NORTH FALLS

Offshore Wind Farm

Report to Inform Appropriate Assessment

Part 4 Offshore Ornithology (Birds Directive Annex 1 and Migratory Species)

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Glossary of Acronyms

AEoI	Adverse Effect on Integrity
AIS	Automatic Identification System
AOE	Alde-Ore Estuary
AON	Apparently Occupied Nests
AOT	Apparently Occupied Territory
BDMPS	Biologically Defined Minimum Population Scale
BTO	British Trust for Ornithology
CEA	Cumulative Effect Assessment
CL(s)	Confidence Limit(s)
CPGR	Counterfactuals of Population Growth Rate
CPS	counterfactuals of Population Size
CRM	Collision Risk Modelling
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
DESNZ	Department for Energy Security and Net Zero
EDA	Effective Displacement Area
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
FFC	Flamborough and Filey Coast
GB	Great Britain
GGOW	Greater Gabbard Offshore Wind Farm
GIS	Geographic Information Systems
GLS	Global Location Sensor
GWF	Galloper Wind Farm
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drill
HDPE	High-Density Polyethylene
HPAI	Highly Pathogenic Avian Influenza
HRA	Habitats Regulations Assessment
HVAC	High Voltage Alternative Current
HVDC	High-Voltage Direct Current
IMO	International Maritime Organisation
INLA	Integrated Nested Laplace Approximation
JNCC	Joint Nature Conservation Committee
KDE	Kernel Density Estimate
LCL	Lower Confidence Limit
LSE	Likely Significant Effect

MaRD	Maximum Rotor Diameter
MHWS	Mean High Water Springs
MiRD	Minimum Rotor Diameter
MMFR	Mean Maximum Foraging Range
NAF	Nocturnal Activity Factor
NE	Natural England
NFOW	North Falls Offshore Wind Ltd
NGET	National Grid Electricity Transmission
NPS	National Policy Statement
NVIS	Night Vision Imaging Systems
OCP	Offshore Converter Platform
OCSS	Offshore Coordination Support Scheme
OSP	Offshore Substation Platform
OTE	Outer Thames Estuary
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PVA	Population Viability Analysis
RIAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for the Protection of Birds
RTD	Red-Throated Diver
RWE	RWE Renewables UK Swindon Limited
SACO	Supplementary Advice on Conservation Objectives
SAC	Special Area of Conservation
sCRM	Stochastic CRM
SD	Standard Deviation
SE	Standard Error
SEP&DEP	Sheringham and Dudgeon Extension Projects
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage (now NatureScot)
SOSS-MAT	Strategic Ornithological Support Services – Migration Assessment Tool
SPA	Special Protection Area
SSER	SSE Renewables Offshore Windfarm Holdings Limited
TDR	Time-Depth Recorder
UCL	Upper Confidence Limit
UK	United Kingdom
WTG	Wind Turbine Generator

Glossary of Terminology

Array area	The offshore wind farm area, within which the wind turbine generators, array cables, platform inter-connector cable, offshore substation platform(s) and/or offshore converter platform will be located.
Array cables	Cables which link the wind turbine generators with each other, the offshore substation platform(s) and/or the offshore converter platform.
Cable circuit (onshore)	The onshore export cables are comprised of cable 'circuits'. Each cable circuit is typically comprised of three power cables, as well as fibre cables and earth cables. It is expected that each circuit would compromise up to seven cables in total.
Cable ducts	Housing for the onshore export cables, typically comprising plastic high-density polyethylene (HDPE) pipes buried underground. Each cable circuit will potentially comprise up to seven individual ducts (i.e. one per cable).
Former array areas	The two distinct offshore wind farm areas (including the 'northern array area' and 'southern array area') which comprised the North Falls offshore wind farm at scoping and PEIR stage.
Horizontal directional drill (HDD)	Trenchless technique to bring the offshore export cables ashore at landfall. The technique will also be the primary trenchless technique used for installation of the onshore export cables at sensitive areas of the onshore cable route.
Landfall	The location where the offshore export cables come ashore at Kirby Brook.
Offshore cable corridor	The corridor of seabed from the array area to the landfall within which the offshore export cables will be located.
Offshore converter platform (OCP)	Should an offshore connection to a third party HVDC cable be selected, an offshore converter platform would be required. This is a fixed structure located within the array area, containing HVAC and HVDC electrical equipment to aggregate the power from the wind turbine generators, increase the voltage to a more suitable level for export and convert the HVAC power generated by the wind turbine generators into HVDC power for export to shore via a third party HVDC interconnector cable.
Offshore export cables	The cables which bring electricity from the offshore substation platform(s) to the landfall, as well as auxiliary cables.
Offshore project area	The overall area of the array area and the offshore cable corridor.
Offshore substation platform(s)	Fixed structure(s) located within the array area, containing HVAC electrical equipment to aggregate the power from the wind turbine generators and increase the voltage to a more suitable level for export to shore via offshore export cables.
Onshore cable route	Onshore route within which the onshore export cables and associated infrastructure would be located.
Onshore export cables	The cables which take the electricity from landfall to the onshore substation. These comprise High Voltage Alternative Current (HVAC) cables, buried underground.
Onshore project area	The boundary within which all onshore infrastructure required for the Project will be located (i.e. landfall; onshore cable route, accesses, construction compounds; onshore substation and cables to the National Grid substation).
Platform interconnector cable	Cable connecting the offshore substation platforms (OSP); or the OSP and offshore converter platform (OCP).
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project Or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Wind turbine generator (WTG)	Power generating device that is driven by the kinetic energy of the wind.

4 Offshore Ornithology (Birds Directive Annex I and Migratory Species)

4.1 Introduction

4.1.1 Background

1. North Falls Offshore Wind Farm (hereafter 'North Falls' or 'the Project') is an extension to the existing Greater Gabbard Offshore Wind Farm (GGOW), in the southern North Sea. When operational, North Falls would have the potential to generate renewable power for approximately 400,000 United Kingdom (UK) homes from up to 57 wind turbines.
2. The offshore project area lies in the Southern North Sea, approximately 40km from the East Anglian coast and the onshore project area is located in the Tendring Peninsula of Essex. The offshore project area is relevant to this Part of the RIAA and includes:
   - The offshore wind farm area (the 'array area') - within which the Wind Turbine Generator(s) (WTGs), Offshore Substation Platform(s) (OSPs), Offshore Converter Platform(s) (OCPs, if required), platform interconnector cable and array cables will be located; and
   - Offshore cable corridor - the corridor of seabed from the array area to the landfall within which the offshore export cables will be located.
3. Effects associated with the onshore project area are assessed in Part 5 Onshore European and Ramsar Sites.
4. The Applicant is North Falls Offshore Wind Ltd (NFOW). NFOW is a joint venture between SSE Renewables Offshore Windfarm Holdings Limited (SSER) and RWE Renewables UK Swindon Limited (RWE).

4.1.2 Purpose of this document

5. The purpose of the Report to Inform Appropriate Assessment (RIAA) is to provide the information necessary for the competent authority to carry out the Appropriate Assessment of the North Falls Offshore Wind Farm (OWF) (hereafter 'North Falls' or 'the Project').
6. This Part of the RIAA provides the shadow Appropriate Assessment for offshore European Sites designated for Birds Directive Annex I and Migratory Species screened in based on the Habitats Regulations Assessment (HRA) Screening Report (RIAA Appendix 1.1, Document Reference: 7.1.1.1) and summarised in Section 4.3.

4.2 Approach to Assessment

7. The list of SPAs and Ramsar sites screened in for assessment for offshore ornithology is given in RIAA Appendix 1.1 (Tables 8.4 and 11.2).
8. The shadow appropriate assessments provided here are divided into sections as follows:

- SPAs with connectivity for breeding seabirds (Section 4.4). This includes sites where Natural England (NE) has advised where there is potential for an Adverse Effect on Integrity (AEoI) for one or more qualifying species in relation to North Falls (Project alone or in-combination): The Outer Thames Estuary (OTE) SPA (red-throated diver (RTD)), the Alde-Ore Estuary (AOE) SPA and Ramsar site (lesser black-backed gull) and Flamborough and Filey Coast (FFC) (kittiwake, guillemot, razorbill);
- SPAs and Ramsar sites screened in for migratory birds other than seabirds (Section 4.5);
- SPAs screened in for seabirds during the non-breeding season (Section 4.6).

9. In Section 4.4, a site description for each designated site is provided. Depending on the information available, this may include information taken from the citation for the site, its conservation objectives, supplementary advice on the conservation objectives, conservation advice, site condition monitoring or other baseline offshore ornithology information.

10. For each qualifying feature screened into the Appropriate Assessment, the following information is provided:
    - The status and condition of the designated population, including any relevant data on population trends;
    - A review of key evidence in support of functional linkage or connectivity between the SPA population and North Falls
    - Information on the ecology of the species as relevant to the assessment
    - An assessment of the potential effects of North Falls on the qualifying feature including a conclusion in relation to the potential for an AEoI; and
    - An assessment of potential effects on the qualifying feature when considering North Falls in-combination with other relevant projects and a conclusion in relation to the potential for an AEoI.

11. Where predicted impacts (either in project alone or in-combination scenarios) equate to an increase of greater than 1% of baseline mortality of the relevant population, then further consideration is undertaken e.g. through population modelling, to determine the significance of the mortality for the population in question. This is the approach recommended by NE (2022a).

12. For the in-combination assessments, OWFs with quantitative information available for a given SPA qualifying feature at the time of preparation of this document have been included. OWFs included in the in-combination assessment are listed in ES Chapter 13 Offshore Ornithology (Document Reference 3.1.15), Table 13.43. This includes OWFs in tiers 1 to 4 (operational projects, projects in construction, consented projects and those with an application submitted but not yet determined), and tier 5 if a PEIR (Preliminary Environmental Information Report) is publicly available (see ES Chapter 13 Offshore Ornithology (Document Reference 3.1.15), Section 13.8.2). The cut-off date for this was the end of March 2024.

13. Since this time, Green Volt and Sheringham Shoal and Dudgeon Extension Projects have been consented; and the ESs for three OWFs, Five Estuaries, Outer Dowsing and Dogger Bank South have been submitted. It is understood that no changes to the predicted displacement and collision mortalities for the two consented sites have been made after March 2024. However, for Five Estuaries and Outer Dowsing, the cumulative assessment here is based on predicted displacement and collision mortalities from the PEIR, and has not been updated to reflect any changes in the Environmental Statements that accompanied the Development Consent Order (DCO) submission.

4.2.1 Consultation

14. Consultation on matters related to the HRA has been undertaken via an Offshore ornithology Expert Topic Group meeting (ETG), including NE and the Royal Society for the Protection of Birds (RSPB). In addition, a draft RIAA (NFOW, 2023) was submitted alongside the PEIR for consultation in July 2023. Stakeholder feedback has been considered in preparing the shadow appropriate assessment included below.
15. A detailed record of offshore ornithology consultation comments and responses regarding screening is included in the HRA screening report (RIAA Appendix 1.1, Document Reference: 7.1.1.1).
16. Consultation on the draft RIAA and an associated method statement regarding the in-combination assessment for RTD is provided in Table 4.1 and Table 4.2, respectively.
17. Further comments in relation to the ornithology matters (which relate to the HRA and EIA) are provided in ES Appendix 13.1 (Document Reference: 3.3.12).
18. Consultation regarding HRA compensation is provided in Annex 1A (Document Reference: 7.2.1.1) of the HRA Derogation Case.

Table 4.1 NE comments on the draft RIAA produced to accompany the PEIR

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
1 Key issue (draft RIAA, Section 7.2.3.1)	The PEIR maintains that the project alone and in-combination will not lead to an AEoI on RTD at OTE SPA. NE's position is that an AEoI is arising on OTE SPA RTD due to displacement impacts from existing and consented OWF. We therefore consider that any additional displacement would add to the in-combination AEoI. The evidence base strongly suggests that the project alone will exert a displacement effect on RTDs in the OTE SPA, which will inevitably impact their distribution in the site, in contravention of the relevant conservation objectives. It is stated that a total area of 149.4 km2, representing 3.8% of the SPA, may be subject to displacement impacts when considering a 12km buffer for North Falls OWF. This buffer distance is considered appropriate as it is informed by evidence from the nearby London Array OWF. NE advises that the proposed western boundary of the southern North Falls array should be amended so that it lies at least 10km away from the SPA to avoid project alone and in-combination AEoI for RTD. In the light of the requirement to demonstrate there are no satisfactory alternatives that would be less damaging to the SPA, NE recommends the full exploration of all measures to avoid, reduce and mitigate the displacement impact on RTDs at the OTE SPA by application of the mitigation hierarchy.	NFOW does not disagree that an adverse effect on RTDs within the OTE SPA from existing OWF displacement cannot be ruled out. However, given existing sources of disturbance it is still considered appropriate to consider the extent of additional displacement / deterioration of perceived habitat quality that might be predicted in relation to North Falls, and whether this is significant in relation to the Conservation Objectives. It is the view of NFOW that the project presents no material contribution to any existing in-combination effect. Moving the North Falls turbine array boundary 10km from the OTE SPA boundary is not feasible, as discussed in the HRA Derogation case. Post-PEIR the boundary of North Falls has been revised and the western boundary of the array area has been moved further away from the OTE SPA, to approximately 4.5km at the nearest point. The revised area of overlap between the 12km buffer of the array area and the SPA is 108.42 km2, representing 2.8% of the total SPA area (3,924km2). For the revised boundary, there is no area of overlap between the North Falls 12km buffer and the OTE SPA which is not already within the 12km buffer of another existing OWF, and /or within an international shipping lane (Figure 4.2). Thus no 'new' areas of the SPA, not already subject to disturbance, would be affected by North Falls	Section 4.4.1.4.4; Habitats Regulations Derogation: Provision of Evidence (Document Reference: 7.2)

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
2. Key issue	NE highlights the underdeveloped and high-level nature of documents relating to compensatory measures. This is of significant concern given the apparent early reliance on compensatory measures from a consenting perspective. We note that our consultation responses on the 'Draft in Principle Compensation Options Review' have not yet been addressed, and the concerns raised in those responses remain. We highlight the significant difficulties experienced by other projects where compensatory measures have been required. Designing and siting measures, as well as evidencing likely effectiveness and connectivity to the impacted SPA or the national site network all present significant challenges. It remains unclear that an appropriate compensatory measure can be identified, secured, and delivered by the project for RTD. We advise the project work collaboratively using the ETG process to accelerate the development of compensatory measures prior to submission. This is a particular priority for RTD and lesser black-backed gull , although it should be noted that NE does not yet believe all options to avoid, reduce and mitigate impacts on these species have been exhausted. Compensatory measures should be considered a last resort once the mitigation hierarchy is exhausted. Where compensatory measures are likely to be required, or there is a level of uncertainty pre-examination, NE advises that the Examination period will be insufficient for measures to be adequately developed and secured. This could carry significant consenting risk.	Further work has been undertaken to progress without prejudice compensation measures, in consultation with NE, through the Evidence Plan Process (EPP)	Appendix 3 Red-throated Diver Compensation Document (Document Reference 7.2.3) – Appendix to the Habitats Regulations Derogation: Provision of Evidence.
22 (Draft RIAA Paragraph 1203)	In addition to the targets quoted, please note also; "Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding) at the following levels: Subtidal sand (220,295.55); Subtidal coarse sediment (73,606.64); Subtidal mixed sediments (62,100.63 ha); Subtidal mud (12,549.14 ha); Circalittoral rock (335.2 ha); and Water column".	The RIAA has been updated to reflect this advice.	Section 4.4.1.4.1

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
	The submitted ES should reflect all relevant Supplementary Advice on Conservation Objectives (SACO) targets.		
23 (Draft RIAA Paragraphs 1212, 1236)	A 1% mortality rate for displaced RTDs is proposed as being an appropriate precautionary estimate. The justification given is that RTDs utilise a range of habitats, prey species, occur at low density and are highly mobile. The Applicant also states, "…it seems biologically implausible that OWF displacement would add substantially to the existing mortality rate of this species.". NE strongly disagrees with this assertion. We consider the available evidence insufficient to facilitate expert judgement of a mortality rate for displaced birds. Furthermore, it is of increasing concern that an apparent lack of population level impact, about which there is some uncertainty, is used as justification to continue increasing the pressure on this species through further displacement. SPAs are classified for being the 'most suitable territories' for the species in question and have a central role in securing the favourable conservation status for the species as a whole. Clearly, the OTE SPA protects vital wintering habitat for this species. We advise due consideration is given to the relative importance of the OTE SPA for wintering RTD within the UK national site network.	NE's concerns are acknowledged. The importance of the OTE SPA for RTD and the existing pressures on this species within the SPA is not in doubt, the change in boundary for North Falls post-PEIR reflects this, as well as the commitment of the Applicant to developing appropriate and effective compensation without prejudice to the outcome of the HRA. The likely range of mortality for displaced RTDs is discussed further in Section 4.4.1.4.4, in the context of the recent JNCC (Joint Nature Conservation Committee) RTD energetics study (Thompson *et al.* 2023) and the NE review of that study. A range of mortality of 1-10% for displaced birds is presented. Although NE disagrees with the statement about 1% mortality, the text has been left more or less as is, as it is believed that this is an appropriate interpretation based on expert judgement. It is not said, nor intended to imply that an apparent lack of population impact justifies further significant displacement pressure on the species within the SPA. Specifically for North Falls, with the change of boundary, the increase in displacement pressure on RTDs within the SPA is considered to be so small as to be immaterial, as argued elsewhere.	Section 4.4.1.4.4

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
		Context on the importance of the SPA within the national site network is included in the section on status (Section 4.4.1.4.1).	
24 (Draft RIAA Paragraphs 1213, 1214)	NE notes that the 12km buffer overlap is in fact (approximately) 153 km^2 due to a 4 km^2 overlap that is not considered. For the calculation of SPA overlap with the project buffer out to 12km, please state the actual area in the submitted ES. With the additional 4 km^2 included we calculate this as representing 3.9% of the SPA area, i.e., a 0.1% increase, but note that the 4 km^2 figure is an approximation. The Joint Statutory Nature Conservation Body (SNCB) Interim Advice on the Treatment Of Displacement For Red-Throated Diver (2022) states that, "For non-breeding red-throated diver, a pragmatic displacement buffer of at least 10km is recommended for use in site characterization, impact assessments and post consent monitoring where a plan or project is within 10km of a Special Protection Area (SPA) designated for non-breeding red-throated diver." Post-consent monitoring at the nearby London Array OWF detected displacement effects at distances of 11.5 km. NE's response to the London Array report is available as, EN010077-005287-DL11 - NE Appendix A23 NE Response London Array OWF Year 3 Final Ornithological Monitoring Report Deadline 11.pdf (planninginspectorate.gov.uk). Digital video aerial surveys of RTD in the OTE SPA 2018 - NECR260 (naturalengland.org.uk) indicated that displacement of RTDs from London Array OWF and its immediate surroundings continued to be detectable in early 2018 – two years after the conclusion of the post-	The additional 4km^2 area referred to by NE was the overlap between the North Falls former northern array area (boundary presented at PEIR) and the OTE SPA. Post – PEIR the boundary has been revised and there is no longer a northern component to the array area. The RIAA submitted with the DCO application considers the complete overlap between the 12km buffer of the revised boundary of the North Falls array area and the OTE SPA.	Section 4.2.3

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
	construction monitoring programme, and four and a half years after London Array OWF was fully commissioned. Therefore, given the proximity of London Array OWF to the proposed North Falls site, NE advises it is appropriate to consider a 12km buffer for consideration of displacement effects in terms of their spatial extent.		
25	We note that population estimates do not account for the 12km buffer overlap in the northern part of the SPA shown in Figure 7.1 Population estimates have been modelled using an Integrated Nested Laplace Approximation (INLA) approach. An appendix is referenced, but this does not appear to have been supplied for review. Therefore, NE cannot comment on the method, or the resulting population estimates and their application for the calculation of predicted mortality in Tables 7.3 and 7.4. NE requests the consideration of the entire 12km buffer area overlap in the submitted ES. We expect that the inclusion of the ~4km^2 area that has not been considered would have little impact on the analysis, but this is not currently clear. Please supply ‘Appendix 2 Modelling the abundance of red-throated divers in the area of overlap between North Falls digital aerial surveys (12km buffer) and the OTE SPA (HiDef report)’ to inform discussions in future ETG, and if deemed an appropriate approach, include in the submitted ES.	In relation to 12km buffer overlap of northern part of SPA, see response to NE comment 24 above. North Falls apologises that this Appendix was omitted from the RIAA accompanying the PEIR. Subsequent to the publication of the PEIR, an error in the modelling of the 2018 data was identified and the report has been updated to correct this and to update the model estimates for the revised North Falls Array boundary. The revised modelling report was provided to NE on 04 March 2024.	RIAA Part 4 Appendix 4.1 (Document Reference: 7.1.4.1)
26 (Draft RIAA Paragraph 1216, Tables 7.3, 7.4)	When rounding the number of RTD displaced NE notes results of >0 but <0.5 have been rounded down (e.g., 0.45 birds displaced assuming 3% of 15 birds has been presented as 0).	Impacts have been rounded up to the nearest whole bird	Section 4.4.1.4.4.1

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
	NE considers that any impact of >0 should be rounded up to 1 bird.		
27 (Draft RIAA Paragraph 1223, 1224)	An effective displacement area (EDA) is described (the area of overlap weighted by the predicted proportion of birds displaced at different distance from OWFs). Following the EA1N/EA2 examination, NE has reflected on the validity of the EDA approach and concluded that these calculations are based on some questionable assumptions and has significant potential to be misleading, especially when the area of habitat over which displacement is occurring is of principle importance. The proportion of the population that is displaced is in no way analogous to the area that birds are subject to displacement from. The logical supposition if the area of 'effective' displacement is 55% would be that the remaining 45% of the area is not subject to displacement effects. This is clearly not the case. The displaced proportion of the population cannot use any of the area, i.e., displacement is occurring over the full extent of the area. Birds that are not displaced are likely (but not necessarily) dispersed over the entire area. Therefore, there is no logical way to proportionally reduce the area of effective habitat loss by the scale of impact on the population. We do recognise the potential value in trying to account for the gradient of effect in spatial terms, but in light of the relevant conservation objectives, NE considers that an area subject to any displacement effect is compromised in its ability to support RTD across the whole of that area. The submitted ES should present the total area over which displacement may occur to calculate the area of the SPA that may be impacted.	It is agreed that on its own EDA is potentially misleading. However, as NE acknowledge, given that studies indicate that RTD displacement from OWFs decreases with distance, it is arguable that also presenting only the area of the SPA subject to some extent of displacement over-estimates the extent of displacement and effective habitat loss. EDA is presented alongside the total area of an SPA subject to some form of displacement to give some context to the total displacement area.	Section 4.4.1.4.4.1

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
28 (Draft RIAA Paragraph 1227)	Other sources of displacement that overlap with the projects 12km buffer are detailed and used as justification to reduce the area over which the project will exert a displacement impact. While it is accepted that there is overlap between the North Falls buffer with shipping routes and other OWFs which may be exerting displacement effects (over a buffer zone) on the RTD population, it is evident that there are still RTDs present in these areas. It is these birds that are being assessed as at risk of displacement from this project. Their apparent tolerance of the already impacted status of the habitat in question is not evidence that a further impact could be tolerated. There is no basis on which to conclude that the project will not additionally impact the distribution of RTDs within the SPA in these areas. The submitted ES should present the total area over which displacement may occur to calculate the area of the SPA that may be impacted.	North Falls agrees with the statement by NE that there will be RTDs present in areas of overlap between the North Falls 12km buffer and the OTE SPA, which also overlap with the 12km buffers of other OWFs and shipping lanes; and that these birds are potentially subject to additional effects of displacement from North Falls. However, it is still considered appropriate to consider the extent of additional displacement / deterioration of perceived habitat quality that might be predicted in relation to North Falls, particularly given the presence of international shipping lanes between the boundary of the Array and the SPA. The RIAA considers the complete overlap between the 12km buffer of the revised boundary of the North Falls array area and the OTE SPA.	Section 4.4.1.4.4.1
29 (Draft RIAA Paragraph 1228)	The Applicant states, "*that North Falls would not contribute significantly to the existing sources of disturbance/displacement for red-throated divers in this area and that a Project alone effect on the distribution of the species within the SPA can be excluded*." NE's position is that an adverse effect on integrity arising from pre-existing OWF displacement effects on the RTD feature of the OTE SPA cannot be ruled out. NE therefore considers any additional displacement would add to the in-combination impact. It is stated that a total area of 149.4 km^2, representing 3.8% of the SPA, may be subject to displacement impacts when considering a 12km buffer for North Falls OWF. This	NFOW does not disagree that an adverse effect on RTDs within the OTE SPA from existing OWF displacement cannot be ruled out. However, as above, given these existing sources of disturbance it is still considered appropriate to consider the extent of additional displacement / deterioration of perceived habitat quality that might be predicted in relation to North Falls, and whether this is significant in relation to the Conservation Objectives. It is the view of NFOW that the Project presents no material contribution to any existing in-combination effect. Post-PEIR the boundary of North Falls has been revised and the western boundary of the array area has been moved further away from the OTE SPA, to	Section 4.4.1.4.4.2

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
	buffer distance is considered appropriate as it is informed by evidence from the nearby London Array OWF. NE advises that the evidence base strongly suggests that the project alone will exert a displacement effect on RTDs in the OTE SPA, which will inevitably impact their distribution in the site, in contravention of the relevant conservation objectives. Accordingly NE advises that identifying avoidance and mitigation measures to reduce the impacts on OTE SPA should be given the highest priority prior to submission.	approximately 4.5km at the nearest point. The revised area of overlap between the 12km buffer of the North Falls array area and the SPA is 108.7 km^2, representing 2.8% of the total SPA area (3,924km^2). For the revised boundary, there is no area of overlap between the North Falls 12km buffer and the OTE SPA which is not already within the 12km buffer of another existing OWF, and /or within an international shipping lane. Thus no 'new' areas of the SPA, not already subject to disturbance, would be affected by North Falls.	
30 (Draft RIAA Paragraph 1238)	The Applicant states that "*it is concluded that adverse effects on the population size of red-throated diver of the Outer Thames Estuary SPA from in-combination displacement from OWFs can be excluded*." NE does not consider that this statement is evidenced. No quantitative or qualitative in-combination assessment of displacement mortality has been carried out. NE suggests further discussion is sought through the ETG's regarding this point.	The assessment has been updated and a quantitative in-combination assessment has been included based on the 2018 SPA survey, with caveats about the robustness of the modelling predictions. The conclusion has been reworded.	Section 4.4.1.4.4.2
31 (Draft RIAA Table 7.7)	The area of the SPA subject to displacement appears to be calculated as being reduced if North Falls OWF is built. It is stated in the table footnotes that, "*Measurements of the overlap between OWF buffers and the SPA take account of areas of overlap between the buffers of more than one OWF, prioritising the OWF which is closest, so no area is counted twice. For the 10-11km buffers, because of the relative positioning of OWFs, the area of overlap is actually larger without North Falls*". NE recommends that further clarity on the methodology used is provided in the ETG, given it appears to result in a reduction in the area of the SPA over which displacement may occur.	The Table (now Table 4.19) has been updated for the RIAA to accompany the DCO submission, based on the revised North Falls array area boundary. The overall area of the SPA within the array areas and 12km buffers of OWFs is greater with North Falls.	Section 4.4.1.4.4.2 (Table 4.19)

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
32 (Draft RIAA Paragraph 1246)	The Applicant highlights that the North Falls OWF increases the area of the SPA subject to displacement by 2% in-combination, from 49% to 51%. This increase is portrayed as insignificant in the context of contribution to the total impact. NE strongly disagrees with this characterisation of the impact. We strongly recommend the project reviews the Secretary of State's HRAs for the East Anglia One North and East Anglia Two OWF. NE considers that for the project to avoid contributing further to the AEoI for RTD at OTE SPA the North Falls project boundary must be moved to at least 10km from the SPA boundary.	The increase in the area of the SPA subject to displacement relates to the area within 12km of OWFs. (As above) given that, for the revised boundary, there is no area of overlap between the North Falls 12km buffer and the OTE SPA which is not already within the 12km buffer of another existing OWF, and /or within an international shipping lane, it is considered that there is no material contribution to an in-combination effect. No 'new' areas of the SPA, not already subject to disturbance, would be affected by North Falls. The SoS HRAs for EA1N and EA2 have been reviewed. In the case of these OWFs, the 12km buffer areas, where they overlap with the OTE, do not also overlap with the 12km buffers of other OWFs or international shipping lanes. Moving the North Falls boundary 10km from the OTE SPA boundary is not a feasible alternative solution, as discussed in the HRA Derogation case.	Section 4.4.1.4.4; Habitats Regulations Derogation: Provision of Evidence (Document Reference: 7.2)
33 (Draft RIAA Paragraph 1247)	The Applicant states, "It is therefore concluded that North Falls would not contribute to a significant increase in the existing in-combination effect of OWFs on the distribution of red-throated divers within the OTE SPA, and specifically in relation to North Falls, an in-combination effect can be excluded." NE reiterates our position that in terms of adding to the spatial area over which displacement impacts are occurring at the OTE SPA, considering the existing AEoI we do not consider any non-trivial additional area impacted to be insignificant. See above comment.	As above.	Section 4.4.1.4.4;

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
34 (Draft RIAA Paragraph 1248)	Compensatory measures are proposed for RTD at the OTE SPA. NE highlights our concerns that it will not be possible to deliver effective compensation at the project level. It should also be noted that compensation is a last resort once the mitigation hierarchy has been exhausted and that it will be necessary to demonstrate no satisfactory alternatives in any derogation case. Again, NE advises that identifying avoidance and mitigation measures should be given the highest priority prior to submission. See comment on RIAA Para 1246.	The comments on the mitigation hierarchy are noted and this issue has been considered and is addressed in the derogation case. Project level compensation has been developed in consultation with NE through the EPP, and options for contribution to strategic compensation measures are also presented.	Habitats Regulations Derogation: Provision of Evidence (Document Reference: 7.2) Appendix 3 Red-throated Diver Compensation Document (Document Reference 7.2.3) – Appendix to the Habitats Regulations Derogation: Provision of Evidence.
35 (Draft RIAA Paragraph 1284)	Impacts arising from recently consented projects with compensatory measures to offset their impacts have been deducted from the in-combination total for lesser black-backed gull. NE advises that in-combination totals should be presented both with and without the impacts of compensated-for projects in the ES, as this is likely to reflect Department for Energy Security and Net Zero's (DESNZ's) assessment requirements, and takes account of the current uncertainty regarding the effectiveness of compensatory measures for seabirds. Impacts arising from consented projects with compensatory measures should be considered in the in-combination impact total.	The advice of NE has been followed.	Section 4.4.2.5.4
36 (Draft RIAA Paragraph 1293)	NE welcomes the early consideration of compensatory measures. Until the impact assessment has been completed it is unclear what scale of impact these measures will need to compensate for. We highlight the inherent difficulties in evidencing and securing acceptable compensatory measures for SPA seabirds that satisfy the requirements of the Habitats Regulations.	The advice is noted. Since receiving feedback on the draft RIAA, NFOW has considered options for further mitigation and consulted with NE over the development of without prejudice compensation measures.	Habitats Regulations Derogation: provision of evidence (Document Reference: 7.2)

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
	We advise that the mitigation hierarchy is followed, which should be exhausted before considering the provision of compensatory measures.		
37 (Draft RIAA Paragraph 1345)	We note that without prejudice compensatory measures have been included for kittiwake, but that we are awaiting updates to the modelling, which will provide updated figures (see comment above on Ch.13 Para. 230). NE will provide further comments when the updated figures are available and would welcome further discussion on this through the ETG process.	The kittiwake Collision Risk Modelling (CRM) has been updated for the DCO submission. North Falls has developed compensation measures for kittiwake in consultation with NE, through the EPP.	Section 4.4.4.5.3 Appendix 4 Kittiwake Compensation Document (Document Reference 7.2.4) – Appendix to the Habitats Regulations Derogation: Provision of Evidence.
38 (Draft In principle Compensation Options Review	We note that many of our previous comments included in Table 2.1 remain unaddressed. We have not repeated those comments here, but they remain valid. Revisit NE's advice on the options review and incorporate into compensation package.	NE's comments on the Draft In Principle Compensation Options Review (Ref 004290164-04) have been taken account of in further development of compensation for lesser black-backed gull and the without prejudice compensation for RTD, kittiwake, guillemot and razorbill. All compensation options presented have been subject to consultation with NE through the EPP.	The following appendices to the Habitats Regulations Derogation: Provision of Evidence provide information on the compensation: • Appendix 2 Lesser Black-backed Gull Compensation Document (Document Reference: 7.2.2); • Appendix 3 Compensation Document (Document Reference: 7.2.3); • Appendix 4 Kittiwake Compensation Document (Document Reference: 7.2.4); and

Comment no. (draft RIAA section)	Comment	Response	Where addressed in the RIAA / DCO application
			• Appendix 5 Guillemot and Razorbill Compensation Document (Document Reference: 7.2.5).

Table 4.2 NE comments on RTD in-combination assessment memo and In principle compensation options technical note

Section	Comment	Response	Where addressed in DCO application
Responses to North Falls memo 004949121-02 on RTD: *response to NE comments from ETG3 / PEIR and way forward for appropriate assessment for Outer Thames Estuary SPA*			
2.1.2	[The North Falls memo states] '*The KDE density surface which has been used is not a sophisticated modelling approach (and HiDef, who undertook both the NE- commissioned 2018 SPA surveys and the North Falls baseline aerial surveys, have advised that they would not use the KDE shapefiles to estimate RTD numbers within discreet areas of the SPA). Nevertheless, the KDE predictions for the SPA area were checked against the design-based SPA population estimates for the two surveys in 2018 and found to be a close match*'. Agreed. NE notes that the use of these data was a pragmatic suggestion to enable a relatively straightforward analysis to be undertaken by the project.	The advice from NE is noted and the Kernel Density Estimate (KDE) predictions have been presented in the RIAA for RTD at the OTE SPA, with caveats.	Section 4.4.1.4.4.2
2.1.2	[The North Falls memo states] '*Thus, applying a constant maximum displacement within 1km buffers, as described for the NE (2022) gradient, may lead to over-estimation*'. Agreed. NE supplied a precautionary displacement gradient for the Project's consideration. We are happy to discuss or review alternative gradients, e.g. informed by fewer more local studies, or those with comparable methods.	The background provided by NE on their displacement gradient for RTD in the letter of 15 December 2023 is welcomed. The updated displacement gradient provided by NE has been used in the RIAA for RTD at the OTE SPA.	Section 4.4.1.4.4.2

Section	Comment	Response	Where addressed in DCO application
	It is of note that the "NE gradient" utilises London Array data for the 7-12 km buffers and Lincs, Lynn & Inner Dowsing data for the 5-6km buffers of relevance to the North Falls overlap with the OTE SPA (See Appendix, Table 1).		
Table 1	Total numbers of RTD predicted to be displaced do not appear to tally with predicted numbers from operational OWFs + EA1N & EA2 + North Falls	The table has been updated in the RIAA. There are small discrepancies in the totals due to rounding.	Section 4.4.1.4.4.2
2.2	[The North Falls memo states] '*At this stage, further supporting information is requested from NE on this gradient*', See Appendix 1 for a note supplied by Rebecca Hall of JNCC, who derived the supplied displacement gradient.	The background provided by NE on their displacement gradient for RTD in the letter of 15 December 2023 is welcomed. The updated displacement gradient provided by NE has been used in the RIAA for RTD at the OTE SPA.	Section 4.4.1.4.4.2
3	[The North Falls memo states] regarding the first option, '*compiling and collating data from baseline surveys and post-consent monitoring of OWFs to be included in the in-combination assessment'* for which '*the position of NFOW is that this approach should therefore not be taken in the in-combination assessment of RTD'*. We welcome the investigation of this approach and agree with the conclusion that the method should not be progressed.	Agreement from NE on this issue is welcomed.	Section 4.4.1.4.4.2
3	[The North Falls memo stated] regarding the second option, '*Subject to discussion with NE, this approach could, however, be presented in the RIAA for North Falls accompanying the DCO submission, with caveats regarding the KDE modelling approach, and the displacement gradients used, such that the resulting predictions of the numbers of RTDs displaced from OWFs in the OTE SPA may not be robust*'. We consider the application of this method to be a pragmatic approach that utilises available data and considers the best available evidence. As no novel method (or updates to this method) has been suggested, we agree that it should be applied and presented in the RIAA to facilitate a quantitative in-combination assessment.	The advice from NE is welcomed and the KDE predictions have been presented in the RIAA for RTD at the OTE SPA, with caveats.	Section 4.4.1.4.4.2

Section	Comment	Response	Where addressed in DCO application
3	'*North Falls apologises that a copy of the HiDef (2023) report on the Inlabru modelling of red-throated diver data from the 2021 North Falls baseline surveys and the 2018 SPA survey was not included with the draft RIAA documents*'. If this modelling is to be submitted with the DCO application, we would appreciate the opportunity to review it at the earliest opportunity and highlight that we may also seek external expert review.	The revised HiDef report is included with the RIAA, and a copy was sent to NE on 04 March 2024, in advance of DCO submission.	Section 4.4.1.4.4.2
Appendix A2	[The North Falls memo states] '*In relation to the likely range of mortality for displaced birds, it is noted that the recent JNCC red-throated diver energetics study (Thompson et al. 2023) concluded that during the non-breeding season the species has the capacity to adapt foraging behaviour to reflect changing conditions, and hence potentially accommodate the additional energetic cost of displacement*'. We have reviewed Thompson et al (2023) and suggest that a more nuanced reading of the conclusions is appropriate when considering the potential adaptability of RTDs in the OTE SPA. Data from Finnish tagged birds (that winter in the southern North Sea) shows that from the end of October onwards the percentage of available daylight hours spent foraging increases from 29% in mid-November to 72% in mid-January. This represents an increase from ca 2.5 hours a day spent foraging in November to ca 6 hours a day in January, when there are only 8-8.5 hours of daylight. The paper demonstrates that RTDs forage almost exclusively during the day. We also note that tagged birds are breeding adults, i.e. experienced individuals. Juvenile and immature birds may need to devote even more time to foraging if their success rate is lower. Ultimately, the energetic costs of this level of foraging in the depths of winter need to be investigated further, but it appears plausible that in fact RTDs are already operating at or close to sustainable limits. Thus, we	The NE advice has been incorporated in the RIAA for RTD at the OTE SPA.	Section 4.4.1.4.4.2

Section	Comment	Response	Where addressed in DCO application
	urge caution in an optimistic reading of the general conclusions made by Thompson et al (2023).		
C1	[The North Falls memo states] '*The estimated abundances from KDE data for the second approach (summing the RTD abundance for each cell) were closest to the SPA abundance estimates in Irwin et al. (2019) (survey 1 (4 February 2018): design-based RTD estimate for SPA 10,148, KDE (sum of cell abundances), 9185; survey 2 (17 February 2018) design based SPA 22,280, KDE (sum of cell abundances) 21,003) and therefore this approach was used*'. We request the abundance estimates derived through the first approach are also detailed to allow comparison. We note that the sum of cell abundances generated are lower (by 5-10%) compared to the SPA design-based abundance estimates. This discrepancy is relatively small, and the estimated abundance from KDE is within the 95% CLs of the design-based estimates. Nonetheless, it would be useful to clarify why this is the case (e.g., expected due to simplistic nature of KDE output or due to clipping/processing of cells overlapping boundaries).	As stated in the memo, KDE estimates for the RTD population of the OTE SPA using the sum of cells approach were 9,185 individuals for survey 1 on 4 February 2018 and 21,004 for survey 2 on 17 February 2018, compared with the design-based estimates of 10,148 (95% CI 7,868-12,544) and 22,280 (15,611- 29,784) (Irwin *et al.* 2019). The corresponding estimates based on the mean RTD density per KDE multiplied by the area cell were much lower. Calculating these for each of the three component areas of the SPA (south, North big and North Small) produced the following estimates (figures in brackets show the mean density of birds per km^2 for a given area as derived from KDE x area km^2): Survey 1: South 290 (0.1260 x 2300.3) North big 33 (0.02685 x 1234.1) North small 10 (0.0256 x 385.1) Total 333 Survey 2: South 566 (0.2460 x 2300.3) North big 199 (0.1606 x 1234.1) North small 14 (0.0360 x 385.1) Total 778	N/A.

Section	Comment	Response	Where addressed in DCO application
		Further detail can be provided on request. Note, the RIAA does not detail the comparison of the two approaches for KDE but refers only to the use of the summed cell approach.	
Table C1 and C2	[The North Falls memo states] '*Footnote 3 - NE advise 100% displacement within an OWF turbine array. The back-calculation method described in 2 above does not work for 100% displacement within the array area based on the NE gradient, as it would involve division by zero… For the purposes of this analysis, a mean has been taken of the observed proportion of birds displaced from OWF turbine arrays, from post-construction monitoring studies of OWFs where the array and/or 12km buffer overlaps with the OTE SPA*'. This method generates an array displacement of 73%, which is lower than that applied to the 1km & 2km buffers by the gradient. As 100% displacement results in a requirement to divide by zero, we advise that it would be appropriate to either consider 99.99% or alternatively, follow the methods applied to the rest of the gradient by selecting the greatest observed displacement from an array. The maximum array displacement being 94% at Kentish Flats (Appendix, Table 1). We note that the mean array displacement over the 5 sites used to inform the gradient is 82%. We also suggest that it would be appropriate to use the relevant London Array data to also consider displacement in the 11km and 12km buffers when using the NE gradient.	The advice of NE has been adopted for the RIAA (94% displacement in an OWF array, and application of the London Array displacement proportions to the 11 and 12km buffers)	Section 4.4.1.4.4.2

4.2.2 Worst case scenario and embedded mitigation

19. The worst case scenarios for construction, operation and decommissioning related to the offshore project area and potential impacts on offshore ornithological designated sites are presented in Table 4.3. The shadow appropriate assessments for each designated site have been based on these worst case scenarios.

Table 4.3 Realistic worst case scenarios

Potential Impact	Parameter	Notes
Displacement / barrier effect during construction	Length of offshore construction period: two years Maximum no. of foundation installation activities occurring at any one time: three (including maximum of two simultaneous pile driving operations) The likely maximum number of vessels operating simultaneously at the peak of the offshore construction activity is 35. Construction vessel two-way round trips to port (vessel movements): 2,532 over two year offshore construction period (average of 1,266 vessel movements per year; 3.5 movements per day) Helicopter movements: *c.* 100 round trips per year (1-2 per week) Installation period for offshore export cables: six months The offshore cable corridor is 57km long; 19km of which (33.3% of the overall length), passes through the OTE SPA. Number of cable laying vessels operating simultaneously: two Speed of cable-laying vessels: 150 - 400 m/h Construction port: To be determined, could be any North Sea port (UK and/or EU).	The worst case scenario is based on the longest construction period and the maximum numbers of plant on site and operational at a given time.
Displacement / barrier effect from offshore infrastructure and associated activities during operation	Array area of 95km^2 with maximum of 57 WTGs at a minimum spacing of 1180m. Maximum of 1,222 vessel round trips per annum to support wind farm operations. Maximum of 100 helicopter round trips per annum (c.1 - 2 per week) for scheduled and unscheduled maintenance. Lighting requirements: Aviation light: • Only on specific structures, usually the perimeter, mounted on the top of the nacelles. • Off during the day. • Red, up to 2,000 Candela (Cd) light displayed at night only. • Dimmable to 200Cd when visibility is greater than 5km at night.	The worst case scenario is based on the array area with 12km buffer for red throated diver (where the 12km buffer overlaps with the OTE SPA), and 2km buffer for other relevant species.

Potential Impact	Parameter	Notes
	• Synchronised flashing Morse "W" • A reduced intensity at and below the horizontal. • 360° visibility • Compatible with Night Vision Imaging Systems (NVIS) • Eight hours required to maintain all aviation warning lights. Helihoist light: • Low intensity green 200Cd light. • Off, unless the WTG is being prepared for helicopter approach	
Collision risk	Two design scenarios: • Minimum Rotor Diameter (MiRD) (smaller turbines) - 57 WTGs, 236m rotor diameter, (air gap 26.6m above Highest Astronomical Tide (HAT); and • Maximum Rotor Diameter (MaRD) - 34 WTGs, 337m rotor diameter, air gap 26.6m above HAT.	CRM has been carried out for both WTG scenarios based on the WTG specifications (see ES Appendix 13.2, Document Reference: 3.3.13). For each bird species, the WTG scenario which produces the highest collision risk has been used in the assessment.

20. Displacement is defined as 'a reduced number of birds occurring within or immediately adjacent to an offshore windfarm' (Furness *et al.*, 2013) and involves birds present in the air and on the water (SNCB, 2017). Birds that do not intend to utilise a wind farm area but would have previously flown through the area on the way to a feeding, resting or nesting area, and which either stop short or detour around a development, are subject to barrier effects (SNCB, 2017).

21. Birds are considered to be most at risk from operational displacement effects when they are resident in an area, for example during the breeding season or wintering season, as opposed to passage or migratory seasons. Birds that are resident in an area may regularly encounter and be displaced by an OWF for example during daily commuting trips to foraging areas from nest sites, whereas birds on passage may encounter (and potentially be displaced from) a particular OWF only once during a given migration journey.

22. For the purposes of assessment of displacement for resident birds, it is usually not possible to distinguish between displacement and barrier effects - for example to define where individual birds may have intended to travel to, or beyond an OWF, even when tracking data are available. Therefore, in the shadow appropriate assessment the effects of displacement and barrier effects on the key seabird species are considered together.

4.2.3 Embedded mitigation

23. This section outlines the embedded mitigation relevant to the Offshore Ornithology assessment, which has been incorporated into the design of North Falls (Table 4.4).

Table 4.4 Embedded mitigation measures

Parameter	Mitigation measures embedded into North Falls design
Offshore cable corridor	Offshore cable corridor site selection sought to minimise overlap with the OTE SPA. Site selection was undertaken in consultation with NE (see Chapter 4 Site Selection and Assessment of Alternatives, Document Reference: 3.1.6). Since consultation on the PEIR and draft RIAA, the number of offshore export cables has reduced from four to two. In addition, following consultation, and in line with paragraph 3.8.76 of National Policy Statement (NPS) EN-3 (DESNZ, 2023), Five Estuaries and North Falls projects have coordinated and the projects have offshore cable corridors which are adjacent or overlapping along their length, which keeps the potential impacts from the projects to a single area of sea and facilitates co-ordination.
Array area	Following PEIR consultation feedback, the array area has been reduced from 149.5km^2 down to 95km^2. This has involved: • a 36% reduction in the size of the southern array (now referred to as the 'array area'), increasing the distance from the OTE SPA; and • 100% removal of the former northern array area.
Reduced turbine numbers	Following PEIR, the maximum number of turbines (assuming the smallest turbine model) has been reduced from 72 to 57 and the number of the largest turbine model has been reduced from 40 to 34.
WTG air gap	A minimum air gap (the distance between the lower rotor tip of a WTG and the sea surface of 27m above MHWS (26.6m above HAT). This is an increase of 5m above the minimum of 22m MHWS required for navigation purposes to reduce collision risk for birds (as most seabirds tend to fly low to the sea surface).
Shipping protocol to minimise disturbance to RTDs	The protocol is designed to minimise disturbance to non-breeding RTD, and would apply during the core winter period between 1 November and 1 March inclusive. Details of the protocol are set out in the Outline Project Environmental Management Plan, Appendix B and include: • designing vessel transit routes during construction, operation and decommissioning as far as possible to minimise transit within the SPA boundary and a 2km buffer; • (in-combination with the above) restricting vessel movements to existing navigation routes (where the densities of divers are typically relatively low); • where it is necessary to go outside of established navigational routes, selecting routes that avoid known aggregations of birds; • maintaining direct transit routes (to minimise transit distances through areas used by divers); • avoidance of over-revving of engines (to minimise noise disturbance); and • briefing of vessel crew on the purpose and implications of these vessel management practices (through, for example, tool-box talks).

4.3 Screening Conclusions

24. Birds present in offshore waters and potentially affected by North Falls are predominantly seabirds (defined for this report as auks, gulls, terns, gannets, skuas, shearwaters, petrels and divers). These species have the potential to be present during the breeding season, non-breeding season and the spring / autumn migration/passage periods. Other bird species that may be affected by North Falls include waterfowl (swans, geese, ducks and waders) and other bird species which may fly through the Project areas during spring and/or autumn migration/passage periods.

25. For offshore ornithology receptors during the breeding season, the HRA screening (RIAA Appendix 1.1, Document Reference: 7.1.1.1) focused on the potential for connectivity between seabirds breeding at colonies which are classified as SPAs, and the Project. This was based on the Mean Maximum Foraging Range (MMFR) as identified by the industry standard report: Woodward *et al.* (2019).

26. Outside the breeding season, seabirds breeding at SPAs located beyond the breeding season foraging range of the Project may spend part or all of the non-breeding season in the vicinity of the Project, either wintering or migrating through on spring and/or autumn passage to wintering areas. During this time the number of SPAs with potential connectivity to North Falls will increase. For seabirds during the non-breeding season, screening is informed by the Furness (2015) report on non-breeding populations of seabirds in UK Waters.

27. Other bird species that may be affected by North Falls include waterfowl (swans, geese, ducks and waders) and other bird species which may fly through the Project areas during spring and/or autumn migration/passage periods. For non-seabird migratory species, SPAs within 100km of the Project were screened in.

28. Thus the HRA screening exercise considered SPAs which either overlap with the offshore footprint of North Falls (array area and offshore cable corridor) or are within the relevant species' foraging ranges during the breeding season, and/or may winter or pass through the site during spring and autumn passage. Further background and rationale for the screening methodology is included in the HRA screening report (RIAA Appendix 1.1, Document Reference: 7.1.1.1).

29. The outcome of the screening exercise (and subsequent consultation with NE) was that the sites and qualifying features in Table 4.5 were screened in for Appropriate Assessment. Further details of screening decisions for individual sites and qualifying features are included in the HRA screening report (RIAA Appendix 1.1, Document Reference: 7.1.1.1).

Table 4.5 North Falls: Summary of HRA screening for UK SPA and Ramsar Sites with offshore ornithology features.

Site	Qualifying Feature Screened In
Outer Thames Estuary SPA	Red-throated diver, non-breeding Common tern, breeding
Alde-Ore Estuary SPA and Ramsar site	Sandwich tern, breeding Lesser black-backed gull, breeding Avocet, breeding Avocet, non-breeding Marsh harrier, breeding Redshank, non-breeding Ruff, non-breeding Notable assemblage of breeding and wintering wetland birds
Sandlings SPA	Nightjar, breeding Woodlark, breeding
Minsmere-Walberswick SPA and Ramsar	Avocet, breeding Marsh harrier, breeding Nightjar, breeding Shoveler, breeding

Site	Qualifying Feature Screened In
	Shoveler, wintering Teal, breeding Gadwall, breeding Gadwall, wintering White-fronted goose, wintering Hen harrier, wintering Assemblage of rare breeding birds associated with marshland and reedbeds
Deben Estuary SPA and Ramsar	Avocet, wintering Dark-bellied brent goose, wintering
Hamford Water SPA and Ramsar	Avocet, wintering Black-tailed godwit, wintering Dark-bellied brent goose, wintering Grey plover, wintering Redshank, wintering, passage Ringed plover, wintering, passage Shelduck, wintering Teal, wintering
Stour and Orwell Estuaries SPA and Ramsar	Avocet, breeding Black-tailed godwit, wintering Dark-bellied brent goose, wintering Dunlin, wintering Grey plover, wintering Knot, wintering Pintail, wintering Redshank, wintering, Redshank, autumn passage Waterbird assemblage (great crested grebe, cormorant, shelduck, wigeon, gadwall, goldeneye, ringed plover, lapwing, curlew, turnstone)
Thanet Coast and Sandwich Bay SPA and Ramsar	Golden plover, wintering Turnstone, wintering
Benacre to Easton Bavents SPA	Marsh harrier, breeding
Colne Estuary SPA and Ramsar	Pochard, breeding Ringed plover, breeding Dark-bellied brent goose, wintering Black-tailed godwit, wintering Hen harrier, wintering Redshank, wintering Waterbird assemblage, wintering (cormorant, mute swan, shelduck, goldeneye, ringed plover, grey plover, sanderling, dunlin, curlew)
Broadland SPA and Ramsar	Marsh harrier, breeding Bewick's swan, wintering Hen harrier, wintering Ruff, wintering Gadwall, wintering Shoveler, wintering Whooper swan, wintering Wigeon, wintering

Site	Qualifying Feature Screened In
Foulness SPA and Ramsar	Sandwich tern, breeding Common tern, breeding Avocet, breeding Ringed plover, breeding Bar-tailed godwit, wintering Dark-bellied brent goose, wintering Grey plover, wintering Hen harrier, wintering Knot, wintering Oystercatcher, wintering Redshank, wintering, passage Waterbird assemblage (shelduck, dunlin, curlew)
Stodmarsh SPA and Ramsar	Gadwall, breeding Gadwall, wintering Bittern, wintering Hen harrier, wintering Shoveler, wintering Breeding bird assemblage (great crested grebe, lapwing, redshank, snipe, grasshopper warbler, Savi's warbler, sedge warbler, reed warbler) Waterbird assemblage, wintering (white-fronted goose, wigeon, mallard, pochard, tufted duck, water rail, lapwing, snipe)
Dengie SPA and Ramsar	Dark-bellied brent goose, wintering Grey plover, wintering Hen harrier, wintering Knot, wintering Waterbird assemblage, wintering (dunlin, black-tailed godwit, bar-tailed godwit)
Blackwater Estuary SPA and Ramsar	Pochard, breeding Ringed plover, breeding Black-tailed godwit, wintering Dark-bellied brent goose, wintering Dunlin, wintering Grey plover, wintering Hen harrier, wintering Waterbird assemblage, wintering (cormorant, shelduck, gadwall, teal, goldeneye, ringed plover, curlew, redshank)
Abberton Reservoir SPA and Ramsar	Coot, wintering Gadwall, wintering Goldeneye, wintering Great crested grebe, wintering Mute swan, wintering Pochard, wintering Shoveler, wintering Teal, wintering Tufted duck, wintering Wigeon, wintering Waterbird assemblage, late summer passage/moult
Crouch and Roach Estuaries SPA and Ramsar	Dark-bellied brent goose, wintering Waterbird assemblage, wintering

Site	Qualifying Feature Screened In
Breydon Water SPA and Ramsar	Common tern, breeding Avocet, wintering Bewick's swan, wintering Golden plover, wintering Lapwing, wintering Ruff, passage Waterbird assemblage
The Swale SPA and Ramsar	Dark-bellied brent goose, wintering Dunlin, wintering Redshank, passage Grey plover, wintering Breeding bird assemblage (shelduck, mallard, moorhen, coot, lapwing, redshank, reed warbler, reed bunting) Waterbird assemblage, wintering (oystercatcher, ringed plover, redshank, shelduck, wigeon, teal, curlew)
Benfleet and Southend Marshes SPA and Ramsar	Dark-bellied brent goose, wintering Dunlin, wintering Grey plover, wintering Knot, wintering Ringed plover, wintering Waterbird assemblage, wintering
Thames Estuary and Marshes SPA and Ramsar	Avocet, wintering Black-tailed godwit, wintering, passage Dunlin, wintering Grey plover, wintering Hen harrier, wintering Knot, wintering Redshank, wintering Ringed plover, passage Waterbird assemblage
Medway Estuary and Marshes SPA and Ramsar	Avocet, breeding Avocet, wintering Dark-bellied brent goose, wintering Dunlin, wintering Grey plover, wintering Knot, wintering Pintail, wintering Redshank, wintering Ringed plover, wintering Shelduck, wintering Breeding bird assemblage (oystercatcher, lapwing, ringed plover, redshank, shelduck, mallard, teal, shoveler, pochard, common tern) Waterbird assemblage, wintering (red-throated diver, great crested grebe, cormorant, mallard, teal, shoveler, pochard, oystercatcher, Bewick's swan, hen harrier, merlin, golden plover, short-eared owl, kingfisher)
Breckland SPA	Nightjar, breeding Stone curlew, breeding Woodlark, breeding

Site	Qualifying Feature Screened In
Dungeness, Romney Marsh and Rye Bay SPA and Ramsar	Avocet, breeding Common tern, breeding Sandwich tern, breeding Marsh harrier, breeding Aquatic warbler, passage Bewick's swan, wintering Bittern, wintering Golden plover, wintering Hen harrier, wintering Ruff, wintering Shoveler, wintering Mute swan, wintering Waterbird assemblage, wintering (European white-fronted goose, wigeon, gadwall, pochard, little grebe, great crested grebe, cormorant, coot, sanderling, whimbrel, common sandpiper, lapwing)
North Norfolk Coast SPA and Ramsar	Common tern, breeding Sandwich tern, breeding
The Wash SPA	Common tern, breeding
Chichester and Langstone Harbours SPA	Common tern, breeding Sandwich tern, breeding
Solent and Southampton Water SPA and Ramsar	Common tern, breeding Sandwich tern, breeding
Flamborough and Filey Coast SPA	Gannet, breeding Guillemot, breeding Kittiwake, breeding Razorbill, breeding Seabird assemblage
Teesmouth and Cleveland Coast SPA	Common tern, breeding
Northumbria Coast SPA	Arctic tern, breeding
Coquet Island SPA	Arctic tern, breeding Common tern, breeding Roseate tern, breeding Sandwich tern, breeding
Farne Islands SPA	Arctic tern, breeding Common tern, breeding Guillemot, breeding Sandwich tern, breeding
Forth Islands SPA	Arctic tern, breeding Common tern, breeding Gannet, breeding Lesser black-backed gull, breeding Puffin, breeding Roseate tern, breeding Sandwich tern, breeding
Imperial Dock Lock, Leith SPA	Common tern, breeding

Site	Qualifying Feature Screened In
Fowlsheugh SPA	Guillemot, breeding Kittiwake, breeding
Ythan Estuary, Sands of Forvie and Meikle Loch (extension) SPA	Common tern, breeding Sandwich tern, breeding
Loch of Strathbeg SPA	Sandwich tern, breeding
Troup, Pennan and Lion's Heads SPA	Guillemot, breeding
Inner Moray Firth SPA and Ramsar	Common tern, breeding
Cromarty Firth SPA	Common tern, breeding
East Caithness Cliffs SPA	Guillemot, breeding Herring gull, breeding Kittiwake, breeding Razorbill, breeding
Caithness and Sutherland Peatlands SPA and Ramsar	Red-throated diver, breeding
North Caithness Cliffs SPA	Guillemot, breeding
Pentland Firth Islands SPA	Arctic tern, breeding
Hoy SPA	Great skua, breeding Red-throated diver, breeding
Auskerry SPA	Arctic tern, breeding
Orkney Mainland Moors SPA	Red-throated diver, breeding
Rousay SPA	Arctic tern, breeding
Marwick Head SPA	Guillemot, breeding
Fair Isle SPA	Arctic tern, breeding Guillemot, breeding
West Westray SPA	Arctic tern, breeding Guillemot, breeding
Papa Westray (North Hill and Holm) SPA	Arctic skua, breeding Arctic tern, breeding
Sumburgh Head SPA	Arctic tern, breeding
Mousa SPA	Arctic tern, breeding
Noss SPA	Gannet, breeding Great skua, breeding Guillemot, breeding
Foula SPA	Arctic tern, breeding Great skua, breeding Guillemot, breeding Puffin, breeding Red-throated diver, breeding

Site	Qualifying Feature Screened In
Papa Stour SPA	Arctic tern, breeding
Fetlar SPA	Arctic tern, breeding Great skua, breeding
Otterswick and Graveland SPA	Red-throated diver, breeding
Ronas Hill – North Roe and Tingon SPA and Ramsar	Great skua, breeding Red-throated diver, breeding
Hermaness, Saxa Vord and Valla Field SPA	Gannet, breeding Great skua, breeding Red-throated diver, breeding

4.4 SPAs with breeding season connectivity for seabirds

4.4.1 Outer Thames Estuary SPA

4.4.1.1 SPA overview

30. The OTE is a marine SPA located adjacent to the east coast of England, between the counties of Norfolk (in the north) and Kent (in the south) and extending into the North Sea. The SPA is divided into three parts, a southern component in the Outer Thames area, a second part extending north along the Suffolk and Norfolk Coast, and a third area further offshore from the Norfolk Coast). The site comprises areas of shallow and deeper water, high tidal current streams and a range of mobile mud, sand, silt and gravely sediments extending into the marine environment, incorporating areas of sand banks often exposed at low tide. Intertidal mud and sand flats are found further towards the coast and within creeks and inlets inland down the Blyth estuary and the Crouch and Roach estuaries. In total, approximately 3,924km^2 of habitat is included within the SPA boundary.

31. The SPA was initially designated in August 2010 solely for non-breeding RTDs, with the boundary based on the distribution of this species as recorded in visual aerial surveys flown in the non-breeding season between 1989 and 2006/07 (NE and JNCC 2010, 2015; O'Brien *et al.* 2012), An extended site was subsequently designated in October 2017, including nearshore areas used for foraging in the breeding season by two additional qualifying species, common tern and little tern (JNCC 2023, NE and JNCC 2015).

4.4.1.2 Conservation Objectives

32. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to the integrity of the National Sites Network, 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; and
- The distribution of qualifying features within the site.

33. Supplementary information on the conservation objectives for qualifying features of the SPA, including specific targets, is provided on NE's designated sites view and referred to below.

4.4.1.3 Shadow Appropriate Assessment

34. The following qualifying features have been screened in for appropriate assessment (Table 4.5):

- Red-throated diver, non-breeding
- Common tern, breeding

4.4.1.4 Red-throated diver

35. RTD has been screened in for appropriate assessment during the non-breeding season in relation to displacement/disturbance effects during the construction/decommissioning and displacement/barrier effects during the operational phase of the development.

4.4.1.4.1 Status

36. At classification, the non-breeding RTD population of the SPA was cited as 6,466 individuals, based on visual aerial surveys between 1989 and 2007 (NE and JNCC 2010, 2015). This was the mean of annual counts over the survey period, with respective minimum and maximum counts of 2,460 and 10,884 individuals recorded during this time (APEM, 2013; Irwin *et al.* 2019).

37. More recently, repeat surveys of the SPA have been undertaken using digital aerial methods, the current standard methodology for offshore ornithology surveys. The SPA population estimate has been revised to 18,079 individuals (NE 2023a), which is the two year peak mean based on surveys in 2013 (APEM 2013) and 2018 (Irwin *et al.* 2019). This represents a 180% increase compared with the population estimate at the time of SPA classification. NE (2023a) state that '*these increases are thought to reflect improved survey methods and techniques, namely the use of digital aerial surveys, which has provided more accurate counts and suggests that previous counts* [from visual aerial surveys] *have been significant underestimates*'. From the recent SPA surveys, the peak estimate of the RTD population was 22,820 individuals from a survey on 17 February 2018, which represented a 68% increase on the peak count of 13,605 individuals for the period 9-12 February 2013, from the 2013 survey. During the 2018 surveys the entire SPA was flown in a single day, whereas in 2013 each survey took place over 2-3 days, so movements of birds between surveys on different days could have affected the estimates produced by the 2013 surveys (noting that such an effect is equally likely to result in overestimation as underestimation).

38. It is not clear whether the methodological changes, from visual to digital aerial surveys, and the period of time over which surveys were flown, account for all the differences between the 1989-2007 estimate and the 2013 and 2018 estimates, or whether there has been a real increase in the RTD population over this period. Visual aerial surveys of the Outer Thames area for the purposes of estimating densities and defining the SPA boundary, were carried out from planes flying transects at 76m (250ft) above the sea surface (O'Brien *et al.* 2012). Bird records (species and numbers) on and flying above the sea were recorded by two observers on either side of the aircraft. Digital aerial surveys involve the use of still or video cameras fixed to the underside of a plane which are used to record images of birds on and flying above the sea. The digital aerial surveys were also flown in transects but at a higher altitude than visual aerial surveys, with a recommended minimum height of 450m to avoid disturbance to birds (Thaxter and Burton 2009). Visual aerial surveys are considered likely to underestimate numbers of birds at sea, due to the potential for observers to miss some birds and disturbance to birds from the low-flying aircraft (Thaxter and Burton 2009). NE (2021) refers to a 2010 study by APEM (cited but no reference provided) indicating that the number of birds recorded by digital aerial stills may be up to 6.5 times higher than that by observers. A comparison of visual and digital (video) aerial surveys flown along the same transects in the southern Baltic Sea on the same day is described by Žydelis *et al.* (2019). Digital aerial surveys were flown first, and the visual surveys followed the same track 20-80 minutes later. For diver species combined (red-throated and black-throated) the reported densities were 0.40 birds per km^2 for visual and 0.47 per km^2 for digital aerial surveys (visual surveys corrected for distance detection bias; Confidence Limits (CLs) are not stated). The two diver species were considered together as identification rate to species level was low in the visual compared with the digital survey dataset (29% compared with 93.5%). The plotted distribution of sightings was generally similar overall, although in some areas birds were detected by one survey method and not the other. Distribution modelling was possible only for the digital aerial surveys, due to the lower number of observations in the visual surveys. Elsewhere, long-term modelling of the distribution of divers in the German North Sea has used combined data from visual aerial, digital aerial surveys, and in some cases ship-based surveys, applying correction factors for differences in detection rate associated with each technique (e.g. Vilela *et al.* 2021, Mendel *et al.* 2019).

