Appendix H

Offshore Ornithology Supporting Information

ORIEL WIND FARM PROJECT

Natura Impact Statement: Offshore Ornithology

Appendix H Offshore Ornithology – Supporting Information

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1 OFFSHORE ORNITHOLOGY

1.1 Introduction

This report describes the potential impacts of the Oriel Wind Farm Project (hereafter referred to as the "Project") on birds in the offshore environment. It considers the potential impact of the Project seaward of the Low Water Mark (LWM) during the construction, operational and maintenance, and decommissioning phases. Potential impacts on birds in the intertidal zone between the High Water Mark (HWM) and LWM are assessed in Appendix I: Onshore Biodiversity – Supporting Information.

The assessment presented is also informed by the following technical reports:

- Appendix D: Benthic Subtidal and Intertidal Ecology – Supporting Information; and
- Appendix F: Fish and Shellfish Ecology – Supporting Information.

This report summarises information contained within the following technical appendices:

- Annex 1: Offshore Ornithology Technical Report;
- Annex 2: Ornithological and Marine Megafauna Aerial Survey Results;
- Annex 3: Migratory Geese Survey Report;
- Annex 4: Offshore Ornithology Collision Risk Modelling;
- Annex 5: Offshore Ornithology Displacement Analysis;
- Annex 6: Offshore Ornithology Migratory Non-Seabirds Collision Risk Modelling;
- Annex 7: Offshore Ornithology Apportioning Impacts to Individual Colonies; and
- Annex 8: Offshore Ornithology Population Viability Analysis.

1.2 Purpose

The primary purpose of this report is to provide supporting information on the potential impacts of the Project on offshore ornithology, which is used to inform the assessment of adverse effects in the Natura Impact Statement (NIS). In particular, this report:

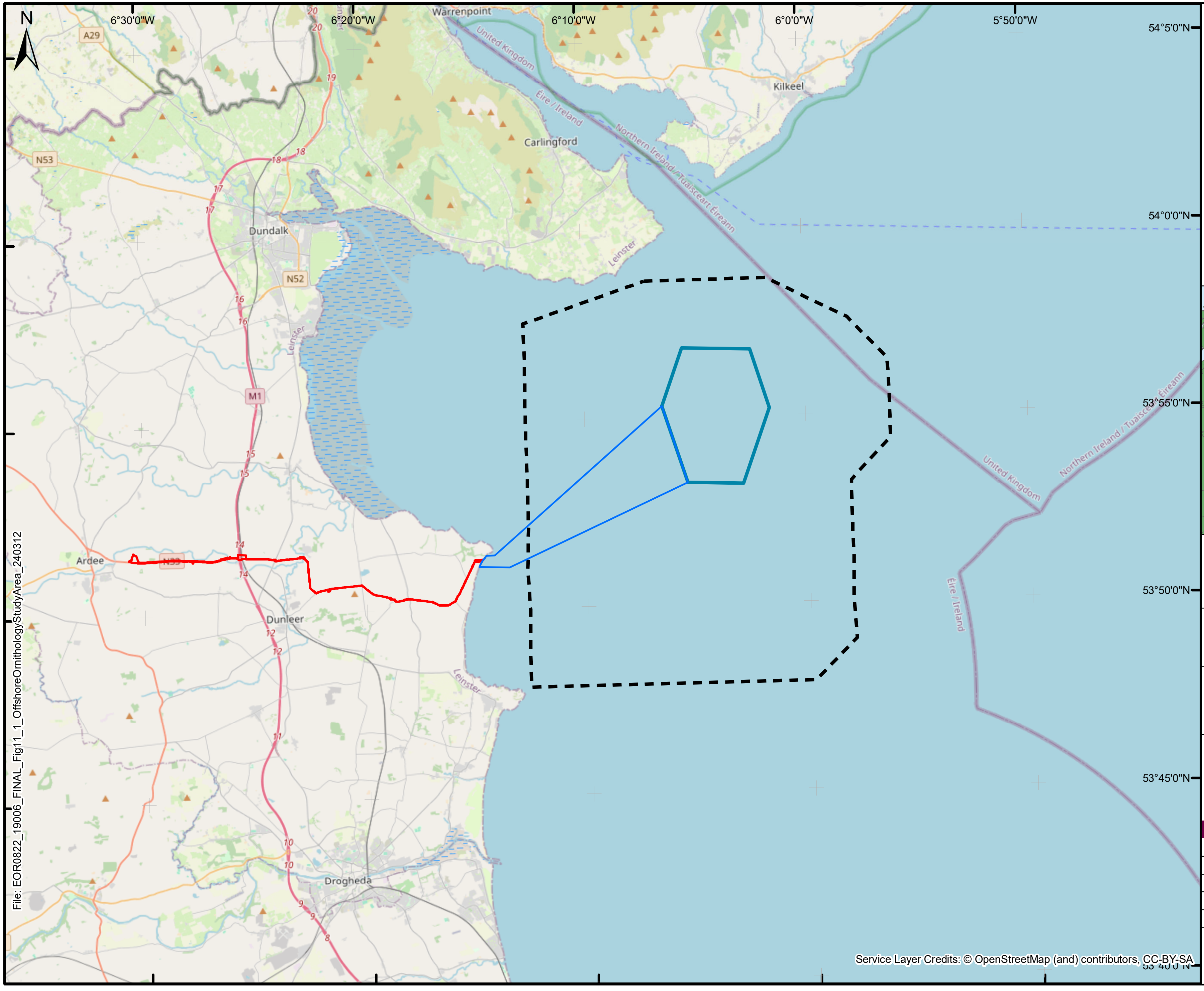
- Identifies European sites which have relevant offshore ornithology qualifying features and presents the existing environmental baseline established from desk studies, site-specific surveys and consultation (section 1.4 and section 3); and
- Identifies potential impacts, their magnitude and their sensitivity on relevant fish and shellfish qualifying features, based on the information gathered (see section 5). An assessment of potential in-combination effects is provided in section 6.

1.3 Zone of Influence

The Zone of Influence (ZoI) varies with each impact source and receptor interaction. The ZoI is contained within the three study areas, described below. Three appropriate study areas have been defined for the development of this technical report, as illustrated within Figure 1-1 and Figure 6-1 and defined as follows:

- **The Offshore Ornithology Study Area:** defined as the extent of the area surveyed during the site-specific boat-based ornithology surveys (Aquafact, 2019) and digital aerial surveys (DAS) (APEM, 2020) and the extent of the offshore cable corridor up to the LWM. The boat and aerial surveys cover a total area of 319.85 km^2 and encompasses the marine habitats within the offshore wind farm area, offshore cable corridor and an additional buffer of varying extent, as illustrated Figure 1-1. The closest distance from the offshore wind farm area to the boundary of the Offshore Ornithology Study Area (i.e. the extent of the survey buffer around the offshore wind farm area) is 3.37 km, with the furthest distance approximately 12.74 km; and

- **The Cumulative Offshore Ornithology Study Area:** where Annex I species under the Birds Directive were identified within the Offshore Ornithology Study Area, mean-maximum foraging ranges (based on those presented in Woodward *et al.* (2019)) of these species have been used to identify potentially connected designated sites for which they are qualifying features. The Cumulative Offshore Ornithology Study Area extends up to 509.4 km around the wind farm area and is based on the northern gannet *Morus bassanus* (hereafter referred to as gannet) mean-maximum plus one standard deviation (SD) foraging distances (Woodward *et al.*, 2019). The mean-maximum foraging range for gannet is the greatest of all the Annex I species selected as part of this assessment, therefore this extent encompasses the foraging ranges from Special Protection Areas (SPAs) of all other relevant seabird species for which the Project potentially has more than a negligible impact, as illustrated in Figure 6-1.



Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Onshore Cable Route
- Offshore Ornithology Study Area / Boat-based and Aerial Survey Area
- Territorial Waters Boundary

Data Sources: Client,

Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 1-1
Offshore Ornithology Study Area

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1.4 Consultation

Table 1-1 summarises the issues identified during consultation activities undertaken to date, which are relevant to offshore ornithology, together with how these issues have been considered in the preparation of this report.

Table 1-1: Summary of key issues raised during consultation on offshore ornithology.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this appendix
October 2019	Department of Agriculture, Environment and Rural Affairs (DAERA): Natural Environment Division – response to scoping.	Raised that qualifying features of Northern Irelands SPAs be considered, in relation to feeding areas, in the preparation of the EIA. In particular, they highlighted potential impacts to: Shearwaters from the Copeland Islands; Terns from Carlingford Lough; and Whooper swan migration corridors.	Ornithological features of SPAs occurring in Northern Ireland, and within the ZoI of the Project have been addressed in section 3 of this report and within the Natura Impact Statement (NIS) provided under separate cover.
October 2019	BirdWatch Ireland – response to scoping.	Provision of I-WeBS data and information on local data. Advised that there are a couple of small black guillemot colonies, one at north side of Dundalk Bay (Giles Quay) and one to the south at Clogher Head.	Detailed baseline characterisation is presented in annex 1: Offshore Ornithology Technical Report.
October 2019	Irish Brent Goose Research Group – response to scoping.	Discussion of potential impacts on migratory Brent goose in late October / November and March / April in Dundalk Bay.	Migratory wildfowl VP surveys were undertaken in autumn 2019 and spring 2020, see annex 3: Migratory Geese Survey Report.
October 2019	ObSERVE – response to data request.	Provision of ObSERVE Project data.	Detailed baseline characterisation is presented in annex 1: Offshore Ornithology Technical Report.
November 2019	Joint Nature Conservation Committee (JNCC) – response to data request.	Provision of European Seabirds at Sea (ESAS) data.	Detailed baseline characterisation is presented in annex 1: Offshore Ornithology Technical Report.
November 2019	A member of the public	Discussion of migratory Brent goose across Dundalk Bay.	Migratory wildfowl VP surveys were undertaken in autumn 2019 and spring 2020, see annex 3: Migratory Geese Survey Report.
June 2020	NPWS – pre-application consultation.	Discussion on project design, ornithology baseline data collection, identification of sensitive receptors, potential impacts and the proposed analytical framework for the seabird assessment.	Desk study information incorporated into baseline characterisation described in annex 1: Offshore Ornithology Technical Report. Desk study and baseline survey method and results are presented in section 2 and 3. Potential impacts are identified in section 5.
January 2023	Members of the public during public consultation	Concerns regarding the Project impacting bird life	The potential effects of the construction, operational and maintenance and decommissioning phases of the Project on offshore ornithology have been considered in section 5 and

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this appendix
			within the NIS provided under separate cover.
	An Bord Pleanála (ABP) – pre - application consultation.	Consideration of potential issues arising from the designation of the North West Irish Sea cSPA. Examine impacts on ornithology resulting from changes to prey.	Qualifying features of the North West Irish Sea cSPA have been addressed in section 3 of this chapter, and within the NIS provided under separate cover. Section 5.2 examines the indirect displacement resulting from changes to prey.
September 2023	DAERA	Consideration should be given to Northern Irish seabird colonies and potential impacts. Specific requests that certain species are included.	Northern Ireland seabird colonies are included within the baseline and apportioning technical reports (annex 1: Offshore Ornithology Technical Report and annex 7: Offshore Ornithology Apportioning Impacts to Individual Colonies). All species which are present during the site-specific surveys have been presented within this report in section 3 and section 5.
October 2023	Isle of Man Government – Territorial Sea Committee	Consideration should be given to Isle of Man seabird colonies and potential impacts. Consideration should be given to the Isle of Man wind farm project (Mooir Vainn)	Isle of Man seabird colonies are included within the baseline and apportioning technical reports (annex 1: Offshore Ornithology Technical Report and annex 7: Offshore Ornithology Apportioning Impacts to Individual Colonies). The Mooir Vannin project has been considered as part of the in-combination effects presented in section 6 of this report.
November 2023	ABP – pre -application consultation.	Engage with other wind farm developers to inform the cumulative impact assessment.	Other Phase 1 projects along the east coast of Ireland have been considered as part of the CIA presented in section 6.

2 METHODOLOGY TO INFORM THE BASELINE

The methodology to inform the baseline was discussed in consultation with key stakeholders (Table 1-1). The approach involved the use of site-specific survey data including boat-based visual surveys, and DAS surveys collected within the Offshore Ornithology Study Area. In addition, data were gathered through a literature review of existing data sources. These baseline data have been used to describe the occurrence, distribution and abundance / density of seabirds and migratory birds in the marine environment with reference to the study areas defined above (section 1.3). Further detail on the approach is provided below and data sources are presented in full within annex 1: Offshore Ornithology Technical Report.

2.1 Desktop study

Information on offshore ornithology within both the Offshore Ornithology Study Area and Cumulative Offshore Ornithology Study Area was collected through a detailed desktop review of existing studies and datasets relevant to the Project.

The key sources (i.e. data and reports) used to inform the baseline characterisation of the Offshore Ornithology Study Area are summarised in Table 2-1 and Table 2-2. These sources provide the most up-to-date data for this report.

Table 2-1: Desk-based data sources and data provisions.

Sources	Data Provision
Ireland’s Marine Atlas	Ireland’s Marine Atlas provides an overview of protected sites in Ireland’s marine environment, as well as a resource to identify other marine developments for cumulative assessment.
NPWS	NPWS provide data on protected species, sites and conservation objectives in Ireland, including site boundaries and an overview of designated sites (SPAs) seabird feature populations and colonies.
DAERA – Northern Ireland	DAERA provides an overview of designated sites (SPAs) in Northern Ireland and details of their seabird feature populations and colonies.
Natural England	Natural England provides an overview of designated sites (SPAs) in England and details of their seabird feature populations and colonies.
Natural Resources Wales (NRW)	NRW provides an overview of designated sites (SPAs) in Wales and details of their seabird feature populations and colonies.
NatureScot (formerly Scottish Natural Heritage)	NatureScot provides an overview of designated sites (SPAs) in Scotland and details of their seabird feature populations and colonies.
European Environment Agency	The European Environment Agency provides detail of species, habitats and protected sites across Europe through the European Nature Information System (EUNIS). This system provides detailed accounts of Natura 2000 sites, including features and population demographics of seabird features.
Seabird distribution and model outputs from ObSERVE	The ObSERVE programme was established by the Department of Communications, Climate Action and Environment (DCCAE) in partnership with the Department of Culture, Heritage and the Gaeltacht (DCHG) with the aim to improve the current knowledge and understanding of protected offshore species and habitats to support sustainable management of offshore activities and the development of appropriate marine conservation strategies. In 2016, an output of the programme ‘The seasonal distribution and abundance of Seabirds in the western Irish Sea, 2016’ was made available.
I-WeBS	I-WeBS is a joint scheme of BirdWatch Ireland and NPWS which aims to monitor the numbers and distribution of waterbird populations wintering in Ireland to enable identification of long-term spatio-temporal trends.
ESAS	ESAS data were amalgamated from a long-running programme of survey and research work on seabirds in the marine environment in the northeast Atlantic since 1979, and in the southwest Atlantic between 1998 and 2002. This data set recorded a wide range of seabirds, divers and seaducks, presented as grid cell densities of each species.

Sources	Data Provision
Seabird Monitoring Programme (SMP)	An ongoing annual monitoring programme of 25 species of seabird that regularly breed in Britain and Ireland. Established in 1986, the SMP was led and co-ordinated by the JNCC in partnership with multiple organisations. As of July 2022, the annual monitoring scheme is organised by the British Trust for Ornithology (BTO) in partnership with JNCC, and the Royal Society for the Protection of Birds (RSPB) as an associate partner. It is supported by a wider advisory group which includes Natural England, NRW, NatureScot and DAERA.

The data collated from these sources provides an overview of seabird populations at both a localised Project level and a regional level. The ESAS database was reviewed for an area comprising the Offshore Ornithology Study Area plus 5 km buffer to provide an overview of the seabird populations within the immediate vicinity of the Project. Likewise, the I-WeBS accounts provide a localised overview of the Dundalk Bay area. The ObSERVE programme provides an overview of seabird populations and densities at a regional level, spanning from Dundalk Bay in the north, to south of Wexford harbour in the south. The second phase of ObSERVE (ObSERVE II) is currently being undertaken between summer 2021 until summer 2025. The data gathered thus far is not currently available for inclusion within this report.

Table 2-2: Summary of key desktop reports or databases considered in this report.

Title	Source	Year	Author
ESAS Database	www.esas.ices.dk	2022	ICES
ObSERVE programme 'The seasonal distribution and abundance of seabirds in the western Irish Sea'	ObSERVE website	2018	DCCAE, NPWS and DCHG
Dundalk Bay (site 0Z401) I-WeBs Database	I-WeBS Website	2022	BirdWatch Ireland and NPWS
Monthly 10km grid square species distribution models of seabird abundance	Journal of Applied Ecology	2019	Waggit *et al.,* (2019) Distribution maps of cetacean and seabird populations in the North-East Atlantic

2.2 Site-specific surveys

An initial programme of baseline boat-based site-specific seabird surveys was carried out between 2006 and 2008 to inform a previous Environmental Impact Statement (EIS) for the Project. In order to update this data and provide suitable data to inform this report, an updated programme of boat-based seabird surveys using standard ESAS methods was commissioned to take place between May 2018 and May 2020. These surveys were undertaken by Aquafact Ltd, Inis Ecology and Galway-Mayo Institute of Technology. Detailed information is provided in annex 1: Offshore Ornithology Technical Report.

In response to the Covid-19 pandemic and associated difficulties in continuation of the boat-based surveys in 2020, a program of six DAS of the Offshore Ornithology Study Area were also undertaken between April and September 2020 by APEM Ltd, with the aim of complementing the boat-based surveys. Detailed information on the aerial survey methods and results is provided in annex 2: Ornithological and Marine Megafauna Aerial Survey Results.

A summary of the surveys undertaken to inform this report are outlined in Table 2-3 below.

Table 2-3: Summary of site-specific survey data.

Title	Extent of survey	Overview of survey	Survey dates	Reference to further information
Boat-based surveys	Offshore Ornithology Study Area	Update to baseline surveys undertaken between 2006-2008. 19 surveys undertaken following ESAS survey method.	May 2018 – May 2020	Annex 1: Offshore Ornithology Technical Report
Digital aerial surveys (DAS)	Offshore Ornithology Study Area	DAS to complement boat-based surveys. Six surveys following the same transects as the boat-based survey	April 2020 – September 2020	Annex 2: Ornithological and Marine Megafauna Aerial Survey Results

2.3 Identification of relevant European sites and features

- All European sites and qualifying features within the Cumulative Offshore Ornithology Study Area = that could be affected by the construction, operational and maintenance, and decommissioning of the Project were identified using the three-step process described below. Step 1: All European sites within the Cumulative Offshore Ornithology Study Area were identified using a number of sources. These included Ireland's Marine Atlas interactive map application (http://atlas.marine.ie/), NPWS website, the European Nature Information System (EUNIS) designated site database, and for sites in Northern Ireland, the JNCC website and the Department for Environment, Food and Rural Affairs (Defra) MAGIC interactive map applications (http://magic.defra.gov.uk/).

- Step 2: Information was compiled on the relevant qualifying features for each of these sites, based on known species occurrences from the desktop review; and

- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site with qualifying features directly overlaps with the offshore wind farm area or offshore cable corridor and therefore has the potential to be directly affected by the Project;
  - The foraging range of a feature of an internationally designated site within the Cumulative Offshore Ornithology Study Area directly overlaps with the Project; and
  - Features of a designated site were either recorded as present during recent site-specific surveys within the offshore wind farm area and offshore cable corridor, or identified during the desktop study as having the potential to occur within the offshore wind farm area and offshore cable corridor.

This process identified the designated sites and their qualifying interest seabird and migratory waterbird features with potential connectivity to the Project, as defined by potential migratory routes (annex 6: Offshore Ornithology Migratory Non-Seabirds Collision Risk Modelling) or published foraging ranges (Woodward *et al.*, 2019).

3 BASELINE ENVIRONMENT

3.1 Relevant European sites

European sites with qualifying ornithological interest features with potential connectivity to the Project were identified within 509.4 km (by marine pathway) of the offshore wind farm area, based on the mean-maximum foraging range plus one SD of gannet (Woodward *et al*., 2019). This defines the Cumulative Offshore Ornithological Study Area and encompasses the foraging ranges from SPAs of all other relevant seabird species for which the Project potentially has more than a negligible impact, with the exception of Manx shearwater. Manx shearwater and fulmar have large published foraging ranges (mean-maximum plus one S.D. is 1346.8 ± 1018.7 km for Manx shearwater and 542.3 ± 657.9 km for fulmar). Whilst there may be associations with more distant SPAs, the extent and frequency of connectivity with sites beyond 509.4 km is likely to be very low, *i.e.* birds from further away are not expected to be present frequently at the offshore wind farm area and they are screened out of further assessment.

European sites within the Cumulative Offshore Ornithological Study Area are described in Table 3-1 below, which lists the breeding seabird interest features for each SPA that is within foraging range (mean maximum plus one S.D.), or the non-breeding migratory waterbird interest features for each SPA where there is potential for migratory movements of birds across the offshore wind farm area.

Seabird species that are qualifying features of an SPA but are beyond the defined foraging range of the offshore wind farm area are not listed in Table 3-1; however a list of all qualifying features of the SPAs are provided in full in annex 1: Offshore Ornithology Technical Report. The listed population sizes for each SPA are derived from the latest updates to the Natura 2000 Standard Data Forms.

The closest distance between the offshore wind farm area and the SPA boundary in Table 3-1 is via marine pathway. During the breeding season, seabirds are highly unlikely to commute across land and will stay in the marine environment, therefore, to calculate the distance between the SPA and the Project a marine pathway measurement is required and not a straight line distance.

The relevant qualifying features (receptors) of SPAs included within this report are those species with a mean maximum foraging range (during the breeding season) or where non-trivial connectivity may exist (during migration or winter) with more distant SPAs, which were recorded during the surveys that could be potentially affected by the Project. Species that were recorded in very small numbers or very infrequently during the baseline surveys are excluded from assessment because the risk of additional mortality in their populations is negligible. The relevant SPA qualifying features listed in Table 3-1 were taken forward for consideration of potential impacts.

Table 3-1: Relevant European sites and qualifying features.

European site	Closest distance to the Project (km)	Relevant qualifying feature and designated population size (for breeding colony SPAs only)
North-west Irish Sea SPA[1]	2 km of the offshore cable corridor traverses the SPA	Classified for the following non-breeding (wintering) bird populations: • Common scoter *Melanitta nigra* • Red-throated diver *Gavia stellata* • Great northern diver *Gavia immer* • Fulmar *Fulmarus glacialis* • Little gull *Hydrocoloeus minutus* • Kittiwake *Rissa tridactyla*

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[1] Candidate and proposed sites, and European sites are collectively referred to as "SACs" and "SPAs". There is no distinction made between candidate/proposed sites and European sites as they have the same level of protection as a matter of domestic law. For the purpose of the report, they are considered one and the same.

European site	Closest distance to the Project (km)	Relevant qualifying feature and designated population size (for breeding colony SPAs only)
		• Black-headed gull *Chroicocephalus ridibundus* • Common gull *Larus canus* • Lesser black-backed gull *Larus fucus* • Herring gull *Larus argentatus* • Great black-backed gull *Larus marinus* • Razorbill *Alca torda* • Guillemot *Uria aalge* Classified for the following breeding bird populations: • Fulmar • Manx shearwater *Puffinus puffinus* • Shag *Phalacrocorax aristotelis* • Cormorant *Phalacrocorax carbo* • Little tern *Sterna albifrons* • Roseate tern *Sterna dougallii* • Common tern *Sterna hirundo* • Arctic tern *Sterna paradisaea* • Puffin *Fratercula arctica* • Lesser black-backed gull • Herring gull • Kittiwake • Razorbill • Guillemot
Carlingford Lough SPA	5.7	Classified for the following breeding bird populations: • Sandwich tern *Sterna sandvicensis* (575 pairs) • Common tern *Sterna hirundo* (339 pairs)
Dundalk Bay SPA	8.0	Classified for the following non-breeding (wintering) bird populations: • Black-headed gull • Common gull • Herring gull
River Nanny Estuary and Shore SPA	24.2	Classified for the following non-breeding (wintering) bird population: • Herring gull
Rockabill SPA	28.5	Classified for the following breeding bird population: • Arctic tern *Sterna paradisaea* (89 pairs) • Common tern *Sterna hirundo* (1,940 pairs)
Skerries Island SPA	33.1	Classified for the following breeding bird populations: • Herring gull (250 pairs) • Cormorant *Phalacrocorax carbo* (558 pairs)
Lambay Island SPA	42.7	Classified for the following breeding bird populations: • Fulmar *Fulmarus glacialis* (635 pairs) • Guillemot *Uria aalge* (59,824 individuals) • Herring gull (1,806 pairs) • Kittiwake *Rissa tridactyla* (4,091 pairs) • Razorbill *Alca torda* (4,337 individuals) • Lesser black-backed gull *Larus fuscus* (309 pairs) • Puffin *Fratercula arctica* (265 individuals)
Strangford Lough SPA	49.4	Classified for the following breeding bird population: • Sandwich tern (593 pairs)

European site	Closest distance to the Project (km)	Relevant qualifying feature and designated population size (for breeding colony SPAs only)
Ireland's Eye SPA	52.7	Classified for the following breeding bird populations: • Guillemot (2,191 individuals) • Herring gull (250 pairs) • Kittiwake (941 pairs) • Razorbill (522 individuals)
Howth Head Coast SPA	55.2	Classified for the following breeding bird population: • Guillemot (995 individuals) • Kittiwake (2,329 pairs) • Razorbill (416 individuals)
Irish Sea Front SPA	56.8	Classified for the following breeding bird population: • Manx shearwater
Copeland Islands SPA	86.8	Classified for the following breeding bird population: • Manx shearwater (4,800 pairs)
Wicklow Head SPA	101.2	Classified for the following breeding bird populations: • Guillemot (420 individuals) • Kittiwake (956 pairs) • Razorbill (186 individuals)
Glannau Aberdaron ac Ynys Enlli SPA	139.6	Classified for the following breeding bird populations: • Manx shearwater (6,930 pairs)
Rathlin Island SPA	145.6	Classified for the following breeding bird population: • Guillemot (41,887 individuals) • Kittiwake (6,822 pairs) • Razorbill (8,922 individuals)
Seas off Wexford SPA[2]	146	Classified for the following breeding bird populations: • Fulmar (from Saltee Islands SPA) • Gannet (from Saltee Islands SPA) • Lesser black-backed gull (from Saltee Islands SPA) • Kittiwake (from Saltee Islands SPA) • Puffin (from Saltee Islands SPA) • Manx shearwater
Ailsa Craig SPA	158.6	Classified for the following breeding bird populations: • Gannet *Morus bassanus* (23,000 pairs) • Kittiwake (3,100 pairs) • Lesser black-backed gull (1,800 pairs)
Morecambe Bay and Duddon Estuary SPA	171.8	Classified for the following breeding bird populations: • Lesser black-backed gull (4,860 pairs)
Ribble and Alt Estuaries SPA	194.5	Classified for the following breeding bird population: • Lesser black-backed gull (1,800 pairs)
Saltee Islands SPA	209.7	Classified for the following breeding bird populations: • Fulmar (525 pairs) • Gannet (2,446 pairs) • Lesser black-backed gull (175 pairs) • Kittiwake (2,125 pairs) • Puffin (1,822 individuals)

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[2] Candidate and proposed sites, and European sites are collectively referred to as "SACs" and "SPAs". There is no distinction made between candidate/proposed sites and European sites as they have the same level of protection as a matter of domestic law. For the purpose of the report, they are considered one and the same.

European site	Closest distance to the Project (km)	Relevant qualifying feature and designated population size (for breeding colony SPAs only)
Skomer, Skokholm and the Seas off Pembrokeshire SPA	238.9	Classified for the following breeding bird populations: • Manx shearwater (150,968 pairs) • Puffin (9,500 pairs)
Grassholm SPA	240.5	Classified for the following breeding bird population: • Gannet (33,000 pairs)
North Colonsay and Western Cliffs SPA	257.1	Classified for the following breeding bird population: • Kittiwake (4,512 pairs)
Horn Head to Fanad Head SPA	295.4	Classified for the following breeding bird populations: • Fulmar (1,974 pairs) • Kittiwake (3,853 pairs)
Helvick Head to Ballyquin SPA	275.6	Classified for the following breeding bird population: • Kittiwake (1,037 pairs)
Tory Island SPA	322.3	Classified for the following breeding bird population: • Fulmar (641 pairs)
West Donegal Coast SPA	338.1	Classified for the following breeding bird population: • Fulmar (1,879 pairs)
Rum SPA	354.7	Classified for the following breeding bird population: • Manx shearwater (61,000 pairs)
Mingulay and Berneray SPA	360.9	Classified for the following breeding bird population: • Fulmar (12,500 pairs)
Beara Peninsula SPA	466.7	Classified for the following breeding bird population: • Fulmar (575 pairs)
Shiant Isles SPA	470.1	Classified for the following breeding bird population: • Fulmar (6,820 pairs)
St Kilda SPA	492.0	Classified for the following breeding bird population: • Manx shearwater (5,000 pairs) • Fulmar (62,800 pairs)
Duvillaun Islands SPA	501.1	Classified for the following breeding bird population: • Fulmar (1,150 pairs)
Deenish Island and Scariff Island SPA	504.0	Classified for the following breeding bird population: • Manx shearwater (2,311 pairs) • Fulmar (325 pairs)

3.2 Relevant qualifying features recorded in the Offshore Ornithology Study Area

A total of 31 bird species were recorded during the site-specific surveys undertaken between May 2018 and September 2020, of which 22 are qualifying features of SPAs in Table 3-1. The 22 qualifying features also are presented in Table 3-2. Further details of the baseline characterisation for each species are included in annex 1: Offshore Ornithology Technical Report, and annex 2: Ornithological and Marine Megafauna Aerial Survey Results.

Where seabirds were not recorded at all over the duration of site-specific surveys (18 surveys), it is considered objectively reasonable using expert judgement to exclude them from further assessment. Seabirds not recorded would likely not use the offshore wind farm area in numbers large enough to warrant further consideration. Therefore the seabirds, and their relevant SPAs, which were not recorded at all during site-specific surveys have been excluded from further assessment.

The total abundance presented in Table 3-2 is derived from summing all records during the site-specific surveys. The level of abundance is categorised as follows: very low < 49 individuals; low: 50 to 199;

moderate: 200 to 999; high: 1000 to 4,999 and very high: > 5,000. If a qualifying feature was present in very low numbers (<49 individuals recorded throughout the combined the site-specific surveys) it is concluded that no adverse impact would occur during any phase of the Project (these species are highlighted in grey).

Species recorded in low numbers (50 to 199 individuals) across all site-specific surveys (18 surveys), are presented within Table 3-3 to understand the importance of the sites to the SPA populations (these species are highlighted in yellow). To account for small populations of species recorded in low numbers a further screening of SPAs within the connectivity range is presented in Table 3-3 for species which were defined as "low" abundance. A species was taken forward to further assessment (e.g. an assessment of collision risk or disturbance and displacement) if the peak count during one survey represents >10% of a single SPA's population. At least 10 % of a single SPA's population was used as in reality the birds would come from multiple different SPAs (and non-SPA) colonies, and therefore presuming that all individuals within the survey area are from one SPA is highly unlikely and not realistic. Due to the sensitively of red-throated diver to disturbance and that the cable corridor overlaps with the North-west Irish Sea SPA, this species and site, are taken through to further assessment.

Species which are recorded in at least moderate numbers (>200 individuals), are instantly taken through for additional assessment (these species are highlighted in green) (see section 5). It should be noted that assessments for other wind farm projects may take a different approach to what is outlined above due to the differences in geographic location and peak site-specific survey counts for seabirds. Differences in seabird peak counts between projects is expected to vary and will result in differences in which seabirds are included/ excluded for further assessment.

Table 3-2: Qualifying features recorded during the site-specific boat-based surveys and/or DAS.

Species	Total abundance in Offshore Ornithology Study Area during site-specific surveys	Peak count during one survey	SPA(s) for which the species is designated with connectivity to the Project	Taken through to additional assessment
Arctic tern	1 Very low	1	• North-west Irish Sea • Rockabill	• No
Black-headed gull	24 Very low	11	• North-west Irish Sea • Dundalk Bay	• No
Common gull	580 Moderate	137	• North-west Irish Sea • Dundalk Bay	• Yes
Common scoter	2,222 High	2,005	• North-west Irish Sea	• Yes
Common tern	77 Low	21	• North-west Irish Sea • Carlingford Lough • Rockabill	• See Table 3-3
Cormorant	78 Low	18	• North-west Irish Sea • Skerries Island	• See Table 3-3
Fulmar	61 Low	21	• North-west Irish Sea • Howth Head Coast • Lambay Island • Seas off Wexford • Saltee Islands • Horn Head to Fanad • Tory Island • West Donegal Coast • Mingulay and Berneray Beara Peninsula • Shiant Isles • St Kilda • Duvilllaun Islands	• See Table 3-3

Species	Total abundance in Offshore Ornithology Study Area during site-specific surveys	Peak count during one survey	SPA(s) for which the species is designated with connectivity to the Project	Taken through to additional assessment
			• Deenish Island and Scariff Island	
Gannet	1,718 High	247	• Ailsa Craig • Seas off Wexford • Saltee Islands • Grassholm	• Yes
Guillemot	24,301 Very high	6,163	• North-west Irish Sea • Lambay Island • Ireland's Eye • Howth Head Coast • Wicklow Head • Rathlin Island	• Yes
Great black-backed gull	908 Moderate	126	• North-west Irish Sea	• Yes
Great northern diver	945 Moderate	285	• North-west Irish Sea	• Yes
Herring gull	730 Moderate	165	• North-west Irish Sea • Dundalk Bay • River Nanny Estuary and Shore • Skerries Island • Lambay Island • Ireland's Eye	• Yes
Kittiwake	1,199 High	238	• North-west Irish Sea • Lambay Island • Ireland's Eye • Howth Head Coast • Wicklow Head • Rathlin Island • Ailsa Craig • Seas off Wexford • Saltee Islands • North Colonsay and Western Cliffs • Horn Head to Fanad • Helvick Head to Ballyquin	• Yes
Lesser black-backed gull	52 Low	20	• North-west Irish Sea • Lambay Island • Ailsa Craig • Morecambe Bay and Duddon Estuary • Ribble and Alt Estuaries • Seas off Wexford • Saltee Islands	• See Table 3-3
Little gull	1 Very low	1	• North-west Irish Sea	• No
Manx shearwater	9,736 Very high	2,094	• North-west Irish Sea • Irish Sea Front • Copeland Islands	• Yes

Species	Total abundance in Offshore Ornithology Study Area during site-specific surveys	Peak count during one survey	SPA(s) for which the species is designated with connectivity to the Project	Taken through to additional assessment
			• Glannau Aberdaron ac Ynys Enlli • Skomer, Skokholm and the Seas off Pembrokeshire • Rum • St Kilda • Deenish Island and Scariff Island • Seas off Wexford	
Puffin	72 Low	24	• North-west Irish Sea • Lambay Island • Seas off Wexford • Saltee Islands • Skomer, Skokholm and the Seas off Pembrokeshire	• See Table 3-3
Razorbill	3,195 High	439	• North-west Irish Sea • Lambay Island • Ireland’s Eye • Howth Head Coast • Wicklow Head • Rathlin Island	• Yes
Red-throated diver	134 Low	27	• North-west Irish Sea	• See Table 3-3
Sandwich tern	19 Very low	3	• Carlingford Lough • Strangford Lough	• No

Table 3-3: Importance to the site for species recorded in low numbers during the site-specific surveys.

Species	Peak count during one survey	SPA	SPA population (at destination)	Peak count as a % of the SPA population	Taken through to further assessment
Common tern	21	• North-west Irish Sea	See Carlingford Lough SPA and Rockabill SPA		
		• Carlingford Lough	339 pairs	3.1	No
		• Rockabill	1,940 pairs	0.5	No
		Total SPA population	2,279 pairs	0.5	No
Cormorant	18	• North-west Irish Sea	N/A	N/A	No
		• Skerries Island	558 pairs	1.6	No
Fulmar	21	• North-west Irish Sea	See Lambay Island SPA		
		• Lambay Island	635 pairs	1.7	No
		• Seas off Wexford	See Saltee Islands SPA		
		• Saltee Islands	525 pairs	2.0	No
		• Horn Head to Fanad	1,974 pairs	0.5	No
		• Tory Island	641 pairs	1.6	No
		• West Donegal Coast	1,879 pairs	0.6	No

Species	Peak count during one survey	SPA	SPA population (at destination)	Peak count as a % of the SPA population	Taken through to further assessment
		• Mingulay and Berneray	12,500 pairs	0.1	No
		• Beara Peninsula	575 pairs	1.8	No
		• Shiant Isles	6,820 pairs	0.2	No
		• St Kilda	62,820 pairs	<0.1	No
		• Duvilllaun Islands	1,150 pairs	0.9	No
		• Deenish Island and Scariff Island	325 pairs	3.2	No
		Total SPA population	89,844 pairs	<0.1	No
Lesser black-backed gull	20	• North-west Irish Sea	See Lambay Island SPA		
		• Lambay Island	309 pairs	3.2	No
		• Ailsa Craig	1,800 pairs	0.6	No
		• Morecambe Bay and Duddon Estuary	4,860 pairs	0.2	No
		• Ribble and Alt Estuaries	1,800 pairs	0.6	No
		• Seas off Wexford	See Saltee Islands SPA		
		• Saltee Islands	175 pairs	5.7	No
		Total SPA population	9,119 pairs	0.1	
Puffin	24	• North-west Irish Sea	See Lambay Island SPA		
		• Lambay Island	265 individuals	9.1	No
		• Seas off Wexford	See Saltee Islands SPA		
		• Saltee Islands	1,822 individuals	1.3	No
		• Skomer, Skokholm and the Seas off Pembrokeshire	9,500 pairs	0.1	No
		Total SPA population	21,087 individuals	0.1	No
Red-throated diver	27	• North-west Irish Sea	827 individuals	3.3	Yes for precaution due to the cable corridor overlapping the SPA.

3.2.1 Seasonality

The majority of SPA qualifying features recorded within the Offshore Ornithology Study Area showed some seasonality in their distribution and abundance during the site-specific surveys, which reflected the timing of the breeding and non-breeding seasons and migratory periods (i.e. pre- and post-breeding).

Species-specific impacts have been assessed in relation to their seasonality as defined in Furness *et al.*, 2015, as shown in Table 3-4 below. Where species seasonality is not included in Furness *et al.* (2015), seasons are defined with reference to Birds of the Western Palearctic (Snow *et al.* 1998) or NatureScot guidance (NatureScot, 2014). The offshore wind farm area is located within the majority of the relevant species' foraging range from breeding colonies (Woodward *et al.,* 2019), therefore where there are overlapping months with the breeding season (e.g. pre- and post-breeding), records from these months have been attributed to the breeding season. Only species which were recorded in numbers greater than "low" (e.g. at least 200 individuals during the site specific surveys) are included within Table 3-4.

Table 3-4: Qualifying features and definitions of their biological seasons.

Qualifying feature	Biological season designated	Breeding	Autumn Migration	Winter	Spring Migration	Non-breeding
Common gull	Non-breeding	May-Aug	n/a	n/a	n/a	Sep-Apr
Common scoter	Non-breeding	May-Aug	Sep-Dec	n/a	Feb-May	n/a
Gannet	Breeding	Apr-Aug	Sep-Nov	n/a	Dec-Mar	n/a
Great black-backed gull	Non-breeding	May-Jul	Aug-Nov	Dec	Jan-April	n/a
Great northern diver	Non-breeding	n/a	Sept-Nov	Dec-Feb	Mar-May	n/a
Guillemot	Breeding and non-breeding	Mar-Jun	Jul-Oct	Nov	Dec-Feb	n/a
Herring gull	Breeding and non-breeding	Mar-Jul	Aug-Nov	Dec	Jan-Apr	n/a
Kittiwake	Breeding	Mar-Jul	Aug-Dec	n/a	Jan-Apr	n/a
Manx shearwater	Breeding and non-breeding	Apr-Aug	Aug-Oct	Nov-Feb	Mar-May	n/a
Razorbill	Breeding and non-breeding	Apr-Jul	Aug-Oct	Nov-Dec	Jan-Mar	n/a

3.2.2 Reference populations

The reference populations for the qualifying interests of breeding colony SPAs have been derived from the latest updates to the Natura 2000 Standard Data Forms and are provided in Table 3-1. Marine SPAs (specifically North-west Irish Sea SPA, Seas off Wexford SPA and the Irish Sea Front SPA) have not had the population defined within Table 3-1. These marine SPAs provide protection for foraging birds during the breeding season or aggregations of wintering individuals during the non-breeding period. Therefore, the total population of each of the marine SPAs is defined by the combined breeding population, for which it protects, and the entire winter Biologically Defined Minimum Population Scales (BDMPS) due to increase mobility of birds during the wintering period (Furness, 2015).

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4 KEY PARAMETERS FOR ASSESSMENT

4.1 Project design parameters

The project description is provided in section 2 of the NIS. Table 4-1 outlines the project design parameters that have been used to inform the assessment of potential impacts of the construction, operation and maintenance and decommissioning phases of the Project on offshore ornithology. The final height of the wind turbine will be confirmed following detailed geotechnical investigations and analysis of ground conditions (see design flexibility details in section: Project Description of the NIS). This report considers the lowest blade tip height of 27 m above LAT (Table 4-1) as this would result in the maximum potential for impacts arising from collision risk. Should the final height of the wind turbine result in a blade tip height greater than 27m, this would also result in a lesser impact from collision. The potential impact is based on the greatest impact and therefore the most precautionary numbers are presented in section 5.

Additionally, due to the potential for unexpected ground conditions and obstructions, the final route and length of the offshore cable and offshore inter-array cables will be confirmed during construction (see design flexibility details in section: Project Description of the NIS). For the purposes of this report the maximum length of cables has been considered (Table 4-1) to ensure the potential for maximum impact is identified. Should the final lengths of cables be less than those specified, then the potential impact will be the same or less than what is outlined in section 5. An alternative route within the offshore wind farm area of offshore cable corridor won’t change the potential impact presented in section 5.

Table 4-1: Project design parameters considered for the assessment of potential impacts on offshore ornithology.

Potential impact	Phase[1] C	O	D	Project design parameters	Justification
Disturbance and displacement	✓	✓	✓	**Construction phase:** Disturbance and displacement from construction activity including: • Installation of 25 wind turbine generators (WTGs) and one offshore substation (OSS); • 26 monopile foundations; • Maximum of 5 hours piling per pile with one pile expected to be installed within each 24-hour period; • Maximum days piling = 26 days Maximum duration of piling: 8 hours per pile; total number of days of piling: 26; • Installation of 41 km of inter-array cables and 16 km offshore cable; • 50% of inter-array cables and 50% of offshore cable may require cable protection; and • Maximum 475 vessel round trips during the construction phase (including jack-up barges, tug/anchor handlers, cable installation vessels, scour/cable protection installation vessels, guard vessels, survey vessels and crew transfer vessels (CTVs)). Offshore construction may take place over a period of 15 months. **Operational and maintenance phase** • Presence and operation of 25 x WTGs and 1 x OSS; and • 352 vessel round trips per year.	Represents the maximum number of vessel movements that would cause greatest disturbance and displacement to birds from offshore wind farm area and offshore cable corridor. Accounts for the number of turbines and structures across the offshore wind farm area. Represents maximum extent and installation duration of cables that would cause greatest disturbance and displacement to birds.

Potential impact	Phase[1]			Project design parameters	Justification
	C	O	D		
				Operational and maintenance phase is 40 years **Decommissioning phase** Disturbance and displacement from decommissioning activity including: - Removal of 25 x WTGs and 1 x OSS; - Maximum 475 vessel round trips during the decommissioning phase. Decommissioning duration assumed to be similar to that for construction but of a lower magnitude than construction	
Indirect displacement resulting from changes to prey and habitats	✓	✓	✓	Project design parameters as described in appendix E: Fish and Shellfish Ecology – Supporting Information and appendix D: Benthic Subtidal and Intertidal Ecology – Supporting Information	Project design parameters as described in appendix E: Fish and Shellfish Ecology – Supporting Information for the following impacts: - Temporary subtidal habitat loss/disturbance during construction; - Long-term subtidal habitat loss during operation and maintenance phase; - Increased suspended sediment concentrations and associated sediment deposition; and - Injury and/or disturbance to fish and shellfish from underwater noise and vibration.
Collision risk	✗	✓	✗	**Operational and maintenance phase** Presence of 25 x WTGs within the offshore wind farm area: - Hub height 145 - 152 m above Lowest Astronomical Tide (LAT); - Lower blade tip height of 27 m above LAT; - Upper blade tip height of 270 m above LAT; and - Maximum rotor diameter of 236 m.	The wind turbine parameters assessed for collision impact risk.
Barrier effect	✗	✓	✗	**Operational and maintenance phase** - Presence of 25 x WTGs within wind farm array area with minimum spacing of 944 m between turbines; and - Presence of one OSS.	Maximum density of turbines and structures across the offshore wind farm area, which represents the greatest potential barrier of birds moving between colonies and foraging grounds, and those migrating through the offshore wind farm area.

1 C= Construction, O = Operation, D = Decommissioning

4.2 Measures included in the Project

As part of the Project design process, a number of measures have been proposed to reduce the potential for impacts on offshore ornithology (see Table 4-2). These measures include designed-in and management measures (controls). As there is a commitment to implementing these measures, they are considered inherently part of the design of the Project and have therefore been considered in the assessment of potential impacts presented in section **5** below (i.e. the determination of magnitude assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 4-2: Measures included in the Project.

Measures included in the Project	Justification
An Environmental Management Plan (EMP) will be implemented during the construction, operational and maintenance, and decommissioning phases of the Project (see appendix K: Management Plans). The EMP includes a plan for minimising disturbance to rafting seabirds from construction vessels. Measures include: • Use of existing navigation approaches to port; avoid over-revving engines to minimise noise; and • Avoidance of rafting seabirds and seaducks enroute between work areas and port, or within the offshore wind farm area and offshore cable corridor, achieved through briefing (e.g. toolbox talks) of vessel crew about the purpose and implications of the vessel management practices.	Rafting seabirds and seaducks may occur within the navigation routes of construction vessels. Due to the infrequency of movements of additional vessel traffic, there is low potential for effects; however, it is best practice to minimise disturbance to birds.
The EMP includes a Marine Pollution Contingency Plan (MPCP) which will include key emergency contact details (e.g. Environmental Protection Agency (EPA)). Measures for the MPCP include: • Designated areas for refuelling where spillages can be easily contained; • Storage of chemicals in secure designated areas in line with appropriate regulations and guidelines; and/A • Double skinning of pipes and tanks containing hazardous substances, and storage of these substances in impenetrable bunds.	To ensure that the potential for release of pollutants from construction, operational and maintenance, and decommissioning plant is minimised. In this manner, accidental release of contaminants from vessels will be strictly controlled, thus providing protection for marine life across all phases of the Project development.

4.3 Impacts scoped out of the assessment

On the basis of the baseline environment and the Project description outlined in section 2 of the NIS , a number of impacts are proposed to be scoped out of the assessment for offshore ornithology. These impacts are outlined, together with a justification for the scoping out decision, in Table 4-3.

Table 4-3: Impacts scoped out of the assessment for offshore ornithology.

Potential impact	Justification
Collision risk to migratory passerines during all phases of the Project.	The risks to migrating passerines are considered negligible, due to the relative size of the Project and the behaviour of the birds (e.g. passage movements restricted to twice annual events, large population sizes and flight heights typically above risk height). Migrating passerines have therefore been scoped out of the assessment.
Direct disturbance and displacement from underwater sound during operations and maintenance phases.	Underwater sound as a result of operation of the wind turbines is extremely unlikely to result in noise levels that would harm birds. In the unlikely event that such low levels of noise emission result in displacement of birds away from wind turbines, this impact would already be accounted for by the above-water operational displacement assessment.
Accidental pollution during all phases of the Project.	Pollution impacts (accidental oil/fuel spills) during all phases of the Project are scoped out on the basis that the implementation of a MPCP will avoid the risk of significant pollution events. Consequently, seabirds and shorebirds are extremely unlikely to be significantly affected by any such pollution impacts.
Indirect impact from underwater sound from wind turbine operation on prey fish species during operations and maintenance phase.	Noise generated by operational wind turbines is of a very low frequency and low sound pressure level (Andersson et al., 2011). Studies have found that sound levels are only high enough to possibly cause a behavioural reaction within metres from a wind turbine (Sigray and Andersson, 2011) and therefore such levels are not considered to have potentially significant effects on fish. The Marine Management Organisation (MMO, 2014) review of post-consent monitoring at offshore wind farms found that available data on the operational wind turbine noise, from the UK and abroad, in general showed that noise levels from operational wind turbines are low and the spatial extent of the potential impact of the

Potential impact	Justification
	operational noise is low. This is supported by project specific modelling which indicated that effects on fish (e.g. injury or behavioural effects) are unlikely to occur for the modelled operational wind turbines (see appendix 10-2: Subsea Noise Technical Report).
Disturbance to birds below the LWM from onshore construction and operational and maintenance phase activities.	Onshore disturbance as a result of noise, vibration, lighting and human presence during the construction phase of the Project will be localised and of short – term duration (i.e. installation works at the landfall including cable trenching and joint bay installation will take c. 4 months). Due to the low magnitude, reversibility and low level of disturbance of onshore installation works on birds below the LWM (i.e. within the offshore environment), this impact has been scoped out from further assessment. Similarly, during the operational and maintenance phase the level of movements (human and vessel) at the operations and maintenance facility, is highly unlikely to lead to an impact below LWM.

5 POTENTIAL IMPACTS

The potential impacts arising from the construction, operational and maintenance and decommissioning phases of the Project are listed in Table 4-1, along with the Project design parameters against which each impact has been assessed. The four potential impacts to offshore ornithology qualifying features are:

- Disturbance and displacement;
- Indirect disturbance and displacement resulting from changes to prey and habitats;
- Collision risk; and
- Barrier effect.

A description of the potential effects on relevant offshore ornithology qualifying features caused by each identified impact is given below.

5.1 Disturbance and displacement

5.1.1 Construction phase

Disturbance as a result of activities during the construction of a wind farm (such as installing foundations, wind turbines, inter-array cabling and associated vessel movements) and the offshore cable has the potential to displace birds from an area of sea in which the activity is occurring. This in effect represents indirect, temporary habitat loss, potentially reducing the area available for those seabirds sensitive to disturbance to forage, loaf and / or moult in the way that they are currently able to within and around the offshore wind farm area and offshore cable corridor. Such disturbance could ultimately affect the demographic fitness (i.e. survival rates and breeding productivity) of displaced birds, as well as potentially impacting on birds in areas that displaced birds move to due to increased competition for resources.

Disturbance associated with construction vessel movements will be of limited duration at any one location, because it is a transient impact as marine vessels move through an area relatively quickly. Vessel movements for the construction of the offshore infrastructure will also be infrequent, amounting to 475 round trips during a construction period of 15 months (averaging just over one round trip per day). Construction activities also result in a point source of disturbance, for example when construction vessels are at a location to undertake piling, drilling and install foundations or the wind turbines. The level of disturbance associated with each location would vary depending on the activity undertaken. As the potential impacts are spatially and temporally restricted, the potential impact is reversible in the short-term as birds are likely to return when activities have been completed at that location. However, there is potential for disturbance around each point source throughout the construction period of 15 months.

Species differ greatly in their susceptibility to disturbance (SNCB, 2022). For example, some auk species (e.g. guillemot and razorbill) have been shown to be disturbed by boats hundreds of metres away (Furness and Wade, 2012); amongst sea ducks, scoters are particularly vulnerable to disturbance by vessels (Kaiser *et al.,* 2006 and Furness *et al*., 2012) and divers show a higher degree of sensitivity and are especially sensitive to approaching boats at a distance of more than 1 km (Garthe and Hüppop, 1994, Schwemmer *et al*., 2011 and Furness and Wade, 2012). Gull species however are known to be attracted by human activities at sea, such as fishing vessels (Garthe and Hüppop, 1994 and Welcker *et al*., 2016), and are usually assumed to be insensitive to anthropogenic disturbance. Assuming there is a single point source of disturbance, potentially affecting birds within an area of 2 km (or 4 km for divers), that would result in a consistently affected area of approximately 12.56 km^2 (or 50.26 km^2 for divers) which varies in its location within the offshore wind farm area and offshore cable corridor. It is therefore possible to apply the mean-peak density of birds recorded in the Offshore Ornithology Study Area to estimate the number of birds potentially displaced temporarily by construction activities. Both diver species (great northern diver and red-throated diver) are more susceptible to distance to vessels traffic and therefore a higher disturbance distance is proposed of 4 km, therefore total displacement of 50.27 km^2.

Species sensitivity to disturbance in response to offshore wind farms has been quantified by several means. A study undertaken by Garthe and Hüppop (2004) developed a scoring system to assess species sensitivity to disturbance by using nine factors derived from the species' attributes; each factor was scored on a five point scale from 1 (low vulnerability) to 5 (high vulnerability). Furness and Wade (2012) reviewed evidence for likely impacts on seabirds in Scottish waters, and constructed indices assessing the relative vulnerability of seabird species' populations to impacts of turbines. Bradbury *et al*. (2014) built upon Furness and Wade (2012) and produced a sensitivity score for species within English waters. The sensitivity scores presented within Bradbury *et al*. (2014) included assessment of displacement/disturbance alongside collision, therefore the sensitivities presented in Table 5-1 are taken from Bradbury *et al*. (2014), unless stated otherwise. This assessment follows the latest guidance from the joint SCNBs (SNCB, 2022) as to which species should be included within the displacement assessment. A screening assessment for construction disturbance has been carried out for each species with consideration of the species' sensitivity rating and abundance in the Offshore Ornithology Study Area (Table 5-1). Only species that were recorded in abundances within the offshore wind farm area and offshore cable corridor of moderate or above **AND** with a sensitivity of moderate or above will be screened in and taken forward for assessment. These criteria do not apply to red-throated diver, as the SNCB guidance (2022) states that assessment should be undertaken for this species.

Table 5-1: Screening for assessment of disturbance and displacement during construction.

Offshore Ornithology IEF	Sensitivity to disturbance and displacement during construction	Abundance recorded in offshore wind farm area and offshore cable corridor	Screened IN or OUT
Common gull	Low	Low	Low sensitivity to disturbance and displacement; low abundance recorded during site-specific surveys within the offshore wind farm area and offshore cable corridor. **Screened OUT**
Common scoter	High	Low	High sensitivity to disturbance and displacement. Generally recorded in low numbers in inshore areas with the exception of April 2020 which recorded over 2,000 individuals, although that was not within the offshore wind farm area or offshore cable corridor. **Screened OUT**
Gannet	Very low	High	High abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement during construction. **Screened OUT**
Great black-backed gull	Very low	Moderate	Moderate abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. **Screened OUT**
Great northern diver	High	Moderate	High sensitivity to disturbance and displacement and moderate abundance. **Screened IN**
Guillemot	Moderate	Very high	Very high abundance recorded in the surveys area and moderate sensitivity to disturbance and displacement. **Screened IN**
Herring gull	Very low	Low	Very low sensitivity to disturbance and displacement and low abundance

Offshore Ornithology IEF	Sensitivity to disturbance and displacement during construction	Abundance recorded in offshore wind farm area and offshore cable corridor	Screened IN or OUT
			recorded during site-specific surveys. **Screened OUT**
Kittiwake	Very low	Moderate	Moderate abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. **Screened OUT**
Manx shearwater	Very low	Very high	Very high abundance but very low sensitivity to disturbance and displacement. **Screened OUT**
Razorbill	Moderate	Very high	Very high abundance recorded in the survey area and has moderate sensitivity to disturbance and displacement. **Screened IN**
Red-throated diver	Very high	Low	Very high sensitivity to disturbance and displacement but low abundance. **Screened IN <u>for precaution</u>**

5.1.1.1 Great northern diver

Assessment of impact – all seasons

The peak levels of activity were recorded during the spring migration (total records of 306 individuals during spring migration (March to May) and winter periods (181 total records), with smaller numbers recorded in the autumn migration (90 total records). Birds recorded in the autumn and spring migration seasons are likely to remain in a location for a shorter period of time as they are on the move and will be less sensitive to displacement as a result. However, the assessment takes a precautionary approach and considers displacement in the context of the peak number of birds recorded during the entire non-breeding bio-season defined as September to May, which includes the autumn and spring migration periods.

A mean-peak density of 1.59 birds/km^2 was estimated in the offshore wind farm area during the non-breeding bio-season (September – May) during the boat-based survey (average peak of 44 birds over the offshore wind farm area). The mean-peak density of birds within the Offshore Ornithology Study Area during DAS was slightly higher with 1.78 birds/km^2.

Based on a mean-peak density of 1.59 birds/ km^2 within the offshore wind farm area and a disturbance distance of up to 50.27 km^2, there could be approximately 89 birds at risk of temporary displacement during one or two non-breeding seasons during which construction would occur. Due to the temporary nature of construction a displacement mortality of 90% displacement and 0.5% mortality is considered realistic. Therefore, the additional mortality of up to 0.45 birds may occur.

The offshore cable corridor overlaps with the North-west Irish Sea SPA, however there is unlikely to be any construction activity during the non-breeding season, with construction occurring in spring or summer. Therefore, there is little potential to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

5.1.1.2 Guillemot

Guillemots were recorded in the Offshore Ornithology Study Area at high densities across all months during the site-specific surveys. Peak occurrences were observed during the DAS undertaken in July, August and September 2020 with peak counts of 3,235, 3,077 and 6,163 individuals on transect respectively.

A mean-peak density of 10.3 birds/km^2 was estimated in the offshore wind farm area during the breeding bio-season from the boat-based surveys, with a peak of 21.4 birds/km^2 from the DAS. In the non-breeding bio-season, there was an estimated mean-peak density of 30.5 birds/km^2 from boat-based surveys and a peak density of 61.9 birds/km^2 from the DAS.

Assessment of impact – all seasons

During the breeding season, based on a mean-peak density of 10.3 to 21.4 birds/km^2 within an area of 12.56 km^2 (radial displacement around a single point of displacement), there would be approximately 129 to 269 birds at risk of temporary disturbance and displacement during one or two breeding seasons during which construction would occur.

During the non-breeding season, based on a mean-peak density of 30.5 to 61.9 birds/km^2 within an area of 12.56 km^2(radial displacement around a single point of displacement), there would be approximately 383 to 777 birds at risk of temporary disturbance and displacement during one or two non-breeding seasons during which construction would occur.

Following the guidance presented by the SNCB (2022), the recommended displacement rate for auk species is between 30 % and 70 %, while advice provided by NatureScot recommends a displacement rate of 60 % and a mortality rate of 1 % (from Marine Scotland Scoping opinion for Seagreen development in the Firth of Forth). For the purposes of this report and considering the temporary and intermittent nature of the construction disturbance, the impact is assessed in the context of 50 % displacement rate and 1 % mortality rate.

Based on these rates, the construction of the offshore wind farm and offshore cable would result in additional mortality of:

- Breeding season: 6.5 to 13.4 birds; and
- Non-breeding season: 19.2 to 38.9 birds.

Due to the lesser estimate of potential mortality during construction than during operational and maintenance, it was not deemed necessary to apportion the impact on the five SPAs for which guillemot is a qualifying feature. Reference to the operational and maintenance assessment should be viewed (section 5.1.2.3). As the increase in baseline mortality during the operational and maintenance phase is <1 %, the impact during the construction phase is not considered to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

5.1.1.3 Razorbill

During the site-specific surveys, razorbill was recorded on transect throughout the survey period with a peak count observed in September 2020 (1,064 individuals). The peak in September 2020 is likely related to post-breeding dispersal of adults and juveniles from breeding sites. However, as there are no large razorbill breeding colonies within close proximity to the Project, numbers during the breeding season (April to July) were relatively low.

A mean-peak density of 0.25 birds/km^2 was estimated in the offshore wind farm area during the breeding bio-season from the boat-based surveys, with a peak of 5.6 birds/km^2 from the DAS. In the non-breeding bio-season, there was an estimated mean-peak density of 10.5 birds/km^2 from boat-based surveys and a peak density of 9.6 birds/km^2 from the DAS.

Assessment of impact – all seasons

During the breeding period, based on a mean-peak density of 0.25 to 5.6 birds/km^2 within an area of 12.56 km^2. There would be approximately 3 to 70 birds at risk of temporary disturbance and displacement during one or two breeding seasons during which construction would occur.

During the non-breeding period, based on a mean-peak density of 9.6 to 10.5 birds/km^2 within an area of 12.56 km^2. There would be approximately 121 to 132 birds at risk of temporary disturbance and displacement during one or two non-breeding seasons during which construction would occur.

Following the guidance presented by the SNCB (2022), the recommended displacement rate for auk species is between 30% and 70% and mortality between 1 and 10%, while advice provided by NatureScot recommends a displacement rate of 60% and a mortality rate of 1% (from Marine Scotland Scoping opinion for Seagreen development in the Firth of Forth). For the purposes of this assessment and considering the temporary and intermittent nature of the construction disturbance, the impact is assessed in the context of 50% displacement rate and 1% mortality rate.

Based on these rates, the construction of the offshore wind farm and offshore cable would result in additional mortality of:

- Breeding season: 0.2 to 3.5 birds; and
- Non-breeding season: 6.0 to 6.6 birds.

Due to the lesser estimate of potential mortality during construction than during operational and maintenance, it was not deemed necessary to apportion the impact on the five SPAs for which razorbill is a qualifying feature. Reference to the operation and maintenance assessment should be viewed (section 5.1.2.4). As the increase in baseline mortality is <1 % during the operational and maintenance phase, the impact during the construction phase is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.1.4 Red-throated diver

Assessment of impact – all seasons

The peak levels of activity were recorded during the spring migration (total records of 27 individuals during spring migration (March to May) and winter periods (24 total records during one winter period), with smaller numbers recorded in the autumn migration (13 total records during one autumn period). Birds recorded in the autumn and spring migration seasons are likely to remain in a location for a shorter period of time as they are on the move and will be less sensitive to displacement as a result. However, the assessment takes a precautionary approach and considers displacement in the context of the peak number of birds recorded during the entire non-breeding bio-season defined as September-May, which includes the autumn and spring migration periods.

A peak density of 0.10 birds/km^2 was estimated in the offshore wind farm area during the non-breeding bio-season (September – May) during the boat-based survey (during the February 2019 survey). The peak density of birds within the Offshore Ornithology Study Area during DAS was slightly lower with 0.09 birds/km^2 (during the April 2020 survey).

Based on a peak density of 0.10 birds/km^2 within the offshore wind farm area and a disturbance distance of up to 50.27 km^2, there could be approximately five birds at risk of temporary displacement during one or two non-breeding seasons during which construction would occur. Due to the temporary nature of construction a displacement mortality of 100% displacement and 1% mortality is considered realistic. Therefore, the additional mortality of up to 0.05 birds may occur.

The offshore cable corridor overlaps with the North-west Irish Sea SPA, however there is unlikely to be any construction activity during the non-breeding season, with construction occurring in spring or summer. Therefore there is little potential to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2 Operational and maintenance phase

During the operational and maintenance phase, the presence of operational turbines has the potential to directly disturb seabirds leading to displacement from the offshore wind farm area including an area of variable size or buffer (depending on sensitivity) around it (Furness *et al*., 2013 and Bradbury *et al.*, 2014). This would most affect those seabird species that are more sensitive to disturbance, although their sensitivity can vary by season and location. For example, the greatest impact is likely to be on breeding seabirds from nearby colonies that have highly specialised (and limited) habitat requirements and limited foraging ranges; it is unlikely that passage birds would be adversely affected by operational and maintenance activities as they are only present in the wind farm area for short periods during migration periods.

The period of time and constancy that individuals within a population may be subject to displacement impacts is uncertain, however it is likely that the impacts will be of higher intensity during the first years of operation, such that additional mortality in the population might be at its greatest in these early years, while in subsequent years it is possible that birds may become habituated to a certain extent, thereby reducing mortality rates.

Similar to the construction phase, seabird species differ in their reactions to offshore operational infrastructure and maintenance activities that accompany them, however the extent to which is still uncertain and subject to ongoing research. Although some species may show little avoidance, others such as divers, auks and pelagic seabirds may not forage or fly within hundreds of metres, or even several kilometres, of turbines. Comparatively, some gull species, cormorant and terns have generally shown little avoidance to wind farms and for instance were seen regularly foraging within the Egmond aan Zee offshore wind farm (Krijgsveld *et al*., 2009 and 2011).

Dierschke *et al.* (2016) reviewed studies from 20 operational wind farms in Europe, assessing the extent of displacement or attraction of 33 seabird species. They found that diver species and gannets showed consistent and strong avoidance behaviour of operational wind farms, whereas fulmar, common scoter, Manx shearwater, razorbill, common guillemot, little gull and sandwich tern showed less consistent displacement. Dierschke *et al.* (2016) suggested that displacement seemed more likely to be a response to the structures themselves, which appeared stronger when the turbines were rotating. However, for some species such as cormorant and shag, the attraction to offshore wind farms is beneficial for providing roosting and basking opportunities and increases in food availability are also apparent for some species.

Studies have shown that generally, migrants appear to be more obviously displaced than resident birds, perhaps due to a lack of habituation (Peterson *et al.,* 2005) and habituation is likely to occur for some species once turbines are operational and human activity is reduced.

As described in the sections above relating to the construction phase, species' sensitivity to disturbance in response to offshore wind farms has been quantified by several means, including studies by Garthe and Hüppop (2004) whereby species sensitivity to disturbance was assessed using nine factors derived from the species' attributes and used a five point scale from 1 (low vulnerability) to 5 (high vulnerability), and Furness *et al.* (2013) which reviewed evidence for likely impacts on seabirds, and constructed indices assessing the relative vulnerability of seabird species' populations to impacts of turbines. Similarly, Bradbury *et al.* (2014) expanded on Furness *et al.* (2013) to incorporate more species and also include an assessment of disturbance and displacement.

There is currently no detailed Irish guidance regarding the method of assessment of displacement of seabirds as a result of offshore wind farms. Guidance for offshore renewable energy Projects published by the DCCAE includes reference to emerging methods for displacement assessment at the time of its publication, namely JNCC report 551 (Busch *et al*., 2015). However, such proposed approaches have largely been superseded. This analysis therefore draws on the most recent recommendations of the joint SNCB guidance (SNCB, 2022), which promotes a displacement matrix approach.

The methodology presented in SNCB (2022) recommends that a matrix is compiled for each key species for a range of displacement levels (at 10% increments) across a range of likely adult mortality levels (at 0, 1%, 2%, 3%, 4%, 5%, 10% and then 10% increments) in each relevant biological season for that species.

Using available evidence on seabird sensitivity and habitat flexibility, a value, or small range of values of displacement rate and associated mortality levels are selected to provide an estimate of the potential losses. The consequent potential losses to the population as a result of displacement is then assessed for each season against an appropriate population scale. For the breeding season, the appropriate regional population covers the total colony counts within mean-maximum foraging range; for the non-breeding season assessment is done against the BDMPS (Furness, 2015).

In order to focus the potential impact of operational and maintenance activities on species' disturbance and displacement within the offshore wind farm area, a screening exercise was undertaken as detailed within Table 5-2 below. Species with a low sensitivity to disturbance and displacement or recorded in low abundances within the offshore wind farm area during the breeding and non-breeding seasons, were screened out from further consideration as potential effects are highly unlikely for those species. Therefore, only species that were recorded in abundances within the offshore wind farm area and offshore cable corridor of moderate or above **AND** with a sensitivity of moderate or above will be screened in and taken forward for assessment of potential impacts. These criteria do not apply to gannet or red-throated diver, as the SNCB guidance (2022) states that assessment should be undertaken for these species.

Table 5-2: Screening for assessment of disturbance and displacement during operation and maintenance.

Offshore Ornithological IEF	Sensitivity to disturbance and displacement during operation and maintenance	Abundance recorded in offshore wind farm area and offshore cable corridor	Screened IN or OUT
Common gull	Low	Low	Low sensitivity to disturbance and displacement; low abundance recorded during site-specific surveys. **Screened OUT**
Common scoter	High	Low	High sensitivity to disturbance and displacement. Generally recorded in low numbers in inshore areas with the exception of April 2020 which recorded over 2,000 individuals, although that was not within the offshore wind farm area or offshore cable corridor. **Screened OUT**
Gannet	Very low	High	High abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. Following SNCB guidance (2022), this species is screened in due to the empirical studies demonstrating they are sensitive to disturbance and displacement post construction (Krijgsveld *et al.*, 2011 and Vanermen *et al*., 2013) **Screened IN**
Great black-backed gull	Very low	Moderate	Moderate abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. **Screened OUT**
Great northern diver	High	Moderate	High sensitivity to disturbance and displacement and moderate abundance. **Screened IN**
Guillemot	Moderate	Very high	Very high abundance recorded in the surveys area and moderate sensitivity to disturbance and displacement. **Screened IN**
Herring gull	Very low	Low	Very low sensitivity to disturbance and displacement and low abundance recorded during site-specific surveys. **Screened OUT**
Kittiwake	Very low	Moderate	Moderate abundance recorded during site-specific surveys however very low sensitivity to disturbance and displacement. **Screened OUT**
Manx shearwater	Very low	Very high	Very high abundance recorded in the survey area, and very low sensitivity to disturbance and displacement. Screened OUT
Razorbill	Moderate	Very high	High abundance recorded in the survey area and moderate sensitivity to disturbance and displacement.

Offshore Ornithological IEF	Sensitivity to disturbance and displacement during operation and maintenance	Abundance recorded in offshore wind farm area and offshore cable corridor	Screened IN or OUT
			Screened IN
Red-throated diver	Very high	Low	Very high sensitivity to disturbance and displacement but low abundance. **Screened IN <u>for precaution</u>**

Displacement matrices are presented for each of the qualifying features screened into the assessment (gannet, great northern diver, guillemot, and razorbill). For guillemot and razorbill, only “sitting” birds (which includes birds observed diving, landing and taking off) were included from the site-specific survey data in the displacement analysis as it is representative of their foraging use of the site, with the behaviour of these species being predominately from the water’s surface. For gannet and divers all behaviours (flying and sitting) were included for displacement assessment as both sitting and flying birds may be actively foraging in the area.

Following the SNCB (2022) guidance, displacement assessment is based on bio-season mean peak abundances. The peak abundance within a bio-season is the highest recorded abundance from surveys within a single bio-season. Mean peak abundance is the mean of peak abundances for each bio-season across a number of years.

The displacement and disturbance during the breeding (Table 5-3) and non-breeding (Table 5-4) periods for the five species included within the assessment. Full displacement matrices are presented within annex 5: Offshore Ornithology Displacement Analysis. For the lower mortality estimate 1 % mortality and 30 % displacement were used for guillemot and razorbill, 1 % mortality and 90 % displacement for great northern diver and red-throated diver and 1 % mortality and 60 % displacement for gannet. For the higher estimate 5 % mortality and 70 % displacement were used for guillemot and razorbill, 1 % mortality and 100 % displacement for great northern diver and red-throated diver and 1 % mortality and 80 % displacement for gannet. It is considered that the actual impact would be between the high and low estimate.

Table 5-3: Estimated mortality for gannet, guillemot and razorbill during the breeding period (all age classes).

Species	Density estimate used	Density estimate (offshore wind farm plus 2 km)	Mortality estimate – low	Mortality estimate – high
Gannet	Boat-based	246	1	2
	DAS	149	1	1
Guillemot	Boat-based	820	2	29
	DAS	1594	5	56
Razorbill	Boat-based	12	0	0
	DAS	353	1	12

Table 5-4: Estimated mortality for great northern diver, guillemot and razorbill during the non-breeding period (all age classes).

Species	Bio-season	Density estimate used	Density estimate (offshore wind farm plus 2 km)	Mortality estimate – low	Mortality estimate – high
Gannet	Spring migration	Boat	43	0	0
	Autumn migration	Boat	336	2	3
Great northern diver	Winter	Boat-based	281	2.5	2.8
		DAS	412	3.7	4.1
Guillemot	Winter	Boat-based	2,670	8	93
		DAS	4,938	15	173
Razorbill	Spring migration	Boat-based	859	3	30
	Autumn migration	Boat-based	962	3	34
		DAS	566	2	20
	Winter	Boat-based	512	2	18
Red-throated diver	Winter	Boat-based and DAS	29	0.26	0.29

5.1.2.1 Gannet

See section 5.4, for the combined disturbance and displacement and collision assessment for gannet.

5.1.2.2 Great northern diver

Divers are generally regarded as being highly sensitive to disturbance and displacement, showing a very high flush distance (i.e. the linear distance from an observer vessel to the birds at the moment of take-off from the water) and are likely to avoid disturbed areas (Garthe *et al.*, 1994; Furness *et al*., 2012; and Bradbury *et al*, 2014). Furthermore, the guidance for undertaking ESAS surveys refer to the need to scan the sea area ahead of the ship “to detect the take-off of usually very wary seaduck and divers well ahead of the approaching platform” (Camphuysen *et al.*, 2004 and Gittings *et al.,* 2015).

The worst-case scenario for great northern diver is that displacement will occur at a constant level within 4 km of the offshore wind farm area, of which between 90 and 100 % of birds will be displaced, leading to a mortality rate of up to 1 % (JNCC, 2022).

5.1.2.2.1 Apportioned non-breeding impact

There is no agreed way to apportion to a marine SPA, whereby the foraging, roosting or aggregation of waterbirds is protected. Due to the offshore cable corridor going through the North-west Irish Sea SPA 100 % of the impacts could be apportioned to this SPA. However, interchange between areas during the non-breeding period is high for a migratory species and therefore the interannual variation will be high.

Burke *et al.* (2018) estimated a non-breeding population of 2,128 for Ireland and given that the peak-mean population estimate for the area within 4 km of the offshore wind farm area was 309 to 412 individuals, it is reasonable to assess the impact against the Irish population estimate of 2,128 individuals in the non-breeding season. Approximate background mortality at a rate of 0.161 gives a background annual mortality of 343 birds. Additional mortality of between 2.5 and 4.1 birds during the non-breeding season would increase annual mortality by 0.72 to 1.20 % when considering the boat-based density or DAS density estimate. However, this approach is very highly precautionary, considering that all birds within the area up to 4 km from the offshore wind farm area are displaced. It is more realistic to consider that there may be high displacement rate in areas closer to the offshore wind farm area with less displacement as distance increases. For example, if there was 100 % displacement within the area up to 2 km from the offshore wind farm area and 50 % displacement between 2 – 4 km from the offshore wind farm area the overall impact would be less. When considering this, the impact would be reduced to 2.0 birds is using the boat-based density estimate and 3.2 for the DAS density estimate. Which would represent up to a 0.93% increase in baseline mortality.

As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

5.1.2.3 Guillemot

The worst-case scenario for guillemot is that displacement will occur at a constant level within 2 km of the offshore wind farm area, of which between 30 and 70 % of birds will be displaced, leading to a mortality rate of between 1 and 5 % (JNCC, 2022). More recent evidence (MacArthur Green, 2023) has indicated that a 70 % displacement rate is not realistic and 50 % is a more realistic scenario from empirical data.

Several studies, such as those by Peterson *et al*. (2006) and Dierschke *et al*. (2016) indicated a level of displacement on guillemots in offshore wind farms that would suggest high sensitivity to disturbance during the operational and maintenance phase of the Project. However, more recent studies undertaken at other offshore wind farm sites have not shown the same level of effect. For example, Dierschke *et al.* (2016) suggested that auk displacement is only partial and negligible at some sites, and studies undertaken at Dutch wind farms have reported displacement effects of less than 50 % (Leopold *et al.*, 2011). At the Robin Rigg offshore wind farm, located in the Irish Sea, the number of guillemot observed during all three phases of development remained comparable, providing no evidence of guillemot displacement (Vallejo *et al.*, 2017).

5.1.2.3.1 SPA weighted proportions during the breeding season

Using the NatureScot apportioning tool, 71.6 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA. The Rathlin Island SPA which is the largest colony within the species foraging range of the Project is predicted to contribute to 16.2 % of the birds within the offshore wind farm area (Table 5-5). The proportional weight column will not equal one as multiple non-SPA colonies make up the regional breeding population but have been excluded from this report.

Table 5-5: Breeding guillemot colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (breeding individuals)	NatureScot colony weight	Proportional weight
Howth Head Coast	1,167	0.015	0.007
Ireland's Eye	5,909	0.084	0.037
Lambay Island	80,377	1.612	0.716
Rathlin Island	200,343	0.364	0.162
Wicklow Head	811	0.003	0.001

5.1.2.3.2 Apportioned breeding impacts

Apportioned mortality for guillemot during the breeding season is presented in Table 5-6 for the greatest range of impacts (2 to 56 from Table 5-3). The lower value is taken from the boat-based survey density estimate and the high value from DAS density estimate.

Estimated number of mortalities from displacement range from <0.1 to 2.7 adult birds, depending on the SPA. This increased baseline mortality between < 0.01 and 0.06 % in adult birds. To align with all projects, the numbers presented within Table 5-6 are for an impact with 50 % displacement occurs and 1 % mortality.

Table 5-6: Apportioned mortality of adult guillemot resulting from displacement during the breeding season.

SPA	Estimated mortality from displacement	Baseline mortality	Increase in baseline mortality (%)
Howth Head Coast	0.0 to 0.0	71	0.02 to 0.04
Ireland's Eye	0.1 to 0.1	360	0.02 to 0.04
Lambay Island	1.4 to 2.7	4,903	0.03 to 0.06
Rathlin Island	0.3 to 0.6	12,221	<0.01 to 0.01
Wicklow Head	0.0 to 0.0	49	0.01 to 0.01

The impact of disturbance and displacement caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 % (Table 5-6), the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.3.3 Apportioned non-breeding impacts

Apportioned mortality for guillemot during the non-breeding season is presented in Table 5-7 for the most impactful and therefore precautionary estimate (8 to 173 from Table 5-3). Estimated number of mortalities from displacement range from <0.1 to 3.19 birds, depending on the colony. This increased baseline mortality between 0.01 and 0.03 %. To align with all projects, the numbers presented within Table 5-6 are for an impact with 50 % displacement occurs and 1 % mortality.

Table 5-7: Apportioned mortality of adult guillemot resulting from displacement during the non-breeding season.

SPA	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Howth Head Coast	902,773	0.0013	0.01 to 0.02	0.01 to 0.03
Ireland's Eye	902,773	0.0065	0.05 to 0.09	0.01 to 0.03
Lambay Island	902,773	0.0890	0.67 to 1.28	0.01 to 0.03
Rathlin Island	902,773	0.2219	1.66 to 3.19	0.01 to 0.03
Wicklow Head	902,773	0.0009	0.01 to 0.01	0.01 to 0.03

The impact of disturbance and displacement caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.3.4 Assessment of impact – all seasons

Combining the impacts from both the breeding and non-breeding seasons provides the annual impact on each SPA that is designated for guillemot. Apportioned annual mortality for guillemot is presented in Table 5-8 for the most impactful and therefore precautionary estimate. Estimated number of mortalities from displacement range from 0.01 to 4.27 birds, depending on the SPA. This increased baseline mortality between 0.02 and 0.09 %, which is considered undetectable in each individual SPA population. SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone and therefore presented within an in-combination assessment (section 6.2) are highlighted in **bold** in Table 5-8.

Table 5-8: Apportioned mortality of adult guillemot resulting from displacement annually.

SPA colony	Estimated mortality from displacement		Increase in baseline mortality (%)	
	Lower estimate	Upper estimate	Lower estimate	Upper estimate
Howth Head Coast	0.02	0.05	0.03	0.06
Ireland's Eye	0.13	**0.25**	0.04	**0.07**
Lambay Island	2.16	**4.27**	0.04	**0.09**
Rathlin Island	2.00	3.87	0.02	0.03
Wicklow Head	0.01	0.02	0.02	0.04

The impact of disturbance and displacement caused by operational and maintenance activities annually is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

5.1.2.4 Razorbill

The worst-case scenario for razorbill is that displacement will occur at a constant level within 2 km of the offshore wind farm area, of which between 30 and 70 % of birds will be displaced, with a mortality rate of between 1% and 5 % (JNCC, 2022). More recent evidence (MacArthur Green, 2023) has indicated that a 70 % displacement rate is not realistic and 50 % is a more realistic scenario from empirical data. To align with all projects, the numbers presented within the following tables are for an impact with 50 % displacement occurs and 1 % mortality.

As with guillemots, the literature has documented various responses of razorbill to operational offshore wind farms, with some studies showing complete displacement from within the offshore wind farm area (Peterson *et al*., 2016 and Dierschke *et al*., 2016), whereas others have shown no evidence of displacement (Vallejo *et al*., 2017).

5.1.2.4.1 SPA weighted proportions during the breeding season

Using the NatureScot apportioning tool, 60.5 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA. Rathlin Island SPA which is the largest colony within the species foraging of the Project is predicted to contribute to 17.7 % of the birds within the offshore wind farm area (Table 5-9). The proportional weight column will not equal one as multiple non-SPA colonies make up the regional breeding population but have been excluded from this report.

Table 5-9: Breeding razorbill colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Howth Head Coast	374	60	0.032	0.015
Ireland's Eye	2,144	57	0.205	0.093
Lambay Island	9,853	48	1.332	0.605
Rathlin Island	30,044	154	0.390	0.177
Wicklow Head	247	106	0.006	0.003

5.1.2.4.2 Apportioned breeding impacts

Apportioned mortality for razorbill during the breeding season is presented in Table 5-10 for the greatest range of impacts (0 to 12 from Table 5-3). The lower value is taken from the boat-based survey density estimate and the high value from DAS density estimate. Estimated number of mortalities from displacement range from 0 to 0.6 adult birds, depending on the SPA. This increased baseline mortality between 0 and 0.06 % in adult birds.

Table 5-10: Apportioned mortality of adult razorbill resulting from displacement during the breeding season.

SPA	Estimated mortality from displacement	Baseline mortality	Increase in baseline mortality (%)
Howth Head Coast	0 to <0.1	39	0 to 0.04
Ireland’s Eye	0.0 to 0.1	225	0 to 0.04
Lambay Island	0.0 to 0.6	1,035	0 to 0.06
Rathlin Island	0.0 to 0.2	3,155	0 to 0.01
Wicklow Head	0 to <0.1	26	0 to 0.01

The impact of disturbance and displacement caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

5.1.2.4.3 Apportioned non-breeding impacts

Apportioned mortality for razorbill during the non-breeding season is presented in Table 5-11 for the most impactful and therefore precautionary estimate (8 to 173 from Table 5-3). Estimated number of mortalities from displacement range from <0.1 to 0.3 birds, depending on the colony. This increased baseline mortality between <0.01 and 0.01 %.

Table 5-11: Apportioned mortality of adult razorbill resulting from displacement during the non-breeding season.

Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Autumn migration	Howth Head Coast	316,928	0.0012	<0.1 to <0.1	0.01 to 0.01
	Ireland's Eye	316,928	0.0068	<0.1 to <0.1	0.01 to 0.01
	Lambay Island	316,928	0.0311	0.1 to 0.1	0.01 to 0.01
	Rathlin Island	316,928	0.0948	0.2 to 0.3	0.01 to 0.01
	Wicklow Head	316,928	0.0010	<0.1 to <0.1	0.01 to 0.01
Spring migration	Howth Head Coast	316,928	0.0012	<0.1 to <0.1	0.01 to 0.01
	Ireland's Eye	316,928	0.0068	<0.1 to <0.1	0.01 to 0.01
	Lambay Island	316,928	0.0311	0.1 to 0.1	0.01 to 0.01
	Rathlin Island	316,928	0.0948	0.2 to 0.2	0.01 to 0.01
	Wicklow Head	316,928	0.0010	<0.1 to <0.1	0.01 to 0.01
Winter	Howth Head Coast	178,289	0.0008	<0.1 to <0.1	<0.01 to <0.01
	Ireland's Eye	178,289	0.0048	<0.1 to <0.1	<0.01 to <0.01
	Lambay Island	178,289	0.0221	<0.1 to <0.1	<0.01 to <0.01
	Rathlin Island	178,289	0.0674	0.1 to 0.1	<0.01 to <0.01
	Wicklow Head	178,289	0.0007	<0.1 to <0.1	<0.01 to <0.01

The impact of disturbance and displacement caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

5.1.2.4.4 Assessment of impact – all seasons

Combining the impacts from both the breeding and non-breeding seasons provides the annual impact on each SPA that is designated for razorbill. Apportioned annual mortality for razorbill is presented in Table 5-12 for the most impactful and therefore precautionary estimate. Estimated number of mortalities from displacement range from <0.1 to 0.84 birds, depending on the SPA. This increased baseline mortality between 0.02 and 0.08 %, which is considered undetectable in each individual SPA population. SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone and therefore presented within an in-combination assessment (section 6.2) are highlighted in **bold** in Table 5-12.

Table 5-12: Apportioned mortality of adult razorbill resulting from displacement annually.

SPA colony	Estimated mortality from displacement		Increase in baseline mortality (%)	
	Lower estimate	Upper estimate	Lower estimate	Upper estimate
Howth Head Coast	0.01	0.02	0.02	0.06
Ireland's Eye	0.04	**0.14**	0.02	**0.06**
Lambay Island	0.16	**0.84**	0.02	**0.08**
Rathlin Island	0.49	0.79	0.02	0.03
Wicklow Head	0.00	0.01	0.02	0.03

The impact of disturbance and displacement caused by operational and maintenance activities annually is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.1.2.5 Red-throated diver

Divers are generally regarded as being highly sensitive to disturbance and displacement, showing a very high flush distance (i.e. the linear distance from an observer vessel to the birds at the moment of take-off from the water) and are likely to avoid disturbed areas (Garthe *et al*., 1994; Furness *et al*., 2012; and Bradbury *et al*, 2014; Thompson *et al*., 2023). Furthermore, the guidance for undertaking ESAS surveys refer to the need to scan the sea area ahead of the ship "to detect the take-off of usually very wary seaduck and divers well ahead of the approaching platform" (Camphuysen *et al.*, 2004 and Gittings *et al.,* 2015).

The worst-case scenario for red-throated diver is that displacement will occur at a constant level within 10 km of the offshore wind farm area, of which between 90 and 100 % of birds will be displaced, leading to a mortality rate of up to 1 % (JNCC, 2022).

5.1.2.5.1 Apportioned non-breeding impact

There is no agreed way to apportion to a marine SPA, whereby the foraging, roosting or aggregation of waterbirds is protected. Due to the offshore cable corridor going through the North-west Irish Sea SPA 100 % of the impacts could be apportioned to this SPA. However, interchange between areas during the non-breeding period is high for a migratory species and therefore the interannual variation will be high. For precaution, all impacts are presented for the North-west Irish Sea SPA.

During the site specific surveys the peak estimate of red-throated diver present within the Offshore Study Area was 29 birds. Therefore when using between 90 and 100 % displacement rate and 1% mortality, between 0.261 to 0.29 additional mortalities.

The documentation for the North-west Irish Sea SPA indicate a population of 827 individual birds (NPWS, 2023). Approximate background mortality at a rate of 0.313 gives a background annual mortality of 259 birds. Additional mortality of between 0.26 and 0.29 birds during the non-breeding season would increase annual mortality by 0.10 to 0.11 %

As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for the North-west Irish Sea SPA from the Project alone.

5.1.3 Decommissioning phase

The effects of decommissioning activities are not expected to be of greater magnitude to those described above arising from construction. Certain activities such as piling would not be required, as the decommissioning phase would involve the removal of the structures and materials originally installed. As this process would require the opposite to construction activities, it is anticipated that the same number and type of vessels and equipment will be required. These activities have already been assessed in the construction section of this assessment and is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.2 Indirect disturbance and displacement resulting from changes to prey and habitats

Potential effects on the fish assemblages during the construction and decommissioning phases of the Project, as identified in appendix D: Benthic Subtidal and Intertidal Ecology – Supporting Information and appendix E: Fish and Shellfish Ecology – Supporting Information, may have indirect effects on designated offshore ornithology features.

The Fish and Shellfish Ecology – Supporting Information appendix identified whitefish (including whiting and mackerel) and shellfish (including edible cockles, *Nephrops* and queen scallops) as important commercial fisheries in the Fish and Shellfish Ecology Study Area. The area was also identified as an important spawning and nursery ground for a number of whitefish species and a recovery ground for cod. High abundances of cod and plaice eggs recorded from the northwest Irish Sea and in particular due east of Dundalk Bay were identified (Roden *and* Ludgate*,* 2003). The area is also known as a spawning ground for whiting and herring. Other prey species found in the Fish and Shellfish Ecology Study Area include Atlantic salmon, pollack, mackerel, haddock and European eel.

5.2.1 Construction phase

Seabirds may be indirectly disturbed and displaced during the construction phase as a result of direct impacts on prey species or habitat, which may result in the loss of a food resource to birds in the offshore wind farm area and offshore cable corridor.

As a result, it is possible that birds may be indirectly displaced by changing foraging movements or other behavioural traits, resulting in a loss of demographic fitness, as well as potentially impacting on birds in areas that displaced birds move to.

The potential construction phase impacts on fish and shellfish receptors are provided in appendix E: Fish and Shellfish Ecology – Supporting Information and include temporary subtidal habitat loss/disturbance, injury and/or disturbance to fish from underwater noise during pile driving and increased Suspended Sediment Concentrations (SSC) and associated sediment deposition. The main fish prey considered in the potential impacts on offshore ornithological features include herring, sprat and sandeel.

5.2.1.1 Potential impact

Temporary habitat loss could potentially affect spawning, nursery or feeding grounds of fish and shellfish receptors, with demersal fish and shellfish, and demersal spawning species the most vulnerable. The Project design parameters assessed in appendix E: Fish and Shellfish Ecology – Supporting Information represented a very small proportion of the Project. The assessment concluded that temporary loss of habitat was considered unlikely to diminish ecosystem functions for fish and shellfish species, which would have an undetectable indirect impact on seabird species.

In relation to the influence of underwater noise affecting fish and shellfish populations, the assessment (appendix E: Fish and Shellfish Ecology – Supporting Information) reported that proposed piling activities will unlikely result in mortality, but some recoverable injury is possible within approximately 1 km of the piling works, particularly for salmonids, scombridae, gadoids and eels, herring, sprat and shads. Behavioural responses were reported to be more likely for gadoids and eels, herring, sprat and shads within hundreds to thousands of metres from the piling source. The overall effect was deemed to have a low magnitude which would have an undetectable indirect impact on seabird species.

With regards to an increase in suspended sediment concentration (SSC), this may lead to a short-term avoidance of affected areas by sensitive fish and shellfish species, although many species are considered to be tolerant of turbid environments and regularly experience changes in the SSC due to the natural variability in the Irish Sea. The assessment concluded that based on the low levels of increased SSC, the localised nature of the impact, and the tolerance of fish and shellfish receptors, the effect would have an undetectable indirect impact on seabird species.

Therefore, the overall impact for seabird receptors is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility. It is predicted that the impact will affect seabirds indirectly. The magnitude is therefore considered to be negligible.

5.2.2 Operational and maintenance phase

Seabirds may also be indirectly disturbed and displaced during the operational and maintenance phase as a result of direct impacts on prey species or habitat, which may result in the loss of a food resource to birds in the offshore wind farm area. Indirect impacts as a result of the operation of the offshore cable are highly unlikely to occur during this phase.

As a result, it is possible that birds may be indirectly displaced by changing foraging movements or other behavioural traits, resulting in a loss of demographic fitness, as well as potentially impacting on birds in areas that displaced birds move to.

The potential operational and maintenance phase impacts on fish and shellfish receptors are provided in appendix E: Fish and Shellfish Ecology – Supporting Information. Those of more than negligible magnitude include long-term subtidal habitat loss, increased suspended sediment concentrations and associated sediment deposition and Electromagnetic Fields (EMF) from subsea electrical cabling. The main fish prey considered in the potential impacts on offshore ornithological features include herring, sprat and sandeel.

5.2.2.1 Potential impact

Habitat loss could potentially affect spawning, nursery or feeding grounds of fish and shellfish receptors, with demersal fish and shellfish, and demersal spawning species the most vulnerable. The Project design parameters assessed in appendix E: Fish and Shellfish Ecology – Supporting Information represented a very small proportion of the offshore wind farm area and offshore cable corridor. The assessment concluded that temporary loss of habitat was predicted to be of highly localised spatial extent and reversible which would have an undetectable indirect impact on seabird species.

With regards to an increase in SSC, this may lead to avoidance of affected areas by sensitive fish and shellfish species, although many species are considered to be tolerant of turbid environments and regularly experience changes in the SSC due to the natural variability in the Irish Sea. The assessment (appendix E: Fish and Shellfish Ecology – Supporting Information) concluded that based on the low levels of increased SSC, the localised nature of the impact, and the tolerance of fish and shellfish receptors, the effect which would have an undetectable indirect impact on seabird species.

Localised EMF may result from the presence and operation of inter-array cables and offshore cable which could potentially affect the sensory mechanisms of some species of fish and shellfish. Based on the localised nature of the impact (metres from the cables), the rapid decay of EMF and the ability of receptors to detect and therefore avoid EMF, the assessment in appendix E: Fish and Shellfish Ecology – Supporting Information would have an undetectable indirect impact on seabird species.

5.2.3 Decommissioning phase

The effects of decommissioning activities are expected to be the same as, but not greater than, the effects from construction.

5.3 Collision risk during operational and maintenance phase

During the operational phase of the Project, the turning rotors of the wind turbines may present a risk of collision for seabirds. Stationary structures, such as the tower, nacelle or when rotors are not operating, are not expected to result in a material risk of collision. When a collision occurs between the turning rotor blade and the bird, it is assumed to result in direct mortality of the bird, which potentially could result in population level impacts.

The ability of seabirds to detect and manoeuvre around wind turbine blades is a factor that is considered when modelling and assessing the risk. In response to this it is standard practice to calculate differing levels of avoidance for different species or species groups. Avoidance rates are applied to collision risk models to predict levels of impact more realistically, based on available literature and expert advice about seabird behaviour and their flight response to wind turbines.

Species differ in their susceptibility to collision risk, depending on their flight behaviour and avoidance responses, and the vulnerability of their populations (Garthe and Hüppop, 2004; Furness and Wade, 2012; Bradbury *et al*., 2014; Wade *et al*., 2016; Ozsanlav-Harris *et al*., 2023). As sensitivity to collision differs considerably between species, species were screened and progressed for assessment on the basis of the density of flying birds recorded within the Offshore Ornithology Study Area and consideration of their perceived risk from collision (Garthe and Hüppop, 2004; Furness and Wade, 2012; Bradbury *et al*., 2014; Wade *et al*., 2016) (Table 5-13).

Five seabird species were identified as potentially at risk due to their recorded abundance in the Offshore Ornithology Study Area and their likelihood of flying at Potential Collision Height (PCH) between the lowest and highest sweep of the wind turbine rotor blades above sea level. The magnitude of change was determined by calculating the estimated number of collisions with the wind turbines and the resulting percentage increase in the background mortality rate.

There is the potential that aviation and navigation lighting on wind turbines might attract seabirds and thus increase the risk of collision. Conversely, aviation and navigation lighting could repel birds moving through the Project. There is little published evidence showing the effects of lighting on seabird collision and displacement, although earlier work on seaducks by Desholm and Kahlert (2005) showed that migrating flocks were more prone to enter the wind farm but the higher risk of collision in the dark was counteracted by increasing distance from individual turbines and flying in the corridors between turbines. For true seabirds, there is published evidence showing that seabirds are less active at night compared to daytime (Kotzerka *et al.,* 2010; Furness *et al*., 2018). Wade *et al*. (2016) ranked vulnerability of seabirds to collision by accounting for the nocturnal activity rate of seabirds. A species was screened in for consideration if the sensitivity of collision is moderate or greater and also an abundance of at least moderate.

Collision Risk Modelling (CRM) was undertaken using the Stochastic Collision Risk Model (sCRM) developed by Marine Scotland (McGregor *et al*., 2018). The User Guide for the sCRM Shiny App provided by Marine Scotland (Donovan, 2017) has been followed for the modelling of collision impacts predicted for the Project. The full methodology is provided in annex 4: Offshore Ornithology Collision Risk Modelling.

All non-seabird species have been screened out on the basis that the Project will have a negligible effect (almost undetectable) as a result of collision risk on migratory non-seabird species (see annex 6: Offshore Ornithology Migratory Non-Seabirds Collision Risk Modelling). For all species assessed within the migratory non-seabird species CRM, the annual collision risk was less than one bird per year.

Table 5-13: Screening for collision risk assessment.

Ornithological receptor	Sensitivity to collision	Abundance recorded in offshore wind farm area	Screened IN or OUT
Common gull	High	Moderate	High risk of collision and recorded in moderate numbers within the offshore wind farm area. **Screened IN**
Common scoter	Low	Very low	Low risk of collision and very low abundance recorded during site-specific surveys in offshore wind farm area. Screened OUT
Gannet	High	High	High risk of collision and high abundance recorded during site-specific surveys. **Screened IN**

Ornithological receptor	Sensitivity to collision	Abundance recorded in offshore wind farm area	Screened IN or OUT
Great northern diver	Low	Moderate	Low risk of collision and moderate abundance recorded during site-specific surveys. Screened OUT
Great-black backed gull	High	Moderate	High risk of collision and moderate abundance recorded during site-specific surveys. **Screened IN**
Guillemot	Very low	Very high	Very high numbers of guillemot were recorded in the offshore wind farm area, however the risk of collision is very low. Screened OUT
Herring gull	Very high	Moderate	Very high risk of collision, moderate abundance recorded during site-specific surveys. **Screened IN**
Kittiwake	High	Moderate	High risk of collision and moderate abundance recorded during site-specific surveys. **Screened IN**
Manx shearwater	Very low	Very high	Very high abundance recorded in the offshore wind farm area but very low collision risk. Screened OUT
Puffin	Very low	Low	Very low risk of collision and low abundance recorded during site-specific surveys. Screened OUT
Razorbill	Very low	High	High numbers of razorbill were recorded in the offshore wind farm area, however the risk of collision is very low. Screened OUT

CRM was undertaken using the Band model (Band, 2012), Options 1 and 2 for the boat-based data and Option 2 for the aerial digital data. The basic band model (Option 1) applies a uniform distribution of bird flights between the lowest and the highest levels of the rotors; the percentage of bird flights passing between the lowest and the highest levels of the rotors (i.e. the proportion of birds at PCH) is determined from observations of bird flight heights made during the baseline boat-based surveys. Option 2 uses generic flight height estimates published by Johnston *et al.* (2014) to determine the proportion of flight activity at PCH.

There is currently no detailed Irish guidance regarding the use of collision risk models or Avoidance Rates (ARs) in the assessment of offshore wind farms on seabirds. The collision risk model incorporated interim guidance on recommended ARs, bird size, flight speed, flight type and nocturnal activity scores (Natural England, 2022). Throughout the assessment, outputs will be contrasted with recently published parameters from JNCC (Ozanlav-Harris et al., 2023). All proposed parameters are set out in table 5-14.

The AR for all species follow guidance from Natural England (2022) and the subsequent JNCC report (Ozsanlav-Harris *et al*., 2023), in the absence of detailed guidance from regulators in Ireland. Within this document, these two ARs will be referred to as “Natural England AR” and “JNCC AR”. The SD is presented alongside the AR, to provide variation around the mean value. The Natural England rates are grouped into species type, with gannet and kittiwake included within the “all gulls rate”, herring gull and great black-backed gull as “large gulls” and common gull as “small gulls”. Species specific AR are provided within the JNCC report for kittiwake, herring gull and great black-backed gull, but gannet and common gull use the “large gull” and “small gull”, respectively.

The biometrics for all species were derived from McGregor *et al*. (2018) and Natural England (2022). Estimates of flight speeds for kittiwake, herring gull, and great black-backed gull were derived from Cook *et al*. (2014), which presents flight speed values taken from Pennycuick (1997) and Alerstam *et al.* (2007). Flight speed for common gull was derived directly from Alerstam *et al.* (2007), due to a suspected error in the Cook *et al.* (2014) data. Flight speed for gannet was derived from both Cook *et al.* (2014) and more recent data present by Skov *et al.* (2018). The nocturnal activity factor are all based on Garthe and Hüppop (2004) other than gannet which is from Furness *et al*. (2018).

Table 5-14: Species parameters (± 1 SD) used for CRM for all five species.

Species	Natural England AR	JNCC AR	Body Length (m)	Wingspan (m)	Flight speed (ms^{-1})	Nocturnal activity
Common Gull	0.995 (± 0.0002)	0.9949 (± 0.0002)	0.41 (±0.005)	1.20 (±0.05)	13.4 (± 0.4)	0.375 (±0.0637)
Gannet	0.993 (± 0.0003)	0.9939 (± 0.0004)	0.94 (±0.0325)	1.72 (±0.0375)	14.9 (± 0)	0.08 (±0.1)
Great black-backed gull	0.994 (± 0.0004)	0.9991 (± 0.0002)	0.71 (±0.035)	1.58 (±0.0375)	12.8 (± 1.2)	0.375 (±0.0637)
Herring gull	0.994 (± 0.0004)	0.9952 (± 0.0003)	0.595 (±0.0225)	1.44 (±0.03)	12.8 (± 1.8)	0.375 (±0.0637)
Kittiwake	0.993 (± 0.0003)	0.9979 (± 0.0013)	0.39 (±0.005)	1.08 (±0.0625)	13.1 (± 0.4)	0.375 (±0.0637)

Collision risk estimates have been calculated using the mean density (± 1 SD) associated with survey data for the 19 months of baseline boat surveys (carried out between May 2018 and May 2020) and six months of aerial digital surveys (carried out between April 2020 and September 2020). For boat-based survey data with more than one survey in a calendar month (irrespective of year), the mean density estimate of the two surveys was used.

The species-specific impacts have been assessed in relation to the relevant seasonal populations as defined in Table 3-4. The breeding season assumes those individuals within foraging range of the Offshore Ornithology Study Area during the breeding season. The non-breeding seasons assumes the estimated non-breeding population present within the region.

Table 5-15: Estimated collisions (both Natural England and JNCC AR) during the breeding and non-breeding season for Band Option 1 and 2 for both the boat-based and DAS density estimate.

Ornithological receptor	Band Model Option	Density estimate	Natural England AR			JNCC AR		
			Breeding season	Non-breeding	Annual	Breeding season	Non-breeding	Annual
Common gull	1	Boat-based	0	10.71	10.71	0	10.78	10.78
	2	Boat-based	0	20.27	20.27	0	20.45	20.45
Gannet (70% macro-avoidance applied)	1	Boat-based	10.31	10.40	20.71	8.96	9.01	17.96
	2	Boat-based	5.08	5.10	10.18	4.34	4.38	8.72
	2	DAS	4.10	N/A	N/A	3.61	N/A	N/A
Great black-backed gull	1	Boat-based	12.68	40.47	53.16	1.95	6.09	8.03
	2	Boat-based	15.70	50.21	65.91	2.44	7.54	9.98
	2	DAS	2.00	N/A	N/A	0.30	N/A	N/A
Herring gull	1	Boat-based	26.32	50.79	77.11	20.99	40.64	61.63
	2	Boat-based	31.34	60.46	91.80	25.12	48.38	73.50
Kittiwake	1	Boat-based	3.99	43.83	47.82	1.52	13.45	14.97

Ornithological receptor	Band Model Option	Density estimate	Natural England AR			JNCC AR		
			Breeding season	Non-breeding	Annual	Breeding season	Non-breeding	Annual
	2	Boat-based	5.83	50.45	56.28	1.74	15.37	17.11
	2	DAS	3.68	N/A	N/A	1.12	N/A	N/A

5.3.1 Common gull

5.3.1.1 Assessment of impact – non-breeding season

Apportioned mortality for common gull during the non-breeding season is presented in Table 5-16 for the range of impacts and therefore precautionary estimate (10.71 to 20.45 from Table 5-15). Estimated number of mortalities from collisions range from 0.79 to 2.72 birds, depending on the SPA. This increased baseline mortality between 0.20 and 0.67 %. SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone and therefore presented within an in-combination assessment (section 6.2) are highlighted in **bold** in Table 5-16.

Table 5-16: Apportioned mortality of common gull resulting from displacement during the non-breeding season.

SPA	SPA population	BDMPS	Proportion SPA / BDMPS	Estimated mortality		Increase in baseline mortality (%)	
				Natural England AR	JNCC AR	Natural England AR	JNCC AR
Dundalk Bay	**1,594**	**21,438**	**0.074**	**0.79 to 1.50**	**0.80 to 1.51**	**0.20 to 0.37**	**0.20 to 0.37**
North-west Irish Sea	**2,866**	**21,438**	**0.133**	**1.42 to 2.70**	**1.43 to 2.72**	**0.35 to 0.67**	**0.35 to 0.67**

The impact of collision caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor directly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

5.3.2 Gannet

See section 5.4, for the combined disturbance and displacement and collision assessment for gannet.

5.3.3 Great black-backed gull

5.3.3.1 Assessment of impact – non-breeding season

Apportioned mortality for great black-backed gull during the non-breeding season is presented in Table 5-17. Estimated number of mortalities from collision range from 0.74 to 0.92 birds when using the Natural England AR and 0.11 to 0.14 birds when using the JNCC AR. This increased baseline mortality between 0.80 and 1.00 %, or 0.12 to 0.15 %. SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone and therefore presented within an in-combination assessment (section 6.2) are highlighted in **bold** in Table 5-17.

Natural England AR are presented as “species group” and therefore are using all large gull species combined (lesser black-backed gull, great black-backed gull and herring gull combined) whereas the JNCC AR are specific to great black-backed gull. Therefore the applicant considers the JNCC AR (Ozanlav-Harris *et al.*, 2023) as the latest available scientific evidence as to great black-backed gull sensitivity to collisions. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

Table 5-17: Apportioned mortality of great black-backed gull resulting from displacement during the non-breeding season.

SPA	SPA population	BDMPS	Proportion SPA / BDMPS	Estimated mortality		Increase in baseline mortality (%)	
				Natural England AR	JNCC AR	Natural England AR	JNCC AR
North-west Irish Sea	**982**	**53,181**	**0.0185**	**0.74 to 0.92**	**0.11 to 0.14**	**0.80 to 1.00**	**0.12 to 0.15**

5.3.4 Herring gull

5.3.4.1 SPA weighted proportions during the breeding season

Using the NatureScot apportioning tool, 22.1 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA. The proportional weight column will not equal one as multiple non-SPA colonies make up the regional breeding population but have been excluded from this report.

Table 5-18: Breeding herring gull colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (breeding individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Ireland's Eye	636	57	0.064	0.057
Lambay Island	1,812	48	0.251	0.221
Skerries Islands	34	39	0.008	0.007

5.3.4.2 Apportioned breeding impacts

Apportioned mortality for herring gull during the breeding season is presented in Table 5-19. Estimated number of mortalities from collision range from 0.04 to 1.90 adult birds, depending on the colony and AR used. This increased baseline mortality between 0.31 and 1.07 % in adult birds.

Table 5-19: Apportioned mortality of breeding adult herring gull resulting from collision during the breeding season.

SPA	Estimated mortality from displacement		Baseline mortality	Increase in baseline mortality (%)	
	Natural England AR	JNCC AR		Natural England AR	JNCC AR
Ireland's Eye	0.41 to 0.49	0.33 to 0.39	106	0.39 to 0.46	0.31 to 0.37
Lambay Island	1.59 to 1.90	1.27 to 1.52	301	0.53 to 0.63	0.42 to 0.51
Skerries Islands	0.05 to 0.06	0.04 to 0.05	6	0.90 to 1.07	0.72 to 0.86

The impact of collisions caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for the Ireland's Eye and the Lambay Island SPA assessed from the Project alone.

Skerries Islands SPA had a small relic population with 17 pairs in 2010, there is no more recent count estimate. Due to the very small size of the SPA an estimated mortality of up to 0.06 birds is predicted to increase the baseline mortality >1 %, the threshold for which a change may be noticeable. However as there is a minute population and 0.06 birds does not represent a true risk to the population (i.e. one bird killed every ~ 16.6 years) it is not deemed proportionate to undertake any more detailed analysis. In addition, when using the JNCC AR would be no adverse effect on the site's integrity as <1 % increase in baseline morality.

5.3.4.3 Apportioned non-breeding impacts

Apportioned mortality for herring gull during the non-breeding season is presented in Table 5-20. Estimated number of mortalities from collision range from 0.01 to 2.01 adult birds, depending on the colony. This increased baseline mortality between 0.11 and 0.18 % in adult birds.

Table 5-20: Apportioned mortality of adult herring gull resulting from collision during the non-breeding season.

SPA colony	BDMPS	Proportion SPA / BDMPS	Estimated mortality		Increase in baseline mortality (%)	
			Natural England AR	JNCC AR	Natural England AR	JNCC AR
Ireland's Eye	98,946	0.0050	0.14 to 0.17	0.11 to 0.13	0.13 to 0.16	0.11 to 0.13
Lambay Island	98,946	0.0165	0.40 to 0.48	0.32 to 0.38	0.13 to 0.16	0.11 to 0.13
Skerries Islands	98,946	0.0005	0.01 to 0.01	0.01 to 0.01	0.13 to 0.16	0.11 to 0.13
North-west Irish Sea	98,946	0.0697	1.69 to 2.01	1.35 to 1.61	0.15 to 0.18	0.12 to 0.14
Dundalk Bay	98,946	0.0076	0.19 to 0.22	0.15 to 0.18	0.15 to 0.18	0.12 to 0.14
River Nanny Estuary and Shore	98,946	0.0005	0.01 to 0.01	0.01 to 0.01	0.15 to 0.18	0.12 to 0.14

The impact of collisions caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

5.3.4.4 Assessment of impact – all seasons

Combining the impacts from both the breeding and non-breeding seasons provides the annual impact on each SPA that is designated for herring gull. Apportioned annual mortality for herring gull is presented in Table 5-21 for the most impactful and therefore precautionary estimate. Estimated number of mortalities from collisions range from 0.01 to 2.37 birds, depending on the SPA. This increased baseline mortality between 0.12 and 1.23 %, which is considered undetectable in each individual SPA population. SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone and therefore presented within an in-combination assessment (section 6.2) are highlighted in **bold** in Table 5-21.

Table 5-21: Apportioned mortality of adult herring gull resulting from collisions annually.

SPA colony	Estimated mortality from collisions		Increase in baseline mortality (%)	
	Natural England AR	JNCC AR	Natural England AR	JNCC AR
Ireland's Eye	**0.55 to 0.65**	**0.44 to 0.52**	**0.52 to 0.62**	**0.42 to 0.50**
Lambay Island	**1.99 to 2.37**	**1.59 to 1.90**	**0.66 to 0.79**	**0.53 to 0.63**
Skerries Islands	0.06 to 0.07	0.05 to 0.06	1.03 to 1.23	0.82 to 0.99
North-west Irish Sea	1.69 to 2.01	1.35 to 1.61	0.15 to 0.18	0.12 to 0.14
Dundalk Bay	0.19 to 0.22	0.15 to 0.18	0.15 to 0.18	0.12 to 0.14

River Nanny Estuary and Shore	0.01 to 0.01	0.01 to 0.01	0.15 to 0.18	0.12 to 0.14

The impact of collisions caused by operational and maintenance activities annually is predicted to be of regional spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for the Ireland's Eye SPA, the Lambay Island SPA, the North-west Irish Sea SPA, the Dundalk Bay SPA and the River Nanny Estuary and Shore SPA assessed from the Project alone.

As described within the breeding season impacts, Skerries Islands SPA had a small relic population with 17 pairs in 2010, there is no more recent count estimate. Due to the very small size of the SPA an estimated mortality of up to 0.07 birds is predicted to increase the baseline mortality >1 %, the threshold for which a change may be noticeable. However as there is a minute population and 0.07 birds does not represent a true risk to the population (i.e. one bird killed every ~ 14.2 years) it is not deemed proportionate to undertake any more detailed analysis. In addition, when using the JNCC AR there would be no adverse effect on the site's integrity as <1 % increase in baseline morality.

5.3.5 Kittiwake

5.3.5.1 SPA weighted proportions during the breeding season

Using the NatureScot apportioning tool, 29.2 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA (Table 5-22). The proportional weight column will not equal one as multiple non-SPA colonies make up the regional breeding population but have been excluded from this report.

Table 5-22: Breeding kittiwake colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (breeding individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Ailsa Craig	980	161	0.012	0.004
Helvick Head to Ballyquin	130	230	0.001	0.000
Horn Head to Fanad Head	4,030	190	0.024	0.007
Howth Head Coast	6,162	59	0.575	0.177
Ireland's Eye	3,220	57	0.327	0.101
Lambay Island	6,640	48	0.963	0.297
North Colonsay and Western Cliffs	6,650	242	0.030	0.009
Rathlin Island	27,412	155	0.298	0.092
Saltee Islands	1,690	204	0.011	0.003
Wicklow Head	1,414	106	0.041	0.013

5.3.5.2 Apportioned breeding impacts

Apportioned mortality for kittiwake during the breeding season is presented in Table 5-23. Estimated number of mortalities from collision range from <0.01 to 0.96 adult birds, depending on the colony. This increased baseline mortality between <0.01 and 0.10 % in adult birds.

Table 5-23: Apportioned mortality of adult kittiwake resulting from collision during the breeding season.

SPA	Estimated mortality from displacement		Baseline mortality	Increase in baseline mortality (%)	
	Natural England AR	JNCC AR		Natural England AR	JNCC AR
Ailsa Craig	0.01 to 0.01	<0.01 to 0.01	143	0.01 to 0.01	<0.01 to 0.01
Helvick Head to Ballyquin	<0.01 to <0.01	<0.01 to <0.01	38	<0.01 to <0.01	<0.01 to <0.01
Horn Head to Fanad Head	0.01 to 0.02	0.01 to 0.02	531	<0.01 to <0.01	<0.01 to <0.01
Howth Head Coast	0.23 to 0.33	0.09 to 0.20	518	0.04 to 0.06	0.02 to 0.04
Ireland's Eye	0.06 to 0.09	0.02 to 0.06	133	0.05 to 0.07	0.02 to 0.04
Lambay Island	0.66 to 0.96	0.25 to 0.59	969	0.07 to 0.10	0.03 to 0.06
North Colonsay and Western Cliffs	0.02 to 0.03	0.01 to 0.02	977	<0.01 to <0.01	<0.01 to <0.01
Rathlin Island	0.20 to 0.30	0.08 to 0.18	4,002	0.01 to 0.01	<0.01 to <0.01
Saltee Islands	0.01 to 0.01	<0.01 to 0.01	303	<0.01 to <0.01	<0.01 to <0.01
Wicklow Head	0.03 to 0.05	0.01 to 0.03	226	0.01 to 0.02	0.01 to 0.01

The impact of collisions caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPA assessed from the Project alone.

5.3.5.3 Apportioned non-breeding impacts

Apportioned mortality for kittiwake during the non-breeding season is presented in Table 5-24 and ranges from <0.01 to 0.02 % increase in baseline mortality.

Table 5-24: Apportioned mortality of adult kittiwake resulting from collision during the non-breeding season.

Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality		Increase in baseline mortality (%)	
				Natural England AR	JNCC AR	Natural England AR	JNCC AR
Post-breeding	Ailsa Craig	508,068	0.0017	0.02 to 0.02	0.01 to 0.01	0.01 to 0.02	<0.01 to <0.01
	Helvick Head to Ballyquin	508,068	0.0002	0.01 to 0.01	<0.01 to <0.01	0.01 to 0.02	<0.01 to <0.01
	Horn Head to Fanad Head	508,068	0.0071	0.07 to 0.08	0.02 to 0.03	0.01 to 0.02	<0.01 to <0.01
	Howth Head Coast	508,068	0.0109	0.07 to 0.08	0.02 to 0.02	0.01 to 0.02	<0.01 to <0.01
	Ireland's Eye	508,068	0.0063	0.02 to 0.02	0.01 to 0.01	0.01 to 0.02	<0.01 to 0.01
	Lambay Island	508,068	0.0131	0.14 to 0.17	0.04 to 0.05	0.01 to 0.02	<0.01 to 0.01
	North Colonsay and Western Cliffs	508,068	0.0118	0.13 to 0.15	0.04 to 0.05	0.01 to 0.02	<0.01 to <0.01
	Rathlin Island	508,068	0.0540	0.60 to 0.69	0.18 to 0.21	0.01 to 0.02	<0.01 to 0.01

Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality		Increase in baseline mortality (%)	
				Natural England AR	JNCC AR	Natural England AR	JNCC AR
	Saltee Islands	508,068	0.0017	0.02 to 0.03	0.01 to 0.01	0.01 to 0.01	<0.01 to <0.01
	Wicklow Head	508,068	0.0014	0.02 to 0.02	0.01 to 0.01	0.01 to 0.01	<0.01 to <0.01
	North-west Irish Sea	508,068	0.0056	0.06 to 0.07	0.02 to 0.02	0.01 to 0.02	<0.01 to 0.01
Pre-breeding	Ailsa Craig	420,138	0.0044	0.02 to 0.03	0.01 to 0.01	0.02 to 0.02	<0.01 to 0.01
	Helvick Head to Ballyquin	420,138	0.0006	0.01 to 0.01	<0.01 to <0.01	0.02 to 0.02	<0.01 to 0.01
	Horn Head to Fanad Head	420,138	0.0182	0.08 to 0.10	0.03 to 0.03	0.02 to 0.02	<0.01 to 0.01
	Howth Head Coast	420,138	0.0279	0.08 to 0.10	0.04 to 0.05	0.02 to 0.02	<0.01 to 0.01
	Ireland's Eye	420,138	0.0182	0.03 to 0.03	0.03 to 0.03	0.02 to 0.02	0.01 to 0.01
	Lambay Island	420,138	0.0376	0.19 to 0.22	0.06 to 0.07	0.02 to 0.02	0.01 to 0.01
	North Colonsay and Western Cliffs	420,138	0.0301	0.16 to 0.18	0.05 to 0.05	0.02 to 0.02	<0.01 to 0.01
	Rathlin Island	420,138	0.1550	0.80 to 0.92	0.24 to 0.28	0.02 to 0.02	0.01 to 0.01
	Saltee Islands	420,138	0.0048	0.03 to 0.03	0.01 to 0.01	0.01 to 0.01	<0.01 to <0.01
	Wicklow Head	420,138	0.0040	0.02 to 0.03	0.01 to 0.01	0.01 to 0.01	<0.01 to <0.01
	North-west Irish Sea	420,138	0.0019	0.02 to 0.02	0.01 to 0.01	0.01 to 0.02	<0.01 to 0.01

The impact of collisions caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site’s integrity for all SPAs assessed from the Project alone.

5.3.5.4 Magnitude of impact – all seasons

Combining the impacts from both the breeding and non-breeding seasons provides the annual impact on each SPA that is designated for kittiwake. Apportioned annual mortality for kittiwake is presented in Table 5-25. Estimated number of mortalities from collisions range from <0.01 to 1.904 birds, depending on the SPA. This increased baseline mortality between 0.01 and 0.14 %, which is considered undetectable in each individual SPA population. SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone and therefore presented within an in-combination assessment (section 6.2) are highlighted in **bold** in Table 5-25.

Table 5-25: Apportioned mortality of adult kittiwake resulting from collisions annually.

SPA	Estimated mortality from collisions		Increase in baseline mortality (%)	
	Natural England AR	JNCC AR	Natural England AR	JNCC AR
Ailsa Craig	0.05 to 0.06	0.02 to 0.02	0.04 to 0.04	0.01 to 0.02
Helvick Head to Ballyquin	0.01 to 0.01	<0.01 to <0.01	0.03 to 0.04	0.01 to 0.01
Horn Head to Fanad Head	0.17 to 0.20	0.06 to 0.07	0.03 to 0.04	0.01 to 0.01

SPA	Estimated mortality from collisions		Increase in baseline mortality (%)	
	Natural England AR	JNCC AR	Natural England AR	JNCC AR
Howth Head Coast	**0.38 to 0.50**	0.15 to **0.28**	**0.07 to 0.10**	0.03 to **0.05**
Ireland's Eye	**0.11 to 0.15**	0.06 to **0.10**	**0.08 to 0.11**	0.05 to **0.07**
Lambay Island	**0.99 to 1.35**	0.35 to **0.71**	**0.10 to 0.14**	0.04 to **0.07**
North Colonsay and Western Cliffs	0.31 to 0.36	0.10 to 0.12	0.03 to 0.04	0.01 to 0.01
Rathlin Island	1.60 to **1.90**	0.51 to 0.67	0.04 to **0.05**	0.01 to 0.02
Saltee Islands	0.06 to 0.07	0.02 to 0.03	0.02 to 0.02	0.01 to 0.01
Wicklow Head	0.07 to 0.09	0.02 to 0.04	0.03 to 0.04	0.01 to 0.02
North-west Irish Sea	0.08 to 0.10	0.03 to 0.03	0.02 to 0.02	0.01 to 0.01

The impact of collision caused by operational and maintenance activities annually is predicted to be of regional spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPA assessed from the Project alone.

5.4 Combined disturbance and displacement and collision risk during the operational and maintenance phase on gannet

Gannet are unique in that they are both sensitive to both displacement (up to 2 km from the wind farm) and collisions for birds that do not avoid the area. Following recommended guidance, a displacement rate of 60 – 80 % and a mortality rate of up to 1 % are applicable (SNCB, 2022). It is recognised that assessing these two potential impacts together could amount to double counting, as birds that are subject to displacement would not be subject to potential collision risk as they are already assumed to have not entered the array area. Equally, birds estimated to be subject to collision risk mortality would not be able to be subjected to displacement consequent mortality as well. As such a 70 % macro-avoidance rate has been applied for gannet (Table 5-15).

Gannet scores low for vulnerability to displacement, however literature suggests that they may exhibit strong macro avoidance (Cook *et al.,* 2004, Rehfisch *et al*., 2014 Humphreys *et al.,* 2015, Dierschke *et al*., 2016 and Weckler *et al.,* 2016), with studies demonstrating between 60 % and 80 % avoidance rates of offshore wind farms. A mortality rate of 1 % has been used for the assessment as gannet are able to utilise a wide range of habitat types and food sources and can range over a large area away from breeding colonies and during migration periods.

The displacement estimates of mortality are presented for the breeding season within Table 5-3 and for the non-breeding season within Table 5-4.

5.4.1 SPA weighted proportions during the breeding season

Using the NatureScot apportioning tool, 45.5 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Ailsa Craig SPA. The Grassholm SPA which is the largest colony within the species foraging range of the Project is predicted to contribute to 23.6 % of the birds within the offshore wind farm area (Table 5-26).

The proportional weight column will not equal one as multiple non-SPA colonies make up the regional breeding population but have been excluded from this report.

Table 5-26: Breeding gannet colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (breeding individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Ailsa Craig	64,452	160.7	0.388	0.455
Grassholm	72,022	246.6	0.201	0.236
Saltee Islands	9,444	203.7	0.034	0.040

5.4.2 Apportioned breeding impacts

Apportioned mortality for gannet during the breeding season is presented in Table 5-27. Estimated number of mortalities from collision range from 0.10 to 2.86 adult birds, depending on the colony. This increased baseline mortality between 0.01 and 0.05 % in adult birds.

Table 5-27: Apportioned mortality of adult gannet resulting from collision and displacement during the breeding season.

SPA	Estimated mortality from collision and displacement		Baseline mortality	Increase in baseline mortality (%)	
	Natural England AR	JNCC AR		Natural England AR	JNCC AR
Ailsa Craig	1.19 to 2.86	1.07 to 2.55	5,221	0.03 to 0.05	0.02 to 0.05
Grassholm	0.61 to 1.48	0.56 to 1.32	5,834	0.01 to 0.03	0.01 to 0.02
Saltee Islands	0.11 to 0.25	0.10 to 0.23	765	0.01 to 0.03	0.01 to 0.03

The combined impact of collisions and disturbance and displacement caused by operational and maintenance activities during the breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is **not** considered to have an adverse effect on the site's integrity for all SPA assessed from the Project alone.

5.4.3 Apportioned non-breeding impacts

Apportioned mortality for gannet during the non-breeding season is presented in Table 5-28. Estimated number of collisions range from 0.01 to 1.48, depending on the SPA. This increased baseline mortality between < 0.01 and 0.03 %, depending on colony.

Table 5-28: Apportioned mortality of gannet resulting from collision and displacement during the non-breeding season.

Bio-season	SPA	BDMPS	Proportion SPA / BDRMS	Estimated mortality from collision and displacement		Increase in baseline mortality (%)	
				Natural England AR	JNCC AR	Natural England AR	JNCC AR
Post-breeding	Ailsa craig	312,206	0.2064	0.71 to 1.33	0.64 to 1.19	0.01 to 0.02	0.01 to 0.03
	Saltee Islands	312,206	0.0227	0.08 to 0.15	0.07 to 0.13	0.01 to 0.02	0.01 to 0.02
	Grassholm	312,206	0.2307	0.80 to 1.48	0.72 to 1.33	0.01 to 0.02	0.01 to 0.03
Pre-breeding	Ailsa craig	312,206	0.1716	0.08 to 0.16	0.07 to 0.15	<0.01 to <0.01	<0.01 to <0.01
	Saltee Islands	375,540	0.0251	0.01 to 0.02	0.01 to 0.02	<0.01 to <0.01	<0.01 to <0.01
	Grassholm	375,540	0.1918	0.09 to 0.18	0.08 to 0.16	<0.01 to <0.01	<0.01 to <0.01

The combined impact of collisions and disturbance and displacement caused by operational and maintenance activities during the non-breeding season is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPA assessed from the Project alone.

5.4.4 Assessment of impact – all seasons

Combining the impacts from both the breeding and non-breeding seasons provides the annual impact on each SPA that is designated for gannet. Apportioned annual mortality for gannet is presented in Table 5-29. Estimated number of mortalities from collisions and disturbance and displacement range from 0.64 to 4.36 birds, depending on the SPA. This increased baseline mortality between 0.02 and 0.224 %, which is considered undetectable in each individual SPA population. SPAs which have more than a >0.05 % increase in baseline population and an estimated mortality of >0.1 bird from the project alone and therefore presented within an in-combination assessment (section 6.2) are highlighted in **bold** in Table 5-29.

Table 5-29: Apportioned mortality of adult gannet resulting from collision and disturbance and displacement annually.

SPA colony	Estimated mortality from collision and disturbance and displacement		Increase in baseline mortality (%)	
	Natural England AR	JNCC AR	Natural England AR	JNCC AR
Ailsa Craig	1.98 to **4.36**	1.79 to **3.89**	0.04 to **0.08**	0.03 to **0.07**
Saltee Islands	**0.70 to 1.65**	**0.64 to 1.47**	**0.09 to 0.22**	**0.08 to 0.19**
Grassholm	1.00 to 1.93	0.89 to 1.73	0.02 to 0.03	0.02 to 0.03

The combined impact of collisions and disturbance and displacement caused by operational and maintenance activities annually is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. It is predicted that the impact will affect the receptor both directly and indirectly. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPA assessed from the Project alone.

5.5 Barrier effect

5.5.1 Operational and maintenance phase

Barrier effects may arise in addition to displacement however, unlike displacement, the effect refers to the disruption of preferred flight lines, so that birds are forced to navigate around an obstacle using alternative routes, which then imposes an additional energetic cost to daily movements (particularly during the breeding season) or migratory routes. This could have long-term implications to changes in bird movements and demographic fitness.

There is a general lack of empirical data to date on barrier effects of offshore wind farms around the Britain and Ireland (Humphreys *et al*., 2015) however studies have shown that a number of highly sensitive species such as seaducks and divers show avoidance responses to offshore wind farms, adjusting their flight trajectories to avoid the offshore wind-farm area post-construction (Peterson *et al.,* 2006 and Masden *et al*., 2010), which under some circumstances may negatively impact on survival rates. In the case of migrating birds, avoidance of a single wind farm may be trivial relative to the total length and cost of the journey, however during the breeding season (as birds travel between foraging grounds and roosting/nesting sites), the impact could be more significant (Masden *et al*., 2010 and Green *et al.,* 2019).

5.5.1.1 Magnitude of impact

For seabird species within mean maximum foraging range of the Project, there could be adverse impacts arising from barrier effects if the presence of offshore wind farm structures (i.e. turbines) prevented access to foraging grounds or forced the individual to circumnavigate the wind farm to/from foraging grounds, as this would lead to higher energy expenditure. The Project is within the mean maximum foraging range of several breeding colonies of gannet, kittiwake, guillemot and razorbill which are qualifying features of nearby SPAs, including Lambay Island, Ireland's Eye, Howth Head Coast, Wicklow Head and Ailsa Craig and could therefore be at risk of a barrier effect.

Gannet and kittiwake have large mean maximum foraging ranges from breeding colonies and generally forage widely. In addition, both gannet and kittiwake have low sensitivity to barrier effects and a low score for habitat flexibility (Maclean *et al*., 2009 and Furness *et al*., 2012), therefore the Project is unlikely to provide a significant barrier to foraging gannets and kittiwakes from these colonies given the species extensive foraging range and efficient flying capabilities. The magnitude for gannets and kittiwakes is therefore considered to be negligible.

For species with a higher sensitivity to barrier effects and that score medium for habitat flexibility, such as guillemot and razorbill (Maclean *et al*., 2009), the offshore wind farm area is unlikely to form a significant part of these species' foraging grounds because the offshore wind farm area is relatively small in the context of their overall ranges. A medium score of '3' means that these species have some flexibility in their habitat ranges and so would be able to move elsewhere. The magnitude for guillemot and razorbill is therefore considered to be low.

The impact of a barrier effect is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect seabirds directly. The magnitude is therefore considered to be negligible or low.

6 IN-COMBINATION EFFECTS

6.1 Methodology

The in-combination assessment takes into account the impact associated with the Project together with other projects. The projects selected as relevant to the in-combination assessment (ICA) are based upon the results of a screening exercise (see appendix J: Screening – In-combination Effects). Each Project has been considered on a case by case basis for screening in or out of this assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

The approach to in-combination examines the effects of the Project alongside the following projects if they fall within the Cumulative Offshore Ornithology Study Area:

- Other projects with consent but not yet constructed/construction not completed;
- Other projects in a consent application process but not yet determined (including planning applications, foreshore lease/licence applications, Dumping at Sea Permit applications;
- Other projects currently operational that were not operational when baseline data were collected, and/or those that are operational but have an ongoing impact; and
- Projects, which satisfy the definition of ‘relevant maritime usage’ under the Maritime Area Planning Act (2021) (i.e. wind farm projects designated as ‘Relevant Projects’ or ‘Phase 1 Projects’) including Arklow Bank II, Dublin Array (formerly Bray Bank and Kish Bank); North Irish Sea Array (NISA), Codling Wind Park (I and II).

The specific projects screened in to the in-combination assessment are outlined in Table 6-1. The location of screened in Projects in relation to the Project is illustrated in Figure 6-1.

Table 6-1: List of other Projects considered within the in-combination assessment.

Project	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
North Irish Sea Array (NISA) offshore wind farm	Maritime Area Consent	16.2	18.1	EIA Scoping Report (2021) refers to the construction of an offshore wind farm of up to 500 MW, consisting of 36 turbines with a maximum height of 320 m and rotor diameter of up to 290 m. Offshore substation platforms may be required.[3]	Unknown	Unknown (Design life minimum 35 years)	Potential for construction, operation and maintenance and decommissioning phases to overlap with the Project.
Dublin Array offshore wind farm	Maritime Area Consent	61.2	56.9	Scoping report (2020) refers to the construction of Bray and Kish offshore wind farm of up to 900 MW, consisting of up to 61 turbines with a maximum height of 308 m and rotor diameter of up to 285 m and up to three offshore substation platforms.[4]	Unknown	Unknown (Design life minimum 35 years)	Potential for construction, operation and maintenance and decommissioning phases to overlap with the Project.
Codling Wind Park	Maritime Area Consent	61.4	57.1	EIA Scoping report (2020) refers to the construction of an offshore wind farm of up to 1500 MW, consisting of up to 140 turbines with a maximum height of 320 m and rotor diameter of up to 288 m. The project will also contain up to five offshore substation platforms.[5]	Unknown	Unknown (Design life minimum 35 years)	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Arklow Bank Wind Farm (Phase 2)	Maritime Area Consent	107.1	104.6	EIA Scoping Report: The project will include between 37 and 56 turbines ad up to two Offshore Substation Platforms (OSP) and foundation substructures. The area	Unknown	Unknown (Design life minimum 35 years)	Potential for overlap with construction, operation and maintenance and decommissioning phases.

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[3] Project website https://northirishseaarray.ie/ states that wind farm will consist of 35 to 46 turbines.

[4] Project website: https://dublinarray.com/project-information/key-facts/ between 39 and 50 turbines, individual turbine capacity 15 MW+, total project capacity 824 MW, individual tip heights between approx. 270 m and 310 m

[5] Project website: https://codlingwindpark.ie/the-project/ max energy output 1300 MW, 100 turbines, turbine tip height max 320 m, states preferred O&M base is Wicklow Town

Project	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
				in which the proposed wind turbines, inter-array cables and OSP(s) will be located on Arklow Bank covers an area of seabed approximately 64km^2.[6]			
Holyhead Deep – Phase 1 (Minesto Tidal Kite)	Operational (partial)	105.7	108	Underwater tidal kites, one 0.5 MW tidal kite operational in 2017, plans for 60 1.2 MW devices.	2017 to *ongoing*	2018 to *ongoing*	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Morgan Offshore Wind Farm – Generation Assets	Planning – Preliminary Environmental Information Report (PEIR) submitted	119.5	124	PEIR indicates 107 wind turbines. 1,500 MW capacity.	Unknown	Unknown	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Arklow Bank Wind Farm Phase 1	Operational	120.2	117.5	Seven 3.6 MW turbines. Hub height 73.5 m. Rotor diameter 124 m.	2002 to 2003	2004 to *2028*	Potential for overlap with operation and maintenance phase.
Mona Offshore Wind Farm	Planning – PEIR submitted	127.1	131.4	PEIR report indicates 107 wind turbines. 1,500 MW capacity.	Unknown	Unknown	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Walney Extension 3 Offshore Wind Farm	Operational	139.9	144.6	40 8.25 MW turbines. Hub height 113 m. Rotor diameter 164 m	2017	2018 to 2039	Potential for overlap with operation and maintenance phase.
Awel y Môr Offshore Wind Farm	Planning - consented	142.4	145.2	50 turbines. Rotor diameter 306 m and a minimum of 11.5 MW per turbine.	*2026 to 2029*	2030 to *2065*	Potential for overlap with construction, operation and maintenance and decommissioning phases.

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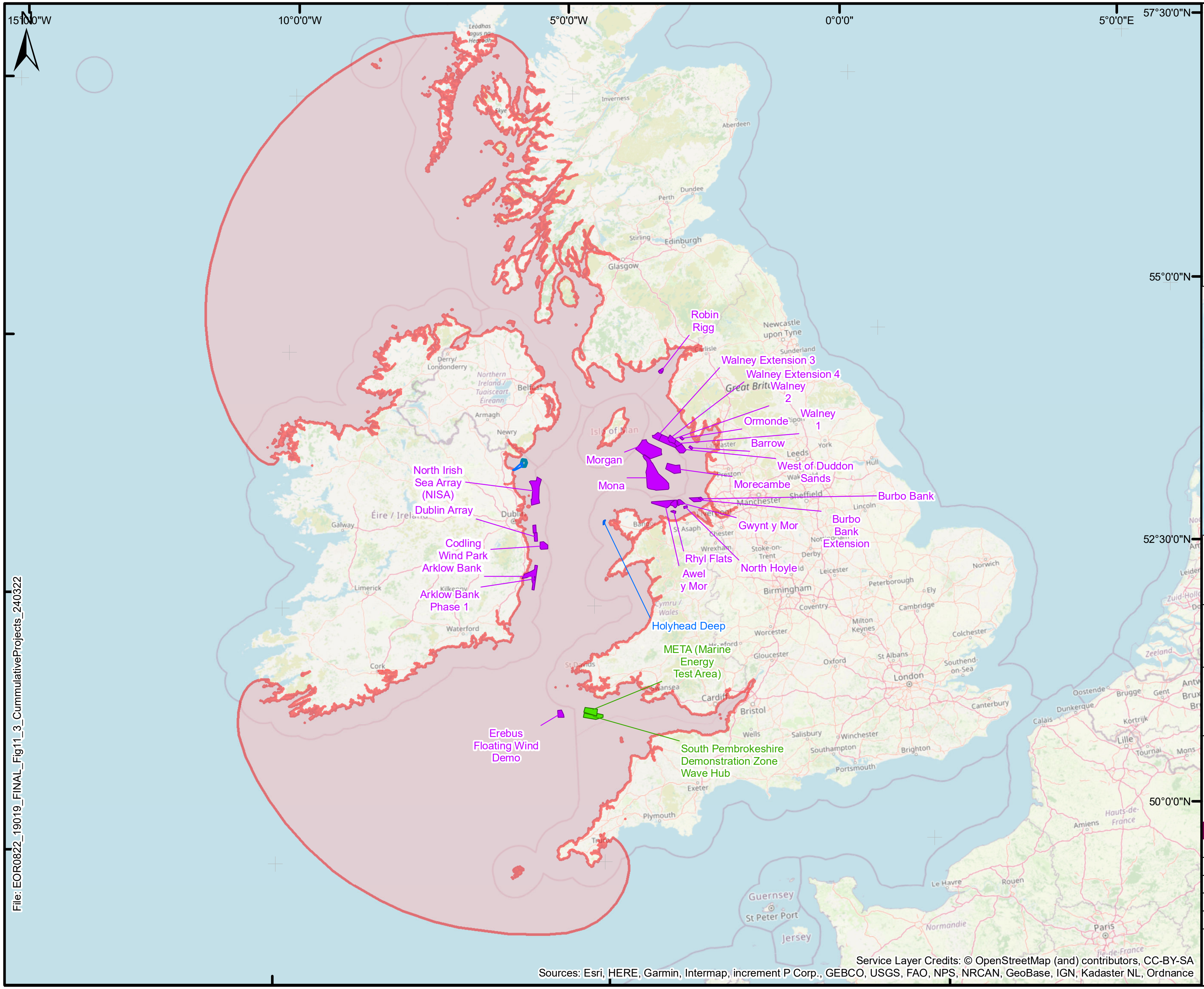
[6] Project website: The development area for the wind farm covers an area of seabed approximately 27 km long and 2.5 km wide. Between 36 and 60 turbines will be deployed on the site, each comprising a foundation, tower, nacelle, and rotor assembly. A number of different turbine models and layouts are being explored to deliver a power generation output from the site of up to 800MW. One to two Offshore Substation Platforms (OSP) and foundation substructures, a network of inter-array cabling and two offshore export cables will also form part of the offshore infrastructure.

Project	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
Walney Extension 4 Offshore Wind Farm	Operational	146	150.6	47 7 MW turbines. Hub height 111 m. Rotor diameter 154 m	2017	2018 to *2039*	Potential for overlap with operation and maintenance phase.
Morecambe Offshore Wind Farm - Generation Assets	Planning – PEIR submitted	151.3	155.2	PEIR report indicates 40 wind turbines. 480 MW capacity.	Unknown	Unknown	Potential for overlap with construction, operation and maintenance and decommissioning phases.
Walney 2 Offshore Wind Farm	Operational	155.8	160.5	51 3.6 MW turbines. Hub height 84 m. Rotor diameter 107 m.	2011	2012 to *2032*	Potential for overlap with operation and maintenance phase.
Walney 1 Offshore Wind Farm	Operational	162.5	166.7	51 3.6 MW turbines. Hub height 84 m. Rotor diameter 107 m.	2010	2010 to *2032*	Potential for overlap with operation and maintenance phase.
West of Duddon Sands Offshore Wind Farm	Operational	162.3	166.7	108 3.6 MW turbines. Hub height 90 m Rotor diameter 120 m.	2013 to 2014	2014 to *2033*	Potential for overlap with operation and maintenance phase.
Gwynt y Mor Offshore Wind Farm	Operational	163.4	166.3	160 3.6 MW turbines. Hub height 98 m. Rotor diameter 107 m.	2012	2015 to *2032*	Potential for overlap with operation and maintenance phase.
Rhyl Flats Offshore Wind Farm	Operational	165.6	168.3	25 3.6 MW turbines. Hub height 80 m. Rotor diameter 107 m.	2007	2009 to *2027*	Potential for overlap with operation and maintenance and decommissioning phases.
Ormonde Offshore Wind Farm	Operational	168.6	173.2	30 5 MW turbines. Hub Height 100 m. Rotor diameter 126 m.	2010	2012 to *2036*	Potential for overlap with operation and maintenance phase.
Robin Rigg Offshore Wind Farm	Operational	173.3	178.5	58 3 MW turbines. Hub height 80 m Rotor diameter 90 m.	2009	2010 to *2030*	Potential for overlap with operation and maintenance phase.
North Hoyle Offshore Wind Farm	Operational	177.1	180.0	30 2 MW turbines. Hub height 70 m. Rotor diameter 80 m.	2003	2004 to *2028*	Potential for overlap with operation and maintenance phase.

Project	Status	Distance from offshore wind farm area (km)	Distance from offshore cable corridor (km)	Description of Project	Dates of construction (if applicable)	Dates of operation (if applicable)	Overlap with Project
Barrow Offshore Wind Farm	Operational	177.2	181.6	30 3 MW turbines. Hub height 75 m. Rotor diameter 90 m.	2005	2006 to *2028*	Potential for overlap with operation and maintenance phase.
Burbo Bank Offshore Wind Farm Extension	Operational	181.1	184.3	32 8.0 MW turbines. Hub height 105 m. Rotor diameter 160 m	2016	2017 to *2045*	Potential for overlap with operation and maintenance phase.
Burbo Bank Offshore Wind Farm	Operational	191.1	194.4	23 3.6 MW turbines. Hub height 78 m. Rotor diameters 107 m.	2006	2007 to *2039*	Potential for overlap with operation and maintenance phase.
Marine Energy Test Areas (META) Pembrokeshire	Operational	253.9	~250	Tidal, wave and floating offshore wind test site.	2019	2019 to *2029*	Potential for overlap with operation and maintenance phase.
Erebus Offshore Wind Farm	Consented (not yet constructed)	267.9	265.4	100 MW capacity demonstration and testing site for floating wind.	*2025*	*2026 to 2051*	Potential for overlap with construction, operation and maintenance and decommissioning phases.
South Pembrokeshire Demonstration Zone – Wave Hub	Planning	273.8	~270	Wave energy test site of 100 MW	2019	*2019 to 2048*	Potential for overlap with construction, operation and maintenance and decommissioning phases.



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File: EOR0822_19019_FINAL_Fig11_3_CummulativeProjects_240322

Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- 🟥 Cumulative Offshore Ornithology Study Area
- 🟪 Offshore Wind Farm
- 🟦 Tidal Project
- 🟩 Wave Project

Data Sources: Client,

Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 6-1
Other projects screened into the in-combination assessment - SCI seabirds

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Issue Details

Drawn By: NG	**Project No.** EOR0822 (MDR1520B)
Checked By: NG	**File Ref:**
Approved By: AOS	EOR0822_ORN_E_19019_FINAL
Scale: 1:5,500,000 @ A4	**Projection:**
Date: 22/03/2024	ITM (IRENET95) Geographic Co-ordinates: ETRS89

NOTE:
1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Malin Head.
3. Ordnance Survey Ireland Licence EN 0005019 ©Copyright Government of Ireland.

Table 6-2 presents the relevant project design parameters from Table 4-1, which are used to assess the potential in-combination effects of the Project with the other Projects identified in Table 6-1 (where information is available).

Impacts have been carried forward for assessment where there is potential for an effect to occur from the Project alone over a scale that could impact cumulatively with other projects within the Cumulative Offshore Ornithology Study Area. This has been applied whereby the Project could contribute to an increase in baseline mortality of >0.05 %. All impacts <0.05 % are considered inconsequential with no potential to interact cumulatively with other projects.

Other aspects, namely indirect impacts associated with prey distribution and availability are very difficult to quantify, and although it is acknowledged that cumulative effects are possible, the magnitude of these impacts is not considered to be significant at a population level for any offshore ornithology receptor and is therefore not considered further within the ICA. The impacts excluded from the cumulative assessment are:

- Indirect impacts (affecting prey species) from airborne noise, underwater sound and the presence of vessels at any phase of the Project as they will be spatially limited and all were predicted as negligible;
- Barrier effects have not been included in the in-combination assessment; although it is acknowledged that cumulative impacts are possible, the magnitude of these impacts is not considered to be significant at a population level for any ornithological receptor when considered alongside the other proposed Irish Sea wind farms due to a separation distance of a least 16 km; and
- Disturbance and displacement during the construction and decommissioning phases; although it is acknowledged that impacts are possible, the spatial magnitude of these impacts is not considered to be cumulative in nature due to the small area over which construction activities occur (point source impacts). There is low likelihood that temporal overlap might occur and if it does there is at least 16 km between the two construction locations. It is not considered significant at a population level for any ornithological receptor when considered alongside the other proposed projects.

Table 6-2: Project design parameters considered for the assessment of potential in-combination impacts on offshore ornithology.

Potential cumulative impact	Phase C	Phase O	Phase D	Project design parameters	Justification
Disturbance and displacement	✗	✓	✗	Project design parameters as described for the Project (Table 4-1) assessed cumulatively with the other projects (Table 6-1).	Outcome of the in-combination assessment will be greatest when the greatest number of other wind farms are considered
Collision risk	✗	✓	✗	Project design parameters as described for the Project (Table 4-1) assessed cumulatively with the other projects (Table 6-1).	Outcome of the in-combination assessment will be greatest when the greatest number of other wind farms are considered

6.2 In-combination assessment

The ICA is limited by the publicly available data upon which to base the assessment. Due to the age of developments in the Irish Sea and surrounding areas which have the potential to have a cumulative impact upon receptors, few have comparable datasets upon which to base an assessment. Additionally, older developments did not carry out certain impact assessments (e.g. displacement and/or collision risk). No attempt has been made to calculate the impacts of these older projects with a large proportion of the impact already present within a species survival rate. As such the CIA is carried out using data from wind farms with available species data to do so.

The Applicant has engaged with the other four Phase 1 offshore wind farm developers on the east coast of Ireland (who hold a Maritime Area Consent) (see Table 6-1) to inform the ICA. A single output for these projects is presented. These projects shared data and outputs from collisions risk modelling and displacement to inform the assessment of potential cumulative impacts on offshore ornithology.

When the assessment of the Project alone (section5) concluded that the Project would have an increase in baseline mortality of <0.05 % the impact from the Project alone is considered inconsequential and not proportionate to include within the ICA. The Project would not materially or measurably contribute to the cumulative impact. All assessments which conclude a <0.05 % increase in baseline mortality are within the natural variation and confidence intervals within which the estimates of density, survival and impacts have been produced. Therefore following the assessment of the gannet alone assessment no CIA was undertaken. Impacts on great northern diver, guillemot, razorbill, common gull, great black-backed gull and herring gull are presented within the ICA.

6.2.1 Disturbance and displacement during operational and maintenance phase

6.2.1.1 Guillemot

Due to variation in methods used to assess annual disturbance and displacement impacts the mid-point of the alone assessment was used, and therefore the estimated number of mortalities is using a 50 % displacement and a 1 % mortality estimate. The number presented for the Project is the higher of either the DAS or boat-based surveys for precaution. Within Table 6-3 N/A indicates that the project did not consider the SPA, mainly due to the SPA being out with the foraging range of the guillemot from the project in question. No other project considered Howth Head Coast SPA nor Rathlin Island SPA for guillemot and therefore those sites are not included within this Table 6-3. The project alone concluded that the impact on Wicklow head was <0.05 % increase in baseline mortality and an estimated mortality of <0.1 bird therefore has not been included within this in-combination assessment.

Table 6-3: Estimated annual mortality of guillemot (all ages) from disturbance and displacement apportioned to the relevant SPAs from the in-combination projects.

Project	SPA	
	Ireland's Eye	Lambay Island
Awel y Môr Mona Offshore Wind Project	0.04	0.6
Project Erebus	N/A	N/A
Minesto Tidal Kite (collisions with tidal kite)	0.2	6.4
In-combination total (consented)	**0.24**	**7**
Mona Offshore Wind Project	0.21	3.17
Morgan Offshore Wind Project Generation Assets	0.15	2.33
Morecambe Offshore Windfarm	No assessment of guillemot was undertaken in the PEIR	
Other phase 1 projects	8.24	76.94
Oriel Wind Farm Project	0.13	2.36
In-combination total (all Projects)	**9.21**	**98.8**

Baseline mortality of SPA	1,313	17,864
In-combination total as a % increase on baseline mortality	**0.70**	**0.55**

The impact of disturbance and displacement caused by operational and maintenance activities annually when all projects are considered in-combination is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

6.2.1.2 Razorbill

Due to variation in methods used to assess annual disturbance and displacement impacts the mid-point of the alone assessment was used, and therefore the estimated number of mortalities is using a 50 % displacement and a 1 % mortality estimate. The number presented for the Project is the higher of either the DAS or boat-based surveys for precaution. Within Table 6-4 N/A indicates that the Project did not consider the SPA, mainly due to the SPA being out with the foraging range of the razorbill from the Project in question. No other Project considered Howth Head Coast SPA, Wicklow Head SPA nor Rathlin Island SPA for razorbill as these SPAs have no connectivity with thew other projects and therefore those sites are not included within Table 6-4.

Table 6-4: Estimated annual mortality of razorbill (all ages) from disturbance and displacement apportioned to the relevant SPAs from the in-combination Projects.

Project	SPA	
	Ireland's Eye	Lambay Island
Awel y Môr Mona Offshore Wind Project	0.02	0.09
Project Erebus	N/A	N/A
Minesto Tidal Kite (collisions with tidal kite)	0.04	0.37
In-combination total (consented)	**0.06**	**0.46**
Mona Offshore Wind Project	No assessment of razorbill was undertaken in the PEIR	
Morgan Offshore Wind Project Generation Assets		
Morecambe Offshore Windfarm		
Other phase 1 projects	1.44	5.64
Oriel Wind Farm Project	0.14	0.83
In-combination total (all Projects)	**1.7**	**7.39**
Baseline mortality of SPA	473	2,175
In-combination total as a % increase on baseline mortality	**0.36**	**0.34**

The impact of disturbance and displacement caused by operational and maintenance activities annually when all projects are considered in-combination is predicted to be of local spatial extent, long term duration, continuous and medium reversibility. As the increase in baseline mortality is <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed from the Project alone.

6.2.2 Collision risk during operational and maintenance phase

The offshore wind farm area, together with that of other Projects may contribute to in-combination collision risk during the operational and maintenance phase. Other projects screened into the assessment within the Cumulative Offshore Ornithology Study Area are presented in Table 6-1, and these are also considered alongside the species' mean maximum foraging range plus one standard deviation (Woodward *et al*., 2019). The four species identified as potentially impacted by the Project alone during operational and maintenance phase were common gull, gannet, herring gull and kittiwake. Assessment of gannet is considered in section 6.2.3 combined with displacement as the species is susceptible to both.

6.2.2.1 Common gull

Within the alone assessment the Dundalk Bay SPA and the North-west Irish Sea SPA were considered during the winter period only. All birds present within the Dundalk Bay SPA and North-west Irish Sea SPA are part of the larger international population which winters in both the UK and Republic of Ireland. The total population which could be present during the winter period is 756,002 birds (713,129 birds from the UK, Channel Isles and Isle of Man (Banks *et al.*, 2007) and an additional 21,438 from Ireland (Burke *et al.*, 2018)). Both Dundalk Bay SPA and North-west Irish Sea SPA represent a small proportion of this winter population, 1,594 and 2,866 birds respectively, which proportionally is 0.0021 and 0.0038 of the whole non-breeding population.

As the increase in baseline mortality was <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination.

Table 6-5: Estimated annual morality of common gull from collisions apportioned to the relevant SPAs from the in-combination Projects.

Project	Site	
	North-west Irish Sea SPA	Dundalk Bay SPA
Awel y Môr Mona Offshore Wind Project	0	0
Project Erebus	0	0
Minesto Tidal Kite (collisions with tidal kite)	0	0
Mona Offshore Wind Project	0.08	0.04
Morgan Offshore Wind Project Generation Assets	0	0
Morecambe Offshore Windfarm	0.01	0.01
Other phase 1 projects	0.60	0.33
Oriel Wind Farm Project	0	0
In-combination total (all Projects)	**0.69**	**0.38**
Baseline mortality of SPA	725	403
In-combination total as a % increase on baseline mortality	**0.10**	**0.09**

6.2.2.2 Great black-backed gull

Within the alone assessment, the North-west Irish Sea SPA was considered during the winter period only. All birds present within the North-west Irish Sea cSPA are part of the larger international population which winters in both the UK and Republic of Ireland. The total population which could be present during the winter period is 53,181 (Furness, 2015). The North-west Irish Sea SPA represent a small proportion of this winter population, with an estimated 982 birds, or a proportion of 0.0185. As it was not always clear which avoidance rates have been used to calculate the impacts, the numbers presented for the older projects are considered an overestimation and have not used the latest evidence on avoidance. When the avoidance rate was known (e.g. Walney Extension and Awel y Môr), the figure presented is has used the latest avoidance rate.

As the increase in baseline mortality was <1 %, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination.

Table 6-6: Estimated annual morality of great black-backed gull from collisions apportioned to the relevant SPAs from the in-combination Projects.

Project	SPA
	North-west Irish Sea
Awel y Môr Mona Offshore Wind Project	0.09
Project Erebus	0.02
Minesto Tidal Kite (collisions with tidal kite)	0
Mona Offshore Wind Project	0.14

Project	SPA North-west Irish Sea
Morgan Offshore Wind Project Generation Assets	0.05
Morecambe Offshore Windfarm	0.02
Walney Extension	0.04
Walney 1 + 2	0.23
Burbo Bank	0.01
Other phase 1 projects	0.06
Oriel Wind Farm Project	0.14
In-combination total (all Projects)	**0.80**
Baseline mortality of SPA	93
In-combination total as a % increase on baseline mortality	**0.86**

6.2.2.3 Herring gull

As stated within section 6.1, only sites for which the Project has a measurable impact (concluded as >0.1 increase in baseline mortality and >0.1 birds) from the project alone, would be included within an in-combination assessment. Therefore, the Ireland's Eye SPA and the Lambay Island SPA are presented within the in-combination assessment. It was predicted that up to 6.97 birds would be killed from collisions that originated from the Lambay Island SPA, with a smaller number of birds from the Ireland's Eye SPA (2.84 birds).

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for both sites is >1 % (Table 6-7) and therefore additional analysis was undertaken, in the form of a PVA. Full details are provided within annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs.

Table 6-7: Estimated annual morality of adult herring gull from collisions apportioned to the relevant SPAs from the in-combination Projects.

Project	SPA	
	Ireland's Eye	Lambay Island
Awel y Môr Mona Offshore Wind Project	No potential for the SPAs to be impacted as outside connectivity range	
Project Erebus		
Minesto Tidal Kite (collisions with tidal kite)		
Mona Offshore Wind Project		
Morgan Offshore Wind Project Generation Assets		
Morecambe Offshore Windfarm		
Phase 1 projects	2.19	4.60
Oriel Wind Farm Project (Natural England AR)	0.65	2.37
In-combination total (all Projects)	**2.84**	**6.97**
Baseline mortality of SPA	106	301
In-combination total as a % increase on baseline mortality	**2.68**	**2.32**

Following the PVA, it was concluded that the counterfactual growth rate was ≥0.995 for Lambay Island SPA, with Ireland's Eye SPA indicating a 0.994 counterfactual growth rate. A counterfactual growth rate of ≥0.995 is considered to be within natural fluctuations of the population and no significant impact is predicted from the increase in mortality of 6.97. An counterfactual growth rate of 0.994 is of low significance, with the impacted population having a 0.5 % change on the growth rate of non-impacted population. The population of herring gull at Ireland's Eye SPA undertook a 29% increase between the Seabird 2000 and Seabird Count national census (Burnell *et al*., 2023). Therefore with an increasing population a counterfactual growth rate of

0.994 is considered insignificant. In addition, the impact from the Project, included within the in-combination assessment is the Natural England AR, if the JNCC AR was presented the impact would be less, and highly likely to result in >0.995 counterfactual of growth rate.

Full calculations and methods are presented in annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs. As the counterfactual growth rate was ≥0.995, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination.

