DOGGER BANK D WIND FARM

Preliminary Environmental Information Report

Volume 2
Appendix 13.2 Offshore Ornithology Baseline Technical Report

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Glossary

Acronym	Definition
BDMPS	Biologically defined minimum population scale
BOU	British Ornithologist’s Union
DAS	Digital aerial survey
DBA	Dogger Bank A
DBB	Dogger Bank B
DBC	Dogger Bank C
DBD	Dogger Bank D
DBS	Dogger Bank South
ECC	Export cable corridor
EIA	Environmental Impact Assessment
ES	Environmental Statement
FFC	Flamborough and Filey Coast
GSD	Ground sampling distance
HPAI	Highly pathogenic avian influenza
OWF	Offshore windfarm
PEIR	Preliminary Environmental Information Report
QA	Quality assurance
SD	Standard deviation
SPA	Special Protection Area
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body

1. Introduction

This section outlines the background to the Dogger Bank D Offshore Windfarm (DBD OWF) and the need to characterise the baseline environment, with specific reference to offshore ornithological aspects. Characterisation of the intertidal environment is provided in full detail within **Volume 2, Appendix 13.5 Intertidal Ornithology Baseline Characterisation Report**.

1.1 Project background

SSE Renewables and Equinor ('the Applicant') are proposing to develop the Dogger Bank D (DBD) Offshore Wind Farm (OWF) within the Dogger Bank Zone, which was originally identified by The Crown Estate in 2008. Within the Dogger Bank Zone, four OWFs have already been granted development consent including Dogger Bank A (DBA) (previously named Creyke Beck A), Dogger Bank B (DBB) (previously named Creyke Beck B), Dogger Bank C (DBC) (previously named Teesside A) and Sofia (previously named Teesside B).

The Array Area for the proposed DBD OWF lies entirely within the former Teesside A OWF (**Figure 1-1**). The former Teesside A OWF has now been split into the pre-construction DBC OWF and the proposed DBD OWF (**Figure 1-2**). DBD is located approximately 210 km offshore from the north-east coast of England at its closest point, with the Array Area covering approximately 262km^2. DBD will comprise both offshore and onshore infrastructure, including an offshore generating station (wind farm), export cables to landfall and an onshore converter station for connection to the electricity transmission network (please see **Volume 1, Chapter 4 Project Description**). The location of DBD is illustrated in **Figure 1-3** along with the location of the ECC and landfall site.

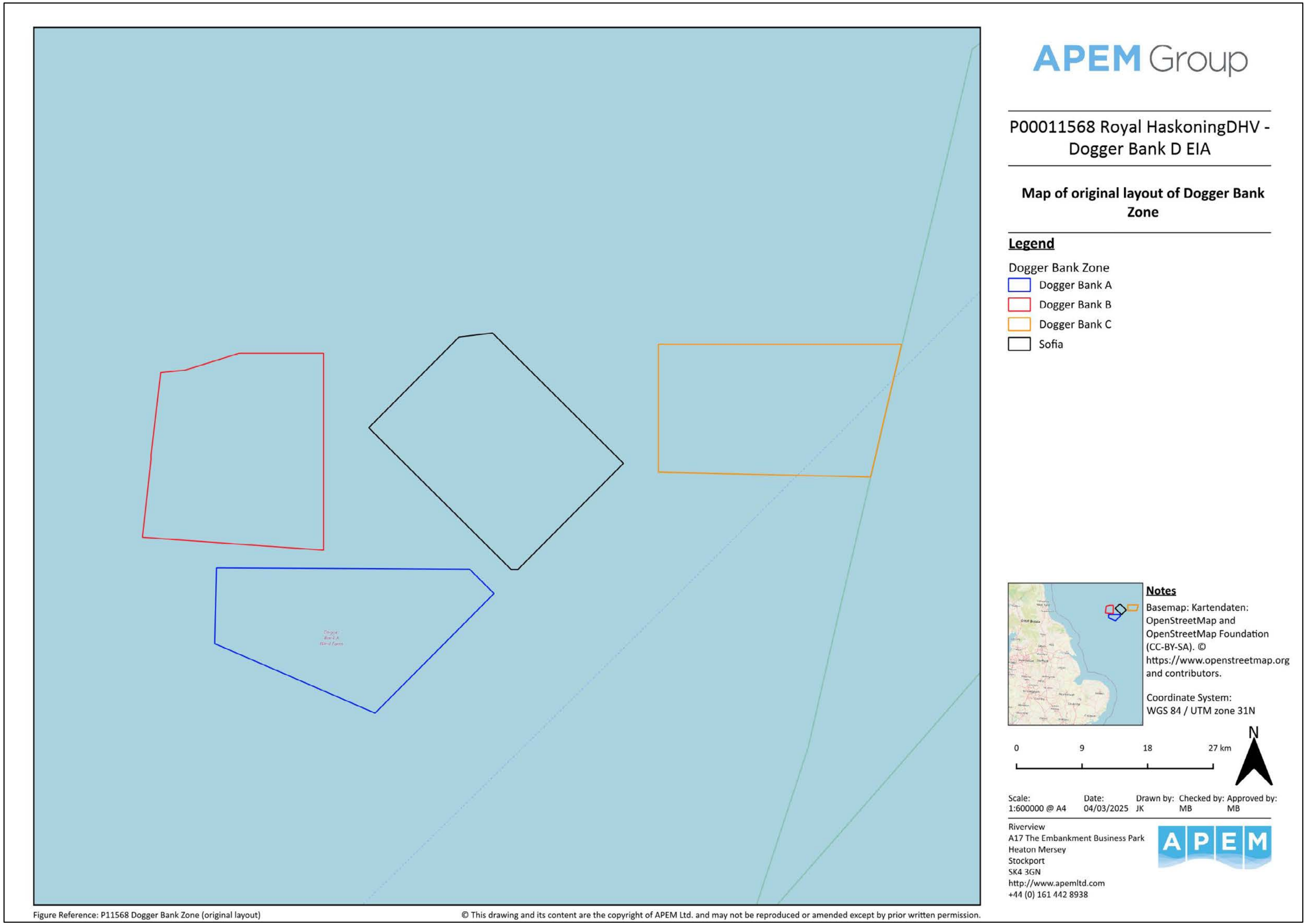

Figure 1-1 Original Dogger Bank Zone layout

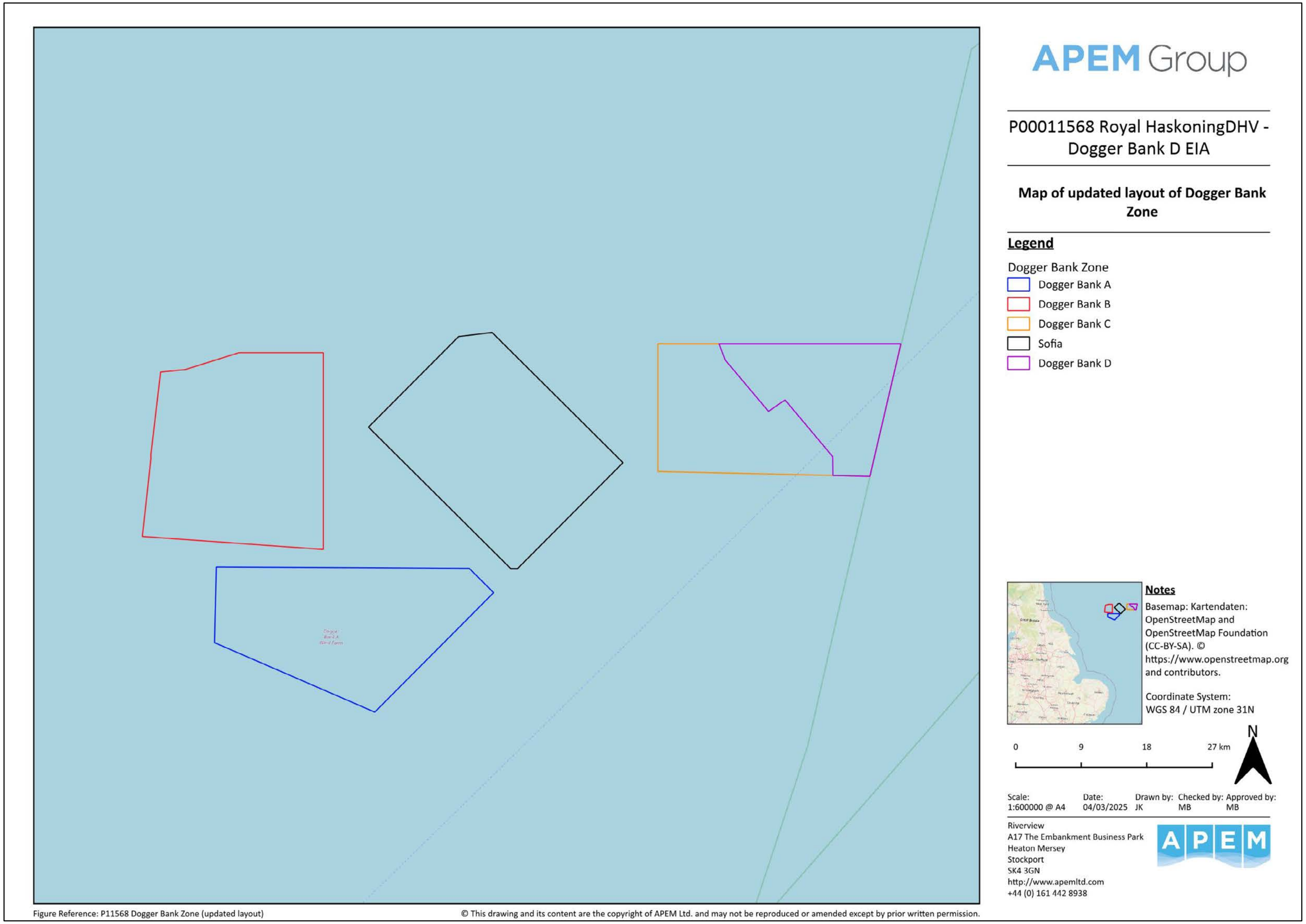

Figure 1-2 Updated Dogger Bank Zone layout

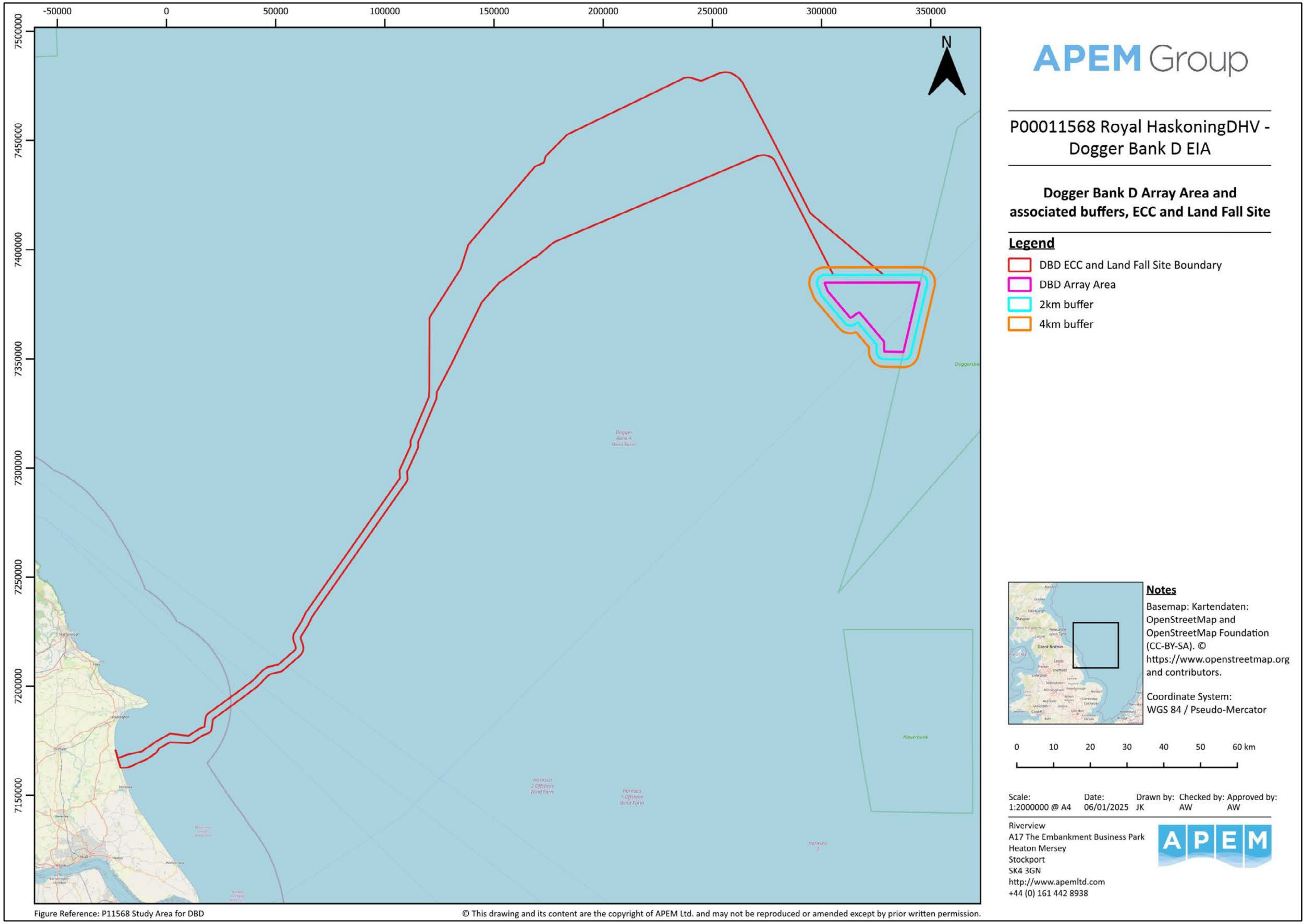

Figure 1-3 Dogger Bank D Array Area plus ECC and buffers (the study area)

1.2 Aims and objectives

The aim of this report is to present and describe the offshore ornithological features within the DBD Array Area, surrounding buffers (up to 4km) and the wider region. These findings are used to determine those bird species that characterise the baseline environment and are of relevance to the assessment of potential impacts from DBD within **Volume 1, Chapter 13 Offshore and Intertidal Ornithology**. Those receptor species are primarily those collectively referred to as 'seabirds' but also birds with seasonal association with offshore waters including divers and migratory birds. The data sources used to define the baseline characterisation are from high-resolution still images collected during site-specific digital aerial surveys (DAS) for birds, as well as from a desk-based review of existing data sources.

The main content of this report surrounds information on seabirds derived from 24 consecutive months of high-resolution DAS, undertaken between October 2021 and September 2023 (inclusive). These survey data were used to determine the following:

- Bird abundance and density estimates (monthly and for bio-seasons) (**Section 4**);
- Behaviour of birds (numbers flying and sitting on the water) (**Section 4**);
- Age classification of key seabird species (**Section 4**); and
- Spatial distribution maps of key seabird species (for bio-seasons) (**Section 4)**.

1.3 Study area

The offshore ornithology study area includes the Array Area and associated buffers and the offshore ECC.

The Array Area (and associated buffers) includes all of the DBD array and a surrounding 4km buffer (**Figure 1-3**). The data obtained for the Array Area were collected through a site-specific survey programme across the area as detailed in **Section 2.3**.

The ECC area allows for a potential future northward extension of the Dogger Bank SAC, as detailed in **Section 4.3.3** of the **Dogger Bank D Wind Farm EIA Scoping Report**.

1.4 Nomenclature

Throughout this report, species names that are used are those in common use among British ornithologists and this corresponds to the "British (English) vernacular name 2022" column of the list of vernacular and scientific names prepared by the British Ornithologists' Union (BOU, 2022). The corresponding scientific names from that publication are listed in the glossary on scientific bird names in **Appendix 1**.

2. Methods

2.1 Offshore ECC Study Area

This section describes the approach to baseline characterisation of the offshore ECC study area. A full overview of the intertidal baseline characterisation is provided in the **Appendix 13.5 Intertidal Ornithology Baseline Characterisation Report**.

2.1.1 Greater Wash SPA area of search (Lawson et al. 2016a)

JNCC commissioned an assessment of the birds within the Greater Wash SPA area, primarily in order to inform the SPA selection/extension process. Aerial observer surveys were flown over eight winter seasons (1988/89, 1989/90, 1991/92, 2002/03, 2004/05, 2005/06, 2006/07 and 2007/08) with results analysed using a distance sampling method. The report focused on three key species of relevance to the SPA selection process: red-throated diver, common scoter and little gull. Population estimates for red-throated diver were calculated, based on the three-year mean peak abundance of 2002/03, 2003/04 and 2005/06, as 1,787 red-throated diver. Little gull population estimates were calculated based on the mean peak abundance of 2004/05 and 2005/06 at 2,153. Common scoter population estimate was calculated based on the four-year mean peak abundance of 2002/03, 2004/05, 2005/06 and 2007/08 at 6,107. The density maps for each of those species, based on all eight years of surveys, are presented below in **Figure 2-1**, **Figure 2-2** and **Figure 2-3**.

The landfall site for DBD is situated at the northernmost tip of the Greater Wash SPA. Red-throated diver distributions within the SPA (**Figure 2-1**), as presented in Lawson *et al.* (2016a), stretch along the coast of the SPA, with highest densities in the centre near The Wash and further south. Although there are divers present near the landfall site, these are in lower numbers than elsewhere within the SPA.

Little gull and common scoter distributions (**Figure 2-2** and **Figure 2-3**) in the Greater Wash SPA do not overlap with the DBD landfall site, with distributions of both species being concentrated around The Wash.

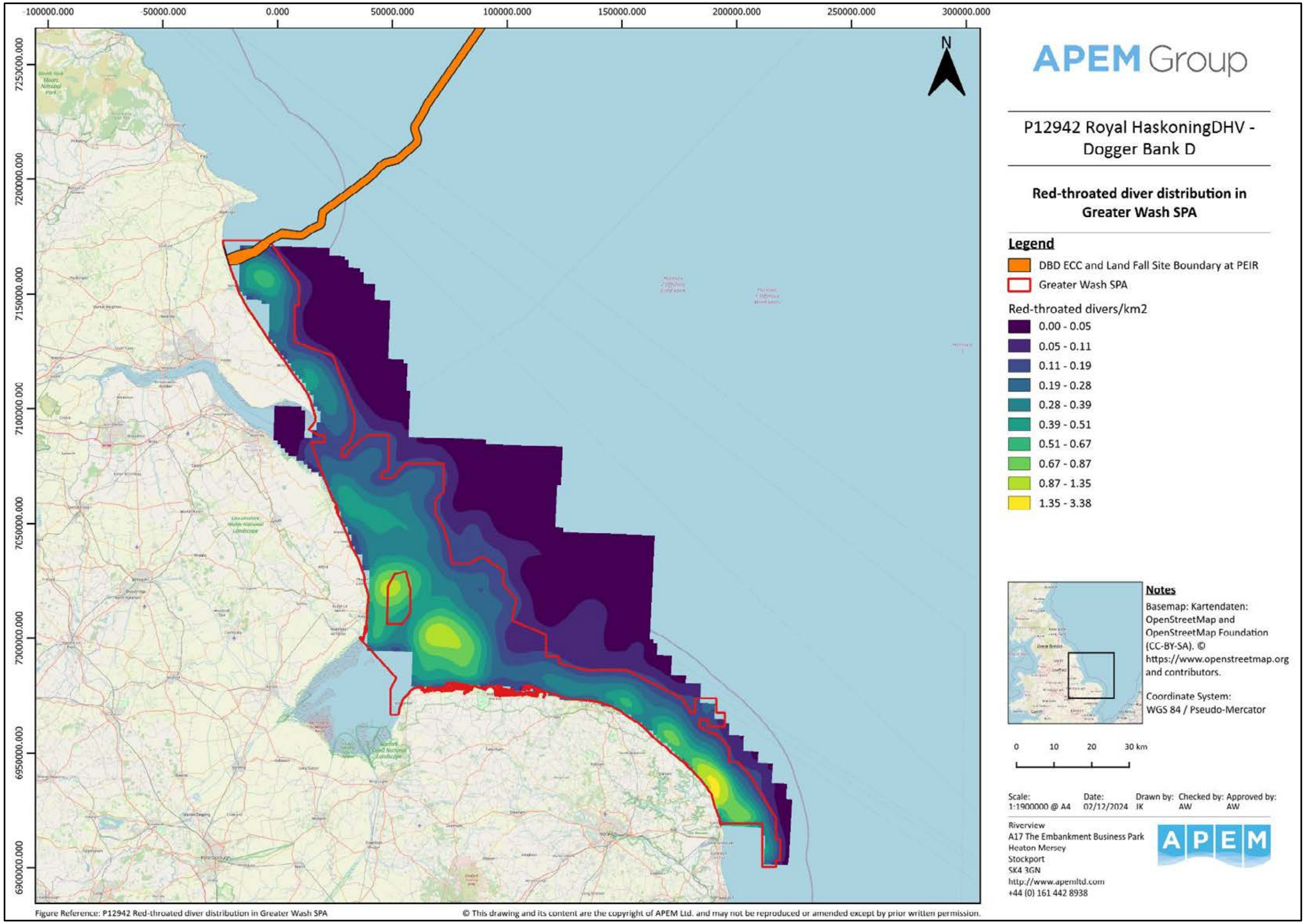

Figure 2-1 DBD landfall site with overlay of Lawson *et al.* (2016a) red-throated diver distribution data

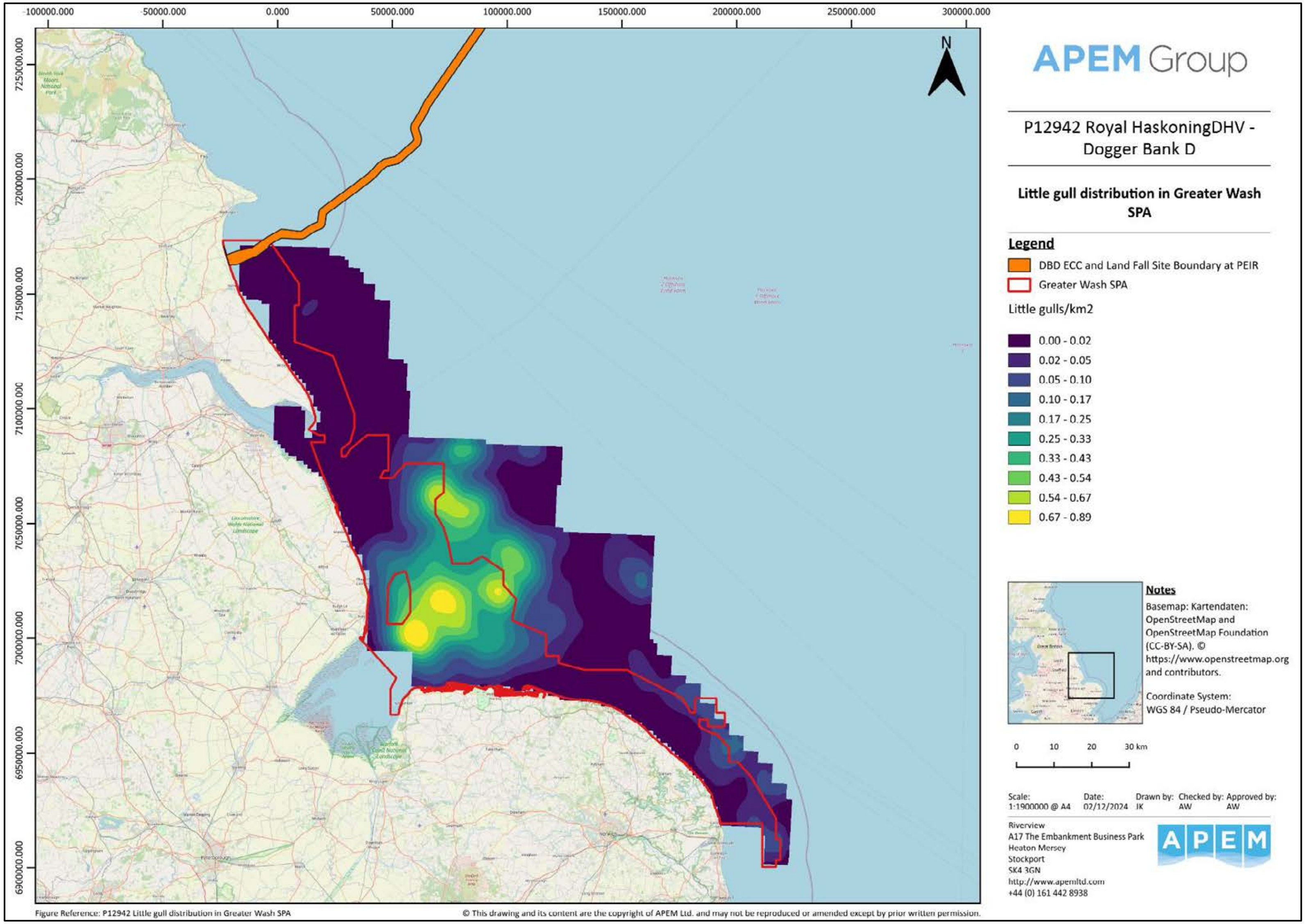

Figure 2-2 DBD landfall site with overlay of Lawson *et al.* (2016a) little gull distribution data

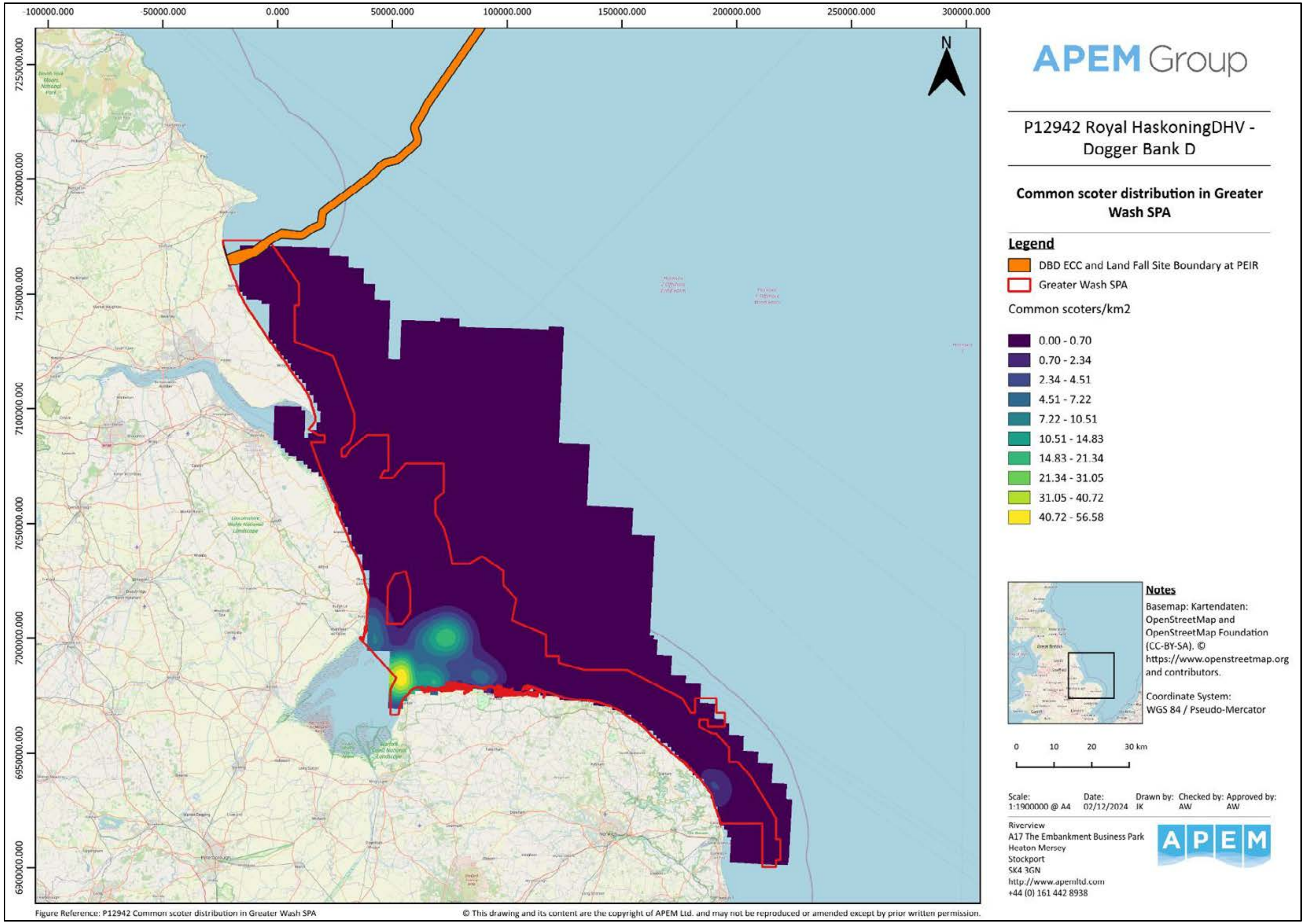

Figure 2-3 DBD landfall site with overlay of Lawson *et al.* (2016a) common scoter distribution data

2.2 Offshore Ornithology

This section describes the approach to baseline characterisation of receptor species within the offshore environment (habitat seaward of the MLWS).

2.2.1 Key data sources

An initial desk-based review of appropriate literature and data sources was undertaken for the Dogger Bank D Offshore Wind Farm EIA Scoping Report (Royal HaskoningDHV, 2023). A further Scoping Report was issued in 2024 (Royal HaskoningDHV, 2024) following the identification of a new grid connection location and the consequent changes in design for the Project. The data sources listed in **Table 2–1**, which were identified in the Scoping Report (Royal HaskoningDHV, 2024), provide coverage of the study area. These data sources and reports were confirmed through the Scoping Opinion as the most appropriate sources to use to determine the baseline for seabird receptor species (PINS, 2024).

Table 2–1 Key sources of offshore ornithological data for DBD

Source	Date	Summary	Coverage of study area
DBD – DAS data	2021 - 2023	DAS conducted by APEM Ltd on a monthly basis between October 2021 and September 2023 inclusive.	DBD Array Area plus a 4km buffer around the Array Area perimeter
Dogger Bank South Offshore Windfarms Environmental Statement (ES) and associated appendices (RWE, 2023a, b and c)	2021 - 2022	DAS conducted by APEM Ltd on a monthly basis between March 2021 and February 2022 inclusive.	Dogger Bank South Array Area at southwest of Dogger Bank Zone
Seabird Tracking Database for Flamborough and Filey Coast SPA (Seabird Tracking Database (2023 a – e)	2010 - 2019	Tracking data for kittiwake and gannet from Flamborough and Filey Coast SPA.	Offshore environment between Flamborough and Filey Coast SPA and the Array Area
Dogger Bank C & Sofia ornithology technical report (Burton *et al.* 2014)	2010 – 2011	Boat-based surveys and DAS of the Dogger Bank Zone between 2010 and 2011 with species accounts for the DBD and Sofia Array Areas.	All of the original Dogger Bank Zone
Dogger Bank A & B ornithology technical report (Burton *et al.* 2013)	2010 – 2011	Boat-based surveys and DAS of the Dogger Bank Zone between 2010 and 2011 with species accounts for the DBA and DBB Array Areas.	All of the original Dogger Bank Zone

2.2.2 Existing data sources (Offshore Ornithology)

Offshore ornithological data have been collected for multiple purposes in the vicinity of DBD and wider UK waters that provide regional and national generic and species-specific information on the distribution, abundance, biological seasons, behaviour and characteristics of birds in the offshore environment. These data sources were considered to characterise the wider region for the purpose of the impact assessments.

2.2.2.1 *Historical Dogger Bank A, Dogger Bank B, Dogger Bank C and Sofia baseline characterisation surveys for offshore ornithology*

Site-specific DAS and boat-based surveys were undertaken in the pre-application phase for DBA, DBB, DBC and Sofia OWFs to provide the ornithological baseline for Environmental Impact Assessment (EIA). These surveys covered the entire original Dogger Bank Zone (**Figure 1-1**), incorporating the DBD Array Area. Boat-based surveys were carried out at approximately monthly intervals from January 2010 to June 2012 with DAS undertaken between April 2010 and June 2012. The boat-based survey method used observation teams and was based on transect distance sampling protocols. The DAS capture video footage of the area for later identification of bird species within the surveyed area. The surveys carried out covered the current DBD Array Area. The key species noted during the surveys of the Dogger Bank Zone included:

- >1% of the North Sea population (Skov *et al.* 1995): Fulmar, gannet, kittiwake, lesser black-backed gull, great black-backed gull, guillemot, razorbill, little auk and puffin.

Based on the latest estimates of seasonal Biologically Defined Minimum Population Scales (BDMPS) (SNCBs, 2024), only two of these species were recorded in numbers exceeding 1% of the North Sea population (kittiwake and puffin). Review of the occurrence and distribution of species within the Dogger Bank Zone baseline data suggested that 11 species (fulmar, gannet, arctic skua, great skua, kittiwake, lesser black-backed gull, great black-backed gull, guillemot, razorbill, little auk and puffin) were occurring regularly in the survey area.

When focussing on DBC and Sofia, of these 11 species, two species (fulmar and lesser black-backed gull) had peak counts during the breeding season, three (gannet, great skua and kittiwake) were present in peak numbers during the migratory seasons, four (great black-backed gull, razorbill, little auk and puffin) had peak counts in the non-breeding season and guillemot showed high counts during all seasons. Arctic skua were only present in low numbers within the DBC and Sofia survey areas.

A similar finding was seen for the DBA and DBB baseline data that suggested 11 species (fulmar, gannet, Arctic skua, great skua, kittiwake, lesser black-backed gull, herring gull, guillemot, razorbill, little auk and puffin) occurred regularly in the survey area. Of these 11 species, two (fulmar and lesser black-backed gull) peaked in abundance during the breeding season, four species (kittiwake, gannet, Arctic skua and great skua) had peak counts in the migratory seasons and five species (herring gull, guillemot, razorbill, little auk and puffin) had peak counts during the non-breeding season.

2.2.2.2 *Dogger Bank South baseline characterisation surveys for offshore ornithology*

Site-specific DAS were undertaken in the pre-application phase for Dogger Bank South (DBS) OWF to provide the ornithological baseline for Environmental Impact Assessment (EIA). These surveys covered the DBS Array Area plus a 4km buffer and were conducted at monthly intervals from March 2021 to February 2023. The DAS were carried out by APEM and captured digital still imagery in a grid-based design. The digital still imagery was later used for identification of bird species within the surveyed area. Further details of the methodology for these surveys are provided in the DBS Offshore Ornithology Technical Appendix (RWE, 2023a).

Based on the seasonal peak abundance estimates provided in the DBS Environmental Statement (ES; RWE, 2023a, the following species were recorded within the DBS Array Areas in numbers exceeding 1% of the North Sea population: kittiwake, guillemot and razorbill.

Review of the occurrence and distribution of species from the DBS baseline data suggested that eight species (fulmar, gannet, great skua, kittiwake, great black-backed gull, guillemot, razorbill, and puffin) occurred regularly in the survey area. Of these eight species, two species (gannet and kittiwake) had peak counts during the breeding season, one (great black-backed gull) had a peak count during the migratory seasons, two (puffin and razorbill) had peak counts in the non-breeding season and three (fulmar, great skua and guillemot) had peak counts during multiple seasons.

These results differ from the DBD survey data that recorded low numbers of great black-backed gull, herring gull, lesser black-backed gull, Arctic skua, great skua and little auk. Reasoning behind the differences between the DBD observations and the baseline data for DBA, DBB, DBC, Sofia and DBS are likely due to variation between areas surveyed such as differing bathymetry and prey availability, alongside wider demographic changes of seabird species within UK North Sea waters since the baseline survey periods for these OWFs.

2.3 Contemporary aerial observer and digital aerial surveys

2.3.1 DBD digital aerial surveys

The most up-to-date and relevant data for the DBD study area (Array Area and 4km buffer) were collected and analysed by APEM through a programme of 24 monthly DAS undertaken between October 2021 and September 2023, inclusive. Surveys were carried out by APEM using high-resolution camera systems to capture digital still imagery in order to assess the abundance, density, behaviour and distribution of birds within the DBD study area. The survey method was designed using a transect-based survey design at 2cm ground sampling distance (GSD) to achieve a minimum of 19.9% coverage of DBD and buffer. The survey dates, start and finish times and percentage coverage are provided in **Table 2–2**.

The flight lines for the DAS are presented in **Figure 2-4**. Ten transects were flown in a north-south orientation. During the surveys in June 2022 and July 2023, small sections of the flight lines were missed due to camera faults whilst in flight, however despite these slight reductions in transit lines, the minimum coverage of 19.9% was achieved. The flight lines for these two surveys are presented in **Figure 2-5** and **Figure 2-6** showing the area of dropped coverage.

Table 2–2 Dates, times and coverage of the first 24 DASs of the DBD study area

Survey	Survey Date	Survey Flight Times (UTC)	Coverage (%)
October 2021	20-10-21	09:47 – 11:34	20.38
November 2021	02-11-21	11:42 – 13:26	20.39
December 2021	12-12-21	10:33 – 12:21	20.40
January 2022	06-01-22	11:14 – 13:04	20.41
February 2022	26-02-22	10:57 – 13:00	20.39
March 2022	18-03-22	14:42 – 16:31	20.58
April 2022	11-04-22	10:05 – 11:55	20.39
May 2022	09-05-22	12:44 – 14:28	20.39
June 2022	01-06-22	10:41 – 12:28	20.58
July 2022	16-07-22	09:54 – 11:42	20.41
August 2022	03-08-22	10:13 – 12:13	20.39
September 2022	21-09-22	10:23 – 12:14	20.38
October 2022	18-10-22	10:38 – 12:56	20.37
November 2022	09-11-22	11:05 – 12:53	20.39
December 2022	16-12-22	12:13 – 14:04	20.39
January 2023	05-01-23	11:19 – 13:18	20.40
February 2023	06-02-23	11:01 – 12:54	20.39
March 2023	03-04-23	10:48 – 12:34	20.33
April 2023	11-04-23	09:23 – 11:11	20.40
May 2023	17-05-23	13:16 – 14:56	20.40
June 2023	12-06-23	09:09 – 11:00	20.37
July 2023	26-07-23	13:38 – 15:59	19.92
August 2023	09-08-23	12:54 – 14:46	20.38
September 2023	05-09-23	13:28 – 15:16	20.38

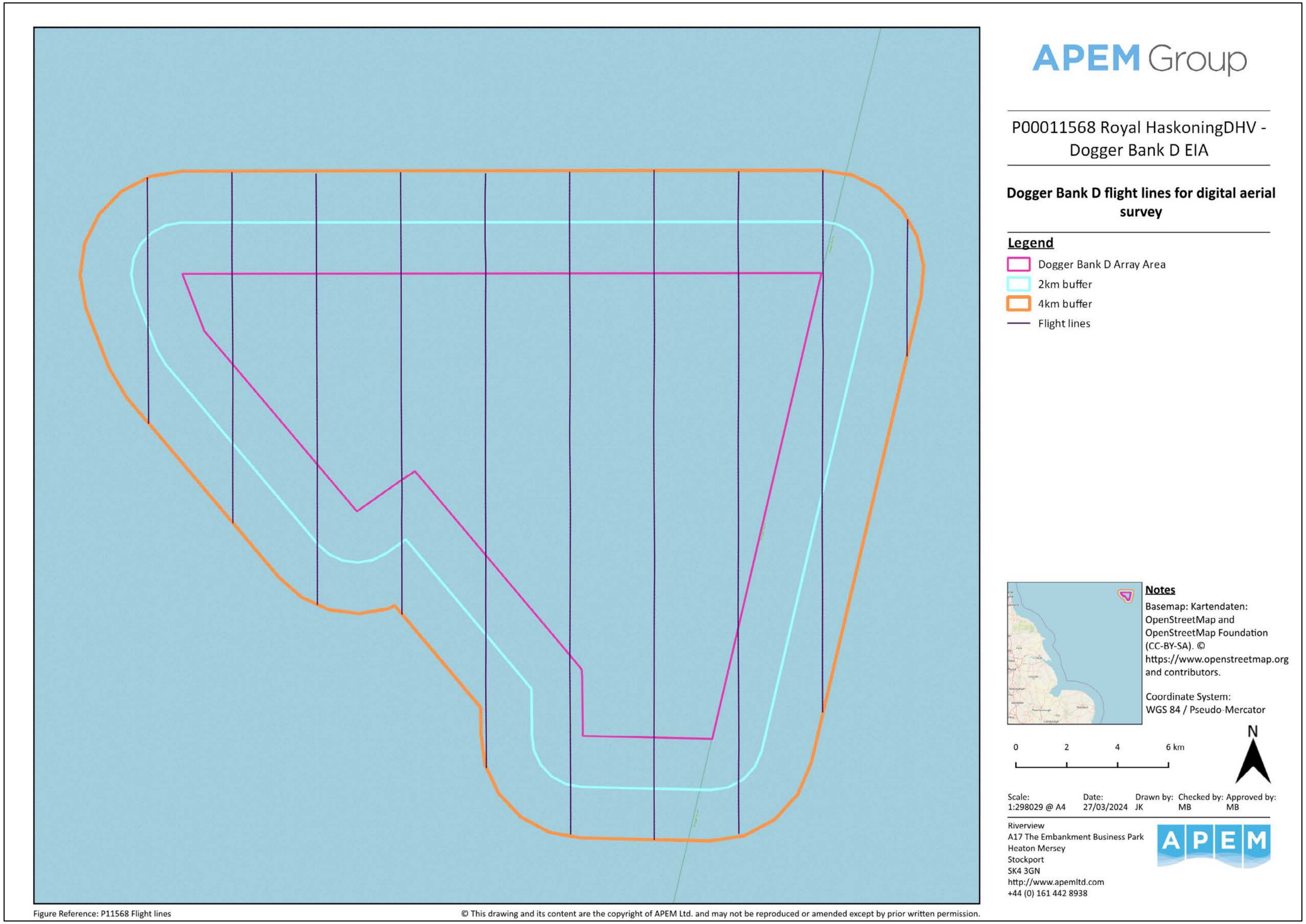

Figure 2-4 Dogger Bank D DAS flight lines

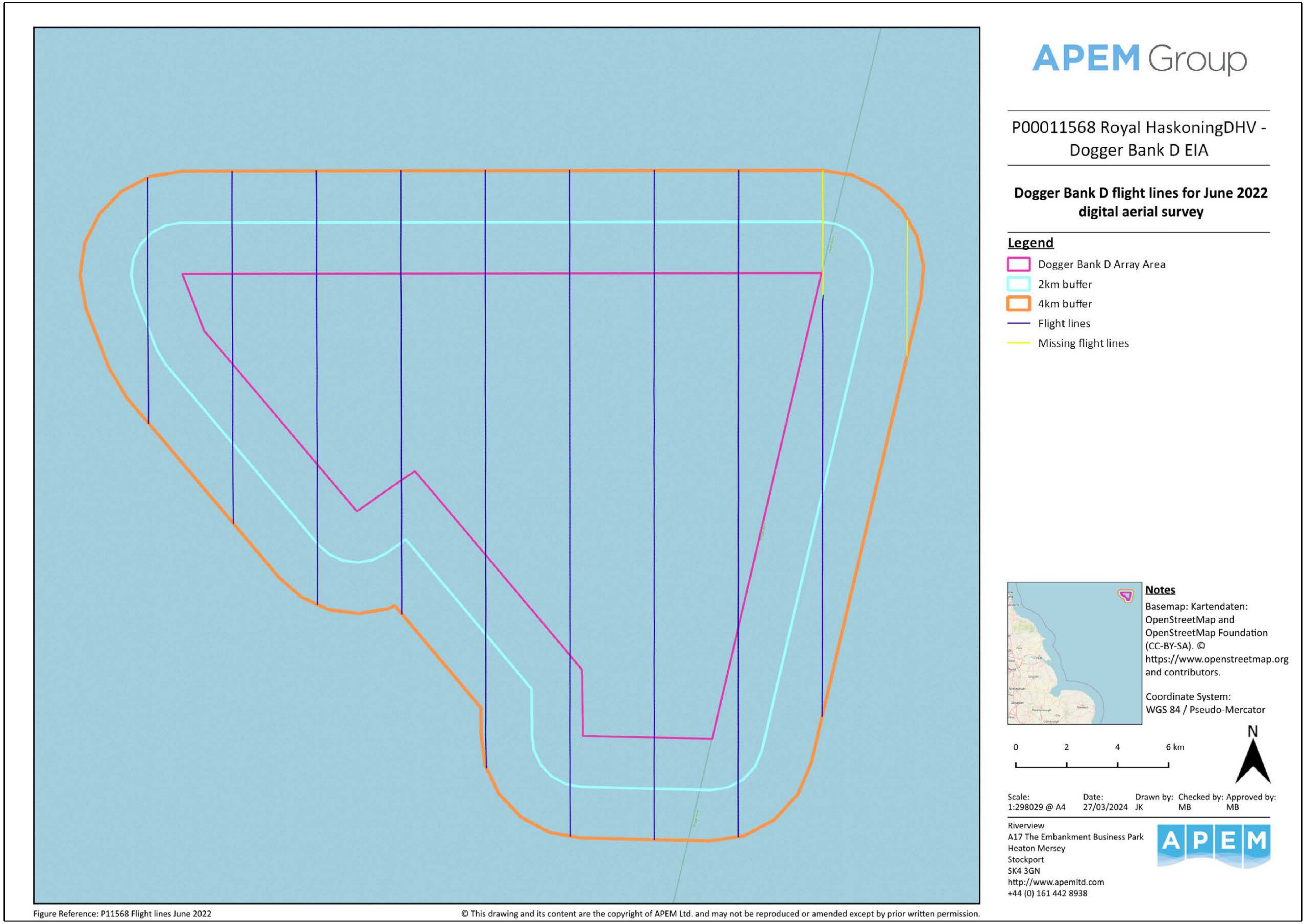

Figure 2-5 Dogger Bank D June 2022 DAS flight lines

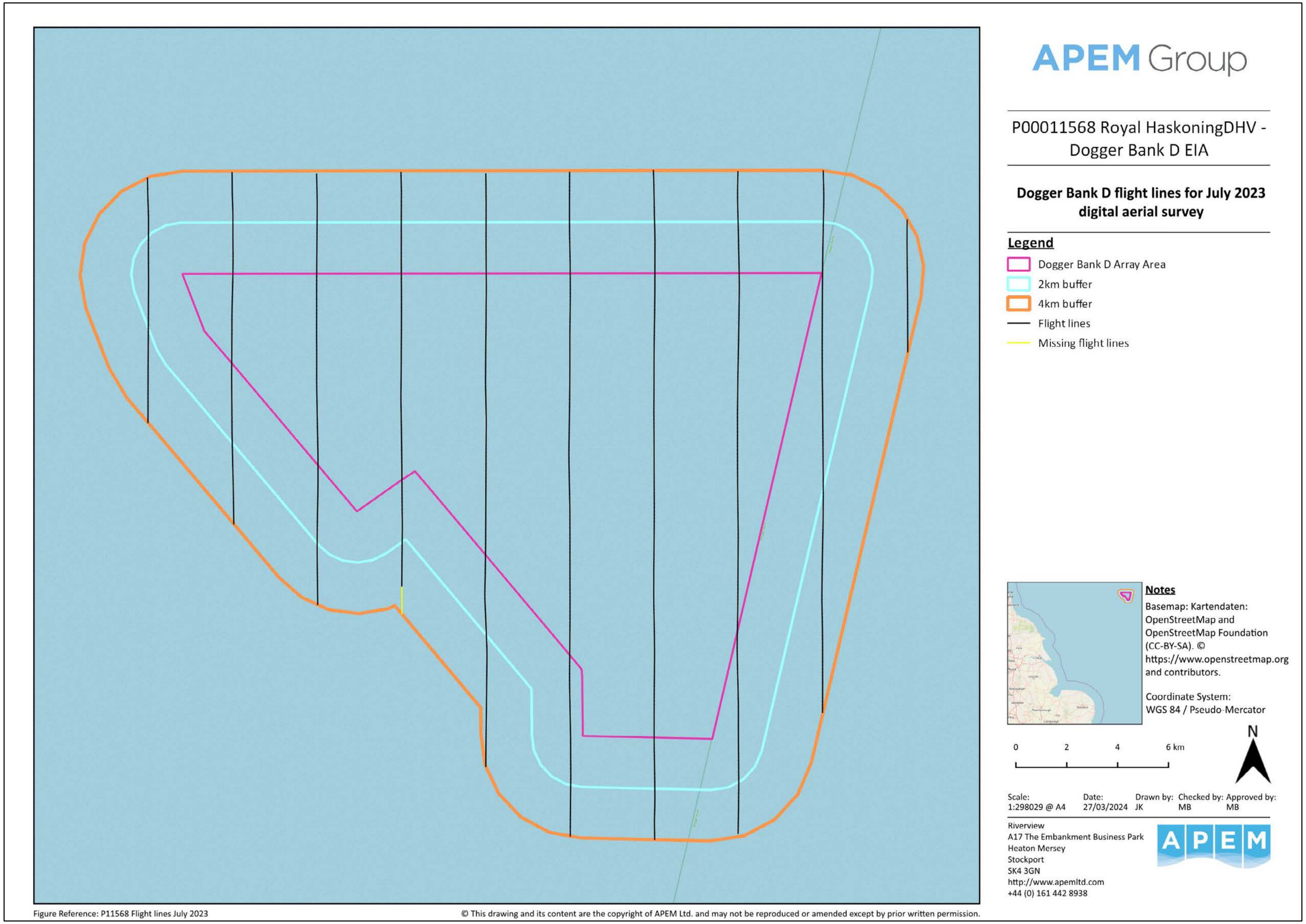

Figure 2-6 Dogger Bank D July 2023 DAS flight lines

2.3.2 Data analysis

Image analysis

The aerial digital still images were analysed to locate, identify and record all birds in the image. Internal quality assurance (QA) was carried out on the data collected from each survey. Images were assessed in batches with a different staff member responsible for each batch. Each image containing birds was reviewed and checked by APEM's dedicated QA team, ensuring that 100% of birds found were subject to internal QA to ensure that species identification was correct. Images containing no birds were removed and kept separately for further internal QA. Of these 'blank' images, 10% were randomly selected for QA. If there was less than 90% agreement, the entire batch was re-analysed independently by a staff member other than the one who initially analysed the imagery.

Design-based Bird Abundance and Density Estimates

For each monthly DAS survey, geo-referenced locations of all birds were recorded within each individual digital still image. Bird locations contained within the study area were then extracted to generate raw count data.

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

$N = iA$

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

A measure of precision was calculated using a Poisson estimator, suitable for a pseudo-Poisson over-dispersed distribution. This produced a coefficient of variation (CV) based on the relationship of the standard error to the mean.

All data analyses and simulations carried out by APEM were conducted in the R programming language (R Development Core Team, 2020) and non-parametric 95% confidence intervals were generated using the R library 'boot' (Canty & Ripley, 2010). This results in species-specific monthly abundance estimates being calculated from the raw count data, with upper and lower confidence limits. Where appropriate, a level of precision is also presented for each monthly abundance estimate. Dividing the monthly abundance estimates by the area covered provides an estimate of the associated density (birds per km^2) for any given species. Outputs for the Array Area, Array Area plus 2km buffer and Array Area plus 4km buffer have been provided for all recorded species in **Appendix 2** and **Appendix 3**.

Species Identification

All birds were first assigned to a species group and, where possible, further identified to species level. Birds which could not be positively identified to species level remained assigned to the broader species group level. For example, a bird first assigned to the species group 'auk species' if not identified as a guillemot/puffin/razorbill/little auk, would remain as an 'auk species' if no species level identification was determined. The species groups and their constituent species are listed in **Table 2–3**.

Table 2–3 Grouping levels for birds with no species level identification

<table>
<tr><th>Species</th><th>Species Grouping Level 1</th><th>Species grouping Level 2</th><th>Species Grouping Level 3</th><th>Species Grouping Level 4</th></tr>
<tr><td>Kittiwake</td><td rowspan="4">Small gull species</td><td rowspan="7">Gull species</td><td rowspan="8">Fulmar/ gull species</td><td rowspan="21">Bird species</td></tr>
<tr><td>Black-headed gull</td></tr>
<tr><td>Mediterranean gull</td></tr>
<tr><td>Common gull</td></tr>
<tr><td>Great black-backed gull</td><td rowspan="3">N/A</td></tr>
<tr><td>Herring gull</td></tr>
<tr><td>Lesser black-backed gull</td></tr>
<tr><td>Fulmar</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Arctic tern</td><td rowspan="2">'Commic tern'</td><td rowspan="2">N/A</td><td rowspan="2">N/A</td></tr>
<tr><td>Common tern</td></tr>
<tr><td>Arctic skua</td><td rowspan="2">Skua species</td><td rowspan="2">N/A</td><td rowspan="2">N/A</td></tr>
<tr><td>Great skua</td></tr>
<tr><td>Guillemot</td><td rowspan="2">Guillemot/ razorbill</td><td rowspan="4">Auk species</td><td rowspan="5">Auk/ shearwater species</td></tr>
<tr><td>Razorbill</td></tr>
<tr><td>Puffin</td><td rowspan="2">N/A</td></tr>
<tr><td>Little auk</td></tr>
<tr><td>Manx shearwater</td><td>Shearwater species</td><td>N/A</td></tr>
<tr><td>Great northern diver</td><td rowspan="2">Diver species</td><td rowspan="2">N/A</td><td rowspan="2">N/A</td></tr>
<tr><td>White-billed diver</td></tr>
<tr><td>Jackdaw</td><td>Passerine species</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Curlew</td><td>Curlew/ whimbrel species</td><td>N/A</td><td>N/A</td></tr>
</table>

Although the majority of individuals recorded from DAS were identified to species level, a number remained identified to group level only. To account for these unidentified individuals, abundance estimates have been updated, where appropriate, to include an attribution of unidentified individuals into the monthly abundance estimates and densities. This is based upon an apportionment of the group level individuals between those species within that group, proportional to the abundance of each species. Apportioning is conducted separately by behaviour, where possible, to allow for the possibility that patterns of occurrence differ depending on behaviour.

During this apportionment process, non-parametric bootstrap samples generated as part of abundance estimate calculations are apportioned individually. This allows for variation between bootstrap samples in the number of individuals identified to group level as well as in the species proportions to be considered and ensures that uncertainty in species-level abundances as well as group-level abundances is fully accounted for within the final apportioned abundance estimates. The final apportioned abundance estimate is then obtained as the mean of the apportioned (and corrected where availability bias applies) bootstrap samples. The upper and lower 95% confidence intervals are also calculated from these bootstrap samples. The CV is similarly calculated from the bootstrap samples and is based on the relationship of the standard deviation to the mean. It is important to note that while this approach is the most suitable method for accounting for uncertainty in the apportioned abundance estimates, the reliance on the randomly sampled bootstraps can result in slight discrepancies between the pre- and post-apportioning abundance estimates (e.g., it is possible for pre-apportioning estimates to be slightly lower than post-apportioning estimates). Where this is the case, preference has been given to the apportioned abundances as they account for all possible sources of uncertainty. The apportioning process is carried out within the R environment (R Development Core Team, 2012).

For each bootstrap, the number of unidentified individuals in a group was allocated in proportion to the relative numbers of the specific species contained within that group based on those records with positive species identification. To apportion individuals identified at group level down to species level for assessment purposes, the following rules were applied, in order of preference:

1) Use the proportion of individuals identified to species level within the species group for the same month, year, area and behaviour;
2) Use the proportion of individuals identified to species level within the species group for the same month, year, and behaviour, but from the wider survey area (if available)
3) Use the proportion of individuals identified to species level within the species group for the same year, area, and behaviour, but from all surveys in the bio-season.
4) Use the proportion of individuals identified to species level within the species group for the same year and behaviour, but from the wider survey area (if available) and all surveys in the bio-season.
5) Use the proportion of individuals identified to species level within the species group for the same year, but for different behaviours, from the wider survey area (if available), and all surveys in the bio-season.

6) Use the proportion of individuals identified to species level within the species group for the same area and behaviour, but from a different year (if available) and all surveys in the bio-season.
7) Use the proportion of individuals identified to species level within the species group for the same behaviour, but from a different year (if available), the wider survey area (if available), and all surveys in the bio-season.
8) Use the proportion of individuals identified to species level within the species group for a different year (if available), different behaviours, from the wider survey area (if available), and all surveys in the bio-season.

Some high-level groups do not undergo apportionment due to the breadth of taxa they encompass. This includes individuals assigned to 'unidentified bird species', 'raptor species', etc. Instances can also occur when there are no positively identified species at any hierarchy level, in which case the group-level individuals are unable to be apportioned.

It is important to highlight that birds that are apportioned from a species group to species level, only use species recorded within the surveys. This method is taken to get the most accurate ratio of the species recorded during survey effort. Although other species may fit in the general species group (i.e. little gull would fit into 'small gull species'), if they were not recorded within the surveys they have not been considered in the apportionment process. Where information from across a bio-season are required in the above hierarchy, bio-season definitions were taken from Furness (2015).

Abundance and density estimates in **Section 4** are inclusive of apportionment. Additional tables in **Appendix 2**provide abundance estimates for each species and species group prior to apportionment, as well as behaviour information relating to flying and sitting birds.

Correction for availability bias

For auk species such as guillemot, razorbill and puffin that make foraging dives underwater, a proportion of individuals will not be detectable at the surface during the analysis of the survey images due to being underwater. Density and abundance estimates therefore need to be adjusted to allow for this 'availability bias'. Although diver species and Manx shearwater display similar foraging activity, there is no robust data on availability bias for these species that are currently recommended for use by Natural England, and therefore, no correction has been applied to these species.

A fixed species-specific correction factor was applied to the number of each auk species recorded on the sea surface. The correction factors are derived from time spent under water (during the chick-rearing stage) from Thaxter *et al*. (2010) for guillemots and razorbills and from records from data loggers from Spencer (2012) for puffins. The correction factors used to multiply the relative abundance estimate of guillemots, razorbills and puffins sitting on the sea surface are 1.311, 1.211 and 1.165, respectively. The use of availability bias and the most appropriate data to use for the Project was discussed within ETG meetings (see Natural England's comment on availability bias from ETG2 Meeting 2 in **Appendix 13.1 Consultation Responses for Offshore and Intertidal Ornithology)**.

Abundance and density estimates in **Section 4** are the corrected monthly abundance and density estimates, having been subjected to this process. Additional tables in **Appendix 2**provide abundance and density estimates of each species and species group prior to correction for availability bias.

Consideration of Biological Seasons

Bird behaviour and abundance varies across a calendar year dependent upon the bio-season. Separate bio-seasons are recognised in this baseline characterisation report in order to establish the level of importance any seabird species has within the DBD study area during any particular period of time. The BDMPS bio-seasons are based on those in Furness (2015), hereafter referred to as BDMPS bio-seasons or bio-seasons (**Table 2–4**). The bio-seasons are defined within this baseline technical report as: return migration, migration-free breeding, post-breeding, migration-free winter, breeding and non-breeding bio-seasons. These six bio-seasons can be applied to different periods within the annual cycle for most species, though not all six are applicable for all seabird species, with different combinations used depending on the biology and life history of a species:

- Return migration: when birds are migrating to breeding grounds;
- Migration-free breeding: when birds are attending colonies, nesting and provisioning young;
- Post-breeding migration: when birds are migrating to wintering areas or dispersing from colonies;
- Migration-free winter: when non-breeding birds are over-wintering in an area;
- Breeding: from modal arrival to the colony at the beginning of breeding to modal departure from the colony; and
- Non-breeding: from modal departure from the colony at the end of breeding to modal return to the colony the following year.

Table 2–4 Bio-seasons used as the basis for the detailed species accounts presented in Section 4, based on Furness (2015) unless specified otherwise

Species	Return Migration	Migration-free Breeding	Post-breeding Migration	Migration-free Winter	Breeding	Non-breeding
Kittiwake	January to April	May to July	August to December	N/A	March to August*	N/A
Common gull**	N/A	N/A	N/A	N/A	May to July	August to April
Great black-backed gull	N/A	N/A	N/A	N/A	Late March to August	September to March
Herring gull	N/A	N/A	N/A	N/A	March - August	September to February
Lesser black-backed gull	March to April	May to July	August to October	November to February	N/A	N/A
Guillemot	N/A	N/A	N/A	N/A	March to July	August to February
Razorbill	January to March	N/A	August to October	November to December	April to July	N/A
Puffin	N/A	N/A	N/A	N/A	April to August	September to March
Great northern diver	March to May	N/A	September to November	December to February	N/A	N/A
Fulmar	December to March	April to August	September to October	November	N/A	N/A
Gannet	December to March	April to August	September to November	N/A	March to September*	N/A

Table Notes: * For this species the 'Breeding' bio-season was identified for the purposes of baseline characterisation, and the 'Migration-free Breeding' bio-season has been used for data presentation only. **Common gull is not included in Furness (2015) – bio-seasons taken from DBD EIA Scoping Report.

Within the DBD Scoping Report bio-seasons for use were identified for each species. For fulmar, gannet, kittiwake and lesser black-backed gull, two different bio-seasons were outlined, using migration-free breeding or the alternative full breeding season (Furness, 2015). Within the baseline report, and in order to provide the greatest breakdown of bio-seasons, the migration-free breeding has been presented for these species. For impact assessments, the Natural England recommended bio-seasons using the full breeding season have been incorporated. An overview of seasons and their representations in the various DBD appendices and chapters is provided in **Table 2–5**.

Table 2–5 Bio-seasons presented within DBD Chapter and Appendices

Species	Seasons represented in Baseline	Seasons represented in technical appendices and Chapters
Kittiwake	Migration-free breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Common gull	Full breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Great black-backed gull	Full breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Herring gull	Full breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Lesser black-backed gull	Migration-free breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Guillemot	Full breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Razorbill	Full breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Puffin	Full breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Great northern diver	Full breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
White-billed diver	Full breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Fulmar	Migration-free breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)
Gannet	Migration-free breeding (Furness et al, 2015)	Full breeding (Furness et al, 2015)

2.3.3 Spatial distribution

For the purposes of this report, the spatial distribution of seabirds within the DBD Array Area and a buffer are presented in the form of 'heatmaps' within each species account. The heatmaps present data on a bio-season basis, pooling multiple months over separate bio-seasons (using the definitions in **Table 2–4**) in order to account for species-specific spatial and temporal distributions for the purposes of defining the DBD ornithological baseline.

To create the heatmaps, point shapefiles were loaded into QGIS and the heatmap plugin for QGIS was installed. The shapefiles were then inputted to the heatmap plugin and a kernel radius of 4km was selected, which was determined to provide the most appropriate smoothing between the data points leaving no gaps in the model outputs. The output raster pixel size was set to 10m. All other default settings within the QGIS heatmap plugin were accepted. The heatmap plugin for each species was then run to generate GeoTIFF heatmaps. Note that heatmaps were produced using data from the entire survey area. The survey area includes any area in which the plane was flown, which in this case contains areas outside of the Array Area plus 4km buffer due to the plane having to turn at the end of each flown transect line, which occurs outside of the 4km buffer area. For species or bio-seasons with a relatively low abundance recorded within the survey area, the distribution point data are included in the heatmaps to provide greater clarity of species distribution within the survey area.

2.3.4 Flight direction

Data were provided on flight direction from the DAS, which are presented in **Appendix 4**. Bearings of bird directions were plotted using the R statistical package to summarise overall directions of movement. The mean angle and mean vector were used to describe directional preferences and extent of 'agreement'. A Rayleigh test that assumes a null hypothesis of uniformity (i.e., scattered orientation in all directions) was applied where a significant test indicates directionality of movement. The blue triangles show the frequency of birds captured flying with the same vector (heading). The red circle represents the critical value of the Rayleigh test of uniformity. The red arrow placement represents the mean vector, and the length of the arrow denotes how the vectors are clustered around the mean vector (longer arrows indicate the data are clustered more closely around the mean). Directionality of movement is significant if the red arrow extends beyond the circle. For each rose diagram, the 'Number of Observations' only accounts for birds with a recorded heading direction; birds with no heading recorded are omitted from these counts and so may not match up with the behaviour counts presented in the Species Accounts or appendices. For any species with less than three individuals recorded as flying, rose diagrams are not presented due to the sample size being too low to draw significant results. In addition, any species for which the results are not significant (p-value >0.05), rose diagrams are not presented. As such, any species with less than three flying individuals in a month, or species with insignificant results, have their flight direction described in the text. The frequency of flight directions is summarised for each monthly DAS survey.

2.3.5 Age ratios

Data were provided on age class from the DAS, which are presented in **Appendix 4**. Age classification of individuals was carried out for all species based on plumage characteristics (Svensson *et al*. 2023; Harrison *et al*. 2021; Howell & Zufelt, 2019). Age classes for each species were assigned based on the age classes identified in the DAS data. A further breakdown of age classifications and plumage identifiers can be found in the individual species accounts within **Section 4**.

2.3.6 Consideration of avian flu within the baseline environment

An outbreak of the H5N1 strain of Highly Pathogenic Avian Influenza (HPAI) occurred in European waters in 2021 and continued into subsequent years (Tremlett *et al*. 2024). The virus, which is spread through contact with contaminated feathers, faeces, surfaces and environments, spread through various species and to numerous colonies around the UK coast (RSPB, 2023) with the number of mortalities demonstrating a conservation threat to numerous seabird colonies (Tremlett *et al*. 2024). The virus was first reported in captive birds within the UK, with early records from wild bird species affecting great skua and barnacle goose (DEFRA, 2022a; RSPB, 2023). Since the outbreak there have been shifts in the species being infected with the virus, with gannet, guillemot, razorbill, puffin and kittiwake becoming infected through the summer of 2022 (DEFRA, 2022b).

The outbreak of HPAI coincided with the DAS data collection for the DBD baseline and so a review of colony trends for key seabird colonies with connectivity to DBD Array Area is required to further understand the potential impact of the virus and what this might mean for the baseline data that was collected.

A HPAI review for gannet, guillemot, razorbill, puffin and kittiwake are found in the respective species accounts in **Section 4**.

2.3.7 Seasonality

For each applicable bio-season, mean peak abundances are provided for each species account, which are derived following the Joint SNCBs Interim Displacement Note guidance (Updated) (UK SNCBs, 2017, updated 2022). Each bio-season is represented twice within the 24 months of surveys and so a mean peak abundance calculation can be conducted. In order to derive the mean peak abundances for each bio-season, the peak count in each separate bio-season is established, including birds on the water and in flight (UK SNCBs, Updated 2022). The peak counts for the same bio-seasons (Year 1 and Year 2) are then averaged to provide a mean peak abundance. An example of mean peak abundance calculations for guillemot in the breeding season is as follows using the example data in **Table 2–6**:

Breeding Season Mean Peak Abundance = (Peak breeding season monthly count for year 1 + Peak breeding season monthly count for year 2)/2

Breeding season Mean Peak Abundance = (2,745.10 + 8,048.45)/2 = 5,397

Mean Peak Density = Mean Peak Abundance / Array Area or relevant area

Table 2–6 Mean Peak Abundance calculation example

Survey	Abundance	Peak abundance	Mean peak abundance
Mar-22	2,745.10		
Apr-22	1,169.95		
May-22	430.73	2,745.10	
Jun-22	146.83		
Jul-22	82.24		
Mar-23	1,203.48		5,396.78
Apr-23	8,048.45		
May-23	259.39	8,048.45	
Jun-23	39.33		
Jul-23	98.1.78		

This process can be done for each bio-season for each species. The annual total is simply the sum of all the applicable bio-season mean peak abundance values for each species.

2.3.8 Consideration of an asymmetrical buffer

The array area of Dogger Bank C (DBC), which is currently in the pre-construction phase, directly abuts the DBD array area. An appropriate method is therefore required to reduce double counting of potential displacement effects from both projects. A previously implemented solution agreed by SNCBs (including Natural England), is to assess against an asymmetrical buffer for abutting projects, as recently implemented for Rampion 2 (WSP, 2024) and Awel Y Mor (RWE, 2022). Although DBC is still at the pre-construction phase, the project will be fully operational before the proposed commissioning timeframe for DBD, therefore enacting a potential displacement effect before DBD is fully commissioned. Therefore, prior to DBD being commissioned, the 'populations' of birds using the DBC array area (and arguably extending into the adjacent parts of the DBD array area as well) will have been subjected to displacement effects already, and the bird densities within the DBC array will (obviously) already equate to those which occur within the array of an operational OWF. Birds which remain within the DBC array area at the point of DBD operation are likely to have either habituated to or tolerate the presence of WTGs making them less likely to be displaced by the operation of DBD, following the conclusions drawn for Rampion 2 and Awel Y Mor. The DBC array area has therefore been excluded from the buffer zones used in calculating the abundance estimates on which the displacement assessment relies (**Figure 2-7**).

Within this baseline report, results for the asymmetrical 2km buffer have been provided, but the full 4km buffer results are provided in **Appendix 2** and **Appendix 3** for full context of the survey area.

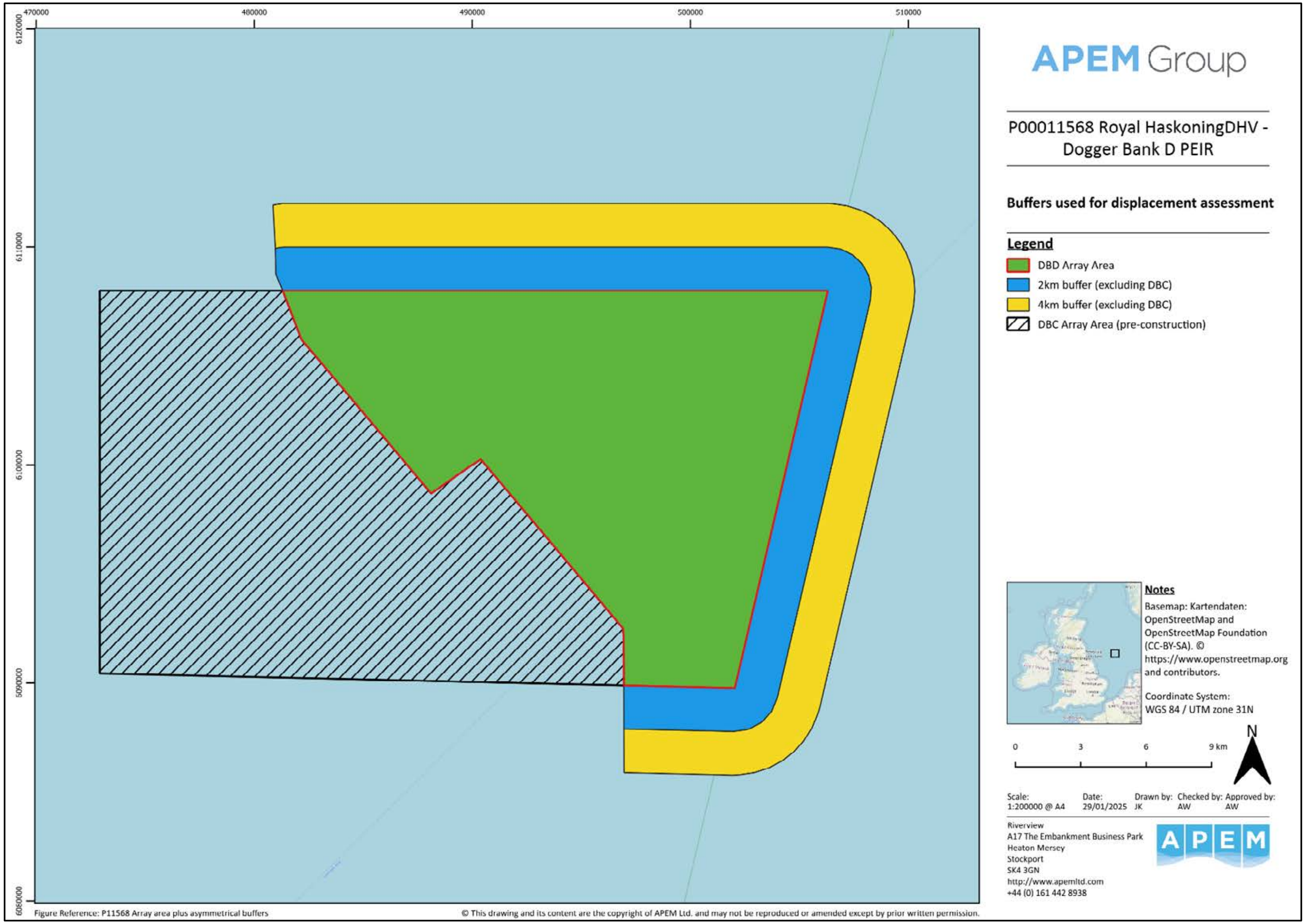

Figure 2-7 Asymmetrical buffers for consideration

3. Results

3.1 Species recorded

A total of 21,638 seabirds were recorded during the 24 aerial surveys undertaken across the DBD Array Area plus a 4km buffer between October 2021 and September 2023. Results comprise a total of 22 seabird species, with guillemot, kittiwake, razorbill and gannet as the most frequently encountered species (**Table 3–1**). These four species accounted for 96.6% of all birds recorded; guillemot (56.9%), kittiwake (26.0%) razorbill (8.4%) and gannet (5.3%). Only 16.0% of all records could not be assigned to species level (**Table 3–2**). Therefore, 84.0% of the bird assemblage was accounted for by a total of 24 species (including curlew and jackdaw). Further discussion in relation to monthly abundance of each species is provided in the species accounts in **Section 4**.

A number of species were recorded in the study area in numbers determined by expert judgement to be too low to warrant detailed species accounts (these species are in italic font within the **Table 3–3**) as any predicted impacts on them would likely be negligible. Species to be considered for assessment were discussed at ETG meetings, with details provided in **Appendix 13.1 Consultation Responses for Offshore and Intertidal Ornithology**. Instead, data for these species are presented in the form of raw counts, abundance estimates, density estimates and any recorded behaviour data within **Appendix 3**. Those species highlighted in bold in **Table 3–3** form the basis of detailed accounts for this baseline technical report. These include species recorded in notable numbers, with the addition of white-billed diver that has notable numbers when considering the species ecology and presence in UK waters. The justification for species being deemed in negligible numbers is provided in Dogger Bank D Offshore Wind Farm Preliminary Environmental Information Report (PEIR) **Volume 1, Chapter 13 Offshore and Intertidal Ornithology**.

Table 3–1 Total counts of birds recorded during aerial surveys of DBD Array Area plus 4km buffer for all surveys, species occurrence during entire survey period, maximum density, maximum population estimate (individuals), 95% confidence limits and coefficient of variation (CV)

Species	Number of Records	Occurrence Over 24 Surveys	Maximum Density Estimate (birds/km^2)	Maximum Population Estimate	95% CL	CV	Month of maximum density
Guillemot	12,317	24	23.14	14,171	5,556 – 24,953	0.02	April 2023
Kittiwake	5,628	23	12.44	7,620	2,803 – 12,782	0.03	April 2023
Razorbill	1,808	22	2.11	1,293	535 – 2,209	0.06	April 2023
Gannet	1,154	24	2.62	1,604	689 – 2,429	0.06	October 2021
Fulmar	399	24	0.74	457	257 - 648	0.10	May 2023
Puffin	93	13	0.26	160	65 - 265	0.18	April 2023
Great northern diver	67	12	0.15	89	25 - 158	0.24	March 2022
Arctic tern	56	3	0.42	260	52 - 654	0.14	July 2023
Little auk	23	1	0.19	114	30 - 213	0.21	January 2023
Common gull	22	12	0.05	30	6 - 90	0.41	September 2022
Great black-backed gull	21	11	0.02	15	5 - 30	0.58	February 2023
Lesser black-backed gull	12	4	0.05	30	6 - 90	0.41	April 2023
Curlew	12	1	0.10	60	12 - 181	0.29	July 2023
White-billed diver	9	3	0.04	27	5 - 48	0.45	November 2022
Herring gull	7	4	0.02	15	3 - 30	0.58	January 2023
Black-headed gull	4	3	0.02	10	2 - 30	0.71	September 2022
Sandwich tern	4	1	0.03	20	4 - 50	0.50	April 2023
Great skua	4	2	0.02	10	2 - 30	0.71	October 2022
Jackdaw	4	1	0.03	20	4 - 59	0.50	March 2023
Manx shearwater	3	1	0.02	15	5 - 30	0.58	May 2022
Mediterranean gull	2	2	0.01	5	1 - 15	1.00	May 2022
Velvet scoter	2	1	0.02	10	2 - 25	0.71	January 2022
Common tern	2	1	0.02	10	2 - 30	0.71	May 2022
Arctic skua	1	1	0.01	5	1 - 15	1.00	October 2022

Table 3–2 Counts of birds not identified to species level

Unidentified Species	Number of Records
Unidentified auk species	4,059
Unidentified gull species	18
Unidentified auk/shearwater species	6
Unidentified fulmar/ gull species	4
Unidentified tern species	7
Unidentified skua species	1
Unidentified shearwater species	1
Unidentified diver species	1
Unidentified passerine species	7
Unidentified wader species	1
Unidentified bird species	15

Table 3–3 Bird species recorded in site-specific DAS of the DBD study area. Species in italic font were recorded in numbers that would likely incur a negligible effect and so detailed species account are not provided

Divers and pelagics	Gulls	Terns	Auks	Other
Gannet	**Kittiwake**	*Arctic tern*	**Guillemot**	*Velvet scoter*
Fulmar	**Common gull**	*Common tern*	**Razorbill**	*Curlew*
Manx shearwater	*Black-headed gull*	*Sandwich tern*	**Puffin**	*Jackdaw*
White-billed diver	*Mediterranean gull*		*Little auk*	
Great northern diver	**Herring gull**			
Great skua	**Lesser black-backed gull**			
Arctic skua	**Great black-backed gull**			

4. Species accounts

The below species accounts present apportioned and corrected (where applicable) abundance and density estimates for birds recorded within DBD plus corresponding buffers. Abundance and density estimates within species-specific buffers of relevance are presented only for those species to be considered at risk of disturbance and displacement, and therefore species not sensitive to displacement will have information presented for the Array Area only. Species-specific buffers for species sensitive to displacement follow those advised through the Joint SNCB Interim Displacement Advice Notes (UK SNCBs, 2017, updated 2022). For all other species of importance, estimated abundance and density are presented for the DBD Array Area alone (**Table 4–1**). Additional spatial distribution maps are presented in bio-seasons for most bird taxa considered of ecological importance, where enough data were available to run heat maps combining data from multiple months.

Table 4–1 Areas of consideration for recorded species

Species	Area considered
Kittiwake	Array Area
Common gull	Array Area
Great black-backed gull	Array Area
Herring gull	Array Area
Lesser black-backed gull	Array Area
Guillemot	Array Area plus 2km buffer
Razorbill	Array Area plus 2km buffer
Puffin	Array Area plus 2km buffer
Great northern diver	Array Area plus 4km buffer
White-billed diver	Array Area plus 4km buffer
Fulmar	Array Area plus 2km buffer
Gannet	Array Area and the Array Area plus 2km buffer

Confidence limits for mean peak abundances are provided in Appendix 13-4: Offshore Displacement Analysis Report for those species considered for displacement assessment. Confidence limits around predicted collision risk are provided in Appendix 13-2: Offshore Collision Risk Modelling for those species considered for collision risk assessment.