39. NE (2023a) SACOs for the OTE SPA includes the following targets for RTD which are considered relevant to the appropriate assessment:

- Maintain the size of the non-breeding population at a level which is at or above 18,079 individuals, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.
- Reduce the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed.
- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.

- Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of the non-breeding/wintering period (moulting, roosting, loafing, feeding) at the following levels: Subtidal sand (220,295.55 ha); Subtidal coarse sediment (73,606.64 ha); Subtidal mixed sediments (62,100.63 ha); Subtidal mud (12,549.14 ha); Circalittoral rock (335.2 ha); and Water column.

40. The shadow appropriate assessment in this section focuses on the conservation objectives related to the numbers and distribution of RTDs within the SPA. Conservation objectives related to supporting habitats and processes are addressed in RIAA Part 2 Benthic Ecology (Document Reference 7.1.2), although in this context it is considered that the precise extent of different sediment types is unlikely to be critical for RTDs.

41. It is noted that the population estimate for the OTE SPA (18,079 individuals) exceeds current estimates of the total numbers of RTDs in UK offshore waters during the non-breeding period, respectively 15,371 individuals during winter and 17,650 during spring and autumn migration seasons (Furness 2015); and 17,000 birds wintering in offshore waters around Great Britain from visual aerial surveys 2001-05 and supplementary data (county bird records and Wetland Bird Survey counts 1995-2005) (O'Brien *et al.* 2008).

42. The OTE is one of seven UK marine SPAs designated for non-breeding concentrations of this species, supporting 54% of the total estimated numbers within all SPAs, based on the population at citation, and 77% considering the most recent SPA population estimate (Table 4.6).

Table 4.6 UK marine SPAs for RTD in the non-breeding season

SPA	Location	SPA citation population, #RTDs	Date	Latest population #RTDs	Date
Outer Thames Estuary	East coast, England	6,466	1989-2006/07	18,079	2013-2018
Greater Wash	East coast, England	1,407	2002/03-2005/06	1,407	n/a
Outer Firth of Forth and St Andrews Bay complex	East coast, Scotland	851	2001/02-2004/05	851	n/a
Moray Firth	East Coast, Scotland	324	2001/02-2006/07	324	n/a
Northern Cardigan Bay	West coast, Wales	1,186	2001/02-2003/04	1186	n/a
Liverpool Bay	West coast, Wales / England	1,171	2004/05-2010/11	1,171	n/a
Solway Firth	West coast, Scotland	521	2001/02-2005/06	521	n/a
Totals		**11,926**		**23,539**	
% in Outer Thames Estuary		**54%**		**77%**	

4.4.1.4.2 Connectivity and seasonal apportionment of potential effects

43. The OTE SPA is designated for RTDs based on the presence of nationally important numbers in the non-breeding season, defined as September to April, and subdivided into Autumn migration (September to November), winter (December and January) and Spring migration (February to April) (Furness 2015) (there may be a few records of the species in the SPA outside this period, but only in small numbers). Thus, the appropriate assessment considers the non-breeding period only.

44. Outside the non-breeding season RTDs migrate northwards to breeding areas on the shoreline or islands within small waterbodies in moorland, tundra or boreal forest environments. Available evidence indicates that individuals wintering in the southern North Sea, including the Outer Thames Estuary SPA, breed in Fennoscandia, Russia and Greenland (Diverlog 2024, Thompson *et al.* 2023, Kleinschmidt *et al.* 2022, Duckworth *et al.* 2022; MacArthur Green and Royal HaskoningDHV 2021a, Furness 2015).

4.4.1.4.3 Effect: Displacement / barrier effect during construction and decommissioning

4.4.1.4.3.1 Array area

45. The array area construction phase would require the mobilisation of vessels, helicopters and equipment and the installation of foundations, turbines, platforms, array cables and inter-platform cables. These activities have the potential to disturb and displace RTDs within and around the array area. Causes of potential disturbance would comprise the presence of construction vessels and associated human activity, noise and vibration from construction activities and lighting associated with construction sites. The level of disturbance at each work location would differ dependent on the activities taking place, but there could be vessel movements at any time of day or night over the construction period.

46. Prior to the installation of turbines (and associated offshore infrastructure) on foundations, there would be no permanent structures above the water surface. During this period, any impacts resulting from disturbance and displacement from construction activities in a given location would be short-term, temporary and reversible in nature, lasting only for the duration of construction activity, with birds expected to return to the area once construction activities have ceased. Once turbines begin to be installed on foundations, then displacement effects would be expected to increase as the number of turbines increases until the array is fully built out and turbines become operational.

47. In their response to the outline method statement for the North Falls EIA (see ES Appendix 13.1, Document Reference: 3.3.12), NE commented '*The construction phase presents a range of potential drivers that may cause displacement of seabirds. This includes vessel movement and construction activities (which may be both spatially and temporally limited), however the physical presence of the constructed turbines is also likely to cause a displacement response. As the construction phase progresses, more turbines are built and the spatial scale increases, until a point when the entire array is constructed, yet not operational, and may present the same displacement stimulus as an operational farm. Therefore, it should not be asserted that displacement will only occur where vessels and construction activities are present; instead we consider that displacement is likely to occur within and around the constructed array areas (due*

to the presence of turbines) and where construction activities are ongoing. This will represent an increasing spatial impact as construction progresses. For assessment of construction phase displacement, we advise North Falls consider the pragmatic method NE advised for PEIR at Hornsea 4 of calculating operational displacement per species and reducing by 50% during the construction period (to broadly reflect reduced spatial and temporal scale) across the range of displacement mortality advised by NE for a particular species. We recommend this approach is taken for construction displacement assessments for red-throated diver, gannet, and auks'.

48. Thus, the assessment of construction disturbance and displacement from the array areas assumes that the Project alone assessment of displacement effects on RTDs will be 50% of those predicted during operation.

49. The assessment of operational disturbance to RTDs is set out in Section 4.4.1.4.4.1 below, including supporting text reviewing empirical evidence on the extent of displacement of RTDs from OWFs, and the potential for displacement to result in mortality of displaced birds, which may increase the mortality rate of the SPA population. The assessment considers potential displacement within a 12km buffer of the array area, where this overlaps with the SPA. Modelled estimates of RTD abundance in this area are available for 2021 (baseline surveys for North Falls) and 2018 (surveys of the SPA, Irwin *et al.* 2019), and two scenarios of the predicted proportion of RTDs displaced in 1km distance buffers from OWFs are considered: a displacement gradient provided by NE; and the displacement gradient reported from post-construction monitoring of the London Array OWF (APEM 2021a). A range of mortality rates of 1-10% is assumed for displaced birds, although it is considered that 1% is the likely maximum rate. The assessment also considers the potential effects of operational displacement on the distribution of RTDs within the SPA.

50. The assessment also covers the decommissioning phase. As a worst case, any effects generated during the decommissioning phase are expected to be similar to those generated during the construction phase. This is because decommissioning would generally involve a reverse of the construction phase through the removal of some structures and materials installed.

4.4.1.4.3.1.1 Project alone assessment

51. The predicted annual displacement mortality of RTDs within the overlap of the North Falls 12km buffer and the SPA, at 1% mortality of displaced birds, is a maximum of 1 bird under all displacement scenarios, equivalent to a maximum 0.03% increase in the population mortality rate (Table 4.9 below). At 10% mortality, the predicted mortality of displaced birds is 6 - 11 per annum under different scenarios, equivalent to a maximum 0.25% increase in the population mortality rate. Considering a 50% reduction in the effects of displacement during construction, which would equate to maximum mortalities of 0.5 RTDs at 1% mortality of displaced birds, and 3 - 5.5 birds at 10% mortality; respectively equivalent to 0.01% and a maximum of 0.13% increase in baseline mortality rate. These potential changes in population mortality rate would be so small as to be undetectable and would not result in an adverse effect on the population size of RTDs within the OTE SPA.

52. During operation the predicted area over which North Falls would potentially exert displacement effects on RTDs within the SPA would be 108.7km^2. Assuming the construction effect would be 50% of this, the displacement area would be 54.4km^2, equivalent to 1.4% of the SPA area. However, as discussed below (Section 4.4.1.4.4.1) all of the area within the SPA where North Falls would potentially displace RTDs, overlaps with areas where RTDs are already potentially subject to displacement, within the 12km buffer of another OWF, and/or International Maritime Organisation (IMO) shipping measures. Thus, North Falls would not add to the existing area of the SPA where divers are already at risk of displacement from OWFs and shipping lanes.

53. It is considered that during construction North Falls would not make a material addition to the existing sources of disturbance/displacement for RTDs in the area of overlap between the 12km buffer and the OTE SPA, and that a Project alone effect on the distribution of the species within the SPA can be excluded, as well as a Project alone effect on the SPA population size.

54. The same conclusion would apply to the decommissioning phase.

4.4.1.4.3.1.2 In-combination assessment

55. The in-combination assessment of displacement/disturbance from the array area during the construction and decommissioning phases references the in-combination assessment of operational displacement from North Falls in Section 4.4.1.4.4.2 below, which considers the potential displacement effects from the North Falls array area during operation in-combination with other operational and consented OWFs within the OTE SPA, and within 12km of the SPA boundary.

56. Predicted operational displacement mortality at North Falls is very small compared to the predicted effects of displacement at operational OWFs, and there is no evidence of a population effect on RTDs within the SPA from displacement from OWFs. The predicted contribution of North Falls to any in-combination displacement effect is extremely small and considered to be non-material compared to that of existing operational OWFs.

57. It is acknowledged that the conclusion of the HRA for EA1N OWF (BEIS 2022a) stated that there is an existing adverse effect on the distribution of RTDs in the SPA due to the in-combination displacement effects of OWFs. However, there is a strong case to be made that the extremely small contribution of North Falls to the existing in-combination effect is not material, given that areas of the SPA potentially subject to displacement effects from North Falls, are already subject to existing displacement effects from OWFs and / or IMO shipping measures.

58. Given the above conclusions for operational displacement of RTDs from North Falls, the same conclusions apply to displacement during construction, assumed to represent 50% of the effects during operation, i.e. that there is no material contribution to any in-combination effect on population size (and no evidence that displacement from OWFs is affecting the SPA population size), nor to any in-combination effect on the distribution of RTDs within the SPA.

59. The same conclusion would also apply during the decommissioning phase.

4.4.1.4.3.2 Offshore cable corridor

60. The offshore cable corridor for North Falls is 57km long. It passes close to and through the southern section of the OTE SPA (RIAA Part 1, Document Reference: 7.1.1, Figure 1.1). A total of 19km of the offshore cable corridor (33.3% of the total length) overlaps with the SPA. With a width of 1km, the total potential overlap between the offshore cable corridor and the SPA is approximately 19km^2, or 0.48% of the SPA area (although this represents the area of search and the actual cable route itself will be much smaller; see RIAA Part 2 Benthic Ecology (Annex I habitat in SACs (Special Area of Conservation) and SPA supporting habitat) (Document Reference: 7.1.2) and ES Chapter 5 Project Description (Document Reference: 3.1.7)).

61. There is potential for disturbance and displacement of RTDs in the construction phase during the six months when the cable is being laid, particularly where the cable corridor passes through the SPA.

62. As for the array area above, as a worst case, any effects generated during the decommissioning of the offshore cable corridor are expected to be similar to those generated during the construction phase.

4.4.1.4.3.2.1 Project alone assessment

63. Divers are known to be displaced from vessels. A selectivity index derived from aerial surveys in the German North Sea indicated that the numbers of divers (red- and black-throated divers could not be reliably distinguished during the surveys) were significantly lower in shipping lanes than in other areas, although there were insufficient data to estimate flush distances of divers from ships (Schwemmer *et al.*, 2011); in this study it was assumed that the responses of red and black-throated divers to disturbance was similar. Fliessbach *et al.* (2019) investigated escape distances of seabirds from ships in the German and Baltic Seas. They reported distances of 1,374 ± SD (Standard Deviation) 416m for individual divers not identified to species and 1,281 ± 424m for flocks of divers not identified to species; 750 ± 437m and 702 ± 348m respectively for individuals and flocks of RTDs; and 721 ± 616 and 562 ± 450m respectively for individuals and flocks of black-throated divers. Irwin *et al.* (2019) reported displacement of RTDs from shipping lanes within the OTE SPA during aerial surveys in 2018, although the effect was not quantified. Observational studies of responses of marine birds to disturbance in Orkney inshore waters found that red-throated and black-throated divers showed similar flush behaviour from ferries, with respectively 75% (n=88) and 62% (n=21) of birds showing an evasive response within 300m of a passing ferry; for RTDs, response rates were 100% within 50m of a ferry, 87% between 50-100m, 60% between 100-200m and 54% within 200-300m. Both Fliessbach *et al.* (2019) and Jarrett *et al.* (2018, 2021) observed that RTDs were highly likely to fly in response to ships whereas black-throated divers were more likely to dive or swim away (in the Orkney study, it was suggested these differences may be related to differences in the timing of moult in the two species, which affects flight ability, although also that RTDs have a lower wing loading and lower energetic costs of take-off than black-throated divers; Jarret *et al.* 2018, 2021). The Orkney study seems to indicate lesser displacement distances from ships than those in the German North Sea, although displacement effects may increase with the size and/or speed of vessels.

64. Up to two cable-laying vessels will be working simultaneously in the offshore cable corridor. On a precautionary basis it is assumed that there would be 100% displacement of all RTDs from a 2km buffer of cable laying activities, (the two cable laying vessels and associated vessels.

65. The number of RTDs that would potentially be at risk of displacement was estimated based on available information on the density of the species within the cable corridor. The majority of the offshore cable corridor (66.5% by length) is outside the baseline survey area for North Falls. The most recently available RTD data for the area of overlap between the offshore cable corridor and the southern component of the SPA (Figure 4.3) shows the three component areas of the SPA) derives from two aerial surveys undertaken in February 2018 (Irwin *et al.*, 2019); which found respective densities of 3.64 and 7.10 RTDs per km^2 in this part of the SPA. These densities derive from the early spring migration period when RTD numbers in the SPA are highest (Webb *et al.*, 2009) and mean densities over the entire non-breeding period would be lower. In addition, most of the offshore cable corridor is outside the SPA (38km of 57km, 66.6% by length) where RTD densities will be lower than within the SPA boundary (O'Brien *et al.*, 2012). Thus the lower density estimate for the southern area of the SPA from the 2018 surveys is selected as a likely precautionary mean density for the cable corridor.

66. The worst case area of displacement, based on a 2km radius from each cable-laying vessel, is 25.2km^2 (2 x 12.6km^2). Based on a density of 3.64 birds per km^2, 92 RTDs would be displaced at any given time. It is considered reasonable to assume that birds will reoccupy areas following the passage of the vessel. The indicative rate of cable installation is 150-400m per hour (ES Chapter 5 Project Description, Document Reference: 3.1.7), which is assumed to be the average speed of the cable laying vessels during this activity. This represents a maximum speed of 6.7m per minute. In context, a modest tidal flow rate for the Outer Thames area is about 30m per minute (derived from Department of Energy and Climate Change (DECC) 2009). The tide would therefore be flowing at least four times faster than the cable laying vessel. Birds on the water surface are likely to be drifting with the tide and moving at the same speed as the tidal flow. Thus, even though they would be moving, during cable-laying the vessels would be effectively stationary as far as the birds are concerned, so the zone of impact around the vessel would be more or less fixed. Consequently, for the purposes of this assessment it can be assumed that the estimated number of RTDs displaced at any one time from cable-laying vessels represents the total number displaced over the course of a single non-breeding season.

67. Assuming 92 birds are displaced and 1-10% mortality of displaced birds, 1-9 birds would suffer mortality each year due to displacement within the offshore cable corridor. Assuming on a precautionary basis that all these birds are associated with the SPA population (although c. 66% of the length of the offshore cable corridor is outside the SPA boundary) of 18,079 individuals and an average annual mortality rate (across age classes) of 0.233 (ES Chapter 13, Table 13.11, Document Reference: 3.1.15), this would represent an increase in baseline mortality rate of 0.02 – 0.21%. A detailed consideration of the likely consequences of displacement for RTDs is included in the assessment of displacement effects for the operational phase (see paragraph 82 below), with 1% mortality considered to be a suitable precautionary assumption for the level

of increase that is biologically plausible in the context of available information on the baseline mortality rate of this species.

68. Construction disturbance and displacement within the North Falls offshore cable corridor would be a temporary effect, due to take place over a period of approximately 6 months (ES Chapter 13, Table 13.1, Document Reference: 3.1.15). The predicted magnitude of increase in RTD mortality would not materially alter the background mortality of the population, would be undetectable and would extend over a short period only. Thus, there would be no adverse effect on the integrity of the OTE SPA as a consequence of this potential effect.

4.4.1.4.3.2.2 In-combination assessment

69. There is overlap between the offshore cable corridors for North Falls and Five Estuaries OWFs (ES Chapter 13, Figure 13.2, Document Reference 3.2.9) and in-combination displacement effects could occur if construction activities in both cable corridors take place at the same time.

70. North Falls has applied to the Offshore Coordination Support Scheme (OCSS) in consortium with National Grid Electricity Transmission (NGET) and Five Estuaries Offshore Wind Farm Ltd for an offshore connection to Sea Link, a marine cable between Suffolk and Kent proposed by NGET as part of their Great Grid Upgrade. Construction of the offshore cable component of this scheme may be ongoing at the same time as the offshore cable corridor for North Falls. However, to avoid cumulative effects with other projects, the PEIR for Sea Link states that except at the landfall areas, all other construction works will be timed outside the months of January – March to avoid the core overwintering period of RTD (AECOM 2023). These months coincide with the peak numbers of RTDs at North Falls (Appendix 13.2, Document Reference: 3.3.13). Thus, this project is not considered in the in-combination assessment here.

71. The worst case scenario would be five cable laying vessels operating at one time: North Falls (two vessels) and Five Estuaries (three vessels), equating to a total area of 63km^2 (5 x 12.6km^2) from which birds could be displaced. At a density of 3.64 birds per km^2, 229 RTDs would be displaced, of which 2 – 23 birds would suffer mortality at 1-10%. Assuming all displaced birds are associated with the SPA population, this would represent an 0.05-0.5% increase in the mortality of the SPA population, with 0.05% considered to be the maximum level of increase that is biologically plausible (see paragraph 1220 below).

72. Construction disturbance and displacement within the North Falls offshore cable corridor would be a temporary effect, due to take place over approximately 6 months for North Falls (ES Chapter 13, Table 13.1, Document Reference: 3.1.15). A precautionary estimate of the predicted magnitude of increase in RTD mortality from in-combination displacement would not materially alter the background mortality of the population and would be undetectable. Thus, there would be no adverse effect on the integrity of the OTE SPA.

4.4.1.4.4 Effect: Displacement / barrier effect during operation

73. The North Falls array area is located 4.5km from the OTE SPA at the nearest point. At this distance there is the potential for displacement effects to RTDs to occur within the SPA boundary.

74. As set out in the offshore ornithology ES Chapter 13 (Section 13.6.2.1, Document Reference: 3.1.15), operational displacement is defined as 'a reduced number of birds occurring within or immediately adjacent to an offshore windfarm' (Furness *et al.* 2013) and involves birds present in the air and on the water (SNCB 2017). Birds that do not intend to utilise an OWF site but would have previously flown through the area on the way to a feeding, resting or nesting area, and which either stop short or detour around an OWF site, are subject to barrier effects (SNCB 2017). For the purposes of assessment of birds present in an OWF site during a given season, it is usually not possible to distinguish between displacement and barrier effects – for example to define where individual birds may have intended to travel to, or beyond an OWF site, even when tracking data are available. Therefore, in this assessment the effects of displacement and barrier effects on non-breeding RTD are considered together.

75. Displacement is linked to disturbance, defined in the context of OWFs, as birds spending extra time and/or energy to avoid structures or human activity associated with the OWF (Furness 2013). Mendel *et al.* (2019) attributed displacement of divers from OWFs to the combined effect of the wind turbines and shipping traffic associated with the turbine array area, and found that these effects could not be separated out in modelling of diver distribution. The assessment of operational displacement for North Falls considers that this is caused by the turbine array and associated shipping traffic.

76. This shadow appropriate assessment assumes that a proportion of the birds recorded during baseline surveys would be subject to displacement from the array area and buffer, and that a proportion of displaced birds would die as a result of displacement. The proportion of RTDs displaced is based on evidence from empirical studies of RTD responses to OWFs; further background on this is provided below. There is no robust empirical evidence to predict the number of displaced divers which might die so the assessment considers a range of 1-10% mortality, based on advice from NE, and identifies what is considered to be the most likely proportion based on expert judgement (see below).

77. Post-construction monitoring studies of OWFs have shown that displacement effects on RTD can occur at considerable distances from OWFs. The joint (UK) SNCBs (2022) advice on displacement of RTD includes a summary of studies from OWFs in the UK, Danish and German North Sea, indicating displacement extending from 0-2km to 20km from the array areas of an OWF. These studies report that 55-100% (mean of 86% based on 8 studies) of birds are displaced within the array area of an OWF, and provide evidence that the proportion of RTDs displaced declines with distance from the OWF with, for example, displacement rates reducing to 12.6% at a distance of 11.5km from the London Array (APEM 2021a). Unsurprisingly, the evidence for declining rates of displacement with increasing distance from OWFs derives mainly from those studies which consider effects over more extensive distances from OWFs.

78. Based on this summary of the available studies, SNCBs (2022) advise that a displacement buffer of at least 10km should be used for impact assessments where a plan or project is within 10km of an SPA designated for non-breeding RTD. Specifically for North Falls, NE has advised for HRA that displacement effects be considered out to 12km from the array area, where this 12km buffer overlaps with the OTE SPA. This is based on the findings from post-construction

monitoring at the London Array OWF (APEM 2021a), within the SPA, which indicated that displacement effects (as determined by reduced densities of RTDs post-construction compared with pre-construction) were detectable out to 11.5km from the array area.

79. It is unknown why RTDs are displaced at such large distances from OWFs. It has been suggested that these might reflect distances moved away from OWFs to alternative areas of preferred habitat (McGregor *et al.* 2022), rather than avoidance of extensive areas around OWFs per-se, which could result in variation in displacement distances between areas and in different directions from a given OWF. Mendel *et al.* (2019) comment that displacement may not be a result of visual cues (a bird sitting on the sea surface may not be able to see a wind farm array at a distance of 10 or 12km); whilst OWFs may enhance mixing in the water column with ecosystem effects manifesting 10-20km from the OWF, which is of a scale similar to the RTD displacement distances identified in some studies. However, the potential mechanisms for such an effect are not clear, nor are the reasons why they might affect RTDs and apparently not other seabird species over such large distances.

80. While OWFs and other anthropogenic activities in the marine environment have demonstrable displacement effects on RTDs, it is unclear how these might interact with other drivers of the non-breeding season distribution of this species offshore, of which habitat and prey availability must be of primary importance. The post-construction monitoring study at the London Array (which compared densities and distribution between the pre- and post-construction periods) found that prior to construction of the OWF, there was a pattern of diver density increasing with distance from the array area up to 9km and then decreasing (APEM 2021a). This suggests that preferred habitat for divers across the whole study area was outside the array area footprint, and that the displacement effects from the OWF should be considered in the context of an existing gradient in density for the species.

81. While studies consistently show avoidance of OWFs by RTDs, with no evidence for habituation, divers are sometimes recorded within and close to OWFs, suggesting a strong avoidance reaction might not always be triggered. For example, Vilela *et al.* (2022) refer to large numbers (100+ birds estimated from Figure A-1 of Vilela *et al.* 2022) of divers within about 5km of an OWF in the German Bight during a survey in March 2021, the first time in their long-term study that such high numbers had been observed close to an OWF. Post-construction surveys of RTDs at Burbo Bank extension OWF in Liverpool Bay, found particularly high numbers of RTDs within the Array Area and 4km buffer in March 2020; this survey coincided with the beginning of UK lockdowns due to coronavirus, and it was speculated that reduced shipping traffic may have led to increased numbers of RTDs (Humphries, 2020).

82. In terms of the potential effects of displacement on the survival rates of RTDs during the non-breeding season, a recent review (MacArthur Green 2019a) considered that displacement could influence the survival of individual RTDs through increased energy costs and/or decreased energy intake. The former could arise if birds had to fly / travel further to avoid OWFs or to reach more distant foraging areas. The latter could arise if birds were displaced to lower quality habitat where food capture rates were reduced, and/or if displacement

resulted in localised increases in the density of divers and, hence, increased intra-specific competition for food. Alternatively, displacement may have no effect on individuals if birds are displaced into equally good habitat so that their energy budget is unaffected, or if birds could buffer any impact on energy budget by adjusting their time budgets (for example by spending a higher proportion of time foraging rather than resting in order to compensate for an increase in energetic costs or reduced food intake rate). From the range of 1-10% mortality advised by NE, it was considered that a 1% mortality rate for displaced birds is an appropriate precautionary estimate. This is for a number of reasons: RTDs appear to utilise a range of offshore habitats and prey species and occur at relatively low densities rather than in large aggregations; they are also highly mobile during the non-breeding season. This flexibility in diet and habitat use indicates displacement from OWFs is unlikely to result in inter-specific competition for prey that might deplete prey resources and affect body condition and survival. The adult mortality rate is estimated at 16% per annum, which will include mortality from existing anthropogenic sources of disturbance and displacement such as shipping traffic. As RTDs tend to fly away from approaching ships, it is likely that the energy costs of this behaviour exceed the costs of avoiding fixed structures such as OWFs. Thus, it seems biologically implausible that OWF displacement would add substantially to the existing mortality rate of this species.

83. This is supported by long-term studies of red-throated (and black-throated) divers in the German North Sea, where no changes in the overall population size during spring migration have been found over the period 2001-2021, despite the construction of 20 OWFs (Vilela *et al.* 2021, 2022). Although the divers changed their distribution, so as to show avoidance of the OWFs, the population size remained stable, suggesting no or minimal consequences for displaced birds.

84. NE has stated they consider there is insufficient evidence to categorically state that there have been no changes in the RTD population size during spring migration in the German North Sea over the stated period, since there have been changes to survey platform, and presumably survey efficiency, during that period. Furthermore, Leemans & Collier (2022) point out that “*the main construction period of offshore wind farms in the German Bight started in 2012 and the most relevant wind farms (closest to the core area of the birds) became operational in 2014/2015. Population level effects may thus not yet have been visible*”.

85. Vilela *et al.* (2022), report fluctuations but no trend in RTD population size in spring between 2001-2021, which includes a seven-year period since OWFs became operational in 2014/15. If the observed displacement from OWFs in this area were to affect the survival of adult birds using this area during the non-breeding season it might be expected that population level effects would have manifested in this seven-year period. Vilela *et al.* (2022) suggest that in this area, the carrying capacity of the available habitat has not been reached. The effects of displacement on RTDs, if any, may be via body condition and perhaps breeding success. This and earlier studies in the same area (Vilela *et al.*, 2021, 2020), use data from visual aerial and digital aerial surveys. It is reported that it was possible to incorporate differences in detection rate between techniques in the statistical analysis. Ship survey data were not included in the analysis as density estimates were considered to have large uncertainties and they were not considered comparable with aerial survey data.

86. Similarly for the OTE SPA, there is no evidence of population decline since the SPA was classified in 2010; the population estimate has increased by 180% during the period in which five OWFs (including extensions) have been constructed and become operational within 12km of the SPA (although as explained above, given the change in survey techniques, it is not possible to say whether there has been a genuine increase over this period but, nonetheless, it is the case that there is no evidence for a decline in population size).

87. In recognition of the sensitivity of RTDs to displacement from OWFs, the time budgets of this species during the non-breeding season have been investigated through fitting Time-Depth Recorder (TDR) and Global Location Sensor (GLS) tags to birds breeding in Finland, Scotland and Iceland (Thompson *et al.* 2023, Duckworth *et al.* 2022, 2020). Birds tagged in Finland migrated through the Baltic Sea during the early part of the non-breeding season, and the southern North Sea, including the OTE, during the latter part of the non-breeding season. Birds tagged in Iceland remained in Icelandic coastal waters and those from Scotland showed a partial migration, some remaining in Scottish waters and others moving southwest or southeast into coastal waters of north and west Britain and Northern Ireland. Thus, in this study, only birds from Finland were likely to use the OTE SPA during the non-breeding season and their behaviour is taken to be representative of birds using the SPA. Assuming that other RTDs breeding in Fennoscandia follow a similar migration pattern to those from Finland, this accords with the findings that RTD numbers in the OTE are highest during the late winter and spring migration period (Webb *et al.* 2009). Thompson *et al.* (2023) combined the TDR and GLS data to classify RTD activity into five behaviours: foraging, resting, flight, active on water (e.g. preening) and swimming. During the non-breeding season birds from Finland spent an average of 3.6 (SE (Standard Error) 0.3) hours foraging per day, varying throughout the season with the shortest foraging time per day in October (when birds were in the Baltic Sea) and the longest time in December and January (when birds were in the southern North Sea); due to limitations of the tags, data was not available for the latter part of the nonbreeding season. Foraging occurred almost exclusively during daylight hours. Thompson *et al.* (2023) concluded that temporal and spatial variation in foraging behaviour suggests that during the non-breeding season, RTDs may have the capacity to adapt their foraging behaviour to potentially accommodate the energetic costs of displacement from OWFs (if any), although this is likely to be constrained by factors such as available daylight and food availability. The availability of suitable alternative habitat is important in terms of accommodating the foraging needs of any displaced birds. NE (2023b) commented on their review of Thompson *et al.* (2023), that '*data from Finnish tagged birds (that winter in the southern North Sea) shows that from the end of October onwards the percentage of available daylight hours spent foraging increases from 29% in mid-November to 72% in mid-January. This represents an increase from ca 2.5 hours a day spent foraging in November to ca 6 hours a day in January, when there are only 8-8.5 hours of daylight. We also note that tagged birds are breeding adults, i.e., experienced individuals. Juvenile and immature birds may need to devote even more time to foraging if their success rate is lower. Ultimately, the energetic costs of this level of foraging in the depths of winter need to be investigated further, but it appears plausible that in fact red-throated divers are already operating at or close to sustainable limits*. *Thus, we urge caution in an optimistic reading of the general conclusions made by Thompson et al (2023)*'.

88. Tracking studies of RTDs captured in the German North Sea indicate that non-breeding season home ranges are extensive (several thousand square kilometres) such that displacement effects of OWFs will affect only a very small part of individual home ranges (Kleinschmidt *et al.* 2022, Nehls *et al.* 2018), and divers have access to extensive alternative areas if displaced from part of their home range. Distribution maps indicate that some of the birds captured in the German North Sea subsequently moved to the UK southern North Sea including the Outer Thames area (Kleinschmidt *et al.* 2022, Diverlog 2024). RTDs tagged at breeding grounds in Finland also moved extensively during the non-breeding season, through the east and west Baltic Sea to the southern North Sea and the east coast of England (Duckworth *et al.* 2022). Thus, there is evidence that RTDs using the OTE during the non-breeding season also have extensive home ranges, such that displacement effects from OWFs would only affect a very small proportion of the area. Given these extensive areas used by RTDs during the non-breeding season, it seems likely that the effects of displacement, if any, will be minimal and may be via body condition and perhaps subsequent breeding success rather than direct mortality.

89. In the context of possible energetic constraints during the non-breeding season, it is perhaps of note that RTDs are rarely reported to suffer mass mortality during seabird 'wrecks' (e.g. Clairbaux *et al.* 2021, Camphuysen *et al.* 1999, Harris and Wanless 1996, Underwood and Stowe 1984). Such wrecks are often associated with severe storms which appear to cause starvation due to interfering with the ability to forage and/or affecting the availability of prey to seabirds (Clairbaux *et al.* 2021). A review of the causes of mass mortalities of seabirds reported four wrecks involving RTDs in the North Atlantic, compared to 34 for guillemot, 25 for seaduck, 21 for razorbill, and 20 for little auk (all species with a similar ecology to RTDs, diving for food from the sea surface); the causes of RTD wrecks were all related to oil contamination, as opposed to food, storms or other causes (Camphuysen *et al.* 1999). This may suggest that RTDs are less energetically constrained during the non-breeding season than other seabird species.

4.4.1.4.4.1 Project alone assessment

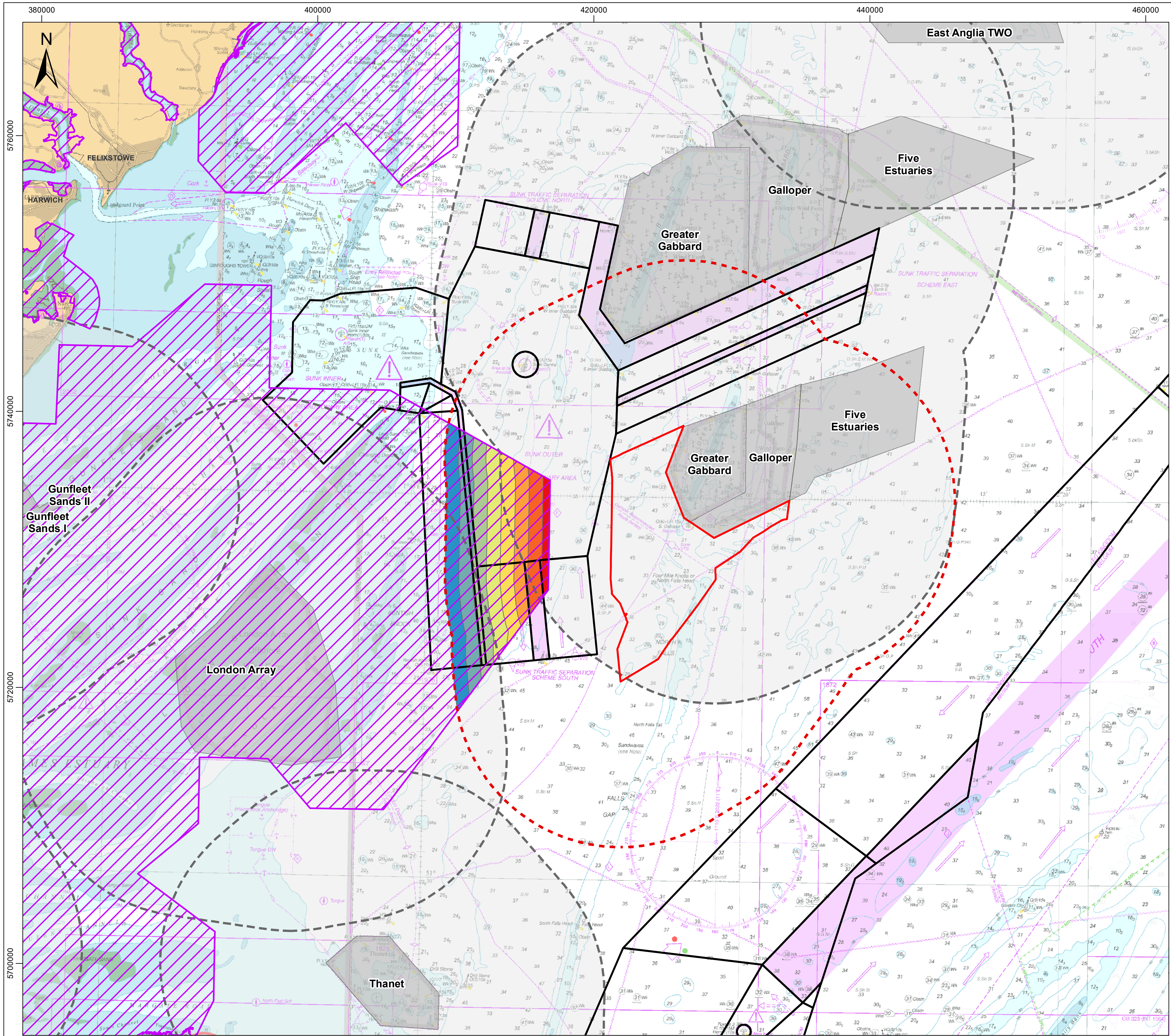
90. The assessment considers the area of the OTE SPA that overlaps with a 12km buffer from the North Falls array area, comprising a total area of approximately 108.7 km^2 (Figure 4.1). This represents 2.8 % of the total area of the OTE SPA. This area, where displacement may potentially affect the numbers and distribution of RTDs within the SPA boundary, has been divided into 1km increments for the purposes of assessing the potential displacement effects from the North Falls array area. It is noted that this area also overlaps with the 12km buffer of GGOW (of which North Falls is an extension), London Array OWF, and an international shipping lane (OWF 12km buffers and ship routing measures are shown in Figure 4.1 and Automatic Identification System (AIS) shipping density data is shown in Figure 4.2). In this area there are likely to be existing displacement effects from OWFs, and shipping traffic is also known to displace RTDs from offshore areas (as discussed further below).

91. NE has provided a gradient of predicted decreasing displacement rates for areas within the arrays of OWFs and 1km buffers out to 12km from an OWF (NE, 2023b). The data used to inform the gradient is from studies at the Gunfleet Sands, Kentish Flats, Lincs, Lynn and Inner Dowsing and London Array OWFs in English waters, as well as from studies on the displacement of non-breeding

RTD in relation to OWFs in the German Bight (NE 2023c). The gradient is based on the maximum recorded displacement within array areas and 1km buffers out to 12km from these OWFs (with the predicted displacement rates presented in Table 4.7). This is updated from the advice provided to North Falls at PEIR, which was a displacement gradient out to 10km from OWFs (NE 2022c) provided to Round 4 OWF developers in the Irish Sea, although not agreed with other SNCBs.

92. The assessment for North Falls uses the NE (2023b) advised gradient to estimate the number of RTDs likely to be displaced in those parts of the sequential 1km buffers from North Falls which overlap with the SPA (based upon applying the advised displacement rates to the estimated number of birds within each 1km buffer section – see below). These areas are shown in Figure 4.1.

93. An alternative gradient of displacement rates is also applied for comparative purposes, based on the proportions of birds estimated to be displaced within the array area and at increasing distances as reported in the post-construction monitoring at the London Array OWF (APEM 2021a, Table 5, page 347). The London Array results are used for this purpose as the monitoring at this OWF provides the most detailed data on displacement of RTDs from an OWF within the OTE SPA and is from a location very close to North Falls (see Figure 4.1). The London Array monitoring is one of the few UK studies to date to investigate displacement from OWFs to distances of 12km and beyond (although displacement is not reported in all directions from the array area, but in study areas extending to the east and north and to the west and south of the array area, APEM 2021a). The London Array displacement proportions for RTD were reported in 0.5km increments, from which an average value for each successive 1km buffer was calculated for use in the current assessment. The key differences between the NE and London Array displacement gradients are in the array area and 1km buffers within 6km of an OWF array, beyond this distance both gradients are more similar, and from the 7-8km buffer onwards the NE gradient is based on data from the London Array (e.g. see Table 4.7).



Legend

- North Falls Array Area
- North Falls Array Area 12km Buffer
- Offshore Wind Farm Site
- Offshore Wind Farm Site 12km Buffer
- IMO Ship Routeing Measures
- Outer Thames Estuary Special Protection Area (SPA)

North Falls Array Area Buffers

- 5 km
- 6 km
- 7 km
- 8 km
- 9 km
- 10 km
- 11 km
- 12 km

0 2.5 5 10 nm

0 5 10 20 km

Drawing Title

North Falls Array Area and Offshore Wind Farm Sites 12km Buffers

Rev	Date	Remarks	Drwn	Chkd
01	09/07/2024	First issue	FC	HR

Drawing Number	Figure Number
PB9244-RHD-ZZ-OF-DR-GS-0605	4.1

Scale	Plot Size	Datum	Projection
1:275,000	A3	WGS84	UTM31N

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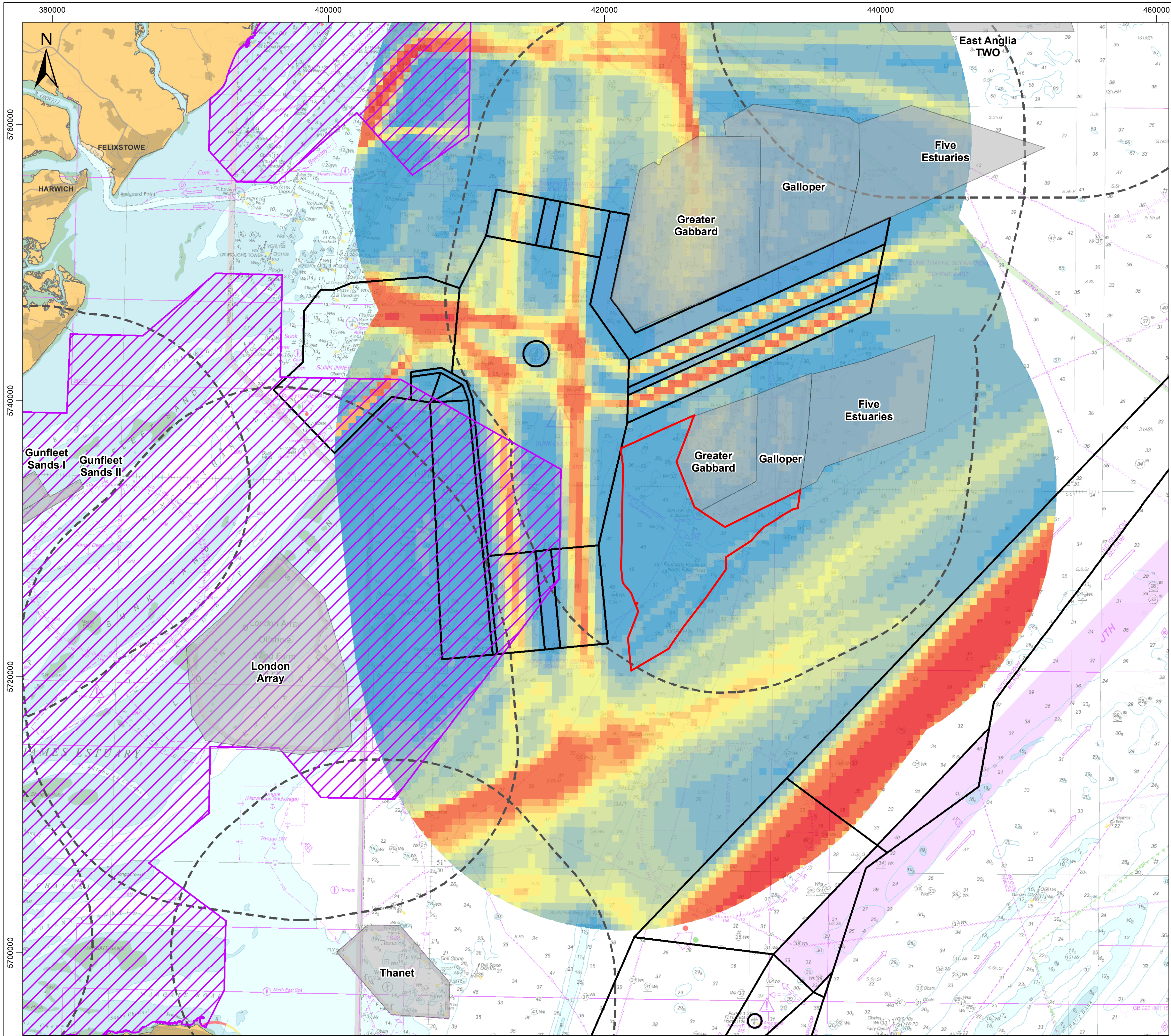
NORTH FALLS
Offshore Wind Farm

File ref: C:\Users\305050\OneDrive - Royal HaskoningDHV\Team - Project-PB9244-North-Falls-Team-Space\WIP\E02 GIS\02_Shared\02_Figures\06_HRA\RIAA\DCO\PB9244_RHD_ZZ_OF_DR_GS_0605_NF_OWFSites_12kmBuffers.mxd



Legend

- North Falls Array Area
- Outer Thames Estuary Special Protection Area (SPA)
- Offshore Wind Farm Site
- Offshore Wind Farm Site 12km Buffer
- IMO Ship Routeing Measures

AIS 2019 Ship Density Data (number of track intersects/year)

- 0 - 100
- 101 - 200
- 201 - 300
- 301 - 400
- 401 - 500
- 501 - 600
- 601 - 700
- 701 - 800
- 801 - 900
- 901 - 1,000
- 1,001 - 2,000
- 2,001 - 3,186

0 2.5 5 10 nm

0 5 10 20 km

Drawing Title

12km Buffers from Offshore Wind Farms and Shipping Density Data

Rev	Date	Remarks	Drwn	Chkd
03	15/02/2024	Third issue	JH	HR
02	09/08/2023	Second issue	FC	HR
01	20/03/2023	First issue	FC	HR

Drawing Number	Figure Number
PB9244-RHD-ZZ-OF-DR-GS-0329	4.2

Scale	Plot Size	Datum	Projection
1:275,000	A3	WGS84	UTM31N

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Offshore Wind Farm

File ref: C:\Users\305050\OneDrive - Royal HaskoningDHV\Team - Project-PB9244-North-Falls-Team-Space\WIP\E02 GIS\02_Shared\02_Figures\06_HRA\RIAA\DCO\PB9244_RHD_ZZ_OF_DR_GS_0329_OWFs12kmBuffers_ShippingDensities.mxd

94. Population estimates of RTD for the area of overlap between the 12km buffer of North Falls and the OTE SPA were derived using an INLA modelling approach (details in RIAA Appendix 4.1, Document Reference: 7.1.4.1) The model was used to generate mean density estimates (with associated CLs) for each 1km buffer within the overlap zone of the array area and the SPA (Figure 4.1). Density estimates were then multiplied by the area of the buffer to obtain abundance estimates.

95. Survey data for the overlap area were available for January and February 2021, from monthly baseline surveys for North Falls (when the baseline survey area was extended to 12km to the west of the former array area boundary, ES Appendix 13.2, Document Reference: 3.3.13); and on two days (4th and 17th) in February 2018, from surveys of the OTE SPA commissioned by NE (Irwin *et al.* 2019). The intention in 2018 was to fly one survey in late January and one in mid-February, but weather and military restriction issues meant this was not possible (Irwin *et al.* 2019).

96. The late winter and spring migration periods were identified for the extended displacement surveys at North Falls, and for surveys for SPA population estimates, because numbers of RTDs in this area are highest at this time (Webb *et al.* 2009). Furthermore, over the two years of baseline surveys for North Falls, RTD was recorded within the core survey area (i.e. the array area plus 4km buffer) in small numbers in only one of the surveys undertaken during the autumn migration period (September to November, inclusive, Furness 2015), with these survey data indicating that January and February is the period of peak abundance (ES Appendix 13.2 (Document Reference: 3.3.13), Table A2.17). Thus, the project alone displacement assessment focuses on the winter and spring migration periods.

97. Density estimates were modelled separately for each individual survey, giving four estimates of abundance for each 1km buffer within the SPA overlap area. Abundance estimates for this area were therefore available for one survey (January 2021) during the winter period (December and January), and three surveys (two in February 2018 and one in February 2021) during the spring migration period (February to April) (Furness 2015). However, for the purposes of the displacement analysis undertaken for the assessment, the first of the 2018 surveys have been allocated to the winter period because it was flown very early in February.

98. Modelled population abundance estimates for RTDs within the area of overlap between the North Falls 12km buffer and the OTE SPA, for the winter and spring migration periods in 2018 and 2021 are shown in Table 4.7 and Table 4.8, respectively. These are given for the individual 1km buffers from North Falls, and for the combined area. For the combined area, the predicted abundances during the winter period were higher in 2018 than 2021; but during spring migration numbers were considerably higher in 2021 than in 2018. In 2018, the predicted numbers in the late February survey were about twice those in the early February survey, and in 2021 the predicted February survey abundance was almost seven times the numbers in the January survey. Thus, there is considerable inter- and intra-annual variation in the numbers of birds using this area.

99. The number of RTDs predicted to be displaced within the SPA overlap area in the winter and spring migration periods for 2018 and 2021 was estimated as the sum of the number of birds predicted to be displaced within each 1km buffer from North Falls, based on; (i) the NE; and (ii) the London Array displacement gradients (Table 4.7 and Table 4.8). For each year, the predicted annual number of birds displaced, and displacement mortality, assuming 1-10% mortality of displaced birds, was summed for the respective winter and spring migration periods. For example, in relation to the number of birds predicted to be displaced in the area of overlap between the 12km buffer of the array area and the OTE SPA, in 2021, a total of 12 RTDs were predicted to be displaced during winter, applying the NE gradient (Table 4.7), and 96 birds were predicted to be displaced during spring migration using the same gradient (Table 4.8); summing these values gives an annual total of 107 birds predicted to be displaced in 2021 based on the NE gradient (Table 4.9) (noting that the seasonal and annual totals in the tables are rounded up to the nearest whole bird (see footnote to Table 4.9), but the sums have been based on the unrounded numbers). The predicted annual mortality of displaced birds, at 1-10%, is expressed as a percentage increase in the baseline annual mortality rate of the SPA population (i.e., in the absence of any wind farm effects) (Table 4.9). For this purpose, an average annual mortality rate across age classes of 0.233 was used (see ES Chapter 13, Table 13.11, Document Reference: 3.1.15).

100. The predicted increases in the mortality rate of the SPA population of RTDs due to displacement from North Falls are shown in Table 4.9. Separate estimates are included for scenarios of 1 and 10% mortality of displaced birds, based on the predicted annual mortality due to displacement in 2018, 2021 and a mean of the two years. As discussed previously (paragraph 82), a recent review of the biologically plausible mortality that could result from displacement effects during the non-breeding period on this species, considered that 1% mortality of displaced birds is an appropriately precautionary estimate for RTD. Based on this, the maximum predicted increase in the SPA mortality rate for RTDs at North Falls is 0.03% (Table 4.9). This magnitude of increase in mortality would not materially alter the background mortality of the SPA population and would be undetectable.

101. Even for scenarios of 10% mortality of displaced birds (considered to be unrealistically high), the maximum predicted increase in mortality would only be 0.25%, which would also not be detectable at a population level. It is concluded that displacement from North Falls alone would not have an adverse effect on the size of the OTE SPA non-breeding population of RTD and would not undermine the NE target to maintain the size of the non-breeding population at a level which is at or above 18,079 individuals, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

Table 4.7 Displacement of RTD within the overlap of North Falls 12km buffer and the OTE SPA, winter period

Buffer distance North Falls (km)	Area of SPA overlap (km^2)	% RTD displaced[1]		Number of RTD[2]			No. RTD displaced NE gradient[3]			No. RTD displaced London Array gradient[3]		
		NE gradient	London Array gradient	4 Feb 18	22 Jan 21	Mean	4 Feb 18	22 Jan 21	Mean	4 Feb 18	22 Jan 21	Mean
0 (within OWF)	0	94.00	54.68	0	0	0	0	0	0	0	0	0
0 -1	0	80.56	46.42	0	0	0	0	0	0	0	0	0
1 - 2	0	74.81	39.96	0	0	0	0	0	0	0	0	0
2 – 3	0	65.39	40.78	0	0	0	0	0	0	0	0	0
3 - 4	0	55.23	37.79	0	0	0	0	0	0	0	0	0
4 - 5	4.2	50.80	32.29	5	1	3	3	1	2	2	1	1
5 - 6	9.7	44.80	33.98	12	2	7	5	1	3	4	1	3
6 - 7	11.4	42.30	35.83	13	3	8	6	1	4	5	1	3
7 - 8	13.1	40.68	40.68	15	4	9	6	2	4	6	2	4
8 - 9	15.0	45.01	45.01	16	5	11	7	3	5	7	3	5
9 - 10	16.7	41.90	41.90	18	7	13	8	3	6	8	3	6
10 - 11	18.4	29.16	29.16	25	11	18	7	3	5	8	4	6
11 - 12	20.2	2.71	2.71	39	14	27	1	1	1	1	1	1
Totals	108.7			140	44	92	41	12	26	39	12	25
Predicted mortality of displaced RTD at 1%							1	1	1	1	1	1
Predicted mortality of displaced RTD at 10%							4	2	3	4	2	3

1. The predicted % of RTDs displaced within an OWF and successive 1km buffers out to 12km, based on the gradient provided by NE, and the post-construction monitoring study of the London Array OWF. 2. The modelled abundance of RTDs within successive 1km buffers of North Falls where they overlap with the OTE SPA (RIAA Appendix 4.1, Document Reference: 7.1.4.1). 3. The number of RTDs predicted to be displaced within each 1km buffer, based on the NE and London Array gradients.

Table 4.8 Displacement of RTD within the overlap of North Falls 12km buffer and the OTE SPA, spring migration

Buffer distance North Falls (km)	Area of SPA overlap (km²)	% RTD displaced[1]		Number of RTD[2]			No. RTD displaced NE gradient[3]			No. RTD displaced London Array gradient[3]		
		NE gradient	London Array gradient	17 Feb 18	13 Feb 21	Mean	17 Feb 18	13 Feb 21	Mean	17 Feb 18	13 Feb 21	Mean
0 (within OWF)	0	94.00	54.68	0	0	0	0	0	0	0	0	0
0 -1	0	80.56	46.42	0	0	0	0	0	0	0	0	0
1 - 2	0	74.81	39.96	0	0	0	0	0	0	0	0	0
2 – 3	0	65.39	40.78	0	0	0	0	0	0	0	0	0
3 - 4	0	55.23	37.79	0	0	0	0	0	0	0	0	0
4 - 5	4.2	50.80	32.29	2	7	4	1	4	2.	1	3	2
5 - 6	9.7	44.80	33.98	3	18	11	2	8	5	1	7	4
6 - 7	11.4	42.30	35.83	4	26	15	2	11	7	2	10	6
7 - 8	13.1	40.68	40.68	6	35	20	3	14	9	3	14	9
8 - 9	15	45.01	45.01	8	46	27	4	21	12	4	21	12
9 - 10	16.7	41.90	41.90	11	53	32	5	22	13	5	22	13
10 - 11	18.4	29.16	29.16	15	58	37	4	15	10	5	17	11
11 - 12	20.2	2.71	2.71	20	63	41	1	2	2	1	2	2
Totals	108.7			66	302	184	18	96	57	18	93	55
Predicted mortality of displaced RTD at 1%							1	1	1	1	1	1
Predicted mortality of displaced RTD at 10%							2	10	6	2	10	6

Buffer distance North Falls (km)	Area of SPA overlap (km²)	% RTD displaced[1]		Number of RTD[2]			No. RTD displaced NE gradient[3]			No. RTD displaced London Array gradient[3]		
		NE gradient	London Array gradient	17 Feb 18	13 Feb 21	Mean	17 Feb 18	13 Feb 21	Mean	17 Feb 18	13 Feb 21	Mean
Notes as per Table 4.7.												

Table 4.9 Predicted annual displacement mortality of RTD within the overlap of North Falls 12km buffer and the OTE SPA and increase in population mortality rate

Year	2018		2021		Mean 2018 and 2021	
	NE displ. gradient	London Array displ. gradient	NE gradient	London Array gradient	NE gradient	London Array gradient
Predicted annual displacement[1]						
No. of RTDs	59	56	107	104	83	80
Predicted annual displacement mortality (number of RTD)[1]						
1% mortality of displaced birds	1	1	1	1	1	1
10% mortality of displaced birds	6	6	11	11	9	8
Predicted % increase in population mortality rate[2]						
1% mortality of displaced birds	0.01	0.01	0.03	0.02	0.02	0.02
10% mortality of displaced birds	0.14	0.13	0.25	0.25	0.20	0.19

1. Note in this table and Table 4.7 and Table 4.8 above, the numbers of RTDs presented are rounded up to the nearest whole bird (for decimal places of 0.1 and above); calculations are however based on the unrounded figures.

2. Based on an SPA population of 18,079 non-breeding individuals of all age classes and an average annual mortality rate across age classes of 0.233 (such that the baseline mortality would be 4212.4 birds per annum)

102. The project alone assessment also considers the effect of North Falls on the distribution of RTDs within the SPA, given the conservation objective to maintain or restore the distribution of qualifying features within the SPA.

103. Displacement of RTDs from an area due to the presence of an OWF is equivalent to effective habitat loss, and will reduce the density of the species in a given area compared with the situation prior to the construction of the OWF. Thus, changes in the absolute and relative densities of RTDs may occur within the area of the SPA close to North Falls.

104. NE has requested that the assessment considers the extent of the SPA where RTDs would be subject to some level of displacement (the area of overlap with an OWF and 12km buffer). In advice received before the North Falls PEIR was published, NE (2022d) also requested that the extent of effective displacement was provided. This is the area of overlap between an OWF and 12km buffer and the SPA weighted by the predicted proportion of birds displaced within the array area and at different distances from the array area. In their comments on the draft RIAA (submitted with PEIR), NE (2023c) noted they had '*reflected on the validity of the Effective Displacement Area approach and concluded…there is no logical way to proportionally reduce the area of effective habitat loss by the scale of impact on the population. The logical supposition if the area of 'effective' displacement is 55% would be that the remaining 45% of the area is not subject to displacement effects. This is clearly not the case. We do recognise the potential value in trying to account for the gradient of effect in spatial terms, but in light of the relevant conservation objectives, NE considers that an area subject to any displacement effect is compromised in its ability to support red-throated*

diver across the whole of that area.' While it is agreed that, on its own, use of an effective displacement area is potentially misleading, given that studies show that RTD displacement from OWFs decreases with distance, and not all birds are displaced from a given area, it is considered by the Applicant that presenting only the area of the SPA subject to some extent of displacement from an OWF over-estimates the extent of displacement and effective habitat loss. Clearly, using the percentage of the SPA affected by any displacement impacts takes no account of the diminishing scale of the potential effect and leads to a potentially misleading overestimate of the scale of the predicted effect. Presenting the effective displacement area alongside the total area of an SPA subject to some form of displacement therefore gives some context to the total displacement area. Thus, both metrics are presented here. It is noted also that the effective displacement area is one of the metrics referenced in the appropriate assessment for RTD and the OTE SPA for the consented East Anglia ONE North (BEIS 2022).

105. The North Falls array area is outside the boundary of the OTE SPA, being a distance of 4.5 km at the nearest point. The displacement area where the 12km buffer of North Falls overlaps with the SPA encompasses 108.7 km^2, representing 2.8% of the SPA area (Table 4.10). The effective displacement area for North Falls, based on the NE and London Array displacement gradients is 35.64 km^2 and 33.64 km^2, respectively, both of which are equivalent to 0.9% of the SPA area.

106. North Falls is an extension to the existing GGOW, and where it overlaps with the SPA boundary, the 12km buffer of North Falls also overlaps with the 12km buffer of GGOW, as well as the 12km buffer of the London Array (Figure 4.1 to Figure 4.3). The area of the SPA where displacement effects would be predicted for North Falls alone (i.e. excluding those areas already within the 12km buffers of operational OWFs) is 54.5 km^2, equivalent to 1.4% of the SPA area.

107. Furthermore, as noted previously, this area of overlap between the 12km buffer of North Falls and the SPA also overlaps almost completely with an IMO international shipping measures (Figure 4.1 and Figure 4.2). Vessel density data for this area for the 12 month period March 2019 to February 2020 (pre-COVID19) are presented in Figure 4.2. These show high densities of shipping (>700 vessels per year) in two lanes, one immediately to the west of the North Falls array area and east of the OTE SPA boundary, and another parallel, high density, area further to the west, overlapping with the OTE SPA boundary and the 12km buffer where North Falls overlaps the SPA. North Falls Shipping Surveys carried out within a study area of 10nm around the array area reported an average of 151 vessels per day in winter 2022, 167 vessels per day in summer 2022 and 141 vessels per day in winter 2024 (ES Appendix 15.1, Document Reference: 3.3.16).

108. Divers are known to be displaced by ships (Mendel *et al.* 2019, Schwemmer *et al.* 2011, Bellebaum *et al.* 2006), so birds using this area will already be subject to displacement effects from shipping lanes as is suggested from the density distribution maps of RTDs in the 2018 surveys (Irwin *et al.* 2019). In the German North Sea, Mendel *et al.* (2019) modelled the effects of OWFs and ships on RTD displacement. Attempting to separating out the effects of both, they found that ships had a strong negative impact on diver abundance within 5km, although it

was not possible to predict the reduction in densities associated with ships independently of those from OWFs.

109. Thus, there is an existing source of displacement for RTDs (the shipping lanes) closer to the SPA boundary than the North Falls OWF, and it seems valid to consider to what extent birds in the area of the SPA closest to the shipping lanes would also be affected by a more distant source of displacement in the form of the North Falls array area.

Table 4.10 Displacement area (area of SPA overlap) and effective displacement area of RTD within the overlap of North Falls 12km buffer and the OTE SPA

Buffer Distance North Falls (km)	Area Of SPA Overlap (km^2)	% RTD Displaced[1]		Effective Displacement Area (km^2)[2]	
		NE Gradient	London Array Gradient	NE Gradient	London Array Gradient
0 (within OWF)	0	94.00	54.68	0	0
0 -1	0	80.56	46.42	0	0
1 – 2	0	74.81	39.96	0	0
2 – 3	0	65.39	40.78	0	0
3 – 4	0	55.23	37.79	0	0
4 – 5	4.20	50.80	32.29	2.11	1.34
5 – 6	9.70	44.80	33.98	4.32	3.28
6 – 7	11.40	42.30	35.83	4.80	4.07
7 – 8	13.10	40.68	40.68	5.31	5.31
8 – 9	15.00	45.01	45.01	6.74	6.74
9 – 10	16.70	41.90	41.90	7.01	7.01
10 – 11	18.40	29.16	29.16	4.81	5.36
11 – 12	20.20	2.71	2.71	0.55	0.55
Totals	108.70			35.64	33.64
% of SPA[3]	2.8%			0.9%	0.9%

1. Displacement gradients from NE, and the post-construction monitoring study of the London Array OWF. 2. Effective displacement is the area of SPA overlap for a given buffer multiplied by the % of RTD predicted to be displaced. The total SPA area is 3924km^2.

110. In summary, the area of overlap between the 12km buffer of North Falls and the OTE SPA, also overlaps with the 12km buffer of another OWF and/or IMO shipping measures, both of which are existing sources of displacement for RTDs (Figure 4.1). Thus no part of the 12km buffer of North Falls overlaps with an area of the SPA which is not already subject to a potential source of displacement for RTDs. It is accepted that RTDs occupying these areas (i.e. birds which have not been displaced from existing OWFs or shipping lanes) may be subject to additional displacement effects from the North Falls array area, however it is considered likely that any further changes in density would be very small and represent no meaningful change to the existing situation.

111. It is considered that North Falls would not contribute significantly to the existing sources of disturbance/displacement for RTDs in the area of overlap between the 12km buffer and the OTE SPA, and that a Project alone effect on the distribution of the species within the SPA can be excluded, as well as a Project alone effect on the SPA population size.

4.4.1.4.4.2 In-combination assessment

112. On the basis of the conclusions of the Project alone assessment of (i) very low predicted annual RTD mortality of 1 bird and <0.1% increase in background mortality, assuming a precautionary scenario of 1% mortality of displaced birds, based on expert opinion; and (ii) no material contribution to the area of the SPA over which RTDs are displaced; there would be no material contribution of the Project to in-combination effects. Accordingly, no in-combination assessment is required for this feature. The conclusion of the assessment is therefore that predicted RTD mortality due to displacement and barrier effects during the operation of North Falls would not adversely affect the integrity of the OTE SPA, either for the project alone or in-combination.

113. Notwithstanding this conclusion, the estimated in-combination mortality, is provided below as context to the Project alone assessment. This information is presented without prejudice to the conclusion above.

114. The in-combination assessment considers the potential operational displacement effects of North Falls OWF and other OWFs within or close to the boundary of the OTE SPA. NE has advised that the following OWFs are considered (for operational sites, the year of full commissioning is given):

- London Array (2013),
- Gunfleet Sands I, II and III (2010),
- Kentish Flats 2005) and Extension (2015),
- GGOW (2013),
- Thanet (2010),
- East Anglia ONE North,
- East Anglia TWO.

115. All of the operational OWFs included in the list were in place four or more years before the baseline surveys for North Falls were carried out, they were therefore part of the environmental conditions at the time the surveys took place, and over this timescale it would be expected that any effects on demographic parameters of RTDs would have fed through to the baseline conditions. Thus their effects on RTDs could be argued to be part of the baseline conditions. However, NE (2022d) has advised that operational wind farms should be included on the basis that there is no clear evidence on the extent that mortality and productivity rates are affected by OWFs, and for the purposes of understanding cumulative displacement effects.

