Pentland floating offshore wind farm

Volume 2: Offshore EIAR

Chapter 12: Marine Ornithology

PENTLAND FLOATING OFFSHORE WIND FARM

OFFSHORE EIAR (VOLUME 2): MAIN REPORT

CHAPTER 12: MARINE ORNITHOLOGY

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GLOSSARY OF PROJECT TERMS

Key Terms	Definition
Dounreay Trì Floating Wind Demonstration Project (the 'Dounreay Trì Project')	The 2017 consented project that was previously owned by Dounreay Trì Limited (in administration) and acquired by Highland Wind Limited (HWL) in 2020. The Dounreay Trì Project consent was for two demonstrator floating Wind Turbine Generators (WTGs) with a marine licence that overlaps with the Offshore Development, as defined. The offshore components of the Dounreay Trì Project consent are no longer being implemented.
Highland Wind Limited	The Developer of the Project (defined below) and the Applicant for the associated consents and licences.
Landfall	The point where the offshore export cable(s) from the PFOWF Array Area, as defined, will be brought ashore.
Offshore Export Cable(s)	The cable(s) that transmits electricity produced by the WTGs to landfall.
Offshore Export Cable Corridor (OECC)	The area within which the offshore export cable(s) will be located.
Offshore Site	The area encompassing the PFOWF Array Area and OECC, as defined.
Onshore Site	The area encompassing the PFOWF Onshore Transmission Infrastructure, as defined.
Pentland Floating Offshore Wind Farm (PFOWF) Array and Offshore Export Cable(s) (the 'Offshore Development')	All offshore components of the Project (WTGs, inter-array and offshore export cable(s), floating substructures, and all other associated offshore infrastructure) required during operation of the Project, for which HWL are seeking consent. The Offshore Development is the focus of this Environmental Impact Assessment Report.
PFOWF Array	All WTGs, inter-array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the PFOWF Array Area, as defined, excluding the offshore export cable(s).
PFOWF Array Area	The area where the WTGs will be located within the Offshore Site, as defined.
PFOWF Onshore Transmission Infrastructure (the 'Onshore Development')	All onshore components of the Project, including horizontal directional drilling, onshore cables (i.e. those above mean low water springs), transition joint bay, cable joint bays, substation, construction compound, and access (and all other associated infrastructure) across all project phases from development to decommissioning, for which HWL are seeking consent from The Highland Council.
PFOWF Project (the 'Project')	The combined Offshore Development and Onshore Development, as defined.

ACRONYMS AND ABBREVIATIONS

AON	Apparently Occupied Nest
AOS	Apparently Occupied Site
AOT	Apparently Occupied Territory
BDMPS	Biologically Defined Minimum Population Scales
BOCC	Birds of Conservation Concern
BTO	British Trust for Ornithology
CaP	Cable Plan
CEH	Centre for Ecology and Hydrology
CEMP	Construction Environmental Management Plan
CMS	Construction Method Statement
CRM	Collision Risk Modelling
ECoW	Environmental Clerk of Works
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMEC	European Marine Energy Centre
EOWDC	European Offshore Wind Deployment Centre
EPS	European Protected Species
ES	Environmental Statement
FAD	Fish Aggregation Device
HDD	Horizontal Directional Drilling
HiDef	HiDef Aerial Surveying Limited
HRA	Habitats Regulations Appraisal
HWL	Highland Wind Limited
IUCN	International Union for Conservation of Nature and Natural Resources
JNCC	Joint Nature Conservation Committee
km	Kilometres
LMP	Lighting and Marking Plan
m	Meters
MS	Marine Scotland
MS-LOT	Marine Scotland Licencing Operations Team

MSS	Marine Scotland Science
NPC	Natural Power Consultants
NS	NatureScot
NSP	Navigational Safety Plan
OECC	Offshore Export Cable Corridor
OEMP	Operational Environmental Management Plan
OSPAR Convention	The Convention for the Protection of the Marine Environment of the North-East Atlantic
PEMP	Project Environmental Monitoring Programme
PFOWF	Pentland Floating Offshore Wind Farm
PVA	Population Viability Analysis
RIAA	Report to Inform the Appropriate Assessment
ROV	Remotely Operated Vehicle
RSPB	Royal Society for the Protection of Birds
SAC	Special Areas of Conservation
SNCB	Statutory Nature Conservation Bodies
SOC	Scottish Ornithologists Club
SOSS	Strategic Ornithological Support Service
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UK	United Kingdom
UKBAP	UK Biodiversity Action Plan
VP	Vantage Point
VMP	Vessel Management Plan
WTG	Wind Turbine Generator
WWT	Wildfowl and Wetlands Trust

12 MARINE ORNITHOLOGY

12.1 Introduction

The potential effects of the Pentland Floating Offshore Wind Farm (PFOWF) Array and Offshore Export Cable(s), hereafter referred to as the 'Offshore Development' during construction, operation and maintenance, and decommissioning on Ornithology are assessed in this chapter. This chapter also includes a review of the potential cumulative impacts with other relevant projects.

The focus of the chapter is on those species, primarily seabirds, that were recorded during the digital aerial survey work undertaken by HiDef Aerial Surveying Limited (HiDef) to inform the Marine Ornithology baseline characterisation (see Section 12.4) and subsequent assessment (see Section 12.6).

The baseline description acknowledges the occurrence of Avian Influenza in the United Kingdom (UK) this year and its widespread effects at breeding seabird colonies in Scotland (see Section 12.4.5.2). Whilst there has been no means of formally taking account of this matter in this ornithological impact assessment, a short summary of the issue has been provided for context.

Assessment in this chapter follows the process of Environmental Impact Assessment (EIA) as described in Section 12.5 and Chapter 6: EIA Methodology.

Most of the Marine Ornithology receptors under consideration in this chapter are qualifying interests of Special Protection Areas (SPAs), therefore the provisions of Habitats Regulations Appraisal (HRA) apply to them. In this regard, the Report to Inform the Appropriate Assessment (RIAA) presents the HRA consideration of potential effects from the Offshore Development on these SPA qualifying interests, and is submitted alongside the Environmental Impact Assessment Report (EIAR) as part of the overall application.

The ornithology impact assessment in this chapter draws upon output from other impact assessments within the Offshore EIAR (Volume 3); including Chapter 8: Water and Sediment Quality; Chapter 9: Benthic Ecology; Chapter 10: Fish and Shellfish Ecology and Chapter 11: Marine Mammals and Other Megafauna where that information is used to inform the assessment, reference to the relevant chapter is given.

HiDef have authored this chapter and have undertaken the survey data collection, analyses and technical modelling (including apportioning, collision risk modelling and displacement analysis) which support this impact assessment. Natural Power Consultants (NPC) have provided third party review.

Table 12.1 provides a list of all the studies relating to Marine Ornithology, supporting the impact assessment presented in this chapter. All supporting studies are available on request from the Marine Scotland Licensing Operations Team (MS-LOT).

Table 12.1 Supporting studies

Details of study	Locations of supporting studies
Baseline Data	Offshore EIAR (Volume 3) Technical Appendix 12.1: Baseline Data
Connectivity and Apportioning	Offshore EIAR (Volume 3) Technical Appendix 12.2: Connectivity and Apportioning
Collision Risk Modelling	Offshore EIAR (Volume 3) Technical Appendix 12.3: Collision Risk Modelling
Displacement Analysis	Offshore EIAR (Volume 3) Technical Appendix 12.4: Displacement Analysis
Population Modelling	Offshore EIAR (Volume 3) Technical Appendix 12.5: Population Modelling
Consultation Advice	Offshore EIAR (Volume 3) Technical Appendix 12.6: Consultation Advice
Report to Inform the Appropriate Assessment	Separate report included as part of the application

Details of study	Locations of supporting studies
2015 Survey Report	Available on request of Marine Scotland
2020 / 21 Survey Report	Available on request of Marine Scotland
Apportioning spreadsheets	Available on request of Marine Scotland
Band (2012) collision risk modelling spreadsheets	Available on request of Marine Scotland
SeabORD model outputs	Available on request of Marine Scotland
Population viability analysis output spreadsheets / plots	Available on request of Marine Scotland

12.2 Legislation, Policy and Guidance

The following relevant legislation, policies and guidance relating to Marine Ornithology were used in preparing this chapter:

12.2.1 Legislation

Relevant legislation has been reviewed and taken into account as part of this assessment. Of particular relevance is:

- EU Habitats Directive (Directive 92/43/EEC) on the Conservation of Natural Habitats and of Wild Fauna and Flora;
- EU Birds Directive (Council Directive 2009/147/EC) on the Conservation of Wild Birds;
- Conservation of European Wildlife and Natural Habitats Convention (Bern convention);
- Conservation (Natural Habitats, etc.) Regulations 1994 (as amended);
- The Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations) implements species protection requirements of the Habitats Directive in inshore waters;
- Marine (Scotland) Act 2010;
- UK Post-2010 Biodiversity Framework, superseding the UK Biodiversity Action Plan (UKBAP), the UK Government’s response to the Convention on Biological Diversity (CBD) 1992; and
- The Wildlife and Countryside Act 1981 (as amended).

12.2.2 Policy

- The European Biodiversity Strategy for 2020 aiming to stop the loss of biodiversity and ecosystem services in the EU;
- The United Nations’ (UN) Convention on Biological Diversity; including the 'Aichi' biodiversity targets;
- The Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention);
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention);
- ‘Scotland’s Biodiversity: It’s in Your Hands’ together with ‘2020 Challenge for Scotland’s Biodiversity’ together comprise the Scottish Biodiversity Strategy; and

- Scotland National Marine Plan:
    - Renewables 5: Renewable energy projects must demonstrate compliance with EIA and HRA legislative requirements.
    - Renewables 6: Cable and network owners and marine users should ensure a co-ordinated and strategic approach to development and activities to minimise impacts on the marine natural environment.
    - Renewables 9: Marine planners and decision makers should support the development of joint research and monitoring programmes for offshore wind and marine renewables energy development.

12.2.3 Guidance

This offshore ornithological impact assessment adopts the good practice guidance set out in the documents below:

- Band (2012): Guidance on using a collision risk model to estimate bird collisions for offshore wind farm developments;
- CIEEM (2018): Guidelines on the approach to EIA, recommends that conservation value is taken into account for ecological receptors;
- Furness *et al.* (2013): Analysis of seabird sensitivity to offshore wind farm developments;
- Furness (2015): Report on Biologically Defined Minimum Population Scales (BDMPS), used to define non-breeding season populations;
- NatureScot (2018): Interim guidance on apportioning impacts from marine renewable developments to breeding seabird populations in Special Protection Areas (SPAs);
- NatureScot (2020a): The effect of aviation obstruction lighting on birds at wind turbines, communication towers and other structures;
- NatureScot (2020b): Guidance on seasonal periods for birds in the Scottish marine environment, used to define breeding seasons for the species of concern in assessment;
- Searle *et al*. (2014; 2018): Guidance on use of SeabORD for displacement modelling;
- Searle *et al*. (2019): Natural England guidance on population modelling;
- SNCB (2014): Advice note from the joint Statutory Nature Conservation Bodies (SNCBs) on avoidance rates to use in collision risk modelling;
- SNCB (2017): Advice note from the joint Statutory Nature Conservation Bodies (SNCBs) on undertaking displacement assessment. Used to consider the risk that birds will be displaced from an operational wind farm development and to estimate the mortality that may arise as a result; and
- Woodward *et al*. (2019): Defines the seabird foraging ranges used for screening designated sites into apportioning calculations.

12.3 Scoping and Consultation

Scoping and consultation have been ongoing throughout the EIA process and have played an important role in ensuring the scope of the baseline characterisation and impact assessment are appropriate with respect to the Offshore Development and the requirements of the regulators and their advisors.

The Offshore EIAR (Volume 3) Technical Appendix 12.6: Consultation Advice provides the full consultation log capturing all the pre-application advice provided in the Scoping Opinion (MS-LOT, 2021), Scoping Opinion Addendum (MS-LOT, 2022) and other relevant consultations in relation to Marine Ornithology. Technical Appendix 12.6 sets out how and where the advice is addressed in this EIAR and in the RIAA.

12.4 Baseline Characterisation

Baseline characterisation is informed by two years of digital aerial survey work (see Section 12.4.3) as well as available literature (see Section 12.4.2). The baseline description is presented in Section 12.4.4 and discusses those species either recorded within the Ornithology Survey Area (as defined below) during the digital aerial survey work or otherwise thought to potentially occur, as advised in the Scoping Opinion (MS-LOT, 2021).

12.4.1 Study Area

The focus of the impact assessment is the potential impacts on Marine Ornithology receptors using the Offshore Development and adjacent waters.

There is variation in species' behaviour and the range over which their populations can be found. During the breeding season, birds are central-placed foragers, they breed at colonies onshore in coastal locations (usually cliffs) and forage at sea. Woodward *et al.* (2019) defines these foraging ranges for each relevant species for use in assessment. During the non-breeding season, seabirds are no longer tied to their colonies and disperse and mix over a much larger geographic scale. Furness (2015) defines these Biologically Defined Minimum Scales (BDMPS) for each relevant species for use in assessment. Potential impacts have therefore been set in the context of a wider study area (see Section 12.4.1) based on seabird foraging ranges during the breeding season and on their wider dispersal during the non-breeding season.

The study area therefore comprises the following areas relevant to the ornithological impact assessment:

- Offshore Development: All offshore components of the Project (Wind Turbine Generators (WTGs), inter-array and Offshore Export Cable(s), floating substructures, and all other associated offshore infrastructure) required during operation of the Project;
- PFOWF Array Area: The area where the WTGs will be located within the Offshore Site;
- Offshore Site; The area encompassing the PFOWF Array Area and the Offshore Export Cable Corridor (OECC); and
- Ornithology Survey Area: The digital aerial surveys for seabird and diver species encompassed the PFOWF Array Area and specified buffer (originally 2 km then extended to 4 km). The survey areas are shown in Figure 12.1 below and Figure 1 in the Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data.

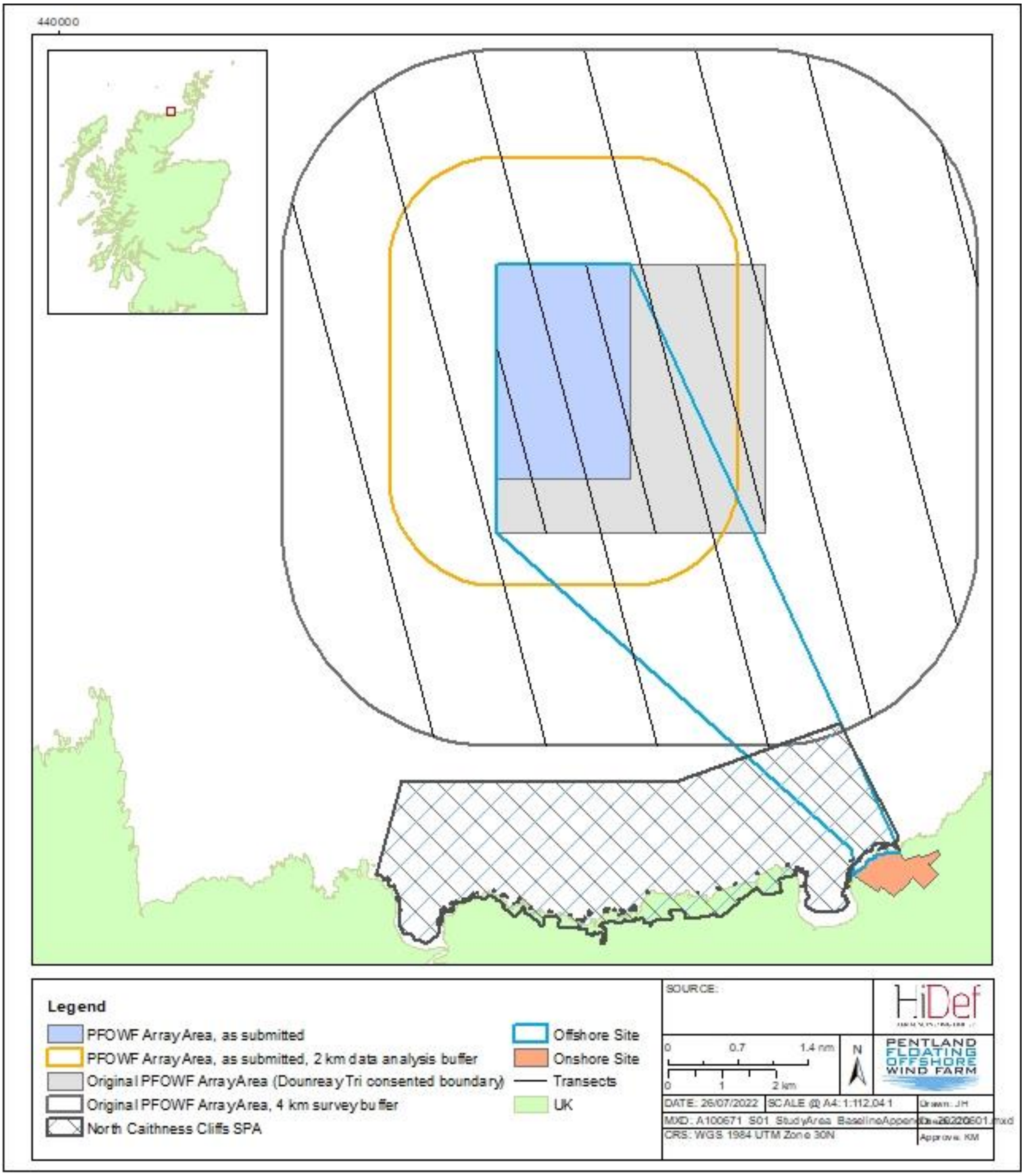

Figure 12.1 PFOWF Array Area, as submitted, with 2 km buffer; including original ornithology survey design and transects (North Caithness Cliffs SPA presented for reference)

12.4.2 Sources of Information

A review was undertaken of the literature and data relevant to this assessment of Marine Ornithology and was used to provide an overview of the existing environment. The primary data sources used in the preparation of this chapter are listed below in Table 12.2.

Table 12.2 Summary of key sources of information pertaining to Marine Ornithology

Title	Source	Year	Author
Seabird Monitoring Programme Database	https://app.bto.org/seabirds/public/index.jsp	current	Joint Nature Conservation Committee (JNCC)
Birds of Scotland	https://www.the-soc.org.uk/about-us/publications/birds-of-scotland	2007	Scottish Ornithologists Club (SOC)
SPA citations and conservation objectives	https://sitelink.nature.scot/home	various	NatureScot
Report on 'Biologically Defined Minimum Population Scales' (BDMPS)	publications.naturalengland.org.uk/publication/6427568802627584	2015	Natural England
Moray West offshore windfarm application and decision	marine.gov.scot/ml/moray-west-offshore-windfarm	2019	Marine Scotland
Moray East offshore wind farm application and decision	marine.gov.scot/ml/moray-east-offshore-wind farm	2014	Marine Scotland
Beatrice offshore wind farm application and decision	marine.gov.scot/ml/beatrice-offshore-wind farm	2014	Marine Scotland
Hywind Scotland offshore wind farm application and decision	marine.gov.scot/ml/hywind-scotland-pilot-park	2015	Marine Scotland
Kincardine floating offshore windfarm application and decision	marine.gov.scot/ml/kincardine-offshore-wind farm-0	2016	Marine Scotland
European Offshore Wind Deployment Centre (EOWDC)	marine.gov.scot/ml/european-offshore-wind-deployment-centre	2014	Marine Scotland
Seagreen offshore wind farm (optimised project) application and decision	marine.gov.scot/ml/seagreen-alpha-and-bravo-offshore-wind-farms	2018	Marine Scotland
Inch Cape offshore wind farm (revised design) application and decision	marine.gov.scot/ml/inch-cape-offshore-wind farm-revised-design	2021	Marine Scotland

Title	Source	Year	Author
Neart na Gaoithe offshore wind farm (revised design) application and decision	marine.gov.scot/ml/neart-na-gaoithe-offshore-wind-farm-revised-design	2019	Marine Scotland
Hornsea project three offshore wind farm application and decision	https://infrastructure.planninginspectorate.gov.uk/projects/eastern/hornsea-project-three-offshore-wind-farm/	2020	Planning Inspectorate
Hornsea project four offshore wind farm application	https://infrastructure.planninginspectorate.gov.uk/projects/yorkshire-and-the-humber/hornsea-project-four-offshore-wind-farm/	current	Planning Inspectorate

12.4.3 Site-Specific Surveys

In January 2015 and September 2020, HiDef were commissioned to undertake a programme of high-resolution digital video aerial surveys of marine megafauna and ornithological activity to support the previously consented Dounreay Tri Floating Wind demonstration Project ('the Dounreay Tri Project') and the current proposal for the Offshore Development.

In total there are 25 surveys available to inform the baseline characterisation for the Offshore Development: a total of 13 surveys in each month between January and December 2015, and 12 monthly surveys between September 2020 and August 2021. Following receipt of the Scoping Opinion, it was agreed with MS-LOT (in their email sent 24th November 2021) that this survey effort would comprise sufficient baseline for the assessment.

As discussed further in the Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data, these surveys focused on the seabird (and other marine fauna) interests and provided coverage of the PFOWF Array Area and specified buffer, as discussed below, to provide a representative sample of activity to characterise baseline conditions.

Figure 12.1 shows the area surveyed and survey transects; spaced at 1 km in the Original PFOWF Array Area and at 2 km in the specified buffers. Whilst a 2 km buffer area was agreed for the Dounreay Tri Project and originally agreed for the Offshore Development, NatureScot (NS) and Royal Society for the Protection of Birds (RSPB) Scotland provided updated advice in response to the Applicant's Scoping Report (HWL, 2020) and requested a 4 km buffer be used for subsequent surveys. Therefore, during the January-December 2015 surveys, a 2 km buffer was used; this was also used for the surveys between September 2020 and March 2021, and then extended to 4 km between April and August 2021 following receipt of the updated advice. Figure 12.1 shows the 4 km survey buffer as applied to the Original PFOWF Array Area, whereas the 2 km buffer shown is that used in the data analysis for the revised and reduced PFOWF Array Area as submitted with this application.

The reduced PFOWF Array Area (see Figure 12.1) now measures 10 km^2 compared to the original area surveyed (25 km^2 for each of the Dounreay Tri Project and the Original PFOWF Array Area). In carrying out the data reanalysis, HiDef checked that there was still sufficient sampling effort and survey coverage for the revised and reduced PFOWF Array Area, as there were fewer and shorter transect lengths being analysed. This confirmed that ~50% coverage has been achieved for the reduced PFOWF Array Area and ~20% in the revised buffer, significantly more coverage than the generally accepted minimum of 10% in both cases.

Transects had a north-west / south-east orientation, principally so that they were perpendicular to the depth contours along the coast, thus helping to reduce variation in bird and mammal abundance between transects.

Details of the digital video aerial survey method, analysis of video footage and pooling of 2015 and 2020/21 data are presented in the Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. In summary, the digital aerial surveys were undertaken using HiDef's Gen II four camera rigs with sensors set to a resolution of 2 cm ground sample distance when flown at ~550 m above sea level.

Each camera sampled a strip of ~125 m width, separated from the next camera by approximately 25 m, which provides a combined sampled width of 500 m within a 575 m overall strip. A minimum sample coverage of 32% of the survey area was achieved.

Data analysis followed a two-stage process in which video footage was reviewed (with a 20% random sample used for audit) then the detected objects were identified to species or species group level (again with 20% selected at random for audit). The audit of both stages requires 90% agreement to be achieved.

Design-based strip transect analyses were used to calculate the density, total estimated population, upper and lower 95% confidence limits, standard deviation and co-efficient of variation for each species and are presented in the Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. Summaries of survey results and of data in the 2 km – 4 km buffer area are also provided in Annex 1 of the appendix. Further information on the original data analysis for each year's survey work (2015 and 2020/2021 respectively) is included in the HiDef survey reports (Table 12.1).

12.4.4 Baseline Description

The following baseline description has been informed by the available guidance listed in Section 12.2, sources of information listed in Section 12.4.2 and the digital video aerial survey work described in Section 12.4.3 and analysed in the Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data.

Several different seabird species were recorded within the Ornithology Survey Area during the 2015 and 2020/21 digital aerial survey work. These will be birds using the area for foraging, resting or other maintenance activities (such as preening) or birds that are transiting the area enroute to other locations. As well as seabirds, there were a few intermittent records of other species including red-throated diver. These are detailed in Tables 5-8 of the Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data.

As discussed in more detail in each of the following species accounts, the species scoped into assessment are:

- Black-legged kittiwake (*Rissa tridactyla*), hereafter 'kittiwake';
- Common guillemot (*Uria aalge*), hereafter 'guillemot';
- Razorbill (*Alca torda*);
- Atlantic puffin (*Fratercula arctica*), hereafter 'puffin';
- Northern fulmar (*Fulmarus glacialis*), hereafter 'fulmar';
- Northern gannet (*Morus bassanus*), hereafter 'gannet';
- Arctic tern (*Sterna paradisaea*);
- Great black-backed gull (*Larus marinus*);
- Great skua (*Stercorarius skua*);
- Herring gull (*Larus argentatus*);
- Red-throated diver (*Gavia stellata*);
- Petrels and shearwaters; and
- Wildfowl and waders.

The species accounts below (see Section 12.4.4.1 – Section 12.4.4.10) focus on the seabirds recorded during digital aerial survey work undertaken for the Offshore Development. Red-throated divers were recorded in minimal numbers during this survey work as discussed in Section 12.4.4.11. Petrel and shearwater species were not recorded during survey work but the potential for their occurrence is discussed in Section 12.4.4.12. Wildfowl and waders may also traverse the area on migration, as discussed in Section 12.4.4.13.

During the breeding season, seabirds are central-placed foragers travelling out from their coastal, onshore breeding colonies to search for prey at sea, to feed themselves and to provision their chicks. The individuals which have been recorded at sea within the PFOWF Array Area have come from several different colonies within foraging range, primarily SPAs. These SPAs have 'connectivity' with the Offshore Development based on species-specific foraging ranges as listed in the Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. Foraging ranges are defined by Woodward *et al*. (2019) as noted in Section 12.2 above.

Apportioning during the breeding season is the process used to determine the proportion of birds recorded within the PFOWF Array Area coming from each breeding colony within foraging range, as further discussed in the Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. The apportioning outputs for each species are summarised in the species accounts below and fully presented in the Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. Almost all the colonies in question are designated as SPAs meaning that predicted effects need to be considered under HRA as well as EIA, as reported in the RIAA.

In the non-breeding season seabirds disperse away from their nesting colonies and travel over much greater distances as described in Furness (2015), the report on 'Biologically Defined Minimum Population Scales' (BDMPS).

Finally, baseline characterisation of the Offshore Export Cable Corridor (OECC) is considered in Section 12.4.4.14.

12.4.4.1 Kittiwake

Kittiwakes are a small gull species with a distinctive call and a strictly coastal distribution. They are currently the most numerous species of gull in the world, distributed across the Arctic and subarctic regions, with more than 50% of the global population found in Europe. In the United Kingdom (UK), a large proportion of their breeding colonies are found in Scotland where the birds nest on clifftops and rock ledges. Outwith the breeding season, they disperse widely at sea, their movements dependent on food availability.

In December 2017, kittiwake was added to the International Union for Conservation of Nature (IUCN) red list, as its global population has declined by over 40% since the 1970s (RSPB, 2018). It has been moved from 'least concern' to 'vulnerable' with the main drivers of population decline considered to be climate change and fisheries impacts on prey species (IUCN, 2018). In this regard, the UK population has also been declining, largely driven by the declines at Scottish colonies as discussed further below. Kittiwakes are red listed as a Bird of Conservation Concern, included on the OSPAR list of Threatened and/or Declining Species and listed on the EC Birds Directive as a migratory species (Eaton *et al.,* 2015; JNCC, 2021a).

Kittiwakes have a relatively large breeding season foraging range, as recorded in Woodward *et al.* (2019) (mean max 156.1 km ±144.5 SD); Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. Table 12.3 collates the key SPAs for kittiwake within foraging range of the PFOWF Array Area. Of these SPAs, most impacts are to be apportioned against North Caithness Cliffs; unsurprising as it is the closest SPA to the PFOWF Array Area. Here, kittiwakes have been declining since SPA designation in 1996 (a citation population of 13,100 Apparently Occupied Nests [AON]) and this baseline scenario has been further explored through the population modelling undertaken for the Offshore Development.

Table 12.3 Key kittiwake SPAs within foraging range of the PFOWF Array Area

SPA	Impact weighting	Most recent population count	Units	Date of count
North Caithness Cliffs	0.717	5,573	AON	2015/2016
East Caithness Cliffs	0.080	24,460	AON	2015
West Westray	0.063	2,755	AON	2017
Cape Wrath	0.025	3,622	AON	2017
Marwick Head	0.025	906	AON	2018

In colonies found around Shetland, Orkney and along the north Caithness coast, over 90% of the kittiwakes' diet is thought to comprise sandeels (*Ammodytes marinus*, Raitt) (Furness & Tasker, 2000). There is an ongoing decline in sandeel abundance in the North Sea which shows a strong regional pattern with the greatest decreases in the north, off Shetland and southern Norway (Heath *et al.,* 2009; Frederiksen *et al.,* 2013; MacDonald *et al.,* 2019a, 2019b; Olin *et al.,* 2020). It is this reduction in sandeels as available prey which appears to be driving the kittiwake population declines in this region, including the 25-year decline recorded at North Caithness Cliffs SPA (Swann, 2018; Marine Scotland, 2020).

Sandeels are affected by climate change and warming sea temperatures are changing their phenology (the timings of their life-cycle) as well as the phenology of their prey. This is causing a 'trophic mismatch' – a poor synchrony between the timing of hatching of sandeel larvae and that of their zooplankton (copepod) prey – resulting in increasingly low recruitment to the adult age-class (Wright & Bailey, 1996; Régnier *et al.,* 2017). This impact is anticipated to increase further, and sandeel populations are likely to further decline, as climate change intensifies (Marine Scotland, 2018).

In the non-breeding season, kittiwake numbers in UK waters are not well known, and apparently vary considerably, perhaps in relation to food supply and weather conditions (Furness, 2015). Kittiwakes disperse widely from their SPA breeding colonies and these birds mix thoroughly with the broader UK population and with birds from overseas (Furness, 2015). According to Figure 15.10 in Furness (2015), the Offshore Development is located in the 'UK North Sea waters' BDMPS, which has an estimated kittiwake population of 829,937 birds during the autumn migration (August-December) and 627,816 birds during the spring migration (January-April).

As recorded by the digital aerial survey work, the abundance of kittiwake in the PFOWF Array Area fluctuated throughout 2015 and 2020/21 with greater abundance during the breeding season and lower abundance during the non-breeding period, including some periods of absence. During the breeding season, a peak population of 134 birds (95% CI 105 – 170) was estimated for June 2021, whilst a peak population of 14 birds (95% CI 6 – 25) was estimated for March 2021 during spring migration, and a peak population of 39 birds (95% CI 12 – 60) estimated for November 2015 during autumn migration; Table 9 and Table 10 in the Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data.

Kittiwakes are scoped in for assessment in relation to potential collision risk with operational WTGs, based on the advice provided in Furness *et al.* (2013). The potential impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling and further considered in Section 12.6 and in the RIAA. Furness *et al.* (2013) suggest that they are not so sensitive to displacement or barrier effects, however, they have also been scoped in for this impact based on the advice in the Scoping Opinion (MS-LOT, 2021). Kittiwake displacement impacts are modelled and discussed in the Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis and assessed in Section 12.6 and in the RIAA.