4.1 Kittiwake

4.1.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of kittiwakes within the Dogger Bank Zone exceeded the 1% threshold for populations of national importance in all three breeding seasons.

In DBA, the variation in abundance across seasons was similar between 2010 and 2011, with monthly abundance estimates peaking in March in both years (3,261 individuals in 2010 and 6,437 individuals in 2011). The monthly abundance estimates for DBB also peaked in March in both years (4,391 individuals in 2010 and 8,247 individuals in 2011). In both years, the highest densities of kittiwake were recorded near the western edge of the survey area (**Figure 4-1** & **Figure 4-2**).

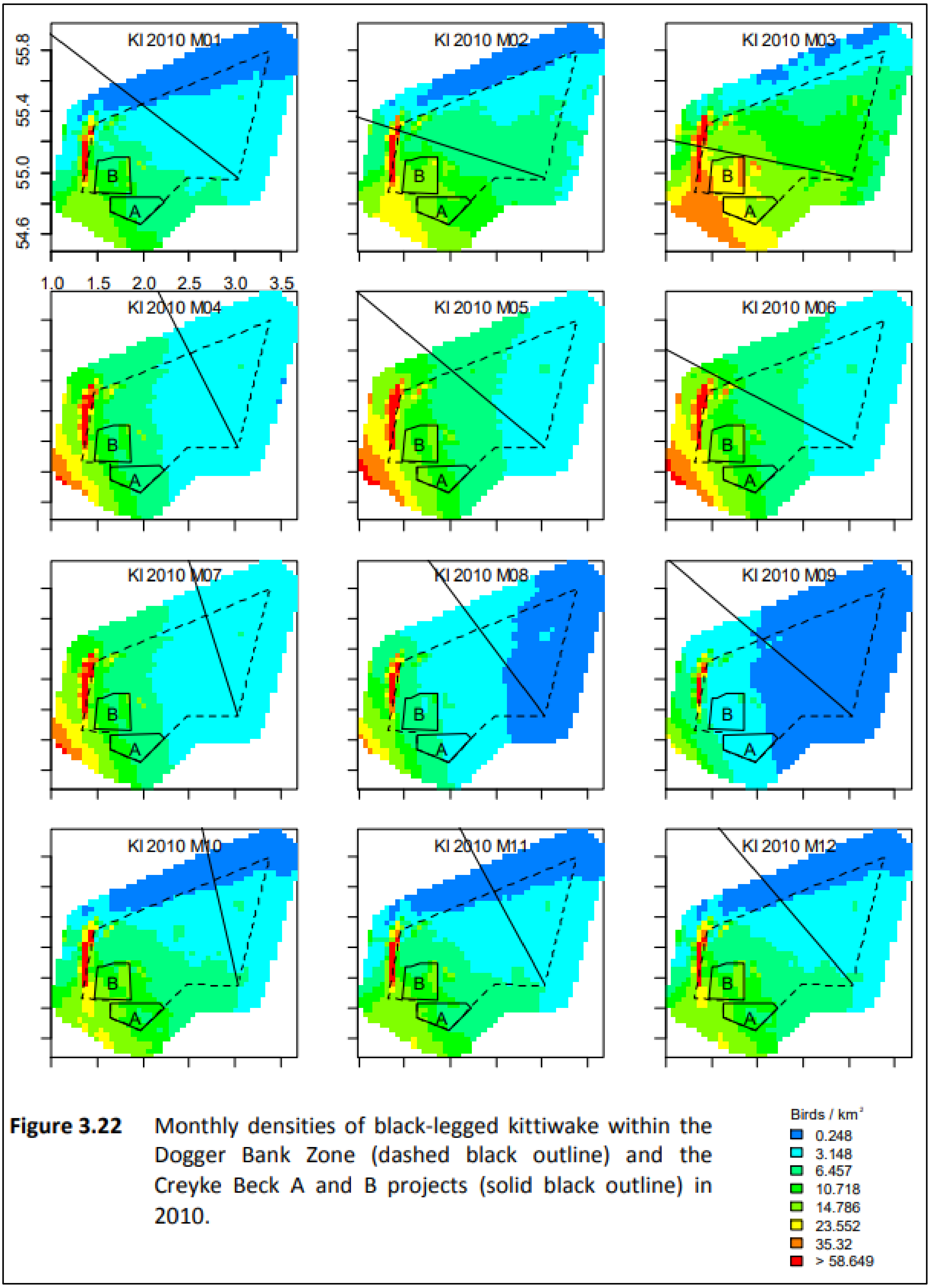

Figure 4-1 Monthly density heatmaps of kittiwake recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton *et al.* (2013))

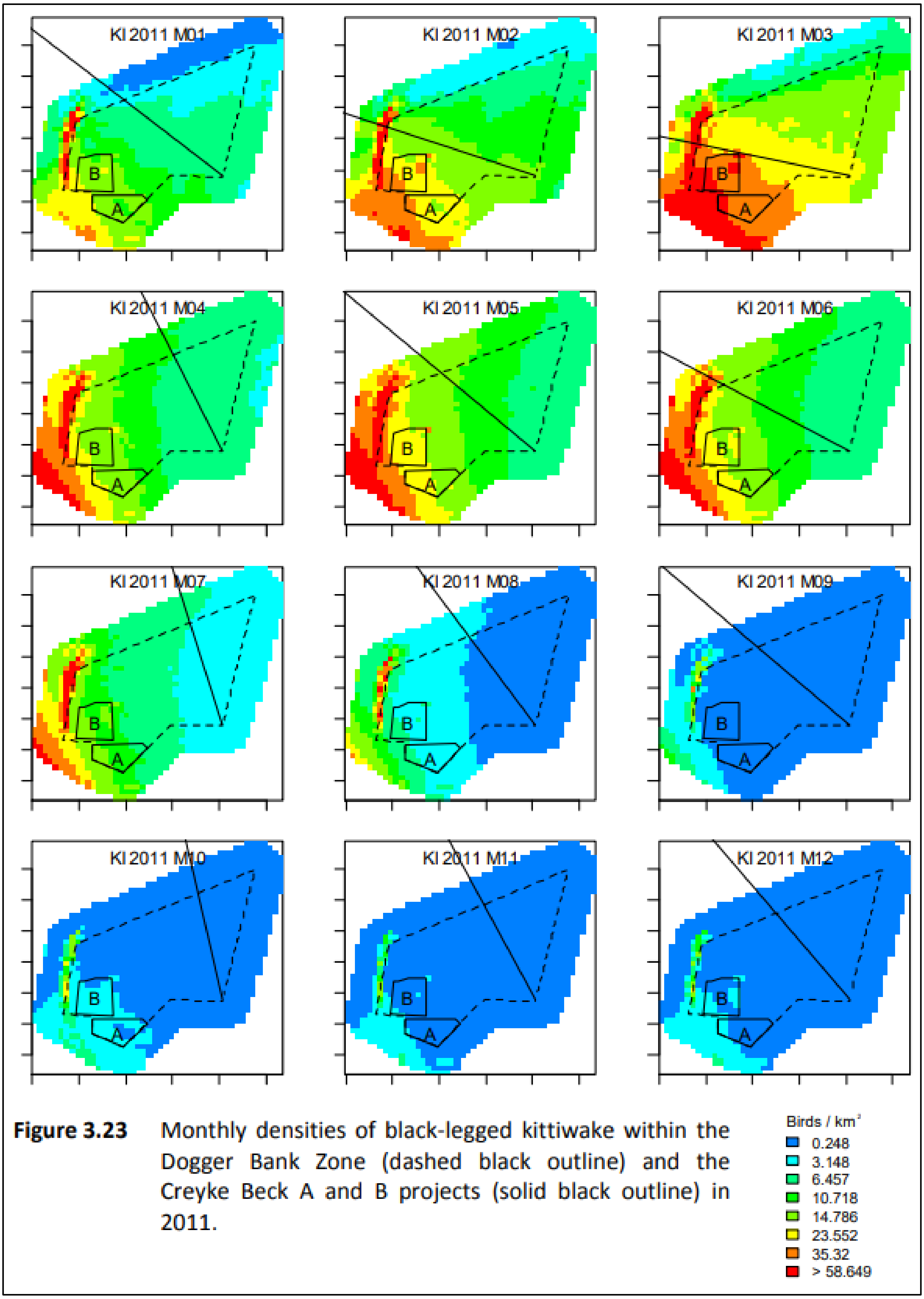

Figure 4-2 Monthly density heatmaps of kittiwake recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2011 (taken from Burton *et al.* (2013))

In the DBC Array Area, monthly baseline population estimates for kittiwake peaked in March across all three years (2,196 individuals in 2010, 4,889 individuals in 2011 and 3,117 individuals in 2012). This was also true for the monthly abundance estimates for Sofia (3,398 individuals in 2010, 6,487 individuals in 2011 and 5,507 individuals in 2012). Throughout the survey period, monthly densities of kittiwake were highest in the south-west of the Dogger Bank Zone (**Figure 4-3**, **Figure 4-4** & **Figure 4-5**).

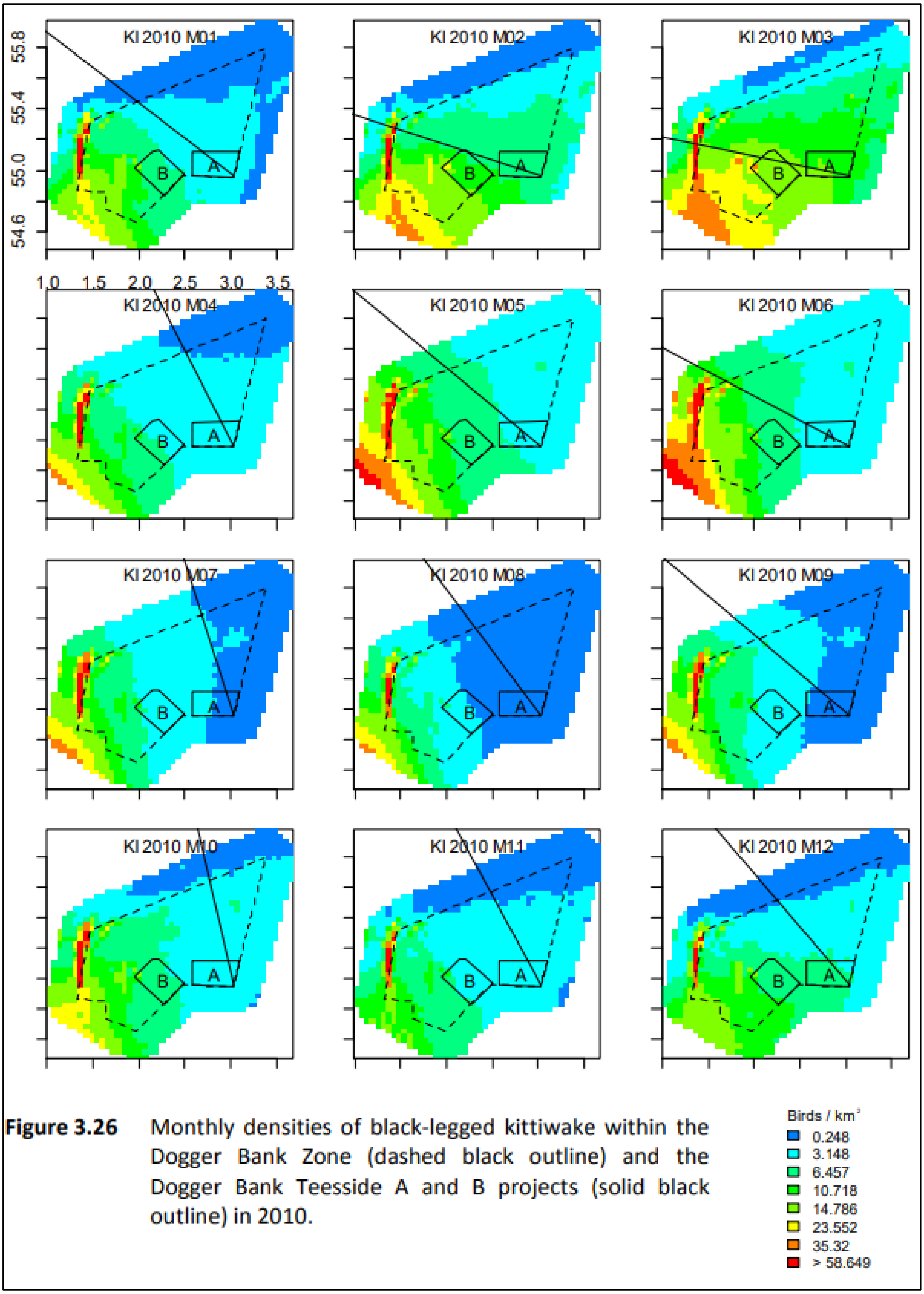

Figure 4-3 Monthly density heatmaps of kittiwake recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in 2010 (taken from Burton *et al.* (2014))

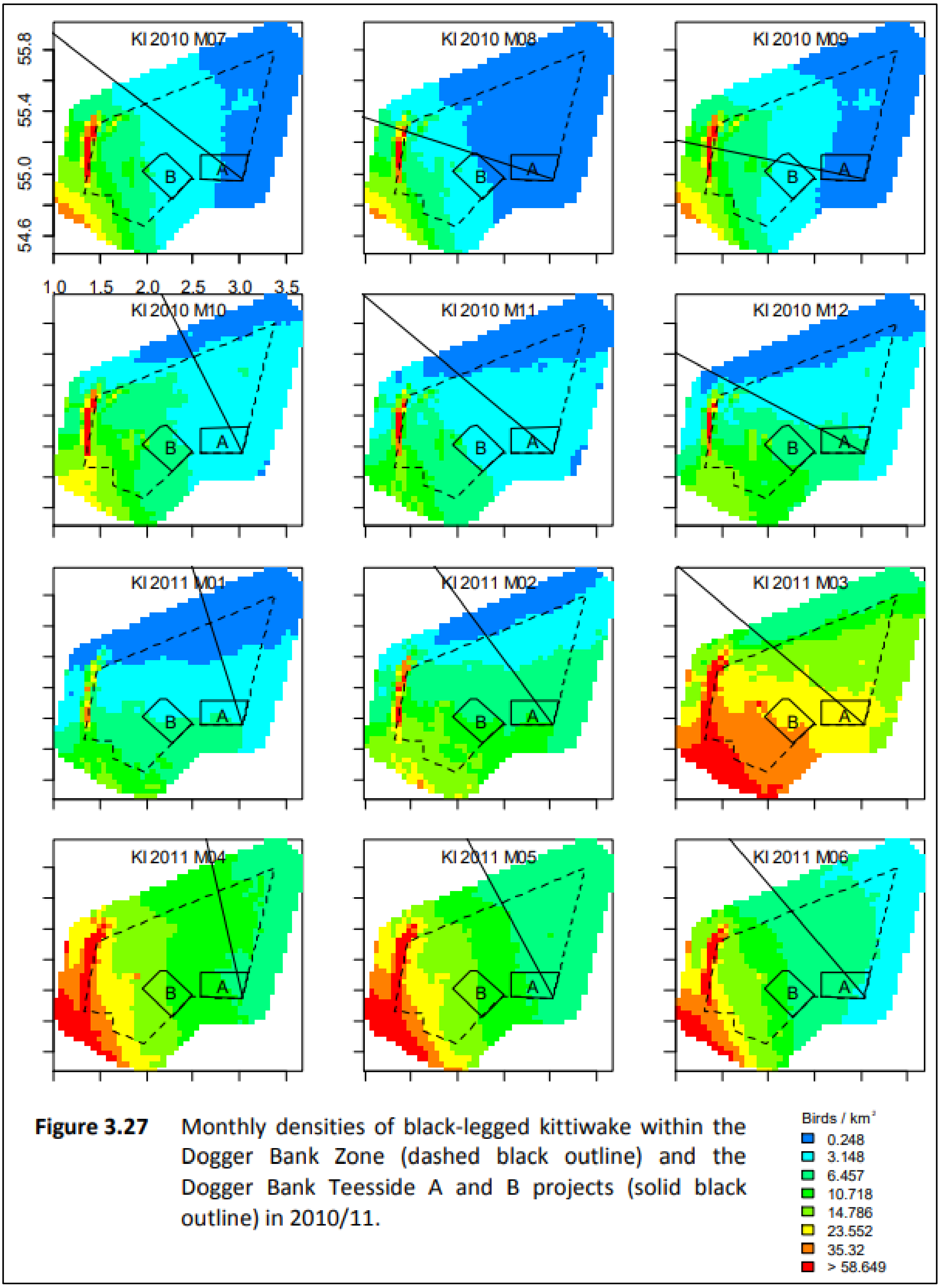

Figure 4-4 Monthly density heatmaps of kittiwake recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2010 to June 2011 (taken from Burton *et al.* (2014))

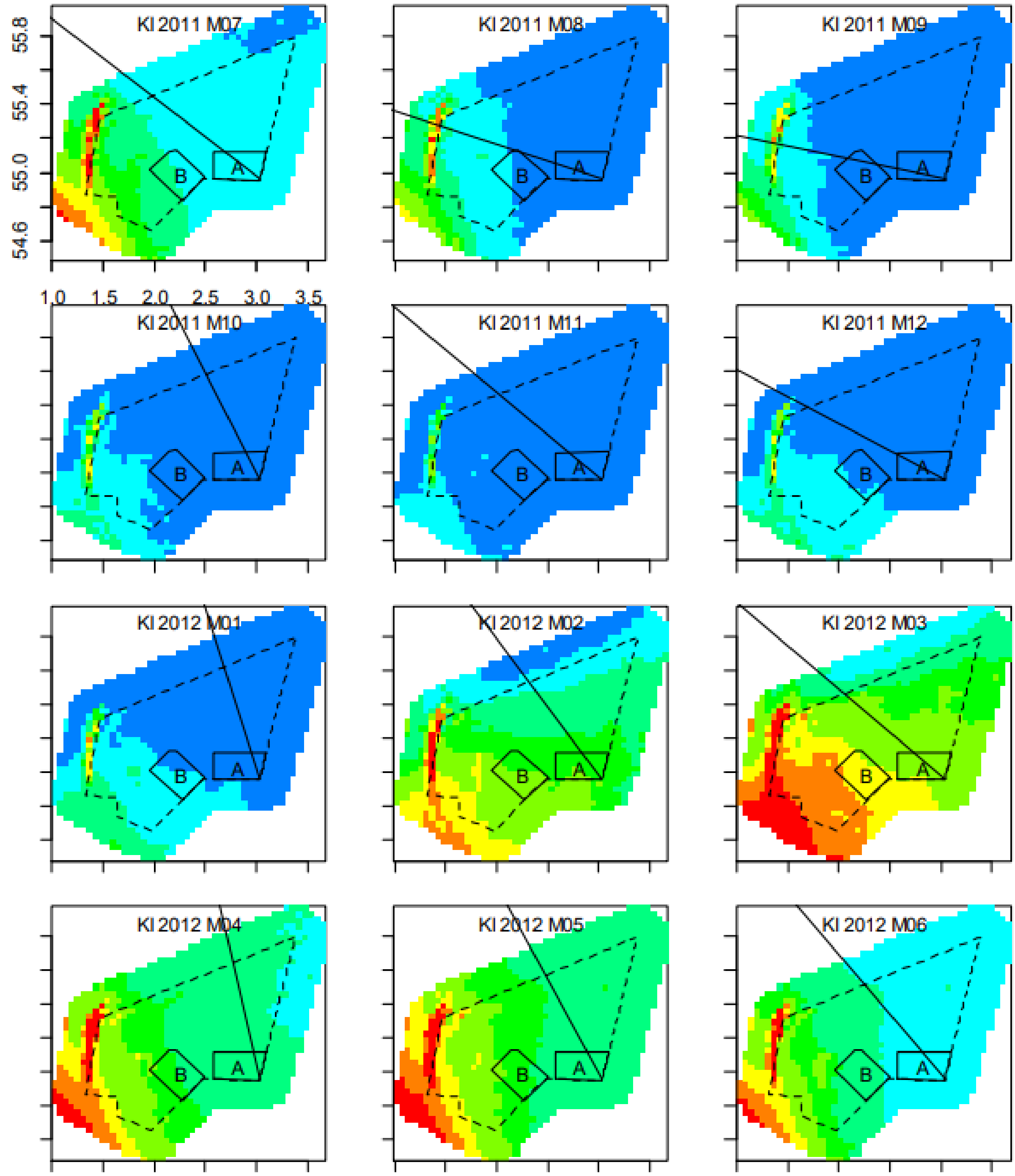

Figure 3.28 Monthly densities of black-legged kittiwake within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2011/12.

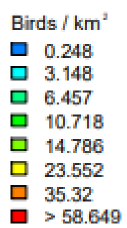

Figure 4-5 Monthly density heatmaps of kittiwake recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2011 to June 2012 (taken from Burton *et al.* (2014))

In DBS, between March 2021 and February 2023, the mean monthly abundance estimates for kittiwake peaked in March for the DBS East Array Area (5,752 individuals) and in August for the DBS West Array Area (4,253 individuals). Density was higher in DBS West during the breeding season and post-breeding migration, whereas in DBS East, density appeared to be higher during the return migration season (**Figure 4-6**, **Figure 4-7** & **Figure 4-8**).

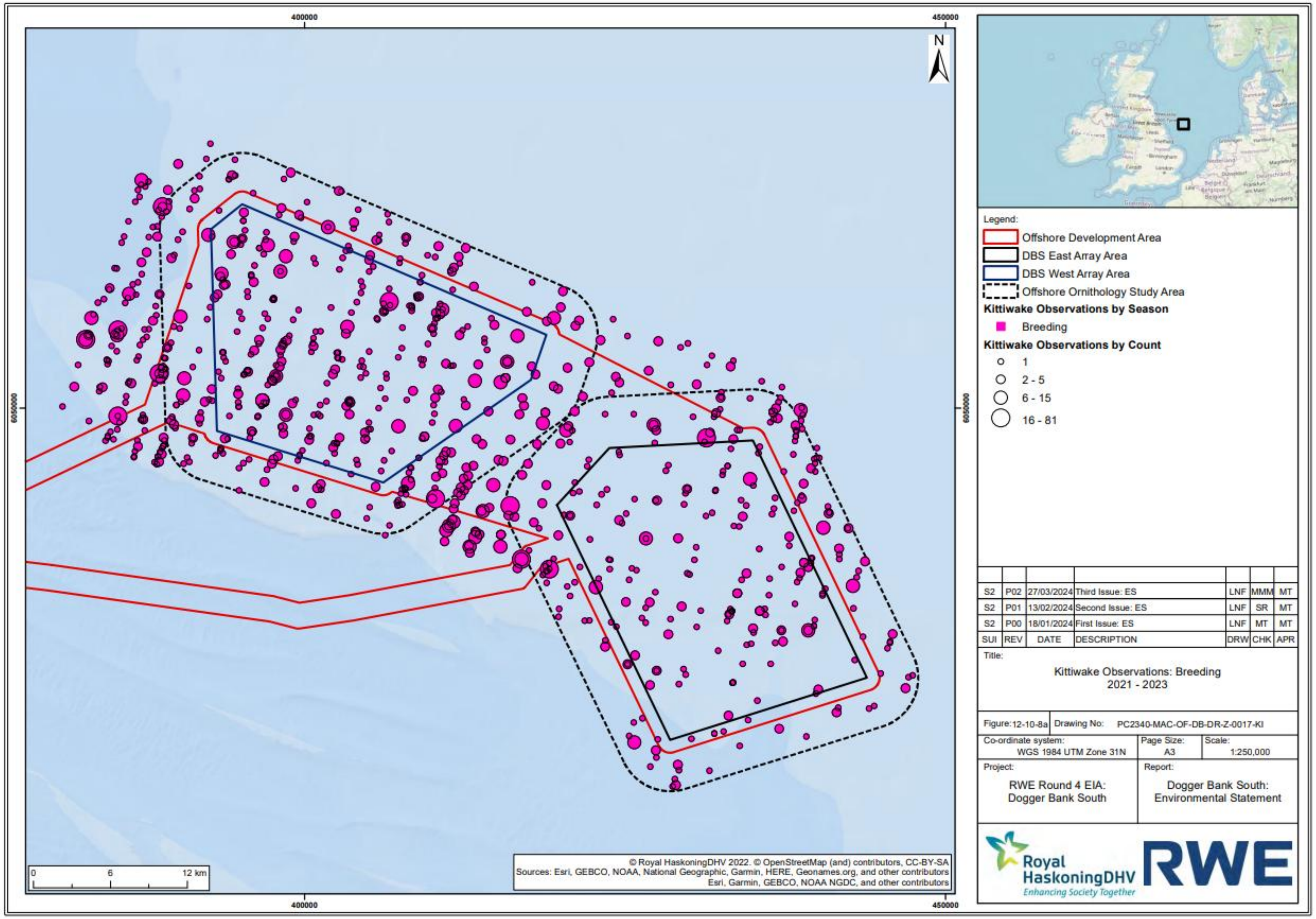

Figure 4-6 Raw counts of kittiwake during the breeding bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

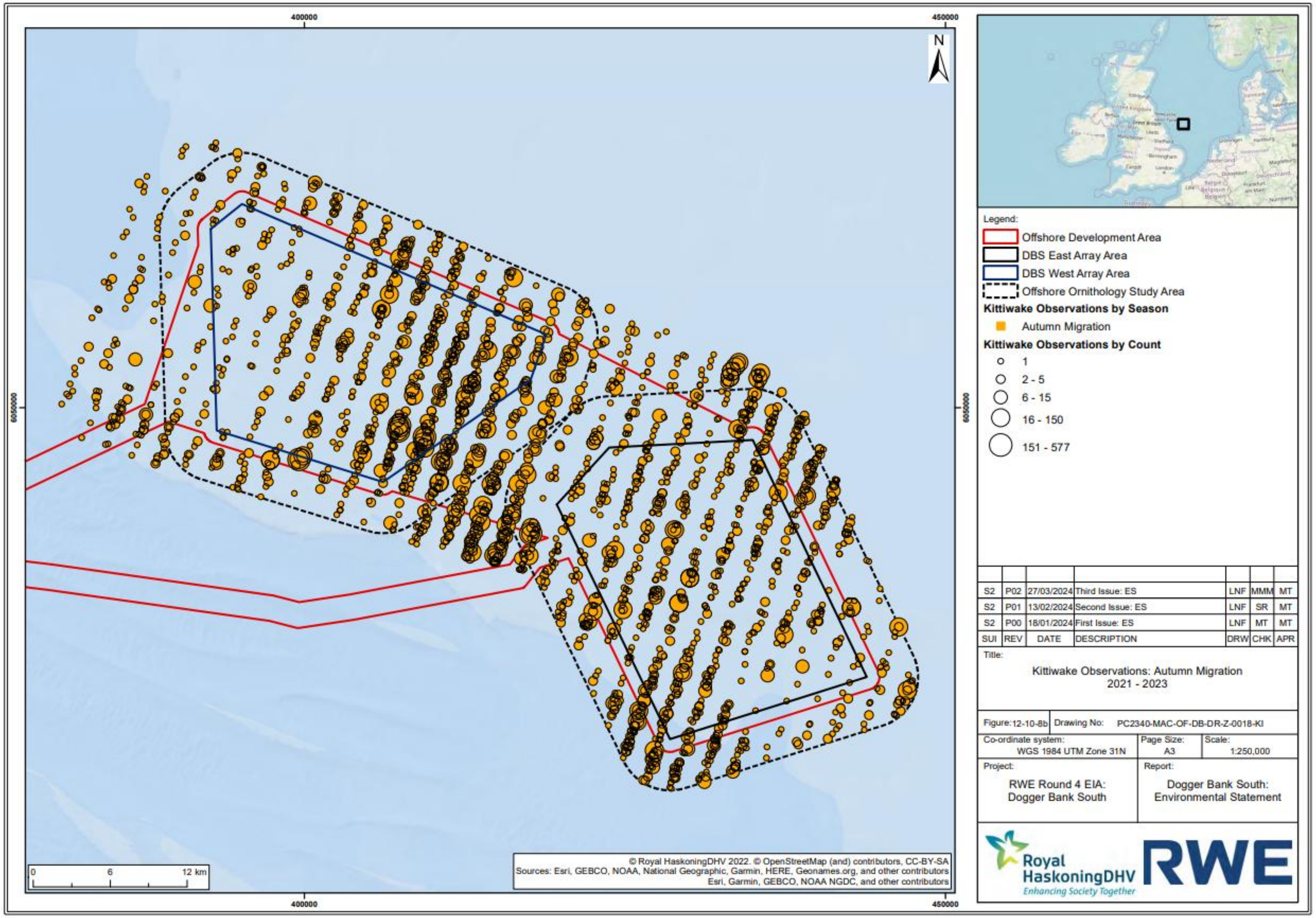

Figure 4-7 Raw counts of kittiwake during the post-breeding migration bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

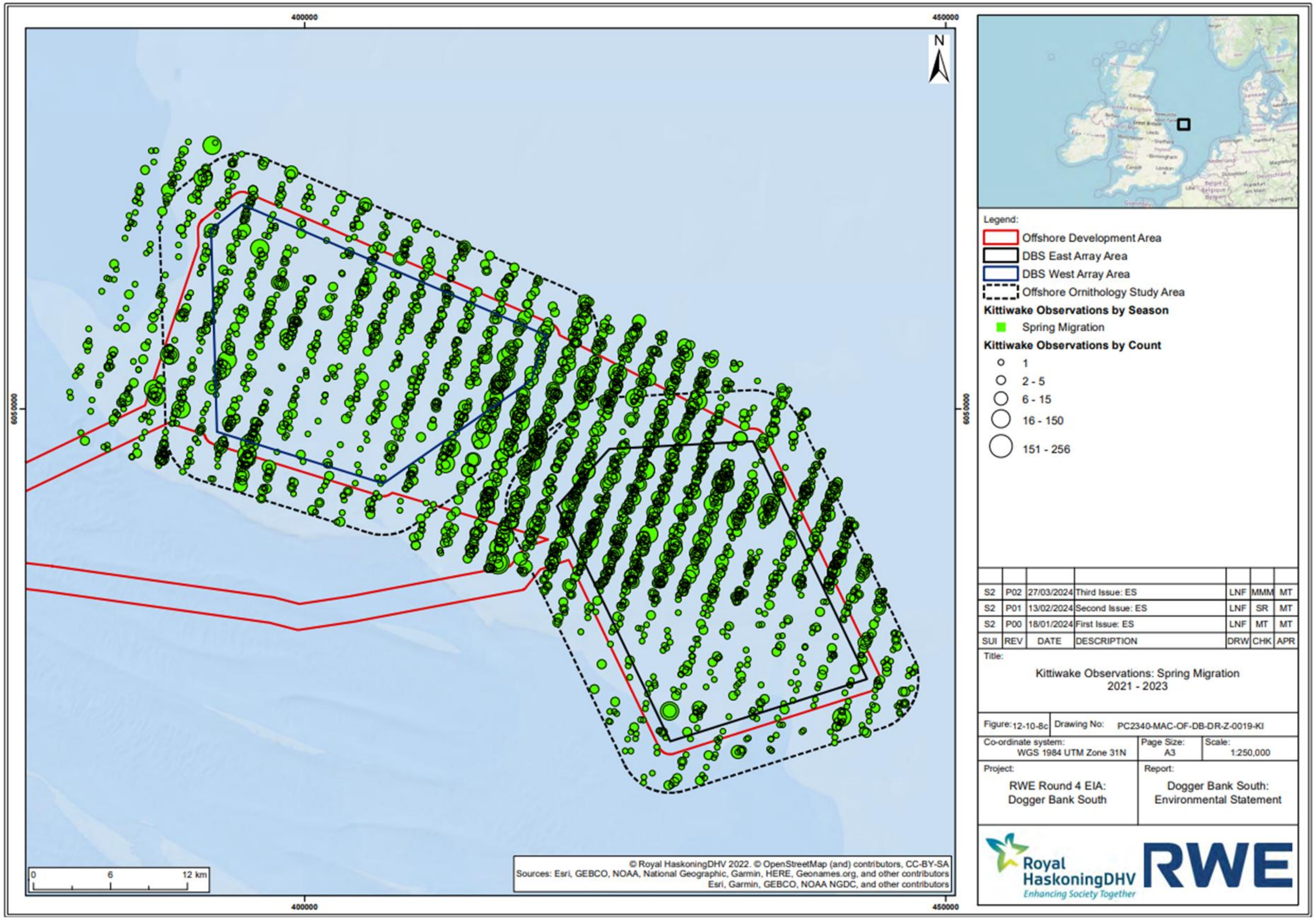

Figure 4-8 Raw counts of kittiwake during the return migration bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

Between 2010 and 2012, kittiwake density was much higher along the western and south-western borders of the Dogger Bank Zone than elsewhere. Kittiwake density was also high in DBS during 2021-2022, with the peak abundance estimate across both the Array Areas surpassing 1% of the North Sea population in March 2021. This indicates that kittiwakes may have also had a south-westerly distribution in the Dogger Bank Zone during these years. As DBD is located within the original DBC (Teesside A) Array Area in the south-east of the Dogger Bank Zone, the density of kittiwakes was low in this area during the 2010-2012 surveys.

Peak abundance and density estimates for all OWF Array Areas in the Dogger Bank Zone and DBS are shown in **Table 4–2**. The abundance and density values for DBS East and West are monthly mean peaks across the two-year survey period (RWE, 2023a; RWE, 2023c) whereas the values for all other OWFs are absolute peaks.

Table 4–2 Peak abundance and density estimates for kittiwake for all OWF projects in the Dogger Bank Zone

Project	Peak abundance	Peak density (individuals/km^2)	Month
Dogger Bank A	6,437	12.49	March 2011
Dogger Bank B	8,247	13.76	March 2011
Dogger Bank C	4,889	8.72	March 2011
Sofia	6,487	10.93	March 2011
Dogger Bank South (East)	5,752	11.97	March 2021/22
Dogger Bank South (West)	4,243	11.99	August 2021/22
Dogger Bank D	1,741	7.21	April 2023

4.1.2 DBD Survey data (aerial survey data 2021-2023)

Kittiwakes were recorded in 23 of the 24 DAS within the DBD Array Area (**Appendix 3**) with a peak abundance in January 2022 (mean abundance estimate 1,893 individuals) for the first year of data. In Year 2, the highest abundance for the DBD array was in April 2023 (1,741 individuals) (**Table 4–3**). Kittiwake densities ranged from 0.02 to 7.21 individuals/km^2 within the DBD Array Area for all behaviours (**Appendix 3**), with an average density of 2.01 individuals/km^2.

Table 4–3 Kittiwake raw counts, total estimated abundance and total estimated density (individuals per km^2) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	127	654	2.49	94	484	1.84	33	170	0.65
Nov-21	53	267	1.02	40	201	0.77	13	65	0.25
Dec-21	290	1,453	5.54	81	406	1.55	209	1,047	3.99
Jan-22	372	1,893	7.21	130	693	2.64	242	1,243	4.74
Feb-22	88	457	1.74	39	202	0.77	49	248	0.95
Mar-22	112	566	2.16	65	328	1.25	47	237	0.9
Apr-22	10	50	0.19	9	45	0.17	1	5	0.02
May-22	54	277	1.06	38	195	0.74	16	82	0.31
Jun-22	73	370	1.41	68	345	1.31	5	25	0.10
Jul-22	2	10	0.04	1	5	0.02	1	5	0.02
Sep-22	6	31	0.12	2	10	0.04	4	20	0.08
Oct-22	183	946	3.61	62	312	1.19	121	624	2.38
Nov-22	16	88	0.34	11	60	0.23	5	27	0.10
Dec-22	41	207	0.79	36	182	0.69	5	25	0.10
Jan-23	161	815	3.11	89	451	1.72	72	365	1.39
Feb-23	52	264	1.01	35	178	0.68	17	86	0.33
Mar-23	35	191	0.73	21	106	0.4	14	88	0.34
Apr-23	340	1,741	6.64	146	762	2.9	194	988	3.77
May-23	61	308	1.17	12	61	0.23	49	248	0.95
Jun-23	205	1,036	3.95	78	394	1.5	127	642	2.45
Jul-23	73	369	1.41	58	293	1.12	15	76	0.29
Aug-23	34	172	0.66	25	126	0.48	9	45	0.17
Sep-23	1	5	0.02	0	0	0.00	1	5	0.02

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Migration-free breeding = purple and Post-breeding migration = orange.

Kittiwake abundance in the DBD Array Area was highest in the return migration bio-season during Year 1 and Year 2 (**Table 4–3**). Overall, abundances in Year 1 were less than Year 2.

4.1.3 Age ratios

Kittiwake age classes were determined upon initial identification from the DAS imagery for the entire study area (Array Area plus 4km buffer). From this information the proportion of age classes observed in each bio-season could be calculated. The initial age class assignment categorised individuals into 'adult' (2nd year or older) plumage, 'juvenile' (1st winter / summer) plumage or 'unknown'. For each of the three bio-seasons the percentage of kittiwakes within the 'unknown' age category was between 36% and 49%. Out of the kittiwakes that did have a positive age identification, the majority were 'adult' plumage that were observed within the study area (45%-61%), with few individuals categorised as 'juvenile' plumage (3%-9%) (**Table 4–4**). Raw counts for each age class are provided in **Appendix 5**

Table 4–4 Kittiwake plumage proportions from raw counts

Bio-season	Plumage proportions (%)		
	Adult	Juvenile	Unknown
Return migration	45	6	49
Migration-free breeding	61	3	36
Post-breeding migration	53	9	38

The unknown birds need to have an age category assigned to them and so two different methods are outlined below which are relevant to kittiwake. Methods include A) apportioning the unknown birds using stable age structures provided in the Natural England and Natural Resource Wales interim guidance note (2024), and B) to apportion the unknown birds based on the ratio of age classes determined through the DAS data.

Apportioning age classes using latest guidance (Approach A)

Correctly aging immature (2nd year or older birds) and adult kittiwakes is not possible due to both age classes having near identical plumage. Therefore, the adult plumage birds identified from the raw counts have been further apportioned using the stable age ratio of the population (Natural England and Natural Resource Wales, 2024) providing a more representative adult and immature age class split. Juvenile birds can be confidently identified due to the clear 'W' pattern in plumage and so this age group needs no further apportionment. The 'unknown' age category has been apportioned using the stable age ratios in order to provide a final apportioned age class for the kittiwakes within DBD (**Table 4–5**). Considering the apportioned age classes for kittiwake, the majority are adult birds (74%-82%) with the remainder being split between immature (7%-14%) and juvenile birds (11%-15%).

Table 4–5 Kittiwake age class proportions apportioned using stable age structure for unknown birds only (Natural England and Natural Resource Wales, 2024)

Bio-season	Age class proportions (%)		
	Adult	Immature	Juvenile
Return migration	74	12	15
Migration-free breeding	82	7	11
Post-breeding migration	75	14	11

Apportioning age classes using DAS data derived age ratios (Approach B)

The ‘unknown’ age category has been apportioned using the ratio of ages identified through the DAS data (see Natural England’s comments on age classes from ETG2 meeting 2 and ET2 meeting 3 in **Appendix 13.1 Consultation Responses for Offshore and Intertidal Ornithology**), in order to provide a final apportioned age class for the kittiwakes within DBD (**Table 4–6**). Considering the apportioned age classes for kittiwake, the majority are adult birds (86-93%) with the remainder being sub-adult birds (7-14%).

Table 4–6 Kittiwake age class proportions apportioned using DAS data

Bio-season	Age class proportions (%)	
	Adult	Sub-adult
Return migration	88	12
Migration-free breeding	93	7
Post-breeding migration	86	14

4.1.4 Biological Season Mean Peak Estimates

Kittiwakes were present in greatest abundance in the DBD Array Area during the return migration bio-season with an estimated mean peak abundance of 1,817 individuals and a mean peak density of 6.92 individuals/km^2 (**Table 4–7** & **Figure 4-9**). The peak count of birds moving through the Array Area in the return migration bio-season differed in Year 1 and Year 2 with regard to timings. The first year of data showed the peak at the start of the bio-season whereas the Year 2 data showed a peak at the end of this bio-season. Aside from the peaks within the return-migration bio-season the abundance of kittiwake in the Array Area stayed relatively low in Year 1. Overall, in Year 2 kittiwake abundance increased with small peaks in number within the post-breeding and migration-free breeding bio-seasons.

Within the DBD Scoping Report bio-seasons for use were identified for each species. For kittiwake, two different bio-seasons were outlined, using migration-free breeding or the alternative full breeding season. Within the baseline report, and in order to provide the greatest breakdown of bio-seasons, the migration-free breeding season has been presented. Although, it must be noted that in further impact assessments, the Natural England recommended bio-seasons using the full breeding season have been incorporated. On review of the data collected for DBD, the Applicant deems the use of the migration-free breeding bio-season description to be most appropriate. Further discussion following PEIR submission is welcome with SNCBs to confirm appropriate seasons for usage in impact assessments going forward.

Table 4–7 Kittiwake bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return migration (January – April)	1,817	6.92	728	2.77	1,116	4.25
Migration-free breeding (May – July)	703	2.68	370	1.41	362	1.38
Post-breeding migration (August – December)	1,200	4.57	398	1.52	836	3.18

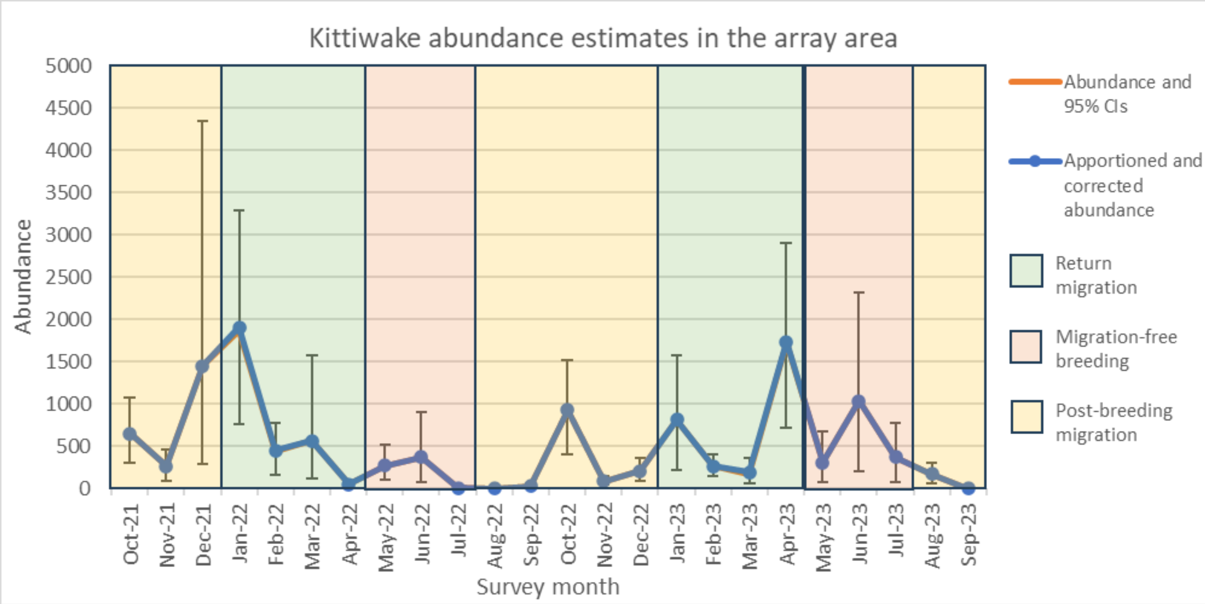

Figure 4-9 Kittiwake abundance estimates for the 24 month survey period within the Array Area (migration-free breeding, return migration and post-breeding migration bio-seasons)

4.1.5 Spatial Density Distribution and Flight Direction

Kittiwakes were distributed in low densities within a clear hotspot at the north-west corner of the DBD survey area across the migration-free breeding and post-breeding migration bio-seasons (**Figure 4-10**). This hotspot remains during the return migration bio-season, however the densities of kittiwake are spread further throughout the Array Area and relevant buffers, with a clear hotspot in the southwest of the Array Area and Array Area plus 4km buffer. This hotspot is the highest density of kittiwake throughout all surveyed bio-seasons.

Monthly flight directions from across the DBD survey area (**Appendix 4**) during the migration-free breeding bio-season showed no clear orientation in a particular direction. This suggests that the kittiwakes observed are either non-breeders loafing in the offshore environment or breeding birds using this area of sea for foraging. The flight directional data shows no clear connectivity to particular colonies, however, this data is only a snapshot of seabird flight behaviour and so conclusions are limited. When foraging, seabirds would be expected to show no clear flight direction as birds often circle or turn frequently as they forage. However, when considering the flight direction data and known tracking data from Flamborough and Filey Coast, Coquet Island and St Abb's Head to Fast Castle SPAs (Seabird Tracking Database, 2023a, b & c) which shows no overlap with the Project area, it is likely that connectivity between the Project area and any individual colony within the migration-free breeding period is limited. The flight direction data show no clear differences between the post-breeding migration bio-season and the return migration bio-season, as the majority of kittiwakes were travelling in a broadly westerly orientation during both periods.

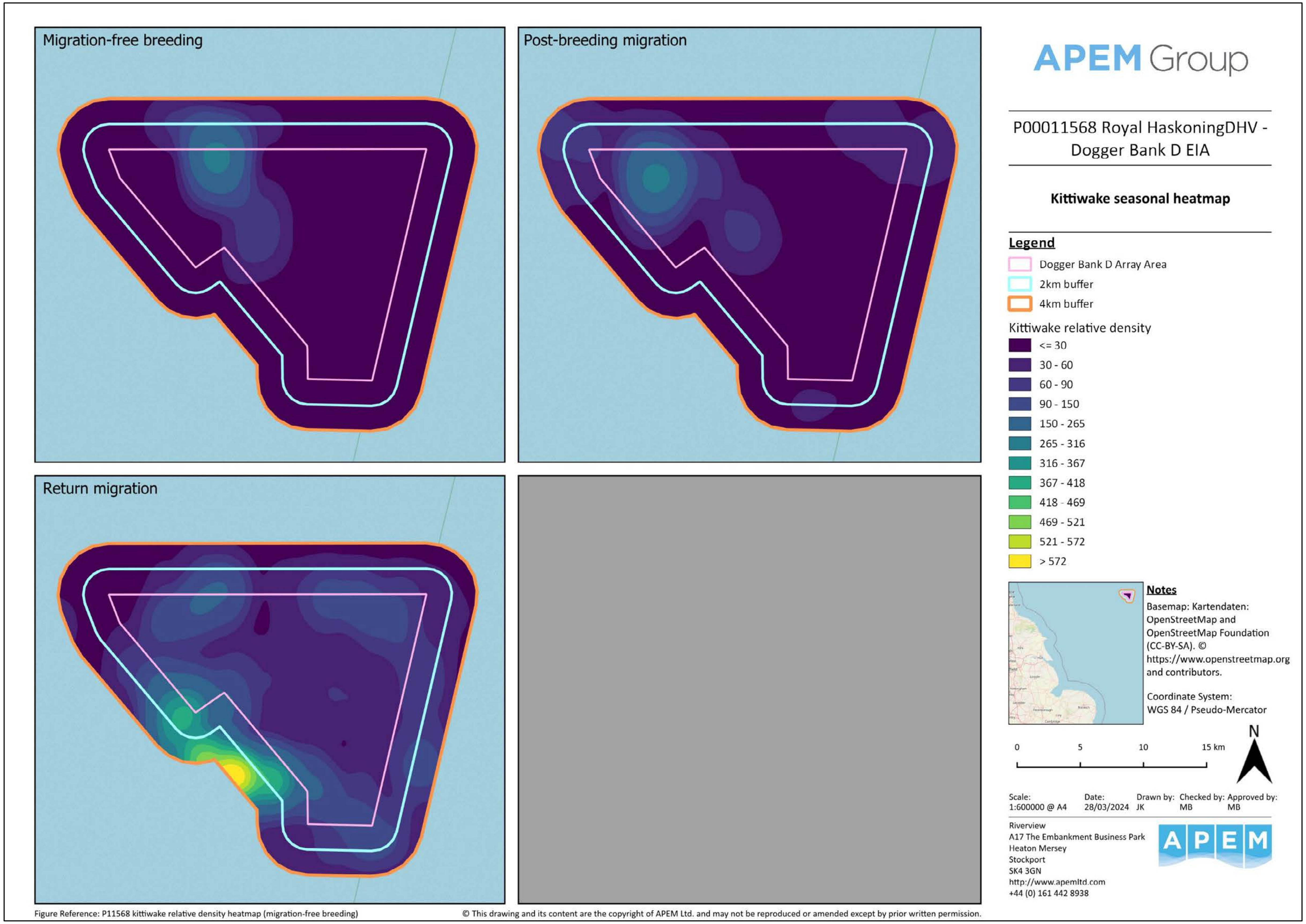

Figure 4-10 Heatmaps of kittiwake distribution in each bio-season

4.1.6 HPAI review

HPAI was first recorded in kittiwakes in the UK in February 2022 (DEFRA, 2022c) with records increasing in number and location since. According to the Tremlett *et al.* (2024) review on HPAI impacts, the number of kittiwake Apparently Occupied Nests (AON) increased by 8% from pre-HPAI to the survey year of 2023 (post outbreak) however, colony specific trends are seen to differ. A more detailed review of Flamborough and Filey Coast SPA and Farne Islands SPA are provided below in order to understand the potential impact of HPAI on kittiwakes at these colonies and how this relates to the baseline data collected for the Project.

Kittiwake AONs at Farne Islands SPA have seen a decrease of 17% from the pre-outbreak baseline count in 2021 to the most recent count taken in 2023 (Tremlett *et al*. 2024). However, the colony trend for the past ten years highlights the inter-annual variability of kittiwakes breeding at the colony with consistent fluctuations in colony count from year to year (**Figure 4-11**). The timing of the DBD baseline data collection represents these frequent and minor changes in the colony counts as would be expected for this colony.

Table 4–8 Kittiwake colony counts at Farne Islands SPA from 2013 to 2023 (SMP, 2024)

Year and colony count (AON)										
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
3,443	4,175	3,956	3,527	4,753	3,158	4,402	4,301	4,303	4,772	3,583

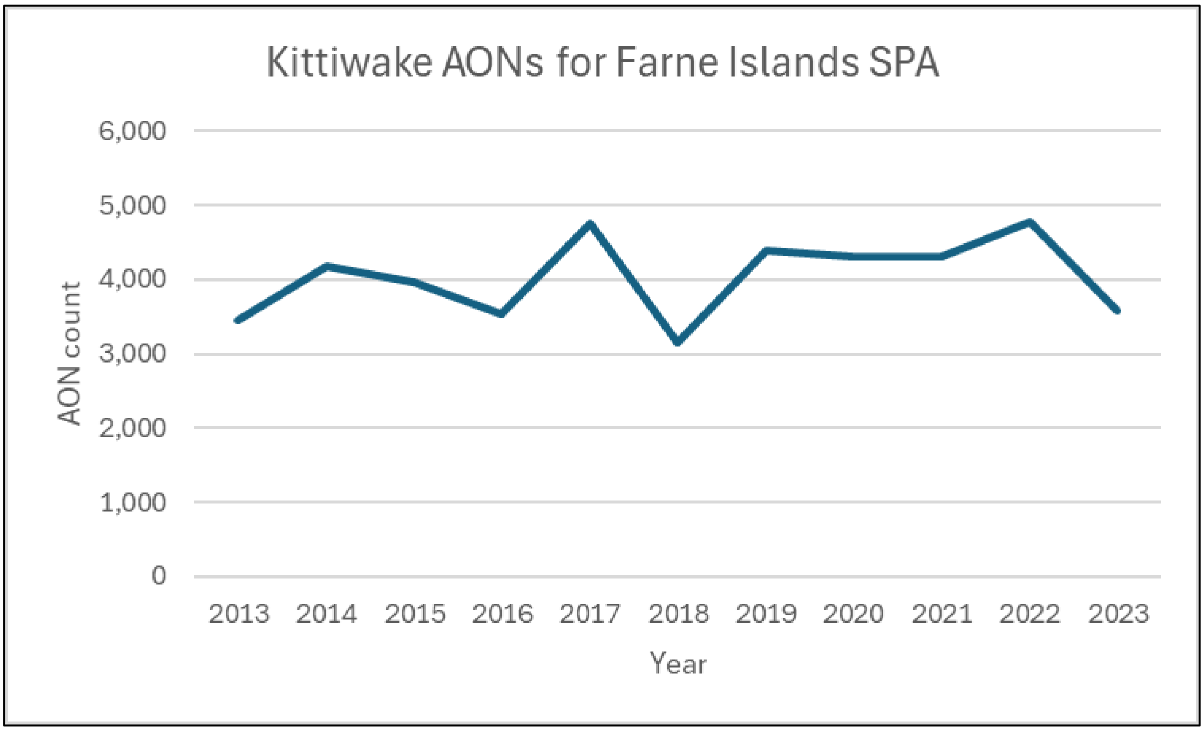

Figure 4-11 Kittiwake colony trend for Farne Islands SPA between 2013 and 2023

Kittiwake AONs at Flamborough and Filey Coast SPA have seen a decrease of 13% from the pre-outbreak baseline count in 2017 to the most recent count taken in 2022 (Tremlett *et al*. 2024). However, the trend of the colony within the four years between the 2017 and 2022 colony counts is unknown and so the full impact of HPAI cannot be concluded (**Figure 4-12**).The 2024 report for Flamborough and Filey Coast (FFC) SPA (Butcher *et al*. 2024) highlights recovery of the colony since 2019 with productivity levels consistently above 0.8. The report also states that occurrences of dead chicks that are of medium to large size is likely due to other factors other than HPAI or adverse weather. The timing of the DBD baseline data collection coincides with data gaps of whole colony counts for the FFC SPA. Pre and post HPAI outbreak records highlight good productivity levels and recovery in the colony which would have been captured in the baseline data.

Table 4–9 Kittiwake colony counts at Flamborough and Filey Coast SPA from 2008 to 2022 (SMP, 2024)

Year and colony count (AON)			
2008	**2016**	**2017**	**2022**
37,617	45,563	45,504	39,653

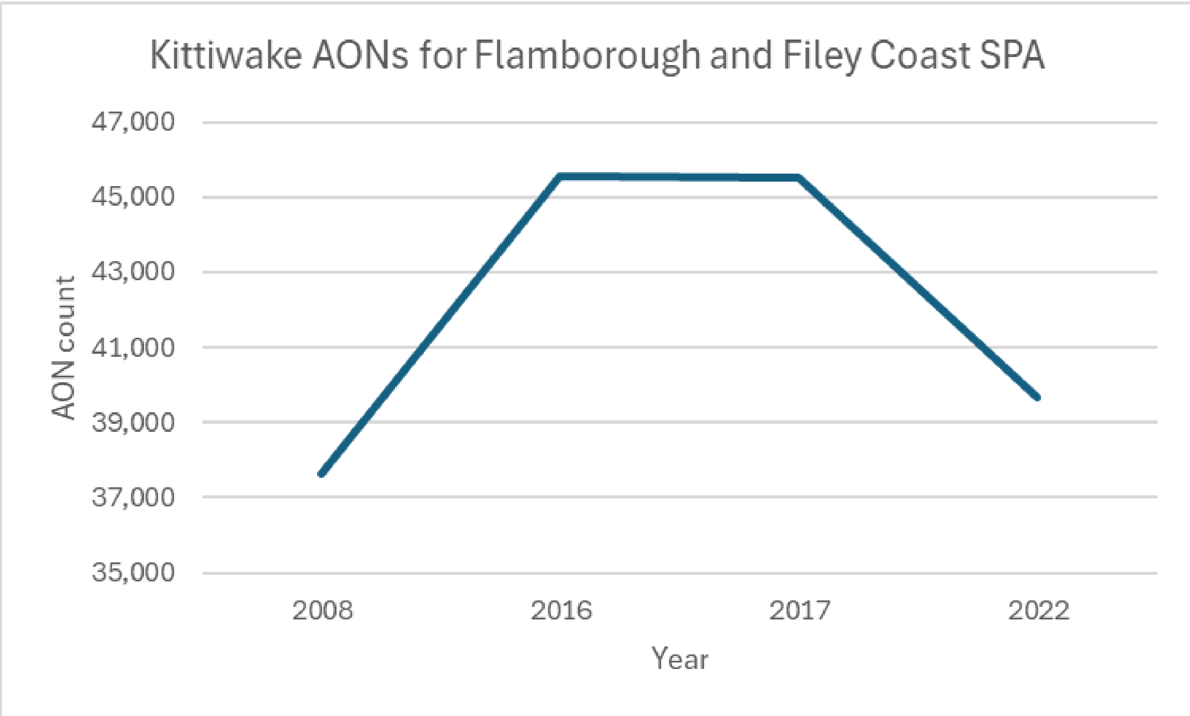

Figure 4-12 Kittiwake colony trend for Flamborough and Filey Coast SPA between 2008 and 2022

4.2 Common gull

4.2.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of common gulls within the Dogger Bank Zone reflected less than 1% of national and regional populations.

In 2010 and 2011, this species was recorded in every month apart from June and December, with monthly abundance estimates peaking in autumn for both DBA (eight individuals) and DBB (10 individuals). In DBC, common gull abundance was also highest in autumn, at 13 individuals, and a peak of 14 individuals was estimated for Sofia in autumn.

In DBS East, common gulls were recorded in January, February, August and November, in the Array Area plus 4km buffer, with a peak abundance estimate of 20 individuals in November for the Array Area. In DBS West, this species was recorded in the Array Area in August and September with a peak abundance of 55 individuals in August. The distribution of common gull records is shown in **Figure 4-13**).

Considering these abundance estimates, common gull density appeared to be low throughout the Dogger Bank Zone during the survey periods and was likely to be low in DBD.

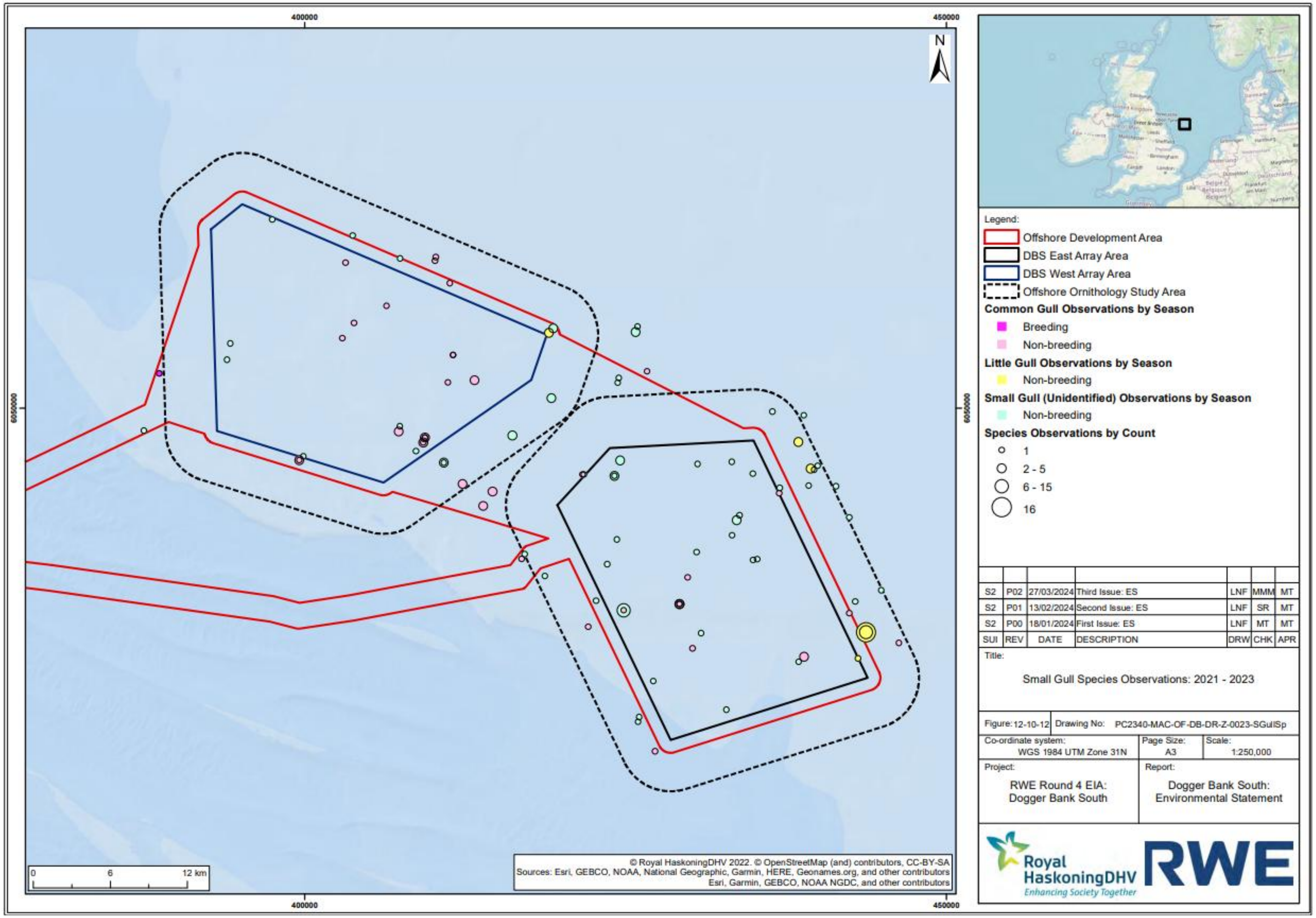

Figure 4-13 Raw counts of common gull, little gull and unidentified small gulls by bio-season during digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

4.2.2 DBD Survey data (aerial survey data 2021-2023)

Common gulls were recorded in seven of the 24 DAS within the DBD Array Area (**Appendix 2**). Abundances were highest in September 2022 (31 individuals) for the first year of data and October 2022 (15 individuals) for the second year of data for the Array Area (**Table 4–10**). Common gull densities ranged from 0.02 to 0.12 individuals/km^2 within the DBD Array Area for all behaviours (**Appendix 2**) with an average density of 0.04 individuals/km^2.

Table 4–10 Common gull raw counts, total estimated abundance and total estimated density (individuals per km^2) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
May-22	1	5	0.02	1	5	0.02	0	0	0.00
Sep-22	6	31	0.12	6	31	0.12	0	0	0.00
Oct-22	3	15	0.06	3	15	0.06	0	0	0.00
Mar-23	2	11	0.04	2	10	0.04	0	0	0.00
Jun-23	1	5	0.02	1	5	0.02	0	0	0.00
Jul-23	1	5	0.02	1	5	0.02	0	0	0.00
Aug-23	1	5	0.02	1	5	0.02	0	0	0.00

*Table note: Bio-seasons are colour coded as follows – Breeding = yellow, Non-breeding = grey

Common gull abundance in the DBD Array Area was highest in the non-breeding bio-season (**Figure 4-14**). Overall, abundances in Year 1 were less than Year 2.

4.2.3 Age ratios

Common gull age classes were determined upon initial identification from the DAS imagery for the entire study area (Array Area plus 4km buffer). From this information the proportion of age classes observed in each bio-season could be calculated. In both the breeding and non-breeding season the majority of common gulls recorded in the DBD Array Area were adults (50% – 63%) with fewer identified as first summer (17%-19%) or first winter birds (6%) (**Table 4–11**). Apportionment of 'unknown' age class was not undertaken for common gull due to the project being outside of the species' known max foraging range (Woodward *et al*. 2019) from any UK SPA, therefore further interrogation of this data was not required for Habitats Regulation Assessment (HRA) breeding apportionment. Raw counts for each age class are provided in **Appendix 5**.

Table 4–11 Common gull age class proportions

Bio-season	Age class proportions (%)			
	Adult	First summer	First winter	Unknown
Breeding	50	17	0	33
Non-breeding	63	19	6	13

4.2.4 Biological Season Mean Peak Estimates

Common gulls were present in greatest abundance in the DBD Array Area during the non-breeding bio-season with an estimated mean peak abundance of 18 individuals and a mean peak density of 0.07 individuals/km^2 (**Table 4–12** & **Figure 4-14**). This peak within the non-breeding bio-season was only demonstrated within the second year of surveys, with another small peak seen at the end of the same non-breeding bio-season. Aside from these peaks, numbers of common gull were low with only a few birds recorded within the Array Area during the breeding bio-season.

Table 4–12 Common gull bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Breeding (May – July)	5	0.02	5	0.02	0	0.00
Non-breeding (August – April)	18	0.07	18	0.07	0	0.00

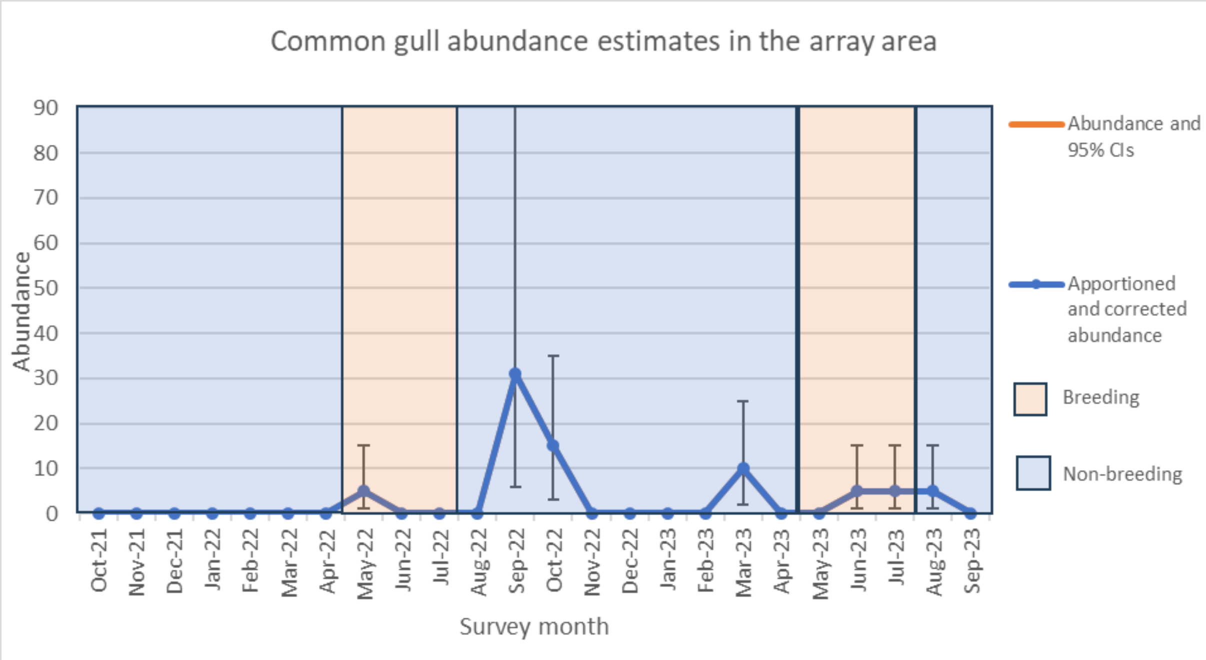

Figure 4-14 Common gull abundance estimates for the 24 month survey period within the Array Area (breeding and non-breeding bio-seasons)

4.2.5 Spatial Density Distribution and Flight Direction

Common gulls were loosely distributed within the DBD survey area in low densities across the breeding bio-season (**Figure 4-15**). During the non-breeding season there was a hotspot of common gull density in the northeast corner of the Array Area. The higher densities within the non-breeding season are likely associated with individuals on migration.

Common gulls were recorded in flight during the breeding and non-breeding bio-seasons across the DBD survey area (**Appendix 4**). Monthly flight directions during the breeding bio-season do not show a predominant orientation which may suggests limited connectivity to particular breeding colonies, although this data is limited as foraging flights would be expected to show no clear flight direction. Given that the project is outside of the species' known max foraging range (Woodward *et al*. 2019) from the coast, any common gull recorded during the breeding bio-season is likely to be a non-breeding bird or undertaking late/early migration. The flight directions during the non-breeding season also show no clear orientation suggesting there is no consistent migratory passage of this species through the Project area, however, this is based on a low sample size.

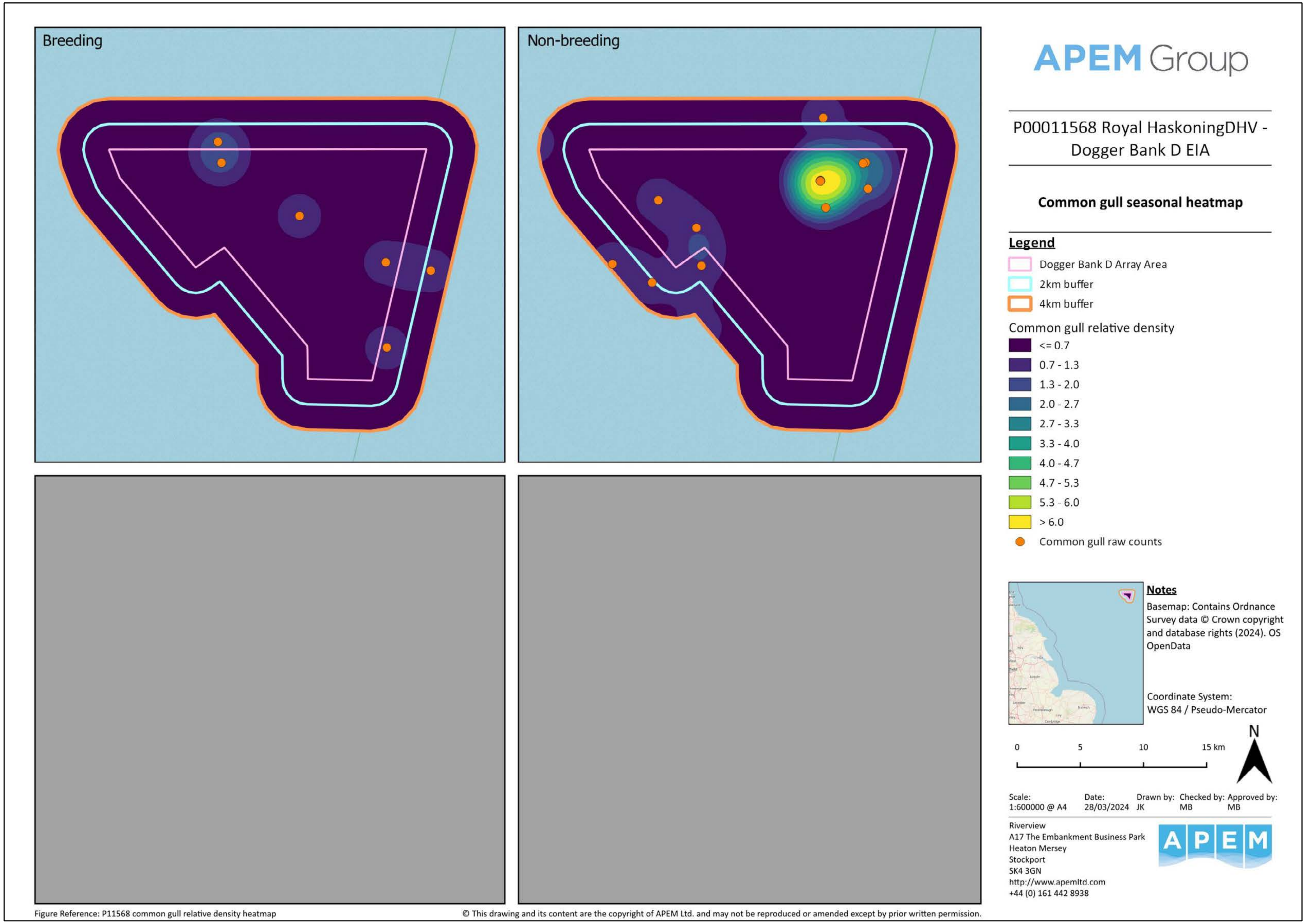

Figure 4-15 Heatmaps of common gull distribution in each bio-season

4.3 Great black-backed gull

4.3.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of great black-backed gulls within the Dogger Bank Zone exceeded the 1% breeding and wintering thresholds for populations of national importance, however there was a high proportion of non-breeders present in the breeding season and the Dogger Bank Zone is beyond the foraging range of any protected breeding site for the species.

In DBA, monthly abundance estimates were similar between the two years, peaking in January 2010 (179 individuals) and February 2011 (126 individuals) in both years. The monthly abundance estimates for DBB also peaked in the same months, with 242 individuals in January 2010 and 171 individuals in February 2011. In both years, the highest densities of great black-backed gulls were recorded in the west and south-west of the survey area where DBA and DBB are situated, particularly in January to March when peak numbers were recorded (**Figure 4-16** & **Figure 4-17**).

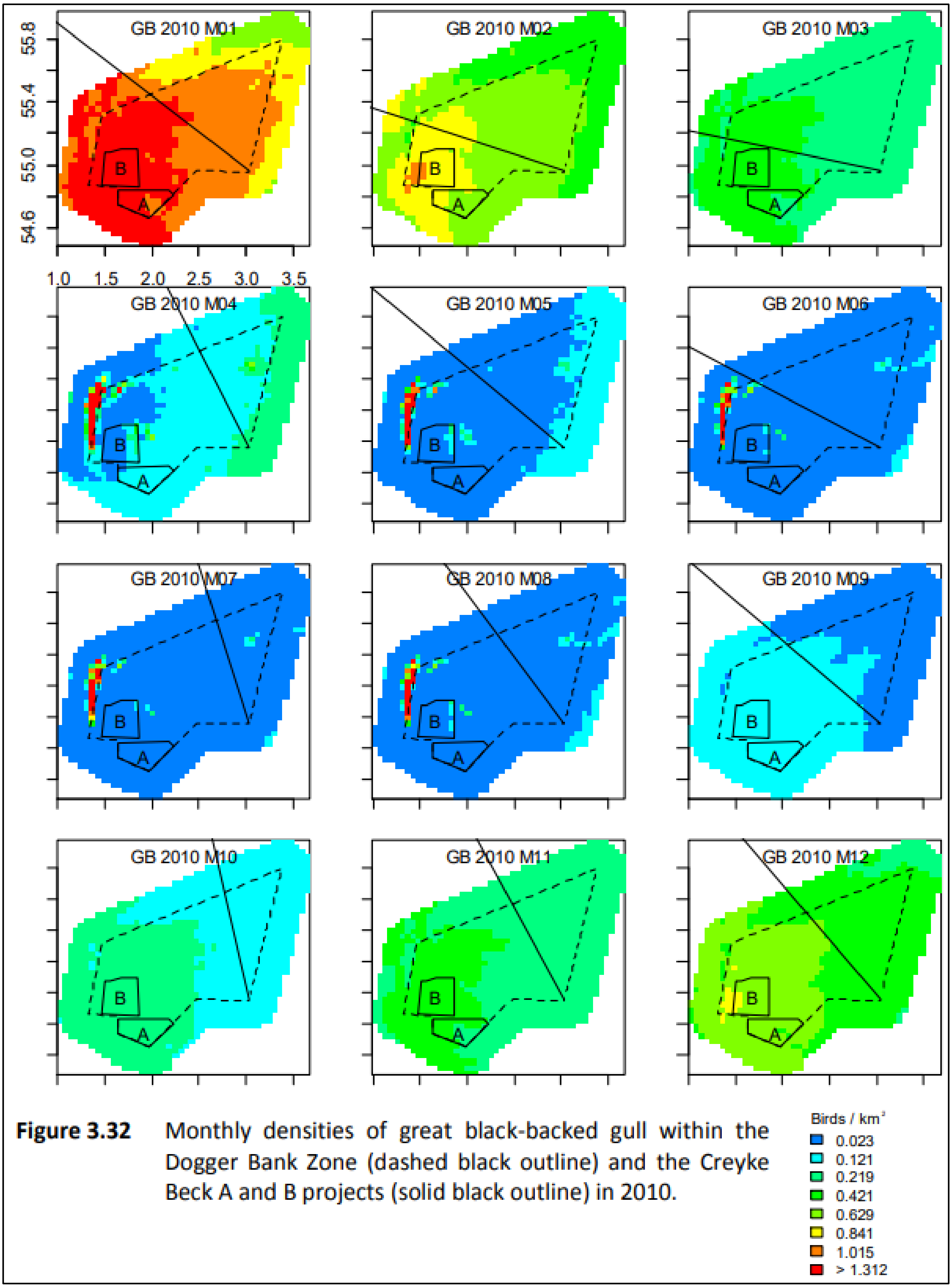

Figure 3.32 Monthly densities of great black-backed gull within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2010.

Figure 4-16 Monthly density heatmaps of great black-backed gull recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton et al. (2013))

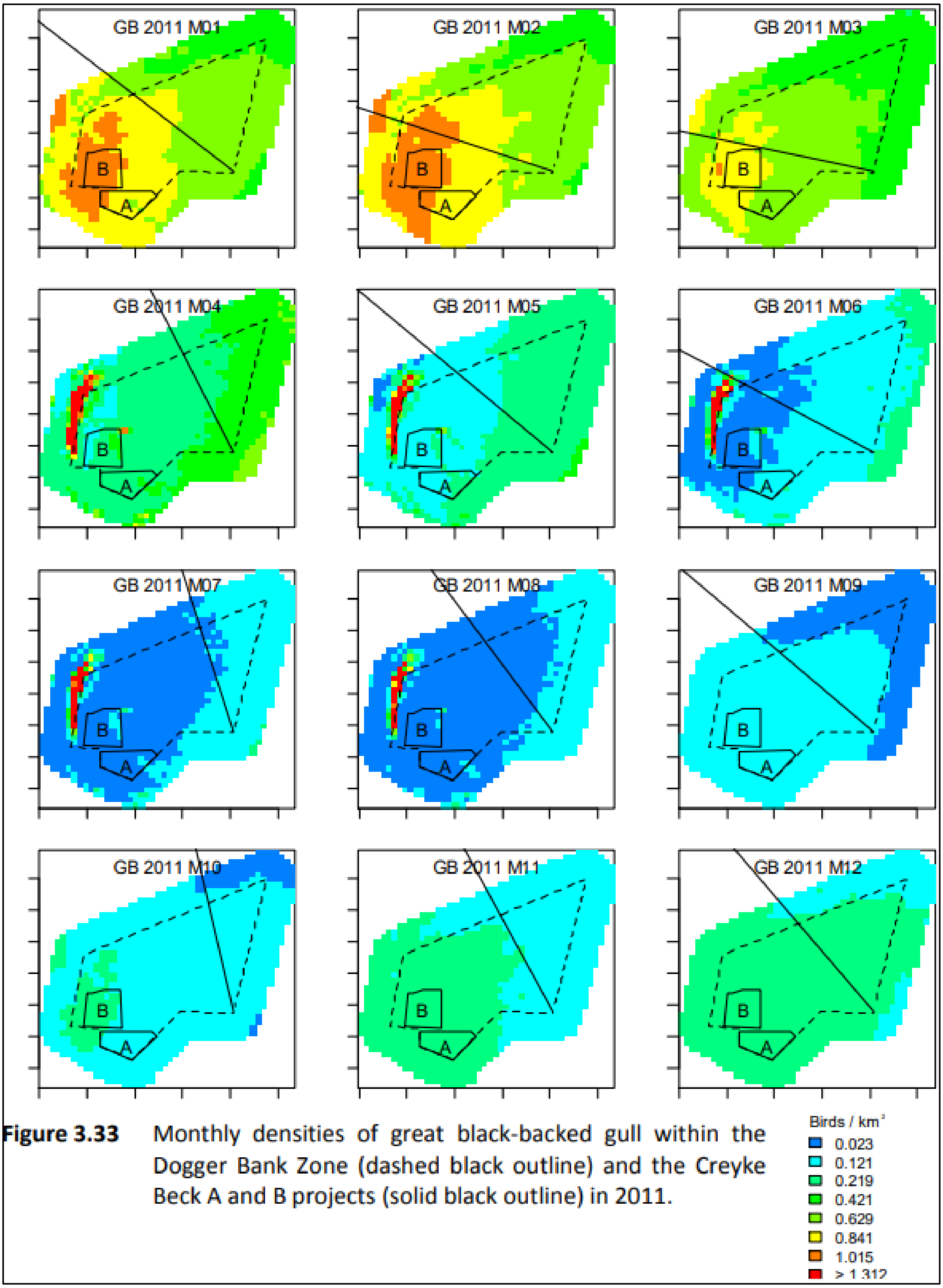

Figure 3.33 Monthly densities of great black-backed gull within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2011.

