TotalEnergies E&P North Sea UK Ltd

Culzean - Floating Offshore Wind Turbine Pilot Project

Appendix F: Ornithological and Marine Mammal Baseline Characterisation (2024)

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TotalEnergies E&P UK Limited

Ornithological and Marine Mammal Baseline Characterisation Surveys

Final Report – Culzean Platform

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Revision and Amendment Register

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1.1	04/01/2024	All	All	Internal review	LJ
1.2	12/01/2024	All	All	Internal Revisions [COM, KS, GI]	LJ

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1. Executive Summary

This report constitutes the final report outlining results from Digital Aerial Surveys (DAS) conducted between September 2022 and September 2023 at the Culzean Platforms Proposed Development Area (PDA) for TotalEnergies E&P UK Limited. Surveys were undertaken using APEM's high-resolution camera system to capture digital still imagery of birds and marine megafauna within the Culzean Platforms Proposed Development Area (PDA) with a 4-kilometre (km) buffer, referred to as the 'Survey Area' for the remainder of this report.

A programme of 13 monthly DAS were successfully carried out between September 2022 to September 2023. The September 2022 DAS was rescheduled to early October 2022 as a result of factors related to the contracting phase while the second survey was completed in late October 2022, subsequently each survey is referred to throughout accordingly. All other surveys were successfully carried out monthly for the duration of this report with no technical or safety issues.

A peak of 457 observations were recorded in late October 2022, of which, 453 were observations of birds and four observations of marine megafauna. The lowest observations counted were four in March 2023, with three birds observed and one marine megafauna. A total of 1,000 birds were recorded during the survey period. The most abundant species recorded were guillemot (n=828), fulmar (n=44), guillemot / razorbill (n=43), razorbill (n=40), great-black backed gull (n=18), kittiwake (n=12), herring gull (n=6), gannet (n=3), common gull (n=2), puffin (n=2), unidentified shearwater (n=1), 'commic' tern (n=1). A total of 19 marine megafauna were recorded during the survey period with the most abundant species recorded harbour porpoise (n=16), dolphin / porpoise (n=2), and basking shark (n=1).

Comparison of avian abundance against national populations were not included in this report due to the low numbers recorded within the Survey Area.

2. Introduction

2.1 Background

APEM were contracted by TotalEnergies E&P UK Limited (hereafter referred to as TotalEnergies) to conduct 13 monthly DAS of the Survey Area commencing in September 2022 and completed in September 2023. The main purpose of the DAS programme was to provide baseline information on the abundance, distribution and behaviour of birds and marine mammals within the Survey Area.

The Survey Area was located off the north-east coast of Scotland, 220 km from the Aberdeenshire coastline (Figure 1) and covered an area of 134.25 square kilometres (km^2). The offshore wind development comprises one turbine at the proposed location shown in Figure 1 and turbine specifications are listed in Table 1. The survey method was designed to optimise the data collection for all bird, marine mammal, and other marine megafauna species using a grid-based survey design to collect still imagery with 1.5-centimetre (cm) resolution. Total captured coverage of 48% was achieved with 10% coverage of the sea surface analysed. The DAS have been carried out to meet the aims and objectives by TotalEnergies to inform future environmental impact assessments for this proposed offshore wind development.

Table 1 Turbine specifications for the proposed Culzean Platforms wind turbine installation

Technical Specification	Measurement (m)
Hub Height	78
Tip Height (upper tip height)	134
Clearance Gap Between Sea Level (minimum blade clearance from sea level)	22
Rotor Swept Area (rotor diameter)	112

2.2 Aim of Report

The report presents information on marine birds, mammals, and other megafauna derived from 13 monthly DAS (September 2022 to September 2023) of the Survey Area. The information that is presented within this report and its appendices includes the following:

- Summary of surveys to date.
- Health and safety summary.
- Design-based abundance and density estimates for all avian and marine mammal species, as well as any other marine megafauna recorded per month within the Survey Area.
- Apportioned species abundance and density estimates and availability bias corrected abundance estimates for auks and harbour porpoises.
- Bird flight heights and direction, with Johnston et al. (2015) flight height comparison.
- Spatial distribution maps of avian, marine mammal, and other marine megafauna species.
- Discussion of ornithology and marine megafauna findings alongside contextual information about UK populations.

3. Survey and Analysis Methodologies

3.1 Digital Aerial Survey Methods

A programme of 13 monthly DAS took place between early October 2022 to September 2023. Surveys were conducted using APEM's bespoke camera system, customised by in-house specialists for surveying the offshore environment. The camera system was integrated with a Global Positioning System (GPS) linked, bespoke flight management system that allowed each survey flight line to be accurately mapped and flown with a high degree of accuracy. The aircraft's internal GPS and Inertial Measurement Unit (IMU) systems record to an accuracy of +/- 3 to 5 m as standard. APEM's flight planning software enabled tolerances along survey lines to be set, meaning the camera system would automatically abort data capture should the aircraft drift away from the planned flight line. Data capture comprised 1.5 cm GSD digital still images collected in a grid-based design. Each image capture node was precisely defined allowing the camera to take digital still images at precise and repeatable locations.

During each DAS, APEM's on-board camera technician continually monitored the imagery to ensure the collected data was fit for purpose. If survey conditions became unsuitable, data collection would cease, and the DAS would be rescheduled at the earliest opportunity. This was not necessary for any of the surveys.

The camera system captured abutting imagery along 10 survey flight lines spaced approximately 1.5 km apart within the Survey Area (Figure 1). The total Survey Area was 134.25 km^2. The aircraft collected the data at an altitude of approximately 1,300 ft (395 m) and a speed of approximately 120 knots. Images were collected continuously along the survey flight lines achieving a total captured coverage of 48% and 10% coverage of the sea surface analysed.

Imagery was captured in raw format and post-processed to ensure optimal quality for subsequent image analysis, extracting information on marine fauna and any anthropogenic features. Upon survey completion, data were checked for correct flight line and image counts, and image quality. Following image analysis, additional quality assurance (QA) processes took place (see Section 3.3).

No health or safety issues were reported during the surveys.

The dates, start, and end times are provided for each DAS in Table 2 with the corresponding weather conditions provided in Table 3.

Table 2 Date and start / end time (Coordinated Universal Time) for each survey during the survey period

Survey Name	Survey No.	Date	UTC Start Time (HH:MM)	UTC End Time (HH:MM)
Early October	Survey 01	01-10-22	11:02	11:42
Late October	Survey 02	25-10-22	12:58	13:42
November	Survey 03	12-11-22	11:20	12:03
December	Survey 04	23-12-22	11:37	12:20
January	Survey 05	05-01-23	10:05	10:51
February	Survey 06	07-02-23	10:26	11:08
March	Survey 07	09-03-23	12:54	13:37
April	Survey 08	02-04-23	15:36	16:18
May	Survey 09	04-05-23	11:26	12:23
June	Survey 10	11-06-23	08:49	09:43
July	Survey 11	26-07-23	13:46	14:29
August	Survey 12	11-08-23	13:59	14:41
September	Survey 13	12-09-23	08:46	09:48

Table 3 Weather conditions recorded for each flight during the survey period

Survey Name	Survey No.	Date	Douglas Sea State[1]	Turbidity[2]	Wind Speed (knots) / Direction	Cloud Cover (%)[3]	Visibility (km)	Air Temp (°C)
Early October	Survey 01	01-10-22	2	1-2	25/W	50-60	10+	9-10
Late October	Survey 02	25-10-22	1	0-1	15/W	10-50	10+	11
November	Survey 03	12-11-22	2	1-2	16/S	100	5+	12
December	Survey 04	23-12-22	1	0	10-13/NE	30	30+	3
January	Survey 05	05-01-23	3	2	14/W	10-15	20+	5
February	Survey 06	07-02-23	2	0	13-16/W	0-10	10+	6-7
March	Survey 07	09-03-23	1	0	4/N	0	10+	4
April	Survey 08	02-04-23	1	0	2-4/SE	0	10+	4
May	Survey 09	04-05-23	3	2	18/E-NE	20	30+	4
June	Survey 10	11-06-23	1	0	13-16/E-E/SE	0	10+	14
July	Survey 11	26-07-23	3	2	17-18/W-NW	60	10+	10
August	Survey 12	11-08-23	1	0	22-26/SW-W	20-90	10+	17
September	Survey 13	12-09-23	3	2	7-8/NW	35	30	11

[1] 0 = Calm (Glassy), 1 = Calm (Rippled), 2 = Smooth, 3 = Slightly Moderate, 4 = Moderate

[2] 0 = Clear, 1 = Slightly Turbid, 2 = Moderately Turbid, 3 = Highly Turbid

[3] 0 = Clear, 1-10 = Few, 11-50 = Scattered, 51-95 = Broken, 96-100 = Overcast

Weather conditions during all surveys were conducive to collecting and analysing imagery for the purpose of providing data on the identification, distribution, and abundance of bird species and marine fauna within the Survey Area. Favourable conditions for surveying were defined as: a cloud base of at least 1,700 ft, visibility of greater than 5 km, wind speed of less than 30 knots, and sea state of 4 (moderate) or less. For safety reasons, no surveying took place in icing conditions.

Measures were taken to minimise glint and glare, such as avoiding surveying when the sun angle had the greatest potential to impact image quality. Furthermore, additional imagery was collected throughout the survey, providing an alternative set of images for analysis to ensure that sufficient coverage is achieved in the case that imagery was affected strongly by glint or glare. Such conditions were not encountered during the 13 surveys and therefore alternative imagery was not used for analysis.

The number of images and coverage collected is presented in Table 4**Table 4**. For all surveys, coverage exceeded the required 10%.

Table 4 Number of images and analysed survey coverage for each DAS during the survey period

Survey No.	No. of image nodes	Analysed Coverage (%)
Survey 01	155	10.91
Survey 02	155	10.91
Survey 03	154	10.84
Survey 04	155	10.91
Survey 05	155	10.91
Survey 06	155	10.91
Survey 07	155	10.91
Survey 08	151	10.63
Survey 09	155	10.84
Survey 10	155	10.91
Survey 11	154	10.84
Survey 12	154	10.84
Survey 13	155	10.91

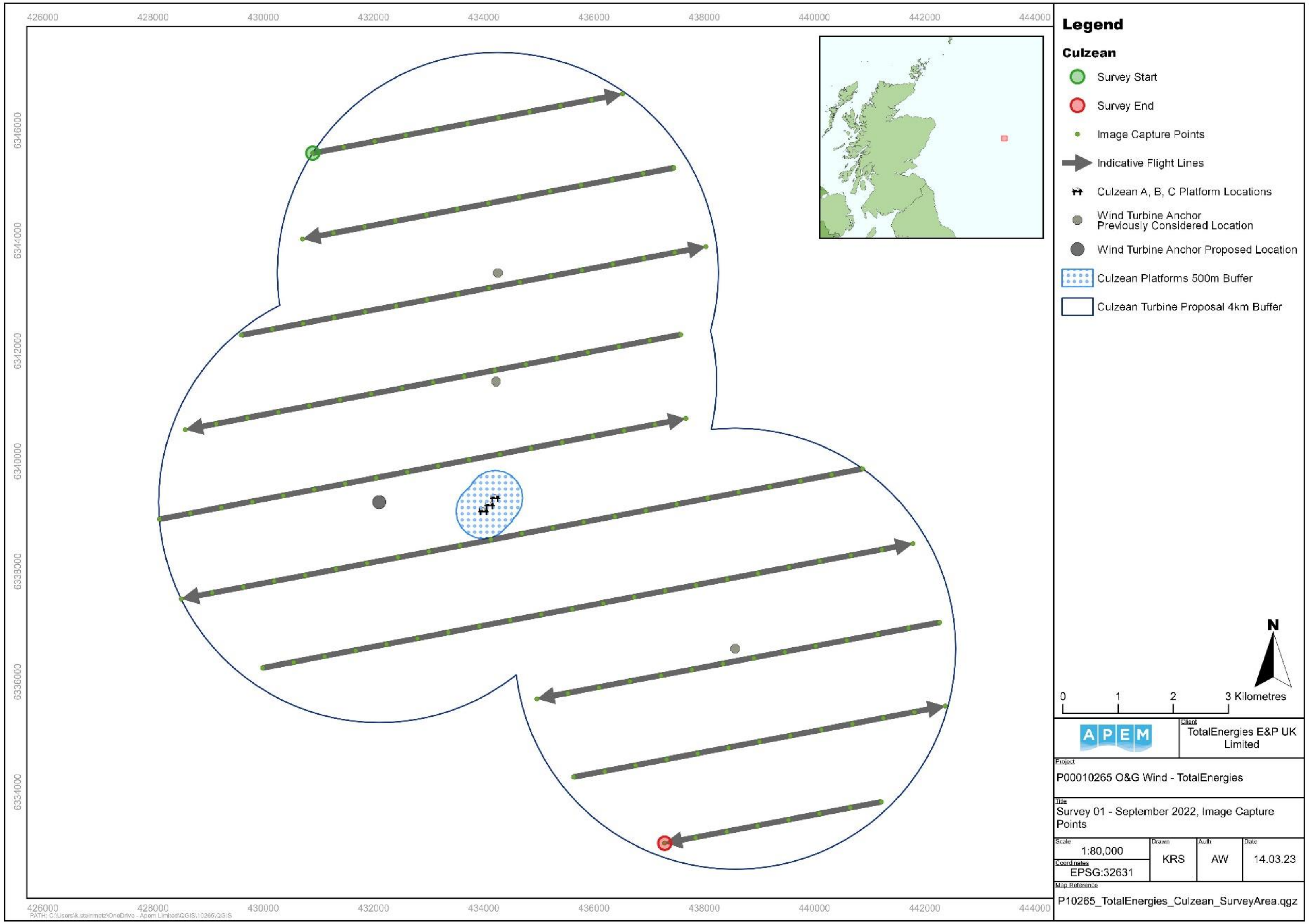


Figure 1 Flight lines and image capture points for the Survey Area

3.2 Species Identification

The images were analysed to enumerate birds and marine mammals to species level where possible. Targets identified from the images were 'snagged' (i.e., located within the images) and categorised.

There were occasions when it was not possible to identify an individual in the imagery to the species level and the individual was therefore identified as belonging to a higher-level taxonomic group (e.g., 'dolphin / porpoise species'). The possible groups and the individual species attributed to them are listed in Table 5 for birds and Table 6 for marine mammals. Whilst some species / groups have been included for clarity as part of the broader group levels (i.e., large and small shearwater species), they were not recorded in the surveys. Likewise, whilst common terns form part of the 'commic' tern designation, no common terns were recorded.

Table 5 Avian species included within 'unidentified' groups during the survey period.

<table>
<tr><th>Species</th><th>Group Level 1</th><th>Group Level 2</th></tr>
<tr><td>Common Tern</td><td rowspan="2">'Commic' Tern</td><td rowspan="2">N/A</td></tr>
<tr><td>Arctic Tern</td></tr>
<tr><td>Guillemot</td><td rowspan="2">Guillemot and / or Razorbill</td><td rowspan="2">N/A</td></tr>
<tr><td>Razorbill</td></tr>
<tr><td>Cory's Shearwater</td><td rowspan="3">Large Shearwater Species</td><td rowspan="4">Shearwater Species</td></tr>
<tr><td>Sooty Shearwater</td></tr>
<tr><td>Great Shearwater</td></tr>
<tr><td>Manx Shearwater</td><td>Small Shearwater Species</td></tr>
</table>

Table 6 Marine mammal species included within 'unidentified' groups during the survey period.

<table>
<tr><th>Species</th><th>Group Level 1</th><th>Group Level 2</th></tr>
<tr><td>Common Dolphin</td><td rowspan="4">Dolphin Species</td><td rowspan="5">Dolphin / Porpoise</td></tr>
<tr><td>Risso's Dolphin</td></tr>
<tr><td>White-beaked Dolphin</td></tr>
<tr><td>Common Bottlenose</td></tr>
<tr><td>Harbour Porpoise</td><td></td></tr>
</table>

3.3 Summary of Quality Assurance

Internal QA was carried out on the data collected from each of the surveys. Images were assessed in batches with a different person responsible for each batch. Each image containing birds and / or marine megafauna was reviewed and checked by APEM's dedicated QA Manager, ensuring that at least 10% of birds and marine megafauna recorded were subject to internal QA to confirm that all species were correctly identified. Images containing no birds and / or marine megafauna were removed and stored separately for further internal QA. Of these 'blank' images, 10% were randomly selected for QA. If there was <90% agreement, the entire batch was re-analysed independently by a different member of staff.

3.4 Species Abundance Estimates

Design-based population estimates were calculated for all birds, marine mammals, and marine megafauna identified in the Survey Area. For each monthly DAS, geo-referenced locations of individuals contained within each individual digital still image were used to generate raw counts.

For each DAS, species-specific abundance and density estimates for Survey Area were produced, with upper and lower confidence limits and precision (Coefficient of Variation; CV). The input data comprised of geo-referenced locations of animals contained within each individual digital still image, which were used to generate the raw counts for the analysis. Individuals located within the Survey Area were used to calculate the abundance estimates. Raw counts were 'clipped' to the Survey Area. Thus, observations outside the Survey Area are excluded. As a result, raw counts presented may not always reflect those reported in the monthly survey reports, which on occasion may include individuals outside the Survey Area that fall within an analysed image on the edge of the buffer. Additionally, any deceased animals were not included in abundance estimate calculations as their occurrence is not a consistent variable that can be predicted for.

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

$N = i\ A$

Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data (Buckland et al., 2004). The statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values were taken as the variability of the statistic over the population (Efron & Tibshirani, 1993).

A measure of precision was calculated using a Poisson precision. This produced a CV based on the relationship of the standard error to the mean (Thomas et al., 2010). A target precision of ≤0.16 allows the detection of a doubling or halving of the population (Bohlin, 1990). Density is expressed as the mean number of animals per km^2. The abundance estimate is the estimated number of animals within the Survey Area. The upper and lower confidence intervals (CI) define the range that the abundance estimate falls within with 95% certainty. The CV is a measure of the precision of the abundance and density estimates. Species recorded in low numbers were not excluded from the calculations, therefore lower confidence can be expected in these cases. (Canty & Ripley, 2021). Abundance estimates are presented in Section 4, and species separated by behaviour can be found in Appendix IV Raw Data Abundance and Density.

All analysis was carried out using the R programming language (R Core Team, 2022) and non-parametric 95% confidence intervals were generated using the 'boot' library of functions.

3.5 Attribution and Apportionment of Unidentified Individuals

Although most individuals recorded from the surveys are identified to species level, a number remained identified to group level only. To account for these unidentified individuals, the abundance estimates within this report includes an attribution of unidentified individuals into the monthly abundance estimates and densities. This is based upon an apportionment of the group level identified individuals between those species within that group that were identified to species level within each individual monthly abundance estimate.

The number of unidentified individuals in a group is proportioned to the specific species that are contained within that group based on the relative abundance of the positively identified species in that month's survey. For example, in the case of guillemot, the count consists of:

Positively identified guillemot + proportion of group level identified as guillemot / razorbill

For the surveys, the individuals identified to group level contained within the dataset were:

- Guillemot / razorbill
- Shearwater species
- 'Commic' tern
- Dolphin / porpoise

Raw counts from the DAS data and abundance estimates prior to any attribution of group level identified birds can be found in Appendix IV Raw Data Abundance and Density, whilst those subject to apportionment are presented in the main body of the report (see Section 4)

Instances can occur when there are no positively identified species in months where group level identified individuals have been recorded. A hierarchical approach was used to such cases with the preferable method being the first or the second, where possible.

i. Use the proportion from the same month, same area (Site only, Buffer only or Survey Area).
ii. Use the proportion from the same bio-season, same area (Site only, Buffer only or Survey Area).

The instances where this occurred were:

- Guillemot / razorbills in Late October and November 2022 for which the same month, same area was used in Late October and the same bio-season, same area was used in November.

The distribution maps of the apportioned records can be found on the Appendix III Distribution maps of apportioned records.

Despite the multifaceted process of apportionment, there were a few instances where it was not possible to assign unidentified individuals recorded during a month to a species. These were:

- Unidentified shearwater species as no shearwaters were identified to species level during the surveys.
- 'Commic terns' as no Arctic or common terns were identified during the surveys.

3.6 Availability Bias

Diving birds, such as guillemots and razorbills, spend time foraging beneath the water surface. As a result of this, an unknown number of birds may go undetected due to the snapshot nature of aerial survey techniques. A correction factor must be applied to account for this 'availability bias'.

The correction factor applied to each relevant auk species was based on that recommended by the Joint Nature Conservation Committee (JNCC) in a submission during the examination phase of the East Anglia ONE offshore windfarm, referred to by JNCC as Method C (JNCC, 2013) with a copy of the specific text provided in Appendix II Correction Factors. This applies a correction factor based on aerial surveys recording 76% of sitting guillemots and 83% of sitting razorbills, as 24% and 17% respectively, of these species will be underwater when aerial imagery is captured. For puffins, correction factors derived from (Spencer, 2012) where used to correct for availability bias. Therefore, to correct for availability bias the 'unavailable' birds were added to the bird totals monthly to create revised population estimates. The correction factors applied to the relative abundance estimate of guillemot, razorbill and puffin sitting on the sea surface were 1.311, 1.211 and 1.165, respectively. The 'corrected' abundance estimates for guillemots, razorbills and puffins are presented in the relevant sections later in this report (see Section 4).

For marine mammals, it is possible from aerial imagery to capture individuals at the sea surface as well as underneath. Correction factors are applied to account for the availability bias of individuals which may be beneath the water surface the moment an image is captured. For harbour porpoise, the seasonal correction factors from (Voet et al., 2017) were applied to the total monthly abundance estimates (submerged and surfacing). The correction factors consider the probability of harbour porpoise being within the upper 2 m of the water column and therefore assumed to be detected by the aerial surveys (Teilmann et al., 2013). The corrected data are presented in Section 5.

The average time spent at the water surface is not as well studied for other marine mammal species as it is for harbour porpoise, although some information does exist (e.g., grey seal, harbour seal, white-beaked dolphin, bottlenose dolphin and Atlantic white-sided dolphin; see Voet et al., 2017). However, as correction factors are only applicable at the species level, the abundance estimates for dolphin species were not corrected for availability bias.

3.7 Species Seasonality and Distribution

Bird behaviour and abundance are recognised to differ across a calendar year dependent upon the season. Separate seasons are recognised in this report to establish the level of importance any seabird species has within the Survey Area during any period. The Biologically Defined Minimum Population Scales (BDMPS) bio-seasons are based on those in Furness (2015) or the British Bird Atlas (Balmer 2004) hereafter referred to as bio-seasons (Table 7).

Table 7 Bio-season data for bird species captured during the Culzean Platforms surveys during the survey period

Species	Migration - spring	Migration-free breeding	Migration - autumn	Winter	Extended Non-breeding
Fulmar	December to March	April to August	September to October	November	n/a
Shearwater species	January to May	March to August	July to November	November to December	August to February
Gannet	December to March	April to August	September to November	n/a	n/a
Kittiwake	January to April	May to July	August to December	n/a	n/a
Common gull	January to April	April to August	August to December	December to February	n/a
Great black-backed gull	January to April	May to July	August to November	December	September to March
Herring gull	January to April	May to July	August to November	December	September to March
'Commic' Tern*	April to May	June to July	July to September	October to March	August to April
Guillemot	n/a	March to June	July to October	November	August to February
Razorbill	January to March	April to July	August to October	November to December	n/a
Guillemot and/or Razorbill	January to March	March to July	July to October	November to December	August to February
Puffin	March to May	June to August	September to November	n/a	n/a

* 'Commic' Tern refers to Arctic / common tern.

For consistency, marine mammal abundance and density have been summarised in a similar way using the seasonal definition according to the correction factors (Voet et al., 2017):

a) Winter: December-February

b) Spring: March-May

c) Summer: June-August

d) Autumn: September-November

Each species recorded during the surveys was geo-referenced, enabling those locations to be related to the boundary of the Survey Area. Maps were produced by species, by month although the above bio-seasons were used in discussion to better understand species distribution in relation to the species' annual cycle.

3.8 Species Distribution Maps

Monthly spatial distribution maps for each species within the Survey Area have been produced using QGIS by separating individual species records during the surveys and representing these as symbols on a map. Symbols are determined by the species group, with a relevant icon and a unique colour assigned on a per species basis, the latter of which allows for a differentiation across the board between species that use the same icon. Icons in the distribution map will appear to overlap when individuals recorded during the surveys are near each other. All distribution maps are presented in Section 4 and Section 5.

3.9 Species Flight Direction Rose Diagrams

The flight directions of flying birds were ascertained from all relevant digital still images. Bearings were plotted as a rose diagram, using the R statistical package, to summarise overall directions of movement. The mean angle and mean vector have been used to describe directional patterns and extent of 'agreement'. A Rayleigh test assuming a null hypothesis of uniformity (i.e., scattered orientation in all directions) was used, whereby a significant test indicates directionality of movement. The blue triangles show the frequency of birds captured flying with the same vector (heading). The red circle represents the critical value of the Rayleigh test of uniformity. The red arrow placement represents the mean vector, and the length of the arrow denotes how the vectors are clustered around the mean vector (longer arrows indicate the data are clustered more closely around the mean). Directionality of movement is significant if the red arrow extends beyond the circle. The rose diagrams are presented in Section 4, although species with fewer than three individuals recorded as flying, have their flight direction described in text, this is due to sample size being too low to draw significant results. Rose diagrams showing less than three individuals can be found in Appendix V Flight Directions.

3.10 Species Flight Heights

Avian flight heights were estimated from digital still images. They were determined using bespoke APEM software that applies a set of rules developed in-house and trigonometry to provide an estimate of flight height above mean sea level (MSL). The accuracy of the application of the trigonometric rules varies depending on the size and position of the bird. The trigonometric calculation is based on species-specific bird measurements, image GSD (the distance between pixel centres), the known height of the aircraft as the image was taken, and the pitch, roll, and yaw of the aircraft. These parameters are entered into APEM's flight height calculator to estimate the height of each individual bird captured in survey images. Flight height estimates are less reliable for birds that are diving or turning sharply (this affects the measurement of body length and wingspan from the image) or other aspects that may affect the body length measurement. Such birds are removed from the sample used to calculate flight heights.

A flight height boxplot and histogram have been produced for each species where sufficient flying birds were recorded (at least three individuals). The boxplots show a 'box' which represents the interquartile range, with the middle bold line representing the median of the data. The 'whiskers' are the largest and smallest non-outliers. The range of the entire data includes the outliers represented by circles. Histograms show the frequency of individuals flying at the heights recorded over the survey period. Boxplots and histograms are presented in Section 6.

4. Species Accounts

The following species accounts present the raw counts, design-based abundance estimates, as well as distribution and seasonal data from the programme of DAS covering the Survey Area between September 2022 to September 2023. Scientific names and taxonomy of species recorded are provided in Appendix I Scientific Names and Taxonomy. A summary of species counts by month are presented in Table 8. No deceased animals were recorded during the survey period.

Table 8 Number of individuals recorded within the Survey Area per survey

Species	S01 Early Oct'22	S02 Late Oct '22	S03 Nov 22	S04 Dec 22	S05 Jan 23	S06 Feb 23	S07 Mar 23	S08 Apr 23	S09 May 23	S10 Jun 23	S11 Jul 23	S12 Aug 23	S13 Sep 23	Total
Fulmar	-	3	3	1	2	5	1	-	20	1	4	2	2	***44***
Unidentified Shearwater	-	1	-	-	-	-	-	-	-	-	-	-		***1***
Gannet	-	-	-	-	-	-	-	-	-	2	-	1		***3***
Kittiwake	-	-	2	-	-	-	-	-	3	1	2	4		***12***
Common Gull	-	-	-	-	-	-	-	-	-	2	-	-		***2***
Great Black-backed Gull	-	2	3	3	3	2	-	1	1	-	-	3		***18***
Herring Gull	-	2	-	3	1	-	-	-	-	-	-	-		***6***
'Commic' Tern†	-	-	-	-	-	-	-	-	-	1	-	-	-	***1***
Guillemot	105	403	198	29	22	9	2	16	7	-	9	7	21	***828***
Razorbill	1	27	4	2	-	3	-	-	-	1	-	1	1	***40***
Guillemot / Razorbill	-	15	24	2	1	-	-	-	-	-	-	-	1	***43***
Puffin	-	-	2	-	-	-	-	-	-	-	-	-	-	***2***
Total Birds	***106***	***453***	***236***	***40***	***29***	***19***	***3***	***17***	***31***	***8***	***15***	***18***	***25***	***1,000***
Harbour Porpoise	-	2	1	1	1	2	1	1	-	7	-	-	**-**	***16***
Dolphin / Porpoise	-	2	-	-	-	-	-	-	-	-	-	-	**-**	***2***
Basking Shark	-	-	-	-	-	-	-	-	-	1	-	-	**-**	***1***
Total Megafauna	***-***	***4***	***1***	***1***	***1***	***2***	***1***	***1***	***-***	***8***	***-***	***-***	***0***	***19***

†*Note: 'Commic' refers to common and / or Arctic tern (*Sterna hirundo / paradisaea*).*

4.1 Fulmar - *Fulmaris glacialis*

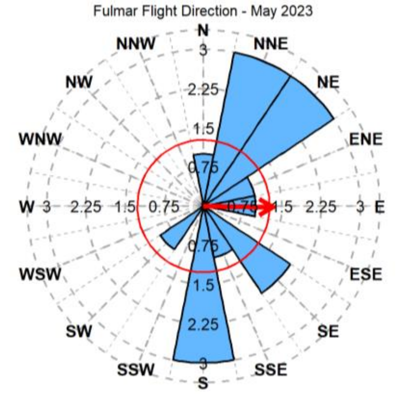
Fulmars were recorded in all survey months except April 2023. A peak raw count of 20 was recorded in May 2023 survey, resulting in an abundance estimate of 173, equating to a density of 1.29 birds/km^2 (Table 9). Fulmars were recorded across all seasons in very low numbers, although, records peaked during their breeding season and higher concentrations were recorded near to the Culzean Platform and in the north of the Survey Area (Figure 9-Figure 12). During the migratory and wintering season, fulmars were also recorded predominantly in the north and east (Figure 3-Figure 8).

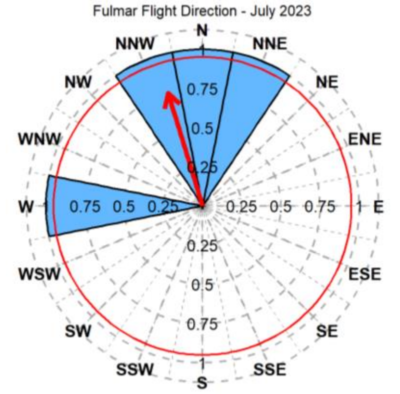
Table 9 Raw counts, abundance and density estimates (individuals per km^2) of fulmars in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S2 Late Oct-22	3	26	3	60	0.57	0.19
S3 Nov-22	3	25	3	67	0.74	0.19
S4 Dec-22	1	8	1	25	1.00	0.06
S5 Jan-23	2	17	2	43	0.70	0.13
S6 Feb-23	5	42	8	91	0.52	0.31
S7 Mar-23	1	8	1	25	1.00	0.06
S9 May-23	20	173	20	474	0.86	1.29
S10 Jun-23	1	8	1	25	1.00	0.06
S11 Jul-23	4	34	8	67	0.50	0.25
S12 Aug-23	2	17	2	42	0.71	0.13
S13 Sep-23	2	17	2	42	0.71	0.13

Significant predominant direction of flight for fulmars (Figure 2) were recorded in May 2023 (east) (Figure 2a) and July 2023 (north-northwest) (Figure 2b).

Fulmars were also recorded flying in October 2022, November 2022, December 2022, January 2023, March 2023, August 2023, and September 2023, but not in any significant predominant direction (Figure 73).





Number of Observations	16	Number of Observations	4
Mean Vector (µ)	91.022	Mean Vector (µ)	343.869
Length of Mean Vector (r)	0.443	Length of Mean Vector (r)	0.752
Rayleigh Test (Z)	3.140	Rayleigh Test (Z)	2.261
Rayleigh Test (p)	0.041	Rayleigh Test (p)	0.100
a. May 2023 (Survey 09)		**b. July 2023 (Survey 11)**	

Figure 2 Summary of significant flight direction of fulmars during survey period

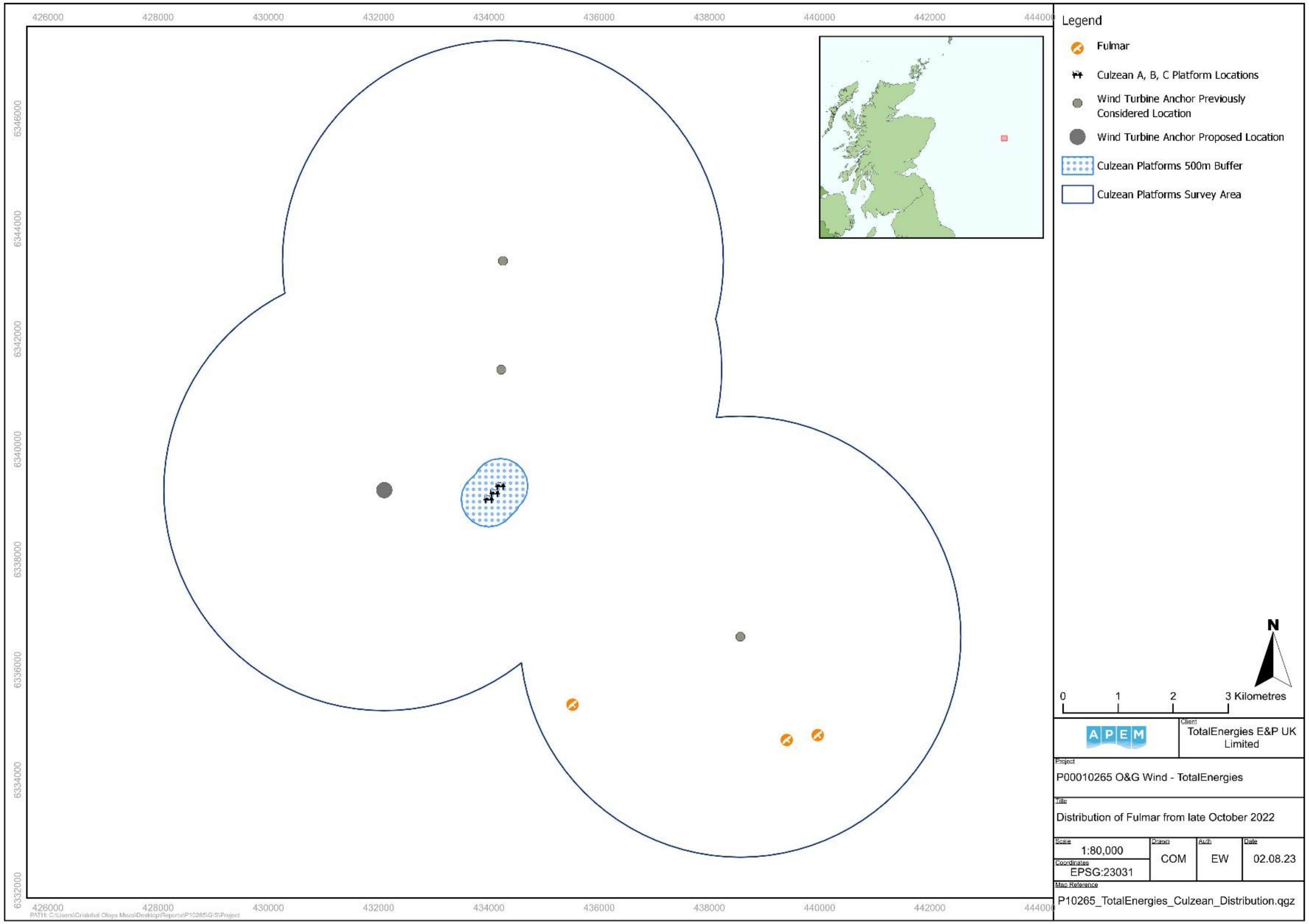


Figure 3 Distribution of fulmars from late October 2022 (Survey 02)

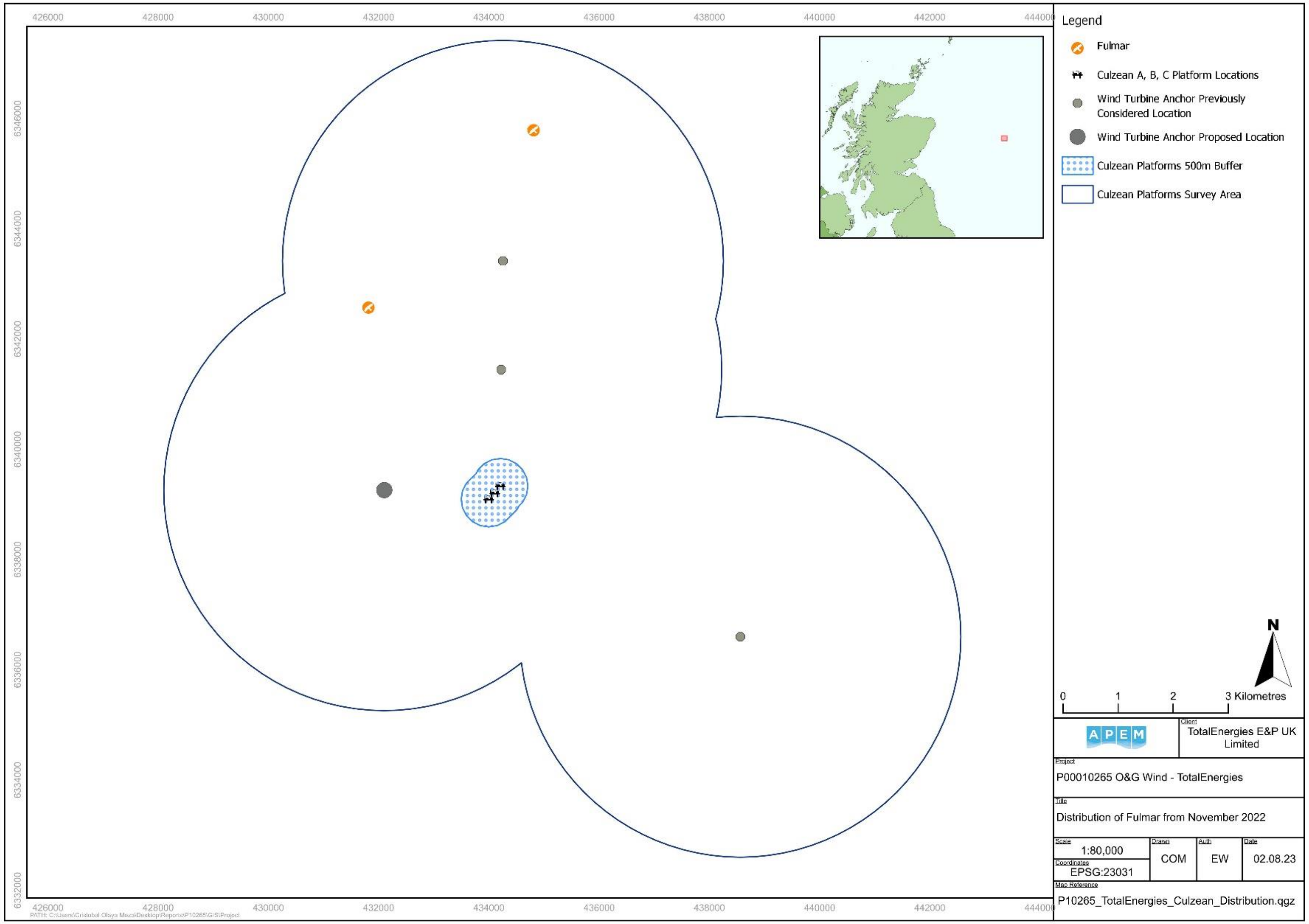


Figure 4 Distribution of fulmars from November 2022 (Survey 03)

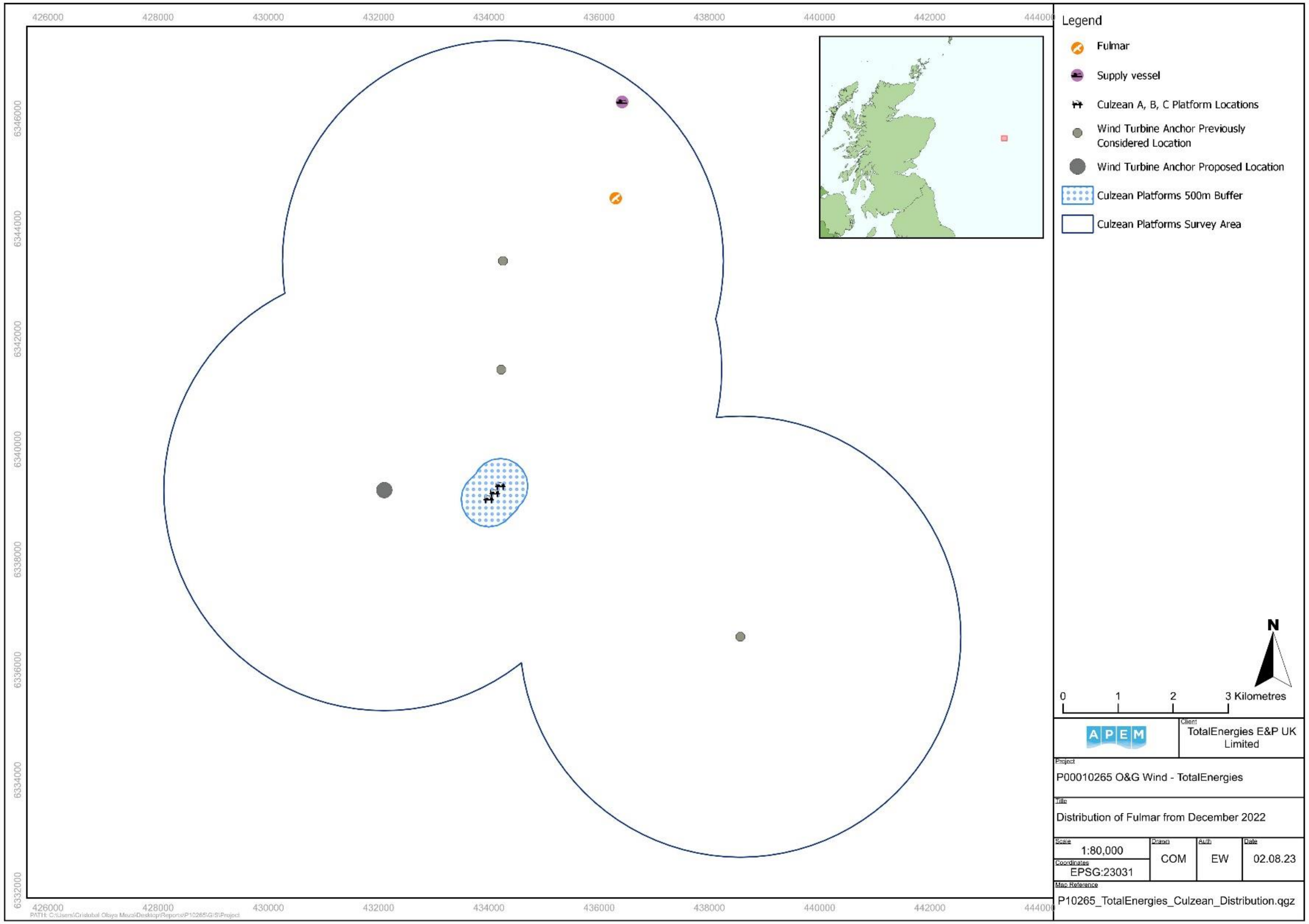


Figure 5 Distribution of fulmars from December 2022 (Survey 04)

