Partners in UK offshore wind

MORGAN OFFSHORE WIND PROJECT GENERATION ASSETS

Preliminary Environmental Information Report

Volume 4, annex 10.1: Offshore ornithology baseline characterisation

Image of an offshore wind farm

April 2023

FINAL

Partners in UK offshore wind

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Glossary

Term	Meaning
Bootstrapping	Bootstrapping is a statistical procedure that resamples a single dataset to create many simulated samples.
Confidence Interval	A confidence interval displays the probability that a parameter will fall between a pair of values around the mean.
Design-based Abundance Estimates	An estimated total abundance of birds within a given area. The design-based method is based on the premise that the portion of the study area that is surveyed is representative of the remainder of the study area.
MRSea	Statistical package to model spatial count data and predict spatial abundances. Package has been developed by the Centre for Research into Ecological and Environmental Modelling (CREEM) specifically for dealing with data collected for offshore wind farm projects.

Acronyms

Term	Meaning
AON	Apparently Occupied Nest
AOS	Apparently Occupied Site
CCW	Countryside Council for Wales
CMACS	Centre for Marine and Coastal Studies
CV	1) Coefficient of Variation (statistics) 2) Cross-Validation (statistics)
ESAS	European Seabirds at Sea (database)
GAM	Generalised Additive Model (statistics)
GPS	Global Positioning System
JNCC	Joint Nature Conservation Committee
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MRSea	Marine Renewable Strategic environmental assessment
QAIC	Quasi-Akaike Information Criterion (statistics)
QBIC	Quasi-Bayesian Information Criterion (statistics)
SALSA	Spatially Adaptive Local Smoothing Algorithm (statistics)
SD	Standard Deviation (statistics)
SMP	Seabird Monitoring Programme (database)
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UD	Utilisation Distribution
WWT	Wildfowl & Wetlands Trust

Units

Unit	Description
°C	Degrees Centigrade
cm	Centimetres
km	Kilometres
km^2	Square kilometres (area)
m	Metres

1 Offshore ornithology baseline characterisation

1.1 Introduction

1.1.1 Background

1.1.1.1 Energie Baden-Württemberg AG and bp Alternative Energy Investments Limited (hereafter referred to as the Applicant) are progressing with development of the Morgan Offshore Wind Project, located in the east Irish Sea, southeast of the Isle of Man.

1.1.1.2 The Morgan Offshore Wind Project is located in the east Irish Sea, approximately 22.3km (12nm) from the Isle of Man and 36.2km (19.5nm) from the northwest coast of England (when measured from Mean High Water Springs (MHWS). The Morgan Array Area is 322.25km^2 in size (see Figure 1.1).

1.1.1.3 This offshore ornithology baseline characterisation technical report provides a detailed baseline characterisation of offshore ornithology associated with the Morgan Offshore Wind Project Generation Assets (hereafter referred to as the Morgan Generation Assets). This offshore ornithology baseline characterisation technical report includes site specific data, where available, collected by the Applicant for their offshore wind portfolio in the east Irish Sea.

1.1.1.4 The Morgan Generation Assets is within the foraging range of several seabird species nesting at colonies designated as Special Protection Areas (SPAs) (qualifying as an individual species and/or within an assemblage of species).

1.1.1.5 This technical report details the findings of the desktop review carried out for the Morgan Generation Assets as well as the site-specific digital aerial surveys carried out to date in the Morgan Offshore Ornithology Array Area study area. This technical report describes the methods used to characterise the baseline conditions (i.e. abundance and distribution of seabirds and other bird groups found in the offshore environment) and presents the results of the desk-based studies and the site-specific digital aerial surveys undertaken to date at the Morgan Array Area, which comprise digital aerial surveys carried out monthly between April 2021 and March 2022 inclusive. Only 12 months of the 24 month programme of digital aerial survey data was available for the analysis and assessment presented in this PEIR.

1.1.1.6 For this technical report, the overarching term ‘seabird’ is used to refer to species that depend on the marine environment for survival at some point in their life cycle. Therefore, in addition to the true seabirds, seaducks and divers and grebes are also included because of their additional reliance on marine areas, especially in the non-breeding season.

1.1.2 Study area

1.1.2.1 The study area for the offshore ornithology Environmental Impact Assessment (EIA) is the Morgan Offshore Ornithology Array Area study area: this includes the Morgan Array Area plus a 10km buffer (Figure 1.1). This area was defined by the extent of the digital aerial bird surveys.

1.1.2.2 There are several protected sites designated for marine and coastal waterbirds with connectivity to the Morgan Generation Assets. Nature conservation designations with relevance to birds comprise Special Protection Area (SPAs) within the National site network in the UK and the Natura 2000 network of European sites in the Republic of Ireland, Ramsar sites, and national (e.g. Sites of Special Scientific Interest (SSSI)) and regional designations.

1.1.2.3 There are no current or proposed designated sites within the Morgan Array Area. There are, however, several SPAs along the west British coastline and east and north coastlines of Ireland and Northern Ireland that support qualifying species that have been recorded during the site-specific digital aerial surveys for the Morgan Generation Assets. Figure 1.2 shows the designated sites (international and national) with relevant ornithology features that are within 100km of the Morgan Array Area and likely to be given consideration within the assessment. This is not an exhaustive representation of all designated sites with connectivity to the Morgan Generation Assets.

1.1.2.4 It is considered that there is the potential for an impact on breeding seabird colonies if the Morgan Generation Assets are located within the regular foraging range of the species. In the absence of specific information on the foraging patterns of breeding birds, Natural England (2022), in the guidance document: *Offshore Wind Marine Environmental* Assessments*: Best Practice Advice for Evidence and Data Standards,* recommends that connectivity is established by the mean maximum (plus one standard deviation (+1 S.D.)) foraging range reported in Woodward *et al*. (2019). Identification of SPAs with breeding seabird interest with potential connectivity to the Morgan Array Area is presented in Table 1.7.

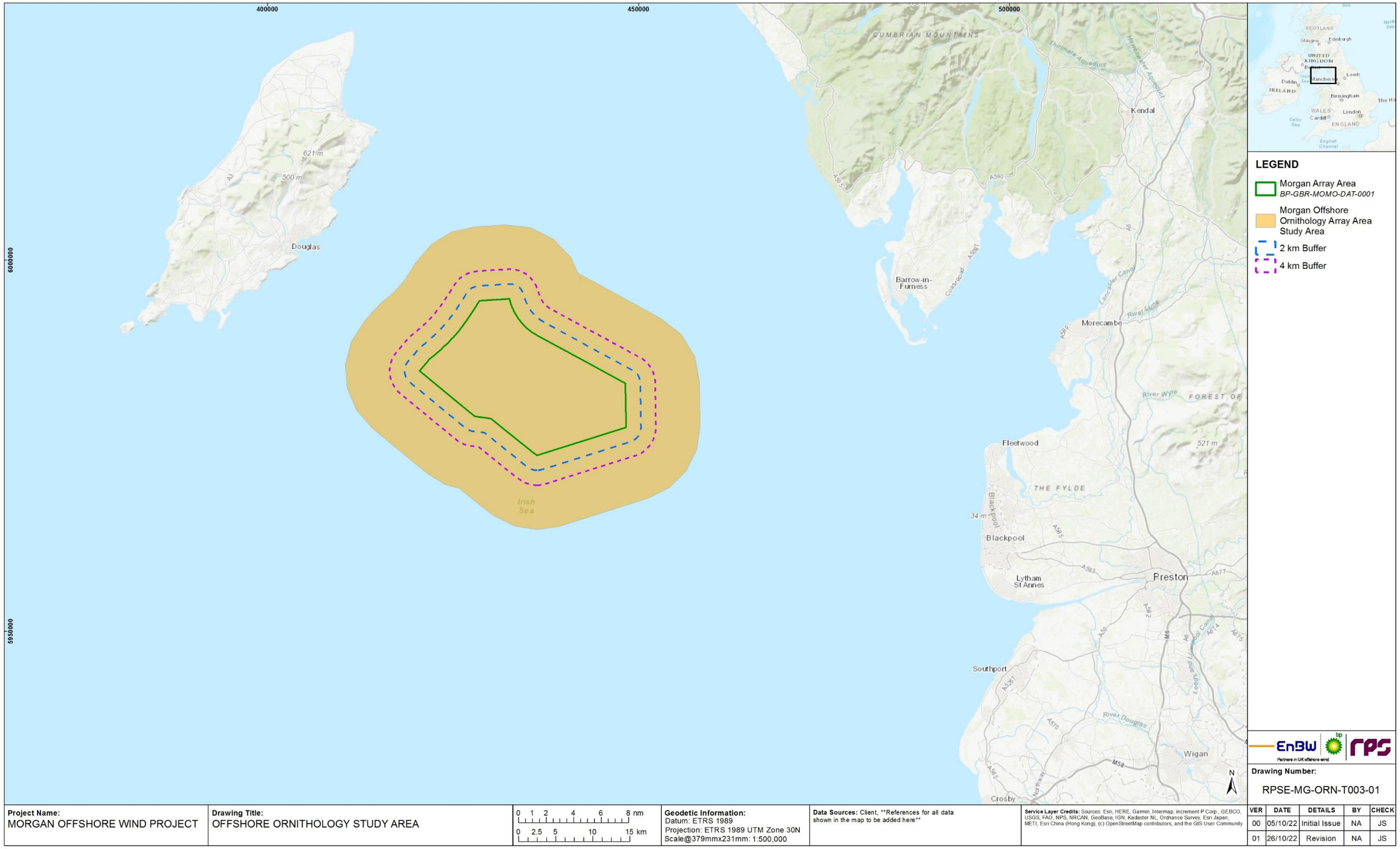


Figure 1.1: Morgan Offshore Ornithology Array Area study area.

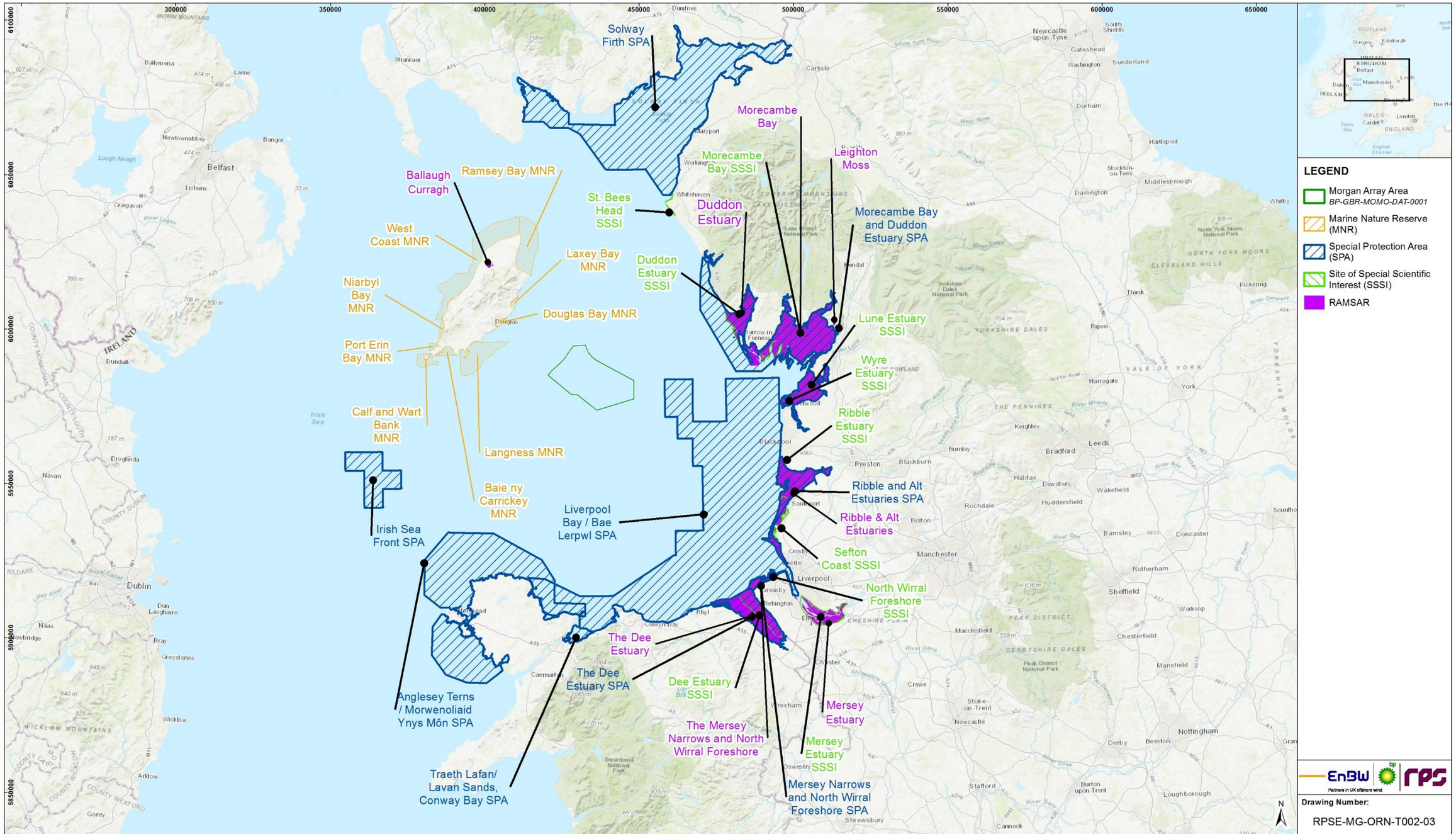


Figure 1.2: Boundaries for protected sites designated for seabirds and coastal birds within 100km of the Morgan Array Area.

1.2 Methodology

1.2.1 Desktop review of data sources

1.2.1.1 Evidence sources and existing datasets have been reviewed to define the seabird baseline and support the findings of the site-specific digital aerial surveys. Both scientific and grey literature were reviewed, and the subsequent data sources relevant to the Morgan Generation Assets identified. Peer-reviewed scientific literature examining seabird distribution and abundance in UK waters was included and grey literature was searched for unpublished reports documenting seabird distribution and abundance. This included survey data collected as part of offshore renewables developments (searched through Marine Data Exchange website (www.marinedataexchange.co.uk)), and survey data from surveillance monitoring undertaken by the Statutory Nature Conservation Bodies (SNCBs).

1.2.1.2 The data that have been collected and used to inform this baseline characterisation annex are summarised in Table 1.1. This includes a description of the data sources, the spatiotemporal coverage of the dataset across the Morgan Generation Assets Scoping Boundary, and any key limitations and assumptions.

Table 1.1: Summary of key desktop datasets and reports.

Source/ Reference	Description	Data source	Date	Site Coverage	Limitations & Assumptions
Cleasby *et al*. (2020)	Identifying important at-sea areas for seabirds using species distribution models and hotspot mapping for four seabird species: black-legged kittiwake, common guillemot, razorbill and European shag.	Tracking data	May to July, (2010 to 2014)	Some overlap with the Morgan Offshore Ornithology Array Area study area but provides information on birds in the wider context of the site.	Only four species analysed and presented
Waggitt *et al*. (2020)	Distribution maps of cetacean and seabird populations in the North-East Atlantic.	Aerial and vessel survey data	1980 to 2018	North-East Atlantic wide coverage and complete overlap with the Morgan Offshore Ornithology Array Area study area.	10km resolution
Wakefield *et al.* (2017)	Breeding density, fine-scale tracking, and large-scale modelling reveal the regional distribution of four seabird species.	Tagging data	2010 to 2014	Some degree of overlap of predicted density in the Morgan Offshore Ornithology Array Area study area and wider Irish Sea.	Coarse scale and restricted to four species during the breeding season
Bradbury *et al.* (2014)	SeaMaST provides evidence on the use of sea areas by seabirds and inshore waterbirds in English territorial waters, mapping their relative sensitivity to offshore wind farm developments.	Boat and aerial surveys	1979 to 2012	Complete overlap with the Morgan Offshore Ornithology Array Area study area.	English territorial waters at a resolution of 3km
Existing offshore wind farm grey literature	Information obtained from several offshore wind farm applications (Awel y Môr, Rhiannon, Ormonde, Walney, West of Duddon Sands, Gwynt y Môr and Burbo Bank).	Boat-based and aerial surveys	Various dates	Some degree of overlap of predicted density with the Morgan Offshore Ornithology Array Area study area and wider east Irish Sea.	Interpretation of the data
JNCC Seabird Monitoring Programme	Seabirds Count and the Seabird Monitoring Programme	Bird counts at breeding colonies	1986 to 2021	Count data at breeding colonies that may have connectivity with the Morgan Offshore Ornithology Array Area study area.	Data may be several years old or incomplete for some colonies.
Mackey and Giménez (2006)	Data Report for offshore seabird populations	European Seabirds at Sea (ESAS) dataset	1979 to 2003	Strategic Environmental Assessment (SEA) – Zone 6 (Irish Sea) overlapping with the Morgan Offshore Ornithology Array Area study area.	Coarse resolution - distribution and density produced for each Strategic Environmental Assessment (SEA).
BirdLife International (2022)	Interface to view seabird tracking database	Seabird tracking data	Various dates	Some overlap of seabird tracks with the Morgan Offshore Ornithology Array Area study area.	Download of Global Positioning System (GPS) tracking data subject to approval from data owner.

1.2.2 Mapping seabirds at sea data sources

1.2.2.1 Supplementary material from Waggitt et *al.* (2020) and Bradbury *et al.* (2014) was used to produce maps showing the spatial variation in densities across seasons in the Morgan Offshore Ornithology Array Area study area. The spatial coverage of both datasets overlapped with the Morgan Array Area.

1.2.2.2 Waggitt et *al*. (2020) have developed an approach to produce distribution maps for 12 seabird species at 10km and monthly resolution in the North-East Atlantic. Bradbury *et al*. (2014) analysed offshore boat and aerial observer surveys spanning from 1979 to 2012 to produce predicted bird densities across a grid covering English territorial waters at a resolution of 3×3km. Monthly relative densities were available in raster and shapefile format, for Waggitt *et al.* (2020) and Bradbury *et al*. (2014) respectively. Using the raster files from Waggitt *et al*. (2020), monthly raster displaying number of individuals per km^2 were aggregated into biological season (breeding and non-breeding) as defined by Furness (2015). The seasonal split for each species (breeding and non-breeding) is shown in Table 1.2.

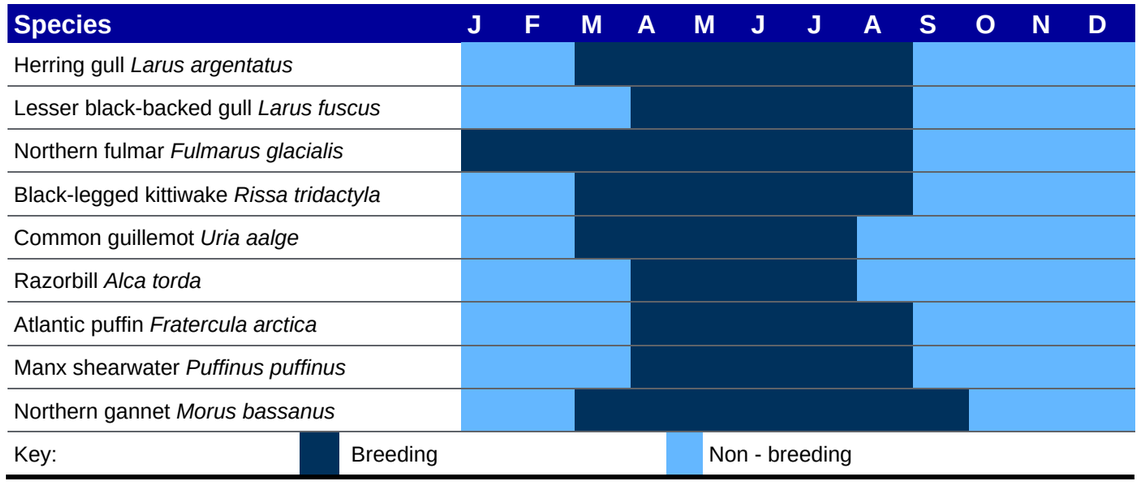
1.2.2.3 Average density per season was mapped in QGIS. For several key seabird species (listed in Table 1.2), the spatial variation in densities was shown at a 10×10km resolution, for an area which included the Morgan Array Area, the 2km, 4km and the 10km buffer zones. Great black-backed gull *Larus marinus* could not be presented

given that the species is not included in the analysis carried out by Waggitt *et al.* (2020). For all key species, the monthly abundance for each zone was produced using the 10×10km tiles displaying densities.

1.2.2.4 Seasonal predicted densities were already available in a shapefile format in Bradbury *et al.* (2014) and were mapped using QGIS. The seasonal split in Bradbury *et al*. (2014) differed to the approach that was followed for visualising the Waggitt *et al*. (2020) data. Bradbury *et al.* (2014) split seasons as followed: summer (April to September) and winter (October to March). Therefore, there must be a degree of caution when interpreting and comparing seasonal variation findings between Bradbury *et al.* (2014) and Waggitt *et al*. (2020).

1.2.2.5 In addition to the seasonal split, the Waggitt *et al*. (2020) study is based on data collected from 1980 to 2018, whilst Bradbury *et al.* (2014) included data collected from 1979 to 2012. Furthermore, the spatial resolution differed between the two studies – ranging from 3×3km in Bradbury *et al.* (2014) to 10×10km in Waggitt *et al*. (2020).

Table 1.2: Annual life cycle across months for key species.



1.2.3 Site-specific digital aerial survey

Survey summary methodology and survey area

1.2.3.1 Digital aerial surveys for seabirds have been undertaken by APEM in the Morgan Offshore Ornithology Array Area study area. Digital aerial surveys commenced in April 2021 and are ongoing. The results of the first 12 months of data, inclusive of March 2022, are presented in this report. Only 12 months of the 24 month programme of digital aerial survey data was available for the analysis and assessment presented in this PEIR. The report will be updated for the Environmental Statement, when the full 24 month programme has been completed.

1.2.3.2 The digital aerial survey method was designed to optimise the data collection for ornithological and marine mammals by using a grid-based collection method with 30% of the sea surface collected and 12% analysed conforming with current industry best-practice. Studies have been undertaken which suggest that baseline surveys should collect a minimum of 10% coverage (BSH, 2013). It is important to note that this study was in relation to transect-based surveys, and it has been suggested that due to the high number of replicates achieved from grid-based surveys this method requires less coverage compared to transect-based surveys (Coppack *et al*. 2017; Weidauer *et al*. 2016). Due to the lack of historic data within the survey area, the survey design process relied on similar projects which have been previously agreed by statutory nature conservation bodies (SNCBs) as suitable for baseline characterisation. Two examples include: Norfolk Boreas which analysed an 8% grid and Gwynt y Môr which analysed a 12% grid. From analysis done so far on the aerial survey data for the Morgan Generation Assets, calculations from effort data demonstrate for the Morgan Offshore Ornithology Array Area study area, the mean area processed was 12.9% (±0.04%) (figures in parentheses are standard errors). These values are higher than the 10% previous minimum coverage suggested by literature (BSH, 2013) and coverage accepted by previous projects.

1.2.3.3 APEM's bespoke camera system was fitted into a twin-engine aircraft, and custom flight planning software allowed each flight line to be accurately mapped for use before and during the flight. The camera system captured abutting still imagery along 18 survey lines which were spaced approximately 2km apart. The aircraft collected the data at an altitude of approximately 396m, and a speed of approximately 120 knots (kn).

1.2.3.4 The images were reviewed by appropriately experienced/qualified analysts to enumerate birds to species level, where possible. Internal quality assurance was undertaken to check for missed targets and to ensure the correct species were identified. Birds identified from the images were 'snagged' (i.e. located within the images) and categorised to the lowest taxonomic level possible. Images were always viewed by a minimum of two members of staff as part of a comprehensive internal quality assurance (QA) process.

1.2.3.5 The direction of birds in flight were recorded from all digital still images. This was undertaken by measuring the axis of bill to tail, within bespoke image analysis software, taking the bearing relative to the bird's head. This bearing was linked to the geo-referenced image and thus provided an accurate representation of bird orientation at time of image capture. These data can be used to explore the predominant flight direction of each species during a digital aerial survey or during a season by the creation of circular statistic outputs termed 'rose diagrams'.

1.2.3.6 All digital aerial surveys were undertaken in weather conditions that did not compromise the ability to provide data on the identification, distribution and abundance of bird species and marine megafauna within the survey area. Favourable conditions for surveying are defined by APEM as a cloud base of >396m, visibility of >5km, wind speed of <30kn and a sea state of no more than Beaufort force 4 (moderate). For health and safety reasons, no digital aerial surveys were to be undertaken in icing conditions.