Figure 4-17 Monthly density heatmaps of great black-backed gull recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2011 (taken from Burton et al. (2013))

In the DBC Array Area, monthly abundance estimates for great black-backed gull peaked in January 2010 (155 individuals), January 2011 (113 individuals) and February 2012 (81 individuals). In the Sofia Array Area, monthly abundance estimates peaked in January 2010 (204 individuals), March 2011 (132 individuals) and February 2012 (95 individuals)

Throughout the survey period, the highest monthly densities of great black-backed gull were recorded in the west and south-west of the Dogger Bank Zone, overlapping with the Sofia Array Area during the winter months in 2010 and 2011 (**Figure 4-18**, **Figure 4-19** and **Figure 4-20**).

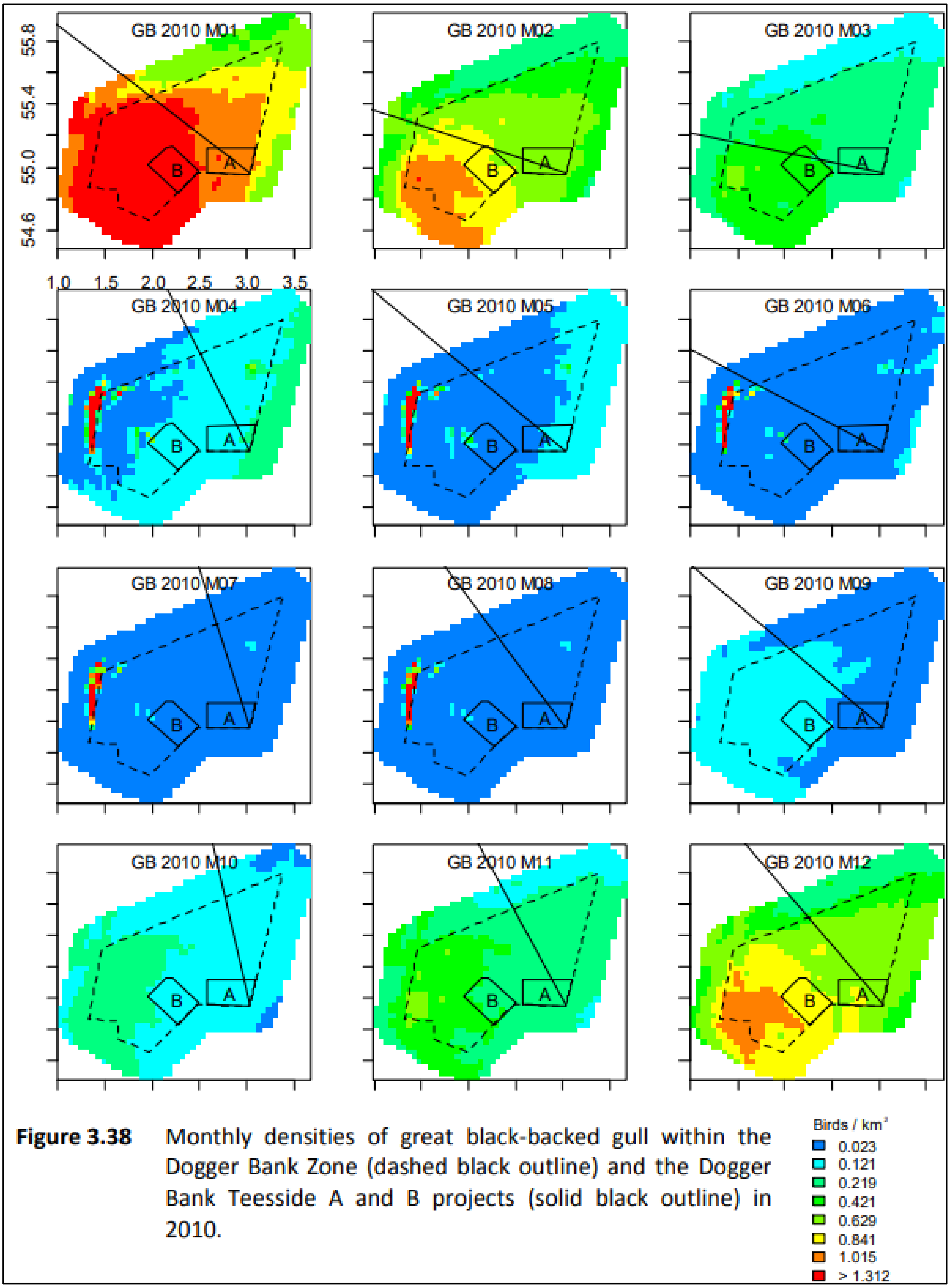

Figure 4-18 Monthly density heatmaps of great black-backed gull recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in 2010 (taken from Burton et al. (2014))

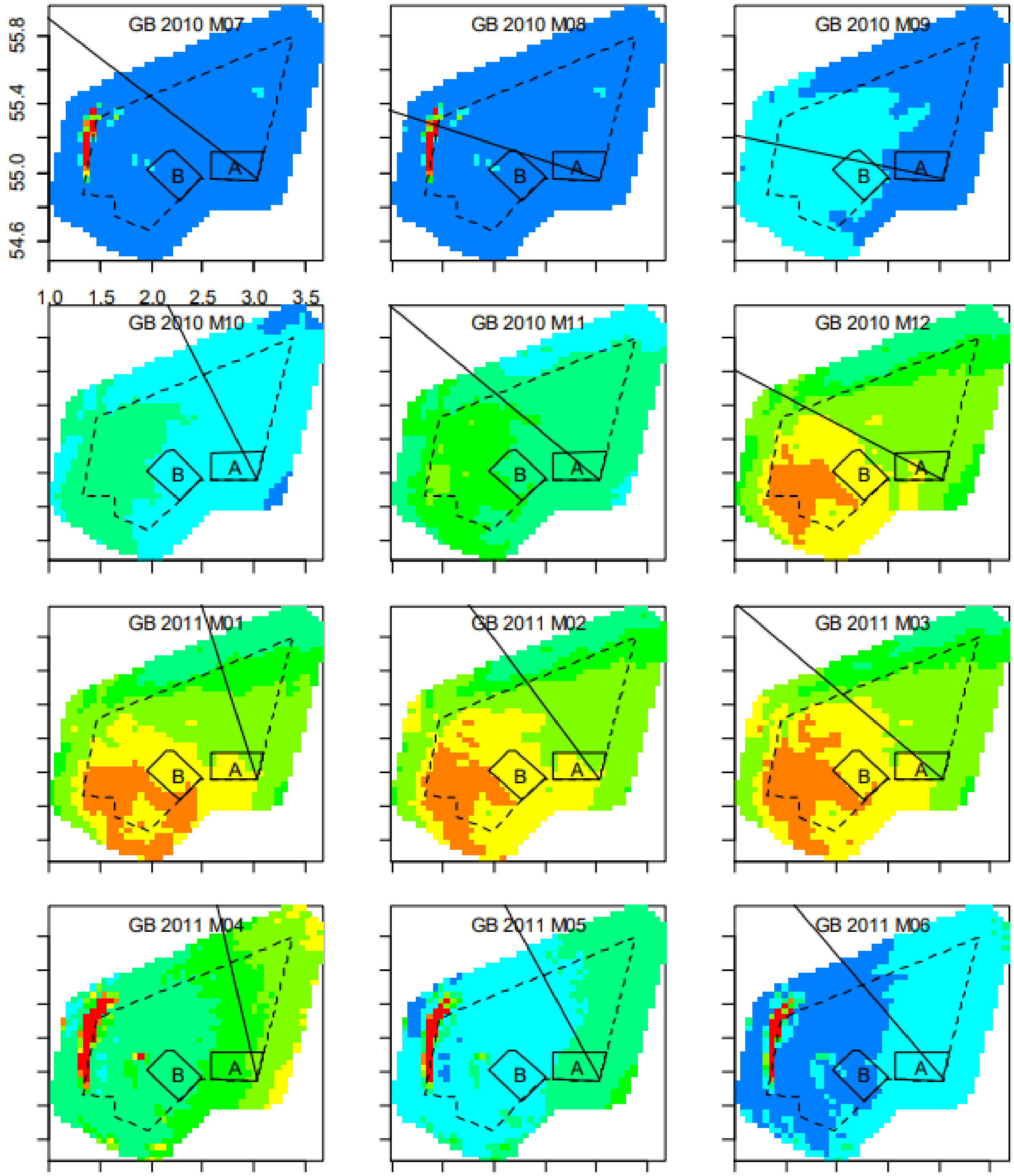

Figure 3.39 Monthly densities of great black-backed gull within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010/11.

Figure 4-19 Monthly density heatmaps of great black-backed gull recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2010 to June 2011 (taken from Burton et al. (2014))

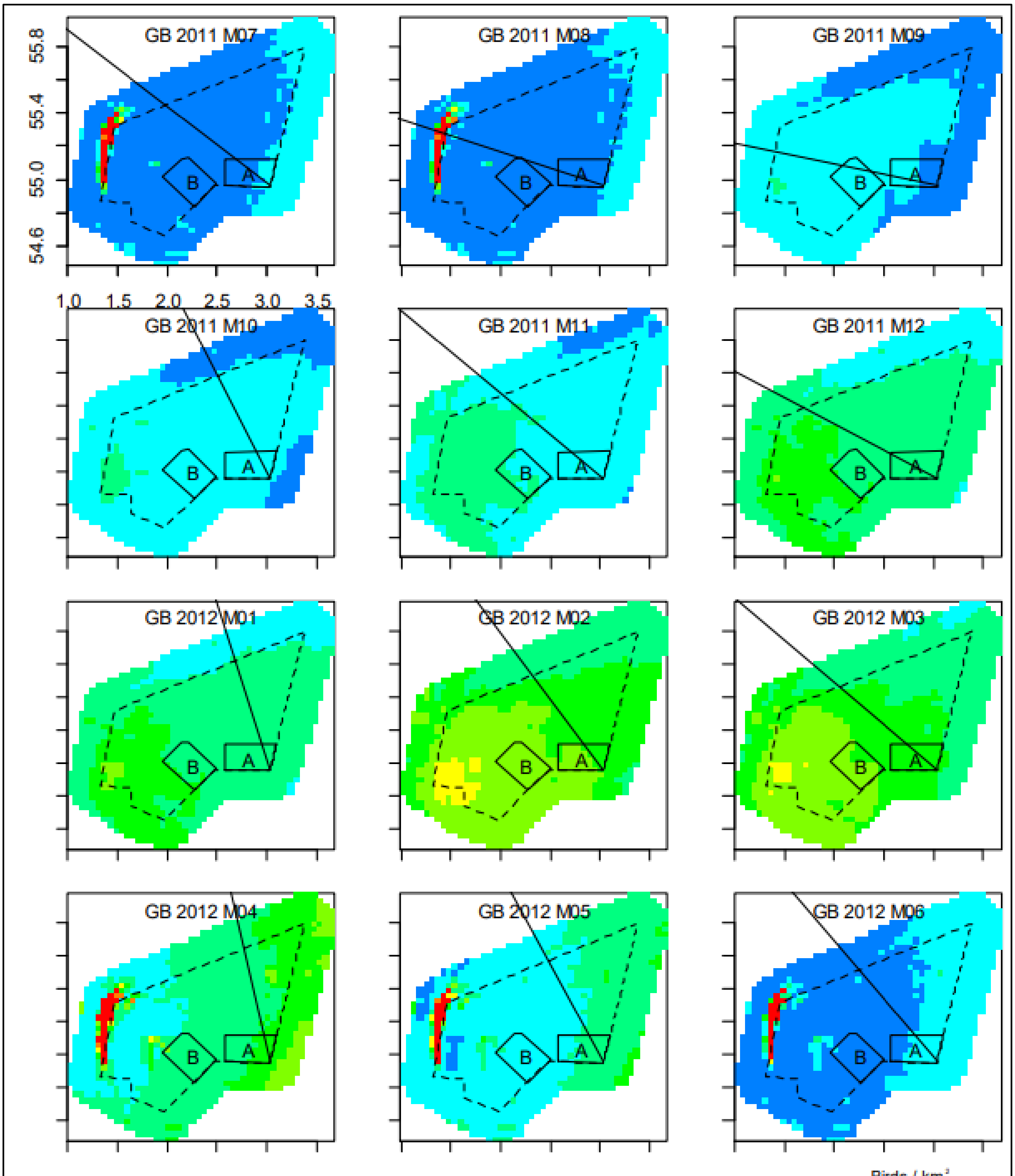

Figure 3.40 Monthly densities of great black-backed gull within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2011/12.

Figure 4-20 Monthly density heatmaps of great black-backed gull recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2011 to June 2012 (taken from Burton et al. (2014))

In DBS, between March 2021 and February 2023, the mean monthly abundance estimates for great black-backed gull peaked in January for the DBS East Array Area (92 individuals). Great black backed gulls were recorded in January, February, March, August, November and December in the DBS East Array Area. They were recorded in January, February, August, September, October and December in DBS West, as well. Abundance peaked in December in DBS West at 30 individuals. In the breeding season, this species was mainly recorded in the 4km buffer of DBS West. During the non-breeding season, great black-backed gulls were more frequent in the DBS West Array Area than in DBS East (**Figure 4-21**).

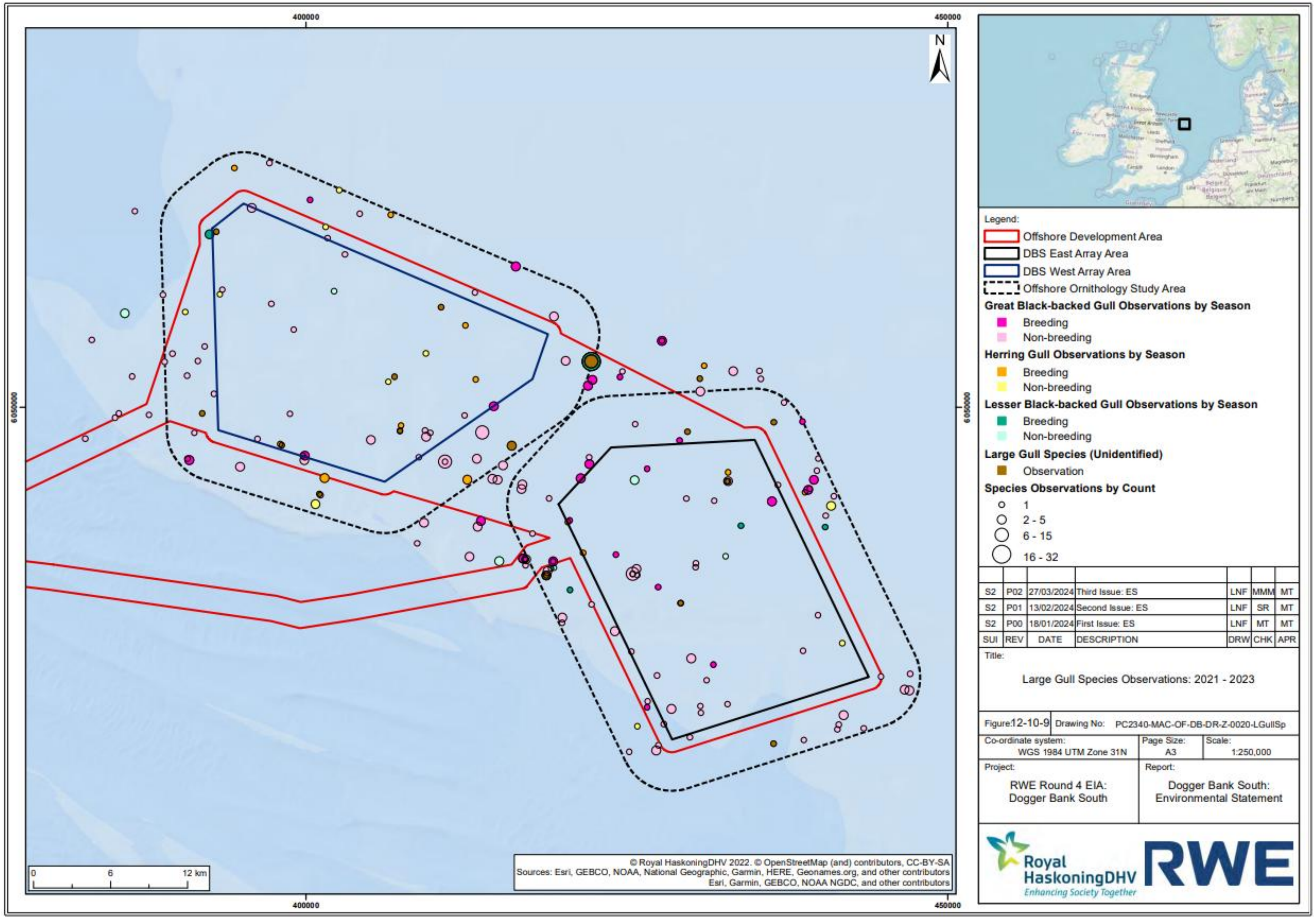

Figure 4-21 Raw counts of great black-backed gull, herring gull and lesser black-backed gull by bio-season during digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

Between 2010 and 2012, great black-backed gull density was highest in the west and south-west of the Dogger Bank Zone, and peak abundance estimates were higher in DBA and DBB than in DBC and Sofia. Therefore, the density of great black-backed gulls in DBD was likely to be low, particularly during the breeding season.

Peak abundance and density estimates for all OWF Array Areas in the Dogger Bank Zone and DBS are shown in **Table 4–13**. The abundance and density values for DBS East and West are monthly mean peaks across the two-year survey period (RWE, 2023a; RWE, 2023c) whereas the values for all other OWFs are absolute peaks.

Table 4–13 Peak abundance and density estimates for great black-backed gull for all OWF projects in the Dogger Bank Zone

Project	Peak abundance	Peak density (individuals/km^2)	Month
Dogger Bank A	179	0.35	January 2010
Dogger Bank B	242	0.40	January 2010
Dogger Bank C	155	0.28	January 2010
Sofia	204	0.34	January 2010
Dogger Bank South (East)	92	0.26	January 2022/23
Dogger Bank South (West)	30	0.08	December 2021/22
Dogger Bank D	10	0.04	February 2023

4.3.2 DBD Survey data (aerial survey data 2021-2023)

Great black-backed gulls were recorded in four of the 24 DAS within the DBD Array Area (**Appendix 2**). An abundance of five individuals was estimated for both months in which great black-backed gulls were present within the Array Area in Year 1 (February and March) (**Table 4–14**). In Year 2 of surveys, the peak count was in February 2023 (10 individuals) for the Array Area. Great black-backed gull densities ranged from 0.02 to 0.04 individuals/km^2 within the DBD Array Area for all behaviours (**Appendix 2**) with an average density of 0.03 individuals/km^2.

Table 4–14 Great black-backed gull raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area.

	DBD Array Area								
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Feb-22	1	5	0.02	0	0	0.00	1	5	0.02
Mar-22	1	5	0.02	1	5	0.02	0	0	0.00
Oct-22	1	5	0.02	0	0	0.00	1	5	0.02
Feb-23	2	10	0.04	0	0	0.00	2	10	0.04

*Table note: Bio-seasons are colour coded as follows – Non-breeding = grey

Great black-backed gulls were only recorded within the non-breeding bio-season within the DBD Array Area, though great black-backed gulls were recorded within the buffer during the breeding bio-season (**Figure 4-22**). Overall, abundances in Year 1 were less than Year 2.

4.3.3 Age ratios

Great black-backed gull age classes were determined upon initial identification from the entire study area (Array Area plus 4km buffer). From this information the proportion of age classes observed in each bio-season could be calculated. Within the non-breeding season 53% of great black-backed gulls in the study area were adults, 20% were first winter birds and 27% were classed as ‘unknown’ for age (**Table 4–15**). For the breeding season 83% were classed at adults and 17% as first winter birds. Apportionment of ‘unknown’ age class was not undertaken for great black-backed gull due to the project being outside of the species’ known max foraging range (Woodward *et al*. 2019) from any UK SPA, therefore further interrogation of this data was not required for HRA breeding apportionment. Raw counts for each age class are provided in **Appendix 5**.

Table 4–15 Great black-backed gull age class proportions

	Age class proportions (%)		
Bio-season	Adult	First winter	Unknown
Breeding	83	17	0
Non-breeding	53	20	27

4.3.4 Biological Season Mean Peak Estimates

Great black-backed gulls were only present within the DBD Array Area during the non-breeding bio-season with an estimated mean peak abundance of eight individuals and a mean peak density of 0.03 individuals/km^2 (**Table 4–16** & **Figure 4-22**). In Year 1 the peak count was seen at the end of the non-breeding season, whereas peaks in Year 2 occurred at the start and end of the non-breeding bio-season.

Current guidance provided by Furness (2015) suggests late March as the start of the breeding bio-season for great black-backed gull. In relation to the two March site-specific DAS surveys, only a single great black-backed gull was recorded in the year 1 survey flown on the 18th March 2022. Furness (2015) does not provide specific details as to cut off dates between a definition of early, mid or late period of a month. The Project considers that a survey flown on the 18th would be categorised as a mid-month survey, meaning the March 2022 survey would be classified as a non-breeding bio-season month, which is the approach taken by the Project. This conclusion aligns with the remaining baseline survey results which did not record a single great black-backed gull in the remaining breeding bio-season months across the two years of survey.

Table 4–16 Great black-backed gull bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Breeding (Late March – August)	0	0.00	0	0.00	0	0.00
Non-breeding (September – March)	8	0.03	3	0.01	8	0.03

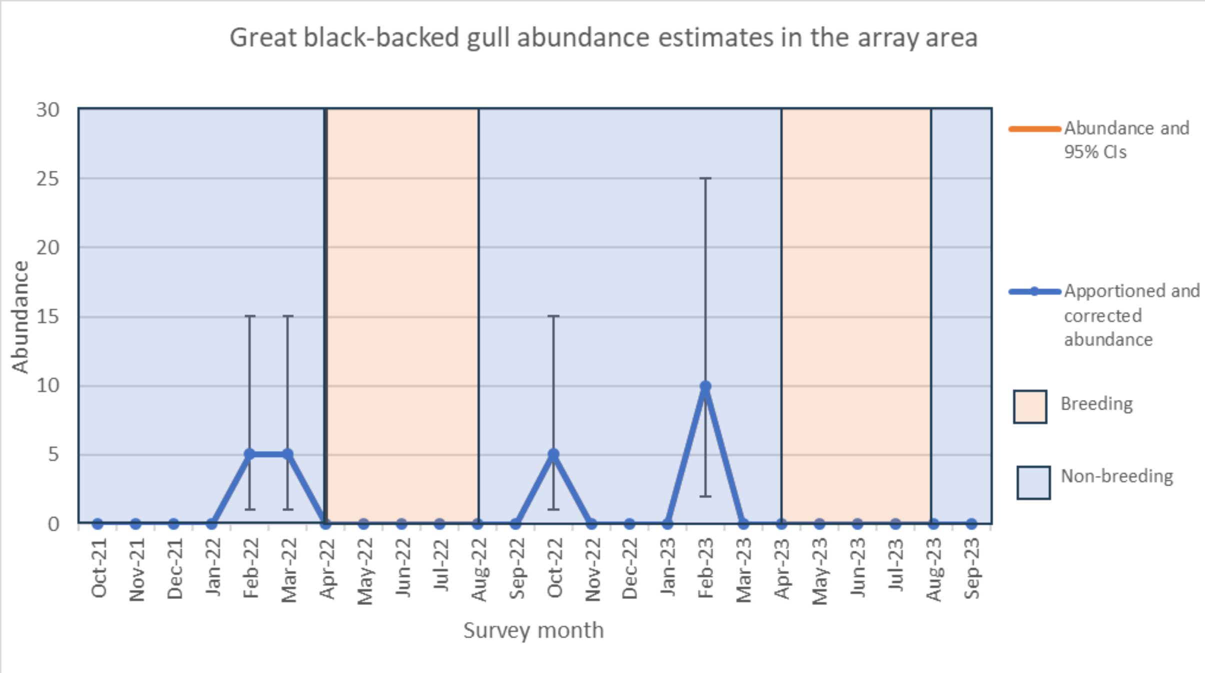

Figure 4-22 Great black-backed gull abundance estimates for the 24 month survey period within the Array Area (breeding and non-breeding bio-seasons)

4.3.5 Spatial Density Distribution and Flight Direction

There were differences in the distributions of great black-backed gulls between the two bio-seasons (**Figure 4-23**). During the non-breeding season observations were spread throughout the Array Area and relevant buffers. Observations in the breeding season were along the western edge of the Array Area buffers, with no observations within the Array Area only.

Monthly flight directions from across the DBD survey area during the breeding bio-season had no particular orientation, indicating that birds observed are likely non-breeders loafing or foraging in the area of sea. No clear flight orientation may suggest limited connectivity to a breeding colony as expected, given the project is located outside of the species' max foraging range (Woodward *et al*. 2019) from the coast. However, these conclusions are restricted by the small sample size and snapshot nature of flight orientation data. In the non-breeding bio-season, directional data show a flight direction of east/west orientation, suggesting birds were observed migrating to and from breeding colonies and wintering areas (**Appendix 4**).

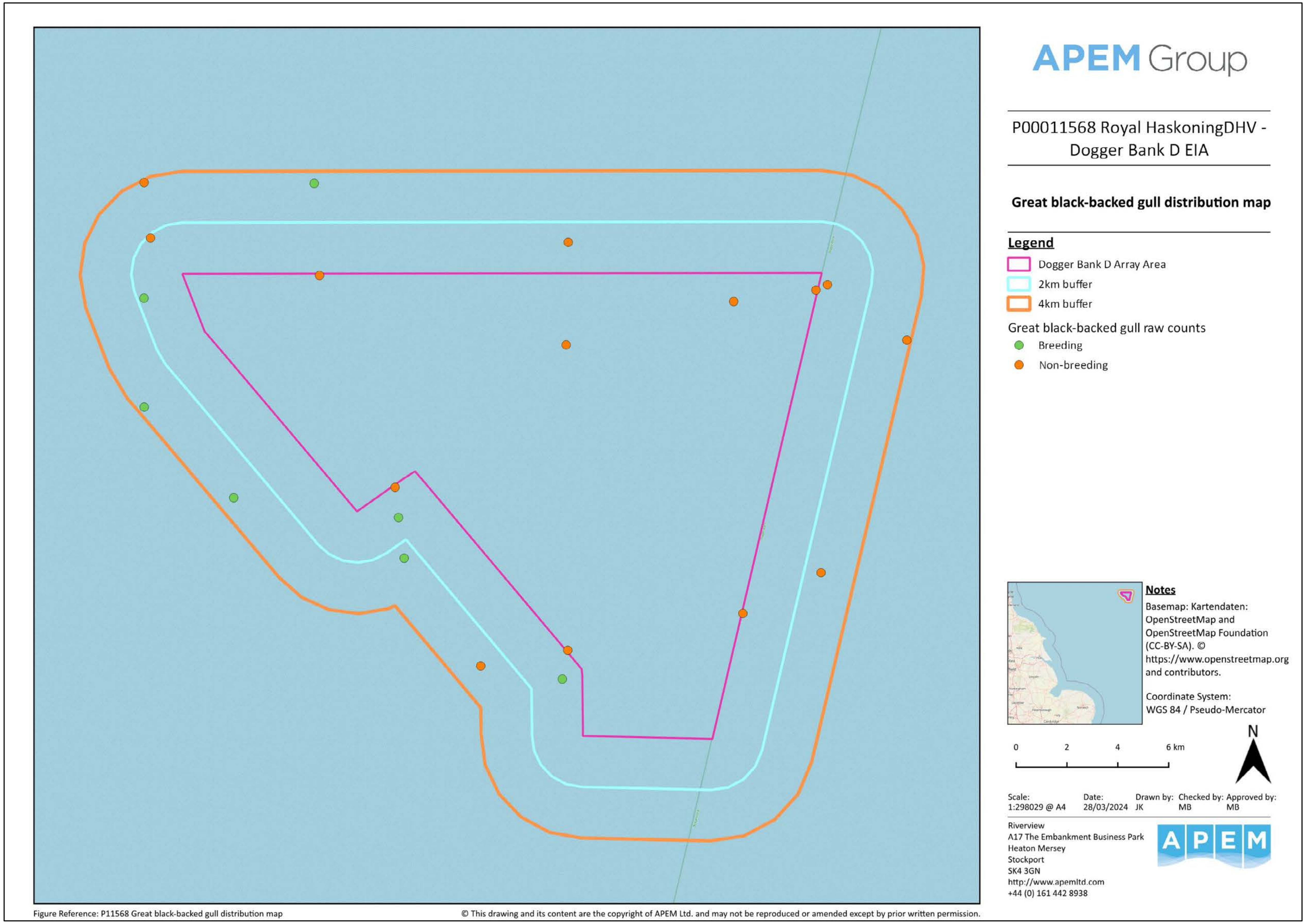

Figure 4-23 Distribution of great black-backed gull raw counts in each bio-season

4.4 Herring gull

4.4.1 Historical data from the Dogger Bank Zone and Dogger Bank South

In 2010 and 2011, herring gull were recorded in the Dogger Bank Zone between October and May. An average monthly abundance of 19 individuals was estimated for DBA, with an estimate of 21 individuals for DBB. In DBC and Sofia, the average monthly abundance estimates for the same time period were 28 and 29 individuals, respectively.

In DBS East, between March 2021 and February 2023, herring gulls were recorded in January, Marchand November in the Array Area, with a mean peak abundance estimate of 12 individuals in June for the Array Area and 145 for the Array Area plus 4km buffer. In DBS West, this species was recorded in January, April, June, August and November in the Array Area. The mean peak abundance estimate was eight individuals for the Array Area, in August and November. The distribution of herring gull records is shown in (**Figure 4-21**).

Considering the abundance estimates above, herring gull density was likely to be low throughout the Dogger Bank Zone during the 2010-2012 surveys. Abundance was slightly higher in DBC and Sofia than in DBA and DBB, indicating that this may also have been the case for DBD.

4.4.2 DBD Survey data (aerial survey data 2021-2023)

Herring gulls were recorded in four of the 24 DAS within the DBD Array Area (**Appendix 3**). Only the January 2022 survey in the first year of surveys recorded any observations of herring gull, providing an abundance estimate of five birds (**Table 4–17**). In Year 2 of surveys, the peak count was in October 2022 (10 individuals) for the Array Area. Herring gull densities ranged from 0.02 to 0.04 individuals/km^2 within the DBD Array Area for all behaviours (**Appendix 3**) with an average density of 0.03 individuals/km^2.

Table 4–17 Herring gull raw counts, total estimated abundance and total estimated density (individuals per km^2) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Jan-22	1	5	0.02	1	5	0.02	0	0	0.00
Oct-22	2	10	0.04	2	10	0.04	0	0	0.00
Jan-23	1	5	0.02	1	5	0.02	0	0	0.00
May-23	1	5	0.02	0	0	0.00	1	5	0.02

*Table note: Bio-seasons are colour coded as follows – Breeding = yellow, Non-breeding = grey

Herring gull abundance in the DBD Array Area was highest in the non-breeding bio-season with only one month within the breeding bio-season recording observations (**Figure 4-24**). Overall, abundances in Year 1 were less than Year 2.

4.4.3 Age ratios

Herring gull age classes were determined upon initial identification from the DAS imagery for the entire survey area (Array Area plus 4km buffer). From this information the proportion of age classes observed in each bio-season could be calculated. During the breeding bio-season herring gull age classes were only classed as 'unknown', however this was only one individual bird. During the non-breeding bio-season all identified herring gulls were given an age class, the majority were classed as adults (67%) with the remainder being classed as first winter (17%) or second winter birds (17%) (**Table 4–18**). Apportionment of 'unknown' age class was not undertaken for herring gull due to the project being outside of the species' known max foraging range (Woodward *et al*. 2019) from any UK SPA, therefore further interrogation of this data was not required for HRA breeding apportionment. Raw counts for each age class are provided in **Appendix 5**.

Table 4–18 Herring gull age class proportions

Bio-season	Age class proportions (%)			
	Adult	Second winter	First winter	Unknown
Breeding	0	0	0	100
Non-breeding	67	17	17	0

4.4.4 Biological Season Mean Peak Estimates

Herring gulls were present in greatest abundance in the DBD Array Area during the non-breeding bio-season with an estimated mean peak abundance of eight individuals and a mean peak density of 0.03 individuals/km^2 (**Table 4–19** & **Figure 4-24**). In Year 1 of surveys, there was a peak in herring gull numbers in January 2022, around the middle of the non-breeding season. This was reflected in Year 2 of the data, with an additional peak towards the start of the non-breeding season in October 2022. No herring gulls were present in the breeding season during Year 1 of surveys but a peak at the start of the breeding season in Year 2 was observed. Apart from the four peaks mentioned, no other observations were made.

Table 4–19 Herring gull bio-season mean peak abundance and density (individuals per km²) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Breeding (March – August)	3	0.01	0	0.00	3	0.01
Non-breeding (September – February)	8	0.03	8	0.03	0	0.00

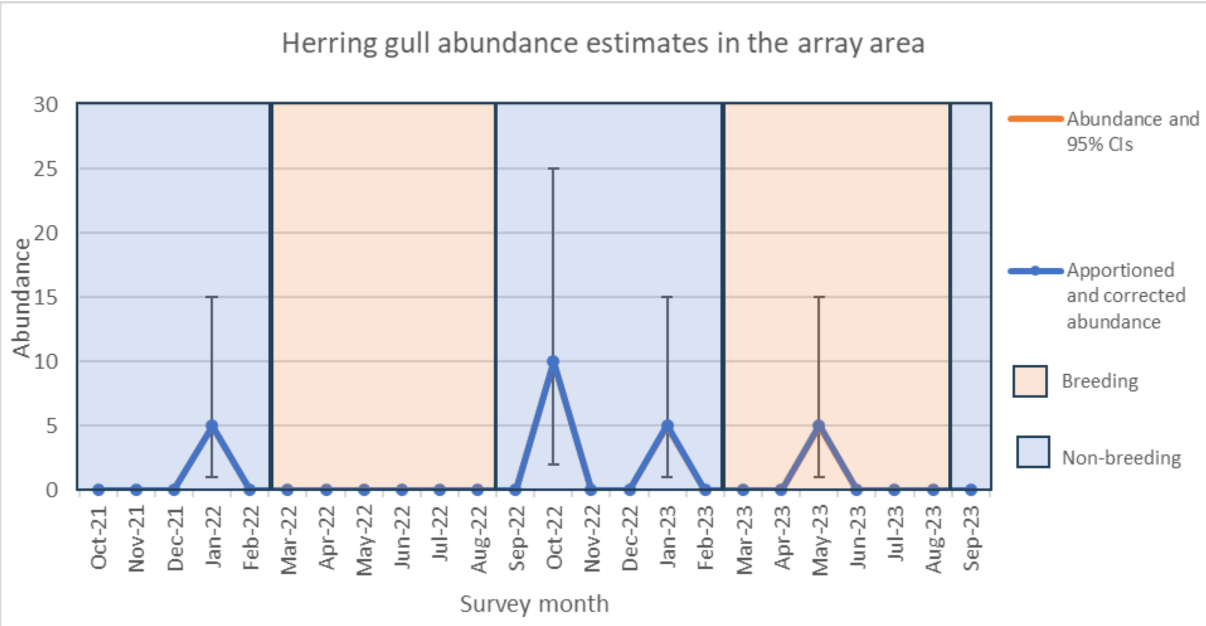

Figure 4-24 Herring gull abundance estimates for the 24 month survey period within the Array Area (breeding and non-breeding bio-seasons)

4.4.5 Spatial Density Distribution and Flight Direction

There was only a single observation of herring gull within the Array Area and associated buffers during the breeding bio-season which was situated at the western edge of the array (**Figure 4-25**). During the non-breeding season observations were spread throughout the northern section of the Array Area and associated buffers.

Herring gulls were only observed in flight across the DBD survey area during the non-breeding bio-season (**Appendix 4**). There were only six observations of birds in flight in total, with the directionality showing no clear orientation.

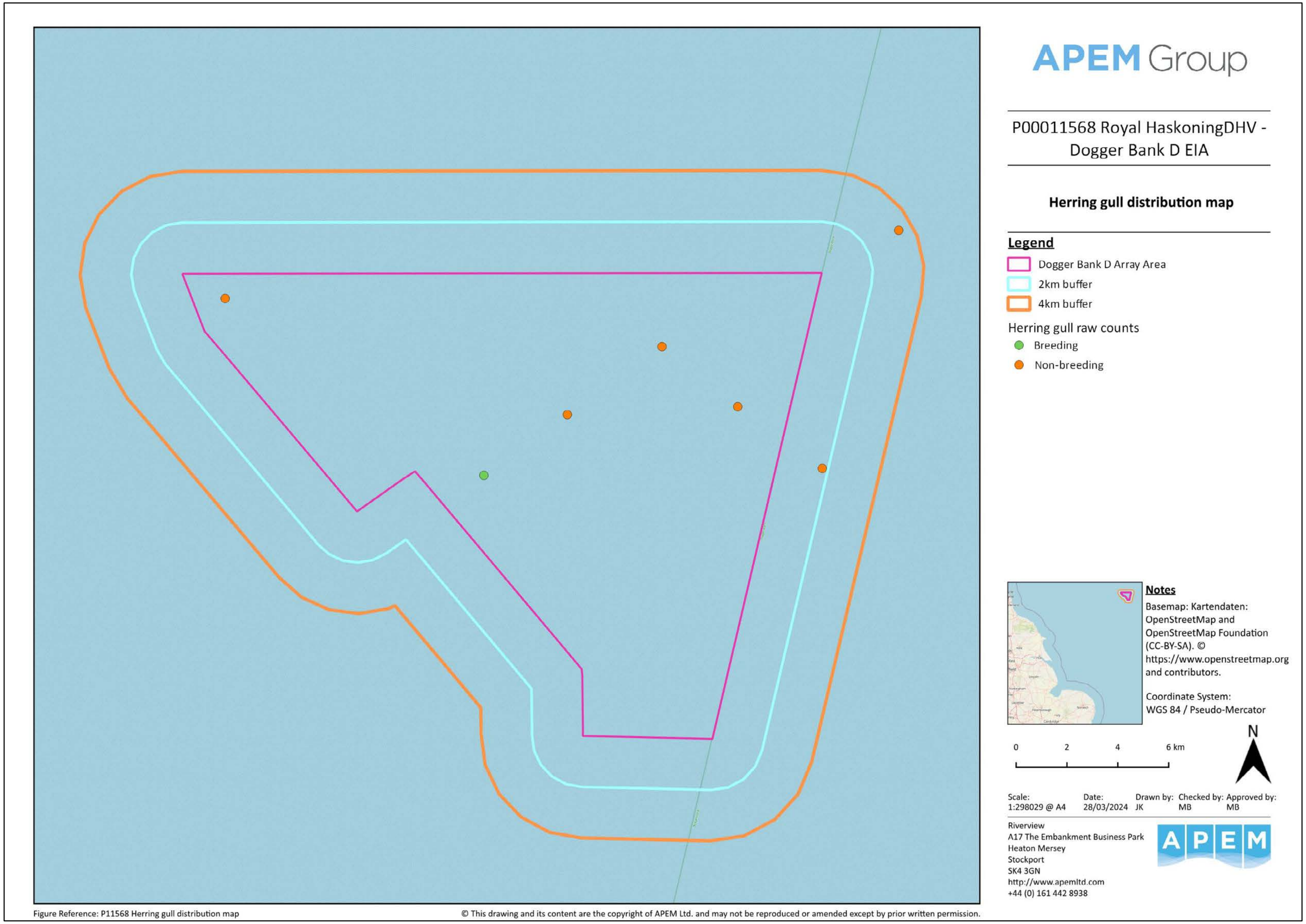

Figure 4-25 Distribution of herring gull raw counts in each bio-season

4.5 Lesser black-backed gull

4.5.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of lesser black-backed gulls within the Dogger Bank Zone exceeded the 1% threshold for populations of national importance in the 2010 breeding season, though some of the birds present may have been from the Scandinavian breeding population (subspecies *intermedius*).

In DBA, monthly abundance estimates were similar between the two years, peaking in June 2010 (104 individuals) and May 2011 (43 individuals) in both years. The monthly abundance estimates for DBB also peaked in the same months, with 156 individuals in June 2010 and 47 individuals in May 2011. Densities of lesser black-backed gulls were higher on the eastern side of the Dogger Bank Zone, as well as a small area along its western edge (**Figure 4-26** & **Figure 4-27**).

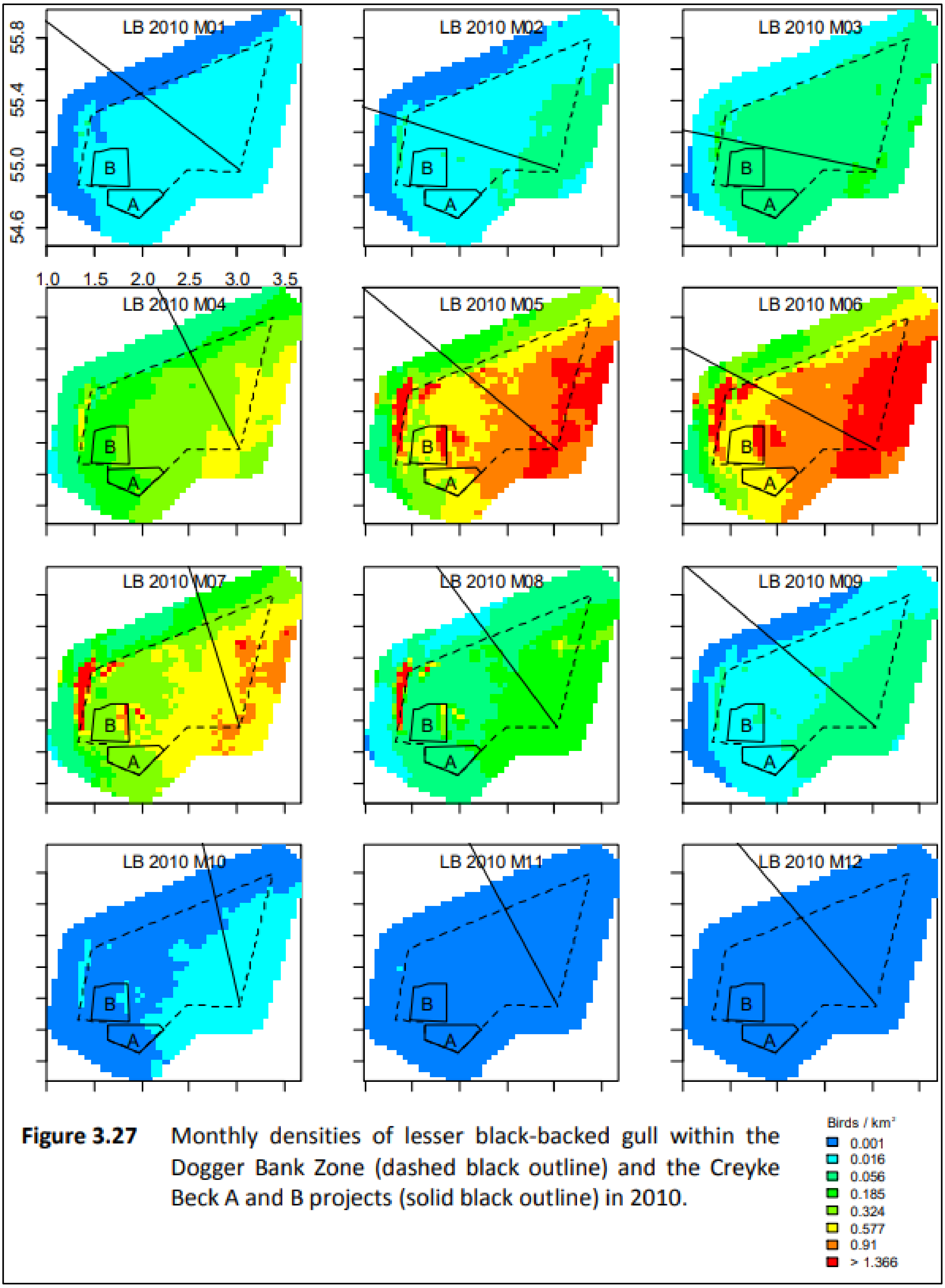

Figure 4-26 Monthly density heatmaps of lesser black-backed gull recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton et al. (2013))

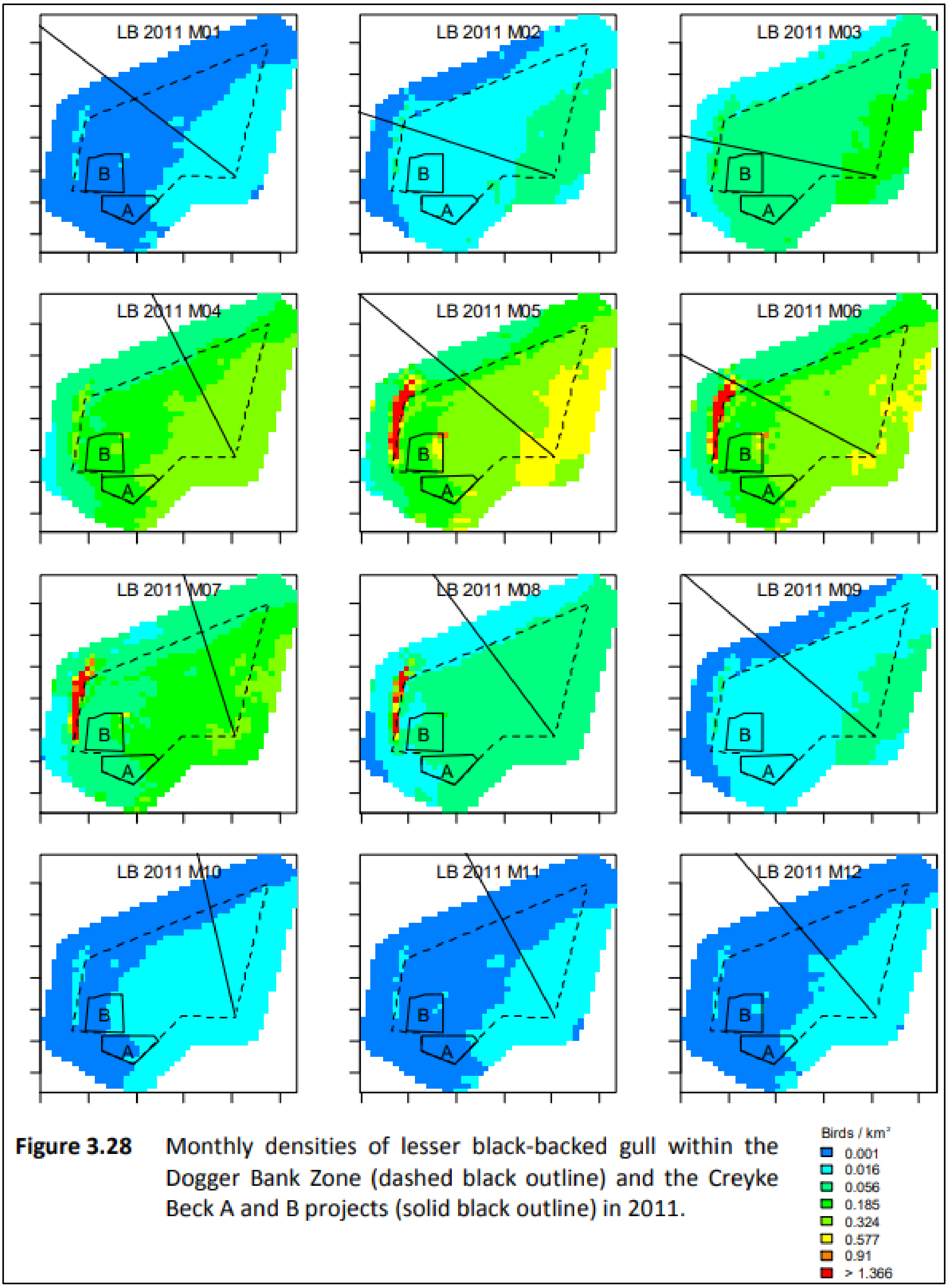

Figure 3.28 Monthly densities of lesser black-backed gull within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2011.

Figure 4-27 Monthly density heatmaps of lesser black-backed gull recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2011 (taken from Burton et al. (2013))

In the DBC Array Area, monthly abundance estimates for lesser black-backed gull peaked in June 2010 (201 individuals), May 2011 (108 individuals) and May 2012 (55 individuals). In the Sofia Array Area, the abundance peaked during the same months, with estimates of 160, 81 and 44 individuals, respectively.

Throughout the survey period, the highest monthly densities of lesser black-backed gull were recorded in the south-east of the Dogger Bank Zone. Densities were particularly high in DBC during the summer months in 2010 (**Figure 4-28**, **Figure 4-29** & **Figure 4-30**).

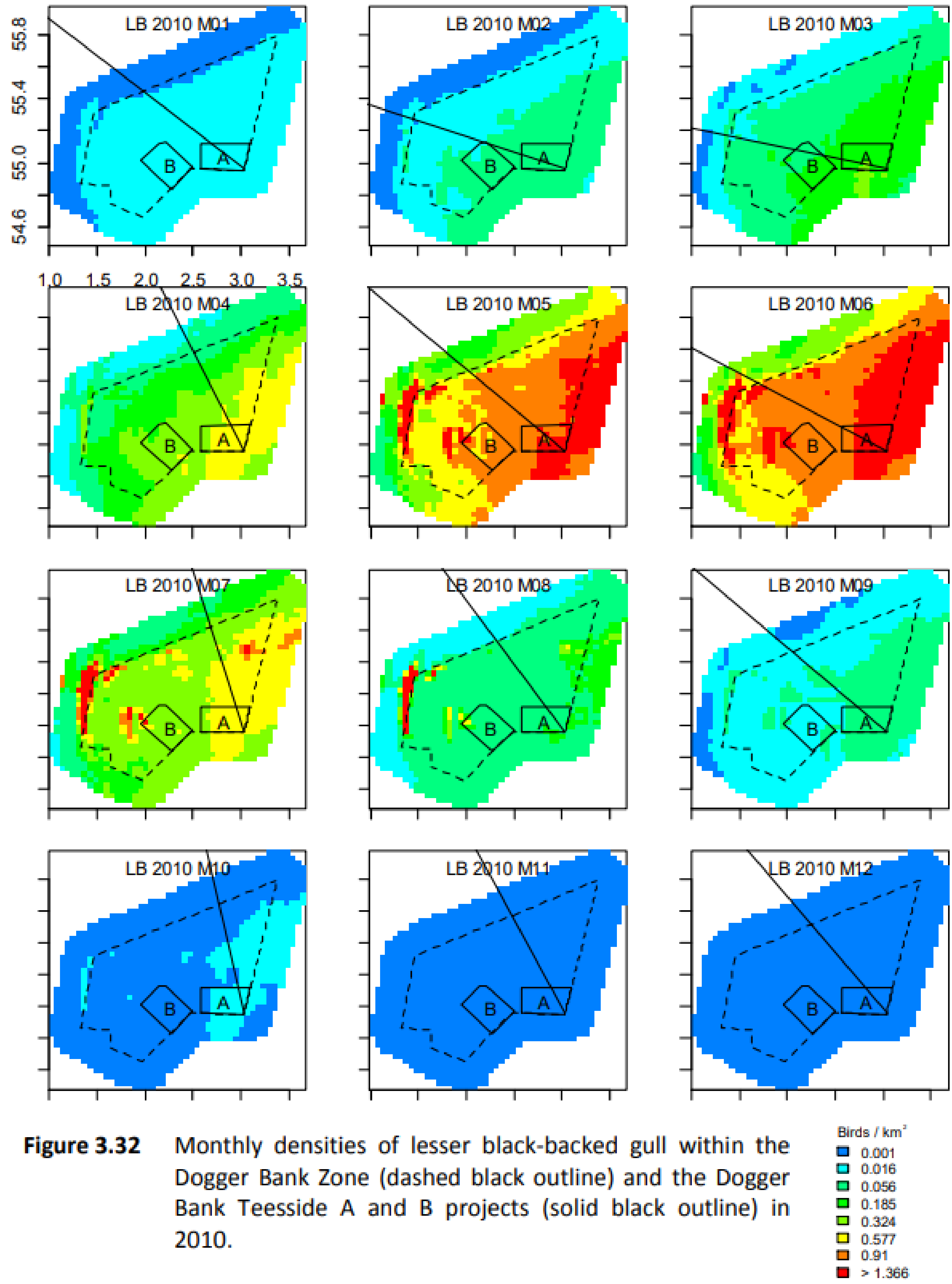

Figure 4-28 Monthly density heatmaps of lesser black-backed gull recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in 2010 (taken from Burton et al. (2014))

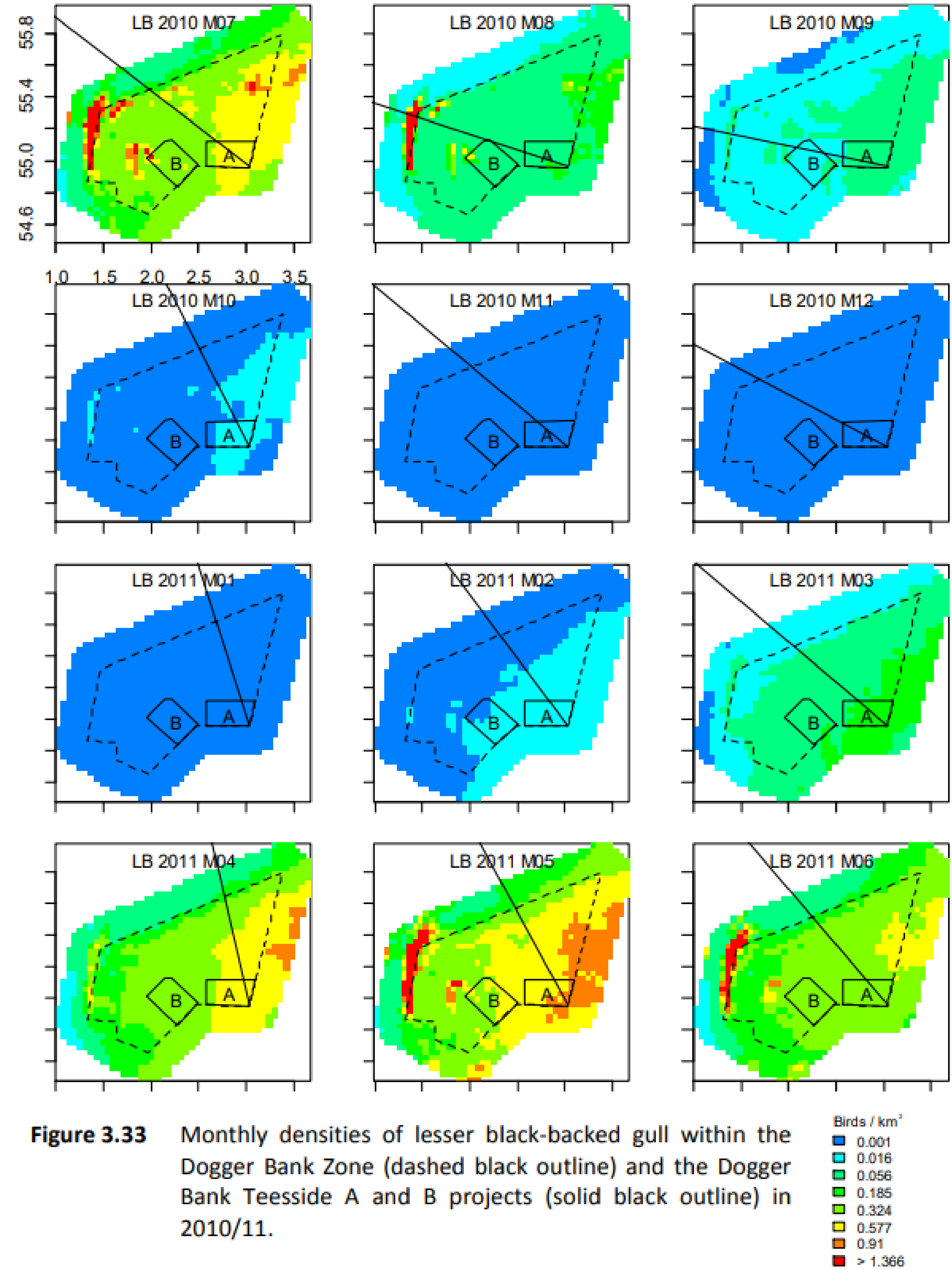

Figure 4-29 Monthly density heatmaps of lesser black-backed gull recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) between July 2010 and June 2011 (taken from Burton et al. (2014))

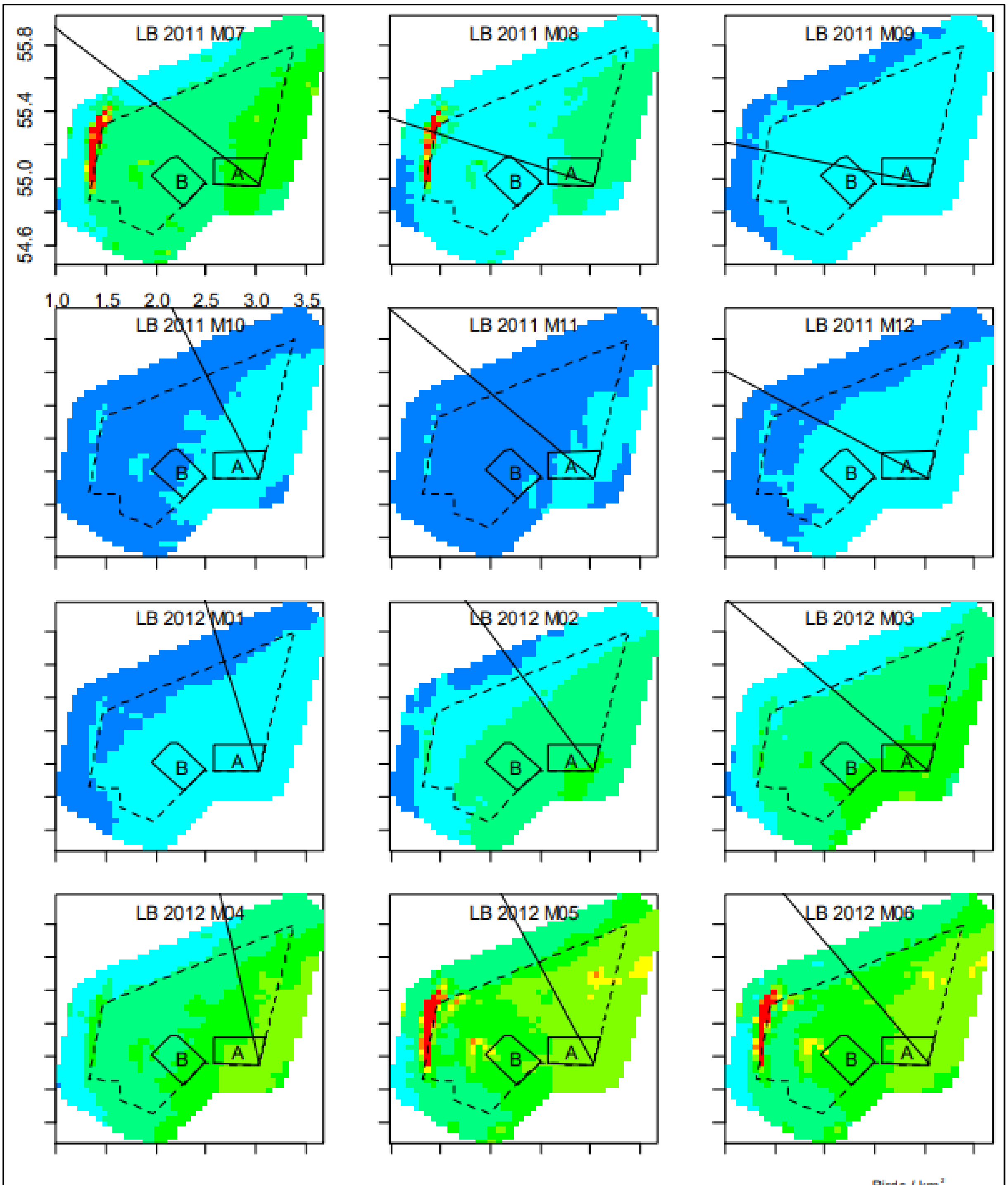

Figure 3.34 Monthly densities of lesser black-backed gull within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2011/12.

Figure 4-30 Monthly density heatmaps of lesser black-backed gull recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) between July 2011 and June 2012 (taken from Burton et al. (2014))

Lesser black-backed gulls were recorded in March, May and August in the DBS East Array Area, with a mean peak abundance of eight individuals in the Array Area in August. In DBS West, this species was only recorded in April, with a mean peak abundance of four individuals. The distribution of raw counts for lesser black-backed gull in DBS is shown in **Figure 4-21**.

The heatmaps of lesser black-backed gull records during the 2010-2012 surveys indicate that the density would have been higher in the DBD Array Area than elsewhere in the Dogger Bank Zone, particularly in the summer of 2010. However, during the summer months in 2011 and 2012, lesser black-backed gull density was highest on the western border of the Dogger Bank Zone.

Peak abundance and density estimates for all OWF Array Areas in the Dogger Bank Zone and DBS are shown in **Table 4–20**. The abundance and density values for DBS East and West are monthly mean peaks across the two-year survey period (RWE, 2023a; RWE, 2023c) whereas the values for all other OWFs are absolute peaks.

Table 4–20 Peak abundance and density estimates for great black-backed gull for all OWF projects in the Dogger Bank Zone

Project	Peak abundance	Peak density (individuals/km^2)	Month
Dogger Bank A	104	0.20	June 2010
Dogger Bank B	156	0.26	June 2010
Dogger Bank C	201	0.36	June 2010
Sofia	160	0.27	June 2010
Dogger Bank South (East)	8	0.02	August 2021/22
Dogger Bank South (West)	4	0.01	April 2021/22
Dogger Bank D	15	0.06	June 2023

4.5.2 DBD Survey data (aerial survey data 2021-2023)

Lesser black-backed gulls were only recorded in two of the 24 DAS within the DBD Array Area (**Appendix 3**). There were no observations of lesser black-backed gull within the first year of survey effort (**Table 4–21**) and during the second year of surveys, there were only observations in two months with an abundance estimate of five individuals in April 2023 and 15 individuals in June 2023 for the Array Area. Lesser black-backed gull densities ranged from 0.02 to 0.06 individuals/km^2 within the DBD Array Area for all behaviours (**Appendix 3**) with an average density of 0.04 individuals/km^2.

Within the DBD Scoping Report bio-seasons for use were identified for each species. For lesser black-backed gull, two different bio-seasons were outlined, using migration-free breeding or the alternative full breeding season. Within the baseline report, and in order to provide the greatest breakdown of bio-seasons, the migration-free breeding season has been presented. Although, it must be noted that in further impact assessments, the Natural England recommended bio-seasons using the full breeding season have been incorporated. On review of the data collected for DBD, the Applicant deems the use of the full breeding bio-season description to be most appropriate. Further discussion following PEIR submission is welcome with SNCBs to confirm appropriate seasons for usage in impact assessments going forward.

Table 4–21 Lesser black-backed gull raw counts, total estimated abundance and total estimated density (individuals per km^2) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Apr-23	1	5	0.02	1	5	0.02	0	0	0.00
Jun-23	3	15	0.06	2	10	0.04	1	5	0.02

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Migration-free breeding = purple

Lesser black-backed gull abundance in the DBD Array Area was highest in the return migration and migration-free breeding bio-seasons (**Figure 4-31**).

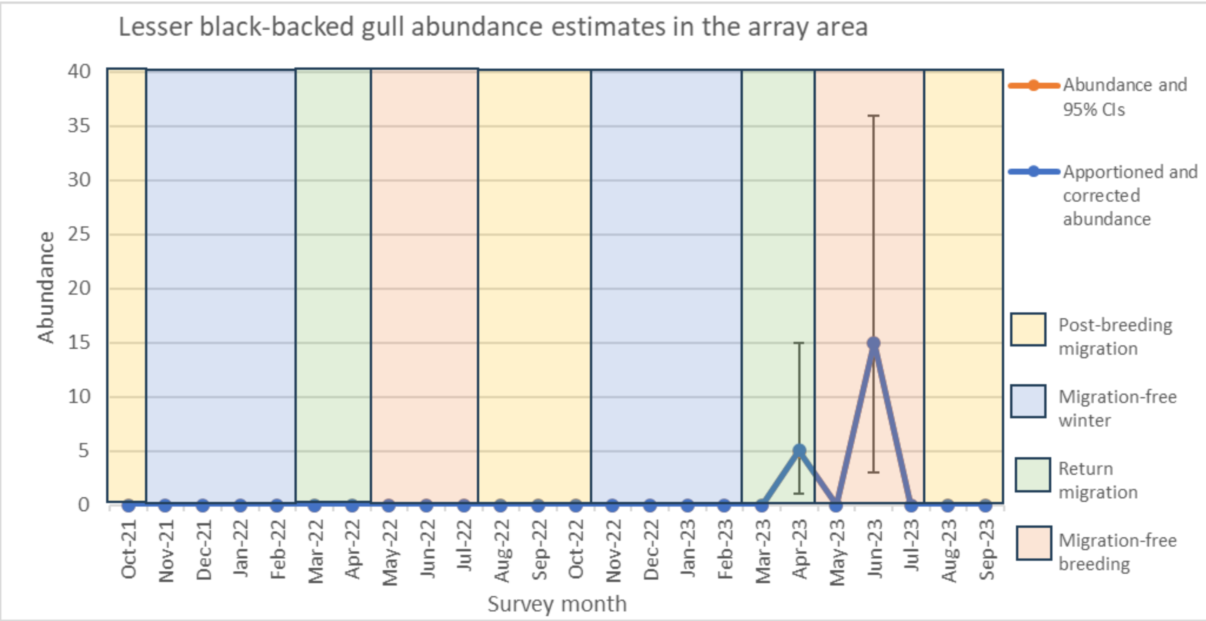

Figure 4-31 Lesser black-backed gull abundance estimates for the 24 month survey period within the Array Area (migration-free breeding, post-breeding migration, migration-free winter and return migration bio-seasons)

4.5.3 Age ratios

Lesser black-backed gull age classes were determined upon initial identification from the DAS imagery for the entire survey area (Array Area plus 4km buffer). From this information the proportion of age classes observed in each bio-season could be calculated. Lesser black-backed gulls were only recorded within the return migration and migration-free breeding bio-seasons and so only ages within these seasons are provided. Within the return migration bio-season 78% of lesser black-backed gulls were classed as adults, 11% as third summer birds and 11% as 'unknown'. Within the migration-free breeding bio-season no adult birds were recorded, with 50% recorded as third summer birds and 50% being classed as 'unknown' (**Table 4–22**). Apportionment of 'unknown' age class was not undertaken for lesser black-backed gull due to the project being outside of the species' known mean max plus one standard deviation (SD) foraging range (Woodward *et al*. 2019) from any UK SPA, therefore further interrogation of this data was not required for HRA breeding apportionment. Raw counts for each age class are provided in **Appendix 5**.

Table 4–22 Lesser black-backed gull age class proportions

Bio-season	Age class proportions (%)		
	Adult	Third summer	Unknown
Return migration	78	11	11
Migration-free breeding	0	50	50
Post-breeding migration	0	0	0
Migration-free winter	0	0	0

4.5.4 Biological Season Mean Peak Estimates

Lesser black-backed gulls were present in greatest abundance in the DBD Array Area during the migration-free breeding bio-season with an estimated mean peak abundance of eight individuals and a mean peak density of 0.03 individuals/km^2 (**Table 4–23** & **Figure 4-31**). This peak of individuals was in the middle of the migration-free breeding bio-season with no observations in the months either side of this, suggesting only sporadic occurrence or numbers of lesser black-backed gull in the area in this bio-season. This is similar to the only other observations that were recorded during Year 2 of the surveys during the return migration bio-season, where birds were again recorded in only one of the monthly surveys. Apart from these observations, no counts were recorded throughout the two years of surveying.

Within the DBD Scoping Report bio-seasons for use were identified for each species. For lesser black-backed gull, two different bio-seasons were outlined, using migration-free breeding or the alternative full breeding season. Within the baseline report, and in order to provide the greatest breakdown of bio-seasons, the migration-free breeding season has been presented. Although, it must be noted that in further impact assessments, the Natural England recommended bio-seasons using the full breeding season have been incorporated. On review of the data collected for DBD, the Applicant deems the use of the migration-free breeding bio-season description to be most appropriate. Further discussion following PEIR submission is welcome with SNCBs to confirm appropriate seasons for usage in impact assessments going forward.

Table 4–23 Lesser black-backed gull bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return Migration (March – April)	3	0.01	3	0.01	0	0.00
Migration-free Breeding (May – July)	8	0.03	5	0.02	3	0.01
Post-breeding Migration (August – October)	0	0.00	0	0.00	0	0.00
Migration-free Winter (November-February)	0	0.00	0	0.00	0	0.00

4.5.5 Spatial Density Distribution and Flight Direction

During the return migration bio-season observations of lesser black-backed gull were mainly at the west of the Array Area and associated buffers (**Figure 4-32**). There were only a few observations within the migration-free breeding bio-season located in the centre of the Array Area and in the north of the Array Area plus 4km buffer.

Lesser black-backed gulls were only observed in flight across the DBD survey area during the return migration and migration-free breeding bio-seasons (**Appendix 4**). Flight direction in the return migration bio-season had a westerly orientation, however this was only recorded within one month and in a single year which does not provide sufficient information in which to deduce behavioural explanations. The case is similar for the breeding bio-season with only a single month within a single year suggesting flight directionality.

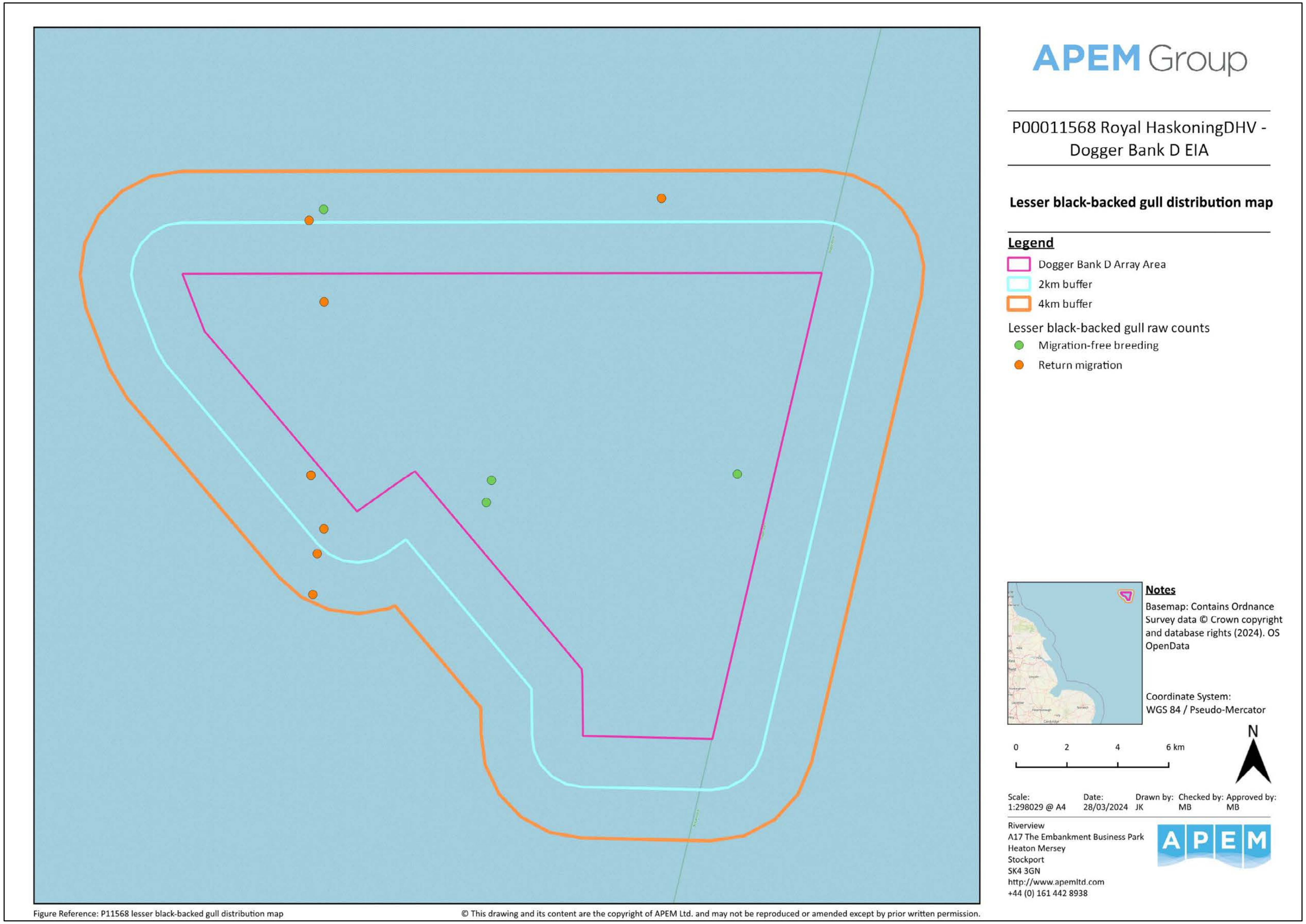

Figure 4-32 Distribution of lesser black-backed gull raw counts in each bio-season

4.6 Guillemot

4.6.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of guillemots within the Dogger Bank Zone exceeded the 1% threshold for populations of national importance in the breeding season and the 1% threshold for international importance in the winter and breeding seasons.

In DBA, monthly abundance estimates differed between 2010 and 2011. In 2010, abundance peaked in February (9,102 individuals), with another peak between October and December. In 2011, the highest abundance estimates occurred in January to April only, peaking at 10,586 individuals in April. In DBB in 2010, guillemot numbers were at their highest between January and February with a peak of 14,510 individuals, with another peak from September to December. In 2011, abundance estimates were high from January to April, peaking at 16,712 individuals in April and remaining low thereafter. In each of the Array Areas, the 1% threshold for a population of national importance was not exceeded. Density was highest in the west and south-west of the Dogger Bank Zone, where DBA and DBB are situated (**Figure 4-33** & **Figure 4-34**).

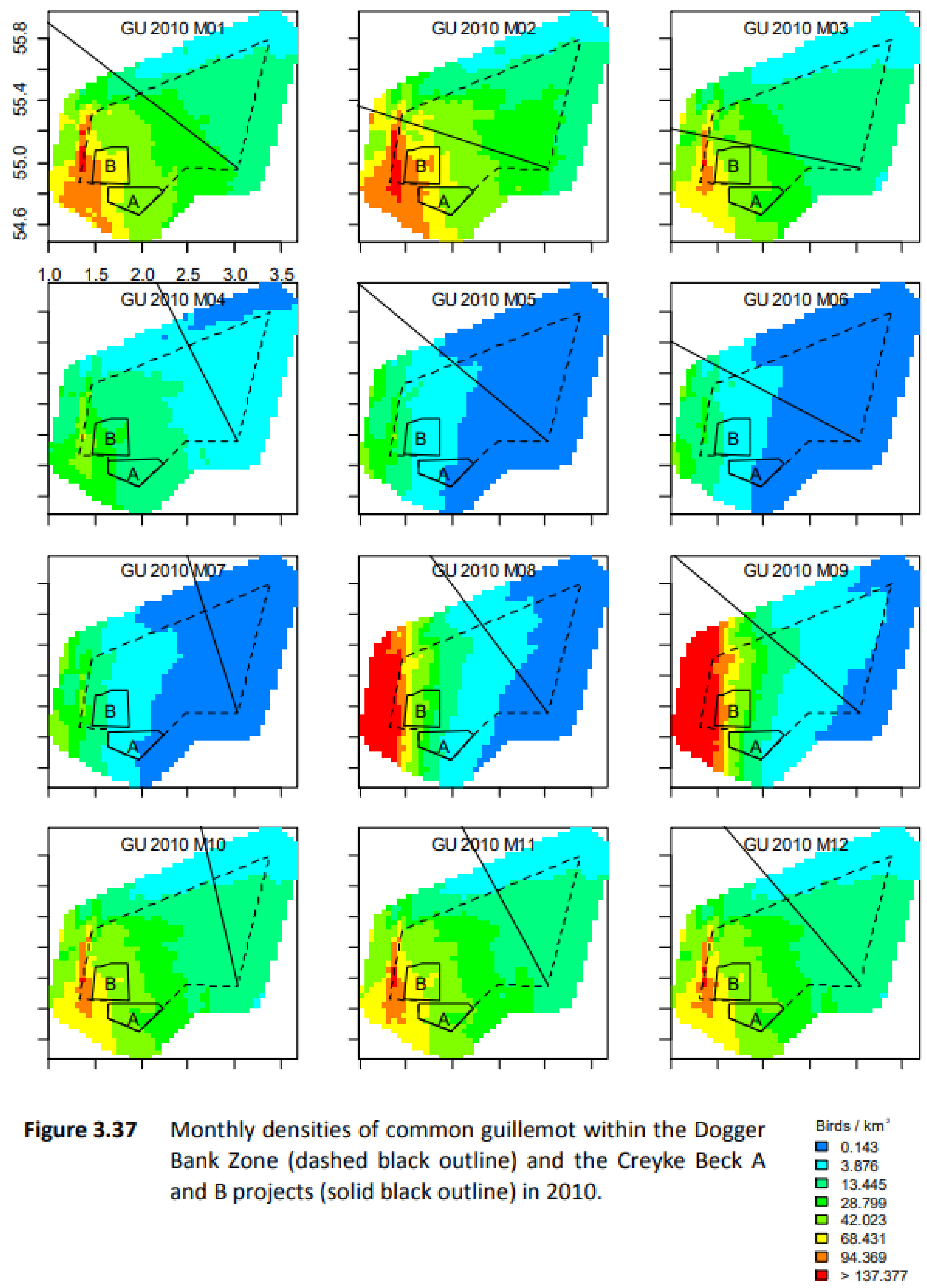

Figure 3.37 Monthly densities of common guillemot within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2010.

