Natural England

Ornithological and Marine Mammal Baseline Characterisation Surveys for the POSEIDON project

January-March (Seasonal) Report – South-West Celtic Sea

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1. Executive Summary

This report constitutes the second seasonal (January to March 2023) report outlining results from digital aerial surveys conducted in March 2023 within the South-West Celtic Sea under the POSEIDON project and commissioned by Natural England. Surveys were undertaken using APEM's high-resolution camera system to capture digital still imagery of birds and marine megafauna within the Survey Area.

The survey was successfully carried out by two planes in a single day in March 2023, with no technical or safety issues. A total of 818 observations were recorded in March 2023, of which 374 were observations of birds and 444 observations of marine megafauna. APEM will continue to monitor the site for these species and others during the remaining seasonal surveys.

2. Introduction

2.1 Background

APEM has been contracted by Natural England for the supply of four seasonal digital aerial surveys within the South-West Celtic Sea, commencing from December 2022. The surveys form part of the POSEIDON project which is led by Natural England and funded through the Crown Estates Offshore Wind Evidence and Change (OWEC) programme. Analysis of existing seabird and marine mammal data for English and Welsh waters identified gaps in the evidence base for the Survey Area. The main purpose of the survey programme is to address these evidence gaps through providing baseline information on the abundance, distribution and behaviour of birds and marine mammals within the Survey Area.

The Survey Area is located within the Celtic Sea to the west of Cornwall and Brittany (**Figure 1**) and covers an area of 18,011 square kilometres (km^2). The survey method has been designed to optimise data collection for all bird, marine mammal, and other marine megafauna species using a transect-based survey design at 1.5-centimetre (cm) ground sampling distance (GSD) to achieve a minimum of 3% captured and 3% analysed coverage using a twin-engine aircraft. These surveys have been carried out to meet the aims and objectives of the work by Natural England and the POSEIDON project.

This report describes the seasonal (January to March 2023) survey, undertaken in March 2023 as part of the survey programme.

2.2 Aim of Report

The report presents information on marine birds, mammals, and other megafauna, which includes the following:

- Description of, and rationale for, survey methods and design
- Map of survey route and coverage
- Survey details as actually flown (including dates/times, weather, and other relevant conditions)
- Raw count observations for behaviours of all avian and marine mammal species, as well as any other marine megafauna recorded per month within the Survey Area.
- Bird flight heights and direction
- Spatial distribution maps of avian, marine mammal, and other marine megafauna species.

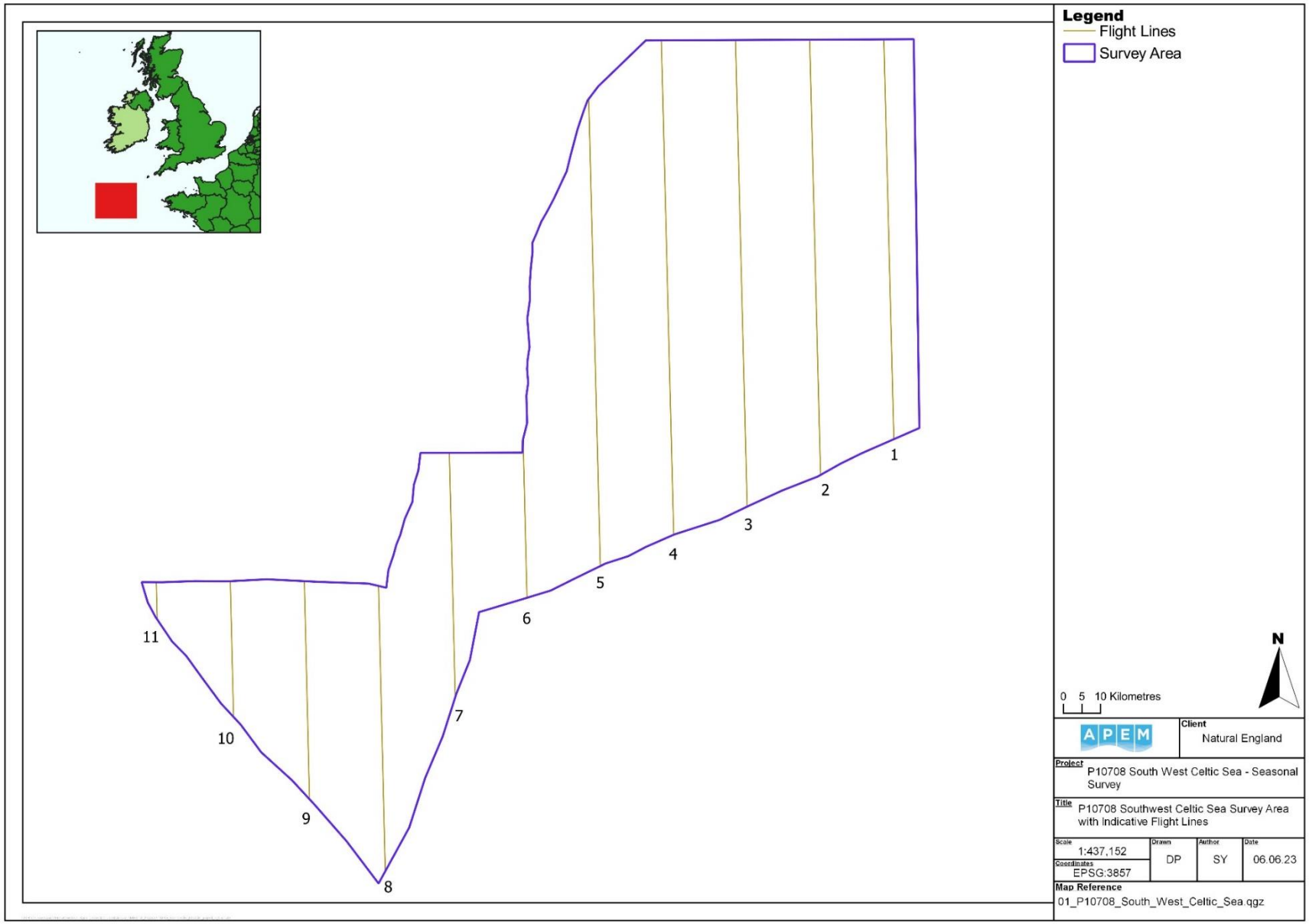

Figure 1 Location of the South-West Celtic Sea Survey Area

3. Survey and Analysis Methodologies

3.1 Digital Aerial Survey Methods

The survey was conducted using APEM's bespoke camera system, termed "Shearwater V", customised by in-house specialists for surveying the offshore environment. The camera system is integrated with custom flight planning software that allows each survey flight line to be accurately mapped before the aircraft leaves the ground. Each image capture node is precisely defined, allowing the system to fire the camera exposures at exactly the right location. This ensures that each survey is flown with the same orientation and the camera is triggered at the same position within set tolerances (**Table 1**). APEM's flight planning software enables 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. The process of automatically aborting data capture is called a 'cutout'. Should this occur, the plane is required to revisit and resurvey the affected section of the survey line.

APEM's on-board camera technician continually monitored the imagery as it was collected to ensure data collected was fit for purpose. The camera technician would make the decision to cease data collection should conditions become unsuitable for surveying or data collection. Subsequently, the survey would then be resumed at the next earliest opportunity. All completed surveys therefore maintained conditions conducive to successful surveying.

Favourable conditions for surveying were defined as: a cloud base (lowest altitude of the visible portion of the cloud) of at least 1,300 ft, according to a geoidal model, to ensure there is no cloud below the planned altitude of the aircraft, visibility of greater than 5 km, wind speed of less than 30 knots, and sea state of 4 (moderate) or less. Naturally, the cloud base may vary in altitude, but aircraft will always fly lower than the lowest cloud level. If cloud base is lower than the planned aircraft altitude the survey would not take place. APEM's flight planning software allows for sideways, up and down movement of the aircraft to set tolerances ensuring the aircraft does not drift away from the line, and altitude remains suitable to achieve the required GSD. Whilst the image footprint and GSD both increase with altitude, the focus of the camera lenses ensures no discernible differences within the range of altitudes potentially flown. Wind speed was recorded at the same altitude as the aircraft, whereas sea state was determined from the appearance of the sea surface recorded by the onboard aerial survey technician. The two measures therefore do not necessarily correlate. For safety reasons, no surveying can take place in icing conditions.

Data capture comprised digital still images of an average 1.5 cm GSD. Images at each camera are processed at each node, resulting in slight variation in GSD across the swath width. GSD is smaller than 1.5 cm GSD at the nadir and increases with distance from the nadir, resulting in an average GSD of 1.5 cm. Image resolution is therefore clearest at the nadir, although the variation is small. Images were collected in a continuous transect-based design along a single line covered by three overlapping cameras, using a Global Positioning System (GPS) linked, bespoke flight management system to ensure the tracks were flown with a high degree of accuracy (**Figure 2**). The aircraft's internal GPS and Inertial Motion Unit (IMU) systems record to an accuracy of +/- 3 to 5 m as standard.

