence base for quantifying the numbers of birds likely to collide with offshore turbines is limited. Therefore, accurately estimating collision risk is still problematic, as is determining the impact that the loss of individual birds has at a species population level.

Collision risk depends on a range of factors related to bird species, numbers, behaviours (including avoidance, flight height and speed, e.g., Johnston *et al.* 2014, Masden *et al.* 2021), weather conditions, topography and the nature of the offshore structure itself, including the use of lighting (Drewitt & Langston 2006). Cook *et al.* (2018) provides a summary of evidence on avoidance by seabirds, focusing on five species considered to be at most risk of collisions (northern gannet, herring gull, lesser and greater black-backed gull and black-legged kittiwake). This review points to evidence of consistent macro avoidance of offshore wind farms by northern gannet (i.e., not entering the OWF footprint), and variable levels of within-wind farm avoidance among gull species (see Cook *et al.* 2014 for a summary of avoidance rates for a broader range of species which are presently accepted and applied in wind farm consenting). Furthermore, results of the ORJIP project at Thanet offshore wind farm (Skov *et al.* 2018) and ornithological work at Aberdeen Offshore Wind Farm (Tjørnløv *et al.* 2021) have provided empirical data on macro, meso and micro avoidance behaviour on several seabird species, along with data on bird flight heights.

The impact of collision may have a disproportionate effect on some species; even low mortality rates on long-lived species with slow maturation rates and low productivity could have a significant impact at the population level (e.g. Drewitt & Langston 2006).

Several studies have sought to examine the relative risk and identify priority species through consideration of reported collisions at existing wind farms, migratory flyways, flight heights and conservation importance (e.g., Langston 2010, Wright *et al.* 2012, WWT Consulting & MacArthur Green Ltd 2014, Cook *et al.* 2014), all of which are key components of understanding the relative risk of interaction.

Approach to assessment

As noted in BEIS (2021), it was not proposed to undertake new collision risk modelling for each of the relevant projects either alone or in-combination, the aim being to use existing published data from recent consenting processes that reflect the latest approaches to collision risk modelling. Sources of information used to underpin the collision risk assessment in Sections 4 and 5 are noted throughout, however, following a review of available collision risk modelling

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[61] SNH (2018). Interim Guidance on Apportioning Impacts from Marine Renewable Developments to Breeding Seabird Populations in Special Protection Areas

outputs for the species and sites relevant to this HRA, it was concluded that data presented in applications for East Anglia One North and East Anglia Two (SPR 2021) were appropriate for those North Sea projects subject to this assessment. For wind farms located in the Irish Sea there are fewer recent wind farm applications containing comprehensive collision risk or displacement modelling. Consequently, the data has been obtained from a number of different assessments including those for Burbo Bank Extension (Dong 2013c) and Walney Extension (Dong 2013d).

Where data are not available for non-breeding features, the SOSSMAT tool (Wright *et al.* 2012, Wright & Austin 2012) has been used with the latest UK population figures for relevant species as provided in Woodward *et al.* (2020) to estimate the potential interaction of birds from the SPA populations relevant to the assessment. Where available, existing assessments have been used to inform the assessment, and additional collision risk assessment has not been undertaken for these species, however, the number of birds potentially interacting with turbines based on a 98% avoidance rate is provided in the context of other parameters such as available flight height information. The consideration of these features and the risk posed by the projects is, therefore, qualitative in nature.

3.1.3 Indirect effects on prey or habitat

Of the projects identified at the screening stage as requiring AA, only Preesall Gas Storage was not an offshore wind farm, and with sources of effect that differ to those outlined above. The discharge of saline water from the outfall will likely result in the mortality of plankton, fish and benthic fauna which come into contact with the brine plume, with mortality predicted where salinity is above 40psu (Halite Energy 2011). No direct effects on bird species are discussed in the applicant's ES, and indirect effects on species which prey on plankton and fish is also not considered in detail. As prey species of birds, the nature and scale of the impact of plankton and fish is an important consideration, the scale of which has been subject to assessment in this HRA.

3.1.4 Approach to assessment

The approach taken to the displacement of birds from the outfall construction activities will follow that outlined above (Section 3.1.1) for relevant groups of species, e.g. divers. The projected scale of indirect effect from the brine discharge will be considered in relation to the information provided by the applicant in their original application, acknowledging that while the whole Preesall gas storage project falls under the Planning Act 2008, the discharge was consented by the Environment Agency under the Water Resources Act 1991. Details of relevance to both sets of consents is considered in the assessment for this project.

3.1.5 Population Viability Analysis

Population Viability Analysis (PVA) has been undertaken for certain qualifying interests following Searle *et al.* (2019), using the Shiny App [62]. The model considered the population size for relevant seabird colonies after 30 years, with inputs for impacts on adult survival based on mortalities associated with collision risk and displacement; these input parameters are noted in each relevant section before presenting the results of the PVA and estimated impacts on population growth rates and counterfactual population sizes are presented. A summary of the data used to input into each of the PVA undertaken to support the Review of Consents HRA is provided in Appendix 2.

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[62] http://ec2-54-229-75-12.eu-west-1.compute.amazonaws.com/shiny/seabirds/PVATool/R/

3.2 Potential impacts in-combination with other plans and projects

Under the Habitats Regulations, and Offshore Habitats Regulations, it is necessary to consider significant effects which are likely to arise in-combination with other plans and projects. Due to the nature of this assessment (i.e. the similar sources of potential effect, range of sites and site features subject to assessment across multiple consents), a number of projects relevant to the in-combination assessment are subject to this HRA. A number of other plans and projects of relevance will themselves not be subject to this AA but are relevant to the in-combination assessment (i.e. they will provide context but cannot be affected by the outcome of this assessment). The sources of effects from these other projects may or may not interact with each other, but the test of relevance is whether they could affect the same receptor or interest feature (i.e. a supporting habitat or species for which a site has been designated).

A range of project types will be considered in the in-combination assessment which include:

- the projects subject to this AA (see Table 1.1); a range of completed and consented projects
- other completed projects (taken here to be fully built out and operational); normally forming part of the baseline conditions
- plans and projects which have approval/consent but have not yet been implemented
- plans and projects which have formally applied for relevant approvals/consents, but which have not yet gained approval

The level of detail available to undertake in-combination assessment decreases from those other projects which are established and operating, to those which are only proposed, and that will affect how robust an assessment can be undertaken, and this is reflected in the tiered approach to assessment that has been adopted (see below).

For certain established and ongoing activities, e.g. fishing, shipping and in some areas, oil and gas related activity, it is not possible to determine what the baseline conditions would be without the impacts of these activities. In most cases this activity is considered as part of the baseline unless specific activities in these sectors are noted as having the potential to contribute to in-combination effects, for example, new oil and gas projects.

3.2.1 Tiered approach to in-combination assessment

For the purposes of this HRA a tiered approach has been adopted that categorises developments based on the level of confidence there is in the project or plan being taken forward and the level of information available to support the HRA at the time of the assessment which was March 2022 (Table 3.2).

- Tier 1 developments are projects that have completed construction and are operational.
- Tier 2 developments are projects that are under construction, consequently, there is a relatively high level of confidence in the final design envelope and the construction schedule.

- Tier 3 developments are projects with consents. There is a high expectation that these projects will be constructed but a relatively low level of confidence in final design envelope and the construction schedule.
- Tier 4 developments are projects for which an application has been made and, under the Planning Act 2008, the examining authority has submitted its recommendation report to the Secretary of State. While there is a low level of confidence in the final design envelope and construction schedule, the project is at an advanced stage of consenting, and the scale of potential effects are relatively well understood.
- Tier 5 developments are projects at an early stage of consenting (e.g., an application may have been accepted for consideration, a scoping opinion has been sought or preliminary environmental information (PEI) has been published[63]). Tier 5 also includes projects which are planned but for which no information on proposed construction methods are available (e.g. there may be an agreement for lease, or the Inspectorate has been notified of an intention to submit a DCO application but no timetable has been set). For these latter proposals, there is not enough information available to consider impacts other than using generic information.

Table 3.2: Tiered plans and projects for the in-combination assessment (as of March 2022)

Tier	Other relevant plans/projects
1	Westermost Rough, Humber Gateway, Race Bank¹, Lynn¹, Inner Dowsing¹, Sheringham Shoal, Dudgeon¹, Hornsea Project One, East Anglia One, Galloper, Greater Gabbard, London Array, Kentish Flats, Kentish Flats Extension, Scroby Sands, Lincs, Thanet, Gunfleet Sands I¹, Gunfleet Sands II, Gunfleet Sands Demo, Rampion¹, Rhyl Flats, North Hoyle, Burbo Bank, Burbo Bank Extension, Ormonde, Barrow, Walney¹, Walney Extension¹, Gwynt y Môr¹, West of Duddon Sands¹, Rhyl Flats, Blyth demonstration sites, Teesside, Methil demonstrator, Kincardine offshore wind farm, Aberdeen Offshore wind farm, Hywind Scotland, Moray East, Beatrice offshore wind farm, relevant aggregate extraction production areas.
2	Triton Knoll¹, Hornsea Project Two¹, Neart Na Gaoithe, SeaGreen, Viking Link.
3	Hornsea Project Three¹, Dogger Bank A&B¹, Dogger Bank C¹, Sofia¹, East Anglia Three¹, Moray West, relevant aggregate extraction exploration and option areas, South Morecambe DP3/DP4 decommissioning plan, Norfolk Boreas, Norfolk Vanguard.
4	East Anglia One North, East Anglia Two.
5	Hornsea Project Four, Rampion 2, Awel y Môr, Sheringham and Dudgeon Extension Projects, Berwick Bank, Five Estuaries Offshore Wind Farm, North Falls Offshore Wind Farm, Marr Bank, Erebus floating wind demonstrator, Eastern HVDC Link, offshore surveys associated with non-exclusive exploration licences[64], CS004 carbon storage appraisal licence.

Notes: ¹projects directly subject assessment in this AA. These would not ordinarily be defined as “other” projects, however, the RoC is considering multiple projects falling within the definition of Tiers 1-3 rather than any project proposals, and constraints on the RoC process as to which consent/SPA combinations may be considered for assessment is such that some projects directly assessed here may also need to be considered in-combination for certain other SPAs they are not being assessed against, but only on an in-combination basis.

[63] e.g. see https://infrastructure.planninginspectorate.gov.uk, https://dns.planninginspectorate.gov.uk/, https://marine.gov.scot/marine-licence-applications

[64] Activities associated with non-exclusive exploration licences issued under the Petroleum Act regime require consenting prior to being undertaken. They are generally consented and conducted over relatively short timeframes, and in view of the high degree of uncertainty associated with these consents, it is proposed a generic consideration of these is made.

Established and ongoing activities, e.g. fishing, shipping and in some areas, oil and gas related activity, were operating before the SPAs were designated. These activities are not specifically listed in Table 3.2 but they are considered within the AA as part of the baseline.

This HRA only makes conclusions with reference to those consents which are within its scope (Section 2.3), and the conclusions of this report should not be taken to prejudge those assessments which are yet to take place or which are underway (e.g. for all Tier 4 and 5 projects). Certain consents subject to this HRA have been operational for some time, including for a significant period following classification of the relevant sites they are being assessed against, and their inclusion in this HRA reflects a historical SPA review requirement.

Projects in Tiers 1-3 have been considered in the in-combination assessment, and the latest available data, for example on collision risk, has been used. The assessment also recognises the temporal nature of incremental in-combination effects which results from additional consenting and, in particular, wind farm deployment. Recognising this, and so as to not prejudge ongoing or future assessments, projects in Tiers 4 and 5 are not considered in the in-combination assessment. It is appropriate that any incremental effect associated with such projects is dealt with in the planning process. Furthermore, to demonstrate the scale of effect of those consents subject to this review relative to other, later, consented projects (again, primarily for offshore wind), figures accompany the in-combination assessment which demonstrate the incremental scale of effect across a consenting timeline, for relevant qualifying species, and against relevant SPA classification dates.

When possible, changes to the status of the listed projects during the RoC AA process, completed in March 2022, have been factored into the assessment (e.g., non-material changes to existing consents, updates to project parameters as part of a consenting process, scoping or PEI submissions, project withdrawals, refusals etc.). Not all the projects listed in Table 3.2 are relevant to every relevant SPA considered in the AA, or every SPA/consent combination, and these are distinguished in Section 5.

4 Appropriate Assessment

4.1 Irish Sea

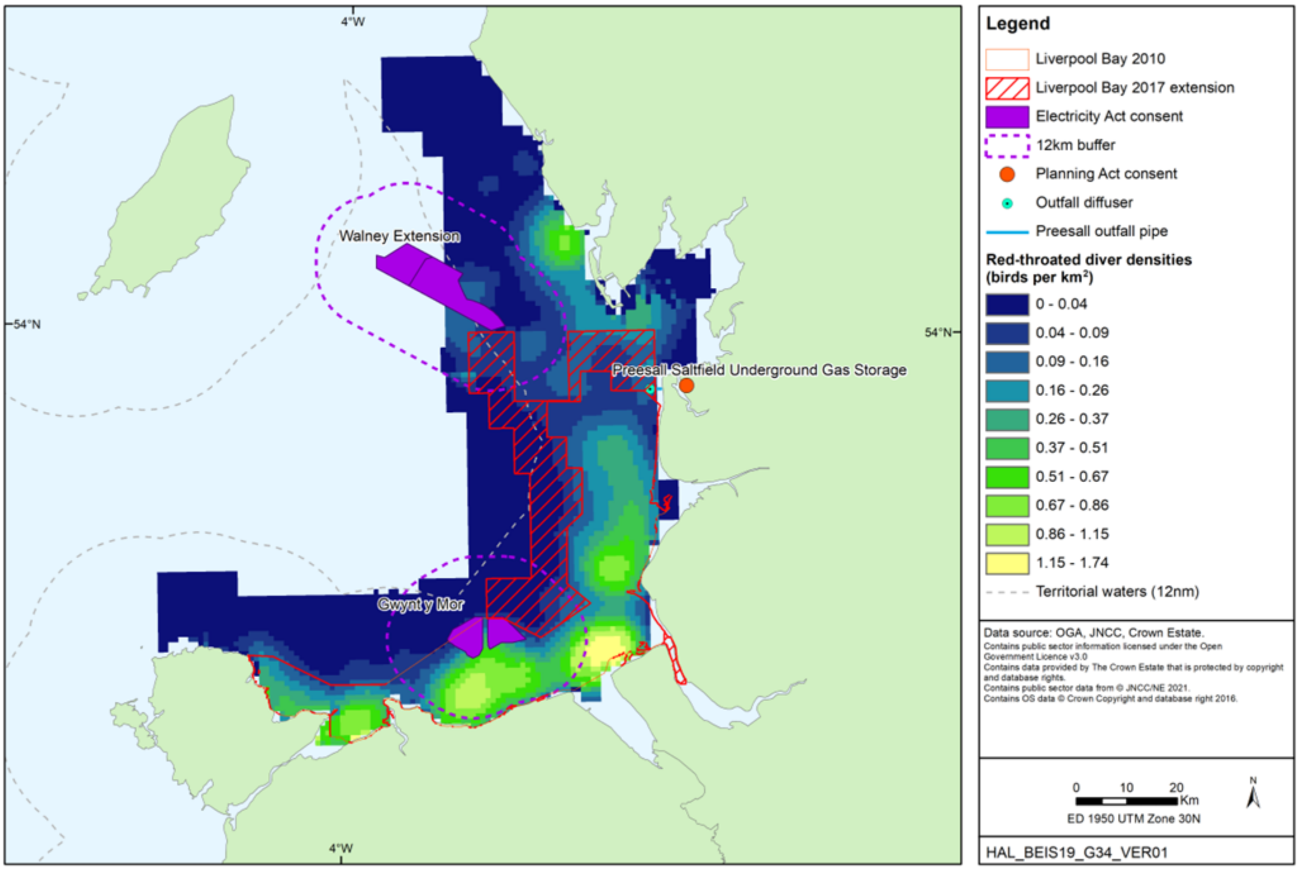
4.1.1 Liverpool Bay SPA

Red-throated diver (Gwynt y Môr, Walney Extension, Preesall Underground Gas Storage)

Displacement of red-throated diver from the Gwynt y Môr and Walney Extensions offshore wind farms, and the works associated with the outfall construction for the Preesall Underground Gas Storage project, have been identified as requiring an AA.

Red-throated divers have been recorded throughout the inshore area of Liverpool Bay SPA, although in the estimated mean density surface based on surveys covering 2004/05, 2005/06, 2006/07, 2007/08 and 2010/11[32] (Lawson *et al.* 2016b), birds occur in higher densities off the North Wales and Merseyside coast, with a maximum density of 1.74 birds/km^2 (Figure 4.1).

Figure 4.1: Red-throated diver densities in Liverpool Bay SPA* and the relevant consents



* Based on data from Lawson *et al*. 2016b.

Gwynt y Môr

Average pre-construction baseline densities of divers within the Gwynt y Môr array area were significantly lower than the maximum density for the SPA and varied between 0.02 and 0.63 birds/km^2. Pre-construction surveys recorded only one individual within the Gwynt y Môr project area and the 2km buffer (APEM, 2015).

The numbers of red-throated diver within the project area of Gwynt y Môr and at 1km buffer intervals out to 12km, which are coincident with Liverpool Bay SPA, have been calculated based on the average density surface of Lawson *et al.* (2016b). This was completed using a GIS which selected each 1km x 1km grid cell in incremental buffers away from the array area. As the density units are in birds/km^2, the average number of birds present was taken to be the sum of the density values within each buffered area (Table 4.1). The displacement of birds within each buffer has been calculated based on the methods outlined in Section 3.1.

The displacement matrix for Gwynt y Môr (Table 4.1) indicates 102 birds would be displaced within the array area and a 12 km buffer, representing ~8.7% of the SPA population. The area of effective displacement has been calculated based on the area contained within each 1km displacement distance from the array area, and the displacement level assumed at each distance (see Table 4.1). For example, the area covered by the 5-6km Gwynt y Môr buffer is 50km^2, however relative to the displacement level assumed at this distance (55%), the effective area of displacement is assumed to be 27km^2.

Assuming a 1% mortality level is associated with such displacement, this would result in the death of ~1 bird which equates to ~0.09% of the SPA population (see Section 2.4). Whilst in the context of the estimated red-throated diver baseline mortality of 16% (Horswill & Robinson 2015), the additional mortalities from displacement are negligible, any displacement of birds would undermine the conservation objective to maintain and restore the distribution of the qualifying features within the SPA.

The displacement matrices predict a change in the distribution of red-throated divers within 12km of the array: however, pre, during, and post-construction monitoring surveys undertaken between 2010/2011 and 2018/2019 at the project area (APEM, 2019) indicate that the density of red-throated divers was consistently low during all phases of the development, and the windfarm had no significant effect on the spatial distribution of red-throated divers within the array area or a 2km buffer.

The maximum number of red-throated divers within the Gwynt y Môr project area was estimated to be six, post-construction. This was higher than during the baseline surveys, but lower than during-construction phase surveys when an estimate of nine individuals were recorded.

Furthermore, the abundance of red-throated divers in the wider area (NW5/ Colwyn Bay) varied from 198 to 932 individuals between 2012/2013 and 2018/2019, but this variation was not related to the construction or operational phases of the development. The peak population estimate pre-construction in 2010/2011 was 458, this decreased to 198 during the first year of post-construction surveys in 2016/17, increased to 932 during the 2017/18 post-construction surveys, but decreased to 254 during the 2018/19.

A statistical Analysis of Variance test was applied to the data and no displacement effect was identified (APEM, 2019). The monitoring report concluded that other environmental variables, such as water depth and weather conditions, determine red-throated diver distribution in

Liverpool Bay SPA. There is evidence that red-throated divers show a strong preference for shallow waters and congregate where water depths are less than 20m, probably because these areas support diver prey species such as herring and sprat (Skov et.al.,2001). It is likely that these variables influence the distribution of red-throated divers in Liverpool Bay.

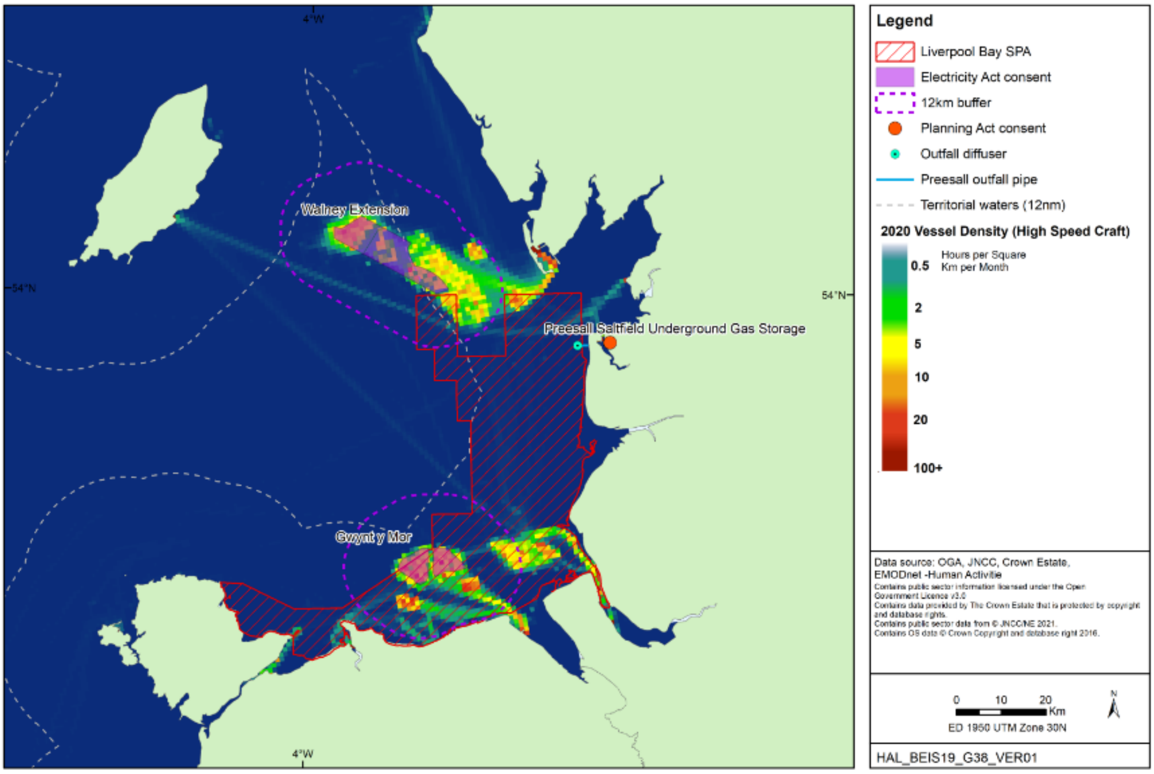
A recent review of the red-throated diver distributions in Liverpool Bay, which was undertaken to inform the Awel y Mor offshore windfarm project (RWE, 2022), asserted that levels of displacement were influenced by quality of the habitat and the dependency of red-throated divers on such habitats. Therefore, the best evidence to inform any assessment of red-throated diver displacement would be site specific data.

Whilst the displacement matrices provide a prediction of the impacts of the project array based on observed effects at other offshore windfarm sites, the monitoring data from the Gwynt y Mor site demonstrates that the turbines associated with this project have not led to the displacement of red-throated divers. It is therefore evident that the displacement matrices were not an accurate predictor of bird displacement in this case have not been relied upon to assess the impacts of Gwynt y Mor on red-throated divers.

There is vessel traffic associated with the maintenance of Gwynt y Môr (APEM, 2019), (Figure 4.2). There are an average of two to three vessel movements to the wind farm array per day[65] from the Port of Mostyn. Maintenance trips from the Port of Mostyn are considered unlikely to result in significant disturbance to red-throated divers, as they use existing shipping routes (NPOWER, 2005). In the context of the wider volume of vessel movements in the Irish Sea and Liverpool Bay SPA, the movement of an additional two to three vessels per day is not considered to be significant. Recent AIS-based data on vessel movements relating to wind farm maintenance in the context of wider vessel movements in Liverpool Bay SPA[66] is shown in Figure 5.2 (also see Section 5.7 of DECC (2016) for a comparison of vessel movement data before and after the installation of Gwynt y Môr).

[65] 728 Vessel movements from shore to the array per year, or approximately two per day.
[66] As shown on vessel (EMODnet) and route density (EMSA) maps: https://www.emodnet-humanactivities.eu/view-data.php (accessed October 2021)

Figure 4.2: Vessel movements related to wind farm maintenance in the Irish Sea, 2020



Walney Extension

The Walney Extension lies outside of the SPA boundary (See Figure 2.6) and therefore there is no direct physical impact on the habitats within the site: however, there is potential for red-throated divers within the site to be displaced by the project.

The displacement matrix (Table 4.2) for Walney Extension indicates that 20 birds could be displaced within the array area and a 12km buffer, representing ~1.7% of the SPA population. Assuming a 1% mortality level is associated with such displacement, this would result in the death of less than 1 bird per year which equates to ~0.02% of the SPA population. Such levels of displacement and mortality are not predicted to affect the red-throated diver population of Liverpool Bay SPA: however, the predicted effects could alter the distribution of birds within the SPA which would undermine the conservation objective to maintain or restore the distribution of qualifying features within the site.

Whilst there is no construction or post-construction monitoring data for red-throated diver for the Walney Extension project, it is noted that the section of the SPA which is closest to the site was not classified for red-throated divers.

Liverpool Bay SPA was classified in 2010 for non-breeding red-throated diver and common scoter. An Environmental Statement was prepared for the Walney Extension offshore windfarm in 2013: the project was approximately 17 km north of the SPA at that time. In 2017, the Liverpool Bay SPA was extended to the north and west (Natural England, Natural Resources Wales and JNCC, 2016). The extension brought it closer to the Walney Extension project area (Figure 4.1). However, the SPA extension included areas for non-breeding little gulls, and foraging areas for little terns and common terns. No changes to the boundary were made based on red-throated diver distribution, and red-throated diver densities within the SPA extension were low compared to the original SPA site.
Baseline red-throated diver densities within the Walney Extension project area were significantly lower than peak densities in Liverpool Bay SPA, being between 0.007 and 0.14

birds/km^2. Divers were recorded in 12 out of 24 surveys undertaken for Walney Extension, with a peak density of 0.16 birds/km^2 in October 2012, and a mean maximum population of 53 in the period October to March (Dong, 2013). It is likely that the distance offshore and the deeper water in and around the project area offer sub-optimal habitat conditions for red-throated diver.

Whilst the extension brings the SPA within 1km of Walney Extension, the extension was not intended to support red-throated divers. It is noted the original SPA boundary mainly coincides with areas of shallow water below 20m in depth, whereas the northeast section of the SPA extension the water is generally over 30m in depth (Webb et. al., 2008). The SPA extension is likely to provide sub-optimal conditions for red-throated diver.

Vessel traffic is associated with the maintenance of Walney Extension (Dong, 2013). However, in the context of the wider volume of vessel movements in the Irish Sea and Liverpool Bay SPA, the movement of an additional two to eight vessels per day[67] is not considered significant. Figure 4.2 demonstrates that vessels associated with Walney Extension do not coincide with the original SPA boundary which was classified for red-throated diver, due to the operations and maintenance port being at Barrow-in-Furness.

Preesall Underground Gas Storage

The average density of red-throated divers within 2km of the proposed outfall for Preesall gas storage is in the range 0.09 to 0.14 birds/km^2.

Potential disturbance impacts of vessel traffic from the construction of the Preesall gas storage brine outfall pipeline on the red-throated diver feature of Liverpool Bay SPA were considered in the original application for the development. At that time Natural England agreed that such impacts could be adequately avoided through the management of vessel movements through a condition of the deemed marine licence associated with the DCO. The condition stated that:

"(1) The licence holder shall prior to the commencement of any stage of the licensed activities agree in writing with the MMO a vessel movement plan for that stage; and no stage of the licensed activities may commence until such a plan for that stage has been agreed and, (2) The licence holder shall carry out the licensed activities in accordance with the approved vessel movement plan, unless otherwise agreed in writing with the MMO[68]."

Though not captured in the deemed marine licence, the decision notice for the project notes that no AA was required at the time, with Natural England affirming in a Statement of Common Ground (SoCG) that a conclusion of no LSE was agreed. This was based on the mitigation and monitoring strategies outlined in the SoCG being fulfilled. These strategies stated that:

"…*the Applicant and Natural England will continue to work together to finalise the precise wording of the Vessel Movement Plan six months before construction begins to allow for the most up to date information on the distribution of sea birds*[69]"

[67] 2,920 Vessel movements per annum were noted in the ES for the project, or eight departures per day.
[68] Section 19 of Schedule 7, of The Preesall Underground Gas Storage Facility Order 2015. Note this condition remains unchanged in the recent variation to this deemed marine licence.
[69] Section 3 of the SoCG between Hyder (on behalf of Halite Energy Group) and Natural England on the topic of Ecology and HRA.

Furthermore, it was assumed that the installation of the pipeline would be undertaken between April and July, effectively negating impacts on this non-breeding feature.

The applicant presented bird data collected from the Liverpool Bay SPA by WWT using aerial surveys in 2002/03 and 2004/05 which recorded no divers within 2km of the brine outfall pipeline. The only record of divers was a few individuals within 4-6km in late winter 2005 (Halite Energy, 2011a). The density surface of Lawson et al. (2016b), based on a wider range of data, indicates an average density of 0.12 birds/km^2 within 2km of the pipeline.

It is therefore concluded that even if works were to take place during the winter months when red-throated diver could be present in the area, and assuming displacement of all birds, the number of birds impacted would be so low that it is unlikely that any mortalities would occur, and there would be no effect on the SPA population.

Similarly, any temporary effect on the habitat or prey of the species from activities associated with the outfall construction is minor, temporary, and not significant. Provided that the original deemed marine licence conditions and mitigation and monitoring methods outlined in the SoCG between the applicant and NE are fulfilled, it is concluded that there will be no adverse effect on the Liverpool Bay SPA population of red-throated diver from the construction of the brine outfall pipeline alone, in view of the site's conservation objectives, as these will not affect the extent, distribution, structure, function and supporting processes of habitats of the feature, nor its population or distribution within the site boundaries, as they will not take place during the non-breeding period.

In addition to the construction of the outfall pipeline, the Preesall gas storage project has been screened in for effects on red-throated diver related to the discharge of the brine from the outfall. The discharge of brine from salt cavern construction is subject to the Environmental Permitting Regulations under the Environment Agency which is outside of the Planning Act 2008 regime.

The Environment Agency granted a discharge consent in connection with a previous planning application in 2007 to permit the discharge of brine of up to 80,000m^3 per day, subject to conditions on the quantity and content of the brine, including its salinity (not exceeding 40psu within 50m, or 10% above ambient conditions within 250m) and presence of other elements (e.g., tributyltin, copper). This was amended in 2011 to update the effective start date such that it related to the project subject to the 2015 DCO, and was extended again though an amendment in 2020[70], the Environment Agency being satisfied that reassessment was not required. The permit is subject to its own conditions, which include water quality monitoring, and several mitigation and monitoring proposals were made as part of the original application to effectively control the discharge (Halite Energy, 2011a).

The project proposals have not changed since the DCO was made, and in view of the low number of birds likely to be present around the outfall, the short range of effects, and those mitigation and monitoring measures secured through the existing discharge consent, adverse effects on integrity can be excluded for the red-throated diver feature of Liverpool Bay SPA from the brine discharge.

Based on an assessment of the information presented above, it is concluded that neither the Gwynt y Mor, Walney Extension or Preesall Underground Gas Storage projects will have an adverse effect on the integrity of the red-throated diver feature of Liverpool Bay SPA alone.

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[70] Permit NW/017290628/003, see *Environmental Statement Vol 1B. Appendix 2.1 Environment Agency Consent to Discharge*. Also see the Environment Agency comments within the MMO response to the DML variation for the project.

Table 4.1: Displacement analysis for red-throated diver within Gwynt y Môr, and within a 12km buffer

Displacement distance	Area of effective displacement (km^2) (%SPA)[1]	Abundance[2]	Displacement level (%)	Mortality (%)												
				1	2	5	10	20	30	40	50	60	70	80	90	100
Within wind farm and to 1km	94 (3.7)	23.37	100	0	0	1	2	5	7	9	12	14	16	19	21	23
1-2km	31 (1.2)	8.13	91	0	0	0	1	1	2	3	4	4	5	6	7	7
2-3km	31 (1.2)	11.17	82	0	0	0	1	2	3	4	5	5	6	7	8	9
3-4km	30 (1.2)	12.35	73	0	0	0	1	2	3	4	5	5	6	7	8	9
4-5km	29 (1.2)	17.39	64	0	0	1	1	2	3	4	6	7	8	9	10	11
5-6km	27 (1.1)	18.01	55	0	0	0	1	2	3	4	5	6	7	8	9	10
6-7km	25 (1.0)	19.54	46	0	0	0	1	2	3	4	4	5	6	7	8	9
7-8km	21 (0.8)	22.13	37	0	0	0	1	2	2	3	4	5	6	7	7	8
8-9km	15 (1.6)	25.38	28	0	0	0	1	1	2	3	4	4	5	6	6	7
9-10km	11 (0.4)	26.72	19	0	0	0	1	1	2	2	3	3	4	4	5	5
10-11km	6 (0.2)	27.56	10	0	0	0	0	1	1	1	1	2	2	2	2	3
11-12km	1 (0.03)	25.28	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total mortality				1	2	5	10	20	31	41	51	61	72	82	92	102
% SPA population				0.09	0.17	0.44	0.87	1.75	2.62	3.50	4.37	5.24	6.12	6.99	7.87	8.74

Notes: [1]the area of effective displacement is taken here to be the area within each of the 1km buffers and the array area which overlaps the site area, relative to the percentage displacement level for each buffer. The percentage coverage of these areas relative to the entire SPA area (2,528km^2) is also noted. [2]indicative abundance based on Lawson *et al.* (2016b).

Table 4.2: Displacement analysis for red-throated diver within Walney Extension, and within a 12km buffer

Displacement distance	Area of effective displacement (km^2) (%SPA)[1]	Abundance[2]	Displacement level (%)	Mortality (%) 1	2	5	10	20	30	40	50	60	70	80	90	100
Within wind farm and to 1km	1 (0.05)	7.10	100	0	0	0	1	1	2	3	4	4	5	6	6	7
1-2km	6 (0.2)	2.45	91	0	0	0	0	0	1	1	1	1	2	2	2	2
2-3km	8 (0.3)	2.44	82	0	0	0	0	0	1	1	1	1	1	2	2	2
3-4km	7 (0.3)	2.61	73	0	0	0	0	0	1	1	1	1	1	2	2	2
4-5km	6 (0.3)	2.33	64	0	0	0	0	0	0	1	1	1	1	1	1	1
5-6km	5 (0.2)	2.66	55	0	0	0	0	0	0	1	1	1	1	1	1	1
6-7km	4 (0.2)	2.42	46	0	0	0	0	0	0	0	1	1	1	1	1	1
7-8km	4 (0.1)	2.55	37	0	0	0	0	0	0	0	0	1	1	1	1	1
8-9km	3 (0.1)	3.00	28	0	0	0	0	0	0	0	0	1	1	1	1	1
9-10km	2 (0.07)	3.42	19	0	0	0	0	0	0	0	0	0	0	1	1	1

Displacement distance	Area of effective displacement (km^2) (%SPA)[1]	Abundance[2]	Displacement level (%)	Mortality (%)												
				1	2	5	10	20	30	40	50	60	70	80	90	100
10-11km	1 (0.04)	3.98	10	0	0	0	0	0	0	0	0	0	0	0	0	0
11-12km	0 (0.004)	4.29	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total mortality				<1	<1	1	2	4	6	8	10	12	14	16	18	20
% SPA population				0.02	0.03	0.09	0.17	0.34	0.52	0.69	0.86	1.03	1.21	1.38	1.55	1.72

Notes: [1]the area of effective displacement is taken here to be the area within each of the 1km buffers and the array area which overlaps the site area, relative to the percentage displacement level for each buffer. The percentage coverage of these areas relative to the entire SPA area (2,528km^2) is also noted. [2]indicative abundance based on Lawson *et al.* (2016b).

Cormorant and red-breasted merganser (Walney Extension, Preesall Saltfield Underground Gas Storage)

Aerial and boat-based surveys covering Walney Extension (Dong 2013a) recorded peak cormorant densities of 0.02 and 0.06 birds/km^2 respectively in the months of April 2012 and August 2012. Red-breasted merganser were recorded in very low numbers from the boat-based surveys covering Walney Extension, with no birds recorded within the array area and a maximum density estimate of 0.01 birds/km^2 within a 4km buffer of the array. With the available data for the wind farm, and assuming a displacement of 4km from the wind farm, mortality is predicted for <1 bird at a mortality rate of 1% for cormorant (0.03% of the SPA population), and <1 bird at the 1% mortality rate for red-breasted merganser (0.03% of the SPA population). In view of the very low number of birds recorded across Walney Extension pre-construction and estimates of displacement mortality which are significantly less than 1% of the SPA population for both species, adverse effects on integrity can be excluded in view of the site's conservation objectives, that is that Walney Extension will not affect the extent, distribution, structure, function and supporting processes of habitats of the feature, nor its population or distribution within the site boundaries.

As noted in Section 3.1, there is the potential for these species to take advantage of enhanced foraging opportunities at wind farms, and roosting cormorant have certainly been noted at North Hoyle (NPOWER 2006), however, both species have also been identified as being of moderate risk of displacement (Bradbury *et al.* 2014). Both species are recorded in very low numbers across both wind farm arrays, consistent with the distribution of the species (e.g. Lawson *et al.* 2016b), noting that this data includes all qualifying interests of the site and so largely reflects the distribution of the most abundant feature, common scoter, however, most birds were recorded further inshore and away from the array area which is typical of the foraging preference for such birds. Significant displacement is not considered likely and adverse effects on integrity for these assemblage features can be excluded. Cormorant and red-breasted merganser are both considered to be at low risk of collision (Furness *et al.* 2013, Bradbury *et al.* 2014), and in view of the very low numbers of birds recorded in relation to the two relevant consents in the winter period, collision risk modelling has not been undertaken for these, and adverse effects on integrity can be excluded.