116. The locations of these OWFs and North Falls in relation to the SPA are shown in Figure 4.3. The figure also shows 12km buffers from each OWF, as this is the distance that NE has advised for consideration of displacement effects (noting that it is a single combined 12km buffer area that is shown for each of Gunfleet

Sands I, II and III, Kentish Flats and Extension, and also for GGOW and Galloper Wind Farm (GWF), as it is considered that these projects would be perceived by RTDs as effectively one OWF).

117. In their response to the North Falls PEIR, NE commented that the submitted ES should consider other displacement-generating projects (including relevant aggregate extraction) projects in the Cumulative Effects Assessment (CEA) and '*the exclusion of displacement causing activities from the CEA on the grounds that they do not have large scale permanent infrastructure does not consider the fact that aggregate extraction and busy commercial shipping lanes can lead to long-term displacement of birds*'. While these comments relate specifically to the CEA rather than the in-combination assessment, they are considered relevant to mention here. The Applicant agrees that that shipping lanes can lead to long-term displacement of RTDs if the shipping traffic is of sufficient frequency to displace birds and prevent the return of birds in between the passage of vessels. It is also considered that shipping lanes are a long-term feature within the OTE area, which was part of the baseline conditions when the digital aerial surveys for the Project were undertaken, and indeed at the time that surveys were undertaken to identify the SPA boundary. Similarly aggregate extraction is an ongoing activity within the SPA where disturbance would take place only when extraction is ongoing and would be spatially limited to areas in the vicinity of extraction vessels. Thus, both shipping lanes and aggregate extraction areas are considered to be part of the baseline conditions of the SPA[1], and it is the view of the Applicant that to consider them in an in-combination assessment would be to effectively double-count their effects. Further, previous cumulative and in-combination assessments of RTD displacement from OWFs have considered only other OWFs and no other activities.

118. Baseline surveys of other OWFs included in the in-combination assessment pre-date the most recent evidence (and associated advice) on the extent of displacement effects of OWFs on RTD, and do not cover areas out to 12km from each OWF. Therefore, estimates specific to each OWF of the number of RTDs likely to be displaced within 12 km buffers, are not available for use within the in-combination assessment.

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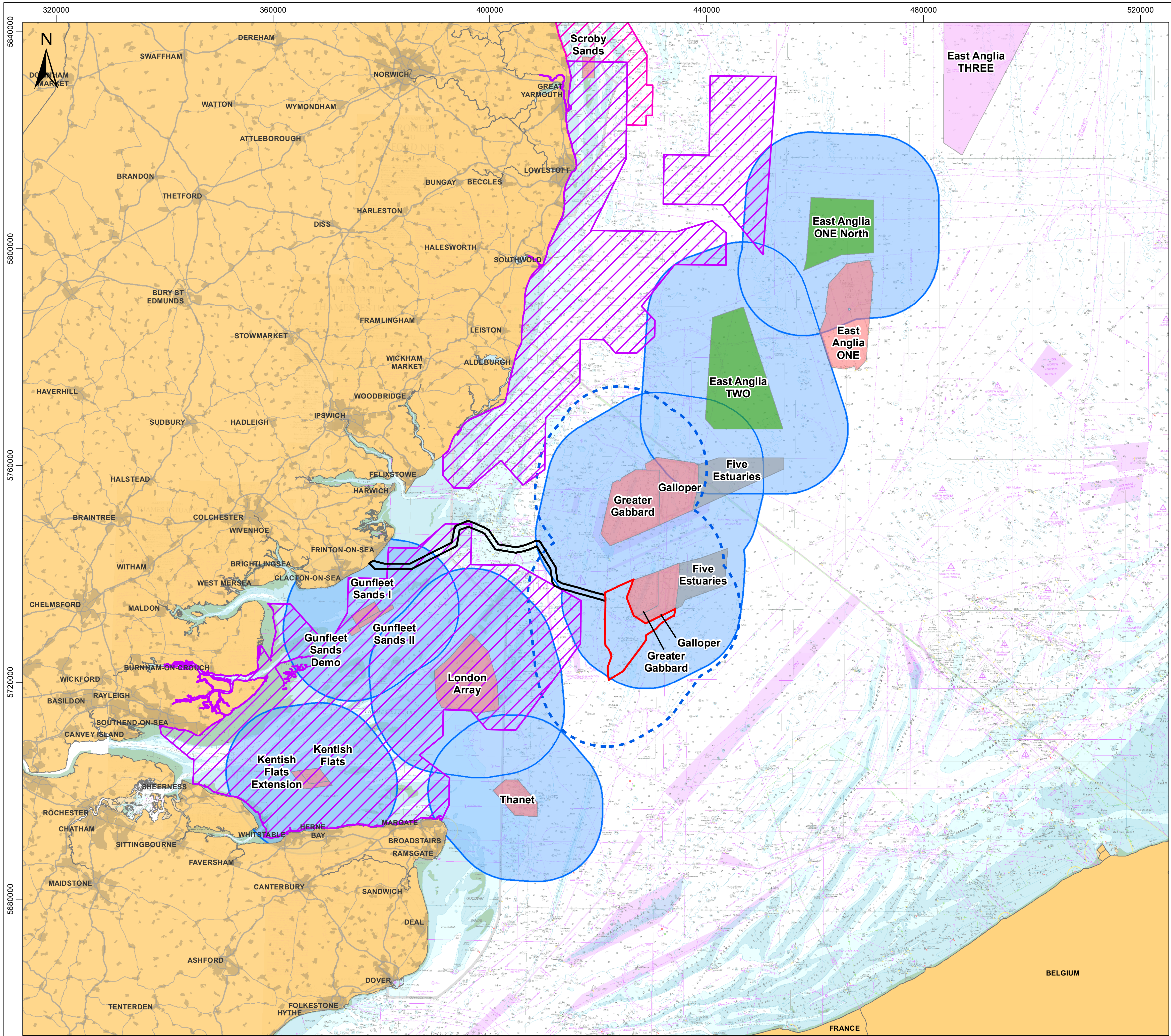
[1] ES Chapter 13, Section 13.8.2 (Document Reference: 3.1.15) refers to a new aggregate extraction area adjacent to the southern boundary of the North Falls array area that became operational in April 2023. However, this area is outside the SPA boundary and will not contribute to displacement within the SPA.



Legend

- North Falls Array Areas
- Offshore Cable Corridor
- Outer Thames Estuary Special Protection Area (SPA)
- Greater Wash Special Protection Area (SPA)
- North Falls Array Areas 12km Buffer
- Offshore Wind Farm 12km Buffer

Offshore Wind Farms

- Active/In Operation
- Consented
- Government Support on Offer
- Pre-Planning Application

0 5 10 20 nm

0 10 20 40 km

Drawing Title

Red Throated Diver Displacement in the Outer Thames Estuary SPA

Rev	Date	Remarks	Drwn	Chkd
01	11/01/2023	First issue	FC	HR

Drawing Number	Figure Number
PB9244-RHD-ZZ-OF-DR-GS-0302	4.3

Scale	Plot Size	Datum	Projection
1:700,000	A3	WGS84	UTM31N

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Enhancing Society Together

NORTH FALLS
Offshore Wind Farm

File ref: C:\Users\305050\OneDrive - Royal HaskoningDHV\Team - Project-PB9244-North-Falls-Team-Space\WIP\E02 GIS\02_Shared\02_Figures\06_HRA\RIAA\DCO\PB9244_RHD_ZZ_OF_DR_GS_0302_RedThroatedDiver_12kmBuffers.mxd

119. During the DCO examination for East Anglia ONE North (EA1N) and TWO (EA2), a model of RTD displacement from OWFs within the OTE SPA was developed (MacArthur Green and Royal HaskoningDHV 2021b). This was based on data from both visual aerial surveys flown in 2002-2007 (i.e. as used to identify the SPA boundary for RTDs) and digital aerial surveys in 2013 and 2018 (commissioned by NE to update the OTE SPA population estimate for RTDs). Thus, the RTD data which were used as model inputs were from surveys which began before all OWFs were commissioned, coincided with the construction and/or early operational period of some OWFs; and included the period when all existing OWFs were operational (in 2018).

120. The modelling made use of a combination of static covariates (bathymetry, distance to coast and shipping traffic density (Marine Management Organisation)) and a time-varying term, distance to OWF (a time-dependent variable, changing as new OWFs came into operation). The modelled relationship between the explanatory variables and observed RTD usage was used to predict RTD abundance in 1km buffers from EA1N and EA2 and OWFs within the SPA boundary, with and without OWF displacement effects, for the purpose of in-combination assessment. Use of this model was considered during the EPP for North Falls, however NE did not endorse its use for the North Falls in-combination assessment, due to concerns about aspects of the model (as set out in NE, 2021b). Although the Applicant for East Anglia ONE North and TWO responded to these concerns (MacArthur Green and Royal HaskoningDHV 2021b), NE has advised North Falls that they consider that there are unresolved issues in relation to the extent to which the model reflects empirical evidence relating to the displacement rates of RTDs within the array areas of OWFs. In response to the NE advice, the model has not been adopted for the in-combination assessment for North Falls. However, the Applicant notes that; (i) many of the concerns raised by NE were addressed by the Applicant for East Anglia ONE North and TWO; (ii) the reality is that there are limitations to all modelling exercises; and (iii) the model in question appears to represent the best available evidence on RTD displacement which is specific to the OTE SPA.

121. For the draft North Falls RIAA, no estimate of the in-combination number of RTDs displaced within the SPA from OWFs was presented, and the in-combination assessment was based on the area of the SPA where birds are potentially subject to some degree of displacement, and the effective displacement area, taking account of decreasing displacement effects with distance from an OWF. As discussed above (paragraph 104), NE no longer endorses the concept of an effective displacement area but it is provided here as context to the displacement area.

122. In this report, a quantitative in-combination assessment is presented using data from the 2018 survey of the SPA (Irwin *et al.* 2019), supplied to North Falls by NE.

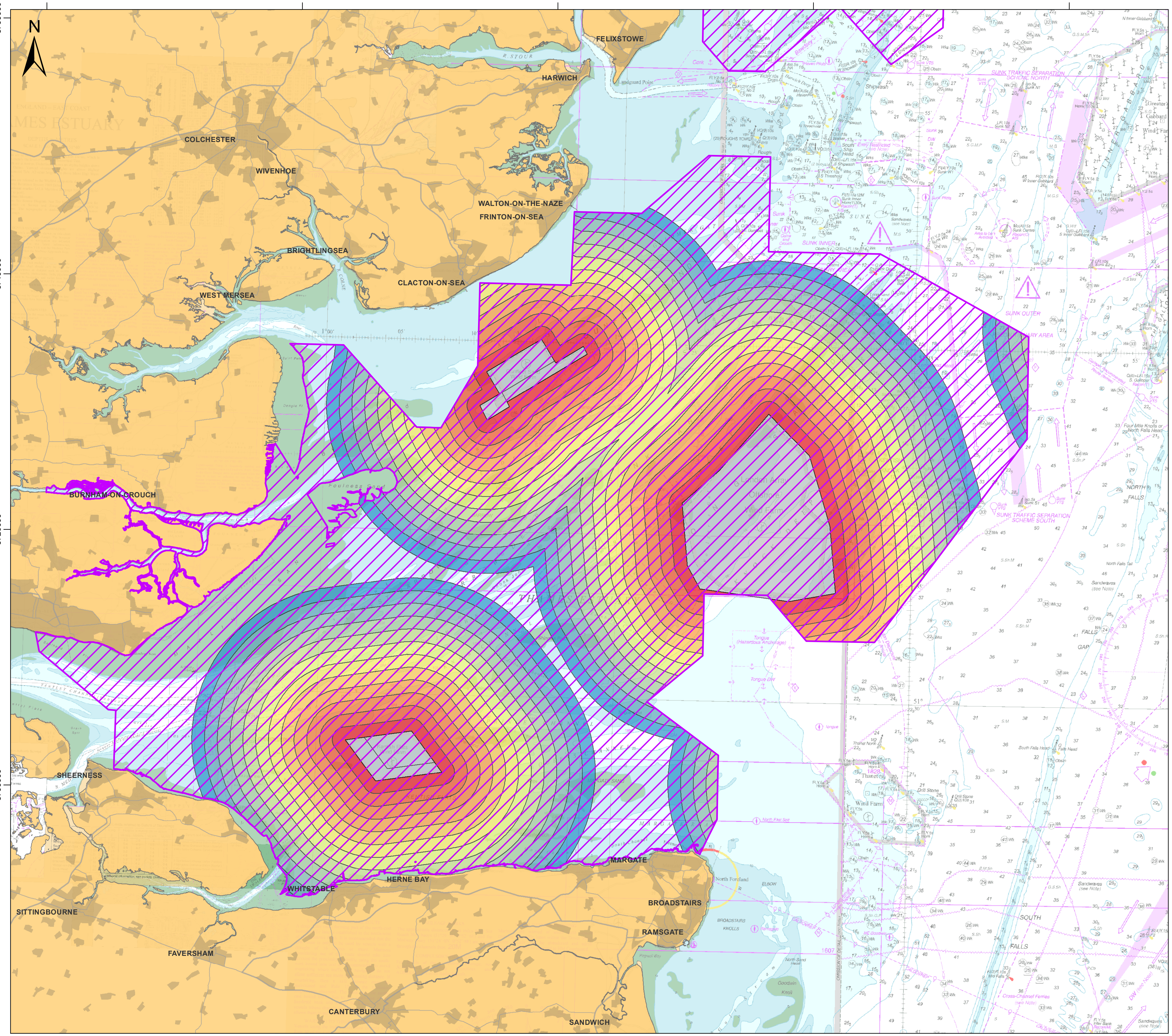
123. The 2018 survey data were used to estimate post-construction densities and abundances for array areas and/or 12km buffers of OWFs in situ in 2018, where these overlapped with the SPA boundary: London Array; Kentish Flats and Extension; Gunfleet Sands I, II and III; Thanet; and GGOW and GWF. Abundances were calculated in Geographic Information Systems (GIS), using the outputs from a density surface derived from KDE modelling of the 2018 survey

data (as described in Irwin *et al.* 2019). The KDE outputs form a grid of cells (each 0.077km^2 in area) within the SPA boundary with estimated mean densities of RTD for each cell (but no associated SD or CLs).

124. For operational OWFs, shapefiles were overlain in GIS with polygons comprising the boundaries of the arrays of operational OWFs within the Outer Thames SPA boundary, and 1km buffers from OWF arrays out to 12km where these overlapped with the SPA boundary. Where the 12km buffers of OWFs overlapped, the 1km buffer strips were coalesced to produce a joint buffer for the OWFs concerned in the area of overlap, prioritising the closest OWF in a given area to avoid double counting of the displacement effects (Figure 4.4). The KDE cells were then clipped to the polygons for OWF arrays and buffers. The abundance of in each array area and buffer was estimated by summing the abundance of each cell within the array area or 1km buffer strip (RTD abundance in each cell calculated as the area of the cell multiplied by the modelled density of RTDs within the cell). GIS was used to clip cells with partial overlap and recalculate the areas of overlap of these cells with the array area or 1km buffer strips.

125. The predicted abundances of RTDs from this analysis for the two SPA surveys carried out in 2018 (4 February 2018 and 17 February 2018; Irwin *et al.* 2019) are shown in Table 4.11 and Table 4.12. For operational OWFs, predicted densities of RTD for 2018 in the absence of displacement from OWFs are back-calculated based on the NE and London Array displacement gradients (e.g. see Table 4.7 above). The methodology for back-calculation is described in the notes for Table 4.11.

126. The 2018 KDE survey outputs were also used to estimate the number of RTDs present within the 12km buffers of EA1N, EA2 and North Falls, where these overlap with the OTE SPA. As these OWFs are not yet constructed, they exerted no displacement effects in 2018 (so that no back-calculation was undertaken for these projects). The NE and London Array displacement gradients were used to predict the number of RTDs that would be displaced, as shown in Table 4.13 and Table 4.14 (EA1N and EA2); and Table 4.15 and Table 4.16 (North Falls).



Legend

- Offshore Wind Farm Site
- Outer Thames Estuary Special Protection Area (SPA)

Offshore Wind Farm Buffers (m)

1
2
3
4
5
6
7
8
9
10
11
12

0 2.5 5 10 nm

0 5 10 20 km

Data Source: © JNCC, 2024. © The Crown Estate, 2024. © HaskoningDHV UK Ltd. 2024. © British Crown and OceanWise, 2024. All rights reserved. License No. EMS-EK001-664144. Not to be used for Navigation. Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors.

Drawing Title

Southern Area of the OTE SPA Showing Array Areas and Coalesced 12km Buffers for Operational OWFs, where these Overlap with the SPA

Rev	Date	Remarks	Drwn	Chkd
01	09/07/2024	First issue	FC	HR

Drawing Number	Figure Number
PB9244-RHD-ZZ-OF-DR-GS-0606	4.4

Scale	Plot Size	Datum	Projection
1:300,000	A3	WGS84	UTM31N

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NORTH FALLS
Offshore Wind Farm

File ref: C:\Users\305050\OneDrive - Royal HaskoningDHV\Team - Project-PB9244-North-Falls-Team-Space\WIP\E02 GIS\02_Shared\02_Figures\06_HRA\RIAA\DCO\PB9244_RHD_ZZ_OF_DR_GS_0606_S_OTE_SPA_OWFBuffers.mxd

Table 4.11 Estimated abundance and back calculated displacement of RTDs from operational OWFs within 12km of the OTE SPA, 4 February 2018 (survey 1)

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)[2]		Predicted number RTDs without displacement[2]	
			NE (NE)	London array (LA)	NE Gradient	LA gradient
0 (Array)	159	198	94.00	54.68	3,289	436
1	90	210	80.56	46.42	1,079	392
2	104	284	74.81	39.96	1,128	474
3	117	349	65.39	40.78	1,008	590
4	131	401	55.23	37.79	894	644
5	142	440	50.80	32.29	893	649
6	150	487	44.80	33.98	883	738
7	162	561	42.30	35.83	972	874
8	154	621	40.68	40.68	1,047	1,047
9	151	668	45.01	45.01	1,215	1,215
10	158	720	41.90	41.90	1,240	1,240
11	161	772	29.16	29.16	1,089	1,089
12	163	811	2.71	2.71	834	834
TOTALS	1,842	6,518			15,565	10,214
PREDICTED NO. OF RTD'S DISPLACED FROM ALL OPERATIONAL OWFS					9,048	3,697

Notes: RTD numbers in the table are rounded up to the nearest integer, although calculations and sums were undertaken on the unrounded numbers.

1. 1km buffer is 0-1km from the Array area boundary, 2km, 1-2km, etc.

2. The predicted numbers of RTDs in the absence of displacement from OWFs have been back calculated based on displacement gradients provided by NE (NE) and the observed displacement gradient from the London Array OWF (LA; APEM 2021a). For example, 210 (209.6 rounded up) RTDs are estimated to be present in 0-1km buffers of OWFs where they overlap with the OTE SPA. Based on the NE gradient, the proportion of birds displaced in this area would be 0.8056 (80.56%), so it is assumed that the 210 birds present

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)[2]		Predicted number RTDs without displacement[2]	
			NE (NE)	London array (LA)	NE Gradient	LA gradient
represent 1-0.8056 = 0.1944 (or 19.44%) of the numbers that would be present without displacement. Thus, the predicted numbers without displacement effects from OWFs are calculated as 209.6 ÷ (1-0.856) = 1079.						

Table 4.12 Estimated abundance and back calculated displacement of RTDs from operational OWFs within 12km of the OTE SPA, 17 February 2018 (survey 2)

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (percentage of RTDs predicted to be displaced)		Predicted number RTDs without displacement[2]	
			NE (NE)	London array (LA)	NE Gradient	LA gradient
0 (Array)	159	267	94.00	54.68	4,448	589
1	90	360	80.56	46.42	1,852	672
2	104	533	74.81	39.96	2,117	888
3	117	686	65.39	40.78	1,982	1,159
4	131	821	55.23	37.79	1,832	1,319
5	142	945	50.80	32.29	1,920	1,395
6	150	1099	44.80	33.98	1,990	1,664
7	162	1308	42.30	35.83	2,266	2,037
8	154	1393	40.68	40.68	2,348	2,348
9	151	1542	45.01	45.01	2,804	2,804
10	158	1681	41.90	41.90	2,893	2,893
11	161	1697	29.16	29.16	2,395	2,395
12	163	1645	2.71	2.71	1,691	1,691

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (percentage of RTDs predicted to be displaced)		Predicted number RTDs without displacement[2]	
			NE (NE)	London array (LA)	NE Gradient	LA gradient
TOTALS	1,842	13,972			30,533	21,849
PREDICTED NO. OF RTD'S DISPLACED FROM ALL OPERATIONAL OWFS					16,562	7,878
Notes: As for **Table 4.11**						

Table 4.13 Estimated abundance and displacement of RTDs from EA1N and EA2 OWFs, 4 February 2018 (survey 1)

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)		Predicted number RTDs with displacement[2]		Predicted number RTDs displaced	
			NE (NE)	London array (LA)	NE Gradient	LA gradient	NE Gradient	LA gradient
0 (Array)	0	0	94.00	54.68	0	0	0	0
1	0	0	80.56	46.42	0	0	0	0
2	0	0	74.81	39.96	0	0	0	0
3	0	0	65.39	40.78	0	0	0	0
4	0	0	55.23	37.79	0	0	0	0
5	0	0	50.80	32.29	0	0	0	0
6	0	0	44.80	33.98	0	0	0	0
7	0	0	42.30	35.83	0	0	0	0
8	0	0	40.68	40.68	0	0	0	0
9	14	15	45.01	45.01	8	8	7	7
10	19	12	41.90	41.90	7	7	5	5
11	25	14	29.16	29.16	10	10	4	4

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)		Predicted number RTDs with displacement[2]		Predicted number RTDs displaced	
			NE (NE)	London array (LA)	NE Gradient	LA gradient	NE Gradient	LA gradient
12	33	24	2.71	2.71	24	24	1	1
TOTALS	**90**	**64**			**48**	**48**	**17**	**17**

Notes: RTD numbers in the table are rounded up the nearest integer.

1. 1km buffer is 0-1km from the Array area boundary, 2km, 1-2km, etc.

2. The predicted RTD numbers with displacement from EA1N and EA2 have been calculated based on the displacement gradients provided by NE (NE) and the observed displacement gradient from the London Array OWF (LA; APEM 2021a), for example at 8-9km from the array boundaries 15 (14.51 birds rounded up) were predicted to be present. The NE and LA gradients predict the proportion of birds displaced at this distance would be 0.4501 (45.01%), so the predicted number remaining if the OWFs were present would be (1-0.4501) x 14.51 = 8 (rounded up to the nearest integer). The predicted number of RTDs displaced is the abundance (KDE model outputs) – (predicted number with displacement).

Table 4.14 Estimated abundance and displacement of RTDs from EA1N and EA2 OWFs, 17 February 2018 (survey 2)

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)		Predicted number RTDs with displacement[2]		Predicted number RTDs displaced	
			NE (NE)	London array (LA)	NE Gradient	LA gradient	NE Gradient	LA gradient
0 (Array)	0	0	94.00	54.68	0	0	0	0
1	0	0	80.56	46.42	0	0	0	0
2	0	0	74.81	39.96	0	0	0	0
3	0	0	65.39	40.78	0	0	0	0
4	0	0	55.23	37.79	0	0	0	0
5	0	0	50.80	32.29	0	0	0	0
6	0	0	44.80	33.98	0	0	0	0
7	0	0	42.30	35.83	0	0	0	0
8	0	0	40.68	40.68	0	0	0	0

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)		Predicted number RTDs with displacement[2]		Predicted number RTDs displaced	
			NE (NE)	London array (LA)	NE Gradient	LA gradient	NE Gradient	LA gradient
9	14	9	45.01	45.01	5	5	4	4
10	19	10	41.90	41.90	6	6	4	4
11	25	15	29.16	29.16	11	11	5	5
12	33	24	2.71	2.71	23	23	1	1
TOTALS	**90**	**55**			**43**	**43**	**13**	**13**
Notes: As per **Table 4.13**								

Table 4.15 Estimated abundance and displacement of RTDs from North Falls OWFs, 4 February 2018 (survey 1)

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)		Predicted number RTDs with displacement[2]		Predicted number RTDs displaced	
			NE (NE)	London array (LA)	NE Gradient	LA gradient	NE Gradient	LA gradient
0 (Array)	0	0	94.00	54.68	0	0	0	0
1	0	0	80.56	46.42	0	0	0	0
2	0	0	74.81	39.96	0	0	0	0
3	0	0	65.39	40.78	0	0	0	0
4	0	0	55.23	37.79	0	0	0	0
5	4	5	50.80	32.29	3	4	3	2
6	10	11	44.80	33.98	6	7	5	4

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)		Predicted number RTDs with displacement[2]		Predicted number RTDs displaced	
			NE (NE)	London array (LA)	NE Gradient	LA gradient	NE Gradient	LA gradient
7	11	12	42.30	35.83	7	8	5	5
8	13	12	40.68	40.68	8	8	5	5
9	15	12	45.01	45.01	7	7	5	5
10	17	14	41.90	41.90	8	8	6	6
11	18	22	29.16	29.16	16	16	7	7
12	20	39	2.71	2.71	38	38	1	1
TOTALS	108	**125**			**90**	**93**	**36**	**33**

Notes: RTD numbers in the table are rounded up the nearest integer. 1. 1km buffer is 0-1km from the Array area boundary, 2km, 1-2km, etc. 2. The predicted RTD numbers with displacement from EA1N and EA2 have been calculated based on the displacement gradients provided by NE (NE) and the observed displacement gradient from the London Array OWF (LA; APEM 2021a), for example at 9-10km from the array boundaries, the NE gradient predicts the proportion of birds displaced would be 0.29, so the predicted number remaining if the OWFs were present would be (1-0.29) x 14 = 10 (values rounded up to the nearest integer) . The predicted number of RTDs displaced is the abundance (KDE model outputs) – predicted number with displacement).

Table 4.16 Estimated abundance and displacement of RTDs from North Falls OWFs, 17 February 2018 (survey 2)

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)		Predicted number RTDs with displacement[2]		Predicted number RTDs displaced	
			NE (NE)	London array (LA)	NE Gradient	LA gradient	NE Gradient	LA gradient
0 (Array)	0	0	94.00	54.68	0	0	0	0
1	0	0	80.56	46.42	0	0	0	0
2	0	0	74.81	39.96	0	0	0	0
3	0	0	65.39	40.78	0	0	0	0
4	0	0	55.23	37.79	0	0	0	0

Array/ buffer[1] (km from array)	Area within SPA (km²)	RTD abundance (KDE model outputs)	Displacement gradient (% of RTDs predicted to be displaced)		Predicted number RTDs with displacement[2]		Predicted number RTDs displaced	
			NE (NE)	London array (LA)	NE Gradient	LA gradient	NE Gradient	LA gradient
5	4	0	50.80	32.29	0	0	0	0
6	10	1	44.80	33.98	0	1	0	0
7	11	1	42.30	35.83	1	1	1	1
8	13	3	40.68	40.68	2	2	2	2
9	15	7	45.01	45.01	4	4	3	3
10	17	10	41.90	41.90	6	6	4	4
11	18.	14	29.16	29.16	10	10	4	4
12	20	19	2.71	2.71	18	18	1	1
TOTALS	108	**52**			**39**	**39**	**13**	**13**
Notes: as for **Table 4.15**								

127. A summary of the predicted number of RTDs displaced within the OTE SPA during the two surveys in February 2018 is shown in Table 4.17 below. The predicted number of RTDs displaced is expressed as a percentage of the estimated total numbers within the SPA for a given survey (design based estimates, as described in Irwin *et al.* 2019), the mean of the two 2018 surveys, and the NE (2023a) SPA population estimate.

Table 4.17 Predicted number of RTDs displaced from OWFs and 12km buffers overlapping the OTE SPA from surveys in February 2018

OWF(s)	Survey date	Predicted # RTDs displaced from OWF(s)[2]		Estimated # RTDs within OTE SPA (95% CLs)[3]	% of estimated # in SPA	
		NE grad.	LA grad.		NE grad.	LA grad.
Operational OWFs[1]	4 Feb 2018	9,048	3,697	10,148 (7,868-12,544)	89%	37%
EA1N and EA2		17	17		0.16%	0.16%
North Falls		36	33		0.35%	0.32%
Total		9,100	3,746		90%	37%
Operational OWFs	17 Feb 2018	16,562	7,878	22,280 (15,611 – 29,784)	74%	36%
EA1N and EA2		13	13		0.06%	0.06%
North Falls		13	13		0.06%	0.06%
Total		16,587	7,903		74%	35%
Operational OWFs	Mean of two surveys	12,805	5,788	16,214 [Mean of estimated numbers in the SPA over the two surveys]	79%	36%
EA1N and EA2		15	15		0.09%	0.09%
North Falls		24	23		0.15%	0.14%
Total		12,843	5,824		79%	36%
Operational OWFs	Mean of two surveys	12,805	5,788	18,079 [SPA population estimate]	71%	32%
EA1N and EA2		15	15		0.08%	0.08%
North Falls		24	23		0.13%	0.13%
Total		12,843	5,824		71%	32%

1. The OWFs comprise London Array, Kentish Flats and Extension, Gunfleet Sands I, II and III; Thanet; and GGOW and GWF. 2. The predicted number of RTDs displaced are based on the KDE density surface for the 2018 surveys of the 2018 SPA, and application of the NE (2023b) gradient and the London Array (APEM 2021a) gradients. For operational OWFs the numbers are predicted by back-calculation, and for EA1N, EA2 and North Falls, by applying displacement gradients to the predicted numbers of RTDs present within the 12km buffers where these overlapped the OTE SPA. 3. Irwin *et al.* (2019) and NE (2023a).

128. Overall, it is predicted that a large proportion of the SPA population is subject to displacement from operational OWFs within 12km of the OTE SPA, particularly for the NE gradient, at 71-89% of the SPA population, and 32-37% using the London Array gradient. There is little data available to calibrate these predictions. Errors could arise if the predictions of RTD numbers within OWFs and 12km buffers within the SPA are inaccurate, and/or if the displacement gradients used do not accurately predict RTD displacement.

129. The KDE density surface which has been used to generate the abundance estimates is not a sophisticated modelling approach. Nevertheless, the KDE predictions for the numbers of RTDs in the SPA were a relatively close match to the design-based SPA population estimates for the two surveys in 2018[2].

130. The two RTD displacement gradients used are evidence based but may not be representative of displacement from all OWFs being considered, as redistribution after displacement may have a strong site-specific effect (Allen *et al.* 2020), may vary seasonally (Vilela *et al.* 2022), and may not be the same in all directions from an OWF (APEM 2021a, Vilela *et al.* 2020). Thus, applying a constant maximum displacement within 1km buffers, as for the NE (2023b) gradient, is likely to lead to over-estimation, as this is based on maximum displacement predictions from post-consent monitoring of a number of OWFs in different areas of the North Sea, such that displacement values from OWFs with the largest predicted displacement will be selected; and further overestimation may result from applying maximum displacement predictions in all directions from an OWF. The NE gradient does not include results from the post-construction monitoring of Burbo Bank Extension OWF, in the Liverpool Bay SPA, in the Irish Sea (Humphreys, 2020). NE commented that they '*looked at the Burbo Bank data but could not easily derive a displacement gradient from it, so it is not used in the proposed gradient calculation*'. Thus, the NE gradient excludes evidence from one UK study where displacement effects of an OWF on RTDs are less clear.

131. Some context for the back-calculated predictions of RTDs displaced from operational OWFs in February 2018 is provided by comparison with the post-construction monitoring study for the London Array (APEM 2021a). It is reported that '*The total relative difference in the modelled diver abundance within the* [London Array OWF] *and up to 11.5 km (noting the irregularity of the … survey areas in relation to the [OWF boundary]) was estimated to be 1,111 individuals which is 6.1% of the OTE SPA conservation objective population size of 18,079'*. This refers to the difference between the numbers of RTDs present within the OWF array area and an 11.5 km buffer, within the core study area, during the post-construction period (2013-2016) compared with the pre-construction period (2010-2011). The core study area for the London Array comprised the turbine array and areas extending up to 15km to the northeast and southwest but did not cover all of the areas within a 12km buffer of the London Array, and thus the post-construction monitoring study does not provide an estimate of the total number of RTDs predicted to be displaced within the 12km buffer. The study results

[2] KDE estimates for the Outer Thames Estuary SPA on 4th and 17th February 2018 respectively were 9,185 and 21,003, compared with the design based estimates of 10,148 and 22,280 (Irwin *et al.* 2019).

suggested that displacement of RTDs with distance might vary in different directions from the London Array OWF such that extrapolating the displacement results for the study area to the entire buffer around the turbine array could introduce bias into the predictions.

132. The predicted 1,111 RTDs displaced from the London Array (array area and part of the 12km buffer as described above) during the post-construction monitoring study represents 19% of the predicted mean of 5,788 birds displaced from the array areas and 12km buffers of operational OWFs overlapping the OTE SPA in February 2018 based on the London Array gradient (Table 4.17), and 9% of the predictions for the same OWFs from the NE gradient (12,805).

133. The displacement gradient from the final post-construction monitoring report for the London Array (APEM 2021a) is an evidence-based gradient from an OWF within the OTE SPA, near North Falls. However, while this is a relatively detailed study, it is apparently based on only one baseline year of pre-construction data compared with three years post-construction, and so has little potential to account for between-year variation in abundance and distribution (noting that a baseline of at least two years is recommended for OWFs, e.g. Allen *et al.* 2020). It presents combined estimates of abundance for three years of post-construction data which may mask variation in RTD numbers, distribution and extent of displacement between individual years and between seasons in a given over-winter period. CLs are included in plotted figures but are not included with the modelled abundance estimates for divers in Appendix 8 of the report (APEM, 2021a) which have been used to derive the gradient.

134. The model of RTD distribution and displacement from OWFs, developed for EA1N and EA2, predicted a worst case in-combination total of 1,433 RTDs at risk of displacement within the OTE SPA, from operational OWFs plus EA1N and EA2 ((MacArthur Green and Royal HaskoningDHV 2021b).

135. Based on the displacement predictions from the February 2018 surveys, the estimated number of RTDs that would suffer mortality at rates of 1% and 10%, and the corresponding percentage increase in the population mortality rate, is shown in Table 4.18. The mean number of birds predicted to be displaced is 5,824 using the London Array gradient and 12,843 using the NE gradient. At 1% mortality of displaced birds, the mean predicted increase in the baseline annual mortality rate of the SPA population is 1% for the London Array gradient and 3% for the NE gradient, at 10% mortality the respective means are 14% and 30%.

Table 4.18 Predicted annual displacement mortality of RTDs from OWFs and 12km buffers overlapping the OTE SPA, and increase in population mortality rate

Survey date	4 Feb 2018		17 Feb 2018		Mean of surveys	
	NE displ. Gradient	London Array displ. Gradient	NE gradient	London Array gradient	NE gradient	London Array gradient
Predicted annual displacement (no. of RTDs)[1]						
Operational OWFs	9,048	3,697	16,562	7,878	12,805	5,788
EA1N and EA2	17	17	13	13	15	15
North Falls	36	33	13	13	24	23

Survey date	4 Feb 2018		17 Feb 2018		Mean of surveys	
	NE displ. Gradient	London Array displ. Gradient	NE gradient	London Array gradient	NE gradient	London Array gradient
Total	**9,100**	**3,746**	**16,587**	**7,903**	**12,843**	**5,824**
Predicted annual displacement mortality (number of RTDs)[1]						
1% mortality of displaced birds						
Operational OWFs	91	37	166	79	128	58
EA1N and EA2	1	1	1	1	1	1
North Falls	1	1	1	1	1	1
Total	91	38	166	79	129	59
10% mortality of displaced birds						
Operational OWFs	905	370	1,657	788	1,281	579
EA1N and EA2	2	2	2	2	2	2
North Falls	4	4	2	2	3	3
Total	**910**	**375**	**1,659**	**791**	**1,285**	**583**
Predicted % increase in population mortality rate[2]						
1% mortality of displaced birds						
Operational OWFs	2	1	4	2	3	1
EA1N and EA2	0.00	0.00	0.00	0.00	0.00	0.00
North Falls	0.01	0.01	0.00	0.00	0.01	0.01
Total	**2**	**1**	**4**	**2**	**3**	**1**
10% mortality of displaced birds						
Operational OWFs	21	9	39	19	30	14
EA1N and EA2	0.04	0.04	0.03	0.03	0.03	0.03
North Falls	0.08	0.08	0.03	0.03	0.06	0.06
Total	**22**	**9**	**39**	**19**	**30**	**14**
1. Numbers of RTDs presented are rounded up to the nearest whole bird; calculations are however based on the actual numbers (i.e. not rounded up). 2. Based on an SPA population of 18,079 non-breeding individuals of all age classes and an average annual mortality rate across age classes of 0.233						

136. EA1N and EA2 OWFs have been consented subject to compensation measures for RTD, which includes diversion of the routes of vessels associated with East Anglia THREE and East Anglia ONE OWFs during the non-breeding season, to reduce shipping disturbance within the SPA. Implementation of these measures

will be overseen by a RTD compensation steering group and measures will be subject to ongoing monitoring (BEIS 2022a). Assuming that the reduction in shipping disturbance within the SPA offsets the predicted displacement mortality of RTDs from EA1N and EA2, then the combined predicted displacement from these OWFs can be deducted from the total. Based on the mean of predicted displacement from the 2018 survey data, the predicted number of RTDs displaced annually would be reduced by 23-24 birds, and the predicted displacement mortality would be reduced by 1 bird at 1% mortality of displaced birds, and 2 birds at 10% mortality of displaced birds. However, these reductions are very small in the context of the number of predicted displacement mortalities from operational OWFs from the 2018 survey data, and would not change the predicted increases in the mortality of RTDs in Table 4.18.

137. Based on the predicted displacement mortality from the 2018 survey data, the increase in population mortality rates for RTDs from the in-combination prediction is at levels where there could potentially be a population effect. A population model has, however, not been run for this species, based on the lack of evidence of a population effect on RTDs within the OTE SPA due to displacement from OWFs. As noted above, the population estimate has increased by 180% from 6,466 non-breeding individuals for the period 1989-2007, to 18,079 individuals for 2013-2015 (Section 4.4.1.4.1). It is possible, but unknown, whether the increase is wholly accounted for by the change of survey method between the two time periods, from visual aerial surveys to digital aerial surveys. It seems highly unlikely however that there has been a decrease in the SPA population over this period, particularly given the increase in estimates between 2013 and 2018 (both of which used digital aerial survey methods). At the time the SPA was first classified in 2010, Scroby Sands[3] and Kentish Flats OWFs had been operational since 2004 and 2005 respectively, and Gunfleet Sands I and II were in construction (NE and JNCC 2010). Since then, Gunfleet Sands III, GGOW, London Array and Kentish Flats Extension OWFs have been constructed and commissioned. Thus, although the number of OWFs within and close to the SPA boundary (and hence also the potential displacement effects) have increased, there is no evidence for decline in the SPA population and it is possible that the population has increased. This suggests that displacement from OWFs has not affected the population size of RTD within the SPA. While NE has cautioned against making any assumptions about trends in the SPA population of RTD given changes in survey methodology (see Section 4.4.1.4.1 above), they have commented, in response to the outline EIA and HRA methodology for North Falls, that '*for red throated diver from the Outer Thames Estuary SPA, impacts on mortality will not be the main issue, but the other factors such the reduction in available habitat, and changes in distribution of the interest feature will be more important*'.

[3] Scroby Sands has not been considered in the shadow in-combination assessment presented here, as it was not included in the list of OWFs advised by Natural England (2022d).

138. Similarly, as discussed above (paragraphs 83 to 85), in the German North Sea, a long-term study found that the abundance of divers during the spring migration period (when peak numbers of birds were present) remained stable between 2001 and 2021 (there were fluctuations but no overall trend), despite this coinciding with OWF construction in this area expanding from 1 to 20 OWFs between 2009 and 2018 (Vilela *et al.* 2021), and from 12 WTGs in 2009 to 1,268 in early 2022 (Vilela *et al.* 2022).

139. Further, a review of the potential effects of displacement on RTD survival reported evidence that populations are limited by availability of suitable breeding habitat (nesting sites within range of foraging areas), rather than competition for resources during the non-breeding season (MacArthur Green 2019a).

140. Given the above, it is considered unlikely that displacement from OWFs is causing adverse effects on the population size of RTD of the OTE SPA. The predicted contribution of North Falls to any in-combination displacement effect is extremely small and considered to be non-material compared to that of existing operational OWFs. Therefore, it is concluded that, for North Falls there is no meaningful contribution to any potential adverse in-combination effect on the OTE SPA in relation to this conservation objective.

141. Displacement from OWFs may, however, also affect the distribution of RTDs within the SPA, by reducing densities in areas within and close to the array areas. As for the project alone, the assessment considers the extent of the SPA where RTDs would be subject to some level of displacement (the displacement area), and the extent of effective displacement (the area of overlap weighted by the predicted proportion of birds displaced at different distances from OWFs).

142. Overlap between the 12km buffers of OWFs and the SPA boundary occurs mostly in the southern component of the SPA (Figure 4.3). This is also the area where RTDs were recorded at highest densities in both SPA surveys flown in February 2018 (Irwin *et al.* 2019). In the 2013 SPA surveys, the highest numbers were recorded in the northern components of the SPA in the January survey, and in the southern component in February (APEM 2013).

143. The in-combination displacement area and the area of effective displacement are shown in Table 4.19, with and without North Falls. Excluding North Falls, the total area of the SPA within 12km of an OWF is 1932.32 km^2, representing 49% of the total SPA area. Including the overlap of the North Falls 12km buffer with the SPA brings the total to 1986.7 km^2, 51% of the SPA area. This is the area of the SPA over which RTDs are considered to be subject to some degree of displacement from OWFs.

144. The effective displacement area is an estimate of the area effectively lost from the SPA due to predicted displacement within and at varying distances from OWFs (see paragraph 104 above, and note NE concerns about this metric). Without North Falls, this is estimated at 692.78 km^2 using the displacement gradient from the London Array OWF, and 926.79 km^2 using the gradient advised by NE (2023b), which accounts for 18 and 24% of the SPA area, respectively. Including North Falls increases these totals to 718.56 and 955.12 km^2, respectively, but these increases are so small relative to the overall SPA area that they do not change the associated percentage values when expressed to the nearest integer (Table 4.19). This is because the additional effects from North

Falls only occur from the 4-5km buffer outwards, where the displacement rates are predicted to be considerably lower than in areas within and closer to OWFs.

Table 4.19 In-combination displacement area and effective displacement area for the OTE SPA, with and without North Falls

Buffer Distance from OWFs (km)	Displacement Area (Area of SPA Overlap, km^2)[1]		% RTD Displaced[2]		Effective Displacement[3] without North Falls (km^2)		Effective Displacement with North Falls (km^2)	
	Without North Falls	With North Falls	NE Gradient	London Array Gradient	NE	London Array	NE	London Array
0 (within OWF)	158.73	158.73	94.00	54.68	149.20	86.79	149.20	86.79
0 -1	90.15	90.15	80.56	46.42	72.63	41.85	72.63	41.85
1 – 2	103.83	103.83	74.81	39.96	77.67	41.49	77.67	41.49
2 – 3	117.03	117.03	65.39	40.78	76.52	47.72	76.52	47.72
3 – 4	131.14	131.14	55.23	37.79	72.43	49.56	72.43	49.56
4 – 5	141.62	145.77	50.80	32.29	71.94	45.73	74.05	47.07
5 – 6	150.31	159.98	44.80	33.98	67.34	51.08	71.67	54.36
6 – 7	162.13	173.47	42.30	35.83	68.58	58.09	73.38	62.16
7 – 8	154.29	167.34	40.68	40.68	62.76	62.76	68.07	68.07
8 – 9	165.43	179.36	45.01	45.01	74.46	74.46	80.73	80.73
9 – 10	176.42	188.45	41.90	41.90	73.92	73.92	78.96	78.96
10 – 11	185.25	188.02	29.16	29.16	54.02	54.02	54.83	54.83
11 – 12	196.00	183.44	2.71	2.71	5.31	5.31	4.97	4.97
Totals	1932.32	1986.70			926.79	692.78	955.12	718.56
% SPA area[4]	49	51			24	18	24	18

1. Measurements of the overlap between OWF buffers and the SPA take account of areas of overlap between the buffers of more than one OWF, prioritising the OWF which is closest, so no area is counted twice. 2. Gradients provided by NE, and the post-construction monitoring study of the London Array OWF. 3. Effective displacement is the area of SPA overlap for a given buffer multiplied by the % of RTDs predicted to be displaced. 4. The total SPA area is 3924km^2.

145. The HRA for EA1N (BEIS 2022a) states that before considering the effects of this development, NE were concerned that there is already an adverse effect on the OTE SPA from the displacement of RTDs from existing OWFs, and that 31% - 47% of the SPA area was already affected (it is understood that these percentages refer to the displacement area as estimated at the time by the Applicant and NE and not the effective displacement area). NE advised that a change in the distribution of this species within the SPA was incompatible with meeting the conservation objective to maintain diver distribution and that this would constitute an AEoI of the SPA. The Secretary of State agreed with this advice and concluded that, based on the EAIN boundary at the time, which was 2km from the SPA boundary, an adverse effect on the SPA could not be excluded as a result of displacement of RTDs from EA1N alone and in-combination with other OWFs. The development was subsequently consented subject to no WTGs being permitted within 8km from the SPA; and compensation measures comprising: management of vessel traffic for East Anglia THREE and East Anglia ONE OWFs to reduce traffic through the SPA, monitoring RTD distribution within the SPA to determine the extent of RTD redistribution; and the establishment of a RTD compensation steering group to identify and implement opportunities for reducing disturbance effects on this species at a strategic level. EA2 was also consented subject to the same compensation measures as EA1N, although in this case no effective change was made the array area boundary, situated 8.3km from the SPA boundary (BEIS 2022b).

146. The conclusion of the HRAs for EA1N and EA2, indicates that the SoS considers there is an existing adverse effect on the distribution of RTDs in the SPA due to the in-combination effects of OWFs.

147. Importantly, however, North Falls makes a very small addition to the in-combination effect from other OWFs, increasing the displacement area by just 2% and the effective displacement area by <1%, when added to the effects of other existing (operational and consented) OWFs (Table 4.19), with the increase in the area over which displacement may potentially occur being associated with the more distant parts of the North Falls 12km buffer within which the predicted displacement rate is low. Further, as described above, all of the overlap between the 12km buffer of North Falls and the SPA also overlaps with existing sources of displacement for RTDs – IMO ship-routeing measures and / or the 12km buffer of another OWF (paragraph 110 above), so that the 12km buffer North Falls does not impact any area of the SPA not already potentially subject to a source of disturbance for RTDs.

148. As noted above, the estimated in-combination displacement mortality is provided as context for the assessment. Given the conclusion that the Project would make no material contribution to the in-combination mortality, there would be no contribution to any adverse effect on integrity to the OTE SPA.

149. Nevertheless, the RIAA presented with the ES for North Falls is accompanied by a without prejudice report on potential compensation measures for RTDs at the OTE SPA.

4.4.1.5 Common tern

150. Common tern from this SPA has been screened in for appropriate assessment due to potential connectivity during the non-breeding (migration) seasons and risk of a collision effect. This applies in relation to the North Falls array area during the operational period (HRA Screening Report, Appendix 1.1, Document Reference: 7.1.1.1).

4.4.1.5.1 Status

151. The OTE SPA protects marine foraging areas for common terns breeding at Foulness SPA, Breydon Water SPA and Scroby Sands, the latter considered to be functionally linked with Breydon Water. At the time of classification, the OTE SPA population was cited as 532 breeding individuals, based on monitoring data from 2011-15 (NE and JNCC 2015). Assuming an annual baseline adult mortality rate of 0.117 (Horswill and Robinson, 2015), 63 breeding adults contributing to the SPA population would be expected to die each year.

4.4.1.5.2 Connectivity and seasonal apportionment of potential effects

152. During the spring and autumn migration periods, common tern breeding at this SPA migrate through UK waters. There is potential connectivity as the North Falls offshore project area is within the UK North Sea and Channel Biologically Defined Minimum Population Scale (BDMPS), as identified by Furness (2015), consisting of 144,911 individuals during migration seasons (late July to early September, and April to May) (Furness, 2015).

153. Based on the SPA population of 532 breeding adults, and a contribution of 70% of SPA adults into the UK North Sea and Channel BDMPS (following 'UK North Sea non-SPA colonies' value for common tern in Furness 2015), 0.26% of the birds occurring in the UK North Sea and Channel BDMPS during the migration seasons, are estimated to be breeding adults from the OTE SPA (noting that this is a likely over-estimate as adults contributing from this SPA include individuals already counted as contributing from the breeding populations of Breydon Water SPA or Foulness SPA in Furness (2015)). Common tern was recorded in the North Falls array area in August only and in the wider survey area in April, May, July, August and September during baseline digital aerial survey programme of the North Falls array area and surrounding buffer areas. These months fall within the species' autumn and spring migration periods, and outside of the species' core 'migration-free' breeding season of June to mid-July as defined by Furness (2015).

4.4.1.5.3 Effect: Collision risk during operation

4.4.1.5.3.1 Project alone assessment

154. During migration seasons, the number of common tern at risk of colliding with turbines at North Falls annually was modelled using the Band (2012) collision risk tool 'Migrant Collision Risk' sub-tool and flight height Option 2 to be 2.53 individuals (95% CL 1.14 – 4.28), based on the maximum-likelihood flight height distributions (and lower and upper 95% CL flight height distributions of common tern from Johnston *et al.* (2014a,b).This modelling assumed 100% of the UK North Sea and Channel BDMPS migration period population (Furness, 2015) undertaking migration within a 10km band from the coast (Wernham *et al.* 2002, WWT and MacArthur Green 2014) – and that this band traverses the mouth of the OTE (under this scenario the 10km band potentially overlaps North Falls). Modelling also assumed an avoidance rate of 0.990. Assuming the percentage

contribution of the SPA to the BDMPS above, 0.007 collisions per year (95% CLs 0.003 – 0.011) are attributable to the OTE SPA. This equates to a 0.01% increase from baseline mortality.

155. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.1.5.3.2 In-combination assessment

156. Common tern migration activity is considered to take place predominantly within 10km from the coast (Wernham *et al.* 2002, WWT and MacArthur Green 2014), such that low numbers of birds, and hence collisions, might be expected at OWFs further from the coast. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the OTE SPA is expected to be very low. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.2 Alde-Ore Estuary SPA and Ramsar site

4.4.2.1 SPA overview

157. Situated on the east Suffolk coast, the Alde Ore Estuary SPA and Ramsar site covers an estuary complex of the rivers Alde, Butley and Ore, including Havergate Island and Orfordness. The designated site supports a variety of habitats for breeding and wintering birds within its boundary, including vegetated shingle, intertidal mudflats, semi-improved grazing marsh, saltmarsh and saline lagoons.

4.4.2.2 Conservation objectives

158. The SPA's conservation objectives are to 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; and
- The distribution of qualifying features within the site.

159. Supplementary advice on the conservation objectives for the AOE SPA, from NE's designated sites view, is referred to in the assessment below.

4.4.2.3 Shadow Appropriate Assessment

160. The following qualifying features have been screened in for appropriate assessment (Table 4.5):

- Sandwich tern, breeding
- Lesser black-backed gull, breeding

- Avocet, breeding and non-breeding
- Marsh harrier, breeding
- Redshank, non-breeding
- Ruff, non-breeding
- Assemblage of breeding and wintering wetland birds

4.4.2.4 Sandwich tern

161. Sandwich tern from this SPA has been screened in for appropriate assessment due to potential connectivity during the breeding and non-breeding (migration) seasons and risk of collision and displacement/barrier effects. This applies in relation to the North Falls array area during the operational period (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.4.2.4.1 Status

162. The 1996 AOE SPA breeding population is cited as 170 pairs of Sandwich tern (the year the site was designated) (JNCC Standard Data Form 2011). NE (2023d) notes that the main SPA colony on Havergate Island disappeared in 1997, and the species has since only nested elsewhere in the SPA and only in some years, with a maximum of 15 pairs in 2003. Monitoring in 2004 and 2009 both recorded just two pairs while monitoring in 2006, 2007 and 2008 counted zero pairs (Furness, 2015). Monitoring of the SPA area in 2018 counted zero Apparently Occupied Nests (AON) (Seabird Monitoring Programme (SMP) database, accessed Jan 2024). Thus, no records of Sandwich tern breeding within the SPA have been found after 2009.

163. The Sandwich tern population of the SPA is subject to a target to restore the size of the breeding population although no numerical target has been set, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent (NE 2023d).

4.4.2.4.2 Connectivity and seasonal apportionment of potential effects

164. During the breeding season, the MMFR +1 SD of Sandwich tern is identified as 34.3km (+ SD 23.2km) (Woodward *et al.* 2019). At a distance of 39.1km from AOE SPA, North Falls array area is outside the MMFR but within the MMFR +1 SD of Sandwich tern. Sandwich tern was recorded during April and May survey visits within the baseline digital aerial survey programme of the North Falls array area and surrounding buffer areas, and these months fall within the species' breeding season in UK waters (April to August, Furness 2015). Therefore, there is potential connectivity to AOE SPA for a collision risk effect pathway during the breeding season.

165. During the spring and autumn migration periods, breeding Sandwich tern from this SPA migrate through UK waters. There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS, as identified by Furness (2015), consisting of 38,051 individuals during migration seasons (July to September, and March to May) (Furness, 2015).

166. Based on the data in Appendix A to Furness (2015), on the contributions of UK SPA and non-SPA populations and overseas populations to each BDMPS, 0.01% of the birds occurring in the UK North Sea and Channel BDMPS during the migration seasons, were estimated to be breeding adults from the AOE SPA.

Sandwich tern was recorded during surveys in April, May and September during baseline digital aerial survey programme of the North Falls array area and surrounding buffer areas, and only in September within the array area. These months fall within the species' migration periods (Furness, 2015).

4.4.2.4.3 Effect: Collision risk during operation

4.4.2.4.3.1 Project alone assessment

167. No Sandwich tern collisions with turbines at North Falls have been predicted in the breeding season (no birds were recorded in flight in the breeding season during baseline digital aerial surveys ES Appendix 13.2 (Document Reference: 3.3.13).

168. During migration seasons, the number of Sandwich tern at risk of colliding with turbines at the North Falls array area annually was modelled using the Band (2012) collision risk tool 'Migrant Collision Risk' sub-tool and flight height option 2 to be 0.71 individuals, based on the UK North Sea and Channel BDMPS migration period population (Furness, 2015) and maximum-likelihood flight height distributions of Sandwich tern from Johnston *et al.* (2014a,b) (0.58 – 2.12 when using respective lower and upper 95% CL flight height distributions), and assuming migration within a 10km band from the coast (Wernham *et al.* 2002, WWT and MacArthur Green 2014) (and this band traversing the mouth of the Thames estuary) and an avoidance rate of 0.990. Assuming the percentage contribution of the SPA to the BDMPS above, zero collisions per year (0.0 – 0.0) are attributable to the AOE SPA and there would be no increase in baseline mortality (and given no breeding of the species has been recorded at the SPA since 2009, it is considered there would be no breeding adults from the SPA contributing to the BDMPS).

169. As noted above, the SPA population is subject to a restore target, although no numerical target has been set. Should the population recover, it is possible that Sandwich terns from the SPA could occur at the North Falls array area during the breeding season and suffer collisions. However, given that the array area is outside the MMFR of this species (but within MMFR + 1SD), it is likely that most or all foraging trips from any SPA population would not extend as far as the array area. Modelling of the foraging distribution of Sandwich terns from breeding colonies, based on tracking data, found that most use was made of coastal waters either side of the colony; the majority of the area used was confined to an area less than that encompassed by MMFR, such that the MMFR would correctly identify areas used but would also include large areas of relatively low importance and be rather precautionary (NE and JNCC 2015; Wilson *et al.* 2014). Thus, collision risk at North Falls would not affect the potential for population recovery at the AOE SPA.

170. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of Sandwich tern at North Falls.

4.4.2.4.3.2 In-combination assessment

171. The collision predictions at North Falls are zero. This means that the operational phase of North Falls would not adversely affect the integrity of the AOE SPA both alone and in-combination with other projects.

4.4.2.4.4 Effect: Displacement / barrier effects during operation

4.4.2.4.4.1 Project alone assessment

172. The number of Sandwich tern potentially subject to displacement and barrier effects from the North Falls array area in the breeding season (based on densities of birds within the array area during baseline digital aerial surveys) is zero. Therefore, the displacement / barrier effects attributed to the AOE SPA during the breeding season are also zero, so there would be no increase in baseline mortality.

173. During migration seasons, the number of Sandwich tern at risk of displacement and barrier effects from the North Falls array area (based on a mean peak density of 0.068 (95% CLs 0 – 0.383) birds within the array area (95.41km^2) during baseline digital aerial surveys) is 7 (95% CL 0 – 36).

174. Assuming the percentage contribution of the SPA to the BDMPS above, the number of Sandwich tern from AOE SPA potentially displaced or experiencing a barrier effect is zero. There would be no increase in baseline mortality.

175. Due to zero individuals from the SPA being likely to experience displacement or barrier effects during migration seasons, no adverse effect on integrity is predicted for this SPA due to displacement or barrier effects of Sandwich tern.

176. As noted above, the SPA population is subject to a restore target, although no numerical target has been set. Should the population recover, it is possible that Sandwich terns from the SPA could occur at the North Falls array area during the breeding season and suffer displacement. However, given that that array area is outside the MMFR of this species (but within MMFR + 1SD), it is likely that most foraging trips from any SPA population would not extend as far as the array area. As for collision risk (above) displacement at North Falls would not affect the potential for population recovery at the AOE SPA.

4.4.2.4.4.2 In-combination assessment

The displacement and barrier effect predictions at North Falls are zero. This means that the operational phase of North Falls would not adversely affect the integrity of the AOE SPA both alone and in-combination with other projects.

4.4.2.5 Lesser black-backed gull

177. Lesser black-backed gull has been screened into the shadow Appropriate Assessment in relation to operational collision risk during the breeding and non-breeding season (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.4.2.5.1 Status

178. The SPA citation at classification in 1986 does not provide details of the numbers of lesser black-backed gulls present, but states that an internationally important population was present. Supplementary advice on NE’s designated sites view (NE 2023d) indicates that the four-year peak mean population at the AOE SPA in the period 1994-1997 was 14,070 breeding pairs (derived from the SMP database), numbers increased to a peak of 23,400 pairs in 2000, but then declined substantially with a five-year peak-mean for 2011-2015 of 1,940 breeding pairs.

179. The primary cause of the decline has been reported to be large-scale abandonment of breeding colonies in response to predation by foxes (Ross-Smith *et al.* 2014a; Mavor *et al.* 2001, 2003), with other possible factors including flooding events, vegetation changes that make the habitat less suitable for breeding gulls, disturbance by non-predatory species (e.g. Chinese water deer), human disturbance and reductions in fisheries discards. The decline has also taken place against a backdrop of large-scale immigration of breeding lesser-black backed gulls to urban environments, where productivity is generally higher (Ross-Smith *et al.* 2014a).

180. NE has set a target to restore the size of the breeding population to a level which is above 14,074 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. As part of compensation measures agreed for the Norfolk Boreas, Norfolk Vanguard, EA1N and EA2 OWFs, a six hectare enclosure with predator exclusion fencing was established at Orford Ness in 2023, to provide nesting habitat for lesser black-backed gulls free from predation and disturbance.

181. Trends in the numbers of lesser black-backed gulls breeding at the AOE SPA are shown in Plate 4.1 (data from SMP, accessed January 2024). This shows nesting numbers at the two main colonies within the SPA: Orford Ness and Havergate Island; since the mid-1980s. Between 1986 and 2008, the largest numbers bred at Orford Ness, increasing from about 5,000 pairs to a peak of 23,000 in 2000, then declining rapidly to around 5,000 pairs per year until 2006, and thereafter to a very low level. Numbers at Havergate were very low until 2006, after which they began to increase such that this site now holds the majority of the SPA population. Havergate Island is an RSPB reserve where management for breeding lesser black-backed gull is a priority.

182. Counts of breeding lesser black-backed gull within the AOE SPA, for the most recent ten-year period, are shown in Table 4.20. Most data derive from the SMP database, with three counts from alternative sources (see table notes). There are no data for Orford Ness in the SMP since 2019. Based on the data (Table 4.20), the ten-year mean for the SPA is 1,814 breeding pairs, or 1,880 breeding pairs considering only years when data for both Havergate and Orford Ness were available. NE (2023d gives 1,940 breeding pairs as the most recent count for the SPA (as above) and downloaded SPA data from the Seabirds Count (Burnell *et al.* 2023) gives 1,767 pairs for the SPA (based on the 2018 count for Orford Ness and the 2019 count for Havergate).

183. For the purposes of the assessment below, the SPA reference population is taken as 1,880 breeding pairs or 3,760 breeding adults. This is considered the most appropriate value as it is based on the most recent years when data from the two main lesser black-backed gull breeding colonies is available.

Table 4.20 Counts of breeding lesser black-backed gulls at the AOE SPA since 2014

Year	Number of breeding pairs of lesser black-backed gull (AON/Pairs)		
	Havergate Island	Orford Ness	SPA
2014	2070	37	2107
2015	2399	60	2459

Year	Number of breeding pairs of lesser black-backed gull (AON/Pairs)		
	Havergate Island	Orford Ness	SPA
2016	1668	91	1759
2017	1714	239	1953
2018	1327	97	1424
2019	1670	-	1670
2020	*1775*	-	1775
2021	1511	*210*	1721
2022	1533	-	1533
2023	1524	*213*	1524
Mean, all years			1814
Mean of years with data from both Havergate and Orford Ness	1880		
Data are all from SMP database (accessed 28 February 2024), except for numbers in italics: Havergate 2020 and Orford Ness 2023 from RSPB Havergate Island team, Orford Ness in 2021 from https://www.bbc.co.uk/news/uk-england-suffolk-61324019; AON = Apparently Occupied Nest, taken as equivalent to the number of breeding pairs.			

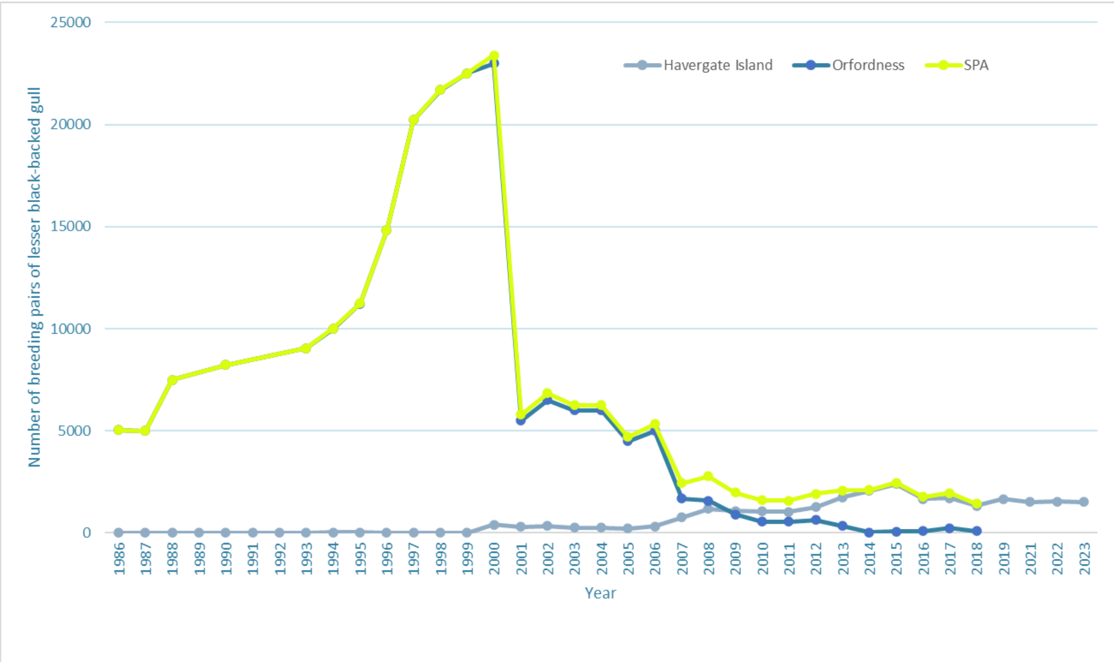

Plate 4.1 Number of breeding lesser-black backed gulls breeding at the AOE SPA since 1986 (showing the two breeding colonies at Havergate Island and Orford Ness separately and the SPA total). Data from SMP database (accessed February 2024)

4.4.2.5.2 Functional linkage and seasonal apportionment of potential effects

4.4.2.5.2.1 Breeding season

184. The North Falls array area is situated 39.1km from the AOE at the nearest point. This is within MMFR + 1SD of lesser black-backed gull (127 ± 109km) from the SPA; as reported by Woodward *et al.* (2019) based on data from 9 studies involving 18 colonies.