On March 6th, two planes were used to survey lines 1 to 4 (take off at 09:12, landing at 14:16), and 5 to 11 (take off at 09:13, landing at 15:06), respectively.

The camera system captured abutting imagery along 11 survey flight lines spaced approximately 20 km apart within the Survey Area (**Figure 2**). The total Survey Area was 18,011 km^2. The aircraft collected the data at an altitude of approximately 1,450 ft (440m) according to the ellipsoid model as recorded by GPS, equivalent to 1,300 ft (395 m) above geoidal mean sea level, and at a speed of approximately 120 knots. Images were collected continuously along the survey flight lines with slight overlap between image nodes. For analysis purposes each transect should be treated as a single sample, therefore for the current survey design, n=11. A total of 6,403 nodes were initially captured.

Of these, 6,304 were used for analysis. The difference reflects nodes removed during clipping to the boundary area, and unusable images removed during processing, for example due to camera misfires. Total coverage was calculated to be 3.45% analysed, generated from 6,304 image nodes (**Table 2**). The target coverage of 3% was achieved including a redundancy of an additional 0.45%, which is over 10% contingency with respect to the target coverage.

Effort data is calculated as the area (km^2) per image footprint using trigonometric methods and the pinhole camera model (the mathematical relationship between the coordinates of a point in three-dimensional space, and its projection onto the image plane of an ideal pinhole camera). Effort is dependent on altitude, camera angle and aircraft position (pitch, roll and yaw), accounting for variation both between image nodes and individual cameras at each node. Effort data is only calculated for analysed images. It is therefore possible that some images have an effort value of zero. Summing analysed footprints and comparing against entire survey area gives the percentage analysed. Effort values provided in the GPS log reflect the total footprint of each image and do not account for overlap. Therefore, summing these values for a survey would result in an overestimate of effort. The true effort for a given survey is calculated geospatially by creating polygons for each image and removing the overlapping areas.

Imagery was captured in raw format and post-processed to ensure optimal quality for the subsequent stage of image analysis, to extract information on marine fauna or other notable occurrences. When the survey was completed, data were checked to ensure the number of lines and the number of images collected was correct, and that the quality of the imagery was acceptable. Once image analysis was completed, further quality assurance (QA) processes took place (see **Section 3.3**).

Survey conditions are summarised in **Table 3**. A light to gentle breeze was recorded throughout the survey, and therefore no health and safety risks were recorded. Weather conditions are defined in **Table 4**.

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.

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, data collected provided coverage of 3.45%, thus exceeding the 3% coverage required, enabling sufficient coverage to be collected should images be affected by glint or glare. No glint or glare was present on any images taken during this survey.

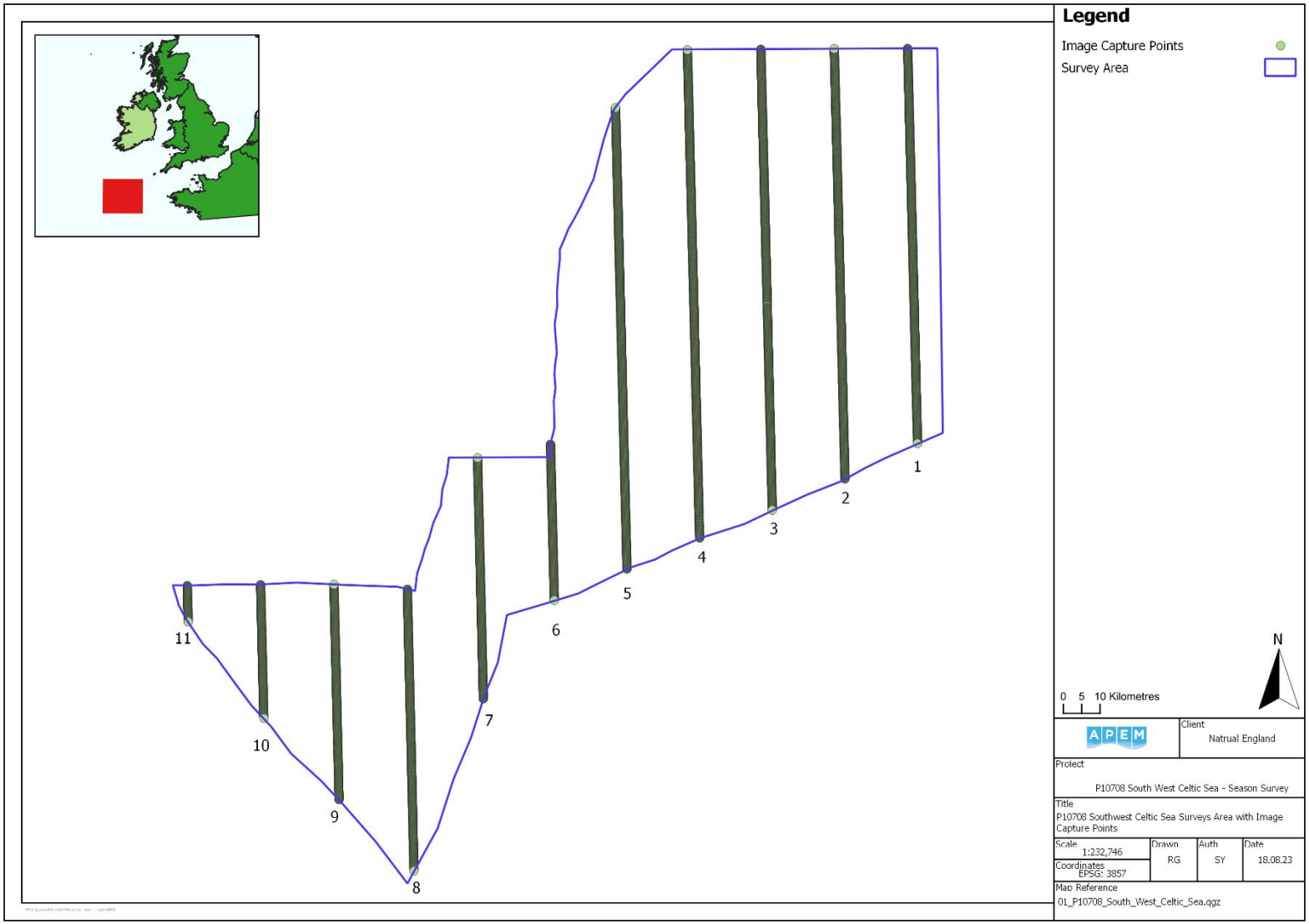

Figure 2 Individual image capture points during the January to March 2023 (March 2023) survey

Table 1 Lateral and vertical camera tolerances (m). A 'cutout' is the process of automatically aborting data capture. Should this occur, the plane is required to revisit and resurvey the affected section of the survey line.

Survey Tolerances	Warning	Cutout	
Lateral Tolerance	30	60	m
Vertical tolerance	15	30 (No auto cutout)	m

Table 2 Image capture and other observations during the January to March 2023 seasonal survey (March 2023).

Survey line	Transect length (km)	N cameras capturing image	N image nodes *(captured)	N image nodes (analysed)	Camera issues	Shipping observations	Anecdotal observations	Health and Safety
1	107.53	3	762	754	-	-	-	-
2	107.85	3	829	821	-	-	-	-
3	126.25	3	888	879	-	-	-	-
4	133.91	3	941	932	-	-	-	-
5	129.50	3	891	881	-	-	-	-
6	49.38	3	308	299	-	-	-	-
7	68.57	3	471	461	-	-	-	-
8	77.69	3	549	539	-	-	-	-
9	59.06	3	420	412	-	-	-	-
10	36.43	3	265	256	-	-	-	-
11	10.03	3	79	70	-	-	-	-

*Due to the vast number of capture points collected during the survey it is not uncommon for camera systems to sometimes miss capture points. Typically, the number of missed capture points is low and random across the site. APEM collected additional data to ensure the required coverage was captured. Additionally, APEM's onboard camera technician monitored data as it was being captured. Surveys are aborted or lines re-surveyed if camera issues impact data collection.

Table 3 Survey conditions during the January to March 2023 seasonal survey (March 2023)

Survey line	Date	Time (UTC) on line (Start / End)	Ground speed (knots)	Cloud cover (%)	Visibility (km)	Outside temperature (°C)	Wind speed (knots)	Wind direction	Sea state (Douglas)	Turbidity
1	06/03/2023	10:27 / 10:57	123	90	>10	5	6	290°	1	0
2	06/03/2023	11:05 / 11:36	125	80	>10	6	7	180°	1	0-1*
3	06/03/2023	11:43 / 12:24	127	90	>10	5	5	290°	1	0-1*
4	06/03/2023	12:31 / 13:06	129	90	>10	5	6	160°	1	0-1*
5	06/03/2023	13:15 / 13:49	122	100	>10	6	7	170°	2	1
6	06/03/2023	12:57 / 13:08	118	100	>10	6	6	210°	2	2
7	06/03/2023	12:33 / 12:50	124	100	>10	6	10	190°	2	2
8	06/03/2023	11:58 / 12:19	115	100	>10	6	4	200°	1	1
9	06/03/2023	11:35 / 11:51	126	100	>10	6	7	180°	1	1
10	06/03/2023	11:15 / 11:26	118	100	>10	6	6	140°	2	1
11	06/03/2023	11:05 / 11:08	120	100	>10	6	5	120°	2	1

*Turbidity varied from 0 to 1 along lines 2,3 and 4.