Direct disturbance of cormorant and red-breasted merganser from the installation of the brine outfall associated with the Preesall Gas Storage project is not predicted, as the information provided to support the HRA for the project indicated that construction would take place in summer months (April-July) to avoid interaction with non-breeding birds. While no offshore survey data for cormorant or red-breaster merganser are available for Preesall to indicate the density of birds offshore, low tide and high tide surveys confirm the presence of both species in low numbers (up to four and two birds respectively). There is no similar commitment to the discharge period of the brine from the project which will take place over the period of approximately five years, which could result in indirect effects on the non-breeding birds as a result of mortality of prey. Information supplied as part of the original application noted that prolonged exposure to salinities of 40psu or greater would result in mortality for most marine species, with sessile and slow-moving fauna most affected. Effects on fish were considered likely to be variable, with demersal species more likely to be subject to prolonged exposure than pelagic fish, with displacement away from the brine outfall expected (Halite Energy 2011b). While no references were provided to evidence the limit of 40psu as a threshold of effect, several studies support a value close to this as causing mortality in a range of marine species (e.g., Fernández-Torquemada & Sánchez-Lizaso 2005, Smyth *et al.* 2014). The conditions or the consent held by Preesall for the discharge are that it must not exceed 40psu within 50m of the diffuser.

In view of the avoidance of the non-breeding period for construction, and the limited scale of potential effects on prey species (50m of the outfall), adverse effects on the integrity of the cormorant and red-breaster merganser assemblage features of the Liverpool Bay SPA from the projects alone can be excluded.

Little tern (Walney Extension, Preesall Saltfield Underground Gas Storage)

The little tern feature of Liverpool Bay SPA was screened in as a likely significant effect could not be discounted based on the distance-based screening criterion such that the site was within the mean maximum foraging range (+1SD) of a relevant consent. Two consents were identified as requiring AA on this basis, which were Walney Extension and the Preesall Saltfield Underground Gas Storage project.

While both projects were either within the Liverpool Bay SPA, or within 1km of its boundaries, the colonies used by little terns are some distance from the boundaries of both projects. The nearest little tern colony to both is at Gronant, which is 73km and 60km from Walney Extension and the Preesall gas storage outfall respectively. This is considerably further than the mean maximum foraging range of 5km for little tern (Woodward *et al.* 2019). Additionally, no little terns were recorded in surveys for Walney Extension (Dong 2013), the third-year post-consent monitoring associated with Walney, the coverage of which is in part relevant to the extension (NIRAS 2015), and the survey of the wider NW3 zone 2004-2008 which included areas closer to the coast inferred a population of only two individuals (as reported in Dong 2013, also see WWT 2008).

Little tern were either not recorded at the location of works associated with the relevant consents or were recorded in very low numbers, and the distance of these works to relevant little tern colonies associated with the SPA is significantly larger than the mean maximum foraging range, and on this basis would not meet the criteria for likely significant effect agreed for the screening stage (BEIS 2021). No interaction with the projects, and no related effects, have been identified.

Common tern (Walney Extension, Preesall Saltfield Underground Gas Storage)

Common tern was screened in as a likely significant effect could not be discounted for Walney Extension and the Preesall Saltfield Underground Gas Storage project. The number of common terns recorded at wind farms in the Irish Sea was low (Table 4.3), and no collisions and related mortality have been calculated for the relevant consents being assessed here.

Of the wind farms located in the Irish Sea, collisions were only estimated for Ormonde and Burbo Bank Extension; neither of these consents were screened in to this HRA as they did not meet the criteria for being subject to review for this site (see BEIS, 2021).

Though the relevant consents and SPA boundary are located within the mean maximum (+1SD) foraging range for common tern (26.9km), they are at a considerably greater distance from the colonies associated with them. The closest common tern colony which is associated with the Liverpool Bay SPA is noted to be Seaforth Nature Reserve, which is 68km and 49km from Walney Extension and the Preesall gas storage outfall respectively, and on this basis would not meet the screening criteria for likely significant effect at the screening stage of this HRA process (see BEIS 2021). Common tern colonies associated with the Ribble and Alt Estuaries SPA[71] are closer to both consents, however, these are still relatively distant (50km

[71] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9005103

for Walney Extension and ~26km for Preesall Gas Storage), are not part of the Liverpool Bay SPA citation, and they have not been considered here.

In view of the low numbers of birds recorded at the location of works associated with the relevant consents, and the distance of these works to relevant common tern colonies associated with the Liverpool Bay SPA, interactions with the projects has been excluded based on the screening criteria applied in BEIS (2021). Based on the information provided above an adverse effect on the common tern feature of Liverpool Bay SPA has been excluded for the projects alone.

Table 4.3: Reported peak abundance and estimated mortality for common terns from wind farms in the Irish Sea for relevant consents

Project	Peak abundance	Estimated collisions	Relevant SPAs
Gwynt y Môr	13	-	Dee Estuary (Extension)
Walney Extension	6	-	Liverpool Bay, Morecambe Bay and Duddon Estuary

Notes:[1]this is the relevant SPA being assessed, but note that the bird abundance and number of collisions are not necessarily attributed to these sites

Little gull (Walney Extension, Preesall Saltfield Underground Gas Storage)

Data sources relating to wind farm collision impacts on little gull within the Irish Sea as part of the assessment for Liverpool Bay SPA have been obtained from individual applications, though those of relevance to this HRA are from Walney Extension (Dong 2013a, Npower 2005). Collision risk modelling undertaken for Walney Extension noted a peak abundance of 28 individuals, with a collision mortality of one bird per year at an avoidance rate of 98%, equivalent to 0.3% of the SPA non-breeding population. The Walney Extension will not affect the extent, distribution, structure, function and supporting processes of habitats of the feature, nor its population or distribution within the site boundaries, and an adverse effect on integrity little gull from the project alone can be excluded.

While no offshore survey data for little gull were collected to inform the Preesall outfall pipeline installation, the density surface of Lawson *et al.* (2016b) reflects a low density of birds near the pipeline outfall location, and interaction with any works associated with construction would be avoided by project timing. There is no similar commitment to the discharge period of the brine from the project, which will take place over the period of approximately five years. This could result in indirect effects on little gull as a result of prey mortality. Information supplied as part of the original application noted that prolonged exposure to salinities of 40psu or greater would result in mortality for most marine species, and particularly sessile fauna, though effects on fish would likely be displacement away from the brine outfall. The conditions or the consent held by Preesall for the discharge, amongst others, are that it must not exceed 40psu within 50m of the diffuser.

In view of the avoidance of the non-breeding period for construction, and the limited scale of potential effects on prey species, an adverse effect on integrity little gull from the project alone can be excluded. That is that the effects associated with the Preesall outfall will not undermine the ability8080 of the site to maintain or restore the extent, distribution, structure, function and supporting processes of habitats on which little gull are reliant, nor that of the population or its distribution within the site boundaries.

4.1.2 Mersey Narrows and Wirral Foreshore SPA

Non-breeding waterbirds: bar-tailed godwit and knot; Waterbird assemblage (Gwynt y Môr)

No assessment has previously been undertaken in relation to Gwynt y Môr for the non-breeding features above, either alone or in-combination with other projects in the Irish Sea which could provide a basis of information to inform the AA. The SOSSMAT tool (Wright *et al.* 2012) was used at the screening stage to identify the potential for interaction between non-breeding features of relevant SPAs and relevant consents. In the absence of site-specific information for Gwynt y Môr, it has been used here again to estimate the number of birds potentially passing over the wind farm in the non-breeding season, based on the UK populations of relevant species in Woodward *et al.* (2020). It should be noted that the SOSSMAT tool makes simplistic assumptions around migration routes and calls for similarly simplistic application of population correction factors on which the outputs rely, and the values presented cannot be specifically related to the relevant SPA being assessed. Flight heights are either not available or are poorly understood for the species considered, and birds on migration may not pass through the rotor swept areas of turbines. For the species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest knot are unlikely to fly within the rotor swept area, though bar-tailed godwit are more likely to interact with turbines. Similarly, available flight height data for the remaining non-breeding features suggests limited potential for interaction on passage to wintering grounds.

In view of the small numbers of birds predicted to potentially interact with turbines, an adverse effect on non-breeding waterbirds can be excluded for the project alone.

Table 4.4: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Mersey Narrow and Wirral Foreshore SPA

Species	Gwynt y Môr	%UK popn.	UK Estimated population[2]	SPA Population
Knot	1,765	0.67	265,000	10,655
Bar-tailed godwit	264	0.49	53,500	3,344
Cormorant[1]	391	0.61	64,500	972
Oystercatcher[1]	2,031	0.67	305,000	2,718
Grey plover[1]	178	0.53	33,500	593
Dunlin[1]	2,455	0.70	350,000	7,645
Redshank[1]	666	0.67	100,000	1,209

Notes: [1]Assemblage feature., [2]Woodward *et al.* (2020). The percentage relative to UK population is provided as it is this population on which the potential for interaction is based. The numbers of birds cannot be directly related to the SPA population and so are not related to this as a percentage.

Common tern (Gwynt y Môr)

As noted above in relation to the common tern feature of Liverpool Bay SPA, very few terns were recorded for Gwynt y Môr and collision risk for the species is therefore expected to be very low. Additionally, while the boundary of the Mersey Narrows and Wirral Foreshore SPA is within 17km of Gwynt y Môr, the common tern colony associated with the site (Seaforth Nature

Reserve) is considerably further (28km) and outside of the mean maximum +1SD foraging range for common tern (26.9km), which was applied as a screening criterion in BEIS (2021).

It is concluded that the project would not affect the extent, distribution, structure, function and supporting processes of habitats of the common tern, nor its population or distribution within the site boundaries. On this basis, adverse effects on the common tern feature of the Mersey Narrows and Wirral Foreshore SPA from Gwynt y Môr can be excluded for the project alone.

4.1.3 Anglesey Terns SPA

Sandwich tern (Burbo Bank Extension)

There is no single data source available relating to the impact of offshore wind farms on Sandwich terns in the Irish Sea. The only collision risk modelling undertaken for Sandwich tern in the Irish Sea has been for Burbo Bank Extension (Dong, 2013a) for which three collisions per year were estimated (Table 4.5); the peak abundance at the Burbo Bank Extension was 177 individuals which is considerably higher than those reported for other wind farms in the Irish Sea. Collision Risk Modelling for the Burbo Bank Extension was undertaken based on an avoidance rate of 98% and estimated three collisions per year; the accepted avoidance rates for all terns is 98.5% (Cook *et al.,* 2014) which is higher than previously used in the modelling for Burbo Bank Extension.

The Sandwich tern feature of Anglesey Terns SPA was screened in as a likely significant effect and could not be discounted based on the distance-based screening criterion such that the site boundary was within the mean maximum foraging range (+1SD) for the species (57.5km), from Burbo Bank Extension. The distance to the nearest relevant colony associated with the SPA (Cemlyn Bay) is 75km. Relatively few birds were noted to be foraging in the surveys for Burbo Bank Extension, with most (79%) noted to be transiting the site, with peak numbers in July and August (Dong, 2013a). While collision risk modelling indicates the potential for mortality of three birds from Burbo Bank Extension, this cannot be directly attributed to Anglesey terns (for example they may in part be attributable to the Dee Estuary SPA).

Given the low number of collisions relative to the population of the Anglesey Terns SPA (equivalent to 0.3% of the SPA population as classified), the most recent counts suggesting a population increase (see Section 2.4.7, equivalent impact on mortality of 0.16% of the most recent 5 year mean population), along with the distance from the colony relevant to this assessment to Burbo Bank Extension (75km), the operation of Burbo Bank Extension will not affect the size of the Anglesey Terns SPA Sandwich tern population, its distribution, or habitat. It is concluded that an adverse effect on Sandwich tern from the project alone can be excluded.

Table 4.5: Estimated peak populations and collision impacts on Sandwich tern in the Irish Sea for relevant consents

Project	Peak abundance	Estimated collisions	Relevant SPA[1]
Burbo Bank Extension	177	3	Anglesey Terns

Project	Peak abundance	Estimated collisions	Relevant SPA[1]
Gwynt y Môr	<10	No CRM undertaken	Dee Estuary (extension)
Walney Extension	6	No CRM undertaken	Morecambe Bay and Duddon Estuary

Notes:[1]this is the relevant SPA being assessed, but note that the bird abundance and number of collisions are not necessarily attributed to these sites

4.1.4 Dee Estuary (extension) SPA

Sandwich tern (Gwynt y Môr)

The Sandwich tern feature of the Dee Estuary SPA is for non-breeding individuals, with the estuary providing a staging post for large numbers of post-breeding Sandwich terns on passage during the beginning of their autumn migration. Peak counts of birds occur in July, with the most recent counts covering the last five years (2015/16-2019/20) having a mean value of 1,623 individuals, relative to the citation population of 957 individuals (1995-1999).

Surveys informing the Gwynt y Môr EIA recorded fewer than 10 individuals within the array area, and more recent digital aerial survey for the proposed Awel y Môr wind farm, which includes an 8km buffer that covers a substantial portion of the Gwynt y Môr area, recorded between one and two individuals in July and August 2019/2020, with an abundance estimate of 17 and 8 respectively. No CRM was undertaken for Gwynt y Môr in relation to this species, and in view of the low numbers of birds, for example, relative to those identified at Burbo Bank Extension (Table 4.5) and the estimated collision risk for three individuals, adverse effects on the Sandwich tern feature of the Dee Estuary SPA from the operation of Gwynt y Môr alone can be excluded.

Common tern (Gwynt y Môr)

Counts of breeding common tern in the Gwynt y Môr array area were low at 13 (Table 4.3), with no collisions predicted in the original environmental statement, and more recent survey data much of the Gwynt y Môr array area (APEM 2021a), indicate a very low number of individuals which were only recorded in the post-breeding migration and return migration periods. Furthermore, while Gwynt y Môr is within 12km of the Dee Estuary SPA site boundary, the wind farm is some distance (36km) from the main common tern colony of the Dee Estuary located at Shotton Lagoons and Reedbeds SSSI, and therefore, outside of the 26.9km mean maximum +1SD foraging range for common tern used as the screening criteria for likely significant effect as part of this HRA (BEIS 2021), and is even further than the maximum recorded range (30km) (Woodward *et al.* 2019).

Based on the above information an adverse effect on the common tern feature of the Dee Estuary SPA from Gwynt y Môr alone can be excluded.

Non-breeding waterbirds: teal, grey plover, dunlin, black-tailed godwit and curlew (Walney, West of Duddon Sands, Ormonde, Gwynt y Môr)

No assessment has previously been undertaken in relation to Gwynt y Môr, Walney, West of Duddon Sands or Ormonde for the non-breeding features above, either alone or in-combination with other projects in the Irish Sea, for the Dee Estuary or other SPAs, which could provide a basis of information to inform the AA. The SOSSMAT tool (Wright *et al.* 2012) was used at the screening stage to identify the potential for interaction between non-breeding features of relevant SPAs and relevant consents.

In the absence of site-specific information, it has been used here to estimate the number of birds potentially passing over the wind farms in the non-breeding season, and how this relates to the wider UK population and that of the relevant SPA population; note that the numbers of birds crossing the project area can be taken to apply to both the winter and spring migration. As noted above in relation to Mersey Narrows and Wirral Foreshore SPA, the SOSSMAT tool makes some simplistic assumptions around migration routes and the values presented cannot be specifically related to the relevant SPA being assessed.

Flight heights are either not available or are poorly understood for the species considered, and birds on migration may not pass through the rotor swept areas of turbines. For the species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, though ducks and godwit are more likely to interact with turbines, and no interaction is expected over the wintering period.

In view of the low numbers of birds predicted to pass through the project array areas relative to the UK population, which would be smaller still relative to the flyway populations, an adverse effect on the non-breeding features of the site from the operation of the Gwynt y Môr, Walney and West of Duddon Sands wind farms alone can be excluded.

Table 4.6: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Dee Estuary SPA

Species	Gwynt y Môr	%UK popn.	Walney	%UK popn.	West of Duddon Sands	%UK popn.	Ormonde	%UK popn.	UK Estimated population[1]	SPA population
Teal	5,794	1.33	6,908	1.59	4,957	1.14	1,987	0.46	435,000	5,251
Grey plover	178	0.53	213	0.64	153	0.46	61	0.18	33,500	1,643
Dunlin	2,455	0.70	2,833	0.81	1,997	0.57	807	0.23	350,000	27,769
Black-tailed godwit	546	1.33	651	1.59	467	1.14	187	0.46	41,000	1,747
Curlew	1,191	0.95	999	0.80	855	0.68	342	0.27	125,000	3,899

Notes: [1]Woodward *et al.* (2020). The percentage relative to UK population is provided as it is this population on which the potential for interaction is based. The numbers of birds cannot be directly related to the SPA population and so are not related to this as a percentage.

4.1.5 Morecambe Bay and Duddon Estuary SPA

Lesser black-backed gull (Burbo Bank Extension, Walney Extension, Preesall Saltfield Underground Gas Storage)

At the time of consenting the Burbo Bank Extension it was concluded that there would be no adverse effect alone or in-combination (which included Walney Extension) for lesser black-backed gull, which is considered to remain relevant to this assessment, and adverse effects on integrity are excluded[72]. Additionally, a recent tagging study of lesser black-backed gulls associated with the South Walney colony (n=37) which is part of the Morecambe Bay and Duddon Estuary SPA, and adjacent urban areas in Barrow-in-Furness (n=32), and carried out 2016-2019 to cover the pre- and post-construction phase of Walney Extension, indicated that use of terrestrial areas dominated the time budgets of the birds, with <1% of the overall time budget or all birds spent within either Walney Extension or Burbo Bank Extension (Clewly *et al.* 2020).

No offshore survey data for lesser black-backed gull were collected to inform the Preesall outfall pipeline installation, however, even if birds were present in reasonable numbers, they would unlikely be significantly affected by the outfall construction activities as they are not sensitive to vessel traffic (Fliessbach *et al.* 2019), and interactions with those non-breeding would be entirely avoided through project timing.

The brine discharge from the pipeline will be continuous over a period of approximately five years, and while no direct source of effect is predicted for foraging seabirds, there is the potential for indirect effects on prey species. Information supplied as part of the original application noted that prolonged exposure to salinities of 40psu or greater would result in mortality for most marine species, and particularly sessile fauna, though effects on fish would likely be displacement away from the brine outfall. The conditions or the consent held by Preesall for the discharge, amongst others, are that it must not exceed 40psu within 50m of the diffuser. An adverse effect on the lesser black-backed gull feature of the site from the projects alone can be excluded.

Mediterranean gull (Walney Extension, Preesall Saltfield Underground Gas Storage)

Mediterranean gull tend to feed in terrestrial or intertidal habitats in the breeding season, though in the non-breeding period, they can feed at the coast and in marine waters (Coulson 2019). It is not clear how far offshore Mediterranean gull forage, because the foraging range of the species presently derived from a single boat-based observation (see Woodward *et al.* 2019, Thaxter *et al.* 2012).

Walney Extension is within 15km of the SPA site boundary, with the nearest coast being nearer 20km (Walney Island), such that few birds from Morecambe Bay are likely to be present at the wind farm. Mediterranean gull was not specifically identified in the aerial surveys for Walney Extension, however, any observed may have been categorised as gull sp., if recorded. With no confirmed sightings of Mediterranean gull at Walney Extension, the species is at very low risk from collision.

An adverse effect on the Mediterranean gull feature of the site from the operation of Walney Extension alone can be excluded.

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[72] Record of the HRA for Burbo Bank Extension, 2014.

No offshore survey data for Mediterranean gull were collected to inform the Preesall outfall pipeline installation, however, even if birds were present in reasonable numbers, they would unlikely be significantly affected by the outfall construction activities as gulls are generally not sensitive to vessel traffic (Fliessbach *et al.* 2019), and interactions with those non-breeding would be entirely avoided through project timing. The brine discharge from the pipeline will be continuous over a period of approximately five years, and while no direct source of effect is predicted for foraging seabirds, there is the potential for indirect effects on prey species. Information supplied as part of the original application noted that prolonged exposure to salinities of 40psu or greater would result in mortality for most marine species, and particularly sessile fauna, though effects on fish would likely be displacement away from the brine outfall. The conditions or the consent held by Preesall for the discharge, amongst others, are that it must not exceed 40psu within 50m of the diffuser. In view of the limited scale of potential effects on prey species, adverse effects on integrity can be excluded.

An adverse effect on the Mediterranean feature of the site from Preesall alone can be excluded.

Waterbird species: black-tailed godwit, whooper swan, little egret, ruff (Burbo Bank Extension, Walney Extension, Preesall Saltfield Underground Gas Storage)

A tracking study of whooper swans including those from Martin Mere in Lancashire (Griffin *et al.* 2011) indicated whooper swan migration tracks either crossing offshore wind farm areas, including West of Duddon Sands, or coming within 5km of other offshore wind farms; 70% of tracked birds from northwest England had tracks crossing wind farm areas). Mean flight height data was also recorded by the GPS tags fitted to the birds, which was 81m (±8m) asl, noting the GPS devices fitted have a considerably large vertical error range, in this case ±22m.

Collision risk assessment was undertaken for Walney Extension for whooper swan, which estimated a collision risk of 1.89 birds/year plus within-winter movements of whooper swan between England and Northern Ireland/Ireland as 2.31 collisions/year (Dong 2013b). That assessment accounted for all birds within the UK population which could be traversing the Irish Sea, and which were relevant to a range of sites including other SPAs such as Martin Mere SPA and Ribble & Alt Estuaries SPA. As this assessment is concentrated only on the Morecambe Bay and Duddon Estuary SPA population of whooper swans, the collisions specific to this site are likely to be less than those predicted as part of the original application, but these cannot be quantified.

In view of the small number of collisions likely attributable to Morecambe Bay and Duddon Estuary SPA, and a lack of any population effect on the species within the site (199 individuals based on a 5 year mean 2015/16-2019/20, compared to a citation population of 113 for the period 2009/10-2013/14, Section 2.4.8), an adverse effect on whooper swan from the Walney Extension alone can be excluded.

No assessment for whooper swan was undertaken for Burbo Bank Extension as part of the original application. Birds estimated to pass through the wind farm have been assessed using the SOSSMAT tool (Table 4.7), and given the location of Morecambe Bay and Duddon Estuary SPA relative to the direction that migratory birds will travel and the location of Burbo Bank Extension, it will not affect the extent, distribution, structure, function and supporting processes of habitats of the feature, or its population or distribution within the site boundaries and an adverse effect on the whooper swan feature of the site from the Burbo Bank Extension alone can be excluded.

The range of little egret has expanded in the UK in recent years (Balmer *et al.* 2013), and the SOSSMAT tool reflects available information on the species at the time of publication, which does not include any migration zones in the Irish Sea. WeBS data informed the addition of little egret to the Morecambe Bay and Duddon Estuary SPA classification, which indicated a five-year peak population of 134 individuals, or ~3% of the UK population. Recent WeBS count data (Frost *et al.* 2021) reflects a further population increase to a five-year peak of 356 individuals (2015/16-2019/20). Despite a lack of data to inform an assessment of effects of Burbo Bank and Walney Extension wind farms on little egret, the habitat preference of the species is such that interaction with either wind farm is unlikely, and an adverse effects on little egret from the projects alone can be excluded.

Black-tailed godwit equivalent to approximately 2.9% of the UK population are expected to cross the two projects. Collision risk modelling undertaken for Walney Extension suggested a risk to five birds at 0% avoidance, and zero birds at 98% avoidance. Collision risk assessment was not undertaken for Burbo Bank Extension, however, noting the comparatively few birds estimated to cross the wind farm relative to Walney Extension, adverse effects on integrity can be excluded. As noted above, the outputs from SOSSMAT are not attributable directly to the relevant SPA, and for those species other than whooper swan, flight heights are either not available or are poorly understood for the species considered. For the other species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, though as noted above, godwit are more likely to interact with turbines and data for egret is lacking.

Table 4.7: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Morecambe Bay and Duddon Estuary SPA

Species	Burbo Bank Extension	%UK popn.	Walney Extension	%UK popn.	UK Estimated population[1]	SPA population
Black-tailed godwit	544	1.33	1,205	2.94	41,000	2,413
Whooper swan	231	1.18	608	3.12	19,500	113
Little egret	0	0.00	0	0.00	11,500	134
Ruff	6	0.65	14	1.52	920	8

Notes: [1]Woodward *et al.* (2020). The percentage relative to UK population is provided as it is this population on which the potential for interaction is based. The numbers of birds cannot be directly related to the SPA population and so are not related to this as a percentage.

Direct disturbance of the non-breeding waterbird species of Morecambe Bay and Duddon Estuary SPA from the installation of the brine outfall associated with the Preesall Gas Storage project is not predicted, as the information provided to support the HRA for the project indicated that construction would take place in summer months (April-July) to avoid interaction with non-breeding birds.

While no offshore survey data for the above species are available for Preesall to indicate the density of birds offshore, low tide and high tide surveys confirm the presence of black-tailed godwit, little egret and ruff. There is no similar seasonal commitment to the discharge period of the brine from the project which will take place over the period of approximately five years. The species of relevance here are not pelagic but may feed in close association with the coast; in view of the location of the brine diffuser some 2km offshore, and the spatial limit to the salinity considered to represent the threshold of effect for the project (i.e. a limit of 40psu at 50m from the diffuser). Based on the information above direct and indirect adverse effects on non-breeding waterbirds from the site from Preesall alone can be excluded.

Sandwich tern (Burbo Bank Extension, Walney Extension, Preesall Saltfield Underground Gas Storage)

While numbers of Sandwich tern recorded at Burbo Bank Extension (Table 4.5) are the greatest for any wind farm in the Irish Sea, the distance between the wind farm and the colony associated with the Morecambe Bay and Duddon Estuary SPA (76km, Hodbarrow) is such that an interaction with the wind farm on the basis of the screening criteria in BEIS (2021) is discounted, and adverse effects from the operation of Burbo Bank Extension can be excluded (noting the mean maximum foraging range +1SD of 57.5km, also see predicted habitat use by foraging breeding terns from Hodbarrow in Win *et al.* 2013).

Walney Extension offshore wind farm is closer to the SPA site boundary (20km) and colony (25km), though available data indicates that only six birds were recorded as part of the surveys informing assessment of the wind farm, with no CRM having been undertaken. Sandwich terns have been noted to forage at greater distance than other tern species, and though foraging in deeper waters has been observed (Perrow 2010), birds typically feed in shallow waters of <15m (Perrow *et al.* 2011, ECON 2014); water depths over Walney Extension are ~22-50m. In view of the low number of recorded birds at Walney Extension and likely low foraging preference at the wind farm, adverse effects on integrity can be excluded.

No offshore survey data for Sandwich tern were collected to inform the Preesall outfall pipeline installation, however, even if birds were present in reasonable numbers, it is unlikely that they would be significantly affected by the outfall construction activities as terns have a low sensitivity to vessel traffic (Fliessbach *et al.* 2019).

The brine discharge from the pipeline will be continuous over a period of approximately five years, and while no direct source of effect is predicted for foraging seabirds, there is the potential for indirect effects on prey species. Information supplied as part of the original application noted that prolonged exposure to salinities of 40psu or higher would result in mortality for most marine species, and particularly sessile fauna, although fish would likely be displacement away from the brine outfall. The conditions of the consent held by Preesall for the discharge, amongst others, are that it must not exceed 40psu within 50m of the diffuser. Additionally, while the outfall is located <1km from the SPA site boundary, the Sandwich tern colony associated with the site at Hodbarrow is some 35km away, and a low number of terns can therefore be expected to be present. In view of the limited scale of potential effects on prey species, adverse effects on integrity can be excluded.

Common tern (Walney Extension, Preesall Saltfield Underground Gas Storage)

Walney Extension is 25km from the nearest colony at Hodbarrow, and so is just within the 26.9km mean maximum (+1SD) foraging range of the species. Consequently, very low numbers of birds were recorded at Walney Extension, with a maximum population estimate of six recorded, with a density of 0.03 birds/km^2, in boat based-surveys covering 2011-2012, and none recorded in nine aerial surveys between January and October 2012. The collision risk for the species is considered to be very low for this project alone. Collision risk modelling was not undertaken for this species as part of the Walney Extension project, and in view of the low numbers of birds likely to be present, along with accepted avoidance rates for the species, adverse effects on integrity can be excluded.

Similarly, while Preesall Gas Storage was screened in on the basis of its location relative to the Morecambe Bay and Duddon Estuary SPA boundary (<1km) relative to the common tern foraging range, the outfall location for the project is some 35km from Hodbarrow. Consequently, no interaction with the pipeline installation or brine discharge are expected and adverse effects on integrity can be excluded.

Little tern (Preesall Saltfield Underground Gas Storage)

While the boundary of the Morecambe Bay and Duddon Estuary SPA is >1km from the Preesall gas storage project outfall pipeline, the nearest little tern colony associated with the SPA at Foulney Island is some 18km away. This is significantly further than the mean maximum foraging range of 5km which was the basis of the breeding seabird screening criteria for this HRA (BEIS 2021). It is considered unlikely that there will be any interaction between terns from this colony and the Preesall outfall, and adverse effects on integrity can be excluded.

4.2 North Sea and Channel

4.2.1 Coquet Island SPA

Puffin (Dogger Bank A&B, Dogger Bank C, Sofia, Hornsea Projects One and Two, Triton Knoll[73])

Puffins are at virtually no risk of collision impacts with very few reports of birds flying at rotor height (Johnston *et al*. 2014). There is potential for puffins to be displaced by offshore wind farms and this could, in theory, cause an increase in adult mortality (Thaxter *et al*. 2016, Wade *et al*. 2016).

Puffins occur widely across the North Sea with lower numbers recorded during the breeding period within the consented offshore wind farms and 2km buffer (Table 4.8). Reported numbers within the area of each of the wind farms plus a 2km buffer that could be impacted during the breeding period range from between 1 and 1,070 individuals and 3 and 2,039 individuals during the non-breeding period (Vattenfall 2019).

Table 4.8: Estimated number of puffins during breeding and non-breeding periods at relevant consented wind farms

Project	Abundance		Relevant SPA
	Breeding	Non-Breeding	
Dogger Bank A	37	295	Coquet Island, Farne Islands
Dogger Bank B	102	743	Coquet Island, Farne Islands
Sofia	35	329	Coquet Island, Farne Islands
Dogger Bank C	34	273	Coquet Island
Hornsea One	1,070	1,257	Coquet Island
Hornsea Two	468	2,039	Coquet Island
Triton Knoll	23	71	Coquet Island
Dudgeon	1	3	Flamborough and Filey Coast
Race Bank	1	10	Flamborough and Filey Coast

Source: Vattenfall (2019b)

There is uncertainty on the level of displacement caused by operating offshore wind farms on puffins and for the purposes of this assessment a range of levels of displacement from between 30% and 70% are presented. Evidence for the levels of displacement from existing wind farms is limited due to most operating wind farms occurring in areas with relatively few puffins, particularly during the breeding period. Post construction monitoring undertaken at the Beatrice wind farm indicates that level of displacement is likely to be at the lower end of the range being considered, i.e. there is evidence that level of displacement is around 30 to 40% (MacArthur Green 2021). The results from the Beatrice study are from a wind farm where high

[73] Note that Race Bank was removed from the review for the puffin feature of the Coquet Island SPA following re-measurement of the distance between the project and SPA (268km) which is greater than the screening criterion based on mean maximum foraging range (+1SD) for puffin (265.4km).

numbers of puffin occur, in particular during the breeding period and are therefore considered most relevant to this assessment.

The level of mortality arising from displacement is also uncertain, with limited evidence on whether any displacement causes an increase in mortality and, if so, what level of mortality occurs to birds that are displaced.

During the breeding period puffins have a large potential foraging range, with a mean maximum (+1SD) of 265.4km and a maximum reported range of 383km (Woodward *et al.* 2019). The area of potential foraging habitat available is therefore between 105,069km^2 and 216,874km^2 respectively. Most foraging occurs closer to the breeding colonies, but puffins may undertake both short and long foraging trips depending on the local conditions (Fayet *et al*. 2021). However, the distance at which the wind farms subject to this assessment are to the SPAs are such that it is predicted relatively few foraging trips will occur within the footprint of each of the relevant wind farms.

Studies using time-depth recorders indicate that puffins are capable of diving to depths of 45m or greater (e.g. Jónsson 2003, Shoji *et al*. 2015). Consequently, a large proportion of their foraging range in the southern and central North Sea is within water depths at which they are known to forage. Results from tracking studies also indicate that puffins are not reliant on any specific area to feed, with birds having low foraging site fidelity and do not make repeated trips to the same area (Fayet *et al*. 2021). Consequently, their distribution is not constrained by habitat (water depth) nor are they reliant on foraging in specific areas. This strongly suggests that any birds that may be displaced would be able to find alternative foraging locations.

On this basis, for the purposes of this assessment, a precautionary 50% level of displacement and 1% mortality rate has been used.

Based on the number of puffins reported at each of the wind farm locations during the breeding and non-breeding periods (Table 4.8), the number of puffins originating from the Coquet Island SPA have been apportioned using the SNH apportioning tool (SNH 2018).

Table 4.9 presents the predicted number of puffins from Coquet Island SPA that could be impacted from the relevant offshore wind farms subject to this assessment. Based on 50% of the puffins displaced and 1% level of mortality no more than 4.4 puffins are predicted to be impacted from any of the relevant offshore wind farms during the breeding period.

Table 4.9: Estimated number of mortalities arising from a range of displacement impacts on puffins from Coquet Island SPA during the breeding period

Project	No. Disp	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mortality					2% Mortality				
Dogger Bank B	39	0.1	0.2	**0.2**	0.2	0.3	0.2	0.3	0.4	0.5	0.5
Dogger Bank A	14	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Dogger Bank C	32	0.1	0.1	**0.2**	0.2	0.2	0.2	0.3	0.3	0.4	0.4
Sofia	13	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Hornsea One	883	2.6	3.5	**4.4**	5.3	6.2	5.3	7.1	8.8	10.6	12.4
Hornsea Two	373	1.1	1.5	**1.9**	2.2	2.6	2.2	3.0	3.7	4.5	5.2
Triton Knoll	17	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2

During the non-breeding period birds from a much wider geographical area compared to that of the breeding period can occur at each of the wind farms and it is not known which breeding colonies the non-breeding season birds originate from. The assessment for the non-breeding period is based on the Biologically Defined Minimum Population Scale (BDMPS) for the North Sea and English Channel non-breeding puffin population which of 231,957 individuals and the proportion of those that originate from the Coquet Island SPA, which is 12,858 individuals (including immatures) (Furness 2015). Therefore, 5.5% of the BDMPS non-breeding period population comprises of birds from the Coquet Island SPA. On this basis it is estimated that 5.5% of the birds occurring within the wind farms are from Coquet Island SPA.

Between 4 and 113 puffins displaced from the relevant offshore wind farms during the non-breeding period are estimated to originate from Coquet Island SPA (Table 4.10). Based on a 50% displacement and a 1% level of mortality between 0 and 0.6 puffin mortalities may occur due to displacement effects from the relevant offshore wind farms (Table 4.11).

Table 4.10: Estimated number of puffins from Coquet Island SPA and the Farne Islands SPA during the non-breeding period

Project	Abundance	Relevant SPA	
	Non-Breeding	Coquet Island	The Farne Islands
Dogger Bank A	295	16	53
Dogger Bank B	743	41	133
Dogger Bank C	273	15	-
Sofia	329	18	59
Hornsea One	1,257	70	-
Hornsea Two	2,039	113	-
Triton Knoll	71	4	-

Notes: Abundance and In-combination total from Vattenfall (2019b)
Proportion of BDMPS population of 231,957 apportioned to:
Coquet Island = 5.5%
The Farne Islands = 17.9%

Table 4.11: Estimated number of mortalities arising from displacement impacts on puffins from Coquet Island SPA during the non-breeding period

Project	No. Disp	30% Disp	40% Disp	50% Disp	60% Disp	70% Disp	30% Disp	40% Disp	50% Disp	60% Disp	70% Disp
		1% mortality					2% mortality				
Dogger Bank A	16	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Dogger Bank B	41	0.1	0.2	**0.2**	0.2	0.3	0.2	0.3	0.4	0.5	0.6
Dogger Bank C	15	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Sofia	18	0.1	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.3

Hornsea One	70	0.2	0.3	**0.3**	0.4	0.5	0.4	0.6	0.7	0.8	1.0
Hornsea Two	113	0.3	0.5	**0.6**	0.7	0.8	0.7	0.9	1.1	1.4	1.6
Triton Knoll	4	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.1

The most recent breeding population surveys undertaken in 2019 reported a puffin population of 25,029 AoB (Apparently Occupied Burrows); 50,058 individuals (SMP 2021). The annual mortality rate of adult puffin is 7.6% (BTO 2022). Consequently, out of an SPA population of 50,058 adult puffins an estimated 3,804 adult puffins die each year. The loss of no more than five puffins per year due to displacement impacts from any single project is below 1% of the annual adult baseline mortality.

Based on a combined breeding and non-breeding period loss of no more than five puffins from any of relevant offshore wind farms alone and the size of the SPA breeding population, which is not in decline, it is not considered that the levels of displacement estimated will result in adverse effects for the puffin feature of Coquet Island SPA for any project alone. That is, the operation of any of the wind farms subject to this review will not affect the size of the Coquet Island SPA puffin population, its distribution, or habitat.

4.2.2 Farne Islands SPA

Puffin (Dogger Bank A&B, Sofia[74])

Puffin is a qualifying feature for the Farne Islands SPA, as part of the seabird assemblage, with a population of 43,752 AoB; 87,504 individuals (SMP 2021). Relatively low numbers of puffin occur within the footprint (plus 2km buffer) of the three relevant wind farms during the breeding period with abundance estimates of between 35 and 102 birds (Table 4.8).

