Salamander Offshore Wind Farm

Offshore EIA Report

Volume ER.A.4.12.1: Offshore Ornithology Baseline Data Report

SALAMANDER

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Salamander Offshore Wind Farm Annex ER.A.4.12.1: Offshore Ornithology Baseline Data Report

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Acronyms and abbreviations

Term	Definition
AoS	Area of Search
ASL	Above Sea Level
ANOVA	Analysis of Variance
BDMPS	Biologically Defined Minimum Population Scales
CReSS	Complex Regional Spatial Smoother
CRM	Collision Risk Modelling
CI	Confidence Interval
CL	Confidence Limit
CV	Coefficient of Variance
DAS	Digital Aerial Survey
DSM	Density Surface Modelling
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
GPS	Global Positioning System
GSD	Ground Sample Distance
HRA	Habitats Regulation Appraisal
INTOG	Innovation and Targeted Oil & Gas
MRSea	Marine Renewables Strategic Environmental Assessment
MSP	Mean Seasonal Peak
SALSA	Spatially Adaptive Local Smoothing Algorithm
SPA	Special Protection Area

1 Introduction

1 The Salamander Offshore Wind Farm (hereafter 'the Salamander Project') is a proposed floating offshore wind farm, located approximately 35km off the northeast coast of Peterhead, Scotland. Salamander Wind Project Company Limited (formerly called Simply Blue Energy (Scotland) Limited), a joint venture between Ørsted, Simply Blue Group and Subsea7.

2 This Annex serves as a baseline characterisation of offshore ornithology features and describes on site populations of seabirds required for ornithological impact modelling: collision risk and distributional responses, as addressed in Annex ER.A.4.12.3: Collision Risk Modelling Report and Annex ER.A.4.12.5 Displacement Assessment.

3 In February 2021 HiDef Aerial Surveying Limited (HiDef) was commissioned to undertake digital aerial survey (DAS); this report only considers ornithological activity. Twenty-four surveys were undertaken between March 2021 and February 2023. The DAS design consisted of 2km-spaced transects across the original Salamander Area of Search (AoS), from which the Offshore Array Area[1] was selected, and a 4km buffer. The original AoS (133.38km^2) and 4km buffer, together referred to as the 'DAS Area', had a total area of 371.93km^2 (Figure 1).

4 At the Ornithology Scoping Workshop held on 28th November 2022, the Offshore Array Area for the Salamander Project was presented to stakeholders. The Offshore Array Area is considerably smaller than the DAS Area, covering 33.23 km^2. Whilst ~12.5% coverage within the Offshore Array Area remains, the reduction in area means that there are fewer transects within the Offshore Array Area than the DAS Area design. The Offshore Array Area plus 4km buffer (176.81 km^2) is intersected by eight transects while the Offshore Array Area plus 2km buffer (92.45 km^2) is intersected by six transects (Figure 1). The Offshore Array Area and 4km buffer are referred to in this report as the 'Offshore Survey Area'.

5 Density Surface Modelling (DSM) for the Offshore Survey Area was undertaken using the Marine Renewables Strategic Environmental Assessment (MRSea), as advised by NatureScot in the Ornithology Scoping Workshop (28th November 2022) and NatureScot guidance (NatureScot, 2023a). This is a model-based approach to density estimation and was used where possible to generate species-specific and survey-specific density surfaces using all the data collected for the DAS Area. The density and abundance estimates were then extracted for the Offshore Array Area (for Collision Risk Modelling (CRM)) and Offshore Array Area plus 2km buffer (for analysis of distributional responses). By utilising all the available data from the DAS Area and selecting data for the Offshore Array Area and buffers, this allowed more robust estimates of density and abundance to be derived, with reduced uncertainty around point estimates. Where data were insufficient and modelling of density surface failed, design-based density and abundance estimation was used[2].

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1 This is the same area as the Exclusivity Agreement awarded to Salamander Wind Project Company (formerly called Simply Blue Energy (Scotland)) by Crown Estate Scotland within the Innovation and Targeted Oil & Gas (INTOG) seabed leasing round.

2 For some species and surveys, data were so few that MRSea models were unable to converge, resulting in no estimate of density or abundance. MRSea uses a Generalised Additive Model (GAM) framework, which generally provides high estimates of density and abundance with lower associated uncertainty. However, MRSea is unable to perform well when sample sizes are low. This is more likely to occur when the survey area is relatively small and the species of interest are relatively widely dispersed. In these cases, design-based density and abundance estimates was used, as this is not as easily affected by sample size.

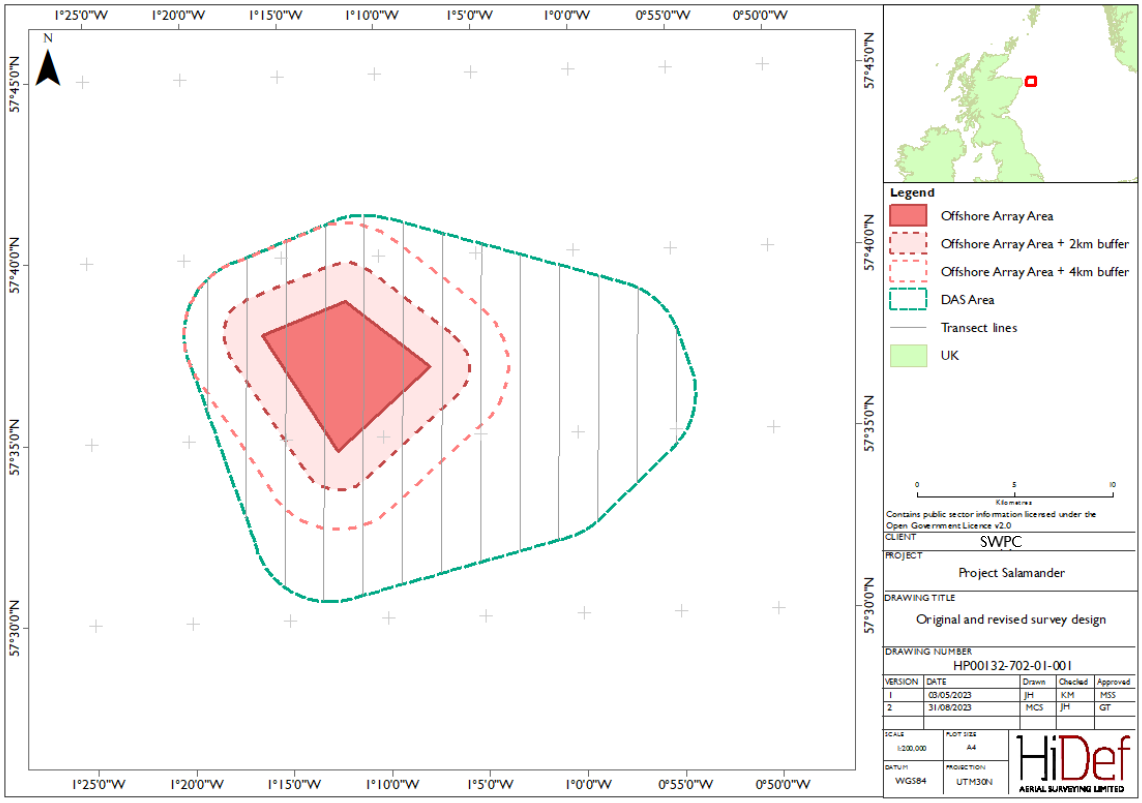

Figure 1 Offshore Array Area, including DAS Area and transects

6 Key species addressed in CRM and assessment of distributional responses for the Salamander Project are based on the number of records in DAS, their known susceptibility (Furness *et al.*, 2013) and whether they are qualifying features of nearby seabird colonies (e.g. Buchan Ness to Collieston Coast Special Protection Area (SPA) and Troup, Pennan and Lion's Heads SPA). The species scoped into assessment are presented in Table 1.

Table 1 Species scoped in for impact modelling

Species	Scientific name	Collision risk	Distributional Responses
Black-legged kittiwake (hereafter 'kittiwake')	*Rissa tridactyla*	✓	✓
Great black-backed gull	*Larus marinus*	✓	✖
Herring gull	*Larus argentatus*	✓	✖
Common guillemot (hereafter 'guillemot')	*Uria aalge*	✖	✓
Razorbill	*Alca torda*	✖	✓
Atlantic puffin (hereafter 'puffin')	*Fratercula arctica*	✖	✓
Northern fulmar (hereafter 'fulmar')	*Fulmarus glacialis*	✓	✖
Northern gannet (hereafter 'gannet')	*Morus bassanus*	✓	✓

7 Following the approach and advice received for other consented offshore wind farm projects around the UK, large gull species and fulmar were scoped out of assessment for distributional responses and guillemot, razorbill and puffin were not considered in assessment of collision risk.

8 To calculate Mean Seasonal Peaks (MSPs) needed for the assessment of distributional responses, seasons were pre-defined following the available guidance (NatureScot, 2023b; 2023c). Seasonal definitions were therefore based on the NatureScot (2020) guidance "*Seasonal Periods for Birds in the Scottish Marine Environment",* as set out in Table 2. Any predicted mortality impacts will be considered in the context of regional populations as defined by the Biologically Defined Minimum Population Scale (BDMPS) (Furness, 2015), as per NatureScot guidance (NatureScot, 2023b).

Table 2 Seasons used for determination of Mean Seasonal Peaks (MSPs) (puffin only assessed during the breeding season) (NatureScot, 2020)

Species	Breeding season	Non-breeding season
Kittiwake	mid Apr – Aug	Sep – mid Apr
Great black-backed gull	Apr – Aug	Sep – Mar
Herring gull	Apr – Aug	Sep – Mar
Guillemot	Apr – mid Aug	Mid Aug – Mar
Razorbill	Apr – mid Aug	Mid Aug – Mar
Puffin	Apr – mid Aug	-
Fulmar	Apr – mid Sep	Mid Sep – Mar
Gannet	mid Mar – Sep	Oct – mid Mar

2 Methods

2.1 Digital aerial surveys

9 A series of strip transects were flown monthly between March 2021 and February 2023 with 2km spacing to achieve approximate site coverage of 12.5%. The DAS survey design consisted of 13 strip transects over the DAS Area, extending roughly north to south, perpendicular to the depth contours along the coast to ensure each transect samples a similar range of habitats (primarily relating to water depth) to reduce the variation in seabird abundance estimates between transects.

10 Surveys were flown using an aircraft equipped with four HiDef Gen II digital video cameras with sensors set to a resolution of 2cm Ground Sample Distance (GSD). Each camera sampled a strip of 125m width, separated from the next camera by ~25m, providing a combined sampled width of 500m within a 575m overall strip. Data from two out of the four cameras were processed with the remaining unprocessed data archived.

11 The aircraft flew at a height of approximately 550m (~1800') Above Sea Level (ASL). Flying at this height ensures there is no risk of flushing species easily disturbed by aircraft. Thaxter *et al.* (2016) recommend a minimum flight altitude of 460 – 500m ASL.

12 Position data for the aircraft were captured from a Garmin Global Positioning System (GPS) Map 296 receiver with differential GPS enabled to give 1m accuracy at one second intervals for later matching to seabird observations. More detail on how data for the DAS Area were analysed can be found in the two-year DAS report (HiDef, 2023).

2.1.1 Data treatment

13 All data within the DAS Area were collated across the two years of surveys. These data were trimmed to the Offshore Array Area and Offshore Array Area plus 2km buffer prior to analysis. The total numbers of species detected in each survey flight for the Offshore Array Area and Offshore Array Area plus 2km buffer are presented in Appendix I: Raw DAS Observations.

14 Records identified to species level (possible, probable and definite) were separated out from records of individuals identified to species group level, and the following analyses undertaken on both datasets. All confidence levels of species identifications were used in analysis.

15 Apportioning of 'unidentified' birds to species level was included for calculating density and population estimates. The number of unidentified birds in each species group were assigned to species where appropriate, based on their respective abundance ratios. For example, if identified guillemots and razorbills occurred in a 4:1 ratio, then 80% of unidentified birds considered to be possibly either of those species would be assigned to guillemot and 20% assigned to razorbill.

16 Population estimates presented per survey are provided to help inform baseline characterisation for the Salamander Project, as set out for each species in Section 3. The required information for impact modelling is set out in Table 3.

Table 3 Required information from Digital Aerial Survey (DAS) for Impact Analysis

Output	Source area	Seabird subset	Requirement
Distributional responses	Offshore Array Area + 2km buffer	All birds (sitting and flying)	MSP population estimates
Collision risk	Offshore Array Area	Flying birds	Monthly densities of flying birds
Age-class analysis	Offshore Array Area + 2km buffer	All birds (sitting and flying)	Proportion of birds in each age class

2.1.2 Population estimates

2.1.2.1 Model-based population estimates

17 Model-based density surface modelling using MRSea in R (Scott-Hayward *et al.*, 2013) was performed following guidance from NatureScot (2023a). HiDef adapted and customised some of the MRSea code so that the modelling approach could cope with the specific nuances of the Salamander Project data (code can be made available on request).

18 Corrections for availability bias were applied where appropriate to apportioned monthly data for sitting birds before modelling was undertaken. For flying birds no corrections for availability bias were applied before modelling. 'All birds' counts includes both sitting and flying birds to which availability bias correction, where required, has been applied to only sitting birds. Data were modelled for the full survey area and results cropped to the Offshore Array Area plus 2km buffer to avoid the impact of edge effects on estimates.

19 The Complex Regional Spatial Smoother (CReSS) spatial modelling method with Spatially Adaptive Local Smoothing Algorithm (SALSA) based model selection was used to model survey-specific bird distribution (Scott-Hayward *et al.*, 2013). These models fit the relationship between the observations (count response variable) and the environment (covariates) at each location to estimate and predict the density of animals.

20 To prepare input data for the species-specific model, for each survey the transects were grouped into segments of ~1km and counts of animals of each species assigned to the mid-point of the appropriate segment. Values of covariates were also assigned to the midpoint of each segment. The resulting data frame therefore contained survey specific species counts and covariate values for each transect segment.

21 To examine the statistical significance of covariates in the predictive model, a one-way Analysis of Variance (ANOVA) was run. Covariates with significant relationships with the observations in the model were further explored by way of partial dependence plots. Further model inference could be made by examining the cumulative residual plots output from the models.

22 Each model was permitted to contain the covariates (Table 4) as a linear or smooth term (or omitted altogether). Smooth function fitting for each covariate was carried out using SALSA (Walker *et al.*, 2011). For both the covariates and spatially based smoothers, model selection was governed using cross validation.

23 Model flexibility for the spatial surfaces was determined by both the number of 'knots' used for the model and the effective range of each knot (the spatial extent to which each knot influences the fitted surface). Since the optimal choices for both features are always unknown, a range of models were considered for the candidate models which vary in both the number of knots specified and the effective range (r-value) of each knot.

24 Species were initially modelled using a 'batch' method. During this approach, for each species, all surveys were included in the same model, using survey ID as an explanatory variable to account for differences between surveys. Any surveys which had less than ten individuals in the apportioned data were not included in the model. Predictions using the 'batch' model used the same knots and environmental covariates for each survey; however, survey ID was set as an interaction term to allow for the influence of knots on the distribution of birds to vary for each survey.

25 It was found that this method occasionally produced unrealistic results when compared to design-based methods for some surveys. If this occurred, analysis was repeated by modelling each survey separately. This allowed for different knot locations and environmental covariates to be used for each model.

26 For surveys where both 'batch' and 'single survey' models were produced, the model which gave the lowest Coefficient of Variance (CV) and/or smallest range for the Confidence Interval (CI) was preferred. Where models were not fitted, due to fewer than ten registrations during the survey, or no suitable model produced, then design-based densities were substituted (see Section 2.1.2.2). Therefore, results show a mixture of batch and single model outputs as well as some design-based outputs.

Table 4 Covariates included in MRSea analyses. *denotes parameters which were only included in 'batch' models.

Model covariate	Definition	Source
Survey ID (factor)*	Unique ID for each survey	Site-specific DAS
Bathymetry	Depth below sea surface (m)	GEBCO Gridded Bathymetry Data 2019
Bathymetric slope	Change in bathymetry between pixels	GEBCO Gridded Bathymetry Data 2019
Bathymetric aspect	Direction bathymetric slope faces	GEBCO Gridded Bathymetry Data 2019
Segment area	Area of each segment within a transect (m^2)	Site-specific DAS
Spatial components	Latitude and Longitude coordinates	GIS (WGS84)

27 The density estimate is expressed as the average number of animals per square km in the Offshore Array Area plus 2km buffer. The upper and lower CLs define the range that the population estimate falls within with 95% certainty. The CV is a measure of the precision of the population and density estimates. Throughout this appendix, CVs are presented alongside CLs, since this metric is comparable across surveys and provides a quick and easy way to interpret variance around presented values. Following changes to the survey design post data collection, sample sizes for many species were small, increasing variation around mean values, leading to large CVs presented for some species/surveys.

2.1.2.2 Design-based population estimates

28 When there were insufficient data available to use model-based density estimation, abundance was estimated using a design-based approach. Population estimates were calculated for the Offshore Array Area, and for the Offshore Array Area plus 2km buffer (Appendix II: Table 38 –Table 46). Each strip transect was treated as a statistically independent random sample from the site. The length and breadth (i.e. the width of the field of view of the camera) of each transect were multiplied to give the transect area; dividing the number of observations for each species on each transect by the transect area gave a point estimate of the density of that species for the transect. The density of animals at the site (and hence the population size), the standard deviation, the 95% CLs, and CV were then estimated using a non-parametric block bootstrap method with replacement (Buckland *et al.,* 2001), to ensure equal transect effort was sampled across each bootstrap iteration. Data were processed in the R programming language (version 4.2.1; R Core team, 2022). Code can be provided on request. More detail on this approach can be found in the two-year DAS report (HiDef, 2023).

29 For surveys where MRSea could not be performed, and there were no resultant density surfaces produced, surfaces produced using Kernel Density Estimation (KDE) were displayed to indicate species distribution across the Offshore Array Area plus 2km buffer. A Watson-Nadaraya type KDE technique was used (Simonoff, 1996), with a leave-one-out cross validation method. For guillemot, razorbill and puffin, KDE surfaces represent relative estimates of density. For some surveys, data were too scarce to present density surfaces using KDE, so raw distribution of birds were plotted instead. Any KDE density surfaces should only be used to infer distribution, and no estimates of abundance or density from this method will be used within ornithological assessment. Surveys where KDE surfaces have been mapped are clearly marked in species distribution maps (Section 3).

2.1.3 Availability bias

30 In wildlife surveys, a proportion of seabirds that spend any time underwater, especially while feeding, will not be detectable at the surface. This 'availability bias' leads to an under-estimate of their abundance from survey data. Within the DAS Area, availability bias corrections were only applied to observations of guillemot, razorbill and puffin due to a lack of available dive duration data for other species. Following Barlow *et al.* (1988) the probability that an animal is available at the surface is calculated as:

$$\Pr(being\ visible) = \frac{(s+t)}{(s+d)}$$

31 Where s is the average time spent at the surface, t is the window of time that the animal is within view and d is the average time below the surface. In the case of digital video surveys, the value of t is negligibly small and is treated as zero.

32 For guillemot and razorbill, data obtained during the breeding season using data loggers were used to estimate availability bias. Thaxter *et al.* (2010) gives mean times for these species engaged in flying, feeding and underwater per trip during the chick-rearing period. Thus, the proportion of time that guillemot and razorbill are available at the surface (Pr(visible)) was estimated at 0.7595 and 0.8182, respectively.

33 For puffin, the results from a study using data loggers reported in Spencer (2012) were used. The results show that puffin spend 14.16% of daylight time underwater. This infers that the proportion of time that puffin were available at the surface (Pr(visible)) was 0.8584.

34 The full method for applying a correction factor to account for availability bias is set out in the two-year DAS report (HiDef, 2023) and results are presented in Appendix II:, Table 38–Table 40. Absolute (adjusted) population estimates are presented in Section 3.5 Guillemot, Section 3.6 Razorbill, and Section 3.7 Puffin, and will be the estimates taken forward for use during Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA). They are used to calculate the MSP required for analysis of distributional responses (Table 3) and discussed below in Section 2.1.4.

2.1.4 Mean seasonal peaks

35 MSP population estimates calculated for each species in the breeding and non-breeding season (see Table 2; puffin only assessed during the breeding season), were taken as an average of the peak estimates in each of the two years of surveying. For example, the MSP population estimate for kittiwake in the breeding season was calculated as the average of the peak count of kittiwake in the breeding season in Year One (2021/22) and the peak count in the breeding season in Year Two (2022/23). Confidence intervals were calculated as an average of the lower and upper CLs of both peak counts and are presented for reference only.

36 For seasons starting or ending halfway through the month, the 15th was used as a mid-month cut off. Surveys were assigned to a season (Table 2) based on the date that the survey was flown.

37 For the three auk species (guillemot, razorbill and puffin), the MSPs relate to absolute estimates of abundance and have been adjusted for availability bias to account for birds likely to be diving at the time of survey (as discussed in Section 2.1.3 and Appendix II: Relative and absolute population estimates).

2.1.5 Age proportions

38 To assess the proportion of birds in each age class (adult, immature, juvenile), the average number of birds recorded in each class was calculated across all surveys that occurred in each season. For example, if there were four surveys in the breeding season in Year One (2021/22) and four surveys in the breeding season in Year Two (2022/23), then the average number of adult birds was calculated across eight surveys. This was conducted using all data within the Offshore Array Area plus 2km buffer. Surveys were assigned to a season based on the date that the survey was flown (Table 2). For seasons starting or ending halfway through the month, the 15th was used as a mid-month cut off. So, a survey undertaken on 20th August would count for the non-breeding season for a species where the breeding season end was declared to be mid-August.

39 The resulting percentage in each class was calculated as a proportion of the sum of the average number in each age class and is presented for species where aging was possible, namely flying birds, for kittiwake, great black-backed gull, herring gull and gannet. In DAS footage, it is only possible to age large auks when adults are in the presence of juveniles during post-breeding dispersal. For these species, any age data is unlikely to be representative of the true population therefore age class data are not presented for guillemot, or razorbill. It is not possible to age puffin from DAS footage.

3 Results

3.1 Survey Results

40 Following data analysis each identified object was assigned to at least a species group, and where possible these were also assigned a species identification, with confidence levels of 'Possible', 'Probable', or 'Definite'. Any animals that could not be identified to species level were assigned to a category 'No ID' in the species column. The analysis of data to species level uses all levels of identification confidence.

41 The total numbers of objects detected in each survey flight that were assigned to species level are presented in Table 32 to Table 37 in Appendix I: Raw DAS Observations for the Offshore Array Area, Offshore Array Area plus 2km buffer, and the DAS Area.

3.2 Kittiwake

42 Kittiwake are deemed sensitive to impacts from both collision risk and distributional responses. Therefore, density estimates for flying birds within the Offshore Array Area are provided for input into CRM (Annex ER.A.4.12.3: Collision Risk Modelling Report), while population estimates for all birds within the Offshore Array Area plus 2km buffer and MSP estimates are provided for input into the assessment of distributional responses (Annex ER.A.4.12.5: Displacement Assessment).

43 Maximum population estimates for the Offshore Array Area ranged from 75 birds (95% CI 8 – 234) in the non-breeding season to 2,425 birds (95% CI 910 – 4,999) in the breeding season (Table 7). Across both seasons, the majority of birds were recorded as adults, with the similar proportions of adults recorded during the breeding season and non-breeding season (Table 5).

44 Within the Offshore Array Area, flying kittiwake were recorded in varying densities (Table 8), ranging between 0.00 birds/km^2 (e.g. October 2021) and 12.73 birds/km^2 (95% CI 6.81 – 21.21; August 2022). Peak densities of flying kittiwake were calculated for June 2021 in Year One and August 2022 in Year Two.

45 Population estimates for all kittiwake in the Offshore Array Area plus 2km buffer varied between months, ranging between 0 birds (e.g. February 2022) and 6,575 birds (95% CI 2,297 – 14,437) in August 2022 (Table 9). The MSP calculated for the breeding season was much higher than that for the non-breeding season with 3,718 birds (95% CI 1,382 – 7,998) and 220 birds (95% CI 49 – 595), respectively (Table 6).

