Ornithology Valuation Assessment

Gwynt Glas Offshore Wind Farm

November 2022

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Commercial in Confidence

Document history

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1. Introduction

Gwynt Glas Offshore Wind Farm Ltd is exploring siting options for the Gwynt Glas Offshore Wind Farm (Gwynt Glas) in the Celtic Sea. Natural Power has been asked to provide an evaluation of ornithological sensitivities within the Area of Search.

The Gwynt Glas Area of Search is located west of the Bristol Channel, in the Celtic Sea, and consists of an area of approximately 1,500 km^2. The area straddles the boundary between Welsh and English territorial sea limits (Figure 1, Appendix A). The site lies 56 km from the Welsh coast and 45 km from the English coast, at their nearest points.

For the purposes of this ornithological assessment, the Area of Search has been divided into three sub areas, named sub area A (covering Welsh territorial waters), sub area B (English waters: north) and sub area C (English waters: south). Where possible, a comparison has been made between these three sub areas, regarding their relative importance to key ornithological features.

This document comprises the following:

1. Desk-based review of existing ornithological data, including European Seabird at Sea (ESAS) data and seabird tracking data relevant to the Gwynt Glas Area of Search; as well as ornithological data contained within reports available for neighbouring offshore wind farm projects (where available);
2. The site-specific contemporary Digital Aerial Survey (DAS) data collected as part of baseline recording (April to September 2021 inclusive), covering the Gwynt Glas Area of Search and a 4 km surrounding buffer;
3. Additional DAS data to form further baseline recording (October 2021 to March 2022 inclusive) covering the Gwynt Glas Area of Search and a 4 km surrounding buffer;
4. Details of ornithological features of interest;
5. Initial Impact Analysis based on the collected one year baseline; and
6. A summary of the main findings and recommendations.

2. Desk-based Review

A desk study/data search has been undertaken to find existing data that can be used to inform the ornithological sensitivity assessment for Gwynt Glas.

Two other offshore wind farm (OWF) projects are currently being proposed close to Gwynt Glas: Erebus OWF and Valorous OWF (Figure 1, Appendix A). This desk study has looked at these two projects to determine if the baseline data and/or assessments collated so far provide data that is relevant and informative to the Gwynt Glas project.

In addition to these projects, Llŷr 1 and Llŷr 2 (south of the Pembrokeshire coast) and Whitecross (north of the Devon and Cornwall coasts) are three 100-megawatt (MW) demonstration sites currently going through plan-level Habitats Regulations Assessment (HRA), prior to agreements for seabed lease being granted. Due to the early stage of these developments, no data is yet available and these projects are not discussed further.

The desk study has also looked at existing seabird data that has been gathered over many years through at sea surveys across the wider area and through tracking of seabirds from specific breeding colonies. Details of these data searches are provided below.

2.1. Erebus Offshore Wind Farm

The proposed Erebus floating offshore wind farm project lies to the north of Gwynt Glas. The planning application for Erebus was submitted in December 2021 and thus the associated documentation[1], including the Offshore Ornithology chapter of the Environmental Statement (ES), was available to consult as part of the desk-based review. The project shall consist of between six and 10 wind turbines and have a capacity of up to 100 MW. The Erebus site is relatively small in extent (43 km^2) and, importantly, it lies closer to the Welsh coast than Gwynt Glas (35 km from the Pembrokeshire coastline). Despite these differences, the baseline data collected for Erebus provides a useful resource when identifying the potential key ornithological features that may need to be considered for an offshore wind farm in the eastern part of the Celtic Sea.

Baseline Surveys and Assessment

The Erebus site was surveyed using data collected by 24 months of DAS (October 2019 to September 2021 inclusive). In addition, specially commissioned reports were produced to inform the assessment, covering:

- An analysis of tracking data from the Grassholm gannet project (Heriot Watt University);
- Guillemot long-term survival data from Skomer (University of Sheffield); and
- An analysis of OxNav Manx shearwater tracking data (University of Oxford).

The latter report also included expert opinion in regard to the importance of the area for Balearic shearwater.

Main Findings

Based upon the results of the baseline surveys, the key ornithological features were considered to be: northern fulmar (fulmar), Manx shearwater, gannet, herring gull, lesser black-backed gull, black-legged kittiwake (kittiwake), puffin, common guillemot (guillemot) and razorbill.

The other seabird species recorded, but which were only recorded infrequently and were considered to be transient, or to have a more inshore distribution, were: great skua, black-headed gull, common gull, Sabine's gull, little gull, Sandwich tern, common tern and Arctic tern.

Two other species were assessed in the impact assessment, despite not being recorded during baseline surveys: Balearic shearwater and storm petrel. This was the result of pre-application discussions with Natural Resources Wales (NRW), the Joint Nature Conservation Committee (JNCC), the Royal Society for the Protection of Birds (RSPB) and the Wildlife Trust of South and West Wales (WTSWW).

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[1] Available at: Document Library | Blue Gem Wind [last accessed 03/02/2022]

The Erebus ecological impact assessment (EcIA) concluded negligible or minor adverse impacts, and no significant effects, on all ornithological features. The cumulative impact assessment also concluded no significant effect on all ornithological features.

As well as the ES, the Erebus project produced a *Habitats Regulations Assessment: Report to Inform Appropriate Assessment* (MarineSpace Ltd, 2021)[1]. Breeding species that were taken forward to Stage 2 (Assessment) were: gannet, Manx shearwater, lesser black-backed gull, kittiwake, guillemot, razorbill and puffin. Balearic shearwater and storm petrel were also taken forward to Stage 2 following consultation.

Potential connectivity between these species and breeding seabird SPAs (using foraging ranges) identified 152 SPA sites. A site-specific apportioning analysis was undertaken, and this concluded that, for all the species considered, a proportional weight for the closest SPA was >0.8, and for the second closest SPA, the proportional weight was <0.04. Therefore, effects to any SPA other than the closest, were considered to be negligible.

Skomer, Skokholm and the Seas off Pembrokeshire SPA was the closest SPA for most of the considered species. The proportional weight for each species (i.e. the proportion of individuals recorded on site considered to have come from this SPA) were: puffin (0.997), Manx shearwater (0.995), lesser black-backed gull (0.978), razorbill (0.892), kittiwake (0.817) and guillemot (0.754). For gannet, the closest SPA was Grassholm (0.995 proportional weight).

Following assessment of these species, for the potential impacts identified, it was determined for all ornithological features that are designated features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA that there was no potential for adverse effect on integrity. The in-combination assessment also determined no potential for an in-combination adverse effect on integrity. The same conclusions were made for Grassholm SPA. Note that both guillemot and gannet were subject to Population Viability Analysis as part of the assessment.

The Irish Sea Front SPA was also assessed, as one of its conservation objectives is to “ensure access to the site from linked breeding colonies”. No potential for an adverse effect on integrity was concluded.

It is understood that the Ornithology chapter is currently under review with regulators and further information has been requested by the Statutory Nature Conservation Bodies.

2.2. Valorous Offshore Wind Farm[2]

Scoping Report

The Scoping Report[3] for the proposed Valorous OWF was produced in early 2021. This site lies adjacent to Erebus, to the north of the Gwynt Glas development area. The Valorous project has an outline area of interest of c.155 km^2 and lies approximately 47 km south-west of the Pembrokeshire coast. Capacity of the project shall be up to 300 MW and shall consist of between 18 and 31 wind turbines.

The Scoping Report states that baseline surveys shall consist of monthly DAS beginning in March or April 2021 and, therefore, these surveys had not begun at the time the Scoping Report was written. Hence, no site-specific baseline data is presented in this scoping document.

A desk-based study was undertaken, however. A search of ESAS data determined that the Valorous array area is important in the breeding season for Manx shearwater, gannet, kittiwake and puffin. In winter, the site is likely to be of importance for guillemot, with an extensive area further offshore, to the south-west, considered to be of interest for its large numbers of wintering lesser black-backed gulls. Data from tracking studies showed the area is used extensively by razorbill and is also used frequently by puffin. The possibility of species of tern being recorded during migration times is also highlighted.

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[2] Should the baseline information be published in the relevant EIA Chapter within a timely manner, this information will be incorporated to inform on this assessment

[3] Available from: Microsoft Word - VAL-CON-MAR-REP-ENV-0002 Scoping Report B01 (bluegemwind.com) [last accessed 03/02/2022]

Scoping Response

Regarding offshore ornithology, the Scoping Response[4] does not offer much guidance in relation to Gwynt Glas, as without having baseline data to comment upon, all ornithological features require 'scoping in' to the ES. However, of interest is a comment from the RSPB that Balearic shearwater also be included in the EIA, as this species is 'critically endangered' and is known to occur in the Celtic Sea.

2.3. Llŷr Offshore Wind Farm[2]

Scoping Report

The Scoping Report[5] for the proposed Llŷr OWF was produced in April 2022. The site, consisting of two adjacent array areas known Llŷr 1 and Llŷr 2, lies adjacent to Erebus, to the north of Gwynt Glas. The Llŷr project has an outline area of interest of 50 km^2 and lies approximately 31 km from the Welsh coastline. The capacity of the project will be up to 200 MW and consist of between 10 and 17 floating wind turbines.

The Scoping Report states that 24 months of monthly DAS surveys will be used to characterise the baseline data, however no specific date ranges were mentioned in the report and no DAS data is provided. Hence, no site-specific baseline data is presented in this scoping document.

Identified in the Scoping Report was that the OWF will pass directly through the Skomer, Skokholm and the Seas off Pembrokeshire SPA, designated for its Manx shearwater, storm petrel, puffin and lesser black-backed gull, as well as a wider seabird assemblage. The Scoping Report also included potential impacts to birds not yet included in the current Gwynt Glas assessment, such as attraction of nocturnal seabirds (e.g. petrels and shearwater) to project infrastructure lighting and increased entanglement risk to diving seabirds from ghost fishing gear catching on project infrastructure.

Scoping Response

Regarding offshore ornithology, the Scoping Response[5] does not offer much guidance in relation to Gwynt Glas, as without having baseline data to comment upon, all ornithological features require 'scoping in' to the ES. RSPB comments regarding Balearic Shearwater were also mentioned within this document as per the Valorous project.

2.4. White Cross Offshore Wind Farm[2]

Scoping Report

The Scoping Report[6] for the White Cross Offshore Wind Farm was produced in January 2022. The site, consisting of up to eight floating turbines to deliver up to 100MW, is located over 52 km off the North Cornwall and North Devon coast. The scoping report includes an initial 12 months of DAS data, as surveys commenced in July 2020 and were completed in June 2021.

Main Findings

Based upon the results of the baseline surveys, the key ornithological features were considered to be: common tern, northern fulmar (fulmar), gannet, great black-backed gull, common guillemot (guillemot), herring gull, black-legged kittiwake (kittiwake), lesser black-backed gull, Manx shearwater, puffin, razorbill and sandwich tern. The most abundant species group were shearwaters, recorded during July and August 2020, as well as March to June 2021(almost all Manx shearwater from Skomer, Skokholm and the Seas off Pembrokeshire SPA).

In addition to the offshore ornithology receptors identified to species level and reported above, a further nine species groups were identified. These were common or Arctic ("commic") tern, auk or shearwater, unidentified auk, black-

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[4] Available from: Public register - Customer Portal (naturalresources.wales) [last accessed 03/02/2022]

[5] Available from: Public register - Customer Portal (naturalresources.wales) [last accessed 20/10/2022]

[6] Available from: PC2978_RHD-ZZ-XX-RP-Z-0009-White-Cross-Offshore-Windfarm-EIA-Scoping-Report.pdf (whitecrossoffshorewind.com) [last accessed 21/10/2022]

backed gull species, unidentified large gull, unidentified shearwater, unidentified small gull, storm-petrel and unidentified tern.

2.5. Waggit *et al*. (2019) Data

Waggitt *et al*. (2019) produced distribution maps for a number of seabird (and marine mammal) species in the north-east Atlantic, by compiling and standardising data from dedicated aerial and vessel surveys, undertaken between 1980 and 2018. They were able to model distribution maps for 12 bird species: fulmar, Manx shearwater, storm petrel, shag, gannet, great skua, kittiwake, herring gull, lesser black-backed gull, puffin, guillemot and razorbill. The outputs display distribution/density maps at 10 km and calendar month resolution, and these have been used to inform this assessment.

To create the figures that are presented within this report, the mean distribution of each species was calculated for each season, using the 'mosaic raster layers' tool in QGIS. The output of this was then clipped to the area of interest. In order to standardise the maps for each of the species, the minimum and maximum averages for all the seasons were then applied to all maps for that species. The resolution of the figures uses a 10 km^2 scale, however densities are shown as birds per km^2.

It should be noted that because of the way the figures in Waggitt *et al*. were produced, the density figures presented in this report generally show the same distribution of birds in all seasonal maps shown for that species, when in reality there is likely to be variation between the breeding and non-breeding seasons. Also, in Natural Power's experience, the densities given in Waggitt *et al*., have been shown to be under-estimates in some cases. However, this still remains a very useful resource in determining relative densities and distributions of seabirds in the waters around the UK.

2.6. Seabird Tracking Database

The Birdlife International seabird tracking database[7] includes data of seabirds tracked at sea, using GPS tags attached to birds from UK breeding colonies. Tracking data of relevance to Gwynt Glas includes data for gannets tagged on Grassholm and puffins, kittiwakes and razorbills tagged on Skomer.

2.7. Literature Search

In addition to the data sources listed above, other relevant published papers have been cited, where this provides further information regarding the distribution or ecology of the ornithological features identified as being of interest in relation to the Gwynt Glas project.

3. Baseline DAS Data

The current programme of digital aerial surveys, undertaken as part of baseline recording, began in April 2021 and will continue until March 2023. Each survey uses 25 parallel transects, running in a north-west to south-east orientation, to cover the array area, plus a 4 km surrounding buffer.

Data available for April 2021 to March 2022 (inclusive) (covering the breeding, post-breeding and over wintering seasons) is presented within this document. In March 2022, the boundary of the survey area was shifted ~4 km to the east to avoid a shipping channel following consultation with a Navigational Consultant. The 4 km buffer applied to the survey area ensures that the original boundary extent is still completely covered.

The programme of surveys aims to collect data for the site and buffer once per calendar month, where weather conditions allow. In months in which a survey was not possible, the survey shall be completed as soon as possible in the following month.

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[7] Available from: Seabird Tracking Database [last accessed 09/02/2022]

During the first iteration of this report (issued April 2022) data collected during surveys undertaken in the period April to September 2021 (inclusive) was summarised. In that period six DAS were carried out. In this, the second iteration of this report, additional data collected during the period October 2021 to March 2022 (inclusive, a further six DAS) is incorporated. Details of the times and dates on which the twelve DAS informing this report were conducted are provided in Table 3.1.

Table 3.1 - Dates and times of DAS undertaken April 2021 to March 2022

Survey Number	Date	Time
1	20 April 2021	08:59 – 12:49
2	19 May 2021	08:31 – 12:26
3	29 June 2021	08:33 – 14:26
4	22 July 2021	08:50 – 12:18
5	2 September 2021*	08:03 – 11:38
6	15 September 2021	07:56 – 11:36
7	23 October 2021	08:50 – 12:45
8	24 November 2021	09:55 – 13:25
9	06 December 2021	10:30 – 14:00
10	21 January 2022	10:20 – 13:30
11	26 February 2022	08:50 – 12:40
12	31 March 2022	09:10 – 13:25

*Source: HiDef. * due to weather, the August survey was undertaken in early September*

Table 3.2 provides an overview of all species recorded during the DAS campaign April 2021 to March 2022. The raw data has been filtered to remove records of birds that lie outside the site boundary and 4 km buffer. In the table, 'September (I)' refers to the 2 September 2021 survey and 'September (II)' refers to the 15 September 2021 survey. Those species that totalled ≥100 records are marked in bold.

Table 3.2 - Summary of bird records (April 2021 to March 2022)

Species	Total No. of Records	Survey with Peak Count	Peak Count
Arctic skua	2	April	2
Arctic tern	4	April	4
Black-headed gull	1	February	1
Common gull	16	November	10
Common tern	15	April	15
Fulmar	**250**	**January**	**49**
Gannet	**1679**	**April**	**454**
Great black-backed gull	76	November	31
Great skua	2	-	1
Guillemot	**6429**	**January**	**1233**
Herring gull	**240**	**July**	**78**
Kittiwake	**1970**	**November**	**696**
Lesser black-backed gull	**274**	**July**	**98**
Little gull	3	April	2

Species	Total No. of Records	Survey with Peak Count	Peak Count
Manx shearwater[8]	**5537**	**June**	**2089**
Puffin	**263**	**April**	**92**
Razorbill	**459**	**February**	**230**
Sabine's gull	1	September (I)	
Storm petrel	**202**	**September (II)**	**193**
Arctic/common tern	5	April	4
Auk species	47	September (II)	27
Auk/shearwater species[8]	52	September (II)	23
Auk/small gull species	3	June	3
Fulmar/gull species	7	May	4
Guillemot/razorbill	31	April	20
Gull species	3	-	1
Large gull species	18	July	8
Small bird species	1	April	
Tern species	1	September (II)	
Wader species	5	July	5

Source: HiDef

In Section 4, the number and density of the key ornithological features are presented for the Gwynt Glas Area of Search, the 4 km surrounding buffer and for the three sub areas. Densities have been calculated using the assumption that the area covered by the video imaging collected during the DAS ('strip width') is 250 m.

[8] To note: No Balearic shearwaters have been recorded during the survey period, however the JNCC flagged that they could be found in the Celtic Sea through winter as they transfer regions and can be difficult to ID from Manx shearwater

4. Ornithological Features of Interest

Based upon the site-specific baseline DAS, completed during April 2021 to March 2022, the following species have been identified as being potential ornithological features of interest at Gwynt Glas: fulmar, Manx shearwater, storm petrel, gannet, herring gull, lesser black-backed gull, puffin and guillemot. These species were recorded most frequently (≥100 records) and are considered likely to require full assessment in the EIA. In the first six months of DAS, kittiwake and razorbill were recorded in relatively small numbers, however they were recorded in much greater numbers in the second six-month period (post-breeding and wintering periods) and these two species are also now considered to be ornithological features of interest (≥100 records).

Finally, Balearic shearwater should also be included in the list of ornithological species of interest. Although not recorded during the baseline DAS completed in April 2021 to March 2022, the consultee responses in relation to both Erebus and Valorous OWFs highlight the conservation status of this species (critically endangered) and the potential for this species to utilise the eastern Celtic Sea.

The seabird species listed above are described in detail in this section of the document.

It should be noted that the list of ornithological features assessed in this section is not comprehensive. Other species have been recorded in small numbers in the baseline surveys (Table 3.2) and it is possible that the status of these species may change as the programme of baseline surveys continues, or that further species may be recorded. Of the other species listed in Table 3.2, great black-backed gull is the next most abundant species, after those listed above and may also require consideration in future.

An important point to consider is that the conservation status of the potential ornithological features of interest identified (or other species) may change, particularly in response to the highly pathogenic avian influenza (HPAI) outbreak which has been impacting UK seabird populations since the 2022 breeding season. The magnitude of impacts of the HPAI outbreak on these bird populations is currently unknown.

4.1. Determining Reference Populations of Ornithological Features

For most seabird species there are a number of years after fledging before a bird becomes sexually mature, and not all adult birds may breed in any given year. Even so, the majority of seabirds recorded on site during that species' breeding season can be considered to be breeding birds. An assessment of impacts therefore needs to identify the likely source of the breeding birds on site in order to determine i) the size of the population utilising the site, compared to the size of the breeding population from which these birds are drawn, and ii) any potential connectivity with SPAs that have breeding seabirds as a designated feature.

To determine whether a site has potential connectivity with an SPA, the mean maximum foraging distance is commonly used. A more precautionary approach is to use mean max foraging distance plus one standard deviation (+1SD) and this measure is now the one usually requested by consultees. This data is provided in Woodward *et al*. (2019).

Table 4.1 lists the SPAs with potential connectivity to the Gwynt Glas Area of Search, based upon the foraging distance of the ornithological features of interest. For all species, except fulmar, mean max foraging distance +1SD has been used to identify SPAs. The extensive foraging range of fulmar (1,200 km, if using mean max +1SD) means that a very large number of SPAs fall within this area. However, as the impacts apportioned to these distantly located designated sites would be negligible in magnitude, consideration is restricted to mean maximum foraging distance for this species.

The SPAs are located in the four nations of the UK, as well as Ireland and France. Table 4.1 should not be regarded as a complete list of all colonies, but rather its inclusion in this document is to provide an illustration as to the magnitude of the breeding population against which those in the site should be assessed. Only SPAs are listed, but other sites with a statutory designation, and which include breeding seabirds in their citation, shall also lay within these search areas (for example Lundy Site of Special Scientific Interest (SSSI)).

The populations stated in Table 4.1 are those given in the SPA citation. The number of breeding birds may now differ from these values. 'Prs' refers to population sizes, estimated by numbers of pairs, and 'ind' refers to population sizes, estimated by the number of individuals. Distances are not the shortest distance between the proposed development site and the protected area, but rather the minimum distance 'by sea' that a seabird would need to travel to move between the two sites without crossing land.

One SPA lies very close to the option area (Skomer, Skokholm & the Seas of Pembrokeshire SPA) and the location of this in relation to Gwynt Glas is shown on Figure 1, Appendix A.

Table 4.1 – Special Protection Areas (SPAs) within foraging distance of Gwynt Glas Area of Search

Species	Within Woodward *et al*. mean max foraging range			Beyond Woodward *et al.* mean max foraging range, but within Woodward *et al*. mean max foraging range plus one S.D.		
	SPA	Distance	Population	SPA	Distance	Population
Fulmar (542.3 ± 657.9 km)	Saltee Islands	112 km	525 prs	Only mean maximum foraging distance included for fulmar.		
	Wicklow Head	192 km	62 prs			
	Howth Head	237 km	33 prs			
	Ireland's Eye	241 km	70 prs			
	Lambay Island	250 km	635 prs			
	Côte de Granit Rose-Sept Iles	261 km	90 prs			
	Cap Sizun	311 km	19 prs			
	Bull & Cow Rocks	315 km	40 prs			
	Deenish Island & Scariff Island	329 km	385 prs			
	Skelligs	342 km	806 prs			
	Blasket Islands	369 km	3,000 prs			
	Dingle Peninsula	374 km	1,016 prs			
	Kerry Head	429 km	421 prs			
	Cliffs of Moher	491 km	3,566 prs			
	Littoral Seino-Marin	485 km	356 prs			
	Inishtrahull	531 km	95 prs			
	High Island, Inishshark & Davillaun	535 km	830 prs			
	Total	**11,949 prs (23,898 ind)**				
Manx shearwater (1346,8 ± 1018.7 km)	Skomer, Skokholm & the Seas of Pembrokeshire	2.88 km	150,968 prs	No additional sites.		
	Aberdaron Coast & Bardsey Island	167 km	6,930 prs			
	Côte de Granit Rose-Sept Iles	261 km	340 prs			
	Deenish Island & Scariff Island	329 km	2,311 prs			

Species	Within Woodward *et al*. mean max foraging range			Beyond Woodward *et al.* mean max foraging range, but within Woodward *et al.* mean max foraging range plus one S.D.		
	SPA	**Distance**	**Population**	**SPA**	**Distance**	**Population**
	Skelligs	342 km	23,500 prs			
	Blasket Islands	369 km	3,000 prs			
	Copeland Islands	383 km	4,800 prs			
	Rum	650 km	61,000 prs			
	Total	**250,149 prs (500,298 ind)**				
	Note also the Irish Sea Front SPA is used by breeding Manx shearwaters (12,039 individuals), which is 266 km from the site.					
Storm petrel (336 km)	Skomer, Skokholm & the Seas of Pembrokeshire	2.88 km	3,500 prs	Not applicable (same as mean max).		
	Isles of Scilly	91 km	1,318 prs			
	Côte de Granit Rose-Sept Iles	260 km	119 prs			
	Bull & Cow Rocks	315 km	3,500 prs			
	Deenish Island & Scariff Island	329 km	1,400 prs			
	Total	**9,837 prs (19,674 ind)**				
Gannet (315.2 ± 194.2 km)	Grassholm	53 km	33,000 prs	Skelligs	342 km	29,683 prs
	Saltee Islands	112 km	2,446 prs	Ailsa Craig	445 km	23,000 prs
	Bull & Cow Rocks	315 km	3,694 prs			
	Total	**39,140 prs (78,280 ind)**		**Total**	**52,683 prs (105,366 ind)**	
Herring gull (58.8 ± 26.6 km)	None			None		
Lesser black-backed gull (127 ± 109 km)	Skomer, Skokholm & the Seas of Pembrokeshire	2.88 km	20,300 prs	No additional sites.		
	Isles of Scilly	91 km	2,461 prs			
	Saltee Islands	112 km	175 prs			
	Total	**22,936 prs (45,872 ind)**				
Kittiwake (156.1 ± 144.5 km)	Skomer, Skokholm & the Seas of Pembrokeshire	2.88 km	Part of 'seabird assemblage' (1015 prs[9])	Wicklow Head	191 km	956 prs
	Saltee Islands	112 km	2,125 prs	Howth Head	237 km	2,329 prs

[9] Count taken from 2022 count sea bird monitoring Seabird Monitoring Programme | JNCC (bto.org)

Species	Within Woodward *et al*. mean max foraging range			Beyond Woodward *et al.* mean max foraging range, but within Woodward *et al.* mean max foraging range plus one S.D.		
	SPA	**Distance**	**Population**	**SPA**	**Distance**	**Population**
	Helvick Head to Ballyquin	149 km	1,037 prs	Ireland's Eye	241 km	941 prs
				Lambay Island	250 km	4,091 prs
	Total		**4,177 prs (8,354 ind)**	**Total**		**8,317 prs (16,634 ind)**
Puffin (137.1 ± 128.3 km)	Skomer, Skokholm & the Seas of Pembrokeshire	2.88 km	9,500 prs	Lambay Island	250 km	132 prs
	Saltee Islands	112 km	911 prs			
	Total		**10,411 prs (20,822 ind)**	**Total**		**132 prs (264 ind)**
Guillemot (73.2 ± 80.5 km)	Skomer, Skokholm & the Seas of Pembrokeshire	2.88 km	Part of 'seabird assemblage' (29,744 ind)	Saltee Islands	112 km	21,436 ind
	Total		**29,744 ind**	**Total**		**21,436 ind**
Razorbill (88.7± 75.9 km)	Skomer, Skokholm & the Seas of Pembrokeshire	2.88 km	Part of 'seabird assemblage' (10,694 ind)	Saltee Islands	112 km	5,200 ind
	Total		**10,694 ind**	**Total**		**5,200 ind**

In addition to the SPAs listed in the table, there are two Ramsar sites on the Channel Islands that are also of relevance. The Channel Islands, having always been outside the EU, have not designated any Natura 2000 sites.

Herm, Jethou and The Humps: this Ramsar site is 327 km from the proposed site. The seabird assemblage includes fulmar (30 apparently occupied nests (AON)), Manx shearwater (15 AON) and storm petrel (0-10 AON).

Alderney West Coast and the Burhou Islands: this Ramsar site is approximately 333 km from the proposed site. The seabird assemblage includes gannet (5,950 pairs) and storm petrel (110 pairs).

For much of the year seabirds are absent from the colonies at which they breed. The time spent away from the breeding location is species dependent. Some species, such as Manx shearwater, winter far from UK waters; whilst others, such as guillemot, may undertake shorter movements. Such movements may take breeders from colonies in the north of the UK to wintering grounds in the southern UK, for example. The movement of birds between breeding and wintering areas may follow predictable routes. Using this information, it is possible to assess birds recorded on site at these other times of year against a reference population.

Table 4.2 provides the Biologically Defined Minimum Population Scale (BDMPS) for the ornithological features of interest, as given in Furness (2015). The relevant geographical areas in relation to Gwynt Glas are either 'UK Western Waters' or 'UK Western Waters plus Channel'. Note that this data is not available for storm petrel.