Based on a mortality rate of 1% an estimated displacement caused mortality of between 0.1 and 0.3 puffins from the Farne Islands SPA may arise during the breeding period for each wind farm alone (Table 4.12).

Table 4.12: Estimated number of mortalities arising from displacement impacts on puffins from The Farne Islands SPA during the breeding period

Project	No. Disp	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mortality					2% Mortality				
Dogger Bank A	21	0.1	0.1	**0.1**	0.1	0.1	0.1	0.2	0.2	0.3	0.3
Dogger Bank B	60	0.2	0.2	**0.3**	0.4	0.4	0.4	0.5	0.6	0.7	0.8
Sofia	21	0.1	0.1	**0.1**	0.1	0.1	0.1	0.2	0.2	0.2	0.3

During the non-breeding period the estimated number of puffins from the Farne Islands SPA within the footprint of each wind farm is estimated to be between 53 and 133 individuals. Based on a 1% level of mortality between 0.3 and 0.7 puffins may die from the impacts caused

[74] Note that Hornsea Two was removed from the review for the puffin feature of the Farne Islands SPA following re-measurement of the distance between the project and SPA (266km) which is greater than the screening criterion based on mean maximum foraging range (+1SD) for puffin (265.4km).

by displacement from the relevant offshore wind farms alone during the non-breeding period (Table 4.13).

Table 4.13: Estimated number of mortalities arising from displacement impacts on puffins from the Farne Island SPA during the non-breeding period

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort					2% Mort.				
Dogger Bank A	53	0.2	0.2	**0.3**	0.3	0.4	0.3	0.4	0.5	0.6	0.7
Dogger Bank B	133	0.4	0.5	**0.7**	0.8	0.9	0.8	1.1	1.3	1.6	1.9
Sofia	59	0.2	0.2	**0.3**	0.4	0.4	0.4	0.5	0.6	0.7	0.8

For each of the relevant wind farms no more than one puffin per year from the Farne Islands is predicted to be impacted by displacement effects. The annual mortality rate of adult puffin is 7.6% (BTO 2022). Consequently, out of an SPA population of 87,504 adult puffins an estimated 6,650 adult puffins die each year. The loss of no more than one puffin per year due to displacement impacts is below 1% of the annual adult baseline mortality.

Based on a combined breeding and non-breeding period loss of no more than one puffin from any of the relevant offshore wind farms alone and the size of the SPA breeding population an adverse effects on the puffin feature of the Farne Islands SPA can be excluded.

Kittiwake (Dogger Bank A&B, Dogger Bank C, Sofia, Hornsea Projects One and Two, Triton Knoll, Race Bank)

Kittiwake is listed as a qualifying feature for the Farne Islands SPA as part of the seabird assemblage. At the time of site designation in 2015 the breeding population is cited as being 8,241 breeding adults (Natural England 2015). The most recent published population count for 2019 is 8,804 individuals and therefore since the time of designation the breeding population has remained relatively stable, with a possible slight increase (SMP 2021).

The current estimate of the mean maximum foraging range for kittiwake is 156.1 ±144.5km (Woodward *et al.* 2019). This is an increase from the previously published foraging range of 60 ±23.3km and therefore several consented projects previously considered to be beyond the foraging range during the breeding season are now within the foraging range of kittiwakes breeding on the Farne Islands SPA.

It is noted that the mean foraging range for kittiwakes breeding at the Farne Islands is 35.6km and the maximum recorded foraging range from birds breeding at this SPA is 111km (Woodward 2020). Although the sample size is relatively small (data from 19 tracked birds) it is indicative of the likely range kittiwakes from the Farne islands will typically forage. None of the projects subject to this review are within the reported maximum foraging range of kittiwakes breeding at the Farne Islands SPA.

The potential impacts on kittiwakes from collision with wind turbines has been assessed in all the applications associated with the relevant consents. The estimated number of impacts for each development both alone and in-combination has varied across projects depending on the approaches used. For the purposes of this assessment outputs from existing collision risk modelling undertaken for East Anglia 1 North and East Anglia two offshore wind farms has been used (SPR 2021a)[75].

During the non-breeding period (autumn and spring migrations) kittiwakes from breeding colonies across a wider geographical area could be impacted and therefore the estimated number of collisions during this period will be from a larger number of colonies. The BDMPS population during the spring migration period (January to April) is 627,816 individuals and, similarly, during the autumn migration period (August to December) the estimated population in the North Sea is 829,937. During both the spring and autumn passage periods 4,132 adult kittiwakes are estimated to be from the Farne Islands (Furness 2015). Consequently, the proportion of the non-breeding periods' populations that could be breeding adults from the Farne Islands SPA is 0.65% during the spring and 0.50% during the autumn.

The estimated number of collisions associated with kittiwakes from the Farne Islands SPA per year from all relevant wind farms is presented in Table 4.14.

Based on the results from the collision risk modelling undertaken for East Anglia One North and East Anglia Two, the SNCB apportioning tool and the BDMPS populations, the annual estimated number of collisions ranges from between 0.2 and 11 birds per year from each of the relevant wind farms. The SPA breeding population is 8,804 individuals (2019 count) (SMP 2021). Consequently, between 0.0% and 0.12% of the kittiwake breeding population could be impacted. The loss of between 0.1 and 11 birds per year equates to between 0.01% and 1.06% of the baseline mortality, based on an adult mortality of 11.8% (BTO, 2022).

Table 4.14: Estimated number of kittiwake collisions on the Farne Islands SPA.

Project	Estimated number of collisions							
	Breeding	Farne Islands	Spring	Farne Islands	Autumn	Farne Islands	Total	Farne Islands Total
Dogger Bank A and B	289	8.7	296	1.5	135	0.9	719	11
Dogger Bank C and Sofia	137	6.2	217	1.1	91	0.6	444	7.9
Hornsea One	44	0.7	21	0.1	56	0.4	121	1.2
Hornsea Two	16	0.2	3	0.0	9	0.1	28	0.3
Race Bank	2	0.0	6	0.0	24	0.2	31	0.2
Triton Knoll	25	0.2	46	0.2	139	0.9	209	1.3

Notes: Estimated number of collisions for each wind farm for each period from SPR (2021).
All numbers have been rounded upwards.
Proportion of BDMPS population apportioned to Farne Islands SPA:
Spring = 0.65%
Autumn = 0.50%
The total number of collisions during the breeding period presumes that all birds impacted are from SPA colonies and are breeding adults. This is highly precautionary as many kittiwakes within the mean maximum foraging range breed outwith SPAs.

[75] The selection of these modelled outputs are purely on the basis of them being the most recently published collision risk estimates that have undergone examination. Their use does not infer in any way that the outputs from collision risk modelling undertaken for other projects are in anyway deficient or incorrect.

Population Viability Analysis has been undertaken for each wind farm alone. Table 4.15 presents the estimated annual growth rate and counterfactual population size for each wind farm after 30 years. All wind farms on their own cause very little or no change to the predicted rate of annual growth. The combined Dogger Bank projects A and B have the largest predicted affect, causing a potential decrease in the growth rate of 0.15% and a difference in the counterfactual population size of 4.7% after 30 years.

Table 4.15: Predicted kittiwake growth rate and population size at the Farne Islands SPA

Impact	Annual Mortality	Counterfactual metric (after 30 years)	
		Growth rate	Population size
Dogger Bank A and B	11	0.9985	0.9534
Dogger Bank C and Sofia	7.9	0.9989	0.9667
Hornsea Project One	1.2	0.9998	0.9951
Hornsea Project Two	0.3	1.0000	0.9982
Race Bank	0.2	1.0000	1.0000
Triton Knoll	1.3	0.9998	0.9950

The kittiwake breeding population at the Farne Islands SPA has remained relatively stable since the site was designated. The results from the PVA indicate that the change in growth rate and counterfactual population will not cause a decrease in the population of more than 4.7% after 30 years from any of the wind farms subject to his review. For four wind farms (Hornsea Project One, Hornsea Project Two, Race Bank, and Triton Knoll) the predicted impacts would cause a change in the counterfactual population of less than 0.5%. On the basis that the population has remained relatively stable and the predicted relatively small decrease in the population over 30 years, it is concluded that the potential impacts from any of the wind farms subject to this review on their own will not cause an adverse effect on site integrity in view of the site's conservation objectives. That is, the operation of any of the wind farms will not affect the size of the Farne Islands SPA kittiwake population, its distribution, or habitat. Consequently, an adverse effect on site integrity from any of the projects alone can be excluded.

4.2.3 Flamborough and Filey Coast SPA

Northern gannet (Dudgeon, Race Bank, Greater Gabbard)

It is recognised that gannet are at risk of collision impacts and, potentially, from the effects of displacement. For the purposes of this assessment, the potential effects from both collision mortality and displacement have been assessed.

The mean maximum foraging range for gannet is 315.2 ±194.2km (Woodward *et al.* 2019). The Dudgeon, Race Bank and Greater Gabbard wind farms are all within the mean maximum foraging ranges of gannets breeding at the Flamborough and Filey Coast SPA. At the time of the last colony count in 2017, the breeding population for gannet at the SPA was 13,392 Apparently Occupied Sites, equivalent to 26,784 breeding adults (SMP 2021). The breeding population has increased since the time of site designation (Table 2.11). The background adult mortality rate is predicted to be 0.081 (BTO 2022), which equates to an annual adult mortality of approximately 2,169 birds per year.

Gannet collision impacts

In support of several wind farm applications extensive collision risk and population modelling has been undertaken to assess the potential impacts wind farms on gannets from the Flamborough and Filey Coast SPA and other breeding colonies. Data presented in recent wind farm applications (Vattenfall, 2019, SPR, 2021) have been included in this assessment.

The estimated number of collisions at Dudgeon, Race Bank and Greater Gabbard offshore wind farms are presented in Table 4.16 (SPR 2021).

Table 4.16: Estimated number of gannet collisions and proportion from Flamborough and Filey Coast SPA

	Breeding season		Autumn		Spring		Annual	
Wind farm	**Total**	**FFC**	**Total**	**FFC**	**Total**	**FFC**	**Total**	**FFC**
Greater Gabbard	14	0	8.8	0.4	4.8	0.3	27.6	0.7
Dudgeon	22.3	22.3	38.9	1.9	19.1	1.2	80.3	25.4
Race bank	33.7	33.7	11.7	0.6	4.1	0.3	49.5	34.6

An estimated 0.7 gannet collision mortalities per year is predicted from the Greater Gabbard project. The loss of 0.7 gannets per year equates to 0.03% of the baseline mortality.

An estimated 25 gannet collision mortalities per year is predicted from the Dudgeon project. The loss of 25 gannets per year equates to 1.2% of the baseline mortality.

An estimated 35 gannet collision mortalities per year is predicted from the Race Bank project. The loss of 35 gannets per year equates to 1.6% of the baseline mortality.

Gannet displacement impacts

The estimated number of gannets displaced from each of the relevant wind farms is presented in Table 4.17 (SPR 2021).

Table 4.17: Estimated number of gannets from Flamborough and Filey Coast SPA displaced by offshore wind farms.

	Breeding season		Autumn		Spring		Annual	
Wind farm	**Total**	**FFC**	**Total**	**FFC**	**Total**	**FFC**	**Total**	**FFC**
Greater Gabbard	252	0	69	3.3	105	6.5	426	9.8
Dudgeon	53	53	25	1.2	11	0.7	89	54.9
Race bank	92	92	32	1.5	29	1.8	153	95.3

There is evidence that gannets do avoid operating wind farms and that displacement levels of greater than 60% can occur (Cook *et al*. 2018; Skov *et al*. 2018). The potential impact from displacement for a species with an extensive foraging range and available prey occurring over a very wide geographical area, is predicted to be low. For the purposes of this assessment a range of displacement and mortality levels are presented, with an 80% level of displacement and 1% rate of mortality being considered most appropriate on the basis of evidence indicating relatively high levels of displacement and the very large area across which gannet are able to forage and find prey. The estimated number of mortalities caused by the effects of displacement on gannet for each of the wind farms during the breeding period is presented in Table 4.18 and during the non-breeding period in Table 4.19.

Based on a level of 80% displacement and 1% mortality, Greater Gabbard offshore wind farm could cause the mortality of up to 0.1 gannets per year, Dudgeon 0.4 birds per year and Race Bank 0.7 birds per year.

Table 4.18: Estimated number of mortalities arising from displacement impacts on gannet from the Flamborough and Filey Coast SPA during the breeding period.

Project	No.	60%	70%	80%	90%	100%	60%	70%	80%	90%	100%
		1% Mort					2% Mort.				
Greater Gabbard	0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dudgeon	53	0.3	0.4	**0.4**	0.5	0.5	0.6	0.7	0.8	1.0	1.1
Race Bank	92	0.6	0.6	**0.7**	0.8	0.9	1.1	1.3	1.5	1.7	1.8

Number of gannet displaced during the breeding period from SPR (2021).

Table 4.19: Estimated number of mortalities arising from displacement impacts on gannet from the Flamborough and Filey Coast SPA during the non-breeding period.

Project	No.	60%	70%	80%	90%	100%	60%	70%	80%	90%	100%
		1% Mortality					2% Mortality				
Greater Gabbard	10	0.1	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Dudgeon	2	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Race Bank	3	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.1	0.1	0.1

Numbers of gannet displaced during the spring and autumn migration periods from SPR (2021).

Population Viability Analysis has been undertaken for each of the projects alone combining estimated collision and displacement mortalities. The results of the PVA are presented in Table 4.20.

Table 4.20: Predicted gannet growth rate and population size at the Flamborough and Filey Coast SPA.

Impact	Annual Mortality	Counterfactual metric (after 30 years)	
		Growth rate	Population size
Greater Gabbard	0.8	0.9996	0.9891
Dudgeon	25.8	0.9989	0.9653
Race Bank	35.1	0.9984	0.9530

The PVA indicates that the annual loss of between 0.8 and 35.1 gannets per year could cause a reduction in the annual growth rate of between 0.04 and 0.16% and a counterfactual population of between 1.1% and 4.7% after 30 years.

Based on the relatively low predicted collision mortality of gannets by any of the relevant wind farms on their own and the results of the PVA which indicate a potential for a negligible decline in the growth rate and small reduction in the counterfactual population, it is concluded that an adverse effect to the gannet feature of Flamborough and Filey Coast SPA can be excluded.

Guillemot (Dudgeon, Race Bank)

Guillemots are recognised to be at very low risk of any collision impacts, but there is evidence of displacement effects from several studies. The reported level of displacement has varied across studies with some results estimating levels of displacement of more than 70% (Vanermen *et al*., 2015, Welcker and Nehls, 2015). However, these studies have either only been undertaken during the non-breeding period or at wind farms beyond the foraging range of breeding guillemots. Initial results from post-construction monitoring undertaken at the Beatrice offshore wind farm indicate very little or no displacement of guillemot occur from a wind farm operating within the foraging range of breeding guillemots (MacArthur Green, 2021). A range of potential levels of displacement from between 30% and 70% and mortality levels of 1% and 2% are presented. For the purposes of this assessment a level of 50% displacement and 1% mortality has been used (Table 4.21).

The mean maximum foraging range for guillemot is 73.2 ± 80.5km (Woodward *et al.* 2019). The Dudgeon offshore wind farm and Race Bank offshore wind farm are located 126km and 100km from the Flamborough and Filey Coast SPA, respectively. Consequently, both wind farms are beyond the mean maximum foraging range during the breeding period but are within the mean maximum + 1SD. The Flamborough and Filey Coast SPA is the only designated site for which guillemot is a qualifying feature within the foraging range of both Dudgeon and Race Bank with a reported breeding population of 84,647 individuals which has remained stable or increased since the time of the original site designation (Table 2.11) (SMP, 2021). The potential impacts from displacement during the breeding period are presumed to be on adult breeding birds originating from this colony.

Peak numbers of guillemot during the breeding period at Dudgeon (including 2km buffer) was 334 individuals with 542 during the non-breeding period (SPR 2021, Vattenfall 2019).

Peak numbers of guillemot at Race Bank during the breeding period was 361 individuals with 708 during the non-breeding period (SPR, 2021, Vattenfall, 2019).

Table 4.21 presents a range of potential guillemot mortalities from Flamborough and Filey Coast SPA that could be caused by impacts from displacement by either the Dudgeon or Race Bank offshore wind farms.

Based on a level of 50% displacement and 1% mortality it is estimated that 1.7 guillemot would die annually due to displacement impacts from Dudgeon offshore wind farm and 1.8 guillemot due to impacts from the Race Bank offshore wind farm during the breeding period.

Table 4.21: Estimated number of mortalities arising from displacement impacts on guillemot from the Flamborough and Filey Coast SPA during the breeding period.

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort					2% Mort.				
Dudgeon	334	1.0	1.3	**1.7**	2.0	2.3	2.0	2.7	3.3	4.0	4.7
Race Bank	361	1.1	1.4	**1.8**	2.2	2.5	2.2	2.9	3.6	4.3	5.1

Numbers of guillemot displaced during the breeding period from (SPR 2021)

During the non-breeding period birds from a much wider geographical area could occur the wind farms. The BDMPS population for guillemot in the North Sea during the non-breeding period is 1,617,306 of which an estimated 4.4% are from the Flamborough and Filey Coast SPA (Furness, 2015). On this basis an estimated 24 guillemots displaced by Dudgeon and 31 by Race Bank during the non-breeding period originate from Flamborough and Filey Coast SPA (Table 4.22). Based on a 50% displacement and a 1% level of mortality between 0.1 and 0.2 guillemots from the Flamborough and Filey Coast SPA may die from the impacts caused by displacement from the relevant offshore wind farms (Table 4.23).

The loss of no more than two birds per year equates to 0.04% of the baseline mortality, based on an adult mortality of 6.4% (BTO 2022) from a population of 84,647 individuals.

Table 4.22: Estimated number of guillemots from Flamborough and Filey Coast SPA during the non-breeding period

Project	Abundance	Relevant SPA
	Non-Breeding	Flamborough and Filey Coast SPA
Dudgeon	542	24
Race Bank	708	31

Abundance and In-combination total from SPR 2021.
BDMPS population 1,617,306 individuals.
Proportion of BDMPS population apportioned to Flamborough and Filey Coast SPA = 4.4%:

Table 4.23: Estimated number of mortalities arising from displacement impacts on guillemot from the Flamborough and Filey Coast SPA during non-breeding period

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort					2% Mort.				
Dudgeon	24	0.1	0.1	**0.1**	0.1	0.2	0.1	0.2	0.2	0.3	0.3
Race Bank	31	0.1	0.1	**0.2**	0.2	0.2	0.2	0.2	0.3	0.4	0.4

Based on an annual loss of no more than two guillemots from either the Dudgeon offshore wind farm or from the Race Bank offshore wind farm, the size of the SPA breeding population and that the population is not in decline, an adverse effect on the integrity of the Flamborough and Filey Coast SPA can be excluded for each project alone.

Razorbill (Dudgeon, Race Bank)

Razorbill are recognised to be at low risk of collision impacts, but displacement effects have been identified. The level of displacement reported has varied across studies with some results from wind farms beyond the foraging range of any breeding razorbills suggesting relatively high levels of displacement of more than 60% (Vanermen *et al.,* 2015, Welcker and Nehls, 2015). Initial results from the Beatrice offshore wind farm indicate little or no displacement, with possible increases in abundance including within the wind farm (MacArthur Green, 2021). A range of potential levels of displacement from between 30% and 70% and mortality levels of 1% and 2% are presented in Table 4.24. For the purposes of this assessment a level of 50% displacement and 1% mortality has been used.

The mean maximum foraging range for razorbill is 88.7±75.9km (Woodward *et al.,* 2019). The Dudgeon offshore wind farm is located 126km from the Flamborough and Filey SPA and Race Bank offshore wind farm is 100km. Consequently, both wind farms are beyond the mean maximum foraging range during the breeding period but within the mean maximum foraging range plus 1SD. The Flamborough and Filey Coast SPA is the only designated site for which razorbill is a qualifying feature within the foraging range of both Dudgeon and Race Bank. Consequently, the potential impacts from displacement during the breeding period are presumed to be on birds from this colony. The breeding population is cited as being 21,140 breeding adults. The population count for 2017 is 27,967 individuals and therefore since the time of designation the breeding population has remained relatively stable, with a possible slight increase (Table 2.11).

Peak numbers of razorbill during the breeding period at Dudgeon (including 2km buffer) was 256 individuals with 346 during both the pre and post-breeding periods and 745 during the non-breeding period (SPR 2021, Vattenfall 2021).

Peak numbers of razorbill at Race Bank during the breeding period was 28 individuals with 42 during both the pre and post breeding periods and 28 during the non-breeding period (SPR 2021, Vattenfall 2021).

Table 4.24 presents the predicted number of razorbills from Flamborough and Filey Coast SPA that could be impacted from the Dudgeon and Race Bank offshore wind farms.

Based on a level of 50% displacement and 1% mortality a total of 1.3 razorbill may die annually due to displacement impacts from Dudgeon offshore wind farm and 0.1 razorbills due to impacts from the Race Bank offshore wind farm during the breeding period (Table 4.24).

Table 4.24: Estimated number of mortalities arising from displacement impacts on razorbills from the Flamborough and Filey Coast SPA during the breeding period.

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort					2% Mort.				
Dudgeon	256	0.8	1.0	**1.3**	1.5	1.8	1.5	2.0	2.6	3.1	3.6
Race Bank	28	0.1	0.1	**0.1**	0.2	0.2	0.2	0.2	0.3	0.3	0.4

Number of razorbill displaced during the breeding period from (SPR 2021).

During the passage and non-breeding periods razorbills from a much wider geographical area compared to that of the breeding period can occur at each of the wind farms and the North Sea population is augmented by a significant number of birds from more northerly colonies. For example, it is estimated that 88% of the birds present in the North Sea during passage periods are not from UK colonies (Furness 2015).

During the passage periods (autumn/post-breeding and spring/pre-breeding) an estimated 3.4% of razorbills occurring in the North Sea are from the Flamborough and Filey Coast SPA. Consequently 12 razorbills from the Flamborough and Filey Coast SPA could be impacted by Dudgeon offshore wind farm during each passage period. Race Bank offshore wind farm could impact on 1.4 razorbills each passage period (Table 4.25).

During the non-breeding period an estimated 20 razorbills from the SPA could be impacted by the Dudgeon offshore wind farm and 0.8 razorbills by the Race Bank offshore wind farm (Table 4.25).

Based on a 50% displacement and a 1% level of mortality between 0 and 0.2 razorbills may die from the impacts caused by displacement each year from the relevant offshore wind farms (Table 4.26).

Table 4.25: Estimated number of razorbills from Flamborough and Filey Coast SPA during the passage and non-breeding periods

Project	Abundance			Flamborough and Filey Coast		
	Post-breeding	Non-breeding	Pre–breeding	Post-breeding	Non-breeding	Pre–breeding
Dudgeon	346	745	346	12	20	12
Race Bank	42	28	42	1.4	0.8	1.4

Notes: Abundance and In-combination total from SPR 2021.
BDMPS population: Passage 591,874, Non-breeding 218,622 individuals.
Passage periods 3.4% from Flamborough and Filey Coast SPA.
Non-breeding period 2.7% from Flamborough and Filey Coast SPA.

Table 4.26: Estimated number of mortalities arising from displacement impacts on razorbill from the Flamborough and Filey Coast SPA during the passage and non-breeding periods combined.

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort					2% Mort.				
Dudgeon	44	0.1	0.2	**0.2**	0.3	0.3	0.3	0.3	0.4	0.5	0.6
Race Bank	4	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.1

The annual loss of 1.5 razorbills per year caused by displacement impacts arising from the Dudgeon offshore wind farm equates to 0.05% of the baseline mortality, based on an adult mortality of 10% (BTO, 2022) from a population of 27,967 individuals.

The loss of 0.1 razorbills per year caused by displacement impacts arising from the Race Bank offshore wind farm equates to 0.003% of the baseline mortality.

Based on an annual loss of less than two razorbills from either the Dudgeon offshore wind farm or from the Race Bank offshore wind farm alone, the size of the SPA breeding population and the fact that the breeding population is not in decline, an adverse effects on the integrity of the Flamborough and Filey Coast SPA can be excluded for each project alone.

Puffin (Dudgeon, Race Bank)

Puffin is a qualifying species of the Flamborough and Filey Coast SPA as part of the breeding seabird assemblage. The population has remained stable or increased since the time of site designation (Table 2.11).

The Flamborough and Filey Coast SPA is the only puffin colony within the mean maximum foraging range (+1SD) for both the Dudgeon and Race Bank wind farms. Consequently, all puffins recorded during the breeding period at these two wind farms are considered to originate from this SPA.

During the breeding period the peak abundance of puffin at both Dudgeon and Race Bank offshore wind farms was one bird (Table 4.8). During the non-breeding period the peak abundance was three birds at Dudgeon and ten birds at Race Bank out of a BDMPS non-breeding population of 231,957 birds, of which 0.41% are apportioned to the Flamborough and Filey Coast SPA (Furness 2015). Therefore, of the ten birds recorded at Race Bank, 0.04 are potentially from the Flamborough and Filey Coast SPA.

Based on a 50% level of displacement and 1% mortality an estimated 0.005 puffins may be impacted each year from each of the two wind farms. Given the very low numbers of puffins recorded at these wind farms, and taking into consideration the predicted levels of displacement and mortality, it is concluded that an adverse effect on the integrity of the puffin feature of Flamborough and Filey Coast SPA can be excluded for each Project alone.

4.2.4 Humber Estuary SPA

Avocet, black-tailed godwit, knot, dunlin, redshank and ruff (Lynn, Inner Dowsing)

No assessment has previously been undertaken in relation to Lynn and Inner Dowsing for the non-breeding features above, either alone or in-combination with other projects in the North Sea which could provide a basis of information to inform the AA. The SOSSMAT tool (Wright *et al.,* 2012) has been used in the absence of site-specific information for the projects[76], to estimate the number of birds potentially passing over the wind farms in the non-breeding season (Table 4.27). As noted above, the outputs from SOSSMAT are not attributable directly to the relevant SPA, and for those species other than whooper swan, flight heights are either not available or are poorly understood for the species considered. For the species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, although godwit are more likely to interact with turbines.

Based on the small numbers of birds predicted to potentially interact with turbines relative to the UK population and, other than avocet, the SPA population of each of the qualifying interests, which would be far greater than any collision related mortality for the species, an adverse effects on the integrity of the site from collision with the non-breeding features of the Humber Estuary SPA can be excluded for the projects alone.

[76] A year 3 post-construction monitoring report is available for Lynn and Inner Dowsing, however, no data on the species considered in this review for the Humber Estuary SPA were included.

Table 4.27: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Humber Estuary SPA

Species	Lynn	% UK popn.	Inner Dowsing	% UK popn.	UK estimated population[1]	SPA population
Avocet	44	0.51	60	0.69	8,700	59
Black-tailed godwit	276	0.67	202	0.49	41,000	1,113
Knot	919	0.35	719	0.27	265,000	28,165
Dunlin	967	0.28	678	0.19	350,000	22,222
Redshank	673	0.67	490	0.49	100,000	4,632
Ruff	3	0.33	3	0.33	920	128

Notes: [1]Woodward *et al.* (2020). The percentage relative to UK population is provided as it is this population on which the potential for interaction is based. The numbers of birds cannot be directly related to the SPA population and so are not related to this as a percentage.

4.2.5 Greater Wash SPA

Red-throated diver (Dogger Bank A&B (export cable), Race Bank)

Red-throated diver occur across the Greater Wash SPA, though higher concentrations of birds, based on aerial surveys between 2002/03 and 2005/06 (Lawson *et al.* 2016a), are located off the Lincolnshire and North Norfolk coasts, with a peak average density of 3.38 birds/km^2. Displacement of red-throated diver from the installation of the Dogger Bank A&B wind farm export cables and the operation of Race Bank have been identified as requiring appropriate assessment.

Average densities of divers within the Race Bank array area are significantly lower than the average peak and vary between 0.09 and 0.19 birds/km^2 (Lawson *et al.* 2016a), with a peak of 0.07 birds/km^2 being recorded in the array area and a 4km buffer in the original application (Centrica 2009); note these were derived from boat-based surveys. The numbers of red-throated diver within the array area of Race Bank and at 1km buffer intervals out to 12km which are also located within the Greater Wash SPA have been calculated based on the average density surface of Lawson *et al.* (2016a) – see Figure 4.1. This was completed using a GIS which selected each 1km x 1km grid cell in incremental buffers away from the array area. As the density units are in birds/km^2, the average number of birds present was taken to be the sum of the density values within each buffered area. The displacement of birds within each buffer has been calculated based on the methods outlined in Section 3.1

The displacement matrix generated for Race Bank (Table 4.28) indicates 49 birds would be displaced within the array area and out to a distance of 12km from it, representing ~3.5% of the SPA population.

The area of effective displacement has been calculated based on the area contained within each 1km displacement distance from the array area, and the displacement level assumed at each distance (see Table 4.28). For example, the area covered by the 5-6km Race Bank buffer is 20km^2, however relative to the displacement level assumed at this distance (55%), the effective area of displacement is assumed to be 11km^2. The area within 12km of the array is 319km^2 or 9% of the SPA area, with an effective displacement area of 128km^2 or 3.6% of the SPA area. Assuming a 1% mortality level is associated with such displacement, this would result in the death of <1 bird which equates to ~0.03% of the SPA population (see Section 2.4) respectively.

In the context of the estimated adult annual survival rate of 0.84 (Horswill & Robinson 2015), or 225 birds for the Greater Wash SPA, and in view of the citation population of 1,407 non-breeding individuals, the incremental mortality for the operation of Race Bank alone is negligible (0.4% of baseline mortality), even assuming displacement occurs out to 12km. Race Bank partly overlaps the boundary of the Greater Wash SPA, and while it can be concluded that impacts on the annual mortality of red-throated diver will not undermine the conservation objective to maintain or restore the population of the site's qualifying features, available evidence suggests that any overlap with apparent areas of red-throated diver use will result in some displacement which may alter the distribution of the species within the site. Studies of wind farm displacement of red-throated diver (see Section 3.1.1) generally note significant reductions in numbers within array areas, with the distance from the wind farm from which diver densities are significantly reduced being highly variable and likely subject to site-specific factors.

The reduction in numbers suggests that habitat within and close to the wind farms post-construction is less favourable to divers. The effect of this displacement on mortality is unknown, as are any effects on the populations of affected areas. For example, surveys of the Outer Thames Estuary SPA do not appear to show a corresponding population response to the estimated displacement of divers by windfarms to date (see Section 3.1.1). Race Bank is located in an area of low average bird density and at some distance from areas of higher usage which are more likely to be associated with areas of important habitat for the species. Furthermore, very low numbers of birds were recorded in surveys related to the original application (up to 0.07 birds/km^2). The monitoring data for Lincs (HiDef 2017), which also covers areas relevant to the Lynn and Inner Dowsing wind farms (all commenced operation 2008-2013), suggests a level of displacement some distance from the wind farm (8km) and a 59% reduction in diver numbers within the array area. HiDef (2017) note that WeBS data covering 2010/11 to 2014/15 indicates that there was a fourfold increase in the 5 year mean peak of divers in the Wash compared to 2002/03-2006/07, with the increase likely reflecting a combination of changes in survey method and natural variation in the abundance of the species, as noted for the Outer Thames Estuary by Webb *et al.* (2009); counts over a wider period covering the last 25 years for the Wash and North Norfolk coast show large inter-annual variation (Frost *et al.* 2021).

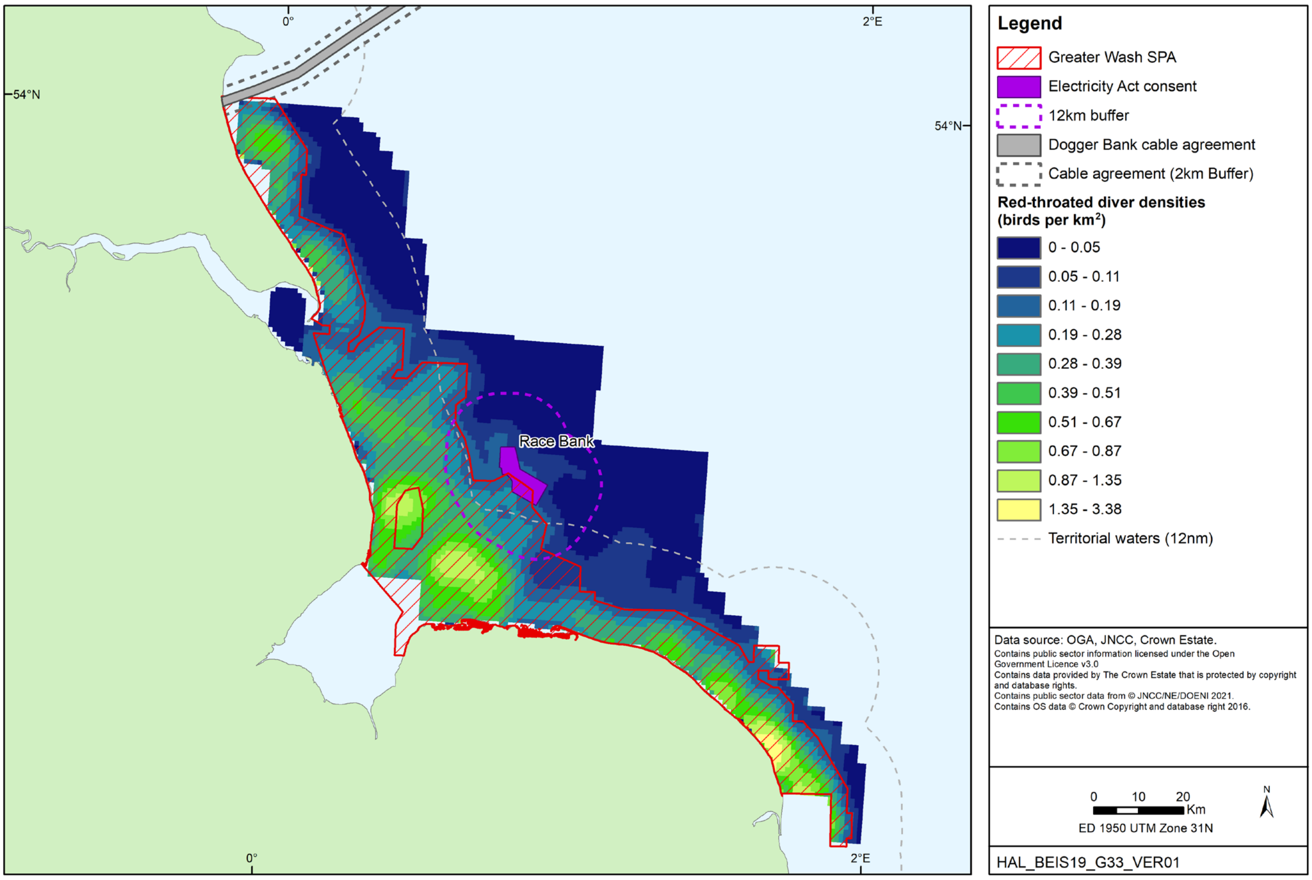
Additionally, work supporting the designation of the Greater Wash SPA notes significant variation in population between survey years (Lawson *et al.* 2016a), and variation in distribution between months and years is also noted by Dong (2016), as part of a shadow AA exercise undertaken for the Greater Wash SPA.

The evidence presented above indicates a lack of apparent population level effects from the operation of the project alone. The assessment of adverse effects on site integrity is hampered by the lack of recent site-specific population monitoring data or monitoring of the distribution of the species within the site (the basis for site selection predating the installation of Race Bank and several other wind farms in the site) including the degree of annual variation, and the absence of any published site status.

Based on an assessment of the information presented above, it is concluded that an adverse effect on the integrity of the red-throated diver feature of the Greater Wash SPA from Race Bank alone can be excluded.

The installation of the Dogger Bank A&B export cable will involve activities within and immediately adjacent to the Greater Wash SPA. The original ornithology data provided to support the consent for the project (Forewind, 2013) indicated a mean population of 4.4 birds for the export cable based on ESAS data, with a density range of 0.01-0.16 birds/km^2. Using the density surface of Lawson *et al.* (2016a) and a 2km buffer around the cable agreement for Dogger Bank A & B, a total of abundance of 4.1 birds has been estimated, from an average density of 0.18 birds/km^2 and an area of effect of 23km^2. Following the approach used in this AA (Section 3.4) for calculating the level of displacement and mortality associated with cable installation works, it is assumed that 100% of birds are displaced within 2km with a corresponding 1% mortality. It is estimated that of the ~4 birds displaced by the activities, subject to these taking place in the wintering period, there would be an associated mortality of <1 bird representing 0.003% of the SPA population. In view of the minor increment to the baseline mortality of birds in the SPA, adverse effects can be excluded for the installation of the Dogger Bank A&B export cable alone. Should works be undertaken outside of the winter season, effects can be avoided in their entirety.

Figure 4.1: Red-throated diver average density and relevant consents subject to AA in relation the Greater Wash SPA



Little tern (Dogger Bank A&B (export cable), Race Bank)

No little terns were recorded in surveys covering the Dogger Bank A&B export cable project (Forewind, 2013) or Race Bank (Centrica, 2009). While the SPA boundary and a number of relevant consents are within the mean maximum (+1SD) foraging range for the species (5km), the key colonies of relevance to the consents at Scolt Head (~30km from Race Bank) and Easington Lagoons (>40km from the Dogger Bank A&B cable), are such that interaction of foraging little terns with these projects and any associated mortality is entirely discounted, and an adverse effect on the integrity of the site can be excluded for these projects alone.

Sandwich tern (Dogger Bank A&B (export cable), Race Bank, Dudgeon, East Anglia One, East Anglia Two)

Sandwich terns associated with the Greater Wash SPA were screened in for effects relating to East Anglia One and East Anglia three. While the site boundaries for the Greater Wash SPA may be within the relevant screening criterion for collision (within the mean maximum +1SD foraging range of 57.5km), the colonies are at considerably greater distance from these consents; 125km and 117km from Blakeney for East Anglia One and East Anglia Three respectively. Both the distance from the colony, and the very low numbers of terns recorded at East Anglia One and Three (ERM 2012), are such that collision risk modelling is not considered necessary, adverse effects on integrity can be excluded for these projects alone.