Table 5 **Percentage of aged kittiwake (n = 264) in each age class averaged across all surveys in each season within the Offshore Array Area plus 2km buffer**

Season	Adult	Immature	Juvenile
Breeding	85.34%	3.88%	10.78%
Non-breeding	84.38%	0.00%	15.63%

Table 6 **Mean seasonal peak population estimates of all kittiwake (flying and sitting) in each season within the Offshore Array Area plus 2km buffer between March 2021 and February 2023**

Kittiwake	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit
Breeding	3718	331	9958
Non-breeding	220	19	919

Table 7 **Monthly population estimates of all kittiwake (flying and sitting) within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)**

Kittiwake	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	12	5	24	6	49.48
23 May 2021	13	7	22	5	38.93
09 June 2021	295	181	438	85	28.90
15 July 2021	322	178	542	133	41.32
19 August 2021	84	46	137	29	34.98
07 September 2021	39	10	108	44	111.79
06 October 2021	55	23	111	28	50.56
10 November 2021*	8	0	25	8	94.02
09 December 2021	0	0	0	0	0.00
07 January 2022	0	0	0	0	0.00
08 February 2022	0	0	0	0	0.00
10 March 2022*	17	0	36	9	50.39
12 April 2022*	9	0	25	9	96.69
14 May 2022	179	80	331	81	45.60
12 June 2022	28	15	45	9	35.59
08 July 2022	183	117	274	48	25.94
17 August 2022	2425	910	4999	1524	62.86
20 September 2022	48	25	82	18	37.99
07 October 2022	37	14	76	22	58.91
02 November 2022	29	11	57	15	52.52
20 December 2022*	9	0	24	9	95.85
04 January 2023	75	8	234	121	160.66
23 February 2023	0	0	0	0	0.00

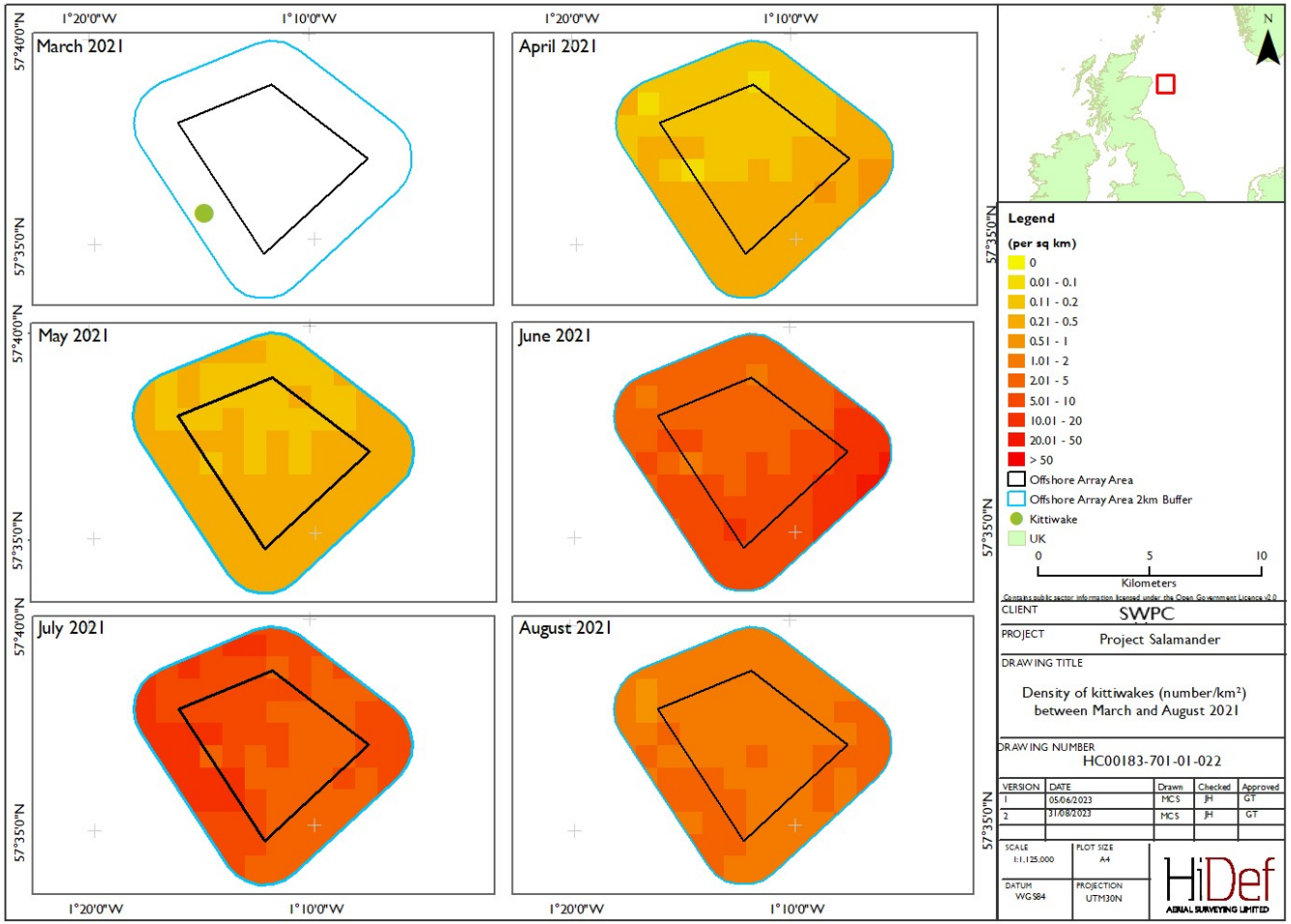

Figure 2 **Kittiwake density (birds/km^2) between March and August 2021. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour)**

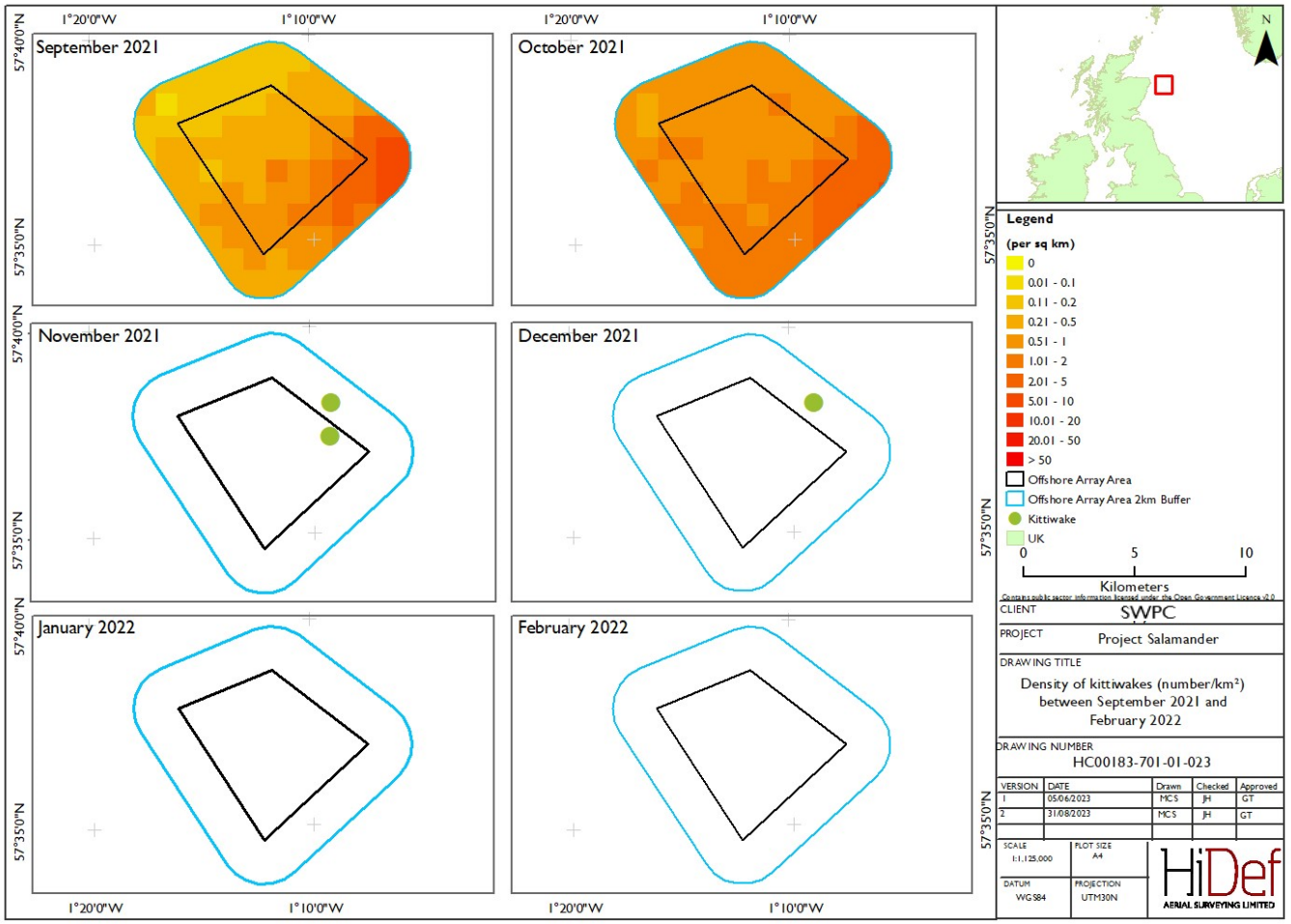

Figure 3 **Kittiwake density (birds/km^2) between September 2021 and February 2022. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour)**

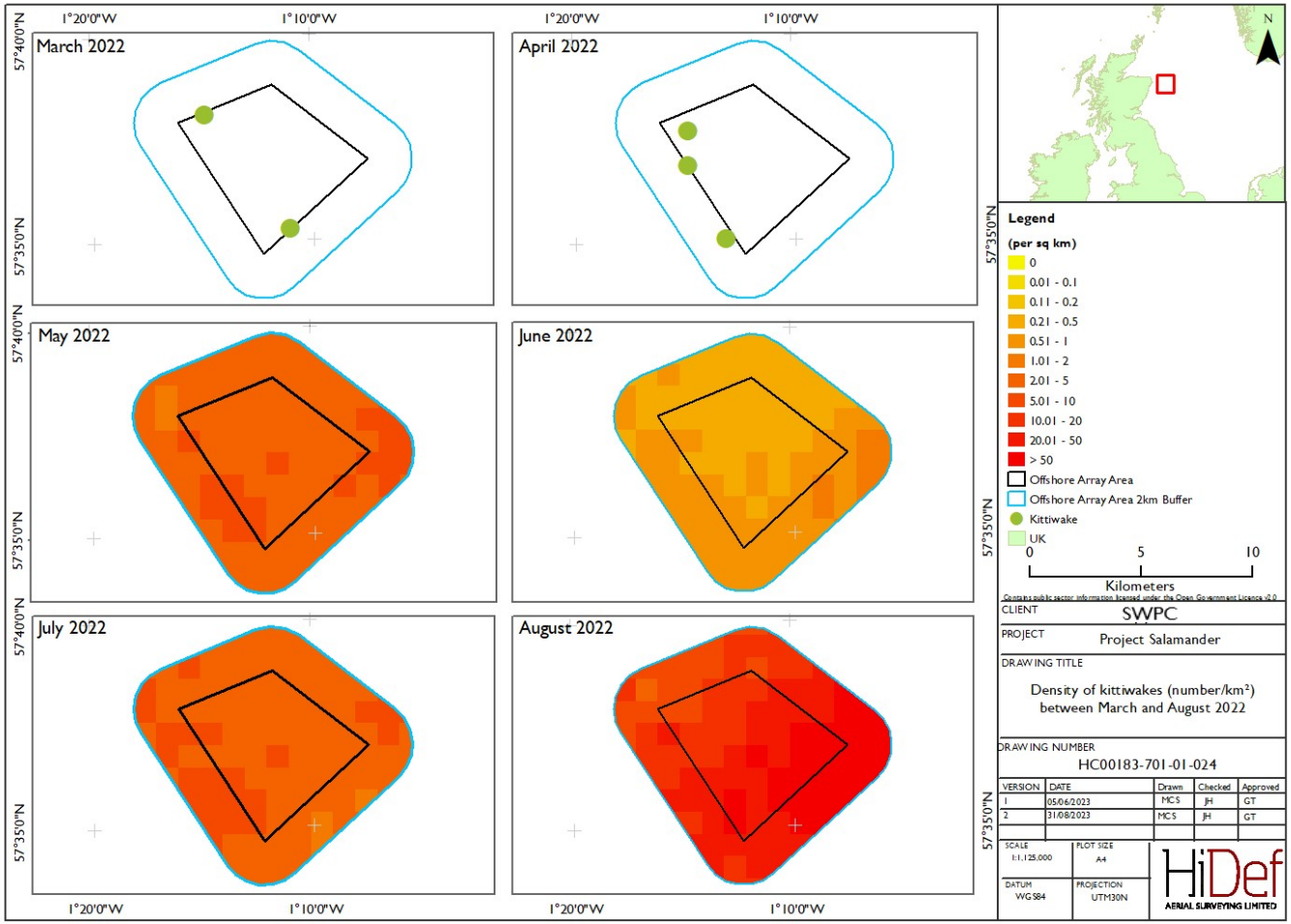

Figure 4 **Kittiwake density (birds/km^2) between March 2022 and August 2022. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour)**

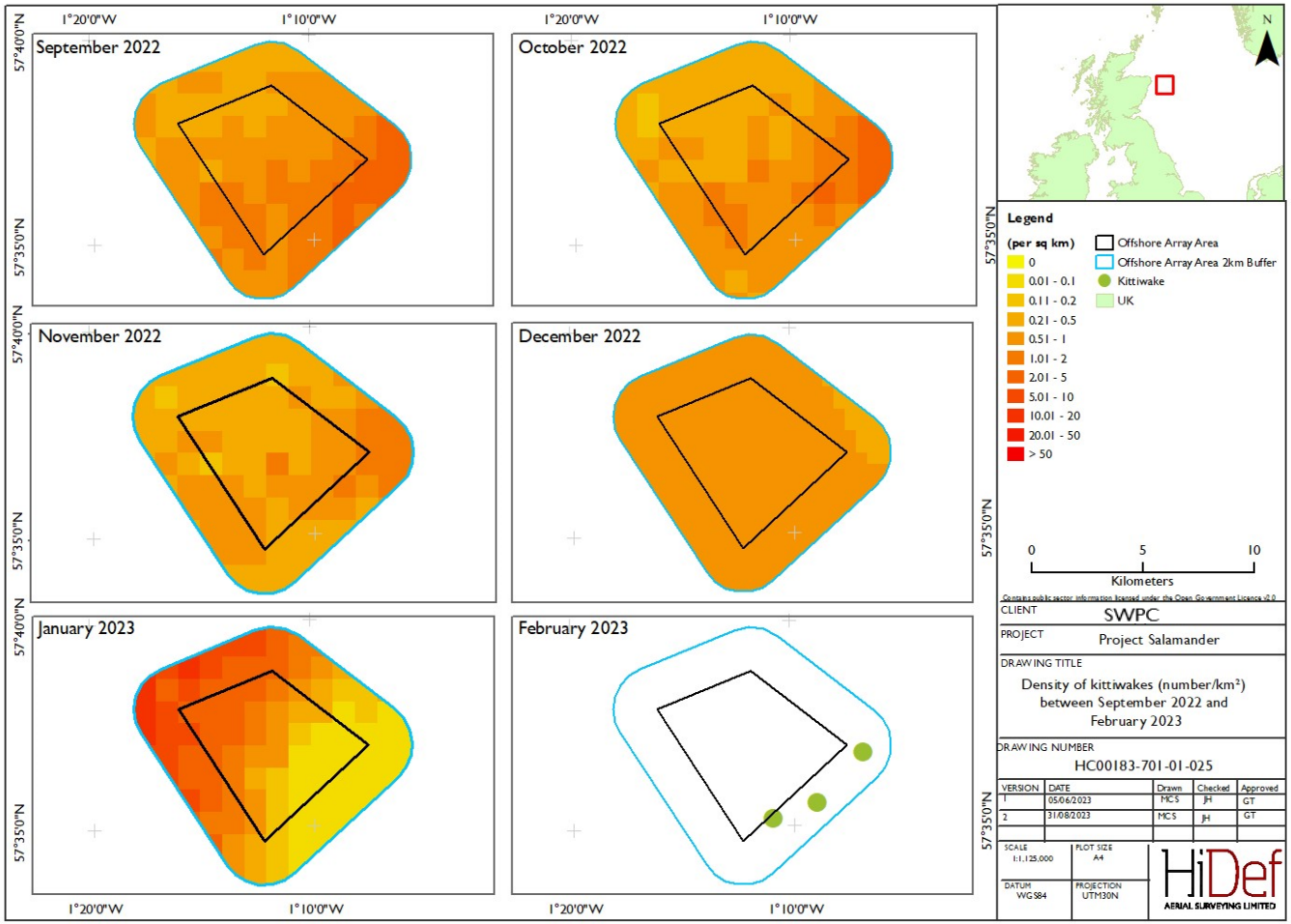

Figure 5 **Kittiwake density (birds/km^2) between September 2022 and February 2023. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour). No MRSea model produced for December 2022; indicative distribution presented through Kernal Density Estimation (KDE) (see section 2.1.2.2)**

3.2.1 Input densities for Collision Risk Modelling (CRM)

Table 8 **Monthly density estimates of flying kittiwake within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)**

Kittiwake	Density estimate (n/km²)	Lower 95% confidence limit (n/km²)	Upper 95% confidence limit (n/km²)	Standard deviation (n/km²)	CV (%)
13 March 2021	0.00	0.00	0.00	0.00	0.00
15 April 2021	0.17	0.03	0.47	0.19	111.76
23 May 2021	0.37	0.15	0.76	0.21	56.76
09 June 2021	3.10	1.51	5.73	1.44	46.45
15 July 2021	2.38	1.47	3.56	0.69	28.99
19 August 2021	1.61	0.81	2.85	0.72	44.72
07 September 2021	0.00	0.00	0.00	0.00	0.00
06 October 2021	0.00	0.00	0.00	0.00	0.00
10 November 2021*	0.24	0.00	0.74	0.24	92.85
09 December 2021	0.00	0.00	0.00	0.00	0.00
07 January 2022	0.00	0.00	0.00	0.00	0.00
08 February 2022	0.00	0.00	0.00	0.00	0.00
10 March 2022*	0.50	0.00	0.98	0.27	51.35
12 April 2022*	0.24	0.00	0.80	0.27	99.92
14 May 2022	1.27	0.62	2.34	0.58	45.67
12 June 2022	0.49	0.19	0.96	0.29	59.18
08 July 2022	2.35	1.32	3.82	0.81	34.47
17 August 2022	12.73	6.81	21.21	4.81	37.78
20 September 2022	0.70	0.23	1.56	0.49	70.00
07 October 2022	0.54	0.24	1.03	0.25	46.30
02 November 2022	0.48	0.13	1.18	0.37	77.08
20 December 2022	0.86	0.42	1.53	0.36	41.86
04 January 2023	0.00	0.00	0.00	0.00	0.00
23 February 2023	0.00	0.00	0.00	0.00	0.00

3.2.2 Input abundance for distributional responses

Table 9 **Monthly population estimates of all kittiwake (flying and sitting) within the Offshore Array Area plus 2km buffer between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)**

Kittiwake	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021*	8	0	23	7	89.79
15 April 2021	32	14	62	15	48.55
23 May 2021	33	17	58	14	40.49
09 June 2021	804	460	1274	276	34.39
15 July 2021	862	467	1558	446	51.69
19 August 2021	209	115	346	75	36.01
07 September 2021	116	27	339	151	130.76
06 October 2021	155	68	302	74	47.42
10 November 2021*	16	0	47	15	91.06
09 December 2021 *	8	0	23	7	89.34
07 January 2022	0	0	0	0	0.00
08 February 2022	0	0	0	0	0.00
10 March 2022*	16	0	32	9	51.86
12 April 2022*	25	0	52	13	54.10
14 May 2022	421	197	769	184	43.67
12 June 2022	75	39	128	30	39.53
08 July 2022	448	280	681	122	27.3
17 August 2022	6575	2297	14437	4363	66.37
20 September 2022	128	64	231	53	41.61
07 October 2022	92	35	199	55	60.33
02 November 2022	68	27	135	35	51.49
20 December 2022*	49	15	89	20	39.57
04 January 2023	284	31	887	469	165.02
23 February 2023*	25	7	46	11	43.92

3.3 Great black-backed gull

46 Great black-backed gull are deemed sensitive to collision with turbines and/or turbine blades therefore density estimates of flying birds within the Offshore Array Area are provided for input into CRM (Annex ER.A.4.12.3: Collision Risk Modelling Report).

47 Great black-backed gull were only recorded within the Offshore Array Area during the non-breeding season with a maximum population estimate of 67 birds (95% CI 21 – 158) (); most birds were aged as adults (Table 10).

48 Within the Offshore Array Area, flying great black-backed gull were only recorded during four surveys (January 2022, November 2022, January 2023 and February 2023), with densities ranging between 0.54 birds/km^2 (95% CI 0.28 – 0.90; November 2022) and 1.06 birds/km^2 (95% CI 0.57 – 1.84; January 2023) (Table 12).

Table 10 Percentage of aged great black-backed gull (n = 22) in each age class averaged across all surveys in each season

Season	Adult	Immature	Juvenile
Breeding	-	-	-
Non-breeding	59.09%	27.27%	13.64%

Table 11 Monthly population estimates of all great black-backed gull (flying and sitting) within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Great black-backed gull	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	0	0	0	0	0.00
23 May 2021	0	0	0	0	0.00
09 June 2021	0	0	0	0	0.00
15 July 2021	0	0	0	0	0.00
19 August 2021	0	0	0	0	0.00
07 September 2021	0	0	0	0	0.00
06 October 2021	0	0	0	0	0.00
10 November 2021	0	0	0	0	0.00
09 December 2021	26	9	57	17	65.02
07 January 2022	60	27	115	30	49.64
08 February 2022	0	0	0	0	0.00
10 March 2022	0	0	0	0	0.00
12 April 2022	0	0	0	0	0.00
14 May 2022	0	0	0	0	0.00
12 June 2022	0	0	0	0	0.00
08 July 2022	0	0	0	0	0.00
17 August 2022	0	0	0	0	0.00
20 September 2022	0	0	0	0	0.00
07 October 2022	0	0	0	0	0.00
02 November 2022	67	21	158	72	106.61
20 December 2022	23	8	53	22	93.10
04 January 2023	29	1	103	78	269.80
23 February 2023*	9	0	22	7	73.83

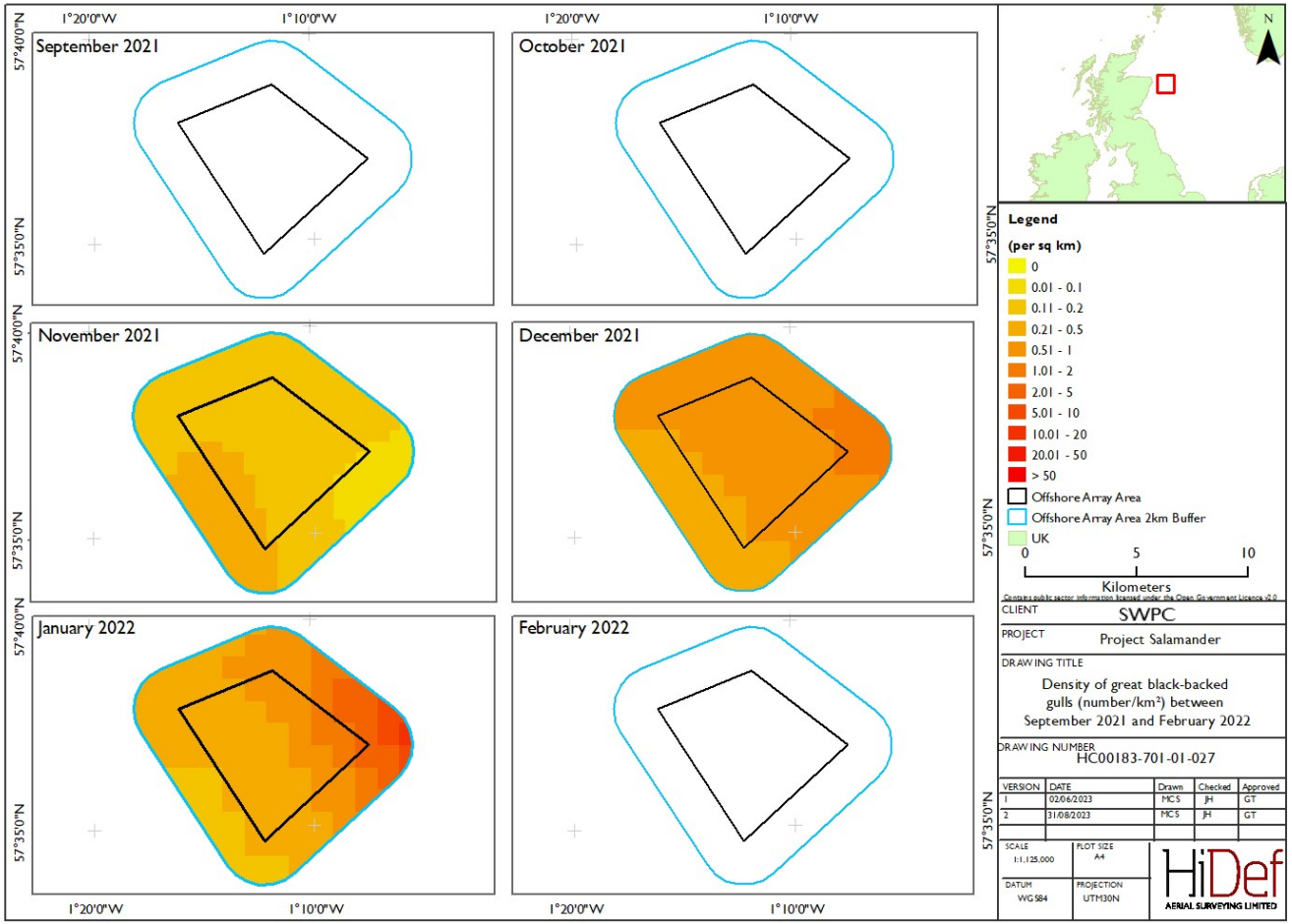

Figure 6 **Great black-backed gull density (birds/km^2) between September 2021 and February 2022. No great black-backed gulls were observed between March and August 2021. No MRSea model produced for November 2021; indicative distribution presented through Kernel Density Estimation (KDE) (see section 2.1.2.2)**