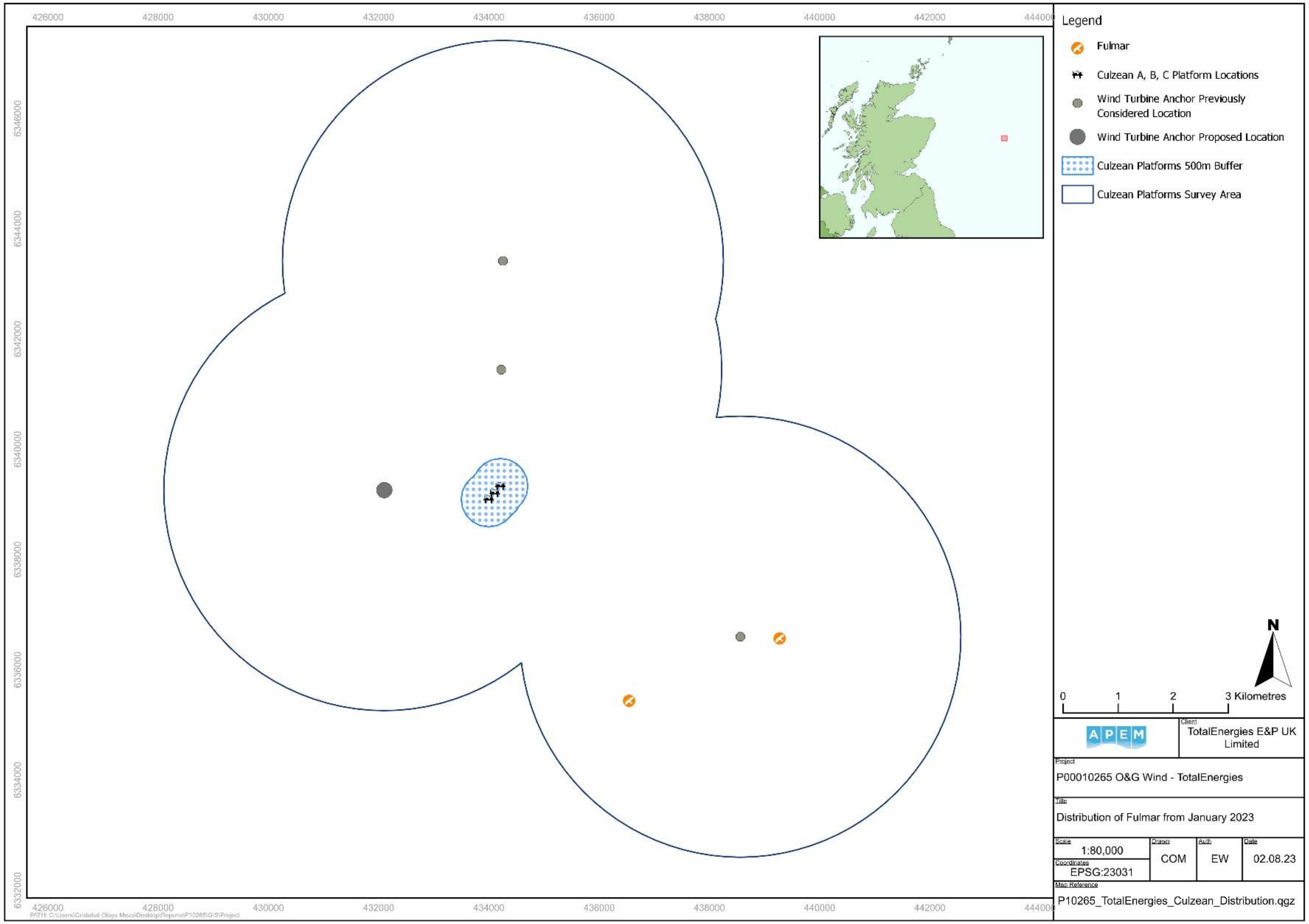


Figure 6 Distribution of fulmars from January 2023 (Survey 05)

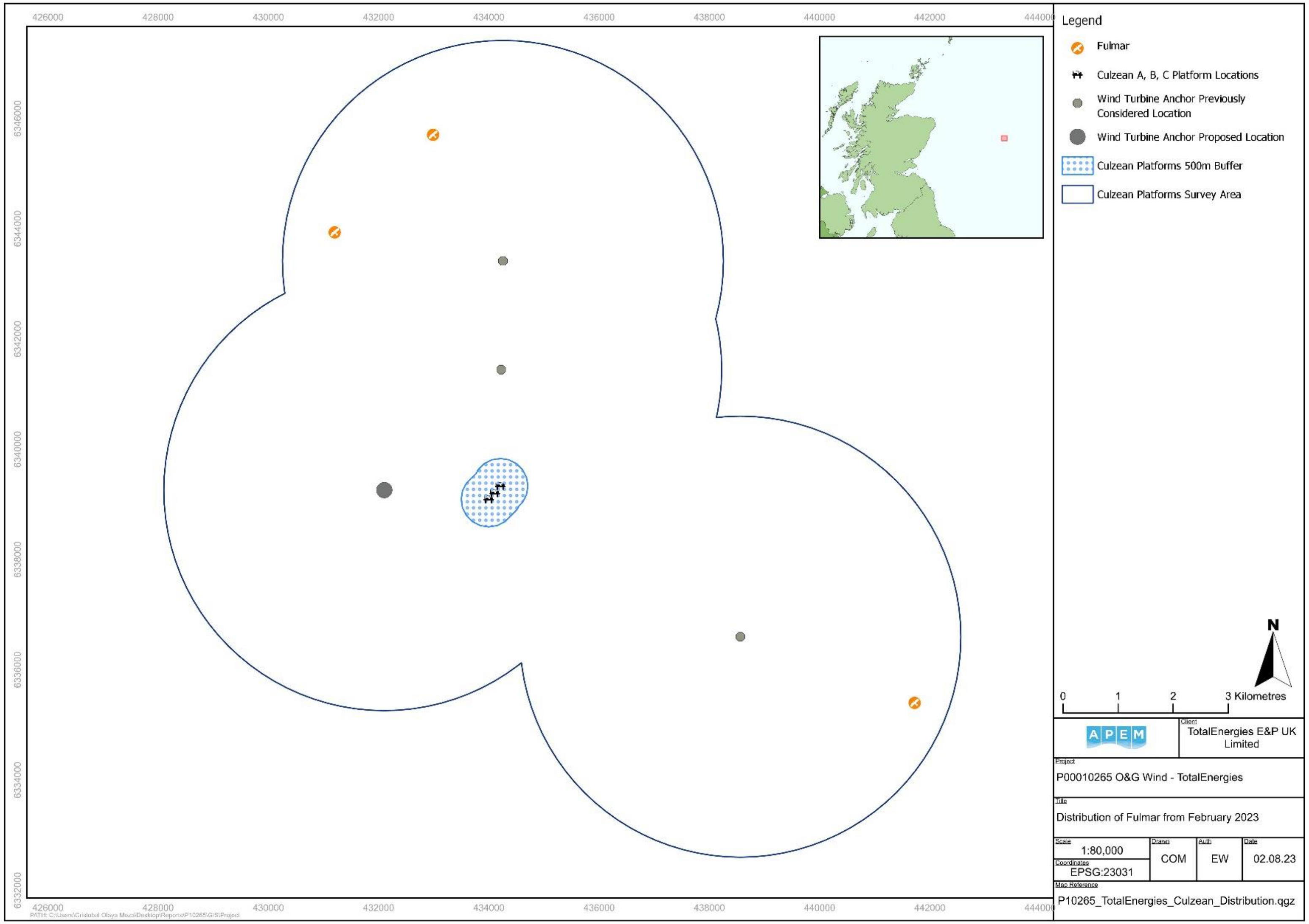


Figure 7 Distribution of fulmars from February 2023 (Survey 06)

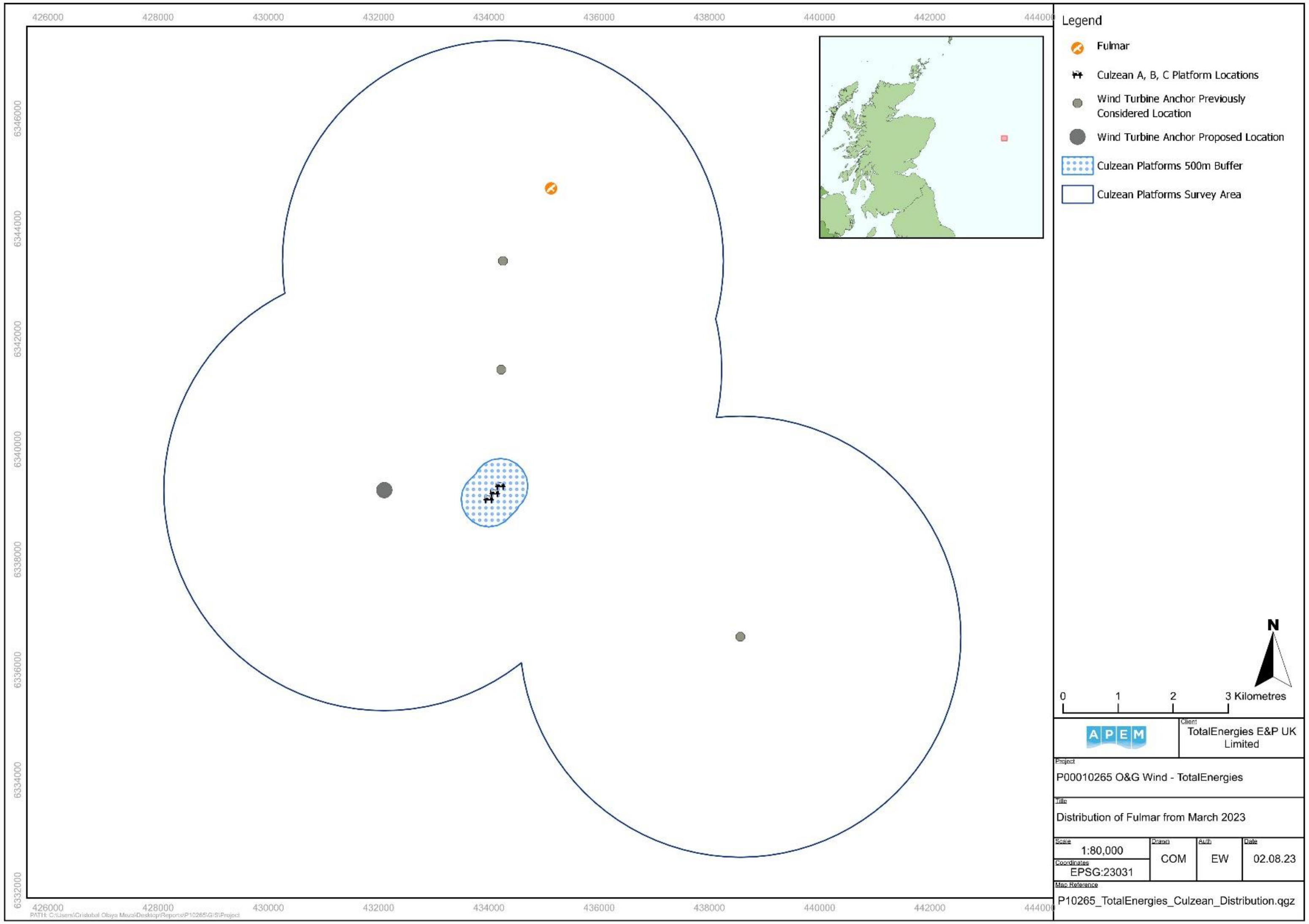


Figure 8 Distribution of fulmars from March 2023 (Survey 07)

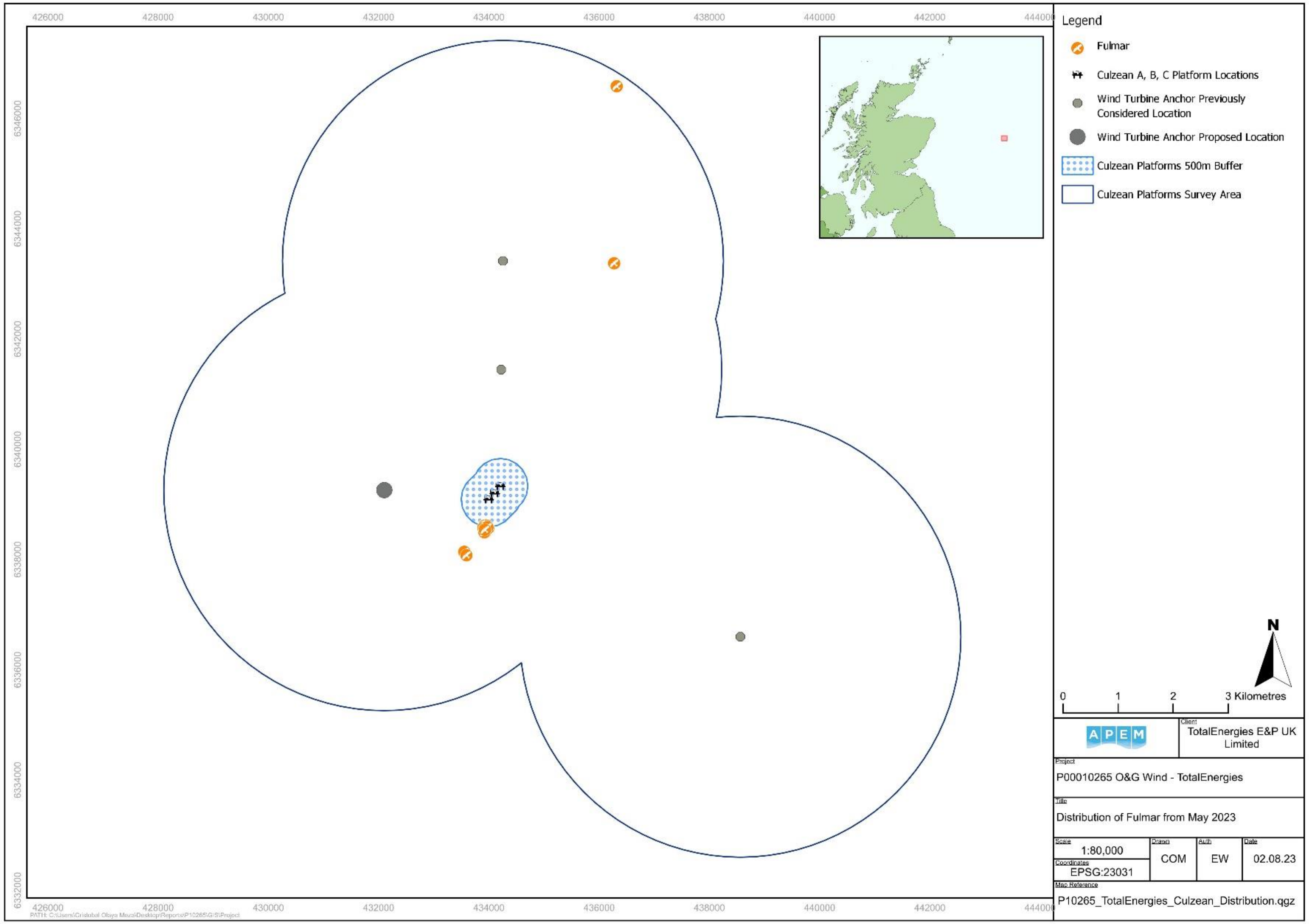


Figure 9 Distribution of fulmars from May 2023 (Survey 09)

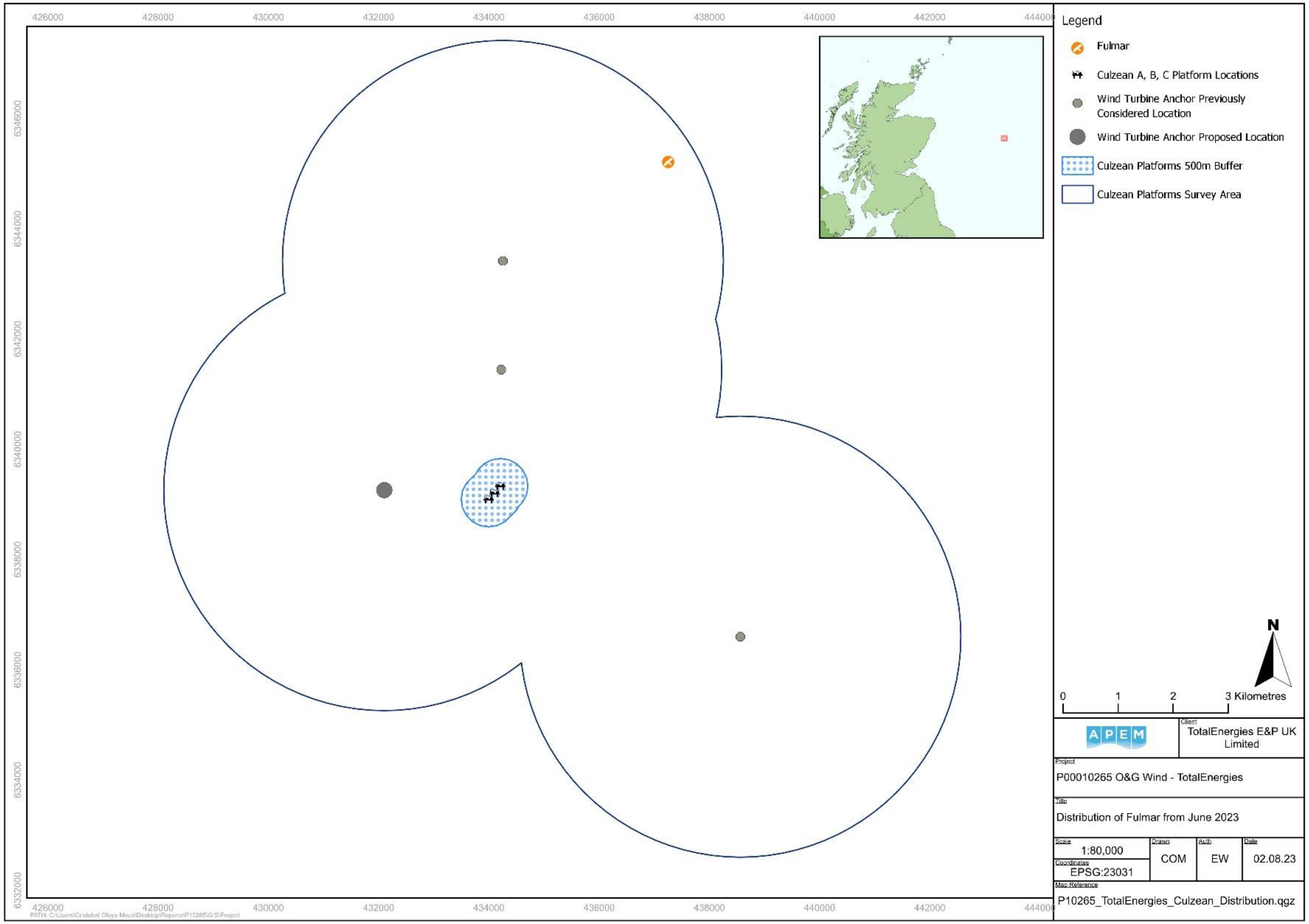


Figure 10 **Distribution of fulmars from June 2023 (Survey 10)**

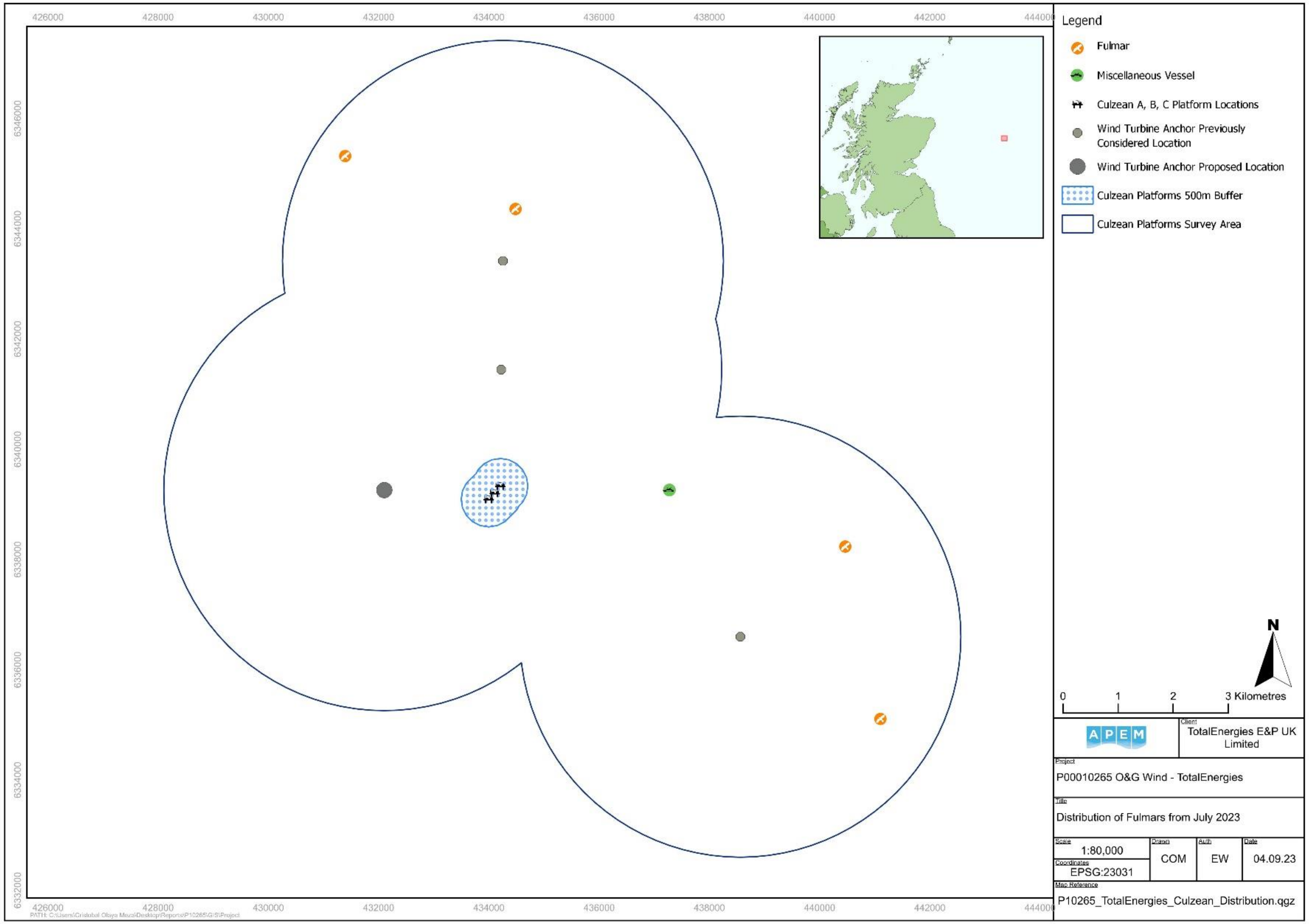


Figure 11 Distribution of fulmars from July 2023 (Survey 11)

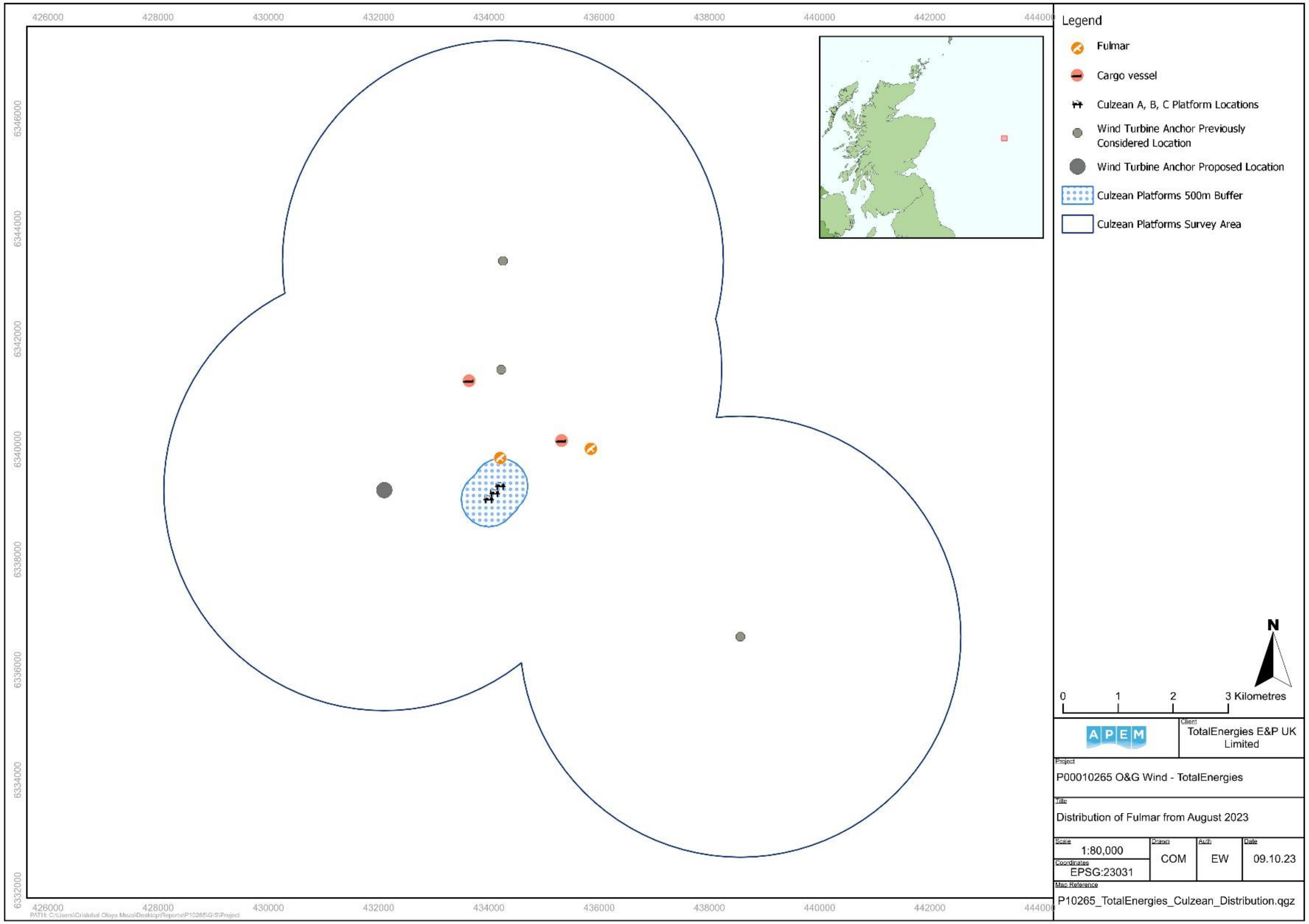


Figure 12 Distribution of fulmars from August 2023 (Survey 12)

4.2 Unidentified Shearwater Species

An individual unidentified shearwater was recorded in later October 2022, resulting in an abundance estimate of nine, equating to a density of 0.07 birds/km^2 (Table 10). The individual unidentified shearwater was recorded during their autumn migration season, in the south of the Survey Area (Figure 13).

No unidentified shearwater species were observed flying during the survey period.

Table 10 Raw counts, abundance and density estimates (individuals per km^2) of unidentified shearwater species in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S2 Late Oct-22	1	9	1	26	1	0.07

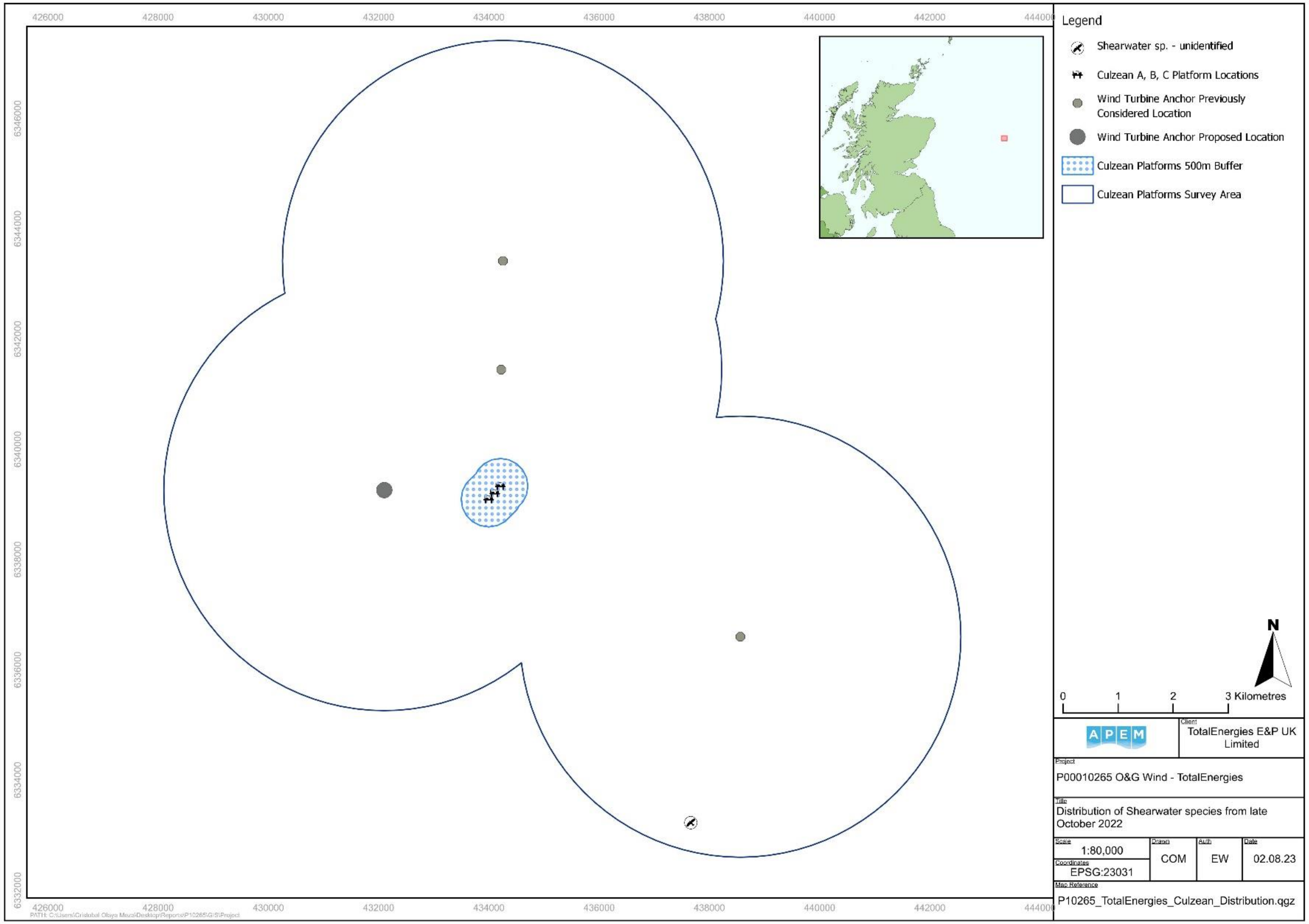


Figure 13 **Distribution of unidentified shearwater species from late October 2022 (Survey 02)**

4.3 Gannet - *Morus bassanus*

Gannets were recorded in the June and August 2023 surveys. A peak raw count of two was recorded in June 2023, resulting in an abundance estimate of 17, equating to a density of 0.13 birds/km^2 (Table 11). Gannets were recorded during their breeding season in very low numbers in the north and east of the Survey Area (Figure 14-Figure 15). They were not recorded during the wintering or migration seasons.

In June 2023, two gannets were recorded flying to the northeast (Figure 74).

Table 11 Raw counts, abundance and density estimates (individuals per km^2) of gannets in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S10 Jun-23	2	17	2	42	0.70	0.13
S12 Aug-23	1	8	1	25	1.00	0.06

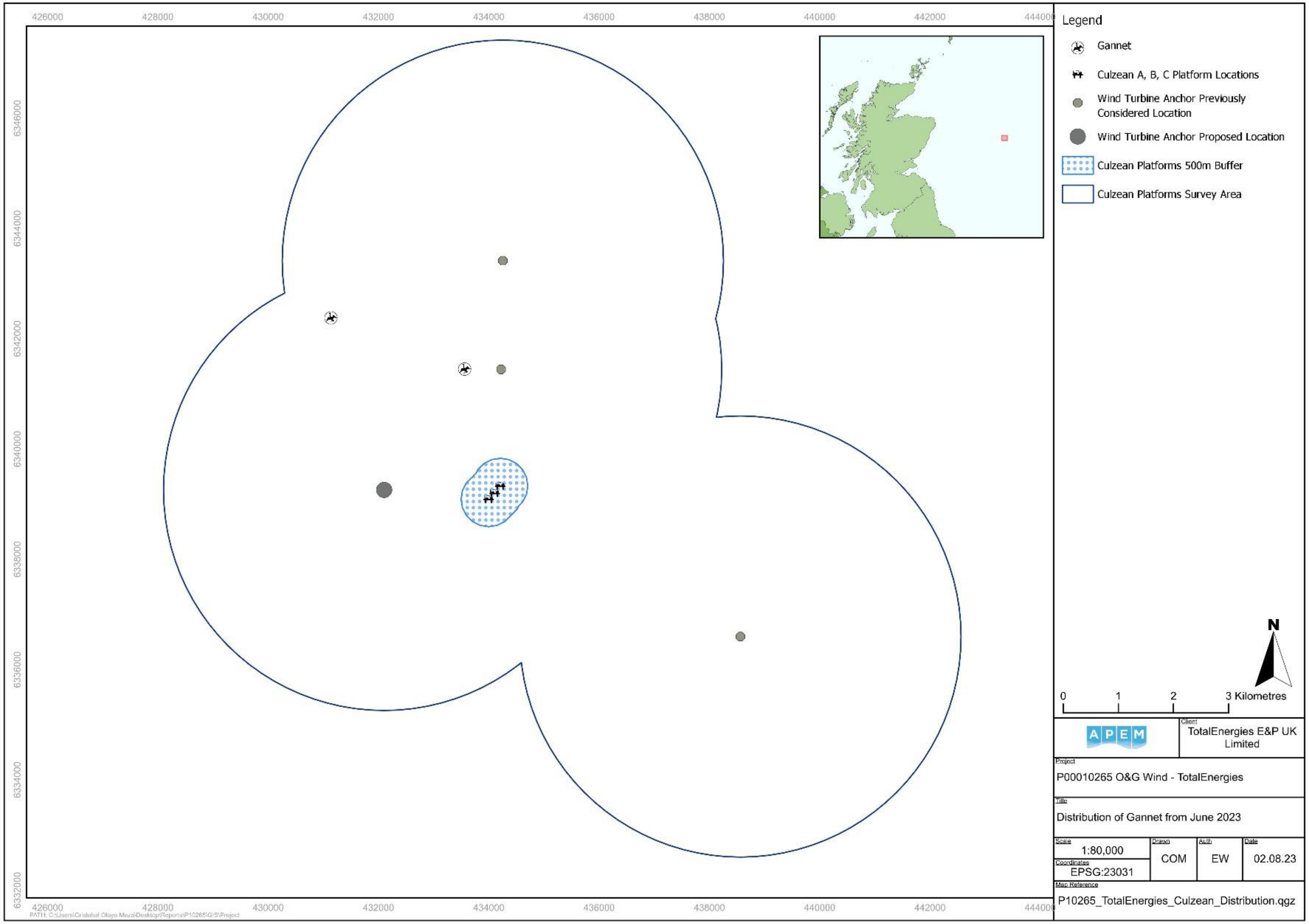


Figure 14 Distribution of gannets from June 2023 (Survey 10)

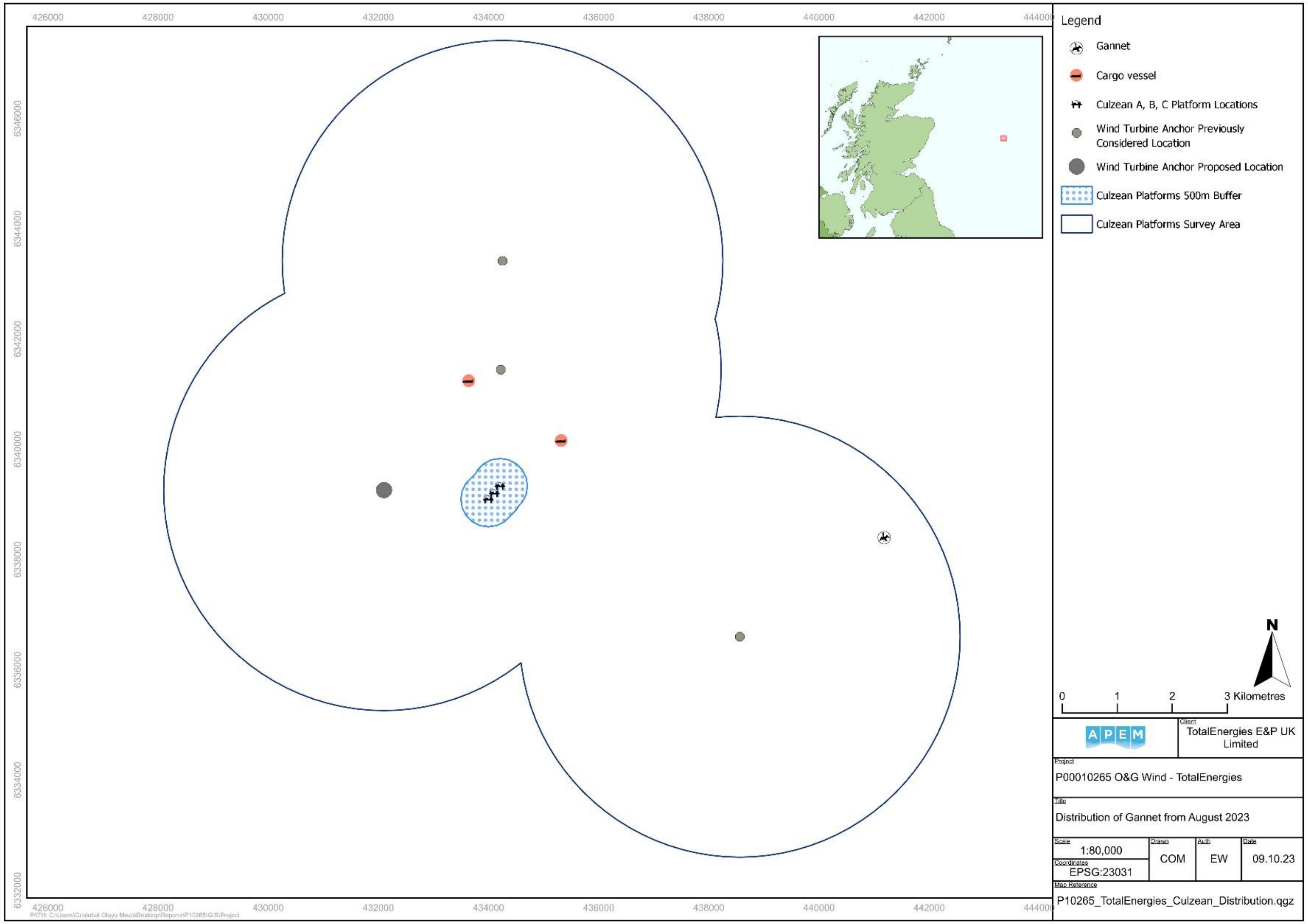


Figure 15 Distribution of gannets from August 2023 (Survey 12)

4.4 Kittiwake - *Rissa tridactyla*

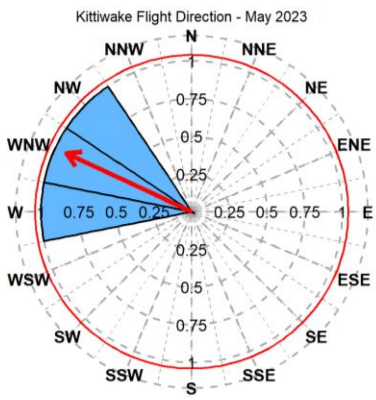
Kittiwakes were recorded in November 2022, and May 2023 to August 2023. A peak raw count of four was recorded in August 2023, resulting in an abundance estimate of 34, equating to a density of 0.25 birds/km^2 (Table 12). Kittiwakes were recorded in the Survey Area during their autumn migration and breeding season in low numbers (Figure 17-Figure 21). They were scattered across the Survey Area with no distributional pattern. Kittiwakes were recorded close to the Culzean Platform during May and August 2023 (Figure 18,Figure 21).

Table 12 Raw counts, abundance and density estimates (individuals per km^2) of kittiwakes in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S3 Nov-22	2	17	2	42	0.70	0.13
S9 May-23	3	26	3	60	0.57	0.19
S10 Jun-23	1	8	1	25	1.00	0.06
S11 Jul-23	2	17	2	42	0.70	0.13
S12 Aug-23	4	34	4	101	0.79	0.25

Significant predominant direction of flight for kittiwakes (Figure 16) was recorded in May 2023 (west-northwest).

Kittiwakes were also recorded flying in November 2022, June2023, July 2023, and August 2023, but not in any significant predominant direction (Figure 75).