Figure 4-33 Monthly density heatmaps of guillemot recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton et al. (2013))

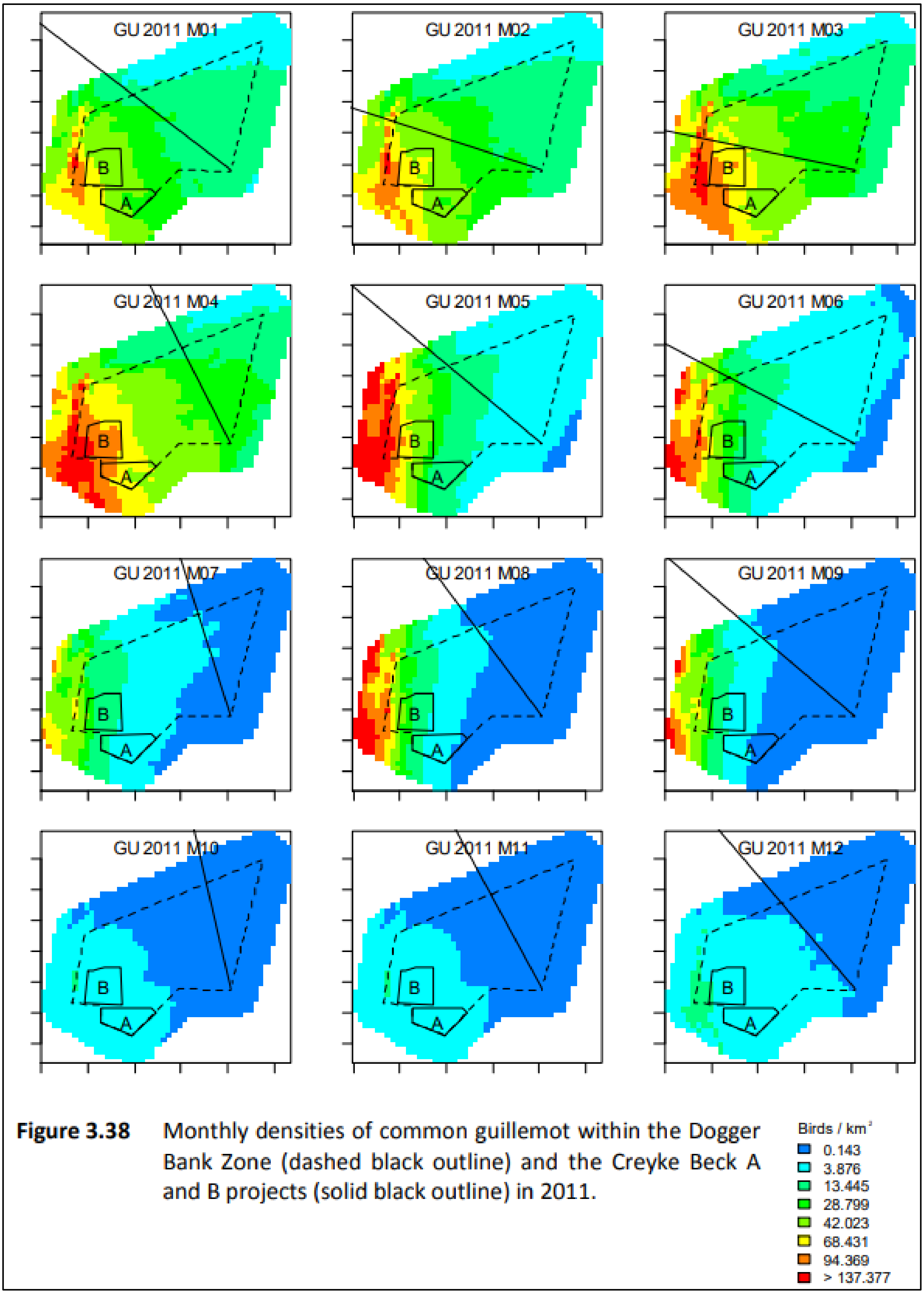

Figure 3.38 Monthly densities of common guillemot within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2011.

Figure 4-34 Monthly density heatmaps of guillemot recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton et al. (2013))

In the DBC Array Area, monthly baseline population estimates for guillemot peaked from January to April and October to December in 2010, with the highest value of 4,196 individuals occurring in December. Guillemot numbers increased during the winter months in 2010/11 and 2011/12 however monthly abundance estimates peaked in April 2011 and 2012, with 6,546 and 6,681 individuals, respectively. The pattern of monthly abundance in 2010 was similar in the Sofia Array Area, with a peak in December of 6,317 individuals. Abundance estimates increased during the winters of 2010/11 and 2011/12 but they peaked in March 2011 and 2012, at 9,719 and 9,645 individuals, respectively. Guillemots had a marked westerly distribution in the Dogger Bank Zone (**Figure 4-35**, **Figure 4-36** & **Figure 4-37**).

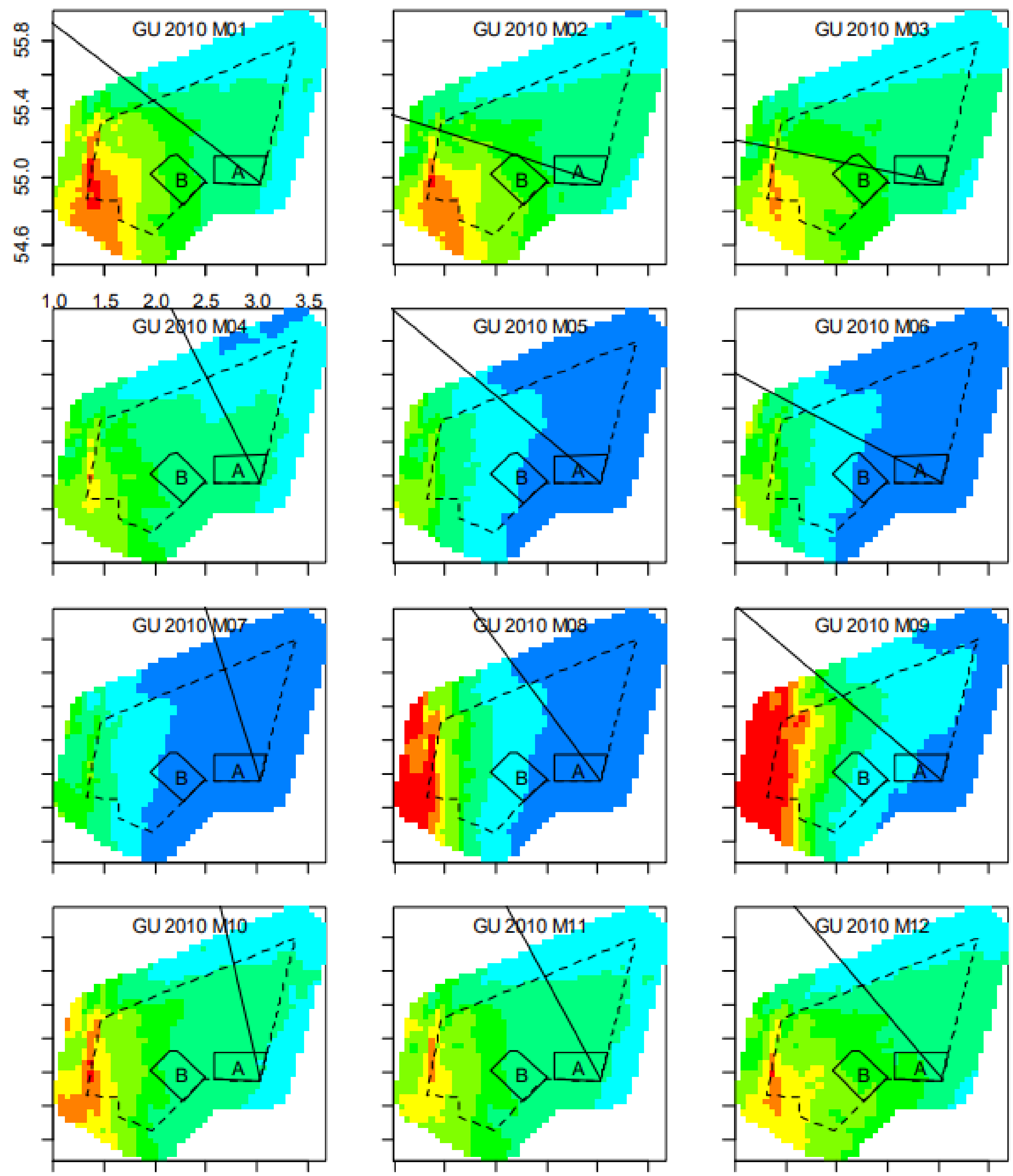

Figure 3.44 Monthly densities of common guillemot within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010.

Figure 4-35 Monthly density heatmaps of guillemot recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in 2010 (taken from Burton et al. (2014))

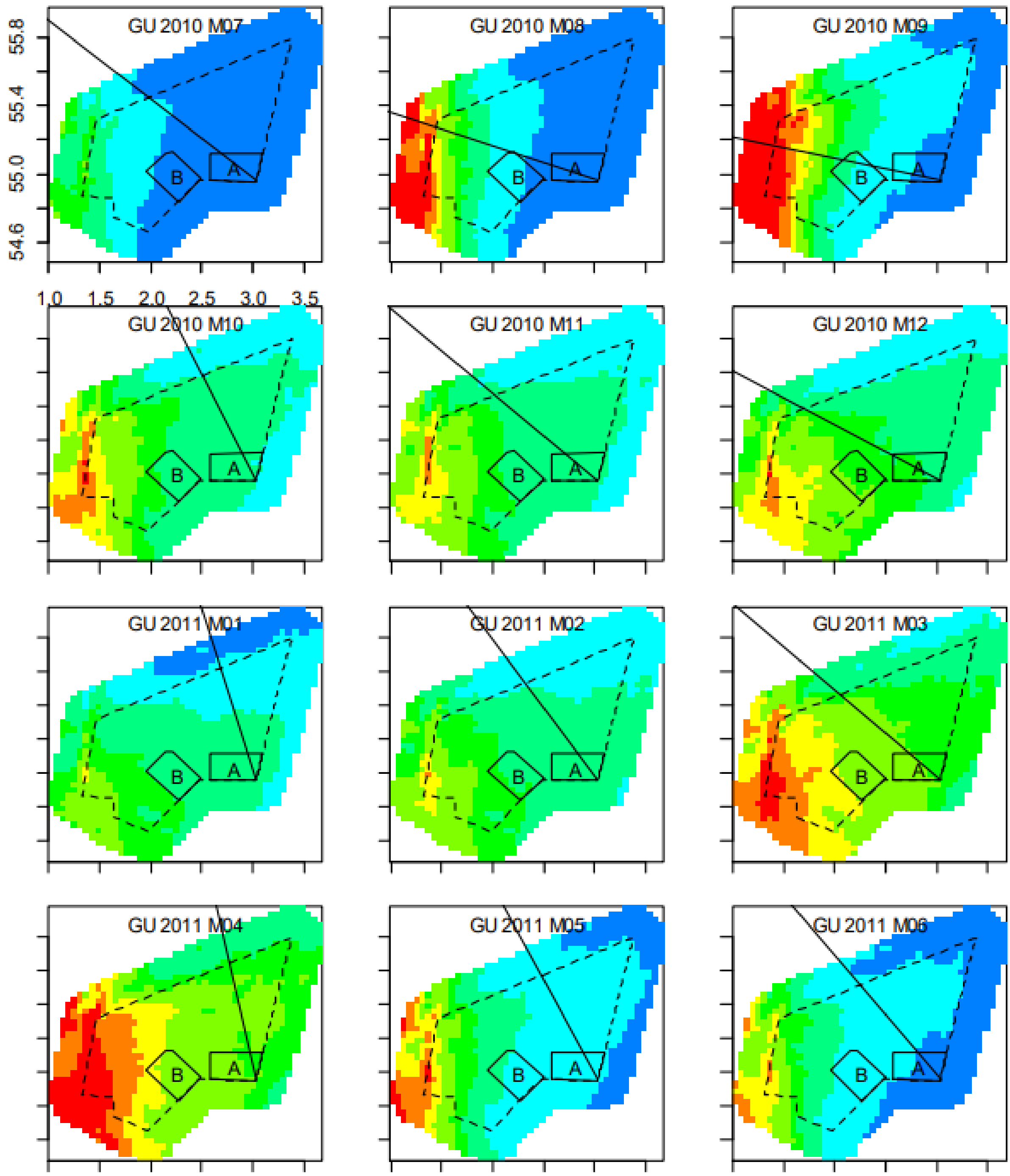

Figure 3.45 Monthly densities of common guillemot within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010/11.

Figure 4-36 Monthly density heatmaps of guillemot recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2010 to June 2011 (taken from Burton et al. (2014))

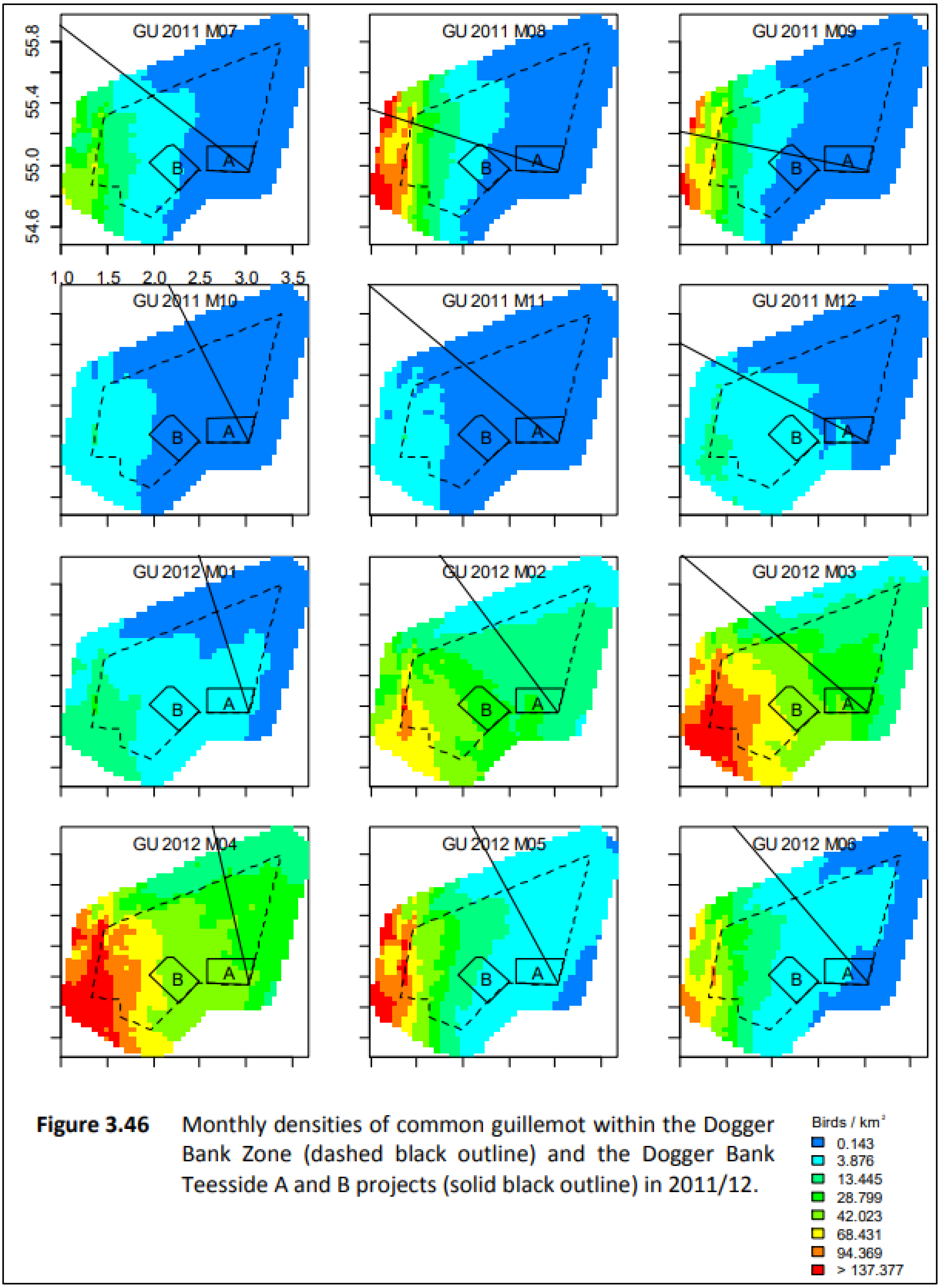

Figure 3.46 Monthly densities of common guillemot within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2011/12.

Figure 4-37 Monthly density heatmaps of guillemot recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2011 to June 2012 (taken from Burton et al. (2014))

In DBS, between March 2021 and February 2023, the mean monthly abundance estimates for guillemot peaked in November for the DBS East Array Area (8,760 individuals) and in August for DBS West (9,548 individuals). Densities appeared to be higher in the central and eastern areas of DBS (**Figure 4-38** & **Figure 4-39**).

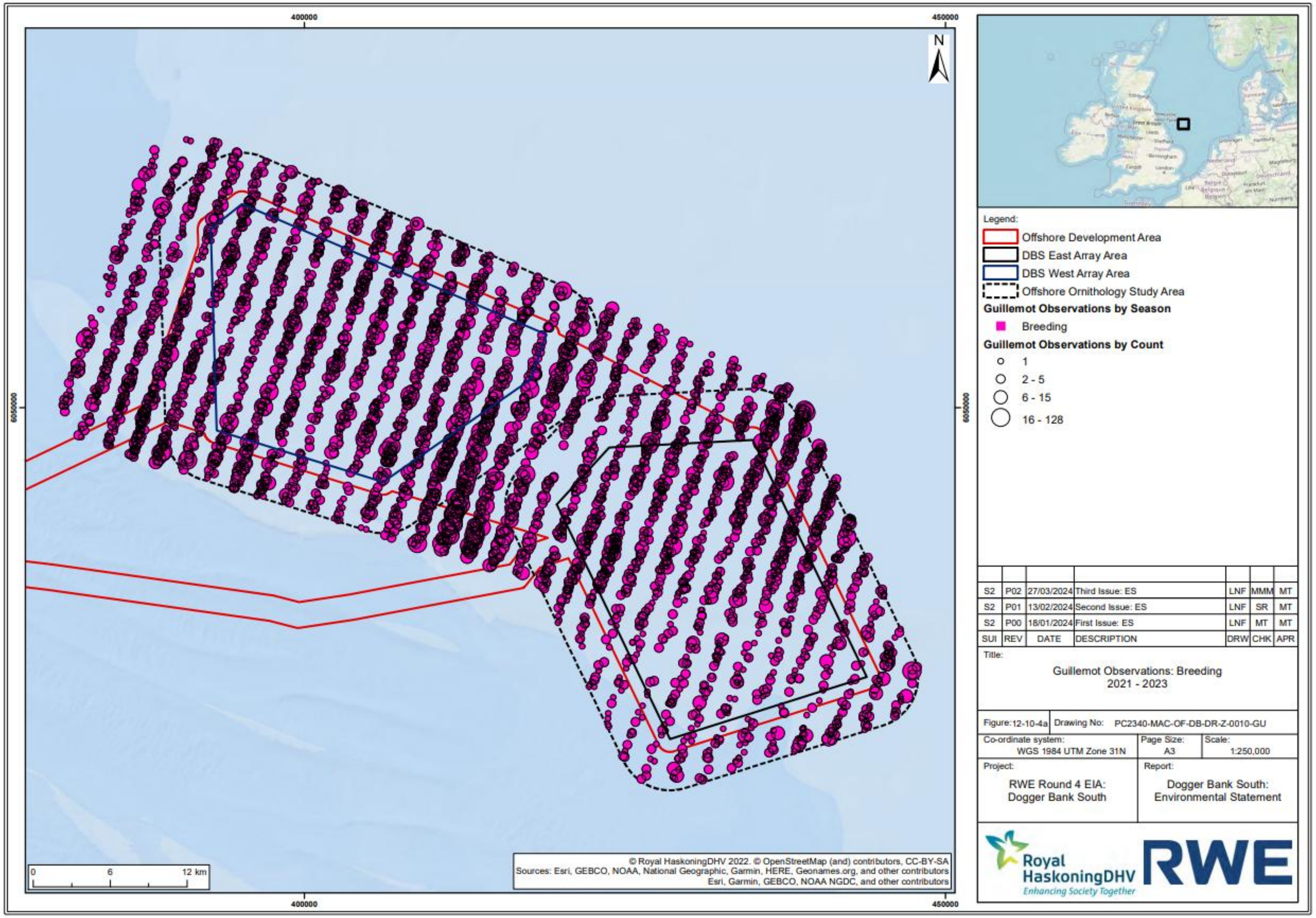

Figure 4-38 Raw counts of guillemot during the breeding bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

Figure 4-39 Raw counts of guillemot during the non-breeding bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

Between 2010 and 2012, guillemot density was much higher in the west of the Dogger Bank Zone than elsewhere. The westerly distribution of records was observed in all survey months Abundance estimates were higher in DBA and DBB than in DBC and Sofia. Therefore, the abundance of guillemots in the DBD Array Area would have been relatively low. Guillemot density was also relatively high in DBS during 2021-2022. This indicates that guillemots may have also had a westerly distribution in the Dogger Bank Zone during these years.

Peak abundance and density estimates for all OWF Array Areas in the Dogger Bank Zone and DBS are shown in **Table 4–24**. The abundance and density values for DBS East and West are monthly mean peaks across the two-year survey period (RWE, 2023a; RWE, 2023c) whereas the values for all other OWFs are absolute peaks.

Table 4–24 Peak abundance and density estimates for guillemot for all OWF projects in the Dogger Bank Zone

Project	Peak abundance	Peak density (individuals/km^2)	Month
Dogger Bank A	10,586	20.53	April 2011
Dogger Bank B	16,712	27.89	April 2011
Dogger Bank C	6,681	11.92	April 2012
Sofia	9,719	16.37	March 2011
Dogger Bank South (East)	8,760	25.10	November 2021/22
Dogger Bank South (West)	9,548	17.32	April 2021/22
Dogger Bank D	8,067	30.75	June 2023

4.6.2 DBD Survey data (aerial survey data 2021-2023)

Guillemots were recorded in all of the 24 DAS within the DBD Array Area and associated buffers (**Appendix 3**). Abundances were highest in November 2021 for the first year of data for both the Array Area (6,729 individuals) and the Array Area plus 2km asymmetrical buffer (11,326 individuals). In Year 2, the highest abundance for the DBD Array Area and the Array Area plus 2km asymmetrical buffer was in April 2023 (8,067 and 10,000 individuals, respectively) (**Table 4–25** & **Table 4–26**). Guillemot densities ranged from 0.26 to 30.75 in the DBD Array Area, and 0.18 to 27.02 individuals/km^2 in the Array Area plus 2km asymmetrical buffer (**Appendix 3**). The average density for the Array Area was 6.58 individuals/km^2 for the Array Area, and 6.92 individuals/km^2 for the Array Area plus 2km asymmetrical buffer, for all behaviours. Most guillemots were observed sitting, with only a small number of birds recorded flying.

Table 4–25 Guillemot raw counts, total estimated abundance and total estimated density (individuals per km^2) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	518	4,505	17.17	2	15	0.06	516	4,490	17.11
Nov-21	561	6,729	25.65	2	20	0.08	559	6,710	25.57
Dec-21	262	2,088	7.96	1	5	0.02	261	2,083	7.94
Jan-22	167	2,397	9.14	4	20	0.08	163	2,377	9.06
Feb-22	208	1,921	7.32	11	60	0.23	197	1,861	7.09
Mar-22	406	2,714	10.34	20	101	0.38	386	2,613	9.96
Apr-22	160	1,162	4.43	10	50	0.19	150	1,112	4.24
May-22	56	429	1.64	0	0	0.00	56	429	1.64
Jun-22	22	145	0.55	0	0	0.00	22	145	0.55
Jul-22	12	79	0.30	0	0	0.00	12	79	0.30
Aug-22	10	67	0.26	0	0	0.00	10	67	0.26
Sep-22	93	814	3.10	0	0	0.00	93	814	3.10
Oct-22	287	2,229	8.50	9	73	0.28	278	2,155	8.21
Nov-22	267	2,143	8.17	7	43	0.16	260	2,100	8.00
Dec-22	65	543	2.07	5	28	0.11	60	515	1.96
Jan-23	232	2,006	7.65	1	8	0.03	231	1,998	7.61
Feb-23	79	669	2.55	3	40	0.15	76	629	2.40
Mar-23	179	1,195	4.55	9	50	0.19	170	1,145	4.36
Apr-23	1,166	8,067	30.75	135	695	2.65	1,031	7,372	28.10
May-23	36	253	0.96	0	0	0.00	36	253	0.96
Jun-23	6	41	0.16	0	0	0.00	6	41	0.16
Jul-23	12	97	0.37	0	0	0.00	12	97	0.37
Aug-23	142	960	3.66	0	0	0.00	142	960	3.66
Sep-23	28	183	0.70	0	0	0.00	28	183	0.70

*Table note: Bio-seasons are colour coded as follows – Breeding = yellow, Non-breeding = grey

Table 4–26 Guillemot raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	679	5,746	15.52	2	15	0.04	677	5,731	15.48
Nov-21	991	11,326	30.60	5	32	0.09	986	11,294	30.51
Dec-21	395	3,091	8.35	3	15	0.04	392	3,077	8.31
Jan-22	275	4,046	10.93	7	46	0.12	268	4,000	10.81
Feb-22	228	2,187	5.91	14	74	0.2	214	2,113	5.71
Mar-22	559	3,743	10.11	23	145	0.39	536	3,598	9.72
Apr-22	292	2,113	5.71	13	65	0.18	279	2,048	5.53
May-22	97	734	1.98	0	0	0.00	97	734	1.98
Jun-22	38	280	0.76	0	0	0.00	38	280	0.76
Jul-22	16	111	0.30	0	0	0.00	16	111	0.30
Aug-22	10	66	0.18	0	0	0.00	10	66	0.18
Sep-22	257	2,168	5.86	0	0	0.00	257	2,168	5.86
Oct-22	402	3,088	8.34	12	89	0.24	390	2,999	8.10
Nov-22	355	2,815	7.61	11	66	0.18	344	2,749	7.43
Dec-22	101	871	2.35	6	32	0.09	95	838	2.26
Jan-23	412	3,485	9.42	2	12	0.03	410	3,473	9.38
Feb-23	122	1,004	2.71	5	49	0.13	117	955	2.58
Mar-23	286	1,921	5.19	11	59	0.16	275	1,862	5.03
Apr-23	1,451	10,000	27.02	158	796	2.15	1,293	9,204	24.87
May-23	52	370	1.00	0	0	0.00	52	370	1.00
Jun-23	12	93	0.25	0	0	0.00	12	93	0.25
Jul-23	24	175	0.47	1	5	0.01	23	170	0.46
Aug-23	263	1,771	4.78	0	0	0.00	263	1,771	4.78
Sep-23	44	299	0.81	0	0	0.00	44	299	0.81

*Table note: Bio-seasons are colour coded as follows – Breeding = yellow, Non-breeding = grey

Guillemot abundance in the DBD Array Area plus 2km asymmetrical buffer was highest in the non-breeding bio-season during Year 1 and the breeding bio-season during Year 2 (**Figure 4-40**). Overall, abundances in Year 2 were less than Year 1.

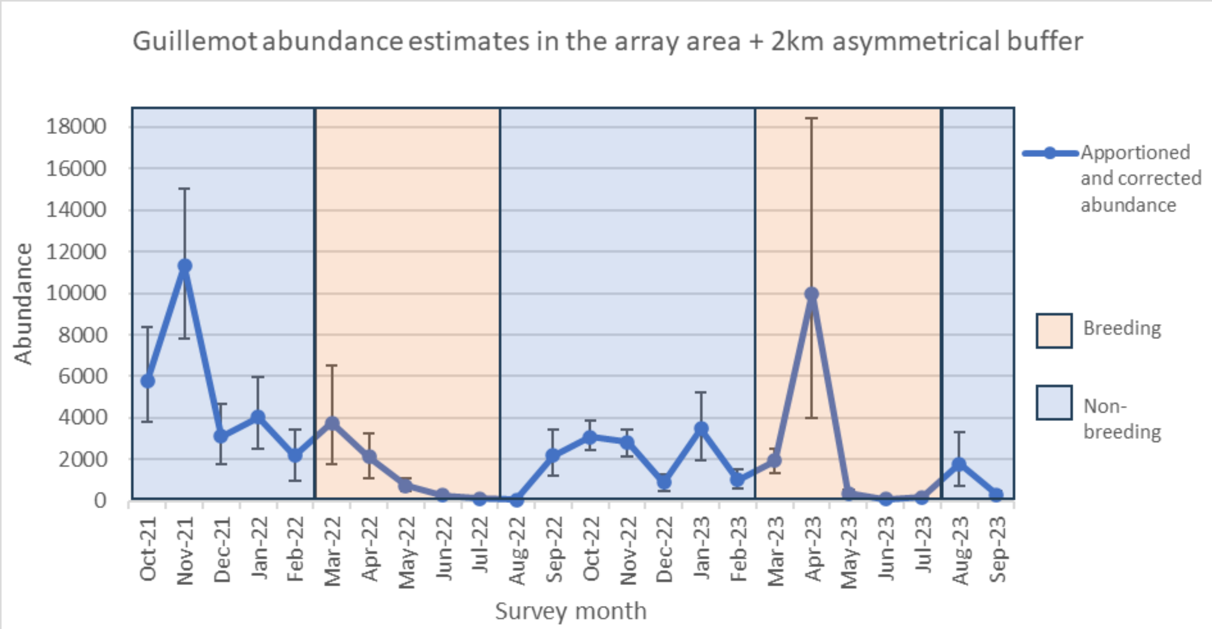

Figure 4-40 Guillemot abundance estimates for the 24 month survey period within the Array Area plus 2km asymmetrical buffer (breeding and non-breeding bio-seasons)

4.6.3 Age ratios

Out of the 12,317 raw count observations for guillemot within the two years of surveys, only 14 individuals were given a specific age class (seven adults and seven juvenile), all others were set as ‘unknown’. Guillemot age classification is only possible from DAS when recently fledged guillemots are still being tended to by the male parent, with the distinguishing feature being the significant difference in size. This therefore means identification of accurate age ratios is not possible for guillemot from the available survey data.

4.6.4 Biological Season Mean Peak Estimates

Guillemots were present in greatest abundance in the DBD Array Area plus 2km asymmetrical buffer during the non-breeding bio-season with an estimated mean peak abundance of 7,406 individuals and a mean peak density of 17.38 individuals/km^2 (**Table 4–27**, **Table 4–28** & **Figure 4-40**). During the first year of surveys guillemot numbers peaked in November 2021 during the non-breeding season with numbers then quickly reducing, suggesting a pulse of birds moving through DBD on migration. Following the peak in November 2021 numbers remained significantly lower for the remainder of the non-breeding season. At the start of the Year 1 breeding bio-season a slight increase in abundance is noted in March, though this is likely to involve birds moving through on migration rather than birds foraging from a colony. Numbers then remain low for the remainder of the breeding bio-season, as to be expected given the project is outside of the species’ mean max plus one SD foraging range from any colony (Woodward *et al*. 2019). Going into the second year of surveys there was an increase in guillemot presence within the Array Area and 2km asymmetrical buffer at the start of the non-breeding bio-season, with the overall number remaining fairly constant throughout the season. A peak of birds was again recorded at the start of the Year 2 breeding bio-season, likely attributible to birds moving through on migration rather than birds foraging from a colony. This quickly reduced, with considerably fewer birds recorded for the remainder of the Year 2 breeding bio-season into the non-breeding bio-season.

Table 4–27 Guillemot bio-season mean peak abundance and density (individuals per km²) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Breeding (March – July)	5,391	20.53	398	1.52	4,993	19.01
Non-breeding (August – February)	4,479	17.06	67	0.25	4,433	16.88

Table 4–28 Guillemot bio-season mean peak abundance and density (individuals per km²) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Breeding (March – July)	6,872	16.12	471	1.10	6,401	15.02
Non-breeding (August – February)	7,406	17.38	82	0.19	7,384	17.32

4.6.5 Spatial Density Distribution and Flight Direction

There is a clear contrast in the density distributions of guillemots between the two bio-seasons (**Figure 4-41**). During the breeding bio-season, there is a density hotspot at the southwest of the Array Area and Array Area plus 2km asymmetrical buffer whereas in the non-breeding bio-season, guillemot densities were overall lower, with a hotspot in the centre of the northern edge of the Array Area and Array Area plus 2km asymmetrical buffer.

Monthly flight directions from across the DBD survey area during the breeding bio-season had no clear orientation, which would be expected for birds using the area for foraging. Although there are limitations with flight orientation data, no clear direction could also suggest that connectivity to any breeding colony is limited, which would be expected given the project is outside of the species' mean max plus one SD foraging range (Woodward *et al*. 2019) from any UK SPA and non-SPA colony. It is likely that any individuals recorded during the breeding bio-season are non-breeders or potentially birds moving through late on migration. A strong southerly flight orientation recorded during April 2023 is speculated to be related to a weather induced displacement event rather than migration, although this would need confirmation against known weather data at the time. During the non-breeding bio-season, the orientation of flights has no specific directionality, suggesting birds are using the offshore environment within this period and migrating to and from breeding colonies (**Appendix 4**).

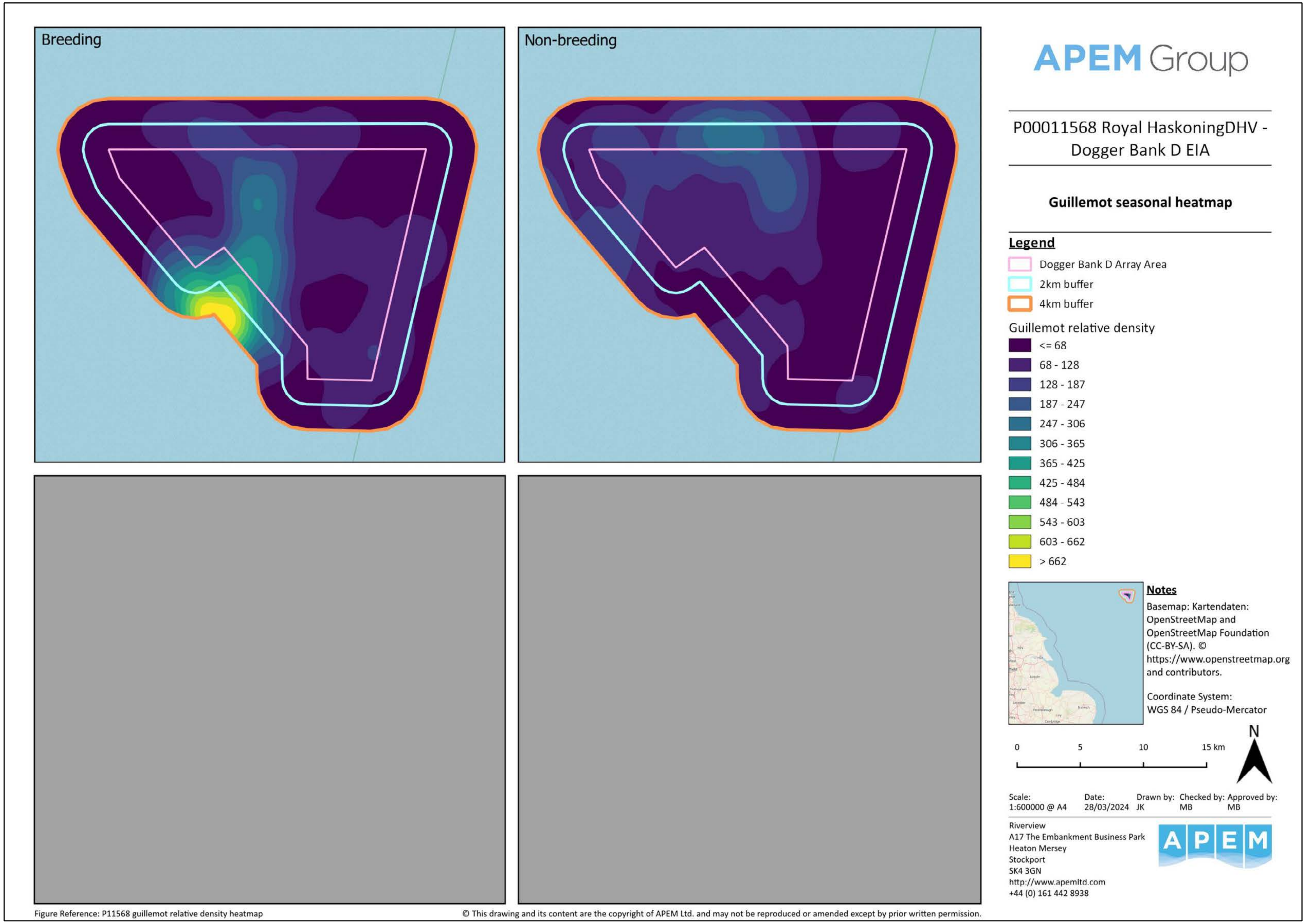

Figure 4-41 Heatmaps of guillemot distribution in each bio-season

4.6.6 HPAI review

HPAI was first recorded in guillemots in the UK in January 2022 (DEFRA, 2022d) with records increasing in number and location since. According to the Tremlett *et al.* (2024) review on HPAI impacts, the number of guillemot individuals recorded at all surveyed sites decreased by 6% from pre-HPAI to the survey year of 2023 (post outbreak). However, colony specific trends are seen to differ. A more detailed review of Flamborough and Filey Coast SPA and Farne Islands SPA are provided below in order to understand the potential impact of HPAI on guillemots at these colonies and how this relates to the baseline data collected for the Project.

The number of guillemot breeding individuals at Farne Islands SPA has seen a decrease of 26% from the pre-outbreak baseline count in 2021 to the most recent count taken in 2023 (Tremlett *et al*. 2024). However, the colony trend for the past ten years highlights variability around the number of guillemots breeding at the colony (**Table 4–29** & **Figure 4-42**). The colony count was already in decline prior to the outbreak of the HPAI virus and so this trend in the colony is not brought on through this impact alone. Therefore, the timing of the DBD baseline data is representative of the baseline count for guillemots at Farne Islands.

Table 4–29 Guillemot colony counts at Farne Islands SPA from 2013 to 2023 (SMP, 2024)

Year and colony count (Individuals)										
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
50,048	51,883	53,461	49,037	48,234	49,972	64,042	63,413	62,936	59,168	46,332

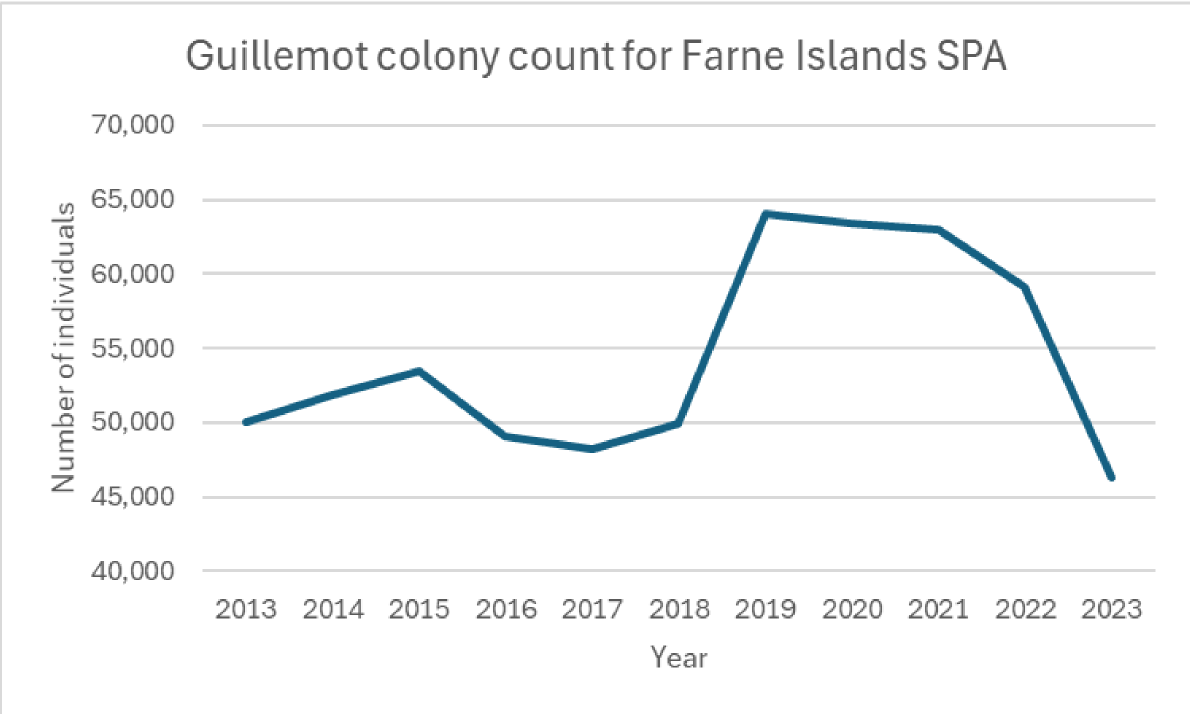

Figure 4-42 Guillemot colony trend for Farne Islands SPA between 2013 and 2023

Guillemots at Flamborough and Filey Coast SPA were not included in the Tremlett *et al.* (2024) HPAI review, however, whole colony counts from 2008 to 2022 (SMP, 2024) highlight continual growth in the guillemot colony (**Table 4–30** & **Figure 4-43**). The 2024 report for FFC SPA (Butcher *et al*. 2024) conducted plot level counts of guillemots within the SPA and suggests that, for the plots considered, the number of guillemot increased from 2020 to 2022, with a slight decline from 2022 to 2024. The report explains that the guillemot colony at FFC SPA has not shown significant negative effects due to the HPAI outbreak. The timing of the DBD baseline data collection would therefore be representative of the baseline colony trend for guillemots breeding at the FFC SPA.

Table 4–30 Guillemot colony counts at Flamborough and Filey Coast SPA from 2008 to 2022 (SMP, 2024)

Year and colony count (Individuals)		
2008	**2017**	**2022**
59,817	84,647	105,832

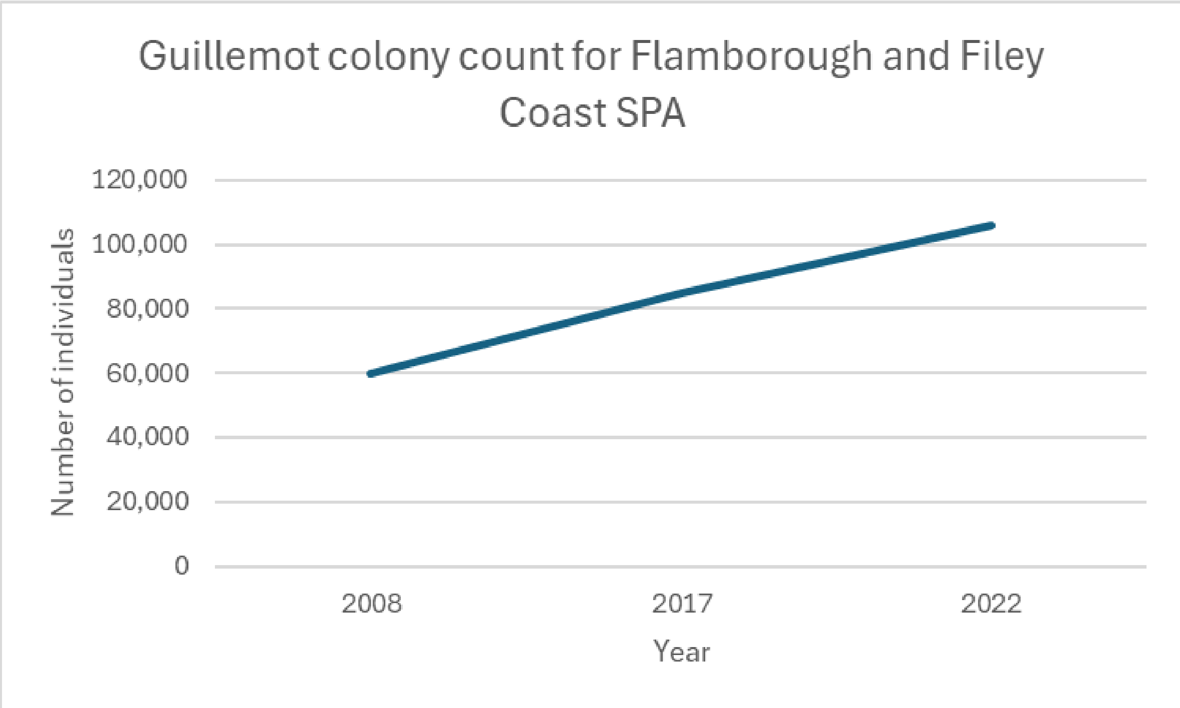

Figure 4-43 Guillemot colony trend for Flamborough and Filey Coast SPA between 2008 and 2022

4.7 Razorbill

4.7.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of razorbills within the Dogger Bank Zone exceeded the 1% threshold for populations of national importance in the breeding season and the 1% threshold for international importance in the winter.

In DBA, monthly abundance estimates differed between 2010 and 2011. In 2010, there were two main peaks in monthly abundance estimates, from January to March and September to December, with the highest value of 4,679 individuals in February. In 2011, there was a single peak from March to April, with the highest value of 5,707 individuals in April. In DBB, there were two main peaks in razorbill abundance from January to March and August to December, with the highest value of 6,187 individuals in February. In 2011, there was a single peak from March to April, with the highest value of 7,430 individuals in April. Density was highest in the west and south-west of the Dogger Bank Zone (**Figure 4-44** & **Figure 4-45**).

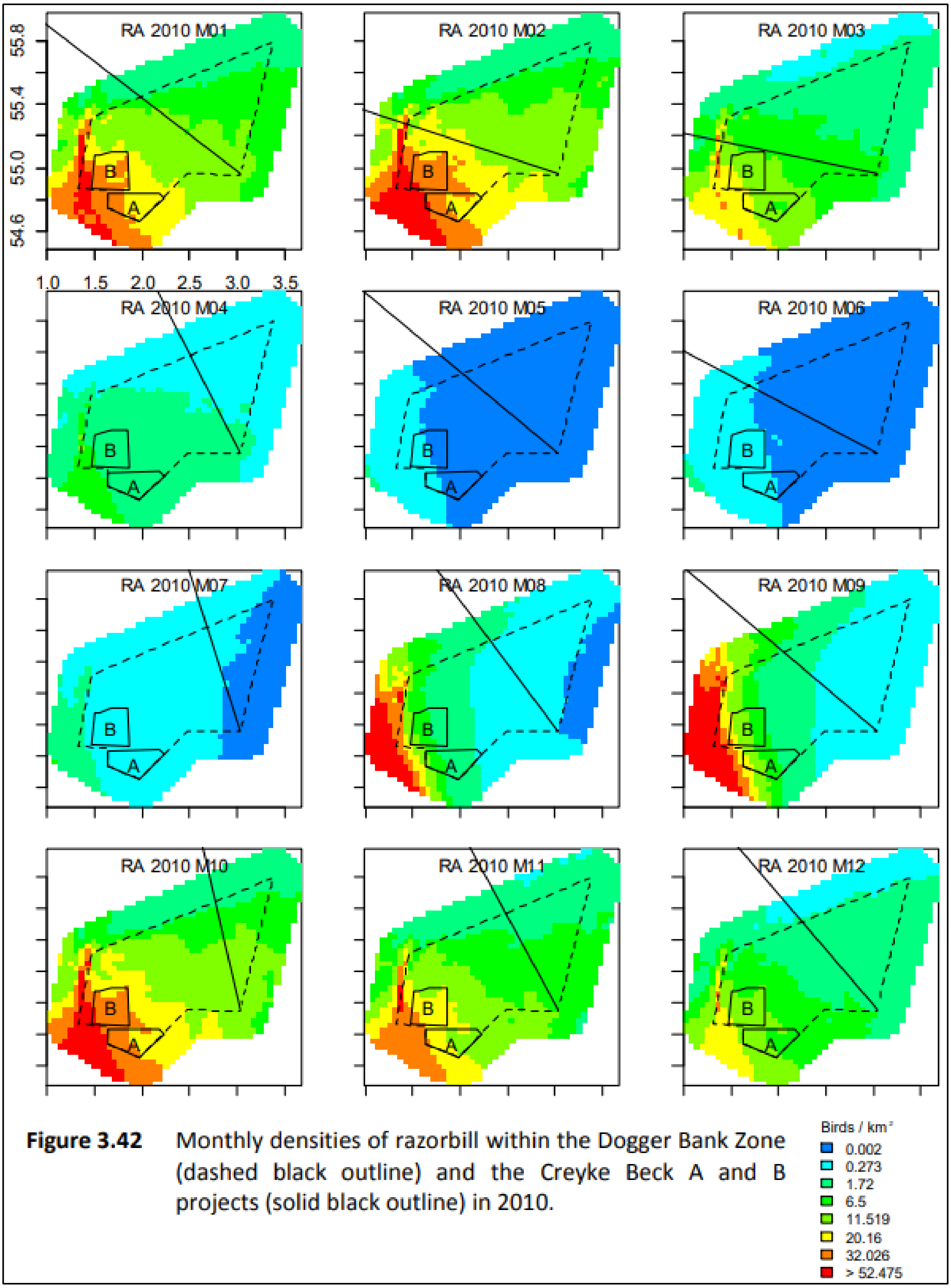

Figure 3.42 Monthly densities of razorbill within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2010.

Figure 4-44 Monthly density heatmaps of razorbill recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton et al. (2013))

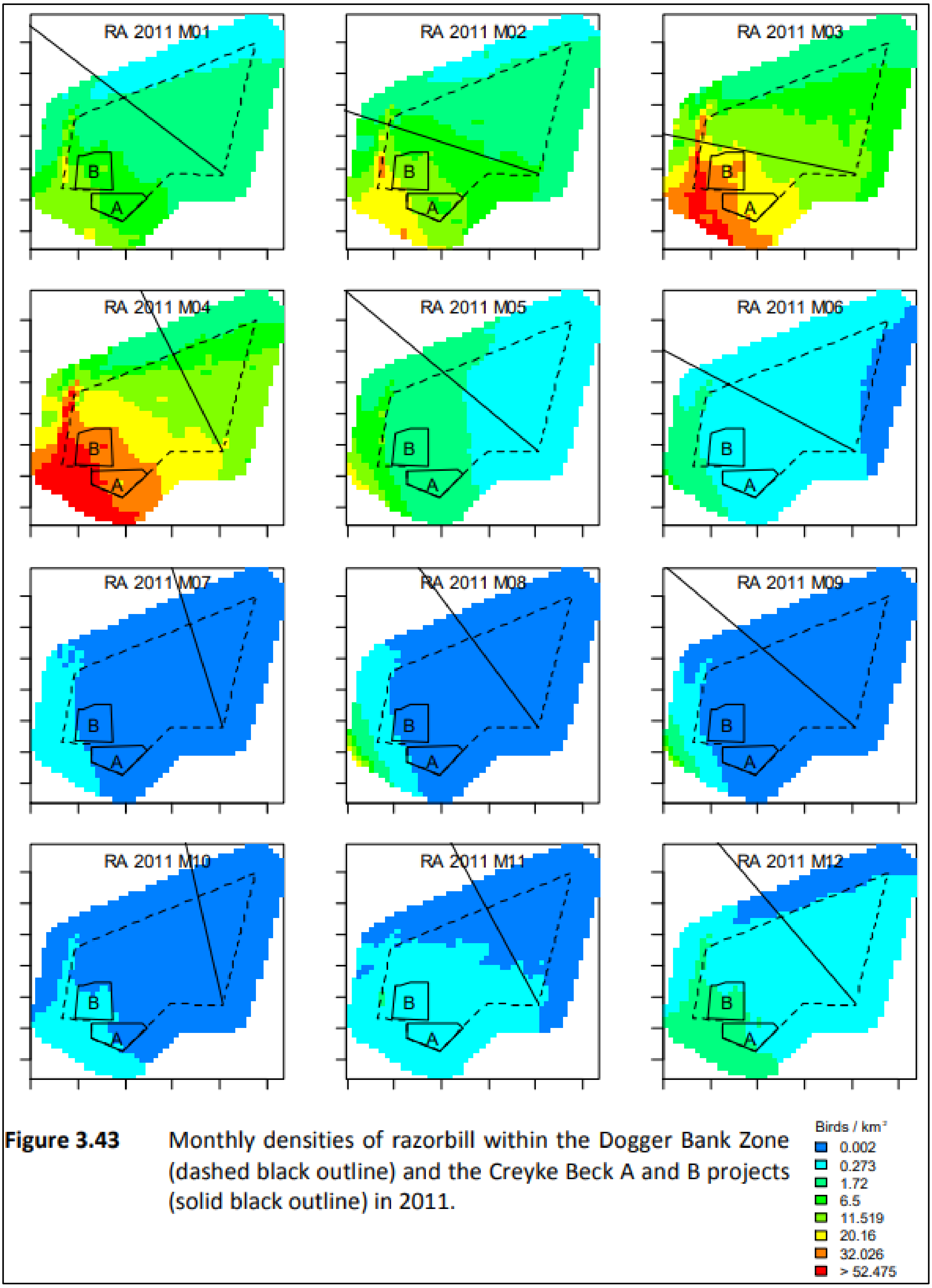

Figure 3.43 Monthly densities of razorbill within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2011.

Figure 4-45 Monthly density heatmaps of razorbill recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2011 (taken from Burton et al. (2013))

In the DBC Array Area, monthly baseline population estimates for razorbill peaked from January to March and October to December in 2010, with the highest value of 1,585 individuals occurring in December. Over the following two survey periods, razorbill numbers peaked in April 2011 (3,009 individuals) and April 2012 (2,464 individuals).

The pattern of monthly abundance in 2010 was similar in the Sofia Array Area, with a peak in December of 2,304 individuals. Abundance estimates increased during the winters of 2010/11 and 2011/12 but they peaked in April 2011 and March 2012, at 4,245 and 3,923 individuals, respectively. Razorbill density was highest in the west and south-west of the Dogger Bank Zone (**Figure 4-46**, **Figure 4-47** & **Figure 4-48**).

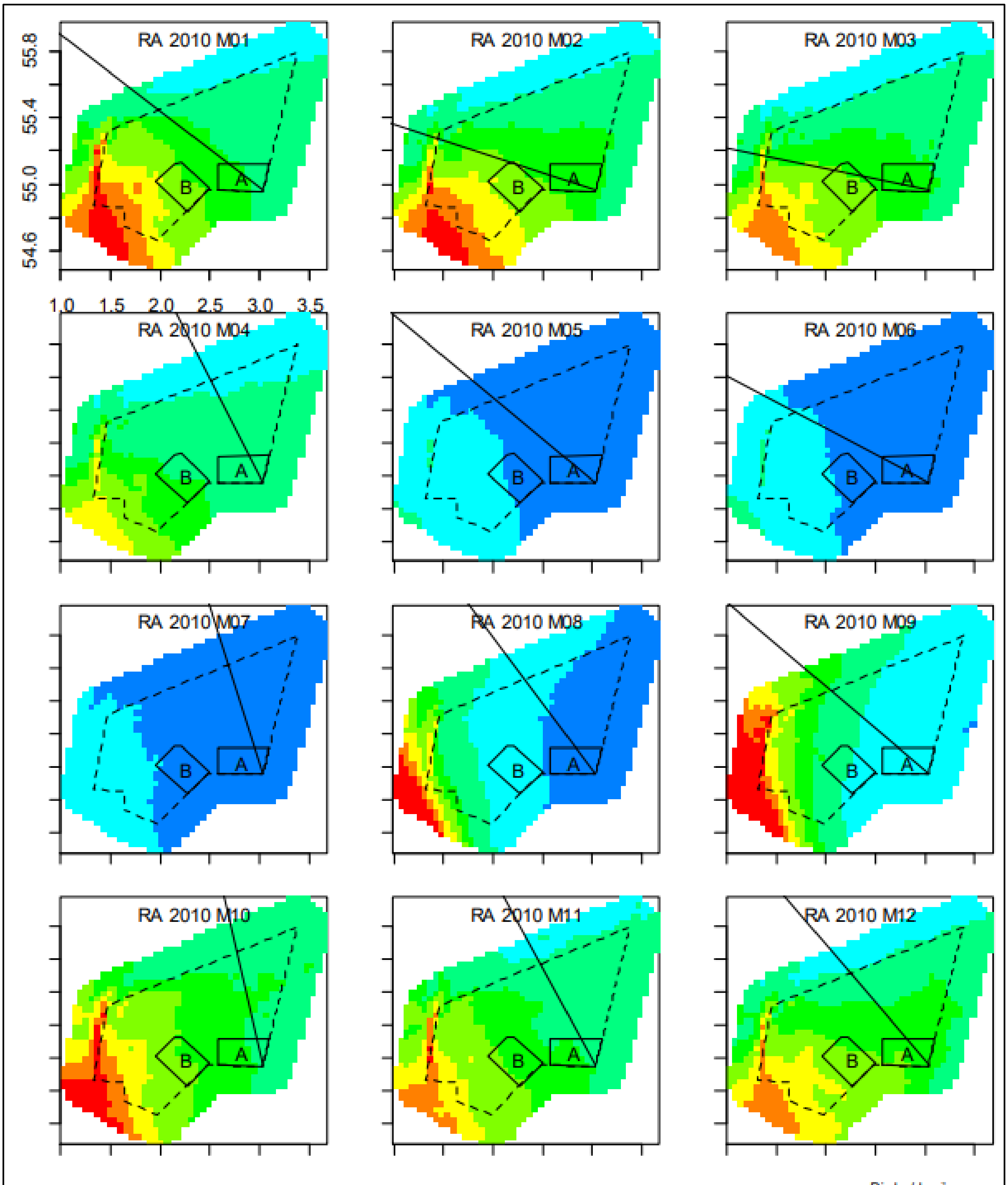

Figure 3.50 Monthly densities of razorbill within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside (solid black outline) in 2010.

Figure 4-46 Monthly density heatmaps of razorbill recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in 2010 (taken from Burton et al. (2014))

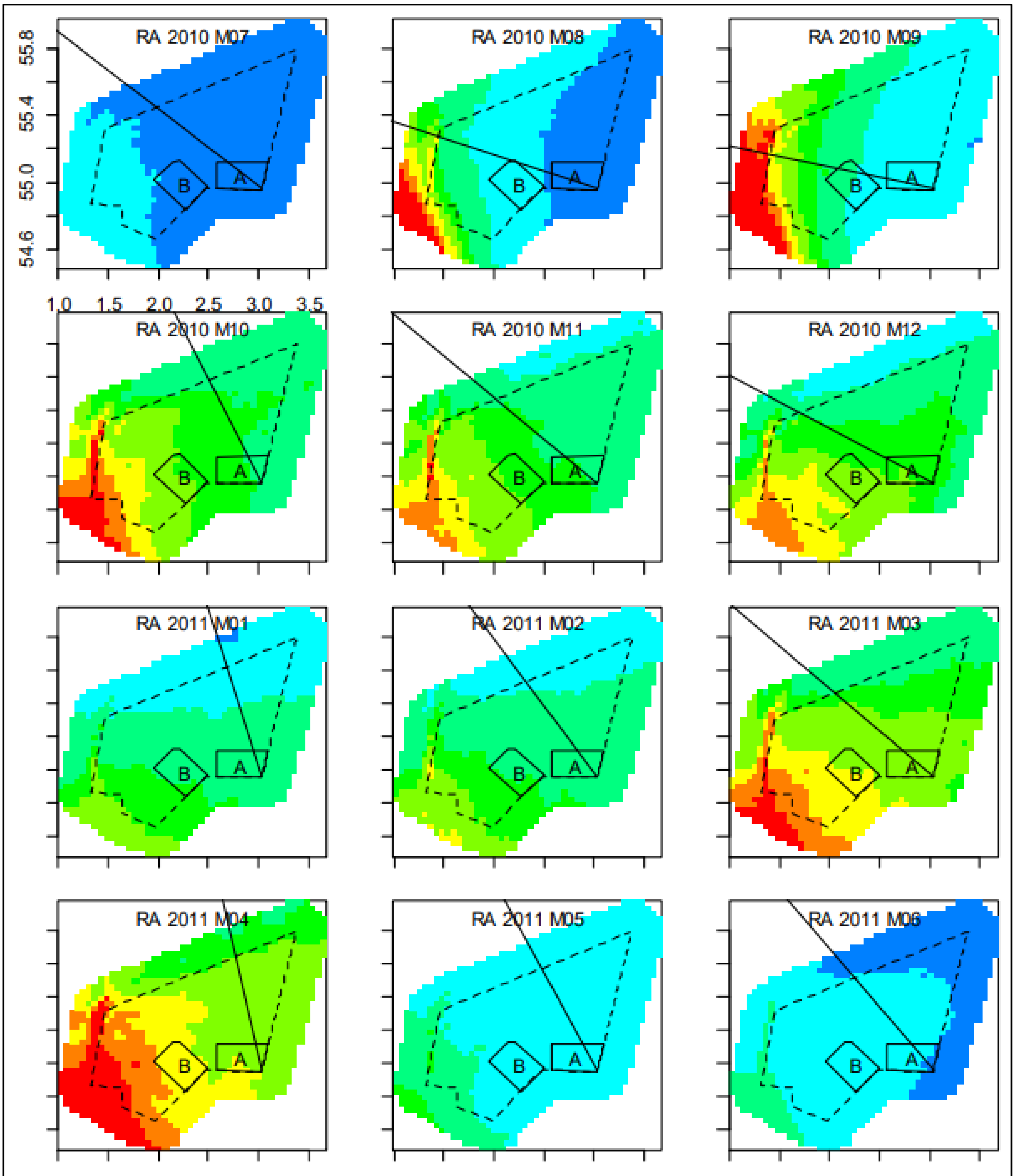

Figure 3.51 Monthly densities of razorbill within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010/11.

Figure 4-47 Monthly density heatmaps of razorbill recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2010 to June 2011 (taken from Burton et al. (2014))

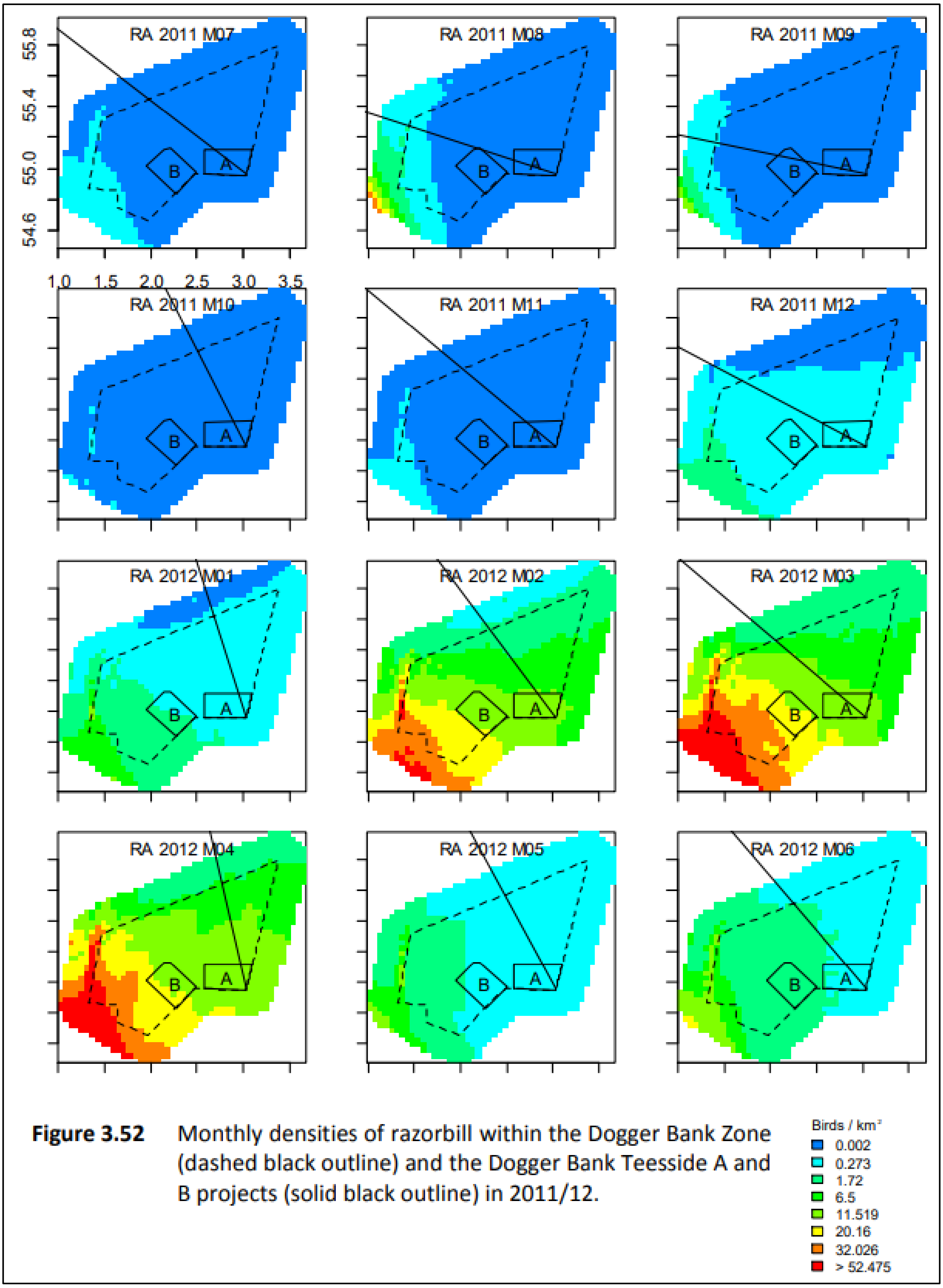

Figure 4-48 Monthly density heatmaps of razorbill recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2011 to June 2012 (taken from Burton et al. (2014))

In DBS, between March 2021 and February 2022, the monthly abundance estimates for razorbill in the Array Area peaked in March in DBS East, at 6,600 individuals, and in April in DBS West, at 3,204 individuals. Densities appeared to be higher in the central and eastern areas of DBS, particularly during the migration seasons and the winter months (**Figure 4-49**, **Figure 4-50**, **Figure 4-51** & **Figure 4-52**).

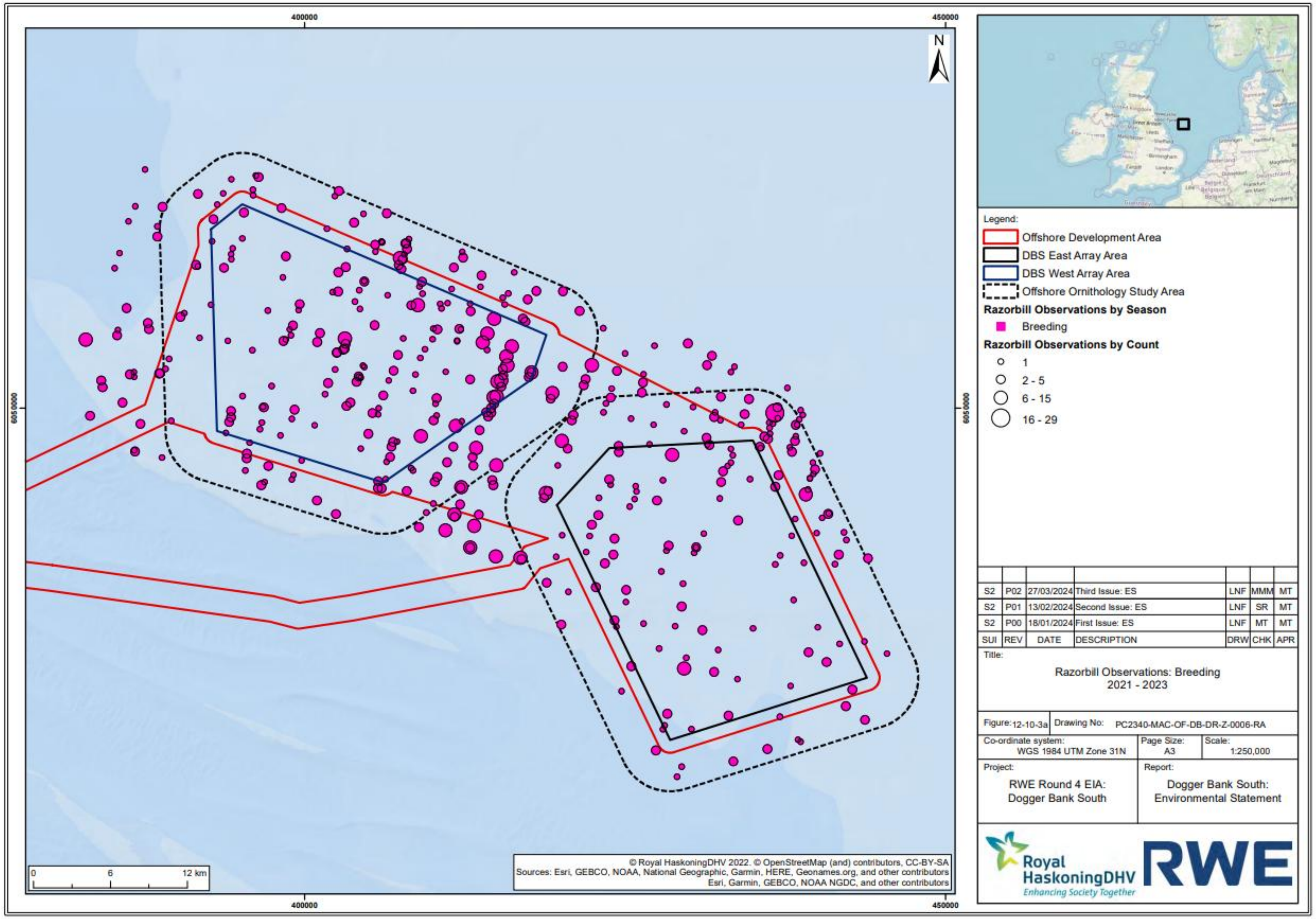

Figure 4-49 Raw counts of razorbill during the breeding bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

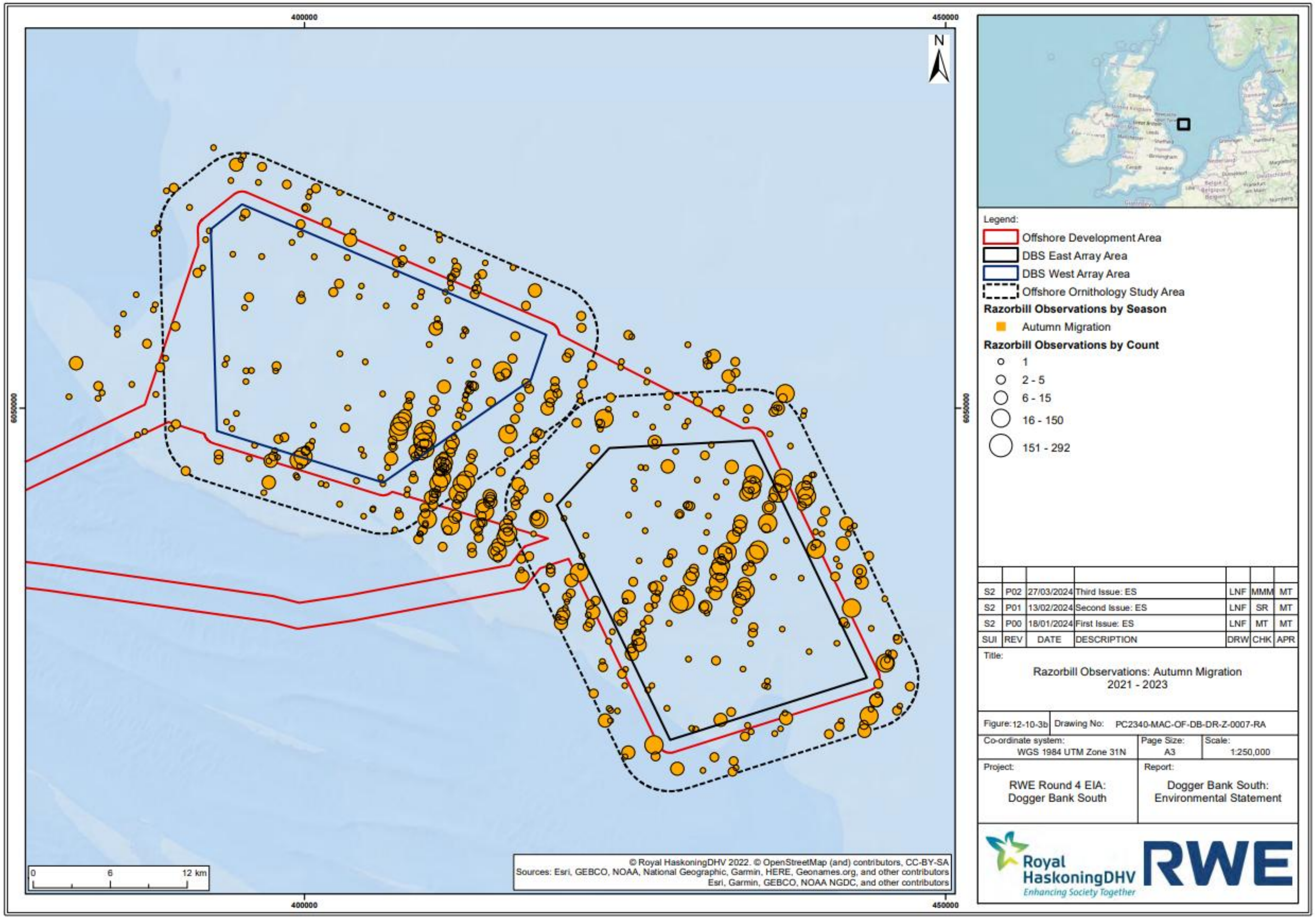

Figure 4-50 Raw counts of razorbill during the post-breeding migration bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

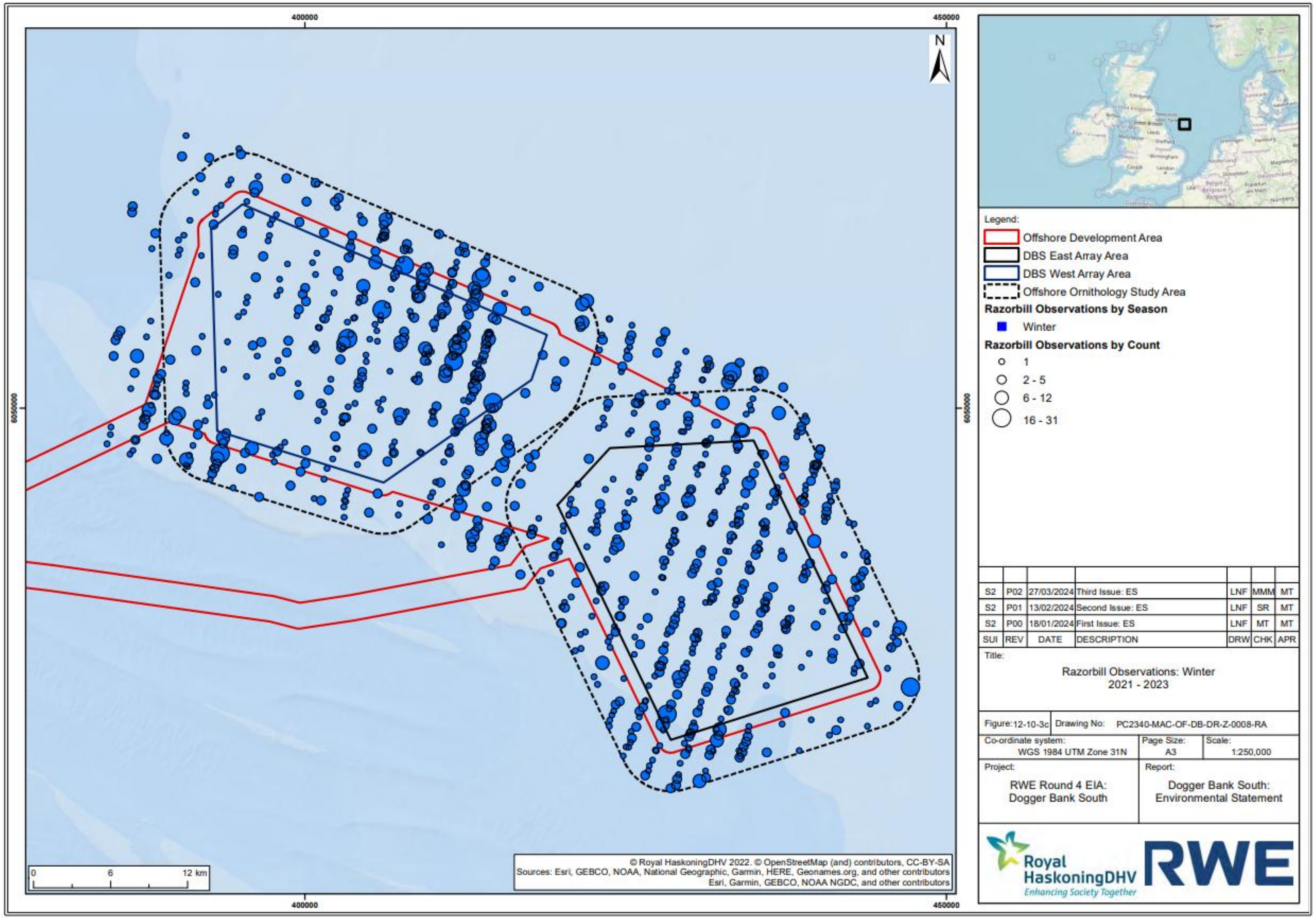

Figure 4-51 Raw counts of razorbill during the migration-free winter bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

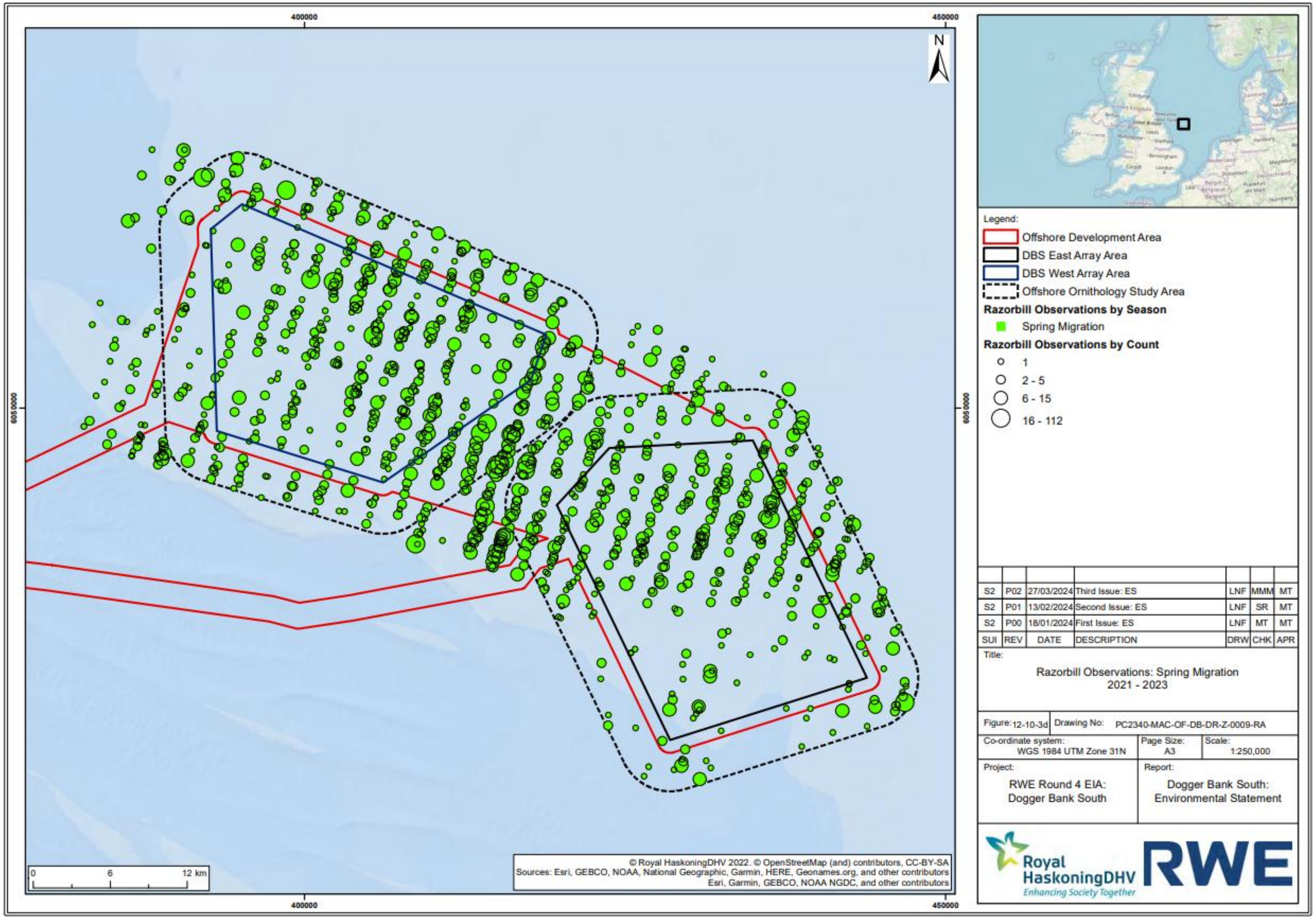

Figure 4-52 Raw counts of razorbill during the return migration bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

The marked south-westerly distribution of razorbill records within the Dogger Bank Zone during the 2010-2012 surveys indicates that the density of razorbills in DBD would have been relatively low. This is reflected in the abundance estimates for the other sites within the Dogger Bank Zone as these were higher for DBA and DBB than for DBC and Sofia. The abundance estimates for razorbill in DBS were also high during 2021-2022 indicating that the distribution of razorbills may have been similar to the distribution observed in 2010-2012.