12.4.4.2 Guillemot

Guillemots are one of the most numerous seabird species recorded at sea around the UK's coasts. They come to land only to nest and the rest of the time are found at sea. After breeding and chick-fledging, the species becomes flightless for an extended period during July and August when the male parent accompanies its chick out to sea. Guillemots are of high conservation status in Scotland; amber listed as a Bird of Conservation Concern and listed in the EC Birds Directive as a migratory species (Eaton *et al.,* 2015; JNCC, 2021b).

Monitoring of guillemot diet has been carried out by the Centre for Ecology and Hydrology (CEH) on the east coast of Scotland at East Caithness Cliffs SPA, Buchan Ness to Collieston Coast SPA and Isle of May SPA with most recent data available for the 2019 breeding season (Andrews *et al.,* 2020). These data indicate that the majority of prey for guillemot in this region are sandeels or clupeids (the latter comprise sprat and herring).

In the PFOWF Array Area, guillemots were the most abundant bird species, present in all months with a peak population estimate of 217 birds (95% CI 75 – 417) in August 2021 (during the breeding season) and 201 birds (95% CI 166 – 223) in September 2020 (during the non-breeding season); Table 15 and Table 16 in the Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. This accounted for the overlap in seasons between NatureScot (2020b) and Furness (2015) guidance, where the peak population estimate recorded on 13th August 2021 was assigned to the breeding season, and the estimate for 24 September 2020 was taken as the peak for the non-breeding season.

Guillemots have a relatively small breeding season foraging range of mean max 73.2 km ±80.5 SD (Woodward *et al.,* 2019); Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. Table 12.4 collates the key SPAs for guillemot within foraging range of the PFOWF Array Area. Of these SPAs, most impacts are to be apportioned against North Caithness Cliffs; unsurprising as it is the closest SPA to the PFOWF Array Area.

In the non-breeding season, NatureScot have advised that impacts are considered against a regional population comprising of all the SPAs listed in Table 12.4 and using the total population estimates, including immatures and juveniles, presented in Table 62 (p374-375), Appendix A of Furness (2015), the BDMPS report. This gives a non-breeding reference population of 848,710 birds, as discussed in the Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning.

Guillemots are scoped in for assessment in relation to potential displacement with operational WTGs, based on the advice provided in Furness *et al.* (2013). The impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis and further considered in Section 12.6 and in the RIAA. Furness *et al.* (2013) consider that they are not particularly sensitive to collision risk with WTG blades as they do not fly high enough, with only 1% flying at blade height, and they have therefore not been scoped in for this impact.

Table 12.4 Key guillemot SPAs within foraging range of the PFOWF Array Area

SPA	Impact weighting	Most recent population count	Units	Date of count
North Caithness Cliffs	0.695	38,898	Individuals	2015/2016
Hoy	0.056	12,198	Individuals	2017
Marwick Head	0.045	11,985	Individuals	2018
East Caithness Cliffs	0.041	148,805	Individuals	2015
Sule Skerry and Sule Stack	0.040	10,068	Individuals	2018
Handa	0.034	54,664	Individuals	2018
West Westray	0.021	28,697	Individuals	2017
Cape Wrath	0.017	38,109	Individuals	2017

12.4.4.3 Razorbill

Razorbills breed commonly around the UK and occur widely at sea where they can sometimes occur in dense concentrations along with guillemots. In UK waters, the species is most abundant during the summer and autumn months and disperses (mainly southwards) during the winter. Like guillemots, the species becomes flightless for an extended period during July and August when the male parent accompanies its chick out to sea. Razorbills are of high conservation status in the UK and are amber listed as a Bird of Conservation Concern and listed on the EC Birds Directive as a migratory species (Eaton *et al.,* 2015; JNCC, 2021c).

Monitoring of razorbill diet has been carried out by CEH on the east coast of Scotland at East Caithness Cliffs SPA, Buchan Ness to Collieston Coast SPA and Isle of May SPA with most recent data available for the 2019 breeding season (Andrews *et al.,* 2020). These data indicate that the majority of prey for razorbill in this region are sandeels or clupeids (the latter comprise sprat and herring).

Over 2015 and 2020/21, the digital aerial survey work recorded a generally low presence of razorbill with some exceptional peak counts; Table 19 and Table 20, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. During the breeding season, the peak population estimate in the PFOWF Array Area is 40 birds (95% CI 13 – 73) in June 2021; Table 19, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. In the non-breeding season, there are two BDMPS periods defined by Furness (2015): migration (Aug-Oct and Jan-Mar) and winter (Nov-Dec). The peak population estimates for each were 10 birds (95% CI 5 – 15) in

August 2021 and four birds (95% CI 0 – 7) in November 2015; Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning.

Like guillemots, razorbills have a relatively small breeding season foraging range as recorded in Woodward *et al.* (2019) (mean max 88.7 km ±75.9 SD); Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. Table 12.5 collates the list of key SPAs for razorbill within foraging range of the PFOWF Array Area.

Furness (2015) defines two non-breeding populations for razorbill: a migration BDMPS (August-October and January-March) and a winter BDMPS (November-December). The PFOWF Array Area is located at the rough boundary between east and west BDMPS and for the purposes of assessment has been determined to fall within the 'UK North Sea and Channel' BDMPS as this holds the majority of birds (95% of adults and 90% of immatures) from colonies in north Caithness (see Section 22.10 and Figure 22.8 in Furness, 2015). In this identified BDMPS, the figures for each non-breeding population are: 591,874 razorbill during migration and 218,622 razorbill over winter.

Razorbills are scoped in for assessment in relation to potential displacement with operational WTGs, based on the advice provided in Furness *et al.* (2013). The impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis and further considered in Section 12.6 and in the RIAA. Furness *et al.* (2013) consider that they are not particularly sensitive to collision risk with WTG blades as they do not fly high enough, with only 1% flying at blade height, and they have therefore not been scoped in for this potential impact.

Table 12.5 Key razorbill SPAs within foraging range of the PFOWF Array Area

SPA	Impact weighting	Most recent population count	Units	Date of count
North Caithness Cliffs	0.357	3,609	Individuals	2015/2016
East Caithness Cliffs	0.162	30,003	Individuals	2015
Handa	0.159	8,207	Individuals	2019
West Westray	0.153	2,159	Individuals	2017
Cape Wrath	0.029	3,246	Individuals	2017

12.4.4.4 Puffin

Puffins are one of the UK's most-recognised seabirds with their bright coloured bills. They are burrow-nesting seabirds so are very vulnerable to terrestrial predators such as rats. As a result, they usually breed on offshore islands and steep coastal cliffs, and such is the case in Scotland. Puffins are migratory; in Scottish waters they are most abundant during the spring and summer months and then disperse (mainly in the North Sea) during the winter. They are of high conservation status in the UK; red listed as a Bird of Conservation Concern and listed on the EC Birds Directive as a migratory species (Eaton *et al.,* 2015; JNCC, 2021d).

Puffins commonly feed on sandeel, but will also hunt for sprat, herring and a wide range of small juvenile gadoid fish. Fish are caught, usually several at a time, by underwater pursuit (Mitchell *et al*., 2004).

In the PFOWF Array Area, puffins were recorded in highest numbers between May and August for both survey years, with a peak population estimate of 419 birds (95% CI 325 - 542) in June 2015 and 2,003 birds (95% CI 1,454 – 2,401) in June 2021. Few to no birds were recorded during the non-breeding season; Table 23 and Table 24, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. There is an overlap in seasons between NatureScot (2020b) and Furness (2015) guidance therefore, August counts (5th August 2015 and 13th August 2021) were assigned to the breeding season.

During the breeding season, puffin have a relatively large breeding season foraging range as recorded in Woodward *et al.* (2019) (mean max 137.18 km ±128.3 SD); Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. Table 12.6 collates the key SPAs for puffin within foraging range of the

PFOWF Array Area. BDMPS puffin populations have not been presented in this baseline due to their minimal occurrence in the non-breeding season (and therefore negligible potential impacts).

Puffins are scoped in for assessment in relation to potential displacement with operational WTGs, based on the advice provided in Furness *et al.* (2013). The impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis and further considered in Section 12.6 and in the RIAA. Furness *et al.* (2013) consider that they are not particularly sensitive to collision risk with WTG blades as they do not fly high enough, with only 1% flying at blade height, and they have therefore not been scoped in for this potential impact.

Table 12.6 Key puffin SPAs within foraging range of the PFOWF Array Area

SPA	Impact weighting	Most recent population count	Units	Date of count
North Caithness Cliffs	0.698	3,053	Individuals	2015/2016
Sule Skerry and Sule Stack	0.282	95,484	Individuals	2018

12.4.4.5 Fulmar

Fulmars are essentially a northern species, breeding on steep cliffs around the Atlantic Ocean and North Sea, from northern Greenland and as far south as northern France. They are a colonial breeder and nest on narrow ledges or in hollows, on or near the coast. They are a long-lived species and may live for more than half a century. They are of high conservation value, amber listed as a Bird of Conservation Concern (Eaton *et al.*, 2015; JNCC, 2021e). They have an endangered status in Europe and more UK colonies are showing a downwards trend than an increasing one (Seabirds Count, 2015-2019[i]).

Fulmars have a very large foraging range, as recorded in Woodward *et al.* (2019) (mean max 542.3 km ±657.9 SD); Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. Table 12.7 collates the key SPAs for fulmar within foraging range of the PFOWF Array Area.

In the PFOWF Array Area, the numbers of fulmar fluctuated throughout the year with the peak counts recorded during the breeding season; Table 27 and Table 28, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. During this time, the peak population estimate was 59 birds (95% CI 38 – 78) recorded in April 2015. In the non-breeding season, the peak population estimate was 9 birds (95% CI 0 – 16) in November 2015, with a peak of 13 birds (95% CI 3 – 25) and 27 birds (95% CI 10 – 49) for each of the autumn and spring migration seasons in September 2020 and January 2021 respectively; Table 27 and Table 28, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data.

Furness (2015) notes that breeding fulmars from Scotland may make foraging trips as far as the mid-Atlantic ridge, and that non-breeding birds may disperse over thousands of kilometres. It may therefore make more sense to consider all UK waters as a single BDMPS for fulmar, rather than try to subdivide into regional populations. Two non-breeding seasons are defined: migration (September-October and December-March) and winter (November-December). Total numbers estimated in UK waters for each period are 1,785,696 birds and 1,125,103 birds respectively (Furness, 2015).

Based on the advice provided by Furness *et al.* (2013), fulmars are not considered at risk to potential collision or displacement with operational WTGs. However, in the absence of any confirmation that they could be excluded from the assessment during pre-application consultation, they have been scoped into the assessment as a precaution. Potential impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling and Technical Appendix 12.4: Displacement Analysis respectively, which have informed the consideration given in Section 12.6 and in the RIAA.

[i] https://jncc.gov.uk/news/seabirds-count/

Table 12.7 Key fulmar SPAs within foraging range of the PFOWF Array Area

SPA	Impact weighting	Most recent population count	Units	Date of count
North Caithness Cliffs	0.890	13,405	AOS*	2015/2016
Hoy	0.088	21,101	AOS	2016/2017/2019

**Apparently Occupied Sites*

12.4.4.6 Gannet

Gannets are endemic to the North Atlantic and most breed in Britain and Ireland, with 21 gannetries in this area, mainly on small, remote islands and two on mainland cliffs. Some colonies have been occupied for centuries and are large and conspicuous. Gannets are of high conservation value, amber listed as a Bird of Conservation Concern and listed on the EC Birds Directive as a migratory species (Eaton *et al.,* 2015; JNCC, 2021f).

Gannets often perform dramatic plunge dives from high in the sky to catch fish at depths of up to 20 m. They are also known to scavenge and will feed on the discards from fishing vessels, where their large size helps them out-compete other scavenging species. In this regard, gannet have a very wide foraging range as recorded in Woodward *et al.* (2019) (mean max 315.2 km ±194.2 SD); Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. Table 12.8 collates the key SPAs for gannet within foraging range of the PFOWF Array Area.

In the PFOWF Array Area, gannets were recorded in relatively low numbers each year with a peak population estimate of 44 birds (95% CI 0 – 71) late in the breeding season (September 2020); Tables 32 and 33 in Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. Again, there is overlap between the breeding seasons advised in NatureScot (2020b) and in Furness (2015); in this regard the September counts were assigned to the breeding season, leaving a peak count of 9 birds (95% CI 7 – 10) during the autumn migration, recorded in October 2020.

According to Furness (2015), there are two non-breeding periods for gannet for which populations have been defined: autumn migration (September-November) and spring migration (December-March). In respect of its BDMPS, the PFOWF Array Area appears to lie within 'UK western waters'; it is difficult to determine this from Figure 7.7 in Furness (2015) but Sule Skerry and Sule Stack, St Kilda, North Rona and Sula Sgeir SPAs to which most gannet recorded on-site are apportioned (Table 12.8), all contribute more birds to this BDMPS than to the one for 'UK North Sea & Channel waters' (compare the respective proportions in Tables 14 and 15 of Appendix A *Contributions of individual SPA populations and of UK non-SPA populations and overseas populations to each BDMPS*; Furness, 2015). For the UK western waters' BDMPS, the estimated gannet populations are 545,954 birds during autumn migration and 661,888 during spring (Furness, 2015).

Gannets are scoped in for assessment in relation to potential collision risk with operational WTGs, based on the advice provided in Furness *et al.* (2013). The potential impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling and further considered in Section 12.6 and in the RIAA. Whilst previously considered to be of low sensitivity to displacement, there does now seem to be increasing evidence (from post-construction monitoring) that they are avoiding wind farms; as advised by Marine Scotland Science (MSS) and NS in the Scoping Opinion (MS-LOT, 2021), they have also been scoped in for this potential impact. Gannet displacement impacts are modelled and discussed in the Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis and are assessed in Section 12.6 and in the RIAA.

Table 12.8 Key gannet SPAs within foraging range of the PFOWF Array Area

SPA	Impact weighting	Most recent population count	Units	Date of count
Sule Skerry and Sule Stack	0.527	9,065	AON/AOS	2013/2018
Forth Islands	0.111	75,259	AOS	2014

SPA	Impact weighting	Most recent population count	Units	Date of count
St Kilda	0.105	60,290	AOS	2015
North Rona and Sula Sgeir	0.102	11,230	AOS	2013
Hermaness, Saxa Vord and Valla Field	0.041	25,580	AOS	2014
Noss	0.035	13,765	AON	2019
Troup, Pennan and Lion`s Heads (Site of Special Scientific Interest [SSSI] feature)	0.029	4,825	AON	2019
Fair Isle	0.011	4,971	AON	2021

12.4.4.7 Arctic tern

Although Arctic terns are the commonest terns breeding in the UK, their numbers are low due to sandeel declines in the North Sea (Vigfusdottir *et al.,* 2013; Perkins *et al.,* 2018). Arctic tern, like the other tern species, show a low degree of site faithfulness from one year to the next. They will often move *en masse* to a new breeding location as a response to predation or habitat change. This can make them hard to census. They are currently on the amber list of the UK Birds of Conservation Concern, on the EC Birds Directive as a migratory species and on Annex I of the EU Birds Directive (2009/147/EEC) (Eaton *et al.,* 2015; JNCC, 2021g).

Arctic terns have a small foraging range, as recorded in Woodward *et al.* (2019) (mean max 25.7 km ±14.8 SD); Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. There are no SPAs for Arctic tern within foraging range of the PFOWF Array Area, but RSPB have identified a number of non-designated breeding colonies which are: Melvich Bay, Caol Loch, Dounreay and Georgemas.

In the PFOWF Array Area, Arctic terns were recorded only during the breeding season and only seven times in total, all during 2015. The peak population estimate was 11 birds (95% CI 5 – 16) in June 2015; Tables 38 and 39, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. As there is overlap between NatureScot (2020b) and Furness (2015) guidance, this peak population estimate was assigned to the breeding season and not to autumn migration. As they were not recorded in the non-breeding season, BDMPS populations have not been presented.

Arctic terns are scoped in for assessment in relation to potential collision risk with operational WTGs, based on the advice provided in Furness *et al.* (2013). The potential impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling and further considered in Section 12.6 and in the RIAA. Furness *et al.* (2013) suggests that they are also sensitive to displacement / barrier effects, and they have therefore also been scoped in for this potential impact. Arctic tern displacement impacts are modelled and discussed in the Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis and are assessed in Section 12.6 and in the RIAA.

12.4.4.8 Great black-backed gull

Great black-backed gulls are the largest of the gull species recorded at the PFOWF Array Area. Norway holds 43% of the breeding pairs in Europe and a much smaller proportion (14%) are found in the UK. Of the UK population most are found in Scotland and are amber listed in the Birds of Conservation Concern (JNCC, 2021h).

In the PFOWF Array Area, great black-backed gulls were only recorded during the non-breeding season (September to March), and in very low numbers. The peak population estimate was of 10 birds (95% CI 9 – 10) in October 2020; Tables 43 and 44, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data.

Therefore, assessment is considered in relation to non-breeding populations only. According to Furness (2015), there is a single non-breeding season for great black-backed gull (September-March) for which the PFOWF Array Area appears to lie in the UK North Sea BDMPS (see Figure 14.8 in Furness [2015]). Great black-backed gulls in the North Sea are highly mobile over the non-breeding season and change distribution with the movement of trawl fisheries effort (Furness, 2015). The non-breeding population estimate for this BDMPS is 91,399 birds (Furness, 2015).

Great black-backed gulls are scoped in for assessment in relation to potential collision risk with operational WTGs, based on the advice provided in Furness *et al.* (2013). The potential impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling and further considered in Section 12.6 and in the RIAA. Furness *et al.* (2013) consider that they are not sensitive to displacement / barrier effects, and they have therefore not been scoped in for this impact.

12.4.4.9 Herring gull

Herring gulls are a well-known British seabird, now found inland and in cities as much as on the coast. Due to ongoing population declines, they are currently on the red list of the UK Birds of Conservation Concern, are a UKBAP priority species and are listed in the EC Birds Directive as a migratory species (Eaton *et al.,* 2015; JNCC, 2021j).

In the PFOWF Array Area, herring gulls were only recorded once over the two years of digital aerial survey work with an abundance estimate of just five birds (95% CI 2 – 7) in October 2015; Table 52 and Table 53, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data.

Therefore, assessment is considered in relation to non-breeding populations only. In this regard, Furness (2015) defines a single non-breeding season for herring gull (September-February) for which the PFOWF Array Area appears to lie in the 'UK North Sea and Channel BDMPS' (Figure 13.8 in Furness [2015]). The non-breeding population estimate for this BDMPS is 466,511 birds (Furness, 2015).

Herring gulls are scoped in for assessment in relation to potential collision risk with operational WTGs, based on the advice provided in Furness *et al.* (2013). The impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling and further considered in Section 12.6 and in the RIAA. Furness *et al.* (2013) consider that they are not so sensitive to displacement or barrier effects, and they have therefore not been scoped in for this potential impact.

12.4.4.10 Great skua

Great skuas have a very restricted breeding range; confined to the northeast Atlantic, the global population is only around 16,000 Apparently Occupied Territories (AOTs), of which 60% are in Scotland, concentrated in Shetland and Orkney (JNCC, 2021i). They are currently on the amber list of the UK Birds of Conservation Concern and on the EC Birds Directive as a migratory species (Eaton *et al.,* 2015; JNCC, 2021i).

Great skuas have a large foraging range, as recorded in Woodward *et al.* (2019) (mean max 443.3 km ±487.9 km SD) and this is considered in Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning.

Table 12.9 collates the key SPAs for great skua within foraging range of the PFOWF Array Area.

Very few great skuas were observed in the PFOWF Array Area, with none in the non-breeding period or autumn migration in either year of survey work. The maximum population estimate was of three birds (95% CI 0 – 5) in June 2015; Tables 47 and Table 48, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. As great skua were only recorded during the breeding season, no BDMPS populations are presented here.

Great skuas are scoped in for assessment in relation to potential collision risk with operational WTGs, based on the advice provided in Furness *et al.* (2013). The potential impacts are modelled in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling and further considered in Section 12.6 and in the RIAA. Furness *et al.* (2013) suggests that they are not as sensitive to displacement or barrier effects as for collision risk, however, as a precaution they have also been scoped in for this potential impact. Great skua displacement impacts are modelled and discussed in the Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis and are assessed in Section 12.6 and in the RIAA.

Table 12.9 Key great skua SPAs within foraging range of the PFOWF Array Area

SPA	Impact weighting	Most recent population count	Units	Date of count
Hoy	0.800	438	AON/AOT	2018
Foula	0.081	1,846	AOT	2015
Handa	0.049	283	AOT	2018
Fair Isle	0.025	430	AOT	2020
Hermaness, Saxa Vord and Valla Field	0.017	955	AOT	2018
Fetlar	0.015	852	AOT	2017
Noss	0.013	476	AOT	2018

12.4.4.11 Red-throated diver

Red-throated divers take their name from their bright red summer breeding plumage. In the north of Scotland, they breed during the summer in freshwater pools close to the coast, where all the UK SPAs for this species are located. During the winter, they primarily migrate southwards to inshore shallow coastal waters. Red-throated divers are currently on the green list of the UK Birds of Conservation Concern (Eaton *et al.,* 2015).

During the summer, red-throated divers are known to forage at sea, but with a small foraging range, as recorded in Woodward *et al.* (2019) (mean max 9.0 km). Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning confirms that there are no red-throated diver SPAs located within foraging range of the PFOWF Array Area, however RSPB have noted that Caithness and Sutherland Peatlands SPA does lie within 9.0 km of the OECC and it is therefore included for consideration in the RIAA.

In the PFOWF Array Area, red-throated divers were observed in very low numbers across the two years of survey: one bird in January 2021 and one bird in June 2021; Table 5 to Table 8, Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data.

According to the advice given in Furness *et al.* (2013), red-throated divers are sensitive to potential displacement or barrier effect with operational WTGs but are considered to be at low risk of collision, with only up to 5% of birds flying at blade height. Because the numbers observed at the PFOWF Array Area are so low, it has not been possible to derive a site population estimate; therefore, potential impacts cannot be quantified (displacement or collision risk) but are effectively zero as discussed in Section 12.6 and in the RIAA.

12.4.4.12 Petrels and shearwaters

HiDef's digital aerial survey work records petrel and shearwater species so that if they were occurring in the PFOWF Array Area during the time of survey then they would be recorded. However, surveys are a 'snapshot' and need to be undertaken during the day owing to light conditions. As petrel and shearwater species may be more active nocturnally and during dawn and dusk periods, their occurrence could potentially be missed due to survey timings. RSPB Scotland have asked that they be considered so they are included in Section 12.6.

In terms of baseline characterisation, RSPB advise that European storm petrel (*Hydrobates pelagicus*), hereafter 'storm petrel' could potentially forage in coastal waters at night (D'Elbée & Hémery, 1998; Thomas *et al*., 2006; Bolton, 2021). Storm petrel are the smallest species of seabird nesting in Britain and Ireland and over 80% of the population is to be found in Scotland, virtually all on remote, rocky islands. They are amber listed on the UK Birds of Conservation Concern (Eaton *et al.,* 2015).

Manx shearwater (*Puffinus puffinus*) is not specifically named in the RSPB Scotland advice but was recorded incidentally during the digital aerial survey work so are also included in Section 12.6 (Offshore EIAR (Volume 3) Technical Appendix: 12.1: Baseline Data). Most of the estimated world population (*c.* 340,000–410,000 pairs) breed in Britain and Ireland, with 40% of the UK population breeding on Rum, and 50% on the

Pembrokeshire islands of Skomer, Skokholm and Middleholm. They are amber on the UK Birds of Conservation Concern (Eaton *et al.,* 2015).

Whilst not specifically named in the RSPB advice, Leach's storm- petrel (*Hydrobates leucorhous*), hereafter 'Leach's petrel' is also included in Section 12.6 as a species that could potentially occur within the PFOWF Array Area at night. Leach's petrel is a summer migrant to coastal areas in Scotland. The largest colony on St Kilda constitutes almost 95% of the breeding British and Irish population (Mitchell *et al.,* 2004). Other, smaller colonies are scattered around the Outer Hebrides, Shetland and Orkney (Mitchell *et al.,* 2004; Forrester *et al.,* 2012). Few birds are recorded outwith the breeding season, when birds tend to be distributed in more oceanic environments beyond the continental shelf break (Stone *et al*., 1995). They are red on the UK Birds of Conservation Concern (Eaton *et al.,* 2015).

According to Furness *et al.* (2013), none of these species are assessed as being particularly sensitive to collision risk as they mostly do not fly at WTG blade height (Cook *et al.*, 2012). In this regard, storm petrels have previously been determined to fly in the lowest 10 m height band above the sea (Cramp, 1977); and Leach's petrel will have a similar behaviour. Manx shearwaters are confirmed to have a maximum flight height of 20 m, based on available tracking data and academic advice, this is also in line with Johnston *et al.,* 2014 flight heights.

None of these species are flagged as being at particular risk from offshore wind displacement impacts either (Furness *et al.,* 2013). They show little disturbance in response to ship or helicopter traffic, and they are flexible in their habitat use as evidenced by their large foraging ranges.

On this basis, the risk of impact from the Offshore Development is considered qualitatively in Section 12.6.

12.4.4.13 Wildfowl and waders

The migration pathways of wildfowl and wader species which winter in the UK have been explored and collated by the British Trust for Ornithology (BTO) (Wright *et al.,* 2012) in their report to the Strategic Ornithological Support Service (SOSS) and by the Wildfowl and Wetlands Trust (WWT) (2014) in their report to Marine Scotland (MS). In this regard, the PFOWF Array Area is located on a migration flyway for various wildfowl and wader species, particularly those migrating from Iceland. The collision risk to such species from wind farm development in Scottish waters has been strategically assessed by WWT (2014): *Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds*.

The potential risk of collision to wildfowl and wader species on migration from the Offshore Development is considered in Section 12.6.2.1. There are no other identified potential impacts from the Offshore Development that could affect these species, as set out in the Scoping Report (HWL, 2020) and confirmed in the Scoping Opinion (MS-LOT, 2021).

12.4.4.14 Offshore Export Cable Corridor

The location of the OECC is shown on Figure 12.1, connecting the PFOWF Array Area to the landfall site. From this, it can be seen that a large amount of the area has been covered by the 4 km survey buffer, so whilst the available data (March – August 2021) has not been specifically analysed for the OECC it is provided for context in Annex A3 of Offshore EIAR (Volume 3): Technical Appendix 12.1: Baseline Data. This indicates that it is the same range of seabird species present in those offshore sections of the OECC as for the PFOWF Array Area and that distribution and abundance are largely similar.

As also shown on Figure 12.1, the nearshore section of the OECC will pass through the marine area associated with the Melvich sub-site of North Caithness Cliffs SPA so that it can be assumed that the birds found nesting in the SPA will likely be using the designated area at sea for foraging and maintenance behaviours. In this regard, the digital aerial survey work does not cover this nearshore section of the OECC and instead it has been addressed by Vantage Point (VP) surveys, carried out from a VP located on Sandside Head scanning an area of sea that includes Sandside Bay as well as the OECC area (see Figure 2; Jackson, 2022). These VP surveys were undertaken twice a month from May – August 2021 and give detailed information on seabird use of this area (Jackson, 2022).

The numbers of seabirds recorded during the VP surveys were considered to be 'low or moderate' and included all of the seabird species found nesting at the SPA: kittiwake, guillemot, razorbill, puffin and fulmar (Jackson, 2022). The survey maps provided as part of this report give further detail on seabird activity and usage of this nearshore section of the OECC. As well as the SPA species recorded, the VP work confirmed minimal presence of red-throated diver (only two individuals recorded in total, both on 30th July 2021, and neither in the OECC area); greater presence of European shag (*Gulosus aristotelis*) and black guillemot (*Cepphus grille*) (see Figure 10; Jackson, 2022); and the location of the Dounreay breeding colony of Arctic tern (~20 pairs) (see Figure 9; Jackson, 2022), with their at sea distribution during VP surveys shown on Figure 11 (Jackson, 2022).

It is primarily construction impacts (installation of the Offshore Export Cable[s]), which will need to be considered in respect of these ornithological interests and which are addressed in Section 12.6.1.1. Any requirement for any remedial protection of Offshore Export Cable(s) within the SPA will also need consideration, as discussed in Section 12.6.2.6.2.

12.4.5 Future Baseline

The baseline description for Marine Ornithology has been detailed in Section 12.4.4 above. The status of breeding seabird populations and their at-sea distributions will continue to change in response to environmental and anthropogenic pressures, particularly those affecting their prey species, including climate change. Climate change and its ecosystem effects are discussed in Section 12.4.5.1, whilst this year's outbreak of avian influenza is discussed in Section 12.4.5.2. Note that the immediate effects of avian influenza are still currently being recorded and the long-term implications for populations of UK breeding seabirds are unknown and uncertain.

Therefore, due to the complex and often compounding nature of environmentally – and anthropogenically – mediated pressures on seabirds (and the other bird species scoped in for assessment), it is not possible to make accurate predictions on changes to the current baseline description for Marine Ornithology over the life-cycle of the Offshore Development.

12.4.5.1 Climate change and ecosystem effects

Climate change is leading to dramatic changes in ecosystem structure through changes in ocean temperature, water stratification and nutrient availability. This is leading to changes in the abundance and diversity of communities at all trophic levels, from primary producers to top predators. As top predators in the marine environment, seabirds are sensitive to changes to the wider ecosystem which propagate through the food chain (Lynam *et al*. 2017). In the UK, declines of 20-30% in the abundance of breeding seabirds since the early 1990s have been driven by climate change (Mitchell *et al*.2018; Mitchell *et al*. 2020).

Climate change primarily affects seabirds indirectly through changes in prey availability, diversity and quality (Lynam *et al*., 2021; Mitchell *et al*., 2020). In the North Sea, the lesser sandeel is an important prey species to seabirds such as puffin, razorbill, shag and kittiwake (Wanless *et al*, 2018). However, since 2000, climate change related factors have led to a decline in both the abundance and the nutritional quality of sandeel and other small planktivorous prey fish (e.g. sprat and herring) (Macdonald *et al*., 2015; Clausen *et al*., 2017; Wanless *et al*., 2018; MacDonald *et al*., 2019). In the North Sea, kittiwake over-winter survival has been observed to be lower following winters with a higher sea surface temperature, and breeding success reduced one year later, which is likely attributed to reduced sandeel availability and quality (Frederiksen *et al*., 2004). On the Isle of May, the energy content of sandeels is estimated to have reduced by up to 70% from 1973 to 2015 (Wanless *et al*, 2018). In the last 25 years, there has been an increase in herring and sprat in guillemot, razorbill and kittiwake diets, which may reflect the declining quality and availability of sandeel (Wanless *et al*., 2018).

Generalist seabird species that feed on a wide range of prey types will be more resilient to changing prey availability than more specialist species (Furness and Tasker, 2000). Water column feeders, such as auks, forage from the seabed (depending on water depth) to the surface and can feed on pelagic and demersal fish and invertebrates such as squid and zooplankton. Surface feeders, including kittiwake and terns, are restricted to prey available within the upper 1-2m of the surface, such as small fish, zooplankton and other invertebrates. Therefore, changes to prey distribution within the water column resulting from changes to stratification or temperature, for example, will affect surface feeding species differently to water column feeding species. Typically, species feeding within the water column are adapting better to changes in prey availability rather than those feeding at the sea surface (Mitchell *et al*., 2020). Additionally, those species with a limited foraging range may not be able to compensate and adapt to changing prey distributions (Mitchell *et al*., 2020; Sadykova *et al*., 2020; Searle *et al*., 2022).