1.2.3.7 Measures were taken to minimise glint and glare (strong reflected light off the sea), that makes finding and identifying bird species and marine megafauna more difficult. On days with minimal cloud, digital aerial surveys were avoided for two hours around midday. This reduced the risk of collecting images that are difficult to analyse.

1.2.3.8 The dates, start and end times for each digital aerial survey are provided in Table 1.3 with the corresponding weather conditions reported in Table 1.4.

Table 1.3: Date and start/end times (Coordinated Universal Time) for each flight for the April 2021 to March 2022 digital aerial surveys.

Survey No.	Date	Flight No.	UTC Start Time (HH:MM)	UTC End Time (HH:MM)
01	17/04/2021	1	08:14	13:03
02	05/05/2021	1	09:05	13:50
03	03/06/2021	1	10:00	15:49
04	05/07/2021	1	12:31	16:59
05	24/08/2021	1	09:03	12:33
05	24/08/2021	2	13:52	15:47
06	08/09/2021	1	08:12	12:33
06	08/09/2021	2	14:57	17:49
07	10/10/2021	1	09:52	14:31
08	04/11/2021	1	10:50	15:33
09	02/12/2021	1	09:54	14:26
10	11/01/2022	1	09:25	14:17
11	27/02/2022	1	09:28	14:14
12	12/03/2022	1	12:05	16:09

Table 1.4: Weather conditions during all digital aerial surveys from April 2021 to March 2022.

[1] = Calm (Glassy), 1 = Calm (Rippled), 2 = Smooth, 3 = Slightly Moderate, 4 = Moderate

[2] = Clear, 1 = Slightly Turbid, 2 = Moderately Turbid, 3 = Highly Turbid

[3] = Clear, 1 to 10 = Few, 11 to 50 = Scattered, 51 to 95 = Broken, 96 to 100 = Overcast

Survey No.	Date	Visibility (km)	Sea State[1]	Glint/ Glare (%)	Turbidity[2]	Cloud (%)[3]	Air Temp (ºC)	Wind Speed (kn)/ Direction
01	17/04/2021	10+	1	-	0	0 to 95	6	5/N
02	05/05/2021	10+	0	-	1	30 to 60	4	10 to 16/N
03	03/06/2021	10+	1	0	1	50 to 60	10 to 11	9 to 22/S to WSW
04	05/07/2021	10+	2	5	1	20 to 40	12	18/SW
05	24/08/2021	10+	2	0 to 25	2	25	15	10/SE
06	08/09/2021	10+	1 to 2	0 to 30	0 to 1	50 to 80	23 to 25	20 to 25/SE
07	10/10/2021	10+	1	0 to 15	0 to 1	25 to 96	12	15/NW
08	04/11/2021	15+	3	0 to 15	2	75 to 80	6	14 to 17/N
09	02/12/2021	10+	1 to 2	0 to 10	2	10 to 40	4 to 5	15/NW
10	11/01/2021	15+	3	0 to 10	3	30 to 99	6 to 7	8 to 16/SW to W
11	27/02/2022	10+	2	0 to 30	1	0	4 to 5	17 to 32/SSE
12	12/03/2022	10+	1 to 2	0	1 to 2	20	5 to 7	7 to 18/S

Abundance estimates

Model-based approach

1.2.3.9 All available digital stills high resolution data collected between April 2021 and March 2022 were utilised in the initial model building stage. The MRSea package was used to predict numbers across the survey area alongside 95% confidence intervals derived from 1,000 bootstraps to provide a range of uncertainty predicted by the model.

1.2.3.10 MRSea is a modelling package executable in the R environment (R Core Team, 2021) based on the generalised additive model framework (GAM), fitting splines through 1- and 2-dimensional data. MRSea was specifically developed to provide a robust tool for estimating the impact of infrastructural developments on bird populations. The advantage of using MRSea over design-based approaches is two-fold: MRSea can handle missing segments and transects better than design-based approaches by using a 2-dimensional Spatially Adaptive Local Smoothing Algorithm (SALSA) (Scott-Hayward *et al.*, 2014); Other environmental covariates (e.g. bathymetric data) can be implemented in the model to further enhance the precision of the abundance and density estimates.

1.2.3.11 The basic model to explain bird abundance had the following form: *Species Count ~ Month + offset(log(area)), family=quasipoisson.*

1.2.3.12 In the first (1-dimensional) stage, the basic model was expanded to include water depth, distance to coast, and bathymetric slope as both linear and smoothed explanatory variables. To reduce autocorrelation, the transects within each survey were used as a blocking structure in the model. In the second (2-dimensional) stage, the x-y coordinates were fitted to the best model from stage 1 using SALSA, and with "Survey date" as an interaction term, allowing for different density surfaces to be estimated for each digital aerial survey. For the model to run properly, a minimum number of birds is required in each month, and it was determined that a minimum of 50 was required to produce sensible outputs. This means that for some species in some months, no distribution maps were generated. These are in grey in section 1.3.3.

1.2.3.13 The best models were selected using tenfold Cross Validation (CV), as this method is considered the gold standard compared to using information criteria like the QAIC and QBIC.

1.2.3.14 All bird behaviours (flying and sitting) were included in this analysis. Therefore, an assumption is made that flying and sitting birds do not differ in their distributions within the survey area. Because a staged approach was used, the model also made certain assumptions about the data in the second stage. The most important assumption was that the effects of environmental covariates was common to all months of data. Note that this does not imply that the relative distribution of birds is the same across all

months, because the density landscape is altered for each month in stage 2 by the 2-dimensional model by using month as an interaction term.

1.2.3.15 The final model for each species was used to predict the numbers and densities of birds across an environmental grid within the Morgan Offshore Ornithology Array Area study area, which spanned the Morgan Array Area with associated 2km and 4km boundaries, as well as the entire digital aerial survey area. Each grid cell in the environmental grid contained an area of 0.1276km^2, which was the smallest resolution available from the bathymetric data. Results are presented in the form of density maps and monthly tables (population size with confidence interval), the latter of which were compared to design-based estimates to further validate the MRSea models.

1.2.3.16 It was only possible to run MRSea for four focal species (Table 1.5), because the spatial model can run into issues when data is too sparse. It was found that when there were at least 50 observations in a single survey, models tended to perform well. Below this threshold, design-based abundance estimates were produced for all species observed between April 2021 and March 2022 (inclusive).

Table 1.5: Number of sightings within the survey area per month for species modelled using MRSea.

Month	Common guillemot	Manx shearwater	Black-legged kittiwake	Northern gannet
17/04/2021	1107	66	151	40
05/05/2021	289	9	57	32
03/06/2021	177	94	26	16
05/07/2021	260	149	7	41
24/08/2021	558	262	63	85
08/09/2021	705	74	49	64
10/10/2021	783	0	185	29
04/11/2021	187	0	64	7
02/12/2021	627	0	423	10
11/01/2021	469	0	276	5
27/02/2022	240	1	120	12
12/03/2022	724	0	281	14

Apportioning of unidentified species

1.2.3.17 For the majority of the digital aerial surveys, there was a proportion of seabirds that were recorded, but not identified to species level. In the case of 'unidentified' seabirds within similar species groups, seabirds are apportioned to the individual species that make up that group. For example, in the case of unidentified common guillemot/razorbill, they were apportioned to razorbill and common guillemot recorded during the digital aerial surveys and apportioning was based on the proportion of seabirds identified to species level within the same survey.

1.2.3.18 There was a total of five broader groups that needed to be apportioned to known species. Explained verbally, the basic idea is that the known (relative) species estimates for each survey month need to increase by proportionally assigning the numbers of the unknown species groups to each of the relevant known species. In formula form, for each known species i and month j, this additional proportion can be written as: $\sum(\text{Proportion})ij = \sum(\text{Unknown})ij/\sum(\text{Known})ij$.

1.2.3.19 The elegance of this analysis lies in the fact that each species will have a single proportional increase assigned to it for each survey month across all unapportioned groups that it belongs to. These proportions can simply be summed to get the total proportional increase. For example, both common guillemot and razorbill numbers are increased by apportioning 'auk/shearwater species', 'auk species' and 'common guillemot/razorbill' to them. Because common guillemot and razorbill belong to the exact same unknown groups, their proportional increase from the apportioning analysis will be the same.

1.2.3.20 For example, a month with 1,200 'common guillemot/razorbill', 200 of which are unknown, 900 identified common guillemot, and 100 identified razorbill. Applying the formula leads to a proportion of: 200 (unknown)/(900 common guillemot + 100 razorbill) = 0.20. Thus, both razorbill and common guillemot need to be increased by 0.20 (or multiplied by 1.20), which leads to an absolute estimate of 900*1.20=1,080 common guillemot and 100*1.2=120 razorbill. The 200 unknown birds have thus been apportioned to razorbill and common guillemot.

1.2.3.21 If the same month had a total of 1,700 auks, comprising the 1,200 birds mentioned above, plus 300 individuals of an unknown species (i.e. common guillemot, razorbill, or Atlantic puffin) and 200 Atlantic puffin, applying the formula again this leads to a proportion of: 300 (unknown)/(900 common guillemot + 100 razorbill + 200 Atlantic puffin) = 0.25.

1.2.3.22 Following the original formula, the proportions from 'common guillemot/razorbill' and 'auk species' can now be summed, leading to a proportional increase of 0.20+0.25=0.45 (or multiply by 1.45) for guillemot and razorbill, and 0+0.25 for Atlantic puffin. This results in 900*1.45=1305 common guillemot, 100*1.45=145 razorbill, and 200*1.25=250 puffin. Both 'common guillemot/razorbill' and 'auk species' have now been apportioned, as 1,305+145+250=1,700.

1.2.3.23 This process is repeated for each of the five unknown groups.

Correction factors to account for availability bias

1.2.3.24 There is an assumption that all seabirds, above the water, are detected during the aerial survey. However, some seabirds (e.g. auks) are not always visible as they spend time foraging beneath the water surface. To account for this, the proportion of time spent on the sea surface needs to be measured and estimates corrected accordingly (Thaxter and Burton, 2009). This is known as availability bias, which can be accounted for by applying a correction factor based on known times spent under water. To calculate the absolute estimate from the relative estimates, the numbers of seabirds observed in the digital aerial surveys are divided by the proportion of time that a bird is expected to be visible at the surface.

1.2.3.25 Availability bias is not known for every species, but is negligible for gulls and terns, as these species spend little time under water. For Northern gannet, although there is no availability bias, there is good information on their foraging patterns. From the

available literature (Garthe *et al*., 2000, 2003, 2007, 2014; Grémillet *et al*., 2006), northern gannet dive on average 2.71 to 4.63 times per hour spent flying, with a mean time spend under water ranging from 6.0 to 10.9 seconds among studies. Therefore, gannet are likely to spend <1% of their foraging time submerged, meaning availability bias is limited for this species. As such, it was not considered necessary to adjust the relative numbers of northern gannet for availability bias in this report.

1.2.3.26 The correction factors applied to sitting common guillemot, razorbill, and puffin were based on JNCC (2013), which assumed that 24.3% of common guillemot, 17.4% of razorbill, and 14.2% of puffin are underwater when digital aerial imagery is captured, leading to correction factors of 1.311, 1.211, and 1.165 respectively. Availability bias correction factors were only applied to estimates of abundance of birds sitting on the sea surface and were not applied to seabirds in flight.

1.2.3.27 Availability bias is corrected for by applying the above correction factors to sitting auks (excluding other behaviours) using the following formula: (Absolute birds) = (Relative birds * pr(sitting)/pr(visible)) + (Relative birds * (1-pr(sitting))).

1.2.3.28 For example, if it was estimated from the visible data (relative number) that there were 1,000 guillemot in an area, 900 of which were sitting, it would result in an adjusted absolute number of: (1,000 * 0.90 * 1.311) + (1,000 * (1-0.90)) = (900 * 1.311) + (1,000 * 0.10) = 1,180 + 100 = 1,280.

Design-based approach

1.2.3.29 Design-based estimates for bird numbers and densities in each month were generated and compared to the MRSea estimates to provide additional validation of the MRSea outputs. Furthermore, design-based estimates were produced for all species recorded during the digital aerial surveys.

1.2.3.30 Design-based estimates and confidence intervals were produced using a non-parametric bootstrapping procedure with 1,000 iterations in the R environment (R Core Team, 2021). Each iteration resampled the full dataset with replacement to create a new dataset that was the same length as the original. In each iteration, the data was subsetted three times to cover each of the four area boundaries (Morgan Array Area + 2km, +4km, and +10km (Morgan Offshore Ornithology Array Area study area)). In each iteration, the number of birds and area covered by the digital aerial surveys were summed for each boundary area and month. From this, the estimated relative bird population for each boundary area could be calculated using the following formula: Relative population estimate = (Birds observed)/(Area covered by digital aerial survey) * (Total area of boundary).

1.2.3.31 Variation around the population estimates was derived from the 1,000 iterations of the non-parametric bootstrap. Upper and lower estimates of the 95% confidence intervals were calculated from the variability in the 1,000 values generated.

1.2.3.32 As per the model-based approach, apportioning of unidentified species and correction factors to account for availability bias were applied to the design-based estimates.

1.3 Baseline characterisation of the Morgan Offshore Ornithology Array Area study area

1.3.1 Review of data sources and desk-based studies

Irish Sea utilisation and seabird colonies within range of the Morgan Generation Assets

1.3.1.1 The Irish Sea separates the islands of Ireland and Great Britain; linked to the Celtic Sea in the south by St George's Channel, and to the Inner Seas off the West Coast of Scotland in the north by the North Channel, also known as the Straits of Moyle. Twenty one species of seabird have been reported as regularly nesting on beaches or cliffs around the Irish Sea (Mitchell *et al.,* 2004) and a large proportion of the Manx shearwater biogeographic population is found breeding on offshore islands around the Irish Sea. During the non-breeding season, large populations of common scoter *Melanitta nigra* and red-throated diver *Gavia stellata* use the shallow waters of Liverpool Bay (Lawson *et al*., 2016).

1.3.1.2 Analysis of ESAS surveys conducted in the Irish Sea from 1980 to 2003 was undertaken for strategic environmental assessments (SEAs) (Mackey and Giménez, 2006). In Area 6 which covers the Irish Sea, Manx shearwater were recorded in high densities of up to eight birds per km^2 during the breeding and post breeding seasons. Northern gannet have also been recorded in high densities in the Irish Sea (up to 2.5 birds per km^2), with concentrations found around the Grassholm colony during the breeding and post-breeding seasons. Common guillemot were abundant (> 5 per km^2) in the east part of the Irish Sea whilst black-legged kittiwake were recorded in high densities across all seasons (up to 2 birds per km^2). Lesser black-backed gull and herring gull had similar nearshore distribution in the Irish Sea (Area 6), with the highest concentrations found along the English coast of the Irish Sea.

1.3.1.3 Cleasby *et al*. (2020) showed how a combination of GPS tracking technology and predictive species distribution modelling can be used to identify seabird hotspots at UK-wide scale. The analysis was limited to common guillemot, razorbill, black-legged kittiwake and European shag *Gulosus aristotelis*. For black-legged kittiwake, the hotspots of activities were along the entire east coast of Scotland and off the coast of Yorkshire, where some of the largest black-legged kittiwake colonies are located. Whilst no hotspots of black-legged kittiwake were identified in the Irish Sea, there were common guillemot hotspots in the Irish Sea, including off the Pembrokeshire coast (Cleasby *et al.,* 2020). The analysis also identified hotspots along the Northern Irish coast and around the Pembrokeshire coast. For European shag, the area covered by hotspots was small and the distribution of hotspots reflected the location of the larger shag colonies and relatively small foraging range. Overall, the findings indicated that during the breeding season, the density of breeding birds was the greatest in close vicinity to the largest colonies, which is typical of central-place foragers.

1.3.1.4 The work by Cleasby *et al.* (2020) was built on earlier work by Wakefield *et al.* (2017) which tracked and modelled the space use (i.e. utilisation distribution (UD)) of black-legged kittiwake, common guillemot, razorbill and European shag at UK-wide level. Composite usage maps predicted that these species forage mainly within 100km of the coast of Scotland. 90% of the UK regional population's UDs also included waters in Dublin Bay and the North Channel of the Irish Sea. In addition to core areas mentioned above, usage hotspots included a large area of the central Irish Sea for

black-legged kittiwake. This latter species was more pelagic, with activity more patchily distributed offshore.

1.3.1.5 There have been several consented and planned offshore developments in the vicinity of the Morgan Generation Assets, which have examined seabird distribution and abundance. For example, boat-based surveys were carried out to the southwest of the Morgan Offshore Ornithology Array Area study area from March 2010 to April 2012 for the Rhiannon offshore wind farm. The species assemblage recorded was primarily composed of petrel *Procellariiformes*, shearwater *Procellariidae*, northern gannet, skua *Stercorarius*, gull *Laridae*, tern *Sternidae* auk *Alcidae*. Manx shearwater dominated the recorded individuals, making up 44% of all birds recorded. Common guillemot and razorbill were the second and third most common species recorded. Seasonal variation was also recorded with many of the more numerous species recorded in higher numbers throughout the spring and summer months (Centrica Array Ltd, 2012). Furthermore, boat-based seabird surveys were carried out within the Irish Sea (to the southeast of the Morgan Offshore Ornithology Array Area study area) in 2014 for the West of Duddon Sands pre-construction and the Walney offshore wind farm year three monitoring. Manx shearwater and common guillemot were the most frequently recorded species and were recorded in all the surveys. Black-legged kittiwake, lesser black-backed gull, and northern gannet were also recorded frequently. The abundance of birds recorded within the offshore wind farms peaked in June and July. There were low numbers of birds in May and August across both survey campaigns (CMACS, 2012; 2014).

1.3.1.6 Foraging ranges of seabirds are species-specific and range from a few kilometres from the colonies (e.g. little tern) to over 1,000km (e.g. Manx shearwater) during the breeding season. Several seabirds from the Irish Sea colonies and from colonies further afield have the potential to use the Morgan Array Area during the breeding season.

1.3.1.7 For the most widespread and abundant seabirds of the central Irish Sea (northern gannet, common guillemot, herring gull, black-legged kittiwake, lesser black-backed gull, Manx shearwater and razorbill), SPA colonies within the species-specific foraging ranges from the Morgan Array Area were identified. We used the mean-maximum foraging ranges compiled by Woodward *et al*. (2019) (Table 1.6). The locations of the breeding sites were sourced from data.gov.uk (Seabird Nesting Counts (British Isles)). The latest colony counts were sourced from the Seabird Monitoring Programme (SMP) online database (https://app.bto.org/seabirds/public/index.jsp). In the SMP online database, the 'Master Site' can be made up of several sites along the coastline. Where a 'Master Site' in the SMP was made up of several nesting sites (i.e. sub-colonies), a centroid was generated for each 'Master Site' and the distance to the Morgan Array Area was calculated. The list of SPAs within range of the Morgan Array Area is shown in Table 1.7. Additional non-SPA colonies located within individual foraging ranges from the Morgan Array Area are listed in Appendix A.

Table 1.6: Mean-maximum foraging ranges with standard deviation (SD) for seabird species (Woodward *et al*., 2019). Sample sizes are shown in parentheses (i.e., no. of individuals tracked).

Species	Mean Max foraging range + SD
Arctic tern	25.7±14.8 (9)
Black-headed gull	18.5 (1)
Common gull	50 (1)
Common tern	18.0±8.9 (16)
Great cormorant	25.6±8.3 (4)
Northern fulmar	542.3±657.9 (16)
Northern gannet	315.2±194.2 (21)
Common guillemot	73.2±80.5 (16)
Herring gull	58.8±26.8 (10)
Black-legged kittiwake	156.1±144.5 (37)
Lesser black-backed gull	127±109 (18)
Little tern	5 (1)
Manx shearwater	1,346.8±1,018.7 (6)
Atlantic puffin	137.1±128.3 (7)
Razorbill	88.7±75.9 (16)
Roseate tern	12.6±10.6 (3)
Sandwich tern	34.3±23.2 (9)
European shag	13.2±10.5 (17)

Table 1.7: SPA colonies (qualifying as an individual species and/or assemblage of species) within individual species range (mean-max foraging range + SD) from the Morgan Array Area.

SPA colonies	Northern gannet	Common guillemot	Herring gull	Black-legged kittiwake	Lesser black-backed gull	Manx shearwater	Razorbill
Ailsa Craig SPA	✓	x	x	✓	x	x	x
Blasket Islands SPA	x	x	x	x	x	✓	x
Copeland Islands SPA	x	x	x	x	x	✓	x
Cruagh Island SPA	x	x	x	x	x	✓	x
Deenish Island and Scariff Island SPA	x	x	x	x	x	✓	x
Aberdaron Coast and Bardsey Island SPA	x	x	x	x	x	✓	x
Grassholm SPA	✓	x	x	x	x	x	x
Helvick Head to Ballyquin SPA	x	x	x	✓	x	x	x
High Island, Inishshark and Davillaun SPA	x	x	x	x	x	✓	x
Howth Head Coast SPA	x	✓	✓	✓	x	x	✓
Inishtrahull Island SPA	x	x	x	x	x	x	x
Ireland's Eye SPA	✓	✓	✓	✓	✓	x	✓
Lambay Island SPA	x	✓	✓	✓	✓	x	✓
Morecambe Bay and Duddon Estuary SPA	x	x	✓	x	x	x	x
North Colonsay and Western Cliffs SPA	x	x	x	✓	x	x	x
Puffin Island SPA, Kerry	x	x	x	x	x	✓	x
Rathlin Island SPA	x	x	x	✓	✓	x	x
Rum SPA	x	x	x	x	x	✓	x
Saltee Islands SPA	✓	x	x	✓	x	✓	x
Skelligs SPA	x	x	x	x	x	✓	x
Skerries Islands SPA	x	x	✓	x	x	x	x
Skomer, Skokholm and the Seas off Pembrokeshire SPA	x	x	x	✓	x	✓	x
St Kilda SPA	x	x	x	x	x	✓	x
Wicklow Head SPA	x	x	x	✓	x	x	✓

Seabirds at sea distribution and abundance in the Morgan Array Area plus buffer zones

Black-legged kittiwake

1.3.1.8 Ship-based and aerial survey data analysed by Waggitt *et al*. (2020) and Bradbury *et al*. (2014) showed black-legged kittiwake to have a patchy seasonal distribution, an overall lower abundance during the breeding season (March to August) and relative low densities. There were however some differences between the two studies during the non-breeding season.

1.3.1.9 In Waggitt *et al*. (2020), the lowest abundance estimates were recorded during the breeding season (March to August), with population estimates ranging from 115 in March to 49 in August within the Morgan Array Area (Table 1.8). Although distribution was similar during the non-breeding season, there was a net increase in densities across the area (Figure 1.3), with the greatest densities found further offshore. In contrast, Bradbury *et al*. (2014) found the highest densities to be further inshore during the breeding season (Figure 1.4).

Table 1.8: Black-legged kittiwake population estimates (data extracted from Waggitt *et al*. (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	161.72	241.44	334.31
Feb	167.60	250.90	346.48
Mar	115.37	172.69	238.44
Apr	72.32	109.44	151.12
May	67.48	101.02	139.51
Jun	59.82	89.55	123.69
Jul	53.19	79.63	110.00
Aug	49.29	73.79	101.94
Sept	78.26	117.14	161.79
Oct	127.84	191.34	264.26
Nov	140.37	201.11	290.17
Dec	152.52	228.31	315.29

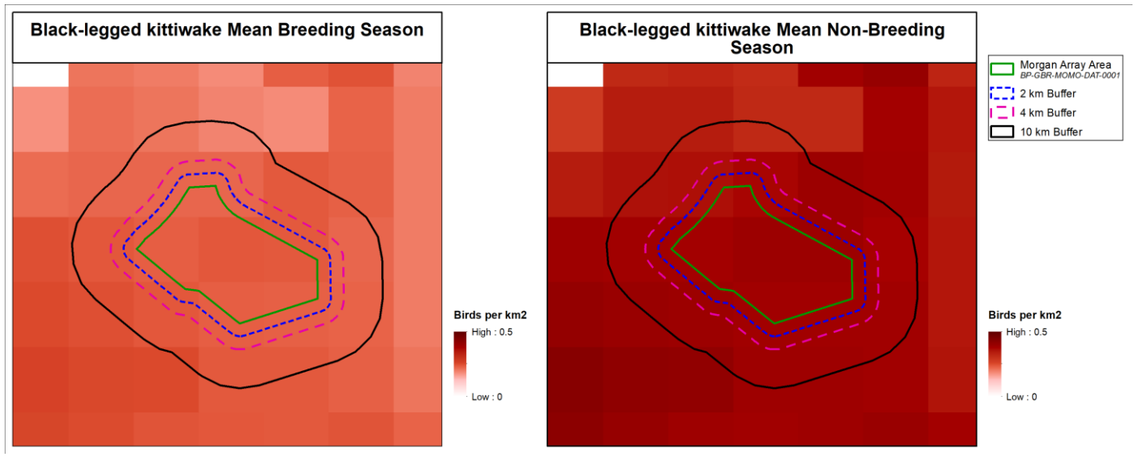


Figure 1.3: Spatial variation in predicted densities (animals per km^2) of black-legged kittiwake per season (data extracted from Waggitt *et al.* (2020)).