Table 4 Explanation of weather conditions.

Wind (Beaufort Scale)			Douglas Sea State			Cloud cover (%)		Turbidity	
Scale	**Description**	**Mean wind speed (knots)**	**Scale**	**Description**	**Wave height**	**% Cover**	**Description**	**Scale**	**Description**
0	Calm	0	0	Calm (glass)	No wave	0	Clear	0	Clear
1	Light air	2	1	Calm (rippled)	0 – 0.10 m	1-10	Few	1	Slightly Turbid
2	Light breeze	5	2	Smooth	0.10 – 0.50 m	11-50	Scattered	2	Moderately Turbid
3	Gentle breeze	9	3	Slightly Moderate	0.50 – 1.25 m	51-95	Broken	3	Highly Turbid
4	Moderate breeze	13	*Surveys not typically flown at sea states > 3.*			Overcast	96-100		
5	Fresh breeze	19	4	Moderate	1.25 – 2.50 m				
6	Strong breeze	24							
7	Near gale	30							
8	Gale	37							

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 digital aerial survey imagery to the species level and the individual was therefore identified as belonging to a higher-level taxonomic group (e.g., 'small gull species' or '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.

Table 5 Avian species included within higher-level taxonomic groups for the January to March 2023 seasonal survey period (March 2023)

<table>
<tr><th>Species</th><th>Group Level 1</th><th>Group Level 2</th><th>Group Level 3</th><th>Group Level 4</th></tr>
<tr><td>Kittiwake</td><td colspan="2">Small Gull species</td><td rowspan="2">Gull species</td><td rowspan="11">Unidentified bird species</td></tr>
<tr><td>Lesser Black-backed Gull</td><td>Black-backed Gull species</td><td>Large Gull species</td></tr>
<tr><td>European Storm Petrel</td><td colspan="3">Storm Petrel species</td></tr>
<tr><td>Guillemot</td><td rowspan="2">Guillemot and / or Razorbill</td><td rowspan="3">Auk species</td><td rowspan="4">Auk and / or shearwater species</td></tr>
<tr><td>Razorbill</td></tr>
<tr><td>Puffin</td><td rowspan="2"></td></tr>
<tr><td>Little Auk</td></tr>
<tr><td>Manx Shearwater</td><td>Small Shearwater species</td><td>Shearwater species</td></tr>
<tr><td>Fulmar</td><td colspan="3">Fulmar</td></tr>
<tr><td>Gannet</td><td colspan="3">Gannet</td></tr>
</table>

Table 6 Marine mammal species included within higher-level taxonomic groups for the January to March 2023 seasonal survey period (March 2023)

Species	Group Level 1	Group Level 2	Group Level 3	Group level 4
Common Dolphin	Dolphin species		Dolphin / Porpoise species	Unidentified Marine Mammal species
Common Bottlenose Dolphin				
Harbour Porpoise				
Beaked Whale	Whale species			
Common Minke Whale				
Cuvier's Beaked Whale				
Northern Bottlenose Whale				
Ocean Sunfish	Bony Fish		Fish species	Unidentified marine megafauna
Atlantic Bluefin Tuna				
Blue Shark	Shark Species			

3.3 Summary of Quality Assurance

Internal QA was carried out on the data collected during the survey. This consists of two steps:

The first step in the QA process, referred to as Blank QA, reviewed percentage agreement between images identified as positive (containing at least one target of interest) and those identified as blank (not containing any targets of interest). A random sample of 20% of survey imagery were subjected to a QA audit review, in which agreement in positive images should reach 90% agreement versus the main analysis of the whole survey. Where 90% agreement was not reached, a complete re-analysis of the survey data was undertaken. This consisted of analysing each image from the survey again, and extra positives from the re-analysis and QA audit are included in the data. For the current survey, the initial agreement was 77%. After re-analysis, agreement of 97% was attained. There was disagreement between three images. After QA, two images were recorded as containing a Manx shearwater and a European storm petrel, respectively, whilst a third image was judged to be a false positive.

The second step of the QA process, referred to as Species ID QA, reviewed species identifications. Target (snag) identifications made by image analysts were reviewed by our dedicated QA team and an agreement rate determined. If the original identification made by the image analyst matched that made by the QA analyst, this was considered agreement. Agreement was also made if the original and the QA identifications were both within the same taxonomic grouping, for example an initial identification of guillemot / razorbill, and a QA identification as guillemot. This method was adopted by BTO's method of species identification QA. A minimum of 10% of snags are checked with the proportion increasing depending on survey difficulty and accuracy of identifications. For this survey 100% of identifications were checked due to the relatively small number of targets overall.

3.4 Species Distribution Maps

Each animal recorded during the surveys was geo-referenced, enabling locations to be related to the boundary of the Survey Area. Corresponding coordinates for each observation were accurate to ±/- 3 to 5 m. Spatial distribution maps for birds and other marine megafauna 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 in close proximity to each other.

3.5 Species Flight Heights

Bird flight heights were estimated from the digital still images using a size-based methodology developed by APEM from techniques described by Johnston and Cook (2016)[1]. 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 (based on reference lengths taken from the literature) bird measurements, image GSD (the distance between pixel centres), the known height of the aircraft as

[1] Johnston, A. and Cook, A.S.C.P., 2016. *How High Do Birds Fly?: Development of Methods and Analysis of Digital Aerial Data of Seabird Flight Heights*. British Trust for Ornithology.

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. Flight height data is included within the separate raw data files.

4. Abundance and distribution

4.1 Abundance

A total of 374 birds were recorded in the Survey Area during the January – March 2023 seasonal (March 2023) survey. Of those, 290 were sitting on the water and 84 were in flight (**Table 7)**. A total of 444 marine megafauna were recorded in the Survey Area (**Table 8**). Scientific names and taxonomy of species recorded are provided in **Appendix I Scientific Names and Taxonomy**.

Table 7 Total number of individuals of birds by species or species group recorded during the January to March 2023 seasonal survey period (March 2023)

Species group	Species	Flying	Sitting	Deceased	Total
Small gulls	Kittiwake	5	5	-	10
	Lesser Black-backed Gull	13	3	-	16
Auk	Auk species	-	31	-	31
	Guillemot	-	2	-	2
	Guillemot / Razorbill	-	2	-	2
	Razorbill	-	1	-	1
	Little Auk	-	48	-	48
	Puffin	1	177	-	178
Fulmar	Fulmar	2	14	-	16
Gannet	Gannet	42	5	-	47
Petrel	European Storm Petrel	19	-	-	19
Shearwater	Manx Shearwater	2	-	-	2
Unidentified bird	Unidentified bird species	-	2	-	2
Total		**84**	**290**	**0**	**374**

Table 8 Total number of individuals of marine megafauna by species or species group recorded during the January to March 2023 seasonal survey period (March 2023)

Species Group	Species	Deeply submerged	Submerged	Surfacing	Deceased	Total
Dolphin	Common Dolphin	25	341	30	1	397
	Bottlenose Dolphin	3	28	1	-	32
Porpoise	Harbour Porpoise		3	-	-	3
Dolphin/Porpoise	Dolphin / Porpoise	1	-	1	-	2
Whale	Beaked Whale species	2	-	-	-	2
	Common Minke Whale	-	1	-	-	1
	Cuvier's Beaked Whale	-	3	-	-	3
	Northern Bottlenose Whale	-	1	-	-	1
Fish	Blue shark	-	1	0	-	1
	Atlantic Bluefin Tuna	-	1	0	-	1
	Ocean Sunfish	-	1	0	-	1
Total		**31**	**380**	**32**	**1**	**444**

4.2 Spatial Distribution

Figure 3 and **Figure 4** show the locations of all birds and other marine megafauna, respectively, recorded in the Survey Area. **Figure 5** to **Figure 8** show the locations of the most abundant birds by species within the Survey Area. **Figure 9** shows the aggregated distribution of less abundant bird species recorded in the Survey Area. **Figure 10** shows the location of common dolphins within the Survey Area and **Figure 11** shows the location of bottlenose dolphins within the Survey Area. **Figure 12** shows the aggregated distribution of less abundant marine megafauna recorded in the Survey Area. Birds were evenly distributed across the Survey Area. Marine megafauna species were also evenly distributed throughout the Survey Area. Note that in some cases, symbols may overlap and appear fewer in number where the distribution of individuals is clustered. This is notably the case for bottlenose dolphins (**Figure 11**).