Boat-based surveys for Dudgeon offshore wind farm recorded 115 Sandwich terns in the array area and a 1km buffer, with a maximum density of 2.15 birds/km^2 largely recorded between early April and through the breeding season (ECON 2009), with birds most likely related to the colonies at Blakeney Point and Scolt Head. At the time these were considered in relation to the North Norfolk Coast SPA, however, these colonies are also those which contribute to the designation of the Greater Wash SPA. Sandwich terns were also recorded in the surveys for Race Bank (Centrica 2009), with peak numbers of birds observed in April to July in 2006 and 2007. A maximum of 149 birds were recorded within the array area and a 1km buffer in July 2007 with a corresponding density of 2.66 birds/km^2.

A HRA was undertaken in relation to the consent of Race Bank and Dudgeon, along with other projects including Sheringham Shoal, Triton Knoll and Docking Shoal (DECC 2012). The HRA for these projects assumed an avoidance rate of 98.83% and an upper annual mortality threshold of 94 birds (noting that JNCC advised that a loss of 75 terns would not have an adverse effect on site integrity). It was estimated that there would be an annual mortality of 26 and 43 birds for Dudgeon and Race Bank respectively and therefore, the projects would not result in adverse effects on site integrity. The assessment at the time was made against a reference population of 6,914 individuals which compares to a population of 7,704 individuals in the citation for the Greater Wash SPA, and recent five year average population estimates based on SMP data being 8,076 and 1,648 individuals for Scolt Head and Blakeney Point respectively (see Section 2.4.10). The assessment was further updated for Race Bank by Dong (2016) for an updated scenario and to support a shadow HRA for the Greater Wash pSPA. The updated assessment, which followed the same methodology as that used in the HRA described above, predicted 16-21 collisions per annum, which is well below the 43 birds previously estimated which was also a maximum placed on the consent for the project. These updated values may be closer to a consideration of the “as built” scenario, and to be consistent, and for the purposes of this assessment, a mortality of up to 43 birds per annum is assumed. In view of the above, adverse effects on integrity can be excluded in view of the site’s conservation objectives, that are, the extent, distribution , structure, function and supporting processes of habitats on which Sandwich terns are reliant is not adversely affected, nor is the population or distribution of the feature within the site boundaries.

Common tern (Dogger Bank A&B (export cable), Race Bank)

The common tern feature of the Greater Wash SPA is centred on the colonies at Holkham, Scolt Head and Blakeney Point on the North Norfolk Coast, all of which are more than 120km from the Dogger Bank A&B export cable. In view of the mean maximum foraging range (+1SD) for the species of 26.9km, interaction with the export cable installation is not expected, and it is concluded that there will be no adverse effects from the project in view of the sites conservation objectives, that is, it will not affect the distribution, extent, structure or function, or supporting processes of the habitats of the species, or have any effect on the population or distribution of the species within the site.

Collision risk modelling undertaken for common tern at Race Bank estimated one collision per year (based on a 98% avoidance rate) (Centrica 2009). This represents approximately 0.1% of the SPA population (Section 4.2), and with an estimated adult annual mortality rate of ~12% (Horswill & Robinson 2015), this would be an increment of 0.8% to the 122 birds predicted to die each year based on the SPA population of 1,020 individuals. Adverse effects on integrity can be excluded in view of the site conservation objectives, that is, it will not affect the distribution, extent, structure or function, or supporting processes of the habitats of the species, or have any effect on the distribution of the species within the site. The estimated single common tern collision per year is not considered likely to affect the population of the site and adverse effects Greater Wash SPA from the operation of Race Bank can be excluded.

Little gull (Dogger Bank A&B (export cable), Race Bank)

Non-breeding little gull associated with the Greater Wash SPA were recorded during 2004/05 and 2005/06, with estimated densities across the site ranging from 0.02-0.89 birds/km^2 (Lawson *et al.,* 2016a). While based on only two seasons of aerial survey data, the available density surface for the species indicates a higher number of birds located off The Wash, North Norfolk Coast, and further offshore to the east of Lincolnshire and The Humber. Moderate densities of approximately 0.5 birds/km^2 were modelled for the Race Bank array area, with densities close to the Dogger Bank A&B array cable in the 0-0.02 birds/km^2 range. The population of the site is given as 1,255 individuals, which represents those birds recorded within the SPA site, however, a wider MoP population for the two seasons was 2,153 individuals – note that a seaward boundary for little gull was not defined as part of the Greater Wash SPA due to the variability in the species distribution and the limited survey data collected.

Collision risk modelling undertaken for Race Bank (Dong, 2016) estimated a collision risk of between 1 bird (99.2% avoidance) and 3 birds (98% avoidance), for both the Band Option 1 and Option 2 models. This is significantly lower than the range of 13-52 collisions using 99.5% and 98% avoidance rates as part of the original application[77], and the 21 estimated based on a 99.2% avoidance rate (SPR, 2020). These latter estimates were based on a wind farm of 206 3MW turbines, the parameters for which differ significantly from the range of scenarios eventually included in the consent (see Section 2.3), i.e., up to 101 turbines, with 91 being built (this being used by Dong 2016, and also assessed by SPR, 2020). Using the most recently accepted collision mortality for little gull at Race Bank based on the 206 turbine scenario (21 birds), this would represent a 1.7% mortality of the SPA population per year, however, based on the same avoidance rate and with modelling updated to represent the as-built parameters of the wind farm, and accounting for the work of Lawson *et al.* (2015a), this reduces to 0.08% of the population (or 0.05% based on the wider surveyed population of 2,153 individuals). In each case, this would represent an increase of 8.4% and 0.4% of the annual adult mortality for the species (Horswill & Robinson, 2015) respectively.

In view of the consent conditions on Race Bank which were made for the purposes of limiting the effect of this and other projects on Sandwich tern (i.e., that no more than 101 turbines may be constructed, significantly less than the 206 turbine scenario on which 21 collisions are based), a consented collision mortality closer to that assessed by Dong (2016) is considered to be appropriate. On this basis, in view of the small numbers of birds for which a collision risk has been identified relative to the SPA population for the species, an adverse effect on the integrity of the site can be excluded for Race Bank alone.

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[77] As noted in Table 6.3.34 of Chapter 6, in: Centrica (2009)

The installation of the Dogger Bank A&B export cable will involve activities within and immediately adjacent to the Greater Wash SPA. No data was provided on the density of little gull within the nearshore or landfall area, though data underpinning the assessment of these areas did not note little gull as a species to be subject to assessment (Forewind, 2013), and the data presented in Lawson *et al.* (2016a) suggests this area is not used by the species in any sizeable number. Little gull have a low sensitivity to ship traffic (Fliessbach *et al.,* 2019), and so the activities associated with the landfall installation for Dogger Bank A&B are unlikely to represent a significant effect for the species, moreover, interaction can be entirely avoided should the landfall activities take place in the summer months. Adverse effects on integrity from the installation of the Dogger Bank A&B export cable can be excluded.

Table 4.28: Displacement analysis for red-throated diver within Race Bank, and within a 12km buffer

Displacement distance	Area of effective displacement (km^2) (%SPA)[1]	Abundance[2]	Displacement level (%)	Mortality (%)												
				1	2	5	10	20	30	40	50	60	70	80	90	100
Within wind farm and to 1km	26 (0.74)	13.44	100	0	0	1	1	3	4	5	7	8	9	11	12	13
1-2km	12 (0.33)	5.32	91	0	0	0	0	1	1	2	2	3	3	4	4	5
2-3km	12 (0.33)	6.52	82	0	0	0	1	1	2	2	3	3	4	4	5	5
3-4km	12 (0.34)	6.06	73	0	0	0	0	1	1	2	2	3	3	4	4	4
4-5km	12 (0.34)	6.25	64	0	0	0	0	1	1	2	2	2	3	3	4	4
5-6km	11 (0.31)	7.56	55	0	0	0	0	1	1	2	2	2	3	3	4	4
6-7km	11 (0.32)	7.26	46	0	0	0	0	1	1	1	2	2	2	3	3	3
7-8km	11 (0.32)	9.40	37	0	0	0	0	1	1	1	2	2	2	3	3	3
8-9km	9 (0.27)	8.97	28	0	0	0	0	1	1	1	1	2	2	2	2	3
9-10km	7 (0.20)	10.92	19	0	0	0	0	0	1	1	1	1	1	2	2	2
10-11km	4 (0.11)	11.92	10	0	0	0	0	0	0	0	1	1	1	1	1	1
11-12km	0.4 (0.01)	14.13	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total mortality				0	1	2	5	10	15	20	24	29	34	39	44	49
% SPA population				0.03	0.07	0.17	0.35	0.70	1.04	1.39	1.74	2.09	2.44	2.78	3.13	3.48

Notes: [1]the area of effective displacement is taken here to be the area within each of the 1km buffers and the array area, relative to the percentage displacement level for each buffer. The percentage coverage of these areas relative to the entire SPA area (3,536m^2) is also noted. The percentage coverage of these areas relative to the entire SPA area (2,528km^2) is also noted. [2]indicative abundance based on Lawson *et al.* (2016b).

Common scoter (Dogger Bank A&B (export cable), Race Bank)

Common scoter were recorded in the surveys that underpinned the selection of the Greater Wash SPA. Of these, the 2006/07 survey was not used as it was deemed unrepresentative, and the spatial coverage of the surveys in the 2002/03 and 2007/08 winter seasons were not complete and did not cover the northern and southern parts of the wider survey area of search. However, these surveys did include the area where the main aggregations of common scoter occurred in the other surveys and were therefore included in the analysis. Numbers of birds were generally low, with few large flocks recorded, and there were problems in generating reliable population estimates from the data, and the mean of peak could not be used for this purpose (Lawson *et al.* 2016a). The population was, therefore, generated using a pooled detection function whereby for each winter season, total common scoter detections were divided by total survey effort. Additional information was used to inform the site selection, since the resulting population did not meet the criteria of 1% of the biogeographic population. This included shore-based data from WeBS and Norfolk Bird and Mammal Reports which helped to corroborate the scale of the population in the nearshore area.

The density surface for common scoter generated using the above survey data is shown in Figure 4.2. Race Bank is some distance offshore, and there are no scoter estimated to be present within 4km of the project. Boat-based surveys undertaken for Race Bank recorded 47 individuals in the wider ornithological study area, and eight within the wind farm and 1km buffer over 25 surveys covering two years between December 2005 to November 2007. While the Environmental Statement for Race Bank does not present a density relating to these observations, indicating that this could not be calculated, a peak density of 0.09 birds/km^2 for the August 2007 survey is noted for the array area and 1km in Appendix A23 of the document, relating to a peak count of five birds. No scoter were recorded in the Race Bank array area and 1km buffer in the wider Greater Wash regional survey of November 2004 to July 2006 (Centrica 2009). Assuming the quoted density of 0.09 birds/km^2, and considering the area of Race Bank and a 4km displacement buffer (after JNCC 2017, also see Section 3.4), at 100% displacement, mortality at the 1% and 10% levels would be in the order of between 0.2 and 2.3 birds respectively, or 0.007 and 0.069% of the SPA non-breeding population (Table 4.29).

Operational maintenance of the wind farm is undertaken from Grimsby Royal Dock in the Humber, with an estimated 244 return trips per year (Dong, 2016). The vessels largely use established shipping routes, and do not cross higher density areas of common scoter within the Greater Wash SPA (Figure 4.3).

In view of the low number of birds recorded at Race Bank across multiple surveys relative to the population recorded for the Greater Wash SPA (3,449, see Section 2.4.10), and also noting that the density surface showing the distribution of the feature within the site at the time of classification indicates no birds are within Race Bank or more than 4km distance from it, and the low likelihood of any significant disturbance from the maintenance vessel traffic, Race Bank is not considered to present any significant levels of disturbance to the species. An adverse effects on the integrity of the site can be excluded from Race Bank alone.

Similarly, the density of birds presented by Lawson *et al.* (2016a) for common scoter within 2km of the Dogger Bank A&B export cable corridor is very low. Data presented for the Dogger Bank consent application notes a mean density of scoter of 0.85 birds/km^2 for the export corridor based on data covering 1979 to 2002 and a derived population of 369.8, with relatively high numbers observed during sea watching activity at Flamborough Head. Assuming a density of 0.85 birds/km^2, noting that the data of Lawson *et al.* (2016a) suggests a much lower density in proximity to the export cable, and using the same methods as applied to red-throated diver above, it is estimated that up to 20 birds could be displaced, with a mortality of <1 bird representing 0.01% of SPA population of common scoter. In view of the minor increment to the baseline mortality of birds in the SPA, adverse effects can be excluded for the installation of the Dogger Bank A&B export cable alone. Should works be undertaken outside of the winter season, effects can be avoided in their entirety.

Figure 4.2: Common scoter average density and relevant consents in the Greater Wash SPA

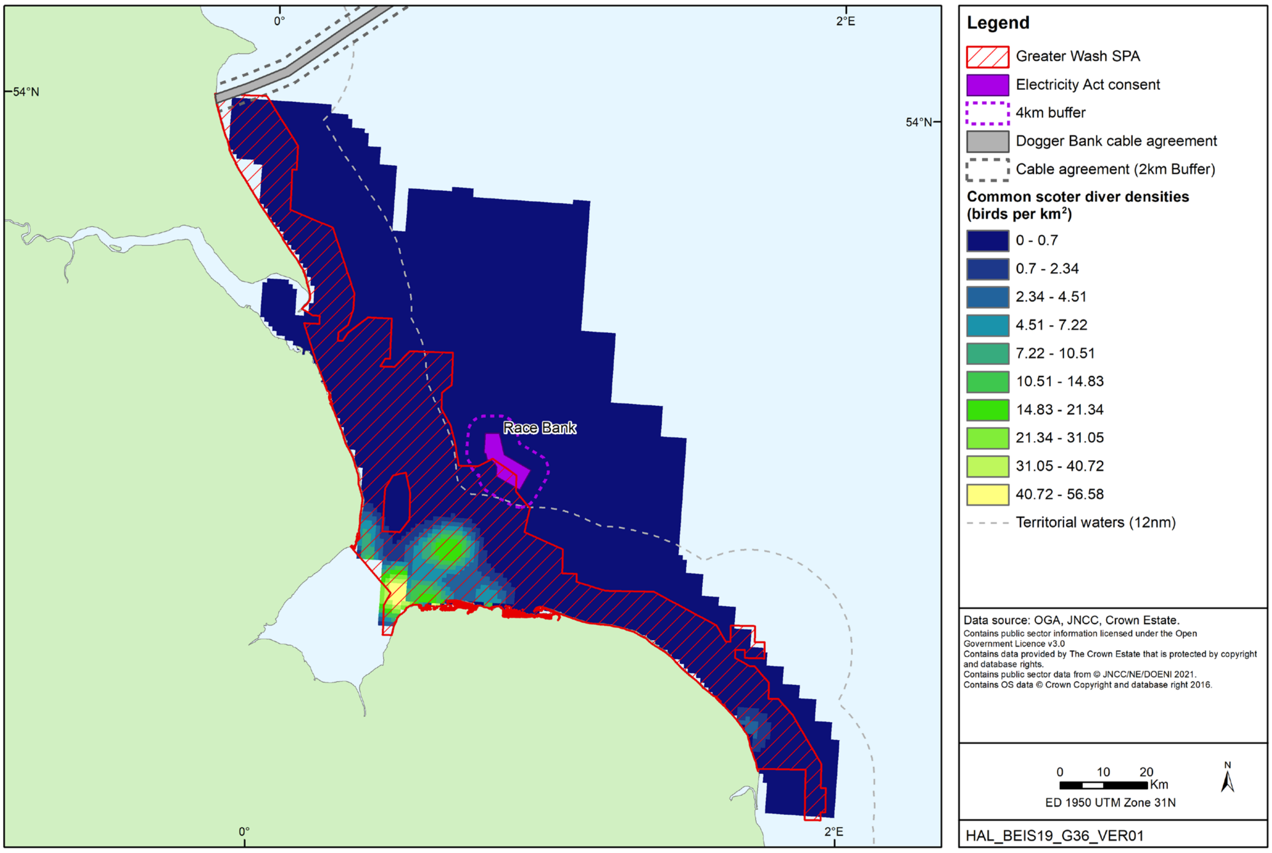


Figure 4.3: Vessel movements related to wind farm maintenance in the Greater Wash, 2020

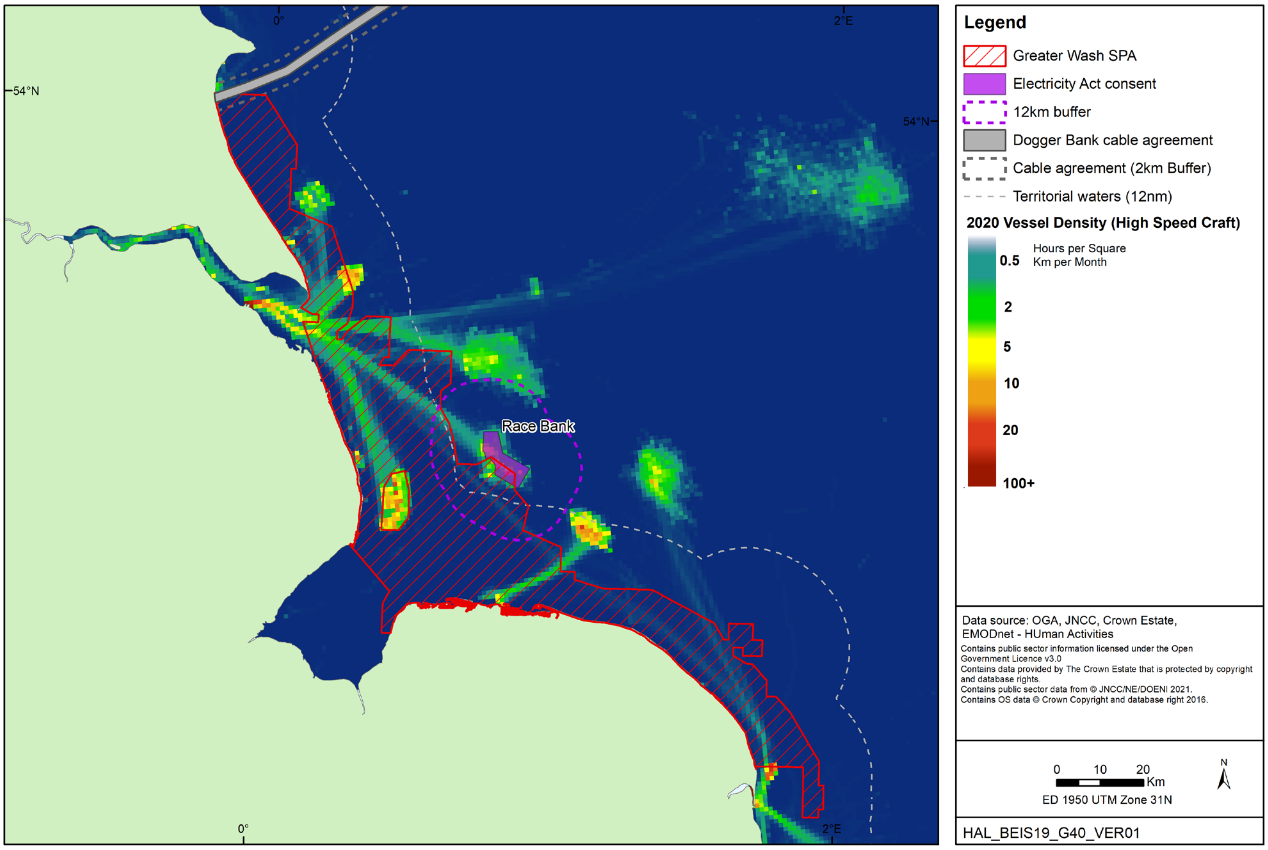


Table 4.29: Displacement matrix for common scoter within Race Bank and a 4km buffer

	Displacement (%)													
Mortality (%)	1	2	3	4	5	10	15	20	30	40	50	80	100	%SPA popn.
1	0.002	0.005	0.007	0.01	0.01	0.02	0.04	0.05	0.07	0.10	0.12	0.19	0.24	0.01
2	0.005	0.01	0.01	0.02	0.02	0.05	0.07	0.10	0.14	0.19	0.24	0.38	0.48	0.01
5	0.01	0.02	0.04	0.05	0.06	0.12	0.18	0.24	0.36	0.48	0.60	0.95	1.19	0.03
10	0.02	0.05	0.07	0.10	0.12	0.24	0.36	0.48	0.72	0.95	1.19	1.91	2.38	0.07
20	0.05	0.10	0.14	0.19	0.24	0.48	0.72	0.95	1.43	1.91	2.38	3.81	4.77	0.14
30	0.07	0.14	0.21	0.29	0.36	0.72	1.07	1.43	2.15	2.86	3.58	5.72	7.15	0.21
40	0.10	0.19	0.29	0.38	0.48	0.95	1.43	1.91	2.86	3.81	4.77	7.63	9.54	0.28
50	0.12	0.24	0.36	0.48	0.60	1.19	1.79	2.38	3.58	4.77	5.96	9.54	11.92	0.35
60	0.14	0.29	0.43	0.57	0.72	1.43	2.15	2.86	4.29	5.72	7.15	11.44	14.30	0.41
70	0.17	0.33	0.50	0.67	0.83	1.67	2.50	3.34	5.01	6.68	8.34	13.35	16.69	0.48
80	0.19	0.38	0.57	0.76	0.95	1.91	2.86	3.81	5.72	7.63	9.54	15.26	19.07	0.55
90	0.21	0.43	0.64	0.86	1.07	2.15	3.22	4.29	6.44	8.58	10.73	17.16	21.46	0.62
100	0.24	0.48	0.72	0.95	1.19	2.38	3.58	4.77	7.15	9.54	11.92	19.07	23.84	0.69

4.2.6 Outer Thames Estuary SPA

Common tern (Galloper, Greater Gabbard)

Common terns associated with the Outer Thames Estuary SPA were screened into the AA on the basis of the site boundary being within the mean maximum (+1SD) foraging range of the Galloper and Greater Gabbard wind farms. The key colonies of the site at Foulness (60km), Breydon Water (67km) and Scroby Sands (67km), are all further than this foraging range (26.9km).

Survey data collected for Galloper indicates a low abundance of birds, with a peak monthly count of four birds (Galloper Wind Farm Ltd, 2011). Higher numbers of birds were recorded in boat-based surveys of Greater Gabbard undertaken in 2008 and 2009, with pre-construction observations ranging from three birds in April, none in May, 16 in July and 34 in August; mean densities were, however, low, at 0.09 birds/km^2 for August (Greater Gabbard Offshore Wind Ltd 2008, 2009). Both sets of data reflect the distance from these wind farms to colonies associated with the Outer Thames Estuary SPA, and that the wind farm areas do not contain suitable tern foraging habitat. In view of the above, it is concluded that Galloper and Greater Gabbard will not result in adverse effects on the common tern feature of the Outer Thames Estuary SPA as a potential interaction can be excluded based on the screening criteria used in BEIS (2021), and therefore also in view of the site's conservation objectives, that is, that the projects will not adversely affect the distribution, extent, structure or function, or supporting processes of the habitats of the species, or have an adverse effect on the distribution of the species within the site.

4.2.7 Stour and Orwell Estuaries (extension) SPA

Avocet (breeding), knot, pintail, waterbird assemblage (Gunfleet Sands I)

No assessment has previously been undertaken in relation to Gunfleet Sands for the non-breeding features above, either alone or in-combination with other projects in the North Sea which could provide a basis of information to inform the AA. The SOSSMAT tool (Wright *et al.* 2012) has been used in the absence of site-specific information for the projects, to estimate the number of birds potentially passing over the wind farm in the non-breeding season (Table 4.30).

The post-construction monitoring report for the project (GoBe Consultants Ltd, 2014) recorded a low number of waterfowl, waders and sea ducks, with curlew not recorded in the array area, but with a population of 0.3 recorded within 1-2km of the wind farm. The operation of the wind farm will not cause adverse effects on the breeding avocet feature of the site. For the species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, though pintail and cormorant are more likely to interact with turbines, noting that for the latter, the blade tip height is only 107m for Gunfleet Sands I. In view of the small numbers of birds predicted to potentially cross the array area relative to the SPA and wider UK population for each of the qualifying interests, noting that these numbers do not specifically relate to the SPA in question, an adverse effect on the integrity of the site can be excluded. That is, Gunfleet Sands I will not adversely affect the distribution, extent, structure or function, or supporting processes of the habitats of the species, or have an adverse effect on the distribution of the species within the site.

Table 4.30: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Stour and Orwell Estuaries (extension) SPA

Species	Gunfleet Sands I	% UK popn.	UK estimated population[2]	SPA population
Knot	545	0.21	265,000	5,970
Pintail	41	0.21	20,000	741
Great crested grebe[1]	81	0.45	18,000	245
Cormorant[1]	70	0.11	64,500	232
Wigeon[1]	917	0.20	450,000	3,979
Gadwall[1]	113	0.36	31,000	97
Goldeneye[1]	45	0.21	21,000	213
Lapwing[1]	1,400	0.22	635,000	6,242
Curlew[1]	301	0.24	125,000	2,153

Notes: [1]Assemblage feature, [2]Woodward *et al.* (2020). The percentage relative to UK population is provided as it is this population on which the potential for interaction is based. The numbers of birds cannot be directly related to the SPA population and so are not related to this as a percentage.

4.2.8 Dungeness, Romney Marsh & Rye Bay SPA

Avocet, bittern, ruff, golden plover (Rampion)

No assessment has previously been undertaken in relation to Rampion for the non-breeding features above, either alone or in-combination with other projects in the North Sea which could provide a basis of information to inform the AA. The SOSSMAT tool (Wright *et al.,* 2012) has been used in the absence of site-specific information for the projects, to estimate the number of birds potentially passing over the wind farm in the non-breeding season (Table 4.31).

The boat-based surveys which informed the ES for the Rampion project did not record any of the species subject to assessment here. For the species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, or else there is a high degree of uncertainty (e.g., for bittern). In view of the small numbers of birds predicted to potentially interact with turbines relative to the SPA population of each of the qualifying interests, adverse effects on integrity can be excluded in view of the site’s conservation objectives. That is, Rampion will not adversely affect the distribution, extent, structure or function, or supporting processes of the habitats of the species, or have an adverse effect on the distribution of the species within the site.

Table 4.31: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Dungeness, Romney Marsh & Rye Bay SPA

Species	Rampion	%UK popn.	UK estimated population[1]	SPA population
Avocet	107	1.23	8,700	62
Bittern	1	0.13	795	5

Species	Rampion	%UK popn.	UK estimated population[1]	SPA population
Ruff	1	0.11	920	51
Golden plover	398	0.10	410,000	4,050

Notes: [1]Woodward *et al.* (2020)

Sandwich tern (Rampion)

The peak count of Sandwich terns at Rampion was 13 individuals (EoN, 2012). The mean abundance estimates for Rampion 2 (note Rampion 2 is not considered in this assessment) is 9 individuals and collision risk modelling available from the Rampion 2 Preliminary Environmental Information Report (PEIR) predicts <1 collision per year (Rampion 2 Offshore Wind Farm, 2021) and no in-combination assessment is presented.

For Rampion, Natural England advised there would be no likely significant effect on Sandwich terns at Chichester and Langstone Harbour SPA and Ramsar and Solent and Southampton Water SPA (PINS, 2014); both SPAs are closer to Rampion than Dungeness, Romney Marsh & Rye Bay SPA. Additionally, Dungeness, Romney Marsh & Rye Bay SPA was screened in for Rampion offshore wind farm on the basis of the distance between the wind farm and site boundary, much of which is a seaward extension (BEIS, 2021). The distance to the nearest colony associated with the SPA (Rye Harbour), is ~72km, and therefore greater than the mean maximum (+1SD) distance for the species of 57.5km (Woodward *et al.,* 2019) which was the basis for screening in BEIS (2021).

In view of the likely low numbers of terns that could interact with the Rampion wind farm, taking account of previous assessments in relation to Rampion, and the BEIS (2021) screening criteria, an adverse effects on the integrity of the site can be excluded. That is, the potential for interaction with the feature is excluded such that Rampion will not adversely affect the distribution, extent, structure or function, or supporting processes of the habitats of the species, or have an adverse effect on the distribution of the species within the site.

5 In-combination assessment

5.1 Irish Sea

Other plans and projects considered to be relevant to the in-combination assessment for Liverpool Bay SPA are listed in Table 5.1 below. As noted in Section 3.2, a number of projects are considered to represent a background level of effect, referred to as the baseline. The date taken to represent that background level of effect has been taken to be that which precedes the information which contributed to the site classification rather than the site classification date itself, with other factors such as whether these other projects could result in a likely significant effect for any of the features being considered (e.g., due to relative distance to the SPA sites and the nature of the projects). For example, in relation to red-throated diver, only projects which are not fully covered by the survey data which underpins the current site population estimate (see Section 2.4.5) are considered to act in-combination.

The potential impacts resulting from those consents subject to the RoC, and this HRA, have already been described in Section 4. Though a full account of these impacts is not repeated here, they are considered in-combination with the projects listed below. It should be noted that this HRA will only make conclusions in relation to the consents subject to review, and where in-combination effects are identified in relation to other projects, these should not be inferred to attach a level of significance, within the meaning of HRA, in particular for tier 4 and 5 projects which are still subject to planning and their own site-specific assessments. In addition, though not represented in Table 5.1, shipping and fishing (and in particular inshore fisheries) were well-established prior to the classification dates of relevant sites and the collection of the data which informed the site selection, and are considered to be part of the baseline.

A number of licence areas (Figure 5.1) are located within the Liverpool Bay SPA which are still within their appraisal term (CS004) or their initial term (Seaward Production Licences). While activities including seismic survey, other shallow geophysical or geotechnical survey, or exploration drilling could take place in these areas, the nature, scale and location of these is not known. Activities may take place at any time during appraisal or initial terms of these licences, and in some instances no activity may take place following desk-based exploration activities (e.g., seismic reprocessing), and the licence may be relinquished without offshore work taking place. There is insufficient definition to make a meaningful assessment of prospective activities in these licence areas, and they are categorised as Tier 5 activities for the purposes of this assessment, however these licences only provide exclusivity to one or more companies for a defined period of time, they do not confer any rights to undertake activities which are subject to additional consenting requirements under the Petroleum Act regime that includes the requirement for EIA and/or HRA.

Table 5.1: Other consented activities of relevance to the in-combination assessment

Consent name	Consent type and completion date	Status	Tier
Activities contributing to baseline levels of effect within available data			
Lennox Wellhead Platform	Petroleum Act – 1996	Operational	1
Douglas Field Platforms	Petroleum Act – 1996	Operational	1
Hamilton Wellhead Platform	Petroleum Act – 1997	Operational	1

Consent name	Consent type and completion date	Status	Tier
South Morecambe Field Platforms	Petroleum Act – 1985	Operational	1
North Hoyle	Electricity Act (S36) – 2003	Operational	1
Barrow	Electricity Act (S36) – 2006	Operational	1
Aggregate areas 392&393	Aggregates from these licence area have been produced over a 20+ year period.	Licensed and actively dredged[80]	1
Activities contributing the in-combination effects assessment			
Walney	Electricity Act (S36) – 20011/12	Operational	1
Burbo Bank	Electricity Act (S36) – 2007	Operational	1
Gwynt y Môr[1]	Electricity Act (S36) – 2013	Operational	1
Ormonde	Electricity Act (S36) – 2012	Operational	1
Rhyl Flats	Electricity Act (S36) – 2009	Operational	1
West of Duddon Sands	Electricity Act (S36) – 2014	Operational	1
Burbo Bank Extension	Planning Act – 2017	Operational	1
Walney extension[1]	Planning Act – 2018	Operational	1
Preesall gas storage[1]	Planning Act – 2015	Consented	3
South Morecambe DP3/DP4 decommissioning	Petroleum Act – 2019	Subject to decommissioning	3
Awel y Môr	Planning Act (application expected Q1 2022)	Pre-planning	5[2]
Aggregate Option and exploration area 1808	Awarded as part of the 2018/19 aggregates tender round.	Option/exploration	5[2]
Carbon storage licence CS004 (ENI UK Limited)	Energy Act 2008 – 2020	Licensed – note this does not confer approval for any activity or project	5[2]
Oil and gas licence blocks in their initial term (exploration and appraisal)	Petroleum Act – various dates	Licensed – note this does not confer approval for any activity or project	5[2]

Notes: [1]consent subject to this RoC HRA, [2]As noted in Section 3.2, Tier 5 projects are considered too ill defined and/or too early in their consenting process to be considered a source of potential effect

5.1.1 Liverpool Bay SPA

Red-throated diver

A number of projects have been identified which could have an in-combination effect on red-throated divers (Figure 5.1).

Figure 5.1: Projects considered in-combination with the relevant consents

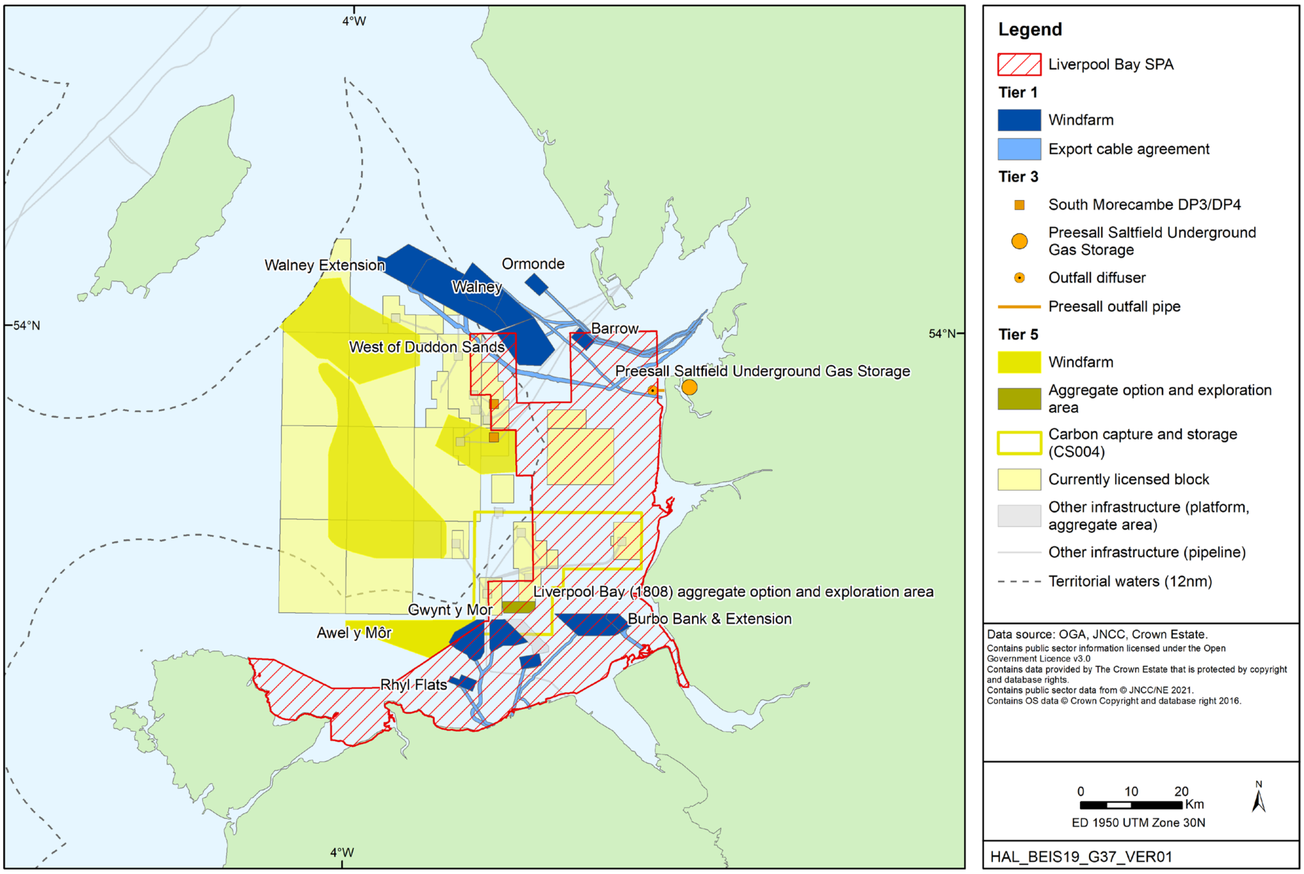


Table 5.3 indicates the predicted combined displacement of red-throated diver for offshore windfarms (see Table 5.1 for list of in-combination windfarm projects). The displacement/ mortality for the broader range of projects listed in Table 5.1 is shown in Table 5.2.

The total number of birds within 12km of the wind farms assessed is estimated to be 577 for the purpose of the model. This represents approximately 50% of the Liverpool Bay SPA red-throated diver population (see Section 2.4.5); however, it is estimated that 345 would be subject to displacement (Table 5.3), or 29.5% of the SPA population.

The area of effective displacement has been calculated based on the area contained within each 1km displacement distance from the array area, and the displacement level assumed at each distance (see Table 5.3). For example, the area covered by the 5-6km buffer for all wind farm arrays relevant to Liverpool Bay SPA is 117km^2, however relative to the displacement level assumed at this distance (55%), the effective area of displacement is assumed to be 64km^2. The overlap of buffers, including those with different displacement levels, has been accounted for such that the maximum effective area of displacement is included but without double counting any area. For completeness, the total area covered out to 12km for all wind farms considered in-combination is 1,386km^2 or 55% of the total SPA area, with an effective area of displacement of 807km^2 or 32% of SPA area.

At a 1% mortality rate the displacement of 345 birds is estimated to result in the death of three birds per year, or 0.29% of the SPA population. At the estimated annual mortality rate of 16% for adult red-throated diver, or 187 individuals, the addition of three birds is not predicted to be significant such that it would result in significant reductions on the population of the qualifying feature.