185. A three-year tracking study of lesser black-backed gulls breeding at Orford Ness in the AOE (Thaxter *et al.* 2015) indicates that the foraging ranges (as defined by the 95% Kernel Density Estimation of the utilisation distribution) of tagged birds overlapped with the array area in only one out of the three breeding seasons encompassed by this study. Birds were tagged after capture at the nest site during early-incubation in 2010 and 2011, and over the three years the study covered the pre-breeding (February to May), breeding (May to July) and post breeding (July to October) periods. The study reported mean offshore foraging ranges (lesser black-backed gulls also forage to a substantial extent in coastal and terrestrial habitats) in 2010, 2011 and 2012 of respectively 33.5 ± 16.1 km (0.4-158.7), 25.1 ± 10.9 km (0.8–124.0) and 14.7 ± 5.7 km (0.4-158.5). Woodward *et al.* (2019) report mean and maximum foraging ranges for birds breeding at Orford Ness of 49.9 km and 124 km based on combined tracking data from the British Trust for Ornithology (BTO) and RSPB (which it is assumed includes the data published in Thaxter *et al.* 2015).

186. A further tracking study of 30 lesser black-backed gulls breeding at Havergate Marshes within the SPA was undertaken in 2019 and 2020 (Green *et al.*, 2021), under the ornithological monitoring programme for GWF. The tracks of respectively 19 and 11 individuals in 2019 and 2020 overlapped with operational OWFs, mainly GGOW and GWF, indicating use during day and night-time. Figures showing the movements of tracked birds show that some individuals also passed through the area identified for the North Falls array. In 2019, 4.30% of the 95% Utilisation Distribution calculated for all tracked birds overlapped with operational or under-construction OWFs, while in 2020, 0.98% of the 95% Utilisation Distribution overlapped with operational OWFs but there was no overlap with OWFs under-construction. Lesser black-backed gulls tend to forage offshore more during chick provisioning, and the lower overlap with OWFs in 2020 was attributed to the poor breeding success of birds at Havergate and, hence, lesser requirements to forage offshore. Within GGOW and GWF offshore substations/ service platforms (but not turbine bases) were used regularly as resting/perching locations. Analysis of movements within the turbine arrays indicated significant meso-avoidance of turbine rows. In 2019, the average offshore foraging range of tracked birds was 31.5 ± 27.0 km, and in 2020, 21.3 ± 19.1 km, which was similar to the estimates generated in the earlier tracking study from 2010 to 2012 (see above).

187. North Falls is not within breeding season foraging range of any other SPA colonies, however there are a number of other (non-SPA) breeding colonies of lesser black-backed gulls within potential foraging range, mostly in urban areas.

188. Recent count data for non-SPA sites in this area are not consistently available in the SMP database. A survey of Suffolk and south Norfolk in 2012 (Piotrowski 2013) reported an estimated 2,882 pairs in urban sites. While these counts are 12 years old, they all date from the same year and have been used here for

estimating the proportion of lesser black-backed gulls recorded at North Falls from the SPA breeding population, and other non-SPA breeding populations. A breakdown is given in Table 4.21 below.

189. Gulls nesting in urban environments (often on elevated surfaces such as flat roofs) are more difficult to count accurately than in natural sites (Burnell 2021, Ross *et al.* 2016), and abnormally wet and cold weather in April and May 2012 was likely to have caused premature failure of some nests, so the estimate from Piotrowski (2013) is likely to be conservative. In the context of an ongoing increase in occupation of urban habitats by nesting lesser black-backed gulls (Burnell 2021), it is assumed that the 2012 data are likely to represent a minimum estimate of the current urban nesting population in the area surveyed in 2012.

190. A review by MacArthur Green of nesting habitats used by lesser black-backed gulls in East Anglia (Royal HaskoningDHV, 2019a) indicated that the AOE held about 98% of the regional breeding population in 1985-96, 89% in 2000, and about 31% in 2012-2016; it was acknowledged that gulls breeding in urban areas may be perceived as a nuisance and subject to control measures, but any reductions in numbers may be temporary until birds find alternative urban sites where they are tolerated. Based on national-scale surveys for urban nesting gulls in 2019 and 2020, using a new survey methodology, it was estimated that two-thirds to four-fifths of the overall English breeding population of lesser black-backed gulls now nest in urban areas (although confidence around these estimates is poor), compared with previous estimates of <10% in 1994 and about 10% around the turn of the century (Burnell 2021, Raven and Coulson 1997). Mapped estimates of mean nesting numbers per 1km square in urban environments in 2019 and 2020 indicate several areas of high density in Suffolk and south Norfolk (Burnell 2021). Thus, it seems likely that the percentage of the regional population of lesser black-backed gulls nesting at the AOE SPA will have decreased further since 2012-2016.

191. Lesser black-backed gulls do not forage only or even predominantly at sea, but also in coastal and terrestrial environments, although there is evidence from some studies that breeding adults may spend more time foraging offshore during chick-rearing, perhaps to meet dietary needs of growing chicks (e.g. Thaxter *et al.* 2015, Royal HaskoningDHV, 2019a). There are relatively few published tracking studies of urban-breeding lesser black-backed gulls. A review of available data, including information from unpublished studies, concluded that urban nesting gulls from some colonies spend time foraging at sea, although it is not clear whether the proportion of time spent at sea is different to that of gulls breeding at natural coastal sites (Royal HaskoningDHV, 2019a). A comparative study of lesser black-backed gulls breeding in neighbouring coastal urban and natural coastal habitats in Cumbria (Langley *et al.* 2022) showed that birds from both breeding colonies spent a small proportion of foraging time in marine habitats, in both cases utilising marine areas at lower rates than would be expected compared with their availability within foraging range. The predominant habitats used were agricultural and coastal (coastal nesting birds) and agricultural, coastal and urban (urban nesting birds), with coastal birds apparently showing a preference for coastal habitats, and urban nesting birds a preference for urban and coastal habitats. Data on the percentage of time spent in different habitats is not presented in Langley *et al.* (2022), apart from bar charts showing

the proportion of gull foraging trip location fixes assigned to seven different habitats. From these it is estimated that about 10% or less of foraging trip fixes were in marine habitats for both coastal and urban nesting birds in 2017 and 2018. Lesser black-backed gulls nesting at Orford Ness spent respectively 14.1 (± (SD) 15.3), 6.2 (±7.0) and 7.7 (± 4.9) % of their time offshore in 2010, 2011 and 2012 (Thaxter *et al.*, 2015).

192. Thus, lesser black-backed gulls recorded in the array area during the breeding season are likely to include birds from the AOE SPA as well as other non-SPA breeding colonies in Suffolk and south Norfolk.

193. NatureScot (2018) guidance on apportioning impacts from OWFs to breeding colonies has been used to estimate the proportion of lesser black-backed gulls from each breeding site likely to occur in the North Falls array area during the breeding season (Table 4.21). The percentage of birds likely to originate from each colony is based on colony, distance and available sea area weightings, calculated as explained in the table notes. Note that data from the AOE colonies (Orford Ness and Havergate Island) are taken from 2012, so as to be concurrent with the other colony counts from 2012. It is estimated that 57% of birds present in the array area during the breeding season would originate from the AOE SPA population (Orford Ness and Havergate). As noted above, the numbers of lesser black-backed gulls breeding at urban sites is likely to have increased since 2012, whereas the numbers of the AOE have remained about the same, so the apportioning may over-estimate the proportion of individuals from SPA breeding colonies at the North Falls array area. (Considering all colonies within MMFR+1SD to have potential connectivity to the North Falls array area would bring in additional breeding sites in North Norfolk, although these more distant colonies would be unlikely to significantly affect the apportioning estimates due to the assumption of an inverse relationship between the number of birds from a colony foraging within a given area and distance; NatureScot 2018).

194. The apportioning for lesser-black-backed gull at the AOE uses the same source material, in terms of breeding colonies and estimates, as used in the draft RIAA consulted on in July 2023 (with updated distances to colonies based on the revised boundary for the North Falls array area). On 6th March 2024, NE requested that the apportioning methodology be aligned with that for Five Estuaries OWF. In the sense that both North Falls Five Estuaries have used the NatureScot (2018) methodology, the approaches are aligned. However, there are differences in the number and location of the non-SPA breeding colonies considered by the two Projects. At the time of writing, the Applicant continues to consider additional breeding colonies of lesser black-backed gull which might be included in relation to apportioning for North Falls.

195. Birds recorded in the array area during the breeding season may also include sub-adult birds and sabbatical adults of breeding age, as well as breeding adults. The mean percentage of lesser black-backed gulls that were identified as adults during monthly baseline surveys in the defined breeding season (March to August) was 83% of records for which the age class could be determined (ES Appendix 13.2 (Document Reference: 3.3.13)); on average 51% of lesser black-backed gulls recorded during aerial surveys in breeding season months could be aged). Thus, these observations confirm that a proportion of birds recorded during the breeding season were sub-adults. It is also likely that a relatively high

proportion of the birds recorded in adult plumage are non-breeders or 'sabbaticals', noting that Horswill and Robinson (2015) estimate that 33.7% of adult lesser black-backed gulls miss breeding in a given year but breed at the same colony in subsequent years, and NatureScot recommend assuming 35% of lesser black-backed gulls recorded in adult plumage on OWF sites during the breeding season are classed 'sabbaticals' (e.g. Royal HaskoningDHV, 2022b). This is not accounted for in the current assessment, making it highly precautionary in this regard.

Table 4.21 Counts of breeding lesser black-backed gulls in Suffolk and south Norfolk 2012 (Piotrowski 2013) and estimates of the apportioning of predicted impacts from North Falls to the different colonies

Colony	No. Pairs	Urban	Natural[1]	Distance to North Falls (km)[2]	Proportion of sea within MMFR[3]	Colony size weighting[4]	Distance weighting[4]	Proportion of sea weighting[4]	Combined weighting[4]	% of birds at North Falls array area from colony[4]
Breydon Water	1	1	-	101	0.70	0.00	148.19	0.05	0.00	0
Great Yarmouth	743	743	-	100	0.71	0.16	149.95	0.04	1.06	4
Southtown/Gorleston	467	467	-	97	0.71	0.10	161.44	0.04	0.72	3
Lowestoft	627	627	-	85	0.71	0.13	207.05	0.05	1.25	5
Beccles	34	34	-	85	0.66	0.01	207.93	0.05	0.07	0
Ellough	12	12	-	84	0.66	0.00	215.72	0.05	0.03	0
Pakefield (south Lowestoft)	31	31	-	83	0.70	0.01	220.87	0.05	0.07	0
Minsmere[5]	1	-	1	62	0.64	0.00	389.02	0.05	0.00	0
Aldeburgh	1	1	-	53	0.62	0.00	526.23	0.05	0.01	0
Orford Ness[6]	640	-	640	48	0.59	0.14	659.41	0.05	4.88	20
Havergate Island[6]	1171	-	1171	48	0.59	0.25	647.15	0.05	8.73	37
Port of Felixstowe	675	675	-	49	0.52	0.14	629.65	0.06	5.55	23
East Ipswich	93	93	-	59	0.50	0.02	426.23	0.06	0.54	2
Ipswich docks & town centre	133	133	-	64	0.48	0.03	369.68	0.07	0.69	3
West Ipswich	36	36	-	66	0.47	0.01	344.03	0.07	0.18	1
Great Blakenham	1	1	-	72	0.47	0.00	290.67	0.07	0.00	0
Stowmarket	6	6	-	82	0.44	0.00	222.46	0.07	0.02	0

Colony	No. Pairs	Urban	Natural[1]	Distance to North Falls (km)[2]	Proportion of sea within MMFR[3]	Colony size weighting[4]	Distance weighting[4]	Proportion of sea weighting[4]	Combined weighting[4]	% of birds at North Falls array area from colony[4]
Mendlesham	22	22	-	83	0.48	0.00	220.29	0.07	0.07	0
Totals	4694	2882	1812	1321	10.66	1.00	6035.96	1.00	23.88	100

1. Typical natural-nesting sites include cliffs, moorland, agricultural land, freshwater margins and islands (Burnell 2021).

2. Distance between the central point of North Falls and the approximate centre of the colony based on descriptions in Piotrowski (2013).

3. The proportion of sea within a circle from each colony with radius equivalent to the foraging range (in this case MMFR, 127km) = (area of sea within 127km of colony / (total area (land and sea) within 127km of colony).

4. The likely proportion of birds from each breeding site at North Falls during the breeding season estimated based on Sottish Natural Heritage (SNH, 2018) apportioning guidance. Colony weighting = site population (individuals) / sum of site populations (individuals); distance weighting = (sum of site distances)^2 / (site distance)^2; proportion of sea weighting = (1 / colony sea proportion / (sum of (1 / colony sea proportions)); combined weighting = colony weight x distance weight x proportion of sea weight; % of birds from site a North Falls = combined site weighting / sum of combined site weight x 100.

5. The numbers of nesting lesser black-backed gulls at this site are controlled (Piotrowski 2013) to reduce predation on other bird species of conservation concern.

6. Counts for breeding colonies within the AOE SPA; the count for Orford Ness is the same as the 2012 count in the SMP database, for Havergate the database records 1267 breeding pairs in 2012.

4.4.2.5.2.2 Non-breeding season

196. Outside the breeding season, lesser black-backed gulls from the AOE SPA colonies migrate away from the breeding colony, with some birds remaining in the UK during the winter and others travelling to continental Europe and north Africa (Thaxter *et al.* 2019). The relevant non-breeding reference population for the region within which the North Falls occurs is the UK North Sea and Channel BDMPS). This consists of 209,007 individuals during autumn migration (September to October), 39,314 individuals during winter (November to February) and 197,483 individuals during spring migration (March) (Furness, 2015). The populations associated with the BDMPS during each of these non-breeding periods comprise both adults and immatures, with it being assumed that the birds deriving from the different source breeding colonies and birds of different age classes are distributed uniformly across the BDMPS. Note, for the project alone assessment of collision risk the non-breeding season is divided into these migration and winter periods, but for the in-combination assessment data from other OWFs is not consistently available for these subdivisions, so a single non-breeding season estimate has to be used.

197. For the project alone assessment, estimates of the proportion of lesser black-backed gulls present in the array area which originate from the AOE SPA during the non-breeding season (and therefore the proportion of predicted mortalities from the SPA population) are based on the SPA population of breeding adults as a proportion of the relevant seasonal BDMPS (UK North Sea and Channel). During autumn migration, winter, and spring migration, 0.61%, 1.63%, and 0.65% respectively of impacts are considered to affect breeding adults from the SPA population (based on data in the appendices to Furness, 2015). For the in-combination assessment, the non-breeding season proportion of adults is based on an average of the seasonal proportions weighted according to the number of months per season within the overall non-breeding period (two months for autumn migration, four months during the winter period and one month for spring migration).

4.4.2.5.3 Project alone assessment

198. The assessment assumes that during the breeding season, 83% of predicted lesser black-backed gull collisions at North Falls involve breeding adults (paragraph 195 above) and, of these, 57% are associated with the AOE SPA population (based on the combined apportioning estimates for the Orford Ness and Havergate Island colonies –Table 4.21).

199. During the non-breeding season months, the proportion of collisions affecting the SPA population of breeding adults is estimated as detailed in paragraph 197 above.

200. Annual predicted mortality from collisions in the array area and the percentage increase in the mortality rate of the SPA population are given in Table 4.22.

201. The methodology for CRM is set out in ES Appendix 13.2 (Document Reference: 3.3.13). Stochastic CRM (sCRM) was run using a nocturnal activity factor of 0.375 (± 0.0637 SD) and an avoidance rate of 0.9939 (±0.0004), as recommended by NE (2023e). The nocturnal activity factor recommended by NE (2022b), (0.375 ± 0.0637) is a central value for use in sCRM which captures a range of 25-50% nocturnal activity, based on the assumption that flight activity is 25-50% of that during the daytime. This may be an over-estimate. A review of seabird nocturnal

activity carried out for East Anglia THREE (MacArthur Green 2015a&b) cites a study of migration behaviour (Klaassen *et al.* 2012) where an average of 48% of daylight and 12% of night was spent in flight, equivalent to 25% nocturnal activity. Ross-Smith *et al.* (2016) found that GPS-tracked lesser black-backed gulls breeding at Orford Ness spent relatively little time flying at night (0.3% of their total time), and also that birds flew at lower altitudes at night, especially over the sea. If this is representative of the behaviour of this species during the breeding season it suggests that the risk of collisions with OWFs at night may actually very small and may even be over-estimated by a nocturnal activity factor of 0.25

202. Results for the two WTG scenarios: the MiRD scenario of 57 smaller turbines (236m rotor diameter), and the MaRDscenario of 34 larger turbines (337m rotor diameter) were very similar; the MaRD scenario was marginally the worst case. The mean predicted collisions under both scenarios represent a 0.7% increase in the annual mortality rate of the SPA population. This level of increase in the mortality rate is unlikely to be detectable when considered in relation to likely natural variation. The upper 95% CLs of the collision risk estimates for both WTG options represent increases of >1% in population mortality rates, although these collision predictions are extremely unlikely to occur.

203. The potential impacts from the predicted project alone mortality have been investigated in more detail using Population Viability Analysis (PVA) for lesser black-backed gull at the AOE SPA run with the NE PVA Tool (Searle *et al.* 2019). The PVA was based on a density independent population model, as recommended by NE (2022a), with the demographic rates for the baseline scenario taken from Horswill and Robinson (2015). However, the available demographic data for lesser black-backed gull were scored as low quality by Horswill and Robinson (2015), with empirical data on juvenile and sub-adult survival rates lacking, so that the juvenile survival rate for herring gull was used instead (as recommended by Horswill and Robinson, 2015). Models were run for a 30 year projection period, with the population projections under baseline conditions (i.e. without any OWF effects) compared with those incorporating the additional mortality predicted from project alone collisions. Full details of the input parameters and modelling approach are included in RIAA Appendix 4.2 (Document Reference: 7.1.4.2).

204. Density independent models incorporate no feedback between population size and demographic rates (such that a population can either increase to infinity (which is biologically implausible) or decrease to extinction. Consequently, the PVA used to assess the population-level impacts assumes that the predicted mortality associated with collisions is entirely additive to the baseline mortality levels that would occur in the absence of these impacts, which is likely to cause overestimation of the resulting population-level impacts. Density dependent models, which incorporate a mechanism for population regulation, are likely to be more realistic (e.g. reproductive rates may be expected to decline as population size increases if an expanding population resulted in competition for food resources and/or suitable nesting sites). Although there is considerable evidence for density dependence operating in seabird populations (e.g. Horswill *et al.* 2016), NE (2022a) advises against the use of density dependent population models due to the lack of empirical evidence of the underpinning mechanisms of density dependent regulation within seabird populations. Thus, the PVA is likely to be precautionary in terms of the predicted level of impact.

205. The population models on which the PVA is based also assumed that the lesser black-backed gull breeding population at the AOE is closed. In reality, this will not be the case as there will be immigration and emigration resulting in exchange of birds between colonies (Ross-Smith *et al.* 2014b) and, again, is likely to result in overestimation of impacts at the scale of the colony population (Miller *et al.* 2019).

206. Due to the intrinsic structure of the population modelling approach, increases in mortality rates will always have some effect on population size and growth rate, such that the counterfactuals of impacted and unimpacted populations will never be greater than 1 and will almost always be less, thus always suggesting a negative effect. What is undefined is the level at which such negative effects could cause detectable adverse effects on a population.

207. The potential impact of the predicted collision mortality on the SPA lesser black-backed population was assessed on the basis of the counterfactuals (or ratios) of population size (CPS) and of annual population growth rate (CPGR), as derived from the PVA. These two metrics have been demonstrated to be relatively insensitive to mis-specification of demographic rates and variation in population trend (Cook and Robinson 2016, Jitlal *et al.* 2017).

208. Model PVA outputs are presented in Table 4.23 for the project alone (and also in-combination) mortality predictions for lesser black-backed gull. The outputs are presented as the CPS and CPGR for models incorporating collision mortality from OWFs (impacted populations) in relation to models without OWF mortality (unimpacted populations). For each mortality level, the table shows the predicted changes in median annual population growth rate, and the counterfactual of population size at year 30 (with upper and lower 95% CLs).

209. For North Falls alone, the mean predicted collision mortality apportioned to the SPA is 3.1 breeding adults per year (Table 4.22). The median predicted reduction in the population growth rate of lesser black-backed gulls at the AOE after 30 years is 0.1% (on the basis of CPGR = 0.999) compared with the unimpacted population, and the predicted reduction in population size after 30 years compared to the unimpacted population is 1.9% (CPS = 0.981) (Table 4.23). At the 95% Lower Confidence Limit (LCL) of the collision estimate (i.e. 0 collisions), there would be no effect on annual population growth rate or population size after 30 years, as this is the same as the baseline scenario with no impacts from OWF collisions. At the 95% Upper Confidence Limit (UCL) of 10.6 collisions per year, the median predicted reduction in the population growth rate is 0.2% (CPGR = 0.988) compared with the unimpacted population, and the predicted reduction in population size after 30 years compared to the unimpacted population is 4.9% (CPS = 0.951) (Table 4.23).

210. Thus the PVA for North Falls alone predicts an extremely small reduction in the annual population growth rate, which after 30 years of operation would result in a very small reduction in population size, based on a mean additional mortality of 3.1 breeding adults per year. The same conclusion applies even when considering the upper 95% CL for the predicted additional mortality, 10.6 collisions), whereas no change to the population growth rate in relation to the LCL of zero predicted collisions. It is considered that the predicted project alone collision mortality would not compromise the conservation objective to maintain or restore the SPA population.

211. It is concluded that predicted collisions at North Falls alone would not have an adverse effect on the AOE SPA breeding population of lesser black-backed gull and would not adversely affect the integrity of the AOE SPA.

Table 4.22 Seasonal and annual collisions for lesser black-backed gull at North Falls apportioned to AOE SPA and increase in SPA population mortality rates (grey shading indicates worst case scenario)

WTG scenario	Statistic	Apportioning[1]	Predicted collisions (sCRM)					Annual collisions as % increase in SPA population mortality rate[2]
			Breed - full	Aut-mig	Winter	Spr-mig	Annual	
MiRD	Mean	All	6.4	0.8	1.3	0	8.5	
		Apportioned to SPA	3.0	0.0	0.0	0.0	3.1	0.7 %
	LCL	All	0	0	0	0	1.6	
		Apportioned to SPA	0.0	0.0	0.0	0.0	0.0	0 %
	UCL	All	22.0	4.7	5.8	0	21.3	
		Apportioned to SPA	10.4	0.0	0.1	0.0	10.5	2.4 %
MaRD	Mean	All	6.5	0.8	1.2	0.0	8.6	
		Apportioned to SPA	3.1	0.0	0.0	0.0	0.0	0.7 %
	LCL	All	0	0	0	0	1.7	
		Apportioned to SPA	0	0	0	0	0.0	0 %
	UCL	All	22.2	5.3	5.8	0	21.0	
		Apportioned to SPA	10.5	0.0	0.1	0.00	10.6	2.5 %

1. SPA apportioning of predicted collisions at North Falls: breeding 57% (assuming 83% of predicted collisions involve breeding adults), autumn migration 0.61%, winter 1.63%, spring migration 0.65%,

2. Based on annual adult mortality rate of 0.115 (Horswill and Robinson 2015, ES Chapter 13, Table 13.11, Document Reference: 13.1.15) and SPA population size of 3760 adult birds

Table 4.23 Outputs from a population model of lesser black-backed gull at AOE SPA (Searle *et al.*, 2019): counterfactuals of population growth rate and size for project alone and in-combination scenarios

Scenario	Predicted Adult mortality	Increase in adult mortality rate	Growth rate (median)	Counter Factual of Population Growth Rate (CPGR, median)	Counterfactual of Population Size (CPS, median) after 30 years	Reduction in growth rate	Reduction in population size
Baseline / 95% LCL Project alone	0	0	1.008	1.000	1.000	n/a	
Project alone mean	3.1	0.7%	1.007	0.999	0.981	0.1%	1.9%
Project alone 95% UCL	10.6	2.4%	1.006	0.998	0.951	0.2%	4.9%
In-combination: Consented OWFs (Tier 1-3), excluding OWFs consented with compensation	47.6	11.0%	0.999	0.992	0.798	0.8%	20.2%
In-combination: Consented OWFs (Tier 1-3), including OWFs consented with compensation	52.5	12.1%	0.998	0.991	0.779	0.9%	22.1%
In-combination: Consented, submitted and OWFs with PEIR available, including effects from OWFs consented with compensation (Tier 1-5)	58.1	13.4%	0.997	0.989	0.720	1.05%	27.99%
In-combination: Consented, submitted and OWFs with PEIR available, excluding OWFs consented with compensation (Tier 1-5)	64.1	14.8%	0.996	0.988	0.696	1.16%	30.42%

4.4.2.5.4 In-combination assessment

212. The in-combination assessment considers the combined predicted collision mortality to lesser black-backed gulls at the AOE SPA from OWFs within foraging range during the breeding season, and within the UK North Sea and Channel BDMPS (Furness, 2015) during the non-breeding season. In each season the predicted collision risk from OWFs within the area of search is apportioned to the SPA. In-combination seasonal and annual totals are set out in Table 4.24.

213. As stated above, the sCRM undertaken for North Falls was based on the most recent advice from NE (2022b). For lesser black-backed gull this recommends that the avoidance rate is reduced from 0.995 to 0.9936 (±0.0001) for the deterministic Band (2012) model (which equates to a 28% increase in predicted collisions); and 0.9939 (±0.0004) for the stochastic (MacGregor et al., 2018) model (equating to a 22% increase in predicted collisions). Collision risk estimates for the majority of OWFs in Table 4.24 pre-date this advice. To increase parity between collision risk estimates from OWFs considered in the in-combination assessment, the collision predictions in the table have been adjusted to reflect the updated avoidance rates (see ES Appendix 13.3, Document Reference: 3.3.14) for methodology and details of the original model option and avoidance rates for OWFs included in the in-combination assessment).

214. During the breeding season, the predicted collision risk for North Falls is apportioned to the AOE SPA as described in Section 4.4.2.5.2 above. The worst case estimate of collision risk is used (i.e. mean of 3.1 collisions as determined for the Maximum turbine scenario, Table 4.22).

215. Other OWFs within breeding season foraging range could be selected based on those within MMFR (127 km) or MMFR +1SD (236 km) (Woodward et al. 2019) of the AOE SPA (Table 4.24 indicates which sites fall within each range). The precautionary approach would be to include all OWFs within MMFR 1SD, although this distance is considerably greater than the maximum at sea foraging range recorded from two tracking studies of lesser black-backed gulls nesting at the SPA (159 km, Thaxter et al., 2015; and 88.7km, Green et al., 2021).

216. For the purposes of the shadow appropriate assessment for North Falls, MMFR + 1SD has been used as a cut off distance, such that OWFs beyond this distance are considered to have no breeding season connectivity with the AOE SPA. For OWFs within MMFR + 1SD, the breeding season apportioning reflects the approach that has been taken in a relevant RIAA, as described below.

217. For GGOW, Gunfleet Sands, Kentish Flats and Extension, London Array, Scroby Sands, Sheringham Shoal, Thanet, Dudgeon, GOW, EA1, EA3, EA1N, EA2, Norfolk Vanguard and Norfolk Boreas, the breeding season apportioning for lesser black-backed gull at the AOE SPA as set out in MacArthur Green and Royal HaskoningDHV (2020) was used.

218. For OWFs where an ES or PEIR has become available subsequent to (and hence not included in) MacArthur Green and Royal HaskoningDHV (2020), breeding season connectivity is ruled out where a development is beyond MMFR +1SD from the AOE SPA, and otherwise is based the approach to the apportioning for lesser black-backed gull at the AOE SPA in the RIAA for the relevant development.

219. Effectively this approach identifies breeding season connectivity for lesser black-backed gull only for OWFs within MMFR of the AOE (Table 4.24). No connectivity is identified for two sites within MMFR – Race Bank (which at 124.4km from the SPA is only just within MMFR of 127km), and Rampion 2 where connectivity with the AOE is not identified during the breeding season in the RIAA for the development (GoBe, 2023b).

220. Outside the breeding season, when lesser black-backed gulls disperse from their breeding colonies, apportioning of non-breeding season collisions to OWFs was based on the AOE SPA population as a proportion of the UK North Sea and Channel BDMPS. As detailed above, the non-breeding season for lesser black-backed gull is divided into spring and autumn migration and winter periods (Furness 2015). However, for many OWFs included in the in-combination assessment there is not enough information to calculate separate estimates for these periods, and only a single estimate is available for the entire non-breeding season. During autumn migration, winter, and spring migration, 0.61%, 1.63%, and 0.65% of collisions, respectively, are considered to affect breeding adult birds from the SPA (based on data in the appendices to Furness, 2015). Given this, a weighted average, based on the number of months allocated to each non-breeding period (assuming a full UK breeding season, Furness 2015), is applied to all OWFs included in the in-combination assessment, which results in 1.2% of the predicted collisions for the non-breeding season being attributed to the SPA breeding population.

221. The annual predicted in-combination mortality for the lesser black-backed gull breeding population at the AOE SPA is 64.1 birds (Table 4.24). Four OWFs have recently been consented subject to compensation for predicted collision mortality at AOE SPA, East Anglia ONE North and TWO, Norfolk Vanguard and Norfolk Boreas. For these projects compensation measures are required to be in place to offset the predicted collision mortality for the AOE SPA population. Taking this into account and deducting the contribution of these OWFs from the in-combination total, gives a potential mortality of 58.1 birds. Of these, North Falls contributes 3.1 birds (mean predicted collision risk), representing 5.3% of the total potential in-combination impact.

222. NE advises that in-combination effects should be considered with and without the impacts of compensated-for projects. Assuming the respective predicted annual mortality totals of 64.1 and 58.1 from OWF collisions involves breeding adults from the SPA population, this represents increases of 14.8% and 13.4% in the population mortality rate.

223. For North Falls, lesser black-backed gulls recorded within the array area during the breeding season included adults and sub-adult birds, and a correction was applied to the breeding season collisions total to account for this. It is understood that similar corrections to the predicted breeding season totals have not been applied to most or all OWFs included in the in-combination assessment where there is breeding season connectivity. This indicates that the numbers of adults predicted to die will be an overestimate. For example, if age distributions of birds occurring on these other OWF sites during the breeding season are as recorded during the aerial surveys at the North Falls array area (83% adult birds) this would reduce the potential in-combination collision mortality by 17%. In addition, a further source of overestimation in the potential breeding season collision

mortality is the absence of any consideration of sabbatical birds (not breeding in a given year), which on the basis of the available evidence is likely to be in the order of 35% of the adults present on these OWF sites (see above). During the non-breeding season the apportioning is based on the estimated proportion of adult birds from the AOE within the seasonal BDMPSs, based on Furness (2015), so is focused on the numbers of breeding adults.

224. As for the project alone assessment, PVA has been run for the predicted in-combination mortality from collisions (Table 4.23).

225. At an in-combination mortality of 58.1 breeding adults, the median predicted reduction in the annual population growth rate of lesser black-backed gulls at the AOE is 1.1% (CPGR = 0.989) compared with an unimpacted population, and the predicted reduction in population size after 30 years compared to the unimpacted population is 28% (CPS = 0.720). At an in-combination mortality of 64.1 breeding adults, the median predicted reduction in the annual population growth rate of lesser black-backed gulls at the AOE is 1.2% (CPGR = 0.988) compared with an unimpacted population, and the predicted reduction in population size after 30 years compared to the unimpacted population is 30% (CPS = 0.696).

226. While the absolute magnitude of the predicted reductions in annual population growth rate are small, they are sufficient to lead to potential reductions in the size of the impacted population relative to that of the unimpacted population of approximately 28-30% after a period of 30 years. The scale of this predicted reduction in relative population size needs to be considered within the context of the various precautionary assumptions incorporated within the assessment (perhaps most notably the absence of any density dependence in the population modelling which underpins the PVA – see above) but given the fact that the SPA population is subject to a restore target, it is considered that the potential for adverse effects on the SPA population of lesser black-backed gull cannot be excluded.

227. PVA was also run for the in-combination collisions for all consented OWFs (Tier 1-3) included in Table 4.24, totals of 47.6 and 52.5 collisions, respectively excluding and including OWFs consented with compensation measures for lesser black-backed gull. Excluding predicted collisions from OWFs with compensation (47.6 breeding adults), the median predicted reduction in the annual population growth rate of lesser black-backed gulls at the AOE is 0.8% (CPGR = 0.992) compared with an unimpacted population, and the predicted reduction in population size after 30 years compared to the unimpacted population is 20.2% (CPS = 0.798); including OWFs with compensation (52.5 breeding adults), the median predicted reduction in the annual population growth rate of lesser black-backed gulls at the AOE is 0.9% (CPGR = 0.991) compared with an unimpacted population, and the predicted reduction in population size after 30 years compared to the unimpacted population is 22.1% (CPS = 0.779). As for the in-combination totals for Tiers 1-5, the magnitudes of the counterfactuals of population size after 30 years indicate that an adverse effect on the SPA population cannot be excluded.

228. There are substantial levels of precaution built into the in-combination mortality predictions. As outlined previously, PVAs are run under an assumption of no density dependence in seabird populations; for OWFs other than North Falls, the proportion of collisions attributed to adult breeding birds may be over-estimated,

no account is taken of the likelihood that a proportion of adult birds recorded within OWFs array areas during the breeding season may be sabbatical birds (not breeding in a given year); and the nocturnal activity rate for the species, assuming that flight activity is 25-50% of daytime levels, may have been over-estimated. Available information for lesser black-backed gull suggests that nocturnal activity values of 25% or less are most realistic (as opposed to a maximum of 50%) and the use of a 25% based nocturnal activity factor could reduce predicted collision rates by approximately 20%, though this varies by OWF location and season/day length (MacArthur Green 2015b). In addition, for OWFs in English waters, collision risk is based on consented worst case rather than as-built OWF parameters, which may lead to the overestimation of collision rates by up to 40% (MacArthur Green, 2017; The Crown Estate and Womble Bond Dickinson, 2021). However, whilst the as-built designs represent the most realistic scenario in terms of the existing collision risk, these are not considered by some stakeholders to be legally secured for projects in English waters, so there is a theoretical (albeit highly unlikely) possibility of further WTG construction on such project sites (The Crown Estate and Womble Bond Dickinson 2021). For OWFs in Scottish waters, CRM predictions based on as-built parameters have been used (where available) as these are accepted by Marine Directorate and NatureScot.

229. As noted previously, the most recent consent applications for OWFs in the southern UK North Sea have been granted subject to compensation measures for lesser black-backed gull at the AOE. These consents are for Norfolk Vanguard, Norfolk Boreas, East Anglia ONE North and East Anglia TWO. In each case the Secretary of State has concluded that an AEoI of the AOE SPA from in-combination collision mortality to lesser black-backed gull cannot be excluded (BEIS 2021, 2022a, b, c).

230. Thus, for North Falls in-combination with other OWFs it is concluded that AEoI in relation to the breeding population of lesser black-backed gull cannot be ruled out. A HRA derogation case (Document Reference: 7.2), including compensation measures for lesser black-backed gull at the AOE is provided with the DCO application.

Table 4.24 In-combination collision risk for lesser black-backed gull at the AOE SPA

Tier	OWF	Overlap with foraging range from AOE[1]			Predicted number of collisions[2] (in total and apportioned to SPA[3])						Consented subject to compensation at AOE
		MMFR + 1SD (236km)	Mean max (127km)	AOE Breeding proportion	Breeding		Non-breeding		Annual		
					Total	SPA	Total	SPA	Total	SPA	
1	Beatrice Demonstrator	No	No		0	0	0	0	0	0	No
1	Beatrice	No	No		0	0	0	0	0	0	No
1	Blyth Demonstration	No	No		0	0	0	0	0	0	No
1	Dudgeon	Yes	Yes	0.15	9.9	1.5	39.2	0.5	49.0	1.9	No
1	East Anglia ONE	Yes	Yes	0.37	7.6	2.8	43.3	0.5	50.8	3.3	No
1	EOWDC (Aberdeen)	No	No		0	0	0	0	0	0	No
1	GWF	Yes	Yes	0.65	35.6	23.1	142.1	1.7	177.7	24.8	No
1	GGOW	Yes	Yes	0.65	15.9	10.3	63.5	0.8	79.4	11.1	No
1	Gunfleet Sands	Yes	Yes	0.35	1.0	0.4	0.0	0	1.0	0.4	No
1	Hornsea Project One	Yes	No		5.6	0	22.3	0.3	27.9	0.3	No
1	Hornsea Project Two	Yes	No		2.6	0	2.6	0	5.1	0	No
1	Humber Gateway	Yes	No		0.4	0	1.4	0	1.8	0	No
1	Hywind	No	No		0	0	0	0	0	0	No
1	Kentish Flats	Yes	Yes	0.38	0.4	0.1	1.7	0	2.0	0.2	No
1	Kentish Flats Extension	Yes	Yes	0.38	0.3	0.1	1.3	0	1.6	0.1	No
1	Kincardine	No	No		0	0	0	0	0.0	0	No
1	Lincs	Yes	(Yes)		2.2	0	8.7	0.1	10.9	0.1	No
1	London Array	Yes	Yes	0.46	0	0	0	0	0	0	No

Tier	OWF	Overlap with foraging range from AOE[1]			Predicted number of collisions[2] (in total and apportioned to SPA[3])						Consented subject to compensation at AOE
		MMFR + 1SD (236km)	Mean max (127km)	AOE Breeding proportion	Breeding		Non-breeding		Annual		
					Total	SPA	Total	SPA	Total	SPA	
1	Lynn and Inner Dowsing	Yes	(No)		0	0	0	0	0	0	No
1	Methil	No	No		0.5	0	0	0	0.5	0	No
1	Moray East	No	No	-	0	0	0	0	0	0	No
1	Race Bank	Yes	(yes)	-	55.3	0	13.8	0.2	69.1	0.2	No
1	Rampion	Yes	No	-	2.0	0	8.1	0.1	10.1	0.1	No
1	Scroby Sands	Yes	Yes	0.01	0	0	0	0	0	0	No
1	Sheringham Shoal	Yes	Yes	0.15	2.2	0.3	8.4	0.1	10.6	0.4	No
1	Teeside	No	No	-	0	0	0	0	0	0	No
1	Thanet	Yes	Yes	0.43	4.1	1.8	16.4	0.2	20.5	2.0	No
1	Triton Knoll	Yes	No	-	9.5	0	37.9	0.5	47.4	0.5	No
1	Westermost Rough	Yes	No	-	0.1	0	0.4	0	0.5	0	No
2	Dogger Bank A and B	No	No	-	3.3	0	13.3	0.2	16.6	0.2	No
2	Dogger Bank C and Sofia	No	No	-	3.1	0	12.3	0.1	15.4	0.1	No
2	Moray West	No	No	-	0	0	0	0	0	0	No
2	Neart na Gaoithe	No	No	-	1.3	0	0	0	1.3	0	No
2	Seagreen Alpha and Bravo	No	No	-	2.7	0	10.8	0.1	13.4	0.1	No
3	East Anglia ONE North	Yes	Yes	0.24	1.2	0.3	0.8	0	1.9	0.3	Yes
3	East Anglia THREE	Yes	Yes	0.24	2.3	0.6	10.5	0.1	12.8	0.7	No

Tier	OWF	Overlap with foraging range from AOE[1]			Predicted number of collisions[2] (in total and apportioned to SPA[3])						Consented subject to compensation at AOE
		MMFR + 1SD (236km)	Mean max (127km)	AOE Breeding proportion	Breeding		Non-breeding		Annual		
					Total	SPA	Total	SPA	Total	SPA	
3	East Anglia TWO	Yes	Yes	0.39	5.4	2.1	0.6	0	6.0	2.1	Yes
3	Hornsea Project Three	Yes	No	-	10.2	0	1.3	0	11.5	0	No
3	Hornsea Project Four	Yes	No	-	1.1	0	0	0	1.1	0	No
3	Inch Cape	No	No	-	0.0	0	0	0	0.0	0	No
3	Norfolk Boreas	Yes	Yes	0.21	7.9	1.7	10.4	0.1	18.3	1.8	Yes
3	Norfolk Vanguard	Yes	Yes	0.17	10.8	1.8	4.6	0.1	15.4	1.9	Yes
3	Green Volt	No	No	-	0	0	0	0	0	0	No
3	Sheringham Shoal and Dudgeon Extensions	Yes	Yes	0.12	2.0	0.3	0.3	0	2.3	0.3	No
4	Berwick Bank	No	No	-	7.7	0	0	0	7.7	0	N/A
4	Rampion 2	Yes	No	-	3.2	0	1.3	0	4.4	0	N/A
4	Five Estuaries[4]	Yes	Yes	0.20	38.1	7.7	6.1	0.1	44.2	7.8	N/A
4	Outer Dowsing[4]	Yes	No	0.12	3.0	0.4	0.7	0	3.7	0.4	N/A
4	West of Orkney	No	No	-	0	0	0	0	0	0	N/A
4	Dogger Bank South[4]	No	No	-	0.5	0	0	0	0.5	0	N/A
	North Falls	Yes	Yes	0.47	6.5	3.1	2.0	0	8.5	3.1	N/A
TOTALS					**265**	**58.3**	**486**	**5.8**	**751**	**64.1**	N/A
TOTAL excluding sites with compensation measures										**58.1**	

Tier	OWF	Overlap with foraging range from AOE[1]			Predicted number of collisions[2] (in total and apportioned to SPA[3])						Consented subject to compensation at AOE
		MMFR + 1SD (236km)	Mean max (127km)	AOE Breeding proportion	Breeding		Non-breeding		Annual		
					Total	SPA	Total	SPA	Total	SPA	

1. Foraging ranges from Woodward *et al.* 2019; brackets indicate where an OWF is only just within or outside a given distance, e.g. at 124.4km from the SPA, Race Bank is only just within mean max foraging range (127km) of AOE.
2. Collision predictions are adjusted to reflect the latest NE advice on avoidance rates.
3. Breeding season apportioning of the AOE population for North Falls is as described in Section 4.4.2.5.2.1 above; for GGOW, Gunfleet Sands, Kentish Flats and Extension, London Array, Scroby Sands, Sheringham Shoal, Thanet, Dudgeon, GOW, EA1, EA3, EA1N, EA2, Norfolk Vanguard and Norfolk Boreas, breeding season apportioning is based on MacArthur Green and Royal HaskoningDHV (2020); and for other OWFs the distance to the AOE SPA and /or information in the most recently available RIAA on apportioning for lesser black-backed gull at the SPA. During the non-breeding season apportioning is based on the AOE SPA population as a proportion of the UK North Sea and Channel BDMPS (Paragraph 220).
4. DCO applications accepted after the cut off date for inclusion in the North Falls assessment (end March 2024), so values in this Table are based on PEIR documents.

4.4.2.6 All Qualifying Migratory Non-Seabird Features

231. The migratory bird species listed in Table 4.25 have been screened in for Appropriate Assessment due to potential risk of collision during passage flights to and from the AOE SPA, if they fly through the North Falls array area (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.4.2.6.1 Status

232. The status of each migratory species screened into the Appropriate Assessment is presented in Table 4.25. The table gives the site population at classification (usually from the SPA citation, sometimes alternative sources if a population estimate for a given species is not included on the citation), the latest available count on NE designated sites view, and the national population as given in Wright *et al.*, (2012).

4.4.2.6.2 Connectivity and seasonal apportionment of potential effects

233. Connectivity between the migratory non-seabird species of the AOE SPA and Ramsar site, and the North Falls array area, was determined using the British Trust for Ornithology SOSS-MAT (Strategic Ornithological Support Services – Migration Assessment Tool) (Wright *et al.* 2012). The SOSS-MAT-estimated passage of individuals per migration period through the North Falls array area for each species was taken forward into the Band (2012) spreadsheet for modelling Migrant Collision Risk. Passage per migration period was apportioned to spring and/or autumn months within the Band (2012) spreadsheet based on details in species accounts within Wright *et al.* (2012). The full methodology for the assessment's use of these tools is detailed in the ES Appendix 13.2 Ornithology Technical Report (Document Reference: 3.3.13).

Table 4.25 Status of migratory species identified as qualifying features for the AOE SPA and Ramsar Site and predicted annual collisions at North Falls

Qualifying feature	SPA population at classification[1]	SPA population updated[1]	National population (Wright et al., 2012)	Predicted annual collisions North Falls (avoidance rate 0.980)
Avocet, breeding, non-breeding	104 pairs (p) (2006) 824 individuals (i) (1989/90-93/94)	46p (2009-13) 1,378i (2015/16-19/20)	877p 7,500i	0.04 0.22
Marsh harrier, breeding	3p (2006)	3p (2013)	201 breeding females	0.02
Redshank, non-breeding	1,662i (1989/90-93/94)	2,187i (2015/16-19/20)	463,800i	1.76
Ruff, non-breeding	13i (1989/90-93/94)	5i (2015/16-19/20)	800i	0.01
1. From NE designated sites view, supplementary advice on conservation objectives; p = breeding pairs, I = individuals.				

4.4.2.7 Avocet

4.4.2.7.1 Project alone assessment

234. The number of avocet from the British breeding population relevant to the SPA breeding population at risk of colliding with turbines at North Falls was calculated to be 0.04 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national breeding population of 877 pairs (Great Britain (GB), Wright *et al.*, 2012),

0.002 collisions per year are attributable to the AOE SPA. The number of avocet from the British non-breeding population relevant to the SPA non-breeding population at risk of colliding with turbines at North Falls was calculated to be 0.22 at an avoidance rate of 0.980. Assuming a national non-breeding population of 7,500 (GB, Wright *et al.* 2012), 0.04 collisions per year are attributable to the AOE SPA, and the total number of collisions attributable to both SPA populations is 0.042 per year.

235. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species as a result of North Falls.

4.4.2.7.2 In-combination assessment

236. Based on the migration corridors identified by Wright *et al.* (2012), it is likely that avocet migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at individual OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the AOE SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.2.8 Marsh harrier

4.4.2.8.1 Project alone assessment

237. The number of marsh harrier at risk of colliding with turbines at North Falls was calculated to be 0.02 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national breeding population of 201 breeding females (and therefore approximate pairs) (UK, Wright *et al*., 2012), 0.0003 collisions per year are attributable to the AOE SPA.

238. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.2.8.2 In-combination assessment

239. Based on the migration corridors identified by Wright *et al.* (2012), it is likely that marsh harrier migration activity is widespread along southern UK coasts and across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at individual OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the AOE SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.2.9 Redshank

4.4.2.9.1 Project alone assessment

240. The number of redshank at risk of colliding with turbines at North Falls was calculated to be 1.76 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 463,800 (advised total passage/wintering population across all races in British waters, Wright *et al.*, 2012), 0.0083 collisions per year are attributable to the AOE SPA.

241. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.2.9.2 In-combination assessment

242. Based on the migration corridors identified by Wright *et al.* (2012), it is likely that redshank migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at individual OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the AOE SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.2.10 Ruff

4.4.2.10.1 Project alone assessment

243. The number of ruff at risk of colliding with turbines at North Falls was calculated to be 0.01 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 800 (Wright *et al.*, 2012), fewer than 0.0001 collisions per year are attributable to the AOE SPA.

244. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.2.10.2 In-combination assessment

245. Based on the migration corridors identified by Wright *et al.* (2012), it is likely that ruff migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at individual OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the AOE SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.2.11 Assemblage of breeding and wintering wetland birds

246. The AOE qualifies under Ramsar criterion 3b as supporting a notable assemblage of breeding and wintering wetland birds. The component species are not named but it is assumed that key component species would be the migratory species listed as SPA qualifying features in Table 4.25 above.

4.4.2.11.1 Project alone assessment

247. For all migratory species assessed individually, very small numbers of collisions during passage flights were predicted at the North Falls array area. It was concluded in each case that the number of collisions would not result in detectable effects on the species population, and no adverse effect on integrity was predicted due to collision mortality of this species. As none of the named or other assemblage species have significant characteristics to their biometrics, migratory behaviour, migratory population or migration corridor which would markedly increase the rate of potential collisions, it is likely that this low rate of collisions would apply to all constituent species of the assemblage of breeding and wintering wetland birds, and that there would be no adverse effect on this qualifying feature.

4.4.2.11.2 In-combination assessment

248. Within the species specific migration corridors identified by Wright *et al.* (2012), it is likely that for each species, migration activity would be widespread across UK waters, such that low numbers of birds, and hence collisions, might be expected at individual OWFs. It is not expected that this will lead to substantial

collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the assemblage of breeding and wintering wetland birds at the AOE SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality.

4.4.3 Foulness SPA and Ramsar

4.4.3.1 SPA overview

249. Foulness SPA lies on the north shore of the Thames Estuary between Southend in the south and the Rivers Roach and Crouch in the north. At almost 11,000 hectares, it is made up of extensive intertidal sand silt flats, saltmarsh, beaches, grazing marshes, rough grass and scrubland. The proposed North Falls array is located approximately 54.0km east of Foulness SPA and Ramsar at its closest point.

250. The site is of international importance for six species and national importance for three species of wintering wildfowl, with the islands, creeks and grazing land forming an integral part of the sheltered feeding and roosting sites. The shell banks support nationally important breeding colonies of little terns, common terns and sandwich terns. Avocets also breed on this site in nationally important numbers.

4.4.3.2 Conservation objectives

251. The SPA's conservation objectives are to 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; and
- The distribution of qualifying features within the site.

4.4.3.3 Shadow Appropriate Assessment

252. The following qualifying features have been screened in for appropriate assessment (Table 4.5):

- Sandwich tern, breeding
- Common tern, breeding
- Avocet, breeding
- Ringed plover, breeding
- Bar-tailed godwit, wintering
- Dark-bellied brent goose, wintering
- Grey plover, wintering

- Hen harrier, wintering
- Knot, wintering
- Oystercatcher, wintering
- Redshank, wintering, passage
- Waterbird assemblage (shelduck, dunlin, curlew)

4.4.3.4 Sandwich tern

253. Sandwich tern from this SPA has been screened in for appropriate assessment due to potential connectivity during the breeding and non-breeding (migration) seasons and risk of collision effects. This applies in relation to the North Falls array area during the operational period (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.4.3.4.1 Status

254. At the time of classification in 1993, the breeding population was cited as 267 pairs of Sandwich tern (English Nature 1993). Furness (2015) refers to an average population of 320 pairs from 1992-1996. These were derived from the cumulative total numbers of Sandwich tern "across all Essex Estuary sites before the phased approach of designating the sites individually" was implemented (NE 2023e). The last breeding pairs recorded at Foulness were 96 pairs in 1986 (NE 2023e). No sandwich terns were recorded there as part of the JNCC Seabird 2000 survey (Mitchell *et al.*, 2004, NE 2023e). Monitoring in 2003 to 2006 all recorded zero pairs (Furness, 2015). Monitoring of the SPA area in 2015 to 2019 also all recorded zero AON (SMP database, accessed Jan 2024). Thus, no records of Sandwich tern breeding within the SPA have been found after 1986.

255. The Sandwich tern population of the SPA is subject to a target to restore the size of the breeding population to a level to be agreed whilst avoiding deterioration from its current level, as indicated by the latest mean peak count or equivalent.

4.4.3.4.2 Connectivity and seasonal apportionment of potential effects

256. During the breeding season, the MMFR +1 SD of Sandwich tern is identified as 34.3km (+ 23.2km) (Woodward *et al.*, 2019). At a distance of 54.0km from Foulness SPA, North Falls is outside the MMFR but within the MMFR+1 SD of Sandwich tern. Sandwich tern was recorded during April and May survey visits within the baseline digital aerial survey programme of the North Falls array area and surrounding buffer areas, and these months fall within the species' breeding season in UK waters (April to August, Furness 2015). Therefore, there is potential connectivity to Foulness SPA for a collision risk effect pathway during the breeding season.

257. During the spring and autumn migration periods, breeding Sandwich tern from this SPA migrate through UK waters. There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS, as identified by Furness (2015), consisting of 38,051 individuals during migration seasons (July to September, and March to May) (Furness, 2015). If Sandwich tern breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for birds from the Foulness SPA – should the breeding population be restored – to be subject to risk of a collision effect at North Falls during the migration period.

258. Based on the data in Appendix A to Furness (2015), on the contributions of UK SPA and non-SPA populations and overseas populations to each BDMPS, 0.00% of the birds occurring in the UK North Sea and Channel BDMPS during the migration seasons, were estimated to be breeding adults from the Foulness SPA. Sandwich tern was recorded during surveys in April, May and September during baseline digital aerial survey programme of the North Falls array area and surrounding buffer areas, and only in September within the array area. These months fall within the species' migration periods (Furness, 2015).

4.4.3.4.3 Effect: Collision risk during operation

4.4.3.4.3.1 Project alone assessment

259. No Sandwich tern collisions with turbines at North Falls were predicted in the breeding season (no birds were recorded in flight during baseline digital aerial surveys (ES Appendix 13.2, Document Reference: 3.3.13).

260. During migration seasons, the number of Sandwich tern at risk of colliding with turbines at North Falls annually modelled using the Band (2012) collision risk tool 'Migrant Collision Risk' sub-tool and flight height option 2 to be 0.71 individuals, based on the UK North Sea and Channel BDMPS migration period population (Furness, 2015) and maximum-likelihood flight height distributions of Sandwich tern from Johnston *et al.* (2014a,b) (0.58 – 2.12 when using respective lower and upper 95% CL flight height distributions), and assuming migration within a 10km band from the coast (Wernham *et al.* 2002, WWT and MacArthur Green 2014) (and this band traversing the mouth of the Thames estuary) and an avoidance rate of 0.990. Assuming the percentage contribution of the SPA to the BDMPS above, zero collisions per year (0.0 – 0.0) are attributable to the Foulness SPA and there would be no increase in baseline mortality (and given the species has not bred since 1986 there would be no breeding adults from the SPA in the BDMPS since this date).

261. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of Sandwich tern at North Falls.

4.4.3.4.3.2 In-combination assessment

262. The collision predictions at North Falls are zero. This means that the operational phase of North Falls would not adversely affect the integrity of the Foulness SPA both alone and in-combination with other projects.

263. As noted above, the SPA population is subject to a restore target, although no numerical target has been set. Should the population recover, it is possible that Sandwich terns from the SPA could occur at North Falls during the breeding season and face collision risk. However, given that that North Falls array is outside the MMFR of this species (but within MMFR + 1SD), it is likely that most or all foraging trips from any SPA population would not extend as far as the array area. Modelling of the foraging distribution of Sandwich terns from breeding colonies, based on tracking data, found that most use was made of coastal waters either side of the colony; the majority of the area used was confined to an area less than that encompassed by MMFR, such that the MMFR would correctly identify areas used but would also include large areas of relatively low importance and be rather precautionary (NE and JNCC 2015; Wilson *et al.* 2014). Thus, collision risk at North Falls would not affect the potential for population recovery at the Foulness SPA.

4.4.3.5 Common tern

264. Common tern from this SPA has been screened in for appropriate assessment due to potential connectivity during the non-breeding (migration) seasons and risk of collision effects. This applies in relation to the North Falls array area during the operational period (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.4.3.5.1 Status

265. At the time of classification in 1993, the breeding population was cited as 170 pairs of common tern (English Nature 1993). Furness (2015) refers to 220 pairs in 1996. These were derived from the cumulative total numbers of common tern "across all Essex Estuary sites before the phased approach of designating the sites individually" was implemented (NE 2023e). Monitoring in 1998 recorded 121 pairs, 130 pairs were recorded in 2000, 72 pairs in 2002, 82 pairs in 2004 and 25 pairs in 2008 (Furness, 2015). NE (2023e) report data from Foulness Bird Group shows a five-year peak mean of 17.5 pairs (2011-15), including 42 pairs at New England creek in 2010 and 34 pairs in 2011. Based on a most recent SPA population of 35 breeding adults (17.5 x 2), and a baseline adult mortality of 0.117 (Horswill and Robinson 2015), there is a baseline mortality of 4.1 breeding adults from this SPA per year.

4.4.3.5.2 Connectivity and seasonal apportionment of potential effects

266. During the spring and autumn migration periods, common tern breeding at this SPA migrate through UK waters. There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS, as identified by Furness (2015), consisting of 144,911 individuals during migration seasons (late July to early September, and April to May) (Furness, 2015). If common tern breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for birds from the Foulness SPA to be subject to risk of a collision effect at North Falls during the migration period.

267. Based on the data in Appendix A to Furness (2015), on the contributions of UK SPA and non-SPA populations and overseas populations to each BDMPS, 0.02% of the birds occurring in the UK North Sea and Channel BDMPS during the migration seasons, are estimated to be breeding adults from the Foulness SPA. Common tern was recorded in the North Falls array area during baseline surveys in August only and in the wider survey area also in surveys in April, May, July, August and September during baseline digital aerial survey programme of the North Falls array area and surrounding buffer areas. Assuming the migration-free breeding period is relevant to North Falls, these months fall within the species' autumn and spring migration periods (Furness, 2015).

4.4.3.5.3 Effect: Collision risk during operation

4.4.3.5.3.1 Project alone assessment

268. During migration seasons, the number of common tern at risk of colliding with turbines at North Falls annually was modelled using the Band (2012) collision risk tool 'Migrant Collision Risk' sub-tool and flight height option 2 to be 2.53 individuals, based on the UK North Sea and Channel BDMPS migration period population (Furness, 2015) and maximum-likelihood flight height distributions of common tern from Johnston *et al.* (2014a,b) (1.14 – 4.28 when using respective lower and upper 95% CL flight height distributions), and assuming migration within a 10km band from the coast (and this band traversing the mouth of the

Thames estuary) and an avoidance rate of 0.990. Assuming the percentage contribution of the SPA to the BDMPS above, 0.001 collisions per year (0.000 – 0.001) are attributable to the Foulness SPA. This equates to a 0.02% increase from baseline mortality.

269. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.5.3.2 In-combination assessment

270. Common tern migration activity is considered to take place within 10km of the coast (Wernham *et al.* 2002, WWT and MacArthur Green 2014), such that low numbers of birds, and hence collisions, might be expected at many OWFs further from the coast. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is expected to be very low. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6 All Qualifying Migratory Non-Seabird Features

4.4.3.6.1 Effect: Collision risk during operation

271. The migratory bird species listed in have been screened in for Appropriate Assessment due to potential risk of collision during passage flights to and from the Foulness SPA, if they fly through the North Falls array area (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.4.3.6.2 Status

272. The status of each migratory species screened into the Appropriate Assessment is presented in Table 4.26. The table gives the site population at classification (usually from the SPA citation, sometimes alternative sources if a population estimate for a given species is not included on the citation), the latest available count on NE designated sites view, and the national population as given in Wright *et al.*, (2012).

Table 4.26 Status of migratory species identified as qualifying features for the Foulness SPA and Ramsar Site and predicted annual collisions at North Falls

Qualifying feature	SPA population (citation)	SPA population updated[1]	National population (Wright *et al.*, 2012)	Predicted annual collisions
Avocet, breeding	26 pairs (p)	21 p (2011-15)	877 p	0.04
Ringed plover, breeding	135 p	3 p (2011-15)	5,438 p	0.02
Bar-tailed godwit, wintering	5,213 individuals (i)	8,491 i (2010-15)	54,280 i	0.34
Dark-bellied brent goose, wintering	13,276 i	10,582 i (2011-15)	91,000 i	2.14
Grey plover, wintering	2,229 i	2,287 i (2011-15)	49,315 i	0.30
Hen harrier, wintering	6 individuals	6 i (2010-14)	750 i	0.01
Knot, wintering	22,151 individuals	23,519 i (2011-15)	338,970 i	0.84

Qualifying feature	SPA population (citation)	SPA population updated[1]	National population (Wright *et al.*, 2012)	Predicted annual collisions
Oystercatcher, wintering	9,805 individuals	16,209 i (2011-15)	320,000 i	0.68
Redshank, wintering	1,540 individuals	1,956 i (2011-15)	463,800 i	1.76
Waterbird assemblage, non-breeding	74,791 individuals	99,005 i (2010/11-2014/15)	-	-
1. From NE designated sites view, supplementary advice on conservation objectives.				

4.4.3.6.3 Connectivity and seasonal apportionment of potential effects

273. Connectivity between the migratory non-seabird species of the Foulness SPA and Ramsar site, and the North Falls Array area, was determined using the British Trust for Ornithology SOSS-MAT (Wright *et al.* 2012). The SOSS-MAT-estimated passage of individuals per migration period through the North Falls Array area for each species was taken forward into the Band (2012) spreadsheet for modelling Migrant Collision Risk. Passage per migration period was apportioned to spring and/or autumn months within the Band (2012) spreadsheet based on details in species accounts within Wright *et al.* (2012). The full methodology for the assessment's use of these tools is detailed in the ES Appendix 13.2 Ornithology Technical Report (Document Reference: 3.3.13).

4.4.3.6.4 Avocet

4.4.3.6.4.1 Project alone assessment

274. The number of avocet from the British breeding population, of relevance to the SPA breeding population, at risk of colliding with turbines at North Falls was calculated to be 0.04 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 877 pairs (GB, Wright *et al*., 2012), 0.0001 collisions per year are attributable to the Foulness SPA.

275. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.4.2 In-combination assessment

276. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that avocet migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.5 Ringed plover

4.4.3.6.5.1 Project alone assessment

277. The number of ringed plover from the British breeding population, of relevance to the SPA breeding population, at risk of colliding with turbines at North Falls was calculated to be 0.02 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 5,438 pairs (GB, Wright *et al*., 2012), fewer than 0.0001 collisions per year are attributable to the Foulness SPA.

278. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.5.2 In-combination assessment

279. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that ringed plover migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.6 Bar-tailed godwit

4.4.3.6.6.1 Project alone assessment

280. The number of bar-tailed godwit at risk of colliding with turbines at North Falls was calculated to be 0.34 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 54,280 (GB and Ireland, Wright *et al*., 2012), 0.0532 collisions per year are attributable to the Foulness SPA.

281. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.6.2 In-combination assessment

282. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that bar-tailed godwit migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.7 Dark-bellied brent goose

4.4.3.6.7.1 Project alone assessment

283. The number of dark-bellied brent goose at risk of colliding with turbines at North Falls was calculated to be 2.14 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 91,000 (GB, Wright *et al*., 2012), 0.249 collisions per year are attributable to the Foulness SPA.

284. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.7.2 In-combination assessment

285. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that dark-bellied brent goose migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on

integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.8 Grey plover

4.4.3.6.8.1 Project alone assessment

286. The number of grey plover at risk of colliding with turbines at North Falls was calculated to be 0.30 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 49,315 (GB and Ireland, Wright *et al*., 2012), 0.0139 collisions per year are attributable to the Foulness SPA.

287. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.8.2 In-combination assessment

288. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that grey plover migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.9 Hen harrier

4.4.3.6.9.1 Project alone assessment

289. The number of hen harrier from the British non-breeding population, relevant to the SPA non-breeding population, at risk of colliding with turbines at North Falls was calculated to be 0.01 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 750 (UK, Wright *et al*., 2012), fewer than 0.0001 collisions per year are attributable to the Foulness SPA.

290. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.9.2 In-combination assessment

291. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that hen harrier migration activity is widespread along southern UK coasts and across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.10 Knot

4.4.3.6.10.1 Project alone assessment

292. The number of knot at risk of colliding with turbines at North Falls was calculated to be 0.84 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 338,970 (GB and Ireland, Wright *et al*., 2012), 0.0583 collisions per year are attributable to the Foulness SPA.

293. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.10.2 In-combination assessment

294. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that knot migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.11 Oystercatcher

4.4.3.6.11.1 Project alone assessment

295. The number of oystercatcher at risk of colliding with turbines at North Falls was calculated to be 0.68 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 320,000 (GB, Wright *et al*., 2012), 0.034 collisions per year are attributable to the Foulness SPA.

296. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.11.2 In-combination assessment

297. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that oystercatcher migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.12 Redshank

4.4.3.6.12.1 Project alone assessment

298. The number of redshank at risk of colliding with turbines at North Falls was calculated to be 1.76 using the SOSS-MAT tool, at an avoidance rate of 0.980. Assuming a national non-breeding population of 463,800 (advised total passage/wintering population across all races in British waters, Wright *et al*., 2012), 0.0074 collisions per year are attributable to the Foulness SPA.

299. This number of collisions would not result in detectable effects on this population. Therefore, no adverse effect on integrity is predicted for this SPA due to collision mortality of this species.

4.4.3.6.12.2 In-combination assessment

300. Based on the migration corridors identified by Wright *et al*. (2012), it is likely that redshank migration activity is widespread across southern UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality of this species.

4.4.3.6.13 Non-breeding waterbird assemblage

301. The Foulness SPA supports an assemblage of non-breeding waterbirds. The named component species are the migratory species listed as SPA qualifying features in Table 4.26 above plus:

- Shelduck
- Dunlin
- Curlew.

4.4.3.6.13.1 Project alone assessment

302. For all migratory species assessed individually, very small numbers of collisions during passage flights were predicted at North Falls array area. It was concluded in each case that the number of collisions would not result in detectable effects on the species population, and no adverse effect on integrity was predicted due to collision mortality of this species. As none of the named or other assemblage species have significant characteristics to their biometrics, migratory behaviour, migratory population or migration corridor which would markedly increase the rate of potential collisions, it is likely that this low rate of collisions would apply to all constituent species of the assemblage of non-breeding wetland birds, and that there would be no adverse effect on this qualifying feature.