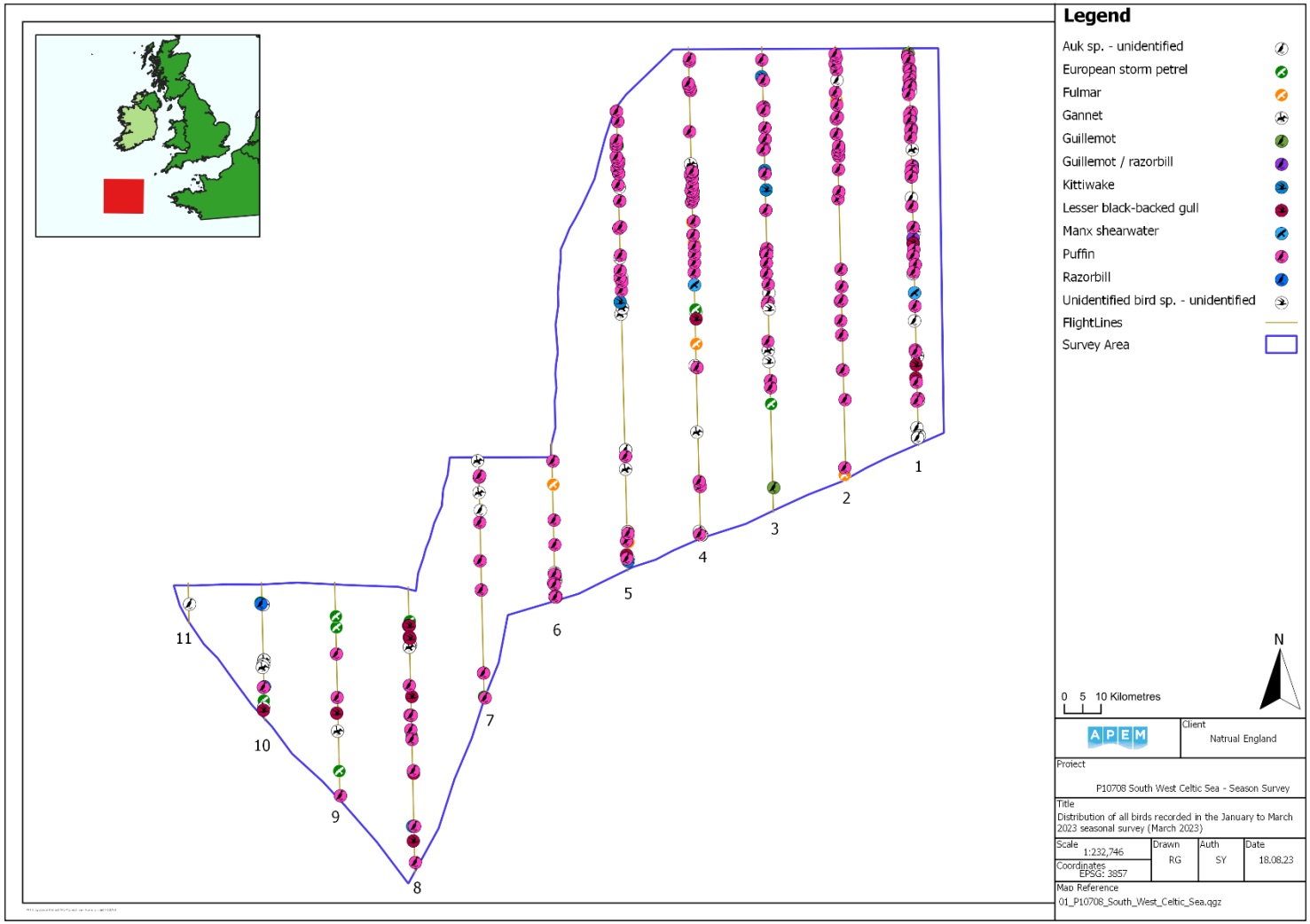

Figure 3 Distribution of all birds recorded in the January to March 2023 seasonal survey (March 2023).

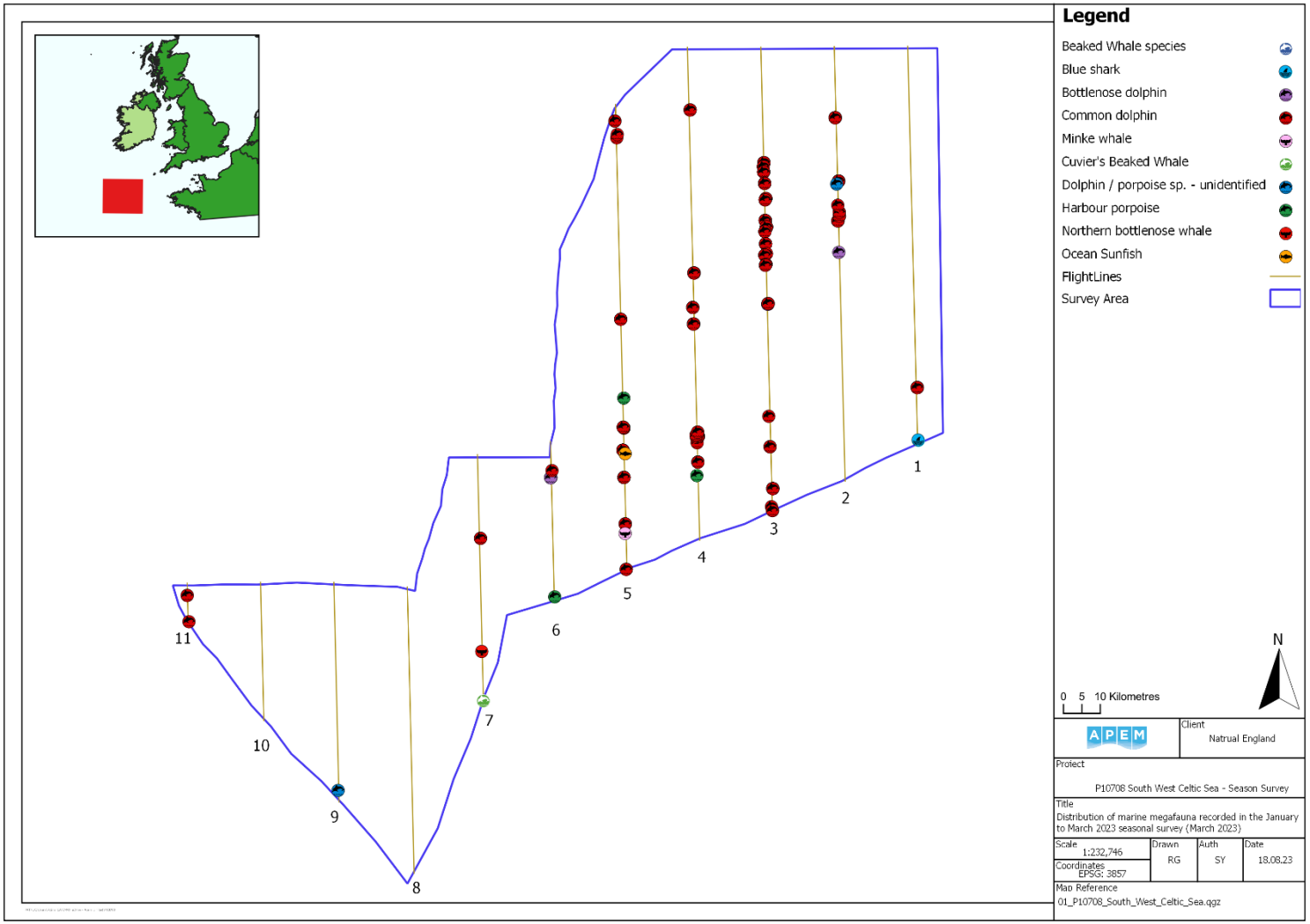

Figure 4 Distribution of all marine megafauna recorded in the January to March 2023 seasonal survey (March 2023)