Table 4.2 – Biologically Defined Minimum Population Scales (BDMPS)

Species	BDMPS – Period and Reference Population (no. of individuals)		
	Autumn Migration	Non-breeding	Spring Migration
Fulmar	September to October 828,194*	November 556,367*	December to March 828,194*
Manx shearwater	August to October	n/a	March to May

Species	BDMPS – Period and Reference Population (no. of individuals)		
	Autumn Migration	Non-breeding	Spring Migration
	1,580,895*		1,580,895*
Gannet	September to November 545,954**	n/a	December to March 661,888**
Herring gull	n/a	September to February 173,299**	n/a
Lesser black-backed gull	August to October 163,304**	November to February 41,159**	March to April 163,304**
Kittiwake	August to December 911,586*	n/a	January to April 691,526*
Puffin	n/a	August to March 304,557**	n/a
Guillemot	n/a	August to February 1,139,220**	n/a
Razorbill	August to October 606,914**	November to December 341,422**	January to March 606,914**

*UK Western Waters plus Channel

** UK Western Waters

Source: Furness (2015)

Due to the presence of Avian Influenza impacting populations since the 2022 breeding season, there is the possibility that the reference populations mentioned in this report may change, potentially to a significant extent. The United Kingdom is home to many internationally and nationally important seabird colonies, of which many have had the presence of HPAI confirmed, such as the Grassholm gannet colony. The lasting impacts of how this pathogen will affect these species is unknown.

4.2. Assessment of Risk

The two main impacts of offshore wind farms upon seabirds are potential for collision (injury or fatalities through contact with infrastructure) and potential for displacement (avoidance of the area resulting in, for example, a loss of foraging grounds). The sensitivity to these impacts varies between species. Species which fly low to the sea's surface (such as Manx shearwater) are at less risk of collision than species that more regularly fly at turbine rotor height (such as gannet). Species that are tolerant and adaptable (such as large gulls) shall be at less risk of displacement than species that are highly sensitive to human activity (such as some species of seaduck).

Furness *et al*. (2013) undertook an assessment of a large suite of bird species found in the offshore environment to allocate a risk score based upon that species perceived sensitivity to the risks of collision and displacement. This data has been used to present sensitivities for the ornithological features of interest (Table 4.3).

Ornithological features with a collision risk score ≥500 are considered in Furness *et al*. (2013) to have high collision sensitivity. However, two of the ornithological features listed (Manx shearwater and guillemot) have been highlighted in yellow in Table 4.3. A precedence was set for the Erebus project when, as a result of consultation, these two ornithological features were assigned as having high sensitivity to collision risk and both species were taken through for full assessment. This appears to have been a result of the perceived importance of the site for these species, rather than a true reflection of their collision risk.

For two species, kittiwake and gannet, contemporary EIA / HRA of OWF in English and Welsh waters present evidence to contradict the displacement sensitivities from Furness *et al*. (2013). Where gannet displacement sensitivity is summarised as low in Furness *et al*. (2013) (marked in red in Table 4.3), the sensitivity of this receptor to displacement is considered high in contemporary assessments. Conversely, where kittiwake displacement sensitivity is summarised as high in Furness *et al*. (2013) (marked in green in Table 4.3), the sensitivity of this receptor to displacement is considered low in contemporary assessments. An example of the treatment for these species can be seen in the Awel y Môr Offshore Ornithology Chapter of the Environmental Impact Assessment Report (EIAR)[10].

Also, in the ES of the Erebus project, although fulmar, herring gull and lesser black-backed gull were scoped out for displacement affects due to their low sensitivity, Manx shearwater and storm petrel (highlighted in Table 4.3) were taken through for full assessment as a result of responses from consultees, despite also being ornithological features usually considered to be at low risk of displacement.

Table 4.3 - Index of sensitivity (risk score and sensitivity level) to collision and displacement

Species	Collision*		Displacement**	
	Risk Score (Index)	Sensitivity	Risk Score (Index)	Sensitivity
Fulmar	48	Low	2	Low
Manx shearwater	0	Low	2	Low
Storm petrel	91	Low	2	Low
Gannet	725	High	3	Low [subsequently **high**]
Herring gull	1306	High	3	Low
Lesser black-backed gull	960	High	3	Low
Kittiwake	523	High	6	High [subsequently **low**]
Guillemot	37	Low	14	High
Razorbill	32	Low	14	High
Puffin	27	Low	10	High

* Collision index scores for the full list of assessed species were values between 0 and 1306.

** Displacement index scores for the full list of assessed species were values between 0 and 32.

Source: Furness et al. (2013)

4.3. Impact Analysis

For For species that are sensitive to displacement and/or collision impacts, initial impact analyses based on the collected one year baseline were run. The analyses should be considered preliminary, as the final assessment (as used in the ES) will use the full DAS dataset. The analyses utilised the hypothetical worst-case scenario of wind farm design parameters, to produce the most conservative estimate of the impacts to the bird species. Band Option 2 modelling, consisting of a basic model that uses the proportion of birds at risk height derived from species-specific flight height distributions provided in Johnstone et al., 2014, was undertaken, and the design and species specifics can be found in Tables 4.4 and 4.5 below.

Table 4.4 – Windfarm Design Parameters used in the CRM

Turbine Specifications	
Air gap (metres)	30
Tidal offset (metres)	Zero offset assumed at this stage

[10] Available from: Volume 2, Chapter 4: Offshore Ornithology (awelymor.cymru) [last accessed 17/11/2022]

Number of turbines	66
Number of blades	3
Maximum chord (blade width; metres)	6.5
Pitch (degrees; including Standard Deviation)	6 degrees
Rotation speed (RPM; including Standard Deviation)	Default, 7.8
Rotor radius (metres)	118

Percent of Time in Operation												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Wind Availability (%)	91.70	91.70	84.95	81.85	80.00	80.85	79.30	82.80	87.00	93.00	89.00	90.10
Downtime (%)	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59	5.59

Table 4.5 – Species Specific Parameters used in the CRM

Parameter Used	Gannet	Herring Gull	Lesser Black-backed Gull	Kittiwake
Avoidance Rate (Standard Deviation)	0.98 (0)	0.995 (0)	0.995 (0)	0.0989 (± 0.001)
Flight Speed (metres/second; Standard Deviation)	14.9 (±1.5)	12.8 (0)	12.8 (0)	13.1 (±1)
Nocturnal Activity Proportion (Standard Deviation)	0.25 (±0.0045)	0.6 (0)	0.6 (0)	0.033 (±0.0045)
Wingspan (Metres; Standard Deviation)	1.72 (±0.04)	1.44 (±0.03)	1.43 (±0.0375)	1.08 (±0.0625)
Body Length (Metres; Standard Deviation)	0.94 (±0.005)	0.595 (±0.0225)	0.58 (±0.03)	0.39 (±0.005)

Species specific proportion of displacement and proportion of mortality were used to predict the most appropriate conservative mortality values from the displacement matrixes (presented in Appendix B) and can be found in Table 4.6 below. These values follow precedent from displacement analyses undertaken for contemporary English and Welsh OWF Impact Assessments such as Awel y Môr.

Table 4.6 – Species Specific Proportion of Displacement and Proportion of Mortality Values

Species	Displacement Proportion (%)	Mortality Proportion (%)
Manx shearwater	30	3
Gannet	80	3
Puffin	70	5
Guillemot	70	5
Razorbill	70	5

4.4. Species Account: Fulmar

Erebus OWF data

Density estimates are not presented in the ES. Peak numbers are presented and these show that the highest numbers of fulmar were recorded in the non-breeding season (peak of 537 individuals recorded in November 2019). Numbers were much lower in the breeding season, with the highest numbers being between four (April 2020) and 16 individuals (September 2020).

White Cross OWF data

Fulmars were recorded in the study area in seven of the 12 monthly surveys and densities were generally low; around 0.2 birds/km^2 or less for all months except December 2020 where the density was 1.83 birds/km^2.

Waggitt *et al*. (2019) data

Density maps for fulmar across the spring migration (December to March), breeding (April to August), autumn migration (September and October) and non-breeding (November) periods, using the data presented by Waggitt *et al*. (2019), can be seen in Figure 2, Appendix A. The figure shows low densities of fulmar within the Gwynt Glas Area of Search in all seasons, but there is evidence of the largest numbers of fulmar being present in the north-west of the Area of Search and lowest numbers being in the south-east of the Area of Search.

Baseline DAS data

Small numbers of fulmar were recorded on all surveys (April 2021 to March 2022), with fewest recorded post-breeding. Tables 4.7 and 4.8 present the number of records and estimated density (birds/km^2) of fulmar per survey, respectively.

Table 4.7 - Fulmar numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	13	3	1	1	1	1	0	1	12	1
May	9	4	7	1	2	0	1	0	6	4
June	2	1	3	1	0	0	2	0	0	1
July	12	2	23	6	0	0	3	0	9	2
Sept I.	3	1	2	1	0	0	0	0	3	1
Sept II.	2	0	2	0	0	0	1	0	1	0
Oct.	0	0	0	0	0	0	0	0	0	0
Nov.	20	4	2	10	2	1	0	0	18	3
Dec.	0	11	0	13	0	0	0	3	0	8
Jan.	36	6	5	2	7	3	1	0	28	3
Feb.	0	6	3	5	0	1	0	4	0	1
Mar.*	13	12	1	1	1	0	1	9	10	4

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.8 - Fulmar density (birds/km2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0.14	0.03	0.02	0.02	0.04	0.04	0.00	0.03	0.38	0.03
May	0.10	0.04	0.11	0.02	0.07	0.00	0.03	0.00	0.19	0.13
June	0.02	0.01	0.05	0.02	0.00	0.00	0.06	0.00	0.00	0.03
July	0.13	0.02	0.37	0.10	0.00	0.00	0.10	0.00	0.28	0.06
Sept. I	0.03	0.01	0.03	0.02	0.00	0.00	0.00	0.00	0.09	0.03
Sept. II	0.02	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.03	0.00
Oct.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov.	0.02	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.06	0.01
Dec.	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.03
Jan.	0.04	0.01	0.00	0.00	0.03	0.01	0.00	0.00	0.09	0.01
Feb.	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Mar.	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01

Source: HiDef/Natural Power

Figures 3 and 4, Appendix A, present the distribution of fulmar records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively. Overall, the data suggests a southerly bias to the records, with most sightings coming from sub area C across both periods.

Impact Analysis

Fulmar are not considered to be sensitive to displacement or collision mortality effects, as per Table 4.3. For this reason, neither displacement or collision mortality impacts analysis were run and no key sensitivities in terms of this species are expected.

Summary

Overall numbers: Low numbers recorded during period April 2021 to September 2021 and also during period October 2021 to March 2022.

Sub area variation: Most records were from sub area C for both periods (but low in all sub areas).

Seasonal variation: As per Furness, 2015, fulmar have four distinct bio-seasons per year: the migratory free breeding season (MFBS) (April to August; 11,949 pairs [11]), the autumn migratory period (September to October; regional population = 828,194 individuals), winter period (November; regional population = 556,367 individuals) and the spring migratory period (December to March; regional population = 828,194 individuals). The most consistent numbers of fulmar were recorded in the non-migratory breeding season, and reduced numbers during the autumn and spring migration.

Assessment of risk: Low risk. Fulmar is at low risk of collision and displacement and was recorded in small numbers. The total observed number of fulmar within the site and buffer during surveys undertaken within the autumn (4 individuals), spring (112 individuals) and winter (36 individuals) seasons all equate to less than 0.01% of the regional seasonal populations. The number of observed fulmar between April and August (Sep I), 96 individuals, makes up less than 0.40% of the regional seasonal population (based on populations accounted for without a standard deviation due to large foraging ranges).

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

[11] See Table 4.1 for breeding populations of colonies considered to have potential connectivity.

Confidence in assessment: High confidence.

4.5. Species Account: Manx shearwater

Erebus OWF data

Density estimates are presented in the ES for Manx shearwater and these show that the largest numbers were recorded in the Erebus OWF survey area in the core breeding season for this species, with lower numbers in the autumn and spring migration periods. Manx shearwater was not recorded in the winter period. Density estimates were: 14.08 birds/km^2 (migration-free breeding); 5.09 (autumn migration) and 0.16 (spring migration). The peak count was made in July (918 individuals in July 2020).

OxNav data of birds tracked from Skomer, Skokholm and Seas off Pembrokeshire SPA showed 21% of tracked Manx shearwaters used the Erebus OWF survey area (array plus 4 km buffer). Tracking showed that the time of day in which birds used the survey area varied through the breeding season. The peak was in the evening (17:00-21:00) in the pre-incubation phase; the peak was in the early morning (02:00-07:00) during incubation; and it was throughout the day (peak 10:00) during the chick-rearing stage. This data suggests that, because aerial surveys can be completed in a matter of hours, the time of day covered by the survey may influence the number of Manx shearwaters recorded.

White Cross OWF data

Manx Shearwater, recorded in July and August 2020 and March to June 2021 in densities ranging from 10 birds per km^2 to 100 birds per km^2.

Waggitt *et al*. (2019) data

Density maps for Manx shearwater, created using the data presented by Waggitt *et al*. (2019), across the spring migration (March to May), breeding (June and July) and autumn migration (August to October) periods, can be seen in Figure 5, Appendix A. The figure shows the largest density of Manx shearwaters within the vicinity of Gwynt Glas are present during the breeding season, which is to be expected given the proximity of the Skomer, Skokholm and Seas off Pembrokeshire SPA. However, densities are much greater to the north and west of the option area, than within the site itself.

Seabird tracking data

The SPA seabird colony on Skomer Island, Pembrokeshire, has been the location for a number of tracking studies of Manx shearwaters. Whilst undertaking the desk study, the most useful data source regarding this tracking was considered to be the paper produced by Dean *et al*. (2015). This paper presents the results of tracking studies of Manx shearwaters from Skomer, alongside tracking from other Manx shearwater colonies (Lundy, Devon; Copeland, County Down; and Rum, Highland). Image 4.1 is taken directly from this paper.

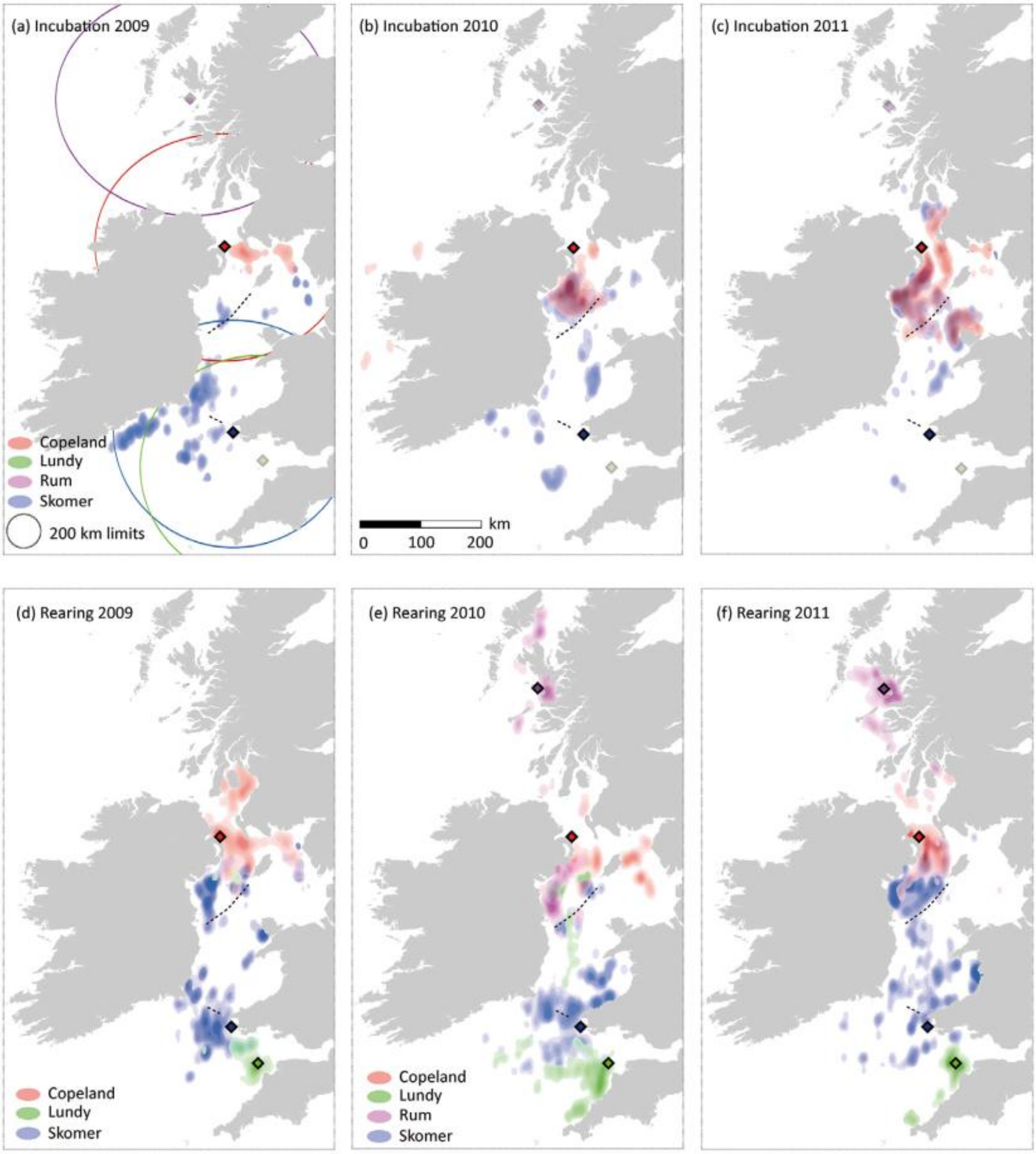


Image 4.1: Summary of Manx shearwater tracking studies from four UK colonies

Image 4.1 shows the core areas used by Manx shearwaters from these different colonies during the periods of egg incubation and chick rearing, from tracking studies undertaken in 2009 and 2010. The data suggests that most Manx shearwaters from Skomer (blue) travel north or west to forage, rather than south (and this research informed the creation of the Irish Sea Front SPA). However, the Gwynt Glas Area of Search does lie within the foraging area utilised by these SPA birds.

The Area of Search is also utilised by Manx shearwaters breeding on Lundy (green). Given that Lundy (an SSSI) lies in the Bristol Channel, with foraging areas mostly located to the west of the island, the position of the proposed development site may be of importance for shearwaters breeding here. Foraging birds from the colonies further north were not recorded within the option area, despite the colonies on Copeland and Rum lying within the mean max foraging distance for Manx shearwater.

Baseline DAS data

During the baseline aerial surveys, undertaken between April 2021 and March 2022 the largest numbers of Manx shearwater were recorded during May, June and March. Relatively low numbers were recorded during the surveys undertaken in July, September (I & II) and October – February (no birds November to January). Tables 4.9 and 4.10

present the number of records and estimated density (birds/km^2) of Manx shearwater per survey, respectively. The largest densities were recorded in sub area A (peak in March 2022). The fewest birds were recorded in sub area C overall.

Table 4.9 - Manx shearwater numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	64	77	79	107	22	32	23	21	19	24
May	332	224	146	178	76	83	245	132	11	9
June	538	942	447	162	89	312	393	597	56	33
July	88	30	41	9	52	9	2	1	34	20
Sept. I	35	89	6	18	0	0	17	42	18	47
Sept. II	10	13	8	10	2	2	3	10	5	1
Oct.	0	0	0	1	0	0	0	0	0	0
Nov.	0	0	0	0	0	0	0	0	0	0
Dec.	0	0	0	0	0	0	0	0	0	0
Jan.	0	0	0	0	0	0	0	0	0	0
Feb.	0	6	0	1	0	0	0	4	0	2
Mar.*	954	376	450	96	656	304	70	7	9	1

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.10 - Manx shearwater density (birds/km^2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0.70	0.85	1.27	1.72	0.78	1.14	0.74	0.68	0.60	0.76
May	3.66	2.47	2.34	2.85	2.70	2.95	7.90	4.26	0.35	0.28
June	5.92	10.37	7.16	2.60	3.16	11.08	12.67	19.25	1.77	1.04
July	0.97	0.33	0.66	0.14	1.85	0.32	0.06	0.03	1.07	0.63
Sept. I	0.39	0.98	0.10	0.29	0.00	0.00	0.55	1.35	0.57	1.48
Sept. II	0.11	0.14	0.13	0.16	0.07	0.07	0.10	0.32	0.16	0.03
Oct.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb.	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Mar.*	1.05	0.41	0.73	0.15	2.35	1.09	0.20	0.02	0.03	0.00

Source: HiDef/Natural Power

Figures 6 and 7, Appendix A, present the distribution of Manx shearwater records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively.

Impact Analysis

As Manx shearwater are sensitive to displacement (Table 4.3), an initial impact analysis was run to determine displacement mortality, as presented in Table 4.11 below. The sites to which the impacts to Manx shearwater would then be apportioned to are presented in Table 4.12.

Table 4.11 – Manx shearwater displacement values

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Bioseason			Spring Migration			MFBS		Autumn Migration				
Bioseasonal displacement mortality			119.7 (30%/3%)*			156.9 (30%/3%)		12.0 (30%/3%)				

*The first number represents the proportion displacement, and the second number represents proportion mortality. Displacement matrixes for this are presented in Appendix B, Tables B.1 – B.3.

Table 4.12 - Sites to which impacts to Manx Shearwater would be apportioned in the associated bioseasons

Season	Site (proportion of impact)*
Spring Migration	Skomer, Skokholm & the Seas of Pembrokeshire (19.1%) Rum (7.7%)
Breeding	Skomer, Skokholm & the Seas of Pembrokeshire (98.6%)
Autumn Migration	Skomer, Skokholm & the Seas of Pembrokeshire (19.1%) Rum (7.7%)

*Only SPAs where the proportion of impact is >5% are shown

Summary

Overall numbers: The species that was recorded in the second greatest numbers during baseline surveys, but numbers are not considered to be particularly high (in a regional context) given the proximity of the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Sub area variation: Highest numbers in sub area A during the first survey period and in sub area B in the second period.

Seasonal variation: As per Furness (2015) Manx shearwater have three distinct bio-seasons per year; MFBS (June to July; 500,298 individuals), spring migration (March to May; regional population = 1,580,895 individuals) and autumn migration (August to October; regional population = 1,580,895 individuals). This corresponds to the data collected, with highest numbers seen during the spring migration and breeding season and very low numbers towards the autumn migration and winter period.

Contextualisation of Impacts:

Table 4.13 - Contextualisation of the impacts to Manx shearwater in terms of EIA and HRA processes.

Period	EIA	HRA
	% of regional population	% of SPA population
Spring migration	<0.01% of the regional spring migratory population	0.01% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population

		<0.01% of Rum SPA population.
Breeding	0.03% of the regional breeding population	0.05% Skomer, Skokholm & the Seas of Pembrokeshire SPA population.
Autumn migration	0.01% of the regional autumn migratory population	<0.01% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population <0.01% of Rum SPA population.

Assessment of risk: Medium risk. Manx shearwater is at low risk of collision and displacement, but Skomer, Skokholm and Seas off Pembrokeshire SPA holds the world's largest breeding colony. The total observed number of Manx shearwater within the Area of Search and buffer during surveys undertaken within the MFBS (2257 individuals), equates to approximately 0.45% of the regional population. The total observed numbers within the spring migration (3851 individuals) and autumn migration (190 individuals) equate to approximately 0.24% and 0.01% (respectively) of the regional populations. The predicted mortalities make up less than 1% of the regional and SPA populations.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: Medium confidence. A second breeding season of surveys may record more birds utilising the site. A precautionary approach was used when assessing collision/displacement risk. There may be cumulative/in-combination effects.

4.6. Species Account: Storm Petrel

Erebus OWF data

Storm petrel was not recorded during the baseline aerial surveys for Erebus OWF.

Waggitt *et al*. (2019) data

Density maps, created using data from Waggitt *et al*. (2019), showing storm petrels in the breeding and non-breeding seasons, can be seen in Figure 8, Appendix A. For the purposes of these figures, the breeding season has been taken to be May to September and the non-breeding season from October to April. The figure shows that very few storm petrels are present in the vicinity of the option area during the non-breeding season. In the breeding season the highest densities occur to the north-west of the site.

Baseline DAS data

Tables 4.14 and 4.15 present the number of records and estimated density (birds/km^2) of storm petrel per survey, respectively. Storm petrels were entirely absent during the October – March, May - July surveys and were recorded in very small numbers in April and early September. The second September survey recorded a large increase, with most birds being recorded in sub area C.

Table 4.14 - Storm petrel numbers across the site and sub areas during each survey (April to September 2021)

Survey	Site		Buffer		Sub area 1		Sub area 2		Sub area 3	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0	7	0	0	0	7	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0

Survey	Site		Buffer		Sub area 1		Sub area 2		Sub area 3	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
Sept I	0	2	0	0	0	0	0	0	0	2
Sept II	6	172	0	15	0	0	0	30	6	142
Oct.	0	0	0	0	0	0	0	0	0	0
Nov.	0	0	0	0	0	0	0	0	0	0
Dec.	0	0	0	0	0	0	0	0	0	0
Jan.	0	0	0	0	0	0	0	0	0	0
Feb.	0	0	0	0	0	0	0	0	0	0
Mar.*	0	0	0	0	0	0	0	0	0	0

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.15 - Storm petrel density (birds/km^2) across the site and sub areas during each survey (April to September 2021)

Survey	Site		Buffer		Sub area 1		Sub area 2		Sub area 3	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0.00	0.08	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept I	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Sept II	0.07	1.89	0.00	0.24	0.00	0.00	0.00	0.97	0.19	4.49
Oct.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: HiDef/Natural Power

Figure 9, Appendix A, presents the distribution of storm petrel records, from the three surveys on which they were recorded.

Impact Analysis

Storm petrel are not considered to be sensitive to displacement or collision mortality effects, as per Table 4.3. For this reason, neither displacement or collision mortality impacts analysis were run and no key sensitivities in terms of this species is expected.

Summary

Overall numbers: Very low, except during September II survey.

Sub area variation: Sub area C accounted for most records.

Seasonal variation: Storm petrels do not have defined BDSMPs, however they were predicted to be present during migration periods only: larger peak on autumn migration and smaller peak on spring migration. The data is consistent with this, as the majority of birds were recorded in September, a smaller number recorded in April and limited to no birds recorded otherwise.

Assessment of risk: Low risk. Storm petrel is at low risk of collision and displacement and is likely to be absent in most months.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: Medium/high confidence. Although usually considered to be a species at low risk of displacement, there is precedence for storm petrel to be fully assessed for displacement impacts.

4.7. Species Account: Gannet

Erebus OWF data

Density estimates are presented in the ES for gannet and these are: 2.05 birds/km^2 (migration-free breeding), 3.04 (autumn migration) and 0.91 (spring migration). Gannets were recorded throughout the year, but only small numbers were recorded in the winter. The largest count was made on an August survey (160 individuals in the array area in August 2020).

The Erebus OWF ES reports that tracking data from gannets breeding on Grassholm SPA shows 44.5% of adults visited the survey area (array plus 4 km) at some point, with 0.2% present at any one time.

The Erebus DAS data recorded 59.3% of gannets in the array area as flying at potential collision risk height (CRH). Erebus used these site-specific flight heights for gannet in their Collision Risk Model (CRM). It should be noted that this is a much greater proportion than that estimated using generic flight height data in literature (7.0% of gannet flights at CRH; Johnston *et al.* (2014)). Natural Power considers standard DAS to be of limited value in determining flight heights, given the high uncertainty in estimates made from this trigonometric approach. Therefore, the use of site-specific flight height data in the Erebus ES is of interest.

White Cross OWF data

Gannets were encountered on all 12 surveys for which information was available. Peak densities were recorded during the breeding season, with up to 3 birds per km^2 and outwith the breeding season densities fell to below 1 bird per km^2.

Waggitt *et al*. (2019) data

Density maps for gannet, from Waggitt *et al*. (2019), covering the spring migration (December to March), breeding (April to August) and autumn migration (September to November) periods, can be seen in Figure 10, Appendix A. The figure shows very low densities in the spring and autumn migration periods. In the breeding season high densities of gannet are recorded to the north of the Gwynt Glas option area (correlating with proximity to the Grassholm SPA), but relatively few gannets are shown to be present within the site.