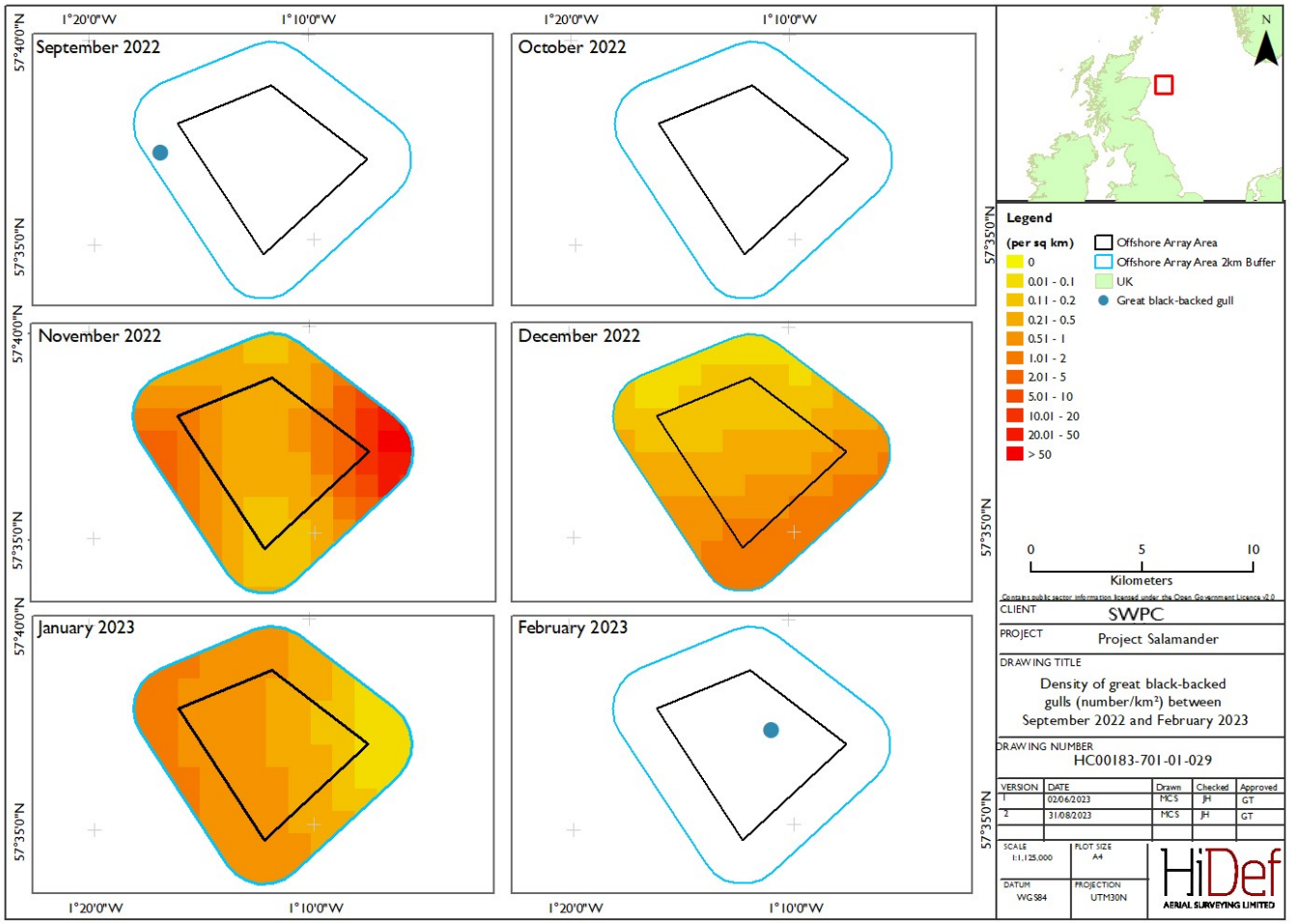

Figure 7 **Great black-backed gull density (birds/km^2) between September 2022 and February 2023. No great-blacked backed gulls were observed between March and August 2022. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour)**

3.3.1 Input densities for Collision Risk Modelling (CRM)

Table 12 Monthly density estimates of flying great black-backed gull within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Great black-backed gull	Density estimate (n/km²)	Lower 95% confidence limit (n/km²)	Upper 95% confidence limit (n/km²)	Standard deviation (n/km²)	CV (%)
13 March 2021	0.00	0.00	0.00	0.00	0.00
15 April 2021	0.00	0.00	0.00	0.00	0.00
23 May 2021	0.00	0.00	0.00	0.00	0.00
09 June 2021	0.00	0.00	0.00	0.00	0.00
15 July 2021	0.00	0.00	0.00	0.00	0.00
19 August 2021	0.00	0.00	0.00	0.00	0.00
07 September 2021	0.00	0.00	0.00	0.00	0.00
06 October 2021	0.00	0.00	0.00	0.00	0.00
10 November 2021	0.00	0.00	0.00	0.00	0.00
09 December 2021	0.00	0.00	0.00	0.00	0.00
07 January 2022	0.69	0.44	1.01	0.19	27.71
08 February 2022	0.00	0.00	0.00	0.00	0.00
10 March 2022	0.00	0.00	0.00	0.00	0.00
12 April 2022	0.00	0.00	0.00	0.00	0.00
14 May 2022	0.00	0.00	0.00	0.00	0.00
12 June 2022	0.00	0.00	0.00	0.00	0.00
08 July 2022	0.00	0.00	0.00	0.00	0.00
17 August 2022	0.00	0.00	0.00	0.00	0.00
20 September 2022	0.00	0.00	0.00	0.00	0.00
07 October 2022	0.00	0.00	0.00	0.00	0.00
02 November 2022	0.54	0.28	0.90	0.21	39.72
20 December 2022	0.00	0.00	0.00	0.00	0.00
04 January 2023	1.06	0.57	1.84	0.42	38.62
23 February 2023*	0.25	0.00	0.65	0.21	73.04

3.4 Herring gull

49 Herring gull are deemed sensitive to collision with turbines and/or turbine blades therefore density estimates of flying birds within the Offshore Array Area are provided for input into CRM (Annex ER.A.4.12.3: Collision Risk Modelling Report).

50 Similar to great black-backed gull, herring gull were only recorded during the non-breeding season with a maximum population estimate within the Offshore Array Area of 203 birds (95% CI 71 – 462) (Table 14). Of the birds recorded, most were aged as adults, with smaller proportions of immature birds recorded (Table 13).

51 Within the Offshore Array Area, flying herring gull were recorded in varying densities (Table 15), ranging between 0.00 birds/km^2 (e.g. July 2021) and 2.33 birds/km^2 (95% CI 0.59 – 5.82; November 2022). Peak densities of flying birds were recorded in December 2021 in Year One and November 2022 in Year Two.

Table 13 Percentage of aged herring gull (n = 27) in each age class averaged across all surveys in each season

Season	Adult	Immature	Juvenile
Breeding	-	-	-
Non-breeding	59.26%	33.33%	7.41%

Table 14 Monthly population estimates of all herring gull (flying and sitting) within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Herring gull	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021*	17	0	40	12	68.99
15 April 2021	0	0	0	0	0.00
23 May 2021	0	0	0	0	0.00
09 June 2021	16	0	35	10	18.58
15 July 2021	0	0	0	0	0.00
19 August 2021	0	0	0	0	0.00
07 September 2021	0	0	0	0	0.00
06 October 2021	0	0	0	0	0.00
10 November 2021	0	0	0	0	0.00
09 December 2021*	17	0	34	9	52.72
07 January 2022	13	5	28	8	60.04
08 February 2022	0	0	0	0	0.00
10 March 2022	0	0	0	0	0.00
12 April 2022	0	0	0	0	0.00
14 May 2022	0	0	0	0	0.00
12 June 2022	0	0	0	0	0.00
08 July 2022	0	0	0	0	0.00
17 August 2022	0	0	0	0	0.00
20 September 2022	0	0	0	0	0.00
07 October 2022	0	0	0	0	0.00
02 November 2022	203	71	462	140	69.08
20 December 2022	0	0	0	0	0.00
04 January 2023	0	0	0	0	0.00
23 February 2023	0	0	0	0	0.00

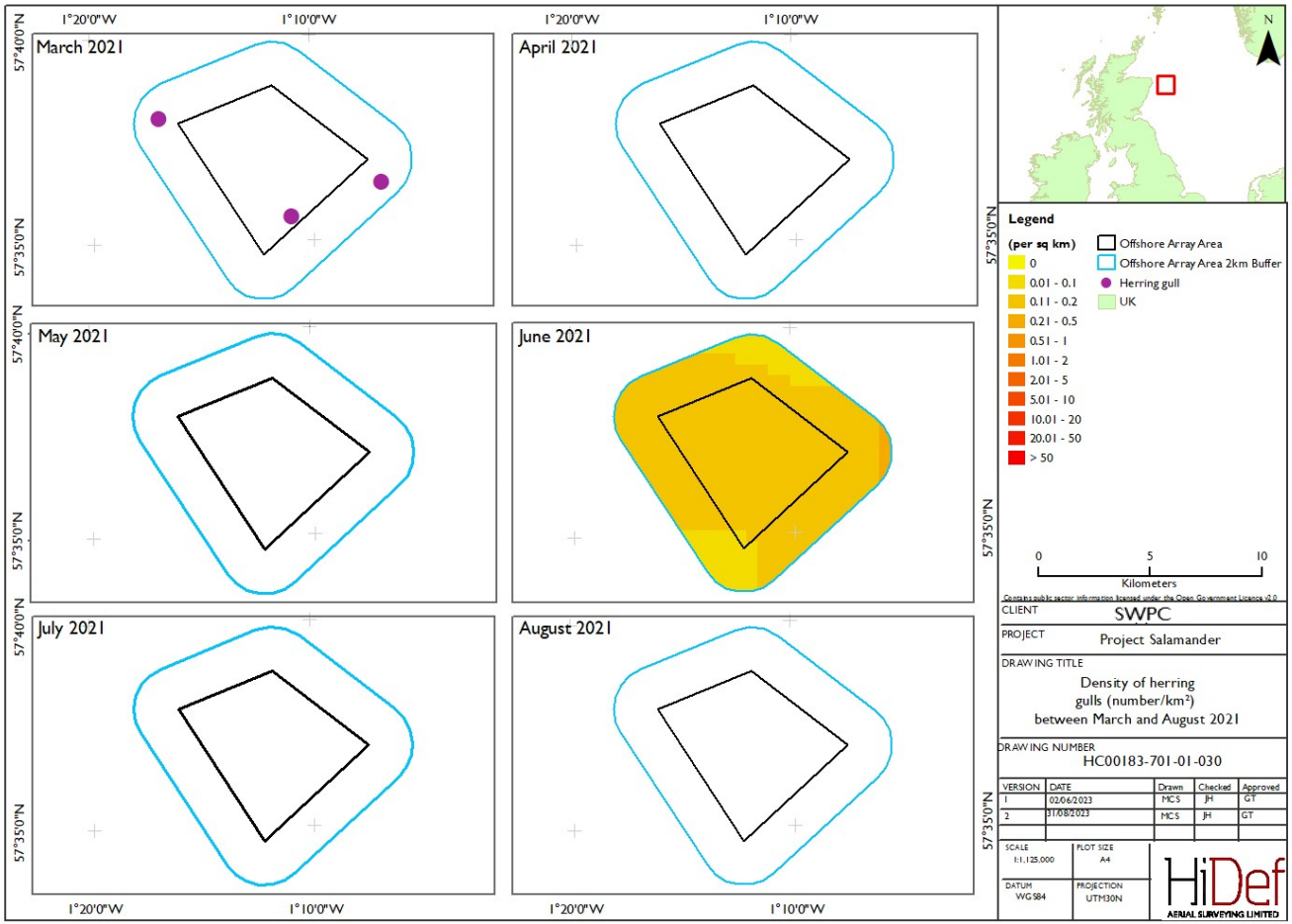

Figure 8 **Herring gull density (birds/km^2) between September 2022 and February 2023. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour).**

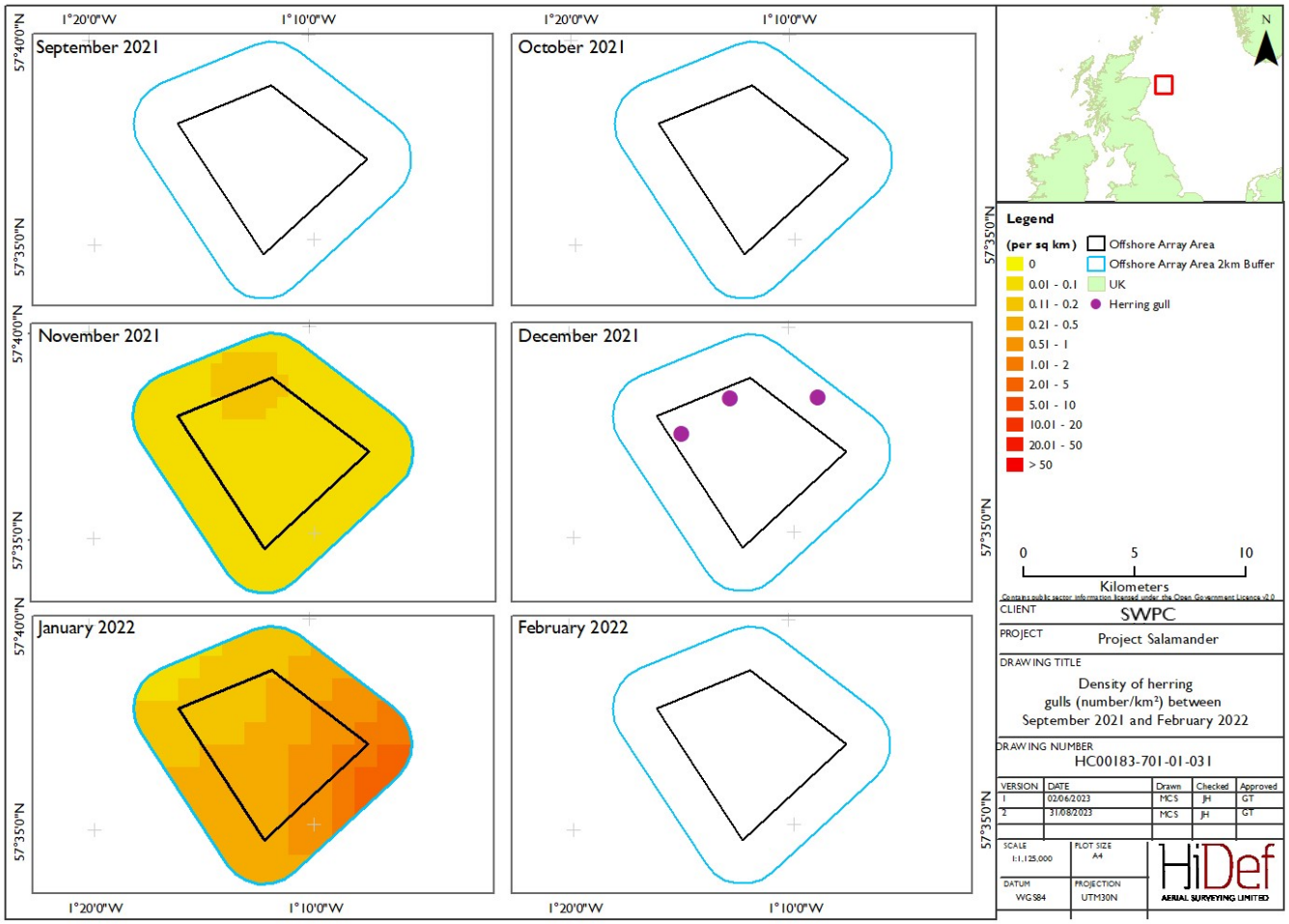

Figure 9 **Herring gull density (birds/km^2) between September 2021 and February 2022. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour). No MRSea model produced for November 2021; indicative distribution presented through Kernel Density Estimation (KDE) (see section 2.1.2.2)**

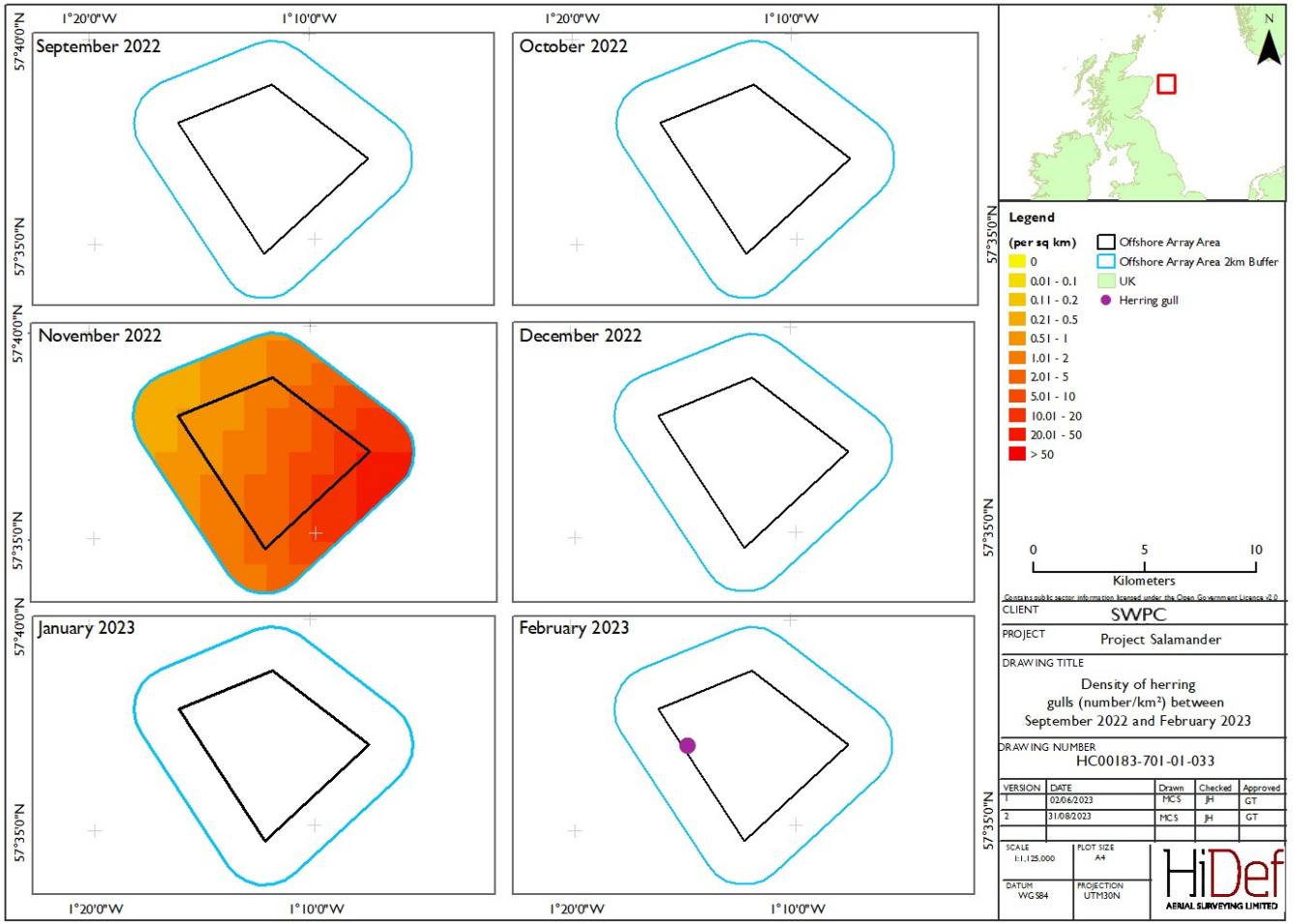

Figure 10 **Herring gull density (birds/km^2) between September 2022 and February 2023. There were no observations of herring gulls between March and August 2022 within the Offshore Array Area plus 2km buffer. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour)**

3.4.1 Input densities for Collision Risk Modelling (CRM)

Table 15 Monthly density estimates of flying herring gull within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Herring gull	Density estimate (n/km²)	Lower 95% confidence limit (n/km²)	Upper 95% confidence limit (n/km²)	Standard deviation (n/km²)	CV (%)
13 March 2021*	0.50	0.00	1.20	0.36	67.34
15 April 2021	0.00	0.00	0.00	0.00	0.00
23 May 2021	0.00	0.00	0.00	0.00	0.00
09 June 2021	0.00	0.00	0.00	0.00	0.00
15 July 2021	0.00	0.00	0.00	0.00	0.00
19 August 2021	0.00	0.00	0.00	0.00	0.00
07 September 2021	0.00	0.00	0.00	0.00	0.00
06 October 2021	0.00	0.00	0.00	0.00	0.00
10 November 2021	0.00	0.00	0.00	0.00	0.00
09 December 2021*	0.49	0.00	1.10	0.27	53.87
07 January 2022*	0.48	0.23	0.68	0.15	26.92
08 February 2022	0.00	0.00	0.00	0.00	0.00
10 March 2022	0.00	0.00	0.00	0.00	0.00
12 April 2022	0.00	0.00	0.00	0.00	0.00
14 May 2022	0.00	0.00	0.00	0.00	0.00
12 June 2022	0.00	0.00	0.00	0.00	0.00
08 July 2022	0.00	0.00	0.00	0.00	0.00
17 August 2022	0.00	0.00	0.00	0.00	0.00
20 September 2022	0.00	0.00	0.00	0.00	0.00
07 October 2022	0.00	0.00	0.00	0.00	0.00
02 November 2022	2.33	0.59	5.82	1.78	76.41
20 December 2022	0.00	0.00	0.00	0.00	0.00
04 January 2023	0.00	0.00	0.00	0.00	0.00
23 February 2023	0.00	0.00	0.00	0.00	0.00

3.5 Guillemot

52 Guillemot are deemed sensitive to distributional responses and therefore population estimates for all birds within the Offshore Array Area plus 2km buffer and MSP estimates are provided for input into the assessment of distributional responses (Annex ER.A.4.12.5: Displacement Assessment).

53 Maximum population estimates for the Offshore Array Area ranged from 1,472 birds (95% CI 1,222–1,740) in the breeding season to 7,743 birds (95% CI 6,911– 8,572) in the non-breeding season (Table 17).

54 Population estimates for guillemot in the Offshore Array Area plus 2km buffer varied (Table 18), ranging from 82 birds (95% CI 67 – 99; January 2023) to 19,502 birds (95% CI 17,814 – 21,270) in August 2022. The MSP calculated for the breeding season was lower than that for the non-breeding season, estimated at 3,616 birds (95% CI 2,898 – 4,442) and 11,779 birds (95% CI 10,620 – 13,033), respectively (Table 16).