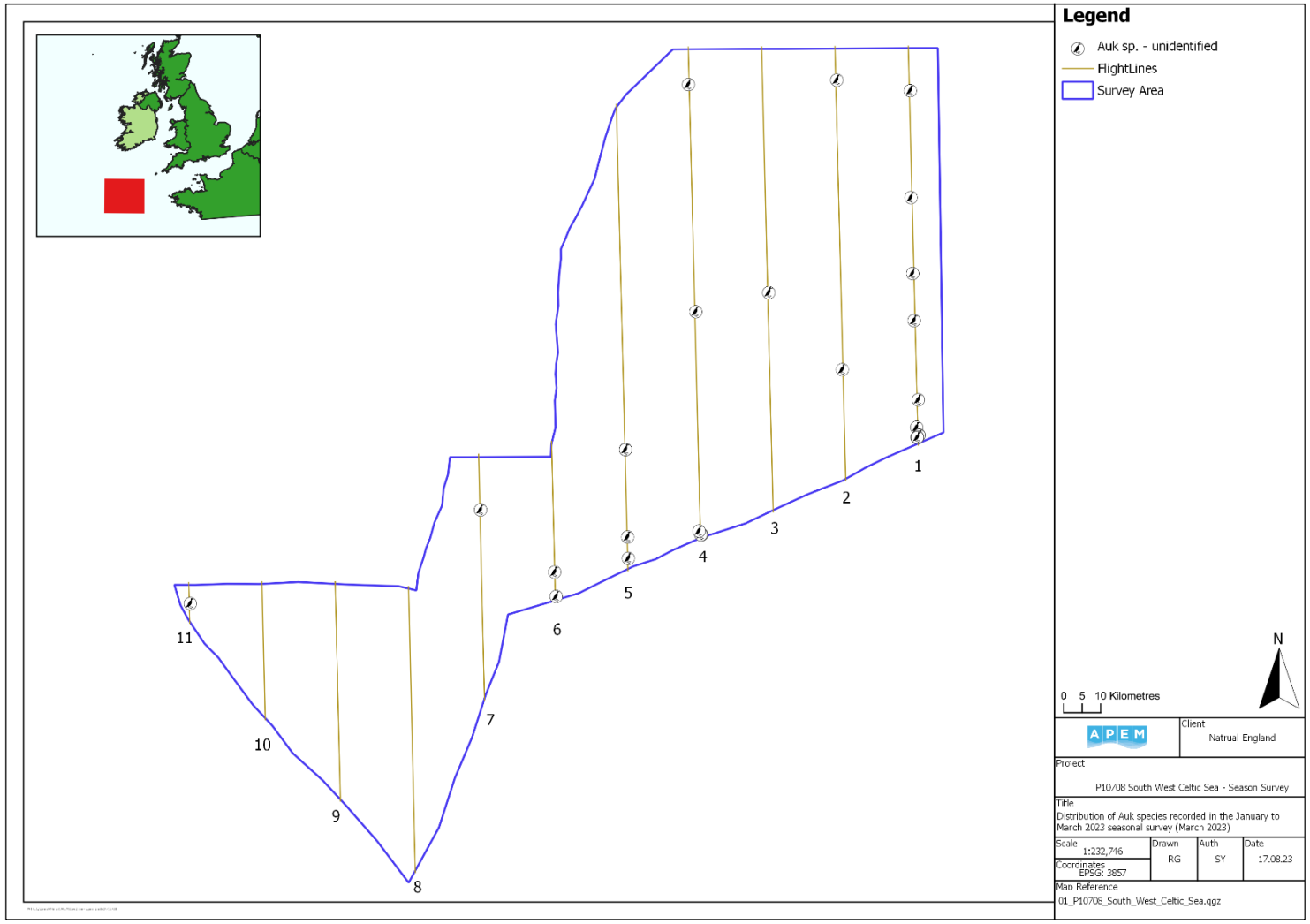

Figure 5 Auk species distribution recorded in the January to March 2023 seasonal survey (March 2023).

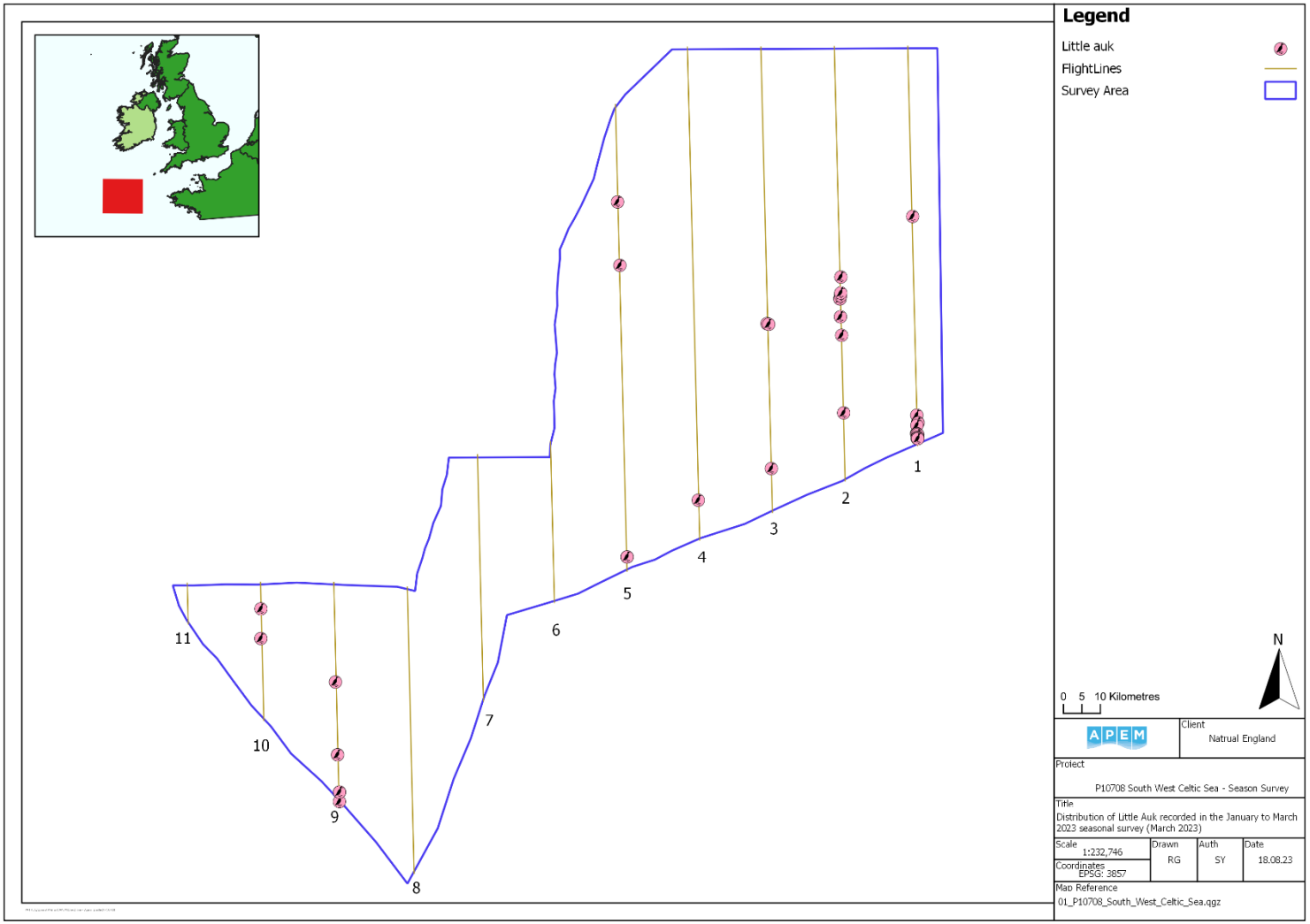

Figure 6 Little Auk species distribution recorded in the January to March 2023 seasonal survey (March 2023).