6.2.2.4 Kittiwake

As stated within section 6.1, only sites for which the Project has a measurable impact (concluded as >0.1 increase in baseline mortality and >0.1 birds) from the project alone, would be included within an in-combination assessment. Therefore, the Ireland's Eye SPA, the Lambay Island SPA, the Howth Head Coast SPA and Rathlin Island SPA are presented within the in-combination assessment for kittiwake. The SPA with the greatest number of predicted mortalities was Rathlin island SPA with up to 13.09 annual mortalities. However it was the Ireland's Eye SPA which the increased annual mortalities had the greatest increase in baseline mortality (1.87 %).

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for three of the SPAs is >1 % (Table 6-8) and therefore additional analysis was undertaken, in the form of a PVA. Full details are provided within annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs. No further analysis was undertaken for Rathlin Island SPA as the increase in baseline mortality of 0.33 the impact is not considered to have an adverse effect on the site's integrity.

Table 6-8: Estimated annual mortality of adult kittiwake from collisions and displacement apportioned to the relevant SPAs from the in-combination projects.

Project	SPA			
	Ireland's Eye	Lambay Island	Howth Head Coast	Rathlin Island
Awel y Môr Mona Offshore Wind Project	0.07	0.15	0.1	N/A
Project Erebus	<0.01	0.01	0.01	N/A
Minesto Tidal Kite (collisions with tidal kite)	No impact predicted from this technology			
Mona Offshore Wind Project	0.6	1.4	1.2	3.29
Morgan Offshore Wind Project Generation Assets	0.6	1.5	1.2	7.39
Morecambe Offshore Windfarm	No data presented within the PIER			
Other phase 1 projects	1.06	7.29	5.54	0.51
Oriel Wind Farm Project (Natural England AR)	0.15	1.35	0.50	1.90
In-combination total	**2.49**	**11.70**	**8.55**	**13.09**
Baseline adult mortality of SPA	133	1,001	518	4,002
In-combination total as a % increase on baseline mortality	**1.87**	**1.17**	**1.65**	**0.33**

Following the PVA, it was concluded that the counterfactual growth rate was ≥0.995 for all three SPAs assessed. A counterfactual growth rate of ≥0.995 is considered to be within natural fluctuations and no impact is predicted from the increase in mortality in-combination. Full calculations and methods are presented in annex 8: Offshore Ornithology Population Viability Analysis, for impacted SPAs. As the counterfactual growth rate was ≥0.995, the impact is not considered to have an adverse effect on the site's integrity for all SPAs assessed in-combination.

6.2.3 Combined disturbance and displacement and collision risk during the operational and maintenance phase on gannet

As stated within section 6.1, only sites for which the Project has a measurable impact (concluded as >0.1 increase in baseline mortality and >0.1 birds) from the project alone, would be included within an in-combination assessment. Therefore, the Alisa Craig SPA and Saltee Islands SPA are presented within the in-combination assessment for kittiwake. The SPA with the greatest number of predicted mortalities was Ailsa Craig SPA with up to 46 annual mortalities.

When considering all of the projects within the Cumulative Offshore Ornithology Study Area the increase in baseline mortality for the SPAs is <1 % (Table 6-9) and therefore no additional analysis was undertaken and the impact is not considered to have an adverse effect on the site's integrity.

Table 6-9: Estimated annual mortality of gannet (adults) from disturbance and displacement and collisions apportioned to the relevant SPAs from the in-combination Projects.

Project	SPA	
	Alisa Craig	Saltee Islands
Minesto Tidal Kite (underwater collisions with tidal kite)	N/A	N/A
Awel y Môr Mona Offshore Wind Project	7.4	N/A
Walney Extension (3 + 4) (collisions only)	25	N/A
Project Erebus	N/A	N/A
Mona Offshore Wind Project	0.7	N/A
Morgan Offshore Wind Project Generation Assets	0.5	N/A
Morecambe Offshore Windfarm	5.11	N/A
Other phase 1 projects	1.55	0.98
Oriel Wind Farm Project (Natural England AR)	5.5	0.54
In-combination total	**45.76**	**1.52**
Baseline adult mortality of SPA	5,383	765
In-combination total as a % increase on baseline mortality	**0.85**	**0.20**

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ANNEX 1: OFFSHORE ORNITHOLOGY TECHNICAL REPORT

ORIEL WIND FARM PROJECT

Natura Impact Statement

Annex 1: Offshore Ornithology Technical Report

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Glossary

Term	Meaning
Birds Directive	European Parliament and Council Directive 2009/147/EC on the conservation of wild birds, a key legislative measure for the protection of birds in the European Union.
Cumulative Impacts	Impacts that result from incremental changes caused by other reasonably foreseeable actions alongside the project in question. This includes the impact of all other developments that were not present at the time of data collection.
Cumulative Offshore Ornithology Study Area	The Cumulative Offshore Ornithology Study Area extends up to 509.4 km around the offshore wind farm area, based on gannet mean-maximum plus one standard deviation foraging distances. The mean-maximum foraging range for gannet is the greatest of all the Annex I species selected for assessment as part of this Technical Report.
Displacement	In relation to offshore wind farm development, displacement refers to a reduced number of birds occurring within or immediately adjacent to an offshore wind farm.
Disturbance	Disturbance occurs when a bird’s normal pattern of activity is interrupted by an anthropogenic activity. Individuals may choose to avoid sources of disturbance (e.g. swimming or flying away) and may not return until sometime later.
Habitat	The natural home or environment of an animal, plant, or other organism.
Louth CDP	Louth County Development Plan.
Migration	The regular seasonal movement, often north and south along a flyway, between breeding and wintering grounds.
Non-statutory stakeholder	Organisations with whom the regulatory authorities may choose to engage who are not designated in law but are likely to have an interest in a proposed development.
Offshore Ornithology Study Area	Defined as the extent of the Survey Area for the site-specific boat-based ornithology surveys which covers a total area of 319.85 km^2 and encompasses the marine habitats within the offshore wind farm area, offshore cable corridor and an additional buffer of varying extent.
On transect	On transect records refer to records of birds made perpendicular to the direction of travel on one side of the boat, out to 300 m. A scan surveys an arc of 90° from directly in front to one side of the vessel, recording all birds within a quadrat with sides 300 m to the front and side of the observer. Also, a “snapshot” was used for flying birds, whereby all birds in flight were recorded every minute within the 300 m quadrat, along with their estimated flight height and direction.
Ornithology	Ornithology is a branch of zoology that concerns the study of birds.
Off Transect	Records of all birds observed outside the on transect boundary as defined above for *on transect*.
Ramsar	International convention on wetlands of international importance.
Sensitivity	Vulnerability of a sensitive receptor to change.
Special Protection Area	A designation under the European Union Directive on the Conservation of Wild Birds. Under this Directive, Member States of the European Union (EU) have a duty to safeguard the habitats of migratory birds and threatened birds.

Acronyms

Term	Meaning
AA	Appropriate Assessment
AIC	Akaike Information Criterion
ACF	Autocorrelation Function
AON	Apparently Occupied Nests
AOS	Apparently Occupied Sites
BoCCI	Birds of Conservation Concern in Ireland
BTO	British Trust for Ornithology
CDS/MCDS	Conventional distance sampling/ Multiple covariate distance sampling
CDP	County Development Plan
CReSS	Complex Region Spatial Smoother
CV	Cross Validation
DAERA	The Department of Agriculture, Environment and Rural Affairs
DAS	Digital aerial surveys
DCCAE	Department of Communications, Climate Action and Environment
DCENR	Department of Communications, Energy and Natural Resources
DECC	Department of the Environment, Climate and Communications
DEFRA	Department for Environment, Food and Rural Affairs
DHLGH	Department of Housing, Local Government and Heritage
ECHA	East Canadian High Arctic
EPS	European Protected Species
ESAS	European Seabirds at Sea
EU	European Union
EUNIS	European Nature Information System
FCS	Favourable Conservation Status
GEE	Generalised Estimating Equations
GLM	General Linear Model
GPS	Global Positioning System
GSD	Ground Sample Distance
IND	Individuals
IUCN	International Union for Conservation of Nature (IUCN)
I-WeBS	Irish Wetland Bird Survey
JNCC	Joint Nature Conservation Committee
LCL	Lower Confidence Limit
LWM	Low water mark
MAGIC	Multi-Agency Geographic Information for the Countryside
MRSea	Marine Renewables Strategic Environmental Assessment R Package
MSL	Mean Sea Level
NBAP	National Biodiversity Action Plan
NGO	Non-government Organisation
NIS	Natura Impact Statement
NMPF	National Marine Planning Framework
NPWS	National Parks and Wildlife Service
NRW	Natural Resources Wales
OREDP	Offshore Renewable Energy Development Plan

Term	Meaning
PVA	Population Viability Analysis
RSPB	Royal Society for the Protection of Birds
QAIC	Quasi-Akaike Information Criterion
SAC	Special Area of Conservation
SALSA	Spatially Adaptive Local Smoothing Algorithm
SCR	Seabird Colony Register
SD	Standard Deviation
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage, now known as NatureScot
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UCL	Upper Confidence Limit
VIF	Variance Inflation Factor
VP	Vantage Point
ZoI	Zone of Impact

Units

Unit	Description
cm	Centimetre (distance)
°	Degrees
°C	Degrees Centigrade
ha	Hectare (area)
km	Kilometres (distance)
kph	Kilometres per hour (speed)
m	Metres (distance)
m/s	Metres per second (wind speed)
MW	Megawatt (power; equal to one million watts)
NM	Nautical Mile (distance; equal to 1.852 km)

1 INTRODUCTION

1.1 Context

This Offshore Ornithology Technical Report provides the baseline characterisation of offshore ornithological features for the Oriel Wind Farm Project (hereafter referred to as “the Project”). This characterisation informs the baseline against which potential impacts of the Project are assessed. The remit of this report covers offshore ornithological receptors up to the Low Water Mark (LWM). Intertidal and onshore ornithology is presented in appendix I: Onshore Biodiversity – Supporting Information.

Key desktop data sources and site-specific surveys have been drawn upon to support the development of this report. A detailed desktop study of existing data sources relating to offshore ornithology interest features was conducted to provide an overview of historic datasets, allowing for identification of species populations and distributions. A review of designated nature conservation sites aided identification of areas and species of conservation importance.

This report includes data collected from the site-specific offshore boat-based seabird surveys (undertaken between May 2018 and May 2020), digital aerial bird surveys undertaken between April and September 2020 and migratory geese vantage point (VP) surveys undertaken in November 2019, December 2019 and April 2020.

The information presented here underpins the Natura Impact Statement (NIS). It is recommended that this Technical Report is read in-conjunction with appendix H: Offshore Ornithology - Supporting Information.

1.2 Project location

The offshore wind farm area is located in the Irish Sea, off the coast of County Louth (approximately 22 km east of Dundalk town centre and 18 km east of Blackrock) (Figure 1-1). The closest wind turbine will be approximately 6 km from the closest shore on the Cooley Peninsula. The offshore cable corridor extends approximately 11 km southwest from the offshore wind farm area to the landfall south of Dunany Point. The onshore cable route extends for approximately 20.1 km to a substation location east of Ardee.

1.3 Aim and structure

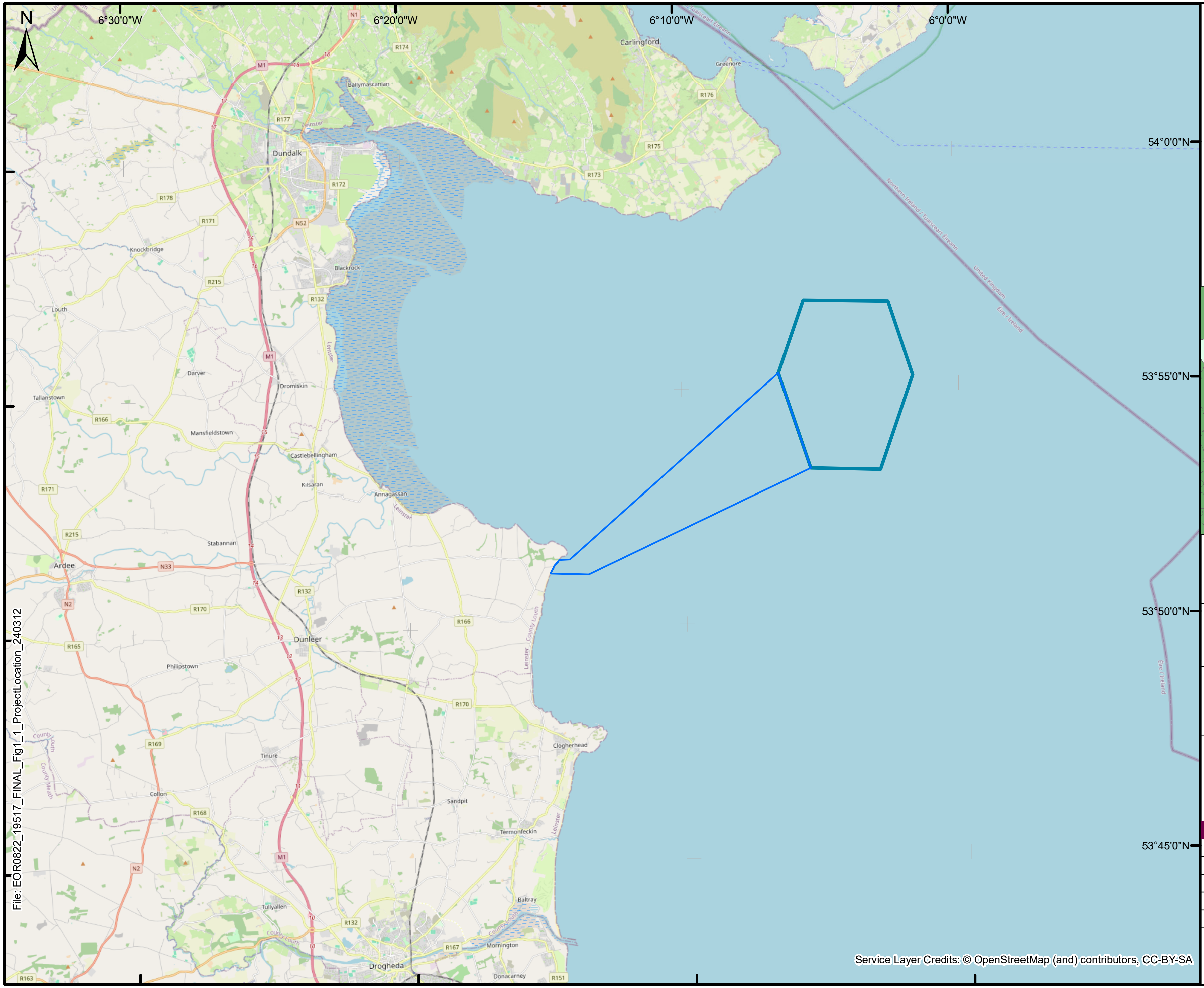
This report provides the baseline characterisation of ornithological features within the defined Offshore Ornithology Study Area (as described in section 3) with the results of both the desk-based data review and site-specific surveys. This report aims to:

- Collate all available ornithological data to date for the Project, and provide a baseline description of the ornithological features present within the offshore wind farm area and offshore cable corridor; and
- Establish the ornithological importance of the offshore wind farm area for breeding, wintering and migratory birds through analysis of site survey data and other available data sources identified through consultation (as discussed in section 5).

This report is structured as follows:

1. Introduction;
2. Relevant Legislation and Guidance;
3. Study Area;
4. Methodology: including desk-based, site survey methods and data interpretation methods;
5. Baseline environment: including regional review, identification of designated sites, description of desk-based data and recent seabird population trends, site-specific survey data and modelling, and individual species accounts; and

6. References.



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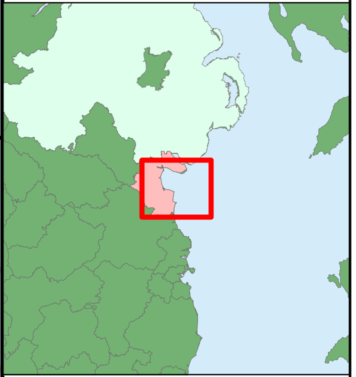
Legend

Offshore Wind Farm Area

Offshore Cable Corridor

Data Sources: Client,



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 1-1
Project Location

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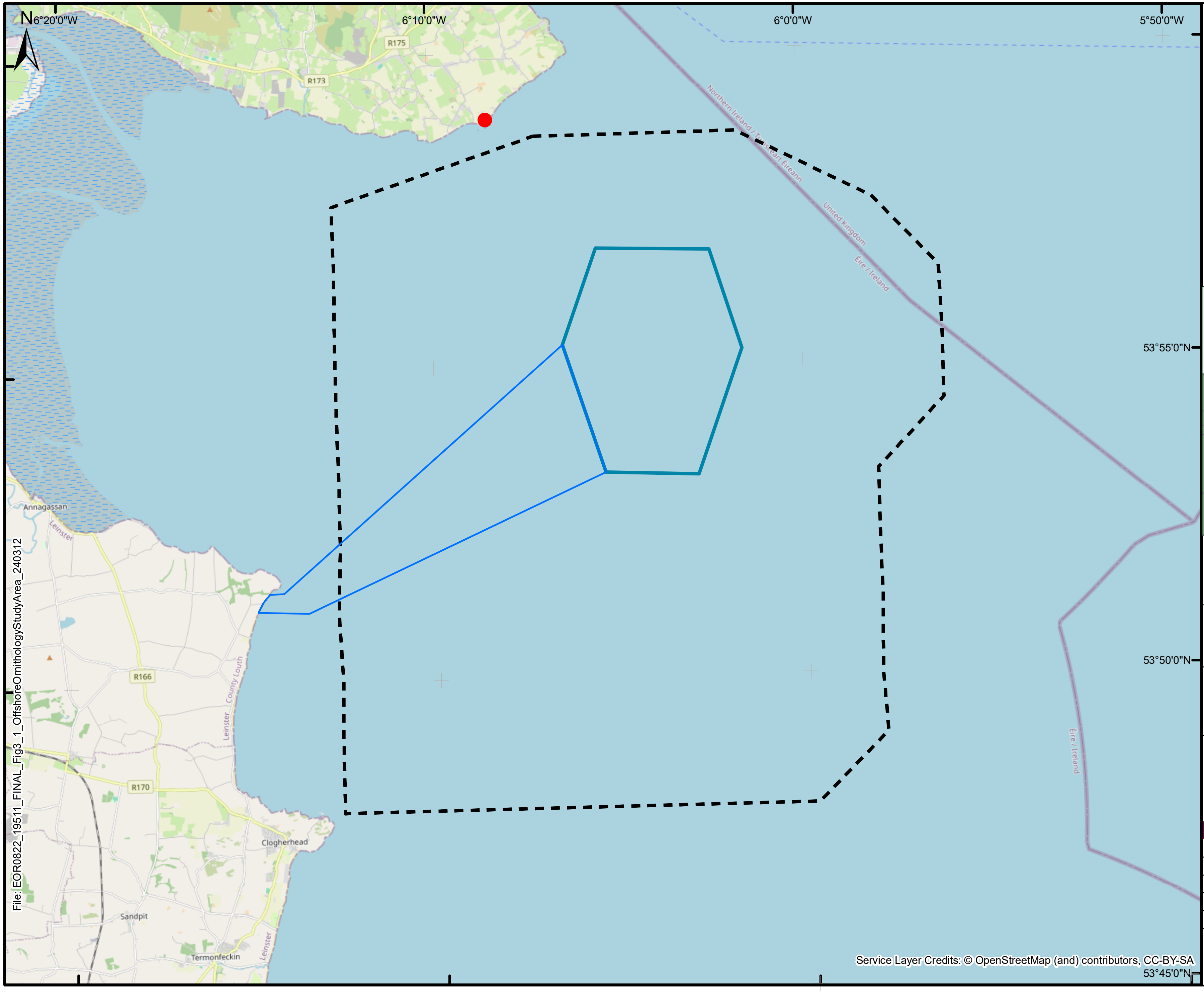
2 STUDY AREA

Two appropriate study areas have been defined for the development of this technical report, as illustrated within Figure 2-1 and Figure 2-2 and defined as follows:

- **The Offshore Ornithology Study Area:** defined as the extent of the area surveyed during the site-specific boat-based ornithology surveys (Aquafact, 2019) and digital aerial surveys (DAS) (APEM, 2020) and the extent of the offshore cable corridor up to the LWM. The boat and aerial surveys cover a total area of 319.85 km^2 and encompasses the marine habitats within the offshore wind farm area, offshore cable corridor and an additional buffer of varying extent, as illustrated Figure 3-1. The closest distance from the offshore wind farm area to the boundary of the Offshore Ornithology Study Area (i.e. the extent of the survey buffer around the offshore wind farm area) is 3.37 km, with the furthest distance approximately 12.74 km;

- **The Cumulative Offshore Ornithology Study Area:** where Annex I species under the Birds Directive were identified within the Offshore Ornithology Study Area, mean-maximum foraging ranges (based on those presented in Woodward *et al.* (2019)) of these species have been used to identify potentially connected designated sites for which they are qualifying features. The Cumulative Offshore Ornithology Study Area extends up to 509.4 km around the wind farm area and is based on the northern gannet *Morus bassanus* (hereafter referred to as gannet) mean-maximum plus one standard deviation (SD) foraging distances (Woodward *et al.*, 2019). The mean-maximum foraging range for gannet is the greatest of all the Annex I species selected for assessment as part of this Technical Report, therefore this extent encompasses the foraging ranges from SPAs of all other relevant seabird species for which the Project potentially has more than a negligible impact, as illustrated on Figure 2-2; and

- **Brent Goose Survey Area:** The migratory geese VP surveys were undertaken from a single coastal VP at Cooley Point, County Louth (see annex 3 of appendix H: Migratory Geese Survey Report).



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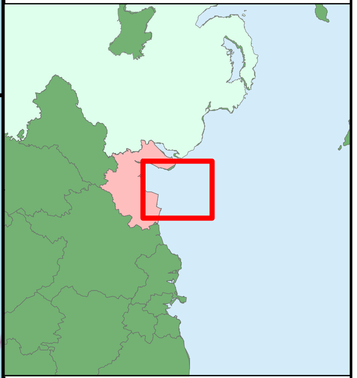
Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Offshore Ornithology Study Area / Boat-based and Aerial Survey Area
- ● Vantage Point Survey Location
- Teritorial Waters Boundary

Data Sources: Client,



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Oriel Wind Farm Project

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Figure 3-1
Offshore Ornithology Study Area

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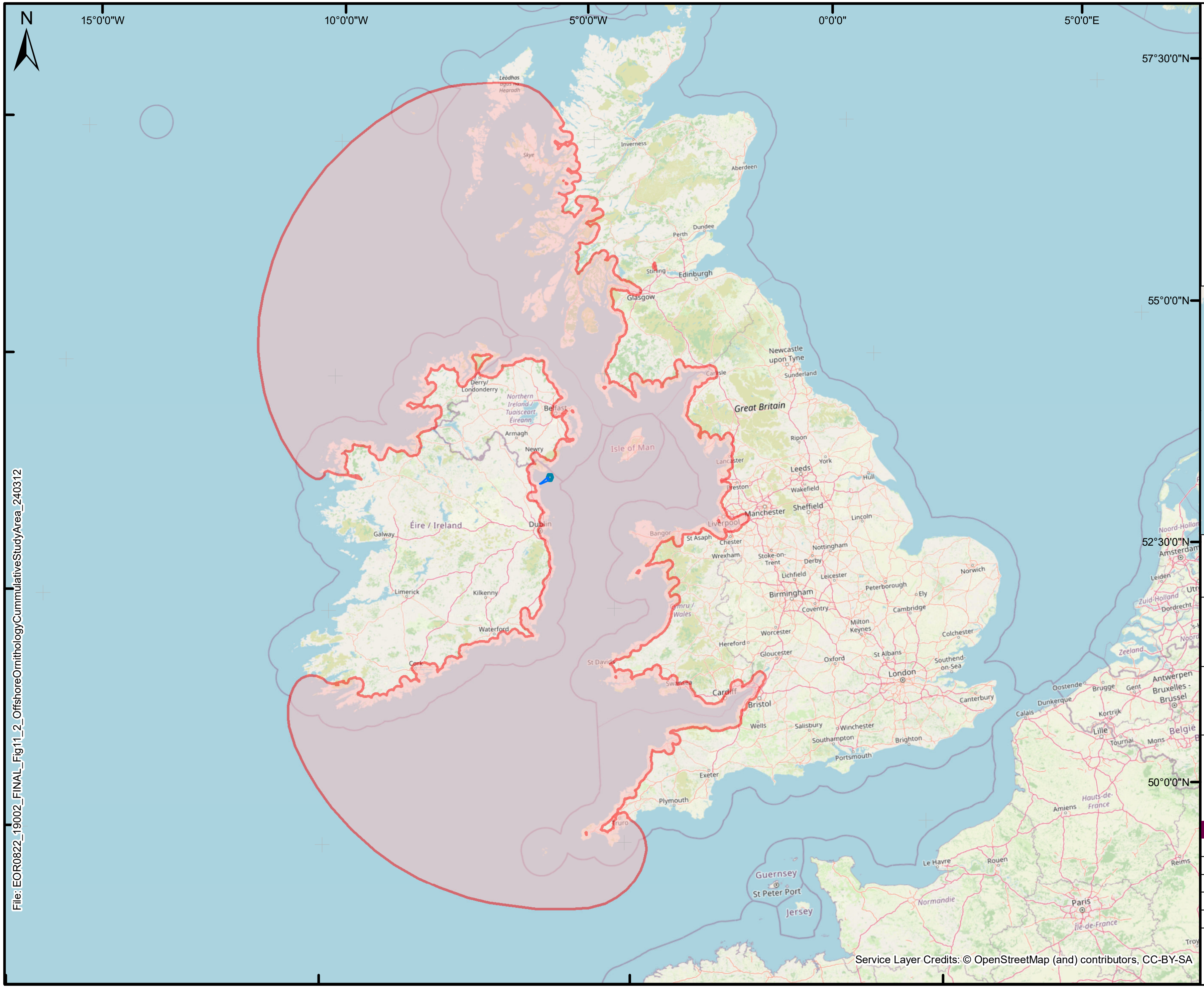

File: EOR0822_19002_FINAL_Fig11_2_OffshoreOrnithologyCummulativeStudyArea_240312

Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- 🟥 Cumulative Offshore Ornithology Study Area

Data Sources: Client,

Client

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Figure 3-2
Cumulative Offshore Ornithology Study Area

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3 METHODOLOGY

3.1 Desk-based review

Information on offshore ornithology within both the Offshore Ornithology Study Area and Cumulative Offshore Ornithology Study Area was collected through a detailed desktop review of existing studies and datasets relevant to the Project. Data was gathered from various sources, including those listed within Table 3-1, while Table 3-2 describes the specific data reports or databases utilised for the development of this report.

Table 3-1: Desk-based data sources and data provisions.

Data Source	Data Provision
Ireland's Marine Atlas	Ireland's Marine Atlas provides an overview of protected sites in Ireland's marine environment, as well as a resource to identify other marine developments for cumulative assessment.
NPWS	NPWS provide data on protected species, sites and conservation objectives in Ireland, including site boundaries and an overview of designated sites (SPAs) seabird feature populations and colonies.
The Department of Agriculture, Environment and Rural Affairs (DAERA)	DAERA provides an overview of designated sites (SPAs) in Northern Ireland and details of their seabird feature populations and colonies.
Natural England	Natural England provides an overview of designated sites (SPAs) in England and details of their seabird feature populations and colonies.
Natural Resources Wales (NRW)	NRW provides an overview of designated sites (SPAs) in Wales and details of their seabird feature populations and colonies.
NatureScot (formerly Scottish Natural Heritage)	NatureScot provides an overview of designated sites (SPAs) in Scotland and details of their seabird feature populations and colonies.
European Environment Agency	The European Environment Agency provides detail of species, habitats and protected sites across Europe through the European Nature Information System (EUNIS). This system provides detailed accounts of Natura 2000 sites, including features and population demographics of seabird features.
Seabird distribution and model outputs from ObSERVE	The ObSERVE programme was established by the Department of Communications, Climate Action and Environment (DCCAE) in partnership with the Department of Culture, Heritage and the Gaeltacht with the aim to improve the current knowledge and understanding of protected offshore species and habitats to support sustainable management of offshore activities and the development of appropriate marine conservation strategies. In 2016, an output of the programme 'The seasonal distribution and abundance of Seabirds in the western Irish Sea, 2016' was made available.
Irish Wetland Bird Survey (I-WeBS)	I-WeBS is a joint scheme of BirdWatch Ireland and NPWS which aims to monitor the numbers and distribution of waterbird populations wintering in the Republic of Ireland to enable identification of long-term spatio-temporal trends.
ESAS	ESAS data were amalgamated from a long-running programme of survey and research work on seabirds in the marine environment in the northeast Atlantic since 1979, and in the southwest Atlantic between 1998 and 2002. This data set recorded a wide range of seabirds, divers and seaducks, presented as grid cell densities of each species.
Seabird Monitoring Programme (SMP)	An ongoing annual monitoring programme of 25 species of seabird that regularly breed in Britain and Ireland. Established in 1986, the SMP was led and co-ordinated by the Joint Nature Conservation Committee (JNCC) in partnership with multiple organisations. As of July 2022, the annual monitoring scheme is organised by the British Trust for Ornithology (BTO) in partnership with JNCC, and RSPB as an associate partner. It is supported by a wider advisory group which includes Natural England, NRW, NatureScot and DAERA.

The data collated from these sources provides an overview of seabird populations at both a localised Project level and a regional level. The ESAS database was reviewed for an area comprising the offshore wind farm area and offshore cable corridor plus 5 km buffer zone to provide an overview of the seabird populations within the immediate vicinity of the Project. Likewise, the I-WeBS accounts provide a localised overview of the Dundalk Bay area. The ObSERVE programme provides an overview of seabird populations and densities at a regional level, spanning from Dundalk Bay in the north, to south of Wexford harbour in the south. Further detail of these programmes is presented within section 4.5.

Table 3-2: Summary of key desktop reports or databases considered in this report.

Title	Author	Year
ESAS	Joint Nature Conservation Committee	2012
ObSERVE programme 'The seasonal distribution and abundance of seabirds in the western Irish Sea'	Department of Communications, Climate Action and Environment, National Parks and Wildlife Service and Department of Culture, Heritage and the Gaeltacht	2018
Dundalk Bay (site 0Z401) I-WeBS Database	BirdWatch Ireland and National Parks and Wildlife Service	2022
Monthly 10 km grid square species distribution models of seabird abundance	Waggit *et al.* (2019) Distribution maps of cetacean and seabird populations in the North-East Atlantic	2019

3.2 Identification of designated sites

All designated sites within the Offshore Ornithology Study Area and Cumulative Offshore Ornithology Study Area that have qualifying features which could be affected by the construction, operation and maintenance, and decommissioning of the Project were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the Offshore Ornithology Study Area and Cumulative Offshore Ornithology Study Area were identified from various sources, including Ireland's Marine Atlas interactive map application (http://atlas.marine.ie/), National Parks and Wildlife Service (NPWS) website, the European Nature Information System (EUNIS) designated site database, and for sites in Northern Ireland, the JNCC website and the Department for Environment, Food and Rural Affairs (DEFRA) MAGIC interactive map applications (http://magic.defra.gov.uk/).
- Step 2: Information was compiled on the relevant features for each of these sites, based on known species occurrences from the desktop review; and
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
    - A designated site directly overlaps with the Project;
    - The ecology of a feature of an internationally designated site (i.e. species foraging range) directly overlaps with the Project; and
    - Sites and associated notified interest features are located within the potential Zone of Impact (ZoI) for impacts associated with the Project.

This high-level screening process aided the identification of designated sites where there is the potential for birds to be affected by the Project, specifically through overlap/impact to a species':

- Foraging ranges (Woodward *et al.*, 2019) with a 5 km inland buffer to account for coastal colonies;
- Resource dependencies;
- Breeding habitat; and
- Migratory routes.

A review of the status of any international and national protected sites designated for waders, wildfowl and seabird features that have the potential to be affected by the Project (NPWS, 2008) was also conducted.

This included a review of the favourable conservation status (FCS) of the designated bird feature(s) for each site.

3.3 Site-specific surveys

An initial programme of baseline boat-based site-specific seabird surveys was carried out between 2006 and 2008. In order to update this data and provide suitable data to inform this report, an updated programme of boat-based seabird surveys was commissioned to take place between May 2018 and May 2020. In response to the Covid-19 pandemic and associated difficulties in continuation of the boat-based surveys in 2020, a program of six monthly aerial digital surveys of the Offshore Ornithology Study Area were also undertaken between April 2020 and September 2020 by APEM Ltd., with the aim of complementing the pre-existing boat-based surveys and providing an additional breeding season of seabird distribution and abundance data.

Vantage point surveys targeting migratory geese and swans were undertaken in the autumn period between November and December 2019 with spring migration surveys undertaken in April 2020. The main objective of these surveys was to record movements of primary target species (brent geese and other large wildfowl) between the VP location at Cooley Point and out across Dundalk Bay to the Offshore Ornithology Study Area, between 5-10 km offshore.

The field survey methods for each survey campaign are presented below.

3.3.1 Field survey methods (2018 to 2020)

Boat-based surveys

This section presents the methodology followed for the 2018 to 2020 boat-based survey programme. The survey schedule is provided in Table 3-3. The surveys are also shown in relation to the eight periods in the annual cycle in Table 3-4. The survey date(s), start and end times and weather conditions are provided for each of the boat-based surveys in Table 3-5.

Table 3-3: Breakdown of the monthly coverage of the boat-based surveys between May 2018 and May 2020.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018					✓	✓	✓	✓	✓	✓	✓*	✓
2019	✓	✓	✓	✓	×	✓	✓	✓	×	✓*	×	✓
2020	✓	×	×	×	✓*							

* Partial coverage – not all transects completed,

✓ Survey complete

× Survey not completed

Table 3-4: Breakdown of the periods of the annual cycle covered during the boat-based surveys.

Period of annual cycle	Period Months	2018	2019	2020	No. of Surveys	No. of Years
Mid winter	Jan-Feb		✓	✓	2	2
Late winter	Feb-Mar		✓✓		2	1
Early breeding season	Apr-mid May	✓	✓		2	2
Mid breeding season	Mid May-mid Jun	✓		✓*	2*	2*
Late breeding season	Mid Jun-Jul	✓	✓✓		3	2
Post breeding / moult	Aug-mid Sep	✓✓	✓		3	2
Autumn	Mid Sep-Oct	✓	✓*		2*	2*
Early winter	Nov-Dec	✓*✓	✓		3*	2*

* Partial coverage – not all transects completed.

Table 3-5: Summary of the boat-based surveys undertaken between May 2018 and May 2020.

Date	Transect Numbers	Start Time	End Time	Sea State at 5 km	Wind (Beaufort) / Direction	Cloud (Oktas)	Sea Swell	Precipitation	Visibility
04/05/2018	1 to 11	07:18	17:21	3 to 4	4 / SW	3 to 8	Low	Nil	Good
08/06/2018	2, 4, 6, 8, 10, 11	07:21	13:43	3 to 4	2 to 3 / NE	3 to 6	Low	Nil	Good
09/06/2018	1, 3, 5, 7, 9	07:10	12:14	1	1 / E	1 to 4	Low	Nil	Good
06/07/2018	1, 3, 5, 7, 9, 11	09:54	15:30	2 to 3	3 / SE	1 to 8	Low	Nil	Good
07/07/2018	2, 4, 6, 8, 10	07:02	11:47	0 to 2	1 to 2 / SE	1 to 6	Slight / low	Nil	Good
30/08/2018	1, 3, 5, 7, 9, 11	10:14	16:01	1 to 2	1 / NW	5 to 8	Low	Nil	Good
31/08/2018	2, 4, 6, 8, 10	07:24	12:11	3 to 5	4 to 5 / SE	1 to 7	Low	Nil	Good
01/09/2018	2, 3, 6 to 11	10:47	18:20	1 to 2	2 / SW	2 to 7	Low / moderate	Nil	Moderate / Good
02/09/2018	1, 4, 5	08:58	11:32	3	3 / S	8	Low	Nil	Moderate / Good
20/10/2018	1, 3, 5, 7, 9, 10, 11	10:19	16:11	3 to 4	3 to 4 / SW	7 to 8	Low	Nil	Good
21/10/2018	2, 4, 6, 8	08:39	12:14	3 to 5	3 to 5 / SW	8	Low	Light / moderate	Moderate / Good
26/11/2018	2, 4, 6, 7, 8, 9	08:06	13:41	4	4 / E to SE	6 to 8	Low / moderate	Nil / light	Good
04/12/2018	4 to 11	08:39	14:31	3	3 / SW	8	Moderate	Nil	Good
05/12/2018	1 to 3	11:50	15:00	2 to 4	3 to 4 / SW	4 to 8	Low	Nil	Good
10/01/2019	5 to 11	09:33	15:05	2 to 3	3 / W	6 to 8	Low	Nil	Good
11/01/2019	1 to 4	08:25	11:32	3	2 to 3 / NW	8	Low	Nil	Good
26/02/2019	2, 4, 6, 8, 10	09:10	14:22	2 to 3	2 to 3 / SE	1	Low	Nil	Good
27/02/2019	1, 3, 5, 7, 9, 11	08:58	13:24	2 to 3	2 to 3 / SW	1 to 8 to	Low	Nil	Moderate / Good
27/03/2019	6 to 11	11:31	16:30	2 to 3	2 to 3 / W	7 to 8 to	Low	Nil	Very good
28/03/2019	1 to 5	08:47	12:53	2 to 4	3 / SW to SE to S	1 to 2 to	Low	Nil	Good
20/04/2019	6 to 11	11:57	17:05	1 to 2	2 / SE	1 to 4 to	Low	Nil	Low / moderate
21/04/2019	1 to 5	09:31	14:11	1 to 3	2 to 3 / W	2 to 7 to	Low	Nil	Good
19/06/2019	4 to 11	08:30	16:20	2	2 to 3 / SW to W to NW	N/A	Low	Nil	Good
20/06/2019	1 to 3	09:49	12:15	3 to 4	3 / W	N/A	Low	Nil	Good
17/07/2019	7 to 11	09:00	13:44	4	4 / SW	N/A	Moderate	Moderate / heavy	Moderate
18/07/2019	1 to 6	09:25	14:20	4	4 to 6 / SW	N/A	Low	Nil	Good
01/08/2019	4 to 11	10:55	18:20	2	1	N/A	Low	Nil	Good
02/08/2019	1 to 3	08:00	10:30	2 to 3	01 to Feb	N/A	Low	Nil	Good
02/10/2019	6 to 11	10:00	15:35	2 to 3	2 to 3 / W	N/A	Low	Nil	Good

Date	Transect Numbers	Start Time	End Time	Sea State at 5 km	Wind (Beaufort) / Direction	Cloud (Oktas)	Sea Swell	Precipitation	Visibility
01/12/2019	7 to 11	10:20	15:00	2	2 / N to NW	N/A	Low	Nil	Good
02/12/2019	1 to 6	08:50	14:30	2	2 to 3 / W	N/A	Low	Nil	Good
21/01/2020	5 to 11	09:38	15:35	1 to 3	N/A	N/A	N/A	N/A	N/A
22/01/2020	1 to 4	09:00	12:06	1	N/A	N/A	N/A	N/A	N/A
20/05/2020	3 to 10	07:56	13:55	N/A	N/A	N/A	N/A	N/A	N/A

Baseline boat-based surveys were carried out within the Offshore Ornithology Study Area comprising the marine habitats within the offshore wind farm area, offshore cable corridor and an additional buffer of varying extent. Transects were spaced at 2 km intervals in compliance with best practice guidelines for surveying (Camphuysen *et al.*, 2004)[1], and were numbered from one in the south to 11 in the north (Figure 3-1).

Weather and sea conditions were recorded for all survey visits. The November 2018, October 2019 and May 2020 surveys were only partially completed due to weather or other logistical constraints, with a single survey visit undertaken in each of those months. In November 2018, alternate transects were covered to achieve representative sampling coverage across the Survey Area. In October 2019, coverage was only achieved of transects 6-11 in the northern half of the Survey Area and in May 2020 transects 3-10 were covered. Surveys were not completed in May 2019, September 2019, November 2019, February 2020 and March 2020 due to adverse weather constraints during planned survey windows.

ESAS census techniques (described within Camphuysen *et al.*, 2004; Johansen *et al.*, 2014) were employed within the survey methods. Surveys were conducted in suitable weather conditions (less than sea state 5), from a ship deck height of 5 m, travelling between 5 and 15 knots (typically 10-11 knots). Observations and notes were recorded by two trained ESAS surveyors.

Records of birds were made perpendicular to the direction of travel on one side of the boat, out to 300 m. A scan surveys an arc of 90° from directly in front to one side of the vessel, recording all birds within a quadrat with sides 300 m to the front and side of the observer. Also, a “snapshot” was used for flying birds, whereby all birds in flight were recorded every minute within the 300 m quadrat, along with their estimated flight height and direction.

Each bird record was allocated to five distance bands:

- A: 0-50 m;
- B: 50-100 m;
- C: 100-200 m;
- D: 200-300 m; and
- E: 300 m+.

Where feasible, the following details were recorded for all bird sightings:

- Species;
- Sex, age and plumage characteristics (species dependent);

---

[1] Line-transects spaced across the Survey Area, a minimum of 0.5 nm (0.9 km) apart up to a maximum spacing of 2 nm (3.7 km).

- Behaviour; and
- Flight height with direction (for flying birds).

Monthly data for each species recorded ‘on transect’ (i.e. within 300 m of one side of the transect) are presented in section 4.5.1. Additional observations of birds recorded during surveys, but not allocated to the transect, are also discussed within section 4.5.1 as ‘All Records’ which includes all birds observed (whether present on the transect or recorded incidentally). Further, records were made of total observations of both individuals and the number of sightings.

Digital aerial surveys

This section summarises the information collected following the completion of the six DAS of the Offshore Ornithology Study Area between April 2020 and September 2020. Full details of the survey methods are provided in annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results. The date(s), start and end times and weather conditions are provided for each of the DAS in Table 3-6.

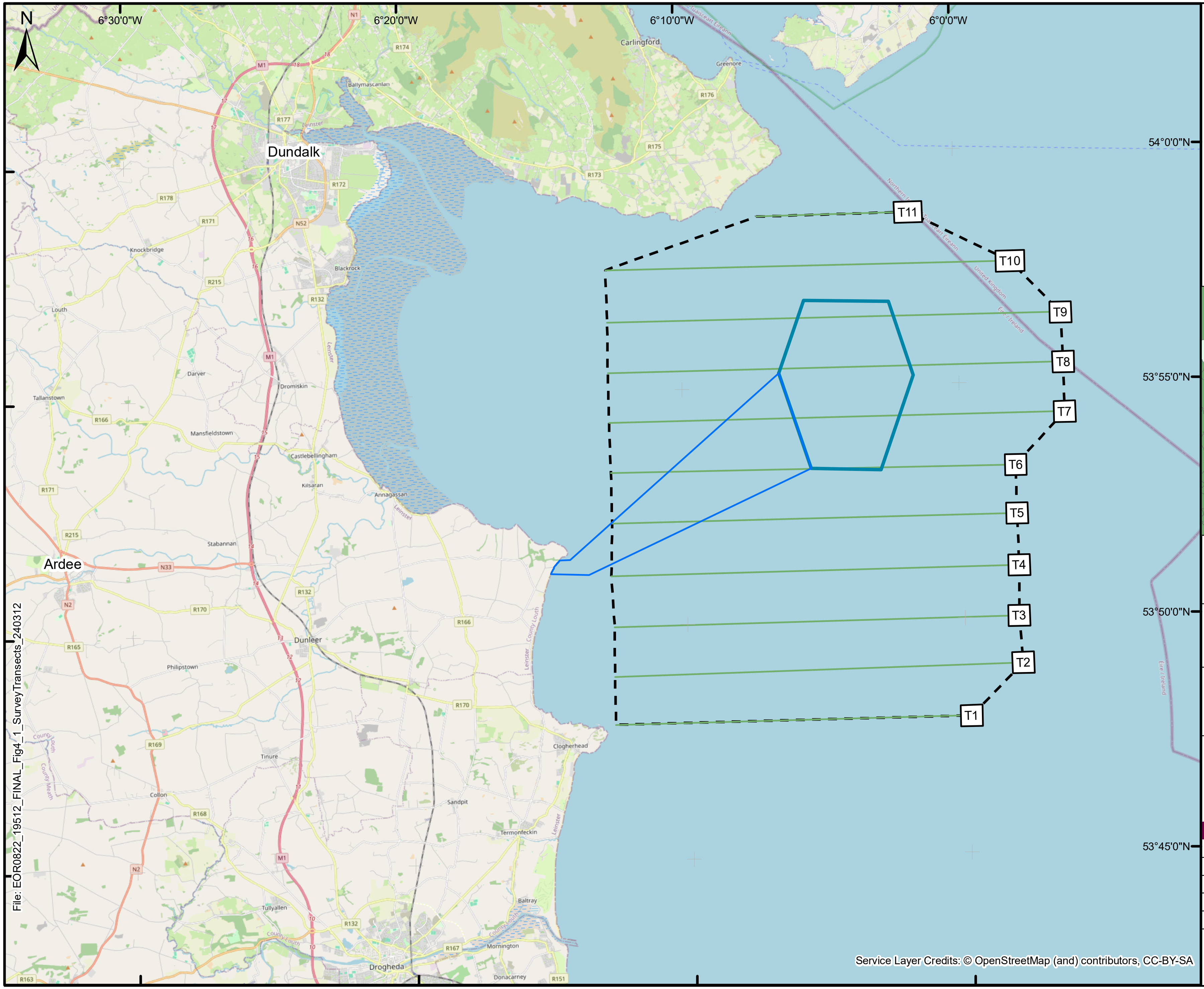
Table 3-6: Survey dates and weather conditions recorded for completed surveys: April 2019 to September 2020.

Survey Number	Date	Start Time	End Time	Sea State at 5 km	Wind (Beaufort) / Direction	Cloud (Oktas)	Visibility	Air Temp (°C)
1	24/04/20	08:00	10:09	1	3 to 4 / W	4	Very good	18
2	02/06/20	12:04	13:58	1	3 / NE	4	Very good	19
3	21/06/20	16:21	17:48	3	4 to 5 / W	2 to 4	Very good	15
4	18/07/20	16:07	17:31	2	3 / NW	4 to 8	Very good	15
5	08/08/20	13:41	14:55	1	3 / NE	0 to 7	Very good	16 to 18
6	03/09/20	07:45	09:19	3	5 / W	4 to 8	Very good	16 to 17

The DAS method was designed to complement the pre-existing boat-based surveys which had already been undertaken, with the same aims and objectives.

The bespoke camera system was fitted into a twin-engine aircraft, data collected were 1.5 cm ground sample distance (GSD) digital still images, using a GPS-linked bespoke flight management system to ensure the tracks were flown with a high degree of accuracy; at least 25% coverage of the sea surface was collected to be analysed. The camera system captured abutting still imagery along the same transect routes used for the boat-based surveys. The aircraft collected the data at an altitude of approximately 395 m, and a speed of approximately 120 knots. The aircraft’s internal Global Positioning System (GPS) and inertial measurement unit (IMU) systems record to an accuracy of +/- 3 to 5 m as standard.

The weather conditions during all surveys were conducive to collecting and analysing imagery for the purpose of providing data on the identification, distribution and abundance of bird species within the Study Area.



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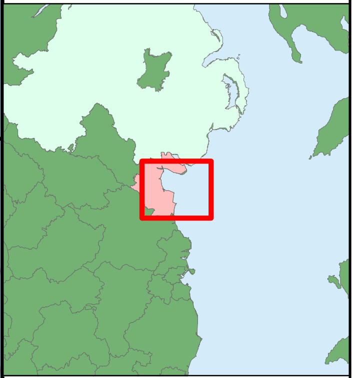
File: EOR0822_19512_FINAL_Fig4_1_SurveyTransects_240312

Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Survey Transects
- Offshore Ornithology Study Area / Boat-based and Aerial Survey Area

Data Sources: Client,



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 4-1 Boat-based and Aerial Survey Transects

A TETRA TECH COMPANY

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Issue Details

Drawn By: NG	**Project No.** EOR0822 (MDR1520B)
Checked By: NG	**File Ref:** EOR0822_ORN_T_19512_FINAL
Approved By: AOS	
Scale: 1:200,000 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 12/03/2024	

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Migratory geese vantage point surveys

This section presents the VP methodology followed for the autumn migration (November 2019 and December 2019) and spring migration (April 2020) survey programme. The survey date(s), start and end times and weather conditions are provided for each of the VP surveys in Table 3-7.

Table 3-7: Survey dates and weather conditions recorded for completed surveys: November / December 2019 and April 2020.

Date	Start Time	End Time	Sea State at 5 km	Wind (Beaufort) / Direction	Cloud (Oktas)	Temp (°C)	Precipitation	Sunset / Sunrise	Visibility
12/11/19	08:00	15:00	3-4	3-4 / W-NW	6	3	None	07:47	Good
25/11/19	09:00	15:30	2-3	2-3 / SE	8	9	Drizzle at times	08:05	Good
26/11/19	08:15	14:45	3	3-4 / SE	8	9	Light showers	08:05	Good
30/11/19	07:50	14:20	3-4	3-4 / ESE	6	6	None	08:20	Good
02/12/19	09:00	15:30	1-2	1-2 / W	4	1	None	08:23	Good
12/12/19	08:40	15:40	2	2 / SW	8	7	None	08:36 / 16:04	Good
20/12/19	10:05	16:35	2-3	2-3 / WSW-W	7	5	Light drizzle at start	08:43 / 16:05	Good
10/04/20	17:30	20:30	2	2 / SW	0	N/A	None	06:33 / 20:20	Good
11/04/20	06:20	09:30	2	2 / SW	8	N/A	None	06:33 / 20:20	Good
11/04/20	17:30	20:30	2	0	8	N/A	None	06:33 / 20:20	Good
12/04/20	11:00	14:00	2	3 / NE	8	N/A	None	06:33 / 20:20	Good
12/04/20	18:30	21:30	2	3 / NE	8	N/A	None	06:33 / 20:20	Good
13/04/20	18:00	21:30	3	3 / NE	8	N/A	None	06:20 / 20:40	Good
14/04/20	18:00	21:00	3	2-3 / NE	0	N/A	None	06:20 / 20:40	Good
15/04/20	16:00	19:00	1	0	0	N/A	None	06:20 / 20:40	Good
16/04/20	06:00	09:00	1	0	0	N/A	None	06:21 / 21:00	Good
16/04/20	18:00	21:00	1	2 / NE	0	N/A	None	06:21 / 21:00	Good
20/04/20	18:00	21:00	1	2 / E	0	N/A	None	06:19 / 20:40	Good
23/04/20	18:30	21:30	2	1 / NE	8	N/A	None	06:19 / 20:40	Good
24/04/20	14:00	17:00	2	1 / NE	1	N/A	None	06:18 / 20:42	Good

Since there is no guidance on VP survey protocols for the Republic of Ireland, guidance developed by Scottish Natural Heritage (SNH) for onshore wind farm ornithology surveys was followed (SNH, 2017).

Surveys to record movements of migratory waterfowl during the 2019/20 autumn and spring migration periods were conducted from a single coastal VP at Cooley Point, County Louth.

The protocol followed during coastal migration surveys was a systematic 180° scan (including overhead) for birds in flight. The primary target species were geese and swans, with secondary target species being ducks, divers, waders, raptors and passerines. Surveys were not undertaken in weather conditions which were likely to preclude migration. Data collected for each observation included:

- Time of observation;
- Species;
- Flock size;
- Flight height bands (1 = 0-20 m, 2 = 20-250 m, 3 = 250-300 m, 4 = > 300 m);

- Flight direction;
- Distance from observer (to the nearest 100 m); and
- Flight lines drawn onto maps, which were later digitised in GIS.

During the autumn migration period, seven surveys totalling 42 hours of observation were undertaken between November and December 2019. Spring migration surveys totalling 40 hours of observation were undertaken in April 2020. Timing of surveys are based on data provided in Fox *et al.* (2017); but these timings are also considered suitable for recording migrating brent geese which were the primary target species.

Full details of the survey methods are provided in annex 3 of appendix H: Migratory Geese Survey Report.

3.3.2 Field survey methods (2006 to 2008)

The 2006 to 2008 survey programme followed a similar field methodology to those described above for the 2018 to 2020 surveys.

A programme of baseline boat-based site-specific seabird surveys was carried out between 2006 and 2008 (Table 3-8). The methods employed for these surveys followed the JNCC Seabirds at Sea survey methods, as described in Walsh *et al.* (1995).

The methodology recorded all birds in a 90º scan from ahead out to 300 m on one side of the boat. Within the transect, most or all of the birds were identified with the naked eye, with binoculars of 7x or 8x magnification also used. Within the JNCC methods, it is noted that the inclusion of all flying birds may lead to significant overestimates. Therefore, scans for flying birds were made every minute (using a timer) and only those seen during the scan and within the 300 m transect were recorded as ‘in transect’.

A robust baseline was gathered in 2006-2008 with two years of survey data. Due to the age of the data, it has not been included in the development of species accounts within this report. However, the 2006-2008 data may be referred to within the appendix H: Offshore Ornithology – Supporting Information for context, particularly in months which have low or no data in recent surveys.

Table 3-8: Boat-based surveys for the Project 2006-2008.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	×	×	×	✓	×	✓	✓	×	×	×	×	×
2007	✓	×	✓	✓	×	✓	×	✓	✓	✓	✓	✓
2008	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×

✓ Survey complete

× Survey not completed

3.4 Data interpretation methods

3.4.1 Distance analysis

Surveying animals by eye carries the potential for decreases in detectability with distance, resulting in negatively biased population estimates (e.g. Skov *et al.* 1995, Ronconi and Burger 2009). This is especially likely for relatively small species on the water, such as auks. Detection is also likely to change according to sea state amongst other factors. Distance analysis can be used to analyse variations in the detectability of birds and correct density estimates accordingly. Buckland *et al.* (2001) define the central concept of distance analysis as the modelling of the detection function, g(x), which is the probability of detecting an object (a bird or group of birds), given that it is at distance x from a transect line or point (see Buckland *et al.* 2001, 2004).

Distance correction analysis makes several important assumptions about the nature of the data: 1) the distribution of birds is random with respect to the transect line, 2) birds are non-aggregated and are evenly distributed across all distance bands and 3) all birds on the transect line at distance 0 (band A in this case) are detected (Thomas *et al.* 2010). As Distance Analysis was only applied to birds on the water, there was limited scope for birds to be attracted to, or be associated, with the vessel. It was also assumed that birds were identified and located in distance bands prior to any response (flushing, swimming or diving) to the vessel, which might violate the assumptions of Distance correction (Buckland *et al.* 2001).

Where sufficient species observations were available models were fitted using various key functions (uniform, half-normal, hazard-rate or gamma), with or without adjustment terms (e.g. cosine, simple polynomial or hermite polynomial). Sea state and cluster / flock size were also investigated as model covariates in determining detection probability. Goodness of fit of potential detection functions can be assessed using chi-square tests, however as the degrees of freedom of the chi-square test is defined as the number of bins minus the number of parameters in the detection function minus 1 (e.g. df =bins-parameters-1). With only four bins, we are can therefore only consider detection functions containing two or less parameters if we are to assess fit in this manner. As we also have a relatively large sample size for some of the species of interest this means that, the chi-square test tends to indicate significant discrepancies between candidate detection functions and the data in any case. As such, visual assessment in combination with Akaike Information Criterion (AIC) values has been used to identify the 'best' model to assess the goodness of fit in the following sections.

Distance analysis was undertaken with all data pooled to maximise the data informing the detection functions and produce a single detection function for each species, where sufficient observations were available to allow this approach.

3.4.2 Spatial abundance mapping – boat-based surveys

The methods described in this section were used to meet the following analyses objectives for those species where sufficient observations were available:

- Spatial abundance maps of each species on the sea within the season and / or month (where appropriate);
- Spatial abundance confidence interval maps for each map produced above; and
- Densities (and associated error) estimated from spatial abundance maps.

Where possible, the bird survey data was analysed using the CReSS approach in a GEE framework with a Spatially Adaptive Local Smoothing Algorithm (SALSA) for model selection (Mackenzie *et al.* 2013). Environmental data was used to predict the density and distribution of species across a defined grid covering the Survey Area. The following environmental covariates were used to predict the species' distributions:

- Bathymetry;
- X and Y coordinates; and
- Distance to coast.

The CReSS modelling technique was developed to deal with spatial smoothing in geographically complex regions (i.e. coastal waters) it has been further developed as part of the MRSea (Scott-Hayward, 2017) R package specifically to deal with data collected for offshore wind farm projects. The modelling technique allowed both spatially auto-correlated and zero-inflated data to be modelled in a robust method. The confidence intervals generated using CReSS incorporate both the uncertainty in the detection function fitting (where applicable) and in the spatial model fitting process (Mackenzie *et al.,* 2013). Using a CReSS modelling method also enabled any spatial autocorrelation within the dataset to be incorporated providing more robust confidence intervals. Autocorrelation Function (ACF) plots allowed detection of spatial autocorrelation, and an appropriate blocking structure was specified within the model to account for any autocorrelation detected this method was appropriate for analysing zero-inflated count data through specification of an appropriate family (quasipoisson) within the modelling process. The MRSea package in R allowed the data to be modelled using regression splines and CReSS smoothing with a SALSA for model selection.

Mapping was undertaken for all boat-based data collected during the survey period; the data were collected along transect lines over the entire survey area, but in some months, some transects were not surveyed resulting in partial spatial coverage (i.e. May 2020 and November 2019). The presence of these missing data means that standard methods for analysing surveys through transforming point data to a smoothed surface (e.g. kernel density estimation) could not be used. As such, we used a SALSA (Walker *et al.,* 2010) within the R package MRSea (Scott-Hayward, 2017). This approach allows for the presence of missing data by exploiting empirical relationships between abundance and other variables (depth and distance to coast) and exploiting commonalities between distributions in different months.

Due to small numbers of observations over several months information was pooled into broad seasons including breeding, non-breeding and pre-breeding seasons and models fitted to each of these for each species of interest with sufficient observations for model convergence (~80). Since there are known differences between spatial distributions across species between breeding, non-breeding and pre-breeding seasons, we only pooled information across months within each of these seasons, and not between seasons. Months were classified by their relationship with the species' breeding behaviours defined as pre-breeding, breeding or non-breeding for each species. Three separate models based on season were fit to each species to allow for differences in the relationships of distance to coast and/or depth, and different levels of smoothness depending on the time of year.

Due to the structure of the data, the gaps in spatial and temporal coverage it has not been possible to fit a density surface that allows the estimate to vary by survey visit (i.e. month and year). Instead we have fitted surfaces that interact with month (data pooled across years where available) allowing estimates to vary spatially across the site by month. We have also fitted year as a fixed term in the model allowing the model surface to rise or fall overall based on the average effect of year on estimates. This has allowed us to produce estimates by month and year but means that in general estimates between years for months in similar seasons can be very similar and, in some cases, the same especially where between year variation (across all months) is not significant.

Crucially, these assumptions do not imply that the distribution of birds across the Study Area needs to be the same. The degree of smoothing for each species and season was determined within the MRSea software using tenfold cross validation in the majority of cases. However, in one instance the cross validation (CV) approach led to unreliable estimates of the upper 95% confidence limit due to external edge effects. In this case the results are presented using Quasi AIC (QAIC) for model fitting. Within each of the models, separate maps with associated 95% lower and upper confidence intervals (LCL and UCL, respectively) were produced for each species and month, where possible.

Availability bias

In wildlife surveys, a proportion of seabirds that spend any time underwater, especially while feeding, will not be detectable at the surface. This may lead to an under-estimate of their abundance during surveys, known as availability bias. For species that make long dives underwater, this bias might be significant (e.g. auks).

There are two main approaches to account for availability bias either by using double platform surveys (for example Borchers *et al.*, 2002) which is logistically difficult to achieve and relatively expensive or by using known data on time spent underwater to apply correction factors to abundance estimates (for example Barlow *et al.*, 1988).

All available data for seabirds relate to diving behaviour obtained by direct observation, or in the case of common guillemot *Uria aalge* (hereafter, referred to as guillemot) and razorbill *Alca torda*, to data obtained during the breeding season using data loggers. Thaxter *et al.* (2010) gives average times for these species engaged in flying, feeding and spent underwater during the chick-rearing period. The correction for availability applied here used the mean time spent underwater (1.9 and 0.8 hours for guillemot and razorbill respectively) as a percentage of the mean time spent at sea not flying (8.0 and 4.6 hours respectively). Thus the percentage time spent underwater for guillemot is 23.75% and for razorbill of 17.4%. To account for this bias scaling factors of 1.2375 and 1.174 have been applied to guillemot and razorbill estimates respectively.

3.4.3 Species abundance estimates – DAS

For each monthly aerial digital survey of the Offshore Ornithology Study Area, geo-referenced locations of seabirds, contained within each individual digital still image, were used to generate raw counts. Seabird locations contained within the boundaries of the two areas: the Offshore Ornithology Study area (which contains the offshore wind farm area), and the offshore wind farm area alone were then extracted using QGIS, providing raw count data. APEM preformed all elements of the DAS analysis.

The raw counts were then divided by the number of images collected to give the mean number of animals per image (i). Population estimates (N) for each survey month were then generated by multiplying the mean number of animals per image by the total number of images required to cover the entire study area (A):

$$N = i\ A$$

Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. The statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values were taken as the variability of the statistic over the population (Efron & Tibshirani, 1993). This results in species-specific monthly abundance estimates being calculated from the raw count data, with upper and lower confidence limits.

4 BASELINE ENVIRONMENT

4.1 Regional review: seabirds in the Irish sea

Ireland has one of the largest marine areas in Europe, around ten times its land area, and a wealth of marine biodiversity as a result (Burke, 2018). Ireland's marine areas offer productive intertidal zones with bays and estuaries which provide vital food resources and essential habitat to many species of birds throughout the year, including non-breeding and passage migrants. To date, 52 species of seabirds have been recorded in Irish waters, 24 of which habitually forage and breed. Of the 24 habitually occulting species, ten are Annex I listed species of the Birds Directive, with nine of these species are listed as Birds of Conservation Concern in Ireland 4 (BoCCI) (Gilbert *et al.,* 2021).

Many seabird species within Ireland are present in numbers of regional, continental or global importance. Ireland supports several species of internationally important numbers, such as the largest European population of roseate tern *Sterna dougallii* at Rockabill (Dublin), or key clusters of European storm-petrel (hereafter, referred to as storm petrel) at Blasket Islands in Kerry (BirdWatch Ireland, 2020a). The Irish Sea supports both truly pelagic seabirds such as northern gannet (hereafter, referred to as gannet), northern fulmar *Fulmarus glacialis* (hereafter, referred to as fulmar) and auks, and other species which spend part of their annual life cycle at sea, such as divers, gulls (including black-legged kittiwake *Rissa tridactyla*, hereafter referred to as kittiwake) and seaducks. Additionally, non-seabird migrants are also present within the Irish Sea region such as wildfowl and waders.

Recent surveys of the Irish Sea identified 97,326 seabirds during the 2016 breeding season, 299,122 seabirds during the autumn of 2016, and 87,180 seabirds during the 2016 winter period. The most frequently sighted and most abundant species within the surveys were razorbill/guillemot, with frequent sightings of gannet, fulmar and gull species (Jessop *et al.*, 2018). The Irish Sea provides important foraging, breeding and wintering grounds for seabird species.

4.2 Designated sites

The Project intersects one European site, namely the North-west Irish Sea SPA[2] for approximately 2 km of the offshore cable corridor. The next closest European site, Carlingford Lough SPA, is located 5.7 km north of the Project.

Individuals from local SPA populations are likely to use or travel through the offshore wind farm area and offshore cable corridor. For seabird species with particularly large foraging ranges (such as gannet) there is the potential for connectivity between the Project and more distant SPAs.

As discussed in section 3, designated sites with offshore ornithology features were identified within and up to 509.4 km of the offshore wind farm area based on the mean-maximum foraging range plus one SD of gannet (Woodward *et al.*, 2019). The mean-maximum foraging range for gannet is the greatest of all the Annex I species selected for assessment as part of this Technical Report, therefore this extent encompasses the foraging ranges from SPAs of all other relevant seabird species for which the Project potentially has more than a negligible impact. These are presented in Table 4-1.

Designated sites and/or foraging ranges of qualifying species which do not overlap with the offshore wind farm area have been identified by "greying out". The closest distance between the offshore wind farm area and the SPA boundary in Table 4-1 is via marine pathway. During the breeding season, seabirds are highly unlikely to commute across land and will stay in the marine environment, therefore, to calculate the distance between the SPA and the project a marine pathway measurement is required and not a straight line distance.

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[2] Candidate and proposed sites, and European sites are collectively referred to as "SACs" and "SPAs". There is no distinction made between candidate/proposed sites and European sites as they have the same level of protection as a matter of domestic law. For the purpose of the report, they are considered one and the same.

Each of the SPA buffer areas presented within Figure 4-1 relate to the largest of the mean-maximum foraging ranges of the species associated with that SPA, for example, if there are three qualifying feature seabird species associated with a SPA, then the buffer shown is for the species with the largest foraging range (and for which there is considered to be potential for more than a negligible impact of the Project).

Although other designated sites have been identified within the larger foraging range of the fulmar, these sites beyond the extent defined by the foraging range of gannet are not considered further due to low abundances of fulmar observed within the Offshore Ornithology Study Area resulting in absence of likely significant impacts.

The designated sites within Table 4-1 include transboundary sites within the jurisdiction of Northern Ireland which fall under responsibility of the DAERA; sites within Scotland, Wales and England fall under the responsibility of NatureScot, NRW and Natural England respectively.

Table 4-1: Designated sites and relevant offshore ornithology qualifying features.

Designated Site	Agency	Relevant qualifying marine bird interest features	Mean Max foraging range + 1 SD (km)	Closest distance to offshore wind farm area (km) (marine pathway)
North-west Irish Sea cSPA	NPWS	Common scoter *Melanitta nigra*	N/A*	The cable corridor goes through the SPA.
		Red-throated diver *Gavia stellata*	N/A*	
		Great northern diver *Gavia immer*	N/A*	
		Fulmar	1,200.2	
		Manx shearwater *Puffinus puffinus*	2,364.7	
		Shag *Phalacrocorax aristotelis*	23.7	
		Cormorant *Phalacrocorax carbo*	33.9	
		Little gull *Hydrocoloeus minutus*	N/A*	
		Kittiwake	300.6	
		Black-headed gull *Chroicocephalus ridibundus*	N/A*	
		Common gull *Larus canus*	N/A*	
		Lesser black-backed gull *Larus fucus*	236	
		Herring gull *Larus argentatus*	236	
		Great black-backed gull *Larus marinus*	N/A*	
		Little tern *Sterna albifrons*	5	
		Roseate tern	23.2	
		Common tern *Sterna hirundo*	26.9	
		Arctic tern *Sterna paradisaea*	40.5	
		Puffin	265.4	

Designated Site	Agency	Relevant qualifying marine bird interest features	Mean Max foraging range + 1 SD (km)	Closest distance to offshore wind farm area (km) (marine pathway)
		Fratercula arctica		
		Razorbill	164.6	
		Guillemot	153.7	
Carlingford Lough SPA	DAERA and NPWS	Sandwich tern *Sterna sandvicensis*	57.5	5.7
		Common tern	26.9	
		Light-bellied brent goose *Branta bernicla hrota*	N/A*	
Dundalk Bay SPA	NPWS	Common gull	N/A*	8.0
		Red-breasted merganser *Mergus serrator*	N/A*	
		Common scoter	N/A*	
		Black-headed gull	N/A*	
		Herring Gull	N/A*	
		Light-bellied brent goose	N/A*	
River Nanny Estuary and Shore SPA	NPWS	Herring Gull	N/A*	24.2
Rockabill SPA	NPWS	Arctic tern	40.5	28.5
		Roseate tern	23.2	
		Common tern	26.9	
Skerries Islands SPA	NPWS	Herring gull	85.6	33.1
		Cormorant	33.9	
		Shag	23.7	
		Light-bellied brent goose	N/A*	
Lambay Island SPA	NPWS	Fulmar	1,200.2	42.7
		Guillemot	153.7	
		Herring Gull	85.6	
		Kittiwake	300.6	
		Razorbill	164.6	
		Lesser black-backed gull	236	
		Puffin	265.4	
		Shag	23.7	
		Cormorant	33.9	
Strangford Lough SPA	DAERA	Sandwich tern	57.5	49.4
		Common tern	26.9	
		Arctic tern	40.5	
		Light-bellied brent goose	N/A*	
Ireland's Eye SPA	NPWS	Herring gull	85.6	52.7
		Guillemot	153.7	
		Kittiwake	300.6	
		Razorbill	164.6	
		Cormorant	33.9	
Howth Head Coast SPA	NPWS	Kittiwake	300.6	55.2

Designated Site	Agency	Relevant qualifying marine bird interest features	Mean Max foraging range + 1 SD (km)	Closest distance to offshore wind farm area (km) (marine pathway)
Irish Sea Front SPA	JNCC	Manx shearwater	2,364.7	56.8
Copeland Islands SPA	DAERA	Manx shearwater	2,364.7	86.8
		Arctic tern	40.5	
Wicklow Head SPA	NPWS	Kittiwake	300.6	101.2
Glannau Aberdaron ac Ynys Enlli SPA	NRW	Manx shearwater	2,364.7	139.6
Rathin Island SPA	DAERA	Kittiwake	300.6	145.6
		Guillemot	153.7	
		Razorbill	164.6	
Ailsa Craig SPA	NatureScot	Gannet	509.4	158.6
		Kittiwake	300.6	
		Lesser black-backed gull	236	
		Guillemot	153.7	
		Herring gull	85.6	
Seas off Wexford cSPA	NPWS	Red-throated diver	9	149.97
		Fulmar	1,200.2	
		Manx shearwater	2,364.7	
		Gannet	509.4	
		Cormorant	33.9	
		Shag	23.7	
		Common scoter	N/A*	
		Mediterranean Gull *Larus melanocephalus*	20	
		Black-headed gull	18.5	
		Lesser black-backed gull	236	
		Herring gull	85.6	
		Kittiwake	300.6	
		Sandwich tern	57.5	
		Roseate tern	23.2	
		Common tern	26.9	
		Arctic tern	40.5	
		Little tern	5	
		Guillemot	153.7	
		Razorbill	164.6	
		Puffin	265.4	
Ribble and Alt Estuaries SPA	Natural England	Lesser black-backed gull	236	194.5
		Common tern	26.9	
Saltee Islands SPA	NPWS	Fulmar	1,200.2	209.7
		Gannet	509.4	
		Lesser black-backed gull	236	
		Kittiwake	300.6	
		Puffin	265.4	

Designated Site	Agency	Relevant qualifying marine bird interest features	Mean Max foraging range + 1 SD (km)	Closest distance to offshore wind farm area (km) (marine pathway)
		Cormorant	33.9	
		Shag	23.7	
		Herring gull	85.6	
		Guillemot	153.7	
		Razorbill	164.6	
Skomer, Skokhom and the Seas off Pembrokeshire SPA	NRW	Manx shearwater	2,364.7	238.9
		Puffin	265.4	
		Storm petrel	336**	
		Lesser black-backed gull	236	
Grassholm SPA	NRW	Gannet	509.4	240.5
North Colonsay and Western Cliffs SPA	NatureScot	Kittiwake	300.6	257.1
		Guillemot	153.7	
Horn Head to Fanad Head SPA	NPWS	Fulmar	1,200.2	269.4
		Kittiwake	300.6	
		Cormorant	33.9	
		Shag	23.7	
		Guillemot	153.7	
		Razorbill	164.6	
Helvick Head to Ballyquin SPA	NPWS	Kittiwake	300.6	275.6
		Cormorant	33.9	
		Herring gull	85.6	
Tory Island SPA	NPWS	Fulmar	1,200.2	301.8
		Puffin	265.4	
		Razorbill	164.6	
West Donegal Coast SPA	NPWS	Fulmar	1,200.2	317.8
		Kittiwake	300.6	
		Cormorant	33.9	
		Shag	23.7	
		Razorbill	164.6	
		Herring gull	85.6	
Rum SPA	NatureScot	Manx shearwater	2,364.7	354.7
		Kittiwake	300.6	
		Guillemot	153.7	
		Red-throated diver	9	
Mingulay and Berneray SPA	NatureScot	Fulmar	1,200.2	360.9
		Kittiwake	300.6	
		Guillemot	153.7	
		Shag	23.7	
		Razorbill	164.6	
		Puffin	265.4	
Beara Peninsula SPA	NPWS	Fulmar	1,200.2	466.7
Shiant Isles SPA	NatureScot	Fulmar	1,200.2	471.0
		Guillemot	153.7	

Designated Site	Agency	Relevant qualifying marine bird interest features	Mean Max foraging range + 1 SD (km)	Closest distance to offshore wind farm area (km) (marine pathway)
		Shag	23.7	
		Kittiwake	300.6	
		Puffin	265.4	
		Razorbill	164.6	
The Bull and The Cow Rocks SPA	NPWS	Gannet	509.4	482.4
		Puffin	265.4	
St Kilda SPA	NatureScot	Fulmar	1,200.2	483.2
		Gannet	509.4	
		Manx shearwater	2,364.7	
		Leach’s storm petrel *Oceanodroma leucorhoa*	657***	
		Storm petrel	336	
		Guillemot	153.7	
		Kittiwake	300.6	
		Puffin	265.4	
		Razorbill	164.6	
Duvillaun Islands SPA	NPWS	Fulmar	1,200.2	484.8
		Storm petrel	336	
Deenish Island and Scariff Island SPA	NPWS	Fulmar	1,200.2	493.2
		Manx shearwater	2,364.7	
		Storm petrel	336	
		Lesser black-backed gull	236	
		Arctic tern	40.5	
Iveragh Peninsula SPA	NPWS	Fulmar	1,200.2	493.6
		Kittiwake	300.6	
		Guillemot	153.7	
Skelligs SPA	NPWS	Fulmar	1,200.2	509.0
		Manx shearwater	2,364.7	
		Gannet	509.4	
		Storm petrel	336	
		Guillemot	153.7	
		Kittiwake	300.6	
		Puffin	265.4	
Boyne Estuary SPA	NPWS	Little tern	5	18.5
Outer Ards SPA	DAERA	Arctic tern	40.5	56.1
		Light-bellied brent goose	N/A*	
South Dublin Bay and Tolka Estuary SPA	NPWS	Arctic tern	40.5	59.0
		Common tern	26.9	
		Roseate tern	23.2	
		Light-bellied brent goose	N/A*	
Dalkey Islands SPA	NPWS	Arctic tern	40.5	67.6
		Common tern	26.9	
		Roseate tern	23.2	
	NPWS	Little tern	5	86.8

Designated Site	Agency	Relevant qualifying marine bird interest features	Mean Max foraging range + 1 SD (km)	Closest distance to offshore wind farm area (km) (marine pathway)
The Murrough SPA		Light-bellied brent goose	N/A*	
		Herring gull	N/A*	
		Red-throated diver	N/A*	
Anglesey Terns SPA	JNCC	Arctic tern	40.5	95.1
		Common tern	26.9	
		Roseate tern	23.2	
		Sandwich tern	57.5	
Larne Lough SPA	DAERA	Common tern	26.9	125.2
		Roseate tern	23.2	
		Sandwich tern	57.5	
		Light-bellied brent goose	N/A*	
Liverpool Bay SPA	JNCC	Little tern	5	127.7
		Common tern	26.9	
		Red-throated diver	N/A*	
		Common scoter	N/A*	
Puffin Island SPA	NRW	Cormorant	33.9	147.8
The Raven SPA	NPWS	Red-throated diver	N/A*	162.9
		Common scoter	N/A*	
		Cormorant	N/A*	
Morecombe Bay and Duddon Estuary SPA	Natural England	Little tern	5	170.8
		Common tern	26.9	
		Sandwich tern	57.5	
Wexford Harbour and Slobs SPA	NPWS	Cormorant	N/A*	177.7
		Light-bellied brent goose	N/A*	
		Red-breasted merganser	N/A*	
		Black-headed gull	N/A*	
		Lesser black-backed gull	N/A*	
		Little tern	5	
Sheep Island SPA	DAERA	Cormorant	33.9	182.4
The Dee Estuary SPA	Natural England	Little tern	5	184.9
		Common tern	26.9	
		Sandwich tern	57.5	
Lady’s Island Lake SPA	DAERA	Arctic tern	40.5	192.7
		Common tern	26.9	
		Roseate tern	23.2	
		Sandwich tern	57.5	
		Black-headed gull	18.5	
Mersey Narrows and North Wirral Foreshore SPA	Natural England	Common tern	26.9	194.7
Keeragh Islands SPA	NPWS	Cormorant	33.9	220.7
Lough Foyle SPA	DAERA	Light-bellied brent goose	N/A*	234.9
Inishtrahull SPA	NPWS	Shag	23.7	240.7

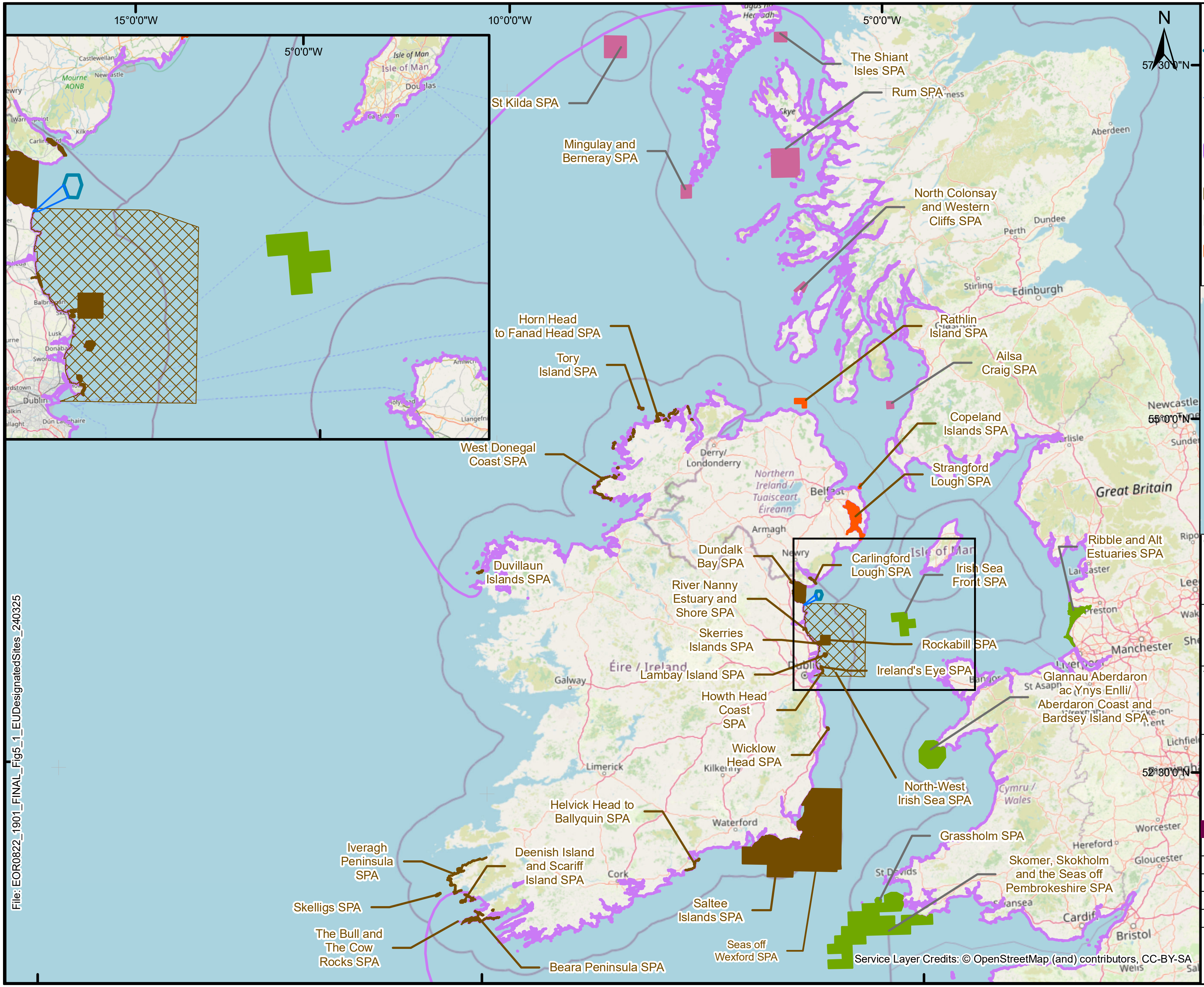
Designated Site	Agency	Relevant qualifying marine bird interest features	Mean Max foraging range + 1 SD (km)	Closest distance to offshore wind farm area (km) (marine pathway)
		Common gull	50**	
Mid-Waterford Coast SPA	NPWS	Cormorant	33.9	250.8
		Herring gull	85.6	
Lough Swilly SPA	NPWS	Black-headed gull	18.5	283.1
		Common tern	26.9	
		Sandwich tern	57.5	
		Red-breasted merganser	N/A*	
		Common gull	N/A*	
Greers Isle SPA	NPWS	Black-headed gull	18.5	295.2
		Sandwich tern	57.5	
		Common gull	50	
Ballymacoda Bay SPA	NPWS	Black-headed gull	N/A*	301.8
		Common gull	N/A*	
		Lesser black-backed gull	N/A*	
Inishbofin, Inishdooey and Inishbeg SPA	NPWS	Lesser black-backed gull	236	302.2
		Common gull	50**	
		Arctic tern	40.5	
Glas Eileanan SPA	NatureScot	Common tern	26.9	303.2
West Donegal Islands SPA	NPWS	Shag	23.7	312.2
		Common gull	50**	
		Herring gull	85.6	
Illancrone and Inishkeeragh SPA	NPWS	Common gull	50**	338.0
		Arctic tern	40.5	
		Little tern	5	
Roaninish SPA	NPWS	Herring gull	85.6	348.1
Sovereign Islands SPA	NPWS	Cormorant	33.9	348.2
Old Head of Kinsale SPA	NPWS	Kittiwake	300.6	357.7
		Guillemot	153.7	
Canna and Sanday SPA	NatureScot	Guillemot	153.7	369.6
		Herring gull	85.6	
		Kittiwake	300.6	
		Puffin	265.4	
		Shag	23.7	
Inishduff SPA	NPWS	Shag	23.7	395.1
Inishmurray SPA	NPWS	Shag	23.7	404.3
		Herring gull	85.6	
		Arctic tern	40.5	
Ardboline Island and Horse Island SPA	NPWS	Cormorant	33.9	413.5
Aughris Head SPA	NPWS	Kittiwake	300.6	420.5
		Shag	23.7	437.1

Designated Site	Agency	Relevant qualifying marine bird interest features	Mean Max foraging range + 1 SD (km)	Closest distance to offshore wind farm area (km) (marine pathway)
Isles of Scilly SPA	Natural England	Lesser black-backed gull	236	
		Storm petrel	336	
		Great black-backed gull	73	
Blacksod Bay/Broad Haven SPA	NPWS	Arctic tern	40.5	453.4
Inishglora and Inishkeeragh SPA	NPWS	Cormorant	33.9	471.0
		Shag	23.7	
		Lesser black-backed gull	236	
		Herring gull	85.6	
		Arctic tern	40.5	
Inishkea Islands SPA	NPWS	Shag	23.7	477.9
		Herring gull	85.6	
		Common gull	50**	
		Arctic tern	40.5	
		Little tern	5	

* Qualifying feature is for wintering population therefore professional judgement is required to determine likely impact.

** The foraging distance presented for storm petrel and common gull is the maximum from a single colony, therefore no mean nor SD.

*** Leach’s storm petrel is a mean value from a single colony (11 birds).



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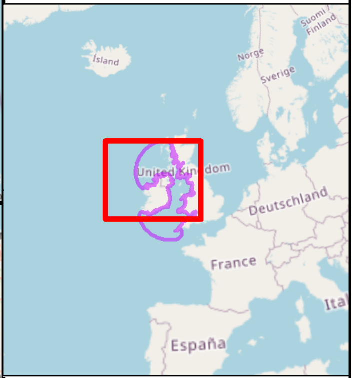
Legend

- Project Offshore Wind Farm Area
- Project Offshore Cable Corridor
- Cumulative Offshore Ornithology Study Area
- Irish SPA
- Irish cSPA
- Northern Irish SPA
- Scottish SPA
- English and Welsh SPA

Data Sources: Client, NPWS, JNCC



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title
Figure 5-1
European Sites within mean-maximum foraging ranges of their qualifying interest features located within Cumulative Offshore Ornithology Study Area

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Issue Details

Drawn By:	MJ	**Project No.**	EOR0822 (MDR1520B)
Checked By:	MJ	**File Ref:**	
Approved By:	AOS		EOR0822_ORN_T_1901_FINAL
Scale:	1:4,000,000@ A4	**Projection:**	ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date:	25/03/2024		

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4.3 Recent seabird population trends

4.3.1 Overview

The following sections provide an overview of the current pressures and data trends on seabird populations based on the long-term Seabird Monitoring Programme (SMP) coordinated by the JNCC.

4.3.2 Current pressures

Seabird species are generally long-lived, with delayed breeding and low annual reproductive outputs. Seabird and coastal bird populations are subject to natural variation in population size and distributions, largely as a result of year to year variation in recruitment success. Therefore, influencing factors to adult survival in seabird species can greatly impact population dynamics but may however be unrecognised for several years (Stienen *et al.*, 2007).

A recent study suggests that, in terms of number of species affected and the average impact, the top three threats to seabird populations globally are invasive species (165 species across all the most threatened groups), bycatch in fisheries (100 species but with the greatest average impact) and climate change (96 species affected) (Dias *et al.*, 2019). Furthermore, it was estimated that more than 170 million individual birds (over 20% of all seabirds) are exposed to the combined impacts of bycatch, invasive alien species and climate change, and over 380 million (45% of all seabirds) are exposed to at least one of these three threats (Dias *et al.*, 2019).

It is estimated that 89% of seabirds affected by climate change are also affected by other threats, such as overfishing. Recent studies have described the greatest threat to fish stocks upon which seabirds forage is the combined effect of climate change and overfishing (Brander, 2007). Consequently, climate change and removal of prey items through overfishing can impact seabird breeding success and survival and, ultimately, population stability (Frederiksen *et al.*, 2004; Ainley and Blight, 2009). Increasing loss of breeding habitat and food resources are noted as key factors for seabird declines, further amplified by overfishing and rising ocean temperatures relating to climate change (Burke, 2018).

Sandeels, which make up a significant component of many of the seabirds' diet, is less likely to be able to adapt to increasing temperatures due to their specific habitat requirements for coarse sandy sediment. Declining recruitment in sandeel in parts of the UK has been correlated with increasing sea temperature (Heath *et al.*, 2012). A study by the BTO also suggested that during the years when a greater proportion of the North Sea's sandeel was fished; the rates of seabird breeding failure increased (Cook *et al.*, 2014). More recent research suggests that a closure of sandeel fishery correlated with an increase in breeding success for kittiwake, but no correlation with razorbill or guillemot (Searle *et al*., 2023).

Seabirds are more threatened globally than any other comparable group of birds with over 25% of species threatened and five percent of species critically endangered (Croxall *et al.*, 2012; Dias *et al.*, 2019). Many of the seabirds of Ireland are listed as vulnerable or endangered at a European or global level, owing to their natural lifecycle traits and increasing pressures on marine environments (Burke, 2018).

During the summer of 2022 there were large-scale outbreaks of avian flu across multiple seabird colonies within Ireland, the UK and throughout Europe. The exact number of birds that died and of which species is not known but any previous population estimates will not have taken account of this potentially reduced population. Colonies were impacted in different ways, with some reporting 100% chick mortality with fewer adult birds impacted, whereas others had large-scale adult die offs (Adlhoch *et al.,* 2022; NatureScot, 2023b; RSPB, 2024). The populations at different colonies provide an understanding of the impact, with a large variation compared to the "baseline" (RPSB, 2024). RSPB coordinated a UK wide study at important seabird colonies to understand the impact, it concluded that, on average there was a reduction in population. Great skua declined that most (-76% decrease) followed by tern species (common tern declined by -42% and sandwich tern declined by -35%) at the monitored colonies. Other species, such as guillemot (-7% decrease) did not seem as impacted).

All of the survey data and population estimates presented within this report precede the HPAI impacts and therefore there is no specific change to the assessment presented. However where an issue to be highlighted at a specific colony, the specific pressures on that colony would be further investigated.

4.3.3 Seabird Monitoring Programme data trends

The Seabird Monitoring Programme (SMP) is an ongoing annual monitoring programme of 25 species that regularly breed in Britain and Ireland. Established in 1986, the SMP was led and co-ordinated by JNCC in partnership with multiple organisations.

From July 2022, the annual monitoring scheme is organised by the BTO in partnership with JNCC, and with the RSPB as an associate partner. It is supported by Natural England, NRW, NatureScot, DAERA, DCCAE and BirdWatch Ireland, alongside a wider advisory group. Close collaboration with organisations in the Republic of Ireland enables all-Ireland interpretation of seabird trends.

Seabird population trends are a key indicator for the marine environment, providing an insight into local fisheries, climatic changes and impact of human activity. A summary of the recent JNCC SMP results are presented within Table 4-2 for the whole of UK and Ireland. Several species have illustrated declines between 2000 and 2019, including fulmar, shag, kittiwake, great black-backed gull, common tern, little tern and Arctic tern. However, several species have presented positive population trend changes between 2000 and 2019, including cormorant, gannet, black-headed gull, Sandwich tern, guillemot, and razorbill (JNCC, 2021).

Table 4-2: Recent seabird population trends, based on the results of the JNCC Seabird Monitoring Programme.

Species	Population Trend Change (%)		
	1969-70 to 1985-88	1985-88 to 1998-2002	2000-2019
Fulmar	77	-3	-33
Manx shearwater	N/A	N/A	N/A
Gannet	39	39	34
Shag	21	-27	-40
Cormorant	9	10	16
Kittiwake	24	-25	-29
Black-headed gull	5	0	26
Common gull	25	36	N/A
Great black-backed gull	-7	-4	-23
Lesser black-backed gull	29	40	N/A
Herring gull	-48	-13	N/A
Great skua	148	26	N/A
Little tern	58	-23	-28
Common tern	9	-9	-3
Arctic tern	50	-31	-5
Sandwich tern	33	-15	5
Guillemot	77	31	60
Black guillemot	N/A	3	N/A
Razorbill	19	21	37
Puffin	15	19	N/A

4.4 Desk-based species data

4.4.1 Overview

This section provides an overview of the data collated from various sources, to provide a summary of seabird populations in the vicinity of the Project. A summary of the data sources from which this section has been developed is illustrated within Table 4-3.

Table 4-3: Summary of key desktop reports or databases considered in this section.

Title	Author	Year
ESAS	Joint Nature Conservation Committee	2012
ObSERVE programme 'The seasonal distribution and abundance of seabirds in the western Irish Sea'	Department of Communications, Climate Action and Environment, National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht.	2018
Dundalk Bay (site 0Z401) I-WeBS Database	BirdWatch Ireland and National Parks and Wildlife Service	2022

4.4.2 European Seabirds at Sea (ESAS)

ESAS data provide the abundance and distribution of seabirds in Irish waters (Dunn, 2012). The datasets consist of the observations of all seabirds and derived grids, showing the density of flying and sitting species on a 3 km grid scale within the area covered. ESAS data were amalgamated from a long-running programme of survey and research work on seabirds in the marine environment in the northeast Atlantic since 1979, and in the southwest Atlantic between 1998 and 2002.

ESAS data was reviewed for an area comprising the offshore wind farm area and offshore cable corridor plus a 5 km buffer zone (see section 3.1). A total of 202 observations of 482 individuals from 10 species were recorded. Data were collected in either January, July or September in 1984, 1988, 1989 and 1995. Data collected provided total observation data and total counts for several species, including fulmar, gannet, great black-backed gull, herring gull, kittiwake, lesser black-backed gull, Manx shearwater, guillemot, guillemot/razorbill, razorbill and shag. A summary of the ESAS data is presented below within Table 4-4.

Table 4-4: Summary of ESAS data within the Offshore Ornithology Study Area.

Species	Year	Month	Total Observations	Total Individuals Recorded
Fulmar	1988	September	4	4
	1989	July	1	1
	1995	January	9	12
Gannet	1988	September	8	11
	1989	July	1	1
	1995	January	2	2
Great black-backed gull	1988	September	2	3
	1995	January	7	18
Herring gull	1995	January	25	47
Kittiwake	1988	September	9	22
	1995	January	32	88
Lesser black-backed gull	1988	September	1	1
	1995	January	4	4
Manx shearwater	1988	September	9	15

Species	Year	Month	Total Observations	Total Individuals Recorded
Guillemot	1984	January	1	1
	1988	September	24	52
	1989	July	4	10
	1995	January	44	168
Guillemot/Razorbill	1988	September	2	4
	1995	January	6	7
Razorbill	1988	September	2	5
	1995	January	3	4
Shag	1995	January	2	2
Totals			**202**	**482**

4.4.3 ObSERVE Programme – The seasonal distribution and abundance of seabirds in the western Irish Sea

In 2016 and early 2017, the ObSERVE programme supported fine-scale aerial surveys to assess the occurrence and distribution of seabird species in the Irish Sea. This section provides a summary of the reported outputs of these surveys (Jessopp *et al.*, 2018).

The surveys gathered data on sightings, density distributions, habitat associations, and abundance estimates for the ObSERVE western Irish Sea survey area. The survey was conducted during the breeding season (June to early July 2016), the post-breeding season (late August to September 2016) and winter (late November 2016 to early January 2017) via 55 parallel survey transects spaced approximately 2 nautical miles (3.7 km) apart, and between 20-30 nautical miles in length covering the east coast of Ireland in the Irish Sea. Surveys covered an area spanning from Dundalk in the north, to south of Wexford harbour in the south. The northern area of the survey region studied within the ObSERVE survey area encompasses the offshore wind farm area.

Across the survey period, there were 13,492 sightings of 45,409 seabirds, representing 29 seabird species or species groups (Jessopp *et al.*, 2018) within the entire ObSERVE survey area. Analysis of this data suggests the western Irish Sea supported 97,326 seabirds during the 2016 breeding season, 299,122 seabirds during the autumn of 2016, and 87,180 seabirds during the 2016 winter period. The most frequently sighted and most abundant species within the surveys were razorbill/guillemot, with frequent sightings of gannet, fulmar and gull species. A summary of the total sightings and individuals across the summer, autumn and winter periods is presented in Table 4-5.

The second phase of ObSERVE (ObSERVE II) is currently being undertaken between summer 2021 until summer 2025. The data gathered thus far is not currently available for inclusion.

Table 4-5: Seabird sightings summary from aerial surveys in the Irish Sea in summer, autumn and winter 2016. 'Sightings' indicates the number of sightings, 'Individuals' indicates the total number of individuals counted (extracted from Jessopp *et al.*, 2018).

Species	Summer		Autumn		Winter	
	Sightings	Individuals	Sightings	Individuals	Sightings	Individuals
Gannet	194	331	445	828	27	33
Cormorant/shag	53	255	50	182	71	106
Fulmar	41	59	571	1,337	75	137
Great skua	-	-	3	4	1	1

Species	Summer		Autumn		Winter	
	Sightings	Individuals	Sightings	Individuals	Sightings	Individuals
Herring/common gull	207	568	145	890	412	1,268
Black-headed gull	6	17	12	67	79	214
Lesser black-backed gull	-	-	25	31	8	8
Great black-backed gull	-	-	74	95	34	48
Black-backed gull species	55	77	42	88	72	171
Little gull	-	-	-	-	37	80
Kittiwake	309	499	326	1,355	310	567
Large gull spp.	9	43	41	724	62	579
Small gull spp.	38	63	31	763	97	144
Manx shearwater	790	3,669	80	1,062	2	5
Shearwater spp.	3	7	-	-	2	4
Petrel spp.	1	1	7	9	-	-
Puffin	23	26	1	1	-	-
Black guillemot	5	6	2	6	-	-
Razorbill/Guillemot	1,800	3,849	3,496	16,444	2,245	4,470
Auk spp.	20	135	2	31	-	-
Arctic/Common tern	299	498	144	737	-	-
Roseate tern	66	131	13	34	-	-
Sandwich tern	39	60	21	30	-	-
Little tern	52	72	23	65	-	-
Tern spp.	7	8	1	4	-	-
Common scoter	-	-	31	855	41	328
Velvet scoter	-	-	6	9	9	30
Scoter spp.	-	-	6	45	4	11
Diver spp.	4	4	115	879	170	252

4.4.4 Irish Wetland Bird Survey (I-WeBS) Data

I-WeBS is a joint scheme of BirdWatch Ireland and NPWS which aims to monitor the numbers and distribution of waterbird populations wintering in the Republic of Ireland to enable identification of long-term spatio-temporal trends. To allow for efficient management of data and observation of populations, data records are clustered within ‘sites’. The Dundalk Bay I-WeBS sites (site 0Z401) database was reviewed to support the development of the baseline information for the Project offshore ornithology features (I-WeBS, 2022).

A total of 227 counts of 50 species were recorded within the I-WeBS Dundalk Bay database, with data provided for the most recently available five-year survey reporting period (2015/16 to 2019/20). The species five-year peak counts and five-year mean counts (2015/16 to 2019/20) have been considered within the development of the species accounts presented within section 4.5.1. Data collected provided total counts for several species, including golden plover, oystercatcher, knot, black-tailed godwit, lapwing, bar-tailed godwit, dunlin, redshank and curlew. Additionally, total counts were also available for several seabirds and divers including black-headed gull, common gull, herring gull, red-throated diver, great northern diver, common scoter and red-breasted merganser.

4.5 Site-specific survey data

This section provides a summary of the analysed site-specific boat-based survey data for the period May 2018 to May 2020 and DAS for the period April 2020 to September 2020 (APEM, 2020).

Table 4-6 presents total numbers of birds recorded for each species encountered ‘on transect’ during fieldwork within the Offshore Ornithology Study Area. “On transect” is only applicable to the boat-based survey data, all DAS data is included. Monthly data for each species recorded on transect are presented in section 4.5.1. Additional observations of birds recorded during the surveys, but not counted while on transect, are also discussed within section 4.5.1 as ‘All Records’ which includes all birds observed (whether present on transect or recorded incidentally).

It is important to note that these numbers should not be taken as absolute; some birds may be recorded multiple times in the same month or even multiple times during one transect during a single survey day. Model derived abundance and density estimates for the most common species, and species for which an impact assessment has been undertaken are presented alongside the raw data within the individual species accounts (section 4.6). The model derived abundance and density estimates were only produced for the offshore wind farm area and associated buffer (2 km).

Table 4-6: Total numbers of birds recorded ‘on transect’ during the monthly boat-based surveys between May 2018 and May 2020 and aerial surveys between April 2020 to September 2020 with associated mean max foraging range.

Species	Transect records	Mean maximum foraging range (±1 SD) (km) (Woodward *et al*., 2019)
Numbers in excess of 500 individuals		
Guillemot	23,878	73.2 ± 80.5
Manx shearwater	8,043	1,346.8 ± 1,018.7
Razorbill	2,955	88.7 ± 75.9
Common scoter	2,222	N/A
Guillemot / razorbill	2,213	N/A
Gannet	1,216	315.2 ± 194.2
Black guillemot	1,135	4.8 ± 4.3
Great northern diver	837	N/A
Kittiwake	742	156.1 ± 144.5
Numbers in excess of 200 individuals and less than 500 individuals		
Great black-backed gull	414	73
Herring gull	359	58.8 ± 26.8
Common gull	323	50
Numbers in excess of 100 individuals and less than 200 individuals		
Shag	183	13.2 ± 10.5
Red-throated diver	106	9
Between 10-100 individuals		
Puffin	68	137.1 ± 128.3
Auk spp.	61	N/A

Species	Transect records	Mean maximum foraging range (±1 SD) (km) (Woodward *et al*., 2019)
Common tern	55	18.0 ± 8.9
Gull spp.	56	N/A
Cormorant	47	25.6 ± 8.3
Fulmar	43	542.3 ± 657.9
Arctic / common tern (comic tern)	26	N/A
Roseate tern	22	12.6 ± 10.6
Sandwich Tern	19	34.3 ± 23.2
Lesser black-backed gull	16	127 ± 109
Small gull spp.	11	N/A
Tern spp.	11	N/A
Less than 10 individuals		
Diver spp.	9	N/A
Red-breasted merganser	8	N/A
Black-headed gull	7	18.5
Arctic skua	7	N/A
Storm petrel	6	336
Cormorant / shag	6	N/A
Great skua	3	443.3 ± 44.6
Meadow pipit	3	N/A
Duck spp.	3	N/A
Dunlin	2	N/A
Arctic tern	1	25.7 ± 14.8
Little gull	1	N/A
Large gull spp.	1	N/A
Great shearwater	1	N/A
Curlew	1	N/A

It was not possible to identify 2,336 individuals (5.2% of all bird records) to species level; these individuals were therefore attributed to a high-level species group which included: guillemot / razorbill, auk species, gull species, small gull species, large gull species, arctic / common tern, tern spp., diver species, cormorant / shag and duck species.

The most commonly observed species recorded on transect was guillemot, comprising over half of all bird records (23,878 guillemot records out of a total of 45,059 birds sighted). Manx shearwater was the second most frequently recorded species (8,043 individuals), followed by razorbill (2,955 individuals), common scoter (2,222 individuals), gannet (1,216 individuals) and black guillemot (1,135 individuals). Over 2,000 individuals were identified as being either guillemot or razorbill.

Several species were observed in numbers in excess of 200 individuals (but less than 500 individuals) including great black-backed gull (414), herring gull (359) and common gull (323), and two species were observed in numbers in excess of 100 individuals (shag (183) and red-throated diver (106)). Puffin, common tern, cormorant, fulmar, roseate tern, Sandwich tern and lesser black-backed gull were observed in numbers between 10 and 100 individuals, while the remaining species had less than ten individuals recorded.

In terms of flight heights, most of the birds observed flying at heights of over 20 m were gulls, with herring gull most likely to be encountered flying over 20 m. The most commonly observed species (guillemot, Manx shearwater and razorbill) were all observed to fly at heights which would typically be below rotor swept height (i.e. < 20 m).

4.5.1 Biological seasons of species recorded on site-specific surveys

Species that were recorded during the boat-based surveys between May 2018 and May 2020 and DAS between April 2020 and September 2020 are shown in Table 4-7, together with an overview of relevant seasons for each species based on information from Furness (2015). Where species seasonality is not included in Furness (2015), seasons are defined with reference to *Birds of the Western Palearctic* (Snow and Perrins, 1998) or NatureScot guidance (NatureScot, 2017). The breeding period presented is the “migration-free breeding period“ (Furness, 2015), whereby the species will be incubating or rearing the eggs/young and therefore will not move away from the nesting location. Non-breeding season is not specified for each species, but includes the autumn migration, winter and spring migration periods. These months are provided as a guide, but individual birds may breed earlier or later and therefore impact the migration timings.

Table 4-7: Species recorded during site-specific surveys and definitions of biological seasons (from Furness *et al.,* 2015, unless otherwise stated).

Species	Migration-free Breeding	Autumn migration	Migration-free Winter	Spring migration	Non-breeding
Arctic skua	May-Jul	Aug-Oct	-	Apr-May	-
Arctic tern	May-Aug	Jul-Sep	-	Apr-May	-
Black-headed gull*	May-Aug	-	-	-	Sep-Mar
Black guillemot	Apr-Aug	-	Sep-Mar	-	-
Common gull*	May-Aug	-	-	-	Sep-Apr
Common scoter*	May-Aug	Sep-Dec	-	Jan-Apr	-
Common tern	May-Aug	Jul-Sep	-	Apr-May	-
Cormorant	Apr-Jul	Aug-Oct	Nov-Jan	Feb-Mar	-
Fulmar	Apr-Aug	Sep-Oct	Nov	Dec-Mar	-
Gannet	Apr-Aug	Sep-Nov	-	Dec-Mar	-
Great black-backed gull	May-Jul	Aug-Nov	Dec	Jan-Apr	-
Great northern diver	-	Sep-Nov	Dec-Feb	Mar-May	-
Great skua	May-Aug	Aug-Oct	Nov-Feb	Mar-Apr	-
Guillemot	Mar-Jun	Jul-Oct	Nov	Dec-Feb	-
Herring gull	May-Jul	Aug-Nov	Dec	Jan-Apr	-
Kittiwake	May-Jul	Aug-Dec	-	Jan-Apr	-
Lesser black-backed gull	May-Jul	Aug-Oct	Nov-Feb	Mar-Apr	-
Little gull*	Apr-Jul	-	-	-	Aug-Apr
Manx shearwater	Apr-Aug	Aug-Oct	Nov-Feb	Mar-May	-
Puffin	May-Jun	Jul-Aug	Sep-Feb	Mar-Apr	-
Razorbill	Apr-Jul	Aug-Oct	Nov-Dec	Jan-Mar	-
Red-throated diver	Mar-Aug	Sep-Nov	Dec-Jan	Feb-Apr	-
Roseate tern	May-Aug	Aug-Sep	-	Apr-May	-
Sandwich tern	Apr-Aug	Jul-Sep	-	Mar-May	-
Shag	Mar-Aug	Sep-Oct	Nov	Dec-Feb	-
Storm petrel**	May-Sep	-	-	-	-

* Information taken from Bird breeding season dates in Scotland (NatureScot, 2017).
** Information taken from Birds of the Western Palearctic (Snow and Perrins, 1998).

4.6 Species Accounts

This section provides an overview of each of the species identified within the Offshore Ornithology Study Area from the desktop data review and/or site-specific surveys. Desk-based data is based on the species accounts presented in Jessopp *et al.*, (2018), which provides a summary of the findings of aerial seabird surveys conducted along the east coast of Ireland in the summer, autumn and winter of 2016/2017 (ObSERVE), and I-WeBS accounts. The desk-based data also draws upon the findings from the National Seabird Monitoring Programme undertaken between 2013 and 2018 (Cummins *et al.,* 2019).

Where available, recent (within the last five summers, 2017 – 2022) SMP colony data is provided for each species. The recent colony counts presented within this section do not represent the colonies used in annex 7 of appendix H: Offshore Ornithology Apportioning Impacts to Special Protection Areas (SPAs) for full methodologies for which colonies are included within the apportioning task). The colonies included are those which are located within the maximum search area from the Cumulative Offshore Ornithology Study Area (see section 2) and the mean max foraging range of the specific species. The counts provided within each species table has a specific unit, either apparently occupied nests (AON), apparently occupied sites (AOS) or individuals (IND), see column headings for detail.

Site-specific data is based on the boat and digital aerial seabird surveys which have been conducted to support the development of this report (Aquafact, 2019 and APEM, 2020). Boat-based data collected up to 2020, analysed by RPS, are also included within this report. In the case of light-bellied brent geese, the site-specific data is based on the VP surveys undertaken during the late autumn (November to December 2019) and spring migration (April 2020) survey programmes which are provided in annex 3 of appendix H: Migratory Geese Survey Report.

4.6.1 Common scoter

Ecology

With an estimated 50 pairs and long-term population declines, common scoter are scarce breeders in Ireland (Gilbert *et al*., 2021) and the UK. This species favours large inland water bodies with tree or shrub cover to aid nesting, however they flock in offshore areas during winter. Common scoter have a preference for shallow waters of less than 20 m depth (optimally 5-15 m) over sandy substrates, generally between 500 m and approximately 2 km from the shore (BirdLife International, 2020). Their diet consists predominantly of molluscs, especially during the winter, although it occasionally forages on other aquatic invertebrates such as crustaceans (e.g. barnacles and shrimps), worms (del Hoyo *et al.*, 1992), echinoderms, isopods, amphipods (Kear, 2005) and insects (e.g. midges and caddisflies) as well as small fish (del Hoyo *et al.*, 1992) and fish eggs (BirdLife International, 2020).

The common scoter is Red-listed as a Bird of High Conservation Concern in the UK and Ireland due to long term (25 year) population declines (Gilbert *et al.,* 2021, Stanbury *et al.,* 2021).

Desk-based data

The 2016/2017 ObSERVE surveys (Jessopp *et al.*, 2018) recorded a total of 72 sightings representing 1,183 individuals within the ObSERVE western Irish Sea survey area, with no sightings in the summer surveys. Sightings were concentrated along the coastline around Dundalk Bay within autumn surveys. Dundalk Bay was observed as an important area for common scoter during winter surveys, although sightings also occurred to the east of Dublin Bay and further from the coast. Observations of common scoter were concentrated around coastal and nearshore waters, illustrating a preference for water depths of 10 m. Mean density of common scoter across the ObSERVE survey area ranged from 0.94 birds/ km^2 in autumn surveys and 0.34 birds/km^2 in winter surveys (Jessopp *et al.*, 2018).

Within the Dundalk Bay I-WeBS site area, common scoter was recorded at levels which exceed National Importance (1% level of 110 birds) with a five-year peak-mean count of 945 individuals (2015/16 to 2019/20). However, populations of common scoter did not exceed levels of International Importance (1% level of 7,500 birds) (Table 4-8).

Table 4-8: Summary of I-WeBS survey counts for common scoter within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
90	11	2,121	945	110	7,500

Site-specific data

Common scoter was present in varying numbers in the Study Area throughout the survey period, with a maximum record of 106 birds recorded (247 total records) during the boat-based transect in January 2019 (Aquafact, 2019) and 2,005 individuals recorded during the DAS in April 2020 (APEM, 2020).

Observations of common scoter were concentrated around the western and northwestern extent of the Study Area, although one flock of birds was also observed at the southern edge of the Study Area in October 2018 and again in November 2018 (Aquafact, 2019). In April 2020, the large flock of common scoter were recorded in the west of the Study Area. There were few birds recorded within the wind farm area.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-9.

Table 4-10 shows the seasonal variation between 2018 and 2020 for all records, which are based on the definitions taken from Snow and Perrins (1998). Figure 4-2 shows the spatial distribution of common scoter during the survey period.

Table 4-9: Transect records and total observations of common scoter from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	10	-	880
June 2018	4	-	8
July 2018	0	-	0
August 2018	0	-	42
September 2018	0	-	0
October 2018	2	-	31
November 2018	8	-	49
December 2018	0	-	43
January 2019	106	-	247
February 2019	0	-	39
March 2019	50	-	86
April 2019	0	-	5
June 2019	0	-	0
July 2019	0	-	0
August 2019	0	-	0
October 2019	3	-	3
December 2019	0	-	0
January 2020	1	-	1
April 2020	-	2,005	2,005
May 2020	0	0	0
June 2020	-	0	0

Month / Year	Boat-based Transect Records	DAS Records	All Records
July 2020	-	4	4
August 2020	-	0	0
September 2020	-	29	29
Total	**184**	**2,038**	**3,472**

Table 4-10: Biological seasonal variation of common scoter recorded between May 2018 and September 2020.

Year	Spring Migration Jan – Apr	Breeding May – Aug	Autumn Migration Sep – Dec	Winter	Non-breeding
2018	-	934	123	-	-
2019	377	0	3	-	-
2020	2,006	4	29	-	-

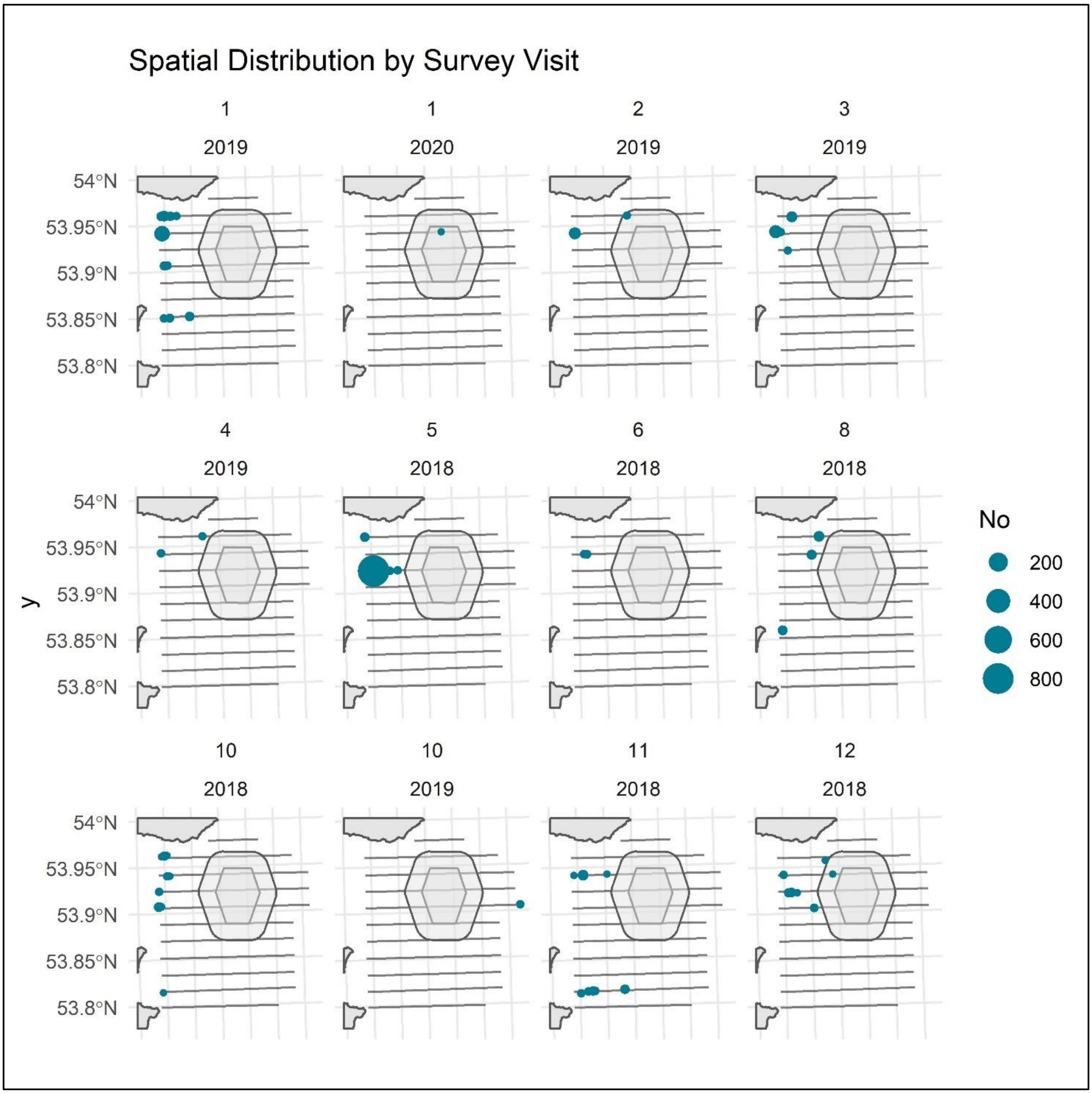

Figure 4-2: Spatial distribution of common scoter records during boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

The peak levels of activity were recorded during the spring migration (up to 2,006 birds), with smaller numbers recorded in the breeding (up to 934 birds) and autumn migration (up to 123 birds) periods.

During the boat-based transect surveys, the majority of birds observed were in flight (flying) (172 individuals, 93.5%) compared to sitting on the sea surface (‘sitting’) (12 individuals, 6.5%). Off transect, a higher proportion of birds were recorded sitting (943 individuals, 75.4%) compared to flying (307 individuals, 24.6%). Flight heights on and off transect were observed between 5 m and 10 m; 20 individuals were observed flying at a height of 20 m off transect.

During the DAS undertaken between April 2020 and September 2020 (APEM, 2020), a total of 2,038 common scoter were identified, of which 2,031 were observed sitting and 7 were recorded flying. Flight heights were not calculated during the DAS.

Table 4-11 below shows the proportion of individuals observed sitting and flying throughout the Study Area between May 2018 and September 2020. Figure 4-3 shows the recorded flight heights of common scoter during the boat-based surveys.

Table 4-11: Proportion of common scoter recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	10	100	0	0	20	2.3	850	97.7
June 2018	4	100	0	0	4	100	0	0
July 2018	No birds recorded							
August 2018	0	0	0	0	42	100	0	0
September 2018	No birds recorded							
October 2018	2	100	0	0	29	100	0	0
November 2018	0	0	8	100	41	100	0	0
December 2018	0	0	0	0	30	69.8	13	30.2
January 2019	106	100	0	0	61	43.2	80	56.7
February 2019	0	0	0	0	39	100	0	0
March 2019	50	100	0	0	36	100	0	0
April 2019	0	0	0	0	5	100	0	0
June 2019	No birds recorded							
July 2019								
August 2019								
October 2019	0	0	3	100	0	0	0	0
December 2019	No birds recorded							
January 2020	0	0	1	100	0	0	0	0
April 2020	3	0.1	2002	99.9	N/A			
May 2020	No birds recorded							
June 2020								
July 2020	4	100	0	0	N/A			
August 2020	No birds recorded							
September 2020	0	0	29	0	N/A			
Total	**172**	**93.5**	**12**	**6.5**	**307**	**24.6**	**943**	**75.4**

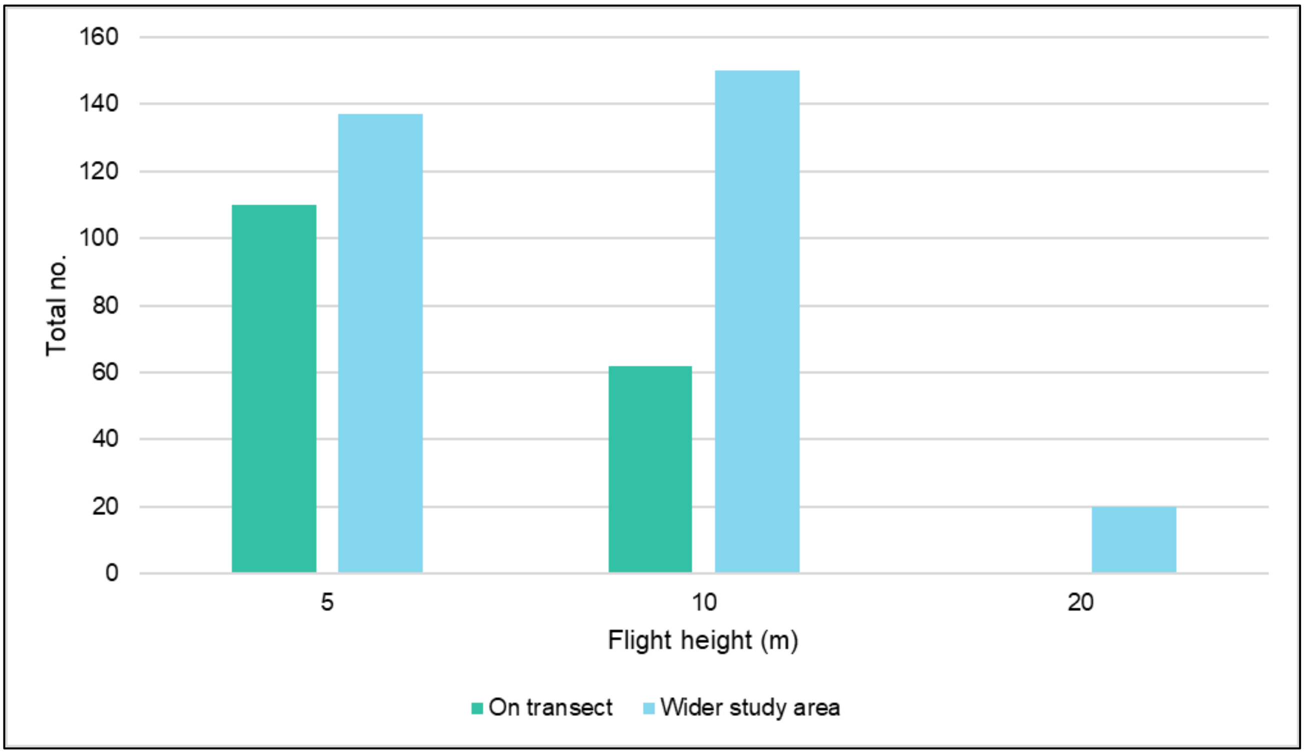

Figure 4-3: Common scoter flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-2), it is not possible to undertake any detailed spatial analysis for this species.

4.6.2 Red-breasted merganser

Ecology

Red-breasted merganser is both a resident species and winter visitor, present in greater numbers during winter months following an influx in individuals from northern and eastern breeding areas (Stone *et al.*, 1995). This species breeds from April in single pairs or colonies (del Hoyo *et al.*, 1992), on islands, small islets, sheltered rivers and lakes in the north and west of Ireland (Balmer *et al.*, 2013). It is gregarious during the winter and on migration, and flocks of up to a hundred or more may be observed in suitable sites during the autumn (BirdLife International, 2019).

Red-breasted merganser are frequent in shallow coastal marine habitats as well as offshore areas (Crowe, 2005), with a preference for clear, shallow waters not affected by heavy wave action. Their diet consists predominantly of small, shoaling marine or freshwater fish, as well as small amounts of plant material and aquatic invertebrates (del Hoyo *et al.*, 1992).

This species is Green-listed Ireland but is Amber-listed in the UK due to declines in non-breeding populations (Gilbert *et al.*, 2021, Stanbury *et al.*, 2021).

Desk-based data

Although no red-breasted merganser were recorded or presented within the ObSERVE 2016/2017 western Irish Sea survey results, I-WeBS surveys within the Dundalk Bay site recorded a five year peak count of 132 between 2015/16 and 2019/20 (Table 4-12). A five-year peak-mean count of 72 between 2015/16 and 2019/20 suggests the population within Dundalk Bay exceeds the National Importance threshold of 25 birds

(I-WeBS, 2022). The population of red-breasted merganser within the Dundalk Bay I-WeBS site does not exceed International Importance thresholds (860 birds).

Table 4-12: Summary of I-WeBS survey counts for red-breasted merganser within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
83	28	132	72	25	860

Site-specific data

Site-specific surveys recorded red-breasted merganser within the Study Area in January and February 2019 and in January 2020; transect recordings in all three months were concentrated in the northwest of the Study Area. There were no red-breasted merganser recorded during the DAS undertaken between April 2020 to September 2020.

During the boat-based transect surveys, two individuals were observed flying at a height of 20 m, although generally the majority of birds were observed flying at a height of 5 m.

A summary of the monthly records from the boat-based surveys is presented in Table 4-13. Figure 4-4 shows the spatial distribution of red-breasted merganser during the survey period.

Table 4-13: Transect records and total observations of red-breasted merganser from boat-based surveys in the Study Area.

Month / Year	Boat-based Transect Records	All Records
May 2018	0	0
June 2018	0	0
July 2018	0	0
August 2018	0	0
September 2018	0	0
October 2018	0	0
November 2018	0	0
December 2018	0	0
January 2019	0	4
February 2019	3	14
March 2019	0	0
April 2019	0	0
June 2019	0	0
July 2019	0	0
August 2019	0	0
October 2019	0	0
December 2019	0	0
January 2020	5	5
May 2020	0	0
Total	**8**	**23**

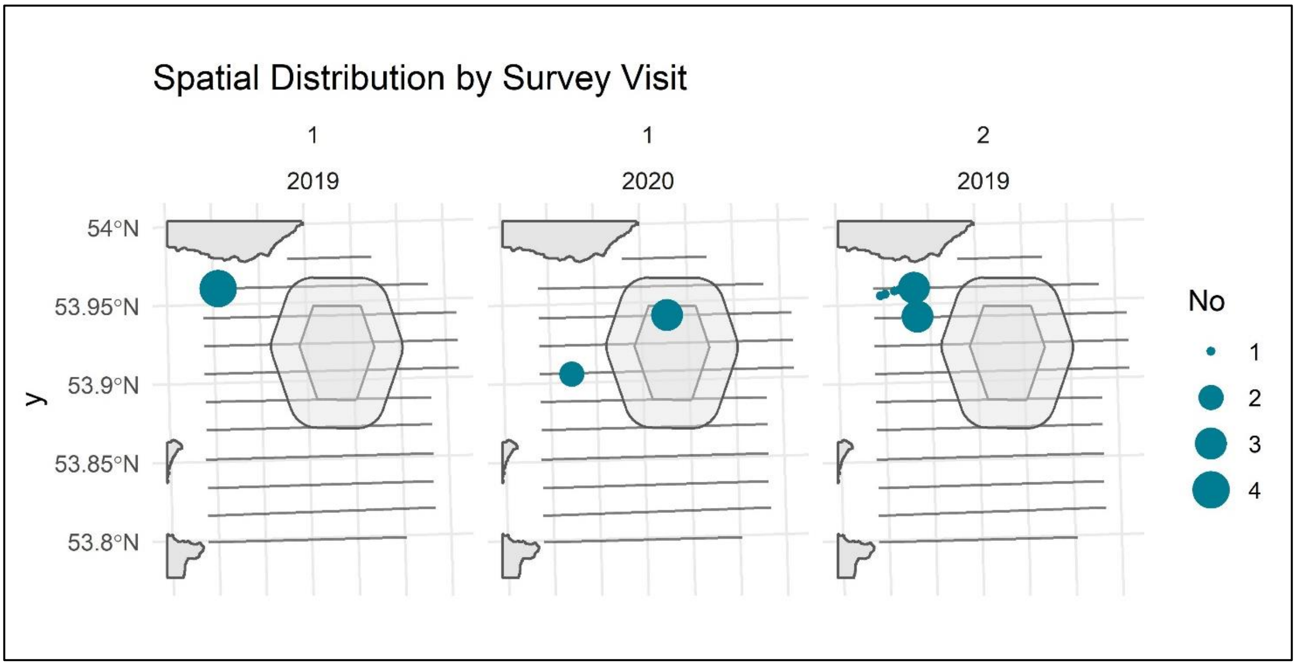

Figure 4-4: Spatial distribution of red-breasted merganser records during boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-4), it is not possible to undertake any detailed spatial analysis for this species.

4.6.3 Red-throated diver

Ecology

Red-throated diver are rare breeders in Ireland, with only six known pairs in County Donegal (BirdWatch Ireland, 2020b). However, this species is present in large numbers around the coastal areas of Ireland for the wintering period and is most commonly observed singly, in pairs or in small, scattered flocks during migration and winter (BirdWatch Ireland, 2020b).

Outside of the breeding season, the species frequents inshore waters along sheltered coasts occasionally occurring inland on lakes, pools, reservoirs and rivers with sandy substrates (del Hoyo *et al.*, 1992). These habitats support their foraging ecology and their diet consists predominantly of fish as well as crustaceans, molluscs, frogs, fish spawn, aquatic insects, annelid worms and plant matter (del Hoyo *et al.*, 1992, BirdLife International, 2020).

The red-throated diver is Amber-listed in Ireland due to its rare breeding ecology and its status as a Species of European Conservation Concern (Gilbert *et al*, 2021).

Desk-based data

The ObSERVE surveys recorded three diver species within the 2016/2017 surveys: red-throated diver, great northern diver and black-throated diver (Jessopp *et al.*, 2018). Due to difficulties with distinguishing between the diver species during aerial surveys, observations were recorded as red-throated diver or great northern diver. A total of 289 observations of 1,135 individuals were recorded within the ObSERVE western Irish Sea survey area. Apart from four summer sightings, observations were made within the autumn and winter surveys with highest densities during the autumn surveys (Jessopp *et al.*, 2018). Observations of divers were concentrated around coastal and nearshore waters, illustrating a preference for water depths of 5-20 m. Further, the distribution of diver observations was concentrated around Dundalk Bay, illustrating the importance of this area to diving species in autumn and winter months. Mean density of all divers across the ObSERVE western Irish Sea survey area ranged from 0.01 birds/km^2 in summer surveys, 0.97 birds/km^2 during autumn surveys and 0.32 birds/km^2 in winter surveys (Jessopp *et al.*, 2018).

Observations of red-throated diver were also recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-14. A five-year peak observation of 39 birds was recorded in the 2016/2017 season, along with a five-year peak-mean count of 23 birds between 2015/16 and 2019/20. The National Importance threshold for red-throated diver is 20 birds, and the International Importance threshold is 3,000 birds. Therefore, red-throated diver numbers in the Dundalk Bay I-WeBS site occasionally exceed levels of National Importance based on the 2016/17 peak count (I-WebS, 2022), but the most recent five-year peak-mean count is well below levels of International Importance.

Table 4-14: Summary of I-WeBS survey counts for red-throated diver within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
31	13	39	23	20	3,000

Site-specific data

During the boat-based transect surveys conducted, there were 87 records of red-throated diver on transect throughout the survey period, with records in all months except between June and July 2018 and between June and September 2019. In 2018, there was an increase in records in August post the breeding period, reflecting the passage of birds from the northwestern breeding areas (Crowe, 2005).

The greatest peak was observed in the spring migration period (February to April) in both 2019 and 2020, with a maximum of 18 birds recorded on transect in February 2019 and 15 birds recorded in April 2020.

The red-throated diver were mainly distributed along the western and northern sides of the Study Area, with the exception of October 2019, where birds were more frequently recorded in the north and east of the area.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-15. Table 4-16 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-5 shows the spatial distribution of red-throated diver during the survey period.

Table 4-15: Transect records and total observations of red-throated diver from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	2
June 2018	0	-	0
July 2018	0	-	0
August 2018	6	-	7
September 2018	2	-	4
October 2018	5	-	5
November 2018	3	-	4
December 2018	5	-	12
January 2019	9	-	12
February 2019	18	-	27
March 2019	6	-	9

Month / Year	Boat-based Transect Records	DAS Records	All Records
April 2019	10	-	10
June 2019	0	-	0
July 2019	0	-	0
August 2019	0	-	0
October 2019	11	-	11
December 2019	1	-	1
January 2020	10	-	10
April 2020	-	15	15
May 2020	1	0	1
June 2020	-	0	0
July 2020	-	0	0
August 2020	-	0	0
September 2020	-	4	4
Total	**87**	**19**	**134**

Table 4-16: Biological seasonal variation of red-throated diver recorded between May 2018 and September 2020.

Year	Spring Migration Feb – Apr	Breeding Mar – Aug	Autumn Migration Sep – Nov	Winter Dec – Jan	Non-breeding
2018 / 2019	0	9	13	24	-
2019 / 2020	27	19	11	11	-
2020	0	15	4	-	-

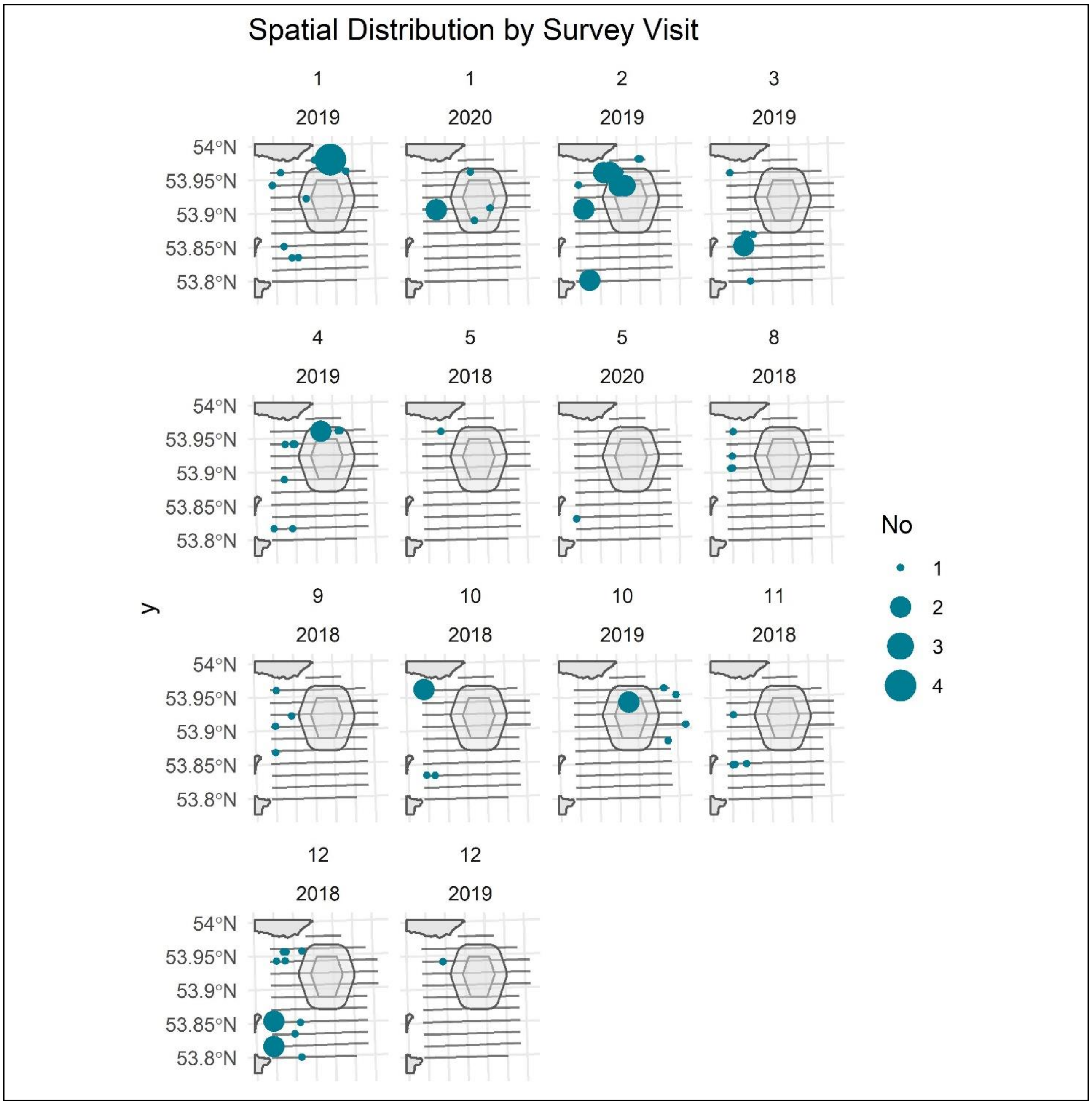

Figure 4-5: Spatial distribution red-throated diver records during boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

Similar levels of activity were recorded during the survey period, with a peak count of up to 19 birds recorded during the breeding season, up to 24 birds during the winter period and 13 to 27 birds recorded during the autumn and spring migration periods respectively.

During the boat-based transect surveys, the majority of birds observed were sitting (84 individuals, 96.5%); whereas off transect, a higher proportion of birds were recorded in flight (27 individuals, 96.4%). Flight heights along the transect route were recorded between 5 m and 10 m, with a small number of birds flying between 20 m and 30 m off transect.

During the DAS undertaken between April 2020 and September 2020 (APEM, 2020), a total of 19 red-throated diver were recorded, of which two were observed in flight and 17 were recorded sitting. One red-throated diver was recorded flying in a northeasterly direction in the April survey and one red-throated diver was recorded flying in a southwesterly direction in the September survey. The red-throated diver were mainly distributed along the western side of the Ornithology Study Area, with only two located in the southeastern area. There were no calculated flight heights for red-throated diver from the APEM surveys.

Table 4-17 below shows the proportion of individuals observed sitting and flying over the transect route and Study Area between May 2018 and September 2020. Figure 4-6 shows the recorded flight heights of red-throated diver during the boat-based surveys.

Table 4-17: Proportion of red-throated diver recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	0	0	0	0	2	100	0	0
June 2018	No birds recorded							
July 2018								
August 2018	0	0	6	100	1	100	0	0
September 2018	0	0	2	100	2	100	0	0
October 2018	0	0	5	100	0	0	0	0
November 2018	0	0	3	100	1	100	0	0
December 2018	0	0	5	100	7	100	0	0
January 2019	2	22.2	7	77.8	3	100	0	0
February 2019	0	0	18	100	9	100	0	0
March 2019	0	0	6	100	2	66.7	1	33.3
April 2019	0	0	10	100	0	0	0	0
June 2019	No birds recorded							
July 2019								
August 2019								
October 2019	0	0	11	100	0	0	0	0
December 2019	0	0	1	100	0	0	0	0
January 2020	0	0	10	100	0	0	0	0
April 2020	1	6.7	14	93.3	N/A			
May 2020	1	100	0	0	0	0	0	0
June 2020	No birds recorded							
July 2020								
August 2020								
September 2020	1	25	3	75				
Total	**3**	**3.5**	**84**	**96.5**	**27**	**96.4**	**1**	**3.6**

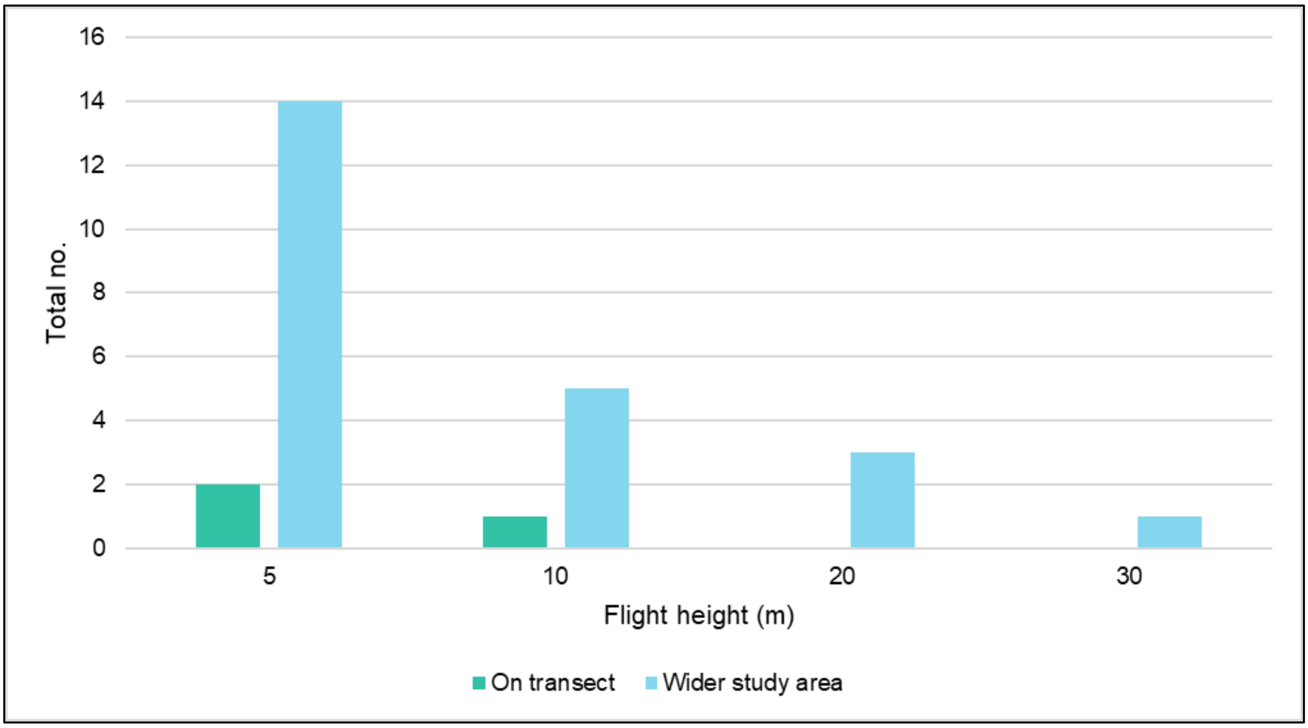

Figure 4-6: Red-throated diver flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-5), it is not possible to undertake any detailed spatial analysis for this species.

4.6.4 Great northern diver

Ecology

Great northern diver are a winter visitor to Ireland and are mainly observed between September to April in offshore regions of the coast (Crowe, 2005; Stone *et al.*, 1995). The closest breeding colonies are in Iceland. Unlike red-throated diver, great northern diver are capable of feeding in deeper waters and are thus observed offshore utilising deeper bays and inlets. Their diet consists predominantly of fish as well as crustaceans, molluscs, aquatic insects, annelid worms, frogs, other amphibians and plant matter (e.g. *Potamogeton* spp., willow *Salix* spp., shoots, roots, seeds, moss and algae) (del Hoyo *et al.*, 1992).

The great northern diver is Amber-listed in the UK and Ireland due to an internationally important wintering population (Gilbert *et al.,* 2021, Stanbury *et al.,* 2021).

Desk-based data

The ObSERVE western Irish Sea surveys recorded three diver species within the 2016/2017 surveys: red-throated diver, great northern diver and black-throated diver (Jessopp *et al.*, 2018). Due to difficulties with distinguishing between the diver species during aerial surveys, observations were recorded as red-throated diver or great northern diver. A total of 289 observations of 1,135 individuals were recorded within the ObSERVE western Irish Sea survey area. Apart from four summer sightings, observations were made within the autumn and winter surveys with highest densities during the autumn surveys (Jessopp *et al.*, 2018). Observations of divers were concentrated around coastal and nearshore waters, illustrating a preference of water depths of 5-20 m. Further, the distribution of diver observations was concentrated around Dundalk Bay, illustrating the importance of this area to diving species in autumn and winter months. Mean density of all divers across the ObSERVE western Irish Sea survey area ranged from 0.01 birds/km^2 in summer surveys, 0.97 birds/km^2 during autumn surveys and 0.32 birds/km^2 in winter surveys (Jessopp *et al.*, 2018).

Observations of great northern diver were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-18. A five-year peak count observation of 33 birds was recorded in the 2016/17 season, along with a five-year peak-mean count of 27 birds between 2015/16 and 2019/20. The National Importance threshold for great northern diver is 20 birds, and the International Importance threshold is 50 birds. Therefore, great northern diver in the Dundalk Bay I-WeBS site are currently exceeding levels of National Importance based on the most recent five-year peak-mean count (2015/16 to 2019/20; I-WeBS, 2022), but do not exceed levels of International Importance.

Table 4-18: Summary of I-WeBS survey counts for great northern diver within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
31	15	33	27	20	50

Site-specific data

Site-specific surveys conducted in 2018 and 2019 recorded great northern diver on transect in all months except July 2018, July 2019 to August 2019 and August 2020 to September 2020. Peak occurrences were observed in January 2020 with 127 birds in the Study Area, and in January 2019 with 61 birds within the Study Area and 76 birds on transect (Aquafact, 2019). Large numbers of individuals were also recorded in May 2018 (49 birds on transect and 83 within the Study Area); this peak in May 2018 is notable as this species typically vacates Irish waters from April (Crowe, 2005; Stone *et al.*, 1995), and is related to poor weather events occurring in spring 2018 which led to delays in departures of birds to their more northerly summer areas (e.g. Iceland and Greenland).

Birds were observed in the northern and western areas of the Study Area throughout winter, although observations were also made of birds in the southern extent of the Study Area in January 2019, December 2019 and January 2020. During the DAS undertaken between April 2020 and September 2020 (APEM, 2020), the distribution of great northern diver was mainly concentrated in the east to north of the Study Area. There were no great northern diver were recorded in the southwest of the Study Area during these surveys.

A summary of the monthly records from the boat-based surveys and DAS is presented in Table 4-19. Table 4-20 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-7 shows the spatial distribution of great northern diver during the boat-based survey period.

Table 4-19: Transect records and total observations of great northern diver from boat-based surveys in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	49	-	83
June 2018	9	-	9
July 2018	0	-	0
August 2018	0	-	1
September 2018	2	-	2
October 2018	60	-	63
November 2018	20	-	25
December 2018	30	-	38
January 2019	61	-	76
February 2019	21	-	24
March 2019	31	-	55

Month / Year	Boat-based Transect Records	DAS Records	All Records
April 2019	53	-	68
June 2019	2	-	2
July 2019	0	-	0
August 2019	0	-	0
October 2019	4	-	4
December 2019	54	-	54
January 2020	127	-	127
April 2020	-	285	285
May 2020	12	9	21
June 2020	-	4	4
July 2020	-	4	4
August 2020	-	0	0
September 2020	-	0	0
Total	**535**	**302**	**945**

Table 4-20: Biological seasonal variation of great northern diver recorded between May 2018 and September 2020.

Year	Spring Migration Mar – May	Breeding Jun – Aug	Autumn Migration Sep – Nov	Winter Dec – Feb	Non-breeding
2018 / 2019	83	10	90	138	-
2019 / 2020	123	2	4	181	-
2020	306	8	0	-	-

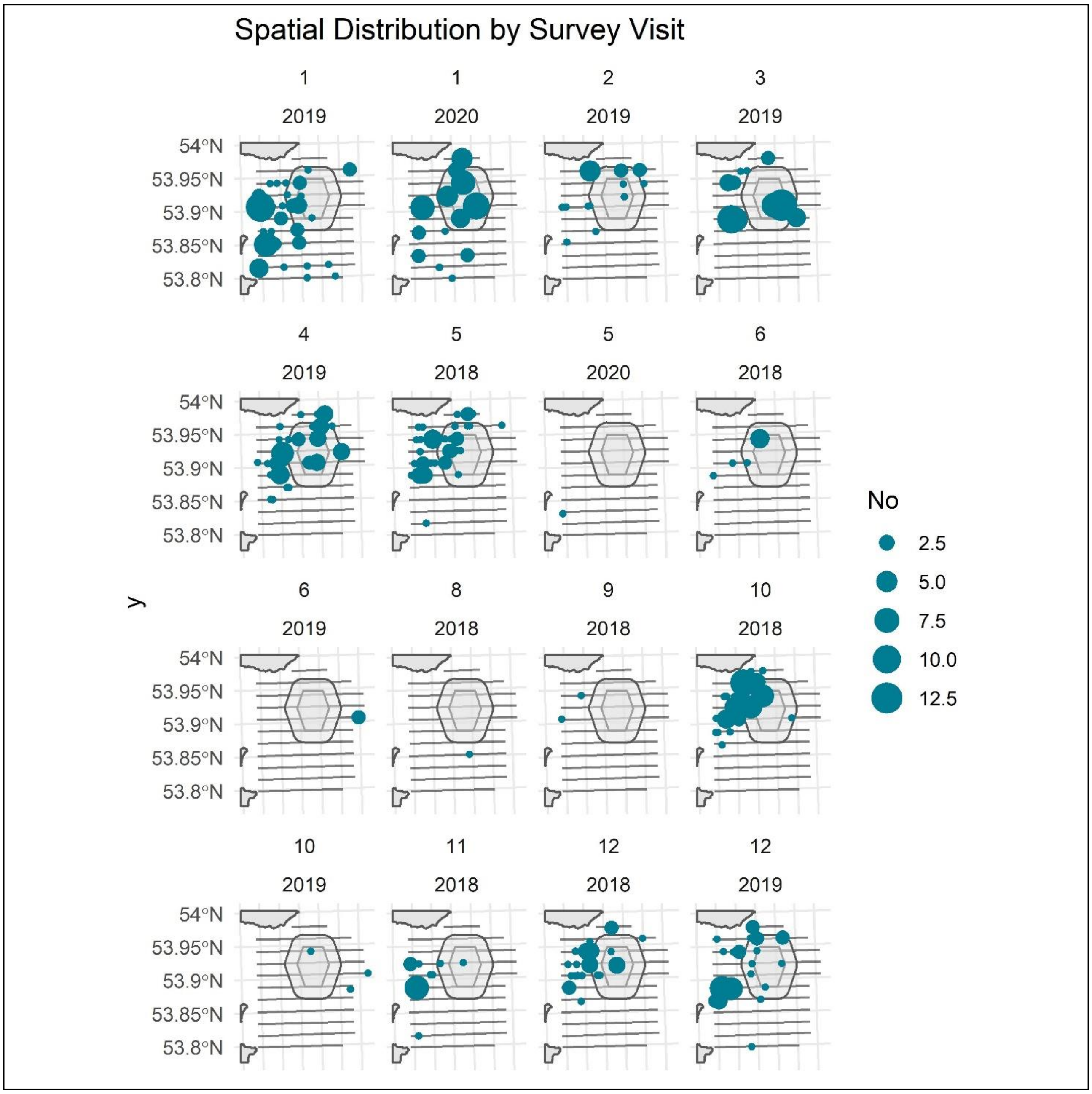

Figure 4-7: Spatial Distribution of great northern diver records during boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

The peak levels of activity were recorded during the spring migration (up to 306 birds) and winter periods (up to 181 birds), with smaller numbers recorded in the migration periods.

During the boat-based transect surveys, over 98% of birds (527 individuals) were observed sitting; between May 2018 and June 2019, there were no records of birds in flight on transect. A higher proportion of birds were observed in flight off transect (24 individuals, 22.2%). Of those birds recorded in flight in the Study Area, flight heights were most frequently observed between 10 m and 20 m.

During the DAS undertaken between April 2020 and September 2020 (APEM, 2020), a total of 302 great northern diver were identified, of which all were observed sitting.

Table 4-21 below shows the proportion of individuals observed sitting and flying over the transect route and Study Area between May 2018 and September 2020. Figure 4-8 shows the recorded flight heights of great northern diver during the boat-based surveys.

Table 4-21: Proportion of great northern diver recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	0	0	49	100	3	8.8	31	91.2
June 2018	0	0	9	100	0	0	0	0
July 2018	No birds recorded							
August 2018	0	0	0	0	1	100	0	0
September 2018	0	0	2	100	0	0	0	0
October 2018	0	0	60	100	2	66.7	1	33.3
November 2018	0	0	20	100	4	80	1	20
December 2018	0	0	30	100	6	75	2	25
January 2019	0	0	61	100	2	13.3	13	86.7
February 2019	0	0	21	100	3	100	0	0
March 2019	0	0	31	100	0	0	24	100
April 2019	0	0	53	100	3	20	12	80
June 2019	0	0	2	100	0	0	0	0
July 2019	No birds recorded							
August 2019								
October 2019	1	25	3	75	0	0	0	0
December 2019	4	7.4	50	92.6	0	0	0	0
January 2020	2	1.6	125	98.4	0	0	0	0
April 2020	0	0	285	100	N/A			
May 2020	1	5	20	95	0	0	0	0
June 2020	0	0	4	100	N/A			
July 2020	0	0	4	100				
August 2020	No birds recorded							
September 2020								
Total	**9**	**1.5**	**527**	**98.5**	**24**	**22.2**	**84**	**77.8**

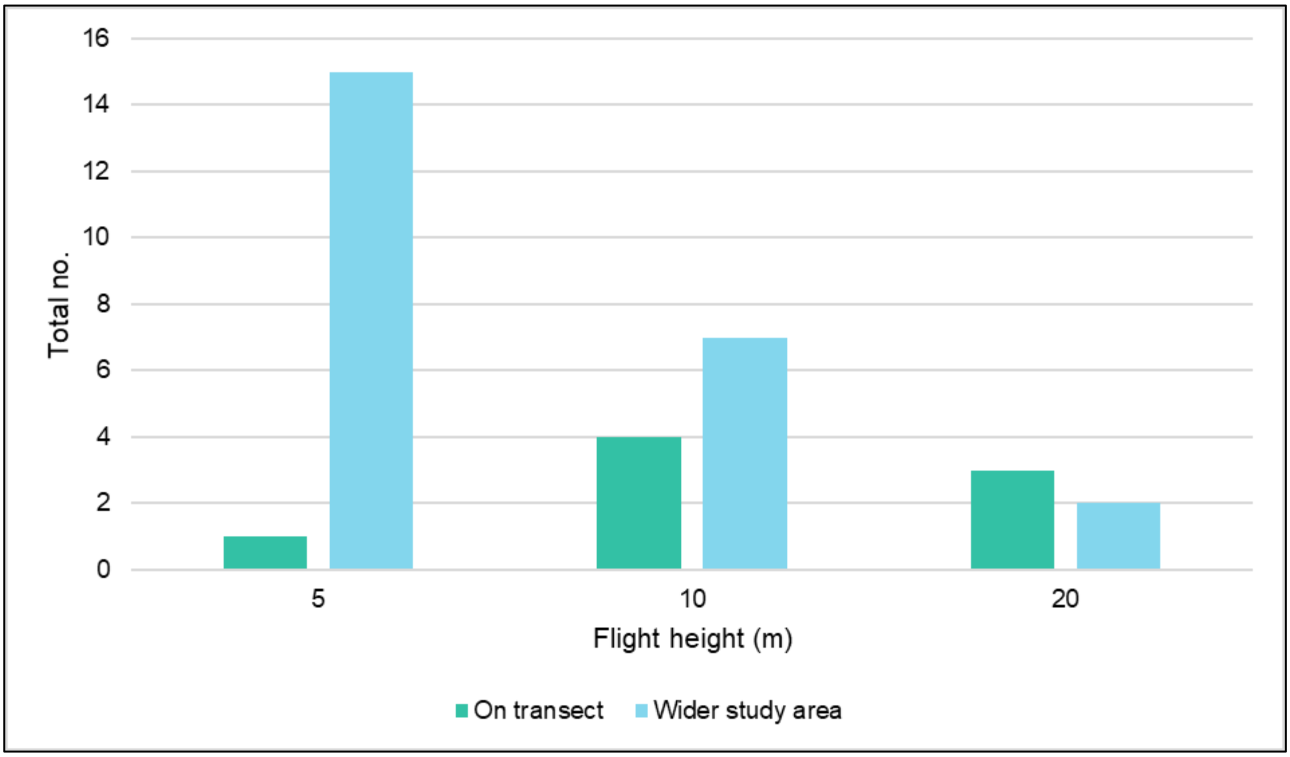

Figure 4-8: Great northern diver flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates from the boat-based surveys

During initial data exploration and model fitting a high co-linearity / correlation between Bathymetry and distance to coast was identified resulting in a prohibitively high variance inflation factor (VIF) for these parameters. Because of this distance to coast was removed from the model. The following refined environmental and spatial covariates were used in the MRSea CreSS:

- Bathymetry;
- Year; and
- X and Y coordinates.

In addition to the co-linearity identified above a low number of observations were also identified in some months for great northern diver and this also inhibited model convergence when using month as an interaction to term. As such seasonal periods were used in place of month for this analysis.

To prepare for the GEE-CreSS analyses, a complete grid of abutting cells based on the survey grid and environmental covariates was constructed to cover the entire survey area. All variables except X and Y co-ordinates were included in the one-dimensional SALSA model selection method (Walker *et al.,* 2011) and automatic model simplification using non-significant p-values was carried out. An appropriate blocking structure using transect ID was included as there was evidence of autocorrelation. Period was fitted as a factor term. This provided the base model for assessment of the 2D spatial smoother.

CreSS was used to fit the spatial density surface and GEEs were used to provide realistic model-based estimates. The GEE-CreSS grid knot locations are included in appendix A.1 of this report. An interaction with month was included to allow the density surface to vary between survey months. Following predictions, bootstrapping was used to generate 95% confidence intervals for each grid cell to allow for an assessment of uncertainty. The bootstrapping procedure incorporated any autocorrelation specified within the prediction model following the CreSS method.

All behaviours (both sitting and flying birds)

Table 4-22, Table 4-23 and Table 4-24 below present the great northern diver modelled abundance estimates for the offshore wind farm area, offshore wind farm area plus 2 km buffer and the Offshore Ornithology Study Area during the boat-based survey data. Both sitting and flying birds are included within the estimate below.

Table 4-22: Great northern diver offshore wind farm area modelled abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	12	7	21
June 2018	4	1	11
July 2018	No birds recorded		
August 2018	0	0	N/A
September 2018	0	0	N/A
October 2018	12	5	30
November 2018	1	0	36
December 2018	8	3	24
January 2019	43	28	63
February 2019	10	2	52
March 2019	45	20	107
April 2019	38	22	63
June 2019	4	1	11
July 2019	No birds recorded		
August 2019			
October 2019	12	5	30
December 2019	8	3	24
January 2020	43	28	63
May 2020	12	7	21

Table 4-23: Great northern diver offshore wind farm area plus 2 km modelled abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	31	18	55
June 2018	7	2	22
July 2018	No birds recorded		
August 2018	0	0	NA
September 2018	0	0	NA
October 2018	43	21	89
November 2018	5	1	109
December 2018	31	15	76
January 2019	115	76	168
February 2019	25	5	112

Month / Year	Estimate	LCL	UCL
March 2019	95	43	215
April 2019	102	56	184
June 2019	7	2	22
July 2019	No birds recorded		
August 2019			
October 2019	43	21	89
December 2019	31	15	76
January 2020	115	76	168
May 2020	31	18	55

Table 4-24: Great northern diver Offshore Ornithology Study Area modelled abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	143	74	300
June 2018	21	6	91
July 2018	No birds recorded		
August 2018	0	0	0
September 2018	7	0	NA
October 2018	112	57	259
November 2018	122	36	779
December 2018	139	76	294
January 2019	326	208	505
February 2019	73	17	328
March 2019	175	77	417
April 2019	374	196	711
June 2019	21	6	91
July 2019	No birds recorded		
August 2019			
October 2019	112	57	259
December 2019	139	76	294
January 2020	326	208	505
May 2020	143	74	300

Flying birds only

There were 32 records of flying great northern diver during the boat-based surveys. Densities of flying birds were derived from the total numbers seen in radial snapshots, divided by the total area surveyed by snapshots (survey effort); that is the number of snapshots multiplied by the snapshot area of 0.09 km^2.