Peak abundance and density estimates for all OWF Array Areas in the Dogger Bank Zone and DBS are shown in **Table 4–31**. The abundance and density values for DBS East and West are monthly mean peaks across the two-year survey period (RWE, 2023a; RWE, 2023c) whereas the values for all other OWFs are absolute peaks.

Table 4–31 Peak abundance and density estimates for razorbill for all OWF projects in the Dogger Bank Zone

Project	Peak abundance	Peak density (individuals/km^2)	Month
Dogger Bank A	5,707	11.07	April 2011
Dogger Bank B	7,430	12.40	April 2011
Dogger Bank C	3,009	5.37	April 2011
Sofia	4,245	7.15	April 2011
Dogger Bank South (East)	3,489	9.99	August 2021/22
Dogger Bank South (West)	3,690	10.4	September 2021/22
Dogger Bank D	1,231	4.69	January 2022

4.7.2 DBD Survey data (aerial survey data 2021-2023)

Razorbills were recorded in 20 of the 24 DAS within the DBD Array Area and 21 within the Array Area plus 2km asymmetrical buffer (**Appendix 3**). Peak abundances for the first year of data were in January 2022 for both the Array Area (1,231 individuals) and the Array Area plus 2km asymmetrical buffer (1,678 individuals). In Year 2, the highest abundance for the DBD Array Area and the Array Area plus 2km asymmetrical buffer was in April 2023 (981 and 1,402 individuals, respectively) (**Table 4–32** & **Table 4–33**). Razorbill densities ranged from 0.02 to 4.69 in the DBD Array Area, and 0.06 to 4.53 individuals/km^2 in the Array Area plus 2km asymmetrical buffer (**Appendix 3**). The average density for the Array Area was 1.03 individuals/km^2 for the Array Area, whilst it was 1.01 individuals/km^2 for the Array Area plus 2km asymmetrical buffer, for all behaviours. Most razorbills were observed sitting, with only a small number of birds recorded flying.

Table 4–32 Razorbill raw counts, total estimated abundance and total estimated density (individuals per km^2) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	16	135	0.51	0	0	0.00	16	135	0.51
Nov-21	11	130	0.50	0	0	0.00	11	130	0.50
Dec-21	17	130	0.50	0	0	0.00	17	130	0.50
Jan-22	97	1,231	4.69	3	15	0.06	94	1216	4.63
Feb-22	60	534	2.04	0	0	0.00	60	534	2.04
Apr-22	11	71	0.27	3	15	0.06	8	56	0.21
May-22	6	41	0.16	0	0	0.00	6	41	0.16
Jun-22	1	6	0.02	0	0	0.00	1	6	0.02
Sep-22	17	136	0.52	2	10	0.04	15	125	0.48
Oct-22	30	223	0.85	3	27	0.10	27	196	0.75
Nov-22	6	45	0.17	0	0	0.00	6	45	0.17
Dec-22	100	748	2.85	21	113	0.43	79	635	2.42
Jan-23	85	683	2.60	1	8	0.03	84	675	2.57
Feb-23	20	156	0.59	0	0	0.00	20	156	0.59
Mar-23	19	117	0.45	2	11	0.04	17	106	0.40
Apr-23	149	981	3.74	16	85	0.32	133	896	3.41
May-23	4	26	0.10	0	0	0.00	4	26	0.10
Jul-23	3	18	0.07	2	10	0.04	1	8	0.03
Aug-23	4	25	0.10	0	0	0.00	4	25	0.10
Sep-23	1	6	0.02	0	0	0.00	1	6	0.02

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Breeding = purple, Post-breeding migration = orange, Migration-free winter = blue

Table 4–33 Razorbill raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	19	154	0.42	0	0	0.00	19	154	0.42
Nov-21	25	250	0.68	3	18	0.05	22	232	0.63
Dec-21	22	161	0.43	0	0	0.00	22	161	0.43
Jan-22	126	1,678	4.53	3	29	0.05	123	1,659	4.48
Feb-22	66	596	1.61	0	0	0.00	66	596	1.61
Mar-22	1	7	0.02	0	0	0.00	1	7	0.02
Apr-22	15	96	0.26	3	15	0.04	12	82	0.22
May-22	10	70	0.19	0	0	0.00	10	70	0.19
Jun-22	3	20	0.05	0	0	0.00	3	20	0.05
Sep-22	51	409	1.11	2	10	0.03	49	399	1.08
Oct-22	47	338	0.91	3	25	0.07	44	313	0.85
Nov-22	7	51	0.14	0	0	0.00	7	51	0.14
Dec-22	121	926	2.50	22	119	0.32	99	807	2.18
Jan-23	159	1,243	3.36	2	12	0.03	157	1,230	3.32
Feb-23	24	184	0.50	0	0	0.00	24	184	0.50
Mar-23	24	152	0.41	2	12	0.03	22	141	0.38
Apr-23	217	1,402	3.79	19	99	0.27	198	1,302	3.52
May-23	5	34	0.09	0	0	0.00	5	34	0.09
Jul-23	4	24	0.06	2	10	0.03	2	14	0.04
Aug-23	7	44	0.12	0	0	0.00	7	44	0.12
Sep-23	6	38	0.10	0	0	0.00	6	38	0.10

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Breeding = purple, Post-breeding migration = orange, Migration-free winter = blue

In Year 1 razorbill abundance in the DBD Array Area plus 2km asymmetrical buffer was highest during the return-migration and post-breeding migration bio-seasons. Razorbill abundance was highest at the beginning of the migration-free breeding bio-season during Year 2 (**Figure 4-53**). Overall, abundances in Year 1 were less than Year 2.

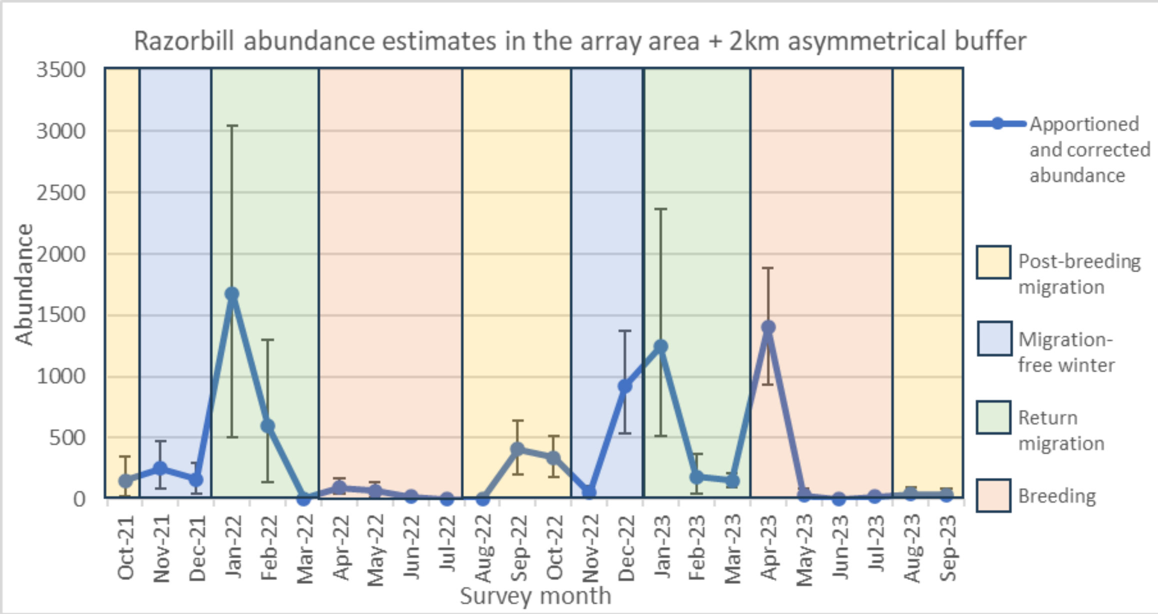

Figure 4-53 Razorbill abundance estimates for the 24 month survey period within the Array Area plus 2km buffer (breeding, post-breeding migration, migration-free winter and return migration-seasons)

4.7.3 Age ratios

Out of the 1,808 raw count observations for razorbill within the two years of surveys, only six individuals were given a specific age class of adult, all remaining observations were set as 'unknown'. Razorbill age classification is only possible from DAS when recently fledged razorbills are still being tended to by the male parent, with the distinguishing feature being the significant difference in size. This therefore means identification of accurate age ratios is not possible for razorbill from the available survey data.

4.7.4 Biological Season Mean Peak Estimates

Razorbills were present in greatest abundance in the DBD Array Area plus 2km asymmetrical buffer during the return migration bio-season with an estimated mean peak abundance of 1,461 individuals and a mean peak density of 3.43 individuals/km^2 (**Table 4–34**, **Table 4–35** & **Figure 4-53**). During the first year of surveys razorbill numbers were relatively low, aside from a substantial spike in abundance within the Array Area plus 2km asymmetrical buffer at the beginning of the return migration bio-season (steadily reducing over the following two months of the bio-season). Within the second year of surveys, the number of razorbill was higher overall. An increase in abundance was seen initially, in the post-breeding migration bio-season, returning to a trough in numbers in the first survey of the migration-free winter bio-season in November. A more significant spike in numbers was then recorded in the second half of this bio-season (December), continuing into the return migration bio-season and decreasing to another trough in February and March. A greater and sharper peak in abundance was recorded in the April survey (the first of the breeding bio-season). Following this, numbers remained low throughout the breeding and into the post-breeding migration bio-season.

Table 4–34 Razorbill bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return Migration (January – March)	957	3.64	13	0.05	946	3.60
Breeding (April – July)	526	2.00	50	0.19	476	1.81
Post-breeding Migration (August – October)	179	0.68	14	0.05	166	0.63
Migration-free Winter (November – December)	439	1.67	57	0.22	383	1.46

Table 4–35 Razorbill bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return Migration (January – March)	1,461	3.43	16	0.04	1,445	3.39
Breeding (April – July)	749	1.76	57	0.13	692	1.62
Post-breeding Migration (August – October)	282	0.66	13	0.03	277	0.65
Migration-free Winter (November – December)	588	1.38	69	0.16	520	1.22

4.7.5 Spatial Density Distribution and Flight Direction

There are clear differences in the density distributions of razorbills for the four bio-seasons (**Figure 4-54**). The migration-free breeding bio-season has the highest density hotspot of all the bio-seasons with a concentration at the southwest corner of the Array Area and Array Area plus 2km asymmetrical buffer. The return migration bio-season has a relatively even spread of razorbills throughout the Array Area and Array Area plus 2km asymmetrical buffer, with a hotspot at the southeast corner. The remaining two bio-seasons have relatively lower densities throughout the Array Area and buffers than the previously described bio-seasons. There is a hotspot for the post-breeding migration bio-season in the northeastern corner of the Array Area and Array Area plus 2km asymmetrical buffer. The migration-free winter bio-season has a hotspot of low numbers of razorbill in the western area of the centre of the Array Area.

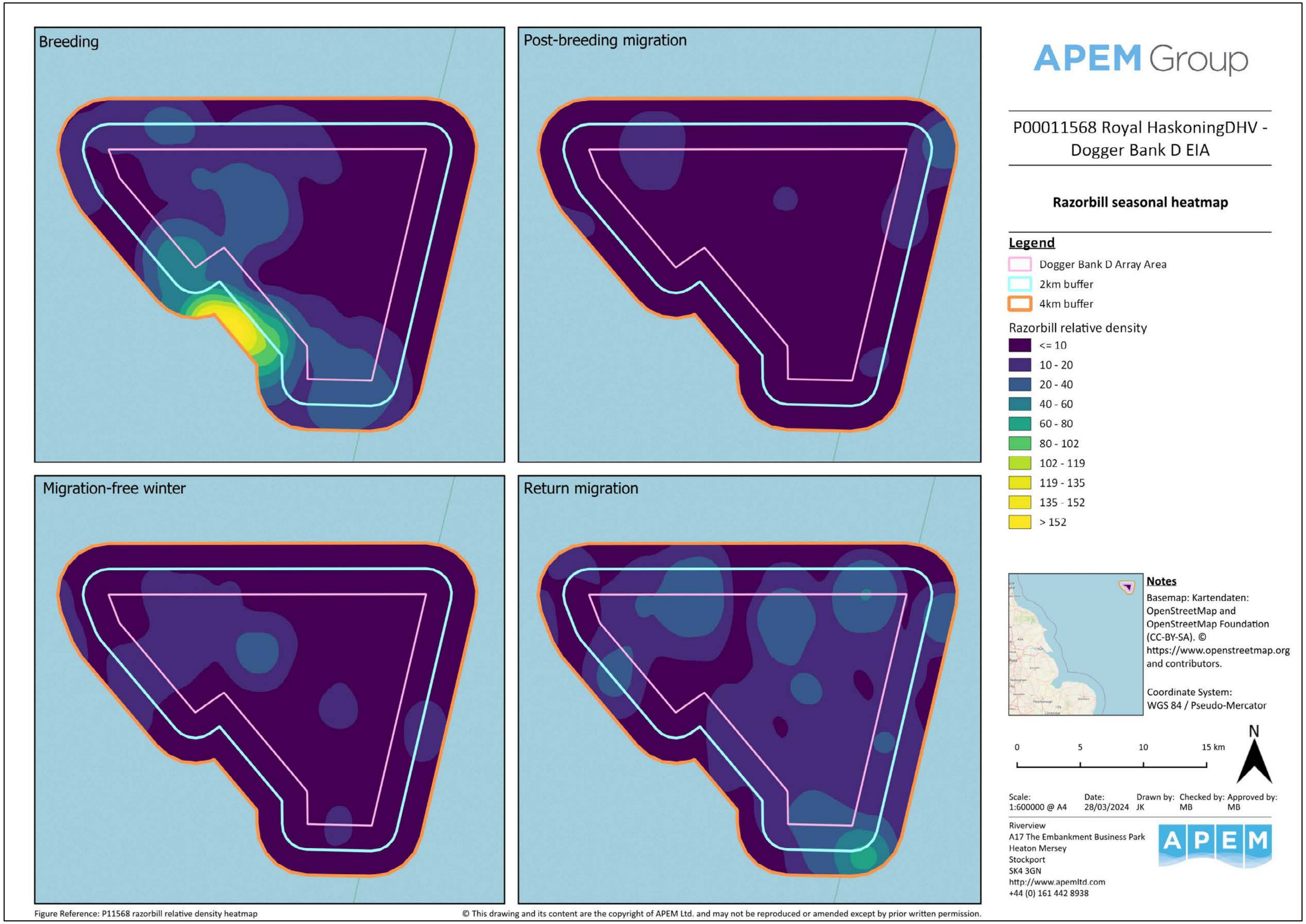

Figure 4-54 Heatmaps of razorbill distribution in each bio-season

Monthly flight directions from across the DBD survey area during the breeding bio-season had no clear orientation, which would be expected for birds using the area to forage. Although there are limitations with flight orientation data, no clear direction could also suggest connectivity to any breeding colony is limited, which would be expected given the project is outside of the species' mean max plus one SD foraging range (Woodward *et al*. 2019) from any UK SPA and non-SPA colony. It is likely that any individuals recorded during the breeding bio-season are non-breeders or potentially birds moving through late on migration. A strong southerly flight orientation recorded during April 2023 (within the migration-free breeding bio-season) is speculated to related to a weather induced displacement event rather than migration, although this would need confirmation against known weather data at the time. During the migration and winter bio-seasons there was no clear directionality in flights observed in razorbills in the DBD Array Area and the relevant 2km asymmetrical buffer suggesting birds are using the offshore environment within this period, although the low sample size limits further conclusions. **Appendix 4**).

4.7.6 HPAI review

According to the Tremlett *et al*. (2024) review on seabird counts post HPAI outbreak, razorbill was assigned a mortality level of low due to the low numbers of deceased birds recorded in surveys. Therefore, due to the low levels of impact of HPAI on razorbill, the baseline data collected will be representative regardless of the outbreak of the virus.

4.8 Puffin

4.8.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of puffins within the Dogger Bank Zone did not exceed the 1% threshold for populations of national importance.

In DBA, monthly abundance estimates differed between 2010 and 2011. In 2010, there were two main peaks in monthly abundance estimates, from January to March and September to December, with the highest estimate of 1,267 individuals occurring in October. In 2011, there was a single peak from January to April, with the highest estimate of 376 individuals occurring in March. In DBB, there were two main peaks in puffin abundance from January to March and September to December, with the highest value of 6,187 individuals in February. In 2011, there was a single peak from January to March, with the highest estimate of 809 individuals occurring in March. Puffin density was highest near the western edge of the Dogger Bank Zone, with another area of high density in the north-east in February and March 2011 (**Figure 4-55** & **Figure 4-56**).

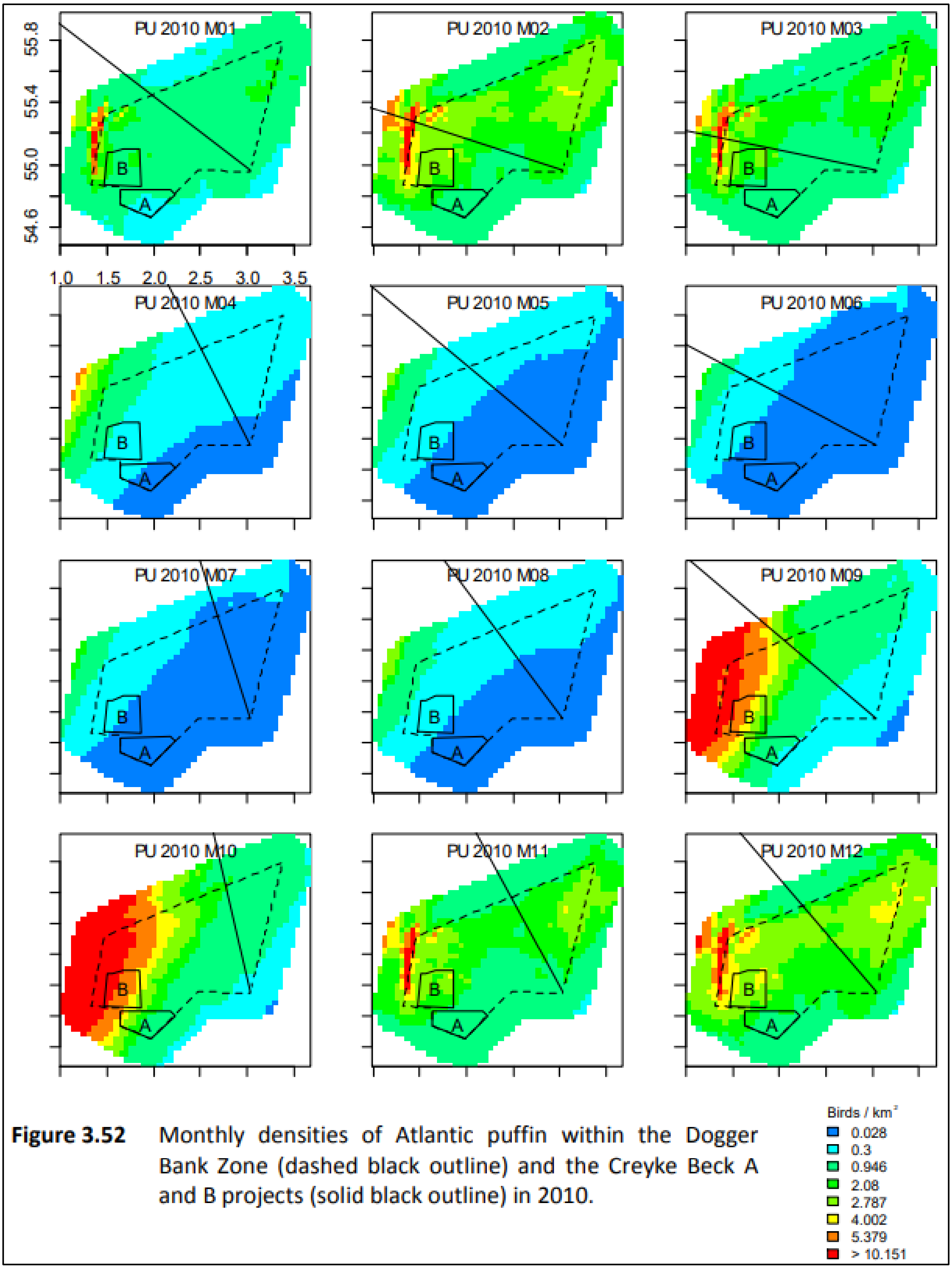

Figure 4-55 Monthly density heatmaps of puffin recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton et al. (2013))

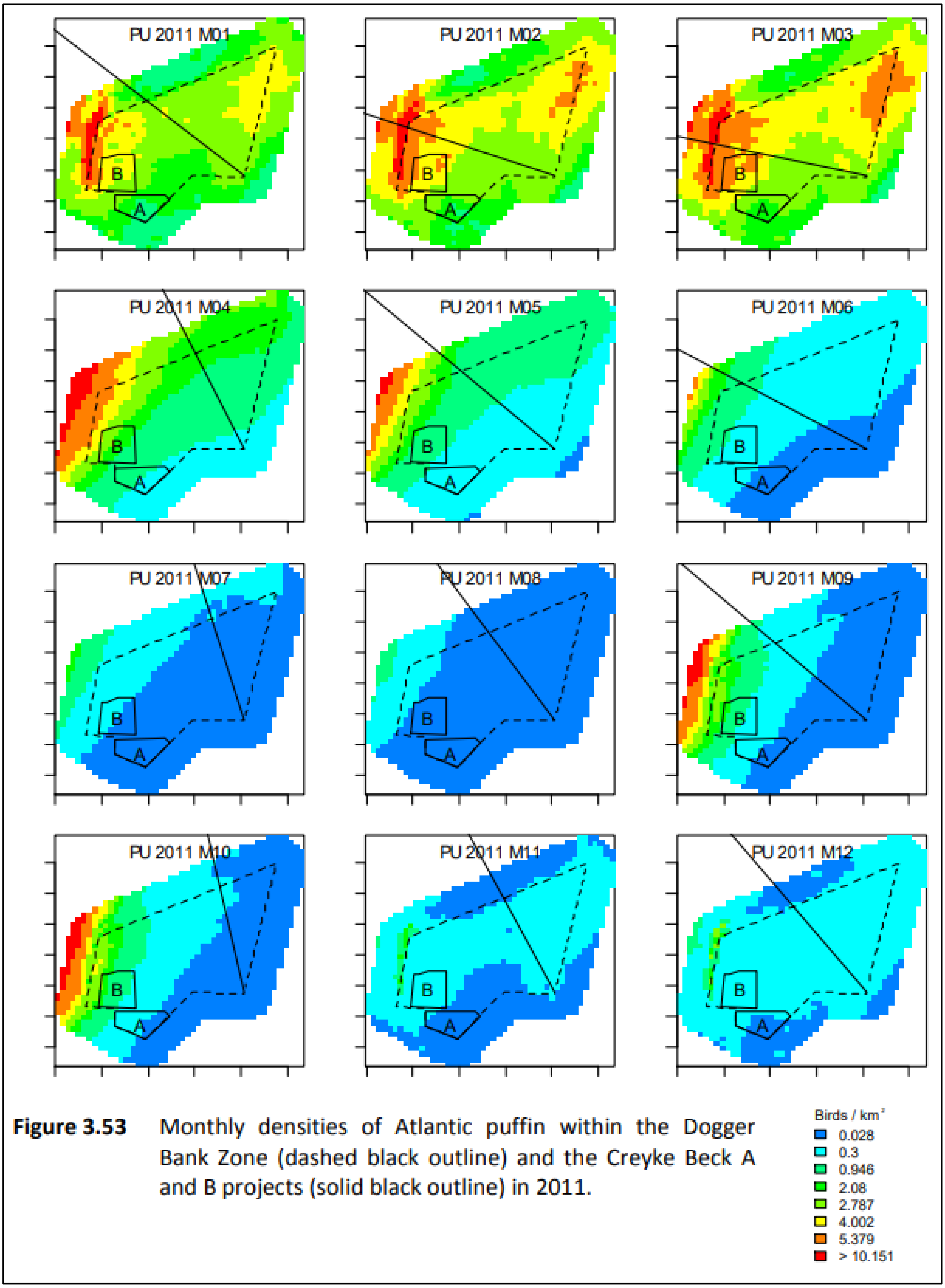

Figure 4-56 Monthly density heatmaps of puffin recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2011 (taken from Burton et al. (2013))

In the DBC Array Area, monthly baseline population estimates for puffin peaked from January to March and September to December in 2010, with the highest value of 422 individuals occurring in December. Over the following two survey periods, puffin numbers peaked in March 2011 (582 individuals) and February 2012 (155 individuals).

The pattern of monthly abundance in 2010 was similar in the Sofia Array Area, with a peak in December of 448 individuals. Over the following survey periods, abundance estimates peaked in March 2011 and 2012, at 608 and 170 individuals, respectively. Puffin density was highest in the west and south-west of the Dogger Bank Zone (**Figure 4-57**, **Figure 4-58** & **Figure 4-59**).

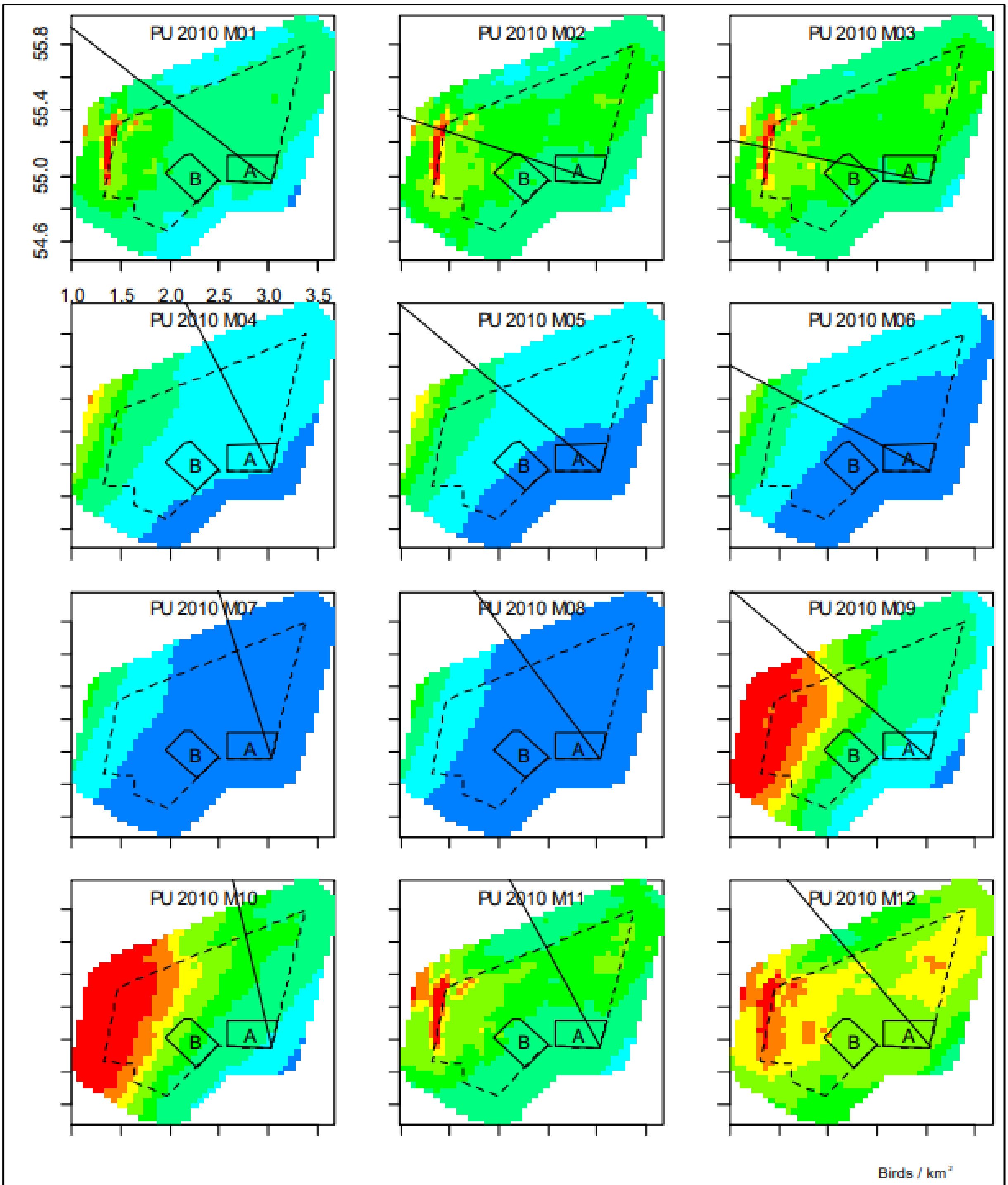

Figure 3.62 Monthly densities of Atlantic puffin within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010.

Figure 4-57 Monthly density heatmaps of puffin recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in 2010 (taken from Burton et al. (2014))

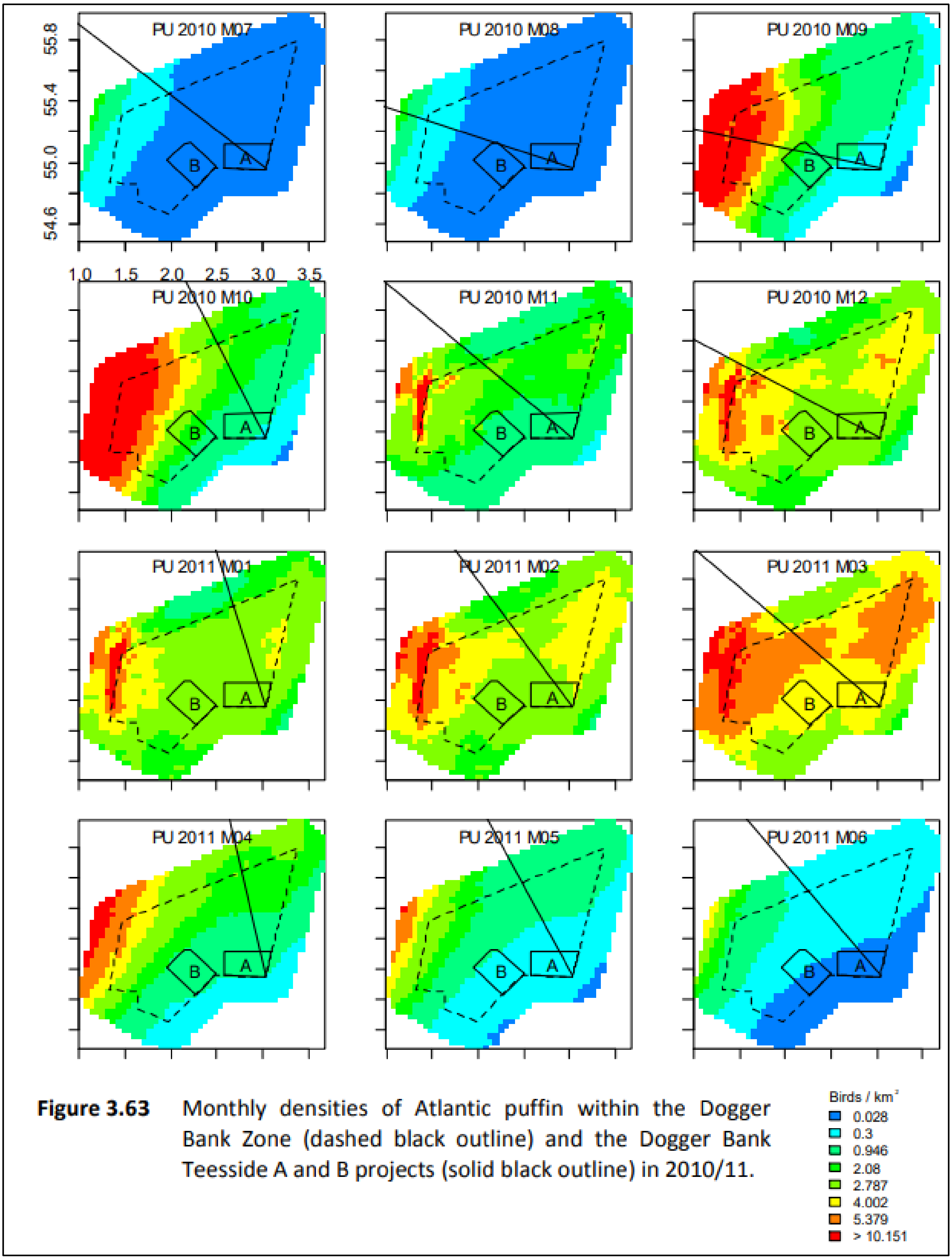

Figure 4-58 Monthly density heatmaps of puffin recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2010 to June 2011 (taken from Burton et al. (2014))

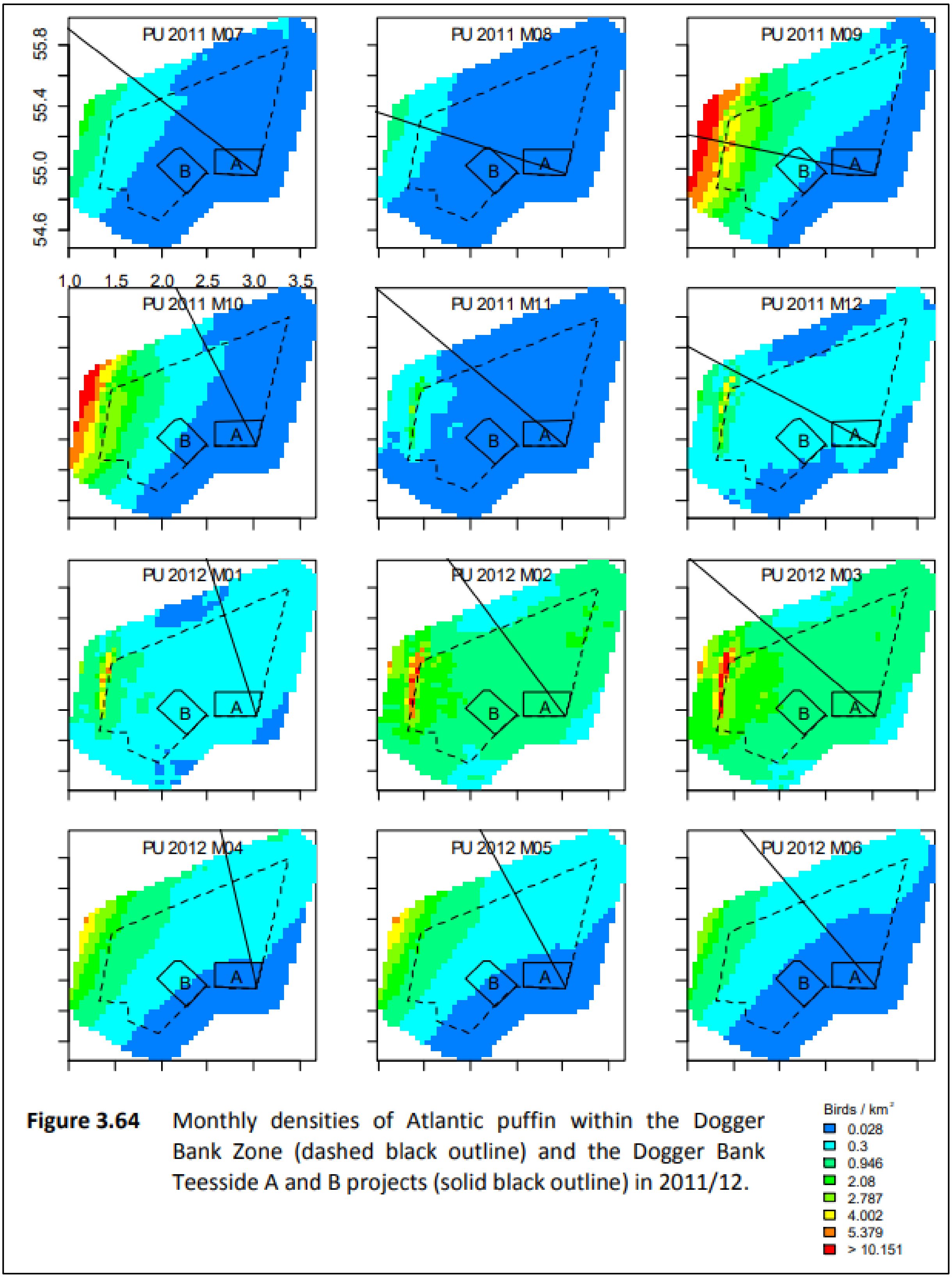

Figure 4-59 Monthly density heatmaps of puffin recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2011 to June 2012 (taken from Burton et al. (2014))

In DBS, between March 2021 and February 2023, the mean monthly abundance estimates for puffin in the Array Area peaked in October in both DBS East and DBS West, at 120 individuals and 101 individuals, respectively. The distribution of raw counts for puffin in DBS is shown in **Figure 4-60**.

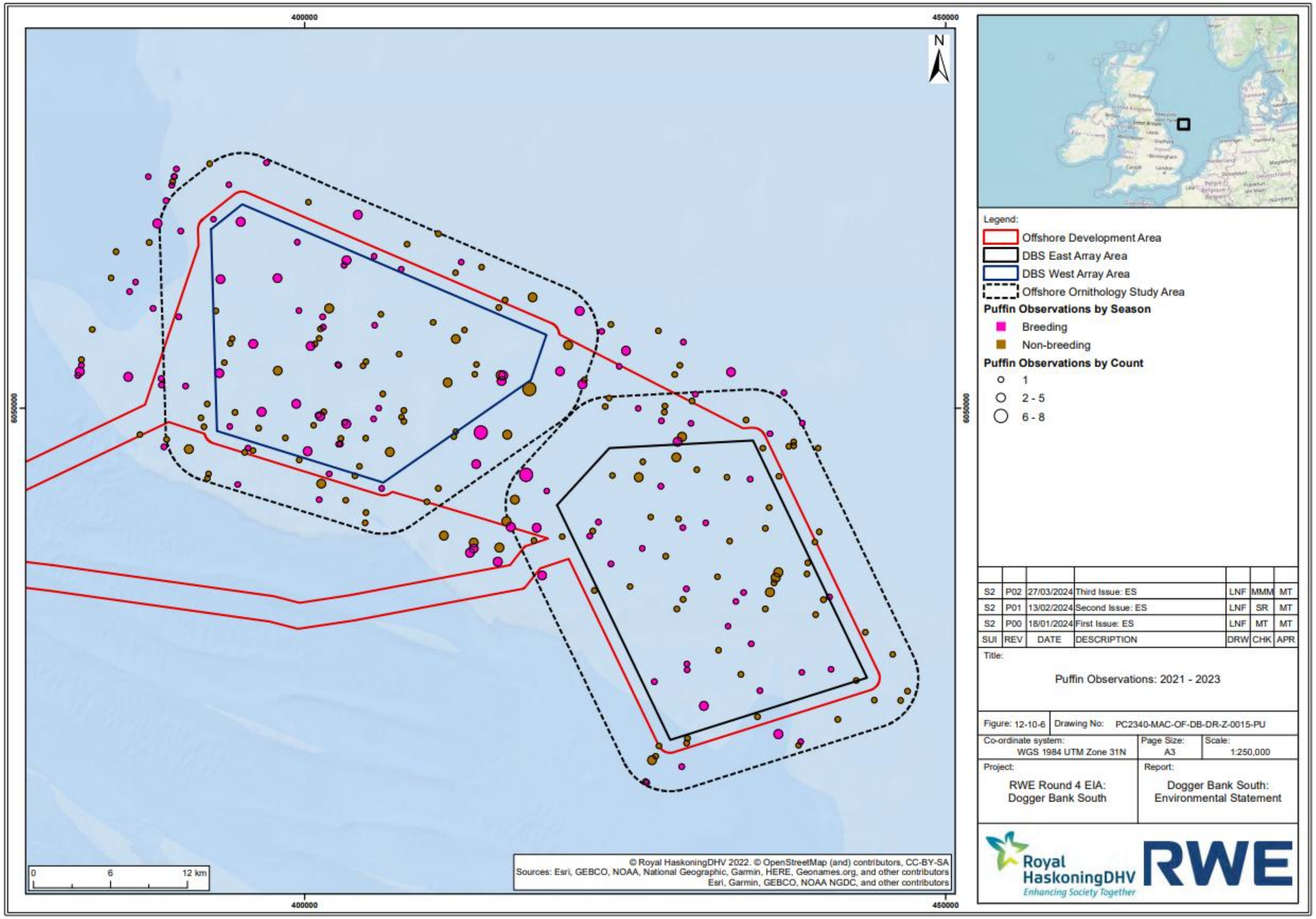

Figure 4-60 Raw counts of puffin by bio-season during digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

Throughout the 2010-2012 surveys, puffins had a westerly distribution in the Dogger Bank Zone and abundance estimates were higher in DBA and DBB than in DBC and Sofia. Therefore, puffin density would have been relatively low in DBD. Puffin density was also low to the south of the Dogger Bank Zone during 2010-2012 and a low density was observed in DBS during 2021-2022 indicating that this trend may have continued.

Peak abundance and density estimates for all OWF Array Areas in the Dogger Bank Zone and DBS are shown in **Table 4–36**. The abundance and density values for DBS East and West are monthly mean peaks across the two-year survey period (RWE, 2023a; RWE, 2023c) whereas the values for all other OWFs are absolute peaks.

Table 4–36 Peak abundance and density estimates for puffin for all OWF projects in the Dogger Bank Zone

Project	Peak abundance	Peak density (individuals/km^2)	Month
Dogger Bank A	1,267	2.46	October 2010
Dogger Bank B	6,187	10.32	February 2010
Dogger Bank C	582	1.04	March 2011
Sofia	608	1.02	March 2011
Dogger Bank South (East)	120	0.35	October 2021/22
Dogger Bank South (West)	101	0.29	October 2021/22
Dogger Bank D	137	0.45	April 2023

4.8.2 DBD Survey data (aerial survey data 2021-2023)

Puffins were recorded in 11 of the 24 DAS within the DBD Array Area and 13 within the Array Area plus 2km asymmetrical buffer (**Appendix 3**). Abundances were highest in May 2022 for the first year of data for both the Array Area (47 individuals) and the Array Area plus 2km asymmetrical buffer (84 individuals). In Year 2 the highest abundance for the DBD Array Area and the Array Area plus 2km asymmetrical buffer was in April 2023 (119 and 137 individuals, respectively) (**Table 4–37** & **Table 4–38**). Puffin densities ranged from 0.02 to 0.45 in the DBD Array Area, and 0.02 to 0.37 individuals/km^2, in the Array Area plus 2km asymmetrical buffer (**Appendix 3**). The average density for both the Array Area and the Array Area plus 2km asymmetrical buffer was 0.08 individuals/km^2, for all behaviours. All puffins recorded were sitting, no observations of puffins in flight were made.

Table 4–37 Puffin raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	2	12	0.05	0	0	0.00	2	12	0.05
Feb-22	1	6	0.02	0	0	0.00	1	6	0.02
Mar-22	1	6	0.02	0	0	0.00	1	6	0.02
Apr-22	2	12	0.05	0	0	0.00	2	12	0.05
May-22	8	47	0.18	0	0	0.00	8	47	0.18
Sep-22	2	12	0.05	0	0	0.00	2	12	0.05
Oct-22	3	18	0.07	0	0	0.00	3	18	0.07
Nov-22	1	7	0.03	0	0	0.00	1	7	0.03
Dec-22	1	6	0.02	0	0	0.00	1	6	0.02
Mar-23	4	24	0.09	0	0	0.00	4	24	0.09
Apr-23	20	119	0.45	0	0	0.00	20	119	0.45

*Table note: Bio-seasons are colour coded as follows – Breeding = yellow, Non-breeding = grey

Table 4–38 Puffin raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	3	18	0.05	0	0	0.00	3	18	0.05
Feb-22	1	6	0.02	0	0	0.00	1	6	0.02
Mar-22	3	18	0.05	0	0	0.00	3	18	0.05
Apr-22	3	18	0.05	0	0	0.00	3	18	0.05
May-22	14	84	0.23	0	0	0.00	14	84	0.23
Jul-22	1	6	0.02	0	0	0.00	1	6	0.02
Sep-22	3	18	0.05	0	0	0.00	3	18	0.05
Oct-22	3	18	0.05	0	0	0.00	3	18	0.05
Nov-22	1	6	0.02	0	0	0.00	1	6	0.02
Dec-22	1	6	0.02	0	0	0.00	1	6	0.02
Mar-23	5	29	0.08	0	0	0.00	5	29	0.08
Apr-23	23	137	0.37	0	0	0.00	23	137	0.37
Jul-23	2	11	0.03	0	0	0.00	2	11	0.03

*Table note: Bio-seasons are colour coded as follows – Breeding = yellow, Non-breeding = grey

In both survey years, puffin abundance in the DBD Array Area plus 2km asymmetrical buffer was highest during the start of the breeding season (**Figure 4-61**). Overall, abundances in Year 1 were less than Year 2.

4.8.3 Age ratios

For all records of puffin the age class was allocated as ‘unknown’, due to there being no readily identifiable features between different age classes within the available survey data.

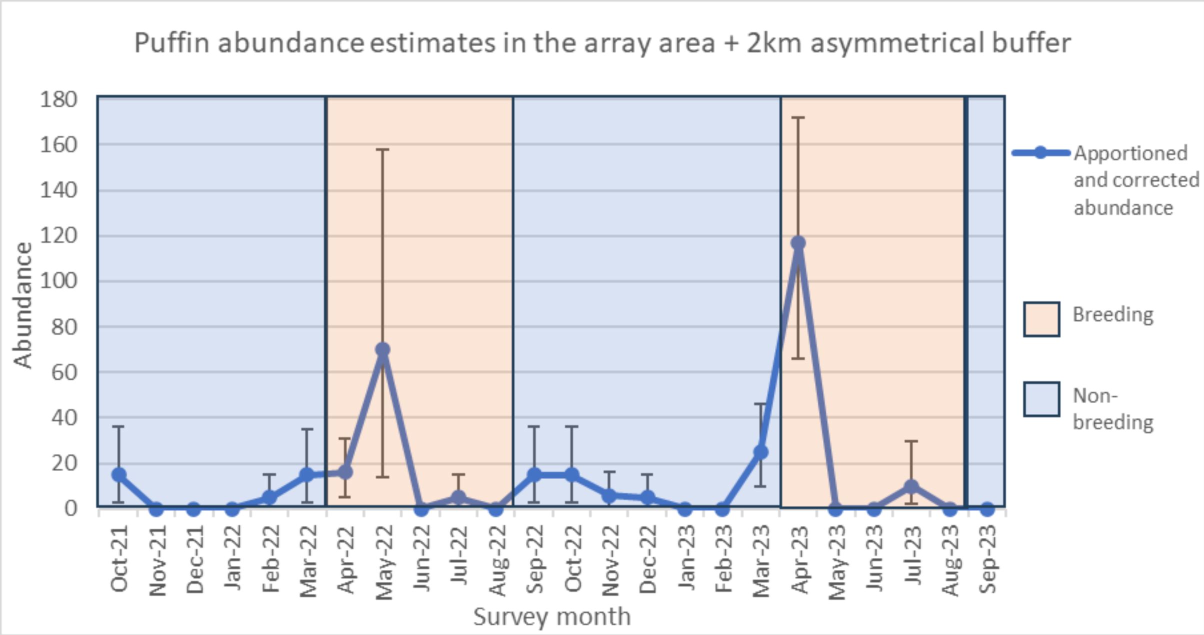

Figure 4-61 Puffin abundance estimates for the 24 month survey period within the Array Area plus 2km buffer (breeding and non-breeding bio-seasons)

4.8.4 Biological Season Mean Peak Estimates

Puffins were present in greatest abundance in the DBD Array Area plus 2km asymmetrical buffer during the breeding bio-season with an estimated mean peak abundance of 111individuals and a mean peak density of 0.26 individuals/km^2 (**Table 4–39, Table 4–40** & **Figure 4-61**). The pattern of puffins recorded within the DBD Array Area and Array Area plus 2km asymmetrical buffer was consistent across the two years of surveys, with numbers remaining low apart from a sharp peak in abundance at the beginning of the breeding bio-season, likely due to birds moving through the Array Area plus 2km asymmetrical buffer whilst still on migration.

Table 4–39 Puffin bio-season mean peak abundance and density (individuals per km²) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Breeding (April – August)	83	0.32	0	0.00	83	0.32
Non-breeding (September - March)	18	0.07	0	0.00	18	0.07

Table 4–40 Puffin bio-season mean peak abundance and density (individuals per km²) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Breeding (April – August)	111	0.26	0	0	111	0.26
Non-breeding (September - March)	24	0.06	0	0	24	0.06

4.8.5 Spatial Density Distribution and Flight Direction

There is a clear contrast in the density distributions of puffins between the two bio-seasons (**Figure 4-62**).Given the low numbers of puffins recorded during the DAS, the raw counts are included in the figure to better illustrate the distribution of records. During the breeding bio-season, there are three density hotspots at the north of the Array Area and Array Area plus 2km asymmetrical buffer with other observations spread relatively evenly throughout the remainder of the Array Area and associated buffers. In the non-breeding bio-season, puffin densities are lower and spread loosely throughout the Array Area and the Array Area plus 2km asymmetrical buffer, though the hotspot with the highest density from the breeding bio-season remains within the non-breeding season in lower numbers.

No puffins were recorded flying within the DBD study area.

3.1.1 HPAI review

According to the Tremlett *et al*. (2024) review on seabird counts post HPAI outbreak, puffin was assigned a mortality level of low due to the low numbers of deceased birds recorded in surveys. Therefore, due to the low levels of impact of HPAI on puffin, the baseline data collected will be representative regardless of the outbreak of the virus.

Figure 4-62 Heatmaps of puffin distribution in each bio-season

3.2 Great northern diver

3.2.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During boat-based surveys of the Dogger Bank Zone in 2010, there were single records of great northern diver in April, May and June. During boat-based surveys in 2011, two great northern divers were recorded in November.

During the DASs of DBS between March 2021 and February 2023, only one great northern diver was observed in the DBS West Array Area, giving an abundance estimate of four individuals. The location of this record is shown in **Figure 4-63**.

Given the very low numbers of great northern diver recorded in the Dogger Bank Zone from 2010-2012 and in DBS from 2021-2022, density was likely to be very low in DBD.

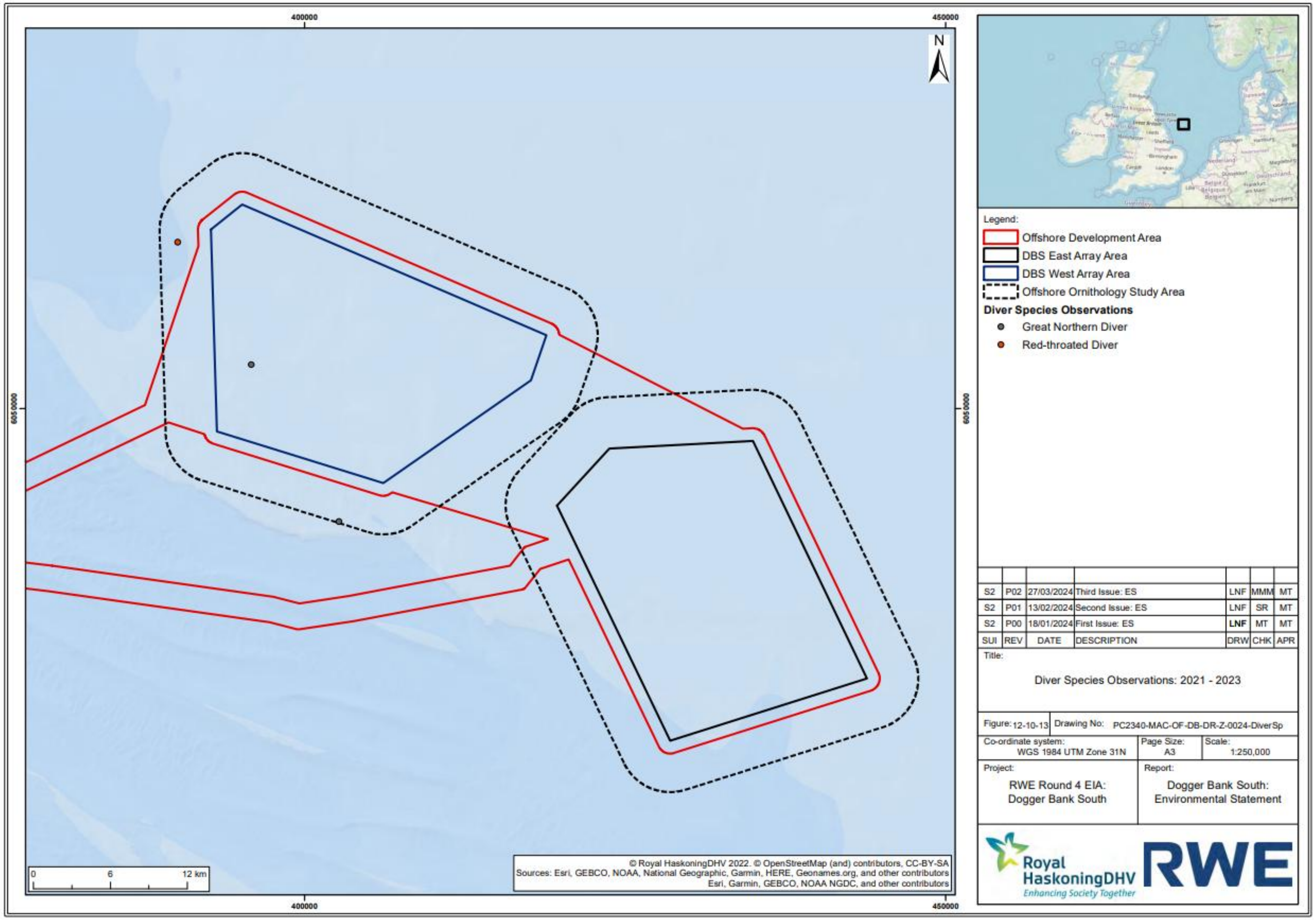

Figure 4-63 Raw counts of great northern diver and red-throated diver by bio-season during digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

3.2.2 DBD Survey data (aerial survey data 2021-2023)

Great northern divers were recorded in 12 of the 24 DAS within the DBD Array Area and Array Area plus 4km buffer (**Appendix 3**). Abundances were highest in March 2022 for the first year of data, for both the Array Area (56 individuals) and the Array Area plus 4km buffer (90 individuals). In Year 2, the highest abundance for the DBD Array Area was in January 2023 (10 individuals), whereas the highest abundance for the Array Area plus 4km buffer was in December 2022 (15 individuals) (**Table 4–41** & **Table 4–42**). Great northern diver densities ranged from 0.02 to 0.21 in the DBD Array Area, and 0.01 to 0.18 individuals/km^2 in the Array Area plus 4km buffer (**Appendix 3**). The average density for the Array Area and the Array Area plus 4km buffer was 0.02 individuals/km^2, for all behaviours. All great northern divers observed were sitting, there were no records of flying birds.

Table 4–41 Great northern diver raw counts, total estimated abundance and total estimated density (individuals per km^2) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Nov-21	1	5	0.02	0	0	0.00	1	5	0.02
Dec-21	7	35	0.13	0	0	0.00	7	35	0.13
Jan-22	2	10	0.04	0	0	0.00	2	10	0.04
Feb-22	1	5	0.02	0	0	0.00	1	5	0.02
Mar-22	11	56	0.21	0	0	0.00	11	56	0.21
Apr-22	1	5	0.02	0	0	0.00	1	5	0.02
Nov-22	1	5	0.02	0	0	0.00	1	5	0.02
Dec-22	1	5	0.02	0	0	0.00	1	5	0.02
Jan-23	2	10	0.04	0	0	0.00	2	10	0.04
Feb-23	1	5	0.02	0	0	0.00	1	5	0.02
Mar-23	1	5	0.02	0	0	0.00	1	5	0.02
Apr-23	1	5	0.02	0	0	0.00	1	5	0.02

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Post-breeding migration = orange and Migration-free winter = blue

Table 4–42 Great northern diver raw counts, total estimated abundance and total estimated density (individuals per km^2) in DBD Array Area plus 4km buffer

DBD Array Area plus 4km buffer									
Survey	All behaviours			Flying			Sitting		
	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Nov-21	2	10	0.02	0	0	0.00	2	10	0.02
Dec-21	13	65	0.13	0	0	0.00	13	65	0.13
Jan-22	5	25	0.05	0	0	0.00	5	25	0.05
Feb-22	2	10	0.02	0	0	0.00	2	10	0.02
Mar-22	18	90	0.18	0	0	0.00	18	90	0.18
Apr-22	1	5	0.01	0	0	0.00	1	5	0.01
Nov-22	1	5	0.01	0	0	0.00	1	5	0.01
Dec-22	3	15	0.03	0	0	0.00	3	15	0.03
Jan-23	2	10	0.02	0	0	0.00	2	10	0.02
Feb-23	2	10	0.02	0	0	0.00	2	10	0.02
Mar-23	2	10	0.02	0	0	0.00	2	10	0.02
Apr-23	1	5	0.01	0	0	0.00	1	5	0.01

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Post-breeding migration = orange and Migration-free winter = blue

In both survey years, great northern diver abundance in the DBD Array Area plus 4km buffer increased towards the end of the post-breeding migration bio-season and remained relatively constant until the start of the return migration bio-season where numbers decreased (**Figure 4-64**). No great northern divers were present in the migration-free breeding bio-season as expected, as they do not regularly breed in the UK. Overall, abundances in Year 2 were less than Year 1.

3.2.3 Age ratios

Of the 67 raw count observations of great northern diver recorded, 65 of these were classed as 'unknown' in terms of age. Only a single individual was classed as an adult with another individual classed as a second winter bird. Assigning an age class to great northern diver during the non-breeding bio-seasons, is difficult as there are only slight differences in plumage between adult and juvenile birds in the available survey data.

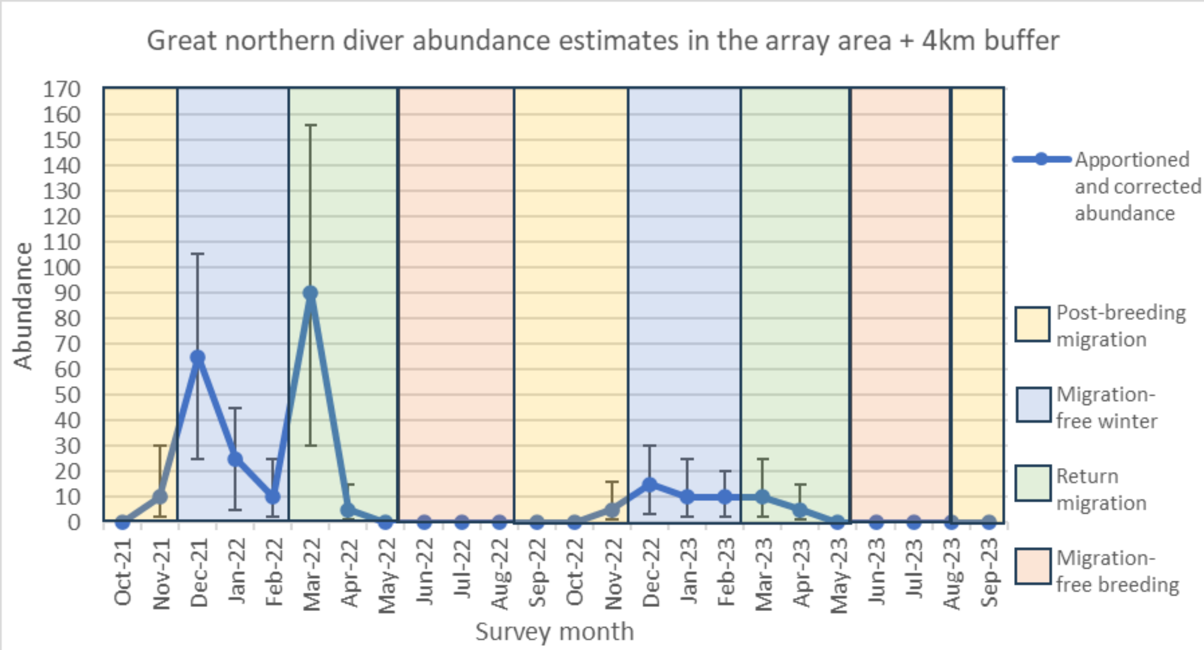

Figure 4-64 Great northern diver abundance estimates for the 24 month survey period within the Array Area plus 4km buffer (migration-free breeding, post-breeding migration, migration-free winter and return migration bio-seasons)

3.2.4 Biological Season Mean Peak Estimates

Great northern divers were present in greatest abundance in the DBD Array Area plus 4km buffer during the return migration bio-season with an estimated mean peak abundance of 50 individuals and a mean peak density of 0.08 individuals/km^2 (**Table 4–43**, **Table 4–44** & **Figure 4-64**). Within the first year of surveys, great northern diver abundances increased at the end of the post-breeding migration bio-season and had two clear peaks at the start of the migration-free winter bio-season and at the start of the return migration bio-season; with numbers declining to the eventual absence of birds at the end of the return migration and during the migration-free breeding bio-seasons. In the second year of surveys, the abundance of great northern divers remained relatively stable upon their return to the area at the end of the post-breeding migration bio-season until the end of the return migration bio-season.

Table 4–43 Great northern diver bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return migration (March – May)	31	0.12	0	0.00	31	0.12
Post-breeding migration (September – November)	5	0.02	0	0.00	5	0.02
Migration-free winter (December – February)	23	0.09	0	0.00	23	0.09

Table 4–44 Great northern diver bio-season mean peak abundance and density (individuals per km²) in DBD Array Area plus 4km buffer

DBD Array Area plus 4km buffer						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return migration (March – May)	50	0.08	0	0.00	50	0.08
Post-breeding migration (September – November)	8	0.01	0	0.00	8	0.01
Migration-free winter (December – February)	40	0.06	0	0.00	40	0.06

3.2.5 Spatial Density Distribution

The density distributions of great northern divers differ between the three bio-seasons (**Figure 4-65**). During both the migration-free winter and the return migration bio-seasons, the distribution of great northern divers is spread throughout the Array Area. In the return migration bio-season there are hotspots at the east and west of the Array Area and Array Area plus 2km asymmetrical buffer. The post-breeding migration bio-season has much lower densities than the other non-breeding bio-seasons.

Figure 4-65 Heatmaps of great northern diver distribution in each bio-season

3.3 White-billed diver

3.3.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During boat-based surveys of the Dogger Bank Zone in 2010, a total of 27 white-billed diver was recorded, with a peak monthly count of 11 individuals in December. During boat-based surveys in 2011, a total of 25 white-billed diver was recorded in January, March, April, November and December, with a peak count of 10 individuals in April. The average monthly population estimate for the Dogger Bank Zone between November and April was 67 individuals in 2010 and 2011 using boat-based survey data. Combining boat-based and aerial survey data gave a higher monthly population estimate of 80 individuals in the Dogger Bank Zone from November to April in 2010, 2010/11 and 2011/12.

The average monthly population estimates for white-billed diver between November and April in the DBA and DBB Array Areas were four and five individuals, respectively. The monthly estimates for DBC and Sofia over the same time period were seven individuals in each Array Area.

No white-billed divers were recorded during the DAS of DBS. The low abundance estimates in each of the Array Areas suggest that white-billed diver abundance was likely low throughout the Dogger Bank Zone and in DBD.

3.3.2 DBD Survey data (aerial survey data 2021-2023)

White-billed divers were recorded in the DBD Array Area in two of the 24 DAS, and in three surveys in the Array Area plus 4km buffer. The estimated abundance was highest in November 2022 within the Array Area (16 individuals) and Array Area plus 2km asymmetrical buffer (27 individuals), both corresponding to a density of 0.06 individuals per km^2 (**Table 4–45** & **Table 4–46**). The average density of white-billed divers was 0.06 individuals/km^2 for the Array Area and 0.03 individuals/km^2 for the Array Area plus 4km buffer, for all behaviours. All white-billed divers observed were sitting. There were no records of flying birds.

3.1.1 Age ratios

For all records of white-billed diver the age class was allocated as ‘unknown’, due to there being no readily identifiable features between different age classes from the available survey data.

3.1.1 Biological Season Mean Peak Estimates

White-billed divers breed in the Arctic and are scarce in UK waters, occurring mainly during migration and in winter. The Dogger Bank Zone is one of the few locations in UK waters where this species is recorded regularly, and records have occurred during surveys of other sites within the wider area.

Table 4–45 White-billed diver raw counts, total estimated abundance and total estimated density (individuals per km2) in DBD Array Area plus 4km buffer

DBD Array Area									
Survey	All behaviours			Flying			Sitting		
	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Nov-21	3	16	0.06	0	0	0.00	3	16	0.06
Jan-22	3	15	0.06	0	0	0.00	3	15	0.06

*Table note: Bio-seasons are colour coded as follows –Post-breeding migration = orange and Migration-free winter = blue

Table 4–46 White-billed diver raw counts, total estimated abundance and total estimated density (individuals per km2) in DBD Array Area

DBD Array Area plus 4km buffer									
Survey	All behaviours			Flying			Sitting		
	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Nov-21	5	27	0.06	0	0	0.00	5	27	0.06
Jan-22	3	15	0.03	0	0	0.00	3	15	0.03
Feb-22	1	5	0.01	0	0	0.00	1	5	0.01

*Table note: Bio-seasons are colour coded as follows – Post-breeding migration = orange and Migration-free winter = blue

All records of white-billed diver in the DBD survey area occurred during one non-breeding season, between November 2021 and February 2022. The mean peak abundance was estimated at eight individuals for the Array Area, with a density of 0.03 individuals/km^2, and 14 individuals for the Array Area plus 4km buffer, with a density of 0.02 individuals/km^2.

3.1.2 Spatial Density Distribution

Within the survey area, white-billed divers were mainly recorded in the north of the Array Area and into the 2km and 4km buffers (**Figure 4-66**).

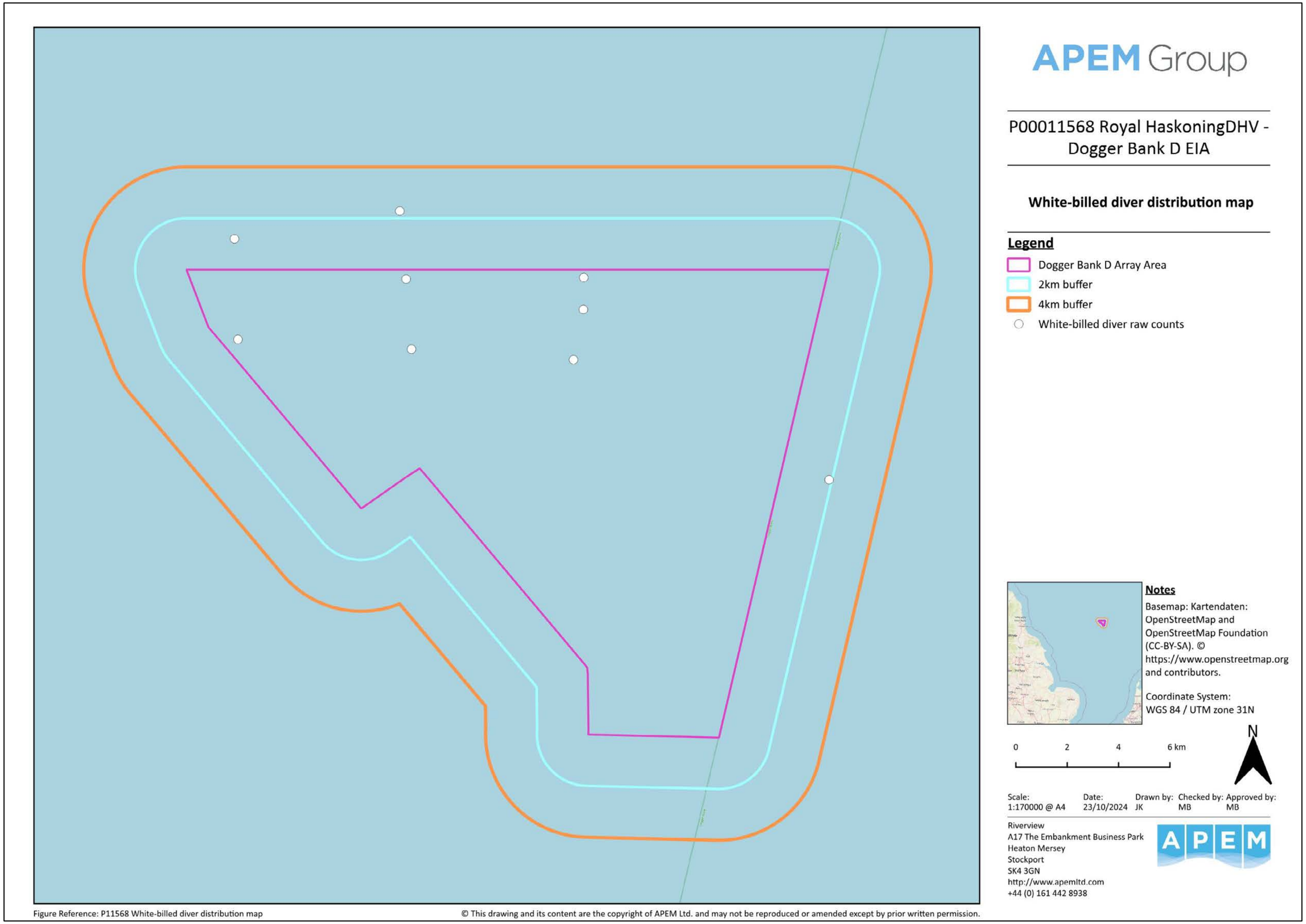

Figure 4-66 Distribution of white-billed diver raw counts (non-breeding season only)

3.2 Fulmar

3.2.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of fulmars within the Dogger Bank Zone exceeded the 1% threshold for populations of national importance during the 2010 breeding season.

In DBA, monthly abundance estimates differed between 2010 and 2011. In 2010, fulmar abundance peaked in May at 315 individuals, whereas in 2011, there were two main peaks in February (102 individuals) and October (118 individuals). Monthly abundance in DBB followed a similar pattern, with peaks of 660 individuals in May 2010, 182 individuals in February 2011 and 211 individuals in October 2011. The density of fulmars was generally highest on the western edge of the Dogger Bank Zone, however there were also large areas of high density in the north-east in 2010 (**Figure 4-67** & **Figure 4-68**).

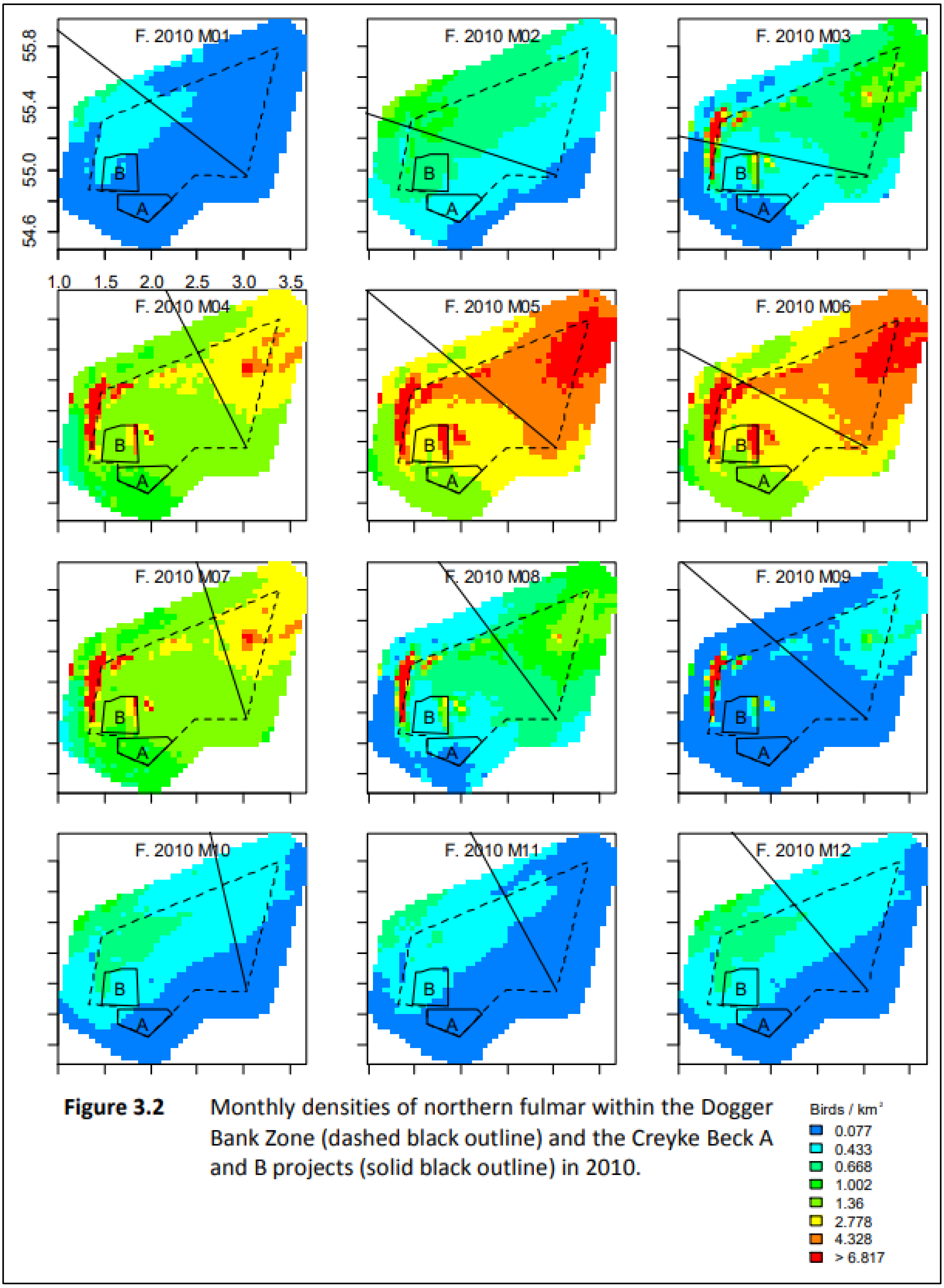

Figure 3.2 Monthly densities of northern fulmar within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2010.