Seabird tracking data

Gannets breeding on Grassholm, Pembrokeshire, have been the object of tracking studies and the seabird tracking database[7] includes the results of these studies. Image 4.2, taken from this resource, shows the movements of breeding gannets from Grassholm. The image displays a large number of tracks, and this hides the detail, but it is clear that the Gwynt Glas option area lies within the foraging range of these SPA birds.

Image 4.2: tracks of gannets from Grassholm[7]

Baseline DAS data

Table 4.16 presents gannet numbers per survey and Table 4.17 presents density (birds/km^2), for the baseline surveys undertaken between April 2021 and March 2022. The surveys with the largest number of records were in April (majority of records in sub area B) and October 2021 (majority records in the buffer).

Table 4.16 - Gannet numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	257	76	76	45	5	17	190	48	62	11
May	45	24	3	10	0	4	8	13	37	7
June	0	113	3	29	0	41	0	68	0	4
July	88	24	89	56	16	7	6	11	66	6
Sept. I	7	29	13	32	0	18	0	3	7	8
Sept. II	21	26	35	25	11	11	8	7	2	8
Oct.	10	20	238	90	1	8	1	5	8	7
Nov.	41	6	47	16	0	0	1	4	40	2
Dec.	0	4	0	3	0	0	0	3	0	1
Jan.	16	2	6	2	0	1	1	0	15	1
Feb.	1	14	2	11	0	2	0	6	1	6
Mar.*	2	16	0	6	2	3	0	3	0	5

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.17 - Gannet density (birds/km^2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	2.83	0.84	1.22	0.72	0.18	0.60	6.13	1.55	1.96	0.35
May	0.50	0.26	0.05	0.16	0.00	0.14	0.26	0.42	1.17	0.22
June	0.00	1.24	0.05	0.46	0.00	1.46	0.00	2.19	0.00	0.13
July	0.97	0.26	1.43	0.90	0.57	0.25	0.19	0.35	2.09	0.19
Sept. I	0.08	0.32	0.21	0.51	0.00	0.64	0.00	0.10	0.22	0.25
Sept. II	0.23	0.29	0.56	0.40	0.39	0.39	0.26	0.23	0.06	0.25
Oct.	0.01	0.02	0.16	0.06	0.00	0.03	0.00	0.02	0.03	0.02
Nov.	0.05	0.01	0.03	0.01	0.00	0.00	0.00	0.01	0.13	0.01
Dec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Jan.	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00
Feb.	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.02	0.00	0.02
Mar.	0.00	0.02	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.02

Source: HiDef/Natural Power

Figures 11 and 12, Appendix A, present the distribution of gannet records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively.

Impact Analysis

As gannet are sensitive to displacement and collision (Table 4.3), an initial impact analysis was run to determine displacement and collision mortality, as presented in Table 4.18 below. The sites to which the impacts to gannet would then be apportioned to are presented in Table 4.19.

Table 4.18 – Predicted gannet collision and displacement mortality values

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bioseason	Spring migration			MFBS					Autumn migration			Spring migration
Bioseasonal displacement mortality	5 (80%/3%)*			93.1 (80%/3%)					77.5 (80%/3%)			
Monthly Collision Mortality Values	0.236	1.746	1.575	11.287	3.807	18.501	3.86	4.663	3.946	3.006	0.8	0.451
Sum of Bioseason Collision mortality	4.91			42.118					7.752			

*The first number represents the proportion displacement, and the second number represents proportion mortality. Displacement matrixes for this are presented in Appendix B, Tables B.4 – B.9

Table 4.19- Sites to which impacts to gannet would be apportioned in the associated bioseasons

Season	Site (proportion of impact)*

MFBS	Grassholm SPA (91.7%)
Autumn Migration	Grassholm SPA (12.1%) Skelligs SPA (10.9%) Ailsa Craig SPA (8.4%)
Spring Migration	Grassholm SPA (10.0%) Skelligs SPA (9.0%) Ailsa Craig SPA (7.0%)

*Only SPA's where the proportion of impact is >5% are shown

Summary

Overall numbers: Numbers were generally considered to be moderate.

Sub area variation: Sub area B accounted for the most records during the first period and sub area C for the most records in the second period.

Seasonal variation: As per Furness (2015) gannet have three distinct bio-seasons per year: spring migration (December to March; 661,888 individuals), MFBS (April to August; 183,646 individuals) and autumn migration (September to November; 545,954 individuals). The general trend of observed data shows high numbers were observed beginning in April, relatively consistent numbers until August, and then minimal numbers from November onwards.

Contextualisation of Impacts:

Table 4.20 - Contextualisation of the impacts to Gannet in terms of EIA and HRA processes.

Impact	Period	EIA	HRA
		% of regional population	% of SPA population
Displacement	MFBS	0.05% of the regional breeding population.	0.13% of the Grassholm SPA population.
	Autumn Migration	0.05% of the regional autumn migratory population.	0.01% of the Grassholm SPA population. 0.01% of the Skelligs SPA population. 0.01% of the Ailsa Craig SPA population.
	Spring Migration	0.01% of the regional spring migratory population.	<0.01% of the Grassholm SPA population. <0.01% of the Skelligs SPA population. <0.01% Ailsa Craig SPA population.
Collision	MFBS	0.02% of the regional breeding population.	0.06% of the Grassholm SPA population.
	Autumn Migration	<0.01% of the regional autumn migratory population.	<0.01% of the Grassholm SPA population. <0.01% of the Skelligs SPA population.

Impact	Period	EIA	HRA
		% of regional population	% of SPA population
			<0.01% of the Ailsa Craig SPA population.
	Spring Migration	<0.01% of the regional spring migratory population.	<0.01% of the Grassholm SPA population. <0.01% of the Skelligs SPA population. <0.01% of the Ailsa Craig SPA population.

Assessment of risk: Medium/high risk. Gannet is considered at high risk of collision and high risk of displacement with regard to published sensitivities to offshore windfarm development and was recorded on the site in moderate numbers. The total observed number of gannet within the Area of Search and buffer during surveys undertaken within the spring (80 individuals) and autumn (575 individuals) equate to approximately 0.01% and 0.11%, respectively, of the regional seasonal populations. The total number observed during the MFBS (483 individuals) equate to approximately 0.62% of the regional seasonal population. The precited mortalities make up less than 1% of the regional and SPA populations.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: Medium confidence. A second breeding season of surveys may record more birds utilising site. There may be cumulative/in-combination effects.

4.8. Species Account: Herring Gull

Erebus OWF data

During baseline DAS, herring gulls were only recorded within the Erebus OWF survey area in five out of the 24 monthly surveys. The highest density estimate for herring gull was that of March 2020: 0.25 birds/km^2.

Digital aerial surveys recorded 60% of herring gulls in the array area to be at potential CRH. Erebus used these site-specific flight heights for herring gull in their CRM. It should be noted that this is a much greater proportion than that estimated using generic flight height data in literature (19% of herring gull flights at CRH; Johnston *et al.* (2014)).

White Cross OWF data

Herring gull was recorded in peak densities of 0.69 birds per km^2 during the breeding season in June 2021, and 0.52 birds per km^2 during the non-breeding season in December 2020.

Waggitt *et al*. (2019) data

Density maps for the herring gull breeding (March to August) and non-breeding (September to February) seasons, taken from Waggitt *et al*. (2019), are shown on Figure 13, Appendix A. The figure shows a greater density of herring gulls in the vicinity of the option area in the non-breeding season, than in the breeding season. There is little apparent variation within the option area, though the eastern half has slightly higher densities than the western half.

Baseline DAS data

Herring gull numbers recorded during the baseline surveys so far are shown in Table 4.21 and the density estimates (birds/km^2) for herring gull are shown in Table 4.22. Very few herring gulls were recorded during the period April 2021 to March 2022, except for the surveys undertaken in July, September II, November and January. The majority of records are found within sub area C or within the buffer.

Table 4.21 - Herring gull numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	3	0	2	0	0	0	0	0	3	0
May	3	4	0	1	0	0	0	0	3	4
June	0	6	0	0	0	0	0	0	0	6
July	1	1	67	9	0	0	0	0	1	1
Sept. I	0	0	0	0	0	0	0	0	0	0
Sept. II	0	0	20	1	0	0	0	0	0	0
Oct.	0	0	0	1	0	0	0	0	0	0
Nov.	6	8	28	23	0	4	0	3	6	1
Dec.	0	8	0	0	0	6	0	1	0	1
Jan.	21	14	6	4	0	0	0	0	21	14
Feb.	0	2	1	0	0	0	0	1	0	1
Mar.*	0	0	0	0	0	0	0	0	0	0

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.22 - Herring gull density (birds/km^2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.09	0.00
May	0.03	0.04	0.00	0.02	0.00	0.00	0.00	0.00	0.09	0.13
June	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19
July	0.01	0.01	1.07	0.14	0.00	0.00	0.00	0.00	0.03	0.03
Sept. I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept. II	0.00	0.00	0.32	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Oct.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov.	0.01	0.01	0.02	0.02	0.00	0.01	0.00	0.01	0.02	0.00
Dec.	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Jan.	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.04
Feb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: HiDef/Natural Power

Figure 14 and Figure 15, Appendix A, present the distribution of herring gull records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively.

<u>Impact Analysis</u>

As herring gull are sensitive to collision impacts (Table 4.3), an initial impact analysis was run to determine collision mortality, as presented in Table 4.23 below. The sites to which the impacts to herring gull would then be apportioned to are not presented as there are no SPAs within the mean max foraging range plus one standard deviation for herring gull that this site could impact.

Table 4.23 – Predicted herring gull collision values

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Monthly Collision Mortality Values	1.937	0.241	0	0	0.518	1.032	0.13	0	0	0	1.103	1.129
Bioseason	Non-breeding season		MFBS						Non-breeding season			
Sum of Bioseason Collision Mortality			1.68						4.41			

<ins>**Summary**</ins>

Overall numbers: Very low numbers within the option area during period April 2021 to March 2022.

Sub area variation: The buffer accounted for the most records during the first period and sub area C accounted for the most records in the second period.

Seasonal variation: As per Furness (2015) herring gull have two distinct bio-seasons per year: MFBS (March to August; no population data[11]) and the non-breeding season (September to February; 173,299 individuals). The data shows relatively low numbers throughout the entire survey period.

Contextualisation of Impacts:

Table 4.24 - Contextualisation of the impacts to Herring gull in terms of EIA and HRA processes.

Period	EIA	HRA
	% of regional population	% of SPA population
MFBS	There is no regional population to compare to and given the very low collision risk mortality (1.68) this is considered very low risk to the regional breeding population.	There are no SPAs within the mean max foraging range plus one standard deviation for herring gull that this site could impact.
Non-breeding season	<0.01% of the regional non-breeding population	

Assessment of risk: Low/medium risk. Herring gull is considered at high risk of collision, but low risk of displacement with regard to published sensitivities to offshore windfarm development and was recorded in very low numbers during the breeding and non-breeding season. The total observed number of herring gull within the Area of Search and buffer during surveys undertaken within the non-breeding season (143 individuals) equates to approximately 0.08% of the regional non-breeding season population. The precited mortalities make up less than 1% of the regional population.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: Medium/high confidence.

4.9. Species Account: Lesser Black-backed Gull

Erebus OWF data

During baseline DAS, lesser black-backed gulls were recorded in low numbers in the migration-free breeding and autumn migration periods. The density estimate peaked at 0.86 birds/km^2 in July 2020.

Digital aerial surveys recorded 77% of lesser black-backed gulls in the array area to be at potential CRH. These site-specific flight heights for lesser black-backed gull were used in the CRM. It should be noted that this is a much greater proportion than that estimated using generic flight height data in literature (26% of lesser black-backed gull flights at CRH; Johnston *et al.* (2014)).

White Cross OWF data

Lesser black-backed gull was recorded at peak densities of 0.07 birds per km^2 during the breeding season in May 2021, and 0.4 birds per km^2 during the non-breeding season in December 2020.

Waggitt *et al*. (2019) data

Density maps for lesser black-backed gull, taken from Waggitt *et al*. (2019), are shown in Figure 16, Appendix A. These show the spring migration (March and April), breeding (May to July), autumn migration (August to October) and non-breeding (November to February) seasons. The density of lesser black-backed gull in the vicinity of the option area is greatest in the breeding season and is higher in the spring migration period than the autumn migration period.

Baseline DAS data

The number and density of lesser black-backed gulls recorded during the baseline surveys (April 2021 to March 2022) are presented in Table 4.25 and Table 4.26, respectively. The largest number of lesser black-backed gulls (in the survey area as a whole) was recorded on the July 2021 survey within the buffer, and April/May also saw larger numbers recorded in Sub area C.

Table 4.25 - Lesser black-backed gull numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	36	5	10	0	0	1	0	0	36	4
May	33	9	0	0	0	0	0	0	33	9
June	0	1	6	2	0	1	0	0	0	0
July	0	8	73	25	0	5	0	1	0	2
Sept I	0	0	0	1	0	0	0	0	0	0
Sept II	0	0	37	1	0	0	0	0	0	0
Oct.	0	0	1	0	0	0	0	0	0	0
Nov.	0	1	2	5	0	0	0	1	0	0
Dec.	0	0	0	0	0	0	0	0	0	0
Jan.	8	0	0	2	0	0	0	0	8	0
Feb.	0	4	0	4	0	2	0	0	0	2
Mar.*	0	0	0	0	0	0	0	0	0	0

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.26 - Lesser black-backed gull density (birds/km^2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0.40	0.06	0.16	0.00	0.00	0.04	0.00	0.00	1.14	0.13
May	0.36	0.10	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.28
June	0.00	0.01	0.10	0.03	0.00	0.04	0.00	0.00	0.00	0.00
July	0.00	0.09	1.17	0.40	0.00	0.18	0.00	0.03	0.00	0.06
Sept I	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Sept II	0.00	0.00	0.59	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Oct.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan.	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Feb.	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Mar.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 17 and Figure 18, Appendix A, present the distribution of lesser black-backed gull records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively.

Impact Analysis

As lesser black-backed gull are sensitive to collision, an initial impact analysis was run to determine collision mortality, as presented in Table 4.27 below. The sites to which the impacts to lesser black-backed gull would then be apportioned to are presented in Table 4.28.

Table 4.27 – Predicted collision mortality of lesser black-backed gulls

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Monthly Collision Mortality Values	0	0.398	0	0.614	1.068	0.213	0.962	0	0	0	0.101	0
Bioseason	Winter		Spring Migration		MFBS			Autumn Migration			Winter	
Sum of Bioseason Collision Mortality	0.499		0.614		2.243			0.0				

Table 4.28 - Sites to which impacts to Lesser black-backed gull would be apportioned in the associated bioseasons

Season	Site (proportion of impact)*
Winter	Skomer, Skokholm & the Seas of Pembrokeshire SPA (98.6%)
Spring Migration	Skomer, Skokholm & the Seas of Pembrokeshire SPA (24.9%)
MFBS	Skomer, Skokholm & the Seas of Pembrokeshire SPA (96.1%)
Autumn Migration	Skomer, Skokholm & the Seas of Pembrokeshire SPA (24.9%)

*Only SPAs where the proportion of impact is >5% are shown

Summary

Overall numbers: Low, but variable numbers recorded.

Sub area variation: The buffer accounted for the most records during the first period and sub area C had the most records (although minimal) in the second period.

Seasonal variation:

As per Furness (2015) lesser black-backed gulls have four distinct bio-seasons per year: spring (March to April; 163,304 individuals), MFBS (May to July; 45,872 individuals), autumn (August to October; 163,304 individuals) and winter (November to February; 41,159 individuals). Higher numbers were observed within the site during the March – July and limited numbers outwith this period.

Contextualisation of Impacts:

Table 4.29 – Contextualization of the impacts to Herring Gull in terms of EIA and HRA processes.

Period	EIA	HRA
	% of regional population	% of SPA population
Winter	<0.01% of the regional wintering population	<0.01% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population.
Spring Migration	<0.01% of the regional spring migratory population	<0.01% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population.
MFBS	<0.01% of the regional breeding population	0.01% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population.
Autumn Migration	There are no predicted mortalities from the autumn migration CRM.	

Assessment of risk: Low risk. Lesser black-backed gull is considered at high risk of collision, but low risk of displacement with regard to published sensitivities to offshore windfarm development and was recorded in low numbers during the breeding season. The total observed number of lesser black-backed gulls within the Area of Search and buffer during surveys undertaken within the spring (52 individuals) and autumn (40 individuals) equate to approximately 0.03% and 0.02%, respectively, of the regional seasonal populations. The total numbers observed during the MFBS (157 individuals), and winter period (26 individuals) equate to approximately 0.34% and 0.06%, respectively, of the regional seasonal populations. The precited mortalities make up less than 1% of the regional and SPA populations.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: High confidence.

4.10. Species Account: Puffin

Erebus OWF data

The baseline DAS data for Erebus OWF showed that the large majority of records came from the breeding season, with peak numbers recorded in April (344 individuals recorded in April 2020). Density estimates were calculated, and these showed a peak density in the migration-free breeding season (4.11 birds/km^2), whilst the density estimate for the non-breeding season was 0.29 birds/km^2.

White Cross OWF data

Puffin densities within the study area were also low; maximum recorded densities were 0.3 birds per km^2 during the non-breeding season in November 2020, and 0.13 birds per km^2 during the breeding season in May 2021.

Waggitt *et al*. (2019) data

Density maps covering the breeding (April to July) and non-breeding (August to March) seasons for puffin, from Waggitt *et al*. (2019), are shown in Figure 19, Appendix A. The highest densities of puffin occur to the north-west of the option area, with relatively few birds in the site itself. Densities in the breeding season are higher than in the non-breeding season.

Seabird tracking data

The seabird tracking database[7] includes the results of a small tracking study that tagged puffins breeding on Skomer. The tracks presented in Image 4.3 are taken from the seabird tracking website. The data shows that, for the tagged birds at least, the core foraging area appears to lie to the north of Gwynt Glas. Tracks from the non-breeding season (not reproduced here) show puffins from Skomer dispersed across European waters and the north Atlantic.

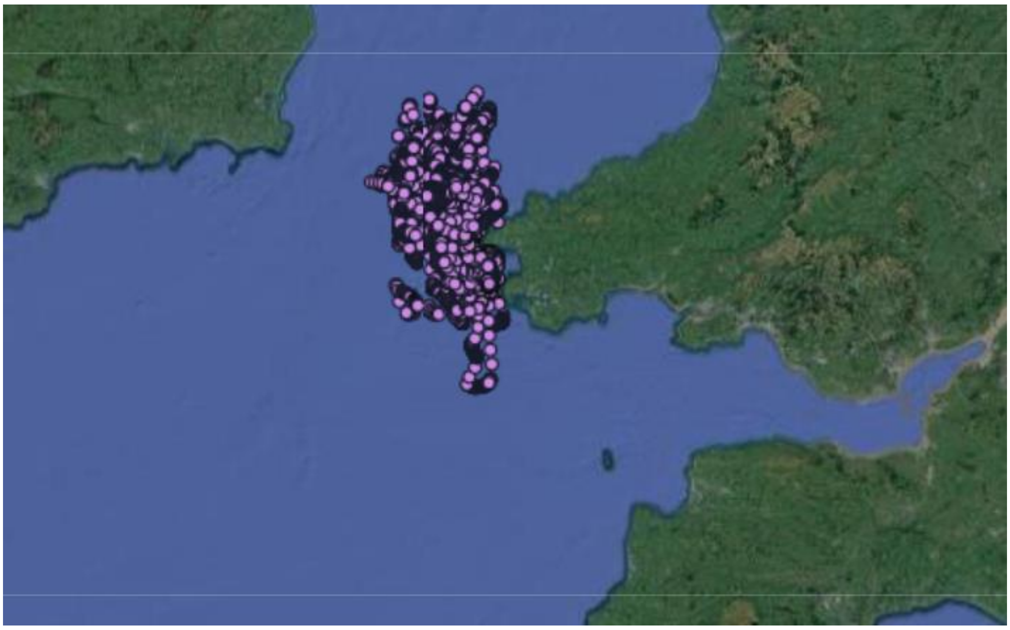


Image 4.3: tracks of puffins from Skomer (breeding season)[7]

Baseline DAS data

The numbers of puffins recorded during the baseline surveys (April 2021 to March 2022) are presented in Table 4.30, with densities (birds/km^2) presented in Table 4.31. The peak counts were made in April 2021 and March 2022, with very few puffins recorded during the period June 2021 to February 2022. Most puffin records came from sub area A.

Table 4.30 - Puffin numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	41	1	50	0	29	0	10	1	2	0
May	17	0	1	2	10	0	4	0	3	0
June	1	0	2	0	0	0	0	0	1	0
July	2	0	2	0	0	0	1	0	1	0
Sept I	1	0	1	0	0	0	1	0	0	0
Sept II	9	0	1	0	8	0	1	0	0	0
Oct.	0	0	2	0	0	0	0	0	0	0

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
Nov.	6	0	3	0	0	0	6	0	0	0
Dec.	0	0	0	0	0	0	0	0	0	0
Jan.	0	0	0	0	0	0	0	0	0	0
Feb.	0	0	0	0	0	0	0	0	0	0
Mar.*	68	12	37	4	27	0	19	7	1	3

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.31 - Puffin density (birds/km^2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0.45	0.01	0.80	0.00	1.03	0.00	0.32	0.03	0.06	0.00
May	0.19	0.00	0.02	0.03	0.36	0.00	0.13	0.00	0.09	0.00
June	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00
July	0.02	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.03	0.00
Sept I	0.01	0.00	0.02	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Sept II	0.10	0.00	0.02	0.00	0.28	0.00	0.03	0.00	0.00	0.00
Oct.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov.	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Dec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jan.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feb.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mar.	0.07	0.01	0.06	0.01	0.10	0.00	0.06	0.02	0.00	0.01

Figures 20 and 21, Appendix A, present the distribution of puffin records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively.

Impact Analysis

As puffin are sensitive to displacement, an initial impact analysis was run to determine displacement mortality, as presented in Table 4.32 below. The sites to which the impacts to puffin would then be apportioned to are presented in Table 4.33.

Table 4.32 – Puffin displacement values

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Bioseason	Non-breeding			MFBS				Non-breeding				
Bioseasonal displacement mortality	28.0 (70%/5%)			28.7 (70%/5%)								

*The first number represents the proportion displacement, and the second number represents proportion mortality. Displacement matrixes for this are presented in Appendix B, Tables B.10 – B.12

Table 4.33 - Sites to which impacts to Puffin would be apportioned in the associated bioseasons

Season	Site (proportion of impact)*

MFBS	Skomer, Skokholm & the Seas of Pembrokeshire (96.0%)
Non-breeding	Skomer, Skokholm & the Seas of Pembrokeshire (6.2%)

*Only SPA's where the proportion of impact is >5% are shown

Summary

Overall numbers: Very low numbers overall, with higher of April and March.

Sub area variation: Most records came from sub area A for both the first and second periods.

Seasonal variation As per Furness (2015) puffin have two distinct bio-seasons per year: MFBS (April to July; 21,086 individuals) and non-breeding (August to March; 304,557 individuals).

Contextualisation of Impacts:

Table 4.34 - Contextualisation of the impacts to Puffin in terms of EIA and HRA processes.

Impact/Period	EIA	HRA
	% of regional pop'n	% of SPA pop'ns
MFBS	0.14% of the regional breeding population.	0.15% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA breeding population
Non-breeding	<0.01% of the regional non-breeding population	0.01% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA non-breeding population

Assessment of risk: Low/medium risk. Puffin is considered at low risk of collision, and high risk of displacement with regard to published sensitivities to offshore windfarm development and was recorded in low numbers during the bulk of the breeding season. The total observed number of puffin within the site and buffer during surveys undertaken within the non-breeding season (99 individuals) and the MFBS (119 individuals) equate to approximately 0.03% and 0.57%, respectively, of the regional seasonal populations. The precited mortalities to the associated SPA's make up less than 1% of the regional and SPA populations.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: Medium confidence. As this species is considered susceptible to displacement, a second breeding season of surveys will provide more confidence that the proposed site is typical in holding low numbers of puffins at this time of year.

4.11. Species Account: Guillemot

Erebus OWF data

Guillemot was the most frequently recorded species during the Erebus OWF baseline surveys and it was recorded year round. The peak population estimate came from August 2020 (post-breeding), when 11,002 individuals were in the array area (22,963 individuals including the 4 km buffer). The peak seasonal density estimates were 32.55 birds/km^2 in the migration-free breeding season and 140.21 birds/km^2 in non-breeding (or post-breeding) season.

Whitecross OWF data

Guillemot peak densities of 21 birds per km^2 were recorded in May 2021, with lower densities outside this time.

Waggitt *et al*. (2019) data

The Waggitt *et al*. (2019) data has been used to create Figure 22, Appendix A, which shows density maps for guillemot in the breeding (March to July) and non-breeding (August to February) seasons. The data shows the highest density of guillemots in the vicinity of the option area occurs in the non-breeding season. Although the highest densities at this time of year occur to the north-west of the option area, within the site itself there is no obvious pattern to guillemot distribution. The data shows a low density of guillemots in the option area during the breeding season, with larger numbers to the north.

Baseline DAS data

The numbers of guillemots recorded during the baseline surveys (April 2021 to March 2022) are presented in Table 4.35, with density estimates (birds/km^2) presented in Table 4.36. High numbers were seen in April 2021 as well as between October 2021 and March 2022, with numbers dropping off between May 2021 and September (II) 2021. No guillemots were recorded within the option area on the September (I) survey. Peak numbers of guillemot were recorded in February 2022.

Table 4.35 - Guillemot numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	339	3	259	4	176	2	99	0	64	1
May	97	1	52	2	44	0	32	1	21	0
June	44	1	33	0	22	0	19	1	3	0
July	12	0	11	0	6	0	3	0	3	0
Sept. I	0	0	2	0	0	0	0	0	0	0
Sept. II	54	0	20	0	45	0	7	0	2	0
Oct.	289	8	296	12	190	5	88	2	11	1
Nov.	392	13	700	25	237	7	90	6	65	0
Dec.	350	5	189	5	12	0	232	5	106	0
Jan.	646	18	543	13	159	6	120	5	367	7
Feb.	698	9	425	13	162	3	270	4	266	2
Mar.*	521	34	275	16	56	5	148	6	160	16

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.36 - Guillemot density (birds/km^2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	3.73	0.03	4.15	0.06	6.25	0.07	3.19	0.00	2.02	0.03
May	1.07	0.01	0.83	0.03	1.56	0.00	1.03	0.03	0.66	0.00
June	0.48	0.01	0.53	0.00	0.78	0.00	0.61	0.03	0.09	0.00
July	0.13	0.00	0.18	0.00	0.21	0.00	0.10	0.00	0.09	0.00
Sept. I	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept. II	0.59	0.00	0.32	0.00	1.60	0.00	0.23	0.00	0.06	0.00
Oct.	0.32	0.01	0.19	0.01	0.68	0.02	0.28	0.01	0.04	0.00
Nov.	0.43	0.01	0.46	0.02	0.85	0.03	0.28	0.02	0.21	0.00
Dec.	0.38	0.01	0.12	0.00	0.04	0.00	0.73	0.02	0.34	0.00
Jan.	0.71	0.02	0.35	0.01	0.57	0.02	0.38	0.02	1.17	0.02
Feb.	0.77	0.01	0.28	0.01	0.58	0.01	0.85	0.01	0.85	0.01
Mar.	0.57	0.04	0.44	0.03	0.20	0.02	0.47	0.02	0.51	0.05

Source: HiDef/Natural Power

Figures 23 and 24, Appendix A, present the distribution of fulmar records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively.

Impact Analysis

As guillemot are sensitive to displacement, an initial impact analysis was run to determine displacement mortality, as presented in Table 4.37 below. The sites to which the impacts to guillemot would then be apportioned to are presented in Table 4.38.

Table 4.37 – Guillemot displacement values

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Bioseason	Non-breeding		MFBS					Non-breeding				
Bioseasonal displacement mortality			194.3 (70%/5%)					356.8 (70%/5%)				

Table 4.38 - Sites to which impacts to guillemot would be apportioned in the associated bioseasons

Season	Site (proportion of impact)*
MFBS	Skomer, Skokholm & the Seas of Pembrokeshire (85.8%) Saltee Islands (14.2%)
Non-breeding	No regional breeding population exceed 5% of regional non-breeding population.