Climate change can also directly affect seabirds through increased frequency of extreme weather. Strong wings increase energy expenditure during flying and foraging, affecting body condition (Kogure *et al.* 2016). During the breeding season, storms can chill eggs, kill nestlings, and prevent adequate foraging to feed chicks, resulting in widespread breeding failures (Frederiksen, 2008; Mitchell *et al*., 2020). Climate change contributes to mass mortality events, such as in winter 2021/22 when large numbers of auks were washed up on coasts of eastern UK and starvation was likely a contributing factor (Fullick *et al*., 2022).

Whilst the impact of climate change on avian ecosystems is clearly evident in Scottish seabird populations, the longer-term projections of the potential changes to seabird populations are not fully understood. The development of this Project, whilst having some potential (but acceptable) minor direct impacts through collision and displacement on seabirds (see Section 12.6 for impacts), will play a key role in helping tackle climate change (see Chapter 20: Climate Change and Carbon). The Project has the potential to save 132,400 tonnes (high emissions scenario) or 166,000 tonnes (low emissions scenario) of carbon dioxide equivalent and, further to this, as the project is a test and demonstrator project the technologies and learnings from this project will help expedite other floating offshore wind farm projects.

12.4.5.2 Avian influenza

Avian influenza (commonly referred to as ‘avian flu’ or ‘bird flu’) is a virus that causes disease in birds, affecting the respiratory, digestive and/or nervous system of many species. Typically, infections are from a low pathogenic viral strain which causes mild illness. However, strains can mutate from, low to high pathogenic strains, which cause severe symptoms often with high mortality rates and which may spread quickly causing an outbreak. The virus has become a disease of global significance due to poultry intensification creating conditions favourable for highly pathogenic strains, with globalisation of the poultry market creating pathways of transmission globally and increased domestic-wild bird interactions due to changing land use (Gilbert and Xiao, 2008).

In October 2021, a new strain of highly pathogenic avian flu (H5N1) was identified in the UK. Since then, 111 further locations of infection in captive birds and poultry, have been identified across the UK, and 288 separate locations of infection across wild birds of 49 species have been identified across 76 countries worldwide (DEFRA, 2022). This has been the highest recent occurrence of highly pathogenic avian flu in the UK with 90 cases of outbreak, compared with 28 in winter 2016/17 and 13 in 2020/21 (Lean *et al*., 2022). The greatest proportion of infections has been observed in Anseriformes (swans, geese and ducks) who form a natural reservoir of the virus. Charadriiformes (waders, gulls and auks) and Accipitriformes (hawks, eagles, vultures, and kites) have also observed high occurrences of the 2021/22 avian flu (DEFRA, 2022).

Avian flu cases in wild birds are continuing to increase in Scotland. As of 14th July 2022, Defra have reported 508 cases observed among 28 species and over 139 locations in Scotland, with highest cases observed in gannet, skua, geese and gull species (NatureScot, 2022a). It is estimated that as many as 64% of great skua on St Kilda and 85% on Rousay have died as of June 2022 (NatureScot, 2022b). More than 10% of the breeding adult great skua had also died at Fair Isle by the end of winter 2021/22 (Banyard *et al*., 2022). Other species, such as gannet, are also being affected, with significantly reduced numbers on Bass Rock in June 2022 and 1 in 10 dead at Hermaness, Shetland, with early estimates of up to 15-25% decline of the species (Martin, 2022).

Shortly after observing their first avian flu case on the 21st June 2022, a large die off of guillemot was reported at St Abbs Head National Nature Reserve, which included 68 chicks (Hall, 2022). The Isle of May recorded their first cases on 30th June 2022 following testing of two dead kittiwakes (Steel, 2022), with early estimates of 9,120 kittiwake mortalities, and large number of gulls and arctic tern also affected by the outbreak (Steel, *pers comm*. 19th July 2022).

In response to the rising number of cases, NatureScot announced an avian flu task force on 14th July 2022 to co-ordinate a national response to the outbreak (NatureScot, 2022a), and important islands for seabird colonies in Scotland such as Isle of May, Isle of Noss and Farne Islands have been closed to visitors.

The immediate and long-term impact of avian flu on seabird colonies is still unknown and uncertain. However, it is clear that the low levels of potential seabird mortality predicted to arise from the Offshore Development (see Section 12,6) would not likely cause additional pressures to seabird colonies on top of the impacts caused by avian flu.

12.4.6 Summary of Baseline Environment

Table 12.10 summarises the key ornithological receptors to be addressed in assessment, as described in Section 12.4.4.

Table 12.10 Key sensitive receptors within the Offshore Development

Receptor	Conservation Status and Designation(s)	Summary
Kittiwake	> Red and vulnerable list of IUCN > Red-listed as a UK Bird of Conservation Concern > Listed OSPAR threatened and/or declining species > SPA qualifying interest	> The abundance of kittiwake in the PFOWF Array Area fluctuated throughout 2015 and 2020/21 with greater abundance during the breeding season and lower abundance during the non-breeding period, including some periods of absence. > Scoped in for collision risk and displacement impacts on a precautionary basis.
Guillemot	> Amber-listed as a UK Bird of Conservation Concern > SPA qualifying interest	> In the PFOWF Array Area, guillemots were the most abundant species, present in all months, with peak population estimates in August 2021 (during the breeding season) and September 2020 (during the non-breeding season). > Scoped in for displacement impacts based on Furness *et al.* (2013).
Razorbill	> Amber-listed as a UK Bird of Conservation Concern > SPA qualifying interest	> Over 2015 and 2020/21, a general low presence of razorbill was recorded with some exceptional peak counts. During the breeding season, peak population estimates were calculated in June 2021, whilst they were calculated in August 2021 and January 2020 for the migration (Aug-Oct and Jan-Mar) and winter (Nov-Dec) periods respectively. > Scoped in for displacement impacts based on Furness *et al.* (2013).
Puffin	> Red-listed as a UK Bird of Conservation Concern > SPA qualifying interest	> In the PFOWF Array Area, puffin were recorded in highest numbers between May and August for both survey years, and few, to no birds were recorded during the non-breeding season. > Scoped in for displacement impacts based on Furness *et al.* (2013).
Fulmar	> Amber-listed as a UK Bird of Conservation Concern > Endangered status in Europe > SPA qualifying interest	> In the PFOWF Array Area, the numbers of fulmar fluctuated throughout the year with the peak counts recorded in January 2021, during spring migration. In the breeding season, the peak population estimates were calculated in April 2015.

Receptor	Conservation Status and Designation(s)	Summary
		> Scoped in for collision risk and displacement impacts on a precautionary basis.
Gannet	> Amber-listed as a UK Bird of Conservation Concern > SPA qualifying interest	> In the PFOWF Array Area, gannets were recorded in relatively low numbers each year with a peak population estimate calculated in September 2020, late in the breeding season. > Scoped in for collision risk and displacement impact on a precautionary basis.
Arctic tern	> Amber-listed as a UK Bird of Conservation Concern > Annex I on the EU Birds Directive > Locally important colonies	> In the PFOWF Array Area, Arctic terns were recorded only during the breeding season and only three times in total, all during 2015. The peak population estimate was calculated in July 2015. The species was not recorded during the non-breeding season. > Scoped in for collision risk and displacement impact on a precautionary basis.
Great black-backed gull	> Amber-listed as a UK Bird of Conservation Concern > Non-breeding season interest	> In the PFOWF Array Area, great black-backed gulls were only recorded during the non-breeding season (September to March, with a peak in October 2020), and in very low numbers. > Scoped in for collision risk based on Furness *et al.* (2013).
Great skua	> Amber-listed as a UK Bird of Conservation Concern > SPA qualifying interest	> Very few great skuas were observed in the PFOWF Array Area, with none in the non-breeding period or autumn migration in either year of survey work. The maximum population estimate was calculated in June 2015. > Scoped in for collision risk and displacement impacts on a precautionary basis.
Herring gull	> Red-listed as a UK Bird of Conservation Concern > Priority species on UK Biodiversity Action Plan > Non-breeding season interest	> In the PFOWF Array Area, herring gulls were only recorded once (October 2015) over the two years of digital aerial survey work. > Scoped in for collision risk based on Furness *et al.* (2013).
Red-throated diver	> Green-listed as a UK Bird of Conservation Concern > SPA qualifying interest	> In the PFOWF Array Area, red-throated divers were observed in very low numbers across the two years of survey, with one bird in 2015 and five birds in 2020/21. > Numbers present were too low to be able to generate site population estimates or quantify either collision risk or displacement impacts.

Receptor	Conservation Status and Designation(s)	Summary
Petrels and shearwaters	> European storm-petrel and Manx shearwater: Amber-listed as UK Birds of Conservation Concern > Leach's petrel: Red-listed as UK Birds of Conservation Concern > SPA qualifying interests	> Qualitative risk of impact was assessed for petrels and shearwaters particularly in relation to nocturnal attraction to WTG lighting as raised by the RSPB Scotland.
Wildfowl and waders	> SPA / Ramsar qualifying interests	> The Offshore Development is located on a migration flyway for various wildfowl and wader species, particularly those migrating from Iceland. > Potential collision risk considered for migratory populations of these species based on review of available literature commissioned by Marine Scotland (MS) and the SOSS.

Potential receptors and impacts scoped into the assessment and impacts scoped out are provided in Section 12.5 along with justification.

12.4.7 Data Gaps and Uncertainties

Due to the highly mobile nature of the species of interest and the nature of the established survey methodology to provide a 'snapshot' of the environment, differences in number of species and which species were recorded is expected between survey years. From the 13 surveys performed in 2015, 4,960 birds of 14 species were recorded, compared to 12,539 birds of 17 species during the 12 surveys in 2020/2021. The higher number of birds recorded in 2020/2021 is primarily due to the increase in survey buffer (4 km) applied between to the surveys undertaken between April and August 2021, compared to the 2 km buffer used in all other surveys. Across the PFOWF Array Area, no apparent gaps in the use of the survey area by seabirds were identified. Widespread and varied use of the PFOWF Array Area was exhibited by a variety of species, especially during the breeding season.

The overall rate of identification to species level was 97% in 2015 compared to 94% in 2020/2021. Low identification rates to species of 83%, 85% and 88% in February, May and August 2021 respectively can likely be attributed to the high proportions of large auks recorded in these surveys, and the difficulties associated with differentiating between guillemot and razorbill, particularly when in moult and accompanied by juveniles. When apportioning of 'unidentified' birds to species level was performed, the number of unidentified birds in each species group were assigned to species where appropriate, based on their respective abundance ratios. For example, if identified guillemots and razorbills occurred in a 4:1 ratio, then 80% of unidentified birds would be assigned to guillemot and 20% assigned to razorbill.

Relatively high abundance of guillemot, kittiwake and puffin are consistent with what is to be expected for the region, considering the proximity to known breeding colonies located at North Caithness Cliffs SPA. The SPA is also designated for the protection of peregrine, of which no individuals were observed in any surveys. Despite Hoy SPA (at ~30 km from the PFOWF Array Area) supporting approximately 14% of the world biogeographic population of great skua (approximately 1,900 pairs), very few individuals were recorded in either the 2015 or the 2020/2021 surveys (8 and 17 records respectively). Arctic skua, for which Hoy SPA is also designated, were also recorded in very low numbers throughout the survey programme (zero individuals, 2015; two individuals, 2020/2021).

12.5 Impact Assessment Methodology

12.5.1 Impacts Requiring Assessment

This assessment covers all potential impacts identified through the scoping process, as well as any further potential impacts that have been highlighted as the EIA has progressed. It should be noted that impacts are not necessarily relevant to all stages of the Offshore Development.

Table 12.11 below indicates all of the potential direct and indirect impacts assessed with regards to Marine Ornithology and indicates the Offshore Development stages to which they relate. Cumulative impacts are discussed in Section 12.7.

Table 12.11 Potential impacts requiring assessment

Potential Impact	Description
Construction	
Potential impact of disturbance/ displacement/ exclusion due to construction noise or physical presence of vessels	Construction of the Offshore Development may lead to disturbance, displacement or exclusion of seabirds from the area where the activity is taking place, effectively resulting in short-term and temporary habitat loss. This includes towing the WTGs to site, installation of the WTGs, floating substructures and associated moorings, and the OECC, where such activity can result in increased levels of noise and of vessel presence.
Potential for a barrier effect due to physical presence of vessels and construction equipment	Barrier effect is the potential for an offshore wind farm and associated activities to prevent birds, including flying birds, from traversing or entering an offshore wind farm. The potential for construction impacts to lead to a barrier effect will be short term and temporary.
Potential change in habitat/prey availability during construction	Disturbance leading to changes in prey abundance or behaviour may lead to less prey being available to foraging seabirds around the Offshore Development (refer to Chapter 9: Benthic Ecology (see Section 8.2) and Chapter 10: Fish and Shellfish (see Section 8.3) for more details). The ability of seabirds to tolerate these changes will depend on the fish species affected in relation to their diet and their flexibility in habitat use.
Potential increase in suspended sediment affecting visibility during construction	This impact may be expected to affect pursuit and plunge foraging seabirds such as the auk species (guillemot, razorbill and puffin) and gannet whilst they are present in the water column. Increases in suspended sediment (turbidity) in the water column, affecting visibility, may reduce foraging success and captures. Conversely, turbid waters could provide greater concealment for foraging auks to approach prey and avoid detection. More details on the potential changes in sediment suspension can be found in Chapter 9: Benthic Ecology and Chapter 10: Fish and Shellfish).
Operation and Maintenance	
Potential collision risk with operational WTGs	This is the risk that any birds entering the operational wind farm site will collide with the WTG blades. There is potential that birds may be injured or killed should they collide with the WTG blades.
Potential displacement impact due to physical presence of WTGs	Displacement is the potential for an offshore wind farm and associated activities to reduce or prevent birds, including flying birds, from using an offshore wind farm. The potential for the physical presence of the Offshore Development wind turbines to lead to displacement during the operation and maintenance of the Offshore Development will be for the duration of the Project, however noise levels will be less, and habituation is more likely to be a factor.
Potential for a barrier effect due to physical presence of WTGs	Barrier effect is the potential for an offshore wind farm and associated activities to prevent birds, including flying birds, from traversing or entering an offshore wind farm. The potential for the physical presence of the Offshore Development (WTGs and operation-maintenance vessels) to lead to a barrier effect will be for

Potential Impact	Description
	the duration of the Project, however noise levels will be less than during construction, and habituation is likely to be a factor.
Potential for entanglement with debris caught on mooring lines	Diving birds have the potential to become entangled with debris caught on mooring lines, particularly 'ghost' or derelict fishing gear. Auk species (guillemot, razorbill and puffin) and gannet all forage for prey in the water column and are able to dive to considerable depths. Offshore wind farm developments have the potential to become "Fish Aggregation Devices" (FADs) which are attractive to fish because seaweed and kelp growing on sub-sea structures and cables provide shelter and habitat for juvenile fish. Increased fish density within the Offshore Development may be attractive to seabirds and consequently increases the risk of entanglement.
Potential disturbance/exclusion due to marine noise and maintenance works	During operation and maintenance such effects cannot be separately assessed from potential displacement due to physical presence of WTGs. This latter impact over-rides any other disturbance or exclusion during operation based on the total rates of displacement and mortality. Such displacement is predicted across the entire PFOWF Array Area and 2 km buffer so that any more localised disturbance due to marine noise and maintenance works is completely subsumed within it, at least for the purposes of assessment.
Potential change in habitat/prey availability due to physical presence of WTGs and cable protection	Disturbance leading to changes in prey abundance or behaviour may lead to less prey being available to foraging seabirds around the Offshore Development (refer to Chapter 9: Benthic Ecology (see Section 8.2) and Chapter 10: Fish and Shellfish (see Section 8.3) for more details). The ability of seabirds to tolerate these changes will depend on the fish species affected in relation to their diet and their flexibility in habitat use.
Potential increase in suspended sediment from operations and maintenance work affecting visibility	Increases in suspended sediment (turbidity) in the water column, affecting visibility, may reduce foraging success and captures for seabirds utilising the water column. The amount of sediment potentially released during operation and maintenance activities is considerably less than that considered for the construction and decommissioning impacts. More details on the potential changes in sediment suspension can be found in Chapter 9: Benthic Ecology and Chapter 10: Fish and Shellfish).
Creation of a roosting habitat or foraging opportunities	Over the operational life-cycle, birds may potentially use the floating substructures as a perching platform. Such new perching areas may allow birds to rest as well as providing easier access to foraging grounds. Potential for foraging opportunities is as per Benthic Ecology (see Section 8.2) and Fish and Shellfish (see Section 8.3).
Decommissioning	
Potential impact of disturbance/ displacement/ exclusion due to decommissioning noise or physical presence of vessels	Decommissioning of the Offshore Development may lead to similar disturbance, displacement or exclusion of seabirds from the area where the activity is taking place as per the construction of the Offshore Development. Effectively, this can result in reduced short-term and temporary habitat loss. This includes decommissioning of the WTGs, floating substructures and associated moorings, and the OECC, where such activity can result in increased levels of noise and of vessel presence.
Potential for a barrier effect due to physical presence of vessels and decommissioning equipment	As for the construction phase, barrier effect during the decommissioning of the Offshore Development is the potential for an offshore wind farm and associated decommissioning activities to prevent birds, including flying birds, from using an offshore wind farm. The potential for decommissioning impacts to lead to a barrier effect will be short term, temporary and less than during construction.
Potential change in habitat/prey availability during decommissioning	Disturbance leading to changes in prey abundance or behaviour may lead to less prey being available to foraging seabirds around the Offshore Development (refer

Potential Impact	Description
	to Chapter 9: Benthic Ecology (see Section 8.2) and Chapter 10: Fish and Shellfish (see Section 8.3) for more details). The ability of seabirds to tolerate these changes will depend on the fish species affected in relation to their diet and their flexibility in habitat use.
Potential increase in suspended sediment affecting visibility during decommissioning	This impact may be expected to affect pursuit and plunge foraging seabirds such as the auk species (guillemot, razorbill and puffin) and gannet whilst they are present in the water column. Increases in suspended sediment (turbidity) in the water column, affecting visibility, may reduce foraging success and captures. Conversely, turbid waters could provide greater concealment for foraging auks to approach prey and avoid detection. More details on the potential changes in sediment suspension can be found in Chapter 9: Benthic Ecology and Chapter 10: Fish and Shellfish).

12.5.2 Impacts Scoped Out

The following impacts were scoped out of the assessment during EIA scoping:

> Potential accidental release of pollutants

This impact has been scoped out based on the applicant submitting a pollution prevention plan as part of the overall Construction Environmental Management Plan (CEMP).

12.5.3 Assessment Methodology

The EIA process and methodology are described in detail in Chapter 6: EIA Methodology.

Project-specific criteria have been used to define and determine the magnitude of impact as detailed below.

Additionally, specific criteria for the sensitivity of Marine Ornithology receptors have been developed and are detailed below, based on the vulnerability, recoverability and value.

12.5.3.1 Defining impact magnitude

Defining impact magnitude requires consideration of how the following factors will impact on the baseline conditions:

- Spatial Extent: The area over which the impact will occur;
- Duration: The period of time over which the impact will occur;
- Frequency: The number of times the impact will occur over the Offshore Development's life-cycle;
- Intensity: The severity of the impact;
- Likelihood: The probability that the impact will occur and also the probability that the receptor will be present; and
- Reversibility: The ability for the receiving environment / exposed receptor to return to baseline conditions.

Based on these parameters, and expert judgement, a summarised description on the assignment of magnitude criteria is provided in Table 12.12.

Table 12.12 Impact magnitude criteria

Magnitude of impact	Definition
High	The impact occurs over a large spatial extent resulting in widespread, long term or permanent changes in baseline conditions, or affecting a large proportion of receptor population. The impact is very likely to occur and /or will occur at a high frequency or intensity.
Moderate	The impact occurs over a local to medium extent, with short to medium term change to baseline conditions, or affecting a moderate proportion of receptor population. The impact is likely to occur and/ or will occur at a moderate frequency or intensity.
Low	The impact is localised and temporary or short term, leading to detectable change in baseline conditions, or noticeable effect on small proportion of receptor population. The impact is unlikely to occur or may occur but at low frequency or intensity.
Negligible	The impact is highly localised and short term with full rapid recovery expected to result in very slight or imperceptible changes to baseline conditions, or receptor population. The impact is very unlikely to occur and if it does will occur at very low frequency or intensity.
No Change	No change from baseline conditions.
Note: The magnitude of an impact is based on a variety of parameters. The definitions provided above are for guidance only and may not be appropriate for all impacts. For example, an impact may occur in a very localised area but at very high frequency / intensity for a long period of time. In such cases expert judgement is used to determine the most appropriate magnitude ranking and this is explained through the narrative of the assessment.	

12.5.3.2 Receptor sensitivity

As part of the assessment of significance of effects it is necessary to determine the receptor sensitivity. Receptor sensitivity is defined as 'the degree to which a receptor is affected by an impact'.

Overall receptor sensitivity is determined by considering a combination of value, adaptability, tolerance and recoverability. This is achieved through applying known research and information on the status and sensitivity of the feature under consideration coupled with professional judgement and past experience.

The ability of a receptor to adapt to change, tolerate, and/or recover and the timing for recovery from potential impacts is key in assessing its vulnerability to the impact under consideration.

Receptor value considers whether, for example, the receptor is rare, has protected or threatened status, importance at local, regional, national or international scale and in the case of biological receptors whether the receptor has a key role in the ecosystem function. Receptor values can range from negligible to very high as described in Table 12.13.

Information used to determine the overall impact sensitivity of valued Marine Ornithological receptors are based on consideration of conservation value, vulnerability and recoverability and are provided in Table 12.14. The regional populations, survival rates and baseline mortalities used during the assessment of collision and displacement impacts are summarised in Table 12.15 for the breeding season and in Table 12.16 for the non-breeding season.

Table 12.13 Value of Marine Ornithology receptors

Value of receptor	Definition
Very high	Receptor of very high importance or rarity; species that are globally threatened such as those listed on the OSPAR list of Threatened and Declining Species, (IUCN Red List of Threatened Species including those listed as endangered or critically endangered and/or a significant proportion of the international population (> 1%) is found within the Offshore Site.
High	Receptor of high importance or rarity, such as species listed on the OSPAR list of Threatened and Declining Species, species listed as near-threatened or vulnerable on the IUCN Red List. Species listed on Annex IV of the EU Habitats Directive as a European Protected Species (EPS) and / or is a qualifying interest of a Special Area of Conservation (SAC), SPA or Ramsar site and a significant proportion of the national population (> 1%) is found within the Offshore Site.
Medium	Receptor of least concern on the IUCN Red List, listed as a breeding species on Schedule 1 of the Wildlife and Countryside Act 1981, a cited interest of a SSSI, listed in the UKBAP or on the Birds of Conservation Concern (BOCC) ‘red list’ and a significant proportion of the regional population (> 1%) is found within the Offshore Site.
Low	Any other species of conservation interest (e.g. BOCC amber listed species).
Negligible	Receptor of very low importance, such as those which are generally abundant around the UK with no specific value or conservation concern.

The overall sensitivity for marine ornithology receptors is thus defined based on expert judgement in line with the above criteria.

Table 12.14 Information used to determine the overall impact sensitivity of valued Marine Ornithological receptors based on in indications of conservation value, vulnerability and recoverability

Species	Value	Factors Affecting Species Sensitivity				Species Vulnerability (Furness & Wade, 2012; Furness *et al.*, 2013; Bradbury *et al.*, 2014; Wade *et al.*, 2016)			
		Clutch size and year of first breeding (Robinson, 2017)	Mean max foraging range + 1 SD (km) (Woodward *et al.*, 2019)	*Regional population trends (1986 – 2019)*	Overall Recoverability	Collision risk	Displacement / Barrier Effects: WTGs	Disturbance: vessels	Indirect effects (disturbance to prey species and habitat loss)
Kittiwake	Very high	2 egg/ 4 years	156.1 ± 144.5	Declining	Low	High	Low	Low	Moderate
Guillemot	High	1 egg/ 5 years	73.2 ± 80.5	Increasing	Moderate	Negligible	High	Moderate	Moderate
Razorbill	High	1 egg / 4 years	88.7 ± 75.9	Increasing	Moderate	Negligible	High	Moderate	Moderate
Puffin	High	1 egg / 5 years	137.1 ± 128.3	Increasing	Moderate	Negligible	Moderate	Moderate	Moderate
Fulmar	High	1 egg / 9 years	542.3 ± 657.9	Declining	Low	Low	Negligible	Negligible	Negligible
Gannet	High	1 egg / 5 years	315.2 ± 194.2	Increasing	High	High	High	Negligible	Negligible
Arctic tern	High	1-2 eggs /	25.7 ± 14.8	Declining	Low	Low	Low	Moderate	Moderate
Great black-backed gull	High	2-3 eggs / 4 years	73	Declining	Low	Very High	Low	Negligible	Negligible
Great skua	High	2 eggs /	443.3 ± 487.9	Unknown	Moderate	Moderate	Low	Negligible	Negligible

Species	Value	Factors Affecting Species Sensitivity				Species Vulnerability (Furness & Wade, 2012; Furness *et al.*, 2013; Bradbury *et al.*, 2014; Wade *et al.*, 2016)			
		Clutch size and year of first breeding (Robinson, 2017)	Mean max foraging range + 1 SD (km) (Woodward *et al.*, 2019)	*Regional population trends (1986 – 2019)*	Overall Recoverability	Collision risk	Displacement / Barrier Effects: WTGs	Disturbance: vessels	Indirect effects (disturbance to prey species and habitat loss)
Herring gull	High	3 eggs / 4 years	58.8 ± 26.8	Declining	Low	Very High	Low	Low	Low
Red-throated diver	High	2 eggs / 3 years	9	Unknown	Low	Moderate	Very High	Very High	Moderate

Table 12.15 Summary information on survival rate, regional breeding populations and associated baseline mortalities to consider impact magnitude in Section 12.6

Species	Adult Survival Rate (Horswill & Robinson, 2015)	Regional Breeding Population (individuals)*	Baseline Mortality (individuals)	0.2% of Baseline Mortalities (individuals)
Kittiwake	0.854 (±0.051 SD)	169,680	24,773	50
Guillemot	0.939 (±0.015 SD)	373,332	22,773	46
Razorbill	0.895 (±0.067 SD)	47,737	5,012	10
Puffin	0.906 (±0.083 SD)	116,543	10,955	22
Fulmar	0.936 (±0.055 SD)	380,460	24,349	49
Gannet	0.919 (±0.042 SD)	409,970	33,208	66
Great skua	0.882 (±0.038 SD)	11,420	1,348	3

** These regional breeding populations are defined and calculated in the Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning: Marine Ornithology: Connectivity and Apportioning. For each species, they comprise the total number of individuals for all relevant SPAs within foraging range, i.e. the 'most recent' SPA population counts are summed for all SPAs within the species' foraging range.*

Arctic tern is not included in the table as impacts are considered in the context of the local breeding colonies identified by RSPB Scotland (see Section 12.4.4.7).

Great black-backed gull and herring gull are not included in the table as they were only recorded in the PFOWF Array Area during the non-breeding season (see Section 12.4.4.8 and Section 12.4.4.9).

Table 12.16 Summary information on survival rate, BDMPS populations and associated baseline mortalities to consider impact magnitude in Section 12.6

Species	Adult Survival Rate (Horswill & Robinson, 2015)	BDMPS non-breeding population (individuals) (Furness, 2015)			Baseline Mortality (individuals)			0.2% of Baseline Mortalities (individuals)		
		Autumn migration season	Non-breeding season	Spring migration season	Autumn migration season	Non-breeding season	Spring migration season	Autumn migration season	Non-breeding season	Spring migration season
Kittiwake	0.854 (±0.051 SD)	829,937	not applicable	627,816	121,171	not applicable	91,661	242	not applicable	183
Guillemot	0.939 (±0.015 SD)	not applicable	848,710	not applicable	not applicable	51,771	not applicable	not applicable	104	not applicable
Razorbill	0.895 (±0.067 SD)	591,874 (combined with spring)	218,622	591,874 (combined with autumn)	62,147	22,955	62,147	124	46	124
Fulmar	0.936 (±0.055 SD)	1,785,696 (combined with spring)	1,125,103	1,785,696 (combined with autumn)	114,285	72,007	114,285	229	144	229
Gannet	0.919 (±0.042 SD)	545,954	not applicable	661,888	44,222	not applicable	53,613	88	not applicable	107
Great black-backed gull	0.930	not applicable	91,399	not applicable	0	6,398	not applicable	not applicable	13	not applicable
Herring gull	0.834 (±0.034 SD)	not applicable	466,511	not applicable	0	77,441	not applicable	not applicable	155	not applicable

Arctic tern and great skua are not included in this table as they were only recorded in the PFOWF Array Area during the breeding season (see Section 12.4.4.7 and 12.4.4.10) and puffin removed based on very low non-breeding season numbers (see Section 12.4.4.4).

12.5.3.3 Evaluation to Determine Significance of Effect

Significance of effect is determined by correlating the magnitude of the impact and the sensitivity of receptor, whilst utilising professional judgement and industry best practice guidance, science and accepted approaches.

To ensure a transparent and consistent approach throughout this Offshore EIAR, a matrix approach has been adopted to guide the assessment of significance of effects (see Table 12.17). Importantly, latitude for professional judgement in the application of this matrix is permitted where deemed appropriate.

Table 12.17 Significance of effects matrix

Significance of Effects Matrix					
Sensitivity of Receptor	Magnitude of Impact				
	No Change	Negligible	Low	Moderate	High
Negligible	Negligible	Negligible	Negligible	Negligible	Minor
Low	Negligible	Negligible	Minor	Minor	Moderate
Moderate	Negligible	Minor	Minor	Moderate	Major
High	Negligible	Minor	Moderate	Major	Major
Very High	Negligible	Minor	Major	Major	Major

Definitions of significance of effect are described in Table 12.18. For the purposes of this Offshore EIAR, any effect with a significance of moderate or greater is generally considered 'significant' in EIA terms and additional mitigations may be required. Effects identified as minor or negligible are generally considered to be 'not significant' in EIA terms.

Table 12.18 Assessment of consequence

Assessment consequence	Description (consideration of receptor sensitivity and value and impact magnitude)	Significance of Effect
Major Effects	Effects (beneficial or adverse) are likely to be highly noticeable and long term, or permanently alter the character of the baseline and are likely to disrupt the function and/or status / value of the receptor. They may have broader systemic consequences. Such adverse effects are a priority for mitigation to avoid or reduce the anticipated significance of the effect.	Significant
Moderate Effects	Effects (beneficial or adverse) are likely to be noticeable and result in lasting changes to the character of the baseline and may cause hardship to, or degradation of, the receptor, although the overall function and value of the baseline / receptor is not disrupted. Such effects are a priority for mitigation to avoid or reduce the anticipated significance of the effects.	Significant
Minor Effects	Effects (beneficial or adverse) are expected to comprise noticeable changes to baseline conditions, beyond natural variation, but are not expected to cause long term degradation, hardship, or impair the function and value of the receptor. Such effects are not typically contentious and will not generally require additional mitigation but may be of interest to stakeholders.	Not Significant
Negligible	Effects are expected to be either indistinguishable from the baseline or within the natural level of variation. These effects do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.	Not Significant

Expert judgement is applied when considering the outputs from the significance of effects matrix (Table 12.17) to determine the final assessment of consequence and ranking to apply (Table 12.18).

12.5.4 Design Envelope Parameters

As detailed in Chapter 5: Project Description, this assessment considers the Offshore Development parameters which are predicted to result in the greatest environmental impact, known as the 'realistic worst case scenario'. The realistic worst case scenario represents, for any given receptor and potential impact on that receptor, various options in the Design Envelope that would result in the greatest potential for change to the receptor in question.