Figure 4-67 Monthly density heatmaps of fulmar recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton et al. (2013))

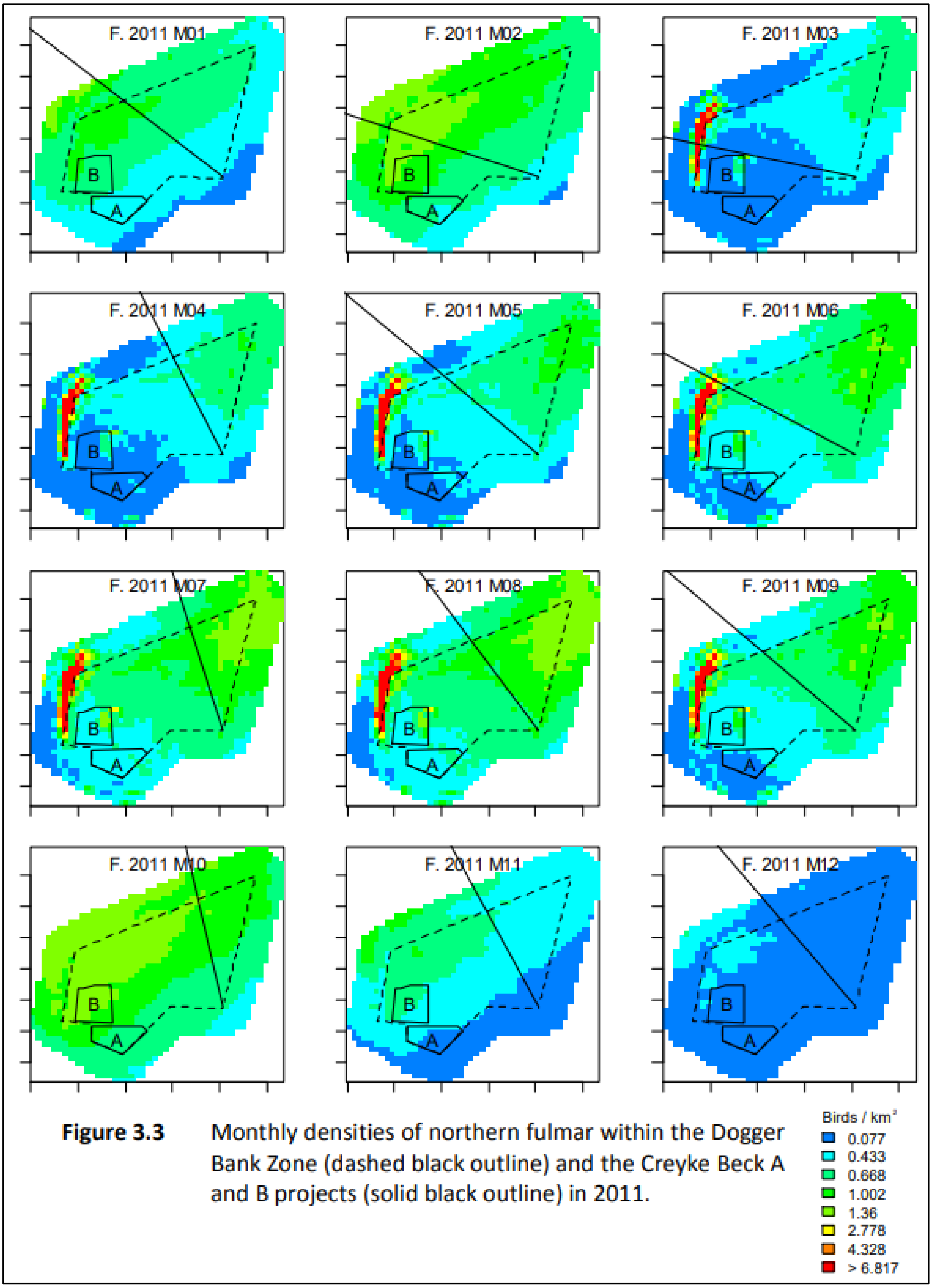

Figure 3.3 Monthly densities of northern fulmar within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2011.

Figure 4-68 Monthly density heatmaps of fulmar recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2011 (taken from Burton et al. (2013))

In the DBC Array Area in 2010, monthly baseline population estimates for fulmar peaked in May at 569 individuals. In the 2010/11 survey period, fulmar numbers peaked at 253 individuals in July 2010, and in 2011/12, the highest abundance estimate of 258 individuals occurred in May 2012.

The pattern of monthly abundance in 2010 was similar in the Sofia Array Area, with a peak in May of 540 individuals. Over the following survey periods, abundance estimates also peaked in July 2010 and May 2012, at 268 and 223 individuals, respectively. Fulmar density was highest in the west, south-west and north-east of the Dogger Bank Zone (**Figure 4-69**, **Figure 4-70** & **Figure 4-71**).

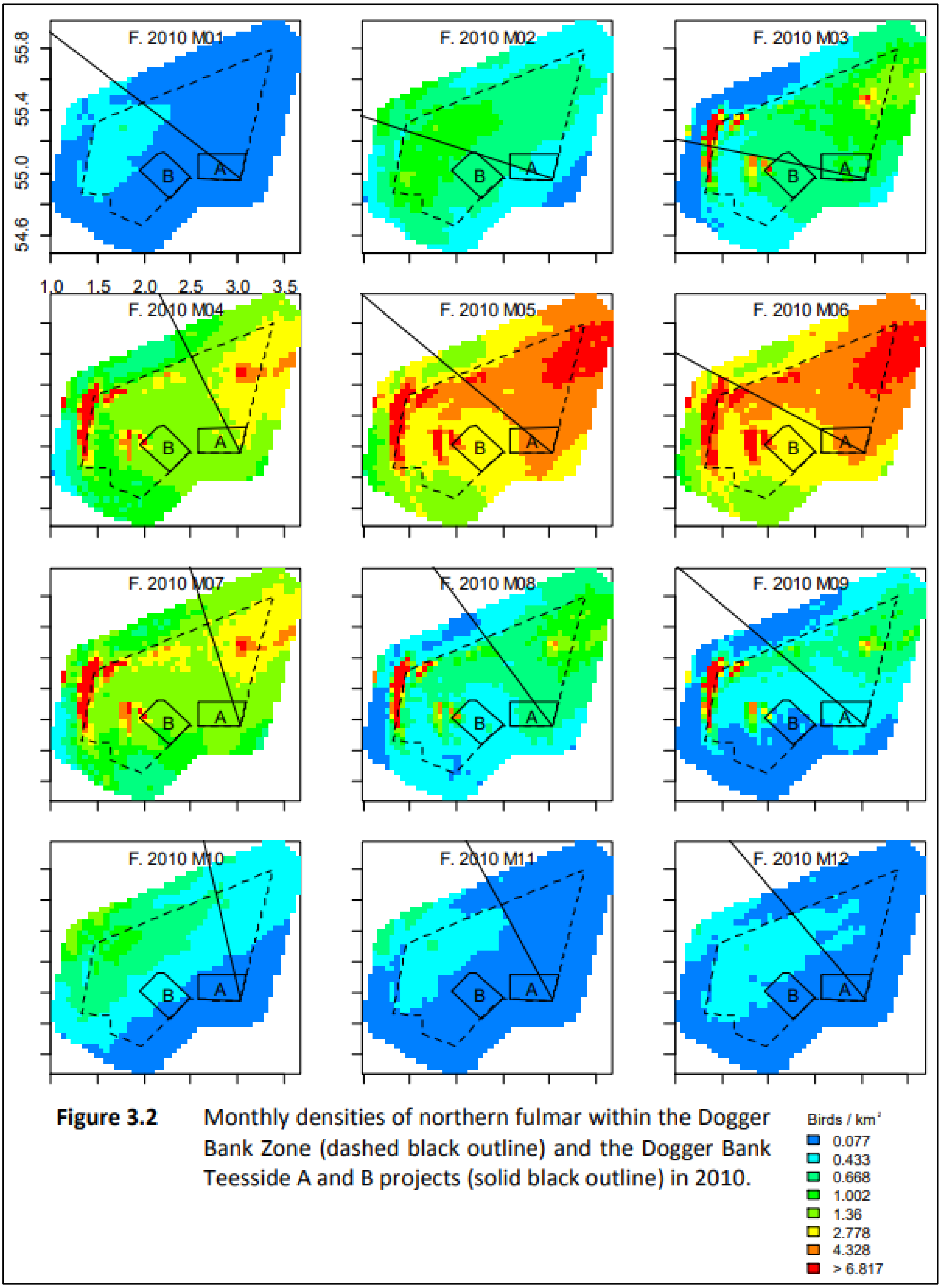

Figure 4-69 Monthly density heatmaps of fulmar recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in 2010 (taken from Burton et al. (2014))

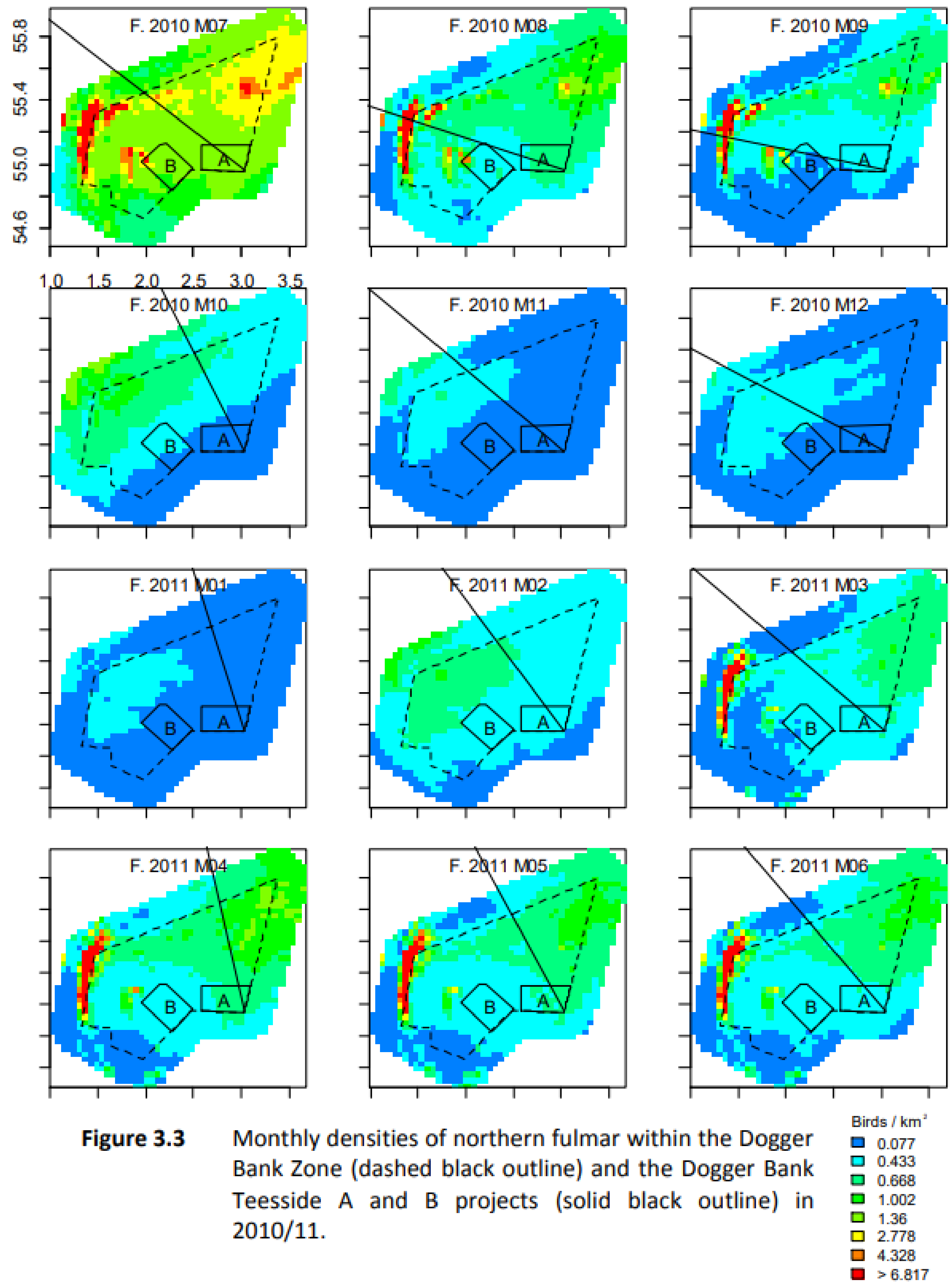

Figure 3.3 Monthly densities of northern fulmar within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010/11.

Figure 4-70 Monthly density heatmaps of fulmar recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2010 to June 2011 (taken from Burton et al. (2014))

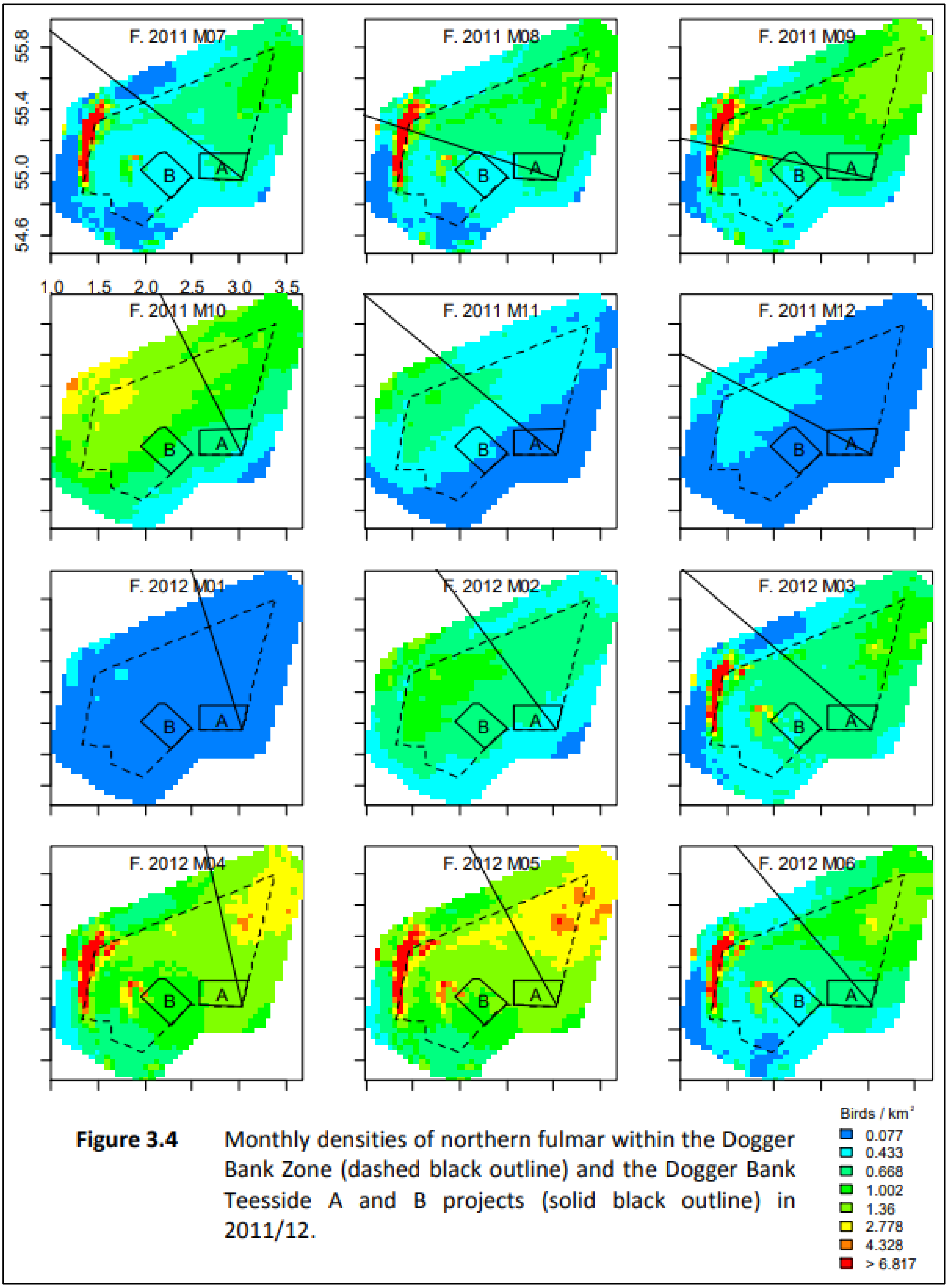

Figure 3.4 Monthly densities of northern fulmar within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2011/12.

Figure 4-71 Monthly density heatmaps of fulmar recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2011 to June 2012 (taken from Burton et al. (2014))

In DBS, between March 2021 and February 2023, fulmar were recorded in all months. Mean monthly abundance estimates for the Array Area peaked in January for DBS East (113 individuals) and in February for DBS West (188 individuals). The distribution of raw counts for fulmar in DBS is shown in **Figure 4-72**. Records of fulmars during autumn migration appeared to be distributed towards the southern and eastern edges of the 4km buffer.

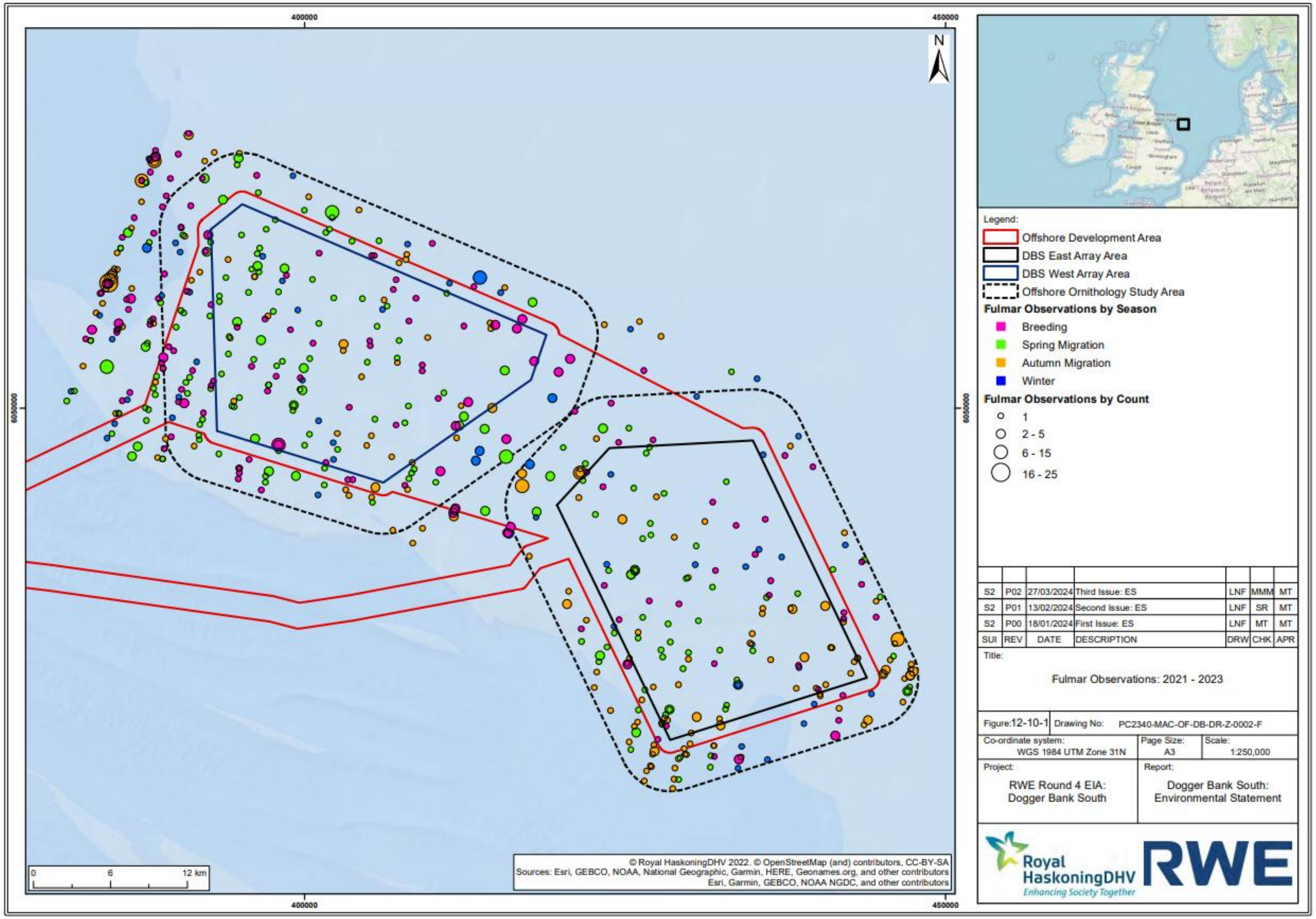

Figure 4-72 Raw counts of fulmar by bio-season during digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

Throughout the 2010-2012 surveys, fulmar density was highest in the west and north-east of the Dogger Bank Zone and abundance estimates were higher in DBA and DBB than in DBC and Sofia. Therefore, fulmar density would have been relatively low in DBD, except during the summer of 2010 when the density was high in DBC. Fulmar density was also low to the south of the Dogger Bank Zone during 2010-2012 and a lower abundance of fulmars was observed in the DBS Array Areas during 2021-2023 indicating that this trend may have continued.

Peak abundance and density estimates for all OWF Array Areas in the Dogger Bank Zone and DBS are shown in **Table 4–47**. The abundance and density values for DBS East and West are monthly mean peaks across the two-year survey period (RWE, 2023a; RWE, 2023c) whereas the values for all other OWFs are absolute peaks.

Table 4–47 Peak abundance and density estimates for fulmar for all OWF projects in the Dogger Bank Zone

Project	Peak abundance	Peak density (individuals/km^2)	Month
Dogger Bank A	315	0.61	May 2010
Dogger Bank B	660	1.10	May 2010
Dogger Bank C	569	1.02	May 2010
Sofia	540	0.91	May 2010
Dogger Bank South (East)	113	0.32	January 2022/23
Dogger Bank South (West)	188	0.53	February 2022/23
Dogger Bank D	278	1.06	May 2023

3.2.2 DBD Survey data (aerial survey data 2021-2023)

Fulmars were recorded in 21 of the 24 DAS within the DBD Array Area and all of the DASs when considering the Array Area plus 2km asymmetrical buffer (**Appendix 3**). Abundances were highest in August 2022 (105 individuals) for the first year of data for the Array Area and in September 2022 (126) for the Array Area plus 2km asymmetrical buffer. In Year 2, the highest abundance for the DBD Array Area and Array Area plus 2km asymmetrical buffer was in May 2023 (278 and 379 individuals, respectively) (**Table 4–48** & **Table 4–49**). Fulmar densities ranged from 0.02 to 1.06 individuals/km^2 in the DBD Array Area, and 0.01 to 1.02 individuals/km^2 in the Array Area plus 2km asymmetrical buffer, for all behaviours (**Appendix 3**). The average density for the Array Area was 0.17 individuals/km^2 and 0.15 individuals/km^2 for the Array Area plus 2km asymmetrical buffer.

Table 4–48 Fulmar raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area

DBD Array Area									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	1	5	0.02	1	5	0.02	0	0	0.00
Nov-21	4	20	0.08	3	15	0.06	1	5	0.02
Jan-22	4	20	0.08	4	20	0.08	0	0	0.00
Feb-22	4	20	0.08	2	10	0.04	2	10	0.04
Mar-22	6	30	0.11	2	10	0.04	4	20	0.08
Apr-22	12	60	0.23	10	50	0.19	2	10	0.04
Jun-22	4	20	0.08	1	5	0.02	3	15	0.06
Jul-22	9	45	0.17	3	15	0.06	6	30	0.11
Aug-22	21	105	0.40	5	25	0.10	16	80	0.30
Sep-22	13	66	0.25	2	10	0.04	11	56	0.21
Oct-22	6	30	0.11	3	15	0.06	3	15	0.06
Dec-22	4	20	0.08	3	15	0.06	1	5	0.02
Jan-23	4	20	0.08	3	15	0.06	1	5	0.02
Feb-23	6	30	0.11	3	15	0.06	3	15	0.06
Mar-23	3	15	0.06	2	10	0.04	1	5	0.02
Apr-23	5	26	0.10	2	10	0.04	3	15	0.06
May-23	55	278	1.06	21	106	0.40	34	172	0.66
Jun-23	11	56	0.21	6	30	0.11	5	25	0.10
Jul-23	6	30	0.11	4	20	0.08	2	10	0.04
Aug-23	9	45	0.17	5	25	0.10	4	20	0.08
Sep-23	2	10	0.04	0	0	0.00	2	10	0.04

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Migration-free breeding = purple, Post-breeding migration = orange, Migration-free winter = blue

Table 4–49 Fulmar raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer									
	All behaviours			Flying			Sitting		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	3	15	0.04	3	15	0.04	0	0	0.00
Nov-21	4	20	0.05	3	15	0.04	1	5	0.01
Dec-21	1	5	0.01	0	0	0.00	1	5	0.01
Jan-22	9	45	0.12	9	45	0.12	0	0	0.00
Feb-22	7	35	0.09	5	25	0.07	2	10	0.02
Mar-22	8	40	0.11	2	10	0.03	6	30	0.08
Apr-22	15	74	0.20	12	60	0.16	3	15	0.04
May-22	1	5	0.01	1	5	0.01	0	0	0.00
Jun-22	5	26	0.07	2	10	0.03	3	16	0.04
Jul-22	10	50	0.14	3	15	0.04	7	35	0.09
Aug-22	21	104	0.28	5	25	0.07	16	79	0.21
Sep-22	25	126	0.34	3	15	0.04	22	111	0.30
Oct-22	12	59	0.16	5	25	0.07	7	34	0.09
Nov-22	1	5	0.01	1	5	0.01	0	0	0.00
Dec-22	6	30	0.08	4	20	0.05	2	10	0.03
Jan-23	12	60	0.16	9	45	0.12	3	15	0.04
Feb-23	13	65	0.18	9	45	0.12	4	20	0.05
Mar-23	3	15	0.04	2	10	0.03	1	5	0.01
Apr-23	6	30	0.08	2	10	0.03	4	20	0.05
May-23	76	379	1.02	27	135	0.36	49	245	0.66
Jun-23	13	65	0.18	6	30	0.08	7	35	0.09
Jul-23	7	35	0.09	4	20	0.05	3	15	0.04
Aug-23	13	65	0.18	8	40	0.11	5	25	0.07
Sep-23	3	15	0.04	1	5	0.01	2	10	0.03

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Migration-free breeding = purple, Post-breeding migration = orange, Migration-free winter = blue

Within the DBD Scoping Report bio-seasons for use were identified for each species. For fulmar, two different bio-seasons were outlined, using migration-free breeding or the alternative full breeding season. Within the baseline report, and in order to provide the greatest breakdown of bio-seasons, the migration-free breeding season has been presented. Although, it must be noted that in further impact assessments, the Natural England recommended bio-seasons using the full breeding season have been incorporated. On review of the data collected for DBD, the Applicant deems the use of the full breeding bio-season description to be most appropriate. Further discussion following PEIR submission is welcome with SNCBs to confirm appropriate seasons for usage in impact assessments going forward.

In Year 1 of surveys, fulmar abundance is highest at the start of the post-breeding migration bio-season (**Figure 4-73**) whereas in Year 2, there is a clear peak in fulmar abundance during the migration-free breeding bio-season. Overall, abundances in Year 1 were less than Year 2.

3.2.3 Age ratios

For all records of fulmar the age class was allocated as 'unknown', due to there being no readily identifiable features between different age classes within the available survey data.

3.2.4 Biological Season Mean Peak Estimates

Fulmars were present in greatest abundance in the DBD Array Area plus 2km asymmetrical buffer during the migration-free breeding bio-season with an estimated mean peak abundance of 242 individuals and a mean peak density of 0.57 individuals/km^2 (**Table 4–50**, **Table 4–51** & **Figure 4-73**). Within the first year of surveys, fulmar abundance stayed relatively constant with an increase from the start of the migration-free breeding bio-season towards a peak in the post-breeding migration bio-season. The second year of surveys showed a slightly different pattern of fulmar abundance, with a spike in abundance recorded in May, in the first half of the migration-free breeding bio-season. Other bio-seasons were in similar abundances to Year 1, remaining relatively consistent.

Within the DBD Scoping Report bio-seasons for use were identified for each species. For fulmar, two different bio-seasons were outlined, using migration-free breeding or the alternative full breeding season. Within the baseline report, and in order to provide the greatest breakdown of bio-seasons, the migration-free breeding season has been presented. Although, it must be noted that in further impact assessments, the Natural England recommended bio-seasons using the full breeding season have been incorporated. On review of the data collected for DBD, the Applicant deems the use of the migration-free breeding bio-season description to be most appropriate. Further discussion following PEIR submission is welcome with SNCBs to confirm appropriate seasons for usage in impact assessments going forward.

Table 4–50 Fulmar bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area

DBD Array Area						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return migration (December – March)	30	0.11	18	0.07	18	0.07
Migration-free breeding (April – August)	192	0.73	78	0.30	126	0.48
Post-breeding migration (September – October)	38	0.14	10	0.04	33	0.13
Migration-free winter (November)	10	0.04	8	0.03	3	0.01

Table 4–51 Fulmar bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer						
Bio-season	All behaviours		Flying		Sitting	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return migration (December – March)	55	0.13	45	0.11	25	0.06
Migration-free breeding (April – August)	242	0.57	98	0.23	162	0.38
Post-breeding migration (September – October)	71	0.17	20	0.05	61	0.14
Migration-free winter (November)	13	0.03	10	0.02	3	0.01

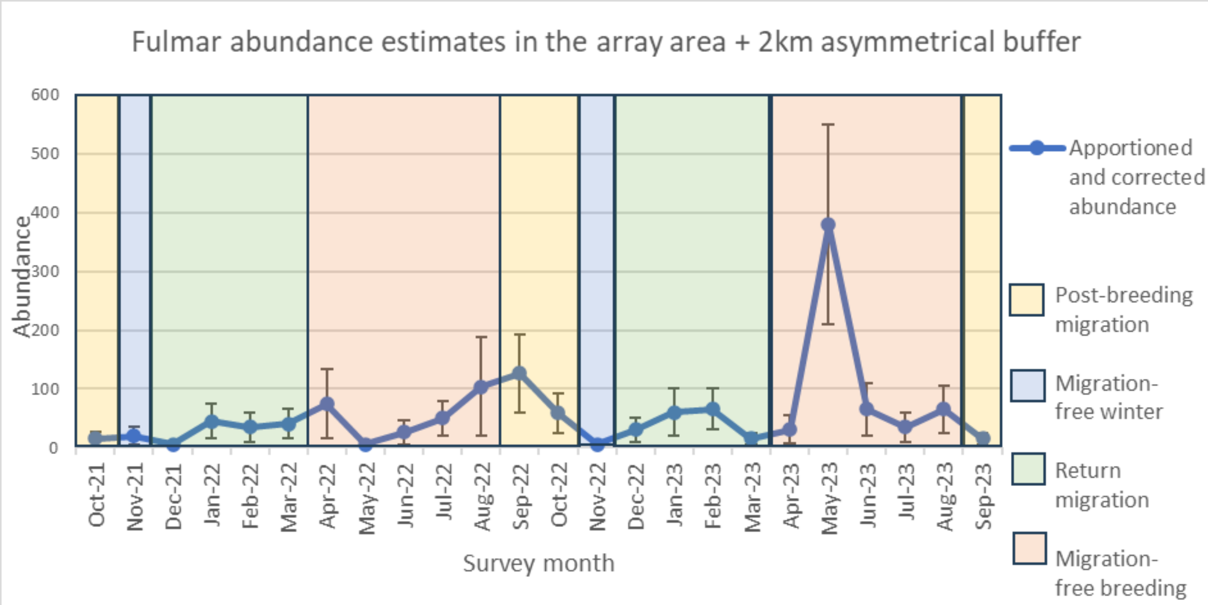

Figure 4-73 Fulmar abundance estimates for the 24 month survey period within the Array Area plus 2km buffer (migration-free breeding, post-breeding migration, migration-free winter and return migration bio-seasons)

3.2.5 Spatial Density Distribution and Flight Direction

Fulmar density distributions are spread throughout the Array Area and Array Area plus 2km asymmetrical buffer during the migration-free breeding, post-breeding migration and return-migration bio-seasons (**Figure 4-74**). There is a defined hotspot of fulmars during the migration-free breeding bio-season, with higher densities observed in the centre of the Array Area. The density of fulmar in the migration-free winter bio-season is much lower than the other seasons, with sporadic observations throughout the Array Area and associated buffers.

Monthly flight directions from across the DBD survey area during the migration-free breeding bio-season had no particular flight direction, likely due to the widespread usage of the North Sea for foraging activities of both breeding and non-breeding birds. During non-breeding periods there was no clear pattern of direction for fulmar over the DBD Array Area; this reflects the widespread usage of the offshore environment by this species in these bio-seasons (**Appendix 4**).

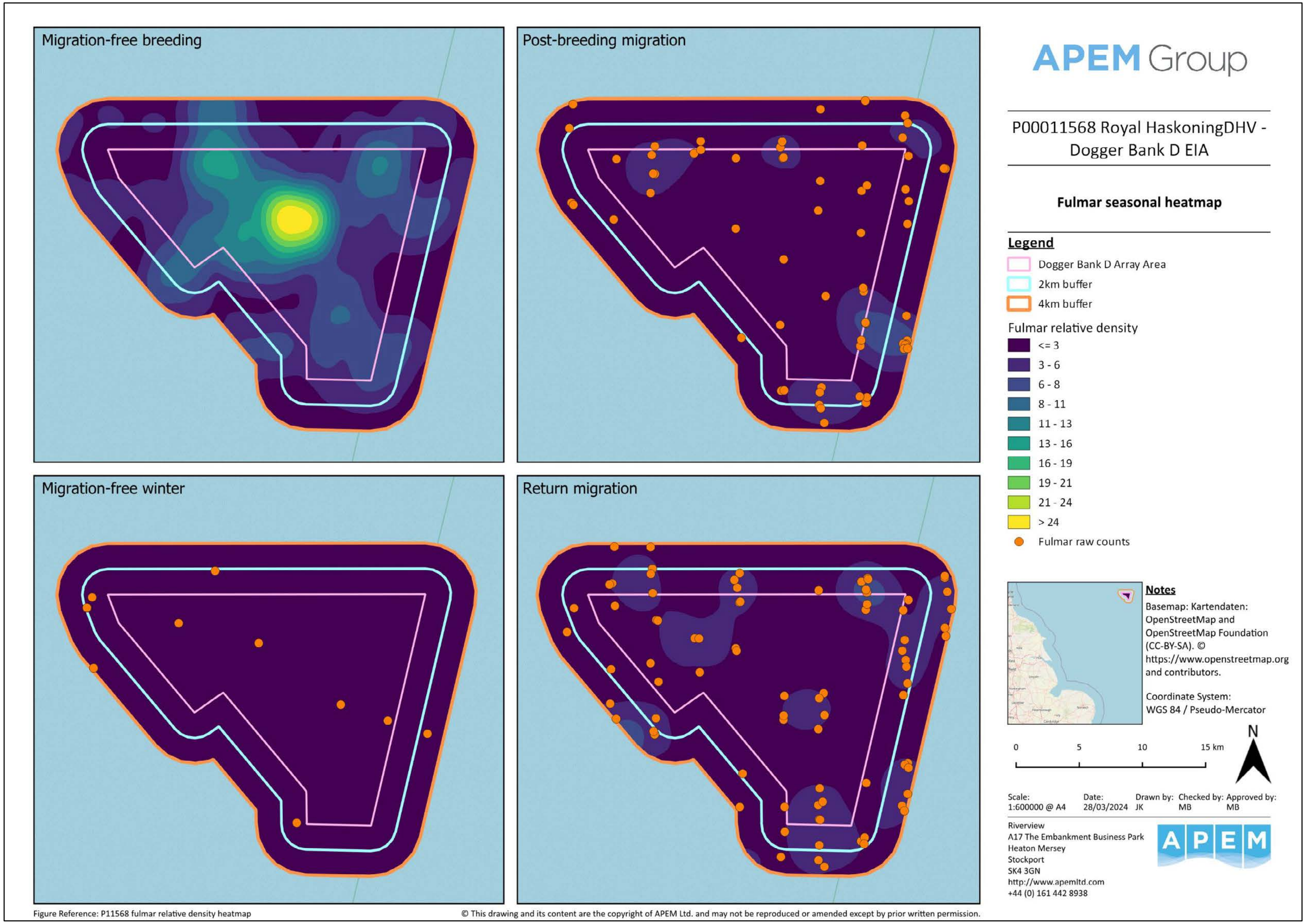

Figure 4-74 Heatmaps of fulmar distribution in each bio-season

3.3 Gannet

3.3.1 Historical data from the Dogger Bank Zone and Dogger Bank South

During the surveys of DBA, DBB, DBC and Sofia between 2010 and 2012, the abundance of gannets within the Dogger Bank Zone exceeded the 1% threshold for populations of national importance during the 2011 and 2012 breeding seasons.

In DBA, monthly abundance estimates showed similarities between 2010 and 2011. Gannet abundance peaked in October in both years, at 247 and 1,050 individuals, respectively. There was an additional peak in March 2011 of 666 individuals. The lowest monthly abundance estimates in each year were eight individuals in April 2010 and 73 individuals in December 2011.

Monthly abundance in DBB followed a similar pattern, with peaks of 321 individuals in October 2010 and 1,362 individuals in October 2011, and lows of 10 individuals in April 2010 and 94 individuals in December 2011. The density of gannets was generally highest in the western and south-western areas of the Dogger Bank Zone (**Figure 4-75** & **Figure 4-76**).

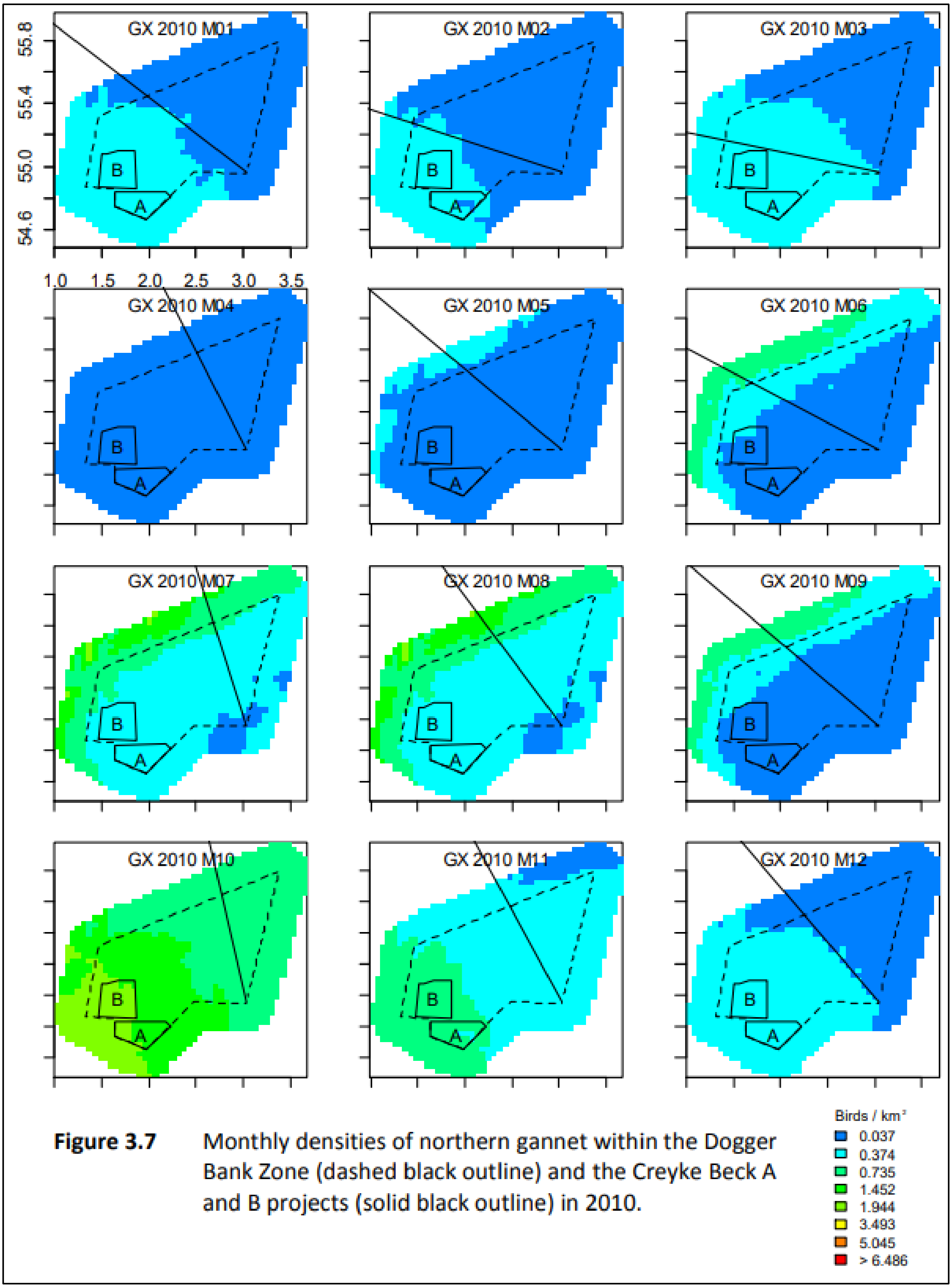

Figure 4-75 Monthly density heatmaps of gannet recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2010 (taken from Burton et al. (2013))

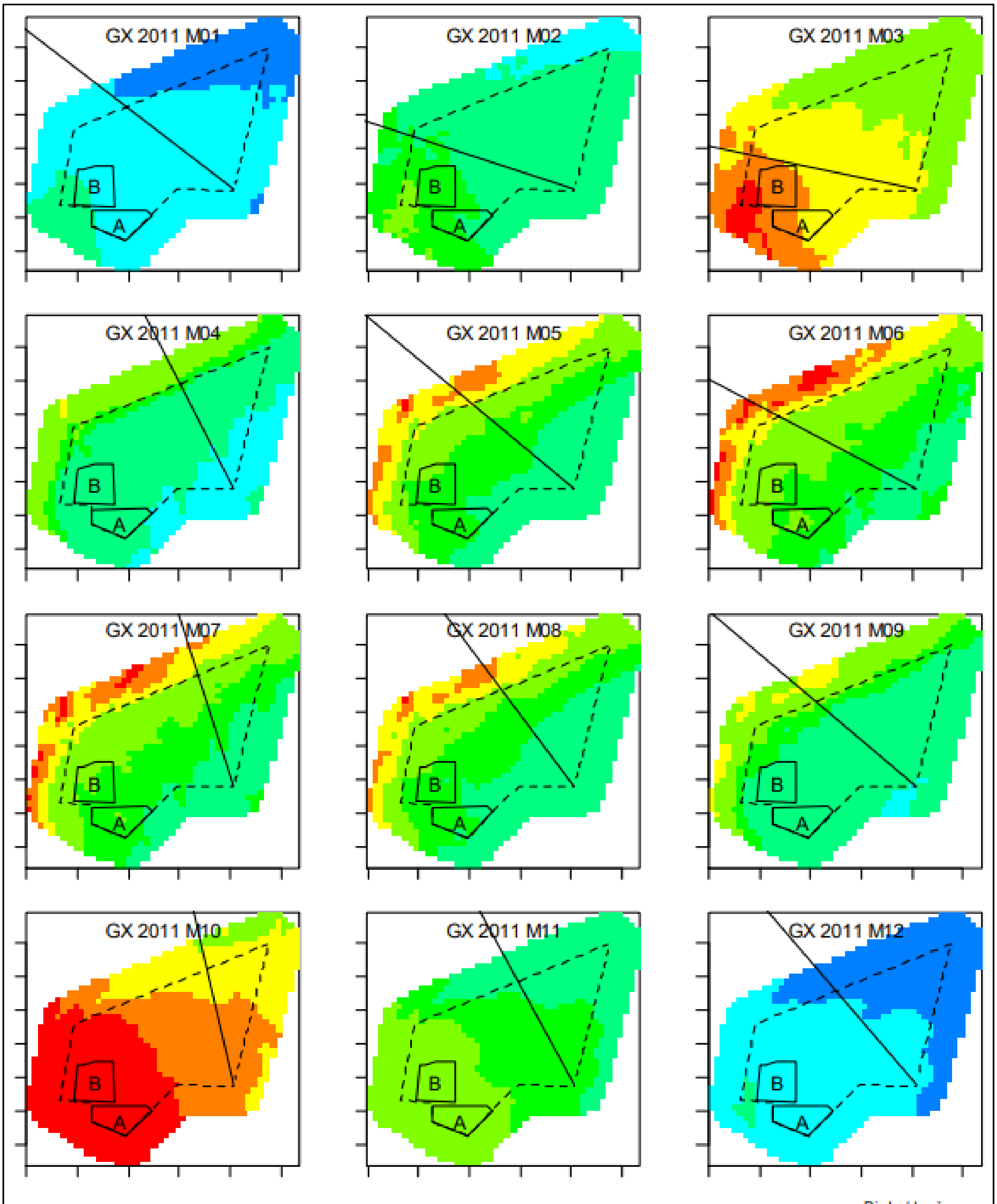

Figure 3.8 Monthly densities of northern gannet within the Dogger Bank Zone (dashed black outline) and the Creyke Beck A and B projects (solid black outline) in 2011.

Figure 4-76 Monthly density heatmaps of gannet recorded in the Dogger Bank Zone during surveys for DBA (Creyke Beck A) and DBB (Creyke Beck B) in 2011 (taken from Burton et al. (2013))

In the DBC Array Area, monthly baseline population estimates for gannet peaked in October 2010 (569 individuals), March 2011 (820 individuals) and March 2012 (1,244 individuals). Abundance estimates for the Sofia Array Area peaked during the same months, at 155, 984 and 1,811 individuals, respectively. Gannet density was generally highest on the northern and western borders of the Dogger Bank Zone, however in March 2011 and March 2012, density was highest in the south and south-west (**Figure 4-77**, **Figure 4-78** & **Figure 4-79**).

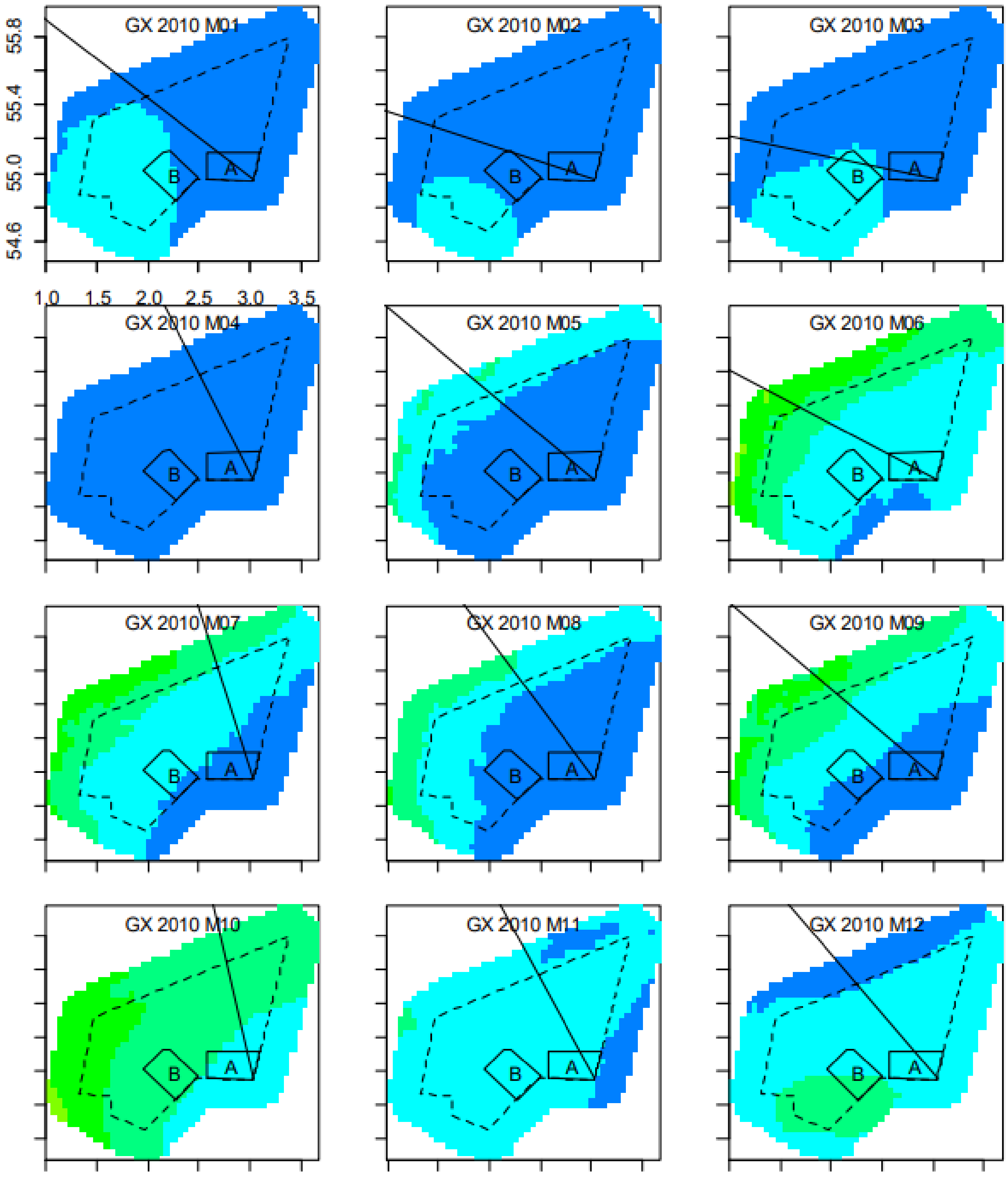

Figure 3.8 Monthly densities of northern gannet within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010.

Figure 4-77 Monthly density heatmaps of gannet recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in 2010 (taken from Burton et al. (2014))

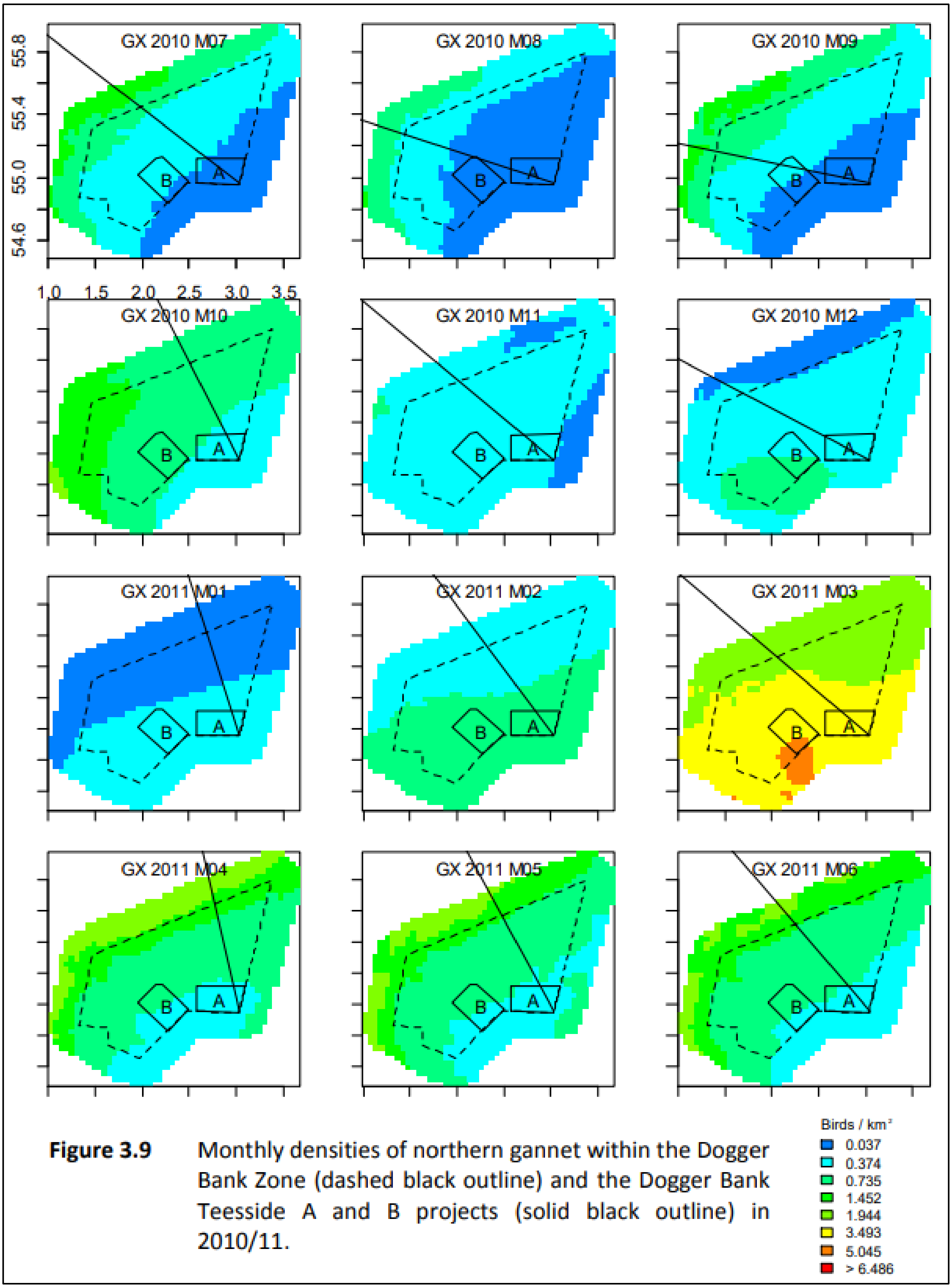

Figure 3.9 Monthly densities of northern gannet within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010/11.

Figure 4-78 Monthly density heatmaps of gannet recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2010 to June 2011 (taken from Burton et al. (2014))

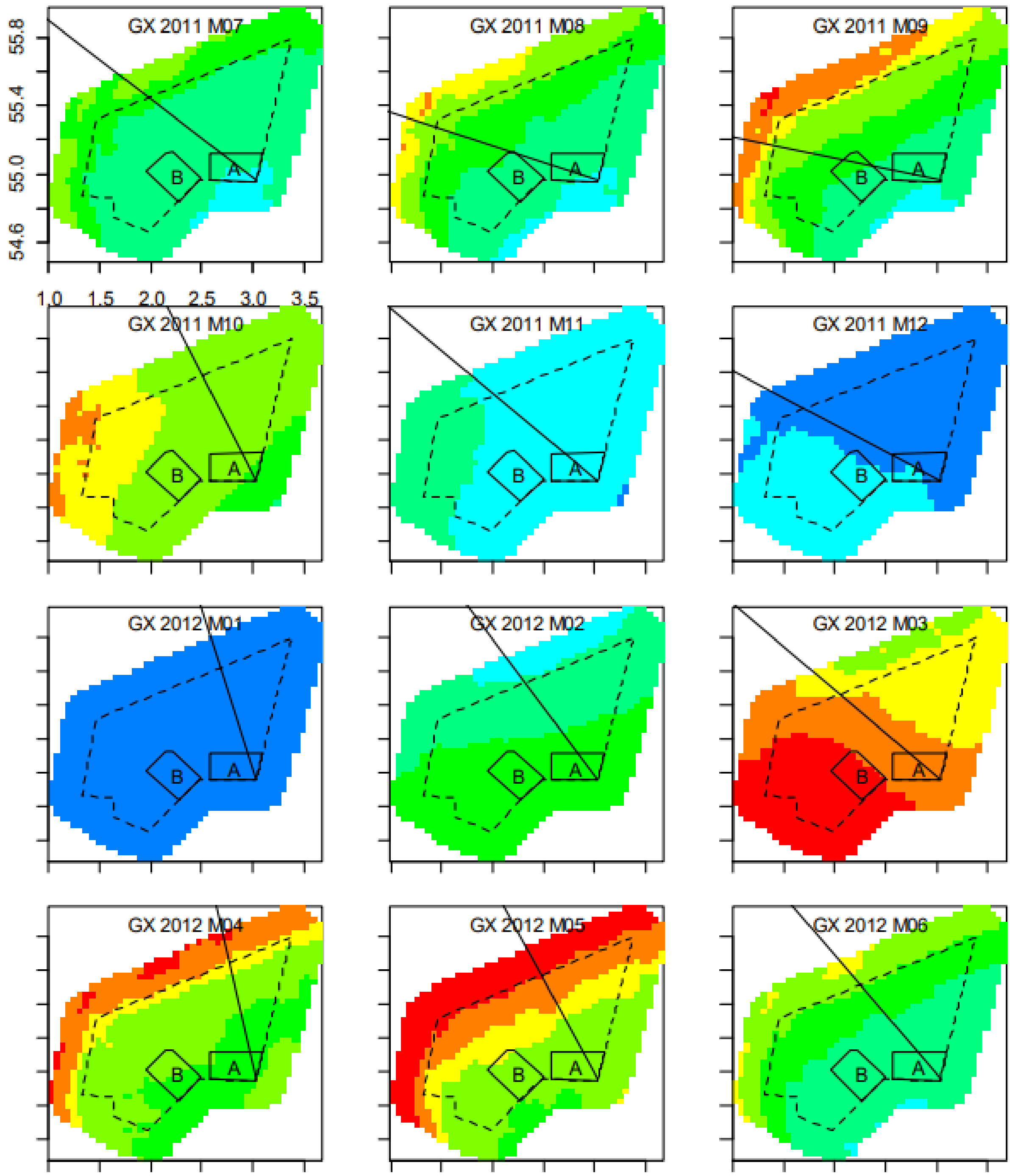

Figure 3.10 Monthly densities of northern gannet within the Dogger Bank Zone (dashed black outline) and the Dogger Bank Teesside A and B projects (solid black outline) in 2010/12.

Figure 4-79 Monthly density heatmaps of gannet recorded in the Dogger Bank Zone during surveys for DBC (Teesside A) and Sofia (Teesside B) in July 2011 to June 2012 (taken from Burton et al. (2014))

In DBS, between March 2021 and February 2023, mean monthly abundance estimates for the Array Area peaked in March for DBS East (598 individuals) and in October for DBS West (617 individuals). The distributions of raw counts for gannet in DBS are shown in **Figure 4-80**, **Figure 4-81** and **Figure 4-82**. Records of gannets during spring migration appeared to be clustered towards the eastern side of DBS.

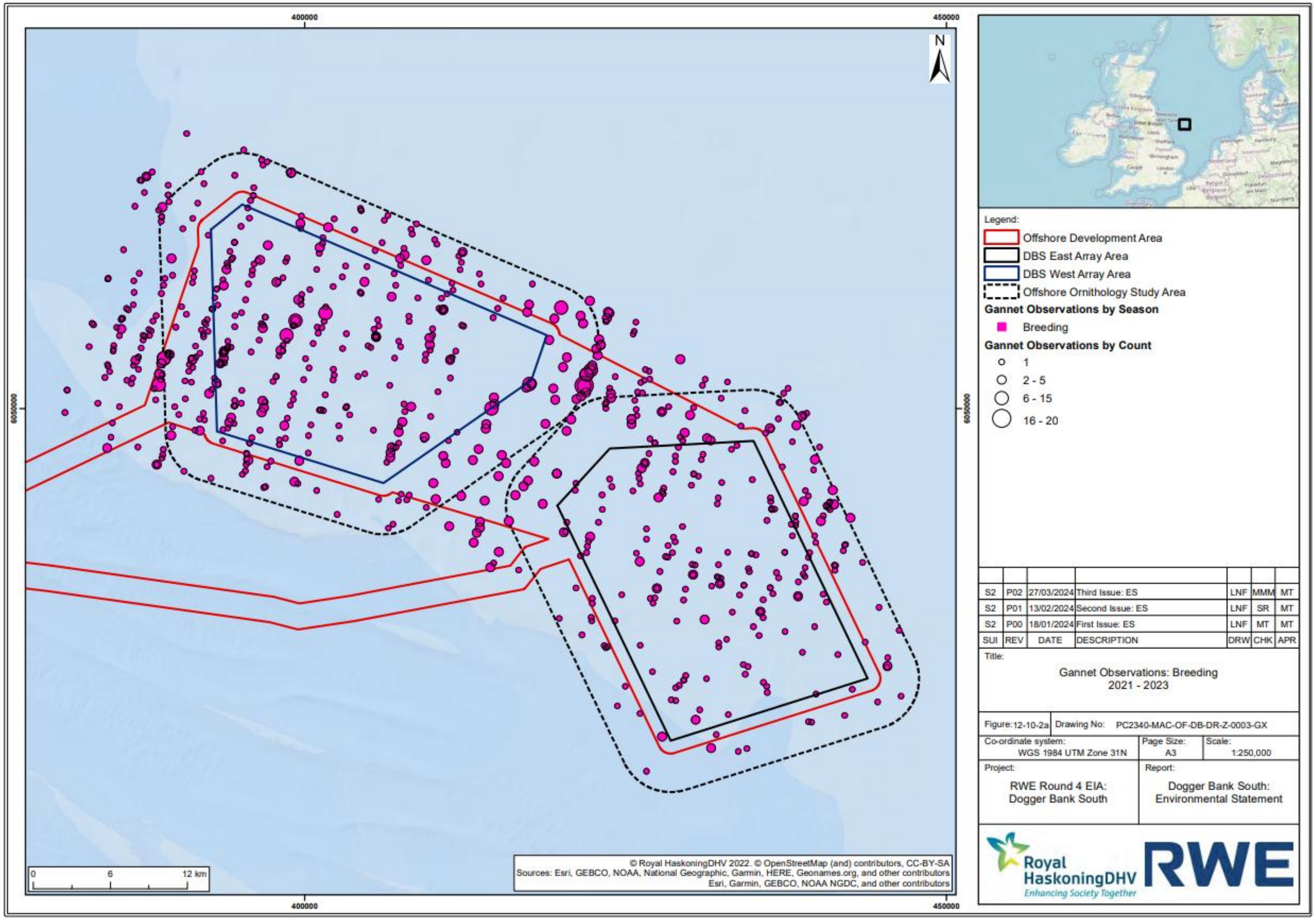

Figure 4-80 Raw counts of gannet during the breeding bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

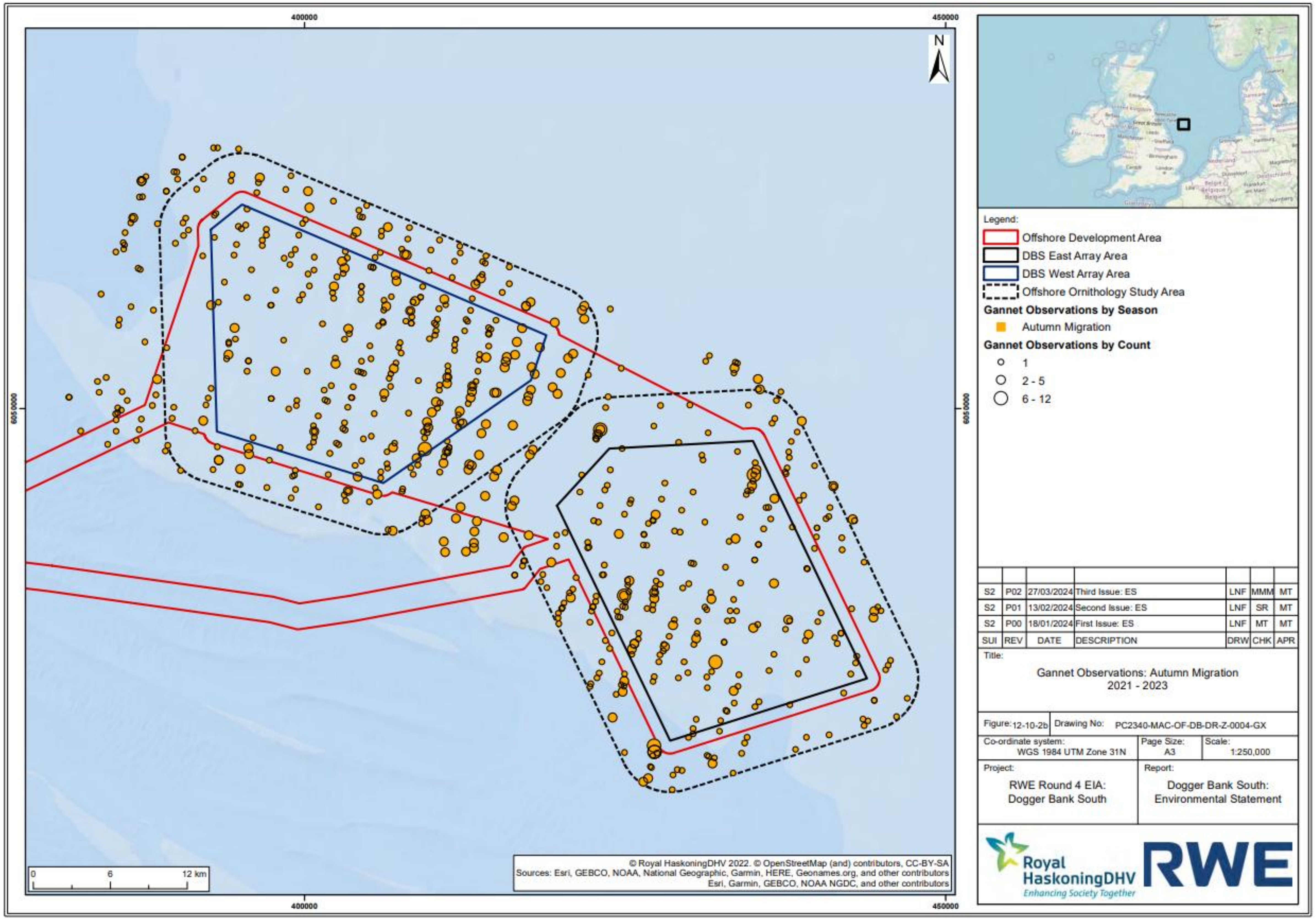

Figure 4-81 Raw counts of gannet during the post-breeding migration bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

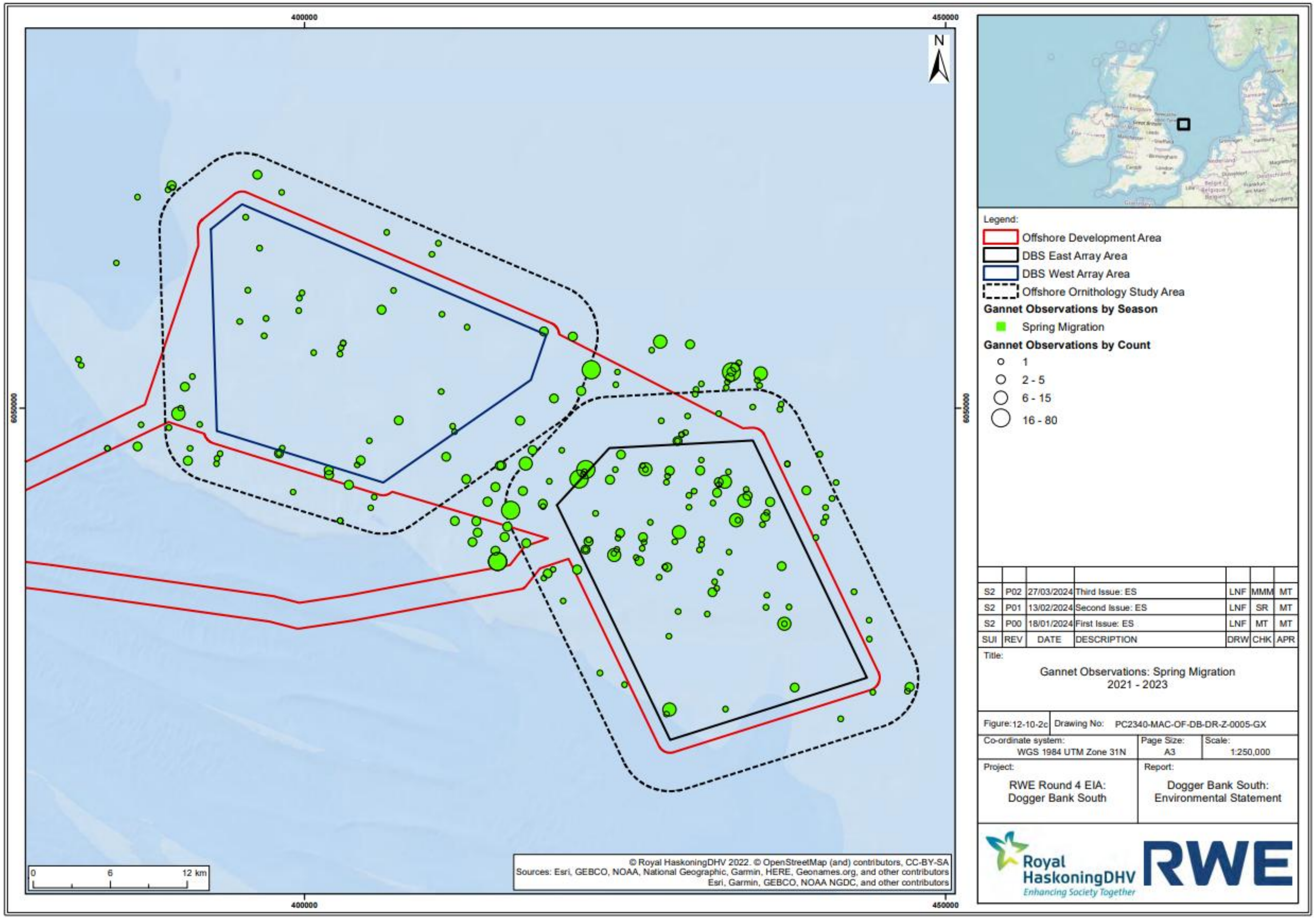

Figure 4-82 Raw counts of gannet during the return migration bio-season from digital aerial surveys of DBS between March 2021 and February 2023 (taken from RWE (2023b))

Throughout the 2010-2012 surveys, gannets were mainly distributed in the west and north of the Dogger Bank Zone. The differences in peak abundance estimates between the different Array Areas were small, however the density heatmaps show that gannet density would have been relatively low in DBD throughout the survey period, apart from March 2012 when density was high in DBC. Gannet density was also lower to the south of the Dogger Bank Zone during 2010-2012 and a lower abundance of gannets was observed in the DBS Array Areas during 2021-2023 indicating that this trend may have continued.

Peak abundance and density estimates for all OWF Array Areas in the Dogger Bank Zone and DBS are shown in **Table 4–52**. The abundance and density values for DBS East and West are monthly mean peaks across the two-year survey period (RWE, 2023a; RWE, 2023c) whereas the values for all other OWFs are absolute peaks.

Table 4–52 Peak abundance and density estimates for gannet for all OWF projects in the Dogger Bank Zone

Project	Peak abundance	Peak density (individuals/km^2)	Month
Dogger Bank A	1,050	2.04	October 2011
Dogger Bank B	1,362	2.27	October 2011
Dogger Bank C	1,244	2.22	March 2012
Sofia	1,811	3.05	March 2012
Dogger Bank South (East)	598	1.71	March 2021/22
Dogger Bank South (West)	617	1.74	October 2021/22
Dogger Bank D	932	3.55	October 2021

3.3.2 DBD Survey data (aerial survey data 2021-2023)

Gannets were recorded in all of the 24 DAS within the DBD Array Area and the Array Area plus 2km asymmetrical buffer (**Appendix 3**). Abundances were highest in October 2021 for the first year of data, for the Array Area (932 individuals) and Array Area plus 2km asymmetrical buffer (1,277 individuals). In Year 2, the highest abundance for the DBD Array Area and Array Area plus 2km asymmetrical buffer was in October 2022 (267 and 348 individuals, respectively) (**Table 4–53** & **Table 4–54**). Gannet densities ranged from 0.02 to 3.55 in the DBD Array Area, and 0.01 to 3.45 individuals/km^2 in the Array Area plus 2km asymmetrical buffer, for all behaviours (**Appendix 2**). The average density for the Array Area was 0.41 individuals/km^2 and 0.40 individuals/km^2 for the Array Area plus 2km asymmetrical buffer.

In Year 1 of surveys, gannet abundance is highest during the post-breeding migration bio-season (**Figure 4-83**). In Year 2, gannet abundance is highest during the post-breeding migration bio-season and at the start of the migration-free breeding bio-season. Overall, abundances in Year 2 were less than Year 1.

Table 4–53 Gannet raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area

	DBD Array Area											
	All behaviours			Flying			Sitting			Diving		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	181	932	3.55	57	293	1.12	122	628	2.39	2	10	0.04
Nov-21	39	196	0.75	21	106	0.40	18	91	0.35	0	0	0.00
Dec-21	1	5	0.02	0	0	0.00	1	5	0.02	0	0	0.00
Jan-22	20	101	0.38	10	50	0.19	10	50	0.19	0	0	0.00
Feb-22	3	15	0.06	3	15	0.06	0	0	0.00	0	0	0.00
Mar-22	16	81	0.31	0	0	0.00	16	81	0.31	0	0	0.00
Apr-22	9	45	0.17	2	10	0.04	7	35	0.13	0	0	0.00
May-22	1	5	0.02	1	5	0.02	0	0	0.00	0	0	0.00
Jun-22	2	10	0.04	1	5	0.02	1	5	0.02	0	0	0.00
Jul-22	5	25	0.1	2	10	0.04	3	15	0.06	0	0	0.00
Aug-22	2	10	0.04	0	0	0.00	2	10	0.04	0	0	0.00
Sep-22	18	92	0.35	1	5	0.02	17	87	0.33	0	0	0.00
Oct-22	53	267	1.02	15	76	0.29	38	191	0.73	0	0	0.00
Nov-22	31	170	0.65	16	88	0.34	15	82	0.31	0	0	0.00
Dec-22	1	5	0.02	1	5	0.02	0	0	0.00	0	0	0.00
Jan-23	4	20	0.08	4	20	0.08	0	0	0.00	0	0	0.00
Feb-23	2	10	0.04	1	5	0.02	1	5	0.02	0	0	0.00

DBD Array Area												
Survey	All behaviours			Flying			Sitting			Diving		
	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Mar-23	5	25	0.1	3	15	0.06	2	10	0.04	0	0	0.00
Apr-23	51	260	0.99	13	66	0.25	38	193	0.74	0	0	0.00
May-23	13	66	0.25	5	25	0.10	8	40	0.15	0	0	0.00
Jun-23	5	25	0.1	2	10	0.04	3	15	0.06	0	0	0.00
Jul-23	1	5	0.02	1	5	0.02	0	0	0.00	0	0	0.00
Aug-23	23	116	0.44	10	50	0.19	13	66	0.25	0	0	0.00
Sep-23	19	96	0.37	5	25	0.10	14	71	0.27	0	0	0.00

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Migration-free breeding = purple, Post-breeding migration = orange

Table 4–54 Gannet raw counts, total estimated abundance and total estimated density (individuals per km²) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer												
	All behaviours			Flying			Sitting			Diving		
Survey	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Oct-21	251	1,277	3.45	96	488	1.32	153	778	2.10	2	10	0.03
Nov-21	64	318	0.86	42	209	0.56	22	109	0.29	0	0	0.00
Dec-21	1	5	0.01	0	0	0.00	1	5	0.01	0	0	0.00
Jan-22	26	130	0.35	16	80	0.22	10	50	0.14	0	0	0.00
Feb-22	7	35	0.09	3	15	0.04	4	20	0.05	0	0	0.00
Mar-22	19	95	0.26	0	0	0.00	19	95	0.26	0	0	0.00
Apr-22	30	149	0.4	6	30	0.08	24	119	0.32	0	0	0.00
May-22	1	5	0.01	1	5	0.01	0	0	0.00	0	0	0.00
Jun-22	3	16	0.04	1	5	0.01	2	10	0.03	0	0	0.00
Jul-22	5	25	0.07	2	10	0.03	3	15	0.04	0	0	0.00
Aug-22	4	20	0.05	0	0	0.00	4	20	0.05	0	0	0.00
Sep-22	32	161	0.43	3	15	0.04	29	146	0.39	0	0	0.00
Oct-22	70	348	0.94	19	95	0.26	51	254	0.69	0	0	0.00
Nov-22	41	222	0.6	25	135	0.36	16	87	0.24	0	0	0.00
Dec-22	8	40	0.11	8	40	0.11	0	0	0.00	0	0	0.00
Jan-23	8	40	0.11	5	25	0.07	3	15	0.04	0	0	0.00

DBD Array Area plus 2km asymmetrical buffer												
Survey	All behaviours			Flying			Sitting			Diving		
	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density	Raw Count	Abundance	Density
Feb-23	5	25	0.07	1	5	0.01	4	20	0.05	0	0	0.00
Mar-23	10	50	0.14	7	35	0.09	3	15	0.04	0	0	0.00
Apr-23	54	272	0.73	14	71	0.19	40	202	0.55	0	0	0.00
May-23	18	90	0.24	6	30	0.08	12	60	0.16	0	0	0.00
Jun-23	5	25	0.07	2	10	0.03	3	15	0.04	0	0	0.00
Jul-23	3	15	0.04	3	15	0.04	0	0	0.00	0	0	0.00
Aug-23	33	165	0.45	15	75	0.20	18	90	0.24	0	0	0.00
Sep-23	21	105	0.28	6	30	0.08	15	75	0.20	0	0	0.00

*Table note: Bio-seasons are colour coded as follows – Return migration = green, Migration-free breeding = purple, Post-breeding migration = orange

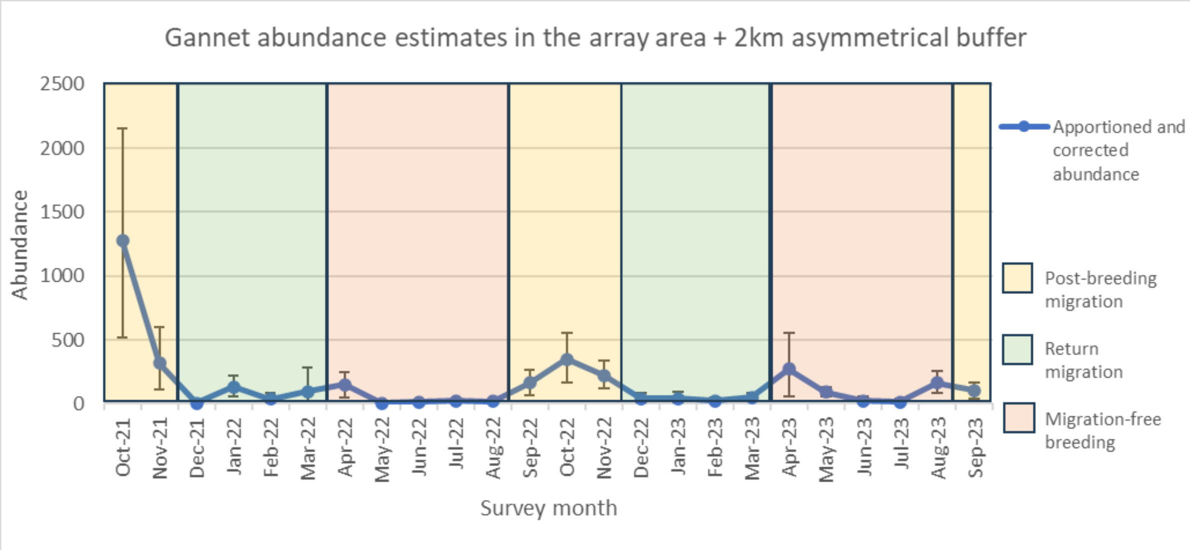

Figure 4-83 Gannet abundance estimates for the 24-month survey period within the Array Area plus 2km buffer (migration-free breeding, return migration and post-breeding migration bio-seasons)

Within the DBD Scoping Report bio-seasons for use were identified for each species. For gannet, two different bio-seasons were outlined, using migration-free breeding or the alternative full breeding season. Within the baseline report, and in order to provide the greatest breakdown of bio-seasons, the migration-free breeding season has been presented. Although, it must be noted that in further impact assessments, the Natural England recommended bio-seasons using the full breeding season have been incorporated. On review of the data collected for DBD, the Applicant deems the use of the full breeding bio-season description to be most appropriate. Further discussion following PEIR submission is welcome with SNCBs to confirm appropriate seasons for usage in impact assessments going forward.

3.3.3 Age ratios

Gannet age classes were determined upon initial identification from the DAS imagery for the entire survey area (Array Area plus 4km buffer). The initial age class assessment categorised individuals into ‘adult’ plumage (over 4th year), ‘juvenile’ plumage (first year), and second through to fourth calendar year plumage. For each of the three bio-seasons the percentage of gannets within the unknown age category was between 16% and 29%. Out of the gannets that did have a positive age identification, the majority were adults that were observed within the survey area (68%-77%) with few individuals categorised as second year (1%-2%), third year (1%-3%), fourth year (1%-2%) and juvenile (first year) birds (two birds) (**Table 4–55**).