*Only SPAs where the proportion of impact is >5% are shown

Summary

Overall numbers: One of the most recorded species overall, during April and October – March and a peak in February. Relatively low numbers recorded during May - September.

Sub area variation: Fairly evenly distributed across the entire Area of Search in both periods.

Seasonal variation: As per Furness (2015) guillemot have two distinct bio-seasons per year: MFBS (March to July; 51,180 individuals) and non-breeding season (August to Feb; 1,139,220 individuals). The desk study suggested most guillemots would be recorded in the non-breeding season, which held true from the observed data. Note the peak month at Erebus was August and this month was not surveyed during the Gwynt Glas 2021 baseline surveys, however this is still sufficient to provide an initial perspective of the site. However, it recommended that additional surveys in August 2023 are carried out to provide a full baseline characterisation.

Contextualisation of Impacts:

Table 4.39 - Contextualisation of the impacts to Guillemot in terms of EIA and HRA processes.

Impact/Period	EIA	HRA
	% of regional pop'n	% of SPA pop'ns
MFBS	0.38% of the regional breeding population	0.56% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population. 0.13% of the Saltee Islands SPA population.

Non-breeding	0.03% of the regional non-breeding population	No relevant SPAs identified.

Assessment of risk: Medium/high risk. Guillemot is considered at low risk of collision and high risk of displacement with regard to published sensitivities to offshore windfarm development. The total observed number of guillemot within the site and buffer during surveys undertaken within the MFBS (1469 individuals) and the non-breeding season (4725 individuals) equate to approximately 4.94% and 0.41%, respectively, of the regional seasonal populations. The precited mortalities to the associated SPAs make up less than 1% of the regional and SPA populations.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: Medium confidence. As this species is considered susceptible to displacement, a second breeding season of surveys will provide more confidence that the proposed site is typical in holding high numbers of guillemots at this time of year.

4.12. Species Account: Kittiwake

Erebus OWF data

Low numbers of kittiwake were recorded during the Erebus OWF baseline surveys in summer, but higher numbers were recorded during the spring and autumn migration periods. The largest population estimate, however, came from a January survey (486 individuals in January 2021). In the breeding season, the peak estimate was of only four individuals, leading to a peak density estimate of 0.02 birds/km*2* for the migration-free breeding period. Peak densities for the autumn and spring migration periods were 18.50 birds/km^2 and 4.65 birds/km^2 respectively.

The baseline DAS recorded 48.8% of kittiwake flights in the array area as being at potential CRH. These site-specific flight heights for kittiwake were used in the CRM. It should be noted that this is a much greater proportion than that estimated using generic flight height data in literature (6.8% of kittiwake flights at CRH; Johnston *et al*. (2014)).

Waggitt *et al*. (2019) data

Density maps for kittiwake in the spring migration (January to April), breeding season (May to July) and autumn (August to December) migration periods, using Waggitt *et al*. (2019) data, are presented in Figure 24, Appendix A. The data shows low numbers of kittiwakes in the vicinity of Gwynt Glas during the breeding season and greater numbers during the migration periods, particularly the spring migration period. The data suggests highest densities during migration periods are found to the north-west of the option area and decreasing numbers of kittiwake as one moves south-east across the site.

Seabird tracking data

The seabird tracking database[7] includes tracks from kittiwakes tagged on Skomer. Tracks are presented that show foraging movements of these kittiwakes in the breeding season. Image 4.4 reproduces these tracks. The figure shows a relatively small area of sea around Skomer is utilised by these tagged birds, and no flights overlapped with the option area.

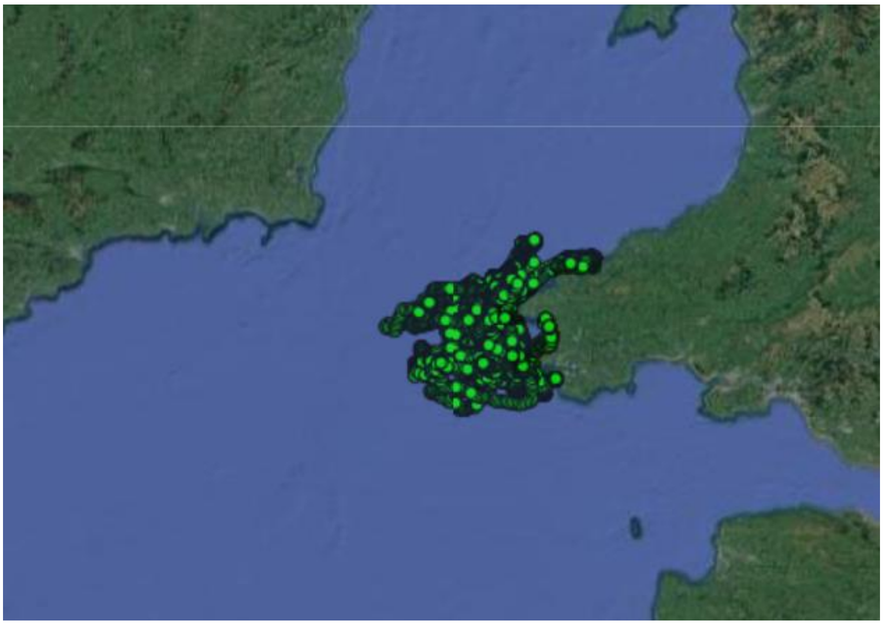


Image 4.4: tracks of kittiwakes from Skomer (breeding season)[7]

The seabird tracking database also presents the tracks of kittiwakes from Skomer in the non-breeding season. Image 4.5 reproduces these tracks. This shows that there is dispersal post-breeding, that takes kittiwakes in all directions across a very wide area. A similar picture is shown by tracked kittiwakes from other colonies (for example those that breed at Rathlin Island, Antrim (Northern Ireland)). Thus, these tracking studies show why it can be expected that dispersal of kittiwakes outside the breeding season is likely to lead to an increase in kittiwake numbers in the vicinity of Gwynt Glas during this season.

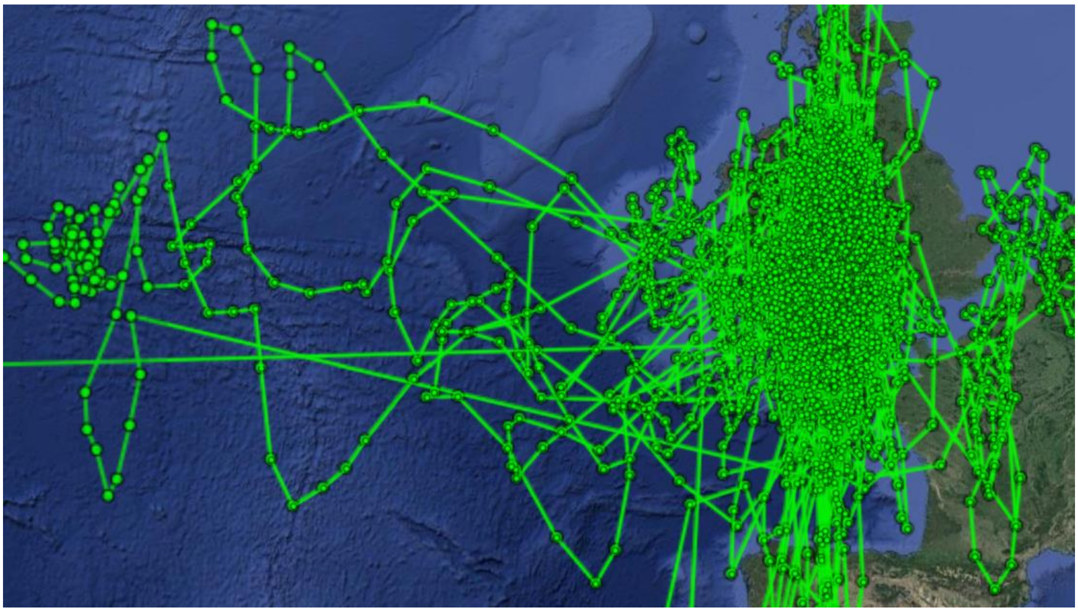


Image 4.5: tracks of kittiwakes from Skomer (non-breeding)[7]

Baseline DAS data

Only 18 kittiwakes were recorded in total over the six months of baseline surveys (April to September 2021), the largest number being five in the July survey. Kittiwake numbers significantly increased in the additional baseline surveys (October 2021 to March 2022). The numbers of kittiwake recorded during the baseline surveys (April 2021 to March 2022) are presented in Table 4.40, with density estimates (birds/km^2) presented in Table 4.41.

Table 4.40 - Kittiwake numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0	0	1	1	0	0	0	0	0	0
May	0	1	0	0	0	0	0	0	0	1
June	1	2	1	0	0	0	1	2	0	0
July	0	3	2	0	0	1	0	1	0	1
Sept. I	1	1	1	1	1	0	0	1	0	0
Sept. II	0	0	0	2	0	0	0	0	0	0
Oct.	4	27	26	134	0	14	2	5	2	8
Nov.	6	89	179	396	0	26	1	44	5	19
Dec.	36	161	9	57	7	25	24	86	5	50
Jan.	37	78	62	64	0	12	6	16	31	50
Feb.	155	197	53	178	25	44	100	92	30	61
Mar.*	1	2	0	1	0	1	1	0	0	1

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.41 - Kittiwake density (birds/km^2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept. I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept. II	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct.	0.00	0.03	0.02	0.09	0.00	0.05	0.01	0.02	0.01	0.03
Nov.	0.01	0.10	0.12	0.26	0.00	0.09	0.00	0.14	0.02	0.06
Dec.	0.04	0.18	0.01	0.04	0.03	0.09	0.08	0.27	0.02	0.16
Jan.	0.04	0.09	0.04	0.04	0.00	0.04	0.02	0.05	0.10	0.16
Feb.	0.17	0.22	0.03	0.12	0.09	0.16	0.32	0.29	0.10	0.19
Mar.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figures 25 and 26, Appendix A, present the distribution of kittiwake records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively. In addition, 'unidentified large gulls' (a category that includes herring gull, lesser black-backed gull and great black-backed gull) is also shown on these figures. Only 76 great black-backed gulls were observed during the 12 DAS, therefore numbers and densities have not been presented.

Impact Analysis

As kittiwake are sensitive to collision (Table 4.3), an initial impact analysis was run to determine collision mortality, as presented in Table 4.42 below. The sites to which the impacts to kittiwake would then be apportioned to are presented in Table 4.43.

Table 4.42 – Kittiwake displacement values

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Monthly Collision Mortality Values* (median value)	3.425	9.077	0.1	0	0.061	0.126	0.186	0.059	0	1.514	3.868	6.574
Bioseason	Spring migration				MFBS			Autumn migration				
Sum of Bioseason Collision Mortality	12.602				0.373			12.015				

Table 4.43 - Sites to which impacts to Kittiwake would be apportioned in the associated bioseasons

Season	Site (proportion of impact)*
Spring migration	N/A
MFBS	Skomer, Skokholm & the Seas of Pembrokeshire (30.8%) Saltee Islands (26.1%) Lambay Island (16.1%) Howth Head (9.9%) Helvick Head to Ballyquin (7.4%) Wicklow Head (5.9%)
Autumn migration	N/A

*Only SPAs where the proportion of impact is >5% are shown

<u>Summary</u>

Overall numbers: Very low numbers during the period April to September 2021, with a significant increase in the second six-month period of DAS surveys. The highest count occurred in November 2021.

Sub area variation: Because of such low numbers, no real trend was observed during the first period, however the majority of the records occurred within the buffer and sub area B during the second period.

Seasonal variation: As per Furness (2015) kittiwake have three distinct bio-seasons per year: spring (January to April; 691,526 individuals), MFBS (May to July; 24,988 individuals) and autumn (August to December; 911,586 individuals). The desk study suggested higher numbers were likely to be present in the period October to March, which was consistent with the observed data.

Contextualisation of Impacts:

Table 4.44 - Contextualisation of the impacts to kittiwake in terms of EIA and HRA processes.

Impact/Period	EIA	HRA
	% of regional pop'n	% of SPA pop'ns
Spring migration	<0.01% of the regional spring migratory population.	N/A

MFBS	<0.01% of the breeding population.	0.01% Skomer, Skokholm & the Seas of Pembrokeshire SPA population. <0.01% of the Saltee Islands SPA population. <0.01% of the Lambay Island SPA population. <0.01% of the Howth Head SPA population. <0.01% of the Helvick Head to Ballyquin SPA population. <0.01% of the Wicklow Head SPA population.
Autumn migration	<0.01% of the regional autumn migratory population.	N/A

Assessment of risk: Medium/high risk. Kittiwake is considered at high risk of collision and low risk of displacement with regard to published sensitivities to offshore windfarm development. The total observed number of kittiwake within the Area of Search and buffer during surveys undertaken within the spring (831 individuals) and autumn (1,124 individuals) both equate to approximately 0.12% of the respective regional seasonal populations. The observed number from the MFBS (10 individuals) equates to approximately 0.16% of the regional seasonal population. The precited mortalities to the associated SPA's make up less than 1% of the regional and SPA populations.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: Medium confidence. As this species is considered susceptible to collision mortality, a second breeding season of surveys will provide more confidence that the proposed site is typical in holding low numbers of kittiwakes at this time of year.

4.13. Species Account: Razorbill

Erebus OWF data

During the Erebus OWF baseline surveys, density estimates for razorbill were determined to be: 0.93 birds/km^2 in the migration-free breeding season, 11.23 in the autumn migration period, 5.15 in the non-breeding season and 4.20 during spring migration. The peak count in the breeding season came from an April survey (84 individuals in the array in April 2020). In the non-breeding season, the peak count in autumn was made on a November survey (250 individuals in November 2019) and in winter from a January survey (363 individuals in January 2021).

White Cross OWF data

Razorbills were recorded at lower densities across the study area, with a clear peak during the non-breeding season (August to March) in December 2020 and January 2021 of 2 to 2.5 birds per km^2.

Waggitt *et al*. (2019) data

Density maps for razorbill have been produced using Waggitt *et al*. (2019) data, for the spring migration (January to March), breeding season (April to July), autumn migration (August to October) and non-breeding season (November and December) periods. These are shown on Figure 27, Appendix A. The figure shows that razorbill are recorded in very low numbers in the vicinity of the Area of Search during the breeding season and autumn migration period.

In all seasons there appears to be larger densities to the north and west of the Area of Search than in the Area of Search itself.

Seabird tracking data

Razorbills tagged on Skomer are included in the tracking study results provided by the seabird tracking database[7]. Image 4.6 shows the movements of these razorbills around Skomer in the breeding season. The data suggests there is no overlap between the foraging areas of the tagged birds and the Gwynt Glas Area of Search.

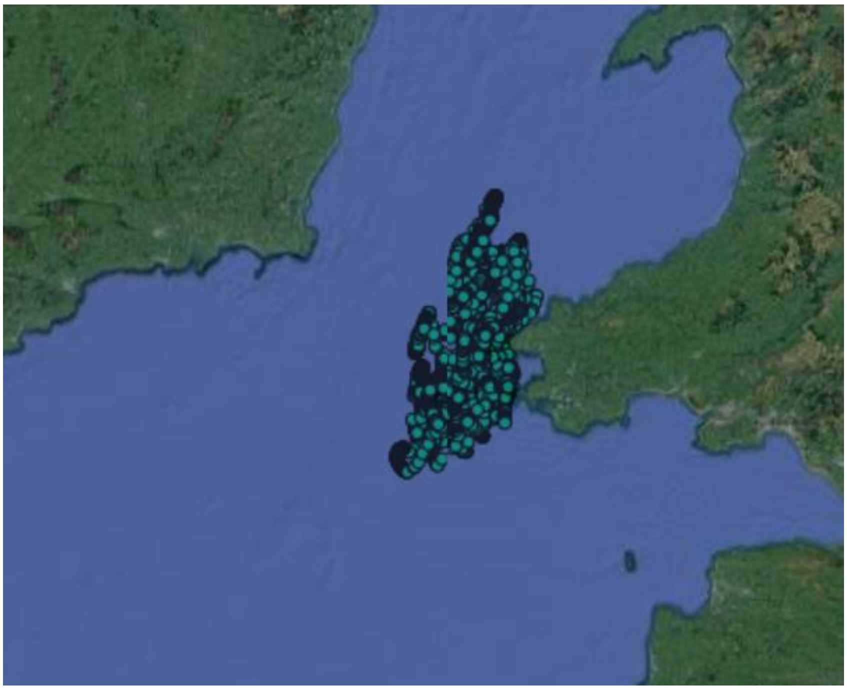


Image 4.6: tracks of razorbill from Skomer (breeding)[7]

Baseline DAS data

During baseline surveys completed in April to September 2021, 26 razorbills were recorded on the April survey and only another five birds were recorded in total across the other five surveys. Razorbill numbers increased in the additional baseline surveys (October 2021 to March 2022). The numbers of razorbill recorded during the baseline surveys (April 2021 to March 2022) are presented in Table 4.45, with density estimates (birds/km^2) presented in Table 4.46.

Table 4.45 - Razorbill numbers across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	16	0	10	0	12	0	3	0	1	0
May	0	0	1	0	0	0	0	0	0	0
June	0	0	2	0	0	0	0	0	0	0
July	1	0	0	0	1	0	0	0	0	0
Sept. I	0	0	0	0	0	0	0	0	0	0
Sept. II	1	0	0	0	1	0	0	0	0	0
Oct.	0	1	3	0	0	1	0	0	0	0
Nov.	0	0	0	0	0	0	0	0	0	0
Dec.	51	0	14	0	0	0	36	0	15	0
Jan.	44	14	21	3	7	14	19	0	18	0
Feb.	158	2	62	7	38	1	102	1	18	0

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
Mar.*	29	6	12	1	4	0	18	4	2	1

Source: HiDef/Natural Power

*Note- site boundary shifted 4km to the East in March 2022

Table 4.46 - Razorbill density (birds/km^2) across the site and sub areas during each survey (April 2021 to March 2022)

Survey	Site		Buffer		Sub area A		Sub area B		Sub area C	
	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight	Sea	Flight
April	0.02	0.00	0.01	0.00	0.04	0.00	0.01	0.00	0.00	0.00
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept. I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sept. II	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oct.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nov.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dec.	0.06	0.00	0.01	0.00	0.00	0.00	0.11	0.00	0.05	0.00
Jan.	0.05	0.02	0.01	0.00	0.03	0.05	0.06	0.00	0.06	0.00
Feb.	0.17	0.00	0.04	0.00	0.14	0.00	0.32	0.00	0.06	0.00
Mar.	0.03	0.01	0.02	0.00	0.01	0.00	0.06	0.01	0.01	0.00

Figures 29 and 30, Appendix A, present the distribution of razorbill records across the April 2021 – September 2021 and October 2021 – March 2022 periods respectively**.** The figure also shows the distribution of all unidentified auk records (which covers 'guillemot/razorbill', 'unidentified auk species' and 'auk/shearwater' records).

Impact Analysis

As razorbill are sensitive to displacement, an initial impact analysis was run to determine displacement mortality, as presented in Table 4.47 below. The sites to which the impacts to razorbill would then be apportioned to are presented in Table 4.48.

Table 4.47 – Razorbill displacement values

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Bioseason	Spring Migration			MFBS				Autumn Migration			Winter	
Bioseasonal displacement mortality	104 (70%/5%)			18.2 (70%/5%)				15.4 (70%/5%)			37.8 (70%/5%)	

Table 4.48- sites to which impacts to Razorbill would be apportioned in the associated bioseasons

Season	Site (proportion of impact)*
Spring migration	Skomer, Skokholm & the Seas of Pembrokeshire (1.8%) Saltee Islands (0.9%)
MFBS	Skomer, Skokholm & the Seas of Pembrokeshire (90.3%)

	Saltee Islands (9.7%)
Autumn migration	Skomer, Skokholm & the Seas of Pembrokeshire (1.8%) Saltee Islands (0.9%)
Winter	Skomer, Skokholm & the Seas of Pembrokeshire (3.1%) Saltee Islands (1.5%)

*Only SPAs where the proportion of impact is >5% are shown

Summary

Overall numbers: Very low numbers during the period April to September 2021, with numbers increasing in the October 2021 to March 2022 surveys to peak in February.

Sub area variation: Too few observations occurred in the first period to determine a pattern, however in the second period the majority of the records were observed in sub area B.

Seasonal variation: As per Furness (2015) razorbill have four distinct bio-seasons per year: MFBS (April to July; 15,894 individuals), autumn migration (August to October; 606,914 individuals), winter (November to December; 341,422 individuals) and spring migration (January to March; 606,914 individuals). The desk study suggested the highest numbers were likely to be present in the non-breeding (November and December) and spring migration (January to March) periods, which was supported by the observed data.

Contextualisation of Impacts:

Table 4.49 - Contextualisation of the impacts to razorbill in terms of EIA and HRA processes.

Period	EIA	HRA
	% of regional population	% of SPA population
Spring migration	0.02% of the regional spring migratory population	0.02% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population. 0.02% of the Saltee Islands SPA population.
MFBS	0.17% of the regional breeding population	0.15% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population. 0.03% of the Saltee Islands SPA population.
Autumn migration	<0.01% of the regional spring migratory population	<0.01% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population. <0.01% of the Saltee Islands SPA population.
Winter	0.01% of the regional wintering population	0.01% of the Skomer, Skokholm & the Seas of Pembrokeshire SPA population. 0.01% of the Saltee Islands SPA population.

Assessment of risk: Low/medium risk. Razorbill is considered at low risk of collision, and high risk of displacement with regard to published sensitivities to offshore windfarm development and was recorded in relatively low numbers. The total observed number of razorbill within the Area of Search and buffer during surveys undertaken within the spring (321 individuals) and autumn (5 individuals) equate to approximately 0.05% and 0.00%, respectively, of the regional seasonal populations. The total numbers observed during the MFBS (30 individuals), and winter period (65 individuals) equate to approximately 0.28% and 0.02%, respectively, of the regional seasonal populations. The precited mortalities to the associated SPA's make up less than 1% of the regional and SPA populations.

- **EIA Risk**- there are no key sensitivities identified
- **HRA Risk**-there are no key sensitivities identified

Confidence in assessment: Medium confidence. As this species is considered susceptible to displacement, a second year of surveys will provide more confidence that the numbers recorded to date are typical for the proposed site.

4.14. Species Account: Balearic Shearwater

Erebus OWF data

No Balearic shearwaters were recorded during the two years of baseline DAS. However, the commissioned report stated that, each year, between 2% and 23% of the global population utilises the Celtic Sea Front, which is located close to the development area.

Waggitt *et al*. (2019) data

The species maps produced by Waggitt et al. (2019) do not include Balearic shearwater.

Other literature

Due to Balearic shearwater's status as a 'critically endangered' European seabird, various studies have been undertaken to better understand the species' ecology. This includes investigations into the species' movements post-breeding, when a proportion of the population move north into the seas off south-west Britain and Ireland.

A JNCC report (Parsons *et al*, 2019) used existing ESAS data to map 'hot spots' for the species in north-western Europe. Image 4.7 is reproduced from this report. It shows an important area lies in the southern Irish Sea, between the south-west coast of Wales and the south-east coast of Ireland. This hotspot does not overlap with Gwynt Glas and there is no evidence that Balearic shearwater would pass through the Area of Search to utilise this hot spot.

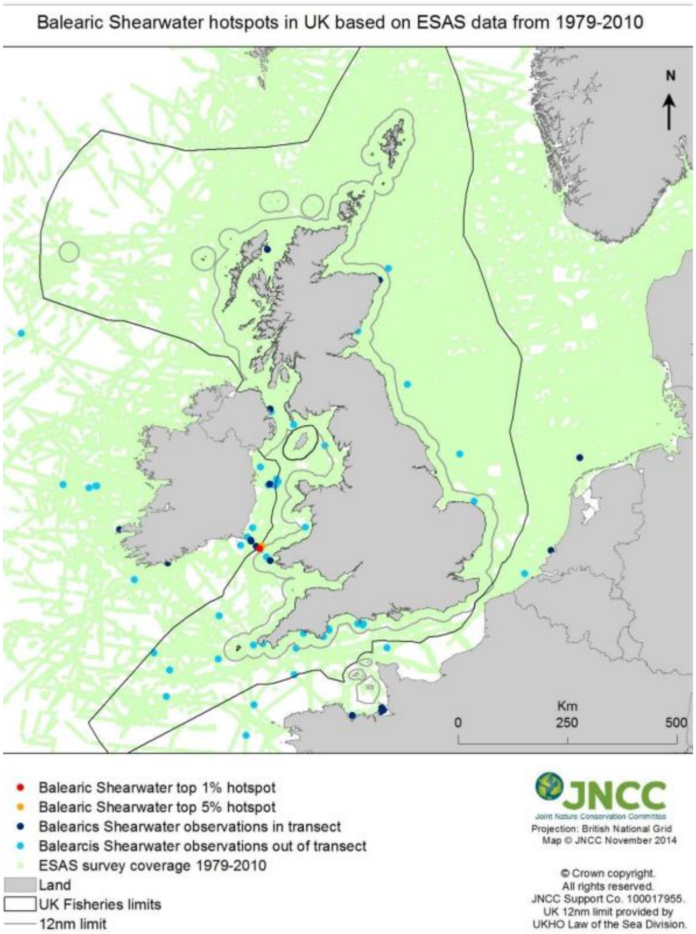


Image 4.7: hotspots for Balearic shearwater using ESAS data (JNCC, 2019)

Phillips *et al*. (2021) undertook a modelling exercise to predict the distribution of Balearic shearwater around the coast of south-west England. The results of this are presented in Image 4.8. This model predicts a high likelihood of presence in the waters north of Cornwall, and this area overlaps with the Area of Search.

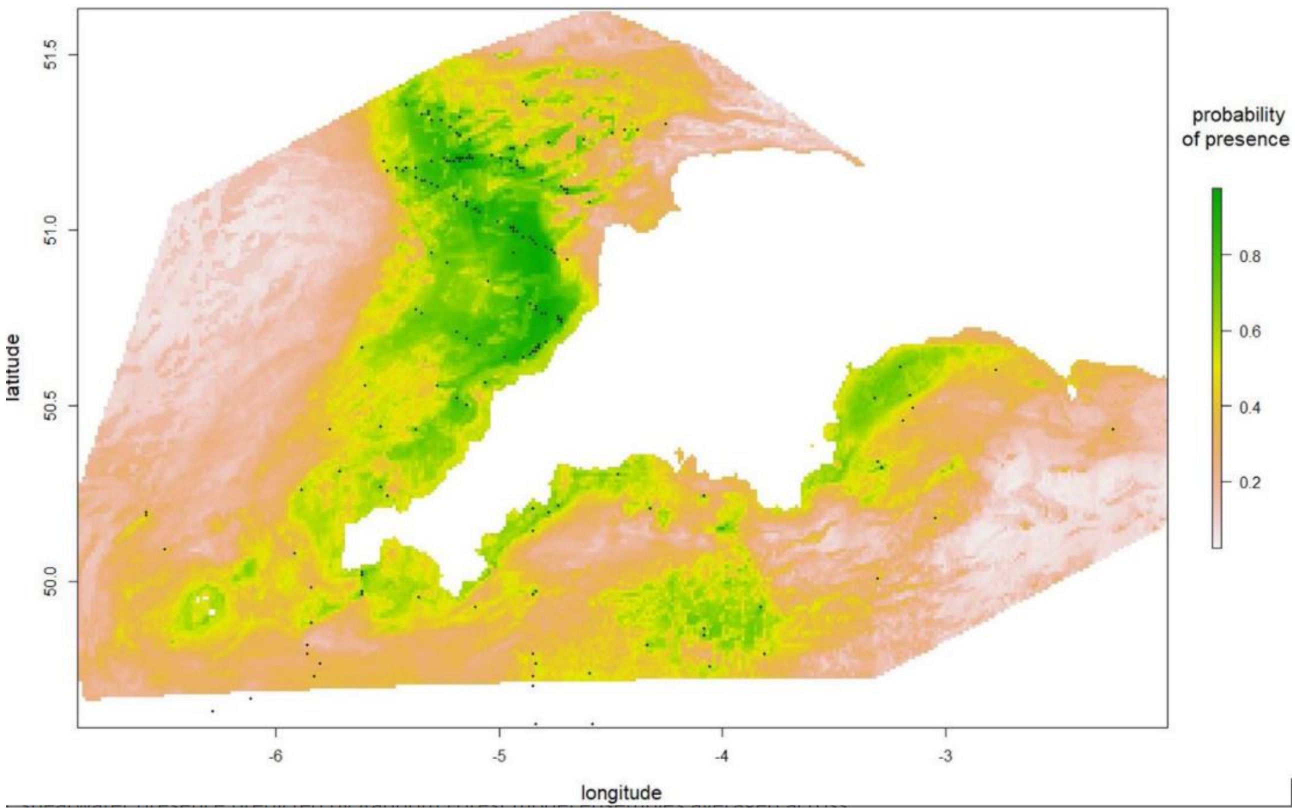


Image 4.8: modelled probability of Balearic shearwater presence (Phillips *et al*. 2021)

Baseline DAS data

No Balearic shearwater records were detected during the baseline DAS completed between April 2021 and March 2022.