Number of Observations	3
Mean Vector (μ)	295.284
Length of Mean Vector (r)	0.917
Rayleigh Test (Z)	2.525
Rayleigh Test (p)	0.069
May 2023 (Survey 09)	

Figure 16 Summary of significant flight direction of kittiwakes during survey period

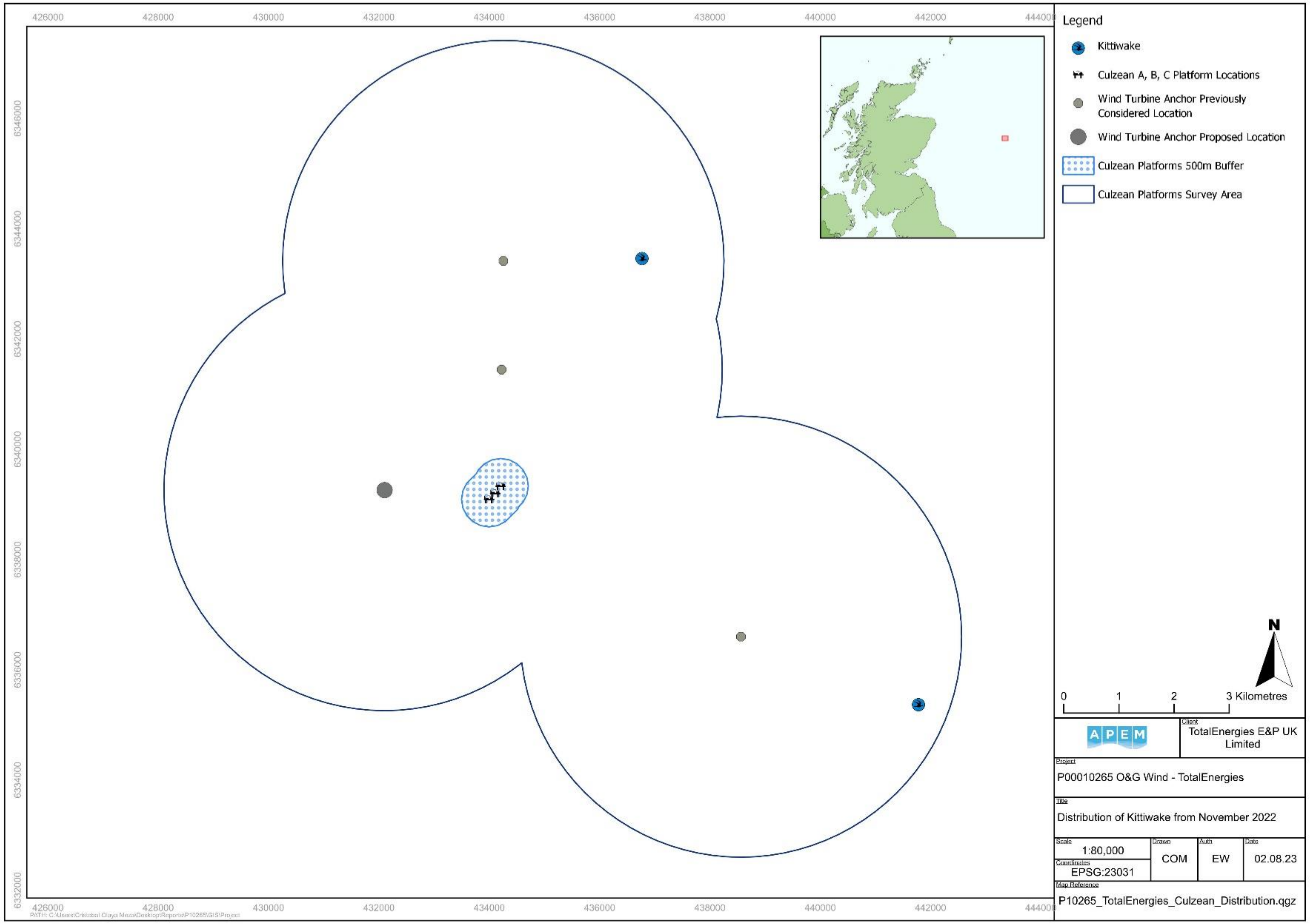


Figure 17 Distribution of kittiwakes from November 2022 (Survey 03)

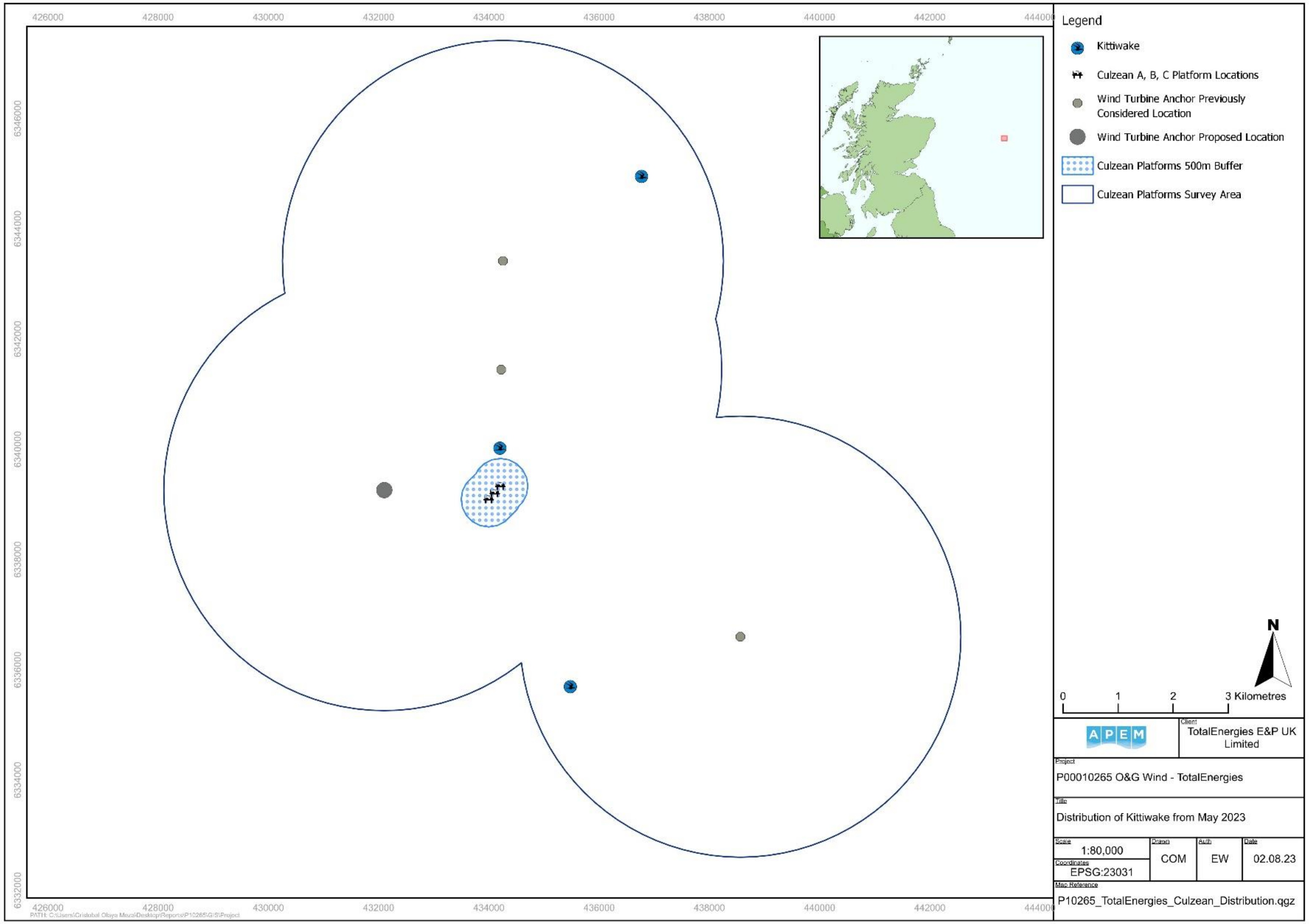


Figure 18 **Distribution of kittiwakes from May 2023 (Survey 09)**

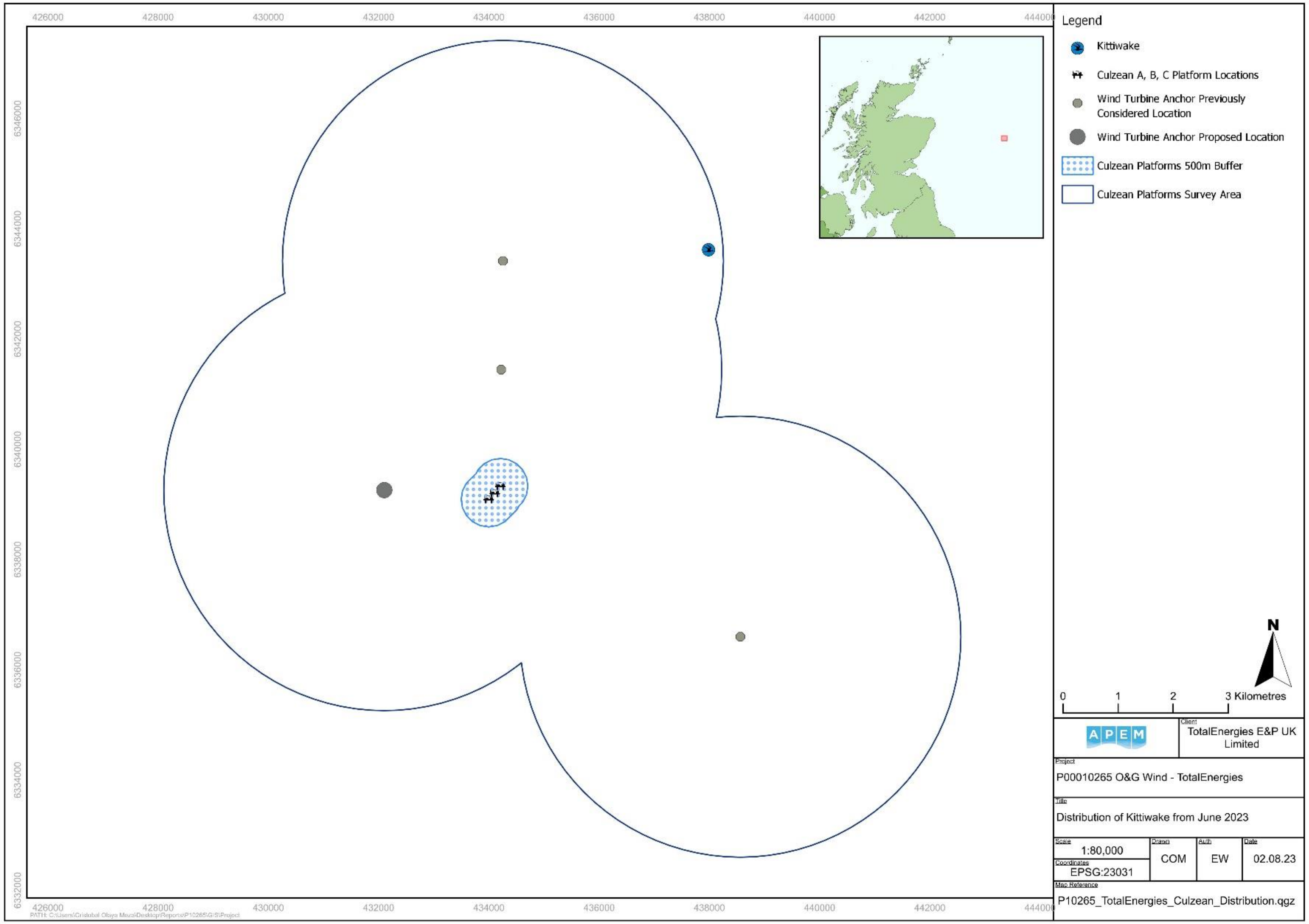


Figure 19 Distribution of kittiwakes from June 2023 (Survey 10)

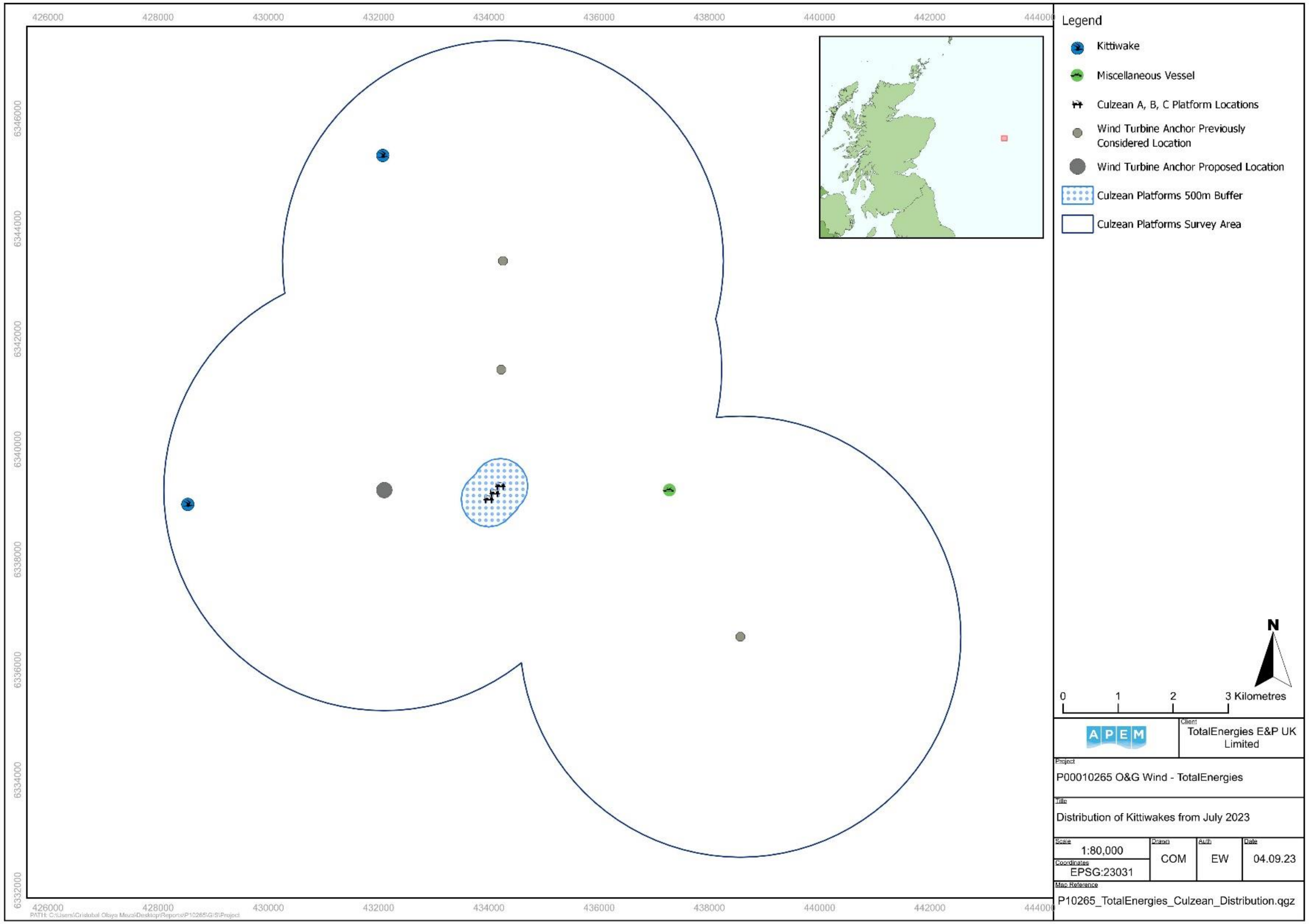


Figure 20 Distribution of kittiwakes from July 2023 (Survey 11)

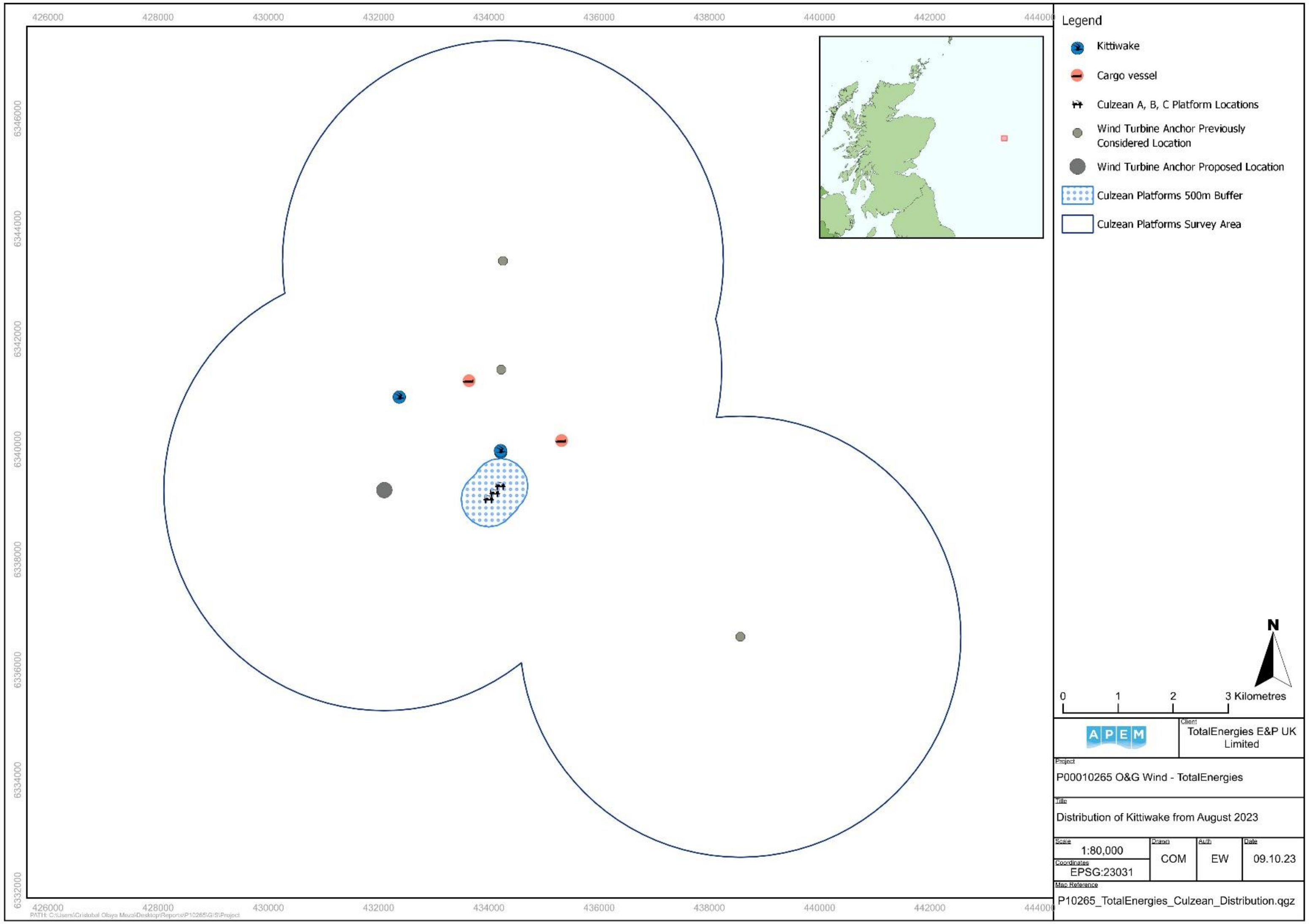


Figure 21 Distribution of kittiwakes from August 2023 (Survey 12)

4.5 Common Gull - *Larus canus*

Common gulls were only recorded in June 2023 during the breeding season, with a raw count of two, resulting in an abundance estimate of 17, equating to a density of 0.13 birds/km^2 (Table 13). Common gulls were recorded in the east of the survey area (Figure 22).

No common gulls were observed flying during the survey period.

Table 13 Raw counts, abundance and density estimates (individuals per km^2) of common gulls in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S10 Jun-23	2	17	2	50	1	0.13

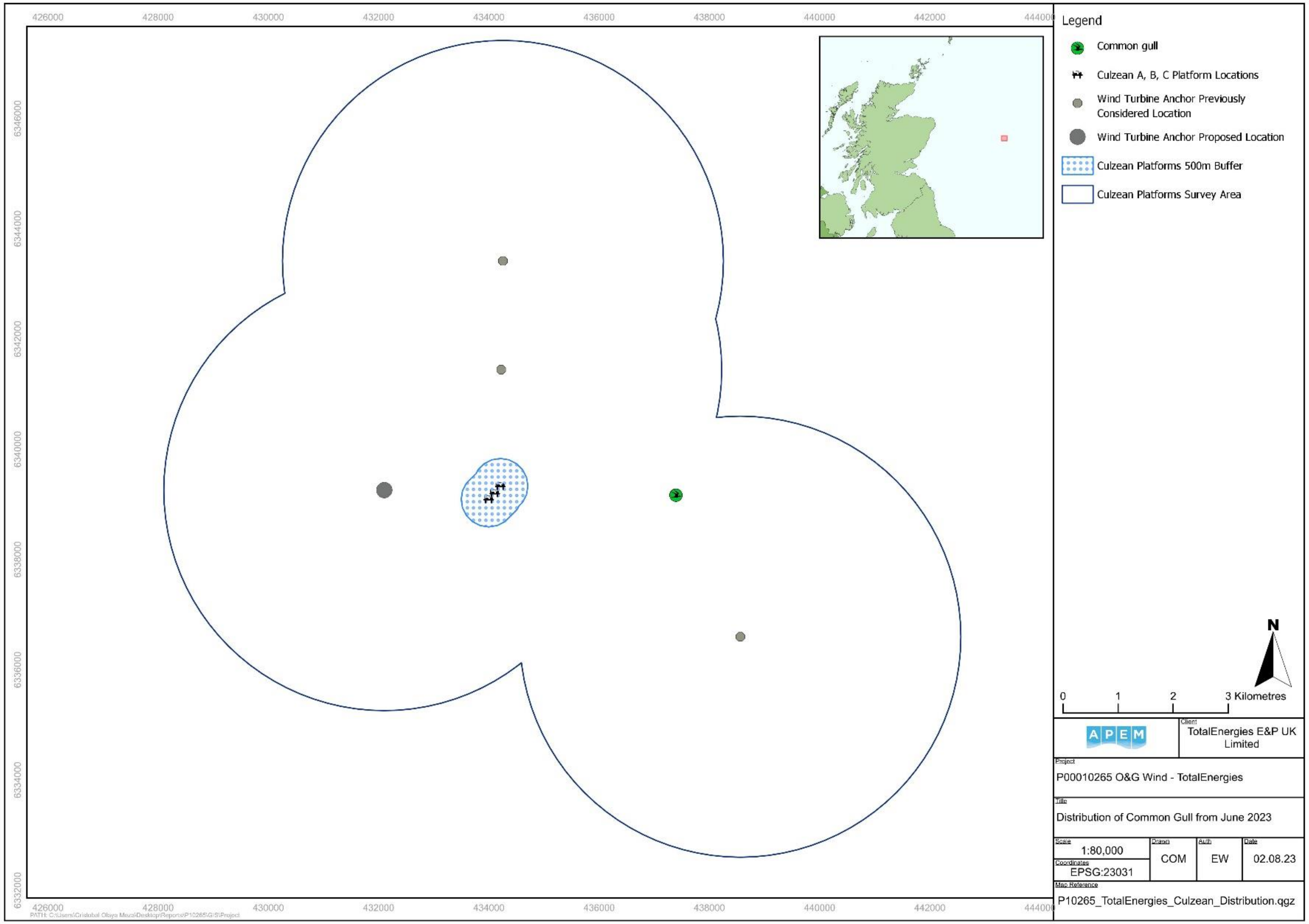


Figure 22 Distribution of common gull from June 2023 (Survey 10)

4.6 Great Black-backed Gull - *Larus marinus*

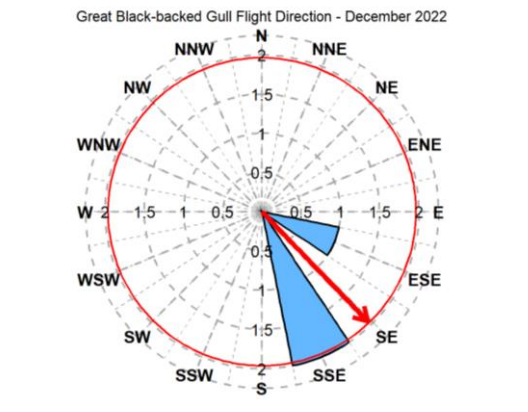
Great black-backed gulls were recorded in late October 2022 to February 2023, April 2023 to May 2023, and August 2023. A peak raw count of three was recorded in November 2022, December 2022, January 2023, and August 2023, resulting in an abundance estimate of 25-26, equating to a density of 0.19 birds/km^2 each (Table 14). Great black-backed gulls were recorded in very low numbers consistently throughout the survey period (Figure 24-Figure 31) and were recorded in both the breeding and non-season season with no distributional pattern.

Table 14 Raw counts, abundance and density estimates (individuals per km^2) of great black-backed gull in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S2 Late Oct-22	2	17	2	43	0.70	0.13
S3 Nov-22	3	25	3	59	0.57	0.19
S4 Dec-22	3	25	3	59	0.57	0.19
S5 Jan-23	3	26	3	51	0.57	0.19
S6 Feb-23	2	17	2	42	0.70	0.13
S8 Apr-23	1	8	1	25	1.00	0.06
S9 May-23	1	9	1	26	1.00	0.07
S12 Aug-23	3	25	3	67	0.74	0.19

Significant predominant direction of flight for great black-backed gulls (Figure 23) were recorded in December 2022 (southeast).

Great black-backed gulls were also recorded flying in October 2022, November 2022, January 2023, February 2023, April 2023, and May 2023, but not in any significant predominant direction (Figure 76).



Number of Observations	3
Mean Vector (µ)	136.815
Length of Mean Vector (r)	0.971
Rayleigh Test (Z)	2.831
Rayleigh Test (p)	0.044
December 2022 (Survey 04)	

Figure 23 Summary of significant flight direction of great black-backed gulls during survey period

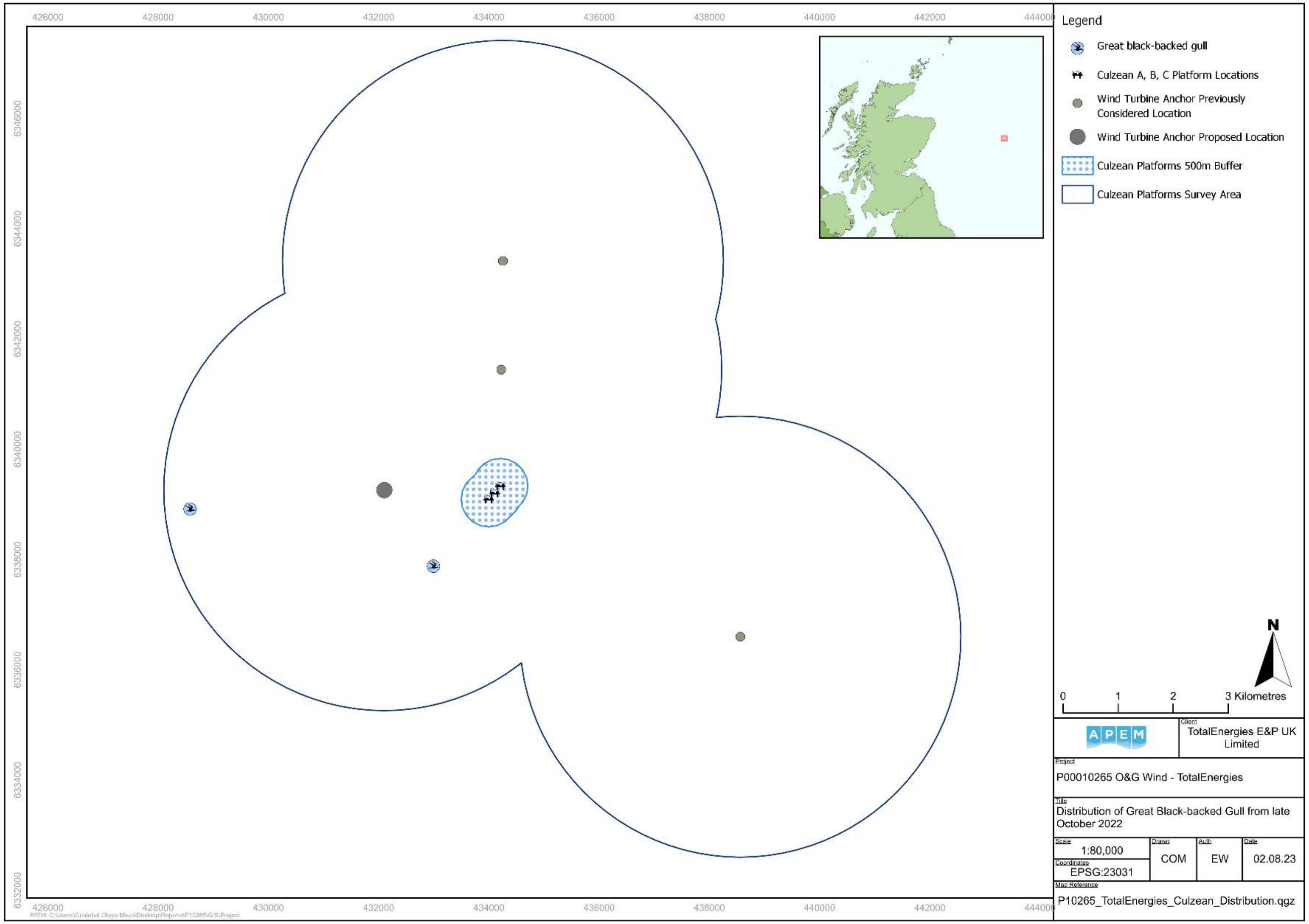


Figure 24 **Distribution of great black-backed gulls from late October 2022 (Survey 02)**

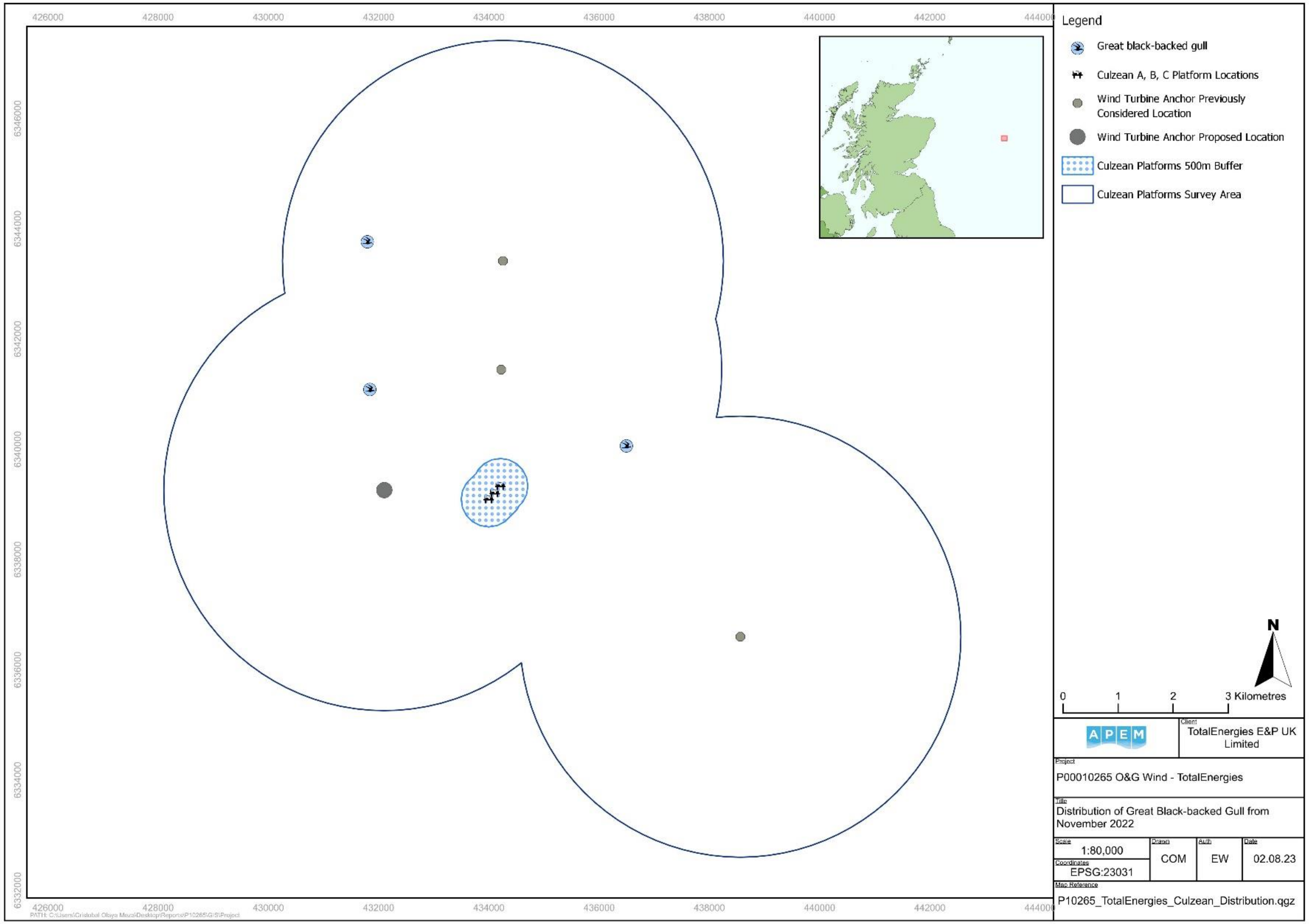


Figure 25 **Distribution of great black-backed gulls from November 2022 (Survey 03)**

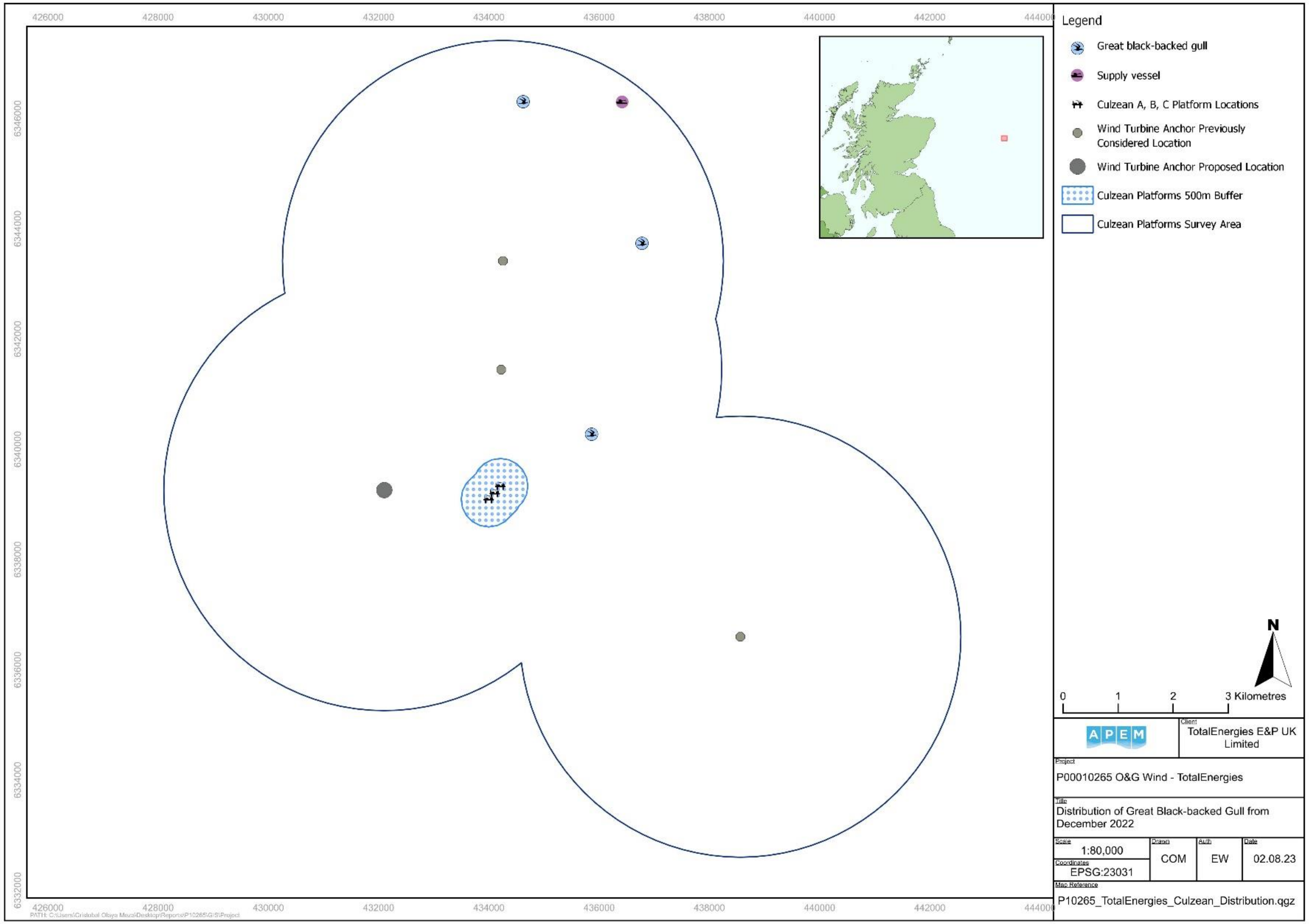


Figure 26 Distribution of great black-backed gulls from December 2022 (Survey 04)

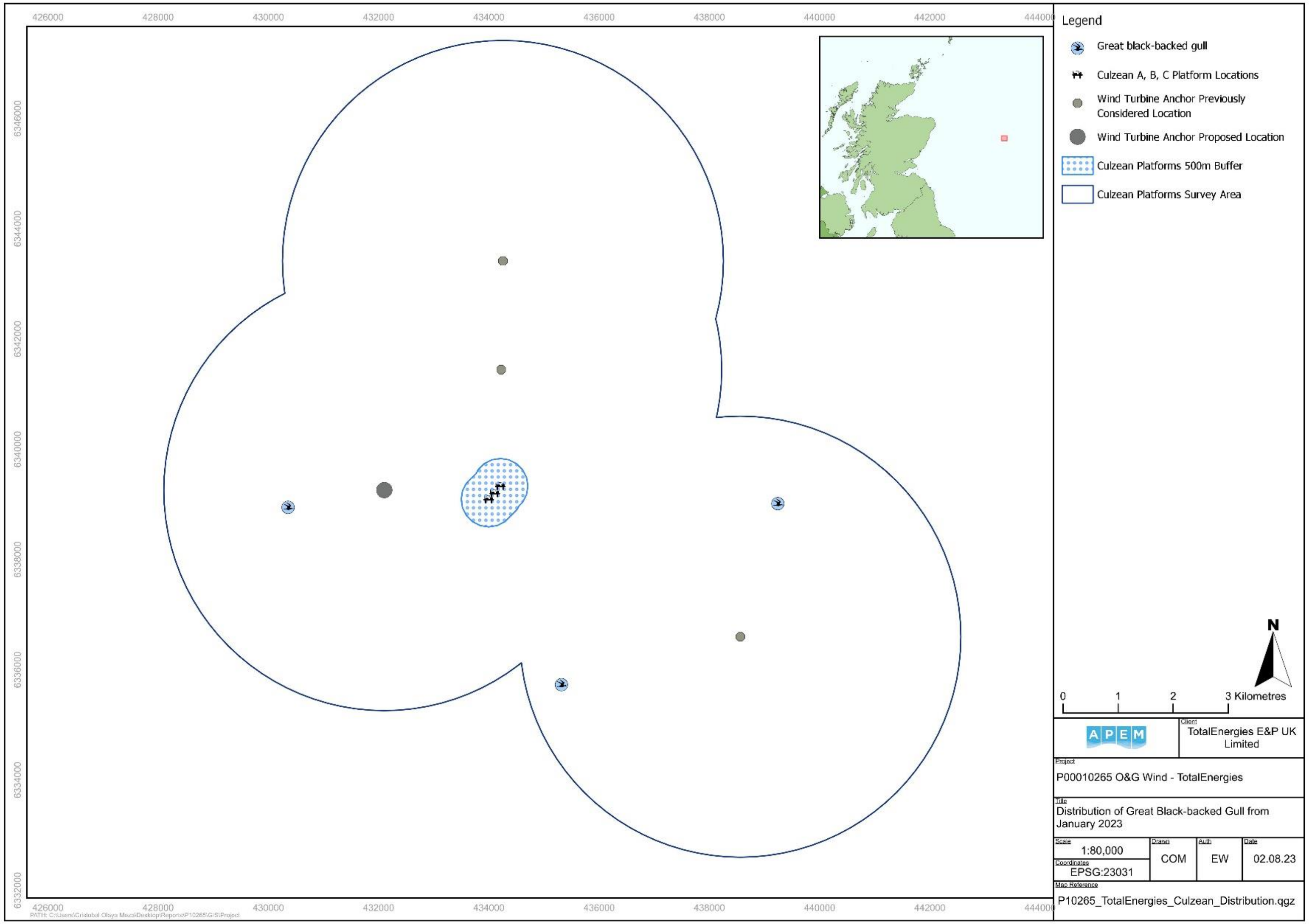


Figure 27 Distribution of great black-backed gulls from January 2023 (Survey 05)

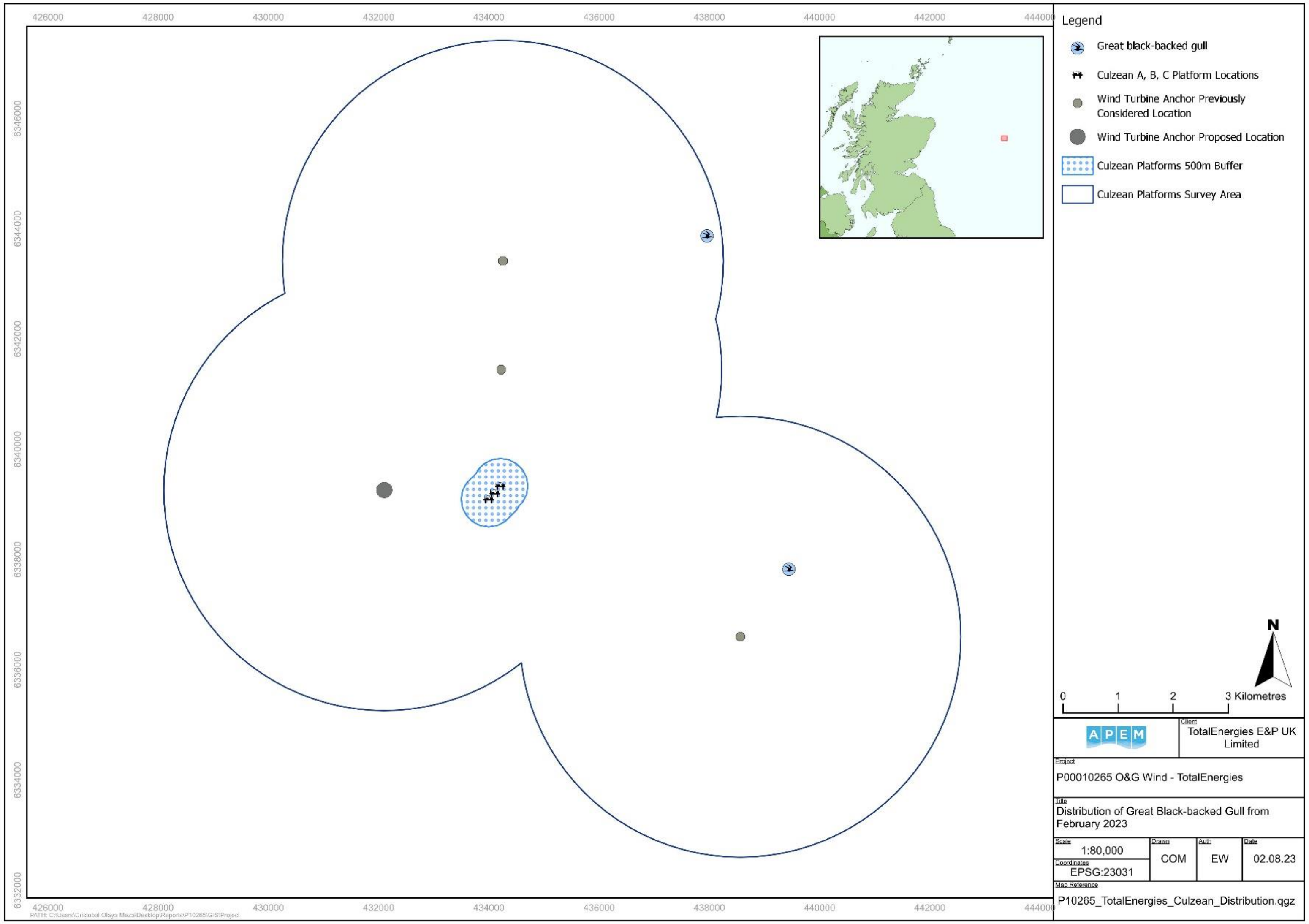


Figure 28 Distribution of great black-backed gulls from February 2023 (Survey 06)

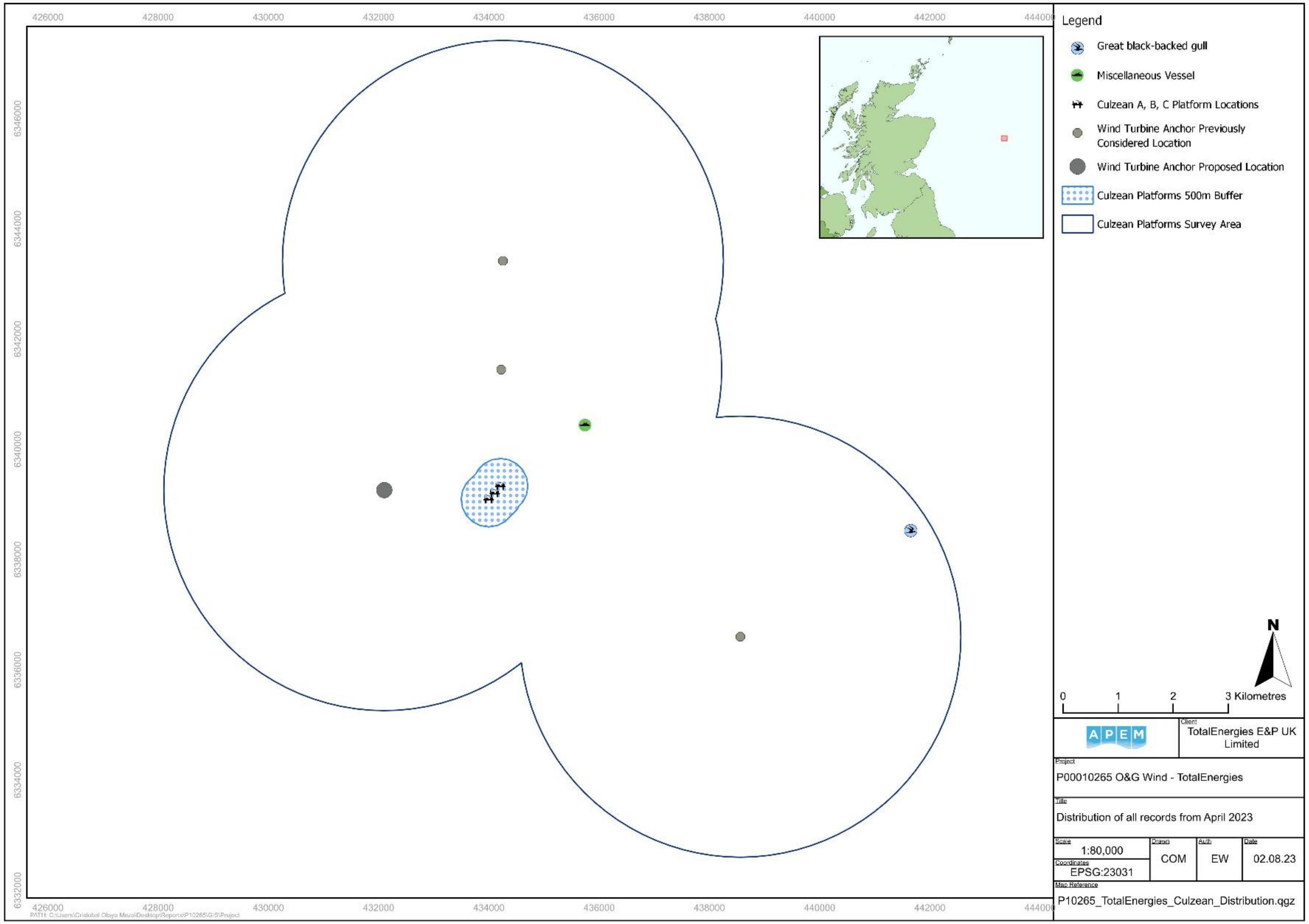


Figure 29 Distribution of great black-backed gulls from April 2023 (Survey 08)