Given that the realistic worst case scenario is based on the design option (or combination of options) that represents the greatest potential for change, confidence can be held that development of any alternative options within the design parameters will give rise to no effects greater or worse than those assessed in this impact assessment. Table 12.19 presents the realistic worst case scenario for potential impacts on marine ornithology receptors during construction, operation and maintenance, and decommissioning phases of the Offshore Development.

For Marine Ornithology, the realistic worst case scenario has been derived by applying a contemporary understanding of species' sensitivities to the proposed activities and identifying which aspects of the Design Envelope would be most likely to result in the largest impact magnitude for each. This includes a consideration of the maximum parameters of components for the Offshore Development with potential to interact with Marine Ornithological receptors.

Where there are a number of options for the various elements of the Offshore Development, the option which has the largest potential impact on the Marine Ornithological receptors has been assessed at the maximum parameters identified.

Table 12.19 Design parameters specific to Marine Ornithology receptor impact assessment

Potential Impact	Design Envelope Scenario Assessed
Construction Phase	
Disturbance/displacement/exclusion due to construction noise or physical presence of vessels Barrier effect due to physical presence of vessels and construction equipment	> Installation of up to seven WTG, predicted to take up to three months between April and September 2026 (Q2/Q3); > Installation of floating substructures (up to seven) including anchors (up to nine per substructure), predicted to take up to three months between April and September 2026 (Q2/Q3); > Impact piling is the noisiest installation option for piled anchors but proposed for a maximum of seven WTGs/substructures, so a maximum of 63 anchors to be impact piled. The activity will be intermittent; the average time will be four hours to drive in the pile and the maximum eight hours; > Drilled piles are the next noisiest installation option for piled anchors, predicted to take up to 63 days in total to install a maximum of 63 anchors; > Installation of the associated moorings, predicted to take up to three months between April and September 2026 (Q2/Q3); > Installation of the OECC, predicted to take up to one month between May and August 2025 or 2026 (Q2/Q3) for both cables; and maximum numbers of construction vessels on-site at any one time: seven vessels.
Change in habitat/prey availability during construction Increase in suspended sediment affecting visibility during construction	**Offshore Export Cable(s)** > A maximum of two offshore export cables which will run from the PFOWF Array Area to landfall; > Maximum total combined length of cable is approximately 25 km; > Maximum trench width 3 m;

Potential Impact	Design Envelope Scenario Assessed
	> Maximum width of cable corridor 15 m (seabed disturbance, not trench width). Seabed prep including boulder removal, seabed levelling etc. will take place within this corridor; > Maximum % of seabed requiring preparation = 100%; > Maximum seabed preparation footprint = 375,000 m2; > Total indicative duration of offshore ops = one month between May and August 2025 or 2026 (Q2/Q3). **Trench and burial methods for the Offshore Export Cable(s) and inter-array cables**: > Pre- or post-lay trenching using a mechanical trenching plough to either create a pre-cut trench which the cable is then installed into, or post-lay trench. A separate backfill plough is then used to push the spoil heaps created by trenching over the cable, thus creating the required cable cover; > Cable lay with post-lay burial using a jetting tool (either self-propelled or mounted as skids onto Remotely Operated Vehicle [ROVs]) which injects water at high pressure into the sediment surrounding the cable. The seabed is temporarily fluidised and the cable is lowered to the required depth. Displaced material is suspended in the water and then resettles over the cable. This process is controlled to ensure that sediment is not displaced too far from the cable; and > Simultaneous cable lay and burial, using a cable plough or a mechanical trencher. These tools bury the cable by lifting the laid cable whilst excavating a trench below, and then replacing the cable at the base of the trench and allowing the soil to naturally backfill behind the plough. **Anchors: Gravity** > Up to nine anchors per WTG with maximum area of seabed preparation (levelling) of 900 m2 per anchor; and > Total indicative duration of offshore ops = four months between April and September 2025 (Q2/Q3).
Operation and Maintenance	
Collision risk with operational WTGs	> Up to seven WTGs; > Maximum rotor diameter of 240m, equating to a total rotor swept area of 316,673 m2; > Minimum blade clearance from sea-level of 35m.
Displacement impact due to physical presence of WTGs	> Assessment based on PFOWF Array Area + 2 km buffer.
Barrier effect due to physical presence of WTGs	> Assessment based on PFOWF Array Area.
Entanglement with debris caught on mooring lines	> Up to seven WTGs; > Maximum number of moorings is nine per substructure / WTG; > Maximum length of mooring that may come into contact with the seabed = 1,485 m per line (90% of total length).

Potential Impact	Design Envelope Scenario Assessed
Disturbance/exclusion due to marine noise and maintenance works Increase in suspended sediment from operations and maintenance work affecting visibility	A 'worst case' for O&M work has not been quantified. Although O&M activities occur over the long-term, operational life-cycle of the Offshore Development, the noise they may create, the sediment they may release and the disturbance they may cause will be much less than that during construction. Impacts will be highly localised and intermittent. Maintenance will be required for: > Up to seven WTGs and floating substructures; > Up to 63 anchors; and > Up to 25 km of offshore export cable. Planned maintenance (scheduled services) includes general inspection and servicing, oil sampling / change, cleaning of equipment, investigation of faults and minor fault rectification, as well as replacement of consumables. These types of maintenance activities will generally take place during the summer months. Unplanned maintenance covers fault rectification, unexpected minor repairs and major component replacements/repairs. As these can't be foreseen, they may take place at any time of the year across the life-cycle of the Offshore Development and may require urgent intervention to rectify any critical issues as quickly as possible.
Change in habitat/prey availability due to physical presence of WTGs and cable protection.	> Seven WTGs: worst case habitat loss arises from use of gravity anchors, nine per WTG with maximum permanent seabed footprint of 625 m2 per anchor; > A maximum of two offshore export cables which will run from the PFOWF Array Area to landfall; > Maximum total combined length of cable is approximately 25 km; and > 50% of the Offshore Export Cable(s) may need protection. 3 m wide trench, plus 1 m either side this would give 7 m wide of rock footprint for 25 km if 2x cables = 87,500 m2 total.
Creation of a roosting habitat or foraging opportunity	> Up to seven WTG and floating substructures.
Decommissioning	
Disturbance/displacement/exclusion due to decommissioning noise or physical presence of vessels	In the absence of detailed information regarding decommissioning works, the implications for offshore ornithology are considered analogous with or likely less than those of the construction phase. Therefore, the worst case parameters defined for the construction phase also apply to decommissioning. The approach to decommissioning is set out in Chapter 5: Project Description; Section 5.11.
Barrier effect due to physical presence of vessels and decommissioning equipment	
Change in habitat/prey availability during decommissioning	
Increase in suspended sediment affecting visibility during decommissioning	

12.5.5 Embedded Mitigation and Management Plans

As part of the Offshore Development design process, a number of designed-in measures and management plans have been proposed to reduce the potential for impacts on Marine Ornithology receptors (Table 12.20). As there is a commitment to implementing these measures which will likely be secured through Section 36 Consent and Marine Licence conditions, they are considered inherently part of the design of the Offshore Development and have therefore been considered in the assessment presented below (i.e. the determination of magnitude of impact and therefore significance of effects assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 12.20 Embedded mitigation measures specific to Marine Ornithology receptors for the Offshore Development

Embedded Mitigation Measures and Management Plans	Justification
Management Plans	
Construction Environmental Management Plan (CEMP)	The CEMP will set out procedures to ensure all activities with potential to affect the environment are appropriately managed and will include: a description of works and construction processes, roles and responsibilities, description of vessel routes and safety procedures, pollution control and spillage response plans, incident reporting, chemical usage requirements, waste management plans, plant service procedures, communication and reporting structures and timeline of work. It will detail the final design selected and take into account Marine Licence Conditions and commitments. The CEMP will help to mitigate the construction impacts on marine ornithological receptors by ensuring that good working practice is implemented on the ground.
Environmental Clerk of Works (ECoW)	An independent ECoW will be appointed to audit site activities and will advise on implementation of mitigation. The ECoW will help to mitigate the construction impacts on marine ornithological receptors by ensuring that good working practice is implemented on the ground.
Offshore Construction Method Statement (CMS)	A CMS will be developed in accordance with the CEMP detailing how project activities and plans identified within the CEMP will be carried out, and also highlighting any possible dangers/risks associated with particular Project activities. The CMS will help to mitigate the construction impacts on marine ornithological receptors by ensuring that good working practice is implemented on the ground.
Project Environmental Monitoring Programme (PEMP)	Through the EIA process, conclusions have been drawn on the potential environmental impact of developing the Offshore Development. Where required, a monitoring programme will be put in place to provide further evidence to support these conclusions and provide information for future offshore wind farm developments. The PEMP will help to understand impacts arising from the Offshore Development on marine ornithological receptors. For Marine Ornithology, MSS and NS have advised that a further year of pre-construction baseline surveys are undertaken for the PFOWF Array Area plus 4 km buffer; this requirement will be included in the PEMP. Additional proportionate monitoring / research relative to ornithology will also be considered to help understand floating wind farm impacts on bird species.
Cable Plan (CaP)	The CaP will detail the location/ route and cable laying techniques of the inter-array and Offshore Export Cable(s) for the Offshore Development. This will be supported by survey results from the geotechnical, geophysical and benthic surveys. The cable plan will detail electromagnetic fields of the cables deployed, target burial depths for the Offshore Export Cable(s) and also detail methods for cable surveys during the operational life of the cables.

Embedded Mitigation Measures and Management Plans	Justification
	The Cable Plan will help to mitigate construction impacts from the Offshore Export Cable(s) on marine ornithological receptors by ensuring that good working practice is implemented on the ground.
Vessel Management Plan (VMP)	A VMP will be prepared for the Offshore Development which will detail the number, type and specification of vessels utilised during construction and operation. This will also detail the ports and transit corridors proposed. The VMP will help to mitigate the construction and O&M impacts on marine ornithological receptors by ensuring that good working practice is implemented on the ground.
Navigational Safety Plan (NSP)	A NSP will be developed for the Offshore Development which will detail all navigational safety measures, construction exclusion zones if required, notices to mariners and radio navigation warnings, anchoring areas, lighting and marking requirements and emergency response procedures during all phases of the project. The NSP sets out the WTG lighting requirements for shipping and navigational safety and will adopt good practice in respect of seabird attraction to lighting.
Lighting and Marking Plan (LMP)	The LMP will provide that the Offshore Development be lit and marked in accordance with the current CAA and MoD aviation lighting policy and guidance. The LMP will also detail the navigational lighting requirements detailed in IALA Recommendation O-139. The LMP sets out the WTG lighting requirements for aviation safety and will adopt good practice in respect of seabird attraction to lighting, as recommended by NatureScot (2020a).
Operational Environmental Management Plan (OEMP)	The developer will collate an OEMP to guide on-going operations and maintenance activities during the life-cycle of the project. The OEMP will also set out the procedures for managing and delivering the specific environmental commitments as per each technical chapter for each receptor over the O&M phase.. The OEMP will help to mitigate the O&M impacts on marine ornithological receptors by ensuring that good working practice is implemented on the ground.
Decommissioning Programme	A Decommissioning Programme will be provided pre-construction to address the principal decommissioning measures for the Offshore Development, this will be written in accordance with applicable guidance and detail the management, environmental management and schedule for decommissioning. The Decommissioning Programme will help to mitigate the decommissioning impacts on marine ornithological receptors by ensuring that good working practice is implemented on the ground.
Embedded Mitigations	
Minimum Air Gap	Minimum air gap increased to 35 m which is a key measure to minimise collision risk to seabird species. Many seabirds fly close to the sea so that increasing the air gap between the lowest sweep of the turbine blades and the sea surface will reduce the potential for interactions between flying seabirds and the rotating WTG blades.
Revised PFOWF Array Area	Reducing the extent of the PFOWF Array Area may help to minimise displacement and barrier effects by presenting a smaller WTG area for birds to avoid or fly around.

12.5.6 Data Gaps and Uncertainties

Data gaps and uncertainties in the ornithological survey data informing baseline characterisation and subsequent assessment are discussed in Section 12.4.6. There are also uncertainties in the input parameters and underpinning assumptions used in each of the key modelling approaches required for the technical assessment including apportioning, collision risk modelling, displacement assessment and population modelling. These aspects are further discussed in each of the relevant technical appendices.

12.6 Assessment of Environmental Effects

12.6.1 Effects During Construction

12.6.1.1 Potential impact of disturbance/displacement/exclusion due to construction noise or physical presence of vessels

Construction of the Offshore Development may lead to disturbance, displacement or exclusion of seabirds from the area where the activity is taking place, effectively resulting in temporary habitat loss. This includes installation of the WTGs, floating substructures and associated moorings, and the OECC, where such activity can result in increased levels of noise and of vessel presence. Details of the construction methodology are set out in Chapter 5 and the Design Envelope parameters considered to be the worst case for assessment are presented in Table 12.19.

These construction activities will be managed through the adoption and implementation of a CEMP, employment of an Environmental Clerk of Works (ECoW) and provision of a Vessel Management Plan (VMP), all included as embedded mitigation in Section 12.5.5.

12.6.1.1.1 PFOWF Array Area – WTG installation

The **sensitivity** of seabirds to displacement/disturbance by construction activities, including the presence of vessels, and associated construction noise is generally **low**. However, many species present at the PFOWF Array Area, especially auks (and red-throated diver, although in very low numbers) are sensitive to disturbance/displacement, albeit most studies have been concerned with displacement from operational wind farms and there is a paucity of data regarding reactions to construction activities.

A variety of vessels will likely be present during installation of the WTG sub-structures and anchors, including tugs and anchor handling vessels. The additional number of vessel movements due to WTG installation (substructures and anchors) will be negligible in relation to the baseline of vessel activity in the area (as described in Chapter 14, Shipping and Navigation). A maximum of ten vessels is confirmed to be on-site at any one time (Table 12.19). Also, vessels involved in WTG installation will transit to the area utilising existing and pre-defined shipping corridors, thereby reducing the spatial extent of any potential impact. Responses to vessels is mixed between species, with guillemots, razorbills and divers known to react more strongly than other species such as kittiwake (Garthe & Hüppop, 2004).

The impacts (direct and indirect) are considered to be of **low magnitude**, as they are localised around the construction activity and associated vessels, occur intermittently and are temporary in nature; they do not compromise the fitness of individual birds and have no population-level consequences. Accounting for the embedded mitigation (as referenced above and in Section 12.5.5) reduces these impacts to a **negligible magnitude**. The **sensitivity** of the ornithology receptors is therefore considered **moderate**, but seabird **vulnerability** to these disturbance/displacement impacts is determined to be **low.**

The **overall effect** on seabirds from construction disturbance/displacement/exclusion during the construction phase is considered to be **minor and not significant** (Table 12.21).

The Scoping Opinion (MS-LOT, 2021) also raises the possibility of seabird impacts from pre-construction activities, as described in Chapter 5: Project Description. Further geophysical and geotechnical surveys are planned to take place in 2022. The risk of any impacts to seabirds from pre-construction work is extremely low. As suggested, any required mitigation for marine mammal interests will further reduce the already low risk of impact to seabirds.

12.6.1.1.2 Offshore Export Cable Corridor (OECC)

The OECC passes through the marine area associated with the Melvich sub-site of North Caithness Cliffs SPA. Installation is proposed to commence during with Horizontal Direction Drill (HDD) commencing in spring/ summer 2024 with the cable installation in May or June 2025.

Seabird species recorded in the area (see Section 12.4.4.14) that could be prone to disturbance by the Offshore Export Cable(s)-laying activities (including the offshore 'punch-out' for the Horizontal Direction Drill (HDD) and the vessels associated with the range of work) are kittiwake, guillemot, puffin and razorbill (qualifying interests of the SPA) as well as shag and black guillemot and Artic tern recorded in the nearshore section of the OECC. Red-throated diver could also potentially be disturbed by the cable-laying activities but have only been recorded in minimal numbers during the digital aerial survey work and VP scans (see Sections 12.4.4.11 and 12.4.4.14).

Vessels engaged in cable-laying activities generally move slowly and are static for long periods, with the process emitting very low levels of noise. Following this, the magnitude of disturbance is likely to be low. Effects are also likely to be temporary and localised, with a low magnitude of effect on populations.

Temporary displacement may occur during offshore export cable-laying, however, as the vessels move, it is assumed that all bird species (estimated to be moderately sensitive, Table 12.21) will return to the area. Displacement is expected to occur over short distances and the availability of suitable habitat within the North Caithness Cliffs SPA suggests significant adverse effects following temporary displacement from foraging habitat are unlikely to occur. Displacement is unlikely to affect the fitness of breeding birds, even those which are displaced daily, with negligible impacts on survival estimated (Searle *et al*., 2014, 2017).

The impacts (direct and indirect) are considered to be of **low magnitude**, as they are localised around the offshore export cable-laying vessels, occur intermittently and are temporary in nature; they do not compromise the fitness of individual birds and have no population-level consequences. Accounting for the embedded mitigation (as referenced above and in Section 12.5.5) reduces these impacts to a **negligible magnitude**. The **sensitivity** of the ornithology receptors is considered **moderate,** but their **vulnerability** to these disturbance/displacement impacts is determined to be **low.**

The **overall effects** on seabirds from proposed offshore export cable-laying activities during the construction phase is considered to be **minor and not significant** (Table 12.21).

12.6.1.2 Potential for a barrier effect due to physical presence of vessels and construction equipment

Seabird species vary in their reactions to offshore WTGs and vessels (Furness & Wade, 2012). Whilst the presence of vessels and equipment associated with construction may cause temporary disturbance to seabirds in the vicinity, disturbance distances tend to be relatively short i.e. local (Garthe & Hüppop, 2004) (disturbance impacts discussed in Section 12.6.1.1). Barrier effects have been investigated with respect to operational wind farms, where notably gannet display high macro-avoidance (Dierschke *et al.,* 2016; Garthe *et al.,* 2017) which implies some degree of displacement and barrier effects; but such studies have not extended to construction activities. Empirical studies show less pronounced responses (compared to gannet) to operating offshore wind farms by auks, and little response by gulls, skuas and terns (Searle *et al.,* 2018 and references therein). It is therefore unlikely that construction activities and vessel presence would present a barrier effect if operational WTGs do not.

The **magnitude of impact** on all species is considered **negligible** as there is no scope for the scale of proposed construction activity at the Offshore Development – vessel presence and construction equipment – to present a barrier to seabird movements. The **sensitivity** of gannet to barrier effects is **high** but given this species has a large foraging range, such effects are likely to be negligible from an energetics perspective (Searle *et al.,* 2014). The **sensitivity** of all other ornithological receptors to barrier effects from construction activities is **moderate.**

The **overall effect** on seabirds from this impact is considered to be **minor and not significant** (Table 12.21).

12.6.1.3 Potential change in habitat/prey availability during construction

As assessed in Section 12.6.1.1, construction noise may also potentially disturb the prey species of seabirds. Potential effects on such prey species are considered in Chapter 10, Fish and Shellfish Ecology. Disturbance leading to changes in prey abundance or behaviour may lead to less prey being available to foraging seabirds around the PFOWF Array Area. The ability of seabirds to tolerate these changes will depend on the fish species affected in relation to their diet and their flexibility in habitat use. It was concluded in Chapter 10, Fish and Shellfish Ecology that disturbance or damage to sensitive fish and shellfish species due to underwater noise generated from construction activities would have a low impact on herring, sandeels and other fish and shellfish species. Without the need for additional mitigations, the overall effect on potential prey species of seabirds were assessed to be not significant and are therefore unlikely to indirectly impact prey availability of seabirds at the PFOWF Array Area.

The area potentially impacted by construction noise is local and the impact is intermittent. The **magnitude of impact** for all receptors is considered **low** (Table 12.21). However, accounting for the embedded mitigation (as referenced above and in Section 12.5.5) reduces these impacts to a **negligible magnitude**.

12.6.1.3.1 Auks

Forging behaviour and diet of the auk species (guillemot, razorbill and puffin) are similar and are considered collectively for the purposes of this assessment.

As pursuit foragers, auks will feed on a variety of fish species, mainly from three families Ammodytidae (mainly Lesser sandeels), Clupeidae (mainly Sprats or young Atlantic Herring *Clupea harengus*) and Gadidae (mainly young Whiting *Merlangius merlangus*, Saithe *Pollachius virens* or Cod *Gadus morhua*) (Mitchell *et al.,* 2004). However, when available they will feed preferentially on sandeel. Wade *et al.* (2016) classified guillemot, razorbill and puffin as being of moderate vulnerability to habitat/prey interactions and therefore likely habitat loss.

Overall, guillemot, razorbill and puffins are considered to be **very high value** receptors because of their protection status under the UK Birds of Conservation Concern lists (Table 12.10). All three species display increasing regional populations, suggesting a **moderate recoverability** rate (Table 12.14). The **sensitivity** of the three auk species to potential change in habitat/prey availability is therefore considered **moderate** and the impact **magnitude low**. Accounting for the embedded mitigation (as referenced above and in Section 12.5.5) reduces these impacts to a **negligible magnitude**.

The **overall effect** will be **minor and not significant** (Table 12.21).

12.6.1.3.2 Kittiwake

Kittiwakes are considered moderately vulnerable to temporary changes in prey due to their surface feeding habits and dependence on the Lesser sandeel during summer months (Furness & Tasker, 2000). As detailed in Chapter 10: Fish and Shellfish, the Offshore Development may provide spawning and nursery grounds for sandeels, herring (*Clupea harengus*) and mackerel (*Scomber scombus*) amongst other prey species. The breeding success of kittiwake was considered highly vulnerable to reduced availability of food near the breeding colonies (Furness & Tasker, 2000). However, they have a relatively large foraging range (Woodward *et al.,* 2019) and during winter months, they forage for a diversity of small fish species (including herring) in pelagic waters of the continental shelf (Wade *et al.,* 2016) and are considered less vulnerable to prey changes during this time. Nevertheless, the regional population is declining and changes to prey, albeit permanent changes to availability, have been implicated (Daunt *et al.,* 2008).

The impacts from noise disturbance on potential prey associated with the Offshore Development are predicted to be local and temporary in nature and will not give rise to long-term changes to habitat/prey availability. Overall, kittiwakes are considered to be **very high value** receptors because of their protection status under the OSPAR, IUCN and the UK Birds of Conservation Concern lists (Table 12.10). Declining regional populations for the species suggest a **low recoverability** rate (Table 12.14). The **sensitivity** of kittiwake to potential change in habitat/prey availability is considered **moderate** and the impact **magnitude** is **low**. However, accounting for the embedded mitigation (as referenced above and in Section 12.5.5) reduces these impacts to a **negligible magnitude**.

The **overall effect** will be **minor and not significant** (Table 12.21).

12.6.1.3.3 Red-throated diver

Red-throated divers are moderately vulnerable having a small foraging range relative to other seabirds (Woodward *et al.,* 2019) and preferably utilise shallow feeding grounds with shellfish banks and so there is little flexibility in foraging habits (Wade *et al.,* 2016). However, the red-throated diver is an opportunistic feeder and can take a broad range of fish species (Guse *et al.,* 2009; Kleinschmidt *et al.,* 2019).

Overall, red-throated divers are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Unknown regional population trends suggest a **low recoverability** rate (Table 12.14). Red-throated divers are therefore considered of **high sensitivity**, but the impact **magnitude** is **low**. However, accounting for the embedded mitigation (as referenced above and in Section 12.5.5) reduces these impacts to a **negligible magnitude.**

The **overall effect** will be **minor and not significant** (Table 12.21).

12.6.1.3.4 All other ornithological receptors

Species such as gannet, fulmar and great skua have foraging ranges of 100s km and are able to readily adapt to any such changes and simply follow the prey / forage in alternative locations where necessary. The foraging ranges of all these other ornithological receptors are very large compared to the area potentially impacted, so that this impact is assessed to be of **negligible magnitude**, localised within the Offshore Development, temporary in nature and without any effect on the fitness of individual birds. All other seabirds screened in for assessment (fulmar, gannet, Arctic tern, great black-backed gull, great skua, herring gull, petrels and shearwaters) are considered to be of **low sensitivity** and **negligible vulnerability** to the disturbance of their prey species.

The **overall effect** on seabirds from this impact is considered to be **negligible and not significant** (Table 12.21).

12.6.1.4 Potential increase in suspended sediment affecting visibility during construction

The potential for release of suspended sediment during construction activities is assessed in Chapter 8, Water and Sediment Quality. It was concluded that increase in suspended sediment arising from construction work (cable installation) within the PFOWF Array Area would be temporary and negligible and will not alter the quality of the designated waters in respect to seabirds over a long time period.

To consider this impact, for the purposes of assessment, it has to be assumed that there will be no disturbance/displacement/exclusion of seabirds, i.e. the impacts assessed in Section 12.6.1.1 do not apply. If seabirds were to be disturbed/displaced/excluded from construction activity, then they would not be coming into contact with any suspended sediment released by this activity.

The potential increase in suspended sediments may be expected to affect pursuit and plunge foraging seabirds such as the auk species (guillemot, razorbill and puffin) and gannet whilst they are present in the water column. Increases in suspended sediment (turbidity) in the water column, affecting visibility, may reduce foraging success and captures. Conversely, turbid waters could provide greater concealment for foraging auks to approach prey and avoid detection (Haney & Stone, 1988). The exact nature of relationships between seabird foraging success and turbidity is generally unknown (Slinsby *et al.,* 2022).

Therefore, the **high value** receptors that are potentially affected (guillemot, razorbill, puffin and gannet), are considered to be of **moderate sensitivity** and **low vulnerability** to any potential increase of suspended sediment in the water column, affecting visibility. This impact is considered to be of low magnitude, localised around the activity that's potentially releasing the sediment, temporary in nature and without any effect on the fitness of individual birds. However, accounting for the embedded mitigation (as referenced above and in Section 12.5.5) reduces these impacts to a **negligible magnitude.** The **overall effect** on diving seabirds from an increase in suspended sediment during construction is considered to be **minor and not significant** (Table 12.21).

Table 12.21 Summary of significance of effects from construction impacts

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
Potential impact of disturbance / displacement / exclusion due to construction noise or physical presence of vessels.	All bird species scoped in for assessment	Moderate	Negligible	> All receptors considered to be of high value and kittiwake very high as set out in Table 12.14. > Effects are localised intermittent and temporary, further reduced by embedded mitigation.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded project mitigation listed in Section 12.5.5 as it was concluded that the effect was not significant.	Not Significant
Potential for a barrier effect due to physical presence of vessels and construction equipment.	All bird species scoped in for assessment	Moderate	Negligible	> All receptors considered to be of high value and kittiwake very high as set out in Table 12.14. > No potential for a barrier effect from scale of activity; vessel presence and construction equipment.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded project mitigation listed in Section 12.5.5 as it was concluded that	Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
							the effect was not significant.	
Potential change in habitat / prey availability during construction.	Auks (guillemot, razorbill, puffin)	Moderate	Negligible	> Auk species considered to be of high value. Effects are localised and temporary, with no impacts on individual fitness of birds.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded project mitigation listed in Section 12.5.5 as it was concluded that the effect was not significant.	Not Significant
	Kittiwake	Moderate	Negligible	> Kittiwake considered to be of very high value. Effects are localised and temporary, with no impacts on individual fitness of birds.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded project mitigation listed in Section 12.5.5 as it was concluded that the effect was not significant.	Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
	Red-throated diver	High	Negligible	> Red-throated diver considered to be of high value. Effects are localised and temporary, with no impacts on individual fitness of birds.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded project mitigation listed in Section 12.5.5 as the numbers observed at the PFOWF Array Area were very low.	Not Significant
	Remaining species scoped in for assessment	Low	Negligible	> Effects are localised and temporary, with no impacts on individual fitness of birds.	Negligible effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded project mitigation listed in Section 12.5.5 as it was concluded that the effect was not significant.	Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
Potential increase in suspended sediment affecting visibility during construction.	Diving seabirds (guillemot, razorbill, puffin, gannet)	Moderate	Negligible	> All receptors considered to be of high value and kittiwake very high as set out inTable 12.14. > Effects are localised and temporary, with no impacts on individual fitness of birds.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded project mitigation listed in Section 12.5.5 as it was concluded that the effect was not significant.	Not Significant

12.6.2 Effects During Operation and Maintenance

12.6.2.1 Potential collision risk with WTGs

This is the risk that any birds entering the operational wind farm site will collide with the WTG blades as modelled and reported in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling. The key seabird species at potential risk of collision are kittiwake, gannet, herring gull, great black-backed gull, great skua, fulmar and Arctic tern, as identified in the baseline characterisation (see Section 12.4.4) and in Table 12.14.

The two modelled WTG scenarios are presented in the Offshore EIAR (Volume 3): Technical Appendix 12.3: Collision Risk Modelling, with the 'worst case' on which assessment is based set out in Table 12.19. An increase in air gap to 35 m has been applied as embedded mitigation (see Section 12.5.5). Choice of Collision Risk Modelling (CRM) model options and avoidance rates for each species is summarised in Table 12.22. In this table, collision mortalities are presented based on CRM using mean monthly densities of birds recorded on-site, whilst the estimated collisions based on worst case maximum monthly densities are given in brackets. Collision mortalities using the maximum input densities are referenced as a 'worst case' for project-alone assessment, whereas those using mean input densities are referenced for the cumulative assessment (Section 12.7) to allow a 'like-for-like' comparison with other developments.

Table 12.22 Summary of estimated mean (maximum) seasonal collision risk mortalities

Species	Band (2012) Model Option	Avoidance Rate (%)	Number of Collisions			
			Breeding Season Mortality	Autumn Migration Mortality	Non-Breeding Season Mortality	Spring Migration Mortality
Kittiwake	2	98.9	7 (12)	1 (3)	not applicable	0 (0)
Fulmar	2	98.0	0 (0)	0 (0)	0 (0)	0 (0)
Gannet	2	98.9	2 (4)	0 (0)	not applicable	0 (0)
Arctic tern	2	98.0	0 (0)	0 (0)	0 (0)	0 (0)
Herring gull	3	99.0	0 (0)	not applicable	0 (0)	not applicable
Great black-backed gull	3	98.9	0 (0)	not applicable	0 (3)	not applicable
Great skua	2	98.0	0 (0)	0 (0)	0 (0)	0 (0)

12.6.2.1.1 Kittiwake

Kittiwakes are considered highly vulnerable to collision impacts due to the proportion of birds flying at potential collision risk height (Johnston *et al.,* 2014) and the time spent flying (41- 60% of time at sea spent flying, Garthe & Hüppop, 2004), during both day and night (Furness & Wade, 2012). Although seasonal variability may occur, kittiwakes forage within the 200 m depth contour of the continental shelf (Kotzerka *et al.,* 2010) potentially making them vulnerable to interactions with offshore wind farms. Kittiwakes also exhibit a relatively large foraging range (mean max 156.1 km ±144.5 SD; Woodward *et al.,* 2019), increasing the possibility for birds from more distant colonies to utilise the PFOWF Array Area.

To estimate the collision mortalities of kittiwake, CRM Option 2 and an avoidance rate of 98.9% were used. A collision mortality of twelve birds was estimated during the breeding season using maximum input densities; three estimated mortalities (at maximum input densities) during the BDMPS autumn migration period, and zero mortalities estimated during spring. Considered against the regional breeding population (170,138 birds) and the regional BDMPS autumn migration season population (829,937 birds), the predicted mortalities do not surpass 0.2% of the baseline mortalities (50 and 242 birds respectively) (Table 12.15 and Table 12.16).