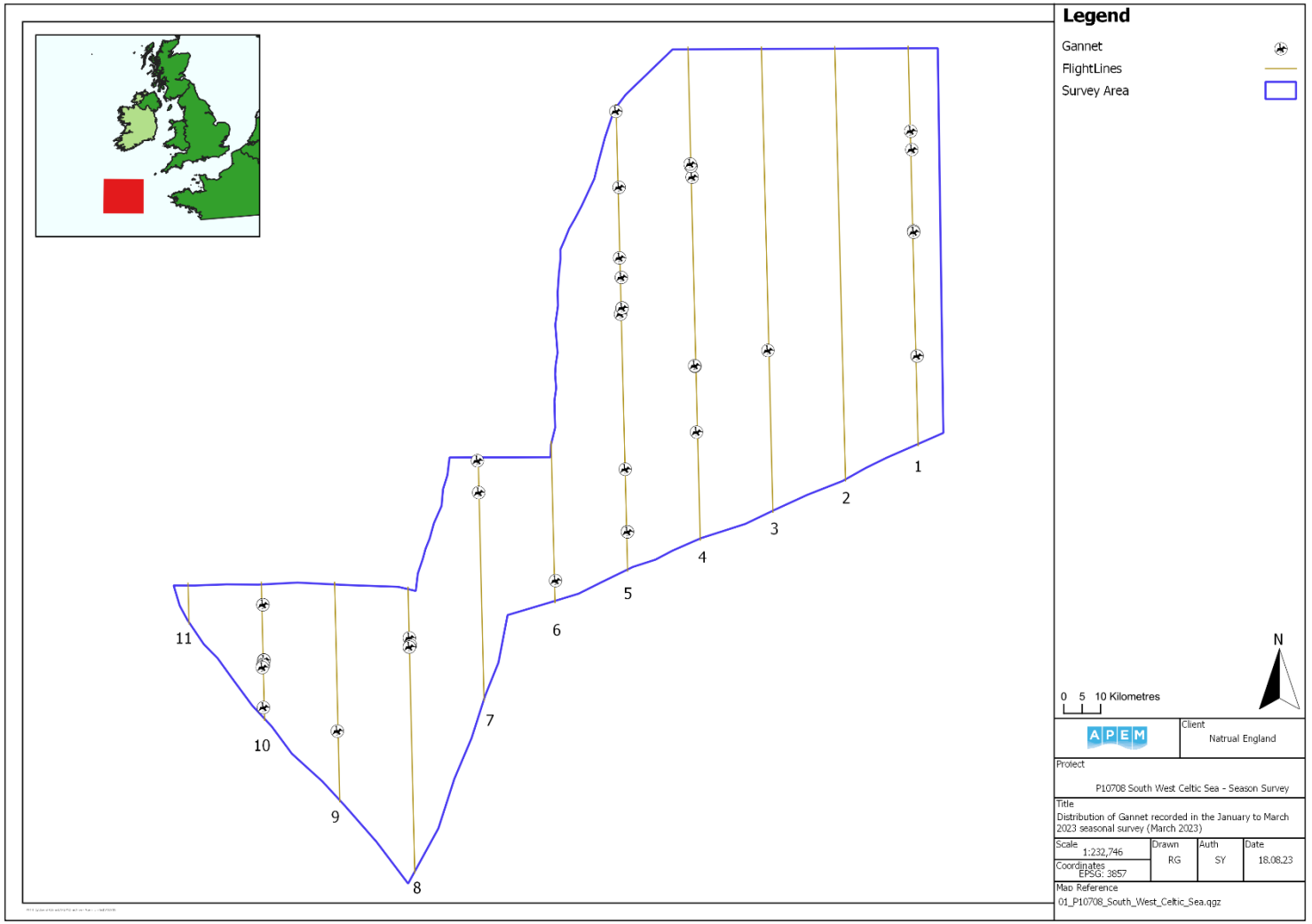

Figure 7 Gannet distribution recorded in the January to March 2023 seasonal survey (March 2023).

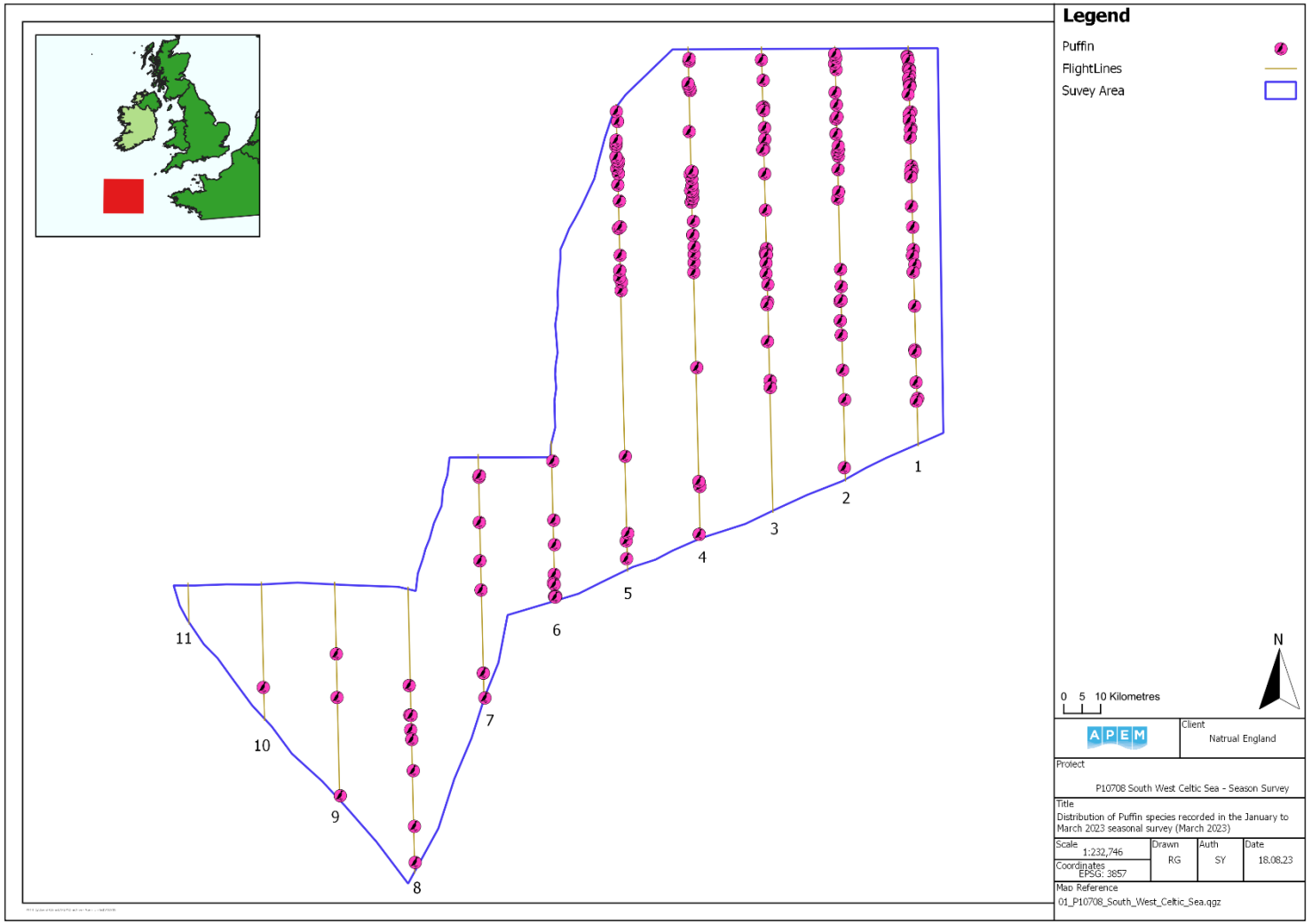

Figure 8 Puffin distribution recorded in the January to March 2023 seasonal survey (March 2023).

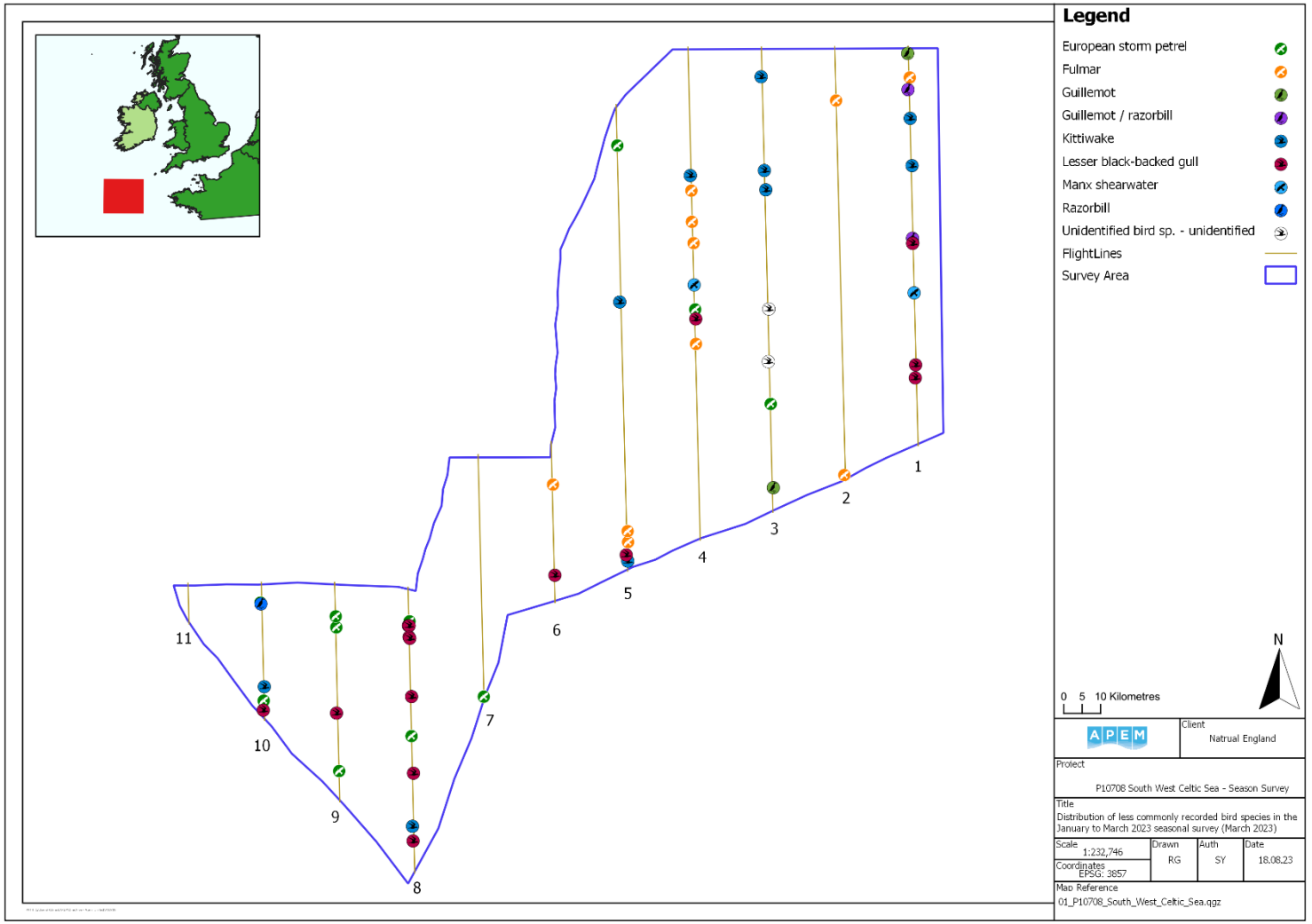

Figure 9 Distribution of less abundant bird species recorded in the January to March 2023 seasonal survey (March 2023).