Non-parametric bootstrap intervals have been used to calculate the standard error and 95% confidence intervals around the observed counts and densities per km^2. The offshore wind farm area has then been used to calculate simple abundances based on density results (Table 4-25 and Table 4-26).

Table 4-25: Great northern diver flying bird offshore wind farm area simple abundance estimates.

Season	Estimate	LCL	UCL
Mid winter	2	0	4
Late winter	2	0	4
Early breeding season	6	0	12
Mid breeding season	4	0	10
Late breeding season	0	0	0
Post breeding / moult	1	0	2
Autumn	2	0	4
Early winter	8	3	13

Table 4-26: Great northern diver flying bird offshore wind farm area plus 2 km simple abundance estimates.

Season	Estimate	LCL	UCL
Mid winter	6	0	12
Late winter	6	0	12
Early breeding season	17	0	35
Mid breeding season	12	0	29
Late breeding season	0	0	0
Post breeding / moult	3	0	6
Autumn	6	0	12
Early winter	23	9	38

Design-based spatial abundance estimates during the DAS

DAS abundance analysis was undertaken by APEM and summarised fully within annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The abundance estimates are presented below for great northern diver (all behaviours) at the different spatial scales (Table 4-27). Detailed methods on calculation of the abundance estimates are presented in section 3.4.3.

Table 4-27: Abundance estimates of great northern diver within the different study areas.

Month / Year	Offshore wind farm area	Offshore wind farm area plus 2 km buffer	Offshore wind farm area plus 4 km buffer
April 2020	102	222	412
May 2020	5	10	21
June 2020	3	6	6
July 2020	6	8	8
August 2020	0	0	0
September 2020	0	0	0

4.6.5 Fulmar

Ecology

Fulmar is a widespread breeding species around the Irish coast, typically breeding on cliffs and rock faces but also occasionally on flatter ground up to 1 km inland (BirdLife International, 2020). The diet of this species comprises of fish, squid and zooplankton (especially amphipods), and they will also scavenge on commercial fishing discards (Phillips *et al.*, 1999). Fulmar are typically surface seizing foragers; however, they also forage through plunge feeding methods (del Hoyo *et al.*, 1992).

Ireland's fulmar population has been increasing in recent years, and therefore this species is Green-listed in Ireland (Gilbert *et al.,* 2021), however Amber-listed for the UK as a whole (Stanbury *et al.,* 2021). To support the SMP, fulmar was one of four priority species counted in 2015 at 31 colonies in the Republic of Ireland. A total of 21,937 AOS were counted which was 33% fewer than the 32,918 AOS recorded during Seabird 2007 (JNCC, 2016).

The Seabirds Count census which was undertaken across Ireland between 2015 and 2018 estimated that the breeding population of fulmar was 32,899 pairs, an increase of 68% over the long term (1985/87 – 2015/18) (Cummins *et al.,* 2019). Colonies at the Cliffs of Moher and Clare Island (two of the most important colonies identified during Seabird 2000) had both undergone significant changes in their site estimates (+36% and -31% respectively). A summary of the population trends of fulmar at a selection of Irish colonies since Seabird 2000 is summarised in Table 4-28 below.

Table 4-28: Population trends of breeding fulmar (AOS) at a selection or Irish colonies since Seabird 2000 (Cummins *et al*., 2019).

Site	Seabird 2000 1998 / 2002	2015 – 2018	% Change Since Seabird 2000
Inishshark Island	603	1,160	+ 92%
Puffin Island	447	670	+ 50%
Cliffs of Moher	3,566	4,842	+ 36%
Cape Clear Island	466	527	+ 13%
Inishturk Island	2,897	2,881	- 1%
Great Skellig	761	725	- 5%
Duvillaun Islands	638	547	- 14%
Little Saltee	205	167	- 19%
Inishvikillane	672	517	- 23%
Clare Island	4,029	2,789	- 31%
Lambay	585	375	- 36%
Great Saltee	315	190	- 40%
Aran Island – Aranmore	1,535	768	- 50%

Within the UK, numbers of fulmar have fallen in all areas, although the greatest declines appear to be at colonies in the north and west of the UK.

A summary of recent (within the last five summers) colony data for fulmar within the Cumulative Offshore Ornithology Study Area is provided in Table 4-29 below. If multiple years are provided, then the mean count is presented. Colonies which recorded zero birds are not included.

Table 4-29: Summary of most recent colony data for fulmar between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AOS) ± SD (if applicable)
Antrim	Blackhead	2017 – 2019	30 ± 0.8
	Causeway Coast	2021	880
	East Antrim Coast	2017 – 2019	44.7 ± 11.1
	Giants Causeway Coast	2018 – 2022	133.3 ± 38.5
	Larne Lough to Portmuck	2017 – 2019	282.7 ± 59.9
	Muck Island	2017 – 2019	65 ± 15.9
	North Antrim coast	2017 – 2019	10 ± 9.9
	Rathlin Island SPA	2021	1,038
	Sheep Island SPA	2021	61
	Whitehead	2017 – 2019	6 ± 0.9
Argyll and Bute	Coll	2018	55
	Gigha	2021	16
	Islay – East (Port Askaig to Bowmore)	2017 – 2021	124.3 ± 32.7
	Islay – West (Port Askaig to Bruichladdich)	2017 – 2021	165.5 ± 127.2
	Isle of Colonsay	2017 – 2021	11.8 ± 1.8
	Keil Point to Kilmanshennachan	2021	21
	North Colonsay and Western Cliffs SPA	2017 – 2022	270 ± 147.8
	North West Iona	2021	10
	Sanda Islands – Kintyre	2019	43
	Sound of Luing	2019	28
	South West Iona and Soa	2017 and 2021	41.5 ± 14.5
	Stac Mhic Mhurchaidh, Reidh Eilean, Eilean Annraidh, Eilean Chalba	2021	38
	Staffa	2018 – 2021	40.7 ± 11.9
	Tiree	2018	1,054
	Treshnish Isles SPA	2017 – 2021	301.5 ± 38.7
Clwyd	Llanddulas Quarries	2017	25
Cork	Baltimore to Glandore Harbour	2017	58
	Beara Peninsula – North	2018	12
	Cork Harbour to Youghal Harbour	2018	91
	Galley Head	2017	19
	Ringabella to Kinsale	2017	100
Cornwall	Bounds Cliff – North Cornwall	2017	74
	Carnweather Point, North Cornwall	2017	25
	Chapel Porth to Perranporth	2017 and 2018	57 ± 38
	Com Head – North Cornwall	2017	23
	Delabole Point – North Cornwall	2017	19
	Godrevy Head to St Agnes SSSI	2020	62
	Gunwallor Fishing Cove to Kynance Cove	2017	39
	Ligger Point to Porth	2017	97
	Mount’s Bay, Cornwall	2021	10
	North Cornwall Coast	2017	113
	Penally to Cornakey	2018	57

County (from SMP)	SMP Master Site	Year(s)	Count (AOS) ± SD (if applicable)
	Pine Haven, North Cornwall	2018	10
	Port Isaac, North Cornwall	2017	60
	Reedy Cliff, North Cornwall	2017	17
	Trerubies Cove – North Cornwall	2017	15
	Tresungers Point, North Cornwall	2017	96
	Trevan Point, North Cornwall	2017	13
	Trevelgue Head to Merope Rocks	2017 and 2019	145.5 ± 2.5
	Varley Head, North Cornwall	2018	8
	West Penwith	2017	93
Cumbria	Parton Bay	2017 – 2021	5.5 ± 3.4
	St Bees Head and Town	2017 – 2021	45 ± 5.7
Devon	Clovelly to Hartland Quay	2017	22
	Lundy	2017 and 2019	246 ± 19
	North Devon Coast	2017	46
	West Exmoor Coast and Woods SSSI	2018	62
Donegal	Gweedore Bay Islands	2018	33
	Inishdooey, Inishbofin, Inishbeg	2018	89
	Malin Peninsula	2018	607
	North Donegal	2018	16
	Rathlin O’Birne Island	2018	5
	Slieve League	2018	31
	Tory Island and Bloody Foreland	2018	3
Down	Maggy’s Leap 1/Donnard Cove	2017 and 2019	1.5 ± 0.5
Dyfed	Aber Bach – Ynys Barry	2018	104
	Abereiddy – Treginnnis, St Davids	2018	27
	Barafundle to Giltar Point	2017 and 2018	86.5 ± 5.5
	Bishop and Clerks and Ramsey	2017 – 2019	272 ± 38.8
	Caldey Island	2017 – 2019	105 ± 4.8
	Cardigan Island and Mwnt to Carreg Lydan	2018	78
	Castlemartin Coast (Berryslade to Barafundle Bay)	2017 – 2019, 2021 and 2022	67.8 ± 11.0
	Dinas Fach, Solva – Newgale (Pen-y-Cwm)	2018	6
	Freshwater West to West Angle Bay	2017	2
	Gilfach yr halen	2018	10
	Little Haven to Newgale	2017	90
	Llangrannog to Penpeles (includes Tresaith SSSI and Aberporth)	2018	24
	Llanrhyslud – Llansanffraed	2018	14
	New Quay to Lochtyn	2018	37
	Newport to Poppit	2018	155
	Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA	2018 and 2021	799 ± 2
	St Anne’s Head (Renny Slip to Dale)	2017	8
	St Bride’s Bay (S and SE)	2017 and 2018	35.5 ± 0.5
	Strumble Head – Pwll Deri	2018	38

County (from SMP)	SMP Master Site	Year(s)	Count (AOS) ± SD (if applicable)
	Strumble Head to Fishguard to Newport	2018	61
	Tenby to Amroth	2017	19
	Treginnis – Dinas Fawr, Solva	2018	41
Gwynedd	Aberdaron Coast and Bardsey Island SPA	2017 – 2019	16 ± 2.8
	Friog	2018	13
	Great Orme and Little Orme	2017 – 2022	28.6 ± 6.1
	Lleyn Peninsula	2018, 2019 and 2021	2.7 ± 0.9
	Puffin Island SPA	2017 – 2019 and 2021	34.3 ± 12.7
	South Stack	2017 – 2019	16.7 ± 6
Isle of Man	East Island	2017	408
	North Island	2017	162
	South Island	2017	423
	West Island	2017	56
Isles of Scilly	Isle of Scilly SPA	2017 – 2021	45.5 ± 2.62
	St Agnes	2017 – 2021	7 ± 1.6
Kyle and Carrick	Ailsa Craig SPA	2017 – 2019 and 2021	115.8 ± 17.3
	Bennane Lea to Games Loup	2018	6
	Culzean Country Park – Sea cliffs	2018	9
	Drumshang to Heads of Ayr	2018	4
	Starling Knowe to Downan Point	2018, 2019 and 2021	5.7 ± 0.9
Lochaber	Canna and Sanday SPA	2017 – 2019, 2021 and 2022	133.3 ± 38.5
	Muck	2018 and 2021	155.5 ± 19.5
	Rum SPA	2021	12
Londonderry	Downhill	2017 – 2019	92 ± 8
	North Antrim coast		14 ± 2.4
Mayo	Downpatrick to Creevagh Heads	2018	71
Skye and Lochalsh	Rubha Hunish	2021	1,045
	Skye	2021	22
	Skye – Strathaird	2021	2
	Skye: Hoe Point to Meanish	2021	234
Sligo	Sligo Bay	2018	2,018
Somerset	Glenthorne to Ivy Stone	2017 and 2018	5 ± 1
South Glamorgan	Nash Point	2018	16
Stewartry	Balcary Point	2018	7
	Barlocco	2021	9
	Meikle Ross and Little Ross	2021	2
	Port O'Warren	2019	9
Waterford	Annestown to Kilmurrin	2018	
	Ardmore to Whiting Bay	2018	13
	Bally Voorey to Stradbally	2018	48
	Bunmahon to Stradbally	2018	52
	Creadan Head to Foilakipeen		54

County (from SMP)	SMP Master Site	Year(s)	Count (AOS) ± SD (if applicable)
	Dungarvan to Ardmore	2018	28
	Illaunglass to Annestown	2018	72
	Kilmurrin Cove to Bunmahon	2018	32
	Portally to Benlea Head	2018	5
	Stradbally to Ballyvoile	2018	21
	Tramore to Illaunglass	2018	42
West Glamorgan	Gower	2018	3
Wicklow	Mizen Head	2018, 2019, 2021 and 2022	38.7 ± 20.8
Wigtown	Castle Point to Portankill (Mull of Galloway) – Tysties	2021	6
	Loch Ryan	2021	3
	Monreith Cliffs and Scar Rocks	2021	4
	Mull of Galloway	2019	1
	Port Mona, Devil’s Bridge, Laggantalluch Head	2017	15
	Portpatrick	2021	88
	Rigg Bay + Cruggleton	2020	4
	Sheddock Cliffs – Burrow Head	2020	6
	West Coast Wigtownshire	2021	5

Desk-based data

The 2016/2017 ObSERVE surveys (Jessopp *et al.*, 2018) recorded a total of 687 sightings of 1,533 individuals within the ObSERVE western Irish Sea survey area across the three survey periods, with 87% of these sightings recorded during the autumn surveys. Observations of fulmar were recorded throughout the ObSERVE western Irish Sea survey area, with a high aggregation in the northeastern extent which is located to the east of the Project. The natural foraging behaviour within deep waters was illustrated, with the majority of sightings made within water depths exceeding 60 m. Mean density of fulmar across the ObSERVE western Irish Sea survey area ranged from 0.07 birds/km^2 in summer surveys, 1.52 birds/km^2 in autumn surveys and 0.16 birds/km^2 in winter surveys (Jessopp *et al.*, 2018). No records of fulmar were presented within the I-WeBS database.

Site-specific data

Observations of fulmar were recorded during eight of the 19 survey months of boat-based transects, with peak counts of 18 birds recorded on transect from a total of 20 birds across the Study Area in July 2018 (Aquafact, 2019). During the DAS two fulmar were identified, one each during April and September 2020. In general, fulmar observations were distributed in the south of the Study Area, both within the offshore wind farm area and buffer.

Although there are no breeding sites within the immediate vicinity of the Project, summer records of fulmar from the site surveys are likely to be birds from breeding colonies around the Irish Sea, reflecting the fulmar’s large foraging range.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-30.

Table 4-31 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-9 shows the spatial distribution of fulmar over the survey period.

Table 4-30: Transect records and total observations of fulmar from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	0
June 2018	3	-	6
July 2018	18	-	20
August 2018	2	-	11
September 2018	2	-	5
October 2018	0	-	0
November 2018	0	-	0
December 2018	0	-	0
January 2019	0	-	0
February 2019	6	-	6
March 2019	0	-	0
April 2019	0	-	1
June 2019	0	-	0
July 2019	0	-	0
August 2019	7	-	7
October 2019	2	-	2
December 2019	0	-	0
January 2020	0	-	0
April 2020	-	1	1
May 2020	1	0	1
June 2020	-	0	0
July 2020	-	0	0
August 2020	-	1	1
September 2020	-	0	0
Total	**41**	**2**	**61**

Table 4-31: Seasonal variation of fulmar recorded between May 2018 and September 2020

Year	Spring Migration Dec – Mar	Breeding Apr – Aug	Autumn Migration Sep – October	Winter Nov	Non-breeding
2018 / 2019	-	37	5	0	-
2019 / 2020	0	14	2	0	-
2020	0	3	0	-	-

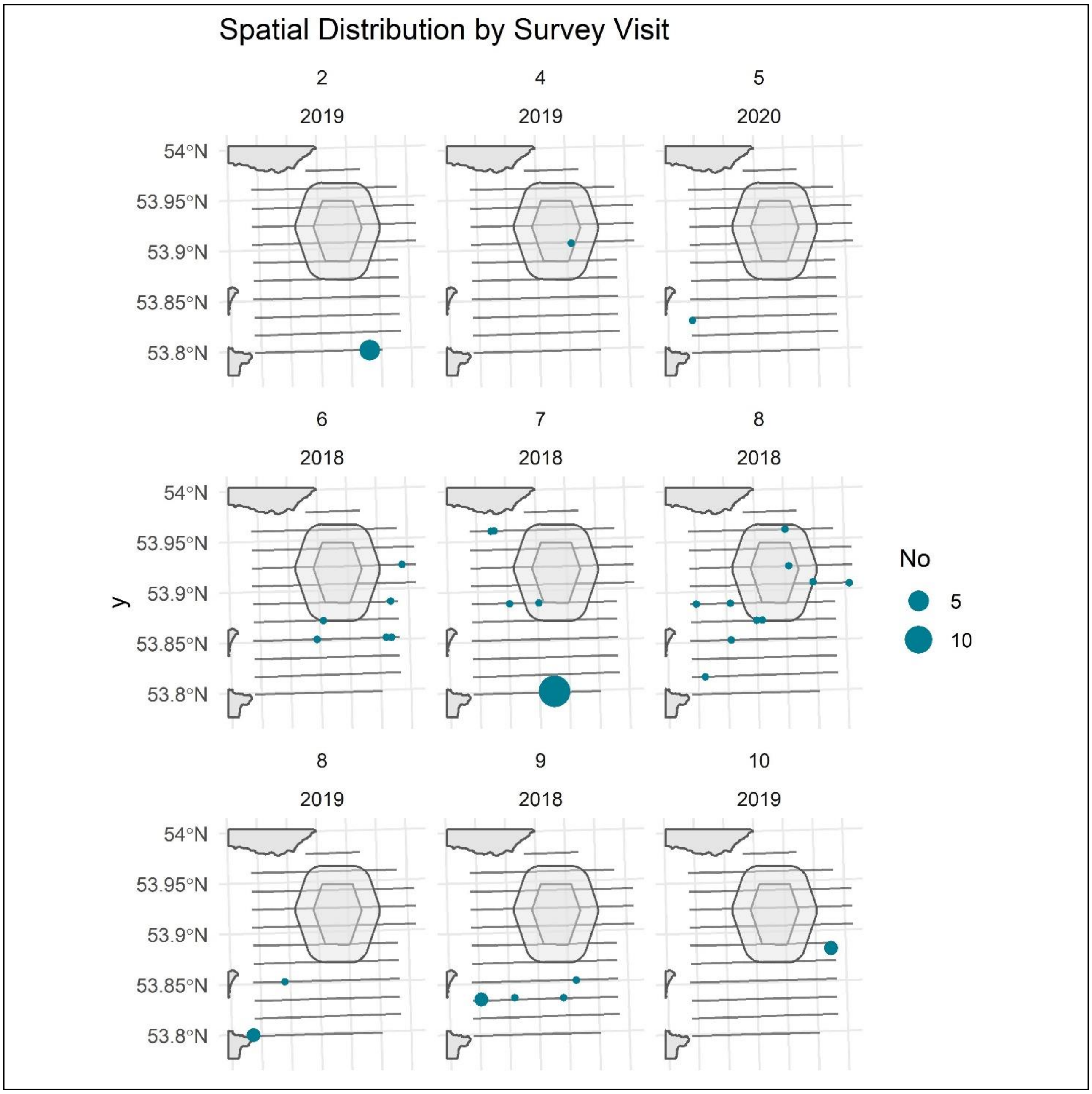

Figure 4-9: Spatial distribution of Fulmar records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

The peak levels of activity were recorded during the breeding season (up to 37 birds), with low numbers of birds recorded during the autumn migration period (up to 5 birds). Fulmar were not recorded during the spring migration or winter periods.

During the boat-based transect surveys, the majority of birds observed were sitting (37 individuals, 90.2%) compared to in flight (4 individuals, 9.8%). Off transect, a higher proportion of birds were recorded in flight (16 individuals, 88.9%) compared to sitting (2 individuals, 11.1%).

Flight heights of fulmar on transect were recorded at 5 m. Off transect, flight heights were observed between 5 m and 10 m.

Table 4-32 below shows the proportion of individuals observed sitting and flying throughout the Study Area between May 2018 and May 2020.

Table 4-32: Proportion of fulmar recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	No birds recorded							
June 2018	1	33.3	2	66.7	3	100.0	0	0
July 2018	0	0	18	100.0	0	0	2	100.0
August 2018	2	100.0	0	0	9	100.0	0	0
September 2018	0	0	2	100.0	3	100.0	0	0
October 2018	No birds recorded							
November 2018								
December 2018								
January 2019								
February 2019	0	0	6	100.0	0	0	0	0
March 2019	No birds recorded							
April 2019	0	0	0	0	1	100.0	0	0
June 2019	No birds recorded							
July 2019								
August 2019	0	0	7	100.0	0	0	0	0
October 2019	0	0	2	100.0	0	0	0	0
December 2019	No birds recorded							
January 2020								
April 2020	0	0	1	100	N/A			
May 2020	1	100.0	0	0	0	0	0	0
June 2020	No birds recorded							
July 2020								
August 2020	1	100	0	0	N/A			
September 2020	No birds recorded							
Total	**5**	**11.6**	**38**	**88.4**	**16**	**88.9**	**2**	**11.1**

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-5), it is not possible to undertake any detailed spatial analysis for this species.

4.6.6 Manx shearwater

Ecology

Manx shearwater are summer visitors to the Irish Sea (Stone *et al.*, 1995) and they tend to have localised, very large breeding colonies on coastal or offshore islands, with nesting occurring in burrows (Mitchell *et al.*, 2004; del Hoyo *et al.*, 1992).

Most of the estimated world population of approximately 340,000–410,000 pairs of Manx shearwater breed in Britain and Ireland. Of the UK population, 40% breed on Rum, and 50% in Pembrokeshire on the adjacent islands of Skomer, Skokholm and Middleholm.

Two colonies (Copeland Islands, Co. Down and Lambay Island, Co. Dublin) are located to the north and south of the Study Area. Big Copeland was estimated to hold 1,766 AOS, with a further 2,867 AOS on nearby Lighthouse Island (total 4,633 individuals). The islands were re-surveyed in 2007, when 1,406 AOS were recorded on Big Copeland and 3,444 AOS on Lighthouse Island (total 4,850) indicating that numbers had changed little overall. Changes at the respective islands between these two censuses (-20% on Big Island and +20% on Lighthouse) may be associated with logistical difficulties in surveying this nocturnal, burrow-nesting species.

It is likely that birds observed foraging within the Irish Sea are from further afield colonies within Scotland (Rum) or Wales (Skomer/Skokholm) (Stone *et al.*, 1994). Manx shearwater forage through pursuit-plunging or pursuit diving, and their diet consists of small fish, crustaceans and plankton. Manx shearwater is an Amber-listed species in the UK and Ireland due to their distribution of more than 50% of the Irish population occurring at fewer than ten sites and a decline in breeding ranges across the UK (Gilbert *et al.,* 2021, Stanbury *et al.,* 2021).

A summary of the recent (within the last five summers) colony data for Manx shearwater within the Cumulative Offshore Ornithology Study Area is provided in Table 4-33 below. If multiple years are provided then the mean count is presented. Colonies which recorded zero birds are not included.

Table 4-33: Summary of most recent colony data for Manx shearwater between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AOS) ± SD (if applicable)
Argyll and Bute	Treshnish Isles SPA	2018	1,992
Devon	Lundy	2017	5,504
Dyfed	Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA	2018	455,156
Isles of Scilly	Isle of Scilly SPA	2017 – 2021	67.5 ± 26.9
	St Agnes Island		27.3 ± 5.3
	St Helen’s		56
Kyle and Carrick	Ailsa Craig SPA	2018	20

Desk-based data

Data collected within the 2016/2017 ObSERVE surveys (Jessopp *et al.*, 2018) observed Manx shearwater as one of the more commonly sighted species within the ObSERVE western Irish Sea survey area. A total of 872 sightings of 4,736 individuals were recorded across the three surveys, the vast majority of which (3,669 individuals) occurred during the breeding season. Observations of Manx shearwater were recorded throughout the ObSERVE western Irish Sea survey area, apart from nearshore areas, and were generally observed 4 km from shore. The natural foraging behaviour within deep waters was illustrated in the records with most sightings made within water depths exceeding 20 m. Mean density of Manx shearwater across the ObSERVE western Irish Sea survey area ranged from 3.37 birds/km^2 in summer surveys, 1.15 birds/km^2 in autumn surveys and 0.01 birds/km^2 in winter surveys (Jessopp *et al.*, 2018). No records of Manx shearwater were presented within the I-WeBS database.

Site-specific data

As summer visitors to Ireland, observations of Manx shearwater were recorded during only the summer survey months (April to September) during site-specific surveys, although two and six observations were made in March and April 2018 respectively, and a further 80 in October 2019.

During the boat-based transects, peak counts were observed towards the end of the nesting period in August 2018, with a total of 1,593 birds recorded of which 990 were recorded on transect (Aquafact, 2019), and again in August 2019, with a total of 2,094 birds recorded on transect.

During the Digital Aerials, 2,377 Manx shearwater were identified across the Study Area, with larger concentrations in the east to southeast of the area. Similar to the observations during the boat-based surveys, a peak count of 1,317 birds was recorded towards the end of the breeding period in August 2020.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-34. Table 4-35 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-10 shows the spatial distribution of Manx shearwater during the survey period.

Table 4-34: Transect records and total observations of Manx shearwater from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	7	-	31
June 2018	150	-	404
July 2018	285	-	630
August 2018	990	-	1,593
September 2018	957	-	1,419
October 2018	0	-	0
November 2018	0	-	0
December 2018	0	-	0
January 2019	0	-	0
February 2019	0	-	0
March 2019	0	-	2
April 2019	1	-	4
June 2019	304	-	304
July 2019	575	-	575
August 2019	2,094	-	2,094
October 2019	80	-	80
December 2019	0	-	0
January 2020	0	-	0
April 2020	-	6	6
May 2020	223	547	770
June 2020	-	90	90
July 2020	-	280	280
August 2020	-	1,317	1,317
September 2020	-	137	137
Total	**5,666**	**2,377**	**9,736**

Table 4-35: Seasonal variation of Manx shearwater recorded between May 2018 and September 2020.

Year	Spring Migration Mar – May	Breeding Apr – Aug	Autumn Migration Sep – Oct	Winter Nov – Feb	Non-breeding
2018 / 2019	31	2,627	1,419	0	-
2019 / 2020	6	2,973	80	0	-
2020	-	2,463	137	-	-

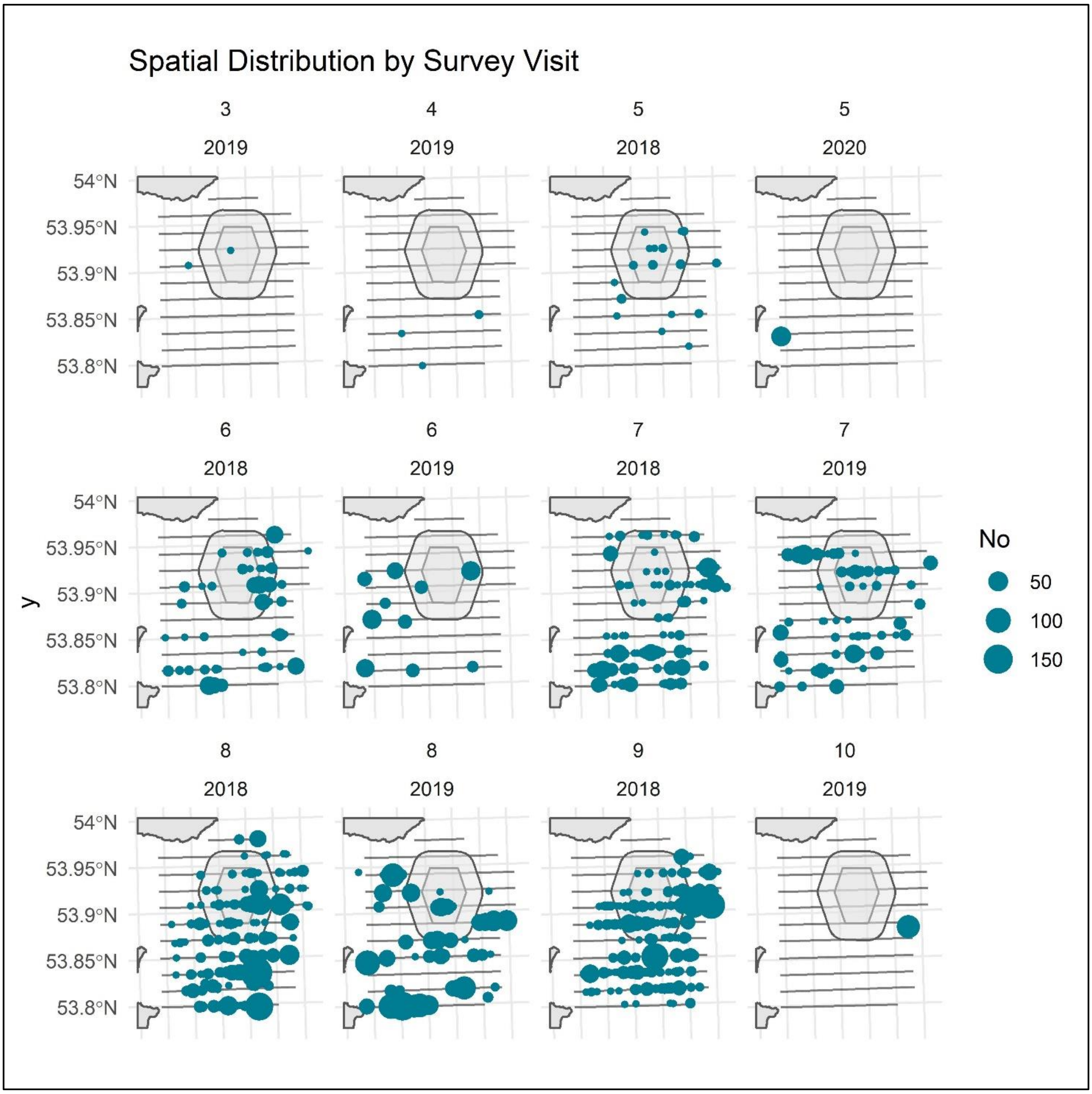

Figure 4-10: Spatial distribution Manx shearwater records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

The peak levels of activity were recorded during the breeding season (up to 2,973 birds), with lower activity recorded during the autumn migration period (up to 1,419 birds). Single numbers of Manx shearwater were recorded during spring migration (up to six birds). No birds were recorded during the winter period (November to February).

During the boat-based transect surveys, the majority of birds observed were observed sitting (5,278 individuals, 93.2%) compared to in flight (388 individuals, 6.8%), whereas off transect, a higher proportion of birds were recorded in flight (1,370 individuals, 80.9%). Flight heights of Manx shearwater were most frequently recorded at 5 m, with only a small number of individuals flying at 10 m.

During the Digital Aerial, flying Manx shearwater were recorded in all six surveys with significant orientations recorded in five surveys. The flying Manx shearwater were significantly orientated around the mean of 126°

in May 2020, 221° in June 2020, 112° in July 2020, 32° in August 2020 and 267° in September 2020. Flight heights were recorded for 133 individuals which resulted in a median altitude of 27 m above mean sea level (MSL).

Table 4-36 below shows the proportion of individuals observed sitting and flying throughout the Study Area between May 2018 and September 2020. Figure 4-11 shows the recorded flight heights of Manx shearwater during the boat-based surveys.

Table 4-36: Proportion of Manx shearwater recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	4	57.1	3	42.9	24	100	0	0
June 2018	13	8.7	137	91.3	184	72.4	70	27.6
July 2018	76	26.7	209	73.3	345	100	0	0
August 2018	45	4.5	945	95.5	390	64.7	213	35.3
September 2018	56	5.9	901	94.1	422	91.3	40	8.7
October 2018	No birds recorded							
November 2018								
December 2018								
January 2019								
February 2019								
March 2019	0	0	0	0	2	100	0	0
April 2019	0	0	1	100	3	100	0	0
June 2019	22	7.2	282	92.8	0	0	0	0
July 2019	60	10.4	515	89.6	0	0	0	0
August 2019	64	3.1	2,030	96.9	0	0	0	0
October 2019	0	0	80	100	0	0	0	0
December 2019	No birds recorded							
January 2020								
April 2020	2	33.3	4	66.7	N/A			
May 2020	366	21.5	404	78.5	0	0	0	0
June 2020	67	83.8	13	16.2	N/A			
July 2020	188	67.1	92	32.9				
August 2020	707	53.7	610	46.3				
September 2020	88	64.2	49	35.8				
Total	**1758**	**21.9**	**6,275**	**78.1**	**1,370**	**80.9**	**323**	**19.1**

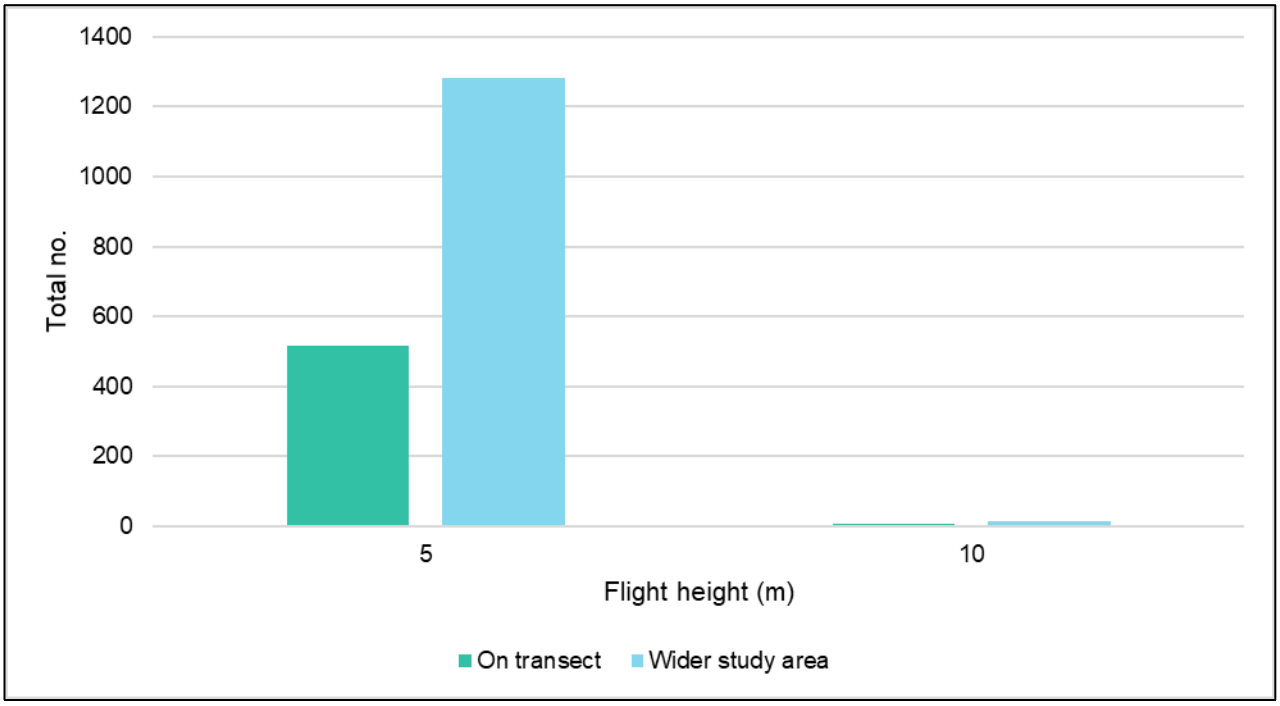

Figure 4-11: Manx shearwater flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates from the boat-based surveys

During initial data exploration and model fitting a high co-linearity / correlation between Bathymetry and distance to coast was identified resulting in a prohibitively high VIF for these parameters. Because of this, distance to coast was removed from the model. The following refined environmental and spatial covariates were used in the MRSea CreSS:

- Bathymetry;
- Year; and
- X and Y coordinates.

To prepare for the GEE-CreSS analyses, a complete grid of abutting cells based on the survey grid and environmental covariates was constructed to cover the entire survey area. All variables except X and Y co-ordinate were included in the one-dimensional SALSA model selection method (Walker *et al.,* 2011) and automatic model simplification using non-significant p-values was carried out. An appropriate blocking structure using transect ID was included as there was evidence of autocorrelation. Period was fitted as a factor term. This model failed to converge and as such depth / bathymetry was removed from the model parameters and a simple linear model with an area offset was used as the base model for assessment of the 2D spatial smoother.

CreSS was used to fit the spatial density surface and GEEs were used to provide realistic model-based estimates. The GEE-CreSS grid knot locations are included in in Appendix A.1. of this report. An interaction with month was included to allow the density surface to vary between survey periods. Survey periods included in this modelling step were limited to those with greater than one observation occurrence of the species to prevent model convergence issues. This meant that modelled abundance estimates could only be produced for mid breeding, late breeding and post breeding periods only.

Following predictions, bootstrapping was used to generate 95 % confidence intervals for each grid cell to allow for an assessment of uncertainty. The bootstrapping procedure incorporated any autocorrelation specified within the prediction model following the CreSS method.

All behaviours (both sitting and flying birds)

Table 4-37 to Table 4-39 below present the Manx shearwater modelled abundance estimates for the offshore wind farm area, offshore wind farm area plus 2 km buffer and Offshore Ornithology Study Area during breeding season periods. Due to model convergence issues it was not possible to include data from other periods and produce estimates for such periods. This is considered likely due to the low numbers of observations during these periods and the excessive number of zero counts present.

Table 4-37: Manx shearwater offshore wind farm area modelled abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
June 2018	78	28	196
July 2018	66	22	222
August 2018	131	69	294
September 2018	227	97	969
June 2019	135	51	363
July 2019	113	35	362
August 2019	225	117	471

Table 4-38: Manx shearwater offshore wind farm area plus 2 km buffer modelled abundance estimates by Period.

Month / Year	Estimate	LCL	UCL
June 2018	254	91	627
July 2018	209	68	731
August 2018	507	283	1,007
September 2018	1,034	532	3,109
June 2019	436	160	1,102
July 2019	360	115	1,169
August 2019	872	481	1,629

Table 4-39: Manx shearwater Offshore Ornithology Study Area modelled abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
June 2018	2,173	812	5,579
July 2018	1,751	638	5,718
August 2018	7,037	4,037	12,825
September 2018	5,504	2,382	14,913
June 2019	3,738	1,400	9,745
July 2019	3,012	1,124	9,527
August 2019	12,102	6,970	21,241

Flying birds only

There were 3,128 records of flying Manx Shearwater over the study period. Densities of flying birds were derived from the total numbers seen in radial snapshots, divided by the total area surveyed by snapshots (survey effort); that is the number of snapshots multiplied by the snapshot area of 0.09 km^2.

Non-parametric bootstrap intervals have been used to calculate the standard error and 95% confidence intervals around the observed counts and densities per km2. The area of the offshore wind farm area has then been used to calculate simple abundances based on density results (Table 4-40 and Table 4-41).

Table 4-40: Manx shearwater flying bird offshore wind farm area simple abundance estimates.

Season	Estimate	LCL (95%)	UCL (95%)
Mid winter	0	0	0
Late winter	0	0	0
Early breeding season	669	411	920
Mid breeding season	564	390	735
Late breeding season	242	175	308
Post breeding / moult	271	225	316
Autumn	0	0	0
Early winter	0	0	0

Table 4-41: Manx shearwater flying bird offshore wind farm area plus 2 km buffer simple abundance estimates.

Season	Estimate	LCL (95%)	UCL (95%)
Mid winter	0	0	0
Late winter	0	0	0
Early breeding season	1,946	1,195	2,676
Mid breeding season	1,640	1,134	2,138
Late breeding season	704	509	896
Post breeding / moult	788	654	919
Autumn	0	0	0
Early winter	0	0	0

Design-based spatial abundance estimates during the DAS

DAS abundance analysis was undertaken by APEM and summarised fully within annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The abundance estimates are presented below for Manx shearwater at the different spatial scales. Table 4-42 presents the abundance estimates for sitting birds only whereas, Table 4-43 presents the abundance estimates for flying birds. Detailed methods on calculation of the abundance estimates are presented in section 3.4.3. When provided the LCL and UCL are presented within brackets after the estimate.

Table 4-42: Abundance estimates of sitting Manx shearwater within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	3 (1 - 8)	2 (1 - 7)
May 2020	44 (16 - 88)	44 (17 - 105)
June 2020	8 (3 - 16)	10 (4 - 20)
July 2020	3 (1 - 8)	5 (2 - 13)
August 2020	3 (1 - 8)	10 (4 - 23)
September 2020	No birds recorded	No birds recorded

Table 4-43: Abundance estimates of flying Manx shearwater within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	No birds recorded	No birds recorded
May 2020	8 (3 - 25)	57 (22 - 162)
June 2020	8 (3 - 24)	13 (5 - 28)
July 2020	3 (1 - 8)	8 (3 - 18)
August 2020	63 (35 - 82)	167 (114 - 227)
September 2020	11 (4 - 25)	39 (21 - 60)

4.6.7 Gannet

Ecology

The gannet is the largest seabird in the North Atlantic, having a wingspan of up to 2 m (6.6 ft), and can be observed around the Irish coastline throughout the year (Balmer *et al.*, 2013) although in scarcer numbers during winter months. Gannet forage through plunge-diving to a depth of up to 35 m, diving at high speeds into the sea with their bodies straight and rigid, wings tucked close to the body but angled back. Gannet forage on a variety of prey species, and they appear to have diet plasticity with different prey recorded at different colonies. Herring and mackerel were the most common prey species at colonies in Shetland, the Firth of Forth and Quebec (Garthe *et al.*, 2007; Lewis *et al.*, 2003) whilst capelin dominated prey in a low Arctic colony in Newfoundland.

Gannet foraging behaviours are supported by their long and narrow wings which are positioned towards the front of the body, allowing efficient use of air currents when flying. This relatively high wing loading results in a fast flight speed (55-65 km/hr) with relatively low manoeuvrability (Nelson, 2010). They usually fly between 3 and 105 m above sea level with most time spent between 11 and 60 m (Thaxter *et al.,* 2015).

The gannet is an Amber-listed species in Ireland due to their distribution of more than 50% of the Irish population occurring at fewer than ten sites (Gilbert *et al.,* 2021, Stanbury *et al.,* 2021). The main colonies in Ireland are located on islands off the coast and include Great Saltee, Bull Rock and Little Skellig. Smaller colonies are also found on Irelands Eye and Clare's Island. A sixth colony on Lambay had established since the last census (in 2007). The most recent census of gannet in Ireland took place in the breeding seasons between 2013 and 2014 (Cummins *et al.,* 2019); the results were largely based on aerial photography and supplemented by land-based VP counts at smaller colonies. The census revealed that the Irish population had increased by an estimated 33% over the 10-year period from 36,111 AOS in 2004 to 47,946 AOS in 2014 (Table 6-41).

Table 4-44: Census totals (AOS) of gannet at Irish colonies for the period 1969-70 to 2013-14 (Cummins *et al.*, 2019).

Site	1969 – 1970	1984 – 1985	1995	2004	2013-2014	% Change Since 2004
Clare Island	0	2	3	3	267	+ 8800%
Little Skellig	Approximately 22,000	22,500	26,436	29,600	35,294	+ 19%
Bull Rock	Approximately 1,500	1,511	1,815	3,694	6,388	+ 73%
Great Saltee	155	710	1,250	2,446	4,722	+ 93%
Ireland’s Eye	-	-	45	285	547	+ 92%
Lambay	-	-	-	-	728	-
National Total	23,655	24,723	29,549	36,111	47,946	+ 33%

The last census to cover all UK gannetries was carried out over two breeding seasons in 2003 and 2004. In 2013 and 2014 all Scottish colonies were surveyed, while Grassholm (Wales) was counted again in 2015. Similarly Irish colonies (Ireland’s Eye, Lambay Island, Bull Rock and Great Saltee) where last counted between 2014 and 2015 The last colony count of St Margaret’s Island (Caldey Island, Pembrokeshire) was undertaken in 2019 and recorded no occupied nests. A small colony (< 50 birds) has been recorded for the first time in 2022 on Middle Mouse off the north coast of Anglesey.

A summary of the recent (within the last 10 summers) colony data for gannet within the Cumulative Offshore Ornithology Study Area and within the mean max foraging range of the species is provided in Table 4-46 below. If multiple years are provided then the mean count is presented.

Table 4-45: Summary of most recent colony data for gannet between 2012 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AOS/AON) ± SD (if applicable)
Cork	Bull Rock	2014	6,388
Donegal	Garven Islands	2016	30
Dublin	Ireland’s Eye	2013 and 2015	448.5 ± 98.5
	Lambay Island	2013 and 2015	827 ± 99
Dyfed	Grassholm SPA	2015	36,011
Gwynedd	Porth Llanlleiana to Porth Eilian	2022	21
Kyle and Carrick	Ailsa Craig SPA	2014	33,226
Wexford	Great Saltee	2013	4,722
Wigtown	Monreith Cliffs and Scar Rocks	2014	2,376

Desk-based data

Data collected within the 2016/2017 ObSERVE surveys (Jessopp *et al.*, 2018) provided a total of 666 sightings of 1,192 gannet across the three surveys within the ObSERVE western Irish Sea survey area. This species was observed predominately in the northern transects of the ObSERVE western Irish Sea survey area, which were located around the Dundalk Bay area. Observations of gannet were far more common in summer and autumn surveys, with sightings of individuals or small groups most frequently observed. Winter sightings were very sparse (27 sightings, 33 individuals) and were exclusively adult birds. Mean density of gannet across the ObSERVE western Irish Sea survey area ranged from 0.88 birds/km^2 in autumn surveys, 0.33 birds/km^2 in summer surveys and 0.03 birds/km^2 in winter (Jessopp *et al.*, 2018). No records of gannet were presented within the I-WeBS database.

Site-specific data

Gannet observations were recorded in all months of the survey period except November 2018, January 2019, December 2019 and January 2020. The greatest abundances were in recorded in September 2018 (247 individuals), August 2018 (183 individuals) and August 2019 (183 individuals), with a total of 1,718 observations recorded within the entire Study Area.

A monthly breakdown of gannet records from the transect surveys and from within the entire Study Area are presented in Table 4-46. Table 4-47 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-12 shows the spatial distribution of gannet during the survey period.

Table 4-46: Transect records and total observations of gannet from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	2	-	12
June 2018	27	-	80
July 2018	17	-	66
August 2018	62	-	199
September 2018	119	-	247
October 2018	23	-	99
November 2018	0	-	0
December 2018	2	-	4
January 2019	0	-	3
February 2019	1	-	3
March 2019	3	-	20
April 2019	8	-	33
June 2019	5	-	5
July 2019	20	-	20
August 2019	183	-	183
October 2019	23	-	23
December 2019	0	-	0
January 2020	0	-	0
April 2020	-	73	73
May 2020	38	127	165
June 2020	-	41	41
July 2020	-	156	156
August 2020	-	145	145
September 2020	-	141	141
Total	**533**	**683**	**1,718**

Table 4-47: Seasonal variation of gannet recorded between May 2018 and September 2020.

Year	Spring Migration Dec – Feb	Breeding Mar – Aug	Autumn Migration Sep – Nov	Winter	Non-breeding
2018 / 2019	10	357	346	-	-
2019 / 2020	0	261	23	-	-
2020	-	580	141	-	-

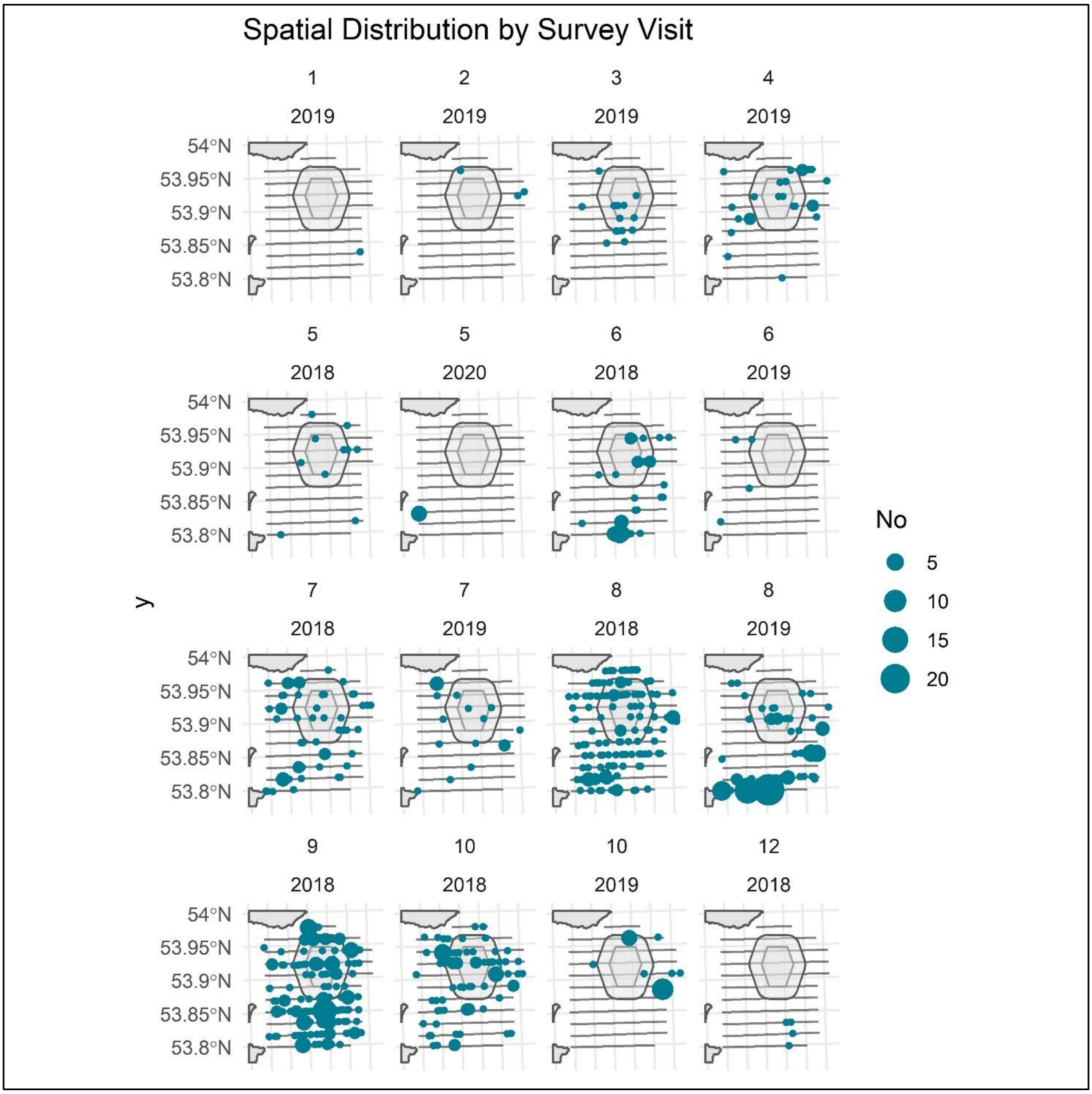

Figure 4-12: Spatial distribution of gannet records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

The peak levels of activity were recorded during the breeding season (Mar-Sep) each year; outside the peak recording period, gannet was typically recorded further offshore (i.e. away from the west and northwest parts of the Study Area). However, during the peak recording months, birds were widespread throughout the Study Area. Single observations for gannet were recorded during the winter months.

During the boat-based transect surveys, the majority of birds (464 individuals, 87.1%) observed along the route were sitting; off transect, a higher proportion of birds (429 individuals, 85.5%) were recorded flying. Flight heights along the transect route were most frequently recorded between 5 m and 30 m with single observations of birds flying between 40 m and 50+ m. Off transect, a greater proportion of birds were recorded flying at 5 m, with a gradual decrease in numbers towards 50 m.

During the DAS (APEM, 2020), a total of 683 gannet were identified, of which 341 were observed sitting and 342 were recorded flying. Flying gannet were recorded in all six surveys and a significant orientation was observed in five of them; orientated around the mean of 99° in April, 108° in May, 225° in June, 88° in August and 233° in September. Flight heights were recorded for 64 individuals which resulted in a median altitude of 21 m above mean sea level (MSL).

Table 4-48 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and September 2020. Figure 4-13 shows the recorded flight heights of gannet during the boat-based surveys.

Table 4-48: Proportion of gannet recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	2	100.0	0	0	9	90.0	1	10.0
June 2018	0	0	27	100.0	33	62.2	20	37.8
July 2018	2	11.8	15	88.2	45	91.8	4	8.2
August 2018	4	6.5	58	93.5	113	82.5	24	17.5
September 2018	16	13.4	103	86.6	114	89.1	14	10.9
October 2018	3	13.0	20	87.0	74	97.4	2	2.6
November 2018	No birds recorded							
December 2018	2	100.0	0	0	2	100.0	0	0
January 2019	0	0	0	0	1	33.3	2	66.7
February 2019	1	100.0	0	0	2	100.0	0	0
March 2019	0	0	3	100.0	15	88.2	2	11.8
April 2019	1	12.5	7	87.5	21	84.0	4	16.0
June 2019	1	20.0	4	80.0	0	0	0	0
July 2019	8	40.0	12	60.0	0	0	0	0
August 2019	6	3.3	177	96.7	0	0	0	0
October 2019	4	17.4	19	82.6	0	0	0	0
December 2019	No birds recorded							
January 2020								
April 2020	39	53.4	34	46.6	N/A			
May 2020	61	37	104	63	0	0	0	0
June 2020	32	78	9	22	N/A			
July 2020	86	55.1	70	44.9				
August 2020	62	42.8	83	57.2				
September 2020	81	57.4	60	42.6				
Total	**411**	**33.8**	**805**	**66.2**	**429**	**85.5**	**73**	**14.5**

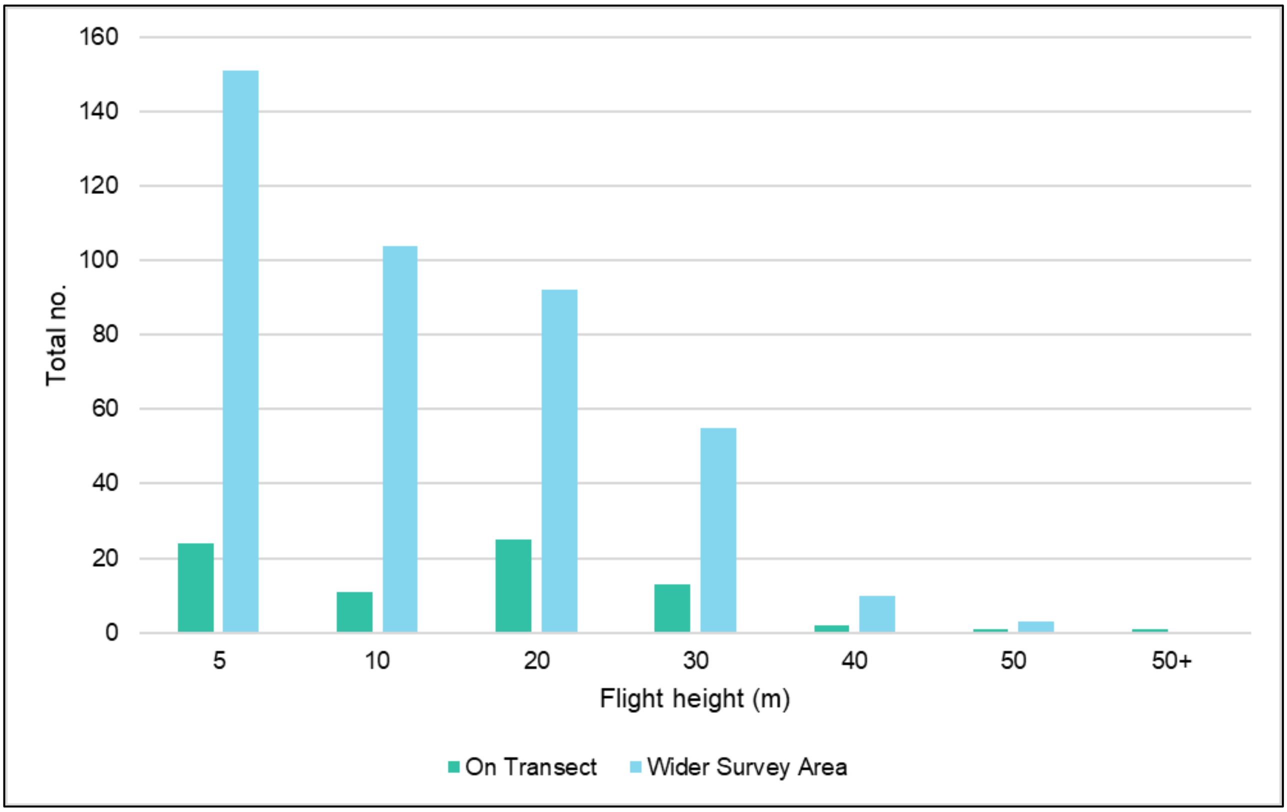

Figure 4-13: Gannet flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates during the boat-based surveys

During initial data exploration and model fitting a high co-linearity / correlation between Bathymetry and distance to coast was identified resulting in a prohibitively high VIF for these parameters. Because of this distance to coast was removed from the model. The following refined environmental and spatial covariates were used in the MRSea CreSS:

- Bathymetry;
- Year; and
- X and Y coordinates.

In addition to the co-linearity identified above a low number of observations were also identified in some months for gannet and this also inhibited model convergence when using month as an interaction to term. As such seasonal periods were used in place of month for this analysis.

To prepare for the GEE-CreSS analyses, a complete grid of abutting cells based on the survey grid and environmental covariates was constructed to cover the entire survey area. All variables except X and Y co-ordinate were included in the one-dimensional SALSA model selection method (Walker *et al.,* 2011) and automatic model simplification using non-significant p-values was carried out. An appropriate blocking structure using transect ID was included as there was evidence of autocorrelation. Period was fitted as a factor term. This provided the base model for assessment of the 2D spatial smoother.

CreSS was used to fit the spatial density surface and GEEs were used to provide realistic model-based estimates. The GEE-CreSS grid knot locations are included in Appendix A1 of this report. An interaction with month was included to allow the density surface to vary between survey months. Following predictions, bootstrapping was used to generate 95 % confidence intervals for each grid cell to allow for an assessment of uncertainty. The bootstrapping procedure incorporated any autocorrelation specified within the prediction model following the CreSS method.

All behaviours (both sitting and flying birds)

Table 4-49 to Table 4-51 below present the gannet modelled abundance estimates for the offshore wind farm area, the offshore wind farm area plus 2 km buffer and the Offshore Ornithology Study Area.

Table 4-49: Gannet modelled sitting bird abundance estimates for offshore wind farm area by survey.

Month / Year	Estimate	LCL	UCL
May 2018	0	0	NA
June 2018	0	0	6
July 2018	7	3	16
August 2018	7	4	3
September 2018	28	18	51
October 2018	5	2	10
February 2019	0	0	NA
March 2019	9	7	12
April 2019	3	1	15
June 2019	0	0	1
July 2019	2	1	6
August 2019	17	10	29
October 2019	12	6	22
May 2020	0	0	NA

Table 4-50: Gannet modelled sitting bird abundance estimates for offshore wind farm area plus 2 km buffer by survey.

Month / Year	Estimate	LCL	UCL
May 2018	0	0	NA
June 2018	2	0	7
July 2018	16	7	40
August 2018	21	12	38
September 2018	79	48	150
October 2018	13	6	32
February 2019	0	0	NA
March 2019	9	7	12
April 2019	9	2	54
June 2019	3	7	14
July 2019	7	2	24
August 2019	54	31	91
October 2019	34	15	74
May 2020	0	0	NA

Table 4-51: Gannet modelled sitting bird abundance estimates for Offshore Ornithology Study Area by survey.

Month / Year	Estimate	LCL	UCL
May 2018	0	0	NA
June 2018	57	25	172
July 2018	66	26	189
August 2018	219	122	404
September 2018	369	196	773
October 2018	61	19	293
February 2019	0	0	NA
March 2019	9	7	12
April 2019	27	6	NA
June 2019	23	9	70
July 2019	27	9	87
August 2019	579	35	928
October 2019	162	47	714
May 2020	0	0	NA

Flying birds only

There are 478 records of flying gannet over the study period. Densities of flying birds were modelled using a similar approach to loafing birds described above where sufficient data was available to do so. For gannet sufficient observations were only available for the early breeding season, mid-breeding season, late breeding season, post breeding / moult and autumn periods to allow modelled estimation of flight densities. These data are presented in Table 4-52 and Table 4-53.

Table 4-52: Gannet flying bird offshore wind farm area abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	1	0	6
June 2018	10	5	28
July 2018	22	12	40
August 2018	127	99	162
September 2018	85	66	110
October 2018	60	47	76
November 2018	0	0	NA
December 2018	0	0	4
January 2019	0	0	NA
February 2019	0	0	10
March 2019	23	14	37
April 2019	21	10	44
June 2019	2	0	10
July 2019	5	1	15
August 2019	3	2	5
October 2019	2	1	3

Month / Year	Estimate	LCL	UCL
December 2019	0	0	0
January 2020	0	0	NA
May 2020	4	1	13

Table 4-53: Gannet flying offshore wind farm area plus 2 km buffer abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	3	0	21
June 2018	31	14	87
July 2018	64	35	122
August 2018	405	321	512
September 2018	257	198	335
October 2018	168	131	217
November 2018	0	0	NA
December 2018	0	0	13
January 2019	1	0	NA
February 2019	39	5	39
March 2019	76	47	134
April 2019	56	26	126
June 2019	7	1	32
July 2019	13	4	45
August 2019	11	6	17
October 2019	4	2	8
December 2019	0	0	0
January 2020	0	0	NA
May 2020	13	4	50

Design-based spatial abundance estimates during the DAS

DAS abundance analysis was undertaken by APEM and summarised fully within annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The abundance estimates are presented below for gannet at the different spatial scales. Table 4-54 presents the abundance estimates for sitting birds only whereas, Table 4-55 presents the abundance estimates for flying birds. Detailed methods on calculation of the abundance estimates are presented in section 3.4.3. When provided the LCL and UCL are presented within brackets after the estimate.

Table 4-54: Abundance estimates of sitting gannet within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	13 (5 - 29)	40 (16 - 87)
May 2020	96 (35 - 256)	100 (39 - 234)
June 2020	No birds recorded	
July 2020	25 (14 - 39)	58 (33 - 89)
August 2020	16 (6 - 33)	58 (35 - 86)

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
September 2020	11 (4 - 19)	39 (21 - 62)

Table 4-55: Abundance estimates of flying gannet within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	No birds recorded	22 (9 - 42)
May 2020	38 (14 - 71)	49 (19 - 85)
June 2020	3 (1 - 8)	10 (4 - 20)
July 2020	30 (11 - 61)	81 (46 - 124)
August 2020	16 (6 - 33)	40 (20 - 63)
September 2020	22 (8 - 66)	81 (34 - 146)

4.6.8 Shag

Ecology

Shag is a coastal, piscivorous seabird that obtains prey by pursuit-diving (Watanuki *et al.,* 2008). Birds are widely dispersed around Ireland throughout the year (Stone *et al.*, 1995). The shag illustrates a strong preference for rocky coasts and islands, although they are also found over shallow, sandy sediments. Shag are almost exclusively benthic feeders, using two very distinct foraging habitats: sandy areas and rocky areas at depths of between 10 and 40 m.

Foraging behaviour differs markedly between habitats; in rocky areas birds travel along the bottom searching for bottom-living fish, whilst in sandy habitat they probe into the sand with their bill to catch lesser sandeels (Watanuki *et al.,* 2008). Long-term variability in the diet of this species has also been recorded (Howells *et al.*, 2018) with dramatic reductions in the frequency of lesser sandeel occurrence between 1984 and 2017 (especially during non-breeding).

The UK shag population increased slightly from 30,000 pairs in 1969-70 to 36,000 pairs in 1985-88, possibly as a result of better coverage of previously inaccessible coastlines through the use of inflatable boats, increased legal protection (e.g. under the Wildlife and Countryside Act 1981, as amended) and reduced persecution. However, numbers had fallen by 27% by the time of Seabird 2000. Severe events, such as those in the winters of 1993/1994 and 2004/2005, considerably affected populations on the east coast of the UK. These trends have resulted in the shag being Red-listed in the UK due to the sharp population declines over 25 years and over the longer term (Stanbury *et al.,* 2021).

In Ireland, the shag is an Amber-listed species due to their distribution of more than 50% of the Irish population occurring at fewer than ten sites (Gilbert *et al*., 2021). Table 4-56 below shows the population estimates of individual shag colonies over time (Cummins *et al*., 2019).

Table 4-56: Census totals (AON) of shag at a selection of Irish colonies for the period since Seabird 2000 (Cummins *et al.,* 2019).

Site	Seabird 2000	2007	2015 – 2018	Change (from Seabird 2000)
Inishmurray	104	-	389	+ 274%
Howth	12	55	41	+ 241%
Ireland’s Eye	32	64	81	+ 153%
Old Head of Kinsale	30	25	46	+ 53%

Site	Seabird 2000	2007	2015 – 2018	Change (from Seabird 2000)
Clare Island	86	-	78	- 9%
Lambay	1,122	1670	469	- 58%
Great Saltee	2,687	-	112	- 58%

A summary of the recent (within the last five summers) colony data for shag within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-57 below. If multiple years are provided then the mean count is presented.

Table 4-57: Summary of most recent colony data for shag between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
Down	Maggy's Leap	2017 and 2019	7 ± 2

Desk-based data

Data collected within the 2016/2017 ObSERVE surveys (Jessopp *et al.*, 2018) did not differentiate between cormorant and shag and were grouped together. A total of 174 observations of 534 birds were recorded across the three survey periods, all of which were recorded within the coastal region of the ObSERVE western Irish Sea survey area. A preference for shallow waters was evident through a peak in the distribution of sightings over water depths of around 10 m, and very few sightings were observed in waters of depths of greater than 20 m. Mean density of cormorants/shags across the ObSERVE western Irish Sea survey area ranged from 0.31 birds/km^2 in summer surveys, 0.3 birds/km^2 in autumn surveys and 0.14 birds/km^2 in winter surveys (Jessopp *et al.*, 2018).

Several observations of shag were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-58. A five-year peak observation of 6 birds was recorded in the 2016/2017 season, along with a five-year peak-mean count of 2 birds between 2015/16 and 2019/20 (I-WeBS, 2022).

Table 4-58: Summary of I-WeBS survey counts for shag within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
1	0	6	2	-	-

Site-specific data

Although shag was recorded during all survey months except March 2019 and July 2019, observations fluctuated throughout the 19 months surveyed, as presented within Table 4-59. Greater numbers were observed during post-breeding dispersal (August to October) and spring migration months (December to February). Peak counts on transect were recorded in December 2019 (25 individuals), October 2018 (24 individuals) and December 2018 (23 birds) (Aquafact, 2019).

A summary of the monthly records from the boat-based transect surveys is presented in Table 4-59. Table 4-60 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Specific counts for shag were not recorded during the Digital Aerials undertaken by APEM between April 2020 and September 2020 and are therefore not included in the tables below. Figure 4-14 shows the spatial distribution of shag during the survey period.

Table 4-59: Transect records and total observations of shag from boat-based surveys in the Study Area.

Month / Year	Transect Records	All Records
May 2018	10	12
June 2018	0	2
July 2018	1	3
August 2018	13	17
September 2018	0	7
October 2018	24	35
November 2018	5	7
December 2018	23	59
January 2019	20	25
February 2019	17	23
March 2019	0	0
April 2019	0	1
June 2019	4	4
July 2019	0	0
August 2019	2	2
October 2019	19	20
December 2019	25	25
January 2020	19	19
May 2020	1	1
Total	**183**	**262**

Table 4-60: Seasonal variation of shag recorded between May 2018 and September 2020.

Year	Spring Migration Dec – Feb	Breeding Mar – Aug	Autumn Migration Sep – Oct	Winter Nov	Non-breeding
2018 / 2019	107	34	42	7	-
2019 / 2020	44	7	20	0	-
2020	-	1	-	-	-

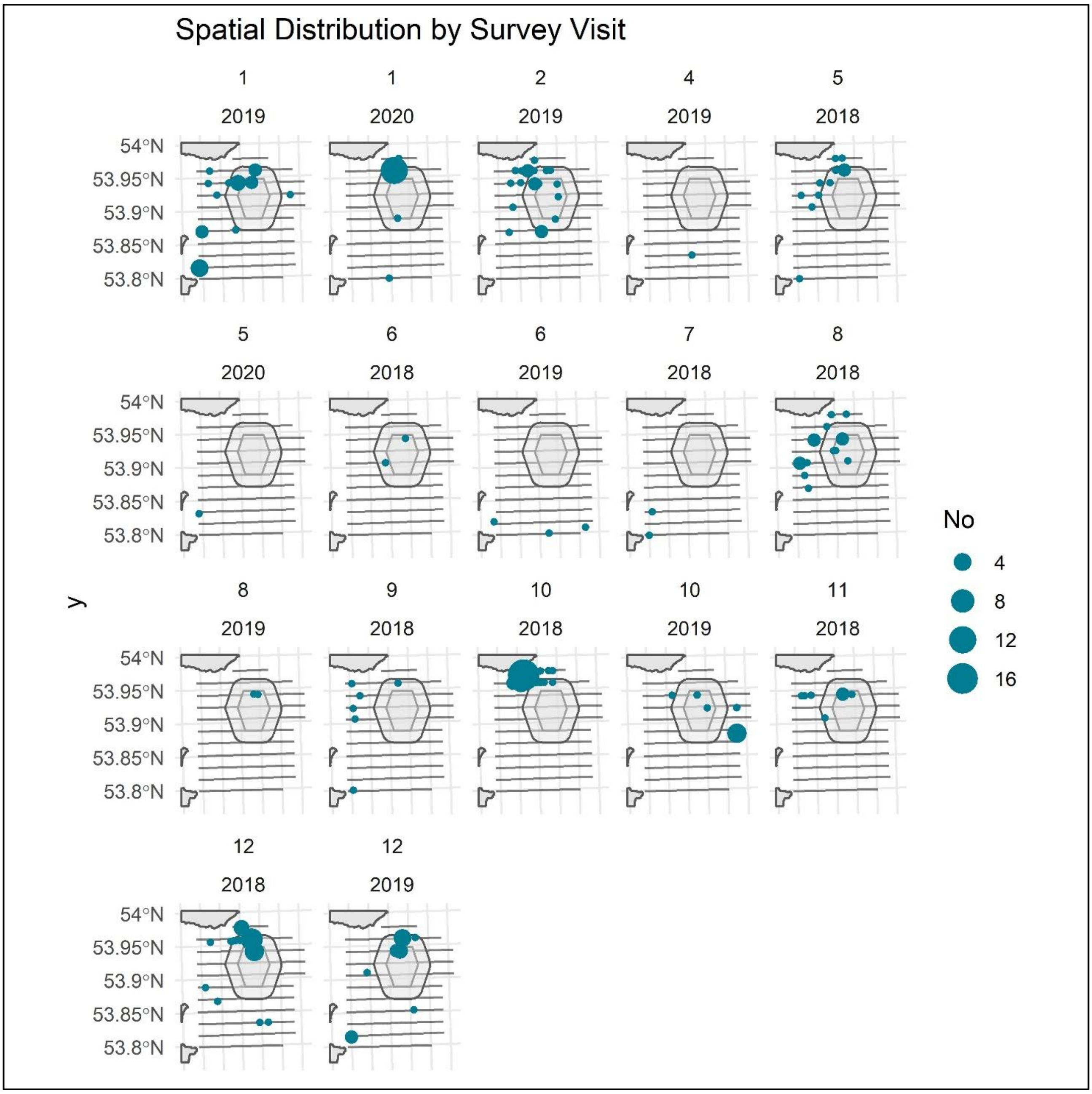

Figure 4-14: Spatial distribution of shag records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, the majority of birds observed were observed sitting (176 individuals, 91.3%) compared to in flight (16 individuals, 8.7%), whereas off transect, a higher proportion of birds were recorded in flight (56 individuals, 70.9%). Flight heights of shag were most frequently recorded at 5 m on and off transect.

During the Digital Aerial, six cormorant / shag were identified: two each in April, May and September 2020. The cormorant / shag individuals were located in pairs, one pair in the southwest corner of the Ornithology Study area, just outside the boundary in April 2020 and the other two pairs located to the northwest of the area.

Table 4-61 below shows the proportion of individuals observed sitting and flying throughout the Study Area between May 2018 and May 2020 (Aquafact, 2019). Figure 4-15 shows the recorded flight heights of shag during the same period.

Table 4-61: Proportion of shag recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	0	0	10	100.0	2	100.0	0	0
June 2018	0	0	0	0	2	100.0	0	0
July 2018	1	100.0	0	0	2	100.0	0	0
August 2018	0	0	13	100.0	4	100.0	0	0
September 2018	0	0	0	0	7	100.0	0	0
October 2018	0	0	24	100.0	10	90.9	1	9.1
November 2018	1	20.0	4	80.0	2	100.0	0	0
December 2018	1	4.3	22	95.7	14	38.9	22	61.1
January 2019	3	15.0	17	85.0	5	100.0	0	0
February 2019	3	17.6	14	82.4	6	100.0	0	0
March 2019	No birds recorded							
April 2019	0	0	0	0	1	100.0	0	0
June 2019	0	0	4	100.0	0	0	0	0
July 2019	No birds recorded							
August 2019	0	0	2	100.0	0	0	0	0
October 2019	2	10.5	17	89.5	1	100.0	0	0
December 2019	2	8.0	23	72.0	0	0	0	0
January 2020	3	15.8	16	84.2	0	0	0	0
May 2020	0	0	1	100.0	0	0	0	0
Total	**16**	**8.7**	**167**	**91.3**	**56**	**70.9**	**23**	**29.1**

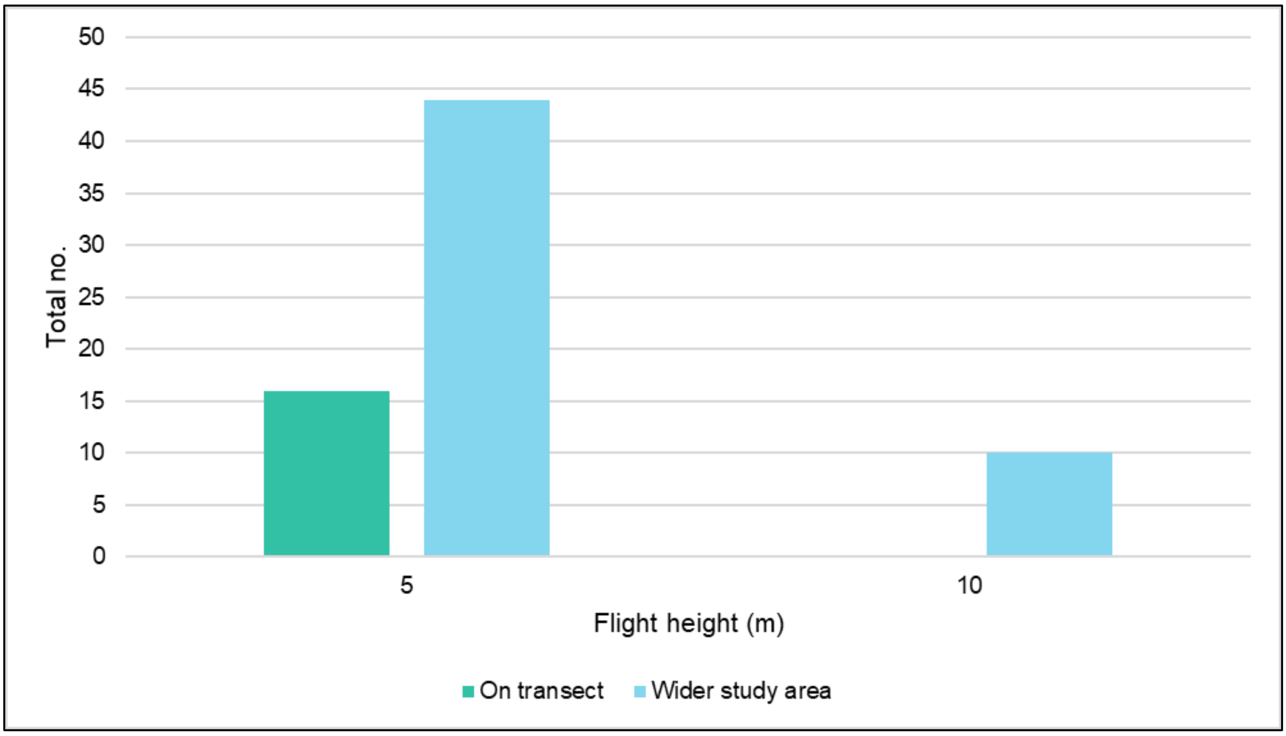

Figure 4-15: Shag flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-14), it is not possible to undertake any detailed spatial analysis for this species.

4.6.9 Cormorant

Ecology

Cormorant can occupy terrestrial and inland habitats and can be observed to nest within trees; however, it also inhabits marine environments such as sheltered coastal areas in estuaries, coastal bays and similar habitats and typically deeper waters and offshore areas (Balmer *et al.*, 2013; BirdLife International, 2020; Mitchell *et al.*, 2004).

Cormorants forage to depths of up to 10 m, and exceptionally down to 35 m (BirdLife International, 2020), up to 20-25 km from its wintering roosts or breeding colonies. As a generalist, cormorant is understood to feed on at least 22 different fish species (BirdLife International, 2019). Their diet consists of fish, including sculpins, capelin, gadids and flatfish (BirdLife International, 2019) as well as crustaceans, amphibians (del Hoyo *et al.*, 1992), molluscs and nestling birds (Brown *et al.*, 1982).

There is pronounced regional variation in the trends of abundance in great cormorant. Populations in northern Scotland have declined severely, whereas in England, inland colonies at least have increased with 2,362 pairs nesting in 2012. In Wales, numbers have been more stable. Increases in abundance up to 1995 are likely to have been facilitated by increased legal protection instigated under the Wildlife and Countryside Act 1981 (as amended). Factors responsible for recent declines are likely to include increased mortality from licensed and unlicensed shooting, as well as possible changes in food availability.

In Northern Ireland, there are only six known cormorant colonies. These held 663 AON during Seabird 2000, which was 10% fewer than that recorded during the SCR Census (736 AON) but six-times more than recorded by Operation Seafarer (108 AON). However, from 2017 to 2018, five colonies (Strangford Lough, Burial Island, Gobbins, Little Skerries and Sheep Island) held 673 AON, a very similar number to the Seabird

2000 count. Table 4-62 shows the census totals (AON) of cormorant at a selection of Irish colonies for the period 1985 – 1988 to 2015 – 2018 (Cummins *et al.,* 2019).

Table 4-62: Census totals (AON) of cormorant at a selection of Irish colonies for the period 1985 – 1988 to 2015 – 2018 (Cummins *et al.,* 2019).

Site	SCR (1985 – 1988)	Seabird 2000 (1998 – 2002)	2015 – 2018	% Change (1998 – 2018)
Ballycotton Island	-	46	75	+ 63%
Capel Island	-	52	82	+ 58%
Ireland’s Eye	19	306	424	+ 39%
Lough Derg	417	207	272	+ 31%
Inishowen Peninsula	-	225	289	+ 28%
Ardboline and Horse Island	-	156	191	+ 22%
Deer Island	-	200	212	+ 6%
Keeragh Islands	239	200	199	- 1%
St. Patrick’s Island	0	558	544	- 3%
Little Saltee	234	273	208	- 24%
Duvillaun Islands	154	20	10	- 50%
Sovereign Islands	-	156	76	- 51%
Lough Scannive	218	160	71	- 56%
Lambay Island	1,027	675	299	- 56%
Lough Cutra	166	150	0	- 100%

Due to a moderate decline in their breeding populations, cormorant is Amber-listed in Ireland (Gilbert *et al*., 2021).

There is no colony data for cormorant within the Cumulative Offshore Ornithology Study Area and within the mean max foraging range of the species. The closest breeding colony is within Strangford Lough approximately 70 km away from the Project and outwith the mean max foraging range + 1 SD of 33.9 km for cormorant.

Desk-based data

Data collected within the 2016/2017 ObSERVE surveys (Jessopp *et al.*, 2018) did not differentiate between cormorant and shag and were grouped together. A total of 174 observations of 534 birds were recorded across the three survey periods, all of which were recorded within the coastal region of the ObSERVE western Irish Sea survey area. A preference for shallow waters was evident through a peak in the distribution of sightings over water depths of around 10 m, and very few sightings were observed in waters of depths of greater than 20 m. Mean density of cormorants/shags across the ObSERVE western Irish Sea survey area ranged from 0.31 birds/km^2 in summer surveys, 0.3 birds/km^2 in autumn surveys and 0.14 birds/km^2 in winter surveys (Jessopp *et al.*, 2018).

Observations of cormorant were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-63. A five-year peak observation of 171 birds was recorded in the 2017/18 season, along with a five-year peak-mean count of 105 birds between 2015/16 and 2019/20. The National Importance threshold for cormorant is 110 birds, and the International Importance threshold is 1,200 birds. Therefore, cormorant in the Dundalk Bay I-WeBS site are currently exceeding levels of National Importance (I-WeBS, 2022), but do not exceed levels of International Importance.

Table 4-63: Summary of I-WeBS survey counts for cormorant within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
72	48	171	105	110	1,200

Site-specific data

Observations of cormorant were recorded across all months of the survey period except for September 2018, June 2019, April 2020 and May 2020. Across all months, records of cormorant were generally low and were made on 20 of the 24 surveys.

Observations of cormorant were closer to shore, along the coastal areas of the western and northwestern extents of the Study Area, reflective of their foraging ecology.

A summary of the monthly records from the boat-based transect surveys and DAS is presented in Table 4-64. Table 4-65 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-16 shows the spatial distribution of cormorant during the boat-based survey period.

Table 4-64: Transect records and total observations of cormorant from boat-based surveys and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	1	-	4
June 2018	1	-	1
July 2018	0	-	1
August 2018	1	-	9
September 2018	0	-	0
October 2018	12	-	18
November 2018	0	-	1
December 2018	3	-	4
January 2019	0	-	2
February 2019	2	-	3
March 2019	0	-	8
April 2019	1	-	3
June 2019	0	-	0
July 2019	2	-	2
August 2019	1	-	1
October 2019	3	-	3
December 2019	3	-	3
January 2020	1	-	1
April 2020	-	0	0
May 2020	0	-	0
June 2020	-	9	9
July 2020	-	3	3
August 2020	-	1	1
September 2020	-	1	1

Month / Year	Boat-based Transect Records	DAS Records	All Records
Total	**31**	**14**	**78**

Table 4-65: Seasonal variation of cormorant recorded between May 2018 and September 2020.

Year	Spring Migration Feb – Mar	Breeding Apr – Jul	Autumn Migration Aug – Oct	Winter Nov – Jan	Non-breeding
2018 / 2019	-	6	27	7	-
2019 / 2020	11	5	4	4	-
2020	-	12	2	-	-

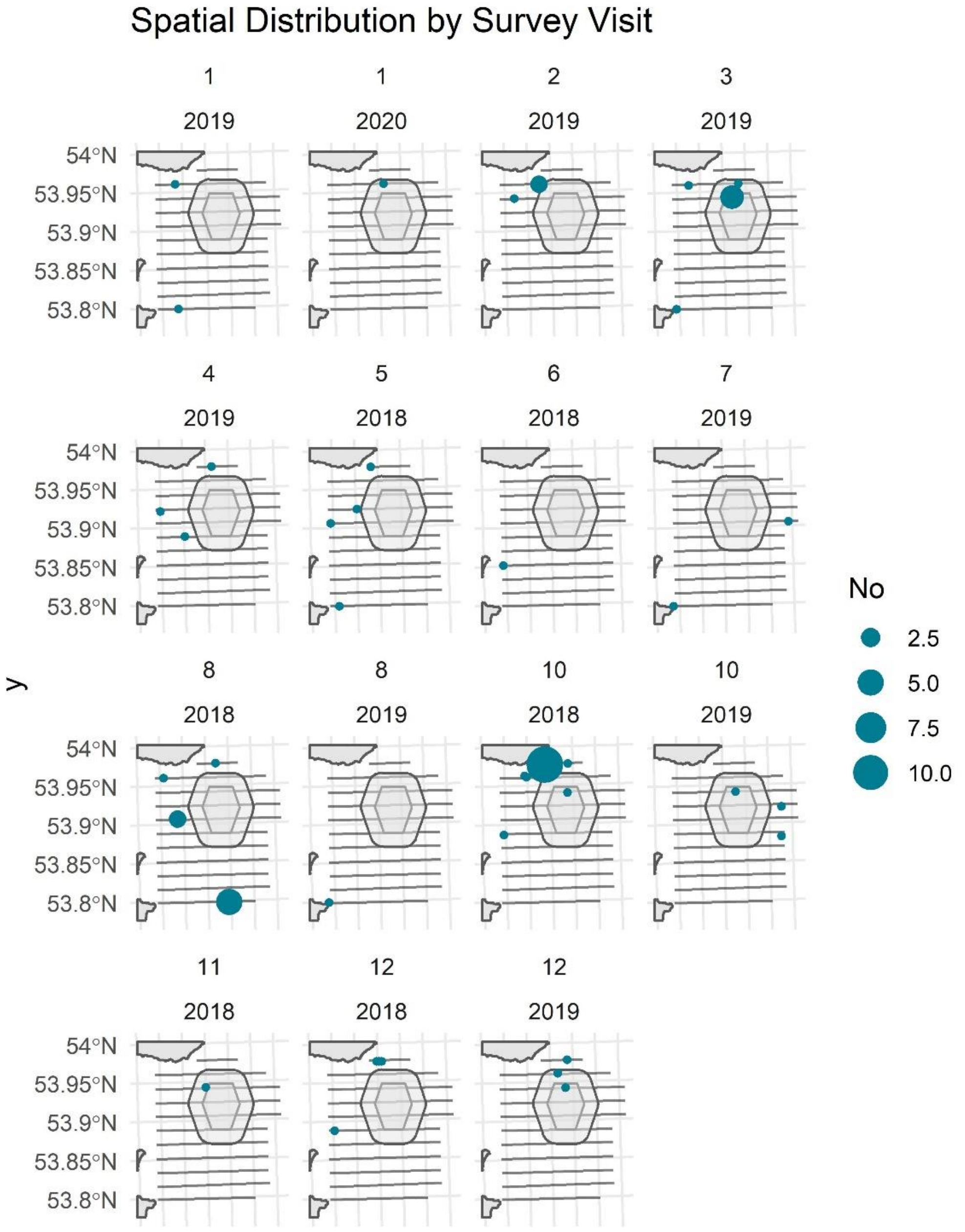

Figure 4-16: Spatial distribution of cormorant records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, the majority of birds observed were observed flying through the Study Area (32 individuals, 94.1%) and on transect (20 individuals, 64.5%), compared to sitting (2 (5.9%) and 11 (35.5%) individuals respectively). Flight heights of cormorant were most frequently recorded at 5 m on and off transect.

Table 4-66 below shows the proportion of individuals observed sitting and flying throughout the Study Area between May 2018 and September 2020. Figure 4-17 shows the recorded flight heights of cormorant during the boat-based survey period.

Table 4-66: Proportion of cormorant recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	0	0	1	100	4	100.0	0	0
June 2018	0	0	1	100	0	0	0	0
July 2018	0	0	0	0	0	0	1	100.0
August 2018	0	0	1	100	8	100.0	0	0
September 2018	No birds recorded							
October 2018	11	91.7	1	8.3	5	83.3	1	16.7
November 2018	0	0	0	0	1	100.0	0	0
December 2018	2	66.7	1	33.3	1	100.0	0	0
January 2019	0	0	0	0	2	100.0	0	0
February 2019	0	0	2	100	1	100.0	0	0
March 2019	0	0	0	0	8	100.0	0	0
April 2019	0	0	1	100	2	100.0	0	0
June 2019	No birds recorded							
July 2019	2	100	0	0	0	0	0	0
August 2019	1	100	0	0	0	0	0	0
October 2019	1	33.3	2	66.7	0	0	0	0
December 2019	3	100	0	0	0	0	0	0
January 2020	0	0	1	100	0	0	0	0
April 2020	0	0	0	0	N/A			
May 2020	No birds recorded							
June 2020	4	44.4	5	56.6	N/A			
July 2020	1	33.3	2	66.6				
August 2020	0	0	1	100				
September 2020	1	100	0	0				
Total	**27**	**58.7**	**19**	**41.3**	**32**	**94.1**	**2**	**5.9**

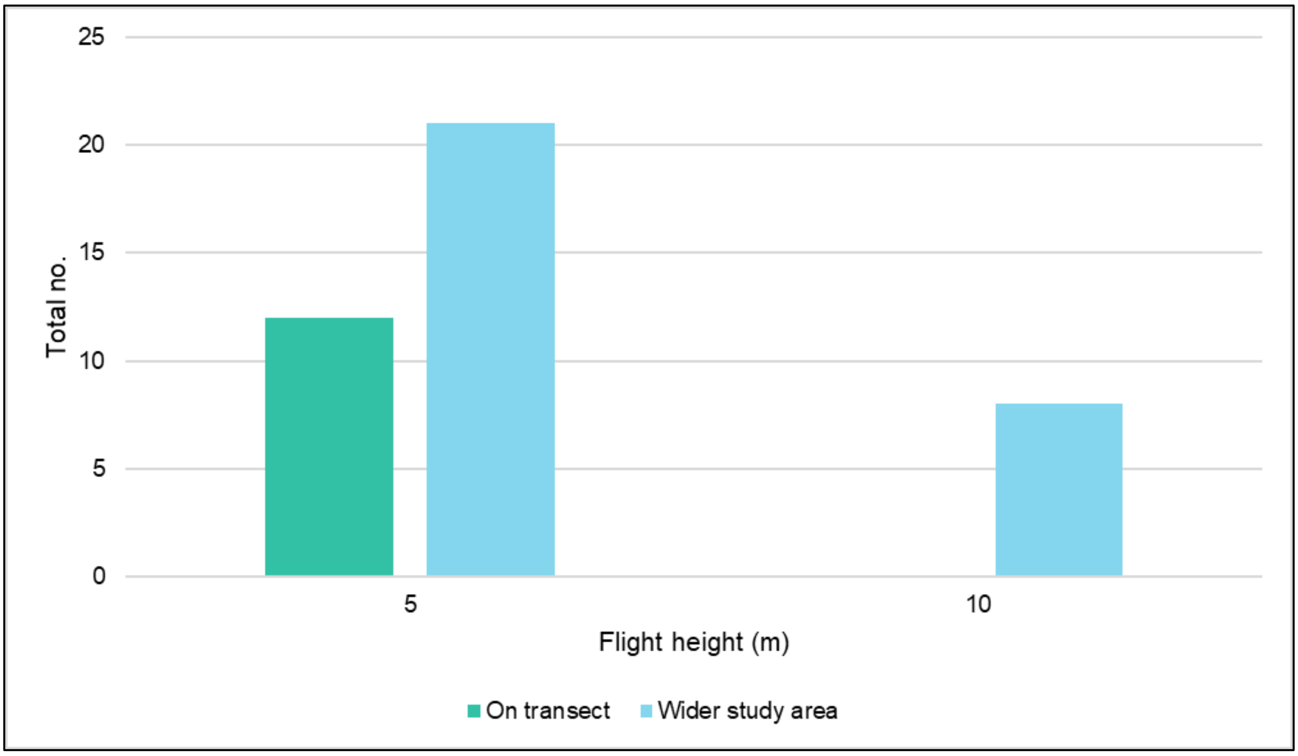

Figure 4-17: Cormorant flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-16), it is not possible to undertake any detailed spatial analysis for this species.

4.6.10 Kittiwake

Ecology

Kittiwake are one of Ireland's most common seabirds and are well distributed around the Irish coast and throughout the Irish sea, with a scattered breeding distribution at colonies at sea cliffs around the coast (Balmer *et al.*, 2013). Kittiwake are migratory and disperse after breeding from coastal areas to the open ocean (del Hoyo *et al.*, 1996). During the winter the species is highly pelagic, usually remaining on the wing out of sight of land (del Hoyo *et al.*, 1996). Kittiwake nest on high, steep, coastal cliffs with narrow ledges in areas with easy access to freshwater (del Hoyo *et al.*, 1996). Kittiwake are pelagic surface feeders feeding in the upper couple of metres of the water column. In the breeding season they feed mainly on small (15-20 cm) pelagic shoaling fish, such as sandeel, sprat and clupeids (del Hoyo *et al.*, 1996) but have been shown to have up to 40 different prey items in their diet (Soanes *et al.*, 2016). At sea during the winter, they will also take planktonic invertebrates and exploit sewage outfalls and fishing vessels (del Hoyo *et al.*, 1996). In the UK and Ireland, kittiwake is Red-listed due to severe declines in breeding population over 25 years and over the longer term (Gilbert *et al.,* 2021, Stanbury *et al.,* 2021).

The national population estimate for kittiwake is lower than that of Seabird 2000 and previous survey estimates, despite an increase in survey efforts (Cummins *et al.*, 2019). In Ireland, the declines are partly due to acute short-term population declines at some of the most important colonies, including Horn Head, Cliffs of Moher and Great Saltee. Table 4-67 shows a comparison of breeding kittiwake numbers between some of these colonies.

Table 4-67: A comparison of breeding kittiwake numbers (AONs) between Seabird 2000 of kittiwake at a selection of Irish colonies for the period 1985 – 1988 to 2015 – 2018 (Cummins *et al.,* 2019).

Site	SCR (1985 – 1988)	Seabird 2000 (1998 – 2002)	2015 – 2018	% Change (since Seabird 2000)
Great Skellig	-	694	789	+ 14%
Howth Head	-	1,906	1,773	- 7%
Doulus Head	-	1,150	994	- 14%
Lambay Island	3,005	4,091	3,320	- 19%
Downpatrick Head to Creevagh Head	-	1,653	1,163	- 30%
Little Skellig	-	250	173	- 31%
Old Head of Kinsale	2,059	1,188	711	- 40.2%
Clare Island	-	1,605	840	- 47.7%
Cliffs of Moher	4,313	7,698	3,981	- 48.3%
Great Saltee	2,908	2,125	1,038	- 51.2%
Horn Head	4,256	3,854	1,820	- 52.8%

A summary of the recent (within the last five summers) colony data for kittiwake within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-68 below. If multiple years are provided then the mean count is presented. Colonies which recorded zero birds are not included.

Table 4-68: Summary of most recent colony data for kittiwake between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
Antrim	Causeway Coast	2021	1,197
	Larne Lough to Portmuck	2017 – 2019	960.3 ± 199.7
	Muck Island	2017 – 2019	400.7 ± 86.6
	North Antrim coast	2017 – 2019	60±24.2
	Rathlin Island SPA	2021	13,706
	Sheep Island SPA	2021	305
Argyll and Bute	Islay – East (Port Askaig to Bowmore)	2017, 2018 and 2021	40.7 ± 17.6
	Islay – West (Port Askaig to Bruichladdich)	2018	123
	Isle of Colonsay	2019	143
	North Colonsay and Western Cliffs SPA	2018	2248
	Sanda Islands – Kintyre	2019	33
	Tiree	2018	233
	Treshnish Isles SPA	2017 – 2019 and 2021	654.3 ± 134.5
Cumbria	St Bees Head and Town	2017 – 2021	724.4 ± 121.4
Donegal	Malin Peninsula	2018	249
Down	Maggy's Leap	2017	76
	Maggy's Leap to Newcastle	2018 and 2019	546.5 ± 33.5
Dublin	Loughshinny to Killiney	2017 and 2018	146.5 ±1 3.5
Dyfed	Bishop and Clerks and Ramsey	2017 – 2019	88.7 ± 8.0

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
	Caldey Island	2017 – 2019 and 2021	248.8 ±16.9
	Castlemartin Coast (Berryslade to Barafundle Bay)	2017 – 2019, 2021 and 2022	1.2 ± 1.2
	Grassholm SPA	2018	30
	New Quay to Lochtyn	2018	332
	Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA	2017, 2018 and 2021	1,337 ± 82.9
Gwynedd	Aberdaron Coast and Bardsey Island SPA	2017 – 2019	112 ± 15.6
	Great Orme and Little Orme	2017 – 2019, 2021 and 2022	1,019.8 ± 102.1
	Lleyn Peninsula	2018, 2019 and 2021	519.3 ± 143.2
	Puffin Island SPA	2017 – 2019 and 2021	334.3 ± 116.4
	South Stack	2017 – 2019 and 2021	8.3 ± 2.4
Isle of Man	North Island	2017	78
	South Island	2017	540
	West Island	2017	54
Kyle and Carrick	Ailsa Craig SPA	2017 – 2019 and 2021	368.3 ± 86.3
Lancashire	Morecambe Central Gas Platform	2020	556
Londonderry	North Antrim Coast	2017 – 2019	204 ± 60.5
Mayo	Downpatrick to Creevagh Heads	2018	561
Sligo	Sligo Bay	2018	28
Stewarty	Balcary Point	2018	114
Waterford	Ardmore to Whiting Bay	2018 and 2019	181.5 ± 44.5
	Creadan Head to Foilakipeen	2018 and 2019	25.5 ± 0.5
	Dungarvan to Ardmore	2018 and 2019	68 ± 3
	Portally to Benlea Head	2018 and 2019	124 ± 24
West Glamorgan	Gower	2018	11
	Mumbles Head	2018	90
Wicklow	Mizen Head	2018, 2019, 2021 and 2022	915.5 ± 272.4
Wigtown	Monreith Cliffs and Scar Rocks	2018	19
	Mull of Galloway	2017 – 2019	83.3 ± 19.3
	Port Mona, Devil’s Bridge, Laggantalluch Head	2019	25

Desk-based data

The kittiwake was one of the most commonly sighted species within the ObSERVE 2016/2017 western Irish Sea surveys (Jessopp *et al.*, 2018), with 945 observations comprising a total of 2,421 individuals sighted across the three survey periods. In autumn, 1,355 individuals were recorded, with 567 in winter and 499 in summer. Although sightings were observed throughout the ObSERVE western Irish Sea survey area, there was a change in sightings distribution between the summer breeding season and the autumn and winter seasons. Sightings during the summer breeding survey period were concentrated in the central ObSERVE survey area around Dublin, spreading north and southwards during non-breeding seasons. Mean density of kittiwake across the ObSERVE western Irish Sea survey area ranged from 0.57 birds/km^2 in summer surveys, 1.47 birds/km^2 in autumn surveys, and 0.57 birds/km^2 in winter surveys (Jessopp *et al.*, 2018). No records of kittiwake were presented within the I-WeBS database.

Site-specific data

Observations of kittiwake were recorded across all survey months, as shown within Table 4-69. Peak counts were recorded in October 2018, when a total of 125 birds were recorded on transect and a total of 238 birds recorded across the Survey Area (Aquafact, 2019). This peak count in October 2018 was attributed to relate to the autumn dispersal of individuals from breeding grounds, while observations of fewer birds during summer months was related to birds remaining within closer proximities to their breeding colonies (Aquafact, 2019). Throughout the remainder of the survey period, kittiwake numbers were consistent across the autumn and winter months. Seasonal variation of kittiwake recorded between May 2018 and September 2020 is shown in Table 4-70.

There were no areas of greater concentration of kittiwake observed within the site surveys, and birds were widely spread throughout the Study Area. Figure 4-18 shows the spatial distribution of birds during the survey period.

Table 4-69: Transect records and total observations of kittiwake from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	23	-	48
June 2018	17	-	65
July 2018	6	-	13
August 2018	7	-	18
September 2018	24	-	45
October 2018	125	-	238
November 2018	14	-	70
December 2018	17	-	87
January 2019	18	-	45
February 2019	85	-	146
March 2019	45	-	62
April 2019	1	-	3
June 2019	14	-	14
July 2019	3	-	3
August 2019	74	-	74
October 2019	35	-	36
December 2019	13	-	13
January 2020	83	-	83
April 2020	-	41	41
May 2020	5	31	36
June 2020	-	2	2
July 2020	-	15	15
August 2020	-	18	18
September 2020	-	24	24
Total	**609**	**131**	**1,199**

Table 4-70: Seasonal variation of kittiwake recorded between May 2018 and September 2020.

Year	Spring Migration Jan – Apr	Breeding May – Jul	Autumn Migration Aug – Dec	Winter	Non-breeding
2018	-	126	458	-	-
2019	256	17	123	-	-
2020	124	53	42	-	-

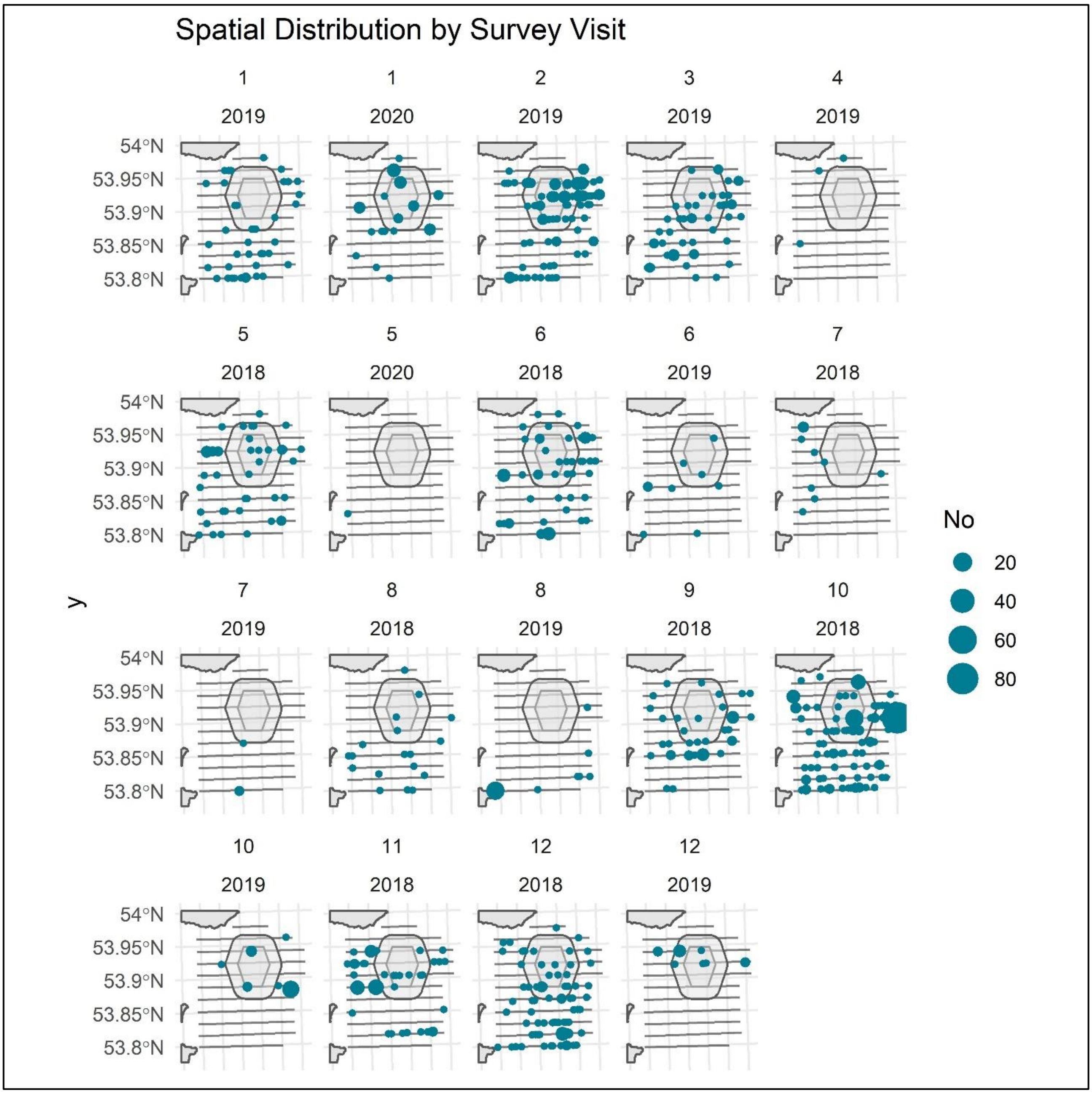

Figure 4-18: Spatial distribution of kittiwake records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, the majority of birds (446 individuals, 73.2%) observed along the route were sitting compared to those observed in flight (163 individuals, 26.8%); off transect, a higher proportion of birds (452 individuals, 98.5%) were recorded flying. Flight heights on transect were recorded between 5 m and 30 m, with a few birds observed flying at 40 m off transect.

During the DAS (APEM, 2020), a total of 131 kittiwake were identified, of which 47 were observed sitting and 84 were recorded flying. Flying kittiwake were recorded in all six surveys; in April 2020, flying kittiwake were significantly orientated around the mean of 28°; in July 2020, flying kittiwake were significantly orientated around the mean of 316°; in September 2020, flying kittiwake were significantly orientated around the mean of 260°. Flight heights were recorded for 64 individuals which resulted in a median altitude of 43.95 m above MSL.

Table 4-71 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and May 2020. Figure 4-19 shows the recorded flight heights of kittiwake during the same period.

Table 4-71: Proportion of kittiwake recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	4	17.4	19	82.6	25	100	0	0
June 2018	4	23.5	13	76.5	46	95.8	2	4.2
July 2018	0	0	6	100	7	100	0	0
August 2018	4	57.1	3	42.9	11	100	0	0
September 2018	8	33.3	16	66.7	21	100	0	0
October 2018	89	71.2	36	28.8	113	100	0	0
November 2018	3	21.4	11	78.6	56	100	0	0
December 2018	6	35.3	11	64.7	70	100	0	0
January 2019	8	44.4	10	55.6	27	100	0	0
February 2019	13	15.3	72	84.7	59	96.7	2	3.3
March 2019	3	6.7	42	93.3	14	82.4	3	17.6
April 2019	1	100	0	0	2	100	0	0
June 2019	4	28.6	10	71.4	0	0	0	0
July 2019	0	0	3	100	0	0	0	0
August 2019	3	4.1	71	95.9	0	0	0	0
October 2019	5	14.3	30	85.7	1	100	0	0
December 2019	1	7.7	12	92.3	0	0	0	0
January 2020	3	3.6	80	96.4	0	0	0	0
April 2020	21		20		N/A			
May 2020	19	52.7	17	47.2	0	0	0	0
June 2020	2	100	0	0	N/A			
July 2020	14	92.3	1	6.7				
August 2020	13	72.2	5	27.8				
September 2020	19	79.2	5	20.8				
Total	**247**	**33.4**	**493**	**66.6**	**452**	**98.5**	**7**	**1.5**

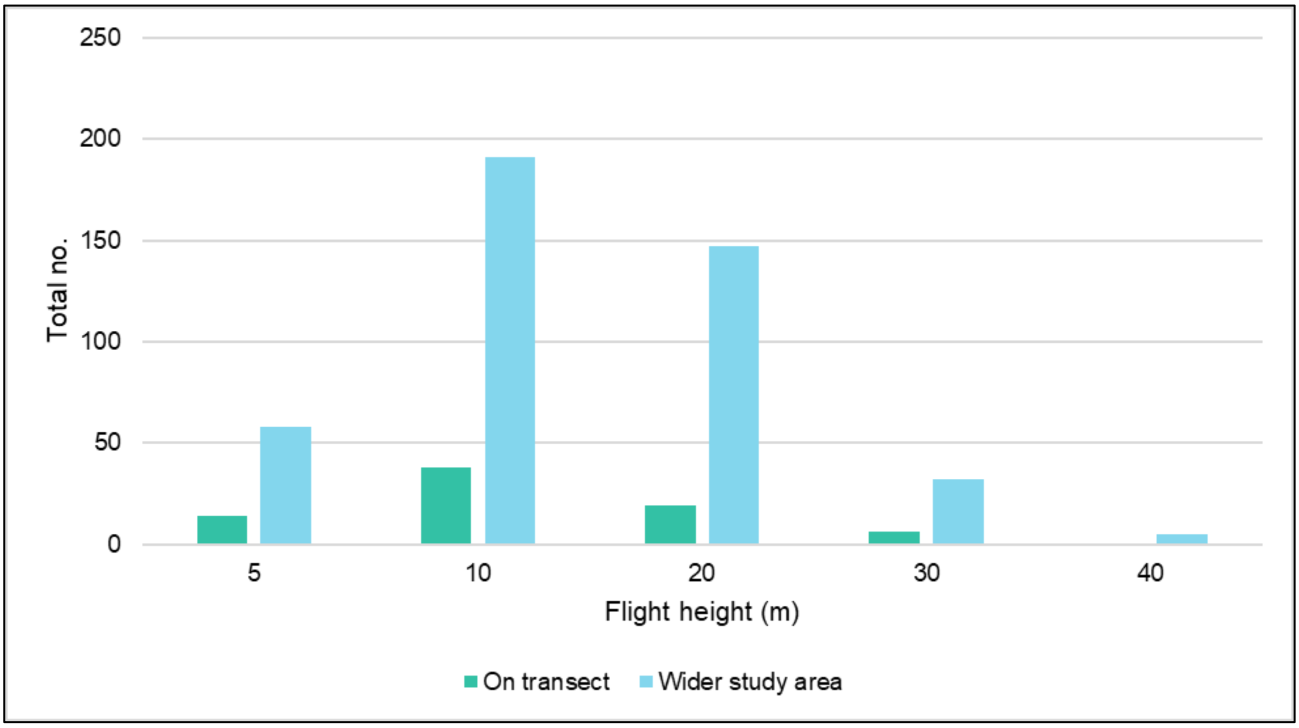

Figure 4-19: Kittiwake flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates during the boat-based surveys

During initial data exploration and model fitting a high co-linear / correlation between Bathymetry and distance to coast was identified resulting in a prohibitively high VIF for these parameters. Because of this distance to coast was removed from the model. The following refined environmental and spatial covariates were used in the MRSea CreSS:

- Bathymetry;
- Year; and
- X and Y coordinates.

To prepare for the GEE-CreSS analyses, a complete grid of abutting cells based on the survey grid and environmental covariates was constructed to cover the entire survey area. All variables except X and Y co-ordinate were included in the one-dimensional SALSA model selection method (Walker *et al.,* 2011) and automatic model simplification using non-significant p-values was carried out. An appropriate blocking structure using transect ID was included as there was evidence of autocorrelation. Month was fitted as a factor term. This provided the base model for assessment of the 2D spatial smoother.

CreSS was used to fit the spatial density surface and GEEs were used to provide realistic model-based estimates. The GEE-CreSS grid knot locations are included in Appendix A1 of this report. An interaction with month was included to allow the density surface to vary between survey months. Following predictions, bootstrapping was used to generate 95 % confidence intervals for each grid cell to allow for an assessment of uncertainty. The bootstrapping procedure incorporated any autocorrelation specified within the prediction model following the CreSS method.

All behaviours (both sitting and flying birds)

Table 4-72 to Table 4-74 below presents the kittiwake modelled abundance estimates for the offshore wind farm area, the offshore wind farm area plus 2 km and the Offshore Ornithology Study Area.

Table 4-72: Kittiwake modelled offshore wind farm area abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	12	6	29
June 2018	6	2	20
July 2018	2	1	11
August 2018	36	15	80
September 2018	14	3	76
October 2018	57	28	146
November 2018	0	0	NA
December 2018	6	1	67
January 2019	23	8	63
February 2019	63	39	100
March 2019	45	26	90
April 2019	0	0	0
June 2019	7	3	24
July 2019	3	1	11
August 2019	36	15	80
October 2019	57	28	146
December 2019	6	1	67
January 2020	23	8	63
May 2020	2	1	10

Table 4-73: Kittiwake modelled offshore wind farm area plus 2 km buffer abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	34	15	89
June 2018	15	5	63
July 2018	7	2	42
August 2018	103	40	258
September 2018	40	7	306
October 2018	161	77	431
November 2018	0	0	NA
December 2018	16	1	289
January 2019	69	23	197
February 2019	187	111	309
March 2019	139	77	281
April 2019	0	0	0
June 2019	19	6	71

Month / Year	Estimate	LCL	UCL
July 2019	9	2	40
August 2019	103	40	258
October 2019	161	77	431
December 2019	16	1	289
January 2020	69	23	197
May 2020	6	2	27

Table 4-74: Kittiwake modelled Offshore Ornithology Study Area abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	197	84	537
June 2018	64	19	293
July 2018	34	7	289
August 2018	0	0	0
September 2018	0	0	0
October 2018	0	0	0
November 2018	0	0	0
December 2018	0	0	0
January 2019	0	0	0
February 2019	902	482	1,716
March 2019	611	335	1,412
April 2019	0	0	0
June 2019	81	23	348
July 2019	43	9	263
August 2019	0	0	0
October 2019	0	0	0
December 2019	0	0	0
January 2020	0	0	0
May 2020	35	9	163

Flying birds

There were 427 records of flying kittiwake over the boat-based study period. Densities of flying birds were modelled using a similar approach to loafing birds described above where sufficient data was available to do so. For kittiwake sufficient observations were available for all months of study. These data are presented in Table 4-75 and Table 4-76.

Table 4-75: Kittiwake flying bird offshore wind farm area modelled abundance estimates.

Month / Year	Estimate	LCL	UCL
May 2018	14	7	27
June 2018	34	23	55
July 2018	1	0	17

Month / Year	Estimate	LCL	UCL
August 2018	12	4	93
September 2018	20	9	53
October 2018	21	14	33
November 2018	146	82	262
December 2018	43	19	91
January 2019	14	6	31
February 2019	212	164	269
March 2019	20	11	42
April 2019	1	0	208
June 2019	7	2	18
July 2019	0	0	5
August 2019	0	0	3
October 2019	1	0	1
December 2019	1	0	4
January 2020	1	0	7
May 2020	3	1	7

Table 4-76: Kittiwake flying bird offshore wind farm area plus 2 km buffer modelled abundance estimates.

Month / Year	Estimate	LCL	UCL
May 2018	39	20	75
June 2018	95	65	156
July 2018	5	2	50
August 2018	42	13	284
September 2018	62	29	165
October 2018	86	58	136
November 2018	446	264	759
December 2018	130	65	251
January 2019	46	21	97
February 2019	581	435	760
March 2019	54	27	125
April 2019	5	1	N/A
June 2019	19	5	51
July 2019	1	0	14
August 2019	1	0	9
October 2019	2	1	6
December 2019	3	1	10
January 2020	4	1	20
May 2020	8	3	19

Design-based spatial abundance estimates during the DAS

DAS abundance analysis was undertaken by APEM and summarised fully within annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The abundance estimates are presented below for kittiwake at the different spatial scales. Table 4-77 presents the abundance estimates for sitting birds only whereas, Table 4-78 presents the abundance estimates for flying birds. Detailed methods on calculation of the abundance estimates are presented in section 3.4.3.

Table 4-77: Abundance estimates of sitting kittiwake within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	16	30
May 2020	32	44
June 2020	0	0
July 2020	0	0
August 2020	0	3
September 2020	3	3

Table 4-78: Abundance estimates of flying kittiwake within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	3	15
May 2020	14	21
June 2020	0	0
July 2020	11	10
August 2020	0	3
September 2020	17	21

4.6.11 Black-headed gull

Ecology

Black-headed gull are less reliant on marine habitats than other gull species, with approximately 44% of black-headed gulls breeding inland in Ireland and Britain (Mitchell *et al.*, 2004). During the breeding season, black-headed gull illustrates a preference for inland, shallow and calm wetland habitats and forms nesting colonies on lakes, lagoons, estuaries, upper zones of saltmarshes and coastal dunes (BirdLife International, 2020; del Hoyo *et al.*, 1996). Throughout the non-breeding winter period, black-headed gull frequents coastal habitats, tidal inshore waters, inlets and estuaries and presents a preference for sandy or muddy beaches (BirdLife International, 2020; del Hoyo *et al.*, 1996). Individuals may also occur inland in ploughed fields, urban parks, sewage farms, reservoirs, ponds and other ornamental water ways (BirdLife International, 2020). The diet of black-headed gulls consists predominantly of aquatic and terrestrial insects, earthworms and marine invertebrates (e.g. molluscs, crustaceans and marine worms) and fish (del Hoyo *et al.*, 1996).

National census data indicate the number of coastal nesting black-headed gulls in the United Kingdom was relatively stable between 1969-70 and 1998–2002. However, there are differences within the census data for the constituent countries of the UK. Over the monitoring period, black-headed gull productivity has fluctuated markedly and is likely to have been affected by predation by American mink, as well as changes in food supply and periods of inclement weather during breeding seasons. This fluctuating productivity trend is common to black-headed gull colonies throughout the UK.

In Ireland, the long-term breeding population trend estimates equate to a modest decline (10.9%) (Cummins *et al.,* 2019).

Table 4-79 below sets out population estimates for a number of sites, including inland breeding colonies.

Table 4-79: Black-headed Gull population estimates for a selection of sites (Cummins *et al.*, 2019).

Site	1977 – 1978	1985 – 1988	2000 – 2002	2007 – 2010	2016 – 2018	% Change (since Seabird 2000)
Lough Carra	1,670	1,668	100	854	656	+ 556%
Lady's Island Lake	-	250	949	-	2,526	+ 166%
Inch Lough	-	-	800	-	1,450	+ 81%
Lough Mask	425	750	329	1041	535	+ 63%
Lough Corrib	2,330	4,342	425	431	669	+ 57%
Lough Derg	-	2,176	-	-	400	-

Due to the long-term declines in black-headed gull breeding populations and breeding ranges over the past 25 years, this species is Amber-listed and a species of high conservation concern in Ireland and the UK (Gilbert *et al*., 2021 and Stanbury *et al.,* 2021).

There is no colony data for black-headed gull within the Cumulative Offshore Ornithology Study Area and within the mean max foraging range of the species. The closest breeding colony is within Strangford Lough approximately 70 km away from the Project and out with the mean max foraging range of 18 km for black-headed gull.

Desk-based data

Data collected within the 2016/2017 ObSERVE western Irish Sea surveys (Jessopp *et al.*, 2018) recorded a total of 97 sightings of 298 black-headed gulls across all three survey seasons. Approximately 72% of these sightings occurred during winter surveys, followed by autumn and summer. Summer survey sightings were concentrated offshore, inshore in autumn and an even distribution was observed in winter. Mean density of black-headed gull across the ObSERVE western Irish Sea survey area ranged between 0.03 birds/km^2 in summer surveys, 0.15 birds/km^2 in autumn surveys, and 0.2 birds/km^2 in winter surveys.

Observations of black-headed gull were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-80. A five-year peak observation of 1,680 birds was recorded in the 2017/2018 season, along with a five-year peak-mean count of 946 birds between 2015/16 and 2019/20 (I-WeBS, 2022).

Table 4-80: Summary of I-WeBS survey counts for black-headed gull within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
1,170	706	1,680	946	-	-

Site-specific data

During the boat-based surveys, black-headed gull was recorded in very low numbers on transect in only three months: October 2018, January 2019 and March 2019. Birds were also recorded within the Survey

Area during July 2018 and December 2019. A total of 22 birds were observed within the Survey Area, with only 5 of these recorded on transect (Aquafact, 2019), as shown within Table 4-81.

Black-headed gull were only identified on two occasions during the Digital Aerials (April 2020). Black-headed Gull were not recorded in the May 2020, June 2020, July 2020, August 2020 and September surveys. The black-headed gulls were recorded flying in a northerly direction in the northeast of the Study Area.

The black-headed gull is a predominately coastal gull species, which reflects the low number of observations of the black-headed gull within the Study Area during these surveys.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-81. Table 4-82 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Snow and Perrins (1998). Figure 4-20 shows the spatial distribution of black-headed gull during the survey period.

Table 4-81: Transect records and total observations of black-headed gull from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	0
June 2018	0	-	0
July 2018	0	-	2
August 2018	0	-	0
September 2018	0	-	0
October 2018	1	-	10
November 2018	0	-	0
December 2018	0	-	0
January 2019	3	-	4
February 2019	0	-	0
March 2019	1	-	3
April 2019	0	-	0
June 2019	0	-	0
July 2019	0	-	0
August 2019	0	-	0
October 2019	0	-	0
December 2019	0	-	3
January 2020	0	-	0
April 2020	-	2	2
May 2020	0	0	0
June 2020	-	0	0
July 2020	-	0	0
August 2020	-	0	0
September 2020	-	0	0
Total	**5**	**2**	**24**

Table 4-82: Seasonal variation of black-headed gull recorded between May 2018 and September 2020.

Year	Spring Migration	Breeding May – Aug	Autumn Migration	Winter	Non-breeding Sep – Mar
2018 / 2019	-	2	-	-	17
2019 / 2020	-	0	-	-	5
2020	-	0	-	-	0

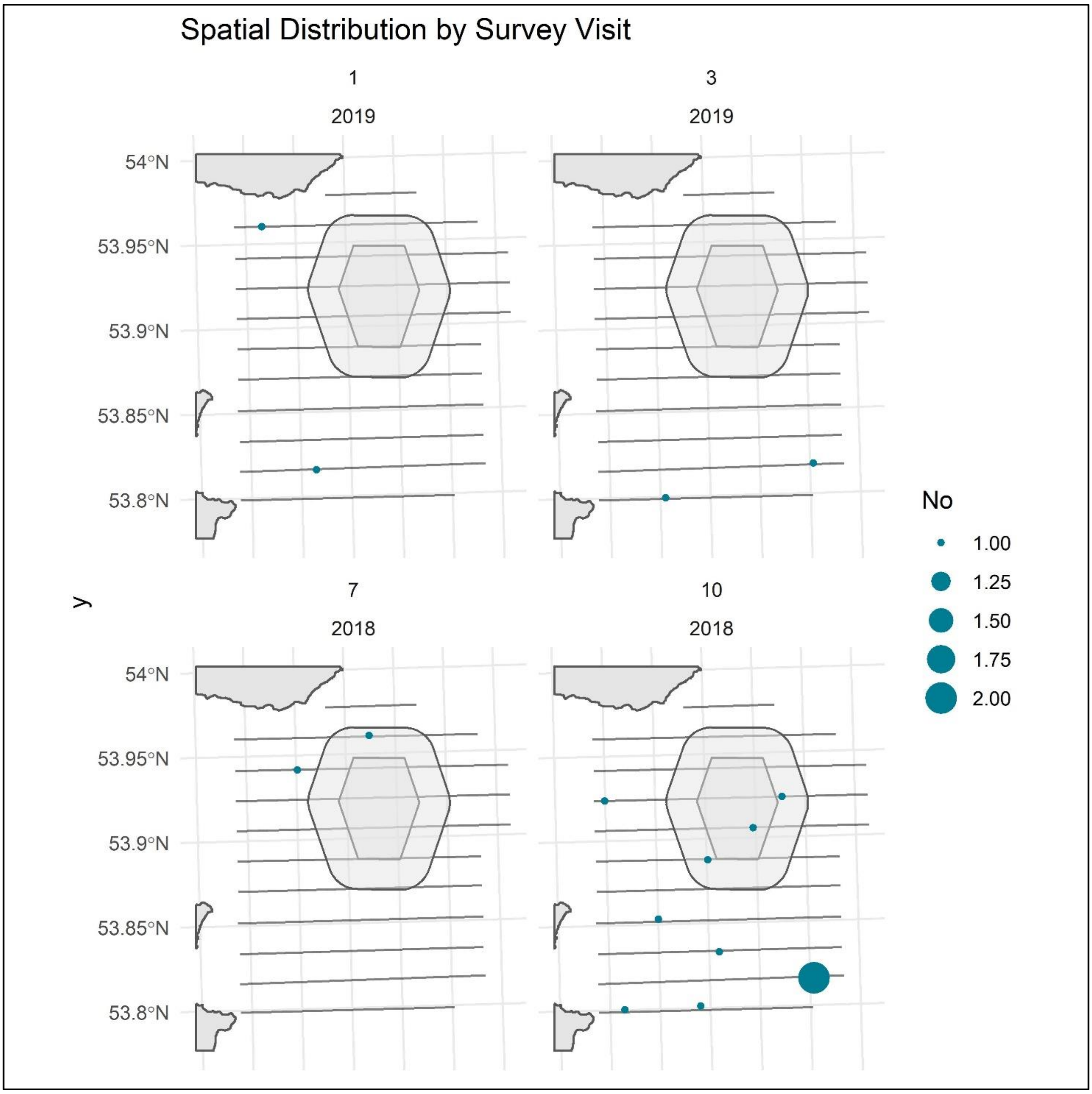

Figure 4-20: Spatial distribution of black-headed gull records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygon.

During the boat-based transect surveys, all birds recorded on transect were sitting compared to those recorded off transect which were observed in flight. Flight heights for black-headed gull off transect were recorded between 5 m and 20 m.

Table 4-83 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and September 2020.

Table 4-83: Proportion of black-headed gull recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	No birds recorded							
June 2018								
July 2018	0	0	0	0	2	100	0	0
August 2018	No birds recorded							
September 2018								
October 2018	0	0	1	100	9	100	0	0
November 2018	No birds recorded							
December 2018								
January 2019	0	0	3	100	1	100	0	0
February 2019	No birds recorded							
March 2019	0	0	1	100	2	100	0	0
April 2019	No birds recorded							
June 2019								
July 2019								
August 2019								
October 2019								
December 2019	0	0	0	0	3	100	0	0
January 2020	No birds recorded							
April 2020	2	100	0	0	N/A			
May 2020	No birds recorded							
June 2020								
July 2020								
August 2020								
September 2020								
Total	**0**	**0**	**5**	**100.0**	**17**	**100.0**	**0**	**0**

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-20), it is not possible to undertake any detailed spatial analysis for this species.

4.6.12 Common gull

Ecology

Common gulls breed along the coast and inland in a variety of sites not necessarily close to wetland (del Hoyo *et al.*, 1996; BirdLife International, 2020), with approximately 57% of pairs breeding in non-coastal habitats (Mitchell *et al.*, 2004). Common gulls are more commonly observed in marine habitats outside of the breeding season, including along the east coast of Ireland (Balmer *et al.*, 2013).

The common gull diet consists of a variety of prey items including earthworms, insects, aquatic and terrestrial invertebrates, crayfish, molluscs and small fish (del Hoyo *et al.*, 1996). It is also an opportunistic forager and will exploit agricultural grain (del Hoyo *et al.*, 1996; Flint *et al.*, 1984).

In Ireland, common gull population estimates represent a significant increase from the Seabird estimate (Table 4-84), equating to an increase of 105% and 57% at coastal and inland sites respectively (Cummins *et al.,* 2019).

Table 4-84: Common gull population estimates for a selection of sites (Cummins *et al.,* 2019).

Site	Seabird 2000	2006 – 2007	2010	Seabird Census (2013 – 2018)	% Change since Seabird 2000
Lough Mask	124	271	230	191	+ 54%
Lough Conn	40	-	15	43	+ 8%
Lough Corrib	176	204	274	155	- 12%
Connermara Lakes	130	-	93	100	- 26%
Lough Carra	65	-	55	34	- 47%
Lough Carrowmore	59	-	55	10	- 83%

The common gull is an Amber-listed species in the UK and Ireland due to moderate declines in their breeding range, and as the species is also listed as a Species of European Conservation Concern (Gilbert *et al*., 2021 and Stanbury *et al*., 2021).

A summary of the recent (within the last five summers) colony data for common gull within the Cumulative Offshore Ornithology Study Area and within the mean max foraging range of the species is provided in Table 4-85 below. If multiple years are provided then the mean count is presented.

Table 4-85: Summary of most recent colony data for common gull between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
Down	Carlingford Lough SPA	2017 – 2021	4.8 ± 2.9

Desk-based data

Data collected within the 2016/2017 ObSERVE western Irish Sea surveys (Jessopp *et al.*, 2018) did not differentiate between herring and common gull and were grouped together. A total of 764 sightings of 2,726 individuals were recorded over the three survey seasons, most commonly observed in the autumn surveys, then winter survey and least in summer surveys. Records were concentrated in the inshore coastal areas of the northern transects during the summer and autumn surveys, particularly along the Drogheda coastline. Mean density of herring/common gull across the ObSERVE western Irish Sea survey area ranged between 0.75 birds/km^2 in summer surveys, 3.82 birds/km^2 in autumn surveys, and 1.76 birds/km^2 in winter surveys.

Observations of common gull were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 5-76. A five-year peak observation of 957 birds was recorded in the 2017/2018 season, along with a five-year peak-mean count of 644 birds between 2015/16 and 2019/20 (I-WeBS, 2022).

Table 4-86: Summary of I-WeBS survey counts for common gull within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
671	440	957	644	-	-

Site-specific data

Common gulls were observed in 14 of the 19 survey months of boat-based surveys, with birds recorded on transect in 13 of those months (Table 4-87). Observations of common gull on transect were not made during the summer breeding months (May to August), excluding a count of probable non-breeders during July 2018 and August 2018, August 2019 and June 2020. Peak counts on transect were recorded in December 2019 with a total of 112 birds observed, followed by April 2019 when 43 birds were recorded (Aquafact, 2019).

During the DAS, nine common gull were identified: six in April 2020, two in May 2020 and one in July 2020 surveys. Common gull were not recorded in the August or September 2020 survey.

Observations of common gull were widespread across the Study Area throughout the survey period.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-87. Table 4-88 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Snow and Perrins (1998). Figure 4-21 shows the spatial distribution of common gull over the survey period.

Table 4-87: Transect records and total observations of common gull from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	0
June 2018	0	-	0
July 2018	12	-	26
August 2018	0	-	3
September 2018	0	-	0
October 2018	13	-	75
November 2018	3	-	18
December 2018	20	-	57
January 2019	22	-	45
February 2019	31	-	64
March 2019	8	-	26
April 2019	43	-	59
June 2019	0	-	0
July 2019	0	-	0
August 2019	6	-	6
October 2019	4	-	5
December 2019	112	-	137
January 2020	49	-	49
April 2020	-	6	6
May 2020	1	2	3

Month / Year	Boat-based Transect Records	DAS Records	All Records
June 2020	-	1	1
July 2020	-	0	0
August 2020	-	0	0
September 2020	-	0	0
Total	**324**	**9**	**580**

Table 4-88: Seasonal variation of common gull recorded between May 2018 and September 2020.

Year	Spring Migration	Breeding May – Aug	Autumn Migration	Winter	Non-breeding Sep – Apr
2018 / 2019	-	29	-	-	344
2019 / 2020	-	6	-	-	197
2020	-	4	-	-	0

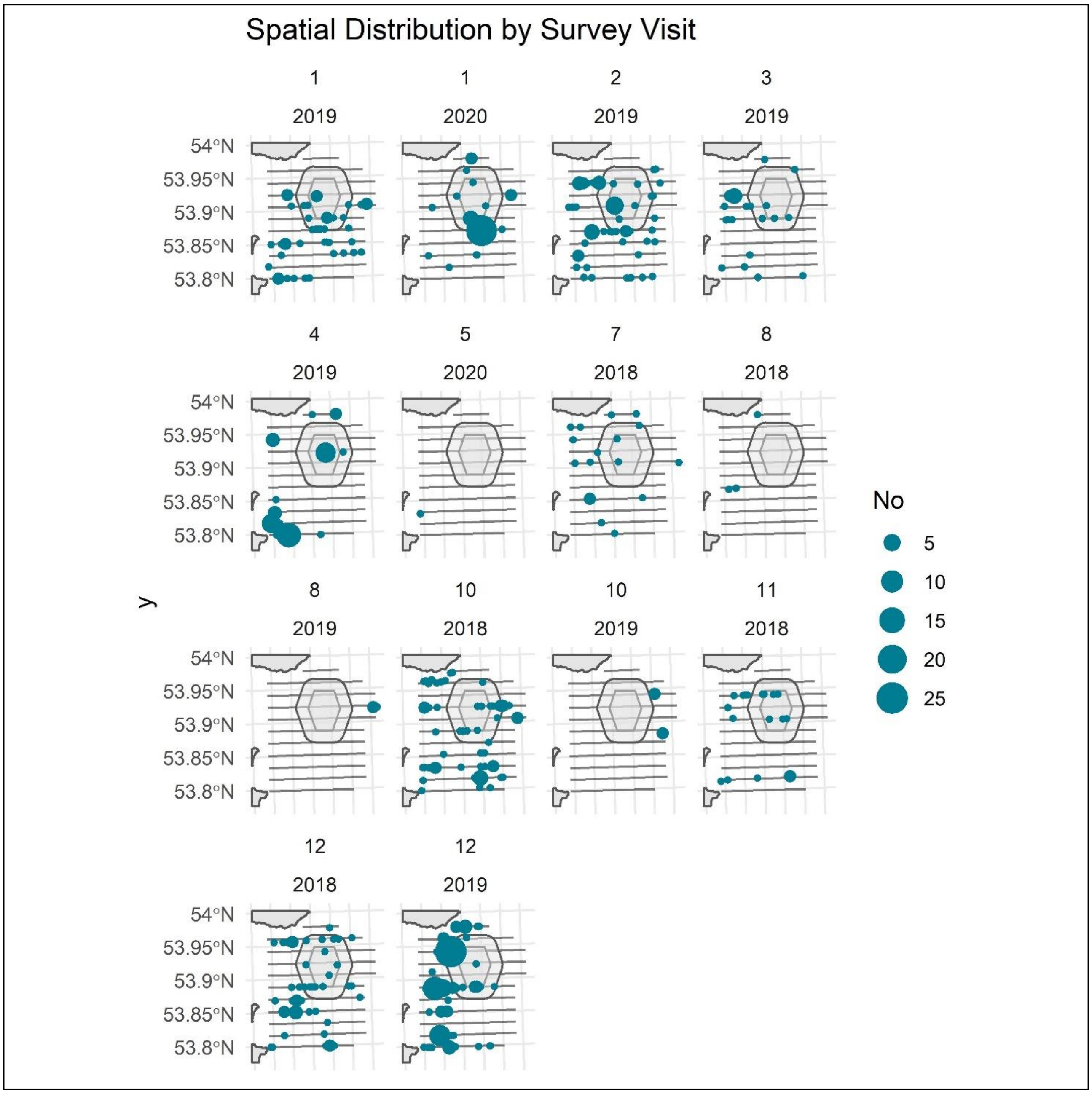

Figure 4-21: Spatial distribution of common gull records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygon.

During the boat-based transect surveys, 206 individuals (63.6%) were observed sitting. Off transect, the majority of birds (246 individuals, 99.6%) were observed in flight. Flight heights on transect were more frequently recorded between 5 m and 10 m, with 30 individuals recorded between 20 m and 30 m.

Table 4-89 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and September 2020. Figure 4-22 shows the recorded flight heights of common gull during the boat-based surveys.

Table 4-89: Proportion of common gull recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	No birds recorded							
June 2018								
July 2018	4	33.3	8	66.7	13	92.9	1	7.1
August 2018	0	0	0	0	3	100	0	0
September 2018	No birds recorded							
October 2018	11	84.6	2	15.4	62	100	0	0
November 2018	1	33.3	2	66.7	15	100	0	0
December 2018	9	45	11	55	37	100	0	0
January 2019	6	27.3	16	72.7	23	100	0	0
February 2019	14	45.2	17	54.8	33	100	0	0
March 2019	2	25	6	75	18	100	0	0
April 2019	0	0	43	100	16	100	0	0
June 2019	No birds recorded							
July 2019								
August 2019	1	167	5	83.3	0	0	0	0
October 2019	0	0	4	100	1	100	0	0
December 2019	56	50	56	50	25	100	0	0
January 2020	13	26.5	36	74.5	0	0	0	0
April 2020	4	66.7	2	33.3	N/A			
May 2020	2	66.7	1	33.3	0	0	0	0
June 2020	No birds recorded				N/A			
July 2020	1	100	0	0				
August 2020	No birds recorded							
September 2020								
Total	**143**	**39.6**	**218**	**61.4**	**246**	**99.6**	**1**	**0.4**

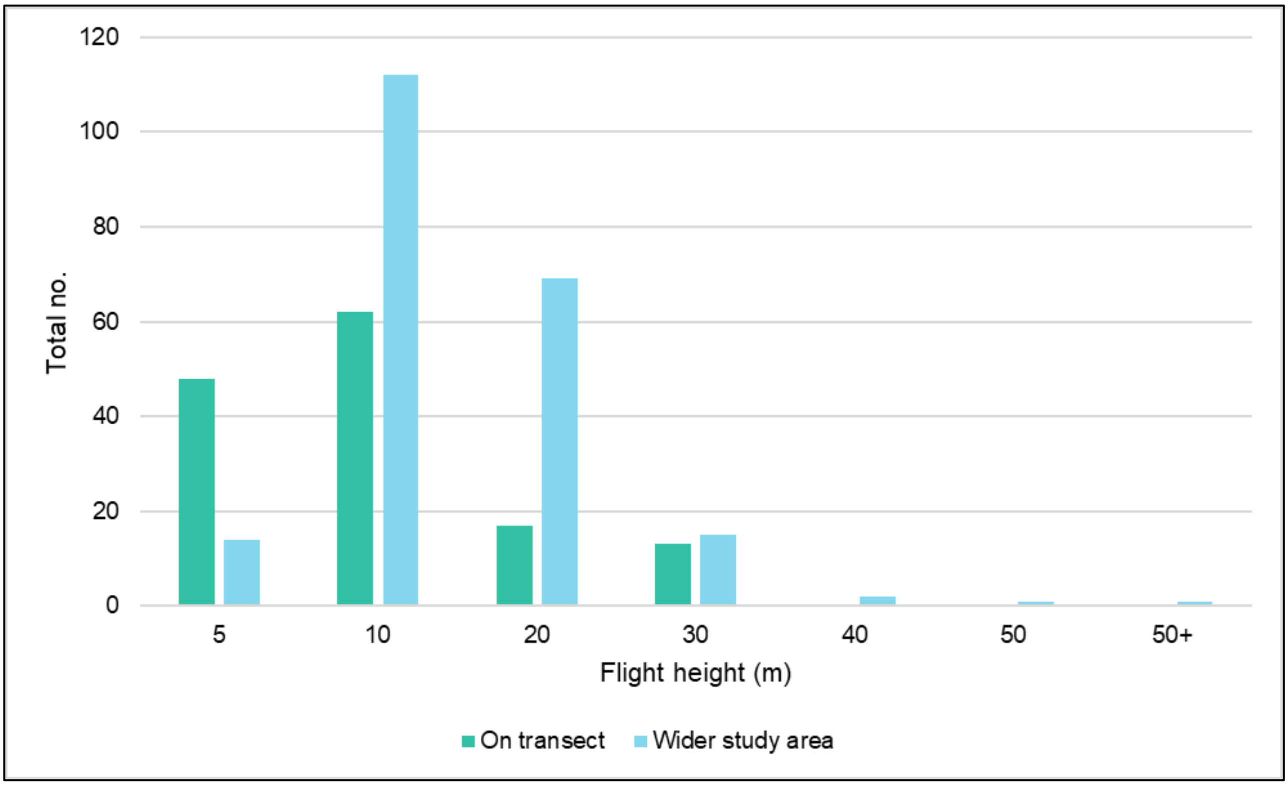

Figure 4-22: Common gull flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates during boat-based surveys

Flying birds

There were 271 records of flying common gull over the study period. The majority of these records were single individuals with smaller numbers of groups of up to 12 birds recorded.

Table 4-90 and Table 4-91 below presents the common gull modelled flight abundance estimates for the offshore wind farm area plus a 2 km buffer during the non-breeding season. Due to model convergence issues it was not possible to include data from other periods and produce estimates for such periods. This is considered likely due to the low numbers of observations during these periods and the excessive number of zero counts present.

Table 4-90: Common gull flying offshore wind farm area modelled abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
August 2018	0	0	NA
September 2018	0	0	NA
October 2018	32	25	44
November 2018	7	4	11
December 2018	27	19	37
January 2019	15	9	24
February 2019	71	51	101
March 2019	8	4	19
August 2019	0	0	NA

Month / Year	Estimate	LCL	UCL
October 2019	15	10	22
December 2019	13	9	19
January 2020	7	4	11

Table 4-91: Common gull flying offshore wind farm area plus 2 km modelled abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
August 2018	1	0	NA
September 2018	0	0	NA
October 2018	93	69	136
November 2018	20	11	36
December 2018	98	71	141
January 2019	45	27	79
February 2019	225	149	349
March 2019	31	14	69
August 2019	0	0	NA
October 2019	45	29	68
December 2019	47	33	71
January 2020	20	11	36

Design-based spatial abundance estimates during the DAS

There were only two observations within the offshore wind farm area plus 2 km buffer during the DAS and therefore no abundance estimates have been produced.

4.6.13 Great black-backed gull

Ecology

Great black-backed gulls are coastally distributed around Ireland and are observed in the Irish Sea (Stone *et al.*, 1995). The species is known to inhabit rocky or sandy coasts, estuaries, inshore and offshore waters and breeds on vegetated islands, dunes, flat-topped stacks, rocky shores, flat beaches and islands in saltmarsh (del Hoyo *et al.*, 1996). Great black-backed gulls also breed inland on islets in freshwater lakes and rivers, and in fields or moorland (BirdLife International, 2020). Similar to other gull species, great black-backed gulls are omnivorous and opportunistic foragers and feed on of fish, adult and young birds, bird eggs, small mammals (such as rabbits, rats and mice), insects, marine invertebrates (molluscs), carrion and refuse (del Hoyo *et al.*, 1996).

The Seabirds Count census undertaken between 2015 and 2018 estimated that the breeding population of great black-backed gull in Ireland was 3,081 pairs, an increase of 6% over the long term (1985/87 – 2015/18); 78% of this population is located within the SPA network (Cummins *et al.,* 2019). Table 4-92 sets out the population estimates of a selection of sites that were covered at least twice during the large survey initiatives since the 1980s.

Table 4-92: Change in the recorded breeding great black-backed gull populations at a selection of Irish colonies (Cummins *et al.*, 2019).

Site	SCR 1985 – 1988	Seabird 2000 1998 – 2002	2015 – 2018	% Change (since Seabird 2000)
Roaninish	250	29	58	+ 100%
Inishmurray	81	117	108	- 8%
Lambay Islands	145	193	99	- 49%
Duvillaun Islands	217	144	65	- 55%

The great black-backed gull is an Amber-listed species in the UK due to moderate declines in their population and range over the past 25 years (Stanbury *et al*., 2021). In Ireland, great black-backed gulls are Green-listed, however there is some uncertainty against the availability of data to confidently confirm their improved status (Gilbert *et al*., 2021).

A summary of the recent (within the last five summers) colony data for great black-backed gull within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-93 below. If multiple years are provided then the mean count is presented.

Table 4-93: Summary of most recent colony data for great black-backed gull between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
Down	Carlingford Lough SPA	2017, 2018 and 2021	2 ± 1.6
	Maggy's Leap	2017 and 2019	1.5 ± 0.5
	Strangford Lough SPA	2017 – 2019	116.7 ± 9.2

Desk-based data

Data collected within the 2016/2017 ObSERVE western Irish Sea surveys (Jessopp *et al.*, 2018) did not differentiate between great and lesser black-backed gull during summer surveys, and these two species were grouped together. However, in autumn and winter surveys these species were recorded separately. There were 39 lesser black-backed gull individuals, 143 greater black-backed gull and 339 black-backed gulls that could not be differentiated to species level observed across the three survey seasons. Although sightings did occur across the ObSERVE western Irish Sea survey area, observations were predominantly in the northern part of the survey area.

Observations of great black-backed gull were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-94. A five-year peak observation of 113 birds was recorded in the 2015/2016 season, along with a five-year peak-mean count of 51 birds between 2015/16 and 2019/20 (I-WeBS, 2022).

Table 4-94: Summary of I-WeBS survey counts for great black-backed gull within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
34	11	113	51	-	-

Site-specific data

Great black-backed gull was recorded on transect during all boat-based surveys (except in July 2019), as shown in Table 4-95. Observations were higher during the breeding season (March to August), however seasonal differences were not clearly apparent. Peak observations of great black-backed gull occurred in April 2019 with 74 individuals recorded on transect out of a total of 126 individuals observed within the Study Area (Aquafact, 2019).

During the DAS, 142 great black-backed gull were identified: 43 in April 2020, 35 in May 2020, one in June 2020, 10 in July 2020, 37 in August 2020 and 16 in the September 2020 surveys.

Observations of great black-backed gull were widespread across the Study Area throughout the survey period.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-95. Table 4-96 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-23 shows the spatial distribution of great black-backed gull during the survey period.

Table 4-95: Transect records and total observations of great black-backed gull from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	6	-	43
June 2018	1	-	8
July 2018	7	-	27
August 2018	18	-	96
September 2018	19	-	77
October 2018	10	-	44
November 2018	6	-	40
December 2018	14	-	57
January 2019	9	-	80
February 2019	17	-	41
March 2019	21	-	55
April 2019	74	-	126
June 2019	1	-	1
July 2019	0	-	0
August 2019	7	-	7
October 2019	25	-	25
December 2019	23	-	25
January 2020	8	-	8
April 2020	-	43	43
May 2020	6	35	41
June 2020	-	1	1
July 2020	-	10	10
August 2020	-	37	37
September 2020	-	16	16
Total	**272**	**142**	**908**

Table 4-96: Seasonal variation of great black-backed gull recorded between May 2018 and September 2020.

Year	Spring Migration Jan – Apr	Breeding May – July	Autumn Migration Aug – Nov	Winter Dec	Non-breeding
2018	-	78	257	57	-
2019	302	1	32	25	-
2020	51	52	53	-	-

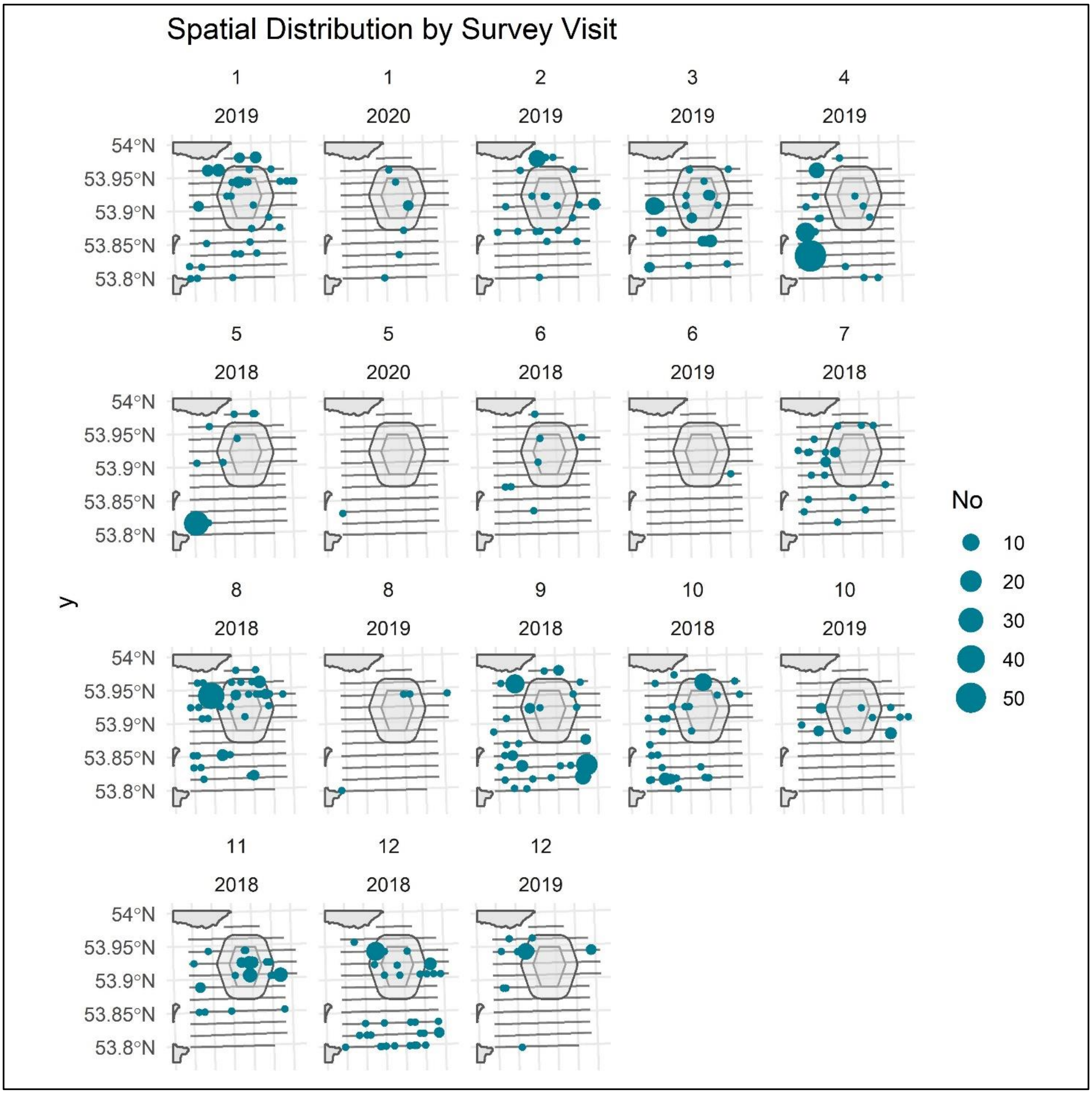

Figure 4-23: Spatial distribution of great black-backed gull records on boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, 214 individuals (78.7%) were observed sitting compared to those in flight (58 individuals, 21.3%). Off Transect, the majority of birds (380 individuals, 76.9%) were observed in flight. Birds were more frequently observed flying at a height of 20 m on and off transect. Smaller numbers of birds were recorded at flight heights of 30 m to 50 m and 50+ m.

Of the 142 birds recorded during the DAS, 27 were observed in flight and 115 were observed sitting. Flying great black-backed gulls were recorded in April, May, June, August and September surveys. Significant orientations were recorded: in April 2020, flying great black-backed gulls were significantly orientated around the mean of 62°; in May 2020, they were orientated around the mean of 94°; and in September 2020, around the mean of 204°. One flying great black-backed gull deemed suitable for flight height determination was recorded, with an altitude of 4.5 m above MSL.

Table 4-97 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and September 2020. Figure 4-24 shows the recorded flight heights of great black-backed gull during the boat-based surveys.

Table 4-97: Proportion of great black-backed gull recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	1	16.7	5	83.3	7	18.9	30	81.1
June 2018	0	0	1	100.0	6	85.7	1	14.3
July 2018	6	85.7	1	14.3	15	75.0	5	25.0
August 2018	4	22.2	14	78.8	69	88.5	9	11.5
September 2018	2	10.5	17	89.5	58	100	0	0
October 2018	3	30.0	7	70.0	34	100	0	0
November 2018	1	16.7	5	89.3	34	100	0	0
December 2018	4	28.6	10	71.4	42	97.7	1	2.3
January 2019	2	22.2	7	78.8	41	57.7	30	42.3
February 2019	12	70.6	5	29.4	16	66.7	8	33.3
March 2019	7	33.3	14	66.7	34	100.0	0	0
April 2019	0	0	74	100	24	46.2	28	53.8
June 2019	1	100	0	0	0	0	0	0
July 2019	No birds recorded							
August 2019	3	42.9	4	57.1	0	0	0	0
October 2019	2	8.0	23	92.0	0	0	0	0
December 2019	2	8.7	21	91.3	0	0	2	100
January 2020	3	37.5	5	62.5	0	0	0	0
April 2020	8	18.6	35	81.4	N/A			
May 2020	16	39	25	61	0	0	0	0
June 2020	1	100	0	0	N/A			
July 2020	0	0	10	100				
August 2020	2	5.4	35	94.6				
September 2020	5	31.3	11	68.7				
Total	**85**	**20.5**	**329**	**79.5**	**380**	**76.9**	**114**	**23.1**

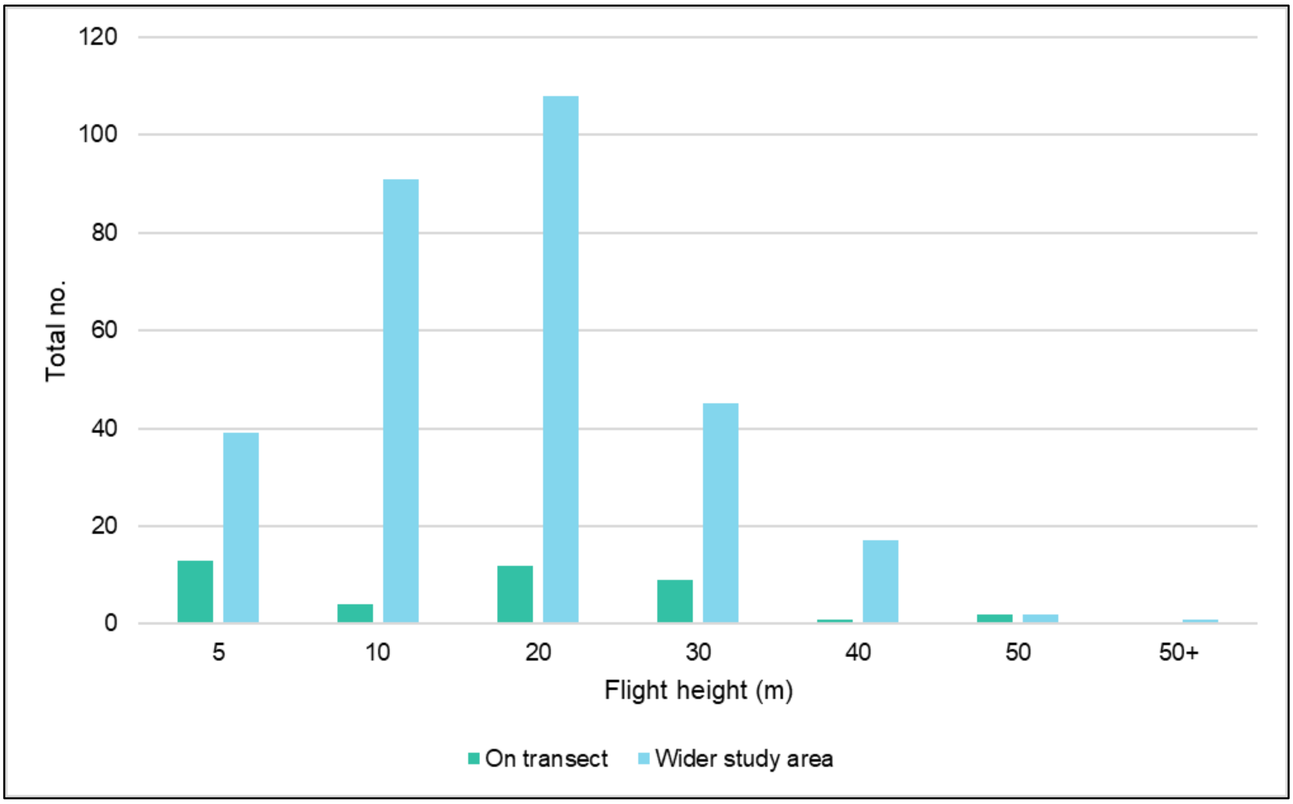

Figure 4-24: Great black-backed gull flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates during boat-based surveys

Flying birds

Table 4-98 and Table 4-99 below presents the great black-backed gull modelled flight abundance estimates for the offshore wind farm area plus a 2 km buffer.

Table 4-98: Great black-backed gull flying offshore wind farm area modelled abundance estimates by survey.

Month / Year	Estimate	LCL	UCL
May 2018	3	1	6
June 2018	2	1	6
July 2018	5	3	11
August 2018	41	9	150
September 2018	3	0	91
October 2018	22	4	141
November 2018	2	0	28
December 2018	74	20	416
January 2019	34	6	168
February 2019	48	22	130
March 2019	11	3	33
April 2019	3	1	9

Month / Year	Estimate	LCL	UCL
June 2019	2	1	6
July 2019	5	3	11
August 2019	1	0	6
October 2019	1	0	5
December 2019	2	0	18
January 2020	2	0	28
May 2020	3	1	6

Table 4-99: Great black-backed gull flying offshore wind farm area plus 2 km buffer modelled abundance estimates.

Month / Year	Estimate	LCL	UCL
May 2018	10	4	22
June 2018	6	2	21
July 2018	18	9	43
August 2018	316	96	1116
September 2018	39	5	428
October 2018	76	14	515
November 2018	7	1	74
December 2018	170	51	905
January 2019	95	21	420
February 2019	117	49	362
March 2019	39	13	125
April 2019	9	3	29
June 2019	6	2	21
July 2019	18	9	43
August 2019	8	1	41
October 2019	2	0	17
December 2019	4	1	36
January 2020	7	1	74
May 2020	10	4	22

Design-based spatial abundance estimates during the DAS

DAS abundance analysis was undertaken by APEM and summarised fully within annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The abundance estimates are presented below for great black-backed gull at the different spatial scales.