Therefore, the impact is considered to be of **low magnitude.** Kittiwakes are considered to be **very high value** receptors because of their protection status under the OSPAR, IUCN and the UK Birds of Conservation Concern lists (Table 12.10). Declining regional populations for the species suggest a **low recoverability** rate (Table 12.14). Therefore, kittiwakes are considered to be of **high sensitivity and vulnerability** to collision risk.

Whilst application of the 'significance of effects' matrix (Table 12.17) would suggest moderate and significant effects this conclusion has been reviewed in light of the advice in Table 12.18 and the outcomes of the Population Viability Analysis (PVA) undertaken to assess the population consequences for kittiwake at North Caithness Cliffs SPA (to which most of the impacts are apportioned) (Technical Appendix 12.5: Population Modelling)**.** In this regard, the PVA confirms that there should be no significant effect on kittiwake population viability at North Caithness Cliffs SPA from estimated collision risk and displacement mortalities combined, with only a 2% reduction in population size at the end of the model period due to these impacts, compared to the baseline predictions.

As set out in Section 12.4.4.1, there have been long-term and ongoing kittiwake population declines in north Scotland, both at the regional and SPA-specific level. Climate change is a key driver for this and so these declines would appear to be irreversible; there is no indication that it will be possible to alter the population trajectory (as this hasn't been achieved in the last twenty years). Against this backdrop, the potential impacts upon kittiwake arising from the Offshore Development are marginal and insignificant in the wider context. They have also been mitigated as far as possible through the use of embedded mitigation (see Section 12.5.5), particularly the increase in minimum air gap to 35 m and commitment to a maximum rotor swept area. Applying expert judgement to consider these issues results in a conclusion that the **overall effects** are **minor and not significant** (Table 12.25).

12.6.2.1.2 Fulmar

Fulmars are not considered vulnerable to collision impacts due to a generally low proportion of birds flying at potential collision risk height (Johnston *et al.,* 2014), a moderate flight agility and the time spent flying (Furness & Wade, 2012). Furthermore, fulmars feed in a wide range of habitats with various diets, often following trawler fleets (Furness & Wade, 2012), and could therefore potentially avoid the PFOWF Array Area by feeding in other areas. Fulmars also present a relatively large foraging range (mean max 542.3 km ±657.9 SD; Woodward *et al.,* 2019), increasing the possibility for birds from further colonies to visit the PFOWF Array Area.

A mean total (annual) collision mortality of zero fulmar was estimated using CRM Option 2 and applying a 98.0% avoidance rate. The magnitude of impact is assessed against the regional breeding population (380,460 birds), the BDMPS migration period population (1,785,696 birds) and BDMPS winter period population (1,125,103 birds) with zero change to baseline mortality for each reference population (49, 229 and 144 birds respectively) (Table 12.15 and Table 12.16).

The impact is defined as being of **no changed magnitude**. Fulmars are considered to be **high value** receptors because of their protection status in Europe and under the UK Birds of Conservation Concern list (Table 12.10). Declining regional populations for the species suggest a **low recoverability** rate (Table 12.14). Therefore, fulmars are considered to be of **low sensitivity and vulnerability** to collision risk.

In conclusion, the **overall effect** to fulmars is considered to be **negligible and not significant** (Table 12.25).

12.6.2.1.3 Gannet

Gannets are considered highly vulnerable to collision impacts due to a generally large proportion of birds flying at potential collision risk height (Johnston *et al.,* 2014). Nocturnal activity of tagged gannets shows there to be very low levels of activity after dark, which is the time at which their ability to detect WTGs is reduced (Furness *et al.* 2018 and references therein). Furness *et al.* (2018) noted that nocturnal activity during the breeding season was 8%, and 3% during the non-breeding season. Gannets also present a relatively large foraging range (mean max 315.2 km ±194.2 SD; Woodward *et al.,* 2019), increasing the possibility for birds from further colonies to visit the PFOWF Array Area.

To estimate the collision mortalities of gannet, the CRM Option 2 and avoidance rate of 98.9% were used. A collision mortality of four birds was estimated during the breeding season using maximum input densities, with zero mortalities estimated during the BDMPS autumn and spring migration periods. Considered against the regional breeding population (409,970 birds), the BDMPS autumn migration period population (545,954 birds) and spring migration period population (661,888 birds), the mortalities do not surpass 0.2% of the baseline mortalities (66, 88 and 107 birds respectively) (Table 12.15 and Table 12.16).

Gannet collision mortalities were also apportioned against the Site of Special Scientific Interest (SSSI) population at Troup, Pennan and Lion's Heads SPA; using a calculated apportioning weighting of 0.029 (Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning. This results in a collision mortality estimate of 0.12 birds to consider in relation to the SSSI population of gannet (9,650 individuals).

In this regard, the impact against both the regional and SSSI population defined as being of **negligible magnitude.** Gannets are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Increasing regional populations for the species suggest a **high recoverability** rate (Table 12.14). Therefore, gannets are considered to be of **high sensitivity and vulnerability** to collision risk.

In conclusion the **overall effect** to gannets is considered to be **minor and not significant** (Table 12.25).

12.6.2.1.4 Arctic tern

Arctic terns are considered slightly vulnerable to collision impacts due to the generally small to null proportion of birds flying at potential collision risk height (Johnston *et al.,* 2014). The species is estimated to spend all its time at sea flying during the day and can be described as a slow flying species with a large tail (Furness & Wade, 2012), making it more adapted to avoid WTG blades. Arctic terns present a relatively small foraging range (mean max 25.7 km ±14.8 SD; Woodward *et al.,* 2019) limiting the potential presence of birds from further colonies in the PFOWF Array Area.

A mean total (annual) collision mortality of zero birds was estimated using the CRM Option 2 and applying a 98.0% avoidance rate. These predicted impacts are considered against the local Arctic tern populations at Melvich Bay, Caol Loch, Dounreay and Georgemas and determined as being of **no changed magnitude**.

Arctic terns are considered to be **high value** receptors because of their protection status in Europe (Annex I EU Birds Directive) and under the UK Birds of Conservation Concern list (Table 12.10). Declining regional populations for the species suggest a **low recoverability** rate (Table 12.14). Therefore, Arctic terns are considered to be of **moderate sensitivity and low vulnerability** to collision risk.

In conclusion, the **overall effect** to Arctic terns is considered to be **negligible and not significant** (Table 12.25).

12.6.2.1.5 Great black-backed gull

Great black-backed gulls are considered highly vulnerable to collision impacts due to a generally large proportion of birds flying at potential collision risk height (Johnston *et al.,* 2014) and the time spent flying, during both day and night (Furness & Wade, 2012). Furthermore, great black-backed gulls feed in a wide range of habitats with various diets (Furness & Wade, 2012), and could potentially avoid the PFOWF Array Area by feeding in other areas. Great black-backed gulls present a relatively moderate foraging range (mean max 73.0 km ±0.0 SD; Woodward *et al.,* 2019), limiting the potential presence of birds from further colonies in the PFOWF Array Area.

A mean total (annual) collision mortality of zero birds was estimated using the CRM Option 3 and applying a 98.9% avoidance rate. Assessed against the BDMPS non-breeding population (91,399 birds), the predicted mortalities do not surpass 0.2% of the baseline mortality (13 birds) (Table 12.15 and Table 12.16).

In this regard, the impact is defined as being of **negligible magnitude**. Great black-backed gulls are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Declining regional populations for the species suggest a **low recoverability** rate (Table 12.14). Therefore, great black-backed gulls are considered to be of **high sensitivity and very high vulnerability** to collision risk.

In conclusion, the **overall effect** to great black-backed gulls is considered to be **minor and not significant** (Table 12.25).

12.6.2.1.6 Herring gull

Herring gulls are considered highly vulnerable to collision impacts due to a generally large proportion of birds flying at potential collision risk height (Johnston *et al.,* 2014) and the time spent flying, during both day and night (Furness & Wade, 2012). Furthermore, herring gulls feed in a wide range of habitats (at sea and inland) with various diets (Furness & Wade, 2012), and could potentially avoid the PFOWF Array Area by feeding in other areas. Herring gulls present a relatively small foraging range (mean max 58.8 km ±26.8 SD; Woodward *et al.,* 2019), limiting the potential presence of birds from further colonies in the PFOWF Array Area.

A mean total (annual) collision mortality of zero birds was estimated using the CRM Option 3 and applying a 99.0% avoidance rate. Assessed against the regional population (466,511 birds) during the BDMPS non-breeding season, the predicted mortalities do not surpass 0.2% of the baseline mortalities (155 birds) (Table 12.15 and Table 12.16).

In this regard, the impact is defined as being of **no changed magnitude.** Herring gulls are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list and UK Biodiversity Action Plan (Table 12.10). Declining regional populations for the species suggest a **low recoverability** rate (Table 12.14). Therefore, herring gulls are considered to be of **high sensitivity and very high vulnerability** to collision risk.

In conclusion, the **overall effect** to herring gull is considered to be **negligible and not significant** (Table 12.25).

12.6.2.1.7 Great skua

Great skuas have been found to fly at lower heights when migrating compared to foraging (Ross-Smith *et al.,* 2016); Furness & Wade, 2012; Johnston *et al.,* 2014), suggesting a greater vulnerability to collision impacts during the breeding season. Furthermore, great skuas rarely fly during the night (when a bird's ability to detect WTG blades is reduced) and have relatively flexible diets, foraging in shallow seas in the continental shelf and around fishing vessels (Furness & Wade, 2012), and could therefore avoid the PFOWF Array Area by feeding in other areas. Great skuas present a relatively large foraging range (mean max 443.3 km ±487.9 SD; Woodward *et al.,* 2019), increasing the possibility for birds from further colonies to visit the PFOWF Array Area.

A mean total (annual) collision mortality of zero birds was estimated using the CRM Option 2 and applying a 98.0% avoidance rate. Considered against the regional breeding population of great skuas (11,420 birds), the predicted mortalities do not surpass 0.2% of the baseline mortalities (3 birds) (Table 12.15 and Table 12.16).

In this regard, the impact is therefore defined as being of **no changed magnitude.** Great skuas are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Unknown regional population trends suggest a **moderate recoverability** rate (Table 12.14). Therefore, great skuas are considered to be of **high sensitivity and moderate vulnerability** to collision risk.

In conclusion, the **overall effect** to great skuas is considered to be **negligible and not significant** (Table 12.25).

12.6.2.1.8 Red-throated diver

Red-throated divers are considered moderately vulnerable to collision impacts due to a generally moderate proportion of birds flying at potential collision risk height (Johnston *et al.,* 2014), a very low manoeuvrability capacity and the time spent flying, during both day and twilight when chick rearing (when bird's ability to detect WTG blades is reduced) (Furness & Wade, 2012). Red-throated divers breed in freshwater habitats or lochs and fly at sea only to forage or migrate south (Forrester *et al.,* 2012). The estimated foraging range for the species is relatively low (mean max 9.0 km ±0.0 SD; Woodward *et al.,* 2019), limiting the potential presence of birds from further colonies in the PFOWF Array Area.

Recorded red-throated diver numbers on-site were so low that collision risk could not be quantified but is effectively zero. The impact is therefore defined as being of **no changed magnitude.** Red-throated divers are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Unknown regional population trends suggest a **low recoverability** rate (Table 12.14). Therefore, red-throated divers are considered to be of **low sensitivity and moderate vulnerability** to collision risk.

In conclusion, the **overall effect** to red-throated divers is considered to be **negligible and not significant** (Table 12.25).

12.6.2.1.9 Wildfowl and waders

Wildfowl and wader collision risk has been addressed strategically in the WWT (2014) report to MS. This collated information on migratory pathways for a range of wildfowl and wader species and determined the migratory fronts. Species which may potentially migrate over the PFOWF Array Area (for which data were available in the WWT report) include whooper swan, pink-footed goose, greylag goose, wigeon, teal, pintail, tufted duck, scaup, long-tailed duck, common scoter and golden plover. None of these species were recorded during the two years of digital aerial survey work except golden plover for which there is an incidental record of one bird recorded on 24th September 2020. This is not surprising given the focus of the digital aerial survey work is on diurnal seabird flight activity at sea, and it is not designed to track the migratory (often nocturnal) movements of wildfowl and waders.

Specific assessment of collision risk from the Offshore Development to wildfowl and wader species is not currently feasible, however, the strategic assessment undertaken by WWT confirmed that ‘the populations of non-seabird species which pass through Scottish waters do not appear to be at risk of significant levels of additional mortality due to collisions with Scottish offshore wind farms’. The amount of development considered in the WWT (2014) report remains ‘worst case’ at the present time, a larger number of WTGs assessed for wildfowl and wader collision risk than what has actually been consented and built out. The Offshore Development along with the other small-scale demonstrators (Kincardine and Hywind) are encompassed by this ‘worst case’ and do not alter the outcomes or conclusions of the strategic assessment.

12.6.2.1.10 Nocturnally active species (including petrels and shearwaters)

The Scoping Opinion (MS-LOT, 2021) also raises the possibility that nocturnally active species, including petrels and shearwaters, may be attracted into the PFOWF Array Area due to the artificial lighting on the WTGs (Table 12.2; NatureScot 2020a). Seabird species have been observed to circle lit structures at night, particularly during poor weather such as rain and fog (Jones, 1980; Longcore *et al.*, 2013; Ronconi *et al.*, 2015). Some species including puffin, fulmar, storm petrel, Leach’s petrel and Manx shearwater are known to be particularly sensitive to artificial lighting especially where it is close to their nesting burrows and when the young birds are first fledging (Rich and Longcore, 2006; Raine *et al*., 2007; Deppe *et al*., 2017; Longcore *et al*., 2018; Rebke *et al.*, 2019).

WTG lighting requirements (for aviation and navigational lighting) will be set out in the Lighting and Marking Plan (LMP) (Table 5.2, Chapter 5). Whilst this artificial lighting could potentially attract species such as puffin, fulmar, storm petrel, Leach’s petrel and Manx shearwater into the PFOWF Array Area it should not in any way increase their exposure to collision risk, as there should be no significant change to their flight height and the birds will continue to fly below the sweep of the WTG blades.

12.6.2.2 Potential displacement impact due to physical presence of WTGs

As identified in Section 12.4.4, displacement assessment has been undertaken for the following species: guillemot, razorbill, puffin, fulmar, gannet, Arctic tern and red-throated diver. Kittiwake have been included for consideration as requested in the Scoping Opinion (MS-LOT, 2021).

Individuals of these species may potentially show some level of avoidance around the operational WTGs and could potentially be displaced from the PFOWF Array Area and maybe also from the 2 km buffer (although this is likely to be to a lesser degree, decreasing with increasing distance from the operational WTGs). Displacement impacts are addressed in detail in Technical Appendix 12.4: Displacement Analysis which discusses methodologies and reports the estimated impacts.

As requested by MSS and NS (advice received 31st March 2022), the distance decay version of SeabORD (v1.3) has been used to model displacement and barrier effects potentially arising from the Offshore Development on kittiwake, guillemot, razorbill and puffin at North Caithness Cliffs SPA. The modelling methodology is described in Section 2.1 of Technical Appendix 12.4: Displacement Analysis, with the results presented in Section 3,1 and Annex 1 of that appendix. SeabORD outputs are summarised in Table 12.23 for the four species.

SeabORD modelling indicates that the updated rates of displacement mortality advised by NS/MSS for use in displacement matrices (SNCB, 2017) are over-estimated in respect of the auk species. And if they are over-estimated for the auks (considered to be most vulnerable to displacement and its energetic consequences) then this will also be the case for all the other species. In this regard, whilst the Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis lists the full range of matrix outputs, the species summaries in Table 12.24 presents estimated displacement mortality at the 'most realistic' mortality rates, informed by comparing the apportioned matrix estimates for North Caithness Cliffs SPA against SeabORD model outputs. This comparison indicates that assessment should be based on a 1% mortality rate for all species except kittiwake and razorbill where a 2% rate is used. The mortality estimates provided in Table 12.24 are for the PFOWF Array Area plus 2 km buffer, except for puffin where it is the figure for the Array Area alone.

Table 12.23 Summary of SeabORD outputs for kittiwake, guillemot, razorbill and puffin in the five sub-sites within North Caithness Cliffs SPA.

	Environmental conditions	Dunnet Head	Duncansby Head	Holburn Head	Melvich	Stroma	SPA total
Additional annual adult mortalities due to the Offshore Development							
Kittiwake	Moderate	0.70	0.20	0.00	1.60	0.10	2.60
Guillemot*	Good	2.31	1.69	0.00	0.77	0.77	5.54
Razorbill	Moderate	0.20	0.10	0.10	0.80	0.10	1.30
Puffin	Moderate	0.50	0.00	0.00	1.30	0.00	1.80

** A scaling factor of 1/0.65 has been applied to the guillemot outputs to account for the fact that simulations were run using only 65% of the population.*

Table 12.24 Summary of estimated seasonal displacement mortalities

Species	Percentage of Birds Displaced (%)	Breeding Season Mortality (%)	Non-Breeding Season Mortality (%)	Number of Birds Displaced			
				Breeding Season Mortality	Autumn Migration Mortality	Non-Breeding Season Mortality	Spring Migration Mortality
Kittiwake	30	2	2	3	1	not applicable	0
Guillemot	60	1	1	7	not applicable	4	not applicable
Razorbill	60	2	1	2	0	0	0
Puffin*	60	1	1	7	not applicable	0	not applicable
Fulmar	30	1	1	3	0	0	1
Gannet	70	1	1	1	0	not applicable	0

Species	Percentage of Birds Displaced (%)	Breeding Season Mortality (%)	Non-Breeding Season Mortality (%)	Number of Birds Displaced			
				Breeding Season Mortality	Autumn Migration Mortality	Non-Breeding Season Mortality	Spring Migration Mortality
Great skua	30	1	1	0	0	0	0
Arctic tern	30	1	1	0	0	not applicable	0

** The displacement matrices appear to be substantially over-estimating the level of potential mortality to puffin, compared to SeabORD modelling. In this regard, the figure presented for puffin is for the PFOWF Array Area alone and excludes the 2 km buffer.*

12.6.2.2.1 Kittiwake

Kittiwakes are typically not considered vulnerable to displacement impacts due to the presence of wind farms (Furness & Wade, 2012) although empirical evidence is mixed. Vanermen *et al.* (2014) report increased foraging rates within a Belgian wind farm array, whilst elsewhere, reductions in kittiwake abundance within operational arrays has been documented (Mendel *et al.,* 2014; Peschko *et al.,* 2020). The magnitude of the displacement response may vary seasonally (Peschko *et al.,* 2020). Kittiwake has been included for consideration as requested in the Scoping Opinion (MS-LOT, 2021). Although seasonal variability may occur, kittiwakes tend to forage within the 200 m depth contour of the continental shelf and other deeper areas (coinciding with the PFOWF Array Area location) and present a relatively large foraging range (mean max 156.1 km ±144.5 SD; Woodward *et al.,* 2019). This, coupled with the value of the foraging habitat within the PFOWF Array Area and the time of year, is likely to influence whether displacement occurs or not.

Kittiwake displacement was investigated both by using SeabORD (for the population at North Caithness Cliffs SPA) and by application of a displacement matrix (SNCB, 2017). Comparison of the two methods and the model outputs indicated that a 2% mortality rate might be most appropriately applied for kittiwake. The percentage of birds displaced was set to 30% across all seasons, and the 2% mortality rate applied to both breeding and non-breeding impacts resulting in estimated mortalities of three birds and one bird respectively (Table 12.24).

Considered against the regional breeding population (170,138 birds) and the BDMPS autumn and spring regional populations (829,937 and 627,816 birds respectively), the estimated kittiwake mortalities (three during the breeding season and one during autumn migration) are well below 0.2% of the baseline mortalities (50, 242 and 183 birds) (Table 12.15 and Table 12.16).

Therefore, the **impact** is defined as being of **negligible magnitude.** Kittiwakes are considered to be **very high value** receptors because of their protection status under the OSPAR, IUCN and the UK Birds of Conservation Concern lists (Table 12.10). Declining regional populations for the species suggest a **low recoverability** (Table 12.14). Kittiwakes are considered to be of **low sensitivity and vulnerability** to displacement.

In conclusion, the **overall effect** to kittiwakes is considered to be **negligible and not significant** (Table 12.25).

12.6.2.2.2 Guillemot

Guillemots are considered highly vulnerable to displacement impacts and generally display evident disturbance reactions to the presence of wind farms (Leopold *et al*., 2013; Mendel *et al.,* 2014; Vanerman *et al.,* 2014; Searle *et al.,* 2014; Wade *et al.,* 2016). The magnitude of the displacement response may vary seasonally (Peschko *et al*., 2020). Whilst post-construction monitoring is still fairly limited, the work which has been done indicates little or no wind farm avoidance, including data from Robin Rigg (Vallejo *et al.*, 2017), North Hoyle (PMSS, 2007) and initial results from Beatrice (McArthur Green, 2019).

Guillemots feed almost exclusively offshore with a preference to feed on sandeel and will travel moderate distances to forage (mean max 73.2 km ±80.5 SD; Woodward *et al.,* 2019). Wade *et al.* (2016) considered guillemots to have moderate habitat use flexibility. Consequently, any displacement may affect guillemots' survival and breeding success (Searle *et al.,* 2014).

Guillemot displacement was investigated both by using SeabORD (for the population at North Caithness Cliffs SPA) and by application of a displacement matrix (SNCB, 2017). Comparison of the two methods and the model outputs indicated that a 1% mortality rate might be most appropriately applied for guillemot. The percentage of birds displaced was set to 60% across all seasons, and the 1% mortality rate applied during both the breeding and non-breeding season. This resulted in estimated mortalities of seven birds and four birds respectively (Table 12.24).

Considered against the regional breeding population (378,293 birds) and regional BDMPS non-breeding population (848,710 birds), the estimated guillemot mortalities are well below 0.2% of the baseline mortalities (46 and 104 birds respectively) (Table 12.15 and Table 12.16).

Therefore, the **impact** is defined as being of **negligible magnitude.** Guillemots are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Increasing regional populations for the species suggest a **moderate recoverability** rate (Table 12.14). Therefore, guillemots are considered to be of **high sensitivity and vulnerability** to displacement.

In conclusion, the **overall effect** to guillemot is considered to be **minor and not significant** (Table 12.25).

12.6.2.2.3 Razorbill

Razorbills are considered moderately vulnerable to displacement impacts, generally showing moderate disturbance reactions to the presence of wind farms (Vanerman *et al.,* 2014; Searle *et al.,* 2014; Wade *et al.,* 2016). Razorbills preferentially forage in shallow waters and selective diet (Forrester *et al.,* 2012), travelling moderate distances to forage (mean max 88.7 km ±75.9 SD; Woodward *et al.,* 2019). Wade *et al.* (2016) considered that razorbill had moderate habitat use flexibility. However, displacement was previously found not to highly effect breeding razorbills survival rate nor breeding success (Searle *et al.,* 2014).

Razorbill displacement was investigated both by using SeabORD (for the population at North Caithness Cliffs SPA) and by application of a displacement matrix (SNCB, 2017). Comparison of the two methods and the model outputs was difficult because predicted estimates were so low. On a precautionary basis, a 2% mortality rate has been applied for razorbill. The percentage of birds displaced was set to 60% across all seasons, and the 2% mortality rate applied to both breeding and non-breeding impacts resulting in estimated mortalities of two birds and zero birds respectively (Table 12.24).

Considered against the regional breeding population (47,737 birds) and the regional BDMPS non-breeding and migration populations (218,622 and 591,874 birds respectively), the estimated razorbill mortalities are below 0.2% of the baseline mortalities (Table 12.15 and Table 12.16).

Therefore, the **impact** is defined as being of **negligible magnitude.** Razorbill are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Increasing regional populations for the species suggest a **moderate recoverability** rate (Table 12.14). Therefore, razorbill are considered to be of **high sensitivity and moderate vulnerability** to displacement.

In conclusion the **overall effect** to razorbill is considered to be **minor and not significant** (Table 12.25).

12.6.2.2.4 Puffin

Puffins are considered moderately vulnerable to displacement impacts. There is little evidence that examines puffin-specific displacement rates. Although Wade *et al.* (2016) concluded that puffins show moderate displacement responses, it should be noted that a lower displacement vulnerability score than for other auk species was assigned. Puffins forage far from their colonies throughout the year with a preference for pelagic waters and more varied diet during the winter (Forrester *et al.,* 2012). Puffins travel long distances to forage (mean max 137.1 km ±128.3 SD; Woodward *et al.,* 2019), and Wade *et al.* (2016) considered this species to have moderate habitat use flexibility.

Note that puffin disperse from North Caithness Cliffs SPA and other SPAs in the region from mid-August onwards. They are not present in the Pentland Firth in any significant numbers over winter with a mean seasonal peak of only six birds in the PFOWF Array Area and 2 km buffer. Therefore, assessment is focused to the breeding period.

Puffin displacement was investigated both by using SeabORD (for the population at North Caithness Cliffs SPA) and by application of a displacement matrix (SNCB, 2017). Comparison of the two methods and the model outputs indicated that the displacement matrix was significantly over-estimating the potential levels of mortality in relation to puffin as further discussed in Technical Appendix 12.4: Displacement Analysis. Even at a 1% rate of mortality, and removing the 2 km buffer, the matrix estimates for puffin are still 4.89 mortalities apportioned against North Caithness Cliffs compared to the 1.8 mortalities predicted by SeabORD (Table 12.23).

Considered against the regional breeding population (116,543 birds), these predicted mortalities are below 0.2% of the baseline mortality (22 birds) (Table 12.15).

In this regard, the **impact** is defined as being of **low magnitude.** Puffins are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Increasing regional populations for the species suggest a **moderate recoverability** rate (Table 12.14). Therefore, puffins are considered to be of **high sensitivity and moderate vulnerability** to displacement.

Whilst application of the 'significance of effects' matrix (Table 12.17) would suggest moderate and significant effects this conclusion has been reviewed in light of the advice in Table 12.18 and the outcomes of the PVA undertaken to assess the population consequences for puffin at North Caithness Cliffs SPA (to which most of the impacts are apportioned) (Technical Appendix 12.5: Population Modelling)**.** The PVA confirms that there should be no significant effect on puffin population viability at North Caithness Cliffs SPA from estimated displacement mortalities either from SeabORD or from the displacement matrix (at a 60% displacement rate and 1% mortality rate). Respectively, there is predicted to be only a 3% or a 4.3% reduction in population size at the end of the PVA model period due to these impacts, compared to baseline (Technical Appendix 12.5: Population Modelling).

Puffin displacement impacts have also been mitigated as far as possible through the use of embedded mitigation (see Section 12.5.5), particularly the significant reduction in the PFOWF Array Area (half what it was originally, see Figure 12.1). Applying expert judgement to consider these issues results in a conclusion that the **overall effects** are **minor and not significant** (Table 12.25).

12.6.2.2.5 Fulmar

Although fulmars are not considered vulnerable to displacement impacts due to the presence of wind farms (Furness *et al.,* 2013; Wade *et al.,* 2016), they were included in the assessment on a precautionary basis. Fulmars feed in a wide range of habitats and have a varied diet (Forrester *et al.,* 2012).

To estimate the displacement mortalities of fulmars, the percentage of birds displaced was set to 30% across all seasons, with a breeding season mortality of 1% and a non-breeding season mortality of 1% (Table 12.24). A displacement mortality of three birds was estimated during the breeding season, zero birds during the BDMPS winter season and autumn migration, and one bird during the BDMPS spring migration (Table 12.24).

Considered against the regional breeding population (380,460 birds), the BDMPS migration and winter populations (1,785,696 and 1,125,103 birds respectively), estimated mortalities are well below 0.2% of the baseline mortalities (49, 229 and 144 birds respectively) (Table 12.15 and Table 12.16).

In this regard, the **impact** is defined as being of **negligible magnitude.** Fulmars are considered to be **high value** receptors because of their protection status in Europe and under the UK Birds of Conservation Concern list (Table 12.10). Declining regional populations for the species suggest a **low recoverability** rate (Table 12.14). Therefore, fulmars are considered to be of **low sensitivity and very low vulnerability** to displacement.

In conclusion, the **overall effect** to fulmar is considered to be **negligible and not significant** (Table 12.25).

12.6.2.2.6 Gannet

Gannets were considered of low vulnerability to displacement impacts by Furness *et al.* (2013) and Wade *et al.* (2016). However, there is empirical evidence to show that gannets are displaced from operational wind farms (Leopold *et al*., 2013; Vanerman *et al*., 2014). McArthur Green (2019) reported no significant change in the abundance of gannets at the Beatrice offshore wind farm pre- and post-construction but did report a strong spatial response with low density at the centre of the operational array. Gannets feed in a wide range of habitats with various diets (Furness & Wade, 2012), therefore resulting in high habitat use flexibility (Wade *et al.,* 2016).

The species also has a relatively large foraging range (mean max 315.2 km ±194.2 SD; Woodward *et al.,* 2019), reducing displacement effects from an energetics perspective (Searle *et al.,* 2014).

To estimate the displacement mortalities of gannets, the percentage of birds displaced was set to 70% across all seasons, with breeding and non-breeding mortality rates of 1% (Table 12.24). A displacement mortality of one bird was estimated during the breeding season, and zero birds during the BDMPS autumn and spring migration periods (Table 12.24).

Considering the single estimated gannet displacement mortality against the regional breeding population (409,970 birds), it is apparent that it is well below 0.2% of the baseline mortality (66 birds) (Table 12.15). This results in only 0.03 displacement mortalities assigned against the SSSI population of gannet at Troup, Pennan and Lion's Heads SPA.

Therefore the **impact** is defined as being of **negligible magnitude.** Gannets are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Increasing regional populations for the species suggest a **high recoverability** rate (Table 12.14). Therefore, gannets are considered to be of **moderate sensitivity and high vulnerability** to displacement.

In conclusion the **overall effect** to gannet is considered to be **minor and not significant** (Table 12.25).

12.6.2.2.7 Arctic tern

Arctic terns are not considered to be highly vulnerable to displacement by the presence of offshore wind farms, with little reaction to wind farms observed at several offshore sites (Dierschke *et al.,* 2016; Wade *et al.,* 2016).

To estimate the displacement mortalities of Arctic terns, the percentage of birds displaced was set to 30% across all seasons, with breeding and non-breeding mortality rates of 1% (Table 12.24). During the breeding season, the mean seasonal peak for Arctic tern was only 46 birds, resulting in an estimated displacement mortality of zero birds. In the BDMPS autumn and spring migration periods, the mean seasonal peaks for each were zero birds, so therefore zero mortality was predicted (Table 12.24).

These predicted **impacts** are considered against the local Arctic tern populations at Melvich Bay, Caol Loch, Dounreay and Georgemas and determined as being of **no changed magnitude**.

Arctic tern are considered to be **high value** receptors because of their protection status in Europe (Annex I EU Birds Directive) and under the UK Birds of Conservation Concern list (Table 12.10). Declining regional populations for the species suggest a **low recoverability** rate (Table 12.14). Therefore, Arctic terns are considered to be of **moderate sensitivity and low vulnerability** to displacement.

In conclusion, the **overall effect** to Arctic terns is considered to be **negligible and not significant** (Table 12.25).

12.6.2.2.8 Great skua

Great skuas are not considered to be highly vulnerable to displacement by the presence of offshore wind farms, with the species ranked as low concern (Furness & Wade, 2012). The relatively large foraging range exhibited by the species (mean max 443.3 km ±487.9 SD; Woodward *et al.,* 2019), suggests high habitat use flexibility, which may reduce negative effects of displacement from the Survey Area.