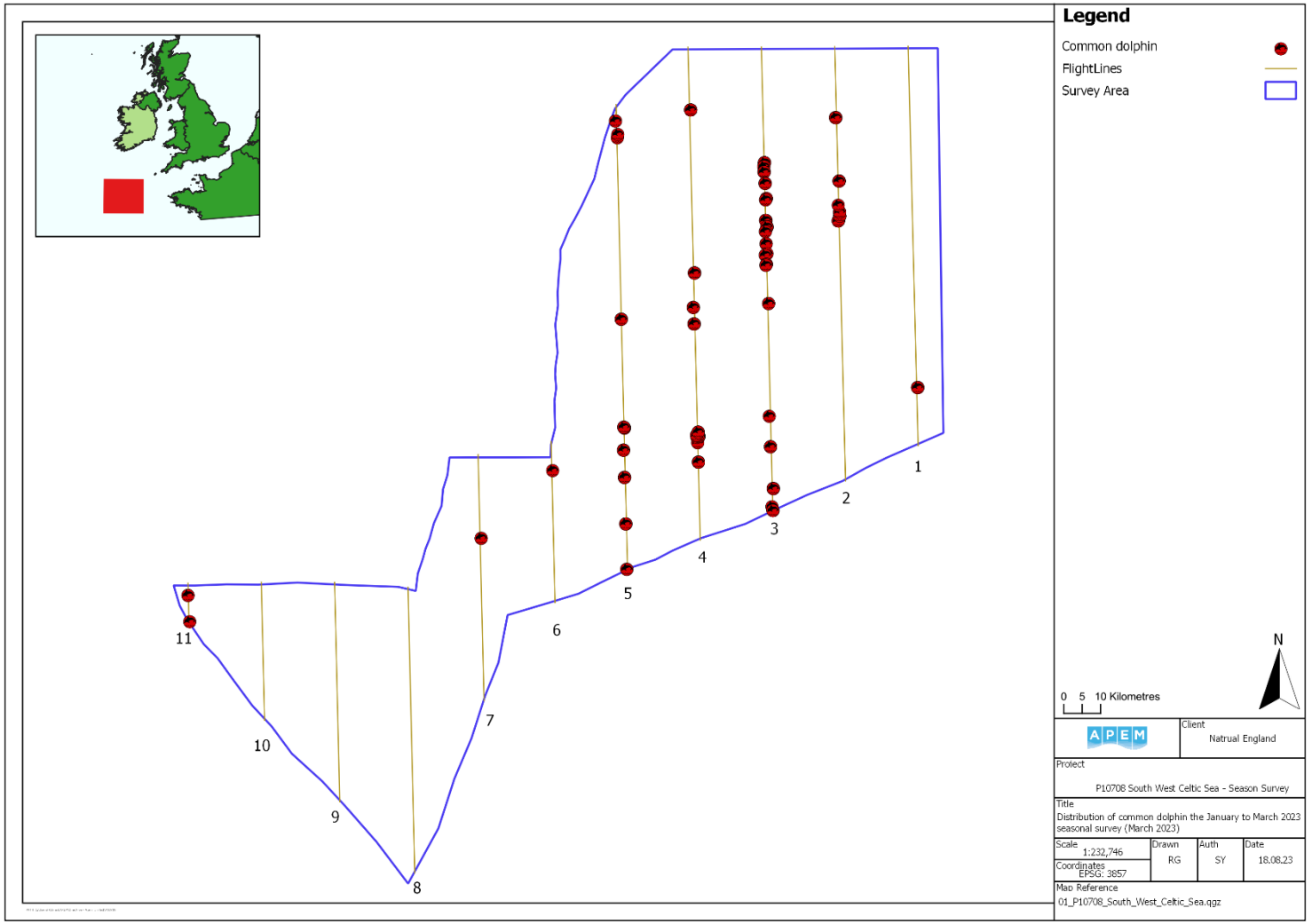

Figure 10 Common dolphin distribution recorded in the January to March 2023 seasonal survey (March 2023).

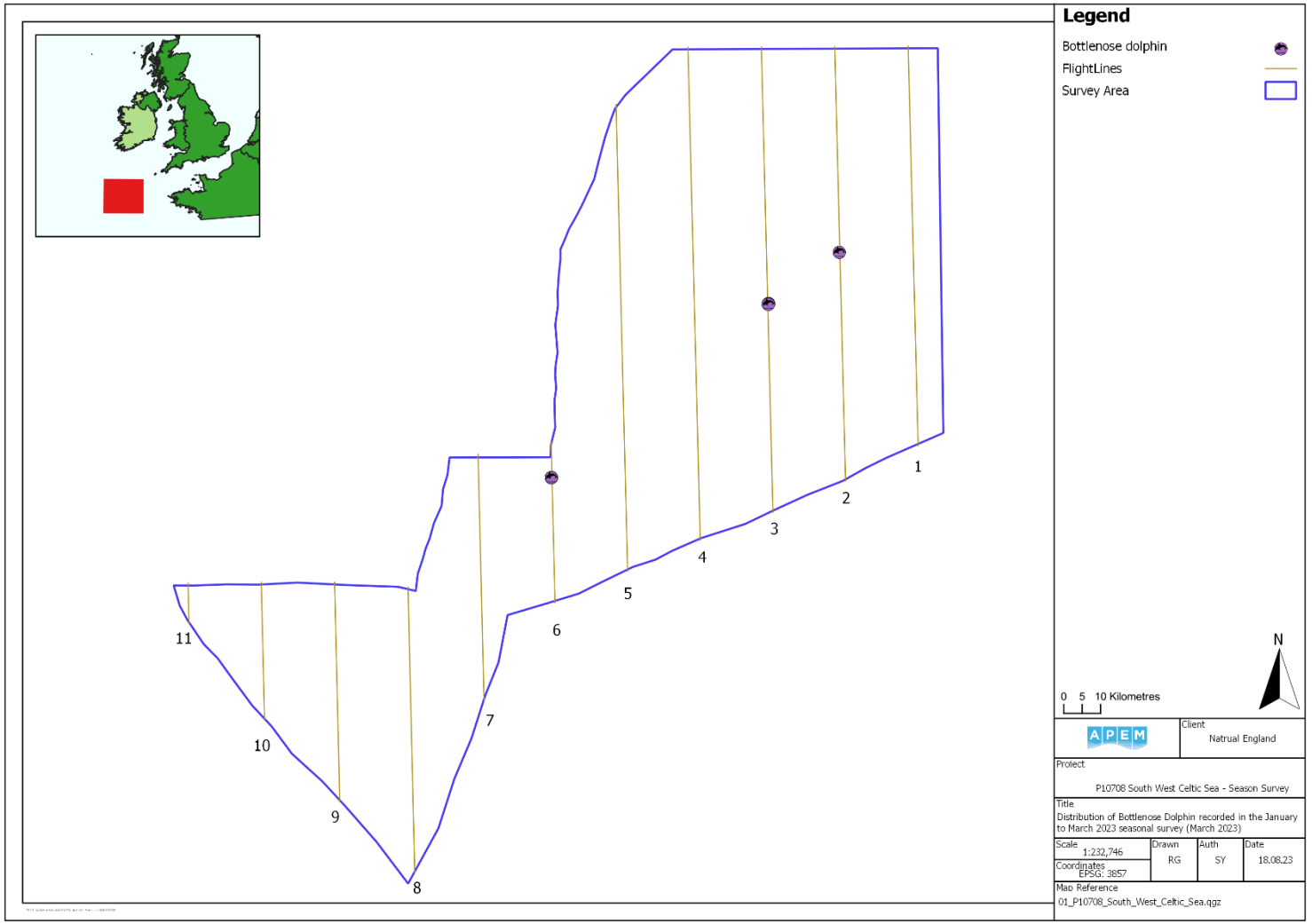

Figure 11 Bottlenose dolphin distribution recorded in the January to March 2023 seasonal survey (March 2023).