Table 4-100 presents the abundance estimates for sitting birds only whereas, Table 4-101 presents the abundance estimates for flying birds. Detailed methods on calculation of the abundance estimates are presented in section 3.4.3. When provided the LCL and UCL are presented within brackets after the estimate.

Table 4-100: Abundance estimates of sitting great black-backed gull within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	13 (5 - 40)	40 (16 - 75)
May 2020	No birds recorded	No birds recorded
June 2020	No birds recorded	No birds recorded
July 2020	No birds recorded	No birds recorded
August 2020	93 (34 - 278)	86 (34 - 250)
September 2020	28 (10 - 83)	26 (10 - 78)

Table 4-101: Abundance estimates of flying great black-backed gull within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	5 (2 - 11)	10 (4 - 22)
May 2020	No birds recorded	No birds recorded
June 2020	No birds recorded	No birds recorded
July 2020	No birds recorded	No birds recorded
August 2020	No birds recorded	No birds recorded
September 2020	3 (1 - 8)	5 (2 - 13)

4.6.14 Lesser black-backed gull

Ecology

The majority of lesser black-backed gulls in Ireland nest at inland lakes in the west of the country, although they are known to nest on buildings around the Dublin area (Balmer *et al.*, 2013; Mitchell *et al.*, 2004). Lesser black-backed gulls inhabit level ground which is well covered with short vegetation, such as sand dunes, tops and ledges of coastal cliffs, rocky offshore islands, saltmarshes and inland on lake margins and rivers (BirdLife International, 2020).

Lesser black-backed gulls are omnivorous and opportunistic feeders that forage at sea and inland, with a diet which consists of small fish (Baltic herring *Clupea harengus*), aquatic and terrestrial invertebrates, bird eggs and nestlings, carrion, rodents, berries and grain (del Hoyo *et al.*, 1996; BirdLife International, 2020). Lesser black-backed gulls are also known to follow fishing fleets and forage on bycatch discards.

The lesser black-backed gull is an Amber-listed species in the UK and Ireland due to moderate declines in their breeding range over the past 20 years and over 50% of their breeding population occurring at ten or fewer sites (Gilbert *et al*., 2021 and Stanbury *et al*., 2021). During the Seabird Count census (Cummins *et al.,* 2019), the population estimate for lesser black-backed gulls was 7,112 pairs (of which 64% were within the SPA network). This was an increase of 145% over the long term (1985/87 – 2015/18). The short and long-term population trends at a coastal and national level indicate an expanding population, however there are some variable trends within more traditional sites, which have seen a marked decrease. Table 4-102 below shows a selection of Irish colonies for lesser black-backed gull (including inland colonies).

Table 4-102: Change in the recorded breeding lesser black-backed gull populations at a selection of Irish colonies (Cummins *et al.*, 2019).

Site	SCR (1985 – 1988)	Seabird 2000 (1998 – 2002)	2015 – 2018	% Change (since Seabird 2000)
Lough Corrib	1,153	6	86	1,333%
Lough Conn – Gull Island	-	10	35	250%
Inishkeas	-	40	93	133%
Puffin Island	55	139	291	109%
Great Saltee	80	144	251	74%
Lough Mask	-	286	422	48%
Lambay Island	150	309	345	12%
Scariff Island	-	97	97	0
Cape Clear Island	103	204	26	-87%
Inishgoosk – Lough Derg, Donegal	-	500	0	-100%

A summary of the recent (within the last five summers) colony data for lesser black-backed within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-103 below. If multiple years are provided then the mean count is presented. Colonies which recorded zero birds are not included.

Table 4-103: Summary of most recent colony data for lesser black-backed gull between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
Antrim	Belfast	2018 and 2019	161 ± 60
	Belfast Harbour	2017 and 2019	1 ± 0
	Causeway Coast	2021	3
	East Antrim Coast	2021	2
	Lough Neagh and Lough Beg SPA	2017, 2018 and 2021	768.7 ± 308.2
	Rathlin Island SPA	2021	519
	Sheep Island SPA	2021	88
Argyll and Bute	Giga	2021	1
	Islay – East (Port Askaig to Bowmore)	2017 and 2018	5.5 ± 4.5
	Islay – West (Port Askaig to Bruichladdich)	2017 – 2019 and 2021	10 ± 3.2
	Jura (West)	2017 – 2019	1.7 ± 0.5
	Loch Fyne	2021	18
	Mull	2021	3
	Sanda Islands	2019	23
	Sound of Jura	2021	14
Clwyd	Kinmel Bay	2019	1
	Llanddulas Quarries	2017	3
	Prestatyn	2019	3

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
	Rhyl	2019	4
Cumbria	Askam-in-Furness	2019	42
	Burrow-in-Furness	2019	435
	Flimby and Risehow	2019	4
	Haverigg and Millom	2019	75
	Siddick	2019	1
	South Solway	2018 and 2019	286.5 ± 26.5
	St Bees Head and Town	2017 – 2020	0.8 ± 0.4
	Walney Urban Gulls	2019	11
	Whitehaven (Buildings)	2018	53
	Workington	2019	7
Donegal	Aran Island	2018	2
	Inishdooey, Inishbofin, Inishbeg	2018	20
	North Donegal	2018	1
Down	Copeland Islands SPA	2018 and 2019	456 ± 91
	Gun’s Island – Northern Island	2022	10
	Strangford Lough SPA	2017 – 2019	323 ± 14.4
Dyed	Aber Bach – Ynys Barry	2017 and 2018	4 ± 1
	Abereiddy – Treginnnis, St Davids	2017 and 2018	4.5 ± 0.5
	Bishop and Clerks and Ramsey	2018	124
	Newport to Poppit	2018	39
	Strumble Head – Pwll Deri	2018	48
	Strumble Head to Fishguard to Newport	2017 and 2018	2.5 ± 1.5
	Treginnis – Dinas Fawr, Solva	2018	67
Gwynedd	Aberdaron Coast and Bardsey Island SPA	2017 – 2019	168.3 ± 6.1
	Aberdyfi	2018	1
	Anglesey Terns / Morwenoliaid Ynys MÃ´n SPA	2017 – 2019	111 ± 14.2
	Bangor and Caernarfon	2019	17
	Barmouth and Fairbourne	2018	2
	Bodorgan Head to Abermenai	2018	4
	Friog	2018	1±0
	Puffin Island SPA	2017	526
	South Stack	2017 – 2019 and 2021	6.3 ± 1.8
Isle of Man	East Island	2017	5
	North Island	2017	2
	South Island	2017	28
	West Island	2017	1
Kyle and Carrick	Ailsa Craig SPA	2017 – 2019	153.3 ± 26.6
	Lady Isle	2018	246
	Starling Knowe to Downan Point	2018	3
Lancashire	Fleetwood	2019	9

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
	Morecambe Bay and Duddon Estuary SPA (Lancashire)	2017 – 2020	1,389 ± 1,040.6
	Ribble and Alt Estuaries SPA	2021	4,489
Merseyside	Seaforth Nature Reserve and Liverpool City	2019	15
	The Dee Estuary SPA	2019	3
Stewarty	Almorness Point	2021	373
	Fleet Bay	2018	8
	Meikle Ross and Little Ross	2018	6
	Port O'Warren	2020	1
Waterford	Bally Voorey to Stradbally	2018	2
	Bunmahon to Stradbally	2018	2
	Dungarvan to Ardmore	2018	2
	Illaunglass to Annestown	2018	2
	Tramore to Illaunglass	2018	5
Wigtown	Loch Ryan	2021	4
	Wigtown Bay Merse and Baldoon	2019	4

Desk-based data

Data collected within the 2016/2017 ObSERVE western Irish Sea surveys (Jessopp *et al.*, 2018) did not differentiate between great and lesser black-backed gulls during summer surveys, and these two species were grouped together. However, in autumn and winter surveys these species were recorded separately. There were 39 lesser black-backed gull individuals, 143 great black-backed gull and 339 black-backed gulls that could not be differentiated to species level observed across the three survey seasons. Although sightings did occur across the ObSERVE western Irish Sea survey area, observations were predominantly in the northern part of the survey area.

Observations of lesser black-backed gulls were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-104. A five-year peak observation of 56 birds was recorded in the 2015/2016 season, along with a five-year peak-mean count of 24 birds between 2015/16 and 2019/20 (I-WeBS, 2022).

Table 4-104: Summary of I-WeBS survey counts for lesser black-backed gull within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
8	2	56	24	-	-

Site-specific data

Although in typically low numbers, lesser black-backed gulls were observed in the site Survey Area during 13 of the total survey months (Table 4-105). However, lesser black-backed gulls were only recorded on six boat-based transects (June 2018, April to August 2019 and December 2019) and on three Digital Aerials (June, July and September 2020).

The small number of observations recorded during the survey period may have been migrants from southern wintering areas to northern breeding sites in Northern Ireland or Scotland (Aquafact, 2019).

Observations of lesser black-backed gull were widespread across the Study Area throughout the survey period.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-105. Table 4-106 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-25 shows the spatial distribution of lesser black-backed gull over the survey period.

Table 4-105: Transect records and total observations of lesser black-backed gull from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	4
June 2018	5	-	20
July 2018	0	-	8
August 2018	0	-	5
September 2018	0	-	2
October 2018	0	-	0
November 2018	0	-	0
December 2018	0	-	0
January 2019	0	-	0
February 2019	0	-	1
March 2019	0	-	0
April 2019	2	-	3
June 2019	1	-	1
July 2019	1	-	1
August 2019	2	-	2
October 2019	0	-	0
December 2019	1	-	1
January 2020	0	-	0
April 2020	-	0	0
May 2020	0	0	0
June 2020	-	2	2
July 2020	-	1	1
August 2020	-	0	0
September 2020	-	1	1
Total	**12**	**4**	**52**

Table 4-106: Seasonal variation of lesser black-backed gull recorded between May 2018 and September 2020.

Year	Spring Migration Mar – Apr	Breeding May – Jul	Autumn Migration Aug – Oct	Winter Nov – Feb	Non-breeding
2018 / 2019	-	32	7	1	-
2019 / 2020	3	2	2	1	-

Year	Spring Migration Mar – Apr	Breeding May – Jul	Autumn Migration Aug – Oct	Winter Nov – Feb	Non-breeding
2020	0	3	1	-	-

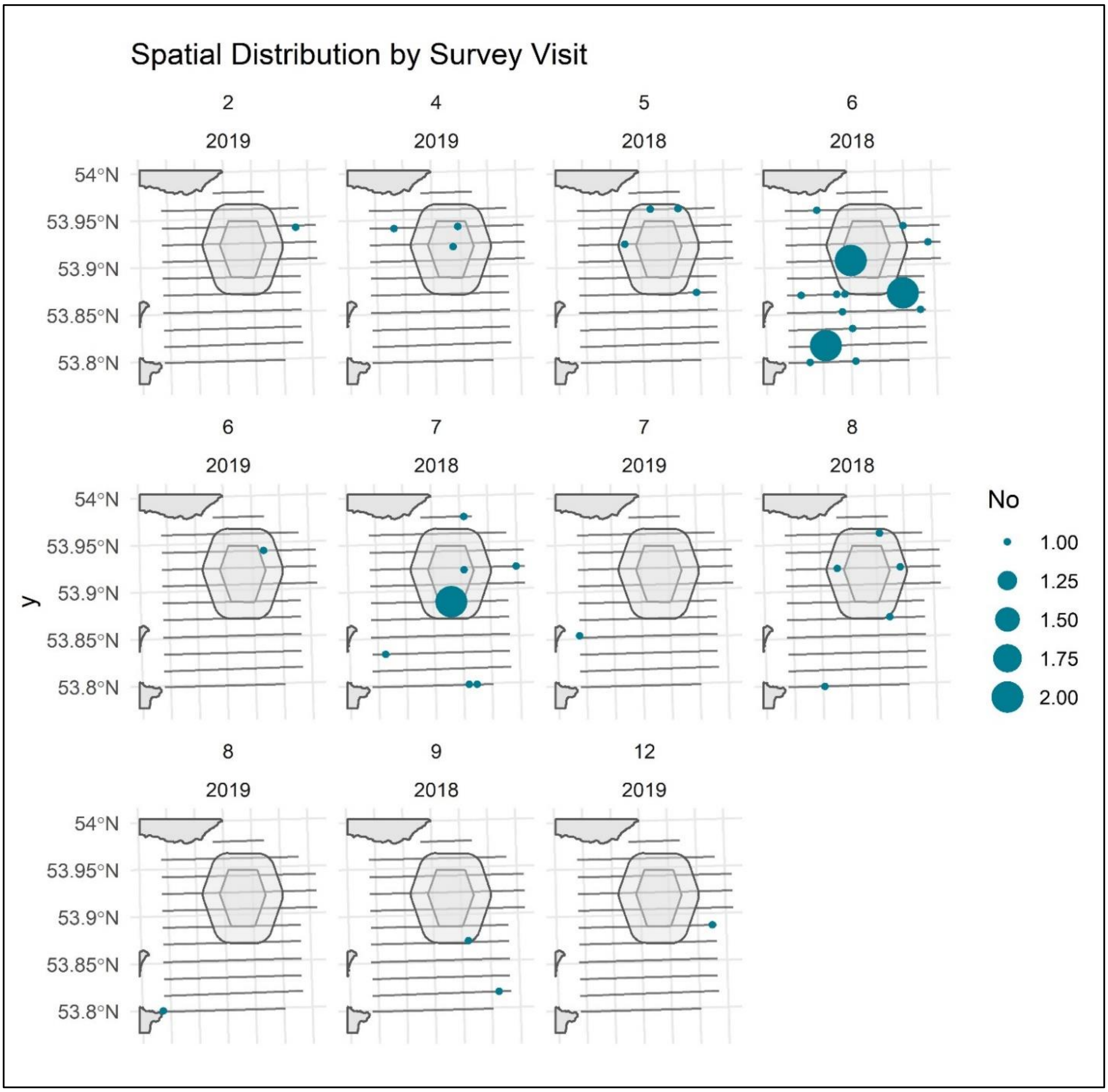

Figure 4-25: Spatial distribution of lesser black-backed gull records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, 75% of individuals (9 birds) were observed flying on transect compared to 25% (3 individuals) sitting. Off transect, the majority of birds (40 individuals, 97.8%) were observed in flight. On transect, flight heights on transect were recorded between 10 m and 20 m. Off transect, lesser black-backed gulls were observed flying between 5 m and 50 m.

Of the 4 birds recorded during the DAS, 2 were observed in flight and 2 were observed sitting. One flying lesser black-backed gull deemed suitable for flight height determination was recorded, with an altitude of 13 m above MSL.

Table 4-107 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and September 2020. Figure 4-26 shows the recorded flight heights of lesser black-backed gull during the boat-based surveys.

Table 4-107: Proportion of lesser black-backed gull recorded flying or sitting during surveys undertaken between May 2018 and September 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	0	0	0	0	4	100	0	0
June 2018	5	100	0	0	19	95.0	1	5.0
July 2018	0	0	0	0	8	100	0	0
August 2018	0	0	0	0	5	100	0	0
September 2018	0	0	0	0	2	100	0	0
October 2018	No birds recorded							
November 2018								
December 2018								
January 2019								
February 2019	0	0	0	0	1	100	0	0
March 2019	No birds recorded							
April 2019	0	0	2	100	1	100	0	0
June 2019	0	0	1	100	0	0	0	0
July 2019	1	100	0	0	0	0	0	0
August 2019	2	100	0	0	0	0	0	0
October 2019	No birds recorded							
December 2019	1	100	0	0	0	0	0	0
January 2020	No birds recorded							
April 2020								
May 2020	2	100	0	0	0	0	0	0
June 2020	No birds recorded							
July 2020	0	0	1	100	N/A			
August 2020	No birds recorded							
September 2020	0	0	1	100	N/A			
Total	**11**	**68.7**	**5**	**31.3**	**40**	**97.8**	**1**	**2.2**

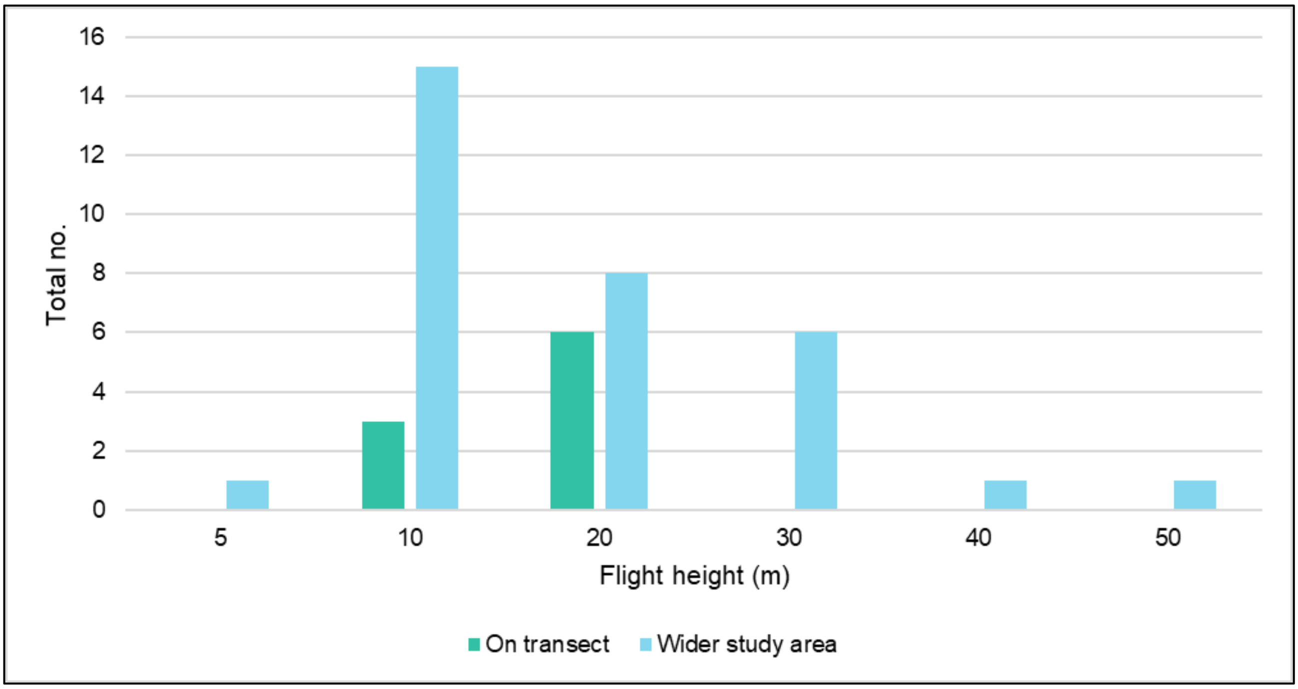

Figure 4-26: Lesser black-backed gull flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-25), it is not possible to undertake any detailed spatial analysis for this species.

4.6.15 Herring gull

Ecology

Herring gulls are coastally distributed in Ireland and in recent years have been observed to move inland during the breeding season to breed on buildings and rooftops in addition to their cliff nest sites (Mitchell *et al.*, 2004). Although the herring gull has no specific breeding habitat, the species shows a preference for rocky shores with cliffs, outlying stacks or islets (del Hoyo *et al.*, 1996). The biggest colonies within Ireland are located on Lambay Island in Co. Dublin, which hosts over 1,800 nests (BirdWatch Ireland, 2020c). A smaller colony is located close to the Study Area at Wicklow Head.

Although herring gulls exploit refuse tips and agricultural areas, their breeding distribution is very coastal in comparison to other *Larus* gulls (excluding *L. marinus*) (Gibbons *et al.*, 1993). This species is a highly opportunistic forager and will exploit any superabundant food source such as fisheries, refuse dumps, sewage outfalls and wharves. The diet has been observed to consist of fish, crabs, earthworms, adult birds, eggs and young birds, rodents and insects (del Hoyo *et al.*, 1996).

Ireland supports internationally important numbers of herring gulls, however due to their long-term population declines over the past 25 years, the herring gull is a Amber-listed species in Ireland (Gilbert *et al*., 2021) and Red-listed in the UK (Stanbury *et al*., 2021). In Ireland, the Seabird Census recorded 10,333 pairs, a 33% decrease over the long term (1985/87 – 2015/18) (Cummins *et al.,* 2019), this is likely due to fluctuations at various sites and recording significant populations at previously unknown colonies. Table 4-108 presents site population abundances as recorded over the SCR, Seabird 2000 and the Seabird Census period.

Table 4-108: Change in the recorded breeding herring gull populations at a selection of Irish colonies (Cummins *et al.*, 2019).

Site	SCR (1985 – 1988)	Seabird 2000 (1998 – 2002)	2015 – 2018	% Change (since Seabird 2000)
Great Saltee	825	43	115	167%
Inishmurray	200	111	246	119%
Glencolumbkille Peninsula	339	236	389	65%
Ireland’s Eye	540	246	318	29%
Cape Clear Island	176	46	29	-37%
Lambay Island	5,500	1,806	906	-50%

A summary of the recent (within the last five summers) colony data for herring gull within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-109 below. If multiple years are provided then the mean count is presented.

Table 4-109: Summary of most recent colony data for herring gull between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
Antrim	Belfast	2018 and 2019	27.5 ± 11.5
Down	Carlingford Lough SPA	2019 and 2021	6.5 ± 5.5
	Gun’s Island – Northern Island	2022	5
	Maggy’s Leap	2019	1
	Outer Ards SPA	2018 and 2019	193 ± 6
	Strangford Lough SPA	2017 – 2019	1,135 ± 97.6
Isle of Man	South Island	2017	536

Desk-based data

Data collected within the 2016/2017 ObSERVE western Irish Sea surveys (Jessopp *et al.*, 2018) did not differentiate between herring and common gull and were grouped together. A total of 764 sightings of 2,726 individuals were recorded over the three survey seasons, most commonly observed in the autumn surveys, then winter survey and least in summer surveys. Records were concentrated in the inshore coastal areas of the northern transects during the summer and autumn surveys, particularly along the Drogheda coastline. Mean density of herring/common gull across the ObSERVE western Irish Sea survey area ranged between 0.75 birds/km^2 in summer surveys, 3.82 birds/km^2 in autumn surveys, and 1.76 birds/km^2 in winter surveys.

Observations of herring gull were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-110.

A five-year peak observation of 9,245 birds was recorded in the 2017/2018 season, along with a five-year peak-mean count of 2,198 birds between 2015/16 and 2019/20 (I-WeBS, 2022).

Table 4-110: Summary of I-WeBS survey counts for herring gull within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 – 2019/2020)	Five-year peak-mean count (2015/2016 – 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
379	165	9,245	2,198	-	-

Site-specific data

Although herring gulls were observed in all twelve survey months, records were only made on transect during nine of these months Table 4-111. Transect records were low during the breeding season (March to August) which reflects local absence of breeding herring gull. The exception to this is in August 2019 when 165 birds were recorded on transect. On transect observations were generally higher in winter months, with peak counts recorded in December 2019 / January 2020 with 122 birds recorded (Aquafact, 2019).

Herring gulls showed no overall distribution pattern and were distributed across the Offshore Ornithology Study Area.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-111. Table 4-112 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-27 shows the spatial distribution of herring gull during the survey period.

Table 4-111: Transect records and total observations of herring gull from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	14
June 2018	4	-	51
July 2018	2	-	20
August 2018	2	-	17
September 2018	0	-	18
October 2018	10	-	75
November 2018	6	-	21
December 2018	5	-	69
January 2019	3	-	47
February 2019	17	-	33
March 2019	15	-	48
April 2019	0	-	20
June 2019	2	-	2
July 2019	4	-	4
August 2019	165	-	165
October 2019	8	-	8
December 2019	52	-	52
January 2020	20	-	20
April 2020	-	2	2
May 2020	0	17	17
June 2020	-	1	1
July 2020	-	24	24
August 2020	-	1	1
September 2020	-	1	1
Total	**315**	**46**	**730**

Table 4-112: Seasonal variation of herring gull recorded between May 2018 and September 2020.

Year	Spring Migration Jan – Apr	Breeding May – Jul	Autumn Migration Aug – Nov	Winter Dec	Non-breeding
2018	-	102	114	69	-
2019	80	239	8	52	-
2020	22	43	1	-	-

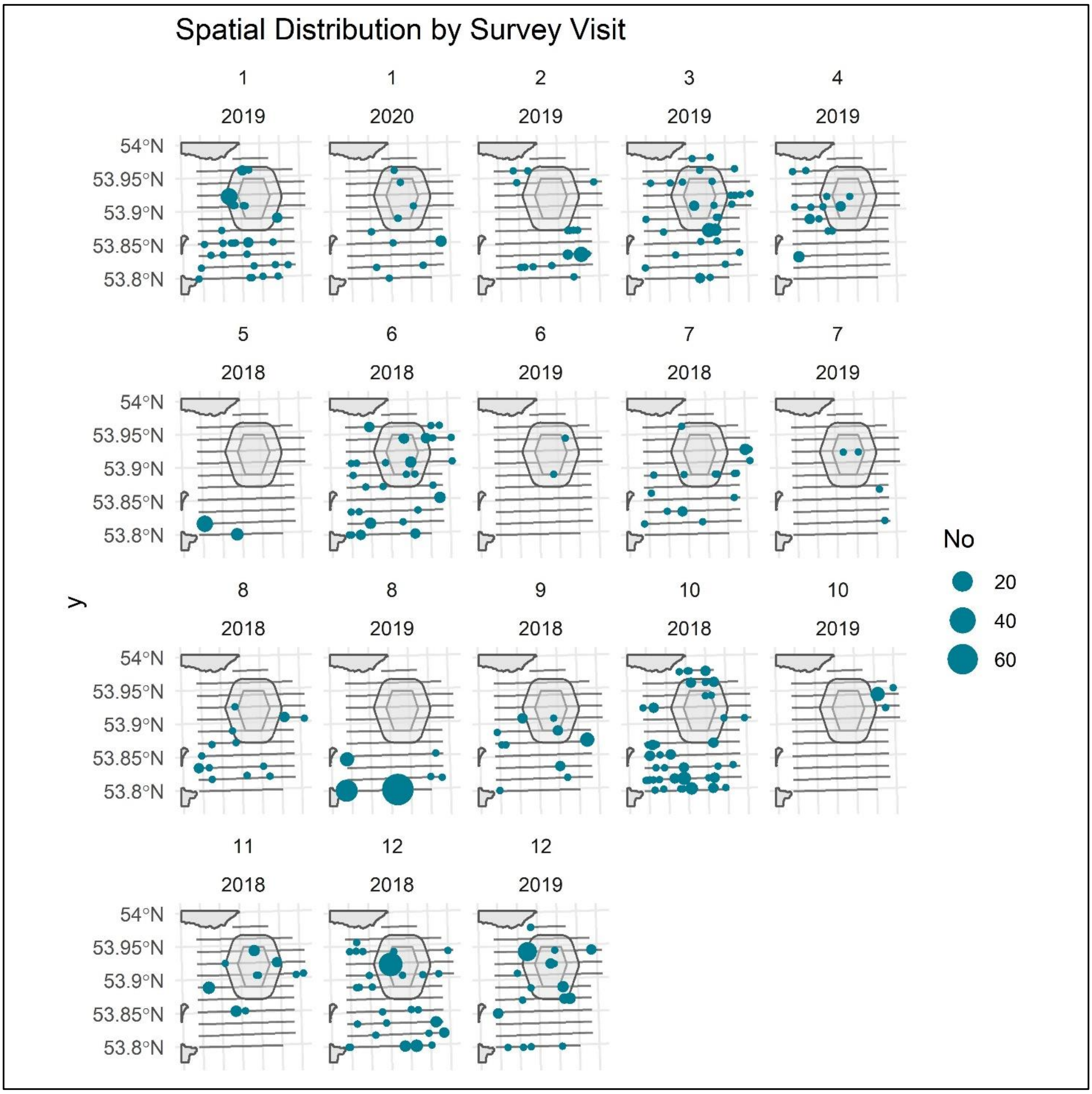

Figure 4-27: Spatial distribution of herring gull records. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, 65.4% of individuals (206 birds) were observed sitting on transect compared to 34.6% (109 individuals) in flight. Off transect, the majority of birds (350 individuals, 94.9%) were observed in flight. On transect, the majority of observed flight heights were between 5 m and 20 m. with lower numbers of individuals recorded between 30 m and 40 m. Off transect, flight heights were observed between 5 m and 50+ m.

Of the 46 herring gull recorded during the DAS, 23 were observed in flight and 23 were observed sitting. Flight height calculations from three birds resulted in a median altitude of 46 m above MSL.

Table 4-113 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and September 2020. Figure 4-28 shows the recorded flight heights of herring gull during the boat-based surveys.

Table 4-113: Proportion of herring gull recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / Year	On Transect				Off transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	0	0	0	0	4	28.6	10	71.4
June 2018	4	100	0	0	44	93.6	3	6.3
July 2018	2	100	0	0	18	100	0	0
August 2018	0	0	2	100	15	100	0	0
September 2018	0	0	0	0	18	100	0	0
October 2018	6	60.0	4	40.0	65	100	0	0
November 2018	2	33.3	4	66.7	15	100	0	0
December 2018	5	100	0	0	64	100	0	0
January 2019	2	66.7	1	33.3	44	100	0	0
February 2019	14	82.4	3	17.6	15	93.8	1	6.2
March 2019	13	86.7	2	13.3	31	93.9	2	6.1
April 2019	0	0	0	0	17	85.0	3	15.0
June 2019	1	50.0	1	50.0	0	0	0	0
July 2019	2	50.0	2	50.0	0	0	0	0
August 2019	25	15.2	140	74.8	0	0	0	0
October 2019	0	0	8	100	0	0	0	0
December 2019	18	34.6	34	65.4	0	0	0	0
January 2020	15	75.0	5	25.0	0	0	0	0
April 2020	1	50.0	1	50.0	N/A			
May 2020	2	100	0	0	0	0	0	0
June 2020	1	100	0	0	N/A			
July 2020	16	66.7	8	33.3				
August 2020	1	100	0	0				
September 2020	1	100	0	0				
Total	**109**	**34.6**	**206**	**65.4**	**350**	**94.9**	**19**	**5.1**

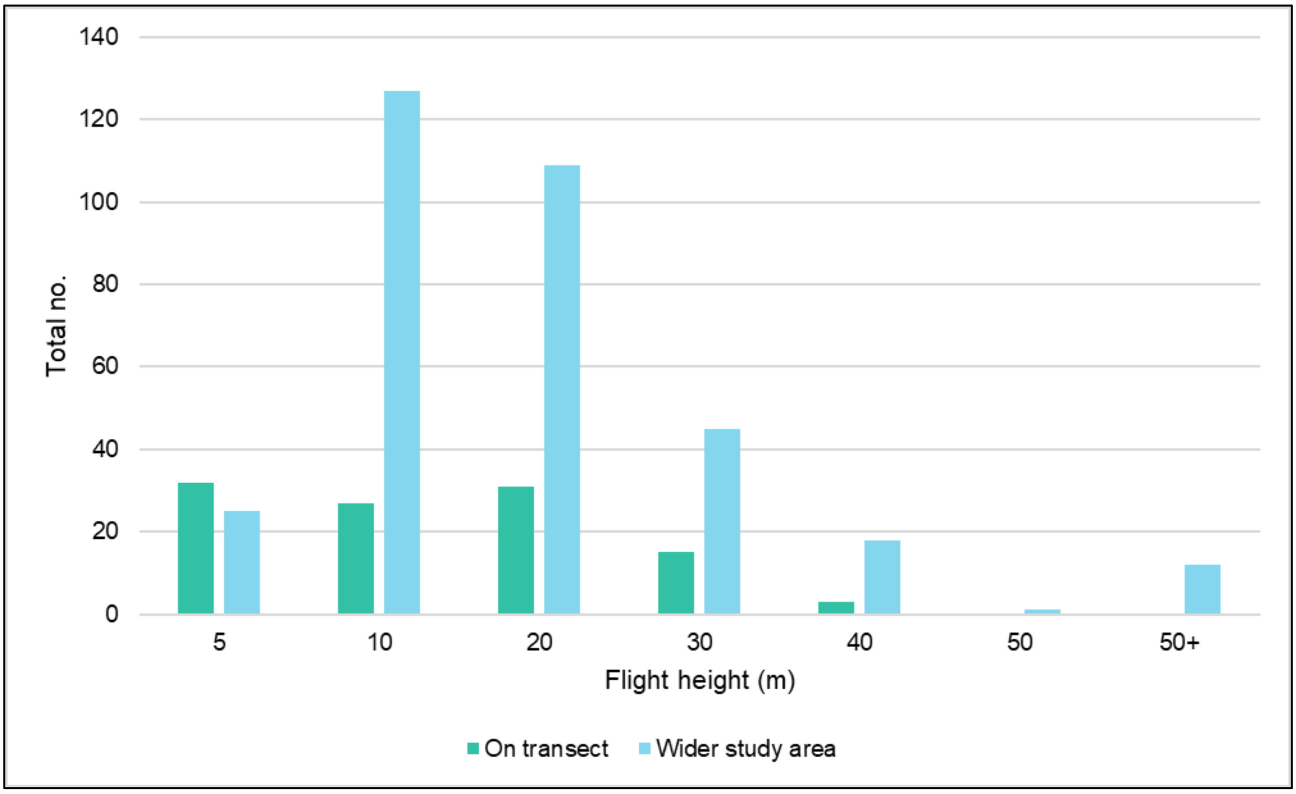

Figure 4-28: Herring gull flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates during boat-based surveys

Flying birds

There were 303 records of flying herring gull over the study period. The majority of these records were single individuals with smaller numbers of groups up to 12 birds in size noted.

Table 4-114 and Table 4-115 below presents the herring gull modelled flight abundance estimates for the offshore wind farm area and the offshore wind farm area plus 2 km buffer.

Table 4-114: Herring gull flying offshore wind farm area modelled abundance estimates by survey.

Month / Year	Offshore wind farm area estimate	Offshore wind farm area LCL	Offshore wind farm area UCL
May 2018	0	0	NA
June 2018	20	16	27
July 2018	7	4	12
August 2018	14	1	204
September 2018	11	2	132
October 2018	6	1	52
November 2018	12	4	40
December 2018	224	126	403
January 2019	38	14	106
February 2019	12	12	44
March 2019	51	30	87

Month / Year	Offshore wind farm area estimate	Offshore wind farm area LCL	Offshore wind farm area UCL
April 2019	8	4	16
June 2019	20	16	27
July 2019	7	4	12
August 2019	2	0	38
Octpber 2019	1	0	9
December 2019	33	16	67
January 2020	12	4	40
May 2020	0	0	NA

Table 4-115: Herring gull flying offshore wind farm area plus 2 km buffer modelled abundance estimates by survey.

Month / Year	Offshore wind farm area estimate	Offshore wind farm area LCL	Offshore wind farm area UCL
May 2018	0	0	NA
June 2018	27	15	61
July 2018	12	4	20
August 2018	24	3	293
September 2018	28	5	234
October 2018	34	12	138
November 2018	30	11	86
December 2018	337	183	650
January 2019	91	35	249
February 2019	159	37	159
March 2019	163	93	299
April 2019	16	4	24
June 2019	27	15	61
July 2019	12	4	20
August 2019	4	0	23
Octpber 2019	5	1	23
December 2019	50	27	109
January 2020	30	11	86
May 2020	0	0	NA

Design-based spatial abundance estimates during the DAS

DAS abundance analysis was undertaken by APEM and summarised fully within annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The abundance estimates are presented below for herring gull at the different spatial scales. Table 4-116 presents the abundance estimates for sitting birds only whereas, Table 4-117 presents the abundance estimates for flying birds. Detailed methods on calculation of the abundance estimates are presented in section 3.4.3. When provided the LCL and UCL are presented within brackets after the estimate.

Table 4-116: Abundance estimates of sitting herring gull within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	No birds recorded	No birds recorded
May 2020	No birds recorded	No birds recorded
June 2020	No birds recorded	No birds recorded
July 2020	No birds recorded	10 (4 - 20)
August 2020	No birds recorded	No birds recorded
September 2020	No birds recorded	No birds recorded

Table 4-117: Abundance estimates of flying herring gull within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	No birds recorded	No birds recorded
May 2020	3 (1 - 8)	10 (4 - 26)
June 2020	No birds recorded	No birds recorded
July 2020	No birds recorded	No birds recorded
August 2020	No birds recorded	No birds recorded
September 2020	No birds recorded	No birds recorded

4.6.16 Great skua

Ecology

Recently, a small population of great skua have been observed breeding within Ireland, with approximately eight breeding pairs at four to five sites (Balmer *et al.*, 2013). Skuas are kleptoparasites (steal food items from other seabirds) and scavengers from fisheries, as well as predating eggs, chicks and other seabirds (Mitchell *et al.*, 2004).

Great skua is an Amber-listed species in the UK and Ireland due to their rare breeding population and localised distribution of breeding sites (Gilbert *et al*., 2021, Stanbury *et al.,* 2021). During the Seabird Census count between 2015 and 2018 great skua were recorded breeding on islands across four counties in Ireland; breeding was confirmed at 13 sites and individuals recorded at a further two occupied territories (Table 4-118). The Irish population was then estimated to be between 13 and 15 breeding pairs, an increase of between 1,200 and 1,400% since Seabird 2000 (Cummins *et al.,* 2019).

Table 4-118: Great skuas breeding across Ireland during the period 2015 – 2018.

County	Confirmed Breeding	Possible / Probable Breeding
Donegal	3	2
Sligo	1	-
Mayo	8	-
Galway	1	-
Total	13	2

A summary of the recent (within the last five summers) colony data for great skua within the Cumulative Offshore Ornithology Study Area is provided Table 4-119 below. If multiple years are provided then the mean count is presented.

Table 4-119: Summary of most recent colony data for great skua between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AOT) ± SD (if applicable)
Antrim	Rathlin Island SPA	2017 and 2021	1.5 ± 0.5
Argyll and Bute	Coll	2018	3
	Islay - West (Port Askaig to Bruichladdich)	2017 – 2019 and 2021	1 ± 0.7
	North Colonsay and Western Cliffs SPA	2018	2
	Oronsay	2017 – 2019	3. 7 ± 0.9
	South West Iona and Soa	2021	1
	Stac Mhic Mhurchaidh, Reidh Eilean, Eilean Annraidh, Eilean Chalba	2021	1
	Staffa	2021	1
	Tiree	2018 and 2019	1±1
	Treshnish Isles SPA	2017 – 2019, 2021 and 2022	4 ± 2.1
Lochaber	Canna and Sanday SPA	2017 – 2019, 2021 and 2022	15.8 ± 5.2
	Heisgeir	2018	2
	Muck	2018	1
Ross and Cromarty	Gruinard Bay	2021	2
	Loch Gairloch	2019	6
	Priest Island SPA	2017, 2018 and 2021	6.7 ± 1.7
	Rubha Reidh Peninsula	2019	1
	Summer Isles	2019	8
Skye and Lochalsh	East Trotternish	2021	1
	Kyleakin to Portree	2021	1
	Raasay	2021	2
	Rubha Hunish	2018, 2019 and 2021	3.3 ± 0.5
	Skye	2021	2
Sutherland	Assynt (Inland Lochs)	2019	1
	Glasleac Island, Soyea Island, Rubha Rodha, Loch Roe	2021	2
	Handa SPA	2018 and 2022	178 ± 105
	Loch Laxford	2017 and 2019	1.5 ± 1.5
	Stoer Headland	2018	1
Western Isles - Comhairle nan eilean	Barra and Vatersay	2021	1
	Bearasay - Lewis	2021	1
	Causamul, Haskeir, Boreray and Spuir	2021	6
	Druim Mor - Lewis	2018 and 2021	18.5 ± 6.5
	Flannan Isles SPA	2021	11
	Gilsay - Harris	2021	1

County (from SMP)	SMP Master Site	Year(s)	Count (AOT) ± SD (if applicable)
	Killegray - Harris	2018	1
	Lewis and Harris - Tysties	2021	2
	Lewis SKUA/GBBG squares	2021	67
	Liungaigh - Harris	2018	1
	Mingulay and Berneray SPA	2021	17
	North Rona and Sula Sgeir SPA	2021	37
	North Uist	2021	2
	Scaravay - Harris	2021	1
	Sound of Barra	2021	1
	Sound of Pabbay	2021	8
	South Uist	2018	2
	St Kilda SPA	2019	211
	Tolsta Head Moir - Lewis	2018 and 2021	24.5 ± 15.5

Desk-based data

The 2016/2017 ObSERVE surveys (Jessopp *et al.*, 2018) recorded a total of four sightings of five individuals within the ObSERVE western Irish Sea survey area across the three survey periods. Four individuals were recorded in autumn, and one individual was recorded in winter. Observations of great skua were concentrated in areas of water depths of between 30-60 m. No records of great skua were presented in the I-WeBS database.

Site-specific data

During the boat-based surveys, observations of great skua were very sparse, with only two individuals recorded on transect in August 2018 and August 2019 (Table 4-120). Records of a further seven birds were made within the Study Area, in June 2018 (one individual), September 2018 (two individuals), October 2018 (two individuals), December 2018 (one individual) and April 2019 (one individual) (Aquafact, 2019). One great skua was identified during the aerial survey of the Study Area in July 2020, located in the southeast. All great skua records were of flying birds.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-120. Figure 4-29 shows the spatial distribution of great skua during the survey period.

Table 4-120: Transect records and total observations of great skua from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	0
June 2018	0	-	1
July 2018	0	-	0
August 2018	1	-	1
September 2018	0	-	2
October 2018	0	-	2
November 2018	0	-	0
December 2018	0	-	1
January 2019	0	-	0
February 2019	0	-	0

Month / Year	Boat-based Transect Records	DAS Records	All Records
March 2019	0	-	0
April 2019	0	-	1
June 2019	0	-	0
July 2019	0	-	0
August 2019	1	-	1
October 2019	0	-	0
December 2019	0	-	0
January 2020	0	-	0
April 2020	-	0	0
May 2020	0	0	0
June 2020	-	0	0
July 2020	-	1	1
August 2020	-	0	0
September 2020	-	0	0
Total	**2**	**1**	**10**

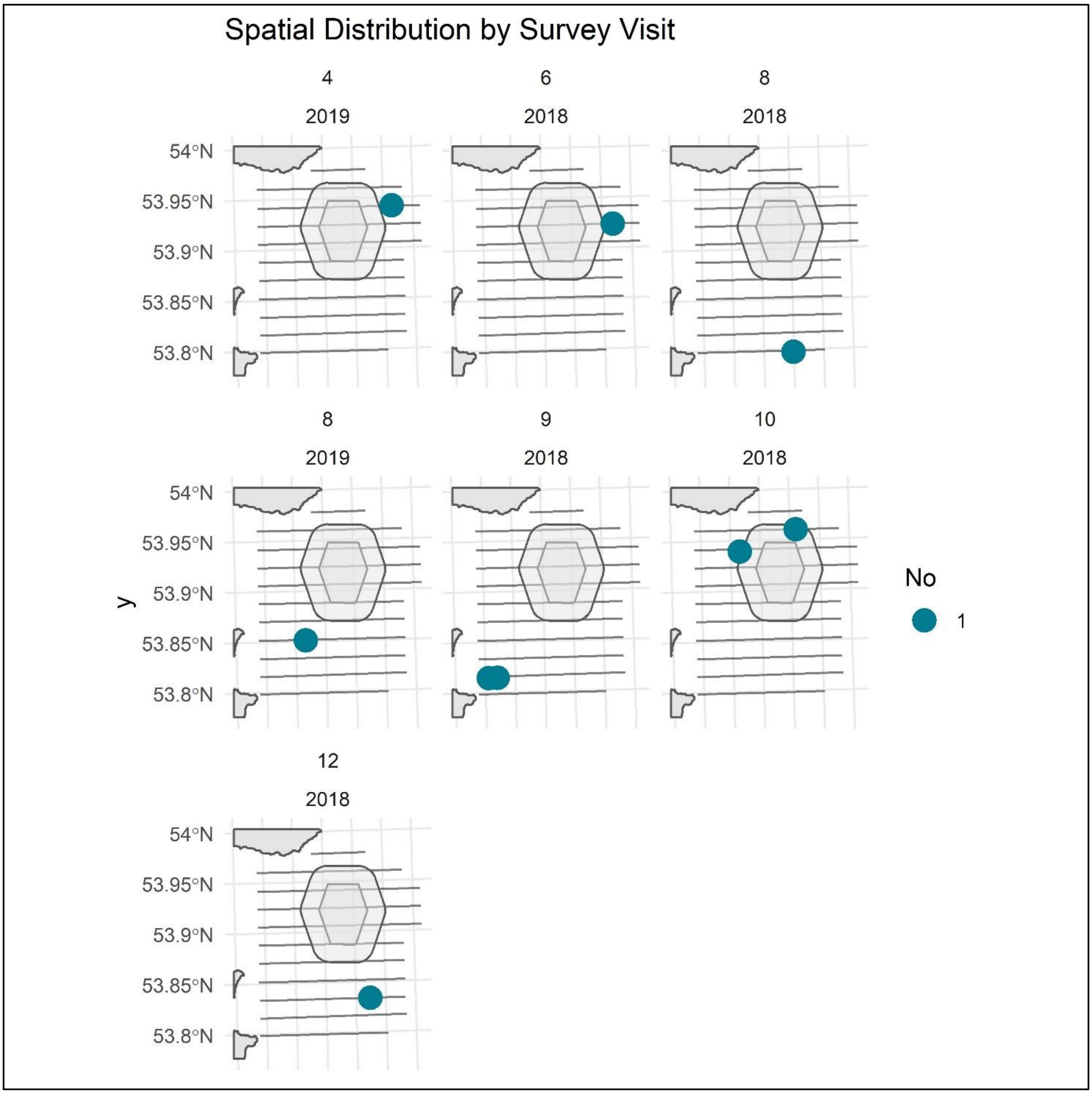

Figure 4-29: Spatial distribution of great skua records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-29), it is not possible to undertake any detailed spatial analysis for this species.

4.6.17 Common tern

Ecology

Common terns are summer visitors in Ireland with breeding colonies located throughout the country, including several located along the east coast of Ireland to the north and south of the offshore wind farm area (Balmer *et al.*, 2013), the closest being including Carlingford Lough. Although common tern is a strongly migratory coastal seabird, that breeds in a variety of habitats in coastal and inland areas, with a preference for nesting on flat rock surfaces on open shingle and sandy beaches, dunes and spits, vegetated dune areas, sandy, rocky islands in estuaries and coastal lagoons amongst others (BirdLife International, 2020; Snow and Perrins, 1998; del Hoyo *et al.*, 1996). When nesting inland, similar habitats are occupied such as sand or shingle lakes shores, shingle banks in rivers, sand- or gravel-pits, marshes, ponds, grassy areas and patches of dredged soil. The diet consists of small fish, planktonic crustaceans and insects (del Hoyo *et al.*, 1996).

In the UK and Ireland, common tern is Amber-listed due to recent moderate short- and long-term declines in their breeding range and localised nature of their breeding populations, with over 50% of their population found in ten or fewer sites (Gilbert *et al*., 2021, Stanbury *et al.,* 2021). According to Cummins *et al.* (2019), the population of common tern in Ireland has increased by 185% since the All-Ireland Tern survey undertaken in 1995. The strong national increase of common tern was attributed to long-standing and ongoing conservation actions at Lady's Island Lake and Rockabill where near year on year increases have been recorded (Table 4-121) (Cummins *et al.,* 2019).

Table 4-121: Common tern population growth at Rockabill and Lady's Island Lake (Cummins *et al.*, 2019).

Site	All-Ireland Tern Survey 1984	All-Ireland Tern Survey 1995	Seabird 2000	Seabird Census (2013 – 2018)	% Change (since Seabird 2000)
Rockabill	89 (5%)	429 (24%)	610 (25%)	2,034 (40%)	+ 233%
Lady's Island Lake[3]	<12 (<1%)	<401 (<23%)	480 (19%)	979 (19%)	+ 104%

A summary of the recent (within the last five summers) colony data for common tern within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-122 below. If multiple years are provided then the mean count is presented.

Table 4-122: Summary of most recent colony data for common tern between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
Down	Carlingford Lough SPA	2017 – 2019 and 2021	120.4 ± 101.7
Dublin	Loughshinny to Killiney	2017 and 2018	2,037 ± 2

Desk-based data

The surveys undertaken within the ObSERVE western Irish Sea survey did not differentiate between common tern and Arctic tern, and thus data were combined. A total of 443 observations of 1,235 individuals were recorded across the summer and autumn, with no sightings recorded during the winter surveys. Sightings were concentrated around Wexford harbour during summer surveys, and within the northern and southern sections of the ObSERVE western Irish Sea survey area during autumn. Mean density of Arctic and common tern across the ObSERVE survey area ranged from 0.49 birds/km^2 in summer surveys and 0.79 birds/km^2 in autumn surveys (Jessopp *et al.*, 2018). No records of common tern were presented in the I-WeBS database.

Site-specific data

A total of 42 records of common tern were recorded on transect in only seven months during the boat-based surveys between August and September 2018 as June and October 2019, as shown in Table 4-123. A peak observation of 21 individuals on transect was recorded in August 2019. All transect records were of terns flying through the Study Area, suggested to be related to post-breeding site dispersals (Aquafact, 2019).

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[3] Early surveys at this site did not distinguish between common and arctic terns.

Recorded flight heights during the boat-based surveys of birds observed within the Study Area were between 5 m and 20 m.

During the DAS, two common tern were observed in the centre and in the west of the Study Area. A summary of the monthly records from the boat-based and DAS is presented in Table 4-123. Figure 4-30 shows the spatial distribution of common tern during the boat-based survey period.

Table 4-123: Transect records and total observations of common tern from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	1
June 2018	0	-	0
July 2018	0	-	0
August 2018	1	-	9
September 2018	2	-	21
October 2018	0	-	0
November 2018	0	-	0
December 2018	0	-	0
January 2019	0	-	0
February 2019	0	-	0
March 2019	0	-	0
April 2019	0	-	0
June 2019	4	-	4
July 2019	4	-	4
August 2019	21	-	21
October 2019	4	-	4
December 2019	0	-	0
January 2020	0	-	0
April 2020	-	0	0
May 2020	6	0	6
June 2020	-	0	0
July 2020	-	0	0
August 2020	-	0	0
September 2020	-	7	7
Total	**42**	**7**	**77**

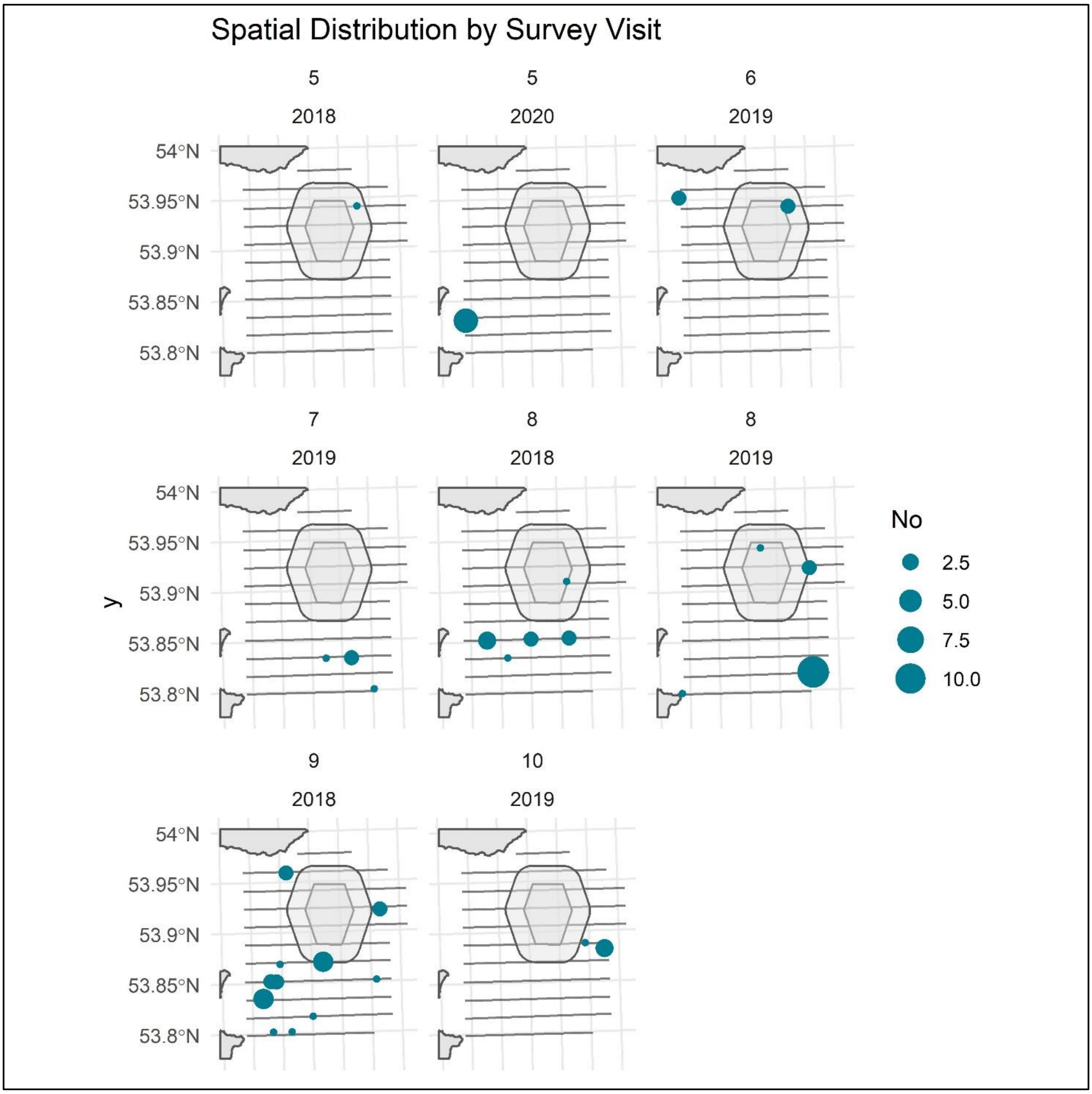

Figure 4-30: Spatial distribution of common tern records. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-30), it is not possible to undertake any detailed spatial analysis for this species.

4.6.18 Roseate tern

Ecology

Roseate tern is a migratory coastal seabird which breeds in large, dense, single or mixed species colonies which can contain up to several thousand pairs (del Hoyo *et al.*, 1996). Roseate terns nest on the ground in a scrape in sand, shingle or coral rubble (del Hoyo *et al.*, 1996) and are restricted to two main colonies in

Ireland which are monitored annually. The Seabird Census undertaken between 2013 – 2018 recorded 1,820 pairs, an increase of 192% since the All-Ireland Tern survey undertaken in 1995 (Cummins *et al.,* 2019); significant conservation management at the two colonies: Rockabill and Lady's Island Lake has contributed to this. Similar to sandwich terns, the national roseate tern population increase coincided with a decline in its breeding range, resulting in an extirpation of those breeding sites along Ireland's Atlantic coast. As indicated by Cummins *et al.* (2019), mortality in the tern's wintering grounds in Ghana is likely to be a key contributor to this species' overall decline.

Roseate terns roost in large groups throughout the year, and forage in either smaller loose groups or larger flocks of several hundred individuals (del Hoyo *et al.*, 1996). Roseate tern forage on small pelagic fish, particularly sandeel, clupeids, gadoids, insects and marine invertebrates (Birdlife International, 2020). Individuals forage through plunge diving, and typically plunge from greater heights than other terns. The roseate tern is Red-listed in the UK (Stanbury *et al*., 2021) and Amber-listed in Ireland (Gilbert *et al*., 2021).

There is no colony data for roseate tern within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species. The closest breeding colony is on Rockabill approximately 36 km away from the Project and outwith the mean max foraging range + 1 SD of 33.2 km for roseate tern. The latest colony data from Rockabill was 1704 nests in 2021 (BirdWatch Ireland, 2021).

Desk-based data

Within the 2016/2017 ObSERVE surveys (Jessopp *et al.*, 2018), 79 observations of 165 roseate terns were made during the summer and autumn surveys, which were concentrated in the northern extent of the ObSERVE western Irish Sea survey area with several observations also recorded around Wexford harbour. Observations of roseate tern were also concentrated over water depths of between 20-50 m, illustrating no association between roseate terns and shallow water sandbanks. Mean density of roseate terns across the ObSERVE western Irish Sea survey area ranged from 0.14 birds/km^2 in summer surveys and 0.04 birds/km^2 in autumn surveys (Jessopp *et al.*, 2018). No records of roseate tern were presented in the I-WeBS database.

Site-specific data

During the boat-based surveys, there was one observation of roseate tern in August 2019 (ten individuals), and an additional record of four roseate terns within the Study Area flying and foraging in July 2018.

During the DAS one roseate tern was identified in July 2020, flying in an easterly direction along the southern edge of the Study Area. A further 11 commic / roseate tern were identified between June 2020 and September 2020; the individuals showed no overall distributional pattern. Figure 4-31 shows the spatial distribution of roseate tern during the boat-based survey period.

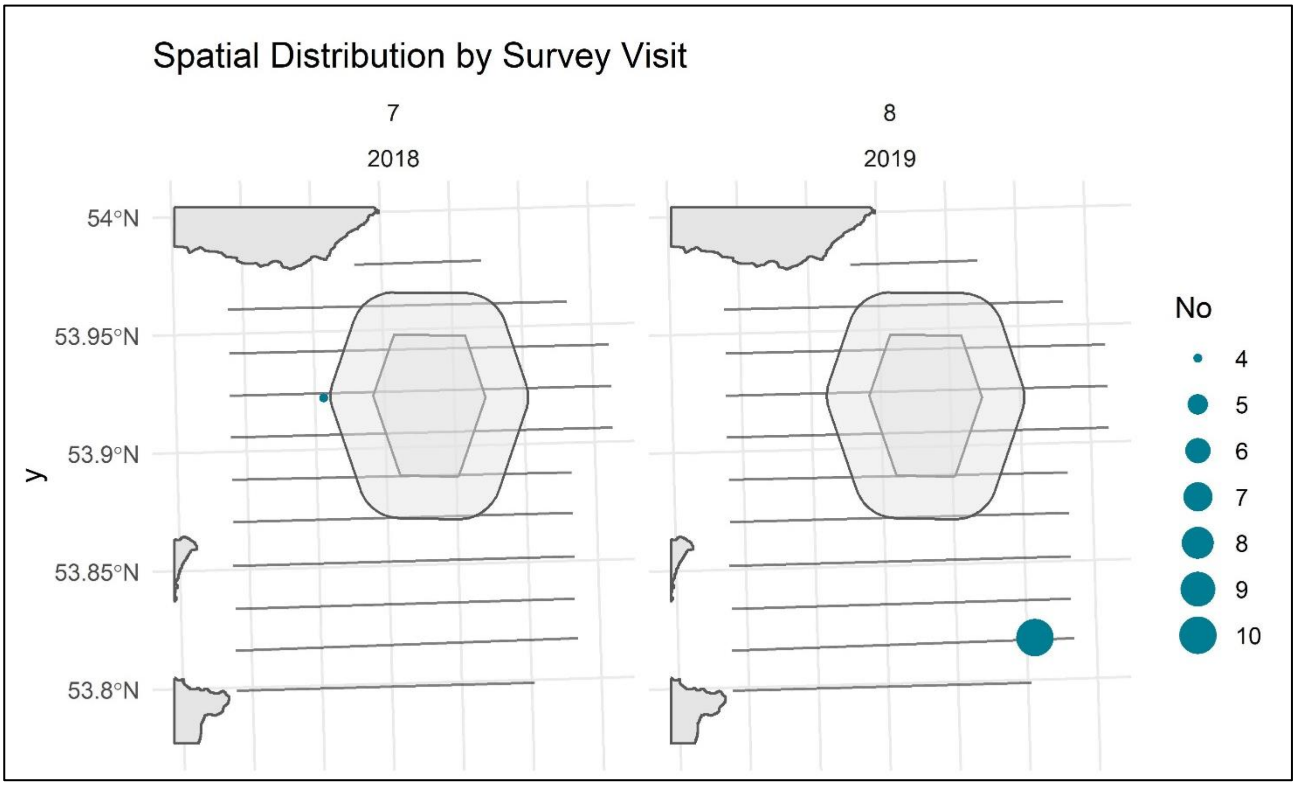

Figure 4-31: Spatial distribution of roseate Tern records. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-31), it is not possible to undertake any detailed spatial analysis for this species.

4.6.19 Sandwich tern

Ecology

The Sandwich tern is a summer visitor to all Irish coasts from March to September and is known to winter in small numbers in Galway Bay and Strangford Lough. Sandwich tern nest in shallow scrapes on open, unvegetated sand, gravel and mud substrates on sandy islands, rocky calcareous islets, sand-spits, sand-dunes and shingle beaches (del Hoyo *et al.*, 1996). Individuals breed in dense colonies with other tern species or black-headed gulls, and forage in large flocks in areas where prey is abundant or concentrated (del Hoyo *et al.*, 1996).

In Ireland, this species' colonies are confined to six counties, the closest of which is Carlingford Lough. Data recorded from seabird surveys during the period 2016 – 2018 of the Seabird Census (Cummins *et al.,* 2019) showed that Sandwich tern bred or attempted to breed at a small number of coastal locations, however the two main colonies at Lady's Island Lake and Inch Lough contribute most to the overall national population estimate (84%). According to Cummins *et al.* (2019), the changes in abundance or presence of Sandwich tern colonies may be driven, in part, by site-specific changes in conditions including recreational pressure, predation and availability of suitable prey during key periods of the breeding season.

Sandwich terns forage on surface-dwelling marine fish (between 9 and 15 cm in length), marine worms and small shrimp and forage through shallow surface dives. The Sandwich tern is Amber-listed in the UK and Ireland (Gilbert *et al*., 2021, Stanbury *et al*., 2021).

A summary of the recent (within the last five summers) colony data for sandwich tern within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-124 below. If multiple years are provided then the mean count is presented.

Table 4-124: Summary of most recent colony data for sandwich tern between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (AON) ± SD (if applicable)
Down	Carlingford Lough SPA	2017 – 2019 and 2021	120.4 ± 101.7

Desk-based data

Approximately 60 observations of 90 Sandwich terns were recorded across the summer and autumn ObSERVE western Irish Sea surveys in 2016/2017 (Jessopp *et al.*, 2018). These observations were concentrated over shallow waters of approximately 10 m depth, and likely associated with sandbanks. Summer distributions were suggested to be influenced by the Lady's Island Lake colony in Wexford, and sightings in the northern area of the survey region were suggested to be non-breeders. Mean density of Sandwich terns across the ObSERVE western Irish Sea survey area ranged from 0.07 birds/km^2 in summer surveys and 0.04 birds/km^2 in autumn surveys (Jessopp *et al.*, 2018). No records of Sandwich tern were presented in the I-WeBS database.

Site-specific data

There were six records of Sandwich tern made on transect during the boat-based surveys; three in July 2019, one in August 2019 and two in September 2019. Additional observations were made off transect in May 2018, July 2018 and two records in August 2018.

During the Digital Aerials, 13 Sandwich tern were identified across the surveys: three in April 2020, two in May 2020, three in June 2020, one in July 2020, one in August 2020 and three in the September surveys. Flying sandwich terns were recorded in all six of the surveys although there was not a significant orientation. In April and September 2020, one and one flying sandwich tern deemed suitable for flight height determination were recorded respectively, the altitude was 60 m above MSL in April and 7 m in September.

Sandwich tern were predominantly recorded along in the western edge and north-western corner of the Ornithology Study Area and in the northwest corner of the Ornithology Study Area, although a few observations were recorded in the east of the area between July and October 2019.

Figure 4-32 shows the spatial distribution of sandwich tern during the boat-based survey period.

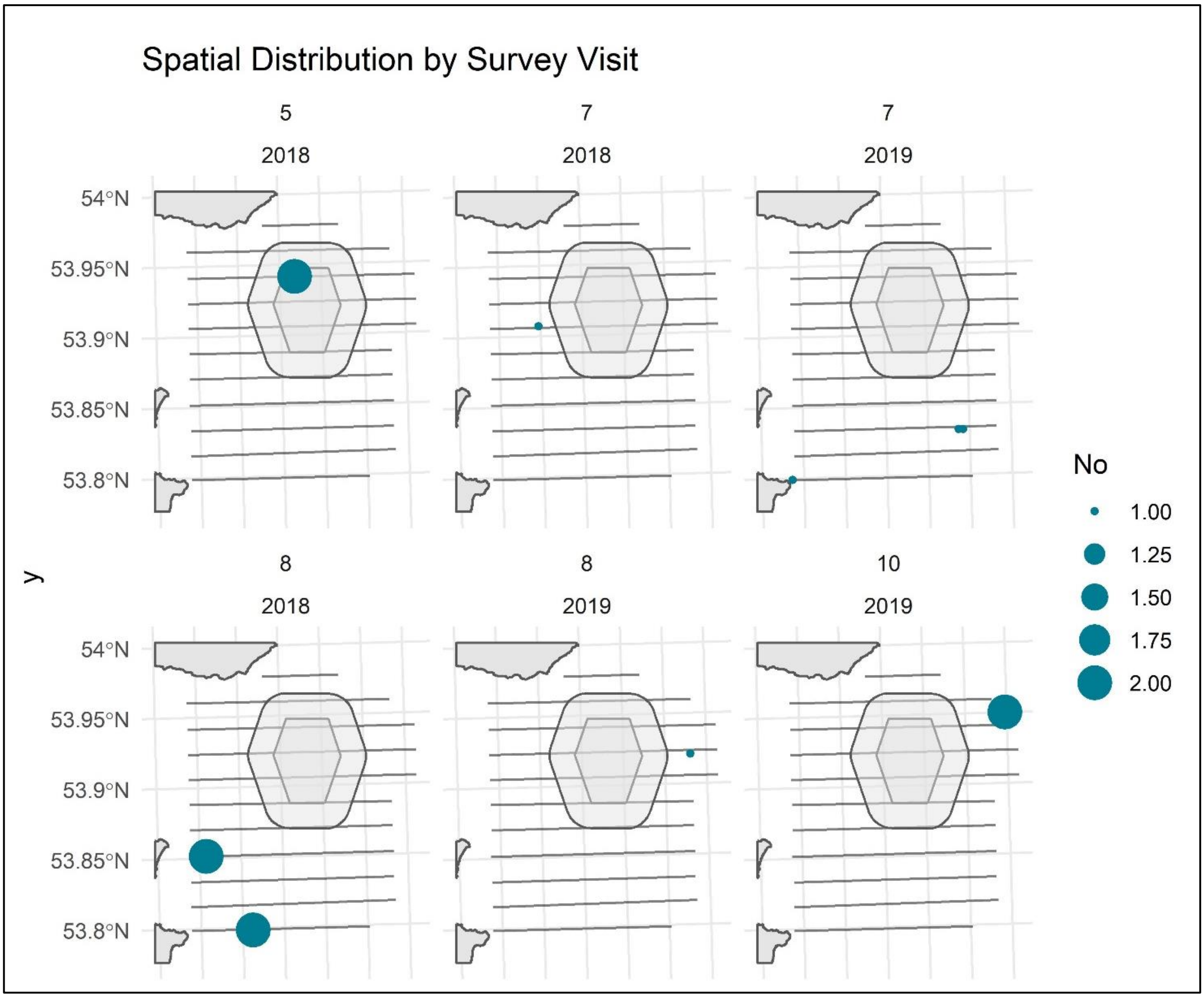

Figure 4-32: Spatial distribution sandwich tern records. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-32), it is not possible to undertake any detailed spatial analysis for this species.

4.6.20 Guillemot

Ecology

Britain and Ireland are home to internationally important populations of guillemot, with 13% of the global population (708,200 pairs) (Mitchell *et al.*, 2004), and a total estimated abundance of 236,654 of these pairs are located in Ireland. The closest breeding colony to the Study Area is on Lambay Island SPA, which recorded 59,983 individuals in 2017.

Guillemot spend most of their time at sea, only coming to land to breed on rocky cliff shores or islands. With extensive suitable habitats existing around Ireland’s coast, breeding sites are known to be located to the south of the Project along the east coast of Ireland.

Most foraging during the breeding season occurs within 10 to 20 km of the colony, although foraging distances of over 100 km have been recorded (BirdLife International, 2020). The main prey items of the adult guillemot are shoaling pelagic fish, mostly sandeel, herring and sprats as well as small gadoids, and they are capable of switching prey in response to availability. Prey are caught by pursuit diving, with birds diving from the surface, typically to depths of less than 50 m, but up to 200 m (BirdLife International, 2020). Guillemot catch prey from the bottom of the water column and carry single prey items back to the colony to provision chicks (Thaxter *et al.*, 2010).

The Seabird Census survey undertaken between 2015 and 2018 recorded guillemot at a total of 40 sites in Ireland, with an estimated 72% increase in the long-term trend (1985/87 – 2015/18) of this species. Approximately 97% of the Irish population are considered to be within the SPA network (Cummins *et al.,* 2019). Both the short- and long-term data trends suggested a strong increase in breeding guillemot in Ireland, with the largest colonies located at Cliffs of Moher, Loop Head, Doulus Head, Great Saltee and Lambay Island, with almost 40% of the national breeding population of guillemot occur on the east coast (Table 4-125). The regional variation in colony growth is likely due to food availability and abundance of preferred prey species.

Table 4-125: Population estimates (individuals) of guillemot at a selection of Irish colonies for the period 1985 - 1988 to 2015 - 2018 (Cummins *et al.,* 2019).

Site	SCR 1985 - 1988	Seabird 2000 1998 - 2002	2015 - 2018	% Change (since Seabird 2000)
Ireland’s Eye	1,458	2,191	4,410	+ 101%
Little Skellig	-	1,129	2,069	+ 83%
Cliffs of Moher	12,957	19,962	34,829	+ 75%
Great Skellig	-	1,422	2,297	+ 62%
Doulus Head	3,497	4,253	6,881	+ 62%
Loop Head	4,010	5,000	7,709	+ 54%
Great Saltee	16,329	21,436	25,851	+ 21%
Old Head of Kinsale	4,179	3,610	4,157	+ 15%
Lambay Island	44,495	60,754	59,983	- 1%
Clare Island	-	2,280	2,168	- 5%
Horn Head	4,806	6,548	5,442	- 17%

As more than 50% of their breeding population occurs at ten sites or fewer, guillemot is an Amber-listed species in Ireland (Gilbert *et al*., 2021).

A summary of the recent (within the last five summers) colony data for guillemot within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-126 below. If multiple years are provided then the mean count is presented.

Table 4-126: Summary of most recent colony data for guillemot between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (IND) ± SD (if applicable)
Antrim	Causeway Coast	2021	278
	Larne Lough to Portmuck	2017 – 2019	2,409 ± 148.1
	Muck Island	2017 – 2019	2,604.7 ± 129.2
	Rathlin Island SPA	2021	149,510
	Sheep Island SPA	2021	703
Gwynedd	Aberdaron Coast and Bardsey Island SPA	2017 – 2019	1,366.3 ± 191.5
	Aberdaron Coast not in SPA	2017 – 2019	54. 3 ± 23.9

County (from SMP)	SMP Master Site	Year(s)	Count (IND) ± SD (if applicable)
	Lleyn Peninsula	2018, 2019 and 2021	12,858.7 ± 1,318.3
	Puffin Island SPA	2017 – 2019 and 2021	3,672.3 ± 395.9
	South Stack	2017 – 2019 and 2021	6,365 ± 832.3
Isle of Man	North Island	2017	471
	South Island	2017	4,085
	West Island	2017	663
Wicklow	Wicklow Head	2018, 2019, 2021 and 2022	899 ± 262.6
Wigtown	Mull Of Galloway	2017 – 2019	359.3 ± 115.7
	Port Mona, Devil's Bridge, Laggantalluch Head	2021	229
	Sheddock Cliffs - Burrow Head	2020	6

Desk-based data

The observations made within the ObSERVE western Irish Sea surveys did not differentiate between razorbill and guillemot, and therefore records were combined into a single group. There was a total of 7,541 sightings of 24,763 individuals across the ObSERVE western Irish Sea survey area, with the majority of these occurring within the autumn surveys. During the summer surveys, sightings were concentrated around the northern extent of the ObSERVE survey area, which includes Dundalk Bay and the offshore wind farm area. Data records did not illustrate a clear association between observations and water depths. Mean density of razorbill and guillemot across the ObSERVE western Irish Sea survey area ranged from 3.95 birds/km^2 in summer surveys, 17.4 birds/km^2 in autumn surveys and 4.61 birds/km^2 in winter surveys (Jessopp *et al.*, 2018). No records of guillemot were presented in the I-WeBS database.

Site-specific data

During the boat-based surveys, guillemot was the most commonly recorded bird on transect, with over 10,000 individuals recorded across the survey period (Table 4-127). During periods of post-fledging dispersal of adults and juveniles from breeding sites between August and September 2018, peak counts were recorded of 1,274 and 1,640 individuals respectively (Table 4-127, Aquafact, 2019). Similar counts were observed in August 2019 and October 2019 with 2,114 and 1,203 birds respectively.

During the DAS, 13,458 guillemot were identified across the surveys, 247 in the April 2020, 529 in May 2020, 207 in June 2020, 3,235 in July 2020, 3,077 in August 2020 and 6,163 in September 2020 surveys. A peak count of 5,562 guillemot in the September 2020.

An additional 2,211 guillemot / razorbill were identified across the DAS: 217 in April 2020, 91 in May 2020, 245 in June 2020, 808 in July 2020, 54 in August 2020 and 796 in September 2020 surveys.

Guillemot were distributed across the Ornithology Study Area with the largest concentrations of individuals in the south to southeast of the area.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-127. Table 4-128 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-33 shows the spatial distribution of guillemot during the boat-based survey period.

Table 4-127: Transect records and total observations of guillemot from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	228	-	277
June 2018	388	-	461
July 2018	247	-	299
August 2018	1,274	-	1,342
September 2018	1,640	-	1,655
October 2018	117	-	214
November 2018	44	-	64
December 2018	181	-	199
January 2019	115	-	201
February 2019	184	-	201
March 2019	179	-	245
April 2019	403	-	451
June 2019	476	-	476
July 2019	736	-	736
August 2019	2,114	-	2,114
October 2019	1,203	-	1,203
December 2019	185	-	185
January 2020	520	-	520
April 2020	-	247	247
May 2020	202	529	529
June 2020	-	207	207
July 2020	-	3,235	3,235
August 2020	-	3,077	3,077
September 2020	-	6,163	6,163
Total	**10,436**	**13,458**	**24,301**

Table 4-128: Seasonal variation of guillemot recorded between May 2018 and September 2020.

Year	Spring Migration Dec – Feb	Breeding Mar - Jun	Autumn Migration Jul - Oct	Winter Nov	Non-breeding
2018 / 2019	-	1,037	3,211	64	-
2019 / 2020	601	1,172	4,035	-	-
2020	705	983	12,475	-	-

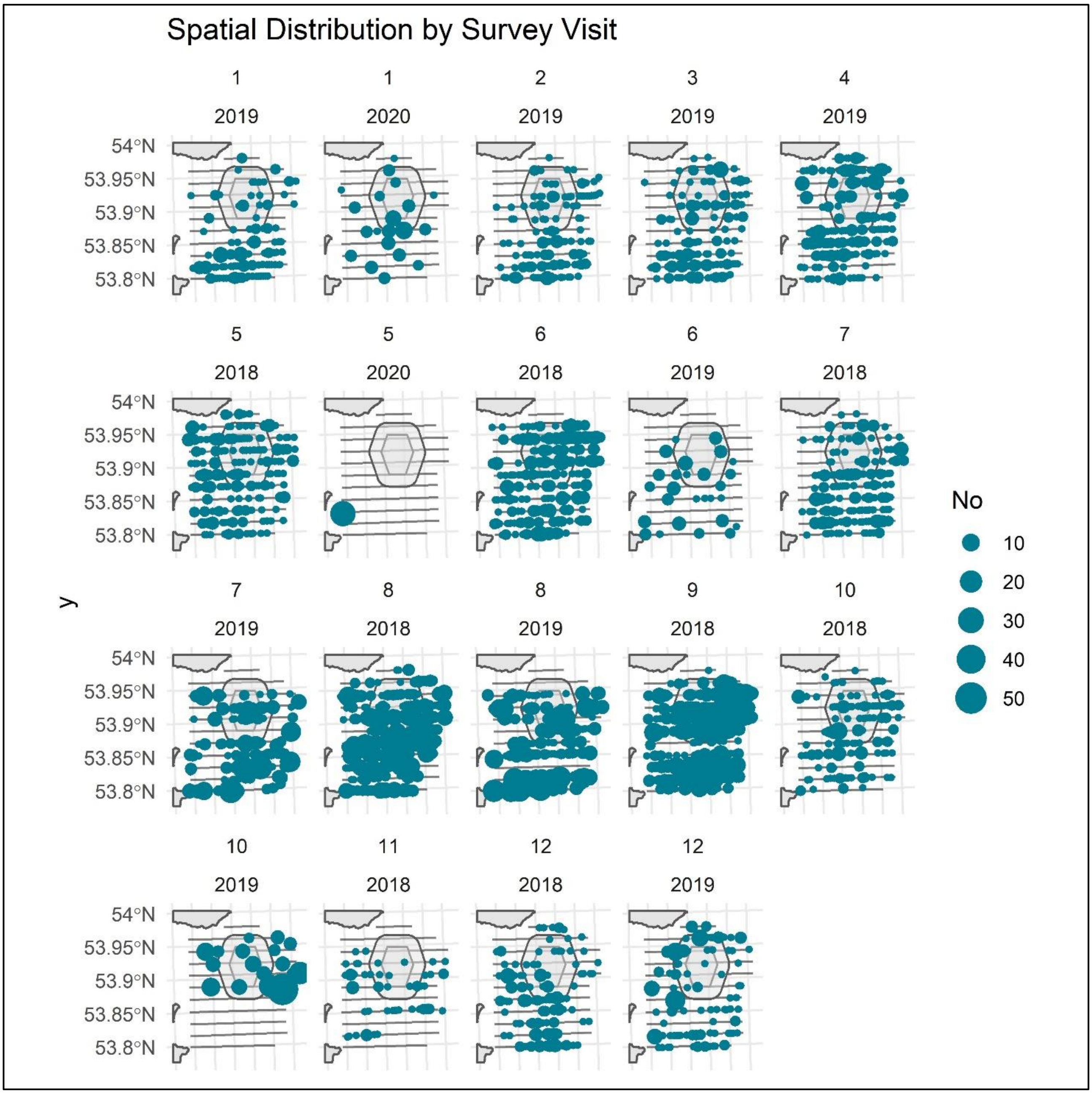

Figure 4-33: Spatial distribution of guillemot records during the boat-based survey. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, 10,236 individuals (98.1%) were observed sitting compared to those in flight (200 individuals, 1.9%). Off transect, the majority of birds (417 individuals, 68.5%) were observed in flight. The majority of guillemot on transect and off transect had a flight height of 5 m; few birds were observed between 10 m and 30 m.

Of the 13,458 birds recorded during the DAS, 150 were observed in flight and 13,308 were observed sitting. Flying guillemot were recorded in the May, June and July surveys. In June guillemot flew in a significant orientation around the mean of 193° and in September guillemot flew in a significant orientation around the mean of 255°. The flight heights of guillemot recorded during the DAS resulted in a median altitude of 17 m above MSL.

Table 4-129 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and May. Figure 4-34 shows the recorded flight heights of guillemot during the same period.

Table 4-129: Proportion of guillemot recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	12	5.3	216	94.7	44	89.8	5	10.5
June 2018	6	1.5	382	98.5	42	57.5	31	42.5
July 2018	7	2.8	240	97.2	23	44.2	29	55.8
August 2018	5	0.4	1,269	99.6	3	4.4	65	95.6
September 2018	7	0.4	1,633	99.6	6	33.3	9	66.7
October 2018	6	5.1	111	94.9	96	99.0	1	1.0
November 2018	0	0	44	100	20	100	0	0
December 2018	1	0.6	180	99.4	18	100	0	0
January 2019	9	7.3	106	92.2	78	90.1	8	9.9
February 2019	2	1.1	182	98.9	16	94.1	1	5.9
March 2019	16	8.9	163	91.1	45	68.2	21	31.8
April 2019	4	1.0	399	99.0	26	54.2	22	45.8
June 2019	25	5.3	451	94.7	0	0	0	0
July 2019	2	0.3	734	99.7	0	0	0	0
August 2019	0	0	2,114	100	0	0	0	0
October 2019	2	0.2	1,201	99.8	0	0	0	0
December 2019	11	5.9	174	94.1	0	0	0	0
January 2020	42	8.1	478	91.9	0	0	0	0
April 2020	46	18.6	201	81.4	N/A			
May 2020	69	9.4	662	90.6	0	0	0	0
June 2020	43	20.8	164	79.2	N/A			
July 2020	26	0.9	3,209	99.1				
August 2020	0	0	3,077	100				
September 2020	9	0.1	6,154	99.9				
Total	**350**	**1.5**	**23,544**	**98.5**	**417**	**68.5**	**192**	**31.5**

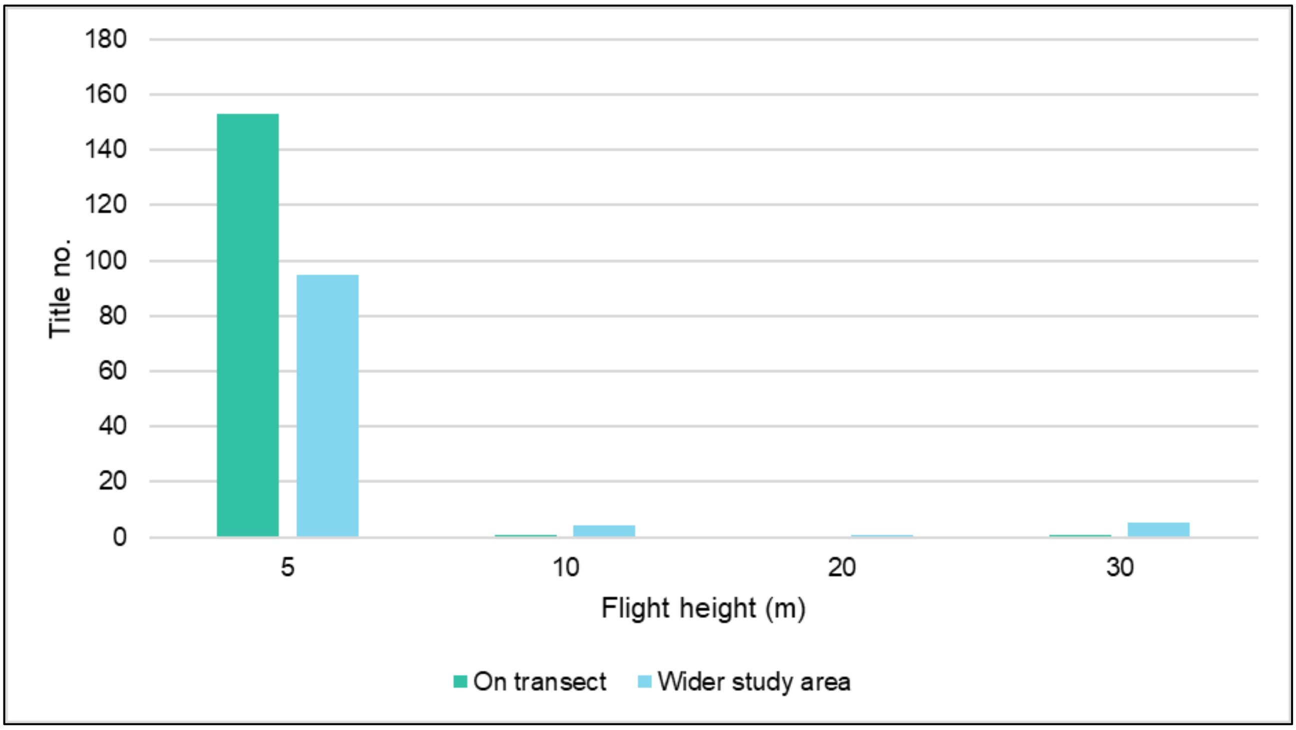

Figure 4-34: Guillemot flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates during boat-based surveys

During initial data exploration and model fitting a high co-linearity / correlation between Bathymetry and distance to coast was identified resulting in a prohibitively high VIF for these parameters. Because of this distance to coast was removed from the model. The following refined environmental and spatial covariates were used in the MRSea CReSS analysis:

- Bathymetry;
- Year; and
- X and Y coordinates.

To prepare for the GEE-CreSS analyses, a complete grid of abutting cells based on the survey grid and environmental covariates was constructed to cover the entire survey area. All variables except X and Y co-ordinate were included in the one-dimensional SALSA model selection method (Walker *et al.* 2011) and automatic model simplification using non-significant p-values was carried out. An appropriate blocking structure using transect ID was included as there was evidence of autocorrelation. Month was fitted as a factor term. This provided the base model for assessment of the 2D spatial smoother.

CReSS was used to fit the spatial density surface and GEEs were used to provide realistic model-based estimates. The GEE-CReSS grid knot locations are included in Appendix A1 of this report. An interaction with month was included to allow the density surface to vary between survey months. Following predictions, bootstrapping was used to generate 95 % confidence intervals for each grid cell to allow for an assessment of uncertainty. The bootstrapping procedure incorporated any autocorrelation specified within the prediction model following the CReSS method.

Sitting birds

Table 4-130 to Table 5-114 below present the guillemot modelled abundance estimates for sitting birds within the offshore wind farm area, the offshore wind farm area plus a 2 km buffer and Offshore Ornithology Study Area.

Table 4-130: Guillemot modelled sitting bird abundance estimates for the offshore wind farm area by survey.

Month / Year	Estimate	Estimate LCL to UCL	Availability Bias Corrected Estimate	Availability Bias Corrected Estimate LCL to UCL
May 2018	67	22 to 263	83	27 to 325
June 2018	156	89 to 335	193	110 to 415
July 2018	78	42 to 153	97	52 to 189
August 2018	266	183 to 405	329	226 to 501
September 2018	669	456 to 985	828	564 to 1,219
October 2018	128	84 to 203	158	104 to 251
November 2018	18	1 to 823	22	1 to 1,018
December 2018	43	21 to 103	53	26 to 127
January 2019	30	10 to 110	37	12 to 136
February 2019	65	44 to 94	80	54 to 116
March 2019	109	82 to 138	135	101 to 171
April 2019	189	75 to 456	234	93 to 564
June 2019	306	171 to 646	379	212 to 799
July 2019	154	88 to 285	191	109 to 353
August 2019	697	498 to 1,016	863	616 to 1,257
October 2019	334	222 to 544	413	275 to 673
December 2019	111	51 to 264	137	63 to 327
January 2020	179	89 to 354	222	110 to 438
May 2020	51	16 to 156	63	20 to 193

Table 4-131: Guillemot modelled sitting bird abundance for offshore wind farm area plus 2 km buffer by survey.

Month / Year	Estimate	Estimate LCL to UCL	Availability Bias Corrected Estimate	Availability Bias Corrected Estimate LCL to UCL
May 2018	231	95 to 753	286	118 to 932
June 2018	447	262 to 892	553	324 to 1,104
July 2018	261	142 to 488	323	176 to 604
August 2018	857	587 to 1,317	1,061	726 to 1,630
September 2018	2,071	1374 to 3,173	2,563	1,700 to 3,927
October 2018	467	306 to 753	578	379 to 932
November 2018	62	7 to 14,522	77	9 to 17,971
December 2018	125	55 to 359	155	68 to 444
January 2019	91	28 to 377	113	35 to 467
February 2019	207	143 to 297	256	177 to 368
March 2019	312	234 to 414	386	290 to 512
April 2019	554	241 to 1202	686	298 to 1,487

Month / Year	Estimate	Estimate LCL to UCL	Availability Bias Corrected Estimate	Availability Bias Corrected Estimate LCL to UCL
June 2019	878	530 to 1716	1,087	656 to 2,124
July 2019	512	307 to 902	634	380 to 1,116
August 2019	2,243	1595 to 3,293	2,776	1974 to 4,075
October 2019	1,223	809 to 2,062	1,513	1001 to 2,552
December 2019	326	137 to 922	403	170 to 1,141
January 2020	541	258 to 1,273	669	319 to 1,575
May 2020	177	71 to 462	219	88 to 572

Table 4-132: Guillemot modelled sitting bird abundance for the Offshore Ornithology Study Area by survey.

Month / Year	Estimate	Estimate LCL to UCL	Availability Bias Corrected Estimate	Availability Bias Corrected Estimate LCL to UCL
May 2018	1,799	835 to 4,279	2,226	1,033 to 5,295
June 2018	1,984	1,130 to 3,682	2,455	1,398 to 4,556
July 2018	2,054	1,214 to 3,692	2,542	1,502 to 4,569
August 2018	7,029	4,945 to 10,472	8,698	6,119 to 12,959
September 2018	11,391	7,432 to 18,354	14,096	9,197 to 22,713
October 2018	4,840	2,892 to 8,624	5,990	3,579 to 10,672
November 2018	498	42 to 187,413	616	52 to 231,924
December 2018	632	266 to 1,942	782	329 to 2,403
January 2019	564	183 to 2,567	698	226 to 3,177
February 2019	1,558	1,136 to 2,122	1,928	1,406 to 2,626
March 2019	1,400	1,038 to 1,988	1,733	1,285 to 2,460
April 2019	2,585	1,168 to 5,619	3,199	1,445 to 6,954
June 2019	3,899	2,279 to 6,994	4,825	2,820 to 8,655
July 2019	4,036	2,506 to 6,638	4,995	3,101 to 8,215
August 2019	18,397	13,754 to 24,970	22,766	17,021 to 30,900
October 2019	12,667	7,834 to 23,029	15,675	9,695 to 28,498
December 2019	1,653	705 to 4,792	2,046	872 to 5,930
January 2020	3,357	1,707 to 7,949	4,154	2,112 to 9,837
May 2020	1,381	646 to 3,183	1,709	799 to 3,939

Flying Birds

There were 406 records of flying guillemot over the study period. Densities of flying birds were derived from the total numbers seen in radial snapshots, divided by the total area surveyed by snapshots (survey effort); that is the number of snapshots multiplied by the snapshot area of 0.09 km^2.

Non-parametric bootstrap intervals have been used to calculate the standard error and 95% confidence intervals around the observed counts and densities per km^2. The area of the offshore wind farm area has then been used to calculate simple abundances based on density results.

The results of these data are shown in Table 4-133 and Table 4-134.

Table 4-133: Guillemot flying bird offshore wind farm area simple abundance estimates.

Month	Estimate	LCL (95%)	UCL (95%)
January	161	119	205
February	10	3	17
March	38	25	53
April	17	5	28
May	198	76	321
June	53	35	69
July	20	12	27
August	4	0	8
September	7	0	15
October	76	46	105
November	14	5	22
December	16	9	23

Table 4-134: Guillemot flying bird offshore wind farm area plus 2 km buffer simple abundance estimates.

Month	Estimate	LCL (95%)	UCL (95%)
January	468	346	596
February	29	9	49
March	111	73	154
April	49	15	81
May	576	221	934
June	154	102	201
July	58	35	79
August	12	0	23
September	20	0	44
October	221	134	305
November	41	15	64
December	47	26	67

Design-based spatial abundance estimates during the DAS

DAS abundance analysis was undertaken by APEM and summarised fully within annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The abundance estimates are presented below for guillemot at the different spatial scales. Table 4-135 presents the abundance estimates for sitting birds only whereas, Table 4-117 presents the abundance estimates for flying birds. Detailed methods on calculation of the abundance estimates are presented in section 3.4.3. When provided the LCL and UCL are presented within brackets after the estimate. Availability biases have been applied to these numbers to account of birds under the water.

Table 4-135: Abundance estimates of sitting guillemot within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	377	518
May 2020	594	735
June 2020	146	247
July 2020	501	1,594
August 2020	354	1,116
September 2020	1,715	4,938

Table 4-136: Abundance estimates of flying guillemot within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	13	26
May 2020	5	21
June 2020	3	12
July 2020	6	8
August 2020	0	0
September 2020	0	0

4.6.21 Black guillemot

Ecology

Black guillemot breed around the coastline of Ireland and are known to breed in areas in the vicinity of the Project with a known colony at Rockabill, Co. Dublin. As pursuit divers, black guillemot forage by propelling themselves through the water in pursuit of benthic fish and invertebrates, including crustaceans (BirdLife International, 2020; Ewins, 1990). Studies have observed sandeels and blennies (particularly butterfish *Pholis gunnellus*) to be the most important species for the black guillemot, however the contributions of these species to the overall diet varies (Ewins, 1990).

The Seabird Census survey undertaken in Ireland between 2017 and 2018 recorded over 3,917 individuals and formed part of an ongoing species-specific assessment; therefore this figure was considered to be a minimum estimate at the national population level (Cummins *et al.,* 2019).

This species is Amber listed in the UK and Ireland as it is a species of European Conservation Concern (Gilbert *et al.,* 2021, Stanbury *et al*., 2021).

Desk-based data

Data collected within the 2016/2017 ObSERVE western Irish Sea surveys (Jessopp *et al.*, 2018) recorded a total of 12 individuals of black guillemot within the ObSERVE survey area during summer and autumn surveys, with an estimated mean density of 0.01 birds/km^2 in both periods (Jessopp *et al.*, 2018). No records of black guillemot were presented within the I-WeBS database.

Site-specific data

During the site surveys, black guillemot was recorded on transect during every month across the survey period with peak counts observed during the aerial surveys in August 2020 (224 individuals) and September

2020 (217 individuals), as described in Table 4-137. Counts were fairly consistent in months outside the core breeding period of April to August when lower numbers were observed in the Survey Area.

Observations of black guillemot were typically recorded closer to the shore and were concentrated in the northwest corner of the Survey Area.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-137. Table 4-138 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-35 shows the spatial distribution of black guillemot during the survey period.

Table 4-137: Transect records and total observations of black guillemot from boat-based surveys and DAS in the Study Area.

Month / year	Boat-based transect records	DAS records	All records
May 2018	6	-	16
June 2018	4	-	9
July 2018	11	-	16
August 2018	50	-	52
September 2018	30	-	32
October 2018	14	-	37
November 2018	26	-	34
December 2018	17	-	37
January 2019	42	-	82
February 2019	37	-	47
March 2019	13	-	28
April 2019	44	-	46
June 2019	6	-	6
July 2019	9	-	9
August 2019	52	-	52
October 2019	103	-	107
December 2019	53	-	53
January 2020	31	-	31
April 2020	-	59	59
May 2020	9	1	10
June 2020	-	38	38
July 2020	-	38	38
August 2020	-	224	224
September 2020	-	217	217
Total	**557**	**577**	**1,280**

Table 4-138: Seasonal variation of black guillemot recorded between May 2018 and September 2020.

Year	Spring Migration	Breeding Apr - Aug	Autumn Migration	Winter Sep - Mar	Non-breeding
2018 / 2019	-	93	-	297	-
2019 / 2020	-	113	-	191	-
2020	-	369	-	217	-

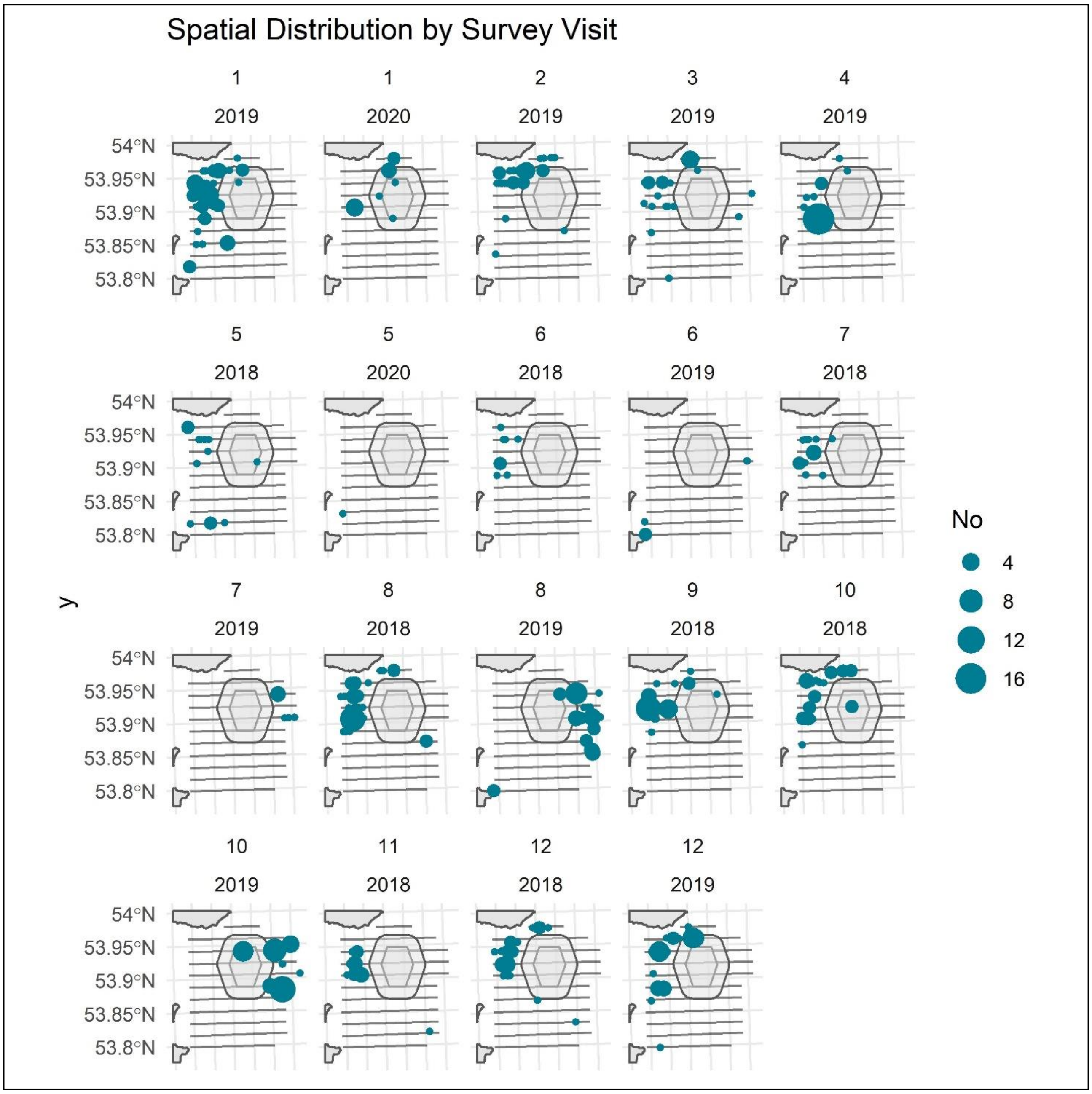

Figure 4-35: Spatial distribution of black guillemot records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, more birds (518 individuals, 93%) were observed sitting compared to those in flight (39 individuals, 7%). Off transect, the majority of birds (143 individuals, 97.9%) were observed in flight. The majority of black guillemot on transect and off transect had a flight height of 5 m; one bird was recorded at a height of 10 m.

Of the 577 birds recorded during the DAS, four were observed in flight and 573 were observed sitting. Flying black guillemot were recorded in April 2020 and July 2020 and were found to have no significant direction of flight. The flight heights of black guillemot recorded during the DAS resulted in a median altitude of 3 m above MSL.

Table 4-139 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and May 2020.

Table 4-139: Proportion of black guillemot recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / year	On transect				Off transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	0	0	6	100	10	100	0	0
June 2018	2	50	2	50	5	100	0	0
July 2018	0	0	11	100	5	100	0	0
August 2018	0	0	50	100	2	100	0	0
September 2018	0	0	30	100	2	100	0	0
October 2018	4	28.6	10	71.4	22	95.7	1	4.3
November 2018	0	0	26	100	8	100	0	0
December 2018	2	11.8	15	89.2	20	100	0	0
January 2019	5	11.9	37	89.1	40	100	0	0
February 2019	3	8.1	34	91.9	10	100	0	0
March 2019	0	0	13	100	15	100	0	0
April 2019	0	0	44	100	2	100	0	0
June 2019	2	33.3	4	66.7	0	0	0	0
July 2019	0	0	9	100	0	0	0	0
August 2019	5	9.6	47	90.4	0	0	0	0
October 2019	9	8.7	94	91.3	2	50	2	50
December 2019	2	3.8	51	96.2	0	0	0	0
January 2020	3	9.7	28	90.3	0	0	0	0
April 2020	2	3.4	57	96.6	N/A			
May 2020	2	20	8	80	0	0	0	0
June 2020	0	0	38	100	N/A			
July 2020	1	2.6	38	97.4				
August 2020	1	0.4	224	99.6				
September 2020	0	0	217	100				
Total	**43**	**3.8**	**1,093**	**96.2**	**143**	**97.9**	**3**	**2.1**

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-35), it is not possible to undertake any detailed spatial analysis for this species.

4.6.22 Razorbill

Ecology

Britain and Ireland are home to internationally important populations of breeding razorbill and support up to 20% of the global population (93,600 pairs) (Mitchell *et al.*, 2004). Razorbill typically inhabit very similar habitats to guillemot, breeding on rocky cliff shores or islands. Razorbill feed mainly on shoaling fish; mostly sandeel for birds at breeding colonies in the British Isles, supplemented by herring, sprat, and rockling. Fish are caught by pursuit diving from the surface, typically to depths of 5 to 30 m, but possibly deeper than 100 m on occasions (BirdLife International, 2011).

Between 2015 and 2018, the population of razorbill in Ireland was estimated to be 33,689 individuals, an increase in the long-term trend by 45%. Over 95% of this population are associated with the SPA network (Cummins *et al.,* 2019). Although the overall trend is positive, site level changes continued to be variable (Table 4-140), such as the population changes at the Cliffs of Moher.

Table 4-140: Ranked census totals (individuals) of razorbill at a selection of Irish colonies for the period 1985 - 1988 to 2015 - 2018 (Cummins *et al.,* 2019).

Site	SCR 1985 - 1988	Seabird 2000 1998 - 2002	2015 - 2018	% Change (since Seabird 2000)
Ireland's Eye	272	522	1,600	+ 207%
Inishnabro	193	319	641	+ 101%
Great Saltee	4,673	3,239	5,669	+ 75%
Lambay Island	3,648	4,337	7,353	+ 70%
Little Saltee	450	500	850	+ 70%
Clare island	-	528	618	+ 17%
Horn Head	5,628	6,739	6,812	+ 1%
Cliffs of Moher	2,398	7,700	4,046	- 48%
Tory Island	614	1,002	951	- 5%

As more than 50% of their breeding population occurs at ten sites or fewer, razorbill is Red-listed species in Ireland (Gilbert *et al*., 2021), although Amber-listed in the UK (Stanbury *et al*., 2021).

A summary of the recent (within the last five summers) colony data for razorbill within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-141 below. If multiple years are provided then the mean count is presented.

Table 4-141: Summary of most recent colony data for razorbill between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (IND) ± SD (if applicable)
Antrim	Causeway Coast	2021	361
	Larne Lough to Portmuck	2017 – 2019	707 ± 132.9
	Muck Island	2017 – 2019	866. 7 ± 183.9
	Rathlin Island SPA	2021	22,421
	Sheep Island SPA	2021	221
Argyll and Bute	Sanda Islands - Kintyre	2019	430
Gwynedd	Aberdaron Coast and Bardsey Island SPA	2017 – 2019	1,877 ± 98.1
	Aberdaron Coast not in SPA	2017 – 2019	31.3 ± 13.3
	Anglesey Terns / Morwenoliaid Ynys MÃ´n SPA	2017	3
	Great Orme and Little Orme	2017 – 2019, 2021 and 2022	250.6 ± 50.5
	Lleyn Peninsula	2018, 2019 and 2021	536.7 ± 88.7
	Puffin Island SPA	2017 – 2019 and 2021	514 ± 108
	South Stack	2017 – 2019 and 2021	1,184.3 ± 135.9
Isle of Man	East Island	2017	100
	North Island	2017	36

County (from SMP)	SMP Master Site	Year(s)	Count (IND) ± SD (if applicable)
	South Island	2017	445
	West Island	2017	101
Kyle and Carrick	Ailsa Craig SPA	2017 – 2019 and 2021	863 ± 212.4
	Finnarts Bay to Finnarts Hill (Finnarts Point) - Tysties	2021	3
	Starling Knowe to Downan Point	2018, 2019 and 2021	22.3 ± 25.2
Wicklow	Wicklow Head	2018, 2019, 2021 and 2022	231.3 ± 74.7
Wigtown	Mull of Galloway	2017 – 2019	45.3 ± 0.9
	Port Mona, Devil's Bridge, Laggantalluch Head	2021	3
	Sheddock Cliffs - Burrow Head	2020	6

Desk-based data

The observations made within the ObSERVE western Irish Sea surveys did not differentiate between razorbill and guillemot, and therefore records were combined into a single group. A total of 7,541 sightings of 24,763 individuals were recorded across the ObSERVE survey area, with the majority of these occurring during the autumn surveys. During the summer surveys, sightings were concentrated around the northern extent of the ObSERVE western Irish Sea survey area, which includes Dundalk Bay and the offshore wind farm area. Data records did not illustrate a clear association between observations and water depths. Mean density of razorbill and guillemot across the ObSERVE western Irish Sea survey area ranged from 3.95 birds/km^2 in summer surveys, 17.4 birds/km^2 in autumn surveys and 4.61 birds/km^2 in winter surveys (Jessopp *et al.*, 2018). No records of razorbill were presented in the I-WeBS database.

Site-specific data

During the site surveys, razorbill was recorded on transect across the survey period with peak in counts observed in September 2020 (1,064 individuals). The peak in September 2020 is likely related to post-breeding dispersal of adults and juveniles from breeding sites. However, as there are no razorbill breeding colonies within the immediate vicinity of the Project, numbers during the breeding season (April to July) were relatively low.

An additional 2,211 guillemot / razorbill were identified across the DAS: 217 in April 2020, 91 in May 2020, 245 in June 2020, 808 in July 2020, 54 in August 2020 and 796 in September 2020 surveys.

Observations of razorbill were concentrated in offshore areas and away from the coastal areas within the west and north-west areas of the Survey Area.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-142. Table 4-143 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-36 shows the spatial distribution of razorbill during the boat-based survey period.

Table 4-142: Transect records and total observations of razorbill from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	10	-	15
June 2018	4	-	10
July 2018	2	-	5

Month / Year	Boat-based Transect Records	DAS Records	All Records
August 2018	138	-	140
September 2018	63	-	65
October 2018	224	-	439
November 2018	28	-	39
December 2018	105	-	111
January 2019	191	-	219
February 2019	98	-	108
March 2019	44	-	51
April 2019	4	-	7
June 2019	12	-	12
July 2019	24	-	24
August 2019	73	-	73
October 2019	54	-	54
December 2019	116	-	118
January 2020	195	-	195
April 2020	-	36	36
May 2020	13	67	18
June 2020	-	295	295
July 2020	-	31	31
August 2020	-	66	66
September 2020	-	1,064	1,064
Total	**1,398**	**1,559**	**3,195**

Table 4-143: Seasonal variation of razorbill recorded between May 2018 and September 2020.

Year	Spring Migration Jan – Mar	Breeding Apr - Jul	Autumn Migration Aug – Oct	Winter Nov - Dec	Non-breeding
2018	-	30	644	150	-
2019	378	43	127	118	-
2020	195	380	1,130	-	-

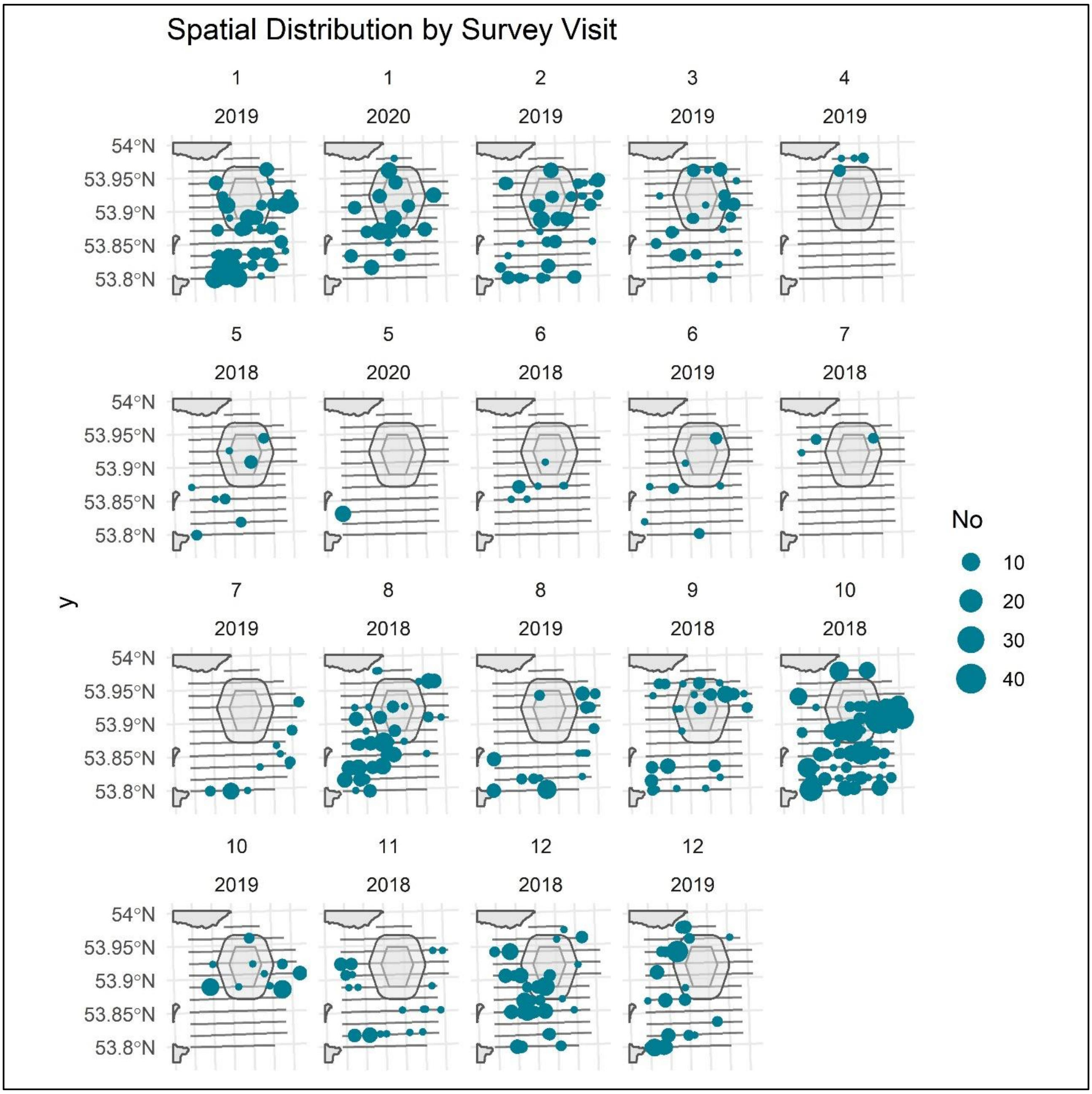

Figure 4-36: Spatial distribution of razorbill records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, the majority of razorbill (1,349 individuals, 96.5%) were observed sitting compared to those in flight (49 individuals, 3.5%). Off transect, the majority of birds (289 individuals, 96.3%) were observed in flight. Razorbill flight heights were frequently recorded at 5 m both on transect and off transect. Sixteen individuals were observed flying between 10 m and 30 m Off transect.

Of the 1,559 razorbill recorded during the DAS, 32 were observed in flight and 1,527 were observed sitting. Flight heights for razorbill were not determined during the DAS.

Table 4-144 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and September 2020. Figure 4-37 shows the recorded flight heights of razorbill during the boat-based surveys.

Table 4-144: Proportion of razorbill recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / Year	On Transect				Off Transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	3	30.0	7	70.0	5	100	0	0
June 2018	1	25.0	3	75.0	6	100	0	0
July 2018	2	100	0	0	3	100	0	0
August 2018	0	0	138	100	2	100	0	0
September 2018	2	3.2	61	96.8	2	100	0	0
October 2018	25	11.2	199	88.8	213	99.1	2	0.9
November 2018	0	0	28	100	11	100	0	0
December 2018	0	0	105	100	3	50.0	3	50.0
January 2019	0	0	191	100	28	100	0	0
February 2019	5	5.1	93	94.9	4	40.0	6	60.0
March 2019	4	9.1	40	90.9	7	100	0	0
April 2019	0	0	4	100	3	100	0	0
June 2019	1	8.3	11	91.7	0	0	0	0
July 2019	0	0	24	100	0	0	0	0
August 2019	0	0	73	100	0	0	0	0
October 2019	2	3.7	52	96.3	0	0	0	0
December 2019	1	0.9	115	99.1	2	100	0	0
January 2020	3	1.5	192	98.5	0	0	0	0
April 2020	23	63.9	13	36.1	N/A			
May 2020	1	1.0	99	99.0	0	0	0	0
June 2020	6	2.0	289	98.0	N/A			
July 2020	0	0	31	100				
August 2020	0	0	66	100				
September 2020	2	0.2	1,064	99.8				
Total	**49**	**3.5**	**1,349**	**96.5**	**289**	**96.3**	**11**	**3.7**

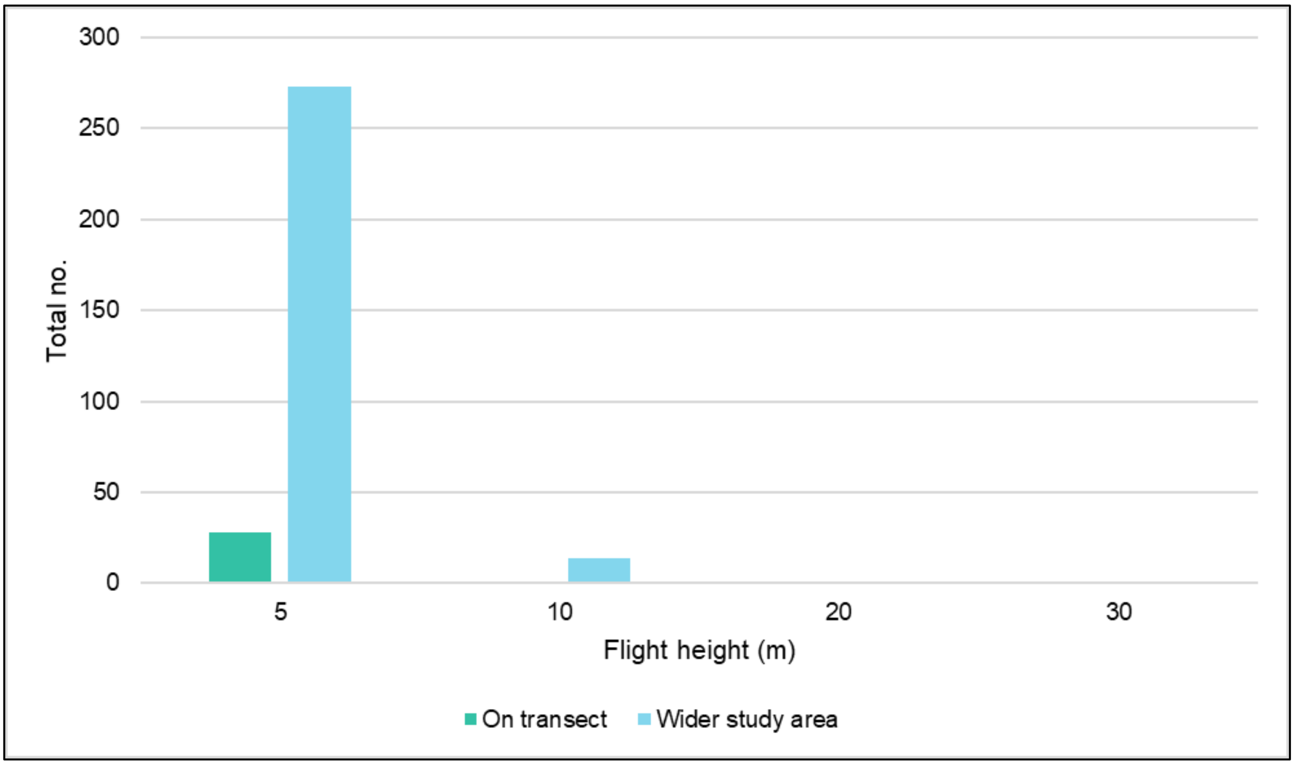

Figure 4-37: Razorbill flight heights observed between May 2018 and May 2020.

Model derived spatial abundance and density estimates during boat-based surveys

During initial data exploration and model fitting a high co-linearity/ correlation between bathymetry and distance to coast was identified resulting in a prohibitively high VIF for these parameters. Because of this distance to coast was removed from the model. The following refined environmental and spatial covariates were used in the MRSea CReSS analysis:

- Bathymetry;
- Year; and
- X and Y coordinates.

To prepare for the GEE-CreSS analyses, a grid of abutting cells based on the transect routes and environmental covariates was constructed to cover the entire survey area. All variables except X and Y co-ordinate were included in the one-dimensional SALSA model selection method (Walker *et al.,* 2011) and automatic model simplification using non-significant p-values was carried out. An appropriate blocking structure using transect ID was included as there was evidence of autocorrelation. Month was fitted as a categorical or factor term. This provided the base model for assessment of the 2D spatial smoother.

CReSS was used to fit the spatial density surface and GEEs were used to provide realistic model-based estimates. The GEE-CReSS grid knot locations are included in Appendix A1 of this report. An interaction with month was included to allow the density surface to vary between survey months. Following predictions, bootstrapping was used to generate 95 % confidence intervals for each grid cell to allow for an assessment of uncertainty. The bootstrapping procedure incorporated any autocorrelation specified within the prediction model following the CReSS method.

All behaviours (both sitting and flying birds)

Table 4-145 to Table 4-147 below presents the razorbill modelled abundance estimates for the offshore wind farm area, offshore wind farm area plus a 2 km buffer and Offshore Ornithology Study Area by survey.

Table 4-145: Razorbill modelled abundance estimates for offshore wind farm area by survey.

Month / Year	Estimate	Estimate LCL to UCL	Availability Bias Corrected Estimate	Availability Bias Corrected Estimate LCL to UCL
May 2018	0	0 to 1,526	0	0 to 1,792
June 2018	1	0 to 7	1	0 to 8
July 2018	0	0 to 0	0	0 to 0
August 2018	38	12 to 192	45	14 to 225
September 2018	44	6 to 289	52	7 to 339
October 2018	307	162 to 618	360	190 to 726
November 2018	5	0 to 606	6	0 to 711
December 2018	118	45 to 362	139	53 to 425
January 2019	249	122 to 498	292	143 to 585
February 2019	30	16 to 49	35	19 to 58
March 2019	17	8 to 32	20	9 to 38
April 2019	1	0 to 17	1	0 to 20
June 2019	10	3 to 46	12	4 to 54
July 2019	0	0 to 1	0	0 to 1
August 2019	21	6 to 110	25	7 to 129
October 2019	172	87 to 342	202	102 to 402
December 2019	66	21 to 178	77	25 to 209
January 2020	210	106 to 484	247	124 to 568
May 2020	7	1 to 26	8	1 to 31

Table 4-146: Razorbill modelled abundance estimates for offshore wind farm area plus 2 km by survey.

Month / Year	Estimate	Estimate LCL to UCL	Availability Bias Corrected Estimate	Availability Bias Corrected Estimate LCL to UCL
May 2018	1	0 to 2,444	1	0 to 2,869
June 2018	2	0 to 14	2	0 to 16
July 2018	0	0 to 0	0	0 to 0
August 2018	155	55 to 596	182	65 to 700
September 2018	151	28 to 818	177	33 to 960
October 2018	1,049	552 to 2,030	1,232	648 to 2,383
November 2018	36	3 to 1,545	42	4 to 1,814
December 2018	436	197 to 1,164	512	231 to 1,367
January 2019	732	360 to 1,484	859	423 to 1,742

Month / Year	Estimate	Estimate LCL to UCL	Availability Bias Corrected Estimate	Availability Bias Corrected Estimate LCL to UCL
February 2019	340	185 to 597	399	217 to 701
March 2019	186	82 to 395	218	96 to 464
April 2019	3	0 to 97	4	0 to 114
June 2019	19	7 to 79	22	8 to 93
July 2019	0	0 to 4	0	0 to 5
August 2019	87	29 to 345	102	34 to 405
October 2019	589	290 to 1,131	691	340 to 1,328
December 2019	245	92 to 625	288	108 to 734
January 2020	617	316 to 1,335	724	371 to 1,567
May 2020	14	4 to 46	16	5 to 54

Table 4-147: Razorbill modelled abundance estimates for the Offshore Ornithology Study Area by survey.

Survey	Estimate	Estimate LCL to UCL	Availability Bias Corrected Estimate	Availability Bias Corrected Estimate LCL to UCL
May 2018	32	7 to 2,926	38	8 to 3,435
June 2018	4	1 to 46	5	1 to 54
July 2018	8	2 to 94	9	2 to 110
August 2018	2,017	951 to 4,754	2,368	1,116 to 5,581
September 2018	944	233 to 4,543	1,108	274 to 5,333
October 2018	3,003	1,556 to 6,348	3,526	1,827 to 7,453
November 2018	1,358	281 to 10,059	1,594	330 to 11,809
December 2018	2,185	1,105 to 4,814	2,565	1,297 to 5,652
January 2019	2,941	1,480 to 6,095	3,453	1,738 to 7,156
February 2019	1,477	758 to 2,728	1,734	890 to 3,203
March 2019	669	279 to 1,792	785	328 to 2,104
April 2019	16	13 to 199	19	15 to 234
June 2019	42	13 to 199	49	15 to 234
July 2019	87	22 to 403	102	26 to 473
August 2019	1,133	501 to 2,659	1,330	588 to 3,122
October 2019	1,686	792 to 3,736	1,979	930 to 4,386
December 2019	1,227	565 to 2,707	1,440	663 to 3,178
January 2020	2,480	1,335 to 4,907	2,912	1,567 to 5,761
May 2020	47	6 to 2,926	55	7 to 3,435

Flying birds

There were 406 records of flying razorbill over the study period. Densities of flying birds were derived from the total numbers seen in radial snapshots, divided by the total area surveyed by snapshots (survey effort); that is the number of snapshots multiplied by the snapshot area of 0.09 km^2.

Non-parametric bootstrap intervals have been used to calculate the standard error and 95% confidence intervals around the observed counts and densities per km^2. The area of the offshore wind farm area has then been used to calculate simple abundances based on density results. These data are shown in Table 4-148 and Table 4-149.

Table 4-148: Razorbill flying bird offshore wind farm area simple abundance estimates.

Month	Estimate	LCL	UCL
January	9	4	14
February	5	0	11
March	6	1	12
April	2	0	4
May	2	0	4
June	2	0	5
July	1	0	3
August	1	0	1
September	2	0	5
October	78	48	108
November	14	6	23
December	1	0	2

Table 4-149: Razorbill flying bird offshore wind farm area plus 2 km buffer simple abundance estimates.

Month	Estimate	LCL (95%)	UCL (95%)
January	26	12	41
February	15	0	32
March	17	3	35
April	6	0	12
May	6	0	12
June	6	0	15
July	3	0	9
August	3	0	3
September	6	0	15
October	227	140	314
November	41	17	67
December	3	0	6

Design-based spatial abundance estimates during the DAS

DAS abundance analysis was undertaken by APEM and summarised fully within annex 2 of appendix H: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The abundance estimates are presented below for razorbill at the different spatial scales. Table 4-150 presents the abundance estimates for sitting birds only whereas, Table 4-151 presents the abundance estimates for flying birds. Detailed methods on calculation of the abundance estimates are presented in section 3.4.3. When provided the LCL and UCL are presented within brackets after the estimate. Availability biases have been applied to these numbers to account of birds under the water.

Table 4-150: Abundance estimates of sitting razorbill within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	11	36
May 2020	27	62
June 2020	154	353
July 2020	13	25
August 2020	No birds recorded	10
September 2020	26	566

Table 4-151: Abundance estimates of flying razorbill within the different study areas.

Month / Year	Abudance estimate within the offshore wind farm area	Abudance estimate within the offshore wind farm area plus 2 km buffer
April 2020	No birds recorded	3
May 2020	No birds recorded	No birds recorded
June 2020	No birds recorded	4
July 2020	No birds recorded	No birds recorded
August 2020	No birds recorded	No birds recorded
September 2020	No birds recorded	No birds recorded

4.6.23 Puffin

Ecology

The puffin breeds in Iceland, Norway, Greenland, Newfoundland, and the Faroe Islands, and as far south as Maine in the west and the west coast of Ireland and parts of the UK in the north and east. The puffin is exclusively marine, found on rocky coasts and offshore islands nesting on grassy maritime slopes, sea cliffs and rocky slopes. Puffins are colonial nesters, excavating burrows on grassy clifftops or reusing existing holes, and on occasion may nest in crevices and among rocks and scree. During the winter it is wide-ranging and is found in offshore and pelagic habitats.

Similar to other auk species, the puffin is a poor flier due to its high wing loading and thus the bird’s flight is direct and low over the surface of the water. As a pursuit-diver, puffin catch most of their prey within 30 m of the water surface but is capable of diving to 60 m (Piatt and Nettleship, 1985; Burger and Simpson, 1986). The puffin forages on juvenile pelagic fishes such as herring, juvenile and adult capelin *Mallotus villosus*, and sandeel (Barrett *et al.*, 1987). During chick rearing periods, birds generally forage within 10 km of their colony, but may range as far as 50 to 100 km or more (Thaxter *et al.*, 2012).

Due to rapid declines in its range since 2010, puffin is rated as vulnerable by the International Union for Conservation of Nature (IUCN) and are Red-listed in the UK and Ireland as a species of European Conservation Concern (Gilbert *et al.,* 2021, Stanbury *et al*., 2021).

A summary of the recent (within the last five summers) colony data for puffin within the Cumulative Offshore Ornithology Study Area and within the mean max (+1 SD) foraging range of the species is provided in Table 4-152 below. If multiple years are provided then the mean count is presented.

Table 4-152: Summary of most recent colony data for puffin between 2017 and 2022.

County (from SMP)	SMP Master Site	Year(s)	Count (IND) ± SD (if applicable)
Antrim	Larne Lough to Portmuck	2017 – 2019	55.3 ± 1.2
	Muck Island	2020	1
	Rathlin Island SPA	2021	407
	Sheep Island SPA	2021	2
Argyll and Bute	Sanda Islands	2019	54
Down	Copeland Islands SPA	2019	106
Dyfed	Bishop and Clerks and Ramsey	2018	120
	Caldey Island	2017 – 2019 and 2021	2.3 ± 1.1
	Castlemartin Coast (Berryslade to Barafundle Bay)	2017 – 2019 and 2021	5.3 ± 5.3
	Skomer, Skokholm and the Seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA		26,944.6 ± 16,018.9
Gwynedd	Aberdaron Coast and Bardsey Island SPA		147.3 ± 15.8
	Aberdaron Coast not in SPA		659.7 ± 31.9
	Anglesey Terns / Morwenoliaid Ynys MÃ´n SPA		524 ± 249.2
	Puffin Island SPA		10 ± 3.7
	South Stack		21.3 ± 5.9
Isle of Man	West Island	2017	8
Kyle and Carrick	Ailsa Craig SPA	2017 – 2019 and 2021	147 ± 45.4
Wigtown	Mull of Galloway	2017 and 2018	0.5 ± 0.5

Desk-based data

A total of 24 observations totalling 27 individuals were recorded within the ObSERVE western Irish Sea survey area during the summer survey. These sighting distributions were consistent with breeding colonies at Ireland’s Eye and the Saltee Islands and illustrated an avoidance of sandbanks and very nearshore waters and preference for depths of between 30-60 m. Mean density of puffins across the ObSERVE survey area in summer was 0.02 birds/km^2 (Jessopp *et al.*, 2018). No records of puffin were presented in the I-WeBS database.

Site-specific data

Observations of puffin during the boat-based surveys were sparse, with records of only single birds made on transect in both June 2018 and July 2018 (Table 4-153). During the DAS, a total of 51 puffin were recorded: two in the April 2020, one in May 2020 seven in June 2020, seven in July 2020, 10 in August 2020 and 24 in September 2020 surveys.

A summary of the monthly records from the boat-based and DAS is presented in Table 4-153. Table 4-154 shows the seasonal variation between 2018 and 2020 for all records and are based on the definitions taken from Furness (2015). Figure 4-38 shows the spatial distribution of puffin during the boat-based surveys.

Table 4-153: Transect records and total observations of puffin from boat-based and DAS in the Study Area.

Month / Year	Boat-based Transect Records	DAS Records	All Records
May 2018	0	-	0
June 2018	4	-	5
July 2018	1	-	1
August 2018	0	-	0
September 2018	0	-	0
October 2018	0	-	0
November 2018	0	-	0
December 2018	0	-	0
January 2019	0	-	0
February 2019	0	-	0
March 2019	0	-	0
April 2019	0	-	0
June 2019	7	-	7
July 2019	1	-	1
August 2019	2	-	2
October 2019	1	-	1
December 2019	0	-	0
January 2020	0	-	0
April 2020	-	2	2
May 2020	4	1	5
June 2020	-	7	7
July 2020	-	7	7
August 2020	-	10	10
September 2020	-	24	24
Total	**20**	**51**	**72**

Table 4-154: Seasonal variation of puffin recorded between May 2018 and September 2020.

Year	Spring migration Mar - Apr	Breeding May - Jun	Autumn migration Jul - Aug	Winter Sep - Feb	Non-breeding
2018 / 2019	-	5	1	0	-
2019 / 2020	0	7	3	1	-
2020	2	12	17	24	-

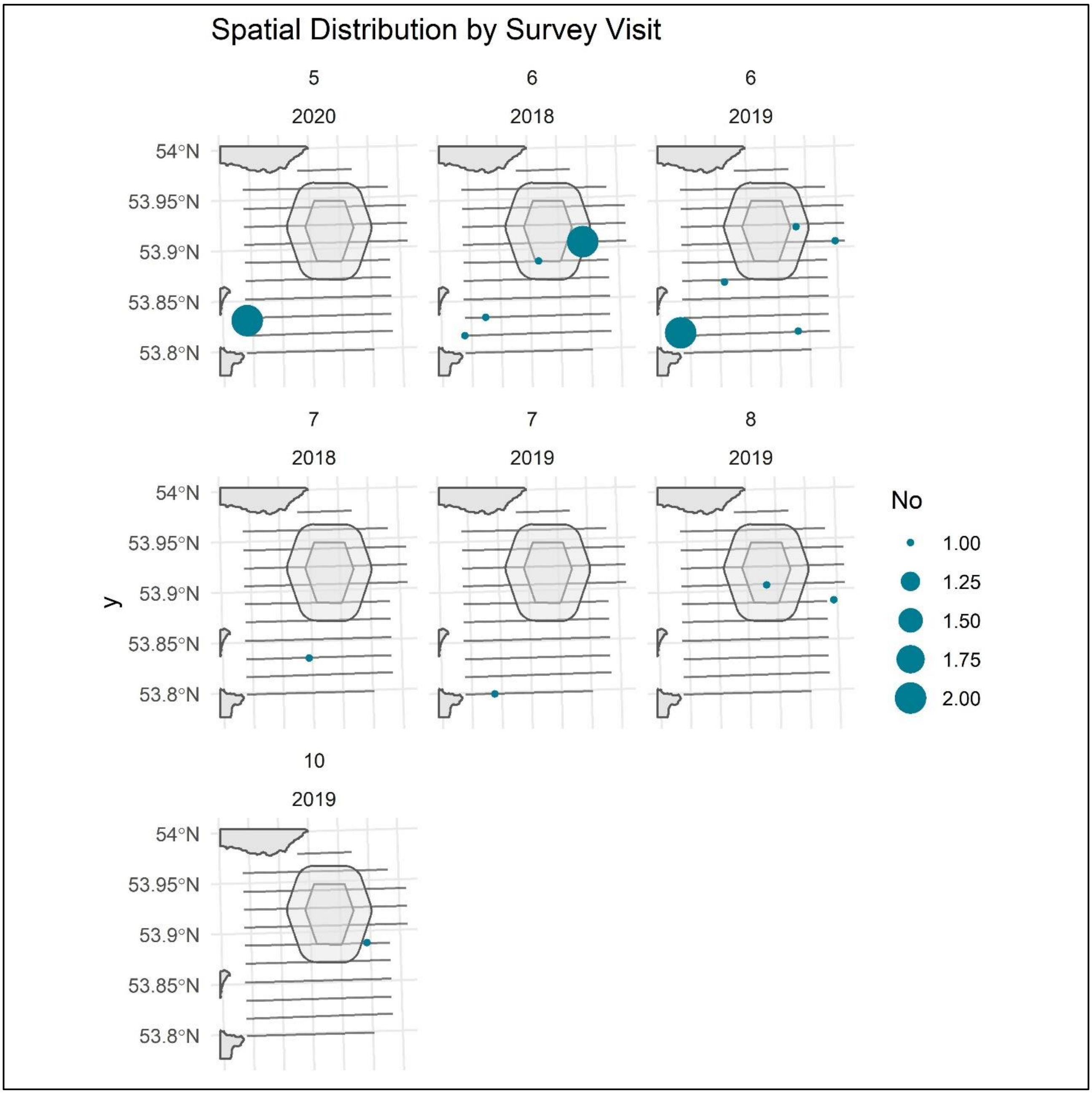

Figure 4-38: Spatial distribution of Puffin records during the boat-based surveys. Transects shown as lines and offshore wind farm area and 2 km buffer shown as polygons.

During the boat-based transect surveys, the majority of puffins (13 individuals, 69.2%) were observed sitting compared to those in flight (49 individuals, 3.5%). All birds off transect were observed in flight at heights of between 5 m and 10 m. All birds recorded during the DAS were observed sitting. Table 4-155 below shows the proportion of individuals observed in flight and sitting on and off transect between May 2018 and September 2020.

Table 4-155: Proportion of puffin recorded flying or sitting during surveys undertaken between May 2018 and May 2020.

Month / year	On transect				Off transect			
	Flying		Sitting		Flying		Sitting	
	No.	%	No.	%	No.	%	No.	%
May 2018	No birds recorded							
June 2018	0	0	1	100	4	100	0	0
July 2018	1	100	0	0	0	0	0	0
August 2018	No birds recorded							
September 2018								
October 2018								
November 2018								
December 2018								
January 2019								
February 2019								
March 2019								
April 2019								
June 2019	2	28.6	5	71.4	0	0	0	0
July 2019	0	0	1	100	0	0	0	0
August 2019	0	0	2	100	0	0	0	0
October 2019	0	0	1	100	0	0	0	0
December 2019	No birds recorded							
January 2020								
April 2020	0	0	2	100	N/A			
May 2020	1	20	4	80	0	0	0	0
June 2020	0	0	7	100	N/A			
July 2020	0	0	7	100				
August 2020	0	0	10	100				
September 2020	0	0	24	100				
Total	**4**	**5.9**	**64**	**94.1**	**4**	**100**	**0**	**0**

Model derived spatial abundance and density estimates

Given the small number of records and their general absence from the offshore wind farm area and its buffer (Figure 4-38), it is not possible to undertake any detailed spatial analysis for this species.

4.6.24 Light-bellied brent goose

Ecology

The light-bellied brent goose is a fully migratory species, on breeding grounds in the Canadian Arctic between June and September. Individuals from that breeding population arrive at wintering grounds in Ireland from mid-September and remain until mid-March or early April. While the birds breed in either small loose colonies or in single pairs, they are highly gregarious during non-breeding periods and gather in groups of up to several thousand individuals (BirdLife International, 2020d; Snow and Perrins, 1998). Light-bellied brent geese are Amber listed in Ireland and UK as a species of European Conservation Concern (Gilbert *et al*., 2021, Stanbury *et al*., 2021).

Light-bellied brent geese breed in the Arctic tundra or close to wet coastal meadows with abundant grassy vegetation (Kear, 2005), or on tundra flats with tidal streams. The species is predominantly coastal outside of the breeding season and can be found in coastal estuaries during the autumn and early winter, and around grasslands from mid-winter until departure in late April for breeding grounds (BirdWatch Ireland, 2020d). Although a mainly herbivorous species, birds may forage on fish eggs, worms, snails and amphipods and is known to forage mostly on eel-grass during wintering months, as well as grass and winter crops.

Desk-based data

No observations of light-bellied brent goose were recorded within the ObSERVE western Irish Sea data, or within the ESAS database. Engagement with key stakeholders from BirdWatch Ireland, the Brent Goose Research Group and a local birdwatching group member provided local information on light-bellied brent goose. Approximately 80-90% of the global population of East Canadian High Arctic (ECHA) brent geese migrate between Canada and Northern Ireland (Strangford Lough). Birds then re-distribute to other coastal sites in Northern Ireland and Ireland during the winter; whether they follow a coastal route, or a direct route is currently unknown. This migration tends to occur in two large pulses of geese passing through the Dundalk Bay area each year: 1 to 2 days in April on northward migration and likewise south in September. Therefore, there is not a daily commute across Dundalk Bay. Ornithological surveys have highlighted high counts of brent geese at Carlingford Lough, which was designated as a SPA.

Observations of light-bellied brent goose were recorded at the Dundalk Bay site within the I-WeBS database, as described within Table 4-156. A five-year peak observation of 2,752 birds was recorded in the 2018/2019 season, along with a five-year peak-mean count of 1,790 birds between 2015/16 and 2019/20. The National Importance threshold for light-bellied brent goose is 350 birds, and the International Importance threshold is 400 birds. Therefore, the light-bellied brent goose population in the Dundalk Bay I-WeBS site is currently exceeding the levels of National Importance and International Importance (I-WeBS, 2022).

Table 4-156: Summary of I-WeBS survey counts for light bellied brent goose within Dundalk Bay site (site code 0Z401, I-WeBS, 2022).

2018/19 count	2019/20 count	Five-year peak count (2015/2016 - 2019/2020)	Five-year peak-mean count (2015/2016 - 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
2752	675	2,752	1,790	350	400

Site-specific data

There were no observations of light-bellied brent goose on transect during the site-specific surveys, but there were two records of light-bellied brent goose observed within the Survey Area; two individuals recorded together in November 2018 and a group of four individuals in January 2019. No goose were recorded during the DAS.

The full results of the migratory geese VP surveys are provided in annex 3 of appendix H: Migratory Geese Survey Report.

4.6.25 Waterfowl and waders

Ecology

Over 50 species of waterbird migrate to Ireland annually and the resource rich wetlands of Ireland support over 750,000 waterbirds each year. These waterbirds seek wetlands which provide resource rich feeding grounds and safe roosting, and the mild and wet winters of Ireland provide ice-free habitats for species such as light-bellied brent goose (see section 4.6.24 above), black-tailed godwit, whooper swan, Greenland white-fronted goose and ringed plover.

Desk-based data

The I-WeBS database of surveys within the Dundalk Bay site provides an overview of the waterfowl and waders which are present within the wider Project region. A summary of the I-WeBS survey counts for the Dundalk Bay site area (site code 0Z401) is presented within Table 4-157. Based on the most recently reported five-year period between 2015/16 and 2019/20, the following species were most commonly recorded (numbers in brackets are five-year peak-mean counts):

- Golden plover (8,250);
- Oystercatcher (5,942);
- Knot (5,264);
- Lapwing (4,776);
- Dunlin (4,612);
- Black-tailed godwit (3,262);
- Bar-tailed godwit (1,857);
- Redshank (1,469);
- Curlew (866); and
- Mallard (754).

Based on the recent five-year peak-mean counts, several of the above listed species exceed the 1% threshold of International Importance, including black-tailed godwit and bar-tailed godwit. All species listed above exceed the 1% threshold of National Importance based on recent five-year peak-mean counts (2013/14 to 2017/2018) (Table 4-157).

Table 4-157: Summary of I-WeBS survey counts for Dundalk Bay site area (site code 0Z401, I-WeBS, 2022).

Species	2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 - 2019/2020)	Five-year peak-mean count (2015/2016 - 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
Golden plover	6,964	10,560	11,200	8,250	920	9,300
Oystercatcher	5,586	3,976	9,660	5,942	610	8,200
Knot	7,856	1,057	7,856	5,264	160	5,300
Lapwing	4,281	5,545	6,732	4,776	850	72,300
Dunlin	6,890	3,575	6,890	4,612	460	13,300
Black-tailed godwit	2,235	2,447	4,227	3,262	200	1,100
Bar-tailed godwit	2,034	2,240	2,240	1,857	170	1,500
Redshank	2,025	856	2,057	1,469	240	2,400
Curlew	922	868	1,322	866	350	7,600
Mallard	454	415	1,281	754	280	53,000
Wigeon	661	572	1,215	745	560	14,000
Teal	667	687	687	586	360	5,000

Species	2018/19 Count	2019/20 Count	Five-year peak count (2015/2016 - 2019/2020)	Five-year peak-mean count (2015/2016 - 2019/2020)	1% National Importance Threshold	1% International Importance Threshold
Greylag goose	360	680	680	403	35	980
Shelduck	338	186	360	339	100	2,500
Grey plover	157	254	289	223	30	2,000
Ringed plover	163	69	395	192	120	540
Pintail	111	91	302	175	20	600
Pink-footed goose	461	-	461	160	-	-
Turnstone	87	194	207	127	95	1,400
Great crested grebe	171	14	171	70	30	6,300
Mute swan	89	38	89	50	90	100
Little egret	37	37	61	48	20	1,100
Goldeneye	28	24	57	39	40	11,400
Greenland white-fronted goose	20	-	39	18	100	190
Greenshank	11	17	22	17	20	3,300
Whimbrel	55	-	55	12	-	-
Snipe	6	2	18	8	-	-
Ruff	5	6	11	8	-	-
Whooper swan	5	-	16	7	150	340
Shoveler	2	-	30	7	20	650
Slavonian grebe	6	2	6	4	-	-
Scaup	-	-	24	5	25	3,100
Tufted duck	-	-	2	1	270	8,900
Little grebe	-	-	3	1	20	4,700
Moorhen	-	-	2	1	-	-
Sanderling	-	-	4	1	85	2,000

Site-specific data

Observations of waterfowl and waders were sparse within the site surveys; however, curlew dunlin, sanderling and turnstone were recorded in low counts during the boat-based and DAS. These records likely refer to migrating birds and indicates use of the Survey Area by birds on passage and migration along the east coast of Ireland, and between Ireland and Britain. A single flock of ten dunlin was recorded in May 2018, along with a flock of ten sanderling and a single turnstone. One curlew was observed during the DASin June 2020. No further observations were made.

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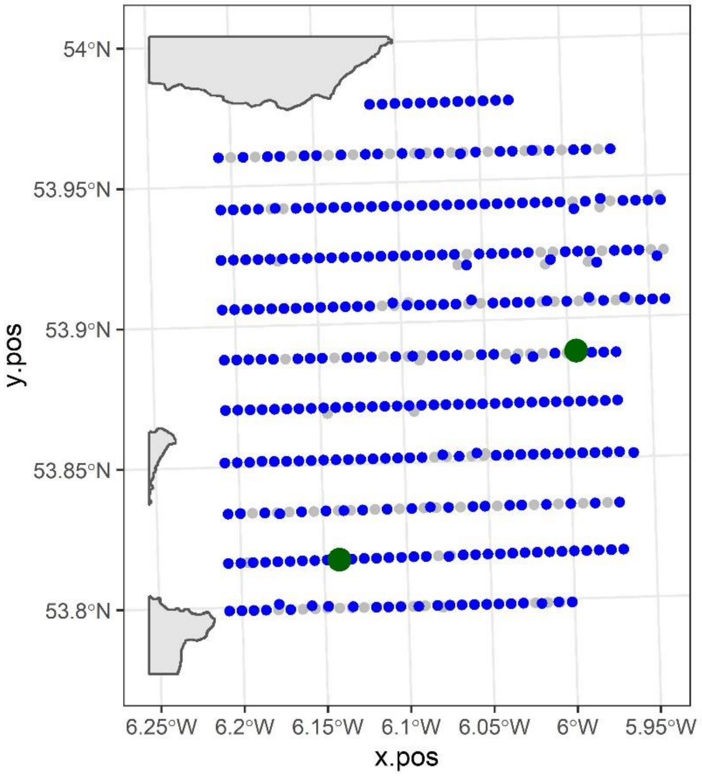
A.1: MRSEA CRESS KNOT SELECTION – BOAT-BASED SURVEY ONLY



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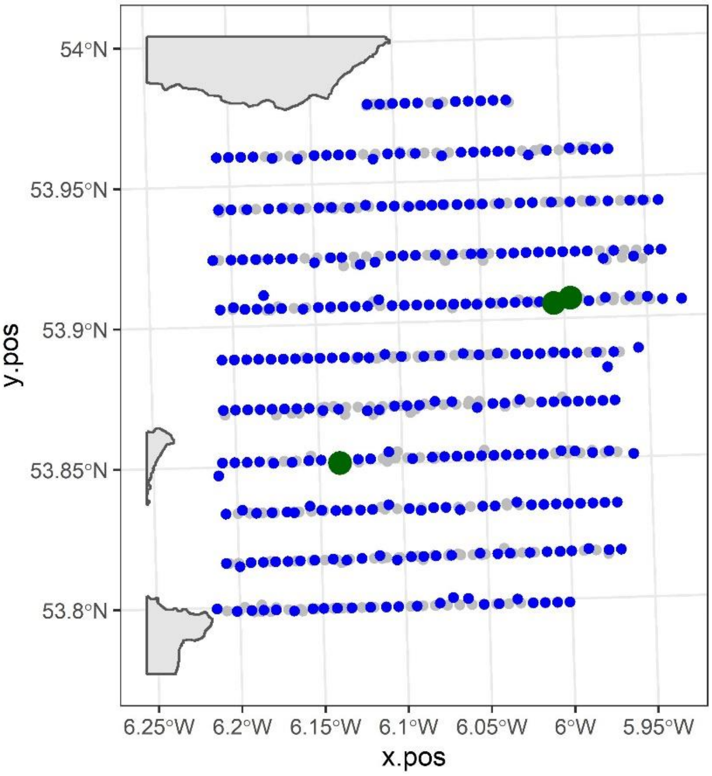

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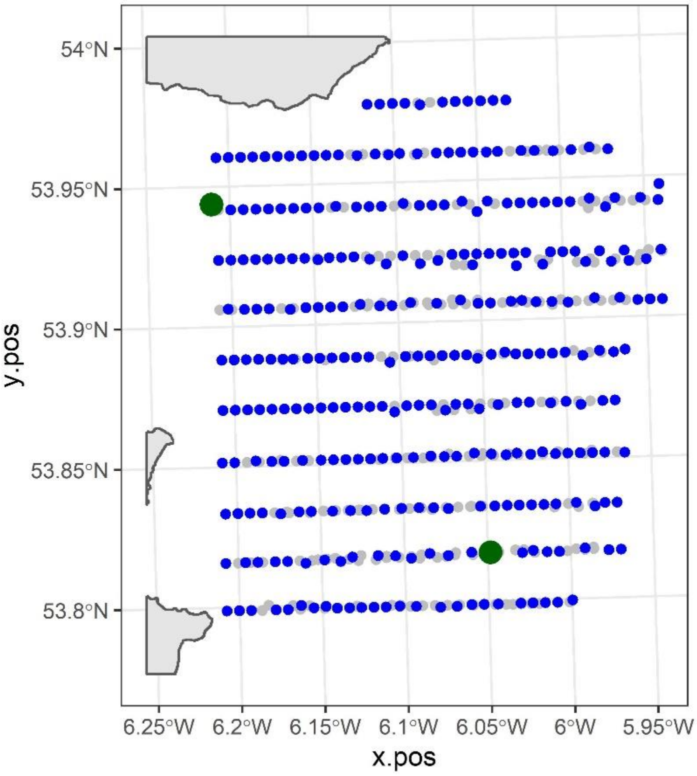

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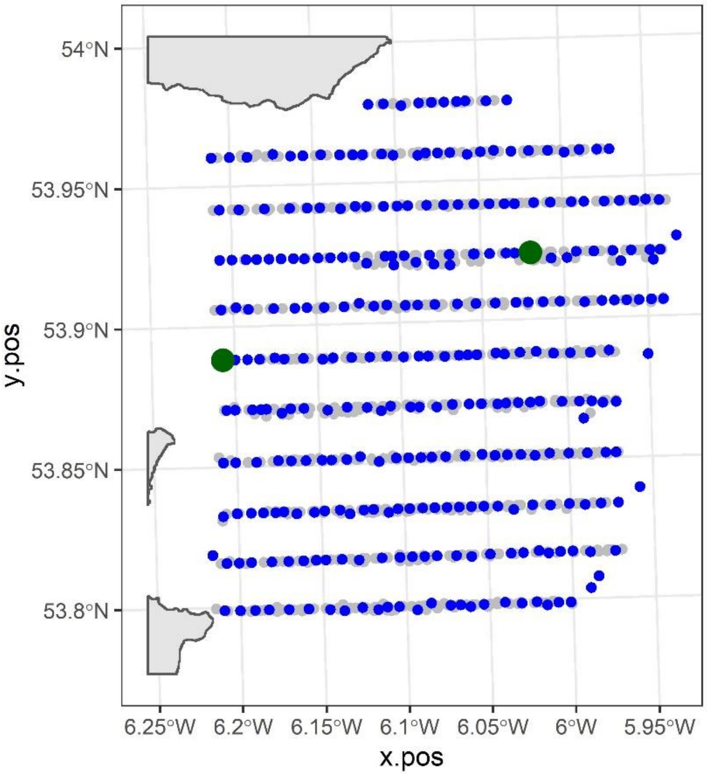

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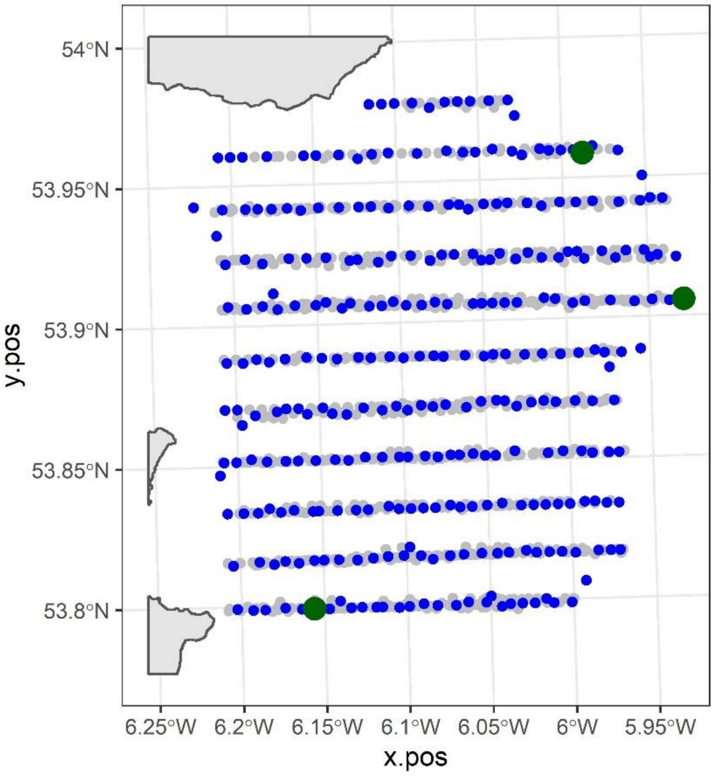

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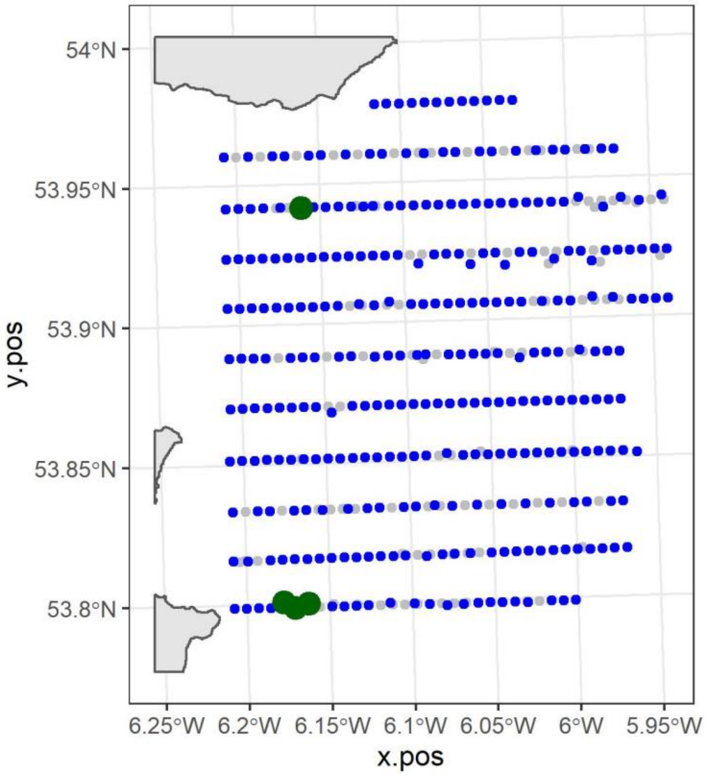
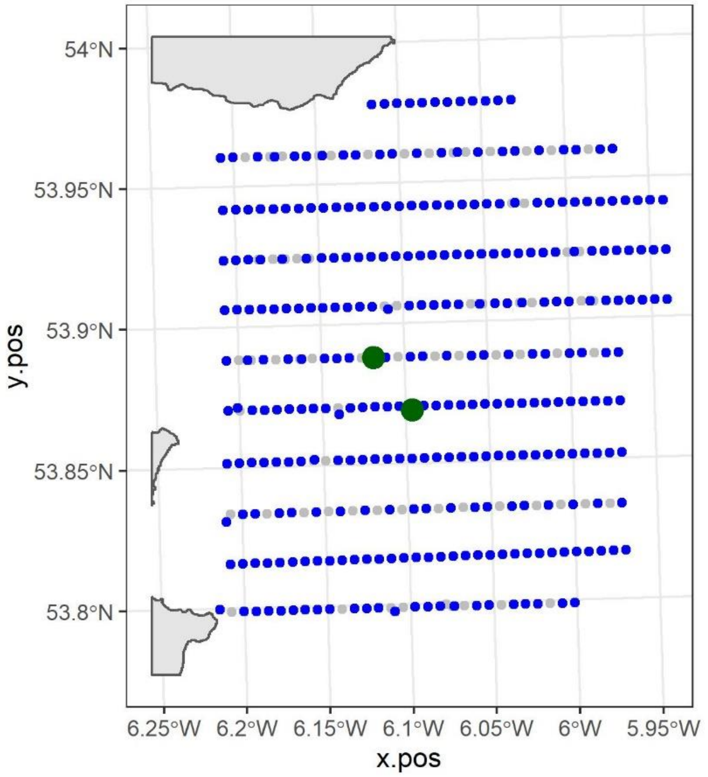


A.1-6: Kittiwake MRSea pre-breeding season knot selection.