To estimate the displacement mortalities of great skuas, the percentage of birds displaced was set to 30% across all seasons, with breeding and non-breeding mortality rates of 1% (Table 12.24). During the breeding season, the mean seasonal peak for great skua was only seven birds, resulting in an estimated displacement mortality of zero birds. In the BDMPS autumn and spring migration periods, the mean seasonal peaks for each were zero birds, so therefore zero mortality was predicted (Table 12.24).

In this regard, the **impact** is defined as being of **no changed magnitude.** Great skuas are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Unknown regional population trends suggest a **moderate recoverability** rate (Table 12.14). Therefore, great skuas are considered to be of **low sensitivity and vulnerability** to displacement.

In conclusion, the **overall effect** to great skua is considered to be **negligible and not significant** (Table 12.25).

12.6.2.2.9 Red-throated diver

Red-throated divers are considered highly vulnerable to displacement by the presence of offshore wind farms, with the species ranked amongst the three species with the highest concerns (Furness *et al.,* 2013; Wade *et al.,* 2016). The estimated foraging range for the species is relatively low compared to other species (mean max 9.0 km ±0.0 SD; Woodward *et al.,* 2019), increasing displacement effects from an energetics perspective. Red-throated divers preferably utilise shallow feeding grounds with shellfish banks and so there is little flexibility in their foraging habits (Wade *et al.,* 2016). However, the red-throated diver is an opportunistic feeder and can take a broad range of fish species (Guse *et al.,* 2009; Kleinschmidt *et al.,* 2019).

Recorded red-throated diver numbers on-site were so low that displacement impacts could not be quantified but are effectively zero.

In this regard, the **impact** is defined as being of **no changed magnitude.** Red-throated divers are considered to be **high value** receptors because of their protection status under the UK Birds of Conservation Concern list (Table 12.10). Unknown regional population trends suggest a **low recoverability** rate (Table 12.14). Therefore, red-throated divers are considered to be of **high sensitivity and very high vulnerability** to displacement.

In conclusion, the **overall effect** to red-throated diver is considered to be **negligible and not significant** (Table 12.25).

12.6.2.3 Potential for a barrier effect due to physical presence of WTGs

Seabird species vary in their reactions to offshore wind farms (Furness & Wade, 2012), of which the continuous presence during the operation and maintenance phase may cause long-term disturbance to seabirds over large distances (Garthe & Hüppop, 2004) (disturbance impacts are discussed in Section 12.6.1.1).

Avoidance behaviour and barrier effects could result in additional energy requirements, depending on the foraging range and body mass of the bird, the number of foraging trips undertaken daily and the flight characteristics (Masden *et al.,* 2010; Fox & Petersen, 2019). Barrier effects, by their nature, are dependent on the size and location of the wind farm in relation to the colony and foraging locations.

Whilst the PFOWF Array Area is located close to the coast (within 7.5 km of nearest colonies at North Caithness Cliffs SPA) it is not anticipated that it will present a significant barrier to seabird movements, particularly considering the auk species. Barrier effects related to the Offshore Development were included as part of the SeabORD modelling for kittiwake, guillemot, razorbill and puffin at North Caithness Cliffs SPA (Technical Appendix 12.4: Displacement Analysis). Although inseparable from displacement impacts, the SeabORD model outputs confirmed that there is no risk of significant barrier effects from such a small-scale development (only 10 km^2), despite its close proximity to a breeding seabird colony (the Melvich SPA sub-site at 7.5 km distance Figure 12.1).

The **sensitivity** of gannet to barrier effects is considered to be **high** but as this species has a large foraging range, such effects are likely to be negligible from an energetics perspective (Searle *et al.,* 2014). Empirical studies show less pronounced avoidance behaviour around operating wind farms by gulls, fulmars and terns (Masden *et al.,* 2010). Therefore, the **sensitivity** of all other ornithological receptors to barrier effects during the operation and maintenance phase is considered to be **moderate.** The **magnitude** of impact on all species is considered **negligible** and the **overall effect** is considered to be **minor and not significant** (Table 12.25).

12.6.2.4 Potential for entanglement with debris caught on mooring lines

This impact is most often considered in respect of marine mammal interests; however, diving birds also have the potential to become entangled with debris caught on mooring lines, particularly ‘ghost’ or derelict fishing gear. Auk species (guillemot, razorbill and puffin) and gannet all forage for prey in the water column and are able to dive to considerable depths; guillemot routinely forage to depths of 60 m (Robinson, 2005). The deepest dives of auks recorded in the non-breeding season from tagged birds on the Isle of May were 118.2, 47.4 and 38.4 m for guillemot, razorbill and puffin respectively (Dunn *et al.,* 2019). Offshore wind farm developments have the potential to become Fish Aggregation Devices (FADs) which are attractive to fish because seaweed and kelp growing on sub-sea structures and cables provide shelter and habitat for juvenile fish. Increased fish density within the Offshore Development may be attractive to seabirds and consequently increases the risk of entanglement.

In a ‘worst case’ scenario, the Offshore Development is committing to a minimal spacing between each WTG of 800m with a maximum of nine moorings per WTG. The according maximum mooring line length based on maximum water depth at the Offshore Development (102 m) would equate to 1,650 m. The moorings would be contained in the boundary of the PFOWF Array Area and will therefore not be extending into the buffer.

Although the overall operation and maintenance strategy for the Offshore Development will be developed post-consent, it is anticipated that the inspections will follow the inspection scheme stipulated by the mooring line original equipment manufacturer (OEM). In this regard there will be inspections to collect and remove debris (such as abandoned fishing nets, pots and other marine rubbish) amongst the mooring lines (see Section 5.10.2, Chapter 5). This embedded mitigation will help reduce the potential likelihood of any entanglement occurring.

If entanglement were to occur it has the potential to result in injury or death to the individual and as such it is considered that diving birds have **high sensitivity** and **high vulnerability** to entanglement. However, the impact is considered to be of **negligible magnitude**, highly unlikely to occur with the risk further reduced by regular inspection, as proposed.

The overall effect on diving seabirds from entanglement with debris caught on mooring lines is therefore considered to be **minor and not significant** (Table 12.25).

12.6.2.5 Potential disturbance / exclusion due to marine noise and maintenance works

As for construction (see Section 12.6.1.1), seabirds are considered to be of **moderate sensitivity** and **low vulnerability** to disturbance/displacement/exclusion impacts from marine noise and vessel presence during operation and maintenance activity. This includes planned and unplanned maintenance activities in relation to all infrastructure through its operational life-cycle – up to seven WTGs, up to 63 anchors and up to 25 km of offshore export cable (Table 12.19).

Whilst operation and maintenance activities occur over the long-term, operational life-cycle of the Offshore Development, the noise they may create, the sediment they may release and the disturbance they may cause will be much less than that arising during construction. Impacts will be highly localised and intermittent. Also, the potential maximum number of vessels on-site at any one time will be significantly less than the construction ‘worst case’.

In this regard, the embedded mitigation for an Offshore Environmental Management Plan (OEMP) (Table 12.20) is relevant to consider and reduces the **magnitude** of the operation and maintenance impacts from low to **negligible**.

Therefore, the **overall effects** on seabirds from all planned and unplanned operation and maintenance activities are assessed as **minor and not significant** (Table 12.25).

12.6.2.6 Potential change in habitat / prey availability due to physical presence of WTGs and cable protection

Chapter 9: Benthic Ecology and Chapter 10: Fish and Shellfish Ecology indicate the potential habitat and prey species to be found in the PFOWF Array Area and along the Offshore Export Cable(s) route. For both chapters, impacts on potential seabird prey receptors (e.g. herring, sandeels) were assessed minor and not significant.

12.6.2.6.1 WTGs

In respect of the direct loss of habitat due to WTGs, the ‘worst case’ scenario comprises the use of nine gravity anchors per WTG, with a loss of ~900 m^2 of seabed per anchor, for a maximum of seven WTGs. This would result in a direct loss of potential habitat of 0.081 km^2, which is only a small fraction of the PFOWF Array Area of 10 km^2 (0.81%) and even less in terms of the seabird foraging ranges under consideration. In this regard, the impact is considered to be of **negligible magnitude** whilst seabirds are of **moderate sensitivity** and **low vulnerability** to it. The **overall effect** is assessed to be **minor and not significant** (Table 12.25).

The possibility that birds may be excluded from accessing available habitat or prey within the PFOWF Array Area is addressed under the displacement assessment in Section 12.6.2.2.

12.6.2.6.2 OECC

Burial of cables is preferred over the addition of cable protection to reduce environmental impact, protect the cable and to reduce risks to all seabed users (Marine Scotland, 2015; JNCC, 2019). When complete burial is not possible, cable protection may be required. However, this should be minimised as it could directly affect and change habitats, potentially including those that support the prey species of seabirds. In this respect, the 'worst case' scenario comprises the protection of up to 50% of the cables, equating to the protection of up to 12,500 m of cable length and a potential maximum area of 87,500 m^2 (Chapter 5: Project Description, Section 5.5.1). In this regard, loss of supporting habitat and prey through cable protection is considered to be of **low magnitude** whilst seabirds are of **moderate sensitivity** and **low vulnerability** to it. The **overall effect** is assessed to be **minor and not significant** (Table 12.25).

12.6.2.7 Potential increase in suspended sediment affecting visibility during operations and maintenance

The potential for release of suspended sediment during wind farm operation and maintenance is assessed in Chapter 8, Water and Sediment Quality. It was concluded that increase in suspended sediment arising from operation and maintenance (floating structure, presence of vessels) within the PFOWF Array Area would be temporary and negligible and will not alter the quality of the designated waters in respect to seabirds.

As discussed in Section 12.6.1.4, this impact may affect diving seabirds whilst they are present in the water column. The amount of sediment potentially released during operation and maintenance activities is considerably less than that considered for the construction and decommissioning impacts.

In this regard, the seabirds potentially affected are considered to be of **moderate sensitivity** and **low vulnerability** to any potential increase of suspended sediment in the water column, affecting visibility. The impact is considered to be of **negligible magnitude** during operations and maintenance and will not affect the fitness of individual birds.

The **overall effect** on diving seabirds from an increase in suspended sediment during operations and maintenance is considered to be **minor and not significant** (Table 12.25).

12.6.2.8 Creation of a roosting habitat or foraging opportunities

Over the operational life cycle, birds may potentially use the floating substructures as a perching platform. Such new perching areas may allow birds to rest as well as providing easier access to foraging grounds (Vanermen *et al.*, 2013). Post-construction monitoring at wind farms in the Netherlands has shown an increase in the abundance of cormorants and gulls following construction (Leopold *et al.*, 2011). Shag have also been observed exhibiting roosting behaviour on offshore wind platforms (Perrow, 2019).

Given the limited number of floating substructures (one per WTG – up to seven), limited area for perching (semi-submerged maximum footprint of 15,625 m^2) and low likelihood of usage, the **magnitude** of impact is considered to be **negligible**. Any such attraction increasing the risk of collision with operational WTGs or of entanglement with mooring lines is also considered to be **negligible**. The **sensitivity** of bird receptors to this effect is considered to be **low** therefore the **overall** assessment concludes that this **effect** is **negligible and not significant** (Table 12.25).

Table 12.25 Summary of significance of effects from operations and maintenance impacts

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
Potential collision risk with operational WTGs	Kittiwake	High	Low	> All receptors considered to be of high value and kittiwake very high as set out in Table 12.14. > Sensitivity of each receptor is derived from Furness *et al.* (2013); see Section 12.4.4. > Professional judgement applied to interpretation of EIA matrix outcomes for kittiwake based on the population modelling undertaken at North	Minor effects	Not Significant	No additional mitigation measures have been identified for these effects above and beyond the embedded Offshore Development mitigation listed in Section12.5.5 as it was concluded that these effects were not significant...	Not Significant
	Guillemot	Low	No change		Negligible effects	Not Significant		Not Significant
	Razorbill	Low	No change		Negligible effects	Not Significant		Not Significant
	Puffin	Low	No change		Negligible effects	Not Significant		Not Significant
	Fulmar	Low	No change		Negligible effects	Not Significant		Not Significant
	Gannet	High	Negligible		Minor effects	Not Significant		Not Significant
	Arctic tern	Moderate	No change		Negligible effects	Not Significant		Not Significant
	Great black-backed gull	High	Negligible		Minor effects	Not Significant		Not Significant
	Great skua	High	No change		Negligible effects	Not Significant		Not Significant
	Herring gull	High	No change		Negligible effects	Not Significant		Not Significant
	Red-throated diver	Low	No change		Negligible effects	Not Significant		Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
				Caithness Cliffs SPA.				
Potential displacement impact due to physical presence of WTGs	Kittiwake	Low	Negligible	> All receptors considered to be of high value and kittiwake very high as set out in Table 12.14. > Sensitivity of each receptor is derived from Furness *et al.* (2013); see Section 12.4.4. > Professional judgement applied to interpretation of EIA matrix outcomes for puffin based on the population modelling undertaken at North	Negligible effects	Not Significant	No additional mitigation measures have been identified for these effects above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	Guillemot	High	Negligible		Minor effects	Not Significant		Not Significant
	Razorbill	High	Negligible		Minor effects	Not Significant		Not Significant
	Puffin	High	Low		Minor effects	Not Significant		Not Significant
	Fulmar	Low	Negligible		Negligible effects	Not Significant		Not Significant
	Gannet	Moderate	Negligible		Minor effects	Not Significant		Not Significant
	Arctic tern	Moderate	No change		Negligible effects	Not Significant		Not Significant
	Great black-backed gull	Low	No change		Negligible effects	Not Significant		Not Significant
	Great skua	Low	No change		Negligible effects	Not Significant		Not Significant
	Herring gull	Low	No change		Negligible effects	Not Significant		Not Significant
	Red-throated diver	High	No change		Negligible effects	Not Significant		Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
				Caithness Cliffs SPA.				
Potential for a barrier effect due to physical presence of WTGs.	All bird species scoped in for assessment	Moderate	Negligible	> 'Most likely' scenario is for a 2.5 km WTG array which should not require Significant energetic cost to fly around.	Minor effects	Not Significant	No additional mitigation measures has been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect is not significant.	Not Significant
Potential for entanglement with debris caught on mooring lines.	Diving seabirds (guillemot, razorbill, puffin, gannet)	High	Negligible	> Highly unlikely to occur and the risk is further reduced by regular inspection of mooring lines, as proposed.	Minor effects	Not Significant	No additional mitigation measures has been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect is not significant	Not Significant
Potential disturbance / exclusion due to marine noise and	All bird species scoped in for assessment	Moderate	Negligible	> Very localised effect and subsumed within the	Minor effects	Not Significant	No additional mitigation measures required for this effect above and beyond the embedded Offshore	Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
maintenance works.				predictions of wider displacement due to presence of wind WTGs.			Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant..	
Potential change in habitat/prey availability due to physical presence of WTGs.	All bird species scoped in for assessment	Moderate	Negligible	> Small amount of direct habitat loss; possibility of wider exclusion assessed as part of displacement analysis.	Minor effects	Not Significant	No additional mitigation measures required for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant...	Not Significant
Potential increase in suspended sediment from operations and maintenance work affecting visibility.	Diving seabirds (guillemot, razorbill, puffin, gannet)	Moderate	Negligible	> Magnitude of impact much lower than that for construction and decommissioning.	Minor effects	Not Significant	No additional mitigation measures required for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not signficant..	Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of Impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effect
Creation of a roosting habitat or foraging opportunities.	All bird species scoped in for assessment	Low	Negligible	- Limited number of floating substructures, limited area for perching and low likelihood of usage.	Negligible effects	Not Significant	No additional mitigation measures required for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant.	Not Significant

12.6.3 Effects During Decommissioning

12.6.3.1 Potential impact of disturbance/displacement/exclusion due to decommissioning noise or physical presence of vessels

As for construction (see Section 12.6.1.1), seabirds are considered to be of **moderate sensitivity** and **low vulnerability** to disturbance/displacement/exclusion impacts from decommissioning noise and vessel presence during decommissioning within the Offshore Development. This includes any indirect effects on their prey species which may also be disturbed or displaced during decommissioning (also considered in Section 12.6.3.3). The impacts (direct and indirect) are considered to be of low magnitude, they are localised around the decommissioning activity and associated vessels, occur intermittently and are temporary in nature; they do not compromise the fitness of individual birds and have no population-level consequences. Accounting for embedded mitigation (a decommissioning programme as referenced above) reduces these impacts to a **negligible magnitude**.

The **overall effect** on seabirds from decommissioning disturbance/displacement/exclusion is considered to be **minor and not significant** (Table 12.26).

12.6.3.2 Potential for a barrier effect due to physical presence of vessels and decommissioning equipment

There is no scope for the scale of proposed decommissioning activity for the Offshore Development – vessel presence and decommissioning equipment – to present a barrier to seabird movements. Seabirds are assessed to be of **moderate sensitivity** and **low vulnerability** to barrier effects, and there is assessed to be **no change** in respect of impact magnitude.

The **overall effect** on seabirds from this impact is considered to be **negligible and not significant** (Table 12.26).

12.6.3.3 Potential change in habitat/prey availability during decommissioning

As assessed in Section 12.6.3.1, decommissioning noise may also potentially disturb the prey species of seabirds. Potential effects on such prey species is considered in the Chapter 10; Fish and Shellfish Ecology. It was concluded that disturbance or damage to sensitive fish and shellfish species due to underwater noise generated from decommissioning activities for the Offshore Development would have a low impact on herring, sandeels and other fish and shellfish species. Without the need for additional mitigations, the overall effect on potential prey species of seabirds were assessed not significant and less than during construction activities and are therefore unlikely to indirectly impact prey availability of seabirds at the PFOWF Array Area.

In this regard, seabird **sensitivity** and **vulnerability** to the disturbance of their prey species during decommissioning is considered equal to those during the construction phase (**moderate** for auks and kittiwake, **high** for red-throated diver and **low** for the other seabird species). Seabirds will readily adapt to any such changes and simply follow the prey / forage in alternative locations where necessary. The foraging ranges of all species are very large compared to the area potentially impacted, so that this impact is assessed to be of **low magnitude** for auks, kittiwake and red-throated diver and **negligible magnitude** for the other seabird species, localised within the Offshore Development, temporary in nature and without any effect on the fitness of individual birds. With the application of embedded mitigation (a decommissioning programme as referenced above) the impacts for all species are reduced to **negligible magnitude**.

The overall effect on diving seabirds from a change in habitat/prey availability is therefore considered to be **minor and not significant** for all species (Table 12.26).

12.6.3.4 Potential increase in suspended sediment affecting visibility during decommissioning

The potential for release of suspended sediment during decommissioning is assessed in Chapter 8, Water and Sediment Quality. It was concluded that increase in suspended sediment arising from decommissioning work for the Offshore Development (cables, anchors, substructures, WTG removal) would be temporary and negligible and will not alter the quality of the designated waters in respect to seabirds.

For those seabird species potentially affected (guillemot, razorbill, puffin and gannet), they are considered to be of **moderate sensitivity** and **low vulnerability** to any potential increase of suspended sediment in the water column, affecting visibility. This impact is localised around the activity that's potentially releasing the sediment, temporary in nature and without any effect on the fitness of individual birds. With the application of embedded mitigation (a decommissioning programme as referenced above) it is determined to be of **negligible magnitude**.

The overall effect on diving seabirds from an increase in suspended sediment is considered to be **minor and not significant** (Table 12.26).

Table 12.26 Summary of significance of effects from decommissioning impacts

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effects
Potential impact of disturbance / displacement / exclusion due to decommissioning noise or physical presence of vessels.	All bird species scoped in for assessment	Moderate	Negligible	> All receptors considered to be of high value and kittiwake very high as set out in Table 12.14. > Effects are localised intermittent and temporary, further reduced by embedded mitigation.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant.	Not Significant
Potential for a barrier effect due to physical presence of vessels and decommissioning equipment.		Moderate	No change	> All receptors considered to be of high value and kittiwake very high as set out in Table 12.14.	Negligible effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that	Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effects
				> No potential for a barrier effect from scale of activity; vessel presence and construction equipment.			this effect was not significant.	
Potential change in habitat / prey availability during decommission-ing.	Auks (guillemot, razorbill, puffin)	Moderate	Negligible	> Auk species considered to be of high value. > Effects are localised and temporary, with no impacts on individual fitness of birds.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant .	Not Significant
	Kittiwake	Moderate	Negligible	> Kittiwake considered to be of very high value.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore	Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effects
				> Effects are localised and temporary, with no impacts on individual fitness of birds.			Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant.	
	Red-throated diver	High	Negligible	> Red-throated diver considered to be of high value. > Effects are localised and temporary, with no impacts on individual fitness of birds.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant.	Not Significant
	Other species scoped in for assessment	Low	Negligible	> Effects are localised and temporary, with no impacts on individual	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development	Not Significant

Summary of Effect	Receptor	Sensitivity of Receptor	Magnitude of impact	Rationale	Consequence	Significance of Effect	Additional Mitigation Requirements	Significance of Residual Effects
				fitness of birds.			mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant.	
Potential increase in suspended sediment affecting visibility during decommissioning.	Diving birds (guillemot, razorbill, puffin, gannet)	Moderate	Negligible	> All receptors considered to be of high value and kittiwake very high as set out in Table 12.14. > Effects are localised and temporary, with no impacts on individual fitness of birds.	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that this effect was not significant	Not Significant

12.7 Assessment of Cumulative Impacts

12.7.1 Introduction

The consideration of projects which could result in potential cumulative impacts is based on the results of the Offshore Development specific impact assessment, above, together with the expert judgement of the specialist consultant and consultation with MSS, NS and RSPB Scotland. The long list of projects considered in relation to cumulative assessment are presented in Table 12.27.

Table 12.27 Long list of projects considered for the Marine Ornithology Cumulative Impact Assessment

Development Type	Project	Status	Distance to the Offshore Development (km)	Species to consider	Data confidence	Risk of potentially significant cumulative impact?
Offshore wind farm	Beatrice	Operational	58	All identified seabirds	Low	Yes
Offshore wind farm	Moray East	Operational	66	All identified seabirds	Low	Yes
Offshore wind farm	Moray West	Consented	64	All identified seabirds	Low	Yes
Offshore wind farm	Hywind Scotland	Operational	184	All identified seabirds	Low	No
Offshore wind farm	Kincardine	Operational	205	All identified seabirds	Low	No
Offshore wind farm	EOWDC	Operational	181	All identified seabirds	Low	No
Offshore wind farm	Neart na Gaoithe	Under construction	264	Gannet	Low	No
Offshore wind farm	Inch Cape	Consented	240	Gannet	Low	No
Offshore wind farm	Seagreen	Under construction	238	Gannet	Low	No
Offshore wind farm	Forthwind (Original / Revised)	Consented / Scoping	271	Gannet	Low	No
Offshore wind farm	Berwick Bank	Scoping	268	Gannet	No available data	Future consideration
Offshore wind farm	West of Orkney	Scoping	20	All identified seabirds	No available data	Future consideration

Development Type	Project	Status	Distance to the Offshore Development (km)	Species to consider	Data confidence	Risk of potentially significant cumulative impact?
Offshore wind farms	ScotWind	Pre-scoping	-	All identified seabirds	No available data	Future consideration
Onshore wind farms, various		Various	-	Red-throated diver	Low	No
North Sea offshore wind farms		Various	-	Kittiwake	Low	Possible
European Marine Energy Centre (EMEC) and Meygen, tidal developments		Various	-	Diving seabirds	Low	No
Ports and harbour development including Scapa deep water quay and Hatston expansion project		Various	-	All identified seabirds	Low	No
SHE Transmission Orkney - Caithness project		Consented	0	All identified seabirds	Low	No

12.7.1.1 Cut-off dates for projects at pre-scoping or scoping stages

The approach to the assessment of projects includes:

> Quantitative assessment of projects submitted to Scoping up to six months prior to PFOWF application submission;

> Qualitative assessment of projects submitted to Scoping up to five months prior to PFOWF application submission; and

> Acknowledgement of projects submitted to Scoping between five and two months prior to submission of the PFOWF application submission.

This approach was shared and agreed with MS-LOT and agreement was confirmed via email on 6th December 2021. The approach to the cumulative assessment is set out in Offshore EIAR (Volume 3): Appendix 6.1. The approach and list of cumulative projects screened into the assessment were provided to MS-LOT and consultees and comments were received on 16th May 2022. These comments have been taken into account within this assessment.

As agreed with MS-LOT, ScotWind Projects and Offshore Wind Round 4 Projects at the pre-scoping stage are acknowledged but no assessment has been undertaken. In the future, when these projects reach application stage, they will need to provide a cumulative assessment that includes consideration of the Offshore Development, as appropriate.

West of Orkney Windfarm (within ScotWind N1 Plan Option area) was submitted for scoping on the cusp of the cut-off for a qualitative assessment with this application to be required (as detailed in Offshore EIAR (Volume 3) Technical Appendix 6.1: Cumulative Projects Approach). However, it was requested by RSPB that the ornithology cumulative assessment should include a qualitative assessment of ScotWind sites so, given that the West of Orkney Windfarm could potentially impact upon some of the same SPA qualifying interests and SPAs as the Offshore Development, a high level qualitative assessment has been included. West of

Orkney Windfarm is still at an early stage of pre-application and there is not yet any HRA screening report available and its potential levels of impact are currently unknown. Once further progressed, West of Orkney will themselves likely be required to undertake a quantitative cumulative (or in-combination) assessment in order to support any application for development consent. This will include consideration of the predicted impacts arising from the Offshore Development, as appropriate.

Although Berwick Bank was submitted for scoping six months prior to the PFOWF application submission; it is not possible to undertake any quantitative assessment of in-combination impacts because the project-alone impacts have not yet themselves been quantified. The only cumulative (or in-combination) impact relevant to consider in relation to Berwick Bank will be its potential estimate of gannet collision / displacement mortality assigned against the Forth Islands SPA population.

For the Offshore Development, a qualitative assessment has been agreed with MS-LOT, NS and MSS (MS-LOT email of 31 March 2022) to consider its negligible impacts on Forth Island SPA gannets in-combination with the consented Forth & Tay wind farms (Neart na Gaoithe, Inch Cape and Seagreen). Berwick Bank is therefore included as part of this consideration, as presented in the RIAA. Once further progressed, Berwick Bank will themselves likely be required to undertake a quantitative cumulative (or in-combination) assessment on Forth Island SPA gannets in order to support any application for development consent. This will include consideration of the predicted impacts arising from the Offshore Development, as appropriate.

Both West of Orkney and Berwick Bank are represented on Figure 12.2 (in pink) as projects with potential cumulative impacts in combination with the Offshore Development, requiring future consideration.

12.7.1.2 Project screening for Marine Ornithology cumulative impact assessment

As advised by NS in the Scoping Opinion (MS-LOT, 2021), there is a seasonal split in the way cumulative impacts are scoped for Marine Ornithology receptors. In the breeding season, scoping for cumulative impacts follows a species-specific and SPA-by-SPA approach to consider the effects on each species from all relevant projects within their mean-max foraging ranges (based on Woodward *et al*., 2019) as applied to each SPA under consideration. In the non-breeding season, scoping for cumulative impacts includes all relevant developments within the region defined for the species, usually the relevant BDMPS advised in Furness (2015) or by another agreed approach (such as NS advice on guillemot, Section 4.3, Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning).

Note that the different phases of each development (Table 12.27) have been considered in respect of their cumulative impacts: construction, operation and maintenance, and decommissioning phases as set out in Sections 12.1.1, 12.7.3 and 12.7.4. Impacts on birds associated with the construction and decommissioning phases of development are usually transient and short-term in nature. They are considered qualitatively in most assessments, and it is not usually possible to fully quantify them.

It is the impacts occurring during the operation and maintenance phase of development that are of most concern: these can be long-term over a 25–30 year life-cycle. Review of the assessment undertaken for the Offshore Development alone would indicate that many of these impacts (Table 12.25) can be screened out of further consideration as there is no risk of potentially significant cumulative impacts. Such impacts screened out include entanglement risk and the minor effects arising from operation and maintenance work.

The main impacts requiring consideration under cumulative impact assessment for the Offshore Development are those related to other offshore wind farms; collision risk and displacement impacts resulting in estimates of mortality that can be considered quantitatively as set out in Sections 12.7.3.1 and 12.7.3.2.

12.7.1.2.1 Consented offshore wind farms

HiDef reviewed all the available Environmental Statement (ES) and EIAR chapters for other offshore wind farms in Scottish waters and the HRA reports and MS Appropriate Assessments for these (Table 12.2). As the most recently published data available, and therefore the most up-to-date, a review was also undertaken of available information for Hornsea project 3 (determined) and Hornsea project 4 (at application) (Table 12.2).

This review confirmed that Hywind Scotland, Kincardine and the European Offshore Wind Deployment Centre (EOWDC) are not affecting the same SPA populations as the Offshore Development, so they are not considered further in respect of cumulative impacts during the breeding season, the key season of concern and period of sensitivity in respect of potential effects on seabirds.

The apportioning undertaken for the Offshore Development (Offshore EIAR (Volume 3: Technical Appendix 12.2: Connectivity and Apportioning) indicated that there could be a level of mortality assigned against gannet at Forth Islands SPA. In this regard, the level of apportioned mortality is very low (less than one bird, displacement and collision risk combined) and further to discussion at the cumulative impacts meeting held on 21 February 2021, it was agreed that no quantitative assessment is required cumulatively with the Forth and Tay wind farms; Neart na Gaoithe, Inch Cape or Seagreen (MSS and NS advice as provided by MS-LOT on 31st March 2022).

The key offshore wind farm projects that have the potential to give rise to quantifiable cumulative effects alongside the Offshore Development are the consented and operational wind farms in the Moray Firth. These are the projects giving rise to estimated collision risk and displacement mortalities potentially affecting the same SPA populations as the Offshore Development, notably the kittiwake, guillemot, razorbill and puffin populations at North Caithness Cliffs SPA as assessed in the RIAA.

12.7.1.2.2 Other developments considered

Other developments are included for qualitative assessment in relation to their construction (see Section 12.7.2), operation and maintenance (12.7.3) and decommissioning effects (12.7.4).

Figure 12.2 illustrates the outcomes of this project screening and the locations of development considered in the Marine Ornithology Cumulative Impact Assessment.