Table 16 Mean seasonal peak population estimates of all guillemot (flying and sitting) in each season within the Offshore Array Area plus 2km buffer between March 2021 and February 2023 (corrected for animals unavailable at the surface)

Guillemot	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit
Breeding	3616	2643	4589
Non-breeding	11779	10215	13343

Table 17 Monthly population estimates for all guillemot (flying and sitting) within the Offshore Array Area between March 2021 and February 2023 (corrected for animals unavailable at the surface)

Guillemot	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	104	77	136	19	18.06
15 April 2021	166	113	236	37	22.47
23 May 2021	68	46	98	16	23.46
09 June 2021	757	656	866	65	8.59
15 July 2021	1259	987	1574	186	14.80
19 August 2021	1453	1306	1616	92	6.34
07 September 2021	1465	1093	1939	256	17.46
06 October 2021	1640	1411	1904	150	9.13
10 November 2021	200	165	242	24	11.75
09 December 2021	501	432	575	43	8.67
07 January 2022	80	67	96	9	11.20
08 February 2022	155	103	221	36	22.99
10 March 2022	132	87	187	31	23.79
12 April 2022	84	43	139	31	36.50
14 May 2022	1375	1202	1566	110	8.03
12 June 2022	167	88	274	60	35.64
08 July 2022	1472	1222	1741	162	11.01
17 August 2022	7743	6911	8572	504	6.50
20 September 2022	2584	1959	3288	408	15.79
07 October 2022	2597	1999	3275	389	14.98
02 November 2022	372	246	527	86	22.99
20 December 2022	30	19	45	8	27.45
04 January 2023	38	31	47	5	12.48
23 February 2023	92	77	110	10	10.97

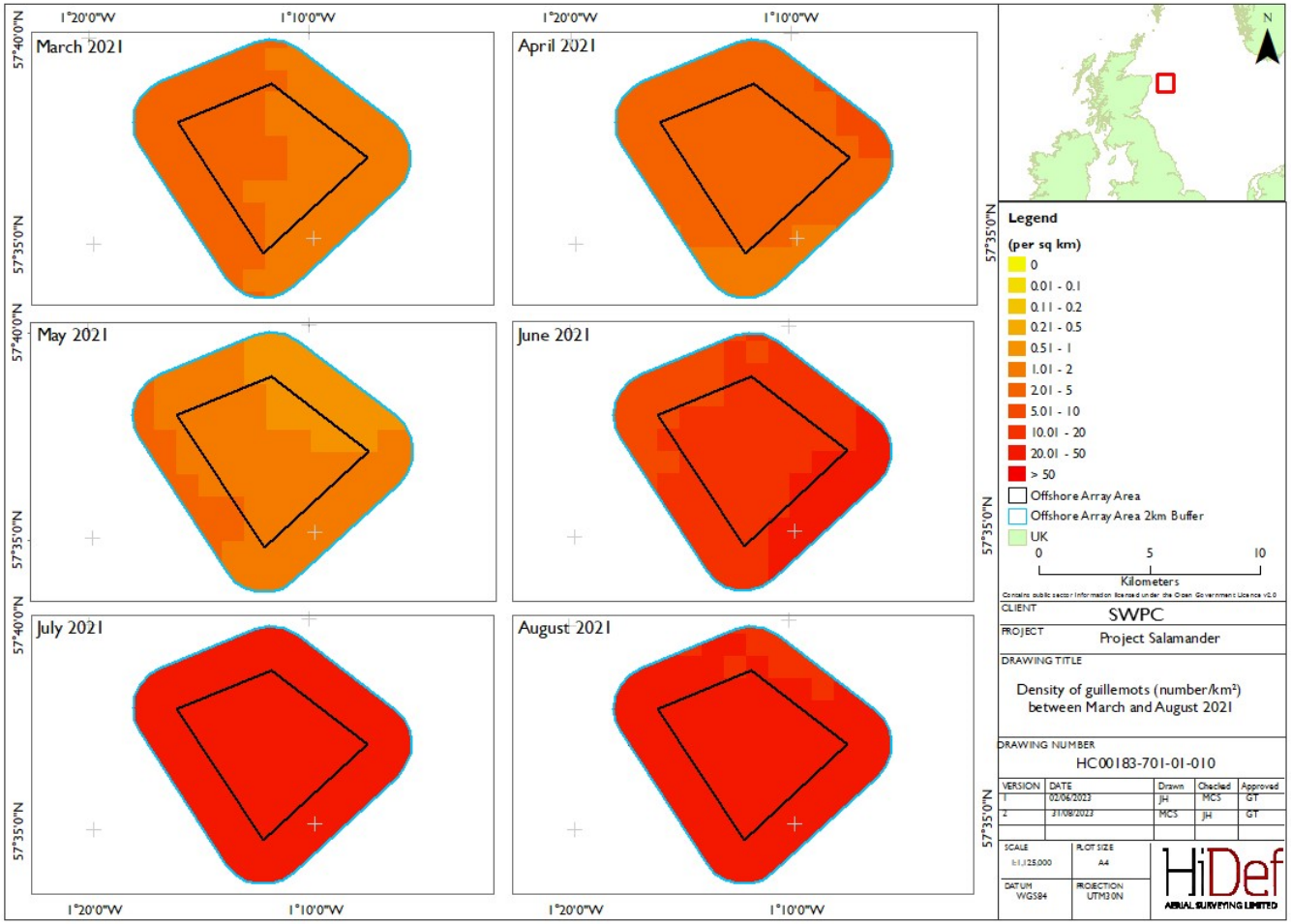

Figure 11 Guillemot density (birds/km^2) between March and August 2021

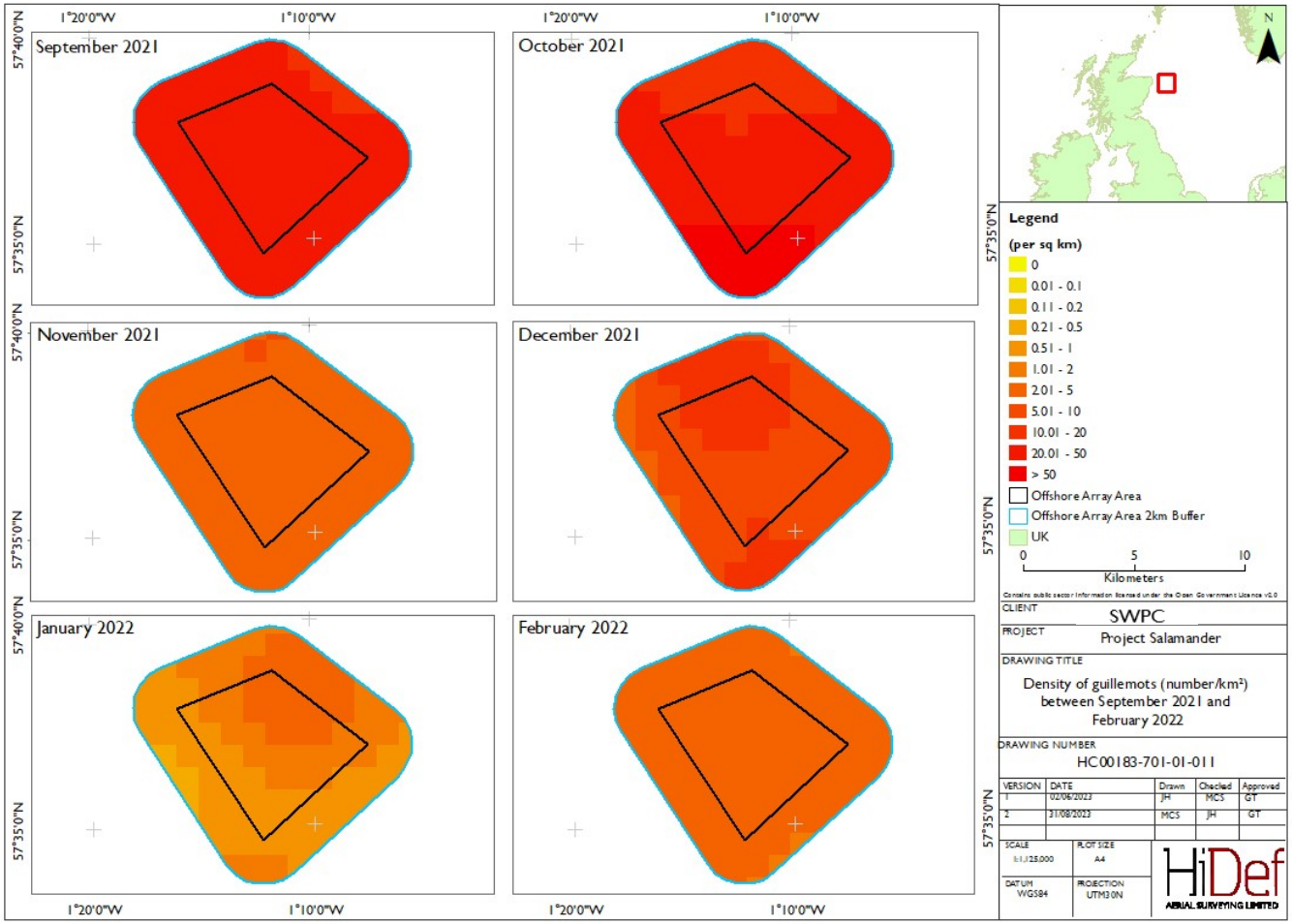

Figure 12 Guillemot density (birds/km^2) between September 2021 and February 2022

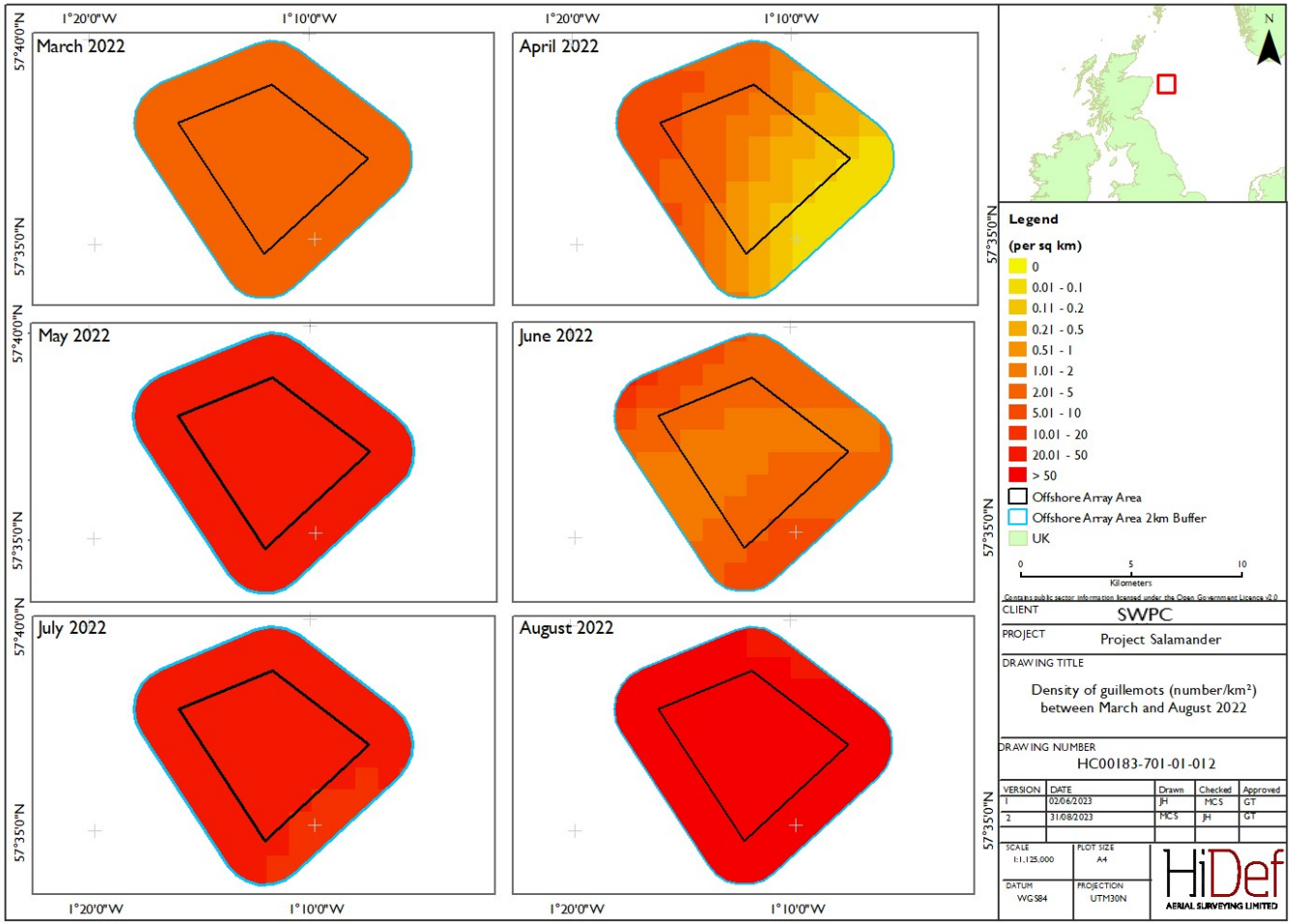

Figure 13 Guillemot density (birds/km^2) between March 2022 and August 2022

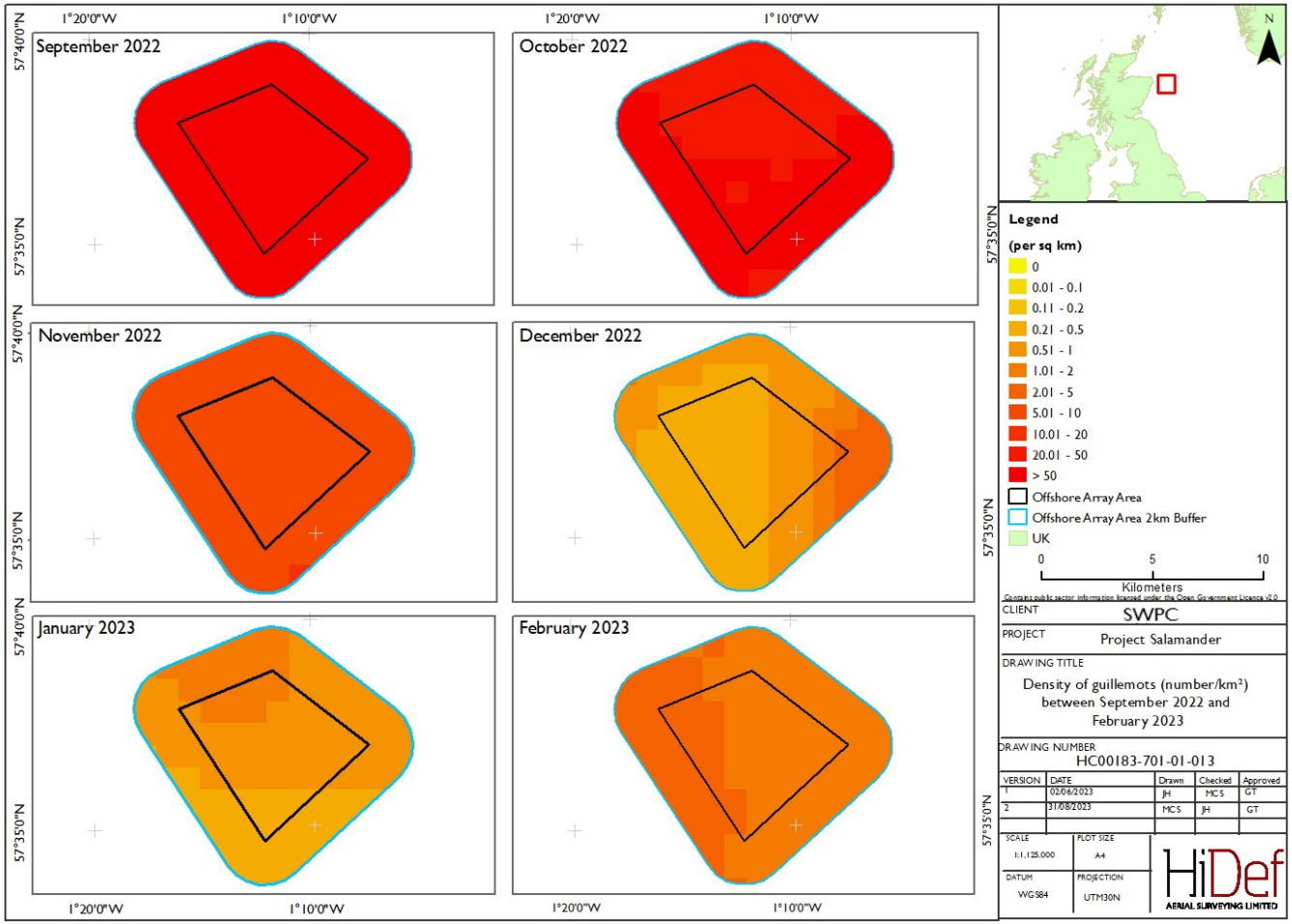

Figure 14 Guillemot density (birds/km^2) between September 2022 and February 2023

3.5.1 Input abundance for distributional responses

Table 18 Monthly population estimates of all guillemot (flying and sitting) within the Offshore Array Area plus 2km buffer between March 2021 and February 2023 (corrected for animals unavailable at the surface)

Guillemot	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	244	184	318	41	16.83
15 April 2021	381	267	534	81	21.15
23 May 2021	167	120	229	34	20.50
09 June 2021	1943	1683	2234	170	8.72
15 July 2021	3851	2901	4968	627	16.28
19 August 2021	3438	3103	3805	211	6.14
07 September 2021	3449	2586	4552	589	17.07
06 October 2021	4056	3426	4795	415	10.24
10 November 2021	478	392	577	56	11.66
09 December 2021	1072	956	1199	74	6.87
07 January 2022	157	134	184	16	9.98
08 February 2022	357	245	492	74	20.74
10 March 2022	244	184	318	41	16.83
12 April 2022	277	139	465	108	39.01
14 May 2022	3197	2795	3638	256	7.99
12 June 2022	541	347	778	135	24.96
08 July 2022	3381	2896	3917	317	9.36
17 August 2022	19502	17814	21270	1049	5.38
20 September 2022	8111	6576	9722	975	12.02
07 October 2022	6143	4737	7712	924	15.05
02 November 2022	914	613	1279	205	22.43
20 December 2022	108	80	142	19	17.88
04 January 2023	82	67	99	10	12.08
23 February 2023	221	182	266	26	11.77

3.6 Razorbill

55 Razorbill are deemed sensitive to distributional response impacts therefore population estimates for all birds within the Offshore Array Area plus 2km buffer and MSP estimates are provided for input into the assessment of distributional responses (Annex ER.A.4.12.5: Displacement Assessment).

56 Maximum population estimates for the Offshore Array Area ranged from 221 birds (95% CI 109 - 393) in the non-breeding season to 250 birds (95% CI 186 - 330) in the breeding season (Table 20).

57 Population estimates for all razorbill in the Offshore Array Area plus 2km buffer varied between months, ranging between 0 birds (e.g. February 2022) and 879 birds (95% CI 515 – 1,399) in August 2022 (Table 21). The MSP calculated for the breeding season was lower compared to the non-breeding season, estimated at 334 birds (95% CI 246 - 452) and 484 birds (95% CI 2,797 - 777), respectively (Table 19). The density of razorbill within the Offshore Array Area plus 2km buffer are presented in Figure 15 to Figure 18, for September and October 2022 surveys, razorbill density is not presented, despite Table 21indicating an abundance of one bird. This abundance estimate is likely an artefact of no-ID apportioning, where unidentified birds are assigned to species based on the proportions of species recorded.

Table 19 Mean seasonal peak population estimates of all razorbill (flying and sitting) in each season within the Offshore Array Area plus 2km buffer between March 2021 and February 2023 (corrected for animals unavailable at the surface)

Razorbill	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit
Breeding	334	198	470
Non-breeding	484	112	882

Table 20 **Monthly population estimates for all razorbill (flying and sitting) within the Offshore Array Area between March 2021 and February 2023 (corrected for animals unavailable at the surface). Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)**

Razorbill	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	30	16	51	11	36.50
23 May 2021	0	0	0	0.00	0.00
09 June 2021	250	186	330	45	17.85
15 July 2021	12	5	23	6	48.10
19 August 2021	41	20	73	17	41.73
07 September 2021	11	3	26	9	81.10
06 October 2021	13	3	31	14	114.52
10 November 2021	0	0	0	0	0.00
09 December 2021	0	0	0	0	0.00
07 January 2022	0	0	0	0	0.00
08 February 2022	0	0	0	0	0.00
10 March 2022	0	0	0	0	0.00
12 April 2022	72	47	107	21	28.71
14 May 2022	26	12	48	12	45.33
12 June 2022	24	3	71	35	147.09
08 July 2022	54	32	86	18	32.87
17 August 2022	221	109	393	89	40.23
20 September 2022*	1	0	1	1	100.00
07 October 2022*	1	0	1	1	100.00
02 November 2022	10	5	17	5	48.76
20 December 2022	0	0	0	0	0.00
04 January 2023	0	0	0	0	0.00
23 February 2023	0	0	0	0	0.00

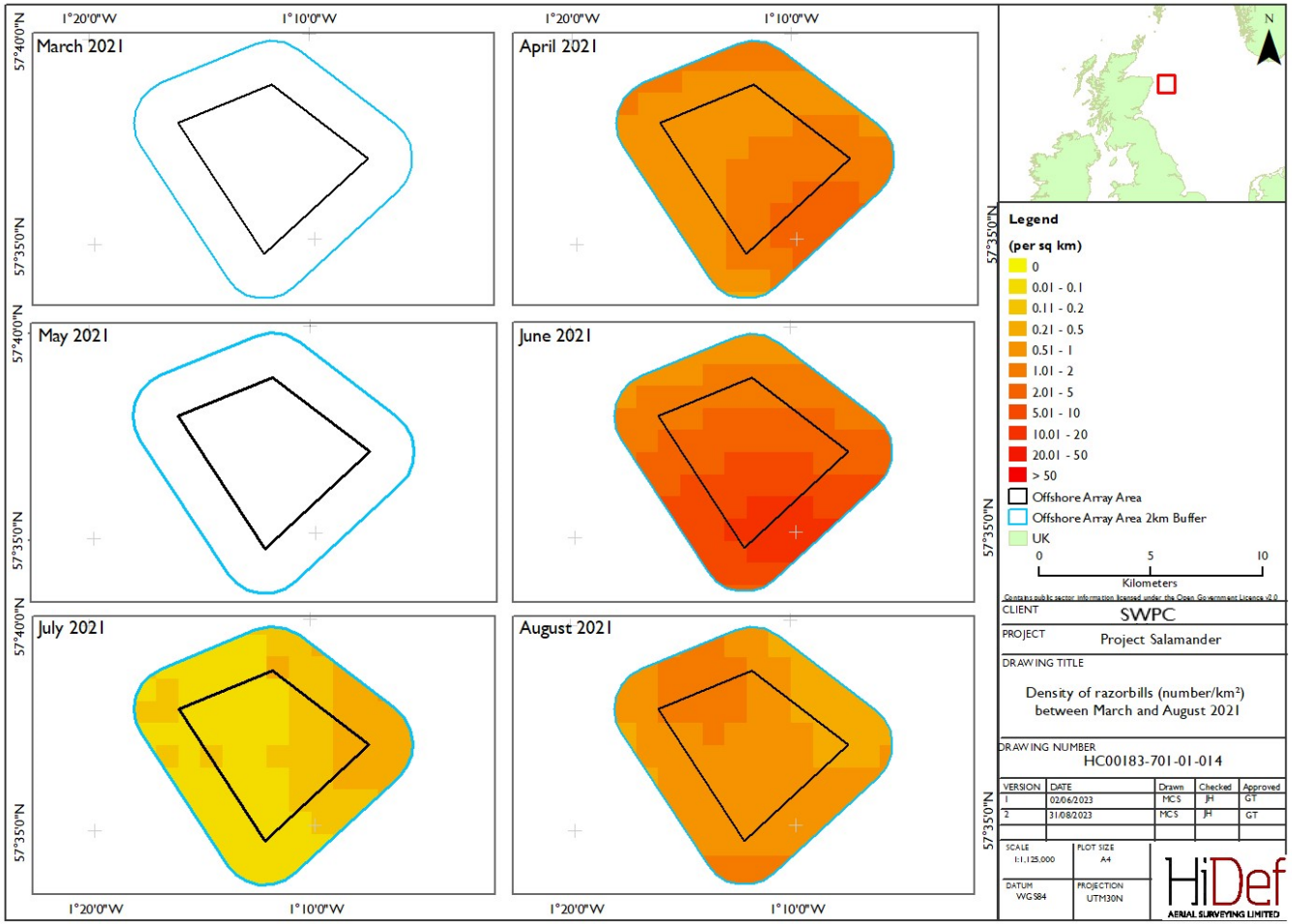

Figure 15 Razorbill density (birds/km^2) between March and August 2021.

