Natural England

Ornithological and Marine Mammal Baseline Characterisation Surveys for the POSEIDON project

April-June (Seasonal) Report – South-West Celtic Sea

Steven Young, Kristina Steinmetz

Client:	**Natural England**
Address:	**4th Floor, Foss House** **Kings Pool** **1-2 Peasholme Green** **York** **YO1 7PX**
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Project Director:	**Dr Stephanie McGovern**
Project Manager:	**Dr Steven Young**
Report Contributors:	**Dr Steven Young, Kristina Steinmetz**

APEM Ltd
Riverview
A17 Embankment Business Park
Heaton Mersey
Stockport
SK4 3GN

Tel: 0161 442 8938
Fax: 0161 432 6083

Registered in England No. 02530851

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1.9	25/10/2024	3.1	5	Update coverage	SY

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1. Executive Summary

This report constitutes the third seasonal (April to June 2023) report outlining results from digital aerial surveys conducted in June 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 in in a single day in June 2023, with no technical or safety issues. A total of 926 observations were recorded in June 2023, of which 520 were observations of birds and 406 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 third seasonal (April to June 2023) survey, undertaken in June 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.

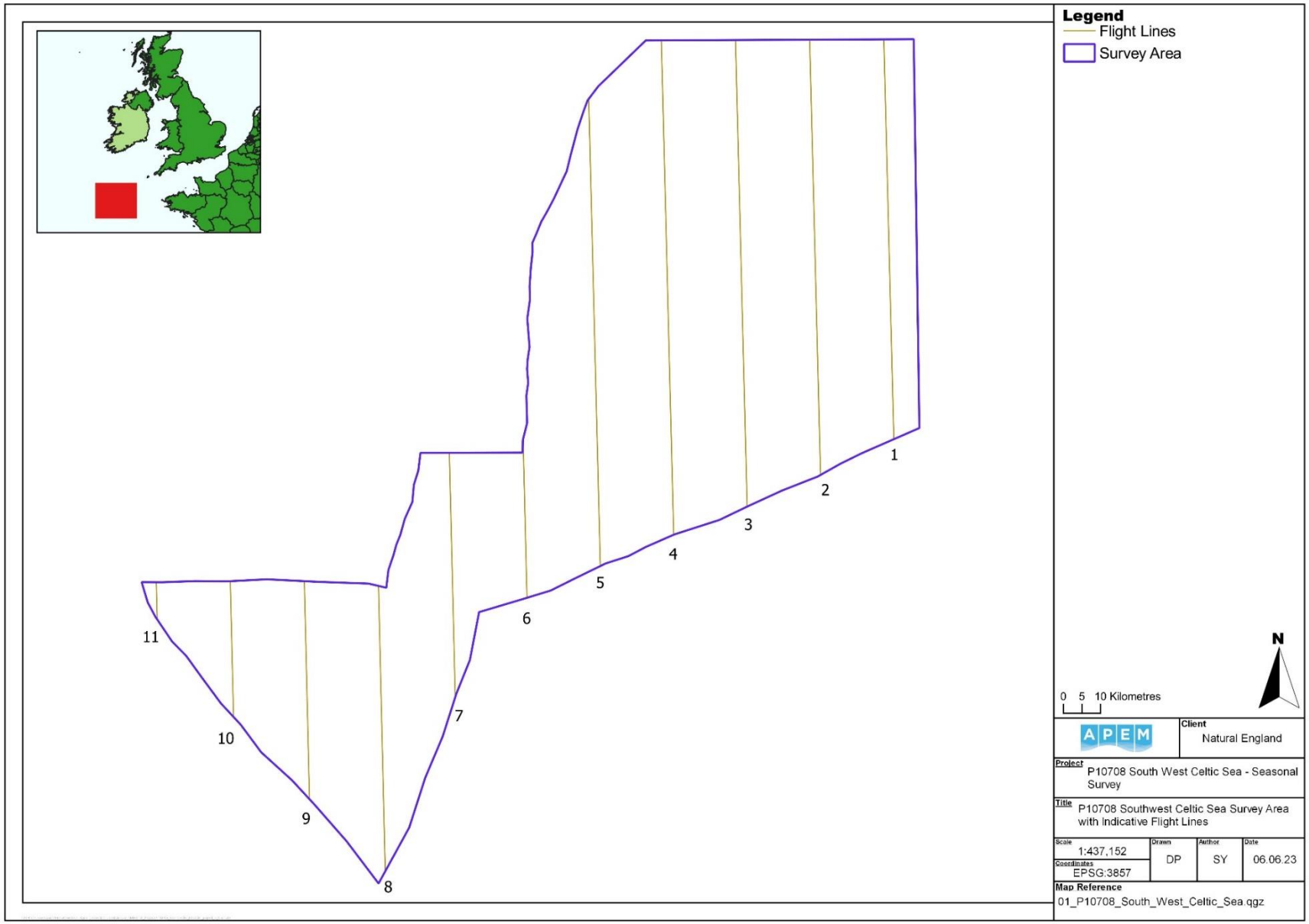

Figure 1 Location of the South-West Celtic Sea Survey Area

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.

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 (440 m) 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. To avoid double-counting due to image overlap, all image footprints are merged into a single file, for which total area is calculated. For analysis purposes each transect should be treated as a single sample, therefore for the current survey design, n=11. A total of 6,401 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 3.40% analysed, generated from 6,401 image nodes. All planned nodes were successfully captured (**Table 2**). The target of 3% coverage achieved, including a redundancy of an additional 0.40%, which is just 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 a 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**. 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 3.40%, thus exceeding the 3% coverage required, enabling sufficient coverage to be collected should images be affected by glint or glare.