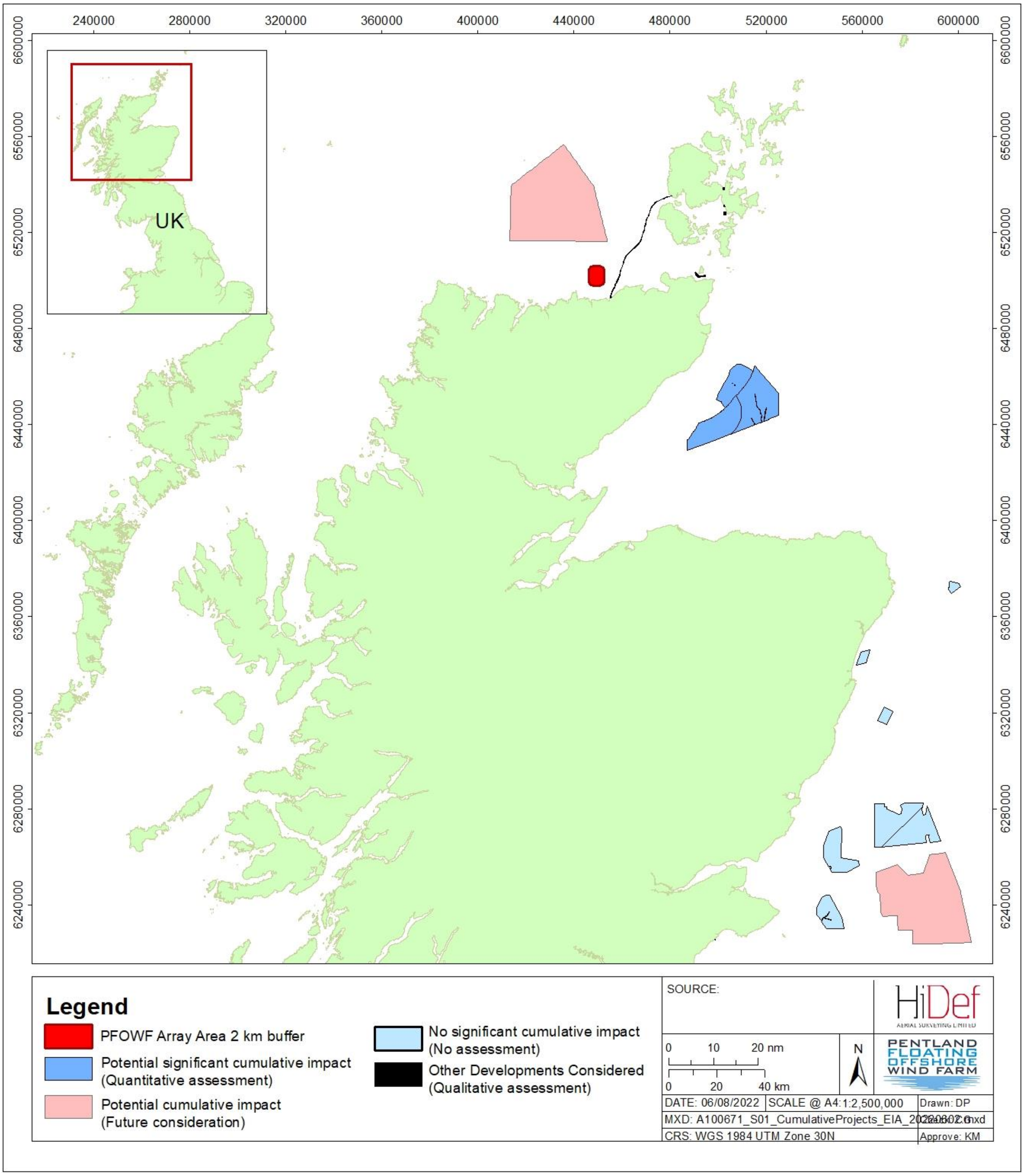

Figure 12.2 Scottish developments considered in project screening for the Marine Ornithology Cumulative Impact Assessment

12.7.2 Cumulative Construction Effects

The following construction impacts have been taken forward for the cumulative assessment against the other developments listed in:

- Disturbance/displacement/exclusion due to construction noise or physical presence of vessels;
- Barrier effect due to physical presence of vessels and construction equipment;
- Change in habitat/prey availability; and
- Increase in suspended sediment affecting visibility.

The most sensitive ornithology receptors to the aforementioned construction impacts are discussed for the Offshore Development alone in Section 12.6.1.

Considering the moderate distance between the Offshore Development and the closest offshore wind farm (Beatrice, approximately 70 km across land) the potential for cumulative impact to occur is low. Additionally, Beatrice offshore wind farm is already fully operational, and thus the construction phases of these two projects will not occur simultaneously, and no cumulative impacts are anticipated.

The Moray East offshore wind farm, located adjacent to the southern boundary of the Beatrice offshore wind farm, has been fully operational since April 2022 and thus the construction of the Offshore Development will not overlap and therefore no cumulative impacts are anticipated.

The Moray West offshore wind farm, neighbour to the Moray East offshore wind farm, is in the pre-construction phase, with construction anticipated in 2022/23 and aiming to be fully operational by 2024/25. The construction period for the Offshore Development is anticipated to commence in spring 2025, pausing over winter and then continuing with a second construction stage in spring and summer 2026, and thus construction of these two projects will not occur simultaneously, and no cumulative impacts are anticipated.

Overall, there will be **no change** to magnitude of the four aforementioned impacts and as such the **magnitude of impact** is still considered to be **minor**, making the **overall effect minor** and **not significant**.

Construction (and decommissioning) impacts on marine ornithology receptors are managed and mitigated for each development on a case-by-case basis via the agreement and implementation of consent/licence conditions relating to environmental management; including, for example, the production and implementation of environmental management plans (Project Environmental Monitoring Programme (PEMP); OEMP), construction method statements (CEMP; Construction Method Statement [CMS]), vessel management plans (VMP) and pollution prevention plans, as well as the employment of an environmental manager or environmental clerk of works (ECoW) to oversee and ensure compliance with the agreed plans.

Such measures have been considered for the Offshore Development as part of the embedded mitigation for the species under consideration (Table 12.20) as discussed in Section 12.5.5.

12.7.3 Cumulative Operation and Maintenance Effects

Review of the project-alone assessment undertaken for the Offshore Development would indicate that many of the operation and maintenance impacts (Table 12.25) can be screened out of further consideration because there is no risk of potentially significant cumulative effects.

The key cumulative impacts that could arise during operation and maintenance of the Offshore Development alongside other relevant projects are these, as assessed below:

- Collision risk with WTGs; and
- Displacement due to physical presence of WTGs (including barrier effects).

In this regard, the key information sources used for cumulative assessment, from which estimated collision and displacement mortalities were obtained for key developments, primarily the Moray Firth offshore wind farms (Table 12.27) are as follows:

- Moray West, Chapter 10 of Offshore EIA Report (MOWWL, 2018a);
- Moray West EIA Addendum (MOWWL, 2018b);
- Moray West, RIAA (MOWWL, 2018c);
- Moray West, MS Appropriate Assessment (MS-LOT, 2019); and
- Hornsea project 4, ES Volume A2, Chapter 5, Offshore and Intertidal Ornithology (Orsted, 2021).

12.7.3.1 Potential cumulative collision risk with WTGs

Species value and species sensitivity to collision risk are the same as that described in Section 12.6.2.1 for assessment of the Offshore Development alone and summarised in Table 12.14. To consider the potential for cumulative collision risk, the significance of the Offshore Development alone impacts are considered on a species-by-species basis. Where estimated collision mortalities from the Offshore Development are zero then they are not considered further because the Offshore Development will not be adding to any cumulative collision risk. Judgements on impact magnitude for estimated collision mortalities greater than zero are set out on a species-by-species basis in each of the summaries below.

12.7.3.1.1 Kittiwake

The Offshore Development-alone collision risk is estimated as seven kittiwake mortalities during the breeding season, and one kittiwake mortality during the BDMPS autumn migration period using mean input densities (see Section 12.6). These mean density values are used to allow a ‘like-for-like’ comparison with the other projects for cumulative assessment where the estimated collision mortalities have all been calculated based on mean densities.

The breeding season kittiwake collision mortalities estimated for the Offshore Development are presented alongside those calculated for Beatrice, Moray East and Moray West, as these are the only other projects scoped in for cumulative effects during the breeding season (see Section 12.7.1).

Table 12.28 presents the total estimated breeding kittiwake collision mortalities at each wind farm (values for the Moray Firth developments obtained from Table 3.51 of the Moray West EIA Addendum (MOWWL, 2018b).

Table 12.28 Cumulative kittiwake collision mortalities during the breeding season[ii]

Wind Farms	Estimated number of mortalities due to collision
PFOWF Array and OECC (the Offshore Development)	7.0
Beatrice	94.7
Moray East	43.6
Moray West	79.0

In this regard, a judgement of EIA significance can be made by comparing the additional pressures the Offshore Development may have on the accepted mortality rates from the Moray Firth wind farms. In the breeding season, it will result in an increase of ~3% in the levels of predicted cumulative collision mortality (Table 12.28). This additional impact on kittiwake arising from the Offshore Development in cumulation is judged to be **minor** and **not significant** (Table 12.19).

In the non-breeding season, there is a single kittiwake collision mortality arising from the Offshore Development to be considered in addition to the cumulative estimates for the other offshore wind farm projects located in

[ii] Collision estimates are from Table 5.60 of Hornsea project four ES Volume A2, Chapter 5, Offshore and Intertidal Ornithology (Orsted, 2021).

the North Sea BDMPS (Table 12.29). In this regard, the predicted level of additional impact from the Offshore Development is 0.04%. This is judged to be **negligible** and **not significant**.

Furthermore, it should be noted that the kittiwake collision mortality estimates consented for Moray West are based on an 85-WTG scenario (MOWWL, 2018b). It is understood that the Design Specification and Layout Plan (DSLP) for this project has been submitted to MS for approval (although at the time of writing it has not yet been approved) and that the final WTG layout for Moray West is likely to be 60 WTGs as currently shown on the project website[iii]: 25 WTGs fewer than in the project consent. In relation to EIA collision risk impacts this means that the predicted kittiwake collisions associated with the Offshore Development (even using maximum input densities) will be well within the in-combination assessment carried out in relation to Moray West.

Table 12.29 North Sea kittiwake cumulative collision mortalities – non-breeding (Hornsea project 4 figures)[i]

Offshore wind farm project	Estimated kittiwake collision mortalities	
	Autumn migration	Spring migration
PFOWF Array and OECC (the Offshore Development)	1	0
Beatrice	10.7	39.8
Blyth Demonstration Site	2.3	1.4
Dogger Bank A & B	135	295.4
Dogger Bank C & Sofia	90.7	216.9
Dudgeon	-	-
Dudgeon Extension Project	8.6	2.2
East Anglia ONE	160.4	46.8
East Anglia ONE North	8.1	3.5
East Anglia THREE	56.5	30.8
East Anglia TWO	5.4	7.4
EOWDC	5.8	1.1
Galloper	27.8	31.8
Greater Gabbard	15	11.4
Gunfleet Sands	-	-
Hornsea Project Four	38.4	25.1
Hornsea Project One	55.9	20.9
Hornsea Project Two	9	3
Hornsea Project Three	6	3
Humber Gateway	3.2	1.9
Hywind Scotland	0.9	0.9
Inch Cape	224.8	63.5
Kentish Flats	0.9	0.7
Kentish Flats Extension	0	2.7
Kincardine	9	1
Lincs, Lynn & Inner Dowsing	0.7	1.2
London Array	2.3	1.8

[iii] https://www.moraywest.com/about-us/project

Offshore wind farm project	Estimated kittiwake collision mortalities	
	Autumn migration	Spring migration
Levenmouth Demonstration Turbine	0	0
Moray East	2	19.3
Moray West	24	7
Neart na Gaoithe	56.1	4.4
Norfolk Boreas	32.2	11.9
Norfolk Vanguard	16.4	19.3
Race Bank	23.9	5.6
Rampion	0	0
Scroby Sands	-	-
Seagreen (Phase 1)	313.1	247.6
Sheringham Shoal	-	-
Sheringham Shoal Extension	1.9	0
Teesside	24	2.5
Thanet	0.5	0.4
Triton Knoll	139	45.4
Westermost Rough	0.2	0.1
Total	1510.7	1177.7

12.7.3.1.2 Fulmar

There are zero (annual) fulmar collision mortalities predicted to arise due to the Offshore Development (see Section 12.6.2.1.2). In this regard, as there is no change in impact magnitude, assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.1.3 Gannet

Gannet collision mortality at mean densities was estimated to be two birds during the breeding season and zero birds during BDMPS autumn and spring migration periods (see Section 12.6.2.1.3). Combined with displacement effects, it is a total of three gannet mortalities needing consideration. It is judged that this additional impact arising from the Offshore Development in cumulation is **minor** and **not significant** (Table 12.18).

In-combination impacts against gannet SPAs, including the Bass Rock gannetry (Forth Islands SPA), are addressed in the RIAA.

12.7.3.1.4 Arctic tern

There are zero (annual) Arctic tern collision mortalities predicted to arise due to the Offshore Development (see Section 12.6.2.1.4). In this regard, as there is no change in impact magnitude, assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.1.5 Great black-backed gull

Cumulative assessment should be carried out on a 'like-for-like' basis; in this case, for great black-backed gull collision risk, it means using the mean density input estimates for CRM as these are what have been used in assessment for all other offshore wind farms in the North Sea BDMPS. On this basis, there are zero great black-backed gull collision mortalities predicted to arise due to the Offshore Development (see Section 12.6.2.1.5). As there is no change in impact magnitude, assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.1.6 Herring gull

There are zero herring gull collision mortalities predicted to arise due to the Offshore Development (see Section 12.6.2.1.6). In this regard, as there is no change in impact magnitude, assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.1.7 Great skua

There are zero great skua collision mortalities predicted to arise due to the Offshore Development (see Section 12.6.2.1.7). In this regard, as there is no change in impact magnitude, assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.1.8 Red-throated diver

Recorded red-throated diver numbers on-site were so low that collision risk could not be quantified but is effectively zero (see Section 12.6.2.1.8). In this regard, there will be no change in impact magnitude, so assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.1.9 Wildfowl and waders

Potential collision risk from the Offshore Development to wildfowl and waders on migration was considered in Section 12.6.2.1.9, referring to the WWT (2014) report on strategic collision risk to these species. In this regard, it was concluded that there would be no significant collision risk arising from the Offshore Development alone or cumulatively with any of the other offshore wind farms in Scottish waters as listed in Table 12.27. Any potential impacts arising from the Offshore Development fall within the worst case cumulative/strategic CRM that's been undertaken (WWT, 2014) and are therefore judged to be **minor** and **not significant** (Table 12.18).

12.7.3.2 Potential cumulative displacement impact due to physical presence of WTGs (including barrier effects)

Species value and species sensitivity to displacement and barrier effects are the same as that described in Section 12.6.2.2 for assessment of the Offshore Development alone and summarised in Table 12.14. To consider the potential for cumulative displacement impacts, the significance of the Offshore Development alone impacts are considered on a species-by-species basis. Where estimated displacement mortalities from the Offshore Development are zero then they are not considered further because the Offshore Development will not be adding to any cumulative impacts. Judgements on impact magnitude for estimated displacement mortalities greater than zero are set out on a species-by-species basis in each of the summaries below.

12.7.3.2.1 Kittiwake

As set out for the project-alone assessment (see Section 12.6.2.2.1), a comparison was made between SeabORD modelling and matrix outputs, indicating that it seemed appropriate to apply a 30% displacement rate across all seasons for kittiwake, and a 2% mortality rate (Table 12.24). This results in estimated mortalities of approximately three birds during the breeding season and one bird during the autumn migration potentially arising due to the Offshore Development (Table 12.30). Beatrice, Moray East and Moray West are the only other projects scoped in for cumulative assessment in respect of kittiwake displacement impacts in the breeding season (see Section 12.7.1). The mean seasonal peak estimates provided in Table 12.30 have been obtained from Tables 6.9.29 and 6.9.30 in the Moray West RIAA (MOWWL, 2018c). Whilst a greater range of North Sea wind farms proposals could potentially be scoped in for the non-breeding season (as for cumulative collision, Table 12.29); kittiwake displacement mortalities have not been quantified for these developments.

A judgement of EIA significance can be made by comparing the additional pressures the Offshore Development may have on the accepted mortality rates from the Moray Firth wind farms (Table 12.30). It will result in an increase of ~3.8% in the levels of predicted cumulative displacement mortality when considered in combination with the consented Moray Firth wind farms. This additional impact on kittiwake arising from the Offshore Development in cumulation is judged to be **minor** and **not significant** (Table 12.18).

Table 12.30 Cumulative kittiwake displacement mortalities

Wind Farms	Mean seasonal peaks			Estimated number of mortalities due to displacement		
	Breeding season	Autumn migration	Spring migration	Breeding season	Autumn migration	Spring migration
Offshore Development	546	118	41	3.28	0.71	0
Beatrice	2,222	No non-breeding assessment		13.33	No non-breeding assessment	
Moray East	4,082	161	1,451	24.49	0.97	8.71
Moray West	6,902	1,470	1,074	41.41	8.82	6.44

12.7.3.2.2 Guillemot

As set out for the project-alone assessment (see Section 12.6.2.2.2), a comparison was made between SeabORD modelling and matrix outputs, indicating that it seemed appropriate to apply a 60% displacement rate across all seasons for guillemot, and a 1% mortality rate. This results in an estimated annual mortality of approximately 11 birds for the Offshore Development (Table 12.31). Beatrice, Moray East and Moray West are the only other projects scoped in for cumulative assessment in respect of guillemot impacts (see Section 12.7.1). Estimated guillemot displacement mortalities are presented for these projects at the same displacement and mortality rates (Table 12.31). The mean seasonal peak guillemot estimates for Moray Firth developments provided in Table 12.31 have been obtained from Tables 6.9.36 and 6.9.37 in the Moray West RIAA (MOWWL, 2018c).

Table 12.31 Cumulative guillemot displacement mortalities

Wind Farms	Mean seasonal peaks		Estimated number of mortalities due to displacement	
	Breeding season	Non-breeding season	Breeding season	Non-breeding season
Offshore Development	1,146	650	6.88	3.90
Beatrice	13,610	2,755	81.67	16.53
Moray East	9,820	1,245	58.92	7.47
Moray West	24,426	38,174	146.56	229.04

A judgement of EIA significance can be made by comparing the additional pressures the Offshore Development may have on the accepted mortality rates from the Moray Firth wind farms, based on the figures presented in Table 12.31. In this regard, it will result in an increase of ~2% in the levels of predicted annual cumulative displacement mortality when considered in combination with the consented Moray Firth wind farms. This additional impact on guillemot arising from the Offshore Development in cumulation is judged to be **minor** and **not significant** (Table 12.18).

12.7.3.2.3 Razorbill

As set out for the project-alone assessment (see Section 12.6.2.2.3), a comparison was made between SeabORD modelling and matrix outputs, indicating that it seemed appropriate to apply a 60% displacement rate across all seasons for razorbill, with a 2% mortality rate in the breeding season and a 1% mortality rate in the non-breeding and migratory seasons. This results in estimated mortalities of approximately two birds and zero birds respectively for the Offshore Development (Table 12.32). Beatrice, Moray East and Moray West are the only other projects scoped in for cumulative assessment in respect of razorbill impacts (see Section 12.7.1). Estimated razorbill displacement mortalities are presented for these projects at the same displacement and mortality rates (Table 12.32). The mean seasonal peak razorbill estimates for Moray Firth developments provided in Table 12.32 have been obtained from Tables 6.9.38 and 6.9.39 in the Moray West RIAA (MOWWL, 2018c).

Table 12.32 Cumulative razorbill displacement mortalities

Wind Farms	Mean seasonal peaks				Estimated number of mortalities due to displacement			
	Breeding season	Autumn migration	Non-breeding season	Spring migration	Breeding season	Autumn migration	Non-breeding season	Spring migration
Offshore Development	134	16	17	14	1.61	0	0	0
Beatrice	873	833	555	833	10.48	4.99	3.33	4.99
Moray East	2,423	1,103	30	168	29.08	6.62	0.18	1.01
Moray West	2,808	3,544	184	3,585	33.70	21.26	1.10	21.51

A judgement of EIA significance can be made by comparing the additional pressures the Offshore Development may have on the accepted mortality rates from the Moray Firth wind farms, based on the figures presented in Table 12.32.

In the breeding season, it will result in an increase of ~2% in the levels of predicted cumulative displacement mortality when considered in combination with the consented Moray Firth wind farms. This additional impact on razorbill arising from the Offshore Development in cumulation is judged to be **minor** and **not significant** (Table 12.18).

In the non-breeding season, there are zero razorbill displacement mortalities predicted to arise due to the Offshore Development. In this regard, as there is no change in impact magnitude, assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.2.4 Puffin

As set out for the project-alone assessment (see Section 12.6.2.2.4), the displacement matrices appear to be substantially over-estimating the level of potential mortality to puffin, compared to SeabORD modelling. The puffin mortality estimate presented in Table 12.33 for the Offshore Development is for the PFOWF Array Area alone and excludes the 2 km buffer. A 60% displacement rate has been applied across all seasons, and a 1% mortality rate. This results in estimated mortalities of approximately seven birds and zero birds respectively for the offshore development (Table 12.33).

Beatrice, Moray East and Moray West are the only other projects scoped in for cumulative assessment in respect of puffin (see Section 12.7.1). Estimated puffin displacement mortalities are also presented for these projects at a 60% displacement rate and 1% mortality rate, including use of a 2 km buffer (Table 12.33).

As discussed in Offshore EIAR (Volume 3): Technical Appendix 12.4: Displacement Analysis, the figure of seven mortalities from the displacement matrix appears to over-estimate probable levels of impact from the Offshore Development. In this regard, a better estimate may be obtained by applying a scaling factor to the SeabORD model output for North Caithness Cliffs SPA (1.8 annual puffin mortalities) using the SPA apportioning weighting (a scaling factor of 1/0.698). This results in an annual total puffin mortality estimate of 2.58 birds for the Offshore Development which can be considered in relation to the annual total for the Moray Firth wind farms of 56.33 birds (Table 12.33).

On this basis, the Offshore Development will result in an increase of ~4.6% in the levels of predicted cumulative displacement mortality when considered in combination with the consented Moray Firth wind farms. This additional impact on puffin arising from the Offshore Development in cumulation is judged to be **minor** and **not significant** (Table 12.18).

Table 12.33 Cumulative puffin displacement mortalities

Wind Farms	Mean seasonal peaks		Estimated number of mortalities due to displacement	
	Breeding season	Non-breeding season	Breeding season	Non-breeding season
Offshore Development	1,211	2	7.27	0
Beatrice	2,858	2,435	17.15	14.61
Moray East	2,795	174	16.77	1.04
Moray West	1,115	12	6.69	0.07

12.7.3.2.5 Fulmar

Fulmar displacement mortality for the Offshore Development alone was estimated to be three birds during the breeding season and one bird during BDMPS spring migration (see Section 12.7.3.2.5). It is judged that this additional impact arising from the Offshore Development in cumulation is **minor** and **not significant** (Table 12.18).

12.7.3.2.6 Gannet

Gannet displacement mortality for the Offshore Development alone was estimated as a single bird during the breeding season and zero birds during BDMPS autumn and spring migration periods (see Section 12.6.2.2.6). Combined with collision effects, it is a total of three gannet mortalities needing consideration under cumulative assessment. It is judged that this additional impact arising from the Offshore Development in cumulation is **minor** and **not significant** (Table 12.18).

In combination impacts against gannet SPAs, including the Bass Rock gannetry (Forth Islands SPA), are addressed in the RIAA.

12.7.3.2.7 Arctic tern

There are zero (annual) Arctic tern displacement mortalities predicted to arise due to the Offshore Development (see Section 12.6.2.2.7). In this regard, as there is no change in impact magnitude, assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.2.8 Great skua

There is a total (annual) displacement mortality of zero great skua estimated for the Offshore Development. (see Section 12.6.2.2.8). In this regard, as there is no change in impact magnitude, assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.3.2.9 Red-throated diver

Recorded red-throated diver numbers on-site were so low that displacement effects could not be quantified but are effectively zero (see Section 12.7.3.2.9). In this regard, there will be no change in impact magnitude, so assessment concludes **negligible effects** that are **not significant** (Table 12.18).

12.7.4 Cumulative Decommissioning Effects

Decommissioning impacts are anticipated to be similar or less than those arising during construction.

The life-cycle of the Offshore Development is anticipated to be 30 years from final commissioning and cumulative impacts with future offshore wind farms (such as ScotWind) are therefore hard to anticipate. However, decommissioning impacts will be localised around the decommissioning activity and associated vessels, will occur intermittently and are temporary in nature. Consequently, they are not estimated to compromise the fitness of individual birds and have no population-level consequences. Furthermore, the decommissioning work will be managed via a decommissioning programme and ECoW ensuring the same degree of environmental protection as that for construction.

Decommissioning impacts were discussed for the Offshore Development alone in Section 12.6.3 and the cumulative construction impacts were discussed in Section 12.1.1. The most sensitive ornithology receptors to cumulative decommissioning impacts therefore remain the same as those considered in these previous sections. Although hard to anticipate, for the purposes of assessment, cumulative decommissioning impacts are considered to be the same, or less, than cumulative construction impacts, therefore the **magnitude of impact** is still considered to be **minor**, making the **overall effect minor** and **not significant**.

12.8 Assessment of Transboundary Effects

Impacts have been considered against regional seabird populations during the breeding and non-breeding seasons (Table 12.15 and Table 12.16). The apportioning carried out in the Offshore EIAR (Volume 3): Technical Appendix 12.2: Connectivity and Apportioning, indicates that there are no protected populations of seabirds (i.e. SPA populations) in the rest of the UK, Ireland or in Europe that will be significantly affected by the Offshore Development other than those assessed in the RIAA.

There may be displacement and collision risk effects associated with the Offshore Development due to the presence of WTGs. During the breeding season, these are highly localised and principally affect seabird populations at the closest SPA, North Caithness Cliffs (the PFOWF Array Area is approximately 7.5 km from the SPA and the Offshore Export Cable overlaps the marine section of the SPA). The regional populations identified during the breeding season do not extend beyond the UK, and for most of the species potentially affected, do not extend beyond north Scotland. Nor is there any risk of significant or measurable transboundary effects arising from the Offshore Development alone against any far-ranging seabirds in the non-breeding season or against any migratory populations of wildfowl and wader species.

12.9 Assessment of Impacts Cumulatively with the Onshore Development

The Onshore Development components are summarised in Chapter 5: Project Description, Section 5.3.2. These Project aspects have been considered in relation to the impacts assessed within this chapter (see Sections 12.6.1.1.2 and 12.6.2.6.2 in relation to the Offshore Export Cable(s) and associated HDD, which are also addressed in the RIAA in respect of the seabird populations at North Caithness Cliffs SPA).

12.10 Mitigation and Monitoring Requirements

12.10.1 Additional Specific Mitigation

There is no requirement for additional mitigation over and above the embedded measures for the Offshore Development proposed in Section 12.5.5, Table 12.20.

12.10.2 Monitoring Requirements

As indicated in Table 12.20, the applicant is committed to monitoring/research to help understand wind farm impacts on bird species and welcome the opportunity to discuss their possible contribution to any monitoring programmes (whether site-specific or more strategic) with MS, NS and RSPB Scotland.

12.11 Inter-relationships

Interrelated effects describe the potential interaction of multiple project impacts upon one receptor which may interact to create a more significant impact on a receptor than when considered in isolation. Interrelated effects may have a temporal or spatial element and may be short-term, temporary or longer-term over the life-cycle of the Offshore Development.

In line with the Scoping Opinion (MS-LOT, 2021) and Scoping Opinion Addendum (MS-LOT, 2022) received, this chapter has assessed all impacts that are relevant to Marine Ornithological receptors during construction, operation and maintenance, and decommissioning phases of the Offshore Development. Therefore, it is considered that the assessment and conclusions presented in Section 12.6 provides a complete and robust assessment of all potential impacts relevant to Marine Ornithological receptors. The assessment has also considered the potential for inter-related effects in relation to Marine Ornithology, and no additional interrelated effects beyond those presented in Section 12.6 have been identified.

Where the assessment contained in this chapter is considered within other assessment chapters, a summary of these interrelationships are presented below in Table 12.34.

Table 12.34 Inter-relationships identified with Marine Ornithology and other receptors in this EIAR

Receptor	Impacts	Description
Marine Physical Processes Water and Sediment Quality	In-direct impacts on birds from suspended sediments	Changes in marine physical processes could lead to suspension of sediments which may affect visibility during construction work, O&M activities and decommissioning, impacting on diving seabirds. These impacts are discussed in Sections 12.6.1.4, 12.6.2.7 and 12.6.3.4 of this chapter.
Benthic Ecology	In-direct impacts on seabird prey species or their supporting habitats	Changes in benthic habitats can lead to an in- direct impact on fish spawning and nursery grounds which rely on these habitats. This includes prey species for seabirds, such as sandeel. Direct impacts to benthic habitats from the Offshore Development are assessed within Chapter 9: Benthic Ecology. Habitat loss of spawning and nursery grounds due to presence of the Offshore Development infrastructure are assessed within Chapter 10: Fish and Shellfish Ecology. Potential impact to birds from changes in habitat/prey availability are assessed in Sections 12.6.1.3, 12.6.2.6 and 12.6.3.3 of this chapter.
Fish and Shellfish Ecology	Potential impacts on seabird prey species or their supporting habitats	Changes in fish and shellfish habitats can lead to an in-direct impact on marine ornithology due to changes in prey availability of fish, which may be impacted due to loss/disturbance of the fish and shellfish habitat on which they rely. Direct impacts to fish and shellfish habitats from the Offshore Development are assessed within Chapter 10: Fish and Shellfish Ecology. Impacts on marine ornithology from potential change in benthic habitat and prey availability are assessed in Sections 12.6.1.3, 12.6.2.6 and 12.6.3.3 of this chapter.
Commercial Fisheries	Potential for entanglement with debris caught on mooring lines	There is potential for lost gear to become entangled with Offshore Development infrastructure, leading to ghost fishing. This can lead to birds, such as diving auk species, becoming entangled whilst foraging. The potential for this to occur and the significance of the impact to birds is assessed in Section 12.6.2.4 of this chapter.
Climate Change and Carbon	In-direct impacts on birds from climate change in combination with the Offshore Development activities.	Climate change is one of the likely drivers for seabird population declines due to phenological effects both on the birds themselves and on their prey species. Likely effects of climate change on sandeel abundance is discussed in relation to declining kittiwake populations in Section 12.4.4.1. Further indirect impacts from climate change on birds have been assessed within Chapter 20: Climate Change and Carbon.

12.12 Summary of Residual Effects

Table 12.35 summarises the effects for all impacts assessed.