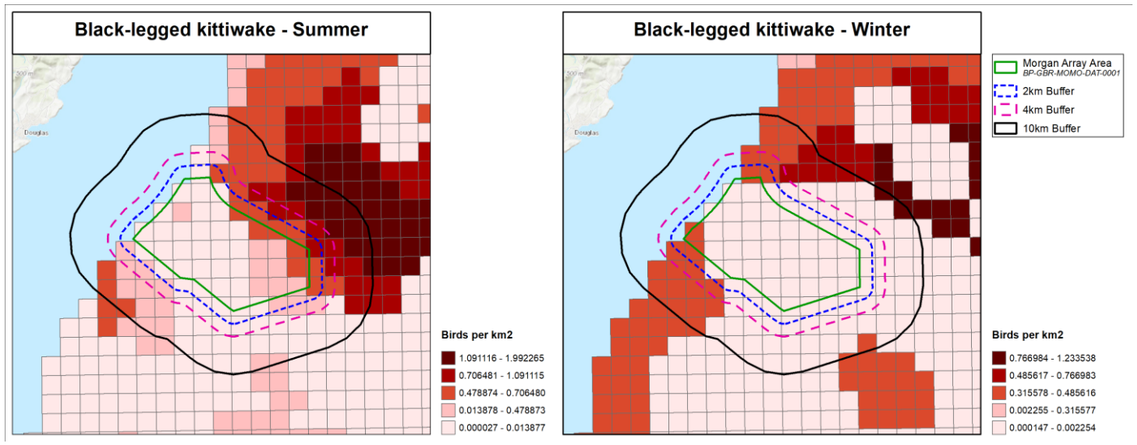


Figure 1.4: Spatial variation in predicted densities (animals per km^2) of black-legged kittiwake per season (data extracted from Bradbury *et al.* (2014)).

Herring gull

1.3.1.10 Herring gull had a very coastal distribution. In both the breeding (March to August) and the non-breeding season (September to February), Waggitt *et al*. (2020) found very low densities and no overlap of hotspot of activities with the Morgan Array Area (Figure 1.5). Population estimates were below 100 individuals in the Morgan Array Area (Table 1.9). Bradbury *et al.* (2014) reported the absence of the species during the breeding season within the Morgan Array Area and increasing densities towards the coast during the non-breeding season (Figure 1.6).

Table 1.9: Herring gull population estimates (data extracted from Waggitt *et al*. (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	49.49	74.98	194.80
Feb	54.59	82.70	115.60
Mar	66.29	100.65	141.45
Apr	72.83	110.86	156.69
May	61.17	93.17	131.75
Jun	46.98	71.57	101.30
Jul	36.26	55.23	78.21
Aug	25.60	38.91	54.72
Sept	21.34	33.24	46.46
Oct	26.28	39.83	55.67
Nov	33.76	51.15	71.50
Dec	42.20	63.94	89.38

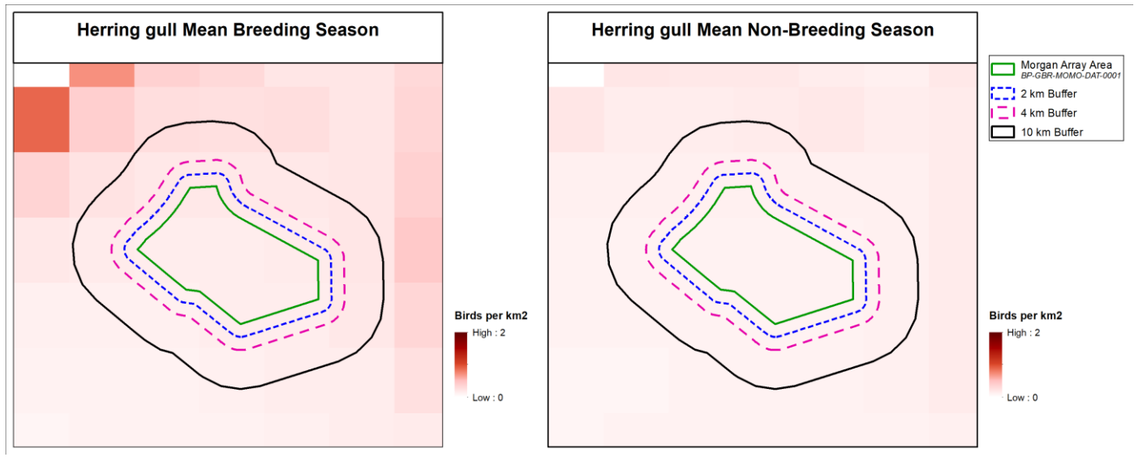


Figure 1.5: Spatial variation in predicted densities (animals per km^2) of herring gull per season (data extracted from Waggitt *et al*. (2020)).

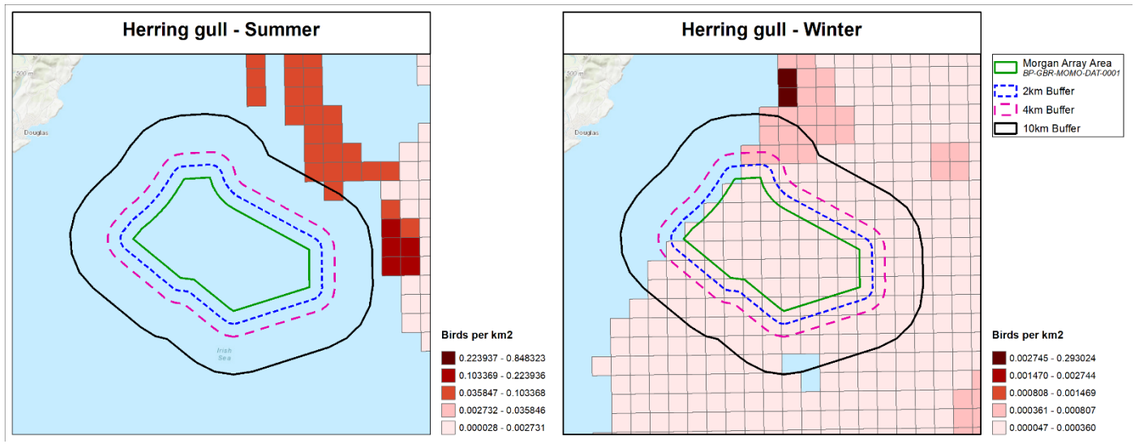


Figure 1.6: Spatial variation in predicted densities (animals per km^2) of herring gull per season (data extracted from Bradbury *et al*. (2014)).

Lesser black-backed gull

1.3.1.11 It is evident from Waggitt *et al.* (2020) and Bradbury *et al.* (2014) that lesser black-backed gull has a very restricted coastal distribution during the breeding season (April to August) owing to their small foraging range (Woodward *et al.,* 2019).

Table 1.10: Lesser black-backed gull population estimates (data extracted from Waggitt *et al*. (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	6.93	10.49	14.57
Feb	6.38	9.65	13.52
Mar	17.29	26.17	36.89
Apr	49.10	74.31	105.37
May	56.51	85.52	121.22
Jun	69.23	104.76	148.43
Jul	83.62	126.54	179.16
Aug	37.20	56.32	79.57
Sept	13.47	20.40	28.62
Oct	11.66	17.65	24.76
Nov	6.38	14.42	20.21
Dec	7.92	12.49	16.81

1.3.1.12 Abundance across the Morgan Array Area peaked at 84 in July (Table 1.10) with birds found predominantly in the east part of the Irish Sea and inshore of the Morgan Array Area (Figure 1.7 and Figure 1.8).

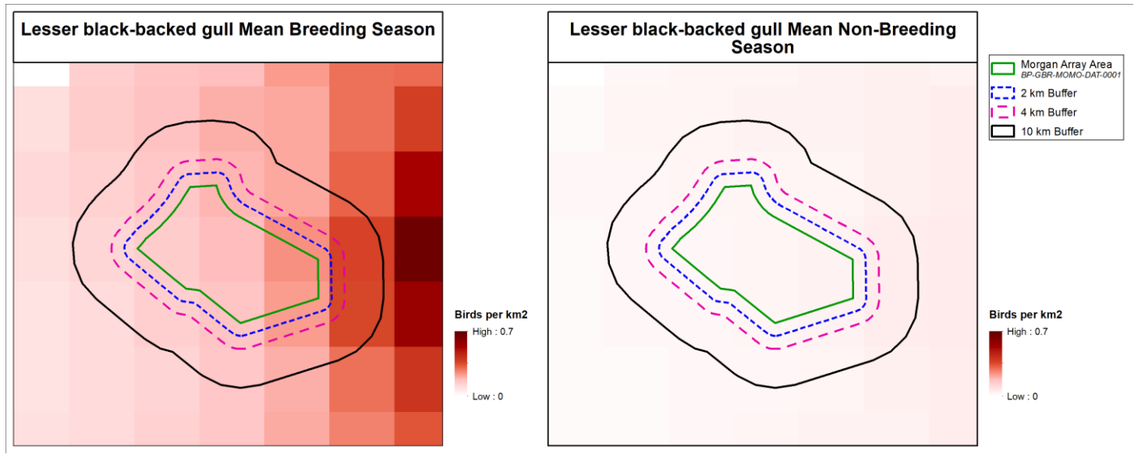


Figure 1.7: Spatial variation in predicted densities (animals per km^2) of lesser black-backed gull per season (data extracted from Waggitt *et al*. (2020)).

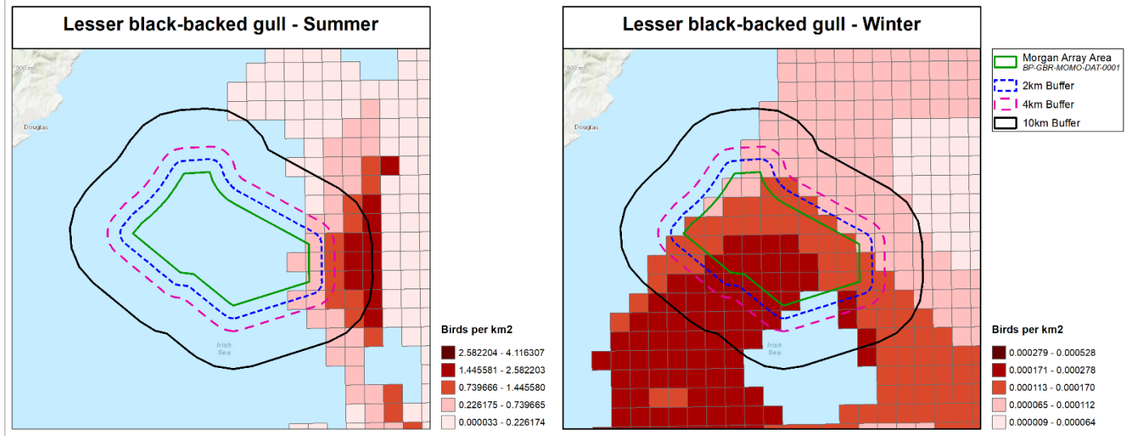


Figure 1.8: Spatial variation in predicted densities (animals per km^2) of lesser-black-backed gull per season (data extracted from Bradbury *et al.* (2014)).

Common guillemot

1.3.1.13 Whilst the distribution of common guillemot was similar between the breeding (March to July) and the non-breeding season (August to February) in Waggitt *et al*. (2020), abundance was greater during the non-breeding season, with over one bird per km^2 predicted to the northwest of the Morgan Array Area (Figure 1.9). Population estimates produced from Waggitt *et al*. (2020) showed the highest abundance from December to February (Table 1.11).

1.3.1.14 The work from Bradbury *et al.* (2014), which examined densities at a much higher spatial resolution showed the distribution of common guillemot along the English coastline with densities exceeding five birds per km^2 (Figure 1.10). During the breeding season, there were hotspots of activity to the southeast of the Morgan Array Area. It is apparent from both studies that the Morgan Array Area does not overlap with hotspots of abundance, which were located further inshore or offshore during the non-breeding and breeding seasons respectively.

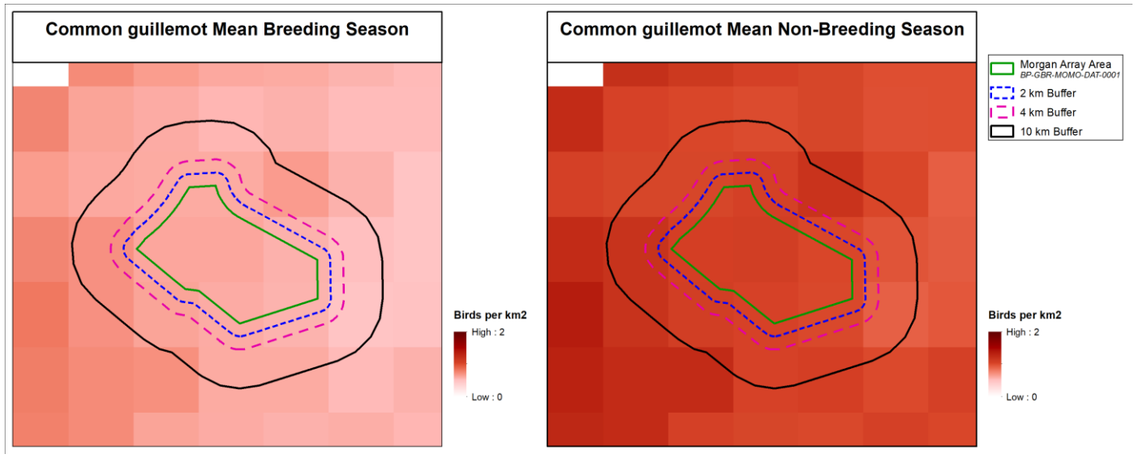


Figure 1.9: Spatial variation in predicted densities (animals per km^2) of common guillemot per season (data extracted from Waggitt *et al.* (2020)).

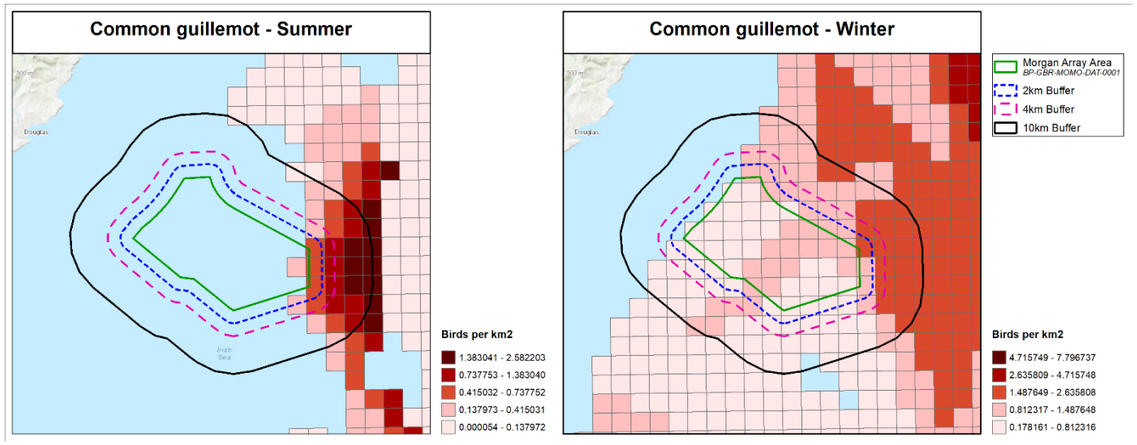


Figure 1.10: Spatial variation in predicted densities (animals per km^2) of common guillemot per season (data extracted from Bradbury *et al*. (2014)).

Table 1.11: Common guillemot population estimates (data extracted from Waggitt *et al.* (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	408.78	612.06	845.79
Feb	431.34	645.83	892.37
Mar	315.42	472.43	652.97
Apr	205.62	308.13	426.17
May	180.59	270.66	374.45
Jun	148.07	221.97	307.25
Jul	121.68	182.46	252.69
Aug	165.00	247.31	342.39
Sept	250.41	375.12	519.01
Oct	281.01	420.90	582.16
Nov	327.60	490.62	678.35
Dec	373.55	559.35	773.11

Razorbill

1.3.1.15 Waggitt *et al*. (2020) showed that razorbill had a similar seasonal distribution to that of common guillemot (Figure 1.11), although abundance was much lower (Table 1.12). Bradbury *et al*. (2014) corroborated the findings in summer (April to September), whilst in winter (October to March), birds were distributed inshore of the Morgan Array Area (Figure 1.12).

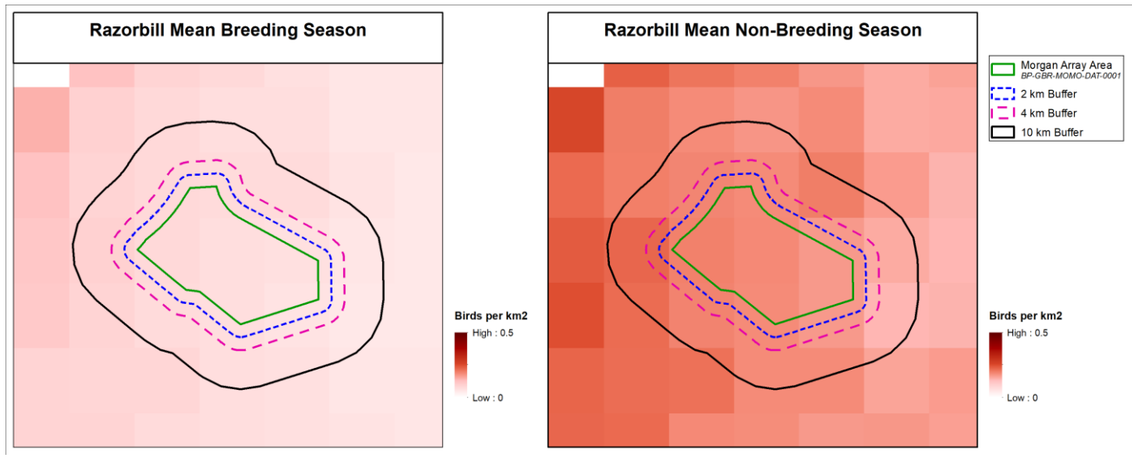


Figure 1.11: Spatial variation in predicted densities (animals per km^2) of razorbill per season (data extracted from Waggitt *et al.* (2020)).

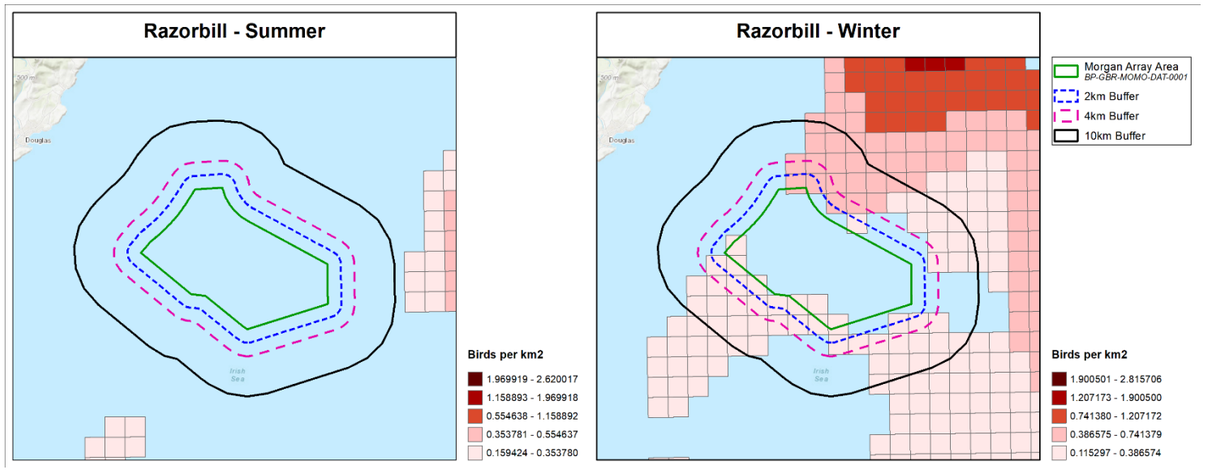


Figure 1.12: Spatial variation in predicted densities (animals per km^2) of razorbill per season (extracted from Bradbury *et al*. (2014)).

Table 1.12: Razorbill population estimates (data extracted from Waggitt *et al.* (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	78.56	117.77	162.80
Feb	84.24	126.27	174.53
Mar	51.74	77.67	107.52
Apr	28.45	42.79	59.37
May	24.61	37.01	51.37
Jun	19.81	29.80	41.38
Jul	16.04	24.14	33.54
Aug	24.68	37.08	51.43
Sept	43.53	65.31	90.41
Oct	49.75	74.62	103.27
Nov	59.66	89.47	123.77
Dec	70.09	105.08	145.30

Atlantic puffin

1.3.1.16 Waggitt *et al*. (2020) found the species in very low densities across the area (Figure 1.13), whilst Bradbury *et al.* (2014) predicted absence of puffin in the area (Figure 1.14). Predicted abundance very rarely exceeded double figures during the breeding season (April to August) and non-breeding season (September to March) within the

Morgan Array Area (Waggitt *et al.*, 2020) (Table 1.13). This is consistent with puffin being observed very infrequently in the aerial survey data.

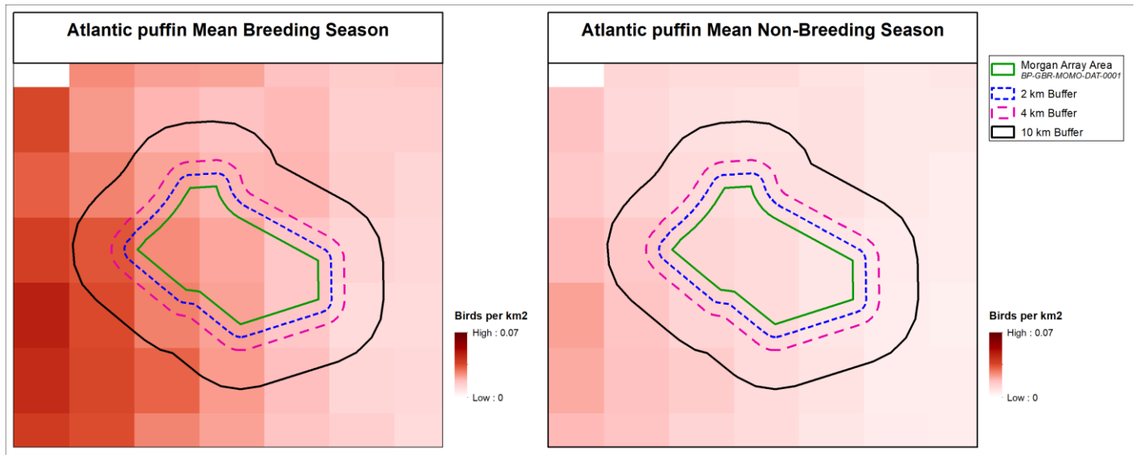


Figure 1.13: Spatial variation in predicted densities (animals per km^2) of Atlantic puffin per season (extracted from Waggitt *et al*. (2020)).

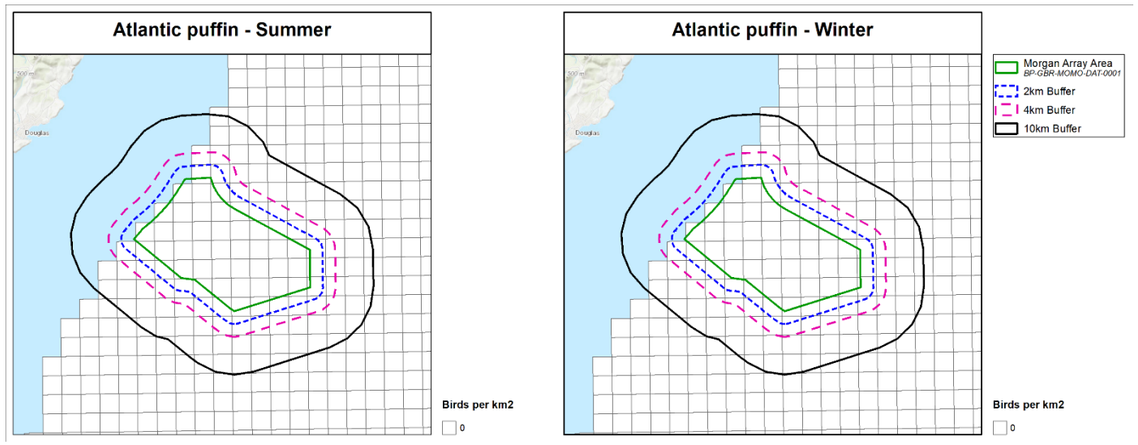


Figure 1.14: Spatial variation in predicted densities (animals per km^2) of Atlantic Puffin per season (extracted from Bradbury et al. (2014)).