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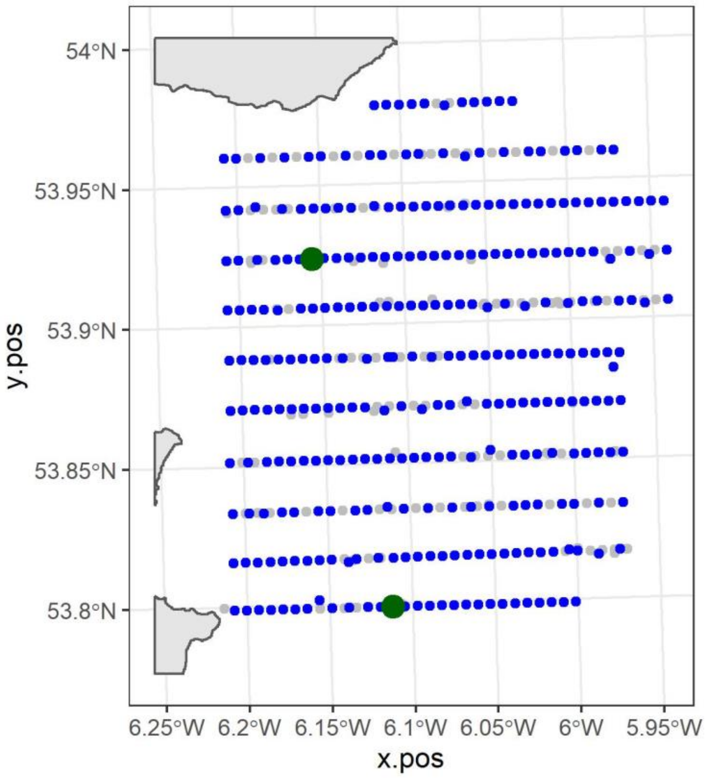
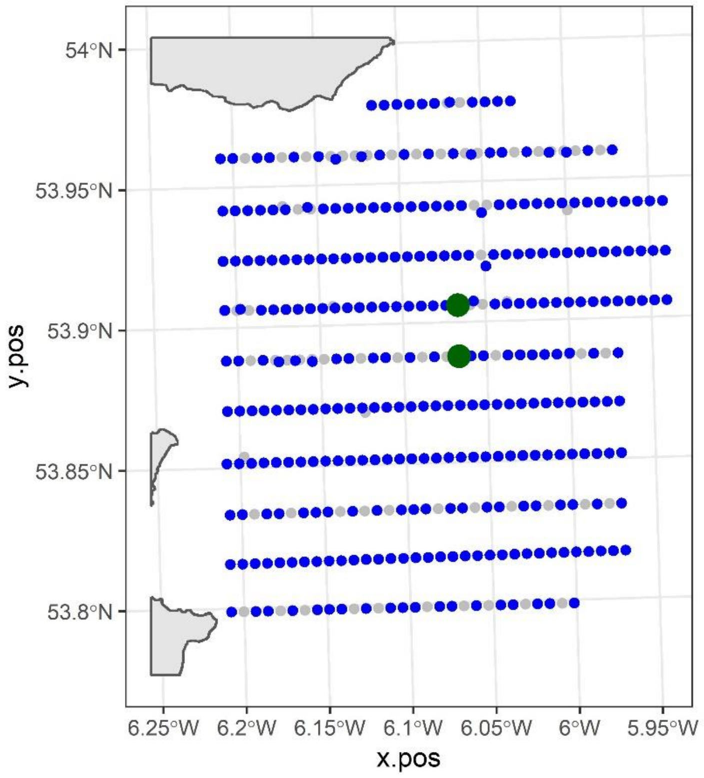
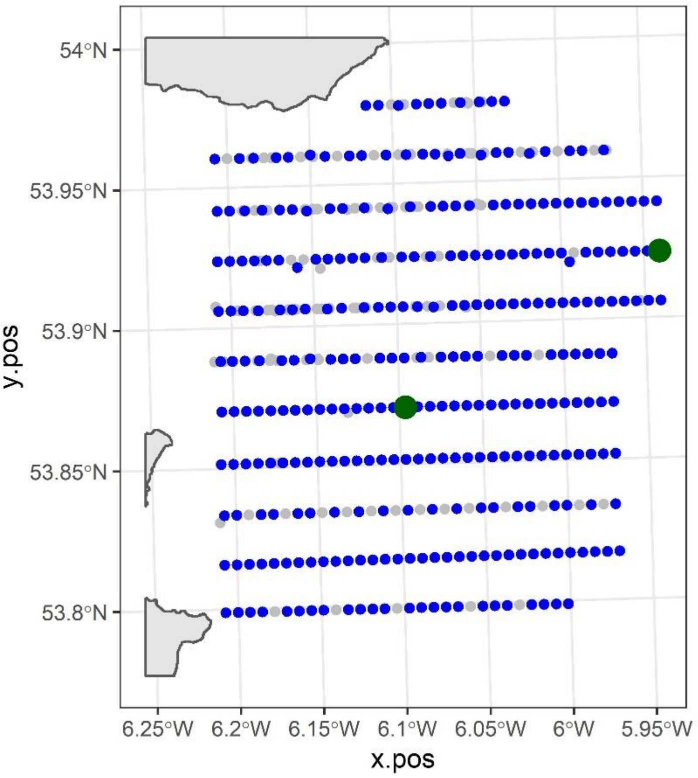


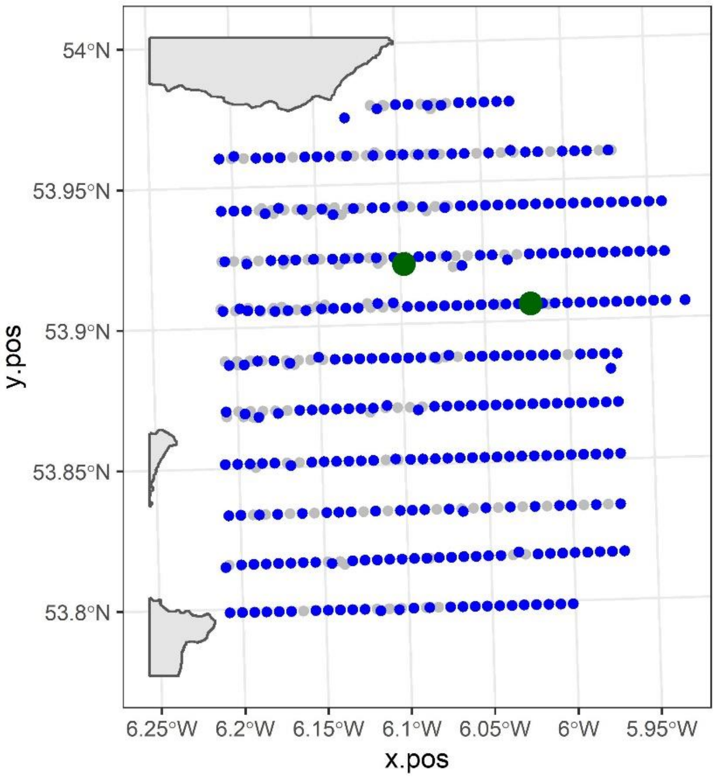
A.1-8: Kittiwake MRSea non-breeding season knot selection.



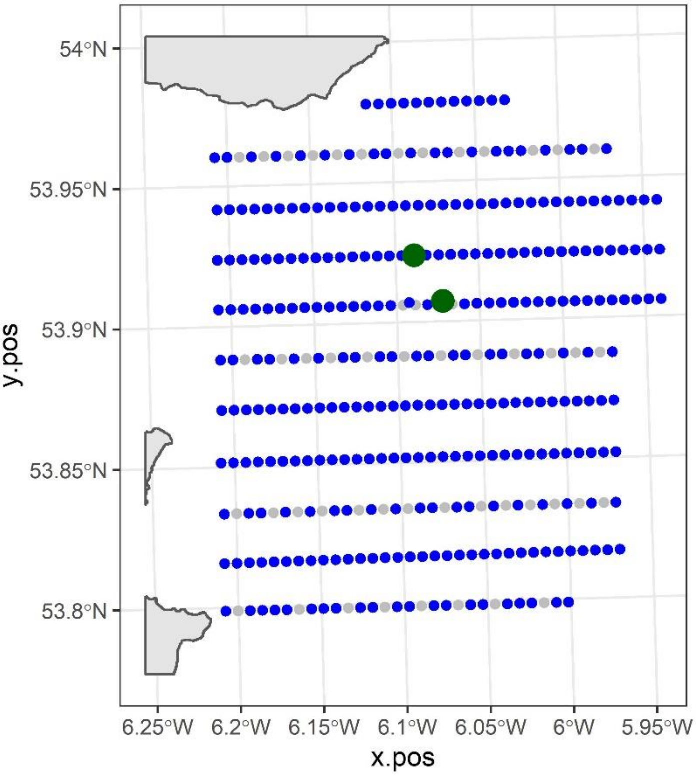
A.1 9: Great Northern Diver MRSea pre-breeding season knot selection.



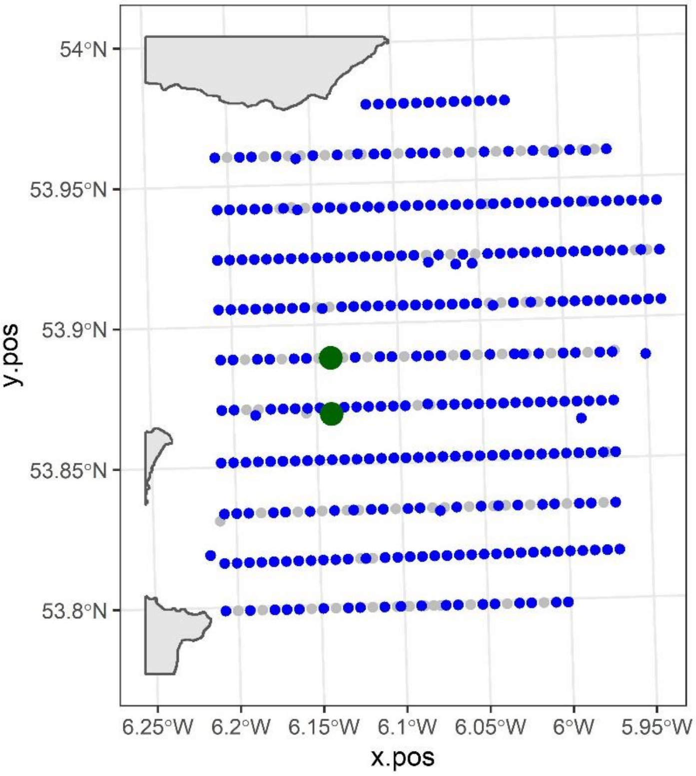
A.1-10: Great Northern Diver MRSea breeding season knot selection.



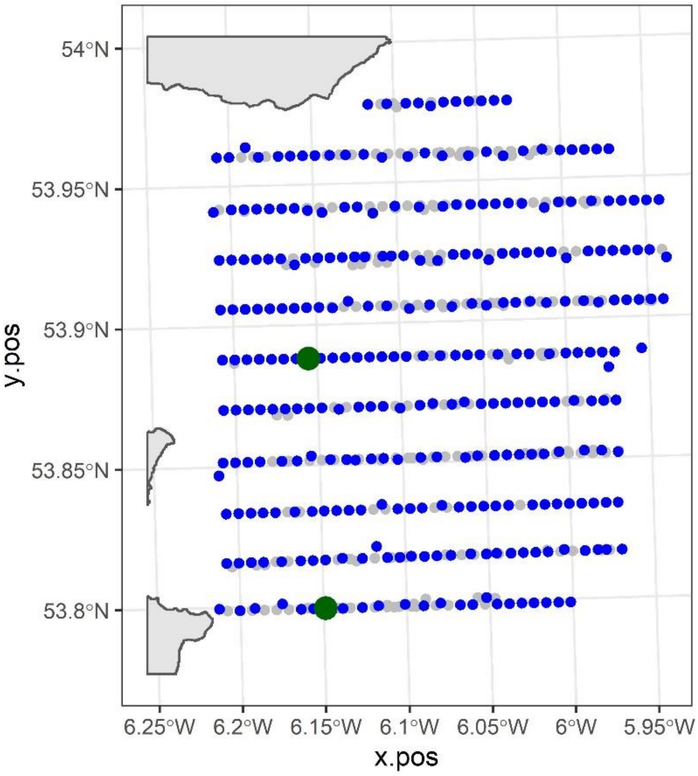
A.1-11: Great Northern Diver MRSea non-breeding season knot selection.



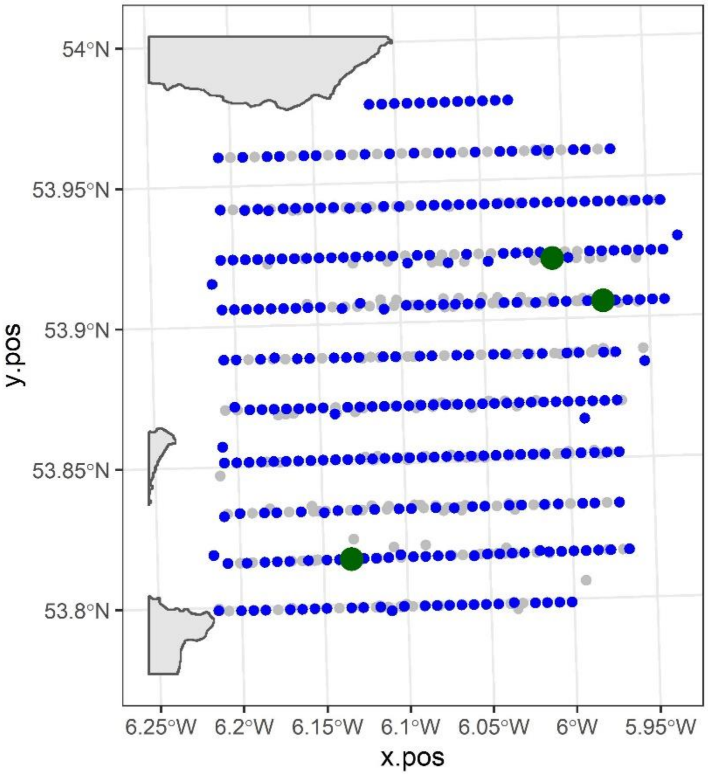
A.1-12: Gannet MRSea pre-breeding season knot selection.



A.1-13: Gannet MRSea breeding season knot selection.



A.1-14: Gannet MRSea non-breeding season knot selection.



A.1-15: Manx shearwater MRSea breeding season knot selection.

ANNEX 2: ORNITHOLOGICAL AND MARINE MEGAFAUNA AERIAL SURVEY RESULTS

ORIEL WIND FARM PROJECT

Natura Impact Statement

Annex 2: Ornithological and Marine Megafauna Aerial Survey Results

MDR1520B
NIS – Annex 2
A1 C01
March 2024

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Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm

Oriel Windfarm Limited

April - September 2020

APEM Ref: P00004972

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3.0	16/12/2020	All	All	Inclusion of September data	KR
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1. Executive Summary

A program of six monthly aerial digital surveys of the Oriel offshore wind farm area and offshore cable corridor in the Irish Sea were undertaken between April and September 2020. Surveys were carried out using APEM Ltd.'s high-resolution camera system to capture digital still imagery, to assess the abundance and distribution of birds and marine megafauna of the Oriel Survey Area. Raw counts and design-based abundance estimates of all species and incidental observations recorded during the surveys are presented here as well as information on species distribution, flight height, and flight direction. The key findings from each of the monthly aerial digital surveys are summarised below.

- Survey 1 – April 2020
    - The total number of birds recorded during the April Survey was 3,082. The most abundant species recorded was common scoter (n= 2,005), followed by great northern diver (n=285), guillemot (n=247), guillemot / razorbill (n=217), gannet (n=73), black guillemot (n=59), great black-backed gull (n=43), kittiwake (n=41), razorbill (n=36), auk species (n=24), red-throated diver (n=15), common gull (n=6), diver species (n=6), Manx shearwater (n=6), sandwich tern (n=3), duck species (n=3), black-headed gull (n=2), herring gull (n=2), puffin (n=2), cormorant / shag (n=2), commic tern (n=2), cormorant (n=1), fulmar (n=1), small gull species (n=1).

    - A total of 18 marine mammals were recorded in the Survey Area during the April survey, these were all recorded as dolphin / porpoise (n=18). No other marine megafauna was recorded during the April survey.

- Survey 2 – May 2020
    - A total of 1,485 birds were recorded in the Survey Area during the May survey. The most abundant species recorded was Manx shearwater (n=547) followed by guillemot (n=529), gannet (n=127), guillemot / razorbill (n=91), razorbill (n=67), great black-backed gull (n=35), kittiwake (n=31), herring gull (n=17), auk species (n=12), great northern diver (n=9), small gull species (n=6), sandwich tern (n=2), commic tern (n=2), lesser black-backed gull (n=2), gull species (n=2), cormorant / shag (n=2), black guillemot (n=1), puffin (n=1), common gull (n=1) and great shearwater (n=1).

    - A total of nine marine mammals were recorded in the Survey Area during the April survey, these were recorded as dolphin / porpoise (n=5) and phocids (n=4). No other marine megafauna was recorded during the April survey.

- Survey 3 – June 2020
    - A total of 963 birds were recorded in the Survey Area during the June survey. The most abundant species recorded was razorbill (n=295), followed by guillemot / razorbill (n=245), guillemot (n=207), Manx shearwater (n=90), gannet (n=41), black guillemot (n=38), cormorant (n=9), auk species (n=7), puffin (n=7), commic / roseate tern (n=5), commic tern (n=4), great northern diver (n=4), diver species (n=3), sandwich tern (n=3), kittiwake (n=2), curlew (n=1), great black-backed gull (n=1) and herring gull (n=1).

    - A total of eight marine mammals were recorded in the Survey Area during the June survey, these were recorded as phocids (n=7), harbour porpoise (n=1). One other marine megafauna was recorded during the June survey, it was identified as shark species (n=1).

- Survey 4 – July 2020
  - A total of 4,640 birds were recorded in the Survey Area during the July survey. The most abundant species recorded was guillemot (n=3,235), followed by guillemot / razorbill (n=808), Manx shearwater (n=280), gannet (n=156), black guillemot (n=38), razorbill (n=31), herring gull (n=24), kittiwake (n=15), auk species (n=10), great black-backed gull (n=10), puffin (n=7), commic tern (n=5), common scoter (n=4), cormorant (n=4), great northern diver (n=4), commic / roseate tern (n=3), common gull (n=2), great skua (n=1), lesser black-backed gull (n=1), roseate tern (n=1) and sandwich tern (n=1).

  - A total of three marine mammals were recorded in the Survey Area during the July survey, these were recorded as phocids (n=3). No other marine megafauna was recorded during the July survey.

- Survey 5 – August 2020
  - A total of 4,965 birds were recorded in the Survey Area during the August survey. The most abundant species recorded was guillemot (n=3,077), followed by Manx shearwater (n=1,317), black guillemot (n=224), gannet (n=145), razorbill (n=66), guillemot / razorbill (n=54), great black-backed gull (n=37), kittiwake (n=18), puffin (n=10), commic tern (n=7), small gull species (n=3), gull species (n=2), auk species (n=1), cormorant (n=1), fulmar (n=1), herring gull (n=1) and sandwich tern (n=1).

  - A total of 20 marine mammals were recorded in the Survey Area during the August survey, these were recorded as dolphin / porpoise (n=15), grey seal (n=2), harbour porpoise (n=2) and phocids (n=1).

- Survey 6 – September 2020
  - A total of 8,652 birds were recorded in the Survey Area during the September. The most abundant species recorded was guillemot (n=6,163), followed by razorbill (n=1,064), guillemot / razorbill (n=796), black guillemot (n=217), gannet (n=141), Manx shearwater (n=137), common scoter (n=29), kittiwake (n=24), puffin (n=24), great black-backed gull (n=16), auk species (n=7), common tern (n=7), commic tern (n=5), red-throated diver (n=4), commic / roseate tern (n=3), sandwich tern (n=3), arctic skua (n=2), cormorant / shag (n=2), gull species (n=2), cormorant (n=1), herring gull (n=1), large gull species (n=1), lesser black-backed gull (n=1), little gull (n=1) and small gull species (n=1).

  - A total of 22 marine mammals were recorded in the Survey Area during the September survey, these were recorded as dolphin / porpoise (n=7), dolphin species (n=3), harbour porpoise (n=3), phocids (n=3), grey seal (n=2), marine mammal species (n=2), baleen whale species (n=1) and common minke whale (n=1). One other marine megafauna was recorded during the September survey, it was identified as leatherback turtle (n=1).

2. Introduction

Parkwind, as investors in Oriel Windfarm Limited, requested APEM Ltd (APEM) to undertake monthly aerial digital surveys of Oriel Offshore Windfarm Ornithology Study area. The primary objective of the work was to assess the abundance and distribution of birds present in the area and to gather information on other marine megafauna, such as marine mammals. This data will meet the aims and objectives of the work required by Oriel Windfarm Limited to inform future environmental impact assessment work for the proposed wind farm development.

The Ornithology Study area is located, in the west of the Irish Sea, off the east coast of Ireland (**Figure 1**). Surveys commenced in April 2020 and were continued for six months. The survey method was designed to complement the pre-existing boat-based surveys which had already been undertaken, with the same aims and objects as this digital aerial survey.

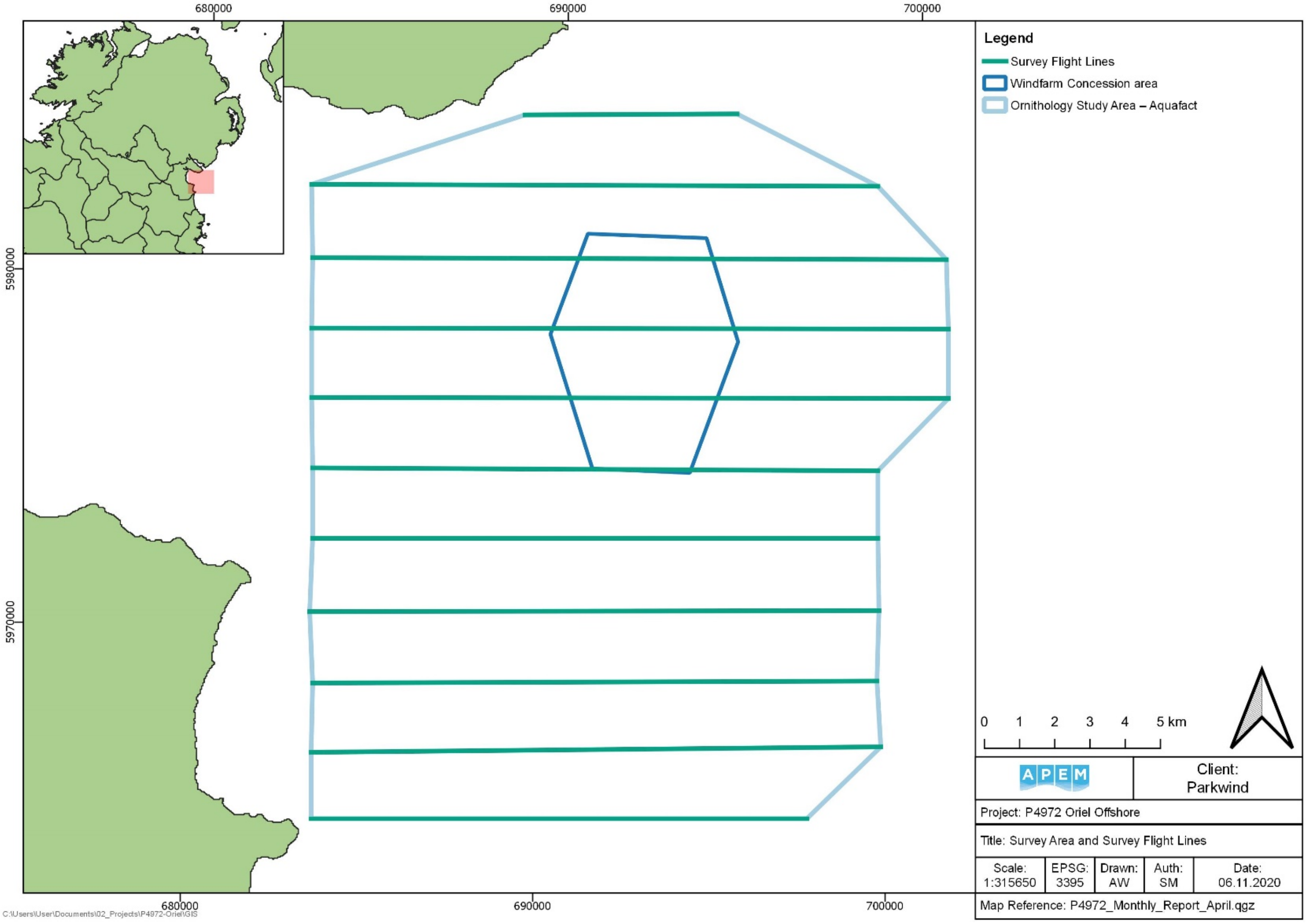

Figure 1 Location of the Oriel Offshore Ornithology Study area, with survey flight lines.

This report summarises the information collected following the completion of the six monthly aerial digital surveys of the Ornithology Study area between April 2020 and September 2020.

The following information is provided in Section 3:

- The number of surveys conducted;
- The dates, start and end times, and weather conditions;
- Survey and analysis methodology; and
- Health and safety notes.

The following information is provided in Section 4:

- Raw counts of observations across surveys from April 2020 to September 2020;

The following information is provided in Section 5:

- Design-based abundances and densities for each bird species / taxonomic group;
- Flight direction information;
- Flight height information; and
- Maps showing the locations of each bird species / taxonomic group.

Anecdotal observations, for example shipping information recorded visually from the aircraft or captured in the imagery, is provided in Section 6.

3. Survey and Analysis Methodologies

3.1 Summary of Aerial Digital Surveys

APEM has a bespoke camera system called "Shearwater IV" customised by in-house specialists for surveying the offshore environment. The camera system is integrated with custom flight planning software that allows each survey transect to be accurately mapped out before the aircraft leaves the ground. Each image node is precisely defined, allowing the system to capture imagery at exactly the right location. The flight planning software ensures that each survey is flown with the same transect orientation and the camera is triggered at the same position along each transect within set tolerances. APEM's planning systems enable tolerances on flight path along survey lines to be set, automatically aborting survey lines that drift away from the aircraft's planned flight line.

APEM's on-board camera technician continually monitored the imagery as it was collected to ensure the data collected was fit for purpose. Both the pilot and camera technician would make the decision to cease data collection should the conditions become unsuitable for surveying and / or data collection. Subsequently, the survey would then be resumed at the next earliest opportunity.

APEM's bespoke camera system was fitted into a twin-engine aircraft, data collected were 1.5 centimetre (cm) ground sample distance (GSD) digital still images, using a GPS-linked bespoke flight management system to ensure the tracks were flown with a high degree of accuracy at least 25% coverage of the sea surface was collected to be analysed. The camera system captured abutting still imagery along 11 survey lines spaced approximately two kilometres (km) between-track, perpendicular to the coastline. The aircraft collected the data at an altitude of approximately 395 meters (m), and a speed of approximately 120 knots. The aircraft's internal Global Positioning System (GPS) and inertial measurement unit (IMU) systems record to an accuracy of +/- 3 to 5 m as standard.

Imagery was captured in raw format and post-processed to ensure optimal quality for the subsequent stage of image analysis, to extract information on marine fauna or other notable occurrences. When a survey is completed, the data are checked to ensure the number of lines and the number of images collected is correct, and that the quality of the imagery is acceptable. Once the image analysis is completed, further Quality Control (QC) processes take place (see **3.2 Summary of Quality Control**).

No health or safety issues were reported during the surveys.

The date(s), and start and end times are provided for each aerial digital survey in **Table 1** with the corresponding weather conditions provided in **Table 2**.

Weather conditions during all surveys were conducive to collecting and analysing imagery for the purpose of providing data on the identification, distribution and abundance of bird species and marine fauna within the Ornithology Study area. Favourable conditions for surveying are defined as a cloud base of > 518 m, visibility of >5 km, wind speed of <30 knots, and sea state of 4 (moderate) or less on the Beaufort scale . For safety reasons, no surveying takes place in icing conditions.

Table 1 **Date and start / end time (Coordinated Universal Time) for each flight for the April 2020 to September 2020 monthly surveys**

Survey No.	Date	Flight Number	UTC Start Time (HH:MM)	UTC End Time (HH:MM)
1	24-04-2020	1	08:00	10:09
2	02-06-2020	1	12:04	13:58
3	21-06-2020	1	16:21	17:48
4	18-07-2020	1	16:07	17:31
5	08-08-2020	1	13:41	14:55
6	03-09-2020	1	07:45	09:19

Table 2 **Weather conditions recorded for completed surveys: April 2019 to March 2020**

Survey No.	Date	Douglas Sea State[1]	Wind Speed (knots) / Direction	Cloud Cover (%)[2]	Visibility (km)	Air Temp (°C)
1	24-04-2020	1	10 - 15 / W	50	> 10 km	18
2	02-06-2020	1	10 / NE	50	> 10 km	19
3	21-06-2020	3	15 - 20 / W	25-50	> 10 km	15
4	18-07-2020	2	10 / NW	50-95	> 10 km	15
5	08-08-2020	1	10 / NE	0-80	> 10 km	16-18
6	03-09-2020	3	20 / W	50-100	> 10 km	16-17

[1] 0 = Calm (Glassy); 1 = Calm (Rippled); 2 = Smooth; 3 = Slightly Moderate; 4 = Moderate

[2] 0 = Clear; 1-10 = Few; 11-50 = Scattered; 51-95 = Broken; 96-100 = Overcast

3.2 Summary of Quality Control

Internal QA was carried out on the data collected from each of the surveys. Images were assessed in batches with a different staff member responsible for each batch. Each image containing birds was reviewed and checked by APEM's dedicated QA Manager, ensuring that 100% of birds found were subject to internal QA to ensure that species identification was correct. Images containing no birds, marine megafauna or anthropological objects of interest were removed and kept separately for further internal QA. Of these 'blank' images, 10% were randomly selected for QA. If there was less than 90% agreement, the entire batch was re-analysed independently by a different staff member than who initially analysed the imagery.

3.3 Species Abundance Estimates

For each monthly aerial digital survey of the Ornithology Study area, geo-referenced locations of marine fauna, contained within each individual digital still image, were used to generate raw counts. Marine fauna locations contained within the boundaries of the two areas: the Ornithology Study area (which contains the Windfarm Concession area), and the Windfarm Concession area alone were then extracted using QGIS, providing raw count data. These data are presented in this annual report for all species.

The raw counts were then divided by the number of images collected to give the mean number of animals per image (i). Population estimates (N) for each survey month were then generated by multiplying the mean number of animals per image by the total number of images required to cover the entire study area (A):

$$N = i\,A$$

Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. The statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values were taken as the variability of the statistic over the population (Efron & Tibshirani, 1993).

A measure of precision was calculated using a Poisson estimator, suitable for a pseudo-Poisson over-dispersed distribution. This produced a CV based on the relationship of the standard error to the mean.

All analyses and data manipulation carried out by APEM were conducted in the R programming language (R Core Team, 2020) and non-parametric 95% confidence intervals were generated using the 'boot' library of function (Canty & Ripley, 2010). This results in species-specific monthly abundance estimates being calculated from the raw count data, with upper and lower confidence limits. Where appropriate, a level of precision is also presented for each monthly abundance estimate. Dividing the monthly abundance estimates by the size of the area covered (Ornithology Study area or Windfarm Concession area) calculates the associated density (e.g. bird per km^2) for any given species.

3.4 Species Distribution Maps

Each individual located by the surveys is geo-referenced and this allows those locations to be related to the boundary of the Ornithology Study area. Distribution maps were produced for each species using QGIS (version 3.10.7) by separating each individual species recorded in all surveys and then representing these individuals as a symbol on a map. Symbols are determined by the species group, with a relevant icon and a unique colour assigned on a per species basis, the latter of which allows a differentiation across the board between species that use the same icon.

3.5 Species Flight Direction Rose Diagrams

The flight direction of birds was recorded from all digital still images. Bearings of bird directions were plotted using Oriana to summarise overall directions of movement. The mean angle and mean vector is used to describe directional preferences and extent of 'agreement'. A Rayleigh test that assumes a null hypothesis of uniformity (i.e. scattered orientation in all directions) was used, where a significant test indicates directionality of movement.

3.6 Avian Flight Altitudes

Bird flight altitude was estimated from the digital still images. It was determined using bespoke APEM software that applies a set of rules developed in-house as well as trigonometry to provide an estimate of flight height above mean sea level (MSL). Flight height boxplot graphs were produced for each species, where possible, by combining the suitable flight height data collected from the survey programme. The 'box' is the interquartile range, with the middle bold line representing the median of the data. The 'whiskers' are the largest and smallest non-outliers. The range of the entire data includes the outliers represented by circles.

4. Raw counts of bird and marine megafauna

A total of 23,787 birds were recorded in the Survey Area during the April 2020, May 2020, June 2020, July 2020, August 2020 and September 2020 surveys (**Table 3**). The most abundant species recorded was guillemot (n=13,458), followed by Manx shearwater (n=2,377), guillemot / razorbill (n=2211), common scoter (n=2,038), razorbill (n=1,559), gannet (n=683), black guillemot (n=577), great northern diver (n=302), great black-backed gull (n=142), kittiwake (n=131), auk species (n=61), puffin (n=51), herring gull (n=46), commic tern (n=25), red-throated diver (n=19), cormorant (n=16), sandwich tern (n=13), commic / roseate tern (n=11), small gull species (n=11), common gull (n=9), diver species (n=9), common tern (n=7), cormorant / shag (n=6), gull species (n=6), lesser black-backed gull (n=4), duck species (n=3), arctic skua (n=2), black-headed gull (n=2), fulmar (n=2), curlew (n=1), great shearwater (n=1), great skua (n=1), large gull species (n=1), little gull (n=1) and roseate tern (n=1).

A total of 80 marine mammals were recorded in the Survey Area during the April 2020, May 2020, June 2020, July 2020, August 2020 and September 2020 surveys (**Table 4**), these were recorded as dolphin / porpoise (n=45), phocids (n=18), harbour porpoise (n=6), grey seal (n=4), dolphin species (n=3), marine mammal species (n=2), baleen whale species (n=1), common minke whale (n=1). Two other marine megafauna were recorded, these were identified as shark species (n=1) and leatherback turtle (n=1;**Table 4**).

Species distribution maps for each survey are included in **Appendix II**.

The total number of birds recorded during the April Survey was 3,082. The most abundant species recorded was common scoter (n= 2,005), followed by great northern diver (n=285), guillemot (n=247), guillemot / razorbill (n=217), gannet (n=73), black guillemot (n=59), great black-backed gull (n=43), kittiwake (n=41), razorbill (n=36), auk species (n=24), red-throated diver (n=15), common gull (n=6), diver species (n=6), Manx shearwater (n=6), sandwich tern (n=3), duck species (n=3), black-headed gull (n=2), herring gull (n=2), puffin (n=2), cormorant / shag (n=2), commic tern (n=2), cormorant (n=1), fulmar (n=1) and small gull species (n=1).

A total of 18 marine mammals were recorded during the April survey, these were all recorded as dolphin / porpoise (n=18). No other marine megafauna was recorded during the April survey.

A total of 1,485 birds were recorded during the May survey. The most abundant species recorded was Manx shearwater (n=547) followed by guillemot (n=529), gannet (n=127), guillemot / razorbill (n=91), razorbill (n=67), great black-backed gull (n=35), kittiwake (n=31), herring gull (n=17), auk species (n=12), great northern diver (n=9), small gull species (n=6), sandwich tern (n=2), commic tern (n=2), lesser black-backed gull (n=2), gull species (n=2), cormorant / shag (n=2), black guillemot (n=1), puffin (n=1), common gull (n=1) and great shearwater (n=1).

A total of nine marine mammals were recorded during the April survey, these were recorded as dolphin / porpoise (n=5) and phocids (n=4). No other marine megafauna was recorded during the April survey.

A total of 963 birds were recorded during the June survey. The most abundant species recorded was razorbill (n=295), followed by guillemot / razorbill (n=245), guillemot (n=207), Manx shearwater (n=90), gannet (n=41), black guillemot (n=38), cormorant (n=9), auk species (n=7), puffin (n=7), commic / roseate tern (n=5), commic tern (n=4), great northern diver (n=4), diver species (n=3), sandwich tern (n=3), kittiwake (n=2), curlew (n=1), great black-backed gull (n=1) and herring gull (n=1).

A total of eight marine mammals were recorded during the June survey, these were recorded as phocids (n=7), harbour porpoise (n=1). One other marine megafauna was recorded during the June survey, it was identified as shark species (n=1).

A total of 4,640 birds were recorded during the July survey. The most abundant species recorded was guillemot (n=3,235), followed by guillemot / razorbill (n=808), Manx shearwater (n=280), gannet (n=156), black guillemot (n=38), razorbill (n=31), herring gull (n=24), kittiwake (n=15), auk species (n=10), great black-backed gull (n=10), puffin (n=7), commic tern (n=5), common scoter (n=4), cormorant (n=4), great northern diver (n=4), commic / roseate tern (n=3), common gull (n=2), great skua (n=1), lesser black-backed gull (n=1), roseate tern (n=1) and sandwich tern (n=1).

A total of three marine mammals were recorded during the July survey, these were recorded as phocids (n=3). No other marine megafauna was recorded during the July survey.

A total of 4,965 birds were recorded in the Survey Area during the August survey. The most abundant species recorded was guillemot (n=3,077), followed by Manx shearwater (n=1,317), black guillemot (n=224), gannet (n=145), razorbill (n=66), guillemot / razorbill (n=54), great black-backed gull (n=37), kittiwake (n=18), puffin (n=10), commic tern (n=7), small gull species (n=3), gull species (n=2), auk species (n=1), cormorant (n=1), fulmar (n=1), herring gull (n=1) and sandwich tern (n=1).

A total of 20 marine mammals were recorded in the Survey Area during the August survey, these were recorded as dolphin / porpoise (n=15), grey seal (n=2), harbour porpoise (n=2) and phocids (n=1).

A total of 8,652 birds were recorded in the Survey Area during the September. The most abundant species recorded was guillemot (n=6,163), followed by razorbill (n=1,064), guillemot / razorbill (n=796), black guillemot (n=217), gannet (n=141), Manx shearwater (n=137), common scoter (n=29), kittiwake (n=24), puffin (n=24), great black-backed gull (n=16), auk species (n=7), common tern (n=7), commic tern (n=5), red-throated diver (n=4), commic / roseate tern (n=3), sandwich tern (n=3), arctic skua (n=2), cormorant / shag (n=2), gull species (n=2), cormorant (n=1), herring gull (n=1), large gull species (n=1), lesser black-backed gull (n=1), little gull (n=1) and small gull species (n=1).

A total of 22 marine mammals were recorded in the Survey Area during the September survey, these were recorded as dolphin / porpoise (n=7), dolphin species (n=3), harbour porpoise (n=3), phocids (n=3), grey seal (n=2), marine mammal species (n=2), baleen whale species (n=1) and common minke whale (n=1). One other marine mega fauna was recorded during the September survey, it was identified as leatherback turtle (n=1).

Table 3 Raw counts of avian species (in taxonomic order) recorded during the April 2020, May 2020, June 2020, July 2020, August 2020 and September 2020 surveys.

Family	Species	Flying	Sitting	Perched	Total
Ducks and Waterfowl	Common Scoter	7	2031	-	2038
	Duck Species	-	3	-	3
Waders	Curlew	1	-	-	1
Gulls and Terns	Kittiwake	84	47	-	131
	Black-headed Gull	2	-	-	2
	Little Gull	1	-	-	1
	Common Gull	7	2	-	9
	Great Black-backed Gull	27	115	-	142
	Herring Gull	23	23	-	46
	Lesser Black-backed Gull	2	2	-	4
	Small Gull Species	2	9	-	11
	Large Gull Species	-	1	-	1
	Gull Species	1	5	-	6
	Sandwich Tern	13	-	-	13
	Roseate Tern	1	-	-	1
	Common Tern	7	-	-	7
	Commic[1] Tern	25	-	-	25
	Commic[1] / Roseate Tern	11	-	-	11
Skua	Great Skua	1	-	-	1
	Arctic Skua	1	1	-	2
Auks	Guillemot	150	13308	-	13458
	Razorbill	32	1527	-	1559
	Black Guillemot	4	573	-	577
	Guillemot / Razorbill	17	2194	-	2211
	Puffin	-	51	-	51
	Auk Species	-	61	-	61
Divers	Red-throated Diver	2	17	-	19
	Great Northern Diver	-	302	-	302
	Diver Species	-	9	-	9
Fulmars and Shearwaters	Fulmar	1	1	-	2
	Great Shearwater	-	1	-	1
	Manx Shearwater	1370	1007	-	2377
Gannet	Gannet	342	341	-	683
Cormorants and Shags	Cormorant	6	10	-	16
	Cormorant / Shag	4	-	2	6
Total Avian Species		***2144***	***21641***	***2***	***23787***

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[1] Includes arctic tern and common tern.

Table 4 Raw counts of marine megafauna species recorded during the April 2020, May 2020, June 2020, July 2020, August 2020 and September 2020 surveys.

Species	Submerged	Surfacing	Total
Grey Seal	3	1	4
Phocids	9	9	18
Dolphin Speices	2	1	3
Harbour Porpoise	3	3	6
Dolphin / Porpoise	40	5	45
Common Minke Whale	1	-	1
Baleen Whale species	1	-	1
Marine Mammal species	2	-	2
Total Marine Mammals	***61***	***19***	***80***
Shark Species	1	-	1
Total Shark Species	***1***	***0***	***1***
Leatherback Turtle	-	1	1
Total Turtle Species	***0***	***1***	***1***

5. Species Accounts

The following species accounts present the raw counts, design-based abundance estimates, density estimates, behavioural and peak month distribution data of the six-month programme of aerial digital surveys of the Ornithology Study area. The density estimates provide the number of individuals per square kilometre (km^2). Abundance estimates have been provided for the Ornithology Study Area and Windfarm Concession Area separately, for each of the two areas the abundance are likely to differ due to the abundance estimates being calculated independently based on the numbers of recorded targets per location and the area covered by said locations. Scientific names and taxonomy of birds and marine fauna are provided in **Appendix I**.

5.1 Common Scoter

Overall 2,038 common scoter were identified during the surveys, 2,005 in April 2020, four in July 2020 and 29 in September 2020. Common scoter were not recorded in the May, June and August 2020 surveys.

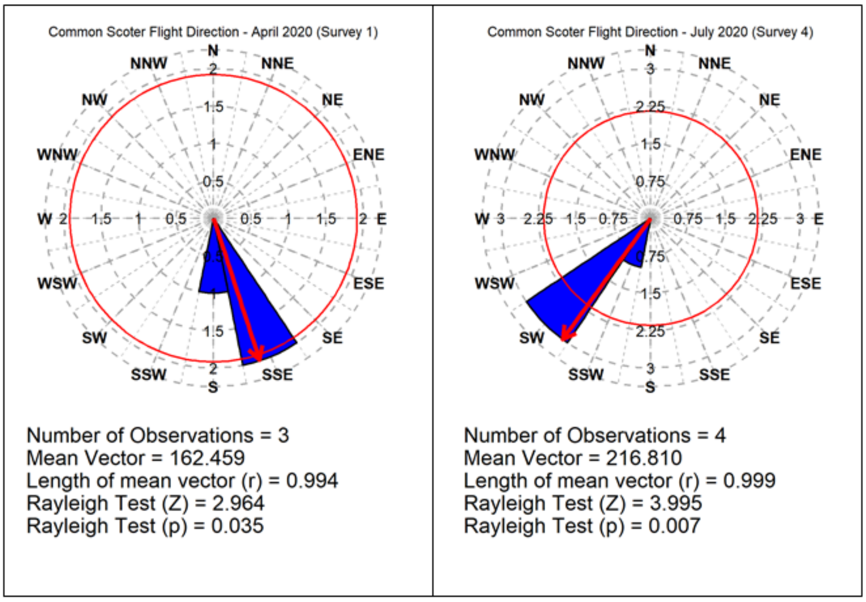
Common scoter were recorded in the Ornithology Study Area in July and September, with a peak raw count of seven resulting in an abundance estimate of 20 (**Table 5**).

In April 2020, flying common scoter were significantly orientated around the mean of 162° (Rayleigh test, p=<0.05, **Figure 2**). In July 2020, flying common scoter were significantly orientated around the mean of 216° (Rayleigh test, p=<0.05, **Figure 2**).

Common scoter were recorded in a large single group west of the Windfarm Concession Area in April 2019, not within the Windfarm Concession Area (**Figure 3**). Common scoter were observed in the north-west corner of the Ornithology Study area. No common scoter were located in the Windfarm Concession area.

Table 5 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of common scoter in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
July-2020	4	11	4	34	0.5	0.03
September -2020	7	20	7	53	0.37796	0.06



Common Scoter Flight Direction - April 2020 (Survey 1)

Number of Observations = 3
Mean Vector = 162.459
Length of mean vector (r) = 0.994
Rayleigh Test (Z) = 2.964
Rayleigh Test (p) = 0.035

Common Scoter Flight Direction - July 2020 (Survey 4)

Number of Observations = 4
Mean Vector = 216.810
Length of mean vector (r) = 0.999
Rayleigh Test (Z) = 3.995
Rayleigh Test (p) = 0.007

Figure 2 Summary of flight direction of common scoter during the April and July 2020 surveys

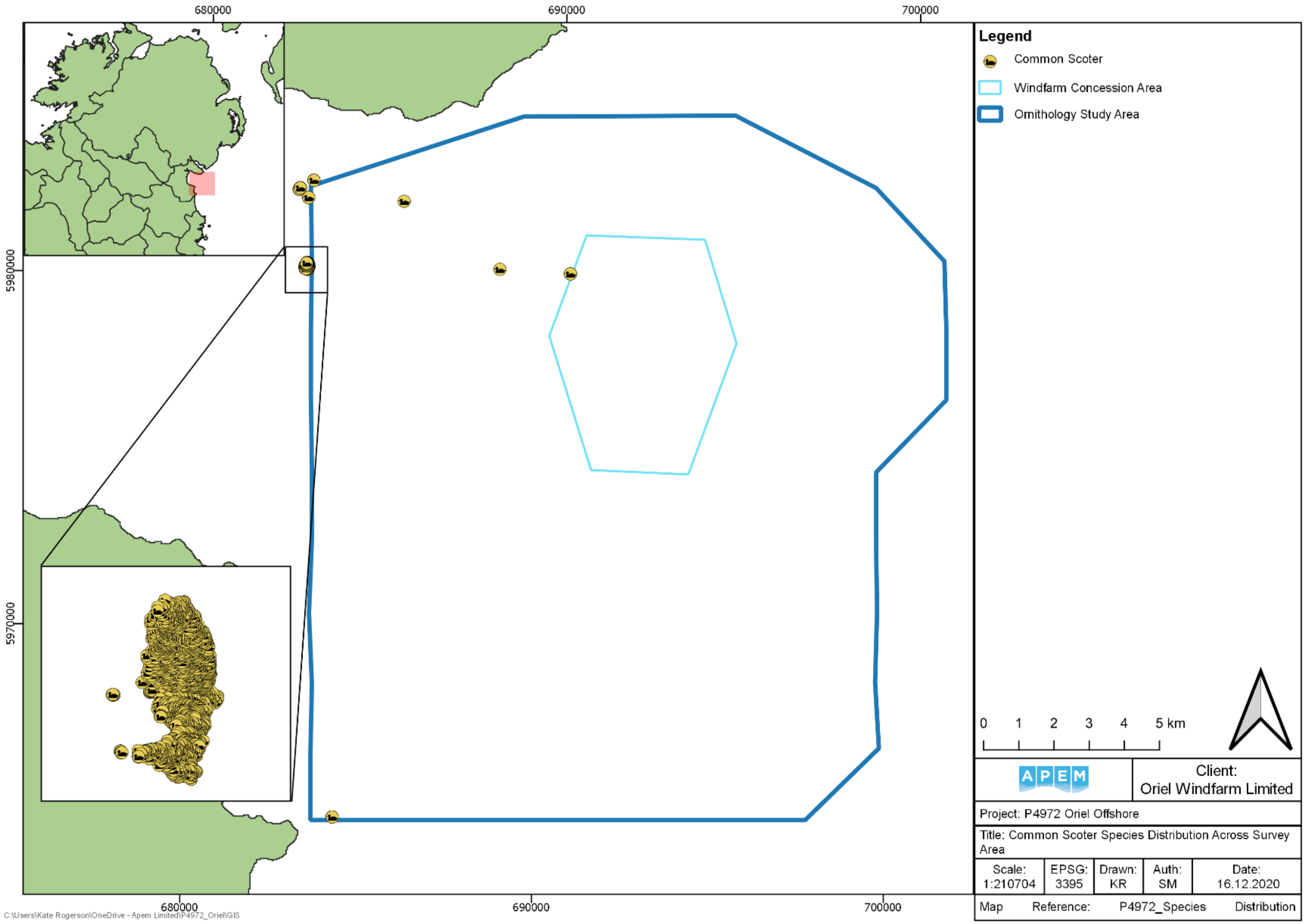


Figure 3 Distribution of common scoter recorded across the Ornithology Study Area

5.2 Duck Species – unidentified

During the April 2020 survey, three unidentified duck species were identified. Unidentified duck species were not recorded in the May 2020, June 2020, July 2020, August 2020 and September 2020 surveys.

The total raw count of three individuals in April 2020 resulted in an abundance estimate of nine for the Ornithology Study Area (**Table 6**).

Unidentified duck species were recorded in a single group to the west of the Windfarm Concession area in April 2020 (**Figure 4**). No unidentified duck species were located in the Windfarm Concession area.

Table 6 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of unidentified duck species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	3	9	3	26	0.57735	0.03

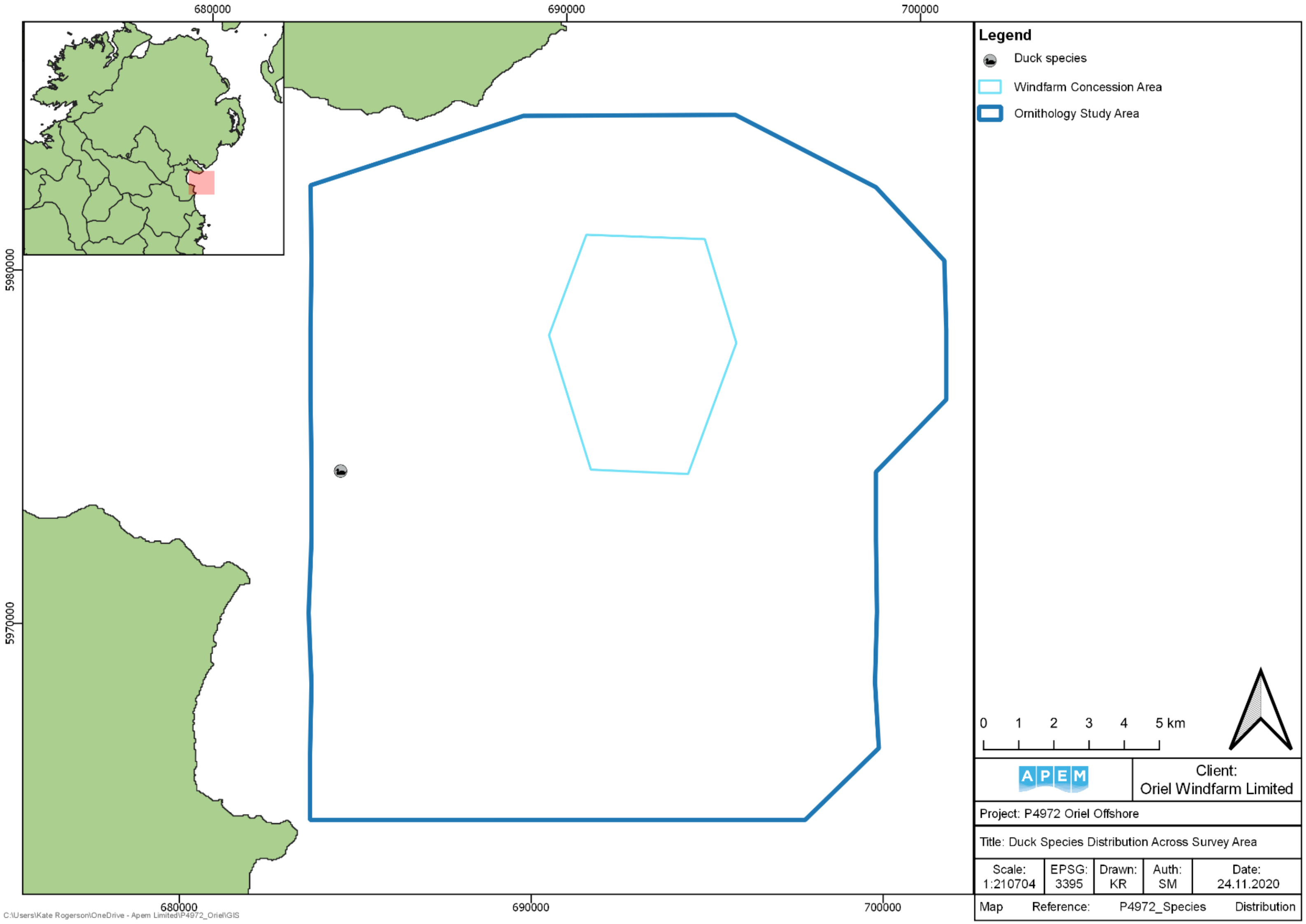


Figure 4 Distribution of duck species recorded across the Ornithology Study Area

5.3 Curlew

During the June 2020 survey, one curlew was identified. Curlew were not recorded in the April 2020, May 2020, July 2020, August 2020 and September surveys.

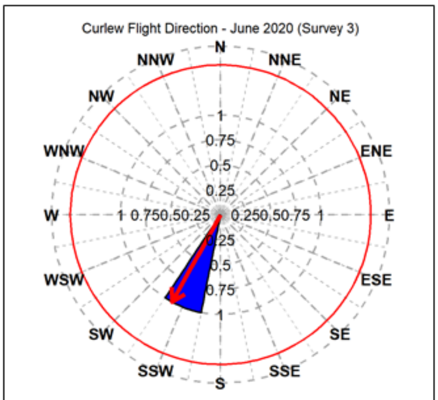
The raw count of one individual resulted in an abundance estimate of three for the Ornithology Study area (**Table 7**).

In June 2020, the curlew was recorded as flying and orientated towards 209° (Rayleigh test, p=>0.05, **Figure 5**).

In June 2020 the curlew was located on the western edge of the Ornithology Study area (**Figure 6**). No curlew were located in the Windfarm Concession area.

Table 7 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of curlew in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
June-2020	1	3	1	9	1	0.01



Number of Observations = 1
Mean Vector = 209.319
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 5 Summary of flight direction of curlew during the June 2020 survey

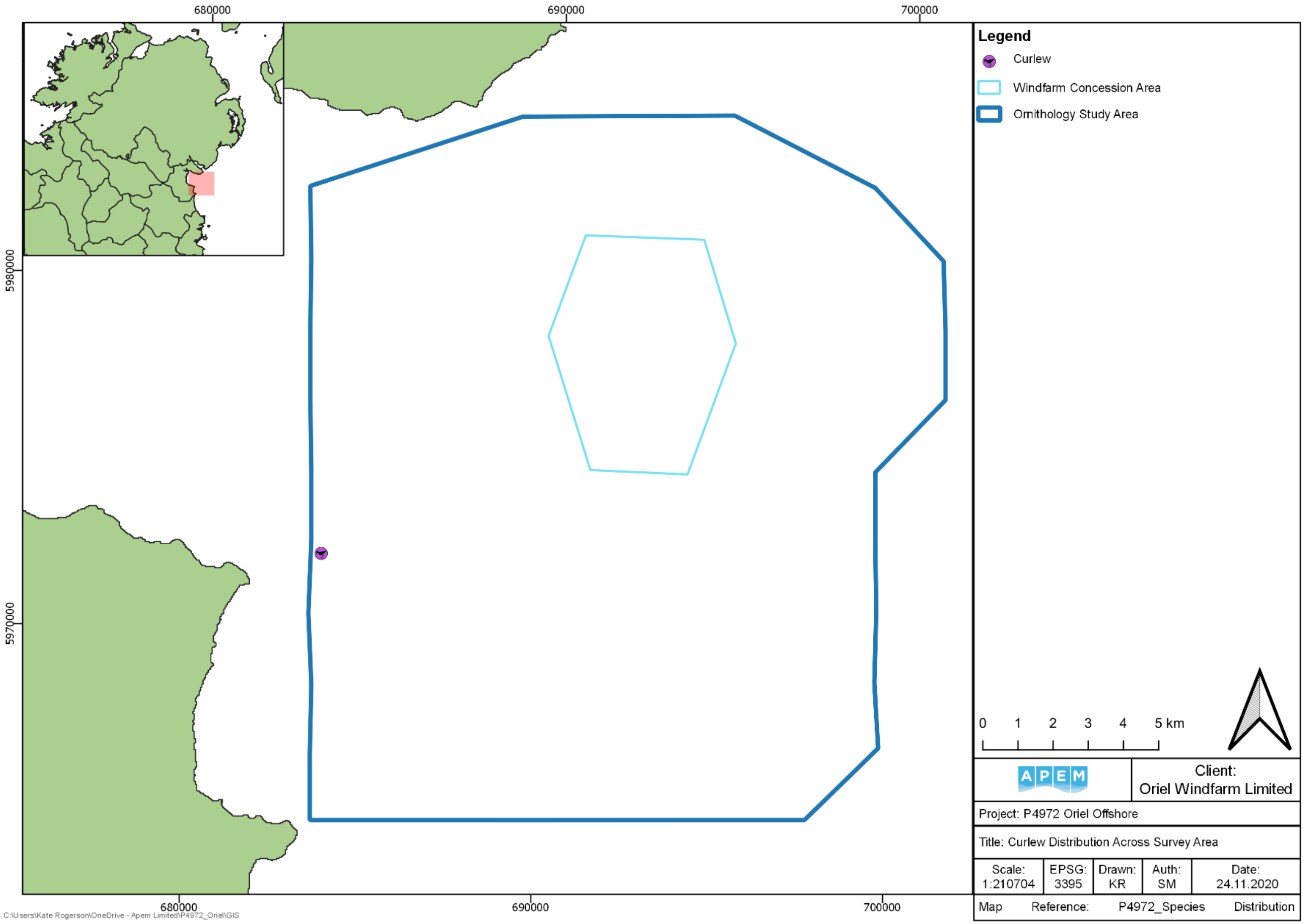


Figure 6 Peak distribution of curlew recorded across the Ornithology Study Area

5.4 Kittiwake

Overall 131 kittiwake were identified across the surveys, 41 in April 2020, 31 in May 2020, two in June 2020, 15 in July 2020, 18 in August 2020 and 24 in September 2020 surveys.

A peak raw count of 40 in April resulted in an abundance estimate of 115 for the Ornithology Study area (**Table 8**).

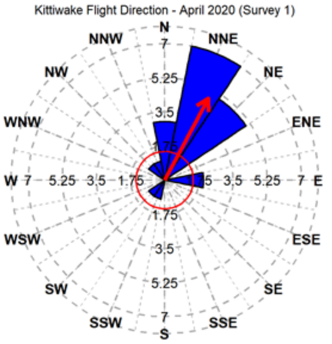
Flying kittiwake were recorded in all six surveys; in April 2020, flying kittiwake were significantly orientated around the mean of 28°; in July 2020, flying kittiwake were significantly orientated around the mean of 316°; in September 2020, flying kittiwake were significantly orientated around the mean of 260° (Rayleigh test, p=<0.05, **Figure 7**).

In April, May, June, July, August and September 2020; two, five, one, three, 10 and seven flying kittiwakes deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 43.95 m above MSL (**Figure 8**).

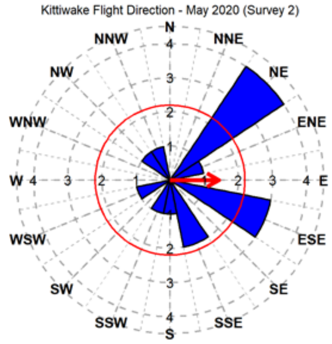
Kittiwake were recorded across the Ornithology Study area (**Figure 9**).

Table 8 Raw counts and abundance and density estimates (No. estimated individuals per km2) of kittiwake in: a) Windfarm Concession area; and b) Ornithology Study area

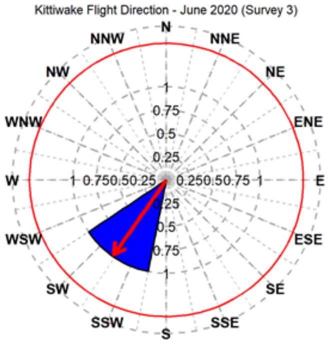
a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	7	19	7	40	0.37796	0.69
May-2020	15	41	15	96	0.2582	1.48
July-2020	4	11	4	33	0.5	0.4
September-2020	6	17	6	50	0.40825	0.61
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	40	115	43	205	0.15811	0.36
May-2020	29	84	29	168	0.1857	0.26
June-2020	1	3	1	9	1	0.01
July-2020	13	37	13	66	0.27735	0.12
August-2020	18	52	32	72	0.2357	0.16
September-2020	20	58	29	96	0.22361	0.18


Kittiwake Flight Direction - April 2020 (Survey 1)

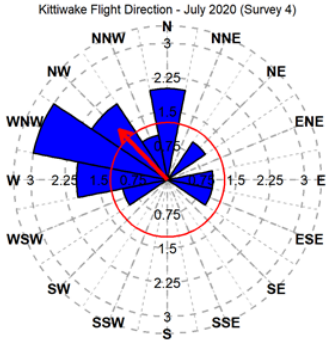
Number of Observations = 21
Mean Vector = 28.367
Length of mean vector (r) = 0.675
Rayleigh Test (Z) = 9.574
Rayleigh Test (p) = <0.001


Kittiwake Flight Direction - May 2020 (Survey 2)

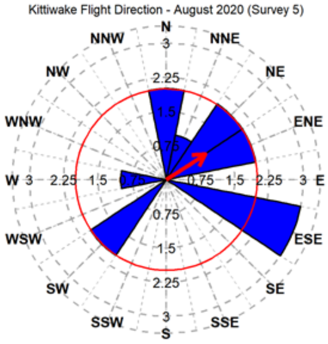
Number of Observations = 15
Mean Vector = 90.193
Length of mean vector (r) = 0.357
Rayleigh Test (Z) = 1.917
Rayleigh Test (p) = 0.148


Kittiwake Flight Direction - June 2020 (Survey 3)

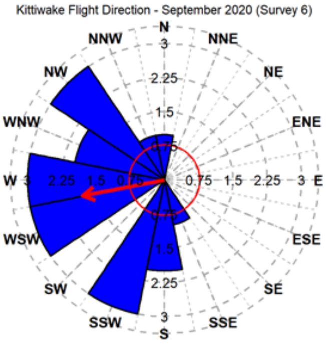
Number of Observations = 2
Mean Vector = 215.318
Length of mean vector (r) = 0.977
Rayleigh Test (Z) = 1.908
Rayleigh Test (p) = 0.155


Kittiwake Flight Direction - July 2020 (Survey 4)

Number of Observations = 14
Mean Vector = 316.808
Length of mean vector (r) = 0.503
Rayleigh Test (Z) = 3.535
Rayleigh Test (p) = 0.026


Kittiwake Flight Direction - August 2020 (Survey 5)

Number of Observations = 13
Mean Vector = 57.042
Length of mean vector (r) = 0.341
Rayleigh Test (Z) = 1.510
Rayleigh Test (p) = 0.224


Kittiwake Flight Direction - September 2020 (Survey 6)

Number of Observations = 19
Mean Vector = 259.508
Length of mean vector (r) = 0.607
Rayleigh Test (Z) = 7.011
Rayleigh Test (p) = <0.001

Figure 7 Summary of flight direction of kittiwake for all six surveys

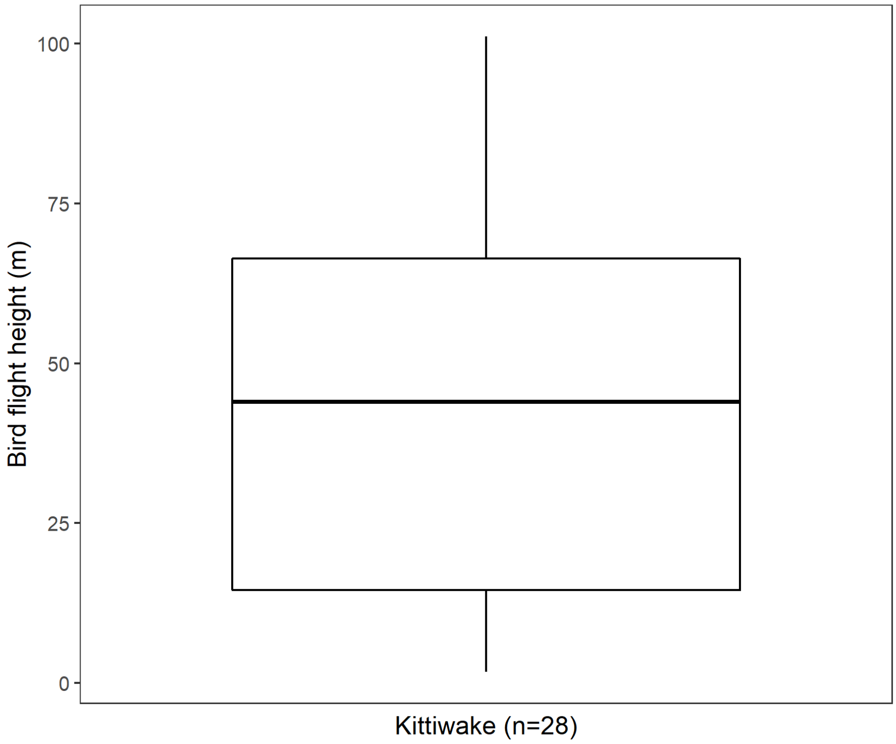


Figure 8 Flight heights of kittiwake (n=28) recorded in the Ornithology Study area

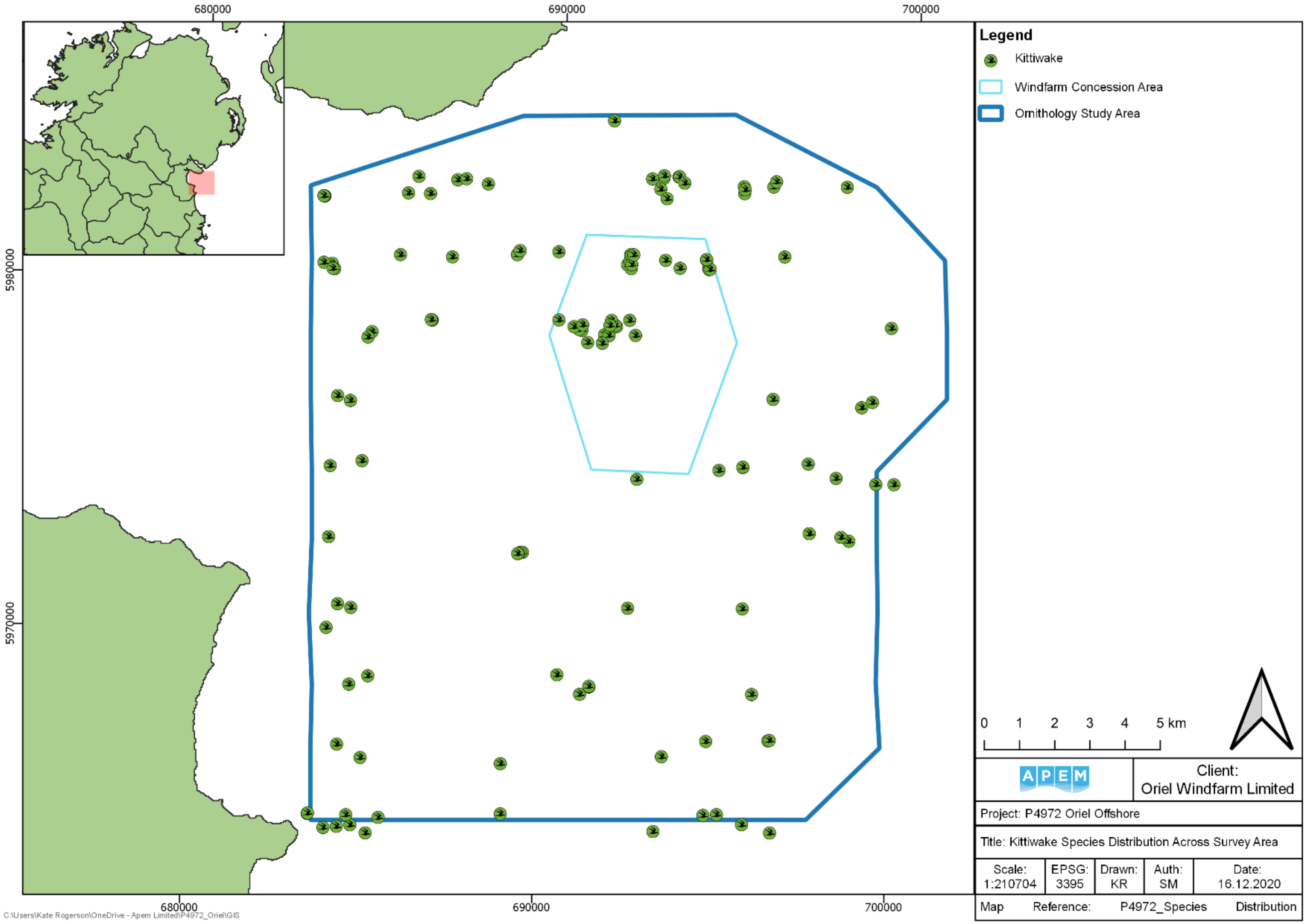


Figure 9 Peak distribution of kittiwake recorded across the Ornithology Study Area

5.5 Black-headed Gull

During the April 2020 survey, two black-headed gull were identified. Black-headed Gull were not recorded in the May 2020, June 2020, July 2020, August 2020 and September surveys.

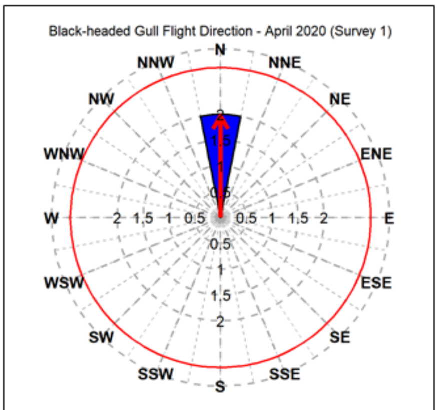
The peak count of two black-headed gulls resulted in an abundance estimate of five for the Windfarm Concession area and wider Ornithology Study area (**Table 9**).

The black-headed gulls were recorded flying in a northerly direction (**Figure 10**).

The black-headed gulls were recorded in the northeast of the Windfarm Concession area (**Figure 11**).

Table 9 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of black-headed gull in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	2	5	2	16	0.70711	0.18
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	2	6	2	17	0.70711	0.02



Number of Observations = 2
Mean Vector = 0.726
Length of mean vector (r) = 0.985
Rayleigh Test (Z) = 1.940
Rayleigh Test (p) = 0.149

Figure 10 Summary of flight direction of black-headed gulls for April 2020 survey

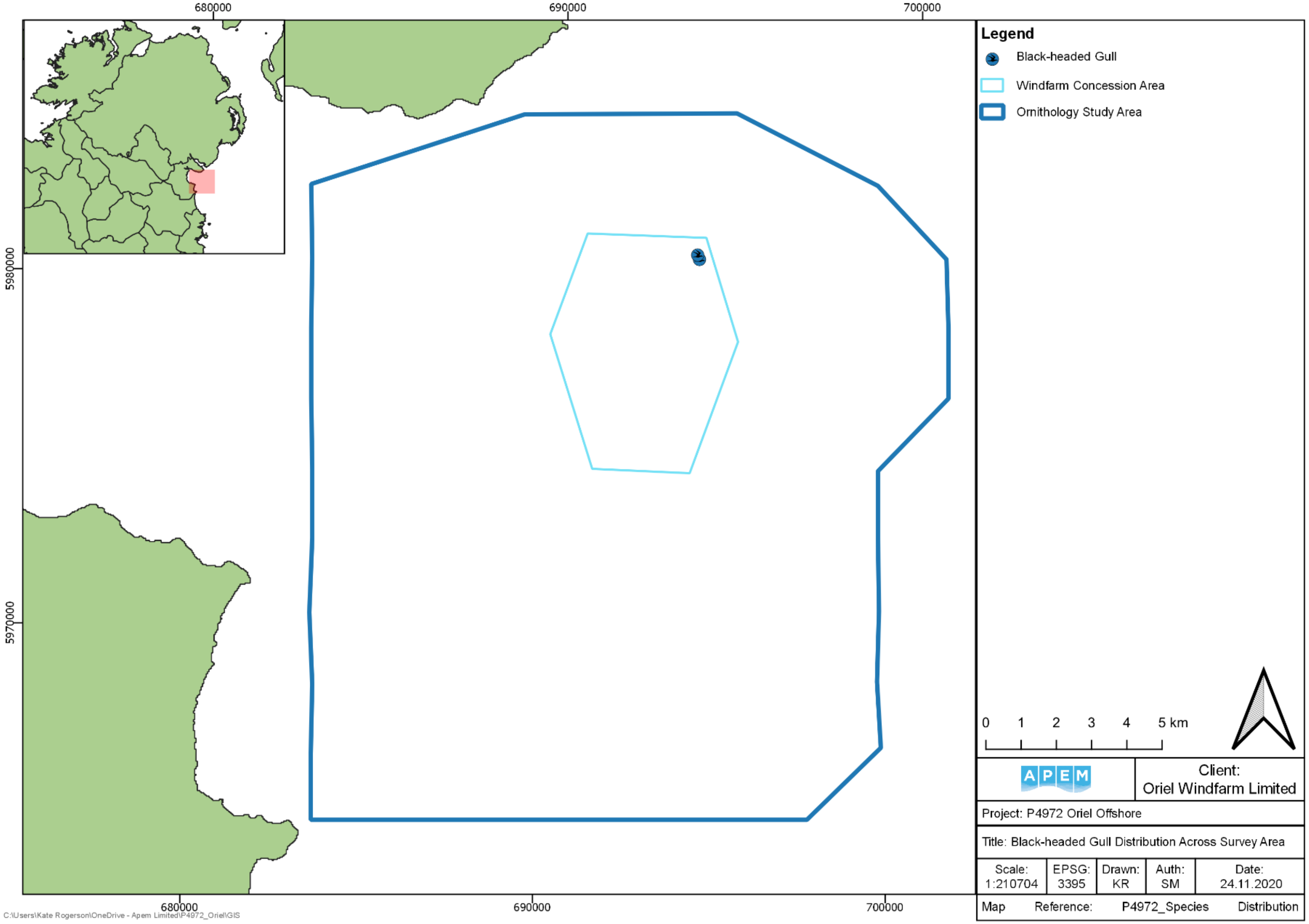


Figure 11 Location of black-headed gulls recorded in the Ornithology Study Area

5.6 Little Gull

During the September 2020 survey, one little gull was identified. Little gull were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The count of one little gull resulted in an abundance estimate of three for the Ornithology Study area (**Table 10**).

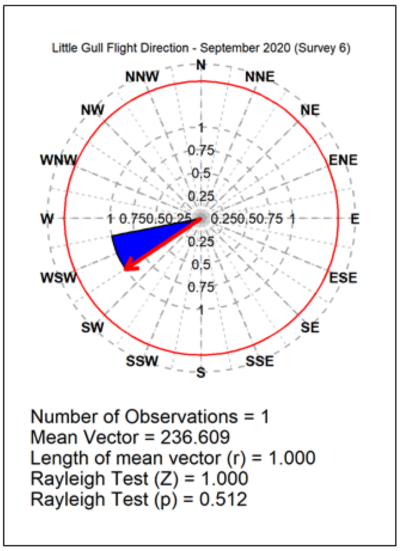
The little gull was recorded flying in a south-westerly direction (**Figure 12**).

The one flying little gull deemed suitable for flight height determination was recorded, with an altitude of 60.2 m above MSL.

The little gull was recorded on the western edge of the Ornithology Study area (**Figure 13**) .

Table 10 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of little gull in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September -2020	1	3	1	9	1	0.01



Number of Observations = 1
Mean Vector = 236.609
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 12 Summary of flight direction of little gull for the September 2020 surveys.

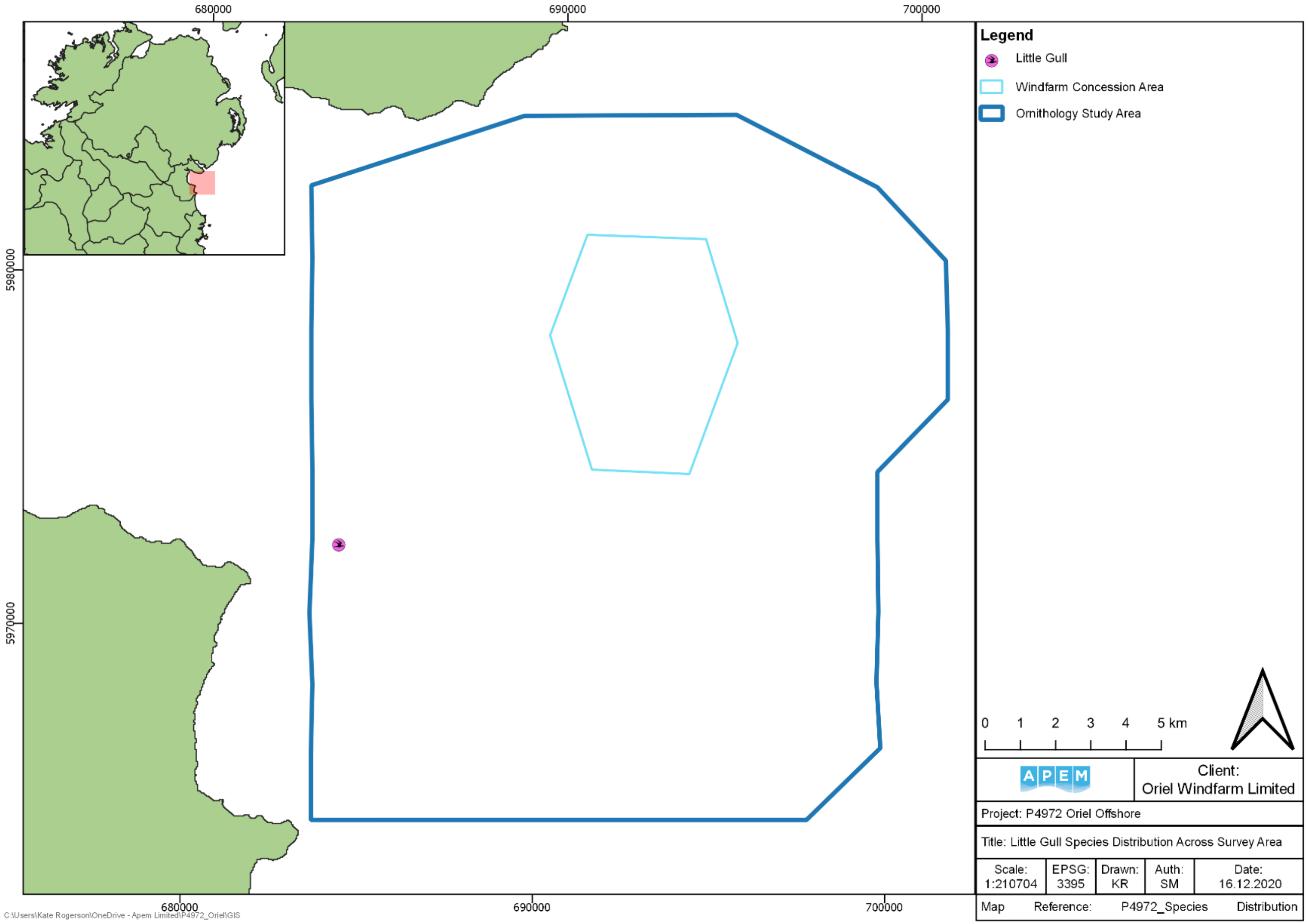


Figure 13 Location of little gull recorded in the Ornithology Study Area

5.7 Common Gull

Overall 9 common gull were identified, six in April 2020, two in May 2020, one in July 2020 surveys. Common gull were not recorded in the August 2020 and September survey.

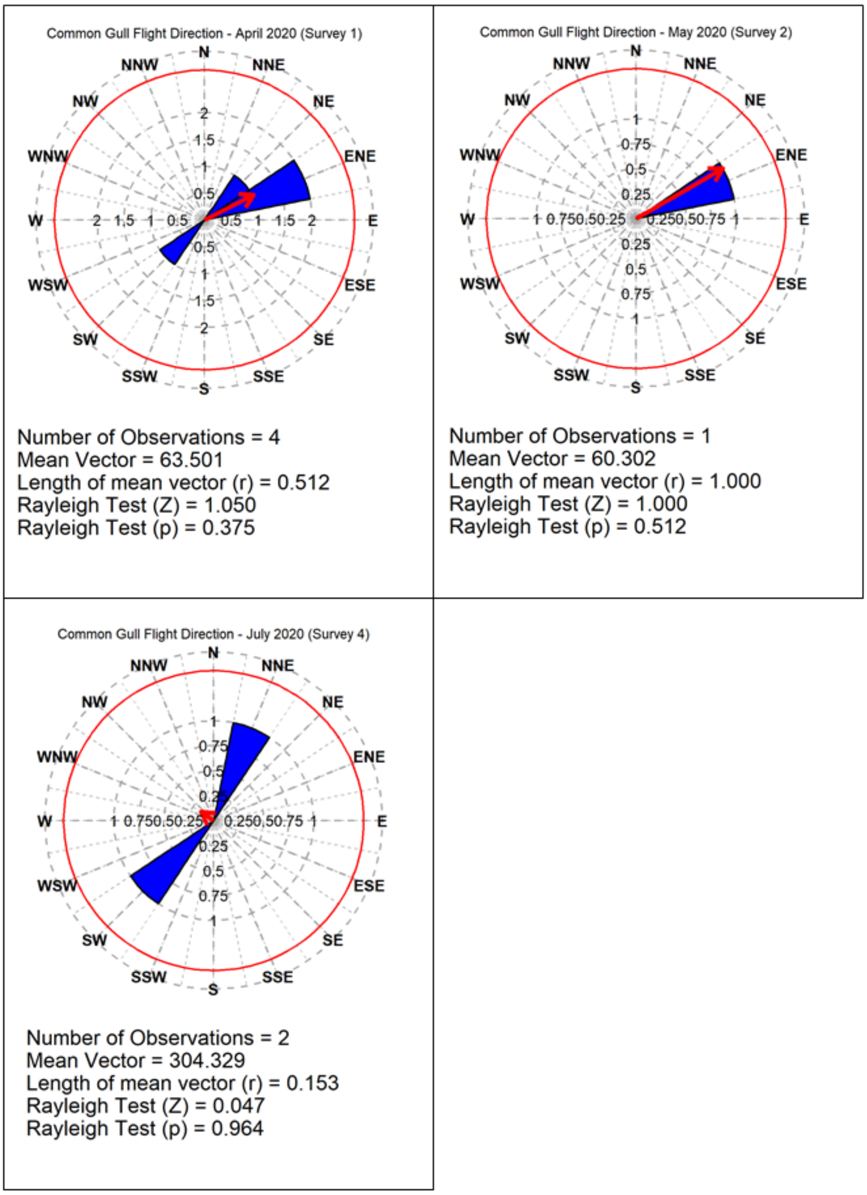
A peak raw count of three were recorded in the Ornithology Study area in April 2020 resulting in an abundance estimate of nine for the Ornithology Study Area (**Table 11**).

Flying common gull were recorded in April, May and July surveys although no significant orientations were identified (Rayleigh test, p=>0.05, **Figure 14**).

Common gulls were recorded across the western side of the Ornithology Study area. No common gulls were recorded in the Windfarm Concession area (**Figure 15**).

Table 11 Raw counts and abundance and density estimates (No. estimated individuals per km2) of common gull in: a) Windfarm Concession area; and b) Ornithology Study area

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	3	9	3	26	0.57735	0.03
July-2020	2	6	2	14	0.70711	0.02



Common Gull Flight Direction - April 2020 (Survey 1)

Number of Observations = 4
Mean Vector = 63.501
Length of mean vector (r) = 0.512
Rayleigh Test (Z) = 1.050
Rayleigh Test (p) = 0.375

Common Gull Flight Direction - May 2020 (Survey 2)

Number of Observations = 1
Mean Vector = 60.302
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Common Gull Flight Direction - July 2020 (Survey 4)

Number of Observations = 2
Mean Vector = 304.329
Length of mean vector (r) = 0.153
Rayleigh Test (Z) = 0.047
Rayleigh Test (p) = 0.964

Figure 14 Summary of flight direction of common gull for the April, May and July 2020 surveys

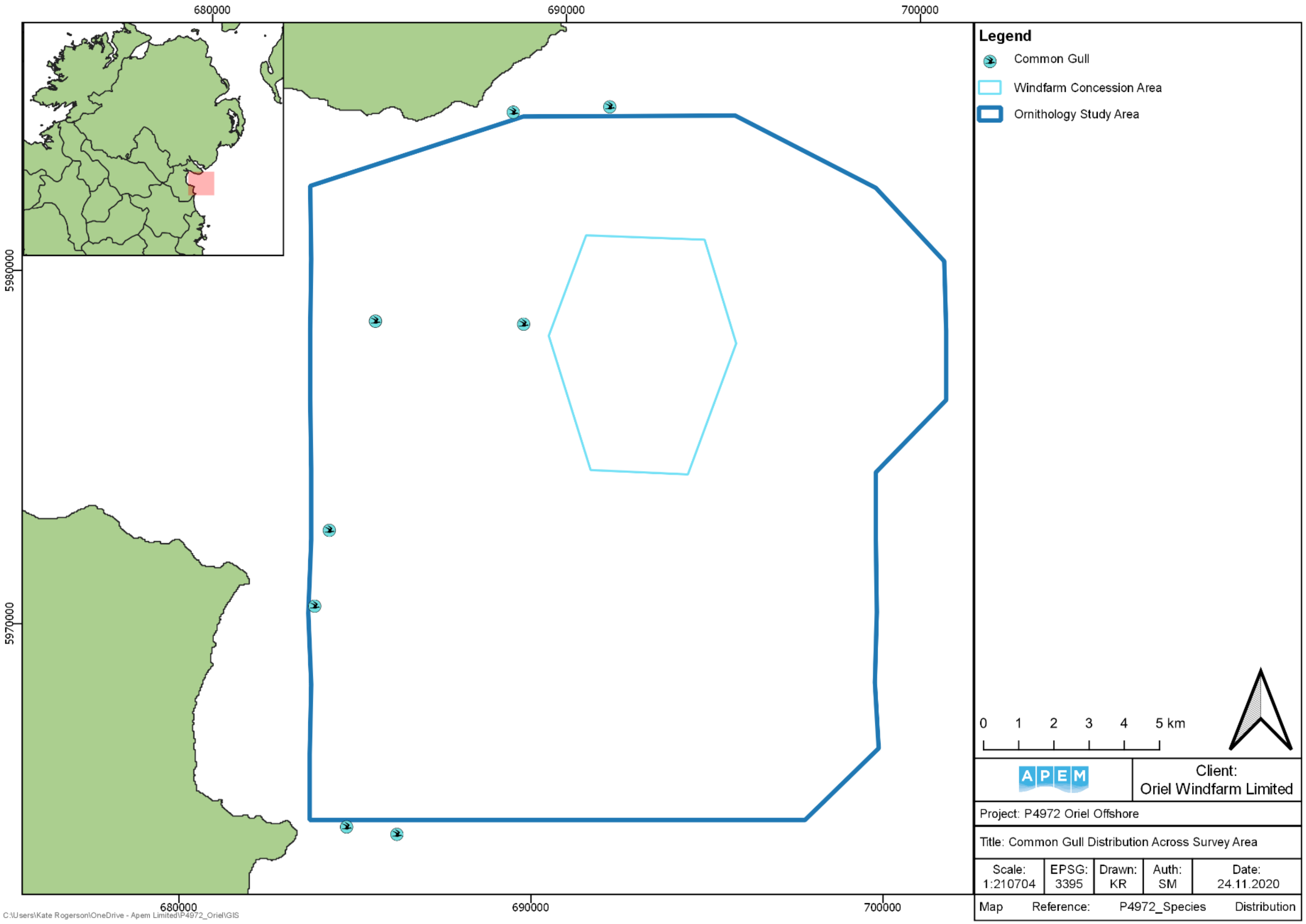


Figure 15 Distribution of common gulls recorded across the Ornithology Study Area

5.8 Great Black-backed Gull

Overall 142 great black-backed gull were identified, 43 in April 2020, 35 in May 2020, one in June 2020, 10 in July 2020, 37 in August 2020 and 16 in September 2020 surveys.

A peak count of 42 great black-backed gulls were recorded in April 2020 resulting in an abundance estimate of 121 for the Ornithology Study Area. A raw count of seven black-backed gulls recorded in the Windfarm Concession area in April 2020 resulting in an abundance estimate of 19 (**Table 12**).

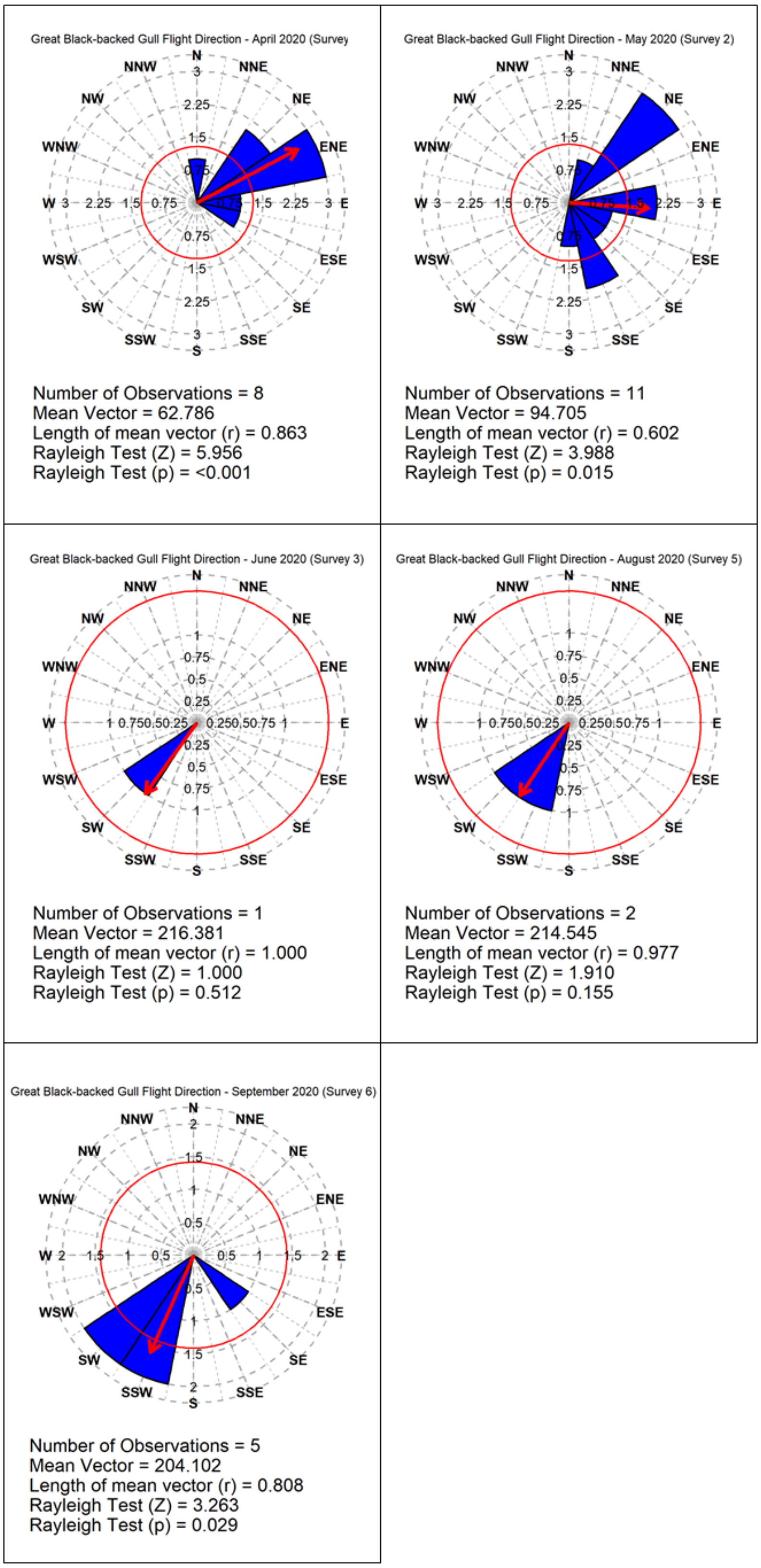
Flying great black-backed gulls were recorded in April, May, June , August and September surveys. Significant orientations were recorded: in April 2020, flying great black-backed gulls were significantly orientated around the mean of 62°; in May 2020, flying kittiwake were significantly orientated around the mean of 94°; in September 2020, flying kittiwake were significantly orientated around the mean of 204° (Rayleigh test, p=<0.05, **Figure 16**).

One flying great black-backed gull deemed suitable for flight height determination was recorded, with an altitude of 4.5 m above MSL.

Great black-backed gulls were distributed across the Ornithology Study area (**Figure 17**).

Table 12 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of great black-backed gull in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	7	19	7	48	0.37796	0.69
August-2020	34	93	34	278	0.1715	3.36
September-2020	11	30	11	91	0.30151	1.08
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	42	121	42	228	0.1543	0.38
May-2020	32	93	32	235	0.17678	0.29
June-2020	1	3	1	9	1	0.01
July-2020	7	20	7	55	0.37796	0.06
August-2020	36	103	36	299	0.16667	0.32
September-2020	15	44	15	108	0.2582	0.14


Great Black-backed Gull Flight Direction - April 2020 (Survey

Number of Observations = 8
Mean Vector = 62.786
Length of mean vector (r) = 0.863
Rayleigh Test (Z) = 5.956
Rayleigh Test (p) = <0.001

Great Black-backed Gull Flight Direction - May 2020 (Survey 2)

Number of Observations = 11
Mean Vector = 94.705
Length of mean vector (r) = 0.602
Rayleigh Test (Z) = 3.988
Rayleigh Test (p) = 0.015

Great Black-backed Gull Flight Direction - June 2020 (Survey 3)

Number of Observations = 1
Mean Vector = 216.381
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Great Black-backed Gull Flight Direction - August 2020 (Survey 5)

Number of Observations = 2
Mean Vector = 214.545
Length of mean vector (r) = 0.977
Rayleigh Test (Z) = 1.910
Rayleigh Test (p) = 0.155

Great Black-backed Gull Flight Direction - September 2020 (Survey 6)

Number of Observations = 5
Mean Vector = 204.102
Length of mean vector (r) = 0.808
Rayleigh Test (Z) = 3.263
Rayleigh Test (p) = 0.029

Figure 16 Summary of flight direction of great black-backed gull for the April, May, June, August and September 2020 surveys

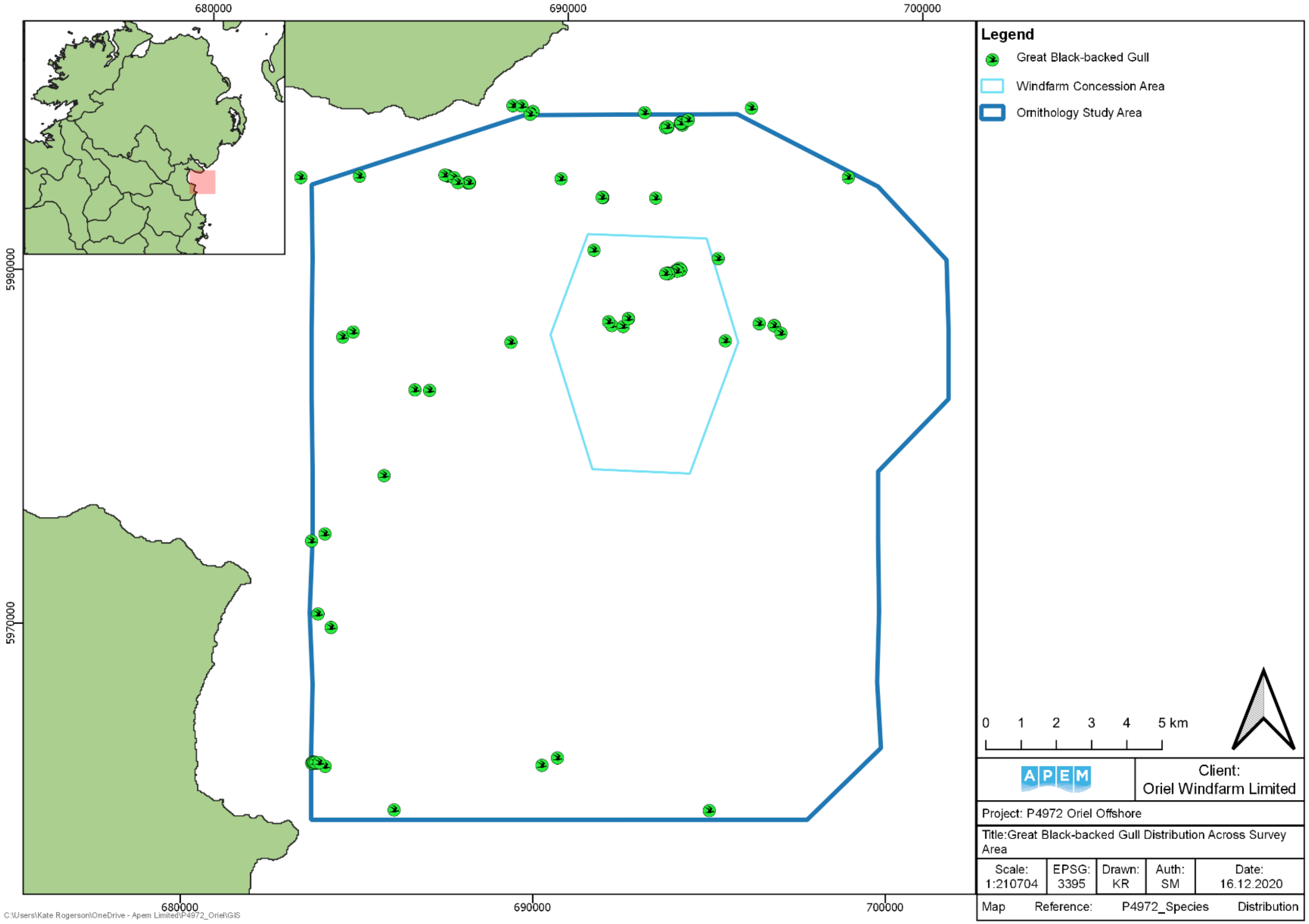


Figure 17 Distribution of great black-backed gull recorded across the Ornithology Study Area

5.9 Herring Gull

Overall 46 herring gull were identified, two in April 2020, 17 in May 2020, one in June 2020, 24 in July 2020, one in August 2020 and one in September 2020 surveys.

A peak raw count of 19 herring gulls in July 2020 resulted in an abundance estimate of 55 for the Ornithology Study area (**Table 13**).

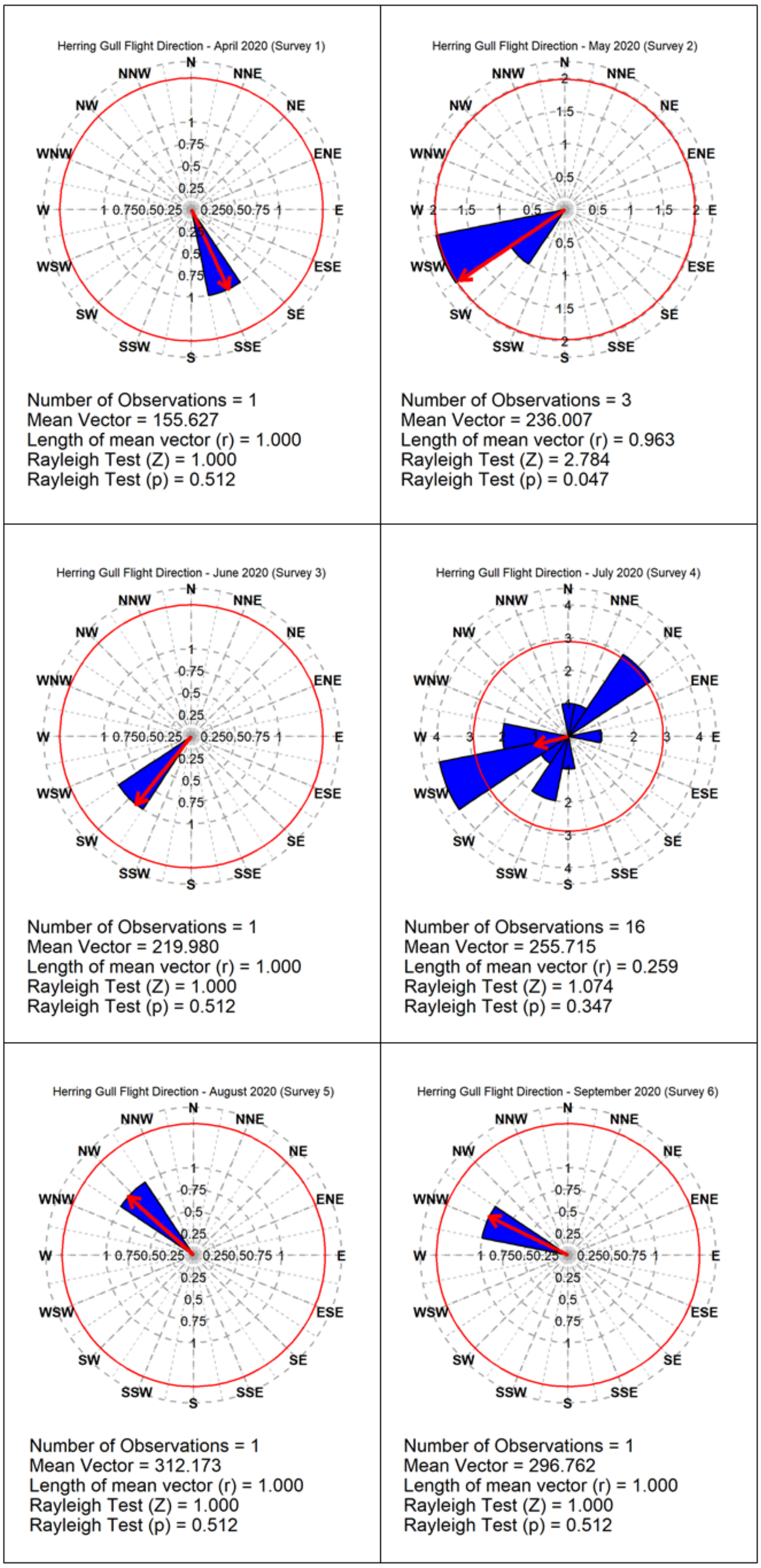
Flying herring gulls were found to have no significant direction of flight in any of the six surveys (**Figure 18**).

In May and July 2020; two and one flying herring gull deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 46 m above MSL (**Figure 19**).

Herring gulls showed no overall distribution pattern, and were distributed across the Ornithology Study area; only one herring gull was located within the Windfarm Concession area (**Figure 20**).

Table 13 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of herring gull in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	9	1	0.01
May-2020	13	38	13	78	0.27735	0.12
June-2020	1	3	1	9	1	0.01
July-2020	19	55	19	106	0.22942	0.17
August-2020	1	3	1	9	1	0.01
September-2020	1	3	1	9	1	0.01



Herring Gull Flight Direction - April 2020 (Survey 1)

Number of Observations = 1
Mean Vector = 155.627
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Herring Gull Flight Direction - May 2020 (Survey 2)

Number of Observations = 3
Mean Vector = 236.007
Length of mean vector (r) = 0.963
Rayleigh Test (Z) = 2.784
Rayleigh Test (p) = 0.047

Herring Gull Flight Direction - June 2020 (Survey 3)

Number of Observations = 1
Mean Vector = 219.980
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Herring Gull Flight Direction - July 2020 (Survey 4)

Number of Observations = 16
Mean Vector = 255.715
Length of mean vector (r) = 0.259
Rayleigh Test (Z) = 1.074
Rayleigh Test (p) = 0.347

Herring Gull Flight Direction - August 2020 (Survey 5)

Number of Observations = 1
Mean Vector = 312.173
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Herring Gull Flight Direction - September 2020 (Survey 6)

Number of Observations = 1
Mean Vector = 296.762
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 18 Summary of flight direction of herring gull during the six surveys

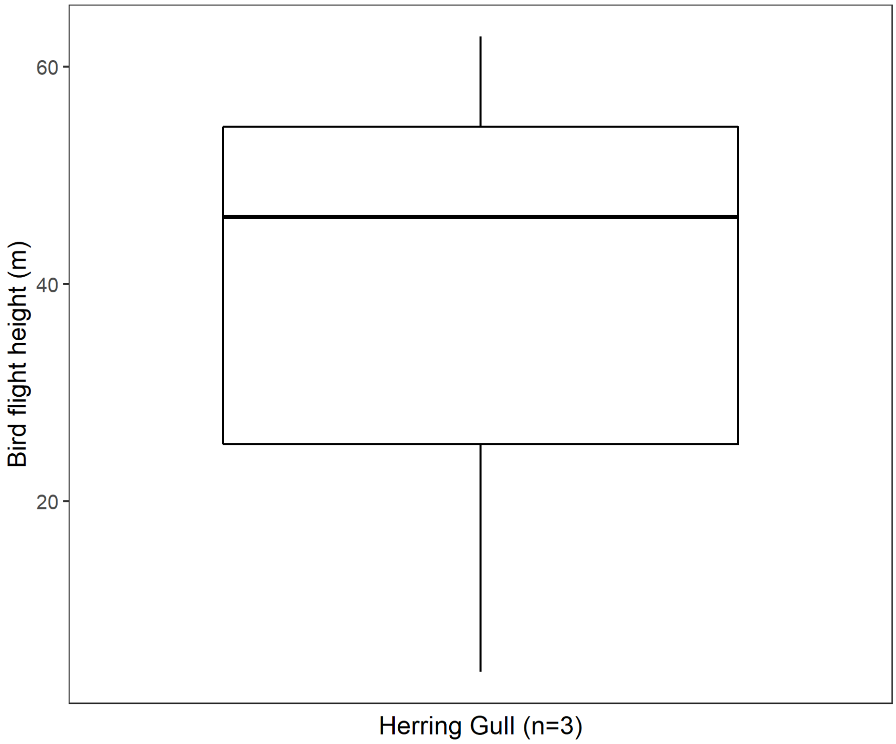


Figure 19 Flight heights of herring gull (n=3) recorded in the Ornithology Study area

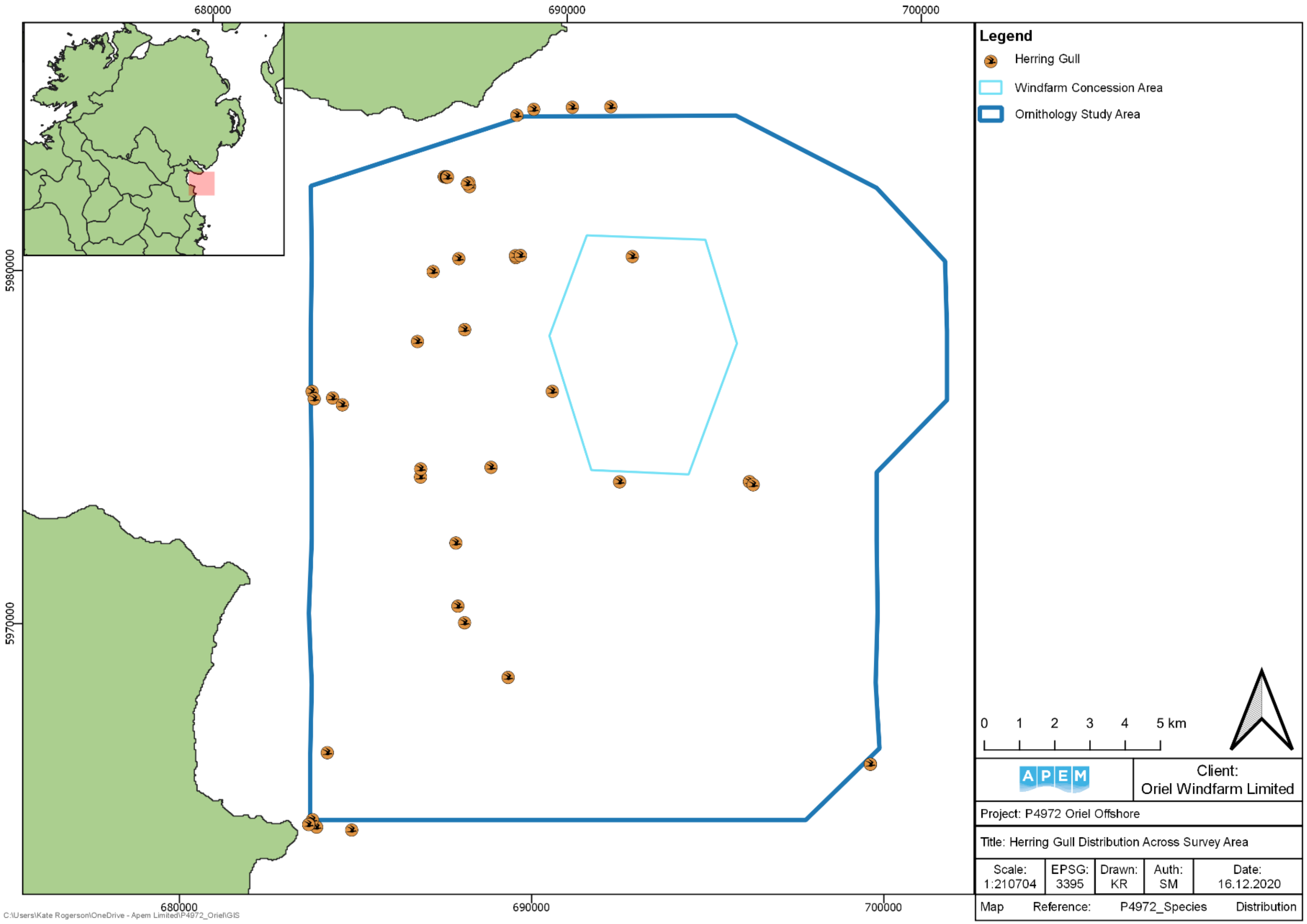


Figure 20 Distribution of herring gull recorded across the Ornithology Study Area

5.10 Lesser Black-backed Gull

Overall four lesser black-backed gull were identified, two in the May 2020, one in the July 2020 and one in the September 2020 surveys. Lesser black-backed gulls were not recorded in the June and August surveys.

The peak count of two lesser black-backed gulls in May 2020 resulted in an abundance estimate of 6 for the Ornithology Study area (**Table 14**).

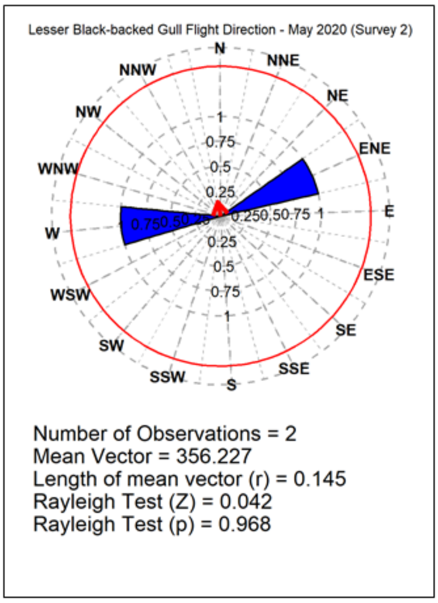
Two lesser black-backed gulls were recorded as flying in the May 2020 survey, although there was not a significant orientation (**Figure 21**).

In May 2020, one flying lesser black-backed gull deemed suitable for flight height determination was recorded, with an altitude of 13 m above MSL.

The lesser black-backed gulls were located in the western side of the Ornithology Study area (**Figure 22**). No lesser black-backed gulls were located in the Windfarm Concession area.

Table 14 Raw counts and abundance and density estimates (No. estimated individuals per km2) of lesser black-backed gull in: a) Windfarm Concession area; and b) Ornithology Study area

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
May-2020	2	6	2	14	0.71	0.02
July-2020	1	3	1	9	1	0.01
September -2020	1	3	1	9	1	0.01



Number of Observations = 2
Mean Vector = 356.227
Length of mean vector (r) = 0.145
Rayleigh Test (Z) = 0.042
Rayleigh Test (p) = 0.968

Figure 21 Summary of flight direction of lesser black-backed gull during the May 2020 survey

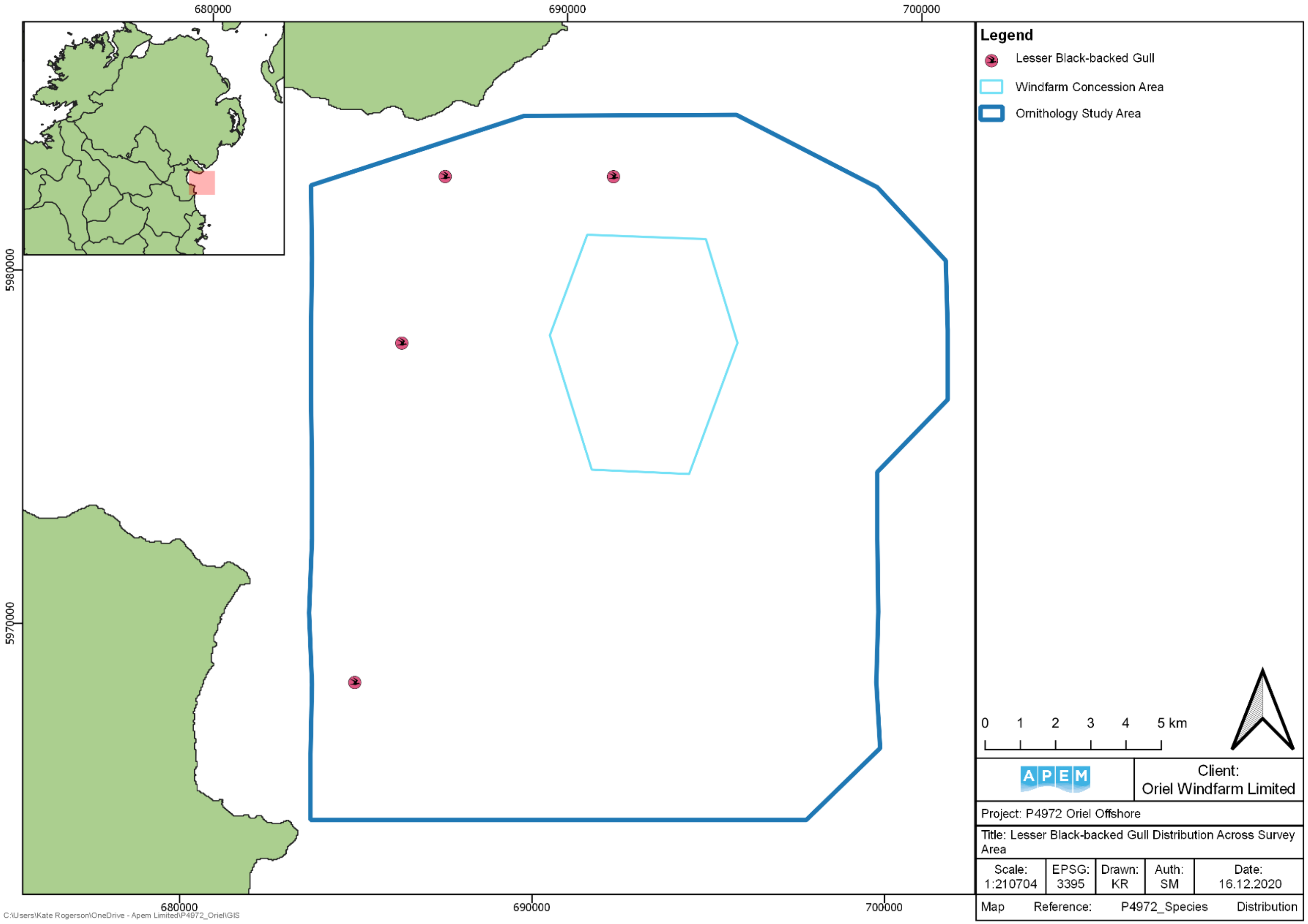


Figure 22 Location of lesser black-backed gulls across the Ornithology Study area

5.11 Gull species – unidentified

Overall, six unidentified gull species were recorded, two during the May 2020, two in the August 2020 and two in the September surveys. Unidentified gull species were not recorded in the April 2020, June 2020 and July 2020 surveys.

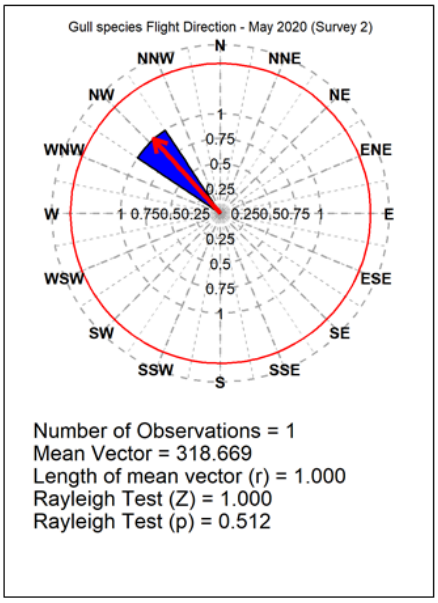
A peak raw count of two unidentified gull species resulted in an abundance estimate of six for the Ornithology Study area (**Table 15**).

One unidentified gull species individual was recorded as flying in a northwest direction (**Figure 23**).

During the May survey, the two unidentified gull species were recorded along the northern edge of the Ornithology Study area; during the August survey one was recorded in the north while the other was recorded to the southwest of the Windfarm Concession area; during the September survey the gulls were recorded to the west and south of the Windfarm Concession area. No unidentified gull species were recorded in the Windfarm Concession area (**Figure 24**).

Table 15 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of gull species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	1	3	1	9	1	0.01
August-2020	2	6	2	14	0.70711	0.02
September-2020	2	6	2	15	0.70711	0.02



Number of Observations = 1
Mean Vector = 318.669
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 23 Summary of flight direction of unidentified gull species during the May 2020 survey

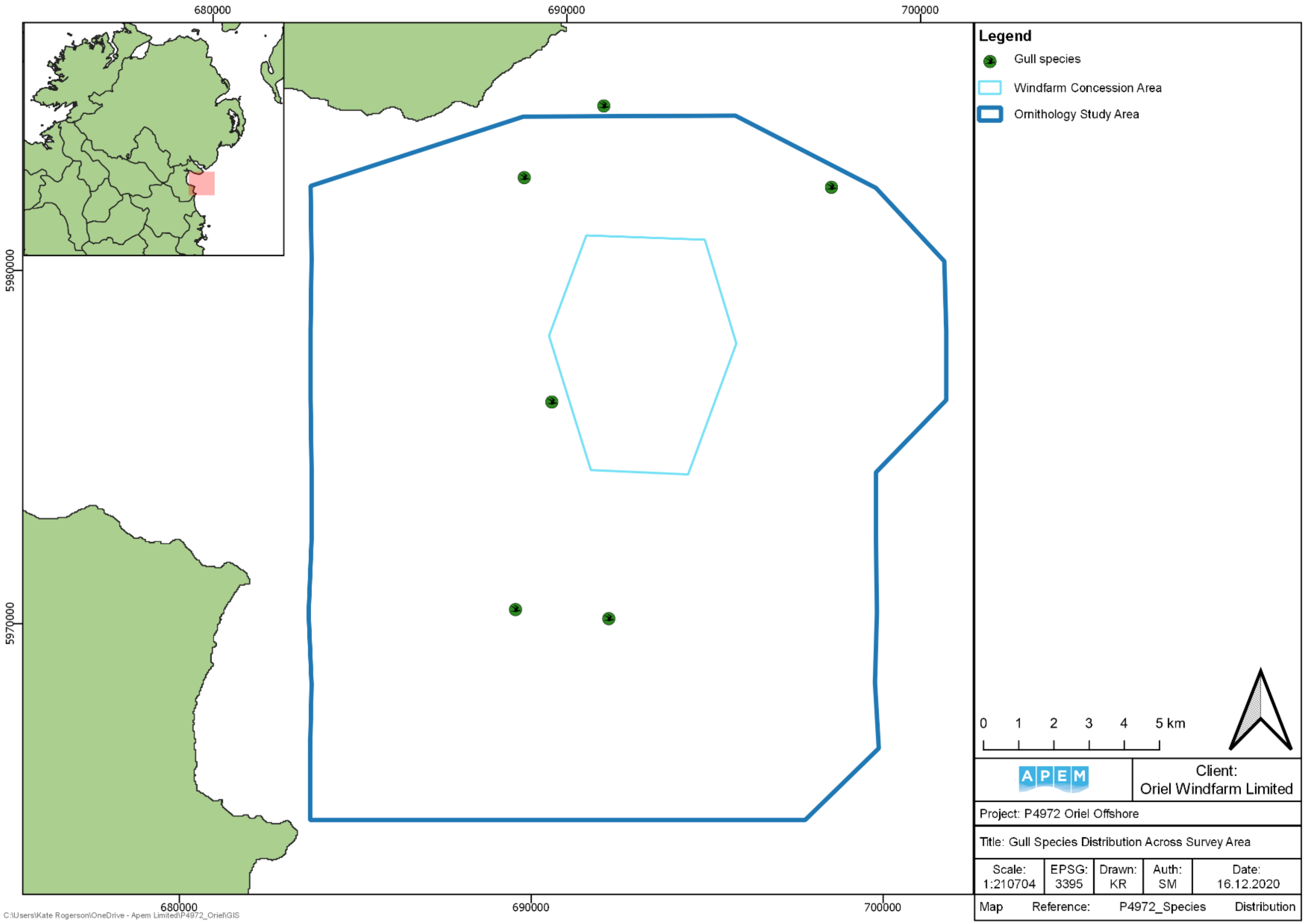


Figure 24 Location of unidentified gull species across the Ornithology Study area

5.12 Small Gull Species – unidentified

Overall 11 unidentified small gull species were identified, one in April 2020, six in May 2020, three in August 2020 and one in September 2020 surveys.

The peak count of six unidentified small gull species in May 2020 resulted in an abundance estimate of 17 for the Ornithology Study Area (**Table 16**).

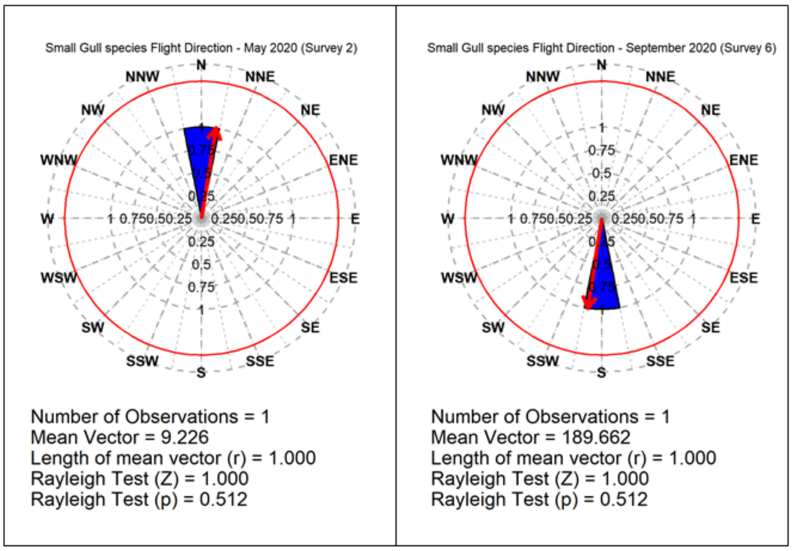
In April, one unidentified small gull species was recorded as flying, the orientation was northerly, while in September, one flying unidentified small gull species was recorded as flying in a southerly direction (**Figure 25**).

Unidentified small gull species showed no overall distribution pattern, and were distributed across the Ornithology Study area (**Figure 26**).

Table 16 Raw counts and abundance and density estimates (No. estimated individuals per km2) of small gull species in: a) Windfarm Concession area; and b) Ornithology Study area

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	2	5	2	11	0.70711	0.18
September-2020	1	3	1	8	1	0.11

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	9	1	0.01
May-2020	6	17	9	26	0.40825	0.05
August-2020	3	9	3	20	0.57735	0.03
September-2020	1	3	1	9	1	0.01



Small Gull species Flight Direction - May 2020 (Survey 2)

Number of Observations = 1
Mean Vector = 9.226
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Small Gull species Flight Direction - September 2020 (Survey 6)

Number of Observations = 1
Mean Vector = 189.662
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 25 Summary of flight direction of unidentified small gull species during the May and September 2020 survey

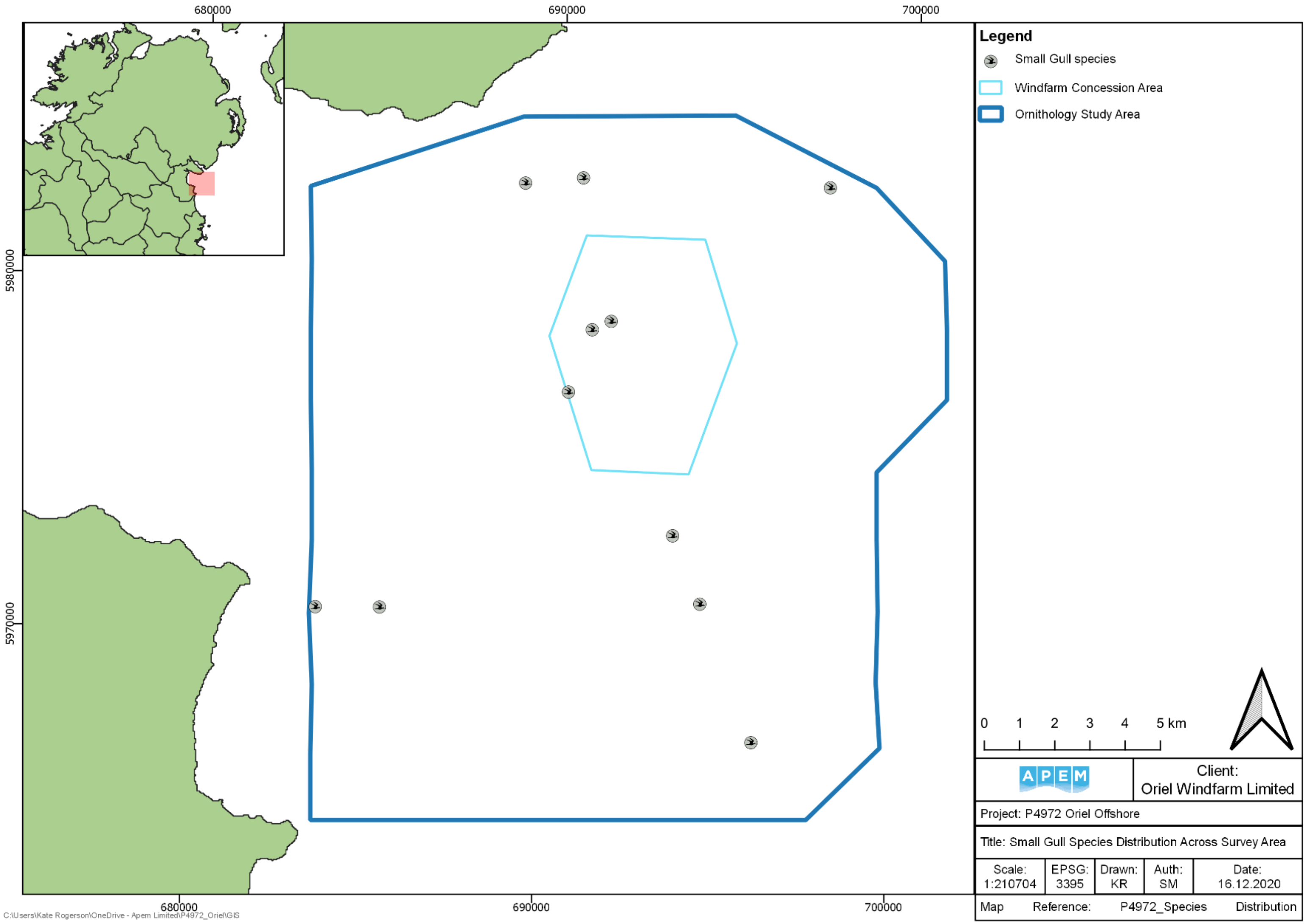


Figure 26 Distribution of unidentified small gull species across the Ornithology Study Area

5.13 Large Gull Species – unidentified

During the September 2020 survey, one unidentified large gull species was recorded. Unidentified large gull species were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The peak count of one unidentified large gull species in September 2020 resulted in an abundance estimate of three for the Ornithology Study Area (**Table 17**).

The large gull species was recorded in the southeast of the Ornithology Study Area (**Figure 27**).

Table 17 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of unidentified large gull species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	1	3	1	9	1	0.01

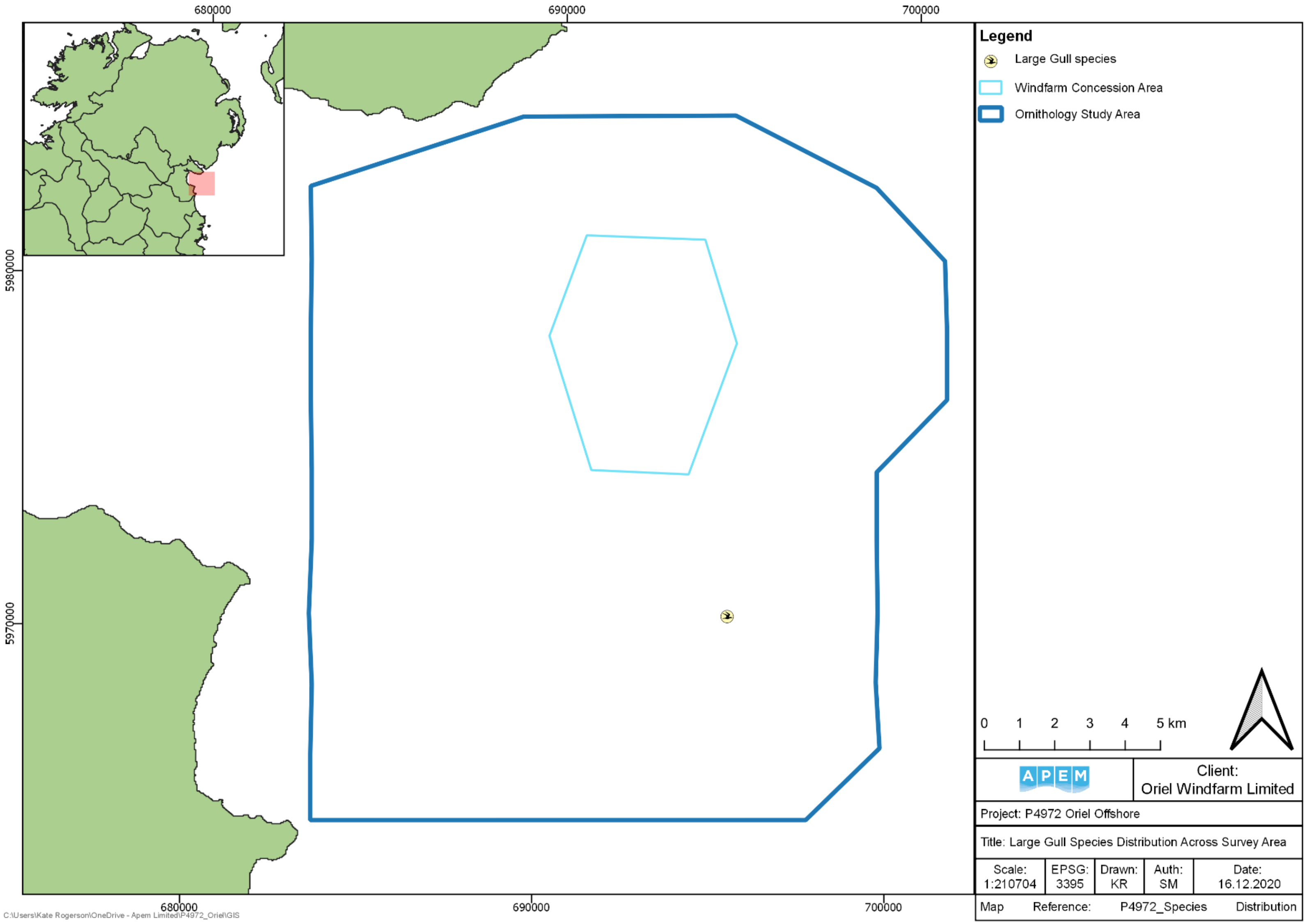


Figure 27 Location of unidentified large gull species across the Ornithology Study area

5.14 Sandwich Tern

Overall 13 sandwich tern were identified across the surveys, three in April 2020, two in May 2020, three in June 2020, one in July 2020, one in August 2020 and three in the September surveys.

The peak count of three sandwich terns in April 2020 resulted in an abundance estimate of nine for the Ornithology Study Area (**Table 18**).

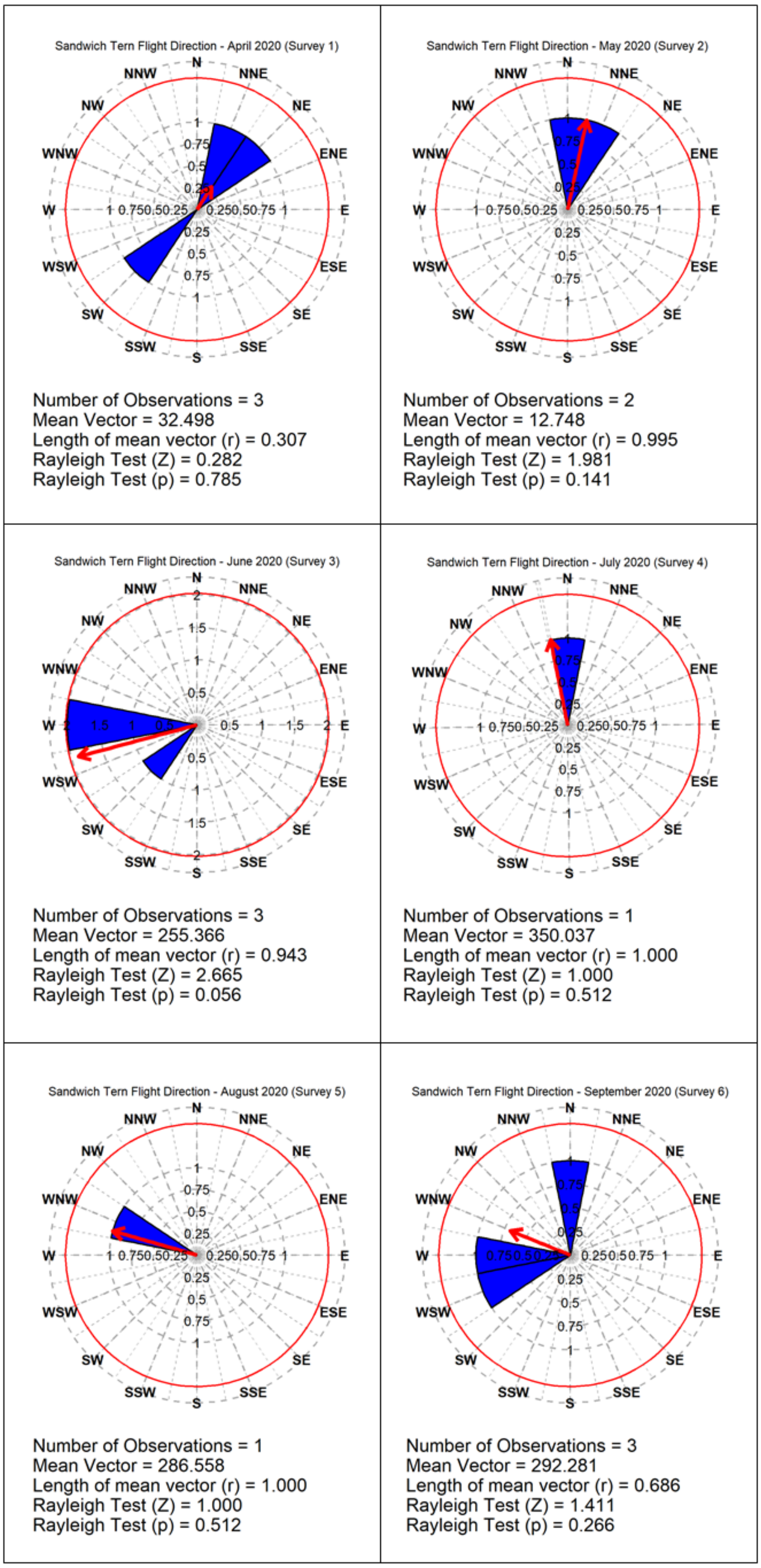
Flying sandwich terns were recorded in all six of the surveys although there was not a significant orientation (**Figure 28**).

In April and September 2020, one and one flying sandwich tern deemed suitable for flight height determination were recorded respectively, the altitude was 60 m above MSL in April and 7 m in September.

Sandwich terns were recorded along in the western edge of the Ornithology area and in the northwest corner of the Ornithology study area (**Figure 29**). One sandwich tern was recorded in the Windfarm Concession area during the September 2020 survey.

Table 18 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of sandwich tern in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
September-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	3	9	3	23	0.57735	0.03
May-2020	1	3	1	9	1	0.01
June-2020	1	3	1	9	1	0.01
July-2020	1	3	1	9	1	0.01
September-2020	3	9	3	18	0.57735	0.03



Sandwich Tern Flight Direction - April 2020 (Survey 1)

Number of Observations = 3
Mean Vector = 32.498
Length of mean vector (r) = 0.307
Rayleigh Test (Z) = 0.282
Rayleigh Test (p) = 0.785

Sandwich Tern Flight Direction - May 2020 (Survey 2)

Number of Observations = 2
Mean Vector = 12.748
Length of mean vector (r) = 0.995
Rayleigh Test (Z) = 1.981
Rayleigh Test (p) = 0.141

Sandwich Tern Flight Direction - June 2020 (Survey 3)

Number of Observations = 3
Mean Vector = 255.366
Length of mean vector (r) = 0.943
Rayleigh Test (Z) = 2.665
Rayleigh Test (p) = 0.056

Sandwich Tern Flight Direction - July 2020 (Survey 4)

Number of Observations = 1
Mean Vector = 350.037
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Sandwich Tern Flight Direction - August 2020 (Survey 5)

Number of Observations = 1
Mean Vector = 286.558
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Sandwich Tern Flight Direction - September 2020 (Survey 6)

Number of Observations = 3
Mean Vector = 292.281
Length of mean vector (r) = 0.686
Rayleigh Test (Z) = 1.411
Rayleigh Test (p) = 0.266

Figure 28 Summary of flight direction of sandwich tern during the six surveys

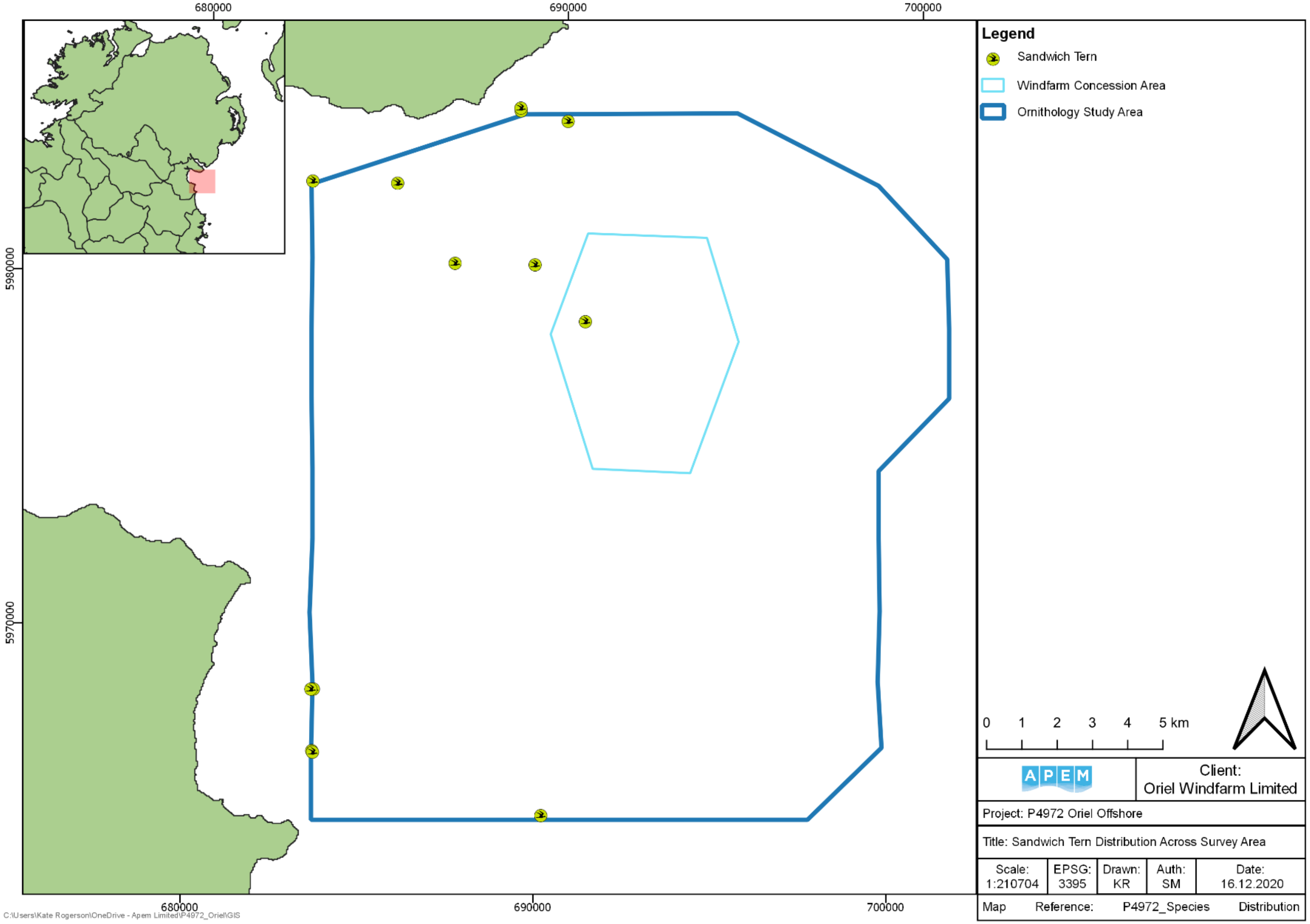


Figure 29 Distribution of sandwich tern recorded across the Ornithology Study area

5.15 Roseate Tern

During the July 2020 survey, one roseate tern were identified. Roseate tern were not recorded in the April 2020, May 2020, June 2020, August 2020 and September 2020 surveys.

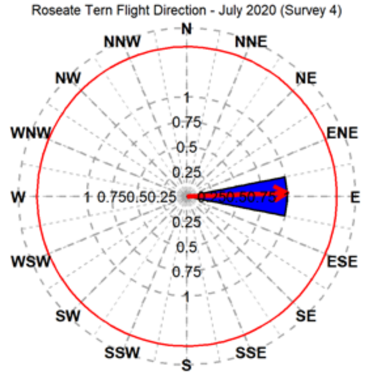
The peak count of one roseate tern produced an abundance estimate of three for the Ornithology Study Area (**Table 19**).

The roseate tern was recorded as flying in an easterly direction (**Figure 30**).

The roseate tern was recorded along the southern edge of the Ornithology Study area. No roseate terns were recorded in the Windfarm Concession area (**Figure 31**).

Table 19 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of roseate tern in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
July-2020	1	3	1	9	1	0.01



Number of Observations = 1
Mean Vector = 88.441
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 30 Summary of flight direction of roseate tern during the July survey

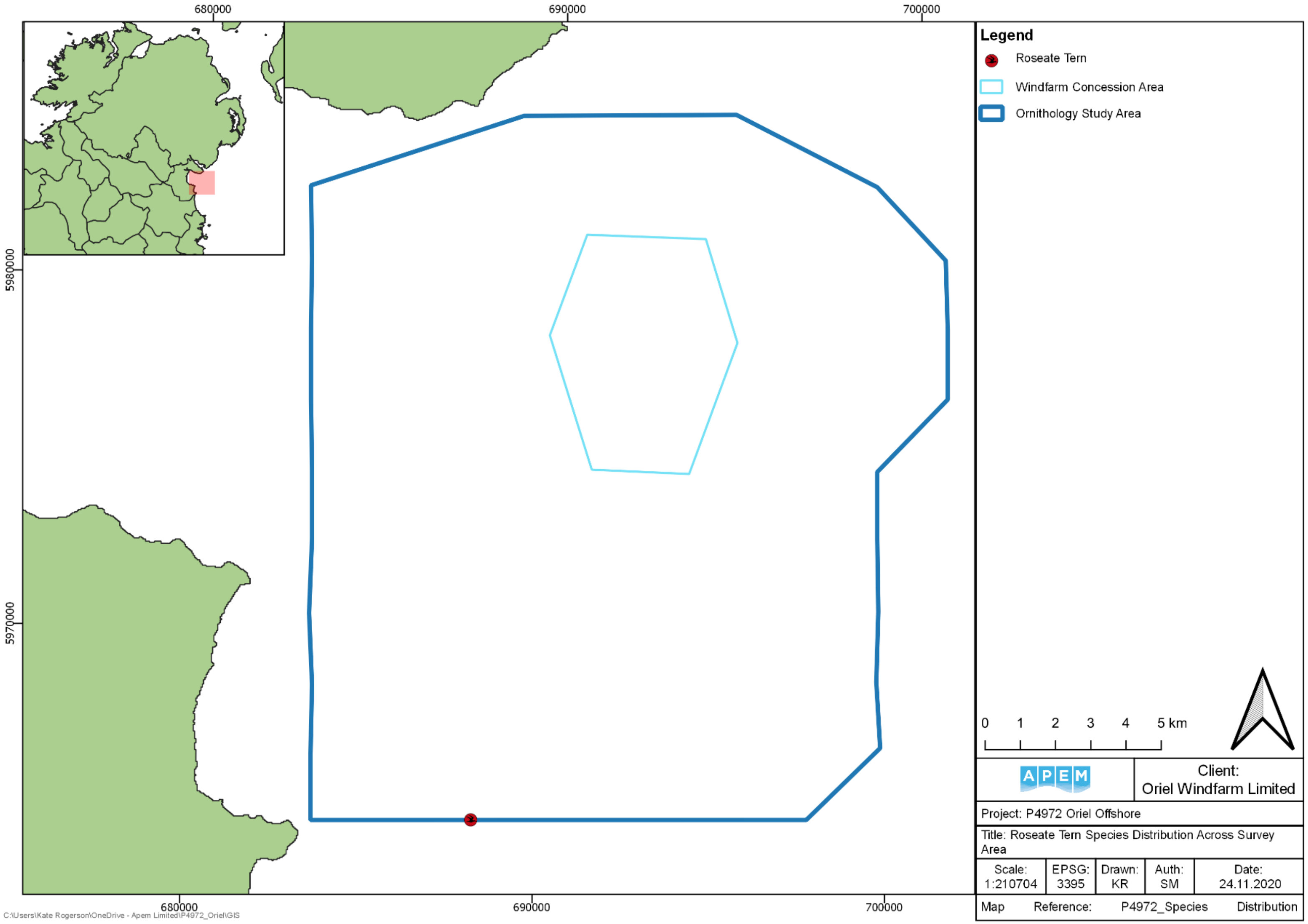


Figure 31 Location of roseate tern recorded in Ornithology Study area

5.16 Common Tern

During the September 2020 survey, seven common tern were identified. Common tern were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The peak count of five common terns resulted in an abundance estimate of 15 for the Ornithology Study area (**Table 20**).

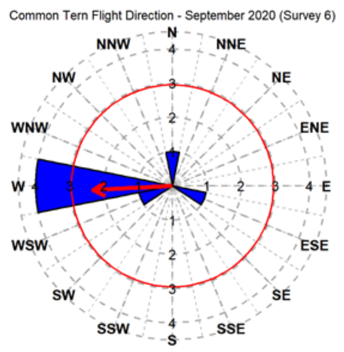
The common terns were recorded as flying, although there was not a significant orientation (**Figure 32**).

In September 2020 two flying common tern deemed suitable for flight height determination were recorded, with heights of 32 and 105 m above MSL.

Common tern were located within the Windfarm Concession Area and on the western boundary of the Ornithology Study Area (**Figure 33**).

Table 20 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of common tern in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
September-2020	2	6	2	17	0.70711	0.22
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
September-2020	5	15	5	32	0.44721	0.05



Number of Observations = 7
Mean Vector = 267.729
Length of mean vector (r) = 0.579
Rayleigh Test (Z) = 2.347
Rayleigh Test (p) = 0.093

Figure 32 Summary of flight direction of common tern during the September 2020 survey.

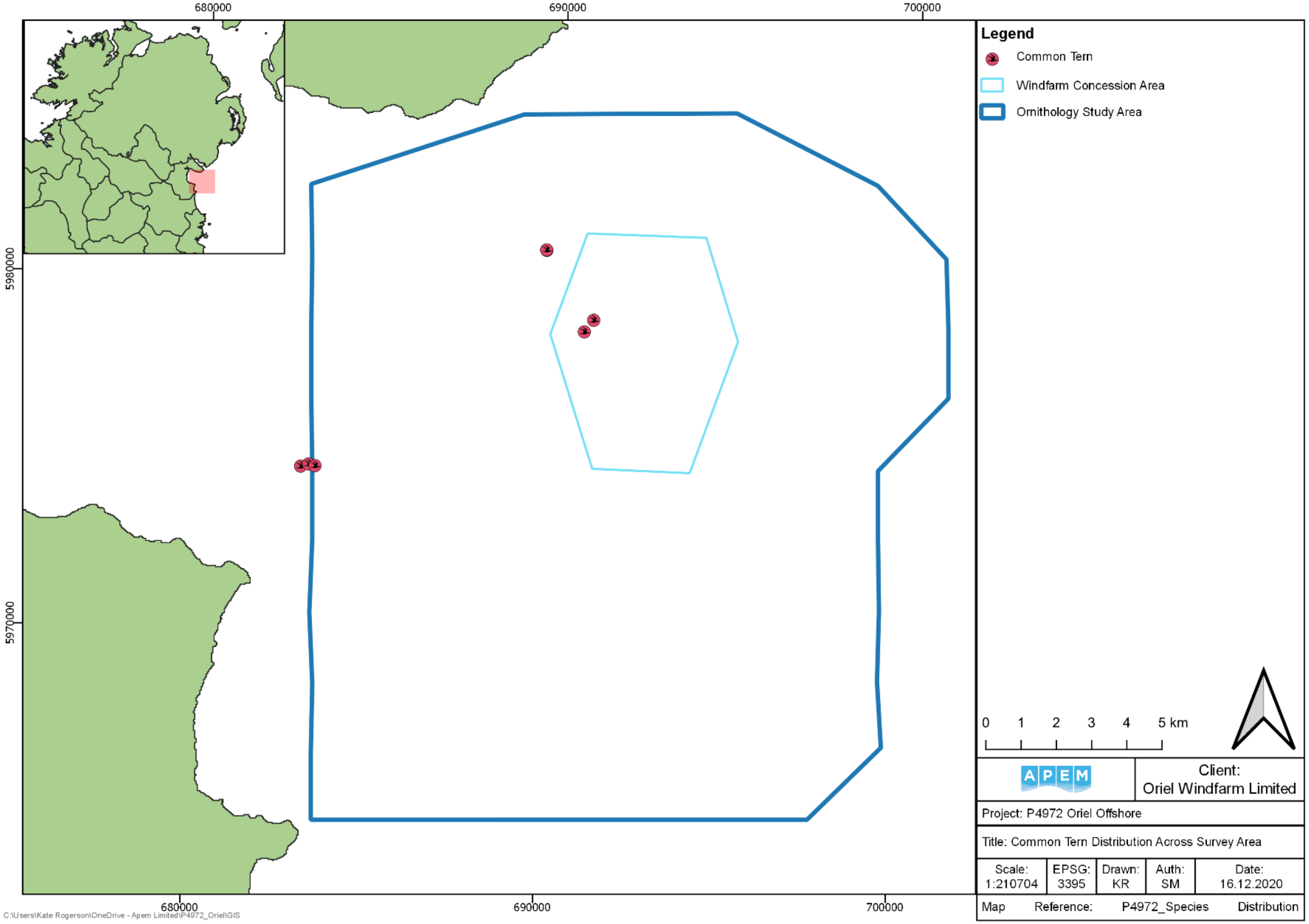


Figure 33 Distribution of common tern across the Ornithology Study Area.

5.17 Commic / Roseate Tern

Overall 11 commic / roseate tern were identified, five in June 2020, three in July 2020 and three in the September 2020 surveys. Commic / roseate tern were not recorded in the April 2020, May 2020 and August 2020 surveys.

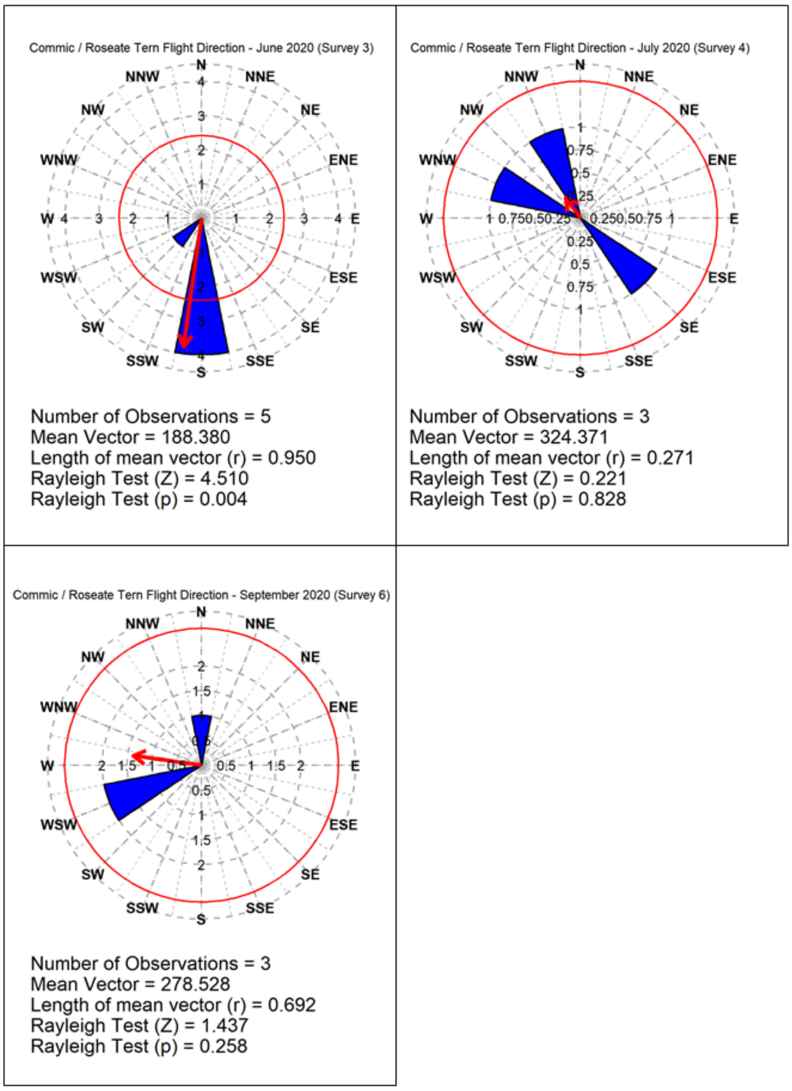
The peak count of five commic / roseate terns resulted in an abundance estimate of 14 for the Ornithology Study area (**Table 21**).

Five flying comic / roseate terns were recorded in the June 2020 survey with a significant orientation around the mean of 188° (Rayleigh test, p=<0.05, **Figure 34**). No significant direction of flying commic / roseate terns was recorded in July and September.

Commic / roseate tern showed no overall distribution pattern and were distributed across the Ornithology Study area (**Figure 35**), although there was a concentration of commic / roseate terns east of the Windfarm Concession area.