Summary

Overall numbers: None recorded during the period April 2021 to March 2022.

Sub area variation: Not applicable.

Seasonal variation: Peak numbers of Balearic shearwaters in UK waters occur during July to September (during the time period covered by baseline surveys).

Assessment of risk: Low risk. Using Manx shearwater as a proxy for Balearic shearwater, this species can be considered to be at low risk of collision, and displacement, and it has yet to be recorded on a survey.

Confidence in assessment: Medium confidence. A precautionary approach that recognises this species ‘critically endangered’ status may be required in the assessment, which could include modelled data as well as baseline survey data.

5. Key findings and recommendations

5.1. Summary of key ornithological features

The summaries provided in the previous chapter for each ornithological feature of interest are collated in Table 5.1. This is based upon the data available to date. For the purposes of this summary table 'numbers on site' have been classed as either high or low (with the exception of razorbill at moderate) and 'seasonal peak' is classed as MFBS, autumn migration or non-breeding season . The 'sub area' column highlights the sub area (A, B or C) that produced most records of that species, with those shown in brackets indicating where all sub areas held low numbers.

Table 5.1 - Summary of key ornithological features

Species	Numbers on site	Bio-seasonal with peak count	Sub area with peak counts	Risk	Confidence
Fulmar	Low	MFBS	C	Low	High
Manx shearwater	High	MFBS	A/B	Medium	Medium
Storm petrel	Low	Autumn migration	C	Low	Medium/high
Gannet	High	MFBS	B/C	Medium/high	Medium
Herring gull	Low	Non-breeding	Buffer/C	Low/medium	Medium/high
Lesser black-backed gull	Low	MFBS	Buffer/C	Low	High
Puffin	Low	MFBS	A	Low/medium	Medium
Guillemot	High	MFBS	Entire site	Medium/high	Medium
Kittiwake	High	MFBS	B	Medium/high	Medium
Razorbill	Moderate	MFBS	B	Low/medium	Medium
Balearic shearwater	Low	MFBS	-	Low	Medium

Manx shearwater, gannet, guillemot and kittiwake were the most recorded species during the April 2021 to March 2022 (inclusive) baseline survey period. Lower numbers were recorded than might have been expected, given the large breeding colonies that lie within foraging distance of the Gwynt Glas Area of Search, but their relative abundance and connectivity to designated sites suggests these are likely to be key species in the EcIA. The risks to these ornithological features are collision risk for gannet and kittiwake and displacement for gannet, guillemot and Manx shearwater (although the latter species is usually considered at low risk of displacement).

Balearic shearwater was not recorded during baseline surveys, despite the peak period for this species in south-west Britain being July to September. Although it is possible that the identification of some individuals are missed during DAS image analysis, the Area of Search does not appear to be utilised by Balearic shearwater. However, consultees may require this species to be included in the EcIA.

5.2. Anticipated Key Impacts

Based on the first year of survey data, the mortality predicted from either displacement or collision did not constitute more than 1% of any regional or SPA population. Therefore, there it is not considered that the site will have any key sensitivities in either an EIA or HRA perspective. However, it should be noted that this report is based on a single year of data and at a project alone level. A second year of data collection is underway and the cumulative impacts will be addressed at a later stage once more information on the surround projects is known.

5.3. Additional surveys

CRM allows a number of options to be modelled. 'Option 1' uses site-specific flight height data, where sufficient data exists. 'Option 2' uses generic flight height data, using species specific flight height data gathered from literature.

Given the limitations in estimating flight heights from standard DAS, Natural Power considers there to be a potential risk in using site-specific data in any future CRM. Should a high collision risk be predicted to have a significant effect for an ornithological feature, as a result of the DAS producing much greater estimates of flight height than is given in standard data, additional validation surveys should be considered to determine the accuracy of these flight height estimates.

Seabirds from the nearest SPAs (Skomer, Skokholm and the Seas off Pembrokeshire SPA; Grassholm SPA) have been subject to a number of tracking studies. It is considered unlikely that additional tracking data shall be required to inform the assessments.

Surveys for non-marine birds passing across the option area (terrestrial birds on migration) are not considered necessary, as the proposed site is not considered to be on a major flyway.

DAS should continue on a monthly basis for a minimum of two years. Monthly surveys are considered sufficient to determine baseline conditions during the breeding season (no additional surveys required) and are considered advantageous in the non-breeding season (no reduction in survey effort at that time of year is recommended).

5.4. Recommendations

Consultation with NRW, JNCC and Natural England following one year of baseline surveys, is recommended.

6. References

Dean, B., Kirk, H., Fayey, A., Shoji, A., Freeman, R., Leonard, K., Perrins, C.M. & Guilford, Y. (2015) Simultaneous multicolony tracking of a pelagic seabird reveals cross-colony utilisation of a shared foraging area. *Marine Ecology Progress Series* 538: 239-248.

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

Furness, R.W. (2015) *Non-breeding season populations of seabirds in UK waters: population sizes for Biologically Defined Minimum Population Scales (BDMPS).* Natural England commissioned report, number 164.

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

Parsons, M., Bingham, C., Allcock, Z., & Kuepfer, A. (2019) *Summary of evidence of Balearic shearwaters in the UK up to 2013*. JNCC Report number 642. JNCC, Peterborough.

Phillips, J.A., Banks, A.N., Bolton, M., Brereton, T., Cazenave, P., Gillies, N., Padget, O., van der Kooij, J., Waggitt, J. & Guilford, T. (2021) Consistent concentrations of critically endangered Balearic shearwaters in UK waters revealed by at-sea surveys. *Ecology and Evolution* 11(4): 1544-1557.

Waggitt, J.J., Evans, P.G.H., Andrade, J., Banks, A.N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C.J., Durinck, J., Felce, T., & Fijn, R.C., García-Barón, I., Garthe, S., Geelhoed, S.C.V., Gilles, A., Goodall, M., Haelters, J., Hamilton, S., Hartny-Mills, L., Hodgins, N., James, K., Jessopp, M., Kavanagh, A.S., Leopold, M., Lohrengel, K., Louzao, M., Markones, N., Martinez-Cedeira, J., Cadhla, O., Perry, S.L., Pierce, G.J., Ridouz, V., Robinson, K.P., Santos, M.B., Saavedra, C., Skov, H., Stienen, E.W.M., Sveegaard, S., Thompson, P., Vavermen, N., Wall, D., Webb, A., Wilson, J., Wanless, S. & Hiddink, J.G. (2019) Distribution maps of cetacean and seabird populations in the North-East Atlantic. *Journal of Applied Ecology* 57: 253-269.

Woodward. I., Thaxter, C.B., Owen, E. & Cook, A.S.C.P. (2019) *Desk-based revision of seabird foraging ranges used for HRA screening.* BTO Research Report, number 724.

Designated sites were identified using the following websites:

https://jncc.gov.uk/our-work/list-of-spas/

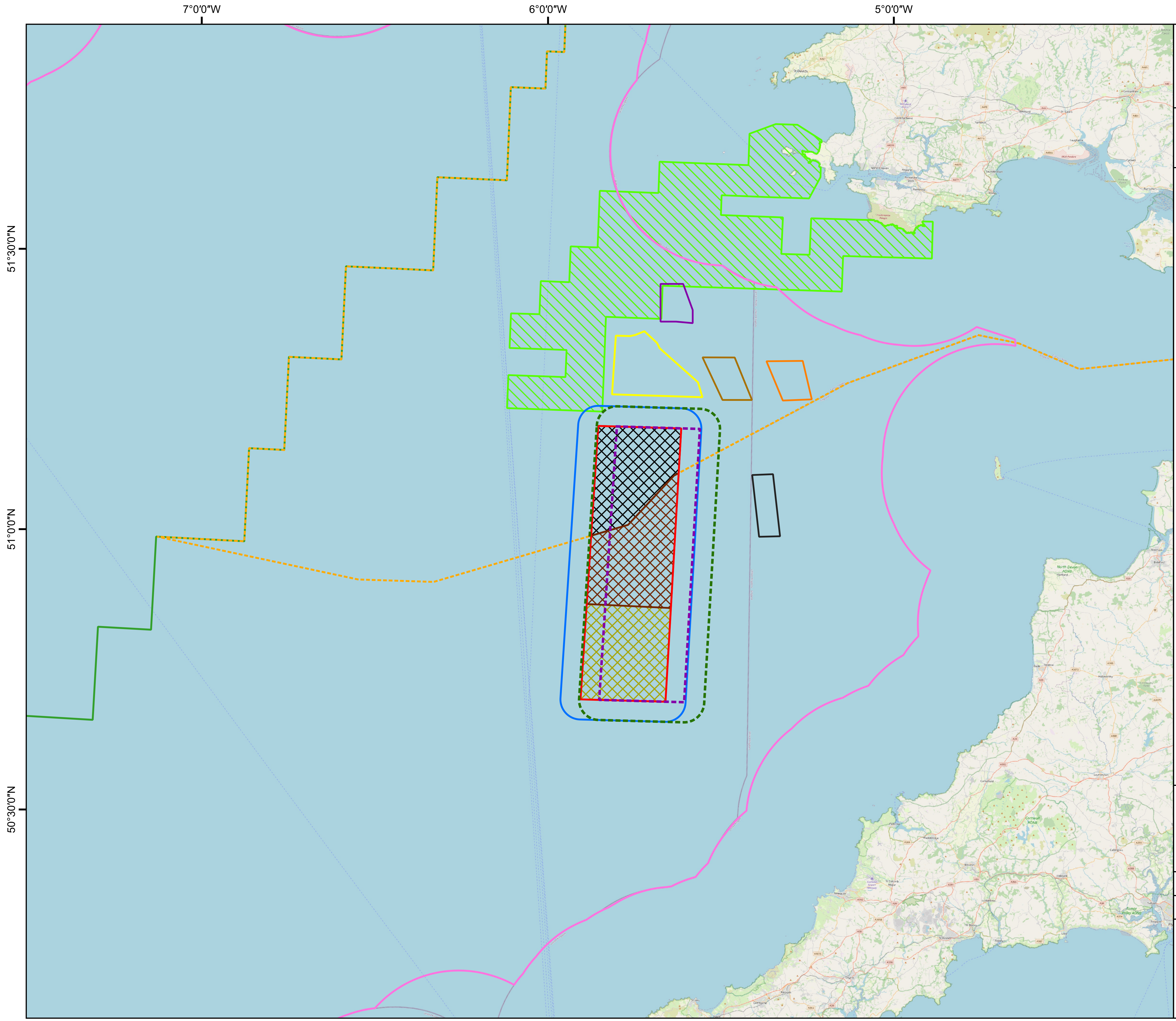
Special Protection Areas (SPA) | National Parks & Wildlife Service (npws.ie)

Natura 2000 Network Viewer (europa.eu)

Appendix A

List of figures[12]

[12] Of note- all figures with the exception of the site location do not reflect the shifted site footprint due to the delay in receiving this information.



Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 1: Site Location

Key

- Gwynt Glas Area of Search
- 4 km buffer of Gwynt Glas Area of Search
- Updated Gwynt Glas Area of Search (March 2022)
- Updated 4 km buffer of Gwynt Glas Area of Search
- Subsite A
- Subsite B
- Subsite C
- Erebus Floating Wind Demo
- Llŷr 2 Wind Farm boundary (Proposed)
- Llŷr 2 Wind farm boundary (Proposed)
- Valorous Wind Farm boundary (Proposed)
- White Cross Wind Farm boundary (Proposed)
- Skomer, Skokholm and the Seas off Pembrokeshire Special Protection Area (SPA)
- 12 nautical mile limit
- Welsh territorial limit
- UK Exclusive Economic Zone

Scale @ A3: 1:750,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 10 20 30 40 km

N

Date: 07-12-22	Prepared by: AC	Checked by: SS
Ref: GB203055_M_023_C		

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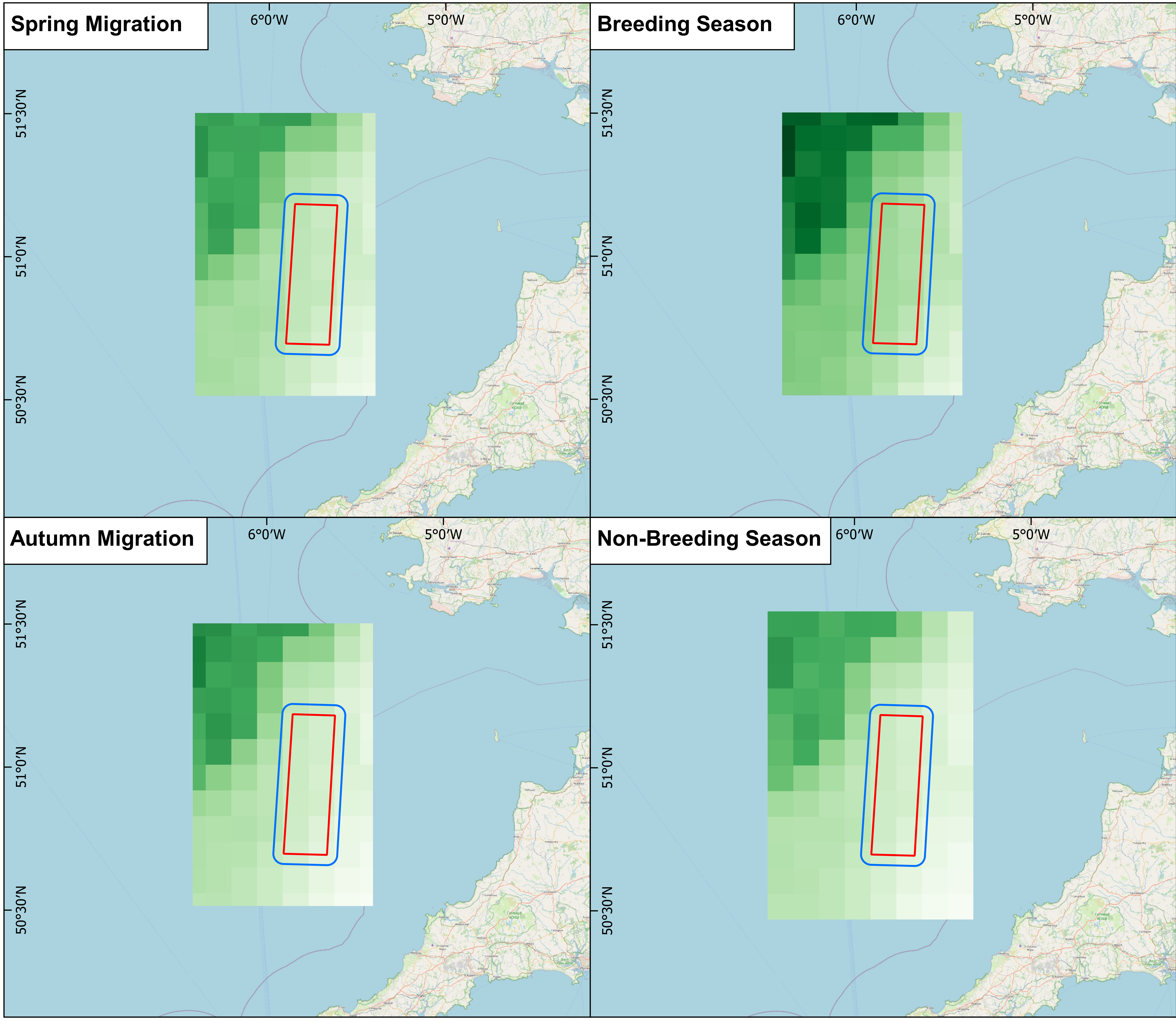

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 2: Fulmar Density Map (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average Number of Fulmar per Km²

- 0.1606
- 0.2271
- 0.2935
- 0.3599
- 0.4264
- 0.4928
- 0.5593
- 0.6206
- 0.6717

Waggitt et al., 2019

Scale @ A3: 1:1,500,000

Coordinate System: WGS84 UTM Zone 30N

0 15 30 45 60 km

N

Date: 18-02-22	Prepared by: JO	Checked by: GG
Ref: GB203055_M_004_A		

Drawing by:

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Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 3: Fulmar Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Fulmar: April and May
- Fulmar: June and July
- Fulmar: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N

0 3 6 9 12 km

N

Date: 18-02-22	Prepared by: JO	Checked by: GG
Ref: GB203055_M_013_A		

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Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 4: Fulmar Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Fulmar: November (No records in October)
- Fulmar: December and January
- Fulmar: February and March

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

Date: 27-09-22	Prepared by: JO	Checked by: SS

Ref: GB203055_M_034_A

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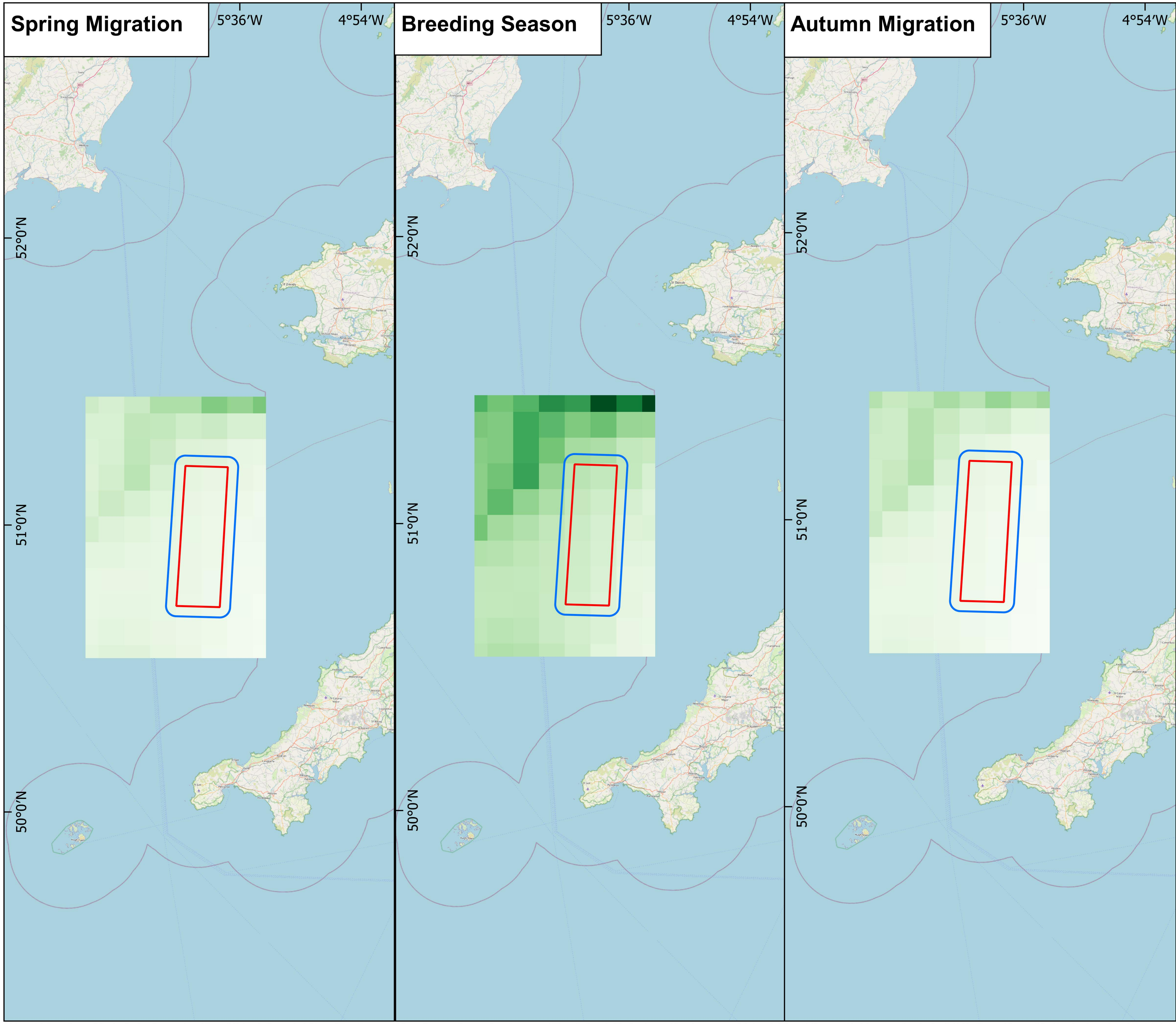

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 5: Manx Shearwater Density Map (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average number of Manx Shearwater per Km²

- 0.0455
- 0.1128
- 0.1800
- 0.2472
- 0.3144
- 0.3817
- 0.4489
- 0.5109
- 0.5627

Waggitt et al., 2019

Scale @ A3: 1:1,500,000
Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84
0 20 40 60 80 km
N

Date: 26-09-22	Prepared by: JO	Checked by: SS
Ref: GB203055_M_012_B		

Drawing by:
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Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 6: Manx Shearwater Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Manx Shearwater: April and May
- Manx Shearwater: June and July
- Manx Shearwater: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 7: Manx Shearwater Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Manx shearwater: October (No records November - January)
- Manx shearwater: February and March

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

Date: 27-09-22	Prepared by: JO	Checked by: SS
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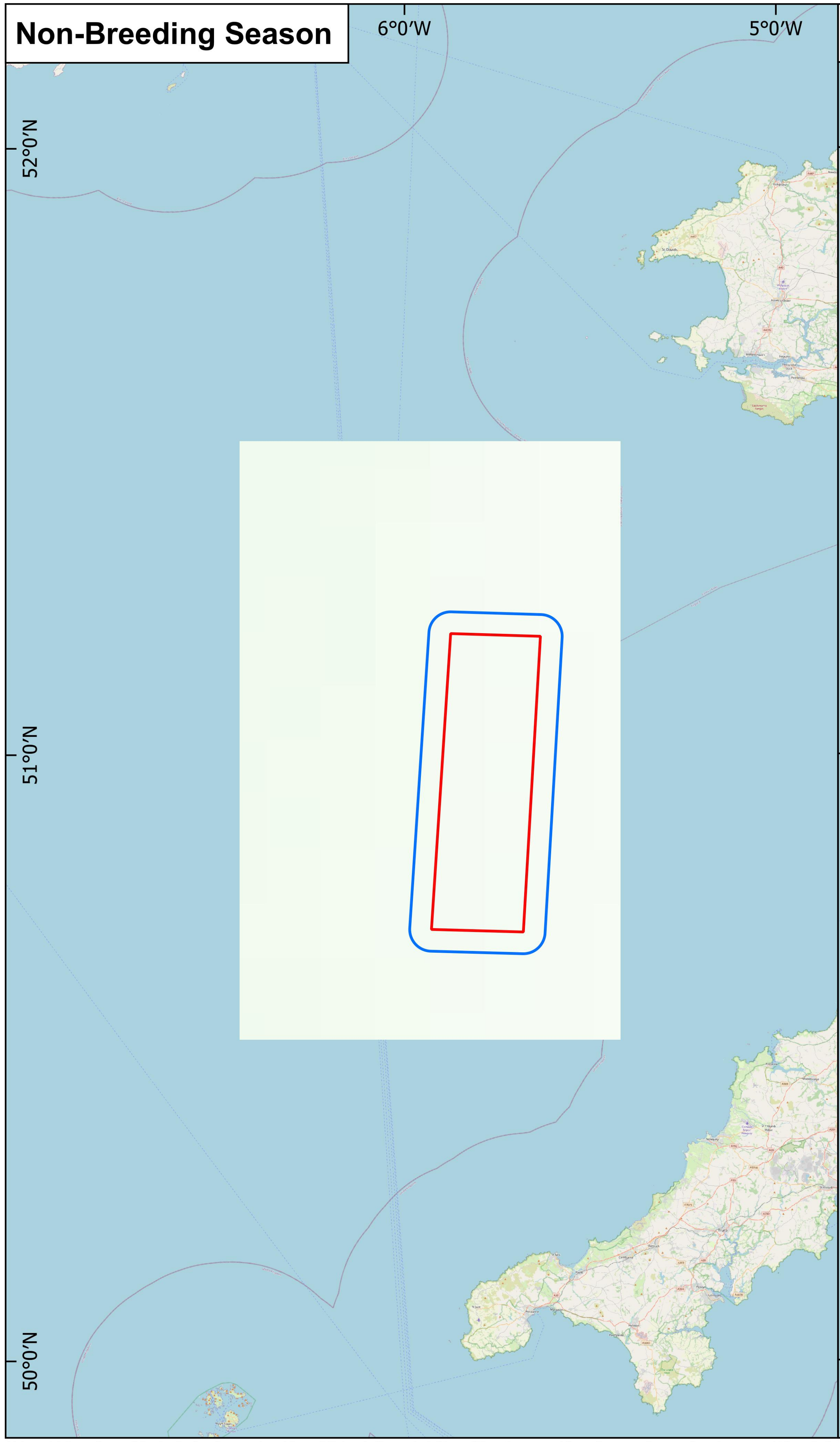

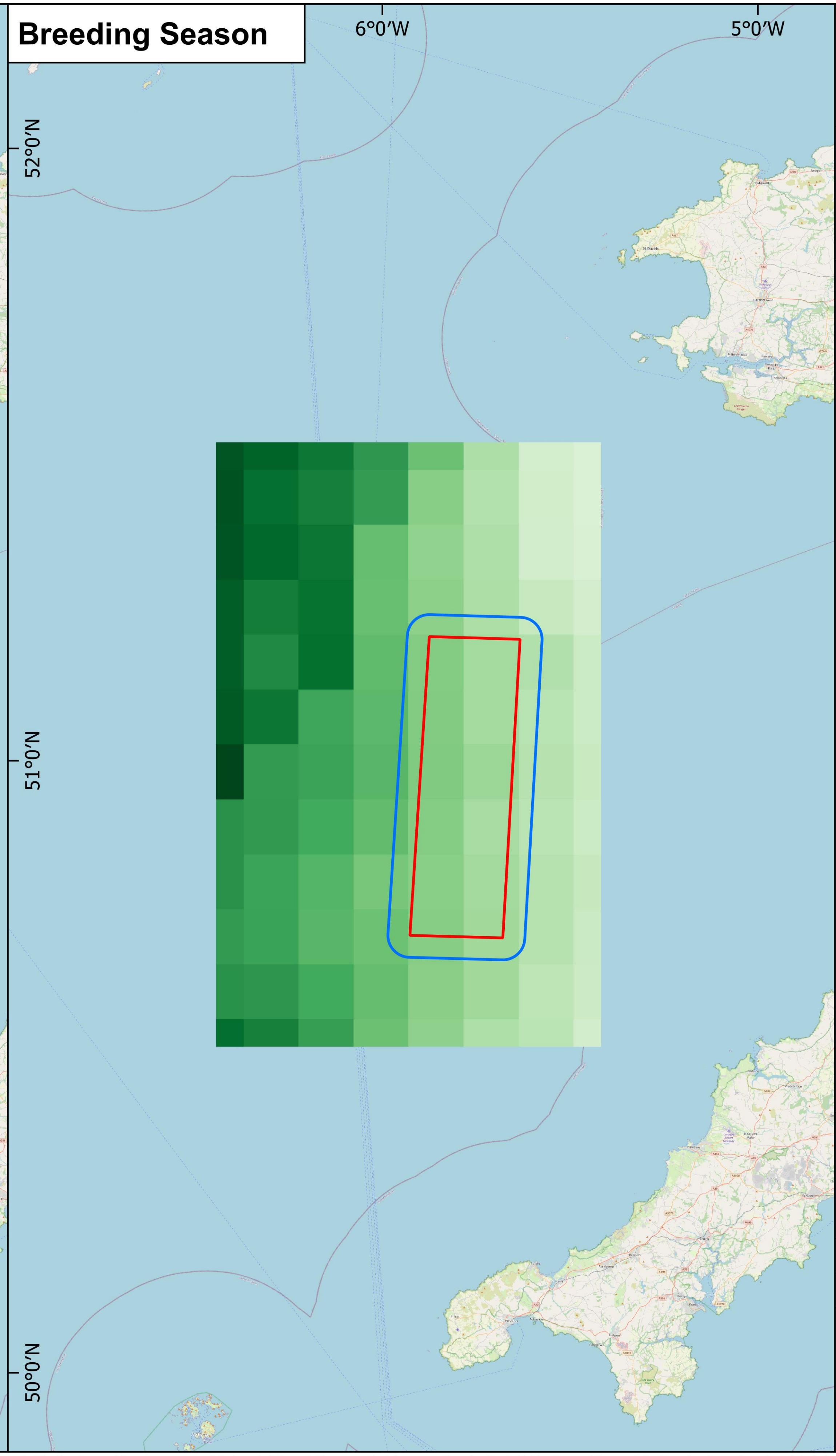

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 8: Storm Petrel Density Map (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average number of Storm Petrel per Km²