Table 1.13: Atlantic puffin population estimates (data extracted from Waggitt *et al*. (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	2.38	3.47	4.91
Feb	2.26	3.38	4.67
Mar	3.39	5.07	7.00
Apr	5.33	7.98	11.02
May	5.83	8.72	12.05
Jun	6.64	9.94	13.73
Jul	7.54	11.28	15.59
Aug	8.19	12.24	16.93
Sept	5.36	8.01	11.07
Oct	3.25	4.86	6.71
Nov	2.88	4.30	5.95
Dec	2.57	3.85	5.32

Northern fulmar

1.3.1.17 The species has a very protracted breeding season (January to August). Both studies reviewed predicted the species to be widespread during the breeding and non-breeding season (Figure 1.15 and Figure 1.16).

1.3.1.18 Abundance steadily increased throughout the breeding season in the Morgan Array Area and peaked in August with a mean of 120 birds (Table 1.14). Waggitt *et al.* (2020) showed densities to increase with increasing distance from the coast (Figure 1.15). However, Bradbury *et al.* (2014) showed densities to be low and distribution to be widespread from September to December (non-breeding season); the highest densities were found at the southwest part of the site, with up to 0.5 birds per km^2 recorded in some areas (Figure 1.16).

Table 1.14: Northern fulmar population estimates (data extracted from Waggitt *et al.* (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	73.60	109.29	149.81
Feb	71.45	106.09	145.41
Mar	80.63	119.75	164.18
Apr	93.54	138.99	190.64
May	98.54	146.43	200.90
Jun	106.43	158.19	217.09
Jul	114.40	170.07	233.47
Aug	119.78	178.10	244.54
Sept	105.38	156.62	214.97
Oct	88.44	131.39	180.23
Nov	82.33	122.29	167.71
Dec	77.15	114.58	157.11

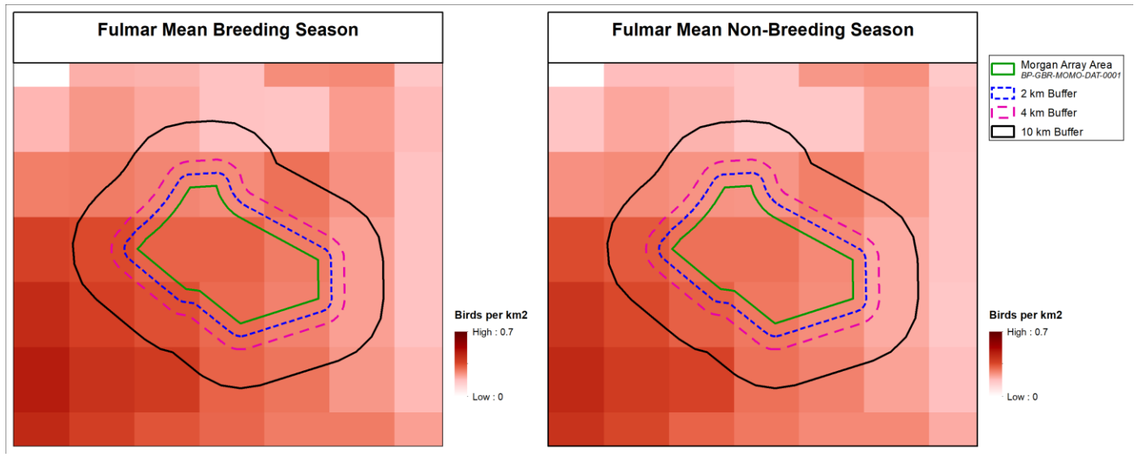


Figure 1.15: Spatial variation in predicted densities (animals per km^2) of northern fulmar per season (extracted from Waggitt *et al.* (2020)).

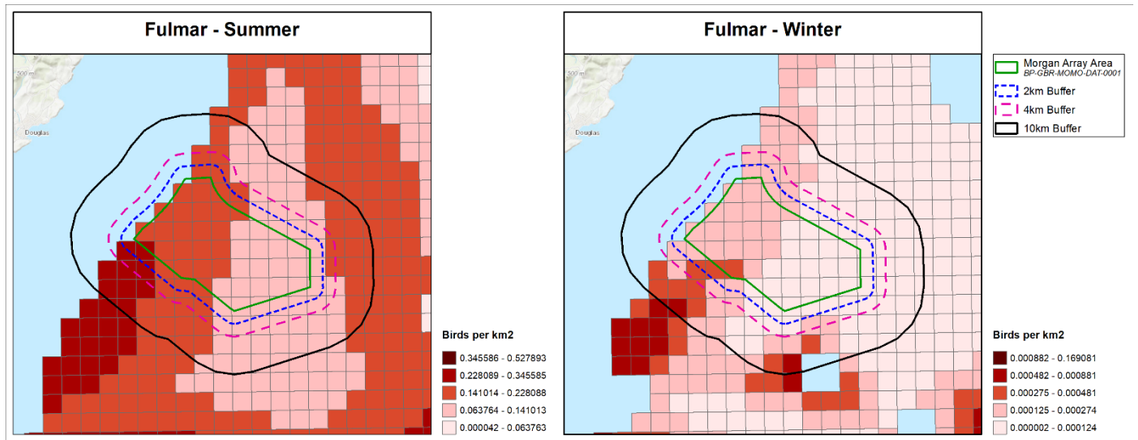


Figure 1.16: Spatial variation in predicted densities (animals per km^2) of northern fulmar per season (extracted from Bradbury *et al.* (2014)).

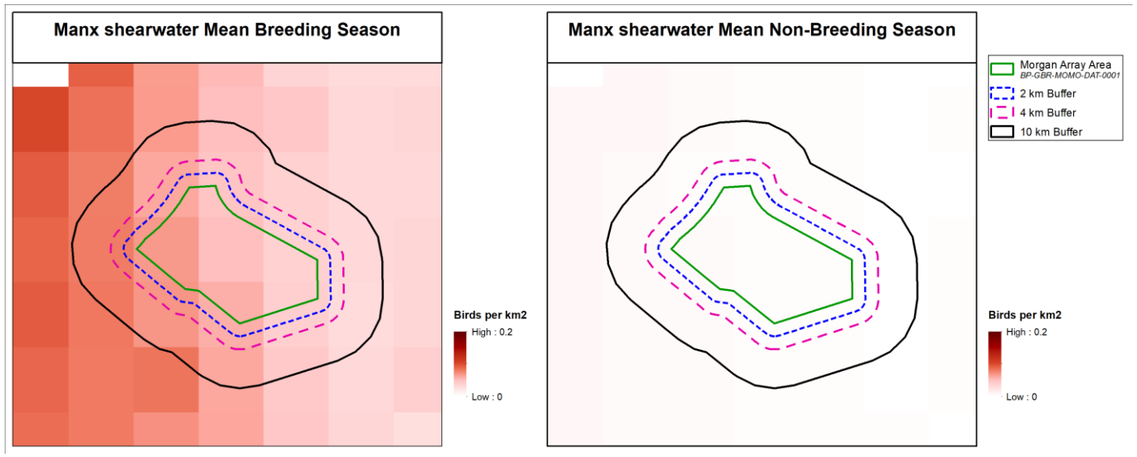


Figure 1.17: Spatial variation in predicted densities (animals per km^2) of Manx shearwater per season (extracted from Waggitt *et al*. (2020)).

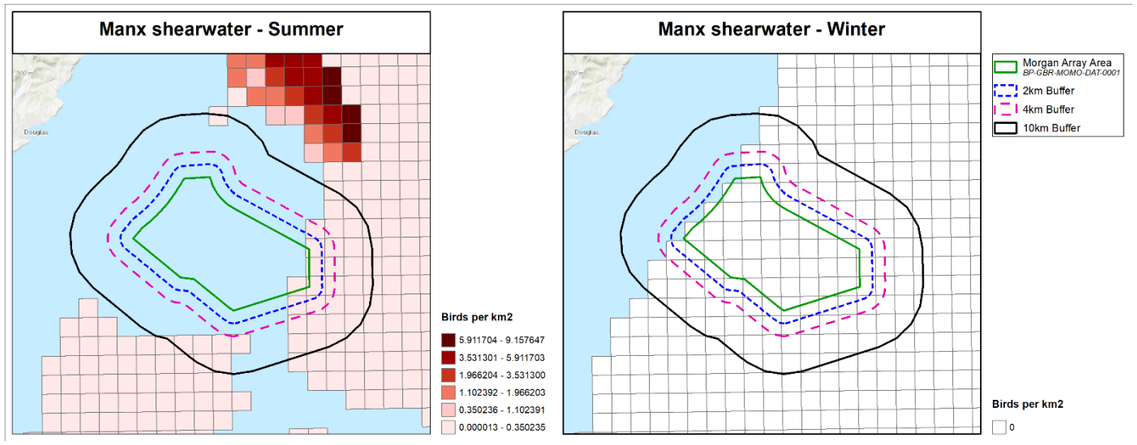


Figure 1.18: Spatial variation in predicted densities (animals per km^2) of Manx shearwater per season (extracted from Bradbury *et al*. (2014)).

Manx shearwater

1.3.1.19 Both Bradbury *et al*. (2014) and Waggitt *et al*. (2020) showed densities to be relatively low during the breeding season (April to August) with less than one bird per km^2 to the east of the Morgan Array Area (Figure 1.17 and Figure 1.18).

1.3.1.20 Monthly population estimates extracted from Waggitt et al. (2020) were very low and ranged from 1 to 36 individuals in the Morgan Array Area (Table 1.15). As expected, densities were low during the non-breeding season (September to March) as Manx shearwater overwinter off the coast of South America.

Table 1.15: Manx shearwater population estimates (extracted from Waggitt *et al.* (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	0.82	1.23	1.70
Feb	0.70	1.05	1.45
Mar	2.37	3.56	4.93
Apr	9.36	14.08	19.49
May	12.44	18.73	25.92
Jun	18.91	28.46	39.41
Jul	28.04	42.20	58.45
Aug	35.93	54.08	74.92
Sept	10.18	15.32	21.22
Oct	2.19	3.29	4.56
Nov	1.49	2.23	3.10
Dec	1.05	1.58	2.18

Northern gannet

1.3.1.21 The work by Waggitt *et al*. (2020), based on aerial and boat-based survey data collected between 1980 to 2018, indicated that northern gannet were found in the highest densities to the west of the Morgan Array Area during the breeding (March to September) and the non-breeding seasons (October to February) (Figure 1.19 and Figure 1.20).

1.3.1.22 As expected, the highest densities were greater during the breeding season as birds from the UK and Irish Western colonies forage in the Irish Sea. The highest abundances were recorded in August in the Morgan Array Area and buffers. Waggitt *et al*. (2020) found the highest densities to the west of the Morgan Array Area (Figure 1.19). In contrast, Bradbury *et al*. (2014) found the highest densities to be northeast of the Morgan Array Area during the breeding season (Figure 1.20).

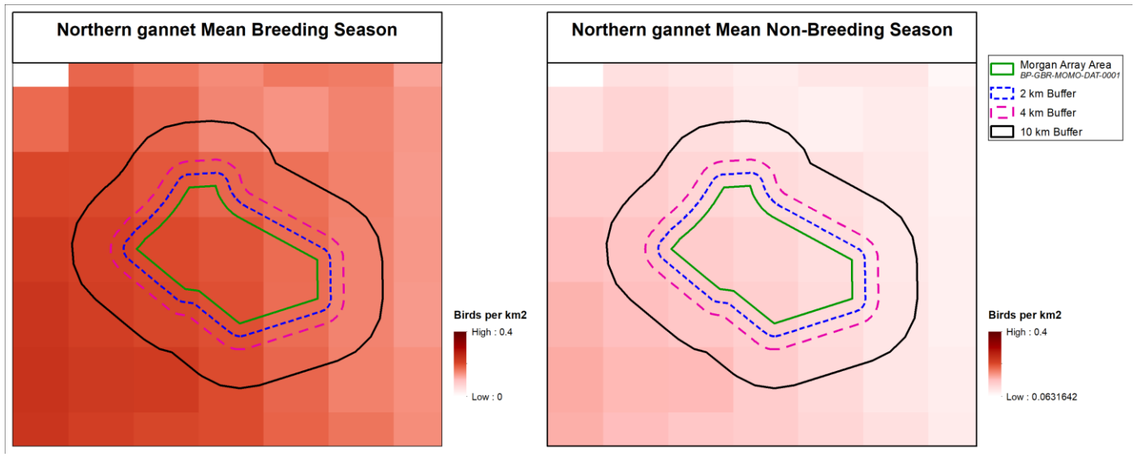


Figure 1.19: Spatial variation in predicted densities (animals per km^2) of northern gannet per season (data extracted from Waggitt *et al.* (2020)).

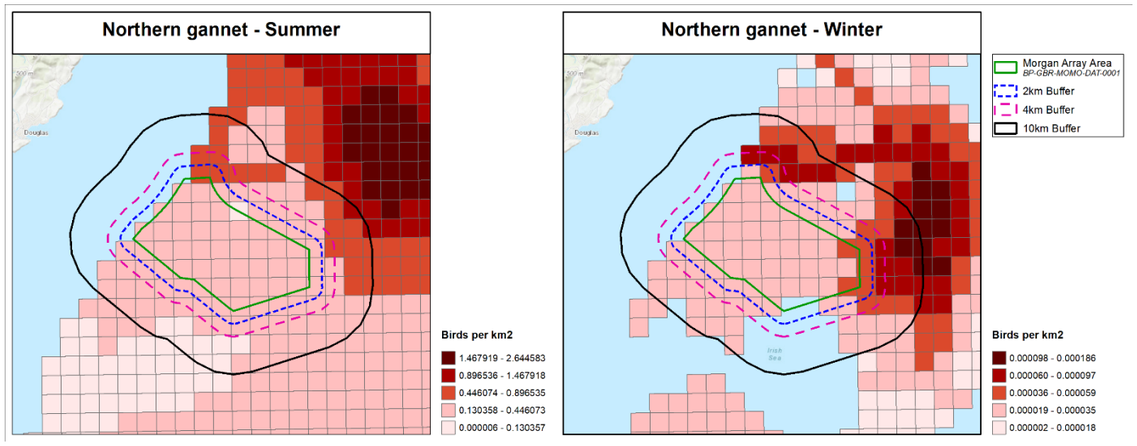


Figure 1.20: Spatial variation in predicted densities (animals per km^2) of northern gannet per season (extracted from Bradbury *et al*. (2014)).

Table 1.16: Northern gannet population estimates (data extracted from Waggitt *et al.* (2020)).

Month	Morgan Array Area	Morgan Array Area + 2km	Morgan Array Area + 4km
Jan	29.99	44.82	61.68
Feb	32.08	47.96	66.01
Mar	35.91	53.69	73.90
Apr	45.71	68.35	94.12
May	51.42	76.90	105.91
Jun	60.93	91.15	125.57
Jul	71.35	106.75	147.13
Aug	78.70	117.77	162.34
Sept	77.64	116.17	160.14
Oct	58.43	87.39	120.39
Nov	41.38	61.87	85.19
Dec	35.73	53.42	73.54

1.3.2 Availability of modern telemetry data and use of the Morgan Array Area by GPS tracked seabirds

Black-legged kittiwake

1.3.2.1 There is evidence that black-legged kittiwake (equipped with geolocators) from the Skomer Island Colony (Wales) use the Morgan Array Area and adjacent waters (BirdLife International, 2022). There must be however a degree of caution when interpreting the data given the low spatial accuracy of geolocators (~200km). Tracked individuals from the Puffin Island colony (Anglesey, Wales) have also shown use of the Morgan Array Area. These birds were equipped with GPS tags which have a much higher spatial accuracy. This latter data set has been used by Wakefield *et al*. (2017) to examine regional distribution whilst Cleasby *et al*. (2020) used it to identify important areas for seabirds at sea around the UK coastline.

Great black-backed gull

1.3.2.2 There is no data available from GPS tracking studies within the species' breeding home range of the Morgan Array Area.

Lesser black-backed gull

1.3.2.3 Over the 2016 to 2019 breeding seasons, individuals were tracked at the South Walney colony (a large but declining coastal colony within the Morecambe Bay and Duddon Estuary SPA, England) and an urban colony in Barrow-in-Furness (Cumbria, England). The majority of individuals tracked from both the South Walney and Barrow colonies made relatively limited use of the marine environment through the 2016 to 2019 breeding seasons (Clewley *et al*., 2021).

Herring gull

1.3.2.4 There are no data available from tracking studies within the species' breeding home range of the Morgan Array Area.

Common guillemot

1.3.2.5 GPS tracking of 15 individuals from the Puffin Island (Anglesey, Wales) and seven individuals from Middle Mouse (Isle of Anglesey, Wales) revealed that tracked birds made use of the nearshore waters. Some tracks however extended further offshore in the Liverpool Bay (BirdLife International, 2022). Across the Irish Sea, GPS tracking of four individuals at Lambay Island (Ireland) showed that the birds remained in the west part of the Irish Sea, and there was no overlap of tracks with the Morgan Array Area. Some of the tracking data has been used by Wakefield *et al*. (2017) and Cleasby *et al*. (2020) in an analysis of distribution of seabirds at sea around the UK coastline.

Razorbill

1.3.2.6 Thirty-four individuals from the nearest colony to the Morgan Array Area, Puffin Island (Anglesey, Wales), were GPS tracked between 2011 and 2013 (BirdLife International, 2022). The data presented in the Seabird Tracking Database (BirdLife International, 2022) showed some tracks to overlap with the Morgan Array Area during the breeding season. GPS tracking has also been carried out at other colonies within the species' breeding home range of the Morgan Array Area: five individuals at Lambay Island (Ireland) and 21 individuals at Bardsey (Wales). The tracks however revealed no connectivity between these colonies and the Morgan Array Area.

Northern fulmar

1.3.2.7 There are no data available from tracking studies within the species' breeding home range of the Morgan Array Area.

Manx shearwater

1.3.2.8 Tracking of individuals at the Bardsey Colony (Wales) in 2017 showed a widespread utilisation of the Irish Sea during the breeding season, including the Morgan Array Area (BirdLife International, 2022). There has also been tracking work of individuals breeding at Lundy Island in 2009 to 2010 (Dean *et al*., 2013), with the data used as evidence for the designation of the Irish Sea Front (ISF) as an SPA. There was however no use of the Morgan Array Area by the Lundy birds. A larger GPS tracking study of 117 individuals captured at the Skomer Island (Wales) and Lighthouse Island in the Copelands group (Northern Ireland) in 2009 to 2011 revealed that birds from the two different colonies foraged in local waters that were exclusive, but overlapped in one key area: the Irish Sea Front (Dean *et al*., 2013). The tracking illustrated little use of the east part of the Irish Sea by the Skomer birds. At the Skomer Island colony, earlier work (2004-2006) showed again the utilisation of the west and north sides of the Irish Sea, whilst few movements were observed eastwards (Guilford *et al*., 2008).

Northern gannet

1.3.2.9 There is a long-term tracking study (2006 to date) of northern gannet at the Grassholm Colony (Pembrokeshire, Wales) whilst short term studies have been carried out at other colonies in the Irish Sea and the west coast of England (e.g. Ailsa Craig (Scotland), Great Saltee (County Wexford, Ireland) and Irelands Eye (County Dublin, Ireland) (BirdLife International, 2022)). According to Wakefield *et al*. (2013), northern gannet tracked from colonies around the British Isles forage in largely mutually exclusive areas. In the Irish Sea, Wakefield *et al*. (2013) showed that individuals from the Ailsa Craig colony were the most likely to be connected to the Morgan Array Area.

1.3.3 Digital aerial survey results

Black-legged kittiwake

1.3.3.1 The species was the most abundant in winter (December and January) and at the start of the breeding season (March and April). The predicted abundance varied greatly for the rest of the breeding season (April to August) (Table 1.17) and the predicted distribution within the Morgan Array Area Offshore Ornithology study area appeared to be variable, with high inter-month variability recorded (Figure 1.21).

1.3.3.2 MRSea estimates for monthly black-legged kittiwake numbers in the Morgan Offshore Ornithology Array Area study area peaked at 3,336 individuals (95% CI range: 2,365 to 4,515) in December 2021. This figure was validated by the design-based estimate of 3,361 individuals (95% CI range: 2,763 to 4,023) (Table 1.17). MRSea estimates for each boundary area can be found in .

1.3.3.3 Design-based estimates produced by behaviour (sitting, flying, and all behaviour) are given for each boundary (Table 1.18; Table 1.19; Table 1.20).

1.3.3.4 Ship-based and aerial survey data analysed by Waggitt *et al.* (2020) and Bradbury *et al.* (2014) showed black-legged kittiwake to have a patchy seasonal distribution, and overall lower abundance during the breeding season (March to August). The results from the digital aerial surveys corroborated these findings.

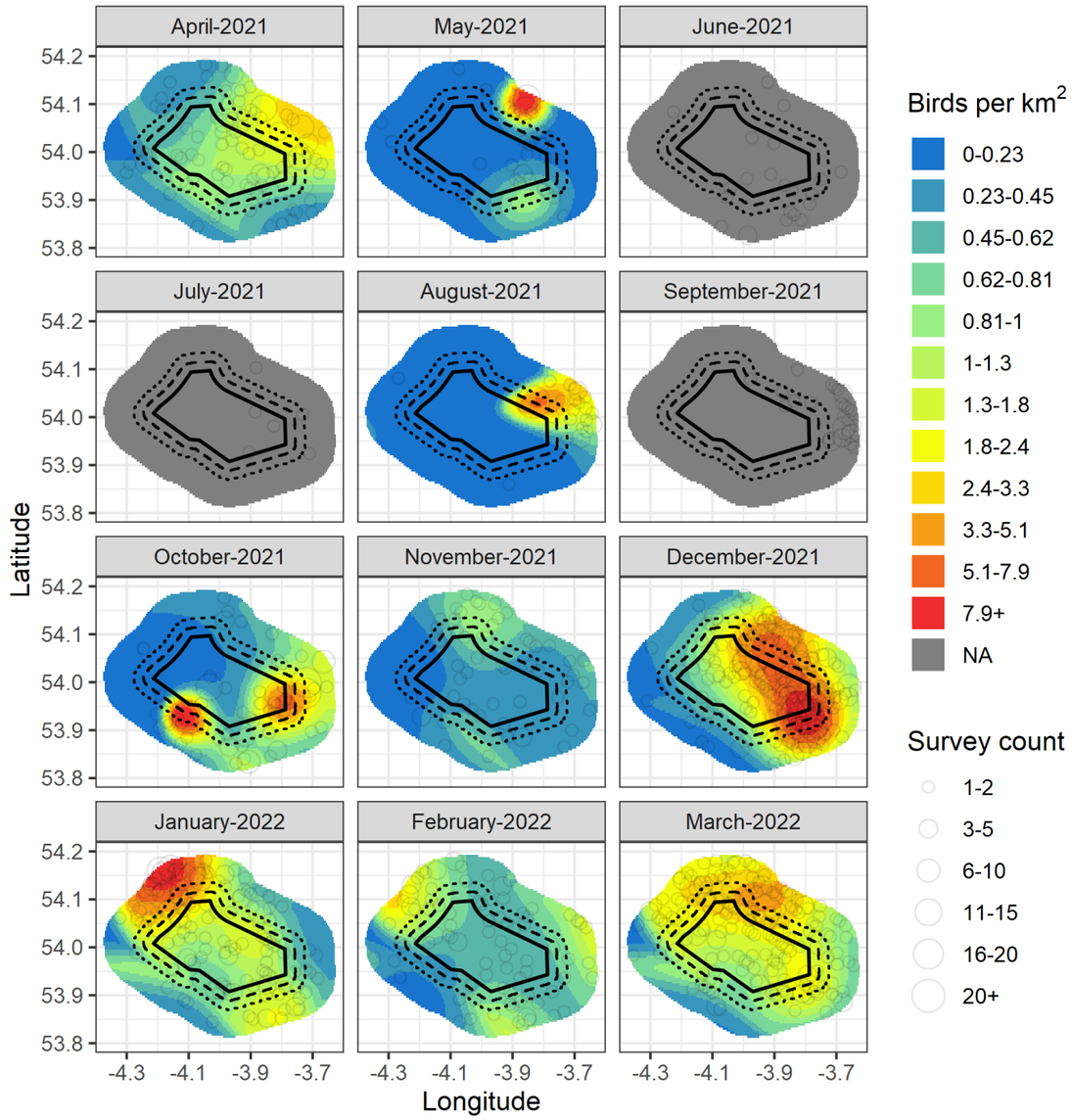


Figure 1.21: Black-legged kittiwake monthly densities (birds per km^2) and raw counts. Estimates are based on the MRSea model outputs.