The ‘unknown’ age category has been apportioned using the proportion of age categories derived from the DAS data in order to provide a final apportioned age class for the gannets within the survey area (**Table 4–56**). Considering the apportioned age classes for gannet, the majority are adult birds (92%-99%) with the remainder being split between second year (2%-3%), third year (1%-3%), and fourth year birds (1%-2%). Raw counts for each age class are provided in **Appendix 5**

Table 4–55 Gannet age class proportions from raw counts

Bio-season	Age class proportions (%)					
	Adult	Fourth calendar year	Third calendar year	Second calendar year	Juvenile	Unknown
Return migration	72	1	0	0	0	27
Migration-free breeding	77	2	3	2	0	16
Post-breeding migration	68	0	1	1	0	29

Table 4–56 Gannet age class proportions with apportionment of 'unknown' age class using DAS data

Bio-season	Age class proportions (%)				
	Adult	Fourth calendar year	Third calendar year	Second calendar year	Juvenile
Return migration	98	1	0	0	0
Migration-free breeding	93	2	3	3	0
Post-breeding migration	96	1	1	2	0

3.3.4 Biological Season Mean Peak Estimates

Gannets were present in greatest abundance in the DBD Array Area plus 2km asymmetrical buffer during the post-breeding migration bio-season with an estimated mean peak abundance of 813 individuals and a mean peak density of 1.91 individuals/km^2 (**Table 4–57**, **Table 4–58** & **Figure 4-83**). In both survey years gannet abundances were highest in the post-breeding migration bio-season. During the first year of surveys gannet numbers dropped from a peak abundance in the post-breeding migration bio-season to lower abundances that remained relatively consistent throughout the return migration and migration-free breeding bio-season. During the second year of surveys gannet abundance started to increase at the beginning of the post-breeding migration bio-season and then reducing towards the end of this bio-season, with low numbers throughout the return migration. A slightly higher peak in abundance was recorded at the beginning of the migration-free breeding bio-season in the second year than in the first year of surveys, with numbers then remaining low for the remainder of this bio-season.

Within the DBD Scoping Report bio-seasons for use were identified for each species. For gannet, two different bio-seasons were outlined, using migration-free breeding or the alternative full breeding season. Within the baseline report, and in order to provide the greatest breakdown of bio-seasons, the migration-free breeding season has been presented. Although, it must be noted that in further impact assessments, the Natural England recommended bio-seasons using the full breeding season have been incorporated. On review of the data collected for DBD, the Applicant deems the use of the migration-free breeding bio-season description to be most appropriate. Further discussion following PEIR submission is welcome with SNCBs to confirm appropriate seasons for usage in impact assessments going forward.

Table 4–57 Gannet bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area

DBD Array Area								
Bio-season	All behaviours		Flying		Sitting		Diving	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return Migration (December – March)	63	0.24	35	0.13	35	0.17	0	0.00
Migration-free Breeding (April – August)	153	0.58	38	0.14	38	0.43	0	0.00
Post-breeding Migration (September – November)	600	2.28	191	0.73	410	1.56	5	0.02

Table 4–58 Gannet bio-season mean peak abundance and density (individuals per km^2) in DBD Array Area plus 2km asymmetrical buffer

DBD Array Area plus 2km asymmetrical buffer								
Bio-season	All behaviours		Flying		Sitting		Diving	
	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density	Bio-season mean peak abundance	Bio-season mean peak density
Return Migration (December – March)	90	0.21	60	0.14	58	0.13	0	0.00
Migration-free Breeding (April – August)	211	0.49	53	0.12	161	0.38	0	0.00
Post-breeding Migration (September – November)	813	1.91	312	0.73	516	1.21	5	0.02

3.3.5 Spatial Density Distribution and Flight Direction

There are clear differences in the density distributions of gannet for the three bio-seasons (**Figure 4-84**). The return migration bio-season has the lowest densities with birds primarily observed along the western edge of the Array Area and associated buffers. Gannet distribution during the migration-free breeding bio-season indicates a hotspot in the south-west corner of the Array Area plus 2km asymmetrical buffer, with other observations spread throughout the Array Area. The post-breeding migration bio-season has the highest densities, with high numbers of observations in the northwest of the Array Area and associated buffers.

Monthly flight directions from across the DBD survey area during the migration-free breeding bio-season showed no clear orientation, which would be expected for birds using the area to forage. Although there are limitations with flight orientation data, no clear direction could also suggest connectivity to a single breeding colony is limited. It is therefore possible that birds observed were non-breeders of a mix of individuals from different colonies. This assumption aligns with known tracking data from Bass Rock (Seabird Tracking Database, 2023d) and Bempton Cliffs (Seabird Tracking Database, 2023e), with no breeding birds from either colony showing any distinct overlap with the DBD Array Area. Several months of both the post-breeding and return migration periods show significant flight orientations. These are broadly in a westerly direction in both migration seasons but may suggest a consistent movement of birds through the DBD Array Area during migratory periods (**Appendix 4**).

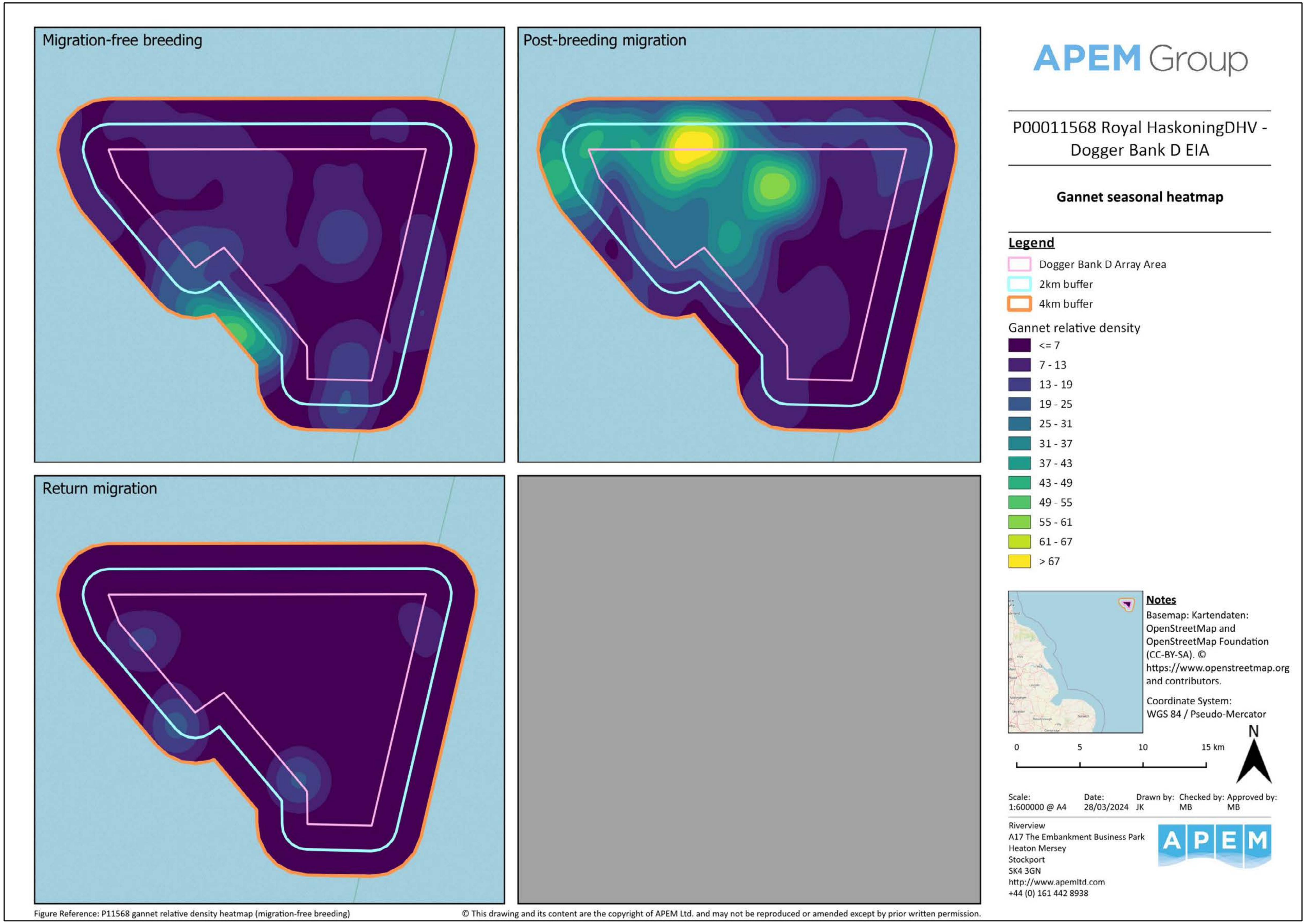

Figure 4-84 Heatmaps of gannet distribution in each bio-season

3.3.6 HPAI review

HPAI was first recorded in gannet in the UK in May 2022 (DEFRA, 2022e) with records increasing in number and location since. According to the Tremlett *et al.* (2024) review on HPAI impacts, the number of gannet AONs or Apparently Occupied Sites (AOS) decreased by 25% from pre-HPAI to the survey year of 2023 (post outbreak). However, colony specific trends are seen to differ. A more detailed review of Flamborough and Filey Coast SPA and Forth Islands SPA are provided below in order to understand the potential impact of HPAI on gannets at these colonies and how this relates to the baseline data collected for the Project.

Gannet AONs at Forth Islands SPA have seen a decrease of 31% from the pre-outbreak baseline count in 2014 to the most recent count taken in 2023 (Harris *et al*. 2023). The colony at Bass Rock saw a large decline in the population due to the outbreak of HPAI (**Figure 4-85** & **Table 4–59**), however, the first signs of the virus at the colony did not occur until 30th June 2022. Since the initial decline in the population (Lane *et al*. 2024), there has been recovery from 2022 to 2023 suggesting an increase of 142% (Harris *et al.* 2023). The fact that HPAI only started to impact the colony at the end of June in 2022 and the subsequent recovery in later counts suggests that the baseline data for DBD is representative of the gannet population, with initial counts occurring prior to HPAI and later counts showing the recovery in the population.

Table 4–59 Gannet colony counts at Forth Islands SPA from 2009 to 2023 (SMP, 2024; Harris *et al.* 2023 and Lane *et al.* 2024)

Year and colony count (AON)				
2009	**2014**	**2021****	**2022***	**2023****
60,853	75,259	81,000	21,227	51,844

*Table note: 2022 count taken from Lane *et al.* (2024) **2021 and 2023 count taken from Harris *et al.* (2023)

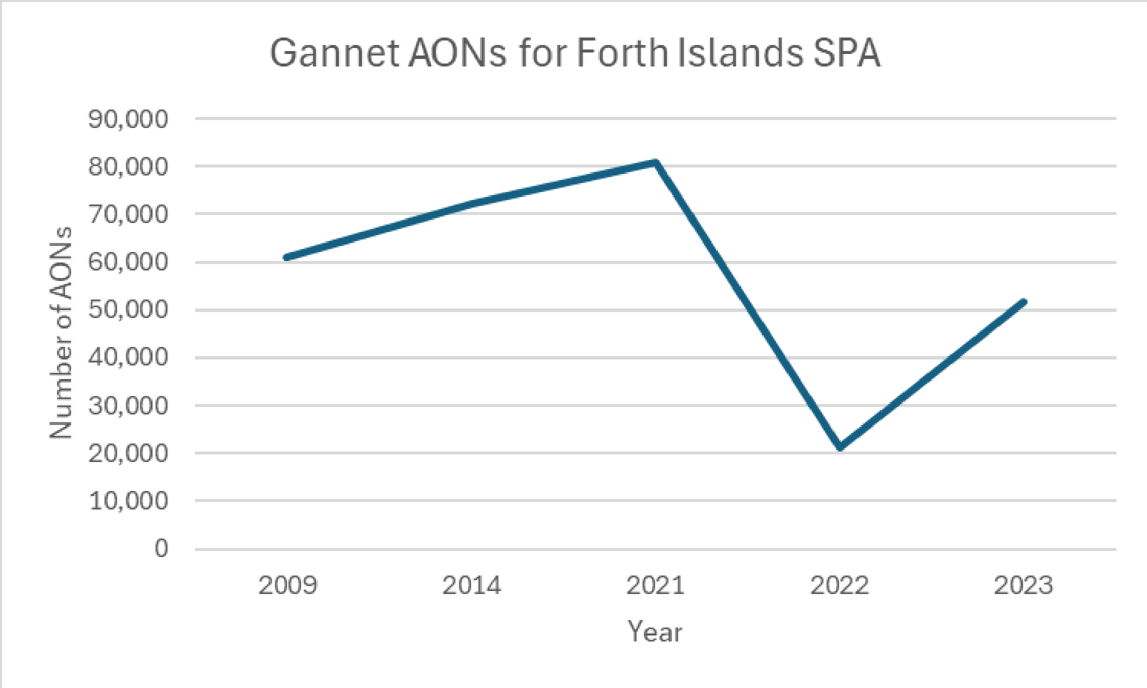

Figure 4-85 Gannet colony trend for Forth Islands SPA between 2009 and 2023

Gannet AOSs at Flamborough and Filey Coast SPA have seen an increase of 14% from the pre-outbreak baseline count in 2017 to the most recent count taken in 2023 (Tremlett *et al*. 2024). Looking at previous colony counts, the general trend is that the colony shows historic increase from year to year (**Table 4–60** & **Figure 4-86**). The fact that the colony shows increasing counts historically and within the baseline data collection highlights that the data used for the Project is representative of the gannet population coming from Flamborough and Filey Coast SPA.

Table 4–60 Gannet colony counts at Flamborough and Filey Coast SPA from 2015 to 2024 (SMP, 2024)

Year and colony count (AOS)				
2015	**2017**	**2022**	**2023**	**2024**
12,494	13,392	13,125	15,233	15,794

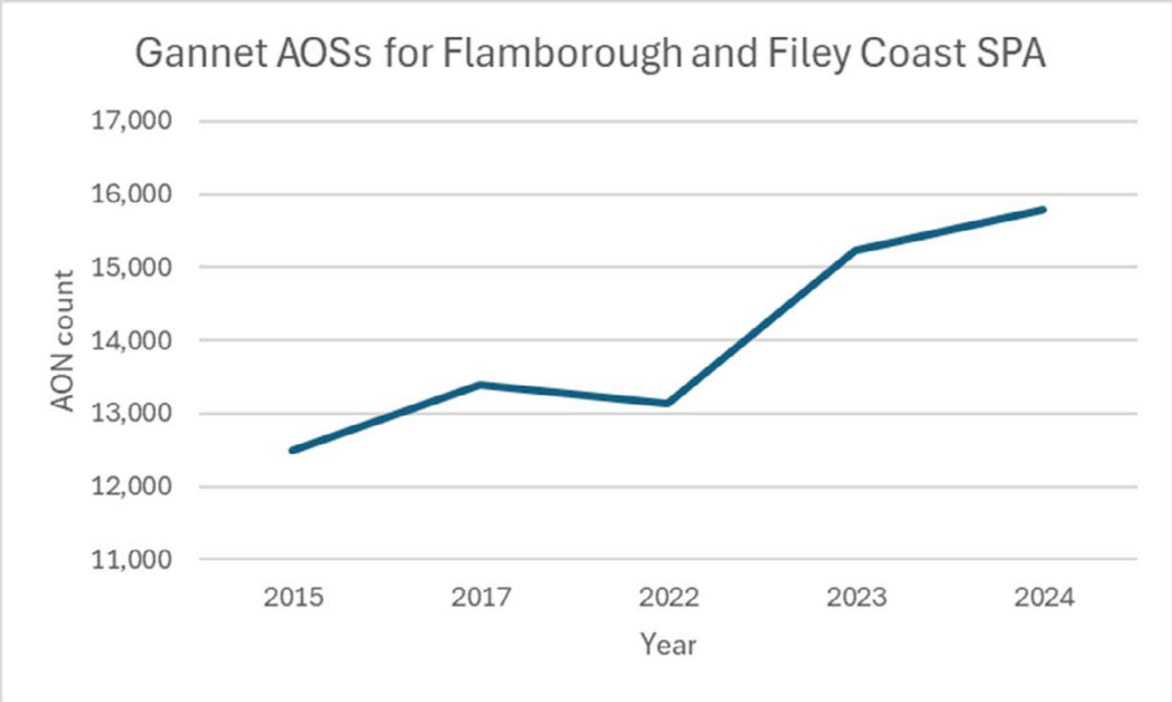

Figure 4-86 Gannet colony trend for Flamborough and Filey Coast SPA between 2015 and 2024

3.4 Other Species Recorded

3.4.1 DBD Survey Data (aerial survey data 2021-2023)

Manx shearwaters were recorded in the DBD Array Area in a single DAS, with a peak estimated abundance of five individuals in May 2022, corresponding to a density of 0.02 individuals/km^2 within the DBD Array Area (**Appendix 3**). The small number of Manx shearwaters recorded across the survey area were loosely distributed within the Array Area and corresponding buffers (**Figure 4-87**).

Great skuas were recorded in the DBD Array Area in two of the 24 months of DAS, with a peak estimated abundance of 10 individuals in October 2022, corresponding to a density of 0.04 individuals per km^2 within the DBD Array Area (**Appendix 3**). The great skuas were recorded toward the north and west of the Array Area and the 2km asymmetrical buffer (**Figure 4-87**).

Arctic skua was not recorded in the DBD Array Area in any of the 24 months of DAS. In the DBD Array Area plus 2km asymmetrical buffer, Arctic skuas were recorded in a single DAS with a peak estimated abundance of five individuals in October 2022, corresponding to a density of 0.01 individuals/km^2 (**Appendix 3**). The low numbers of Arctic skua were recorded in the 2km asymmetrical buffer of the Array Area in the north-east corner (**Figure 4-87**).

Black-headed gulls were recorded in the DBD Array Area in two of the 24 DAS, with a peak estimated abundance of 10 individuals in September 2022, corresponding to a density of 0.04 individuals/km^2 (**Appendix 3**). Black-headed gulls were recorded loosely through the Array Area and the 2km asymmetrical buffer (**Figure 4-87**).

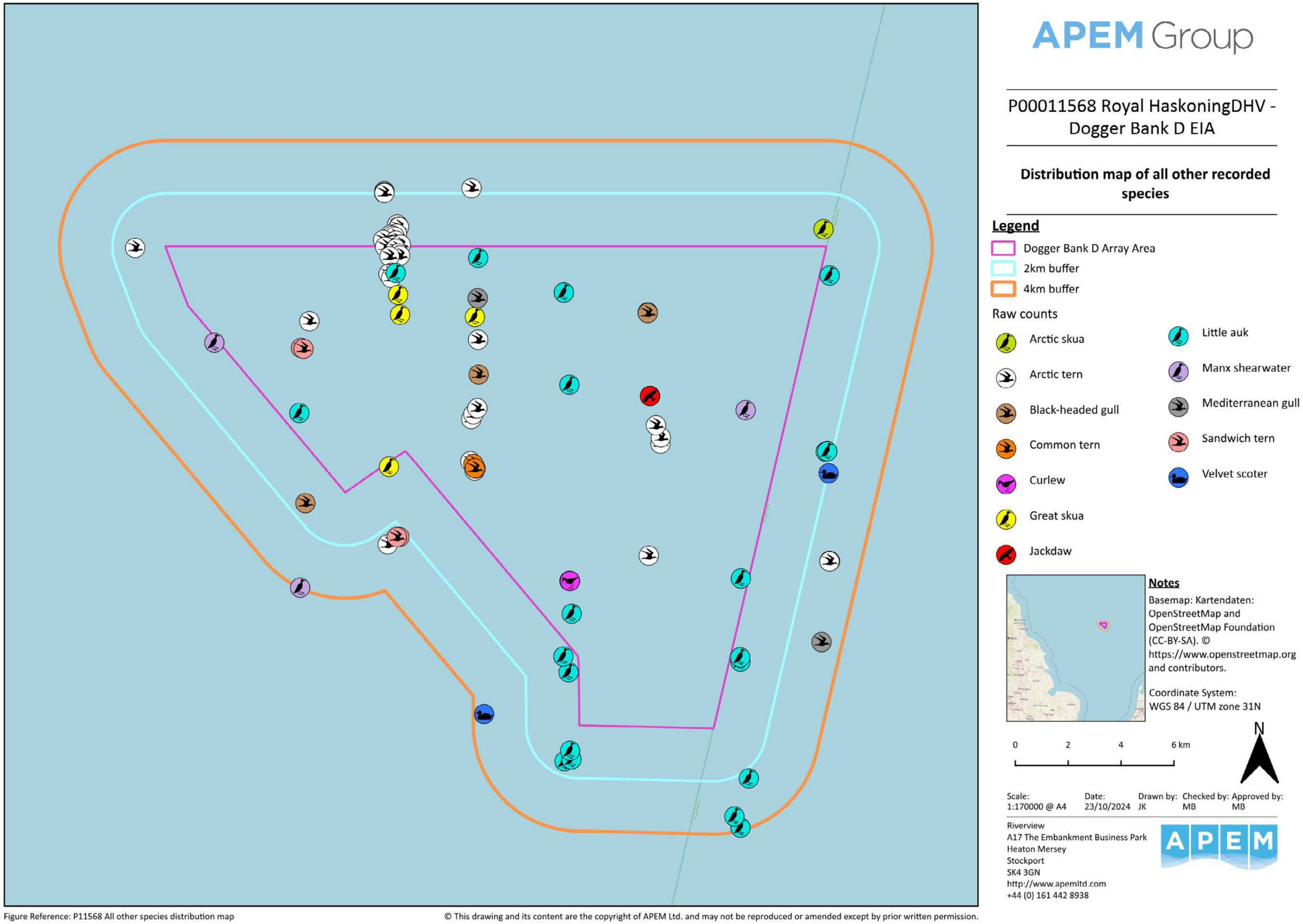

Figure 4-87 Other species recorded in the DBD digital aerial surveys 2021-2023

Mediterranean gulls were recorded in the DBD Array Area in a single DAS, with a peak estimated abundance of five individuals in May 2022, corresponding to a density of 0.02 individuals/km^2 within the DBD Array Area (**Appendix 3**). The low numbers of Mediterranean gull were recorded loosely throughout the Array Area and relevant buffers (**Figure 4-87**).

Arctic terns were recorded in the DBD Array Area in two of the 24 months of DAS, with a peak estimated abundance of 86 individuals in July 2023, corresponding to a density of 0.33 individuals per km^2 within the DBD Array Area (**Appendix 3**). Within the survey area, Arctic terns were loosely recorded, however, there are a few more concentrated records in the centre and towards the north of the area (**Figure 4-87**).

Common terns were recorded in the DBD Array Area in a single DAS, with a peak estimated abundance of 17 individuals in May 2022, corresponding to a density of 0.06 individuals/km^2 within the DBD Array Area (**Appendix 3**).The small number of common tern records were in the centre of the Array Area (**Figure 4-87**).

Sandwich terns were recorded in the DBD Array Area in a DAS, with a peak estimated abundance of ten individuals in April 2023, corresponding to a density of 0.04 individuals/km^2 within the DBD Array Area (**Appendix 3**). The small numbers of sandwich terns were recorded to the west of the Array Area and relevant buffers (**Figure 4-87**).

Little auks were recorded in the DBD Array Area in a single DAS, with a peak estimated abundance of 43 individuals in January 2023, corresponding to a density of 0.16 individuals/km^2 within the DBD Array Area (**Appendix 3**). Little auks were recorded throughout the Array Area and the relevant buffers (**Figure 4-87**).

Velvet scoters were only recorded within the Array Area plus 4km buffer in a single DAS, with a peak estimated abundance of five individuals in January 2022, corresponding to a density of 0.01 individuals/km^2 within the DBD Array Area plus 4km buffer (**Appendix 3**). The records of velvet scoter were located in the south-west corner of the Array Area plus 4km buffer (**Figure 4-87**).

4. References

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Appendix 1 Scientific names and taxonomy

Common name	Scientific name
Velvet scoter	*Melanitta fusca*
Curlew	*Numenius arquata*
Kittiwake	*Rissa tridactyla*
Black-headed gull	*Chroicocephalus ridibundus*
Mediterranean gull	*Ichthyaetus melanocephalus*
Common gull	*Larus canus*
Lesser black-backed gull	*Larus fuscus*
Herring gull	*Larus argentatus*
Great black-backed gull	*Larus marinus*
Sandwich tern	*Thalasseus sandvicensis*
Common tern	*Sterna hirundo*
Arctic tern	*Sterna paradisaea*
Arctic skua	*Stercorarius parasiticus*
Great skua	*Stercorarius skua*
Little auk	*Alle alle*
Guillemot	*Uria aalge*
Razorbill	*Alca torda*
Puffin	*Fratercula arctica*
Great northern diver	*Gavia immer*
White-billed diver	*Gavia adamsii*
Fulmar	*Fulmarus glacialis*
Manx shearwater	*Puffinus puffinus*
Gannet	*Morus bassanus*
Jackdaw	*Coloeus monedula*

Appendix 2 Abundance and behaviour information for all birds (excluding Apportionment and Correction for Availability Bias)

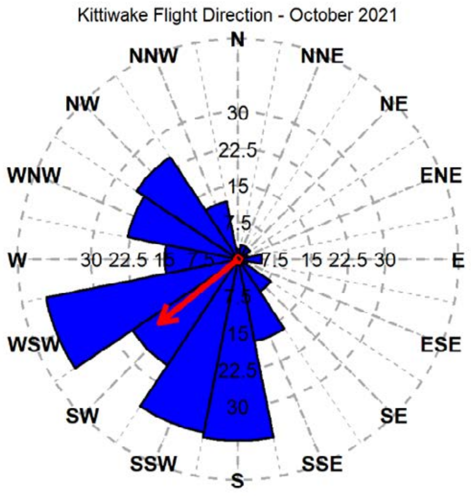
See document: (for client – Appendix 2 and 3 only)

Appendix 3 Abundance and behaviour information for all birds (including Apportionment and Correction for Availability Bias)

See document: (for client – Appendix 2 and 3 only)

Appendix 4 Flight Direction Rose Diagrams

Kittiwake rose diagrams (2021-2023)



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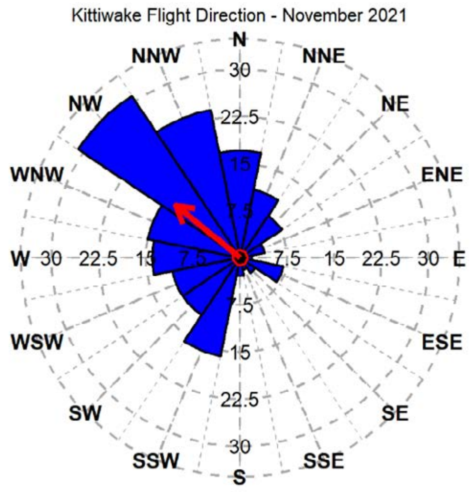

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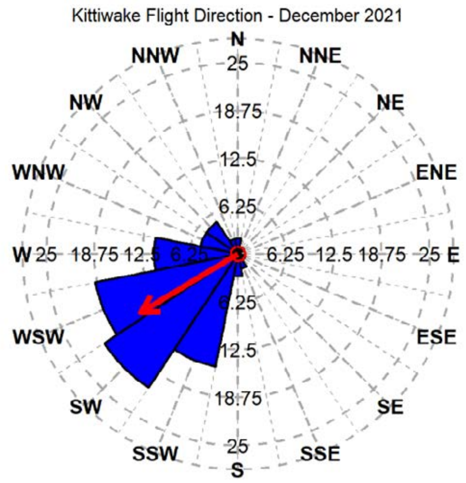

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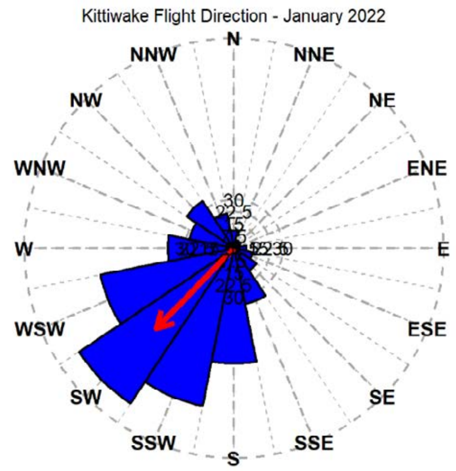

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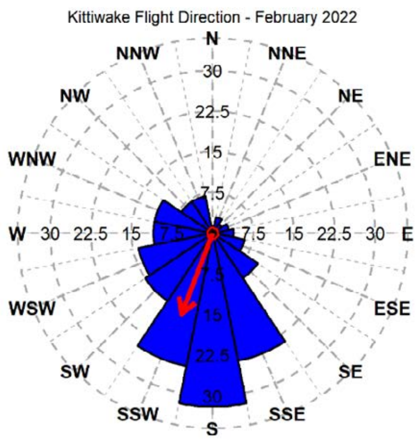

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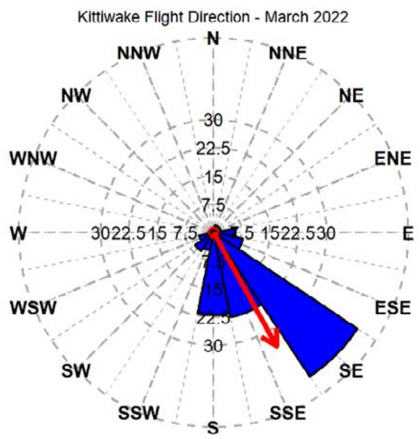

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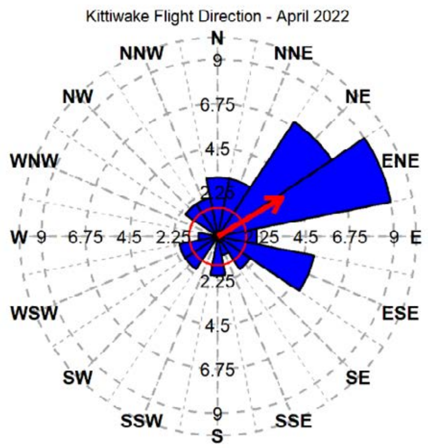

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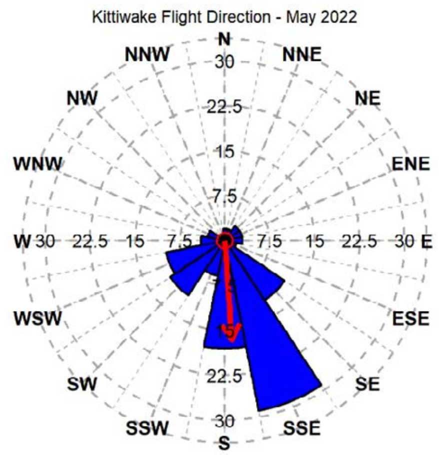

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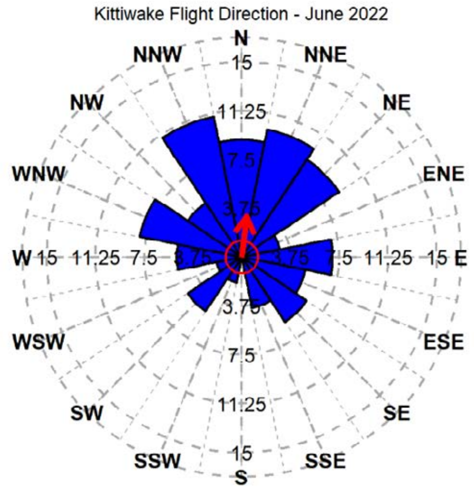

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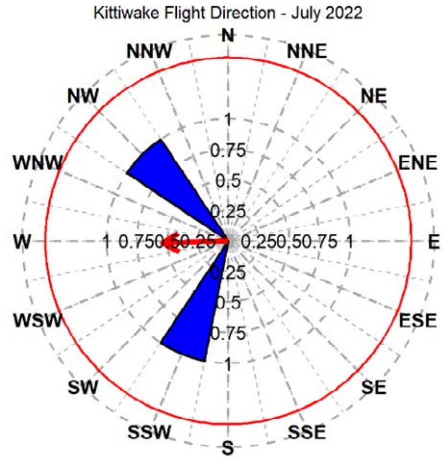

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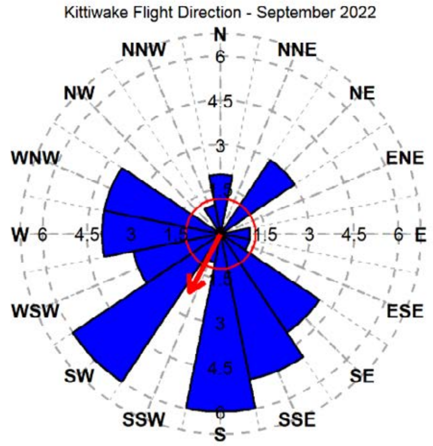

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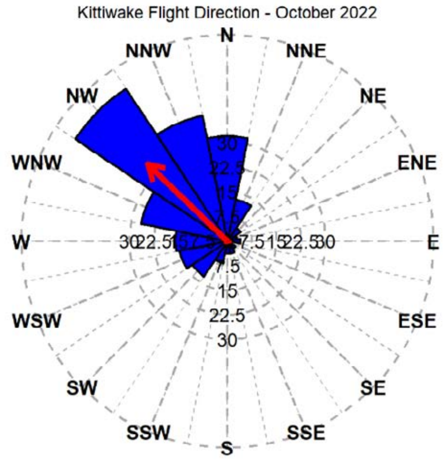

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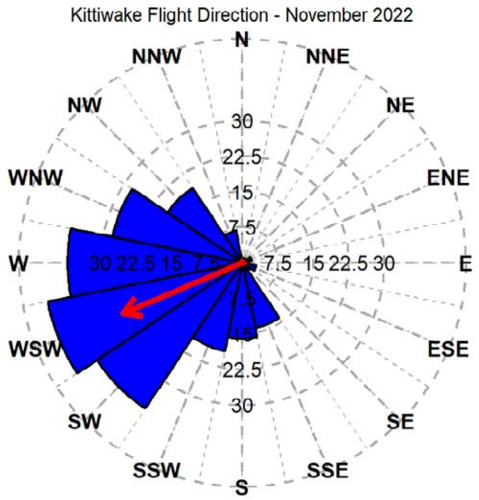

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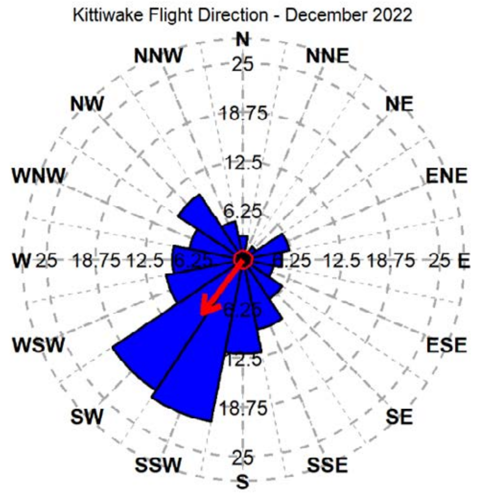

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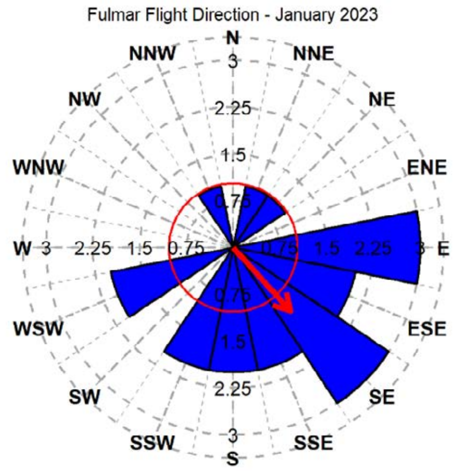

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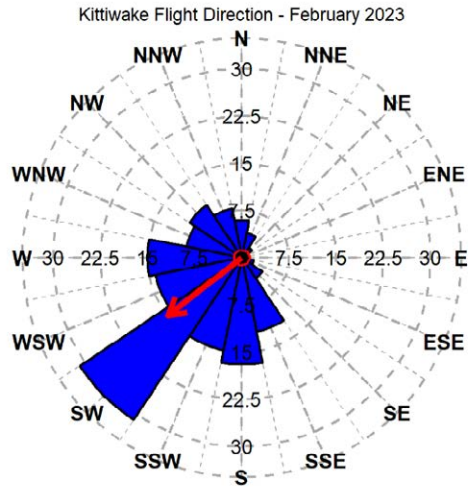

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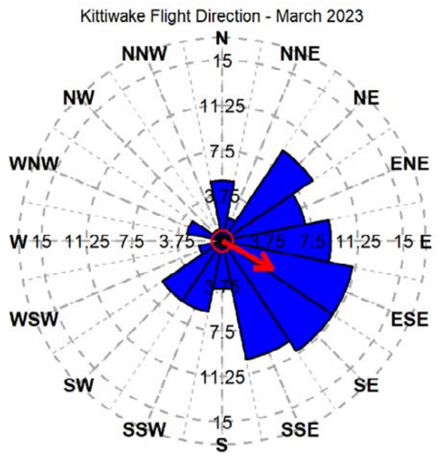

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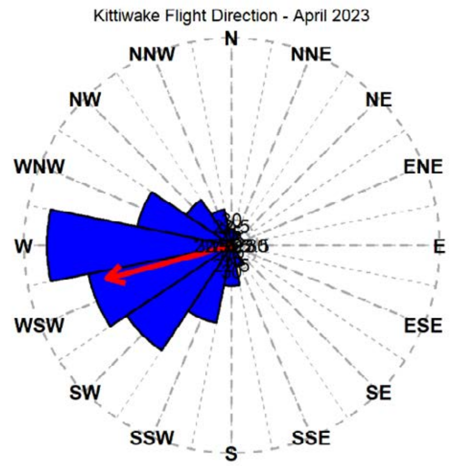

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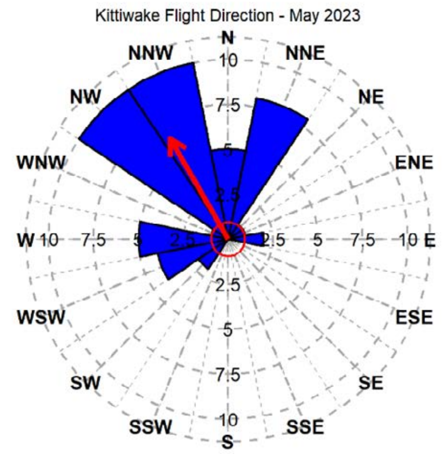
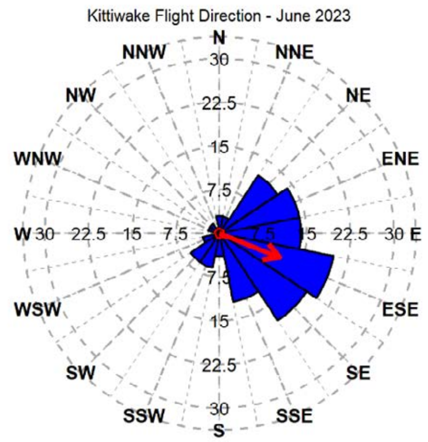
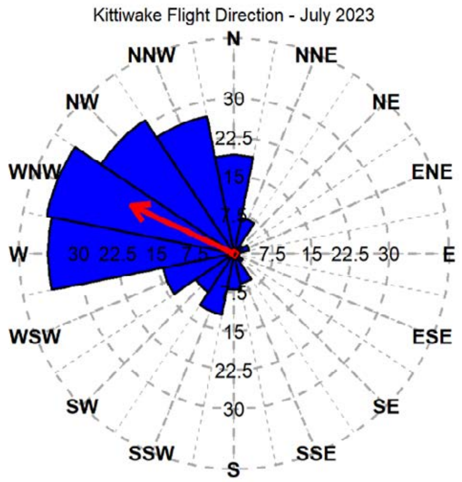
Rayleigh Test (Z) = 470.249
Rayleigh Test (p) = <0.001



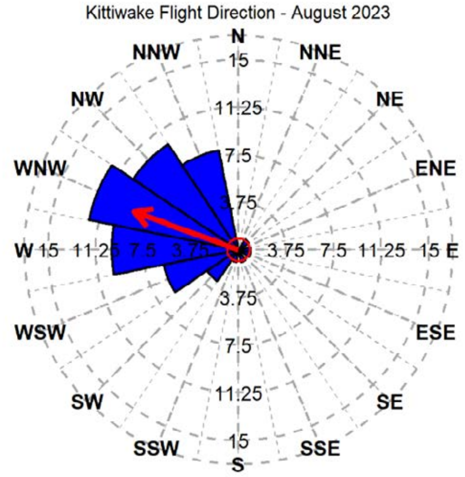
Number of Observations = 49
Mean Vector = 330.848
Length of mean vector (r) = 0.642
Rayleigh Test (Z) = 20.189
Rayleigh Test (p) = <0.001



Number of Observations = 120
Mean Vector = 112.092
Length of mean vector (r) = 0.555
Rayleigh Test (Z) = 36.966
Rayleigh Test (p) = <0.001

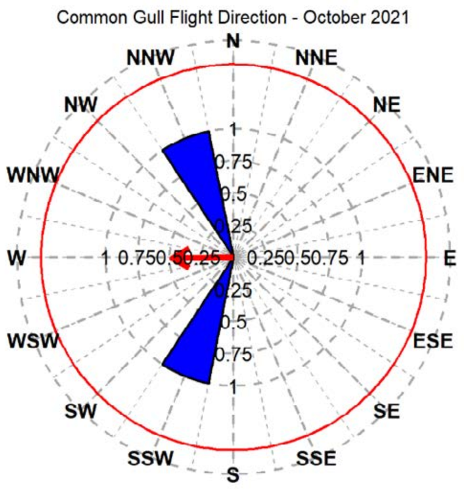


Number of Observations = 214
Mean Vector = 295.220
Length of mean vector (r) = 0.591
Rayleigh Test (Z) = 74.818
Rayleigh Test (p) = <0.001

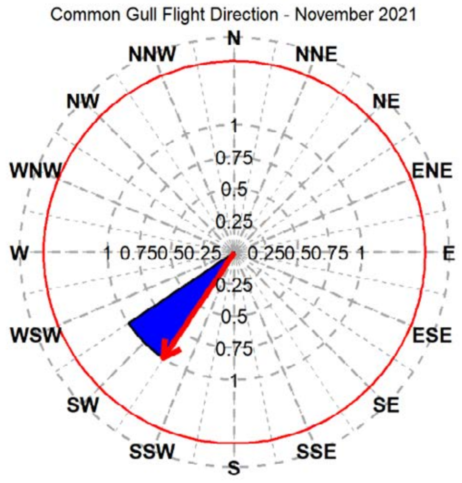


Number of Observations = 54
Mean Vector = 290.861
Length of mean vector (r) = 0.726
Rayleigh Test (Z) = 28.461
Rayleigh Test (p) = <0.001

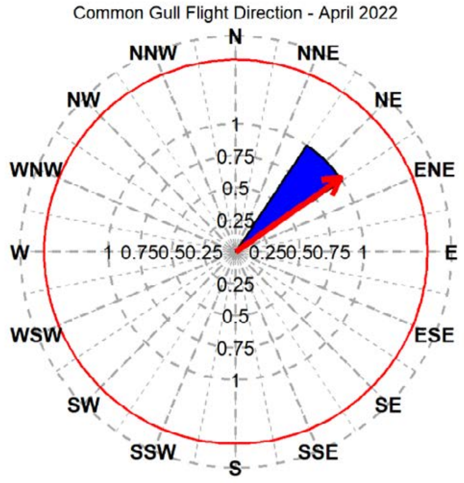
Common gull rose diagrams (2021-2023)



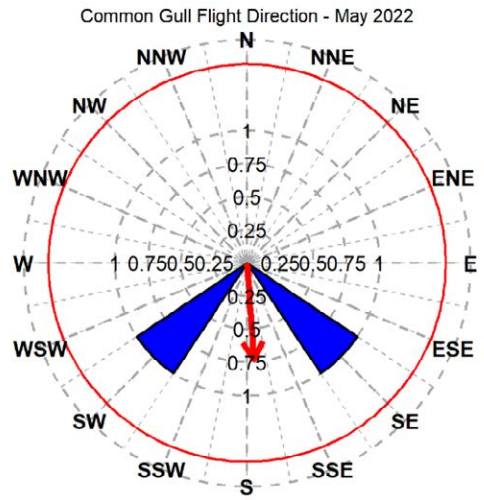
Number of Observations = 2
Mean Vector = 269.303
Length of mean vector (r) = 0.478
Rayleigh Test (Z) = 0.456
Rayleigh Test (p) = 0.695



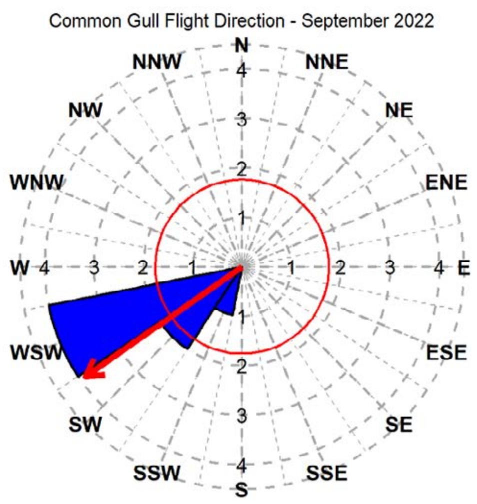
Number of Observations = 1
Mean Vector = 214.614
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



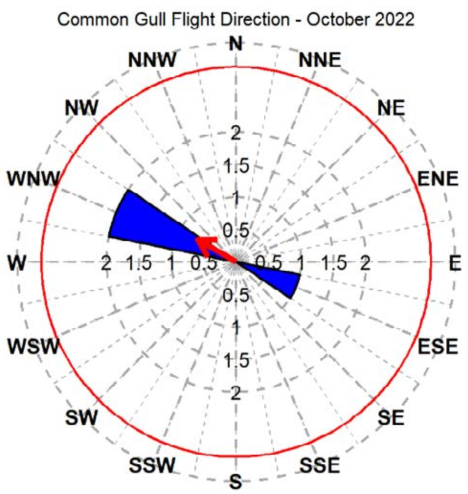
Number of Observations = 1
Mean Vector = 55.153
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



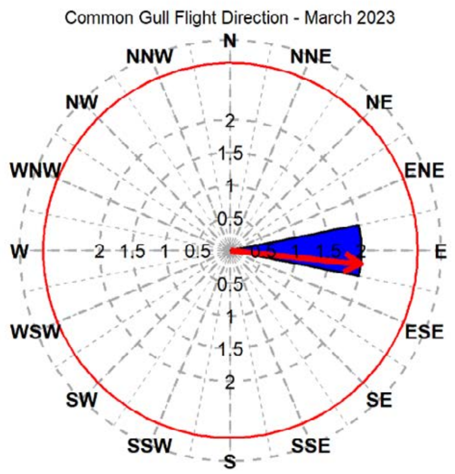
Number of Observations = 2
Mean Vector = 176.724
Length of mean vector (r) = 0.729
Rayleigh Test (Z) = 1.063
Rayleigh Test (p) = 0.402



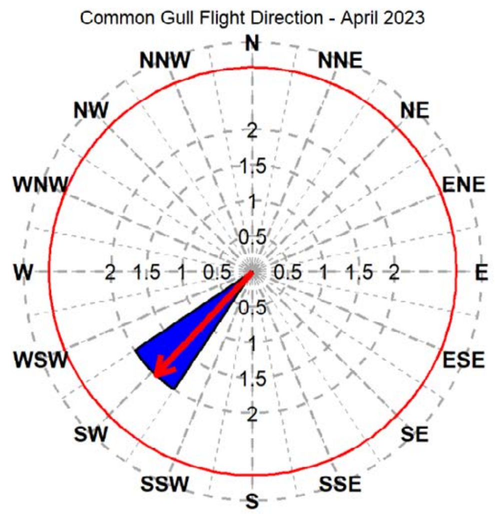
Number of Observations = 7
Mean Vector = 235.588
Length of mean vector (r) = 0.970
Rayleigh Test (Z) = 6.592
Rayleigh Test (p) = <0.001



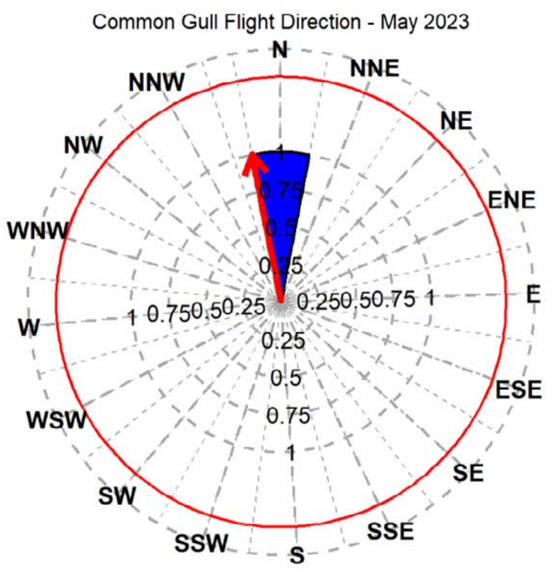
Number of Observations = 3
Mean Vector = 300.797
Length of mean vector (r) = 0.339
Rayleigh Test (Z) = 0.346
Rayleigh Test (p) = 0.743



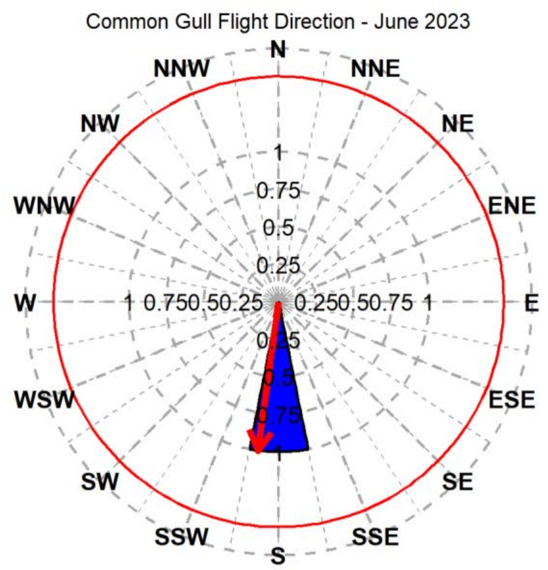
Number of Observations = 2
Mean Vector = 96.749
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.999
Rayleigh Test (p) = 0.137



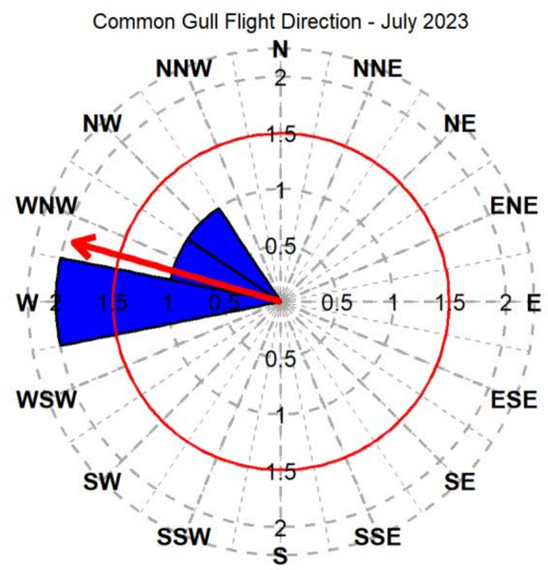
Number of Observations = 2
Mean Vector = 223.667
Length of mean vector (r) = 0.996
Rayleigh Test (Z) = 1.986
Rayleigh Test (p) = 0.140



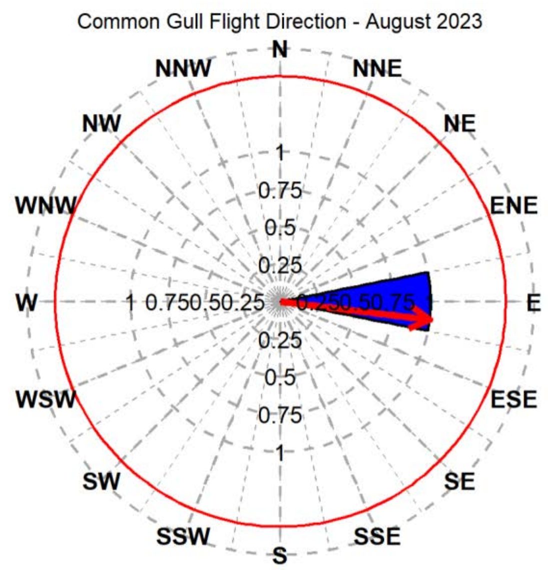
Number of Observations = 1
Mean Vector = 356.253
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



Number of Observations = 1
Mean Vector = 188.625
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

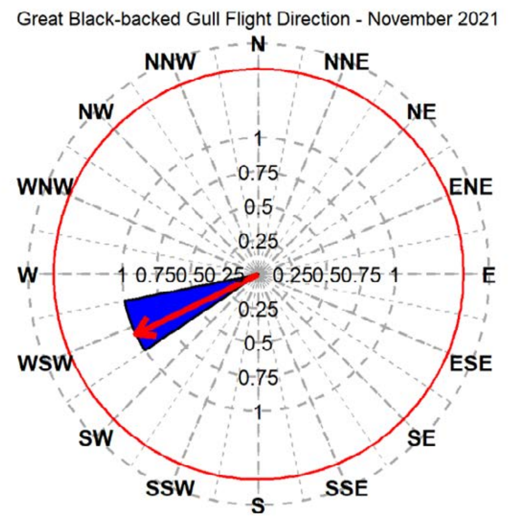


Number of Observations = 4
Mean Vector = 286.779
Length of mean vector (r) = 0.957
Rayleigh Test (Z) = 3.666
Rayleigh Test (p) = 0.013

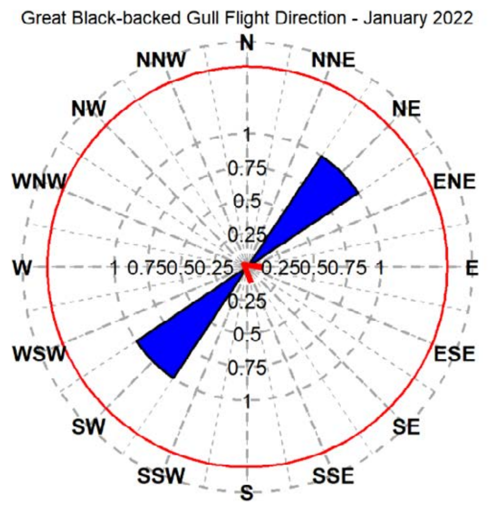


Number of Observations = 1
Mean Vector = 97.341
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

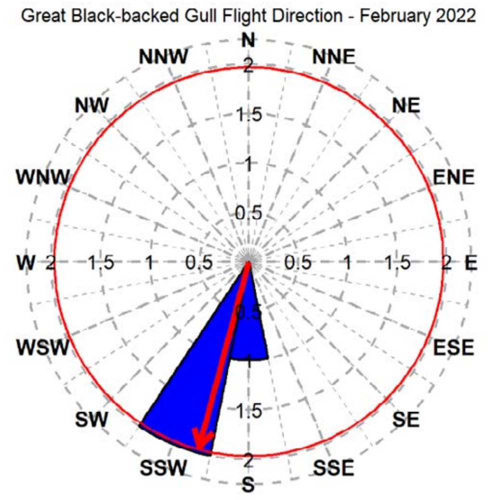
Great black-backed gull rose diagrams (2021-2023)



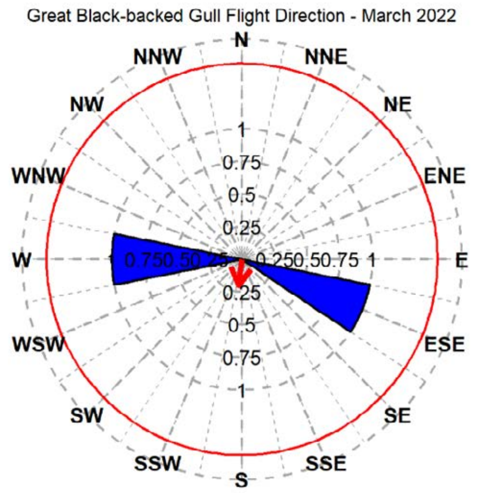
Number of Observations = 1
Mean Vector = 244.094
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



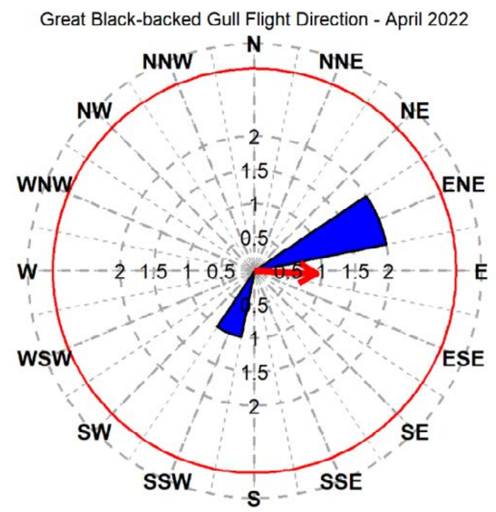
Number of Observations = 2
Mean Vector = 310.196
Length of mean vector (r) = 0.032
Rayleigh Test (Z) = 0.002
Rayleigh Test (p) = 0.998



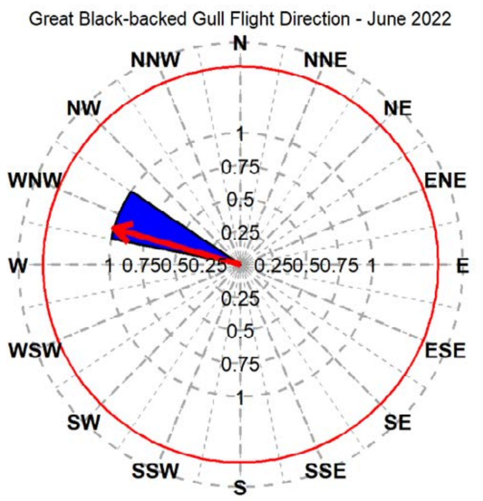
Number of Observations = 3
Mean Vector = 195.179
Length of mean vector (r) = 0.969
Rayleigh Test (Z) = 2.820
Rayleigh Test (p) = 0.045



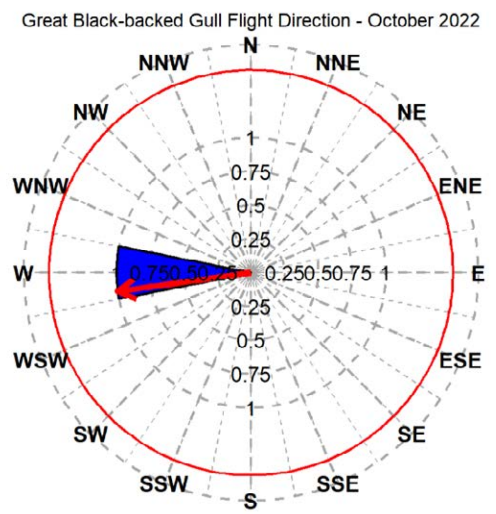
Number of Observations = 2
Mean Vector = 188.566
Length of mean vector (r) = 0.198
Rayleigh Test (Z) = 0.078
Rayleigh Test (p) = 0.941



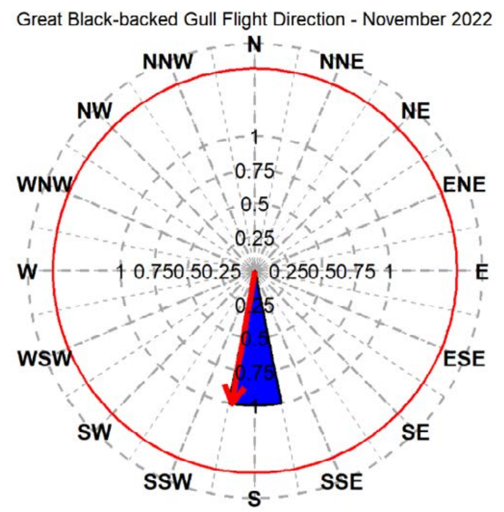
Number of Observations = 3
Mean Vector = 93.270
Length of mean vector (r) = 0.462
Rayleigh Test (Z) = 0.640
Rayleigh Test (p) = 0.570



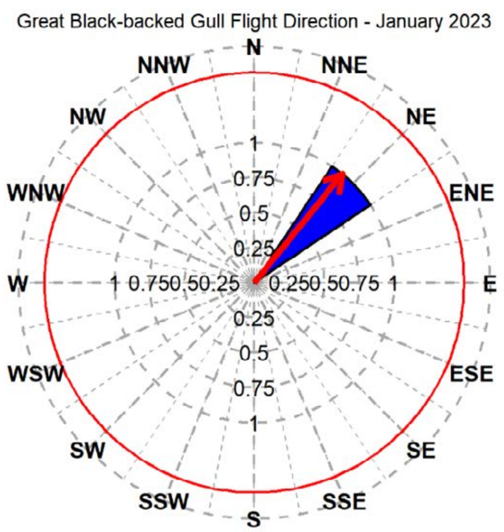
Number of Observations = 1
Mean Vector = 286.023
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



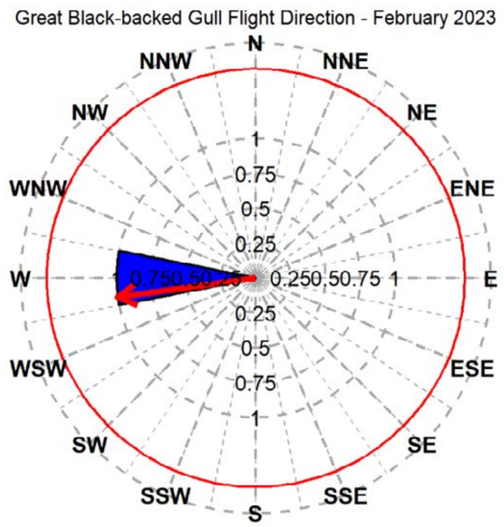
Number of Observations = 1
Mean Vector = 262.510
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



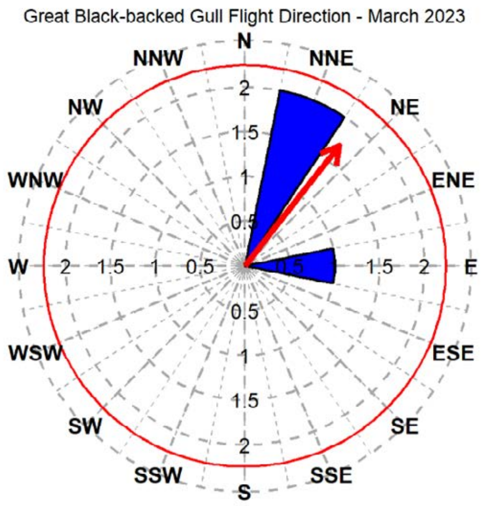
Number of Observations = 1
Mean Vector = 190.556
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



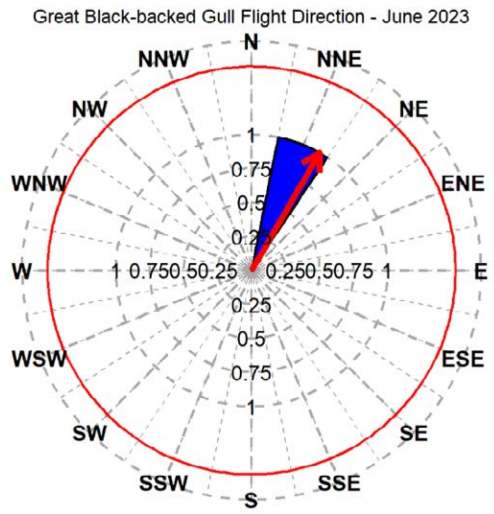
Number of Observations = 1
Mean Vector = 39.554
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



Number of Observations = 1
Mean Vector = 262.989
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

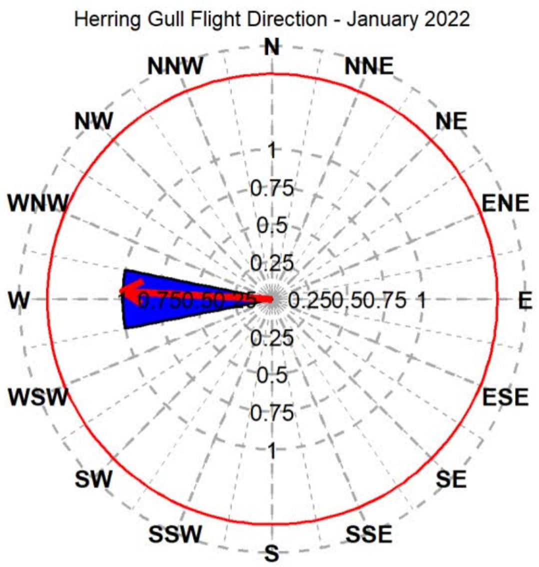


Number of Observations = 3
Mean Vector = 38.028
Length of mean vector (r) = 0.851
Rayleigh Test (Z) = 2.172
Rayleigh Test (p) = 0.110

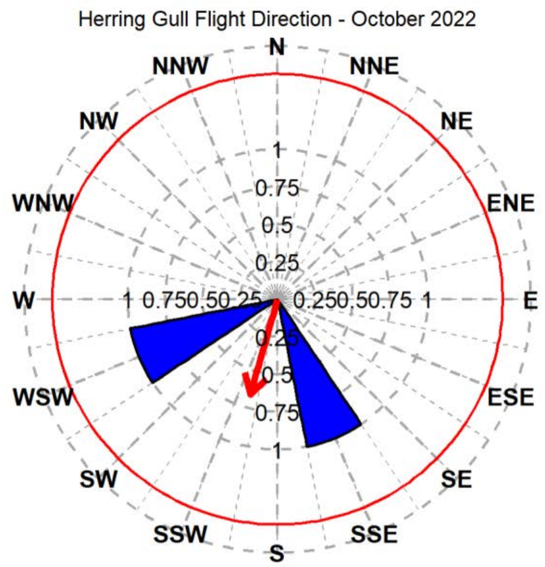


Number of Observations = 1
Mean Vector = 30.141
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

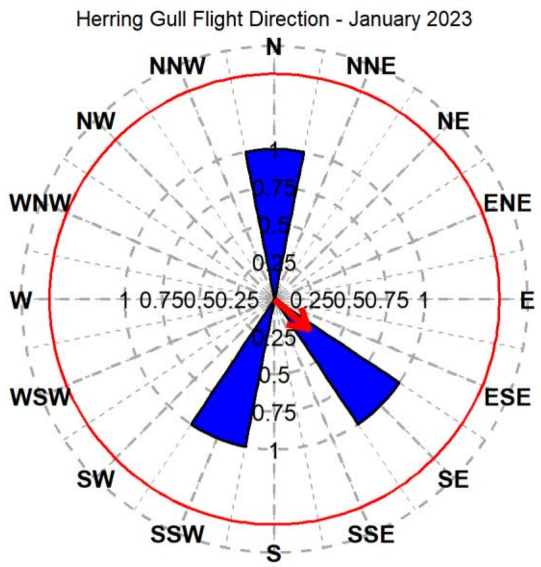
Herring gull rose diagrams (2021-2023)



Number of Observations = 1
Mean Vector = 273.026
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

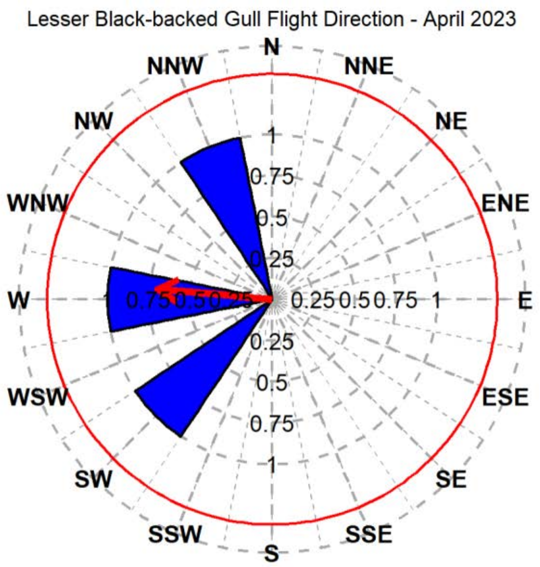


Number of Observations = 2
Mean Vector = 196.656
Length of mean vector (r) = 0.660
Rayleigh Test (Z) = 0.872
Rayleigh Test (p) = 0.482

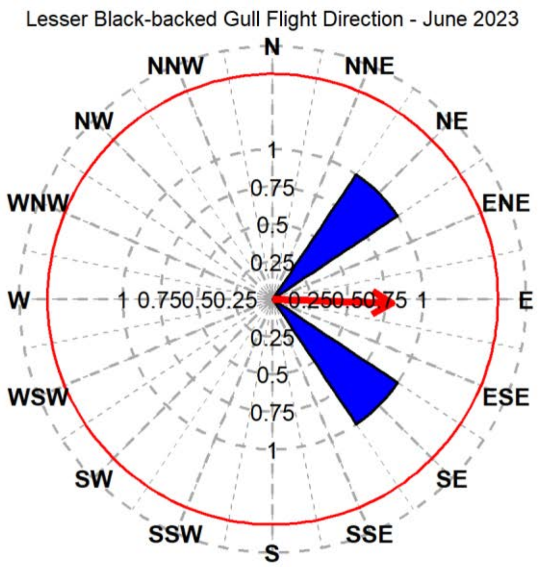


Number of Observations = 3
Mean Vector = 131.555
Length of mean vector (r) = 0.301
Rayleigh Test (Z) = 0.273
Rayleigh Test (p) = 0.792

Lesser black-backed gull rose diagrams (2012-2023)

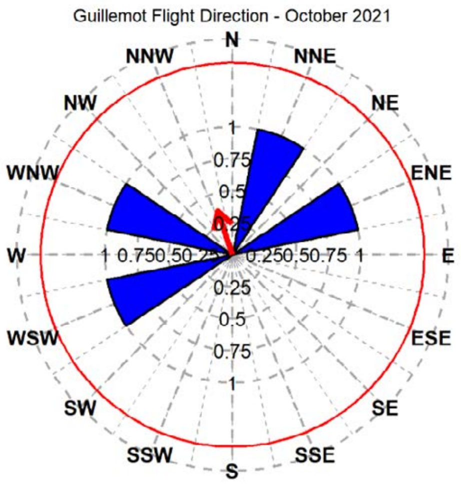


Number of Observations = 3
Mean Vector = 275.606
Length of mean vector (r) = 0.698
Rayleigh Test (Z) = 1.460
Rayleigh Test (p) = 0.252

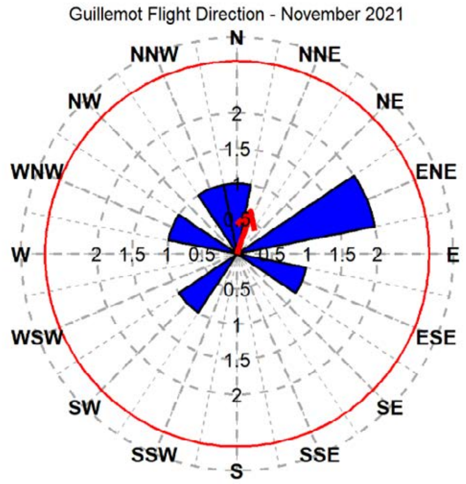


Number of Observations = 2
Mean Vector = 92.185
Length of mean vector (r) = 0.794
Rayleigh Test (Z) = 1.261
Rayleigh Test (p) = 0.329

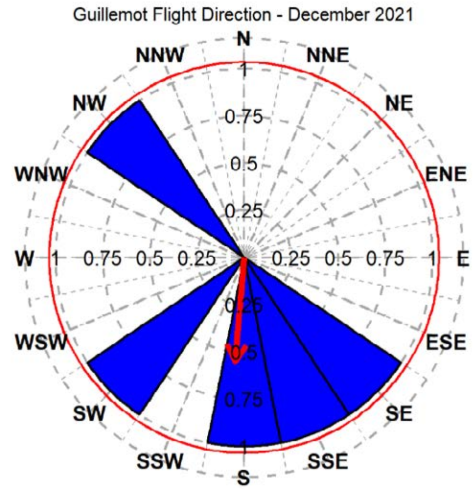
Guillemot rose diagrams (2021-2023)



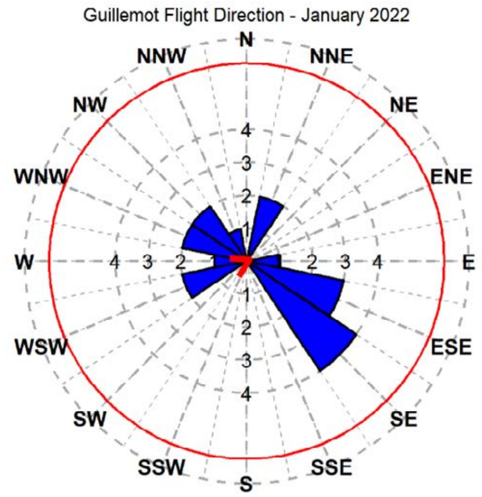
Number of Observations = 4
Mean Vector = 341.922
Length of mean vector (r) = 0.360
Rayleigh Test (Z) = 0.518
Rayleigh Test (p) = 0.626



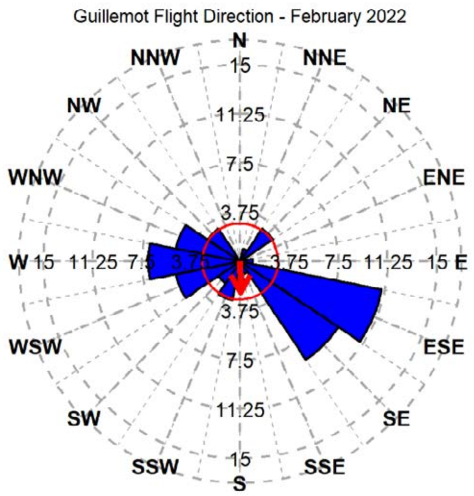
Number of Observations = 7
Mean Vector = 18.242
Length of mean vector (r) = 0.312
Rayleigh Test (Z) = 0.683
Rayleigh Test (p) = 0.522



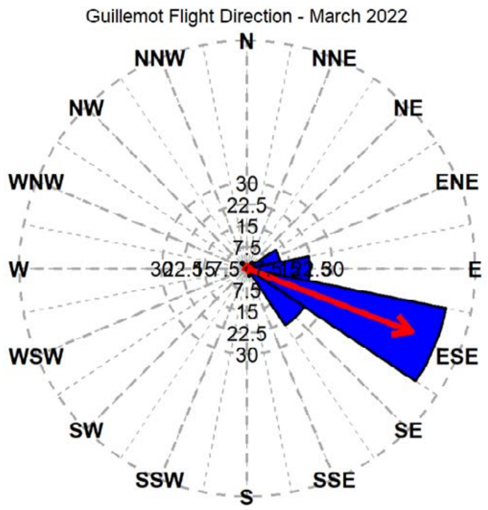
Number of Observations = 5
Mean Vector = 185.973
Length of mean vector (r) = 0.554
Rayleigh Test (Z) = 1.532
Rayleigh Test (p) = 0.225



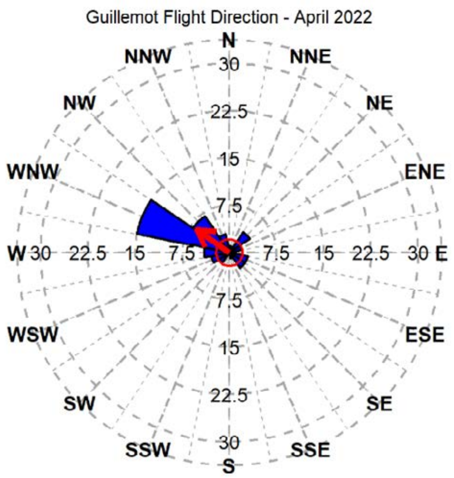
Number of Observations = 18
Mean Vector = 63.962
Length of mean vector (r) = 0.022
Rayleigh Test (Z) = 0.009
Rayleigh Test (p) = 0.991



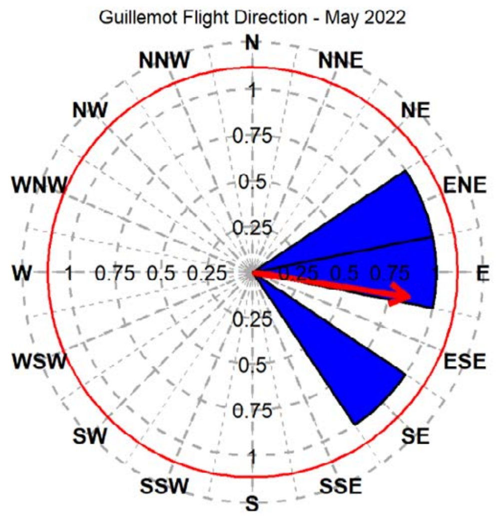
Number of Observations = 53
Mean Vector = 179.630
Length of mean vector (r) = 0.214
Rayleigh Test (Z) = 2.425
Rayleigh Test (p) = 0.088



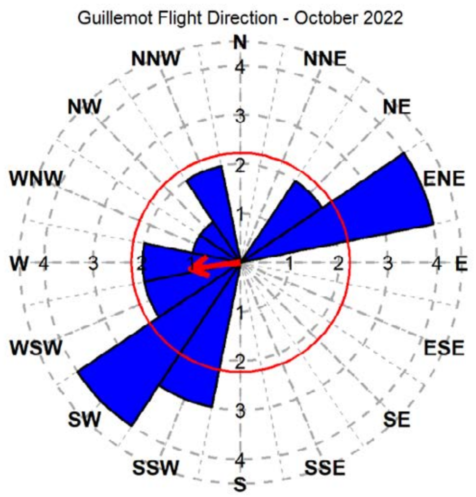
Number of Observations = 141
Mean Vector = 111.213
Length of mean vector (r) = 0.867
Rayleigh Test (Z) = 105.939
Rayleigh Test (p) = <0.001



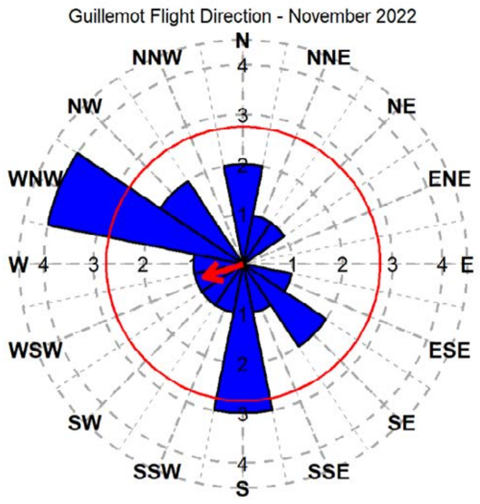
Number of Observations = 50
Mean Vector = 305.442
Length of mean vector (r) = 0.416
Rayleigh Test (Z) = 8.653
Rayleigh Test (p) = <0.001