- 0.0006
- 0.0062
- 0.0118
- 0.0175
- 0.0231
- 0.0287
- 0.0343
- 0.0395
- 0.0438

Scale @ A3: 1:1,000,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 10 20 30 40 km

N

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Title:

Figure 9: Storm Petrel Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Storm Petrel: April and May
- Storm Petrel: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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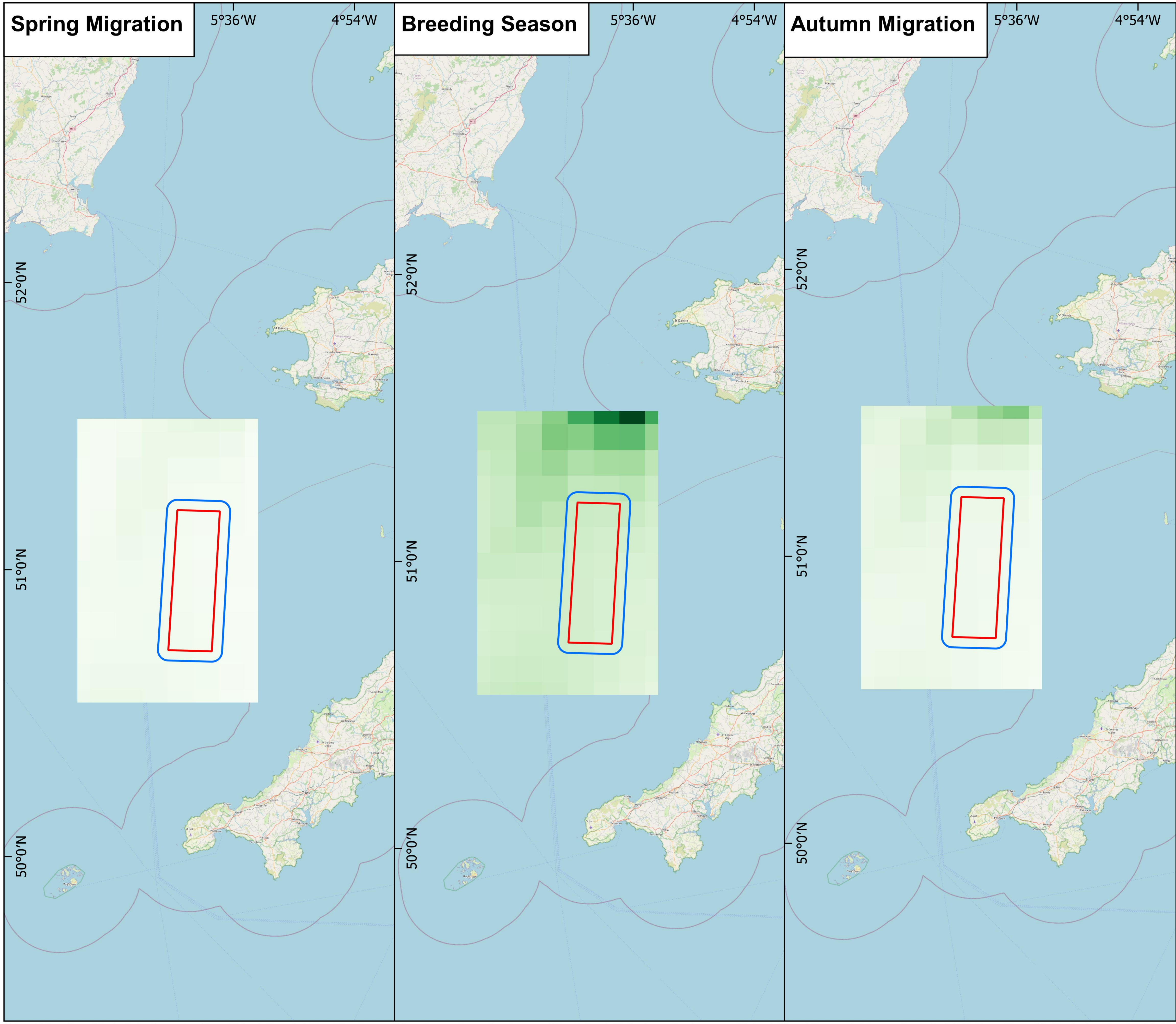

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 10: Northern Gannet Density Map (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average number of Northern Gannet per Km²

- 0.2288
- 0.3275
- 0.4262
- 0.5248
- 0.6235
- 0.7222
- 0.8209
- 0.9120
- 0.9879

Waggitt et al., 2019

Scale @ A3: 1:1,500,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 20 40 60 80 km

N

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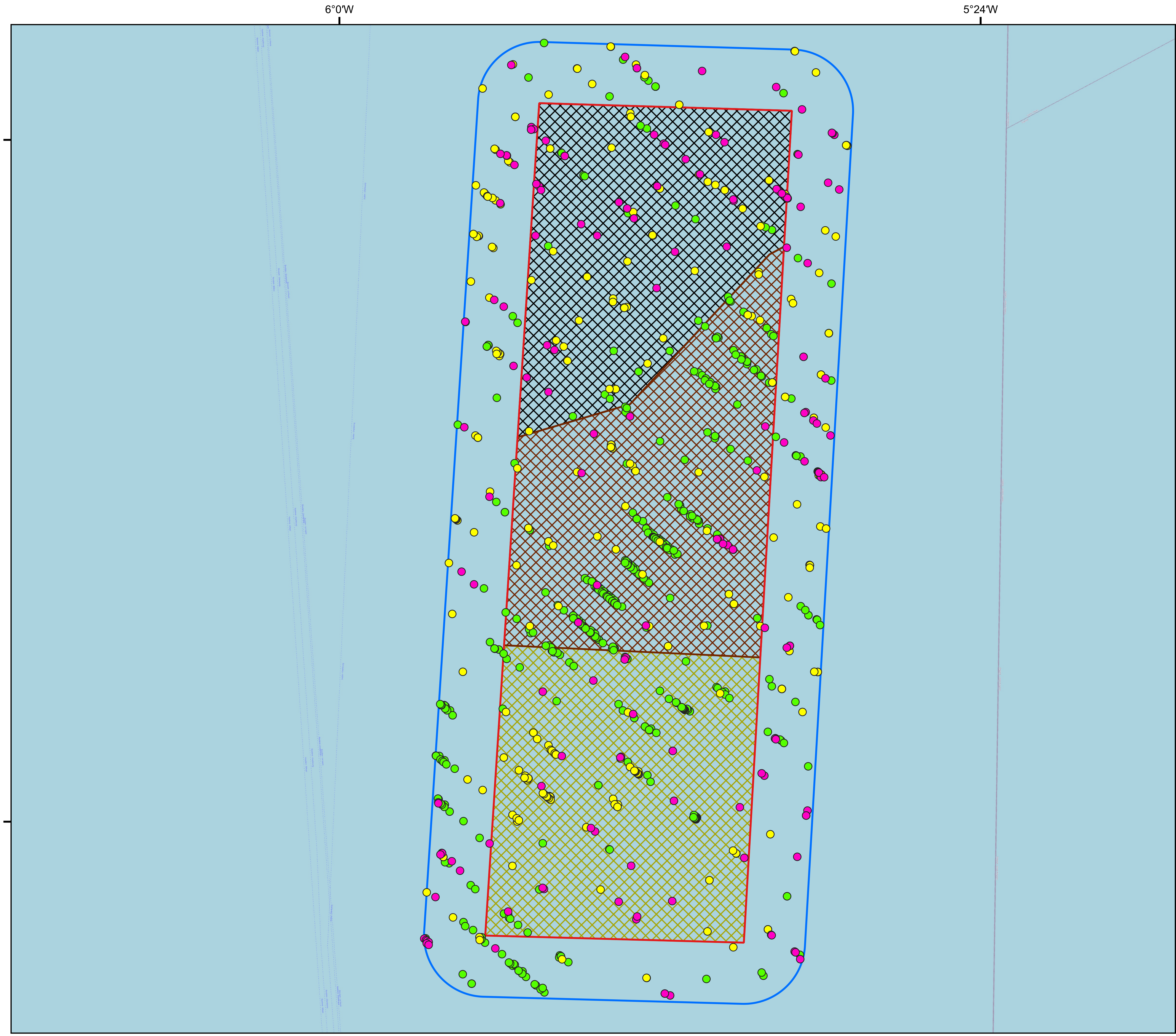

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 11: Gannet Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Gannet: April and May
- Gannet: June and July
- Gannet: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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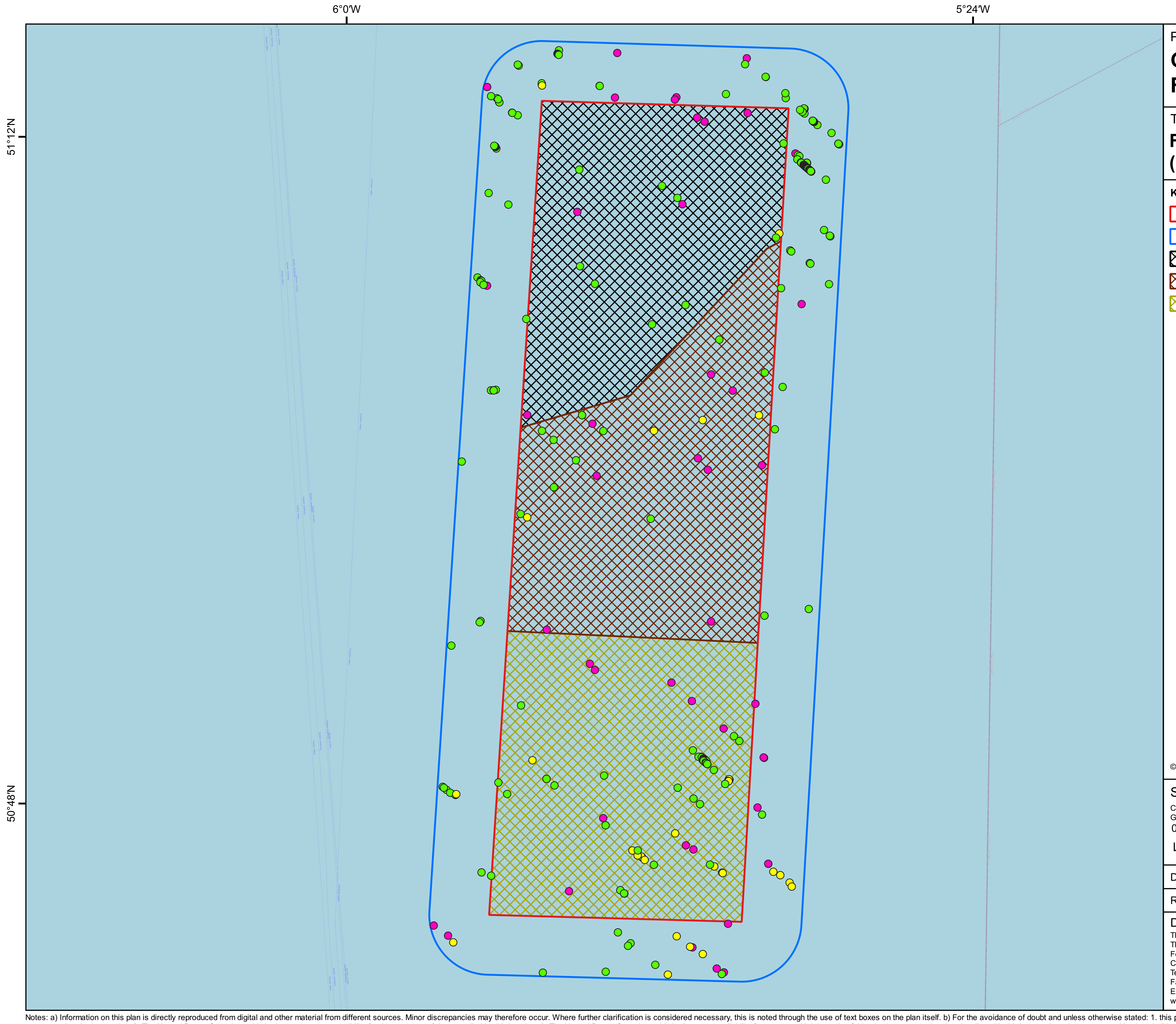

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 12: Gannet Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Gannet: October and November
- Gannet: December and January
- Gannet: February and March

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Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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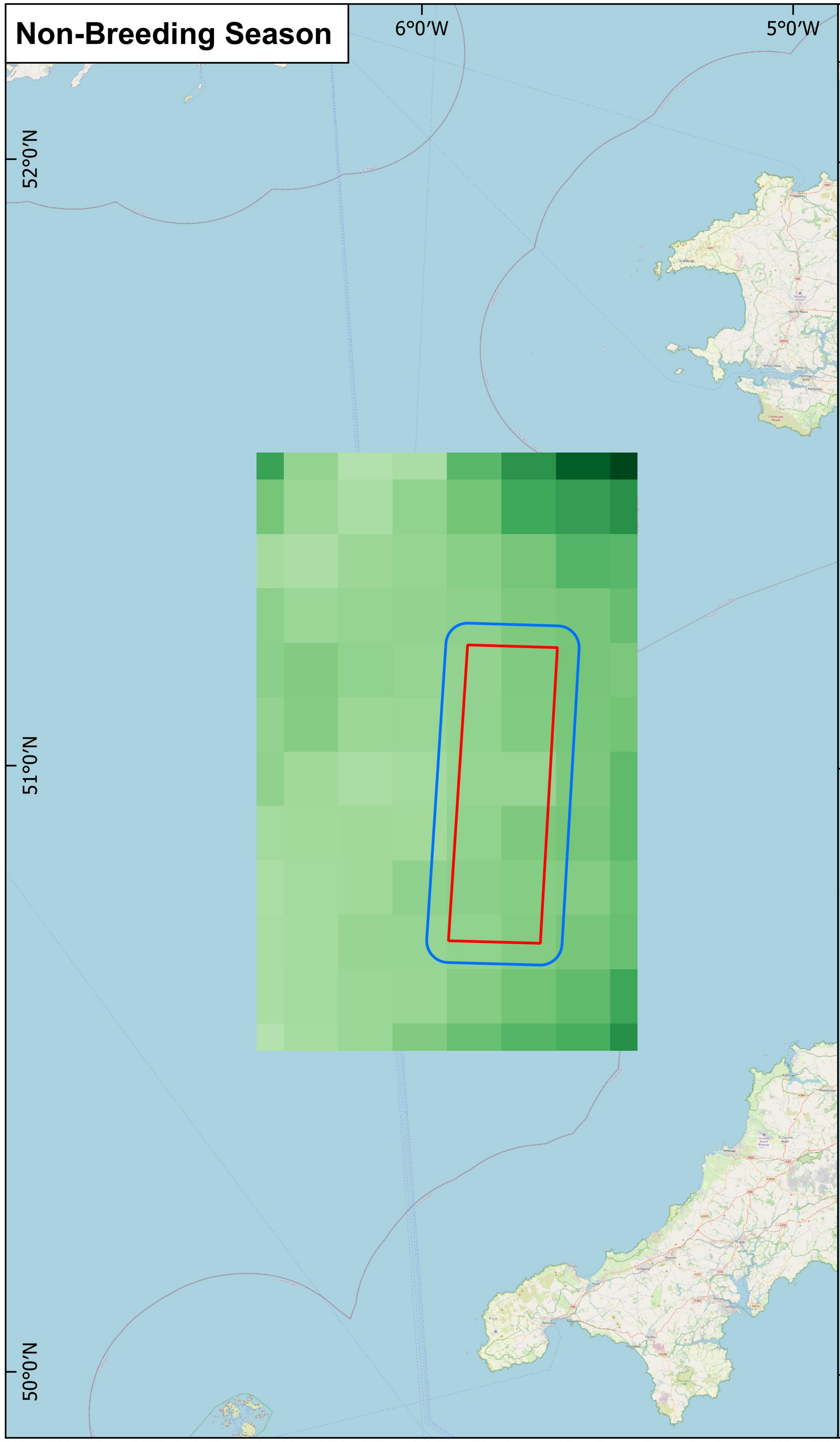

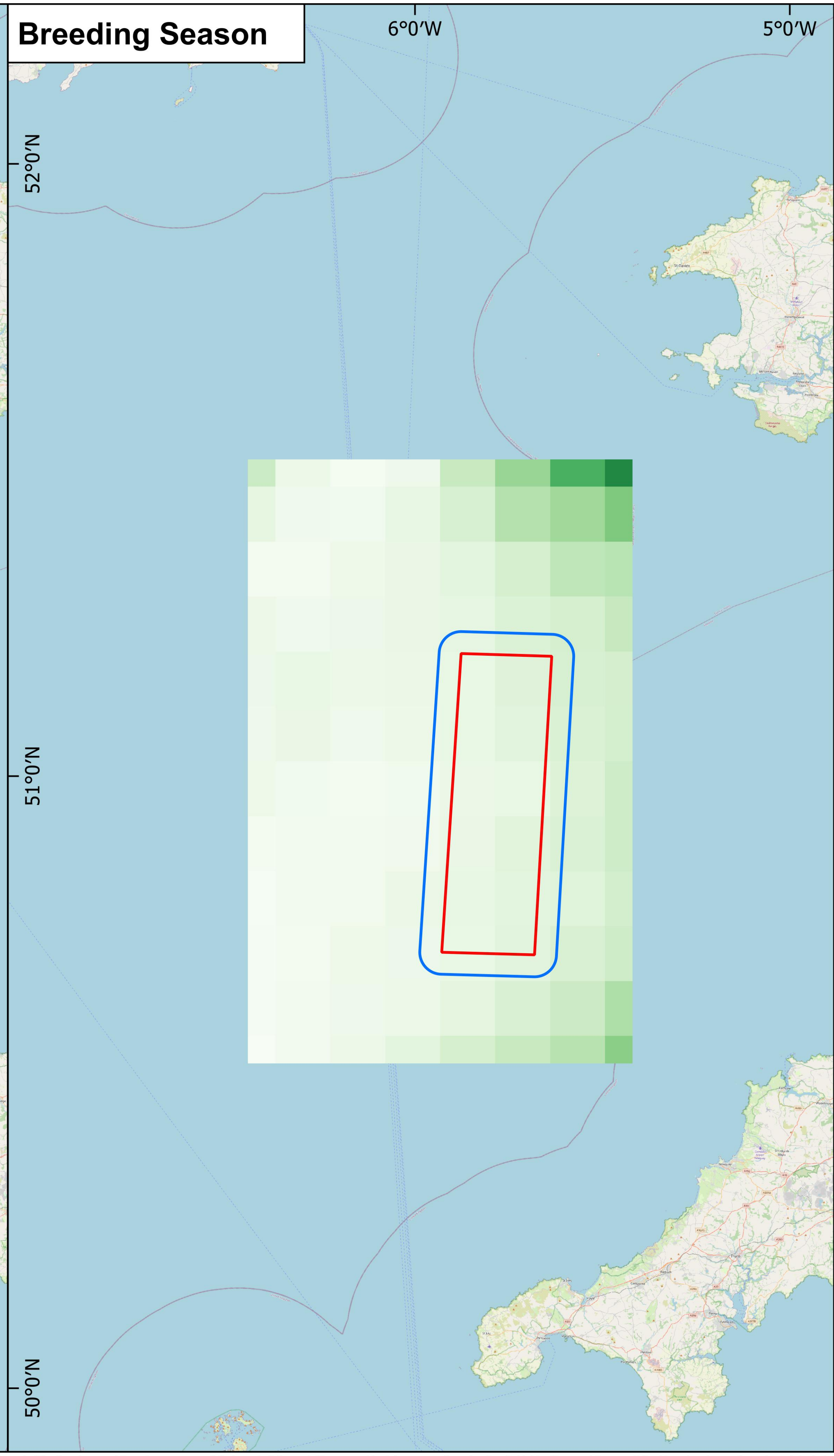

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 13: Herring Gull Density (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average number of Herring Gull per Km²

- 0.0269
- 0.0325
- 0.0381
- 0.0438
- 0.0494
- 0.0550
- 0.0607
- 0.0659
- 0.0702

Scale @ A3: 1:1,000,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 10 20 30 40 km

N

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Title:

Figure 14: Herring gull Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Herring gull: April and May
- Herring gull: June and July
- Herring gull: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 15: Herring Gull Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Herring gull: October and November
- Herring gull: December and January
- Herring gull: February and March

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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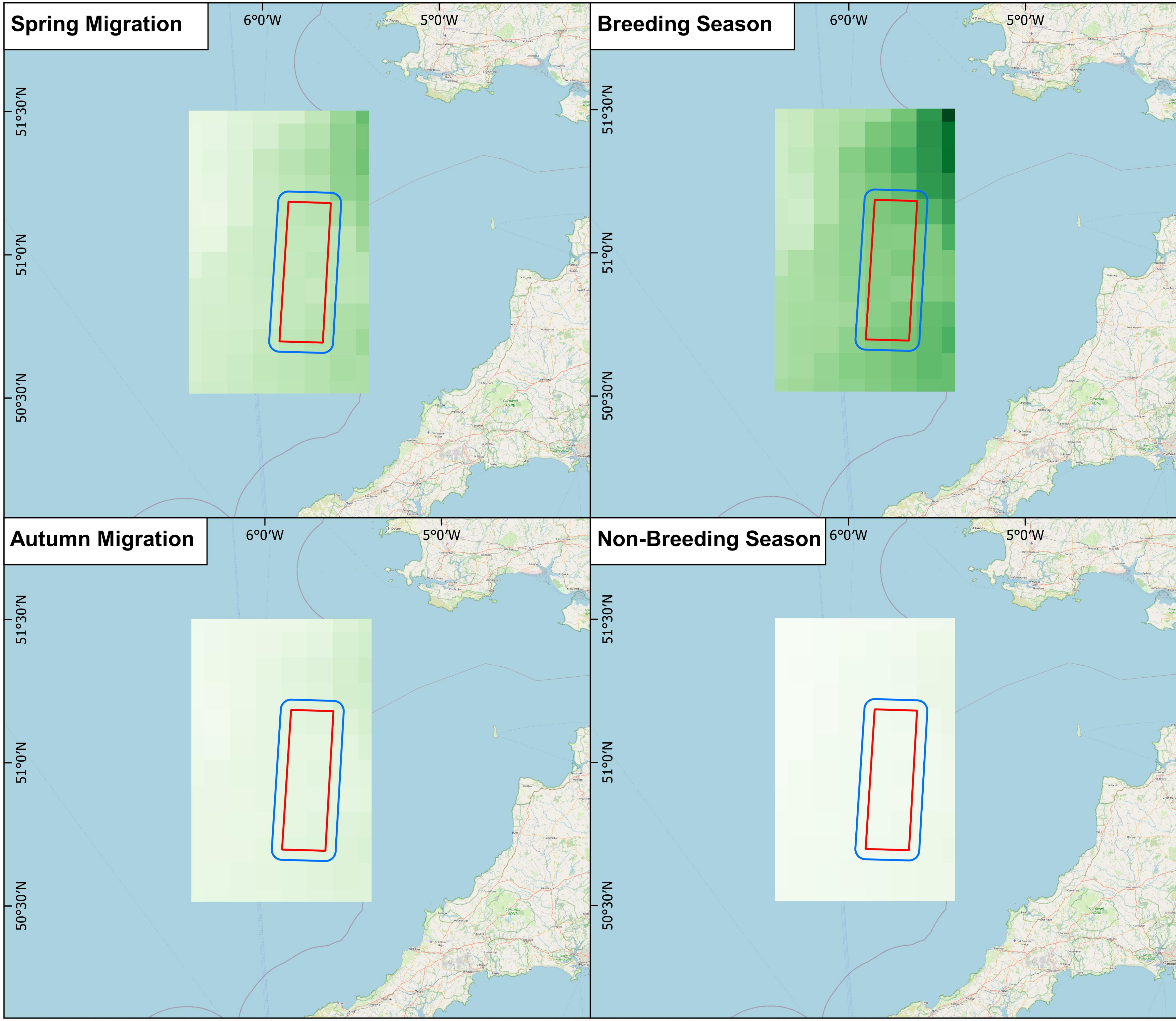

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 16: Lesser Black-Backed Gull Density (Waggitt et al., 2019)

Key

Gwynt Glas option area

4 km buffer of Gwynt Glas option area

Average number of Lesser Black-Backed Gull per Km²

0.0131
0.0453
0.0774
0.1095
0.1417
0.1738
0.2059
0.2356
0.2603

Scale @ A3: 1:1,500,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 15 30 45 60 km

N

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Title:

Figure 17: Lesser Black-Backed Gull Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Lesser Black-Backed gull: April and May
- Lesser Black-Backed gull: June and July
- Lesser Black-Backed gull: September

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Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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Title:

Figure 18: Lesser Black-backed Gull Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Lesser black-backed gull: October and November
- Lesser black-backed gull: December and January
- Lesser black-backed gull: February and March