Table 12.35 Summary of residual effects for Marine Ornithology

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
Construction / installation					
Potential impact of disturbance / displacement / exclusion due to construction noise or physical presence of vessels	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Potential for a barrier effect due to physical presence of vessels and construction equipment	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Potential change in habitat / prey availability during construction	Auks (guillemot, razorbill, puffin)	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	Kittiwake	Minor effect	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was	Not Significant

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
				concluded that these effects were not significant.	
	Red-throated diver	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	Other species scoped in for assessment	Negligible effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Potential increase in suspended sediment affecting visibility during construction	Diving seabirds (guillemot, razorbill, puffin, gannet)	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant..	Not Significant
Operation and Maintenance					
Potential collision risk with operational WTGs	Kittiwake	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was	Not Significant
	Guillemot	Negligible effects	Not Significant		Not Significant
	Razorbill	Negligible effects	Not Significant		Not Significant

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
	Puffin	Negligible effects	Not Significant	concluded that these effects were not significant.	Not Significant
	Fulmar	Negligible effects	Not Significant		Not Significant
	Gannet	Minor effects	Not Significant		Not Significant
	Arctic tern	Negligible effects	Not Significant		Not Significant
	Great black-backed gull	Minor effects	Not Significant		Not Significant
	Great skua	Negligible effects	Not Significant		Not Significant
	Herring gull	Negligible effects	Not Significant		Not Significant
	Red-throated diver	Negligible effects	Not Significant		Not Significant
Potential displacement due to physical presence of WTGs	Kittiwake	Negligible effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	Guillemot	Minor effects	Not Significant		Not Significant
	Razorbill	Minor effects	Not Significant		Not Significant
	Puffin	Minor effects	Not Significant		Not Significant
	Fulmar	Negligible effects	Not Significant		Not Significant
	Gannet	Minor effects	Not Significant		Not Significant
	Arctic tern	Negligible effects	Not Significant		Not Significant
	Great black-backed gull	Negligible effects	Not Significant		Not Significant
	Great skua	Negligible effects	Not Significant		Not Significant
	Herring gull	Negligible effects	Not Significant		Not Significant

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
	Red-throated diver	Minor effects	Not Significant		Not Significant
Potential for a barrier effect due to physical presence of WTGs	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Potential for entanglement with debris caught on mooring lines	Diving seabirds (guillemot, razorbill, puffin, gannet)	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Potential disturbance / exclusion due to marine noise and maintenance works	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Potential change in habitat/prey availability due to physical presence of WTGs	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant..	Not Significant

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
Potential increase in suspended sediment from operations and maintenance work affecting visibility	Diving seabirds (guillemot, razorbill, puffin, gannet)	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Creation of a roosting habitat or foraging opportunities	All bird species scoped in for assessment	Negligible effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Decommissioning					
Potential impact of disturbance / displacement / exclusion due to decommissioning noise or physical presence of vessels	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Potential for a barrier effect due to physical presence of vessels and decommissioning equipment	All bird species scoped in for assessment	Negligible effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
Potential change in habitat / prey availability during decommissioning	Auks (guillemot, razorbill, puffin)	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	Kittiwake	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	Red-throated diver	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Potential increase in suspended sediment	Diving birds (guillemot, razorbill, puffin, gannet)	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect	Not Significant

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
affecting visibility during decommissioning				above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	
Cumulative					
All construction / installation impacts	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
Operation: collision risk	Kittiwake	No risk of significant additional collision impacts arising from the Offshore Development		No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	Fulmar	No risk of significant additional collision impacts arising from the Offshore Development			Not Significant
	Gannet	No risk of significant additional collision impacts arising from the Offshore Development			Not Significant
	Arctic tern	Minor effects	Not Significant		Not Significant
	Great black-backed gull	No risk of significant additional collision impacts arising from the Offshore Development			Not Significant
	Herring gull	Minor effects	Not Significant		Not Significant

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
	Great skua	Minor effects	Not Significant		Not Significant
	Red-throated diver	Minor effects	Not Significant		Not Significant
	Wildfowl and waders	Minor effects	Not Significant		Not Significant
Operation: displacement	Kittiwake	No risk of significant additional displacement impacts arising from the Offshore Development		No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
	Guillemot	No risk of significant additional displacement impacts arising from the Offshore Development			Not Significant
	Razorbill	No risk of significant additional displacement impacts arising from the Offshore Development			Not Significant
	Puffin	No risk of significant additional displacement impacts arising from the Offshore Development			Not Significant
	Fulmar	No risk of significant additional displacement impacts arising from the Offshore Development			Not Significant
	Gannet	No risk of significant additional displacement impacts arising from the Offshore Development			Not Significant
	Arctic tern	Minor effects	Not Significant		Not Significant
	Great skua	Minor effects	Not Significant		Not Significant

Predicted Effect	Receptor	Assessment Consequence	Significance	Mitigation identified	Significance of Residual Effect
	Red-throated diver	Minor effects	Not Significant		Not Significant
All other operation and maintenance impacts	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant
All decommissioning impacts	All bird species scoped in for assessment	Minor effects	Not Significant	No additional mitigation measures have been identified for this effect above and beyond the embedded Offshore Development mitigation listed in Section 12.5.5 as it was concluded that these effects were not significant.	Not Significant

12.13 References

ABPmer. (2019). Sectoral Marine Plan for Offshore Wind Energy Strategic Habitat Regulations Appraisal (HRA): Screening and Appropriate Assessment Information Report – Final.

Andrews, C., Newell, M.A., Harris, M.P., Bennett, S.I., Wanless, S. & Daunt, F. (2020). Diet of common guillemot and razorbill at East Caithness, Buchan Ness to Collieston Coast and Isle of May in 2019. NERC Environmental Information Data Centre.

Band, W. (2012). Using a collision risk model to assess bird collision risks for offshore wind farms. Report to the Crown Estate Strategic Ornithological Services (SOSS).

Banyard, A. C., Lean, F., Robinson, C., Howie, F., Tyler, G., Nisbet, C. & Seekings, J. (2022). Detection of Highly Pathogenic Avian Influenza Virus H5N1 Clade 2.3.4.4b in Great Skuas: A Species of Conservation Concern in Great Britain. *Viruses,* **14(2)**, pp.212.

Bolton, M. (2021). GPS tracking reveals highly consistent use of restricted foraging areas by European storm-petrels *Hydrobates pelagicus* breeding at the largest UK colony: implications for conservation management. *Bird Conservation International*, **31(1)**: 35-52.

Bradbury, G., Trinder, M., Furness, B., Banks, A.N., Caldow, R.W.G. & Hume, D. (2014). Mapping seabird sensitivity to offshore wind farms. *Plos One*, **12(1)**: e0170863.

CIEEM. (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland: terrestrial, freshwater, coastal and marine. CIEEM.

Clausen, L. W., Rindorf, A., van Deurs, M., Dickey-Collas, M. & Hintzen N. T. (2017). Shifts in North Sea forage fish productivity and potential fisheries yield. *Journal of Applied Ecology*, **55(3)**, 1092-1101.

Cook, A.S.C.P., Johnston, A., Wright, L.J. & Burton, N.H.K. (2012). A review of flight heights and avoidance rates of birds in relation to offshore wind farms. Strategic Ornithological Support Services. Project SOSS-02. BTO Research report No: 618.

Cramp, S. (1977). Handbook of the birds of Europe, the Middle East and North Africa. The birds of the western Palaearctic. Vol. I. Oxford, London and New York.

D’Elbée, J. & Hémery, G. (1998). Diet and foraging behaviour of the British storm-petrel *Hydrobates pelagicus* in the bay of Biscay during summer. *Ardea*, **86(1)**: 1-10.

Daunt, F., Wanless, S., Greenstreet, S.P.R., Jensen, H., Hamer, K.C. & Harris, M.P. (2008). The impact of the sandeel fishery closure on seabird food consumption, distribution, and productivity in the northwestern North Sea. *Canadian Journal of Fisheries and Aquatic Sciences,* **65(3)**: 362-381.

Deppe, L., Rowley, O., Rowe, L.K., Shi, N., MacArthur, N., Gooday, O. & Goldstien, S.J. (2017). Investigation of fallout events in Hutton’s shearwaters (*Puffinus huttoni*) associated with artificial lighting. *Notornis,* **64**: 181-191.

DEFRA. (2022). Updated Outbreak Assessment #29. Highly pathogenic avian influenza (HPAI) in the UK and Europe 4th July 2022. *Defra*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1089228/Highly_pathogenic_avian_influenza__HPAI__in_the_UK_and_Europe__4_July_2022_.pdf [Accessed 19/072022].

Dierschke, V., Furness, R.W. & Garthe, S. (2016). Seabirds and offshore wind farms in European waters: Avoidance and attraction. *Biological Conservation*, **202**: 59-68.

Dias, M.P., Martin, R., Pearmain, E. J., Burfield, I. J., Small, C., Phillips, R.A., Yates, O., Lascelles, B., Borboroglu, P. G. & Croxall, J. P. (2019). Threats to seabirds: A global assessment. *Biological Conservation*, **237**, 525-537.

Dunn, R.E., Wanless, S., Green, J.A., Harris, M.P. & Daunt, F. (2019). Effects of body size, sex, parental care and moult strategies on auk diving behaviour outside the breeding season. *Journal of Avian Biology,* **50(7)**: e02012.

Eaton, M., Aebischer, N., Brown, A., Hearn, R., Lock, L., Musgrove, A., Noble, D., Stroud, D. & Gregory, R. (2015). Birds of Conservation Concern 4: the population status of birds in the UK, Channel Islands and Isle of Man. *British Birds*, **108**: 708-746.

Forrester, R., Andrews, I., McInerny, C., Murray, R., McGowan, B., Zonfrillo, B., Betts, M., Jardine, D. & Grundy, D. (2012). The Birds of Scotland. The Scottish Ornithologists' Club.

Forrester, R., Andrews, I., McInerny, C., Murray, R., McGowan, B., Zonfrillo, B., Betts, M., Jardine, D. & Grundy, D. (2012). *The Birds of Scotland*. The Scottish Ornithologists' Club

Fox, A.D. & Petersen, I.B. (2019). Offshore wind farms and their effects on birds*. Dansk Orn. Foren. Tidsskr*., **113**: 86-101.

Frederiksen, M., Wanless, S., Harris, M.P., Rothery, P. & Wilson, L.J. (2004). The role of industrial fisheries and oceanographic change in the decline of North Sea black-legged kittiwakes. *Journal of Applied Ecology*, **41**: 1129–1139.

Frederiksen, M., Daunt, F., Harris, M.P. & Wanless, S. (2008). The demographic impact of extreme events: stochastic weather drives survival and population dynamics in a long-lived seabird. *Journal of Animal Ecology*, **77**: 1020–1029.

Frederiksen, M., Anker-Nilssen, T., Beaugrand, G. & Wanless, S. (2013). Climate, copepods and seabirds in the boreal Northeast Atlantic – current state and future outlook. *Global Change Biology*, **19**: 364-372.

Fullick, E., Bidewell, C. A., Duff, J. P., Holmes, J. P, Howie, F., Robinson, C. Goodman, G., Beckmann, K. M. & Philbey, A. W. (2022). Mass mortality of seabirds in GB. *Veterinary Record*. **190(3)**, 129-130.

Furness, R. & Tasker, M.L. (2000). Seabird-fishery interactions: Quantifying the sensitivity of seabirds to reductions in sandeel abundance, and identification of key areas for sensitive seabirds in the North Sea. *Marine Ecology-progress Series*, **202**: 253-264.

Furness, B. & Wade, H. (2012). Vulnerability of Scottish Seabirds to Offshore Wind Turbines. Report by MacArthur Green. Report for Marine Scotland Science.

Furness, R.W., Wade, H.M. & Masden, E.A. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management*, **119**: 56-66.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, No.164.

Garthe, S. & Hüppop, O. (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *Journal of Applied Ecology,* **41(4)**: 724-734.

Garthe, S., Markones, N. & Corman, A.M. (2017). Possible impacts of offshore wind farms on seabirds: a pilot study in northern gannets in the southern North Sea. *Journal of Ornithology*, **158**: 345-349.

Gilbert, M. & Xiao, X. (2008). Climate change and avian influenza. *Revue scientifique et technique (International Office of Epizootics),* **27(2)**, pp.459-466.

Guse, N., Garthe, S. & Schirmeister, B. (2009). Diet of red-throated divers *Gavia stellata* reflects the seasonal availability of Atlantic herring *Clupea harengus* in the southwestern Baltic Sea. *J Sea Res,* **62(4)**: 268-275.

Hall, R. M. (2022). The impact of avian flu. *National Trust Scotland*. https://www.nts.org.uk/stories/the-impact-of-avian-flu [Accessed 19/072022].

Haney, C.J. & Stone, A. (1988). Seabird Foraging Tactics and Water Clarity: Are Plunge Divers Really in the Clear? *Marine Ecology Progress Series*, **49**: 1-9.

Heath, M., Edwards, M., Furness, R., Pinnegar, J. & Wanless, S. (2009). A review from above: changing seas, seabirds and food sources. MCCIP Ecosystems Linkages Report Card.

Highland Wind Limited (HWL) (2020). Request for Scoping Opinion. Pentland Floating Offshore Wind Farm EIA Scoping Report. A-100671-S00-REPT-001. 16th December 2020. https://marine.gov.scot/data/scoping-request-pentland-floating-offshore-wind-farm [Accessed 25/08/2021].

Horswill, C. & Robinson, R.A. (2015). Review of seabird demographic rates and density dependence. JNCC Report No: 552. JNCC.

IUCN. (2018). Black-legged kittiwake. https://www.iucnredlist.org/species/22694497/155617539 [Accessed 20/05/2022].

Jackson (2022). Pentland Floating OWF: Baseline Onshore Bird Survey 2021 Technical. Report prepared by Atlantic Ecology Limited on behalf of Xodus Group and COP.JNCC, (2019). Natural England and JNCC advice on key sensitivities of habitats and Marine Protected Areas in English Waters to offshore wind farm cabling within Proposed Round 4 leasing areas. https://data.jncc.gov.uk/data/3c9f030c-5fa0-4ee4-9868-1debedb4b47f/NE-JNCC-advice-key-sensitivities-habitats-MPAs-offshore-windfarm-cabling.pdf [Accessed 28/07/2022].

JNCC, (2021a). *Black-legged kittiwake (Rissa tridactyla).* http://jncc.gov.uk/our-work/black-legged-kittiwake-rissa-tridactyla/ [Accessed 28/10/2021].

JNCC, (2021b). *Guillemot (Uria aalge)*. http://jncc.gov.uk/our-work/guillemot-uria-aalge/ [Accessed 28/10/2021].

JNCC, (2021c). *Razorbill (Alca torda)*. http://jncc.gov.uk/our-work/razorbill-alca-torda/ [Accessed 28/10/2021].

JNCC, (2021d). *Atlantic puffin (Fratercula arctica)* http://jncc.gov.uk/our-work/atlantic-puffin-fratercula-arctica/ [Accessed 28/10/2021].

JNCC, (2021e). Northern f*ulmar (Fulmarus glacialis).* http://jncc.gov.uk/our-work/northern-fulmar-fulmarus-glacialis/ [Accessed 28/10/2021].

JNCC, (2021f). *Northern gannet (Morus bassanus).* https://jncc.gov.uk/our-work/northern-gannet-morus-bassanus/ [Accessed 28/10/2021].

JNCC, (2021g). *Arctic tern (Sterna paradisea).* http://jncc.gov.uk/our-work/arctic-tern-sterna-paradisaea/ [Accessed 17/12/2021].

JNCC, (2021h). *Great black-backed gull (Larus marinus).* https://jncc.gov.uk/our-work/great-black-backed-gull-larus-marinus/ [Accessed 17/12/2021].

JNCC, (2021i). *Great skua (Stercorarius skua).* https://jncc.gov.uk/our-work/great-skua-stercorarius-skua/ [Accessed 17/12/2021].

JNCC, (2021j). *Herring gull (Larus argentatus).* http://jncc.gov.uk/our-work/herring-gull-larus-argentatus/ [Accessed 28/10/2021].

Johnston, A., Cook, A.S., Wright, L.J., Humphreys, E.M. & Burton, N.H. (2014). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. *Journal of Applied Ecology,* **51(1)**: 31-41.

Jones, E. (1980). A survey of burrow-nesting petrel at Macquarie Island based upon remains left by predators. *Notornis,* **27**: 11-20.

Kleinschmidt, B., Burger, C., Dorsch, M., Nehls, G., Heinanen, S., Morkunas, J., Zydelis, R., Moorhouse-Gann, R.J., Hipperson, H., Symondson, W.O.C. & Quillfeldt, P. (2019). The diet of red-throated divers (*Gavia stellata*) overwintering in the German Bight (North Sea) analysed using molecular diagnostics. *Marine Biology,* **166**: 77.

Kogure, Y., Sato, K., Watanuki, Y., Wanless, S. & Daunt, F. (2016). European shags optimize their flight behavior according to wind conditions. *Journal of Experimental Ecology,* **219**: 311−318.

Kotzerka, J., Garthe, S. & Hatch, S.A. (2010). GPS tracking devices reveal foraging strategies of Blacklegged Kittiwakes. *Journal of Ornithology*, **151**: 459-467.

Lean, F., Vitores, A. G., Reid, S. M., Banyard, A. C, Brown, H. I., Núñez, A. & Hansen, R. D. E. (2022). Gross pathology of high pathogenicity avian influenza virus H5N1 2021–2022 epizootic in naturally infected birds in the United Kingdom. *One Health,* **14 (2).** https://doi.org/10.1016/j.onehlt.2022.100392.

Leopold, M.F., Dijkman, E.M., Teal, L. & OWEZ-Team. (2011). Local birds in and around the offshore wind farm Egmond aan Zee (OWEZ) – (T-0 & T-1, 2022-2010). IMARES report.

Leopold, M., van Bemmelen, R. & Zuur, A. (2013). Responses of Local Birds to the Offshore Wind Farms PAWP and OWEZ off the Dutch mainland coast (Report No. C151/12). Report by IMARES - Wageningen UR.

Longcore, T., Rich, C., Mineau, P., MacDonald, B., Bert, D.G., Sullivan, LM., Mutrie, E., Gauthreaux Jr, S.A., *et al.* (2013). Avian mortality at communication towers in the United States and Canada: which species, how many, and where? *Biological Conservation*, **158**: 410-419.

Longcore, T., Rodrigues, A., Witherington, B., Penniman, J.F., Herf, L. & Herf. M. (2018). Rapid assessment of lamp spectrum to quantify ecological effects of light at night. *Journal of Experimental Zoology,* **329**: 511-521.

Lynam, C.P., Llope, M., Möllmann, C., Helaouët, P., Bayliss-Brown, G.A. & Stenseth, N.C. (2017). Interaction between top-down and bottom-up control in marine food webs. *Proceedings of the National Academy of Sciences*, **114(8)**: 1952-1957.

MacArthur Green (2019). Norfolk Vanguard Offshore Wind Farm. The Applicant Responses to First Written Questions. Appendix 3.3 - Operational Auk and Gannet Displacement: update and clarification.

MacDonald, A., Heath, M., Edwards, M., Furness, R., Pinnegar, J.., Wanless, S., Speirs, D. & Greenstreet, S. (2015). Climate driven trophic cascades affecting seabirds around the British Isles. *Oceanography and Marine Biology - An Annual Review*, **53**: 55-80.

MacDonald, A., Heath, M.R., Greenstreet, S.P.R. & Speirs, D.C. (2019a). Timing of sandeel spawning and hatching off the east coast of Scotland. *Frontiers in Marine Science*, **6**: 70.

MacDonald, A., Speirs, D.C., Greenstreet, S.P.R, Bouclott, P. & Heath, M.R. (2019b). Trends in sandeel growth and abundance off the east coast of Scotland. *Frontiers in Marine Science*, **6**: 201.

Marine Scotland. (2015). National Marine Plan. https://www.gov.scot/publications/scotlands-national-marine-plan/pages/15/ [Accessed 20/06/2022].

Marine Scotland. (2020). Case study: sandeels in Scottish waters. https://marine.gov.scot/sma/assessment/case-study-sandeels-scottish-waters [Accessed 20/05/2022].

Martin, M. (2022). RSPB Avian Influenza update. *RSPB*.
https://community.rspb.org.uk/ourwork/b/scotland/posts/avian-influenza-update [Accessed 19/07/ 2022].

Masden, E.A., Haydon, D.T., Fox, A.D. & Furness, R.W. (2010). Barriers to movement: modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. *Marine Pollution Bulletin*, **60**: 1085-1091.

Masden, E.A. (2015). Developing an avian collision risk model to incorporate variability and uncertainty. *Scottish Marine and Freshwater Science***, 6(14)**.

McArthur Green. (2019). Beatrice Wind Farm Year 1 Post-construction Ornithological Monitoring Report 2019. https://marine.gov.scot/sites/default/files/bowl_2019_post-con_monitoring_report_v2.2_30042021.pdf [Accessed 25/05/2022].

McGinty, N., Barton, A.D., Record, N.R., Finkel, Z.V., Johns, D.G., Stock, C.A. & Irwin, A.J. (2021). Anthropogenic climate change impacts on copepod trait biogeography. *Global Change Biology*, **27(7)**: 1431-1442.

Mendel, B., Kotzerka, J., Sommerfeld, J., Schwemmer, H., Sonntag, N. & Garthe, S. (2014). Effects of the alpha ventus offshore test site on distribution patterns, behaviour and flight heights of seabirds. In Ecological Research at the Offshore Windfarm alpha ventus (pp. 95-110). Springer Fachmedien Wiesbaden

Mitchell, P.I., Newton, S.F., Ratcliffe, N. & Dunn, T.E. (2004). Seabird populations of Britain and Ireland. T. & AD Poyser, London.Mitchell, I., Aonghais Cook, A., Douse, A., Foster, S., Kershaw, M., Neil McCulloch, N., Murphy, M. & Hawkridge, J. (2018). Marine Bird Breeding Success/failure. UK Marine Online Assessment Tool. https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/birds/breedingsuccess/ [Accessed 04/08/2022].

Mitchell, I., Daunt, F., Frederiksen, M. & Wade, K. (2020). Impacts of climate change on seabirds, relevant to the coastal and marine environment around the UK. *MCCIP Science Review* **2020**: 382–399.

MS-LOT. (2019). Moray West offshore windfarm application and decision, including appropriate assessment. marine.gov.scot/ml/moray-west-offshore-windfarm [Accessed 20/03/2022].

MS-LOT. (2021). Scoping Opinion adopted by the Scottish Ministers under: The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017. Pentland Floating Offshore Wind Farm Scoping Report. 28th September 2021. https://marine.gov.scot/sites/default/files/pfowf_scoping_opinion.pdf [Accessed 29/09/2021].

MS-LOT. (2022). Scoping Opinion Addendum adopted by the Scottish Ministers under: The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017. Pentland Floating Offshore Wind Farm Scoping Addendum Report. 16th May 2022. https://marine.gov.scot/sites/default/files/scoping_opinion_10.pdf [Accessed 17/05/2022].

Moray Offshore Windfarm (West) Limited (MOWWL). (2018a). Moray West Offshore Windfarm: Environmental Impact Assessment Report. Volume 2, Chapter 10: Offshore Ornithology. 536pp. https://marine.gov.scot/sites/default/files/00538033.pdf [Accessed 10/01/2022].

MOWWL. (2018b). Moray West Offshore Windfarm – Addendum to Section 36 Consent and Marine Licence Application. 634pp. http://marine.gov.scot/datafiles/lot/Moray_West/Addendum/Volume%201%20-%20Addendum%20Report.pdf [Accessed 10/01/2022].

MOWWL. (2018c). Moray West Offshore Windfarm: Report to Inform Appropriate Assessment. riaa_report_with_appendices.pdf (marine.gov.scot) [Accessed 10/01/2022].

NatureScot. (2018). Interim Guidance on apportioning impacts from marine renewable developments to breeding seabird populations in SPAs. https://www.nature.scot/doc/interim-guidance-apportioning-impacts-marine-renewable-developments-breeding-seabird-populations [Accessed 25/08/2021].

NatureScot. (2020a). The effect of aviation obstruction lighting on birds at wind turbines, communication towers and other structures. NatureScot Information Note https://www.nature.scot/sites/default/files/2020-10/Wind%20farm%20impacts%20on%20birds%20-%20Turbine%20lighting%20and%20birds%20-%20Information%20Note.pdf [Accessed 20/04/2022].

NatureScot. (2020b). Seasonal periods for birds in the Scottish marine environment. Short Guidance Note. https://www.nature.scot/sites/default/files/2020-10/Guidance%20note%20-%20Seasonal%20definitions%20for%20birds%20in%20the%20Scottish%20Marine%20Environment.pdf [Accessed 25/08/2021].

NatureScot. (2022a). Avian flu task force announced. https://www.nature.scot/avian-flu-task-force-announced [Accessed 19/072022].

NatureScot. (2022b). Island nature reserve closes to protect seabirds. https://www.nature.scot/island-nature-reserves-close-protect-seabirds [Accessed 19/072022].

Newson, S.E., Mitchell, P.I., Parsons, M., O'Brien, S.H., Austin, G.E., Benn, S., Black, J., Blackburn, J., Brodie, B., Humphreys, E. & Leech, D. (2008). Population decline of Leach's Storm-petrel Oceanodroma leucorhoa within the largest colony in Britain and Ireland. *Seabird.* **21**: 77-84.

Olin, A.B., Banas, N.S., Wright, P.J., Heath, M.R. & Nager, R.G. (2020). Spatial synchrony of breeding success in the blacklegged kittiwake *Rissa tridactyla* reflects the spatial dynamics of its sandeel prey. *Marine Ecology Progress Series*, **638**: 177-190.

Orsted. (2021). Hornsea Four Environmental Statement. Volume A2 Chapter 5: Offshore & Intertidal Ornithology. 212pp. https://infrastructure.planninginspectorate.gov.uk (reference EN010098) [Accessed 10/01/2022].

Perkins, A., Ratcliffe, N., Suddaby, D., Ribbands, N., Smith, C., Ellis, P., Meek, E. & Bolton, M. (2018). Combined bottom-up and top-down pressures drive catastrophic population declines of Arctic skuas in Scotland. *Journal of Animal Ecology,* **87(6)**: 1573-1586.

Perrow, M.R. (2019). Wildlife and Wind Farms, Conflicts and Solutions, Volume 3. Offshore Potential Effects. Pelagic Publishing, Exeter, UK.Peschko, V., Mendel, B., Müller, S., Markones, N., Mercker, M. & Garthe, S. (2020). Effects of offshore windfarms on seabird abundance: Strong effects in spring and in the breeding season. Marine Environmental Research, **162**: 105-157

Peschko, V., Mendel, B., Müller, S., Markones, N., Mercker, M. and Garthe, S. (2020). Effects of offshore windfarms on seabird abundance: Strong effects in spring and in the breeding season. *Marine Environmental Research,* **162**: 105-157.PMSS. (2007). North Hoyle Annual FEPA Monitoring Report 2005-06 – Ornithology.

Raine, H., Borg, J.J., Raine, A., Bairner, S. & Borg-Cardona, M. (2007). Light Pollution and its effects on Yelkouan Shearwaters in Malta; causes and solutions. BirdLife Malta.

Rebke, M., Dierschke, V., Weiner, C.N., Aumüller, R., Hill, K. & Hill, R. (2019). Attraction of nocturnally migrating birds to artificial light: the influence of colour, intensity and blinking mode under different cloud cover conditions. *Biological Conservation,* **233**: 220-227.

Régnier, T., Gibb, F.M. and Wright, P.J. (2017). Importance of trophic mismatch in a winter-hatching species: evidence from lesser sandeel. *Marine Ecology Progress Series,* **567**: 185-197.

Rich, C. & Longcore, T. (2006). *Ecological consequences of artificial lighting. Island* Press, Washington, D.C., USA.

Robinson, R.A. (2005) BirdFacts: profiles of birds occurring in Britain & Ireland - BTO Research Report No: 407. http://www.bto.org/birdfacts [Accessed on 14/05/2022].

Robinson, R.A. (2017). BirdFacts: profiles of birds occurring in Britain and Ireland. http://www.bto.org/birdfacts [Accessed 14/05/2022].

Ronconi, R.A., Allard, K.A. & Taylor, P.D. (2015). Bird interactions with offshore oil and gas platforms: review of impacts and monitoring techniques. *Journal of Environmental Management,* **147**: 34-45.

Ross-Smith, V.H., Thaxter, C.N., Masden, E.A., Shamoun-Baranes, J., Burton, N.H.K., Wright, L.J., Rehfish, M.M. & Johnston, A. (2016). Modelling flight heights of lesser black-backed gulls and great skuas from GPS: a Baeysian approach. *Journal of Applied Ecology,* **53**: 1676-1685.

Royal Society for the Protection of Birds (RSPB). (2018). Kittiwake joins the Red List of birds facing risk of global extinction. / https://www.rspb.org.uk/about-the-rspb/about-us/media-centre/press-releases/kittiwake-joins-the-red-list-of-birds-facing-risk-of-global-extinction [Accessed 20/05/2022].

Sadykova, D., Scott, B.E., De Dominicis, M., Wakelin, S.L., Wolf, J. & Sadykov, A. (2020). Ecological costs of climate change on marine predator–prey population distributions by 2050. *Ecology and evolution*, **10(2)**: 1069-1086.

Searle, K.R., Mobbs, D., Butler, A., Bogdanova, M., Freeman, S., Wanless, S. & Daunt, F. (2014). Population Consequences of Displacement from Proposed Offshore Wind Energy Developments for Seabirds Breeding at Scottish SPAs (CR/2012/03). Report to Marine Science Scotland.

Searle, K.R., Mobbs, D.C., Butler, A., Furness, R.W., Trinder, M.N. & Daunt. F. (2018). Finding out the fate of displaced birds (FCR/2015/19). Scottish Marine and Freshwater Science Volume 9 No: 08.

Searle, K., Mobbs, D., Daunt, F. and Butler, A. (2019). A population viability analysis modelling tool for seabird species. Natural England Commissioned Report No. 274.

Searle, K. R., Regan, C. E., Perrow, M. R., Butler, A., Rindorf, A., Harris, M. P., Newell, M. A., Wanless, S. & Daunt, F. (2022). Effects of a fishery closure and prey abundance on seabird diet and breeding success: implications for strategic fisheries management and seabird conservation. https://masts.ac.uk/news/eight-new-reports-published-from-scottish-marine-energy-research-scotmer-programme/ [Accessed 04/08/2022].

Slingsby, J., Scott, B.E., Kregting, L., McIlvenny, J., Wilson, J., Yanez, M., Langlois, S. and Williamson, B.J. (2022). Using Unmanned Aerial Vehicle (UAV) Imagery to Characterise Pursuit-Diving Seabird Association With Tidal Stream Hydrodynamic Habitat Features. *Front. Mar. Sci.,* **9**: 820722.

SNCB. (2014). Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review.

SNCB. (2017). Joint SNCB Interim displacement advice notice, Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Reed, T., Tasker, M.L., Camphuysen, C.J. & Pienkowski, M.W. (1995). *An Atlas of Seabird Distribution in North-west European Waters.* Joint Nature Conservation Committee, Peterborough.

Swann, B. (2018). Seabird counts at North Caithness Cliffs SPA in 2015 and 2016 for Marine Renewables Casework. Scottish Natural Heritage Research Report No: 965.

Thomas, R.J., Medeiros, R.J. & Pollard, A.L. (2006). Evidence for nocturnal inter-tidal foraging by European storm-petrels *Hydrobates pelagicus* during migration. *Atlantic seabirds*, **8(1/2)**: 87-96.

Vallejo, G.C., Grellier, K., Nelson, E.J., McGregor, R.M., Canning, S.J., Caryl, F.M. & McLean, N. (2017). Responses of two marine top predators to an offshore wind farm. *Ecological Evolution*, **7 (21)**: 8698-8708.

Vanermen, N., Stienen, E.W.M, Courtens, W., Onkelinx, T., Van de walle, M. & Verstraete, H. (2013). Bird monitoring at offshore wind farms in the Belgian part of the North Sea. Inbo report.

Vanermen, N., Onkelinx, T., Courtens, W., Van de walle, M., Verstaete, H. & Stienen, E.W.M. (2014). Seabird avoidance/attraction at an offshore wind farm in the Belgian part of the North Sea. *Hydrobiologia*, **756**: 51-61.

Vigfusdottir, F., Gunnarsson, T.G. & Gill, J.A. (2013). Annual and between-colony variation in productivity of Arctic terns in West Iceland. *Bird Study*, **60(3)**: 289-297.

Wade, H.M., Masden E.A., Jackson A.C. & Furness R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. *Marine Policy*, **70**: 108-113.

Wanless, S., Harris, M. P., Newell, M. A., Speakman, J. R. & Daunt, F. (2018). Community-wide decline in the occurrence of lesser sandeels (*Ammodytes marinus*) in seabird chick diets at a North Sea colony. *Marine Ecology Progress Series*. **600**: 193-206

Woodward, I., Thaxter, C.B., Owen, E. & Cook, A.S.C.P. (2019). Desk-based revision of seabird foraging ranges used for HRA screening. BTO research report No: 724.

Wright. P.J. & Bailey, M.C. (1996). Timing of hatching in *Ammodytes marinus* from Shetland waters and its significance to early growth and survivorship. *Marine Biology*, **126**: 143-152.

Wright, L.J., Ross-Smith, V.H., Austin, G.E., Massimino, D., Dadam, D., Cook, A.S.C.P., Calbrade, N.A. & Burton, N.H.K. (2012). Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex 1 species). BTO research report No: 592.

Wildfowl and Wetlands Trust (WWT). (2014). Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds. Scottish Marine and Freshwater Science Report Volume 5 No 12. WWT report for Marine Scotland Science.