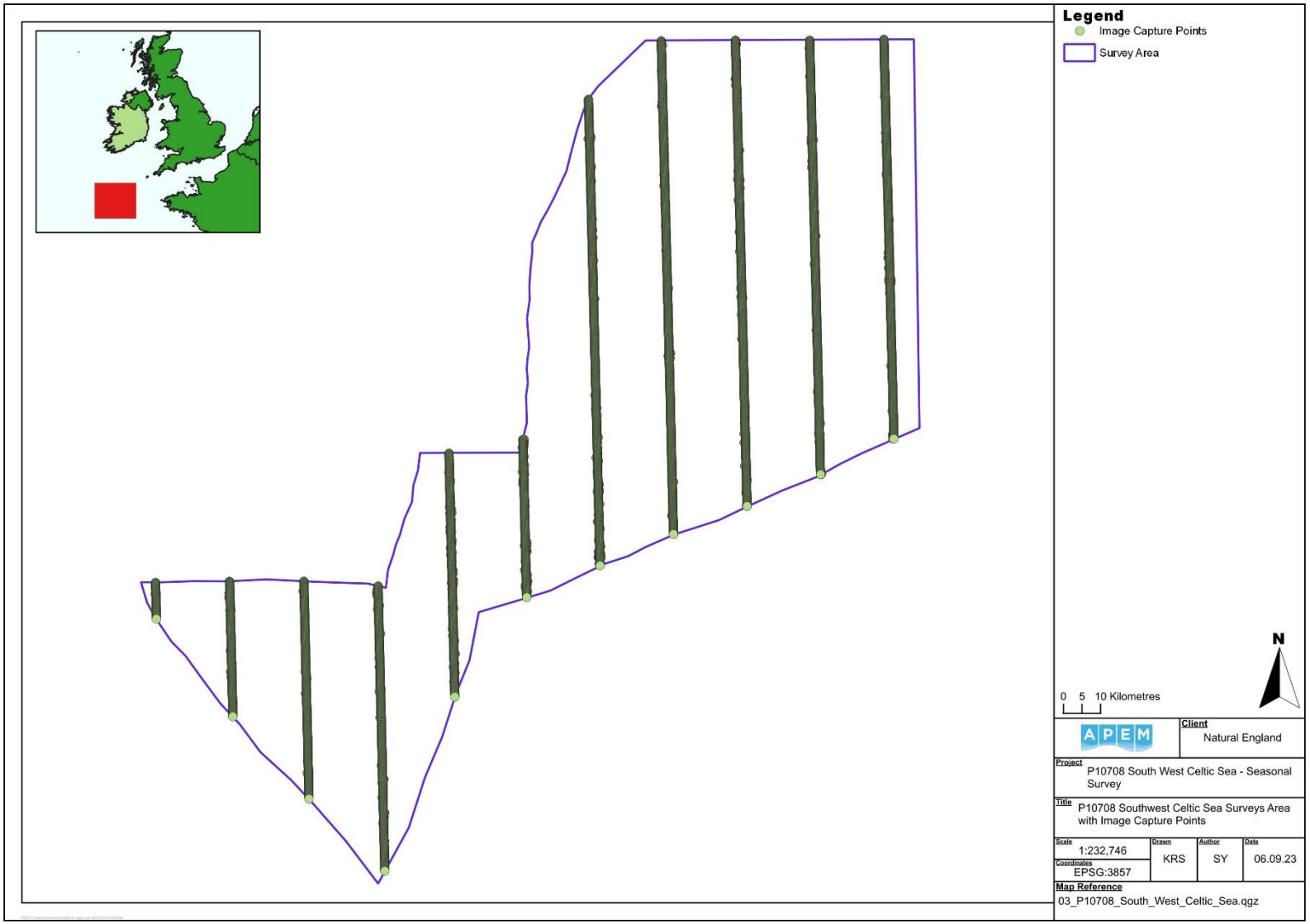

Figure 2 Individual image capture points during the April to June 2023 (June 2023) survey

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 April to June 2023 seasonal survey (June 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	107.538	3	762	754	-	-	Clouds, dropped altitude to 1,250 ft.	-
2	116.94	3	829	820	-	-	Clouds, dropped altitude to 1,250 ft., breaching marine mammal 09:51	-
3	125.48	3	888	880	-	1	Clouds, dropped altitude to 1,250 ft., tanker between lines 3-4, pod of dolphins 11:18	-
4	132.89	3	941	932	-	-	Clouds, dropped altitude to 1,250 ft.	-
5	125.57	3	891	881	-	-	Clouds, dropped altitude to 1,250 ft., pod of dolphins, multiple, 15:03	-
6	45.52	3	308	299	-	-	Pod of dolphins, multiple, 15:59	-
7	65.60	3	471	461	-	Large tanker next to line	Cloud near end of line	-
8	76.70	3	547	539	-	-	Very good sea state and glint	-
9	58.58	3	420	412	-	-	Glint improved along 003° bearing	-
10	36.35	3	265	256	-	-	Unavoidable glint in C0022 along 183° bearing	-
11	9.83	3	79	70	-	-	Unavoidable glint in C0022 along 183° bearing	-

*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 April to June 2023 seasonal survey (June 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	21/06/2023	09:14 / 09:34	121	50	>10	14-15	7	270°	1-2	2
2	21/06/2023	09:51 / 10:22	119	50	>10	15	7	270°	1-2	2
3	21/06/2023	11:17 / 11:55	124	40	>10	15-16	7	290°	0-1	0-1
4	21/06/2023	10:35 / 11:11	116	50	>10	15	7	270°	1-2	1-2
5	21/06/2023	14:58 / 15:38	117	50	>10	15	8	290°	1	1
6	21/06/2023	15:49 / 16:00	123	50	>10	15	8	290°	1	1
7	21/06/2023	11:24 / 11:42	130	30-40	>10	15	4	190°	0-1	0
8	21/06/2023	10:50 / 11:11	125	30-40	>10	15	4	270°	1	0-1