The HRA for the 2018/19 aggregates tender round concluded no likely significant effect alone or in-combination for Area 1808 in relation to Liverpool Bay SPA, however, it was noted that due to uncertainties associated with the nature of the production of aggregates, that further assessment would be required should this proceed following exploration. There is, therefore, a high level of uncertainty in terms of the nature of scale of activity which may take place within the area. Based on historical usage patterns in areas currently and previously licenced, the spatial extent and overall extraction time is relatively low on an annual basis (for example, between 1998 and 2017, the annual newly dredged area for the whole northwest licenced area varied from a maximum of 1.7km^2 in 1999 to 0.04km^2 in 2008, with a total cumulative area over the same time period of 12km^2). The density of divers located within the aggregates area and a 2km buffer is estimated to be an average of 0.02 birds/km^2, or a total of 1.38 birds. In the worst-case scenario of activity taking place in the wintering period, and assuming all birds are displaced, the resulting mortality at 1% would be 0.014 birds. As noted above, any extraction would be subject to environmental assessment which would take account of the red-throated diver feature of Liverpool Bay SPA, but for the purposes of this assessment, there is presently insufficient information to understand the scale of potential extraction from the area, or its timing in relation to the wintering period for divers in the site.

The South Morecambe DP3 and DP4 platforms are being decommissioned[78]. This involved the plugging and abandonment of wells, and will result in the removal of the topside structures and jackets using a monohull crane vessel[79]. These activities are typical of the kind that take place across fields in the North Sea and Irish Sea, and the temporary presence of a rig, construction support vessels and crane vessel are not likely to significantly add to levels of disturbance already attributable to normal field activities and wider shipping in the area. The Environmental Assessment for the Decommissioning Programme did not highlight any concerns in relation to the red-throated diver feature of the Liverpool Bay SPA, although it did not consider displacement as a source of effect.

The average density of divers located within 2km of the DP4 platform (DP3 being located 1.5km outside of the site) are very low (average 0.01 birds/km^2, with a corresponding abundance estimate of 0.16 birds). The schedule for the removal of the jackets provided in the decommissioning programme is not specific enough to understand the potential seasonal effect of the operations from an in-combination perspective, but in view of the location of the platforms, and the very low numbers of divers present, no diver mortality is predicted.

Table 5.2: In-combination red-throated diver mortality

Consent name	Average density (birds/km^2)	Estimated abundance	Estimated mortality
Activities contributing the in-combination effects assessment			
Preesall gas storage[1]	0.12	1.8	0.02
South Morecambe DP3/DP4 decommissioning	0.01 (DP4)	0.16	none
Wind farms (Gwynt y Môr, Burbo Bank, Burbo Bank Extension, Rhyl Flats, West of Duddon Sands, Walney, Walney Extension) – see Table 5.3	-	576	3

[78] https://www.gov.uk/guidance/oil-and-gas-decommissioning-of-offshore-installations-and-pipelines (accessed October 2021)
[79] https://www.spirit-energy.com/newsroom/press-releases/dp3-dp4-removal-by-pioneering-spirit/ (accessed October 2021)

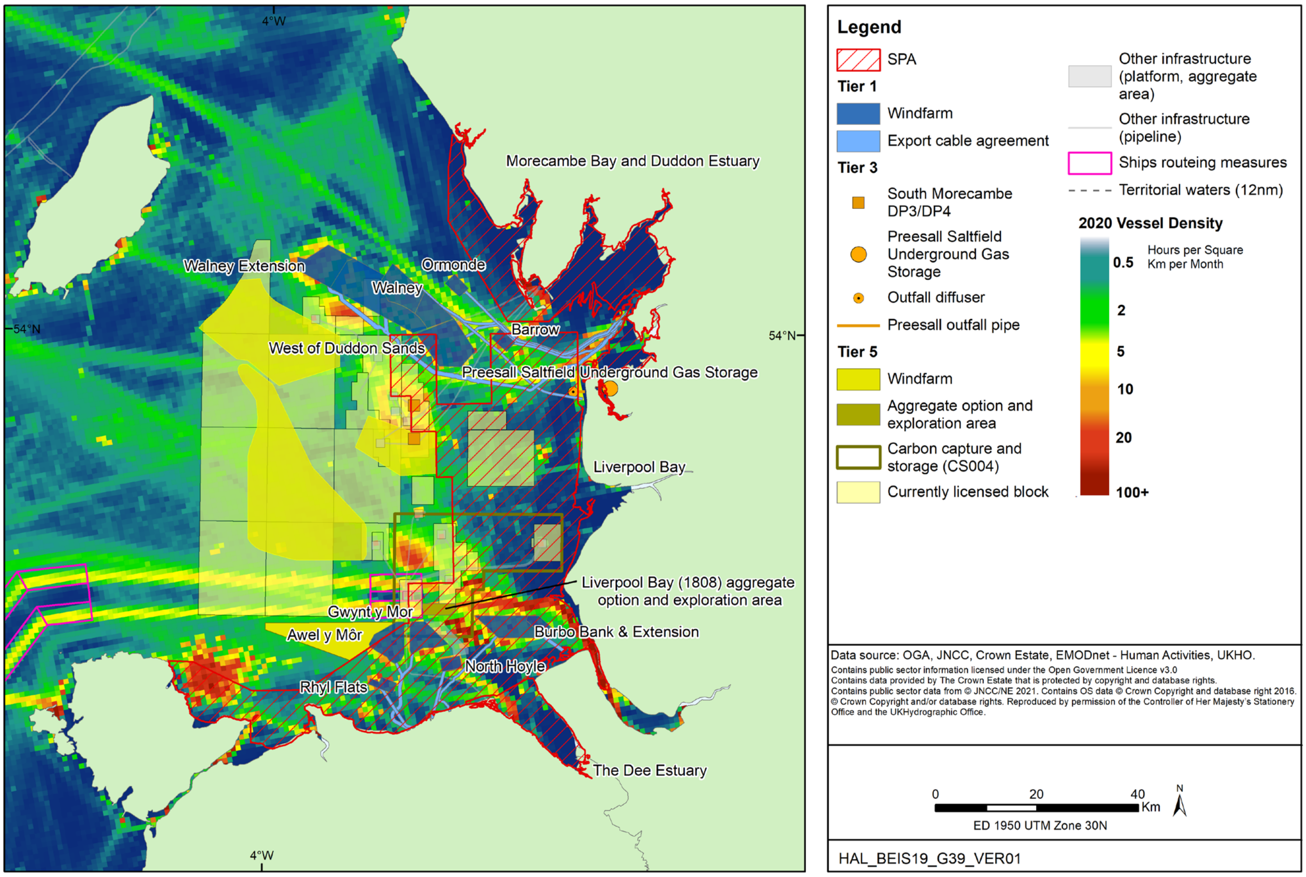
Note:[1]effects from Preesall Gas Storage would only occur if activities are undertaken in the wintering period. As noted in Section 4.1.1, the timing of installation is proposed for between the months of April and July, negating impacts on red-throated diver.

Based on the estimated mortality resulting from the projects relevant to this assessment (Table 5.2), in-combination with other relevant plans and projects, the population of the red-throated diver qualifying feature will not be adversely affected and the conservation objective specifically relating to population will not be undermined. This should also be considered in the context of post-construction monitoring data (see Section 4.1.1 and below).

With regards to displacement effects, whilst the displacement model estimates that 29.5% of the red-throated diver population could be displaced by windfarms, survey data for Gwynt y Môr (APEM, 2019) covering the pre-construction, construction and post-construction periods of the development showed no evidence of displacement effects within the array, a 2km buffer or the wider survey area covering Colwyn Bay. Furthermore, it was noted that the Walney Extension is over 12km from the section of the SPA that was classified for red-throated diver and is therefore unlikely to cause displacement of red-throated divers in the SPA.

Post-construction monitoring data was also available for Ormonde (CEMAS, 2014), Walney (Walney Offshore Windfarm, 2014) and Burbo Bank (SeaScape Energy, 2009) offshore windfarms. Baseline populations of red-throated divers in vicinity of these projects was too low to detect post-construction displacement effects. For Ormonde and Walney, which lie to the north of the SPA, it is likely that the habitats here are sub-optimal for red-throated divers. For Burbo Bank, it is suggested that high levels of baseline disturbance from shipping deters birds from using the area (SeaScape Energy, 2009), (Figure 5.2).

Figure 5.2: Vessel traffic in the Irish Sea, 2020



The assessment of adverse effects on the red-throated diver feature of Liverpool Bay SPA is constrained by a lack of recent data on the red-throated diver population and distribution; the degree of annual variation; and the absence of a published site conservation status. There are also gaps in the evidence base for the post-construction displacement effects of windfarm arrays in Liverpool Bay SPA. However, the post-construction monitoring reports that are available are considered to represent the best evidence on the displacement of red-throated divers relevant to the site. Based on these reports, it is concluded that adverse effects can be excluded for Gwynt y Môr, Walney Extension and Preesall gas storage in-combination with other projects.

Table 5.3: Liverpool Bay SPA in-combination displacement analysis for red-throated diver

Displacement distance	Area of effective displacement (km^2) (%SPA)[1]	Abundance	Displacement level (%)	Mortality (%)												
				1	2	5	10	20	30	40	50	60	70	80	90	100
Within wind farm and to 1km	228 (9)	96.41	100	1	2	5	10	19	29	39	48	58	67	77	87	96
1-2km	100 (4)	44.47	91	0	1	2	4	8	12	16	20	24	28	32	36	40
2-3km	96 (3.8)	52.58	82	0	1	2	4	9	13	17	22	26	30	34	39	43
3-4km	92 (3.6)	52.16	73	0	1	2	4	8	11	15	19	23	27	30	34	38
4-5km	81 (3.2)	55.52	64	0	1	2	4	7	11	14	18	21	25	28	32	36
5-6km	64 (2.5)	55.08	55	0	1	2	3	6	9	12	15	18	21	24	27	30
6-7km	52 (2.1)	53.12	46	0	0	1	2	5	7	10	12	15	17	20	22	24
7-8km	41 (1.6)	46.94	37	0	0	1	2	3	5	7	9	10	12	14	16	17
8-9km	27 (1)	35.88	28	0	0	1	1	2	3	4	5	6	7	8	9	10
9-10km	16 (0.6)	35.21	19	0	0	0	1	1	2	3	3	4	5	5	6	7
10-11km	8 (0.3)	26.19	10	0	0	0	0	1	1	1	1	2	2	2	2	3
11-12km	1 (0.03)	23.09	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total mortality				3	7	17	35	69	104	138	173	207	242	276	311	345
% SPA population				0.29	0.59	1.47	2.95	5.90	8.85	11.79	14.74	17.69	20.64	23.59	26.54	29.49

Notes: [1] the area of effective displacement is taken here to be the area within each of the 1km buffers and the array area which overlaps the site area, relative to the percentage displacement level for each buffer. The percentage coverage of these areas relative to the entire SPA area (2,528km^2) is also noted. [2]indicative abundance based on Lawson *et al.* (2016b).

Little gull

Data sources relating to collision impacts on little gull within the Irish Sea as part of the assessment for Liverpool Bay SPA have been obtained from the individual applications (Dong, 2013a, Npower, 2005), as there is no single previously published in-combination assessment for little gull in this region. Burbo Bank Extension (not directly subject to review for little gull) and Walney Extension undertook collision risk modelling for their projects alone, but not in-combination. Some of the applications for other wind farms in the Irish Sea region, e.g., Gwynt y Môr, Barrow and Rhyl Flats do not have the information required to undertake in-combination collision risk modelling. The predicted number of little gull collisions from wind farms within the Irish Sea is presented in Table 5.4. The two wind farms that reported the highest peak abundance within the wind farm area and 4km buffer are Burbo Bank Extension (Dong, 2013c) and Walney Extension (Dong, 2013d). Each wind farm estimated one collision per year with an avoidance rate of 98%. All other wind farms for which there are data, recorded considerably fewer little gulls and are therefore predicted to have broadly proportionally lower collision impacts.

The higher number of birds recorded at Walney Extension, West of Duddon Sands and Burbo Bank Extension is consistent with the density surface for the species produced by Lawson *et al.* (2016b). The eastern extent of Gwynt y Môr is within the area bound by the maximum curvature of the species, but in lower densities than that observed further to the north in the site (though not more than that predicted for Burbo Bank Extension). Collision mortality of two little gull is predicted from available data for the Liverpool Bay SPA. It is acknowledged that the population for this species is relatively small at 319 individuals, and that mortality of two would be equivalent to 0.9% of the SPA population, though there is a large degree of inter-annual variability in the population estimates informing the site, which are based on only two years data for 2004/05 and 2005/06; no recent updates are available. An adult survival rate of 0.8 is noted for little gull by Horswill & Robinson (2015), however the authors note that there are significant information gaps relating to mortality rates for non-breeding little gull in the UK. Assuming such a rate would mean the collision risk of two birds represents 3% of the baseline mortality. In view of the low overall numbers of birds recorded, and low number of collisions predicted in available data, it is concluded that adverse effects on integrity can be excluded in view of the site’s conservation objectives, that is, the projects will not adversely affect the extent, distribution, structure, function and supporting processes of habitats on which little gull are reliant, nor is the population or distribution of the feature within the site boundaries adversely affected.

Table 5.4: Reported peak abundance and estimated mortality on little gulls from wind farms in the Irish Sea

Project	Peak abundance	Estimated collisions
Barrow	-	-
Burbo Bank	0	0
Burbo Bank Extension	45	1
Gwynt y Môr	?	-
North Hoyle	3	-
Ormonde	0	0

Project	Peak abundance	Estimated collisions
Rhyl Flats	-	-
Walney Extension	28	1
Walney	7	-
West of Duddon Sands	10	-
Total	**-**	**2**

Cormorant and red-breasted merganser (Walney Extension, Preesall Saltfield Underground Gas Storage)

In addition to the displacement already accounted for in relation to Walney Extension (Section 4.1.1, <1 bird at the 1% mortality level assuming 100% displacement within 4km of the array), that for Burbo Bank Extension, Rhyl Flats, Ormonde and West of Duddon Sands has also been considered. Data is lacking to consider Walney and Gwynt y Môr, though for the latter, it was noted that cormorant was rarely observed in surveys, with birds preferring shallower, inshore waters. No cormorants were recorded in the Ormonde surveys both within the wind farm and out to 1km, which was the survey extent, and there were none recorded at West of Duddon Sands in aerial surveys covering the period August 2002 to August 2005 both within the array and out to 2km. Two cormorants were recorded in boat-based surveys covering May 2004 to September 2005. A mean peak of 62 birds was recorded within the Burbo Bank Extension array and out to 4km. Assuming all birds are displaced within Burbo Bank Extension and at a mortality rate of 1%, <1 bird would die per year from the operation of the project. Taking the available data together including both the limited numbers of birds recorded in relevant projects, and estimated mortality of <1 bird (0.11% of the SPA population), adverse effects on integrity can be excluded in view of the site's conservation objectives, and Walney Extension in combination with other plans and projects will not affect the extent, distribution, structure, function and supporting processes of habitats of the feature, nor its population or distribution within the site boundaries. Similarly, Cormorant and red-breasted merganser are both considered to be at low risk of collision (Furness *et al.* 2013, Bradbury *et al.* 2014), and in view of the low numbers of birds potentially present across the array areas of the relevant projects, adverse effects on integrity can be excluded.

For red-breasted merganser, birds were either not recorded (Walney, Burbo Bank Extension, West of Duddon Sands), displayed a coastal distribution away from the wind farm (Ormonde) or were recorded in very low numbers (Rhyl Flats). A specific value for red-breasted merganser is not available for Rhyl Flats, however, of the sea duck observed in surveys, 99% were common scoter with only 1% being merganser with a peak density of sea duck of 6.38 birds/km^2 was recorded in an aerial survey from February 2004 (ESS 2007). In view of the assessment already made for Walney Extension (Section 4.1.1) of an estimated mortality of <1 bird, and available data on the presence of red-breaster merganser in relation to those other relevant projects noted above, adverse effects on integrity can be excluded in view of the site's conservation objectives, and Walney Extension in-combination with other projects will not affect the extent, distribution, structure, function and supporting processes of habitats of the feature, nor its population or distribution within the site boundaries.

As noted in Section 4.1.1, direct disturbance of cormorant and red-breasted merganser from the installation of the brine outfall associated with the Preesall Gas Storage project is not predicted, as the information provided to support the HRA for the project indicated that construction would take place in summer months (April-July) to avoid interaction with non-breeding birds. Avoiding any interaction with the features precludes an impact in-combination with other plans and projects from such disturbance.

5.1.2 Dee Estuary SPA

Sandwich tern

There is no single data source available relating to Sandwich terns in the Irish Sea which could form the basis for an assessment for most of the relevant consents included in the in-combination assessment. The only collision risk modelling undertaken for Sandwich tern in the Irish Sea has been for Burbo Bank Extension (Dong, 2013a) for which three collisions per year were estimated using a 98% avoidance rate (Table 5.5); the peak abundance at the Burbo Bank Extension was 177 individuals which is considerably higher than those reported for other wind farms in the Irish Sea. This abundance is consistent with the location of Burbo Bank Extension relative to the Dee Estuary SPA and the other wind farms in the Irish Sea, along with the abundance of birds recorded there.

The population of Sandwich tern at the site has increased from the 957 individuals included in the citation (5 year mean 1995-1999) to a more recent count of 1,623 individuals (5 year mean 2015/16-2019/20). A mortality of three birds would represent 0.3% of the citation population or 0.18% of the more recent count. Based on the available data for Sandwich tern collision mortality for projects relevant to the in-combination effects assessment, effects on the population of the feature are not predicted, and adverse effects on integrity can be excluded. That is, the projects will not adversely affect the extent, distribution, structure, function and supporting processes of habitats on which Sandwich terns are reliant, nor is the population or distribution of the feature within the site boundaries.

Table 5.5: Estimated peak populations and collision impacts on Sandwich tern in the Irish Sea and Greater Wash

Project	Peak abundance	Estimated collisions
Barrow	?	?
Burbo	-	-
Burbo Bank Extension	177	3
Gwynt y Môr	<10	No CRM
North Hoyle	-	-
Ormonde	2	No CRM
Rhyl Flats	-	-

Non-breeding waterbirds: teal, grey plover, dunlin, black-tailed godwit and curlew

There are no data from previous assessments of relevant projects to inform the in-combination assessment. In the absence of site-specific information, the SOSSMAT tool (Wright *et al.* 2012) has been used to estimate the number of birds potentially passing over the relevant wind farms in the non-breeding season, based on the UK populations of relevant species in Woodward *et al.* (2020).

All the wind farms in the Irish Sea noted in Table 5.1 have been included. The values presented are based on a number of assumptions and cannot be specifically related to the Dee Estuary SPA, but provide some indication of the potential for interaction with the relevant species (Table 5.6). Consideration of in-combination effects using the SOSSMAT tool is also complicated by the arrangement of certain project areas that could result in double counting, such that those figures presented below are considered to be highly conservative. Flight heights are either not available or are poorly understood for the species considered, and birds on migration may not pass through the rotor swept areas of turbines. For the species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, though ducks and godwit are more likely to interact with turbines.

In view of the relatively small numbers of birds predicted to pass through the project array areas relative to the UK population, assuming an avoidance rate of 98%, the low level of potential interaction during migration, and a lack of interaction over winter, adverse effects on site integrity from the operation of Walney, West of Duddon Sands, Ormonde, Gwynt y Môr, in-combination with other relevant wind farm projects, can be excluded.

5.1.3 Mersey Narrows and Wirral Foreshore SPA

Non-breeding waterbirds: bar-tailed godwit and knot; Waterbird assemblage

The same approach has been taken in considering the potential for effects for the non-breeding features of the Mersey Narrows and Wirral Foreshore SPA (Table 5.7). For the species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest knot are unlikely to fly within the rotor swept area, though bar-tailed godwit are more likely to interact with turbines. Similarly, available flight height data for the remaining non-breeding features suggests limited potential for interaction on passage to wintering grounds, and there is no expected interaction over winter.

In view of the relatively small numbers of birds predicted to pass through the project array areas relative to the UK population, assuming an avoidance rate of 98%, the low level of potential interaction during migration, and a lack of interaction over winter, adverse effects on site integrity from the operation of Gwynt y Môr, in-combination with other relevant wind farm projects, can be excluded.

Table 5.6: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Dee Estuary SPA

Species	Gwynt y Môr	%UK popn.	Walney	%UK popn.	West of Duddon Sands	%UK popn.	Ormonde	%UK popn.	Burbo Bank extension	%UK popn.	Rhyl Flats	%UK popn.	Walney extension	%UK popn.	%UK population at 98% avoidance for all wind farms	UK Estimated population[1]	SPA population
Teal	5,794	1.33	6,908	1.59	4,957	1.14	1,987	0.46	5,769	1.33	2,554	0.59	12,785	2.94	1.87	435,000	5,251
Grey plover	178	0.53	213	0.64	153	0.46	61	0.18	178	0.53	79	0.24	394	1.18	0.75	33,500	1,643
Dunlin	2,455	0.7	2,833	0.81	1,997	0.57	807	0.23	2,415	0.69	1,061	0.30	5,348	1.53	0.97	350,000	27,769
Black-tailed godwit	546	1.33	651	1.59	467	1.14	187	0.46	544	1.33	241	0.59	1,205	2.94	1.87	41,000	1,747
Curlew	1,191	0.95	999	0.8	855	0.68	342	0.27	995	0.80	440	0.35	2,204	1.76	1.12	125,000	3,899

Notes: [1]Woodward *et al.* (2020).

Table 5.7: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Mersey Narrow and Wirral Foreshore SPA

Species	Gwynt y Môr	%UK popn.	Walney	%UK popn.	West of Duddon Sands	%UK popn.	Ormonde	%UK popn.	Burbo Bank extension	%UK popn.	Rhyl Flats	%UK popn.	Walney extension	%UK popn.	%UK population at 98% avoidance for all wind farms	UK Estimated population[1]	SPA Population
Knot	1,765	0.67	2,104	0.79	1,510	0.57	604	0.23	1,757	0.66	778	0.29	3,894	1.47	0.94	265,000	10,655
Bar-tailed godwit	264	0.49	311	0.58	222	0.41	90	0.17	262	0.49	115	0.21	579	1.08	0.69	53,500	3,344
Cormorant[1]	391	0.61	466	0.72	334	0.52	134	0.21	389	0.60	172	0.27	863	1.34	0.85	64,500	972
Oystercatcher[1]	2,031	0.67	2,422	0.79	1,738	0.57	696	0.23	2,022	0.66	895	0.29	4,482	1.47	0.94	305,000	2,718
Grey plover[1]	178	0.53	213	0.64	153	0.46	61	0.18	178	0.53	79	0.24	394	1.18	0.75	33,500	593
Dunlin[1]	2,455	0.70	2,833	0.81	1,997	0.57	807	0.23	2,415	0.69	1,061	0.30	5,348	1.53	0.97	350,000	7,645
Redshank[1]	666	0.67	794	0.79	570	0.57	228	0.23	663	0.66	294	0.29	1,470	1.47	0.94	100,000	1,209

Notes: [1]Woodward *et al.* (2020)

Table 5.8: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Morecambe Bay and Duddon Estuary SPA

Species	Gwynt y Môr	%UK popn.	Walney	%UK popn.	West of Duddon Sands	%UK popn.	Ormonde	%UK popn.	Burbo Bank Extension	%UK popn.	Rhyl Flats	%UK popn.	Walney Extension	%UK popn.	%UK population at 98% avoidance for all wind farms	UK Estimated population[1]	SPA population
Black-tailed godwit	546	1.33	651	1.59	467	1.14	187	0.46	544	1.33	241	0.59	1,205	2.94	1.87	41,000	2,413
Whooper swan	240	1.23	279	1.43	206	1.06	82	0.42	231	1.18	108	0.55	608	3.12	1.80	19,500	113
Little egret	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00	11,500	134
Ruff	6	0.65	7	0.76	5	0.54	2	0.22	6	0.65	3	0.33	14	1.52	0.93	920	8

Notes: [1]Woodward *et al.* (2020)

5.1.4 Morecambe Bay and Duddon Estuary SPA

Lesser black-backed gull

At the time of consenting the Burbo Bank Extension it was concluded that there would be no adverse effect alone or in-combination. If the same approach is followed by the RoC AA considering collision risk outputs for Walney Extension (Table 5.9) (Dong, 2014), the predicted number of collisions remains below the previously accepted level of impact. Based on the available data for lesser black-backed gull collision mortality for projects relevant to the in-combination effects assessment, effects on the population of the feature are not predicted, and adverse effects on integrity from in-combination effects can be excluded.

Furthermore, as noted in Section 4.1.5, a recent tagging study of lesser black-backed gulls associated with the South Walney colony (n=37) which is part of the Morecambe Bay and Duddon Estuary SPA, and adjacent urban areas in Barrow-in-Furness (n=32), and carried out 2016-2019 to cover the pre- and post-construction phase of Walney Extension, indicated that use of terrestrial areas dominated the time budgets of the birds, with <1% of the overall time budget or all birds spent within either Walney Extension or Burbo Bank Extension (Clewly *et al.* 2020).

Table 5.9: Estimated collision impacts during the breeding season on lesser black-backed gull

Project	Morecambe Bay SPA
Barrow	13
Burbo Bank	0
Burbo Bank Extension	26
Gwynt y Môr	3
North Hoyle	0
Ormonde	14
Rhyl Flats	0
Walney Extension	14
Walney	20
West of Duddon Sands	22
Total as assessed	**112**

Common tern

The number of common terns recorded at consented wind farms located in the Irish Sea has been low, with the highest abundance being within Burbo Bank extension at 405 individuals with an associated collision risk mortality of up to 39 individuals. In view of the common tern foraging range (mean maximum +1SD of 26.9km), it is unlikely those associated with colonies relevant to Morecambe Bay and Duddon Estuary SPA are foraging within Burbo Bank Extension, which is ~48km from the SPA site boundary. As noted in Section 4.1.5, collision risk modelling was not undertaken for this species as part of the Walney Extension, and in view of the low numbers of birds likely to be present, and accepted avoidance rates for the species, adverse effects on integrity can be excluded. This may similarly be extended to the other relevant wind farms including Walney, West of Duddon Sands and Ormonde (Table 5.10). Of the other projects for which data are available, Ormonde predicted mortality of one bird, equivalent to 0.18% of the citation population, however, it is noted that this has substantially reduced in recent years (see Section 2.4.8), such that a single collision represents 1.1% of a recent count of only 89 individuals (average 2015-2019). In view of the limited data and low levels of abundance of birds in relevant wind farms, adverse effects from the operation of Walney Extension in-combination with other projects can be excluded.

Table 5.10: Reported peak abundance and estimated mortality for common terns from wind farms in the Irish Sea

Project	Peak abundance	Estimated collisions
Burbo Bank	-	-
Burbo Bank Extension	405	16 – 39
Gwynt y Môr	13	-
Ormonde	7	1
Rhyl Flats	-	-
Walney Extension	6	-
Walney	7	-
West of Duddon Sands	15	-
Total	**-**	**40**

Sandwich tern

Data is not available on the collision risk to Sandwich tern from the relevant consents in the Irish Sea, largely because few birds were recorded, and no collision risk modelling has been undertaken other than for Burbo Bank Extension. The wind farm is just within the mean maximum foraging range +1SD for Sandwich tern (57.5km), however birds recorded at Burbo Bank may be from other sites, such as the Dee Estuary SPA (see Section 4.1.4) and the three predicted collisions may not be attributable to Morecambe Bay and Duddon Sands SPA. Based on the available evidence, adverse effects on the integrity of the site are excluded for Burbo Bank Extension, Walney Extension and Preesall Saltfield Underground Gas Storage in-combination with other plans and projects.

Table 5.11: Reported peak abundance and estimated mortality for Sandwich terns from wind farms in the Irish Sea

Project	Peak abundance	Estimated collisions
Burbo	-	-
Burbo Bank Extension	177	3
Gwynt y Môr	<10	No CRM
North Hoyle	-	-
Ormonde	2	No CRM
Rhyl Flats	-	-

Project	Peak abundance	Estimated collisions
Walney	3	No CRM
Walney Extension	6	No CRM
West of Duddon Sands	6	No CRM

Waterbird species: black-tailed godwit, whooper swan, little egret, ruff

As noted in Section 4.1.5, collision risk modelling for whooper swan has only been undertaken for Walney Extension including for within-winter movements of swans between England and Northern Ireland/ Ireland. Dong (2013b) estimated a cumulative collision risk of 3.88 birds per year based on a 98% avoidance rate, for six wind farms (Barrow, Ormonde, Robin Rigg, Walney, Walney Extension, West of Duddon Sands), though this did not account for other projects in the Irish Sea including Gwynt y Môr, Burbo Bank and Burbo Bank Extension), but given the migratory routes of birds from the north (other than little egret), these projects are of less relevance to a consideration of Morecambe Bay and Duddon Estuary SPA.

As with other non-breeding feature considerations, these numbers are not directly attributable to the Morecambe Bay and Duddon Estuary SPA, but represent the potential collision risk for the entire population of swans migrating across this area. For the other species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, though as noted above, godwit are more likely to interact with turbines and data for egret is lacking.

Both available data for collision risk in relation to whooper swan and the potential for interaction (based on a 98% avoidance rate) relative to the UK population are such that adverse effects on site integrity from the operation of Burbo Bank Extension and Walney Extension can be excluded. No in-combination effects were identified in relation to the construction of the Preesall outfall in view of the proposed timing of activities; the brine discharge levels; and the lack of interaction with any of the relevant species.

5.2 North Sea and Channel

As noted in Section 3.2, certain well established activities are considered to be part of the baseline, and were contributing to a level of disturbance/displacement prior to site classification, therefore, only those activities representing an incremental in-combination effect above that baseline are considered in this assessment.

The date of site classification may be some time following the collection of the data informing site selection, and so for the purposes of this assessment, the baseline is taken to be prior to the dates of those surveys which contributed to the populations and distributions of species of site qualifying interests. The activities identified to be part of the baseline, along with those activities which are relevant to the in-combination effects assessment, are listed in Table 5.12 and Figure 5.3 and are distinguished by their tier which reflects the level of project definition available to undertake an assessment. In addition, though not represented in Table 5.12, shipping and fishing (and in particular inshore fisheries) were well-established prior to the surveys informing the Greater Wash SPA site selection and are considered to be part of the baseline.

Table 5.12: Tier 1 to Tier 3 consented activities of relevance to the in-combination assessment for North Sea SPAs

Consent name	Consent type and completion date	Status	Tier
Activities contributing to baseline levels of effect within available data			
Aggregate areas 514/1, 106/1, 106/2, 106/3, 197, 400, 493, 481/1, 481/2, 254	Aggregates from these licence area have been produced over a 20+ year period.	Licenced and actively dredged[80]	1
Hewett Field platforms	Petroleum Act – 1983	Operating	1
Pipelines related to the Easington, Theddlethorpe and Bacton terminals	Petroleum Act – various 1975 to 2002	Operating/subject to decommissioning	1
Activities covered in the in-combination assessment			
Beatrice	Electricity Act (S36) – 2019	Operational	1
Blyth Demonstration Project	DECC (S36)/MMO – 2017	Operational	1
Dogger Bank Creyke Beck Projects A and B [1]	Planning Act	Consented/Under construction	2
Dogger Bank Teesside Projects C and Sofia [1]	Planning Act	Consented/Under construction	2
Dudgeon	Electricity Act (S36) – 2017	Operational	1
East Anglia ONE	Planning Act – 2020	Operational	1
East Anglia THREE	Planning Act	Consented	1
European Offshore Wind Deployment Centre	Electricity Act (S36) – 2018	Operational	1
Firth of Forth Alpha and Bravo	Electricity Act (S36)	Under construction	2
Galloper	Planning Act – 2018	Operational	1
Greater Gabbard	Electricity Act (S36) – 2012	Operational	1
Gunfleet Sands I and II	Electricity Act (S36) – 2010	Operational	1
Hornsea Project One	Planning Act – 2020	Operational	1
Hornsea Project Two	Planning Act	Under construction	2
Hornsea Project Three	Planning Act	Consented	3
Humber Gateway	Electricity Act (S36) – 2015	Operational	1
Hywind	Marine and Coastal Access Act – 2017	Operational	1
Inch Cape	Electricity Act (S36)	Consented	3

[80] See: The Crown Estate and the British Marine Aggregate Producers Association (2021) The area involved 23rd annual report Marine aggregate extraction 2020, and, The Crown Estate and the British Marine Aggregate Producers Association (2018) Marine aggregate dredging 1998-2017 a twenty-year review.

Consent name	Consent type and completion date	Status	Tier
Kentish Flats	Electricity Act (S36) – 2005	Operational	1
Kentish Flats Extension	Planning Act – 2015	Operational	1
Kincardine	Electricity Act (S36) – 2021	Operational	1
Lincs	Electricity Act (S36) – 2013	Operational	1
London Array	Electricity Act (S36) – 2013	Operational	1
Lynn and Inner Dowsing	Electricity Act (S36) – 2008	Operational	1
Methil	Electricity Act (S36) – 2016	Operational	1
Moray Firth (EDA)	Electricity Act (S36)	Under construction	2
Moray West	Electricity Act (S36) – 2019	Consented	3
Neart na Gaoithe	Electricity Act (S36)	Under construction	2
Norfolk Boreas	Planning Act	Consented	3
Norfolk Vanguard	Planning Act	Consented	3
Race Bank [1]	Electricity Act (S36) – 2018	Operational	1
Rampion	Planning Act – 2018	Operational	1
Scroby Sands	Electricity Act (S36) – 2002	Operational	1
Sheringham Shoal	Electricity Act (S36) – 2012	Operational	1
Teesside	Electricity Act (S36) – 2014	Operational	1
Thanet	Electricity Act (S36) – 2010	Operational	1
Triton Knoll	Planning Act	Under construction	2
Westermost Rough	Electricity Act (S36) – 2014	Operational	1
Viking Link	Marine and Coastal Access Act – 2021[2]	Under construction	2
Tolmount Field	Petroleum Act – 2020	Operational	1
York Field	Petroleum Act – 2012	Operational	1

Notes: [1]consent subject to this RoC HRA; [2]the cable works within the Greater Wash SPA are partly complete, however, post-cable lay stabilisation/protection work is ongoing. [3]As noted in Section 3.2, Tier 5 projects are considered too ill defined and/or too early in their consenting process to be considered a source of potential effect.

5.2.1 Greater Wash SPA

Red-throated diver

Several non-wind farm projects have taken place, or are taking place, in the Greater Wash SPA which include the pipelines associated with the York and Tolmount gas fields which have their landfall at Easington, and the Viking Link interconnector which is presently under construction and has its landfall at Bicker Fen in Lincolnshire. These projects all involved pipelay or cable lay barge or vessel activity in the nearshore and through the SPA and crossing areas used by non-breeding red-throated diver. The timing of the activities associated with these projects has effectively precluded the potential for significant interaction with the feature as they were all completed between the months of April and August[81], and therefore outside of the main wintering and migration periods. The exception is that of Viking Link; the first 51km of the cable has been installed in summer 2021, however, post-cable lay stabilisation/protection work is ongoing (e.g., at cable and pipeline crossings), some of which are within the Greater Wash SPA, although this was expected to be complete by October 2021.

Figure 5.3: Other relevant projects in relation to Greater Wash SPA

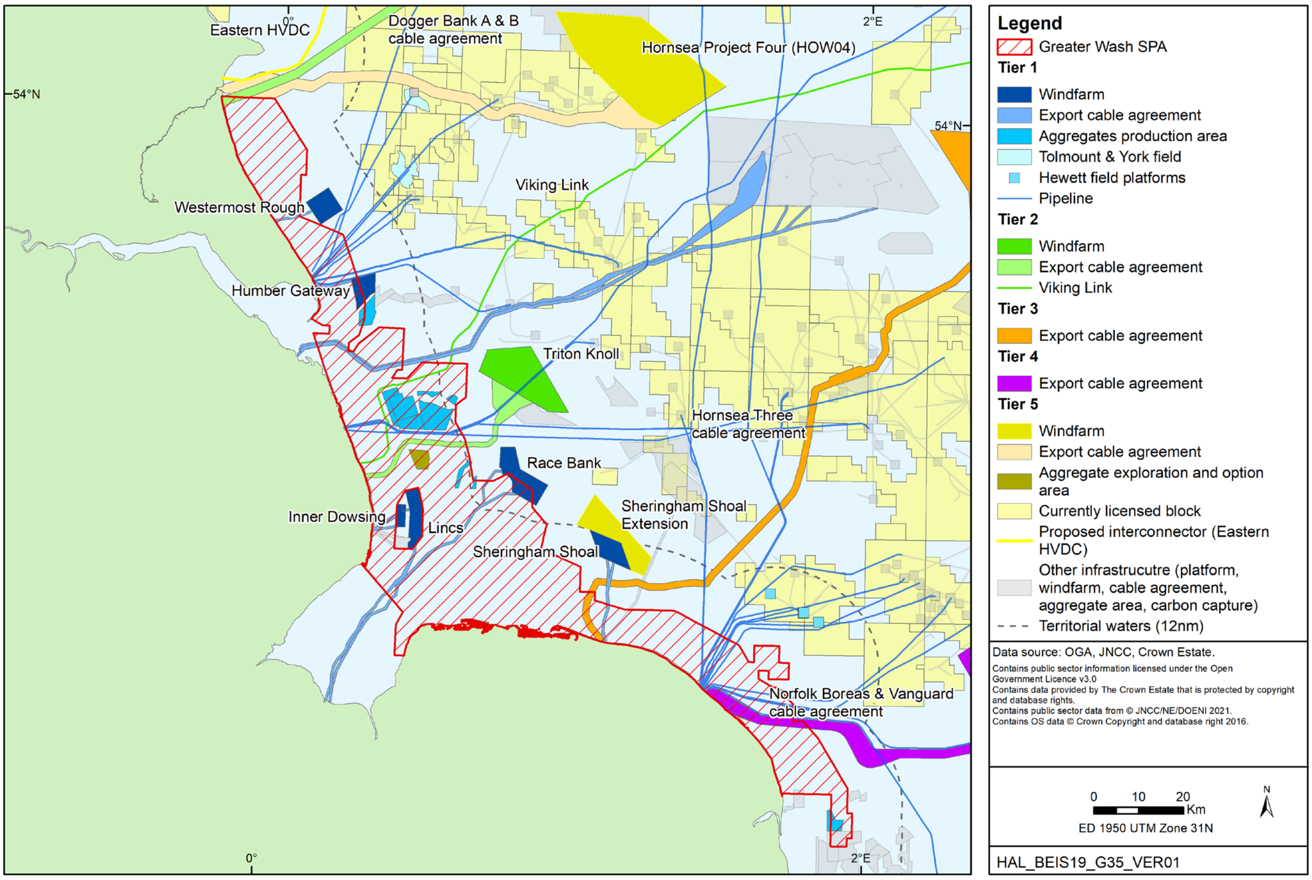


Table 5.14 indicates the predicted level of displacement of red-throated diver for all the offshore wind farms contributing to the in-combination assessment listed in Table 5.12, and the displacement/mortality for the broader range of the projects is shown in Table 5.13. The total abundance of all birds within 12km of the wind farms assessed is 812, or approximately 58% of the Greater Wash SPA red-throated diver population (see Section 2.4.10), however, it is estimated that some 423 would be subject to displacement.