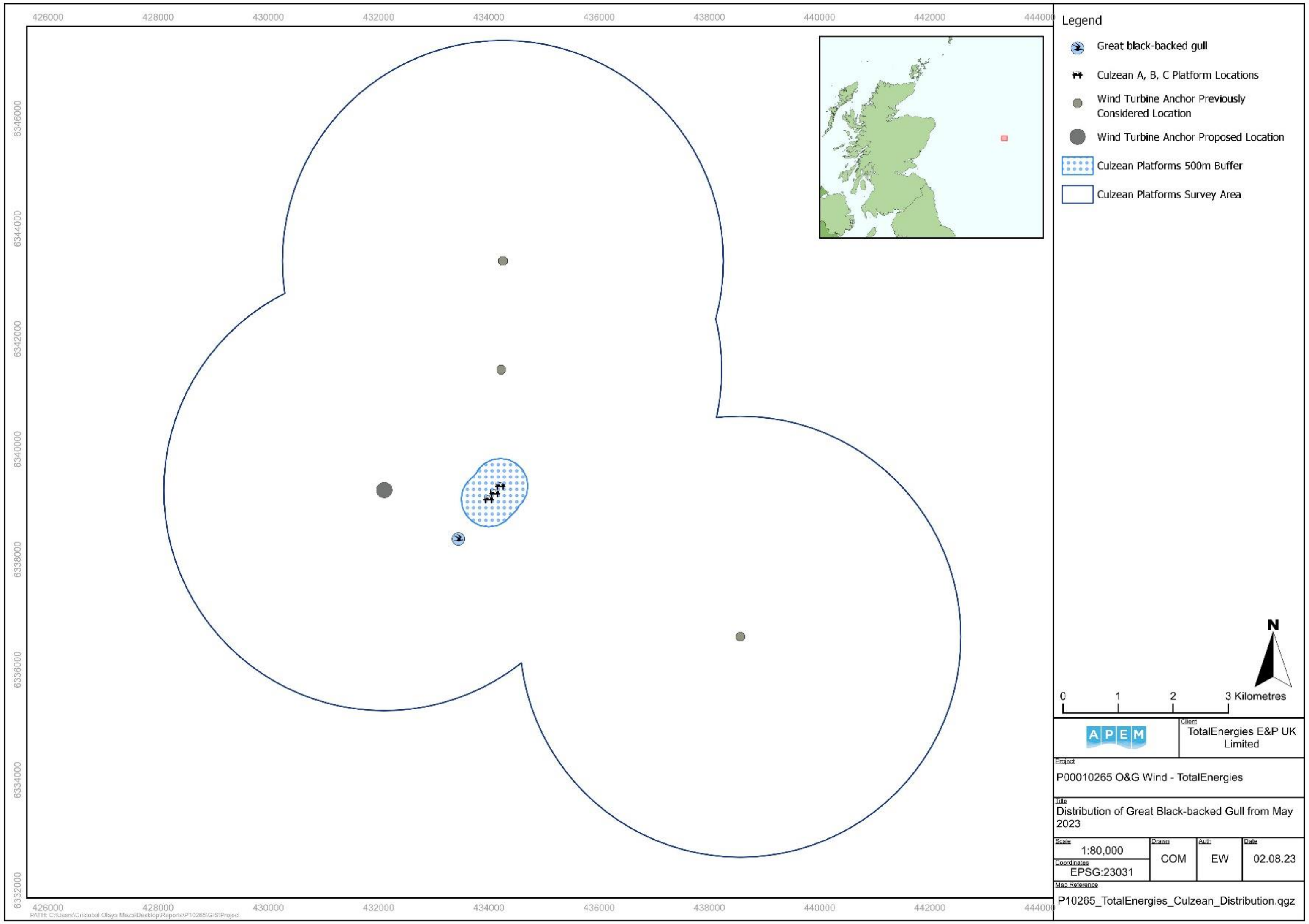


Figure 30 **Distribution of great black-backed gulls from May 2023 (Survey 09)**

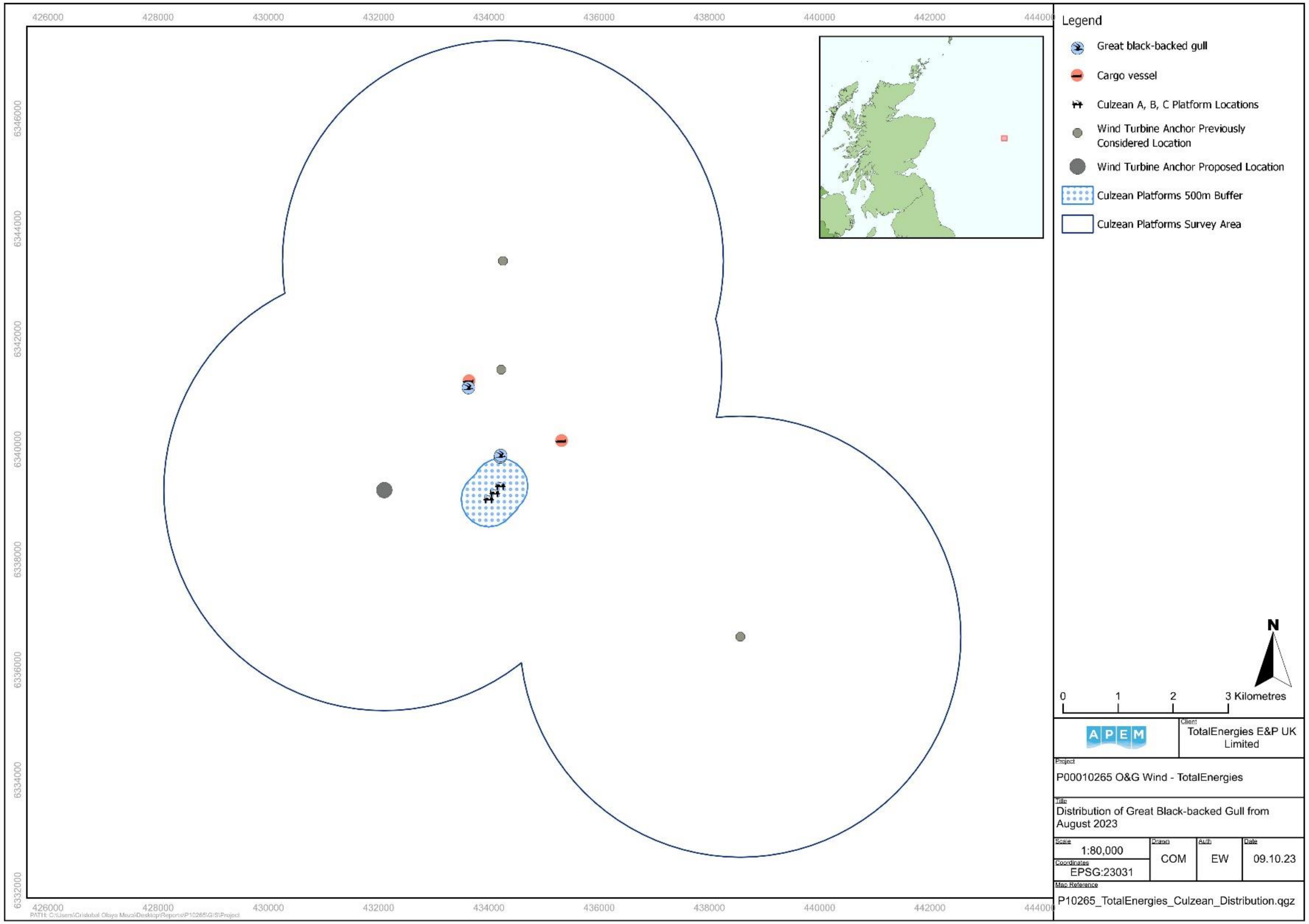


Figure 31 **Distribution of great black-backed gulls from August 2023 (Survey 12)**

4.7 Herring Gull - *Larus argentatus*

Herring gulls were recorded in late October 2022, December 2022, and January 2023. A peak raw count of three was recorded in December 2022, resulting in an abundance estimate of 25, equating to a density of 0.19 birds/km^2 (Table 15). Herring gulls were recorded in the non-breeding season in very low numbers, close to the Culzean Platforms to the east and south (Figure 32-Figure 34).

In January 2023, a single herring gull was recorded flying west (Figure 77).

Table 15 Raw counts, abundance and density estimates (individuals per km^2) of herring gulls in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S2 Late Oct-	2	17	2	51	1	0.13
S4 Dec-22	3	25	3	76	1	0.19
S5 Jan-23	1	9	1	34	1	0.07

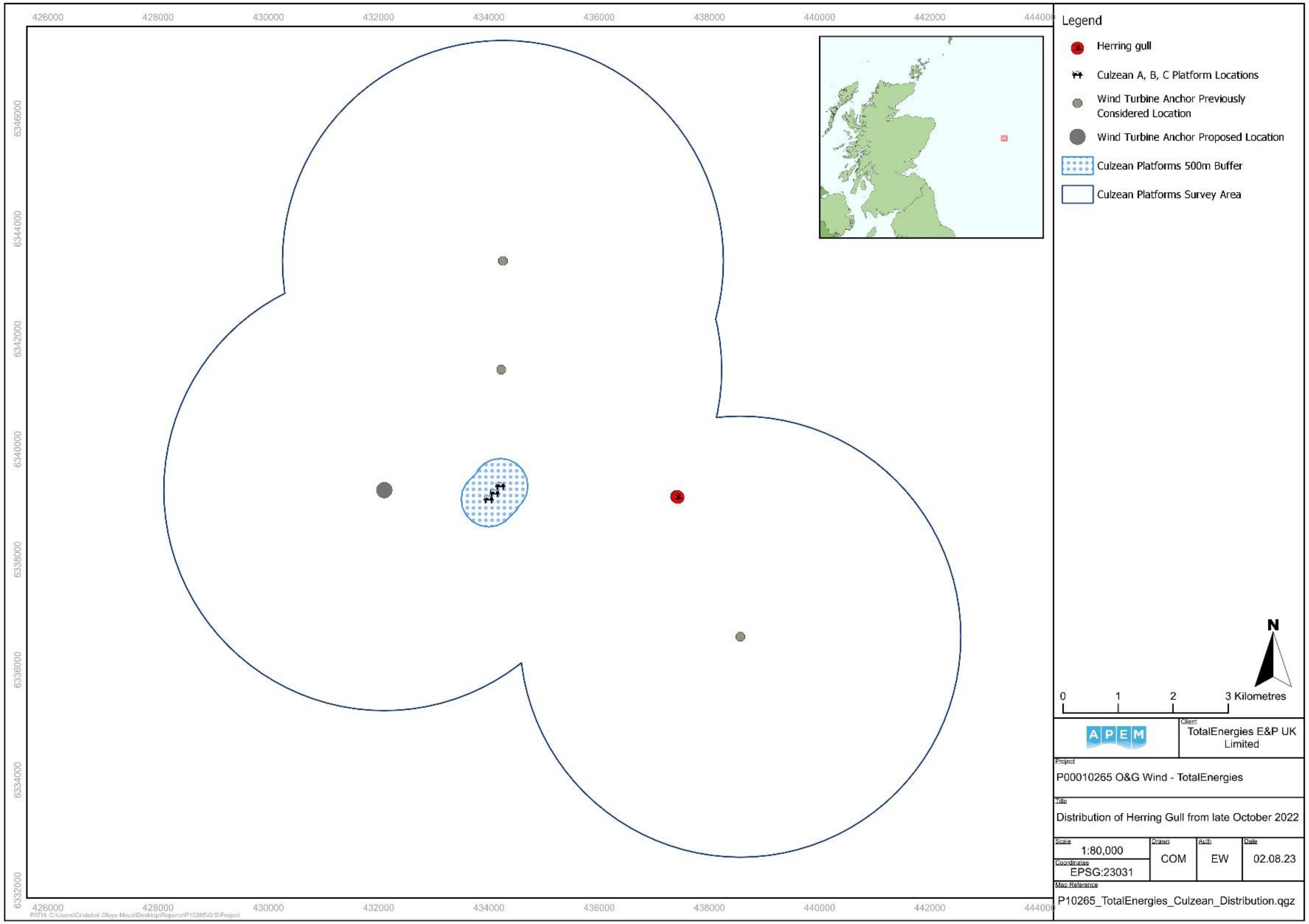


Figure 32 Distribution of herring gull from late October 2022 (Survey 02)

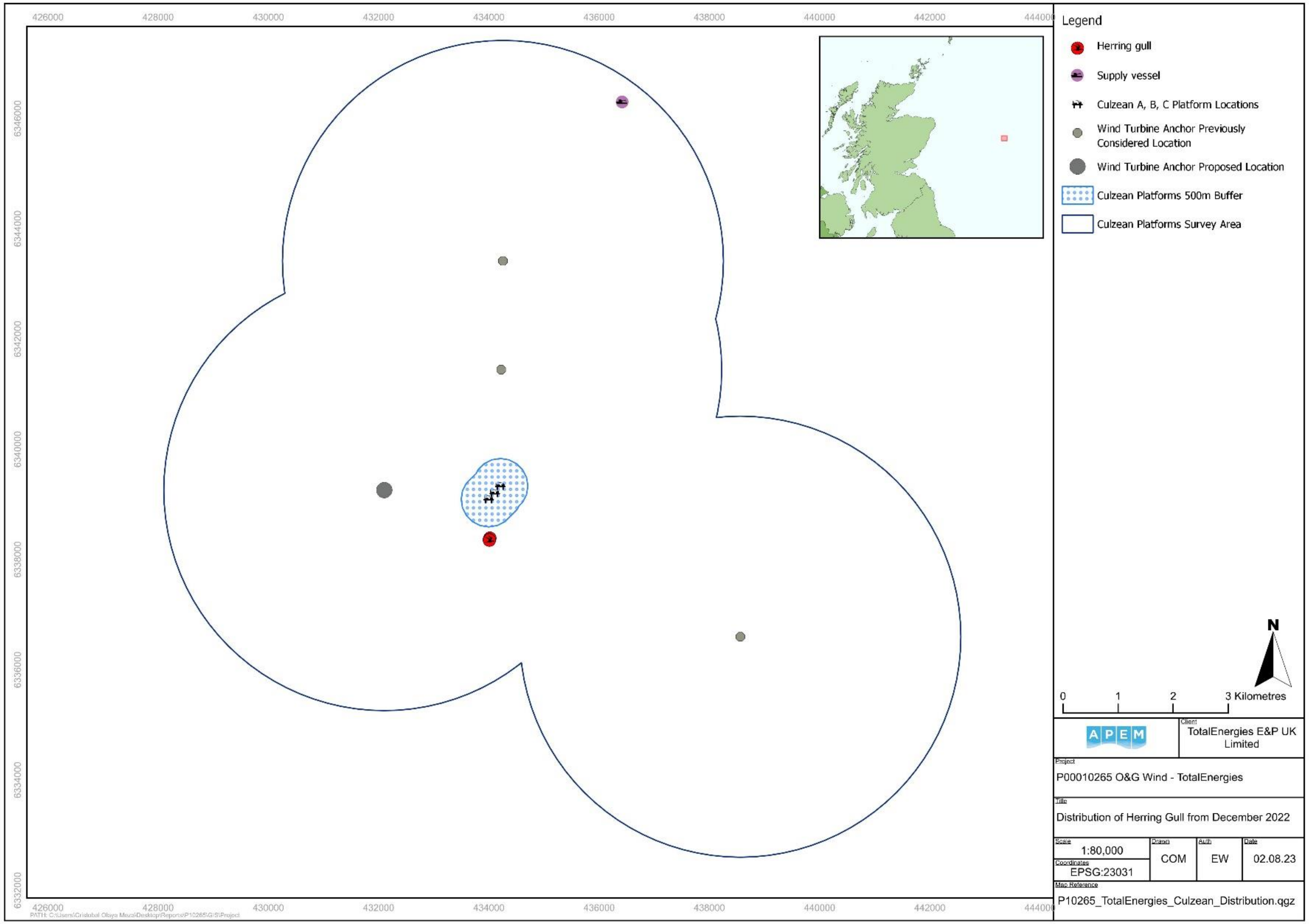


Figure 33 Distribution of herring gull from late December 2022 (Survey 04)

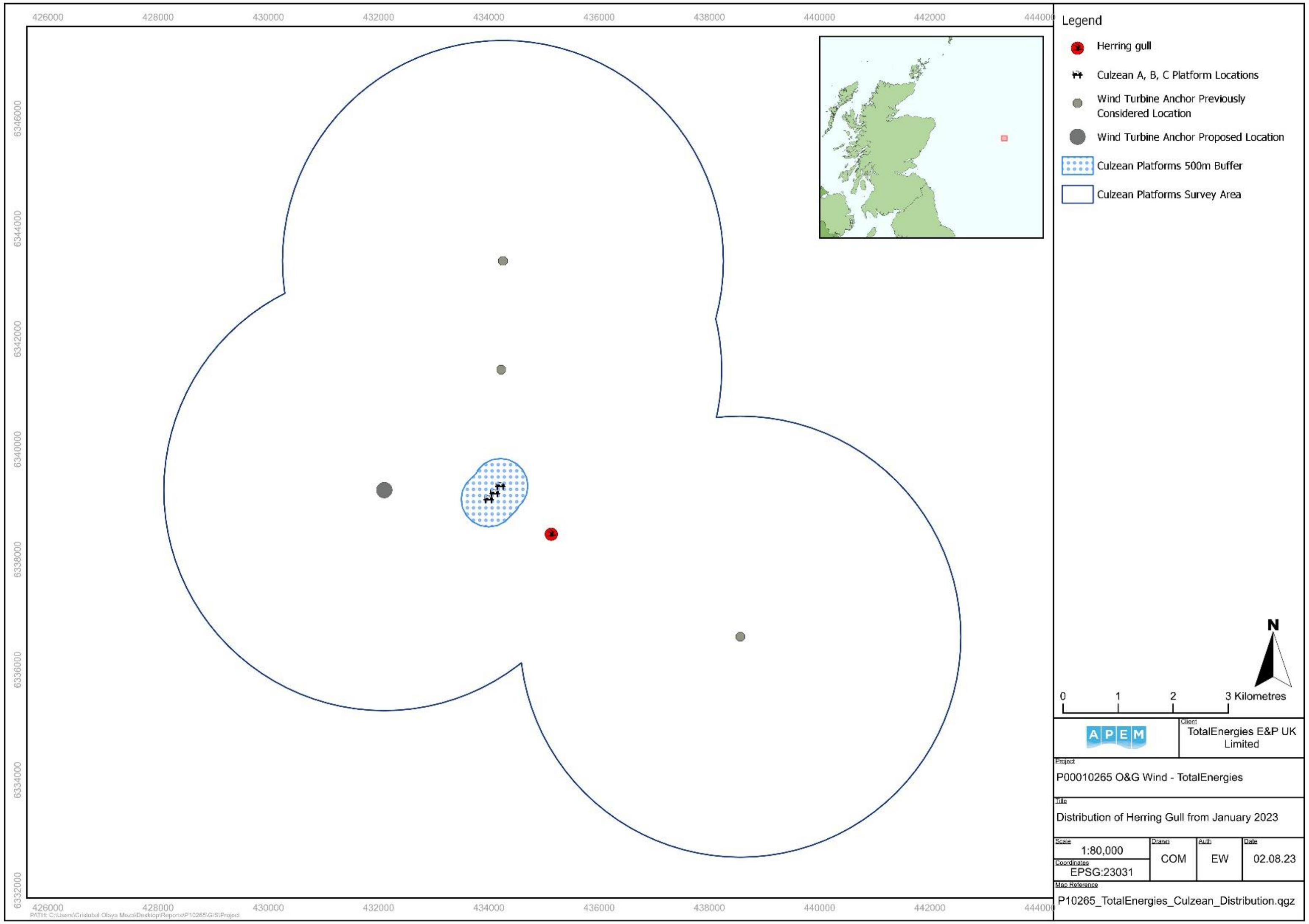


Figure 34 Distribution of herring gulls from January 2023 (Survey 05)

4.8 'Commic' Tern - *Sterna hirunda / Sterna paradisaea*

An individual 'commic' tern was recorded in June 2023, resulting in an abundance estimate of eight equating to a density of 0.06 birds/km^2 (Table 16). The 'commic' tern was recorded during the Arctic / common tern breeding season in the very south of the Survey Area (Figure 35).

In June 2023, a single 'commic' tern was recorded flying north-northeast (Figure 78).

Table 16 Raw counts, abundance and density estimates (individuals per km^2) of 'commic' terns in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S10 Jun-23	1	8	1	25	1	0.06

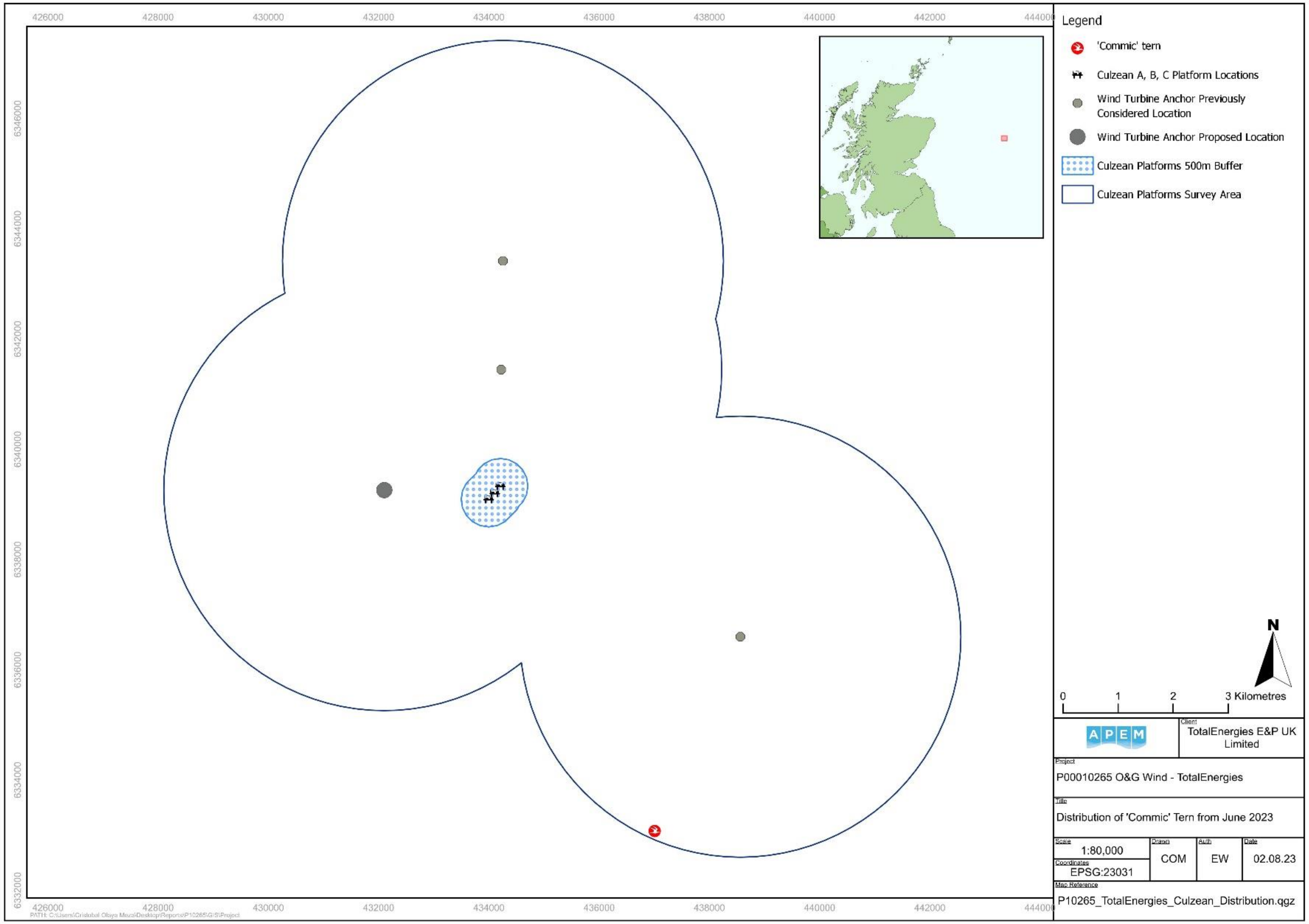


Figure 35 Distribution of 'commic' tern from June 2023 (Survey 10)

4.9 Guillemot - *Uria aalge*

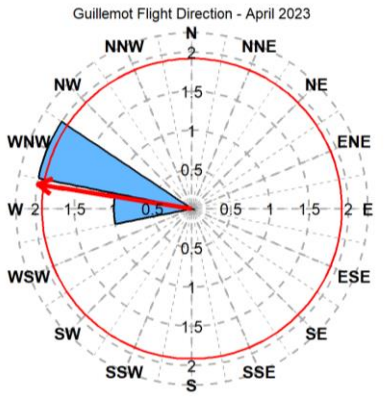
Guillemots were recorded in all surveys except June 2023. A peak raw count of 403 was recorded in late October 2022, resulting in an abundance estimate of 4,677 (apportioned and corrected for availability bias), equating to a density of 34.84 birds/km^2 (Table 17). Guillemots were recorded in the highest concentrations during their non-breeding season (Figure 37-Figure 42, Figure 47), and raw counts peaked during their autumn migration (Figure 38-Figure 38, Figure 46, Figure 47). They were recorded throughout the Survey Area, although lower numbers were recorded centrally. During the wintering season, the majority of guillemots were recorded south of the Culzean Platform (Figure 39). Low numbers were recorded across the Survey Area during the breeding season (Figure 43-Figure 45).

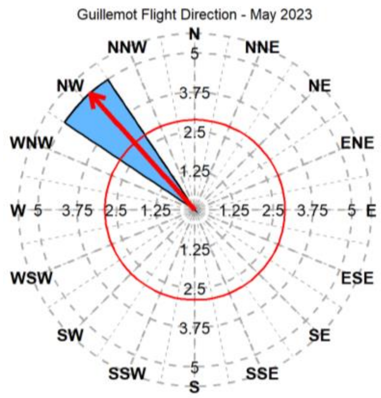
Table 17 Raw counts, abundance and density estimates (individuals per km^2) for guillemots in Survey Area

Survey	Raw count	Total Unapportioned					Total Apportioned		Total Apportioned and Corrected	
		Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
S1 Early Oct-22	105	875	550	1,275	0.10	6.53	875	6.52	1,145	8.53
S2 Late Oct-22	403	3,448	2,721	4,261	0.05	25.71	3,569	26.59	4,677	34.84
S3 Nov-22	198	1,661	1,133	2,265	0.07	12.39	1,860	13.85	2,427	18.08
S4 Dec-22	29	245	144	364	0.19	1.83	261	1.94	342	2.55
S5 Jan-23	22	189	103	283	0.21	1.41	198	1.47	260	1.93
S6 Feb-23	9	75	25	133	0.33	0.56	75	0.56	98	0.73
S7 Mar-23	2	17	2	42	0.71	0.13	16	0.12	18	0.14
S8 Apr-23	16	135	68	211	0.25	1.01	135	1.01	169	1.26
S9 May-23	7	60	7	155	0.38	0.45	60	0.45	65	0.49
S11 Jul-23	9	76	17	143	0.33	0.57	75	0.56	96	0.71
S12 Aug-23	7	59	17	118	0.38	0.44	59	0.44	77	0.58
S13 Sep-23	23	195	93	288	0.21	1.45	203	1.51	266	1.98

Significant predominant direction of flight for guillemots (Figure 36) was recorded in April 2023 (west) (Figure 36a) and May 2023 (northwest) (Figure 36b).

Guillemots were also recorded flying in September 2022, March 2023, and July 2023, but not in any significant predominant direction (Figure 79).





Number of Observations	3	Number of Observations	5
Mean Vector (µ)	279.817	Mean Vector (µ)	318.598
Length of Mean Vector (r)	0.995	Length of Mean Vector (r)	0.996
Rayleigh Test (Z)	2.970	Rayleigh Test (Z)	4.963
Rayleigh Test (p)	0.035	Rayleigh Test (p)	0.001
A. April 2023 (Survey 08)		**B. May 2023 (Survey 09)**	

Figure 36 Summary of significant flight direction of guillemots during survey period

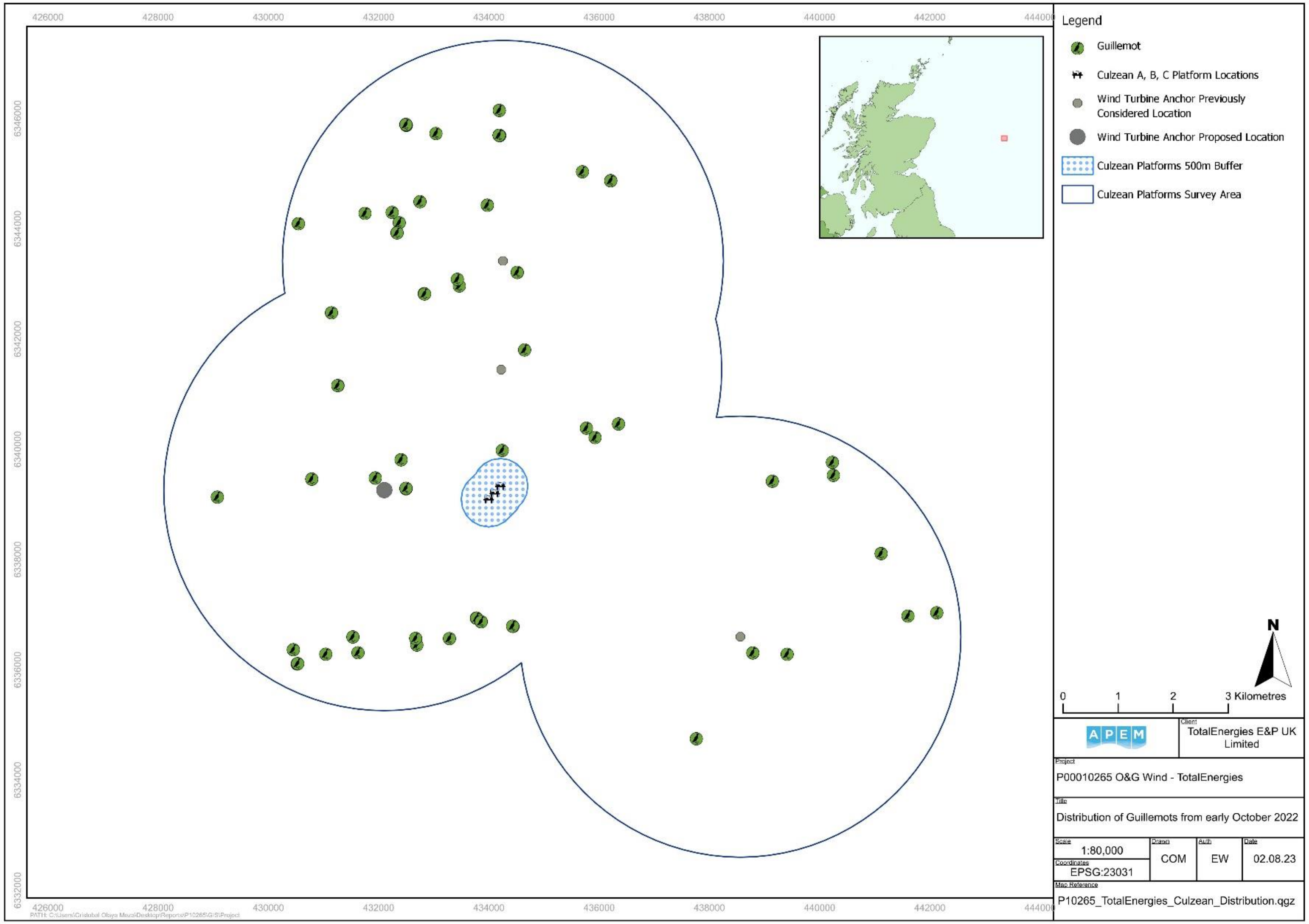


Figure 37 Distribution of guillemots from early October 2022 (Survey 01)

Figure 38 **Distribution of guillemots from late October 2022 (Survey 02)**

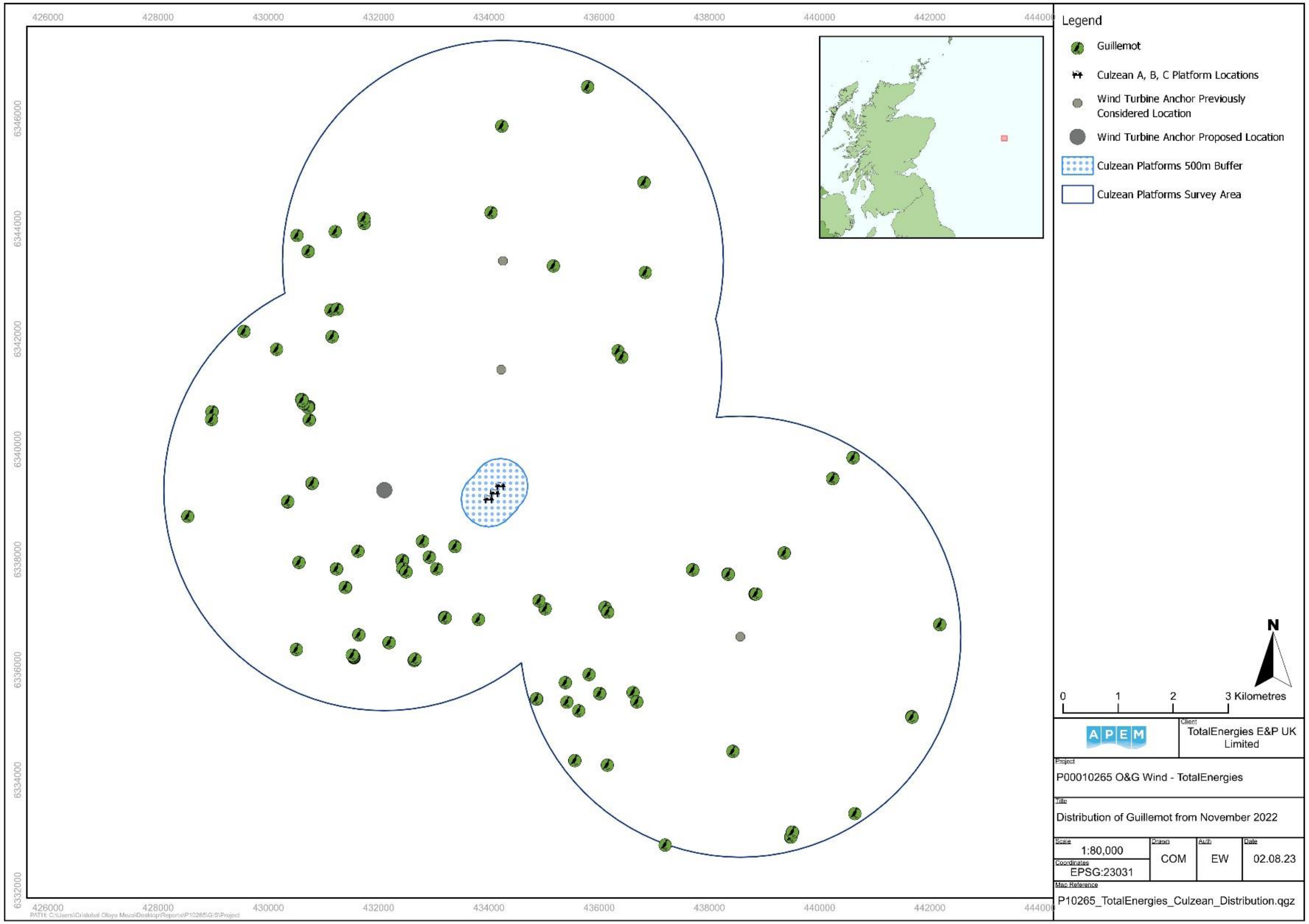


Figure 39 Distribution of guillemots from November 2022 (Survey 03)

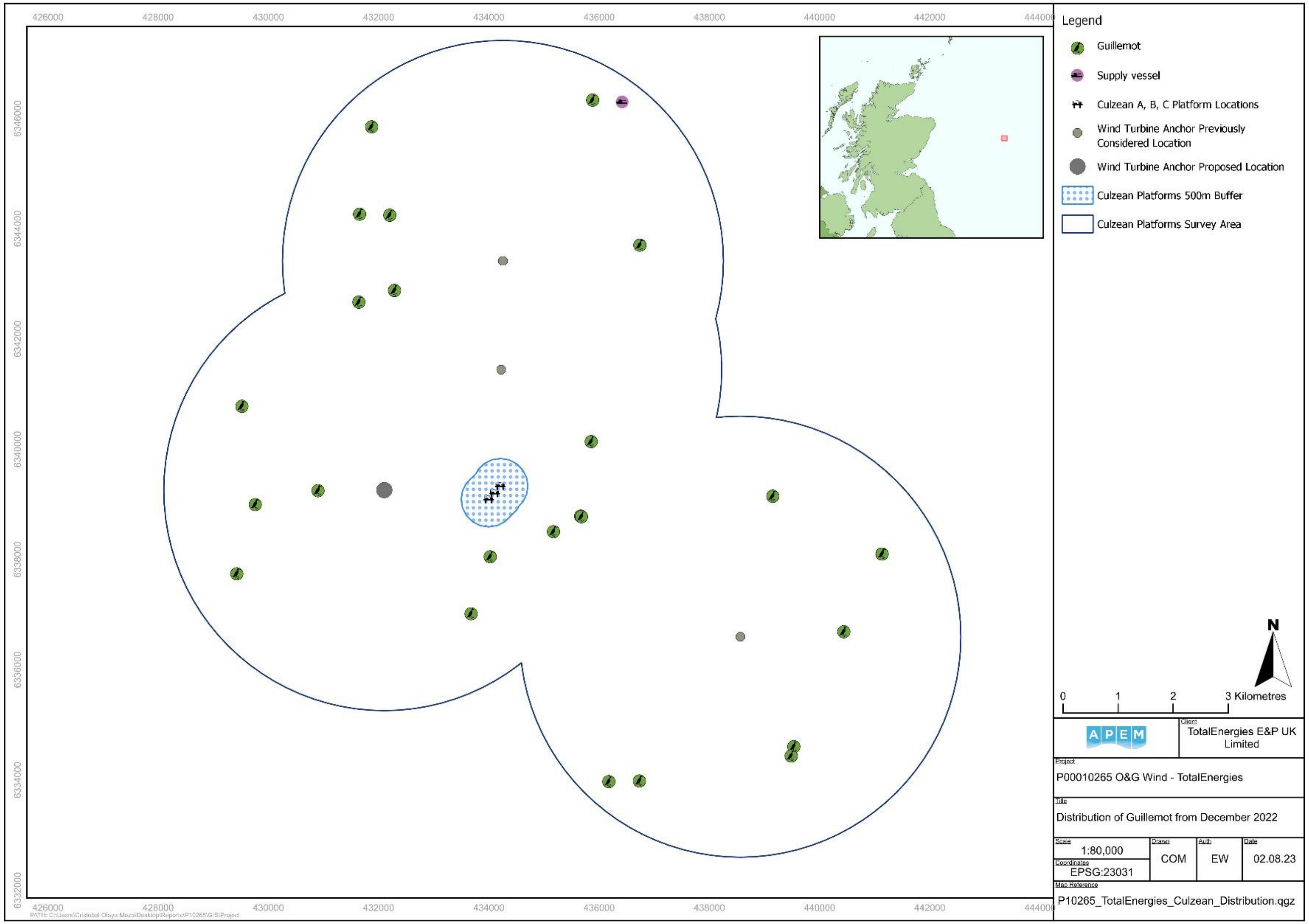


Figure 40 Distribution of guillemots from December 2022 (Survey 04)

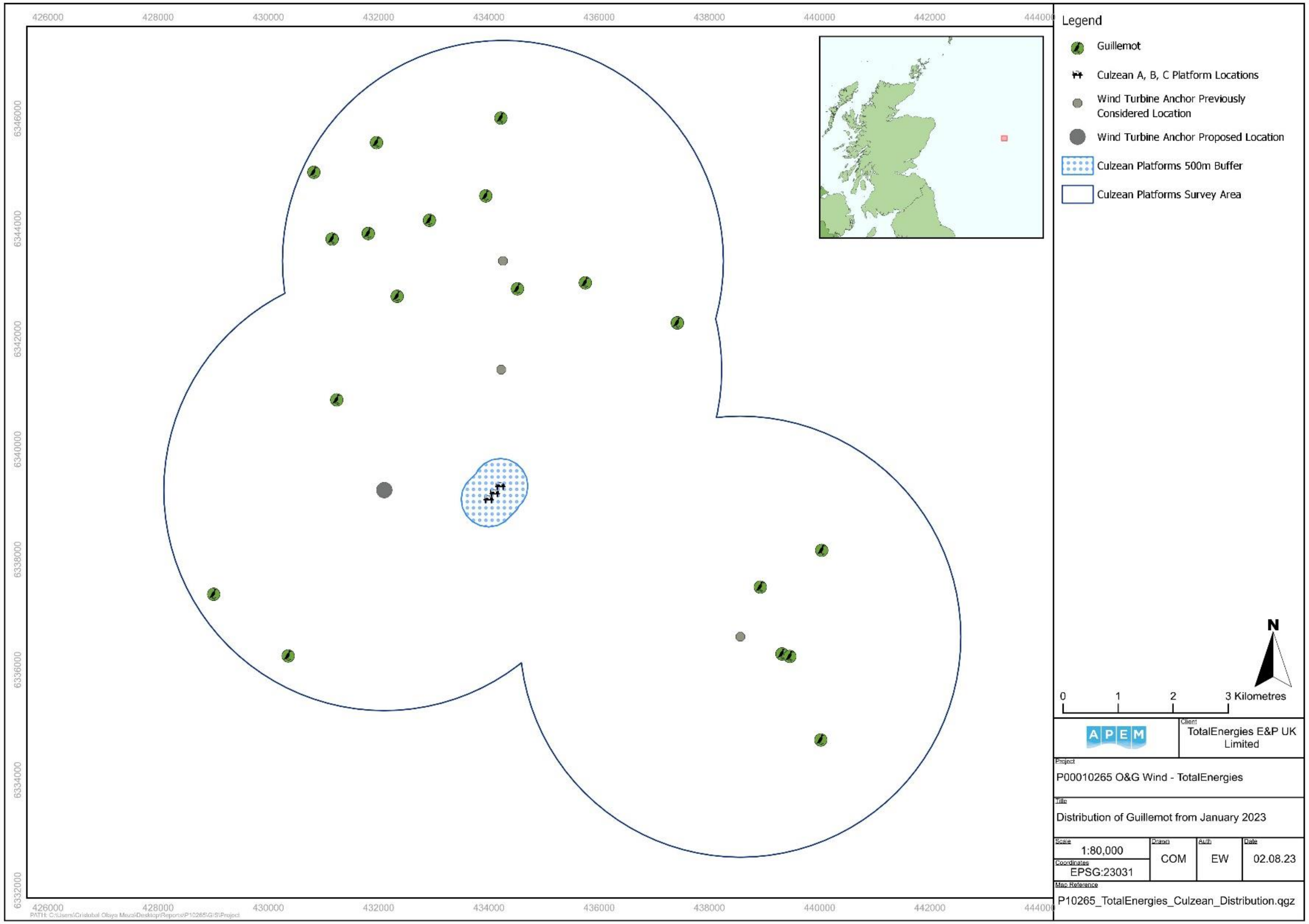


Figure 41 Distribution of guillemots from January 2023 (Survey 05)