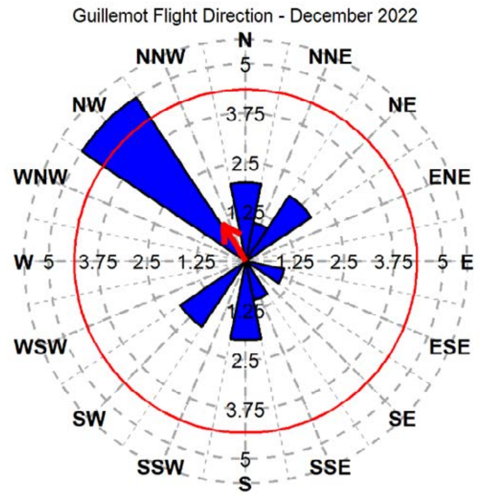
Number of Observations = 3
Mean Vector = 99.128
Length of mean vector (r) = 0.854
Rayleigh Test (Z) = 2.187
Rayleigh Test (p) = 0.108



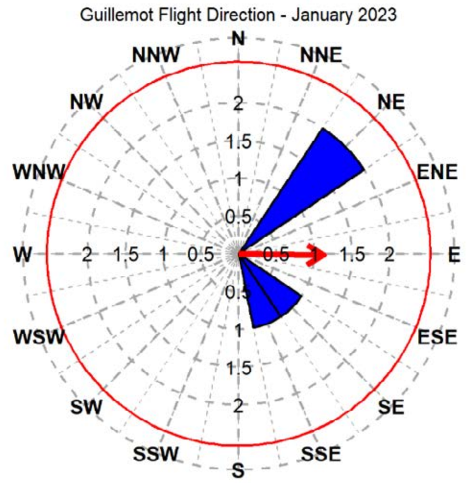
Number of Observations = 21
Mean Vector = 263.679
Length of mean vector (r) = 0.255
Rayleigh Test (Z) = 1.367
Rayleigh Test (p) = 0.258



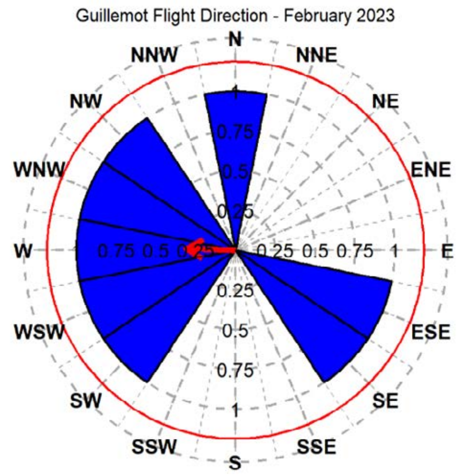
Number of Observations = 21
Mean Vector = 251.774
Length of mean vector (r) = 0.206
Rayleigh Test (Z) = 0.894
Rayleigh Test (p) = 0.414



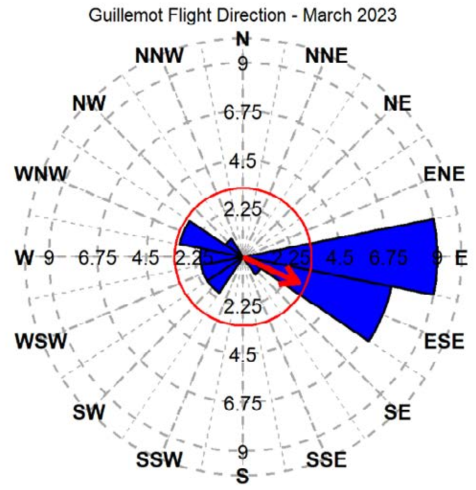
Number of Observations = 16
Mean Vector = 329.408
Length of mean vector (r) = 0.215
Rayleigh Test (Z) = 0.738
Rayleigh Test (p) = 0.485



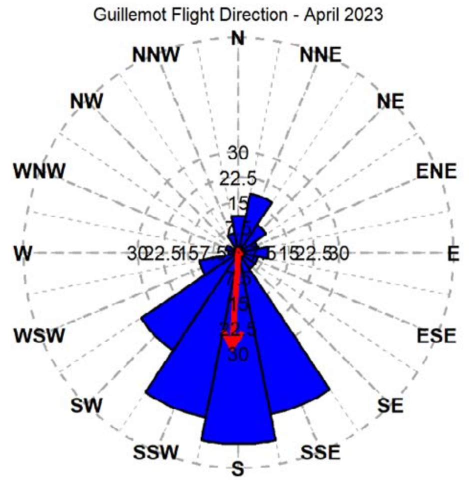
Number of Observations = 4
Mean Vector = 91.746
Length of mean vector (r) = 0.563
Rayleigh Test (Z) = 1.268
Rayleigh Test (p) = 0.301



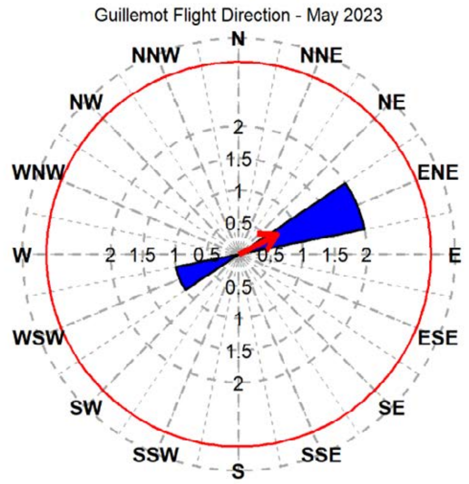
Number of Observations = 8
Mean Vector = 272.310
Length of mean vector (r) = 0.310
Rayleigh Test (Z) = 0.770
Rayleigh Test (p) = 0.477



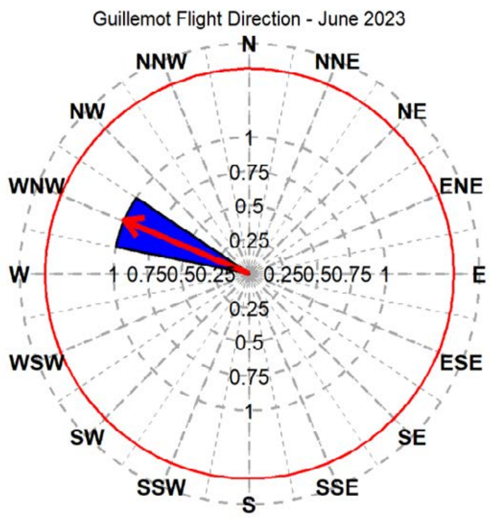
Number of Observations = 27
Mean Vector = 115.415
Length of mean vector (r) = 0.312
Rayleigh Test (Z) = 2.635
Rayleigh Test (p) = 0.071



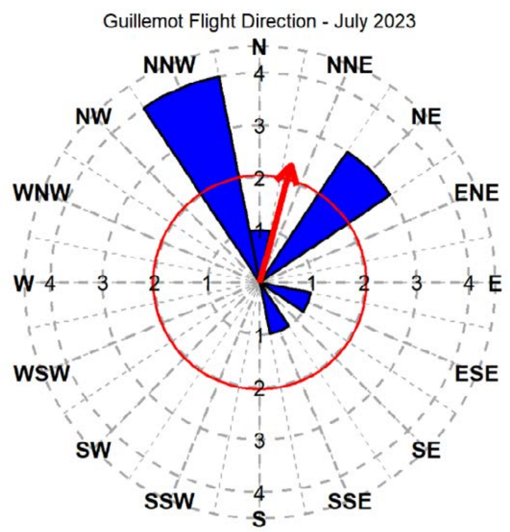
Number of Observations = 283
Mean Vector = 184.108
Length of mean vector (r) = 0.497
Rayleigh Test (Z) = 69.892
Rayleigh Test (p) = <0.001



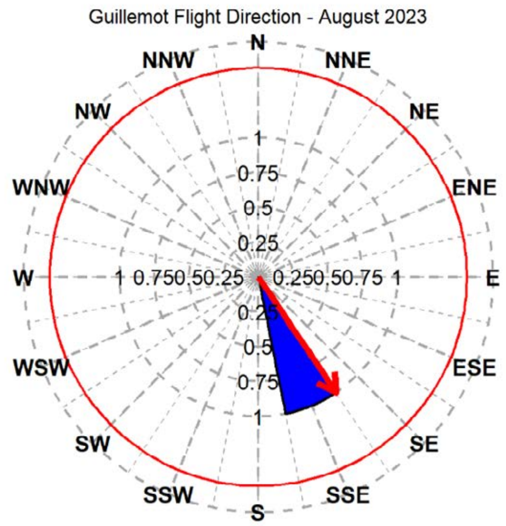
Number of Observations = 3
Mean Vector = 63.028
Length of mean vector (r) = 0.333
Rayleigh Test (Z) = 0.333
Rayleigh Test (p) = 0.751



Number of Observations = 1
Mean Vector = 293.578
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

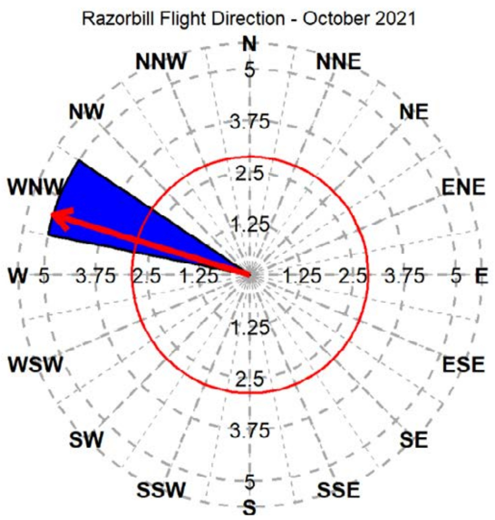


Number of Observations = 10
Mean Vector = 15.305
Length of mean vector (r) = 0.578
Rayleigh Test (Z) = 3.337
Rayleigh Test (p) = 0.031

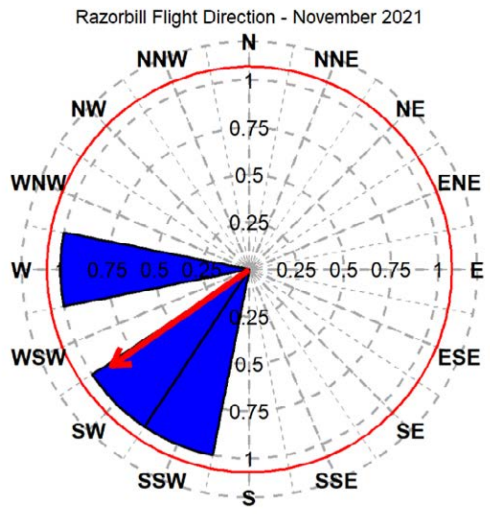


Number of Observations = 1
Mean Vector = 146.337
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

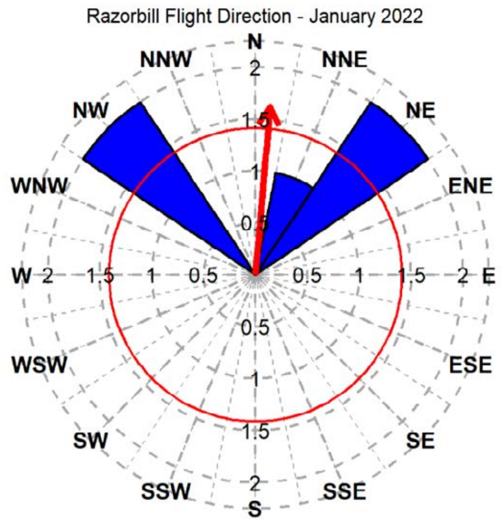
Razorbill rose diagrams (2021-2023)



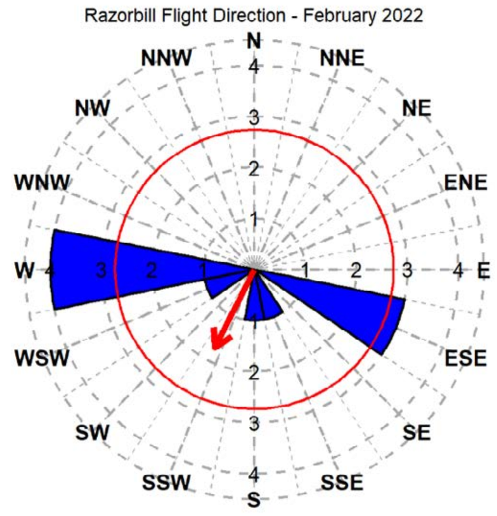
Number of Observations = 5
Mean Vector = 287.770
Length of mean vector (r) = 0.998
Rayleigh Test (Z) = 4.979
Rayleigh Test (p) = 0.001



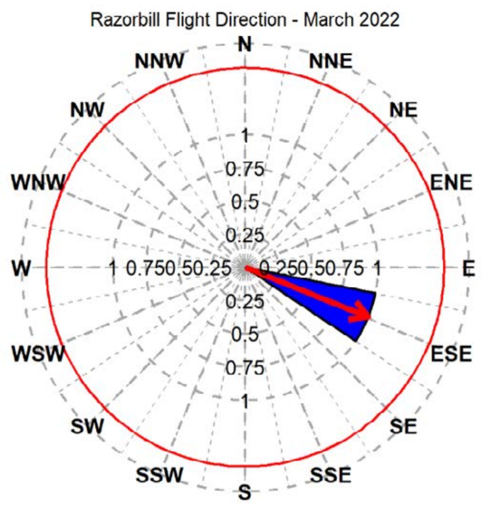
Number of Observations = 3
Mean Vector = 235.909
Length of mean vector (r) = 0.890
Rayleigh Test (Z) = 2.377
Rayleigh Test (p) = 0.084



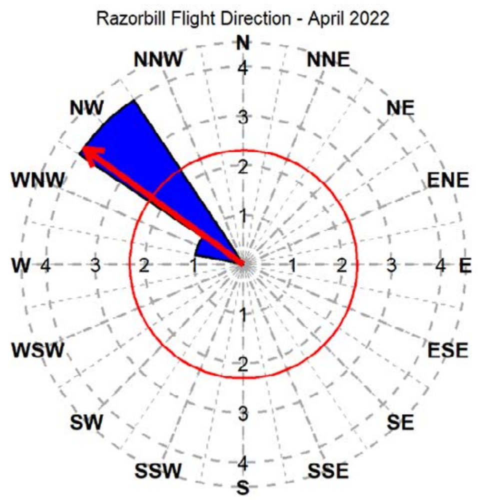
Number of Observations = 5
Mean Vector = 5.473
Length of mean vector (r) = 0.810
Rayleigh Test (Z) = 3.281
Rayleigh Test (p) = 0.028



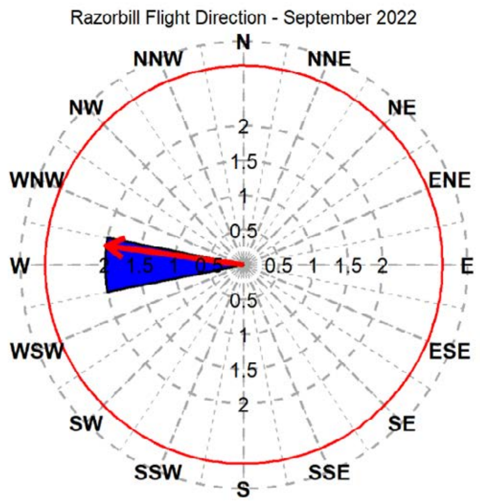
Number of Observations = 10
Mean Vector = 207.559
Length of mean vector (r) = 0.430
Rayleigh Test (Z) = 1.852
Rayleigh Test (p) = 0.158



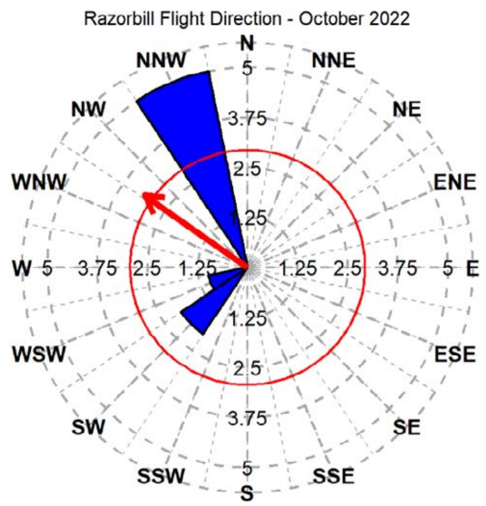
Number of Observations = 1
Mean Vector = 112.552
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



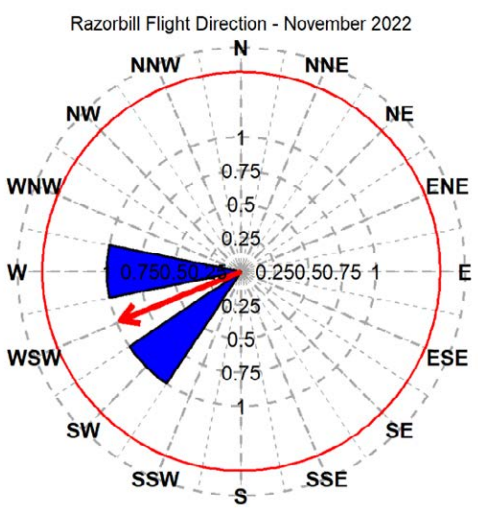
Number of Observations = 5
Mean Vector = 306.594
Length of mean vector (r) = 0.993
Rayleigh Test (Z) = 4.932
Rayleigh Test (p) = 0.001



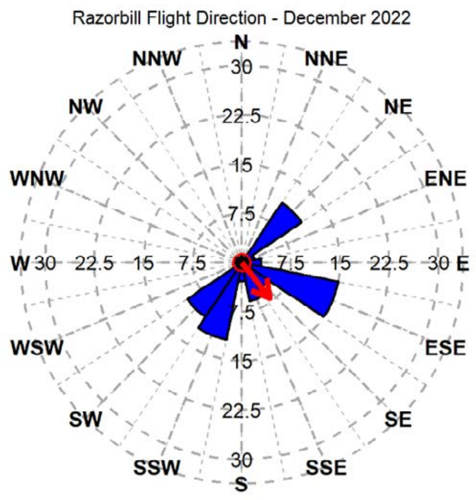
Number of Observations = 2
Mean Vector = 278.968
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 2.000
Rayleigh Test (p) = 0.137



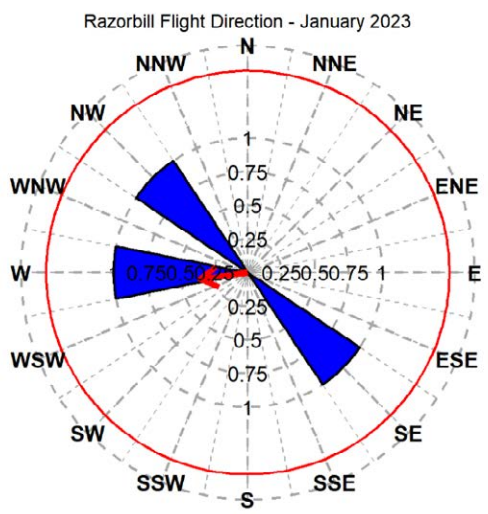
Number of Observations = 8
Mean Vector = 305.434
Length of mean vector (r) = 0.626
Rayleigh Test (Z) = 3.138
Rayleigh Test (p) = 0.038



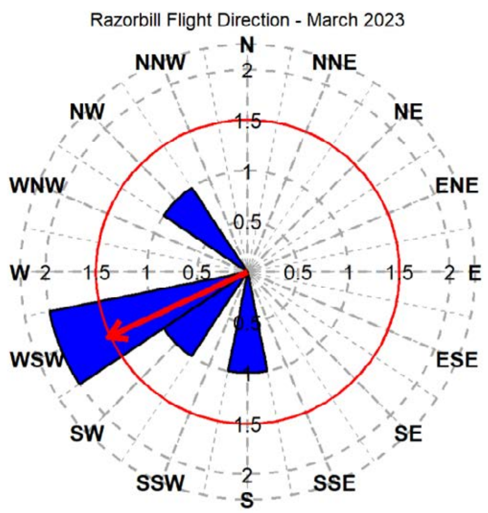
Number of Observations = 2
Mean Vector = 248.334
Length of mean vector (r) = 0.967
Rayleigh Test (Z) = 1.869
Rayleigh Test (p) = 0.163



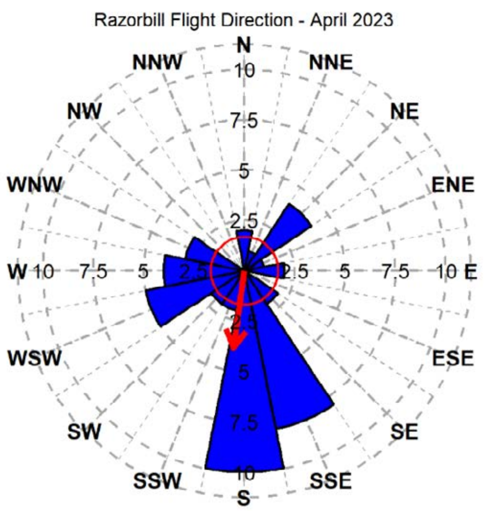
Number of Observations = 71
Mean Vector = 142.076
Length of mean vector (r) = 0.457
Rayleigh Test (Z) = 14.842
Rayleigh Test (p) = <0.001



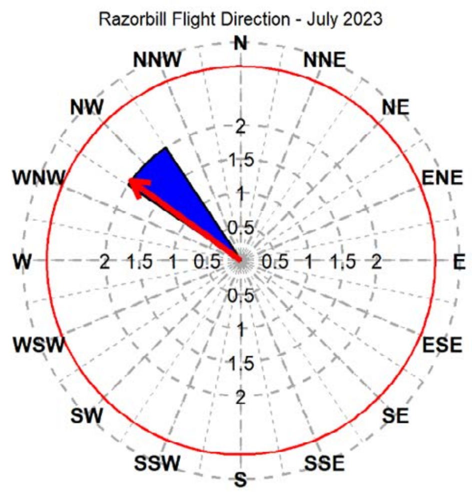
Number of Observations = 3
Mean Vector = 262.580
Length of mean vector (r) = 0.359
Rayleigh Test (Z) = 0.386
Rayleigh Test (p) = 0.716



Number of Observations = 5
Mean Vector = 245.748
Length of mean vector (r) = 0.762
Rayleigh Test (Z) = 2.902
Rayleigh Test (p) = 0.046

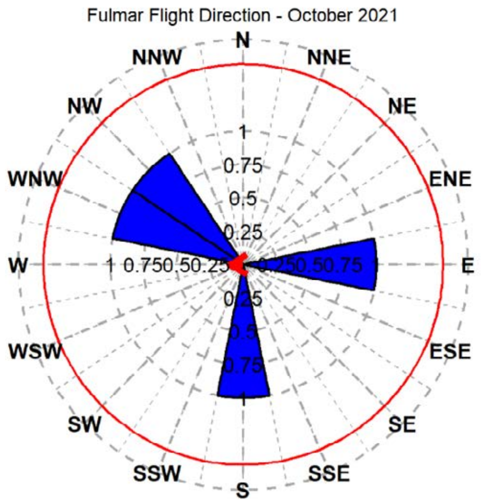


Number of Observations = 46
Mean Vector = 188.464
Length of mean vector (r) = 0.384
Rayleigh Test (Z) = 6.797
Rayleigh Test (p) = <0.001

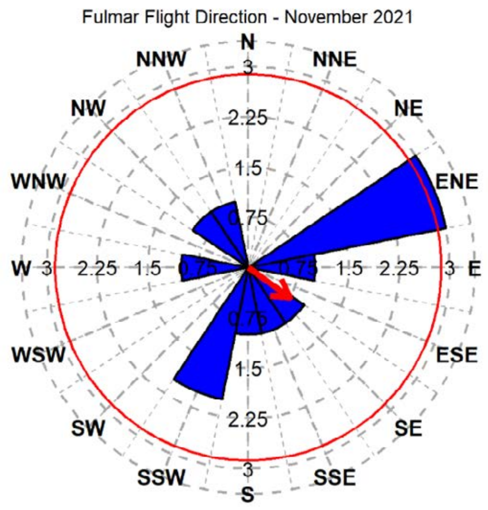


Number of Observations = 2
Mean Vector = 306.496
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.999
Rayleigh Test (p) = 0.137

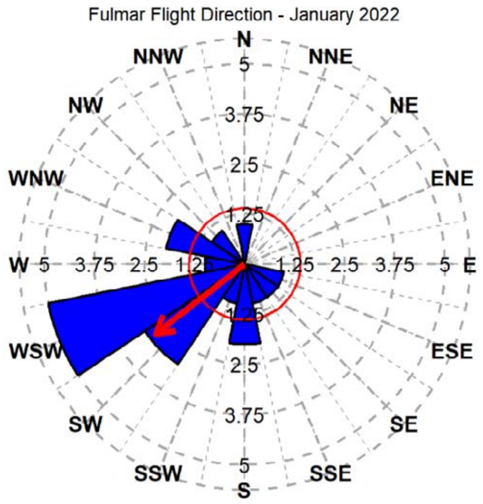
Fulmar rose diagrams (2021-2023)



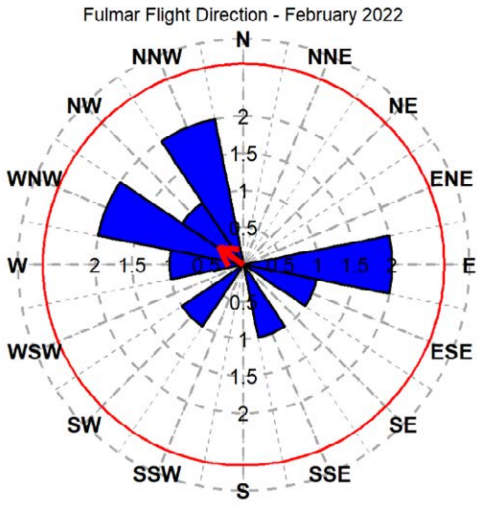
Number of Observations = 4
Mean Vector = 268.791
Length of mean vector (r) = 0.105
Rayleigh Test (Z) = 0.044
Rayleigh Test (p) = 0.962



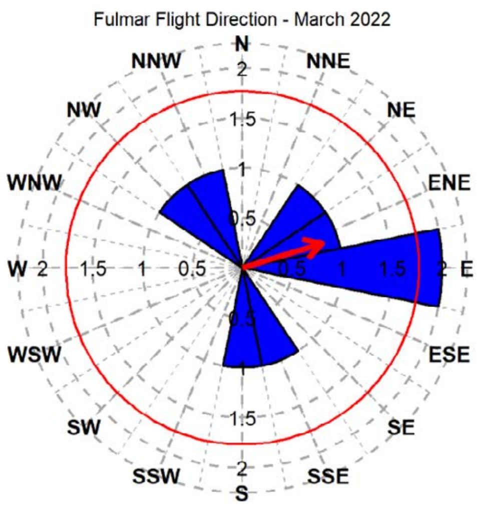
Number of Observations = 12
Mean Vector = 126.652
Length of mean vector (r) = 0.255
Rayleigh Test (Z) = 0.783
Rayleigh Test (p) = 0.466



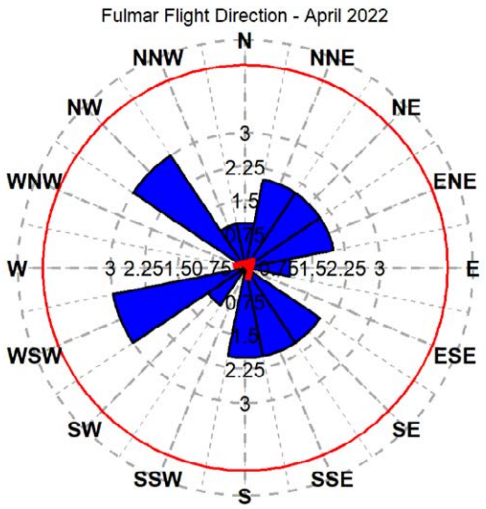
Number of Observations = 19
Mean Vector = 232.314
Length of mean vector (r) = 0.564
Rayleigh Test (Z) = 6.054
Rayleigh Test (p) = 0.002



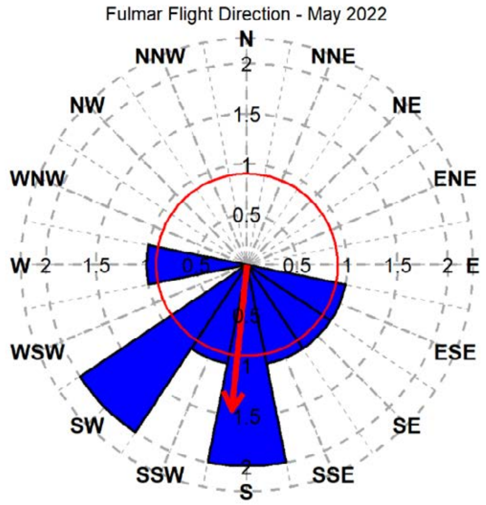
Number of Observations = 11
Mean Vector = 304.852
Length of mean vector (r) = 0.198
Rayleigh Test (Z) = 0.430
Rayleigh Test (p) = 0.661



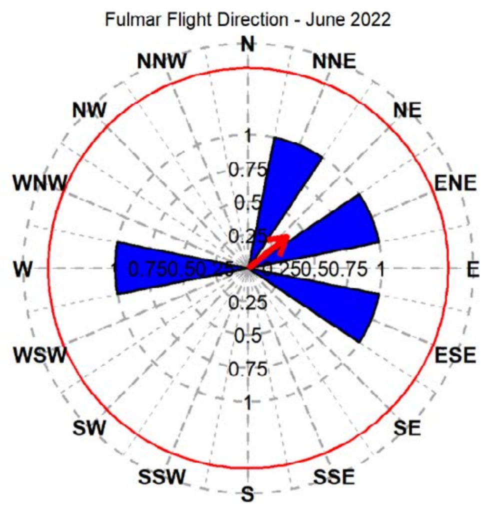
Number of Observations = 8
Mean Vector = 73.892
Length of mean vector (r) = 0.416
Rayleigh Test (Z) = 1.383
Rayleigh Test (p) = 0.258



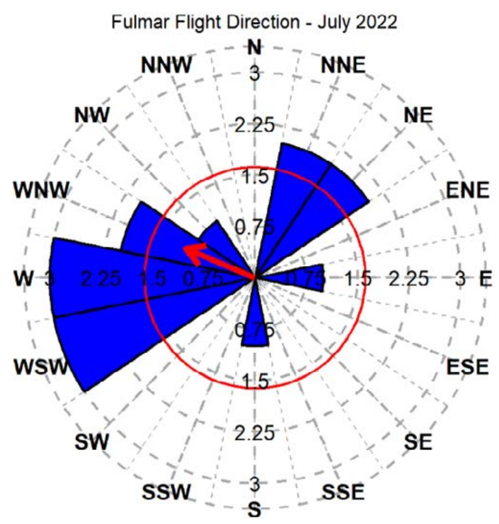
Number of Observations = 22
Mean Vector = 44.065
Length of mean vector (r) = 0.076
Rayleigh Test (Z) = 0.127
Rayleigh Test (p) = 0.883



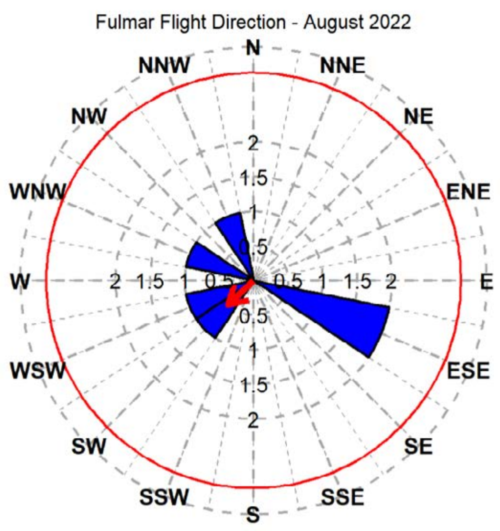
Number of Observations = 9
Mean Vector = 186.064
Length of mean vector (r) = 0.724
Rayleigh Test (Z) = 4.713
Rayleigh Test (p) = 0.006



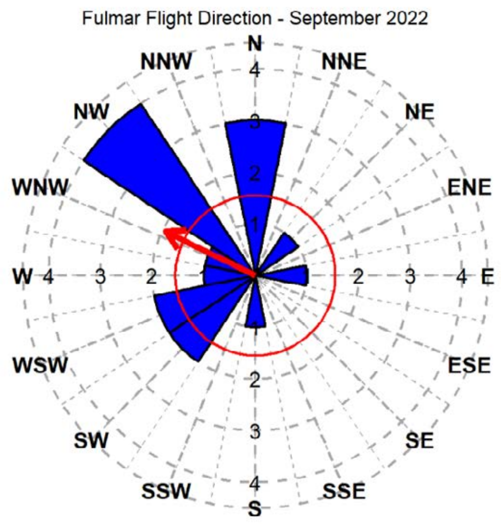
Number of Observations = 4
Mean Vector = 51.116
Length of mean vector (r) = 0.371
Rayleigh Test (Z) = 0.552
Rayleigh Test (p) = 0.606



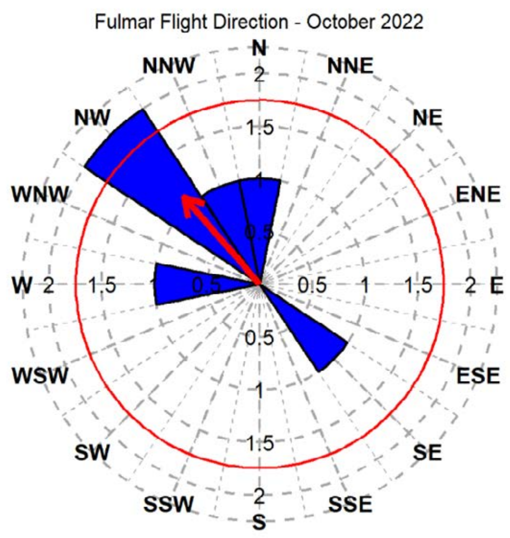
Number of Observations = 15
Mean Vector = 293.874
Length of mean vector (r) = 0.365
Rayleigh Test (Z) = 1.993
Rayleigh Test (p) = 0.136



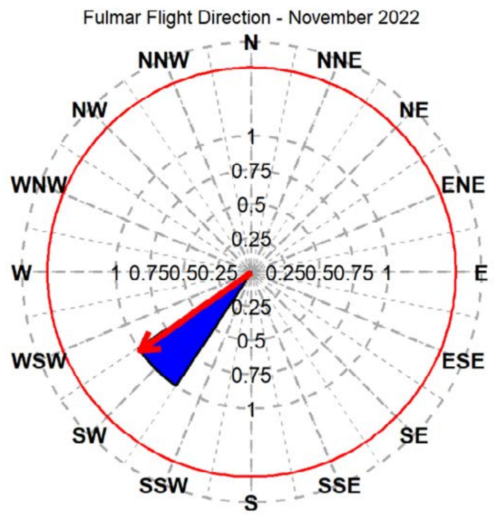
Number of Observations = 6
Mean Vector = 226.703
Length of mean vector (r) = 0.255
Rayleigh Test (Z) = 0.389
Rayleigh Test (p) = 0.696



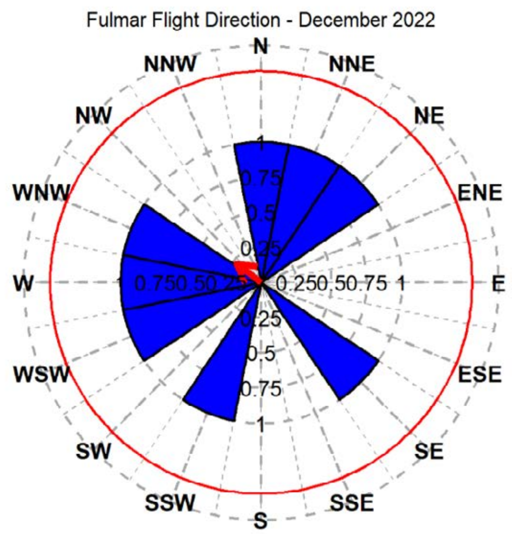
Number of Observations = 16
Mean Vector = 296.420
Length of mean vector (r) = 0.483
Rayleigh Test (Z) = 3.725
Rayleigh Test (p) = 0.022



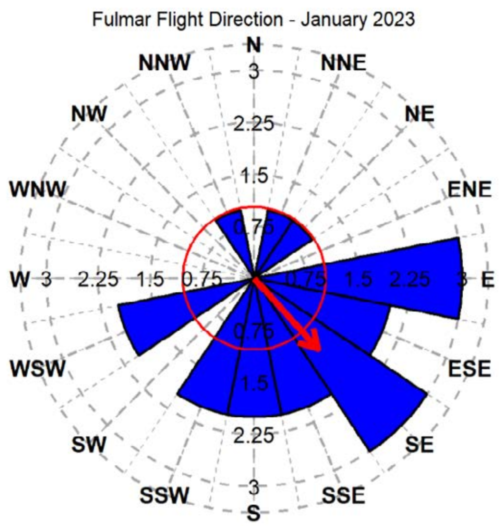
Number of Observations = 6
Mean Vector = 319.428
Length of mean vector (r) = 0.547
Rayleigh Test (Z) = 1.793
Rayleigh Test (p) = 0.170



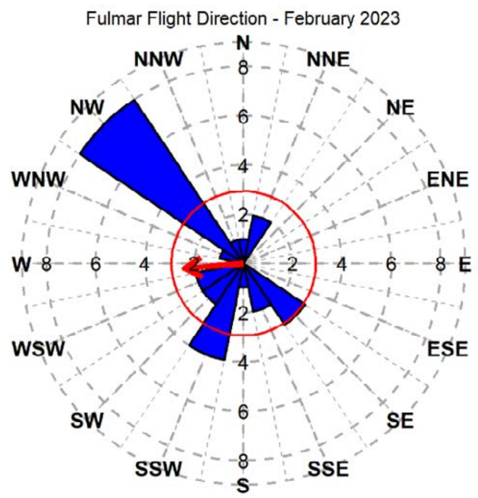
Number of Observations = 1
Mean Vector = 235.423
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512



Number of Observations = 8
Mean Vector = 307.779
Length of mean vector (r) = 0.219
Rayleigh Test (Z) = 0.385
Rayleigh Test (p) = 0.694

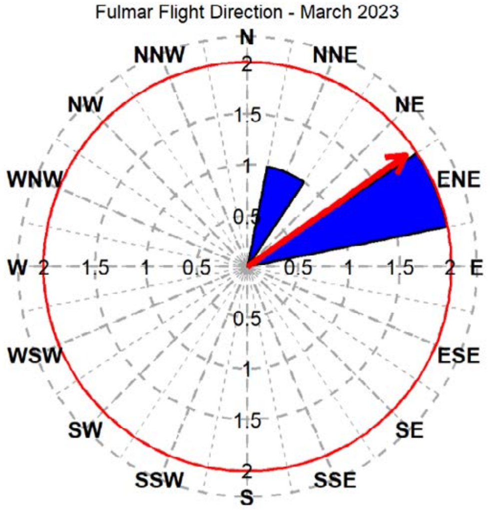


Number of Observations = 19
Mean Vector = 138.939
Length of mean vector (r) = 0.457
Rayleigh Test (Z) = 3.965
Rayleigh Test (p) = 0.017



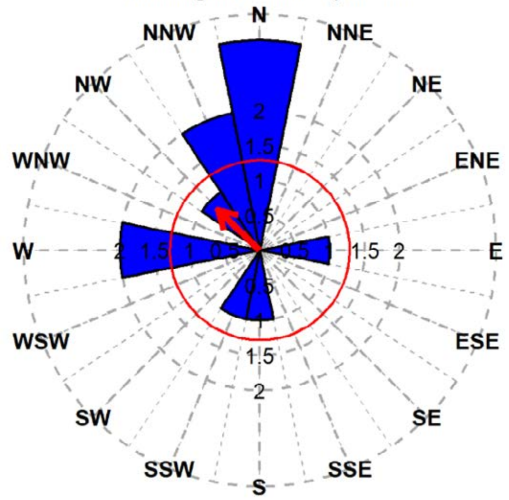
Number of Observations = 27
Mean Vector = 265.887
Length of mean vector (r) = 0.301
Rayleigh Test (Z) = 2.451
Rayleigh Test (p) = 0.085

Fulmar Flight Direction - March 2023



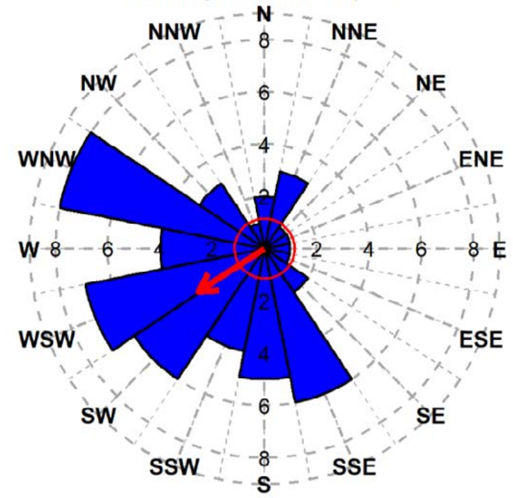
Number of Observations = 3
Mean Vector = 55.358
Length of mean vector (r) = 0.950
Rayleigh Test (Z) = 2.708
Rayleigh Test (p) = 0.053

Fulmar Flight Direction - April 2023



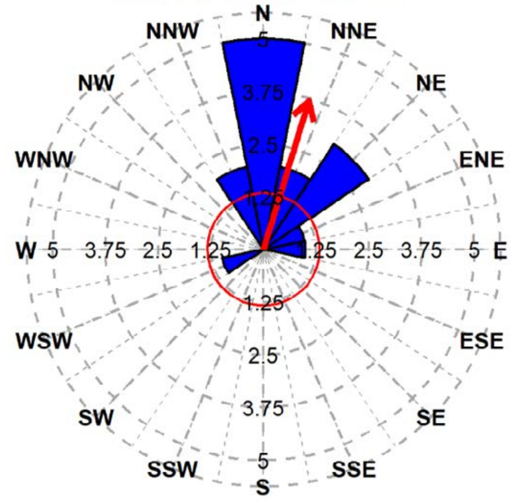
Number of Observations = 11
Mean Vector = 314.031
Length of mean vector (r) = 0.416
Rayleigh Test (Z) = 1.908
Rayleigh Test (p) = 0.149

Fulmar Flight Direction - May 2023



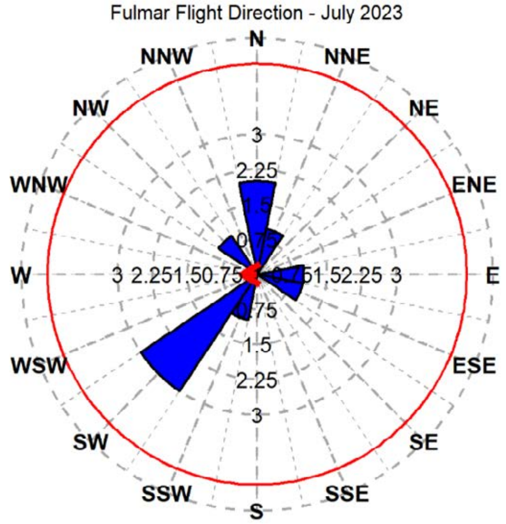
Number of Observations = 55
Mean Vector = 237.705
Length of mean vector (r) = 0.379
Rayleigh Test (Z) = 7.880
Rayleigh Test (p) = <0.001

Fulmar Flight Direction - June 2023



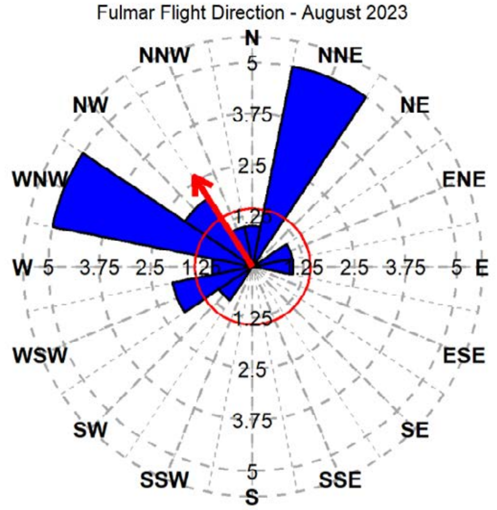
Number of Observations = 15
Mean Vector = 17.516
Length of mean vector (r) = 0.737
Rayleigh Test (Z) = 8.145
Rayleigh Test (p) = <0.001

Fulmar Flight Direction - July 2023



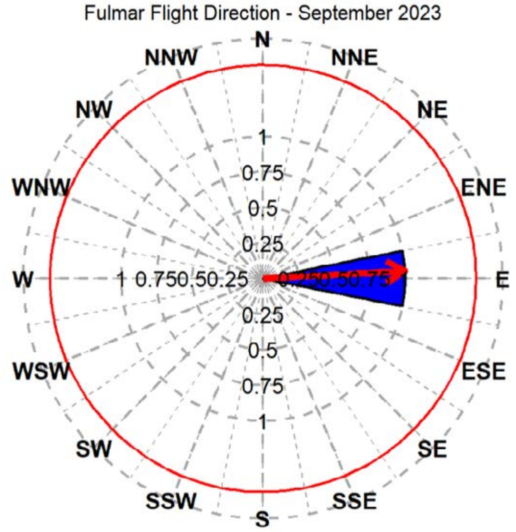
Number of Observations = 10
Mean Vector = 270.021
Length of mean vector (r) = 0.111
Rayleigh Test (Z) = 0.124
Rayleigh Test (p) = 0.888

Fulmar Flight Direction - August 2023



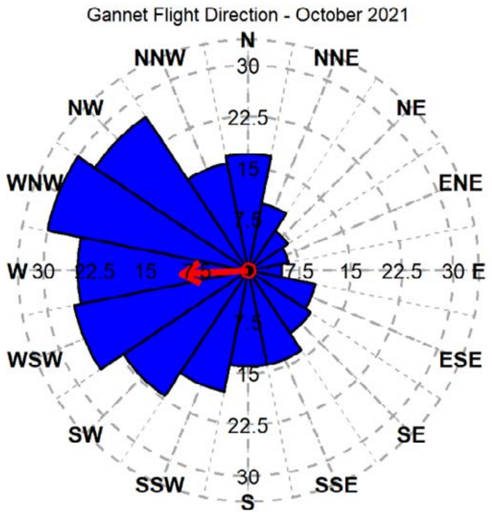
Number of Observations = 20
Mean Vector = 327.436
Length of mean vector (r) = 0.526
Rayleigh Test (Z) = 5.537
Rayleigh Test (p) = 0.003

Fulmar Flight Direction - September 2023

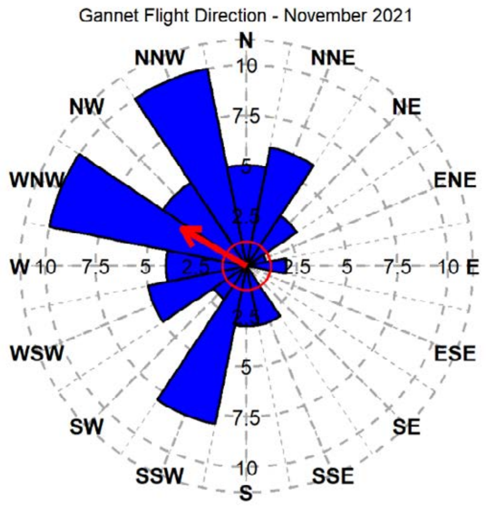


Number of Observations = 1
Mean Vector = 87.508
Length of mean vector (r) = 1.000
Rayleigh Test (Z) = 1.000
Rayleigh Test (p) = 0.512

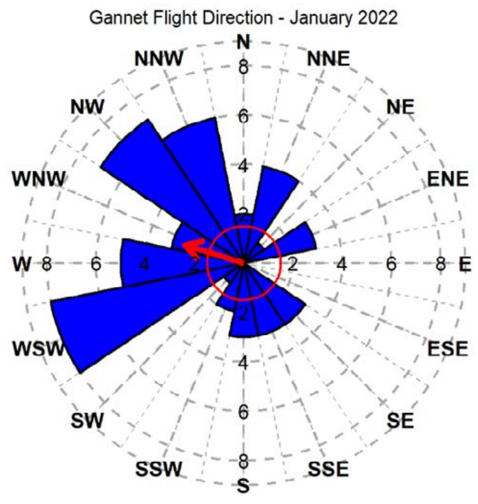
Gannet rose diagrams (2021-2023)



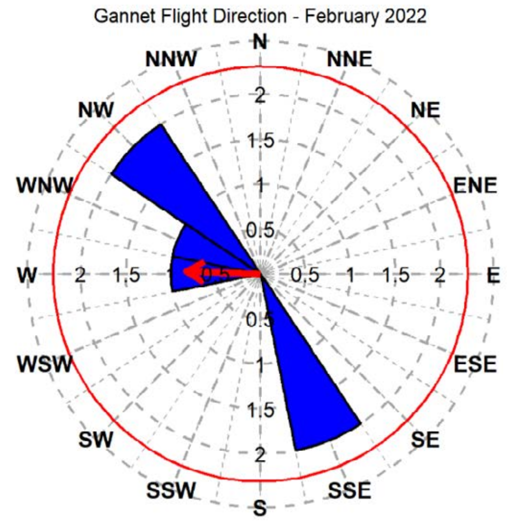
Number of Observations = 258
Mean Vector = 267.867
Length of mean vector (r) = 0.325
Rayleigh Test (Z) = 27.312
Rayleigh Test (p) = <0.001



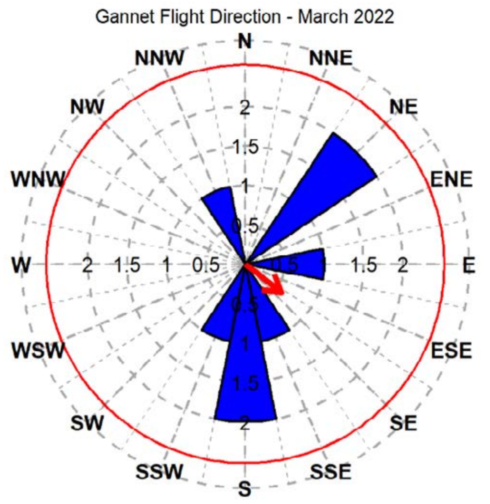
Number of Observations = 67
Mean Vector = 300.013
Length of mean vector (r) = 0.369
Rayleigh Test (Z) = 9.142
Rayleigh Test (p) = <0.001



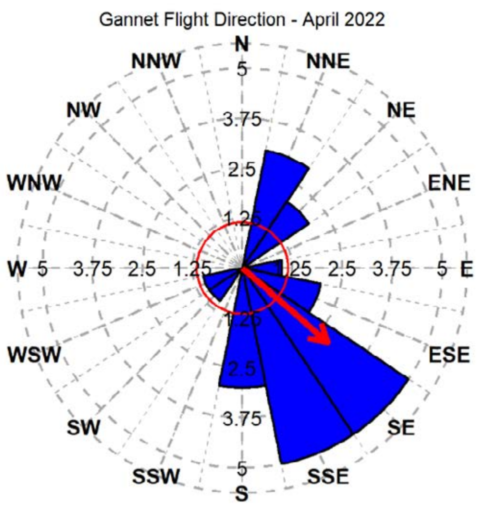
Number of Observations = 51
Mean Vector = 287.236
Length of mean vector (r) = 0.312
Rayleigh Test (Z) = 4.971
Rayleigh Test (p) = 0.007



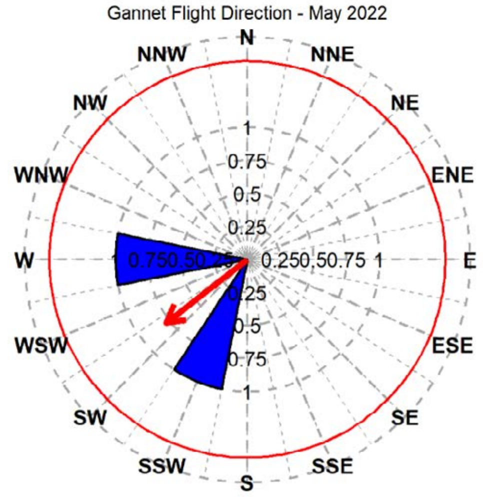
Number of Observations = 6
Mean Vector = 272.614
Length of mean vector (r) = 0.414
Rayleigh Test (Z) = 1.026
Rayleigh Test (p) = 0.375



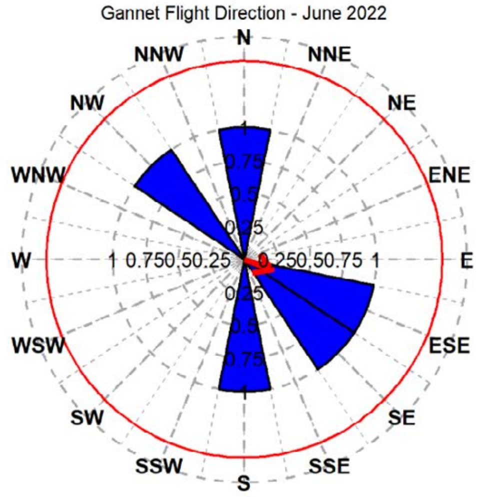
Number of Observations = 8
Mean Vector = 128.610
Length of mean vector (r) = 0.291
Rayleigh Test (Z) = 0.678
Rayleigh Test (p) = 0.522



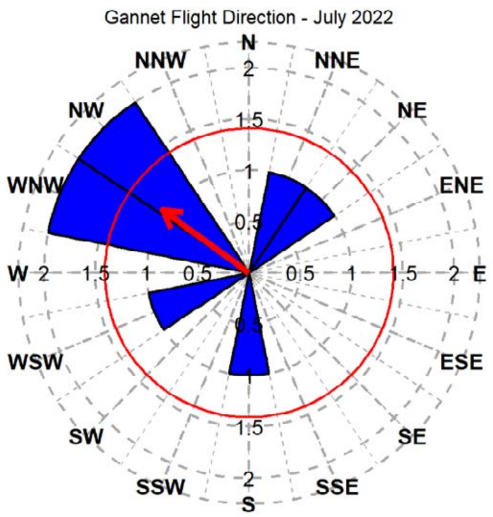
Number of Observations = 23
Mean Vector = 131.273
Length of mean vector (r) = 0.565
Rayleigh Test (Z) = 7.354
Rayleigh Test (p) = <0.001



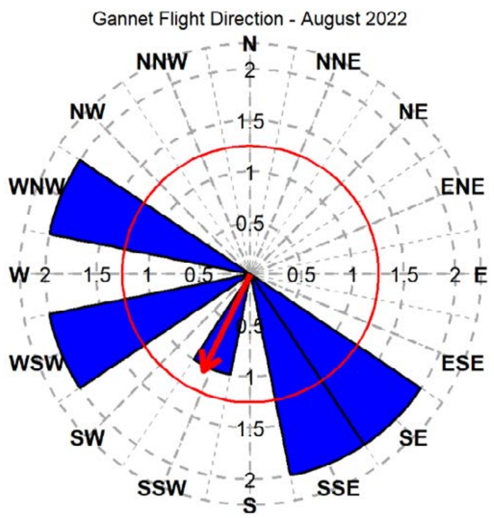
Number of Observations = 2
Mean Vector = 232.469
Length of mean vector (r) = 0.779
Rayleigh Test (Z) = 1.215
Rayleigh Test (p) = 0.345



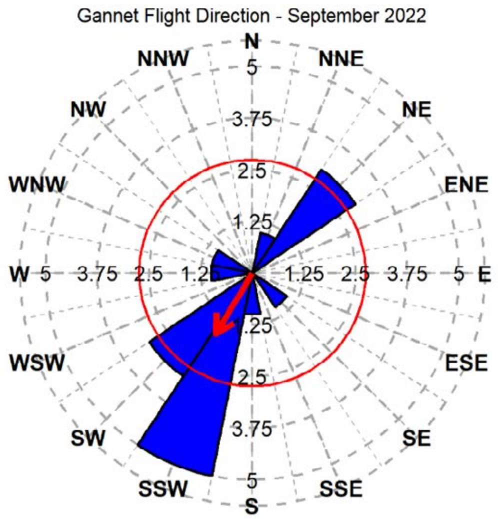
Number of Observations = 5
Mean Vector = 110.828
Length of mean vector (r) = 0.223
Rayleigh Test (Z) = 0.248
Rayleigh Test (p) = 0.797



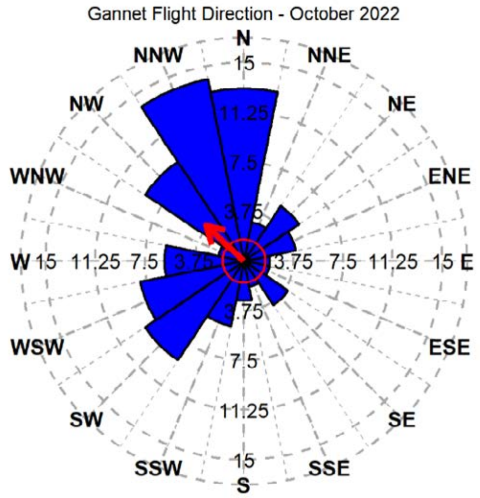
Number of Observations = 8
Mean Vector = 306.286
Length of mean vector (r) = 0.522
Rayleigh Test (Z) = 2.181
Rayleigh Test (p) = 0.112



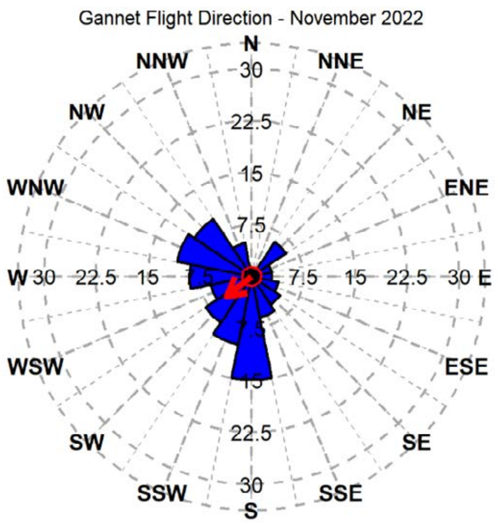
Number of Observations = 9
Mean Vector = 206.681
Length of mean vector (r) = 0.522
Rayleigh Test (Z) = 2.455
Rayleigh Test (p) = 0.083



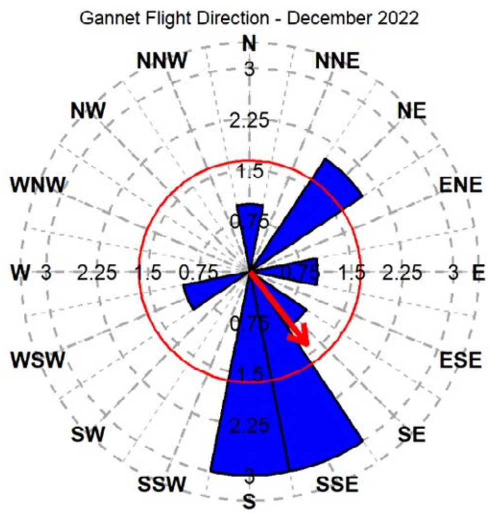
Number of Observations = 16
Mean Vector = 211.537
Length of mean vector (r) = 0.341
Rayleigh Test (Z) = 1.863
Rayleigh Test (p) = 0.156



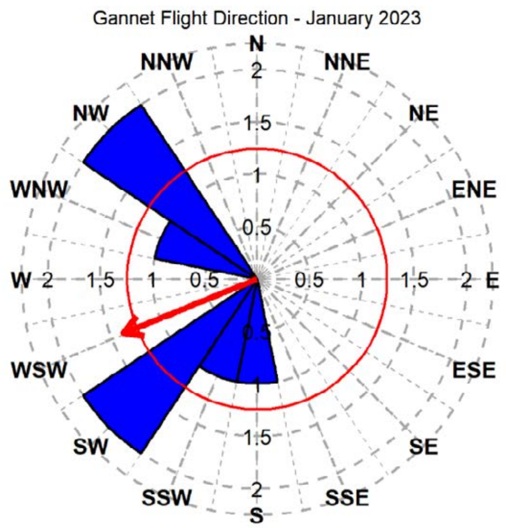
Number of Observations = 91
Mean Vector = 313.955
Length of mean vector (r) = 0.281
Rayleigh Test (Z) = 7.174
Rayleigh Test (p) = <0.001



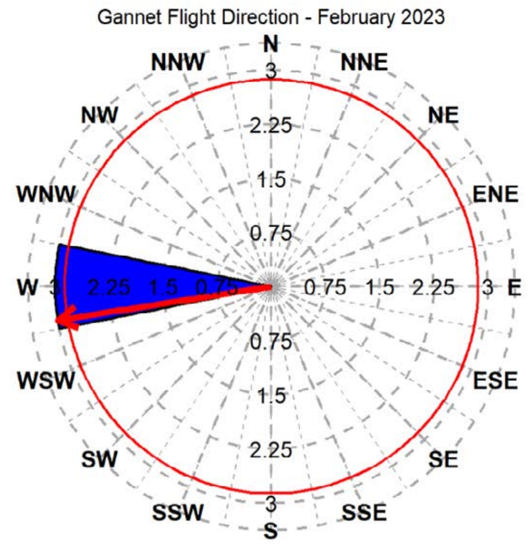
Number of Observations = 103
Mean Vector = 232.488
Length of mean vector (r) = 0.303
Rayleigh Test (Z) = 9.460
Rayleigh Test (p) = <0.001



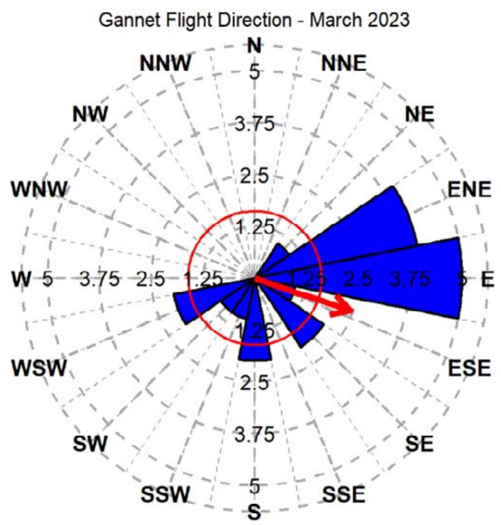
Number of Observations = 12
Mean Vector = 142.515
Length of mean vector (r) = 0.450
Rayleigh Test (Z) = 2.429
Rayleigh Test (p) = 0.086



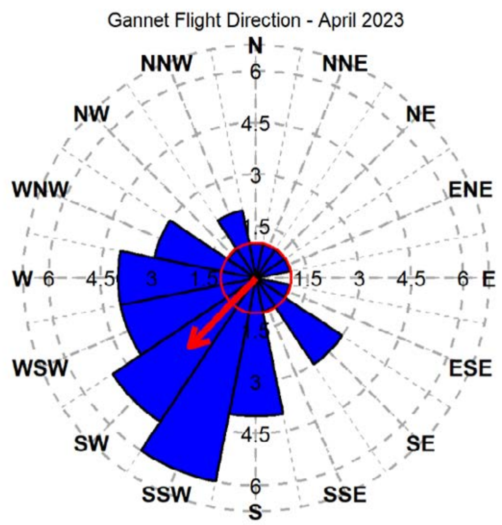
Number of Observations = 7
Mean Vector = 248.170
Length of mean vector (r) = 0.688
Rayleigh Test (Z) = 3.310
Rayleigh Test (p) = 0.030



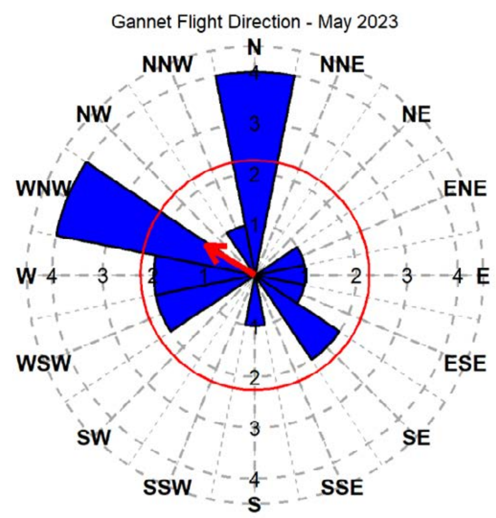
Number of Observations = 3
Mean Vector = 261.681
Length of mean vector (r) = 0.998
Rayleigh Test (Z) = 2.987
Rayleigh Test (p) = 0.034



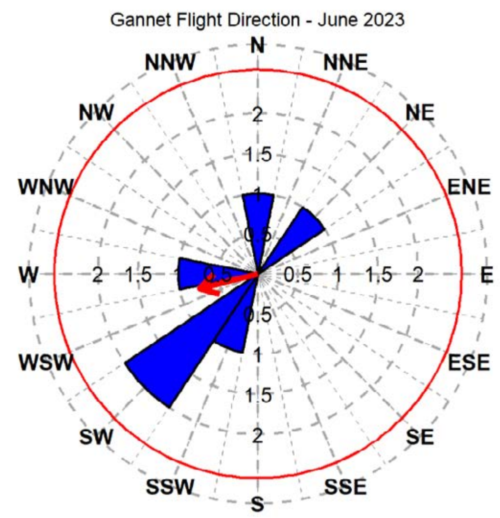
Number of Observations = 19
Mean Vector = 109.414
Length of mean vector (r) = 0.486
Rayleigh Test (Z) = 4.487
Rayleigh Test (p) = 0.010



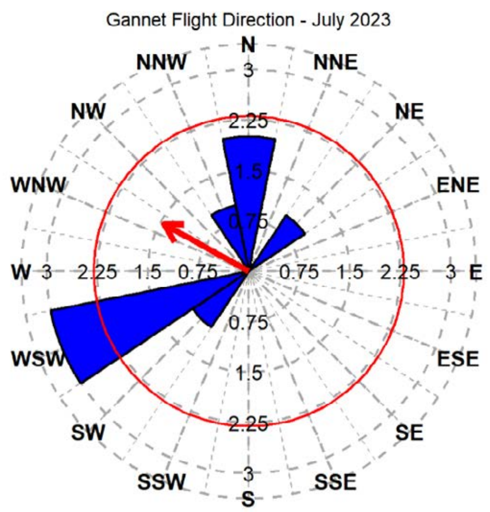
Number of Observations = 38
Mean Vector = 224.729
Length of mean vector (r) = 0.459
Rayleigh Test (Z) = 8.023
Rayleigh Test (p) = <0.001



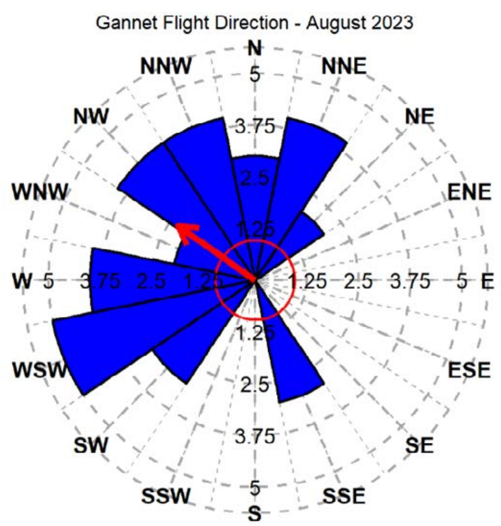
Number of Observations = 19
Mean Vector = 301.267
Length of mean vector (r) = 0.278
Rayleigh Test (Z) = 1.471
Rayleigh Test (p) = 0.232



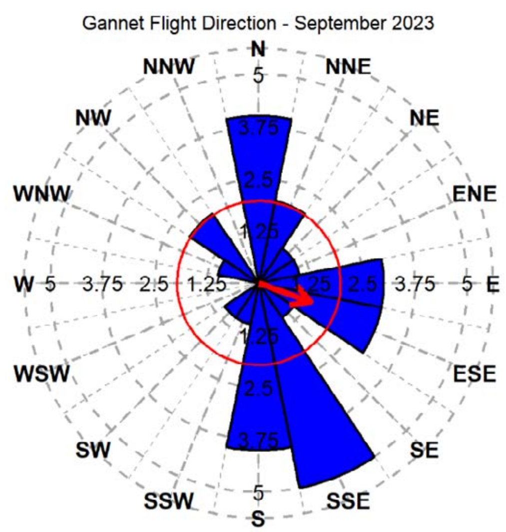
Number of Observations = 6
Mean Vector = 256.325
Length of mean vector (r) = 0.375
Rayleigh Test (Z) = 0.844
Rayleigh Test (p) = 0.449



Number of Observations = 8
Mean Vector = 299.182
Length of mean vector (r) = 0.479
Rayleigh Test (Z) = 1.835
Rayleigh Test (p) = 0.161



Number of Observations = 34
Mean Vector = 305.133
Length of mean vector (r) = 0.455
Rayleigh Test (Z) = 7.034
Rayleigh Test (p) = <0.001



Number of Observations = 29
Mean Vector = 110.626
Length of mean vector (r) = 0.262
Rayleigh Test (Z) = 1.987
Rayleigh Test (p) = 0.137

Appendix 5 Monthly age classes

Kittiwake age classes (unapportioned)

Survey	Age classes of raw counts (birds)		
	Adult	Sub-adult	Unknown
Oct-21	114	39	46
Nov-21	77	20	44
Dec-21	81	4	209
Jan-22	463	52	231
Feb-22	100	5	67
Mar-22	67	5	60
Apr-22	27	3	13
May-22	80	8	28
Jun-22	65	9	23
Jul-22	2	0	1
Aug-22	0	0	0
Sep-22	111	2	0
Oct-22	156	21	163
Nov-22	81	25	43
Dec-22	70	20	18
Jan-23	212	58	155
Feb-23	85	8	51
Mar-23	41	12	93
Apr-23	495	58	972
May-23	115	5	7
Jun-23	99	6	223
Jul-23	179	0	40
Aug-23	55	0	5
Sep-23	1	0	0

Kittiwake age classes (with apportionment of adults and 'unknown' using Applicant's Approach)

Survey	Age classes of raw counts (birds)		
	Adult	Immature	Juvenile
Oct-21	123	23	53
Nov-21	90	17	33
Dec-21	191	36	67
Jan-22	524	99	122
Feb-22	123	23	25
Mar-22	91	17	23
Apr-22	30	6	7
May-22	84	16	16
Jun-22	68	13	16
Jul-22	2	0	0
Aug-22	0	0	0
Sep-22	93	18	2
Oct-22	227	43	70
Nov-22	93	18	38
Dec-22	69	13	25
Jan-23	269	51	105
Feb-23	101	19	23
Mar-23	89	17	40
Apr-23	985	187	352
May-23	101	19	7
Jun-23	214	40	73
Jul-23	174	33	12
Aug-23	49	9	2
Sep-23	1	0	0

Kittiwake age classes (with apportionment of adults and 'unknown' using SNCB's Approach)

Survey	Age classes of raw counts (birds)	
	Adult	Sub-adult
Oct-21	155	44
Nov-21	116	25
Dec-21	266	28
Jan-22	667	79
Feb-22	159	13
Mar-22	120	12
Apr-22	39	4
May-22	105	11
Jun-22	85	12
Jul-22	3	0
Aug-22	0	0
Sep-22	111	2
Oct-22	300	40
Nov-22	119	30
Dec-22	86	22
Jan-23	349	76
Feb-23	130	14
Mar-23	123	23
Apr-23	1,355	170
May-23	121	6
Jun-23	296	32
Jul-23	214	5
Aug-23	59	1
Sep-23	1	0

Common gull age classes

Survey	Age classes of raw counts (birds)			
	Adult	First summer	First winter	Unknown
Oct-21	0	0	0	1
Nov-21	1	0	0	0
Dec-21	0	0	0	0
Jan-22	0	0	0	0
Feb-22	0	0	0	0
Mar-22	0	0	0	0
Apr-22	0	0	0	1
May-22	0	1	0	1
Jun-22	0	0	0	0
Jul-22	0	0	0	0
Aug-22	0	0	0	0
Sep-22	4	2	0	0
Oct-22	2	0	1	0
Nov-22	0	0	0	0
Dec-22	0	0	0	0
Jan-23	0	0	0	0
Feb-23	0	0	0	0
Mar-23	2	0	0	0
Apr-23	0	1	0	0
May-23	0	0	0	1
Jun-23	1	0	0	0
Jul-23	2	0	0	0
Aug-23	1	0	0	0
Sep-23	0	0	0	0

Great black-backed gull age classes

Survey	Age classes of raw counts (birds)		
	Adult	First winter	Unknown
Oct-21	0	0	0
Nov-21	0	1	0
Dec-21	0	0	0
Jan-22	0	0	3
Feb-22	1	0	1
Mar-22	0	1	0
Apr-22	2	1	0
May-22	2	0	0
Jun-22	1	0	0
Jul-22	0	0	0
Aug-22	0	0	0
Sep-22	0	0	0
Oct-22	2	0	0
Nov-22	0	0	0
Dec-22	0	0	0
Jan-23	1	1	0
Feb-23	3	0	0
Mar-23	1	0	0
Apr-23	0	0	0
May-23	0	0	0
Jun-23	0	0	0
Jul-23	0	0	0
Aug-23	0	0	0
Sep-23	0	0	0

Herring gull age classes

Survey	Age classes of raw counts (birds)			
	Adult	Second winter	First winter	Unknown
Oct-21	0	0	0	0
Nov-21	0	0	0	0
Dec-21	0	0	0	0
Jan-22	0	1	0	0
Feb-22	0	0	0	0
Mar-22	0	0	0	0
Apr-22	0	0	0	0
May-22	0	0	0	0
Jun-22	0	0	0	0
Jul-22	0	0	0	0
Aug-22	0	0	0	0
Sep-22	0	0	0	0
Oct-22	2	0	0	0
Nov-22	0	0	0	0
Dec-22	0	0	0	0
Jan-23	2	0	1	0
Feb-23	0	0	0	0
Mar-23	0	0	0	0
Apr-23	0	0	0	0
May-23	0	0	0	1
Jun-23	0	0	0	0
Jul-23	0	0	0	0
Aug-23	0	0	0	0
Sep-23	0	0	0	0

Lesser black-backed gull age classes

Survey	Age classes of raw counts (birds)		
	Adult	Third summer	Unknown
Oct-21	0	0	0
Nov-21	0	0	0
Dec-21	0	0	0
Jan-22	0	0	0
Feb-22	0	0	0
Mar-22	0	1	0
Apr-22	1	0	0
May-22	0	0	0
Jun-22	0	0	0
Jul-22	0	0	0
Aug-22	0	0	0
Sep-22	0	0	0
Oct-22	0	0	0
Nov-22	0	0	0
Dec-22	0	0	0
Jan-23	0	0	0
Feb-23	0	0	0
Mar-23	1	0	0
Apr-23	5	0	1
May-23	0	0	0
Jun-23	0	2	2
Jul-23	0	0	0
Aug-23	0	0	0
Sep-23	0	0	0

Guillemot age classes

Survey	Age classes of raw counts (birds)		
	Adult	Juvenile	Unknown
Oct-21	0	0	886
Nov-21	0	0	1715
Dec-21	0	0	602
Jan-22	0	0	398
Feb-22	0	0	344
Mar-22	0	0	960
Apr-22	0	0	445
May-22	0	0	154
Jun-22	0	0	58
Jul-22	6	6	18
Aug-22	0	0	14
Sep-22	0	0	509
Oct-22	0	0	635
Nov-22	0	0	613
Dec-22	0	0	155
Jan-23	0	0	650
Feb-23	0	0	216
Mar-23	0	0	473
Apr-23	0	0	2836
May-23	0	0	92
Jun-23	0	0	31
Jul-23	1	1	40
Aug-23	0	0	376
Sep-23	0	0	83

Razorbill age classes

Survey	Age classes of raw counts (birds)		
	Adult	Third winter	Unknown
Oct-21	0	0	26
Nov-21	6	0	43
Dec-21	0	0	28
Jan-22	0	0	193
Feb-22	0	0	126
Mar-22	0	0	10
Apr-22	0	0	27
May-22	0	0	25
Jun-22	0	0	3
Jul-22	0	0	0
Aug-22	0	0	0
Sep-22	0	0	120
Oct-22	0	0	62
Nov-22	0	0	23
Dec-22	0	0	185
Jan-23	0	0	261
Feb-23	0	0	58
Mar-23	0	0	47
Apr-23	0	0	534
May-23	0	0	7
Jun-23	0	0	1
Jul-23	0	0	5
Aug-23	0	0	12
Sep-23	0	0	6

Gannet age classes (unapportioned)

Survey	Age classes of raw counts (birds)					
	Adult	Fourth calendar year	Third calendar year	Second calendar year	Juvenile	Unknown
Oct-21	128	1	2	0	0	188
Nov-21	82	0	0	0	0	12
Dec-21	0	0	0	0	0	1
Jan-22	42	0	0	0	0	2
Feb-22	9	0	0	0	0	0
Mar-22	0	0	0	0	0	34
Apr-22	30	0	0	0	0	30
May-22	2	0	0	0	0	0
Jun-22	6	0	0	0	0	0
Jul-22	7	1	0	1	1	1
Aug-22	9	0	0	0	0	0
Sep-22	32	1	0	6	0	6
Oct-22	110	0	1	2	0	0
Nov-22	99	0	0	0	0	0
Dec-22	12	0	0	0	0	0
Jan-23	12	0	0	0	0	0
Feb-23	5	0	0	0	0	1
Mar-23	22	1	0	0	0	0
Apr-23	137	0	0	0	0	0
May-23	18	2	3	0	0	3
Jun-23	6	0	0	2	0	2
Jul-23	1	2	0	1	0	0
Aug-23	28	0	5	3	0	15
Sep-23	27	0	3	1	1	0

Gannet age classes (with apportionment of 'unknown' using DAS data)

Survey	Age classes of raw counts (birds)				
	Adult	Fourth calendar year	Third calendar year	Second calendar year	Juvenile
Oct-21	307	3	5	3	0
Nov-21	93	0	0	0	0
Dec-21	1	0	0	0	0
Jan-22	44	0	0	0	0
Feb-22	9	0	0	0	0
Mar-22	32	0	1	1	0
Apr-22	59	0	0	1	0
May-22	2	0	0	0	0
Jun-22	6	0	0	0	0
Jul-22	8	1	0	1	1
Aug-22	9	0	0	0	0
Sep-22	38	1	0	6	0
Oct-22	110	0	1	2	0
Nov-22	99	0	0	0	0
Dec-22	12	0	0	0	0
Jan-23	12	0	0	0	0
Feb-23	6	0	0	0	0
Mar-23	22	1	0	0	0
Apr-23	137	0	0	0	0
May-23	21	2	3	0	0
Jun-23	8	0	0	2	0
Jul-23	1	2	0	1	0
Aug-23	42	0	5	3	0
Sep-23	27	0	3	1	1