The area of effective displacement has been calculated based on the area contained within each 1km displacement distance from the array area, and the displacement level assumed at each distance (see Table 5.14). For example, the area covered by the 5-6km buffer for all wind farm arrays relevant to the Greater Wash SPA is 163km^2, however relative to the displacement level assumed at this distance (55%), the effective area of displacement is assumed to be 89km^2. The overlap of buffers, including those with different displacement

[81] The York Field pipeline was installed in July 2012, Tolmount in April to August 2020, and the first 51km of the Viking Link project in May to July 2021.

levels, has been accounted for such that the maximum effective area of displacement is included but without double counting any area. For completeness, the total area covered out to 12km for all wind farms considered in-combination is 1,852m^2 or 52% of the total SPA area, though the effective displacement area has a total of 796km^2 or 22.5% of the SPA area.

At a 1% mortality rate this would equate to a mortality of 4 birds per year, or 0.3% of the SPA population. At the estimated annual mortality rate of 16% for adult red-throated diver, or 225 individuals based on the SPA population, the addition of 4 birds is not predicted to be significant such that the conservation objective of the site specifically relating to population will not be undermined.

As noted in Section 3.1.1, evidence of displacement of red-throated diver by wind farms suggests that the habitat within wind farm arrays, and around these to varying degrees, is less favourable than prior to construction due to displacement, with no evidence to date of habituation of the species to the presence of wind turbine structures. There is also no evidence of population level effects to date, with the populations relating to the Outer Thames Estuary SPA and Greater Wash SPA inferred to have increased in recent years (noting the significant inter-annual variation in populations wintering in the sites); see Sections 3.1.1 and 4.2.5.

The evidence presented above indicates a lack of apparent population level effects from the operation of the projects in-combination. The assessment of adverse effects on site integrity is hampered by the lack of recent site-specific population monitoring data, or monitoring of the distribution of the species within the site (the basis for site selection pre-dating the installation of the majority of wind farms considered) including the degree of annual variation, and the absence of any published site status. It is concluded that there are no adverse effects on the first four conservation objectives. For the fifth, maintaining or restoring the distribution of the qualifying features within the site, based on site specific data and wider evidence, on balance it is concluded that an adverse effect on the integrity of the site from the installation and operation of Race Bank in-combination with other relevant projects can be excluded.

The cable corridor for Hornsea Three and Norfolk Boreas/Vanguard also cross the Greater Wash SPA. A mortality of 0.21 birds was estimated for works associated with the Hornsea Three cable corridor, based on a 100% displacement to 2km from the works, and a 1% mortality rate (Ørsted 2018). Also, the conclusion of the HRA for the project, in-combination with other plans and projects, was that the potential increase in red-throated diver displacement and disturbance from Hornsea Three with other plans or projects would not represent an adverse effect upon the integrity of the Greater Wash SPA; note this in-combination assessment included all of those wind farms listed in Table 5.12 (BEIS 2020).

For Norfolk Vanguard, a mortality of two to four birds was estimated, similarly following an assumption of 100% displacement within 2km of the cable installation works. The maximum number of birds dispersed was estimated to be 85 based on an area of disturbance of 25.2km^2 and a peak abundance of 3.38 birds/km^2, the cable coming ashore across an area of higher density within the wider Greater Wash SPA; a mortality of 5% was assumed by the applicant. In both cases, this mortality would only arise if works were undertaken in the non-breeding period. No evidence was available for a number of other relevant wind farm export cables (Westermost Rough, Humber Gateway, Lincs, Sheringham Shoal) and so mortality was estimated for these on the same basis as that set out in Section 4.2.5. The export cables for Inner Dowsing, Triton Knoll and Race Bank were all installed in summer months (summer 2008, 2020 and 2017 respectively) and so are not considered relevant to this assessment. It is not predicted that the above sources of in-combination effect would result in an effect on the population of red-throated diver such that an adverse effect on the site integrity of the Greater Wash SPA would occur. That is because the works would not undermine the conservation objectives and adversely affect the extent, distribution, structure, function and supporting processes of habitats on which red-throated diver are reliant, nor the population or distribution of the feature within the site boundaries. This is both due to the very low levels of estimated mortality and the temporary nature of the activities.

Vessel traffic associated with the maintenance of the wind farms considered above largely use established routes from the ports in The Humber, the exception being Sheringham Shoal, which has its operational and maintenance base at Wells-next-the-Sea (Figure 4.3), and routes to the Lincs, Lynn and Inner Dowsing wind farms which have created additional traffic along the inshore area of Lincolnshire (see Section 5.7 of DECC (2016) for a comparison of vessel movement data before and after the installation of wind farms in the Greater Wash including Humber Gateway, Lincs, Lynn, Inner Dowsing and Sheringham Shoal). Maintenance traffic to the wind farms occurs year round, though there is a seasonal component to this traffic, with higher levels of activity generally recorded in the summer months. Traffic is relatively low (annual average of 0.6-2 hours/km^2/month in 2020) compared with elsewhere in the Greater Wash area, for example routes from The Humber being ~20 hours/km^2/month with those closer to the estuary mouth being substantially larger (>200 hours/km^2/month). While vessel traffic will have increased for wind farm maintenance, it is concluded that an adverse effect on the integrity of the site from the incremental presence of vessels associated with wind farm maintenance can be excluded.

Table 5.13: In-combination red-throated diver mortality, Greater Wash SPA

Consent name	Estimated abundance	Estimated mortality
Activities contributing the in-combination effects assessment		
Wind farms arrays (Humber Gateway, Westermost Rough, Scroby Sands, Inner Dowsing, Lincs, Race Bank, Triton Knoll, Sheringham Shoal)	423	4
Wind farm export cables (Hornsea Three[1], Norfolk Vanguard/Boreas[1], Dogger Bank A&B[1], Westermost Rough, Humber Gateway, Lincs, Sheringham Shoal)	21 (Hornsea Three) 85 (Norfolk Vanguard/Boreas) 4 (Dogger Bank) 6 (Westermost Rough) 13 (Humber Gateway) 33 (Lincs) 17 (Sheringham Shoal)	4.95

Notes: [1]subject to being undertaken in the wintering period

Table 5.14: Greater Wash SPA in-combination displacement analysis for red-throated diver; wind farm array areas

Displacement distance	Area of effective displacement (km^2) (%SPA)[1]	Abundance	Displacement level (%)	Mortality (%)												
				1	2	5	10	20	30	40	50	60	70	80	90	100
Within wind farm and to 1km	85 (2.4)	34.01	100	1	2	5	11	22	33	44	55	65	76	87	98	109
1-2km	75 (2.1)	39.12	91	0	1	2	5	9	14	18	23	28	32	37	41	46
2-3km	86 (2.4)	45.97	82	0	1	2	5	9	14	19	24	28	33	38	42	47
3-4km	94 (2.6)	48.92	73	0	1	2	4	9	13	17	22	26	30	35	39	43
4-5km	94 (2.7)	52.46	64	0	1	2	4	8	12	16	20	25	29	33	37	41
5-6km	89 (2.5)	59.51	55	0	1	2	4	8	12	16	20	24	28	32	36	39
6-7km	86 (2.4)	61.14	46	0	1	2	3	7	10	13	16	20	23	26	29	33
7-8km	73 (2.1)	62.11	37	0	1	1	3	5	8	11	13	16	19	21	24	27
8-9km	56 (1.6)	57.57	28	0	0	1	2	4	6	8	9	11	13	15	17	19
9-10km	37 (1.1)	58.54	19	0	0	1	1	2	4	5	6	7	9	10	11	12
10-11km	19 (0.5)	59.28	10	0	0	0	1	1	2	3	3	4	4	5	6	6
11-12km	2 (0.05)	54.89	1	0	0	0	0	0	0	0	0	0	0	0	1	1
Total mortality				4	8	21	42	85	127	169	212	254	296	339	381	423
% SPA population				0.30	0.60	1.50	3.01	6.02	9.03	12.04	15.05	18.05	21.06	24.07	27.08	30.09

Notes: [1]the area of effective displacement is taken here to be the area within each of the 1km buffers and the array area, relative to the percentage displacement level for each buffer. The percentage coverage of these areas relative to the entire SPA area (3,536m^2) is also noted. The percentage coverage of these areas relative to the entire SPA area (2,528km^2) is also noted. [2]indicative abundance based on Lawson *et al.* (2016b).

Little gull

The most recent in-combination collision risk modelling for little gull and the Greater Wash SPA is presented in SPR (2020). Wind farms to the north of The Humber including Westermost Rough, and Humber Gateway are outside of the core area used by little gull occurring within the site, and other wind farms in the region are outside of, and at some distance from, the site (e.g., the Hornsea, Norfolk and East Anglia projects). The exceptions are Lincs, Inner Dowsing and Lynn which are in close proximity to areas of higher use (see Lawson *et al.* 2016a), however, no collision risk data is available for these projects.

The total estimated annual number of collisions based on a 98% avoidance rate for available project data within the SPA site is 19 individuals per year (SPR, 2020), equivalent to 1.5% of the SPA non-breeding population (or 0.88% based on the wider population estimate of 2,153 individuals, see Section 4.2.5). There has been no recent update to the population estimate for little gull in relation to the Greater Wash SPA, and the non-breeding UK population of little gull is poorly understood. Large numbers of little gull are known to occur on passage in the Greater Wash area which are greater than the cited population, for example, the five-year average annual peak of birds observed at Hornsea Mere in September on the Holderness coast is 1,661 (15/16-19/20), although there is significant interannual variability; 4,100 were observed in 17/18 but only 420 in 19/20 (Frost *et al.* 2021). Similarly, large numbers of birds have been observed in September at Spurn with up to 10,000 in 2003, and while shore-based counts of such large flocks introduce the potential for double-counting, other notable counts at Flamborough of 8,034 in the same year indicate a likely high number of birds at this time (Hartley 2004). The wider flyway population of the southern North Sea has been previously estimated at 75,000 (Stienen *et al.* 2007). In view of the scale of the wider population, the likely annual variation, and annual adult mortality rate (Horswill & Robinson 2015, noting the uncertainty in the figure of 0.8), an adverse effect on the integrity of the site from the additional mortality of 19 birds can be excluded for the projects listed below in-combination.

Table 5.15: Estimated collision impacts on little gulls from wind farms impacting on the Greater Wash SPA

Wind farm	Annual Collisions	Avoidance Rate	Collisions updated for 99.2% avoidance rate
Triton Knoll	65	98	15[1]
Race Bank	52	98	1[2]
Sheringham Shoal	8	98	3
Total	125	-	19

Notes: [1]based on a 90 turbine scenario as per *The Triton Knoll Offshore Wind Farm (Amendment) Order 2018* which amends the development consent for the project to match the as-built parameters, [2]based on the as-built scenario of 91 turbines which is closer to the consented wind farm of 101 turbines, than that of 206 turbines assessed as part of the application or later in-combination tabulations (e.g. SPR 2020); the output reflects, amongst other things, the data of Lawson *et al.* (2016a) which was not available at the time of the original consent application

Sandwich tern

Sandwich terns have been recorded at both Dudgeon and Race Bank in moderate numbers, being associated with the Blakeney Point and Scolt Head colonies of the Greater Wash SPA.

The HRA undertaken in relation to the consent of Race Bank and Dudgeon, along with other projects including Sheringham Shoal, Triton Knoll and Docking Shoal (DECC, 2012), estimated a maximum mortality across all of the projects of 94 individuals (noting that JNCC advised that a loss of 75 terns would not have an adverse effect on site integrity).

The estimated annual mortality for the projects (excluding Docking Shoal, consent for which was refused) are shown in Table 5.16. The assessment at the time was made against a reference population of 6,914 individuals which compares to a population of 7,704 individuals in the citation for the Greater Wash SPA, and recent five-year average population estimates based on SMP data being 8,076 and 1,648 individuals for Scolt Head and Blakeney Point respectively (see Section 2.4.10). While the assessment for Race Bank was updated by Dong (2016), this more closely reflects the “as built” scenario; for the purposes of this assessment, the previous mortality of up to 43 birds per annum is assumed. The projects of Lynn, Lincs and Inner Dowsing, while within the foraging range of Sandwich tern, were not included in the assessment as it was noted that the terns did not routinely cross the Lynn Deeps, with birds concentrated to the east of the channel. While this appears to be largely the case, Sandwich terns have been recorded at Lynn, Inner Dowsing and Lincs wind farms, however, abundance for all tern species recorded in the wind farms was relatively low, at 36 individuals post construction (HiDef 2017).

No collision risk modelling for Sandwich tern is available for Lynn, Lincs and Inner Dowsing to inform this assessment, however, in view of the previous HRA conclusions based on conservative wind farm array sizes, and the low numbers of birds recorded at Lynn, Lincs and Inner Dowsing, an adverse effect on the integrity of the site can be excluded for the projects in-combination with other projects.

Table 5.16: Estimated number of Sandwich tern collisions in the Greater Wash

Project	Estimated collisions
Dudgeon	26
Race Bank	43
Sheringham Shoal	13
Triton Knoll	8
Total	**90**

Source: DECC (2012)

Common tern

Collision risk modelling undertaken for common tern at Race Bank estimated one collision per year (based on a 98% avoidance rate). In-combination collision risk modelling undertaken for wind farms in the Greater Wash area (DOWL, 2010) estimated a total of nine collisions per year (Table 5.17). The mortality of nine individuals per year represents approximately 0.9% of the SPA population, and based on the adult survival rate of the species (0.883; Horswill & Robinson 2015) this would represent 15% of the ~60 individuals expected to die each year. Based on an assessment of the information presented above an adverse effect on the integrity of the site from the project in-combination with other projects can be excluded.

Table 5.17: Estimated number of common tern collisions from wind farms in Greater Wash area

Greater Wash projects	Estimated collisions
Dudgeon	2
Race Bank	1
Lincs	2
Lynn and Inner Dowsing	<1
Sheringham Shoal	3
Total	**9**

Source: DOWL (2010)

Common scoter

A displacement matrix for common scoter in the Greater Wash SPA is shown in Table 5.19. The assessment followed the same methods outlined in Section 4.2.5 in relation to the assessment of the species in relation to Race Bank and the Dogger Bank A&B export cable (i.e. a 4km buffer, and assuming 100% displacement, with mortality rates if 1-100% presented).

The highest densities of common scoter are located in The Wash and off the North Norfolk Coast, and are some distance from the majority of the wind farms located in the wider Greater Wash area. The in-combination effects displacement matrix considers the Humber Gateway, Westermost Rough, Scroby Sands, Sheringham Shoal, Lynn, Lincs and Inner Dowsing wind farms. Very low levels of mortality are predicted (2 to 17 birds at the 1% and 10% mortality levels) relative to the SPA population of 3,449 individuals. Vessel traffic associated with the maintenance of the wind farms considered above largely use established routes from the ports in The Humber, the exception being Sheringham Shoal, which has its operational and maintenance base at Wells-next-the-Sea. The routes avoid high density areas of common scoter and are not considered to be a source of in-combination mortality for common scoter, such that they would undermine the site's conservation objectives.

A number of non-wind farm projects have taken place, or are taking place, in the Greater Wash SPA which include the pipelines associated with the York and Tolmount gas fields which have their landfall at Easington, and the Viking Link interconnector which is presently under construction and has its landfall at Bicker Fen in Lincolnshire. These projects all involved pipelay or cable lay barge or vessel activity in the nearshore and through the SPA, though they crossed areas of lower abundance of common scoter, limiting the potential for disturbance. The timing of the activities associated with these projects has effectively precluded the potential for significant interaction with the feature as they were all completed between the months of April and August[82], and therefore outside of the main wintering and migration periods. The exception is that of Viking Link; the first 51km of the cable has been installed in summer 2021, however, post-cable lay stabilisation/protection work was ongoing later in 2021(e.g. at cable and pipeline crossings), some of which are within the Greater Wash SPA,

[82] The York Field pipeline was installed in July 2012, Tolmount in April to August 2020, and the first 51km of the Viking Link project in May to July 2021.

though these were expected to be complete by October 2021. The location of these works is outside of the area of higher scoter abundance.

Based on an assessment of the information presented above, an adverse effect on the integrity of the site can be excluded for the project in combination with other projects.

5.2.2 Humber Estuary SPA

Some recent projects have undertaken collision risk assessment of migratory non-seabird features (Hornsea Two, Norfolk Vanguard and Boreas, East Anglia Three), which has included a number of species relevant to the Humber Estuary SPA. Due to the very low numbers of birds recorded in site surveys, SOSSMAT (Wright *et al.* 2012) was used to estimate numbers of birds potentially crossing each array area, and collisions were calculated following Band (2012).

A summary of the results of collision mortality for species relevant to the Humber Estuary SPA are shown in Table 5.18 based on a precautionary 98% avoidance rate. It should be noted for this table, and for Table 5.21 and Table 5.22, that these collisions are not attributed to any particular SPA, but reflect potential mortality associated with wider migration of the species to a range of sites in the UK and beyond. None of the assessments attributed any of these collision related mortalities to the Humber Estuary SPA, despite some projects (Hornsea 1 and 2) being relatively close to the site. For the species considered, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, though godwit are more likely to interact with turbines, however, note the relatively few collisions identified for other relevant projects (e.g. Hornsea One and Two).

In view of the small numbers of birds predicted to pass through the project array areas relative to the UK population (2.6-3.6%), the low likelihood of interaction and few predicted collisions from available data (Table 5.18), adverse effects on site integrity from collision with the non-breeding features of the site from the operation of Lynn and Inner Dowsing, in-combination with other relevant projects, can be excluded.

Table 5.18: Collision mortality for species relevant to the Humber Estuary SPA for wind farms of relevance to the in-combination effects assessment, for spring and autumn migration

Species	Hornsea 2	Hornsea 3	Norfolk Vanguard	Norfolk Boreas	East Anglia Three
Knot	24	1.3	12.3	9.9	1
Black-tailed godwit	1.2	2.72	-	-	-
Dunlin	-	22.8	26.9	23	12
Redshank	-	-	1	0.8	0
Avocet	-	-	0.8	0.7	-

Source: MacArthur Green (2019a, b, c), Ørsted (2018), SmartWind (2015)

5.2.3 Stour and Orwell Estuaries (extension) SPA

As above, the SOSSMAT tool (Wright *et al.* 2012) has been used in the absence of site-specific information for the relevant projects, to estimate the number of birds potentially passing over the wind farms in the non-breeding season (Table 5.22). For the species considered below, the generic migration flight heights published in Wright *et al.* (2012) suggest waders on migration are unlikely to fly within the rotor swept area of wind farms, though pintail and cormorant are more likely to interact with turbines. In view of the small numbers of birds predicted to potentially cross the array areas relative to the SPA and wider UK population for each of the qualifying interests, noting that these numbers do not specifically relate to the SPA in question, an adverse effects on integrity can be excluded for the operation of Gunfleet Sands I in-combination with the other wind farms noted in Table 5.12, in view of the site's conservation objectives.

Table 5.19: In-combination displacement matrix for common scoter for the Greater Wash SPA

		Displacement													%SPA popn
		1	2	3	4	5	10	15	20	30	40	50	80	100	
Mortality	1	0.017	0.034	0.051	0.07	0.08	0.17	0.25	0.34	0.51	0.68	0.85	1.36	1.69	0.05
	2	0.034	0.07	0.10	0.14	0.17	0.34	0.51	0.68	1.02	1.36	1.69	2.71	3.39	0.10
	5	0.08	0.17	0.25	0.34	0.42	0.85	1.27	1.69	2.54	3.39	4.23	6.78	8.47	0.25
	10	0.17	0.34	0.51	0.68	0.85	1.69	2.54	3.39	5.08	6.78	8.47	13.55	16.94	0.49
	20	0.34	0.68	1.02	1.36	1.69	3.39	5.08	6.78	10.16	13.55	16.94	27.10	33.88	0.98
	30	0.51	1.02	1.52	2.03	2.54	5.08	7.62	10.16	15.25	20.33	25.41	40.66	50.82	1.47
	40	0.68	1.36	2.03	2.71	3.39	6.78	10.16	13.55	20.33	27.10	33.88	54.21	67.76	1.96
	50	0.85	1.69	2.54	3.39	4.23	8.47	12.70	16.94	25.41	33.88	42.35	67.76	84.70	2.46
	60	1.02	2.03	3.05	4.07	5.08	10.16	15.25	20.33	30.49	40.66	50.82	81.31	101.64	2.95
	70	1.19	2.37	3.56	4.74	5.93	11.86	17.79	23.72	35.57	47.43	59.29	94.86	118.58	3.44
	80	1.36	2.71	4.07	5.42	6.78	13.55	20.33	27.10	40.66	54.21	67.76	108.41	135.52	3.93
	90	1.52	3.05	4.57	6.10	7.62	15.25	22.87	30.49	45.74	60.98	76.23	121.97	152.46	4.42
	100	1.69	3.39	5.08	6.78	8.47	16.94	25.41	33.88	50.82	67.76	84.70	135.52	169.40	4.91

Table 5.20: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Humber Estuary SPA

Species	Lynn	% UK popn.	Inner Dowsing	% UK popn.	Dogger Bank A	Dogger Bank B	% UK popn.	Norfolk Vanguard	% UK popn.	Norfolk Boreas	% UK popn.	Hornsea 1/2	% UK popn.	Hornsea 3	% UK popn.	Triton	% UK popn.
Avocet	44	0.51	60	0.69	0	0	0.00	319	3.67	513	5.90	0	0.00	2	0.02	72	0.83
Black-tailed godwit	276	0.67	202	0.49	646	570	2.97	901	2.20	1,105	2.69	477	1.16	541	1.32	698	1.70
Knot	919	0.35	719	0.27	2,297	2,061	1.64	5,097	1.92	5,241	1.98	1,768	0.67	2790	1.05	2430	0.92
Dunlin	967	0.28	678	0.19	4,586	4,024	2.46	6,375	1.82	7,816	2.23	3,376	0.96	3,777	1.08	3,553	1.02
Redshank	673	0.67	490	0.49	1,552	1,370	2.92	2,204	2.20	2,703	2.70	1,145	1.15	1,315	1.31	1,730	1.73
Ruff	3	0.33	3	0.33	12	10	2.39	24	2.61	25	2.74	9	0.96	13	1.37	8	0.92

Table 5.21: SOSSMAT estimate of bird interaction for non-breeding features cited as part of the Humber Estuary SPA (continued)

Species	Race Bank	% UK popn.	Sheringham Shoal	% UK popn.	Westermost Rough	% UK popn.	Humber Gateway	% UK popn.	Dudgeon	% UK popn.	%UK population at 98% avoidance for all wind farms	UK estimated population[2]	SPA population
Avocet	60	0.69	66	0.76	0	0.00	0	0.00	55	0.63	2.74	8,700	59
Black-tailed godwit	397	0.97	478	1.17	419	1.02	429	1.05	332	0.81	3.64	41,000	1,113
Knot	1,346	0.51	1638	0.62	1388	0.52	1427	0.54	1155	0.44	2.28	265,000	28,165
Dunlin	2,405	0.69	2482	0.71	1919	0.55	2073	0.59	1434	0.41	2.60	350,000	22,222
Redshank	970	0.97	1174	1.17	1028	1.03	1054	1.05	824	0.82	3.65	100,000	4,632
Ruff	5	0.54	6	0.62	5	0.52	5	0.54	5	0.54	2.88	920	128

Notes: [2]Woodward *et al.* (2020)

Table 5.22: SOSSMAT estimate of bird interaction for non-breeding features cited as part of Stour and Orwell Estuaries (extension) SPA

Species	Gunfleet Sands I	% UK popn.	Gunfleet Sands II	% UK popn.	Kentish Flats	% UK popn.	Thanet	% UK popn.	London Array	% UK popn.	Greater Gabbard/Galloper	% UK popn.	East Anglia One	% UK popn.	%UK population at 98% avoidance for all wind farms	UK estimated population[2]	SPA population
Knot	545	0.21	566	0.21	446	0.17	1,746	0.66	2,114	0.80	5,019	1.89	5,329	2.01	1.19	265,000	5,970
Pintail	41	0.21	42	0.21	50	0.25	131	0.66	158	0.79	378	1.89	400	2.00	1.20	20,000	741
Great crested grebe[1]	81	0.45	84	0.47	63	0.35	260	1.44	307	1.71	623	3.46	692	3.84	2.34	18,000	245
Cormorant[1]	70	0.11	72	0.11	57	0.09	223	0.35	270	0.42	645	1.00	683	1.06	0.63	64,500	232
Wigeon[1]	917	0.20	952	0.21	749	0.17	2,936	0.65	3,553	0.79	8,473	1.88	8,976	1.99	1.18	450,000	3,979
Gadwall[1]	113	0.36	118	0.38	93	0.30	363	1.17	440	1.42	875	2.82	965	3.11	1.91	31,000	97
Goldeneye[1]	45	0.21	47	0.22	37	0.18	146	0.70	176	0.84	420	2.00	445	2.12	1.25	21,000	213
Lapwing[1]	1,400	0.22	1,454	0.23	1,131	0.18	4,469	0.70	5,398	0.85	12,856	2.02	13,394	2.11	1.26	635,000	6,242
Curlew[1]	301	0.24	313	0.25	246	0.20	965	0.77	1,168	0.93	2,617	2.09	2,872	2.30	1.36	125,000	2,153

Notes:[1]Assembalge feature, [2]Woodward *et al.* (2020)

5.2.4 Coquet Island SPA

Puffin

There is potential for in-combination impacts from displacement on puffin arising during the breeding and non-breeding periods. The estimated total number of puffins from all wind farms within 265.4km of the Coquet Island SPA during the breeding period is 1,840 individuals. Based on a level of 50% displacement and 1% mortality, it is estimated that a total of 9.2 puffins may die due to the potential impacts from displacement during the breeding period (Table 5.23).

Table 5.23: Estimated number of mortalities arising from displacement impacts on adult puffins from Coquet Island SPA during the breeding period (relevant consents are shaded)

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mortality					2% Mortality				
Blyth Demo	183	0.5	0.7	**0.9**	1.1	1.3	1.1	1.5	1.8	2.2	2.6
Teesside	18	0.1	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.3
Neart Na Gaoithe	31	0.1	0.1	**0.2**	0.2	0.2	0.2	0.2	0.3	0.4	0.4
Inch Cape	70	0.2	0.3	**0.3**	0.4	0.5	0.4	0.6	0.7	0.8	1.0
Seagreen A	53	0.2	0.2	**0.3**	0.3	0.4	0.3	0.4	0.5	0.6	0.7
Seagreen B	75	0.2	0.3	**0.4**	0.4	0.5	0.4	0.6	0.7	0.9	1.0
Kincardine	2	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dogger Bank B	39	0.1	0.2	**0.2**	0.2	0.3	0.2	0.3	0.4	0.5	0.5
Westermost Rough	15	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
AOWF	4	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Dogger Bank A	14	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Humber Gateway	5	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Sofia	13	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Hywind	14	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Hornsea Two	373	1.1	1.5	**1.9**	2.2	2.6	2.2	3.0	3.7	4.5	5.2
Triton Knoll	17	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Hornsea One	883	2.6	3.5	**4.4**	5.3	6.2	5.3	7.1	8.8	10.6	12.4
Dogger Bank C	32	0.1	0.1	**0.2**	0.2	0.2	0.2	0.3	0.3	0.4	0.4
In-comb'n Total	1,840	5.5	7.4	**9.2**	11.0	12.9	11.0	14.7	18.4	22.1	25.8

During the non-breeding period birds from a much wider geographical area compared to that of the breeding period can occur at each of the wind farms and it is not known which breeding colonies the non-breeding season birds originate from. The assessment for the non-breeding period is based on the Biologically Defined Minimum Population Scale (BDMPS) for the North Sea and English Channel non-breeding puffin population of 231,957 and the proportion of those that originate from the Coquet Island SPA which is 12,858 individuals (Furness 2015). Therefore, 5.5% of the BDMPS non-breeding period population comprises of birds from the

Coquet Island SPA. On this basis it is estimated that 5.54% of the birds occurring within the wind farms during the non-breeding period are from Coquet Island SPA.

During the non-breeding period an estimated 19,369 puffins could be displaced by offshore wind farms (Appendix 1). Based on the BDMPS estimate of 5.54% of birds originating from Coquet Island SPA, a total of 1,074 puffins from the SPA could be displaced during the non-breeding period with a possible mortality of 5.4 birds (Table 5.24).

In-combination impacts from displacement during the breeding and non-breeding periods could cause 15 puffin mortalities per year.

Table 5.24: Estimated number of mortalities arising from displacement impacts on adult puffins from Coquet Island SPA during the non-breeding period

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% mortality					2% mortality				
Dogger Bank A	16	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Dogger Bank B	41	0.1	0.2	**0.2**	0.2	0.3	0.2	0.3	0.4	0.5	0.6
Dogger Bank C	15	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Sofia	18	0.1	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.3
Hornsea One	70	0.2	0.3	**0.3**	0.4	0.5	0.4	0.6	0.7	0.8	1.0
Hornsea Two	113	0.3	0.5	**0.6**	0.7	0.8	0.7	0.9	1.1	1.4	1.6
Triton Knoll	4	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.1
In-comb'n Total	1,074	3.2	4.3	**5.4**	6.4	7.4	6.4	8.6	10.7	12.3	15.3

The loss of 15 birds per year equates to 0.39% of the baseline mortality, based on an adult mortality of 7.6% (BTO, 2022) from a population of 50,058 individuals. Population Viability Analysis indicates that the annual loss of 15 puffins per year could cause a reduction in the annual growth rate of 0.03% and a reduction in the population size of 0.8% (Table 5.25).

Table 5.25: Puffin population viability analysis results for Coquet SPA

Impact	Annual Mortality	Counterfactual metric (after 30 years)	
		Growth rate	Population size
50% disp. 1% Mort.	15	0.9997	0.9915

Based on the relatively low level of in-combination impact compared to the breeding population of 50,058 individuals, it is concluded that an adverse effect on the puffin feature of Coquet Island SPA can be excluded. That is, the in-combination impacts will not affect the size of the Coquet Island SPA puffin population, its distribution or habitat. This conclusion is supported by the results of the PVA which indicates that the very small decrease in the annual growth rate and subsequent counterfactual population after 30 years of impacts will not likely be detectable against natural population variations.

5.2.5 Farne Islands SPA

Puffin

There is potential for in-combination impacts from displacement effects on puffin from the Farne Islands SPA during the breeding and non-breeding periods. The estimated total number of puffins from all wind farms within 265.4km of the Farne Islands SPA during the breeding period is 936 individuals. Based on a level of 50% displacement causing 1% mortality an estimated 4.7 puffins may die because of displacement (Table 5.26).

During the non-breeding period a total 3,467[83] puffins from the SPA may be displaced causing mortality of 17.3 puffins (Table 5.27). Due to the in-combination impacts arising from displacement an estimated in-combination annual mortality total of 22 puffins per year could occur.

Table 5.26: Estimated number of mortalities arising from displacement impacts on adult puffins from The Farne Islands SPA during the breeding period (relevant consents are shaded)

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mortality					2% Mortality				
Blyth Demo	52	0.2	0.2	**0.3**	0.3	0.4	0.3	0.4	0.5	0.6	0.7
Neart Na Gaoithe	114	0.3	0.5	**0.6**	0.7	0.8	0.7	0.9	1.1	1.4	1.6
Inch Cape	178	0.5	0.7	**0.9**	1.1	1.2	1.1	1.4	1.8	2.1	2.5
Seagreen A	168	0.5	0.7	**0.8**	1.0	1.2	1.0	1.3	1.7	2.0	2.3
Seagreen B	232	0.7	0.9	**1.2**	1.4	1.6	1.4	1.9	2.3	2.8	3.3
Teesside	16	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Kincardine	5	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Aberdeen	11	0.0	0.0	**0.1**	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Hywind	33	0.1	0.1	**0.2**	0.2	0.2	0.2	0.3	0.3	0.4	0.5
Dogger Bank B	60	0.2	0.2	**0.3**	0.4	0.4	0.4	0.5	0.6	0.7	0.8
Dogger Bank A	21	0.1	0.1	**0.1**	0.1	0.1	0.1	0.2	0.2	0.3	0.3
Westermost Rough	20	0.1	0.1	**0.1**	0.1	0.1	0.1	0.2	0.2	0.2	0.3
Sofia	21	0.1	0.1	**0.1**	0.1	0.1	0.1	0.2	0.2	0.2	0.3
Humber Gateway	6	0.0	0.0	**0.0**	0.0	0.0	0.0	0.1	0.1	0.1	0.1
In-comb'n Total	936	2.8	3.7	**4.7**	5.6	6.6	5.6	7.5	9.4	11.2	13.1

[83] Based on non-breeding season displacement of 19,168 puffins (Appendix 1) and 17.9% of the birds originating from the Farne Islands SPA.

Table 5.27: Estimated number of mortalities arising from displacement impacts on adult puffins from the Farne Islands SPA during the non-breeding period

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort					2% Mort.				
Dogger Bank A	53	0.2	0.2	**0.3**	0.3	0.4	0.3	0.4	0.5	0.6	0.7
Dogger Bank B	133	0.4	0.5	**0.7**	0.8	0.9	0.8	1.1	1.3	1.6	1.9
Sofia	59	0.2	0.2	**0.3**	0.4	0.4	0.4	0.5	0.6	0.7	0.8
In-comb'n Total	3,467	10.4	13.9	**17.3**	20.9	24.3	20.9	27.8	34.8	41.7	48.7

The loss of 22 birds per year equates to 0.33% of the baseline mortality, based on an adult mortality of 7.6% (BTO 2022) from a population of 87,504 individuals.

Population Viability Analysis indicates that the annual loss of 22 puffins per year could cause a reduction in the annual growth rate of 0.03% and a reduction in the population size of 0.9%. (Table 5.28).

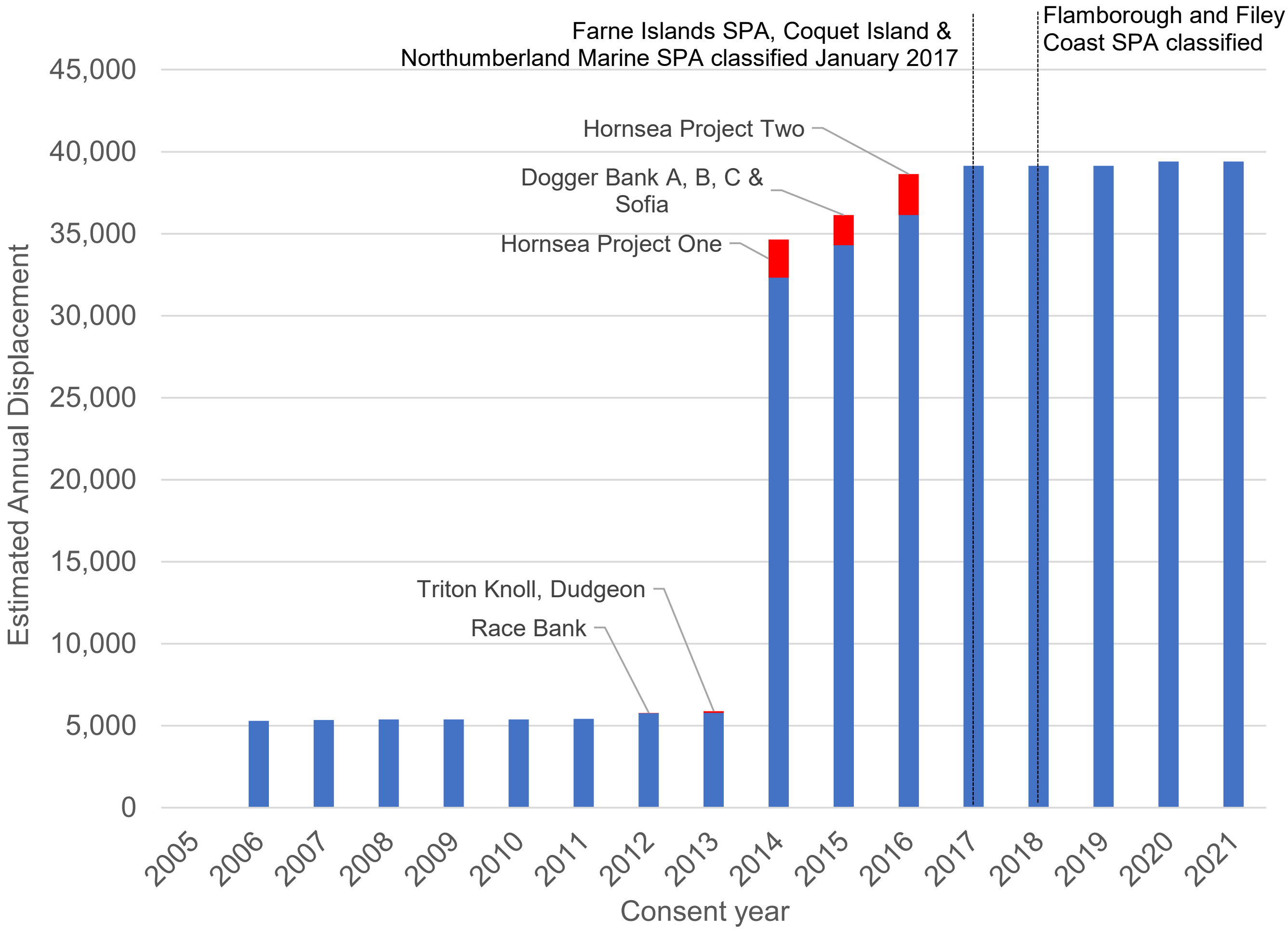
Table 5.28: Puffin population modelling results for Farne Islands SPA

Impact	Annual Mortality	Counterfactual metric (after 30 years)	
		Growth rate	Population size
50% disp. 1% Mort.	22	0.9997	0.9909

Based on the relatively low level of predicted in-combination impact compared to the breeding population of 87,504 individuals, it is concluded that an adverse effect on the puffin feature of Farne Islands SPA can be excluded. That is, the in-combination impacts, including the Dogger Bank A, Dogger Bank B and Sofia offshore wind farms will not affect the size of the Farne Islands SPA puffin population, its distribution, or habitat. This conclusion is supported by the results of the PVA which indicates that the very small decrease in the annual growth rate and subsequent counterfactual population after 30 years of impacts will not likely be detectable against natural population variations.