4.4.3.6.13.2 In-combination assessment

303. Within the species-specific migration corridors identified by Wright *et al.* (2012), it is likely that for each species, migration activity would be widespread across UK waters, such that low numbers of birds, and hence collisions, might be expected at individual OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with the assemblage of non-breeding wetland birds at the Foulness SPA is likely to be very small. Therefore, no adverse effect on integrity is predicted for this SPA due to in-combination collision mortality.

4.4.4 Flamborough and Filey Coast SPA

4.4.4.1 SPA overview

304. The FFC SPA was designated in 2018. It is a geographical extension to the former Flamborough Head and Bempton Cliffs SPA, which was designated in 1993, to include Filey Cliffs, an additional section of coastline north. (Thus the FFC SPA now subsumes this previous designation).

305. The SPA is located on the Yorkshire coast between Bridlington and Scarborough, and is composed of two sections. The northern section runs from Cunstone Nab to Filey Brigg. The southern section runs from Speeton to South Landing, and includes Bempton Cliffs and Flamborough Head. The seaward boundary extends 2km offshore and applies to both sections of the SPA. The proposed North Falls array is located approximately 288km south from FFC SPA at its closest point.

306. The predominantly chalk cliffs of Flamborough Head rise to 135m and have been eroded into a series of bays, arches, pinnacles and gullies, as well as sheer cliffs. The cliffs from Filey Brigg to Cunstone Nab are formed from various sedimentary rocks including shales and sandstones. The adjacent sea out to 2km is characterised by reefs supporting kelp forest communities in the shallow subtidal,

and faunal turf communities in deeper water. The southern side of Filey Brigg shelves off gently from the rocks to the sandy bottom of Filey Bay.

307. The SPA cliffs support internationally important breeding colonies of seabirds. The marine extension is used by seabirds from these colonies for behaviours such as loafing, preening and courtship.

4.4.4.2 Conservation Objectives

308. The SPA's conservation objectives are to 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; and
- The distribution of qualifying features within the site.

4.4.4.3 Shadow Appropriate Assessment

309. All qualifying species of this designated site have been screened into the shadow Appropriate Assessment (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1). These are breeding gannet, breeding kittiwake, breeding guillemot, and breeding razorbill. The breeding seabird assemblage is also a qualifying feature.

4.4.4.4 Gannet

4.4.4.4.1 Status

310. Within the FFC SPA, gannets nest along a 5km stretch of the Bempton Cliffs. Numbers have increased steadily since the colony was established in the 1930s (Cramp *et al.*, 1974). Aitken *et al.*, (2017)) gives counts of 2,552 pairs in 1999 and 6,386 in 2008, demonstrating that colony size more than doubled over this period. JNCC (2021) indicates that on average, the colony grew by 700 pairs each year between 2009 and 2017, with the growth rate of the population increasing after 2000 and the potential for further increase apparent from the large numbers of sub-adult birds associated with the colony (Langston *et al.*, 2013; Aitken *et al.* 2017). The colony counts between 1986 and 2023, along with a linear trend line (as fitted to the count data), are presented in Plate 4.2. Between 1986 and 2017, the average annual increase in counts of apparently occupied nests was 12%, whilst it was 4% over the period 2012 to 2017, indicating a slowing of the growth rate in more recent years. In 2022 an outbreak of Highly Pathogenic Avian Influenza (HPAI) occurred at the gannet colony, described as a localised but major impact by Butcher *et al.* (2023); and resulting in the whole colony count for 2022 being lower than in 2017. A repeat count in 2023 found gannet numbers had increased compared to 2022 and 2017 (Plate 4.2), despite evidence of a small number of HPAI infected adults and chicks in 2023.

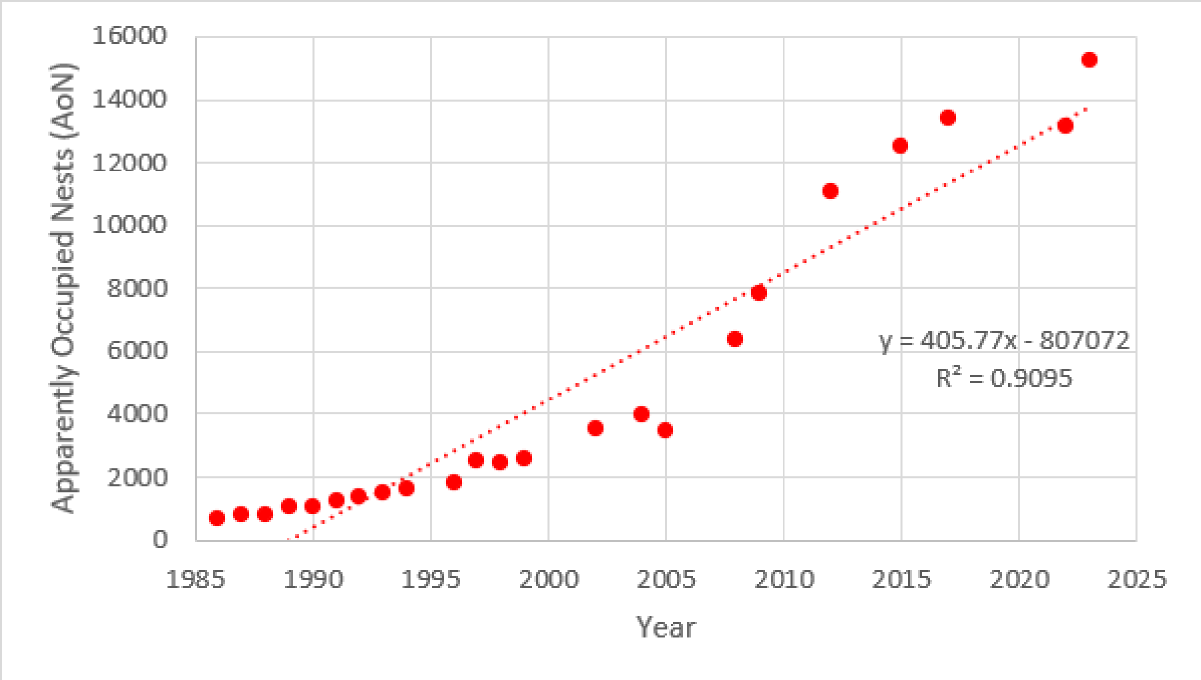

Plate 4.2 Gannet Counts (ANO) at the FFC SPA between 1986 and 2023, with Linear Trendline

311. The cited SPA breeding population at classification was 8,469 pairs (equivalent to 16,938 breeding adults), based on the mean count for the period 2008 to 2012; with subsequent whole colony counts of 12,494 and 13,392 pairs respectively in 2015 and 2017 (NE, 2023f). Whole colony counts in 2022 and 2023 recorded 13,125 pairs and 15,233 pairs respectively (Clarkson *et al.*, 2022; Butcher *et al.* 2023; SMP database). The mean of these two most recent counts (14,179 pairs, or 28,358 adults) is used as the reference population for the assessment. Using the published adult mortality rate of 8.1% (Horswill and Robinson, 2015), 2,297 birds would be expected to die annually from the breeding adult population of 28,358 individuals under baseline conditions.

312. NE SACOs for gannet at the FFC SPA (NE, 2023f) are as follows:

- Maintain the size of the breeding population at a level which is above 8,469 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent;
- Maintain safe passage of birds moving between nesting and feeding areas;
- Restrict the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed;
- Restrict predation and disturbance caused by native and non-native predators;
- [Maintain or recover] productivity so that breeding success is maximised within the constraints of the site.
- Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System;

- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised;
- Maintain the extent, distribution and availability of suitable breeding habitat which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) at: current extent;
- Maintain the distribution, abundance and availability of key food and prey items (e.g. herring, mackerel, sprat, sandeel) at preferred sizes;
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels;
- Maintain the dissolved oxygen concentration at levels equating to High Ecological Status (specifically ≥5.7mg per litre (at 35 salinity) for 95% of the year), avoiding deterioration from existing levels;
- Maintain water quality and specifically mean winter dissolved inorganic nitrogen at a concentration equating to High Ecological Status (specifically mean winter dissolved inorganic nitrogen is <12µM for coastal waters), avoiding deterioration from existing levels;
- Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels; and
- Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

4.4.4.4.2 Functional Linkage and Seasonal Apportionment of Potential Effects

4.4.4.4.2.1 Breeding Season

313. The North Falls array area is 297 km from the FFC SPA based on the closest distance by sea between the array area and the SPA boundary (288 km straight line distance including land crossing).

314. NE (2022a) advises that MMFR + 1SD, based on the latest review of tracking studies of breeding adults by Woodward *et al.* (2019), is used to identify breeding seabird colonies with potential connectivity with an SPA, subject to a check of any colony-specific foraging range data. The MMFR of gannet is 315.2km and the SD is 194.2km, giving a total MMFR + 1SD of 509.4 km. The mean maximum breeding season foraging range of gannet from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 229.4km (±124.3km) based on data from seven studies. The updated review of Woodward *et al.* (2019), based on data from 21 studies, gives a considerably larger MMFR.

315. Modelled at-sea utilisation distributions of adult birds from the FFC SPA during the breeding season have been published, based on GPS tracking data (Langston *et al.*, 2013; Wakefield *et al.*, 2013). Tracked birds tended to fly out to the east, east-north-east and east-south-east of the breeding colony, and none travelled further south than Great Yarmouth on the Norfolk coast, so none of the flight paths were within about 100km of the North Falls array area. These data

indicate that the North Falls array area is beyond the foraging range (as indicated by the flight paths of individual birds and the 95% utilisation distribution from Kernel Density Estimation) of gannets breeding at FFC SPA. There is clearly theoretical connectivity between the SPA and the array area during the breeding season based on the potential extent of the foraging range (MMFR + 1SD), but the evidence from the available tracking data suggests that the array area and the habitats surrounding are not of any importance to the SPA population of breeding adult gannets during the breeding season and are, at most, little used by these birds.

316. The array area is not within MMFR+1SD of breeding gannets from any other SPA. At 560 km from the Forth Islands SPA, the North Falls array area is within maximum foraging range (709 km, Woodward *et al.* 2019) of breeding gannets from this SPA. However, foraging range data presented by Wakefield *et al.* (2013) indicate that gannets breeding at the Forth Islands SPA are highly unlikely to occur at the array area during the breeding season. This is thought to be due to the distance between the SPA and the array area, and the fact that the foraging ranges of gannets from different breeding colonies tend not to overlap. Furthermore, extensive tracking data from adult gannets from the Forth Islands SPA show no evidence of usage of waters as far south as the array area and 2km buffer during the breeding season (Lane *et al.* 2020).

317. Adult plumage gannets present at the North Falls array area during the full breeding season (March to September; Furness, 2015) are therefore assumed to originate from the FFC SPA, even though it seems likely that a high proportion of these birds will be non-breeding adults.

318. In addition, some of the gannets recorded at the array area during the breeding season will be sub-adult birds. During the full breeding season, of 147 gannets recorded during the baseline surveys of the North Falls study area, 98 were assigned to an age class, and of these, 68 birds (69.4% of those assigned to an age class) were classified as adults on the basis of plumage (ES Appendix 13.2 (Document Reference: 3.3.13), Section 2.2.2.3, Table 2.11), It is therefore assumed, on a highly precautionary basis, that this proportion of the gannets recorded at North Falls during the full breeding season are breeding adult birds from the FFC SPA.

4.4.4.4.2.2 Non-breeding seasons

319. Outside the breeding season, adult gannets from breeding colony populations, including the FFC SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. During this time, they are assumed to range more widely and to mix with gannets of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea and Channel BDMPS. This consists of 456,298 individuals during autumn migration (September to November), and 248,385 individuals during spring migration (December to March) (Furness, 2015).

320. During autumn migration, all of the FFC SPA breeding adults are thought to be present in the BDMPS, representing 4.8% of the total BDMPS population (an estimated 22,122 individuals from FFC SPA (2012 population) from a total population of 456,298 individuals; Furness, 2015). It is therefore assumed that the percentage of gannets recorded at North Falls during the autumn migration season that are breeding adult birds from the FFC SPA is 4.8%.

321. During spring migration 70% of FFC SPA breeding adults are thought to be present in the BDMPS, representing 6.2% of the BDMPS population (an estimated 15,485 individuals (2012) from a total population of 248,385 individuals). It is therefore assumed in the autumn migration season that the percentage of gannets recorded during the North Falls surveys that are adult birds from the FFC SPA is 6.2%.

4.4.4.4.3 Potential effects on the qualifying feature

322. The gannet qualifying feature of the FFC SPA has been screened into the shadow Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects and collision.

4.4.4.4.3.1 Project alone assessment

4.4.4.4.3.1.1 Effect: Operational phase displacement / barrier effects

323. As stated in ES Chapter 13, Section 13.6.2.1 (Document Reference: 3.1.15) for the purposes of assessment of birds present in an OWF site during a given season, it is usually not possible to distinguish between displacement and barrier effects, i.e. to define whether individual birds may have intended to travel to, or beyond an OWF site, even when tracking data are available. Therefore, in this assessment the effects of displacement and barrier effects on gannet are considered together.

324. During the breeding season, displacement from an OWF might also affect the body condition, and hence survival, of chicks (which depend on parent birds to deliver food until they leave the nest). In the absence of empirical evidence of this effect, and guidance on its incorporation in displacement assessments, the assessment presented here focuses on potential effects on the survival of adult birds breeding at FFC SPA (as is the basis of the approach of the SNCB (2017) displacement guidance).

325. The assessment assumes that a proportion of the birds present in the North Falls array area and 2km buffer would be displaced during the operation of the OWF, and that a proportion of displaced birds would die as a result of displacement (SNCBs, 2017). Abundance estimates for gannet for the array area and its 2km buffer, apportioned to the FFC SPA breeding population, have been used to produce displacement matrices. Mean peak seasonal and annual populations at the North Falls array area and 2km buffer, and the numbers of breeding adults apportioned to the FFC SPA, are given in Table 4.27.

Table 4.27 Seasonal and annual populations of gannets at the North Falls array area and 2km buffer, and numbers apportioned to FFC SPA,

Period	Breeding Season	Autumn Migration	Spring Migration	Annual
	Mar-Sep	Oct-Nov	Dec-Feb	Jan-Dec
Mean peak population (95% CLs)*	69 (6-173)	287 (105-575)	290 (19-658)	645 (129 – 1,406)
% attributed to FFC SPA (population of breeding adults)	69.4%	4.8%	6.2%	
Numbers apportioned to the FFC SPA (population of breeding adults)	48 (4-120)	14 (5-28)	18 (2 – 41)	80 (10 – 188)
*From ES Appendix 13.2 (Document Reference: 3.3.13).				

326. Based on advice from NE (comments on the outline method statement for North Falls, ES Appendix 13.1 (Document Refence: 3.3.12), Section 1.1.3) displacement rates of 60% to 80% are considered. These rates are in line with recent research on gannet displacement by OWFs (Cook *et al.* 2018, Peschko *et al.*, 2021, Pavat *et al.*, 2023) and the findings of Skov *et al.* (2018).

327. The mortality rate of displaced birds due to displacement is assumed to be a maximum of 1%. This value has been selected because gannet is known to possess high habitat flexibility (Furness and Wade, 2012) and an extensive foraging range in the breeding season (Woodward *et al.*, 2019). This suggests that displaced birds will readily find alternative habitats, including for the purposes of foraging. Displacement assessments based on 1% mortality of displaced gannets have been undertaken for OWFs recently undergoing DCO examination (e.g. Sheringham and Dudgeon Extension Projects (SEP&DEP), the most recently consented sites). The use of 1% as a precautionary value is backed-up by a review of the evidence for mortality rates of displaced gannets (APEM, 2022) which considers studies using simulation models of displacement to predict changes in mortality rates and inferred evidence from increasing numbers of gannets breeding at Heligoland in the German North Sea, where OWFs have been in operation since 2014. The review suggests that mortality rates for displaced gannets are negligible or less than 1% during the breeding and non-breeding season. For a detailed review of displacement effects on gannets from OWFs refer to ES Chapter 13 Offshore Ornithology (Document Reference: 3.1.15).

328. At displacement rates of 60% to 80% and a mortality rate of 1% for displaced birds, 0-1 SPA breeding adults would be predicted to die each year due to displacement from the array area and 2km buffer (with the ranges around this value as defined by the 95% CLs for the mean peak abundance being: 95% LCL zero breeding adults, 95% UCL 1-2 breeding adults) (Table 4.28).

329. The above estimates of potential mortality due to displacement are equivalent to an increase in annual mortality rate for the FFC SPA breeding population of 0.02% to 0.03% due to displacement impacts from North Falls alone (with the ranges around those values as defined by the 95% CLs for the mean peak abundance being: 95% LCL 0.00-0.00%; 95% UCL 0.05% to 0.07%) (Table 4.29).

330. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in the baseline annual mortality rates would occur under any combination of the range of displacement and mortality rates considered.

331. It is also noted that over 50% of the annual displacement mortality is predicted to occur during the breeding season (Table 4.27). The assumption of breeding season connectivity with North Falls is highly precautionary, given that during a tracking study, none of the tagged gannets breeding at the FFC SPA travelled as far south as the North Falls array area (Section 4.4.4.4.2, breeding season). Thus, it is considered that the annual mortality of gannets at North Falls from displacement has been over-estimated.

332. It is concluded that predicted gannet mortality due to operational phase displacement at North Falls alone would not adversely affect the integrity of the FFC SPA.

Table 4.28 Displacement matrix for FFC SPA gannet for the project alone. The cells show the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality (LCL and UCL = upper and lower 95% confidence limits). Grey cells identify the range of displacement and mortality rates considered in the assessment. Red text identifies values of predicted mortality which represent a 1% or more increase in the population mortality rate (with reference to Table 4.29)

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0	0	0	0	0	1	2	2	4	6	8
	20%	0	0	0	1	1	2	3	5	8	13	16
	30%	0	0	1	1	1	2	5	7	12	19	24
	40%	0	1	1	1	2	3	6	10	16	25	32
	50%	0	1	1	2	2	4	8	12	20	32	40
	60%	0	1	1	2	2	5	10	14	24	38	48
	70%	1	1	2	2	3	6	11	17	28	45	56
	80%	1	1	2	3	3	6	13	19	32	51	64
	90%	1	1	2	3	4	7	14	22	36	57	72
	100%	1	2	2	3	4	8	16	24	40	64	80

LCL	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0	0	0	0	0	0	0	0	1	1	1
	20%	0	0	0	0	0	0	0	1	1	2	2
	30%	0	0	0	0	0	0	1	1	2	2	3
	40%	0	0	0	0	0	0	1	1	2	3	4
	50%	0	0	0	0	0	1	1	2	3	4	5
	60%	0	0	0	0	0	1	1	2	3	5	6
	70%	0	0	0	0	0	1	1	2	4	6	7
	80%	0	0	0	0	0	1	2	2	4	7	8
	90%	0	0	0	0	0	1	2	3	5	7	9
	100%	0	0	0	0	1	1	2	3	5	8	10

UCL	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0	0	1	1	1	2	4	6	9	15	19
	20%	0	1	1	2	2	4	8	11	19	30	38
	30%	1	1	2	2	3	6	11	17	28	45	57
	40%	1	2	2	3	4	8	15	23	38	60	75
	50%	1	2	3	4	5	9	19	28	47	75	94
	60%	1	2	3	5	6	11	23	34	57	90	113
	70%	1	3	4	5	7	13	26	40	66	106	132
	80%	2	3	5	6	8	15	30	45	75	121	151
	90%	2	3	5	7	8	17	34	51	85	136	170
	100%	2	4	6	8	9	19	38	57	94	151	188

Table 4.29 Displacement matrix for FFC SPA gannet for the project alone. The cells show the % increase in the mortality rate of the SPA population associated with the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality given in Table 4.28 (LCL and UCL = upper and lower 95% confidence limits). Grey cells identify the range of displacement and mortality rates considered in the assessment.

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0.00%	0.01%	0.01%	0.01%	0.02%	0.03%	0.07%	0.10%	0.17%	0.28%	0.35%
	20%	0.01%	0.01%	0.02%	0.03%	0.03%	0.07%	0.14%	0.21%	0.35%	0.55%	0.69%
	30%	0.01%	0.02%	0.03%	0.04%	0.05%	0.10%	0.21%	0.31%	0.52%	0.83%	1.04%
	40%	0.01%	0.03%	0.04%	0.06%	0.07%	0.14%	0.28%	0.42%	0.69%	1.11%	1.39%
	50%	0.02%	0.03%	0.05%	0.07%	0.09%	0.17%	0.35%	0.52%	0.87%	1.39%	1.73%
	60%	0.02%	0.04%	0.06%	0.08%	0.10%	0.21%	0.42%	0.62%	1.04%	1.66%	2.08%
	70%	0.02%	0.05%	0.07%	0.10%	0.12%	0.24%	0.49%	0.73%	1.21%	1.94%	2.43%
	80%	0.03%	0.06%	0.08%	0.11%	0.14%	0.28%	0.55%	0.83%	1.39%	2.22%	2.77%
	90%	0.03%	0.06%	0.09%	0.12%	0.16%	0.31%	0.62%	0.94%	1.56%	2.50%	3.12%
	100%	0.03%	0.07%	0.10%	0.14%	0.17%	0.35%	0.69%	1.04%	1.73%	2.77%	3.47%
LCL	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.02%	0.04%	0.05%
	20%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.03%	0.05%	0.07%	0.09%
	30%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.03%	0.04%	0.07%	0.11%	0.14%
	40%	0.00%	0.00%	0.01%	0.01%	0.01%	0.02%	0.04%	0.05%	0.09%	0.14%	0.18%
	50%	0.00%	0.00%	0.01%	0.01%	0.01%	0.02%	0.05%	0.07%	0.11%	0.18%	0.23%
	60%	0.00%	0.01%	0.01%	0.01%	0.01%	0.03%	0.05%	0.08%	0.14%	0.22%	0.27%
	70%	0.00%	0.01%	0.01%	0.01%	0.02%	0.03%	0.06%	0.09%	0.16%	0.25%	0.32%
	80%	0.00%	0.01%	0.01%	0.01%	0.02%	0.04%	0.07%	0.11%	0.18%	0.29%	0.36%
	90%	0.00%	0.01%	0.01%	0.02%	0.02%	0.04%	0.08%	0.12%	0.20%	0.33%	0.41%
	100%	0.00%	0.01%	0.01%	0.02%	0.02%	0.05%	0.09%	0.14%	0.23%	0.36%	0.45%
UCL	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0.01%	0.02%	0.02%	0.03%	0.04%	0.08%	0.16%	0.25%	0.41%	0.66%	0.82%
	20%	0.02%	0.03%	0.05%	0.07%	0.08%	0.16%	0.33%	0.49%	0.82%	1.31%	1.64%
	30%	0.02%	0.05%	0.07%	0.10%	0.12%	0.25%	0.49%	0.74%	1.23%	1.97%	2.46%
	40%	0.03%	0.07%	0.10%	0.13%	0.16%	0.33%	0.66%	0.98%	1.64%	2.63%	3.28%
	50%	0.04%	0.08%	0.12%	0.16%	0.21%	0.41%	0.82%	1.23%	2.05%	3.28%	4.10%
	60%	0.05%	0.10%	0.15%	0.20%	0.25%	0.49%	0.98%	1.48%	2.46%	3.94%	4.92%
	70%	0.06%	0.11%	0.17%	0.23%	0.29%	0.57%	1.15%	1.72%	2.87%	4.59%	5.74%
	80%	0.07%	0.13%	0.20%	0.26%	0.33%	0.66%	1.31%	1.97%	3.28%	5.25%	6.56%
	90%	0.07%	0.15%	0.22%	0.30%	0.37%	0.74%	1.48%	2.22%	3.69%	5.91%	7.38%
	100%	0.08%	0.16%	0.25%	0.33%	0.41%	0.82%	1.64%	2.46%	4.10%	6.56%	8.20%

4.4.4.4.3.1.2 Effect: Collision risk

333. Information for collision risk to adult gannets belonging to the FFC SPA breeding population (based on the 'worst case' MiRD Scenario, Section 4.2.2) is presented in Table 4.30. Collision estimates, calculated using the sCRM (McGregor *et al.,* 2018), are presented by biological season. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is also presented. Parameters used in the sCRM were agreed with NE during the ETG process and are described in Chapter 13 Offshore Ornithology (Document Reference: 3.1.15) and ES Appendix 13.2 Offshore Ornithology Technical Report (Document Reference: 3.3.13) of the ES. In accordance with NE advice, a 70% macro-avoidance correction was applied to gannet density data (i.e. for birds in flight within the array area) used in the sCRM.

Table 4.30 Predicted seasonal and annual collision mortality for breeding adult gannets at the array area as apportioned to FFC SPA, with corresponding increases to baseline mortality of the population

Period	Breeding Season	Autumn Migration	Spring Migration	Annual
	Mar-Sep	Oct-Nov	Dec-Feb	Jan-Dec
Total collisions[1] (mean and 95% CIs)	0.57 (0.03-1.78)	0.89 (0.13-2.35)	0.64 (0.03-2.11)	2.10 (0.18-6.24)
% apportioned to the SPA (population of breeding adults)	69.4%	4.8%	6.2%	-
Total SPA collisions (apportioned to the FFC SPA population of breeding adults) (mean and 95% CIs)	0.40 (0.02-1.23)	0.04 (0.01-0.11)	0.04 (0.00-0.11)	0.48 (0.03-1.48)
Mortality increase[2] (mean and 95% CIs)	0.02% (0.00-0.05%)	0.00% (0.00-0.00%)	0.00% (0.00-0.01%)	0.02% (0.00-0.06%)

[1] Based on worst case MiRD Scenario. sCRM Option 2, avoidance rate 0.9928 (±0.0003), plus 70% macro-avoidance; monthly collision risk predictions in ES Appendix 13.2 (Document Reference: 3.3.13).

[2] Background annual mortality of FFC SPA 2,297 birds, assuming reference population of 28,358 birds and adult mortality of 8.1% (Horswill and Robinson, 2015)

334. Based on the mean collision rates, the annual total of breeding adult gannets from FFC SPA at risk of collision as a result of the Project is 0.5 (95% CLs 0.0-1.5). This would increase the existing mortality of the SPA breeding population by 0.02% (95% CLs 0.00-0.06%).

335. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CI value is used, since this upper value gives a predicted mortality increase of 0.06%.

336. As for displacement, more than 50% of the predicted annual collision mortality is during the breeding season, for which the assumption of breeding season connectivity between the FFC SPA and North Falls is highly precautionary (see paragraph 331 above). Thus, even at 0.5 birds per annum, the annual collision risk may be an over-estimate.

337. It is concluded that predicted gannet mortality due to collision at North Falls would not adversely affect the integrity of the FFC SPA.

4.4.4.4.3.1.3 Effect: Combined Displacement/Barrier Effects and Collision Risk

338. The mean (plus 95% CLs) combined displacement and collision rates from North Falls alone, apportioned to adult gannets from the FFC SPA breeding population are presented in Table 4.31.

Table 4.31 Predicted annual mean and 95% CLs displacement and collision mortality of FFC SPA breeding adult gannets at the North Falls array area, along with increases to existing annual mortality of the population

Annual displacement mortality[1]	Annual collision mortality	Annual displacement and collision mortality	% annual mortality increase[2]
0.6 (0.1-1.3)	0.5 (0.0-1.5)	1.1 (0.1-2.8)	0.05% (0.00-0.12%)

[1] Assumes displacement rate of 0.700 and mortality rate of 1% of displaced birds.

[2] Background annual mortality of FFC SPA 2,297 birds, assuming reference population of 28,358 birds and adult mortality of 8.1% (Horswill and Robinson, 2015)

339. The estimated annual combined mortality is 1.1 birds (95% CIs 0.1-2.8). This would increase the existing mortality of the SPA breeding population by 0.05% (95% CLs 0 – 0.12%). Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates are likely in a typical year of impacts due to the Project.

340. As above, more than 50% of the predicted displacement and collision mortality occurs during the breeding season, when the assumption of connectivity between the SPA breeding population of gannet is highly precautionary (Section 4.4.4.4.2, breeding season; paragraphs 331 and 336) such that the combined annual mortality from collision and displacement is considered to be an over-estimate.

341. It is concluded that based on predicted gannet mortality due to the combined effects of operational phase displacement and collision there is no potential for North Falls alone to have an adverse effect on the integrity of the FFC SPA.

4.4.4.4.3.2 In-combination assessment

4.4.4.4.3.2.1 Effect: Operational phase displacement / barrier effects

342. Based on the Project alone assessment of very low predicted gannet mortality due to operational displacement and collision risk, a mean of 1.1 birds equivalent to a substantially <0.1% increase in background mortality, there would be no material contribution of the Project to in-combination effects. Accordingly, no in-combination assessment is required for this feature. The conclusion of the assessment is therefore that predicted gannet mortality due to displacement and barrier effects would not adversely affect the integrity of the FFC SPA, either for the project alone or in-combination.

343. Notwithstanding this conclusion, an estimate of in-combination mortality and a PVA is provided below, to provide context to the Project alone assessment. The in-combination mortality is presented separately for each of the displacement and collision effects, as well as for both effects combined. This information is presented without prejudice to the conclusion above.

344. Seasonal and annual population estimates of breeding gannets at risk of displacement at all OWFs included in the in-combination assessment are presented in Table 4.32 along with the numbers apportioned to the FFC SPA. This information and breeding season apportioning was taken primarily from the numbers presented at Deadline 8 of the DCO Examination for SEP&DEP (Royal HaskoningDHV 2023a) but updated with new information that has become available since then for some OWFs (see Table 4.32).

345. The cut off for inclusion of other OWFs into the in-combination assessment was the end of March 2024, as the calculations and checks underpinning the in-combination assessment had been completed by this time. Since this cut-off, Green Volt and Sheringham Shoal and Dudgeon Extension Projects have been consented; and the ESs for three OWFs, Dogger Bank South, Five Estuaries and Outer Dowsing, have been submitted. It is understood that no changes to the predicted displacement and collision mortalities for the two consented sites have been made after March 2024. However, for Dogger Bank South, Five Estuaries and Outer Dowsing, the in-combination assessment here is based on predicted displacement and collision mortalities from the PEIR for each project, and has not been updated to reflect any changes in the ESs that accompanied the DCO submission.

346. The estimated annual total of breeding adult gannets from FFC SPA present and at risk of displacement from all OWFs within the UK North Sea BDMPS combined is 10,530 (Table 4.32). Of this total, North Falls contributes 0.8% (80 birds). Using displacement rates of 60% to 80% and a mortality rate of 1% of displaced birds, between 63 and 84 breeding adults from the FFC SPA population are predicted to die each year (Table 4.33).

Table 4.32 Seasonal and annual population estimates of gannets at risk of displacement at North Falls and other OWFs included in the in-combination assessment; and apportionment (breeding adult birds) to the FFC SPA

Tier	OWF	Seasonal Population at Risk of Displacement[1]							
		Breeding		Autumn Migration		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Beatrice	151	0	0	0	0	0	151	0.0
1	Beatrice Demonstrator	No estimate available							
1	Blyth Demonstration	No estimate available							
1	Dudgeon	53	53	25	1	11	1	89	54.9
1	East Anglia ONE	161	161	3638	175	76	5	3875	340.3
1	EOWDC (Aberdeen)	35	0	5	0.2	0	0	40	0.2
1	Galloper	360	0	907	44	276	17	1543	60.6
1	Greater Gabbard	252	0	69	3	105	7	426	9.8
1	Gunfleet Sands	0	0	12	1	9	1	21	1.1
1	Hornsea Project One	671	671	694	33	250	16	1615	719.8
1	Hornsea Project Two	457	457	1140	55	124	8	1721	519.4
1	Humber Gateway	No estimate available							
1	Hywind	10	0	0	0	4	0.2	14	0.2
1	Kentish Flats	No estimate available							
1	Kentish Flats Extension	0	0	13	1	0	0	13	0.6
1	Kincardine	120	0	0	0	0	0	120	0.0
1	Lincs, Lynn and Inner Dowsing	No estimate available							
1	London Array	No estimate available							

Tier	OWF	Seasonal Population at Risk of Displacement[1]							
		Breeding		Autumn Migration		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Methil	23	0	0	0	0	0	23	0.0
1	Moray Firth East	564	0	292	14	27	2	883	15.7
1	Race Bank	92	92	32	2	29	2	153	95.3
1	Rampion	0	0	590	28	0	0	590	28.3
1	Scroby Sands	No estimate available							
1	Sheringham Shoal	47	47	31	1	2	0.1	80	48.6
1	Teesside	1	0.5	0	0	0	0	1	0.5
1	Thanet	No estimate available							
1	Triton Knoll	211	211	15	1	24	1	250	213.2
1	Westermost Rough	No estimate available							
2	Dogger Bank (formerly Creyke Beck) A and B	1155	578	2048	98	394	24	3597	700.2
2	Dogger Bank C (formerly Teesside A) and Sofia (formerly Teesside B)	2250	1125	887	43	464	29	3601	1196.3
2	Moray West	2827	0	439	21	144	9	3410	30.0
2	Neart na Gaoithe	1987	0	552	26	281	17	2820	43.9
2	Firth of Forth (Seagreen) Alpha and Bravo	2956	0	664	32	332	21	3952	52.5
3	East Anglia ONE North	149	149	468	22	44	3	661	174.2
3	East Anglia THREE	412	412	1269	61	524	32	2205	505.4
3	East Anglia TWO	192	192	891	43	192	12	1275	246.7
3	Hornsea Project Three	1333	844	984	47	524	32	2841	923.7

Tier	OWF	Seasonal Population at Risk of Displacement[1]							
		Breeding		Autumn Migration		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
3	Hornsea Project Four	976	883	790	38	401	25	2167	945.9
3	Inch Cape	2398	0	703	34	212	13	3313	46.9
3	Norfolk Boreas	1229	1229	1723	83	526	33	3478	1344.3
3	Norfolk Vanguard	271	271	2453	118	437	27	3161	415.8
Total (tier 1-3 projects)[2]		21343	7375	21334	1024	5412	336	48089	8735
3	Green Volt[3]	120	2	16	1	49	4	256	7.6
3	SEP&DEP	440	337	638	31	58	4	1136	371.6
4	Berwick Bank[4]	4735	55	1500	72	269	17	6504	143.5
4	Dogger Bank South[5]	1038	519	1020	49	17	1	2075	569.0
4	Five Estuaries[6]	233	78	640	31	67	4	940	112.8
4	Outer Dowsing[7]	847	419	169	8	172	11	1188	437.9
4	Rampion 2[8]	111	0	102	5	123	8	336	12.5
4	West of Orkney[9]	958	0	1171	56	77	5	2206	61.0
	North Falls[10]	69	48	287	14	290	18	646	79.6
Total (all projects)		**29894**	**8834**	**26877**	**1290**	**6535**	**406**	**63304**	**10530**

1. Seasonal and annual populations of gannets within the OWF array and buffer (2km in most cases, but the buffer zones included in this assessment varied between 0-4km depending on the data available) and the numbers apportioned to the FFCFFC SPA. Numbers and breeding season apportioning based on Royal HaskoningDHV (2023a) and updated for OWFs where new information has become available, see footnotes below: 2. Total does not include Green Volt and Sheringham and Dudgeon Extension Projects, consented after the cut-off date of end March 2024 for updates to the North Falls offshore ornithology assessment. 3 APEM (2023a), Royal HaskoningDHV (2023b); 4 Pelagica and Cork Ecology (2022), Royal HaskoningDHV (2022b); 5. RWE (2023), 50% apportioning during the breeding season, as for other Dogger Bank Projects. 6. GoBe (2023c, d). 7. GoBe (2023e), GoBe and SLR (2023). 8. GoBe (2023a, b), 8. MacArthur Green (2023); 10. Table 4.27.

Table 4.33 In-combination displacement matrix for FFC SPA gannet. The cells show the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality. Grey cells identify the range of displacement and mortality rates considered in the assessment. Red text identifies values of predicted mortality which represent a 1% or more increase in the population mortality rate (with reference to Table 4.34)

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	11	21	32	42	53	105	211	316	527	842	1053
	20%	19	38	57	76	95	190	379	569	948	1516	1895
	30%	32	63	95	126	158	316	632	948	1580	2527	3159
	40%	42	84	126	168	211	421	842	1264	2106	3370	4212
	50%	53	105	158	211	263	527	1053	1580	2633	4212	5265
	60%	63	126	190	253	316	632	1264	1895	3159	5055	6318
	70%	74	147	221	295	369	737	1474	2211	3686	5897	7371
	80%	84	168	253	337	421	842	1685	2527	4212	6739	8424
	90%	95	190	284	379	474	948	1895	2843	4739	7582	9477
	100%	105	211	316	421	527	1053	2106	3159	5265	8424	10530

Table 4.34 In-combination displacement matrix for FFC SPA gannet. The cells show the % increase in the mortality rate of the SPA population associated with the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality given in Table 4.33. Grey cells identify the range of displacement and mortality rates considered in the assessment.

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0.5%	0.9%	1.4%	1.8%	2.3%	4.6%	9.2%	13.8%	23.1%	36.9%	46.1%
	20%	0.8%	1.7%	2.5%	3.3%	4.2%	8.3%	16.6%	24.9%	41.5%	66.5%	83.1%
	30%	1.4%	2.8%	4.2%	5.5%	6.9%	13.8%	27.7%	41.5%	69.2%	110.8%	138.4%
	40%	1.8%	3.7%	5.5%	7.4%	9.2%	18.5%	36.9%	55.4%	92.3%	147.7%	184.6%
	50%	2.3%	4.6%	6.9%	9.2%	11.5%	23.1%	46.1%	69.2%	115.4%	184.6%	230.7%
	60%	2.8%	5.5%	8.3%	11.1%	13.8%	27.7%	55.4%	83.1%	138.4%	221.5%	276.9%
	70%	3.2%	6.5%	9.7%	12.9%	16.2%	32.3%	64.6%	96.9%	161.5%	258.4%	323.0%
	80%	3.7%	7.4%	11.1%	14.8%	18.5%	36.9%	73.8%	110.8%	184.6%	295.3%	369.2%
	90%	4.2%	8.3%	12.5%	16.6%	20.8%	41.5%	83.1%	124.6%	207.7%	332.3%	415.3%
	100%	4.6%	9.2%	13.8%	18.5%	23.1%	46.1%	92.3%	138.4%	230.7%	369.2%	461.5%

347. The estimated increase in mortality of FFC SPA breeding gannets due to in-combination displacement impacts is between 2.8% and 3.7% (based on a population size of 28,358 breeding adults and a baseline annual adult mortality rate of 8.1%, Horswill and Robinson 2015). Increases in the existing mortality rate of greater than 1% could be detectable against natural variation.

348. PVA for the FFC SPA population is presented below for the combined in-combination displacement and collision impacts.

4.4.4.4.3.2.2 Effect: Collision risk

349. Seasonal and annual totals of estimated collision mortality of adult gannets from the FFC SPA breeding population at all OWFs included in the in-combination assessment are presented in Table 4.35. This information was taken primarily from the numbers presented at Deadline 8 of the DCO Examination for SEP&DEP (Royal HaskoningDHV 2023a) but updated with new information that has since become available for some OWFs (see Table 4.35).

350. The latest advice from NE for gannet sCRM recommends that (i) gannet densities from baseline surveys within OWF array areas should be reduced by 70% to account for high macro-avoidance; (ii) that the avoidance rate for collision risk modelling is increased from 0.989 to 0.9928 (±0.0003) for the stochastic (MacGregor *et al.*, 2018) model, and 0.9924 (±0.0001) for the deterministic Band (2012) model; and (iii) and the nocturnal activity factor (the proportion of birds estimated to be active at night compared with daytime) for this species is reduced from 0.1-0.2 to 0.08 (±0.10). To reflect the most recent NE advice and increase parity between collision risk estimates from OWFs included in the in-combination assessment, collision predictions in Table 4.35 have been adjusted for 70% macro-avoidance and updated avoidance rates; no adjustment for nocturnal activity factor was made (see ES Appendix 13.3 (Document Reference: 3.3.14 for full details of the calculations).

351. Collision rates for other OWFs in English waters included in the in-combination assessment are based largely on consented OWF designs. This represents a highly precautionary position, since many OWFs are built out with smaller numbers of larger turbines than the consented design. These will have substantially lower collision rates, particularly in cases where the as-built nameplate capacity is lower than the consented nameplate capacity (notes in ES Appendix 13.3, Table 2.1 (Document Reference: 3.3.14), indicate where there is a substantial difference between consented and installed designs). Previous estimates indicate that using as-built OWF designs would reduce in-combination collision rates for gannet at the FFC SPA by 32% (Trinder, 2017). Whilst the collision risk for the as-built scenario represents the most realistic estimate, these OWF designs are not considered to be legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, though extremely unlikely, possibility of additional turbines being added to the design of existing OWFs without requirement for further consent. As a result, CRM outputs using as-built OWF designs in English OWFs are not presented. For OWFs in Scottish waters collision risk estimates for the as-built designs, if different from consented designs (and if available), are used, as these are accepted by Marine Scotland and NatureScot. This source of overestimation in the predicted collision risk should be considered during the interpretation of CRM outputs.

Table 4.35 Seasonal and annual collision risk estimates of gannets at North Falls and other OWFs included in the in-combination assessment; and apportionment (breeding adult birds) to the FFC SPA

Tier	OWF	Seasonal estimated collision mortality[1]							
		Breeding		Autumn Migration		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Beatrice	7.8	0.0	10.1	0.5	2.0	0.1	19.8	0.6
1	Beatrice Demonstrator	0.2	0.0	0.3	0.0	0.2	0.0	0.7	0.0
1	Blyth Demonstration	0.7	0.0	0.4	0.0	0.6	0.0	1.7	0.1
1	Dudgeon	4.6	4.6	8.1	0.4	4.0	0.2	16.6	5.3
1	East Anglia ONE	0.7	0.7	27.2	1.3	1.3	0.1	29.2	2.1
1	EOWDC (Aberdeen)	0.9	0.0	1.1	0.1	0.0	0.0	1.9	0.1
1	Galloper	3.8	0.0	6.4	0.3	2.6	0.2	12.8	0.5
1	Greater Gabbard	2.9	0.0	1.8	0.1	1.0	0.1	5.7	0.1
1	Gunfleet Sands	No estimate available							
1	Hornsea Project One	2.4	2.4	6.6	0.3	4.7	0.3	13.7	3.0
1	Hornsea Project Two	1.5	1.5	2.9	0.1	1.2	0.1	5.6	1.7
1	Humber Gateway	0.4	0.4	0.2	0.0	0.3	0.0	0.9	0.4
1	Hywind	1.2	0.0	0.2	0.0	0.2	0.0	1.5	0.0
1	Kentish Flats	0.3	0.0	0.2	0.0	0.2	0.0	0.7	0.0
1	Kentish Extension	No estimate available							
1	Kincardine	0.6	0.0	0.0	0.0	0.0	0.0	0.6	0.0
1	Lincs	0.4	0.4	0.3	0.0	0.4	0.0	1.1	0.5
1	London Array	0.5	0.0	0.3	0.0	0.4	0.0	1.1	0.0

Tier	OWF	Seasonal estimated collision mortality[1]							
		Breeding		Autumn Migration		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Lynn and Inner Dowsing	0.1	0.1	0.0	0.0	0.1	0.0	0.2	0.1
1	Methil	1.8	0.0	0.0	0.0	0.0	0.0	1.8	0.0
1	Moray Firth East	16.7	0.0	7.3	0.4	1.8	0.1	25.9	0.5
1	Race Bank	7.0	7.0	2.4	0.1	0.8	0.1	10.3	7.2
1	Rampion	7.5	0.0	13.2	0.6	0.4	0.0	21.1	0.7
1	Scroby Sands	No estimate available							
1	Sheringham Shoal	2.9	2.9	0.7	0.0	0.0	0.0	3.6	3.0
1	Teesside	1.0	0.5	0.4	0.0	0.0	0.0	1.4	0.5
1	Thanet	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0
1	Triton Knoll	5.6	5.6	13.3	0.6	6.2	0.4	25.1	6.6
1	Westermost Rough	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
2	Dogger Bank (formerly Creyke Beck) A and B	16.8	8.4	17.3	0.8	11.3	0.7	45.4	9.9
2	Dogger Bank C (formerly Teesside A) and Sofia (formerly Teesside B)	3.1	1.5	2.1	0.1	2.2	0.1	7.4	1.8
2	Moray West	2.1	0.0	0.4	0.0	0.2	0.0	2.7	0.0
2	Neart na Gaoithe[2]	18.4	0.0	1.5	0.1	1.4	0.1	21.3	0.2
2	Firth of Forth (Seagreen) Alpha and Bravo[3]	61.3	0.0	2.9	0.1	1.5	0.1	65.7	0.2
3	East Anglia ONE North	2.6	2.6	2.3	0.1	0.2	0.0	5.1	2.7
3	East Anglia THREE	1.3	1.3	6.9	0.3	2.0	0.1	10.2	1.7
3	East Anglia TWO	2.6	2.6	4.8	0.2	0.8	0.1	8.2	2.9

Tier	OWF	Seasonal estimated collision mortality[1]							
		Breeding		Autumn Migration		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
3	Hornsea Project Three	2.1	1.3	1.0	0.0	0.8	0.1	3.9	1.4
3	Hornsea Project Four	3.3	3.1	1.1	0.1	0.3	0.0	4.6	3.2
3	Inch Cape[4]	22.4	0.0	1.0	0.0	0.8	0.1	24.3	0.1
3	Norfolk Boreas	2.9	2.9	2.6	0.1	0.8	0.1	6.4	3.1
3	Norfolk Vanguard	1.7	1.7	3.9	0.2	1.1	0.1	6.7	2.0
Total (tier 1-3 projects)[5]		**22.0**	**51.5**	**151.1**	**7.3**	**52.0**	**3.2**	**415.0**	**62.0**
3	Green Volt[6]	4.7	0.1	0.2	0.0	0.5	0.0	5.4	0.1
3	SEP&DEP	0.4	0.3	0.6	0.0	0.0	0.0	1.0	0.3
4	Berwick Bank[7]	28.6	0.33	2.7	0.1	0.4	0.0	31.7	0.5
4	Dogger Bank South[8]	7.6	3.8	2.8	0.1	0.0	0.0	10.4	3.9
4	Five Estuaries[9]	2.3	0.8	2.5	0.1	0.3	0.0	5.1	0.9
4	Outer Dowsing[10]	3.0	1.5	0.4	0.0	0.4	0.0	3.8	1.5
4	Rampion 2[11]	3.0	0.0	1.4	0.1	0.6	0.0	5.0	0.1
4	West of Orkney[12]	11.9	0.0	2.4	0.1	0.3	0.0	14.6	0.1
	North Falls[13]	0.6	0.4	0.9	0.0	0.6	0.0	2.1	0.5
Total (all projects)		**274.0**	**58.7**	**165.0**	**7.9**	**55.1**	**3.4**	**494.1**	**70.0**

1. Numbers and breeding season apportioning based on Royal HaskoningDHV (2023a) and updated for OWFs where new information has become available, see footnotes below. Numbers in table rounded to 1 decimal place but totals are based on unrounded numbers. 2. EDF Renewables (2019). 3. Seagreen (2022). 4. ICOL (2018). 5. Total excludes Green Volt and SEP&DEP which were consented after the cut-off date of end March 2024 for inclusion in the North Falls assessment. 6. APEM (2023a). 7. Pelagica and Cork Ecology (2022), HiDef (2022), (Developer Approach) Royal HaskoningDHV 2022b. 8. RWE (2023). 9. GoBe (2023c, d). 10. GoBe (2023e), GoBe and SLR (2023). 11. GoBe (2023a, b), APEM (2023b). 12. MacArthur Green (2023). 13.Table 4.32,

352. The total predicted annual collision mortality for breeding adult gannets from the FFC SPA is 70 individuals (Table 4.35). North Falls contributes 0.5 birds to this total, or 0.7%. The predicted in-combination mortality would increase the baseline adult mortality rate of the FFC SPA breeding adult gannet population by 3.1% (based on a population size of 28,358 breeding adults and a baseline annual adult mortality rate of 8.1%, Horswill and Robinson 2015). This magnitude of increase could result in detectable population level effects.

4.4.4.4.3.2.3 Effect: Combined Displacement/Barrier Effects and Collision Risk

353. The operation and maintenance phase, in-combination mortality values (for disturbance and displacement, and collision risk combined) for gannet at FFC SPA are presented in Table 4.36. Assuming a displacement rate of 70% and 1% mortality of displaced birds, the total annual mortality would be 144 adult birds.

Table 4.36 Predicted in-combination annual displacement and collision mortality of FFC SPA breeding adult gannets, along with increase to existing annual mortality of the population

Annual displacement mortality[1]	Annual collision mortality	Annual displacement and collision mortality	% annual mortality increase[2]
74	70	144	6.3%

[1] Assumes displacement rate of 0.700 and mortality rate of 1% of displaced birds.

[2] Background annual mortality of FFC SPA 2,297 birds, assuming reference population of 28,358 birds and adult mortality of 8.1% (Horswill and Robinson, 2015)

354. Based on the FFC SPA population of 28,358 birds and a background mortality of 8.1% (2,297 birds per annum), an increase in mortality of 144 birds would increase background mortality by 6.3%.

355. As increases in the existing mortality rate exceeding 1% may be detectable at a population level, PVA was undertaken to assess the population-level impacts from these effects.

356. PVA has been run with the NE PVA Tool (Searle *et al.* 2019) and based on a density independent population model, as recommended by NE (2022a), with the demographic rates for the baseline scenario taken from Horswill and Robinson (2015). Models were run for a 30 year period, with the population projections under baseline conditions (i.e. without any OWF effects) compared with those incorporating the additional mortality predicted from the in-combination displacement and collisions effects combined. Full details of the input parameters and modelling approach are included in RIAA Appendix 4.1 Offshore Ornithology PVA Report (Document Reference: 7.1.4.1). The levels of additional mortality considered in the PVA were as specified in Table 4.36, with the PVA projections extending over an assumed 30 year operational period.

357. Density independent models incorporate no feedback between population size and demographic rates, such that a population can either increase to infinity (which is biologically implausible) or decrease to extinction. Consequently, the PVA used to assess the population-level impacts assumes that the predicted mortality associated with the wind farm effects is entirely additive to the baseline mortality levels that would occur in the absence of these effects, which is likely to cause overestimation of the resulting population-level impacts. Density dependent models, which incorporate a mechanism for population regulation, are likely to be more realistic (e.g. reproductive rates may be expected to decline as

population size increases if an expanding population resulted in competition for food resources and/or suitable nesting sites). Although there is considerable evidence for density dependence operating in seabird populations (e.g. Horswill *et al.* 2016), NE (2022a) advises against the use of density dependent population models due to the lack of empirical evidence of the underpinning mechanisms of density dependent regulation within seabird populations. As a consequence, the resulting PVA is likely to give overly precautionary outputs because it does not allow for the operation of compensatory density dependence to offset (to some degree at least) the additional mortality from the wind farm effects (e.g. Horswill *et al.* 2016).

358. The population models on which the PVA is based also assumed that the gannet breeding population at the FFC SPA is a closed population. In reality, this will not be the case as there will be immigration and emigration resulting in exchange of birds with other breeding colony populations; this, again, is likely to result in overestimation of impacts at the scale of the colony population (Miller *et al.* 2019).

359. The potential impact of the predicted displacement and collision mortality on the SPA gannet population was assessed on the basis of CPS and CPGR, as derived from the PVA. The CPS is the median of the ratio of the end-point size of the impacted to un-impacted (or baseline) population, expressed as a proportion, and CPGR is the median of the ratio of the annual growth rate of the impacted to un-impacted population, expressed as a proportion. These two metrics have been demonstrated to be relatively insensitive to mis-specification of demographic rates and variation in population trend (Cook and Robinson 2016, Jitlal *et al.* 2017).

360. Due to the intrinsic structure of the population modelling approach, increases in mortality rates will always have some effect on population size and growth rate, such that the counterfactuals of impacted to unimpacted populations will never be greater than 1 and will almost always be less, thus always suggesting a negative effect. What is undefined is the level at which such negative effects could cause adverse effects on a population.

361. A summary of PVA outputs is presented in Table 4.37. At the in-combination mortality (collisions plus displacement) of 144 adults per year from the FFC SPA breeding population, the median CPGR and CPS are 0.996 and 0.888 respectively (Table 4.37). This indicates that the annual growth rate would be reduced by 0.4% for the impacted population compared to the unimpacted population, and that the impacted population would be 11.2% smaller than the unimpacted population after 30 years.

Table 4.37 PVA Outputs for the FFC SPA breeding gannet population in relation to the predicted collision and displacement effects resulting from North Falls in-combination with other projects

Scenario	Adult mortality	Growth rate (median)	Counterfactual metric (after 30 years)		Reduction in growth rate of impacted vs unimpacted population	Reduction in population size of impacted vs unimpacted population
			Population size (CPS)	Median growth rate (CPGR)		
Baseline (unimpacted)	0	1.006	1.000	1.000	n/a	n/a
In-combination (displacement plus collisions)	144	1.002	0.996	0.888	0.4%	11.2%

362. The counterfactuals calculated from the model outputs should be interpreted according to the level of precautionary assumptions made both within the PVAs themselves, and the processes that were undertaken to produce the inputs into the PVAs. These include:

- The use of mean peak abundance estimates in displacement modelling may result in estimates of displaced birds being unrealistically high because they are likely to over-estimate the number of birds typically occurring in this area during a given season (on the basis that the mean peak count for a given season over two years will exceed the mean count over the same time);
- The mortality rate assumed for displaced birds (1%) is likely to be overestimated, given the extensive distances over which the species forages, and flexibility of habitat use (see paragraph 327 above);
- For OWFs other than North Falls, gannet collision risk estimates have been adjusted for the latest NE advice on macro-avoidance and avoidance rates, but not for the latest advice on a reduced nocturnal activity rate (the proportion of birds estimated to be active at night compared with daytime, see paragraph 350 above) as the latter would require collision risk models to be re-run. A reduced nocturnal activity rate (of 0.08, compared with values of 0.1-0.2, and 0-0.25 at which CRM has been run for other OWFs in the in-combination assessment) would also result in lower estimates of collision risk, although it is not possible to estimate the extent of any reduction without running comparative models for a sample of OWFs;
- The use of consented designs (as opposed to as-built) for English OWFs in the CRM will overestimate the predicted mortality, because as-built projects are typically associated with lower collision risk than the worst case consented envelope (see paragraph 351 above);
- For some OWFs included in the in-combination totals, collision and displacement mortality estimates during the breeding season will apply to birds of all ages, with no apportioning having been undertaken to account for sub-adult birds. In Table 4.32 and Table 4.35, for OWFs in tiers 1 – 3, the total breeding season numbers of gannets at risk of displacement and

total predicted collisions for a given OWF are in many cases the same as the numbers apportioned to the FFC SPA. Assuming that the breeding season totals for these OWFs include birds of all age classes, this indicates that the total apportioned to the SPA also includes birds of all age classes);

- The PVA does not incorporate density dependence, which means the outputs of the model are likely to be precautionary; and
- The FFC SPA gannet population is modelled as a closed population, with no emigration or immigration occurring.

363. The assessment considers whether there is potential for the in-combination displacement and collision effects of OWFs to prevent the Conservation Objective for the gannet population size of the FFC SPA being met. As stated above (Section 4.4.4.4.1), this is to maintain the size of the breeding population at a level which is above 8,469 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

364. Whilst there is no agreed threshold beyond which an effect could or should be considered significant, the median CPGR derived from the PVA represents a relatively small (0.4%) reduction to the growth rate of a population which on average increased at a rate of 12% annually between 1986 and 2017, and of 4% annually between 2012 and 2017. The population in 2022 was reduced by 2% compared with 2017, which as far as is known is attributable to the HPAI outbreak, but in 2023 it had increased again by 16% compared to the 2022 count, and 14% compared with the 2017 count (Section 4.4.4.4.1). This suggests the potential for rapid recovery from HPAI and a return to an increasing trend (subject to any other limitations on colony size, such as availability of suitable nesting habitat).

365. NE have previously assessed population trends recorded at other gannet colonies in Britain, Ireland and the Channel Islands (NE, 2022f). The average annual growth rate calculated over a period of more than 90 years from colony establishment is 1.8%. The mean annual growth rate over the most recent years of their records (80+ years) has been 1.2% per annum (or 1.3% excluding Sula Sgeir, as the growth rate at this colony is likely to be reduced by an annual licenced harvest of gannet chicks). Pre-HPAI, the FFC SPA growth rates are substantially greater than this, and, as above, the most recent count suggests the colony is recovering from the HPAI outbreak and continuing the long term increase is continuing.

366. The predicted reduction in the population annual growth rate of 0.4% from the in-combination displacement and collision effects of OWFs is considered unlikely to result in population decline, but at most is expected to cause a slowing of the population growth. The CPS suggests a 11.2% reduction in population size after 30 years compared with the baseline scenario without OWF effects, which is a relatively small change, and likely to be an over-estimate given the sources of precaution in the assessment. Given the long-term growth of this population, such a change would also be highly unlikely to prevent the conservation objectives from being met.

367. As context, it is noted that NE (2022e) concluded no AEoI for gannet at the FFC SPA based on a predicted in-combination collision plus displacement mortality of 355 birds per year (equivalent to a 16.38% increase in the mortality of the SPA

breeding population, CPGR 0.9842 and CPS 0.6108, compare with Table 4.37 above), stating, '*the FFC gannet population is believed to be robust enough to allow the conservation objective to maintain the population at (or above) designation levels and sustain additional alone and in-combination mortalities from the offshore wind farms'*. This total of 355 mortalities included an estimated in-combination collision mortality of 293 birds per year, which was calculated prior to the updated advice on CRM for this species, incorporating 70% macro-avoidance and an increased avoidance rate (see paragraph 350 above). Thus a previous in-combination collision plus displacement total considered not to affect the integrity of the FFC SPA, exceeds the total of 144 mortalities presented above (Table 4.36), incorporating the reduced collision risk.

368. As noted above, the information on estimated in-combination collision and displacement mortality and PVA is provided as context for the assessment, given the conclusion that North Falls would make no material contribution to the in-combination mortality.

4.4.4.5 Kittiwake

4.4.4.5.1 Status

369. The SPA citation population of 44,520 AONs is based on the kittiwake counts undertaken in 2008 (Bempton and Flamborough Head original SPA) and between 2009-2011 (including the SPA Filey coast extension) and assumes that 1 AON represents 1 breeding pair (so equating to 89,040 breeding adult birds). Most of the kittiwakes (approximately 89%) nest in the southern Bempton to Flamborough Head part of the SPA; the rest breed on the cliffs in the northern part of the SPA (i.e., at Filey).

370. Since the SPA citation counts (2008-2011) there was an apparent modest increase in numbers, from 44,520 pairs to 51,001 pairs in 2016 (Babcock *et al.*, 2016) and 51,535 pairs in 2017 (2017 count of AON, SMP 2024, Aitken *et al.* 2017). The most recent whole-colony count in 2022 found 44,574 pairs, a decline since 2017; during the 2022 count period some deaths from HPAI were considered likely for some species (although kittiwake is not mentioned), and after the count was completed larger numbers of dead adult and juvenile birds, including kittiwakes, were reported on local beaches and on and below the cliffs (Clarkson *et al.* 2022). No full colony count for 2023 is available. However, SPA monitoring (Butcher *et al.*, 2023) confirmed that productivity in 2023 was the highest recorded since 2010 (1.02 chicks per pair), despite recorded outbreaks of HPAI within the colony in 2023. The 2022 count (44,574 pairs or 89,148 adult birds) is therefore used as the reference population for the assessment.

371. There is uncertainty over the long-term trend in the size of this SPA population, with an apparent peak count in 1987 of 83,700 pairs at Flamborough and Bempton Cliffs (NE 2020) and over 85,000 pairs with Filey cliffs included (Clarkson *et al.* 2022). This suggests that the population underwent a major decline between the late 1980s and late 1990s. However, there is uncertainty over the veracity of the 1987 count, with a lack of supporting detail being available on survey methods. More recent whole-colony counts include observations made from land and sea (from small boats able to access close to shore). An enquiry into the RSPB Bempton Cliffs annual reports from the 1970s and 1980s, from which the earlier counts were derived, indicated that most counts made were land-based with estimates calculated for (at least some) sections of cliff that were

not visible from land. As large areas of the colony are not visible from land it is considered that these whole colony estimates should be treated with caution (Carkson *et al.* 2022). Furthermore, associated monitoring of breeding productivity during the late 1980s and 1990s predicts an increasing, not declining, population trend during this period (Coulson 2011, 2017), and does not align with the suggestion of a marked decline between the late 1980s and late 1990s. As such, it is unclear whether this SPA population has been subject to an increase from the 1950s to late 1980s, followed by a marked long-term decline, or a gradual increase since the 1950s (with reference to trends reported in Clarkson *et al.* 2022). Despite this uncertainty the SPA conservation objectives are based on the premise that the population has undergone a marked long-term decline, with the SACOs for the '*breeding population: abundance*' attribute having the target of restoring the size of the breeding population at a level which is above 83,700 breeding pairs, whilst avoiding deterioration from its current level.

4.4.4.5.2 Connectivity and seasonal apportionment of potential effects

4.4.4.5.2.1 Breeding season

372. The seabird colonies within the FFC SPA are the only SPA colonies where kittiwake is a qualifying interest that are close enough to North Falls to be candidates for breeding season connectivity.

373. North Falls is 297 km from FFC SPA based on the closest distance by sea between the array area and the SPA boundary (288.4km straight line distance including land crossing). As the SPA boundary includes a 2km marine extension, the North Falls array area is approximately 299km from the nearest coastal area within the SPA where kittiwakes might nest.

374. The breeding season MMFR of breeding kittiwakes based on tracking data from 37 colonies around the UK is 156.1km (Woodward *et al.*, 2019), well short of the distance between this SPA and the North Falls array area. However, there is substantial between-colony variation, with the birds at some colonies showing a tendency to travel further than those at others. NE (2022a) advises that MMFR + 1SD, based on the latest review of tracking studies of breeding adults by Woodward *et al.* (2019) is used to determine the potential for connectivity between an OWF site, which equates to 300.6km (156.1 + 144.5) for kittiwake. While a strict application of this foraging distance would mean the North Falls array is just within foraging range of kittiwakes breeding at FFC SPA, the evidence from tracking studies of the breeding kittiwake from the SPA indicates that they do not travel as far south as the Outer Thames area.

375. A considerable amount of tracking information has been collected for kittiwakes breeding in the FFC SPA colonies over the past 25 years, which provides information on the likely strength of breeding season connectivity with the array area. These studies have consistently demonstrated that there is no overlap between the typical foraging patterns from adult birds attending the SPA colonies and North Falls, for example:

- The 2015 Bempton Seabird Report (Babcock et al, 2015) provided details of tracking studies undertaken between 2010 and 2014. 125 tracks (89 from Flamborough and 36 from Filey) were recorded during this period. All tracks were broadly east or southeast of the colonies, and none showed birds travelling south within c.100km of the North Falls array area.

- A tracking study of kittiwakes breeding at FFC SPA in 2017 found an average foraging range of 88.65km (range 3.2 – 324km), with birds travelling into the North Sea, north-east and south-east of the breeding colony (Wischnewski *et al.*, 2017) although, as above, none travelling within c. 100km of the North Falls array area.

376. Woodward *et al.* (2019) include summary foraging range metrics for three breeding kittiwake tracking studies conducted within the FFC SPA and involving a total 163 individual adults (and which include the two studies detailed above). Again, none of the track routes of the 163 birds studied came within approximately 100 km of the array area. Not only were the distances travelled to foraging locations generally much shorter than the distance to the array area, but also the flight routes taken by birds were not in the direction of the array area. Similarly (and as expected based upon the above details), the modelled foraging distributions of breeding kittiwake from the FFC SPA, as derived from tracking data, show that the predicted areas of usage are distant from the array area (Cleasby *et al.* 2018 and 2020).

377. RSPB's Future of the Atlantic Marine Environments studies have shown some extremely long foraging trips for kittiwakes (as reported in various publications, such as Fair Isle Bird Observatory annual reports). However, those extreme values tend to occur at colonies where food supply is extremely poor and breeding success is low (for example Orkney and Shetland). Daunt *et al.* (2002) point out that seabirds, as central place foragers, have an upper limit to their potential foraging range from the colony, set by time constraints. For example, they assess this limit to be 73km for kittiwake based on foraging flight speed and time required to catch food, based on observations of birds from the Isle of May. This means that kittiwakes would be unable to consistently travel more than 73km from the colony and provide enough food to keep chicks alive.