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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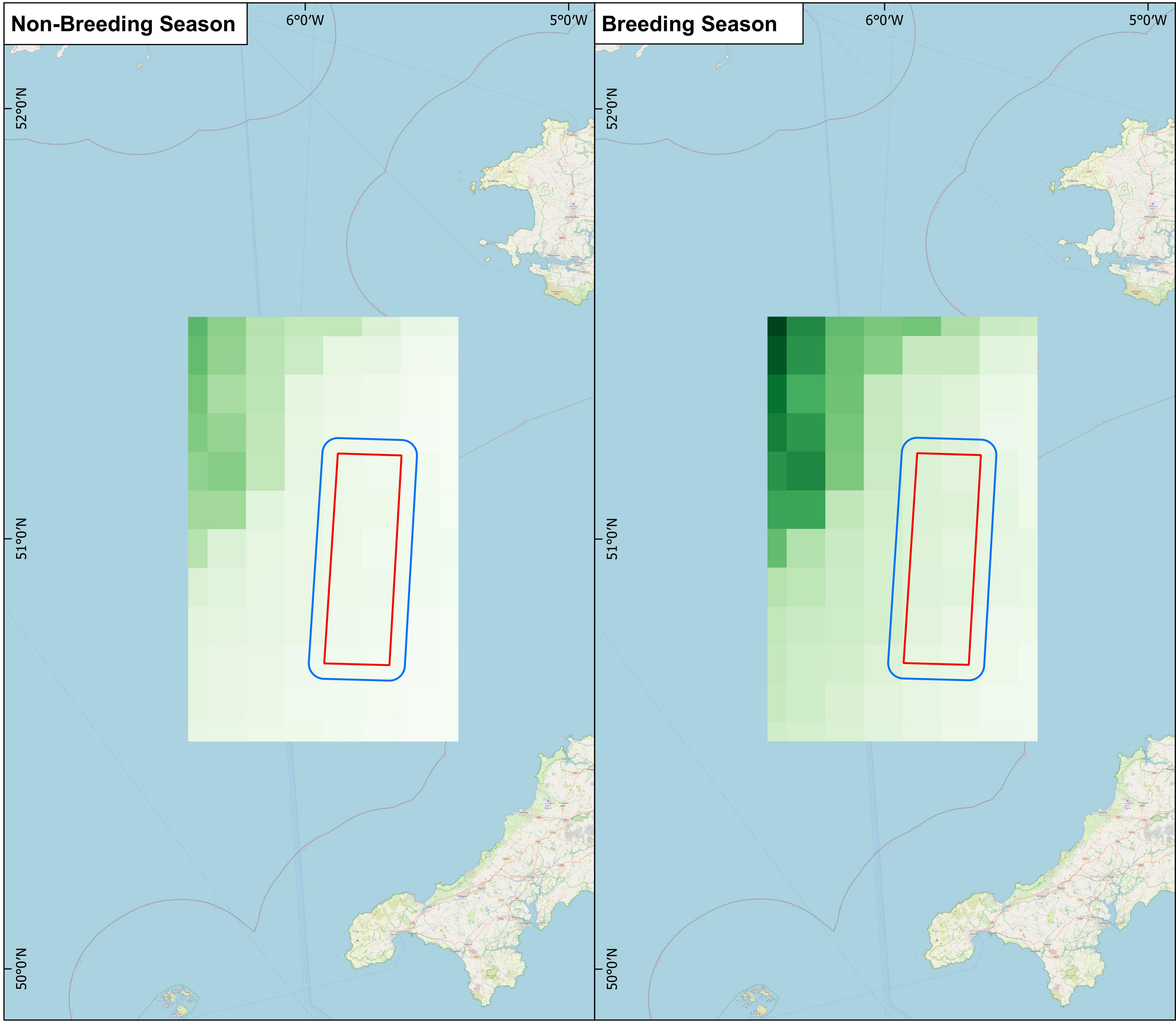

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 19: Puffin Density (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average number of Puffin per Km²

- 0.0021
- 0.0064
- 0.0106
- 0.0149
- 0.0191
- 0.0234
- 0.0276
- 0.0315
- 0.0348

Scale @ A3: 1:1,000,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 10 20 30 40 km

N

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Title:

Figure 20: Puffin Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Puffin: April and May
- Puffin: June and July
- Puffin: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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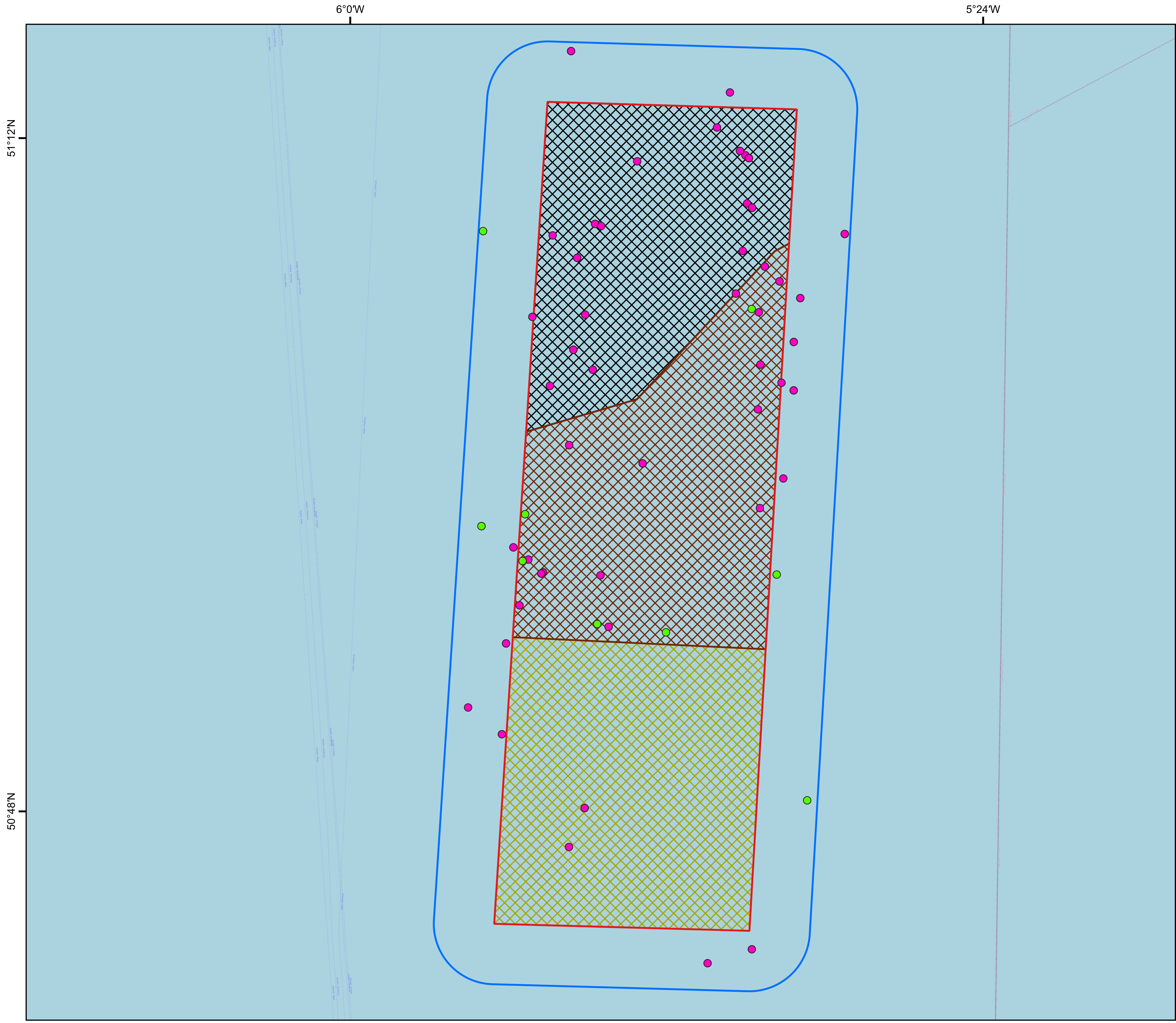

Project:

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Title:

Figure 21: Puffin Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Puffin: October and November (No records December - February)
- Puffin: March

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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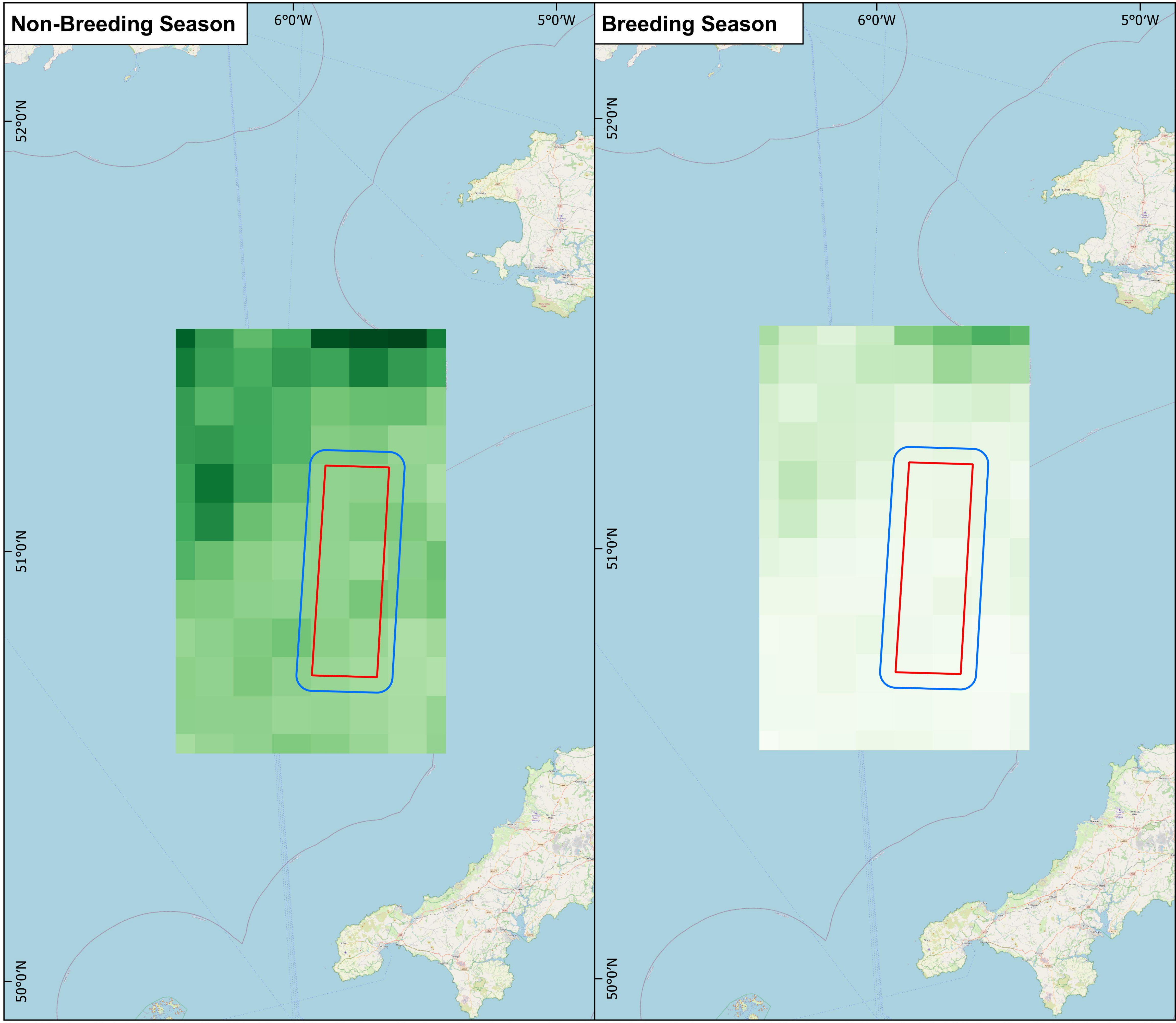

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 22: Guillemot Density (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average number of Guillemot per Km²

- 0.3412
- 0.4252
- 0.5093
- 0.5933
- 0.6773
- 0.7613
- 0.8454
- 0.9229
- 0.9876

Waggitt et al., 2019

Scale @ A3: 1:1,000,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 10 20 30 40 km

N

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Title:

Figure 23: Guillemot Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Guillemot: April and May
- Guillemot: June and July
- Guillemot: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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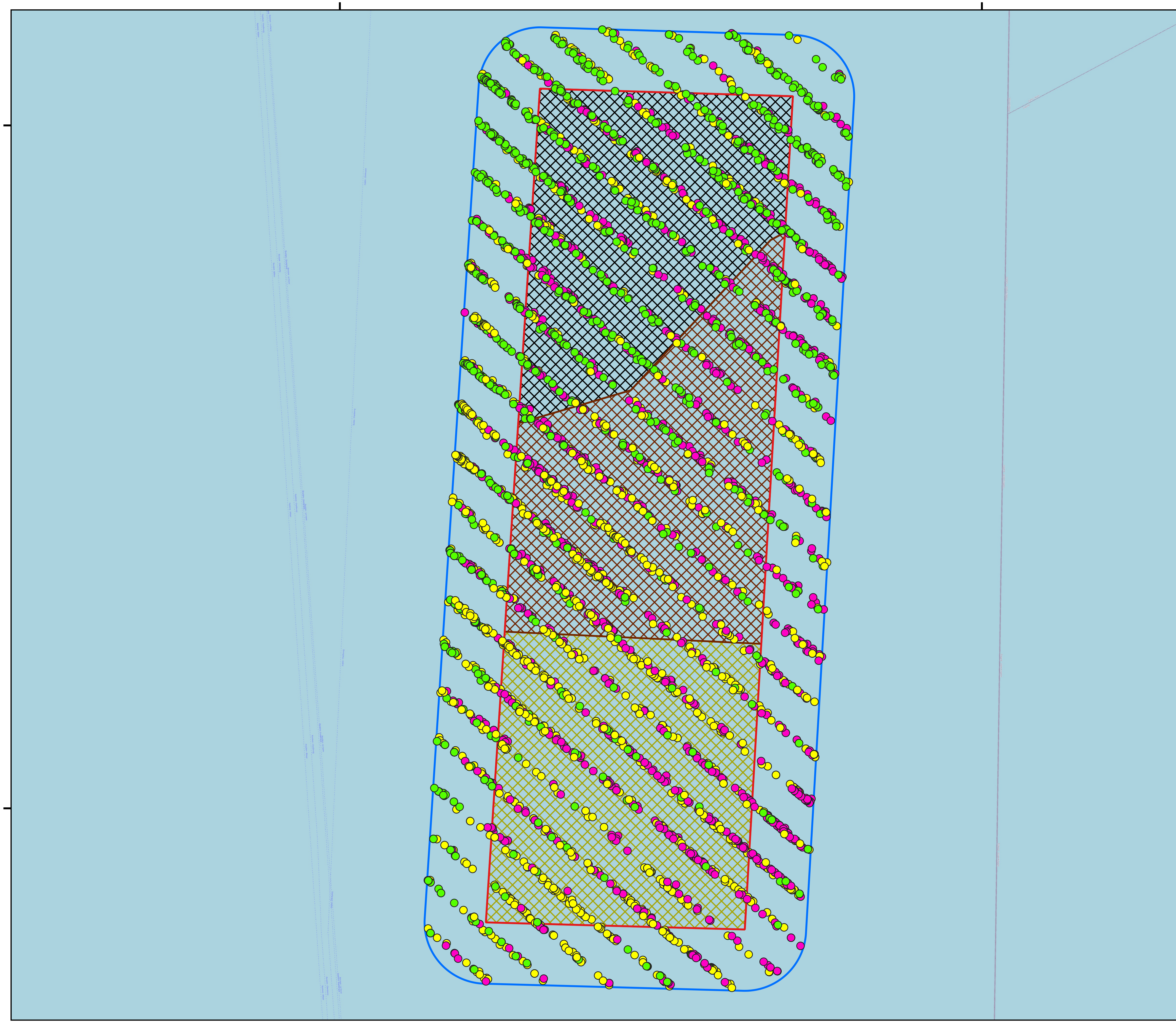

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 24: Guillemot Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Guillemot: October and November
- Guillemot: December and January
- Guillemot: February and March

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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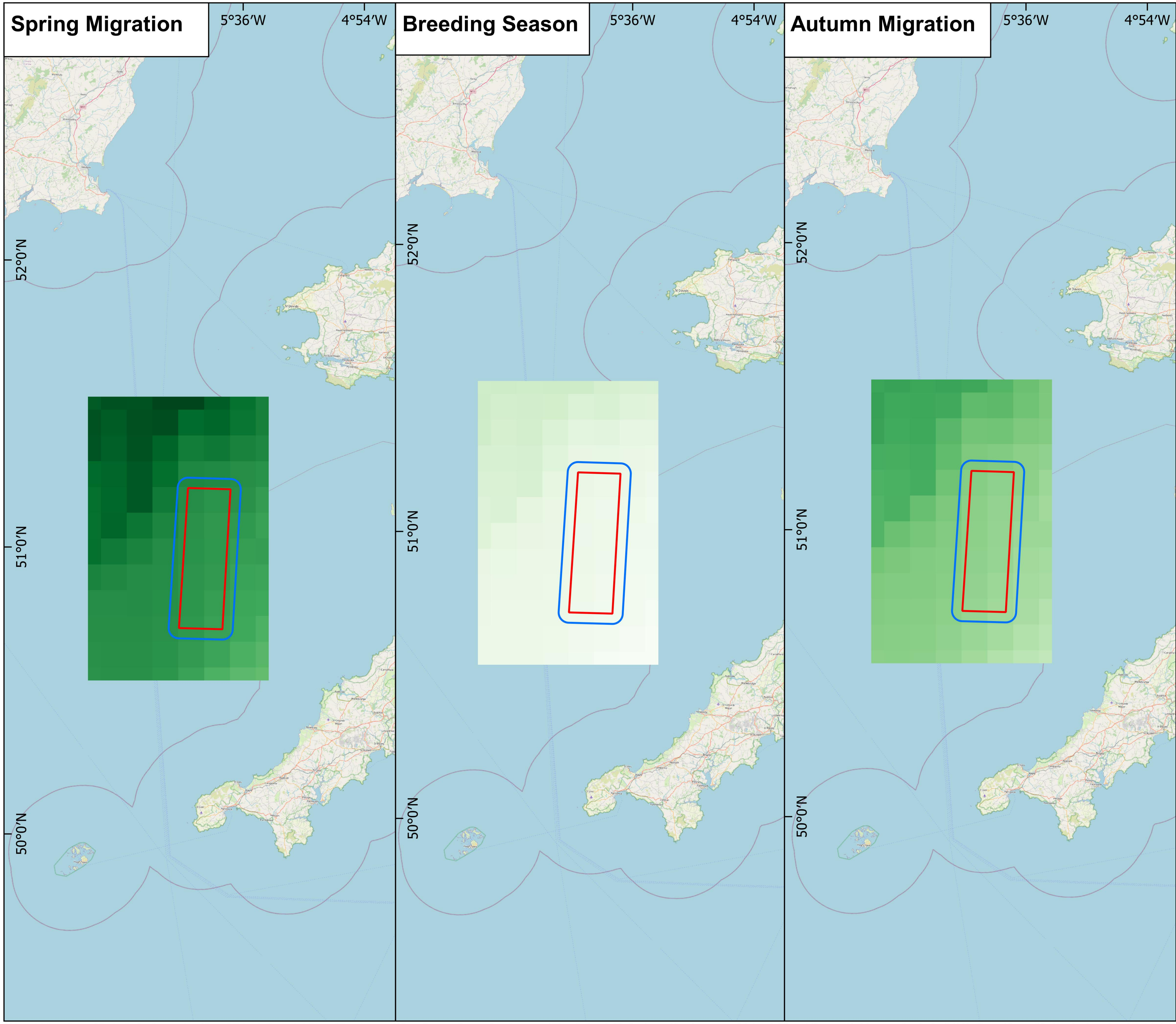

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 25: Kittiwake Density (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average number of Kittiwake per Km²

- 0.1148
- 0.1617
- 0.2085
- 0.2554
- 0.3023
- 0.3492
- 0.3960
- 0.4393
- 0.4754

Scale @ A3: 1:1,500,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 20 40 60 80 km

N

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Title:

Figure 26: Kittiwake, Great Black-Backed Gull and Large Gull Species Distribution (April to September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Kittiwake: April and May
- Kittiwake: June and July
- Kittiwake: September
- Great Black-Backed Gull: April and May
- Great Black-Backed Gull: June and July
- Great Black-Backed Gull: September
- Large Gull Species: April and May
- Large Gull Species: June and July
- Large Gull Species: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

Date: 27-09-22	Prepared by: JO	Checked by: SS

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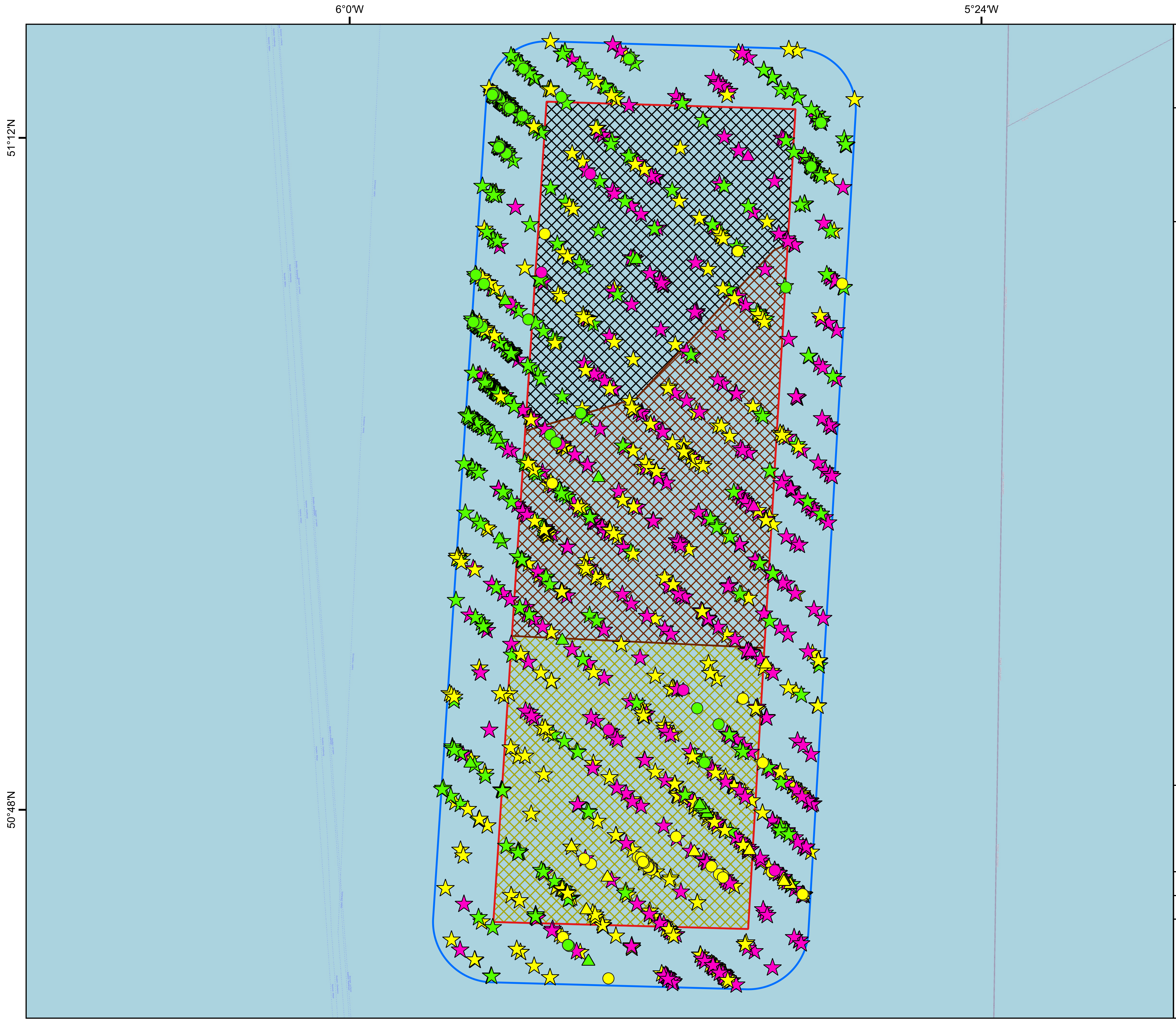

Project:

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Title:

Figure 27: Kittiwake, Great Black-backed Gull and Large Gull Species Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Kittiwake: October and November
- Kittiwake: December and January
- Kittiwake: February and March
- Great black-backed gull: October and November
- Great black-backed gull: December and January
- Great black-backed gull: February and March
- Large gull species: October and November
- Large gull species: December and January
- Large gull species: February and March

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

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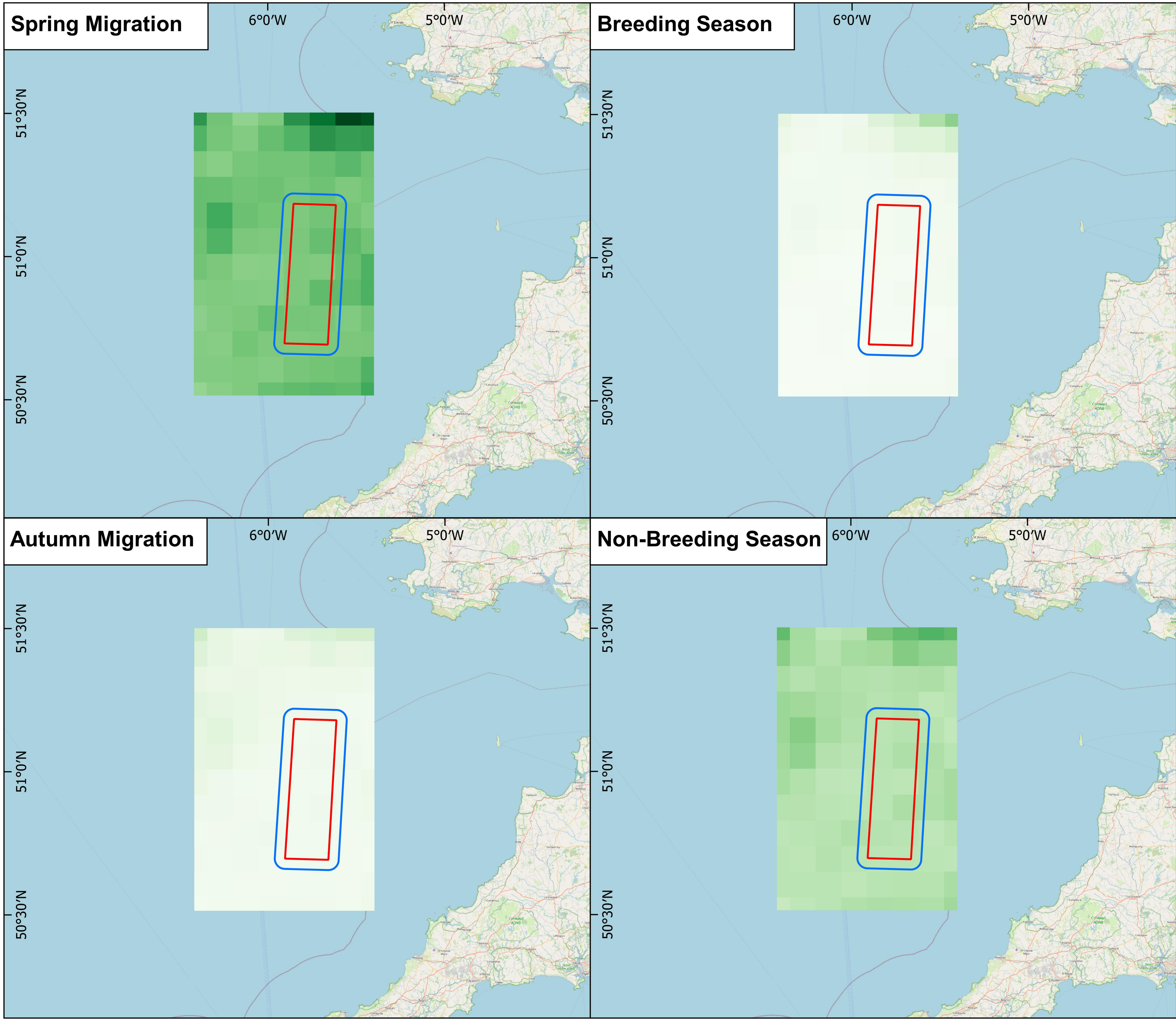

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 28: Razorbill Density (Waggitt et al., 2019)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area

Average number of Razorbill per Km²

- 0.0252
- 0.0561
- 0.0871
- 0.1181
- 0.1491
- 0.1801
- 0.2111
- 0.2397
- 0.2636

Waggitt et al., 2019

Scale @ A3: 1:1,500,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 15 30 45 60 km

N

Date: 27-09-22	Prepared by: JO	Checked by: SS
Ref: GB203055_M_006_B		

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Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 29: Razorbill and Unidentified Auks Distribution (April - September 2021)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Razorbill: April and May
- Razorbill: June and July
- Razorbill: September
- Unidentified Auks: April and May
- Unidentified Auks: June and July
- Unidentified Auks: September