For context, the cumulative estimated annual displacement of puffin by consent year for all North Sea wind farms (e.g., from Beatrice to Thanet), and with no reference to a particular SPA (though will include individuals from Coquet Island SPA and Farne Islands SPA), is presented in Figure 5.4. The attribution to the cumulative totals for displacement by the projects subject to assessment in this AA is marked in red on the charts against their consent year. Most displacement is associated with projects consented in and after 2014, this is after the date on which Race Bank, Dudgeon and Triton Knoll were consented, with these two projects having a very small increment to displacement of the species. More moderate contributions to the incremental displacement of puffin are made by Hornsea Projects One and Two, Dogger Bank A, B, C and Sofia, though these are small relative to the overall displacement associated with the broader range of projects consented in 2014 onwards.

Figure 5.4: Cumulative estimated annual puffin displacement by offshore wind project consent date. The contribution to the displacement total in each consenting year for the relevant projects assessed in this AA and the classification date of the relevant site are noted



Kittiwake

There is potential for in-combination impacts on kittiwake arising during the breeding and non-breeding periods.

The estimated number of collisions per year from all Tier 1 to Tier 3 wind farms and those apportioned to the Farne Islands SPA are presented in Appendix 1.

Based on the results from the apportioning undertaken it is estimated that there is potential for 36.8 kittiwakes per year to be impacted during the breeding period by all wind farms within the mean maximum foraging range (+1SD) of the Farne Islands SPA.

During the non-breeding period (autumn and spring migrations) kittiwakes from breeding colonies across a wider geographical area could be impacted and therefore the estimated number of collisions during this period will be from a larger number of colonies. The BDMPS population during the spring migration period (January to April) is 627,816 individuals and, similarly, during the autumn migration period (August to December) the estimated population in the North Sea is 829,937. During both the spring and autumn passage periods 4,132 adult kittiwakes are estimated to be from the Farne Islands (Furness 2015). Consequently, the proportion of the non-breeding periods' populations that could be breeding adults from the Farne Islands SPA is 0.65% during the spring and 0.50% during the autumn.

During the non-breeding period it is estimated that 15.8 kittiwakes from the Farne Islands SPA could be impacted; 9.9 during the autumn migration and 5.9 during the spring migration. An annual total of 52.7 kittiwakes could be impacted (Table 5.29).

Table 5.29: Estimated number of adult kittiwake collisions per year for the Farne Islands SPA.

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	Farne Islands	Total	Farne Islands	Total	Farne Islands	Total	Farne Islands
1	Race Bank	1.9	0.0	23.9	0.2	5.6	0.0	31.4	0.2
1	Hornsea One	44.0	0.7	55.9	0.4	20.9	0.1	120.8	1.2
2	Triton Knoll	24.6	0.2	139.0	0.9	45.4	0.2	209.0	1.3
2	Hornsea Two	16.0	0.2	9.0	0.1	3.0	0.0	28.0	0.3
3	Dogger Bank C and Sofia	136.9	6.2	90.7	0.6	216.9	1.1	444.5	7.9
3	Dogger Bank A and B	288.6	8.7	135.0	0.9	295.4	1.5	719.0	11.0
Total (all Tier 1 – 3 projects)		1,205	36.8	1,530.7	9.9	1,177.8	5.9	3,913.9	52.7

Note: the in-combination total includes the relevant wind farms subject to this review.

The potential loss of 53 kittiwakes per year equates to 5% of the baseline mortality, based on an adult mortality of 11.8% (BTO, 2022) from a population of 8,804 individuals.

The results from the PVA in-combination impacts undertaken to determine whether the potential impacts from collision could cause a population level effect that could affect the integrity of the site are presented in Table 5.30.

The in-combination collision impact from all wind farms could cause a decrease in the growth rate of 0.7% and after 30 years a counterfactual change in population size of 20.7%. The contribution to the in-combination impact made by each of the relevant wind farms is presented as the difference between the total in-combination impact and the counterfactual metrics without the wind farm impacts, i.e., the difference between the counterfactual growth rate or counterfactual population size is the contribution each wind farm makes to the in-combination impact.

Table 5.30: Kittiwake annual in-combination collision mortality, predicted counterfactual growth rate and population size.

Wind farm	No. of collisions	Density independent metric after 30 years		Difference	
		Growth rate	Population size	Growth rate	Population size
Dogger Bank A and B	41.4	0.9942	0.8348	0.0016	0.0416
Dogger Bank C and Sofia	44.5	0.9937	0.8222	0.0011	0.0290
Hornsea Project One	51.2	0.9928	0.7985	0.0002	0.0053

Wind farm	No. of collisions	Density independent metric after 30 years		Difference	
		Growth rate	Population size	Growth rate	Population size
Hornsea Project Two	52.1	0.9926	0.7959	0.0000	0.0027
Race Bank	52.2	0.9926	0.7949	0.0000	0.0017
Triton Knoll	51.1	0.9928	0.7981	0.0002	0.0049
In-combination Total	52.4	0.9926	0.7932	-	-

Note: the number of collisions is the in-combination total minus the number of collisions estimated for the individual wind farm (e.g. Dogger Bank A and B: 52.4 – 11 = 41.4).

The results from the PVA indicate that in the absence of:

- Dogger Bank A and B the counterfactual growth rate may be 0.9942, a difference in growth rate of 0.16% in the absence of the two wind farms.
- Dogger Bank C and Sofia the counterfactual growth rate may be 0.9937, a difference of 0.11% in the absence of the two wind farms.
- Hornsea Project One the counterfactual growth rate may be 0.9928, a difference of 0.02% in the absence of the wind farm.
- Hornsea Project Two the counterfactual growth rate may be 0.9926, a difference of <0.01% in the absence of the wind farm.
- Race Bank the counterfactual growth rate may be 0.9926, a difference of <0.01% in the absence of the wind farm
- Triton Knoll the counterfactual growth rate may be 0.9928, a difference of 0.02% in the absence of the wind farm.

During the breeding period an estimated 36.8 kittiwakes may be impacted. However, a proportion of the potential impacts are predicted to arise at wind farms significantly beyond the maximum recorded foraging range of 111km recorded from tracked birds originating from the Farne Islands, and although there is potential for impacts from wind farms beyond this range during the breeding period, they will very likely be substantially lower than those estimated via the apportioning tool used for this assessment. Furthermore, it is noted that none of the wind farms subject to this review are within the mean maximum foraging range of kittiwake.

The predicted number of collisions during the breeding period have only been apportioned across SPA colonies and do not include non-SPA breeding kittiwakes. An estimated 45% of the breeding kittiwake population in the UK does not occur within an SPA and there is a significant non-SPA breeding population of kittiwakes breeding along the east coast of Scotland and northeast England. Birds from these colonies, particularly those closer to wind farms at greater distance from the Farne Islands, will be more likely to account for a significant proportion of the potential impacts.

The kittiwake population at the Farne Islands SPA is relatively stable with no reported declines in the breeding population since designation (Table 2.18). The PVA indicates that there is potential for an in-combination impact on the growth rate of no more than 0.16% and a change in the counterfactual population of 4.1%, for Dogger Bank Projects A and B. For all other in-combination scenarios the potential impacts are lower.

Based on the results from the PVA and the evidence from tracking data indicating that breeding kittiwakes from the Farne Islands are unlikely to be impacted by any of the relevant projects, which are all beyond the mean maximum recorded foraging range for this species from this SPA, the risk of impacts during the breeding period project are relatively very low. Along with the recognition that approximately 45% of the impacts within this assessment may be from non-SPA colonies, it is concluded that an adverse effect on the kittiwake feature of Farne Islands SPA can be excluded.

5.2.6 Flamborough and Filey Coast SPA

Guillemot

There is potential for in-combination impacts on guillemot arising during the breeding and non-breeding periods.

The estimated total number of guillemots displaced from all Tier 1 to Tier 3 wind farms within the mean maximum foraging range (+1SD) of 153.7km from the Flamborough and Filey Coast SPA during the breeding period is 16,206 individuals, which, based on a 50% level of displacement and a 1% rate of mortality could cause the mortality of 81 guillemots during the breeding period (Table 5.31).

During the non-breeding period a total of 167,311 guillemots could be displaced by all Tier 1 to Tier 3 wind farms, of which an estimated 7,362 guillemots could be from the Flamborough and Filey Coast SPA (see Appendix 1). Based on a 50% level of displacement and 1% level of mortality the effects from displacement could cause the potential mortality of 37 guillemots (Table 5.32). A combined annual total of 117 guillemots per year may die due to the in-combination impacts arising from displacement.

The loss of 117 guillemots per year equates to 2.15% of the baseline mortality, based on an adult mortality of 6.4% (BTO, 2022) from a population of 84,647 individuals.

Table 5.31: Estimated number of mortalities arising from displacement impacts on adult guillemots from The Flamborough and Filey Coast SPA during the breeding period.

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort.					2% Mort.				
Westermost Rough	347	1.0	1.4	**1.7**	2.1	2.4	2.1	2.8	3.5	4.2	4.9
Humber Gateway	99	0.3	0.4	**0.5**	0.6	0.7	0.6	0.8	1.0	1.2	1.4
Teesside	58	0.2	0.2	**0.3**	0.3	0.4	0.3	0.5	0.6	0.7	0.8
Triton Knoll	425	1.3	1.7	**2.1**	2.6	3.0	2.6	3.4	4.3	5.1	6.0
Hornsea Two	3,581	10.7	14.3	**17.9**	21.5	25.1	21.5	28.7	35.8	43.0	50.1
Lincs & LID	582	1.7	2.3	**2.9**	3.5	4.1	3.5	4.7	5.8	7.0	8.1
Race Bank	361	1.1	1.4	**1.8**	2.2	2.5	2.2	2.9	3.6	4.3	5.1
Hornsea One	4,554	13.7	18.2	**22.8**	27.3	31.9	27.3	36.4	45.5	54.6	63.8
Blyth Demo	264	0.8	1.1	**1.3**	1.6	1.8	1.6	2.1	2.6	3.2	3.7
Dudgeon	334	1.0	1.3	**1.7**	2.0	2.3	2.0	2.7	3.3	4.0	4.7
Sheringham Shoal	390	1.2	1.6	**2.0**	2.3	2.7	2.3	3.1	3.9	4.7	5.5
Dogger Bank A	1,893	5.7	7.6	**9.5**	11.4	13.2	11.4	15.1	18.9	22.7	26.5

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort.					2% Mort.				
Dogger Bank B	3,318	10.0	13.3	**16.6**	19.9	23.2	19.9	26.5	33.2	39.8	46.4
Hornsea Three	0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
In-comb'n Total	16,206	48.6	64.8	**81.0**	97.2	113.4	97.2	129.6	162.1	194.5	226.9

Table 5.32: Estimated number of mortalities arising from displacement impacts on adult guillemots from The Flamborough and Filey Coast SPA during the non-breeding period.

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort.					2% Mort.				
Race Bank	24	0.1	0.1	**0.1**	0.1	0.2	0.1	0.2	0.2	0.3	0.3
Dudgeon	31	0.1	0.1	**0.2**	0.2	0.2	0.2	0.2	0.3	0.4	0.4
In-comb'n Total	7,362	22.1	29.4	**36.8**	44.2	51.5	44.2	58.9	73.6	88.3	103.1

Population Viability Analysis indicates that the potential annual loss of 117 guillemots per year could cause a reduction in the annual growth rate of 0.27% and a reduction in the counter factual population size of 4.7% (Table 5.33).

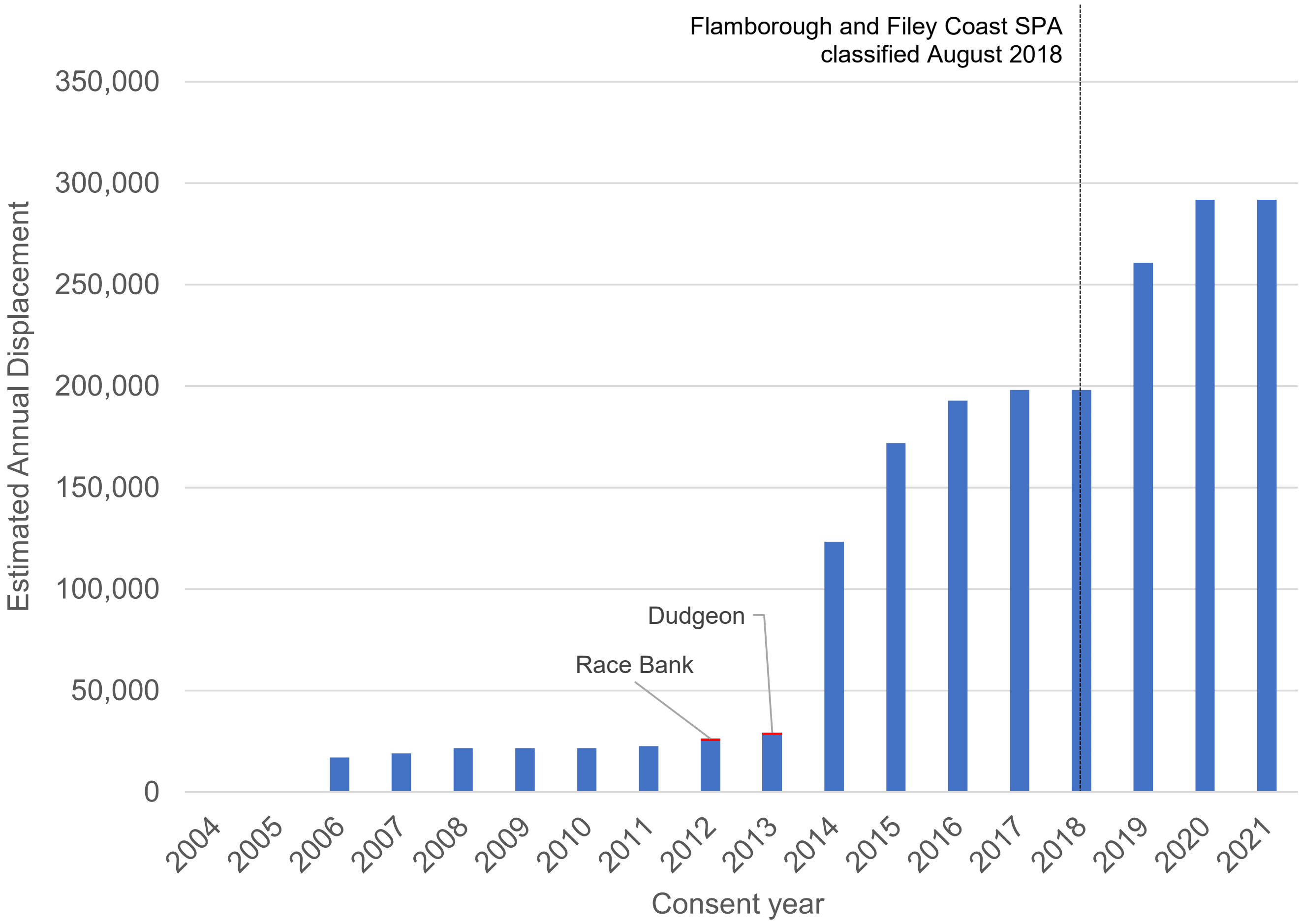
Table 5.33: Guillemot population in-combination modelling results for Flamborough and Filey Coast SPA

Impact	Annual Mortality	Counterfactual metric (after 30 years)	
		Growth rate	Population size
50% disp. 1% Mort.	117	0.9984	0.9531

The predicted reduction in the growth rate of no more than 0.27% will not cause a decline in the population below that at the time of designation. The population is predicted to continue to increase, albeit at a marginally slower rate over a period of 30 years. It is concluded that an adverse effect on the guillemot feature of Flamborough and Filey Coast SPA can be excluded. That is, the in-combination impacts, including the Dudgeon and Race Bank offshore wind farms will not affect the size of the Flamborough and Filey Coast SPA guillemot population, its distribution, or habitat.

For context, the cumulative estimated annual displacement of guillemot by consent year for all North Sea wind farms (e.g., from Beatrice to Thanet), and with no reference to a particular SPA, is presented in Figure 5.5. The attribution to the cumulative totals for displacement by the two projects subject to assessment in this AA is marked in red on the charts against their consent year. Most displacement is associated with projects consented in and after 2014, and after the date on which Race Bank and Dudgeon were consented.

Figure 5.5: Cumulative estimated annual guillemot displacement by offshore wind project consent date. The contribution to the displacement total in each consenting year for the relevant projects assessed in this AA and the classification date of the relevant site are noted



Razorbill

There is potential for in-combination impacts arising during the breeding and non-breeding periods. The estimated total number of razorbills from all wind farms within 164.6km of the Flamborough and Filey Coast SPA during the breeding period is 4,171 individuals (Appendix 1) (SPR 2021).

Based on a 50% level of displacement and 1% mortality, the in-combination impacts from displacement during the breeding period potentially causes 21 mortalities per year (Table 5.34).

During the non-breeding period (including spring and autumn periods) a total of 90,971 razorbill could be displaced by all Tier 1 to Tier 3 wind farms, of which an estimated 2,924 could be from the Flamborough and Filey Coast SPA (see Appendix 1). Based on a 50% level of displacement and 1% level of mortality the effects from displacement could cause the potential mortality of 15 razorbills (Table 5.35).

In-combination displacement impacts could cause the mortality of 36 razorbills per year. The loss of 36 razorbill per year equates to 1.3% of the baseline mortality, based on an adult mortality of 10% (BTO, 2022) from a population of 27,967 individuals.

Table 5.34: Estimated number mortalities arising from potential displacement impacts from Tier 1 to Tier 3 wind farms on adult razorbill from The Flamborough and Filey Coast SPA during the breeding period

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort.					2% Mort.				
Westermost Rough	91	0.3	0.4	**0.5**	0.5	0.6	0.5	0.7	0.9	1.1	1.3
Humber Gateway	27	0.1	0.1	**0.1**	0.2	0.2	0.2	0.2	0.3	0.3	0.4
Teesside	15	0.0	0.1	**0.1**	0.1	0.1	0.1	0.1	0.2	0.2	0.2
Triton Knoll	40	0.1	0.2	**0.2**	0.2	0.3	0.2	0.3	0.4	0.5	0.6
Hornsea Two	1,210	3.6	4.8	**6.1**	7.3	8.5	7.3	9.7	12.1	14.5	16.9
Lincs and LIDS	45	0.1	0.2	**0.2**	0.3	0.3	0.3	0.4	0.5	0.5	0.6
Race Bank	28	0.1	0.1	**0.1**	0.2	0.2	0.2	0.2	0.3	0.3	0.4
Hornsea One	535	1.6	2.1	**2.7**	3.2	3.7	3.2	4.3	5.3	6.4	7.5
Blyth Demo	112	0.3	0.4	**0.6**	0.7	0.8	0.7	0.9	1.1	1.3	1.6
Dudgeon	256	0.8	1.0	**1.3**	1.5	1.8	1.5	2.0	2.6	3.1	3.6
Sheringham Shoal	0	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dogger Bank A	375	1.1	1.5	**1.9**	2.3	2.6	2.3	3.0	3.8	4.5	5.3
Dogger Bank B	461	1.4	1.8	**2.3**	2.8	3.2	2.8	3.7	4.6	5.5	6.5
Hornsea Three	630	1.9	2.5	**3.2**	3.8	4.4	3.8	5.0	6.3	7.6	8.8
Sofia	346	1.0	1.4	**1.7**	2.1	2.4	2.1	2.8	3.5	4.2	4.8
In-comb'n Total	4,171	12.5	16.7	**20.9**	25.0	29.2	25.0	33.4	41.7	50.1	58.4

Notes: Number of razorbills displaced during the breeding period from SPR (2021).
Number of razorbills displaced for Blyth Demonstrator Project and Teesside have been apportioned between Flamborough and Filey Coast and the Farne Islands SPAs

Table 5.35: Estimated number of mortalities arising from displacement impacts on adult razorbill from the Flamborough and Filey Coast SPA during the non-breeding period

Project	No.	30%	40%	50%	60%	70%	30%	40%	50%	60%	70%
		1% Mort					2% Mort.				
Dudgeon	44	0.1	0.2	**0.2**	0.3	0.3	0.3	0.3	0.4	0.5	0.6
Race Bank	4	0.0	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0	0.1
In-comb'n Total	2,924	8.8	11.7	**14.6**	17.5	20.4	17.5	23.3	29.2	35.0	40.8

Note: in-combination total includes Dudgeon and Race Bank offshore wind farms.

Population Viability Analysis indicates that the annual loss of 36 razorbills per year could cause a reduction in the annual growth rate of 0.2% and a counterfactual population of 4.7% after 30 years (Table 5.36).

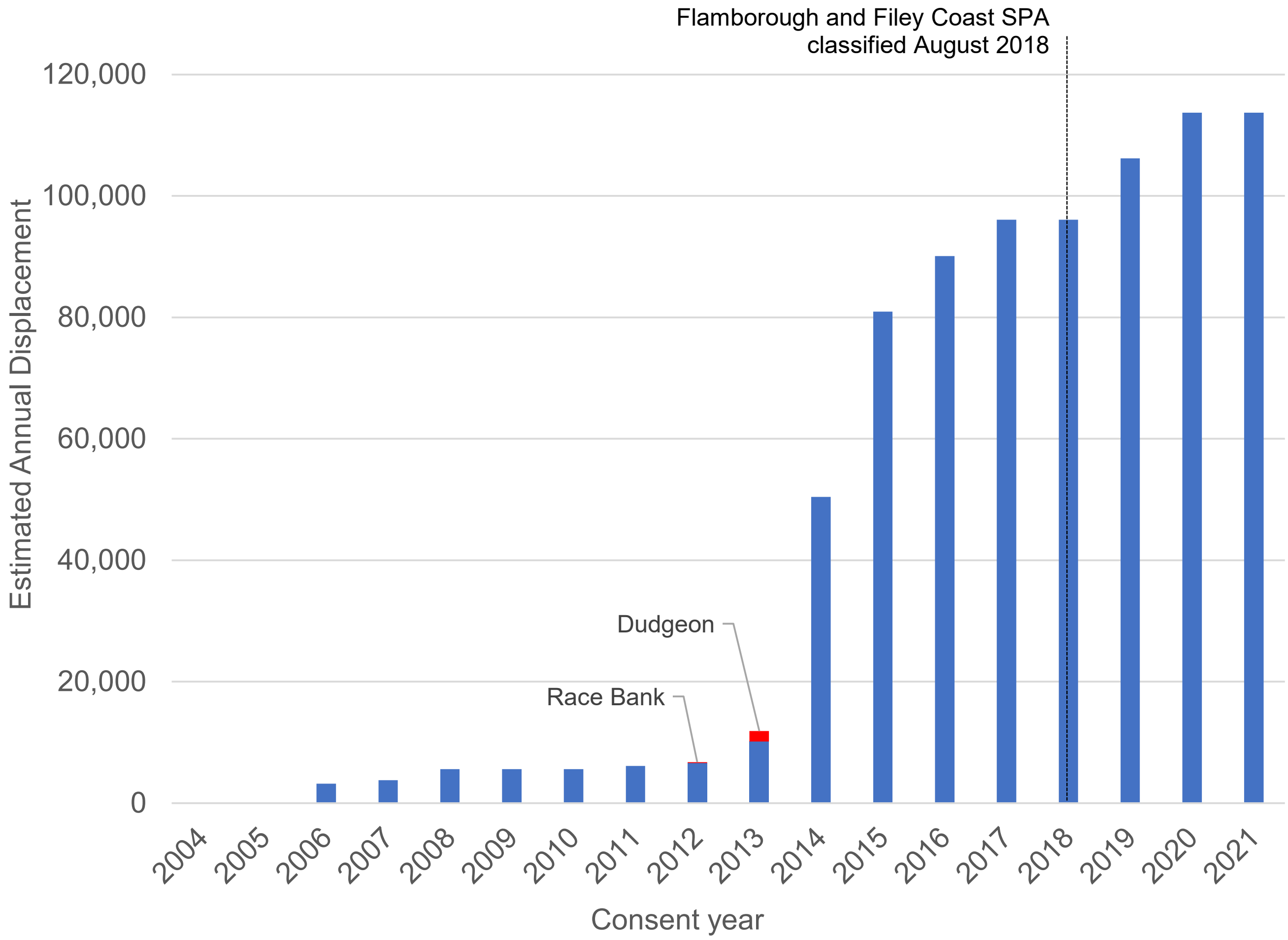
Table 5.36: Razorbill in-combination modelling results for Flamborough and Filey Coast SPA

Impact	Annual Mortality	Counterfactual metric (after 30 years)	
		Growth rate	Population size
50% disp. 1% Mort.	36	0.9984	0.9532

The predicted reduction in the growth rate of no more than 0.2% in a population that has increased from 21,000 individuals at the time of designation to over 27,000 in 2017 (Table 2.11) is not predicted to cause a decline in the population below that at the time of designation. It is concluded that an adverse effect on the razorbill feature of the Flamborough and Filey Coast SPA can be excluded. That is, the in-combination impacts, including the Dudgeon and Race Bank offshore wind farms will not affect the size of the Flamborough and Filey Coast SPA razorbill population, its distribution, or habitat.

For context, the cumulative estimated annual displacement of razorbill by consent year for all North Sea wind farms (e.g. from Beatrice to Thanet), and with no reference to a particular SPA, is presented in Figure 5.6. The attribution to the cumulative totals for displacement by the two projects subject to assessment in this AA is marked in red on the charts against their consent year. The majority of displacement is associated with projects consented in and after 2014, and after the date on which Race Bank and Dudgeon were consented.

Figure 5.6: Cumulative estimated annual razorbill displacement by offshore wind project consent date. The contribution to the mortality total in each consenting year for the relevant projects assessed in this AA and the classification date of the relevant site are noted



Puffin

There is potential for an in-combination impact on puffin from the Flamborough and Filey Coast SPA during the breeding and non-breeding periods. The wind farms (Dudgeon and Race Bank) alone are predicted to impact on no more than 0.005 puffins per year. This level of impact is so low that there will be no measurable level of in-combination impact. It is concluded that an adverse effect on the puffin feature of the Flamborough and Filey Coast SPA can be excluded. That is, the in-combination impacts arising from displacement mortality is so low that it will not affect the size of the Flamborough and Filey Coast SPA puffin population, its distribution, or habitat.

Gannet

There is potential for an in-combination impact on gannet from the Flamborough and Filey Coast SPA during the breeding and non-breeding periods.

The estimated number of gannets impacted by collision by each wind farm in the North Sea is presented in Appendix 1. A total of 266 gannets are predicted to be impacted each year from wind farms located within the mean maximum foraging range[84]. A further 57 gannets may be impacted during the non-breeding period. In total an estimated 242 gannets per year from the Flamborough and Filey Coast SPA may be impacted by collisions from existing or consented offshore wind farms (Table 5.37).

An estimated 242 gannet collision mortalities per year is predicted to arise from the in-combination offshore wind farm impacts. The loss of 242 gannets per year equates to 11.1% of the baseline mortality for the Flamborough and Filey Coast SPA.

The potential in-combination impacts arising from displacement are presented in Appendix 1. A total of 4,651 gannets from Flamborough and Filey Coast SPA are predicted to be impacted by displacement during the breeding season by wind farms within the mean maximum foraging range. During the non-breeding periods a further 956 gannets may be impacted during the non-breeding period. In total an estimated 7,357 gannets per year from the Flamborough and Filey Coast SPA may be displaced from existing or consented offshore wind farms (Table 5.38).

Table 5.37: Estimated number of adult gannet collisions from offshore wind farms and proportion associated with Flamborough and Filey Coast SPA (source SPR 2021).

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Greater Gabbard	14.0	0.0	8.8	0.4	4.8	0.3	27.6	0.7
1	Dudgeon	22.3	22.3	38.9	1.9	19.1	1.2	80.3	25.4
1	Race Bank	33.7	33.7	11.7	0.6	4.1	0.3	49.5	34.5
Total (all Tier 1 -3 projects)		1,767	208	789	38	320	21	2,876	266

Note: the total for all Tier 1 to 3 projects includes the totals from Greater Gabbard, Dudgeon and Race Bank offshore wind farms

Table 5.38: Estimated number of adult gannet displaced from offshore wind farms and proportion associated with Flamborough and Filey Coast SPA (source SPR 2021)

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Greater Gabbard	252	0	69	3.3	105	6.5	426	9.8
1	Dudgeon	53	53	25	1.2	11	0.7	89	54.9
1	Race Bank	92	92	32	1.5	29	1.8	153	95.3

[84] During the breeding period gannets have extensive foraging ranges with a mean maximum of 315.2 +/- 194.2km. Assessing the impacts on the mean maximum foraging range +1 SD would include wind farms and gannetries during the breeding period that are located over 500km away. There is very good evidence that during the breeding period gannets from different colonies predominantly forage in separate geographical areas and therefore there will be little overlap in the foraging ranges of gannets beyond the mean maximum foraging range (Wakefield *et al.* 2013). Consequently, this in-combination assessment is based on the mean maximum foraging range and not the +1 standard deviation.

Tier	Wind farm	Breeding season		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
Total (all Tier 1 -3 projects)		19,774	6,151	19,103	917	4,670	290	43,547	7,357

Based on a level of 80% displacement and 1% mortality, the in-combination impacts from displacement could cause the mortality of up to 49 gannets during the breeding period and 9 per year during the non-breeding period; an annual mortality of 59 birds per year (Table 5.39).

Table 5.39: Estimated number of mortalities arising from displacement impacts on gannet from the Flamborough and Filey Coast SPA during the breeding period.

Season	No.	60%	70%	80%	90%	100%	60%	70%	80%	90%	100%
		1% Mort					2% Mort.				
Breeding	6,151	37	43	**49**	55	62	74	86	98	111	123
Autumn	917	5	6	**7**	8	9	11	13	15	16	18
Spring	290	2	2	**2**	3	3	3	4	5	5	6
Total	7,357	44	51	**59**	66	74	88	103	118	132	147

Number of gannet displaced from SPR (2021).

It is estimated that the combined in-combination impacts from collision mortality and displacement effects could cause 325 gannet mortalities per year.

Population Viability Analysis has been undertaken on the potential loss of 325 gannets per year from the Flamborough and Filey Coast SPA. The results of the PVA are presented in Table 5.40.

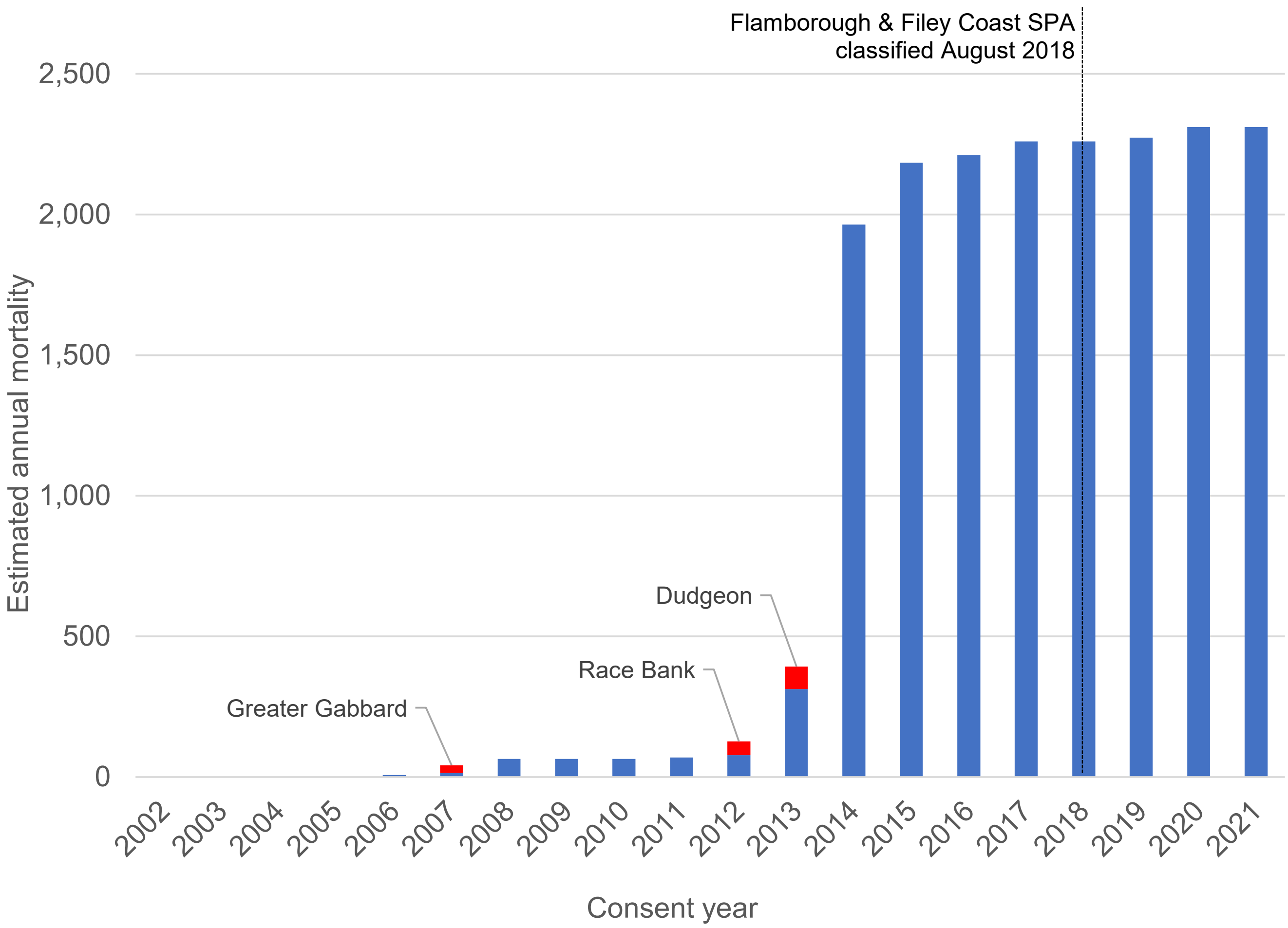
Table 5.40: Predicted gannet growth rate and population size at the Flamborough and Filey Coast SPA with in-combination collision and displacement mortality

Impact	Annual Mortality	Counterfactual metric (after 30 years)	
		Growth rate	Population size
Collision	266	0.9889	0.7094
Displacement	59	0.9975	0.9268
Combined	325	0.9865	0.6573

The PVA indicates that the annual loss of 325 gannets per year from collision impacts and displacement effects could cause a reduction in the annual growth rate of 1.3% and a counterfactual population of 34.3% after 30 years. The results from the PVA indicate that, although there will be a reduction in the size of the breeding population after 30 years compared to if there were no impacts, the gannet breeding population will continue to increase with the in-combination loss of 325 birds per year. The growth rate in recent years has been approximately 10% per year, consequently the potential reduction in the annual growth rate by 1.3% will not stop the continuing increase in the gannet population at this colony. It is concluded that an adverse effect on the gannet feature of the Flamborough and Filey Coast SPA can be excluded. That is, the in-combination impacts arising from collision mortality and displacement effects will not affect the size of the Flamborough and Filey Coast SPA gannet population, its distribution, or habitat.

For context, the cumulative estimated annual mortality of gannets by consent year for all North Sea and Channel wind farms (e.g. from Beatrice to Rampion), and with no reference to a particular SPA, is presented in Figure 5.7. The attribution to the cumulative totals for mortality by the three projects subject to assessment in this AA is marked in red on the charts against their consent year. The majority of the collision risk is associated with projects consented in and after 2014, and after the date on which Greater Gabbard, Race Bank and Dudgeon were consented.

Figure 5.7: Cumulative estimated annual collision mortality for gannet by offshore wind project consent date. The contribution to the mortality total in each consenting year for the relevant projects assessed in this AA and the classification date of the relevant site are noted



6 Conclusion

The Secretary of State has carefully considered the information presented within those applications for consent previously made for a number of energy projects in relation to a number of SPAs and related features, and as identified in Section 2 and in BEIS (2021); see Table 6.1. The assessment has included consideration of former consent decision conclusions, including of HRAs, and the latest accepted information submitted in examination for relevant projects, along with other published information.

The assessment and conclusions in this report are based on consented parameters for projects. Apart from a single gas storage project, all of the consents screened into this assessment were for offshore wind farm projects (Section 2.3). There is a propensity in wind farm applications to apply the Rochdale Envelope approach to assessment to allow design flexibility and to accommodate the pace of technological change, with the result that consented project parameters (the consented scenario) are generally different to that which is constructed (the as-built scenario); of particular relevance to this HRA are the number and size of wind turbines built, which are generally fewer and larger than those consented.