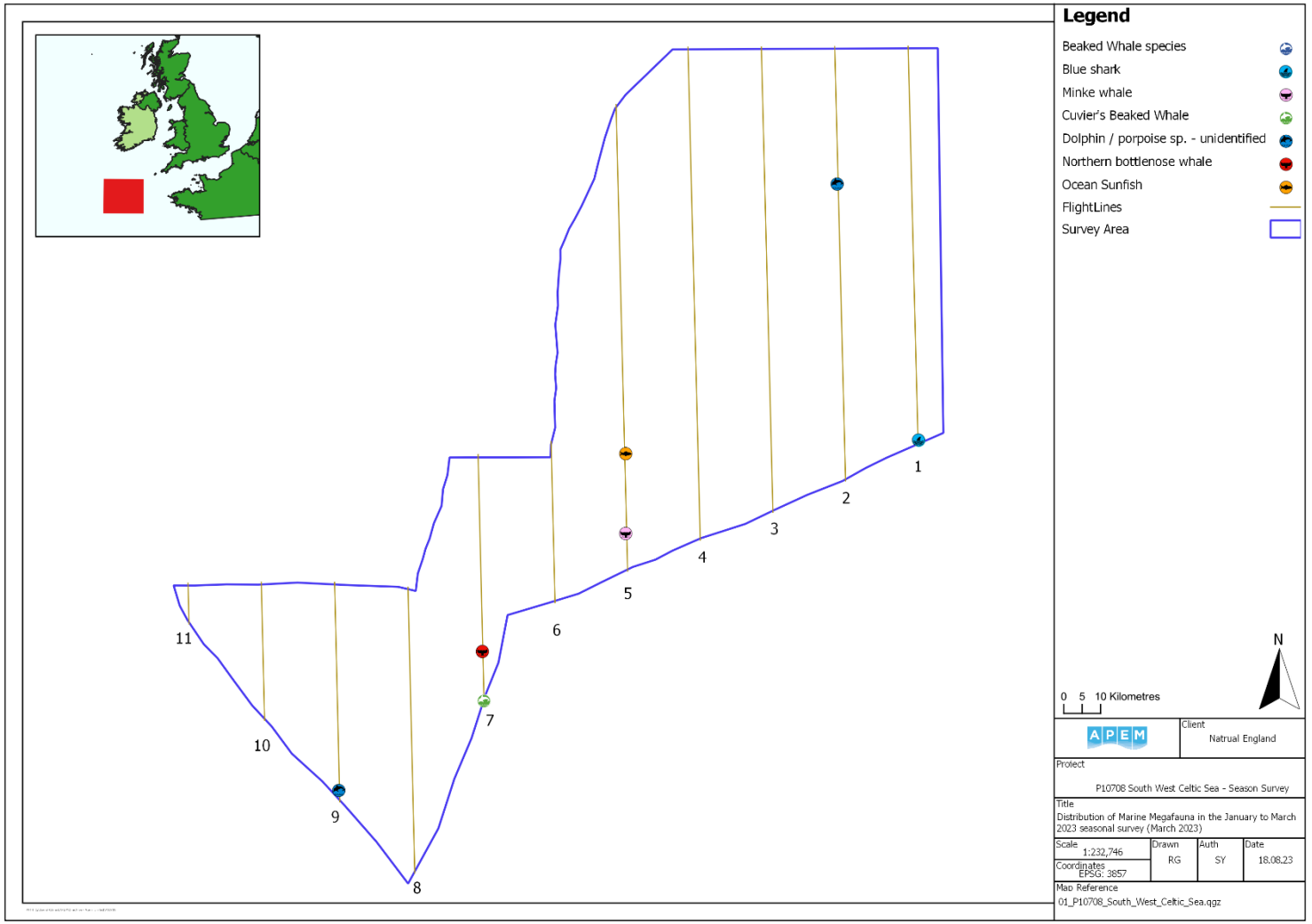

Figure 12 Distribution of less abundant marine megafauna recorded in the January to March 2023 seasonal survey (March 2023).

5. Abiotic Structures and Observations

No vessels or other abiotic structures were observed during the survey.

Appendix I Scientific Names and Taxonomy

Scientific names and taxonomy for all species can be found in the below appendix.

Species	Scientific.Name
Kittiwake	*Rissa tridactyla*
Lesser Black-backed Gull	*Larus fuscus*
Guillemot	*Uria aalge*
Razorbill	*Alca torda*
Little Auk	*Alle alle*
Puffin	*Fratercula arctica*
Fulmar	*Fulmarus glacialis*
Gannet	*Morus bassanus*
European Storm Petrel	*Hydrobates pelogicus*
Manx Shearwater	*Puffinus puffinus*
Common Dolphin	*Delphinus delphis*
Bottlenose Dolphin	*Tursiops truncatus*
Harbour Porpoise	*Phocoena phocoena*
Common Minke Whale	*Balaenoptera acutorostrata*
Cuvier's Beaked Whale	*Ziphius cavirostris*
Northern Bottlenose Whale	*Hyperoodon ampullatus*
Blue Shark	*Prionace glauca*
Atlantic Bluefin Tuna	*Thunnus thynnus*
Ocean Sunfish	*Mola mola*

Appendix II Example images (snags) of birds and marine mammals.

Images are jpeg files of a lower resolution than those used by image analysts when performing identifications.

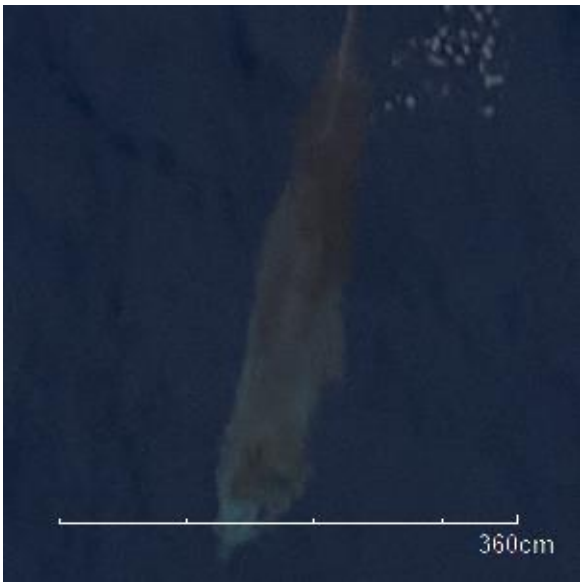

Figure 13 Cuvier's beaked whale

Figure 14 Common dolphin.

Figure 15 Lesser black-backed gull in flight

Figure 16 Gannet in flight,

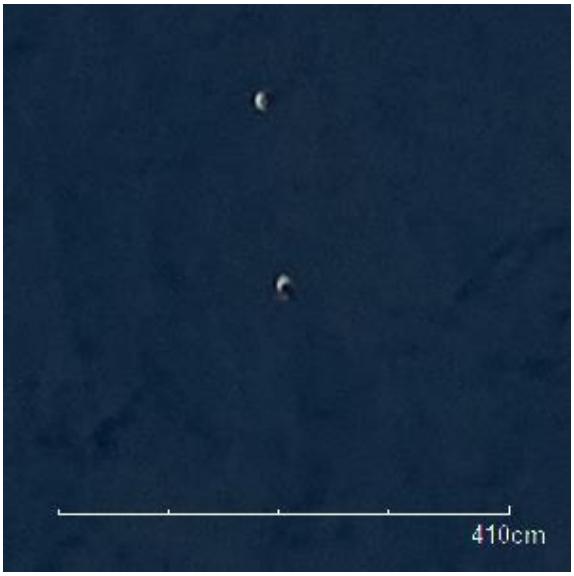

Figure 17 Puffin

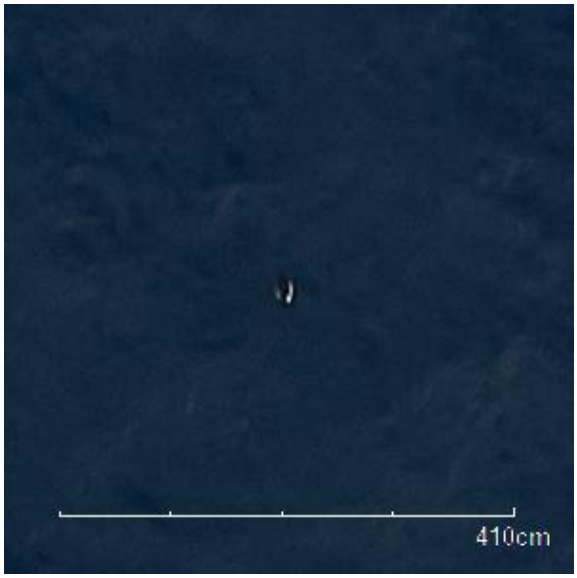

Figure 18 Razorbill

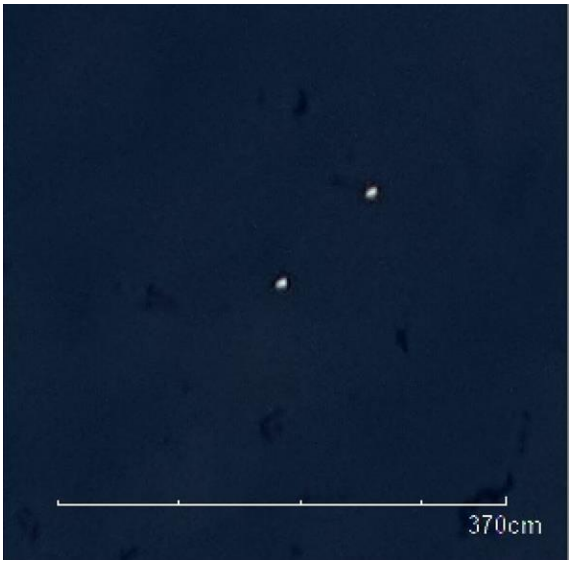

Figure 19 Little auk