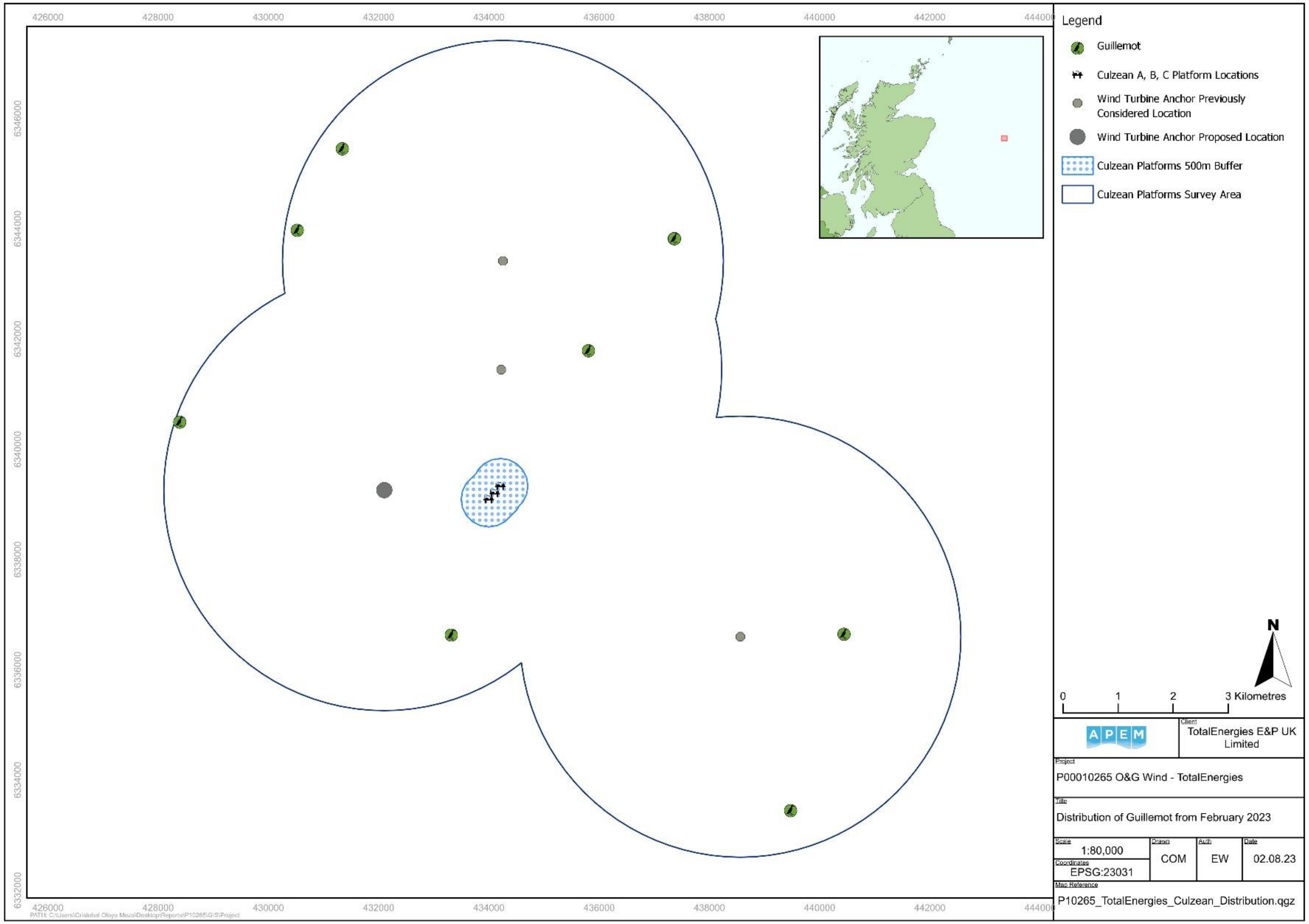


Figure 42 Distribution of guillemots from February 2023 (Survey 06)

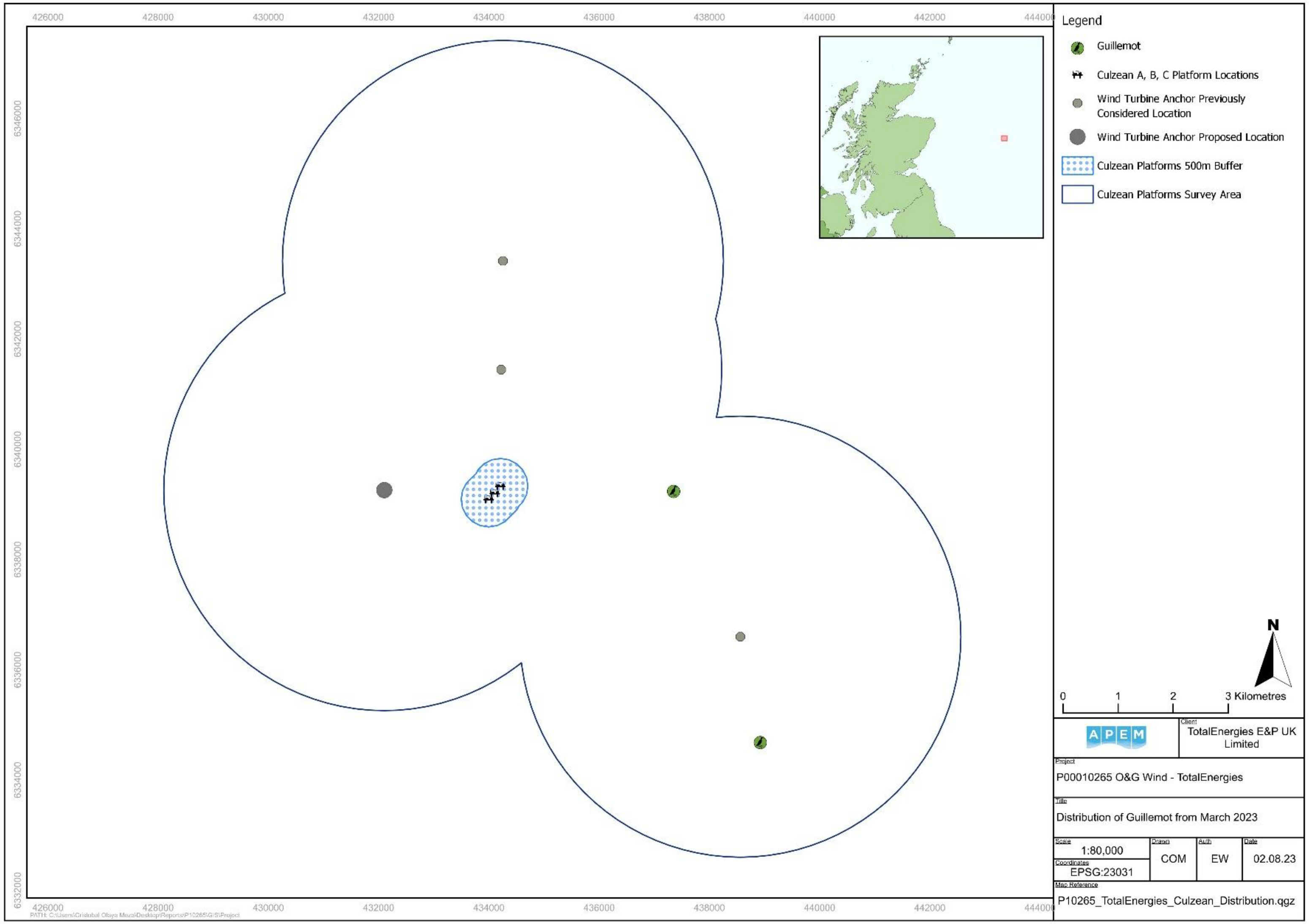


Figure 43 Distribution of guillemots from March 2023 (Survey 07)

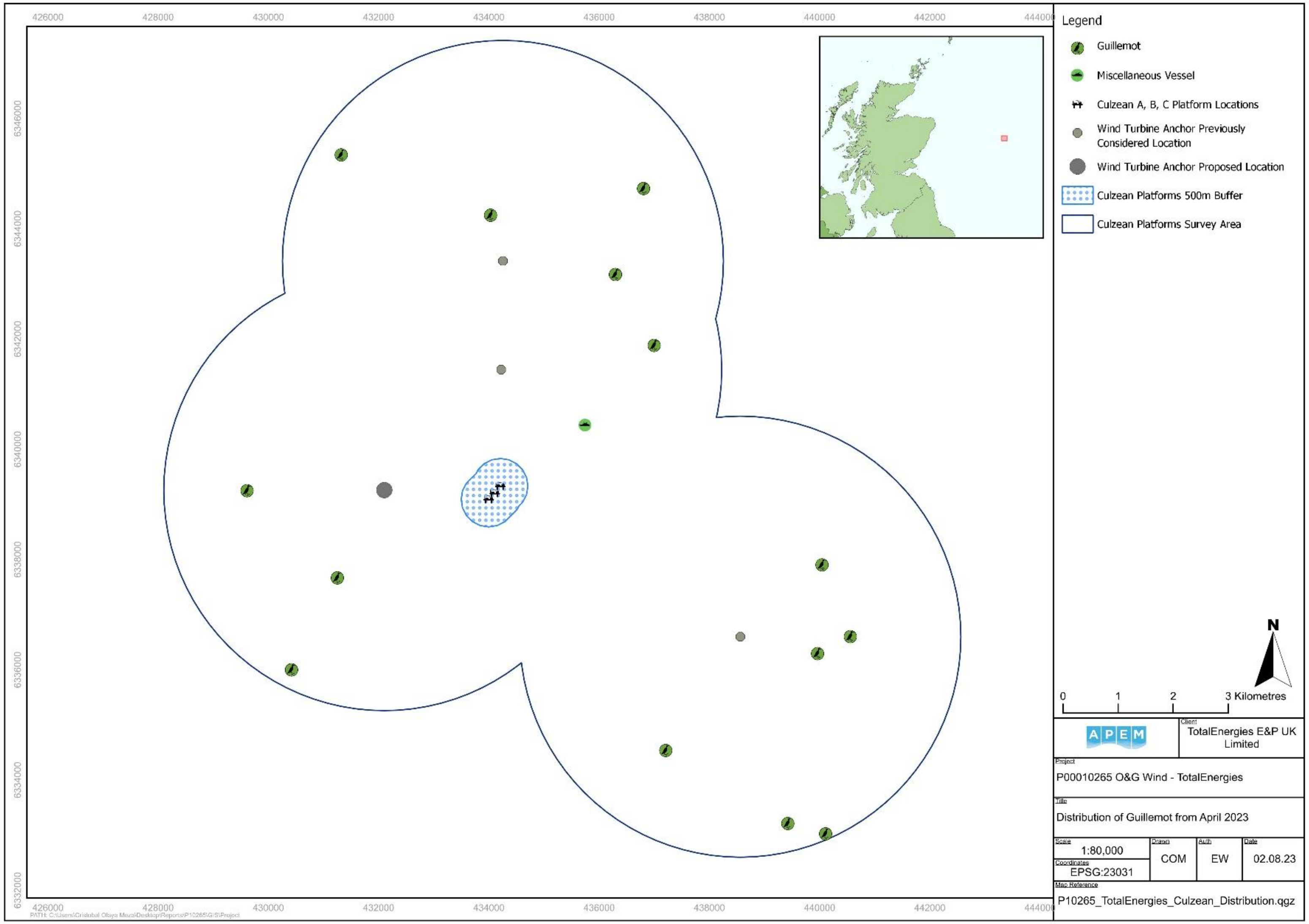


Figure 44 Distribution of guillemots from April 2023 (Survey 08)

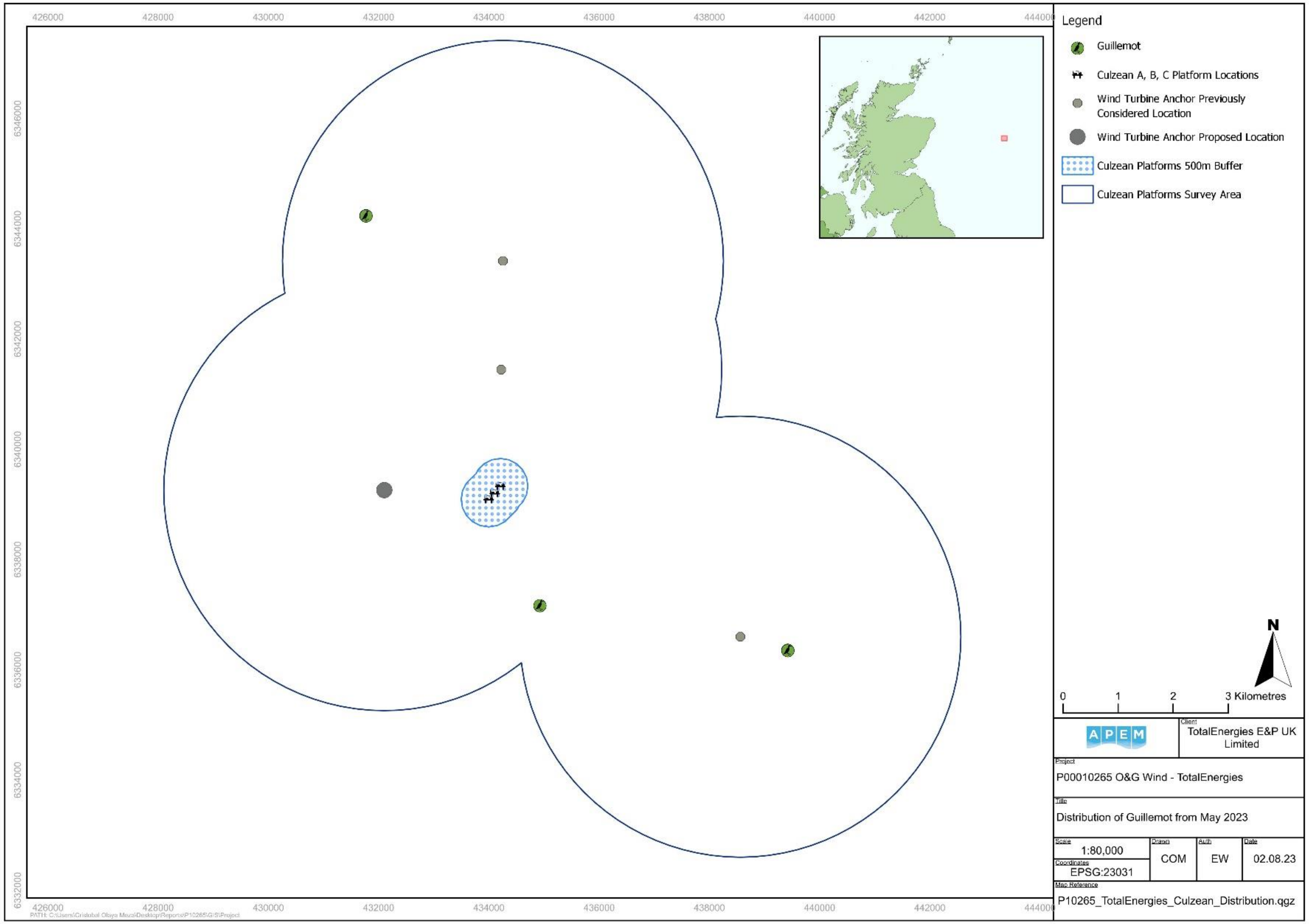


Figure 45 Distribution of guillemots from May 2023 (Survey 09)

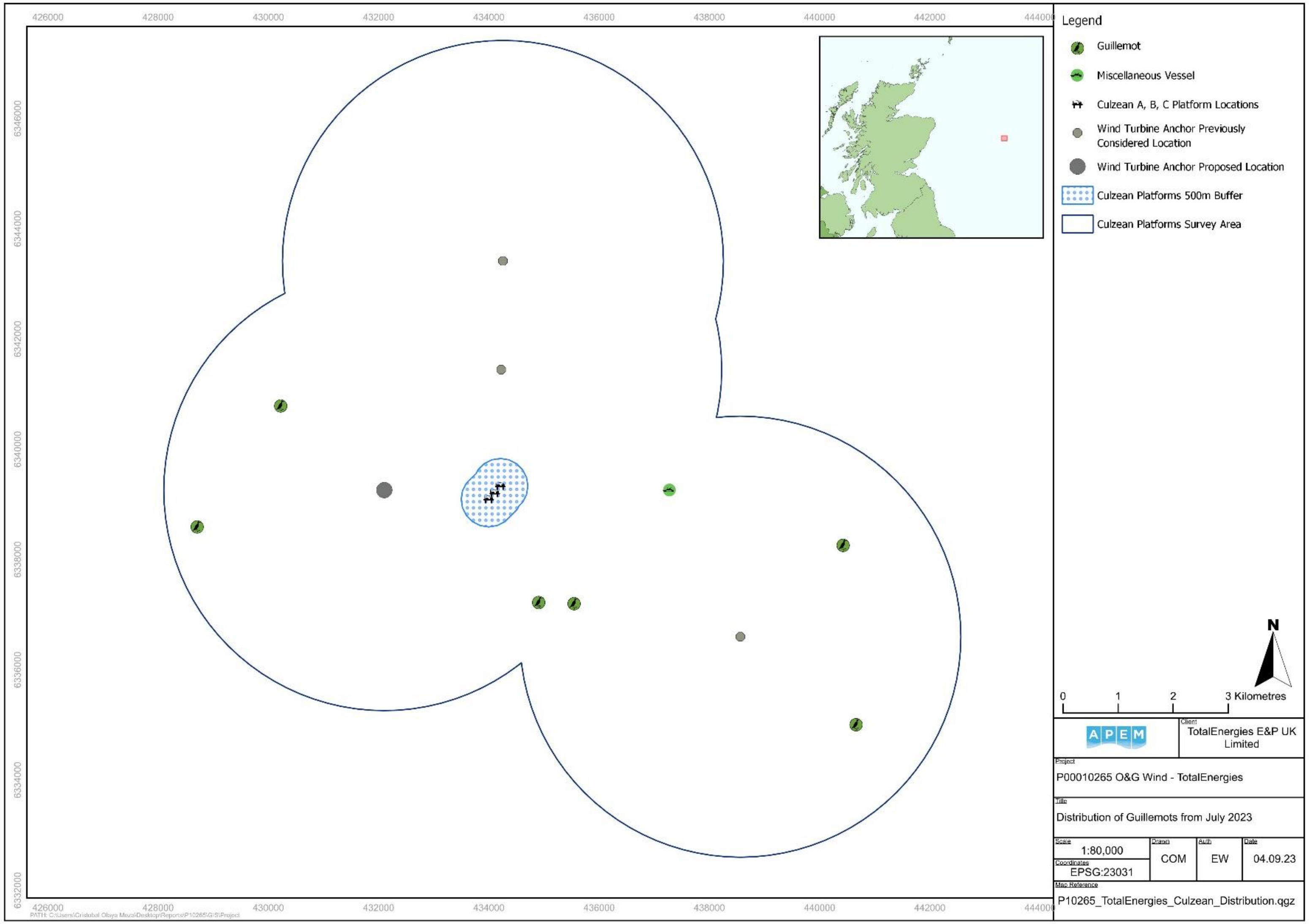


Figure 46 **Distribution of guillemots from July 2023 (Survey 11)**

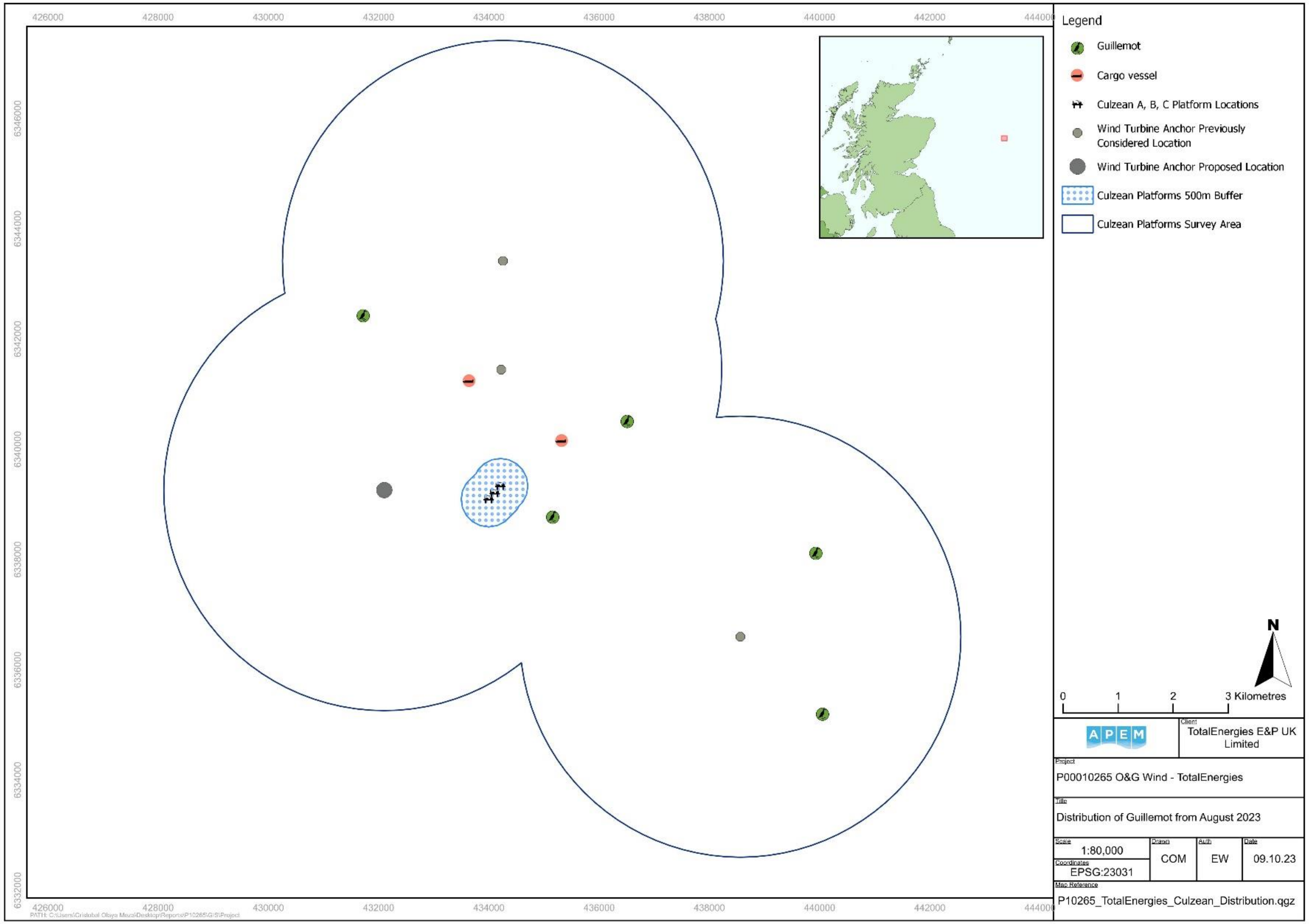


Figure 47 Distribution of guillemots from August 2023 (Survey 12)

4.10 Razorbill - *Alca torda*

Razorbills were recorded in early October 2022 to December 2022, February 2023, June 2023, August to September 2023. A peak raw count of 27 was recorded in late October 2022, resulting in an abundance estimate of 289 (apportioned and corrected for availability bias), equating to a density of 2.15 birds/km^2 (Table 18). Razorbills were recorded in the highest concentrations towards the end of their autumn migratory season (Figure 49). Razorbills showed no distributional patterns and were recorded scattered across the Survey Area. During the breeding and wintering season, razorbills were recorded in very low numbers. (Figure 53**,** Figure 50**-**Figure 51).

No razorbills were observed flying during the survey period.

Table 18 Raw counts, abundance and density estimates (individuals per km^2) for razorbills in Survey Area

Survey	Raw count	Total Unapportioned					Total Apportioned		Total Apportioned and Corrected	
		Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
S1 Early Oct-22	1	8	1	25	1.00	0.06	8	0.06	10	0.07
S2 Late Oct-22	27	231	111	376	0.19	1.72	239	1.78	289	2.15
S3 Nov-22	4	34	4	84	0.50	0.25	37	0.28	45	0.34
S4 Dec-22	2	17	2	42	0.71	0.13	18	0.13	22	0.16
S6 Feb-23	3	25	3	58	0.58	0.19	25	0.19	30	0.23
S10 Jun-23	1	8	1	25	1.00	0.06	8	0.06	10	0.07
S12 Aug-23	1	8	1	25	1.00	0.06	8	0.06	10	0.07
S13 Sep-23	1	8	1	25	1.00	0.06	8	0.06	10	0.08

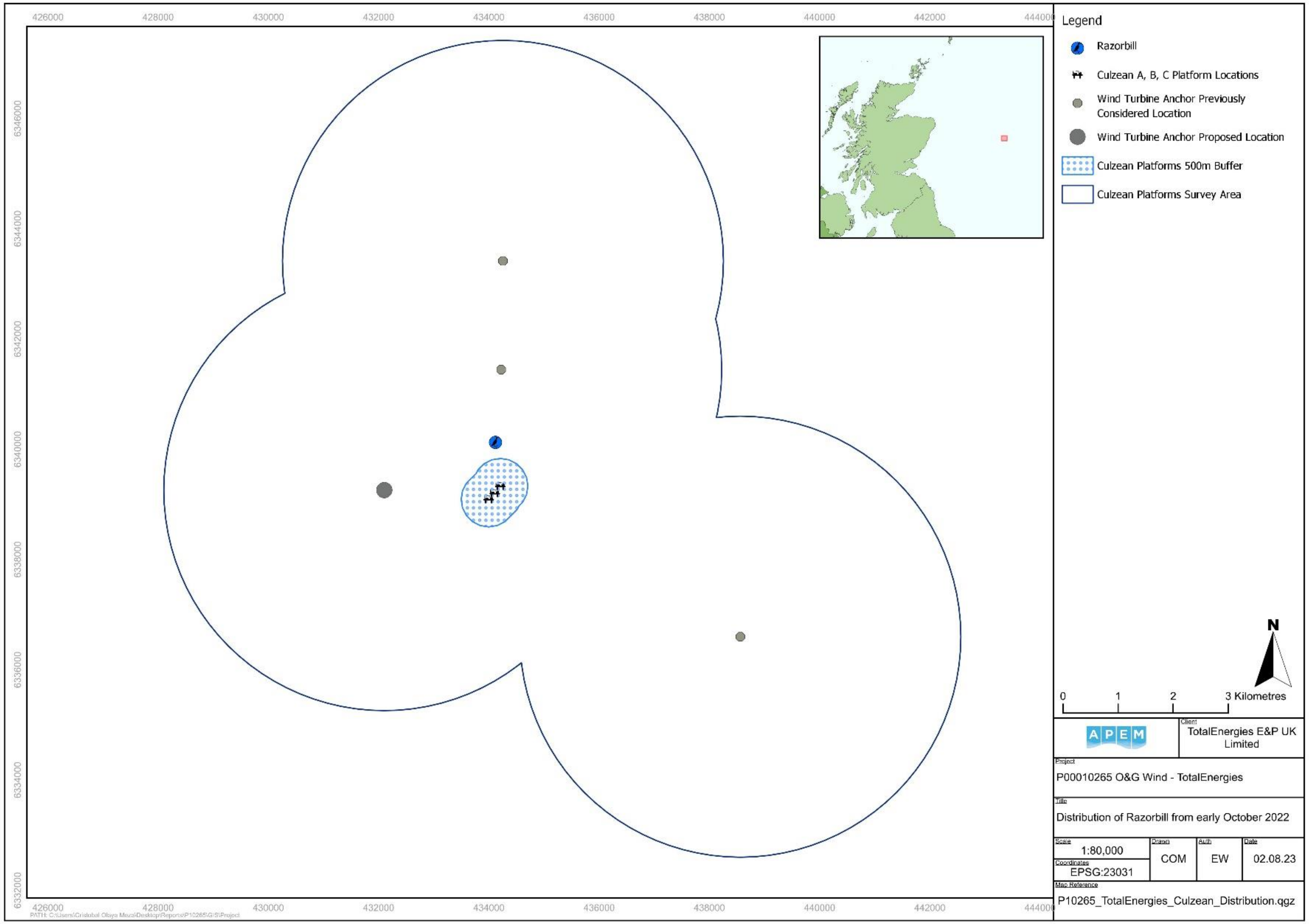


Figure 48 **Distribution of razorbills from early October 2022 (Survey 01)**

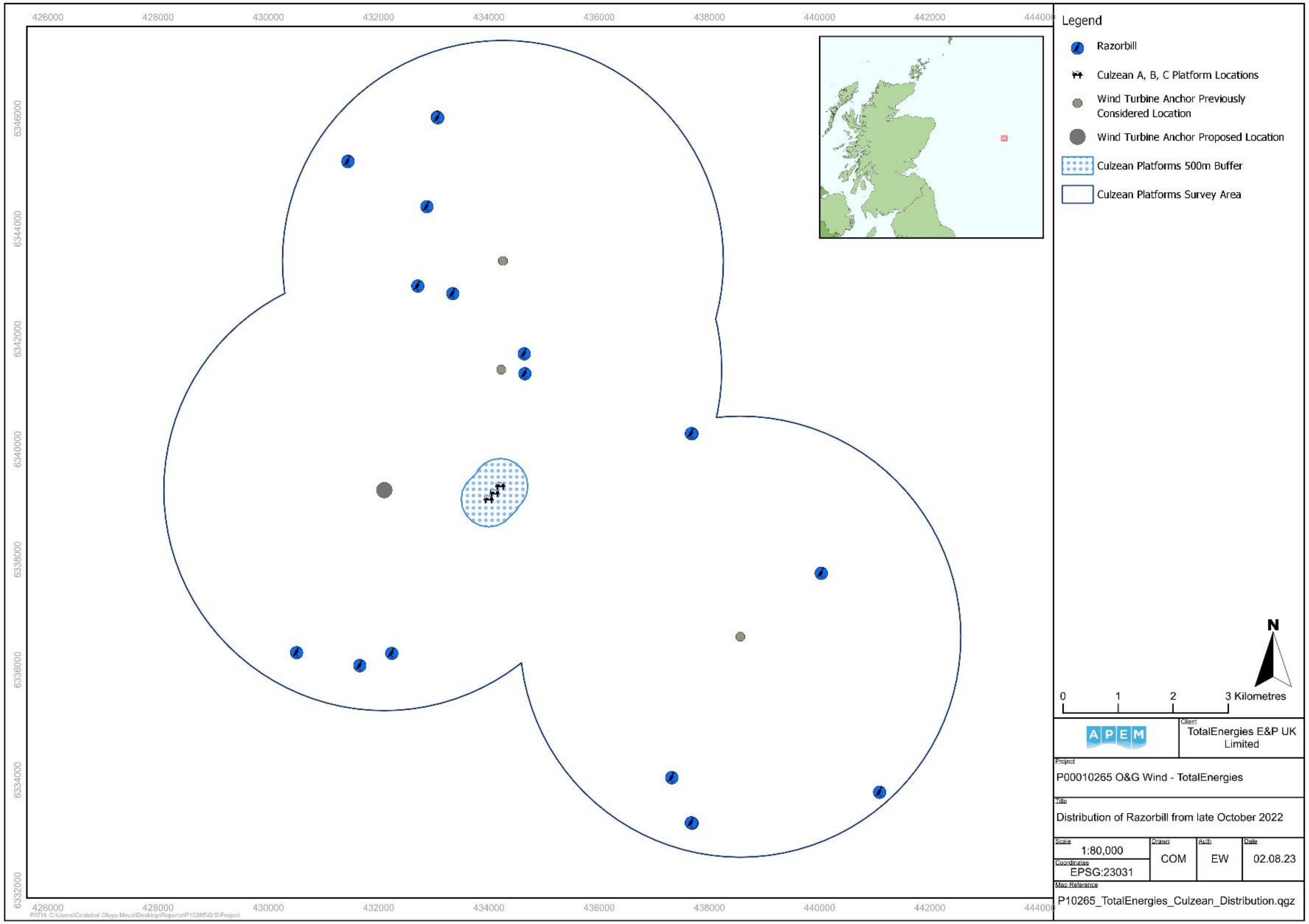


Figure 49 Distribution of razorbills from late October 2022 (Survey 02)

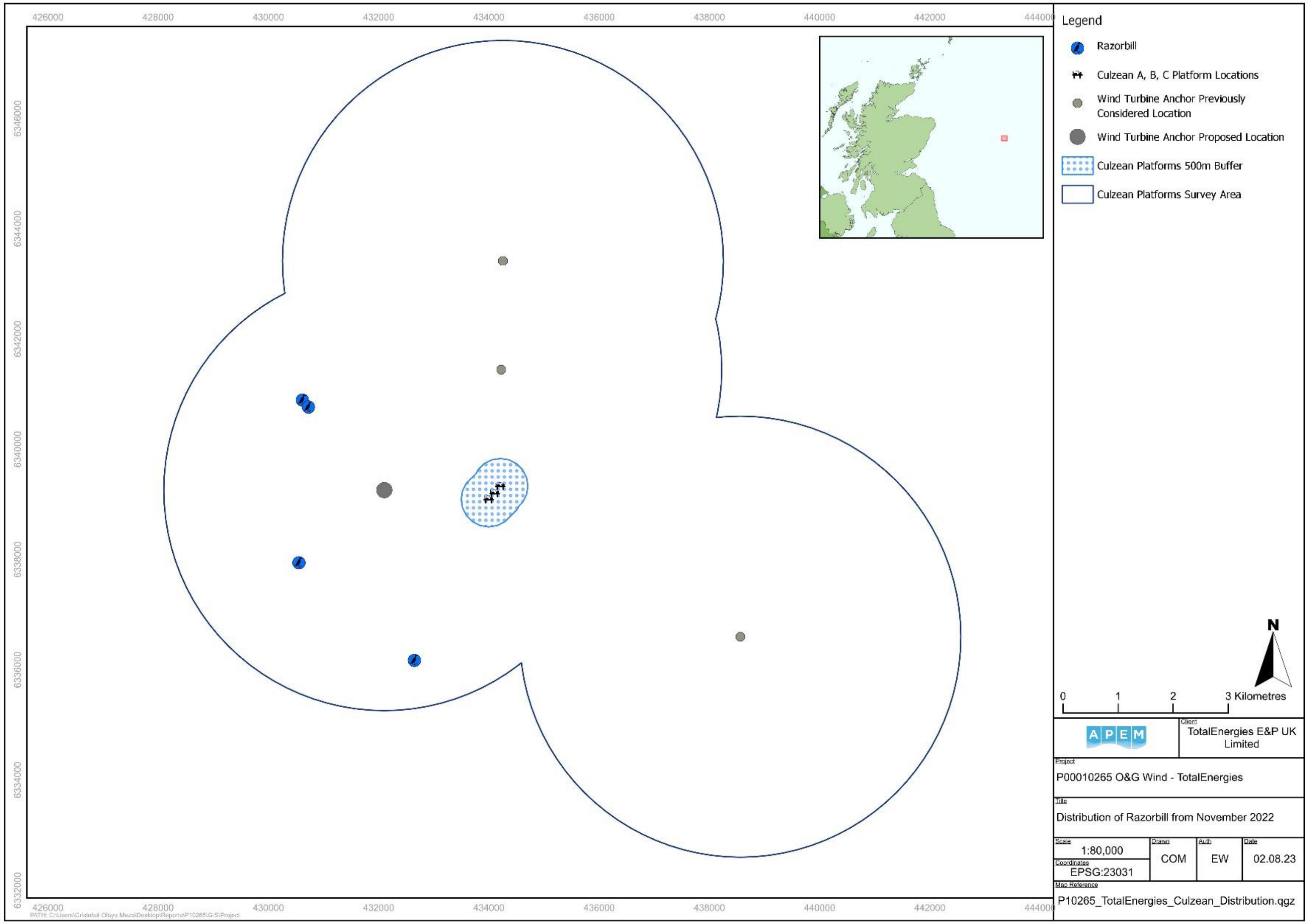


Figure 50 Distribution of razorbills from November 2022 (Survey 03)

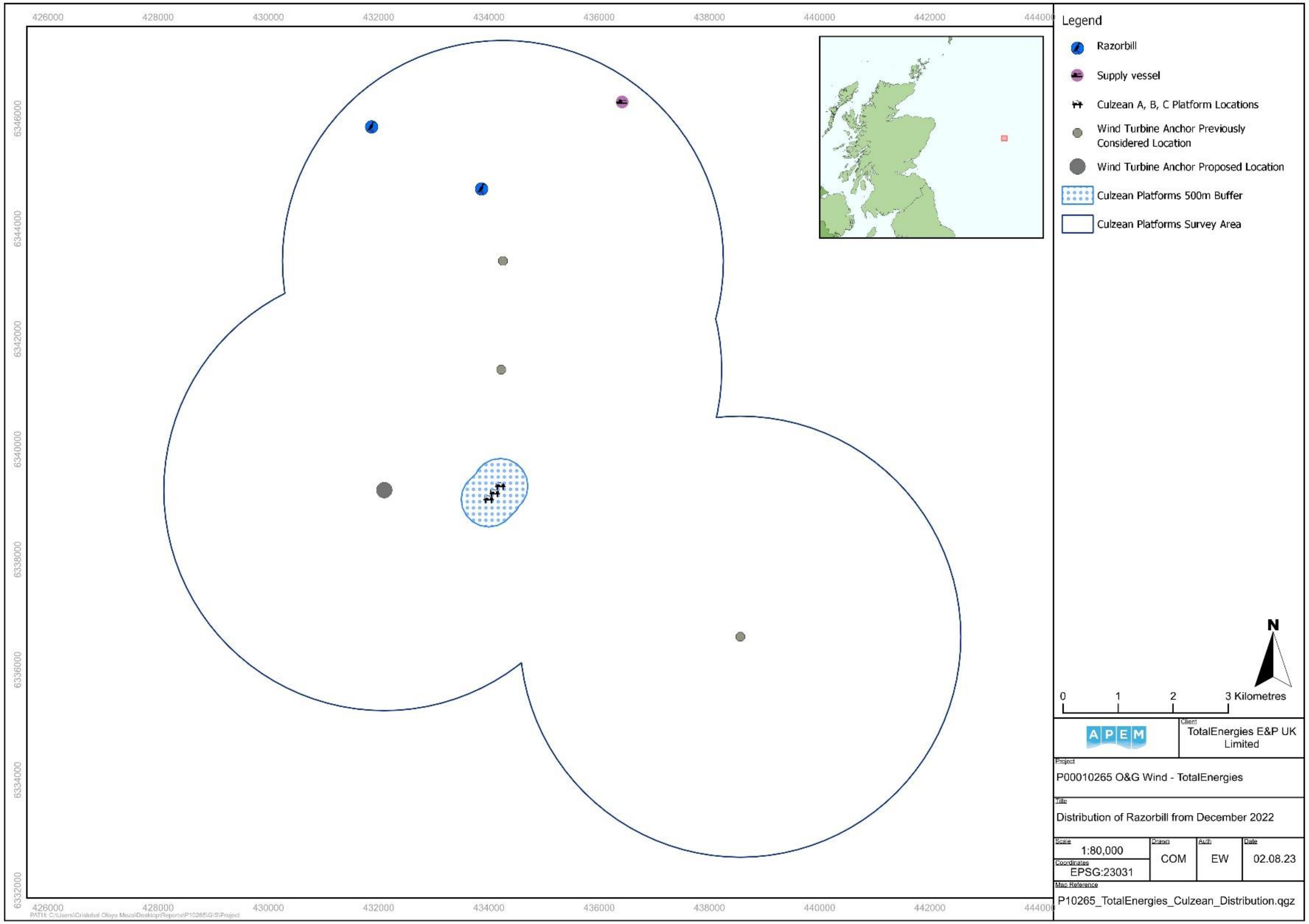


Figure 51 Distribution of razorbills from December 2022 (Survey 04)

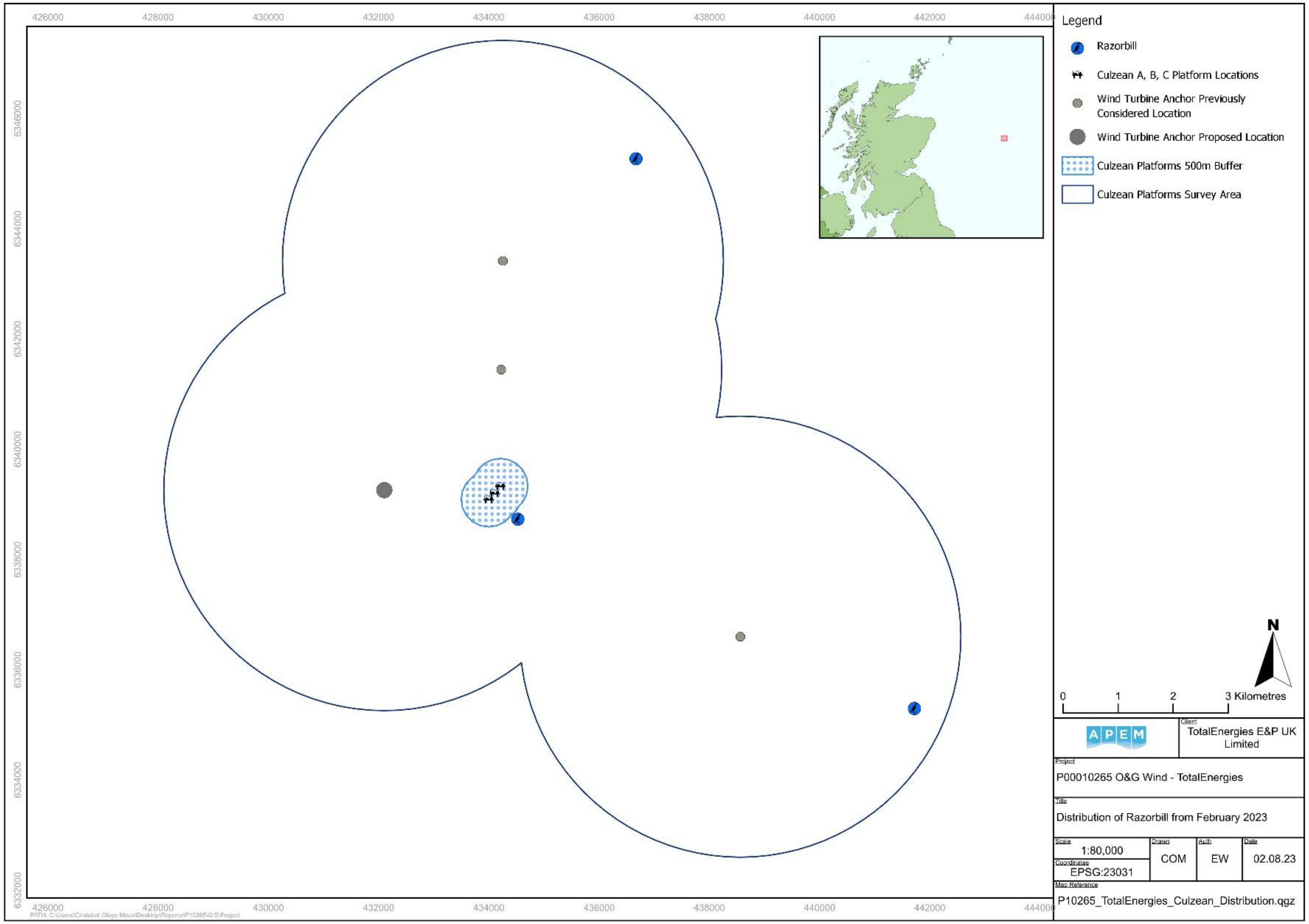


Figure 52 **Distribution of razorbills from February 2023 (Survey 06)**

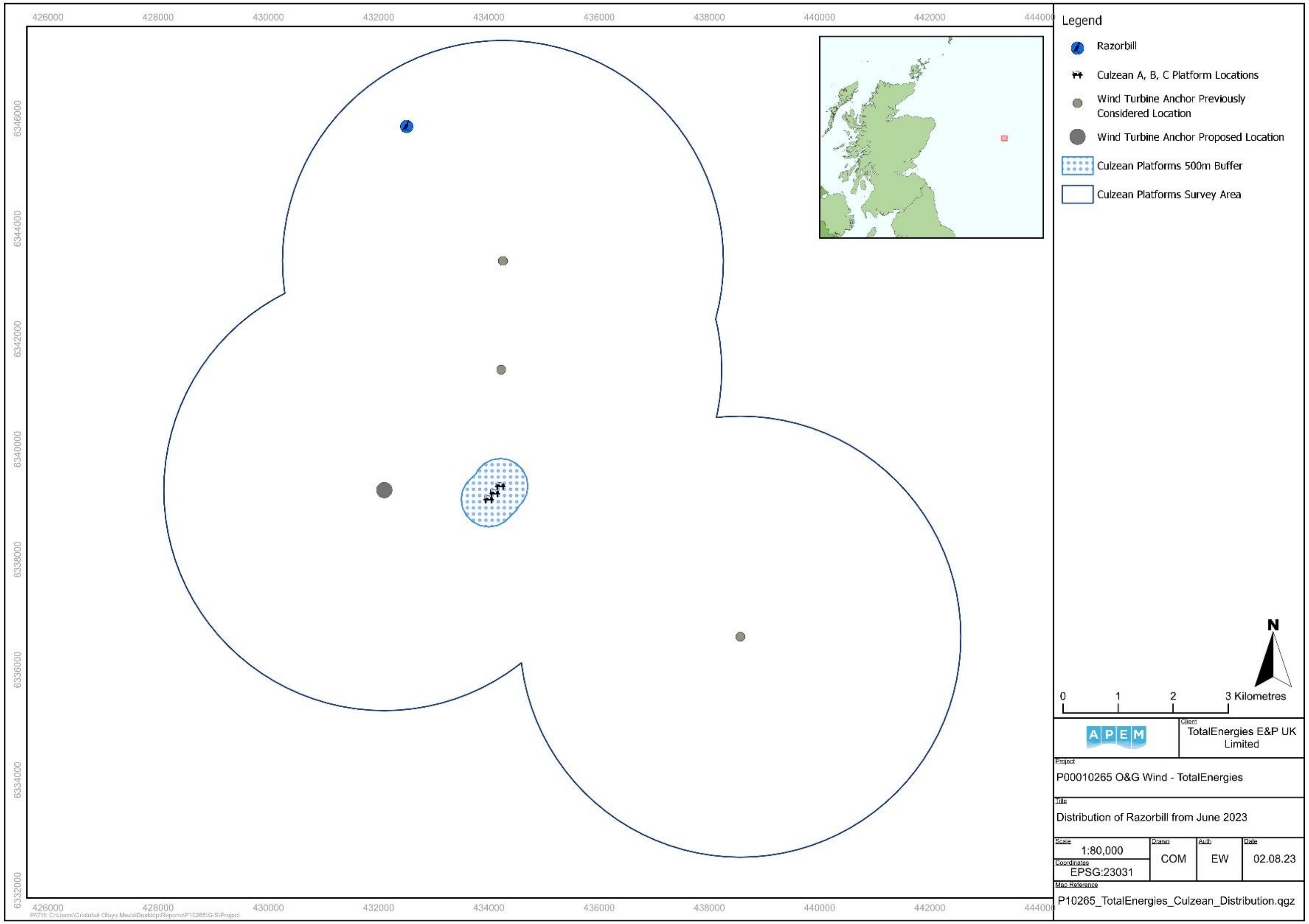


Figure 53 **Distribution of razorbills from June 2023 (Survey 10)**

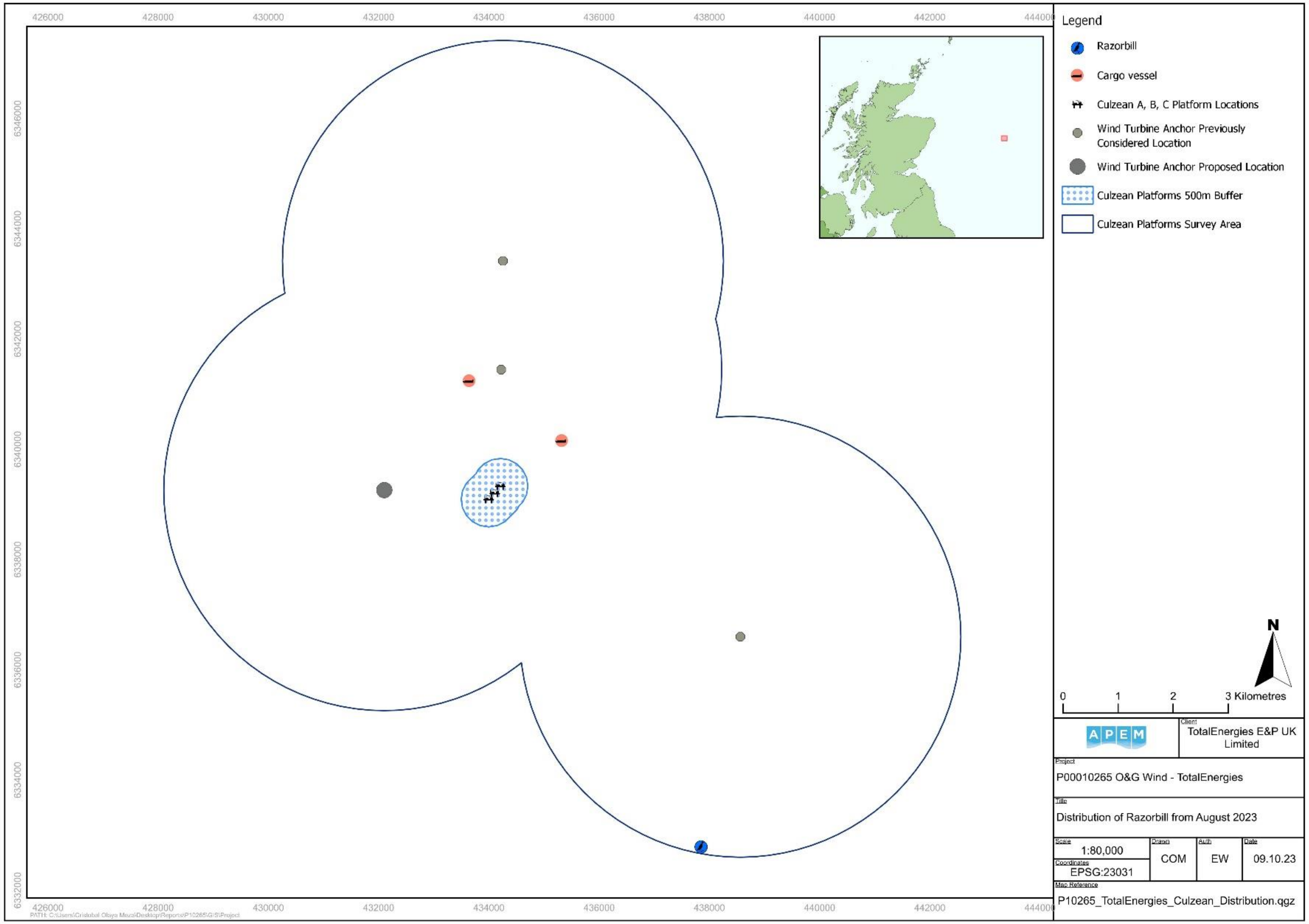


Figure 54 **Distribution of Razorbills from August 2023 (Survey 12)**

4.11 Puffin - *Fratercula arctica*

Two puffins were recorded in the November 2023 survey, leading to an abundance estimate of 20 (corrected for availability bias), equating to a density of 0.15 birds/km^2 (Table 19). The puffins were recorded in the east and west of the Survey Area during the species' autumn migration season (Figure 55).