Table 1.17: Black-legged kittiwake (all behaviour) design-based and MRSea population estimates (Pop) and Density (D) for the Morgan Array Area plus 10km buffer.

		MRSea estimates		Design-based estimates	
Year	**Month**	**Pop**	**D**	**Pop**	**D**
1	Apr	1,165 (784 to 1,629)	0.85 (0.57 to 1.18)	1,174 (860 to 1,513)	0.85 (0.62 to 1.10)
1	May	463 (263 to 804)	0.34 (0.19 to 0.58)	488 (243 to 787)	0.35 (0.18 to 0.57)
1	Jun	n/a	n/a	210 (117 to 330)	0.15 (0.08 to 0.24)
1	Jul	n/a	n/a	55 (23 to 103)	0.04 (0.02 to 0.07)
1	Aug	495 (124 to 1665)	0.36 (0.09 to 1.21)	479 (178 to 899)	0.35 (0.13 to 0.65)
1	Sep	n/a	n/a	378 (215 to 582)	0.27 (0.16 to 0.42)
1	Oct	1,398 (517 to 3,079)	1.02 (0.38 to 2.24)	1,385 (688 to 2,193)	1.01 (0.50 to 1.59)
1	Nov	511 (297 to 792)	0.37 (0.22 to 0.58)	515 (362 to 671)	0.37 (0.26 to 0.49)
1	Dec	3,336 (2,365 to 4,515)	2.42 (1.72 to 3.28)	3,361 (2,763 to 4,023)	2.44 (2.01 to 2.92)
1	Jan	2,129 (1,371 to 3,102)	1.55 (1.00 to 2.25)	2,137 (1,721 to 2,612)	1.55 (1.25 to 1.90)
1	Feb	927 (647 to 1,296)	0.67 (0.47 to 0.94)	925 (729 to 1,173)	0.67 (0.53 to 0.85)
1	Mar	2,135 (1,330 to 3,154)	1.55 (0.97 to 2.29)	2,161 (1,754 to 2,671)	1.57 (1.27 to 1.94)

Table 1.18: Design-based black-legged kittiwake (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	121 (76 to 188)	0.37 (0.23 to 0.58)	171 (107 to 234)	0.34 (0.21 to 0.47)	240 (159 to 331)	0.35 (0.23 to 0.48)	443 (325 to 571)	0.32 (0.24 to 0.41)
1	May	71 (34 to 126)	0.22 (0.11 to 0.39)	92 (44 to 141)	0.18 (0.09 to 0.28)	124 (75 to 189)	0.18 (0.11 to 0.27)	300 (149 to 483)	0.22 (0.11 to 0.35)
1	Jun	33 (10 to 68)	0.10 (0.03 to 0.21)	44 (15 to 79)	0.09 (0.03 to 0.16)	61 (26 to 108)	0.09 (0.04 to 0.16)	145 (81 to 228)	0.11 (0.06 to 0.17)
1	Jul	19 (0 to 41)	0.06 (0.00 to 0.13)	19 (0 to 41)	0.04 (0.00 to 0.08)	33 (6 to 61)	0.05 (0.01 to 0.09)	47 (19 to 88)	0.03 (0.01 to 0.06)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	201 (0 to 520)	0.40 (0.00 to 1.04)	215 (0 to 524)	0.31 (0.00 to 0.76)	395 (147 to 742)	0.29 (0.11 to 0.54)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	14 (0 to 30)	0.03 (0.00 to 0.06)	38 (14 to 64)	0.05 (0.02 to 0.09)	232 (131 to 356)	0.17 (0.10 to 0.26)
1	Oct	99 (17 to 205)	0.30 (0.05 to 0.63)	126 (38 to 233)	0.25 (0.08 to 0.47)	281 (91 to 550)	0.40 (0.13 to 0.79)	464 (231 to 735)	0.34 (0.17 to 0.53)
1	Nov	92 (53 to 150)	0.28 (0.16 to 0.46)	138 (81 to 207)	0.28 (0.16 to 0.41)	175 (111 to 258)	0.25 (0.16 to 0.37)	394 (277 to 514)	0.29 (0.20 to 0.37)
1	Dec	1,007 (737 to 1,357)	3.09 (2.26 to 4.16)	1,358 (1,023 to 1,713)	2.71 (2.04 to 3.41)	1,768 (1,380 to 2,183)	2.55 (1.99 to 3.14)	2,741 (2,253 to 3,282)	1.99 (1.64 to 2.38)
1	Jan	204 (144 to 292)	0.63 (0.44 to 0.89)	381 (275 to 507)	0.76 (0.55 to 1.01)	449 (338 to 599)	0.65 (0.49 to 0.86)	1,185 (954 to 1,448)	0.86 (0.69 to 1.05)
1	Feb	125 (69 to 210)	0.38 (0.21 to 0.64)	187 (119 to 271)	0.37 (0.24 to 0.54)	265 (180 to 362)	0.38 (0.26 to 0.52)	624 (492 to 792)	0.45 (0.36 to 0.58)
1	Mar	290 (184 to 414)	0.89 (0.57 to 1.27)	441 (317 to 580)	0.88 (0.63 to 1.16)	606 (435 to 809)	0.87 (0.63 to 1.17)	1,115 (905 to 1,378)	0.81 (0.66 to 1.00)

Table 1.19: Design-based black-legged kittiwake (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	200 (126 to 310)	0.61 (0.39 to 0.95)	281 (177 to 387)	0.56 (0.35 to 0.77)	396 (262 to 546)	0.57 (0.38 to 0.79)	731 (535 to 942)	0.53 (0.39 to 0.68)
1	May	45 (22 to 79)	0.14 (0.07 to 0.24)	58 (28 to 88)	0.12 (0.06 to 0.18)	78 (47 to 119)	0.11 (0.07 to 0.17)	188 (94 to 304)	0.14 (0.07 to 0.22)
1	Jun	15 (5 to 30)	0.04 (0.01 to 0.09)	20 (7 to 35)	0.04 (0.01 to 0.07)	27 (12 to 48)	0.04 (0.02 to 0.07)	65 (36 to 102)	0.05 (0.03 to 0.07)
1	Jul	3 (0 to 7)	0.01 (0.00 to 0.02)	3 (0 to 7)	0.01 (0.00 to 0.01)	5 (1 to 10)	0.01 (0.00 to 0.01)	8 (3 to 15)	0.01 (0.00 to 0.01)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	43 (0 to 110)	0.08 (0.00 to 0.22)	45 (0 to 111)	0.07 (0.00 to 0.16)	84 (31 to 157)	0.06 (0.02 to 0.11)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	9 (0 to 19)	0.02 (0.00 to 0.04)	24 (9 to 41)	0.03 (0.01 to 0.06)	147 (83 to 226)	0.11 (0.06 to 0.16)
1	Oct	196 (33 to 407)	0.60 (0.10 to 1.25)	251 (75 to 463)	0.50 (0.15 to 0.92)	557 (180 to 1,090)	0.80 (0.26 to 1.57)	921 (457 to 1,458)	0.67 (0.33 to 1.06)
1	Nov	28 (16 to 46)	0.09 (0.05 to 0.14)	42 (25 to 63)	0.08 (0.05 to 0.13)	54 (34 to 79)	0.08 (0.05 to 0.11)	121 (85 to 157)	0.09 (0.06 to 0.11)
1	Dec	228 (167 to 307)	0.70 (0.51 to 0.94)	307 (231 to 387)	0.61 (0.46 to 0.77)	400 (312 to 494)	0.58 (0.45 to 0.71)	620 (509 to 742)	0.45 (0.37 to 0.54)
1	Jan	164 (116 to 235)	0.50 (0.36 to 0.72)	307 (221 to 407)	0.61 (0.44 to 0.81)	361 (272 to 481)	0.52 (0.39 to 0.69)	952 (767 to 1,164)	0.69 (0.56 to 0.85)
1	Feb	60 (33 to 101)	0.18 (0.10 to 0.31)	90 (57 to 131)	0.18 (0.11 to 0.26)	128 (87 to 175)	0.18 (0.13 to 0.25)	300 (237 to 381)	0.22 (0.17 to 0.28)
1	Mar	272 (173 to 388)	0.84 (0.53 to 1.19)	414 (298 to 544)	0.82 (0.59 to 1.08)	568 (408 to 759)	0.82 (0.59 to 1.09)	1,046 (849 to 1,293)	0.76 (0.62 to 0.94)

Table 1.20: Design-based black-legged kittiwake (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	321 (202 to 498)	0.98 (0.62 to 1.53)	452 (284 to 621)	0.90 (0.57 to 1.24)	637 (421 to 877)	0.92 (0.61 to 1.26)	1,174 (860 to 1,513)	0.85 (0.62 to 1.10)
1	May	116 (56 to 205)	0.36 (0.17 to 0.63)	150 (72 to 229)	0.30 (0.14 to 0.46)	202 (122 to 309)	0.29 (0.18 to 0.44)	488 (243 to 787)	0.35 (0.18 to 0.57)
1	Jun	47 (15 to 99)	0.14 (0.05 to 0.30)	64 (22 to 114)	0.13 (0.04 to 0.23)	88 (38 to 156)	0.13 (0.05 to 0.22)	210 (117 to 330)	0.15 (0.08 to 0.24)
1	Jul	22 (0 to 48)	0.07 (0.00 to 0.15)	23 (0 to 47)	0.04 (0.00 to 0.09)	38 (7 to 71)	0.05 (0.01 to 0.10)	55 (23 to 103)	0.04 (0.02 to 0.07)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	244 (0 to 630)	0.49 (0.00 to 1.26)	261 (0 to 635)	0.38 (0.00 to 0.91)	479 (178 to 899)	0.35 (0.13 to 0.65)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	23 (0 to 49)	0.05 (0.00 to 0.10)	61 (22 to 105)	0.09 (0.03 to 0.15)	378 (215 to 582)	0.27 (0.16 to 0.42)
1	Oct	295 (49 to 612)	0.90 (0.15 to 1.88)	377 (113 to 697)	0.75 (0.22 to 1.39)	837 (271 to 1,640)	1.21 (0.39 to 2.36)	1,385 (688 to 2,193)	1.01 (0.50 to 1.59)
1	Nov	120 (69 to 195)	0.37 (0.21 to 0.60)	180 (105 to 271)	0.36 (0.21 to 0.54)	228 (145 to 337)	0.33 (0.21 to 0.49)	515 (362 to 671)	0.37 (0.26 to 0.49)
1	Dec	1,235 (903 to 1,663)	3.79 (2.77 to 5.10)	1,666 (1,254 to 2,100)	3.32 (2.50 to 4.18)	2,167 (1,692 to 2,677)	3.12 (2.44 to 3.86)	3,361 (2,763 to 4,023)	2.44 (2.01 to 2.92)
1	Jan	368 (260 to 526)	1.13 (0.80 to 1.61)	688 (497 to 914)	1.37 (0.99 to 1.82)	810 (611 to 1,080)	1.17 (0.88 to 1.55)	2,137 (1,721 to 2,612)	1.55 (1.25 to 1.90)
1	Feb	185 (102 to 311)	0.57 (0.31 to 0.95)	277 (176 to 402)	0.55 (0.35 to 0.80)	393 (267 to 537)	0.57 (0.38 to 0.77)	925 (729 to 1,173)	0.67 (0.53 to 0.85)
1	Mar	563 (358 to 802)	1.73 (1.10 to 2.46)	855 (615 to 1,125)	1.70 (1.23 to 2.24)	1,174 (843 to 1,569)	1.69 (1.21 to 2.26)	2,161 (1,754 to 2,671)	1.57 (1.27 to 1.94)

Great black-backed gull

1.3.3.5 Design-based estimates were produced despite the very low total sample size (75 sightings recorded between April 2021 and March 2022).

1.3.3.6 Design-based estimates produced by behaviour (sitting, flying, and all behaviour) are given for each boundary (Table 1.21; Table 1.22; Table 1.23). The highest population estimate was recorded in January 2022 with 230 individuals (95% CI range: 79 to 417) for the Morgan Offshore Ornithology Array Area study area (Table 1.23). The species was most frequently recorded during the non-breeding period (Table 1.23).

Herring gull

1.3.3.7 Herring gull has a coastal distribution. In both the breeding (March to August) and the non-breeding season (September to February), Waggitt *et al.* (2020) found very low densities within the Morgan Array Area.

1.3.3.8 The digital aerial survey results confirmed this patten of usage, with only 144 confirmed sightings of herring gull recorded between April 2021 and March 2022. Despite the small sample size, design-based estimates were produced by behaviour (sitting, flying, and all behaviour) and given for each boundary (Table 1.24; Table 1.25; Table 1.26).

1.3.3.9 As expected, the species was most frequently recorded outside the breeding season. Within the Morgan Offshore Ornithology Array Area study area, the highest population estimate (all behaviour) was recorded in January 2022, with 599 individuals (95% CI range: 126 to 1,209).

Lesser black-backed gull

1.3.3.10 Similar to herring gull, lesser black-backed gull has a very restricted coastal distribution during the breeding season (April to August) (Waggitt *et al*., 2020; Bradbury *et al*., 2014); the review of desk-based studies showed a low utilisation of the Morgan Array Area.

1.3.3.11 There were 74 sightings of lesser black-backed gull recorded across the digital aerial surveys between April 2021 and March 2022. The relative paucity of sightings during the surveys validated the findings of the desk-based studies reviewed in this report (Waggitt *et al*., 2020; Bradbury *et al.,* 2014).

1.3.3.12 Despite the low sample size (74 sightings) design-based estimates produced by behaviour (sitting, flying, and all behaviour) are given for each boundary (Table 1.27; Table 1.28; Table 1.29).

1.3.3.13 The species was most frequently recorded during the breeding season. Within the Morgan Offshore Ornithology Array Area study area, the highest population estimate (all behaviour) was recorded in September 2021 with 322 individuals (95% CI range: 115 to 624)

Table 1.21: Design-based great black-backed gull (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	9 (0 to 26)	0.01 (0.00 to 0.02)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	8 (0 to 25)	0.02 (0.00 to 0.08)	16 (0 to 33)	0.03 (0.00 to 0.07)	24 (8 to 58)	0.03 (0.01 to 0.08)	146 (88 to 227)	0.11 (0.06 to 0.16)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	24 (6 to 49)	0.02 (0.00 to 0.04)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	32 (14 to 58)	0.10 (0.04 to 0.18)	34 (13 to 59)	0.07 (0.03 to 0.12)	69 (22 to 141)	0.10 (0.03 to 0.20)	82 (28 to 149)	0.06 (0.02 to 0.11)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	4 (0 to 12)	0.01 (0.00 to 0.02)	8 (0 to 20)	0.01 (0.00 to 0.03)	47 (19 to 84)	0.03 (0.01 to 0.06)
1	Mar	6 (0 to 14)	0.02 (0.00 to 0.04)	11 (2 to 21)	0.02 (0.00 to 0.04)	18 (8 to 34)	0.03 (0.01 to 0.05)	25 (11 to 39)	0.02 (0.01 to 0.03)

Table 1.22: Design-based great black-backed gull (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	1 (0 to 3)	0.00 (0.00 to 0.01)	2 (0 to 4)	0.00 (0.00 to 0.01)	3 (1 to 7)	0.00 (0.00 to 0.01)	18 (11 to 28)	0.01 (0.01 to 0.02)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (2 to 16)	0.01 (0.00 to 0.01)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.02 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	Jan	57 (24 to 105)	0.18 (0.08 to 0.32)	62 (24 to 106)	0.12 (0.05 to 0.21)	124 (39 to 254)	0.18 (0.06 to 0.37)	148 (51 to 268)	0.11 (0.04 to 0.19)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	4 (0 to 12)	0.01 (0.00 to 0.02)	8 (0 to 20)	0.01 (0.00 to 0.03)	47 (19 to 84)	0.03 (0.01 to 0.06)
1	Mar	17 (0 to 37)	0.05 (0.00 to 0.11)	30 (6 to 55)	0.06 (0.01 to 0.11)	48 (22 to 91)	0.07 (0.03 to 0.13)	67 (29 to 105)	0.05 (0.02 to 0.08)

Table 1.23: Design-based great black-backed gull (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	9 (0 to 26)	0.01 (0.00 to 0.02)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	9 (0 to 29)	0.03 (0.00 to 0.09)	18 (0 to 38)	0.04 (0.00 to 0.07)	27 (9 to 66)	0.04 (0.01 to 0.09)	165 (98 to 255)	0.12 (0.07 to 0.19)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	32 (8 to 65)	0.02 (0.01 to 0.05)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.02 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	Jan	89 (38 to 163)	0.27 (0.12 to 0.50)	96 (38 to 166)	0.19 (0.08 to 0.33)	193 (61 to 396)	0.28 (0.09 to 0.57)	230 (79 to 417)	0.17 (0.06 to 0.30)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.02 (0.00 to 0.05)	16 (0 to 40)	0.02 (0.00 to 0.06)	95 (38 to 168)	0.07 (0.03 to 0.12)
1	Mar	24 (0 to 51)	0.07 (0.00 to 0.16)	41 (8 to 76)	0.08 (0.02 to 0.15)	66 (31 to 125)	0.09 (0.04 to 0.18)	93 (40 to 144)	0.07 (0.03 to 0.10)

Table 1.24: Design-based herring gull (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	71 (20 to 135)	0.05 (0.01 to 0.10)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 17)	0.01 (0.00 to 0.01)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	5 (0 to 15)	0.01 (0.00 to 0.02)	25 (5 to 54)	0.02 (0.00 to 0.04)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	7 (0 to 24)	0.02 (0.00 to 0.07)	7 (0 to 24)	0.01 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	46 (15 to 83)	0.03 (0.01 to 0.06)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	4 (0 to 12)	0.01 (0.00 to 0.02)	4 (0 to 12)	0.01 (0.00 to 0.02)	16 (4 to 32)	0.01 (0.00 to 0.02)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	24 (0 to 61)	0.02 (0.00 to 0.04)
1	Dec	30 (10 to 59)	0.09 (0.03 to 0.18)	39 (14 to 68)	0.08 (0.03 to 0.14)	60 (24 to 110)	0.09 (0.03 to 0.16)	87 (40 to 147)	0.06 (0.03 to 0.11)
1	Jan	90 (22 to 186)	0.28 (0.07 to 0.57)	89 (22 to 180)	0.18 (0.04 to 0.36)	290 (35 to 640)	0.42 (0.05 to 0.92)	343 (72 to 693)	0.25 (0.05 to 0.50)
1	Feb	8 (0 to 20)	0.02 (0.00 to 0.06)	8 (0 to 20)	0.02 (0.00 to 0.04)	8 (0 to 20)	0.01 (0.00 to 0.03)	16 (4 to 32)	0.01 (0.00 to 0.02)
1	Mar	4 (0 to 14)	0.01 (0.00 to 0.04)	9 (0 to 24)	0.02 (0.00 to 0.05)	32 (13 to 61)	0.05 (0.02 to 0.09)	75 (36 to 124)	0.05 (0.03 to 0.09)

Table 1.25: Design-based herring gull (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	53 (15 to 101)	0.04 (0.01 to 0.07)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 17)	0.01 (0.00 to 0.01)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	3 (0 to 10)	0.00 (0.00 to 0.01)	16 (3 to 36)	0.01 (0.00 to 0.03)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	10 (0 to 33)	0.03 (0.00 to 0.10)	10 (0 to 33)	0.02 (0.00 to 0.07)	11 (0 to 33)	0.02 (0.00 to 0.05)	64 (21 to 116)	0.05 (0.02 to 0.08)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	4 (0 to 12)	0.01 (0.00 to 0.02)	4 (0 to 12)	0.01 (0.00 to 0.02)	16 (4 to 32)	0.01 (0.00 to 0.02)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	16 (5 to 32)	0.05 (0.02 to 0.10)	21 (8 to 37)	0.04 (0.02 to 0.07)	33 (13 to 60)	0.05 (0.02 to 0.09)	47 (22 to 80)	0.03 (0.02 to 0.06)
1	Jan	67 (16 to 138)	0.21 (0.05 to 0.42)	66 (16 to 134)	0.13 (0.03 to 0.27)	216 (26 to 476)	0.31 (0.04 to 0.69)	256 (54 to 516)	0.19 (0.04 to 0.37)
1	Feb	8 (0 to 20)	0.02 (0.00 to 0.06)	8 (0 to 20)	0.02 (0.00 to 0.04)	8 (0 to 20)	0.01 (0.00 to 0.03)	16 (4 to 32)	0.01 (0.00 to 0.02)
1	Mar	3 (0 to 11)	0.01 (0.00 to 0.03)	7 (0 to 18)	0.01 (0.00 to 0.04)	25 (10 to 48)	0.04 (0.01 to 0.07)	58 (28 to 96)	0.04 (0.02 to 0.07)

Table 1.26: Design-based herring gull (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	124 (34 to 235)	0.09 (0.02 to 0.17)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	16 (0 to 34)	0.01 (0.00 to 0.02)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.01 (0.00 to 0.04)	41 (8 to 91)	0.03 (0.01 to 0.07)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	18 (0 to 57)	0.06 (0.00 to 0.18)	18 (0 to 57)	0.04 (0.00 to 0.11)	18 (0 to 56)	0.03 (0.00 to 0.08)	109 (36 to 198)	0.08 (0.03 to 0.14)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.02 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	32 (8 to 65)	0.02 (0.01 to 0.05)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	24 (0 to 61)	0.02 (0.00 to 0.04)
1	Dec	46 (15 to 91)	0.14 (0.05 to 0.28)	60 (22 to 105)	0.12 (0.04 to 0.21)	93 (37 to 169)	0.13 (0.05 to 0.24)	134 (62 to 227)	0.10 (0.04 to 0.16)
1	Jan	158 (38 to 324)	0.48 (0.12 to 0.99)	155 (38 to 314)	0.31 (0.08 to 0.63)	506 (61 to 1,116)	0.73 (0.09 to 1.61)	599 (126 to 1,209)	0.43 (0.09 to 0.88)
1	Feb	15 (0 to 41)	0.05 (0.00 to 0.12)	15 (0 to 40)	0.03 (0.00 to 0.08)	16 (0 to 40)	0.02 (0.00 to 0.06)	32 (8 to 64)	0.02 (0.01 to 0.05)
1	Mar	8 (0 to 25)	0.02 (0.00 to 0.08)	16 (0 to 42)	0.03 (0.00 to 0.08)	57 (23 to 109)	0.08 (0.03 to 0.16)	133 (64 to 220)	0.10 (0.05 to 0.16)

Table 1.27: Design-based lesser black-backed gull (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	13 (0 to 40)	0.03 (0.00 to 0.08)	27 (0 to 68)	0.04 (0.00 to 0.10)	54 (13 to 108)	0.04 (0.01 to 0.08)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 26)	0.01 (0.00 to 0.02)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	7 (0 to 22)	0.01 (0.00 to 0.04)	7 (0 to 22)	0.01 (0.00 to 0.03)	148 (90 to 226)	0.11 (0.07 to 0.16)
1	Sep	2 (0 to 7)	0.01 (0.00 to 0.02)	17 (0 to 39)	0.03 (0.00 to 0.08)	17 (0 to 39)	0.02 (0.00 to 0.06)	86 (31 to 167)	0.06 (0.02 to 0.12)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 25)	0.01 (0.00 to 0.04)	8 (0 to 25)	0.01 (0.00 to 0.02)
1	Feb	8 (0 to 24)	0.02 (0.00 to 0.07)	8 (0 to 24)	0.02 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	24 (0 to 48)	0.02 (0.00 to 0.04)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	17 (0 to 42)	0.01 (0.00 to 0.03)

Table 1.28: Design-based lesser black-backed gull (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	4 (0 to 13)	0.01 (0.00 to 0.03)	9 (0 to 23)	0.01 (0.00 to 0.03)	18 (4 to 36)	0.01 (0.00 to 0.03)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	2 (0 to 6)	0.00 (0.00 to 0.01)	2 (0 to 6)	0.00 (0.00 to 0.01)	44 (26 to 67)	0.03 (0.02 to 0.05)
1	Sep	5 (0 to 18)	0.02 (0.00 to 0.05)	46 (0 to 106)	0.09 (0.00 to 0.21)	46 (0 to 106)	0.07 (0.00 to 0.15)	235 (84 to 456)	0.17 (0.06 to 0.33)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.29: Design-based lesser black-backed gull (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	18 (0 to 54)	0.04 (0.00 to 0.11)	36 (0 to 90)	0.05 (0.00 to 0.13)	72 (17 to 145)	0.05 (0.01 to 0.10)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 26)	0.01 (0.00 to 0.02)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	9 (0 to 28)	0.02 (0.00 to 0.06)	9 (0 to 28)	0.01 (0.00 to 0.04)	192 (116 to 293)	0.14 (0.08 to 0.21)
1	Sep	7 (0 to 24)	0.02 (0.00 to 0.08)	63 (0 to 145)	0.13 (0.00 to 0.29)	63 (0 to 145)	0.09 (0.00 to 0.21)	322 (115 to 624)	0.23 (0.08 to 0.45)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 25)	0.01 (0.00 to 0.04)	8 (0 to 25)	0.01 (0.00 to 0.02)
1	Feb	8 (0 to 24)	0.02 (0.00 to 0.07)	8 (0 to 24)	0.02 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	24 (0 to 48)	0.02 (0.00 to 0.04)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	17 (0 to 42)	0.01 (0.00 to 0.03)

Common guillemot

1.3.3.14 Common guillemot was the most abundant seabird species recorded during the digital aerial surveys, with most birds found on the sea. Common guillemot distribution was heterogeneous depending on year and month. Whilst birds were widespread across the Morgan Array Area plus 10km buffer during pre-breeding in March 2022 and April 2021, the birds were distributed to the southeast and east of the Morgan Array Area from June to December 2021, where densities upwards of 39 birds per km^2 were recorded (Figure 1.22).