Table 21 Raw counts and abundance and density estimates (No. estimated individuals per km2) of commic / roseate tern in: a) Windfarm Concession area; and b) Ornithology Study area

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
July-2020	1	3	1	8	1	0.11
September-2020	2	6	2	17	0.70711	0.22
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	5	14	5	43	0.44721	0.04
July-2020	3	9	3	17	0.57735	0.03
September-2020	2	6	2	18	0.70711	0.02



Commic / Roseate Tern Flight Direction - June 2020 (Survey 3)

Number of Observations = 5
Mean Vector = 188.380
Length of mean vector (r) = 0.950
Rayleigh Test (Z) = 4.510
Rayleigh Test (p) = 0.004

Commic / Roseate Tern Flight Direction - July 2020 (Survey 4)

Number of Observations = 3
Mean Vector = 324.371
Length of mean vector (r) = 0.271
Rayleigh Test (Z) = 0.221
Rayleigh Test (p) = 0.828

Commic / Roseate Tern Flight Direction - September 2020 (Survey 6)

Number of Observations = 3
Mean Vector = 278.528
Length of mean vector (r) = 0.692
Rayleigh Test (Z) = 1.437
Rayleigh Test (p) = 0.258

Figure 34 Summary of flight direction of commic / roseate tern during the June, July and September 2020 surveys

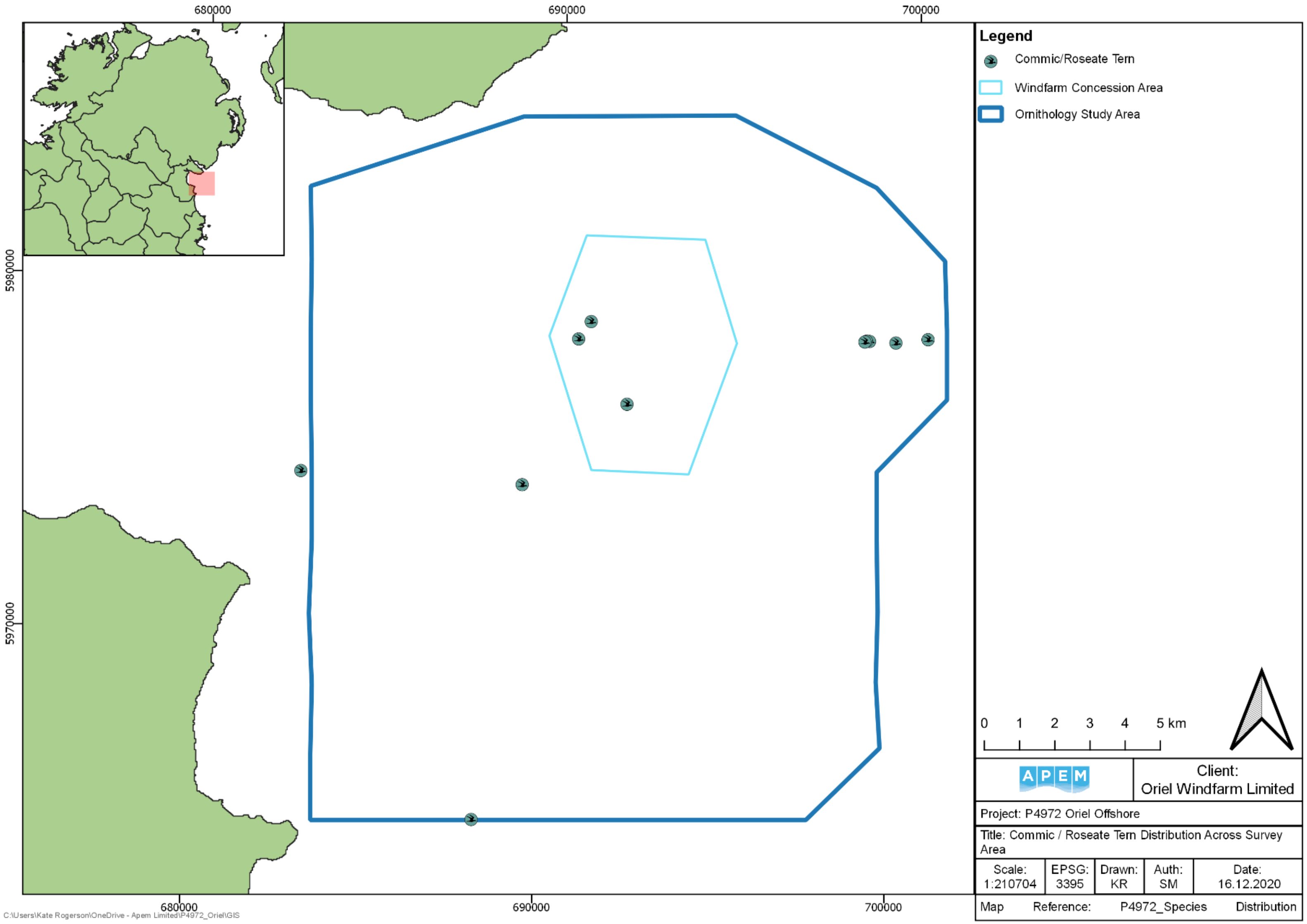


Figure 35 Distribution of commic / roseate tern across the Ornithology Study area

5.18 Commic Tern

Overall 25 commic terns were identified, two in April 2020, two in May 2020, four in June 2020, five in July 2020, seven in August 2020 and five in September 2020 surveys.

The peak raw count of seven commic terns in August resulted in an abundance estimate of 20 commic terns for the Ornithology Study Area (**Table 22**).

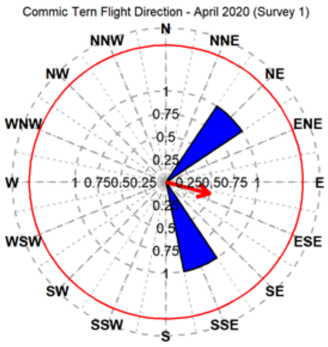
Flying commic terns recorded in all six surveys, a significant orientation was recorded in the July survey with birds flying around a mean orientation of 133°; in August survey with birds flying around a mean orientation of 187°; in September survey with birds flying around a mean orientation of 271° (Raleigh test, p=<0.05, **Figure 36**).

In May, June and August 2020, one, one and two flying common gull deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 18 m above MSL (**Figure 37**).

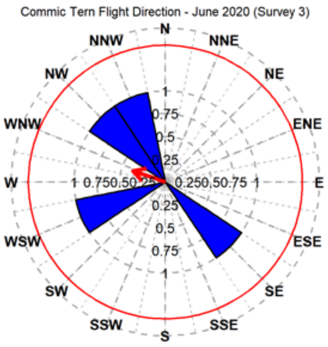
Commic tern showed no overall distribution pattern and were distributed across the Ornithology Study area (**Figure 38**).

Table 22 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of commic tern in: a) Windfarm Concession area; and b) Ornithology Study area**

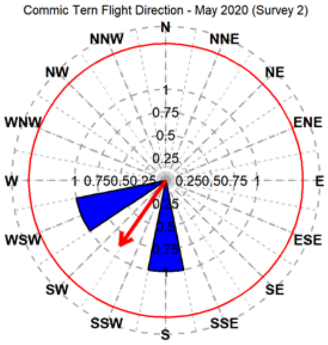
a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	8	1	0.11
August-2020	4	11	4	33	0.5	0.4
September-2020	4	11	4	33	0.5	0.4
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	9	1	0.01
May-2020	1	3	1	9	1	0.01
June-2020	3	9	3	20	0.57735	0.03
July-2020	5	14	5	34	0.44721	0.04
August-2020	7	20	7	52	0.37796	0.06
September-2020	5	15	5	38	0.44721	0.05


Commic Tern Flight Direction - April 2020 (Survey 1)

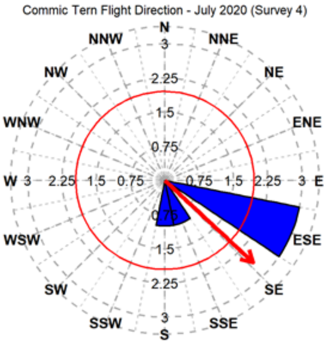
Number of Observations = 2
Mean Vector = 105.339
Length of mean vector (r) = 0.488
Rayleigh Test (Z) = 0.477
Rayleigh Test (p) = 0.683


Commic Tern Flight Direction - June 2020 (Survey 3)

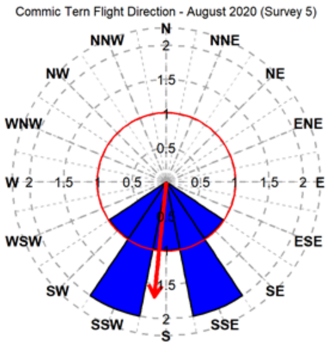
Number of Observations = 4
Mean Vector = 289.148
Length of mean vector (r) = 0.374
Rayleigh Test (Z) = 0.559
Rayleigh Test (p) = 0.602


Commic Tern Flight Direction - May 2020 (Survey 2)

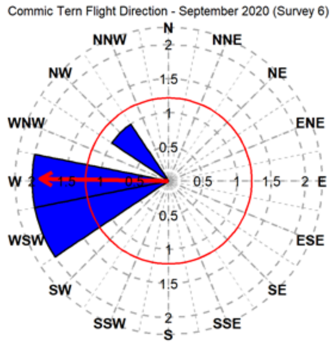
Number of Observations = 2
Mean Vector = 215.818
Length of mean vector (r) = 0.863
Rayleigh Test (Z) = 1.490
Rayleigh Test (p) = 0.257


Commic Tern Flight Direction - July 2020 (Survey 4)

Number of Observations = 5
Mean Vector = 133.488
Length of mean vector (r) = 0.880
Rayleigh Test (Z) = 3.871
Rayleigh Test (p) = 0.012


Commic Tern Flight Direction - August 2020 (Survey 5)

Number of Observations = 7
Mean Vector = 186.820
Length of mean vector (r) = 0.845
Rayleigh Test (Z) = 4.997
Rayleigh Test (p) = 0.003


Commic Tern Flight Direction - September 2020 (Survey 6)

Number of Observations = 5
Mean Vector = 271.014
Length of mean vector (r) = 0.941
Rayleigh Test (Z) = 4.428
Rayleigh Test (p) = 0.004

Figure 36 Summary of flight direction of commic tern during the six surveys

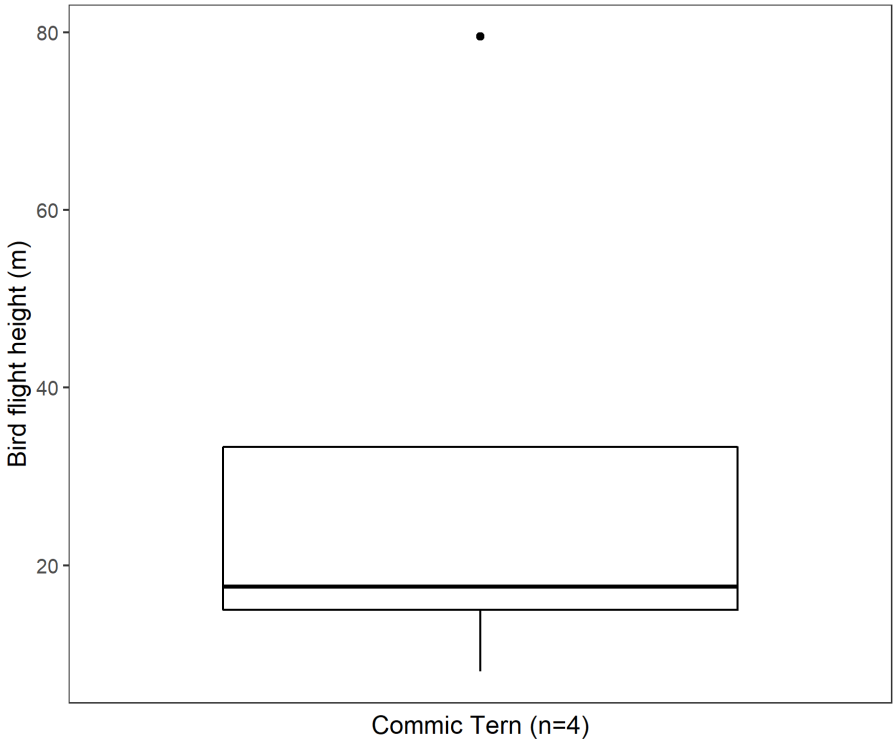


Figure 37 Flight heights of commic tern (n=4) recorded in the Ornithology Study area

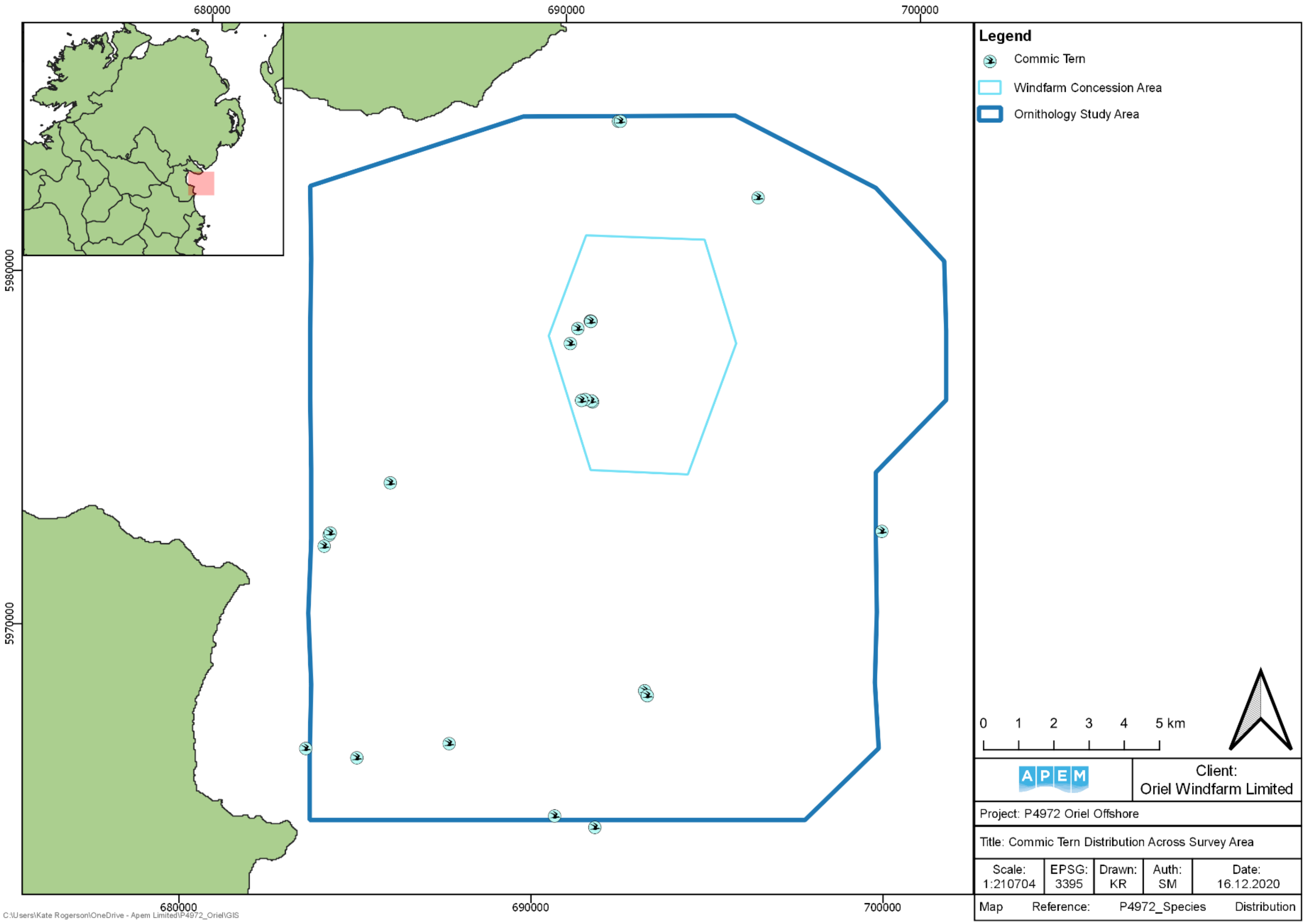


Figure 38 Distribution of commic tern recorded across the ornithology Study area

5.19 Great Skua

During the July 2020 survey, one great skua was identified. Great Skua were not recorded in the April 2020, May 2020, June 2020, August 2020 and September 2020 surveys.

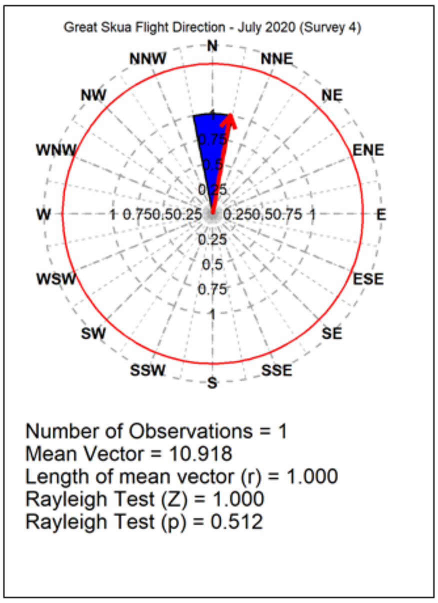
The great skua resulted in an abundance estimate of three for the Ornithology Study area (**Table 23**).

The great skua was recorded flying in a northerly direction (**Figure 39**).

The great skua was located southeast of the Windfarm Concession area. No great skua were recorded in the Windfarm Concessions area (**Figure 40**).

Table 23 Raw counts and abundance and density estimates (No. estimated individuals per km2) of great skua in: a) Windfarm Concession area; and b) Ornithology Study area

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
July-2020	1	3	1	9	1	0.01



Number of Observations = 1
Mean Vector = 10.918
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 39 Summary of flight direction of great skua during the July survey

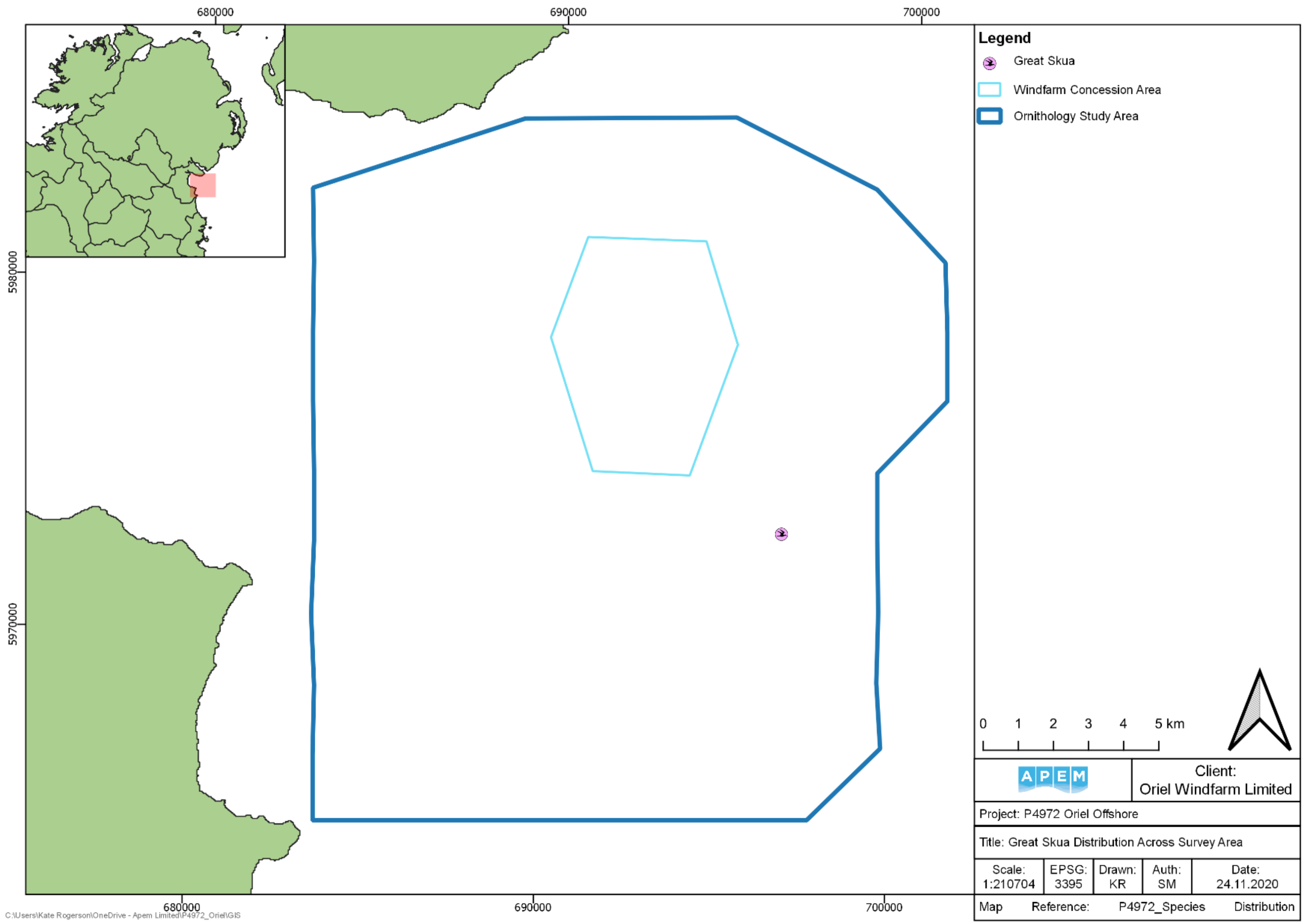


Figure 40 Location of great skua in the Ornithology Study area

5.20 Arctic Skua

During the September 2020 survey, two arctic skua were recorded. Arctic skua were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The peak count of two arctic skua resulted in an abundance estimate of six for the Ornithology Study area (**Table 24**).

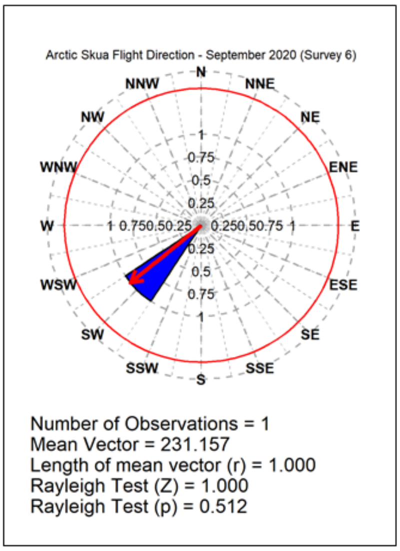
One arctic skua was recorded flying in a south-westerly direction (**Figure 41**).

The flying arctic skua recorded in September 2020 was deemed suitable for flight height determination, and an altitude of 9 m above MSL was recorded.

One arctic skua was located in the northwest of the Ornithology Study Area, while the other was in the southeast corner of the Ornithology Study Area (**Figure 42**).

Table 24 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of arctic skua in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	2	6	2	12	0.70	0.02



Number of Observations = 1
Mean Vector = 231.157
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 41 Summary of flight direction of arctic skua during the September 2020 survey

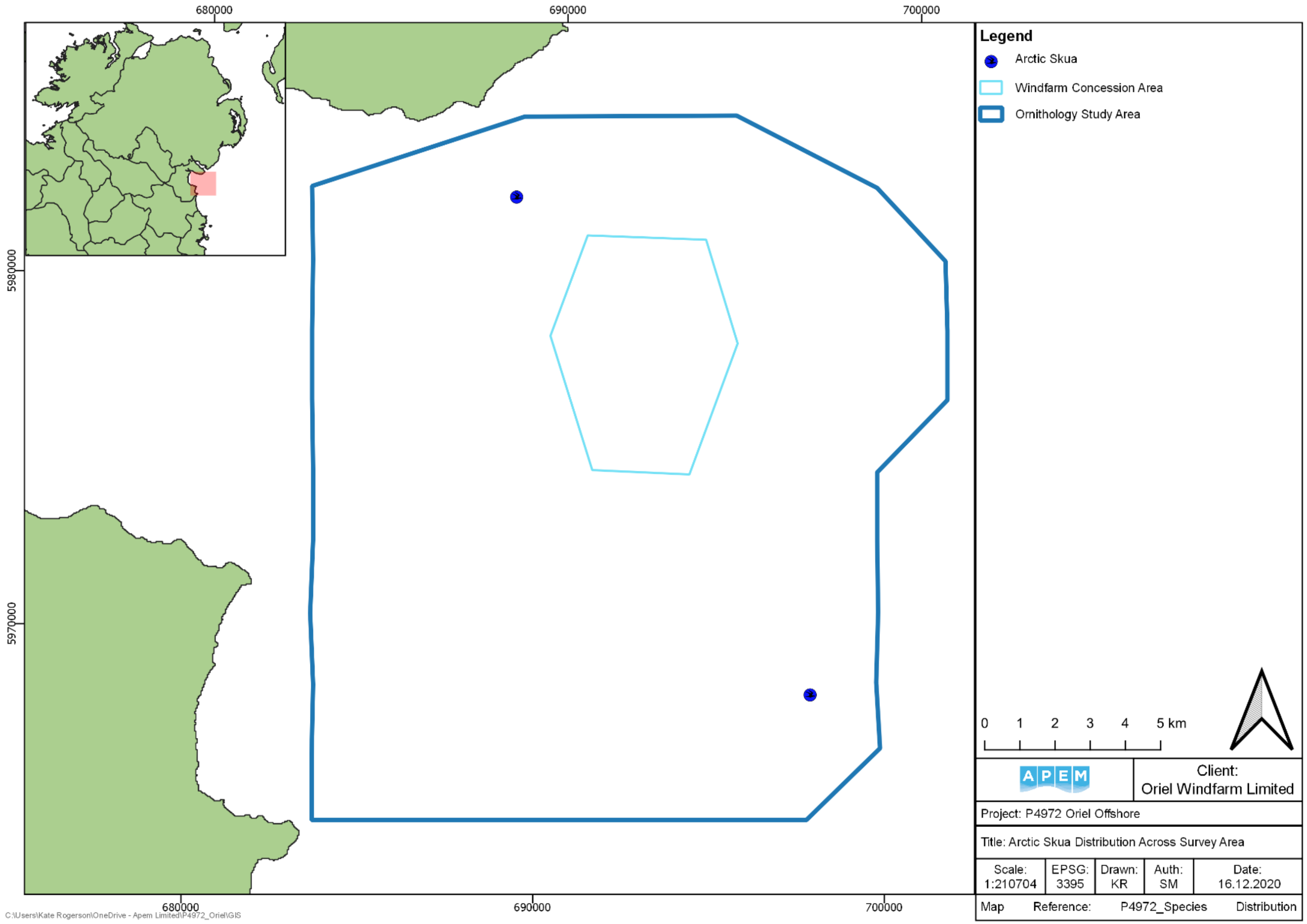


Figure 42 Location of arctic skua in the Ornithology Study Area.

5.21 Guillemot

Overall 13,458 guillemot were identified across the surveys, 247 in the April 2020, 529 in May 2020, 207 in June 2020, 3,235 in July 2020, 3,077 in August 2020 and 6,163 in September 2020 surveys.

A peak count of 5,562 guillemot in the September 2020 survey resulted in an abundance estimate of 16,228 across the Ornithology Study area (**Table 25**). In the same month a raw count of 430 guillemot in the Windfarm concession area resulted in an abundance estimate of 1,185 for the Windfarm Concession area.

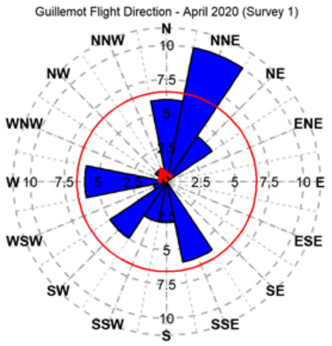
Flying guillemot were recorded in May, June and July surveys. In June guillemot flew in a significant orientation around the mean of 193° and in September guillemot flew in a significant orientation around the mean of 255° (Raleigh test, p=<0.05, **Figure 43**).

In April, May, June and July 2020; five, three, seven and two flying guillemot deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 17 m above MSL (**Figure 44**).

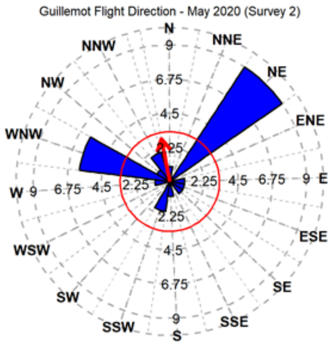
Guillemot were distributed across the Ornithology Study area with the largest concentrations of individuals in the south to southeast of the area (**Figure 45**).

Table 25 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of guillemot in: a) Windfarm Concession area; and b) Ornithology Study area**

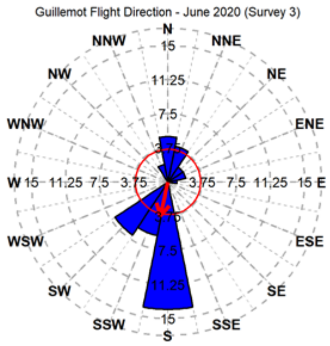
a) Windfarm Concession area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	36	96	36	176	0.16667	3.46
May-2020	143	393	143	874	0.08362	14.18
June-2020	29	79	29	149	0.1857	2.85
July-2020	72	199	105	313	0.11785	7.18
August-2020	99	270	125	414	0.1005	9.74
September-2020	430	1185	780	1475	0.04822	42.76
b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	218	629	456	791	0.06773	1.97
May-2020	492	1426	742	2122	0.04508	4.46
June-2020	182	523	345	706	0.07412	1.64
July-2020	2636	7565	4687	10518	0.01948	23.65
August-2020	2742	7877	4588	11236	0.0191	24.63
September-2020	5562	16228	11913	19866	0.01341	50.74



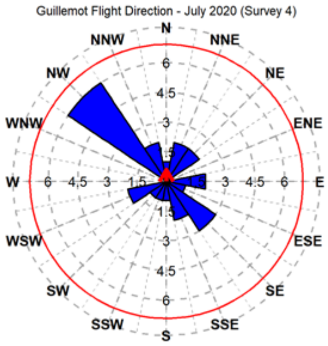
Number of Observations = 46
Mean Vector = 334.242
Length of mean vector (r) = 0.099
Rayleigh Test (Z) = 0.446
Rayleigh Test (p) = 0.642



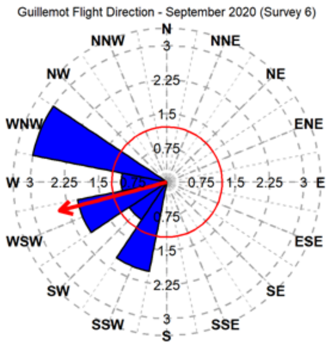
Number of Observations = 26
Mean Vector = 354.088
Length of mean vector (r) = 0.315
Rayleigh Test (Z) = 2.583
Rayleigh Test (p) = 0.074



Number of Observations = 43
Mean Vector = 193.194
Length of mean vector (r) = 0.270
Rayleigh Test (Z) = 3.142
Rayleigh Test (p) = 0.042



Number of Observations = 26
Mean Vector = 0.740
Length of mean vector (r) = 0.099
Rayleigh Test (Z) = 0.256
Rayleigh Test (p) = 0.777



Number of Observations = 9
Mean Vector = 255.409
Length of mean vector (r) = 0.809
Rayleigh Test (Z) = 5.897
Rayleigh Test (p) = <0.001

Figure 43 Summary of flight direction of guillemot during the April, May, June, July and September 2020 surveys

Figure 44 Flight heights of guillemot (n=17) recorded in the Ornithology Study area

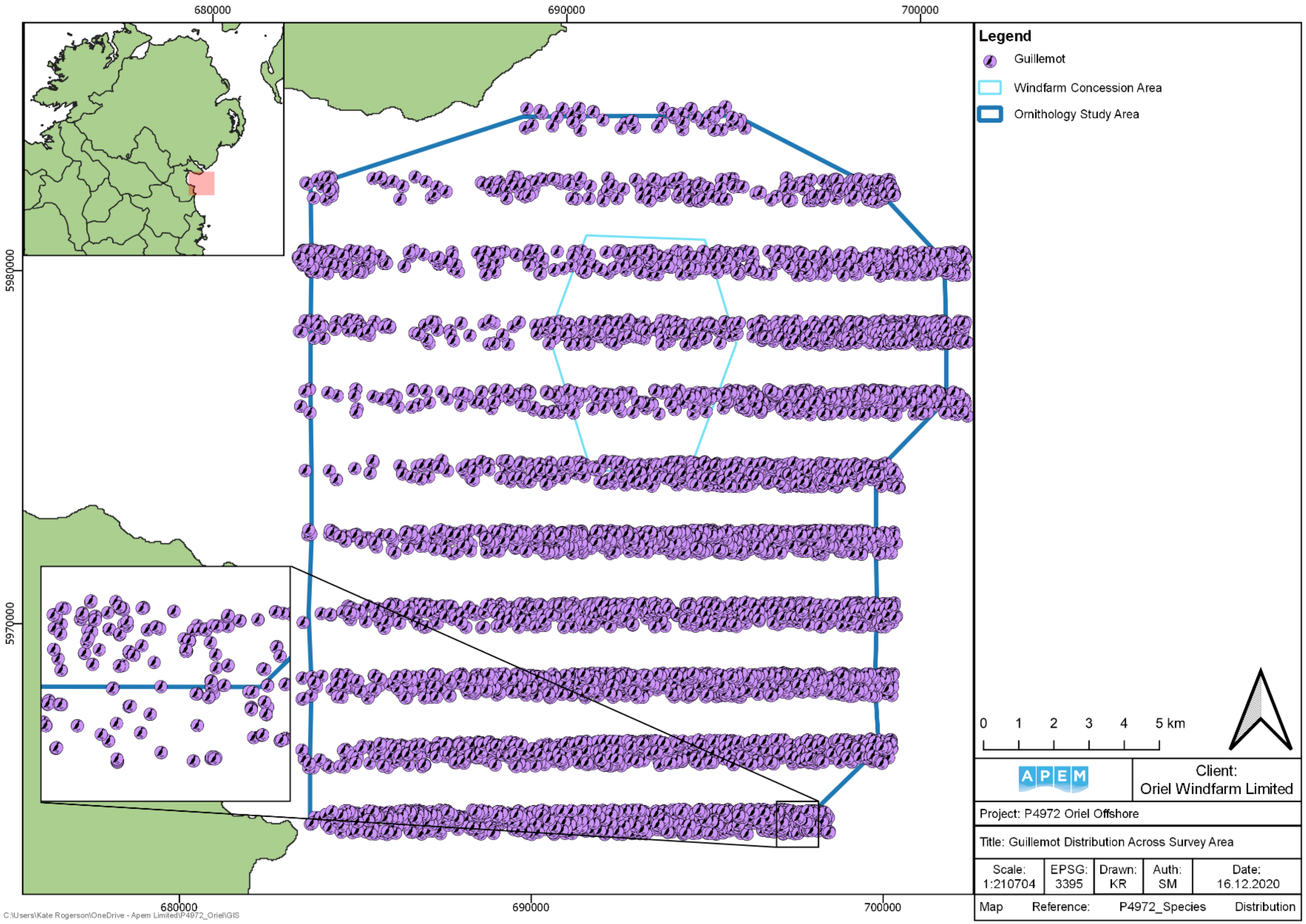


Figure 45 Distribution of guillemot recorded across the Ornithology Study area

5.22 Razorbill

Overall 1,559 razorbill were identified, 36 in the April 2020, 67 in May 2020, 295 in June 2020, 31 in July 2020, 66 in August 2020 and 1,064 in September 2020 surveys.

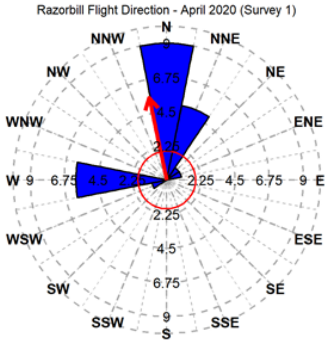
A peak raw count of 952 in September 2020 resulted in an abundance estimate of 2,778 for the Ornithology Study area (**Table 26**).

Flying herring gulls were found to have a significant direction of flight for in the April 2020 survey. Flying razorbill were significantly orientated around the mean of 348° (Rayleigh test, p=<0.05, **Figure 46**).

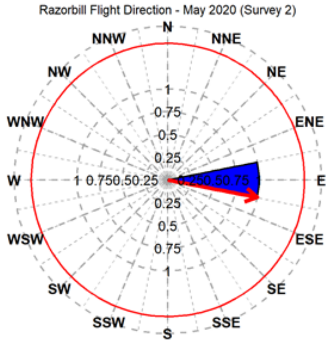
Herring gulls showed no predominant pattern of distribution, due to occurring throughout the extent of the Ornithology Study area across the survey period (**Figure 47**). Although there were higher concentrations of razorbill along the western side of the Ornithology Study are.

Table 26 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of razorbill in: a) Windfarm Concession area; and b) Ornithology Study area**

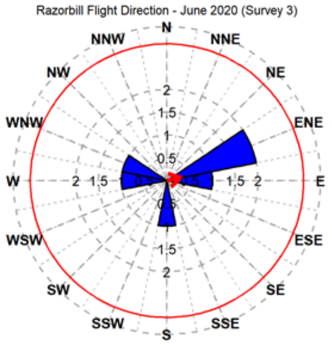
a) Windfarm Concession area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	1	3	1	8	1	0.11
May-2020	7	19	7	30	0.37796	0.69
June-2020	32	87	60	125	0.17678	3.14
July-2020	2	6	2	17	0.70711	0.22
September-2020	72	198	99	298	0.11785	7.15
b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	23	66	23	121	0.20851	0.21
May-2020	49	142	70	226	0.14286	0.44
June-2020	267	767	422	1223	0.0612	2.4
July-2020	26	75	43	106	0.19612	0.23
August-2020	54	155	95	218	0.13608	0.48
September-2020	952	2778	2107	3376	0.03241	8.69



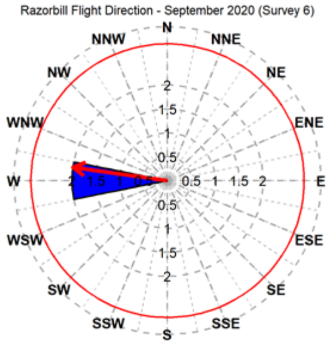
Number of Observations = 23
Mean Vector = 348.669
Length of mean vector (r) = 0.615
Rayleigh Test (Z) = 8.689
Rayleigh Test (p) = <0.001



Number of Observations = 1
Mean Vector = 101.171
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



Number of Observations = 6
Mean Vector = 78.281
Length of mean vector (r) = 0.158
Rayleigh Test (Z) = 0.149
Rayleigh Test (p) = 0.871



Number of Observations = 2
Mean Vector = 278.625
Length of mean vector (r) = 0.999
Rayleigh Test (Z) = 1.998
Rayleigh Test (p) = 0.138

Figure 46 Summary of flight direction of razorbill during the April, May, June and September 2020 surveys.

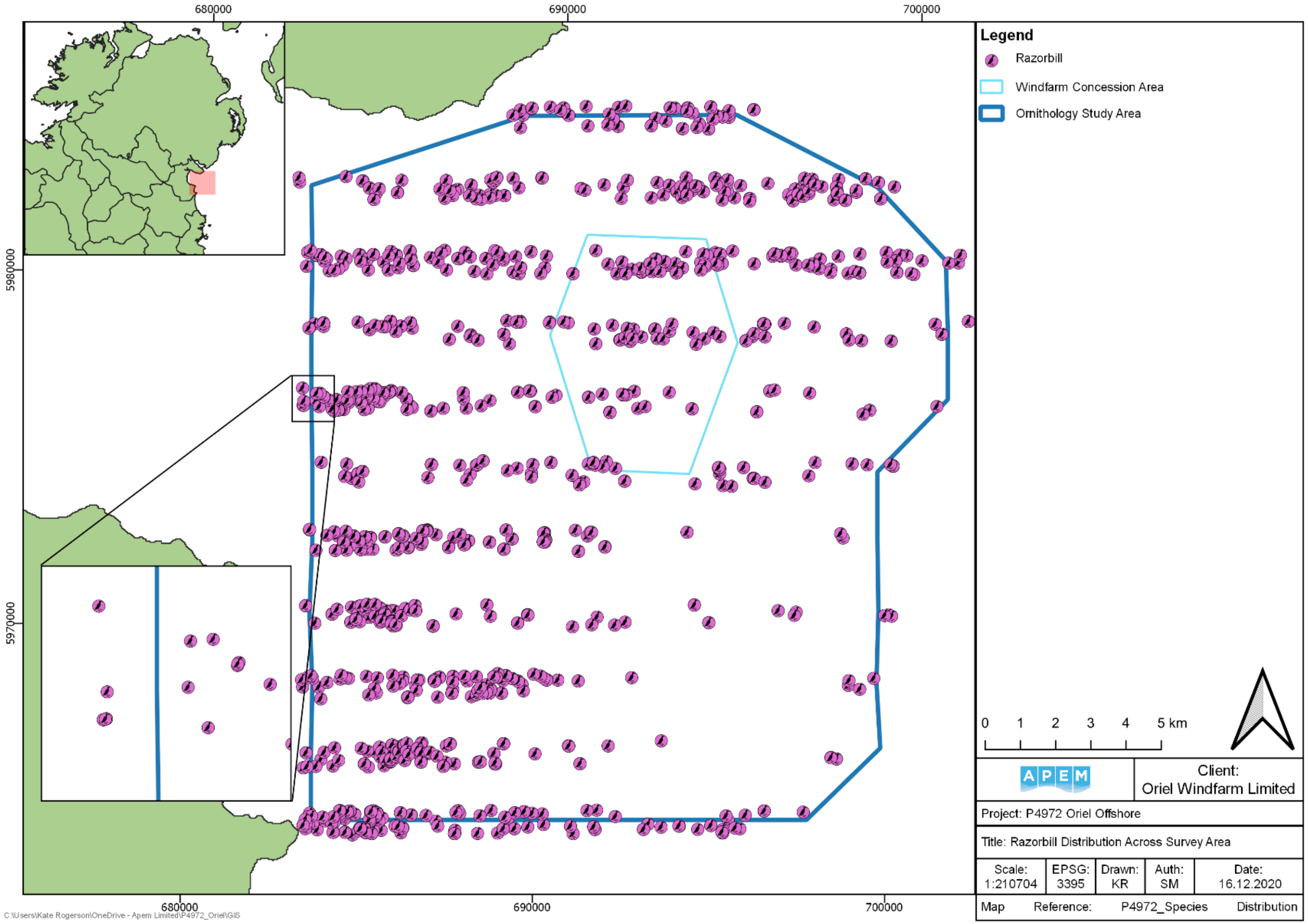


Figure 47 Distribution of razorbill recorded across the Ornithology Study area

5.23 Black Guillemot

Overall 577 black guillemot were identified across the survey period; 59 in the April 2020, one in May 2020, 38 in June 2020, 38 in July 2020, 224 in August 2020 and 217 in September 2020 surveys.

A peak raw count of 201 in September 2020 resulted in an abundance estimate of 586 for the Ornithology Study Area (**Table 27**).

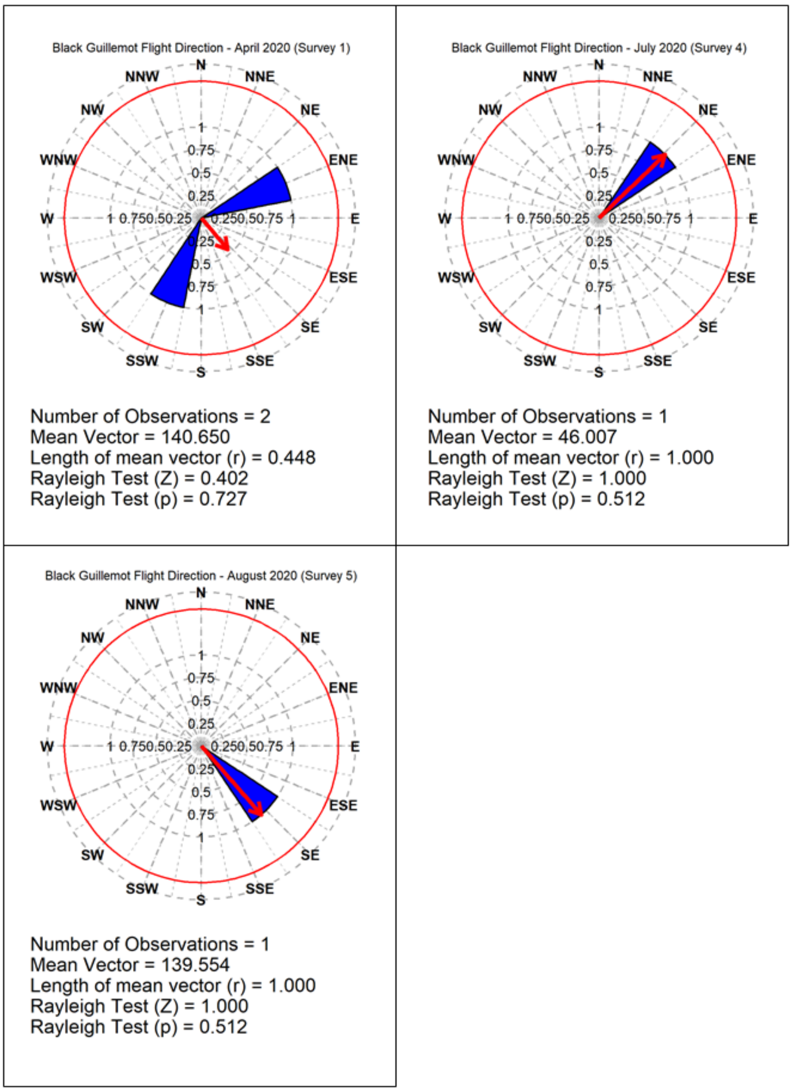
Flying black guillemot were recorded in April 2020 and July 2020 and were found to have no significant direction of flight (**Figure 48**).

In August 2020, one flying guillemot deemed suitable for flight height determination was recorded, with an altitude of 3 m above MSL.

Black guillemot were concentrated to the east to northeast of the Windfarm Concession area (**Figure 49**).

Table 27 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of black guillemot in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	8	1	0.11
June-2020	2	5	2	16	0.70711	0.18
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	57	165	61	294	0.13245	0.52
May-2020	1	3	1	9	1	0.01
June-2020	36	103	36	190	0.16667	0.32
July-2020	37	106	37	221	0.1644	0.33
August-2020	184	529	184	971	0.07372	1.65
September-2020	201	586	201	1284	0.07053	1.83



Number of Observations = 2
Mean Vector = 140.650
Length of mean vector (r) = 0.448
Rayleigh Test (Z) = 0.402
Rayleigh Test (p) = 0.727

Number of Observations = 1
Mean Vector = 46.007
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Number of Observations = 1
Mean Vector = 139.554
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 48 Summary of flight direction of black guillemot during the April, July and August 2020 surveys

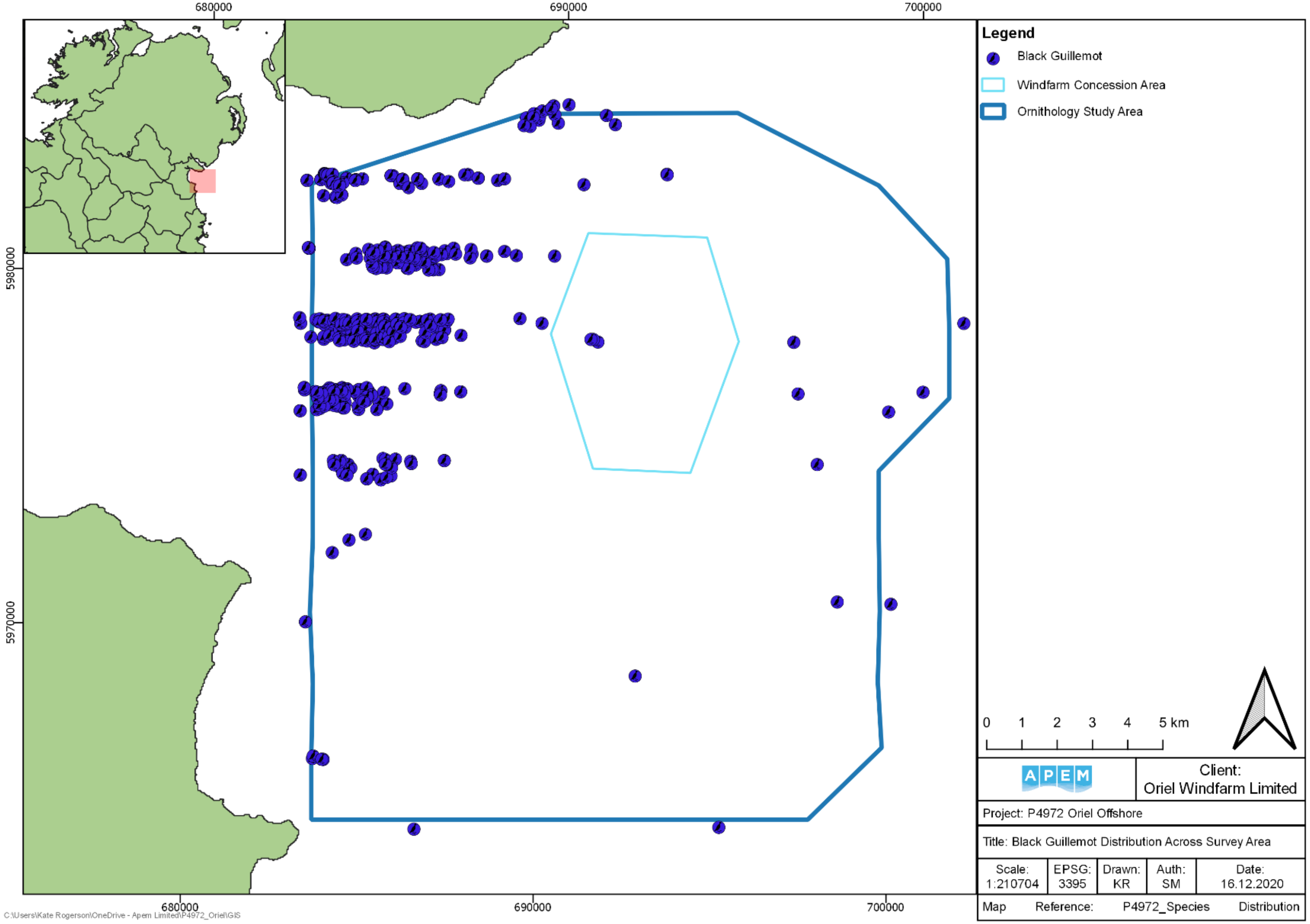


Figure 49 Distribution of black guillemot recorded across the Ornithology Study area

5.24 Guillemot / Razorbill

Overall 2,211 guillemot / razorbill were identified across the Surveys; 217 in April 2020, 91 in May 2020, 245 in June 2020, 808 in July 2020, 54 in August 2020 and 796 in September 2020 surveys.

A peak raw count of 758 in July resulted in an abundance estimate of 2,175 for the Ornithology Study area (**Table 28**).

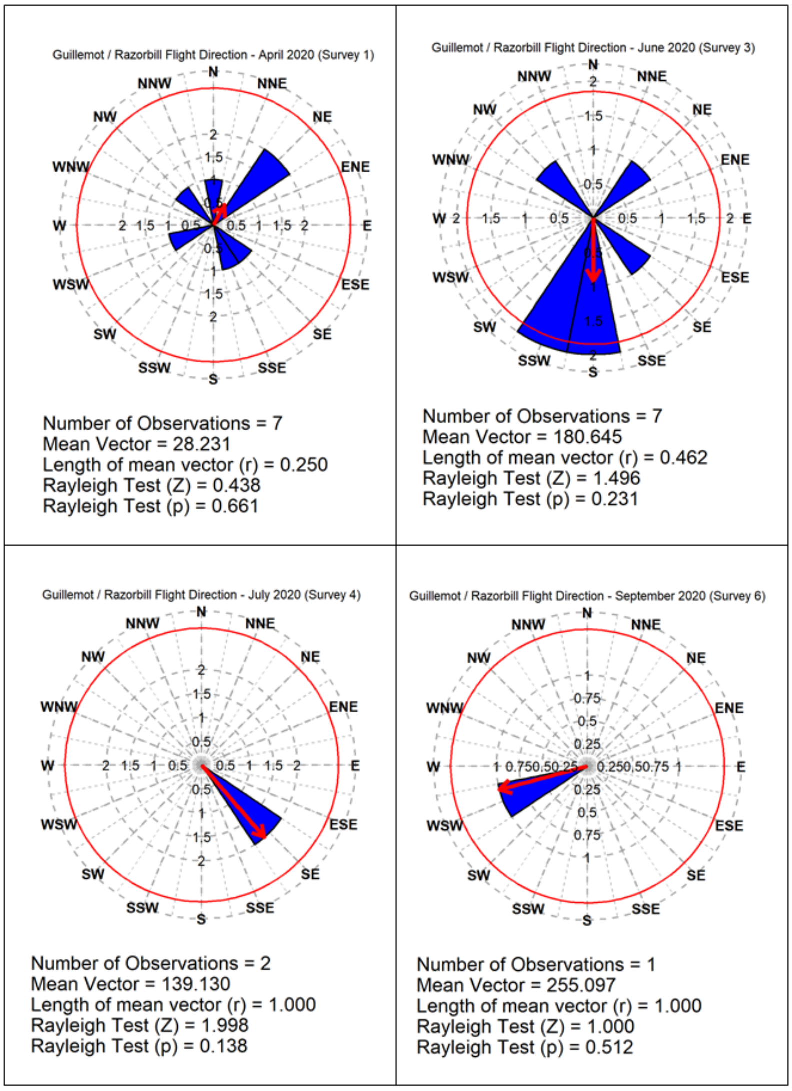
Flying guillemot / razorbill were recorded in April, June, July and September although none showed a significant predominant direction of flight (Rayleigh test, p=>0.05, **Figure 50**).

In June 2020, two flying guillemot / razorbill deemed suitable for flight height determination were recorded, altitude of 33 and 59 m above MSL were recorded.

Guillemot / razorbill showed no predominant pattern of distribution and occurred throughout the extent of the Ornithology Study area (**Figure 51**).

Table 28 Raw counts and abundance and density estimates (No. estimated individuals per km2) of guillemot / razorbill in: a) Windfarm Concession area; and b) Ornithology Study area

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	75	200	75	396	0.11547	7.22
May-2020	23	63	23	126	0.20851	2.27
June-2020	27	73	27	212	0.19245	2.63
July-2020	70	194	152	257	0.11952	7
September-2020	52	143	52	229	0.13868	5.16
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	194	560	283	886	0.0718	1.75
May-2020	85	246	148	357	0.10847	0.77
June-2020	217	623	333	970	0.06788	1.95
July-2020	758	2175	1421	2856	0.03632	6.8
August-2020	49	141	57	253	0.14286	0.44
September-2020	658	1920	1187	2693	0.03898	6



Guillemot / Razorbill Flight Direction - April 2020 (Survey 1)

Number of Observations = 7
Mean Vector = 28.231
Length of mean vector (r) = 0.250
Rayleigh Test (Z) = 0.438
Rayleigh Test (p) = 0.661

Guillemot / Razorbill Flight Direction - June 2020 (Survey 3)

Number of Observations = 7
Mean Vector = 180.645
Length of mean vector (r) = 0.462
Rayleigh Test (Z) = 1.496
Rayleigh Test (p) = 0.231

Guillemot / Razorbill Flight Direction - July 2020 (Survey 4)

Number of Observations = 2
Mean Vector = 139.130
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.998
Rayleigh Test (p) = 0.138

Guillemot / Razorbill Flight Direction - September 2020 (Survey 6)

Number of Observations = 1
Mean Vector = 255.097
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 50 Summary of flight direction of guillemot / razorbill during the April, June, July and September 2020 surveys

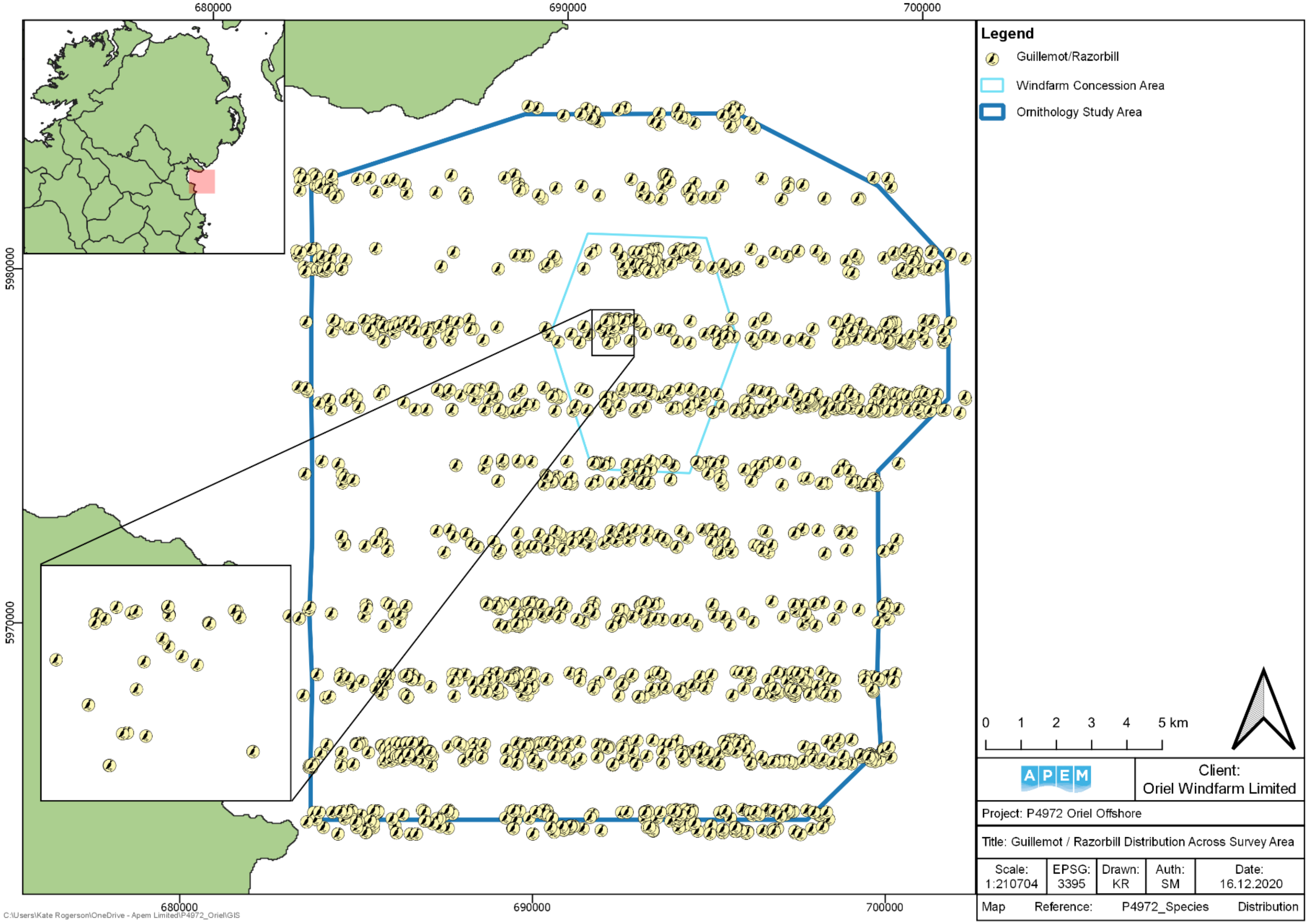


Figure 51 Distribution of guillemot / razorbill recorded across the Ornithology Study area

5.25 Puffin

Overall 51 puffin were identified across the surveys, two in the April 2020, one in May 2020 seven in June 2020, seven in July 2020, 10 in August 2020 and 24 in September 2020 surveys.

A peak raw count of 21 in September 2020 resulted in an abundance estimate of 61 for the Ornithology Study area (**Table 29**).

No flying puffin were recorded during the surveys.

There was no spatial distribution pattern in the locations for puffin across the Ornithology Study area (**Figure 52**).

Table 29 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of puffin in: a) Windfarm Concession area; and b) Ornithology Study area**

<table>
<tr><th colspan="7">a) Windfarm Concession area</th></tr>
<tr><th>Survey</th><th>Raw Count</th><th>Abundance</th><th>Lower CI</th><th>Upper CI</th><th>Precision</th><th>Density</th></tr>
<tr><td>April-2020</td><td>1</td><td>3</td><td>1</td><td>8</td><td>1</td><td>0.11</td></tr>
<tr><td>August-2020</td><td>1</td><td>3</td><td>1</td><td>8</td><td>1</td><td>0.11</td></tr>
<tr><th colspan="7">b) Ornithology Study area</th></tr>
<tr><th>Survey</th><th>Raw Count</th><th>Abundance</th><th>Lower CI</th><th>Upper CI</th><th>Precision</th><th>Density</th></tr>
<tr><td>April-2020</td><td>1</td><td>3</td><td>1</td><td>9</td><td>1</td><td>0.01</td></tr>
<tr><td>May-2020</td><td>1</td><td>3</td><td>1</td><td>9</td><td>1</td><td>0.01</td></tr>
<tr><td>June-2020</td><td>4</td><td>11</td><td>4</td><td>20</td><td>0.5</td><td>0.03</td></tr>
<tr><td>July-2020</td><td>7</td><td>20</td><td>7</td><td>46</td><td>0.37796</td><td>0.06</td></tr>
<tr><td>August-2020</td><td>9</td><td>26</td><td>9</td><td>55</td><td>0.33333</td><td>0.08</td></tr>
<tr><td>September-2020</td><td>21</td><td>61</td><td>21</td><td>117</td><td>0.21822</td><td>0.19</td></tr>
</table>

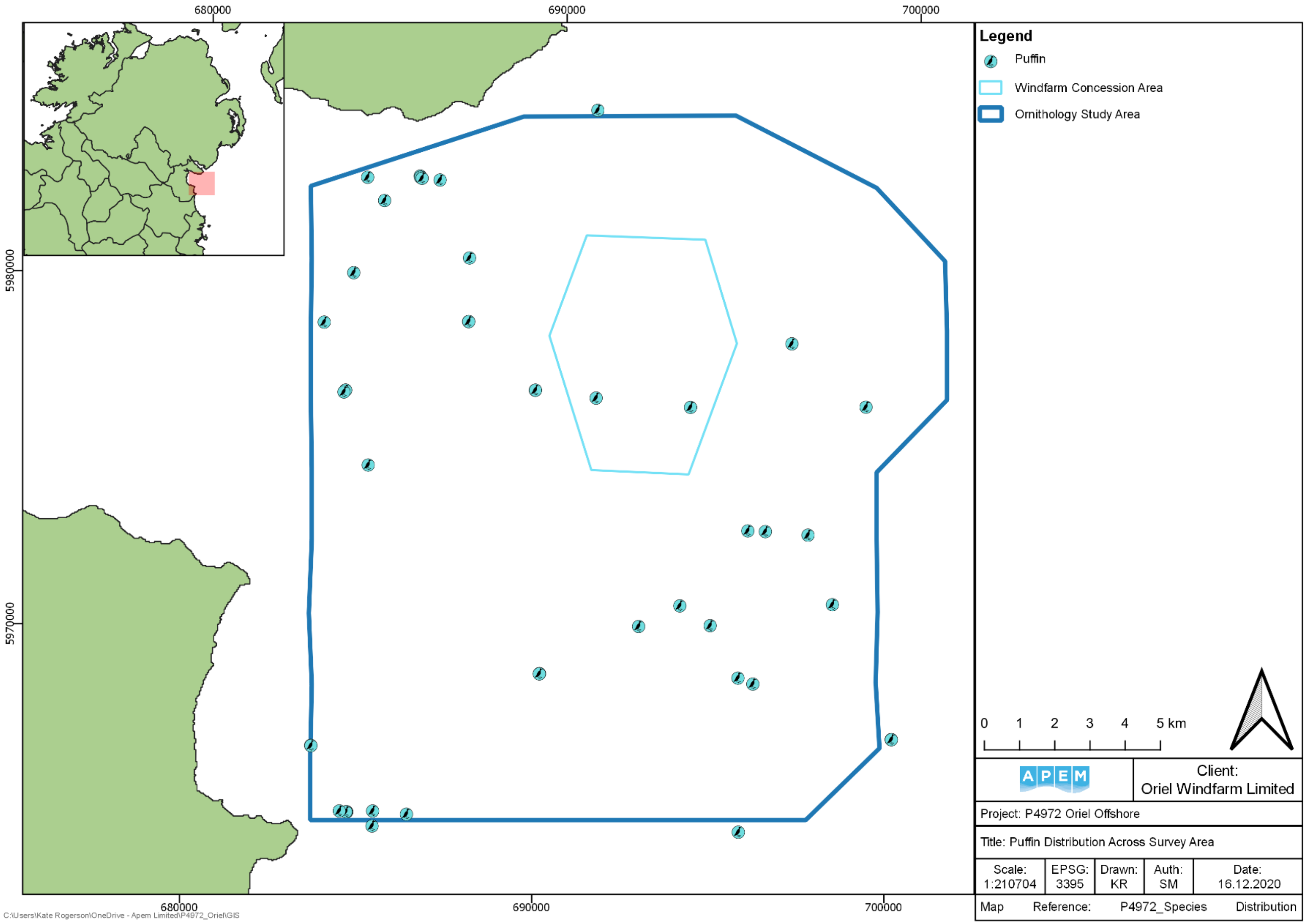


Figure 52 Distribution of puffin recorded across the Ornithology Study area

5.26 Auk Species - unidentified

Overall 61 unidentified auk species were recorded on the surveys; 24 in April 2020,12 in May 2020, seven in June 2020, ten in July 2020, one in August 2020 and seven in September 2020 surveys.

A peak raw count of 24 in April 2020 resulted in an abundance estimate of 69 for the Ornithology Study area (**Table 30**).

No flying unidentified auk species were recorded.

Unidentified auk species were recorded throughout the Ornithology Study area (**Figure 53**).

Table 30 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of auk species in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	4	11	4	24	0.5	0.4
May-2020	2	5	2	11	0.70711	0.18
June-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	24	69	29	121	0.20412	0.22
May-2020	12	35	12	58	0.28868	0.11
June-2020	7	20	7	52	0.37796	0.06
July-2020	10	29	10	66	0.31623	0.09
September-2020	7	20	7	47	0.37796	0.06

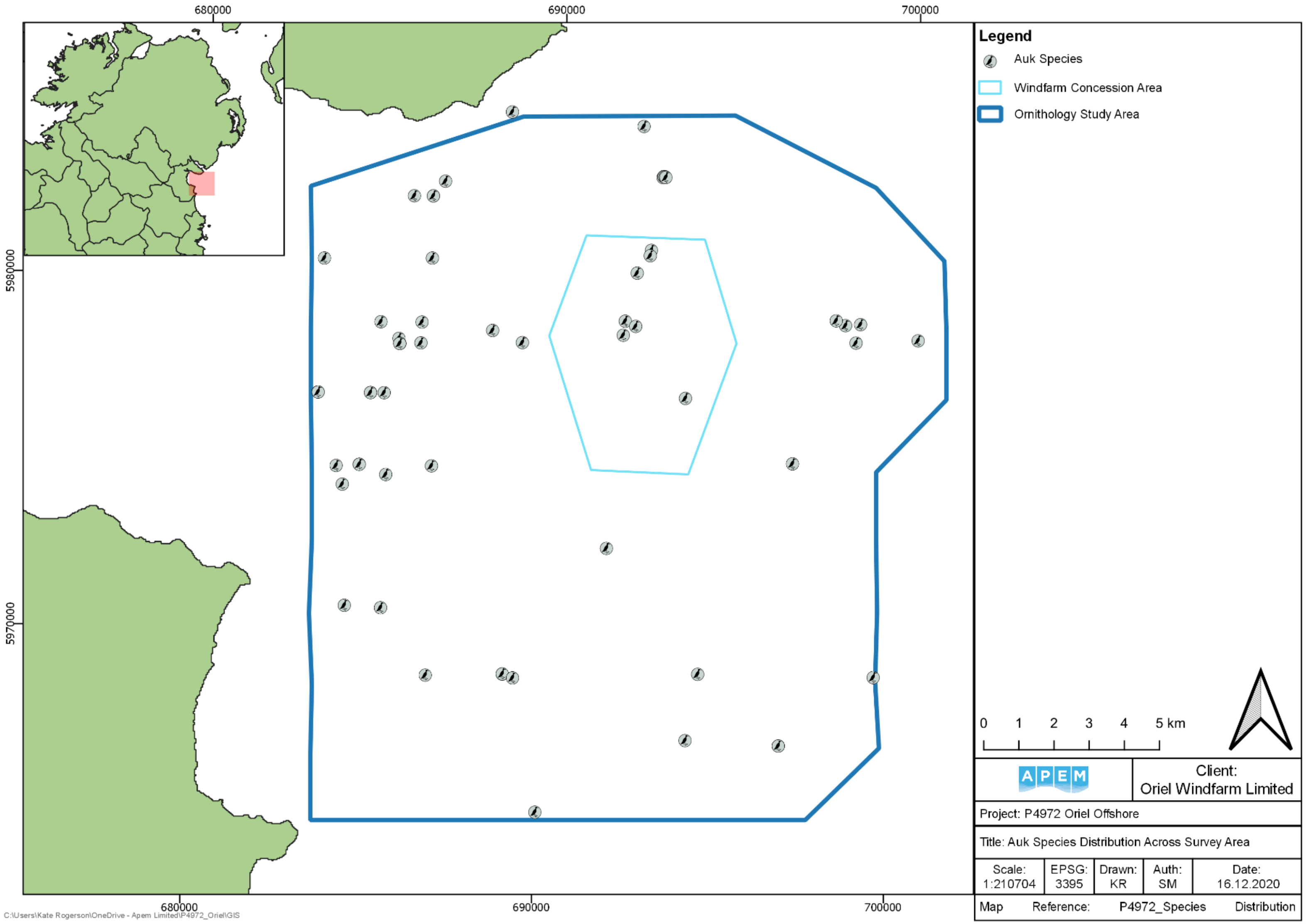


Figure 53 Distribution of unidentified auk species recorded across the Ornithology Study area

5.27 Red-throated Diver

Overall 19 red-throated diver were recorded, 15 in April 2020 and four in September 2020 surveys. Red-throated diver were not recorded in the May 2020, June 2020, July 2020 and August 2020 surveys.

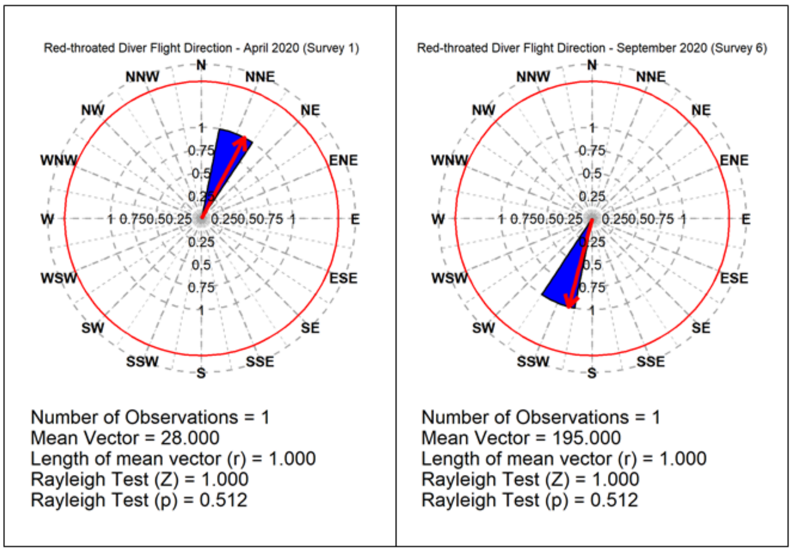
A peak raw count of ten red-throated diver resulted in an abundance estimate of 29 for the Ornithology Study area (**Table 31**).

One red-throated diver was recorded flying in a north-easterly direction in the April survey and one red-throated diver was recorded flying in a south-westerly direction in the September survey (**Figure 54**).

The red-throated diver were mainly distributed along the western side of the Ornithology Study area (**Figure 55**), with only two located in the south eastern area. No red-throated diver were recorded in the Windfarm Concession area.

Table 31 Raw counts and abundance and density estimates (No. estimated individuals per km2) of red-throated diver in: a) Windfarm Concession area; and b) Ornithology Study area

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	10	29	20	38	0.31623	0.09
September-2020	4	12	4	23	0.5	0.04



Number of Observations = 1
Mean Vector = 28.000
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Number of Observations = 1
Mean Vector = 195.000
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 54 Summary of flight direction of red-throated diver during the April and September 2020 survey

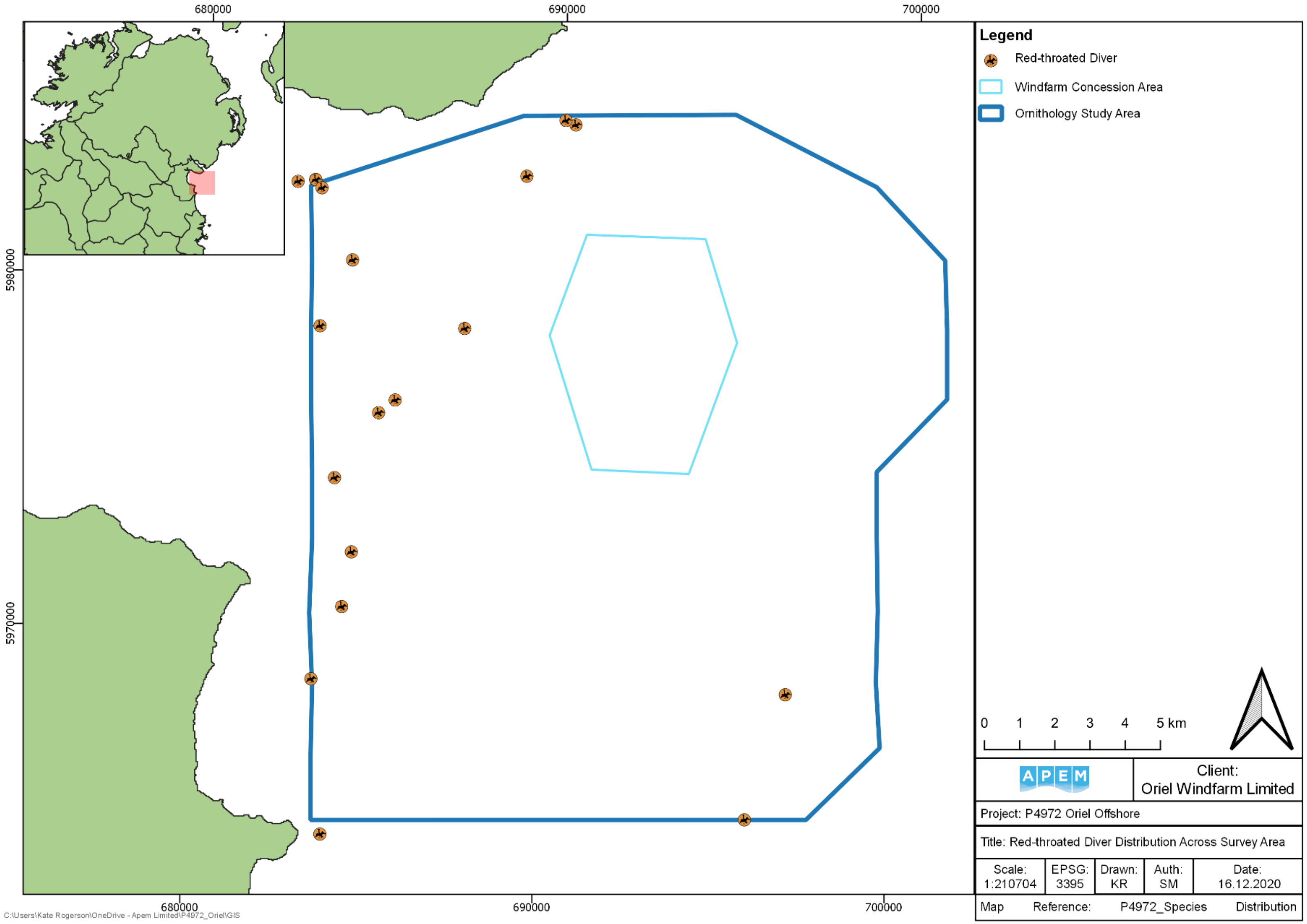


Figure 55 Distribution of red-throated diver recorded across the Ornithology Study area

5.28 Great Northern Diver

Overall 302 great northern diver were identified, 285 in April 2020, 9 in May 2020, 4 in June 2020 and 4 in July 2020 surveys. Great northern divers were not recorded in the August 2020 and September 2020 surveys.

A peak count of 268 great northern diver was recorded in April 2020 and resulted in an abundance estimate of 774 in the Ornithology Study area (**Table 32**).

The great northern divers were concentrated in the east to north of the Ornithology Study area. No great northern divers were recorded in the southwest of the Study area (**Figure 56**).

Table 32 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of great northern diver in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	38	102	38	144	0.16222	3.68
May-2020	2	5	2	16	0.70711	0.18
July-2020	2	6	2	11	0.70711	0.22
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	268	774	390	1221	0.06108	2.42
May-2020	9	26	9	55	0.33333	0.08
June-2020	3	9	3	23	0.57735	0.03
July-2020	4	11	4	26	0.5	0.03

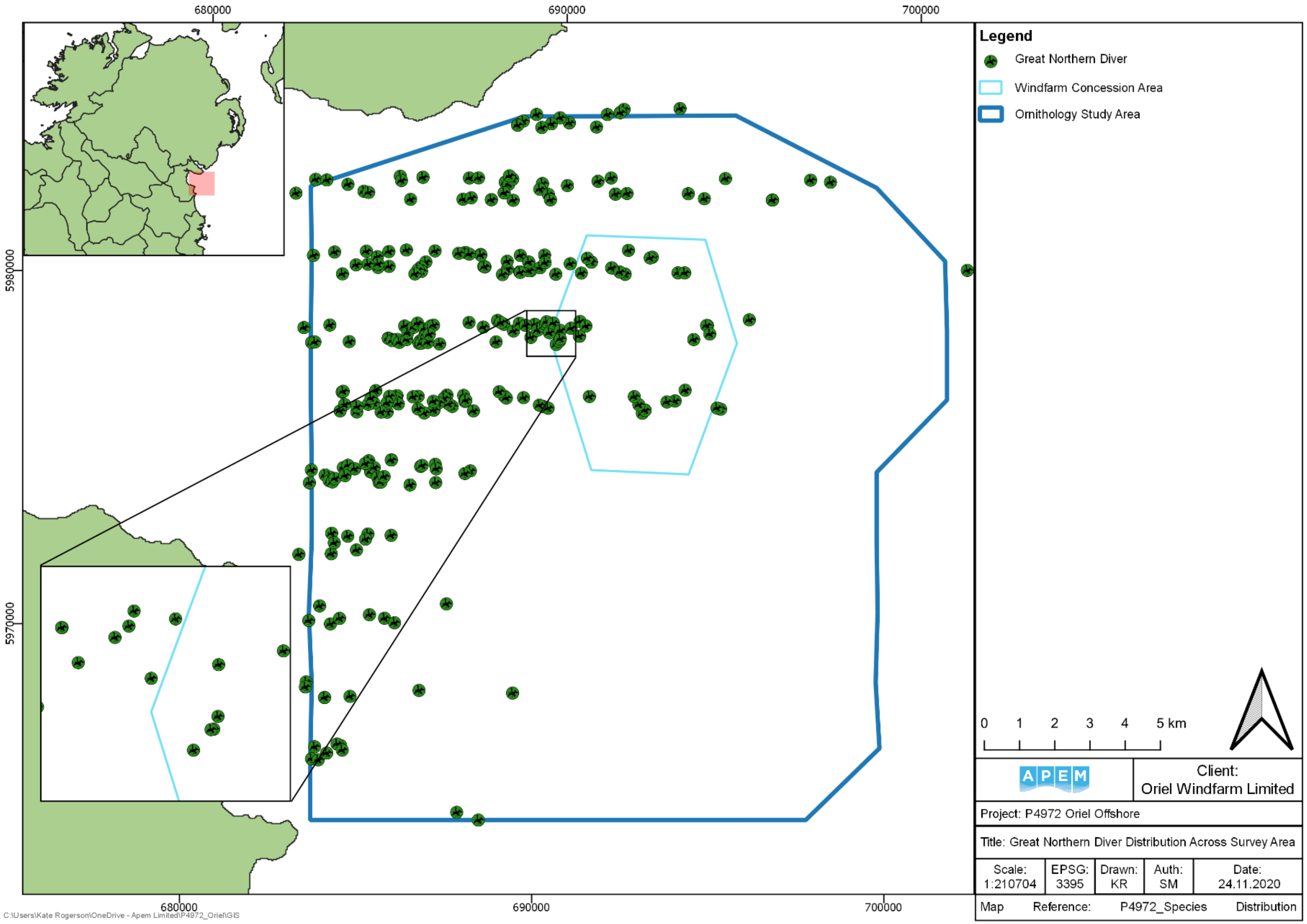


Figure 56 Distribution of great northern diver recorded across the Ornithology Study area

5.29 Diver species – unidentified

Overall nine unidentified diver species were identified, six in April 2020 and three in June 2020 surveys. Unidentified diver species were not recorded in May 2020, July 2020, August 2020 and September 2020 surveys.

A peak raw count of five resulted in an abundance estimate of nine for the Ornithology Study area (**Table 33**).

Unidentified diver species were located throughout the western side of the Ornithology Study area. One identified diver species was recorded in the Windfarm Concession area (**Figure 57**).

Table 33 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of diver species in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	5	14	5	29	0.44721	0.04
June-2020	3	9	3	17	0.57735	0.03

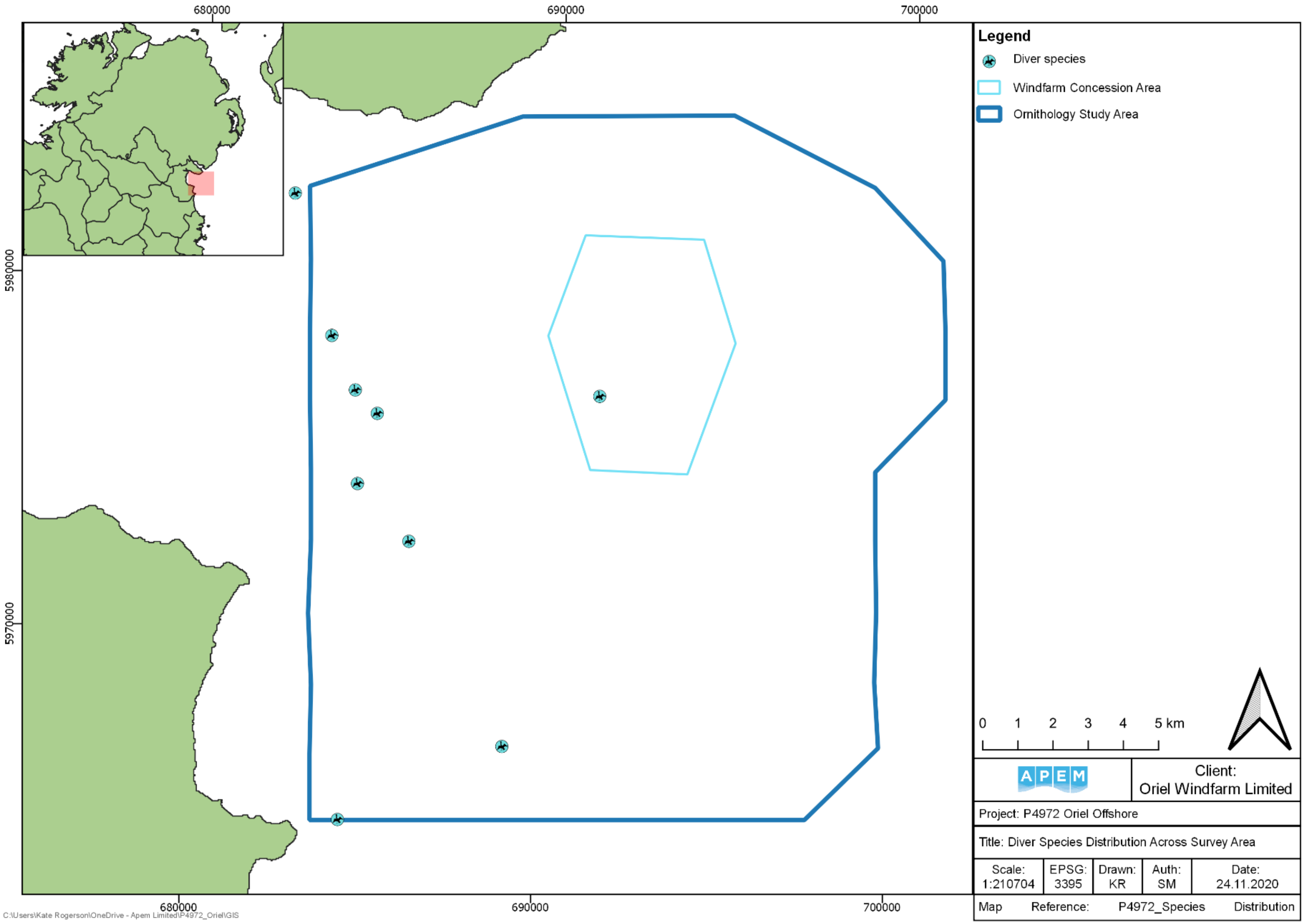


Figure 57 Distribution of unidentified diver species recorded across the Ornithology Study area

5.30 Fulmar

Overall two fulmar were identified, one each during the April 2020 and August 2020 surveys. Fulmar were not recorded in the May 2020, June 2020, July 2020 and September 2020 surveys.

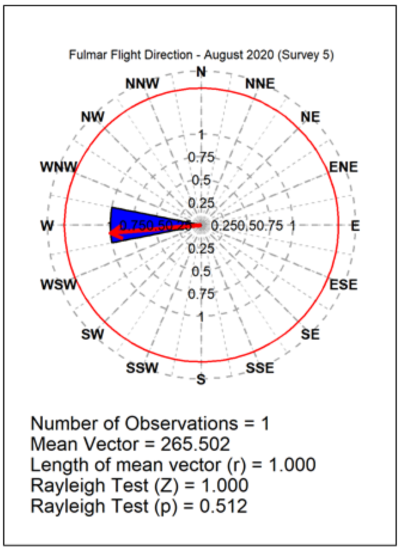
The counts of one fulmar resulted in an abundance estimate of three for the Ornithology Study area (**Table 34**).

One fulmar was recorded flying in a westerly direction during the August survey (**Figure 58**).

The fulmar individuals were located to the east and west of the Windfarm Concession area (**Figure 59**). No fulmar were recorded in the Windfarm Concession area.

Table 34 Raw counts and abundance and density estimates (No. estimated individuals per km2) of fulmar in: a) Windfarm Concession area; and b) Ornithology Study area

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	1	3	1	9	1	0.01
August-2020	1	3	1	9	1	0.01



Number of Observations = 1
Mean Vector = 265.502
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 58 Summary of flight direction of fulmar during the August survey

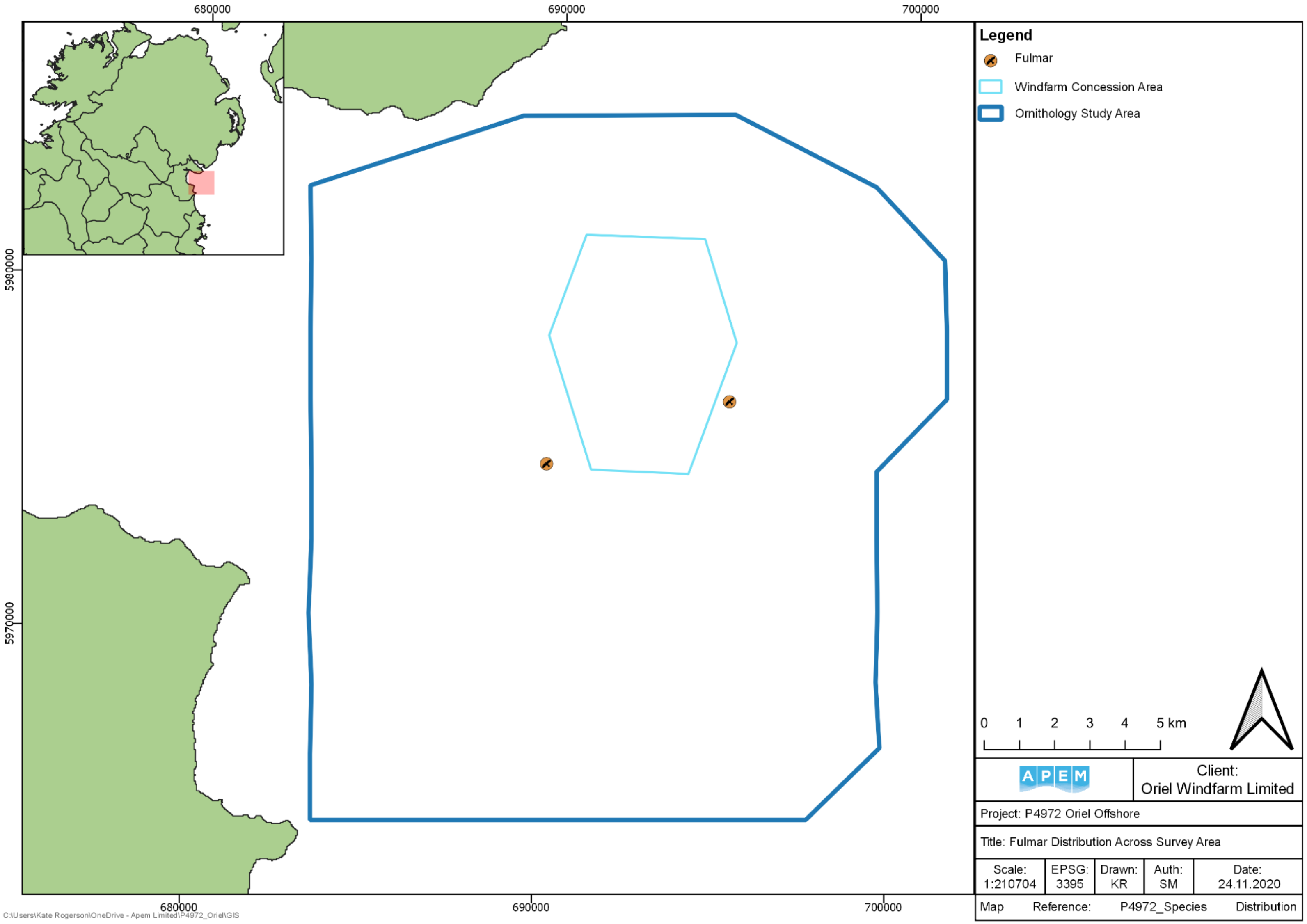


Figure 59 Location of fulmar recorded across the Ornithology Study area

5.31 Great Shearwater

During the May 2020 survey, one great shearwater were identified. Great Shearwater were not recorded in the April 2020, June 2020, July 2020, August 2020 and September 2020 surveys.

The single count resulted in resulted in an abundance estimate of three for the Ornithology Study area (**Table 35**).

The great shearwater was located on the western edge of the Ornithology Study area to the west of the Windfarm Concession area (**Figure 60**).

Table 35 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of great shearwater in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
May-2020	1	3	1	9	1	0.01

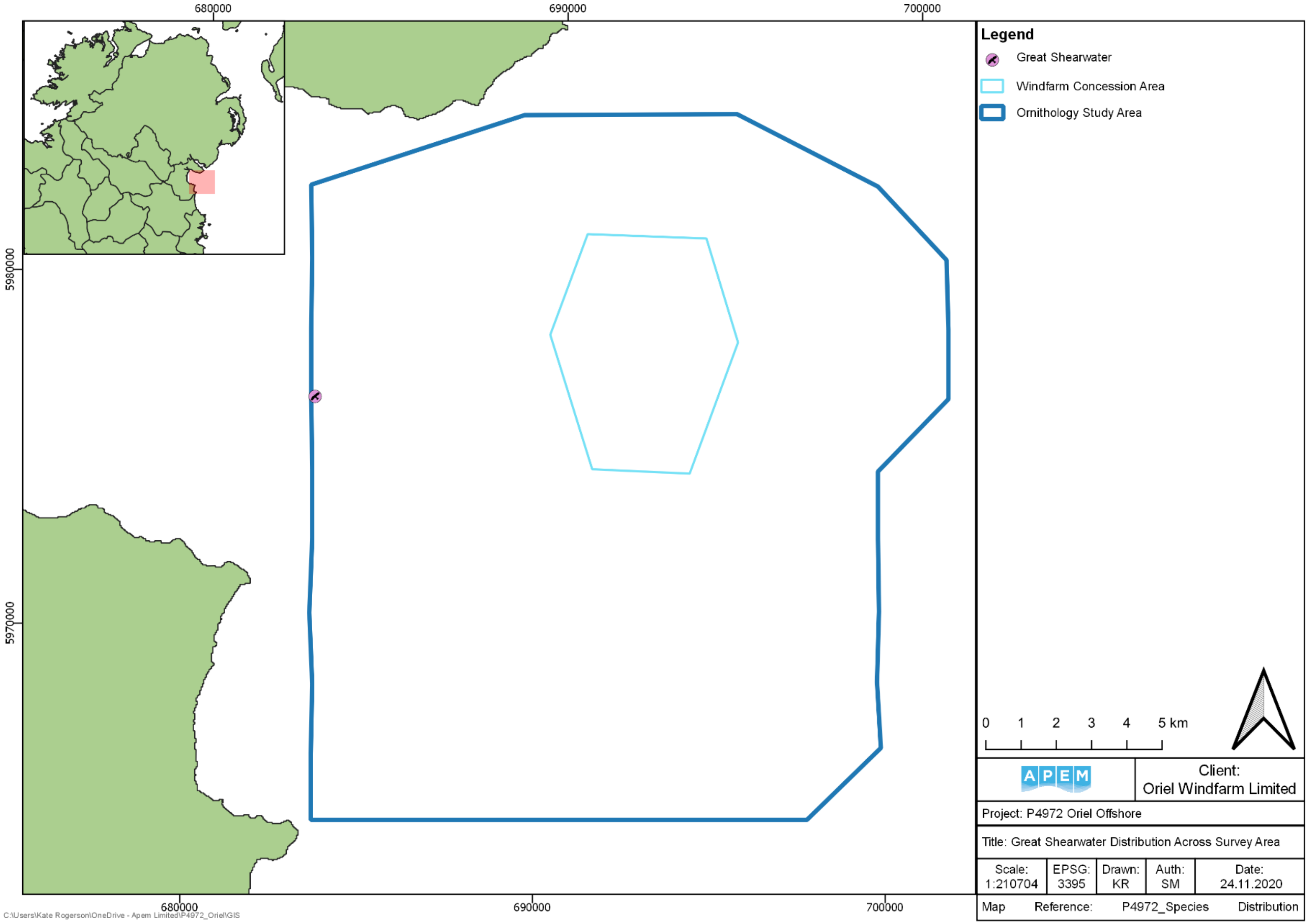


Figure 60 Location of great shearwater recorded across the Ornithology Study area

5.32 Manx Shearwater

Overall 2,377 Manx shearwater were identified, six in April 2020, 547 in May 2020, 90 in June 2020, 280 in July 2020, 1,317 in August 2020 and 137 in September 2020 surveys

The peak raw count of 1,245 Manx shearwater in August 2020 resulted in an abundance estimate of 3,577 in the Ornithology Study area (**Table 36**).

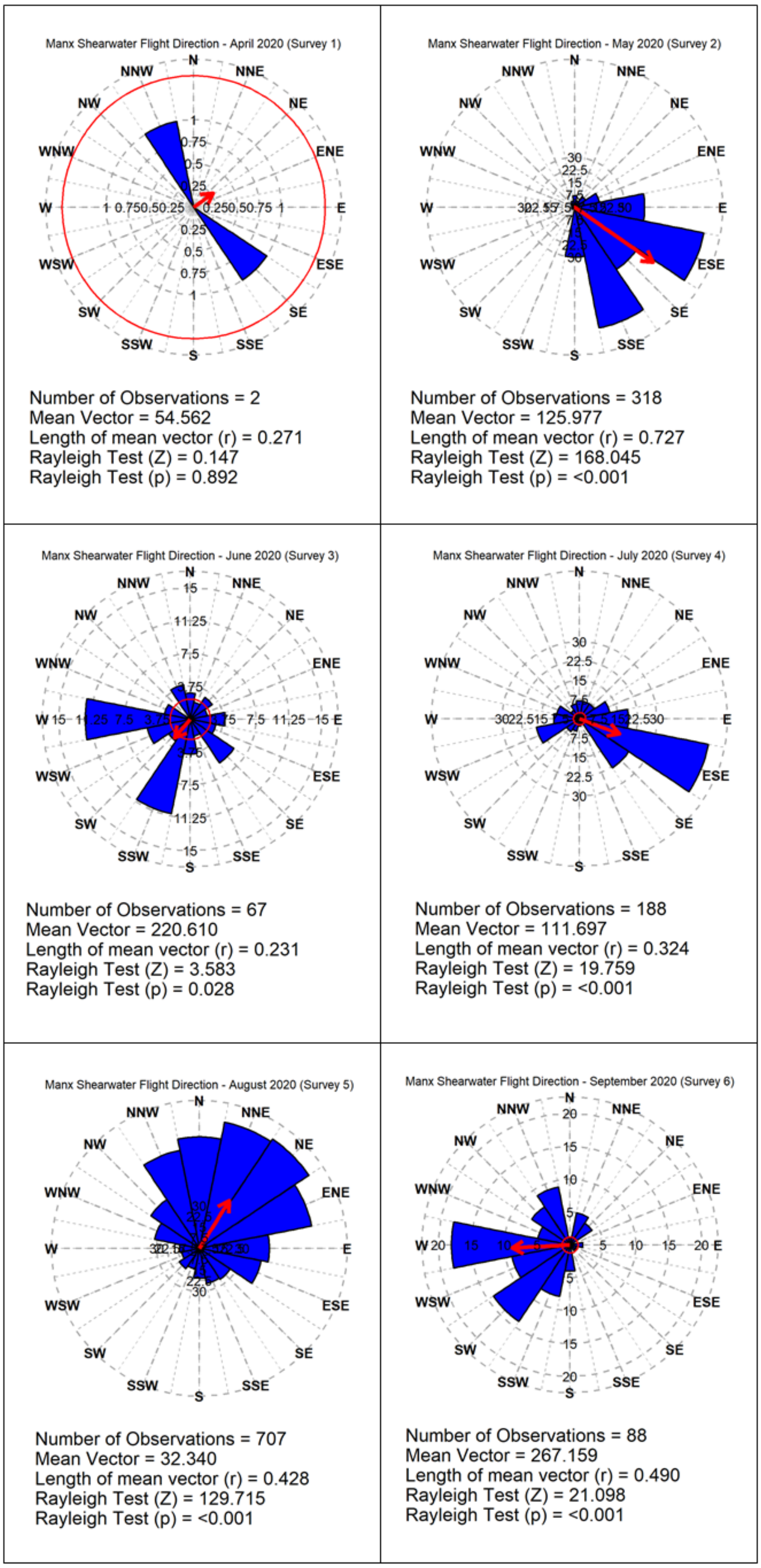
Flying Manx shearwaters were recorded in all six surveys with significant orientations recorded in five surveys. The flying Manx shearwater were significantly orientated around the mean of 126° in May 2020, 221° in June 2020, 112° in July 2020, 32° in August 2020 and 267° in September 2020 (Rayleigh test, p=<0.05, **Figure 61**).

In May, June, July, August and September 2020; 35, nine, five, 80 and four flying Manx shearwater deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 17 m above MSL (**Figure 62**).

Manx shearwater were observed across the Ornithology Study area, there were larger concentrations in the east to southeast of the area (**Figure 63**).

Table 36 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of Manx shearwater in: a) Windfarm Concession area; and b) Ornithology Study area**

<table>
<tr><th colspan="7">a) Windfarm Concession area</th></tr>
<tr><th>Survey</th><th>Raw Count</th><th>Abundance</th><th>Lower CI</th><th>Upper CI</th><th>Precision</th><th>Density</th></tr>
<tr><td>April-2020</td><td>1</td><td>3</td><td>1</td><td>8</td><td>1</td><td>0.11</td></tr>
<tr><td>May-2020</td><td>19</td><td>52</td><td>19</td><td>104</td><td>0.22942</td><td>1.88</td></tr>
<tr><td>June-2020</td><td>6</td><td>16</td><td>6</td><td>41</td><td>0.40825</td><td>0.58</td></tr>
<tr><td>July-2020</td><td>2</td><td>6</td><td>2</td><td>17</td><td>0.70711</td><td>0.22</td></tr>
<tr><td>August-2020</td><td>24</td><td>65</td><td>35</td><td>85</td><td>0.20412</td><td>2.35</td></tr>
<tr><td>September-2020</td><td>4</td><td>11</td><td>4</td><td>25</td><td>0.5</td><td>0.4</td></tr>
<tr><th colspan="7">b) Ornithology Study area</th></tr>
<tr><th>Survey</th><th>Raw Count</th><th>Abundance</th><th>Lower CI</th><th>Upper CI</th><th>Precision</th><th>Density</th></tr>
<tr><td>April-2020</td><td>5</td><td>14</td><td>5</td><td>26</td><td>0.44721</td><td>0.04</td></tr>
<tr><td>May-2020</td><td>484</td><td>1403</td><td>484</td><td>2873</td><td>0.04545</td><td>4.39</td></tr>
<tr><td>June-2020</td><td>73</td><td>210</td><td>106</td><td>356</td><td>0.11704</td><td>0.66</td></tr>
<tr><td>July-2020</td><td>112</td><td>321</td><td>118</td><td>594</td><td>0.09449</td><td>1</td></tr>
<tr><td>August-2020</td><td>1245</td><td>3577</td><td>1640</td><td>5665</td><td>0.02834</td><td>11.18</td></tr>
<tr><td>September-2020</td><td>88</td><td>257</td><td>117</td><td>408</td><td>0.1066</td><td>0.8</td></tr>
</table>



Manx Shearwater Flight Direction - April 2020 (Survey 1)

Number of Observations = 2
Mean Vector = 54.562
Length of mean vector (r) = 0.271
Rayleigh Test (Z) = 0.147
Rayleigh Test (p) = 0.892

Manx Shearwater Flight Direction - May 2020 (Survey 2)

Number of Observations = 318
Mean Vector = 125.977
Length of mean vector (r) = 0.727
Rayleigh Test (Z) = 168.045
Rayleigh Test (p) = <0.001

Manx Shearwater Flight Direction - June 2020 (Survey 3)

Number of Observations = 67
Mean Vector = 220.610
Length of mean vector (r) = 0.231
Rayleigh Test (Z) = 3.583
Rayleigh Test (p) = 0.028

Manx Shearwater Flight Direction - July 2020 (Survey 4)

Number of Observations = 188
Mean Vector = 111.697
Length of mean vector (r) = 0.324
Rayleigh Test (Z) = 19.759
Rayleigh Test (p) = <0.001

Manx Shearwater Flight Direction - August 2020 (Survey 5)

Number of Observations = 707
Mean Vector = 32.340
Length of mean vector (r) = 0.428
Rayleigh Test (Z) = 129.715
Rayleigh Test (p) = <0.001

Manx Shearwater Flight Direction - September 2020 (Survey 6)

Number of Observations = 88
Mean Vector = 267.159
Length of mean vector (r) = 0.490
Rayleigh Test (Z) = 21.098
Rayleigh Test (p) = <0.001

Figure 61 Summary of flight direction of Manx shearwater during the six surveys

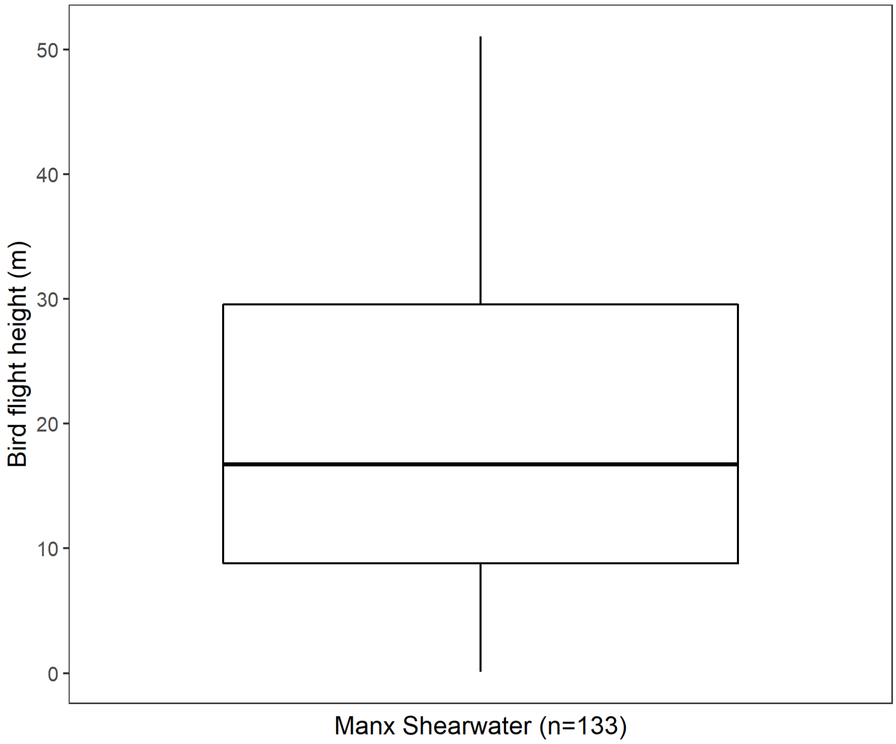


Figure 62 Flight heights of Manx shearwater (n=133) recorded in the Ornithology Study area

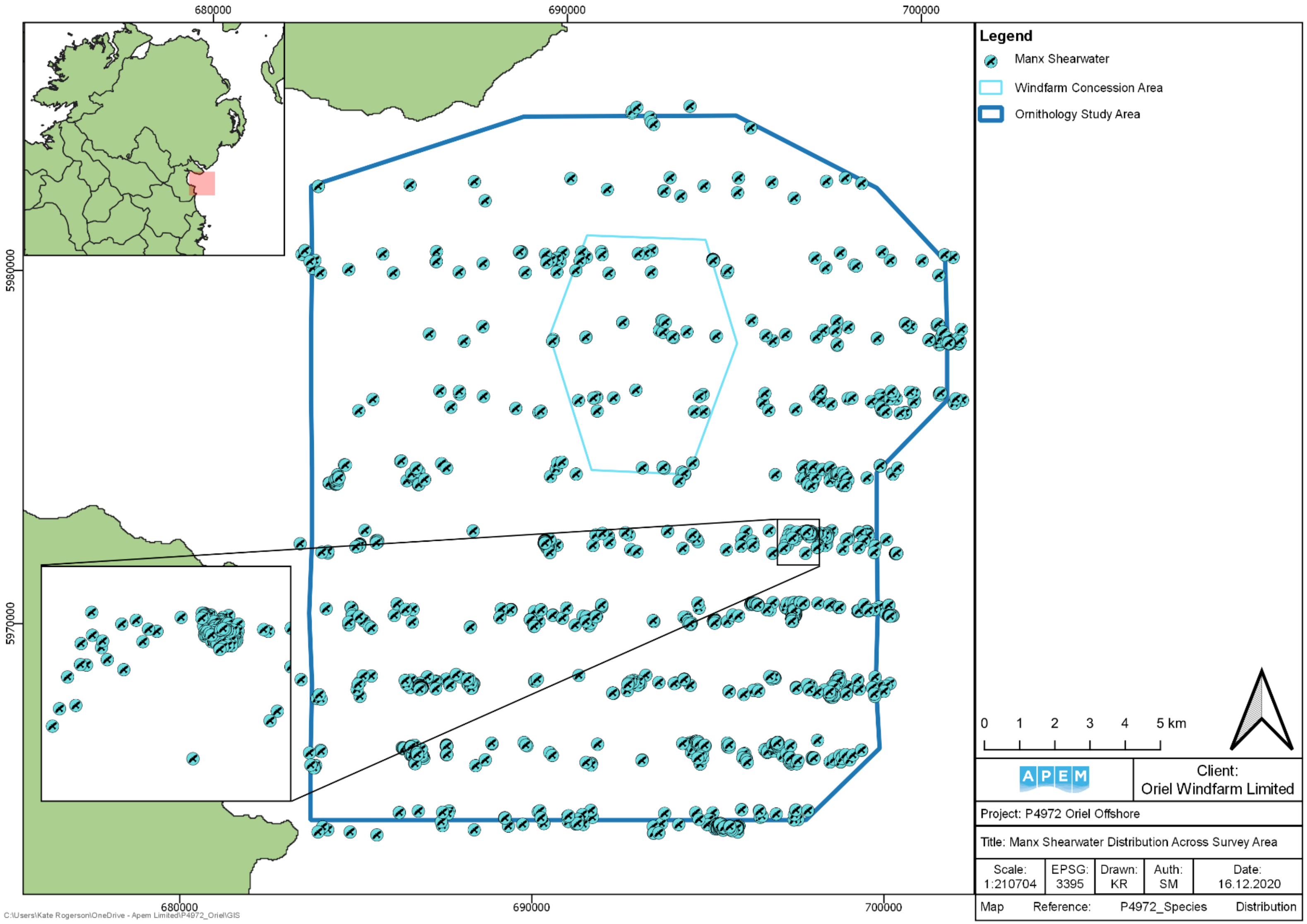


Figure 63 Distribution of Manx shearwater recorded across the Ornithology Study area

5.33 Gannet

Overall 683 gannet were identified, 73 in April 2020, 127 in May 2020, 41 in June 2020, 156 in July 2020, 145 in August 2020 and 141 in September 2020 surveys.

A peak count of 144 in July 2020 resulted in an abundance estimate of 413 for the Ornithology Study area (**Table 37**).

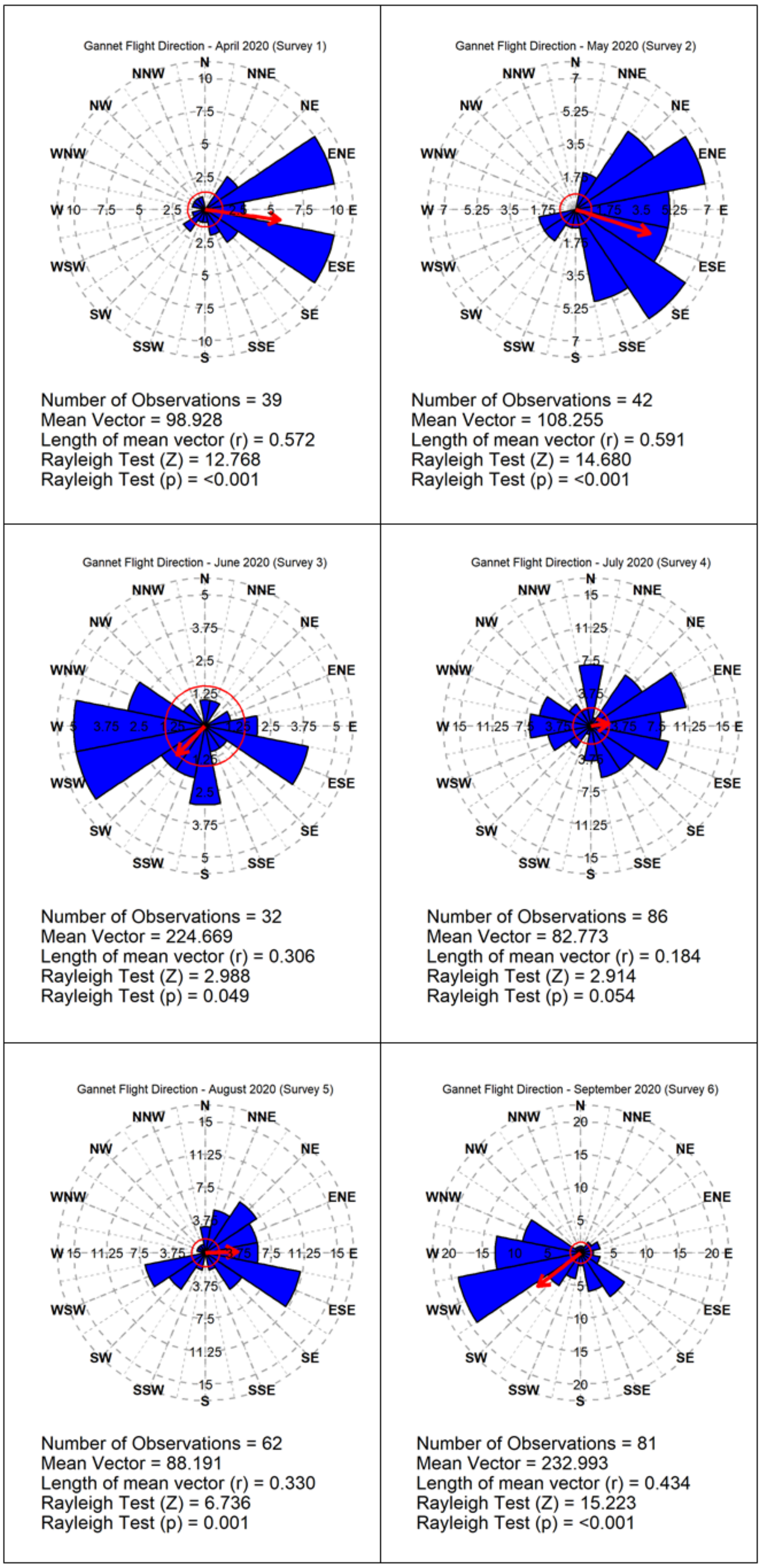
Flying gannet were recorded in all six surveys, and a significant orientation was observed in four of the surveys. The flying gannet were significantly orientated around the mean of 99° in April 2020, 108° in May 2020, 225° in June 2020, 88° in August 2020 and 233° in September 2020 (Rayleigh test, p=<0.05, **Figure 64**).

In April, May, June, July, August and September 2020; five, 13, eight, five, 19 and 14 flying gannet deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 21 m above MSL (**Figure 65**).

There is no spatial distribution pattern in the locations of gannet, with gannet observed across the Ornithology Study area (**Figure 66**).

Table 37 Raw counts and abundance and density estimates (No. estimated individuals per km2) of gannet in: a) Windfarm Concession area; and b) Ornithology Study area

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	5	13	5	27	0.44721	0.47
May-2020	49	135	49	300	0.14286	4.87
June-2020	1	3	1	8	1	0.11
July-2020	20	55	33	77	0.22361	1.98
August-2020	12	33	12	55	0.28868	1.19
September-2020	12	33	12	77	0.28868	1.19
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	64	185	66	326	0.125	0.58
May-2020	122	354	148	641	0.09054	1.11
June-2020	33	95	52	135	0.17408	0.3
July-2020	144	413	238	583	0.08333	1.29
August-2020	120	345	221	477	0.09129	1.08
September-2020	124	362	175	627	0.0898	1.13



Gannet Flight Direction - April 2020 (Survey 1)

Number of Observations = 39
Mean Vector = 98.928
Length of mean vector (r) = 0.572
Rayleigh Test (Z) = 12.768
Rayleigh Test (p) = <0.001

Gannet Flight Direction - May 2020 (Survey 2)

Number of Observations = 42
Mean Vector = 108.255
Length of mean vector (r) = 0.591
Rayleigh Test (Z) = 14.680
Rayleigh Test (p) = <0.001

Gannet Flight Direction - June 2020 (Survey 3)

Number of Observations = 32
Mean Vector = 224.669
Length of mean vector (r) = 0.306
Rayleigh Test (Z) = 2.988
Rayleigh Test (p) = 0.049

Gannet Flight Direction - July 2020 (Survey 4)

Number of Observations = 86
Mean Vector = 82.773
Length of mean vector (r) = 0.184
Rayleigh Test (Z) = 2.914
Rayleigh Test (p) = 0.054

Gannet Flight Direction - August 2020 (Survey 5)

Number of Observations = 62
Mean Vector = 88.191
Length of mean vector (r) = 0.330
Rayleigh Test (Z) = 6.736
Rayleigh Test (p) = 0.001

Gannet Flight Direction - September 2020 (Survey 6)

Number of Observations = 81
Mean Vector = 232.993
Length of mean vector (r) = 0.434
Rayleigh Test (Z) = 15.223
Rayleigh Test (p) = <0.001

Figure 64 Summary of flight direction of gannet during the six surveys

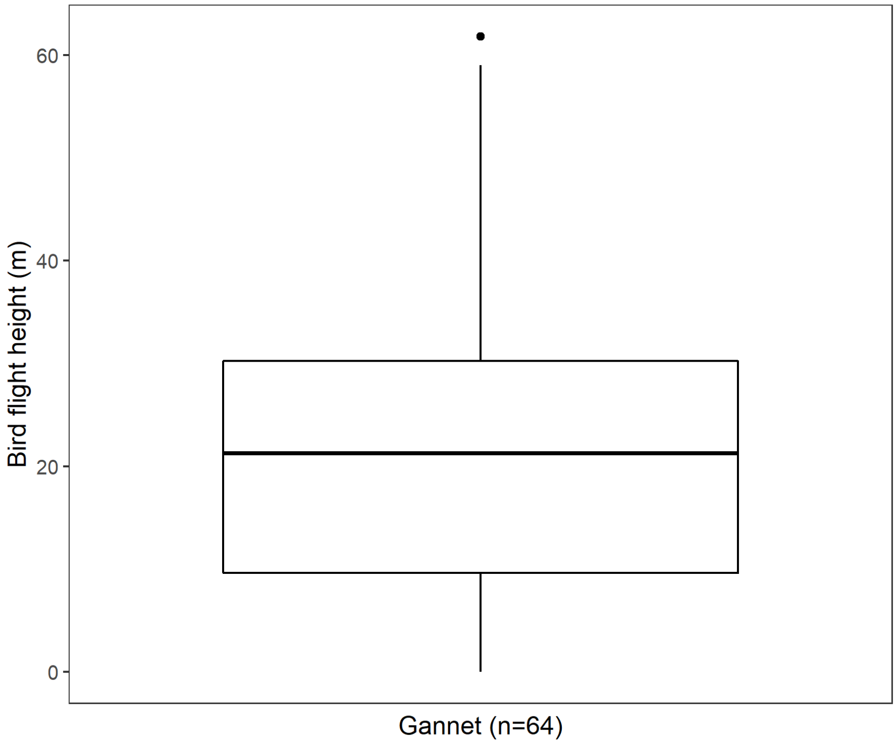


Figure 65 Flight heights of gannets (n=64) recorded in the Ornithology Study area

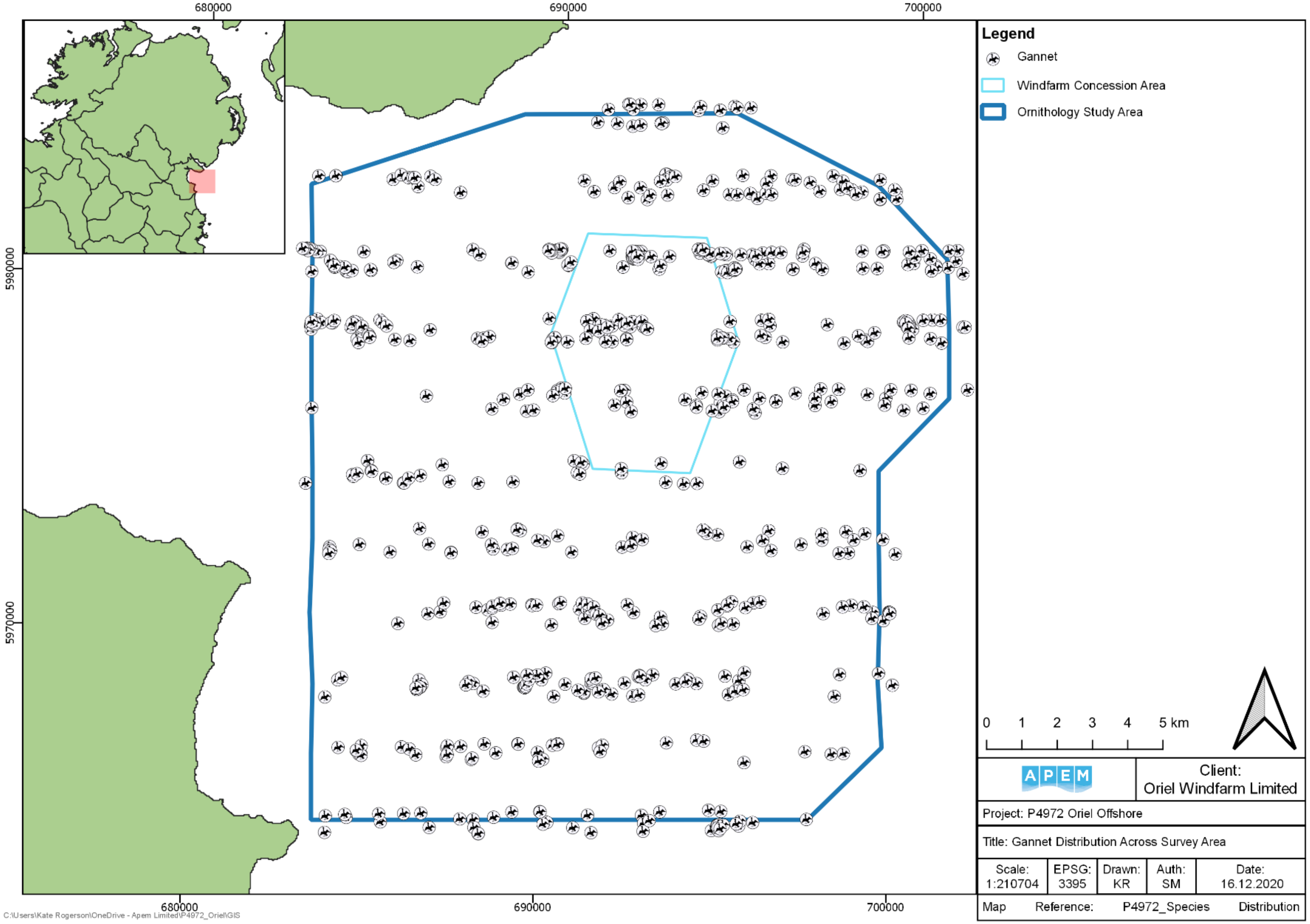


Figure 66 Distribution of gannet recorded across the Ornithology Study area

5.34 Cormorant

Overall 16 cormorant were identified in the surveys, one in April 2020, nine in June 2020, four in July 2020, one in August 2020 and one in September 2020 surveys. Cormorant were not identified in May 2020 survey.

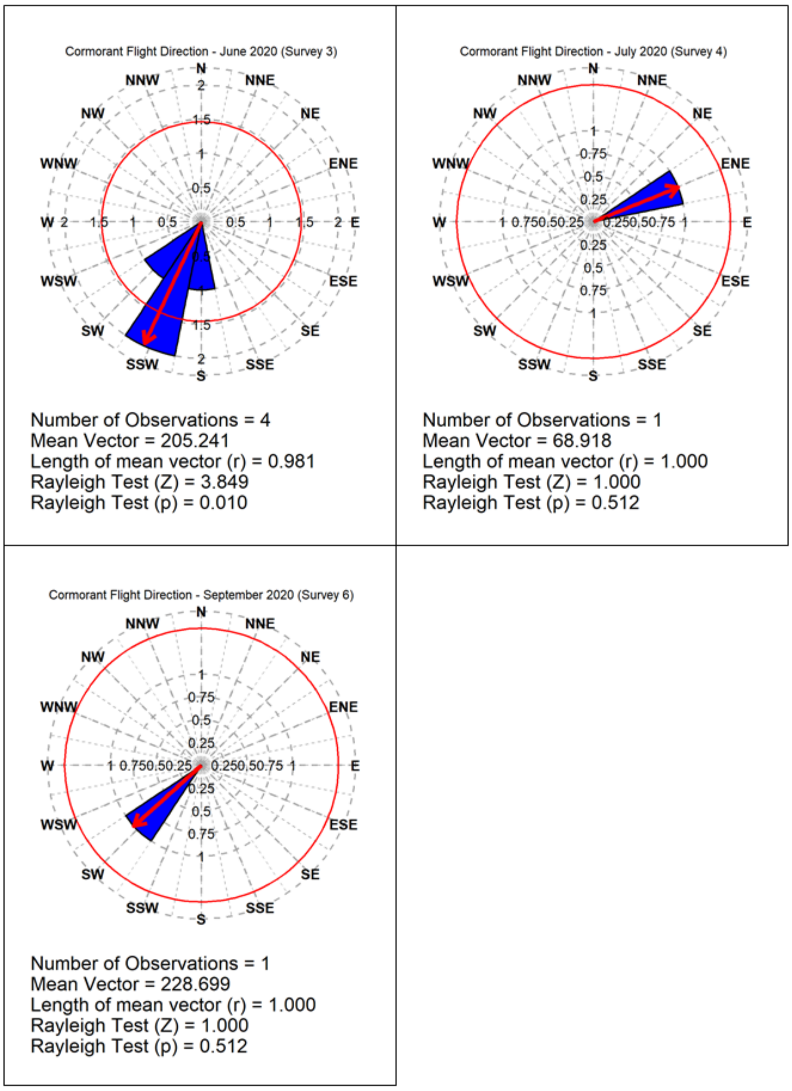
A peak count of nine cormorants in June 2020 resulted in an abundance estimate of 26 for the Ornithology Study area (**Table 38**).

Flying cormorants were observed in June, July and September surveys. In June 2020 the flying gannets were significantly orientated around a mean of 205° (Rayleigh test, p=<0.05, **Figure 67**)

The cormorants were loosely located across the Ornithology Study area (**Figure 68**).

Table 38 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of cormorant in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
July-2020	2	6	2	17	0.70711	0.22
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	9	26	9	55	0.33333	0.08
July-2020	3	9	3	26	0.57735	0.03
August-2020	1	3	1	9	1	0.01
September-2020	1	3	1	9	1	0.01



Number of Observations = 4
Mean Vector = 205.241
Length of mean vector (r) = 0.981
Rayleigh Test (Z) = 3.849
Rayleigh Test (p) = 0.010

Number of Observations = 1
Mean Vector = 68.918
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Number of Observations = 1
Mean Vector = 228.699
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

Figure 67 Summary of flight direction of cormorant during the June, July and September 2020 surveys

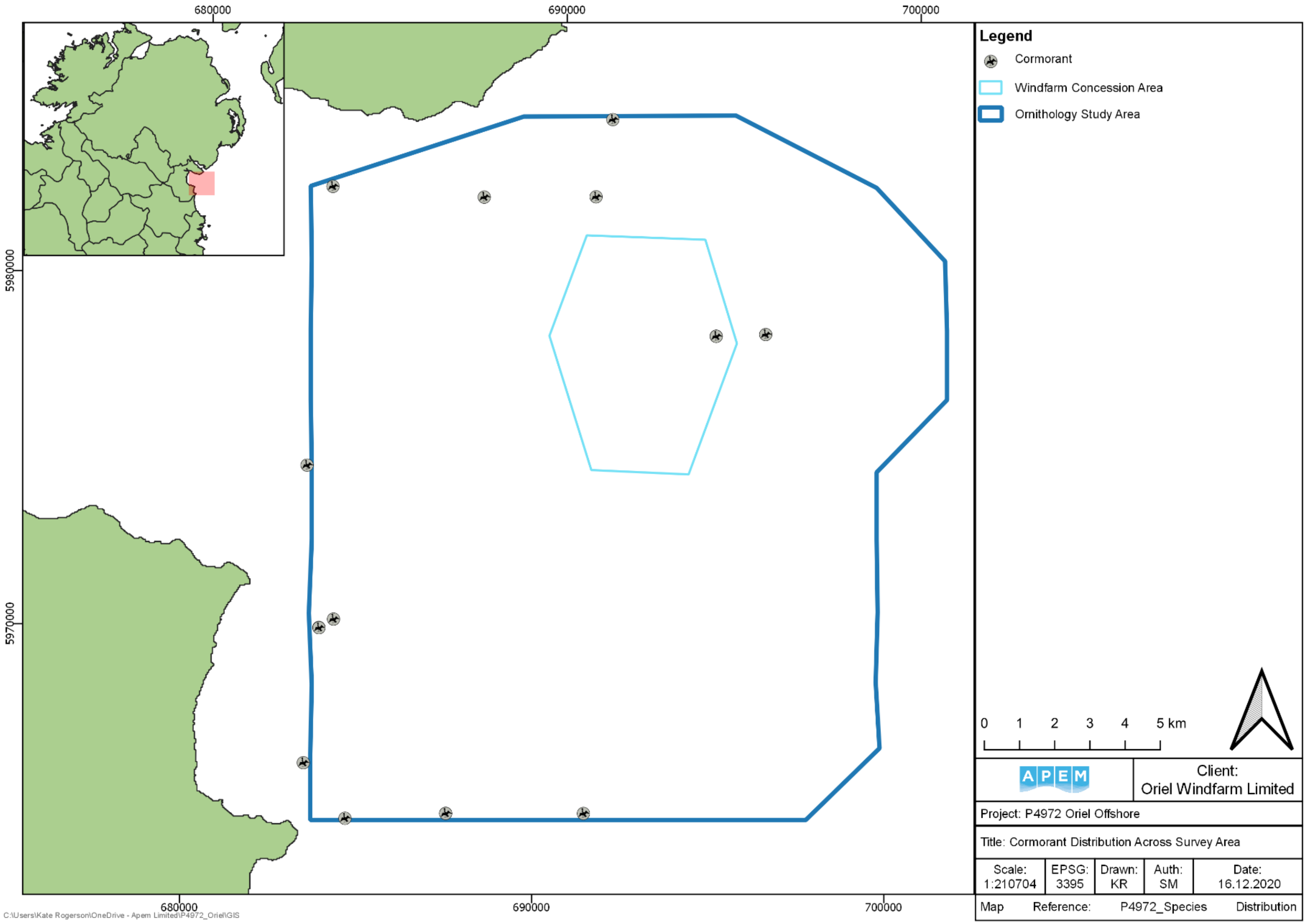


Figure 68 Distribution of cormorant recorded across the Ornithology Study area

5.35 Cormorant / Shag

Overall six cormorant / shag were identified, two in April 2020, two in May 2020 and two in September 2020 surveys. Cormorant / shag were not recorded in June, July and August 2020 surveys.

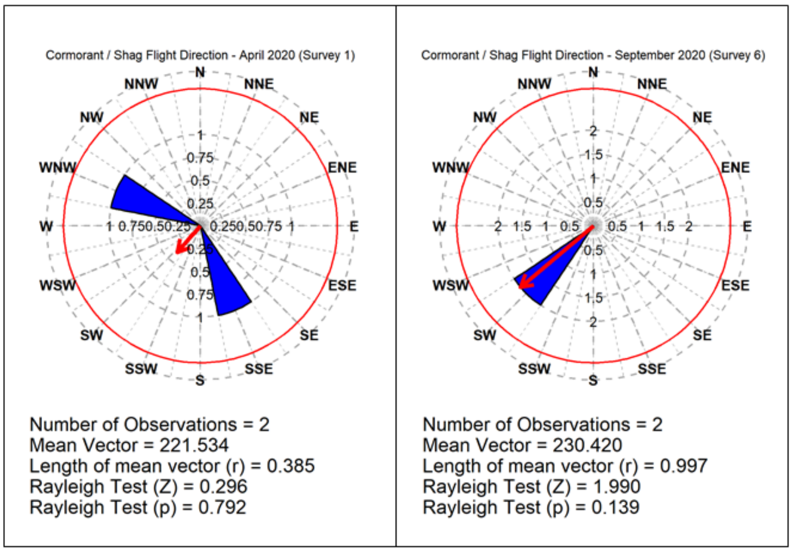
A peak raw count of two in May 2020 resulted in abundance estimates of six in the Ornithology Study area (**Table 39**).

Flying cormorant / shag were recorded in the April and September surveys. In the April 2020 survey, one flew in a west- northwest direction and the second flew in a south-southeast direction. In September, the two flying birds flew in a southern-westerly direction (**Figure 69**).

The cormorant / shag individuals were located in pairs, one pair in the southwest corner of the Ornithology Study area, just outside the boundary in April 2020 and the other two pairs located to the northwest of the Windfarm Concession area (**Figure 70**). No cormorant / shag individuals were recorded in the Windfarm Concession area.

Table 39 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of cormorant / shag in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	2	6	2	17	0.70711	0.02
September	2	6	2	18	0.70711	0.02



Cormorant / Shag Flight Direction - April 2020 (Survey 1)

Number of Observations = 2
Mean Vector = 221.534
Length of mean vector (r) = 0.385
Rayleigh Test (Z) = 0.296
Rayleigh Test (p) = 0.792

Cormorant / Shag Flight Direction - September 2020 (Survey 6)

Number of Observations = 2
Mean Vector = 230.420
Length of mean vector (r) = 0.997
Rayleigh Test (Z) = 1.990
Rayleigh Test (p) = 0.139

Figure 69 Summary of flight direction of cormorant / shag during the April and September 2020 survey

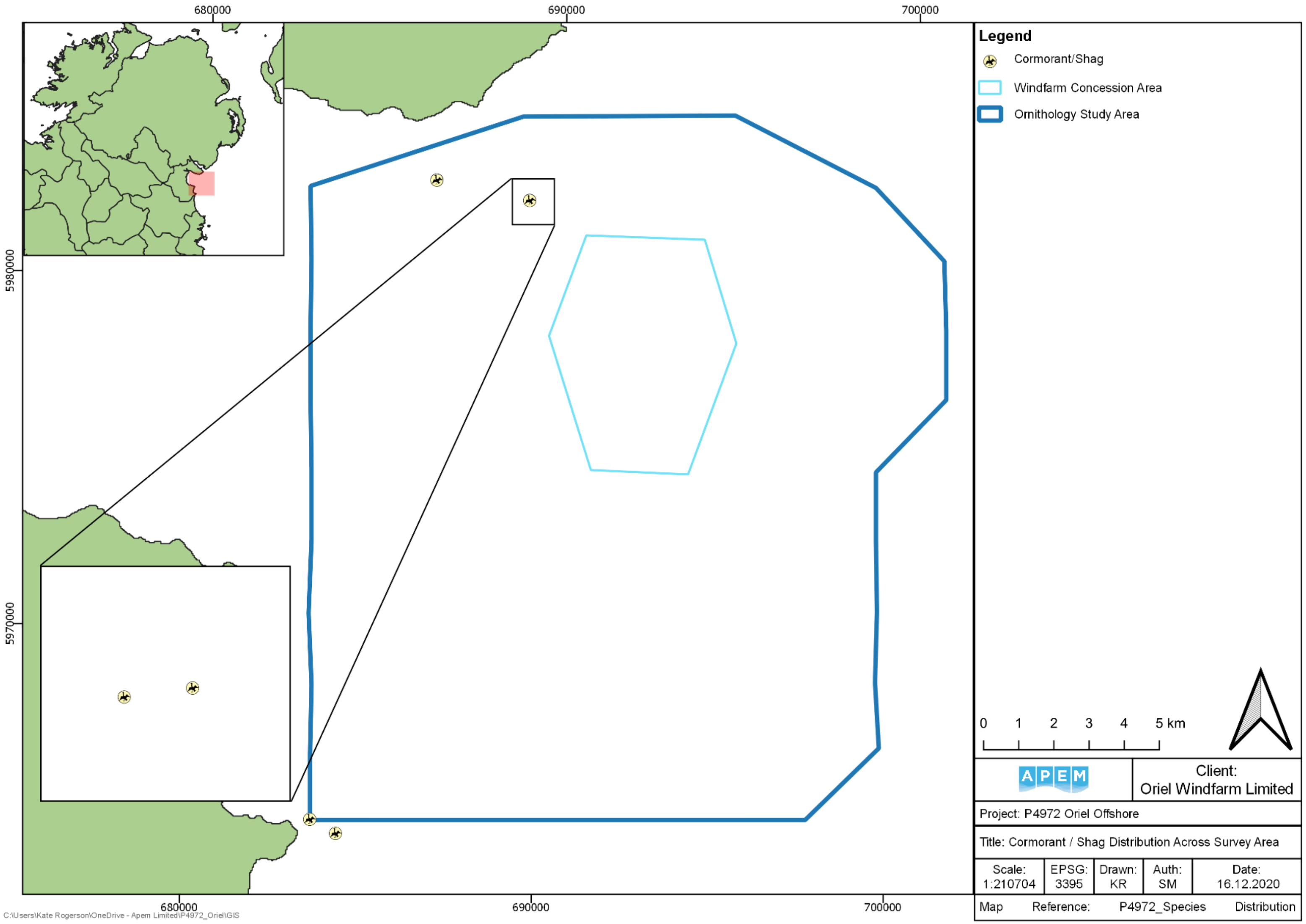


Figure 70 Location of cormorant / shag recorded across the Ornithology Study area

5.36 Grey Seal

Overall four grey seal were identified in the surveys, two in the August 2020 and two in September 2020 Surveys. Grey seal were not recorded in the April 2020, May 2020, June 2020 and July 2020 surveys.

A peak count of two grey seal in August 2020 resulted in an abundance estimate of six for the Ornithology Study area (**Table 40**).

Grey seal were recorded in the north east of the Ornithology Study area (**Figure 71**). No grey seal were recorded in the Windfarm Concession area.

Table 40 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of grey seal in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
August-2020	2	6	2	14	0.70711	0.02
September-2020	2	6	2	18	0.70711	0.02

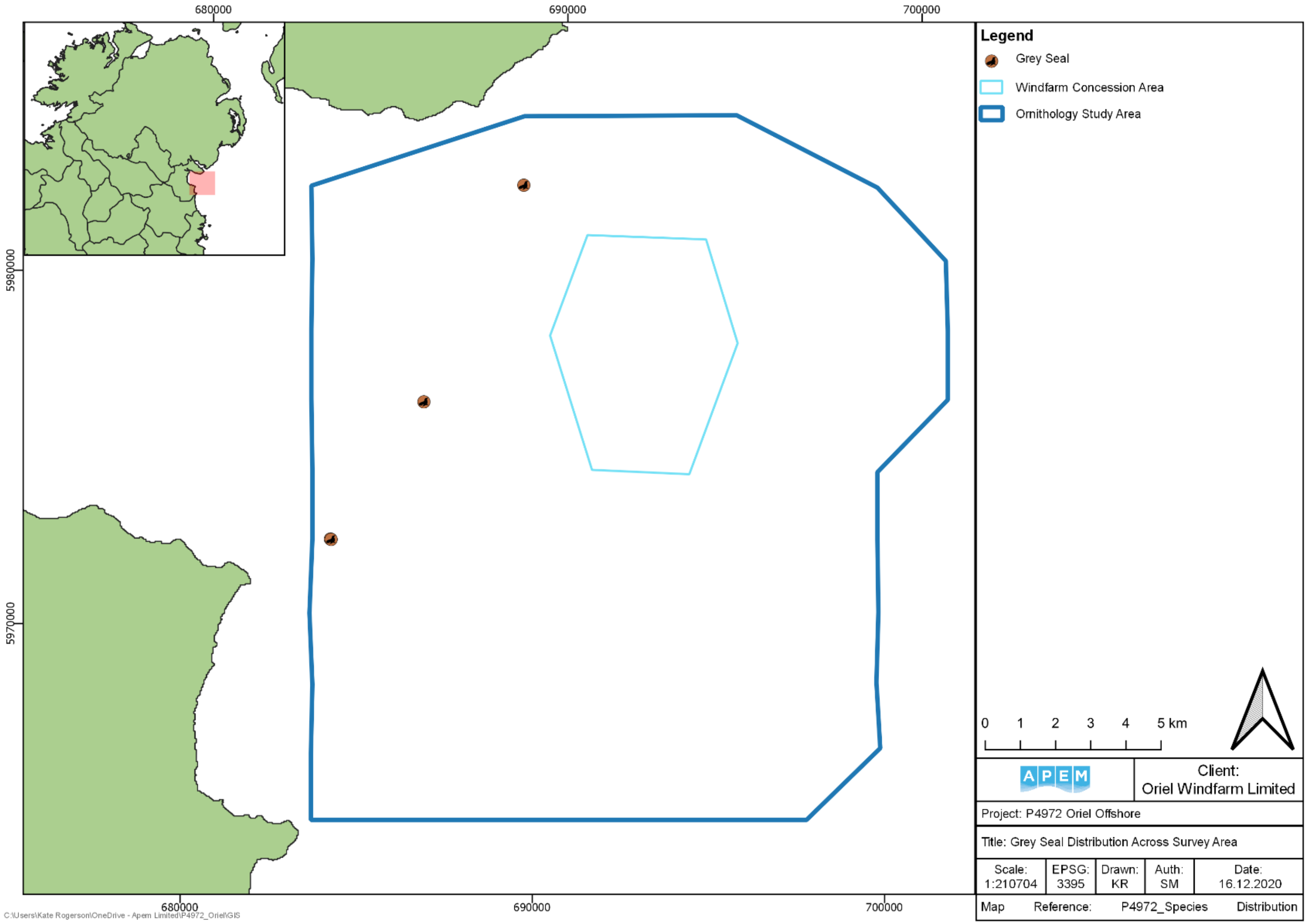


Figure 71 Distribution of grey seal recorded across the Ornithology Study area

5.37 Phocids – unidentified

Overall 18 phocids were identified in the surveys, four in May 2020, seven in June 2020, three in July 2020, one in August 2020 and three in September 2020 surveys. Phocids were not recorded in the April 2020 survey.

A peak count of seven phocids in June 2020 resulted in an abundance estimate of 20 for the Ornithology Study area (**Table 41**).

Phocids showed no spatial distribution pattern and were recorded across the Ornithology Study area (**Figure 72**).

Table 41 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of phocids in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	3	8	3	16	0.57735	0.29
September-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	3	9	3	17	0.57735	0.03
June-2020	7	20	7	34	0.37796	0.06
July-2020	2	6	2	14	0.70711	0.02
September-2020	2	6	2	15	0.70711	0.02

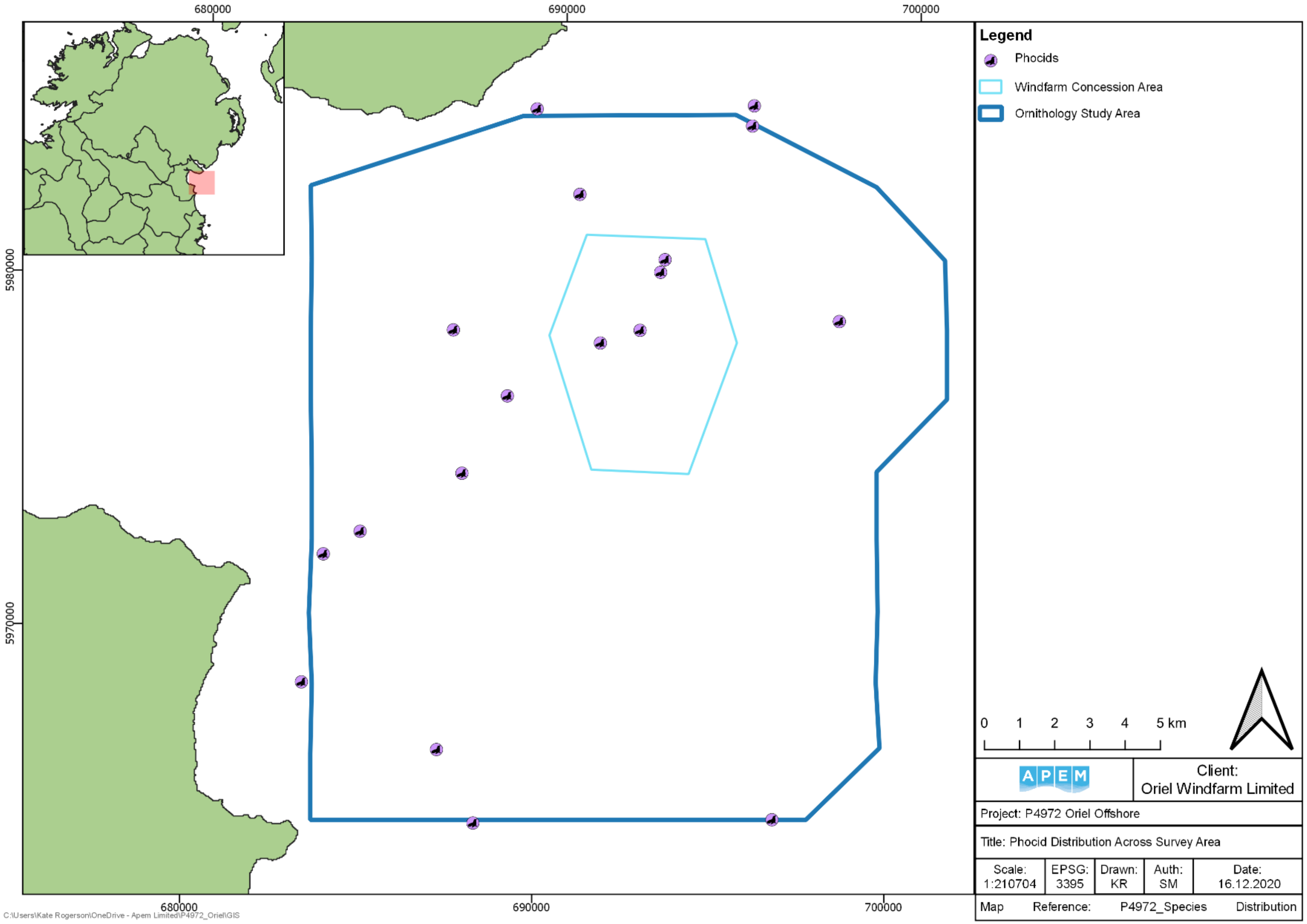


Figure 72 Distribution of phocids recorded across the Ornithology Study area

5.38 Dolphin Species – unidentified

During the September 2020 survey, three unidentified dolphin species were recorded. Dolphin species were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

A peak count of two unidentified dolphin species in September 2020 resulted in an abundance estimate of six for the Ornithology Study area (**Table 42**).

Unidentified dolphin species were located across the south of the Ornithology Study area (**Figure 73**).

Table 42 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of harbour porpoise in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	2	6	2	18	0.70711	0.02

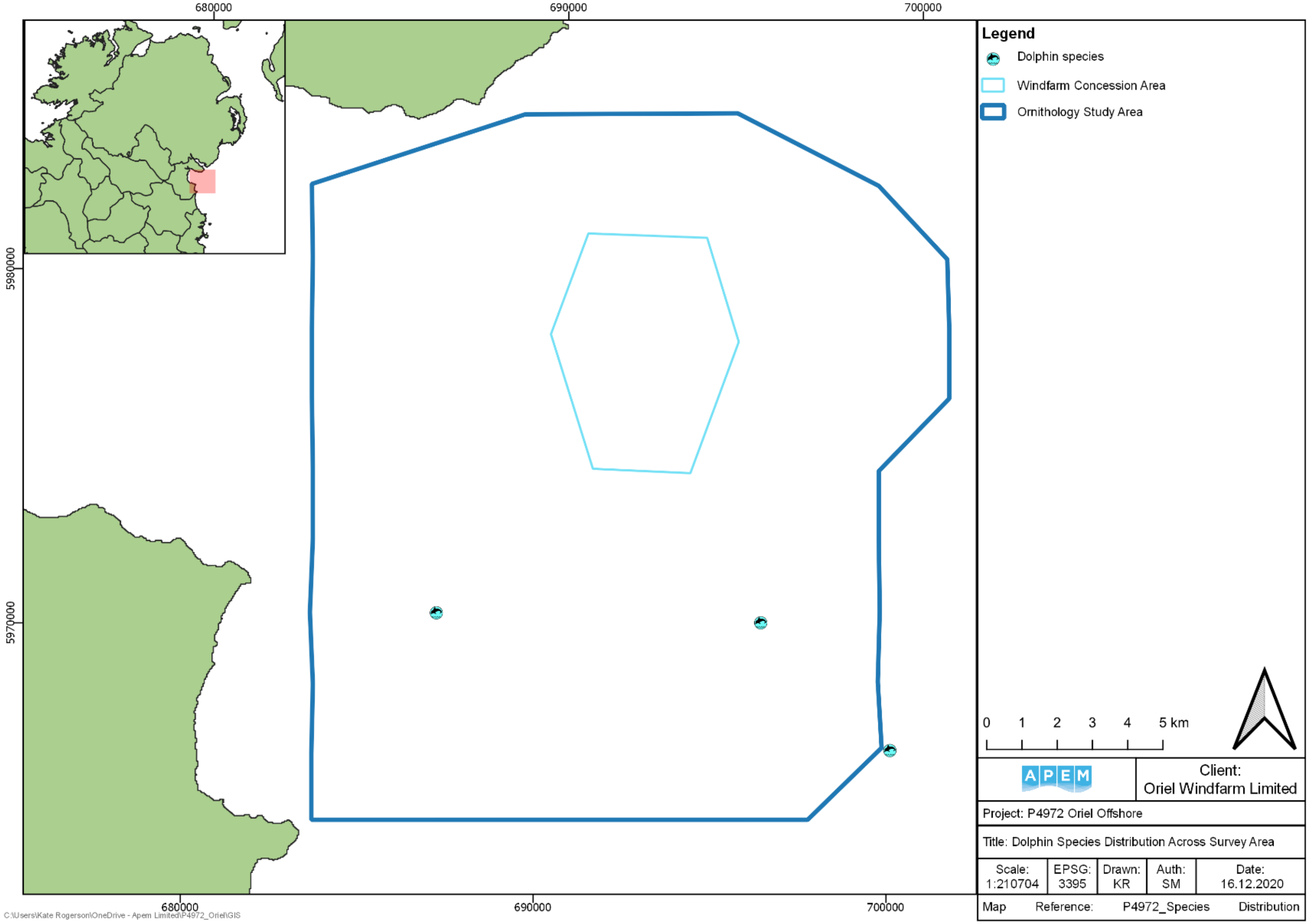


Figure 73 Location of unidentified dolphin species recorded in the Ornithology Study area

5.39 Harbour Porpoise

Overall six harbour porpoise were identified, one in the June 2020, two in the August 2020 and three in September 2020 surveys. Harbour Porpoise were not recorded in the April 2020, May 2020 and July 2020 surveys.

A peak count of three harbour porpoise in September 2020 resulted in an abundance estimate of nine for the Ornithology Study area (**Table 43**).

The harbour porpoise recorded in June and one recorded in August were both outside of the boundary for the Ornithology Study area along the southern edge (**Figure 74**), while the second to be recorded in August was observed in the west of the Ornithology Study area and the three recorded in September were observed in the centre-south of the Ornithology Study area.

Table 43 Raw counts and abundance and density estimates (No. estimated individuals per km2) of harbour porpoise in: a) Windfarm Concession area; and b) Ornithology Study area

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
August-2020	1	3	1	9	1	0.01
September-2020	3	9	3	18	0.57735	0.03

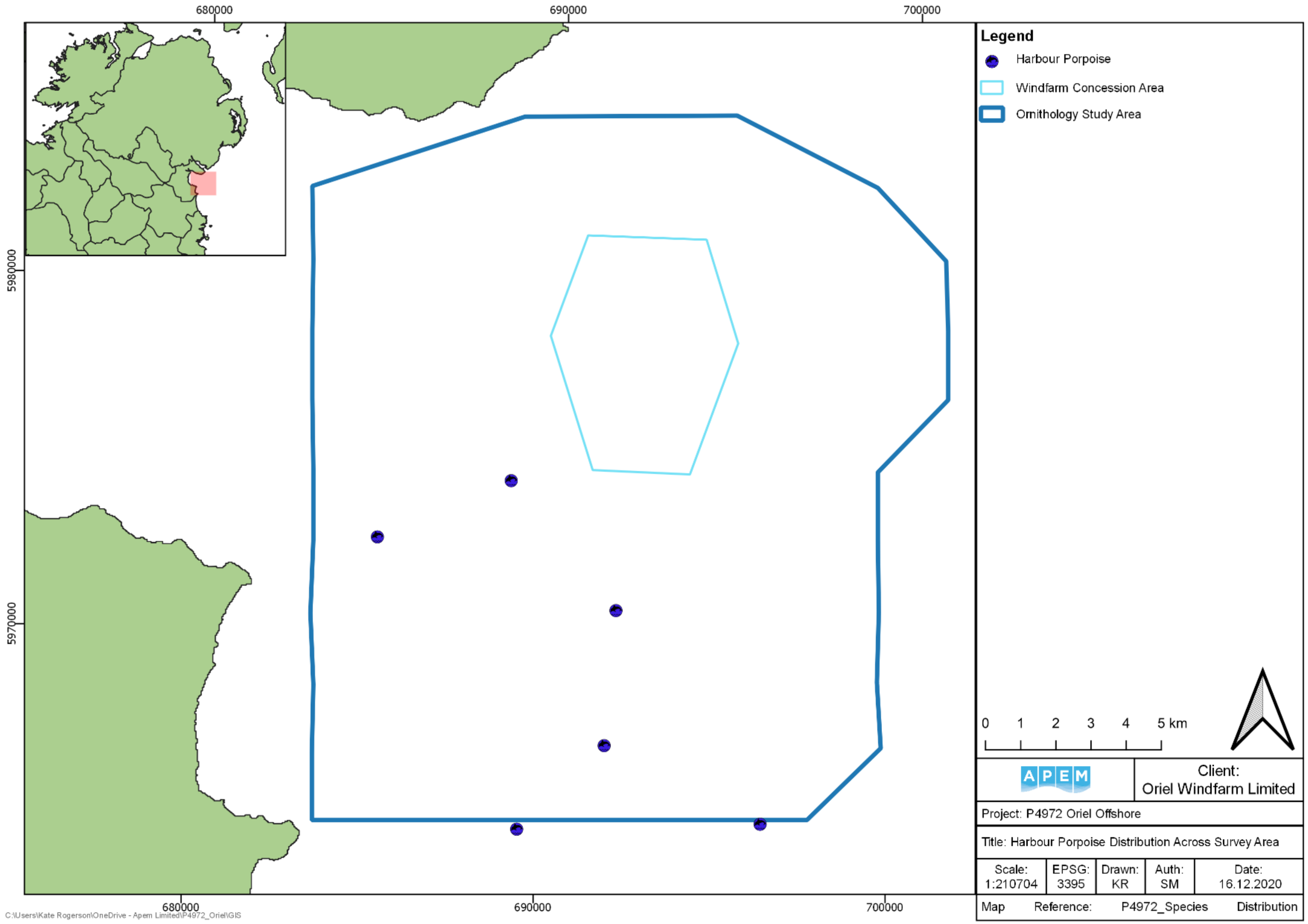


Figure 74 Location of harbour porpoise recorded in the Ornithology Study area

5.40 Dolphin / Porpoise Species – unidentified

Overall 45 dolphin / porpoise were identified, 18 in April 2020, five in May 2020, 15 August 2020 and seven in September 2020 surveys.

The peak count of 16 dolphin / porpoise in April 2020 resulted in an abundance estimate of 46 for the Ornithology Study area (**Table 44**).

Dolphin / porpoise were observed across the Ornithology Study area (**Figure 75**).

Table 44 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of dolphin / porpoise in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	9	24	9	64	0.33333	0.87
May-2020	3	8	3	16	0.57735	0.29
b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	16	46	16	95	0.25	0.14
May -2020	5	14	5	29	0.44721	0.04
August-2020	15	43	15	83	0.2582	0.13
September-2020	6	18	6	32	0.40825	0.06

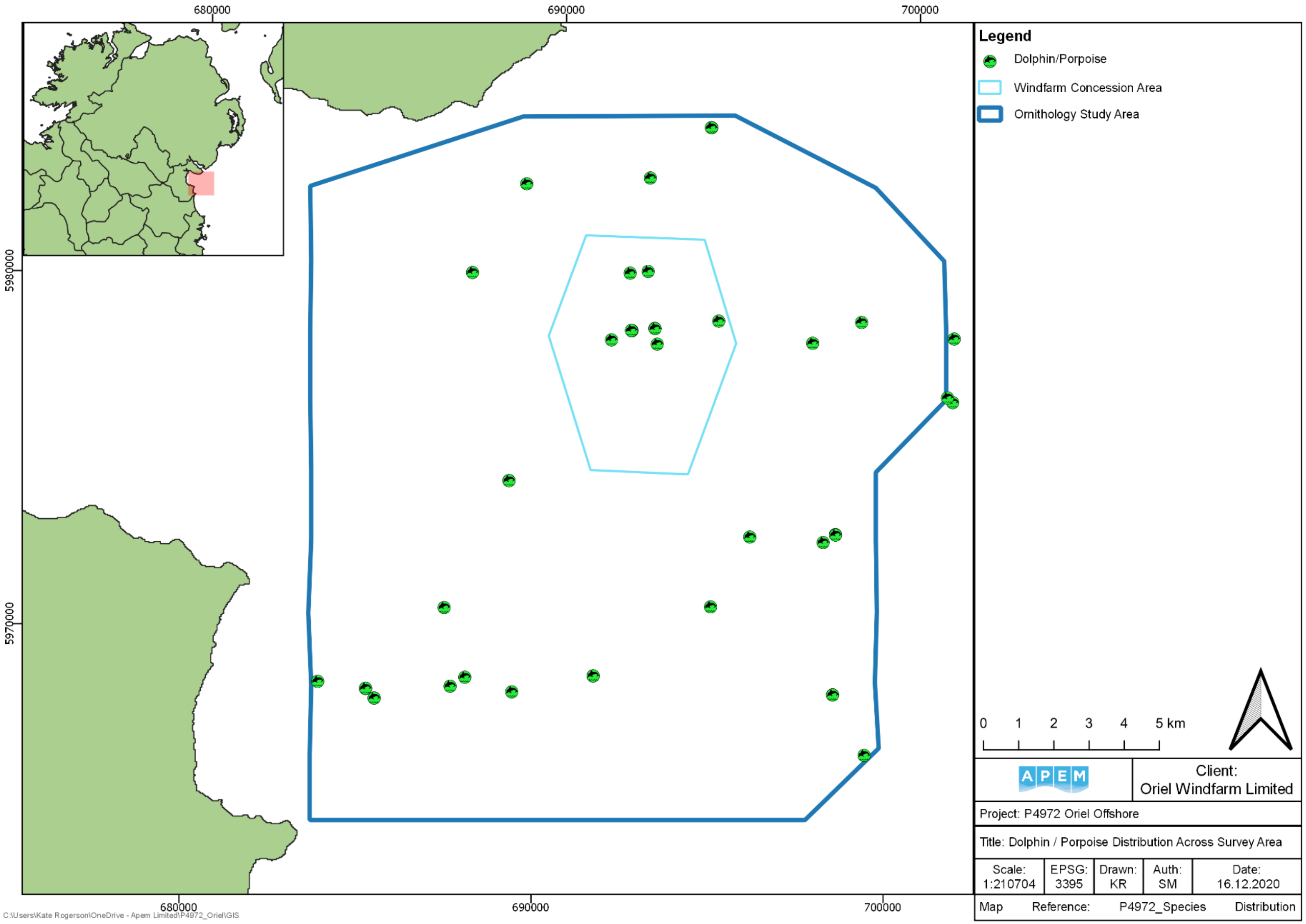


Figure 75 Distribution of dolphin / porpoise recorded in the Ornithology Study area

5.41 Common Minke Whale

During the September 2020 survey, one common minke whale were identified. No common minke whale were recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The single count resulted in an abundance estimate of three for the Ornithology Study area (**Table 45**).