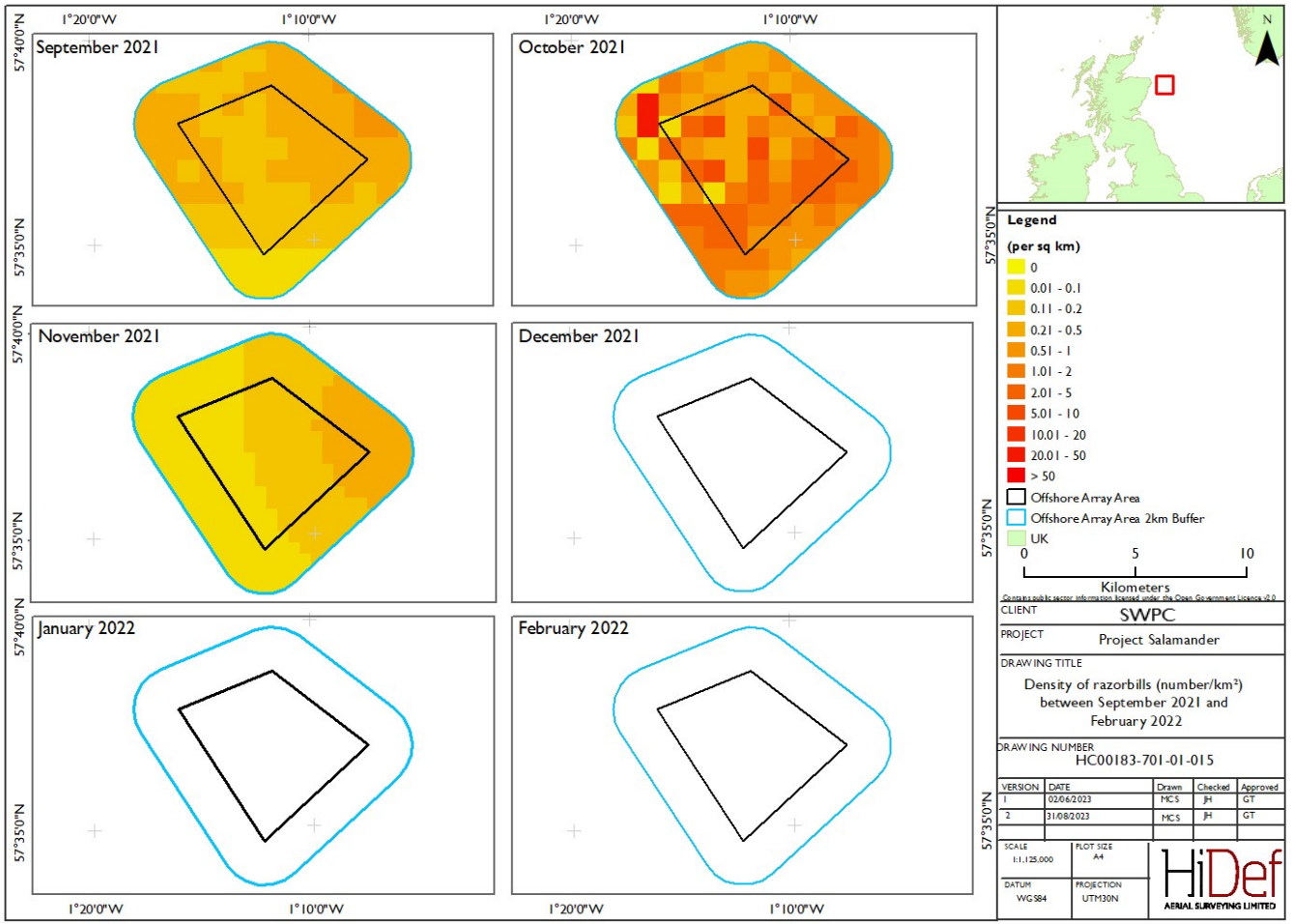

Figure 16 **Razorbill density (birds/km^2) between September 2021 and February 2022. No MRSea model produced for November 2021; indicative distribution presented through Kernal Density Estimation (KDE) (see section 2.1.2.2)**

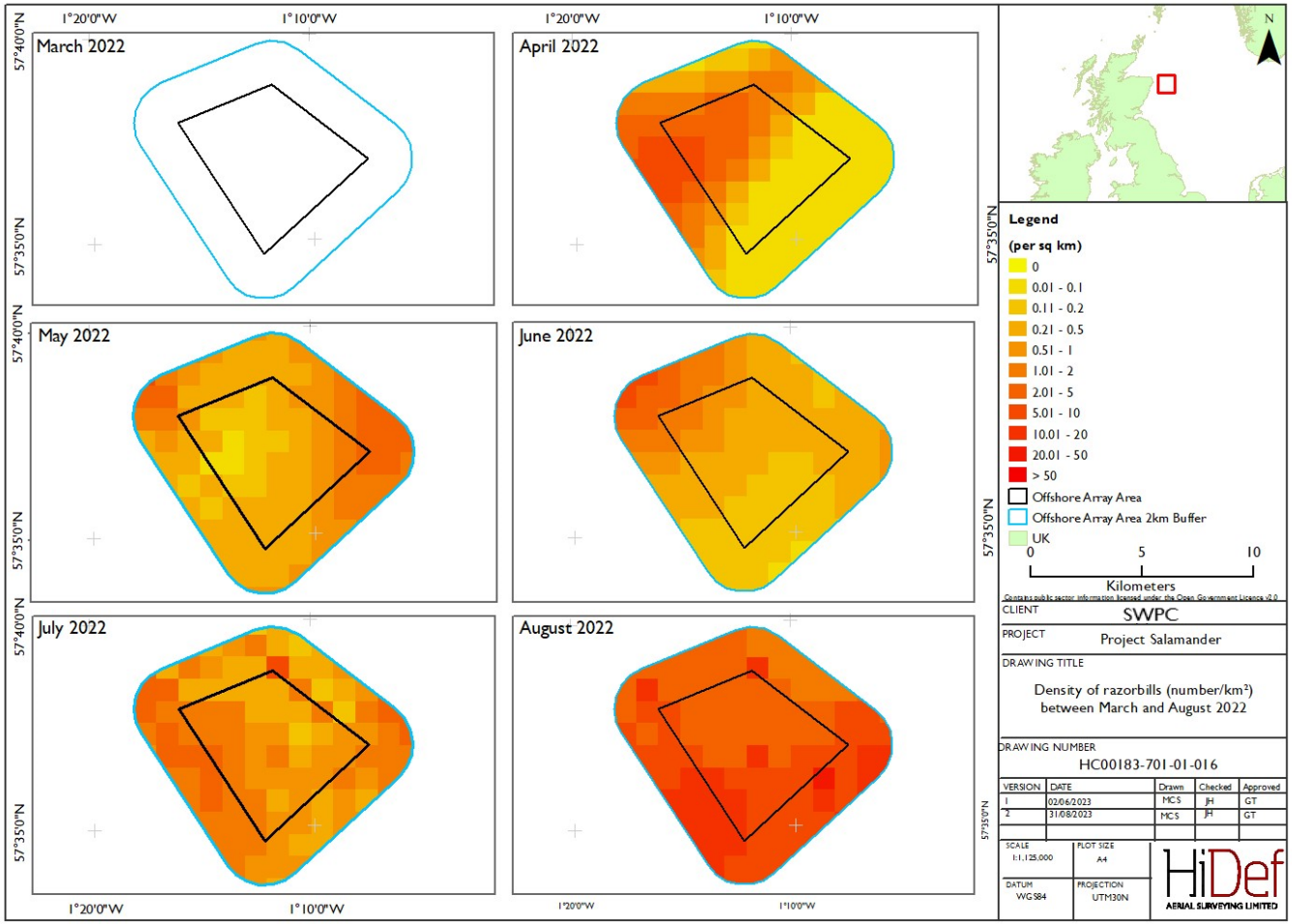

Figure 17 Razorbill density (birds/km^2) between March 2022 and August 2022

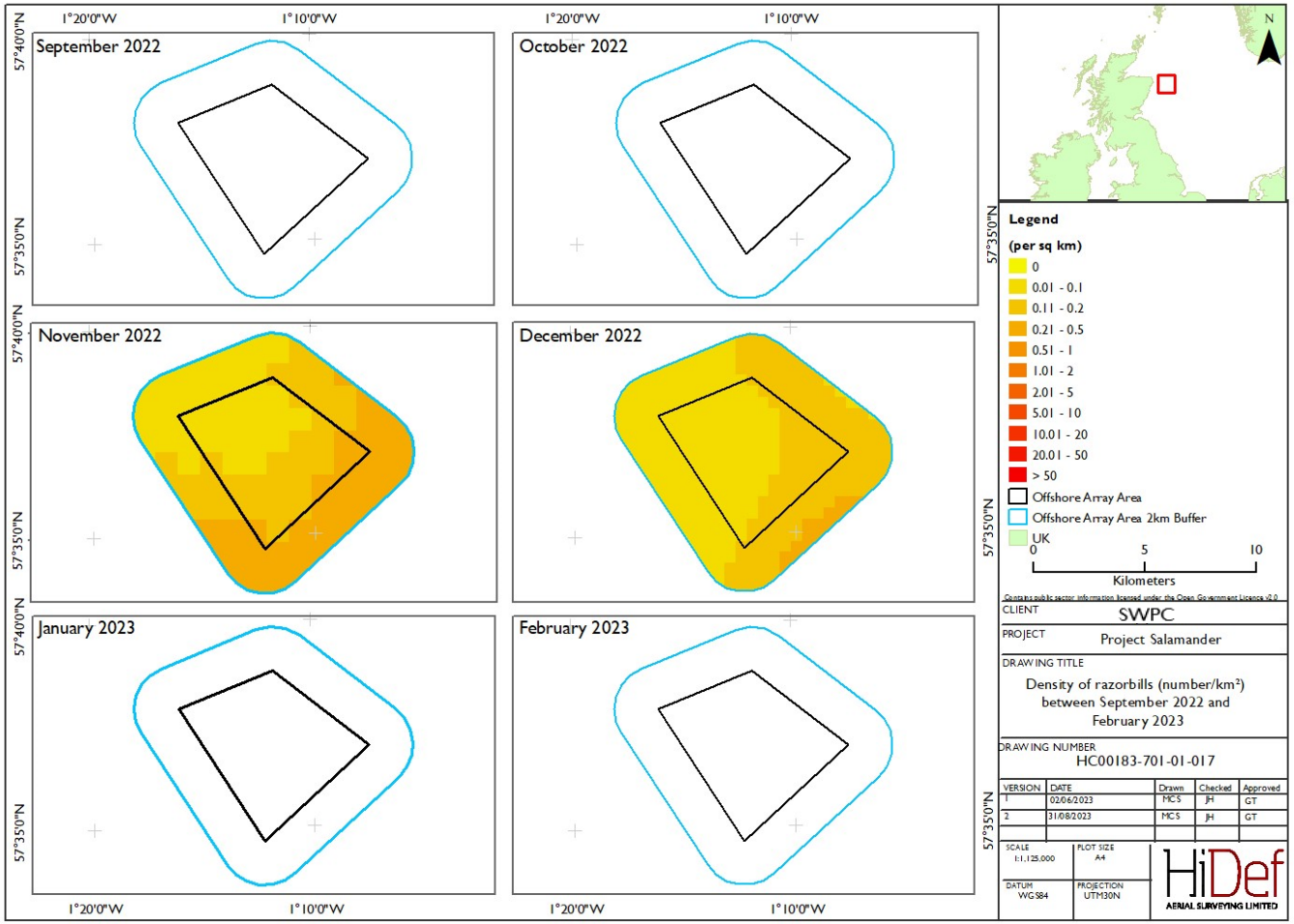

Figure 18 **Razorbill density (birds/km^2) between September 2022 and February 2023. No MRSea model produced for December 2022; indicative distribution presented through Kernel Density Estimation (KDE) (see section 2.1.2.2)**

3.6.1 Input abundance for distributional responses

Table 21 Monthly population estimates of all razorbill (flying and sitting) within the Offshore Array Area plus 2km buffer between March 2021 and February 2023 (corrected for animals unavailable at the surface). Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Razorbill	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	145	95	209	36	24.48
23 May 2021	0	0	0	0	0.00
09 June 2021	528	399	696	90	17.11
15 July 2021	17	6	39	12	69.06
19 August 2021	89	44	155	35	39.67
07 September 2021	27	8	64	20	74.51
06 October 2021	32	8	75	33	104.20
10 November 2021*	20	0	39	12	60.00
09 December 2021	0	0	0	0	0.00
07 January 2022	0	0	0	0	0.00
08 February 2022	0	0	0	0	0.00
10 March 2022	0	0	0	0	0.00
12 April 2022	140	93	208	37	26.79
14 May 2022	110	71	167	31	27.76
12 June 2022	83	20	211	94	113.06
08 July 2022	136	82	219	44	32.38
17 August 2022	879	515	1399	284	32.33
20 September 2022*	1	1	1	1	100.00
07 October 2022*	1	0	1	1	100.00
02 November 2022	35	20	61	17	48.29
20 December 2022*	13	1	29	10	76.92
04 January 2023	0	0	0	0	0.00
23 February 2023	0	0	0	0	0.00

3.7 Puffin

58 Puffin are deemed sensitive to distributional response impacts therefore population estimates for all birds within the Offshore Array Area plus 2km buffer and MSP estimates are provided for input into the assessment of distributional responses (Annex ER.A.4.12.5: Displacement Assessment).

59 The maximum population estimate for the Offshore Array Area during the breeding season was estimated as 226 birds (95% CI 190– 266) (Table 23).

60 Population estimates for puffin in the Offshore Array Area plus 2km buffer varied (Table 24), ranging from 0 birds (95% CI 0 - 0) in many winter months to 3,119 birds (95% CI 2,706– 3,555) in August 2022. The MSP for the breeding season was calculated from estimates in June 2021 and May 2022, calculated at 357 birds (95% CI 290 – 441) (Table 22). Note that August surveys were after the mid-month cut-off and so contribute to the subsequent (non-breeding) season, rather than the breeding season (see Section 2.1.4 for more detail).

Table 22 Mean seasonal peak population estimates of all puffin (flying and sitting) in the breeding season within the Offshore Array Area plus 2km buffer between March 2021 and February 2023 (corrected for animals unavailable at the surface)

Puffin	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit
Breeding	357	261	453

Table 23 Monthly population estimates of all puffin (flying and sitting) within the Offshore Array Area between March 2021 and February 2023 (corrected for animals unavailable at the surface)

Puffin	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	37	26	50	8	20.60
23 May 2021	0	0	0	0	0.00
09 June 2021	66	45	94	15	23.14
15 July 2021	20	13	29	5	27.20
19 August 2021	98	82	116	10	10.32
07 September 2021	247	216	280	20	8.10
06 October 2021	43	27	61	11	24.83
10 November 2021	0	0	0	0	0.00
09 December 2021	0	0	0	0	0.00
07 January 2022	0	0	0	0	0.00
08 February 2022	0	0	0	0	0.00
10 March 2022	0	0	0	0	0.00
12 April 2022	0	0	0	0	0.00
14 May 2022	226	190	266	24	10.8
12 June 2022	6	1	22	9	140.87
08 July 2022	26	12	47	11	43.92
17 August 2022	1216	1019	1432	125	10.27
20 September 2022	102	75	137	19	18.40
07 October 2022	12	8	18	3	23.88
02 November 2022	0	0	0	0	0.00
20 December 2022	0	0	0	0	0.00
04 January 2023	0	0	0	0	0.00
23 February 2023	0	0	0	0	0.00