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

Date: 27-09-22	Prepared by: JO	Checked by: SS
Ref: GB203055_M_022_B		

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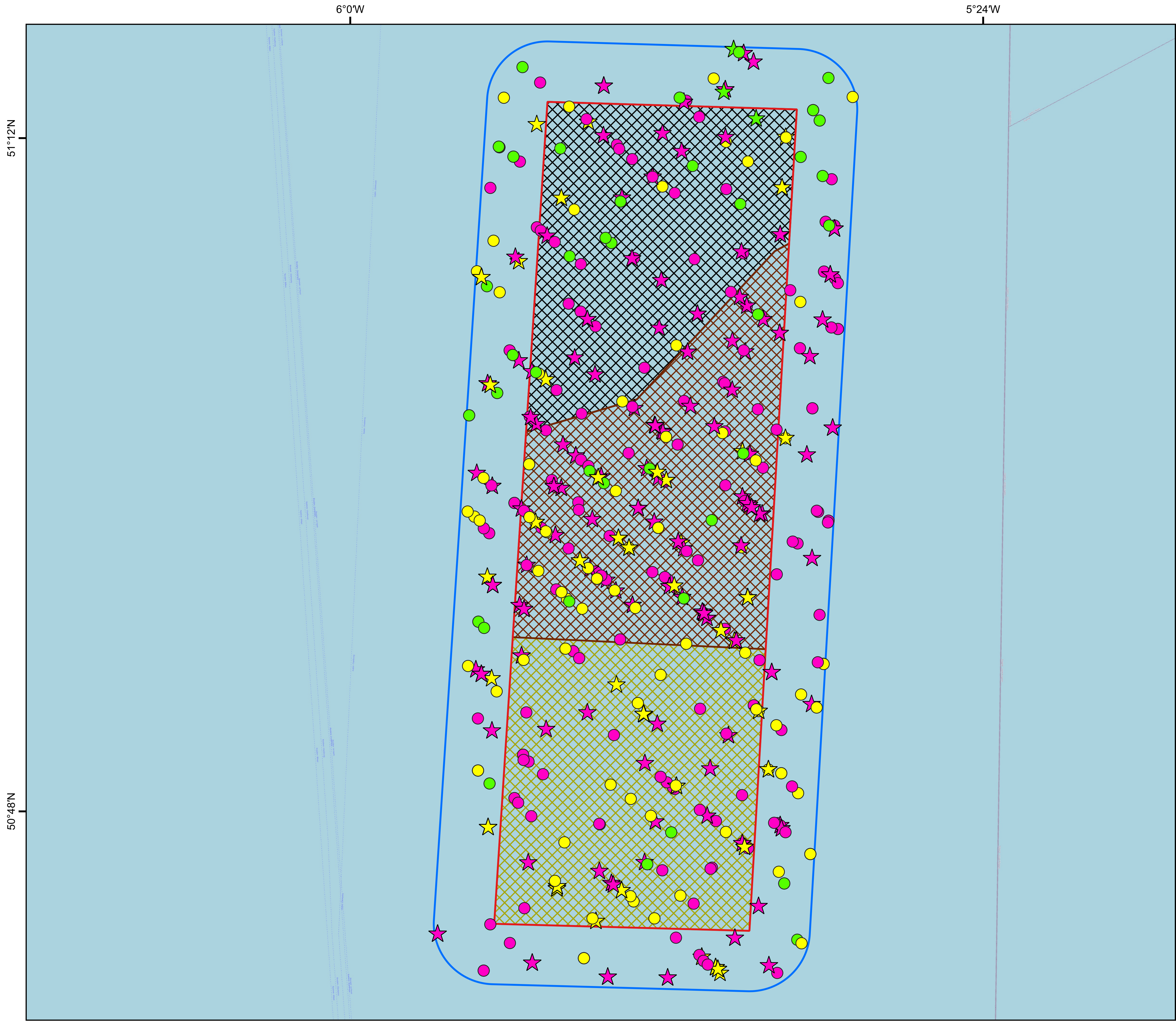

Project:

Gwynt Glas Offshore Wind Farm, Celtic Sea

Title:

Figure 30: Razorbill and Unidentified Auk Species Distribution (October 2021 to March 2022)

Key

- Gwynt Glas option area
- 4 km buffer of Gwynt Glas option area
- Subsite A
- Subsite B
- Subsite C
- Razorbill: October and November
- Razorbill: December and January
- Razorbill: February and March
- Unidentified auks: October and November
- Unidentified auks: December and January
- Unidentifed auks: February and March

Scale @ A3: 1:250,000

Coordinate System: WGS84 UTM Zone 30N
Graticules: WGS84

0 3 6 9 12 km

N

Date: 27-09-22	Prepared by: JO	Checked by: SS

Ref: GB203055_M_042_A

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Appendix B

Displacement Matrixes

Table B.1- Manx shearwater Displacement Spring Migration

	Proportion Mortality															
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	1.3	2.7	4	5.3	6.7	13.3	26.6	39.9	53.2	66.5	79.8	93.1	106.4	119.7	133
	10%	13.3	26.6	39.9	53.2	66.5	133	266.1	399.1	532.2	665.2	798.2	931.3	1064.3	1197.4	1330.4
	20%	26.6	53.2	79.8	106.4	133	266.1	532.2	798.2	1064.3	1330.4	1596.5	1862.6	2128.6	2394.7	2660.8
	30%	39.9	79.8	119.7	159.6	199.6	399.1	798.2	1197.4	1596.5	1995.6	2394.7	2793.8	3193	3592.1	3991.2
	40%	53.2	106.4	159.6	212.9	266.1	532.2	1064.3	1596.5	2128.6	2660.8	3193	3725.1	4257.3	4789.4	5321.6
	50%	66.5	133	199.6	266.1	332.6	665.2	1330.4	1995.6	2660.8	3326	3991.2	4656.4	5321.6	5986.8	6652
	60%	79.8	159.6	239.5	319.3	399.1	798.2	1596.5	2394.7	3193	3991.2	4789.4	5587.7	6385.9	7184.2	7982.4
	70%	93.1	186.3	279.4	372.5	465.6	931.3	1862.6	2793.8	3725.1	4656.4	5587.7	6519	7450.2	8381.5	9312.8
	80%	106.4	212.9	319.3	425.7	532.2	1064.3	2128.6	3193	4257.3	5321.6	6385.9	7450.2	8514.6	9578.9	10643.2
	90%	119.7	239.5	359.2	478.9	598.7	1197.4	2394.7	3592.1	4789.4	5986.8	7184.2	8381.5	9578.9	10776.2	11973.6
	100%	133	266.1	399.1	532.2	665.2	1330.4	2660.8	3991.2	5321.6	6652	7982.4	9312.8	10643.2	11973.6	13304

Table B.2- Manx shearwater Displacement MFBS

		Proportion Mortality														
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	1.7	3.5	5.2	7	8.7	17.4	34.9	52.3	69.7	87.2	104.6	122	139.5	156.9	174.3
	10%	17.4	34.9	52.3	69.7	87.2	174.4	348.7	523	697.4	871.8	1046.1	1220.4	1394.8	1569.2	1743.5
	20%	34.9	69.7	104.6	139.5	174.4	348.7	697.4	1046.1	1394.8	1743.5	2092.2	2440.9	2789.6	3138.3	3487
	30%	52.3	104.6	156.9	209.2	261.5	523.1	1046.1	1569.1	2092.2	2615.2	3138.3	3661.3	4184.4	4707.4	5230.5
	40%	69.7	139.5	209.2	279	348.7	697.4	1394.8	2092.2	2789.6	3487	4184.4	4881.8	5579.2	6276.6	6974
	50%	87.2	174.3	261.5	348.7	435.9	871.8	1743.5	2615.2	3487	4358.8	5230.5	6102.2	6974	7845.8	8717.5
	60%	104.6	209.2	313.8	418.4	523.1	1046.1	2092.2	3138.3	4184.4	5230.5	6276.6	7322.7	8368.8	9414.9	10461
	70%	122	244.1	366.1	488.2	610.2	1220.4	2440.9	3661.3	4881.8	6102.2	7322.7	8543.1	9763.6	10984.1	12204.5
	80%	139.5	279	418.4	557.9	697.4	1394.8	2789.6	4184.4	5579.2	6974	8368.8	9763.6	11158.4	12553.2	13948
	90%	156.9	313.8	470.7	627.7	784.6	1569.2	3138.3	4707.4	6276.6	7845.8	9414.9	10984	12553.2	14122.4	15691.5
	100%	174.3	348.7	523	697.4	871.8	1743.5	3487	5230.5	6974	8717.5	10461	12204.5	13948	15691.5	17435

Table B.3- Manx shearwater Displacement Autumn Migration

	Proportion Mortality															
Proportion Displaced		**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	1%	0.1	0.3	0.4	0.5	0.7	1.3	2.7	4	5.3	6.7	8	9.3	10.6	12	13.3
	10%	1.3	2.7	4	5.3	6.7	13.3	26.6	39.9	53.2	66.5	79.8	93.1	106.4	119.7	133
	20%	2.7	5.3	8	10.6	13.3	26.6	53.2	79.8	106.4	133	159.6	186.2	212.8	239.4	266
	30%	4	8	12	16	20	39.9	79.8	119.7	159.6	199.5	239.4	279.3	319.2	359.1	399
	40%	5.3	10.6	16	21.3	26.6	53.2	106.4	159.6	212.8	266	319.2	372.4	425.6	478.8	532
	50%	6.7	13.3	20	26.6	33.2	66.5	133	199.5	266	332.5	399	465.5	532	598.5	665
	60%	8	16	23.9	31.9	39.9	79.8	159.6	239.4	319.2	399	478.8	558.6	638.4	718.2	798
	70%	9.3	18.6	27.9	37.2	46.5	93.1	186.2	279.3	372.4	465.5	558.6	651.7	744.8	837.9	931
	80%	10.6	21.3	31.9	42.6	53.2	106.4	212.8	319.2	425.6	532	638.4	744.8	851.2	957.6	1064
	90%	12	23.9	35.9	47.9	59.9	119.7	239.4	359.1	478.8	598.5	718.2	837.9	957.6	1077.3	1197
	100%	13.3	26.6	39.9	53.2	66.5	133	266	399	532	665	798	931	1064	1197	1330

Table B.4- Gannet Displacement Spring Migration

	Proportion Mortality															
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	0	0	0.1	0.1	0.1	0.2	0.4	0.6	0.8	1	1.3	1.5	1.7	1.9	2.1
	10%	0.2	0.4	0.6	0.8	1	2.1	4.2	6.3	8.4	10.5	12.6	14.7	16.8	18.9	21
	20%	0.4	0.8	1.3	1.7	2.1	4.2	8.4	12.6	16.8	21	25.2	29.4	33.6	37.8	42
	30%	0.6	1.3	1.9	2.5	3.2	6.3	12.6	18.9	25.2	31.5	37.8	44.1	50.4	56.7	63
	40%	0.8	1.7	2.5	3.4	4.2	8.4	16.8	25.2	33.6	42	50.4	58.8	67.2	75.6	84
	50%	1	2.1	3.1	4.2	5.2	10.5	21	31.5	42	52.5	63	73.5	84	94.5	105
	60%	1.3	2.5	3.8	5	6.3	12.6	25.2	37.8	50.4	63	75.6	88.2	100.8	113.4	126
	70%	1.5	2.9	4.4	5.9	7.4	14.7	29.4	44.1	58.8	73.5	88.2	102.9	117.6	132.3	147
	80%	1.7	3.4	5	6.7	8.4	16.8	33.6	50.4	67.2	84	100.8	117.6	134.4	151.2	168
	90%	1.9	3.8	5.7	7.6	9.5	18.9	37.8	56.7	75.6	94.5	113.4	132.3	151.2	170.1	189
	100%	2.1	4.2	6.3	8.4	10.5	21	42	63	84	105	126	147	168	189	210

Table B.5- Gannet Displacement Autumn Migration

		Proportion Mortality														
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	0.3	0.6	1	1.3	1.6	3.2	6.5	9.7	12.9	16.2	19.4	22.6	25.8	29.1	32.3
	10%	3.2	6.5	9.7	12.9	16.2	32.3	64.6	96.9	129.2	161.6	193.9	226.2	258.5	290.8	323.1
	20%	6.5	12.9	19.4	25.8	32.3	64.6	129.2	193.9	258.5	323.1	387.7	452.3	517	581.6	646.2
	30%	9.7	19.4	29.1	38.8	48.5	96.9	193.9	290.8	387.7	484.6	581.6	678.5	775.4	872.4	969.3
	40%	12.9	25.8	38.8	51.7	64.6	129.2	258.5	387.7	517	646.2	775.4	904.7	1033.9	1163.2	1292.4
	50%	16.2	32.3	48.5	64.6	80.8	161.6	323.1	484.6	646.2	807.8	969.3	1130.8	1292.4	1454	1615.5
	60%	19.4	38.8	58.2	77.5	96.9	193.9	387.7	581.6	775.4	969.3	1163.2	1357	1550.9	1744.7	1938.6
	70%	22.6	45.2	67.9	90.5	113.1	226.2	452.3	678.5	904.7	1130.8	1357	1583.2	1809.4	2035.5	2261.7
	80%	25.8	51.7	77.5	103.4	129.2	258.5	517	775.4	1033.9	1292.4	1550.9	1809.4	2067.8	2326.3	2584.8
	90%	29.1	58.2	87.2	116.3	145.4	290.8	581.6	872.4	1163.2	1454	1744.7	2035.5	2326.3	2617.1	2907.9
	100%	32.3	64.6	96.9	129.2	161.6	323.1	646.2	969.3	1292.4	1615.5	1938.6	2261.7	2584.8	2907.9	3231

Table B.6- Gannet Displacement MFBS

	Proportion Mortality														
Proportion Displaced		**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	1%	0.4	0.8	1.2	1.6	1.9	3.9	7.8	11.6	15.5	19.4	23.3	27.2	31	34.9	38.8
	10%	3.9	7.8	11.6	15.5	19.4	38.8	77.6	116.4	155.2	194.1	232.9	271.7	310.5	349.3	388.1
	20%	7.8	15.5	23.3	31	38.8	77.6	155.2	232.9	310.5	388.1	465.7	543.3	621	698.6	776.2
	30%	11.6	23.3	34.9	46.6	58.2	116.4	232.9	349.3	465.7	582.1	698.6	815	931.4	1047.9	1164.3
	40%	15.5	31	46.6	62.1	77.6	155.2	310.5	465.7	621	776.2	931.4	1086.7	1241.9	1397.2	1552.4
	50%	19.4	38.8	58.2	77.6	97	194.1	388.1	582.1	776.2	970.2	1164.3	1358.3	1552.4	1746.4	1940.5
	60%	23.3	46.6	69.9	93.1	116.4	232.9	465.7	698.6	931.4	1164.3	1397.2	1630	1862.9	2095.7	2328.6
	70%	27.2	54.3	81.5	108.7	135.8	271.7	543.3	815	1086.7	1358.3	1630	1901.7	2173.4	2445	2716.7
	80%	31	62.1	93.1	124.2	155.2	310.5	621	931.4	1241.9	1552.4	1862.9	2173.4	2483.8	2794.3	3104.8
	90%	34.9	69.9	104.8	139.7	174.6	349.3	698.6	1047.9	1397.2	1746.4	2095.7	2445	2794.3	3143.6	3492.9
	100%	38.8	77.6	116.4	155.2	194.1	388.1	776.2	1164.3	1552.4	1940.5	2328.6	2716.7	3104.8	3492.9	3881

Table B.7- Puffin Displacement MFBS

	Proportion Mortality															
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	0.1	0.2	0.2	0.3	0.4	0.8	1.6	2.5	3.3	4.1	4.9	5.7	6.6	7.4	8.2
	10%	0.8	1.6	2.5	3.3	4.1	8.2	16.4	24.6	32.8	41	49.2	57.4	65.6	73.8	82
	20%	1.6	3.3	4.9	6.6	8.2	16.4	32.8	49.2	65.6	82	98.4	114.8	131.2	147.6	164
	30%	2.5	4.9	7.4	9.8	12.3	24.6	49.2	73.8	98.4	123	147.6	172.2	196.8	221.4	246
	40%	3.3	6.6	9.8	13.1	16.4	32.8	65.6	98.4	131.2	164	196.8	229.6	262.4	295.2	328
	50%	4.1	8.2	12.3	16.4	20.5	41	82	123	164	205	246	287	328	369	410
	60%	4.9	9.8	14.8	19.7	24.6	49.2	98.4	147.6	196.8	246	295.2	344.4	393.6	442.8	492
	70%	5.7	11.5	17.2	23	28.7	57.4	114.8	172.2	229.6	287	344.4	401.8	459.2	516.6	574
	80%	6.6	13.1	19.7	26.2	32.8	65.6	131.2	196.8	262.4	328	393.6	459.2	524.8	590.4	656
	90%	7.4	14.8	22.1	29.5	36.9	73.8	147.6	221.4	295.2	369	442.8	516.6	590.4	664.2	738
	100%	8.2	16.4	24.6	32.8	41	82	164	246	328	410	492	574	656	738	820

Table B.8- Puffin Displacement Non-breeding season

	Proportion Mortality															
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	0.1	0.2	0.2	0.3	0.4	0.8	1.6	2.4	3.2	4	4.8	5.6	6.4	7.2	8
	10%	0.8	1.6	2.4	3.2	4	8	16	24	32	40	48	56	64	72	80
	20%	1.6	3.2	4.8	6.4	8	16	32	48	64	80	96	112	128	144	160
	30%	2.4	4.8	7.2	9.6	12	24	48	72	96	120	144	168	192	216	240
	40%	3.2	6.4	9.6	12.8	16	32	64	96	128	160	192	224	256	288	320
	50%	4	8	12	16	20	40	80	120	160	200	240	280	320	360	400
	60%	4.8	9.6	14.4	19.2	24	48	96	144	192	240	288	336	384	432	480
	70%	5.6	11.2	16.8	22.4	28	56	112	168	224	280	336	392	448	504	560
	80%	6.4	12.8	19.2	25.6	32	64	128	192	256	320	384	448	512	576	640
	90%	7.2	14.4	21.6	28.8	36	72	144	216	288	360	432	504	576	648	720
	100%	8	16	24	32	40	80	160	240	320	400	480	560	640	720	800

Table B.9- Guillemot Displacement MFBS

		Proportion Mortality														
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	0.6	1.1	1.7	2.2	2.8	5.6	11.1	16.7	22.2	27.8	33.3	38.9	44.4	50	55.5
	10%	5.6	11.1	16.7	22.2	27.8	55.5	111	166.6	222.1	277.6	333.1	388.6	444.2	499.7	555.2
	20%	11.1	22.2	33.3	44.4	55.5	111	222.1	333.1	444.2	555.2	666.2	777.3	888.3	999.4	1110.4
	30%	16.7	33.3	50	66.6	83.3	166.6	333.1	499.7	666.2	832.8	999.4	1165.9	1332.5	1499	1665.6
	40%	22.2	44.4	66.6	88.8	111	222.1	444.2	666.2	888.3	1110.4	1332.5	1554.6	1776.6	1998.7	2220.8
	50%	27.8	55.5	83.3	111	138.8	277.6	555.2	832.8	1110.4	1388	1665.6	1943.2	2220.8	2498.4	2776
	60%	33.3	66.6	99.9	133.2	166.6	333.1	666.2	999.4	1332.5	1665.6	1998.7	2331.8	2665	2998.1	3331.2
	70%	38.9	77.7	116.6	155.5	194.3	388.6	777.3	1165.9	1554.6	1943.2	2331.8	2720.5	3109.1	3497.8	3886.4
	80%	44.4	88.8	133.2	177.7	222.1	444.2	888.3	1332.5	1776.6	2220.8	2665	3109.1	3553.3	3997.4	4441.6
	90%	50	99.9	149.9	199.9	249.8	499.7	999.4	1499	1998.7	2498.4	2998.1	3497.8	3997.4	4497.1	4996.8
	100%	55.5	111	166.6	222.1	277.6	555.2	1110.4	1665.6	2220.8	2776	3331.2	3886.4	4441.6	4996.8	5552

Table B.10- Guillemot Displacement Non-breeding Season

	Proportion Mortality															
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	1	2	3.1	4.1	5.1	10.2	20.4	30.6	40.8	51	61.2	71.4	81.5	91.7	101.9
	10%	10.2	20.4	30.6	40.8	51	101.9	203.9	305.8	407.7	509.7	611.6	713.5	815.4	917.4	1019.3
	20%	20.4	40.8	61.2	81.5	101.9	203.9	407.7	611.6	815.4	1019.3	1223.2	1427	1630.9	1834.7	2038.6
	30%	30.6	61.2	91.7	122.3	152.9	305.8	611.6	917.4	1223.2	1529	1834.7	2140.5	2446.3	2752.1	3057.9
	40%	40.8	81.5	122.3	163.1	203.9	407.7	815.4	1223.2	1630.9	2038.6	2446.3	2854	3261.8	3669.5	4077.2
	50%	51	101.9	152.9	203.9	254.8	509.7	1019.3	1529	2038.6	2548.2	3057.9	3567.5	4077.2	4586.9	5096.5
	60%	61.2	122.3	183.5	244.6	305.8	611.6	1223.2	1834.7	2446.3	3057.9	3669.5	4281.1	4892.6	5504.2	6115.8
	70%	71.4	142.7	214.1	285.4	356.8	713.5	1427	2140.5	2854	3567.5	4281.1	4994.6	5708.1	6421.6	7135.1
	80%	81.5	163.1	244.6	326.2	407.7	815.4	1630.9	2446.3	3261.8	4077.2	4892.6	5708.1	6523.5	7339	8154.4
	90%	91.7	183.5	275.2	366.9	458.7	917.4	1834.7	2752.1	3669.5	4586.9	5504.2	6421.6	7339	8256.3	9173.7
	100%	101.9	203.9	305.8	407.7	509.7	1019.3	2038.6	3057.9	4077.2	5096.5	6115.8	7135.1	8154.4	9173.7	10193

Table B.11- Razorbill Displacement Spring Migration

		Proportion Mortality														
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	0.3	0.6	0.9	1.2	1.5	3	5.9	8.9	11.9	14.9	17.8	20.8	23.8	26.7	29.7
	10%	3	5.9	8.9	11.9	14.9	29.7	59.4	89.1	118.8	148.6	178.3	208	237.7	267.4	297.1
	20%	5.9	11.9	17.8	23.8	29.7	59.4	118.8	178.3	237.7	297.1	356.5	415.9	475.4	534.8	594.2
	30%	8.9	17.8	26.7	35.7	44.6	89.1	178.3	267.4	356.5	445.6	534.8	623.9	713	802.2	891.3
	40%	11.9	23.8	35.7	47.5	59.4	118.8	237.7	356.5	475.4	594.2	713	831.9	950.7	1069.6	1188.4
	50%	14.9	29.7	44.6	59.4	74.3	148.6	297.1	445.6	594.2	742.8	891.3	1039.8	1188.4	1337	1485.5
	60%	17.8	35.7	53.5	71.3	89.1	178.3	356.5	534.8	713	891.3	1069.6	1247.8	1426.1	1604.3	1782.6
	70%	20.8	41.6	62.4	83.2	104	208	415.9	623.9	831.9	1039.8	1247.8	1455.8	1663.8	1871.7	2079.7
	80%	23.8	47.5	71.3	95.1	118.8	237.7	475.4	713	950.7	1188.4	1426.1	1663.8	1901.4	2139.1	2376.8
	90%	26.7	53.5	80.2	107	133.7	267.4	534.8	802.2	1069.6	1337	1604.3	1871.7	2139.1	2406.5	2673.9
	100%	29.7	59.4	89.1	118.8	148.6	297.1	594.2	891.3	1188.4	1485.5	1782.6	2079.7	2376.8	2673.9	2971

Table B.12- Razorbill Displacement MFBS

		Proportion Mortality														
Proportion Displaced		**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	1%	0.1	0.1	0.2	0.2	0.3	0.5	1	1.6	2.1	2.6	3.1	3.6	4.2	4.7	5.2
	10%	0.5	1	1.6	2.1	2.6	5.2	10.4	15.6	20.8	26	31.2	36.4	41.6	46.8	52
	20%	1	2.1	3.1	4.2	5.2	10.4	20.8	31.2	41.6	52	62.4	72.8	83.2	93.6	104
	30%	1.6	3.1	4.7	6.2	7.8	15.6	31.2	46.8	62.4	78	93.6	109.2	124.8	140.4	156
	40%	2.1	4.2	6.2	8.3	10.4	20.8	41.6	62.4	83.2	104	124.8	145.6	166.4	187.2	208
	50%	2.6	5.2	7.8	10.4	13	26	52	78	104	130	156	182	208	234	260
	60%	3.1	6.2	9.4	12.5	15.6	31.2	62.4	93.6	124.8	156	187.2	218.4	249.6	280.8	312
	70%	3.6	7.3	10.9	14.6	18.2	36.4	72.8	109.2	145.6	182	218.4	254.8	291.2	327.6	364
	80%	4.2	8.3	12.5	16.6	20.8	41.6	83.2	124.8	166.4	208	249.6	291.2	332.8	374.4	416
	90%	4.7	9.4	14	18.7	23.4	46.8	93.6	140.4	187.2	234	280.8	327.6	374.4	421.2	468
	100%	5.2	10.4	15.6	20.8	26	52	104	156	208	260	312	364	416	468	520

Table B.13- Razorbill Displacement Autumn Migration

		Proportion Mortality														
Proportion Displaced		1%	2%	3%	4%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	1%	0	0.1	0.1	0.2	0.2	0.4	0.9	1.3	1.8	2.2	2.6	3.1	3.5	4	4.4
	10%	0.4	0.9	1.3	1.8	2.2	4.4	8.8	13.2	17.6	22	26.4	30.8	35.2	39.6	44
	20%	0.9	1.8	2.6	3.5	4.4	8.8	17.6	26.4	35.2	44	52.8	61.6	70.4	79.2	88
	30%	1.3	2.6	4	5.3	6.6	13.2	26.4	39.6	52.8	66	79.2	92.4	105.6	118.8	132
	40%	1.8	3.5	5.3	7	8.8	17.6	35.2	52.8	70.4	88	105.6	123.2	140.8	158.4	176
	50%	2.2	4.4	6.6	8.8	11	22	44	66	88	110	132	154	176	198	220
	60%	2.6	5.3	7.9	10.6	13.2	26.4	52.8	79.2	105.6	132	158.4	184.8	211.2	237.6	264
	70%	3.1	6.2	9.2	12.3	15.4	30.8	61.6	92.4	123.2	154	184.8	215.6	246.4	277.2	308
	80%	3.5	7	10.6	14.1	17.6	35.2	70.4	105.6	140.8	176	211.2	246.4	281.6	316.8	352
	90%	4	7.9	11.9	15.8	19.8	39.6	79.2	118.8	158.4	198	237.6	277.2	316.8	356.4	396
	100%	4.4	8.8	13.2	17.6	22	44	88	132	176	220	264	308	352	396	440

Table B.14- Razorbill Displacement Winter Season

		Proportion Mortality														
Proportion Displaced		**1%**	**2%**	**3%**	**4%**	**5%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	1%	0.1	0.2	0.3	0.4	0.5	1.1	2.2	3.2	4.3	5.4	6.5	7.6	8.6	9.7	10.8
	10%	1.1	2.2	3.2	4.3	5.4	10.8	21.6	32.4	43.2	54	64.8	75.6	86.4	97.2	108
	20%	2.2	4.3	6.5	8.6	10.8	21.6	43.2	64.8	86.4	108	129.6	151.2	172.8	194.4	216
	30%	3.2	6.5	9.7	13	16.2	32.4	64.8	97.2	129.6	162	194.4	226.8	259.2	291.6	324
	40%	4.3	8.6	13	17.3	21.6	43.2	86.4	129.6	172.8	216	259.2	302.4	345.6	388.8	432
	50%	5.4	10.8	16.2	21.6	27	54	108	162	216	270	324	378	432	486	540
	60%	6.5	13	19.4	25.9	32.4	64.8	129.6	194.4	259.2	324	388.8	453.6	518.4	583.2	648
	70%	7.6	15.1	22.7	30.2	37.8	75.6	151.2	226.8	302.4	378	453.6	529.2	604.8	680.4	756
	80%	8.6	17.3	25.9	34.6	43.2	86.4	172.8	259.2	345.6	432	518.4	604.8	691.2	777.6	864
	90%	9.7	19.4	29.2	38.9	48.6	97.2	194.4	291.6	388.8	486	583.2	680.4	777.6	874.8	972
	100%	10.8	21.6	32.4	43.2	54	108	216	324	432	540	648	756	864	972	1080

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