The HRA covers 23 consents, 18 of which are operational, and of these, there is a notable difference between the scale of the consented scenario and the as-built scenario for 10 of them. The approach of assessing consented parameters is consistent with previous HRAs for offshore wind farms, however, it should be noted that the estimated impacts on birds based on as-built scenarios, particularly for collision impacts, will be smaller than that under the consented scenario.

The Secretary of State, having considered the environmental and project-specific information of relevance to the project/ site and feature combinations assessed in this AA, has concluded that an adverse effect on the integrity of protected sites can be excluded for all projects alone or in-combination with other plans and projects (Table 6.1).

Table 6.1: European sites and related features, and the consents subject to assessment

Project	Site	Features	Adverse effect	
			Alone	In-combination
Walney	Copeland Islands SPA	Manx shearwater	×	×
	Dee Estuary (extension) SPA	Non-breeding waterbirds (teal, grey plover, dunlin, black-tailed godwit and curlew)	×	×
Walney Extension	Morecambe Bay and Duddon Estuary SPA	Black-tailed godwit, whooper swan, little egret, Mediterranean gull, lesser black-backed gull and ruff, Sandwich tern, common tern	×	×
	Liverpool Bay SPA	Red-throated diver, common tern, little tern, little gull, cormorant, red-breasted merganser	×	×

Project	Site	Features	Adverse effect Alone	Adverse effect In-combination
	Irish Sea Front SPA	Manx shearwater	×	×
	Skomer, Skokholm and the Seas off Pembrokeshire SPA	Manx shearwater	×	×
West of Duddon Sands	Copeland Islands SPA	Manx shearwater	×	×
	Dee Estuary (extension) SPA	Non-breeding waterbirds (teal, grey plover, dunlin, black-tailed godwit and curlew)	×	×
Ormonde	Copeland Islands SPA	Manx shearwater	×	×
	Dee Estuary (extension) SPA	Non-breeding waterbirds (teal, grey plover, dunlin, black-tailed godwit and curlew)	×	×
Preesall Saltfield Underground Gas Storage	Liverpool Bay SPA	Red-throated diver, common tern, little tern, little gull, cormorant, red-breasted merganser	×	×
	Morecambe Bay and Duddon Estuary SPA	Black-tailed godwit, whooper swan, little egret, Mediterranean gull, lesser black-backed gull and ruff, Sandwich tern	×	×
Burbo Bank Extension	Skomer, Skokholm and the Seas off Pembrokeshire SPA	Manx shearwater	×	×
	Anglesey Terns SPA	Sandwich tern	×	×
	Morecambe Bay and Duddon Estuary SPA	Black-tailed godwit, whooper swan, little egret, Mediterranean gull, lesser black-backed gull and ruff, Sandwich tern	×	×
Gwynt y Môr	Copeland Islands SPA	Manx shearwater	×	×
	Dee Estuary (extension) SPA	Sandwich tern, common tern, non-breeding waterbirds (teal, grey plover, dunlin, black-tailed godwit and curlew)	×	×
	Liverpool Bay SPA	Red-throated diver	×	×
	Mersey Narrows and Wirral Foreshore SPA	Breeding/non-breeding common tern. Non-breeding bar-tailed godwit and knot. Waterbird assemblage.	×	×

Project	Site	Features	Adverse effect	
			Alone	In-combination
Dogger Bank A & B	Coquet Island SPA	Puffin (assemblage feature)	×	×
	Farne Islands SPA	Puffin, kittiwake (assemblage features)	×	×
	Northumberland Marine SPA	Puffin, kittiwake (assemblage feature)	×	×
Dogger Bank C	Coquet Island SPA	Puffin (assemblage feature)	×	×
	Farne Islands SPA	Kittiwake (assemblage feature)	×	×
	Northumberland Marine SPA	Puffin, kittiwake (assemblage feature)	×	×
Sofia	Coquet Island SPA	Puffin (assemblage feature)	×	×
	Farne Islands SPA	Puffin, kittiwake (assemblage features)	×	×
	Northumberland Marine SPA	Puffin, kittiwake (assemblage feature)	×	×
Hornsea Project One	Coquet Island SPA	Puffin (assemblage feature)	×	×
	Farne Islands SPA	Kittiwake (assemblage feature)	×	×
	Northumberland Marine SPA	Puffin, kittiwake (assemblage feature)	×	×
Hornsea Project Two	Coquet Island SPA	Puffin (assemblage feature)	×	×
	Farne Islands SPA	Kittiwake (assemblage feature)	×	×
	Northumberland Marine SPA	Puffin, kittiwake (assemblage feature)	×	×
Triton Knoll	Coquet Island SPA	Puffin (assemblage feature)	×	×
	Farne Islands SPA	Kittiwake (assemblage feature)	×	×
	Northumberland Marine SPA	Puffin, kittiwake (assemblage feature)	×	×
Dogger Bank A&B (export cable)	Greater Wash SPA	Red-throated diver, common scoter, little tern, Sandwich tern, common tern, little gull	×	×

Project	Site	Features	Adverse effect: Alone	Adverse effect: In-combination
Race Bank	Farne Islands SPA	Kittiwake (assemblage feature)	×	×
	Northumberland Marine SPA	Puffin, kittiwake (assemblage feature)	×	×
	Flamborough and Filey Coast SPA	Northern gannet, guillemot, razorbill, puffin (assemblage feature).	×	×
	Greater Wash SPA	Red-throated diver, common scoter, little tern, Sandwich tern, common tern, little gull	×	×
Dudgeon	Northumberland Marine SPA	Kittiwake	×	×
	Flamborough and Filey Coast SPA	Northern gannet, guillemot, razorbill, puffin (assemblage feature).	×	×
	Greater Wash SPA	Sandwich tern	×	×
Inner Dowsing	Humber Estuary SPA	Avocet, black-tailed godwit, knot, dunlin, redshank and ruff	×	×
Lynn	Humber Estuary SPA	Avocet, black-tailed godwit, knot, dunlin, redshank and ruff	×	×
East Anglia One	Greater Wash SPA	Sandwich tern	×	×
East Anglia Three	Greater Wash SPA	Sandwich tern	×	×
Galloper	Outer Thames Estuary SPA	Common tern	×	×
Greater Gabbard	Flamborough and Filey Coast SPA	Northern gannet	×	×
	Outer Thames Estuary SPA	Common tern	×	×
Gunfleet Sands I	Stour and Orwell Estuaries (extension) SPA	Avocet, knot, pintail, waterbird assemblage	×	×
Rampion	Dungeness, Romney Marsh & Rye Bay SPA	Avocet, bittern, ruff, golden plover, Sandwich tern	×	×

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Appendix 1: Collision, Displacement and Population Data

Gannet

Predicted number of gannets impacted from collisions by offshore wind farms and apportioned impacts to the Flamborough and Filey Coast SPA (Source SPR 2021)

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	SPA	Total	FFC	SPA	FFC	Total	SPA
1	Greater Gabbard	14.0	0.0	8.8	0.4	4.8	0.3	27.6	0.7
1	Gunfleet Sands	-						0.0	0.0
1	Kentish Flats	1.4	0.0	0.8	0.0	1.1	0.1	3.3	0.1
1	Lincs	2.1	2.1	1.3	0.1	1.7	0.1	5.1	2.3
1	London Array	2.3	0.0	1.4	0.1	1.8	0.1	5.5	0.2
1	Lynn and Inner Dowsing	0.2	0.2	0.1	0.0	0.2	0.1	0.5	0.3
1	Scroby Sands	-						0.0	0.0
1	Sheringham Shoal	14.1	14.1	3.5	0.2	0.0	0.0	17.6	14.3
1	Teesside	4.9	2.4	1.7	0.1	0.0	0.0	6.6	2.5
1	Thanet	1.1	0.0	0.0	0.0	0.0	0.0	1.1	0.0
1	Humber Gateway	1.9	1.9	1.1	0.1	1.5	0.9	4.5	2.9
1	Westermost Rough	0.2	0.2	0.1	0.0	0.2	0.0	0.5	0.2
1	Hywind	5.6	0.0	0.8	0.0	0.8	0.1	7.2	0.1
1	Kincardine	3.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0
1	Beatrice	37.4	0.0	48.8	2.3	9.5	0.6	95.7	2.9
1	Dudgeon	22.3	22.3	38.9	1.9	19.1	1.2	80.3	25.4
1	Galloper	18.1	0.0	30.9	1.5	12.6	0.8	61.6	2.3
1	Race Bank	33.7	33.7	11.7	0.6	4.1	0.3	49.5	34.6
1	Rampion	36.2	0.0	63.5	3.1	2.1	0.1	101.8	3.2
1	Hornsea Project One	11.5	11.5	32.0	1.5	22.5	1.4	66.0	14.4
1	Blyth Demo.	3.5	0.0	2.1	0.1	2.8	0.2	8.4	0.3
1	East Anglia ONE	3.4	3.4	131.0	6.3	6.3	0.4	140.7	10.1
1	EOWDC (Aberdeen)	4.2	0.0	5.1	0.3	0.1	0.0	9.4	0.3

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	SPA	Total	FFC	SPA	FFC	Total	SPA
1	Inch Cape	336.9	0.0	29.2	1.4	5.2	0.3	371.3	1.7
1	Methil	6.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0
1	Moray Firth (EDA)	80.6	0.0	35.4	1.7	8.9	0.6	124.9	2.3
2	Firth of Forth Alpha and Bravo	800.8	0.0	49.3	2.4	65.8	4.1	915.9	6.5
2	Neart na Gaoithe	143.0	0.0	47.0	2.3	23.0	1.4	213.0	3.7
2	Triton Knoll	26.8	26.8	64.1	3.1	30.1	1.9	121.0	31.8
2	Hornsea Project Two	7.0	7.0	14.0	0.7	6.0	0.4	27.0	8.1
3	Dogger Bank C and Sofia	14.8	7.4	10.1	0.5	10.8	0.7	35.7	8.6
3	Dogger Bank A and B	81.1	40.6	83.5	4.0	54.4	3.4	219.0	48.0
3	East Anglia THREE	6.1	6.1	33.3	1.6	9.6	0.6	49.0	8.3
3	Hornsea Project Three	10.0	6.0	5.0	0.0	4.0	0.0	19.0	6.0
3	Moray West	10.0	0.0	2.0	0.1	1.0	0.1	13.0	0.2
3	Norfolk Vanguard	8.2	8.2	18.6	0.9	5.3	0.3	32.1	9.4
3	Norfolk Boreas	14.1	14.2	12.7	0.6	3.9	0.2	30.7	15.1
	Total Tier 1 to Tier 3 projects	1,767	208	789	38	320	21	2,876	266

Predicted number of gannets impacted from displacement by offshore wind farms and apportioned impacts to the Flamborough and Filey Coast SPA (Source SPR 2021)

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	SPA	Total	SPA	Total	SPA	Total	SPA
1	Greater Gabbard	252	0	69	3.3	105	6.5	426	9.8
1	Gunfleet Sands	0	0	12	0.6	9	0.6	21	1.2
1	Kentish Flats	No data							
1	Lincs	No data							
1	London Array	No data							
1	Lynn and Inner Dowsing	No data							
1	Scroby Sands	No data							
1	Sheringham Shoal	47	47	31	1.5	2	0.1	80	48.6

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	SPA	Total	SPA	Total	SPA	Total	SPA
1	Teesside	1	0.5	0	0	0	0	1	0.5
1	Thanet	No data							
1	Humber Gateway	No data							
1	Westermost Rough	No data							
1	Hywind	10	0	0	0	4	0.2	14	0.2
1	Kincardine	120	0	0	0	0	0	120	0
1	Beatrice	151	0	0	0	0	0	151	0
1	Dudgeon	53	53	25	1.2	11	0.7	89	54.9
1	Galloper	360	0	907	43.5	276	17.1	1543	60.6
1	Race Bank	92	92	32	1.5	29	1.8	153	95.3
1	Rampion	0	0	590	28.3	0	0	590	28.3
1	Hornsea Project One	671	671	694	33.3	250	15.5	1,615	719.8
1	Blyth Demo.	No data							
1	East Anglia ONE	161	161	3,638	174.6	76	4.7	3,875	340.3
1	EOWDC (Aberdeen)	35	0	5	0.2	0	0	40	0.2
1	Inch Cape	2,398	0	703	33.7	212	13.1	3,313	46.8
1	Methil	23	0	0	0	0	0	23	0
1	Moray Firth (EDA)	564	0	292	14	27	1.7	883	15.7
2	Firth of Forth Alpha and Bravo	2,956	0	664	31.9	332	20.6	3,952	52.5
2	Neart na Gaoithe	1,987	0	552	26.5	281	17.4	2,820	43.9
2	Triton Knoll	211	211	15	0.7	24	1.5	250	213.2
2	Hornsea Project Two	457	457	1,140	54.7	124	7.7	1,721	519.4
3	Dogger Bank C and Sofia	1,155	577.5	2,048	98.3	394	24.4	3,597	700.2
3	Dogger Bank A and B	2,250	1,125	887	42.6	464	28.8	3,601	1196.4
3	East Anglia THREE	412	412	1,269	60.9	524	32.5	2,205	505.4
3	Hornsea Project Three	1,333	844	984	47	524	32.5	2,841	923.5
3	Moray West	2,827	0	439	21.1	144	8.9	3,410	30
	Total Tier 1 to 3 projects	18,274	4,651	14,927	716.1	3,707	229.8	36,908	5596.9

Kittiwake

Predicted number of kittiwakes impacted by offshore wind farms and apportioned impacts to the Farne Islands SPA (Source SPR 2021)

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	SPA	Total	SPA	Total	SPA	Total	SPA
1	Greater Gabbard	1.1	0.0	15.0	0.1	11.4	0.1	27.5	0.2
1	Gunfleet Sands	No data							
1	Kentish Flats	0.0	0.0	0.9	0.0	0.7	0.0	1.6	0.0
1	Lincs	0.7	0.3	1.2	0.0	0.7	0.0	2.6	0.3
1	London Array	1.4	0.0	2.3	0.0	1.8	0.0	5.5	0.0
1	Lynn and Inner Dowsing	No data							
1	Scroby Sands	No data							
1	Sheringham Shoal	No data							
1	Teesside	38.4	1.1	24.0	0.2	2.5	0.0	64.9	1.3
1	Thanet	0.2	0.0	0.5	0.0	0.4	0.0	1.1	0.0
1	Humber Gateway	1.9	0.0	3.2	0.0	1.9	0.0	7.0	0.0
1	Westermost Rough	0.1	0.0	0.2	0.0	0.1	0.0	0.4	0.0
1	Hywind	16.6	1.0	0.9	0.0	0.9	0.0	18.4	1.0
1	Kincardine	22.0	0.0	9.0	0.1	1.0	0.0	32.0	0.1
1	Beatrice	94.7	0.0	10.7	0.1	39.8	0.2	145.2	0.3
1	Dudgeon	No data							
1	Galloper	6.3	0.0	27.8	0.2	31.8	0.2	65.9	0.3
1	Race Bank	1.9	0.0	23.9	0.2	5.6	0.0	31.4	0.2
1	Rampion	54.4	0.0	37.4	0.2	29.7	0.1	121.5	0.4
1	Hornsea One	44.0	0.7	55.9	0.4	20.9	0.1	120.8	1.2
1	Blyth Demon.	1.7	0.5	2.3	0.0	1.4	0.0	5.4	0.5
1	East Anglia ONE	1.8	0.0	160.4	1.0	46.8	0.2	209.0	1.3
1	EOWDC (Aberdeen)	11.8	0.5	5.8	0.0	1.1	0.0	18.7	0.5
1	Moray Firth (EDA)	43.6	2.6	2.0	0.0	19.3	0.1	64.9	2.8
2	Firth of Forth Alpha and Bravo	153.1	8.2	313.1	2.0	247.6	1.2	713.8	11.4
2	Inch Cape	13.1	0.5	224.8	1.5	63.5	0.3	301.4	2.3
2	Methil	0.4	0.0	0.0	0.0	0.0	0.0	0.4	0.0

		Breeding season		Autumn migration		Spring migration		Annual	
Tier	Wind farm	Total	SPA	Total	SPA	Total	SPA	Total	SPA
2	Neart na Gaoithe	32.9	1.3	56.1	0.4	4.4	0.0	93.4	1.7
2	Triton Knoll	24.6	0.2	139.0	0.9	45.4	0.2	209.0	1.3
2	Hornsea Project Two	16.0	0.2	9.0	0.1	3.0	0.0	28.0	0.3
3	Dogger Bank C and Sofia (Teesside)	136.9	6.2	90.7	0.6	216.9	1.1	444.5	7.9
3	Dogger Bank A and B (Creyke Beck)	288.6	8.7	135.0	0.9	295.4	1.5	719.0	11.0
3	East Anglia THREE	6.1	0.0	69.0	0.4	37.6	0.2	112.7	0.6
3	Hornsea Project Three	77.0	0.0	38.0	0.2	8.0	0.0	123.0	0.3
3	Norfolk Vanguard	21.8	0.0	16.4	0.1	19.3	0.1	57.5	0.2
3	Moray West	79.0	4.8	24.0	0.2	7.0	0.0	110.0	5.0
3	Norfolk Boreas	13.3	0.0	32.2	0.2	11.9	0.1	57.4	0.3
	Total all Tier 1 -3 Projects	1,205.4	36.8	1,530.7	9.9	1,177.8	5.9	3,913.9	52.7

No data – No suitable data available for undertaking collision risk modelling on kittiwakes.

Puffin

Puffin populations used in this HRA (Source Vattenfall 2019b)

Project	Breeding season	Non-breeding season
Aberdeen	42	82
Beatrice	2858	2435
Blyth Demonstration	235	123
Dogger Bank A (Creyke Beck A)	37	295
Dogger Bank B (Creyke Beck B)	102	743
Dogger Bank C (Teesside A)	34	273
Sofia (Dogger Bank Teesside B)	35	329
Dudgeon	1	3
East Anglia ONE	16	32
East Anglia THREE	181	307
Galloper	0	1
Greater Gabbard	0	1
Hornsea Project One	1070	1257
Hornsea Project Two	468	2039
Hornsea Project Three	253	127
Humber Gateway	15	10
Hywind	119	85
Inch Cape	2956	2688
Kincardine	19	0
Lincs and LID6	3	6
London Array I & II	0	1
Moray	2795	656
Neart na Gaoithe	2562	2103
Race Bank	1	10
Seagreen A	2572	1526
Seagreen B	3582	3863
Sheringham Shoal	4	26
Teesside	35	18
Thanet	0	0
Triton Knoll	23	71

Project	Breeding season	Non-breeding season
Westermost Rough	61	35
Norfolk Boreas	0	23
Seasonal Total	20,079	19,168

Note: Norfolk Boreas added based on peak number recorded (Vattenfall 2019a)

Guillemot

Estimated number of guillemots at offshore wind farms in the North Sea and the proportion at Flamborough and Filey Coast SPA (source SPR 2021).

Tier	Windfarm	Breeding season		Nonbreeding season		Annual	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
1	Gunfleet Sands	0	0	363	16	363	16
1	Kentish Flats	0	0	3	0	3	0
1	Kentish Flats Extension	0	0	4	0	4	0
1	Greater Gabbard	345	0	548	24	893	24
1	Lincs & LID	582	582	814	36	1,396	618
1	London Array	192	0	377	17	569	17
1	Scroby Sands	No estimate available					
1	Sheringham Shoal	390	390	715	32	1,105	422
1	Teesside	267	58	901	40	1,168	98
1	Thanet	18	0	124	6	142	6
1	Humber Gateway	99	99	138	6	237	105
1	Westermost Rough	347	347	486	21	833	368
1	Hywind	249	0	2,136	94	2,385	94
1	Kincardine	632	0	0	0	632	0
1	Beatrice	13,610	0	2,755	121	16,365	121
1	Dudgeon	334	334	542	24	876	358
1	Galloper	305	0	593	26	898	26
1	Race Bank	361	361	708	31	1,069	392
1	Rampion	10,887	0	15,536	684	26,423	684
1	Hornsea Project One	9,836	4,554	8,097	356	17,933	4,910
1	Blyth Demo.	1,220	264	1,321	58	2,541	322
1	East Anglia ONE	274	0	640	28	914	28
1	EOWDC	547	0	225	10	772	10
1	Moray Firth (EDA)	9,820	0	547	24	10,367	24
2	Firth of Forth Alpha	13,606	0	4,688	206	18,294	206
2	Firth of Forth Bravo	11,118	0	4,112	181	15,230	181
2	Inch Cape	4,371	0	3,177	140	7,548	140
2	Methil	25	0	0	0	25	0

Tier	Windfarm	Breeding season		Nonbreeding season		Annual	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
2	Neart na Gaoithe	1,755	0	3,761	166	5,516	166
2	Triton Knoll	425	425	746	33	1,171	458
2	Hornsea Project Two	7,735	3,581	13,164	579	20,899	4,161
2	East Anglia THREE	1,744	0	2,859	126	4,603	126
3	Sofia (Teesside B)	5,211	1,824	3,701	163	8,912	1,987
3	Dogger Bank A (Creyke Beck A)	5,407	1,893	6,142	270	11,549	2,163
3	Dogger Bank B (Creyke Beck B)	9,479	3,318	10,621	467	20,100	3,785
3	Dogger Bank C (Teesside A)	3,283	1,149	2,268	100	5,551	1,249
3	Moray West	24,426	0	38,174	1,680	62,600	1,680
3	Hornsea Project Three	13,374	0	17,772	782	31,146	782
3	Norfolk Boreas	7,767	0	13,777	606	21,544	606
3	Norfolk Vanguard	4,320	0	4,776	210	9,096	210
Total (all Tier 1 to Tier 3)		**164,361**	**19,179**	**167,311**	**7,362**	**331,672**	**26,541**

Razorbill

Estimated number of razorbills at offshore wind farms in the North Sea and the proportion at Flamborough and Filey Coast SPA (source SPR 2021)

Tier	Windfarm	Breeding season		Autumn		Non-breeding		Spring		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Gunfleet Sands	0	0	0	0	30	1	0	0	30	1
1	Kentish Flats	No estimate available									
1	Greater Gabbard	0	0	0	0	387	11	84	3	471	13
1	Lincs & LID	45	45	34	1	22	1	34	1	135	48
1	London Array	14	0	20	1	14	0	21	1	69	2
1	Scroby Sands	No estimate available									
1	Sheringham Shoal	106	0	1,343	46	211	6	30	1	1,690	52
1	Teesside	16	15	61	2	2	0	20	1	99	18
1	Thanet	3	0	0	0	14	0	21	1	38	1
1	Humber Gateway	27	27	20	1	13	0	20	1	80	29
1	Westermost Rough	91	91	121	4	152	4	91	3	455	102
1	Hywind	30	0	719	24	10				759	24
1	Kincardine	22	0		0					22	0
1	Beatrice	873	0	833	28	555	15	833	28	3,094	72
1	Dudgeon	256	256	346	12	745	20	346	12	1,693	300
1	Galloper	44	0	43	2	106	3	394	13	587	18
1	Race Bank	28	28	42	1	28	1	42	1	140	32
1	Rampion	630	0	66	2	1,244	34	3,327	113	5,267	149
1	Hornsea One	1,109	535	4,812	164	1,518	41	1,803	61	9,242	800
1	Blyth Demo.	121	112	91	3	61	2	91	3	364	120
1	Dogger Bank (Creyke Beck) A	1,250	375	1,576	54	1,728	47	4,149	141	8,703	616
1	Dogger Bank (Creyke Beck) B	1,538	461	2,097	71	2,143	58	5,119	174	10,897	765

Tier	Windfarm	Breeding season		Autumn		Non-breeding		Spring		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	EOWDC	161	0	64	2	7	0	26	1	258	3
1	Moray Firth (EDA)	2,423	0	1,103	38	30	1	168	6	3,724	44
2	Firth of Forth Alpha	5,876	0	0		1,103	30			6,979	30
2	Firth of Forth Bravo	3,698	0	0		1,272	34			4,970	34
2	Inch Cape	1,436	0	2,870	98	651	18			4,957	115
2	Methil	4	0	0	0	0	0	0	0	4	0
2	Dogger Bank C (Teesside A)	834	0	310	11	959	26	1,919	65	4,022	102
2	Dogger Bank Sofia (Teesside B)	1,153	346	592	20	1,426	39	2,953	100	6,124	505
2	Neart na Gaoithe	331	0	5,492	187	508	14			6,331	200
2	Triton Knoll	40	40	254	9	855	23	117	4	1,266	76
2	Hornsea Two	2,511	1,210	4,221	144	720	19	1,668	57	9,120	1,430
2	East Anglia ONE	16	0	26	1	155	4	336	11	533	17
3	East Anglia THREE	1,807	0	1,122	38	1,499	41	1,524	52	5,952	130
3	Hornsea Three	630	630	2,020	69	3,649	99	2,105	72	8,404	870
3	Moray West	2,808	0	3,544	121	184	5	3,585	122	10,121	247
3	Norfolk Boreas	630	0	263	9	1,065	29	345	12	2,303	49
3	Norfolk Vanguard	879	0	866	21	839	23	924	31	3,508	75
	Total (all projects above)	**31,440**	**4,171**	**34,971**	**1,184**	**23,905**	**649**	**32,095**	**1,091**	**122,411**	**7,089**

Appendix 2: Population Viability Analysis

The following presents a summary of the results of the Population Viability Analysis (PVA) undertaken to support the Review of Consents HRA.

The PVA was undertaken in January 2022 using the Natural England commissioned PVA tool published in August 2019 and available online (Searle *et al*. 2019)[85].

Black-legged Kittiwake

The PVA tool has been used to predict future growth rates and population levels of kittiwake from the Farne Islands SPA under different in-combination scenarios with or without impacts from the relevant wind farms that are subject to this assessment, namely: Dogger Bank A and B, Dogger Bank C and Sophia, Hornsea Project One, Hornsea Project Two, Race Bank and Triton Knoll.

The following data were used to populate the PVA model for kittiwake:

Basic PVA Information		
PVA run details		Simulation
Case studies		None
Basic information about the form of PVA	*Model to use for environmental stochasticity*	Beta/Gamma
	Choose model for density dependence	No density dependence
	Include demographic stochasticity in model?	Yes
Simulation	*Number of simulations*	5000
	Random seed	223
	Years of Burn-in	0

Baseline Demographic Rates		
Species-specific values	*Species*	Black-legged kittiwake
Region type to use for breeding success data		site
Available colony-specific survival rate		National
Sector to use within breeding success region		Farne Islands

[85] http://publications.naturalengland.org.uk/publication/4926995073073152
Searle, K., Mobbs, D., Daunt, F. and Butler, A. (2019). A Population Viability Analysis Modelling Tool for Seabird Species. Natural England Commissioned Reports, Number 274.

Baseline Demographic Rates		
Age at First breeding		4
Productivity Parameters	*Maximum brood size per pair*	2
Number of sub-populations		1
Units for initial population size		Breeding adults
Options for immatures	*Are baseline demographic rates specified separately for immatures?*	Yes
Baseline demographic rates 1		
Initial Year		2019
Initial population size		8804
Productivity rates per pair	*Mean*	0.823793103448276
	Standard deviation	0.315893447147513
Adult survival	*Mean*	0.854
	Standard deviation	0.077
Immature survival rates		
Mean for age class 0-1	*Mean*	0.79
	Standard deviation	0
Mean for age classes 1-4	*Mean*	0.854
		0.077

Impacts		
Number of scenarios of impact		7
Options	*Are impacts applied separately to each subpopulation?*	No
	Are impacts specified separately for immatures?	No
	Are standard errors of impacts available?	No
	Should random seeds be matched for impact scenarios?	No
Form of impact		Relative
Years at which impacts are assumed to begin and end		2020 - 2050
Scenario A: all in-comb	*Impact on adult survival rate*	0.00600863
Scenario B: DBAandB absent		0.0047592
Scenario C: DBCandSofia absent		0.00511131

Impacts		
Scenario D: H1 absent		0.00587233
Scenario E: H2 absent		0.00597456
Scenario F: RB absent		0.0059632
Scenario G: TK absent		0.00586097
Summary FarneKits		
First year to include outputs		2020
Final year to include outputs		2050
Output: Target population size	*Target population size*	blank
	Quasi-extinction threshold	blank
Units for output		Breeding adults

Northern Gannet

The PVA tool has been used to predict future growth rates and population levels of gannet from the Flamborough and Filey Coast SPA from the relevant wind farms that are subject to this assessment, namely: Dudgeon, Race Bank and Greater Gabbard.

The following data were used to populate the PVA model for Northern Gannet

Basic PVA Information		
PVA run details		Simulation
Case studies		None
Basic information about the form of PVA	*Model to use for environmental stochasticity*	Beta/Gamma
	Choose model for density dependence	No density dependence
	Include demographic stochasticity in model?	Yes
Simulation	*Number of simulations*	5000
	Random seed	354
	Years of Burn-in	0

Baseline Demographic Rates		
Species-specific values	*Species*	Northern gannet
Region type to use for breeding success data		Country
Available colony-specific survival rate		National

Baseline Demographic Rates		
Sector to use within breeding success region		England
Age at First breeding		5
Productivity Parameters	*Maximum brood size per pair*	1
Number of sub-populations		1
Units for initial population size		Breeding adults
Options for immatures	*Are baseline demographic rates specified separately for immatures?*	Yes
Baseline demographic rates 1		
Initial Year		2017
Initial population size		26,784
Productivity rates per pair	*Mean*	0.7975
	Standard deviation	0.0663225769291748
Adult survival	*Mean*	0.919
	Standard deviation	0.042
Immature survival rates		
Mean for age class 0-1	*Mean*	0.424
	Standard deviation	0.045
Mean for age classes 1-2	*Mean*	0.829
	Standard deviation	0.026
Mean for age classes 2-3	*Mean*	0.891
	Standard deviation	0.019
Mean for age classes 3-4	*Mean*	0.895
	Standard deviation	0.019
Mean for age classes 4-5	*Mean*	0.919
	Standard deviation	0.042

Impacts		
Number of scenarios of impact		3
Options	*Are impacts applied separately to each subpopulation?*	No
	Are impacts specified separately for immatures?	No
	Are standard errors of impacts available?	No

Impacts		
	Should random seeds be matched for impact scenarios?	No
Form of impact		Relative
Years at which impacts are assumed to begin and end		2022- 2052
Scenario A: Greater Gabbard	*Impact on adult survival rate*	0.00002987
Scenario B: Dudgeon		0.00096326
Scenario C: Race Bank		0.00131048
Summary		
First year to include outputs		2022
Final year to include outputs		2052
Output: Target population size	*Target population size*	Blank
	Quasi-extinction threshold	Blank
Units for output		Breeding adults

Puffin

The PVA tool has been used to predict future growth rates and population levels of puffin from Croquet SPA from in-combination impacts from offshore wind farms.

The following data were used to populate the PVA model for Atlantic Puffin at Croquet SPA and Farne Islands SPA

Basic PVA Information		
PVA run details		Simulation
Case studies		None
Basic information about the form of PVA	*Model to use for environmental stochasticity*	Beta/Gamma
	Choose model for density dependence	No density dependence
	Include demographic stochasticity in model?	Yes
Simulation	*Number of simulations*	5000
	Random seed	34
	Years of Burn-in	0

Baseline Demographic Rates		
Species-specific values	*Species*	Atlantic puffin

Baseline Demographic Rates		
Region type to use for breeding success data		Country
Available colony-specific survival rate		National
Sector to use within breeding success region		England
Age at First breeding		5
Productivity Parameters	*Maximum brood size per pair*	1
Number of sub-populations		1
Units for initial population size		Breeding adults
Options for immatures	*Are baseline demographic rates specified separately for immatures?*	Yes
Baseline demographic rates 1		
Initial Year		2019
Initial population size (Croquet)		50,058
Initial population size (Farnes).		87,504
Productivity rates per pair	*Mean*	0.769090909090909
	Standard deviation	0.175361099310865
Adult survival	*Mean*	0.907
	Standard deviation	0.083
Immature survival rates		
Mean for age class 0-1	*Mean*	0.709
	Standard deviation	0.108
Mean for age classes 1-2	*Mean*	0.709
	Standard deviation	0.108
Mean for age classes 2-3	*Mean*	0.709
	Standard deviation	0.108
Mean for age classes 3-4	*Mean*	0.76
	Standard deviation	0.093
Mean for age classes 4-5	*Mean*	0.805
	Standard deviation	0.083

Impacts		
Number of scenarios of impact		2

Impacts		
Options	*Are impacts applied separately to each subpopulation?*	No
	Are impacts specified separately for immatures?	No
	Are standard errors of impacts available?	No
	Should random seeds be matched for impact scenarios?	No
Form of impact		Relative
Years at which impacts are assumed to begin and end		2022- 2052
Scenario A: Croquet in-combination	*Impact on adult survival rate*	0.00021975
Scenario B: Croquet In-combination		
Scenario A: Farne Islands in-combination	*Impact on adult survival rate*	0.00025142
Scenario B: Farne Islands in-combination		0.00069825
Summary Puffin		
First year to include outputs		2022
Final year to include outputs		2052
Output: Target population size	*Target population size*	Blank
	Quasi-extinction threshold	Blank
Units for output		Breeding adults

Common guillemot

The PVA tool has been used to predict future growth rates and population levels of guillemot from the Flamborough and Filey Coast SPA from in-combination impacts from offshore wind farms.

The following data were used to populate the PVA model for guillemot

Basic PVA Information		
PVA run details		Simulation
Case studies		None
Basic information about the form of PVA	*Model to use for environmental stochasticity*	Beta/Gamma
	Choose model for density dependence	No density dependence
	Include demographic stochasticity in model?	Yes
Simulation	*Number of simulations*	5000
	Random seed	413
	Years of Burn-in	0

Baseline Demographic Rates		
Species-specific values	*Species*	Common guillemot
Region type to use for breeding success data		Site
Available colony-specific survival rate		National
Sector to use within breeding success region		Flamborough Head and Bempton Cliffs
Age at First breeding		6
Productivity Parameters	*Maximum brood size per pair*	1
Number of sub-populations		1
Units for initial population size		Breeding adults
Options for immatures	*Are baseline demographic rates specified separately for immatures?*	Yes
Baseline demographic rates 1		
Initial Year		2017
Initial population size		84,647
Productivity rates per pair	*Mean*	0.724117647058824
	Standard deviation	0.118060303633853

Baseline Demographic Rates		
Adult survival	*Mean*	0.94
	Standard deviation	0.025
Immature survival rates		
Mean for age class 0-1	*Mean*	0.56
	Standard deviation	0.058
Mean for age classes 1-2	*Mean*	0.792
	Standard deviation	0.152
Mean for age classes 2-3	*Mean*	0.917
	Standard deviation	0.098
Mean for age classes 3-4	*Mean*	0.938
	Standard deviation	0.107
Mean for age classes 4-5	*Mean*	0.94
	Standard deviation	0.025
Mean for age classes 5-6	*Mean*	0.94
	Standard deviation	0.025

Impacts		
Number of scenarios of impact		2
Options	*Are impacts applied separately to each subpopulation?*	No
	Are impacts specified separately for immatures?	No
	Are standard errors of impacts available?	No
	Should random seeds be matched for impact scenarios?	No
Form of impact		Relative
Years at which impacts are assumed to begin and end		2022- 2052
Scenario A: in-combination	*Impact on adult survival rate*	0.00119319
Scenario B: in-combination		
Summary		
First year to include outputs		2022
Final year to include outputs		2052
Output: Target population size	*Target population size*	Blank
	Quasi-extinction threshold	Blank

Impacts		
Units for output		Breeding adults

Razorbill

The PVA tool has been used to predict future growth rates and population levels of razorbill from the Flamborough and Filey Coast SPA from in-combination impacts from offshore wind farms.

The following data were used to populate the PVA model for guillemot

Basic PVA Information		
PVA run details		Simulation
Case studies		None
Basic information about the form of PVA	*Model to use for environmental stochasticity*	Beta/Gamma
	Choose model for density dependence	No density dependence
	Include demographic stochasticity in model?	Yes
Simulation	*Number of simulations*	5000
	Random seed	118
	Years of Burn-in	0

Baseline Demographic Rates		
Species-specific values	*Species*	Razorbill
Region type to use for breeding success data		Site
Available colony-specific survival rate		National
Sector to use within breeding success region		Flamborough Head and Bempton Cliffs
Age at First breeding		5
Productivity Parameters	*Maximum brood size per pair*	1
Number of sub-populations		1
Units for initial population size		Breeding adults
Options for immatures	*Are baseline demographic rates specified separately for immatures?*	Yes
Baseline demographic rates 1		
Initial Year		2017
Initial population size		27,967
Productivity rates per pair	*Mean*	0.618888888888889
	Standard deviation	0.0749073501808141

Baseline Demographic Rates		
Adult survival	*Mean*	0.895
	Standard deviation	0.067
Immature survival rates		
Mean for age class 0-1	*Mean*	0.63
	Standard deviation	0
Mean for age classes 1-2	*Mean*	0.63
	Standard deviation	0
Mean for age classes 2-3	*Mean*	0.895
	Standard deviation	0.067
Mean for age classes 3-4	*Mean*	0.895
	Standard deviation	0.067
Mean for age classes 4-5	*Mean*	0.895
	Standard deviation	0.067

Impacts		
Number of scenarios of impact		2
Options	*Are impacts applied separately to each subpopulation?*	No
	Are impacts specified separately for immatures?	No
	Are standard errors of impacts available?	No
	Should random seeds be matched for impact scenarios?	No
Form of impact		Relative
Years at which impacts are assumed to begin and end		2022- 2052
Scenario A: in-combination	*Impact on adult survival rate*	0.00100118
Scenario B: in-combination		0.00279258
Summary		
First year to include outputs		2022
Final year to include outputs		2052
Output: Target population size	*Target population size*	Blank
	Quasi-extinction threshold	Blank
Units for output		Breeding adults

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