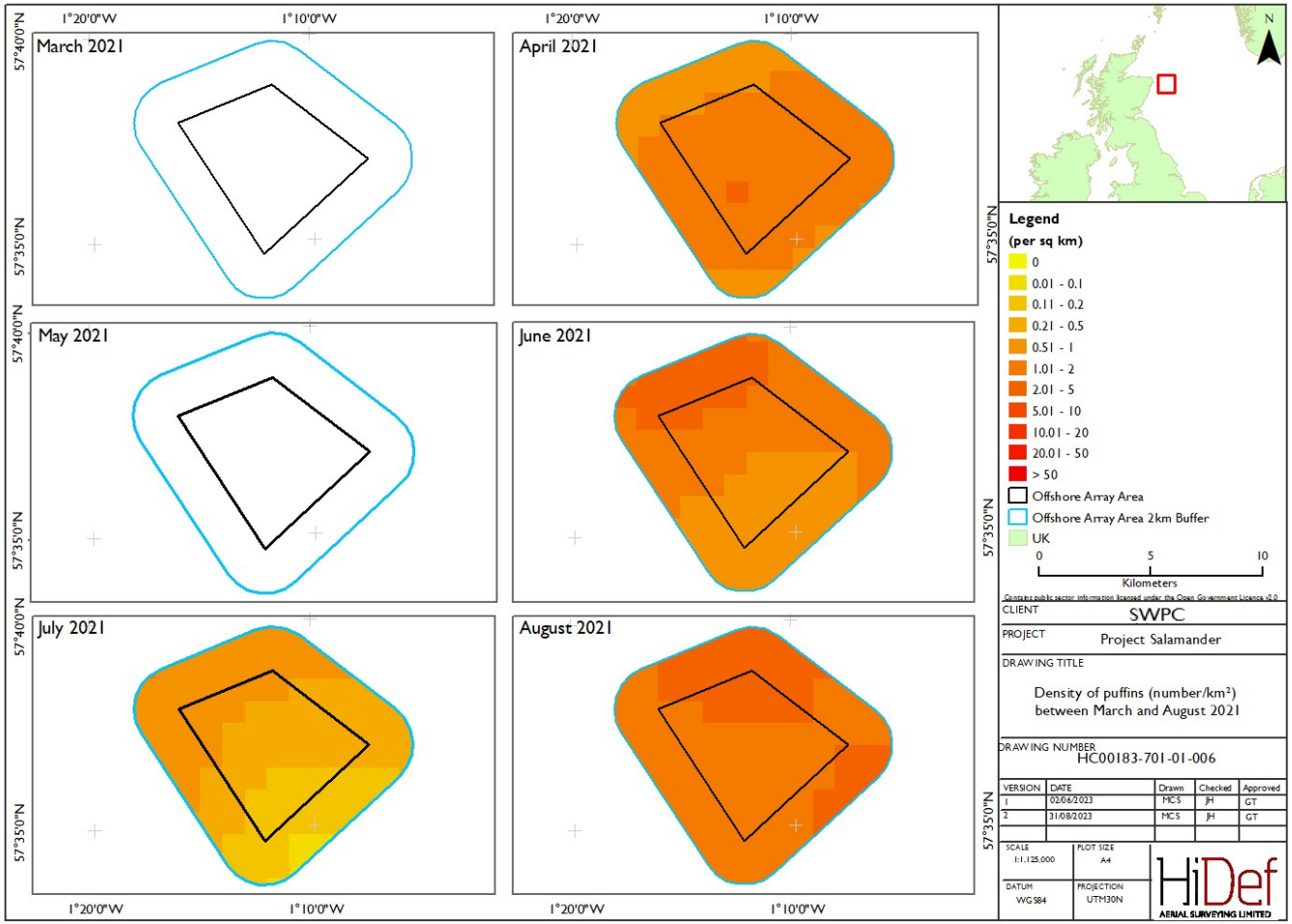

Figure 19 **Puffin density (birds/km^2) between March and August 2021**

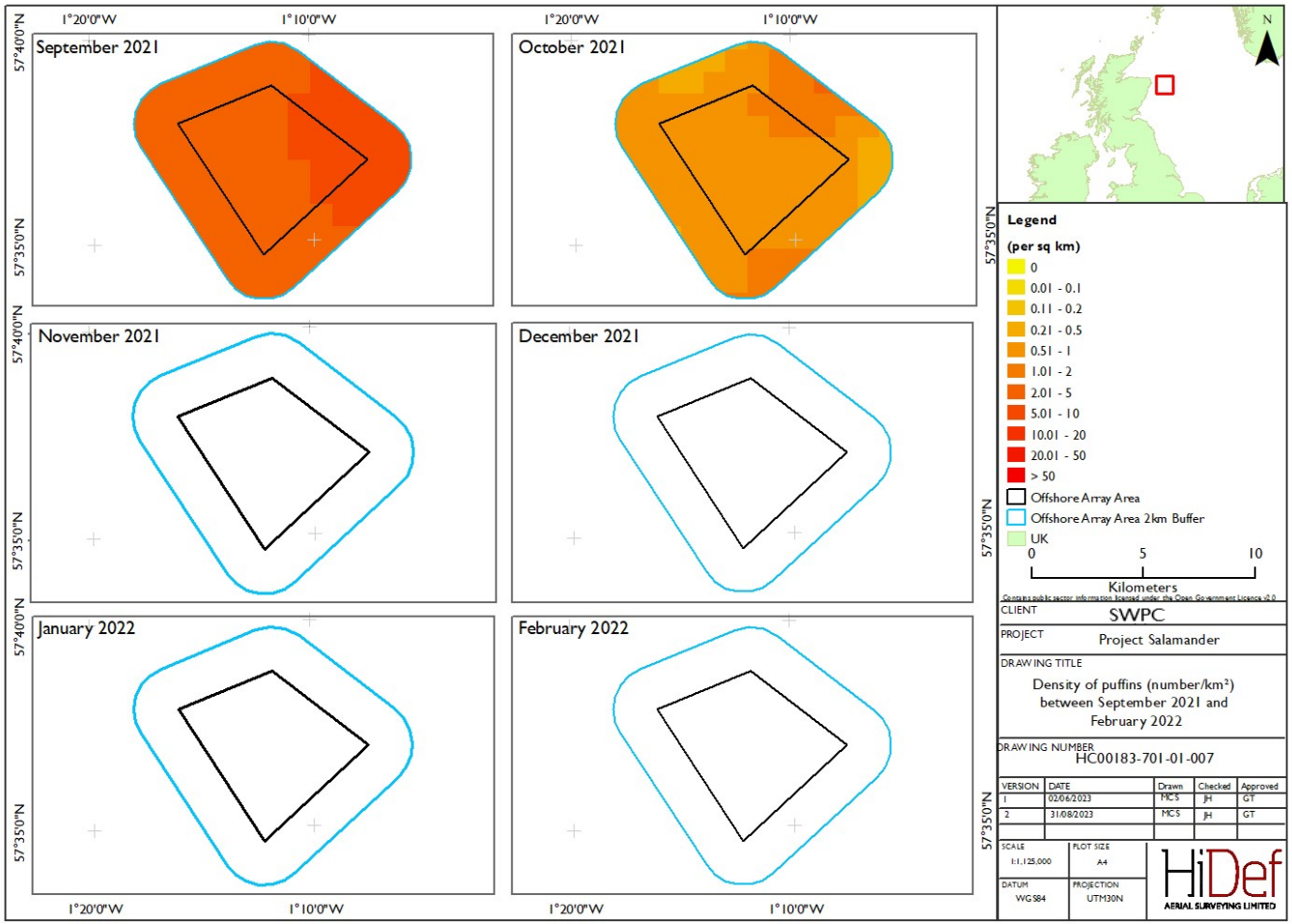

Figure 20 Puffin density (birds/km^2) between September 2021 and February 2022

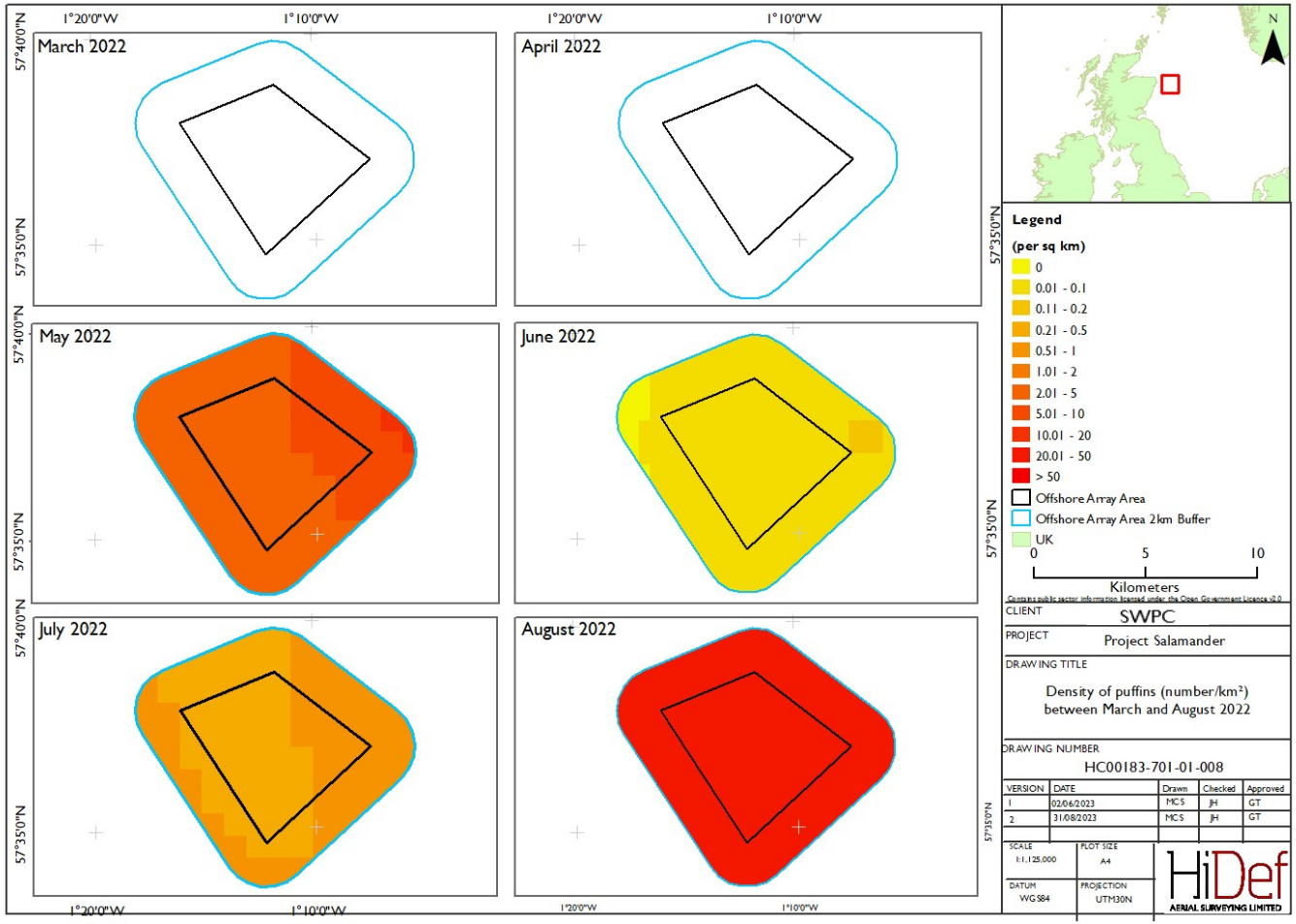

Figure 21 Puffin density (birds/km^2) between March 2022 and August 2022

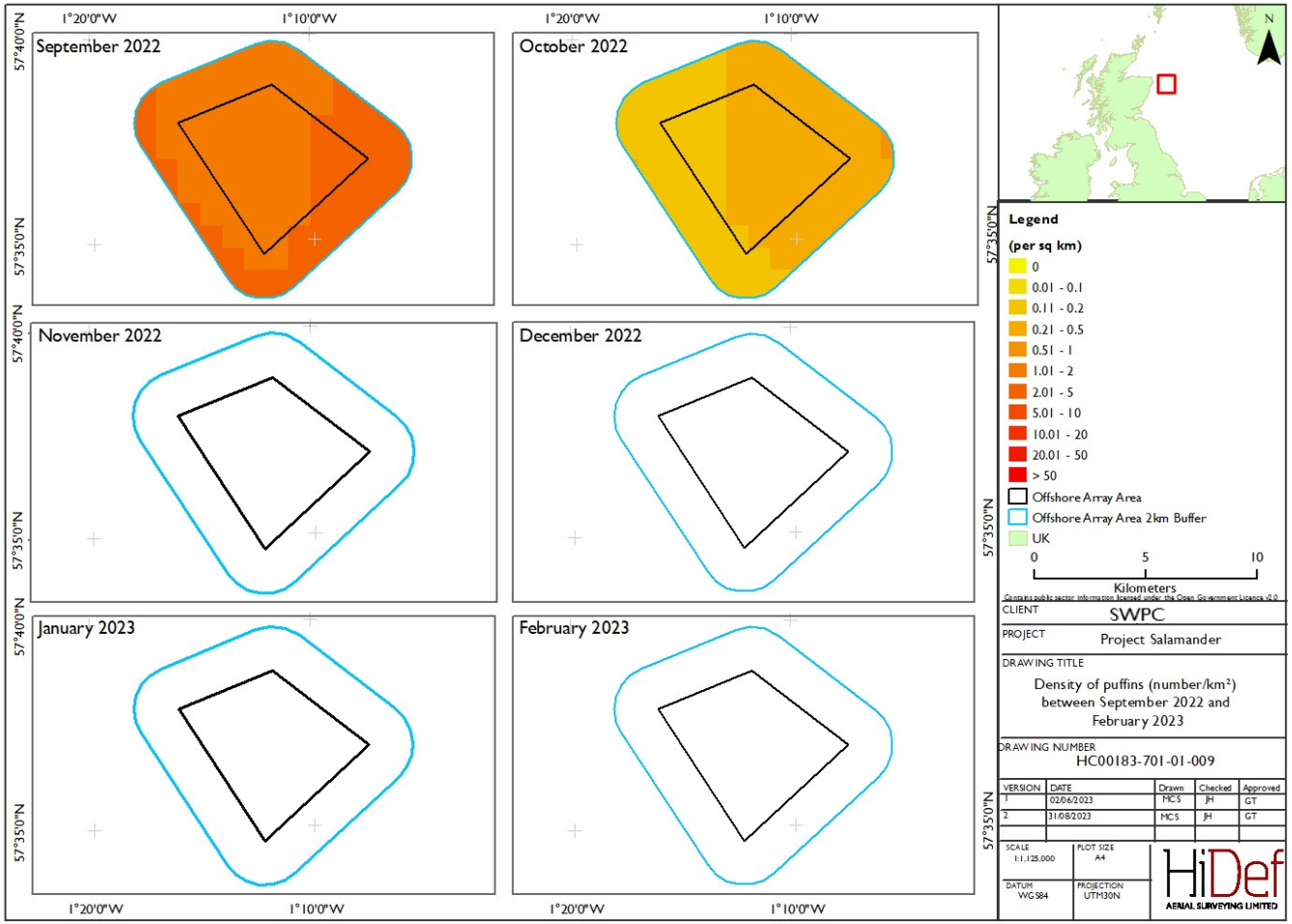

Figure 22 Puffin density (birds/km^2) between September 2022 and February 2023

3.7.1 Input abundance for distributional responses

Table 24 Monthly population estimates of all puffin (flying and sitting) within the Offshore Array Area plus 2km buffer between March 2021 and February 2023 (corrected for animals unavailable at the surface)

Puffin	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	91	64	127	20	21.42
23 May 2021	0	0	0	0	0.00
09 June 2021	159	112	223	35	21.94
15 July 2021	53	36	75	14	25.75
19 August 2021	239	202	281	24	9.90
07 September 2021	584	516	658	43	7.35
06 October 2021	101	74	132	20	19.34
10 November 2021	0	0	0	0	0.00
09 December 2021	0	0	0	0	0.00
07 January 2022	0	0	0	0	0.00
08 February 2022	0	0	0	0	0.00
10 March 2022	0	0	0	0	0.00
12 April 2022	0	0	0	0	0.00
14 May 2022	555	467	659	60	10.80
12 June 2022	12	1	41	16	138.79
08 July 2022	65	37	108	24	36.30
17 August 2022	3119	2706	3555	256	8.21
20 September 2022	259	199	337	43	16.53
07 October 2022	30	21	41	7	21.80
02 November 2022	0	0	0	0	0.00
20 December 2022	0	0	0	0	0.00
04 January 2023	0	0	0	0	0.00
23 February 2023	0	0	0	0	0.00

3.8 Fulmar

61 Fulmar were to be assessed for collision risk therefore density estimates of flying birds within the Offshore Array Area are provided for input into CRM (Annex ER.A.4.12.3: Collision Risk Modelling Report).

62 Maximum population estimates within the Offshore Array Area ranged between 329 birds (95% CI 213 – 480) and 1,850 birds (95% CI 1,002 – 3,093) for the breeding and non-breeding season, respectively (Table 25). Generally, population estimates were higher during the late summer / autumn except for November 2022 where estimates peaked at 1,850 birds (95% CI 1,002 – 3,093; Table 25).

63 Within the Offshore Array Area, densities of flying fulmar varied between months (Table 26), ranging between 0.00 birds/km^2 (e.g. March and April 2021) and 38.34 birds/km^2 (95% CI 29.53 – 48.70; November 2022). Peak densities of flying fulmar were estimated in July 2021 in Year One and November 2022 in Year Two.

Table 25 Monthly population estimates of all fulmar (flying and sitting) within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Fulmar	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	0	0	0	0	0.00
23 May 2021	31	16	54	12	40.22
09 June 2021	40	25	58	10	25.37
15 July 2021	329	213	480	84	25.53
19 August 2021	95	61	137	24	24.85
07 September 2021	70	50	96	14	20.21
06 October 2021	58	39	83	14	23.69
10 November 2021	45	24	80	18	39.09
09 December 2021	32	23	42	6	17.84
07 January 2022	45	31	62	9	20.90
08 February 2022	33	24	45	6	19.35
10 March 2022	42	31	54	7	17.40
12 April 2022	16	9	25	5	30.91
14 May 2022*	17	0	40	12	68.16
12 June 2022	35	16	70	18	50.64
08 July 2022	65	53	79	8	12.47
17 August 2022	74	40	131	30	40.31
20 September 2022	215	168	267	31	14.34
07 October 2022	13	4	32	11	79.44
02 November 2022	1850	1002	3093	671	36.24
20 December 2022	100	49	168	39	39.10
04 January 2023	67	2	125	514	772.74
23 February 2023	30	21	41	6	20.02

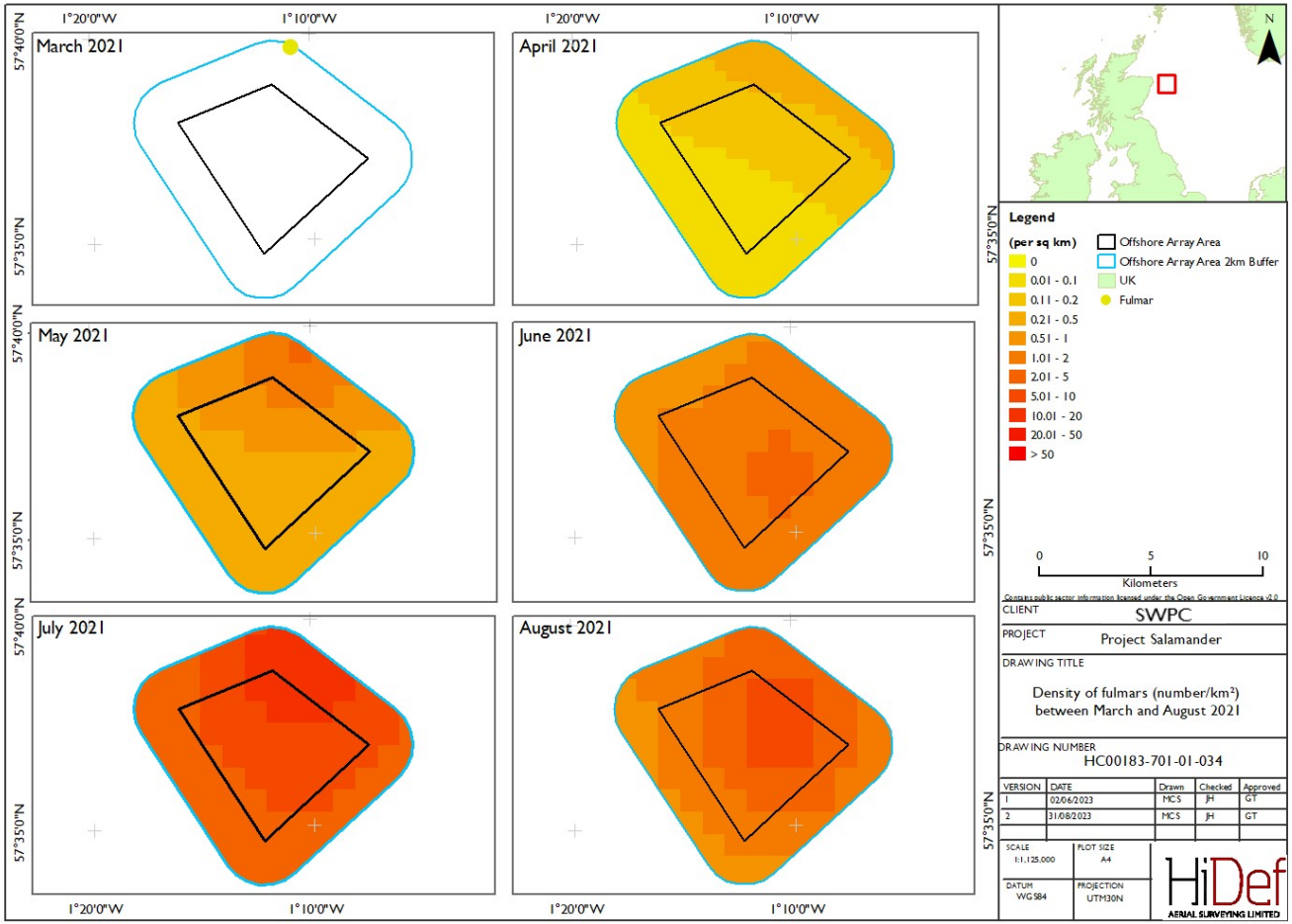

Figure 23 **Fulmar density (birds/km^2) between March and August 2021. Raw observations are presented for surveys where records were sparse and would create 'flat' density surfaces (i.e. they would appear uniform in colour). No MRSea model produced for April 2021; indicative distribution presented through Kernel Density Estimation (KDE) (see section 2.1.2.2)**

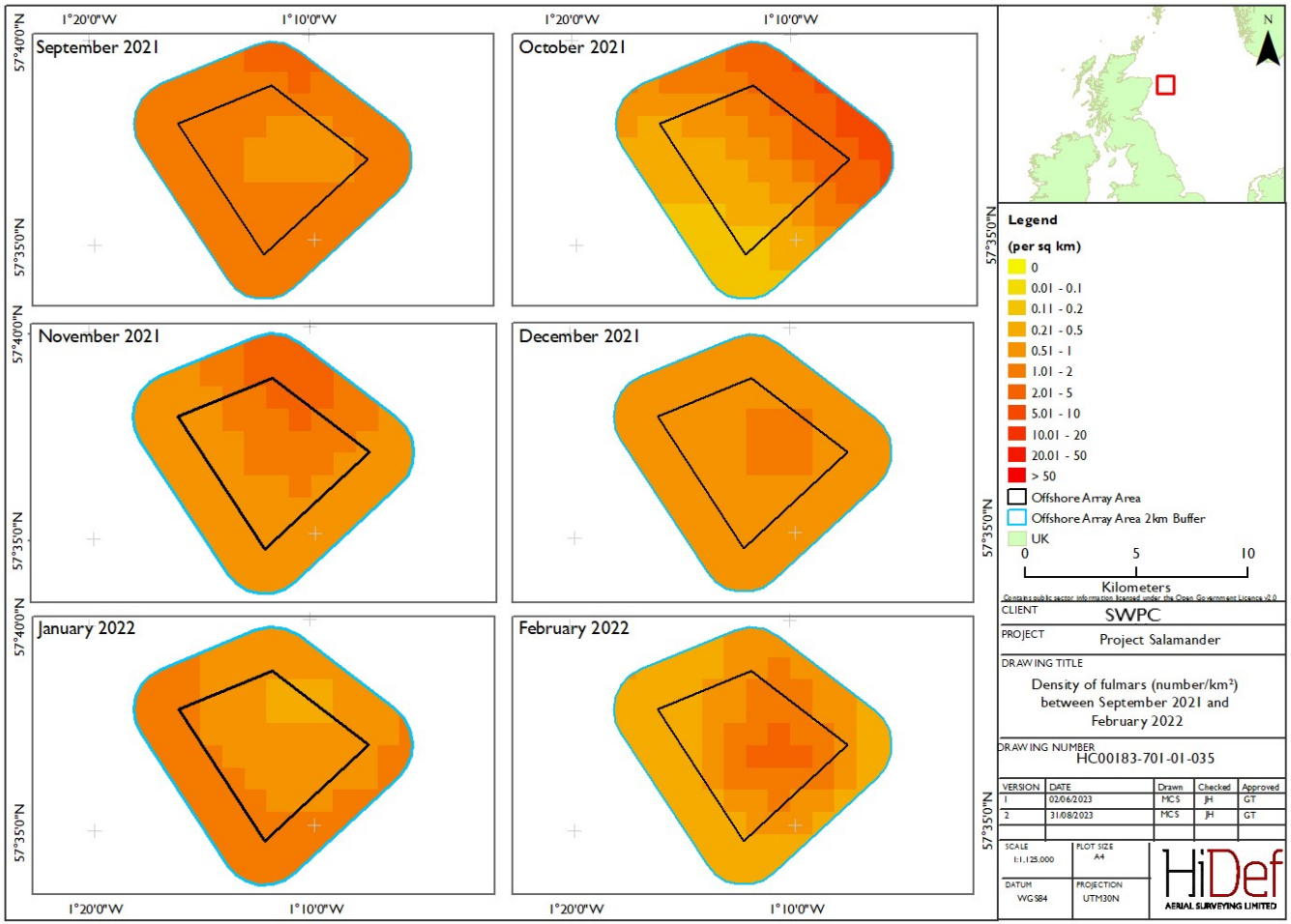

Figure 24 Fulmar density (birds/km^2) between September 2021 and February 2022

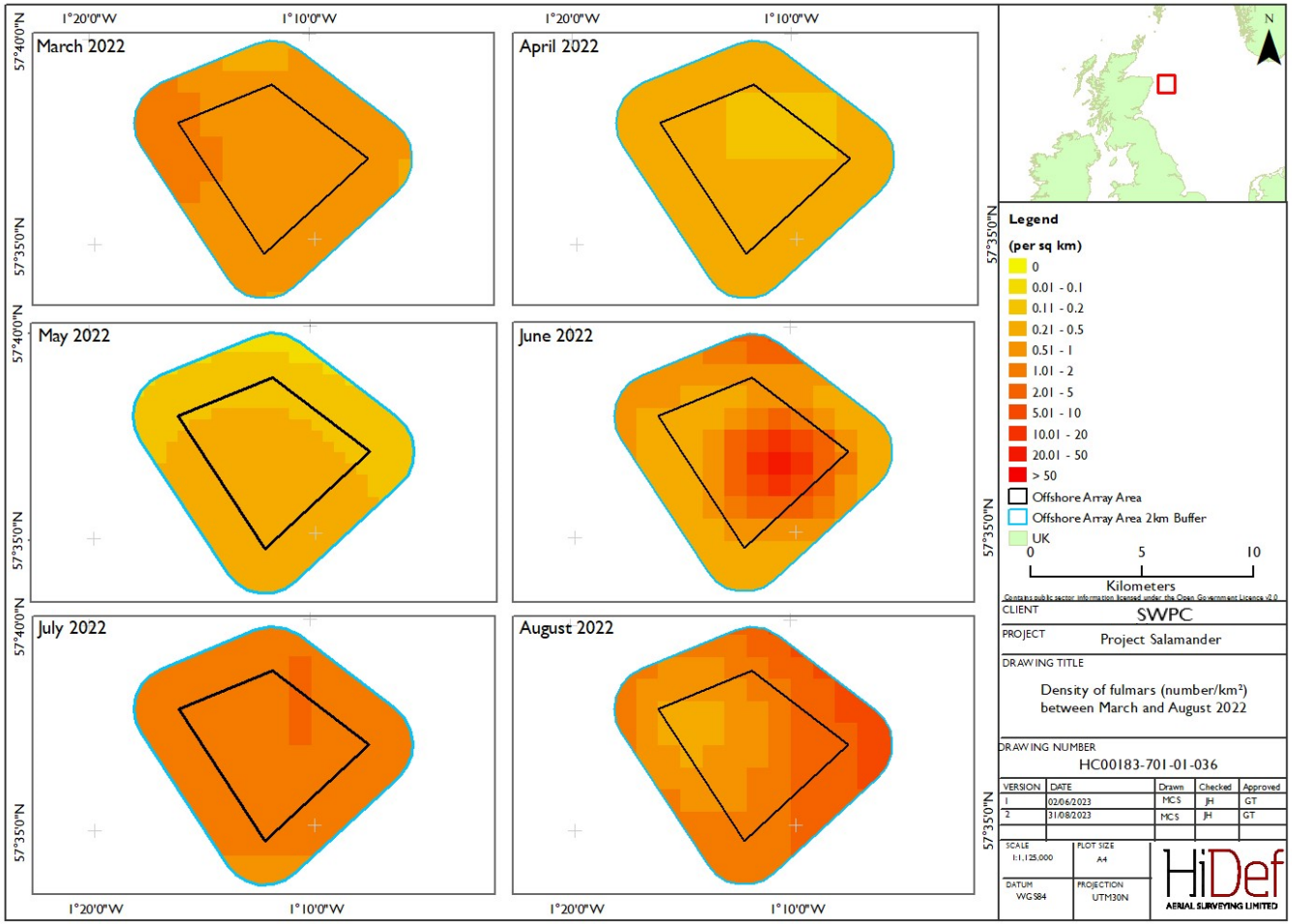

Figure 25 **Fulmar density (birds/km^2) between March 2022 and August 2022. No MRSea model produced for May 2022; indicative distribution presented through Kernel Density Estimation (KDE) (see section 2.1.2.2)**

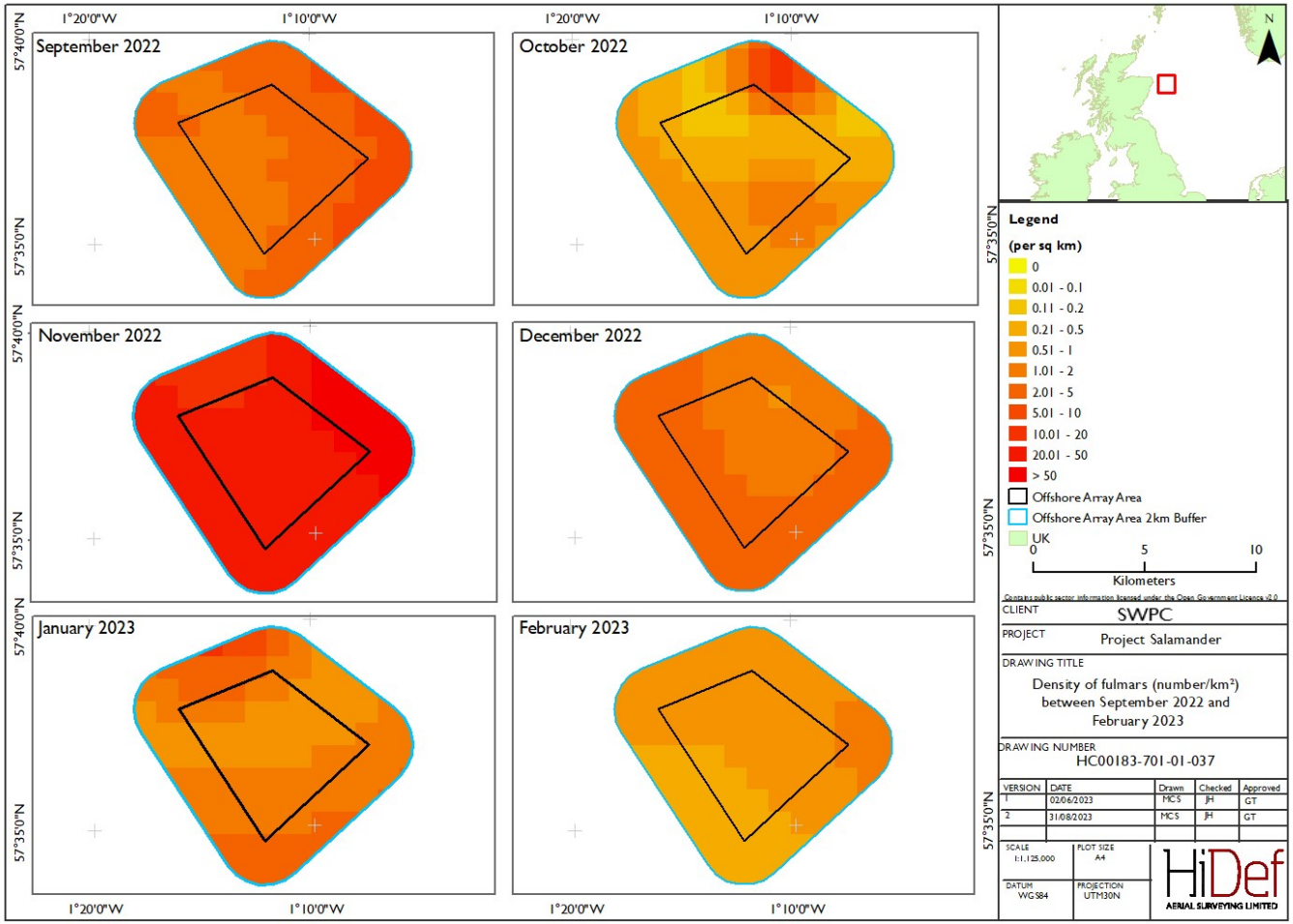

Figure 26 **Fulmar density (birds/km^2) between September 2022 and February 2023**

3.8.1 Input densities for Collision Risk Modelling (CRM)

Table 26 Monthly density estimates of flying fulmar within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Fulmar	Density estimate (n/km²)	Lower 95% confidence limit (n/km²)	Upper 95% confidence limit (n/km²)	Standard deviation (n/km²)	CV (%)
13 March 2021	0.00	0.00	0.00	0.00	0.00
15 April 2021	0.00	0.00	0.00	0.00	0.00
23 May 2021	0.75	0.44	1.20	0.00	0.00
09 June 2021	0.23	0.08	0.55	0.00	0.00
15 July 2021	1.30	0.93	1.76	0.00	0.00
19 August 2021	0.81	0.58	1.11	0.00	0.00
07 September 2021	0.32	0.15	0.58	0.00	0.00
06 October 2021*	0.25	0.00	0.61	0.18	71.19
10 November 2021	0.45	0.11	1.11	0.00	0.00
09 December 2021	0.54	0.25	1.02	0.00	0.00
07 January 2022	1.09	0.75	1.55	0.00	0.00
08 February 2022	0.60	0.31	1.04	0.00	0.00
10 March 2022	0.70	0.23	1.63	0.00	0.00
12 April 2022	0.53	0.37	0.73	0.00	0.00
14 May 2022*	0.25	0.00	0.61	0.18	71.89
12 June 2022	0.32	0.16	0.59	0.13	52.00
08 July 2022	1.28	0.87	1.80	0.00	0.00
17 August 2022	1.46	1.03	1.98	0.25	26.04
20 September 2022	0.88	0.54	1.35	0.28	28.87
07 October 2022	0.24	0.07	0.65	0.16	34.78
02 November 2022	38.34	29.53	48.70	7.07	15.42
20 December 2022	1.69	0.88	2.88	0.00	0.00
04 January 2023*	4.33	1.31	7.91	1.78	40.89
23 February 2023	0.77	0.55	1.05	0.00	0.00

3.9 Gannet

64 Gannet are deemed sensitive to impacts from both collision risk and distributional responses, therefore density estimates for flying birds within the Offshore Array Area are provided for input into CRM (Annex ER.A.4.12.3: Collision Risk Modelling Report), while population estimates for all birds within the Offshore Array Area plus 2km buffer and MSP estimates are provided for input into the assessment of distributional responses (Annex ER.A.4.12.5: Displacement Assessment).