378. Hamer *et al.* (1993) recorded kittiwake foraging ranges exceeding 40 km in 1990 when sandeel stock biomass was very low, and this was accompanied by very low breeding success at the study colony in Shetland (zero chicks per nest) However, in 1991 when sandeel abundance was higher, 98% of trips were <5 km and breeding success was 0.98 chicks per nest. Kotzerka *et al.* (2010) reported a maximum foraging range of 59 km, with a mean range of around 25km for a kittiwake colony in Alaska. On the basis of results from the above studies, the array area is considered too far from the FFC SPA colonies to sustain successful provisioning of chicks.

379. Based on plumage, kittiwakes recorded in the North Falls study area during baseline surveys in the breeding season included both adult (84% of birds that could be aged from plumage) and sub-adult birds (16% of birds that could be aged from plumage, noting that overall 45% of kittiwake images recorded during the breeding season could not be aged from plumage). As stated above, there is no evidence that breeding kittiwakes from FFC SPA travel to the North Falls array area during the breeding season. Adult birds recorded at North Falls may include breeding birds from colonies closer to the array area, including two artificial rigs off the Sizewell coast, about 51 km to the north-west of the array area. These rigs are reported to have held 502 AON (equivalent to pairs) in 2008, the most recent count (SMP 2024). The colony on buildings at Lowestoft harbour is located 77 km to the north north-west of the closest part of the array area and which is

reported to have held 446 AON in 2018, the most recent available count (SMP 2024). No tracking data are available for kittiwakes breeding in the Lowestoft or Sizewell colonies. However, the distance from these colonies to all parts of the array area is clearly well within the typical foraging range of breeding kittiwakes (Woodward *et al.*, 2019). Some of the adult-plumaged birds recorded at North Falls in the breeding season may not be actively breeding. Kittiwakes adopt adult plumage by their third year (and in many cases are indistinguishable from adult birds in their second summer (Grant, 1986)) but (on average) do not start to breed until four years old (Coulson 2011), and so a proportion of birds recorded in adult plumage during offshore surveys will be immatures. Additionally, the review of seabird demographic parameters by Horswill and Robinson (2015) estimates that 18.0 – 20.8% of adult kittiwakes opt out of breeding in a given year. Although there is no tracking data for adults that take such a 'sabbatical year' they would clearly not be subject to the same spatial constraints as actively breeding birds, and therefore might be more likely to exploit foraging grounds that are further from breeding colonies and beyond the typical foraging range of actively breeding birds.

380. Although the tracking data for FFC are to a large extent limited to the chick-rearing period (as opposed to encompassing the full breeding season), they provide no evidence to suggest that kittiwakes breeding at the FFC SPA will make use of the North Falls array area during the breeding season. Given this evidence and the fact that the North Falls Array is only just within the breeding season MMFR plus 1SD for kittiwake, it is concluded that there is no breeding season connectivity with the FFC SPA. Accordingly, no birds have been apportioned to FFC SPA for this season.

4.4.4.5.2.2 Non-breeding season

381. Adult kittiwakes (and juveniles) leave their breeding colony as soon as their chicks fledge, which typically happens in the last week of July or the first week of August. At the same time fledglings become independent of their parents. Freed from the constraint of colony attendance, kittiwakes typically disperse away from the colony. Evidence from numbered metal rings and geo-location tags put on kittiwakes at their breeding colonies show that there is considerable variability between individuals in the extent, timing and rate of post-breeding movements (Frederiksen *et al*., 2012; Wernham *et al.*, 2002). At one extreme, birds from UK east coast colonies have been recorded on the Newfoundland Banks off Canada (approximately 4,000 km to the west) before the end of August, whereas other birds may stay within the region through the autumn and winter. Throughout the non-breeding period kittiwakes are free to wander widely, and most live an essentially pelagic life, frequenting areas with suitable food supplies. The ringing and tagging data also shows that there is a considerable mixing of birds from different breeding areas, with the North Sea hosting wintering birds from breeding colonies in eastern UK, northern Europe, Scandinavia, Spitzbergen and the Barents Sea (Furness 2015, Frederiksen *et al*. 2012; Wernham *et al.*, 2002).

382. For the purposes of apportioning effects during the non-breeding periods (i.e. the autumn and spring passage periods – Furness 2015), the BDMPS approach is used (Furness 2015). This assumes that birds (of all age classes) associated with breeding colonies in the UK and elsewhere in northern Europe contribute birds to the relevant BDMPS population, which in this case is determined to be the UK North Sea. This population is estimated to comprise 829,937 individuals of all

ages during autumn passage (August to December) and 627,816 individuals of all ages during spring passage (January to April), based upon the proportions of adult and immature birds from the different contributory breeding colonies and populations which are estimated to occur within the UK North Sea during these periods (Furness 2015). It is assumed that birds of all age classes from the different contributory colonies and populations are evenly distributed throughout the BDMPS.

383. During the autumn migration season, Furness (2015) estimates that 60% of the FFC SPA breeding adults are present in the BDMPS (45,140 individuals, assuming an SPA population of 75,234 adults) representing 5.4% of the BDMPS population (i.e. 45,140 as a percentage of 829,937).

384. During the spring migration season, 60% of SPA breeding adults are also assumed to be present in the BDMPS, representing 7.2% of the BDMPS population (i.e. 45,140 as a percentage of 627,816). It is therefore assumed that 5.4% and 7.2% of impacts are apportioned to the FFC SPA during the autumn and spring migration seasons respectively.

4.4.4.5.3 Effect: Collision risk (kittiwake)

385. Mortality from collision with WTGs is considered to be the only impact from the project that would affect kittiwakes. The magnitude of this risk to individual SPA qualifying kittiwake population has been assessed through CRM to estimate how many birds may potentially be killed, and apportioning this mortality between colonies according to potential connectivity (as discussed above).

386. The methodology for CRM is set out in ES Appendix 13.2 (Document Reference: 3.3.13). Stochastic CRM was run using a nocturnal activity factor of 0.375 (± 0.0637 SD) and an avoidance rate of 0.9928 (±0.0003), as recommended by NE (2022b). The nocturnal activity factor (NAF) recommended by NE (2022b), (0.375 ± 0.0637) is a central value for use in sCRM which captures a range of 25-50% nocturnal activity, based on the assumption that flight activity is 25-50% of that during the daytime. The NAF may be an overestimate; based on empirical evidence, respective nocturnal activity rates for the breeding and non-breeding seasons of 20% and 17% have been identified as the most appropriate values (Furness 2019; Royal HaskoningDHV, 2019b). Outputs were based on Option 2 of the sCRM which uses the generic flight height data (Johnston *et al.* 2014a and b) and assumes a uniform distribution of flight heights across the rotor swept zone.

387. The predicted total mortality from the CRMs are similar for the two scenarios examined, with total annual mortality (i.e. all age groups) ranging from a mean of 19.2 to 20.2 birds per annum, and a mean of 0.7 to 0.8 collisions per annum apportioned to breeding adults from the SPA (Table 4.38).

Table 4.38 Seasonal and annual collisions for kittiwake at North Falls apportioned to the FFC SPA (breeding adults) and increase in SPA population mortality rates (grey shading indicates worst case scenario)

WTG scenario	Statistic	Apportioning[1]	Predicted collisions (sCRM)				Annual collisions as % increase in SPA population mortality rate[2]
			Breed - full	Aut-mig	Spr-mig	Annual	
MiRD	Mean	All	8.13	3.42	7.62	19.16	-
		Apportioned to SPA	0.00	0.19	0.55	0.73	0.01%
	LCL	All	0.46	0.39	0.85	7.39	-
		Apportioned to SPA	0.00	0.02	0.06	0.08	0.00%
	UCL	All	23.36	9.30	29.93	39.34	-
		Apportioned to SPA	0.00	0.51	2.15	2.66	0.02%
MaRD	Mean	All	8.76	3.64	7.83	20.24	-
		Apportioned to SPA	0.00	0.20	0.56	0.76	0.01%
	LCL	All	0.45	0.48	0.94	7.37	-
		Apportioned to SPA	0.00	0.03	0.07	0.09	0.00%
	UCL	All	24.56	9.86	30.43	43.59	-
		Apportioned to SPA	0.00	0.54	2.19	2.72	0.02%

1. SPA apportioning of predicted collisions at North Falls: breeding 0.0%, autumn migration 5.4%, spring migration 7.2%,

2. Based on annual adult mortality rate of 0.146 (Horswill and Robinson 2015, ES Chapter 13, Table 13.11, Document Reference: 3.1.15) and SPA population size of 89,148 adult birds

4.4.4.5.3.1 Project alone assessment

388. The assessment assumes that no kittiwake collisions are apportioned to the FFC SPA colonies during the breeding season. During the autumn and spring migration periods, when adults breeding at the SPA disperse away from the breeding colony, the proportion of collisions in the array area affecting adult kittiwake from the SPA breeding population is estimated based on the predicted contribution to the BDMPS (paragraphs 383 and 384 above). The project alone collisions would therefore be limited to the non-breeding season, although they are expressed here as an annual effect on the SPA population of breeding adults for the purposes of the shadow Appropriate Assessment (as is the industry standard approach).

389. Annual predicted mortality, for the two turbine scenarios (Section 4.2.2), from collisions in the array area is given in Table 4.38. The table also shows the equivalent increases in mortality of adult kittiwakes from the SPA breeding population for collisions predicted under each scenario, based on an assumed baseline annual adult mortality rate of 14.6% (Horswill and Robinson, 2015) and an SPA population of 89,148 breeding adult birds (44,574 pairs, see Section 4.4.4.5.1 above). The worst case scenario, a mean of 0.76 and upper 95% CL of 2.72 collisions per year, apportioned to the FFC SPA, is equivalent respectively to a 0.01% and 0.02% increase in the baseline mortality rate of the SPA population (Table 4.38).

390. At these levels no detectable effects on the SPA population of breeding adults would be expected. The predicted change is well below the nominal 1% change threshold considered appropriate for triggering additional assessment analysis such as undertaking population viability modelling.

391. It is therefore concluded that collision mortality of kittiwakes caused by North Falls alone would not adversely affect the integrity of FFC SPA.

4.4.4.5.3.2 In-combination assessment

392. On the basis of the conclusions of the Project alone assessment of very low predicted kittiwake mortality, i.e. a mean value of 0.76 birds and significantly below 0.1% increase in background mortality (Table 4.38), there would be no material contribution of the Project to in-combination effects. Accordingly, no in-combination assessment is required for this feature. The conclusion of the assessment is therefore that predicted kittiwake mortality due to collision risk would not adversely affect the integrity of the FFC SPA, either for the project alone or in-combination.

393. Notwithstanding this conclusion, an estimate of in-combination mortality and a PVA is provided below, to provide context to the Project alone assessment. This information is presented without prejudice to the conclusion above.

394. The in-combination assessment considers the combined predicted collision risk to kittiwakes at the FFC SPA from OWFs within foraging range during the breeding season, and within the UK North Sea BDMPS (Furness 2015) during the spring and autumn migration seasons. In each season the predicted collision risk from OWFs within the area of search is apportioned to the SPA. In-combination seasonal and annual totals are set out in Table 4.39.

395. For North Falls, the mean collision risk predictions for the worst case-scenario (Maximum scenario) have been used (Table 4.38). Seasonal and annual

kittiwake mortality estimates for other OWFs included in the in-combination assessment are presented in Table 4.39 along with the numbers apportioned to the FFC SPA. This information was taken from the numbers presented at Deadline 8 of the DCO Examination for SEP&DEP (Royal HaskoningDHV 2023a) and updated with new information that has become available since then for some OWFs. The cut off for inclusion of new information from other OWFs to the in-combination assessment was the end of March 2024.

396. Where the avoidance rates used for other OWFs are known, collision estimates have been updated to reflect NE's current recommended rates, as used in the Project-alone assessment (to 0.9924 (±0.0001) for the deterministic Band (2012) model and 0.9928 (±0.0003) for the stochastic (MacGregor *et al.*, 2018) model; see ES Appendix 13.3 (Document Reference: 3.3.14) for details of calculations). Thus, the collision risk estimates for OWFs in Table 4.39 may differ from those given in the site specific documentation (the ES, RIAA and/or Technical report(s)).

397. For consented OWFs where the Secretary of State concluded that an adverse effect on integrity in respect of the kittiwake feature of FFC SPA could not be ruled out, compensatory measures have been required. This is assumed to reduce the net effect of these projects to zero. The in-combination totals in Table 4.39 have therefore been presented both with and without values for these projects (East Anglia ONE North, East Anglia TWO, Hornsea Project Three, Norfolk Boreas, Norfolk Vanguard, Hornsea Project Four and SEP&DEP).

398. For OWFs in English waters, the potential collision mortalities presented in Table 4.39 are based largely on consented designs, which represents a highly precautionary position because for many of these projects the actual as-built designs are associated with lower potential collision mortality (e.g. because fewer WTGs are included in the final built design than are considered for the worst case consented design; ES Appendix 13.3 (Document Reference: 3.3.14) provides further detail on OWFs where this applies). It has been estimated that basing the in-combination numbers on the collision predictions derived from the as-built designs can reduce the totals by up to 15% for kittiwake (MacArthur Green 2017). However, whilst the as-built designs represent the most realistic scenario in terms of the existing collision risk, these are not legally secured, so there is a theoretical (albeit highly unlikely) possibility of further WTG construction on such project sites without the requirement for further consent (The Crown Estate and Womble Bond Dickinson 2021). For OWFs in Scottish waters, collision predictions based on as-built parameters have been used (where available) as these are accepted by Marine Directorate and NatureScot.

399. In addition to the in-combination totals relying on the consented designs, other elements of precaution include the fact that the collision mortality estimates will be based largely on an assumed 50% NAF (whereas the best available evidence suggests rates of approximately 20% are more likely – see above, MacArthur Green 2019a).

400. The overestimation of collision risk should be considered during the interpretation of CRM outputs.

Table 4.39 In-combination collision risk for kittiwake at the FFC SPA

Tier	OWF	Predicted number of collisions (in total (adjusted for latest NE advice on avoidance rates) and apportioned to SPA[2])								Consented subject to compensation for kittiwake at FFC SPA
		Breeding		Autumn Migration		Spring Migration		Annual		
		Total	SPA	Total	SPA	Total	SPA	Total	SPA	
1	Beatrice	65.4	0.0	7.4	0.4	27.5	2.0	100.3	2.4	No
1	Beatrice Demonstrator	0.0	0.0	2.0	0.1	1.6	0.1	3.6	0.2	No
1	Blyth Demonstration	1.2	1.2	1.6	0.1	1.0	0.1	3.7	1.3	No
1	Dudgeon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	No
1	East Anglia ONE	1.2	0.6	110.8	6.0	32.3	2.3	144.4	8.3	No
1	EOWDC (Aberdeen)	8.2	0.0	4.0	0.2	0.8	0.1	12.9	0.3	No
1	GWF	4.4	2.2	19.2	1.0	22.0	1.6	45.5	4.8	No
1	GGOW	0.8	0.4	10.4	0.6	7.9	0.6	19.0	1.5	No
1	Gunfleet Sands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	No
1	Hornsea Project One	30.4	25.2	38.6	2.1	14.4	1.0	83.5	28.3	No
1	Hornsea Project Two	11.1	9.2	6.2	0.3	2.1	0.1	19.3	9.7	No
1	Humber Gateway	1.8	1.8	2.2	0.1	1.3	0.1	5.3	2.0	No
1	Hywind	11.5	0.0	0.6	0.0	0.6	0.0	12.6	0.1	No
1	Kentish Flats	0.0	0.0	0.6	0.0	0.5	0.0	1.1	0.1	No
1	Kentish Flats Extension	0.0	0.0	0.0	0.0	2.7	0.2	2.7	0.2	No
1	Kincardine	15.2	0.0	6.2	0.3	0.7	0.0	22.1	0.4	No
1	Lincs	0.6	0.6	0.8	0.0	0.5	0.0	1.9	0.7	No
1	London Array	1.0	0.5	1.6	0.1	1.2	0.1	3.8	0.7	No

Tier	OWF	Predicted number of collisions (in total (adjusted for latest NE advice on avoidance rates) and apportioned to SPA[2])								Consented subject to compensation for kittiwake at FFC SPA
		Breeding		Autumn Migration		Spring Migration		Annual		
		Total	SPA	Total	SPA	Total	SPA	Total	SPA	
1	Lynn and Inner Dowsing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	No
1	Methil	0.4	0.0	0.0	0.0	0.0	0.0	0.4	0.0	No
1	Moray East	30.1	0.0	1.4	0.1	13.3	1.0	44.8	1.0	No
1	Race Bank	1.3	1.3	16.5	0.9	3.9	0.3	21.7	2.5	No
1	Rampion	37.6	0.0	25.8	1.4	20.5	1.5	83.9	2.9	No
1	Scroby Sands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	No
1	Sheringham Shoal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	No
1	Teeside	26.5	26.5	16.6	0.9	1.7	0.1	44.8	27.6	No
1	Thanet	0.1	0.0	0.3	0.0	0.3	0.0	0.8	0.0	No
1	Triton Knoll	17.0	17.0	96.0	5.2	31.4	2.3	144.4	24.4	No
1	Westermost Rough	0.1	0.1	0.1	0.0	0.1	0.0	0.3	0.2	No
2	Dogger Bank A and B	199.4	38.6	93.3	5.0	204.1	14.7	496.8	58.3	No
2	Dogger Bank C and Sofia	94.6	18.2	62.7	3.4	149.9	10.8	307.1	32.4	No
2	Seagreen Alpha and Bravo	118.2	0.0	98.3	5.3	23.2	1.7	239.7	7.0	No
2	Moray West	54.6	0.0	16.6	0.9	4.8	0.3	76.0	1.2	No
2	Neart na Gaoithe	8.5	0.0	16.8	0.6	1.7	0.1	27.0	0.7	No
3	East Anglia ONE North	27.9	14.0	5.6	0.3	2.4	0.2	35.9	14.4	Yes

Tier	OWF	Predicted number of collisions (in total (adjusted for latest NE advice on avoidance rates) and apportioned to SPA[2])								Consented subject to compensation for kittiwake at FFC SPA
		Breeding		Autumn Migration		Spring Migration		Annual		
		Total	SPA	Total	SPA	Total	SPA	Total	SPA	
3	East Anglia THREE	4.2	2.1	47.7	2.6	26.0	1.9	63.8	6.6	No
3	East Anglia TWO	20.4	10.2	3.7	0.2	5.1	0.4	29.2	10.8	Yes
3	Hornsea Project Three	53.2	53.2	26.3	1.4	5.5	0.4	85.0	55.0	Yes
3	Hornsea Project Four	51.5	48.6	9.6	0.5	3.2	0.2	64.3	49.4	Yes
3	Inch Cape	27.6	0.0	18.0	1.0	4.1	0.3	49.7	1.3	No
3	Norfolk Boreas	9.2	2.4	22.2	1.2	8.2	0.6	39.7	4.2	Yes
3	Norfolk Vanguard	15.1	2.5	11.3	0.6	13.3	1.0	39.7	4.1	Yes
	TOTAL tiers 1-3[3]	**948**	**276.4**	**796**	**43.0**	**640**	**46.0**	**2369**	**364.9**	
3	Green Volt	7.2	0.0	5.7	0.3	1.3	0.1	14.3	0.4	No
3	SEP&DEP	6.8	5.7	4.1	0.2	0.9	0.1	11.8	6.0	Yes
4	Berwick Bank	294.3	0.3	107.1	5.8	71.9	5.2	473.3	11.2	n/a
4	Five Estuaries[4]	16.0	0.0	11.2	0.6	7.8	0.6	35.0	1.2	n/a
4	Outer Dowsing[4]	28.1	14.3	18.1	1.0	50.4	3.7	99.4	19.0	n/a
4	Rampion 2	1.2	0.0	10.1	0.5	17.8	1.3	29.1	1.8	n/a
4	West of Orkney	34.4	0.0	15.8	0.9	4.4	0.3	54.5	1.2	n/a
4	Dogger Bank South[4]	164.4	31.8	47.9	2.6	29.5	2.1	241.9	36.5	n/a
	North Falls	8.8	0.0	3.6	0.2	7.8	0.6	20.2	0.8	n/a
TOTAL including sites consented with compensation measures								**3348**	**443**	
TOTAL excluding sites consented with compensation measures									**305**	

Tier	OWF	Predicted number of collisions (in total (adjusted for latest NE advice on avoidance rates) and apportioned to SPA[2])								Consented subject to compensation for kittiwake at FFC SPA
		Breeding		Autumn Migration		Spring Migration		Annual		
		Total	SPA	Total	SPA	Total	SPA	Total	SPA	

1. Foraging ranges from Woodward *et al.* 2019. 2. The seasonal and total numbers of collisions for each OWF were derived from those presented at Deadline 8 of the DCO Examination for SEP&DEP
2. (Royal HaskoningDHV 2023a), except for North Falls (Section 4.4.4.5.2 above) and other sites listed below. Where avoidance rates were known, values have been corrected to NE recommended rate (to 0.9924 (±0.0001) for the deterministic Band (2012) model and 0.9928 (±0.0003) for the stochastic (MacGregor *et al.*, 2018) model, see ES Appendix 13.3, Document Reference: 3.3.14). Values for Berwick Bank, Green Volt, Rampion 2, West of Orkney, Dogger Bank South, Five Estuaries and Outer Dowsing have been derived from the respective PEIR or submission documents, with corrected avoidance rates. During autumn and spring migration apportioning is based on the FFC SPA population as a proportion of the UK North Sea BDMPS, respectively 0.054 and 0.072 (Furness 2015). Breeding season apportioning of the FFC population for North Falls is as described in Section 4.4.4.5.3.1 above. For other OWFs breeding season apportioning has been undertaken as presented at Deadline 8 of the DCO Examination for SEP&DEP (Royal HaskoningDHV 2023a), or respective PEIR/submission documents for Tier 4/5 projects as above. 3. Excludes Green Volt and SEP&DEP, consented after the cut off date for inclusion in the North Falls assessment (March 2024) (although no changes to the collision risk for kittiwake were made at consent, so the numbers in the table remain correct).

4. DCO applications accepted after the cut off date for inclusion in the North Falls assessment (end March 2024), so values in this Table are based on PEIR documents.

401. Based upon the data in Table 4.39, the potential collision mortality of kittiwakes from the FFC SPA due to North Falls in-combination with other OWFs equates to 443 adult birds, discounting compensatory measures for kittiwakes proposed for a number of consented developments, and 305 adult birds with the compensatory measures taken into account. This assumes that projects consented subject to compensation measures will ensure the predicted mortality of breeding adult kittiwakes from the SPA (resulting from the project in question) is offset by those compensation measures, so that their contribution to the in-combination total will be effectively zero (with the measures put in place to date focussed on increasing the number of recruits into the SPA population).

402. North Falls contributes 0.8 birds, representing 0.3% of the in-combination total when the existing compensatory measures are taken into account.

403. Annual collision mortality of 443 and 305 adult birds would increase the baseline mortality rate of the SPA breeding kittiwake population respectively by 3.4% and 2.3%, based on a population size of 89,148 adults (Clarkson *et al.* 2022) and an adult baseline mortality rate of 0.146 (Horswill and Robinson 2015). Such increases are of sufficient magnitude to potentially result in a detectable impact at the population level. Given this, PVA has been run for the predicted in-combination mortality (both with and without compensatory measures for existing projects) to further assess the potential population level impact (Table 4.40).

404. Outputs included the two key metrics which are recommended for use in interpretating PVAs on the basis that they have relatively low sensitivity to factors such as varying population status and the mis-specification of the demographic rates underpinning the population model (Cook and Robinson 2015, Jitlal *et al.,* 2017). These metrics are:

- The CPS - the median of the ratio of the end-point size of the impacted to un-impacted (or baseline) population, expressed as a proportion.
- The CPGR - the median of the ratio of the annual growth rate of the impacted to un-impacted population, expressed as a proportion.

405. The assessment focusses on the outputs from the PVA which is based upon a density independent population model, using demographic rates as specified in Horswill and Robinson (2015) and which was undertaken using a matched runs approach. The key outputs from this PVA are found in Table 4.40.

406. At an in-combination mortality of 443 breeding adults (discounting compensation measures for existing projects), the median predicted reduction in the annual population growth rate of kittiwakes at the FFC SPA is 0.3% (CPGR = 0.997) compared with the unimpacted population, and the predicted reduction in population size compared to the unimpacted population after 30 years is 10.2% (CPS = 0.898). At an in-combination mortality of 305 breeding adults (accounting for compensation measures for existing projects), the median predicted reduction in the annual population growth rate is 0.2% (CPGR = 0.998) compared with an unimpacted population, and the predicted reduction in population size compared to the unimpacted population after 30 years is 7.1% (CPS = 0.929).

407. As noted previously, the most recent consent applications for OWFs in the southern UK North Sea have been granted subject to compensation measures for kittiwakes from FFC SPA. As such measures are legally secured, it is considered appropriate that the assessment assumes that such compensation reduces net mortality apportioned to the SPA to zero for the applicable projects, and therefore the latter values above are considered to provide the most realistic assessment.

Table 4.40 PVA results for kittiwake at FFC SPA: counterfactuals of population annual growth rate and population size resulting from the predicted in-combination collision mortality, including and excluding compensation from existing projects

Scenario	Adult Mortality due to collisions	Growth rate (median)	Counterfactual metric (after 30 years)		Reduction in growth rate	Reduction in population size
			Median growth rate (CPGR)	Population size (CPS)		
Baseline (no collision mortality from OWFs)	0	1.008	1.000	1.000	N/A	N/A
In-combination, no compensation	443	1.004	0.997	0.898	0.3%	10.2%
In-combination, including compensation	305	1.005	0.998	0.929	0.2%	7.1%

408. The scale of these predicted reductions in growth rate and relative population size after 30 years needs to be considered within the context of the various precautionary assumptions incorporated within the assessment.

409. A density independent population model assumes no population regulation and, as such, is biologically implausible. As a consequence, the resulting PVA is likely to give overly precautionary outputs because it does not allow for the operation of compensatory density dependence to offset (to some degree at least) the additional mortality from collisions (e.g. Horswill *et al.* 2016). The population model also assumes that the SPA kittiwake population is a closed population, without immigration from, or emigration to, other colony populations, which will not be the case (e.g. Reynolds *et al.*, 2009). This, again, is likely to result in overestimation of impacts at the scale of the colony population (Miller *et al.* 2019).

410. In addition, there are substantial levels of precaution built into the in-combination mortality predictions. The nocturnal activity rate for the species, assuming that flight activity is 25-50% of daytime levels, may have been over-estimated (para 386). For OWFs in English waters, collision risk is based on consented worst case rather than as-built OWF parameters, which may lead to the overestimation of collision rates by up to 15% (MacArthur Green, 2017; The Crown Estate and Womble Bond Dickinson, 2021; see para 398 above). In addition, for a number of OWFs included in the in-combination assessment, the breeding season apportioning does not take account of the fact that a proportion of adult plumage birds recorded during the breeding season will not yet have reached actual breeding age (so overestimating the apportioning to the adult age class); and for most OWFs no allowance is made that an additional proportion of adult-plumage

birds will be sabbatical adults, deciding not to breed in a given year (see para 379).

411. The SACOs for the FFC SPA kittiwake population include a target to restore the population size to 83,700 breeding pairs, which is nearly twice the current population size of 44,574 pairs in 2022 (Clarkson *et al.* 2022). This is despite the uncertainty over the veracity of the evidence pertaining to size of this population in the late 1980s and, hence, the long-term status of the population (as detailed above, see para 371). The Applicant acknowledges that recent DCO decisions for other OWFs in English North Sea waters have concluded that there is an adverse in-combination effect. However, North Falls has no material contribution to any adverse effect on integrity to the FFC SPA. The worst case scenario, a mean of 0.8 collisions per year, apportioned to the FFC SPA, is equivalent to a 0.01% increase in the baseline mortality rate of the SPA population at which levels there would be no detectable effects on the SPA population of breeding adults. It is therefore concluded that there is no adverse effect on integrity from North Falls, alone or in-combination, in relation to the kittiwake feature of the FFC SPA.

412. As noted above, the information on estimated in-combination collision mortality and PVA is provided as context for the assessment, given the conclusion that the Project would make no material contribution to the in-combination mortality.

413. Notwithstanding this conclusion, an HRA Derogation case without prejudice is provided for kittiwake at the FFC, with proposed compensation measures described in the Kittiwake Compensation Document (Document Reference: 7.2.4).

4.4.4.6 Guillemot

414. This species has been screened in to the shadow Appropriate Assessment in relation to operational displacement / barrier effect during the breeding and non-breeding seasons.

4.4.4.6.1 Status

415. The FFC SPA breeding guillemot population was cited as 41,607 pairs (or 83,214 breeding adults) based on the mean count of individuals present on land during the period 2008-2011. A whole-colony count for the SPA in 2017 reported 60,877 pairs (or 121,754 breeding adults) (Aitken *et al.* 2017). The most recent whole-colony count for the SPA (in 2022) was 74,989 pairs (or 149,978 breeding adults) (Clarkson *et al.* 2022); this is used as the reference population for the assessment. The population trend from field counts of individuals shows an average annual increase of almost 3.5% from 1987 to 2022 (with the field counts at the Flamborough Head and Bempton Cliffs colony, which holds the bulk of the SPA population, increasing over threefold from ~30,000 to ~100,000 breeding adults during this period). The SPA population has shown a consistently increasing trend since at least the 1960s (Clarkson *et al.* 2022). SACOs (NE 2023f) set a target to maintain the size of the breeding population at a level which is above 41,607 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

4.4.4.6.2 Functional Linkage and Seasonal Apportionment of Potential Effects

4.4.4.6.2.1 Breeding season

416. North Falls is 297 km from the FFC SPA based on the closest distance by sea between the array area and the SPA boundary (288.4km straight line distance including land crossing). As the SPA boundary includes a 2km marine extension, by sea (guillemots would not be expected to fly over land) the North Falls array area is approximately 299km from the nearest coastal area within the SPA where guillemots might nest.

417. NE (2022a) advises that MMFR + 1SD, based on the latest review of tracking studies of breeding adults by Woodward *et al.* (2019), is used to identify breeding seabird colonies with potential connectivity with an SPA, subject to a check of any colony-specific foraging range data. Woodward *et al.* (2019) estimates the MMFR of guillemot as 73.2km (± 80.5km SD). This value includes data from breeding guillemots at Fair Isle, where reduced prey availability was considered to have significantly increased the distances that birds travelled to forage during the breeding seasons in which tracking was undertaken. Excluding the Fair Isle study, on the basis that the extensive foraging range values were not representative and would bias the estimate of MMFR, the MMFR is 55.7km (±39.7km S.D.) (Woodward *et al*. 2019). NE (2022e) has indicated that it is reasonable to exclude the extreme Fair Isle values when considering the potential breeding season foraging range for the FFC SPA guillemot population. The breeding season MMFR of guillemot in the previous review of seabird foraging ranges (Thaxter *et al.* 2012) was 84.2km (±50.1km S.D.) based on data from six sites. The more recent review, based on data from 16 sites, therefore estimates a smaller mean-maximum foraging range (Woodward *et al.* 2019).

418. The distance between the North Falls array area and the FFC SPA is therefore nearly three times the breeding season MMFR + 1 SD (55.7 km + 39.7 km = 95.4km) of guillemots.

419. Modelled at-sea distributions of breeding adults, from tracking data collected during the breeding season from foraging breeding adult individuals (Cleasby *et al.* 2018, 2020; Wakefield *et al.* 2017), also suggest that the array area is a considerable distance beyond the foraging range (i.e., beyond the 95% utilisation distribution) of guillemots from the FFC SPA.

420. On this basis, no connectivity is identified, and no effect is expected to occur on the SPA population in the breeding season. The evidence strongly suggests that none (or so few as to be inconsequential to the assessment) of the guillemots recorded at the North Falls array area during the breeding season are breeding adults from FFC SPA. Accordingly, no birds from FFC SPA have been apportioned to the assessment during the breeding season (Table 4.41).

421. The array area is not within foraging range of breeding guillemots from any other SPA (or indeed non-SPA) colonies (Mitchell *et al.* 2004, Burnell *et al.* 2023). Therefore, based on the above foraging range data and utilisation distribution modelling, it is likely that the birds recorded at the array area during the breeding season are non-breeding adults or sub-adult birds which have not yet reached breeding age. This may include birds associated with FFC SPA and other breeding colonies (e.g. immature birds which have fledged from such colonies in previous years).

4.4.4.6.2.2 Non-breeding season

422. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all age classes from breeding colonies in the UK and other countries. During this time therefore, adults from the FFC SPA breeding population might encounter North Falls (as well as other OWFS within the BDMPS area that are situated beyond the breeding season foraging range).

423. The relevant non-breeding season (August to February) reference population is the UK North Sea and Channel BDMPS (Furness 2015) consisting of 1,617,306 individuals of all age classes. During the non-breeding season, the proportion of SPA breeding adults from the FFC SPA population contributing to the UK North Sea and Channel BDMPS is estimated from ringing and tracking data to be 0.9 (Furness 2015). Using the estimate of the SPA population of 79,282 breeding adults from the 2008 breeding season[4] (Furness 2015), the number of adults from FFC SPA present in this non-breeding season BDMPS is estimated to be 71,354. Therefore, 4.4% (71,384 / 1,617,306 x 100) of birds present at North Falls in the non-breeding season are considered to be breeding adults from the FFC SPA population.

424. The mean peak guillemot population estimate at the North Falls array area during the non-breeding season (array area + 2km buffer, the estimated zone of influence for displacement effects) is 5,365 birds (95% CI 868 – 14,674). Therefore, the estimated number of breeding adult guillemots from FFC SPA present at North Falls during the non-breeding season is 236 (95% CI 38 - 646) (Table 4.41).

Table 4.41 Seasonal and annual population estimates of guillemots at North Falls (array area and 2km buffer) and numbers apportioned to FFC SPA

Breeding season (migration free)		Non-breeding season		Annual	
Mean peak	Apportioned to FFC SPA	Mean peak	Apportioned to FFC SPA	Total	Apportioned to FFC SPA
866 (242 – 2346)	0	5365 (868 – 14674)	236 (38 – 646)	6231 (1110 – 17020)	236 (38 – 646)
1. See ES Appendix 13.2 (Document Reference: 3.3.13) Section 4 for details of how seasonal peak means and upper and lower 95% CLs (values in parentheses) were calculated.					

4.4.4.6.3 Effects: displacement / barrier effect during operation

425. As stated in ES Chapter 13, Section 13.6.2.1 (Document Reference: 3.1.15), for the purposes of assessment of birds present in an OWF array area and buffer during a given season, it is usually not possible to distinguish between displacement and barrier effects (i.e. to define whether individual birds may have intended to travel to, or beyond an OWF site) even when tracking data are

[4] The 2008 estimate is used (as opposed to more recent estimates) because it provides an estimate which is relatively contemporary with the other national and colony population estimates from which the BDMPS population size is derived (Furness 2015).

available. Therefore, in this assessment the effects of displacement and barrier effects on guillemot are considered together (as is standard practice within the industry).

426. The assessment assumes that a proportion of the birds present in the North Falls array area and 2km buffer would be displaced during the operation of the OWF, and that a proportion of displaced birds would die as a result of displacement. For guillemot, SNCBs (2017) advise that displacement rates of 30% to 70% are considered, along with a range of mortality rates from 1% to 10% of displaced birds.

427. The upper values within these ranges of displacement and mortality rates are considered to be overly precautionary. The available evidence suggests that auks (guillemots and razorbills) tend to be displaced from OWFs, with displacement rates varying between sites but, on average, it is considered that densities within OWFs tend to be approximately half of those occurring in the habitats around the OWF (MacArthur Green 2019a). Displacement may also occur from a buffer zone around the OWF although the available evidence suggests this does not usually extend as far as 2km out from the OWF. Based on consideration of the quality of, or confidence in, the studies used to derive the recommended range of displacement rates, as well as those studies demonstrating no significant displacement, the findings from a detailed review by APEM (2022) suggest that a displacement rate of 50% is appropriate (and sufficiently precautionary) for guillemot.

428. Mortality as a result of displacement could occur due to increased energy expenditure and / or decreased energy intake (e.g. from increased flight time or increased intra-specific competition resulting from higher densities of birds occurring in foraging habitat outside OWFs). However, OWFs represent a small proportion of the available foraging habitat for guillemot in the North Sea and increases in densities outside OWFs as a result of displacement are likely to be negligible (MacArthur Green 2019a). When considered within the context of a baseline annual mortality rate (i.e. in the absence of OWF effects) for adult guillemots of 6.1% (Horswill and Robinson 2015), increases due to displacement are more likely to be at the lower range of the advised rates, if not below these (MacArthur Green 2019a). Thus, based on consideration of available evidence, together with what is biologically plausible, both MacArthur Green (2019) and APEM (2022) suggest that a displacement rate of 50% and mortality rate amongst displaced birds of 1% are sufficiently precautionary.

429. For Hornsea Project Four (HP4), the Secretary of State is understood to have based the consent decision on displacement and mortality rates of 70% and 2% for guillemot and razorbill (DESNZ, 2023). Predicted mortality under the two scenarios identified in the above paragraph (50% displacement /1% mortality of displaced birds and 70%/2%) scenario is presented in the assessment, as well as the SNCB advised range of 30-70%/ 1-10%).

430. A more detailed review of the evidence in relation to displacement of auks from OWFs is included in ES Chapter 13, Section 13.6.2.1.1 (Document Reference: 3.1.15).

431. In the absence of OWF effects, the baseline mortality of the FFC SPA breeding adult population is estimated to be 9,149 adult birds per year, based on an adult population of 149,978 breeding adults (Clarkson *et al.* 2022) and an adult annual

mortality rate of 6.1% (Horswill and Robinson 2015, ES Chapter 13, Table 13.11, Document Reference: 3.1.15).

4.4.4.6.3.1 Project Alone assessment

432. Based on the seasonal mean peak abundances, the estimated total number of adult guillemots which are part of the breeding population at the FFC SPA present at the array area (and 2km buffer) and potentially subject to displacement by the North Falls project alone is 236 (95% CI 38 - 646) (Table 4.41). As no breeding season connectivity has been identified, the project alone displacement effects would therefore be limited to the non-breeding season, although they are expressed here as an annual effect on the SPA population of breeding adults for the purposes of the shadow Appropriate Assessment (as is the standard industry approach).

433. At displacement rates of 30% to 70% and mortality rates of 1% to 10% for displaced birds, 1 to 17 SPA breeding adults would be predicted to die each year due to displacement from North Falls (with the ranges around those values as defined by the 95% CLs for the mean peak abundance being: 95% LCL 0 to 3 breeding adults, 95% UCL 2 to 45 breeding adults) (Table 4.42). These estimates of potential mortality would cause the annual mortality rate for the FFC SPA breeding population to increase by zero to 0.2% due to displacement impacts from North Falls alone (with the ranges around those values as defined by the 95% CLs for the mean peak abundance being: 95% LCL zero; 95% UCL zero to 0.5%) (Table 4.43).

434. Using the evidence-based displacement rate of 50% and a 1% mortality rate for displaced birds, annual mortality in the FFC SPA breeding guillemot population would increase by 1 bird (95% CLs 0-3 birds), equivalent to no increase in population mortality rate due to impacts from North Falls alone. At a displacement rate of 70% and mortality of 2%, annual mortality would increase by 3 birds (95% CLs 1-9 birds), equivalent to an increase in mortality rate of zero (95% CLs zero to 0.1%).

435. Increases in the existing mortality rate of less than 1% are unlikely to be detectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered for the project alone.

436. It is concluded that predicted guillemot mortality due to operational phase displacement at North Falls alone would not adversely affect the integrity of the FFC SPA.

437. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the displacement rates is of high applicability and quality. Also, whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on consideration of the plausible extent of such effects within the context of the species biology. Notably, this species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.* 2014; Furness & Wade 2012; Garthe & Hüppop 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. On the advice of SNCBs (2017), the seasonal populations of guillemots at OWFs (array area and 2km buffer) are based on mean peak counts for the relevant seasonal period over the two years of baseline surveys, which is

likely to over-estimate the number of birds typically occurring in this area during a given season (on the basis that these values will exceed the mean count). Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CL mean peak abundances are used to calculate the potential mortality and consequent increases in baseline mortality rate of the SPA adult population, with this being the case even when the overly precautionary rates of 70% displacement and 10% mortality are applied.

Table 4.42 Displacement matrix for guillemot for the project alone. The cells show the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality (LCL and UCL = upper and lower 95% confidence limits). Grey cells identify the range of displacement and mortality rates considered in the assessment. Red text identifies values of predicted mortality which represent a 1% or more increase in the population mortality rate (with reference to Table 4.43)

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0	0	1	1	1	2	5	7	12	19	24
	20%	0	1	1	2	2	5	9	14	24	38	47
	30%	1	1	2	3	4	7	14	21	35	57	71
	40%	1	2	3	4	5	9	19	28	47	76	94
	50%	1	2	4	5	6	12	24	35	59	94	118
	60%	1	3	4	6	7	14	28	42	71	113	142
	70%	2	3	5	7	8	17	33	50	83	132	165
	80%	2	4	6	8	9	19	38	57	94	151	189
	90%	2	4	6	8	11	21	42	64	106	170	212
	100%	2	5	7	9	12	24	47	71	118	189	236
LCL	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0	0	0	0	0	0	1	1	2	3	4
	20%	0	0	0	0	0	1	2	2	4	6	8
	30%	0	0	0	0	1	1	2	3	6	9	11
	40%	0	0	0	1	1	2	3	5	8	12	15
	50%	0	0	1	1	1	2	4	6	10	15	19
	60%	0	0	1	1	1	2	5	7	11	18	23
	70%	0	1	1	1	1	3	5	8	13	21	27
	80%	0	1	1	1	2	3	6	9	15	24	31
	90%	0	1	1	1	2	3	7	10	17	27	34
	100%	0	1	1	2	2	4	8	11	19	31	38
UCL	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	1	1	2	3	3	6	13	19	32	52	65
	20%	1	3	4	5	6	13	26	39	65	103	129
	30%	2	4	6	8	10	19	39	58	97	155	194
	40%	3	5	8	10	13	26	52	77	129	207	258
	50%	3	6	10	13	16	32	65	97	161	258	323
	60%	4	8	12	15	19	39	77	116	194	310	387
	70%	5	9	14	18	23	45	90	136	226	362	452
	80%	5	10	15	21	26	52	103	155	258	413	517
	90%	6	12	17	23	29	58	116	174	291	465	581
	100%	6	13	19	26	32	65	129	194	323	517	646

Table 4.43 Displacement matrix for guillemot for the project alone. The cells show the % increase in the mortality rate of the SPA population associated with the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality given in Table 4.42 (LCL and UCL = upper and lower 95% confidence limits). Grey cells identify the range of displacement and mortality rates considered in the assessment.

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%
	20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%	0.5%
	30%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.2%	0.4%	0.6%	0.8%
	40%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.5%	0.8%	1.0%
	50%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.3%	0.4%	0.6%	1.0%	1.3%
	60%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.5%	0.8%	1.2%	1.5%
	70%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	0.5%	0.9%	1.4%	1.8%
	80%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	0.6%	1.0%	1.7%	2.1%
	90%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.5%	0.7%	1.2%	1.9%	2.3%
	100%	0.0%	0.1%	0.1%	0.1%	0.1%	0.3%	0.5%	0.8%	1.3%	2.1%	2.6%
LCL	**Mortality**											
Displacement		**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
	10%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
	30%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
	40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%
	50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%
	60%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%
	70%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%
	80%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.3%
	90%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%
	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%
UCL	**Mortality**											
Displacement		**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
	10%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	0.6%	0.7%
	20%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.3%	0.4%	0.7%	1.1%	1.4%
	30%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	0.6%	1.1%	1.7%	2.1%
	40%	0.0%	0.1%	0.1%	0.1%	0.1%	0.3%	0.6%	0.8%	1.4%	2.3%	2.8%
	50%	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	0.7%	1.1%	1.8%	2.8%	3.5%
	60%	0.0%	0.1%	0.1%	0.2%	0.2%	0.4%	0.8%	1.3%	2.1%	3.4%	4.2%

Mean	Mortality											
	70%	0.0%	0.1%	0.1%	0.2%	0.2%	0.5%	1.0%	1.5%	2.5%	4.0%	4.9%
	80%	0.1%	0.1%	0.2%	0.2%	0.3%	0.6%	1.1%	1.7%	2.8%	4.5%	5.6%
	90%	0.1%	0.1%	0.2%	0.3%	0.3%	0.6%	1.3%	1.9%	3.2%	5.1%	6.4%
	100%	0.1%	0.1%	0.2%	0.3%	0.4%	0.7%	1.4%	2.1%	3.5%	5.6%	7.1%

4.4.4.6.3.2 In-combination assessment

438. On the basis of the conclusions of the Project alone assessment of very low predicted guillemot mortality of between 1 and 3 birds, and below 0.1% increase in background mortality, assuming a realistic, evidence-based precautionary scenario of 50% displacement/1% mortality and a more precautionary scenario of 70% displacement/2% mortality, there would be no material contribution of the Project to in-combination effects. Accordingly, no in-combination assessment is required for this feature. The conclusion of the assessment is therefore that predicted guillemot mortality due to displacement and barrier effects would not adversely affect the integrity of the FFC SPA, either for the project alone or in-combination.

439. Notwithstanding this conclusion, the estimated in-combination mortality, together with a PVA, is provided below as context to the Project alone assessment. This information is presented without prejudice to the conclusion above.

440. Seasonal and annual population estimates of breeding guillemot at all OWFs included in the in-combination assessment are presented in Table 4.44 along with the numbers apportioned to the FFC SPA. This information was taken from the numbers presented at Deadline 8 of the DCO Examination for SEP&DEP (Royal HaskoningDHV 2023a) and updated with new information that was available at the time of writing for some OWFs (see Table 4.44). The cut off for inclusion of other OWFs in the in-combination assessment was the end of March 2024[5].

441. In accordance with the approach adopted for SEP&DEP (Royal HaskoningDHV 2023a), the in-combination assessment has presented three different scenarios for the contribution of HP4 project. These scenarios used different approaches to seasonal apportioning of birds, and comprise the ‘HP4 Applicant’s approach’, NE ‘standard approach’, and NE ‘bespoke approach’. For their ‘bespoke approach’, NE requested that the non-breeding season was split into a chick rearing/moult period (August and September) with a 60% apportionment rate, and the remaining non-breeding period (October to February) with an apportionment rate of 4.4%, and a breeding season apportionment of 100%; thus adding an additional ‘chick rearing/moult season’ to the ‘breeding’ and ‘non-breeding’ seasons specified by Furness (2015). This is understood to be based on the presence of peak densities of guillemot at HP4 during baseline surveys in August

[5] Since January 2024, Green Volt, and Sheringham Shoal and Dudgeon Extension Projects have been consented; and the ESs for Five Estuaries and Outer Dowsing have been submitted. The RIAA is based on the PEIR values for Five Estuaries and Outer Dowsing. It is understood that no changes to the cumulative values for the newly consented sites have been made.

and September (the period immediately post breeding), and the presence of adult birds and juveniles at this time (APEM 2021b). The Applicant argued against the NE bespoke approach and presented an alternative approach with the mean for the non-breeding season weighted to account for high densities of guillemots during post-breeding dispersal in August and September (giving an overall 13.12% apportionment in the non-breeding season), and 55.8% apportionment during the breeding season (accounting for the presence of sub-adult birds and breeding birds on sabbatical); the NE 'standard' approach is based on 4.4% and 100% apportionment during the non-breeding and breeding seasons respectively (APEM, 2022). The HRA for HP4 (DESNZ 2023) indicates that the Examining Authority agreed with the use of NE's bespoke approach to defining an additional season for guillemot. Although it is not specifically stated whether the Secretary of State agreed with this approach, it is considered appropriate to infer that the decision for HP4 was based on this approach.

442. For the avoidance of doubt in relation to the breeding season, apportioning of guillemots to the FFC SPA during the breeding season for OWFs contributing to the in-combination assessment (Table 4.44) is (as stated above) based on the SEP&DEP deadline 8 updates (Royal HaskoningDHV 2023a) where this information is still current. However, this has been updated where new information was available at the time of writing for a given OWF, and for additional OWFs where quantitative information on guillemot numbers has become available in the public domain since the SEP&DEP document was published (see table notes). The breeding season apportioning is taken to represent an estimate of the number of breeding adults from the FFC SPA that could be present at a given OWF and buffer area, as opposed to the total numbers of breeding adults and associated sub-adult birds from the SPA. However, for OWFs with 100% apportioning of birds at risk of displacement to the FFC SPA (Table 4.44), this is highly likely to overestimate the number of adult birds from the FFC SPA present, as a proportion of the birds recorded at every OWF is expected to include sub-adults as well as adults (noting that estimates of the population age structure for guillemot generally suggest that sub adults comprise close to 50% of the overall population – e.g. Furness 2015). It is also noted in this context, that using breeding season apportioning based on that undertaken for previous OWF assessment means that breeding adults from the FFC SPA are assumed to occur at the array area and buffer of some OWFs beyond the most recent (Woodward *et al.* 2019) estimate of MMFR + 1SD (95.4km) (such that, if apportioning was updated to reflect the latest value for MMFR + 1SD, the numbers allocated to some OWFs during the breeding season would be reduced, and the overall total apportioned to FFC would also reduce).

443. The in-combination assessment considers the potential effects with and without the HP4 project; for which the Secretary of State concluded that an adverse effect on integrity in relation to guillemots from FFC SPA could not be ruled out when considered in-combination with other plans or projects[6]. The agreed derogation and compensation case is assumed to reduce the net effect of HP4 to zero.

[6] Since the end of January 2024, SEP&DEP has also been consented subject to compensation for guillemot, but after the cut-off date for inclusion if the North Falls in-combination assessment.

Therefore, it is appropriate to present an in-combination effect that assumes no contribution from this project.

444. The estimated annual total of breeding adult guillemots from FFC SPA present and at risk of displacement from all OWFs within the UK North Sea BDMPS combined is 83,725 including HP4 (NE bespoke approach) and 51,416 excluding HP4 (Table 4.44). Of this total, North Falls contributes only 236 birds, respectively representing 0.3% and 0.5% of the in-combination totals with and without HP4.

Table 4.44 Seasonal and annual population estimates of all guillemots at North Falls and other OWFs included in the in-combination assessment; and breeding adult birds apportioned to FFC SPA.

Tier	OWF	Distance from FFC (km)	Number of guillemots at risk of displacement[1]							Consented subject to compensation for guillemot at FFC
			Breeding		Chick rearing /moult	Non-Breeding		Annual		
			Total	FFC	FFC	Total	FFC	Total	FFC	
1	Beatrice	464.1	13,610	0	n/a	2,755	121	16,365	121	-
1	Beatrice Demonstrator	460.48	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-
1	Blyth Demonstration	116.7	1,220	0	n/a	1,321	58	2,541	58	-
1	Dudgeon	126.3	334	0	n/a	542	24	876	24	-
1	East Anglia ONE	260.5	274	0	n/a	640	28	914	28	-
1	EOWDC (Aberdeen)	343.9	547	0	n/a	225	10	772	10	-
1	Galloper	270.5	305	0	n/a	593	26	898	26	-
1	Greater Gabbard	270.7	345	0	n/a	548	24	893	24	-
1	Gunfleet Sands	274.5	0	0	n/a	363	16	363	16	-
1	Hornsea Project One	114.0	9,836	4,554	n/a	8,097	357	17,933	4,911	-
1	Hornsea Project Two	97.7	7,735	3,581	n/a	13,164	581	20,899	4,162	-
1	Humber Gateway	52.1	99	99	n/a	138	6	237	105	-
1	Hywind	362.2	249	0	n/a	2,136	94	2,385	94	-
1	Kentish Flats and Extension	300.9	0	0	n/a	7	0	7	0	-
1	Kincardine	316.8	632	0	n/a	0	0	632	0	-
1	Lincs and Lynn and Inner Dowsing	100.4	582	0	n/a	814	36	1,396	36	-

Tier	OWF	Distance from FFC (km)	Number of guillemots at risk of displacement[1]							Consented subject to compensation for guillemot at FFC
			Breeding		Chick rearing /moult	Non-Breeding		Annual		
			Total	FFC	FFC	Total	FFC	Total	FFC	
1	London Array	285.8	192	0	n/a	377	17	569	17	-
1	Methil	271.7	25	0	n/a	0	0	25	0	-
1	Moray Firth East	453.1	9,820	0	n/a	547	24	10,367	24	-
1	Race Bank	100.7	361	0	n/a	708	31	1,069	31	-
1	Rampion	375.8	10,887	0	n/a	15,536	685	26,423	685	-
1	Scroby Sands	200.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-
1	Sheringham Shoal	126.9	390	0	n/a	715	31	1,105	31	-
1	Teeside	63.5	267	267	n/a	901	40	1,168	307	-
1	Thanet	313.4	18	0	n/a	124	5	142	5	-
1	Triton Knoll	80.9	425	425	n/a	746	33	1,171	458	-
1	Westermost Rough	31.4	347	347	n/a	486	21	833	368	-
2	Dogger Bank (formerly Creyke Beck) A and B	128.6	14,886	5,210	n/a	16,763	738	31,649	5,948	-
2	Dogger Bank C (formerly Teeside A) and Sofia (formerly Teeside B)	162.5	8,494	2,973	n/a	5,969	263	14,463	3,236	-
2	Moray West	453.1	24,426	0	n/a	38,174	1,680	62,600	1,680	-
2	Neart na Gaoithe	246.3	1,755	0	n/a	3,761	165	5,516	165	-
2	Seagreen (Forth) Alpha and Bravo	263.2	24,724	0	n/a	8,800	387	33,524	387	-

Tier	OWF	Distance from FFC (km)	Number of guillemots at risk of displacement[1]							Consented subject to compensation for guillemot at FFC
			Breeding		Chick rearing /moult	Non-Breeding		Annual		
			Total	FFC	FFC	Total	FFC	Total	FFC	
3	East Anglia ONE North	246.8	4,183	0	n/a	1,888	83	6,071	83	-
3	East Anglia THREE	239.2	1,744	0	n/a	2,859	126	4,603	126	-
3	East Anglia TWO	253.8	2,077	0	n/a	1,675	74	3,752	74	-
3	Hornsea Project Four (HP4) (Applicant's approach)[2]	63.0	9,382	5,235	n/a	36,965	2,666	46,347	7,901	Yes
	HP4 (NE 'standard approach')[2]		9,382	9,382	n/a	36,965	1,631	46,347	11,013	
	HP4 (NE 'bespoke approach')[2]		9,382	9,382	22,179	36,965	748	46,347	32,309	
3	Hornsea Project Three[3]	147.3	13,374	0	n/a	17,772	782	31,146	782	-
3	Inch Cape	266.1	4,371	0	n/a	3,177	140	7,548	140	-
3	Norfolk Boreas	217.0	7,767	0	n/a	13,777	606	21,544	606	-
3	Norfolk Vanguard	202.9	4,320	0	n/a	4,776	210	9,096	210	-
3	Green Volt[4]	324.9	4,429	0	n/a	16,105	709	20,534	709	-
3	SEP&DEP	115.5	4,934	0	n/a	15,972	703	20,906	703	Yes
4	Berwick Bank[5]	211.6	44,171	0	n/a	74,154	3,263	118,325	3,263	-
4	Dogger Bank South[6]	97.2	31,587	14,625	n/a	25,342	1,118	56,929	15,742	-
4	Five Estuaries[7]	275.5	1,201	0	n/a	3,698	163	4,899	163	-
4	Outer Dowsing[8]	92.9	16,445	4,687	n/a	11,208	494	27,653	5,181	-

Tier	OWF	Distance from FFC (km)	Number of guillemots at risk of displacement[1]							Consented subject to compensation for guillemot at FFC
			Breeding		Chick rearing /moult	Non-Breeding		Annual		
			Total	FFC	FFC	Total	FFC	Total	FFC	
4	Rampion 2[9]	376.4	134	0	n/a	5,723	252	5,857	252	-
4	West of Orkney[10]	556.7	4,861	0	n/a	4,275	188	9,136	188	-
	North Falls	288.5	**866**	**0**	**n/a**	**5,365**	**236**	**6,231**	**236**	
Total (HP4 Applicant's approach)			***288,631***	***42,003***	**n/a**	***369,681***	***17,314***	***658,312***	***59,317***	
Total (HP4 NE 'standard' approach)			***288,631***	***46,150***	**n/a**	***369,681***	***16,279***	***658,312***	***62,429***	
Total (HP4 NE 'bespoke' approach)			***288,631***	***46,150***	***22,179***	***369,681***	***15,396***	***658,312***	***83,725***	
Total excluding compensated site (HP4)			***279.249***	***36,768***	**n/a**	***332,716***	***14,648***	***611,965***	***51,416***	

Notes:

1. The standard area is the OWF plus a 2km buffer (SNCBs 2017), however the buffer zones included in this assessment varied between 0-4km depending on the data available. OWF seasonal and annual totals of guillemots at risk of displacement and apportioned to FFC follow those of (Royal HaskoningDHV 2023a), except where footnoted (see also ES Appendix 13.3, Document Reference: 3.3.14).

2. For Hornsea Project Four (HP4) three sets of values are presented in alignment with Royal HaskoningDHV (2023a). The NE bespoke approach with the non-breeding season split into the chick rearing/moult period (August and September) with a 60% apportionment rate, and the remaining non-breeding period (October to February) with a 4.4% apportionment rate, and 100% breeding season apportionment; an alternative approach from the Applicant with the non-breeding season mean weighted to account for high densities of guillemots during August and September (overall a 13.12% non-breeding season apportionment), and 55.8% apportionment during the breeding season (accounting for the presence of sub-adult birds and breeding birds on sabbatical); the NE standard approach is based on respectively 4.4% and 100% apportionment during the non-breeding and breeding seasons respectively .

3. The East Anglia ONE North /East Anglia TWO Deadline 11 Offshore Ornithology Cumulative and In-Combination Collision Risk and Displacement Update (MacArthur Green and Royal HaskoningDHV 2021c) and Hornsea Project 4 Deadline 6 (APEM and Gobe Consultants 2022) revised totals for Hornsea Project Three and identified 64% of the guillemots present during the breeding season as being apportioned to the FFC SPA (i.e. 8,502 birds). However, given the site is beyond MMFR = 1SD for guillemot (95.4km, Woodward *et al.* 2019), it was determined that adult guillemot from the SPA were not present on the project array area during the breeding season and the apportionment estimates refers instead to immature birds associated with the SPA population (see NIRAS 2019, 2021). As such, the above totals apportioned to the SPA do not include any adult birds from Hornsea Three during the breeding season.

4. Total seasonal population estimates from APEM (2022). It has been assumed that no birds would be apportioned to FFC SPA during the breeding season (project is beyond MMFR +1SD from FFC), and 4.4% apportioned during the non-breeding season.

Tier	OWF	Distance from FFC (km)	Number of guillemots at risk of displacement[1]							Consented subject to compensation for guillemot at FFC
			Breeding		Chick rearing /moult	Non-Breeding		Annual		
			Total	FFC	FFC	Total	FFC	Total	FFC	

5. Total seasonal population estimates from Pelagica and Cork Ecology (2022), Royal HaskoningDHV (2022b). It has been assumed that no birds would be apportioned to FFC SPA during the breeding season (project is beyond MMFR + 1SD from FFC, and 4.4% apportioned during the non-breeding season.

6. Total seasonal population estimates from RWE Renewables (2023). It has been assumed that breeding season apportioning uses the same rate as used for Hornsea Projects One and Two (46.3%, as presented for SEP&DEP in-combination assessment (Royal HaskoningDHV (2023)), as Dogger Bank South is a similar distance from FFC SPA; 4.4% apportioned during the non-breeding season.

7. Seasonal population estimates and apportioning to FFC as per GoBe (2023b, c).

8. Seasonal population estimates and apportioning to FFC as per GoBe and SLR (2023).

9. Total seasonal population estimates from GoBe (2023a). It has been assumed that no birds would be apportioned to FFC SPA during the breeding season (project is beyond MMFR +1SD, and 4.4% apportioned during the non-breeding season.

10. Total seasonal population estimates from MacArthur Green (2023). It has been assumed that no birds would be apportioned to FFC SPA during the breeding season (as project >mean maximum+1SD foraging range for guillemot (154km, Woodward *et al.* 2019)), and 44% apportioned during the non-breeding season.

445. Displacement matrices for the in-combination totals of guillemots at risk of displacement, with and without HP4, are presented in Table 4.45 and Table 4.47, and the corresponding increases in the mortality rate of the FFC SPA population in Table 4.46 and Table 4.48.

Table 4.45 In-combination displacement matrix for guillemot from FFC SPA (including *HP4 NE bespoke approach*). The cells show the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality. Grey cells identify the range of displacement and mortality rates considered in the assessment. Red text indicates where a given value of predicted mortality represents an increase of 1% or more in the baseline mortality rate (with reference to Table 4.46 below).

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	84	167	251	335	419	837	1674	2512	4186	6698	8372
	20%	167	335	502	670	837	1674	3349	5023	8372	13396	16745
	30%	251	502	754	1005	1256	2512	5023	7535	12559	20094	25117
	40%	335	670	1005	1340	1674	3349	6698	10047	16745	26792	33490
	50%	419	837	1256	1674	2093	4186	8372	12559	20931	33490	41862
	60%	502	1005	1507	2009	2512	5023	10047	15070	25117	40188	50235
	70%	586	1172	1758	2344	2930	5861	11721	17582	29304	46886	58607
	80%	670	1340	2009	2679	3349	6698	13396	20094	33490	53584	66980
	90%	754	1507	2261	3014	3768	7535	15070	22606	37676	60282	75352
	100%	837	1674	2512	3349	4186	8372	16745	25117	41862	66980	83725

Table 4.46 In-combination displacement matrix for guillemot from FFC SPA (including *HP4 NE bespoke approach*). The cells show the % increase in the mortality rate of the SPA population associated with the number of predicted bird mortalities per annum at given rates of displacement and mortality. Grey cells identify the range of displacement and mortality rates considered in the assessment.

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0.9%	1.8%	2.7%	3.7%	4.6%	9.2%	18.3%	27.5%	45.8%	73.2%	91.5%
	20%	1.8%	3.7%	5.5%	7.3%	9.2%	18.3%	36.6%	54.9%	91.5%	146%	183%
	30%	2.7%	5.5%	8.2%	11.0%	13.7%	27.5%	54.9%	82.4%	137%	220%	275%
	40%	3.7%	7.3%	11.0%	14.6%	18.3%	36.6%	73.2%	110%	183%	293%	366%
	50%	4.6%	9.2%	13.7%	18.3%	22.9%	45.8%	91.5%	137%	229%	366%	458%
	60%	5.5%	11.0%	16.5%	22.0%	27.5%	54.9%	110%	165%	275%	439%	549%
	70%	6.4%	12.8%	19.2%	25.6%	32.0%	64.1%	128%	192%	320%	512%	641%
	80%	7.3%	14.6%	22.0%	29.3%	36.6%	73.2%	146%	220%	366%	586%	732%
	90%	8.2%	16.5%	24.7%	32.9%	41.2%	82.4%	165%	247%	412%	659%	824%
	100%	9.2%	18.3%	27.5%	36.6%	45.8%	91.5%	183%	275%	458%	732%	915%

Table 4.47 In-combination displacement matrix for guillemot from FFC SPA (*excluding compensated project; HP4*). The cells show the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality. Grey cells identify the range of displacement and mortality rates considered in the assessment. Red text indicates where a given value of predicted mortality represents an increase of 1% or more in the baseline mortality rate (with reference to Table 4.48 below).

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	51	103	154	206	257	514	1028	1542	2571	4113	5142
	20%	103	206	308	411	514	1028	2057	3085	5142	8227	10283
	30%	154	308	463	617	771	1542	3085	4627	7712	12340	15425
	40%	206	411	617	823	1028	2057	4113	6170	10283	16453	20566
	50%	257	514	771	1028	1285	2571	5142	7712	12854	20566	25708
	60%	308	617	925	1234	1542	3085	6170	9255	15425	24680	30849
	70%	360	720	1080	1440	1800	3599	7198	10797	17995	28793	35991
	80%	411	823	1234	1645	2057	4113	8227	12340	20566	32906	41133
	90%	463	925	1388	1851	2314	4627	9255	13882	23137	37019	46274
	100%	514	1028	1542	2057	2571	5142	10283	15425	25708	41133	51416

Table 4.48 In-combination displacement matrix for guillemot from FFC SPA (*excluding compensated project; HP4*). The cells show the % increase in the mortality rate of the SPA population associated with the number of predicted bird mortalities per annum at given rates of displacement and mortality given in Table 4.47. Grey cells identify the range of displacement and mortality rates considered in the assessment.