1.3.3.15 Within the Morgan Array Area plus 10km buffer, the highest estimates were recorded in April 2021 with 13,281 individuals (95% CI range: 10,543 to 16,504), December 2021 with 11,326 individuals (95% CI range: 6,473 to 17,570), and March 2022 with 10,506 individuals (95% CI range: 8,452 to 12,803). Numbers declined into the breeding season, suggesting that the area was of lower importance for common guillemot during the breeding season (Table 1.30). MRSea estimates for each boundary area can be found in Appendix B.

1.3.3.16 Density estimates were similar between design-based and MRSea predictions in the Morgan Array Area plus 10km buffer zone. Design-based estimates produced by behaviour (sitting, flying, and all behaviour) are given for each boundary (Table 1.31; Table 1.32; Table 1.33).

1.3.3.17 During the breeding season, Bradbury *et al.* (2014) showed hotspots of activity to the east of the Morgan Array Area, confirming the general pattern of usage from the digital aerial survey data analysis.

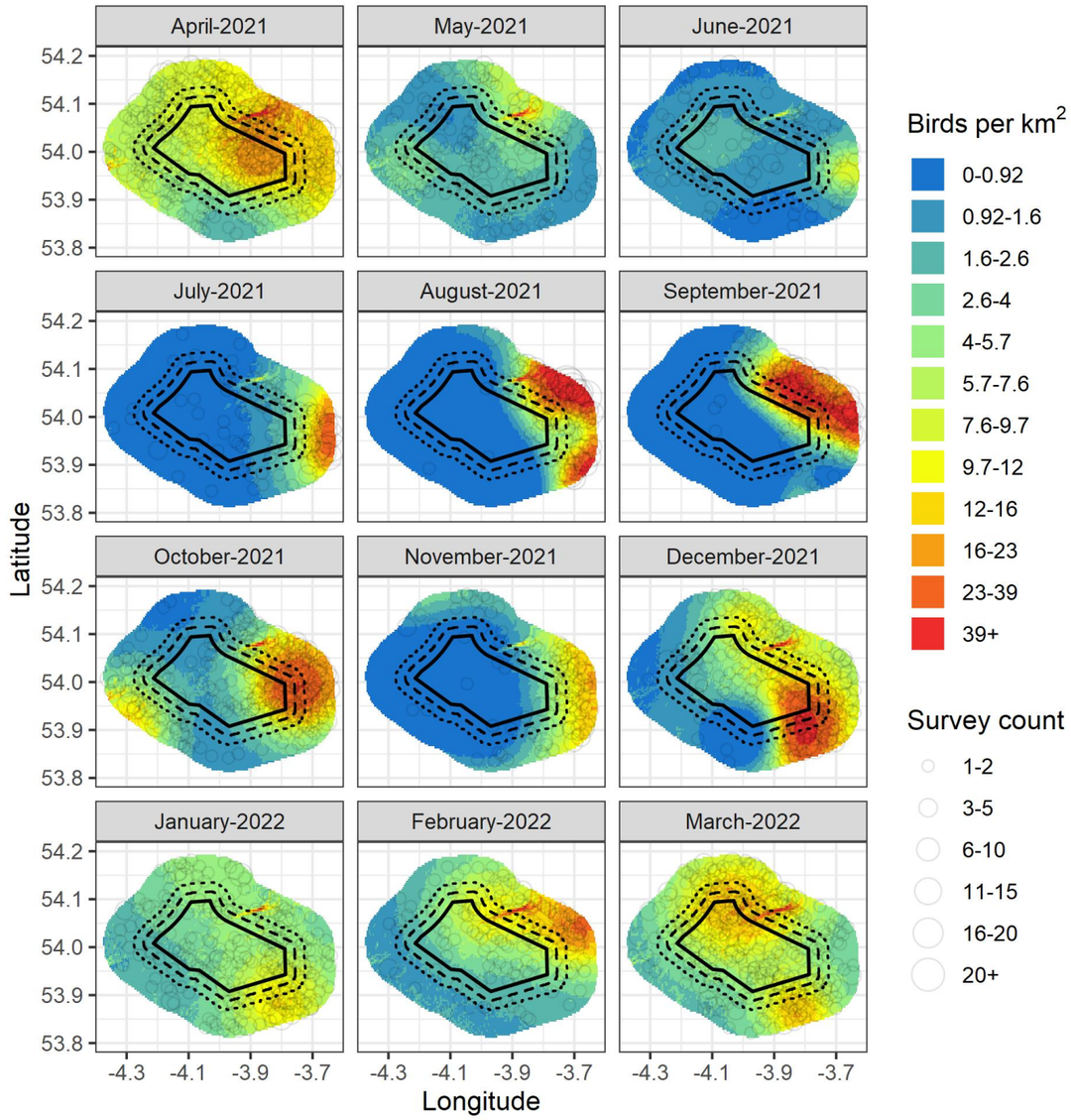


Figure 1.22: Common guillemot monthly densities (birds per km^2) and raw counts. Estimates are based on the MRSea model outputs.

Table 1.30: Common guillemot (all behaviour) design-based and MRSea population estimates for the Morgan Array Area plus 10km buffer zone.

		MRSea estimates		Design-based estimates	
Year	Month	Pop	D	Pop	D
1	Apr	13,281 (10,543 to 16,504)	9.65 (7.66 to 11.99)	13,268 (11,856 to 14,736)	9.64 (8.61 to 10.70)
1	May	3,451 (2,053 to 5,451)	2.51 (1.49 to 3.96)	3,420 (2,564 to 4,363)	2.48 (1.86 to 3.17)
1	Jun	2,051 (1,365 to 2,988)	1.49 (0.99 to 2.17)	2,048 (1,597 to 2,623)	1.49 (1.16 to 1.91)
1	Jul	2,711 (1,694 to 3,988)	1.97 (1.23 to 2.90)	2,710 (2,162 to 3,359)	1.97 (1.57 to 2.44)
1	Aug	5,803 (4,358 to 7,602)	4.22 (3.17 to 5.52)	5,971 (4,748 to 7,356)	4.34 (3.45 to 5.34)
1	Sep	8,523 (5,942 to 11,699)	6.19 (4.32 to 8.50)	8,484 (6,945 to 10,242)	6.16 (5.04 to 7.44)
1	Oct	8,954 (7,184 to 10,906)	6.50 (5.22 to 7.92)	8,891 (7,513 to 10,363)	6.46 (5.46 to 7.53)
1	Nov	2,850 (2,069 to 3,827)	2.07 (1.50 to 2.78)	2,920 (2,317 to 3,511)	2.12 (1.68 to 2.55)
1	Dec	11,326 (6,473 to 17,570)	8.23 (4.70 to 12.76)	11,485 (9,574 to 13,700)	8.34 (6.95 to 9.95)
1	Jan	6,512 (4,962 to 8,304)	4.73 (3.60 to 6.03)	6,552 (5,703 to 7,509)	4.76 (4.14 to 5.45)
1	Feb	6,966 (5,157 to 9,069)	5.06 (3.75 to 6.59)	6,985 (5,775 to 8,157)	5.07 (4.19 to 5.92)
1	Mar	10,506 (8,452 to 12,803)	7.63 (6.14 to 9.30)	10,592 (9,198 to 12,055)	7.69 (6.68 to 8.76)

Table 1.31: Design-based common guillemot (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	38 (30 to 47)	0.12 (0.09 to 0.14)	54 (45 to 64)	0.11 (0.09 to 0.13)	76 (65 to 87)	0.11 (0.09 to 0.13)	146 (131 to 162)	0.11 (0.09 to 0.12)
1	May	6 (4 to 8)	0.02 (0.01 to 0.02)	9 (6 to 11)	0.02 (0.01 to 0.02)	13 (10 to 16)	0.02 (0.01 to 0.02)	27 (20 to 34)	0.02 (0.01 to 0.03)
1	Jun	12 (7 to 18)	0.04 (0.02 to 0.05)	18 (13 to 26)	0.04 (0.03 to 0.05)	26 (18 to 35)	0.04 (0.03 to 0.05)	53 (41 to 68)	0.04 (0.03 to 0.05)
1	Jul	2 (1 to 3)	0.01 (0.00 to 0.01)	3 (2 to 4)	0.01 (0.00 to 0.01)	5 (3 to 6)	0.01 (0.00 to 0.01)	16 (13 to 20)	0.01 (0.01 to 0.01)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	2 (1 to 2)	0.01 (0.00 to 0.01)	3 (2 to 4)	0.01 (0.00 to 0.01)	4 (3 to 5)	0.01 (0.00 to 0.01)	9 (7 to 10)	0.01 (0.01 to 0.01)
1	Nov	3 (1 to 6)	0.01 (0.00 to 0.02)	7 (4 to 11)	0.01 (0.01 to 0.02)	14 (9 to 19)	0.02 (0.01 to 0.03)	72 (57 to 86)	0.05 (0.04 to 0.06)
1	Dec	84 (54 to 125)	0.26 (0.16 to 0.38)	136 (96 to 176)	0.27 (0.19 to 0.35)	217 (163 to 277)	0.31 (0.23 to 0.40)	408 (340 to 487)	0.30 (0.25 to 0.35)
1	Jan	14 (10 to 18)	0.04 (0.03 to 0.05)	19 (15 to 24)	0.04 (0.03 to 0.05)	25 (21 to 31)	0.04 (0.03 to 0.04)	53 (46 to 61)	0.04 (0.03 to 0.04)
1	Feb	91 (61 to 126)	0.28 (0.19 to 0.39)	114 (83 to 156)	0.23 (0.17 to 0.31)	164 (126 to 210)	0.24 (0.18 to 0.30)	359 (297 to 420)	0.26 (0.22 to 0.30)
1	Mar	6 (4 to 7)	0.02 (0.01 to 0.02)	9 (7 to 10)	0.02 (0.01 to 0.02)	13 (11 to 15)	0.02 (0.02 to 0.02)	22 (19 to 25)	0.02 (0.01 to 0.02)

Table 1.32: Design-based common guillemot (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	3,397 (2,736 to 4,213)	10.42 (8.39 to 12.92)	4,853 (4,001 to 5,762)	9.67 (7.97 to 11.48)	6,789 (5,800 to 7,817)	9.78 (8.35 to 11.26)	13,121 (11,725 to 14,574)	9.53 (8.52 to 10.59)
1	May	718 (487 to 993)	2.20 (1.49 to 3.04)	1,068 (806 to 1,398)	2.13 (1.61 to 2.79)	1,579 (1,229 to 1,964)	2.27 (1.77 to 2.83)	3,393 (2,544 to 4,328)	2.46 (1.85 to 3.14)
1	Jun	434 (248 to 671)	1.33 (0.76 to 2.06)	690 (475 to 986)	1.38 (0.95 to 1.96)	986 (682 to 1,312)	1.42 (0.98 to 1.89)	1,995 (1,555 to 2,555)	1.45 (1.13 to 1.86)
1	Jul	287 (154 to 474)	0.88 (0.47 to 1.45)	471 (301 to 704)	0.94 (0.60 to 1.40)	810 (561 to 1,075)	1.17 (0.81 to 1.55)	2,694 (2,149 to 3,339)	1.96 (1.56 to 2.43)
1	Aug	167 (30 to 316)	0.51 (0.09 to 0.97)	680 (374 to 1,097)	1.35 (0.75 to 2.19)	1,184 (758 to 1,640)	1.71 (1.09 to 2.36)	5,971 (4,748 to 7,356)	4.34 (3.45 to 5.34)
1	Sep	390 (235 to 605)	1.20 (0.72 to 1.85)	1,117 (796 to 1,500)	2.23 (1.59 to 2.99)	2,632 (1,946 to 3,340)	3.79 (2.80 to 4.81)	8,484 (6,945 to 10,242)	6.16 (5.04 to 7.44)
1	Oct	1,709 (1,175 to 2,387)	5.24 (3.60 to 7.32)	2,884 (2,213 to 3,691)	5.75 (4.41 to 7.35)	4,086 (3,299 to 5,114)	5.88 (4.75 to 7.36)	8,883 (7,505 to 10,353)	6.45 (5.45 to 7.52)
1	Nov	137 (57 to 240)	0.42 (0.17 to 0.74)	282 (155 to 448)	0.56 (0.31 to 0.89)	553 (356 to 770)	0.80 (0.51 to 1.11)	2,849 (2,260 to 3,425)	2.07 (1.64 to 2.49)
1	Dec	2,286 (1,455 to 3,391)	7.01 (4.46 to 10.40)	3,683 (2,602 to 4,790)	7.34 (5.19 to 9.55)	5,895 (4,416 to 7,531)	8.49 (6.36 to 10.85)	11,077 (9,234 to 13,214)	8.05 (6.71 to 9.60)
1	Jan	1,672 (1,271 to 2,189)	5.13 (3.90 to 6.71)	2,352 (1,871 to 2,930)	4.69 (3.73 to 5.84)	3,078 (2,553 to 3,773)	4.43 (3.68 to 5.43)	6,499 (5,657 to 7,448)	4.72 (4.11 to 5.41)
1	Feb	1,678 (1,124 to 2,314)	5.15 (3.45 to 7.10)	2,097 (1,528 to 2,867)	4.18 (3.04 to 5.71)	3,027 (2,317 to 3,862)	4.36 (3.34 to 5.56)	6,625 (5,478 to 7,737)	4.81 (3.98 to 5.62)
1	Mar	2,679 (2,073 to 3,497)	8.22 (6.36 to 10.72)	4,083 (3,293 to 4,971)	8.14 (6.56 to 9.91)	6,080 (5,033 to 7,229)	8.76 (7.25 to 10.41)	10,570 (9,179 to 12,030)	7.68 (6.67 to 8.74)

Table 1.33: Design-based common guillemot (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	3,435 (2,767 to 4,260)	10.53 (8.48 to 13.06)	4,907 (4,046 to 5,827)	9.78 (8.06 to 11.61)	6,865 (5,865 to 7,904)	9.89 (8.45 to 11.38)	13,268 (11,856 to 14,736)	9.64 (8.61 to 10.70)
1	May	724 (491 to 1,000)	2.22 (1.51 to 3.07)	1,077 (812 to 1,409)	2.15 (1.62 to 2.81)	1,592 (1,239 to 1,979)	2.29 (1.78 to 2.85)	3,420 (2,564 to 4,363)	2.48 (1.86 to 3.17)
1	Jun	445 (255 to 689)	1.37 (0.78 to 2.11)	709 (488 to 1,012)	1.41 (0.97 to 2.02)	1,012 (701 to 1,347)	1.46 (1.01 to 1.94)	2,048 (1,597 to 2,623)	1.49 (1.16 to 1.91)
1	Jul	289 (154 to 477)	0.88 (0.47 to 1.46)	474 (303 to 708)	0.94 (0.60 to 1.41)	815 (564 to 1,082)	1.17 (0.81 to 1.56)	2,710 (2,162 to 3,359)	1.97 (1.57 to 2.44)
1	Aug	167 (30 to 316)	0.51 (0.09 to 0.97)	680 (374 to 1,097)	1.35 (0.75 to 2.19)	1,184 (758 to 1,640)	1.71 (1.09 to 2.36)	5,971 (4,748 to 7,356)	4.34 (3.45 to 5.34)
1	Sep	390 (235 to 605)	1.20 (0.72 to 1.85)	1,117 (796 to 1,500)	2.23 (1.59 to 2.99)	2,632 (1,946 to 3,340)	3.79 (2.80 to 4.81)	8,484 (6,945 to 10,242)	6.16 (5.04 to 7.44)
1	Oct	1,711 (1,177 to 2,390)	5.25 (3.61 to 7.33)	2,887 (2,215 to 3,694)	5.75 (4.41 to 7.36)	4,090 (3,303 to 5,119)	5.89 (4.76 to 7.37)	8,891 (7,513 to 10,363)	6.46 (5.46 to 7.53)
1	Nov	140 (58 to 246)	0.43 (0.18 to 0.76)	289 (159 to 460)	0.58 (0.32 to 0.92)	567 (365 to 790)	0.82 (0.53 to 1.14)	2,920 (2,317 to 3,511)	2.12 (1.68 to 2.55)
1	Dec	2,370 (1,509 to 3,516)	7.27 (4.63 to 10.78)	3,819 (2,698 to 4,966)	7.61 (5.38 to 9.90)	6,112 (4,578 to 7,808)	8.80 (6.59 to 11.25)	11,485 (9,574 to 13,700)	8.34 (6.95 to 9.95)
1	Jan	1,686 (1,282 to 2,206)	5.17 (3.93 to 6.77)	2,371 (1,886 to 2,954)	4.73 (3.76 to 5.89)	3,103 (2,574 to 3,803)	4.47 (3.71 to 5.48)	6,552 (5,703 to 7,509)	4.76 (4.14 to 5.45)
1	Feb	1,769 (1,185 to 2,440)	5.42 (3.63 to 7.48)	2,211 (1,611 to 3,023)	4.41 (3.21 to 6.02)	3,192 (2,442 to 4,072)	4.60 (3.52 to 5.86)	6,985 (5,775 to 8,157)	5.07 (4.19 to 5.92)
1	Mar	2,685 (2,077 to 3,504)	8.23 (6.37 to 10.75)	4,091 (3,300 to 4,981)	8.15 (6.58 to 9.93)	6,093 (5,044 to 7,245)	8.77 (7.26 to 10.43)	10,592 (9,198 to 12,055)	7.69 (6.68 to 8.76)

Razorbill

1.3.3.18 No MRSea model was run for razorbill due to its densities being too low. The highest number of razorbill was recorded in December 2021, with an abundance estimate of 1,184 individuals (95% CI range: 582 to 1,843). At this time of the year, the species is wintering and foraging far out at sea. Generally, population estimates for razorbill were very low (Table 1.34).

1.3.3.19 Design-based estimates produced by behaviour (sitting and flying) are given for each boundary (Table 1.34; Table 1.35; Table 1.36).

1.3.3.20 The distribution pattern was similar to guillemot, where Bradbury *et al.* (2014) demonstrated that abundance was the highest outside of the survey area, in the west part of the Morecambe Bay and Duddon Estuary SPA.

Table 1.34: Design-based razorbill (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	1 (0 to 2)	0.00 (0.00 to 0.01)	3 (1 to 5)	0.01 (0.00 to 0.01)	3 (2 to 6)	0.01 (0.00 to 0.01)	9 (5 to 12)	0.01 (0.00 to 0.01)
1	Nov	1 (0 to 3)	0.00 (0.00 to 0.01)	1 (0 to 3)	0.00 (0.00 to 0.01)	3 (0 to 7)	0.00 (0.00 to 0.01)	12 (4 to 21)	0.01 (0.00 to 0.01)
1	Dec	5 (0 to 10)	0.01 (0.00 to 0.03)	6 (1 to 12)	0.01 (0.00 to 0.02)	11 (4 to 22)	0.02 (0.01 to 0.03)	28 (14 to 44)	0.02 (0.01 to 0.03)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	2 (1 to 5)	0.01 (0.00 to 0.01)	3 (1 to 6)	0.01 (0.00 to 0.01)	3 (1 to 6)	0.00 (0.00 to 0.01)	11 (7 to 15)	0.01 (0.00 to 0.01)

Table 1.35: Design-based razorbill (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	77 (31 to 139)	0.24 (0.10 to 0.43)	120 (52 to 195)	0.24 (0.10 to 0.39)	186 (106 to 285)	0.27 (0.15 to 0.41)	540 (360 to 761)	0.39 (0.26 to 0.55)
1	May	11 (0 to 35)	0.03 (0.00 to 0.11)	33 (0 to 69)	0.07 (0.00 to 0.14)	45 (11 to 91)	0.06 (0.02 to 0.13)	99 (43 to 194)	0.07 (0.03 to 0.14)
1	Jun	72 (10 to 134)	0.22 (0.03 to 0.41)	94 (30 to 166)	0.19 (0.06 to 0.33)	94 (31 to 166)	0.14 (0.04 to 0.24)	183 (106 to 302)	0.13 (0.08 to 0.22)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	20 (0 to 41)	0.01 (0.00 to 0.03)
1	Sep	11 (0 to 35)	0.03 (0.00 to 0.11)	11 (0 to 35)	0.02 (0.00 to 0.07)	21 (0 to 46)	0.03 (0.00 to 0.07)	159 (66 to 266)	0.12 (0.05 to 0.19)
1	Oct	41 (10 to 85)	0.13 (0.03 to 0.26)	100 (47 to 176)	0.20 (0.09 to 0.35)	132 (67 to 226)	0.19 (0.10 to 0.33)	327 (198 to 471)	0.24 (0.14 to 0.34)
1	Nov	14 (0 to 42)	0.04 (0.00 to 0.13)	13 (0 to 41)	0.03 (0.00 to 0.08)	40 (0 to 96)	0.06 (0.00 to 0.14)	172 (52 to 303)	0.13 (0.04 to 0.22)
1	Dec	198 (16 to 422)	0.61 (0.05 to 1.30)	227 (47 to 474)	0.45 (0.09 to 0.94)	465 (158 to 883)	0.67 (0.23 to 1.27)	1,156 (568 to 1,799)	0.84 (0.41 to 1.31)
1	Jan	120 (0 to 273)	0.37 (0.00 to 0.84)	118 (0 to 266)	0.24 (0.00 to 0.53)	119 (0 to 263)	0.17 (0.00 to 0.38)	393 (176 to 666)	0.29 (0.13 to 0.48)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	133 (0 to 368)	0.19 (0.00 to 0.53)	271 (27 to 594)	0.20 (0.02 to 0.43)
1	Mar	137 (36 to 270)	0.42 (0.11 to 0.83)	163 (62 to 311)	0.33 (0.12 to 0.62)	191 (62 to 323)	0.27 (0.09 to 0.47)	625 (375 to 845)	0.45 (0.27 to 0.61)

Table 1.36: Design-based razorbill (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	77 (31 to 139)	0.24 (0.10 to 0.43)	120 (52 to 195)	0.24 (0.10 to 0.39)	186 (106 to 285)	0.27 (0.15 to 0.41)	540 (360 to 761)	0.39 (0.26 to 0.55)
1	May	11 (0 to 35)	0.03 (0.00 to 0.11)	33 (0 to 69)	0.07 (0.00 to 0.14)	45 (11 to 91)	0.06 (0.02 to 0.13)	99 (43 to 194)	0.07 (0.03 to 0.14)
1	Jun	72 (10 to 134)	0.22 (0.03 to 0.41)	94 (30 to 166)	0.19 (0.06 to 0.33)	94 (31 to 166)	0.14 (0.04 to 0.24)	183 (106 to 302)	0.13 (0.08 to 0.22)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	20 (0 to 41)	0.01 (0.00 to 0.03)
1	Sep	11 (0 to 35)	0.03 (0.00 to 0.11)	11 (0 to 35)	0.02 (0.00 to 0.07)	21 (0 to 46)	0.03 (0.00 to 0.07)	159 (66 to 266)	0.12 (0.05 to 0.19)
1	Oct	42 (10 to 87)	0.13 (0.03 to 0.27)	103 (49 to 181)	0.20 (0.10 to 0.36)	135 (69 to 232)	0.20 (0.10 to 0.33)	336 (203 to 483)	0.24 (0.15 to 0.35)
1	Nov	14 (0 to 45)	0.04 (0.00 to 0.14)	14 (0 to 44)	0.03 (0.00 to 0.09)	43 (0 to 102)	0.06 (0.00 to 0.15)	184 (56 to 323)	0.13 (0.04 to 0.23)
1	Dec	203 (16 to 433)	0.62 (0.05 to 1.33)	233 (48 to 485)	0.46 (0.10 to 0.97)	477 (162 to 905)	0.69 (0.23 to 1.30)	1,184 (582 to 1,843)	0.86 (0.42 to 1.34)
1	Jan	120 (0 to 273)	0.37 (0.00 to 0.84)	118 (0 to 266)	0.24 (0.00 to 0.53)	119 (0 to 263)	0.17 (0.00 to 0.38)	393 (176 to 666)	0.29 (0.13 to 0.48)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	133 (0 to 368)	0.19 (0.00 to 0.53)	271 (27 to 594)	0.20 (0.02 to 0.43)
1	Mar	139 (37 to 275)	0.43 (0.11 to 0.84)	166 (63 to 317)	0.33 (0.12 to 0.63)	194 (64 to 329)	0.28 (0.09 to 0.47)	636 (382 to 860)	0.46 (0.28 to 0.62)

Northern fulmar

1.3.3.21 The species was frequently recorded (54 sightings), albeit as single individuals. The relative low numbers of monthly sightings meant that only design-based estimates were produced (Table 1.37; Table 1.38; Table 1.39).