65 Maximum population estimates for the Offshore Array Area ranged from 234 birds (95% CI 95 – 448) and 291 birds (95% CI 225 – 366) in the non-breeding and breeding seasons, respectively (Table 29). Generally, birds were recorded throughout both breeding seasons with few birds recorded in the non-breeding season outside of the peak in November 2022. Population estimates peaked in August 2021 in Year 1 and November 2022 in Year 2 (Table 29).

66 Across all seasons, most birds recorded were aged as adults with no immature and few juvenile birds recorded in the non-breeding season (Table 27).

67 Population estimates for all gannet in the Offshore Array Area plus the 2km buffer varied between months, ranging between 0 birds (e.g. January 2022) and 705 birds (95% CI 298 - 1401) in November 2022 (Table 31). The MSP calculated for the breeding season was slightly higher than that for the non-breeding season, calculated at 442 birds (95% CI 324- 590) and 363 birds (95% CI 156 – 715), respectively (Table 28).

68 Within the Offshore Array Area, flying gannet were recorded in varying densities (Table 30), ranging between 0.00 birds/km^2 (e.g. March 2021 and July 2022) and 3.17 birds/km^2 (95% CI 1.93 – 4.81; November 2022). Peak densities of flying gannet were calculated for August 2021 in Year One and November 2022 in Year Two.

Table 27 Percentage of aged gannet (n = 80) in each age class averaged across all surveys in each season

Season	Adult	Immature	Juvenile
Breeding	83.33%	13.89%	2.78%
Non-breeding	97.73%	0.00%	2.27%

Table 28 Mean seasonal peak population estimates of all gannet (flying and sitting) in each season within the Offshore Array Area plus 2km buffer between March 2021 and February 2023

Gannet	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit
Breeding	442	262	622
Non-breeding	369	35	922

Table 29 Monthly population estimates of all gannet (flying and sitting) within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Gannet	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	12	5	25	6	51.57
23 May 2021	25	13	44	10	38.33
09 June 2021	55	30	93	21	37.47
15 July 2021	37	22	57	11	30.33
19 August 2021	291	225	366	44	15.01
07 September 2021	18	5	43	12	69.77
06 October 2021	20	15	28	4	20.80
10 November 2021*	8	0	22	8	96.76
09 December 2021	0	0	0	0	0.00
07 January 2022	0	0	0	0	0.00
08 February 2022	0	0	0	0	0.00
10 March 2022	11	6	20	4	39.42
12 April 2022*	8	0	20	6	71.72
14 May 2022*	9	0	25	8	94.85
12 June 2022	33	13	17	13	39.96
08 July 2022	12	5	24	6	48.69
17 August 2022	71	43	108	30	42.42
20 September 2022	40	24	66	13	32.15
07 October 2022	0	0	0	0	0.00
02 November 2022	234	95	448	130	55.59
20 December 2022	0	0	0	0	0.00
04 January 2023	0	0	0	0	0.00
23 February 2023	0	0	0	0	0.00

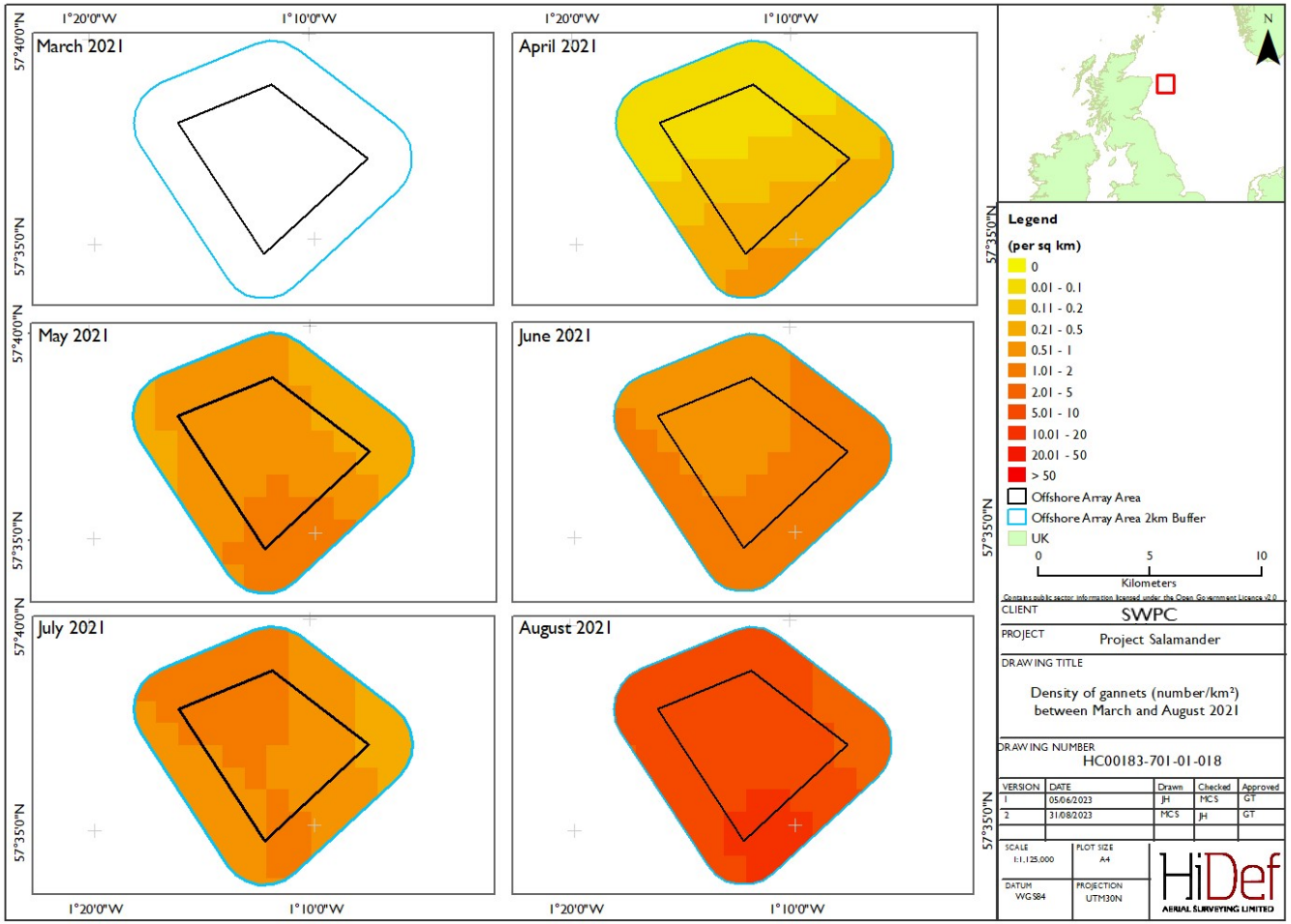

Figure 27 Gannet density (birds/km^2) between March and August 2021

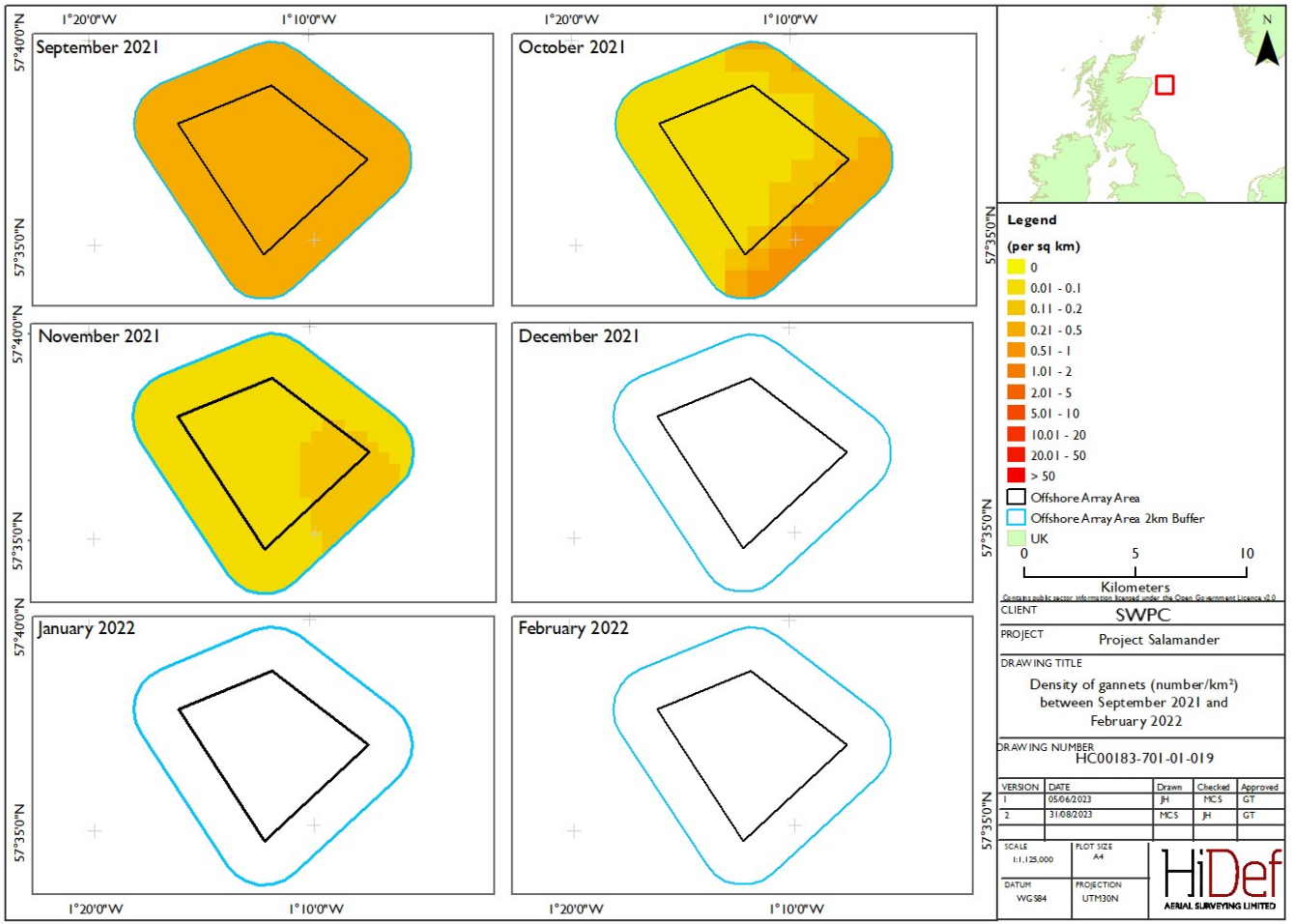

Figure 28 **Gannet density (birds/km^2) between September 2021 and February 2022. No MRSea model produced for November 2021; indicative distribution presented through Kernel Density Estimation (KDE) (see section 2.1.2.2)**

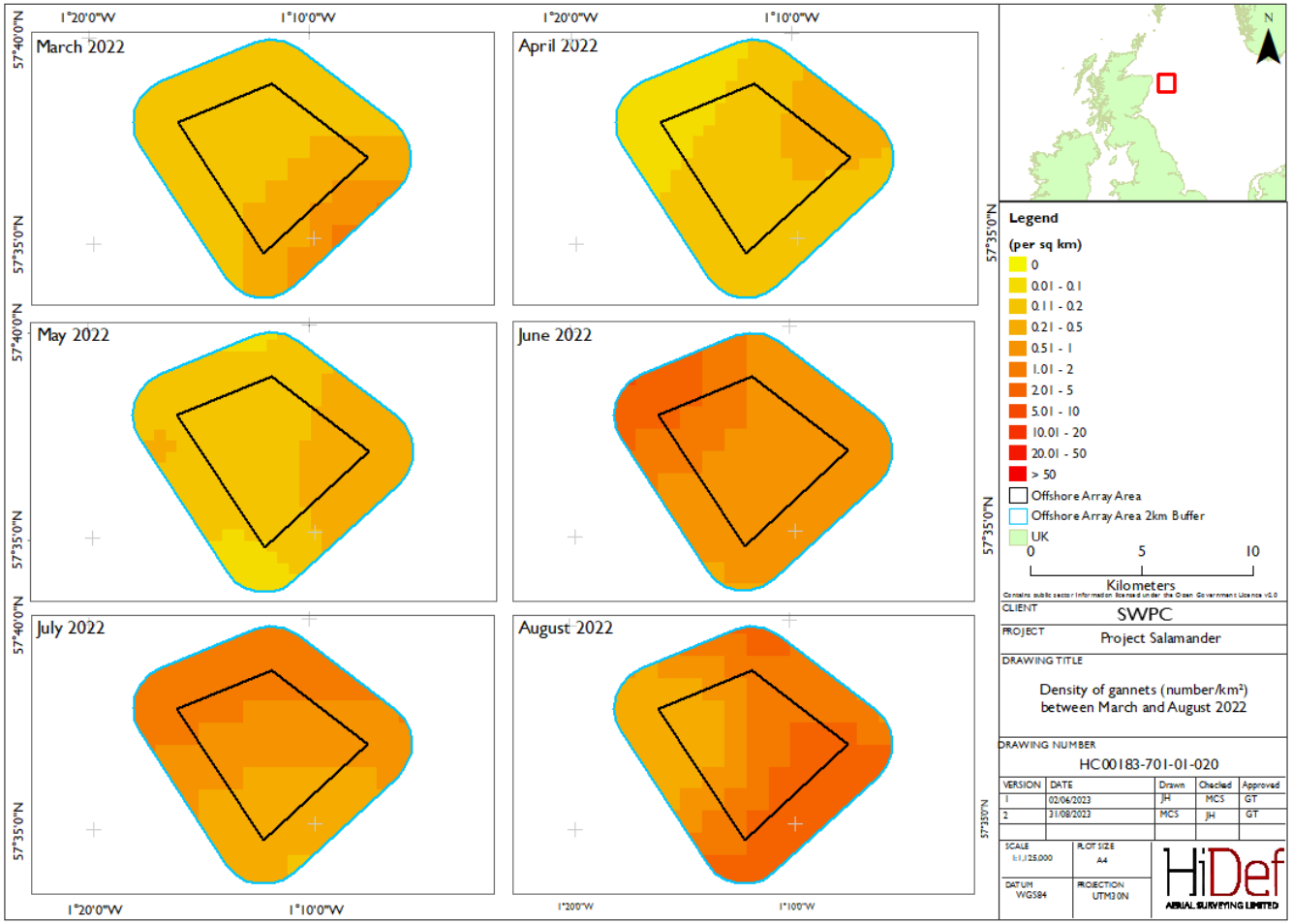

Figure 29 **Gannet density (birds/km^2) between March 2022 and August 2022. No MRSea model produced for April and May 2022; indicative distribution presented through Kernel Density Estimation (KDE) (see section 2.1.2.2)**

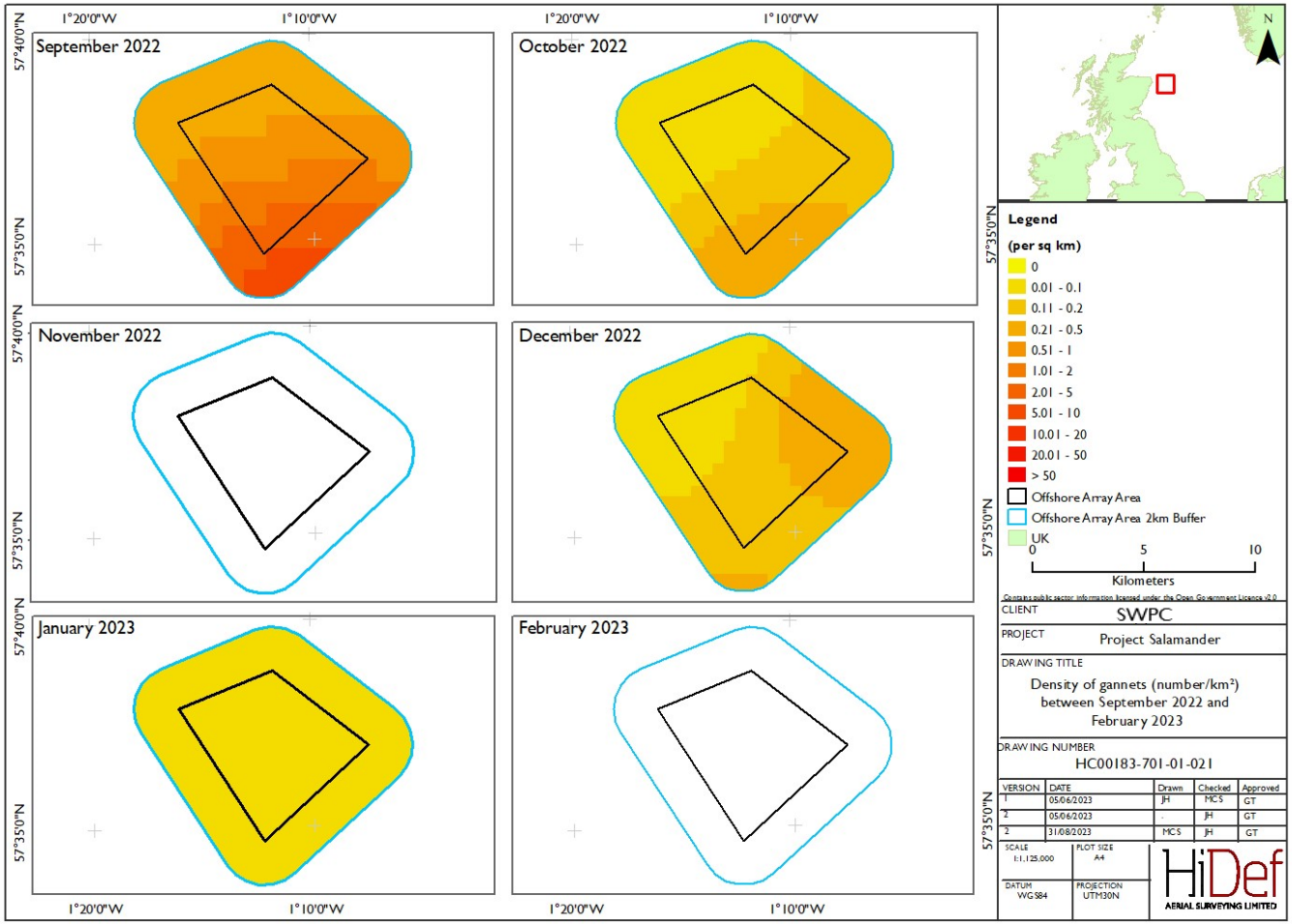

Figure 30 **Gannet density (birds/km^2) between September 2022 and February 2023. No MRSea model produced for October and December 2022; indicative distribution presented through Kernel Density Estimation (KDE) (see section 2.1.2.2)**

3.9.1 Input densities for Collision Risk Modelling (CRM)

Table 30 Monthly density estimates of flying gannet within the Offshore Array Area between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Gannet	Density estimate (n/km²)	Lower 95% confidence limit (n/km²)	Upper 95% confidence limit (n/km²)	Standard deviation (n/km²)	CV (%)
13 March 2021	0.00	0.00	0.00	0.00	0.00
15 April 2021	0.00	0.00	0.00	0.00	0.00
23 May 2021	1.28	0.59	2.41	0.58	45.43
09 June 2021	1.09	0.56	1.87	0.43	39.82
15 July 2021*	0.24	0.00	0.76	0.27	100.15
19 August 2021	2.70	1.71	4.06	0.71	26.16
07 September 2021	0.22	0.05	0.59	0.20	89.55
06 October 2021	0.44	0.13	1.03	0.30	69.72
10 November 2021*	0.23	0.00	0.69	0.24	97.10
09 December 2021	0.00	0.00	0.00	0.00	0.00
07 January 2022*	0.25	0.00	0.59	0.18	65.69
08 February 2022	0.00	0.00	0.00	0.00	0.00
10 March 2022	0.77	0.28	1.57	0.44	57.53
12 April 2022*	0.25	0.00	0.60	0.18	66.39
14 May 2022	0.00	0.00	0.00	0.00	0.00
12 June 2022	0.00	0.00	0.00	0.00	0.00
08 July 2022	0.00	0.00	0.00	0.00	0.00
17 August 2022	0.51	0.15	1.14	0.36	69.98
20 September 2022	0.72	0.30	1.41	0.39	54.16
07 October 2022	0.00	0.00	0.00	0.00	0.00
02 November 2022	3.17	1.93	4.81	0.87	27.34
20 December 2022	0.00	0.00	0.00	0.00	0.00
04 January 2023	0.00	0.00	0.00	0.00	0.00
23 February 2023	0.00	0.00	0.00	0.00	0.00

3.9.2 Input abundance for distributional responses

Table 31 Monthly population estimates of all gannet (flying and sitting) within the Offshore Array Area plus 2km buffer between March 2021 and February 2023. Asterix denotes surveys where design-based estimation was used, due to data limitations (see section 2.1.2)

Gannet	Population estimate	Lower 95% confidence limit	Upper 95% confidence limit	Standard deviation	CV (%)
13 March 2021	0	0	0	0	0.00
15 April 2021	31	16	58	14	44.19
23 May 2021	60	30	106	23	39.03
09 June 2021	175	120	247	39	22.12
15 July 2021	89	53	139	27	30.2
19 August 2021	676	521	849	101	14.97
07 September 2021	43	13	103	30	69.06
06 October 2021	20	14	29	4	21.95
10 November 2021*	9	0	24	7	84.06
09 December 2021	0	0	0	0	0.00
07 January 2022	0	0	0	0	0.00
08 February 2022	0	0	0	0	0.00
10 March 2022	32	18	54	11	35.12
12 April 2022*	16	0	28	7	43.57
14 May 2022*	9	0	23	7	84.53
12 June 2022	84	45	138	39	46.19
08 July 2022	31	15	57	14	45.45
17 August 2022	208	126	331	82	39.30
20 September 2022	43	13	103	38	28.55
07 October 2022*	8	0	23	7	82.68
02 November 2022	705	298	1401	391	55.42
20 December 2022*	17	0	48	16	93.42
04 January 2023	0	0	0	0	0.00
23 February 2023	0	0	0	0	0.00

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Appendix I: Raw DAS observations

69 In February 2021 HiDef were commissioned to undertake DAS. Twenty-four surveys were undertaken between March 2021 and February 2023. The DAS cover the original AoS (133.38km^2) plus 4km buffer (371.93km^2) (the DAS Area; Figure 1).

70 Raw DAS observations are reported for the Offshore Array Area, Offshore Array Area plus 2km buffer and the DAS Area (Table 32-Table 37).