Mean	Mortality										
		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
Displacement	10%	0.6%	1.1%	1.7%	2.2%	2.8%	5.6%	11.2%	16.9%	28.1%	45.0%	56.2%
	20%	1.1%	2.2%	3.4%	4.5%	5.6%	11.2%	22.5%	33.7%	56.2%	89.9%	112%
	30%	1.7%	3.4%	5.1%	6.7%	8.4%	16.9%	33.7%	50.6%	84.3%	135%	169%
	40%	2.2%	4.5%	6.7%	9.0%	11.2%	22.5%	45.0%	67.4%	112%	180%	225%
	50%	2.8%	5.6%	8.4%	11.2%	14.1%	28.1%	56.2%	84.3%	141%	225%	281%
	60%	3.4%	6.7%	10.1%	13.5%	16.9%	33.7%	67.4%	101.2%	169%	270%	337%
	70%	3.9%	7.9%	11.8%	15.7%	19.7%	39.3%	78.7%	118%	197%	315%	393%
	80%	4.5%	9.0%	13.5%	18.0%	22.5%	45.0%	89.9%	135%	225%	360%	450%
	90%	5.1%	10.1%	15.2%	20.2%	25.3%	50.6%	101.2%	152%	253%	405%	506%
	100%	5.6%	11.2%	16.9%	22.5%	28.1%	56.2%	112%	169%	281%	450%	562%

446. The predicted annual number of mortalities of adult guillemots that breed at the FFC SPA, and increase in baseline population mortality rates for the range of in-combination displacement scenarios considered in the assessment are given in Table 4.49. The estimated increase in mortality rate of the FFC SPA breeding population due to in-combination displacement impacts is between 1.7% and 64.1%. All predicted increases in the existing mortality rate are greater than 1% and could be detectable against natural variation.

Table 4.49 Predicted number of mortalities of adult guillemots that breed at the FFC SPA and % increases in baseline mortality rate for different in-combination scenarios

Scenario / Displacement and mortality rates	Annual predicted mortality, no. guillemots	% increase in baseline mortality rate of FFC breeding adult population[1]
In-combination, including HP4 (NE bespoke approach)		
30% displacement, 1% mortality	251	2.7 %
50% displacement, 1% mortality	419	4.6 %
70% displacement, 2% mortality	1,172	12.8 %
70% displacement, 10% mortality	5,861	64.1 %

Scenario / Displacement and mortality rates	Annual predicted mortality, no. guillemots	% increase in baseline mortality rate of FFC breeding adult population[1]
In-combination, excluding HP4		
30% displacement, 1% mortality	154	1.7 %
50% displacement, 1% mortality	257	2.8 %
70% displacement, 2% mortality	720	7.9 %
70% displacement, 10% mortality	3,599	39.3 %
1. based on a population size of 149,978 breeding adults and a baseline annual mortality rate of 6.1%, Horswill and Robinson 2015)		

447. Given the potential scale of the in-combination displacement mortality, PVA has been run for each in-combination scenario to assess the potential population level impact.

448. PVA has been run with the NE PVA Tool (Searle *et al.* 2019) using a density independent population model, as recommended by NE (2022a), with the demographic rates for the baseline scenario taken from Horswill and Robinson (2015). Models were run for a 30 year period, with the population projections under baseline conditions (i.e. without any OWF effects) compared with those incorporating the additional mortality predicted from the in-combination displacement effects. Full details of the input parameters and modelling approach are included in RIAA Appendix 4.2 (Document Reference: 7.1.4.2).

449. Density independent models incorporate no feedback between population size and demographic rates, such that a population can either increase to infinity (which is biologically implausible) or decrease to extinction. Consequently, the PVA used to assess the population-level impacts assumes that the predicted mortality associated with displacement is entirely additive to the baseline mortality that would occur in the absence of these impacts. This is likely to cause overestimation of the resulting population-level impacts. Density dependent models, which incorporate a mechanism for population regulation, are likely to be more realistic (e.g. reproductive rates may be expected to decline as population size increases if an expanding population resulted in competition for food resources and/or suitable nesting sites). Although there is considerable evidence for density dependence operating in seabird populations (e.g. Horswill *et al.* 2016), NE (2022a) advises against the use of density dependent population models due to the lack of empirical evidence of the underpinning mechanisms of density dependent regulation within seabird populations. As a consequence, the resulting PVA is likely to give overly precautionary outputs because it does not allow for the operation of compensatory density dependence to offset (to some degree at least) the additional mortality from displacement (e.g. Horswill *et al.* 2016).

450. The population models on which the PVA is based also assumed that the guillemot breeding population at the FFC SPA is a closed population. In reality,

this will not be the case as there will be immigration and emigration resulting in exchange of birds with other breeding colony populations (e.g. Reynolds *et al.*, 2009); this, again, is likely to result in overestimation of impacts at the scale of the colony population (Miller *et al.* 2019).

451. The potential impact of the predicted displacement mortality on the SPA guillemot population was assessed on the basis of CPS and CPGR, as derived from the PVA. The CPS is the median of the ratio of the end-point size of the impacted to un-impacted (or baseline) population, expressed as a proportion, and CPGR is the median of the ratio of the annual growth rate of the impacted to un-impacted population, expressed as a proportion. These two metrics have been demonstrated to be relatively insensitive to mis-specification of demographic rates and variation in population trend (Cook and Robinson 2016, Jitlal *et al.* 2017).

452. Due to the intrinsic structure of the population modelling approach, increases in mortality rates will always have some effect on population size and growth rate, such that the counterfactuals of impacted to unimpacted populations will never be greater than 1 and will almost always be less, thus always suggesting a negative effect. What is undefined is the level at which such negative effects could cause adverse effects on a population.

453. PVA outputs are presented in Table 4.50. As noted above (Section 4.4.4.6.1) the context for the assessment is that the guillemot breeding population at FFC SPA increased on average 3.5% per annum between 1987 to 2022. HPAI has been detected in guillemots at FFC, described as causing 'limited mortality' in 2023 (Butcher *et al.*, 2023), and 'some mortality' in 2022 (Clarkson *et al.* 2022). Daily checks for HPAI mortality in 2023, along a 2km section of Bempton Cliffs (part of the FFC SPA) recorded monthly peak counts of less than 10 dead adult auks in all months between March and September, except June when recorded adult auk mortality was just over 10 birds. Mortality of 'jumpling' auks (guillemot and razorbill chicks at or close to the age at which they leave their nests) was recorded in June (peak count between 15-20 birds) and July (peak count <10 birds) (Butcher *et al.* 2023). Despite the HPAI outbreak, the guillemot population in 2022 increased by 4.5% compared with the previous whole-colony count in 2017, and, while a whole colony count was not carried out in 2023, the number of individuals counted in sample areas (study plots) was the highest recorded since annual counts of study plots began in 2009 (Butcher *et al.*, 2023).

454. Including HP4, at 50% displacement and 1% mortality, considered the most realistic precautionary scenario based on a review of evidence relating to the effects of displacement on guillemot mortality (see above), the predicted reduction in population growth rate is 0.2%, and the reduction in population size of the impacted compared to unimpacted population over 30 years is 5.6%. Excluding HP4, the predicted reduction in growth rate of the impacted compared to unimpacted population over the same period is 0.1%, and for population size 3.5%. Based on these very small, predicted changes, and considering sources of precaution, notably the use of a density independent model, it is considered that these scenarios do not indicate a change in population size that would be significant in the context of the target to maintain the size of the breeding population above the citation level. whilst avoiding deterioration from its current level (as set out within the SACOs for FFC SPA).

Table 4.50 Outputs from Population Viability Analyses for the FFC SPA guillemot population in relation to the potential in-combination mortality due to displacement from OWFs

Displacement scenario	Adult mortality	Growth rate (median)	Counterfactual metric (after 30 years)		Reduction in growth rate of impacted vs unimpacted population	Reduction in population size of impacted vs unimpacted population
			Population size (CPS)	Median growth rate (CPGR)		
Baseline	0	1.038	1.000	1.000	n/a	n/a
In-combination, including HP4 (NE bespoke approach)						
30% displacement, 1% mortality	251	1.037	0.966	0.999	0.1%	3.4%
50% displacement, 1% mortality	419	1.036	0.944	0.998	0.2%	5.6%
70% displacement, 2% mortality	1,172	1.033	0.850	0.995	0.5%	15%
70% displacement, 10% mortality	5,861	1.012	0.447	0.974	2.6%	55.3%
In-combination, excluding HP4						
30% displacement, 1% mortality	154	1.038	0.979	0.999	0.1%	2.1%
50% displacement, 1% mortality	257	1.037	0.965	0.999	0.1%	3.5%
70% displacement, 2% mortality	720	1.035	0.905	0.997	0.3%	9.5%
70% displacement, 10% mortality	3,599	1.022	0.608	0.984	1.6%	39.2%

455. Under the more precautionary scenario of 70% displacement and 2% mortality, including HP4, the predicted reduction in population growth rate is 0.5%, and the reduction in population size of the impacted compared to unimpacted population over 30 years is 15%. Excluding HP4, the predicted reduction in growth rate over the same period is 0.3%, and for population size 9.5%.

456. Clearly, higher rates of displacement and mortality for displaced birds result in greater levels of predicted impacts and at the upper range of the advised rates (i.e. 70% displacement and 10% mortality of displaced birds), the CPS and CPGR values are markedly lower and represent a more substantive potential impact. However, these higher displacement rates are not supported by the available evidence, whilst such high levels of mortality are not considered to be biologically plausible. It is also the case that the CPS and CPGR metrics described above

derive from a density independent population model, which assumes no population regulation (and, as such, is also biologically implausible).

457. As noted above, the information on estimated in-combination displacement mortality and PVA is provided as context for the assessment. Given the conclusion that the Project would make no material contribution to the in-combination mortality, there would be no contribution to any adverse effect on integrity to the FFC SPA.

4.4.4.7 Razorbill

458. This species has been screened in to the shadow Appropriate Assessment in relation to operational displacement / barrier effect during the breeding, migration and wintering seasons.

4.4.4.7.1 Status

459. The FFC SPA breeding razorbill population was cited as 10,570 pairs (or 21,140 breeding adults), based on the mean count of individuals on land during the period 2008-2011. A whole-colony count for the SPA in 2017 reported 20,253 pairs (or 40,506 breeding adults) (Aitken *et al.* 2017). The most recent whole-colony count in 2022 found 30,673 pairs (or 61,345 breeding adults) (Clarkson *et al.* 2022), an increase of 52% on the 2017 count. The 2022 count is used as the reference population for the assessment. The population trend from field counts shows an average annual increase of 6% per year since 1987, and a 230% increase since 2000 (Clarkson *et al.* 2022). SACOs (NE 2023f) set a target to maintain the size of the breeding population at a level which is above 10,570 breeding pairs. whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

4.4.4.7.2 Connectivity and Seasonal Apportionment of Potential Effects

4.4.4.7.2.1 Breeding season

460. North Falls is 297 km from the FFC SPA based on the closest distance by sea between the array area and the SPA boundary (288.4km straight line distance including land crossing). As the SPA boundary includes a 2km marine extension, by sea (razorbills would not be expected to fly over land), North Falls is approximately 299km from the nearest coastal area within the SPA where razorbills might nest.

461. NE (2022a) advises that MMFR + 1SD, based on the latest review of tracking studies of breeding adults by Woodward *et al.* (2019), is used to identify breeding seabird colonies with potential connectivity with an SPA, subject to a check of any colony-specific foraging range data. Woodward *et al.* (2019) estimates the MMFR of razorbill as 88.7km ± 75.9 km SD. This value includes data from breeding razorbills at Fair Isle where reduced prey availability was considered to have significantly increased the distances that birds travelled to forage during the breeding seasons in which tracking was undertaken. Excluding the Fair Isle study, on the basis that the extensive foraging range values were not representative and would bias the estimate of MMFR, the MMFR is 73.8km (± 48.4km SD) (Woodward *et al.* 2019). NE (2022e) has indicated that it is reasonable to exclude the extreme Fair Isle values when considering the potential breeding season foraging range for the FFC SPA razorbill population. The MMFR of razorbill in the previous review of seabird foraging ranges (Thaxter *et al.* 2012) was 48.5 km (±35.0km SD) based on data from four sites. The more recent

review, based on 16 sites, therefore estimates a larger MMFR (Woodward *et al.* 2019).

462. The distance between the North Falls array area and the FFC SPA is therefore more than twice the breeding season MMFR + 1 SD (73.8km + 48.4km = 122.2km) for razorbill.

463. Modelled at-sea distributions of breeding adults, from tracking data collected during the breeding season from foraging breeding adult individuals (Cleasby *et al.* 2018, 2020; Wakefield *et al.* 2017), also suggest that the array area is a considerable distance beyond the breeding season foraging range (i.e., beyond the 95% utilisation distribution) of razorbill from the FFC SPA.

464. On this basis, no connectivity is identified, and no effect is expected to occur on the SPA population in the breeding season. The evidence strongly suggests that no (or so few as to be inconsequential to the assessment) razorbills recorded at the North Falls array area during the breeding season are breeding adults from FFC SPA. Accordingly, no birds from FFC SPA have been apportioned to the assessment during the breeding season (Table 4.51).

465. The array area is not within foraging range of breeding razorbill from any other SPA (or indeed non-SPA) colonies (Mitchell *et al.* 2004, Burnell *et al.* 2023). Therefore, based on the above foraging range data and utilisation distribution modelling, it is likely that birds recorded at the array area during the breeding season are non-breeding adults or sub-adult birds which have not yet reached breeding age. This may include birds associated with FFC SPA and other breeding colonies (e.g. immature birds which have fledged from such colonies in previous years).

4.4.4.7.2.2 Autumn migration season

466. Outside the breeding season, adult razorbills from the FFC SPA breeding population are assumed to range widely and to mix with razorbills of all age classes from breeding colonies in the UK and other countries. At this time therefore, breeding adults from the FFC SPA might encounter North Falls (as well as other OWFS within the BDMPS area that are situated beyond the breeding season foraging range).

467. The non-breeding season (July to March) is divided into spring and autumn migration seasons, and a winter period. During the migration seasons (July to October, and January to March), the relevant reference population to North Falls is the UK North Sea and Channel BDMPS (Furness 2015) consisting of 591,874 individuals across all age classes.

468. During each of the two migration seasons, all SPA breeding adults from FFC are assumed to be present in the UK North Sea and Channel BDMPS, based on ringing and tracking data (Furness 2015). Using the estimated SPA population of 20,002 breeding adults (from the 2008 season, Furness 2015), 3.4% (20,002 / 591,874 x 100) of the BDMPS population is estimated to derive from FFC SPA. Assuming even mixing of birds during migration seasons, this means that 3.4% of razorbills present at North Falls in the migration seasons would be breeding adults from the FFC SPA population.

469. The mean peak razorbill population estimate at North Falls (array area + 2km buffer, the estimated zone of influence for displacement effects) during the autumn or post-breeding migration season is 248 (95% CLs 8 – 607). Therefore,

the estimated number of breeding adult razorbills from FFC SPA present at North Falls during the autumn migration season is 8 (95% CLs 0 – 21) (Table 4.51).

4.4.4.7.2.3 Winter season

470. In the winter season (November to December, Furness 2015), the UK North Sea and Channel BDMPS (Furness 2015) consists of 218,622 individuals across age classes. At this time, 30% of breeding adults from FFC SPA are estimated, from ringing and tracking data, to be present in the UK North Sea and Channel. Based on the 2008 estimated SPA population of 20,002 breeding adults (Furness 2015), 2.7% ((0.3 x 20002) / 218,622 x 100) of birds present in the BDMPS during winter are estimated to derive from the SPA. Assuming even mixing of birds within the BDMPS, then at North Falls in the winter season 2.7% of razorbills would be breeding adults from the FFC SPA population.

471. The mean peak razorbill population estimate at the North Falls array area + 2km buffer during the winter season is 1,781 (95% CLs 1,239 – 2,548). Therefore, the estimated number of breeding adult razorbills from FFC SPA present at North Falls during the winter season is 48 (95% CLs 33 – 69) (Table 4.51).

4.4.4.7.2.4 Spring migration season

472. As detailed for the Autumn migration season, 3.4% of razorbills present at North Falls in the Spring migration season are considered to be breeding adults from the FFC SPA population.

473. The mean peak razorbill population estimate at North Falls during the spring or return migration season is 1,741 (95% CLs 413 – 4,907). Therefore, the estimated number of breeding adult razorbills from FFC SPA present at North Falls during the spring migration season is 59 (95% CI 14 – 167) (Table 4.51).

Table 4.51 Seasonal and annual population estimates (number of individuals) of razorbills at

Breeding (migration-free), Mean peak	Autumn migration, Mean peak	Winter, Mean peak	Spring migration, Mean peak	Annual
Array area and 2km buffer[1]				
104 (0 – 328)	248 (8 – 607)	1,781 (1,239 – 2,548)	1,741 (413 – 4,907)	3,874 (1,660 – 8,390)
Apportioned to FFC SPA				
0	8 (0 – 21)	48 (33 – 69)	59 (14 – 167)	116 (48 – 256)
1. See ES Appendix 13.2 (Document Reference: 3.3.13) Section 4 for details of how seasonal peak means and upper and lower 95% CLs (values in parentheses) were calculated.				

4.4.4.7.3 Effect: Displacement / barrier effect during operation

474. As stated in ES Chapter 13 Section 13.6.2.1.1 (Document Reference: 3.1.15), for the purposes of assessment of birds present in an OWF array area and buffer during a given season, it is usually not possible to distinguish between displacement and barrier effects - for example to define where individual birds may have intended to travel to, or beyond an OWF site, even when tracking data are available. Therefore, in this assessment the effects of displacement and barrier effects on razorbill are considered together (as is standard practice within the industry).

475. The assessment assumes that a proportion of the birds present in the North Falls array area and 2km buffer would be displaced during the operation of the OWF, and that a proportion of displaced birds would die as a result of displacement; for razorbill, SNCBs (2017) advise that displacement rates of 30% to 70% are considered, along with a range of mortality rates from 1% to 10% of displaced birds.

476. The upper values within those ranges are considered to be overly precautionary, both for displacement and mortality. The available evidence suggests that auks (guillemots and razorbills) tend to be displaced from OWFs, with displacement rates varying between sites but, on average, it is considered that densities within OWFs tend to be approximately half of those occurring in the habitats around the OWF (MacArthur Green 2019a). Displacement may also occur from a buffer zone around the OWF although the available evidence suggests this does not usually extend as far as 2km out from the OWF. Based on consideration of the quality of, or confidence in, the studies used to derive the recommended range of displacement rates, as well as those studies demonstrating no significant displacement, the findings from a detailed review by APEM (2022) suggest that a displacement rate of 50% is appropriate (and sufficiently precautionary) for razorbill.

477. Mortality as a result of displacement could occur due to increased energy expenditure and / or decreased energy intake (e.g. from increased flight time or increased intra-specific competition resulting from higher densities of birds occurring in foraging habitat outside OWFs). However, OWFs represent a small proportion of the available foraging habitat for razorbills in the North Sea and increases in densities outside OWFs due to displacement are likely to be negligible (MacArthur Green 2019a). When considered within the context of a baseline annual mortality rate (i.e. in the absence of OWF effects) for adult razorbills of 10.5% (Horswill and Robinson 2015), increases due to displacement are more likely to be at the lower range of the advised rates, if not below these (MacArthur Green 2019a). Thus, based on consideration of available evidence, together with what is biologically plausible, both MacArthur Green (2019a) and APEM (2022) suggest that a displacement rate of 50% and mortality rate amongst displaced birds of 1% are sufficiently precautionary.

478. For Hornsea Project Four (HP4), the Secretary of State is understood to have based the consent decision on displacement and mortality rates of 70% and 2% for guillemot and razorbill (DESNZ, 2023). Predicted mortality under the two scenarios identified in the above paragraph (50% displacement /1% mortality of displaced birds and 70%/2%) scenario is presented in the assessment, as well as the SNCB advised range of 30-70%/ 1-10%).

479. A more detailed review of the evidence in relation to displacement of auks from OWFs is included in ES Chapter 13, Section 13.6.2.1.1 (Document Reference: 3.1.15).

480. In the absence of OWF effects, the baseline mortality of the FFC SPA breeding adult population of razorbill is estimated to be 6,441 individuals per year, based on a population of 61,345 breeding adults (Clarkson *et al.* 2022) and an annual adult mortality rate of 0.105 (1 – survival rate from Horswill and Robinson 2015, ES Chapter 13, Table 13.11, Document Reference: 3.1.15).

4.4.4.7.3.1 Project alone assessment

481. Based on the seasonal mean peak abundances, the estimated total number of adult razorbills that breed at the FFC SPA present at North Falls array area and 2km buffer and potentially subject to displacement by the Project alone is 116 (95% CI 48 – 256) (Table 4.51). As no breeding season connectivity has been identified, the Project alone displacement effects would be limited to the non-breeding season, although they are expressed here as an annual effect on the SPA breeding population for the purposes of the shadow Appropriate Assessment (as is the standard industry approach).

482. At displacement rates of 30% to 70% and mortality rates of 1% to 10% for displaced birds, zero to 8 SPA breeding adults would be predicted to die each year due to displacement from North Falls (95% LCL 0-3 breeding adults, 95% UCL 1-18 breeding adults) (Table 4.52).This would increase annual mortality within the FFC SPA breeding adult population by zero to 0.1% (95% LCL 0.0% - 0.1%; 95% UCL 0% - 0.3%) (Table 4.53).

483. Using an evidence-based displacement rate of 50% and a mortality rate for displaced birds of 1%, annual mortality in the FFC, 1 adult razorbill (95% CLs 0-1) from the breeding SPA population would be predicted to die each year due to displacement, equivalent to no increase in the baseline mortality of the SPA breeding adult razorbill population (for the mean predicted mortality or 95% CLs).

484. At a displacement rate of 70% and mortality of 2%, annual mortality would increase by two breeding adults (95% CLs 1-4), also equivalent to no increase in baseline mortality rate (95% CLs zero-0.1%).

485. Increases in the existing mortality rate of less than 1% are unlikely to be detectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered for the Project alone.

486. It is concluded that predicted razorbill mortality due to operational phase displacement at North Falls alone would not adversely affect the integrity of the FFC SPA.

Table 4.52 Displacement matrix for razorbill for the project alone. The cells show the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality (LCL and UCL = upper and lower 95% confidence limits). Grey cells identify the range of displacement and mortality rates considered in the assessment. Red text identifies values of predicted mortality which represent a 1% or more increase in the population mortality rate (with reference to Table 4.53)

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0	0	0	0	1	1	2	3	6	9	12
	20%	0	0	1	1	1	2	5	7	12	19	23
	30%	0	1	1	1	2	3	7	10	17	28	35
	40%	0	1	1	2	2	5	9	14	23	37	46
	50%	1	1	2	2	3	6	12	17	29	46	58
	60%	1	1	2	3	3	7	14	21	35	56	69
	70%	1	2	2	3	4	8	16	24	40	65	81
	80%	1	2	3	4	5	9	19	28	46	74	93
	90%	1	2	3	4	5	10	21	31	52	83	104
	100%	1	2	3	5	6	12	23	35	58	93	116

LCL	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0	0	0	0	0	0	1	1	2	4	5
	20%	0	0	0	0	0	1	2	3	5	8	10
	30%	0	0	0	1	1	1	3	4	7	11	14
	40%	0	0	1	1	1	2	4	6	10	15	19
	50%	0	0	1	1	1	2	5	7	12	19	24
	60%	0	1	1	1	1	3	6	9	14	23	29
	70%	0	1	1	1	2	3	7	10	17	27	33
	80%	0	1	1	2	2	4	8	11	19	31	38
	90%	0	1	1	2	2	4	9	13	21	34	43
	100%	0	1	1	2	2	5	10	14	24	38	48

UCL	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0	1	1	1	1	3	5	8	13	21	26
	20%	1	1	2	2	3	5	10	15	26	41	51
	30%	1	2	2	3	4	8	15	23	38	62	77
	40%	1	2	3	4	5	10	21	31	51	82	103
	50%	1	3	4	5	6	13	26	38	64	103	128
	60%	2	3	5	6	8	15	31	46	77	123	154
	70%	2	4	5	7	9	18	36	54	90	144	179
	80%	2	4	6	8	10	21	41	62	103	164	205
	90%	2	5	7	9	12	23	46	69	115	185	231
	100%	3	5	8	10	13	26	51	77	128	205	256

Table 4.53 Displacement matrix for razorbill for the project alone. The cells show the % increase in the mortality rate of the SPA population associated with the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality given in Table 4.52. (LCL and UCL = upper and lower 95% confidence limits). Grey cells identify the range of displacement and mortality rates considered in the assessment.

Mean	Mortality										
Displacement	1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
10%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%
20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%
30%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%	0.5%
40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	0.6%	0.7%
50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.7%	0.9%
60%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.5%	0.9%	1.1%
70%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.3%	0.4%	0.6%	1.0%	1.3%
80%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.3%	0.4%	0.7%	1.1%	1.4%
90%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.5%	0.8%	1.3%	1.6%
100%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	0.5%	0.9%	1.4%	1.8%
LCL	**Mortality**										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
30%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%
40%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%
50%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%
60%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	0.4%
70%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%	0.5%
80%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.5%	0.6%
90%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.5%	0.7%
100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	0.6%	0.7%
UCL	**Mortality**										
Displacement	**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**50%**	**80%**	**100%**
10%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.4%
20%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.2%	0.4%	0.6%	0.8%
30%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	0.6%	1.0%	1.2%
40%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.3%	0.5%	0.8%	1.3%	1.6%
50%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	0.6%	1.0%	1.6%	2.0%
60%	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.5%	0.7%	1.2%	1.9%	2.4%
70%	0.0%	0.1%	0.1%	0.1%	0.1%	0.3%	0.6%	0.8%	1.4%	2.2%	2.8%
80%	0.0%	0.1%	0.1%	0.1%	0.2%	0.3%	0.6%	1.0%	1.6%	2.5%	3.2%
90%	0.0%	0.1%	0.1%	0.1%	0.2%	0.4%	0.7%	1.1%	1.8%	2.9%	3.6%
100%	0.0%	0.1%	0.1%	0.2%	0.2%	0.4%	0.8%	1.2%	2.0%	3.2%	4.0%

487. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the displacement rates is of high applicability and quality. Also, whilst there is limited available evidence to inform mortality rates, 1% is

considered to be sufficiently precautionary based consideration of the plausible extent of such effects within the context of the species biology. Notably, this species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.* 2014; Furness & Wade 2012; Garthe & Hüppop 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. On the advice of SNCBs (2017), the seasonal populations of razorbill at OWFs (array area and 2km buffer) are based on mean peak counts for the relevant seasonal period over the two years of baseline surveys, which is likely to over-estimate the number of birds typically occurring in this area during a given season (on the basis that these values will exceed the mean count). Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and consequent increases in baseline mortality rate of the SPA adult population (even when the overly precautionary rates of 70% displacement and 10% mortality are applied).

4.4.4.7.3.2 In-combination assessment

488. On the basis of the conclusions of the Project alone assessment of very low predicted razorbill mortality (i.e. a mean of between 1 and 2 birds, giving a less than 0.1% increase in background mortality, for both a realistic, evidence-based, scenario of 50% displacement/1% mortality and a highly precautionary scenario of 70% displacement/2% mortality) there would be no material contribution of the Project to in-combination effects. Accordingly, no in-combination assessment is required for this feature. The conclusion of the assessment is therefore that predicted razorbill mortality due to displacement and barrier effects would not adversely affect the integrity of the FFC SPA, either for the project alone or in-combination.

489. Notwithstanding this conclusion, an estimate of in-combination mortality, together with a PVA, is provided below as context to the Project alone assessment. This information is presented without prejudice to the conclusion above.

490. Seasonal and annual population estimates of breeding adult razorbill at all OWFs included in the in-combination assessment are presented in Table 4.54 along with the numbers apportioned to the FFC SPA This information was taken from the numbers presented at Deadline 8 of the DCO Examination for SEP&DEP (Royal HaskoningDHV 2023a) and updated with new information that has become available since then for some OWFs (see Table 4.54).The cut off for inclusion of other OWFs into the in-combination assessment was the end of March 2024[7].

491. In accordance with the approach adopted for SEP&DEP (Royal HaskoningDHV 2023a), the in-combination assessment has presented three different scenarios for the contribution of HP4. These scenarios used different approaches to seasonal apportioning of birds, and comprise the ‘HP4 Applicant’s approach’, NE ‘standard approach’, and NE ‘bespoke approach’. For their ‘bespoke approach’,

[7] Since January 2024, Green Volt, and Sheringham Shoal and Dudgeon Extension Projects have been consented; and the ESs for Five Estuaries and Outer Dowsing have been submitted. The RIAA is based on the PEIR values for Five Estuaries and Outer Dowsing. It is understood that no changes to the cumulative values for the newly consented sites have been made.

NE requested that the post-breeding migration season (renamed to the ‘chick rearing/moult period’) apportionment to the FFC SPA was increased to 66%, and the remaining non-breeding seasons used the standard apportioning rates as used by the Applicant. The HRA for HP4 (DESNZ 2023) indicates that the Examining Authority agreed with the use of NE’s bespoke approach for razorbill, applying a displacement rate of 70% and a mortality rate of 2%. Although it is not specifically stated whether the Secretary of State agreed with this, it is considered appropriate to infer that the decision for HP4 was based on this approach.

492. For the avoidance of doubt in relation to the breeding season, apportioning of razorbill to the FFC SPA during the breeding season for OWFs contributing the in-combination assessment (Table 4.54) is (as stated above) based on the SEP&DEP deadline 8 updates (Royal HaskoningDHV 2023a) where this information is still current. However, this has been updated where new information has become available for a given OWF and for additional OWFs where quantitative information on razorbill numbers has become available in the public domain since the SEP&DEP document was published (see table notes). The breeding season apportioning is taken to represent an estimate of the number of breeding adults from the SPA that could be present at a given OWF and buffer area, as opposed to the total numbers of breeding adults and associated sub-adult birds from the SPA. However, for OWFs with 100% apportioning of birds at risk of displacement to the FFC SPA, this approach is highly likely to overestimate the number of adult birds from the FFC SPA present, as a proportion of the birds recorded at every OWF during the breeding season is expected to include sub-adults as well as adults (noting that estimates of the population age structure for razorbill generally suggest that sub adults comprise close to 50% of the overall population – e.g. Furness 2015).

493. The estimated total of adult razorbills that breed at the FFC SPA and which are at risk of displacement from all OWFs combined within the UK North Sea BDMPS year-round is 16,153, assuming the NE ‘bespoke approach’ for HP4 (Table 4.54). Of this total, North Falls contributes only 116 birds, equating to 0.7% of the in-combination totals.

Table 4.54 Seasonal and annual population estimates of razorbills at North Falls and other OWFs included in the in-combination assessment; and apportionment to the FFC SPA (breeding adult population)

Tier	OWF	Seasonal Population At Risk Of Displacement[1]									
		Breeding		Autumn Migration		Non-Breeding		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Beatrice	873	0	833	28	555	15	833	28	3094	72
1	Beatrice Demonstrator	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Blyth Demonstration	121	0	91	3	61	2	91	3	364	8
1	Dudgeon	256	0	346	12	745	20	346	12	1694	44
1	East Anglia ONE	16	0	26	1	155	4	336	11	533	16
1	EOWDC (Aberdeen)	161	0	64	2	7	0	26	1	258	3
1	Galloper	44	0	43	1	106	3	394	13	587	18
1	Greater Gabbard	0	0	0	0	387	10	84	3	471	13
1	Gunfleet Sands	0	0	0	0	30	1	0	0	30	1
1	Hornsea Project One	1109	535	4812	164	1518	41	1803	61	9242	800
1	Hornsea Project Two	2511	1210	4221	143	720	19	1668	57	9119	1,430
1	Humber Gateway	27	0	20	1	13	0	20	1	80	2
1	Hywind	30	0	719	24	10	0	0	0	759	25
1	Kentish Flats and Extension	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Kincardine	22	0	0	0	0	0	0	0	22	0
1	Lincs, Lynn and Inner Dowsing	45	0	34	1	22	1	34	1	134	3
1	London Array	14	0	20	1	14	0	20	1	68	2

Tier	OWF	Seasonal Population At Risk Of Displacement[1]									
		Breeding		Autumn Migration		Non-Breeding		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
3	Methil	4	0	0	0	0	0	0	0	4	0
1	Moray Firth East	2423	0	1103	37	30	1	168	6	3724	44
1	Race Bank	28	0	42	1	28	1	42	1	140	4
1	Rampion	630	0	66	2	1244	34	3327	113	5267	149
1	Scroby Sands	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Sheringham Shoal	106	0	1343	46	211	6	30	1	1691	52
1	Teesside	16	0	62	2	2	0	20	1	99	3
1	Thanet	3	0	0	0	14	0	21	1	38	1
1	Triton Knoll	40	0	254	9	855	23	117	4	1265	36
1	Westermost Rough	91	91	121	4	152	4	91	3	455	102
2	Dogger Bank (formerly Creyke Beck) A and B	2788	836	3673	125	3871	105	9268	315	19600	1381
2	Dogger Bank C (formerly Teesside A) and Sofia (formerly Teesside B)	1987	596	902	31	2385	64	4872	166	10147	857
2	Moray West	2808	0	3544	120	184	5	3585	122	10121	247
2	Neart na Gaoithe	331	0	5492	187	508	14	n/a	n/a	6331	200
2	Seagreen Alpha and Bravo	9574	0	n/a	n/a	2375	64	n/a	n/a	11949	64
3	East Anglia ONE North	403	0	85	3	54	1	207	7	749	11
3	East Anglia THREE	1807	0	1122	38	1499	40	1524	52	5952	130
3	East Anglia TWO	281	0	44	1	136	4	230	8	691	13

Tier	OWF	Seasonal Population At Risk Of Displacement[1]									
		Breeding		Autumn Migration		Non-Breeding		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
3	Hornsea Project Four (HP4) (Applicant's approach)[2]	386	215	4311	146	455	12	449	15	5601	388
	HP4 (NE 'standard approach')[2]	386	386	4311	146	455	12	449	15	5601	559
	HP4 (NE 'bespoke approach')[2]	386	386	4311	2845	455	12	449	15	5601	3,258
3	Hornsea Project Three	630	0	2020	69	3649	99	2105	72	8404	239
3	Inch Cape	1436	0	2870	98	651	18	n/a	n/a	4957	115
3	Norfolk Boreas	630	0	263	9	1065	29	345	12	2303	49
3	Norfolk Vanguard	879	0	866	29	839	23	924	31	3508	84
Total (tier 1-3 projects, excluding HP4)		**32,124**	**3,268**	**35,100**	**1,193**	**24,094**	**651**	**32,530**	**1,106**	**123,848**	**6,218**
4	Berwick Bank[3]	4,040	0	8,849	301	1,399	38	7,480	254	21,768	593
4	Green Volt[4]	457	0	56	2	15	0	28	1	556	3
4	Rampion 2[5]	32	0	26	1	1193	32	6303	214	7,554	247
4	SEP&DEP	1,239	85	4,500	153	1,531	41	464	16	7,734	296
4	West of Orkney[6]	141	0	167	6	19	1	132	4	459	11
4	Dogger Bank South[7]	5313	2561	1238	42	4117	111	8628	293	19296	3007
4	Five Estuaries[8]	90	0	284	10	1046	10	757	26	2,177	45
4	Outer Dowsing[9]	5163	2737	2339	79	2570	24	5229	177	15301	3017
	North Falls	**104**	**0**	**248**	**8**	**1781**	**48**	**1741**	**59**	**3874**	**116**
Total (HP4 Applicant's approach)		***49,090***	***8,867***	***57,118***	***1,941***	***38,221***	***968***	***63,741***	***2,166***	***208,169***	***13,941***
Total (HP4 NE 'standard' approach)		***49,090***	***9,038***	***57,118***	***1,941***	***38,221***	***968***	***63,741***	***2,166***	***208,169***	***14,112***

Tier	OWF	Seasonal Population At Risk Of Displacement[1]									
		Breeding		Autumn Migration		Non-Breeding		Spring Migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
Total (HP4 NE 'bespoke' approach)		***49,090***	***9,038***	***57,118***	***4,640***	***38,221***	***968***	***63,741***	***2,166***	***208,169***	***16,811***

Notes:

1. The preferred standard area is the OWF plus a 2km buffer, however the buffer zones included in this assessment varied between 0-4km depending on the data available. Project total and FFC estimates follow those of Royal HaskoningDHV (2022a, 2023a), except where footnoted.

2. For Hornsea Project Four (HP4) three sets of values are presented in alignment with Royal HaskoningDHV (2023a). For the NE bespoke approach, 100% of birds were apportioned to migration-free breeding season, the post-breeding migration bio-season (renamed to the 'chick rearing/moult period') apportionment was 66%, and the remaining non-breeding bio-seasons used the standard apportioning rates as used by the Applicant (3.38% in spring and 2.74% in winter). For the NE standard approach, 100% of birds were apportioned during the breeding season, 2.74% during winter, and 3.38% during spring and autumn. The Applicant's approach used the same values as the NE standard approach, but with breeding season apportionment reduced to 55.8%.

3. Total seasonal population estimates from Pelagica and Cork Ecology (2022), Royal HaskoningDHV (2022b). It has been assumed that no birds would be apportioned to FFC SPA during the breeding season (project is beyond MMFR + 1SD from FFC), 3.4% apportioned during the autumn and spring migration periods, and 2.7% during the winter period.

4. Total seasonal population estimates from APEM (2022). It has been assumed that no birds would be apportioned to FFC SPA during the breeding season (project is beyond MMFR +1SD from FFC), 3.4% apportioned during the autumn and spring migration periods, and 2.7% during the winter period.

5. Total seasonal population estimates from GoBe (2023a). It has been assumed that no birds would be apportioned to FFC SPA during the breeding season (project is beyond MMFR +1SD, 3.4% apportioned during the autumn and spring migration periods, and 2.7% during the winter period.

6. Total seasonal population estimates from MacArthur Green (2023). It has been assumed that no birds would be apportioned to FFC SPA during the breeding season (project is beyond MMFR +1SD, 3.4% apportioned during the autumn and spring migration periods, and 2.7% during the winter period.

7. Total seasonal population estimates from RWE Renewables (2023). It has been assumed that breeding season apportioning uses the same rate as used for Hornsea Projects One and Two (48.2%, as presented for SEP&DEP in-combination assessment (Royal HaskoningDHV (2023a)), as Dogger Bank South is a similar distance from FFC SPA; 3.4% apportioned during the autumn and spring migration periods, and 2.7% during the winter period.

8. Seasonal population estimates and apportioning to FFC as per GoBe (2023c, d).

9. Seasonal population estimates and apportioning to FFC as per GoBe (2023e) and GoBe and SLR (2023)

494. The displacement matrix for the in-combination total of razorbills at risk of displacement, is presented in Table 4.55, and the corresponding increases in the mortality rate of the FFC SPA population in Table 4.56.The in-combination total used for the purposes of the assessment includes the NE bespoke approach to apportioning (see para 491 above) for HP4. This is considered an appropriately precautionary value as the NE approach was agreed by the Examining Authority for HP4, and is inferred to be the approach on which the consent decision for HP4 was based.

Table 4.55 In-combination displacement matrix for razorbill from FFC SPA (*including HP4, NE bespoke approach*). The cells show the number of predicted bird mortalities (to the nearest integer) per annum at given rates of displacement and mortality. Grey cells identify the range of displacement and mortality rates considered in the assessment. Red text indicates where a given value of predicted mortality represents an increase of 1% or more in the baseline mortality rate (with reference to Table 4.56below).

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	17	34	50	67	84	168	336	504	841	1345	1681
	20%	30	61	91	121	151	303	605	908	1513	2421	3026
	30%	50	101	151	202	252	504	1009	1513	2522	4035	5043
	40%	67	134	202	269	336	672	1345	2017	3362	5380	6724
	50%	84	168	252	336	420	841	1681	2522	4203	6724	8406
	60%	101	202	303	403	504	1009	2017	3026	5043	8069	10087
	70%	118	235	353	471	588	1177	2354	3530	5884	9414	11768
	80%	134	269	403	538	672	1345	2690	4035	6724	10759	13449
	90%	151	303	454	605	756	1513	3026	4539	7565	12104	15130
	100%	168	336	504	672	841	1681	3362	5043	8406	13449	16811

Table 4.56. In-combination displacement matrix for razorbill from FFC SPA (*including HP4, NE bespoke approach*). The cells show the % increase in the mortality rate of the SPA population associated with the number of predicted bird mortalities per annum at given rates of displacement and mortality given in Table 4.55. Grey cells identify the range of displacement and mortality rates considered in the assessment.

In-combination

Mean	Mortality											
Displacement		1%	2%	3%	4%	5%	10%	20%	30%	50%	80%	100%
	10%	0.3%	0.5%	0.8%	1.0%	1.3%	2.6%	5.2%	7.8%	13.0%	20.9%	26.1%
	20%	0.5%	0.9%	1.4%	1.9%	2.3%	4.7%	9.4%	14.1%	23.5%	37.6%	47.0%
	30%	0.8%	1.6%	2.3%	3.1%	3.9%	7.8%	15.7%	23.5%	39.1%	62.6%	78.3%
	40%	1.0%	2.1%	3.1%	4.2%	5.2%	10.4%	20.9%	31.3%	52.2%	83.5%	104.4%
	50%	1.3%	2.6%	3.9%	5.2%	6.5%	13.0%	26.1%	39.1%	65.2%	104.4%	130.5%
	60%	1.6%	3.1%	4.7%	6.3%	7.8%	15.7%	31.3%	47.0%	78.3%	125.3%	156.6%
	70%	1.8%	3.7%	5.5%	7.3%	9.1%	18.3%	36.5%	54.8%	91.3%	146.2%	182.7%
	80%	2.1%	4.2%	6.3%	8.4%	10.4%	20.9%	41.8%	62.6%	104.4%	167.0%	208.8%
	90%	2.3%	4.7%	7.0%	9.4%	11.7%	23.5%	47.0%	70.5%	117.4%	187.9%	234.9%
	100%	2.6%	5.2%	7.8%	10.4%	13.0%	26.1%	52.2%	78.3%	130.5%	208.8%	261.0%

495. The predicted annual number of razorbill mortalities involving adults that breed at the FFC SPA, and the associated increase in baseline population mortality rates, for the range of in-combination displacement scenarios considered in the assessment are given in Table 4.57. The estimated increase in mortality rate of the FFC SPA breeding population due to in-combination displacement impacts is between 0.8% and 18.3%. Where predicted increases in the existing mortality rate are greater than 1%, these could be detectable against natural variation.

Table 4.57 Predicted number of breeding adult razorbill mortalities and % increases in baseline mortality rate for different in-combination scenarios

Scenario / Displacement and mortality rates	Annual predicted mortality, no. razorbills	% increase in baseline mortality rate of FFC breeding adult population[1]
In-combination, including HP4 (NE bespoke approach)		
30% displacement, 1% mortality	50	0.8%
50% displacement, 1% mortality	84	1.3%
70% displacement, 2% mortality	235	3.7%
70% displacement, 10% mortality	1,177	18.3%
1. based on a population size of 61,345 breeding adults and a baseline annual mortality rate of 10.5%, (Horswill and Robinson 2015)		

496. Given the potential scale of the in-combination displacement mortality, PVA has been run for each in-combination scenario to assess the potential population level impact.

497. PVA has been run with the NE PVA Tool (Searle *et al.* 2019) using a density independent population model, as recommended by NE (2022a), with the demographic rates for the baseline scenario taken from Horswill and Robinson (2015). Models were run for a 30 year period, with the population projections under baseline conditions (i.e. without any OWF effects) compared with those incorporating the additional mortality predicted from the in-combination displacement effects. Full details of the input parameters and modelling approach are included in RIAA Appendix 4.2 (Document Reference: 7.1.4.2).

498. Density independent models incorporate no feedback between population size and demographic rates, such that a population can either increase to infinity (which is biologically implausible) or decrease to extinction. Consequently, the PVA used to assess the population-level impacts assumes that the predicted mortality associated with displacement is entirely additive to the baseline mortality that would occur in the absence of these impacts. This is likely to cause overestimation of the resulting population-level impacts. Density dependent models, which incorporate a mechanism for population regulation, are likely to be more realistic (e.g. reproductive rates may be expected to decline as population size increases if an expanding population resulted in competition for food resources and/or suitable nesting sites). Although there is considerable evidence

for density dependence operating in seabird populations (e.g. Horswill *et al.* 2016), NE (2022a) advises against the use of density dependent population models due to the lack of empirical evidence of the underpinning mechanisms of density dependent regulation within seabird populations. As a consequence, the resulting PVA is likely to give overly precautionary outputs because it does not allow for the operation of compensatory density dependence to offset (to some degree at least) the additional mortality from displacement (e.g. Horswill *et al.* 2016).

499. The population models on which the PVA is based also assumed that the razorbill breeding population at the FFC SPA is a closed population. In reality, this will not be the case as there will be immigration and emigration resulting in exchange of birds with other breeding colony populations (e.g. Reynolds *et al.*, 2009); this, again, is likely to result in overestimation of impacts at the scale of the colony population (Miller *et al.* 2019).

500. The potential impact of the predicted displacement mortality on the SPA razorbill population was assessed using CPS and CPGR, as derived from the PVA. The CPS is the median of the ratio of the end-point size of the impacted to un-impacted (or baseline) population, expressed as a proportion, and CPGR is the median of the ratio of the annual growth rate of the impacted to un-impacted population, expressed as a proportion. These two metrics have been demonstrated to be relatively insensitive to mis-specification of demographic rates and variation in population trend (Cook and Robinson 2016, Jitlal *et al.* 2017).

501. Due to the intrinsic structure of the population modelling approach, increases in mortality rates will always have some effect on population size and growth rate, such that the counterfactuals of impacted to unimpacted populations will never be greater than 1 and will almost always be less, thus always suggesting a negative effect. What is undefined is the level at which such negative effects could cause adverse effects on a population.

502. PVA outputs are presented in Table 4.58. As noted above (Section 4.4.4.7.1) the context for the assessment is that the razorbill breeding population at FFC SPA increased on average 6% per annum since 1987, and by 52% between 2017 and 2022. HPAI has been detected in razorbills at FFC, described as ‘limited mortality’ in auks (mainly guillemot) in 2023 (Butcher *et al.*, 2023), and ‘some mortality’ in 2022 (Clarkson *et al.* 2022). Daily checks for HPAI mortality in 2023, along a 2km section of Bempton Cliffs (part of the FFC SPA) recorded monthly peak counts of less than 10 dead adult auks in all months between March and September, except June when recorded adult auk mortality was just over 10 birds. Mortality of ‘jumpling’ auks (guillemot and razorbill chicks at or close to the age at which they leave their nests) was recorded in June (peak count between 15-20 birds) and July (peak count <10 birds) (Butcher *et al.* 2023) Despite the HPAI outbreak, the razorbill population in 2022 had doubled compared with the previous whole-colony count in 2017(Clarkson *et al.* 2022), and, while a whole colony count was not carried out in 2023, the number of birds counted in sample areas of the breeding colony (study plots) was the highest recorded since annual counts of study plots began in 2009 (Butcher *et al.*, 2023).

503. At 50% displacement and 1% mortality, considered the most realistic precautionary scenario based on a review of evidence relating to the effects of

displacement on razorbill mortality (see above), the predicted reduction in population growth rate is 0.1% and the reduction in population size of the impacted compared to unimpacted population over 30 years is 2.9%. Based on these very small, predicted changes, and considering sources of precaution, notably the use of a density independent model, it is considered that these scenarios do not indicate a change in population size that would be significant in the context of the target to maintain the size of the breeding population above the citation level, whilst avoiding deterioration from its current level (as set out within the SACOs for FFC SPA).

Table 4.58 Outputs from Population Viability Analyses for the FFC SPA razorbill population in relation to the potential in-combination mortality due to displacement from OWFs

Displacement scenario	Adult mortality	Growth rate (median)	Counterfactual metric (after 30 years)		Reduction in growth rate	Reduction in population size
			Population size (CPS)	Median growth rate (CPGR)		
Baseline	0	1.005	1.000	1.000	N/A	N/A
In-combination, including HP4 (NE bespoke approach)						
30% displacement, 1% mortality	50	1.004	0.982	0.999	0.1%	1.8%
50% displacement, 1% mortality	84	1.004	0.971	0.999	0.1%	2.9%
70% displacement, 2% mortality	235	1.002	0.919	0.997	0.3%	8.1%
70% displacement, 10% mortality	1,177	0.991	0.657	0.987	1.3%	34.3%

504. Under the more precautionary scenario of 70% displacement and 2% mortality, the predicted reduction in population growth rate is 0.3%, and the reduction in population size of the impacted compared to unimpacted population over 30 years is 8.1%.

505. Clearly, higher rates of displacement and mortality for displaced birds result in greater levels of predicted impacts and at the upper range of the advised rates (i.e. 70% displacement and 10% mortality of displaced birds), the CPS and CPGR values are markedly lower and represent a more substantive potential impact. However, these higher displacement rates are not supported by the available evidence, whilst such high levels of mortality are not considered to be plausible. It is also the case that the CPS and CPGR metrics described above derive from a density independent population model, which assumes no population regulation (and, as such, is also biologically implausible).

506. In the HRA for HP4, the Secretary of State concluded that in-combination displacement mortalities would not undermine the conservation objective to maintain the size of the FFC SPA population of razorbill, and AEoI of the SPA could be excluded from the in-combination effects of HP4 and other OWFs (DESNZ, 2023).

507. As noted above, the information on estimated in-combination displacement mortality and PVA is provided as context for the assessment, given the conclusion that the Project would make no material contribution to the in-combination mortality.

4.4.4.8 *Assemblage of breeding seabirds*

4.4.4.8.1 Status

508. The breeding seabird assemblage qualifying feature for FFC SPA comprised 216,730 individual seabirds at classification, and 298,544 individuals in 2017 (Lloyd *et al.*, 2019). The SACOs (Natural England, 2023f) for the seabird assemblage feature of the FFC SPA includes the following attributes and associated targets:

- Abundance: Maintain the overall abundance of the assemblage at a level which is above 216,730 individuals whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.
- Diversity: Maintain the species diversity of the assemblage.
- Supporting habitats – extent and distribution of supporting habitat for the breeding season: Maintain the extent, distribution and availability of suitable breeding habitat which supports the feature for all necessary stages of its breeding cycle.
- Supporting habitats – quality of supporting breeding habitat: Maintain the structure, function and availability of the following habitats which support the assemblage feature for all stages (breeding, moulting, roosting, loafing, feeding) of the breeding period; [vegetated sea cliff and water column].

509. There is potential for North Falls (in relation to both project alone and in-combination effects) to have effects on the overall abundance and species diversity of the seabird assemblage qualifying feature, as well as on supporting habitats. This is considered in the sections below.

510. The assemblage comprises nine species:

- Gannet
- Kittiwake
- Guillemot
- Razorbill
- Fulmar
- Puffin
- Herring gull
- Cormorant
- Shag

511. Of these, the first four (gannet, kittiwake, guillemot and razorbill) are qualifying species of FFC SPA in their own right, and detailed assessment on the potential effects on these species has therefore been considered separately (respectively Sections 4.4.4.4, 4.4.4.5, 4.4.4.6 and 4.4.4.7 above).

4.4.4.8.2 Assessment of Effect on Integrity (Alone and In-Combination)

4.4.4.8.2.1 Assemblage of species: Abundance

512. For each of the assemblage species, the predicted effects on abundance is as follows:

- Gannet: The assessment of effects on gannet populations from FFC SPA are presented in Section 4.4.4.4. This concludes that combined displacement and collision mortality as a result of North Falls would be 1.1 adults per annum, and that there would be no contribution by the Project to in-combination effects.
- Kittiwake: The assessment of effects on kittiwake populations from FFC SPA are presented in Section 4.4.4.5. This concludes that under a worst case, mean mortality as a result of collision at North Falls would be 0.76 adults per annum, and that there would be no contribution by the Project to in-combination effects.
- Guillemot: The assessment of effects on guillemot populations from FFC SPA are presented in Section 4.4.4.6. This concludes that mean displacement mortality as a result of North Falls would be 1 adult per annum, and that there would be no contribution by the Project to in-combination effects.
- Razorbill: The assessment of effects on razorbill populations from FFC SPA are presented in Section 4.4.4.7. This concludes that mean displacement mortality as a result of North Falls would be 1 adult per annum, and that there would be no contribution by the Project to in-combination effects.
- Fulmar: No measurable effects on fulmars from FFC SPA are predicted, both during and outside the breeding season, due to the low sensitivity of this species to collision and disturbance/displacement effects, and the low frequency and abundance of fulmar records during baseline surveys. The total unapportioned mortality due to collision is predicted to be less than 1 individual per year (0.14; ES Appendix 13.2, Document Reference: 3.3.13), and therefore mortality apportioned to the FFC SPA would be below detectable levels.
- Puffin: North Falls is beyond the MMFR for puffins from FFC SPA (119.6km (±131.2km); Woodward *et al.*, 2019), therefore no breeding season connectivity between the FFC population and North Falls is predicted. During the non-breeding season (mid-August to March; Furness, 2015), unapportioned population estimates (wind farm +2km buffer) for this species are zero for all months except March, where 1 bird has been estimated (ES Appendix 13.2, Document Reference: 3.3.13). This species could be at risk of displacement from the wind farm array; however, as the apportioned peak seasonal population during the non-breeding season would be significantly below 1 individual, no measurable effects on this feature are predicted.
- Herring gull: North Falls is beyond the MMFR for herring gulls from FFC SPA (58.8km (±26.8km); Woodward *et al.*, 2019), therefore no breeding season connectivity between the FFC population and North Falls is predicted. This species could be at risk of collision with the turbine array; however, during the non-breeding season (September to February; Furness, 2015), no unapportioned collision mortality is predicted (ES Appendix 13.2, Document

Reference: 3.3.13). Therefore, no measurable effects on this species are predicted.

- Cormorant and shag: Population estimates for cormorant at North Falls (array area+2km buffer) are zero for all months, and shag was not recorded during baseline surveys (ES Appendix 13.2, Document Reference: 3.3.13). No effects on populations from FFC SPA are therefore predicted.

513. Together, the combined annual mortality for all species in the assemblage would be less than four birds. This is considered to be inconsequential in the context of the total SPA assemblage (i.e. 216,730 individuals) and below a threshold that would be detectable against background variation. There would also be no measurable contribution to in-combination effects.

4.4.4.8.2.2 Assemblage of Species: Diversity

514. Based on the information set out above and the assessments of the individual FFC SPA species populations which have been undertaken, it is considered that there is no potential for any of the nine species to be lost from the FFC SPA breeding population as a result of effects from North Falls, either for the project alone or in-combination with other projects.

4.4.4.8.2.3 Supporting Habitat: Extent and Distribution of Supporting Habitat for the Breeding Season; and Supporting habitat: Quality of Supporting Breeding Habitat

515. FFC SPA is located 288km from the North Falls array, at its closest point. For assemblage species that are within the breeding season foraging range (i.e. kittiwake and fulmar), it will be the case that areas closer to individual breeding sites within the SPA are likely to be of greater importance to foraging adult birds from the colony; i.e. that North Falls will be located outside the core foraging range for these species.

516. Furthermore, at a distance of 288km from the breeding colony, and assuming 50% of the area around the colony is sea, the available foraging area would be approximately 130,288km^2. The North Falls array would have a total area of approximately 95km^2, which represents <0.1% of the available sea area at this distance from the colony. Even if this was within a core foraging area for birds from the FFC SPA colony during the breeding season, it is very unlikely that this would represent a significant effect on the extent of available habitat for qualifying species. Therefore, taking into account the distance from the SPA and the fact that North Falls is considered to be outside of core foraging areas for all assemblage species, it can be concluded that there would be no AEoI from North Falls on the extent, distribution or quality of supporting habitat for assemblage species during the breeding season, and that any such effects are so minor (and unlikely to manifest) that they would not contribute in a meaningful way to any in-combination effect with other projects.

4.4.4.8.2.4 Conclusion to assessment of effects on FFC SPA seabird assemblage

517. Given the above, it is concluded that the effects from North Falls, both alone and in-combination with other projects, would not result in an adverse effect on the breeding seabird assemblage qualifying feature of the FFC SPA.

4.5 SPA and Ramsar sites screened in for connectivity for migratory species other than seabirds

4.5.1 Overview

518. This section includes shadow appropriate assessments for SPA and Ramsar sites where 1 or more migratory non-seabird features (including waterbird assemblage features) are screened for potential collision risk during the operation and maintenance phase; where the species' migratory corridor may result in individuals flying through North Falls (Wright *et al.* 2012).

519. The migratory non-seabird species and designated sites screened in are:

- Aquatic warbler (Dungeness, Romney Marsh and Rye Bay SPA and Ramsar);
- Avocet (GB non-breeding (Hamford Water SPA and Ramsar, Deben Estuary SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, Medway Estuary and Marshes SPA and Ramsar, and Breydon Water SPA and Ramsar);
- Avocet (GB breeding) (Stour and Orwell Estuaries SPA and Ramsar, Minsmere-Walberswick SPA and Ramsar, Medway Estuary and Marshes SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar);
- Bewick's swan (Broadland SPA and Ramsar, Dungeness, Romney Marsh and Rye Bay SPA and Ramsar, and Breydon Water SPA and Ramsar);
- Bittern (GB non-breeding) (Stodmarsh SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar);
- Black-tailed godwit (*islandica*) (Hamford Water SPA and Ramsar, Stour and Orwell Estuaries SPA and Ramsar, Colne Estuary SPA and Ramsar, Blackwater Estuary SPA and Ramsar, and Thames Estuary and Marshes SPA and Ramsar);
- Coot (Abberton Reservoir SPA and Ramsar);
- Dark-bellied brent goose (Hamford Water SPA and Ramsar, Stour and Orwell Estuaries SPA and Ramsar, Deben Estuary SPA and Ramsar, Colne Estuary SPA and Ramsar, Dengie SPA and Ramsar, Blackwater Estuary SPA and Ramsar; The Swale SPA and Ramsar, Crouch and Roach Estuaries SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar);
- Dunlin (Stour and Orwell Estuaries SPA and Ramsar, Blackwater Estuary SPA and Ramsar, The Swale SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar);
- Gadwall (Minsmere-Walberswick SPA and Ramsar, Stodmarsh SPA and Ramsar, Abberton Reservoir SPA and Ramsar and Broadland SPA and Ramsar);

- Golden plover (Thanet Coast and Sandwich Bay SPA and Ramsar, Dungeness, Romney Marsh and Rye Bay SPA and Ramsar, and Breydon Water SPA and Ramsar);
- Goldeneye (Abberton Reservoir SPA and Ramsar);
- Great crested grebe (Abberton Reservoir SPA and Ramsar);
- Grey plover (Hamford Water SPA and Ramsar, Stour and Orwell Estuaries SPA and Ramsar, Dengie SPA and Ramsar, Blackwater Estuary SPA and Ramsar; The Swale SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar);
- Hen harrier (Minsmere-Walberswick SPA and Ramsar, Colne Estuary SPA and Ramsar, Stodmarsh SPA and Ramsar, Dengie SPA and Ramsar, Blackwater Estuary SPA and Ramsar, Broadland SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar);
- Knot (Stour and Orwell Estuaries SPA and Ramsar, Dengie SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar);
- Lapwing (Breydon Water SPA and Ramsar); and
- Marsh harrier (Minsmere-Walberswick SPA and Ramsar, Benacre to Easton Bavents SPA, Broadland SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar);
- Mute swan (Abberton Reservoir SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar);
- Nightjar (Sandlings SPA, Minsmere-Walberswick SPA and Ramsar, and Breckland SPA);
- Pintail (Stour and Orwell Estuaries SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar);
- Pochard (Colne Estuary SPA and Ramsar, Blackwater Estuary SPA and Ramsar, and Abberton Reservoir SPA and Ramsar);
- Redshank (Hamford Water SPA and Ramsar, Stour and Orwell Estuaries SPA and Ramsar, Colne Estuary SPA and Ramsar, The Swale SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar);
- Ringed plover (GB non-breeding) (Hamford Water SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar);
- Ringed plover (GB breeding) (Colne Estuary SPA and Ramsar, and Blackwater Estuary SPA and Ramsar);

- Ruff (GB non-breeding) (Broadland SPA and Ramsar, Dungeness, Romney Marsh and Rye Bay SPA and Ramsar, and Breydon Water SPA and Ramsar);
- Shelduck (Hamford Water SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar);
- Shoveler (Minsmere-Walberswick SPA and Ramsar, Stodmarsh SPA and Ramsar, Abberton Reservoir SPA and Ramsar, Broadland SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar);
- Stone curlew (Breckland SPA);
- Teal (Hamford Water SPA and Ramsar, Minsmere-Walberswick SPA and Ramsar, and Abberton Reservoir SPA and Ramsar);
- Tufted duck (Abberton Reservoir SPA and Ramsar);
- Turnstone (Thanet Coast and Sandwich Bay SPA and Ramsar);
- White-fronted goose (Minsmere-Walberswick SPA and Ramsar);
- Whooper swan (Broadland SPA and Ramsar);
- Wigeon (Abberton Reservoir SPA and Ramsar, and Broadland SPA and Ramsar); and
- Woodlark (Sandlings SPA and Breckland SPA);
- (plus bar-tailed godwit, curlew, oystercatcher, sanderling and the above species as named components of non-breeding waterbird assemblage features, or assemblage of breeding birds features, of SPA and Ramsar sites).

520. The above migratory non-seabird populations of screened-in SPA and Ramsar sites are considered together within this section of the assessment.

4.5.2 Shadow Appropriate Assessment

4.5.2.1 Migratory non-seabird species which are qualifying features in their own right

4.5.2.1.1 Connectivity and seasonal apportionment of potential effects

521. Connectivity between the migratory species of SPA and Ramsar sites above, and the North Falls array area, was determined using the British Trust for Ornithology SOSS-MAT (Wright *et al.* 2012). The SOSS-MAT-estimated passage of individuals per migration period through the North Falls array area for each species was taken forward into the Band (2012) spreadsheet for modelling Migrant Collision Risk. Passage per migration period was apportioned to spring and/or autumn months within the Band (2012) spreadsheet based on details in species accounts within Wright *et al.* (2012). The full methodology for the assessment's use of these tools is detailed in the ES Appendix 13.2 Ornithology Technical Report (Document Reference: 3.3.13).