The common minke whale was observed on the southwest tip of the Windfarm Concession Area (**Figure 76**).

Table 45 Raw counts and abundance and density estimates (No. estimated individuals per km2) of shark species in: a) Windfarm Concession area; and b) Ornithology Study area

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	1	3	1	9	1	0.01

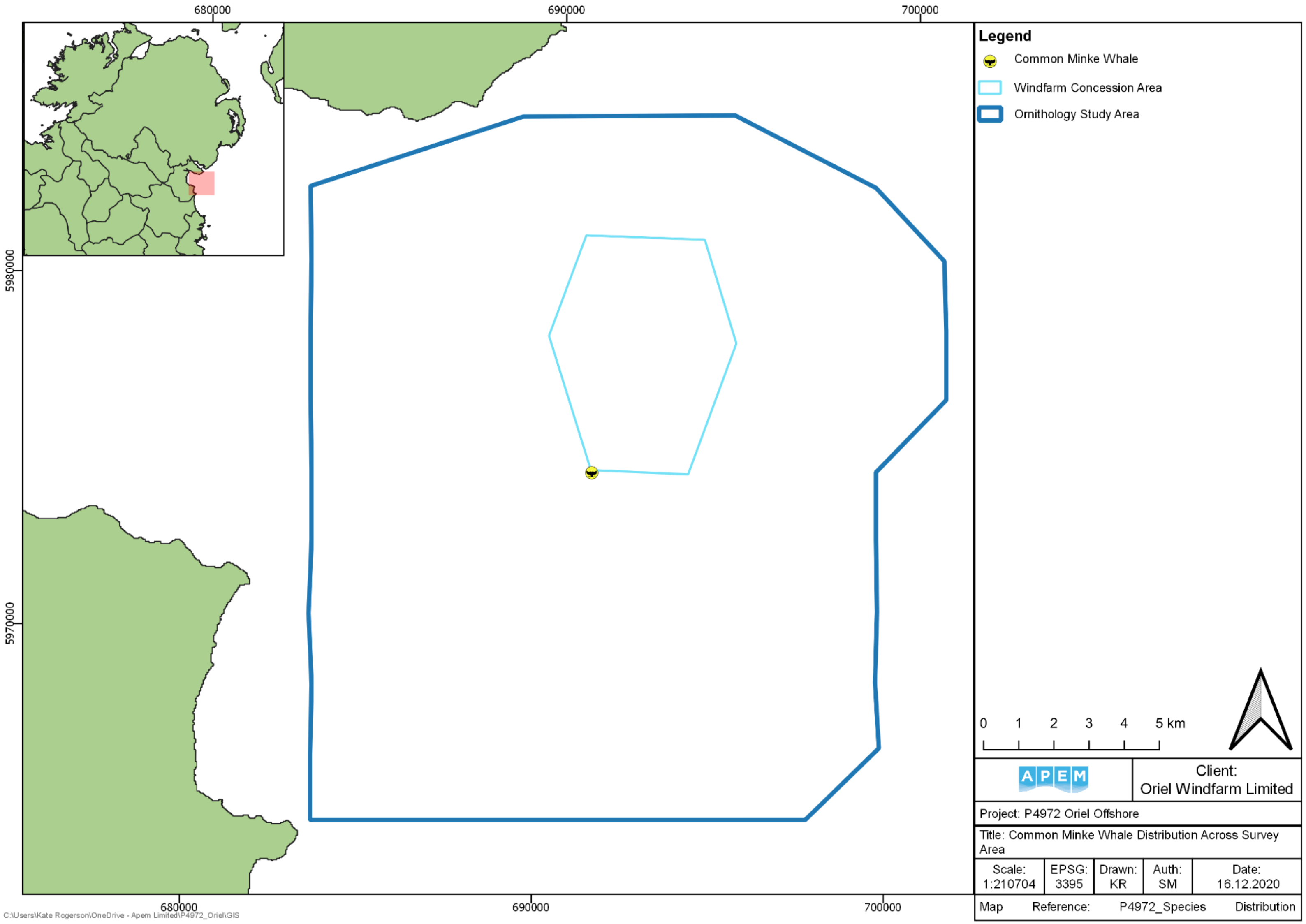


Figure 76 Location of common minke whale in the Ornithology Survey area.

5.42 Baleen Whale Species – unidentified

During the September 2020 survey, one unidentified baleen whale species was recorded. Baleen Whale species were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The single count resulted in an abundance estimate of three for the Ornithology Study area (**Table 46**).

The unidentified baleen whale was located in the southeast of the Ornithology Study area (**Figure 77**).

Table 46 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of shark species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	1	3	1	9	1	0.01

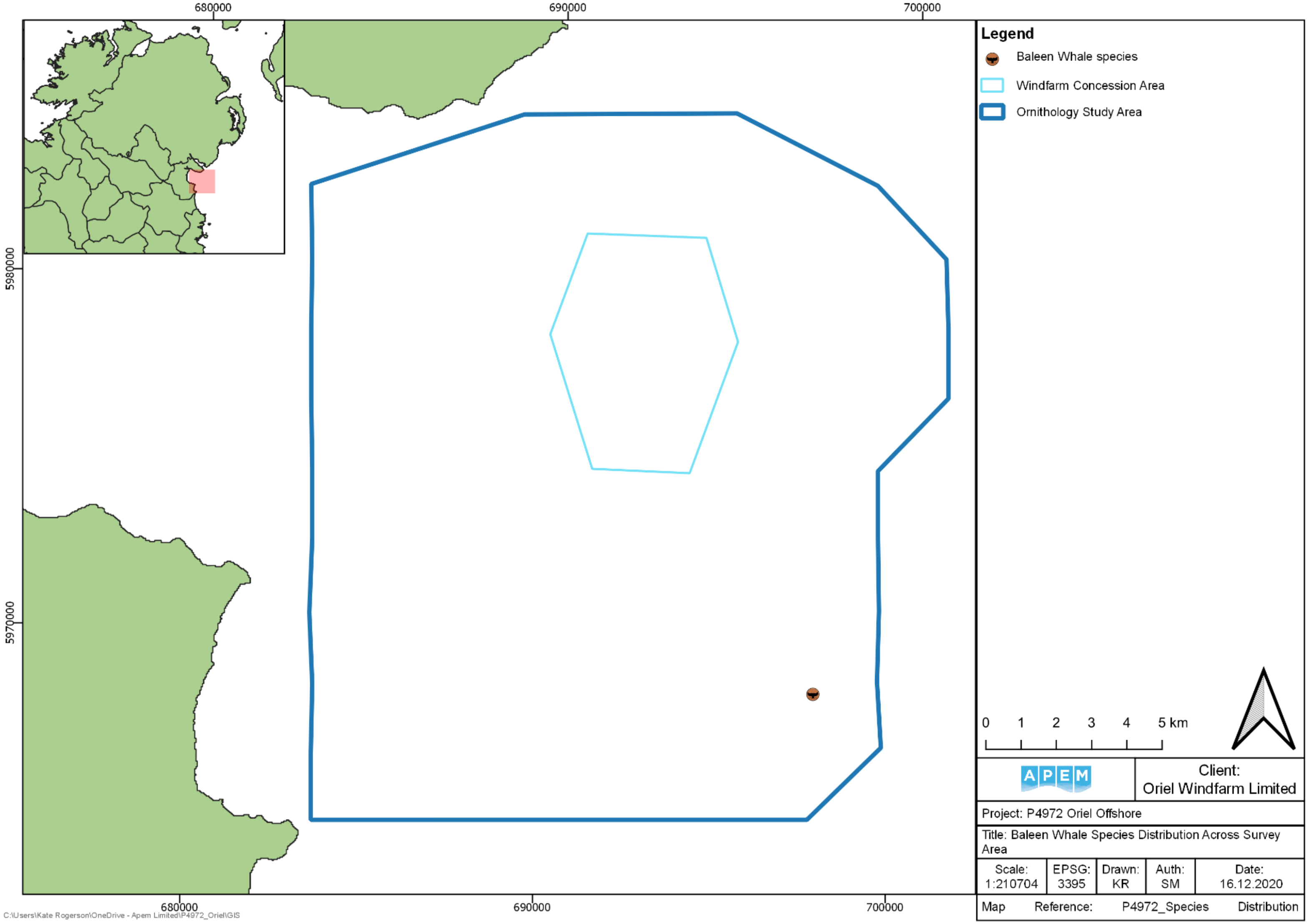


Figure 77 Location of unidentified baleen whale in the Ornithology Survey area.

5.43 Marine Mammal Species – unidentified

During the September 2020 survey, two unidentified marine mammal species were recorded. Marine Mammal species were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The single count resulted in an abundance estimate of three for the Ornithology Study area (**Table 47**).

The unidentified marine mammals were located to the east of the Windfarm Concession Area and in the southwest of the Ornithology Study area (**Figure 78**).

Table 47 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of marine mammal species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	1	3	1	9	1	0.01

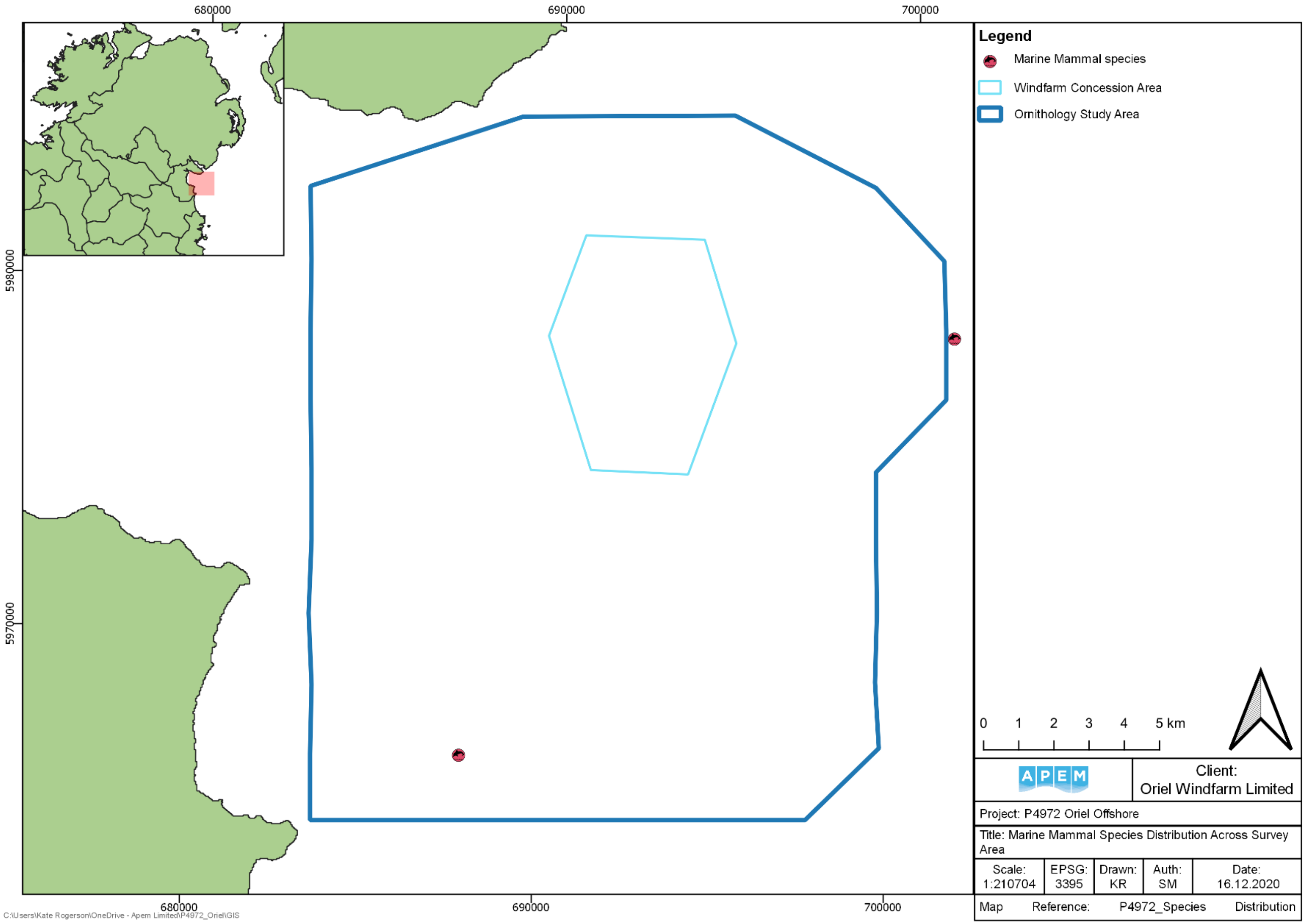


Figure 78 Location of unidentified marine mammal species in the Ornithology Survey area.

5.44 Shark Species – unidentified

One unidentified shark species was observed in the June 2020 survey. No unidentified shark species were recorded in the April, May or July surveys.

The single count resulted in an abundance estimate of three for the Ornithology Study area (**Table 48**).

The unidentified shark species was located to the west of the Windfarm Concession area (**Figure 79**).

Table 48 Raw counts and abundance and density estimates (No. estimated individuals per km2) of shark species in: a) Windfarm Concession area; and b) Ornithology Study area

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	1	3	1	9	1	0.01

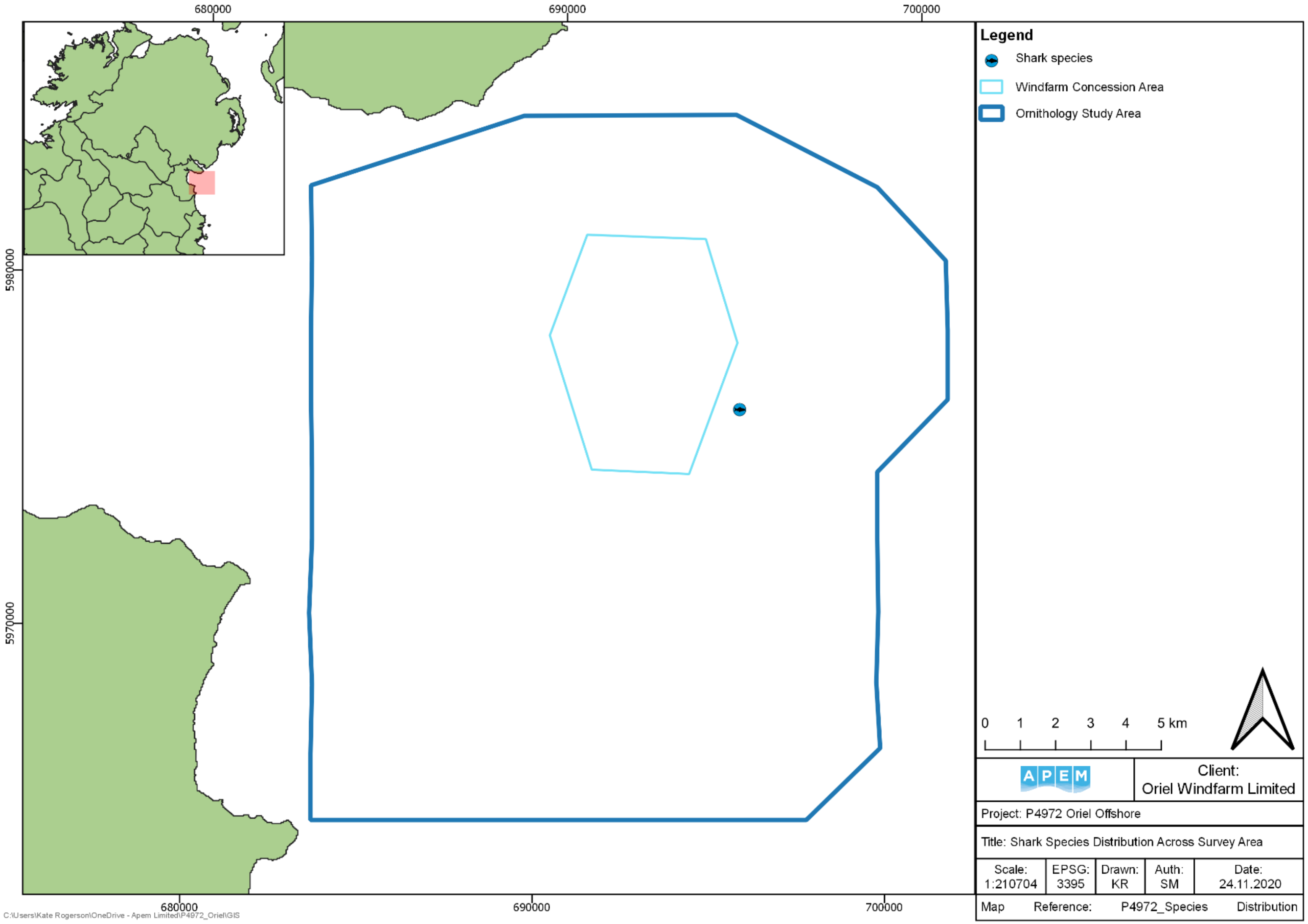


Figure 79 Location of unidentified shark species recorded across the Ornithology Study area

5.45 Leatherback Turtle

During the September 2020 survey, one leatherback turtle was recorded. Leatherback turtles were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The leatherback turtle was located outside the northern boundary of the Ornithology Study area (**Figure 80**).

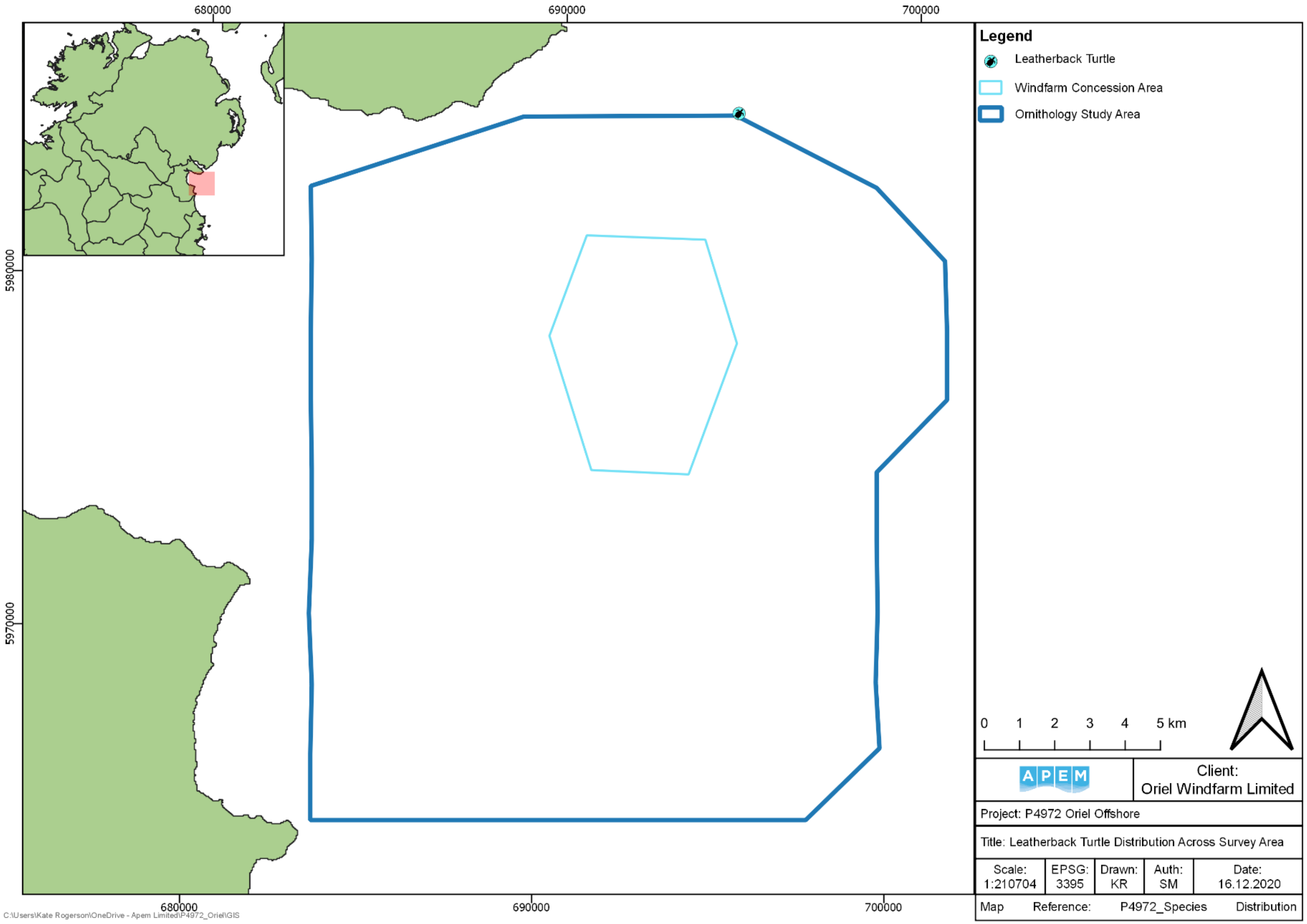


Figure 80 Location of leatherback turtle in the Ornithology Study area

6. Observations of Abiotic Structures

In April 2020, a total of seven anthropogenic objects were recorded in the Ornithology Study area. These were recorded sailing boats (n=3), fishing vessel (n=2), buoy (n=2). No vessels were recorded visually from the aircraft.

In May 2020, a total of seven anthropogenic objects were recorded in the Ornithology Study area, these were recorded as sailing boat (n=3), fishing vessel (n=2) and buoy (n=2). No vessels were recorded in the imagery. One fishing trawler (with an easterly bearing) was recorded visually from the aircraft.

In June 2020, two anthropogenic objects were recorded in the imagery. These were recorded as buoy (n=2) . No vessels were recorded visually from the aircraft.

In July 2020, one anthropogenic object was recorded in the imagery. This was recorded as buoy (n=1) No vessels were recorded visually from the aircraft.

In August 2020, nine anthropogenic objects were recorded in the imagery, these were recorded as recreational fishing vessel (n=4), fishing vessel (n=3) and buoy (n=2). A sailing boat (with a southerly bearing) was recorded visually from the aircraft.

In September 2020, three anthropogenic objects were recorded in the imagery, there were recorded as fishing vessel (n=2) and buoy (n=1). A fishing vessel (with a northerly bearing) was recorded visually from the aircraft.

7. References

Canty, A. & Ripley, B. 2010. *boot: bootstrap R (S-Plus) functions*. R package version 1.2-42.

Efron, B. & Tibshirani, R.J. 1993. *An introduction to the bootstrap*. Chapman & Hall, London.
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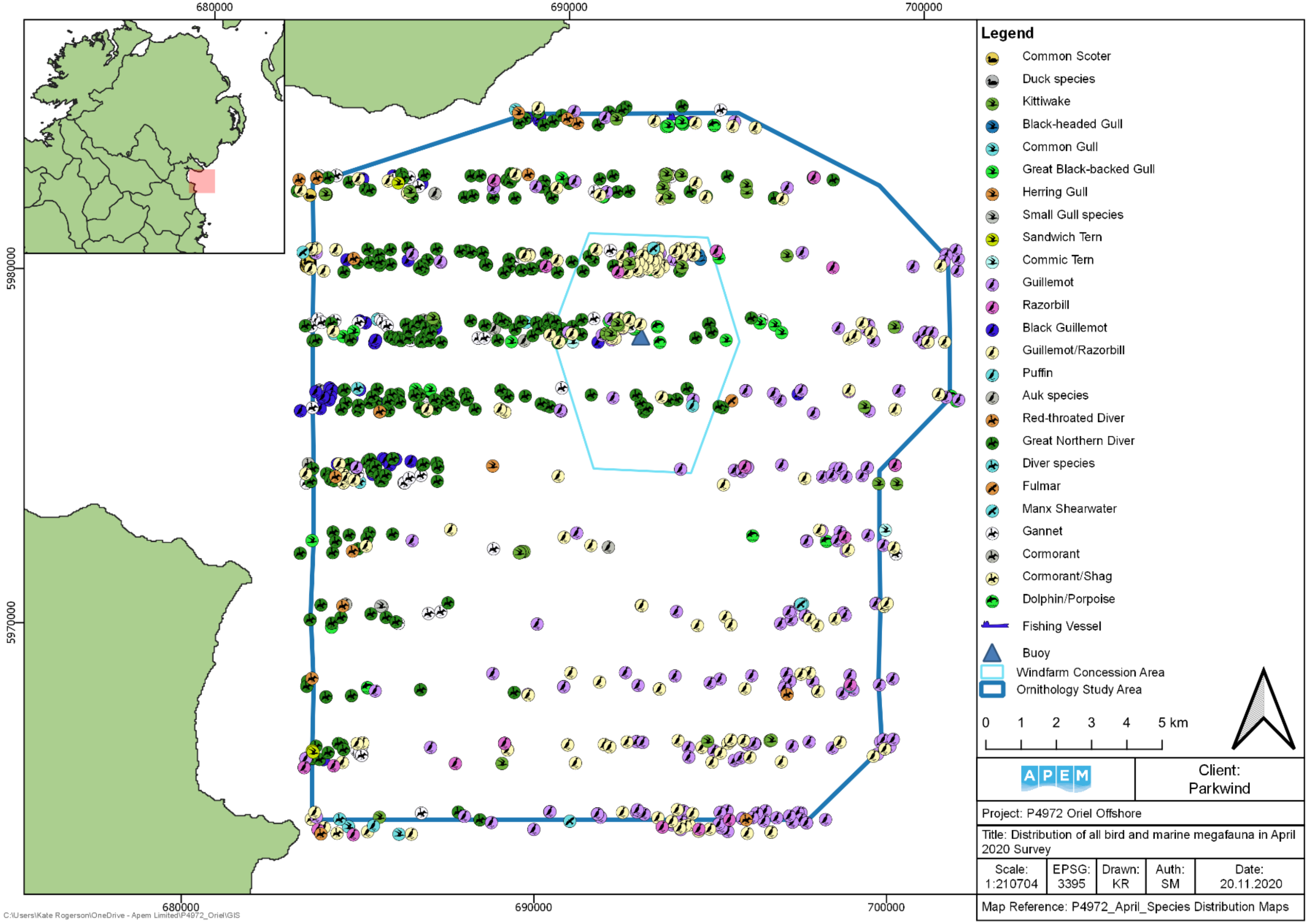
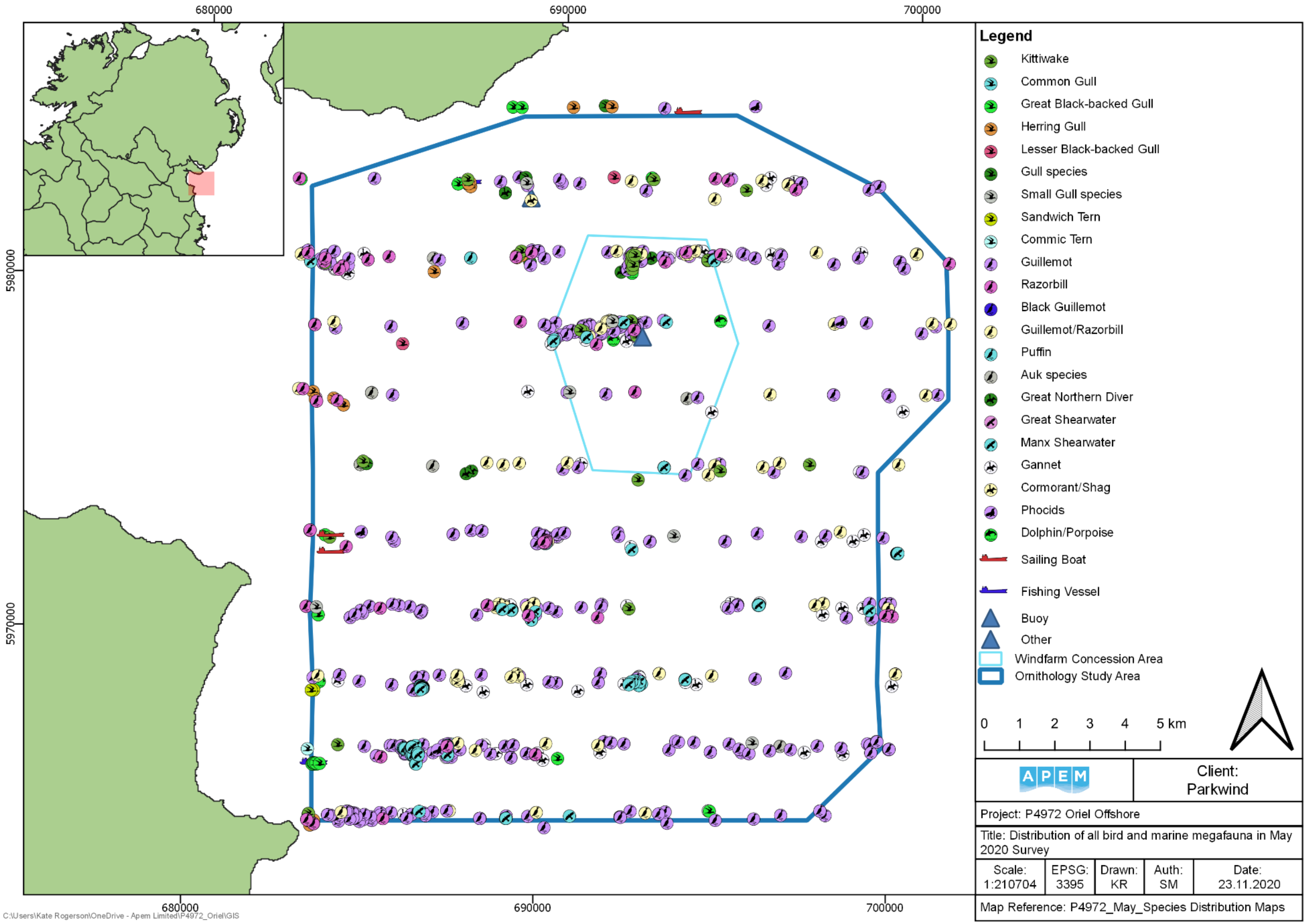
R Core Team, 2020. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Appendix I Scientific Names and Taxonomy

Common Name	Scientific Name	Family	Class
Common Scoter	*Melanitta nigra*	Anatidae	Aves
Curlew	*Numenius arquata*	Scolopacidae	Aves
Kittiwake	*Rissa tridactyla*	Laridae	Aves
Black-headed Gull	*Chroicocephalus ridibundus*	Laridae	Aves
Little Gull	*Hydrocoloeus minutus*	Laridae	Aves
Common Gull	*Larus canus*	Laridae	Aves
Great Black-backed Gull	*Larus marinus*	Laridae	Aves
Herring Gull	*Larus argentatus*	Laridae	Aves
Lesser Black-backed Gull	*Larus fuscus*	Laridae	Aves
Sandwich Tern	*Thalasseus sandvicensis*	Laridae	Aves
Roseate Tern	*Sterna dougallii*	Laridae	Aves
Common Tern	*Sterna hirundo*	Laridae	Aves
Arctic Tern	*Sterna paradisaea*	Laridae	Aves
Great Skua	*Stercorarius skua*	Stercorariidae	Aves
Arctic Skua	*Stercorarius parasiticus*	Stercorariidae	Aves
Guillemot	*Uria aalge*	Alcidae	Aves
Razorbill	*Alca torda*	Alcidae	Aves
Black Guillemot	*Cepphus grylle*	Alcidae	Aves
Puffin	*Fratercula arctica*	Alcidae	Aves
Red-throated Diver	*Gavia stellata*	Gaviidae	Aves
Great Northern Diver	*Gavia immer*	Gaviidae	Aves
Fulmar	*Fulmarus glacialis*	Procellariidae	Aves
Great Shearwater	*Ardenna gravis*	Procellariidae	Aves
Manx Shearwater	*Puffinus puffinus*	Procellariidae	Aves
Gannet	*Morus bassanus*	Sulidae	Aves
Shag	*Phalacrocorax aristotelis*	Phalacrocoracidae	Aves
Cormorant	*Phalacrocorax carbo*	Phalacrocoracidae	Aves
Grey Seal	*Halichoerus grypus*	Phocidae	Mammalia
Common Dolphin	*Delphinus delphis*	Delphinidae	Mammalia
Harbour Porpoise	*Phocoena phocoena*	Phocoenidae	Mammalia
Common Minke Whale	*Balaenoptera acutorostrata*	Balaenopteridae	Mammalia
Leatherback Turtle	*Dermochelys coriacea*	Dermochelyidae	Reptilia

Appendix II Species distribution Maps per survey

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Legend
Kittiwake
Common Gull
Great Black-backed Gull
Herring Gull
Lesser Black-backed Gull
Gull species
Small Gull species
Sandwich Tern
Commic Tern
Guillemot
Razorbill
Black Guillemot
Guillemot/Razorbill
Puffin
Auk species
Great Northern Diver
Great Shearwater
Manx Shearwater
Gannet
Cormorant/Shag
Phocids
Dolphin/Porpoise
Sailing Boat
Fishing Vessel
Buoy
Other
Windfarm Concession Area
Ornithology Study Area
0 1 2 3 4 5 km
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Parkwind
Project: P4972 Oriel Offshore
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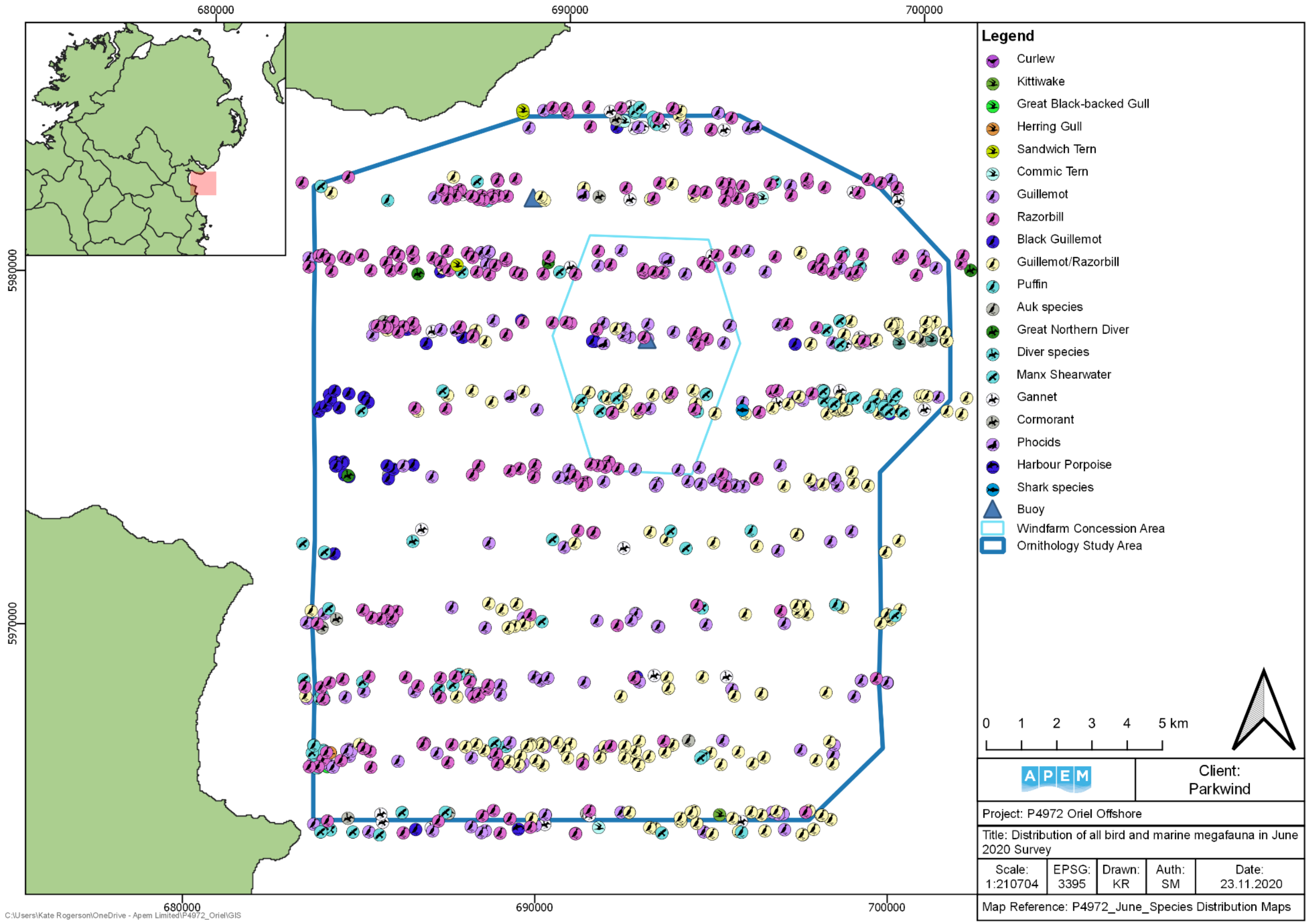
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Guillemot/Razorbill
Puffin
Auk species
Great Northern Diver
Diver species
Manx Shearwater
Gannet
Cormorant
Phocids
Harbour Porpoise
Shark species
Buoy
Windfarm Concession Area
Ornithology Study Area
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Parkwind
Project: P4972 Oriel Offshore
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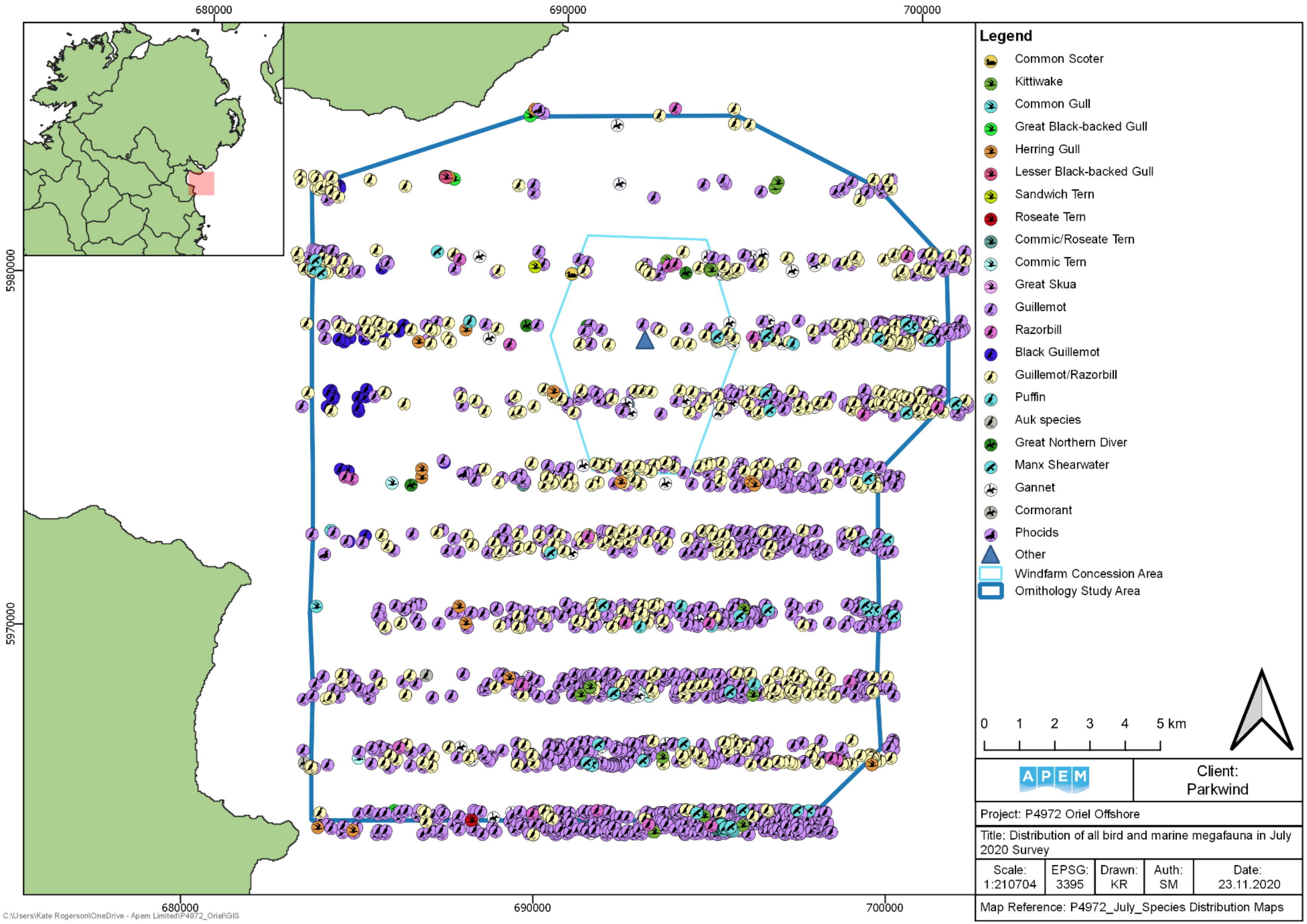
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Herring Gull
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Sandwich Tern
Roseate Tern
Commic/Roseate Tern
Commic Tern
Great Skua
Guillemot
Razorbill
Black Guillemot
Guillemot/Razorbill
Puffin
Auk species
Great Northern Diver
Manx Shearwater
Gannet
Cormorant
Phocids
Other
Windfarm Concession Area
Ornithology Study Area
0 1 2 3 4 5 km
APEM
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Project: P4972 Oriel Offshore
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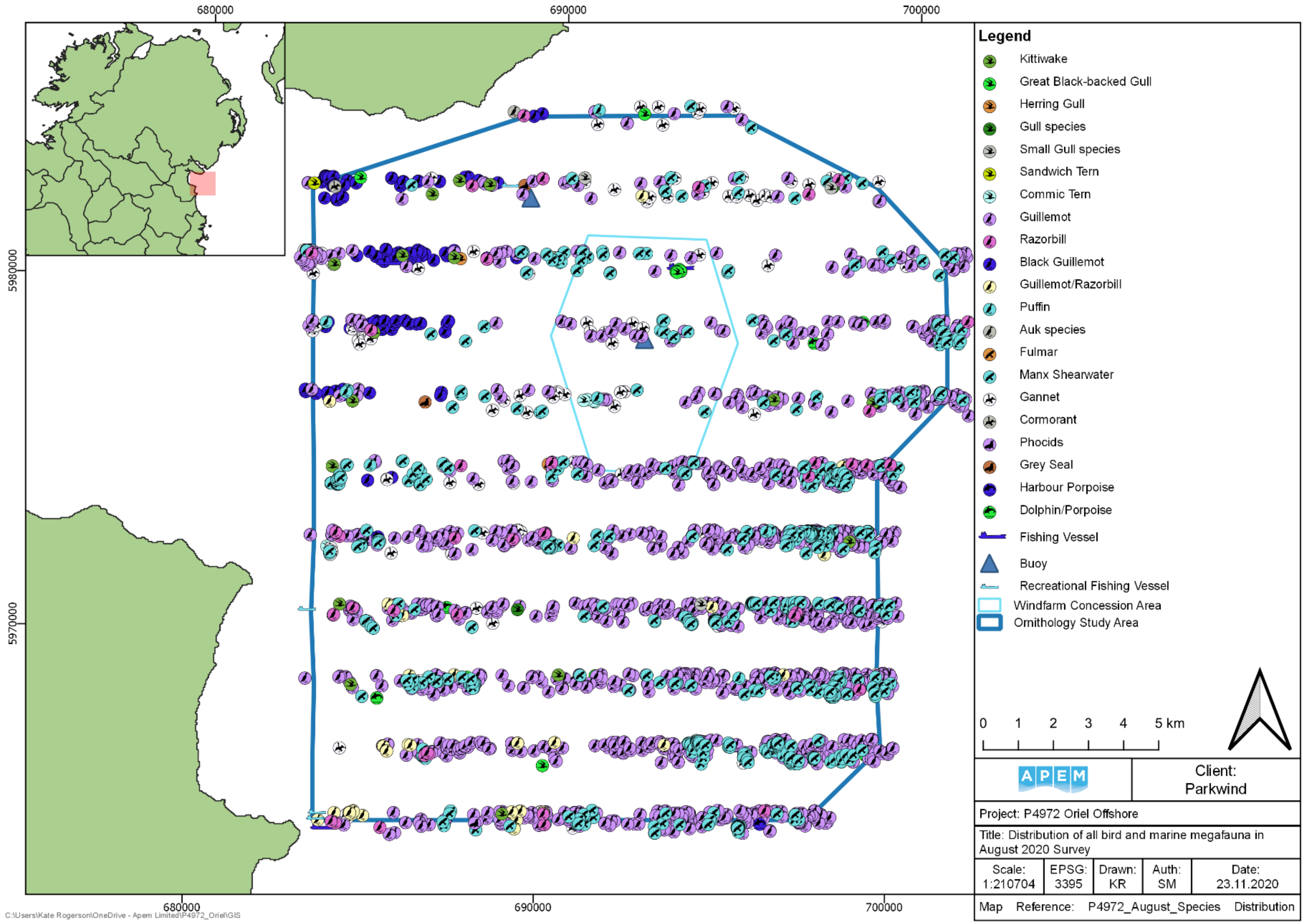
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Auk species
Fulmar
Manx Shearwater
Gannet
Cormorant
Phocids
Grey Seal
Harbour Porpoise
Dolphin/Porpoise
Fishing Vessel
Buoy
Recreational Fishing Vessel
Windfarm Concession Area
Ornithology Study Area
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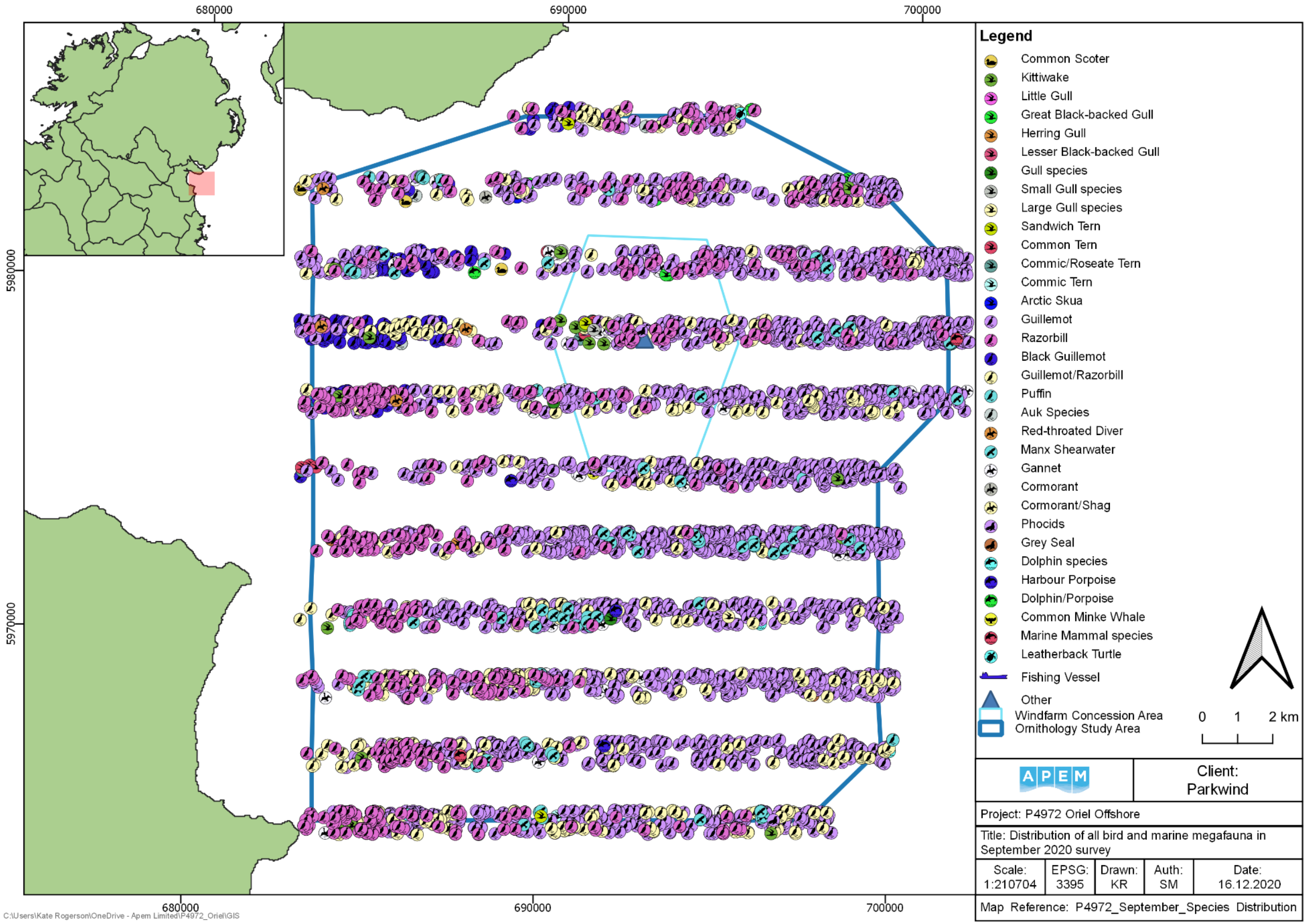
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Kittiwake
Little Gull
Great Black-backed Gull
Herring Gull
Lesser Black-backed Gull
Gull species
Small Gull species
Large Gull species
Sandwich Tern
Common Tern
Commic/Roseate Tern
Commic Tern
Arctic Skua
Guillemot
Razorbill
Black Guillemot
Guillemot/Razorbill
Puffin
Auk Species
Red-throated Diver
Manx Shearwater
Gannet
Cormorant
Cormorant/Shag
Phocids
Grey Seal
Dolphin species
Harbour Porpoise
Dolphin/Porpoise
Common Minke Whale
Marine Mammal species
Leatherback Turtle
Fishing Vessel
Other
Windfarm Concession Area
Ornithology Study Area
0
1
2 km
APEM
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Project: P4972 Oriel Offshore
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ANNEX 3: MIGRATORY GEESE SURVEY REPORT

C1 – Public

MAKING COMPLEX EASY

A TETRA TECH COMPANY

ORIEL WIND FARM PROJECT

Natura Impact Statement

Annex 3: Migratory Geese Survey Report

MDR1520B
NIS – Annex-3
A1 C01
March 2024

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  1.2 Aim and structure 1

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1 INTRODUCTION

RPS was commissioned by Oriel Windfarm Limited (OWL) to undertake an Ecological Survey for Birds at Cooley Point, County Louth for the Oriel Wind Farm Project (hereafter referred to as “the Project”). The proposed Project involves the construction of an offshore wind farm in the Irish Sea east of Dundalk Bay.

The target species for these surveys were light bellied brent geese *Branta bernicla hrota*, a fully migratory species that typically arrives at its wintering grounds in Ireland from mid-September, remaining until mid-March or early April. The surveys were commissioned in response to information provided by consultees which suggested that there may be some movement of this species across Dundalk Bay, particularly during the autumn.

This report includes data collected from the site-specific migratory geese vantage point (VP) surveys undertaken between November 2019 and December 2019 and in April 2020.

It is recommended that this annex is read in-conjunction with appendix H: Offshore Ornithology – Supporting Information and annex 1 of appendix H: Offshore Ornithology Technical Report.

1.1 Project location

The Project is located in the Irish Sea, off the coast of County Louth (approximately 22 km east of Dundalk town centre and 18 km east of Blackrock). The closest wind turbine will be approximately 6 km from the closest shore on the Cooley Peninsula. The offshore cable corridor extends approximately 11 km southwest from the wind farm area to the landfall south of Dunany Point.

1.2 Aim and structure

This report has been written in accordance with the Chartered Institute of Ecological and Environmental Management (CIEEM) Guidelines for Ecological Report Writing (CIEEM, 2017).

The aim of the report is to provide a description of the bird survey methods used and the results of bird surveys. The purpose of this report is to investigate the potential for interaction between migratory light-bellied brent geese and the Project turbines.

This report is structured as follows:

1. Introduction;
2. Methodology; and
3. Results.

2 METHODOLOGY

2.1 Statement of authority

The ornithological surveys were undertaken by Nick Veale (between November and December 2019) and Breffni Martin (April 2020) for and on behalf of RPS.

Nick Veale is a self-employed environmental consultant and holds a BSc (Hons) in Environmental Science and an MSc in Environmental Management. Nick has over 19 years' experience in the field of ecology and environmental consultancy. Nick has a wealth of experience in ornithology and extensive expertise in upland bird surveys, breeding bird surveys, vantage point surveys, wetland bird surveys and wintering bird surveys. Nick is also trained and accredited by the Field Studies Council (FSC) as a European Seabirds at Sea (ESAS) surveyor and has over 8 years' professional experience on offshore energy projects.

Breffni Martin is a local ornithologist who provided local information and has observed and photographed light-bellied brent geese on migration in the area over a period of 15 years, as well as participating in organised bird census surveys such as Irish Wetland Bird Survey (IWeBS). He holds a BSc in Biology from University College Dublin and is chairman and founder of the Louth Nature Trust.

The report author, Adam McClure, is a Senior Ecologist with RPS and holds a BSc (Hons) in Palaeoecology and Archaeology with over 10 years of experience in field of ornithology. Adam has extensive expertise in breeding bird surveys, vantage point surveys, wetland bird surveys, wintering bird surveys and is a licensed bird ringer. He is the County Antrim Regional Representative for the British Trust for Ornithology (BTO). Adam is also a Full member of CIEEM and is currently a member of the CIEEM Irish Section Committee.

The report has been reviewed Sam O'Hara, a Senior Ecologist with RPS who holds a BSc (Hons) in Ecology and has over five years of experience in the field of ecology. Sam has experience of ecological field survey including habitat, mammal and bird survey and is a protected species licence holder. Sam is an Associate member of CIEEM.

The information prepared and provided is true and accurate at the time of issue of this report and has been prepared and provided in accordance with the CIEEM Code of Professional Conduct (CIEEM, 2019). We confirm that the professional judgement expressed herein is the true and bona fide opinion of our professional ecologists.

2.2 Vantage point survey

Since there is no guidance on vantage point (VP) survey protocols for the Republic of Ireland, guidance developed by Scottish Natural Heritage (SNH) for onshore wind farm ornithology surveys was followed (SNH, 2017).

Surveys to record movements of migratory waterfowl during the autumn migration (November and December 2019) and spring migration (April 2020) were conducted from a single coastal VP at Cooley Point, County Louth (OS Grid Reference IJ 220 050).

The main objective is to record movements of primary target species, between the VP location across Dundalk Bay to the offshore wind farm area, 6-12 km offshore.

The protocol followed during coastal migration surveys was a systematic 180° scan (including overhead) for birds in flight.

The primary target species were geese and swans, with secondary target species being ducks, divers, waders, raptors and passerines.

Surveys were not undertaken in weather conditions which were likely to preclude migration.

Data collected for each observation included:

- Time of observation;

- Species;
- Flock size;
- Flight height band(s) (1 = 0-20 m, 2 = 20-250 m, 3 = 250-300 m, 4 = >300 m);
- Flight direction;
- Distance from observer (to the nearest 100 m); and
- Flight lines drawn onto maps, which were later digitised via geographic information system (GIS) mapping.

During the autumn migration period, seven surveys totalling 42 hours of observation were undertaken between November and December 2019. Spring migration surveys totalling 40 hours of observation were undertaken in April 2020.

The timings of surveys are based on data provided in Fox *et al.* (2017), but these timings are also considered suitable for recording migrating brent geese which were the primary target species.

3 RESULTS

3.1 Vantage point survey

A total of 42 survey hours for migratory species were conducted in November and December 2019, with 186 flights recorded. In April 2020, a total of 40 survey hours were undertaken, with 15 flights recorded. The survey date start and end times and weather conditions are provided for each of the VP surveys in Table 3-1 below. Full details of the species recorded during the surveys are provided in appendix A.1 of this report.

Table 3-1: Survey dates and weather conditions recorded for completed surveys: November / December 2019 and April 2020.

Date	Start Time	End Time	Cloud (Oktas)	Visibility (km)	Wind (Beaufort) / Direction	Temp (°C)	Precipitation	Sunset / Sunrise	Sea State at 5 km
12/11/19	08:00	15:00	6	Good (> 3-5)	3-4 / W-NW	3	None	07:47	3-4
25/11/19	09:00	15:30	8	Good (> 3-5)	2-3 / SE	9	Drizzle at times	08:05	2-3
26/11/19	08:15	14:45	8	Good (> 3-5)	3-4 / SE	9	Light showers	08:05	3
30/11/19	07:50	14:20	6	Good (> 3-5)	3-4 / ESE	6	None	08:20	3-4
02/12/19	09:00	15:30	4	Good (> 3-5)	1-2 / W	1	None	08:23	1-2
12/12/19	08:40	15:40	8	Good (> 3-5)	2 / SW	7	None	08:36 / 16:04	2
20/12/19	10:05	16:35	7	Good (> 3-5)	2-3 / WSW-W	5	Light drizzle at start	08:43 / 16:05	2-3
10/04/20	17:30	20:30	7	Good (> 3-5)	2 / SW	10	None	20:18	2-3
11/04/20	06:20	09:30	3	Good (> 3-5)	Nil	10	None	06:33	0-1
11/04/20	17:30	20:30	4	Good (> 3-5)	Nil	12	None	20:20	0-1
12/04/20	11:00	14:00	4	Good (> 3-5)	3 / NE	9	None	06:30	3-4
12/04/20	18:30	21:30	2	Good (> 3-5)	3 / NE	11	None	20:22	3-4
13/04/20	18:00	21:30	4	Good (> 3-5)	3 / NE	11	None	20:24	3-4
14/04/20	18:00	21:00	8	Good (> 3-5)	Nil	13	None	20:26	0-1
15/04/20	16:00	19:00	8	Good (> 3-5)	Nil	12	None	20:28	0-1
16/04/20	06:00	09:00	8	Good (> 3-5)	2 / NE	10	None	06:21	0-1
16/04/20	18:00	21:00	8	Good (> 3-5)	2 / NE	12	None	20:30	2-3
20/04/20	18:00	21:00	8	Good (> 3-5)	2 / E	12	None	20:37	2-3
23/04/20	18:30	21:30	5	Good (> 3-5)	1 / NE	13	None	20:43	1-2
24/04/20	14:00	17:00	8	Good (> 3-5)	1 / NE	12	None	20:45	1-2

3.1.1 Target species

Light-bellied brent goose was the only target species observed, with 45 individual bird flights recorded across the 17 survey dates. Flocks were also observed feeding on the shoreline and sitting on the sea surface (Table 3-2). All records were within height-band 1 (i.e. 0-20 m).

Table 3-2: Light-bellied brent goose flights recorded during the surveys.

Date	No. of bird flights	No. birds observed on sea surface / shoreline	Total no. of birds
12/11/19	6	0	66
25/11/19	4	0	56
26/11/19	3	0	40
30/11/19	3	0	47
02/12/19	8	0	106
12/12/19	5	62	100
20/12/19	3	32	62
10/04/20	2	0	437
11/04/20	2	0	287
12/04/20	2	0	567
13/04/20	1	0	218
14/04/20	3	0	1,635
15/04/20	0	0	0
16/04/20	2	0	55
20/04/20	1	5	50
23/04/20	0	1	1
24/04/20	0	0	0
Total	**45**	**100**	**3727**

Between November and December 2019, the majority of light-bellied brent geese were observed flying east to west past the survey location. The majority of individual bird flights were observed between 100 m and 500 m offshore, with the exception of one flock of 22 individuals which were observed approximately 1.5 km offshore in November 2019. Flights of target species are shown in appendix A.2 of this report.

In April 2020, regular commuting of light-bellied brent geese was observed with birds flying low east to west past Cooley Point. These numbers increased until 14 April, following which numbers significantly dropped off, suggesting that a significant migratory move was made in the night or morning of 14/15 April. No geese were seen flying across Dundalk Bay from Dunany Point towards the mouth of Carlingford Lough; instead individuals were observed flying close to the shore, using the traditional roosting areas at Lurgangreen, Ballymascanlon Bay and Rockmarshal as bases for migration. These are shown in Figure 3-1 and Figure 3-2 below.

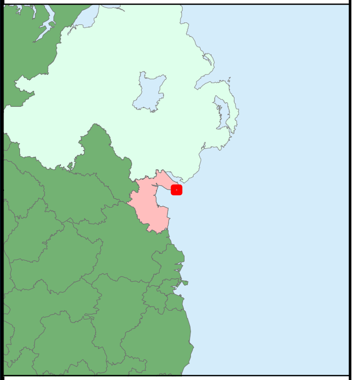
Service Layer Credits: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Legend

● Cooley Point vantage point survey location

↔ Typical flight path of light-bellied brent geese

Data Sources: Client,



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 3-1
Typical flight path of light-bellied brent geese commuting past Cooley Point.

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Issue Details

Drawn By: NA	**Project No.** EOR0822 (MDR1520B)
Checked By: NA	**File Ref:** EOR0822_ORN_T_19522_FINAL
Approved By: AO	
Scale: 1:21,074 @ A4	**Projection:** ITM (IRENET95) Geographic Co-ordinates: ETRS89
Date: 08/03/23	

NOTE:
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2. All levels are referred to Ordnance Datum, Malin Head.
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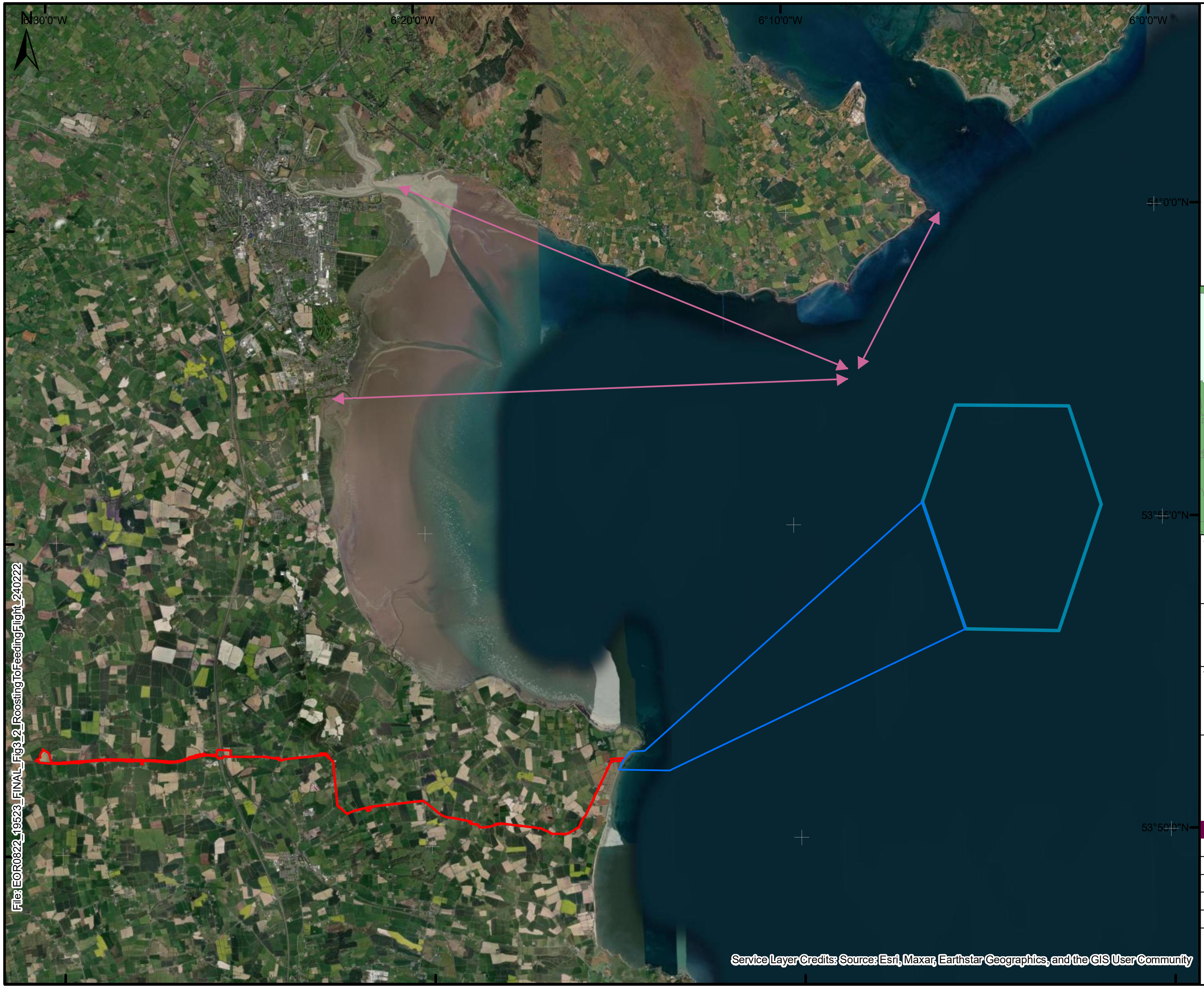
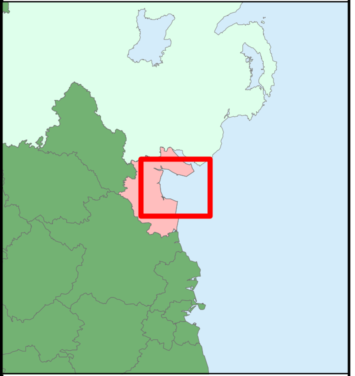


Legend

- Offshore Wind Farm Area
- Offshore Cable Corridor
- Onshore Cable Route
- ↔ Typical roosting to feeding flight path

Data Sources: Client,



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title

Figure 3-2
Typical roosting to feeding flight path of light-bellied brent geese in Dundalk Bay

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Issue Details

Drawn By: NG	**Project No.** EOR0822 (MDR1520B)
Checked By: NG	**File Ref:**
Approved By: AOS	EOR0822_ORN_T_19523_FINAL
Scale: 1:150,000 @ A4	**Projection:**
Date: 12/03/2024	ITM (IRENET95) Geographic Co-ordinates: ETRS89

NOTE:
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3.1.2 Secondary species

A total of 154 flights, representing 23 secondary species were recorded (Table 3-3 below), of which 150 were in height-band 1 (i.e. 0-20 m) and four were within height-band 2 (i.e. 20-250 m).

The most commonly recorded species was common scoter *Melanitta nigra* with 37 flights and 1,448 individual birds observed over the survey period.

Table 3-3: Secondary species recorded during the surveys.

Secondary Species	Total No. of Flights	Total No. of Birds
Bar-tailed godwit *Limosa lapponica*	2	5
Black-tailed godwit *Limosa limosa*	2	34
Curlew *Numenius arquata*	16	33
Common scoter *Melanitta nigra*	37	1,448
Dunlin *Calidris alpina*	7	129
Eider *Somateria mollissima*	1	5
Great crested grebe *Podiceps cristatus*	7	12
Greenshank *Tringa nebularia*	1	2
Golden plover *Pluvialis apricaria*	1	28
Grey plover *Pluvialis squatarola*	1	3
Knot *Calidris canutus*	1	18
Lapwing *Vanellus vanellus*	1	21
Great northern diver *Gavia immer*	11	11
Oystercatcher *Haematopus ostralegus*	17	46
Peregrine *Falco peregrinus*	1	1
Red-throated diver *Gavia stellata*	21	33
Redshank *Tringa totanus*	1	2
Red-breasted merganser *Mergus serrator*	12	40
Ringed plover *Charadrius hiaticula*	4	24
Sanderling *Calidris alba*	2	34
Shelduck *Tadorna tadorna*	4	12
Turnstone *Arenaria interpres*	2	13
Whimbrel *Numenius phaeopus*	2	4

4 REFERENCES

CIEEM (2017) *Guidelines for Ecological Report*. Chartered Institute of Ecology and Environmental Management, Winchester.

CIEEM (2019) *Code of Professional Conduct*. Chartered Institute of Ecology and Environmental Management, Winchester.

Fox, T., Francis, I., Norriss, D. & Walsh, A. (2017) *Report of the 2016/17 international census of Greenland White-fronted Geese*. Greenland White-fronted Goose Study, Rønde, Denmark and Wexford, Ireland.

SNH (2017) *Recommended bird survey methods to inform impact assessment of onshore wind farms*. SNH Guidance. SNH, Battleby.

A.1 Raw data

Site	Oriel Migration
Date	12/11/2019
Observer	N VEALE
Location	VP Cooley Point
Start Time	08:00
Finish Time	15:00
Sunrise/~~sunset~~	07:47

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3			**VP Locations**			
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**		Cooley Point			
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	08:00	4	W	0	5/8	2	2	0	4	TEMP 3oc
Hr 2	09:00	4	W	0	7/8	2	2	0	4	
Hr 3	10:00	4	W	0	6/8	2	2	0	4	TEMP 4oc
Hr 4	12:00	3	WNW	0	6/8	2	2	0	4	
Hr 5	13:00	3	WNW	0	6/8	2	2	0	3	TEMP 6oc
Hr 6	14:00	3	WNW	0	6/8	2	2	0	3	

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)
Primary target species: All geese and swans. Secondary target species: Seaduck, waders, raptors and migrant passerines

6 TARGET FLIGHTS

26 BRENT FEEDING ON THE INTERTIDAL SHORELINE AT THE POINT

Vantage Point Watch Recording Sheet

Sheet number /

Site: Cooley Point	Vantage Point Location:	Date: 12/11/2019	Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 08:00

Finish Time: 15:00

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	RH	2	400	08:12	S		2			SEASTATE 4
2	CX	90	2000	08:39	SW	1				LANDED WITH RAFT OF APROXIMATLY 900 cx
3	CX	29	800	09:27	SSW	1				
4	PB	15	300	09:49	SW	1				
5	DN	6	100	09:55	SW	1				
6	PB	23	800	10:23	NE	1				
7	ND	1	500	10:50	W	1				
8	CU	1	100	12:02	S	1				
9	CX	39	2500	12:24	SSW	1				
10	CU	2	100	12:26	SW	1				
11	TT	1	600	12:29	SW	1				
12	RH	1	500	12:42	SW	1				
13	PB	11	200	12:50	SW	1				LANDED IN POOL INFRONT OF VP 4AD 7JUV
14	OC	4	100	13:19	NNW	1				
15	RH	1	800	13:20	SW	1				
16	PB	6	100	13:28	SW					6 ADULTS
17	DN	16	100	13:49	SW	1				
18	ND	1	1000	14:04	NE	1				

Vantage Point Watch Recording Sheet

Sheet number /

Site: Cooley Point

Vantage Point Location:

Date: 12/11/2019

Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 08:00

Finish Time: 15:00

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
19	PB	5	300	14:28	SW	1				2 AD 3 JUV
20	PE	1	100	14:50	SW	1				JUV PERIGRINE HUNTING ALONG SHORE LANDED SOUTH OF VP ON SEAWALL OF CARPARK
21	PB	6	100	14:50	SW	1				2 ADULTS 4 JUV
22	RH	1	600	14:50	NE		2			
23	CX	36	1200	14:52	SSW	1				

Site	Oriel Migration
Date	25/11/2019
Observer	N VEALE
Location	VP Cooley Point
Start Time	09:00
Finish Time	15:30
Sunrise/~~sunset~~	08:05

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3			**VP Locations** Cooley Point			
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	09:00	3	ESE	1	8/8	2	2	0	3	TEMP 9oc
Hr 2	10:00	3	ESE	1	8/8	2	2	0	3	
Hr 3	11:00	3	SE	0	8/8	2	2	0	3	TEMP 10oc
Hr 4	12:30	2	SE	1	7/8	2	2	0	3	
Hr 5	13:30	2	SE	1	8/8	2	2	0	2	TEMP 9oc
Hr 6	14:30	2	SE	0	8/8	2	2	0	2	

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)
Primary target species: All geese and swans. Secondary target species: Seaduck, waders, raptors and migrant passerines

4 TARGET FLIGHTS

Vantage Point Watch Recording Sheet

Sheet number 1 / 2

Site: Cooley Point

Vantage Point Location:

Date: 25/11/2019

Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 09:00

Finish Time: 15:30

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	13RP / 9TT / 3RK	14	>100	09:00	SW	1				ON SHORE JUST NORTH OF VP FLUSHED AND FLEW NE
2	OC	6	100	09:16	SW	1				
3	CX	54	1000	09:22	S	1				
4	PB	19	100	09:46	SW	1				
5	PB 2AD/ 4 JUV	6	100	09:59	SW	1				FAMILY GROUP
6	BA	2	100	10:15	SW	1				
7	PB	14	300	10:37	SW	1				
8	RH	2	300	10:46	SW	1				
9	CX	85	100	11:01	SW	1				
10	DN	12	100	11:14	SW	1				
11	CU	3	100	11:24	SW	1				
12	CX 10M/5F	15	500	11:26	NE	1				
13	CU	2	100	11:47	SW	1				
14	RH	1	400	13:03	NE	1				
15	PB	17	400	13:29	NE	1				
16	CX	7	100	13:50	SW	1				
17	CX	26	500	14:06	N	1				
18	BA	3	100	14:23	SW	1				

Vantage Point Watch Recording Sheet

Sheet number 2 / 2

Site: Cooley Point

Vantage Point Location:

Date: 25/11/2019

Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 09:00

Finish Time: 15:30

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
19	CU	3	100	14:28	SW	1				
20	RH	1	500	14:30	SW	1				
21	CX	72	700	14:31	NNE	1				
22	WM	2	100	14:32	SW	1				
23	DN	24	>100	14:38	NE	1				
24	CU	3	100	14:39	SW	1				
25	CX	63	1500	14:42	S	1				
26	CX	32	1500	14:48	S	1				
27	ND	1	500	15:02	SSW	1				
28	E	5	300	15:12	NE	1				
29	CX	9	1000	15:21	N	1				

Site	Oriel Migration
Date	26/11/2019
Observer	NICK VEALE
Location	VP Cooley Point
Start Time	08:15
Finish Time	14:45
Sunrise/~~sunset~~	08:05

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4			**VP Locations**			
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**		Cooley Point			
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	08:15	3	E	2	8/8	2	2	0	3	TEMP 9oc LIGHT RAIN
Hr 2	09:15	3	SE	2	8/8	2	2	0	3	LIGHT RAIN
Hr 3	10:15	4	ESE	2	8/8	2	2	0	3	TEMP 10oc LIGHT RAIN
Hr 4	11:45	4	ESE	1	7/8	2	2	0	3	DRIZZLE
Hr 5	12:45	4	SE	0	8/8	2	2	0	3	TEMP 9oc
Hr 6	13:45	3	SSE	0	8/8	2	2	0	3	

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)
Primary target species: All geese and swans. Secondary target species: Seaduck, waders, raptors and migrant passerines

3 TARGET FLIGHTS

Vantage Point Watch Recording Sheet

Sheet number 1 / 2

Site: Cooley Point

Vantage Point Location:

Date: 26/11/2019

Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 08:15

Finish Time: 14:45

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	RH	2	100	08:15	N	1				
2	DN	31	100	08:17	SW	1				
3	PB	4	100	08:21	SW	1				1 ADULT 3 JUV
4	RH	2	300	08:44	SW	1				
5	GG	1	300	09:01	SW	1				
6	CU	1	100	09:26	SW	1				
7	CX	58	1000	09:32	S	1				
8	OC	2	100	09:38	SW	1				
9	ND	1	400	10:13	NW	1				
10	PB	22	1500	10:41	SW	1				FLIGHT PICKED UP IN SCOPE
11	ND	1	500	11:12	S	1				
12	PB	14	200	11:57	SW	1				4 AD / 10 JUV
13	RP	5	0	12:15	SW	1				ON SHORELINE NEAR VP WITH FLOCK OF TT
14	TT	12	0	12:16	SW	1				LANDED WITH RP
15	RK	2	100	12:34	SW	1				
16	CX	38	1000	12:53	SW	1				
17	RH	2	700	13:09	SW	1				
18	RM	4	300	13:20	SW	1				

Vantage Point Watch Recording Sheet

Sheet number 2 / 2

Site: Cooley Point

Vantage Point Location:

Date: 26/11/2019

Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 08:15

Finish Time: 14:45

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
19	CX	5	300	13:24	NNE	1				
20	CU	2	100	13:28	SW	1				
21	CX/ 1M/2F	3	200	13:32	SW	1				
22	GG	1	600	13:34	SW	1				
23	CX	18	400	13:56	N	1				
24	WM	2	100	14:07	SW	1				
25	CX	39	800	14:10	NNW	1				
26	RH	1	300	14:13	NE	1				
27	KN	18	100	14:20	SW	1				
28	OC	1	100	14:23	N	1				
29	CX	9	1000	14:25	NE	1				
30	CX	23	800	14:39	N	1				
31	GG	2	400	14:41	SW	1				
32	GP	28	200	14:43	SW	1				

Site	Oriel Migration
Date	30/11/2019
Observer	NICK VEALE
Location	VP Cooley Point
Start Time	07:50
Finish Time	14:20
Sunrise/~~sunset~~	08:20

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3			**VP Locations** Cooley Point			
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	07:50	3	ESE	0	6/8	2	2	0	3	TEMP 6oc
Hr 2	08:50	3	ESE	0	78	2	2	0	3	
Hr 3	09:50	4	ESE	0	6/8	2	2	0	3	TEMP 7oc
Hr 4	11:20	4	ESE	0	7/8	2	2	0	4	
Hr 5	12:20	4	ESE	0	5/8	2	2	0	4	TEMP 6oc
Hr 6	13:20	3	E	0	4/8	2	2	0	4	

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)
Primary target species: All geese and swans. Secondary target species: Seaduck, waders, raptors and migrant passerines

3 TARGET FLIGHTS

QUIET

Vantage Point Watch Recording Sheet

Sheet number 1 / 1

Site: Cooley Point

Vantage Point Location:

Date: 30/11/2019

Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 07:50

Finish Time: 14:20

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	RM	1	100	08:02	NE	1				
2	CX	67	800	08:08	SW	1				
3	CX	125	1000	08:15	SW	1				
4	OC	4	100	09:27	SW	1				
5	RM	2	100	09:39	SW	1				
6	PB	32	300	10:07	SW	1				
7	PB	10	200	10:28	SW	1				4 ADULT 6 JUV
8	RM	2	200	11:07	SW	1				
9	CU	3	100	11:20	SW	1				
10	PB	5	100	11:23	SW	1				LANDED AT FRESH WATER ON TEMPELTOWN BEACHW
11	CX	16	600	12:48	SW	1				
12	OC	2	100	12:54	SW	1				
13	RM	20	200	13:20	SW	1				
14	RH	2	100	13:53	SW	1				
15	SS	22	100	14:01	SW	1				
16	OC	3	100	14:03	SW	1				
17	RH	1	300	14:16	SW	1				
18										

Site	Oriel Migration
Date	02/12/2019
Observer	NICK VEALE
Location	VP Cooley Point
Start Time	09:00
Finish Time	15:30
Sunrise/~~sunset~~	08:23

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4			**VP Locations** Cooley Point			
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	09:00	1	W	0	2/8	2	2	1	1	TEMP 0oc GROUNDFROST
Hr 2	10:00	1	WNW	0	2/8	2	2	0	1	
Hr 3	11:00	2	WNW	0	4/8	2	2	0	1	TEMP 2oc
Hr 4	12:30	2	W	0	4/8	2	2	0	2	
Hr 5	13:30	2	W	0	5/8	2	2	0	2	TEMP 2oc
Hr 6	14:30	2	WSW	0	5/8	2	2	0	2	

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)
Primary target species: All geese and swans. Secondary target species: Seaduck, waders, raptors and migrant passerines

8 TARGET FLIGHTS

Vantage Point Watch Recording Sheet

Sheet number 1 / 2

Site: Cooley Point

Vantage Point Location:

Date:
02/12/2019

Observer:
NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 09:00

Finish Time: 15:30

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	CU	5	100	09:04	SW	1				
2	CX	9	500	09:07	NE	1				3M/7F
3	PB	26	500	09:15	SW	1				
4	CX	75	1000	09:16	NE	1				
5	OC	1	100	09:19	SW	1				
6	GG	3	300	09:34	SW	1				
7	RM	1	100	09:54	SW	1				
8	CX	45	800	09:55	SW	1				
9	PB	11	100	09:57	NE	1				FLUSHED FROM SHORE BY DOG AND WALKER
10	RH	2	100	10:25	SW	1				
11	OC	2	100	10:48	SW	1				
12	PB	13	100	11:02	SW	1				6 ADULTS 7 JUV HEADING SOUTH
13	SU	2	200	11:38	SW	1				
14	RH	2	100	11:56	SW	1				
15	ND	1	600	12:39	SW	1				
16	BW	18	200	12:56	NE	1				
17	PB	4	200	13:20	SW	1				ADULTS
18	RH	1	100	13:46	N	1				

Vantage Point Watch Recording Sheet

Sheet number 2 / 2

Site: Cooley Point

Vantage Point Location:

Date: 02/12/2019

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 09:00

Finish Time: 15:30

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
19	RP	5	0	14:13	NE	1				IN FRONT OF VP
20	PB	5	100	14:19	SW	1				
21	CU	1	100	14:27	NE	1				
22	RP	5	100	14:29	SW	1				
23	ND	1	400	14:46	NE		2			
24	PB	17	300	15:05	SW	1				
25	CU	1	100	15:13	SW	1				
26	PB	21	600	15:20	SW	1				
27	CU	2	100	15:22	SW	1				
28	PB	9	100	15:23	W	1				LANDED AT FRESH WATER ON TEMPELTOWN BEACH
29	SU	2	200	15:23	SW	1				

Site	Oriel Migration
Date	12/12/2019
Observer	NICK VEALE
Location	VP
Start Time	08:40
Finish Time	15:40
Sunrise/sunset	08:36/16:04

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3			**VP Locations** Cooley Point			
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	08:40	3	SW	0	8/8	2	2	0	2	TEMP 6oc
Hr 2	09:40	2	SW	0	8/8	2	2	0	2	
Hr 3	10:40	2	WSW	0	8/8	2	2	0	2	TEMP 7oc
Hr 4	12:40	2	WSW	0	8/8	2	2	0	2	
Hr 5	13:40	2	WSW	0	8/8	2	2	0	2	TEMP 7oc
Hr 6	14:40	2	WSW	0	8/8	2	2	0	2	

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)
Primary target species: All geese and swans. Secondary target species: Seaduck, waders, raptors and migrant passerines

5 TARGET FLIGHTS
62 BRENT FEEDING ON THE SHORELINE BETWEEN COOLEY AND BALLAGAN. OBSERVED DURING 1 HOUR BREAK.

Vantage Point Watch Recording Sheet

Sheet number 1 / 2

Site: Cooley Point

Vantage Point Location:

Date: 12/12/2019

Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 08:40

Finish Time: 15:40

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	CX	31	1000	08:41	SW	1				
2	SU	4	200	08:44	SW	1				
3	ND	1	500	08:52	SSW		2			
4	L	21	100	08:56	SW	1				
5	BW	16	200	08:59	SW	1				
6	GG	2	400	09:05	NE	1				
7	RH	2	300	09:11	SW	1				
8	DN	14	100	09:28	SW	1				
9	PB	3	400	10:06	SW	1				
10	CX	53	1200	10:28	SW	1				
11	OC	2	100	11:18	SW	1				
12	GG	2	400	11:35	SW	1				
13	PB	8	200	13:04	SW	1				3 ADULTS 5 YOUNG
14	PB	11	400	13:08	SW	1				LOOKED LIKE 2 FAMILY GROUPS 4 ADULTS
15	PB	3	100	13:31	SW	1				ADULTS
16	RH	1	500	13:54	SW	1				
17	GV	3	100	14:06	SW	1				
18	PB	13	700	14:23	NE	1				

Vantage Point Watch Recording Sheet

Sheet number 2 / 2

Site: Cooley Point

Vantage Point Location:

Date: 12/12/2019

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 08:40

Finish Time: 15:40

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
19	RM	1	300	14:46	NNE	1				
20	CX	8	600	14:59	SW	1				
21	CU	1	100	15:08	SW	1				
22	RH	1	300	15:11	SW	1				
23	CX	28	800	15:15	NE	1				
24	CX	65	800	15:16	NE	1				
25	RM	4	200	15:23	NE	1				2M,2F
26	GK	2	100	15:19	SW	1				
27	CU	2	100	15:27	NE	1				
28	DN	26	100	15:32	SW	1				
29	SS	12	100	15:32	SW	1				
30	RH	3	500	15:34	SW	1				

Site	Oriel Migration
Date	20/12/2019
Observer	NICK VEALE
Location	VP
Start Time	10:05
Finish Time	16:35
Sunrise/sunset	08.43/16:05

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4			**VP Locations**			
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**		Cooley Point			
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	10:05	3	WSW	1	8/8	2	2	0	2	TEMP 4oc Light drizzle
Hr 2	11:05	3	WSW	1	8/8	2	2	0	3	Light drizzle
Hr 3	12:05	3	W	0	7/8	2	2	0	3	TEMP 5oc
Hr 4	13:35	2	W	0	7/8	2	2	0	2	
Hr 5	14:35	2	W	0	6/8	2	2	0	2	TEMP 7oc
Hr 6	15:35	2	WSW	0	6/8	2	2	0	2	

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)
Primary target species: All geese and swans. Secondary target species: Seaduck, waders, raptors and migrant passerines

3 TARGET FLIGHTS

32 BRENT FEEDING ON THE SHORELINE NORTH OF COOLEY POINT OBSERVED DURING BREAK

Vantage Point Watch Recording Sheet

Sheet number 1 / 2

Site: Cooley Point

Vantage Point Location:

Date: 20/12/2019

Observer: NICK VEALE

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 10:05

Finish Time: 16:35

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	RH	1	200	10:07	NE	1				
2	ND	1	400	10:11	SW	1				
3	OC	2	100	10:12	SW	1				
4	CX	80	700	10:14	NE	1				
5	OC	2	100	10:37	SW	1				
6	OC	2	100	11:02	SW	1				
7	CX	48	800	11:24	NNE	1				
8	ND	1	500	11:46	S	1				
9	PB	14	200	13:09	SW	1				
10	CU	1	100	13:34	SW	1				
11	RM	2	300	13:53	SW	1				
12	RP	9	100	14:09	SW	1				
13	CX	16	1000	14:22	SW	1				4M,2F
14	OC	8	100	14:23	NE	1				
15	PB	6	100	14:47	SW	1				
16	PB	10	200	15:02	SW	1				
17	OC	3	100	15:06	NNE	1				
18	RM	2	300	15:09	NE	1				1M1F

Vantage Point Watch Recording Sheet

Sheet number 2 / 2

Site: Cooley Point	Vantage Point Location:	Date: 20/12/2019	

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 10:05

Finish Time: 16:35

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
19	OC	1	100	15:25	NE	1				
20	OC	1	100	15:37	NE	1				
21	RH	2	300	15:40	SSW	1				
22	CX	9	1500	15:52	S	1				
23	SU	4	200	16:04	SW	1				
24	GG	1	400	16:11	SW	1				
25	CX	23	1000	16:29	NE	1				
26	ND	1	400	16:34	SSW	1				

Site	Oriel Migration
Date	10/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	1730
Finish Time	2030
~~Sunrise~~/sunset	2020

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	1730	2	SW	0	7 / 8	2	2	0	2-3	Temp: 10°C
Hr 2										
Hr 3										
Hr 4										
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

Two flocks passed westwards at dusk

Vantage Point Watch Recording Sheet

Sheet number 1 / 1

Site: Cooley Point

Vantage Point Location:

Date: 10/04/20

Observer:
Breffni
Martin

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1730

Finish Time: 2030

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	242	100	2012	w	1				
2	PB	195	100	2019	w	1				

Site	Oriel Migration
Date	11/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	0620 / 1730
Finish Time	0930 / 2030
Sunrise/sunset	0633 / 2020

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	0620	0	N/A	0	3 / 8	2	2	0	0-1	Temp: 10°C
Hr 2										
Hr 3										
Hr 4	1730	0	N/A	0	4 / 8	2	2	0	0-1	Temp: 12°C
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

One flock passed eastwards at dawn
One small flock passed westwards at dusk

Vantage Point Watch Recording Sheet

Sheet number 1 / 2

Site: Cooley Point

Vantage Point Location: Cooley point

Date: 11/04/20

Observer:
Breffni
Martin

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 0620

Finish Time: 0930

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	265	50m	2012	e	1				

Vantage Point Watch Recording Sheet

Sheet number 2 / 2

Site: Cooley Point

Vantage Point Location: Cooley Point

Date: 11/04/20

For primary target species record details on this sheet plus draw flightlines on map For secondary target species only record details on this sheet (no flightlines)

Start Time: 1730

Finish Time: 2030

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	22	50m	2019	w	1				

Site	Oriel Migration
Date	12/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	1100 / 1830
Finish Time	1400 / 2130
Sunrise/sunset	0633 / 2020

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	1100	3	NE	0	4/8	2	2	0	3-4	Temp: 9°C
Hr 2										
Hr 3										
Hr 4	1830	3	NE	0	2/8	2	2	0	3-4	Temp: 11°C
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

One flock passed eastwards at dawn
One small flock passed westwards at dusk

Vantage Point Watch Recording Sheet

Sheet number 1 / 2

Site: Cooley Point	Vantage Point Location: Cooley Point	Date: 12/04/20	Observer: Breffni Martin

For primary target species record details on this sheet plus draw flightlines on map For secondary target species only record details on this sheet (no flightlines)	Start Time: 1100 Finish Time: 1400

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	456	50m	1230	e	1				

Vantage Point Watch Recording Sheet

Sheet number 2 / 2

Site: Cooley Point

Vantage Point Location: Cooley Point

Date: 12/04/20

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1830

Finish Time: 2130

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	111	50m	1852	w	1				

Site	Oriel Migration
Date	13/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	1800
Finish Time	2130
~~Sunrise~~/sunset	2024

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4			**VP Locations**			
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**		Cooley Point			
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	1800	3	NE	0	4 / 8	2	2	0	3-4	Temp: 11°C
Hr 2										
Hr 3										
Hr 4										
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

One flock passed eastwards in the evening

Vantage Point Watch Recording Sheet

Sheet number 1 / 1

Site: Cooley Point	Vantage Point Location: Cooley point	Date: 13/04/20	Observer: Breffni Martin

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1800

Finish Time: 2130

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	218	50m	1821	e	1				

Site	Oriel Migration
Date	14/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	1800
Finish Time	2100
~~Sunrise~~/sunset	2040

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	1800	0	N/A	0	8 / 8	2	2	0	0-1	Temp: 13°C
Hr 2	1900	0	N/A	0	8 / 8	2	2	0	0-1	
Hr 3	2000	0	N/A	0	8 / 8	2	2	0	0-1	
Hr 4										
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

Three flocks passed westwards in the evening

Vantage Point Watch Recording Sheet

Sheet number 1 / 1

Site: Cooley Point

Vantage Point Location: Cooley Point

Date: 14/04/20

Observer:
Breffni
Martin

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1800

Finish Time: 2100

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	781	50m	1850	W	1				
2	PB	542	50m	1956	W					
3	PB	312	100m	2010	w					

Site	Oriel Migration
Date	15/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	1600
Finish Time	1900
~~Sunrise~~/sunset	2028

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	1600	0	N/A	0	8 / 8	2	2	0	0-1	Temp: 12°C
Hr 2										
Hr 3										
Hr 4										
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

No birds observed

Vantage Point Watch Recording Sheet

Sheet number 1 / 1

Site: Cooley Point	Vantage Point Location: Cooley Point	Date: 15/04/20	Observer: Breffni Martin

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1600

Finish Time: 1900

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	

Site	Oriel Migration
Date	16/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	0600 / 1800
Finish Time	0900 / 2100
Sunrise/sunset	0621 / 2030

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	0600	2	NE	0	8 / 8	2	2	0	0-1	Temp: 10°C
Hr 2										
Hr 3										
Hr 4	1800	2	NE	0	8 / 8	2	2	0	2-3	Temp: 12°C
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

One small flock passed east in morning and another west in evening

Vantage Point Watch Recording Sheet

Sheet number 1 / 2

Site: Cooley Point	Vantage Point Location: Cooley Point	Date: 16/04/20	Observer: Breffni Martin

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 0600

Finish Time: 0900

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	32		0825		1				

Vantage Point Watch Recording Sheet

Sheet number 2 / 2

Site: Cooley Point

Vantage Point Location: Cooley Point

Date: 16/04/20

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1800

Finish Time: 2100

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	23		2012		1				

Site	Oriel Migration
Date	20/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	1800
Finish Time	2100
~~Sunrise~~/sunset	2037

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	1800	2	E	0	8 / 8	2	2	0	2-3	Temp: 12°C
Hr 2										
Hr 3										
Hr 4										
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

One small flock passed west in late evening; a party of five birds were feeding on the rocks and remained on the water after dusk

Vantage Point Watch Recording Sheet

Sheet number 1 / 1

Site: Cooley Point

Vantage Point Location: Cooley Point

Date: 20/04/20

Observer:
Breffni
Martin

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1730

Finish Time: 2030

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	
1	PB	45		2048	w	1				

Site	Oriel Migration
Date	23/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	1830
Finish Time	2130
~~Sunrise~~/sunset	2043

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	1830	1	NE	0	5 / 8	2	2	0	1-2	Temp: 13°C
Hr 2										
Hr 3										
Hr 4										
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

A single bird remained on the water throughout the watch, occasionally calling as though waiting for a flock.

Vantage Point Watch Recording Sheet

Sheet number 1 / 1

Site: Cooley Point

Vantage Point Location: Cooley Point

Date: 23/04/20

Observer:
Breffni
Martin

For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1830

Finish Time: 2130

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	

Site	Oriel Migration
Date	24/04/20
Observer	Breffni Martin
Location	Cooley Point
Start Time	1400
Finish Time	1700
~~Sunrise~~/sunset	2042

W-Speed		**W-Direction**	**Rain**		**Cloud Cover**		**Cloud Height**		**Visibility**	
Calm	0	Use 16 point	None	0	In eighths		<150m	0	Poor (<1km)	0
Light air	1	Compass	Drizzle/Mist	1	*e.g.*	3/8	150-500m	1	Moderate (1-3km)	1
Light breeze	2	N	Light showers	2			>500m	2	Good (>3-5km)	2
Gentle breeze	3	NNE	Heavy showers	3						
Mod. breeze	4	NE	Heavy rain	4						
Fresh breeze	5	ENE								
Strong breeze	6	E	**Snow**		**Frost**					
Mod. gale	7	Etc	None	0	None	0				
Fresh gale	8		On site	1	Ground	1				
Strong gale	9		High ground	2	All day	2				
Whole gale	10									
Storm	11									
Hurricane	12									

VP Locations

Cooley Point

Weather	*Start time*	*Wind speed*	*Wind direction*	*Rain*	*Cloud cover*	*Cloud height*	*Visibility*	*Frost*	*Seastate at 5km*	*Notes:*
Hr 1	1400	1	NE	0	8 / 8	2	2	0	1-2	Temp: 12°C
Hr 2										
Hr 3										
Hr 4										
Hr 5										
Hr 6										

Field Notes (summaries of target and secondary species recorded, details of any disturbance, etc.)

No birds observed

Vantage Point Watch Recording Sheet

Sheet number 1 / 1

Site: Cooley Point

Vantage Point Location: Cooley Point

Date: 24/04/20

Observer:
Breffni
Martin

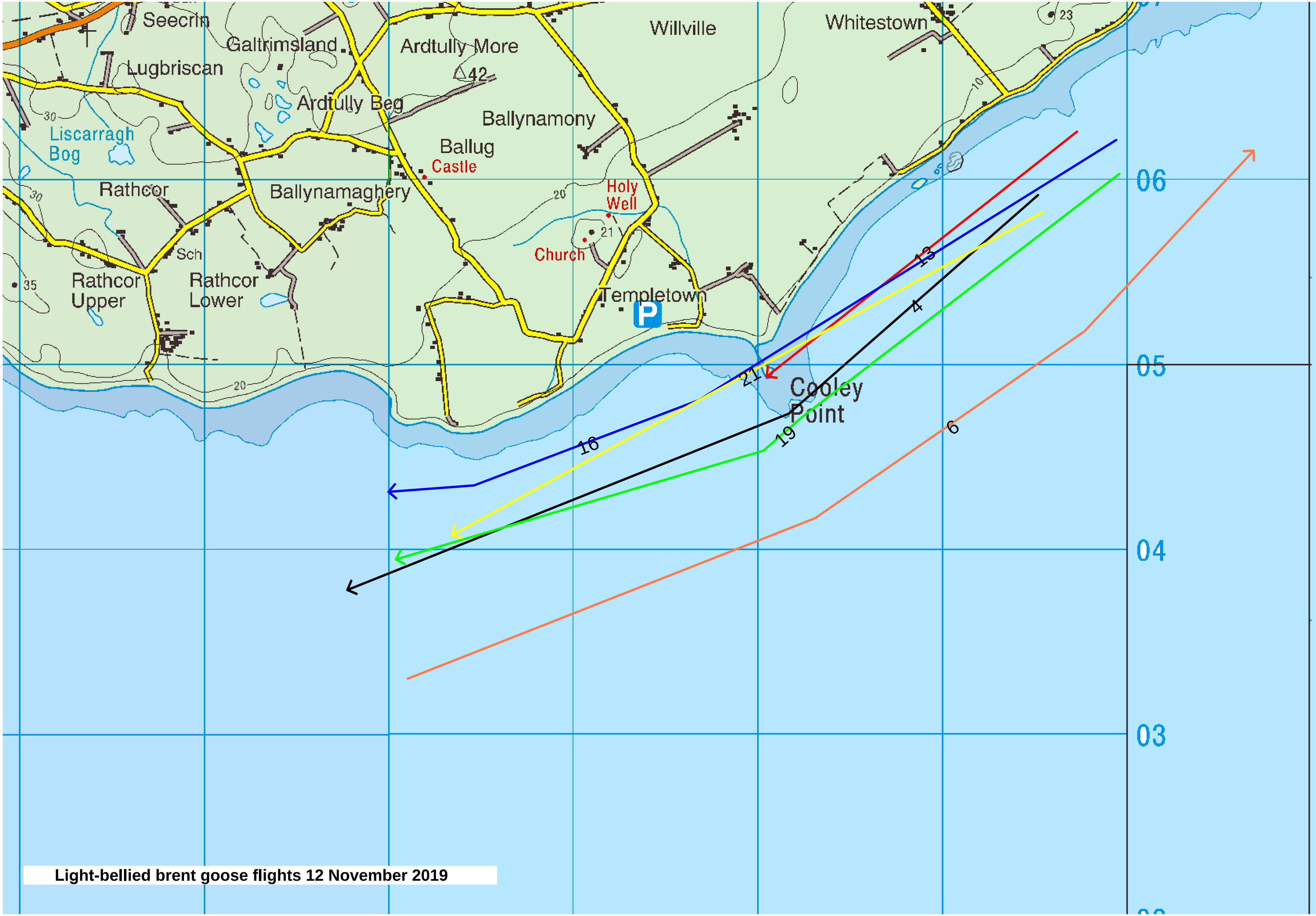
For primary target species record details on this sheet plus draw flightlines on map
For secondary target species only record details on this sheet (no flightlines)

Start Time: 1400

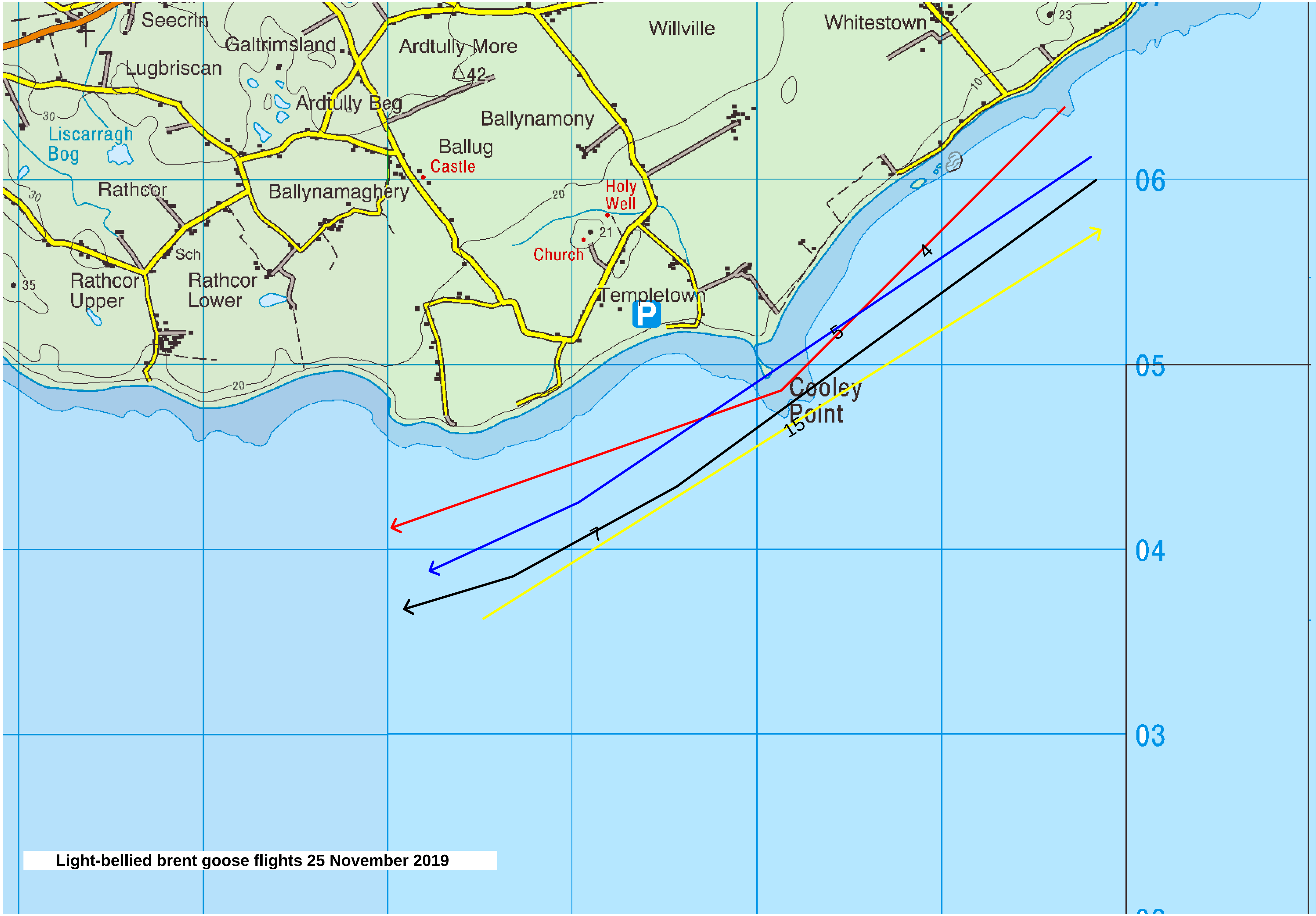
Finish Time: 1700

Flight no.	Sp code/sex/age	Flock size	Nearest distance to flock (to 100m)	Start Time	Flight direction	Height bands: 1 = <20m, 2 = 20 – 250m, 3 = 250 - 300m, 4 = >300m. TICK AS APPROPRIATE				Notes
						1	2	3	4	

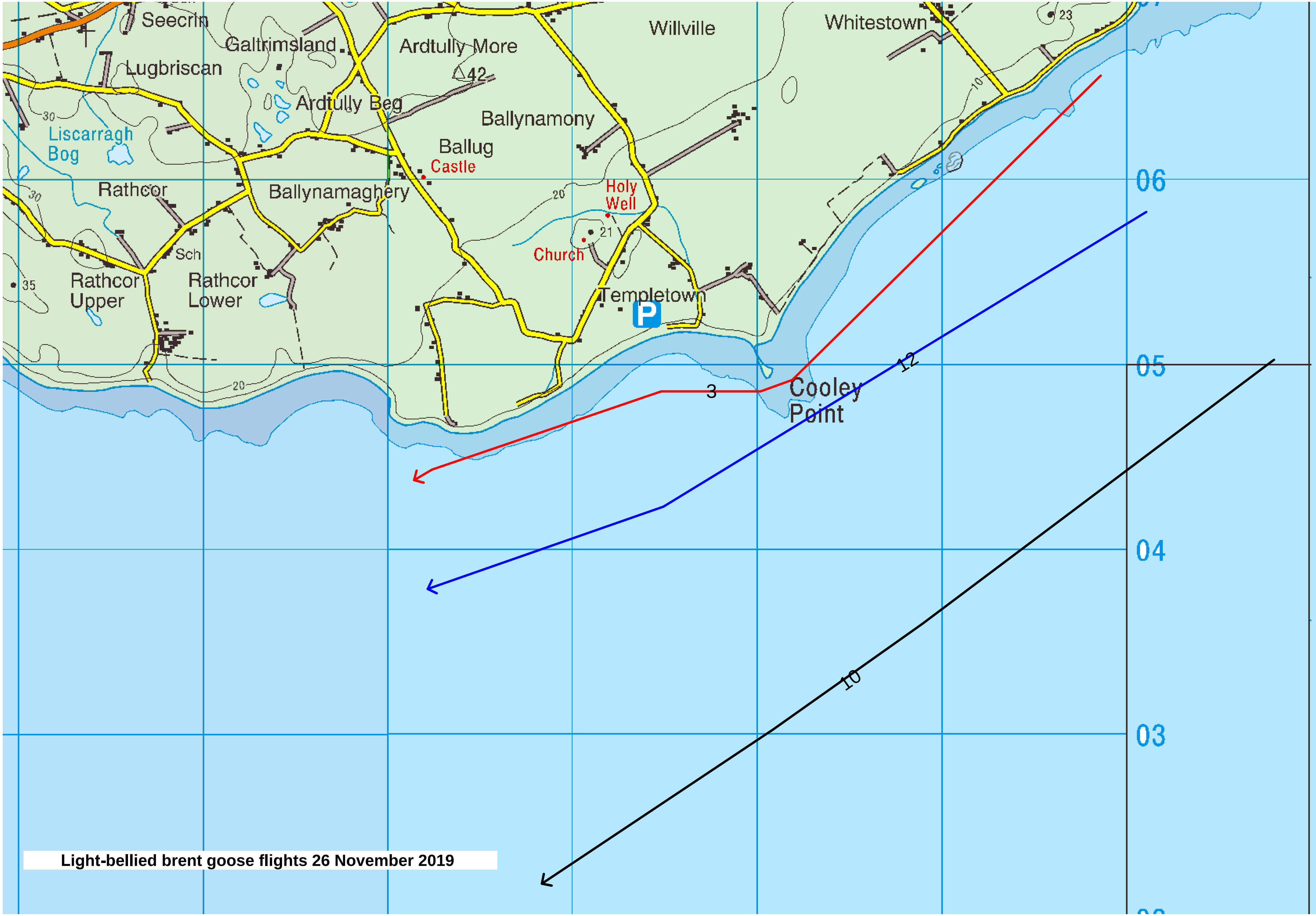
A.2 Flight Paths November - December 2019



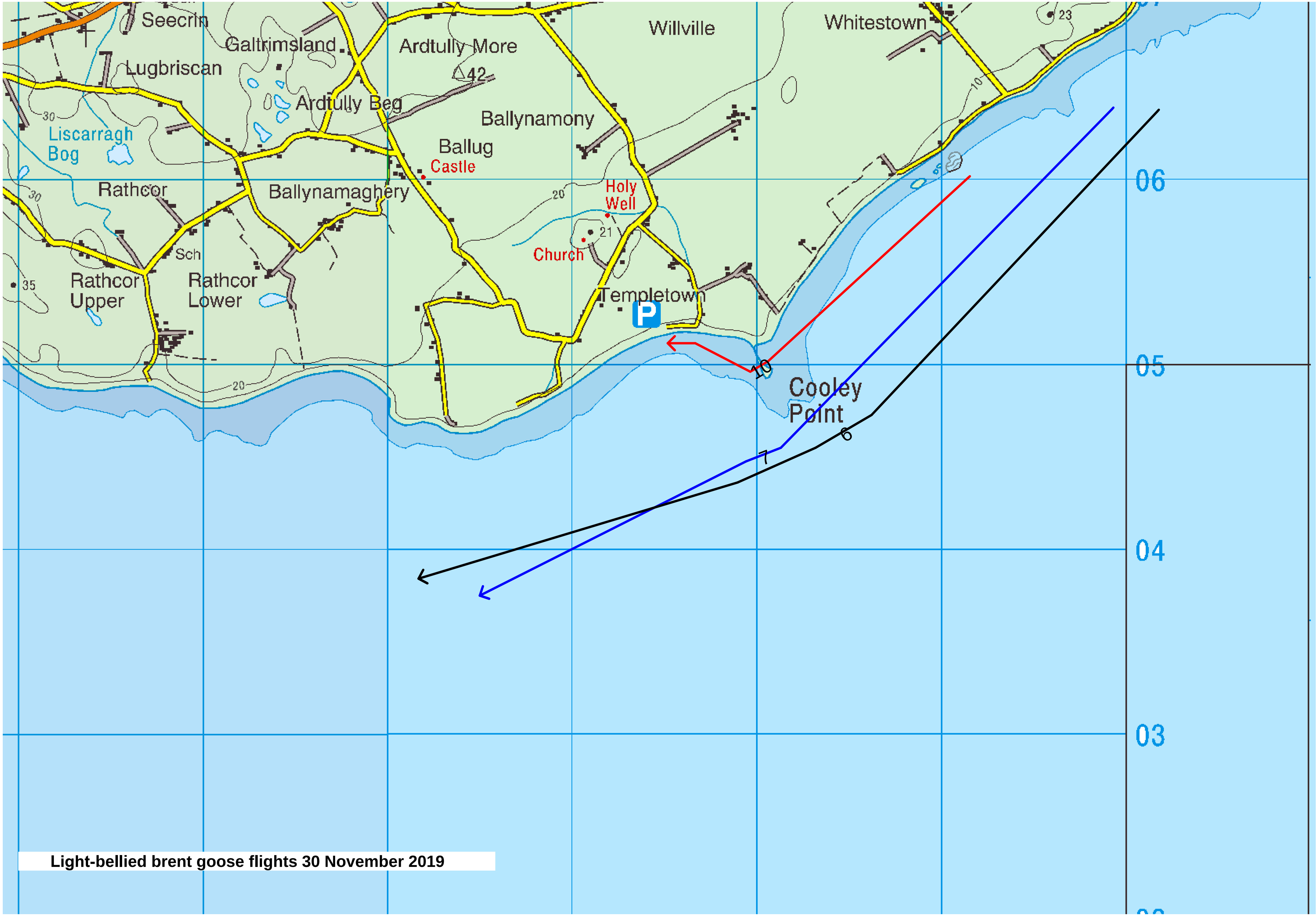
Light-bellied brent goose flights 12 November 2019



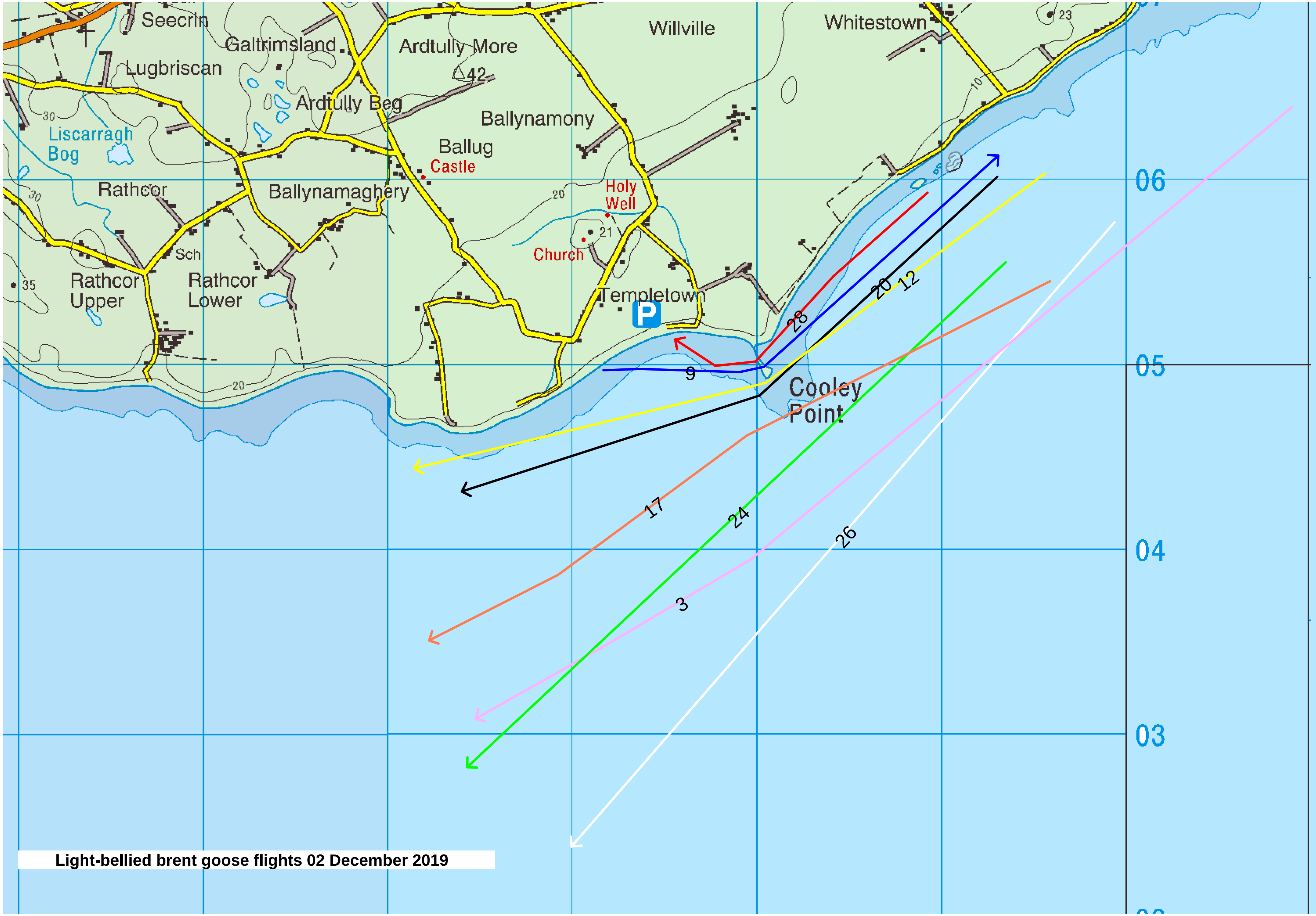
Light-bellied brent goose flights 25 November 2019



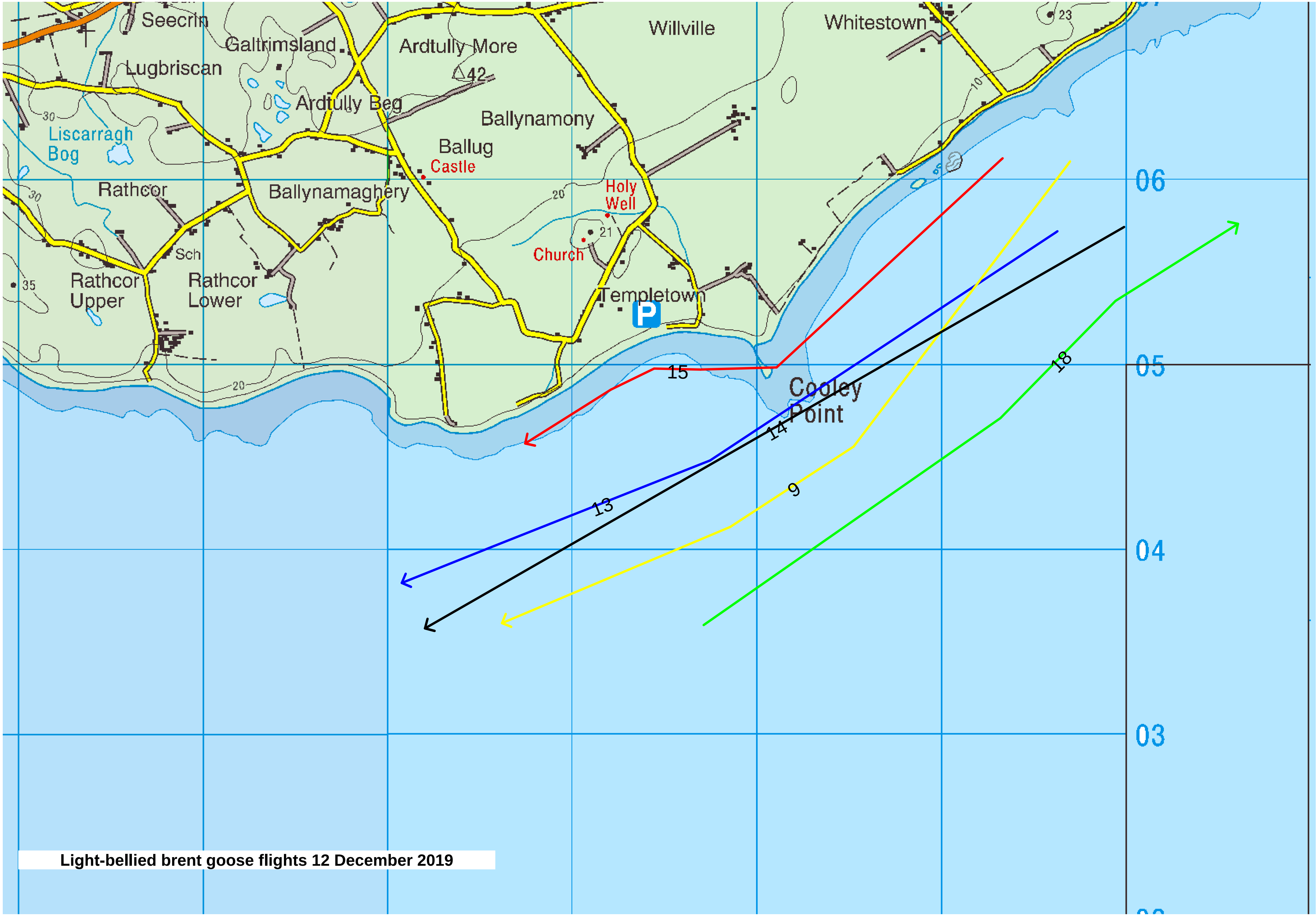
Light-bellied brent goose flights 26 November 2019



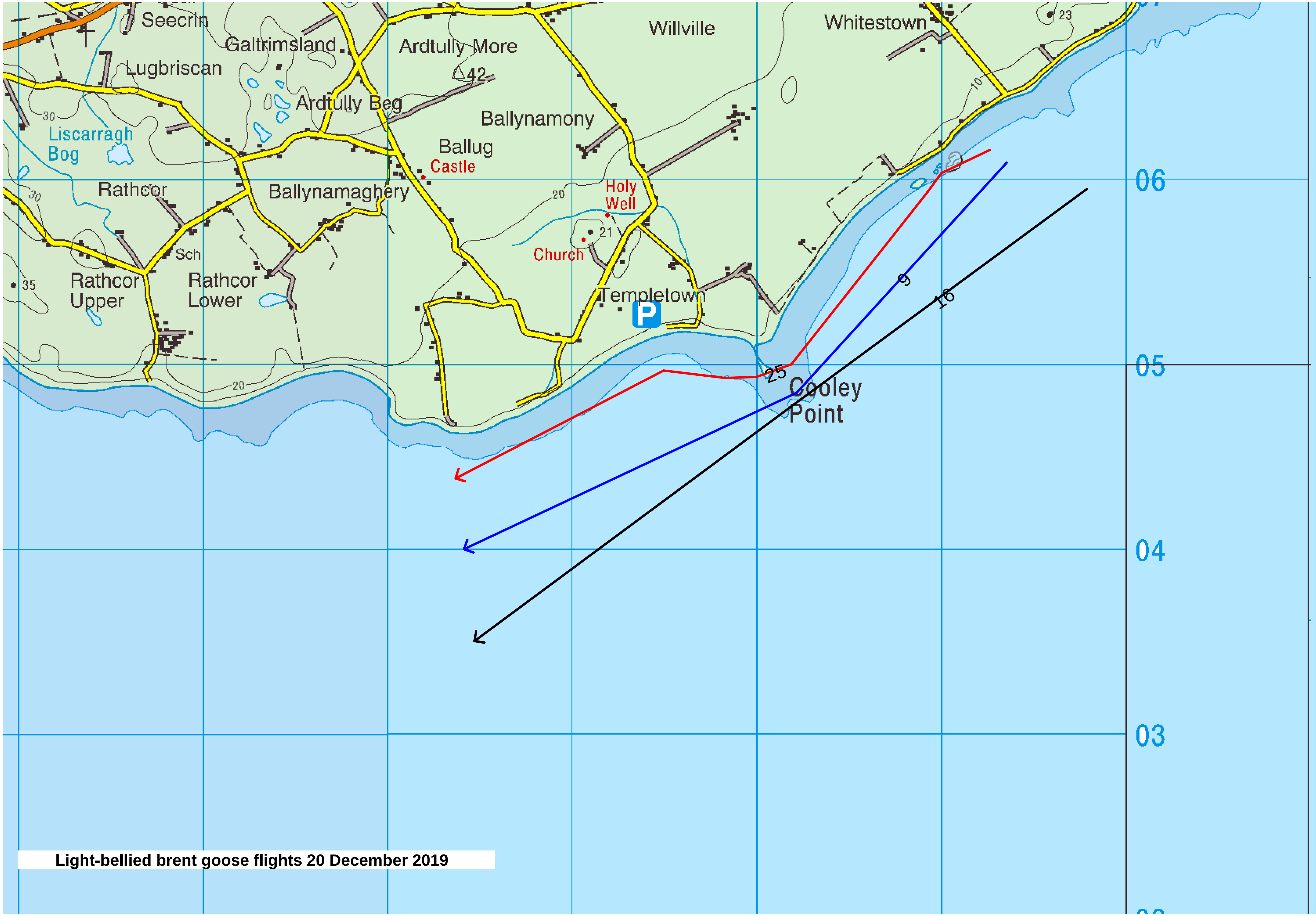
Light-bellied brent goose flights 30 November 2019



Light-bellied brent goose flights 02 December 2019



Light-bellied brent goose flights 12 December 2019



Light-bellied brent goose flights 20 December 2019

ANNEX 4: OFFSHORE ORNITHOLOGY COLLISION RISK MODELLING

ORIEL WIND FARM PROJECT

Natura Impact Statement

Annex 4: Offshore Ornithology Collision Risk Modelling

MDR1520B
NIS – Annex 4
A1 C01
March 2024

rpsgroup.com

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1 INTRODUCTION

1.1 Purpose of the report

This technical report has been produced for the purpose of describing the collision risk modelling (CRM) methodology and results, in support of appendix H: Offshore Ornithology – Supporting Information of the Oriel Wind Farm Project NIS. The collision modelling was initially undertaken by APEM Ltd (hereafter APEM) and updated by RPS based on the seabird densities and abundances presented in annex 1: Offshore Ornithology Technical Report and annex 2: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm.

1.2 Project background

Oriel Windfarm Ltd ("the Applicant") is proposing to develop the Oriel Wind Farm Project, hereafter referred to as 'the Project". The offshore wind farm area is located in the Irish Sea, off the coast of County Louth (approximately 22 km east of Dundalk town centre and 18 km east of Blackrock). The closest wind turbine will be approximately 6 km from the closest shore on the Cooley Peninsula. The offshore cable corridor extends approximately 11 km southwest from the wind farm area to the landfall south of Dunany Point. The Project will comprise both onshore and offshore infrastructure including 25 offshore wind turbine generators (WTGs), associated foundations and inter-array cabling, offshore substation, one offshore cable within a defined offshore cable corridor, a landfall, onshore cable route and an onshore substation for connection to the electricity transmission network.

1.3 Collision risk modelling

There is potential risk to birds from offshore wind farms through collision with WTGs and associated infrastructure. There is an increase in potential risk of collision with WTGs if they are located in areas of high bird densities in which there is a high level of flight activity. That high level of flight activity can be associated with locations where food supplies are concentrated or with areas where there is a high turnover of individuals (possibly commuting daily between nesting and feeding areas or passing through the area on seasonal migrations). The potential collision risk can be estimated using CRM.

CRM has been carried out for ornithological receptors that are considered to be potentially vulnerable to collision with WTGs (seabirds in this instance). Five seabird species have been identified as potentially at risk due to their recorded abundance in the offshore wind farm area and their likelihood of flying at potential collision height (PCH) between the lowest and highest sweep of the WTG rotor blades above sea level:

- Gannet (*Morus bassanus*);
- Kittiwake (*Rissa tridactyla*);
- Common gull (*Larus canus*);
- Herring gull (*Larus argentatus*); and
- Great black-backed gull (*Larus marinus*).

2 METHODOLOGY

2.1 Guidance and models

The five species selected for CRM were screened in for assessment based on their perceived vulnerability to collision (Furness *et al*., 2013; Ozsanlav-Harris *et al*., 2023), together with their abundance within the baseline dataset (including 19 months of boat-based surveys and six months of digital aerial surveys (DAS); annex 1: Offshore Ornithology Technical Report and annex 2: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm).

Collision risk modelling was undertaken using the stochastic Collision Risk Model (sCRM) developed by Marine Scotland (McGregor *et al.,* 2018). The sCRM provides a user-friendly 'Shiny App' online interface which allows for variability in input parameters to be incorporated into the model, producing predicted collision estimates with associated uncertainty. Models were run deterministically for each seabird species (as set out in Department of Communications, Climate Action & Environment (DCCAE) 2018) guidance), rather than stochastically. Additionally, the sCRM provides a useful audit trail of input parameters and outputs, enabling reviewers to easily assess and reproduce the results of any modelling scenario. The User Guide for the sCRM Shiny App provided by Marine Scotland (Donovan, 2018) has been followed for the modelling of collision impacts predicted for the Mona Array Area.

There is currently no detailed Irish guidance regarding the use of collision risk models or avoidance rates (ARs) in the assessment of offshore wind farms on seabirds. The collision risk model incorporated interim guidance on recommended ARs, bird size, flight speed, flight type and nocturnal activity scores (Natural England, 2022). Throughout the document, outputs will be contrasted with recently published parameters from JNCC (Ozanlav-Harris *et al.,* 2023). All proposed parameters are set out in section 2.2.

Collision risk models were run using Band Option 1 and 2 of the sCRM. When using Band Option 1, the proportion of birds flying at collision risk height was determined using the results from the site specific boat-based surveys (Table 2-5) The proportion of birds flying at collision risk height was determined using generic flight height data rather than site-based data. These generic data were taken from Johnston *et al.* (2014a; 2014b), who analysed flight height measurements from surveys conducted at 32 sites around the UK.

2.2 CRM input parameters

As the sCRM has been run deterministically, an evidence-led approach was used to determine the parameters used to model collision risk for each species. The values describe the proposed wind farm design described in appendix H: Offshore Ornithology – Supporting Information. An overview of the input parameters used for the Applicant's single design scenario are provided in Table 2-1 to Table 2-5.

2.2.1 Offshore Wind Farm project design parameters

Input parameters for the wind turbine specifications used within the CRM are shown in Table 2-1 and Table 2-2. These values are based on the project description, as described in section 2 of the main NIS document.

Wind farm width was calculated using the longest distance across the offshore wind farm area, which is used in the CRM to calculate the maximum amount of time a bird could spend in the wind farm if it flew in a straight line through the longest length. The latitude is for the centroid of the offshore wind farm area.

The values presented below are considered the value which equates to the largest impact on the ornithological features. If the parameters were to be marginally altered a lesser impact would be expected. Therefore, the CRM assesses the maximal potential impact on protected species.

Table 2-1: Wind farm specifications used within the CRM.

Input Parameter (units)	Value
Number of turbines	25
WTG model (megawatt (MW))	15
Number of blades	3
Rotor radius (m)	118
Minimum air gap (m) (lowest astronomical tide (LAT))	27

Input Parameter (units)	Value
Maximum blade width (m)	7
Tidal offset (m) (mean sea level (MSL))	2.75
Wind farm width (km)	7.37
Latitude (degrees)	54.05486
Rotation speed (rotations per minute (rpm))	8.1 (± 0.3)
Large array correction	Yes
Pitch (^{o})	10

Table 2-2: Theoretical operational time of the project turbines as provided by the Applicant.

Month	Wind availability (%)	Expected WTG downtime (%)
January	95	1
February	96	1
March	95	2
April	93	1
May	92	2
June	90	2
July	90	3
August	90	4
September	93	4
October	95	3
November	95	1
December	95	1

2.2.2 Avoidance rates

The species-specific ARs that were applied in the CRM are presented in Table 2-3. The AR for all species follow guidance from Natural England (2022) and the subsequent JNCC report (Ozsanlav-Harris *et al.*, 2023), in the absence of detailed guidance from regulators in Ireland. Within this document, these two ARs will be referred to as “Natural England AR” and “JNCC AR”. The standard deviation (SD) is presented alongside the AR, to provide variation around the mean value. The Natural England rates are grouped into species type, with gannet and kittiwake included within the “all gulls rate”, herring gull and great black-backed gull as “large gulls” and common gull as “small gulls”. Species specific AR are provided within the JNCC report for kittiwake, herring gull and great black-backed gull, but gannet and common gull use the large and small gull, respectively.

Table 2-3: AR used for CRM for all five species.

Species	AR of each species assessed	
	Natural England AR (± 1 SD)	JNCC AR (± 1 SD)
Gannet	0.993 (± 0.0003)	0.9939 (± 0.0004)
Kittiwake	0.993 (± 0.0003)	0.9979 (± 0.0013)
Common Gull	0.995 (± 0.0002)	0.9949 (± 0.0002)
Herring gull	0.994 (± 0.0004)	0.9952 (± 0.0003)
Great black-backed gull	0.994 (± 0.0004)	0.9991 (± 0.0002)

2.2.3 Other species-specific parameters

In addition to the ARs, there are other specific-specific parameters included within the CRM, these are provided in Table 2-4. The biometrics for all species were derived from McGregor *et al*. (2018) and Natural England (2022). Estimates of flight speeds for kittiwake, herring gull, and great black-backed gull were derived from Cook *et al*. (2014), which presents flight speed values taken from Pennycuick (1997) and Alerstam *et al.* (2007). Flight speed for common gull was derived directly from Alerstam *et al.* (2007), due to a suspected error in the Cook *et al.* (2014) data. Flight speed for gannet was derived from both Cook *et al.* (2014) and more recent data present by Skov *et al.* (2018). The nocturnal activity factor are all based on Garthe & Hüppop (2004) other than gannet which is from Furness *et al*. (2018).

Table 2-4: Species biometrics used for CRM.

Species	Species-specific parameters			
	Body Length (m)	Wingspan (m)	Flight speed (ms^{-1})	Nocturnal activity
Gannet	0.94 (±0.0325)	1.72 (±0.0375)	14.9 (± 0)	0.08 (±0.1)
Kittiwake	0.39 (±0.005)	1.08 (±0.0625)	13.1 (± 0.4)	0.375 (±0.0637)
Common gull	0.41 (±0.005)	1.20 (±0.05)	13.4 (± 0.4)	0.375 (±0.0637)
Herring gull	0.595 (±0.0225)	1.44 (±0.03)	12.8 (± 1.8)	0.375 (±0.0637)
Great black-backed gull	0.71 (±0.035)	1.58 (±0.0375)	12.8 (± 1.2)	0.375 (±0.0637)

2.2.4 Proportion at potential collision risk height (PCH)

From the boat-based site-specific surveys, the proportion of individuals flying at PCH for use in Band Option 1 for each species were obtained providing a generic PCH per species which is used in this model (Table 2-5).

Species recorded in flight were assigned to the following height bands; 0-5 m, 5-10 m, 10-20 m, 20-30 m, 30-40 m, 40-50 m and above 50 m. To calculate PCH, the number of records across the year and from the flight height category “20-30 m” and above, were summed and divided by the total recorded for each species.

Table 2-5: Proportion at PCH used for Band Option 1 for the boat-based survey data modelling.

Species	PCH (%)
Gannet	17.3
Kittiwake	8.4
Common gull	9.0
Herring gull	21.1
Great black-backed gull	22.4

2.2.5 Density of birds in flight

Density estimates ± SD were determined for the Project using data collected from 19 months of baseline boat-based surveys (carried out between May 2018 and May 2020) and six months of DAS (carried out between April 2020 and September 2020), the results of which are presented in annex 1: Offshore Ornithology Technical Report and annex 2: Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm. The density data presented in Table 2-6 and

Table **2-7** are inclusive of apportionment of unidentified birds and corrections for availability bias, where appropriate.

SDs were estimated using the following equation:

$$1 \text{ SD} \approx (\text{Upper CL} - \text{Lower CL})/4$$

For boat-based survey data with more than one survey in a calendar month, the mean density estimate of the two surveys was used. For calculation of SDs the maximum estimate of the two upper confidence limits and the minimum of the two lower confidence limits were selected.

For the DAS data, species which were subject to apportionment between sitting and flying birds, the upper and lower confidence intervals of flying birds were estimated assuming the ratio between the mean and the upper/lower confidence limit remained the same between un-apportioned and apportioned estimates for flying birds.

For the DAS, no common gull or herring gull were recorded within the six month survey period, therefore collision risk was assessed for the remaining three species only.

Additionally, the guidance provided by Natural England (2022) states that in order to account for macro-avoidance, the densities of gannet used for collision risk modelling should be reduced by 65 to 85% to account for macro-avoidance which is not incorporated into the ARs. To address this Natural England propose reducing input densities by 70%. A specific scenario where densities within the Oriel Array Area were reduced by 70% for northern gannet is therefore also presented.

Table 2-6: Mean density of each species (± SD) during the boat-based surveys used with the CRM.

Month	Gannet	Gannet (70 % macro-avoidance)	Kittiwake	Common gull	Herring gull	Great black-backed gull
Jan	0 (0 - 0)	0 (0 - 0)	0.27 (0 - 0.55)	0.4 (0.22 - 0.58)	0.9 (0 - 1.82)	0.65 (0 - 2.16)
Feb	0 (0 - 0)	0 (0 - 0)	7.65 (6.7 - 8.6)	2.56 (2.11 - 3.01)	0.43 (0.14 - 0.72)	1.73 (0.76 - 2.71)
Mar	0.83 (0.62 - 1.04)	0.25 (0.19 - 0.31)	0.72 (0.44 - 1)	0.29 (0.15 - 0.42)	1.84 (1.33 - 2.35)	0.4 (0.13 - 0.67)
Apr	0.76 (0.45 - 1.06)	0.23 (0.14 - 0.32)	0.04 (0 - 1.91)	0 (0 - 0)	0.29 (0.18 - 0.4)	0.11 (0.04 - 0.18)
May	0.09 (0 - 0.21)	0.03 (0 - 0.06)	0.31 (0.07 - 0.54)	0 (0 - 0)	0 (0 - 0)	0.11 (0.06 - 0.15)
Jun	0.22 (0 - 0.47)	0.07 (0 - 0.14)	0.74 (0.26 - 1.22)	0 (0 - 0)	0.72 (0.62 - 0.82)	0.07 (0.03 - 0.12)
Jul	0.49 (0.14 - 0.84)	0.15 (0.04 - 0.25)	0.02 (0 - 0.17)	0 (0 - 0)	0.25 (0.18 - 0.32)	0.18 (0.11 - 0.25)
Aug	2.35 (0.9 - 3.79)	0.71 (0.27 - 1.14)	0.22 (0 - 1.06)	0 (0 - 0)	0.29 (0 - 2.13)	0.76 (0 - 2.11)
Sep	3.07 (2.67 - 3.46)	0.92 (0.80 - 1.04)	0.72 (0.32 - 1.12)	0 (0 - 0)	0.4 (0 - 1.57)	0.11 (0 - 0.93)
Oct	1.12 (0.44 - 1.79)	0.34 (0.13 - 0.54)	0.4 (0.1 - 0.69)	0.85 (0.54 - 1.15)	0.13 (0 - 0.6)	0.41 (0 - 1.69)
Nov	0 (0 - 0)	0 (0 - 0)	5.27 (3.64 - 6.89)	0.25 (0.19 - 0.32)	0.43 (0.11 - 0.76)	0.07 (0 - 0.32)
Dec	0 (0 - 0)	0 (0 - 0)	0.79 (0 - 1.61)	0.72 (0.47 - 0.97)	4.64 (1.15 - 8.13)	1.37 (0 - 5.12)

Table 2-7: Mean density of each species (± SD) during the DAS used with the CRM.

Month	Gannet	Gannet (70 % macro-avoidance)	Kittiwake	Great black-backed gull
Jan	No Survey			
Feb	No Survey			
Mar	No Survey			
Apr	0 (0 - 0)	0 (0 - 0)	0.11 (0.05 - 0.17)	0.18 (0.1 - 0.26)
May	1.37 (0.86 - 1.89)	0.41 (0.26 - 0.57)	0.51 (0.31 - 0.7)	0 (0 - 0)
Jun	0.11 (0.05 - 0.17)	0.03 (0.02 - 0.05)	0 (0 - 0)	0 (0 - 0)
Jul	1.08 (0.63 - 1.53)	0.32 (0.19 - 0.46)	0.4 (0.14 - 0.66)	0 (0 - 0)
Aug	0.58 (0.33 - 0.82)	0.17 (0.10 - 0.25)	0 (0 - 0)	0 (0 - 0)
Sep	0.79 (0.27 - 1.32)	0.24 (0.08 - 0.40)	0.61 (0.22 - 1.01)	0.11 (0.05 - 0.17)
Oct	No Survey			
Nov	No Survey			
Dec	No Survey			

3 RESULTS

This section provides the standard outputs from the CRM for each of the five seabird species modelled. Tabulated monthly results are presented in Table 3-1 to Table 3-10. Each table is colour coded into the different season (pre-breeding migration [green], breeding [blue], post-breeding migration [yellow] and non-breeding season [grey]) for ease of comparison within appendix H: Offshore Ornithology – Supporting Information whereby potential impacts are separated into specific season.

3.1 Gannet (no macro-avoidance)

3.1.1 Boat-based estimates

Table 3-1 presents the monthly and annual predicted gannet collision rates for Band Option 1 and 2 using the boat-based survey density input data. Both the Natural England and JNCC AR are presented within Table 3-1.

Table 3-1: Mean number of gannet collisions per month for Band Option 1 & 2 from boat-based density estimates.

	Natural England AR		JNCC AR	
Month	**Band Option 1**	**Band Option 2**	**Band Option 1**	**Band Option 2**
January	0	0	0	0
February	0	0	0	0
March	5.80	2.85	5.14	2.51
April	5.98	2.94	5.22	2.55
May	1.01	0.50	0.90	0.44
June	2.53	1.25	2.19	1.04
July	4.80	2.35	4.15	2.01
August	20.06	9.86	17.38	8.43
September	21.28	10.43	18.36	8.92
October	7.57	3.74	6.52	3.18
November	0	0	0	0
December	0	0	0	0
Annual	**69.04**	**33.91**	**59.87**	**29.09**

3.1.2 DAS estimates

Table 3-2 presents the monthly and annual predicted gannet collision rates for Band Option 1 and 2 using the DAS density input data. Both the Natural England and JNCC AR are presented within Table 3-2.

Table 3-2: Mean number of gannet collisions per month for Band Option 2 from DAS density estimates.

	Natural England AR	JNCC AR
Month	**Band Option 2**	**Band Option 2**
January	No survey	
February	No survey	
March	No survey	
April	0	0
May	6.14	5.46
June	0.48	0.42
July	4.74	4.15

Month	Natural England AR Band Option 2	JNCC AR Band Option 2
August	2.33	2.01
September	2.62	2.29
October	No survey	
November	No survey	
December	No survey	
Total collisions	**16.32**	**14.32**

3.2 Gannet (70 % macro-avoidance)

3.2.1 Boat-based estimates

Table 3-3 presents the monthly and annual predicted gannet collision rates for Band Option 1 and 2 using the boat-based survey density input data and applying a 70 % reduction, due to macro-avoidance (displacement). Both the Natural England and JNCC AR are presented within Table 3-3.

Table 3-3: Mean number of gannet collisions per month for Band Option 1 & 2 from boat-based density estimates and applying 70 % macro-avoidance.

	Natural England rates		JNCC rates	
Month	Band Option 1	Band Option 2	Band Option 1	Band Option 2
January	0	0	0	0
February	0	0	0	0
March	1.74	0.86	1.54	0.75
April	1.79	0.88	1.57	0.77
May	0.30	0.15	0.27	0.13
June	0.76	0.38	0.66	0.31
July	1.44	0.71	1.25	0.60
August	6.02	2.96	5.21	2.53
September	6.38	3.13	5.51	2.68
October	2.27	1.12	1.96	0.95
November	0	0	0	0
December	0	0	0	0
Annual	**20.71**	**10.18**	**17.96**	**8.72**

3.2.2 DAS estimates

Table 3-4 presents the monthly and annual predicted gannet collision rates for Band Option 1 and 2 using the DAS density input data. Both the Natural England and JNCC AR are presented within Table 3-4.

Table 3-4: Mean number of gannet collisions per month for Band Option 2 from DAS density estimates and applying 70 % macro-avoidance.

Month	Natural England AR Band Option 2	JNCC AR Band Option 2
January	No survey	
February	No survey	
March	No survey	
April	0	0

Month	Natural England AR Band Option 2	JNCC AR Band Option 2
May	1.84	1.64
June	0.14	0.13
July	1.42	1.25
August	0.70	0.60
September	0.79	0.69
October	No survey	
November	No survey	
December	No survey	
Total collisions	**4.89**	**4.30**

3.3 Kittiwake

3.3.1 Boat-based estimates

Table 3-5 presents the monthly and annual predicted kittiwake collision rates for Band Option 1 and 2 using the boat-based survey density input data. Both the Natural England and JNCC AR are presented within Table 3-5.

Table 3-5: Mean number of kittiwake collisions per month for Band Option 1 & 2 from boat-based density estimates.

	Natural England rates		JNCC rates	
Month	Band Option 1	Band Option 2	Band Option 1	Band Option 2
January	0.91	1.05	0.28	0.32
February	19.75	22.73	6.04	6.90
March	2.20	2.53	0.68	0.78
April	0.16	0.19	0.05	0.06
May	1.21	1.40	0.37	0.42
June	2.69	3.10	0.81	0.93
July	0.09	0.10	0.03	0.03
August	0.90	1.04	0.26	0.30
September	2.20	2.53	0.65	0.74
October	1.31	1.50	0.40	0.46
November	13.80	15.88	4.27	4.87
December	2.60	3.00	0.82	0.94
Annual	**47.83**	**55.05**	**14.66**	**16.75**

3.3.2 DAS estimates

Table 3-6 presents the monthly and annual predicted gannet collision rates for Band Option 1 and 2 using the DAS density input data. Both the Natural England and JNCC AR are presented within Table 3-6.

Table 3-6: Mean number of kittiwake collisions per month for Band Option 2 from DAS density estimates.

Month	Natural England AR Band Option 2	JNCC AR Band Option 2
January	No survey	

	Natural England AR	JNCC AR
Month	Band Option 2	Band Option 2
February	No survey	
March	No survey	
April	0.40	0.12
May	2.14	0.65
June	0	0
July	1.54	0.47
August	0	0
September	2.05	0.63
October	No survey	
November	No survey	
December	No survey	
Total collisions	**6.13**	**1.88**

3.4 Common gull

3.4.1 Boat-based estimates

Table 3-7 presents the monthly and annual predicted common gull collision rates for Band Option 1 and 2 using the boat-based survey density input data. Both the Natural England and JNCC AR are presented within Table 3-7.

Table 3-7: Mean number of common gull collisions per month for Band Option 1 & 2 from boat-based density estimates.

	Natural England rates		JNCC rates	
Month	Band Option 1	Band Option 2	Band Option 1	Band Option 2
January	0.85	1.60	0.86	1.62
February	5.24	9.92	5.25	9.96
March	0.71	1.34	0.71	1.34
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	1.93	3.65	1.98	3.75
November	0.52	0.98	0.52	0.98
December	1.46	2.76	1.46	2.78
Annual	**10.71**	**20.27**	**10.78**	**20.45**

3.5 Herring gull

3.5.1 Boat-based estimates

Table 3-8 presents the monthly and annual predicted kittiwake collision rates for Band Option 1 and 2 using the boat-based survey density input data. Both the Natural England and JNCC AR are presented within Table 3-8.

Table 3-8: Mean number of herring gull collisions per month for Band Option 1 & 2 from boat-based density estimates.

	Natural England rates		JNCC rates	
Month	**Band Option 1**	**Band Option 2**	**Band Option 1**	**Band Option 2**
January	7.36	8.75	5.77	6.94
February	2.96	3.52	2.24	2.68
March	13.42	15.99	10.74	12.86
April	2.22	2.64	1.75	2.09
May	0	0	0	0
June	5.82	6.93	4.65	5.56
July	2.05	2.44	1.61	1.92
August	2.81	3.34	2.24	2.69
September	3.57	4.26	2.91	3.47
October	1.17	1.40	0.96	1.15
November	3.06	3.64	2.43	2.91
December	32.67	38.89	26.33	31.23
Annual	**77.10**	**91.80**	**61.61**	**73.50**

3.6 Great black-backed gull

3.6.1 Boat-based estimates

Table 3-9 presents the monthly and annual predicted kittiwake collision rates for Band Option 1 and 2 using the boat-based survey density input data. Both the Natural England and JNCC AR are presented within Table 3-9.

Table 3-9: Mean number of great black-backed gull collisions per month for Band Option 1 & 2 from boat-based density estimates.

	Natural England rates		JNCC rates	
Month	**Band Option 1**	**Band Option 2**	**Band Option 1**	**Band Option 2**
January	5.96	7.39	0.91	1.13
February	12.74	15.81	1.95	2.42
March	3.60	4.47	0.54	0.67
April	1.01	1.26	0.15	0.19
May	1.03	1.28	0.15	0.19
June	0.67	0.82	0.10	0.12
July	1.64	2.04	0.25	0.31
August	8.33	10.30	1.30	1.63
September	1.13	1.40	0.17	0.21
October	4.18	5.19	0.61	0.75
November	0.65	0.81	0.10	0.12
December	12.21	15.14	1.81	2.24
Annual	**53.16**	**65.91**	**8.03**	**9.98**

3.6.2 DAS estimates

Table 3-10 presents the monthly and annual predicted gannet collision rates for Band Option 1 and 2 using the DAS density input data. Both the Natural England and JNCC AR are presented within Table 3-10.

Table 3-10: Mean number of great black-backed gull collisions per month for Band Option 2 from DAS density estimates.

Month	Natural England AR Band Option 2	JNCC AR Band Option 2
January	No survey	
February	No survey	
March	No survey	
April	2.00	0.30
May	0	0
June	0	0
July	0	0
August	0	0
September	1.09	0.17
October	No survey	
November	No survey	
December	No survey	
Total collisions	**3.09**	**0.47**

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ANNEX 5: OFFSHORE ORNITHOLOGY DISPLACEMENT ANALYSIS

ORIEL WIND FARM PROJECT

Natura Impact Statement

Annex 5: Offshore Ornithology Displacement Analysis

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1 INTRODUCTION

1.1 Purpose of the report

This technical report has been prepared for the purpose of describing the displacement analysis methodology and results, in support of the impact assessment of seabirds presented appendix H: Offshore Ornithology – Supporting Information of the Oriel Wind Farm Project NIS. The displacement analysis has been undertaken by APEM Ltd (hereafter APEM) based on seabird densities and abundances presented in annex 1: Offshore Ornithology Technical Report.

1.2 Project background

Oriel Windfarm Limited (‘the Applicant’) is proposing to develop the Oriel Wind Farm Project, an offshore wind farm (OWF), hereafter referred to as ‘the Project”. The offshore wind farm area is located in the Irish Sea, off the coast of County Louth (approximately 22 km east of Dundalk town centre and 18 km east of Blackrock). The closest wind turbine will be approximately 6 km from the closest shore on the Cooley Peninsula. The offshore cable corridor extends approximately 11 km southwest from the wind farm area to the landfall south of Dunany Point. The Project will comprise both offshore and onshore infrastructure including 25 offshore wind turbines generators (WTGs), associated foundations and inter-array cabling, offshore substation, offshore cable within a defined offshore cable corridor, a landfall, onshore cable route and an onshore substation for connection to the electricity transmission network.

2 DISPLACEMENT ANALYSIS

The presence of WTGs and other activities associated with an offshore wind farm have the potential to directly displace seabirds that would normally reside within and around the area of sea where the Project is proposed. This effect represents indirect habitat loss, potentially reducing the area available for those seabirds sensitive to disturbance to forage, loaf and / or moult in the way that they are currently able to within and around the offshore wind farm area. There is also the potential for the construction and decommissioning of WTGs, offshore substation and offshore cable laying to directly disturb and displace seabirds.

2.1 Displacement matrix approach

There is currently no detailed Irish guidance regarding the method of assessment of displacement of seabirds as a result of offshore wind farms. Guidance for offshore renewable energy projects published by the Department of Communications, Climate Action & Environment (DCCAE) (DCCAE, 2014) includes reference to emerging methods for displacement assessment at the time of its publication, namely JNCC report 551 (Busch *et al.*, 2015). However, at this time such proposed approaches have not been used in other offshore wind farm assessments. This analysis therefore draws on the most recent recommendations of the UK Statutory Nature Conservation Bodies (SNCB, 2022), which promotes a displacement matrix approach.

The methodology presented in SNCB (2022) recommends that a matrix is compiled for each key species for a range of displacement levels (at 10% increments) across a range of likely adult mortality levels (at 0, 1%, 2%, 3%, 4%, 5%, 10% and then 10% increments) in each relevant biological season for that species.

Using available evidence on seabird sensitivity and habitat flexibility, a value, or small range of values of displacement rate and associated mortality levels are selected to provide an estimate of the potential losses. The consequent potential losses to the population as a result of displacement is then assessed for each season against an appropriate population scale. For the breeding season, the appropriate regional population covers the total colony counts within mean-maximum foraging range; for the non-breeding season, the appropriate regional population is based on species specific biologically defined minimum population scales (BDMPS), (Furness, 2015).

This technical report presents the results for the displacement matrices. The estimated losses and potential effect on the seasonal populations are discussed in the assessment presented in appendix H: Offshore Ornithology – Supporting Information of the Oriel Wind Farm Project NIS.

2.2 Species of interest

Species vary in their sensitivity to disturbance and displacement with some species displaying large levels of displacement (e.g. divers, SNCB, 2022), whereas other species have little sensitivity (e.g. Manx shearwater; Bradbury *et al*., 2014). Within the guidance (SNCB, 2022), only species scoring over three on either the “disturbance susceptibility” or “habitat specialisation” criteria (adapted from Furness *et al*., 2013 and Bradbury *et al*., 2014) should be taken forward for assessment of displacement impacts. In addition, the abundance of species within the Offshore Ornithology Study Area needs to be accounted for, and only species deemed to have moderate abundance (see appendix H: Offshore Ornithology – Supporting Information and annex 1: Offshore Ornithology Technical Report) and scoring three or above were included within this assessment.

The following species were identified as the ‘key’ species to include in the displacement assessment due to their sensitivity to disturbance effects and their relative abundance in the offshore ornithology study area:

- Great northern diver (*Gavia immer*);
- Gannet (*Morus bassanus*);
- Guillemot (*Uria aalge*); and
- Razorbill (*Alca torda*).

This technical report presents the baseline data on the four key species screened in for the assessment of potential disturbance and displacement as a result of the construction, operation, and decommissioning phases of the Project.

2.3 Displacement buffers

Different seabird species exhibit different responses to WTGs and offshore wind farms, with consideration of the distance away from offshore wind farms being required out to specific buffer distances. The scale of the potential displacement outside of an offshore wind farm's footprint to account for different buffer distances applied in this report is in response to guidance in the literature. Following the guidance (SNCB, 2022), this report presents displacement matrices for great northern diver within the offshore wind farm area and a 4 km buffer whilst gannet, guillemot and razorbill matrices are for within the offshore wind farm area and a 2 km buffer.

2.4 Data sources for displacement matrices

The data contributing to this annex are from 19 months of boat-based surveys undertaken from May 2018 to May 2020 (see annex 1: Offshore Ornithology Technical Report for a complete list of boat-based survey months within this period) and six months of aerial digital surveys completed by APEM from April 2020 to September 2020. The boat-based survey data comprise abundance estimates within the relevant potential impact area (offshore wind farm area plus appropriate buffer) with correction for availability bias applied for guillemot and razorbill. The aerial digital survey data abundance estimates include apportionment for unidentified birds and correction for availability bias applied for guillemot and razorbill.

Displacement matrices are presented for each of the four species (great northern diver, gannet, guillemot and razorbill) including data on different species behaviours. For great northern diver, guillemot and razorbill only "sitting" birds (which includes birds observed diving, landing and taking off) were included from the site-specific survey data in the displacement analysis due to the foraging behaviour of these species being predominately from the water's surface. For gannet all behaviours (flying and sitting) were included.

2.5 Data limitations

The data within this report are reliant upon site-specific boat-based and aerial digital surveys undertaken over the offshore ornithology study area for periods of 24 months (with data available for 19 months) and six months, respectively. These data are considered to be the most reliable sources for characterising the baseline environment for offshore ornithology. However, using these data to characterise the abundances for each species within individual bio-seasons or extended bio-seasons (as described in section 2.6 of this report and section 4.4 of annex 1: Offshore Ornithology Technical Report) is subject to interpretation.

Consideration should also be given to missing months from the boat-based survey data over the 24 month period, to the limited temporal coverage within a single year for the aerial digital survey data, migratory movements of birds being subject to variation between species and between years, the age classification of birds within each bio-season and connectivity to breeding colonies. Therefore, these data may be used for the impact assessments accompanying the development application in differing manners, depending upon additional factors considered when assessing the potential impacts and/ or effects of displacement on these species.

2.6 Data presentation of displacement by bio-seasons

In order to provide a more visual approach to presenting data on the species considered for displacement within the tables contained in this report, a colour coding has been used to represent different bio-seasons and combined / extended bio-seasons. For each species, the months defining each bio-season are different; the number of bio-seasons also varies between species. Bio-seasons are based on Furness (2015) for all species in this analysis. The bio-seasons used for each species and the constituent months are presented in Table 2-1 below.

Table 2-1: Bio-season colour coding.

Bio-season	Great Northern Diver	Gannet	Guillemot	Razorbill
Return Migration (Green)	N/A	Dec – Mar	N/A	Jan – Mar
Migration-free Breeding (Purple)	N/A	Apr – Aug	N/A	Apr – Jul
Post-breeding Migration (Red)	N/A	Sep – Nov	N/A	Aug – Oct
Migration-free Winter (Blue)	N/A	N/A	N/A	Nov – Dec
Extended Breeding (Pink)	N/A	N/A	Mar – Jul	N/A
Extended Non-breeding (Yellow)	Sep - May	N/A	Aug – Feb	N/A

2.7 Bio-season peak and mean peaks

Following the SNCB (2022) guidance, displacement assessment is based on bio-season mean peak abundances. The peak abundance within a bio-season is the highest recorded abundance from surveys within a single bio-season. Mean peak abundance is the mean of peak abundances for each bio-season across a number of years. Note that, as described in section 2.4, the data for this analysis are based on 19 monthly boat-based surveys and six monthly aerial digital surveys.