No puffins were observed flying during the survey period.

Table 19 Raw counts, abundance and density estimates (individuals per km^2) with correction factor applied in Survey Area

Survey	Raw count	Total Uncorrected					Total Corrected	
		Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Abundance Est.	Density (km^2)
S3 Nov-22	2	17	2	42	0.71	0.13	20	0.15

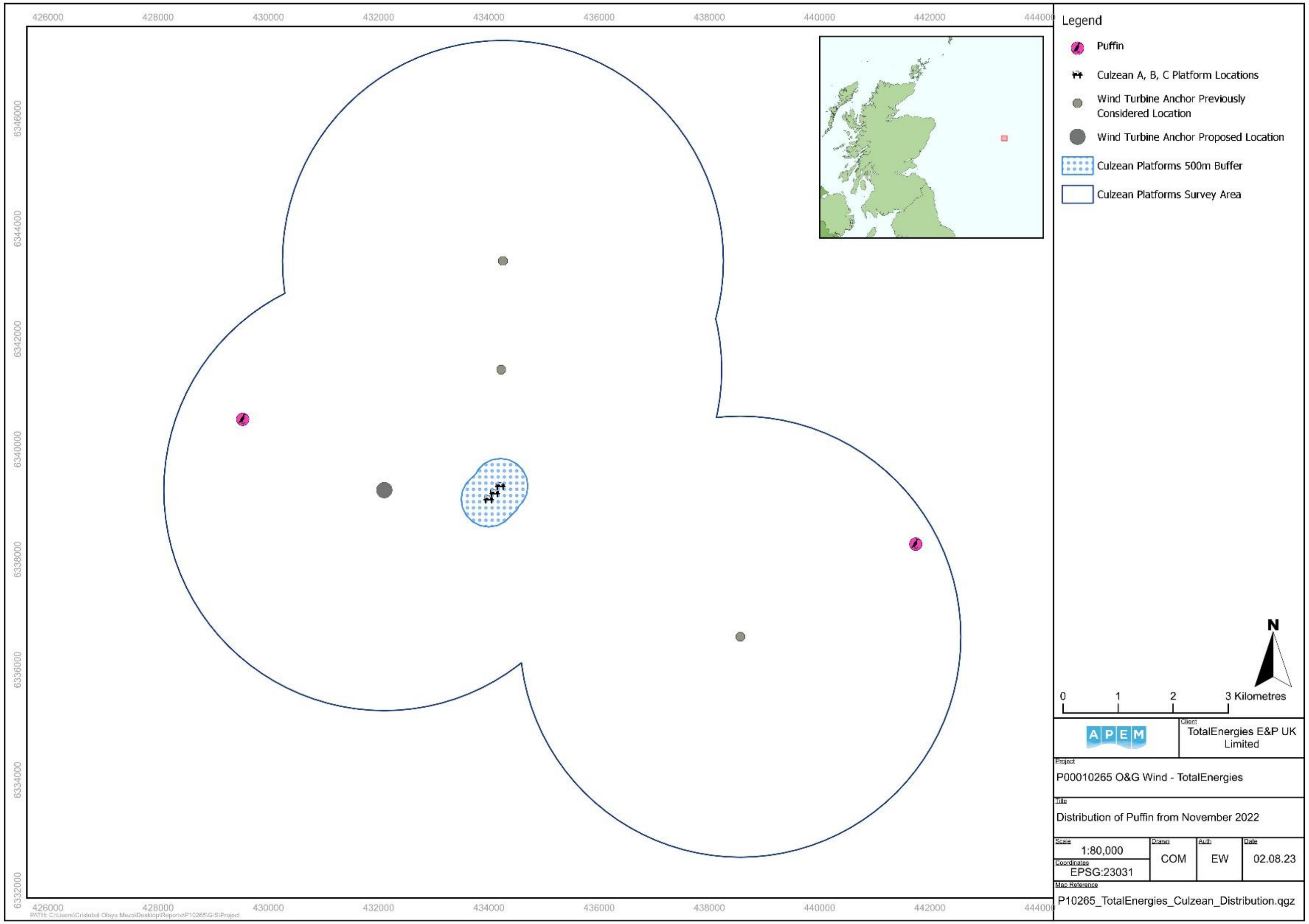


Figure 55 Distribution of puffins from November 2022 (Survey 03)

5. Marine megafauna

5.1 Harbour Porpoise - *Phocoena phocoena*

Harbour porpoises were recorded in late October 2022 to April 2023, and June 2023. A peak raw count of seven was recorded in June 2023, leading to an abundance estimate of 108 (apportioned and corrected for availability bias), equating to a density of 0.80 marine mammals/km^2 (Table 20). Harbour porpoises were recorded in low numbers through the seasons although peaked in the summer season (Figure 63) and were recorded scattered across the Survey Area. They were predominantly recorded in the east and south of Survey Area during winter (Figure 58-Figure 60), autumn (Figure 56-Figure 57) and spring (Figure 61-Figure 62).

Table 20 Raw counts, abundance and density estimates (individuals per km^2) for harbour porpoises in Survey Area

Survey	Raw count	Total Unapportioned					Total Apportioned		Total Apportioned and Corrected	
		Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
S2 Late Oct-22	2	17	2	43	0.71	0.13	35	0.26	77	0.57
S3 Nov-22	1	8	1	25	1.00	0.06	8	0.06	18	0.13
S4 Dec-22	1	8	1	25	1.00	0.06	8	0.06	17	0.13
S5 Jan-23	1	9	1	26	1.00	0.07	9	0.07	19	0.14
S6 Feb-23	2	17	2	50	0.71	0.13	16	0.12	34	0.25
S7 Mar-23	1	8	1	34	1.00	0.06	8	0.06	14	0.10
S8 Apr-23	1	8	1	25	1.00	0.06	8	0.06	14	0.10
S10 Jun-23	7	58	8	125	0.38	0.43	58	0.43	108	0.80

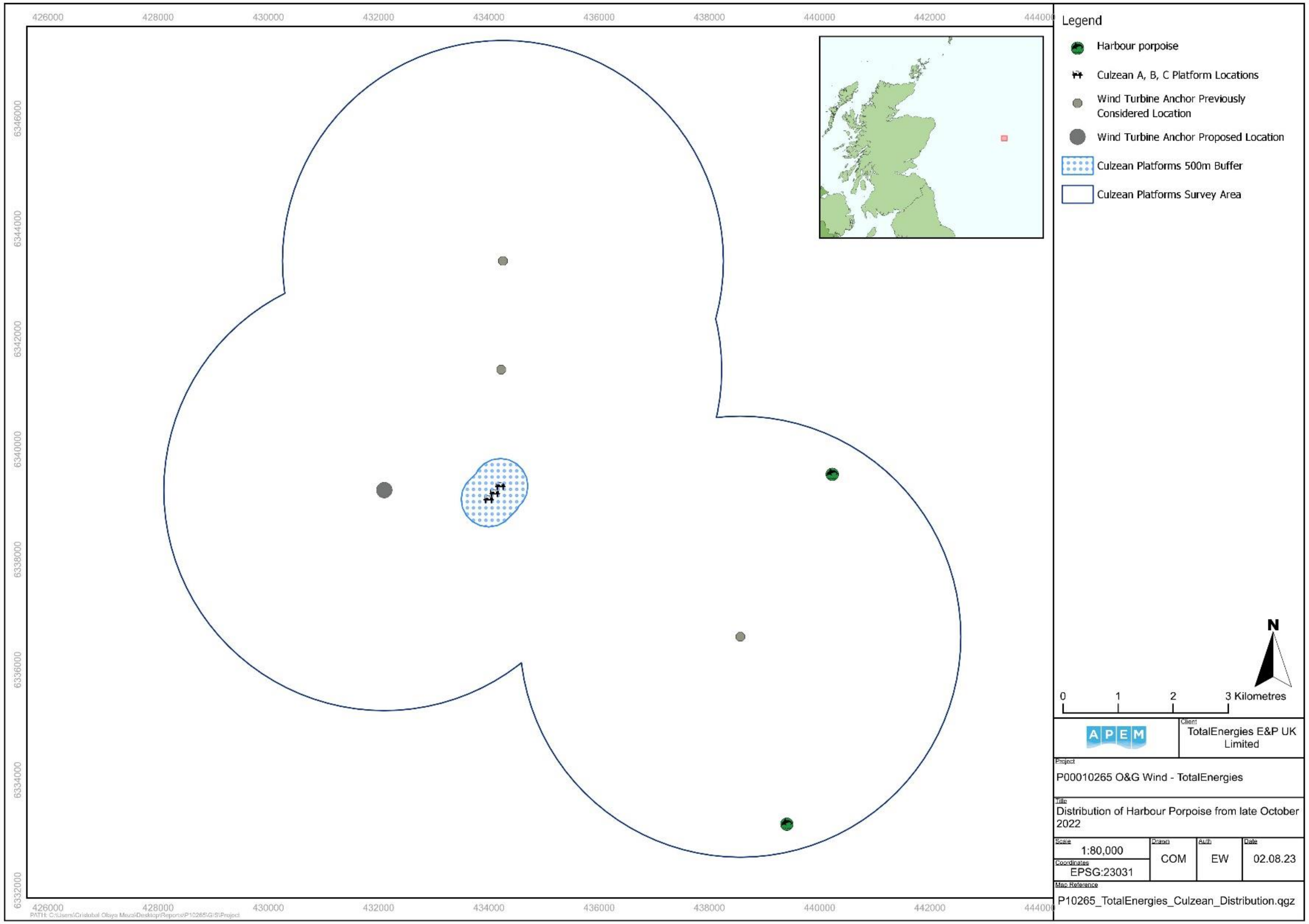


Figure 56 **Distribution of harbour porpoises from late October 2022 (Survey 02)**

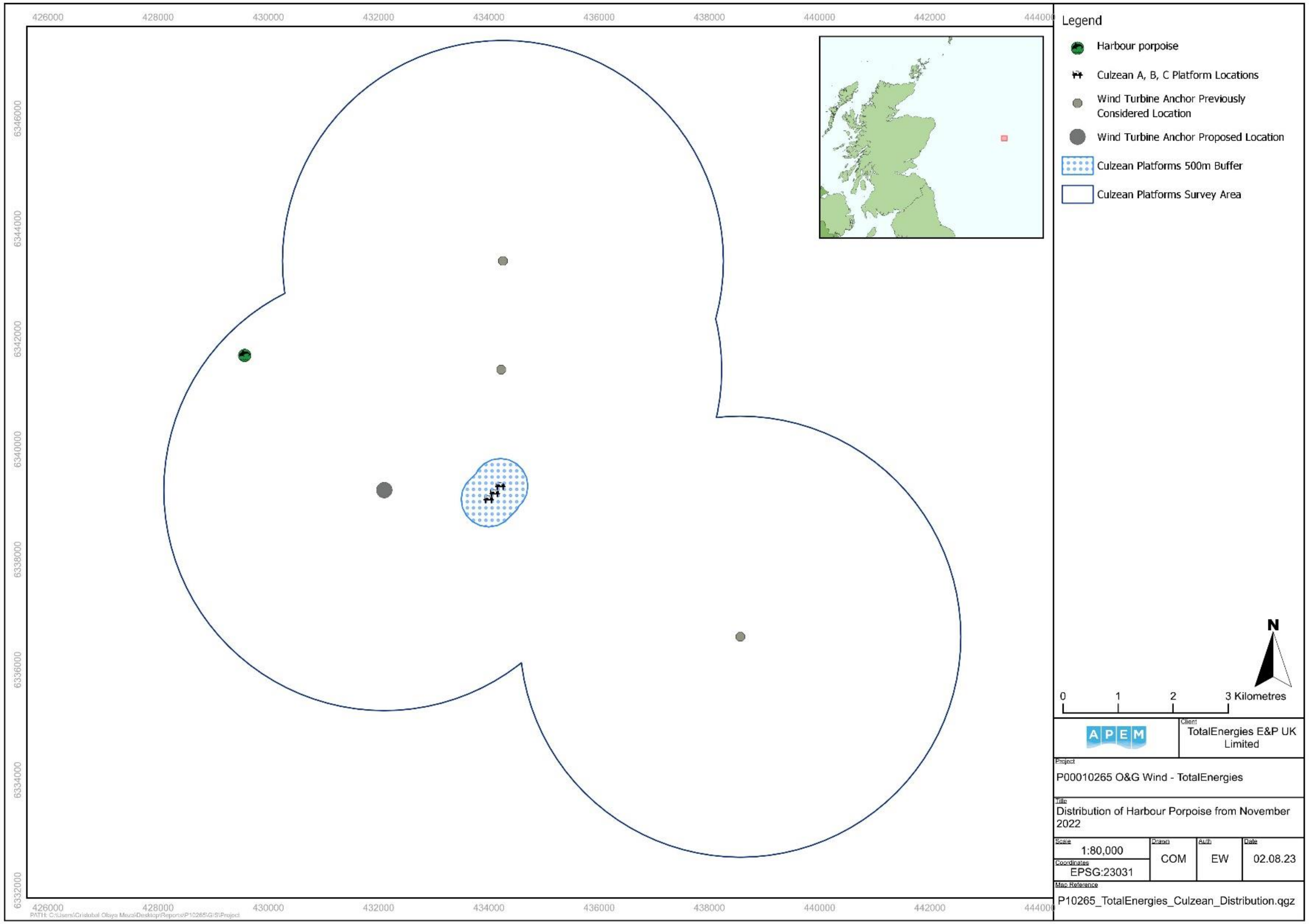


Figure 57 Distribution of harbour porpoises from November 2022 (Survey 03)

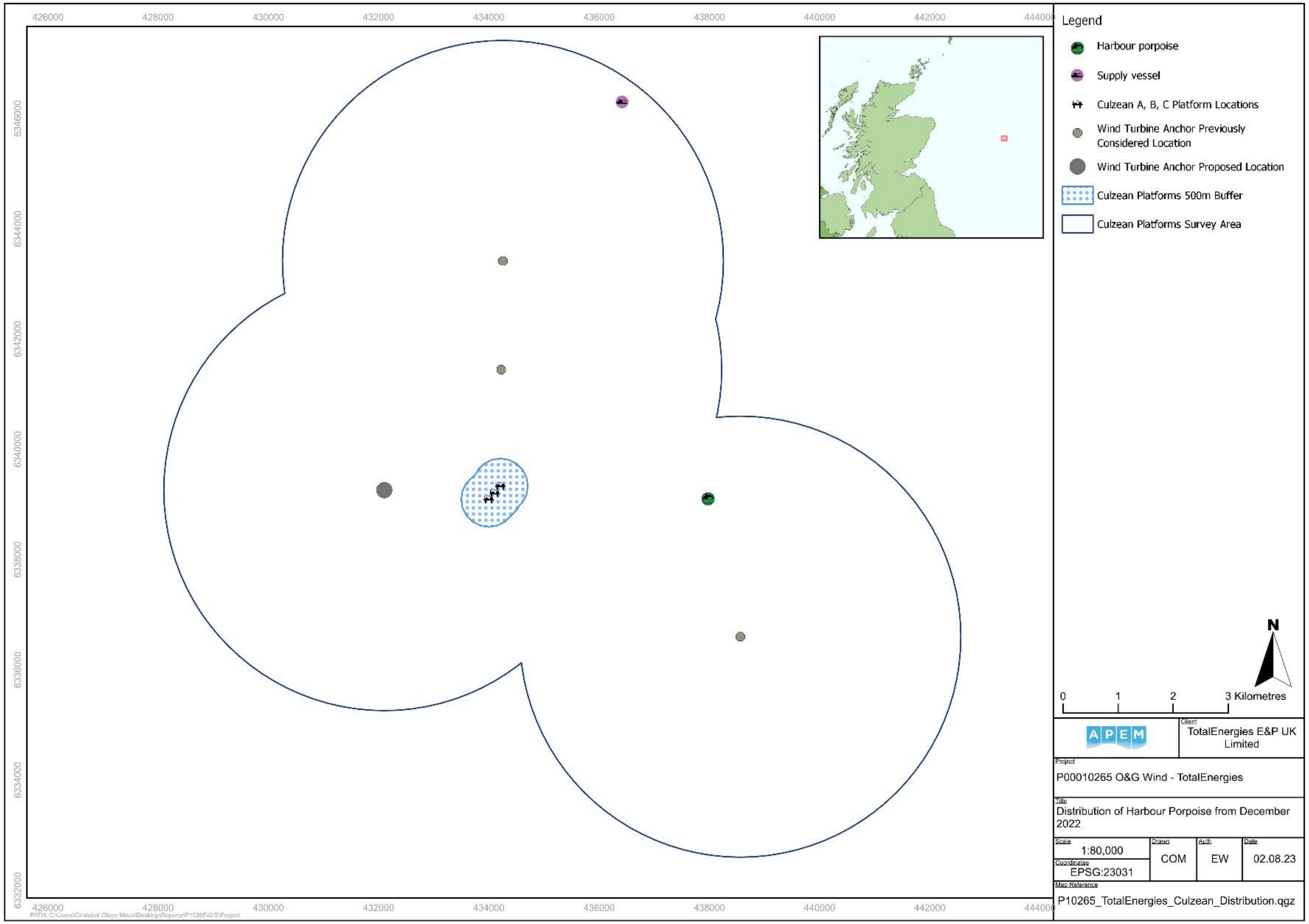


Figure 58 Distribution of harbour porpoises from December 2022 (Survey 04)

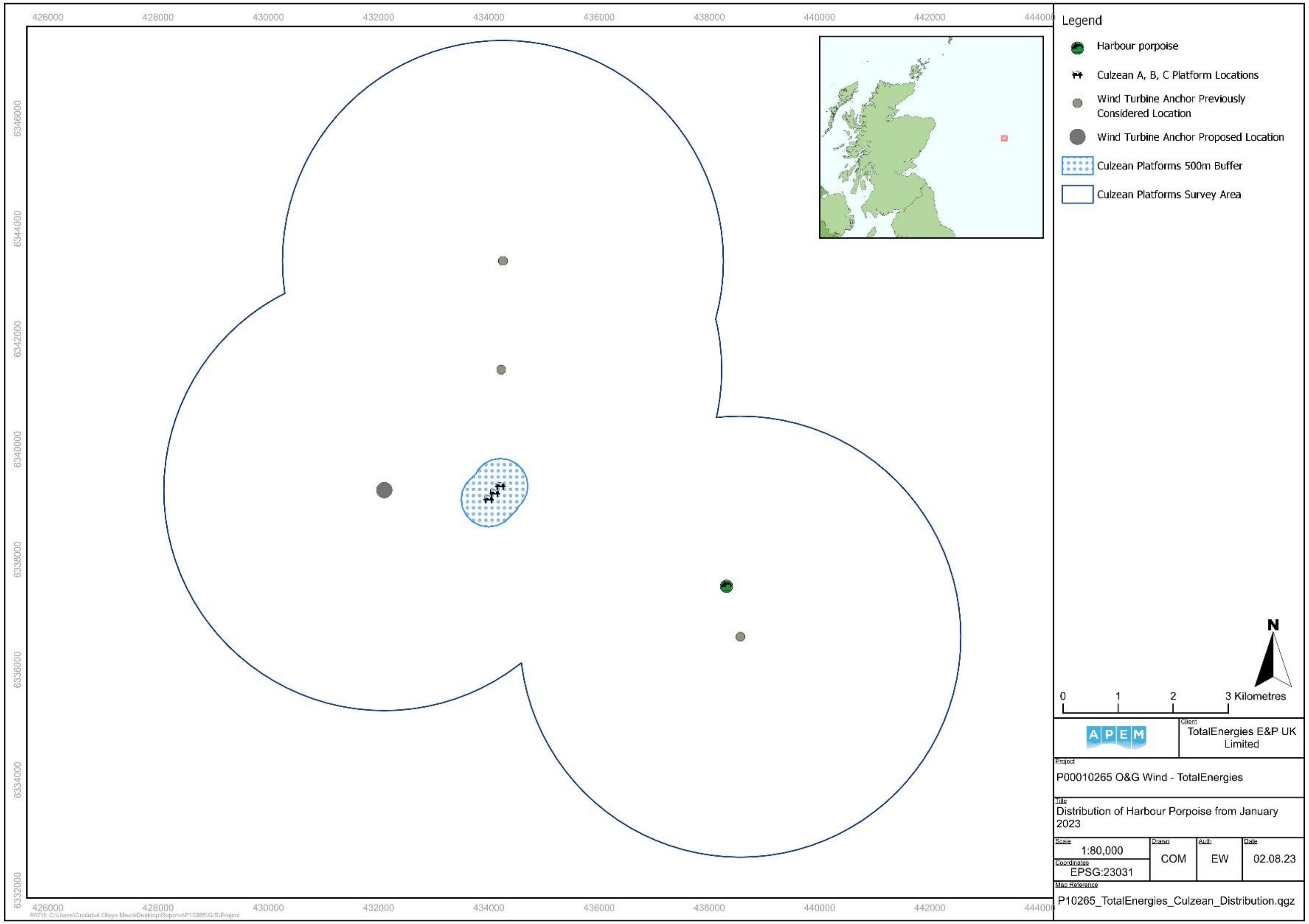


Figure 59 Distribution of harbour porpoises from January 2023 (Survey 05)

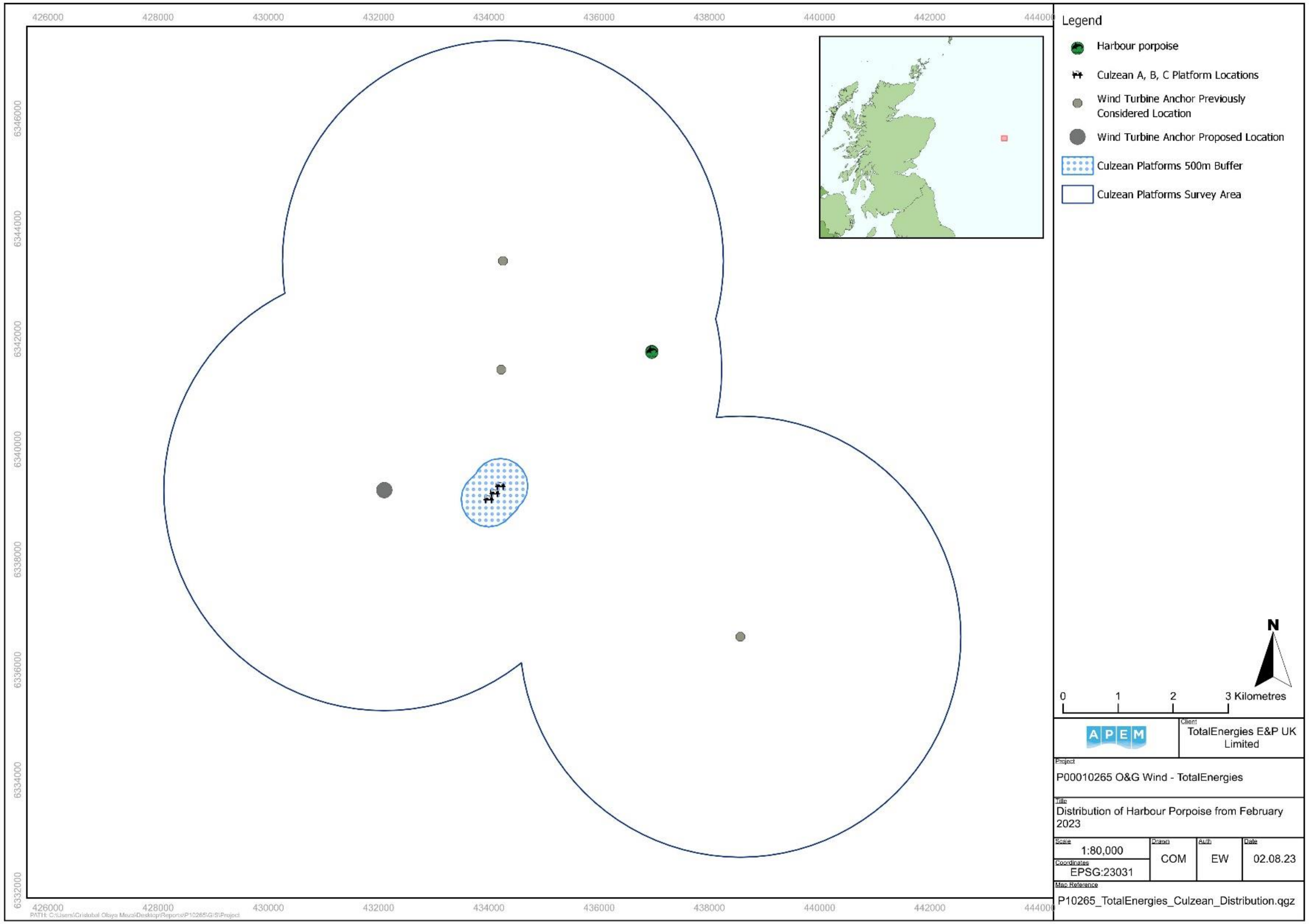


Figure 60 Distribution of harbour porpoises from February 2023 (Survey 06)

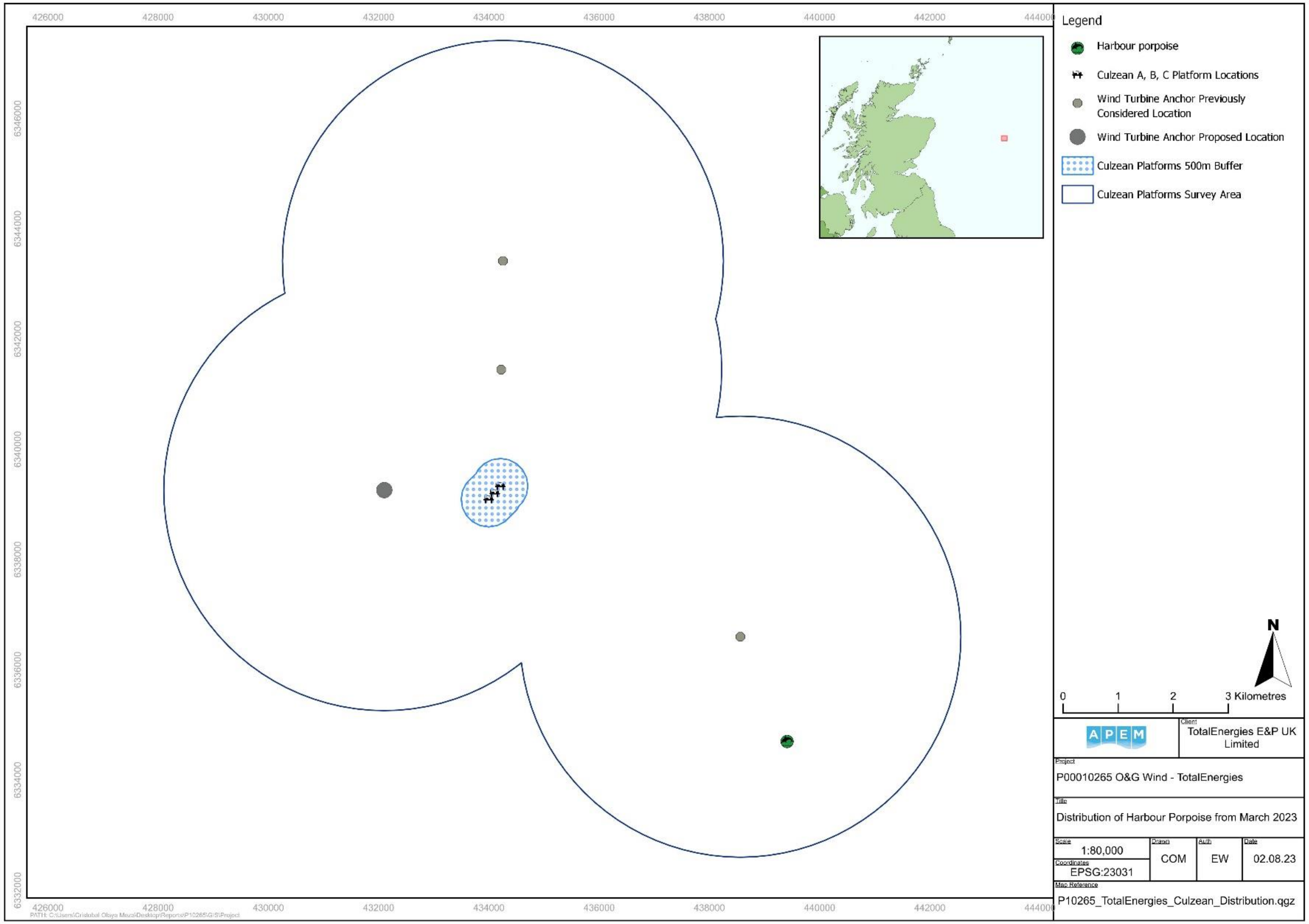


Figure 61 **Distribution of harbour porpoises from March 2023 (Survey 07)**

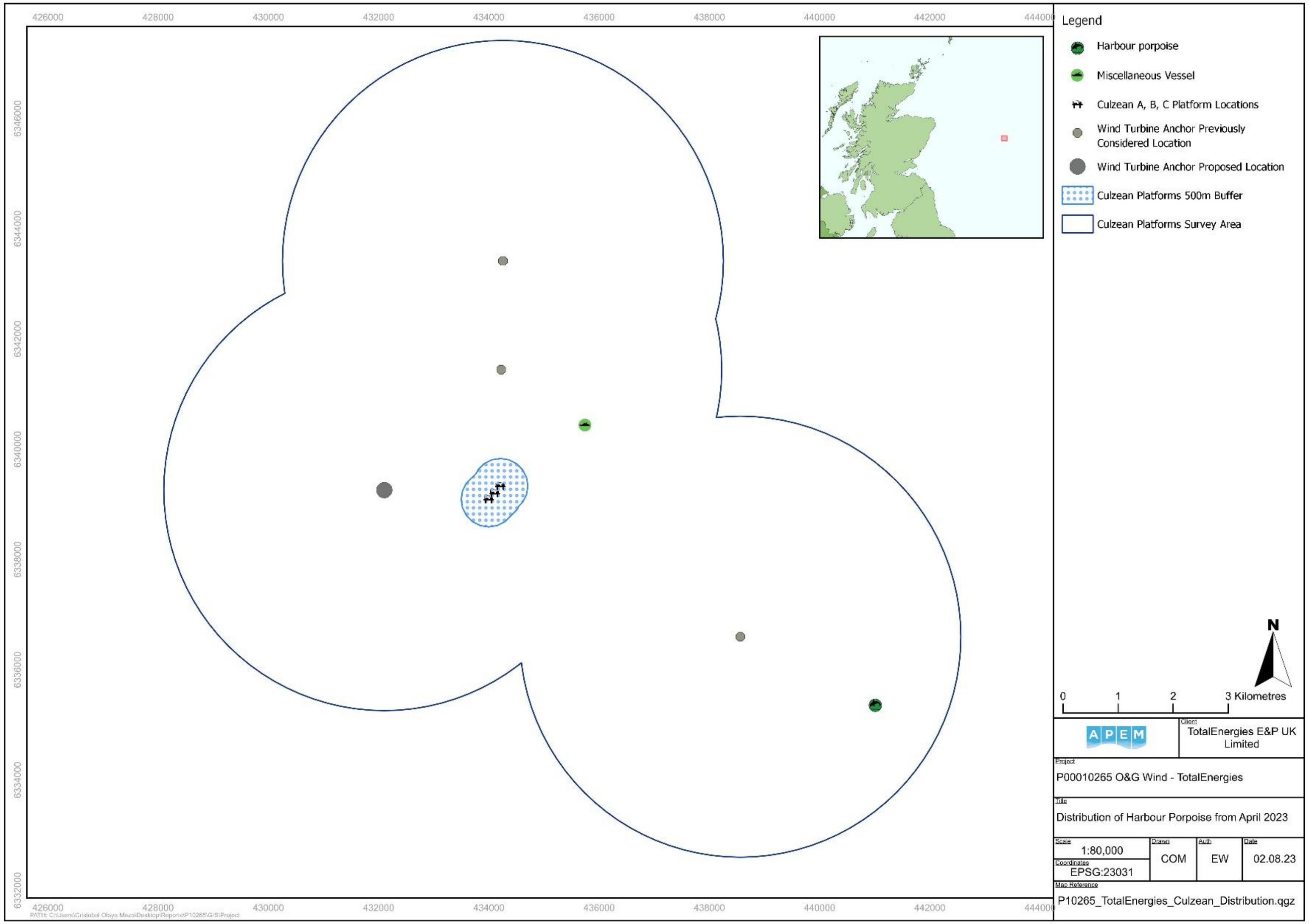


Figure 62 Distribution of harbour porpoises from April 2023 (Survey 08)

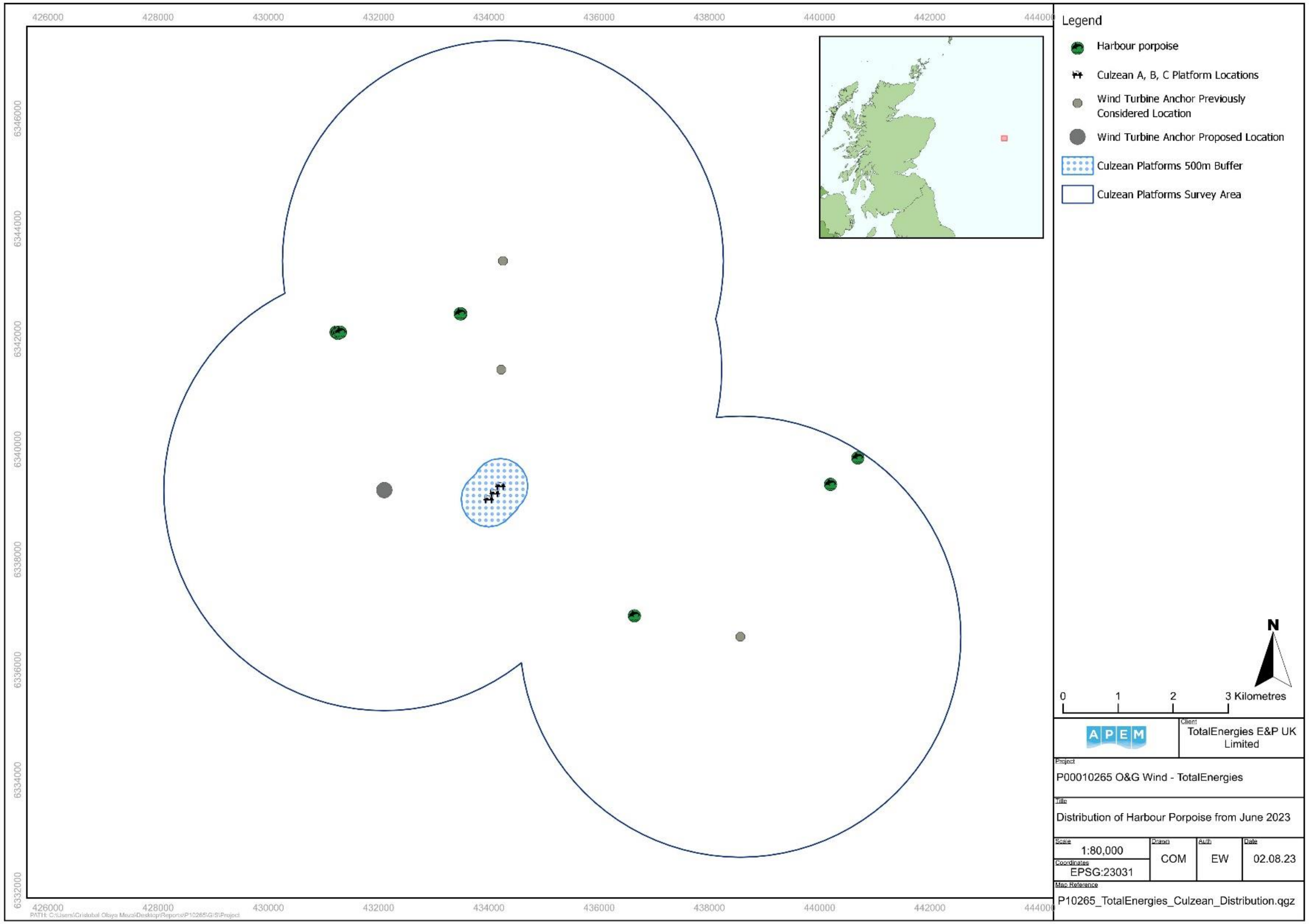


Figure 63 **Distribution of harbour porpoises from June 2023 (Survey 10)**

5.2 Basking shark - *Cetorhinus maximus*

An individual basking shark was recorded in the June 2023 survey, leading to an abundance estimate of eight, equating to a density of 0.06 shark/km^2 (Table 21). The basking shark was recorded in the southeast of the Survey Area (Figure 64).