1.3.3.22 The design-based estimates peaked in January 2022 and were followed by a decline in population size throughout the breeding and post-breeding season. This is contrary to the work of Waggitt *et al*. (2020) which showed a steady increase in abundance throughout the breeding season in the Morgan Array Area, with a peak in abundance predicted in August.

1.3.3.23 However, the level of abundance reported by Waggitt *et al*. (2020) was in line with the results of the digital aerial surveys, indicating that the area was of low importance for northern fulmar. A maximum design-based estimate of 143 birds (95% CI range: 8 to 293) was recorded within the Morgan Array Area plus 10km buffer zone.

Table 1.37: Design-based northern fulmar (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	12 (0 to 27)	0.04 (0.00 to 0.08)	25 (0 to 52)	0.05 (0.00 to 0.10)	25 (0 to 52)	0.04 (0.00 to 0.08)	38 (13 to 73)	0.03 (0.01 to 0.05)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	16 (0 to 40)	0.01 (0.00 to 0.03)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	31 (8 to 64)	0.02 (0.01 to 0.05)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	4 (0 to 12)	0.01 (0.00 to 0.02)	8 (0 to 16)	0.01 (0.00 to 0.01)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (2 to 16)	0.01 (0.00 to 0.01)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	1 (0 to 3)	0.00 (0.00 to 0.01)	1 (0 to 3)	0.00 (0.00 to 0.00)	8 (0 to 19)	0.01 (0.00 to 0.01)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	63 (0 to 137)	0.19 (0.00 to 0.42)	66 (4 to 146)	0.13 (0.01 to 0.29)	66 (4 to 145)	0.09 (0.01 to 0.21)	71 (4 to 147)	0.05 (0.00 to 0.11)
1	Feb	6 (0 to 18)	0.02 (0.00 to 0.06)	6 (0 to 18)	0.01 (0.00 to 0.04)	6 (0 to 18)	0.01 (0.00 to 0.03)	23 (6 to 48)	0.02 (0.00 to 0.03)
1	Mar	4 (0 to 12)	0.01 (0.00 to 0.04)	4 (0 to 12)	0.01 (0.00 to 0.02)	19 (4 to 35)	0.03 (0.01 to 0.05)	31 (11 to 51)	0.02 (0.01 to 0.04)

Table 1.38: Design-based northern fulmar (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	2 (0 to 5)	0.01 (0.00 to 0.02)	5 (0 to 10)	0.01 (0.00 to 0.02)	5 (0 to 10)	0.01 (0.00 to 0.02)	8 (3 to 15)	0.01 (0.00 to 0.01)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	4 (0 to 12)	0.01 (0.00 to 0.02)	8 (0 to 16)	0.01 (0.00 to 0.01)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	24 (6 to 49)	0.02 (0.00 to 0.04)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	7 (0 to 21)	0.01 (0.00 to 0.04)	7 (0 to 20)	0.01 (0.00 to 0.03)	47 (0 to 117)	0.03 (0.00 to 0.08)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	Jan	63 (0 to 137)	0.19 (0.00 to 0.42)	66 (4 to 146)	0.13 (0.01 to 0.29)	66 (4 to 145)	0.09 (0.01 to 0.21)	71 (4 to 147)	0.05 (0.00 to 0.11)
1	Feb	2 (0 to 6)	0.01 (0.00 to 0.02)	2 (0 to 6)	0.00 (0.00 to 0.01)	2 (0 to 6)	0.00 (0.00 to 0.01)	8 (2 to 16)	0.01 (0.00 to 0.01)
1	Mar	4 (0 to 12)	0.01 (0.00 to 0.04)	4 (0 to 12)	0.01 (0.00 to 0.02)	19 (4 to 35)	0.03 (0.01 to 0.05)	31 (11 to 51)	0.02 (0.01 to 0.04)

Table 1.39: Design-based northern fulmar (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	15 (0 to 32)	0.04 (0.00 to 0.10)	30 (0 to 63)	0.06 (0.00 to 0.13)	30 (0 to 63)	0.04 (0.00 to 0.09)	46 (15 to 88)	0.03 (0.01 to 0.06)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	16 (0 to 40)	0.01 (0.00 to 0.03)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	31 (8 to 64)	0.02 (0.01 to 0.05)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.01 (0.00 to 0.03)	15 (0 to 32)	0.01 (0.00 to 0.02)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	31 (8 to 65)	0.02 (0.01 to 0.05)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.02 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	55 (0 to 136)	0.04 (0.00 to 0.10)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	Jan	126 (0 to 275)	0.39 (0.00 to 0.84)	131 (7 to 292)	0.26 (0.01 to 0.58)	132 (7 to 291)	0.19 (0.01 to 0.42)	143 (8 to 293)	0.10 (0.01 to 0.21)
1	Feb	8 (0 to 24)	0.02 (0.00 to 0.07)	8 (0 to 24)	0.02 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	31 (8 to 64)	0.02 (0.01 to 0.05)
1	Mar	8 (0 to 24)	0.02 (0.00 to 0.07)	8 (0 to 24)	0.02 (0.00 to 0.05)	37 (7 to 70)	0.05 (0.01 to 0.10)	61 (23 to 103)	0.04 (0.02 to 0.07)

Manx shearwater

1.3.3.24 As expected, Manx shearwater was absent or near absent during the non-breeding season (September to March) as the species overwinters off the coast of South America.

1.3.3.25 Within the Morgan Array Area plus 10km buffer zone, the highest abundance was recorded in August 2021, with an estimated 2,096 birds (95% range: 658 to 6,883). The design-based estimate for that month yielded a similar population size of 2,023 individuals (95% range: 954 to 3,378; Table 1.40). MRSea estimates for each boundary area can be found in Appendix B.

1.3.3.26 The presence of Manx shearwater in the breeding season suggested that these birds might be associated with the Welsh colonies and thus foraged within the Morgan Array Area plus 10km buffer zone. There was a hotspot of high densities to the east and northeast of the Morgan Array Area where densities exceeding 8.8 individuals per km^2 were recorded in August 2021.

1.3.3.27 Within the Morgan Array Area, design-based estimates peaked at 189 individuals (95% range: 94 to 315) in July 2021.

1.3.3.28 Design-based estimates produced by each behaviour (flying, sitting and all behaviour) are given for each boundary (Table 1.41; Table 1.42; Table 1.43).

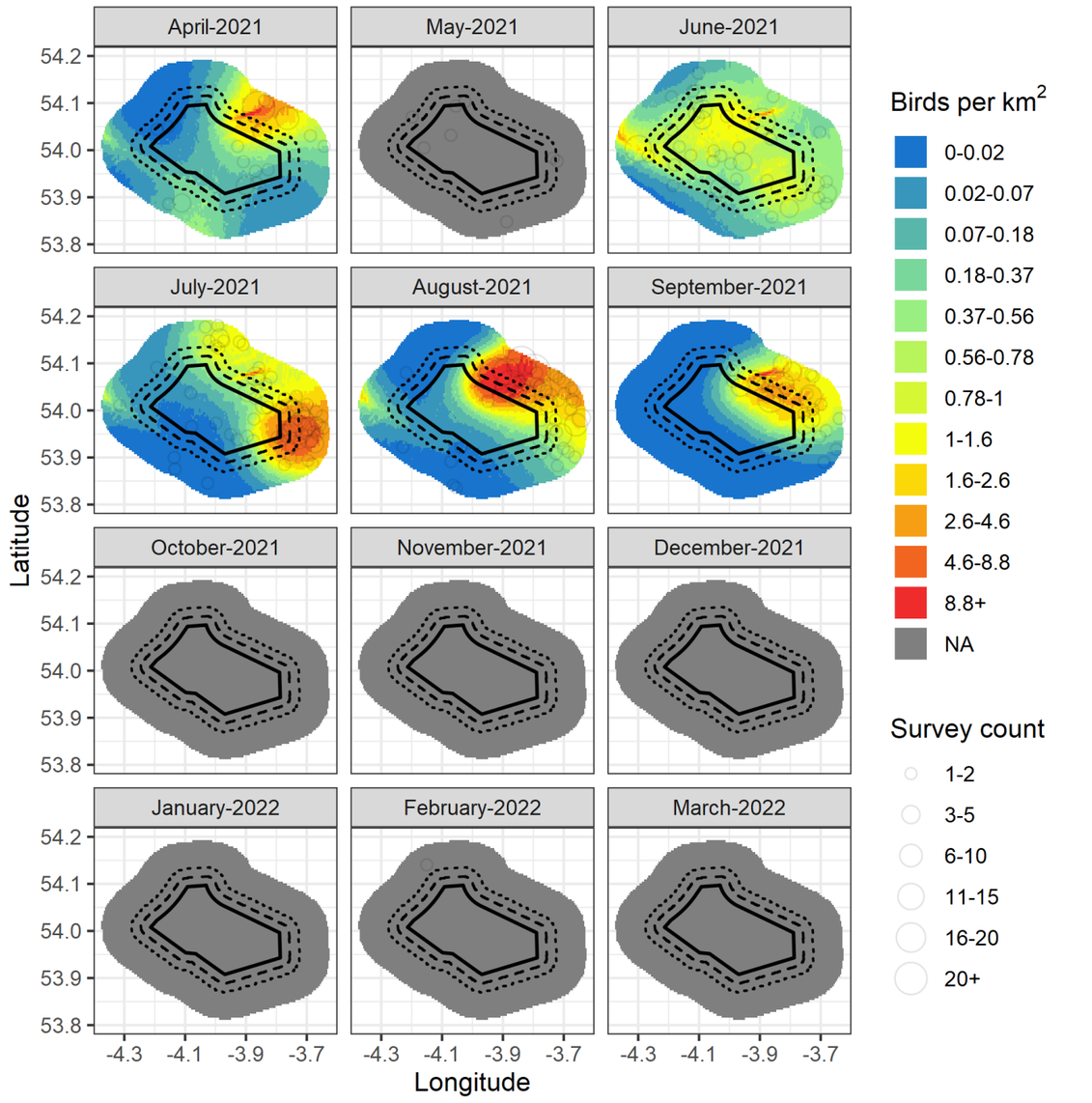


Figure 1.23: Manx shearwater monthly densities (birds per km^2) and raw counts. Estimates are based on the MRSea model outputs.

Table 1.40: Manx shearwater (all behaviour) design-based and MRSea population estimates for the Morgan Array Area plus 10km buffer zone.

		MRSea estimates		Design-based estimates	
Year	**Month**	**Pop**	**D**	**Pop**	**D**
1	Apr	518 (158 to 1,789)	0.38 (0.11 to 1.30)	513 (153 to 971)	0.37 (0.11 to 0.71)
1	May	n/a	n/a	71 (23 to 122)	0.05 (0.02 to 0.09)
1	Jun	736 (356 to 1,418)	0.53 (0.26 to 1.03)	737 (406 to 1,109)	0.54 (0.29 to 0.81)
1	Jul	1,161 (546 to 2,231)	0.84 (0.40 to 1.62)	1,166 (718 to 1,707)	0.85 (0.52 to 1.24)
1	Aug	2,096 (658 to 6,883)	1.52 (0.48 to 5.00)	2,023 (954 to 3,378)	1.47 (0.69 to 2.45)
1	Sep	576 (293 to 1,030)	0.42 (0.21 to 0.75)	580 (274 to 891)	0.42 (0.20 to 0.65)
1	Oct	n/a	n/a	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	n/a	n/a	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	n/a	n/a	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	n/a	n/a	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	n/a	n/a	8 (0 to 24)	0.01 (0.00 to 0.02)
1	Mar	n/a	n/a	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.41: Design-based Manx shearwater (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	15 (3 to 28)	0.05 (0.01 to 0.09)	20 (7 to 36)	0.04 (0.01 to 0.07)	25 (11 to 47)	0.04 (0.02 to 0.07)	93 (28 to 177)	0.07 (0.02 to 0.13)
1	May	8 (0 to 16)	0.02 (0.00 to 0.05)	10 (2 to 22)	0.02 (0.00 to 0.04)	18 (5 to 35)	0.03 (0.01 to 0.05)	24 (8 to 41)	0.02 (0.01 to 0.03)
1	Jun	159 (79 to 265)	0.49 (0.24 to 0.81)	232 (129 to 356)	0.46 (0.26 to 0.71)	371 (174 to 646)	0.53 (0.25 to 0.93)	620 (341 to 932)	0.45 (0.25 to 0.68)
1	Jul	58 (24 to 104)	0.18 (0.07 to 0.32)	134 (74 to 221)	0.27 (0.15 to 0.44)	419 (160 to 731)	0.60 (0.23 to 1.05)	791 (487 to 1,157)	0.57 (0.35 to 0.84)
1	Aug	2 (0 to 5)	0.01 (0.00 to 0.02)	18 (8 to 31)	0.04 (0.02 to 0.06)	235 (24 to 457)	0.34 (0.03 to 0.66)	425 (200 to 709)	0.31 (0.15 to 0.52)
1	Sep	11 (0 to 29)	0.03 (0.00 to 0.09)	53 (5 to 116)	0.11 (0.01 to 0.23)	132 (52 to 234)	0.19 (0.07 to 0.34)	204 (96 to 313)	0.15 (0.07 to 0.23)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.42: Design-based Manx shearwater (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	69 (12 to 127)	0.21 (0.04 to 0.39)	88 (30 to 164)	0.18 (0.06 to 0.33)	114 (49 to 211)	0.16 (0.07 to 0.30)	420 (126 to 794)	0.30 (0.09 to 0.58)
1	May	16 (0 to 33)	0.05 (0.00 to 0.10)	21 (5 to 44)	0.04 (0.01 to 0.09)	37 (10 to 70)	0.05 (0.01 to 0.10)	47 (15 to 81)	0.03 (0.01 to 0.06)
1	Jun	30 (15 to 50)	0.09 (0.05 to 0.15)	44 (24 to 68)	0.09 (0.05 to 0.13)	71 (33 to 123)	0.10 (0.05 to 0.18)	118 (65 to 177)	0.09 (0.05 to 0.13)
1	Jul	27 (12 to 49)	0.08 (0.04 to 0.15)	64 (35 to 105)	0.13 (0.07 to 0.21)	199 (76 to 348)	0.29 (0.11 to 0.50)	376 (231 to 550)	0.27 (0.17 to 0.40)
1	Aug	6 (0 to 20)	0.02 (0.00 to 0.06)	67 (29 to 116)	0.13 (0.06 to 0.23)	883 (89 to 1,720)	1.27 (0.13 to 2.48)	1,598 (754 to 2,669)	1.16 (0.55 to 1.94)
1	Sep	21 (0 to 53)	0.06 (0.00 to 0.16)	97 (10 to 215)	0.19 (0.02 to 0.43)	243 (96 to 431)	0.35 (0.14 to 0.62)	376 (178 to 578)	0.27 (0.13 to 0.42)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.43: Design-based Manx shearwater (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	84 (15 to 155)	0.26 (0.04 to 0.48)	108 (37 to 201)	0.21 (0.07 to 0.40)	139 (59 to 257)	0.20 (0.09 to 0.37)	513 (153 to 971)	0.37 (0.11 to 0.71)
1	May	23 (0 to 49)	0.07 (0.00 to 0.15)	31 (7 to 65)	0.06 (0.01 to 0.13)	55 (15 to 106)	0.08 (0.02 to 0.15)	71 (23 to 122)	0.05 (0.02 to 0.09)
1	Jun	189 (94 to 315)	0.58 (0.29 to 0.97)	276 (153 to 424)	0.55 (0.31 to 0.85)	442 (207 to 769)	0.64 (0.30 to 1.11)	737 (406 to 1,109)	0.54 (0.29 to 0.81)
1	Jul	85 (36 to 153)	0.26 (0.11 to 0.47)	198 (109 to 326)	0.39 (0.22 to 0.65)	619 (235 to 1,079)	0.89 (0.34 to 1.55)	1,166 (718 to 1,707)	0.85 (0.52 to 1.24)
1	Aug	8 (0 to 25)	0.02 (0.00 to 0.08)	85 (37 to 147)	0.17 (0.07 to 0.29)	1,118 (113 to 2,176)	1.61 (0.16 to 3.13)	2,023 (954 to 3,378)	1.47 (0.69 to 2.45)
1	Sep	32 (0 to 82)	0.10 (0.00 to 0.25)	150 (15 to 331)	0.30 (0.03 to 0.66)	375 (148 to 665)	0.54 (0.21 to 0.96)	580 (274 to 891)	0.42 (0.20 to 0.65)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Northern gannet

1.3.3.29 As expected, abundance was low during the non-breeding season with most of the birds departing to wintering grounds off the coast of West Africa.

1.3.3.30 The highest abundance in the survey area was recorded in August, with 679 (95% range: 377 to 1,080) (Table 1.44). MRSea estimates for each boundary area can be found in Appendix B.

1.3.3.31 The distribution of northern gannet during the key breeding months was patchy, and the highest densities were found outside the Morgan Array Area in the north and the southeast (Figure 1.24). This suggests that the Morgan Array Area is not favoured by foraging Northern gannet.

1.3.3.32 Design-based estimates produced by each behaviour (flying, sitting and all behaviour) are given for each boundary (Table 1.45; Table 1.46; Table 1.47).

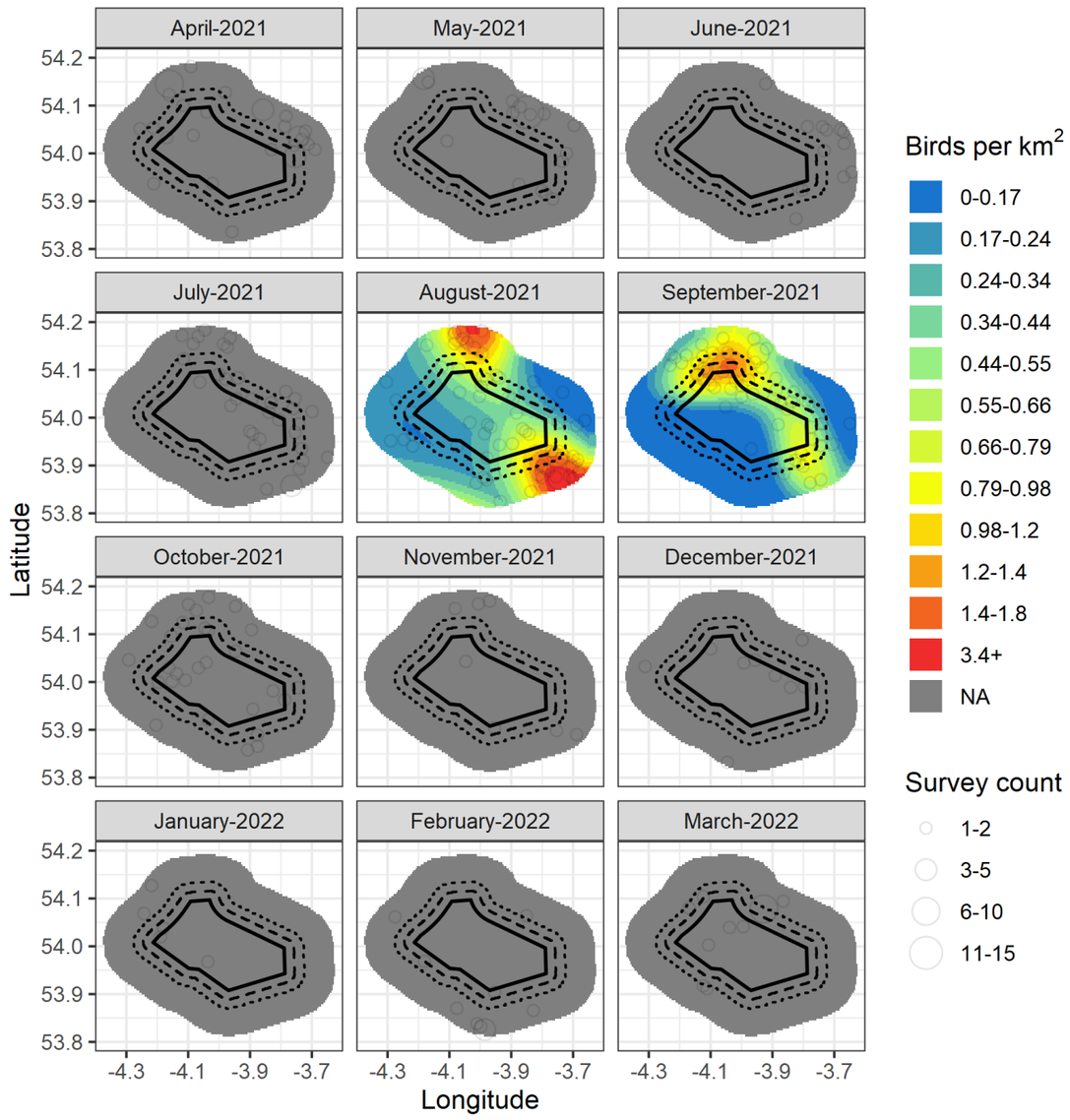


Figure 1.24: Northern gannet monthly densities (birds per km^2) and raw counts. Estimates are based on the MRSea model outputs.

Table 1.44: Northern gannet (all behaviour) design-based and MRSea population estimates for the Morgan Array Area plus 10km buffer zone.