The bio-season peak and mean peak abundances used for these analyses are presented in Table 2-2 for the boat-based survey data and Table 2-3 for the digital aerial survey data. For some of the boat-based and all of the aerial survey data, it was only possible to calculate the peak bio-season abundance due to missing months of second year survey data.

Table 2-2: Boat-based bio-season mean peak or peak (indicated by an *) abundances used for displacement assessment.

Bio-season	Survey Area	Great Northern Diver	Gannet	Guillemot	Razorbill
Return Migration	Offshore Wind Farm Area	N/A	16	N/A	292*
	Offshore Wind Farm Area plus 2 km buffer	N/A	43	N/A	859*
Migration-free Breeding	Offshore Wind Farm Area	N/A	79	N/A	7
	Offshore Wind Farm Area plus 2 km buffer	N/A	264	N/A	12
Post-breeding Migration	Offshore Wind Farm Area	N/A	113*	N/A	281
	Offshore Wind Farm Area plus 2 km buffer	N/A	336*	N/A	962
Migration-free Winter	Offshore Wind Farm Area	N/A	N/A	N/A	139*
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	N/A	512*
Extended Breeding	Offshore Wind Farm Area	N/A	N/A	286	N/A
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	820	N/A
Extended Non-breeding	Offshore Wind Farm Area	44	N/A	846	N/A
	Offshore Wind Farm Area plus 2 km buffer	115	N/A	2,670	N/A
	Offshore Ornithology Study Area	281	N/A	N/A	N/A

Table Note: *Due to insufficient amount of second year data value presented is for the peak first year bio-season abundance only.

Table 2-3: Aerial digital bio-season peak abundances used for displacement assessment.

Bio-season	Survey Area	Great Northern Diver	Gannet	Guillemot	Razorbill
Return Migration	Offshore Wind Farm Area	N/A	N/A	N/A	N/A
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	N/A	N/A
Migration-free Breeding	Offshore Wind Farm Area	N/A	135	N/A	154
	Offshore Wind Farm Area plus 2 km buffer	N/A	149	N/A	353
Post-breeding Migration	Offshore Wind Farm Area	N/A	N/A	N/A	265*
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	N/A	566*
Migration-free Winter	Offshore Wind Farm Area	N/A	N/A	N/A	N/A
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	N/A	N/A
Extended Breeding	Offshore Wind Farm Area	N/A	N/A	594	N/A
	Offshore Wind Farm Area plus 2 km buffer	N/A	N/A	1,594	N/A
Extended Non-breeding	Offshore Wind Farm Area	102**	N/A	1,715*	N/A
	Offshore Wind Farm Area plus 2 km buffer	222**	N/A	4,938*	N/A
	Offshore Wind Farm Area plus 4 km buffer	412**	N/A	N/A	N/A

Table Note: *Bio-season peak based on only two months (August and September). ** Bio-season peak based on only three months (April, May and September).

3 RESULTS

The following sections provide the displacement matrices for each of the key species for each relevant bio-season based on the baseline data from the two data platforms: boat-based survey 2018-20 and aerial survey 2020, for the offshore wind farm area and the offshore wind farm area plus the appropriate buffer.

3.1 Great northern diver boat-based displacement matrices

Table 3-1: Boat-based displacement matrix presenting the mean peak number of great northern divers in the offshore wind farm area only, during the non-breeding bio-season.

Great northern diver displacement rates (based on non-breeding population of 44 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	4
20	0	0	0	0	0	0	1	2	3	4	4	5	6	7	8	9
30	0	0	0	0	1	1	1	3	4	5	7	8	9	11	12	13
40	0	0	0	1	1	1	2	4	5	7	9	11	12	14	16	18
50	0	0	0	1	1	1	2	4	7	9	11	13	15	18	20	22
60	0	0	1	1	1	1	3	5	8	11	13	16	18	21	24	26
70	0	0	1	1	1	2	3	6	9	12	15	18	22	25	28	31
80	0	0	1	1	1	2	4	7	11	14	18	21	25	28	32	35
90	0	0	1	1	2	2	4	8	12	16	20	24	28	32	36	40
100	0	0	1	1	2	2	4	9	13	18	22	26	31	35	40	44

Table 3-2: Boat-based displacement matrix presenting the mean peak number of great northern divers in the offshore wind farm area plus 2 km buffer, during the non-breeding bio-season.

Great northern diver displacement rates (based on non-breeding population of 115 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
10	0	0	0	0	0	1	1	2	3	5	6	7	8	9	10	12
20	0	0	0	1	1	1	2	5	7	9	12	14	16	18	21	23
30	0	0	1	1	1	2	3	7	10	14	17	21	24	28	31	35
40	0	0	1	1	2	2	5	9	14	18	23	28	32	37	41	46
50	0	1	1	2	2	3	6	12	17	23	29	35	40	46	52	58
60	0	1	1	2	3	3	7	14	21	28	35	41	48	55	62	69
70	0	1	2	2	3	4	8	16	24	32	40	48	56	64	72	81
80	0	1	2	3	4	5	9	18	28	37	46	55	64	74	83	92
90	0	1	2	3	4	5	10	21	31	41	52	62	72	83	93	104
100	0	1	2	3	5	6	12	23	35	46	58	69	81	92	104	115

Table 3-3: Boat-based displacement matrix presenting the mean peak number of great northern divers in the offshore wind farm area plus 4 km buffer, during the non-breeding bio-season.

Great northern diver displacement rates (based on non-breeding population of 281 for offshore ornithology study area)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
10	0	0	1	1	1	1	3	6	8	11	14	17	20	22	25	28
20	0	1	1	2	2	3	6	11	17	22	28	34	39	45	51	56
30	0	1	2	3	3	4	8	17	25	34	42	51	59	67	76	84
40	0	1	2	3	4	6	11	22	34	45	56	67	79	90	101	112
50	0	1	3	4	6	7	14	28	42	56	70	84	98	112	126	141
60	0	2	3	5	7	8	17	34	51	67	84	101	118	135	152	169
70	0	2	4	6	8	10	20	39	59	79	98	118	138	157	177	197
80	0	2	4	7	9	11	22	45	67	90	112	135	157	180	202	225
90	0	3	5	8	10	13	25	51	76	101	126	152	177	202	228	253
100	0	3	6	8	11	14	28	56	84	112	141	169	197	225	253	281

3.2 Great northern diver aerial digital displacement matrices

Table 3-4: Aerial digital displacement matrix presenting the peak number of great northern divers in the offshore wind farm area only, during the non-breeding bio-season.

Great northern diver displacement rates (based on non-breeding population of 102 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
10	0	0	0	0	0	1	1	2	3	4	5	6	7	8	9	10
20	0	0	0	1	1	1	2	4	6	8	10	12	14	16	18	20
30	0	0	1	1	1	2	3	6	9	12	15	18	21	24	28	31
40	0	0	1	1	2	2	4	8	12	16	20	24	29	33	37	41
50	0	1	1	2	2	3	5	10	15	20	26	31	36	41	46	51
60	0	1	1	2	2	3	6	12	18	24	31	37	43	49	55	61
70	0	1	1	2	3	4	7	14	21	29	36	43	50	57	64	71
80	0	1	2	2	3	4	8	16	24	33	41	49	57	65	73	82
90	0	1	2	3	4	5	9	18	28	37	46	55	64	73	83	92
100	0	1	2	3	4	5	10	20	31	41	51	61	71	82	92	102

Table 3-5: Aerial digital displacement matrix presenting the peak number of great northern divers in the offshore wind farm area plus 2 km buffer, during the non-breeding bio-season.

Great northern diver displacement rates (based on non-breeding population of 222 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
10	0	0	0	1	1	1	2	4	7	9	11	13	16	18	20	22
20	0	0	1	1	2	2	4	9	13	18	22	27	31	36	40	44
30	0	1	1	2	3	3	7	13	20	27	33	40	47	53	60	67
40	0	1	2	3	4	4	9	18	27	36	44	53	62	71	80	89
50	0	1	2	3	4	6	11	22	33	44	56	67	78	89	100	111
60	0	1	3	4	5	7	13	27	40	53	67	80	93	107	120	133
70	0	2	3	5	6	8	16	31	47	62	78	93	109	124	140	155
80	0	2	4	5	7	9	18	36	53	71	89	107	124	142	160	178
90	0	2	4	6	8	10	20	40	60	80	100	120	140	160	180	200
100	0	2	4	7	9	11	22	44	67	89	111	133	155	178	200	222

Table 3-6: Aerial digital displacement matrix presenting the peak number of great northern divers in the offshore wind farm area plus 4 km buffer, during the non-breeding bio-season.

Great northern diver displacement rates (based on non-breeding population of 412 for offshore wind farm area plus 4 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	2	2	2	3	3	4	4
10	0	0	1	1	2	2	4	8	12	16	21	25	29	33	37	41
20	0	1	2	2	3	4	8	16	25	33	41	49	58	66	74	82
30	0	1	2	4	5	6	12	25	37	49	62	74	87	99	111	124
40	0	2	3	5	7	8	16	33	49	66	82	99	115	132	148	165
50	0	2	4	6	8	10	21	41	62	82	103	124	144	165	185	206
60	0	2	5	7	10	12	25	49	74	99	124	148	173	198	222	247
70	0	3	6	9	12	14	29	58	87	115	144	173	202	231	260	288
80	0	3	7	10	13	16	33	66	99	132	165	198	231	264	297	330
90	0	4	7	11	15	19	37	74	111	148	185	222	260	297	334	371
100	0	4	8	12	16	21	41	82	124	165	206	247	288	330	371	412

3.3 Gannet boat-based displacement matrices

Table 3-7: Boat-based displacement matrix presenting the mean peak number of gannets in the offshore wind farm area only, during the return migration bio-season.

Gannet displacement rates (based on the return migration population of 16 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2
20	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3
30	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
40	0	0	0	0	0	0	1	1	2	3	3	4	4	5	6	6
50	0	0	0	0	0	0	1	2	2	3	4	5	6	6	7	8
60	0	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
70	0	0	0	0	0	1	1	2	3	4	6	7	8	9	10	11
80	0	0	0	0	1	1	1	3	4	5	6	8	9	10	12	13
90	0	0	0	0	1	1	1	3	4	6	7	9	10	12	13	14
100	0	0	0	0	1	1	2	3	5	6	8	10	11	13	14	16

Table 3-8: Boat-based displacement matrix presenting the mean peak number of gannets in the offshore wind farm area plus 2 km buffer, during the return migration bio-season.

Gannet displacement rates (based on the return migration population of 43 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	2	2	3	3	3	4	4
20	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	9
30	0	0	0	0	1	1	1	3	4	5	6	8	9	10	11	13
40	0	0	0	1	1	1	2	3	5	7	9	10	12	14	15	17
50	0	0	0	1	1	1	2	4	6	9	11	13	15	17	19	21
60	0	0	1	1	1	1	3	5	8	10	13	15	18	20	23	26
70	0	0	1	1	1	1	3	6	9	12	15	18	21	24	27	30
80	0	0	1	1	1	2	3	7	10	14	17	20	24	27	31	34
90	0	0	1	1	2	2	4	8	11	15	19	23	27	31	34	38
100	0	0	1	1	2	2	4	9	13	17	21	26	30	34	38	43

Table 3-9: Boat-based displacement matrix presenting the mean peak number of gannets in the offshore wind farm area only, during the migration-free breeding bio-season.

Gannet displacement rates (based on migration-free breeding population of 79 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
10	0	0	0	0	0	0	1	2	2	3	4	5	6	6	7	8
20	0	0	0	0	1	1	2	3	5	6	8	9	11	13	14	16
30	0	0	0	1	1	1	2	5	7	9	12	14	17	19	21	24
40	0	0	1	1	1	2	3	6	9	13	16	19	22	25	28	32
50	0	0	1	1	2	2	4	8	12	16	20	24	28	32	36	40
60	0	0	1	1	2	2	5	9	14	19	24	28	33	38	43	47
70	0	1	1	2	2	3	6	11	17	22	28	33	39	44	50	55
80	0	1	1	2	3	3	6	13	19	25	32	38	44	51	57	63
90	0	1	1	2	3	4	7	14	21	28	36	43	50	57	64	71
100	0	1	2	2	3	4	8	16	24	32	40	47	55	63	71	79

Table 3-10: Boat-based displacement matrix presenting the mean peak number of gannets in the offshore wind farm area plus 2 km buffer, during the migration-free breeding bio-season.

Gannet displacement rates (based on migration-free breeding population of 246 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
10	0	0	0	1	1	1	2	5	7	10	12	15	17	20	22	25
20	0	0	1	1	2	2	5	10	15	20	25	29	34	39	44	49
30	0	1	1	2	3	4	7	15	22	29	37	44	52	59	66	74
40	0	1	2	3	4	5	10	20	29	39	49	59	69	79	88	98
50	0	1	2	4	5	6	12	25	37	49	61	74	86	98	110	123
60	0	1	3	4	6	7	15	29	44	59	74	88	103	118	133	147
70	0	2	3	5	7	9	17	34	52	69	86	103	120	137	155	172
80	0	2	4	6	8	10	20	39	59	79	98	118	137	157	177	196
90	0	2	4	7	9	11	22	44	66	88	110	133	155	177	199	221
100	0	2	5	7	10	12	25	49	74	98	123	147	172	196	221	246

Table 3-11: Boat-based displacement matrix presenting the peak number of gannets in the offshore wind farm area only, during the post-breeding migration bio-season.

Gannet displacement rates (based on post-breeding migration population of 113 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
10	0	0	0	0	0	1	1	2	3	5	6	7	8	9	10	11
20	0	0	0	1	1	1	2	5	7	9	11	14	16	18	20	23
30	0	0	1	1	1	2	3	7	10	14	17	20	24	27	31	34
40	0	0	1	1	2	2	5	9	14	18	23	27	32	36	41	45
50	0	1	1	2	2	3	6	11	17	23	28	34	40	45	51	57
60	0	1	1	2	3	3	7	14	20	27	34	41	47	54	61	68
70	0	1	2	2	3	4	8	16	24	32	40	47	55	63	71	79
80	0	1	2	3	4	5	9	18	27	36	45	54	63	72	81	90
90	0	1	2	3	4	5	10	20	31	41	51	61	71	81	92	102
100	0	1	2	3	5	6	11	23	34	45	57	68	79	90	102	113

Table 3-12: Boat-based displacement matrix presenting the peak number of gannets in the offshore wind farm area plus 2 km buffer, during the post-breeding migration bio-season.

Gannet displacement rates (based on post-breeding migration population of 336 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3
10	0	0	1	1	1	2	3	7	10	13	17	20	24	27	30	34
20	0	1	1	2	3	3	7	13	20	27	34	40	47	54	60	67
30	0	1	2	3	4	5	10	20	30	40	50	60	71	81	91	101
40	0	1	3	4	5	7	13	27	40	54	67	81	94	108	121	134
50	0	2	3	5	7	8	17	34	50	67	84	101	118	134	151	168
60	0	2	4	6	8	10	20	40	60	81	101	121	141	161	181	202
70	0	2	5	7	9	12	24	47	71	94	118	141	165	188	212	235
80	0	3	5	8	11	13	27	54	81	108	134	161	188	215	242	269
90	0	3	6	9	12	15	30	60	91	121	151	181	212	242	272	302
100	0	3	7	10	13	17	34	67	101	134	168	202	235	269	302	336

3.4 Gannet aerial digital displacement matrices

Table 3-13: Aerial digital displacement matrix presenting the peak number of gannets in the offshore wind farm area only, during the migration-free breeding bio-season.

Gannet displacement rates (based on migration-free breeding population of 135 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
10	0	0	0	0	1	1	1	3	4	5	7	8	9	11	12	14
20	0	0	1	1	1	1	3	5	8	11	14	16	19	22	24	27
30	0	0	1	1	2	2	4	8	12	16	20	24	28	32	36	41
40	0	1	1	2	2	3	5	11	16	22	27	32	38	43	49	54
50	0	1	1	2	3	3	7	14	20	27	34	41	47	54	61	68
60	0	1	2	2	3	4	8	16	24	32	41	49	57	65	73	81
70	0	1	2	3	4	5	9	19	28	38	47	57	66	76	85	95
80	0	1	2	3	4	5	11	22	32	43	54	65	76	86	97	108
90	0	1	2	4	5	6	12	24	36	49	61	73	85	97	109	122
100	0	1	3	4	5	7	14	27	41	54	68	81	95	108	122	135

Table 3-14: Aerial digital displacement matrix presenting the peak number of gannets in the offshore wind farm area plus 2 km buffer, during the migration-free breeding bio-season.

Gannet displacement rates (based on migration-free breeding population of 149 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
10	0	0	0	0	1	1	1	3	4	6	7	9	10	12	13	15
20	0	0	1	1	1	1	3	6	9	12	15	18	21	24	27	30
30	0	0	1	1	2	2	4	9	13	18	22	27	31	36	40	45
40	0	1	1	2	2	3	6	12	18	24	30	36	42	48	54	60
50	0	1	1	2	3	4	7	15	22	30	37	45	52	60	67	75
60	0	1	2	3	4	4	9	18	27	36	45	54	63	72	80	89
70	0	1	2	3	4	5	10	21	31	42	52	63	73	83	94	104
80	0	1	2	4	5	6	12	24	36	48	60	72	83	95	107	119
90	0	1	3	4	5	7	13	27	40	54	67	80	94	107	121	134
100	0	1	3	4	6	7	15	30	45	60	75	89	104	119	134	149

3.5 Guillemot boat-based displacement matrices

Table 3-15: Boat-based displacement matrix presenting the mean peak number of guillemots in the offshore wind farm area only, during the breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 286 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
10	0	0	1	1	1	1	3	6	9	11	14	17	20	23	26	29
20	0	1	1	2	2	3	6	11	17	23	29	34	40	46	51	57
30	0	1	2	3	3	4	9	17	26	34	43	51	60	69	77	86
40	0	1	2	3	5	6	11	23	34	46	57	69	80	92	103	114
50	0	1	3	4	6	7	14	29	43	57	72	86	100	114	129	143
60	0	2	3	5	7	9	17	34	51	69	86	103	120	137	154	172
70	0	2	4	6	8	10	20	40	60	80	100	120	140	160	180	200
80	0	2	5	7	9	11	23	46	69	92	114	137	160	183	206	229
90	0	3	5	8	10	13	26	51	77	103	129	154	180	206	232	257
100	0	3	6	9	11	14	29	57	86	114	143	172	200	229	257	286

Table 3-16: Boat-based displacement matrix presenting the mean peak number of guillemots in the offshore wind farm area plus 2 km buffer, during the breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 820 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	2	2	3	4	5	6	7	7	8
10	0	1	2	2	3	4	8	16	25	33	41	49	57	66	74	82
20	0	2	3	5	7	8	16	33	49	66	82	98	115	131	148	164
30	0	2	5	7	10	12	25	49	74	98	123	148	172	197	221	246
40	0	3	7	10	13	16	33	66	98	131	164	197	230	262	295	328
50	0	4	8	12	16	21	41	82	123	164	205	246	287	328	369	410
60	0	5	10	15	20	25	49	98	148	197	246	295	344	394	443	492
70	0	6	11	17	23	29	57	115	172	230	287	344	402	459	517	574
80	0	7	13	20	26	33	66	131	197	262	328	394	459	525	590	656
90	0	7	15	22	30	37	74	148	221	295	369	443	517	590	664	738
100	0	8	16	25	33	41	82	164	246	328	410	492	574	656	738	820

Table 3-17: Boat-based displacement matrix presenting the mean peak number of guillemots in the offshore wind farm area only, during the non-breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 846 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	8
10	0	1	2	3	3	4	8	17	25	34	42	51	59	68	76	85
20	0	2	3	5	7	8	17	34	51	68	85	101	118	135	152	169
30	0	3	5	8	10	13	25	51	76	101	127	152	178	203	228	254
40	0	3	7	10	14	17	34	68	101	135	169	203	237	271	304	338
50	0	4	8	13	17	21	42	85	127	169	211	254	296	338	380	423
60	0	5	10	15	20	25	51	101	152	203	254	304	355	406	457	507
70	0	6	12	18	24	30	59	118	178	237	296	355	414	473	533	592
80	0	7	14	20	27	34	68	135	203	271	338	406	473	541	609	676
90	0	8	15	23	30	38	76	152	228	304	380	457	533	609	685	761
100	0	8	17	25	34	42	85	169	254	338	423	507	592	676	761	846

Table 3-18: Boat-based displacement matrix presenting the mean peak number of guillemots in the offshore wind farm area plus 2 km buffer, during the non-breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 2,670 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	1	1	1	3	5	8	11	13	16	19	21	24	27
10	0	3	5	8	11	13	27	53	80	107	133	160	187	214	240	267
20	0	5	11	16	21	27	53	107	160	214	267	320	374	427	481	534
30	0	8	16	24	32	40	80	160	240	320	400	481	561	641	721	801
40	0	11	21	32	43	53	107	214	320	427	534	641	747	854	961	1,068
50	0	13	27	40	53	67	133	267	400	534	667	801	934	1,068	1,201	1,335
60	0	16	32	48	64	80	160	320	481	641	801	961	1,121	1,281	1,442	1,602
70	0	19	37	56	75	93	187	374	561	747	934	1,121	1,308	1,495	1,682	1,869
80	0	21	43	64	85	107	214	427	641	854	1,068	1,281	1,495	1,708	1,922	2,136
90	0	24	48	72	96	120	240	481	721	961	1,201	1,442	1,682	1,922	2,162	2,403
100	0	27	53	80	107	133	267	534	801	1,068	1,335	1,602	1,869	2,136	2,403	2,670

3.6 Guillemot aerial digital displacement matrices

Table 3-19: Aerial digital displacement matrix presenting the peak number of guillemots in the offshore wind farm area only, during the breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 594 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
10	0	1	1	2	2	3	6	12	18	24	30	36	42	48	53	59
20	0	1	2	4	5	6	12	24	36	48	59	71	83	95	107	119
30	0	2	4	5	7	9	18	36	53	71	89	107	125	143	160	178
40	0	2	5	7	10	12	24	48	71	95	119	143	166	190	214	238
50	0	3	6	9	12	15	30	59	89	119	148	178	208	238	267	297
60	0	4	7	11	14	18	36	71	107	143	178	214	249	285	321	356
70	0	4	8	12	17	21	42	83	125	166	208	249	291	333	374	416
80	0	5	10	14	19	24	48	95	143	190	238	285	333	380	428	475
90	0	5	11	16	21	27	53	107	160	214	267	321	374	428	481	534
100	0	6	12	18	24	30	59	119	178	238	297	356	416	475	534	594

Table 3-20: Aerial digital displacement matrix presenting peak number of guillemots in the offshore wind farm area plus 2 km buffer, during the breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 1,594 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	1	2	3	5	6	8	10	11	13	14	16
10	0	2	3	5	6	8	16	32	48	64	80	96	112	128	143	159
20	0	3	6	10	13	16	32	64	96	128	159	191	223	255	287	319
30	0	5	10	14	19	24	48	96	143	191	239	287	335	383	430	478
40	0	6	13	19	26	32	64	128	191	255	319	383	446	510	574	638
50	0	8	16	24	32	40	80	159	239	319	398	478	558	638	717	797
60	0	10	19	29	38	48	96	191	287	383	478	574	669	765	861	956
70	0	11	22	33	45	56	112	223	335	446	558	669	781	893	1,004	1,116
80	0	13	26	38	51	64	128	255	383	510	638	765	893	1,020	1,148	1,275
90	0	14	29	43	57	72	143	287	430	574	717	861	1,004	1,148	1,291	1,434
100	0	16	32	48	64	80	159	319	478	638	797	956	1,116	1,275	1,434	1,594

Table 3-21: Aerial digital displacement matrix presenting the peak number of guillemots in the offshore wind farm area only, during the non-breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 1,715 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	1	1	2	3	5	7	9	10	12	14	15	17
10	0	2	3	5	7	9	17	34	51	69	86	103	120	137	154	171
20	0	3	7	10	14	17	34	69	103	137	171	206	240	274	309	343
30	0	5	10	15	21	26	51	103	154	206	257	309	360	412	463	514
40	0	7	14	21	27	34	69	137	206	274	343	412	480	549	617	686
50	0	9	17	26	34	43	86	171	257	343	429	514	600	686	772	857
60	0	10	21	31	41	51	103	206	309	412	514	617	720	823	926	1,029
70	0	12	24	36	48	60	120	240	360	480	600	720	840	960	1,080	1,200
80	0	14	27	41	55	69	137	274	412	549	686	823	960	1,097	1,235	1,372
90	0	15	31	46	62	77	154	309	463	617	772	926	1,080	1,235	1,389	1,543
100	0	17	34	51	69	86	171	343	514	686	857	1,029	1,200	1,372	1,543	1,715

Table 3-22: Aerial digital displacement matrix presenting the peak number of guillemots in the offshore wind farm area plus 2 km buffer, during the non-breeding bio-season.

Guillemot displacement rates (based on non-breeding population of 4,938 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	1	2	2	5	10	15	20	25	30	35	40	44	49
10	0	5	10	15	20	25	49	99	148	198	247	296	346	395	444	494
20	0	10	20	30	40	49	99	198	296	395	494	593	691	790	889	988
30	0	15	30	44	59	74	148	296	444	593	741	889	1,037	1,185	1,333	1,482
40	0	20	40	59	79	99	198	395	593	790	988	1,185	1,383	1,580	1,778	1,975
50	0	25	49	74	99	123	247	494	741	988	1,235	1,482	1,728	1,975	2,222	2,469
60	0	30	59	89	119	148	296	593	889	1,185	1,482	1,778	2,074	2,370	2,667	2,963
70	0	35	69	104	138	173	346	691	1,037	1,383	1,728	2,074	2,420	2,766	3,111	3,457
80	0	40	79	119	158	198	395	790	1,185	1,580	1,975	2,370	2,766	3,161	3,556	3,951
90	0	44	89	133	178	222	444	889	1,333	1,778	2,222	2,667	3,111	3,556	4,000	4,445
100	0	49	99	148	198	247	494	988	1,482	1,975	2,469	2,963	3,457	3,951	4,445	4,938

3.7 Razorbill boat-based displacement matrices

Table 3-23: Boat-based displacement matrix presenting the peak number of razorbills in the offshore wind farm area only, during the return migration bio-season.

Razorbill displacement rates (based on the return migration population of 292 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
10	0	0	1	1	1	1	3	6	9	12	15	18	20	23	26	29
20	0	1	1	2	2	3	6	12	18	23	29	35	41	47	53	58
30	0	1	2	3	4	4	9	18	26	35	44	53	61	70	79	88
40	0	1	2	4	5	6	12	23	35	47	58	70	82	93	105	117
50	0	1	3	4	6	7	15	29	44	58	73	88	102	117	131	146
60	0	2	4	5	7	9	18	35	53	70	88	105	123	140	158	175
70	0	2	4	6	8	10	20	41	61	82	102	123	143	164	184	204
80	0	2	5	7	9	12	23	47	70	93	117	140	164	187	210	234
90	0	3	5	8	11	13	26	53	79	105	131	158	184	210	237	263
100	0	3	6	9	12	15	29	58	88	117	146	175	204	234	263	292

Table 3-24: Boat-based displacement matrix presenting the peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the return migration bio-season.

Razorbill displacement rates (based on the return migration population of 859 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	9
10	0	1	2	3	3	4	9	17	26	34	43	52	60	69	77	86
20	0	2	3	5	7	9	17	34	52	69	86	103	120	137	155	172
30	0	3	5	8	10	13	26	52	77	103	129	155	180	206	232	258
40	0	3	7	10	14	17	34	69	103	137	172	206	241	275	309	344
50	0	4	9	13	17	21	43	86	129	172	215	258	301	344	387	430
60	0	5	10	15	21	26	52	103	155	206	258	309	361	412	464	515
70	0	6	12	18	24	30	60	120	180	241	301	361	421	481	541	601
80	0	7	14	21	27	34	69	137	206	275	344	412	481	550	618	687
90	0	8	15	23	31	39	77	155	232	309	387	464	541	618	696	773
100	0	9	17	26	34	43	86	172	258	344	430	515	601	687	773	859

Table 3-25: Boat-based displacement matrix presenting the mean peak number of razorbills in the offshore wind farm area only, during the migration-free breeding bio-season.

Razorbill displacement rates (based on migration-free breeding population of 7 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
20	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
30	0	0	0	0	0	0	0	0	1	1	1	1	1	2	2	2
40	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3
50	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3
60	0	0	0	0	0	0	0	1	1	2	2	2	3	3	4	4
70	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
80	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
90	0	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
100	0	0	0	0	0	0	1	1	2	3	3	4	5	5	6	7

Table 3-26: Boat-based displacement matrix presenting the mean peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the migration-free breeding bio-season.

Razorbill displacement rates (based on migration-free breeding population of 12 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
20	0	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2
30	0	0	0	0	0	0	0	1	1	1	2	2	3	3	3	4
40	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5
50	0	0	0	0	0	0	1	1	2	2	3	4	4	5	5	6
60	0	0	0	0	0	0	1	1	2	3	4	4	5	6	6	7
70	0	0	0	0	0	0	1	2	3	3	4	5	6	7	8	8
80	0	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
90	0	0	0	0	0	1	1	2	3	4	5	6	8	9	10	11
100	0	0	0	0	0	1	1	2	4	5	6	7	8	10	11	12

Table 3-27: Boat-based displacement matrix presenting the mean peak number of razorbills in the offshore wind farm area only, during the post-breeding migration bio-season.

Razorbill displacement rates (based on post-breeding migration population of 281 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	3	3
10	0	0	1	1	1	1	3	6	8	11	14	17	20	22	25	28
20	0	1	1	2	2	3	6	11	17	22	28	34	39	45	51	56
30	0	1	2	3	3	4	8	17	25	34	42	51	59	67	76	84
40	0	1	2	3	4	6	11	22	34	45	56	67	79	90	101	112
50	0	1	3	4	6	7	14	28	42	56	70	84	98	112	126	141
60	0	2	3	5	7	8	17	34	51	67	84	101	118	135	152	169
70	0	2	4	6	8	10	20	39	59	79	98	118	138	157	177	197
80	0	2	4	7	9	11	22	45	67	90	112	135	157	180	202	225
90	0	3	5	8	10	13	25	51	76	101	126	152	177	202	228	253
100	0	3	6	8	11	14	28	56	84	112	141	169	197	225	253	281

Table 3-28: Boat-based displacement matrix presenting the mean peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the post-breeding migration bio-season.

Razorbill displacement rates (based on post-breeding migration population of 962 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	2	3	4	5	6	7	8	9	10
10	0	1	2	3	4	5	10	19	29	38	48	58	67	77	87	96
20	0	2	4	6	8	10	19	38	58	77	96	115	135	154	173	192
30	0	3	6	9	12	14	29	58	87	115	144	173	202	231	260	288
40	0	4	8	12	15	19	38	77	115	154	192	231	269	308	346	385
50	0	5	10	14	19	24	48	96	144	192	240	288	337	385	433	481
60	0	6	12	17	23	29	58	115	173	231	288	346	404	462	519	577
70	0	7	13	20	27	34	67	135	202	269	337	404	471	538	606	673
80	0	8	15	23	31	38	77	154	231	308	385	462	538	615	692	769
90	0	9	17	26	35	43	87	173	260	346	433	519	606	692	779	865
100	0	10	19	29	38	48	96	192	288	385	481	577	673	769	865	962

Table 3-29: Boat-based displacement matrix presenting the peak number of razorbills in the offshore wind farm area only, during the migration-free winter bio-season.

Razorbill displacement rates (based on the migration-free winter population of 139 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
10	0	0	0	0	1	1	1	3	4	6	7	8	10	11	13	14
20	0	0	1	1	1	1	3	6	8	11	14	17	19	22	25	28
30	0	0	1	1	2	2	4	8	13	17	21	25	29	33	38	42
40	0	1	1	2	2	3	6	11	17	22	28	33	39	44	50	56
50	0	1	1	2	3	3	7	14	21	28	35	42	49	56	63	70
60	0	1	2	3	3	4	8	17	25	33	42	50	58	67	75	83
70	0	1	2	3	4	5	10	19	29	39	49	58	68	78	88	97
80	0	1	2	3	4	6	11	22	33	44	56	67	78	89	100	111
90	0	1	3	4	5	6	13	25	38	50	63	75	88	100	113	125
100	0	1	3	4	6	7	14	28	42	56	70	83	97	111	125	139

Table 3-30: Boat-based displacement matrix presenting the peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the migration-free winter bio-season.

Razorbill displacement rates (based on the migration-free winter population of 512 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
10	0	1	1	2	2	3	5	10	15	20	26	31	36	41	46	51
20	0	1	2	3	4	5	10	20	31	41	51	61	72	82	92	102
30	0	2	3	5	6	8	15	31	46	61	77	92	108	123	138	154
40	0	2	4	6	8	10	20	41	61	82	102	123	143	164	184	205
50	0	3	5	8	10	13	26	51	77	102	128	154	179	205	230	256
60	0	3	6	9	12	15	31	61	92	123	154	184	215	246	276	307
70	0	4	7	11	14	18	36	72	108	143	179	215	251	287	323	358
80	0	4	8	12	16	20	41	82	123	164	205	246	287	328	369	410
90	0	5	9	14	18	23	46	92	138	184	230	276	323	369	415	461
100	0	5	10	15	20	26	51	102	154	205	256	307	358	410	461	512

3.8 Razorbill aerial digital displacement matrices

Table 3-31: Aerial digital displacement matrix presenting the peak number of razorbills in the offshore wind farm area only, during the migration-free breeding bio-season.

Razorbill displacement rates (based on migration-free breeding population of 154 for offshore wind farm area only)																
Displacement (%)	Mortality Rates (%)															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2
10	0	0	0	0	1	1	2	3	5	6	8	9	11	12	14	15
20	0	0	1	1	1	2	3	6	9	12	15	19	22	25	28	31
30	0	0	1	1	2	2	5	9	14	19	23	28	32	37	42	46
40	0	1	1	2	2	3	6	12	19	25	31	37	43	49	56	62
50	0	1	2	2	3	4	8	15	23	31	39	46	54	62	69	77
60	0	1	2	3	4	5	9	19	28	37	46	56	65	74	83	93
70	0	1	2	3	4	5	11	22	32	43	54	65	76	86	97	108
80	0	1	2	4	5	6	12	25	37	49	62	74	86	99	111	123
90	0	1	3	4	6	7	14	28	42	56	69	83	97	111	125	139
100	0	2	3	5	6	8	15	31	46	62	77	93	108	123	139	154

Table 3-32: Aerial digital displacement matrix presenting the peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the migration-free breeding bio-season.

Razorbill displacement rates (based on migration-free breeding population of 353 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	4
10	0	0	1	1	1	2	4	7	11	14	18	21	25	28	32	35
20	0	1	1	2	3	4	7	14	21	28	35	42	49	56	63	71
30	0	1	2	3	4	5	11	21	32	42	53	63	74	85	95	106
40	0	1	3	4	6	7	14	28	42	56	71	85	99	113	127	141
50	0	2	4	5	7	9	18	35	53	71	88	106	123	141	159	176
60	0	2	4	6	8	11	21	42	63	85	106	127	148	169	190	212
70	0	2	5	7	10	12	25	49	74	99	123	148	173	198	222	247
80	0	3	6	8	11	14	28	56	85	113	141	169	198	226	254	282
90	0	3	6	10	13	16	32	63	95	127	159	190	222	254	286	317
100	0	4	7	11	14	18	35	71	106	141	176	212	247	282	317	353

Table 3-33: Aerial digital displacement matrix presenting the peak number of razorbills in the offshore wind farm area only, during the post-breeding migration bio-season.

Razorbill displacement rates (based on post-breeding migration population of 265 for offshore wind farm area only)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1	1	1	1	2	2	2	2	3
10	0	0	1	1	1	1	3	5	8	11	13	16	19	21	24	26
20	0	1	1	2	2	3	5	11	16	21	26	32	37	42	48	53
30	0	1	2	2	3	4	8	16	24	32	40	48	56	63	71	79
40	0	1	2	3	4	5	11	21	32	42	53	63	74	85	95	106
50	0	1	3	4	5	7	13	26	40	53	66	79	93	106	119	132
60	0	2	3	5	6	8	16	32	48	63	79	95	111	127	143	159
70	0	2	4	6	7	9	19	37	56	74	93	111	130	148	167	185
80	0	2	4	6	8	11	21	42	63	85	106	127	148	169	190	212
90	0	2	5	7	10	12	24	48	71	95	119	143	167	190	214	238
100	0	3	5	8	11	13	26	53	79	106	132	159	185	212	238	265

Table 3-34: Aerial digital displacement matrix presenting the peak number of razorbills in the offshore wind farm area plus 2 km buffer, during the post-breeding migration bio-season.

Razorbill displacement rates (based on post-breeding migration population of 566 for offshore wind farm area plus 2 km buffer)																
Displacement (%)	**Mortality Rates (%)**															
	0	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	2	2	3	3	4	5	5	6
10	0	1	1	2	2	3	6	11	17	23	28	34	40	45	51	57
20	0	1	2	3	5	6	11	23	34	45	57	68	79	91	102	113
30	0	2	3	5	7	8	17	34	51	68	85	102	119	136	153	170
40	0	2	5	7	9	11	23	45	68	91	113	136	158	181	204	226
50	0	3	6	8	11	14	28	57	85	113	141	170	198	226	255	283
60	0	3	7	10	14	17	34	68	102	136	170	204	238	272	306	340
70	0	4	8	12	16	20	40	79	119	158	198	238	277	317	356	396
80	0	5	9	14	18	23	45	91	136	181	226	272	317	362	407	453
90	0	5	10	15	20	25	51	102	153	204	255	306	356	407	458	509
100	0	6	11	17	23	28	57	113	170	226	283	340	396	453	509	566

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ANNEX 6: OFFSHORE ORNITHOLOGY MIGRATORY NON-SEABIRDS COLLISION RISK MODELLING

ORIEL WIND FARM PROJECT

Natura Impact Statement

Annex 6: Offshore Ornithology Migratory Non-Seabirds Collision Risk Modelling

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Acronyms

Term	Meaning
BTO	British Trust for Ornithology
CRM	Collision Risk Model
GIS	Geographical Information System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
RoI	Republic of Ireland
SOSS	Strategic Ornithological Support Services
SOSSMAT	Strategic Ornithological Support Services Migration Assessment Tool
SPA	Special Protected Area
UK	United Kingdom
WTG	Wind Turbine Generator

1 INTRODUCTION

1.1 Oriel Wind Farm Project

Oriel Windfarm Limited (‘the Applicant’) is proposing to develop the Oriel Wind Farm Project, an offshore wind farm, hereafter referred to as ‘the Project”. The Project is located in the northern Irish Sea, off the coast of County Louth (approximately 22 km east of Dundalk town centre and 18 km east of Blackrock). The Project will comprise both offshore and onshore infrastructure including 25 offshore wind turbine generators (WTGs), associated foundations and inter-array cables, offshore substation, offshore cable within a defined offshore cable corridor, a landfall, onshore cable within a defined onshore cable route and an onshore substation for connection to the electricity transmission network. The closest wind turbine will be approximately 6 km from the closest shore on the Cooley Peninsula. The offshore cable corridor extends approximately 11 km southwest from the wind farm area to the landfall south of Dunany Point.

1.2 Ornithological background

The islands of Britain and Ireland are located along the east Atlantic flyway - a migration route that connects bird species’ breeding sites to wintering sites (Boere *et al.*, 2006; Wright *et al.*, 2012). Therefore, the islands of Britain and Ireland are of key importance for many over-wintering and migrating birds that move through the area in large numbers during the spring and autumn passage periods. Ireland supports a large over-wintering population of waterbirds (Crowe *et al.*, 2008; Burke *et al.*, 2018), originating from the Arctic and sub-Artic regions (e.g. Iceland and Scandinavia). Whilst some bird species will follow the coastline during their migration journey, other groups of species (e.g. waders and passerines) will undertake long journeys across open seas, often flying at high altitudes depending on the weather conditions. Wildfowl species are known to follow a coastal route during their migration (when in sight of land). However, many wildfowl species do undertake open-sea movements to reach their wintering or moulting grounds (e.g. Shelduck *Tadorna tardorna*; Green *et al.*, 2019).

Through bird global positioning system (GPS) tracking studies, there is a greater understanding of sea crossing movements and the interactions of migratory birds with the landscape, including artificial structures. Because of the development of offshore wind energy and possible interactions with migrating birds, concerns have been raised about the potential risk of collision of migrating birds with offshore wind farms, in particular non-seabird species which may use the UK and the Irish network of Special Protected Areas (SPAs).

The Strategic Ornithological Support Services (SOSS) Migration Assessment Tool (hereafter referred to as SOSSMAT) was developed to identify non-seabird migratory species at risk of collision with offshore wind farms (Wright *et al.*, 2012). An extensive review of migratory movements, combined with the use of geographical information system (GIS)/worksheet tool, generate the number of migratory birds expected to fly through a proposed development site. The derived parameters from the SOSSMAT tool can be subsequently used in a Collision Risk Model (CRM) to calculate the probability of collision (e.g. using the Band *et al.* (2012) CRM).

To address the concerns about the potential collision risk of the Project with migratory non-seabird species flying along and across the Irish Sea, collision risk has been assessed using the SOSSMAT tool and the Band *et al.* (2012) CRM.

1.3 Purpose of the report

This technical report provides estimates of the collision risk to migratory non-seabird species (excluding “true seabirds”, gulls, cormorants and divers) as a result of the Project. The report has been produced in support of appendix H: Offshore Ornithology – Support Information. RPS has undertaken the collision modelling which is based on species/populations identified to be at risk of crossing the Project during migratory movements.

2 METHODOLOGY

The SOSSMAT tool was used to assess the risk of offshore wind farm development to migratory birds designated as features of SPAs in the UK and Ireland. Instructions are given in Wright *et al.* (2012). The resulting number of birds estimated to interact with the offshore wind farm area was inputted into the Band (2012) single transit collision risk model to estimate the collision risk to each species.

2.1 Selecting connectivity lines with development in SOSSMAT

First, the SOSSMAT GIS tool was used to define lines of migration (as identified by Wright *et al*., 2012), which intersected with the offshore wind farm area. According to the sections of the coastline defined in the SOSSMAT tool (Table 2-1; Figure 2-1) and the position of the offshore wind farm area, the migration routes that included a start or end point bordering the Irish Sea were selected. The routes selected are shown in Table 2-1. These routes followed the broad migrating patterns known to occur across Britain and Ireland as described below:

- Birds from Iceland, Canada and Greenland moving through and overwintering in Ireland;
- Birds from the Arctic and sub-Arctic (further to the east) moving through Britain and over-wintering in Ireland; and
- Birds from Arctic and sub-Arctic moving through Ireland to winter further south (e.g. Spain).

Table 2-1: Migration routes selected and corresponding SOSSMAT code.

Start Migration	End Migration	SOSSMAT Code
England and Wales Irish Sea	Northern Ireland Celtic Seas coast	EWINIC
Northern Ireland Celtic Seas coast	Scottish mainland Celtic Seas coast	NICSCS
Northern Ireland Celtic Seas coast	Scottish mainland Hebridean Seas coast	NICSHS
Republic of Ireland - Celtic Seas eastern coast	Republic of Ireland - Celtic Seas eastern coast	RIERIE
Republic of Ireland - Celtic Seas eastern coast	England and Wales Bristol Channel	RIEEWB
Republic of Ireland - Celtic Seas eastern coast	England and Wales Irish Sea	RIEEWI
Republic of Ireland - Celtic Seas eastern coast	Scottish mainland Celtic Seas coast	RIESCS
Republic of Ireland - Celtic Seas eastern coast	Spanish north coast	RIESPA
Spanish north coast	Northern Ireland Celtic Seas coast	SPANIC
England and Wales Irish Sea	Northern Ireland Celtic Seas coast	EWINIC

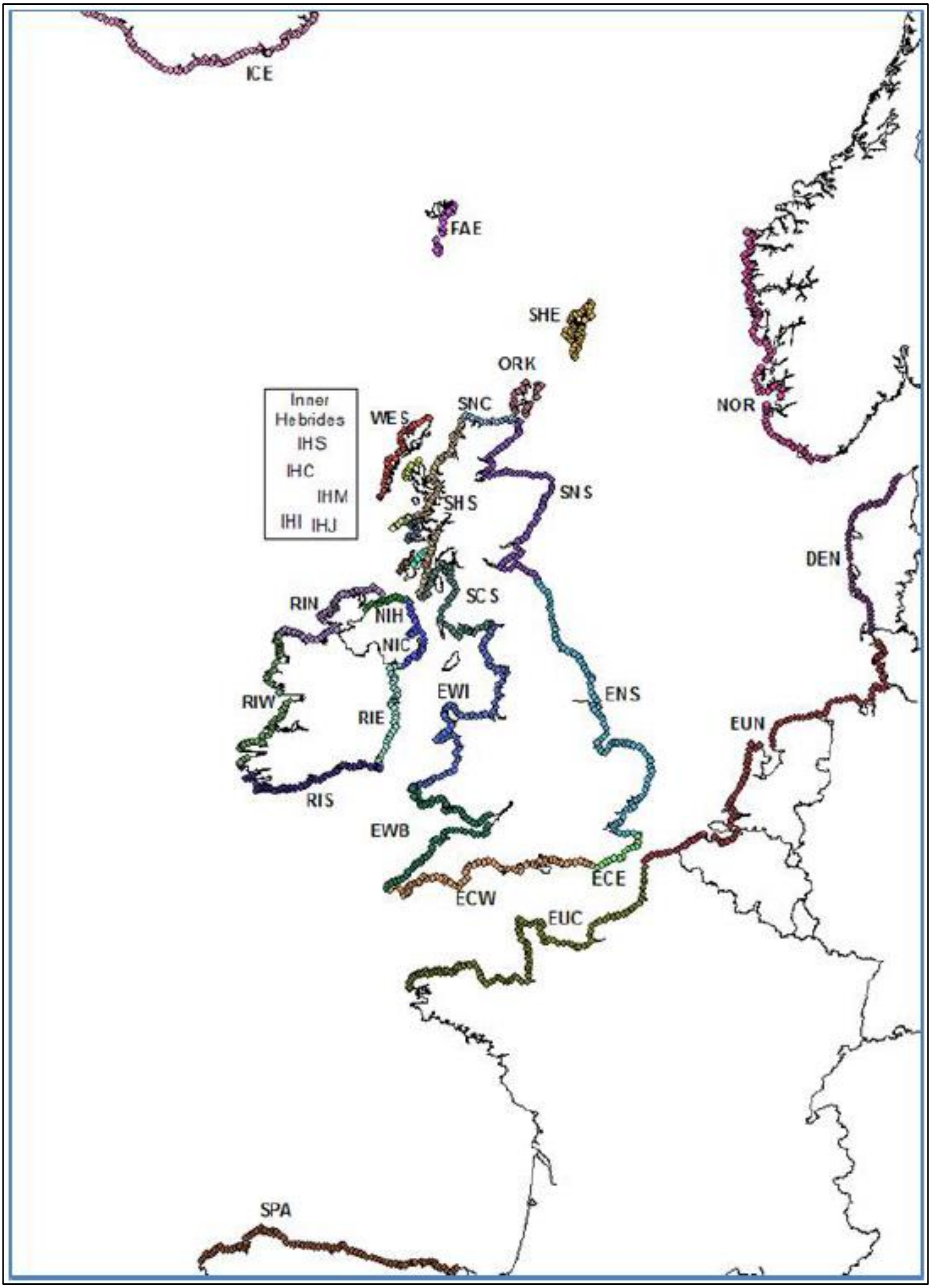

Figure 2-1: Coastal zones defined for the SOSSMAT.

2.2 Population size and population correction factor

The percentage of lines crossing the offshore wind farm area was derived for each species known to migrate along the route selected in SOSSMAT. At this stage, 'true seabirds', all gull species, cormorants and diver species were excluded, to focus the assessment on migratory non-seabird species. In SOSSMAT, the numbers of birds crossing the offshore wind farm area were calculated by adding parameters for population size and population correction factor (% of the population using the relevant sea crossing). Population size estimates were input into SOSSMAT using the Irish winter population (which included both Northern Ireland and the Republic of Ireland (RoI)) (Burke *et al*., 2018), British winter estimate (Frost *et al*., 2019) or the most recent international estimate from BirdLife International (BirdLife International, 2022) or Wetlands International (Wetlands International, 2022). Breeding population estimates were input from the United Kingdom (UK) and RoI combined from Article 12 species trend reports (European Union, 2022). As a precautionary approach, assumptions taken in Wright *et al*. (2012) were followed where the scale and magnitude of the migration were unknown. Therefore, in most instances, the entire population estimation presented in Table 2-2 was used.

Table 2-2: Species vernacular name (including scientific name), population size, and geographic population selected in the SOSSMAT tool.

Vernacular name	Scientific name	Population Estimate	Geographic Population
Whooper swan	*Cygnus cygnus*	15,370	Irish
Greenland white-fronted goose	*Anser albifrons flavirostris*	9,590	Irish
Light-bellied brent goose (Canadian population)	*Branta bernicla hrota*	37,000	International
Shelduck	*Tadorna tadorna*	10,160	Irish
Wigeon	*Mareca penelope*	55,730	Irish
Gadwall	*Mareca strepera*	890	Irish
Teal	*Anas crecca*	35,740	Irish
Mallard	*Anas platyrhynchos*	28,230	Irish
Pintail	*Anas acuta*	1,570	Irish
Shoveler	*Spatula clypeata*	2,020	Irish
Pochard	*Aythya ferina*	11,150	Irish
Tufted duck	*Aythya fuligula*	27,470	Irish
Scaup	*Aythya marila*	2,650	Irish
Long-tailed duck	*Clangula hyemalis*	13,071	British and RoI
Common scoter	*Melanitta nigra*	10,640	Irish
Goldeneye	*Bucephala clangula*	3,820	Irish
Red-breasted merganser	*Mergus serrator*	2,430	Irish
Great crested grebe	*Podiceps cristatus*	2,930	Irish
Slavonian grebe	*Podiceps auritus*	86	Irish
Hen harrier (breeding)	*Circus cyaneus*	702	UK and RoI
Merlin	*Falco columbarius*	61,750	International
Corncrake (breeding)	*Crex crex*	153	UK and RoI
Oystercatcher (breeding)	*Haematopus ostralegus*	196,714	UK and RoI
Oystercatcher (non-breeding)	*Haematopus ostralegus*	60,540	Irish
Ringed plover (breeding)	*Charadrius hiaticula*	12,966	UK and RoI
Ringed plover (non-breeding)	*Charadrius hiaticula*	11,660	Irish
Golden plover (breeding)	*Pluvialis apricaria*	101,242	UK and RoI
Golden plover (non-breeding)	*Pluvialis apricaria*	92,060	Irish
Grey plover	*Pluvialis squatarola*	2,940	Irish

Vernacular name	Scientific name	Population Estimate	Geographic Population
Lapwing	*Vanellus vanellus*	84,690	Irish
Knot	*Calidris canutus*	16,270	Irish
Sanderling	*Calidris alba*	8,420	Irish
Purple sandpiper	*Calidris maritima*	660	Irish
Dunlin (wintering)	*Calidris alpina alpina*	45,760	Irish
Dunlin (passage and breeding)	*Calidris alpina schinzii and Calidris alpina arctica*	848,740	International
Snipe	*Gallinago gallinago*	1,000,000	British
Black-tailed godwit	*Limosa limosa*	19,800	Irish
Bar-tailed godwit	*Limosa lapponica*	16,530	Irish
Whimbrel	*Numenius phaeopus*	3,840[1]	British
Curlew (breeding)	*Numenius arquata*	117,744	UK and RoI
Curlew (non-breeding)	*Numenius arquata*	35,240	Irish
Greenshank	*Tringa nebularia*	1,320	Irish
Redshank (breeding)	*Tringa totanus*	23,800	
Redshank (non-breeding)	*Tringa totanus robusta*	9,480	
Turnstone	*Arenaria interpres*	4,360	
Short-eared owl (breeding)	*Asio flammeus*		

1. Population estimate presented for Whimbrel is from Wright *et al.* (2012) for spring passage.

2.3 Collision risk modelling and avoidance rates

As recommended in the SOSSMAT guidance, the Band (2012) single transit CRM was used. Input parameters for the WTG specifications used within the CRM are shown in Table 2-3. These values are based on the project design parameters as described in section 2 of the main NIS document. Species/populations input parameters are shown in Table 2-4. While species biometrics (length and wingspan) were taken from the British Trust for Ornithology (BTO) BirdFacts resource (Robinson, 2005), flight speeds from Alerstam *et al*. (2007) were used for most species. For a few species, there were no estimations in Alerstam *et al*. (2007). As such, the same assumptions were made following Marine Scotland (2014) in their document *Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds*, whereby flight speed of species for which insufficient evidence existed were derived from species of similar genus and flight characteristics (e.g. European golden plover and American golden Plover *Pluvialis dominica*).

Proportion flying at rotor height given for a species group (e.g. wildfowl, wader etc.) in Wright *et al*. (2012) were used in the CRM. At-risk population resulted from the calculations in the SOSSMAT worksheet (see section 2.2).

Table 2-3: Parameters used within mCRM.

Item	Value
WTG capacity (MW)	15
Number of Turbines	25
No. of Blades	3
Rotation Speed (rpm)	8.1 (± 0.3)
Rotor Radius (m)	118
Minimum Air Gap (m) (LAT)	27
Hub Height (m) (LAT)	145-152

Item	Value
Max. Blade Width (m)	7
Pitch (°)	10
Tidal Offset (m) (MSL)	2.75
Width of Wind Farm (km)[1]	7.37
Latitude (°)[2]	54.05486

1. Maximum width (northwest corner to southeast corner).

2. Latitude was calculated from the centroid of the offshore wind farm area.

Table 2-4: Species/populations parameters used in the Band *et al*. (2012) single transit CRM.

Species	Length (m)	Wingspan (m)	Flight speed (ms^{-1})	Proportion at rotor height (%)	At-risk population (population estimate/number of crossings in footprint of Project)
Dunlin (passage and breeding)	0.18	0.4	15.3	25	2,263
Snipe	0.27	0.47	17.1	25	1,777
Oystercatcher (breeding)	0.42	0.83	13	25	350
Golden plover (non-breeding)	0.28	0.72	13.7	25	327
Lapwing	0.3	0.84	11.9	25	301
Oystercatcher (non-breeding)	0.42	0.83	13	25	215
Curlew (breeding)	0.55	0.9	16.3	25	209
Golden plover (breeding)[1]	0.28	0.72	13.7	25	180
Wigeon	0.48	0.8	20.6	15	198
Dunlin (wintering)	0.18	0.4	15.3	25	163
Light-bellied brent goose (Canadian population)	0.58	1.15	17.7	30	155
Teal	0.36	0.61	19.7	15	127
Curlew (non-breeding)	0.55	0.9	16.3	25	125
Mallard	0.65	0.98	18.5	15	100
Tufted duck	0.44	0.7	21.1	15	98
Redshank (non-breeding)[1]	0.28	0.62	12.3	25	85
Bar-tailed godwit	0.38	0.75	18.3	25	81
Redshank (breeding)	0.28	0.62	12.3	25	79
Whooper swan	1.525	2.305	17.3	50	75
Black-tailed godwit[1]	0.42	0.76	18.3	25	70
Greenland white-fronted goose	0.72	1.46	16.1	30	60
Knot	0.24	0.59	20.1	25	58
Merlin[1]	0.28	0.56	10.1	50	55
Pochard	0.46	0.77	23.6	15	44
Ringed plover (non-breeding)	0.19	0.52	19.5	25	41
Common scoter	0.49	0.84	22.1	1	38
Shelduck	0.67	1.33	15.4	15	36
Turnstone	0.23	0.54	14.9	25	34
Sanderling	0.2	0.42	15.3	25	30
Long-tailed duck	0.44	0.76	20.3	15	23

Species	Length (m)	Wingspan (m)	Flight speed (ms^{-1})	Proportion at rotor height (%)	At-risk population (population estimate/number of crossings in footprint of Project)
Ringed plover (breeding)	0.19	0.52	19.5	25	23
Short-eared owl[1]	0.38	1.02	9.1	50	15
Goldeneye	0.46	0.72	20.3	15	14
Great crested grebe[1]	0.48	0.88	18.6	10	14
Whimbrel	0.41	0.82	16.3	25	14
Scaup	0.51	0.84	21.3	15	11
Grey Plover	0.28	0.77	17.9	25	10
Red-breasted merganser	0.55	0.78	19.7	15	9
Shoveler[1]	0.48	0.77	18.5	15	8
Pintail	0.58	0.88	20.6	15	6
Greenshank	0.32	0.69	12.3	25	5
Purple sandpiper[1]	0.21	0.44	15.3	25	4
Gadwall[1]	0.51	0.9	18.5	15	4
Hen harrier	0.48	1.1	9.1	50	2
Corncrake[1]	0.28	0.5	10	50	<1
Slavonian grebe[1]	0.45	0.86	18.6	10	<1

1. In the absence of data in Alerstam et al. (2007), the flight speed was from a bird species of a similar genus/group and with similar biometrics (i.e. wingspan and length).

As birds may avoid the offshore wind farm area (through macro, meso or micro avoidance), an avoidance rate must be applied to the collision risk model theoretical predictions. There is currently no detailed Irish guidance regarding the use of collision risk models or avoidance rates in the assessment of offshore wind farms on birds. Rather than using species-specific avoidance rates, a range of avoidance rates (i.e. 95.00%, 98.00%, 99.00% and 99.50%) has been applied, as recommended by Band (2012).

3 RESULTS

3.1 Migratory non-seabird species

The species presented in Table 3-1 were considered in the Band (2012) single transit CRM. Wader species, which predominately breed in the Arctic and sub-Arctic regions, were estimated to move through the offshore wind farm area in the highest numbers. For all species, it was assumed that there were two migration periods per year (e.g. spring and autumn) through the area. Table 3-1 presents the number of birds crossing the site annually, considering the spring and autumn passage.

Table 3-1: Percentage of the population and total numbers (ranked by abundance) crossing the offshore wind farm area per annum.

Species	Percentage crossing	Estimated number crossing
Dunlin (passage and breeding)	0.18	2,263
Snipe	0.18	1,777
Oystercatcher (breeding)	0.18	350
Golden plover (non-breeding)	0.18	327
Lapwing	0.18	301
Oystercatcher (non-breeding)	0.18	215
Curlew (breeding)	0.18	209
Wigeon	0.18	198
Golden plover (breeding)	0.18	180
Dunlin (wintering)	0.18	163
Light-bellied brent Goose (Canadian population)	0.21	155
Teal	0.18	127
Curlew (non-breeding)	0.18	125
Mallard	0.18	100
Tufted duck	0.18	98
Redshank (non-breeding)	0.18	85
Bar-tailed godwit	0.24	81
Redshank (breeding)	0.18	79
Whooper swan	0.25	75
Black-tailed godwit	0.18	70
Greenland white-fronted goose	0.31	60
Knot	0.18	58
Merlin	0.18	55
Pochard	0.20	44
Ringed plover (non-breeding)	0.18	41
Common scoter	0.18	38
Shelduck	0.18	36
Turnstone	0.18	34
Sanderling	0.18	30
Long-tailed duck	0.18	23
Ringed plover (breeding)	0.18	23
Short-eared owl	0.18	15
Goldeneye	0.18	14
Great crested grebe	0.25	14
Whimbrel	0.18	14

Species	Percentage crossing	Estimated number crossing
Scaup	0.20	11
Grey plover	0.18	10
Red-breasted merganser	0.18	9
Shoveler	0.20	8
Pintail	0.18	6
Greenshank	0.21	5
Purple sandpiper	0.28	4
Gadwall	0.21	4
Hen harrier	0.27	2
Corncrake	0.20	<1
Slavonian grebe	0.18	<1

3.2 Numbers of collisions predicted using a range of avoidance rates

Even assuming a highly precautionary avoidance rate of 95%, the numbers of collisions were very low and predicted to be below one bird per annum for all species considered (Table 3-2). Because of their breeding population size and migration routes through the Irish Sea, wader species were at the greatest risk of collision. Of the species/populations considered, passage and breeding dunlin were predicted to be the most at risk, with a predicted 0.42 collisions per year assuming a 95% avoidance rate.

Wildfowl species (swan, ducks and geese) were well represented in this assessment, but the resulting predictions were very low. Of the wildfowl species, whopper swan had the highest predicted number of collisions although this was negligible at one collision estimated approximately every 14 years.

Other migrant species considered in the assessment were raptors, and this group included merlin, short-eared owl and hen harrier. For those species, there is insufficient information on migratory routes and population size. Therefore, a highly precautionary approach was taken when assuming population size and proportion of population moving through the Irish Sea. Despite the highly precautionary assumptions, the numbers of collisions were predicted to be negligible for all species (less than one bird per year). Unlike wader and wildfowl species, the number of raptors species breeding and wintering in Ireland and the UK is relatively low. However, when considering the fatalities in the context of the overall population size of raptors, the number of total annual estimated collisions for raptors is undetectable.

Table 3-2: Migrant non-seabird annual collision risk for the Project.

Species	Number of collisions per year				
	No avoidance	95.0%	98.0%	99.0%	99.5%
Dunlin (passage and breeding)	8.32	0.42	0.17	0.08	0.04
Snipe	7.67	0.38	0.15	0.08	0.04
Oystercatcher (breeding)	0.84	0.04	0.02	0.01	< 0.01
Golden Plover (non-breeding)	1.35	0.07	0.03	0.01	0.01
Lapwing	1.30	0.06	0.03	0.01	0.01
Oystercatcher (non-breeding)	1.02	0.05	0.02	0.01	0.01
Curlew (breeding)	1.12	0.06	0.02	0.01	0.01
Wigeon	0.63	0.03	0.01	0.01	< 0.01
Golden plover (breeding)	0.75	0.04	0.02	0.01	< 0.01
Dunlin (wintering)	0.60	0.03	0.01	0.01	< 0.01
Light-bellied brent goose (Canadian population)	1.04	0.05	0.02	0.01	< 0.01
Teal	0.36	0.02	0.01	< 0.01	< 0.01

Species	Number of collisions per year				
	No avoidance	95.0%	98.0%	99.0%	99.5%
Curlew (non-breeding)	0.68	0.03	0.01	0.01	< 0.01
Mallard	0.36	0.02	0.01	< 0.01	< 0.01
Tufted duck	0.29	0.01	0.01	< 0.01	< 0.01
Redshank (non-breeding)	0.36	0.02	0.01	< 0.01	< 0.01
Bar-tailed godwit	0.39	0.02	0.01	< 0.01	< 0.01
Redshank (breeding)	0.34	0.02	0.01	< 0.01	< 0.01
Whooper swan	1.39	0.07	0.03	0.01	0.01
Black-tailed godwit	0.34	0.02	0.01	< 0.01	< 0.01
Greenland white-fronted goose	0.43	0.02	0.01	< 0.01	< 0.01
Knot	0.25	0.01	0.01	< 0.01	< 0.01
Merlin	0.49	0.02	0.01	< 0.01	< 0.01
Pochard	0.13	0.01	< 0.01	< 0.01	< 0.01
Ringed plover (non-breeding)	0.19	0.01	< 0.01	< 0.01	< 0.01
Common scoter	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Shelduck	0.11	0.01	< 0.01	< 0.01	< 0.01
Turnstone	0.13	0.01	< 0.01	< 0.01	< 0.01
Sanderling	0.11	0.01	< 0.01	< 0.01	< 0.01
Long-tailed duck	0.07	< 0.01	< 0.01	< 0.01	< 0.01
Ringed plover (breeding)	0.10	< 0.01	< 0.01	< 0.01	< 0.01
Short-eared owl	0.16	0.01	< 0.01	< 0.01	< 0.01
Goldeneye	0.04	< 0.01	< 0.01	< 0.01	< 0.01
Great crested grebe	0.03	< 0.01	< 0.01	< 0.01	< 0.01
Whimbrel	0.07	< 0.01	< 0.01	< 0.01	< 0.01
Scaup	0.03	< 0.01	< 0.01	< 0.01	< 0.01
Grey plover	0.05	< 0.01	< 0.01	< 0.01	< 0.01
Red-breasted merganser	0.03	< 0.01	< 0.01	< 0.01	< 0.01
Shoveler	0.02	< 0.01	< 0.01	< 0.01	< 0.01
Pintail	0.02	< 0.01	< 0.01	< 0.01	< 0.01
Greenshank	0.03	< 0.01	< 0.01	< 0.01	< 0.01
Purple sandpiper	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Gadwall	0.01	< 0.01	< 0.01	< 0.01	< 0.01
Hen harrier	0.02	< 0.01	< 0.01	< 0.01	< 0.01
Corncrake	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Slavonian grebe	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

4 DISCUSSION

The SOSSMAT tool, developed by Wright *et al*. (2012), was used to identify non-seabird migratory species at risk of collision with the Project. The number crossing the site was estimated (as a proportion of the overall population flying along the migratory corridor) and used in a single transit collision risk model (Band, 2012). Even under a highly precautionary approach of bird movements and avoidance, the number of collisions did not exceed one per annum for any of the species considered in this assessment.

Based on this assessment, it is concluded that the Project will have a negligible effect (almost undetectable) on migratory non-seabird species. This lack of effect could be explained by the relatively small size of the Project and the low likelihood of the offshore wind farm area intersecting with known migration routes – as identified by Wright *et al*. (2012). The number of potential migration routes through the Project was between 0.18 and 0.35 % of all potential migration routes.

It is noted that there is a degree of uncertainty about migration routes at sea, although new findings from tracking studies are contributing to increasing the knowledge of bird migration. A number of species which can be fitted with fine-resolution tracking devices (e.g. GPS/GSM) are the focus of these studies and the number of studies is ever increasing. It is widely accepted that migratory movements of birds in offshore waters tend to occur over a broad front, hence the predictions in this assessment that collision risk to all migratory non-seabird species will be negligible. However, waterbird species may use the coast as a sightline to migrate, with inshore areas possibly acting as migratory corridors. Without fine-resolution GPS tracking data and insight into local migratory movement patterns at SPAs, uncertainty around migration routes associated with local populations will persist. Studies into flight behaviour of birds around offshore wind farms will help resolve these uncertainties (e.g. Skov *et al.*, 2018 and studies at Aberdeen Offshore Wind Farm and Neart na Gaoithe Offshore Wind Farm). The Project offers an opportunity to contribute to such strategic monitoring and knowledge base through a targeted post-construction monitoring study, if deemed required.

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ANNEX 7: OFFSHORE ORNITHOLOGY APPORTIONING IMPACTS TO INDIVIDUAL COLONIES

ORIEL WIND FARM PROJECT

Natura Impact Statement

Annex 7: Offshore Ornithology Apportioning Impacts to Individual Colonies

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1 INTRODUCTION

1.1 Project background

Oriel Windfarm Limited (‘the Applicant’) is proposing to develop the Oriel Wind Farm Project, an offshore wind farm, hereafter referred to as ‘the Project”. The Project is located in the western Irish Sea and is located within the territorial waters of the Republic of Ireland. The Project will comprise both offshore and onshore infrastructure including 25 offshore wind turbines generators (WTGs), associated foundations and inter-array cabling, offshore substation, offshore export cable within a defined offshore cable corridor, a landfall, onshore cable and an onshore substation for connection to the electricity transmission network.

1.2 Background to apportioning

When assessing the impact of a proposed offshore wind farm, it is crucial to determine the impact that such development will have on breeding seabird populations. Seabirds nest in colonies of variable sizes around the coastline (Mitchell *et al.*, 2004) and most species have large foraging ranges at sea (Woodward *et al*., 2019). Establishing the connectivity between marine renewable sites and colonies, which are often protected as Special Protection Areas (SPAs), is a key element of the assessment of impact. A theoretical approach was developed by Scottish Natural Heritage (SNH, 2018) (now known as NatureScot) to determine the proportion of birds from SPA sites which use proposed development areas. The tools allow to ‘apportion’ the impact of a marine renewable site to multiple SPAs.

1.3 Purpose of the report

The *primary purpose* of this report is to apportion predicted mortalities from collisions and displacement of the Project to seabird colonies designated as SPAs (i.e. qualifying as an individual species and/or assemblage of species). As there are no defined seabird colonies for marine SPA’s (i.e. those designated to protect foraging areas), they have not been included in the apportioning of potential impacts (e.g. North-west Irish Sea SPA).

This report presents the method used and apportions the potential impacts of the Project, on SPAs that support qualifying species deemed to be adversely impacted by the Project. It utilises outcomes from other reports, including the collision risk and displacement analyses (annex 4 of appendix H: Offshore Ornithology Collision Risk Modelling and annex 5 of appendix H: Offshore Ornithology Displacement Analysis).

The species presented within this report are limited to the species for which an impact assessment was undertaken in appendix H: Offshore Ornithology – Supporting Information for either displacement or collision. Displacement as a result of the construction, operational and maintenance or decommissioning phases was considered for common guillemot (*Uria aalge*) (hereafter referred to as guillemot), great northern diver (*Gavia immer*), northern gannet (*Morus bassanus*) (hereafter, referred to as gannet) and razorbill (*Alca torda*). The risk of collision as a result of the Project was assessed for black-legged kittiwake (*Rissa tridactyla*) (hereafter referred to as kittiwake), common gull (*Larus canus*), gannet, great black-backed gull (*Larus marinus*) and herring gull (L*arus argentatus*).

There are no SPAs designated for breeding great northern diver within the Cumulative Offshore Ornithology Study Area and the species is not considered further in this report. Similarly, there are no breeding common gull nor great black-backed gull SPAs within 50 km and 73 km of the Project, the mean-maximum foraging range (MMFR) of common gull and great black-backed gull, respectively. The Cumulative Offshore Ornithology Study Area is defined as the MMFR plus one standard deviation (SD) of gannet (Woodward *et al.,* 2019) as the theoretical maximal zone of influence of the Project.

2 METHODOLOGY

Apportioning undertaken for the Project is based on the NatureScot ‘theoretical approach’ method for the breeding season (SNH, 2018). Apportioning during the non-breeding season utilises elements from within Furness (2015) but is adapted to include the abundance estimates for the entire Irish Sea.

For apportioning estimated mortalities associated with an offshore wind farm that may occur in the breeding season to seabirds from those SPAs within a species' MMFR of the Project, there is a two-step approach as outlined in the NatureScot method:

- Apportion estimated mortalities between SPA and non-SPA breeding colonies within foraging range of the wind farm. This is done using the most recent counts for each colony; and
- The estimated mortalities assigned to the SPA component are further apportioned between the individual SPAs within foraging range. This is done by using the Seabird 2000 counts as a reference point.

In this report, the choice was made to base the apportioning on the most recent counts, given that many colony counts have been updated since the NatureScot method was published. Colony counts were extracted from the Seabird Monitoring Programme (SMP) online database (available online at: https://app.bto.org/seabirds/public/index.jsp).

2.1 Identification of designated sites

All SPAs that have connectivity to the Project, defined by the MMFR (plus one SD) of that SPA's qualifying ornithological interest features were identified. Connectivity between an SPA and the Project was defined by the MMFR of each species as shown in Table 2-1 from Woodward *et al*. (2019). A total of 12 different SPAs were identified and included within this apportioning report.

Table 2-1: MMFR for each species and associated SPAs.

Species	Mean max foraging range (km) + SD (sample size – number of studies)	SPA(s) within MMFR of each species
Gannet	315.2 ± 194.2 (31)	• Ailsa Craig • Grassholm • Ireland's Eye • Saltee Islands • Lambay Island
Guillemot	73.2 ± 80.5 (7)	• Howth Head Coast • Ireland's Eye • Lambay Island • Rathlin Island • Wicklow Head
Herring gull	58.8 ± 26.8 (7)	• Howth Head Coast • Ireland's Eye • Lambay Island • Skerries Islands
Kittiwake	156.1 ± 144.5 (19)	• Ailsa Craig • Helvick Head to Ballyquin • Horn Head to Fanad Head • Howth Head Coast • Ireland's Eye • Lambay Island • North Colonsay and Western Cliffs • Rathlin Island • Saltee Islands • Wicklow Head
Razorbill	88.7 ± 75.9 (8)	• Howth Head Coast • Ireland's Eye

Species	Mean max foraging range (km) + SD (sample size – number of studies)	SPA(s) within MMFR of each species
		• Lambay Island • Rathlin Island • Wicklow Head

2.2 Defining bio-seasons

Bio-seasons used within the assessment were defined according to the breeding, non-breeding and migratory season (autumn and spring migration) based on Furness (2015) (Table 2-2). Colour-coding has been used to define the four main bio-seasons presented in Table 2-2.

Table 2-2: Seasonal definitions as the basis for assessment.

Species	Pre-breeding season/spring migration	Breeding season (migration free if provided in Furness, 2015)	Post breeding season/autumn migration	Non-breeding/winter season
Gannet	December to March	April to August (migration free)	September to November	N/A
Guillemot	N/A	March to July	N/A	August to February
Herring gull	N/A	March to August	N/A	September to February
Kittiwake	January to April	May to July (migration free	September to December	N/A
Razorbill	January to March	April to July	August to October	November to December

2.3 Mortality estimates

The mortality estimates are provided in Table 2-3 from collision and displacement. There were up to three estimates provided for the number of birds that might collide or be displaced due to the varying methodologies of the surveys that took place and analysis undertaken.

For collisions, within the Band (2012) model, both site specific and generic flight heights can be used providing different estimates of collision. Option 1 uses site specific flight heights (obtained from the boat based surveys), whereas Option 2 uses flight heights from Johnston *et al.* (2014). Both the Natural England avoidance rates (ARs) and the JNCC ARs are presented. Natural England interim avoidance is not species specific, whereas the JNCC AR are. See annex 4: of appendix H Offshore Ornithology Collision Risk Modelling for full methods of the CRM.

Within the results section below (section 3), only the maximum and minimum of the three estimates is presented within the assessment to reduce repetition and for precaution.

Table 2-3: Estimated mortalities per species and seasons from collision risk and/or displacement.

Species	Season	Survey technique (Band Model Option)	Estimated mortality collisions		Estimated mortality displacement	Estimated mortality combined
			Natural England AR	JNCC AR		
Gannet (70% macro-avoidance	Pre-breeding	Boat (BM1)	1.74	1.54	0	1.54 to 1.74
		Boat (BM2)	0.86	0.75	0	0.75 to 0.86
	Breeding	Boat (BM1)	10.31	8.96	1 to 2	9.96 to 12.31

Species	Season	Survey technique (Band Model Option)	Estimated mortality collisions		Estimated mortality displacement	Estimated mortality combined
			Natural England AR	JNCC AR		
included in collisions)		Boat (BM2)	5.08	4.34	1 to 2	5.34 to 7.08
		Aerial (BM2)	4.10	3.61	1	4.61 to 5.10
	Post-breeding	Boat (BM1)	8.65	7.47	2 to 3	9.47 to 11.63
		Boat (BM2)	4.25	3.63	2 to 3	5.63 to 7.25
Guillemot	Breeding	Boat	-		2 to 29	2 to 29
		Aerial	-		5 to 56	5 to 56
	Non-breeding	Boat	-		8 to 93	8 to 93
		Aerial	-		15 to 173	15 to 173
Herring gull	Breeding	Boat (BM1)	26.32	20.99	-	20.99 to 26.32
		Boat (BM2)	31.34	25.12	-	25.12 to 31.34
	Non-breeding	Boat (BM1)	50.79	40.64	-	40.64 to 50.79
		Boat (BM2)	60.46	48.38	-	48.38 to 60.46
Kittiwake	Pre-breeding	Boat (BM1)	23.02	7.05	-	7.05 to 23.02
		Boat (BM2)	26.5	8.06	-	8.06 to 26.5
	Breeding	Boat (BM1)	3.99	1.52	-	1.52 to 3.99
		Boat (BM2)	5.83	1.74	-	1.74 to 5.83
		Aerial (BM2)	4.1	3.61	-	3.61 to 4.1
	Post-breeding	Boat (BM1)	20.81	6.4	-	6.4 to 20.81
		Boat (BM2)	23.95	7.31	-	7.31 to 23.95
Razorbill	Pre-breeding	Boat	-		3 to 30	3 to 30
	Breeding	Boat	-		0	0
		Aerial	-		1 to 12	1 to 12
	Post-breeding	Boat	-		3 to 34	3 to 34
		Aerial	-		2 to 20	2 to 20
	Non-breeding	Boat	-		2 to 18	2 to 18

2.4 Age composition

Specific additional mortalities for a set of impact scenarios representing bird deaths due to turbine collisions and habitat displacement effects, or their combined effect, were provided for two population groups based on age-class breeding ability: adults (i.e. breeding age-classes) and sub-adults (i.e. immature age-classes). Demographic rates from Horswill and Robinson (2015) were used to calculate the expected stable proportions in each age class for each species during the breeding season. Non-breeding age class proportions were taken from Furness (2015).

Every breeding season, a proportion of adult birds will be taking a sabbatical from breeding. Therefore, these birds need to be removed from assessment as overestimation of potential effects to SPA populations would occur if sabbatical impacts were not removed. The proportion of adults taking sabbatical from breeding each year for each species are also presented within Table 2-4; these have been taken from The Crown Estate’s Plan Level Habitat Regulation Assessment document (Niras, 2021). These sabbatical rates are applied to impacts assigned to adult birds after age-class apportioning.

Table 2-4: Age class percentages used in apportioning impacts.

Species	Season	Adult %	Immatures %	Sabbaticals (% of adult birds)
Gannet	Breeding	56.8	43.2	10
	Non-breeding	55.2	44.8	-
Guillemot	Breeding	52.2	47.8	7
	Non-breeding	57.5	42.5	-
Herring gull	Breeding	42.2	57.8	35
	Non-breeding	47.8	52.2	-
Kittiwake	Breeding	52.7	47.3	10
	Non-breeding	53.2	46.8	-
Razorbill	Breeding	53.3	46.7	7
	Non-breeding	57.1	42.9	-

2.5 Apportioning impacts during the breeding season

NatureScot guidance (SNH, 2018) was followed to apportion impacts to seabirds from the SPAs within a species' foraging range of the Project. Impacts were apportioned between all breeding colonies (both SPA and non-SPA) within the foraging range of each species using the most recent colony counts (obtained from the SMP). The centroid of the Project was determined in QGIS and buffer zones equating to the species' home range (Table 2-1) were produced. As recommended by SNH (2018), the mean-max foraging range from Woodward *et al.* (2019) was used. Each seabird colony located within the species' foraging range of the Project were selected. In the SMP, a 'Master Site' can be made up of several sites along the coastline. Where a 'Master Site' in the SMP was made up of several nesting sites (i.e. sub-colonies), a centroid was generated for each 'Master Site' and the distance between the 'Master Site' centroid and the Project centroid was calculated. For each 'Master Site', the proportion of the species' foraging range at sea was calculated. Finally, the parameters were inputted into Excel to calculate the apportioning value for each colony. The calculations are based on foraging range and three colony-specific parameters:

i. Colony size (in individuals);

ii. Distance of colony – measured from the central point of the Project to the central point of the colony; and

iii. Sea area (the extent of the open sea within the foraging range of the relevant species).

The parameters are combined to produce an overall weighting factor and the calculation is made as follows:

$$\text{Colony Weight} = \frac{\text{Colony Population}}{\text{Sum of Populations}} \times \frac{\text{Sum of Distance\^{}2}}{\text{Colony Distance\^{}2}} \times \frac{\text{1/Colony Sea Proportion}}{\text{Sum of }\left(\frac{1}{\text{Colony Sea Propotions}}\right)}$$

Each colony weight is then used to calculate the proportion of birds attributed to each SPA by calculating (*colony weight / sum of all colony weights*). This proportion is then used to calculate the estimated number of mortalities from the project that can be apportioned to each colony.

2.6 Apportioning impacts during the non-breeding season

To apportion non-breeding season effects from the Project between relevant SPAs, the contribution of adult and immature birds from an individual SPA was calculated as a proportion of the BDMPS defined in Furness (2015). The number of induvial birds within each BDMPS has been adapted from Furness (2015) to increase the representation of Irish colonies. Therefore an "adapted Furness" approach has been used in defining the BDMPS of the Irish Sea. Model estimates of the proportion of adults or immatures in spatially distinct BDMPS were used to calculate the contribution of each breeding colony SPAs to the Irish Sea.

3 RESULTS

3.1 Gannet

3.1.1 Colony weighted proportions

Using the NatureScot apportioning tool, 46 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Ailsa Craig SPA. The Grassholm SPA which is the largest colony within the species foraging range of the Project is predicted to contribute to ~24 % of the birds within the offshore wind farm area (Table 3-1).

Table 3-1: Breeding gannet colony weighting factors used for apportioning impacts on colonies.

Colony	Gannet is a qualifying feature of the site	Colony size (individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Ailsa Craig SPA	Yes	64,452	160.7	0.39	0.46
Grassholm SPA	Yes	72,022	246.6	0.20	0.24
Saltee Islands SPA	Yes	9,444	203.7	0.03	0.04
Ireland's Eye SPA	No	700	56.8	0.04	0.04
Lambay Ireland SPA	No	1,852	47.1	0.14	0.16
Combined non-SPA	N/A	2,427	N/A	0.06	0.07

3.1.2 Apportioned breeding impacts

Table 3-2 shows the minimum and maximum mortality resulting from collision (when using the Natural England AR) and displacement. The minimum and maximum variation occurs within the density estimate presented (boat-based or DAS), the Band Model option (Band Option 1 and Band Option 2) and the range of displacement mortality estimates. The largest estimate of mortality was from Ailsa Craig SPA, with up to 2.86 adult birds. The highest increase in baseline mortality of adult birds was at Lambay Island SPA, where a 0.68 % increase was predicted when taking the maximum impact.

Table 3-3 shows the minimum and maximum mortality resulting from collision (when using the JNCC AR) and displacement. The largest estimate of mortality was from Ailsa Craig SPA, with up to 2.55 adult birds. The highest increase in baseline mortality of adult birds was at Lambay Island SPA, where a 0.60 % increase was predicted when taking the maximum impact.

Table 3-2: Apportioned mortality of gannet resulting from collision and displacement during the breeding season when using the Natural England AR (Sab = sabbatical, Ad = adult, Im = immature).

Colony	Estimated mortality from collision and displacement			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Ailsa Craig SPA	0.13 to 0.32	1.19 to 2.86	1.00 to 2.42	5,221	15,318	0.02 to 0.05	0.01 to 0.02
Grassholm SPA	0.07 to 0.16	0.61 to 1.48	0.52 to 1.25	5,834	17,117	0.01 to 0.03	<0.01 to 0.01
Saltee Islands SPA	0.01 to 0.03	0.11 to 0.25	0.09 to 0.22	765	2,244	0.01 to 0.03	<0.01 to 0.01
Ireland’s Eye SPA	0.01 to 0.03	0.11 to 0.26	0.09 to 0.22	57	166	0.19 to 0.46	0.06 to 0.13
Lambay Island SPA	0.05 to 0.11	0.42 to 1.01	0.36 to 0.86	150	440	0.28 to 0.68	0.08 to 0.19
Combined non-SPA	0.02 to 0.05	0.17 to 0.41	0.14 to 0.35	197	577	0.09 to 0.21	0.03 to 0.06

Table 3-3: Apportioned mortality of gannet resulting from collision and displacement during the breeding season when using the JNCC AR (Sab = sabbatical, Ad = adult, Im = immature).

SPA colony	Estimated mortality from collision and displacement			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Ailsa Craig	0.12 to 0.28	1.07 to 2.55	0.91 to 2.16	5,221	15,318	0.02 to 0.05	0.01 to 0.01
Grassholm	0.06 to 0.15	0.56 to 1.32	0.47 to 1.12	5,834	17,117	0.01 to 0.02	0.00 to 0.01
Saltee Islands	0.01 to 0.03	0.10 to 0.23	0.08 to 0.19	765	2,244	0.01 to 0.03	0.00 to 0.01
Ireland's Eye	0.01 to 0.03	0.10 to 0.23	0.08 to 0.20	57	166	0.17 to 0.41	0.05 to 0.12
Lambay Island	0.04 to 0.10	0.38 to 0.90	0.32 to 0.76	150	440	0.25 to 0.60	0.07 to 0.17
Combined non-SPA	0.02 to 0.04	0.15 to 0.37	0.13 to 0.31	197	577	0.08 to 0.19	0.02 to 0.05

3.1.3 Apportioned non-breeding impacts

Apportioned mortality for gannet during the non-breeding season is presented in Table 3-4 when using the Natural England AR and Table 3-5 when using the JNCC AR. Estimated number of collisions range from <0.01 to 1.48 (Natural England AR) and <0.01 to 1.33 (JNCC AR), depending on the colony. This increased baseline mortality between < 0.01 and 0.03 % (Natural England AR) and <0.01 and 0.02 % (JNCC AR), depending on colony.

Table 3-4: Apportioned mortality of gannet resulting from collision and displacement during the non-breeding season when using the Natural England AR.

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Adult	Post-breeding	Ailsa craig	312,206	0.206	0.71 to 1.33	0.01 to 0.03
		Saltee Islands	312,206	0.023	0.08 to 0.15	0.01 to 0.02
		Ireland's Eye	312,206	0.002	0.01 to 0.01	0.01 to 0.03
		Grassholm	312,206	0.231	0.80 to 1.48	0.01 to 0.03
		Lambay Island	312,206	0.006	0.02 to 0.04	0.01 to 0.03
	Pre-breeding	Ailsa craig	312,206	0.172	0.08 to 0.16	<0.01 to <0.01
		Saltee Islands	375,540	0.025	0.01 to 0.02	<0.01 to <0.01
		Ireland's Eye	375,540	0.002	<0.01 to <0.01	<0.01 to <0.01
		Grassholm	375,540	0.192	0.09 to 0.18	<0.01 to <0.01
		Lambay Island	375,540	0.006	0.02 to 0.04	0.01 to 0.03
Immature	Post-breeding	Ailsa craig	375,540	0.187	0.52 to 0.97	<0.01 to 0.01
		Saltee Islands	223,799	0.021	0.06 to 0.11	<0.01 to <0.01
		Ireland's Eye	223,799	0.002	0.01 to 0.01	<0.01 to 0.01
		Grassholm	223,799	0.209	0.58 to 1.09	<0.01 to 0.01
		Lambay Island	223,799	0.007	0.02 to 0.03	<0.01 to 0.01
	Pre-breeding	Ailsa craig	269,199	0.155	0.06 to 0.12	<0.01 to <0.01
		Saltee Islands	269,199	0.023	0.01 to 0.01	<0.01 to <0.01
		Ireland's Eye	269,199	0.002	<0.01 to <0.01	<0.01 to <0.01
		Grassholm	269,199	0.173	0.07 to 0.14	<0.01 to <0.01
		Lambay Island	269,199	0.004	<0.01 to <0.01	<0.01 to <0.01

Table 3-5: Apportioned mortality of gannet resulting from collision and displacement during the non-breeding season when using the JNCC AR.

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Adult	Post-breeding	Ailsa craig	312,206	0.206	0.64 to 1.19	0.01 to 0.02
		Saltee Islands	312,206	0.023	0.07 to 0.13	0.01 to 0.02
		Ireland's Eye	312,206	0.002	0.01 to 0.01	0.01 to 0.02
		Grassholm	312,206	0.231	0.72 to 1.33	0.01 to 0.02
		Lambay Island	312,206	0.006	0.02 to 0.03	0.01 to 0.02
	Pre-breeding	Ailsa craig	312,206	0.172	0.07 to 0.15	<0.01 to <0.01
		Saltee Islands	375,540	0.025	0.01 to 0.02	<0.01 to <0.01
		Ireland's Eye	375,540	0.002	<0.01 to <0.01	<0.01 to <0.01
		Grassholm	375,540	0.192	0.08 to 0.16	<0.01 to <0.01
		Lambay Island	375,540	0.006	0.02 to 0.03	0.01 to 0.02
Immature	Post-breeding	Ailsa craig	375,540	0.187	0.47 to 0.88	<0.01 to 0.01
		Saltee Islands	223,799	0.021	0.05 to 0.10	<0.01 to <0.01
		Ireland's Eye	223,799	0.002	0.01 to 0.01	<0.01 to 0.01
		Grassholm	223,799	0.209	0.53 to 0.98	<0.01 to 0.01
		Lambay Island	223,799	0.007	0.02 to 0.03	<0.01 to 0.01
	Pre-breeding	Ailsa craig	269,199	0.155	0.05 to 0.11	<0.01 to <0.01
		Saltee Islands	269,199	0.023	0.01 to 0.02	<0.01 to <0.01
		Ireland's Eye	269,199	0.002	<0.01 to <0.01	<0.01 to <0.01
		Grassholm	269,199	0.173	0.06 to 0.12	<0.01 to <0.01
		Lambay Island	269,199	0.004	<0.01 to <0.01	<0.01 to <0.01

3.2 Guillemot

3.2.1 SPA weighted proportions

Using the NatureScot apportioning tool, 72 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA. The Rathlin Island SPA which is the largest colony within the species foraging range of the Project is predicted to contribute to 16 % of the birds within the offshore wind farm area (Table 3-6).

Table 3-6: Breeding guillemot colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Howth Head Coast	1,167	60	0.01	0.01
Ireland's Eye	5,909	57	0.08	0.04
Lambay Island	80,377	48	1.61	0.72
Rathlin Island	200,343	154	0.36	0.16

SPA Colony	Colony size (individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Wicklow Head	811	106	<0.01	<0.01
Combined non-SPA	64,639	N/A	0.17	0.08

3.2.2 Apportioned breeding impacts

Apportioned mortality for guillemot during the breeding season is presented in Table 3-7. Estimated number of mortalities from displacement range from <0.1 to 19.17 adult birds, depending on the colony. This increased baseline mortality between < 0.01 and 0.40 % in adult birds when considered a 70 % displacement and a 5 % mortality.

Table 3-7: Apportioned mortality of guillemot resulting from displacement during the breeding season (Sab = sabbatical, Ad = adult, Im = immature).

SPA colony	Estimated mortality from displacement			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Howth Head Coast	<0.01 to 0.02	0.01 to 0.17	0.01 to 0.18	71	233	0.01 to 0.24	<0.01 to 0.08
Ireland’s Eye	<0.01 to 0.11	0.03 to 0.98	0.04 to 1.00	360	1,179	0.01 to 0.27	<0.01 to 0.08
Lambay Island	0.07 to 2.09	0.67 to 18.85	0.68 to 19.17	4,903	16,038	0.01 to 0.38	<0.01 to 0.12
Rathlin Island	0.02 to 0.47	0.15 to 4.26	0.15 to 4.33	12,221	39,976	<0.01 to 0.03	<0.01 to 0.01
Wicklow Head	<0.01 to <0.01	<0.01 to 0.03	<0.01 to 0.03	49	162	<0.01 to 0.07	<0.01 to 0.02
Combined non-SPA	0.01 to 0.22	0.07 to 2.02	0.07 to 2.06	3,844	12,576	<0.01 to 0.05	<0.01 to 0.02

3.2.3 Apportioned non-breeding impacts

Apportioned mortality for guillemot during the non-breeding season is presented in Table 3-8. Estimated number of mortalities from displacement range from <0.01 to 22.08 birds, depending on the colony. This increased baseline mortality between < 0.01 and 0.18 %.

Table 3-8: Apportioned mortality of guillemot resulting from displacement during the non-breeding season.

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Adult	Non-breeding	Howth Head Coast	902,773	0.001	0.01 to 0.13	0.01 to 0.18
		Ireland’s Eye	902,773	0.007	0.03 to 0.65	0.01 to 0.18
		Lambay Island	902,773	0.089	0.41 to 8.86	0.01 to 0.18
		Rathlin Island	902,773	0.222	1.02 to 22.08	0.01 to 0.18
		Wicklow Head	902,773	0.001	<0.01 to 0.09	0.01 to 0.18
Immature		Howth Head Coast	664,625	0.001	<0.01 to 0.09	<0.01 to 0.05
		Ireland’s Eye	664,625	0.006	0.02 to 0.46	<0.01 to 0.05
		Lambay Island	664,625	0.085	0.29 to 6.25	<0.01 to 0.05
		Rathlin Island	664,625	0.212	0.72 to 15.58	<0.01 to 0.05
		Wicklow Head	664,625	0.001	<0.01 to 0.06	<0.01 to 0.05

3.3 Herring gull

3.3.1 SPA weighted proportions

Using the NatureScot apportioning tool, 22 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA. The largest number of breeding herring gull are associated with the coastal urban areas within Dublin, Balbriggan and Howth (72 %).

Table 3-9: Breeding herring gull colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Ireland’s Eye	636	57	0.06	0.06
Lambay Island	1,812	48	0.25	0.22
Skerries Islands	34	39	0.01	0.01
Combined non-SPA	7,184	N/A	0.81	0.72

3.3.2 Apportioned breeding impacts

Table 3-10 shows the minimum and maximum mortality resulting from collision (when using the Natural England AR) and displacement. The minimum and maximum variation occurs within the density estimate presented (boat-based or DAS), the Band Model option (Band Option 1 and Band Option 2) and the range of displacement mortality estimates. The largest estimate of mortality was from Lambay Island SPA, with up to 1.90 adult birds. The highest increase in baseline mortality for adult birds was at Skerries Islands SPA, where a 1.07% increase was predicted when taking the maximum impact.

Table 3-11 shows the minimum and maximum mortality resulting from collision (when using the JNCC AR) and displacement. The largest estimate of mortality was from Lambay Island SPA, with up to 1.52 adult birds. The highest increase in baseline mortality for adult birds was at Skerries Islands SPA, where a 0.86% increase was predicted when taking the maximum impact.

Table 3-10: Apportioned mortality of herring gull resulting from collision during the breeding season using the Natural England AR (Sab = sabbatical, Ad = adult, Im = immature).

SPA colony	Estimated mortality from collision			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Ireland's Eye	0.22 to 0.26	0.41 to 0.49	0.86 to 1.03	106	154	0.39 to 0.46	0.56 to 0.67
Lambay Island	0.86 to 1.02	1.59 to 1.90	3.36 to 4.00	301	438	0.53 to 0.63	0.77 to 0.91
Skerries Islands	0.03 to 0.03	0.05 to 0.06	0.11 to 0.13	6	8	0.90 to 1.07	1.30 to 1.55
Combined non-SPA	2.78 to 3.31	5.17 to 6.15	10.89 to 12.96	1,193	1,736	0.43 to 0.52	0.63 to 0.75

Table 3-11: Apportioned mortality of herring gull resulting from collision during the breeding season using the JNCC AR (Sab = sabbatical, Ad = adult, Im = immature).

SPA colony	Estimated mortality from collision			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Ireland's Eye	0.18 to 0.21	0.33 to 0.39	0.69 to 0.82	106	154	0.31 to 0.37	0.45 to 0.54
Lambay Island	0.68 to 0.82	1.27 to 1.52	2.68 to 3.21	301	438	0.42 to 0.51	0.61 to 0.73
Skerries Islands	0.02 to 0.03	0.04 to 0.05	0.09 to 0.10	6	8	0.72 to 0.86	1.04 to 1.24

SPA colony	Estimated mortality from collision			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Combined non-SPA	2.22 to 2.65	4.12 to 4.93	8.68 to 10.39	1,193	1,736	0.35 to 0.41	0.50 to 0.60

3.3.3 Apportioned non-breeding impacts

Apportioned mortality for herring gull during the non-breeding season is presented in Table 3-12 when using the Natural England AR and Table 3-13 when using the JNCC AR. Estimated number of collisions range from <0.1 to 0.5 (Natural England AR) and <0.1 to 0.4 (JNCC AR), depending on the colony. This increased baseline mortality between 0.13 and 0.16 % (Natural England AR) and 0.10 and 0.13 % (JNCC AR), depending on colony.

Table 3-12: Apportioned mortality of herring gull resulting from collision during the non-breeding season when using the Natural England AR.

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Adult	Non-breeding	Ireland's Eye	98,946	0.0050	0.1 to 0.1	0.13 to 0.16
		Lambay Island	98,946	0.0165	0.4 to 0.5	0.13 to 0.16
		Skerries Islands	98,946	0.0005	<0.1	0.13 to 0.16
Immature		Ireland's Eye	97,845	0.0049	0.1 to 0.2	0.12 to 0.15
		Lambay Island	97,845	0.0161	0.4 to 0.5	0.12 to 0.15
		Skerries Islands	97,845	0.0005	<0.1	0.12 to 0.15

Table 3-13: Apportioned mortality of herring gull resulting from collision during the non-breeding season when using the JNCC AR.

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Adult	Non-breeding	Ireland's Eye	98,946	0.0050	0.1 to 0.1	0.11 to 0.13
		Lambay Island	98,946	0.0165	0.3 to 0.4	0.11 to 0.13
		Skerries Islands	98,946	0.0005	<0.1	0.11 to 0.13
Immature		Ireland's Eye	97,845	0.0049	0.1 to 0.1	0.10 to 0.12
		Lambay Island	97,845	0.0161	0.3 to 0.4	0.10 to 0.12
		Skerries Islands	97,845	0.0005	<0.1	0.10 to 0.12

3.4 Kittiwake

3.4.1 SPA weighted proportions

Using the NatureScot apportioning tool, 35 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA (Table 3-14).

Table 3-14: Breeding kittiwake colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Ailsa Craig	980	161	0.01	0.00
Helvick Head to Ballyquin	260	230	0.00	0.00
Horn Head to Fanad Head	3,640	190	0.02	0.01
Howth Head Coast	3,546	59	0.36	0.12
Ireland's Eye	910	57	0.10	0.03
Lambay Island	6,640	48	1.05	0.35
North Colonsay and Western Cliffs	6,694	242	0.03	0.01
Rathlin Island	27,412	155	0.33	0.11
Saltee Islands	2,076	204	0.01	0.00
Wicklow Head	1,546	106	0.05	0.02
Combined non-SPA	24570	N/A	1.05	0.35

3.4.2 Apportioned breeding impacts

Table 3-15 shows the minimum and maximum mortality resulting from collision (when using the Natural England AR) and displacement. The minimum and maximum variation occurs within the density estimate presented (boat-based or DAS), the Band Model option (Band Option 1 and Band Option 2) and the range of displacement mortality estimates. The largest estimate of mortality was from Lambay Island SPA, with up to 0.99 adult birds. The highest increase in baseline mortality for adult birds was at Lambay Island SPA, where a 0.10 % increase was predicted when taking the maximum impact.

Table 3-16 shows the minimum and maximum mortality resulting from collision (when using the JNCC AR) and displacement. The largest estimate of mortality was from Lambay Island SPA, with up to 0.61 adult birds. The highest increase in baseline mortality for adult birds was at Lambay Island SPA, where a 0.06 % increase was predicted when taking the maximum impact.

Table 3-15: Apportioned mortality of kittiwake resulting from collision during the breeding season using the Natural England AR (Sab = sabbatical, Ad = adult, Im = immature).

SPA colony	Estimated mortality from collision			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Ailsa Craig	<0.01 to <0.01	0.01 to 0.01	0.01 to 0.01	143	148	0.01 to 0.01	0.01 to 0.01
Helvick Head to Ballyquin	<0.01 to <0.01	<0.01 to <0.01	<0.01 to <0.01	38	39	<0.01 to <0.01	<0.01 to <0.01
Horn Head to Fanad Head	<0.01 to <0.01	0.02 to 0.02	0.01 to 0.02	531	549	<0.01 to <0.01	<0.01 to <0.01
Howth Head Coast	0.02 to 0.03	0.23 to 0.34	0.22 to 0.33	518	535	0.05 to 0.07	0.04 to 0.06
Ireland's Eye	<0.01 to 0.01	0.07 to 0.10	0.06 to 0.09	133	137	0.05 to 0.07	0.05 to 0.07
Lambay Island	0.05 to 0.07	0.68 to 0.99	0.65 to 0.96	969	1,001	0.07 to 0.10	0.07 to 0.10
North Colonsay and Western Cliffs	<0.01 to <0.01	0.02 to 0.03	0.02 to 0.03	977	1,009	<0.01 to <0.01	<0.01 to <0.01
Rathlin Island	0.02 to 0.02	0.21 to 0.31	0.20 to 0.30	4,002	4,133	0.01 to 0.01	<0.01 to 0.01
Saltee Islands	<0.01 to <0.01	0.01 to 0.01	0.01 to 0.01	303	313	<0.01 to <0.01	<0.01 to <0.01
Wicklow Head	<0.01 to <0.01	0.03 to 0.05	0.03 to 0.05	226	233	0.01 to 0.02	0.01 to 0.02

SPA colony	Estimated mortality from collision			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Combined non-SPA	0.05 to 0.07	0.68 to 1.00	0.66 to 0.96	3,587	3,705	0.02 to 0.03	0.02 to 0.03

Table 3-16: Apportioned mortality of kittiwake resulting from collision during the breeding season using the JNCC AR (Sab = sabbatical, Ad = adult, Im = immature).

SPA colony	Estimated mortality from collision			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Ailsa Craig	<0.01 to <0.01	<0.01 to 0.01	<0.01 to 0.01	143	148	<0.01 to 0.01	<0.01 to 0.01
Helvick Head to Ballyquin	<0.01 to <0.01	<0.01 to <0.01	<0.01 to <0.01	38	39	<0.01 to <0.01	<0.01 to <0.01
Horn Head to Fanad Head	<0.01 to <0.01	0.01 to 0.01	0.01 to 0.01	531	549	<0.01 to <0.01	<0.01 to <0.01
Howth Head Coast	0.01 to 0.02	0.09 to 0.21	0.09 to 0.20	518	535	0.02 to 0.04	0.02 to 0.04
Ireland's Eye	<0.01 to <0.01	0.02 to 0.06	0.02 to 0.06	133	137	0.02 to 0.04	0.02 to 0.04
Lambay Island	0.02 to 0.05	0.26 to 0.61	0.25 to 0.59	969	1,001	0.03 to 0.06	0.02 to 0.06
North Colonsay and Western Cliffs	<0.01 to <0.01	0.01 to 0.02	0.01 to 0.02	977	1,009	<0.01 to <0.01	<0.01 to <0.01
Rathlin Island	0.01 to 0.01	0.08 to 0.19	0.08 to 0.18	4,002	4,133	<0.01 to <0.01	<0.01 to <0.01
Saltee Islands	<0.01 to <0.01	<0.01 to 0.01	<0.01 to 0.01	303	313	<0.01 to <0.01	<0.01 to <0.01
Wicklow Head	<0.01 to <0.01	0.01 to 0.03	0.01 to 0.03	226	233	0.01 to 0.01	0.01 to 0.01
Combined non-SPA	0.02 to 0.05	0.26 to 0.62	0.25 to 0.60	3,587	3,705	0.01 to 0.02	0.01 to 0.02

3.4.3 Apportioned non-breeding impacts

Apportioned mortality for gannet during the non-breeding season is presented in Table 3-17 when using the Natural England AR and Table 3-18 when using the JNCC AR. Estimated number of collisions range from <0.1 to 0.9 (Natural England AR) and <0.1 to 0.3 (JNCC AR), depending on the colony. This increased baseline mortality between 0.01 and 0.02 % (Natural England AR) and <0.01 and 0.01 % (JNCC AR), depending on colony.

Table 3-17: Apportioned mortality of kittiwake resulting from collision during the non-breeding season when using the Natural England AR.

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Adult	Post-breeding	Ailsa Craig	508,068	0.002	0.02 to 0.02	0.01 to 0.02
		Helvick Head to Ballyquin	508,068	<0.001	0.01 to 0.01	0.01 to 0.02

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
		Horn Head to Fanad Head	508,068	0.006	0.07 to 0.08	0.01 to 0.02
		Howth Head Coast	508,068	0.006	0.07 to 0.08	0.01 to 0.02
		Ireland's Eye	508,068	0.002	0.02 to 0.02	0.01 to 0.02
		Lambay Island	508,068	0.013	0.14 to 0.17	0.01 to 0.02
		North Colonsay and Western Cliffs	508,068	0.012	0.13 to 0.15	0.01 to 0.02
		Rathlin Island	508,068	0.054	0.60 to 0.69	0.01 to 0.02
		Saltee Islands	508,068	0.002	0.02 to 0.03	0.01 to 0.01
		Wicklow Head	508,068	0.002	0.02 to 0.02	0.01 to 0.01
	Pre-breeding	Ailsa Craig	420,138	0.002	0.02 to 0.03	0.02 to 0.02
		Helvick Head to Ballyquin	420,138	<0.001	0.01 to 0.01	0.02 to 0.02
		Horn Head to Fanad Head	420,138	0.007	0.08 to 0.10	0.02 to 0.02
		Howth Head Coast	420,138	0.007	0.08 to 0.10	0.02 to 0.02
		Ireland's Eye	420,138	0.002	0.03 to 0.03	0.02 to 0.02
		Lambay Island	420,138	0.016	0.19 to 0.22	0.02 to 0.02
		North Colonsay and Western Cliffs	420,138	0.013	0.16 to 0.18	0.02 to 0.02
		Rathlin Island	420,138	0.065	0.80 to 0.92	0.02 to 0.02
		Saltee Islands	420,138	0.002	0.03 to 0.03	0.01 to 0.01
		Wicklow Head	420,138	0.002	0.02 to 0.03	0.01 to 0.01
Immature	Post-breeding	Ailsa Craig	387,615	0.002	0.02 to 0.02	0.01 to 0.01
		Helvick Head to Ballyquin	387,615	<0.001	<0.01 to <0.01	0.01 to 0.01
		Horn Head to Fanad Head	387,615	0.006	0.06 to 0.06	0.01 to 0.01
		Howth Head Coast	387,615	0.006	0.05 to 0.06	0.01 to 0.01
		Ireland's Eye	387,615	0.002	0.02 to 0.02	0.01 to 0.02
		Lambay Island	387,615	0.014	0.13 to 0.15	0.01 to 0.02
		North Colonsay and Western Cliffs	387,615	0.011	0.10 to 0.12	0.01 to 0.01
		Rathlin Island	387,615	0.056	0.55 to 0.63	0.01 to 0.02
		Saltee Islands	387,615	0.002	0.02 to 0.03	0.01 to 0.01
		Wicklow Head	387,615	0.002	0.02 to 0.02	0.01 to 0.01
	Pre-breeding	Ailsa Craig	320,532	0.002	0.02 to 0.02	0.01 to 0.01
		Helvick Head to Ballyquin	320,532	<0.001	<0.01 to 0.01	0.01 to 0.01
		Horn Head to Fanad Head	320,532	0.006	0.06 to 0.07	0.01 to 0.01
		Howth Head Coast	320,532	0.006	0.06 to 0.07	0.01 to 0.01
		Ireland's Eye	320,532	0.002	0.02 to 0.02	0.01 to 0.02
		Lambay Island	320,532	0.013	0.14 to 0.16	0.01 to 0.02
		North Colonsay and Western Cliffs	320,532	0.011	0.12 to 0.14	0.01 to 0.01
		Rathlin Island	320,532	0.053	0.57 to 0.65	0.01 to 0.02

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
		Saltee Islands	320,532	0.002	0.02 to 0.03	0.01 to 0.01
		Wicklow Head	320,532	0.002	0.02 to 0.02	0.01 to 0.01

Table 3-18: Apportioned mortality of kittiwake resulting from collision during the non-breeding season when using the JNCC AR.

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Adult	Post-breeding	Ailsa Craig	508,068	0.002	0.01 to 0.01	<0.01 to <0.01
		Helvick Head to Ballyquin	508,068	<0.001	<0.01 to <0.01	<0.01 to <0.01
		Horn Head to Fanad Head	508,068	0.006	0.02 to 0.03	<0.01 to <0.01
		Howth Head Coast	508,068	0.006	0.02 to 0.02	<0.01 to <0.01
		Ireland's Eye	508,068	0.002	0.01 to 0.01	<0.01 to 0.01
		Lambay Island	508,068	0.013	0.04 to 0.05	<0.01 to 0.01
		North Colonsay and Western Cliffs	508,068	0.012	0.04 to 0.05	<0.01 to <0.01
		Rathlin Island	508,068	0.054	0.18 to 0.21	<0.01 to 0.01
		Saltee Islands	508,068	0.002	0.01 to 0.01	<0.01 to <0.01
		Wicklow Head	508,068	0.002	0.01 to 0.01	<0.01 to <0.01
	Pre-breeding	Ailsa Craig	420,138	0.006	0.01 to 0.01	<0.01 to 0.01
		Helvick Head to Ballyquin	420,138	0.002	<0.01 to <0.01	<0.01 to 0.01
		Horn Head to Fanad Head	420,138	<0.001	0.03 to 0.03	<0.01 to 0.01
		Howth Head Coast	420,138	0.008	0.04 to 0.05	<0.01 to 0.01
		Ireland's Eye	420,138	0.012	0.03 to 0.03	0.01 to 0.01
		Lambay Island	420,138	0.008	0.06 to 0.07	0.01 to 0.01
		North Colonsay and Western Cliffs	420,138	0.016	0.05 to 0.05	<0.01 to 0.01
		Rathlin Island	420,138	0.013	0.24 to 0.28	0.01 to 0.01
		Saltee Islands	420,138	0.065	0.01 to 0.01	<0.01 to <0.01
		Wicklow Head	420,138	0.002	0.01 to 0.01	<0.01 to <0.01
Immature	Post-breeding	Ailsa Craig	387,615	0.002	<0.01 to 0.01	<0.01 to <0.01
		Helvick Head to Ballyquin	387,615	0.002	<0.01 to <0.01	<0.01 to <0.01
		Horn Head to Fanad Head	387,615	0.002	0.02 to 0.02	<0.01 to <0.01
		Howth Head Coast	387,615	<0.001	0.02 to 0.02	<0.01 to <0.01
		Ireland's Eye	387,615	0.006	0.01 to 0.01	<0.01 to <0.01
		Lambay Island	387,615	0.006	0.04 to 0.05	<0.01 to <0.01
		North Colonsay and Western Cliffs	387,615	0.002	0.03 to 0.04	<0.01 to <0.01
		Rathlin Island	387,615	0.014	0.17 to 0.19	<0.01 to <0.01
		Saltee Islands	387,615	0.011	0.01 to 0.01	<0.01 to <0.01

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
		Wicklow Head	387,615	0.056	0.01 to 0.01	<0.01 to <0.01
	Pre-breeding	Ailsa Craig	320,532	0.002	0.01 to 0.01	<0.01 to <0.01
		Helvick Head to Ballyquin	320,532	0.002	<0.01 to <0.01	<0.01 to <0.01
		Horn Head to Fanad Head	320,532	0.002	0.02 to 0.03	<0.01 to <0.01
		Howth Head Coast	320,532	<0.001	0.03 to 0.04	<0.01 to <0.01
		Ireland's Eye	320,532	0.007	0.02 to 0.02	<0.01 to <0.01
		Lambay Island	320,532	0.010	0.04 to 0.05	<0.01 to <0.01
		North Colonsay and Western Cliffs	320,532	0.006	0.04 to 0.04	<0.01 to <0.01
		Rathlin Island	320,532	0.013	0.17 to 0.20	<0.01 to <0.01
		Saltee Islands	320,532	0.011	0.01 to 0.01	<0.01 to <0.01
		Wicklow Head	320,532	0.053	0.01 to 0.01	<0.01 to <0.01

3.5 Razorbill

3.5.1 SPA weighted proportions

Using the NatureScot apportioning tool, 60 % of the birds recorded in the Project in the breeding season would be predicted to originate from the Lambay Island SPA. Rathlin Island SPA which is the largest colony within the species foraging of the Project is predicted to contribute to 17 % of the birds within the offshore wind farm area (Table 3-19).

Table 3-19: Breeding razorbill colony weighting factors used for apportioning impacts on SPAs.

SPA Colony	Colony size (individuals)	Distance to the Project centre (km)	NatureScot colony weight	Proportional weight
Howth Head Coast	374	60	0.03	0.01
Ireland's Eye	2,144	57	0.20	0.09
Lambay Island	9,853	48	1.33	0.60
Rathlin Island	30,044	154	0.39	0.18
Wicklow Head	247	106	0.01	<0.01
Combined non-SPA	13,224	N/A	0.24	0.11

3.5.2 Apportioned breeding impacts

Apportioned mortality for razorbill during the breeding season is presented in Table 3-20. Estimated number of mortalities from displacement range from 0 to 3.48 adult birds, depending on the colony. This increased baseline mortality between 0 and 0.34 % in adult birds when considered a 70 % displacement and a 5 % mortality.

Table 3-20: Apportioned mortality of razorbill resulting from displacement during the breeding season (Sab = sabbatical, Ad = adult, Im = immature).

SPA colony	Estimated mortality from displacement			Baseline mortality		Increase in baseline mortality (%)	
	Sab	Ad	Im	Ad	Im	Ad	Im
Howth Head Coast	0 to 0.01	0 to 0.08	0 to 0.08	39	51	0 to 0.21	0 to 0.16
Ireland's Eye	0 to 0.06	0 to 0.53	0 to 0.52	225	294	0 to 0.24	0 to 0.18
Lambay Island	0 to 0.39	0 to 3.48	0 to 3.39	1,035	1,350	0 to 0.34	0 to 0.25
Rathlin Island	0 to 0.11	0 to 1.02	0 to 0.99	3,155	4,117	0 to 0.03	0 to 0.02
Wicklow Head	0 to <0.01	0 to 0.02	0 to 0.02	26	34	0 to 0.06	0 to 0.05
Combined non-SPA	0 to 0.07	0 to 0.62	0 to 0.60	1,389	1,812	0 to 0.04	0 to 0.03

3.5.3 Apportioned non-breeding impacts

Apportioned mortality for razorbill during the non-breeding season is presented in Table 3-21. Estimated number of mortalities from displacement range from <0.1 to 1.8 birds, depending on the colony. This increased baseline mortality between < 0.01 and 0.06 % in adult birds considered a 70 % displacement and a 5 % mortality.

Table 3-21: Apportioned mortality of razorbill resulting from displacement during the non-breeding season.

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
Adult	Post-breeding	Howth Head Coast	316,928	0.001	<0.01 to 0.02	<0.01 to 0.06
		Ireland's Eye	316,928	0.007	0.01 to 0.13	<0.01 to 0.06
		Lambay Island	316,928	0.031	0.04 to 0.60	<0.01 to 0.06
		Rathlin Island	316,928	0.095	0.11 to 1.84	<0.01 to 0.06
		Wicklow Head	316,928	0.001	<0.01 to 0.02	<0.01 to 0.06
	Pre-breeding	Howth Head Coast	316,928	0.001	<0.01 to 0.02	0.01 to 0.05
		Ireland's Eye	316,928	0.007	0.01 to 0.12	0.01 to 0.05
		Lambay Island	316,928	0.031	0.05 to 0.53	0.01 to 0.05
		Rathlin Island	316,928	0.095	0.16 to 1.62	0.01 to 0.05
		Wicklow Head	316,928	0.001	<0.01 to 0.01	0.01 to 0.05
	Non-breeding	Howth Head Coast	178,289	0.001	<0.01 to 0.01	<0.01 to 0.02
		Ireland's Eye	178,289	0.005	0.01 to 0.05	<0.01 to 0.02
		Lambay Island	178,289	0.022	0.03 to 0.23	<0.01 to 0.02
		Rathlin Island	178,289	0.067	0.08 to 0.69	<0.01 to 0.02
		Wicklow Head	178,289	0.001	<0.01 to 0.01	<0.01 to 0.02
Immature	Post-breeding	Howth Head Coast	289,986	0.001	<0.01 to 0.01	<0.01 to 0.03
		Ireland's Eye	289,986	0.005	<0.01 to 0.08	<0.01 to 0.03
		Lambay Island	289,986	0.025	0.02 to 0.37	<0.01 to 0.03
		Rathlin Island	289,986	0.077	0.07 to 1.12	<0.01 to 0.03
		Wicklow Head	289,986	0.001	<0.01 to 0.01	<0.01 to 0.03
	Pre-breeding	Howth Head Coast	289,986	0.001	<0.01 to 0.01	<0.01 to 0.03
		Ireland's Eye	289,986	0.006	0.01 to 0.07	<0.01 to 0.03
		Lambay Island	289,986	0.025	0.03 to 0.33	<0.01 to 0.03
		Rathlin Island	289,986	0.078	0.10 to 1.00	<0.01 to 0.03

Age	Bio-season	SPA colony	BDMPS	Proportion SPA / BDRMS	Estimated mortality	Increase in baseline mortality (%)
		Wicklow Head	289,986	0.001	<0.01 to 0.01	<0.01 to 0.03
	Non-breeding	Howth Head Coast	163,133	<0.001	<0.01 to <0.01	<0.01 to <0.01
		Ireland's Eye	163,133	0.001	<0.01 to 0.01	<0.01 to <0.01
		Wicklow Head	163,133	0.005	<0.01 to 0.03	<0.01 to <0.01
		Lambay Island	163,133	0.014	0.01 to 0.11	<0.01 to <0.01
		Rathlin Island	163,133	<0.001	<0.01 to <0.01	<0.01 to <0.01
		Wicklow Head	316,928	0.001	<0.01 to 0.02	<0.01 to 0.06

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A.1: Parameters used to calculate colony weighting and proportional weighting for birds during the breeding season

Table A.1: Parameters used to calculate colony weighting and proportional weighting for gannet during the breeding season.

Gannet colonies	Pop.[1]	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	Weighting	Proportion
Ailsa Craig SPA	64452	160.7	25820.02	0.65	0.35	0.42	7.59	0.12	0.39	0.455
Grassholm SPA	72022	246.6	60835.27	0.62	0.38	0.47	3.22	0.13	0.20	0.236
Saltee Islands SPA	9444	203.7	41501.77	0.66	0.34	0.06	4.72	0.12	0.03	0.040
Ireland's Eye SPA	700	56.8	3227.25	0.63	0.37	0.00	60.74	0.13	0.04	0.042
Lambay Island SPA	1852	47	2217.59	0.63	0.37	0.01	88.39	0.13	0.14	0.161
SPA Total	**148470**									**0.934**
Monreith Cliffs and Scar Rocks	4752	122	14803.10	0.62	0.38	0.03	13.24	0.13	0.06	0.065
Porth Llanlleiana to Porth Eilian	42	120	14492.85	0.62	0.38	0.00	13.52	0.13	0.00	0.001
Garvan Islands	60	182	33115.16	0.70	0.30	0.00	5.92	0.10	0.00	0.000
Non-SPA Total	**4854**								**0.06**	**0.066**
Sum	**153324**	**1139**	**196013**	**5.14**	**2.86**	**1.00**	**197.35**	**1.00**	**0.85**	**1.00**

1: Pop. = No. of individuals.

Table A.2: Parameters used to calculate colony weighting and proportional weighting for guillemot during the breeding season.

Guillemot colonies	Pop.	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	Weighting	Proportion
Howth Head Coast SPA	871	60	3551.81	0.47	0.53	0.00	93.74	0.05	0.015	0.007
Ireland's Eye SPA	4410	57	3231.52	0.47	0.53	0.02	103.04	0.05	0.084	0.037
Lambay Island SPA	59983	48	2271.25	0.47	0.53	0.23	146.60	0.05	1.612	0.716
Rathlin Island SPA	149510	154	23674.78	0.50	0.50	0.57	14.06	0.05	0.364	0.162
Wicklow Head SPA	605	106	11237.29	0.53	0.47	0.00	29.63	0.04	0.003	0.001
SPA Total	**215379**									**0.923**
Aberdaron Coast and Bardsey Island SPA	1112	155	23916.79	0.57	0.43	0.00	13.92	0.04	0.00	0.00
Aberdaron Coast not in SPA	94	154	23644.43	0.57	0.43	0.00	14.08	0.04	0.00	0.00
Bray Head	1413	81	6523.31	0.50	0.50	0.01	51.04	0.05	0.01	0.01
Causeway Coast	278	148	21950.03	0.51	0.49	0.00	15.17	0.04	0.00	0.00
Larne Lough to Portmuck	2617	103	10522.08	0.49	0.51	0.01	31.64	0.05	0.01	0.01
Lleyn Peninsula	3295	163	26591.10	0.55	0.45	0.01	12.52	0.04	0.01	0.00
Lleyn Peninsula (Carreg y Llam)	11000	150	22374.63	0.55	0.45	0.04	14.88	0.04	0.03	0.01
Monreith Cliffs and Scar Rocks	350	122	14803.10	0.49	0.51	0.00	22.49	0.05	0.00	0.00
Muck Island	2782	106	11213.23	0.49	0.51	0.01	29.69	0.05	0.01	0.01
Mull of Galloway	277	112	12519.97	0.51	0.49	0.00	26.59	0.04	0.00	0.00
North Island (Isle of Man)	471	119	14221.41	0.51	0.49	0.00	23.41	0.04	0.00	0.00
Port Mona, Devil's Bridge, Laggantalluch Head	229	110	12087.68	0.51	0.49	0.00	27.55	0.05	0.00	0.00
Porth Llanlleiana to Porth Eilian	5550	120	14508.99	0.59	0.41	0.02	22.95	0.04	0.02	0.01
Puffin Island SPA	4200	151	22702.96	0.55	0.45	0.02	14.67	0.04	0.01	0.00
Sheep Island SPA	703	149	22252.85	0.51	0.49	0.00	14.96	0.04	0.00	0.00

Guillemot colonies	Pop.	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	Weighting	Proportion
South Island (Isle of Man)	4085	86	7478.72	0.55	0.45	0.02	44.52	0.04	0.03	0.01
South Stack	7914	114	13031.53	0.60	0.40	0.03	25.55	0.04	0.03	0.01
West Island (Isle of Man)	663	93	8654.62	0.54	0.46	0.00	38.47	0.04	0.00	0.00
Non-SPA Total	**47033**	**124**							**0.173**	**0.077**
Sum	**262412**	**2659**	**332964.06**	**12.00**	**11.00**	**1.00**	**831.20**	**1.00**	**2.25**	**1.00**

Table A.3: Parameters used to calculate colony weighting and proportional weighting for razorbill during the breeding season.

Razorbill colonies	Pop.	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	Weighting	Proportion
Howth Head Coast SPA	279	60	3551.81	0.47	0.53	0.01	138.30	0.03	0.032	0.015
Ireland's Eye SPA	1600	57	3231.52	0.47	0.53	0.04	152.00	0.04	0.205	0.093
Lambay Island SPA	7353	48	2271.25	0.47	0.53	0.18	216.27	0.03	1.332	0.605
Rathlin Island SPA	22421	154	23674.78	0.47	0.53	0.54	20.75	0.03	0.390	0.177
Wicklow Head SPA	184	106	11237.29	0.51	0.49	0.00	43.71	0.03	0.006	0.003
SPA Total	**31837**									**0.89**
Aberdaron Coast and Bardsey Island SPA	1972	155	23916.79	0.56	0.44	0.05	20.54	0.03	0.03	0.01
Aberdaron Coast not in SPA	134	154	23644.43	0.55	0.45	0.00	20.77	0.03	0.00	0.00
Ailsa Craig SPA	1161	161	25820.02	0.42	0.58	0.03	19.02	0.04	0.02	0.01
Bray	150	81	6523.31	0.48	0.52	0.00	75.30	0.03	0.01	0.00
Carmel Head South	0	114	13054.73	0.55	0.45	0.00	37.63	0.03	0.00	0.00
Causeway Coast	361	147	21585.42	0.50	0.50	0.01	22.76	0.03	0.01	0.00
East Island (Isle of Man)	100	108	11643.19	0.49	0.51	0.00	42.19	0.03	0.00	0.00
Great Orme and Little Orme	168	159	25245.42	0.50	0.50	0.00	19.46	0.03	0.00	0.00
Larne Lough to Portmuck	679	103	10522.08	0.48	0.52	0.02	46.68	0.03	0.03	0.01
Lleyn Peninsula	292	163	26591.10	0.54	0.46	0.01	18.47	0.03	0.00	0.00
Lleyn Peninsula (Carreg y Llam)	519	150	22374.63	0.53	0.47	0.01	21.95	0.03	0.01	0.00
Meikle Ross & Little Ross	3	159	25308.29	0.41	0.59	0.00	19.41	0.04	0.00	0.00
Muck Island	1048	106	11213.23	0.48	0.52	0.03	43.81	0.03	0.04	0.02
Mull of Galloway	44	112	12519.97	0.48	0.52	0.00	39.23	0.03	0.00	0.00
North Island (Isle of Man)	36	119	14221.41	0.47	0.53	0.00	34.54	0.04	0.00	0.00
Point Lynas to Trwyn Du	9	144	20835.50	0.52	0.48	0.00	23.58	0.03	0.00	0.00
Port Mona, Devil's Bridge, Laggantalluch Head	37	111	12241.52	0.48	0.52	0.00	40.13	0.03	0.00	0.00
Puffin Island (Gwynedd)	457	151	22702.96	0.51	0.49	0.01	21.64	0.03	0.01	0.00
Sanda Islands - Kintyre	430	155	24002.02	0.45	0.55	0.01	20.47	0.04	0.01	0.00
Sheep Island SPA	221	149	22252.85	0.51	0.49	0.01	22.07	0.03	0.00	0.00
Skerry Islands	15	150	22447.09	0.54	0.46	0.00	21.88	0.03	0.00	0.00

Razorbill colonies	Pop.	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	Weighting	Proportion
South Island (Isle of Man)	389	86	7478.72	0.51	0.49	0.01	65.68	0.03	0.02	0.01
South Stack	1479	114	13031.53	0.55	0.45	0.04	37.69	0.03	0.04	0.02
Starling Knowe to Downan Point	64	139	19409.84	0.44	0.56	0.00	25.31	0.04	0.00	0.00
West Island (Isle of Man)	101	93	8654.62	0.49	0.51	0.00	56.76	0.03	0.00	0.00
Non-SPA Total	**9869**								**0.237**	**0.108**
Sum	**41706**	**3706**	**491207.31**	**14.82**	**15.18**	**1.00**	**1388.00**	**1.00**	**2.20**	**1.00**

Table A.4: Parameters used to calculate colony weighting and proportional weighting for herring gull during the breeding season.

Herring gull colonies	Pop.	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	Weighting	Proportion
Ireland's Eye SPA	636	57	3227.25	0.54	0.46	0.07	14.69	0.07	0.064	0.057
Lambay Island SPA	1812	48	2302.30	0.55	0.45	0.19	20.60	0.07	0.251	0.221
Skerries Islands SPA	34	39	1487.79	0.51	0.49	0.00	31.87	0.07	0.008	0.007
SPA Total	**2482**									**0.284**
Belfast	86	76	5777.05	0.13	0.87	0.01	8.21	0.13	0.009	0.008
Bray Head	4	81	6523.31	0.54	0.46	0.00	7.27	0.07	0.000	0.000
Dublin City Centre, Skerries and Balbriggan	3468	50	2486.31	0.46	0.54	0.36	19.07	0.08	0.536	0.472
Dun Laoghaire (Urban Area)	2	70	4945.51	0.51	0.49	0.00	9.59	0.07	0.000	0.000
Howth Head Coast SPA	18	60	3605.49	0.55	0.45	0.00	13.15	0.07	0.002	0.001
Howth village	920	59	3514.64	0.54	0.46	0.10	13.49	0.07	0.086	0.076
Loughshinny to Killiney	86	36	3514.64	0.54	0.46	0.01	13.49	0.07	0.008	0.007
Loughshinny to Killiney (Dalkey Island)	38	72	2552.83	0.54	0.46	0.00	18.57	0.07	0.005	0.004
Monaghan Lakes	16	51	2552.83	0.13	0.87	0.00	18.57	0.13	0.004	0.003
Strangford Lough	2546	70	4926.68	0.55	0.45	0.26	9.62	0.06	0.163	0.144
Non-SPA Total	**7184**								**0.814**	**0.716**
Sum	**9666**	**768**	**47416.61**	**6.08**	**6.92**	**1.00**	**198.20**	**1.00**	**1.14**	**1.00**

Table A.5: Parameters used to calculate colony weighting and proportional weighting for kittiwake during the breeding season.

Kittiwake Colonies - SMP master site	Pop	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	NatureScot Weighting	NatureScot prop
Ailsa Craig SPA	490	161	25820.0	0.471	0.529	0.013	53.459	0.020	0.013	0.004
Helvick Head to Ballyquin SPA	130	230	52778.9	0.650	0.350	0.003	26.153	0.013	0.001	0.000
Horn Head to Fanad Head SPA	1820	190	36174.2	0.643	0.357	0.047	38.158	0.013	0.024	0.008
Howth Head Coast SPA	1773	59	3532.7	0.462	0.538	0.045	390.731	0.020	0.361	0.119
Ireland's Eye SPA	455	57	3236.0	0.463	0.537	0.012	426.547	0.020	0.101	0.033
Lambay Island SPA	3320	48	2264.8	0.463	0.537	0.085	609.471	0.020	1.050	0.347
North Colonsay and Western Cliffs SPA	3347	242	58767.6	0.572	0.428	0.086	23.488	0.016	0.033	0.011
Rathlin Island SPA	13706	155	24042.5	0.572	0.428	0.350	57.412	0.016	0.325	0.108
Saltee Island SPA	1038	204	41501.8	0.576	0.424	0.027	33.259	0.016	0.014	0.005
Wicklow Head SPA	773	106	11236.0	0.462	0.538	0.020	122.849	0.020	0.049	0.016
SPA Total	**26852**									**0.651**
Aberdaron Coast and Bardsey Island SPA	90	155	23916.8	0.381	0.619	0.002	57.714	0.023	0.003	0.001
Ardmore to Whiting Bay	226	247	60836.6	0.650	0.350	0.006	22.689	0.013	0.002	0.001
Balcary Point	114	177	31427.2	0.438	0.562	0.003	43.921	0.021	0.003	0.001
Bishop & Clerks and Ramsey	83	234	54924.2	0.570	0.430	0.002	25.131	0.016	0.001	0.000
Bray Head	873	81	6523.3	0.470	0.530	0.022	211.599	0.020	0.095	0.031
Caldey Island	271	269	72572.9	0.570	0.430	0.007	19.020	0.016	0.002	0.001
Causeway Coast	562	148	21950.0	0.510	0.490	0.014	62.885	0.019	0.017	0.006
Creadan Head to Foilakipeen	26	205	41820.8	0.598	0.402	0.001	33.006	0.015	0.000	0.000
Downhill	92	147	21548.6	0.542	0.458	0.002	64.056	0.017	0.003	0.001

Kittiwake Colonies - SMP master site	Pop	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	NatureScot Weighting	NatureScot prop
Dunmore East to Red Head	401	207	42645.6	0.600	0.400	0.010	32.367	0.015	0.005	0.002
Giants Causeway Coast	13	148	21964.4	0.526	0.474	0.000	62.844	0.018	0.000	0.000
Grassholm	30	247	60835.3	0.547	0.453	0.001	22.690	0.017	0.000	0.000
Great Orme and Little Orme	992	159	25245.4	0.346	0.654	0.025	54.676	0.025	0.034	0.011
Inishtrahull Island SPA (assemblage)	7	185	34078.3	0.586	0.414	0.000	40.505	0.016	0.000	0.000
Islay - East (Port Askaig to Bowmore)	59	186	34542.5	0.533	0.467	0.002	39.960	0.018	0.001	0.000
Islay - West (Port Askaig to Bruichladdich)	246	217	47136.3	0.559	0.441	0.006	29.284	0.017	0.003	0.001
Larne Lough to Portmuck	1145	103	10592.1	0.450	0.550	0.029	130.317	0.021	0.079	0.026
Lleyn Peninsula	965	163	26600.0	0.370	0.630	0.025	51.892	0.024	0.030	0.010
Loughshinny to Killiney (Rockabill)	165	36	1292.6	0.452	0.548	0.004	1067.867	0.021	0.093	0.031
Maggy's Leap	656	32	1040.1	0.426	0.574	0.017	1327.064	0.022	0.484	0.160
Meikle Ross & Little Ross	0	159	25308.3	0.427	0.573	0.000	54.540	0.022	0.000	0.000
Monreith Cliffs and Scar Rocks	19	122	14803.1	0.417	0.583	0.000	93.246	0.022	0.001	0.000
Morecambe Central Gas Platform	220	179	31929.5	0.390	0.610	0.006	43.230	0.023	0.006	0.002
Muck Island	519	106	11213.2	0.453	0.547	0.013	123.098	0.021	0.034	0.011
Mull of Galloway	61	112	12483.6	0.416	0.584	0.002	110.571	0.022	0.004	0.001
New Quay to Lochtyn	332	221	48739.0	0.463	0.537	0.008	28.321	0.020	0.005	0.002
North Antrim coast	242	148	21794.9	0.533	0.467	0.006	63.332	0.018	0.007	0.002

Kittiwake Colonies - SMP master site	Pop	Distance	Distance ^2	Proportion at Sea	1 - Psea	Colpop/ sumpop	Sum dist2/ col dist2	Colsea/ sumsea	NatureScot Weighting	NatureScot prop
North Island (Isle of Man)	78	119	14221.4	0.381	0.619	0.002	97.060	0.023	0.005	0.001
Point Lynas to Trwyn Du	156	131	17136.2	0.338	0.662	0.004	80.550	0.025	0.008	0.003
Port Mona, Devil's Bridge, Laggantalluch Head	25	110	12087.7	0.418	0.582	0.001	114.193	0.022	0.002	0.001
Portally to Benlea Head	100	208	43299.0	0.603	0.397	0.003	31.879	0.015	0.001	0.000
Porth Llanlleiana to Porth Eilian	0	120	14509.0	0.339	0.661	0.000	95.136	0.025	0.000	0.000
Puffin Island, Anglesey	313	151	22703.0	0.341	0.659	0.008	60.799	0.025	0.012	0.004
Sanda Islands - Kintyre	33	156	24303.5	0.483	0.517	0.001	56.795	0.020	0.001	0.000
Sheep Islands SPA	230	149	22252.9	0.512	0.488	0.006	62.029	0.018	0.007	0.002
Skerry Islands	76	150	22447.1	0.532	0.468	0.002	61.492	0.018	0.002	0.001
Skomer SPA (assemblage)	1439	248	61663.9	0.565	0.435	0.037	22.385	0.016	0.014	0.004
South Island (Isle of Man)	553	85	7151.7	0.370	0.630	0.014	193.007	0.024	0.065	0.021
South Stack	10	114	13031.5	0.344	0.656	0.000	105.922	0.025	0.001	0.000
St Bees Head and Town	809	172	29744.0	0.417	0.583	0.021	46.407	0.022	0.021	0.007
West Island (Isle of Man)	54	93	8654.6	0.375	0.625	0.001	159.490	0.024	0.005	0.002
Non-SPA Total	12285								**1.055**	**0.349**
Sum	**39137**	**7848.523**	**1380324.5**	**24.576**	**26.424**	**1.000**	**6884.494**	**1.000**	**3.026**	**1.000**

ANNEX 8: OFFSHORE ORNITHOLOGY POPULATION VIABILITY ANALYSIS

ORIEL WIND FARM PROJECT

Natura Impact Statement

Annex 8: Offshore Ornithology Population Viability Analysis

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1 INTRODUCTION

1.1 Project background

Oriel Windfarm Limited (‘the Applicant’) is proposing to develop the Oriel Wind Farm Project, an offshore wind farm, hereafter referred to as ‘the Project”. The Project is located in the western Irish Sea and is located within the territorial waters of the Republic of Ireland. The Project will comprise both offshore and onshore infrastructure including 25 offshore wind turbines generators (WTGs), associated foundations and inter-array cabling, offshore substation, offshore cable within a defined offshore cable corridor, a landfall, onshore cable and an onshore substation for connection to the electricity transmission network.

1.2 Background to this report

Renewable energy projects in the marine environment, such as offshore wind farms, have the potential to impact seabirds through several processes such as collision with wind turbine blades resulting in mortality, or displacement from an area due to the presence of wind turbines. The outputs from the collision risk and displacement analysis are presented within the following annexes; in annex 4: Offshore Ornithology Collision Risk Modelling and annex 5: Offshore Ornithology Displacement Analysis. The estimated mortalities were apportioned by age-class and season to relevant SPAs using the methods and weightings set out in annex 7: Offshore Ornithology Apportioning Impacts to Special Protection Areas (SPAs).

These impacts affect individuals, but the in-combination effects (when the project alone effects are considered alongside any effects from other projects on the same receptor) have the potential to affect the productivity or elevate the baseline mortality of a population. The Habitat Regulation Assessment (HRA) process provides for the assessment of such potential effects as a consequence of offshore wind farms at varying population scales, from a single Special Protection Area (SPA) colony to the wider biogeographic population. Other plans and projects included were Awel y Môr Mona Offshore Wind Project, Project Erebus, Minesto Tidal Kite (collisions with tidal kite), Mona Offshore Wind Project, Morgan Offshore Wind Project Generation Assets, Morecambe Offshore Windfarm, Arklow Bank Wind Park, Codling Wind Park, Dublin Array and North Irish Sea Array.

One method to estimate the effect that offshore wind projects alone or in-combination may have on a population is through Population Viability Analysis (PVA). PVA provides a robust framework using demographic parameters to predict changes in the population, using statistical population models to forecast future changes over a set period. Comparisons are made between ‘baseline’ conditions whereby conditions remain unimpacted and under ‘impacted’ conditions where an impact is applied to a population by the alteration of demographic parameters. Population metrics that are derived from comparisons of ‘baseline’ and ‘impacted’ predictions generated by PVAs can then be used to assess the significance of the anticipated additional mortality associated with planned developments.

As part of the Project’s alone and in-combination assessments (as detailed in appendix H: Offshore Ornithology – Supporting Information), the species taken forward to PVA were:

- Herring gull (*Larus argentatus)*; and

- Kittiwake (*Rissa tridactyla)*.

PVA was carried out as part of the in-combination assessment due to appendix H: Offshore Ornithology – Supporting Information indicating that baseline mortality from the operations and maintenance of the Project, in-combination with other projects would exceed a 1% baseline mortality threshold for herring gull populations at two SPAs; Ireland’s Eye SPA and Lambay Island SPA. In addition, the in-combination assessment concluded that impacts at three SPAs designated for kittiwake would also exceed the 1% increase in baseline morality, namely Howth Head Coast SPA, Ireland’s Eye SPA and Lambay Island SPA.

Generally, based on findings from PVA for bird species, it would be considered that increases in mortality rates of less than 1% would be undetectable in terms of changes in population size, whereas increases above 1% may produce detectable effects (Natural England, 2022) and hence require further assessment.

The assessment presented within appendix H: Offshore Ornithology – Supporting Information for all other species in all seasons was below 1% and hence no further assessment was required. Only offshore wind farms with publicly available impact assessment data were included in the assessment.

2 METHODOLOGY

PVA was undertaken using the Seabird PVA Tool developed by Natural England (Searle *et al*., 2019). The Seabird PVA Tool was accessed via the ‘Shiny App’ interface, which is a user-friendly graphical user interface accessible via a standard web-browser that uses the nepva R package to perform the modelling and analysis. The tool constructs a stochastic Leslie matrix and can assess any type of impact in terms of change to demographic parameters, or as a cull or harvest of a fixed size per year (Searle *et al*., 2019). The PVA was run using Tool version 2, with R version 3.5.1, PVA package version: 4.18 (with UI version 1.7)

2.1 Modelling approach

The potential impacts of the Project on the population growth and size of seabird species inhabiting SPAs were predicted using PVA.

Additional annual mortality (combined breeding and non-breeding season mortality estimates) was derived by summing the apportioned collision and/or displacement mortality estimates combined for the species/SPA combination. This was done by age class (adult and immature) based on the age class information from stable age population models using Furness (2015).

All PVA models were undertaken using the ‘Simulation’ run type, which is used to simulate population trajectories based on the specified demographic parameters, initial population sizes and scenarios the user inputs into the model.

The tool includes an option to switch the model to run as either density independent, or density dependent. Density dependence is self-evident in the natural environment, as without density dependence, populations would grow exponentially. For seabird populations, the mechanisms as to how this operates are largely uncertain. If density dependence is mis-specified in an assessment, the modelled predictions may be unreliable. Therefore, it is more typical to use density independent models for seabird assessments, despite the lack of biologically necessary density dependence. As such, density independent models lack any means by which a population can recover once it has been reduced beyond a certain point, they are therefore appropriate for impact assessment purposes on the grounds that they provide a precautionary approach (Ridge *et al.,* 2019).

Environmental stochasticity, which accounts for the variation arising from environmental changes affecting individuals in the same group (e.g. between-year differences in weather conditions), was incorporated in the models at the level of productivity and survival rates. For each simulated year, a value for each demographic rate was randomly generated from a probability distribution defined by the mean and standard deviation estimates of that rate for the population under consideration.

Demographic stochasticity, which accounts for individual-level variation affecting transition probabilities between age-classes, was included in the models. For large populations, like the ones considered in this analysis, the effects of environmental stochasticity are deemed more important than those associated with demographic stochasticity (Morris and Doak, 2002). However, including demographic stochasticity will not cause any issues when simulating larger populations (WWT Consulting, 2012) and hence has been included.

PVA outputs can either be expressed as the Counterfactual of Population Size (CPS) or the Counterfactual of the Population Growth Rate (CPGR) depending on if density dependence is included within the model. As models within this report have been run using density independence, the CPGR is considered more robust and informative. While both CPS and CPGR are provided, the interpretation of the density independent PVA outputs focusses on the CPGR.

2.2 Model parameterisation

Input demographic parameters use SPA-specific estimates when available (see appendix A.1: Seabird PVA Parameter Log). In cases where local estimates were unavailable, preference was given to broader scale estimates based on combined independent studies collated in Horswill and Robinson (2015), see Table 2-1. In the absence of local estimates, combined regional and national level estimates are believed to generate parameter values that express more accurately the underlying degree of uncertainty in model simulations.

Table 2-1: Species demographic rates used in population viability analysis.

Species		Survival Rates						Productivity	Age at first breeding	Eggs per pair
		$S_{0\text{->}1}$	$S_{1\text{->}2}$	$S_{2\text{->}3}$	$S_{3\text{->}4}$	$S_{4\text{->}5}$	S_A			
Herring gull	Mean	0.794	0.834	0.834	0.834	0.834	0.834	0.615	5	3
	SD	0.079	0.079	0.079	0.079	0.079	0.079	0.476		
Kittiwake	Mean	0.790	0.854	0.854	0.854	0.854	0.854	0.604	4	2
	SD	0.077	0.077	0.077	0.077	0.077	0.077	0.326		

The colony counts for each of the SPAs were provided from JNCC as two validated datasheets of all colony count data for the UK and Ireland within the Seabird Monitoring Programme (SMP) database for 1998 to 2022 (Table 1.2). For the species of interest here (Table 2-2), the database summarised counts by subsites and whole SPAs; “counts” are recorded as individuals or Apparently Occupied Nests (AON) or Apparently Occupied Sites (AOS). Ideally, counts should be concurrent across breeding colonies of interest. However, for many SPAs, counts are divided by subsite and not all subsites are censused every year. Entire counts for SPAs comprising multiple subsites are often only achieved over a period of years.

Table 2-2: SPA starting populations.

Species	SPA	Breeding adults	Baseline mortality	Year of count
Herring Gull	Ireland’s Eye	636	106	2015
	Lambay Island	1,812	301	2015
Kittiwake	Howth Head Coast	3,546	518	2015
	Ireland’s Eye	910	133	2015
	Lambay Island	6,640	1,001	2015

2.3 Simulation parameterisation

All PVA modelling in this technical report was undertaken with environmental and deterministic stochasticity. To ensure robust results, all simulations were set to run 5,000 times. All models were run for a 40 year time span to account for difference in individual project lifespans. A range of years are presented in the result tables below 25, 30, 35 and 40 years (section 3).

Modelling has also been undertaken including ‘burn in’ within the model. It has been assumed that any impacts on populations commenced the year following latest population counts. A ‘burn in’ period was applied, which allows for a stable age structure to form when starting to run the model. Models were run for each species/SPA combination separately taking the associated adult population size estimate as a starting condition. Herring gull was modelled within the burn in period due to the model being unable to run, however a burn in period was applied for kittiwake.

Although impacts are only reported with respect to the adult numbers, impacts within the simulations were also applied proportionally to immature age-classes (based upon the stable age distribution from eigen-decomposition of the Leslie matrix).

2.4 Species specific input parameters

1.1.1 Herring gull

The collision risk values used in the PVA assessment for the selected species are based on the in-combination table (Table 6-7) within appendix H: Offshore Ornithology - Supporting Information. The in-combination impact values are presented in Table 2-3.

Table 2-3: Adult herring gull impacts for individual SPA colonies considered within the PVA.

SPA	Estimated annual mortality (in-combination)	Increase in baseline morality (%)	Impact on adult survival rate
Ireland's Eye	2.84	2.68	0.00447
Lambay Island	6.97	2.32	0.00385

1.1.2 Kittiwake

The collision risk values used in the PVA assessment for the selected species are based on the in-combination table (Table 6-8) within appendix H: Offshore Ornithology - Supporting Information. The in-combination impact values are presented in Table 2-4.

Table 2-4: Adult kittiwake impacts for individual SPA colonies considered within the PVA.

SPA	Estimated annual mortality (in-combination)	Increase in baseline morality (%)	Impact on adult survival rate
Howth Head Coast	8.55	1.65	0.00235
Ireland's Eye	2.49	1.87	0.00274
Lambay Island	11.70	1.17	0.00176

3 RESULTS

3.1 Herring gull

1.1.3 Ireland's Eye SPA

The counterfactual growth rate for herring gull from the Ireland's Eye SPA remained at 0.994 across the 30 to 40 year model run with the counterfactual of final population size approximately 85% less than the unimpacted scenario. An impact of 0.995 is considered insignificant and within the natural fluctuations of a population.

The addition of herring gull collision impacts from the Project cumulatively with other identified projects would reduce the growth rate of the Ireland's Eye SPA population by no more than 0.574% when using the largest collision risk estimate (Table 3-1).

Table 3-1: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for herring gull at Ireland's Eye SPA.

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in Growth Rate (%)
2050	25	0	0.964	0.925	1.000			
		2.84	0.959	0.920	0.995	0.995	0.882	0.544
2055	30	0	0.964	0.929	0.998			
		2.84	0.959	0.923	0.992	0.994	0.860	0.556
2060	35	0	0.964	0.931	0.994			
		2.84	0.959	0.926	0.989	0.994	0.842	0.557
2065	40	0	0.964	0.933	0.992			
		2.84	0.958	0.927	0.987	0.994	0.826	0.575

1.1.4 Lambay Island SPA

The counterfactual growth rate for herring gull from the Lambay Island SPA remained at 0.995 across the 25 to 40 year model run with the counterfactual of final population size (after 40 years) approximately 82% less than the unimpacted scenario. An impact of the CPGR of ≥0.995 is considered insignificant and within the natural fluctuations.

The addition of herring gull collision impacts from the Project cumulatively with other identified projects would reduce the growth rate of the Lambay Island SPA population by no more than 0.48% when using the largest collision risk estimate (Table 3-2).

Table 3-2: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for herring gull at Lambay SPA.

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in Growth Rate (%)
2050	25	0	0.965	0.927	1.000			
		6.97	0.960	0.923	0.996	0.995	0.886	0.471
2055	30	0	0.964	0.930	0.997			
		6.97	0.960	0.925	0.993	0.995	0.863	0.471
2060	35	0	0.964	0.933	0.995			
		6.97	0.960	0.928	0.990	0.995	0.845	0.474
2065	40	0	0.964	0.935	0.992			
		6.97	0.960	0.930	0.987	0.995	0.821	0.476

3.2 Kittiwake

1.1.5 Howth Head Coast SPA

The counterfactual growth rate for kittiwake from the Howth Head Coast SPA remained at 0.997 across the 25 to 40 year model run with the counterfactual of population size (after 40 years) approximately 88% less than the unimpacted scenario. An impact of the CPGR of ≥0.995 is considered insignificant and within the natural fluctuations.

The addition of kittiwake collision impacts from the Project cumulatively with other identified projects would reduce the growth rate of the Howth Head Coast SPA population by no more than 0.277 % when using the largest collision risk estimate (Table 3-3).

Table 3-3: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for kittiwake at Howth Head Coast SPA.

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2050	25	0	0.999	0.966	1.031			
		8.55	0.996	0.963	1.029	0.997	0.931	0.277
2055	30	0	0.999	0.968	1.028			
		8.55	0.996	0.966	1.026	0.997	0.918	0.277
2060	35	0	0.999	0.971	1.026			
		8.55	0.996	0.968	1.023	0.997	0.906	0.277

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2065	40	0	0.999	0.973	1.024			
		8.55	0.996	0.971	1.021	0.997	0.893	0.278

1.1.6 Ireland's Eye SPA

The counterfactual growth rate for kittiwake from the Ireland's Eye SPA remained at 0.997 across the 25 to 40 year model run with the counterfactual of population size (after 40 years) approximately 88% less than the unimpacted scenario. An impact of the CPGR of ≥0.995 is considered insignificant and within the natural fluctuations.

The addition of kittiwake collision impacts from the Project cumulatively with other identified projects would reduce the growth rate of the Ireland's Eye SPA population by no more than 0.327 % when using the largest collision risk estimate (Table 3-4).

Table 3-4: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for kittiwake at Ireland's Eye SPA.

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2050	25	0	0.999	0.965	1.031			
		2.49	0.995	0.962	1.028	0.997	0.924	0.327
2055	30	0	0.999	0.968	1.028			
		2.49	0.995	0.965	1.025	0.997	0.911	0.325
2060	35	0	0.999	0.971	1.026			
		2.49	0.995	0.967	1.023	0.997	0.897	0.324
2065	40	0	0.998	0.973	1.024			
		2.49	0.995	0.969	1.020	0.997	0.878	0.321

1.1.7 Lambay Island SPA

The counterfactual growth rate for kittiwake from the Lambay Island SPA remained at 0.998 across the 25 to 40 year model run with the CPS (after 40 years) approximately 91% less than the unimpacted scenario. An impact of the CPGR of ≥0.995 is considered insignificant and within the natural fluctuations.

The addition of kittiwake collision impacts from the Project cumulatively with other identified projects would reduce the growth rate of the Lambay Island SPA population by no more than 0.218 % when using the largest collision risk estimate (Table 3-5).

Table 3-5: Growth rates of simulated populations under different impact scenarios for the 25 to 40 years post-construction projections for kittiwake at Lambay Island SPA.

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2050	25	0	0.999	0.966	1.031			
		11.7	0.997	0.964	1.029	0.998	0.947	0.206

Projection year	Years since impact	Additional adult mortalities	Mean growth rate	2.5 percentile of simulated growth rate	97.5 percentile of simulated growth rate	Mean CPGR	Mean CPS	Reduction in growth rate (%)
2055	30	0	0.999	0.968	1.028			
		11.7	0.997	0.966	1.026	0.998	0.938	0.210
2060	35	0	0.999	0.971	1.026			
		11.7	0.997	0.969	1.024	0.998	0.928	0.206
2065	40	0	0.999	0.973	1.024			
		11.7	0.997	0.971	1.022	0.998	0.917	0.218

3.3 Summary

The results from the PVA indicate that the impacts are likely to not result in significant deviation from the baseline conditions with the mean reduction in growth rate <0.5 % for four of the five PVAs undertaken. A mean CPGR of 0.995 or a reduction of growth rate <0.5 % are the same metric. This would be considered insignificant magnitude.

The change in growth rate for herring gull at Ireland’s Eye SPA is predicted to be marginally >0.5 %. The growth rate if predicted to be 0.575 % less in 2065 with the impacted scenario compared to the baseline. This would be considered of low magnitude.

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A.1: SEABIRD PVA PARAMETER LOG

Herring Gull Ireland’s Eye SPA

Basic information
Run had reference name “Herring Gull Ireland’s Eye SPA”
PVA model run type: simplescenarios
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd. I
nclude demographic stochasticity in model?: Yes.
Number of simulations: 5,000. Random seed: 0.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Herring Gull.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National.
Sector to use within breeding success region: Global.
Age at first breeding: 5.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 636 in 2015
Productivity rate per pair: mean: 0.615 , sd: 0.476
Adult survival rate: mean: 0.834 , sd: 0.079
Immatures survival rates:
Age class 0 to 1 - mean: 0.794 , sd: 0.079 , DD: NA
Age class 1 to 2 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 2 to 3 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 3 to 4 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 4 to 5 - mean: 0.834 , sd: 0.079 , DD: NA

Impact scenario inputs
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact scenario outputs
Scenario 1
All subpopulations
Impact on productivity rate mean: 0, se: N/A
Impact on adult survival rate mean: 0.00447, se: N/A

Herring Gull Lambay Island SPA

Basic information
Run had reference name “Herring Gull Lambay Island SPA”
PVA model run type: simplescenarios
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5,000. Random seed: 0.
Years for burn-in: 0.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Herring Gull.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National.
Sector to use within breeding success region: Global.
Age at first breeding: 5.
Is there an upper constraint on productivity in the model?: Yes, constrained to 3 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 1812 in 2015
Productivity rate per pair: mean: 0.615 , sd: 0.476
Adult survival rate: mean: 0.834 , sd: 0.079
Immatures survival rates:
Age class 0 to 1 - mean: 0.794 , sd: 0.079 , DD: NA
Age class 1 to 2 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 2 to 3 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 3 to 4 - mean: 0.834 , sd: 0.079 , DD: NA
Age class 4 to 5 - mean: 0.834 , sd: 0.079 , DD: NA

Impact scenario inputs
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact scenario outputs
Scenario 1
All subpopulations
Impact on productivity rate mean: 0, se: N/A
Impact on adult survival rate mean: 0.00385, se: N/A

Kittiwake Howth Head Coast SPA

Basic information

This run had reference name “Kitti_Howth”.
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 3546 in 2015

Productivity rate per pair: mean: 0.604 , sd: 0.326

Adult survival rate: mean: 0.854 , sd: 0.077

Immatures survival rates:

Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA

Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA

Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts

Number of impact scenarios: 1.

Are impacts applied separately to each subpopulation?: No

Are impacts of scenarios specified separately for immatures?: No

Are standard errors of impacts available?: No

Should random seeds be matched for impact scenarios?: No

Are impacts specified as a relative value or absolute harvest?: relative

Years in which impacts are assumed to begin and end: 2025 to 2065

Impact on Demographic Rates

Scenario A - Name:

All subpopulations

Impact on productivity rate mean: 0 , se: NA

Impact on adult survival rate mean: 0.00235 , se: NA

Kittiwake Ireland's Eye SPA

Basic information
This run had reference name "Kitti_Ireland".
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates
Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1
Initial population values: Initial population 910 in 2015
Productivity rate per pair: mean: 0.604 , sd: 0.326
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA
Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts
Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact on Demographic Rates
Scenario A - Name:
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00274 , se: NA

Kittiwake Lambay Island SPA

Basic information

This run had reference name “Kitti_Lambay”.
PVA model run type: simplescenarios.
Model to use for environmental stochasticity: betagamma.
Model for density dependence: nodd.
Include demographic stochasticity in model?: Yes.
Number of simulations: 5000.
Random seed: 0.
Years for burn-in: 5.
Case study selected: None.

Baseline demographic rates

Species chosen to set initial values: Black-Legged Kittiwake.
Region type to use for breeding success data: Global.
Available colony-specific survival rate: National. Sector to use within breeding success region: Global.
Age at first breeding: 4.
Is there an upper constraint on productivity in the model?: Yes, constrained to 2 per pair.
Number of subpopulations: 1.
Are demographic rates applied separately to each subpopulation?: No.
Units for initial population size: breeding.adults
Are baseline demographic rates specified separately for immatures?: Yes.

Population 1

Initial population values: Initial population 6640 in 2015
Productivity rate per pair: mean: 0.604 , sd: 0.326
Adult survival rate: mean: 0.854 , sd: 0.077
Immatures survival rates:
Age class 0 to 1 - mean: 0.79 , sd: 0.077 , DD: NA
Age class 1 to 2 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 2 to 3 - mean: 0.854 , sd: 0.077 , DD: NA
Age class 3 to 4 - mean: 0.854 , sd: 0.077 , DD: NA

Impacts

Number of impact scenarios: 1.
Are impacts applied separately to each subpopulation?: No
Are impacts of scenarios specified separately for immatures?: No
Are standard errors of impacts available?: No
Should random seeds be matched for impact scenarios?: No
Are impacts specified as a relative value or absolute harvest?: relative
Years in which impacts are assumed to begin and end: 2025 to 2065

Impact on Demographic Rates

Scenario A - Name:
All subpopulations
Impact on productivity rate mean: 0 , se: NA
Impact on adult survival rate mean: 0.00176 , se: NA