Table 21 Raw counts, abundance and density estimates (individuals per km^2) of basking shark in the Survey Area

Survey	Raw Count	Abundance	95% CI Lower	95% CI Upper	Precision (CV)	Density
S10 Jun-23	1	8	1	25	1	0.06

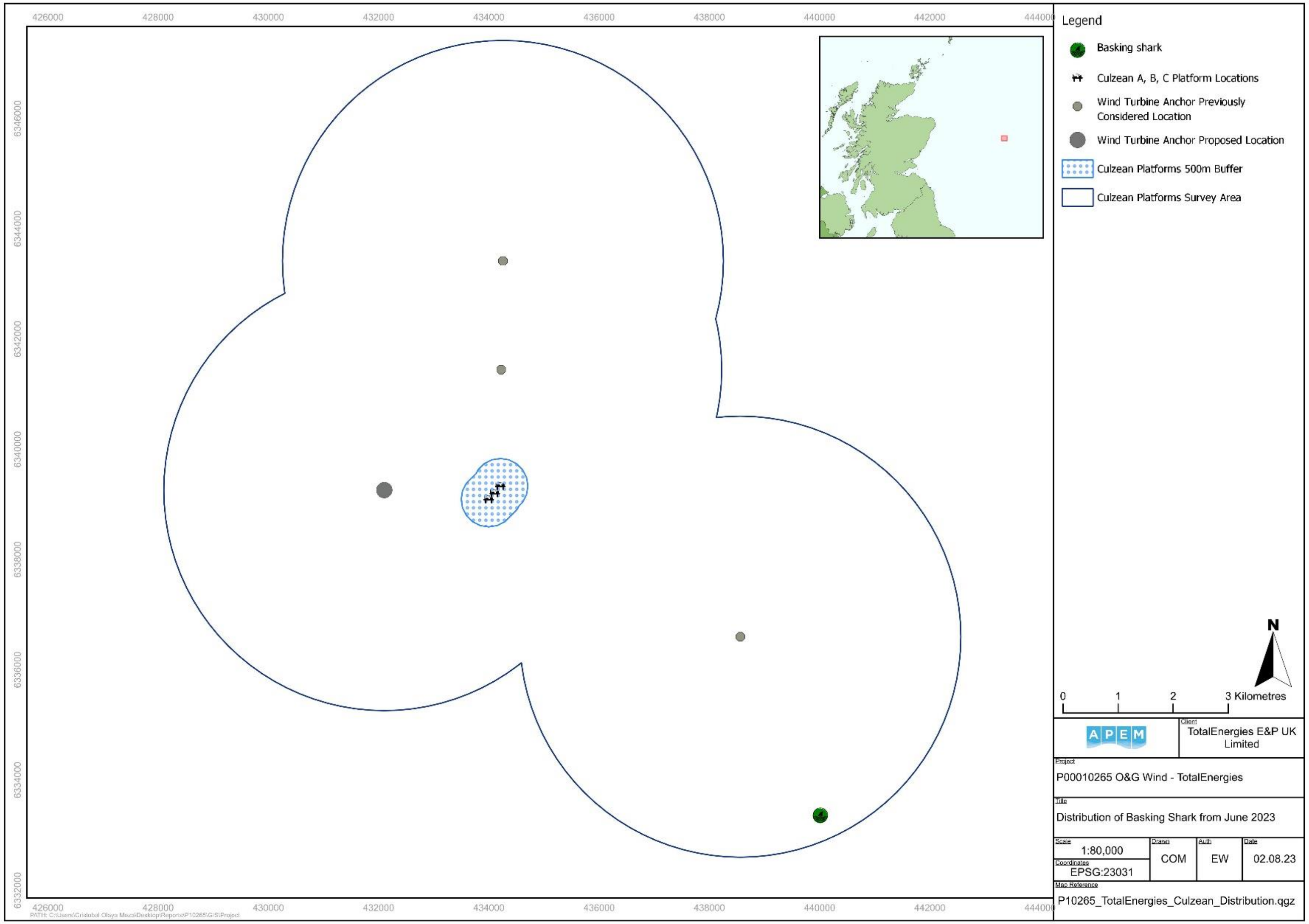


Figure 64 **Distribution of basking shark from June 2023 (Survey 10)**

6. Avian Flight Heights

Of the 1,000 birds that were imaged during the 13 DAS, 73 were recorded in flight of which 18 were suitable for flight height estimation (23%; Figure 65). Below, boxplots and histograms are presented for species with more than 3 birds recorded as suitable for flight height. In addition, one (n=1) herring gull was estimated to be flying 146.7 m above mean sea level (MSL).

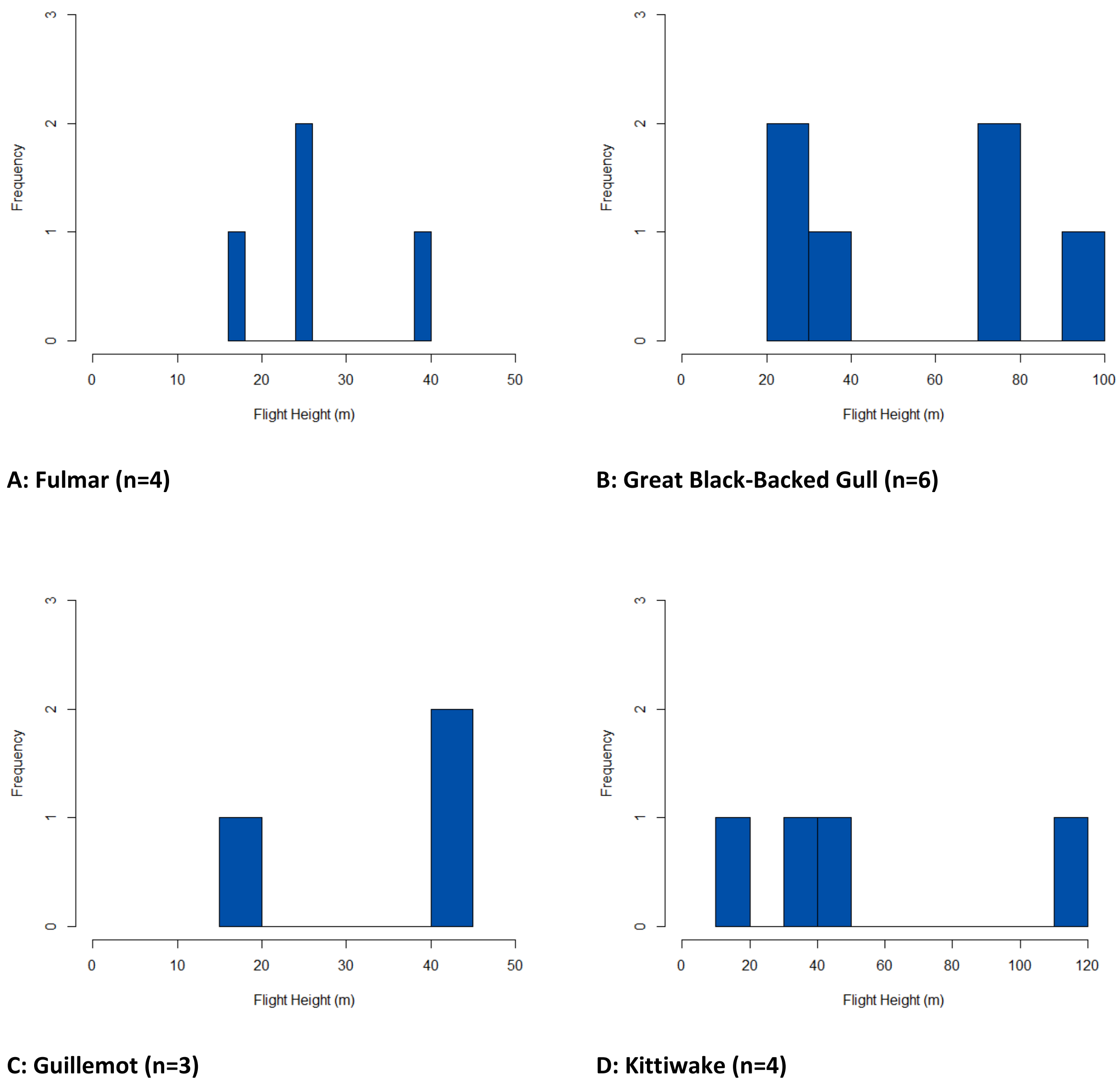


Figure 65 Frequency histograms of flight heights for species (n ≥ 3) recorded in the Culzean Platform Survey Area

Site-specific flight heights per species (n ≥ 3) were estimated as height above MSL (Figure 66).

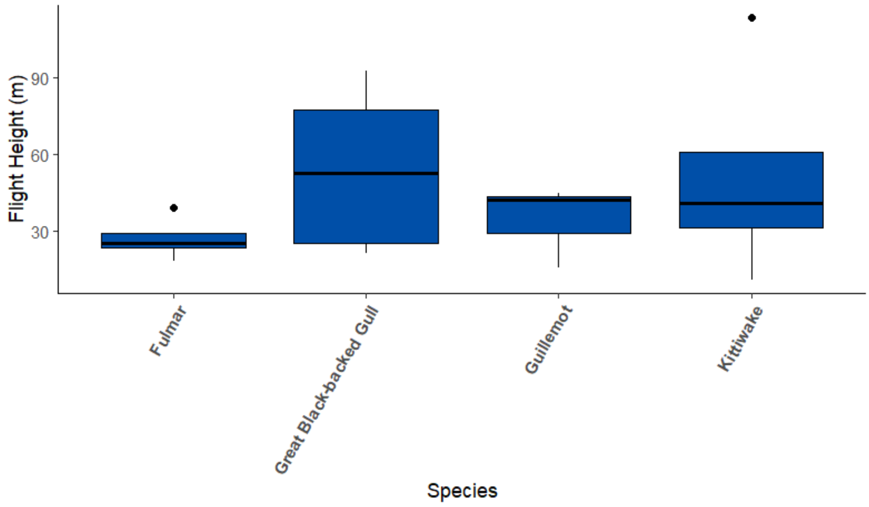


Figure 66 Flight heights for species recorded in the Culzean Platform Survey Area (including median [min-max]): fulmar (n=4, med:25 [18-39]), great black-backed gull (n=6, med:53 [21-93]), guillemot (n=3, med:42 [15-45]), and kittiwake (n=4, med:41 [10-114])

The sample size of suitable flying birds captured within these surveys is small and unlikely to be indicative of the wider population, therefore limiting the useability of the calculated flight heights. Typically, when considering site-specific data for collision risk modelling (CRM), only calculated flight heights derived from a minimum of 100 individuals per species would be used (e.g., Johnston and Cook, 2016; Cook et al., 2018). Regardless of this, NatureScot guidance recommends the use of generic data for collision risk modelling because if the stochastic CRM (sCRM) is used, recalculation of seabird avoidance rates to obtain site-specific estimates would be required (NatureScot, 2023a). In practice this would be a challenge and therefore consequently Johnston et al. (2014) flight heights are provided as well as the site-specific estimates (Table 22).

The modelling of bird flight heights by Johnston et al. (2014) collated data recorded from surveys of 32 potential offshore wind farm developments and estimated the proportion of different species recorded flying at potential collision height in relation to wind turbines. For the modelling, 'at risk' height was determined to be 20-120 m above sea level, to correspond with the heights covered by the rotor swept zone of turbines. The Culzean Platform proposed turbine specification is 22-134 m above sea level and proportion at potential collision risk height has been estimated for relevant species within this range (Table 22).

Table 22 Proportion at potential collision risk height (PCH; %) for species recorded (≥3) in the Culzean Platform Survey Area

Species	Johnston et al. (2014) PCH (%)			Culzean Platform PCH (%)		
	22-134 m	LCL (%)	UCL (%)	22-134 m	LCL (%)	UCL (%)
Fulmar (n=4)	0.50	0.00	7.00	75.00	0.00	100.00
Great Black-backed Gull (n=6)	30.00	25.00	41.00	83.33	67.00	100.00
Guillemot (n=3)	0.20	0.00	8.00	66.67	0.00	100.00
Kittiwake (n=4)	12.00	9.00	15.00	75.00	50.00	100.00

In the Survey Area, the proportion of individuals flying at a potential collision risk height exceeded those in Johnston et al. (2014) within the same range. The greatest difference was fulmar with 0.5% in the generic data versus 75% in the site-specific data (Table 22). It is important, however, to acknowledge the variations in methodologies employed for calculating flight heights and the uncertainties associated with these methods. Moreover, the comparison includes numerous sites from the generic data used in Johnston et al. (2014), which covered a broader geographic range, compared with the offshore site where the Culzean Platform Survey Area is located, which inherently may influence the flying behaviour of seabirds such as foraging and migration. Additionally, the small sample size of suitable flying birds within the Survey Area limits accuracy of the data. It should also be noted that guillemots are not assessed for collision risk modelling, as they are generally not considered to fly within the potential collision risk zone. Instead, they are assessed for displacement.

Johnston et al*.* (2014) flight height distribution models are mostly observer data gathered from ship-based observations from numerous sites across the UK and Europe. A direct comparison between vessel based, at sea observations by visual observers, with aircraft-based observations using remote sensing techniques should be approached with caution.

There is spatial and temporal variation in seabirds and as a result it is highly likely that site-specific avian flight heights calculated for the Culzean Platform Survey Area using APEM's data collection and analytical methods will be different to the flight heights from the combined dataset of Johnston et al. (2014) and that of other UK and European OWF sites.

APEM's DAS programme was undertaken at a flight height to minimise disturbance to seabirds and marine megafauna. This contrasts with visual observations, mostly from a survey vessel that cause disturbance by attracting and flushing birds that are to be recorded, an inherent bias on vessel-based observations (Žydelis et al., 2019). Additionally, due to the fast-paced nature of vessel-based observations they are required to be made in a much tighter timeframe. These time restraints are minimal in digital imagery methods and therefore more time can be taken to ensure the correct identification is made, consequently reducing the observer bias compared to vessel-based surveys (Žydelis et al., 2019).

The main limitation to 'size-based' flight height methods is that much of the standard deviation in each estimate is due to the natural variation in the body length of species. The estimated body length for each individual from the digital imagery is compared with reference lengths either from literature or other sources. Rather than a known, specific, individual body length, body lengths are compared from a range to generate the estimate of flight height, providing greater uncertainty than there would otherwise be.

Due to these limitations, it is not possible to ascribe the cause of any potential difference that may occur in flight heights between APEM's method and those presented in (Johnston et al., 2014). Bowgen & Cook (2018) and Johnston & Cook (2016) provide further information regarding comparisons of different seabird flight height methods, including data collected from a vessel, aerial (digital still and video images), LiDAR, and laser rangefinders.

7. Abiotic Structures and Observations

- The following abiotic structures were observed during the survey period:
- In December 2022 (Survey 04), two small vessels, two tanker vessels and one unknown vessel were recorded visually from the aircraft. One supply vessel was recorded in the imagery.
- In March 2023 (Survey 07), one unidentified vessel was observed visually from the aircraft and no observations in the imagery.
- In April 2023 (Survey 08), one oil rig maintenance vessel was recorded visually from the aircraft, and one unidentified vessel was recorded in the imagery.
- In May 2023 (Survey 09), the presence of ships and helicopters were noted from the aircraft and no observations in the imagery.
- In July 2023 (Survey 11), one unidentified vessel recorded in the imagery and no observations from the aircraft.
- In August 2023 (Survey 12), two cargo ships were recorded in the imagery and there were no observations from the aircraft.
- In September 2023 (Survey 13), rig support ships were recorded from the aircraft and no observations in the imagery.

In October to November 2022 (Survey 01-03), January to February 2023 (Surveys 05-06), and June 2023 (Survey 10), there were no observations in the imagery or visually from the aircraft.

8. Discussion

A summary of the main abundance findings and distribution patterns, where applicable, are presented below. For each species group, cross-referencing with relevant literature has been performed to inform the findings of the surveys, as well as form a basis for expectations of species occurrence and seasonality where applicable. Unidentified species are excluded from this discussion.

8.1 Special Protected Areas

The North Sea represents an important area for birds; the area is used by species passing through either on migration or to and from breeding colonies (Furness, 2015). There are no Special Protected Areas (SPAs) within 100 km, as a general guide, of the Culzean Platform Survey Area although it is acknowledged that designated species associated with SPAs outside of this range may utilise the site during migration.

At c. 220 km offshore, the Culzean Platform Survey Area is within the distances of foraging ranges for some of the designated species of the nearest SPAs located on the Aberdeenshire coast (Buchan Ness to Collieston Coast SPA, Troup Pennan and Lions Heads SPA, and Fowlsheugh SPA) (Woodward et al., 2019), mainly fulmars (1200.2 km) and kittiwakes (300.6 km) (NatureScot, 2023b). The Outer Firth of Forth and St Andrews Bay Complex SPA, is located within 300 km from the Survey Area. Gannets are a qualifying feature for this SPA, with the Survey Area within the distance of gannets' foraging range (509.4 km) (NatureScot, 2023b).

8.2 Fulmar

Fulmars mainly breed on sea cliffs, but have been found to nest on level ground, on buildings and in burrows. A highly pelagic species, fulmars spend most of their non-breeding period at sea. At around 500,000 breeding pairs, the UK holds around 8% of the species global breeding populations (Cordes et al., 2015; Mitchell et al., 2004). The UK population has declined since the late 1990s and fulmars are now on the amber list of Birds of Conservation Concern (Cordes et al., 2015; Stanbury et al., 2021).

In Aberdeenshire, the fulmar population was increasing until Seabird 2000 (Mitchell et al., 2004), but since then have declined. Fulmars are a qualifying feature for the Troup, Pennan and Lion's Heads SPA, the Buchan Ness to Collieston Coast SPA, and the Fowlsheugh SPA, with 1,894, 826 and 525 Apparently Occupied Sites (AOS), respectively, reported in the 2023 seabird count. For the three SPAs, recent reports show a decline of numbers (JNCC, 2021; 2023). As mentioned above, the Survey Area is within the foraging range of fulmars from those three SPAs.

8.3 Gannets

Gannets breed in colonies on islands and mainland cliff sites. Gannets are present around the UK coast all year round, spending their non-breeding season foraging at sea (Hume et al., 2016). Gannets have been found to travel as far as 400 km on foraging trips (Langston et al., 2013), while NatureScot reports a foraging range of 509.4 km (NatureScot, 2023b). In Aberdeenshire, there is a colony within the Troup Head SPA with 1,085 Apparent Occupied Nest (AON) (Mitchell et al., 2004). The world's largest gannetry is located at Bass Rock, located approximately 150 km from the Survey Area. Individuals from this gannetry are known to forage in waters off the coast of Aberdeenshire particularly during the breeding season (Lane et al., 2019; 2020). Additionally, as mentioned previously, gannets are a qualifying species for the Outer Firth of Forth and St Andrews Bay Complex SPA, which is approximately 300 km away from the site, distance within the foraging range of the gannets.

8.4 Small gulls

Kittiwakes were the most abundant species of small gull recorded in the Survey Area. They are the most numerous gull species in the world, with Europe supporting more than 50% of the population. However, since the 1990s, the species has seen a rapid decline and is classed as Vulnerable according to the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (BirdLife International. 2019). The kittiwake is the most numerous gull species in the world, with Europe supporting more than 50% of the population. However, since the 1990s, its population has seen a rapid decline and was classed as Vulnerable on the IUCN Red List of Threatened Species in 2017. The Scottish population of kittiwakes saw a 21% decrease between Operation Seafarer (Cramp et al., 1974) (346,097 AON (apparently occupied nests) and the Seabird 2000 census (Mitchell et al., 2004) (282,213 AON). Kittiwakes breed on sea cliffs in colonies which can contain several thousand pairs. They also nest on manmade structures such as buildings or bridges, providing them with protection from ground predators (Johansen et al., 2020). During the breeding season, kittiwakes primarily feed on small pelagic shoaling fish. However, they are also known to scavenge around fishing boats. Outside of the breeding season, kittiwakes are largely pelagic and spend vast amounts of time out at sea (JNCC, 2021). The following protected areas local to the Survey Area list breeding kittiwakes as a qualifying feature: Troup, Pennan and Lion's Heads SPA, Buchan Ness to Collieston Coast SPA, and Fowlsheugh SPA. These sites also appear to reflect highest kittiwake numbers in winter as recorded by Non-Estuarine Waterbird Survey III (NEWS III) (Austin et al., 2017). The specific populations of these three SPAs have seen a decreased, as reported in the latest seabird census published in 2023 (JNCC, 2023).

In the UK, common gulls largely breed in Northern Ireland and the North of Scotland, with a population of 11,141 AON in Orkney and 468 in Caithness (Mitchell et al., 2004). However, common gulls can be seen throughout the UK during non-breeding winter months, mainly feeding on agricultural land. The winter population in Aberdeenshire is estimated at 3,237 individuals (Austin et al., 2017). The most recent seabird census, published in 2023, saw a general decrease of the British and Irish populations of common gulls (JNCC, 2023).

8.5 Large gulls

Great black-backed gulls have an extensive breeding range across the north Atlantic which has expanded throughout the 20th century. In Scotland, this species breeds almost exclusively in coastal areas. Key breeding colonies are situated in the north and west of Scotland, with breeding sites more sparsely distributed in Aberdeenshire are scarce. A total of 51 AON were recorded between Banff and Aberdeen in Seabird 2000 (Mitchell et al., 2004). Their preferred breeding grounds are around coastal areas, with almost 95% of the national population nesting in coastal areas. Seabird Count published in 2023, reports a generalized decrease on Great Black-backed gulls' populations (JNCC, 2023).

Herring gulls are widespread around the UK coastline. Herring gulls are currently included on the red list of Birds of Conservation Concern within the UK (Stanbury et al., 2021), coastal breeding populations have declined dramatically in recent decades (Mitchell et al., 2004). Herring gulls also commonly breed on rooftops where numbers of nesting birds have increased (Balmer et al., 2013; Rock, 2005). These trends are reflected in Aberdeenshire where coastal populations in Banff & Buchan and in Gordon have declined by 76% (27,748 to 6,671 AON) and 79% (4,037 to 853 AON) between

Operation Seafarer Seabird 2000, respectively. In contrast, populations in the city of Aberdeen have increased at an annual rate of 22.4% within the same timeframe from 130 AON to 3,522 AON largely due to all these nesting in rooftops (Mitchell et al., 2004).

8.6 Terns

Terns exhibit a fragmented global distribution (Nisbet & Ratcliffe, 2008) and populations in the Atlantic have decreased substantially in recent years (Eaton et al., 2015). However, the most recent census, published in 2023 (Seabird Count), reports that Roseate terns' populations from the UK and Ireland have generally increased, while Sandwich and common tern have remained stable, and little and Arctic tern have decreased (JNCC, 2023).

As migrant breeders, Arctic terns spend April to September in the UK, and the winter, non-breeding months in the southern hemisphere. Arctic terns breed mainly on the coast but can also be found inland in habitats such as lakes, reservoirs, and flooded gravel pits (Hume et al., 2016). In Scotland, the largest breeding colonies are in Orkney and Shetland. Few small colonies exist in Aberdeenshire with 260 AOB recorded during Seabird 2000 (Mitchell et al., 2004).

Like other tern species, common terns are a migrant breeder in the UK where they start arriving in mid-April and leave their colonies in late summer. Though they breed primarily on the coast, they can also be found inland at lakes, reservoirs, and flooded gravel pits (Hume et al., 2016). In Scotland, the Sands of Forvie and Meikle Loch SPA hosts the second largest colony at 242 AON in 2019 (JNCC, 2021).

8.7 Auks

Guillemots are typically at their nesting colonies between March and July, following which they spend the non-breeding season almost exclusively at sea and are rarely seen in inshore waters during winter (Waggitt et al., 2020). The species in known to breed all around the Scottish coastline where suitable habitat exists and is listed as a qualifying feature for Troup, Pennan and Lion's Heads SPA, Buchan Ness to Collieston Coast SPA and Fowlsheugh SPA. While the colony at the Troup, Pennan and Lion's Heads SPA has decreased by 48% between 2001 and 2017, the Buchan Ness to Collieston Coast SPA colony has remained stable, and the Fowlsheugh SPA colony has increased by 12% now hosting 69,828 individuals (JNCC, 2021).

Like guillemots, razorbills also return to their breeding colonies between March and April and depart in August spending the non-breeding season at sea. Razorbills are not as widespread as guillemots and nest in more secluded sites such as screes and fissures in cliffs. During the breeding season, razorbills typically remain within 26 km of their breeding sites for foraging purposes, though longer trips have also been observed (Isaksson et al., 2019). Outside of the breeding season, they use offshore waters along the UK North Sea coast for foraging where wintering areas can vary between years and individuals may also leave the North Sea during winter, unlike other auk species (Glew et al., 2019). In Aberdeenshire, there is a small colony at Troup, Pennan and Lion's Heads SPA (4,422 individuals in 2017) and are listed as a qualifying feature for the Fowlsheugh SPA which saw a population increase of 121% between 1999 and 2018, now hosting 14,063 individuals (JNCC, 2021).

Outside the breeding season, puffins are strictly pelagic and rarely seen close to shore (Hin & Soudijn, 2021). Puffins breed in the UK between April and early August, following which they spend the non-breeding season at sea. The 'SEA678 Data Report for Offshore Seabird Populations' report found Atlantic puffins to be sparsely distributed during the winter and autumn months. Owing to their activity at breeding sites during the day, puffins are more accessible than other burrow-nesting species such as Manx shearwaters, resulting in greater confidence of population estimates. While many breeding colonies are situated further south in Fife and further north in Orkney and Shetland, Seabird 2000 identified 1,720 AOB between Banff and Aberdeen. Puffins are known to undertake foraging trips of up to 200 km (Thaxter et al., 2012), individuals from breeding colonies elsewhere in Scotland may be observed along the Aberdeenshire coast.

8.8 Dolphins and Porpoise

Harbour porpoises are a European Protected Species under the EU Habitats Directive and are predominantly found over the UK continental shelf in waters less than 200 m in depth (IAMMWG et al., 2015). Harbour porpoises are the only porpoise species, as well as being the smallest and most abundant cetacean species, found in UK waters. They are resident all year round and inhabits shelf areas, coastal waters and are rarely observed in waters deeper than 200m (Shirihai & Jarrett, 2006). They are typically very shy animals and tend to avoid both anthropogenic activity such as boats, and other marine mammal species. Harbour porpoises are usually found alone or in small groups but can be seen in larger groups when feeding. Harbour porpoises are generally difficult to detect in the field due to only surfacing briefly and their slow forward-rolling movement minimising the level of splash produced. They are most often recorded solitary or in small groups, unlike most delphinid species (Hammond et al., 2002, 2017; Reid et al., 2003).

8.9 Shark

Basking sharks have a global distribution (Dolton et al., 2020). They are capable of transoceanic migrations, with three hotspots identified within the North Atlantic Ocean (the coastal waters of Ireland, the UK, and the USA), and with one individual having been recorded traveling up to 4,632 km from Ireland to the Massachusetts coast of America (Johnston et al., 2019).

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Appendix I Scientific Names and Taxonomy

Scientific names and taxonomy, including JNCC categories are presented here.

Common Name	Scientific Name	Family	Class
Fulmar	*Fulmarus glacialis*	Procellariidae	Aves
Gannet	*Morus bassanus*	Sulidae	Aves
Kittiwake	*Rissa tridactyla*	Laridae	Aves
Common Gull	*Larus canus*	Laridae	Aves
Great Black-Backed Gull	*Larus marinus*	Laridae	Aves
Guillemot	*Uria aalge*	Alcidae	Aves
Razorbill	*Alca torda*	Alcidae	Aves
Puffin	*Fratercula arctica*	Alcidae	Aves
Harbour Porpoise	*Phocoena phocoena*	Phocoenidae	Mammalia
Basking Shark	*Cetorhinus maximus*	Cetorhinidae	Elasmobranchii

Appendix II Correction Factors

9.1 Guillemot and Razorbill

The correction factor applied to each relevant species is based on that recommended by JNCC in a submission during the examination phase of the East Anglia ONE OWF, referred to by JNCC as Method C. A copy of the text on Method C is provided below. This has been taken from Paragraph 5.6.5 of this document:

> Joint Nature Conservation Committee (2013). JNCC Expert Statement on Ornithological Issues for Written Representations in Respect of East Anglia ONE Offshore Windfarm by Dr Sophy Allen. Joint Nature Conservation Committee, Aberdeen.

METHOD C

Guillemots

Underwater (1.9h) / [Sea surface (5.1h) + Diving activity (2.9h)] = 0.2375

Therefore, for **guillemot availability** JNCC would calculate ***g(0)* = 0.7625**

Razorbills

Underwater (0.8h) / [Sea surface (3.1h) + Diving activity (1.5h)] = 0.1739

Therefore, for **razorbill availability** JNCC would calculate ***g(0)* = 0.8261**

This works on the following assumptions:

1. That all birds observed on the water in the project area are undertaking a foraging trip (in most cases this seems appropriate);
2. That 'birds in flight' are adequately characterised within the 'birds in flight' quotion of the Thaxter et al. (2010) figures (i.e. that portion which has been removed from the Correction Factor calculation;
3. That the proportions of time spent foraging underwater are representative of behaviour throughout the year (i.e. not just the breeding season – the period in which this proportional data was calculated from by Thaxter et al. 2010), should the Correction Factor be applied to annual abundance estimates.

9.2 Puffins

The correction factors applied to puffin monthly abundance estimates were derived from a study conducted by (Spencer, 2012). This study investigated the diving behaviours of puffins from breeding colonies on Petite Manan Island, Maine, between 2008 and 2009. Diving data was successfully collected across a total of 13 birds, which collated 8,097 dives across the survey period. It was discovered that puffins spent 14.16% of their time underwater, suggesting that their availability at the surface was 0.8584. This correlates to a correction factor of 1.165.

9.3 Harbour Porpoise

Aerial digital surveys are commonly used to capture marine mammals for baseline characterisation of offshore wind farm sites in the UK. The benefit of this method includes the permanent record which allows for third party corroboration on species identification as well as allowing for group size and behaviour to be re-examined, if required.

The correction factors which were applied to harbour porpoise monthly abundance estimates are described in (Voet et al., 2017). This was based on a study by Teilmann et al. (2013) which tagged 35 harbour porpoises in the waters around Denmark using satellite transmitters. The satellite tags collected data on average for 135 days (minimum was 25 days and maximum was 349 days). Amongst other variables that were studied, the percentage of time spent in the upper 2m of the water column was recorded and analysed. There was no significant difference in time spent in the upper 2m between sex or geographical location of tagging. There was also no significant correlation between the length of the harbour porpoise and time spent at 0-2m. However, month was identified as a significant effect and therefore varied between season. The correction factors were applied to the total abundance (surfacing and submerged individuals) as per the recommendation by Teilmann et al. (2013). The correction factors applied are provided in Table 23.

Table 23 Seasonal harbour porpoise correction factors

Season	Correction Factor
Spring (Mar-May)	0.571
Summer (Jun-Aug)	0.547
Autumn (Sep-Nov)	0.455
Winter (Dec-Feb)	0.472

Appendix III Distribution Maps of Apportioned Records

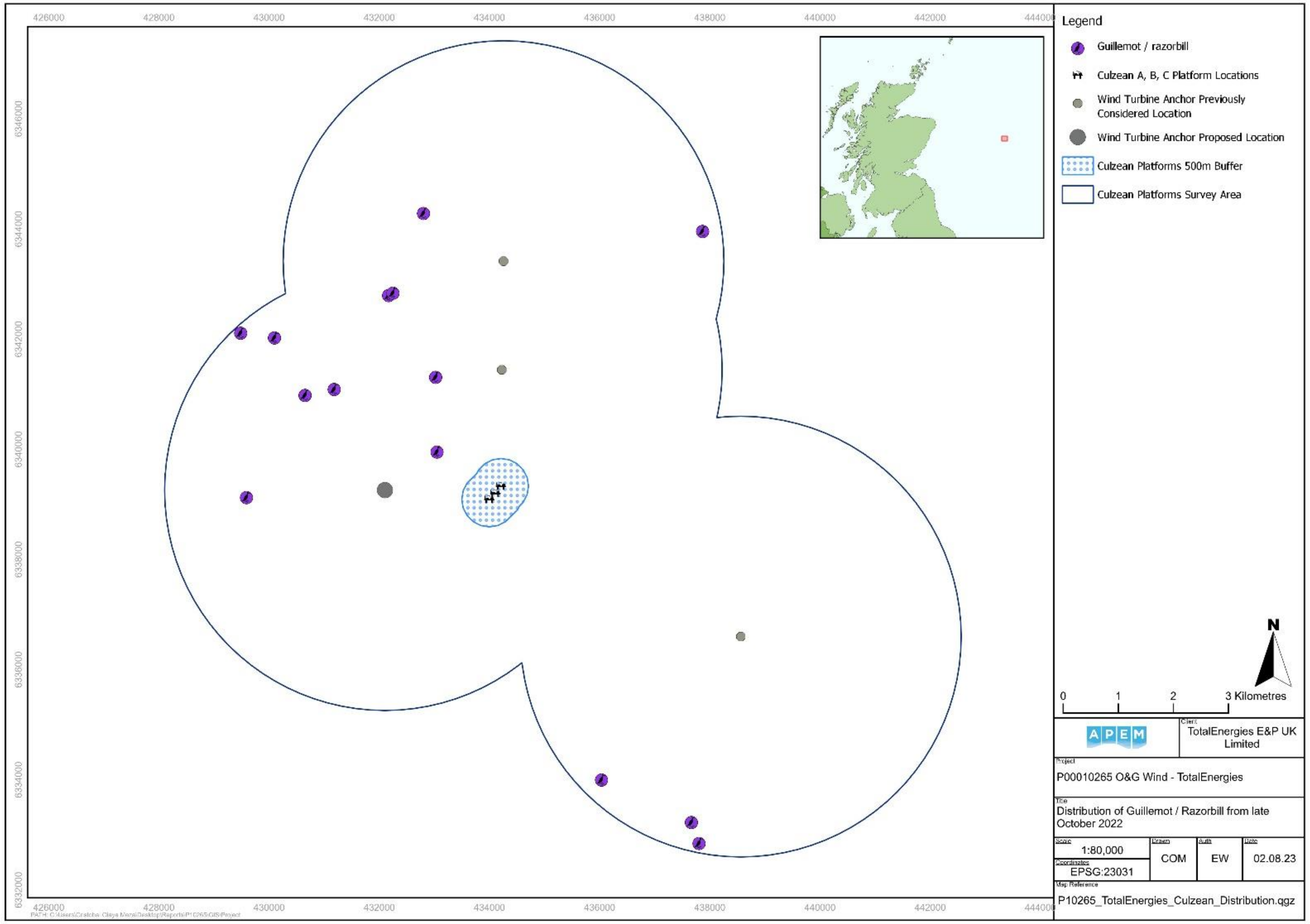


Figure 67 Distribution of guillemot / razorbills from late October 2022 (Survey 02)

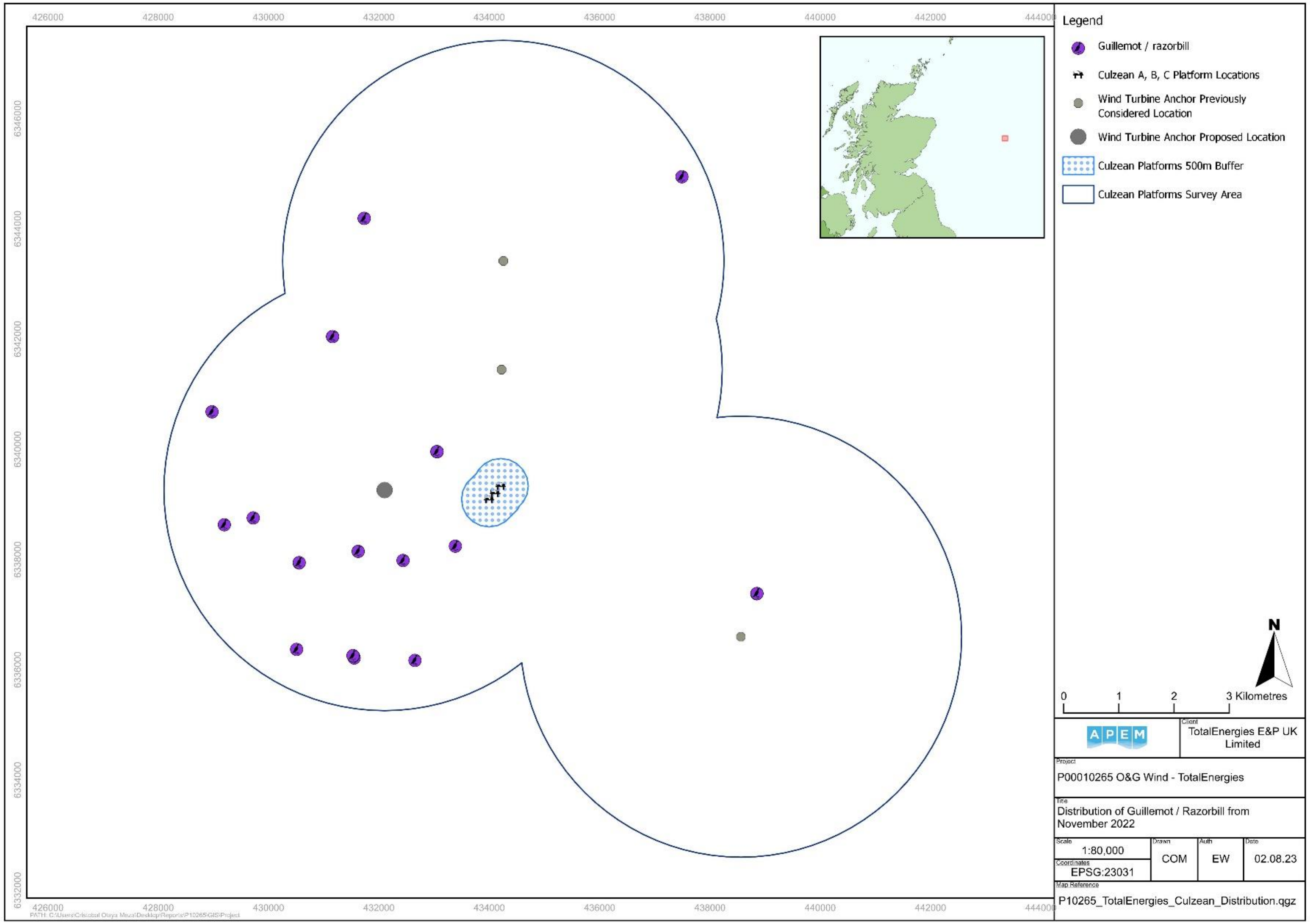


Figure 68 **Distribution of guillemot / razorbills from November 2022 (Survey 03)**

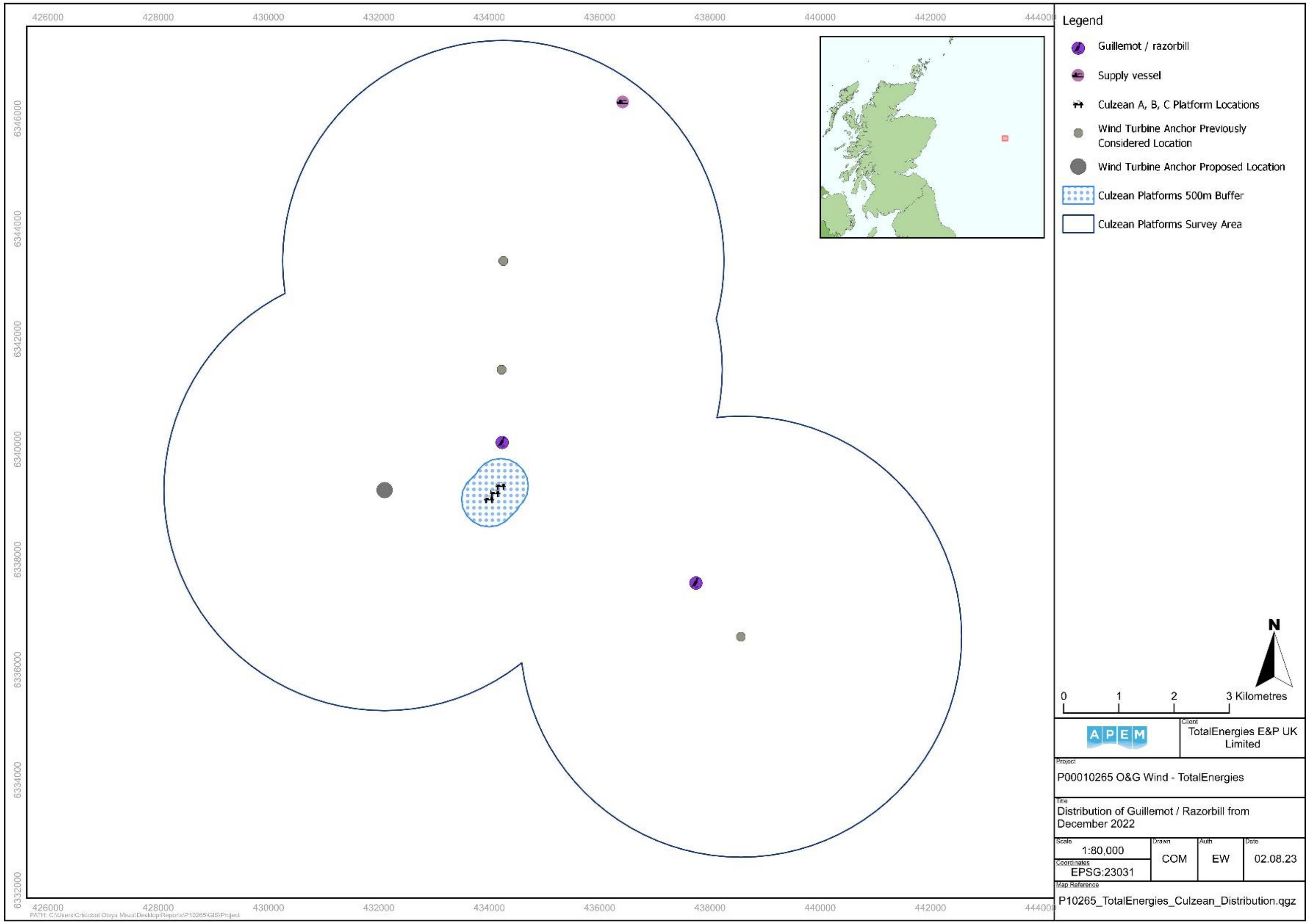


Figure 69 **Distribution of guillemot / razorbills from December 2022 (Survey 04)**

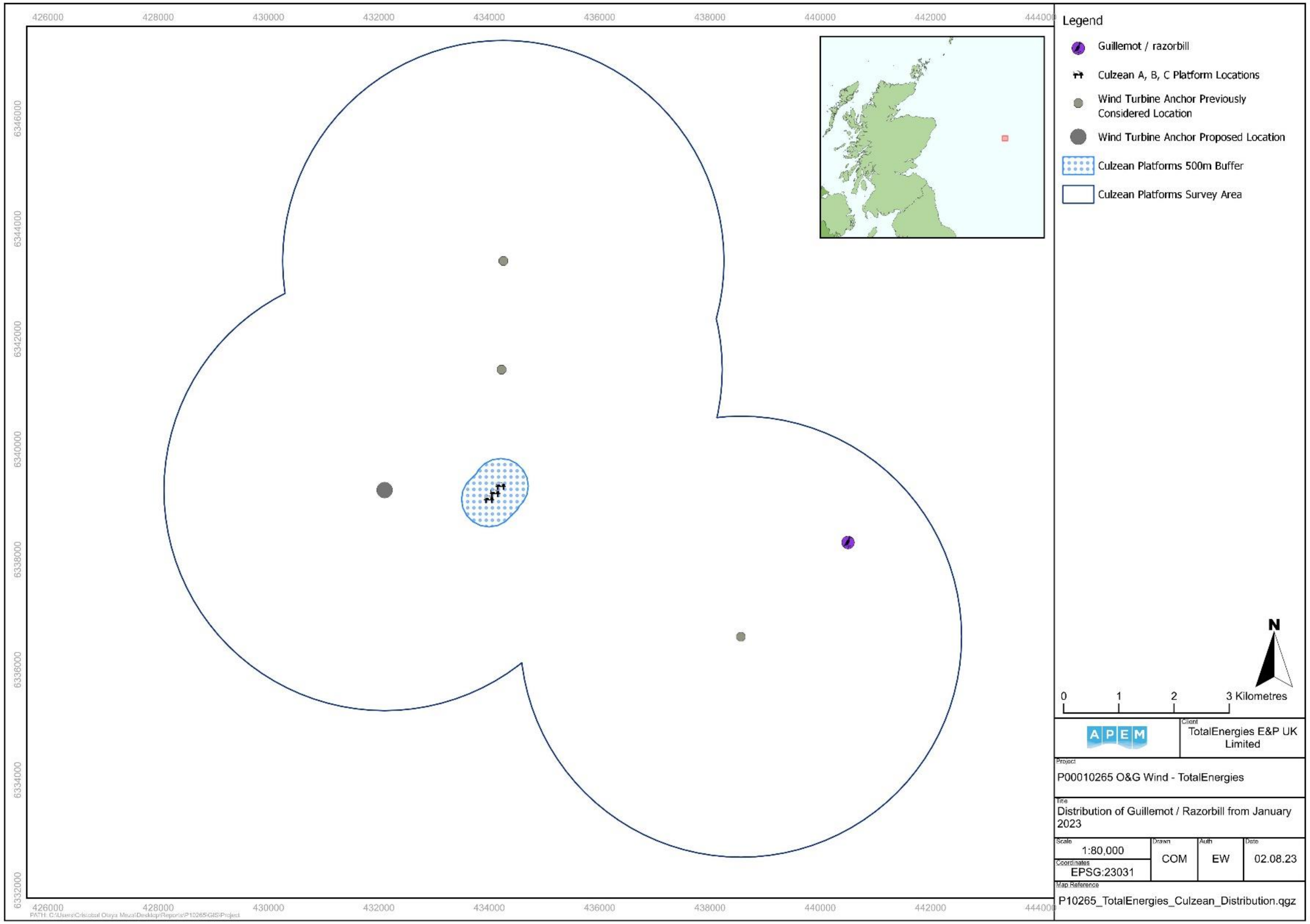


Figure 70 **Distribution of guillemot / razorbills from January 2023 (Survey 05)**