		MRSea estimates		Design-based estimates	
Year	**Month**	**Pop**	**D**	**Pop**	**D**
1	Apr	n/a	n/a	309 (173 to 477)	0.22 (0.13 to 0.35)
1	May	n/a	n/a	252 (130 to 401)	0.18 (0.09 to 0.29)
1	Jun	n/a	n/a	125 (61 to 199)	0.09 (0.04 to 0.14)
1	Jul	n/a	n/a	315 (218 to 452)	0.23 (0.16 to 0.33)
1	Aug	679 (377 to 1,080)	0.49 (0.27 to 0.78)	665 (522 to 852)	0.48 (0.38 to 0.62)
1	Sep	504 (250 to 917)	0.36 (0.18 to 0.66)	499 (387 to 663)	0.36 (0.28 to 0.48)
1	Oct	n/a	n/a	219 (133 to 304)	0.16 (0.10 to 0.22)
1	Nov	n/a	n/a	54 (23 to 104)	0.04 (0.02 to 0.08)
1	Dec	n/a	n/a	78 (31 to 138)	0.06 (0.02 to 0.10)
1	Jan	n/a	n/a	39 (8 to 71)	0.03 (0.01 to 0.05)
1	Feb	n/a	n/a	91 (30 to 159)	0.07 (0.02 to 0.12)
1	Mar	n/a	n/a	109 (30 to 222)	0.08 (0.02 to 0.16)

Table 1.45: Design-based northern gannet (flying) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	9 (2 to 20)	0.03 (0.01 to 0.06)	15 (5 to 28)	0.03 (0.01 to 0.06)	23 (9 to 40)	0.03 (0.01 to 0.06)	77 (43 to 119)	0.06 (0.03 to 0.09)
1	May	6 (0 to 17)	0.02 (0.00 to 0.05)	10 (0 to 20)	0.02 (0.00 to 0.04)	19 (6 to 36)	0.03 (0.01 to 0.05)	102 (53 to 163)	0.07 (0.04 to 0.12)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	13 (0 to 31)	0.03 (0.00 to 0.06)	17 (0 to 40)	0.02 (0.00 to 0.06)	70 (34 to 112)	0.05 (0.02 to 0.08)
1	Jul	36 (13 to 64)	0.11 (0.04 to 0.20)	64 (35 to 106)	0.13 (0.07 to 0.21)	92 (54 to 139)	0.13 (0.08 to 0.20)	192 (133 to 275)	0.14 (0.10 to 0.20)
1	Aug	45 (23 to 73)	0.14 (0.07 to 0.22)	73 (40 to 104)	0.15 (0.08 to 0.21)	115 (73 to 160)	0.17 (0.10 to 0.23)	258 (203 to 331)	0.19 (0.15 to 0.24)
1	Sep	47 (20 to 82)	0.15 (0.06 to 0.25)	94 (54 to 140)	0.19 (0.11 to 0.28)	150 (104 to 210)	0.22 (0.15 to 0.30)	280 (217 to 373)	0.20 (0.16 to 0.27)
1	Oct	26 (12 to 46)	0.08 (0.04 to 0.14)	38 (19 to 61)	0.08 (0.04 to 0.12)	48 (27 to 74)	0.07 (0.04 to 0.11)	75 (46 to 105)	0.05 (0.03 to 0.08)
1	Nov	6 (0 to 21)	0.02 (0.00 to 0.07)	13 (0 to 27)	0.03 (0.00 to 0.05)	13 (0 to 27)	0.02 (0.00 to 0.04)	46 (20 to 89)	0.03 (0.01 to 0.06)
1	Dec	32 (9 to 65)	0.10 (0.03 to 0.20)	32 (9 to 63)	0.06 (0.02 to 0.13)	32 (9 to 63)	0.05 (0.01 to 0.09)	47 (18 to 83)	0.03 (0.01 to 0.06)
1	Jan	6 (0 to 16)	0.02 (0.00 to 0.05)	9 (0 to 19)	0.02 (0.00 to 0.04)	9 (0 to 19)	0.01 (0.00 to 0.03)	16 (3 to 29)	0.01 (0.00 to 0.02)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	19 (0 to 46)	0.04 (0.00 to 0.09)	19 (0 to 46)	0.03 (0.00 to 0.07)	75 (25 to 133)	0.05 (0.02 to 0.10)
1	Mar	11 (0 to 24)	0.03 (0.00 to 0.07)	11 (0 to 24)	0.02 (0.00 to 0.05)	46 (7 to 94)	0.07 (0.01 to 0.14)	55 (15 to 111)	0.04 (0.01 to 0.08)

Table 1.46: Design-based northern gannet (sitting) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	28 (5 to 60)	0.09 (0.02 to 0.18)	45 (16 to 83)	0.09 (0.03 to 0.17)	68 (27 to 119)	0.10 (0.04 to 0.17)	232 (130 to 358)	0.17 (0.09 to 0.26)
1	May	9 (0 to 24)	0.03 (0.00 to 0.07)	14 (0 to 29)	0.03 (0.00 to 0.06)	28 (9 to 52)	0.04 (0.01 to 0.07)	150 (77 to 238)	0.11 (0.06 to 0.17)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	10 (0 to 24)	0.02 (0.00 to 0.05)	13 (0 to 31)	0.02 (0.00 to 0.04)	55 (27 to 87)	0.04 (0.02 to 0.06)
1	Jul	23 (8 to 41)	0.07 (0.03 to 0.12)	41 (23 to 68)	0.08 (0.04 to 0.14)	59 (34 to 89)	0.08 (0.05 to 0.13)	123 (85 to 176)	0.09 (0.06 to 0.13)
1	Aug	71 (36 to 115)	0.22 (0.11 to 0.35)	115 (63 to 164)	0.23 (0.13 to 0.33)	181 (114 to 253)	0.26 (0.16 to 0.36)	407 (319 to 521)	0.30 (0.23 to 0.38)
1	Sep	37 (16 to 63)	0.11 (0.05 to 0.19)	73 (42 to 109)	0.15 (0.08 to 0.22)	117 (81 to 163)	0.17 (0.12 to 0.24)	218 (169 to 290)	0.16 (0.12 to 0.21)
1	Oct	50 (23 to 88)	0.15 (0.07 to 0.27)	73 (37 to 116)	0.15 (0.07 to 0.23)	92 (52 to 141)	0.13 (0.07 to 0.20)	143 (87 to 199)	0.10 (0.06 to 0.14)
1	Nov	1 (0 to 4)	0.00 (0.00 to 0.01)	2 (0 to 5)	0.00 (0.00 to 0.01)	2 (0 to 5)	0.00 (0.00 to 0.01)	8 (3 to 15)	0.01 (0.00 to 0.01)
1	Dec	22 (6 to 43)	0.07 (0.02 to 0.13)	21 (6 to 42)	0.04 (0.01 to 0.08)	21 (6 to 42)	0.03 (0.01 to 0.06)	31 (12 to 55)	0.02 (0.01 to 0.04)
1	Jan	9 (0 to 24)	0.03 (0.00 to 0.07)	14 (0 to 28)	0.03 (0.00 to 0.06)	14 (0 to 28)	0.02 (0.00 to 0.04)	23 (5 to 43)	0.02 (0.00 to 0.03)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	4 (0 to 9)	0.01 (0.00 to 0.02)	4 (0 to 9)	0.01 (0.00 to 0.01)	15 (5 to 27)	0.01 (0.00 to 0.02)
1	Mar	11 (0 to 24)	0.03 (0.00 to 0.07)	11 (0 to 24)	0.02 (0.00 to 0.05)	46 (7 to 94)	0.07 (0.01 to 0.14)	55 (15 to 111)	0.04 (0.01 to 0.08)

Table 1.47: Design-based northern gannet (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	37 (7 to 79)	0.11 (0.02 to 0.24)	60 (22 to 111)	0.12 (0.04 to 0.22)	91 (37 to 158)	0.13 (0.05 to 0.23)	309 (173 to 477)	0.22 (0.13 to 0.35)
1	May	16 (0 to 41)	0.05 (0.00 to 0.12)	24 (0 to 48)	0.05 (0.00 to 0.10)	47 (15 to 88)	0.07 (0.02 to 0.13)	252 (130 to 401)	0.18 (0.09 to 0.29)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	22 (0 to 55)	0.04 (0.00 to 0.11)	31 (0 to 71)	0.04 (0.00 to 0.10)	125 (61 to 199)	0.09 (0.04 to 0.14)
1	Jul	59 (21 to 104)	0.18 (0.07 to 0.32)	105 (58 to 174)	0.21 (0.12 to 0.35)	151 (88 to 229)	0.22 (0.13 to 0.33)	315 (218 to 452)	0.23 (0.16 to 0.33)
1	Aug	117 (58 to 188)	0.36 (0.18 to 0.58)	188 (103 to 267)	0.37 (0.21 to 0.53)	296 (187 to 413)	0.43 (0.27 to 0.60)	665 (522 to 852)	0.48 (0.38 to 0.62)
1	Sep	84 (36 to 145)	0.26 (0.11 to 0.44)	168 (95 to 249)	0.33 (0.19 to 0.50)	267 (185 to 374)	0.39 (0.27 to 0.54)	499 (387 to 663)	0.36 (0.28 to 0.48)
1	Oct	76 (35 to 134)	0.23 (0.11 to 0.41)	111 (56 to 177)	0.22 (0.11 to 0.35)	140 (79 to 216)	0.20 (0.11 to 0.31)	219 (133 to 304)	0.16 (0.10 to 0.22)
1	Nov	7 (0 to 25)	0.02 (0.00 to 0.08)	15 (0 to 32)	0.03 (0.00 to 0.06)	15 (0 to 32)	0.02 (0.00 to 0.05)	54 (23 to 104)	0.04 (0.02 to 0.08)
1	Dec	54 (15 to 108)	0.17 (0.05 to 0.33)	53 (15 to 105)	0.11 (0.03 to 0.21)	53 (15 to 105)	0.08 (0.02 to 0.15)	78 (31 to 138)	0.06 (0.02 to 0.10)
1	Jan	16 (0 to 40)	0.05 (0.00 to 0.12)	23 (0 to 47)	0.05 (0.00 to 0.09)	23 (0 to 47)	0.03 (0.00 to 0.07)	39 (8 to 71)	0.03 (0.01 to 0.05)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	22 (0 to 56)	0.04 (0.00 to 0.11)	22 (0 to 55)	0.03 (0.00 to 0.08)	91 (30 to 159)	0.07 (0.02 to 0.12)
1	Mar	23 (0 to 47)	0.07 (0.00 to 0.14)	23 (0 to 47)	0.05 (0.00 to 0.09)	92 (15 to 189)	0.13 (0.02 to 0.27)	109 (30 to 222)	0.08 (0.02 to 0.16)

Other species

Other species list and raw counts

1.3.3.33 Other true seabird species were present in very low numbers across the site (e.g. Atlantic puffin and storm petrel species).

1.3.3.34 Seaducks and divers were absent from the site given the distance to the coastline and water depth.

1.3.3.35 The rest of the species recorded are expected to be transient through the site (e.g. terns, gulls, and waders).

Table 1.48: Other species/groups recorded during April 2021 to March 2022 ranked by abundance.

Species/Groups	Flying	Other behaviour	Total
Common gull	1	19	20
Puffin	10	0	10
Ruff	0	10	10
Common tern	0	6	6
Little gull	0	5	5
Turnstone	0	4	4
Great skua	1	1	2

Other species design-based abundance (ranked by taxonomic order)

1.3.3.36 Given the paucity of sightings, only design-based estimates of total numbers were produced and are presented in taxonomic order (Table 1.49; Table 1.50; Table 1.51; Table 1.52; Table 1.53; Table 1.54; Table 1.55).

1.3.3.37 A very small number of turnstone and ruff were recorded in the Morgan Offshore Ornithology Array Area study area during just one survey, presumably while migrating in May 2021 (turnstone) and August 2021 (ruff) (Table 1.49; Table 1.50).

1.3.3.38 Design-based estimates of little gull and common gull did not exceed 100 individuals in the Morgan Offshore Ornithology Array Area study area (Table 1.51; Table 1.52), with peak estimates of 30 and 55 respectively during the winter months.

1.3.3.39 Common tern were only recorded in May 2021 with a design-based estimate of 62 individuals in the Morgan Offshore Ornithology Array Area study area (Table 1.53).

1.3.3.40 Single great skuas were recorded in August 2021 and October 2021, resulting in design-based estimates of eight individuals in the Morgan Offshore Ornithology Array Area study area (Table 1.54)

1.3.3.41 Puffin numbers peaked in May 2021 with 56 individuals (95% CI range: 9 to 106), most of which were outside of the 4km buffer zone, suggesting the Morgan Array Area is of negligible importance to puffin.

Table 1.49: Design-based turnstone (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	31 (0 to 96)	0.06 (0.00 to 0.19)	32 (0 to 96)	0.05 (0.00 to 0.14)	32 (0 to 96)	0.02 (0.00 to 0.07)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.50: Design-based ruff (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	75 (0 to 243)	0.05 (0.00 to 0.18)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.51: Design-based little gull (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	7 (0 to 24)	0.02 (0.00 to 0.07)	7 (0 to 24)	0.01 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	7 (0 to 24)	0.02 (0.00 to 0.07)	7 (0 to 24)	0.01 (0.00 to 0.05)	15 (0 to 39)	0.02 (0.00 to 0.06)	30 (8 to 64)	0.02 (0.01 to 0.05)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.52: Design-based common gull (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.01 (0.00 to 0.03)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	7 (0 to 23)	0.01 (0.00 to 0.03)	38 (7 to 70)	0.03 (0.01 to 0.05)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	7 (0 to 25)	0.01 (0.00 to 0.05)	7 (0 to 25)	0.01 (0.00 to 0.04)	8 (0 to 25)	0.01 (0.00 to 0.02)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.02 (0.00 to 0.05)	8 (0 to 24)	0.01 (0.00 to 0.03)	55 (23 to 106)	0.04 (0.02 to 0.08)
1	Jan	8 (0 to 24)	0.02 (0.00 to 0.07)	15 (0 to 39)	0.03 (0.00 to 0.08)	39 (0 to 86)	0.06 (0.00 to 0.12)	47 (0 to 95)	0.03 (0.00 to 0.07)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.53: Design-based common tern (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	61 (0 to 193)	0.09 (0.00 to 0.28)	62 (0 to 192)	0.05 (0.00 to 0.14)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.54: Design-based great skua (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	8 (0 to 24)	0.01 (0.00 to 0.02)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	7 (0 to 23)	0.01 (0.00 to 0.05)	7 (0 to 23)	0.01 (0.00 to 0.03)	8 (0 to 23)	0.01 (0.00 to 0.02)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

Table 1.55: Design-based Atlantic puffin (all behaviour) population estimates (Pop) and density (D) with lower and upper (95%) confidence limits for each month surveyed from April 2021 to March 2022 (Year 1).

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	0 (0 to 0)	0.00 (0.00 to 0.00)	18 (0 to 37)	0.04 (0.00 to 0.07)	18 (0 to 37)	0.03 (0.00 to 0.05)	19 (0 to 38)	0.01 (0.00 to 0.03)
1	May	0 (0 to 0)	0.00 (0.00 to 0.00)	18 (0 to 48)	0.04 (0.00 to 0.10)	18 (0 to 48)	0.03 (0.00 to 0.07)	56 (9 to 106)	0.04 (0.01 to 0.08)
1	Jun	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Jul	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	9 (0 to 28)	0.01 (0.00 to 0.02)
1	Aug	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Sep	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Oct	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Nov	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Dec	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	9 (0 to 29)	0.01 (0.00 to 0.02)
1	Jan	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Feb	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)
1	Mar	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)	0 (0 to 0)	0.00 (0.00 to 0.00)

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Appendix A: Colonies Counts

A.1 Northern gannet colony counts (no. of apparently occupied sites (AOS)/apparently occupied nest (AON))

SPA name	Qualifying feature	No. of AOS	Year
Ailsa Craig SPA	Individual	32226	2014
Grassholm SPA	Individual	36011	2015
Great Saltee Island	Individual	2446	2004
Ireland's Eye SPA	Individual	350	2015

A.2 Manx shearwater (no. of apparently occupied sites (AOS)/apparently occupied nest (AON))

SPA name	Qualifying feature	No. of AOS	Year
Copeland Islands SPA	Individual	4850	2007
Deenish Island and Scariff Island SPA	Individual	2010	2000
Puffin Island SPA, Kerry	Individual	6329	2000
Rum SPA	Individual	120000	2001
St Kilda SPA	Individual	1299	1999
Skomer and Skokholm SPA	Individual	455156	2018
Glannau Aberdaron ac Ynys Enlli/Aberdaron Coast and Bardsey Island	Individual	16183	2001
Saltee Islands SPA	Individual	250	2002 & 2002
Skelligs SPA	Individual	738	2001
Blasket Islands SPA	Individual	19534	2000 & 2001
High Island, Inishshark and Davillaun SPA	Individual	869	2001 & 2015
Cruagh Island (Connemara Islands)	Individual	3286	2001

A.3 Common guillemot (no. of individuals)

SPA name	Qualifying feature	No. of individuals	Year
Howth Head Coast SPA	Individual	871	2015
Ireland's Eye SPA	Individual	4410	2015
Lambay Island SPA	Individual	59983	2015

A.4 Razorbill (no. of individuals)

SPA name	Qualifying feature	No. of individuals	Year
Wicklow Head SPA	Individual	232	2019
Howth Head Coast SPA	Individual	279	2015
Ireland's Eye SPA	Individual	1600	2015
Lambay Island SPA	Individual	7353	2015

A.5 Lesser black-backed gull (no. of individuals)

SPA name	Qualifying interest	No. of individuals	Year
Ireland's Eye SPA	Individual	5	2015
Lambay Island SPA	Individual	476	2010
Rathlin Island SPA	Assemblage	519	2021
Ailsa Craig SPA	Individual	189	2019
Morecambe Bay and Duddon Estuary	Individual	413	1996/2017/2018/2020
Ribble and Alt Estuaries SPA	Individual	7022	2016

A.6 Herring gull (no. of apparently occupied nest (AON))

SPA name	Qualifying interest	No. of AON	Year
Ireland's Eye SPA	Individual (listed as optional)	358	2015
Lambay Island SPA	Individual (listed as optional)	135	2015
Skerries Islands SPA	Individual (listed as optional)	27	2007
Howth Head Coast SPA	Individual (listed as optional)	9	2015
Morecambe Bay and Duddon Estuary SPA	Individual	445	2016-2020

A.7 Great black-backed gull

SPA name	Qualifying feature	No. of AON	Year
Ireland's Eye SPA	Individual (listed as optional)	154	2015
Lambay Island SPA	Individual (listed as optional)	99	2015

A.8 Black-legged kittiwake

SPA name	Qualifying feature	No. of AON	Year
Helvick Head to Ballyquin SPA	Individual	168	1999 & 2018
Saltee Islands SPA	Individual	845	2013
Wicklow Head SPA	Individual	848	2019
Howth Head Coast SPA	Individual	3081	2015
Ireland's Eye SPA	Individual	1610	2015
Lambay Island SPA	Individual	3320	2015
Rathlin Island SPA	Individual	7983	2011 & 2013
Inishtrahull Island SPA	Individual	7	2016
Ailsa Craig SPA	Individual	300	2019
North Colonsay and Western Cliffs SPA	Individual	143	2018
Skomer, Skokholm and the Seas off Pembrokeshire SPA	Assemblage	1236	2018

Appendix B: MRSea estimates for each boundary area

B.1 Black-legged kittiwake (MRSea estimates)

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	304 (210-413)	0.93 (0.64-1.26)	460 (317-631)	0.91 (0.63-1.25)	625 (429-861)	0.90 (0.62-1.24)	1,165 (784-1,629)	0.85 (0.57-1.18)
1	May	55 (19-117)	0.17 (0.06-0.36)	95 (31-210)	0.19 (0.06-0.42)	145 (49-320)	0.21 (0.07-0.46)	463 (263-804)	0.34 (0.19-0.58)
1	Jun	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Jul	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Aug	50 (4-243)	0.15 (0.01-0.74)	132 (13-599)	0.26 (0.03-1.19)	233 (30-974)	0.33 (0.04-1.40)	495 (124-1,665)	0.36 (0.09-1.21)
1	Sep	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Oct	285 (100-658)	0.87 (0.31-2.01)	588 (199-1,367)	1.17 (0.40-2.71)	909 (307-2,101)	1.30 (0.44-3.02)	1,398 (517-3,079)	1.02 (0.38-2.24)
1	Nov	112 (72-163)	0.34 (0.22-0.50)	177 (109-263)	0.35 (0.22-0.52)	251 (150-380)	0.36 (0.22-0.55)	511 (297-792)	0.37 (0.22-0.58)
1	Dec	1,008 (752-1,313)	3.08 (2.30-4.01)	1,619 (1,190-2,139)	3.21 (2.36-4.25)	2,209 (1,604-2,941)	3.17 (2.30-4.22)	3,336 (2,365-4,515)	2.42 (1.72-3.28)
1	Jan	384 (242-575)	1.17 (0.74-1.76)	634 (403-945)	1.26 (0.80-1.88)	934 (599-1,379)	1.34 (0.86-1.98)	2,129 (1,371-3,102)	1.55 (1.00-2.25)
1	Feb	185 (134-246)	0.56 (0.41-0.75)	292 (211-393)	0.58 (0.42-0.78)	417 (301-564)	0.60 (0.43-0.81)	927 (647-1,296)	0.67 (0.47-0.94)
1	Mar	512 (354-698)	1.56 (1.08-2.13)	830 (558-1,158)	1.65 (1.11-2.30)	1,170 (767-1,663)	1.68 (1.10-2.39)	2,135 (1,330-3,154)	1.55 (0.97-2.29)

B.2 Common guillemot (MRSea estimates)

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	Month	Pop	D	Pop	D	Pop	D	Pop	D
1	Apr	3,725 (2,878-4,715)	11.38 (8.80-14.41)	5,427 (4,281-6,758)	10.78 (8.50-13.42)	7,187 (5,726-8,876)	10.32 (8.22-12.74)	13,281 (10,543-16,504)	9.65 (7.66-11.99)
1	May	692 (440-1,009)	2.11 (1.35-3.08)	1,110 (708-1,624)	2.20 (1.41-3.22)	1,595 (1,011-2,346)	2.29 (1.45-3.37)	3,451 (2,053-5,451)	2.51 (1.49-3.96)
1	Jun	485 (343-662)	1.48 (1.05-2.02)	730 (520-988)	1.45 (1.03-1.96)	1,001 (714-1,354)	1.44 (1.02-1.94)	2,051 (1,365-2,988)	1.49 (0.99-2.17)
1	Jul	242 (159-347)	0.74 (0.49-1.06)	419 (268-613)	0.83 (0.53-1.22)	687 (435-1,008)	0.99 (0.62-1.45)	2,711 (1,694-3,988)	1.97 (1.23-2.90)
1	Aug	184 (116-274)	0.56 (0.35-0.84)	458 (315-642)	0.91 (0.63-1.28)	957 (689-1,298)	1.37 (0.99-1.86)	5,803 (4,358-7,602)	4.22 (3.17-5.52)
1	Sep	389 (241-594)	1.19 (0.74-1.81)	1,135 (767-1,605)	2.25 (1.52-3.19)	2,528 (1,744-3,496)	3.63 (2.50-5.02)	8,523 (5,942-11,699)	6.19 (4.32-8.50)
1	Oct	1,483 (1,125-1,859)	4.53 (3.44-5.68)	2,707 (2,110-3,334)	5.38 (4.19-6.62)	4,230 (3,355-5,157)	6.07 (4.82-7.40)	8,954 (7,184-10,906)	6.50 (5.22-7.92)
1	Nov	146 (85-224)	0.45 (0.26-0.68)	318 (201-467)	0.63 (0.40-0.93)	623 (420-883)	0.89 (0.60-1.27)	2,850 (2,069-3,827)	2.07 (1.50-2.78)
1	Dec	2,420 (1,495-3,580)	7.40 (4.57-10.94)	4,101 (2,444-6,180)	8.14 (4.85-12.27)	6,006 (3,496-9,167)	8.62 (5.02-13.16)	11,326 (6,473-17,570)	8.23 (4.70-12.76)
1	Jan	1,505 (1,231-1,809)	4.60 (3.76-5.53)	2,369 (1,908-2,883)	4.70 (3.79-5.72)	3,330 (2,640-4,105)	4.78 (3.79-5.89)	6,512 (4,962-8,304)	4.73 (3.60-6.03)
1	Feb	1,489 (1,201-1,808)	4.55 (3.67-5.52)	2,338 (1,859-2,877)	4.64 (3.69-5.71)	3,321 (2,596-4,137)	4.77 (3.73-5.94)	6,966 (5,157-9,069)	5.06 (3.75-6.59)
1	Mar	2,869 (2,340-3,440)	8.77 (7.15-10.51)	4,359 (3,545-5240)	8.65 (7.04-10.40)	5,910 (4,795-7,121)	8.48 (6.88-10.22)	10,506 (8,452-12,803)	7.63 (6.14-9.30)

B.3 Manx shearwater (MRSea estimates)

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	65 (21-180)	0.20 (0.07-0.55)	117 (38-330)	0.23 (0.07-0.65)	190 (60-554)	0.27 (0.09-0.80)	518 (158-1,789)	0.38 (0.11-1.30)
1	May	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Jun	253 (159-379)	0.77 (0.49-1.16)	372 (220-583)	0.74 (0.44-1.16)	483 (270-795)	0.69 (0.39-1.14)	736 (356-1,418)	0.53 (0.26-1.03)
1	Jul	120 (50-220)	0.37 (0.15-0.67)	273 (114-512)	0.54 (0.23-1.02)	489 (209-932)	0.70 (0.30-1.34)	1,161 (546-2,231)	0.84 (0.40-1.62)
1	Aug	197 (67-644)	0.60 (0.21-1.97)	467 (138-1,828)	0.93 (0.27-3.63)	869 (240-3,508)	1.25 (0.34-5.04)	2,096 (658-6,883)	1.52 (0.48-5.00)
1	Sep	99 (43-190)	0.30 (0.13-0.58)	193 (86-354)	0.38 (0.17-0.70)	302 (143-536)	0.43 (0.21-0.77)	576 (293-1,030)	0.42 (0.21-0.75)
1	Oct	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Nov	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Dec	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Jan	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Feb	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Mar	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

B.4 Northern gannet (MRSea estimates)

		Morgan Array Area		Morgan Array Area + 2km		Morgan Array Area + 4km		Morgan Offshore Ornithology Array Area study area	
Year	**Month**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**	**Pop**	**D**
1	Apr	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	May	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Jun	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Jul	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Aug	127 (81-184)	0.39 (0.25-0.56)	209 (131-305)	0.41 (0.26-0.60)	304 (185-452)	0.43 (0.26-0.64)	679 (377-1,080)	0.49 (0.27-0.78)
1	Sep	103 (49-187)	0.31 (0.15-0.57)	192 (93-346)	0.38 (0.18-0.68)	287 (141-513)	0.41 (0.20-0.73)	504 (250-917)	0.36 (0.18-0.66)
1	Oct	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Nov	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Dec	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Jan	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Feb	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1	Mar	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a