Table 32 Number of objects detected per survey, assigned to species level in the Offshore Array Area between March 2021 and February 2022

Species	Scientific name	Month												Total
		Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	
Kittiwake	*Rissa tridactyla*	0	0	1	25	36	7	0	1	1	0	0	0	71
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Common gull	*Larus canus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Great black-backed gull	*Larus marinus*	0	0	0	0	0	0	0	0	0	3	1	0	4
Herring gull	*Larus argentatus*	1	0	0	1	0	0	0	0	0	2	2	0	6
Common tern	*Sterna hirundo*	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic tern	*Stercorarius parasiticus*	0	0	0	0	0	3	0	0	0	0	0	0	3
Guillemot	*Uria aalge*	9	7	1	24	137	73	90	68	11	26	5	15	466
Razorbill	*Alca torda*	0	1	0	15	0	2	0	0	0	0	0	0	18
Puffin	*Fratercula arctica*	0	3	0	7	1	10	15	1	0	0	0	0	37
Fulmar	*Fulmarus glacialis*	0	0	4	6	60	16	1	3	4	1	1	2	98
Gannet	*Morus bassanus*	0	1	2	3	4	35	0	0	1	0	1	0	47

Table 33 Number of objects detected per survey, assigned to species level in the Offshore Array Area plus 2km buffer between March 2021 and February 2022

Species	Scientific name	Month												Total
		Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	
Kittiwake	*Rissa tridactyla*	1	3	4	72	46	23	7	8	2	1	0	0	167
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Little gull	*Hydrocoloeus minutus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Common gull	*Larus canus*	0	0	0	0	0	0	0	1	0	0	0	0	1
Great black-backed gull	*Larus marinus*	0	0	0	0	0	0	0	0	1	7	5	0	13
Herring gull	*Larus argentatus*	3	0	0	2	0	0	0	0	1	3	2	0	11
Common tern	*Sterna hirundo*	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic tern	*Sterna paradisaea*	0	0	0	0	0	3	0	0	0	0	0	0	3
Guillemot	*Uria aalge*	25	31	10	120	290	236	277	197	30	79	11	34	1340
Razorbill	*Alca torda*	0	13	0	38	0	6	5	3	2	0	0	0	67
Puffin	*Fratercula arctica*	0	12	0	10	1	16	34	5	0	0	0	0	78
Fulmar	*Fulmarus glacialis*	1	1	9	11	93	26	16	18	7	9	8	7	206
Gannet	*Morus bassanus*	0	3	5	12	6	94	1	2	1	0	1	0	125

Table 34 Number of objects detected per survey, assigned to species level in the DAS Area between March 2021 and February 2022

Species	Scientific name	Month												Total
		Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	
Kittiwake	*Rissa tridactyla*	5	15	13	290	220	84	14	86	5	2	3	3	740
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Little gull	*Hydrocoloeus minutus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Common gull	*Larus canus*	0	0	0	0	1	0	1	2	0	0	0	0	4
Great black-backed gull	*Larus marinus*	0	0	0	0	0	0	0	0	7	22	35	3	67
Iceland gull	*Larus glaucoides*	0	0	0	0	0	0	0	0	0	0	0	0	0
Herring gull	*Larus argentatus*	5	0	0	9	0	1	0	0	1	9	17	2	44
Lesser black-backed gull	*Larus fuscus*	0	0	0	0	0	0	0	0	0	0	1	0	1
Common tern	*Sterna hirundo*	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic tern	*Sterna paradisaea*	0	0	0	0	0	3	0	0	0	0	0	0	3
Great skua	*Stercorarius skua*	0	0	0	0	0	1	0	1	0	0	0	0	2
Arctic skua	*Stercorarius parasiticus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	*Uria aalge*	72	114	40	815	941	858	831	1021	172	259	37	77	5237
Razorbill	*Alca torda*	0	33	2	112	11	22	10	11	5	2	0	0	208
Puffin	*Fratercula arctica*	0	33	5	41	13	45	152	24	0	0	0	0	313
Red-throated diver	*Gavia stellata*	0	0	0	0	0	0	0	0	0	0	0	0	0
European storm-petrel	*Hydrobates pelagicus*	0	0	0	0	0	8	0	0	0	0	0	0	8

Species	Scientific name	Month												Total
		Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	
Fulmar	*Fulmarus glacialis*	4	6	22	40	190	64	59	164	40	36	62	39	726
Gannet	*Morus bassanus*	2	12	18	64	22	210	16	17	2	1	16	2	382

Table 35 Number of objects detected per survey, assigned to species level in the Offshore Array Area between March 2022 and February 2023

Species	Scientific name	Month												Total
		Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	
Kittiwake	*Rissa tridactyla*	2	2	13	3	18	49	2	4	0	1	0	0	94
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	0	0	0	1	0	0	0	0	1
Common gull	*Larus canus*	0	0	0	0	0	0	0	0	1	0	0	0	1
Great black-backed gull	*Larus marinus*	0	0	0	0	0	0	0	0	3	0	7	1	11
Herring gull	*Larus argentatus*	0	0	0	0	0	0	0	0	4	0	0	4	8
Common tern	*Sterna hirundo*	0	0	0	0	0	6	0	0	0	0	0	0	6
Arctic tern	*Stercorarius parasiticus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	*Uria aalge*	4	8	75	11	74	394	224	185	23	1	2	5	1006
Razorbill	*Alca torda*	0	7	0	0	6	22	0	0	0	0	0	0	35
Puffin	*Fratercula arctica*	0	0	10	0	0	66	16	0	0	0	0	0	92
Fulmar	*Fulmarus glacialis*	0	0	2	1	7	13	14	2	123	4	18	5	189
Gannet	*Morus bassanus*	1	1	1	1	1	5	0	0	4	0	0	0	14

Table 36 Number of objects detected per survey, assigned to species level in the Offshore Array Area plus 2km buffer between March 2022 and February 2023

Species	Scientific name	Month												Total
		Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	
Kittiwake	*Rissa tridactyla*	2	3	35	5	65	428	8	7	3	6	0	3	565
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	0	0	0	1	0	0	0	0	1
Little gull	*Hydrocoloeus minutus*	0	0	0	0	0	4	0	0	0	0	0	0	4
Common gull	*Larus canus*	0	0	0	0	0	0	0	0	1	0	0	0	1
Great black-backed gull	*Larus marinus*	0	0	0	0	0	0	1	0	47	5	9	1	63
Herring gull	*Larus argentatus*	0	0	0	0	0	0	0	0	137	0	0	4	141
Common tern	*Sterna hirundo*	0	0	0	0	0	7	0	0	0	0	0	0	7
Arctic tern	*Sterna paradisaea*	0	0	0	0	0	1	0	0	0	0	0	0	1
Guillemot	*Uria aalge*	13	38	212	34	220	1219	647	563	47	3	7	12	3015
Razorbill	*Alca torda*	0	9	4	0	19	63	0	0	2	1	0	0	98
Puffin	*Fratercula arctica*	0	0	35	1	1	221	28	1	0	0	0	0	287
Fulmar	*Fulmarus glacialis*	5	2	3	2	19	37	33	4	766	18	32	9	930
Gannet	*Morus bassanus*	4	2	1	5	3	15	2	1	93	2	0	0	128

Table 37 Number of objects detected per survey, assigned to species level in the DAS Area between March 2022 and February 2023

Species	Scientific name	Month												Total
		Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	
Kittiwake	*Rissa tridactyla*	9	6	113	39	133	988	41	20	13	28	64	9	1463
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	0	0	0	1	0	0	0	0	1
Little gull	*Hydrocoloeus minutus*	0	0	0	0	0	4	0	0	0	0	0	0	4
Common gull	*Larus canus*	0	0	0	0	0	0	0	0	1	0	0	0	1
Great black-backed gull	*Larus marinus*	0	1	0	0	0	0	1	0	82	23	470	3	580
Iceland gull	*Larus glaucoides*	0	0	0	0	0	0	0	0	0	0	1	0	1
Herring gull	*Larus argentatus*	1	0	0	0	1	0	0	0	166	1	171	4	344
Lesser black-backed gull	*Larus fuscus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Common tern	*Sterna hirundo*	0	0	0	0	0	8	0	0	0	0	0	0	8
Arctic tern	*Sterna paradisaea*	0	0	2	0	0	10	0	0	0	0	0	0	12
Great skua	*Stercorarius skua*	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic skua	*Stercorarius parasiticus*	0	0	0	0	0	1	0	0	0	0	0	0	1
Guillemot	*Uria aalge*	101	76	874	196	918	4629	3795	1542	373	57	18	61	12640
Razorbill	*Alca torda*	9	20	27	15	67	253	1	7	29	5	0	0	433
Puffin	*Fratercula arctica*	0	1	172	1	9	1553	105	3	0	0	0	0	1844
Red-throated diver	*Gavia stellata*	0	0	1	0	0	0	0	0	0	0	0	0	1
European storm petrel	*Hydrobates pelagicus*	0	0	0	0	0	0	0	0	0	0	0	0	0

Species	Scientific name	Month												Total
		Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	
Fulmar	*Fulmarus glacialis*	26	13	9	25	64	241	208	59	2315	132	3782	49	6924
Gannet	*Morus bassanus*	12	6	8	22	10	86	57	7	147	8	60	1	424

Appendix II: Relative and absolute population estimates for auk species

71 In wildlife surveys, a proportion of seabirds or marine mammals that spend any time underwater, especially while feeding, will not be detectable at the surface. This 'availability bias' leads to an under-estimate of their abundance during surveys as outlined in HiDef (2023).

72 Table 38 to Table 46 present relative and absolute estimates of density and abundance for guillemot, razorbill and puffin i.e. estimates of density and abundance are presented where availability bias is and is not accounted for. Only absolute estimates (those which have been corrected to account for individuals unable to be detected during surveys) are used within the EIA and HRA. For a full explanation of the method to account for availability bias please refer to Section 2.1.3.

Table 38 Relative and absolute monthly density and population estimates for guillemot in the DAS Area between March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Guillemot	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	1.66	619	475	777	79	12.72	1.95	729	457	1011	106	14.54
15 April 2021	2.58	961	645	1287	169	17.60	3.24	1210	761	1722	206	17.02
23 May 2021	0.88	326	191	479	76	23.18	1.11	418	197	710	110	26.32
09 June 2021	18.03	6708	4863	8595	966	14.39	23.62	8788	6456	11499	1353	15.40
15 July 2021	21.04	7831	5944	10078	1046	13.35	27.67	10300	7780	13173	1470	14.27
19 August 2021	19.02	7079	6247	7897	416	5.88	25.10	9339	8246	10381	585	6.26
07 September 2021	17.99	6697	4621	8881	1101	16.44	23.68	8814	5974	11578	1571	17.82
06 October 2021	22.80	8483	5840	10959	1317	15.52	30.24	11252	7784	14734	1903	16.91
10 November 2021	3.77	1404	1118	1682	140	9.91	4.94	1841	1494	2214	194	10.54
09 December 2021	5.77	2147	1795	2493	177	8.23	7.58	2821	2319	3320	259	9.18
07 January 2022	0.82	307	212	412	51	16.59	1.07	398	261	536	74	18.59
08 February 2022	1.68	624	404	838	113	17.97	2.19	821	483	1169	165	20.10
10 March 2022	2.21	817	590	1049	121	14.82	2.88	1067	750	1387	168	15.75
12 April 2022	1.78	659	77	1569	384	58.23	1.82	672	46	1575	385	57.29
14 May 2022	18.81	6997	6329	7813	393	5.61	24.69	9182	8180	10393	560	6.10

Guillemot	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
12 June 2022	4.20	1562	1065	2131	333	21.33	5.56	2071	1426	2797	360	17.38
08 July 2022	19.80	7363	5999	8896	912	12.38	26.74	9946	8047	12006	1059	10.65
17 August 2022	102.32	38056	29608	47447	4596	12.07	135.17	50276	38240	62142	6458	12.85
20 September 2022	80.04	29770	26765	33064	1844	6.19	108.2	40246	35594	45660	2810	6.98
07 October 2022	33.17	12338	9701	15510	1486	12.04	43.76	16278	12637	20640	2172	13.34
02 November 2022	8.43	3134	2140	4147	530	16.89	11.04	4109	2856	5454	739	17.98
20 December 2022	1.48	550	307	876	143	25.90	1.94	722	354	1132	199	27.56
04 January 2023	0.39	145	108	182	20	13.35	0.51	189	137	243	26	13.76
23 February 2023	1.36	503	382	640	67	13.28	1.73	640	453	852	91	14.22

Table 39 Relative and absolute monthly density and population estimates for razorbill in the DAS Area March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Razorbill	Relative estimates						Absolute estimates					
	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
15 April 2021	0.75	278	177	389	54	19.42	0.83	310	166	488	60	19.35
23 May 2021	0.05	20	0	49	14	69.76	0.06	24	0	60	20	83.33
09 June 2021	2.49	928	652	1209	144	15.45	3.01	1121	777	1473	206	18.38
15 July 2021	0.25	93	37	149	29	31.45	0.30	113	35	205	42	37.17
19 August 2021	0.55	206	91	349	67	32.53	0.67	251	101	446	99	39.44
07 September 2021	0.23	85	18	167	39	45.08	0.27	101	22	209	55	54.46
06 October 2021	0.25	92	27	169	37	39.62	0.29	111	32	199	52	46.85
10 November 2021	0.11	41	16	65	14	32.63	0.13	50	20	83	20	40.00
09 December 2021	0.04	17	1	40	11	62.89	0.05	21	1	48	16	76.19
07 January 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
08 February 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
10 March 2022	0.19	72	2	169	45	62.73	0.20	78	1	209	48	61.54
12 April 2022	0.45	168	16	387	97	57.43	0.46	169	8	365	97	57.40
14 May 2022	0.69	256	152	400	80	31.13	0.72	266	109	446	98	36.84
12 June 2022	0.32	121	0	312	83	68.3	0.4	149	0	375	117	78.52

Razorbill	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
08 July 2022	1.56	582	419	751	89	15.26	1.88	701	484	982	122	17.4
17 August 2022	5.63	2093	1309	2913	411	19.62	6.85	2549	1633	3640	583	22.87
20 September 2022	0.02	8	1	24	8	90.06	0.02	10	1	29	11	110
07 October 2022	0.16	58	1	134	34	57.7	0.18	71	1	154	47	66.2
02 November 2022	0.69	256	180	354	58	22.7	0.79	297	177	440	81	27.27
20 December 2022	0.13	47	5	91	21	45.05	0.16	59	13	111	30	50.85
04 January 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
23 February 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00

Table 40 Relative and absolute monthly density and population estimates for puffin in the DAS Area between March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Puffin	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
15 April 2021	0.82	306	196	442	65	21.09	0.97	360	226	504	91	25.28
23 May 2021	0.13	48	11	85	20	40.01	0.13	49	0	103	30	61.22
09 June 2021	1.28	478	331	614	71	14.79	1.48	552	389	709	101	18.30
15 July 2021	0.39	146	75	236	42	28.75	0.45	171	86	276	59	34.50
19 August 2021	1.33	497	345	645	79	15.87	1.56	580	402	749	110	18.97
07 September 2021	3.70	1378	1183	1547	95	6.89	4.30	1599	1357	1823	136	8.51
06 October 2021	0.71	264	178	343	42	15.88	0.83	308	213	401	59	19.16
10 November 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
09 December 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
07 January 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
08 February 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
10 March 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
12 April 2022	0.02	8	0	24	8	98.03	0.02	10	0	28	11	110.00
14 May 2022	4.05	1507	1072	1997	240	15.88	4.72	1754	1253	2319	336	19.16
12 June 2022	0.02	8	0	24	8	96.32	0.02	9	0	28	11	122.22

Puffin	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
08 July 2022	0.53	198	125	282	40	20.18	0.62	232	142	332	58	25
17 August 2022	35.41	13171	9456	17503	2043	15.51	41.38	15391	10937	21177	2999	19.49
20 September 2022	2.74	1018	716	1324	152	14.94	3.18	1186	860	1549	214	18.04
07 October 2022	0.19	73	47	102	15	19.87	0.22	85	54	116	21	24.71
02 November 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
20 December 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
04 January 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
23 February 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00

Table 41 Relative and absolute monthly density and population estimates for guillemot in the Offshore Array Area between March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Guillemot	Relative estimates						Absolute estimates					
	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	2.81	93	70	121	16	17.15	3.13	104	77	136	19	18.06
15 April 2021	3.60	120	82	165	27	22.77	4.99	166	113	236	37	22.47
23 May 2021	1.67	56	32	90	17	31.07	2.04	68	46	98	16	23.46
09 June 2021	11.81	392	317	475	50	12.75	22.79	757	656	866	65	8.59
15 July 2021	37.92	1260	928	1650	219	17.35	37.90	1259	987	1574	186	14.8
19 August 2021	32.87	1092	1020	1171	46	4.22	43.72	1453	1306	1616	92	6.34
07 September 2021	36.79	1223	928	1593	206	16.86	44.09	1465	1093	1939	256	17.46
06 October 2021	40.32	1340	1089	1640	170	12.71	49.35	1640	1411	1904	150	9.13
10 November 2021	4.16	138	100	192	29	21.26	6.03	200	165	242	24	11.75
09 December 2021	9.26	308	244	384	43	13.92	15.09	501	432	575	43	8.67
07 January 2022	1.22	41	30	53	7	17.34	2.39	80	67	96	9	11.20
08 February 2022	3.81	127	91	169	25	19.44	4.68	155	103	221	36	22.99
10 March 2022	1.61	54	27	90	22	41.66	3.96	132	87	187	31	23.79
12 April 2022	3.45	115	92	141	16	13.72	2.51	84	43	139	31	36.5
14 May 2022	27.12	901	662	1209	171	18.97	41.37	1375	1202	1566	110	8.03

Guillemot	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
12 June 2022	3.27	109	79	149	21	19.54	5.03	167	88	274	60	35.64
08 July 2022	28.53	948	749	1163	127	13.42	44.30	1472	1222	1741	162	11.01
17 August 2022	147.94	4916	3755	6338	808	16.44	233.03	7743	6911	8572	504	6.50
20 September 2022	90.03	2991	2495	3539	320	10.71	77.76	2584	1959	3288	408	15.79
07 October 2022	63.27	2102	1640	2633	304	14.48	78.15	2597	1999	3275	389	14.98
02 November 2022	6.54	217	136	321	58	26.91	11.21	372	246	527	86	22.99
20 December 2022	1.15	38	24	58	11	27.92	0.90	30	19	45	8	27.45
04 January 2023	0.69	23	17	31	4	19.33	1.14	38	31	47	5	12.48
23 February 2023	2.23	74	59	91	10	13.35	2.78	92	77	110	10	10.97

Table 42 Relative and absolute monthly density and population estimates for razorbill in the Offshore Array Area March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Razorbill	Relative estimates						Absolute estimates					
	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
15 April 2021	0.95	32	17	55	13	40.65	0.91	30	16	51	11	36.5
23 May 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
09 June 2021	4.36	145	86	228	45	30.8	7.52	250	186	330	45	17.85
15 July 2021	0.13	4	2	9	2	53.77	0.37	12	5	23	6	48.1
19 August 2021	0.96	32	12	69	20	61.94	1.22	41	20	73	17	41.73
07 September 2021	0.53	17	5	44	13	74.81	0.34	11	3	26	9	81.1
06 October 2021	0.29	10	2	27	9	97.55	0.38	13	3	31	14	114.52
10 November 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
09 December 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
07 January 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
08 February 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
10 March 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
12 April 2022	2.14	71	46	108	21	29.88	2.16	72	47	107	21	28.71
14 May 2022	1.21	40	18	80	23	56.81	0.78	26	12	48	12	45.33
12 June 2022	0.47	16	1	45	56	355.9	0.71	24	3	71	35	147.09

Razorbill	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
08 July 2022	1.32	44	32	59	8	19.11	1.61	54	32	86	18	32.87
17 August 2022	5.84	194	101	321	73	37.57	6.65	221	109	393	89	40.23
20 September 2022	0.03	1	0	1	1	71.79	0.03	1	0	1	1	100
07 October 2022	0.03	1	0	1	1	71.74	0.03	1	0	1	1	100
02 November 2022	0.14	5	3	8	2	36.6	0.29	10	5	17	5	48.76
20 December 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
04 January 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
23 February 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00

Table 43 Relative and absolute monthly density and population estimates for puffin in the Offshore Array Area between March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Puffin	Relative estimates						Absolute estimates					
	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
15 April 2021	1.36	45	32	67	12	26.05	1.11	37	26	50	8	20.6
23 May 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
09 June 2021	1.61	54	37	75	12	21.46	1.99	66	45	94	15	23.14
15 July 2021	0.39	13	7	23	5	39.15	0.59	20	13	29	5	27.2
19 August 2021	2.39	80	58	108	15	19.33	2.95	98	82	116	10	10.32
07 September 2021	5.65	188	159	224	21	10.96	7.42	247	216	280	20	8.1
06 October 2021	1.25	42	30	60	9	21.98	1.28	43	27	61	11	24.83
10 November 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
09 December 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
07 January 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
08 February 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
10 March 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
12 April 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
14 May 2022	4.55	151	120	187	21	13.81	6.80	226	190	266	24	10.8
12 June 2022	0.00	0	0	0	0	0.00	0.19	6	1	22	9	140.87

Puffin	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
08 July 2022	0.58	19	10	39	10	50.24	0.78	26	12	47	11	43.92
17 August 2022	35.06	1165	982	1381	123	10.53	36.59	1216	1019	1432	125	10.27
20 September 2022	3.45	115	85	154	21	18.37	3.07	102	75	137	19	18.4
07 October 2022	0.00	0	0	0	0	0.00	0.37	12	8	18	3	23.88
02 November 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
20 December 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
04 January 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
23 February 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0

Table 44 Relative and absolute monthly density and population estimates for guillemot in the Offshore Array Area plus 2km buffer between March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Guillemot	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	2.36	219	167	280	36	16.21	2.63	244	184	318	41	16.83
15 April 2021	3.07	285	197	390	62	21.85	4.11	381	267	534	81	21.15
23 May 2021	1.46	135	83	208	39	28.55	1.80	167	120	229	34	20.5
09 June 2021	15.21	1413	1196	1641	138	9.76	20.92	1943	1683	2234	170	8.72
15 July 2021	31.70	2944	2186	3823	495	16.81	41.46	3851	2901	4968	627	16.28
19 August 2021	27.53	2557	2378	2756	116	4.54	37.01	3438	3103	3805	211	6.14
07 September 2021	30.14	2799	2163	3618	446	15.94	37.14	3449	2586	4552	589	17.07
06 October 2021	34.97	3248	2640	4012	422	12.99	43.67	4056	3426	4795	415	10.24
10 November 2021	4.00	371	314	434	37	9.91	5.14	478	392	577	56	11.66
09 December 2021	7.85	729	587	898	94	12.86	11.54	1072	956	1199	74	6.87
07 January 2022	1.02	95	70	124	16	17.39	1.69	157	134	184	16	9.98
08 February 2022	3.18	296	220	386	51	17.36	3.84	357	245	492	74	20.74
10 March 2022	2.69	250	170	356	58	23.39	2.63	244	184	318	41	16.83
12 April 2022	3.69	343	297	395	30	8.72	2.99	277	139	465	108	39.01
14 May 2022	25.75	2391	2136	2675	166	6.96	34.42	3197	2795	3638	256	7.99

Guillemot	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
12 June 2022	5.69	528	344	781	137	26.04	5.82	541	347	778	135	24.96
08 July 2022	24.46	2272	1811	2786	299	13.16	36.40	3381	2896	3917	317	9.36
17 August 2022	171.70	15948	14116	18076	1220	7.65	209.97	19502	17814	21270	1049	5.38
20 September 2022	79.76	7408	6267	8692	735	9.92	87.33	8111	6576	9722	975	12.02
07 October 2022	52.53	4879	3822	6117	707	14.5	66.13	6143	4737	7712	924	15.05
02 November 2022	5.76	535	338	791	143	26.77	9.84	914	613	1279	205	22.43
20 December 2022	1.01	94	59	143	26	27.34	1.16	108	80	142	19	17.88
04 January 2023	0.57	53	40	70	10	18.69	0.89	82	67	99	10	12.08
23 February 2023	1.91	178	140	220	24	13.74	2.38	221	182	266	26	11.77

Table 45 Relative and absolute monthly density and population estimates for razorbill in the Offshore Array Area plus 2km buffer March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Razorbill	Relative estimates						Absolute estimates					
	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
15 April 2021	0.85	79	45	133	31	39.41	1.57	145	95	209	36	24.48
23 May 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
09 June 2021	3.28	305	176	495	104	34.16	5.69	528	399	696	90	17.11
15 July 2021	0.15	14	6	27	7	48.41	0.18	17	6	39	12	69.06
19 August 2021	0.77	71	27	167	51	71.08	0.96	89	44	155	35	39.67
07 September 2021	0.41	38	11	91	26	68.07	0.29	27	8	64	20	74.51
06 October 2021	0.28	26	7	71	22	83.95	0.34	32	8	75	33	104.2
10 November 2021	0.17	16	0	31	8	50.25	0.22	20	0	39	12	60
09 December 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
07 January 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
08 February 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
10 March 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
12 April 2022	1.49	139	96	201	36	25.96	1.50	140	93	208	37	26.79
14 May 2022	1.02	95	46	19	59	61.87	1.19	110	71	167	31	27.76
12 June 2022	0.63	59	6	141	216	368.82	0.89	83	20	211	94	113.06

Razorbill	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
08 July 2022	1.25	116	87	154	21	17.98	1.46	136	82	219	44	32.38
17 August 2022	8.13	755	591	941	111	14.69	9.47	879	515	1399	284	32.33
20 September 2022	0.01	1	1	1	1	49.75	0.01	1	1	1	1	100
07 October 2022	0.01	1	0	1	1	77.74	0.01	1	0	1	1	100
02 November 2022	0.28	26	14	44	10	39.41	0.37	35	20	61	16.69	48.29
20 December 2022	0.11	10	1	24	7	64.81	0.14	13	1	29	10	76.92
04 January 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0
23 February 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0

Table 46 Relative and absolute monthly density and population estimates for puffin in the Offshore Array Area plus 2km buffer between March 2021 and February 2023, accounting for the potential number of birds estimated as being unavailable for detection

Puffin	Relative estimates						Absolute estimates					
	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km²)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
13 March 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
15 April 2021	1.18	110	82	153	24	21.63	0.98	91	64	127	20	21.42
23 May 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
09 June 2021	1.51	141	102	187	26	18.32	1.71	159	112	223	35	21.94
15 July 2021	0.46	42	24	72	15	35.66	0.57	53	36	75	14	25.75
19 August 2021	2.08	193	145	252	33	16.94	2.58	239	202	281	24	9.9
07 September 2021	5.08	472	406	555	45	9.47	6.29	584	516	658	43	7.35
06 October 2021	1.05	98	74	131	18	18.51	1.09	101	74	132	20	19.34
10 November 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
09 December 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
07 January 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
08 February 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
10 March 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
12 April 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
14 May 2022	4.58	425	337	527	58	13.54	5.98	555	467	659	60	10.8
12 June 2022	0.11	10	1	36	14	138.8	0.13	12	1	41	16	138.79

Puffin	Relative estimates						Absolute estimates					
	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)	Density estimate (n/km^2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate	CV (%)
08 July 2022	0.59	54	31	101	25	46.24	0.70	65	37	108	24	36.3
17 August 2022	29.61	2750	2340	3240	279	10.16	33.58	3119	2706	3555	256	8.21
20 September 2022	3.08	286	222	373	46	16.1	2.79	259	199	337	43	16.53
07 October 2022	0.36	33	14	54	12	34.52	0.32	38	9	64	17	44.74
02 November 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
20 December 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
04 January 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
23 February 2023	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00