Table 4.59: Summary of British Trust for Ornithology SOSS-MAT migration modelling and Band (2012) collision risk modelling results for migratory non-seabird species of screened-in designated sites

Species	Annual Migrant Passage Estimate Through North Falls (SOSS-MAT, Wright *et al.* 2012)	Annual Collisions Estimate (Band (2012) Option 1, 98% Avoidance)
Aquatic warbler	3	0.00
Avocet (GB breeding)	208	0.04
Avocet (GB non-breeding)	1246	0.22
Bar-tailed godwit	2218	0.34
Bewick's swan	984	0.48
Bittern (GB non-breeding)	28	0.02
Black-tailed godwit *islandica*	1114	0.18
Coot	6096	2.04
Curlew	2752	0.44
Dark-bellied brent goose	10010	2.14
Dunlin *alpina*	15452	2.10
Gadwall	828	0.08
Golden plover	13304	1.92
Goldeneye	1192	0.12
Great crested grebe	982	0.08
Grey plover	1976	0.30
Hen harrier (GB non-breeding)	16	0.01
Knot	6208	0.84
Lapwing	25304	4.06
Marsh harrier (GB breeding)	38	0.02
Mute swan	0	0
Nightjar	418	0.14
Oystercatcher	4004	0.68
Pintail	584	0.06
Pochard	3614	0.34
Redshank	12464	1.76
Ringed plover (breeding)	146	0.02

Species	Annual Migrant Passage Estimate Through North Falls (SOSS-MAT, Wright *et al.* 2012)	Annual Collisions Estimate (Band (2012) Option 1, 98% Avoidance)
Ringed plover (non-breeding)	731	0.10
Ruff	40	0.01
Sanderling	466	0.06
Shelduck	1592	0.18
Shoveler	882	0.08
Stone-curlew	51	0.02
Teal	4834	0.44
Tufted duck	5650	0.52
Turnstone	744	0.10
White-fronted goose	344	0.08
Whooper swan	22	0.02
Wigeon	20178	1.92
Woodlark	500	0.14

Table 4.60: Increase in baseline mortality for migratory non-seabird species of screened-in designated sites as a result of estimated North Falls collision mortality rates

Species	SPAs where Qualifying Feature (in distance order from North Falls)	UK Population (Wright *et al.* 2012)	Adult Baseline Mortality (Robinson 2005)	UK Baseline Mortality	Increase in Baseline Mortality at 0.980 Avoidance Rate (%)
Aquatic warbler	Dungeness, Romney Marsh and Rye Bay SPA and Ramsar	33	-	-	0.00
Avocet (GB breeding)	Stour and Orwell Estuaries SPA and Ramsar, Minsmere-Walberswick SPA and Ramsar, Medway Estuary and Marshes SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar	1754	0.220	386	0.01
Avocet (GB non-breeding)	Hamford Water SPA and Ramsar, Deben Estuary SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, Medway Estuary and Marshes SPA and Ramsar, and Breydon Water SPA and Ramsar	7500	0.220	1650	0.01
Bar-tailed godwit	(Assemblage non-breeding)	54280	0.285	15470	0.00
Bewick's swan	Broadland SPA and Ramsar, Dungeness, Romney Marsh and Rye Bay SPA and Ramsar, and Breydon Water SPA and Ramsar	7380	0.141	1041	0.05
Bittern (GB non-breeding)	Stodmarsh SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar	600	0.300	180	0.01
Black-tailed godwit *islandica*	Hamford Water SPA and Ramsar, Stour and Orwell Estuaries SPA and Ramsar, Colne Estuary SPA and Ramsar, Blackwater Estuary SPA and Ramsar, and Thames Estuary and Marshes SPA and Ramsar	56880	0.060	3413	0.01
Coot	Abberton Reservoir SPA and Ramsar	213160	0.299	63735	0.00
Curlew	(Assemblage non-breeding)	191650	0.101	19357	0.00
Dark-bellied brent goose	Hamford Water SPA and Ramsar, Stour and Orwell Estuaries SPA and Ramsar, Deben Estuary SPA and Ramsar, Colne Estuary SPA and Ramsar, Dengie SPA and Ramsar, Blackwater Estuary SPA and Ramsar; The Swale SPA and Ramsar, Crouch and Roach Estuaries SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar	91000	0.100	9100	0.02
Dunlin *alpina*	Stour and Orwell Estuaries SPA and Ramsar, Blackwater Estuary SPA and Ramsar, The Swale SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, Thames	438480	0.260	114005	0.00

Species	SPAs where Qualifying Feature (in distance order from North Falls)	UK Population (Wright *et al.* 2012)	Adult Baseline Mortality (Robinson 2005)	UK Baseline Mortality	Increase in Baseline Mortality at 0.980 Avoidance Rate (%)
	Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar				
Gadwall	Minsmere-Walberswick SPA and Ramsar, Stodmarsh SPA and Ramsar, Abberton Reservoir SPA and Ramsar and Broadland SPA and Ramsar	25630	0.280	7176	0.00
Golden plover	Thanet Coast and Sandwich Bay SPA and Ramsar, Dungeness, Romney Marsh and Rye Bay SPA and Ramsar, and Breydon Water SPA and Ramsar	400000	0.270	108000	0.00
Goldeneye	Abberton Reservoir SPA and Ramsar	29665	0.228	6764	0.00
Great crested grebe	Abberton Reservoir SPA and Ramsar	24385	0.250	6096	0.00
Grey plover	Hamford Water SPA and Ramsar, Stour and Orwell Estuaries SPA and Ramsar, Dengie SPA and Ramsar, Blackwater Estuary SPA and Ramsar; The Swale SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar	49315	0.270	13315	0.00
Hen harrier (GB non-breeding)	Minsmere-Walberswick SPA and Ramsar, Colne Estuary SPA and Ramsar, Stodmarsh SPA and Ramsar, Dengie SPA and Ramsar, Blackwater Estuary SPA and Ramsar, Broadland SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar	750	0.190	143	0.01
Knot	Stour and Orwell Estuaries SPA and Ramsar, Dengie SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar	338970	0.159	53896	0.00
Lapwing	Breydon Water SPA and Ramsar	620000	0.295	182900	0.00
Marsh harrier (GB breeding)	Minsmere-Walberswick SPA and Ramsar, Benacre to Easton Bavents SPA, Broadland SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar	402	0.260	105	0.02
Nightjar	Sandlings SPA, Minsmere-Walberswick SPA and Ramsar, and Breckland SPA	9200	0.300	2760	0.01
Oystercatcher	(Assemblage non-breeding)	320000	0.120	38400	0.00

Species	SPAs where Qualifying Feature (in distance order from North Falls)	UK Population (Wright *et al.* 2012)	Adult Baseline Mortality (Robinson 2005)	UK Baseline Mortality	Increase in Baseline Mortality at 0.980 Avoidance Rate (%)
Pintail	Stour and Orwell Estuaries SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar	30235	0.337	10189	0.00
Pochard	Colne Estuary SPA and Ramsar, Blackwater Estuary SPA and Ramsar, and Abberton Reservoir SPA and Ramsar	75780	0.350	26523	0.00
Redshank	Hamford Water SPA and Ramsar, Stour and Orwell Estuaries SPA and Ramsar, Colne Estuary SPA and Ramsar, The Swale SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar	463800	0.260	120588	0.00
Ringed plover (breeding)	Colne Estuary SPA and Ramsar, and Blackwater Estuary SPA and Ramsar	10876	0.228	2480	0.00
Ringed plover (non-breeding)	Hamford Water SPA and Ramsar, Benfleet and Southend Marshes SPA and Ramsar, Thames Estuary and Marshes SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar	34000	0.228	7752	0.00
Ruff	Broadland SPA and Ramsar, Dungeness, Romney Marsh and Rye Bay SPA and Ramsar, and Breydon Water SPA and Ramsar	800	0.476	381	0.00
Sanderling	(Assemblage non-breeding)	22680	0.170	3856	0.00
Shelduck	Hamford Water SPA and Ramsar, and Medway Estuary and Marshes SPA and Ramsar	75610	0.114	8620	0.00
Shoveler	Minsmere-Walberswick SPA and Ramsar, Stodmarsh SPA and Ramsar, Abberton Reservoir SPA and Ramsar, Broadland SPA and Ramsar, and Dungeness, Romney Marsh and Rye Bay SPA and Ramsar	20545	0.420	8629	0.00
Stone-curlew	Breckland SPA	694	0.168	117	0.02
Teal	Hamford Water SPA and Ramsar, Minsmere-Walberswick SPA and Ramsar, and Abberton Reservoir SPA and Ramsar	255010	0.470	119855	0.00
Tufted duck	Abberton Reservoir SPA and Ramsar	146610	0.290	42517	0.00
Turnstone	Thanet Coast and Sandwich Bay SPA and Ramsar	59810	0.140	8373	0.00

Species	SPAs where Qualifying Feature (in distance order from North Falls)	UK Population (Wright *et al.* 2012)	Adult Baseline Mortality (Robinson 2005)	UK Baseline Mortality	Increase in Baseline Mortality at 0.980 Avoidance Rate (%)
White-fronted goose	Minsmere-Walberswick SPA and Ramsar	2400	0.276	662	0.01
Whooper swan	Broadland SPA and Ramsar	11000	0.199	2189	0.00
Wigeon	Abberton Reservoir SPA and Ramsar, and Broadland SPA and Ramsar	522370	0.470	245514	0.00
Woodlark	Sandlings SPA and Breckland SPA	6128	0.400	2451	0.01

4.5.2.1.2 Project alone assessment

522. The modelled annual migrant passage through the North Falls array area (taking in all migration periods relevant to the species and the geographic region in which the North Falls array area is situated), and the associated annual collision mortality at North Falls as modelled by the Band (2012) spreadsheet (based on flight height Option 1 and a 98% avoidance rate) is reported for each migratory species in Table 4.59.

523. UK population (Wright *et al.* 2012) and baseline mortality rate (calculated from adult survival rates in Robinson (2005)) for each migratory species are shown in Table 4.60, along with resulting baseline annual mortality of each species. Assuming impacts on populations of SPA and Ramsar sites are proportional to impacts on the overall UK population for each species, annual collision mortality for each migratory species at North Falls in Table 4.59 generally represents a 0.01% or lower increase from baseline mortality. In all cases the modelled increase from baseline mortality is 0.05%, or less.

524. This increase in mortality, both in absolute terms and as a percentage increase from annual baseline mortality, means that collision effects at North Falls are not sufficient to be detectable against natural variation in any of the migratory bird species assessed. As a result, the apportioned effect on the population of each SPA or Ramsar site for which a species has been screened in is also indicated to not be detectable against natural variation for any of the species assessed.

525. On this basis, there is no potential for an AEoI to the conservation objectives of migratory non-seabird features and assemblages of the SPAs and Ramsar sites screened in due to potential collision risk effects from North Falls alone.

4.5.2.1.3 In-combination assessment

526. Based on the migration corridors identified by Wright *et al.* (2012), it is indicated that migration activity of all of the assessed species is widespread across UK waters, such that low numbers of birds, and hence collisions, might be expected at many OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities, the number of birds associated with an individual SPA or Ramsar is likely to be very small to the point of being undetectable against natural variation (as is the case for North Falls). Therefore, no adverse effect on Integrity is predicted for the migratory non-seabirds and screened-in SPA and Ramsar sites above due to in-combination collision mortality.

4.5.2.2 Assemblages of breeding and wintering wetland birds

4.5.2.2.1 Project alone assessment

527. For all migratory species assessed individually, very small numbers of collisions during passage flights were predicted at North Falls array area. It was concluded in each case that the number of collisions would not result in detectable effects on the species population, and no adverse effect on integrity was predicted due to collision mortality of each species. As none of the named or other assemblage species have significant characteristics to their biometrics, migratory behaviour, migratory population or migration corridor which would markedly increase the rate of potential collisions, it is likely that this low rate of collisions would apply to all constituent species of the assemblage of breeding and wintering wetland birds,

and that there would be no adverse effect on the integrity of any assemblage qualifying feature.

4.5.2.2.2 In-combination assessment

528. Within the species specific migration corridors identified by Wright *et al.* (2012), it is likely that for each species, migration activity would be widespread across UK waters, such that low numbers of birds, and hence collisions, might be expected at individual OWFs. It is not expected that this will lead to substantial collision rates at any OWF in particular, and of those mortalities the number of birds associated with the assemblage of breeding and wintering wetland birds is likely to be very small. Therefore, no adverse effect on integrity is predicted for any SPA due to in-combination collision mortality of an assemblage qualifying feature (via collision mortality in a constituent species).

4.6 SPAs screened in for seabirds during the non-breeding season

4.6.1 SPAs screened in for connectivity for Sandwich tern in the migration seasons

4.6.1.1 Overview

529. This section provides the shadow appropriate assessment for North Falls, collectively for the Sandwich tern features of SPAs (in addition to Foulness SPA above) screened in for potential connectivity in the operation and maintenance phase for collision risk effects during their migration seasons (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

530. Furness (2015) considers two seasons for Sandwich tern in UK waters in addition to the breeding season:

- The autumn migration season: July to September, inclusive.
- The spring migration season: March to May, inclusive.

531. The SPAs screened in are:

- Dungeness, Romney Marsh and Rye Bay SPA
- North Norfolk Coast SPA
- Chichester and Langstone Harbours SPA
- Solent and Southampton Water SPA
- Coquet Island SPA
- Farne Islands SPA
- Forth Islands SPA
- Ythan Estuary, Sands of Forvie and Meikle Loch SPA
- Loch of Strathbeg SPA.

4.6.1.2 Shadow Appropriate Assessment

4.6.1.2.1 Status

532. SPA population at citation and updated SPA population based on the most recent colony data within the SMP database (accessed February 2024) are shown in Table 4.61. There was a HPAI outbreak within seabird populations in UK waters in 2021 and 2022. Updated populations of SPAs are largely from 2023 but others are less recently surveyed or reported within the SMP database, therefore some SPA data is post-HPAI while those from 2018 and 2020 are pre-HPAI.

4.6.1.2.2 Connectivity and seasonal apportionment of potential effects

533. During the migration seasons, breeding adult Sandwich tern from North Sea SPAs migrate through UK North Sea and Channel waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS as identified by Furness (2015), comprising 38,051 individuals in the migration seasons. If Sandwich tern breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for breeding adult Sandwich tern of screened in SPAs to be subject to risk of collision at North Falls during the migration seasons.

534. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during migration seasons (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls in migration seasons are shown in Table 4.61.

Table 4.61: Apportionment of potential Sandwich tern collision mortality from North Falls to SPAs during the (combined) spring and autumn migration seasons in the UK North Sea and English Channel

SPA	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality for each SPA during migration seasons (breeding adults per annum) (95% CLs)	SPA population (citation)	SPA population (updated) (SMP database)	SPA (updated) population baseline mortality rate percentage increase during migration seasons (%)
Dungeness, Romney Marsh and Rye Bay SPA	1.68	0.018 (0.015-0.054)	420 p	320 p (2018)	0.03
North Norfolk Coast SPA	21.73	0.154 (0.126-0.461)	3700 p	3770 p (2023)	0.02
Chichester and Langstone Harbours SPA	0.03	0.000 (0.000-0.001)	31 p	217 p (2023)	0.00
Solent and Southampton Water SPA	0	0	231 p	93 p (2020)	0
Coquet Island SPA	3.52	0.025 (0.020-0.075)	1590 p	1161 p (2023)	0.01
Farne Islands SPA	4.33	0.031 (0.025-0.092)	2070 p	173 p (2023)	0.09
Forth Islands SPA	0	0	440 p	0	0
Ythan Estuary, Sands of Forvie and Meikle Loch SPA	2.97	0.021 (0.017-0.063)	600 p	903 p (2023)	0.01
Loch of Strathbeg SPA	0	0	530 p	0	0

4.6.1.2.3 Effect: Collision risk during operation

4.6.1.2.3.1 Project alone assessment

535. During migration seasons, the number of Sandwich tern at risk of colliding with turbines at North Falls annually is modelled, through use of the Band (2012) spreadsheet tool 'migrant collision risk' output, to be 0.71 individuals, based on the UK North Sea and Channel BDMPS migration period population (Furness, 2015), an assumed 10km band of migration from the coast (Wernham *et al.* 2002, WWT and MacArthur Green 2014) (and this band traversing the mouth of the Thames estuary), maximum-likelihood flight height distributions of Sandwich tern from Johnston *et al.* (2014a,b) and an avoidance rate of 0.990. The apportioned collision mortality for Sandwich tern of each SPA, assuming the percentage contribution of each SPA to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.61. The percentage increase from baseline mortality associated with the modelled annual collision mortality is also shown in Table 4.61. For all SPAs and populations assessed there is modelled to be 0.09% or lower increase from baseline mortality.

536. This number of collisions would not result in effects on SPA breeding adult populations which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for these SPAs due to collision mortality of Sandwich tern.

4.6.1.2.3.2 In-combination assessment

537. The number of collisions apportioned to each SPA would not make a detectable or significant contribution to an in-combination effect of multiple projects on the assessed SPAs. Therefore, any potential for an in-combination effect of collision can be ruled out withjn this assessment.

4.6.2 SPAs screened in for connectivity for common tern in the migration seasons

4.6.2.1 Overview

538. This section provides the shadow appropriate assessment for North Falls collectively for the common tern features of SPAs (in addition to OTE SPA and Foulness SPA), screened in for potential connectivity in the operation and maintenance phase for collision risk effects during their migration seasons (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

539. Furness (2015) considers two seasons for common tern in UK waters in addition to the breeding season:

- The autumn migration season is considered to span late July to early September, inclusive.
- The spring migration season is considered to span April to May, inclusive.

540. The additional SPAs screened in are:

- Dungeness, Romney Marsh and Rye Bay SPA
- Breydon Water SPA
- North Norfolk Coast SPA
- The Wash SPA

- Chichester and Langstone Harbours SPA
- Solent and Southampton Water SPA
- Teesmouth and Cleveland Coast SPA
- Coquet Island SPA
- Farne Islands SPA
- Forth Islands SPA
- Imperial Dock Lock SPA
- Ythan Estuary, Sands of Forvie and Meikle Loch SPA
- Inner Moray Firth SPA
- Cromarty Firth SPA

4.6.2.2 Shadow Appropriate Assessment

4.6.2.2.1 Status

541. SPA population at citation and updated SPA population based on the most recent colony data within the SMP database (accessed February 2024) are shown in Table 4.62. There was a HPAI outbreak within seabird populations in UK waters in 2022. Updated populations of SPAs are largely from 2023 but others are less recently surveyed or reported within the SMP database, therefore some SPA data is post-HPAI while others are pre-HPAI.

4.6.2.2.2 Connectivity and seasonal apportionment of potential effects

542. During the migration seasons, breeding adult common tern from North Sea SPAs migrate through UK North Sea and Channel waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS as identified by Furness (2015), comprising 144,911 individuals in the migration seasons. If common tern breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for breeding adult common tern of screened in SPAs to be subject to risk of collision at North Falls during the migration seasons.

543. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during migration seasons (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls in migration seasons are shown in Table 4.62.

Table 4.62: Apportionment of potential common tern collision mortality from North Falls to SPAs during the (combined) spring and autumn migration seasons in the UK North Sea and English Channel

SPA	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality for each SPA during migration seasons (breeding adults per annum) (95% CLs)	SPA population (citation)	SPA population (updated) (SMP database)	SPA (updated) population baseline mortality rate percentage increase during migration seasons (%)
Dungeness, Romney Marsh and Rye Bay SPA	0.10	0.003 (0.001-0.004)	188 p	100 p (2022)	0.01
Breydon Water SPA	0.09	0.002 (0.001-0.004)	155 p	88 p (2022)	0.01
North Norfolk Coast SPA	0.19	0.005 (0.002-0.008)	460 p	131 p (2023)	0.02
The Wash SPA	0.21	0.005 (0.002-0.009)	152 p	150 p (2023)	0.01
Chichester and Langstone Harbours SPA	0.07	0.002 (0.001-0.003)	85 p	93 p (2023)	0.01
Solent and Southampton Water SPA	0.27	0.007 (0.003-0.012)	267 p	102 p (2020)	0.03
Teesmouth and Cleveland Coast SPA	0.19	0.005 (0.002-0.008)	399 p	389 (2018)	0.01
Coquet Island SPA	1.01	0.025 (0.011-0.043)	740 p	1875 p (2022)	0.01
Farne Islands SPA	0.09	0.002 (0.001-0.004)	230 p	38 p (2023)	0.02
Forth Islands SPA	0.02	0.001 (0.000-0.001)	334 p	120 p (2022)	0.00
Imperial Dock Lock SPA	0.79	0.020 (0.009-0.034)	558 p	350 p (2023)	0.02
Ythan Estuary, Sands of Forvie and Meikle Loch SPA	0	0	265 p	130 p (2023)	0

SPA	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality for each SPA during migration seasons (breeding adults per annum) (95% CLs)	SPA population (citation)	SPA population (updated) (SMP database)	SPA (updated) population baseline mortality rate percentage increase during migration seasons (%)
Inner Moray Firth SPA	0	0	310 p	0	0
Cromarty Firth SPA	0.07	0.002 (0.001-0.003)	294 p	0 p (2023)	(0)

4.6.2.2.3 Effect: Collision risk during operation

4.6.2.2.3.1 Project alone assessment

544. During migration seasons, the number of common tern at risk of colliding with turbines at North Falls annually is modelled, through use of the Band (2012) spreadsheet tool 'migrant collision risk' output, to be 2.53 individuals, based on the UK North Sea and Channel BDMPS migration period population (Furness, 2015), an assumed 10km band of migration from the coast (Wernham *et al.* 2002, WWT and MacArthur Green 2014) (and this band traversing the mouth of the Thames estuary), maximum-likelihood flight height distributions of common tern from Johnston *et al.* (2014a,b) and an avoidance rate of 0.990. The apportioned collision mortality for common tern of each SPA, assuming the percentage contribution of each SPA to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.62. The percentage increase from baseline mortality associated with the modelled annual collision mortality is also shown in Table 4.62. For all SPAs and populations assessed there is modelled to be 0.03% or lower increase from baseline mortality.

545. This number of collisions would not result in effects on SPA breeding adult populations which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for these SPAs due to collision mortality of common tern.

4.6.2.2.3.2 In-combination assessment

546. The number of collisions apportioned to each SPA would not make a detectable or significant contribution to an in-combination effect of multiple projects on the assessed SPAs. Therefore, any potential for an in-combination effect of collision can be ruled out within this assessment.

4.6.3 SPAs screened in for connectivity for Arctic tern in the migration seasons

547. This section provides the shadow appropriate assessment for North Falls, collectively for the Arctic tern features of additional SPAs screened in for potential connectivity in the operation and maintenance phase for collision risk effects during their migration seasons (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.6.3.1 Overview

548. Furness (2015) considers two seasons for Arctic tern in UK waters in addition to the breeding season:

- The autumn migration season is considered to span July to early September, inclusive.
- The spring migration season is considered to span late April to May, inclusive.

549. The additional SPAs screened in are:

- Northumbria Coast SPA
- Coquet Island SPA
- Farne Islands SPA
- Forth Islands SPA

- Pentland Firth Islands SPA
- Auskerry SPA
- Rousay SPA
- Fair Isle SPA
- West Westray SPA
- Papa Westray (North Hill and Holm) SPA
- Sumburgh Head SPA
- Mousa SPA
- Foula SPA
- Papa Stour SPA
- Fetlar SPA.

4.6.3.2 Shadow Appropriate Assessment

4.6.3.2.1 Status

550. SPA population at citation and updated SPA population based on the most recent colony data within the SMP database (accessed February 2024) are shown in Table 4.63. There was a HPAI outbreak within seabird populations in UK waters in 2022. Updated populations of SPAs are largely from 2023 but others are less recently surveyed or reported within the SMP database, therefore some SPA data is post-HPAI while others are pre-HPAI.

4.6.3.2.2 Connectivity and seasonal apportionment of potential effects

551. During the migration seasons, breeding adult Arctic tern from North Sea SPAs migrate through UK North Sea and Channel waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS as identified by Furness (2015), comprising 163,930 individuals in the migration seasons. If Arctic tern breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for breeding adult Arctic tern of screened in SPAs to be subject to risk of collision at North Falls during the migration seasons.

552. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during migration seasons (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls in migration seasons are shown in Table 4.63.

Table 4.63: Apportionment of potential Arctic tern collision mortality from North Falls to SPAs during the (combined) spring and autumn migration seasons in the UK North Sea and English Channel

SPA	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality for each SPA during migration seasons (breeding adults per annum) (95% CLs)	SPA population (citation)	SPA population (updated) (SMP database)	SPA (updated) population baseline mortality rate percentage increase during migration seasons (%)[1]
Northumbria Coast SPA	1.46	0.009 (0.001-0.054)	1549 p	1610 p (2023)	0.00
Coquet Island SPA	1.49	0.009 (0.001-0.056)	700 p	1578 p (2022)	0.00
Farne Islands SPA	2.34	0.014 (0.001-0.087)	2840 p	834 p (2023)	0.00
Forth Islands SPA	0.32	0.002 (0.000-0.012)	540 p	0 p (2023)	(0)
Pentland Firth Islands SPA	0	0	1200 p	135 i (2021)	(0)
Auskerry SPA	0.82	0.005 (0.000-0.031)	780 p	200 i (2018)	0.01
Rousay SPA	0.07	0.000 (0.000-0.002)	1000 p	9 p (2018)	0.00
Fair Isle SPA	0.03	0.000 (0.000-0.001)	1120 p	295 p (2023)	0.00
West Westray SPA	0.55	0.003 (0.000-0.020)	1200 p	0 p (2021)	(0)
Papa Westray (North Hill and Holm) SPA	0.19	0.001 (0.000-0.007)	1950 p	70 p (2023)	0.00
Sumburgh Head SPA	0.22	0.001 (0.000-0.008)	700 p	732 i (2018)	0.00
Mousa SPA	0.02	0.000 (0.000-0.001)	767 p	102 i (2023)	0.00
Foula SPA	0.02	0.000 (0.000-0.001)	1100 p	19 p (2018)	0.00
Papa Stour SPA	1.29	0.008 (0.001-0.048)	1000 p	590 i + 8 p (2021)	0.01
Fetlar SPA	0.02	0.000 (0.000-0.001)	520 p	187 i + 1 p (2018)	0.00

1. The change in baseline mortality is calculated relative to the adult mortality rate for Arctic tern of 0.163 from Horswill and Robinson (2015) (i.e., 1 – (adult survival rate of 0.837), see also ES Chapter 13, Table 13.11, Document Reference: 3.1.15).

4.6.3.2.3 Effect: Collision risk during operation

4.6.3.2.3.1 Project alone assessment

553. During migration seasons, the number of Arctic tern at risk of colliding with turbines at North Falls annually is modelled, through use of the Band (2012) spreadsheet tool 'migrant collision risk' output, to be 0.59 individuals, based on the UK North Sea and Channel BDMPS migration period population (Furness, 2015), an assumed 20km band of migration from the coast (and this band traversing the mouth of the Thames estuary), maximum-likelihood flight height distributions of Arctic tern from Johnston *et al.* (2014a,b) and an avoidance rate of 0.990. The apportioned collision mortality for Arctic tern of each SPA, assuming the percentage contribution of each SPA to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.63. The percentage increase from baseline mortality associated with the modelled annual collision mortality is also shown in Table 4.63. For all SPAs and populations assessed there is modelled to be 0.01% or lower increase from baseline mortality.

554. This number of collisions would not result in effects on SPA breeding adult populations which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for these SPAs due to collision mortality of Arctic tern.

4.6.3.2.3.2 In-combination assessment

555. The number of collisions apportioned to each SPA would not make a detectable or significant contribution to an in-combination effect of multiple projects on the assessed SPAs. Therefore, any potential for an in-combination effect of collision can be ruled out within this assessment.

4.6.4 SPAs screened in for connectivity for guillemot in the non-breeding season

4.6.4.1 Overview

556. This section provides the shadow appropriate assessment for North Falls, collectively for the guillemot features of SPAs (in addition to FFC SPA, Section 4.4.4.6), screened in for potential connectivity in the operation and maintenance phase for displacement and barrier effects during the non-breeding season (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

557. Furness (2015) considers the non-breeding season for common guillemot in UK waters to be August to the following February, inclusive.

558. The SPAs screened in and assessed in this section are:

- Farne Islands SPA;
- Fowlsheugh SPA;
- Troup, Pennan and Lion's Heads SPA;
- East Caithness Cliffs SPA;
- North Caithness Cliffs SPA;
- Marwick Head SPA;
- Fair Isle SPA;
- West Westray SPA;

- Noss SPA; and
- Foula SPA.

4.6.4.2 Shadow Appropriate Assessment

4.6.4.2.1 Status

559. For each SPA, populations at citation and updated SPA populations based on the most recent colony data within the SMP database (accessed February 2024) are shown in Table 4.64. There was a HPAI outbreak within seabird populations in UK waters in 2021 and 2022. Updated populations of SPAs are largely from 2023 but others are less recently surveyed or reported within the SMP database, therefore some SPA data is post-HPAI while others are pre-HPAI.

4.6.4.2.2 Connectivity and seasonal apportionment of potential effects

560. During the non-breeding season, the majority of breeding adult guillemot from Northern Isles and UK North Sea coast SPAs remain in UK North Sea waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS, as identified by Furness (2015), consisting of 1,617,306 individuals (Furness, 2015). If guillemot breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for breeding adults of the guillemot qualifying features of screened-in SPAs to be subject to risk of displacement / barrier effects at North Falls during the non-breeding period.

561. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during the non-breeding season (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls during the non-breeding season are shown in Table 4.64.

Table 4.64: Apportionment of potential guillemot displacement and mortality from North Falls to SPAs during the non-breeding season in the UK North Sea and English Channel

SPA	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned displacement mortality based on 30-70% Displacement and 1-10% Mortality for each SPA (breeding adults per annum)[1]	SPA population (citation) (breeding adults)	SPA population (updated) (breeding adults) (SMP database)	SPA (updated) population baseline annual mortality rate percentage increase (%)[2]
Farne Islands SPA	3.73	0.60 – 14.02	46,998	62,085 (2023)	0.02 – 0.37
Fowlsheugh SPA	2.98	0.48 – 11.20	56,450	108,612 (2023)	0.01 – 0.17
Troup, Pennan and Lion's Heads SPA	0.95	0.15 – 3.57	44,600	41,088 (2023)	0.01 – 0.14
East Caithness Cliffs SPA	9.22	1.48 – 34.67	106,700	123,405 (2015)	0.02 – 0.46
North Caithness Cliffs SPA	4.07	0.65 – 15.30	38,300	49,778 (2023)	0.02 – 0.50
Marwick Head SPA	0.96	0.15 – 3.61	37,700	12,800 (2021)	0.02 – 0.46
Fair Isle SPA	1.13	0.18 – 4.25	32,300	19,974 (2021)	0.01 – 0.35
West Westray SPA	2.93	0.47 – 11.02	42,150	32,945 (2023)	0.02 – 0.55
Noss SPA	1.28	0.20 – 4.81	38,970	19,354 (2023)	0.02 – 0.41
Foula SPA	1.44	0.23 – 5.41	37,500	7,087 (2021)	0.05 – 1.25

1. Apportioned based on the number of guillemots potentially subject to displacement from the North Falls array area in the non-breeding season (based on densities of birds in the array area and 2km buffer) during baseline digital aerial surveys is 5,365 (95% CLs 868 - 14,674) individuals during the non-breeding season (ES Chapter 13, Table 13.17, Document Reference: 3.1.15). Assuming a 30 to 70% rate of displacement of birds within the array area plus 2 km buffer area and a 1 to 10% mortality rate of displaced birds), the number of guillemot displacement mortalities due to North Falls annually is estimated to be 16 (95% CLs 3 - 44) to 376 (95% CLs 61 – 1,027) individuals during the non-breeding season.
2. The change in baseline mortality is calculated relative to the adult mortality rate for guillemot of 0.061 from Horswill and Robinson (2015) (i.e., 1 – (adult survival rate of 0.939), see also ES Chapter 13, Table 13.11, Document Reference: 3.1.15).

4.6.4.2.3 Effect: Displacement / barrier effects during operation

4.6.4.2.3.1 Project alone assessment

562. The apportioned displacement mortality for guillemot of each SPA, assuming the percentage contribution of each SPA to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.64. The percentage increase from baseline mortality associated with the modelled annual displacement mortality is also shown in Table 4.64.

563. At 1% mortality of displaced birds, the predicted increases in baseline rate are <0.05% for all SPAs. At 10% mortality of displaced birds, for all but one SPA, there is modelled to be less than a 0.55% increase from baseline mortality. Percentage change from baseline mortality for Foula SPA was 1.25% when assuming the maximum advised displacement rate of 70% and maximum advised mortality of displaced birds of 10% (UK SNCBs 2017).

564. Reviews of available evidence on the potential mortality of auks subject to displacement from OWFs concluded that the mortality rate would be considerably less than 10%, and a 50% rate of displacement and 1% mortality of displaced birds was appropriately precautionary (Norfolk Vanguard 2019; APEM 2022, see Section 4.4.1.4.3). Based on these parameters, the percentage increase in baseline mortality for Foula SPA is 0.09%, and lower for all other sites. For the Hornsea Project Four HRA (DESNZ, 2023), the SoS is understood to have based the consent decision on displacement and mortality rates of 70% and 2% for guillemot and razorbill. Based on these parameters, the percentage increase in baseline mortality for Foula SPA is 0.25%, and lower for all other sites.

565. These predicted increases in the baseline mortality rates from displacement from North Falls alone would not result in effects on the SPA breeding populations which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for any assessed SPA due to displacement mortality of guillemot.

4.6.4.2.3.2 In-combination assessment

566. On the basis that, assuming realistic (but still precautionary) displacement and mortality rates of 50%/1%, the level of morality increase is less than 0.1%, it can be concluded that the level of mortality apportioned to each SPA would not make a detectable contribution to an in-combination effect of multiple projects on any assessed SPA. Therefore, any potential for an in-combination effect of displacement effects can be ruled out within this assessment.

4.6.5 SPAs screened in for connectivity for gannet in the migration seasons

567. This section provides the shadow appropriate assessment for North Falls, collectively for the gannet features of SPAs (in addition to FFC SPA, Section 4.4.4): Forth Islands SPA, Noss SPA and Hermaness, Saxa Vord and Valla Field SPA), screened in for potential connectivity in the operation and maintenance phase for collision risk effects and displacement and barrier effects, during the migration seasons (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.6.5.1 Overview

568. Furness (2015) considers two migration seasons appropriate for gannet in addition to the breeding season:

- The autumn migration season is considered to span September to November, inclusive.
- The spring migration season is considered to span December to the following March, inclusive. (No separate 'winter' period is defined for the species by Furness (2015)).

4.6.5.2 Shadow Appropriate Assessment

4.6.5.2.1 Status

569. SPA population at citation and updated SPA population based on the most recent colony data within the SMP database (accessed February 2024) are shown in Table 4.65. Populations of all SPAs included in this assessment show an increase relative to citation (noting that updated SPA population data pre-date the onset of a HPAI outbreak within seabird populations in UK waters in 2021 and 2022).

4.6.5.2.2 Connectivity and seasonal apportionment of potential effects

570. During the spring and autumn migration periods, the majority of breeding adult gannets from Northern Isles and UK North Sea coast SPAs migrate through UK North Sea waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS, as identified by Furness (2015), consisting of 456,299 individuals during autumn migration and 248,385 individuals during spring migration (Furness, 2015). If gannet breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for breeding adults of the gannet qualifying features of Forth Islands SPA, Noss SPA or Hermaness, Saxa Vord and Valla Field SPA to be subject to risk of a collision, or displacement and barrier effects at North Falls during the migration periods.

571. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during autumn and spring migration (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls in autumn and spring are shown in Table 4.65.

4.6.5.2.3 Effect: Combined collision and displacement/barrier effects during operation

4.6.5.2.3.1 Project alone assessment

572. During migration seasons, the number of gannets at risk of colliding with turbines at North Falls annually is modelled using the sCRM tool to be 0.927 individuals during autumn migration and 0.688 individuals during spring migration. The apportioned collision mortality for gannet of each SPA, assuming the percentage contribution of each SPA to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.65. The apportioned displacement mortality for gannet of each SPA is shown in Table 4.66. The apportioned combined collision and displacement/barrier mortality for gannet of each SPA is shown in Table 4.67. The published adult mortality rate of gannet is 8.1% or 0.081 (Horswill and Robinson 2015). The percentage increase from baseline mortality associated with the modelled combined annual collision and displacement/barrier mortality is also shown in Table 4.67. For all SPAs there is modelled to be a 0.01% to 0.02% increase from baseline mortality.

573. This very small, predicted change in the baseline mortality rate would not result in effects on SPA breeding adult populations which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for any SPA due to collision and displacement mortality of this species.

4.6.5.2.3.2 In-combination assessment

574. The level of mortality apportioned to each SPA would not make a detectable contribution to an in-combination effect of multiple projects on Forth Islands SPA, Noss SPA or Hermaness, Saxa Vord and Valla Field SPA. Therefore, any potential for an in-combination effect of collision and displacement can be ruled out within this assessment.

Table 4.65: Apportionment of potential gannet collision mortality from North Falls to SPAs during the autumn and spring migration seasons in the UK North Sea and English Channel

SPA	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality estimate in each season (breeding adults)	SPA population (citation)	SPA population (updated) (SMP database)	SPA (updated) population baseline annual mortality rate percentage increase (%)
Forth Islands SPA	Autumn	24.32	0.23			
	Spring	31.27	0.22			
	Annual total		0.45	43,200	110,964	0.01
Noss SPA	Autumn	3.42	0.03			
	Spring	5.51	0.04			
	Annual total		0.07	13,720	19,534	0.00
Hermaness, Saxa Vord and Valla Field SPA	Autumn	8.54	0.08			
	Spring	13.73	0.10			
	Annual total		0.18	32,800	48,706	0.00

Table 4.66: Apportionment of potential gannet displacement mortality from North Falls to SPAs in the UK North Sea and English Channel during the autumn and spring migration seasons

SPA	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned displacement mortality based on 60-80% Displacement and 1% Mort for each SPA (breeding adults)	SPA population (citation)	SPA population (updated) (SMP database)	SPA (updated) population baseline annual mortality rate percentage increase (%)[2]
Forth Islands SPA	Autumn	24.32	0.42 – 0.56			
	Spring	31.27	0.54 – 0.73			
	Annual total		0.96 – 1.29	43,200	110,964	0.01
Noss SPA	Autumn	3.42	0.06 – 0.08			
	Spring	5.51	0.09 – 0.13			
	Annual total		0.15 – 0.21	13,720	19,534	0.01
Hermaness, Saxa Vord and Valla Field SPA	Autumn	8.54	0.15 – 0.20			
	Spring	13.73	0.24 – 0.32			
	Annual total		0.39 – 0.52	32,800	48,706	0.01

1. Apportioned based on the number of gannets potentially subject to displacement from the North Falls array area in the migration seasons (based on densities of birds in the array area and 2km buffer) during baseline digital aerial surveys: 287 (95% CLs 105 - 575) individuals in autumn and 290 (95% CLs 19 – 658) individuals in spring. Assuming a 60 to 80% rate of displacement of birds within the array area and 2 km buffer and a 1% rate of mortality of displaced birds, the number of gannet displacement mortalities due to North Falls annually is estimated to be 1.72 to 2.30 individuals during autumn migration and 1.74 to 2.32 individuals during spring migration.

2. The change in baseline mortality is calculated relative to the adult mortality rate for gannet of 0.081 from Horswill and Robinson (2015) (i.e., 1 – (adult survival rate of 0.919), see also ES Chapter 13, Table 13.11, Document Reference: 3.1.15).

Table 4.67: Apportionment of potential combined gannet collision and displacement mortality from North Falls to SPAs in the UK North Sea and English Channel during the autumn and spring migration seasons

SPA	Season	Apportioned combined collision and displacement mortality for each SPA (breeding adults)	SPA population (citation)	SPA population (updated) (SMP database)	SPA (updated) population baseline annual mortality rate percentage increase (%)
Forth Islands SPA	Autumn	0.65 – 0.79			
	Spring	0.76 – 0.95			
	Annual total	1.41 – 1.74	43,200	110,964	0.02
Noss SPA	Autumn	0.09 – 0.11			
	Spring	0.13 – 0.17			
	Annual total	0.22 – 0.28	13,720	19,534	0.01 - 0.02
Hermaness, Saxa Vord and Valla Field SPA	Autumn	0.23 – 0.28			
	Spring	0.34 – 0.42			
	Annual total	0.57 – 0.70	32,800	48,706	0.01 - 0.02

4.6.6 SPAs screened in for connectivity for gulls in non-breeding seasons

4.6.6.1 Overview

575. This section provides the shadow appropriate assessment for North Falls, collectively for the gull features of SPAs (in addition to AOE SPA and FFC SPA, Section 4.4.4): Forth Islands SPA, Fowlsheugh SPA and East Caithness Cliffs SPA. These have been screened in for potential connectivity in the operation and maintenance phase for collision risk effects during their non-breeding season or seasons (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

576. Furness (2015) considers a single non-breeding season for herring gull (September to the following February, inclusive).

577. Furness (2015) considers two seasons to be appropriate for kittiwake in addition to the breeding season: The autumn migration season is considered to span August to December, inclusive. The spring migration season is considered to span January to April, inclusive. (No separate 'winter' period is defined for the species by Furness (2015)).

578. Furness (2015) considers three seasons for lesser black-backed gull in addition to the breeding season: The autumn migration season is considered to span August to October, inclusive. The winter season is considered to span November to the following February, inclusive. The spring migration season is considered to span March to April, inclusive.

4.6.6.2 Shadow Appropriate Assessment

4.6.6.2.1 Status

579. SPA population at citation and updated SPA population based on the most recent colony data within the SMP database (accessed February 2024) are shown in Table 4.68. Populations of all SPAs included in this collective assessment show a decrease relative to citation (noting that updated SPA population data predate the onset of a HPAI outbreak within seabird populations in UK waters in 2022).

4.6.6.2.2 Connectivity and seasonal apportionment of potential effects

580. During their non-breeding seasons, the majority of breeding adult gulls from UK North Sea coast SPAs remain in UK North Sea waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea BDMPS (kittiwake) and UK North Sea and Channel BDMPS (herring gull, lesser black-backed gull), as identified by Furness (2015). If gull breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for breeding adults of the gull qualifying features of Forth Islands SPA, Fowlsheugh SPA and East Caithness Cliffs SPA to be subject to risk of collision at North Falls during the non-breeding season or seasons.

581. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during non-breeding seasons (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls in autumn and spring are shown in Table 4.68.

4.6.6.2.3 Effect: Collision risk during operation

4.6.6.2.3.1 Project alone assessment

582. During non-breeding seasons, the number of lesser black-backed gull at risk of colliding with turbines at North Falls annually is modelled using the sCRM tool to be 0.802 individuals during autumn migration, 1.226 individuals during winter and 1.551 individuals during spring migration. The number of kittiwake at risk of colliding with turbines at North Falls annually is modelled to be 4.14 during autumn migration and 11.503 individuals during spring migration. The number of herring gull at risk of colliding with turbines at North Falls annually is modelled to be zero during the non-breeding season. The apportioned collision mortality for gulls of each SPA, assuming the percentage contribution of each SPA to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.68. The percentage increase from baseline mortality associated with the modelled annual collision mortality is also shown in Table 4.68. For all SPAs and populations assessed there is modelled to be less than 0.5% increase from baseline mortality.

583. This number of collisions would not result in effects on SPA breeding adult populations which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for these SPAs due to collision mortality of gull species.

4.6.6.2.3.2 In-combination assessment

The number of collisions apportioned to each SPA would not make a detectable contribution to an in-combination effect of multiple projects on Forth Islands SPA, Fowlsheugh SPA or East Caithness Cliffs SPA. Therefore, any potential for an in-combination effect of collision can be ruled out within this assessment.

Table 4.68: Apportionment of potential gull collision mortality from North Falls to SPAs during their non-breeding seasons in the UK North Sea (kittiwake), or UK North Sea and English Channel (herring gull, lesser black-backed gull)

SPA	Species	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality for each SPA (breeding adults)	SPA population (citation)	SPA population (updated) (SMP database)	SPA (updated) population baseline mortality rate percentage increase (%)[1]
Forth Islands SPA	Lesser black-backed gull	Spring	1.63	0.03			
		Migration-free winter	4.09	0.05			
		Autumn	1.54	0.01			
		Annual total		0.09	3,000	450	0.17
Fowlsheugh SPA	Kittiwake	Autumn	1.35	0.06			
		Spring	1.78	0.20			
		Annual total		0.26	69,740	30,966	0.01
East Caithness Cliffs SPA	Herring gull	Non-breeding	1.44	0	18,740	5,826	0
	Kittiwake	Autumn	5.84	0.24			
		Spring	7.72	0.89			
		Annual total		1.13	63,860	34,042	0.02

1. The change in baseline mortality is calculated relative to the adult mortality rate from Horswill and Robinson (2015) (i.e., 1 – (adult survival rate), see also ES Chapter 13, Table 13.11, Document Reference: 3.1.15); lesser black-backed gull: 1-0.885=0.115; kittiwake: 1-0.854=0.146; herring gull: 1-0.834=0.166

4.6.7 SPAs screened in for connectivity for razorbill in the migration and winter seasons

4.6.7.1 Overview

584. This section provides the shadow appropriate assessment for North Falls, collectively for razorbill features of SPAs (in addition to FFC SPA), screened in for potential connectivity in the operation and maintenance phase for displacement and barrier effects during the non-breeding (migration and winter) seasons.

585. Furness (2015) considers three seasons for razorbill in UK waters in addition to the breeding season:

- The autumn migration season is considered to be August to October, inclusive.
- The winter season is considered to be November to December, inclusive.
- The spring migration season is considered to be January to March, inclusive.

586. The only SPA screened in and assessed in this section is East Caithness Cliffs SPA (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.6.7.2 Shadow Appropriate Assessment

4.6.7.2.1 Status

587. At the time of classification in 1996, the East Caithness Cliffs SPA breeding population was cited as 9259 pairs of razorbill. Monitoring in 1999 recorded 12,500 pairs (Furness, 2015). The SMP database (accessed Feb 2024) reports 18,524 individuals in 2015 which converts to 12,411 pairs when the correction factor of 0.67 is applied to counts of individuals at the colony (Harris 1989). Based on the most recent SPA population of 24,822 breeding adults, and a baseline adult mortality rate of 0.105 (Horswill & Robinson 2015), 2606 SPA breeding adults would be expected to die each year.

4.6.7.2.2 Connectivity and seasonal apportionment of potential effects

588. During the migration seasons, and to a lesser extent in winter, breeding adult razorbill from East Caithness Coast SPA remain in UK North Sea waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS, as identified by Furness (2015), consisting of 591,874 individuals during the migration seasons and 218,622 individuals during winter (Furness, 2015). If razorbill breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for breeding adults of the East Caithness Cliffs SPA to be subject to risk of displacement at North Falls during the migration and winter seasons.

589. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during the non-breeding season (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls is 4.22% in the migration seasons and 3.43% in winter.

Table 4.69: Apportionment of potential razorbill displacement and mortality from North Falls to SPAs during the autumn migration, winter and spring migration seasons in the UK North Sea and English Channel

SPA	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned displacement mortality based on 30-70% Displacement and 1-10% Mort for each SPA (breeding adults)[1]	SPA population (citation) (breeding adults)	SPA population (updated) (breeding adults) (SMP database)	SPA (updated) population baseline annual mortality rate percentage increase (%)[2]
East Caithness Cliffs SPA	Autumn	4.22	0.03 – 0.73			
	Winter	3.43	0.18 – 4.29			
	Spring	4.22	0.22 – 5.15			
	Annual total		0.43 – 10.17	18,518	24,822	0.02 – 0.39

1. Apportioned based on the number of razorbills potentially subject to displacement from the North Falls array area in the non-breeding seasons (based on densities of birds in the array area and 2km buffer during baseline digital aerial surveys): 248 (95% CLs 8 - 607) individuals in autumn migration, 1,781 (95% CLs 1,239 – 2,548) individuals in winter and 1,741 (95% CLs 413- 4,907) individuals in spring migration (ES Chapter 13, Table 13.17, Document Reference: 3.1.15). Assuming a 30 to 70% rate of displacement of birds within the array area and 2 km buffer area and a 1 to 10% mortality rate of displaced birds, the number of razorbill displacement mortalities due to North Falls annually is estimated to be 0.7 to 17.4 individuals during autumn migration, 5.3 to 125 individuals during the winter, and 5.2 to 122 individuals during spring migration.

2. The change in baseline mortality is calculated relative to the adult mortality rate for razorbill of 0.105 from Horswill and Robinson (2015) (i.e., 1 – (adult survival rate of 0.895), see also ES Chapter 13, Table 13.11, Document Reference: 3.1.15).

4.6.7.2.3 Effect: Displacement / barrier effects during operation

4.6.7.2.3.1 Project alone assessment

590. The apportioned displacement mortality for razorbill at East Caithness Cliffs SPA in each season and annually, assuming the percentage contribution of the SPA population to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.69. The percentage increase from baseline mortality associated with the modelled annual displacement mortality is 0.02 at 1% mortality of displaced birds, and 0.39% at 10% mortality (Table 4.69).

591. Reviews of available evidence on the potential mortality of auks subject to displacement from OWFs concluded that the mortality rate would be considerably less than 10%, and a 50% rate of displacement and 1% mortality of displaced birds was appropriately precautionary (APEM 2022, MacArthur Green 2019a, see Section 4.4.4.6.3 above). Based on these parameters, the percentage increase in baseline mortality at East Caithness Cliffs SPA is 0.03%. For the Hornsea Project Four HRA (DESNZ, 2023), the SoS is understood to have based the consent decision on displacement and mortality rates of 70% and 2% for guillemot and razorbill. Based on these parameters, the percentage increase in baseline mortality at East Caithness Cliffs SPA is 0.08%.

592. These predicted changes to baseline mortality would not result in effects on the SPA breeding population which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for East Caithness SPA due to displacement mortality of razorbill.

4.6.7.2.3.2 In-combination assessment

593. The predicted increase to the baseline mortality of the SPA population from North Falls alone is very small and would not make a detectable contribution to any in-combination effect of multiple projects on East Caithness Cliffs SPA. Therefore, any potential for an in-combination effect of displacement can be ruled out within this assessment.

4.6.8 SPAs screened in for connectivity for great skua in the migration seasons

4.6.8.1 Overview

594. This section provides the shadow appropriate assessment for North Falls collectively for the great skua features of the SPAs screened in for potential connectivity in the operation and maintenance phase for collision risk effects during their migration seasons (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

595. Furness (2015) considers three seasons for great skua in UK waters in addition to the breeding season.

- The autumn migration season is considered to span August to October, inclusive.
- The winter season is considered to span November to the following February, inclusive.
- The spring migration season is considered to span March to April, inclusive.

596. The SPAs screened in are:

- Hoy SPA
- Noss SPA
- Foula SPA
- Fetlar SPA
- Ronas Hill - North Roe and Tingon SPA, and
- Hermaness, Saxa Vord and Valla Field SPA.

4.6.8.2 Shadow Appropriate Assessment

4.6.8.2.1 Status

597. SPA population at citation and updated SPA population based on the most recent colony data within the SMP database (accessed February 2024) are shown in Table 4.70. Populations of all SPAs included in this collective assessment show a decrease relative to citation (noting that updated SPA populations are all from 2023 and follow the onset of a HPAI outbreak within seabird populations in UK waters in 2021 and 2022, with severe effects on great skua (Tremlett *et al.* 2024, Furness *et al.* 2023).

Table 4.70: Apportionment of potential great skua collision mortality from North Falls to SPAs during the migration seasons and winter in the UK North Sea and English Channel

SPA	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality for each SPA (breeding adults per annum)	SPA population (citation, pairs)	SPA population (updated) (SMP database, pairs)	SPA (updated) population baseline mortality rate percentage increase (%)[1]
Hoy SPA	Autumn	8.26	0.00			
	Winter	0	0			
	Spring	9.52	0.00			
	Annual total		**0.00**	1,900	398 (2023)	**0.00**
Noss SPA	Autumn	2.85	0.00			
	Winter	0	0			
	Spring	3.29	0.00			
	Annual total		**0.00**	410	69 (2023)	**0.02**
Foula SPA	Autumn	10.17	0.00			
	Winter	0	0			
	Spring	11.71	0.00			
	Annual total		**0.01**	2,170	308 (2023)	**0.01**
Fetlar SPA	Autumn	3.59	0.00			
	Winter	0	0			
	Spring	4.14	0.00			
	Annual total		**0.00**	512	255 (2023)	**0.00**
Ronas Hill - North Roe and Tingon SPA	Autumn	1.16	0.00			
	Winter	0	0			
	Spring	1.33	0.00			
	Annual total		**0.00**	130	100	**0.00**

SPA	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality for each SPA (breeding adults per annum)	SPA population (citation, pairs)	SPA population (updated) (SMP database, pairs)	SPA (updated) population baseline mortality rate percentage increase (%)[1]
					(2023)	
Hermaness, Saxa Vord and Valla Field SPA	Autumn	6.01	0.00			
	Winter	0	0			
	Spring	6.92	0.00			
	Annual total		**0.00**	630	208 (2023)	**0.01**

1. The change in baseline mortality is calculated relative to the adult mortality rate for great skua of 0.118 from Horswill and Robinson (2015) (i.e., 1 – (adult survival rate of 0.882)).

4.6.8.2.2 Connectivity and seasonal apportionment of potential effects

598. During the migration seasons, breeding adult great skua from Northern Isles SPAs migrate through UK North Sea waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS as identified by Furness (2015), comprising 19,556 individuals in autumn and 8,485 individuals in spring. If great skua breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for breeding adult great skua of screened in SPAs to be subject to risk of collision at North Falls during the migration seasons. (Breeding adults of UK SPAs are not considered to remain in UK North Sea waters during winter (Furness 2015).)

599. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during migration and winter seasons (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls in autumn, winter and spring are shown in Table 4.70.

4.6.8.2.3 Effect: Collision risk during operation

4.6.8.2.3.1 Project alone assessment

600. During migration seasons, the number of great skua at risk of colliding with turbines at North Falls annually is modelled, through use of the Band (2012) spreadsheet tool 'migrant collision risk' output, to be 0.034 individuals during autumn migration and 0.015 individuals during spring migration, based on the UK North Sea and Channel BDMPS passage period populations (Furness, 2015), an assumed 40km band of migration from the coast, maximum-likelihood flight height distributions of great skua from Johnston *et al.* (2014a,b) and an avoidance rate of 0.990. The apportioned collision mortality for great skua of each SPA, assuming the percentage contribution of each SPA to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.70. The percentage increase from baseline mortality associated with the modelled annual collision mortality is also shown in Table 4.70. For all SPAs and populations assessed there is modelled to be 0.02% or lower increase in baseline mortality.

601. This number of collisions would not result in effects on SPA breeding adult populations which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for these SPAs due to collision mortality of great skua.

4.6.8.2.3.2 In-combination assessment

602. The number of collisions apportioned and predicted increase in baseline mortality rate for each SPA would not make a detectable contribution to an in-combination effect of multiple projects on the assessed SPAs. Therefore, any potential for an in-combination effect of collision can be ruled out within this assessment.

4.6.9 SPAs screened in for connectivity for Arctic skua in the migration seasons

4.6.9.1 Overview

603. The potential for LSE from North Falls has been assessed in this section collectively for Arctic skua features of the SPAs screened in for potential connectivity in the operation and maintenance phase for collision risk effects during their migration seasons.

604. Furness (2015) considers two seasons for Arctic skua in UK waters in addition to the breeding season.

- The autumn migration season is considered to span August to October, inclusive.
- The spring migration season is considered to span April to May, inclusive.

605. The only SPA screened in and assessed in this section is Papa Westray (North Hill and Holm) SPA (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

4.6.9.2 Shadow Appropriate Assessment

4.6.9.2.1 Status

606. At the time of classification in 1996, the Papa Westray (North Hill and Holm) SPA breeding population was cited as 135 pairs of Arctic skua. Further monitoring in 2011 recorded 25 pairs, and 22 pairs were recorded in 2012 (Furness, 2015). Monitoring of the SPA area in 2019 counted 24 Apparently Occupied Territory (AOT), and the most recent count in 2023 recorded 18 AOT (noting that this was post-outbreak of HPAI in UK seabird populations in 2022) (SMP database, accessed Jan 2024). Based on the most recent SPA population 36 breeding adults (18 x 2) and an annual baseline adult mortality rate of 0.090 (Horswill and Robinson, 2015), 3.25 breeding adults from the SPA population would be expected to die each year.

4.6.9.3 Connectivity and seasonal apportionment of potential effects

607. During the spring and autumn migration periods, breeding Arctic skua from this SPA migrate through UK waters. There is potential connectivity as North Falls is within the UK North Sea and Channel BDMPS, as identified by Furness (2015), consisting of 6,427 individuals during autumn migration and 1,227 individuals during spring migration. If Arctic skua breeding populations from all SPAs bordering this area were to mix widely within the BDMPS area, then there is potential for birds from the Papa Westray (North Hill and Holm) SPA to be subject to risk of a collision effect at North Falls during the migration seasons.

608. Based on the data in Appendix A to Furness (2015), on the contributions of UK SPA and non-SPA populations and overseas populations to each BDMPS, 0.40% of the birds occurring in the UK North Sea and Channel BDMPS during the autumn migration, and 1.47% of the birds occurring in the UK North Sea and Channel BDMPS during the spring migration, are estimated to be breeding adults from the Papa Westray (North Hill and Holm) SPA (Furness, 2015). Arctic skua was recorded during one survey in the 24-month baseline digital aerial survey programme of the North Falls array area and surrounding buffer areas. The species was recorded in November, i.e., most closely associated with the species' autumn migration period (Furness, 2015).

Table 4.71: Apportionment of potential Arctic skua collision mortality from North Falls to SPAs during the migration seasons in the UK North Sea and English Channel

SPA	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned collision mortality for each SPA (breeding adults)	SPA population (citation) (pairs)	SPA population (updated) (breeding adults) (SMP database)	SPA (updated) population baseline mortality rate percentage increase (%)[1]
Papa Westray (North Hill and Holm) SPA	Autumn	0.40	0.00	-	-	-
	Spring	1.47	0.00	-	-	-
	Annual total		**0.00**	135	18 (2023)	**0.00**

1. The change in baseline mortality is calculated relative to the adult mortality rate for Arctic skua of 0.09 from Horswill and Robinson (2015) (i.e., 1 – (adult survival rate of 0.910)).

4.6.9.3.1 Effect: Collision risk during operation

4.6.9.3.1.1 Project alone assessment

609. The number of Arctic skua at risk of colliding with turbines at North Falls annually was calculated, through use of the Band (2012) spreadsheet tool 'migrant collision risk' output, to be 0.008 individuals in autumn and 0.001 individuals during spring (ES Appendix 13.2, Document Reference: 3.3.13). This was based on the UK North Sea and Channel BDMPS passage period populations (Furness, 2015), and maximum-likelihood flight height distributions of Arctic skua from Johnston *et al.* (2014a,b), assuming migration within a 20km band from the coast (and this band traversing the mouth of the Thames estuary) and an avoidance rate of 0.990.

610. The apportioned collision mortality for Arctic skua of Papa Westray (North Hill & Holm) SPA in each season, assuming the percentage contribution of the SPA to North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.71, including the annual total collision mortality. The percentage increase from baseline mortality associated with the modelled annual collision mortality is also shown in Table 4.71. The predicted mortality due to collision effects represents less than a 0.01% increase from baseline mortality.

611. This number of collisions would not result in effects on the SPA breeding population which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for the Papa Westray (North Hill & Holm) SPA due to collision mortality of Arctic skua.

4.6.9.3.1.2 In-combination assessment

612. The very small number of collisions apportioned and the predicted change in baseline mortality rate for the SPA population would not make a detectable contribution to an in-combination effect of multiple projects on the Papa Westray (North Hill & Holm) SPA. Therefore, any potential for an in-combination effect of collisions can be ruled out within this assessment.

4.6.10 SPA and Ramsar sites screened in for connectivity for RTD in the autumn migration, spring migration and winter seasons

4.6.10.1 Overview

613. The potential for LSE from North Falls has been assessed in this section for RTD breeding features of SPA and Ramsar sites (in addition to OTE SPA, Section 4.4.1), screened in for potential connectivity in the operation and maintenance phase for displacement and barrier effects during the non-breeding (migration and winter) seasons (RIAA Appendix 1.1 HRA Screening Report, Document Reference: 7.1.1.1).

614. Furness (2015) considers three seasons for RTD in UK waters in addition to the breeding season.

- The autumn migration season, September to November, inclusive.
- The winter season, December to the following January, inclusive.
- The spring migration season, February to April, inclusive.

615. The additional SPAs screened in and assessed in this section are:

- Caithness and Sutherland Peatlands SPA
- Hoy SPA
- Orkney Mainland Moors SPA
- Foula SPA
- Otterswick and Graveland SPA
- Ronas Hill - North Roe and Tingon SPA; and
- Hermaness, Saxa Vord and Valla Field SPA.

4.6.10.2 Shadow Appropriate Assessment

4.6.10.2.1 Status

616. SPA population at citation and updated SPA population based on more recent SPA population data per Furness (2015) are shown in Table 4.72.

4.6.10.2.2 Connectivity and seasonal apportionment of potential effects

617. During the migration and winter seasons, the breeding adult RTD from Northern Isles and north-east Scotland SPAs are considered from a desk-based review of evidence to remain in UK North Sea waters (Furness 2015). There is potential connectivity as North Falls is within the UK North Sea waters BDMPS comprising 13,277 individuals during migration seasons, and the southwest North Sea BDMPS, consisting of 10,177 individuals during winter (Furness 2015). If RTD breeding populations from all SPAs bordering this area were to mix widely within these BDMPS areas, then there is potential for breeding adults of the RTD qualifying features of screened-in SPAs to be subject to risk of displacement at North Falls during the migration and winter seasons.

618. Based on the number of SPA breeding adults estimated to be present within the UK North Sea and Channel during the migration and winter seasons (Furness 2015), the percentage contribution of breeding adults of each SPA to the seasonal populations present at North Falls during the migration and winter seasons are shown in Table 4.72.

619. It should be noted, however that the results of more recent geolocator and stable isotope analysis study by Duckworth *et al.* (2022) provide a caveat to this assessment, in that breeding adults from Shetland and Orkney were found to winter within waters of northern Scotland, relatively close to their breeding areas, or to move southwards to the mainland coast of Scotland or Northern Ireland, thus not travelling into the southern North Sea. On this basis, connectivity between North Falls and SPAs for breeding RTD in Scotland may be considerably weaker than implied by the review by Furness (2015). This is likely to mean that the assessment presented below (which assumes connectivity on the basis of Furness, 2015) incorporates additional precaution, and will overestimate the actual effects on these SPAs.

Table 4.72: Apportionment of potential RTD displacement mortality from North Falls to SPAs during the migration and winter seasons in the UK North Sea and English Channel

SPA	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned displacement mortality based on 100% Displacement and 1-10% Mort for each SPA (breeding adults)[1]	SPA population (citation) (breeding adults)	SPA population (updated) (breeding adults) (Furness 2015)	SPA (updated) population baseline mortality rate percentage increase (%)[2]
Caithness and Sutherland Peatlands SPA	Autumn	0.66	0			
	Winter	0.18	0.00 – 0.00			
	Spring	0.66	0.01 – 0.04			
	Annual total		0.01 – 0.05	178	92	0.03 – 0.34
Hoy SPA	Autumn	0.86	0			
	Winter	0.24	0.00 – 0.01			
	Spring	0.86	0.01 – 0.06			
	Annual total		0.01 – 0.06	112	120	0.03 – 0.32
Orkney Mainland Moors SPA	Autumn	0.40	0			
	Winter	0.11	0.00 – 0.00			
	Spring	0.40	0.00 – 0.03			
	Annual total		0.00 – 0.03	30	56	0.03 – 0.32
Foula SPA	Autumn	0.17	0			
	Winter	0.05	0.00 – 0.00			
	Spring	0.17	0.00 – 0.01			
	Annual total		0.00 – 0.01	22	24	0.03 – 0.31
	Autumn	0.36	0			

SPA	Season	SPA breeding adult population as a percentage of the North Sea and English Channel (Furness 2015) (%)	Apportioned displacement mortality based on 100% Displacement and 1-10% Mort for each SPA (breeding adults)[1]	SPA population (citation) (breeding adults)	SPA population (updated) (breeding adults) (Furness 2015)	SPA (updated) population baseline mortality rate percentage increase (%)[2]
Otterswick and Graveland SPA	Winter	0.10	0.00 – 0.00			
	Spring	0.36	0.00 – 0.02			
	Annual total		0.00 – 0.03	54	50	0.04 – 0.33
Ronas Hill - North Roe and Tingon SPA	Autumn	0.72	0			
	Winter	0.20	0.00 – 0.00			
	Spring	0.72	0.01 – 0.05			
	Annual total		0.01 – 0.05	100	100	0.03 – 0.32
Hermaness, Saxa Vord and Valla Field SPA	Autumn	0.23	0			
	Winter	0.06	0.00 – 0.00			
	Spring	0.23	0.00 – 0.02			
	Annual total		0.00 – 0.02	56	32	0.04 – 0.31

1. Apportioned based on the number of RTDs potentially subject to displacement from the North Falls array area in the non-breeding seasons (based on densities of birds in the array area and 4km buffer during baseline digital aerial surveys): zero individuals in autumn migration season, 20 (95% CLs 0 - 44) individuals in winter and 66 (95% CLs 12 - 149) individuals in the spring migration season (ES Chapter 13, Table 13.17, Document Reference: 3.1.15). Assuming a 100% rate of displacement of birds within the array area plus 4 km buffer area, and a 1 to 10% rate of mortality of displaced birds, the number of RTD displacement mortalities due to North Falls annually is estimated to be zero individuals during autumn migration, 0.2 to 2 individuals during winter, and 0.7 to 6.6 individuals during spring migration.

2. The change in baseline mortality is calculated relative to the adult mortality rate for RTD of 0.160 from Horswill and Robinson (2015) (i.e., 1 – (adult survival rate of 0.840), see also ES Chapter 13, Table 13.11, Document Reference: 3.1.15).

4.6.10.2.3 Effect: Displacement / barrier effects during operation

4.6.10.2.3.1 Project alone assessment

620. The apportioned displacement mortality for RTDs at screened-in SPAs, assuming the percentage contribution of each SPA population to the North Falls is equal to contribution to the BDMPS as above, is shown in Table 4.72 for in each season and annually.

621. The assessment presents mortality values, and percentage increases in baseline mortality of SPA breeding adults, for the range of 1 – 10% mortality of displaced birds. As discussed in Section 4.4.1.4.3 above, a maximum 1% mortality of displaced RTDs is considered most likely based on expert opinion.

622. The percentage increase from baseline mortality associated with the modelled annual displacement mortality is also shown in Table 4.72. At 1% mortality of displaced birds, the range of predicted mortalities due to displacement at all SPAs represents less than a 0.05% increase from baseline mortality; at 10% mortality the predicted increase in baseline mortality is no more than 0.5% for any SPA.

623. These predicted changes from baseline mortality are not predicted to result in effects on the breeding adult population of any SPA which are detectable against natural variation. Therefore, no adverse effect on integrity is predicted for any SPA assessed in this section due to displacement mortality of RTD.

4.6.10.2.3.2 In-combination assessment

624. The predicted increase to the baseline mortality of each SPA from displacement at North Falls alone is very small and would not make a detectable contribution to an in-combination effect of multiple projects on any assessed SPA. Therefore, any potential for an in-combination effect of displacement can be ruled out.

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