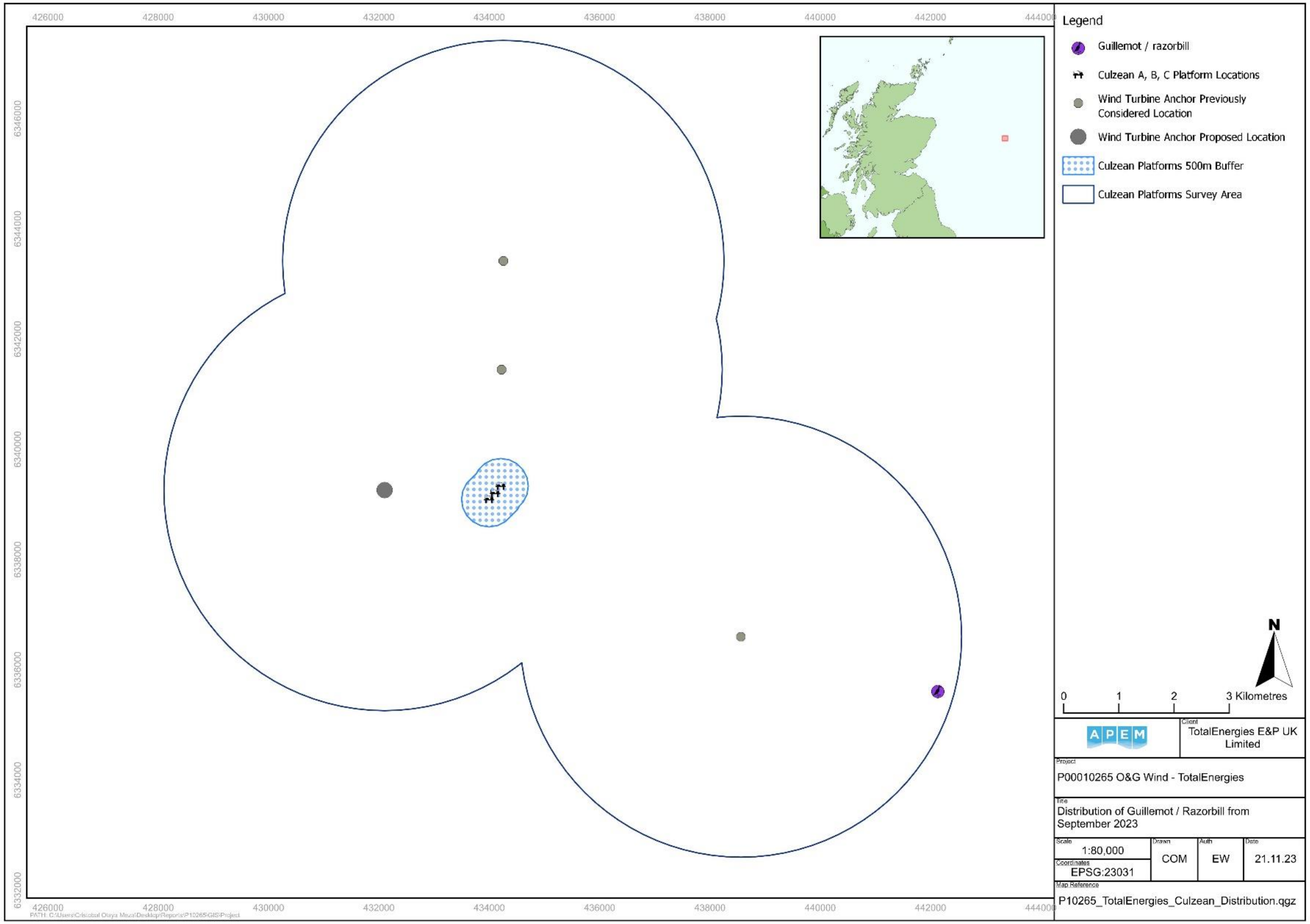


Figure 71 Distribution of guillemot / razorbills from September 2023 (Survey 13)

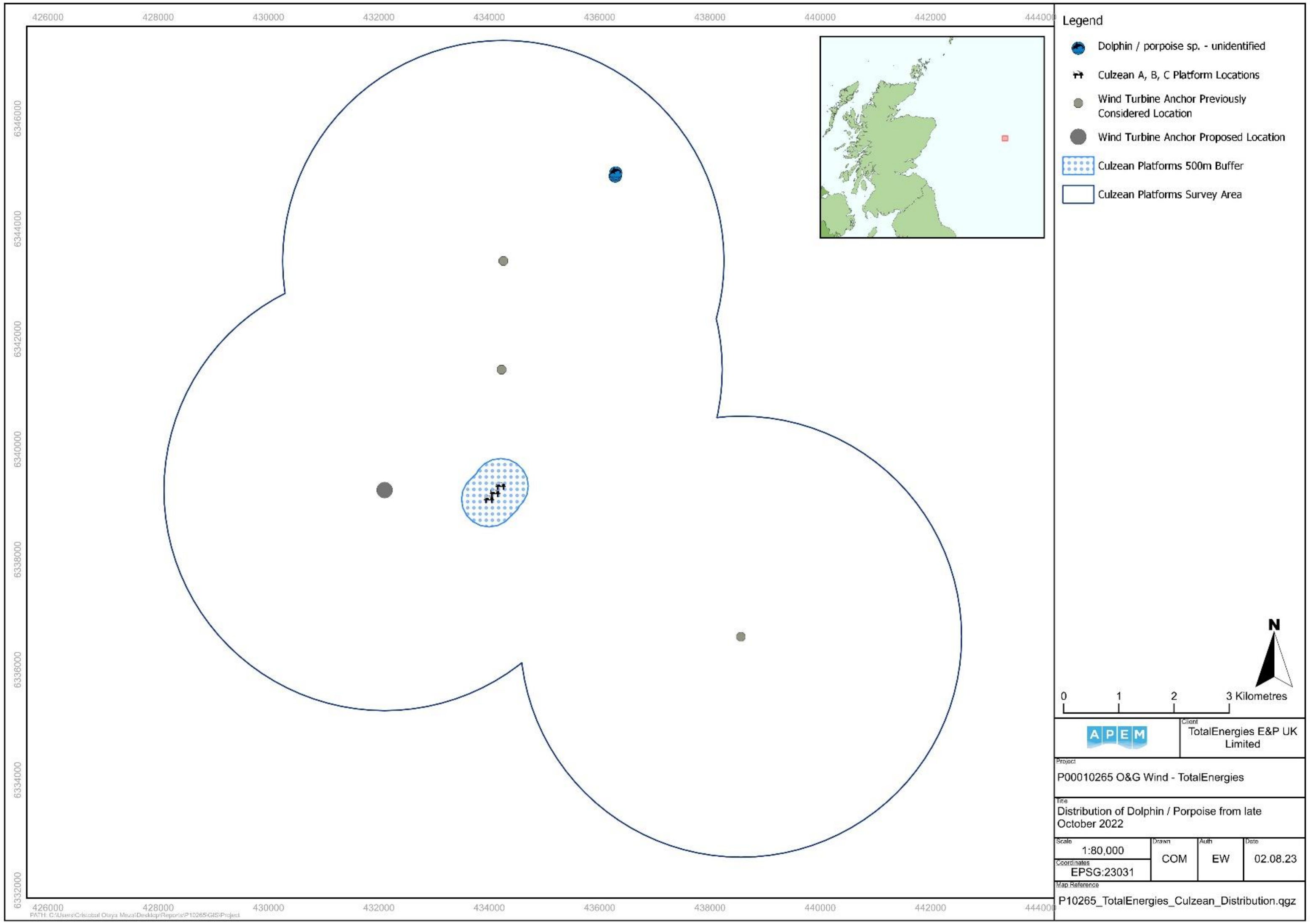


Figure 72 Distribution of dolphin / porpoise from Late October 2022 (Survey 02)

Appendix IV Raw Data Abundance and Density

This appendix presents abundance estimates and densities with behaviours for all species throughout the survey programme. Tables are also presented for species where apportionment and availability bias corrections have been applied.

9.4 Fulmar

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S2 Late Oct-22	1	9	1	26	1.00	0.07	2	17	2	43	0.70	0.13	3	26	3	60	0.57	0.19
S3 Nov-22	1	8	1	25	1.00	0.06	2	17	2	42	0.70	0.13	3	25	3	67	0.74	0.19
S4 Dec-22	-	-	-	-	-	-	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06
S5 Jan-23	1	9	1	26	1.00	0.07	1	9	1	26	1.00	0.07	2	17	2	43	0.70	0.13
S6 Feb-23	3	25	3	58	0.57	0.19	2	17	2	50	1.00	0.13	5	42	8	91	0.52	0.31
S7 Mar-23	-	-	-	-	-	-	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06
S9 May-23	4	34	4	78	0.61	0.25	16	138	16	405	0.94	1.03	20	173	20	474	0.86	1.29
S10 Jun-23	1	8	1	25	1.00	0.06	-	-	-	-	-	-	1	8	1	25	1.00	0.06
S11 Jul-23	-	-	-	-	-	-	4	34	8	67	0.50	0.25	4	34	8	67	0.50	0.25
S12 Aug-23	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06	2	17	2	42	0.71	0.13
S13 Sep-23	-	-	-	-	-	-	2	17	2	42	0.71	0.13	2	17	2	42	0.71	0.13

9.5 Unidentified Shearwater species

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S2 Late Oct-22	1	9	1	34	1.00	0.07	-	-	-	-		-	1	9	1	26	1.00	0.07

9.6 Gannet

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S10 Jun-23	-	-	-	-	-	-	2	17	2	42	0.70	0.13	2	17	2	42	0.70	0.13
S12 Aug-23	-	-	-	-	-		1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06

9.7 Kittiwake

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S3 Nov-22	-	-	-	-	-	-	2	17	2	42	0.70	0.13	2	17	2	42	0.70	0.13
S9 May-23	-	-	-	-	-	-	3	26	3	52	0.57	0.19	3	26	3	60	0.57	0.19
S10 Jun-23	-	-	-	-	-	-	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06
S11 Jul-23	-	-	-	-	-	-	2	17	2	42	0.70	0.13	2	17	2	42	0.70	0.13
S12 Aug-23	3	25	3	76	1.00	0.19	1	8	1	25	1.00	0.06	4	34	4	101	0.79	0.25

9.8 Common Gull

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S10 Jun-23	2	17	2	50	1.00	0.13	-	-	-		-	-	2	17	2	50	1.00	0.13

9.9 Great Black-backed Gull

Survey	Sitting						Perched						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S2 Late Oct-22	-	-	-	-	-	-	-	-	-	-	--		2	17	2	43	0.70	0.13	2	17	2	43	0.70	0.13
S3 Nov-22	2	17	2	42	0.70	0.13	-	-	-	-	-	-	1	8	1	25	1.00	0.06	3	25	3	59	0.57	0.19
S4 Dec-22	-	-	-	-	-	-	-	-	-	-	-	-	3	25	3	59	0.57	0.19	3	25	3	59	0.57	0.19
S5 Jan-23	1	9	1	26	1.00	0.07	-	-	-		-	-	2	17	2	43	0.70	0.13	3	26	3	51	0.57	0.19
S6 Feb-23	1	8	1	25	1.00	0.06	-	-	-	-	-	-	1	8	1	25	1.00	0.06	2	17	2	42	0.70	0.13
S8 Apr-23	-	-	-	-	-	-	-	-	-	-	-	-	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06
S9 May-23	-	-	-	-	-	-	-	-	--	-	-	-	1	9	1	26	1.00	0.07	1	9	1	26	1.00	0.07
S12 Aug-23	2	17	2	67	1	0.13	1	8	1	25	1.00	0.06	-	-	-	-	-	-	3	25	3	67	0.74	0.19

9.10 Herring Gull

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S2 Oct-22	2	17	2	51	1.00	0.13	-	-	-	-	-	-	2	17	2	51	1.00	0.13
S4 Dec-22	3	25	3	76	1.00	0.19	-	-	-	-	-	-	3	25	3	76	1.00	0.19
S5 Jan-23	-	-	-	-	-	-	1	9	1	26	1.00	0.07	1	9	1	34	1.00	0.07

9.11 'Commic' Tern

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km²)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km²)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km²)
S10 Jun-23	-	-	-	-	-	-	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06

9.12 Guillemot

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S1 Early Oct-22	104	867	542	1,275	0.21	6.47	1	8	1	25	1.00	0.06	105	875	550	1,275	0.21	6.53
S2 Late Oct-22	403	3,448	2,661	4,338	0.12	25.71	-	-	-	-	-	-	403	3,448	2,721	4,261	0.12	25.71
S3 Nov-22	198	1,661	1,175	2,265	0.17	12.39	-	-	-	-	-	-	198	1,661	1,133	2,265	0.17	12.39
S4 Dec-22	29	245	152	364	0.22	1.83	-	-	-	-	-	-	29	245	144	364	0.22	1.83
S5 Jan-23	22	189	103	274	0.24	1.41	-	-	-	-	-	-	22	189	103	283	0.24	1.41
S6 Feb-23	9	75	25	133	0.36	0.56	-	-	-	-	-	-	9	75	25	133	0.36	0.56
S7 Mar-23	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06	2	17	2	42	0.70	0.13
S8 Apr-23	13	110	51	169	0.29	0.82	3	25	3	68	0.74	0.19	16	135	68	211	0.27	1.01
S9 May-23	2	17	2	52	1.00	0.13	5	43	5	121	0.82	0.32	7	60	7	155	0.65	0.45
S11 Jul-23	8	67	17	135	0.46	0.5	1	8	1	25	1.00	0.06	9	76	17	143	0.42	0.57
S12 Aug-23	7	59	17	118	0.47	0.44	-	-	-	-	-	-	7	59	17	118	0.47	0.44
S13 Sep-23	23	195	93	288	0.21	1.45	-	-	-	-	-	-	23	195	93	288	0.21	1.45

Survey	Sitting Apportioned		Flying Apportioned		Total Apportioned	
	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
S1 Early Oct-22	867	6.46	8	0.06	875	6.52
S2 Late Oct-22	3,560	26.52	9	0.07	3,569	26.59
S3 Nov-22	1,826	13.60	34	0.25	1,860	13.85
S4 Dec-22	261	1.94	0	0.00	261	1.94
S5 Jan-23	198	1.47	0	0.00	198	1.47
S6 Feb-23	75	0.56	0	0.00	75	0.56
S7 Mar-23	8	0.06	8	0.06	16	0.12
S8 Apr-23	110	0.82	25	0.19	135	1.01
S9 May-23	17	0.13	43	0.32	60	0.45
S11 Jul-23	67	0.50	8	0.06	75	0.56
S12 Aug-23	59	0.44	0	0.00	59	0.44
S13 Sep-23	203	1.51	0	0.00	203	1.51

Survey	Sitting Apportioned and Corrected		Flying Apportioned and Corrected		Total Apportioned and Corrected	
	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
S1 Early Oct-22	1,137	8.47	8	0.06	1,145	8.53
S2 Late Oct-22	4,668	34.77	9	0.07	4,677	34.84
S3 Nov-22	2,393	17.83	34	0.25	2,427	18.08
S4 Dec-22	342	2.55	0	0.00	342	2.55
S5 Jan-23	260	1.93	0	0.00	260	1.93
S6 Feb-23	98	0.73	0	0.00	98	0.73
S7 Mar-23	10	0.08	8	0.06	18	0.14
S8 Apr-23	144	1.07	25	0.19	169	1.26
S9 May-23	22	0.17	43	0.32	65	0.49
S11 Jul-23	88	0.65	8	0.06	96	0.71
S12 Aug-23	77	0.58	0	0.00	77	0.58
S13 Sep-23	266	1.98	0	0.00	266	1.98

9.13 Razorbill

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S1 Early Oct-22	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	25	1.00	0.06
S2 Late Oct-22	27	231	111	368	0.29	1.72	-	-	-	--	-	-	27	231	111	376	0.29	1.72
S3 Nov-22	4	34	4	76	0.61	0.25	-	-	-	--	-	-	4	34	4	84	0.61	0.25
S4 Dec-22	2	17	2	42	0.70	0.13	-	-	-	--	-	-	2	17	2	42	0.70	0.13
S6 Feb-23	3	25	3	58	0.57	0.19	-	-	-	--	-	-	3	25	3	58	0.57	0.19
S10 Jun-23	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	25	1.00	0.06
S12 Aug-23	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	25	1.00	0.06
S13 Sep-23	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	25	1.00	0.06

Survey	Sitting Apportioned		Flying Apportioned		Total Apportioned	
	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
S1 Early Oct-22	8	0.06	0	0.00	8	0.06
S2 Late Oct-22	239	1.78	0	0.00	239	1.78
S3 Nov-22	37	0.28	0	0.00	37	0.28
S4 Dec-22	18	0.13	0	0.00	18	0.13
S6 Feb-23	25	0.19	0	0.00	25	0.19
S10 Jun-23	8	0.06	0	0.00	8	0.06
S12 Aug-23	8	0.06	0	0.00	8	0.06
S13 Sep-23	8	0.06	0	0.00	8	0.06

Survey	Sitting Apportioned and Corrected		Flying Apportioned and Corrected		Total Apportioned and Corrected	
	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
S1 Early Oct-22	10	0.07	0	0.00	10	0.07
S2 Late Oct-22	289	2.15	0	0.00	289	2.15
S3 Nov-22	45	0.34	0	0.00	45	0.34
S4 Dec-22	22	0.16	0	0.00	22	0.16
S6 Feb-23	0	0.00	0	0.00	0	0.00
S10 Jun-23	10	0.07	0	0.00	10	0.07
S12 Aug-23	10	0.07	0	0.00	10	0.07
S13 Sep-23	10	0.08	0	0.00	10	0.08

9.14 Guillemot / Razorbill

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
Late Oct-22	14	120	51	197	0.31	0.89	1	9	1	26	1.00	0.07	15	128	60	214	0.31	0.95
Nov-22	20	168	84	277	0.28	1.25	4	34	4	101	1.00	0.25	24	201	101	327	0.28	1.5
Dec-22	2	17	2	42	0.70	0.13	-	-	-	--	-	-	2	17	2	42	0.70	0.13
Jan-23	1	9	1	34	1.00	0.07	-	-	-	--	-	-	1	9	1	34	1.00	0.07
Sep-23	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	25	1.00	0.06

9.15 Puffin

Survey	Sitting						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
Nov-22	2	17	2	42	0.70	0.13	-	-	-	--	-	-	2	17	2	42	0.70	0.13

Survey	Sitting Apportioned		Flying Apportioned		Total Apportioned	
	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
Nov-22	17	0.13	0	0.00	17	0.13

Survey	Sitting Apportioned and Corrected		Flying Apportioned and Corrected		Total Apportioned and Corrected	
	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
Nov-22	20	0.15	0	0.00	20	0.15

9.16 Harbour Porpoise

Survey	Submerged						Surfacing						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S2 Late Oct-22	1	9	1	26	1.00	0.07	1	9	1	26	1.00	0.07	2	17	2	43	0.70	0.13
S3 Nov-22	-	-	-	--	-	-	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06
S4 Dec-22	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	25	1.00	0.06
S5 Jan-23	-	-	-	--	-	-	1	9	1	26	1.00	0.07	1	9	1	26	1.00	0.07
S6 Feb-23	1	8	1	25	1.00	0.06	1	8	1	25	1.00	0.06	2	17	2	50	1.00	0.13
S7 Mar-23	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	34	1.00	0.06
S8 Apr-23	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	25	1.00	0.06
S10 Jun-23	5	42	8	92	0.52	0.31	2	17	2	50	1.00	0.13	7	58	8	125	0.55	0.43

Survey	Submerged Apportioned		Surfacing Apportioned		Deeply Submerged Apportioned		Total Apportioned	
	Abundance Est.	Density (km²)	Abundance Est.	Density (km²)	Abundance Est.	Density (km²)	Abundance Est.	Density (km²)
S2 Late Oct-22	35	0.26	26	0.19	9	0.07	0	0.00
S3 Nov-22	8	0.06	0	0.00	8	0.06	0	0.00
S4 Dec-22	8	0.06	8	0.06	0	0.00	0	0.00
S5 Jan-23	9	0.07	0	0.00	9	0.07	0	0.00
S6 Feb-23	16	0.12	8	0.06	8	0.06	0	0.00
S7 Mar-23	8	0.06	8	0.06	0	0.00	0	0.00
S8 Apr-23	8	0.06	8	0.06	0	0.00	0	0.00
S10 Jun-23	59	0.44	42	0.31	17	0.13	0	0.00

Survey	Submerged Apportioned and Corrected		Surfacing Apportioned and Corrected		Deeply Submerged Apportioned and Corrected		Total Apportioned and Corrected	
	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)	Abundance Est.	Density (km^2)
S2 Late Oct-22	57	0.43	20	0.15	0	0.00	77	0.57
S3 Nov-22	0	0.00	18	0.13	0	0.00	18	0.13
S4 Dec-22	17	0.13	0	0.00	0	0.00	17	0.13
S5 Jan-23	0	0.00	19	0.14	0	0.00	19	0.14
S6 Feb-23	17	0.13	17	0.13	0	0.00	34	0.25
S7 Mar-23	14	0.10	0	0.00	0	0.00	14	0.10
S8 Apr-23	14	0.10	0	0.00	0	0.00	14	0.10
S10 Jun-23	77	0.57	31	0.23	0	0.00	108	0.80

9.17 Dolphin / Porpoise

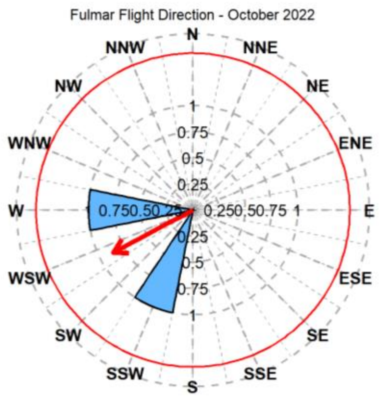
Survey	Submerged						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
S2 Late Oct-22	2	17	2	51	1.00	0.13	-	-	-	--	-	-	2	17	2	51	1.00	0.13
-	-	-	--	-	-	-	-	-	--	-	-	-	-	-	--	-	-	-

9.18 Basking Shark

Survey	Submerged						Flying						Total					
	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)	Count	Abundance Est.	95% CI Lower	95% CI Upper	Precision (CV)	Density (km^2)
Jun-23	1	8	1	25	1.00	0.06	-	-	-	--	-	-	1	8	1	25	1.00	0.06

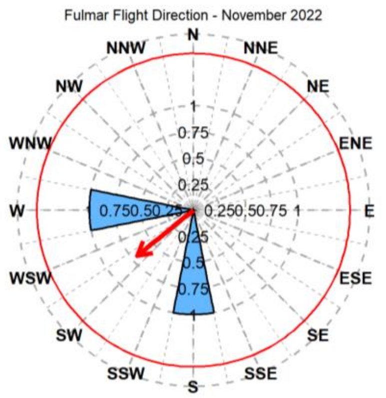
Appendix V Flight Directions

9.19 Fulmar



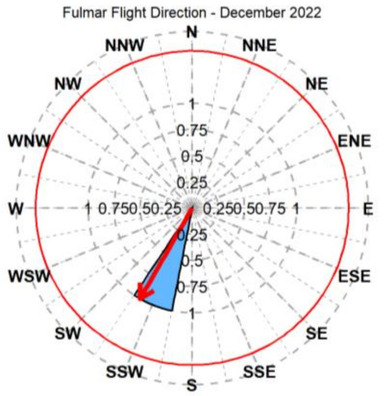
Number of Observations	2
Mean Vector (µ)	242.615
Length of Mean Vector (r)	0.862
Rayleigh Test (Z)	1.487
Rayleigh Test (p)	0.258

A. October 2022 (Survey 02)



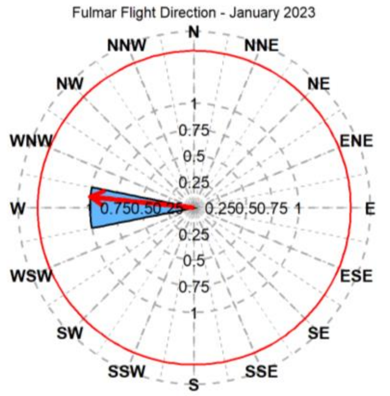
Number of Observations	2
Mean Vector (µ)	231.333
Length of Mean Vector (r)	0.692
Rayleigh Test (Z)	0.959
Rayleigh Test (p)	0.444

B. November 2022 (Survey 03)



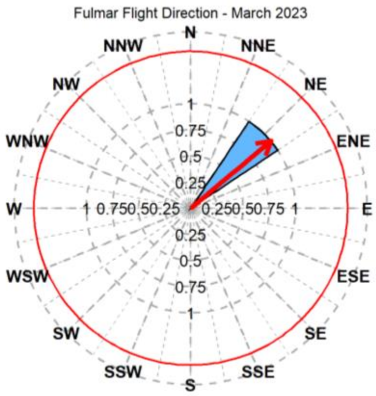
Number of Observations	1
Mean Vector (µ)	210.016
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

C. December 2022 (Survey 04)



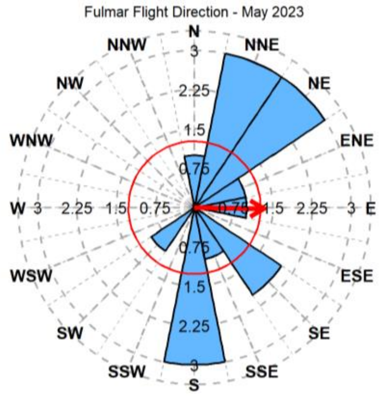
Number of Observations	1
Mean Vector (µ)	276.092
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

D. January 2023 (Survey 05)



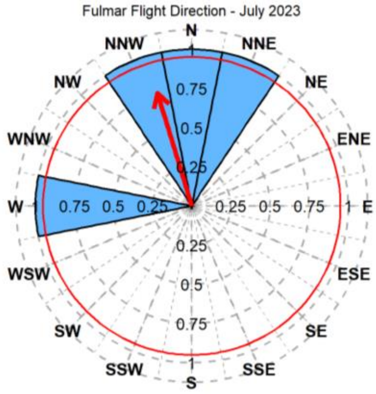
Number of Observations	1
Mean Vector (µ)	50.835
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

E. March 2023 (Survey 07)



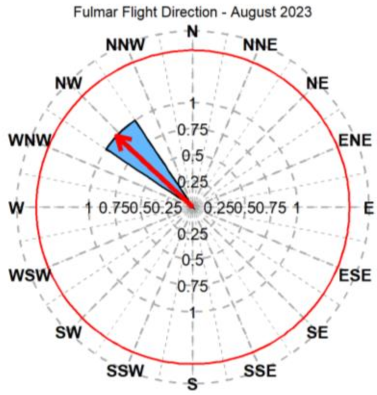
Number of Observations	16
Mean Vector (µ)	91.022
Length of Mean Vector (r)	0.443
Rayleigh Test (Z)	3.140
Rayleigh Test (p)	0.041

F. May 2023 (Survey 09)



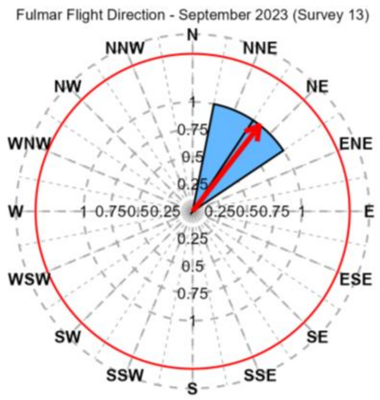
Number of Observations	4
Mean Vector (µ°)	343.869
Length of Mean Vector (r)	0.752
Rayleigh Test (Z)	2.261
Rayleigh Test (p)	0.100

G. July 2023 (Survey 11)



Number of Observations	1
Mean Vector (µ°)	313.902
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

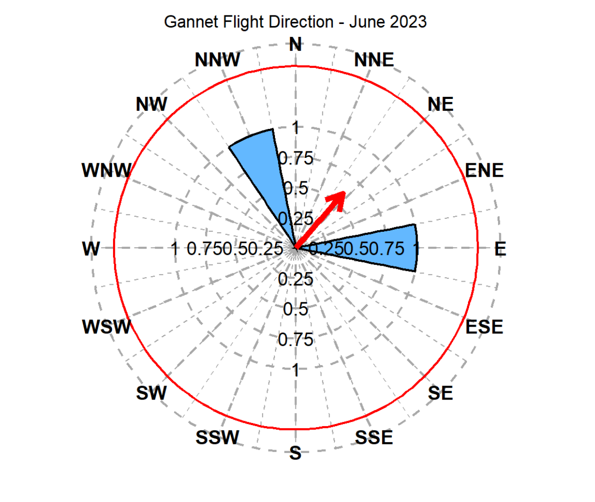
H. August 2023 (Survey 12)



Number of Observations	2
Mean Vector (µ°)	38.666
Length of Mean Vector (r)	0.993
Rayleigh Test (Z)	1.974
Rayleigh Test (p)	0.142
I. September 2023 (Survey 13)	

Figure 73 Summary of non-significant flight direction of fulmars during survey period

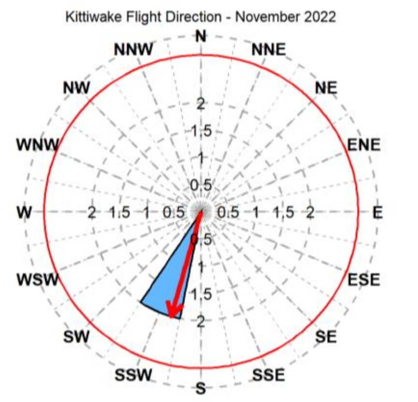
9.20 Gannet



Number of Observations	2
Mean Vector (µ)	41.240
Length of Mean Vector (r)	0.590
Rayleigh Test (Z)	0.696
Rayleigh Test (p)	0.565
June 2023 (Survey 10)	

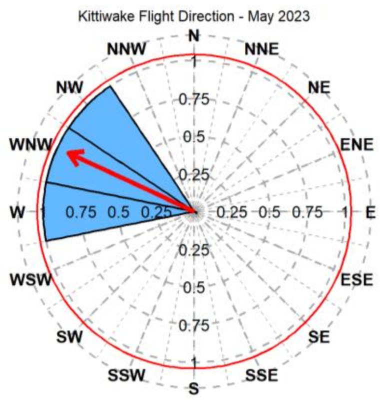
Figure 74 Summary of non-significant flight direction of gannets during survey period

9.21 Kittiwake



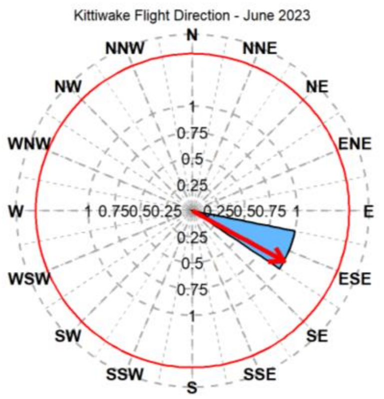
Number of Observations	2
Mean Vector (µ)	196.926
Length of Mean Vector (r)	0.995
Rayleigh Test (Z)	1.982
Rayleigh Test (p)	0.141

A. November 2022 (Survey 03)



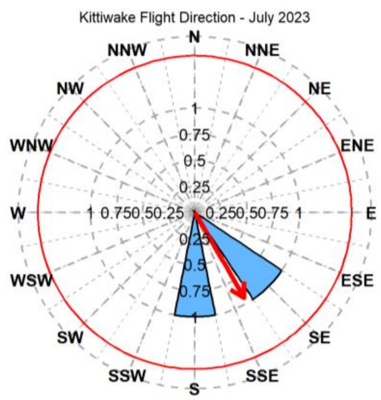
Number of Observations	3
Mean Vector (µ)	295.284
Length of Mean Vector (r)	0.917
Rayleigh Test (Z)	2.525
Rayleigh Test (p)	0.069

B. May 2023 (Survey 09)



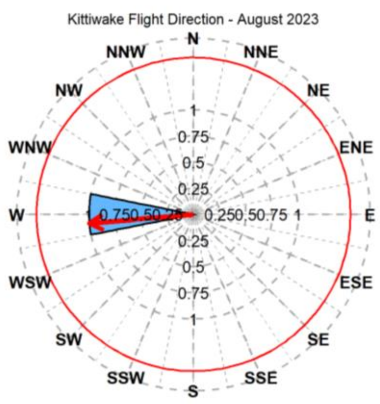
Number of Observations	1
Mean Vector (µ)	119.455
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

C. June 2023 (Survey 10)



Number of Observations	2
Mean Vector (µ)	150.889
Length of Mean Vector (r)	0.941
Rayleigh Test (Z)	1.772
Rayleigh Test (p)	0.184

D. July 2023 (Survey 11)

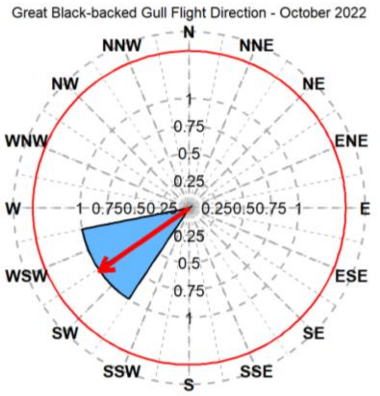


Number of Observations	1

Mean Vector (μ)	265.934
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	5.12
E. August 2023 (Survey 12)	

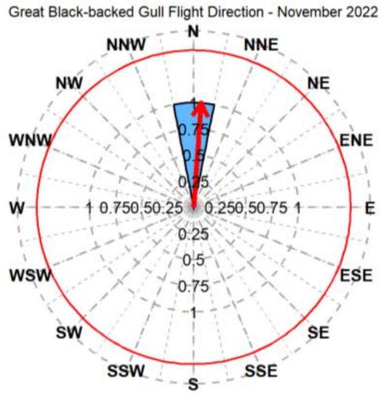
Figure 75 Summary of non-significant flight direction of kittiwakes during survey period

9.22 Great Black-backed Gull



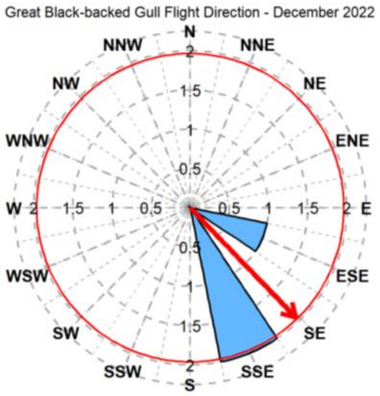
Number of Observations	2
Mean Vector (µ)	235.827
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.999
Rayleigh Test (p)	0.137

A. October 2022 (Survey 02)



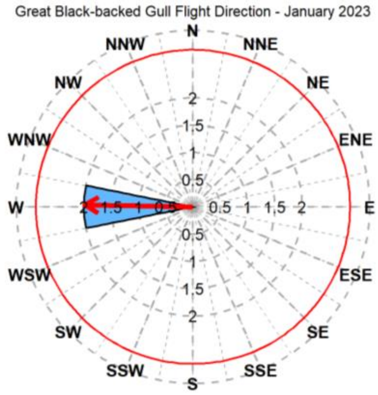
Number of Observations	1
Mean Vector (µ)	4.417
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

B. November 2022 (Survey 03)



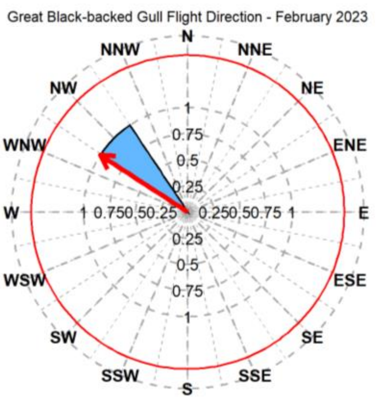
Number of Observations	3
Mean Vector (µ)	136.815
Length of Mean Vector (r)	0.971
Rayleigh Test (Z)	2.831
Rayleigh Test (p)	0.044

C. December 2022 (Survey 04)

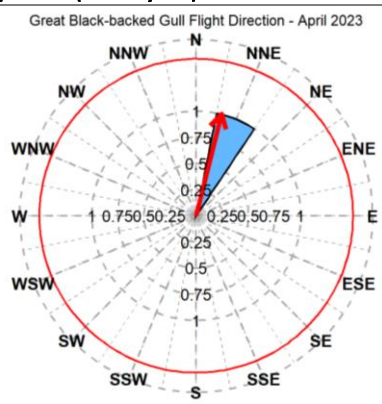


Number of Observations	2
Mean Vector (µ)	271.098
Length of Mean Vector (r)	0.993
Rayleigh Test (Z)	1.974
Rayleigh Test (p)	0.142

D. January 2023 (Survey 05)



Number of Observations	1
Mean Vector (µ)	303.809



Number of Observations	1
Mean Vector (µ)	14.428

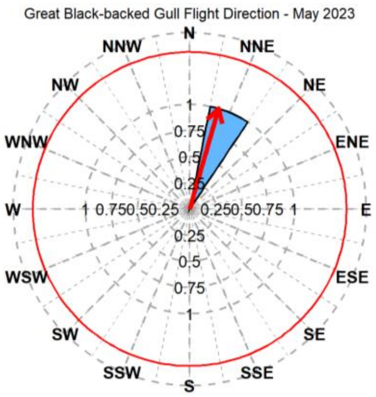
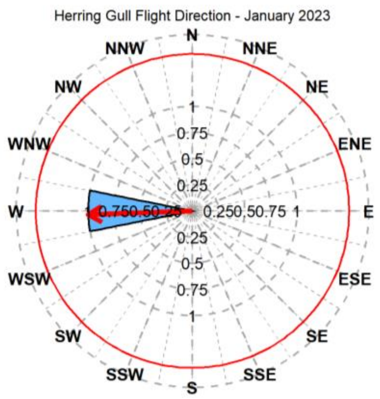
Length of Mean Vector (r)	1.000	Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000	Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512	Rayleigh Test (p)	0.512
E. February 2023 (Survey 06)		**F. April 2023 (Survey 08)**	
			
Number of Observations	1		
Mean Vector (μ°)	16.923		
Length of Mean Vector (r)	1.000		
Rayleigh Test (Z)	1.000		
Rayleigh Test (p)	0.512		
G. May 2023 (Survey 09)			

Figure 76 Summary of non-significant flight direction of great black-backed gulls during survey period

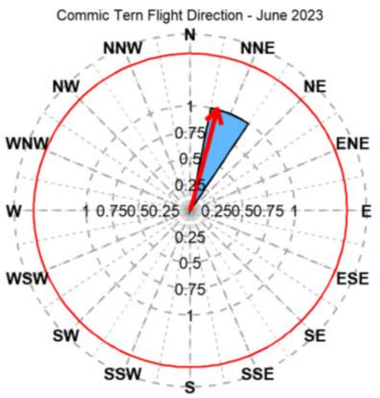
9.23 Herring Gull



Number of Observations	1
Mean Vector (µ)	268.161
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
January 2023 (Survey 05)	

Figure 77 Summary of non-significant flight direction of herring gulls during survey period

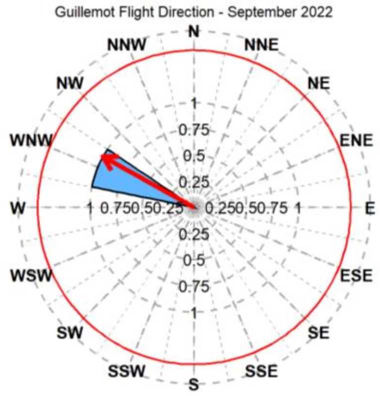
9.24 'Commic' Tern



Number of Observations	1
Mean Vector (μ)	15.483
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
June 2023 (Survey 10)	

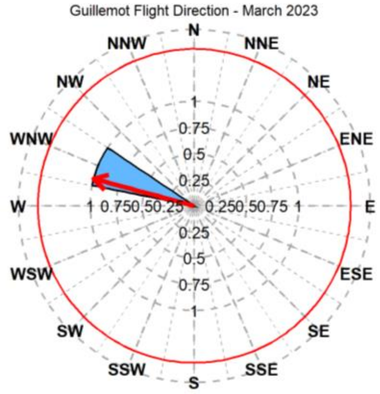
Figure 78 Summary of non-significant flight direction of 'commic' terns during survey period

9.25 Guillemot



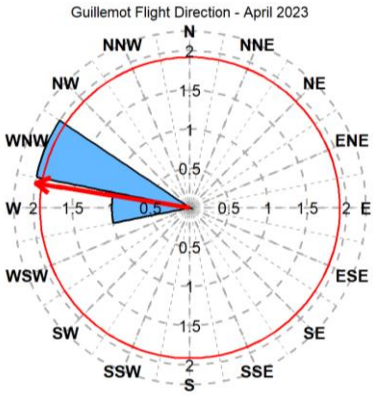
Number of Observations	1
Mean Vector (µ)	299.080
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

A. September 2022 (Survey 01)



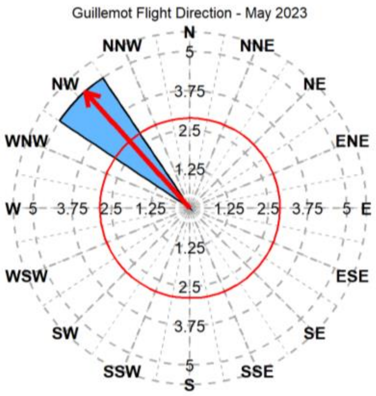
Number of Observations	1
Mean Vector (µ)	285.389
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

B. March 2023 (Survey 07)



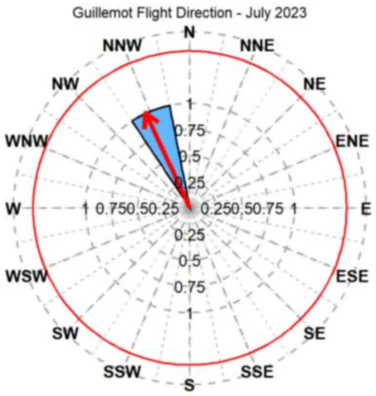
Number of Observations	3
Mean Vector (µ)	279.817
Length of Mean Vector (r)	0.995
Rayleigh Test (Z)	2.970
Rayleigh Test (p)	0.035

C. April 2023 (Survey 08)



Number of Observations	5
Mean Vector (µ)	318.598
Length of Mean Vector (r)	0.996
Rayleigh Test (Z)	4.963
Rayleigh Test (p)	0.001

D. May 2023 (Survey 09)

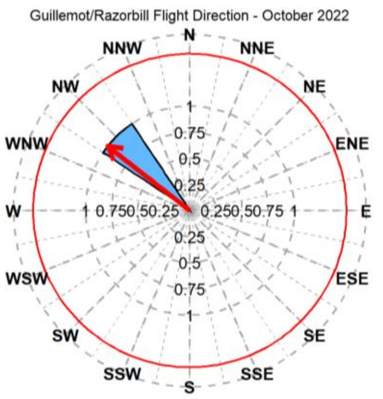


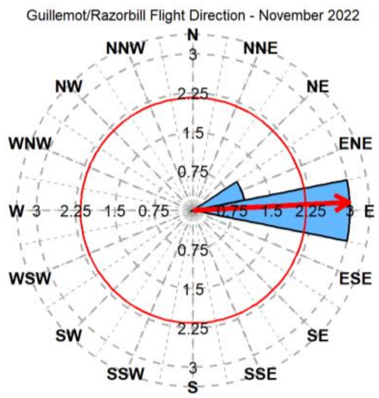
Number of Observations	1
Mean Vector (µ)	335.327

Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
E. July 2023 (Survey 11)	

Figure 79 Summary of non-significant flight direction of guillemots during survey period

9.26 Guillemot / Razorbill





Number of Observations	1	Number of Observations	4
Mean Vector (µ)	308.344	Mean Vector (µ)	87.215
Length of Mean Vector (r)	1.000	Length of Mean Vector (r)	0.994
Rayleigh Test (Z)	1.000	Rayleigh Test (Z)	3.952
Rayleigh Test (p)	0.512	Rayleigh Test (p)	0.008
A. October 2022 (Survey 02)		**B. November 2022 (Survey 03)**	

Figure 80 Summary of non-significant flight direction of guillemots / razorbills during survey period