9	21/06/2023	10:30 / 10:45	130	30-40	>10	15	4	270°	1	0-1
10	21/06/2023	10:11 / 10:21	125	30-40	>10	15	4	270°	2	0-1
11	21/06/2023	10:01 / 10:03	125	30-40	>10	15	4	270°	2	0-1

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 April to June 2023 seasonal survey period (June 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>Great Black-backed Gull</td><td>Black-backed Gull</td><td>Large Gull species</td><td>Gull species</td><td rowspan="10">Unidentified bird species</td></tr>
<tr><td>European Storm Petrel</td><td colspan="3" rowspan="2">Storm Petrel species</td></tr>
<tr><td>Leach's Storm Petrel</td></tr>
<tr><td>Cory's Shearwater</td><td rowspan="3">Large Shearwater species</td><td rowspan="4">Shearwater species</td><td rowspan="4">Auk and / or 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>
<tr><td>Fulmar</td><td colspan="3">Fulmar</td></tr>
<tr><td>Fulmar</td><td colspan="3">Gannet</td></tr>
</table>

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

Species	Group Level 1	Group Level 2	Group Level 3	Group Level 4
Pygmy Sperm Whale	Whale species		Cetacean species	Marine Mammal species
Pilot Whale				
Common Dolphin	Dolphin species	Dolphin / Porpoise species		
Risso's Dolphin				
Common Bottlenose Dolphin				

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 94%. No re-analysis was necessary on this occasion.

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 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

[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.

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 520 birds were recorded in the Survey Area during the April – June 2023 seasonal (June 2023) survey. Of those, 306 were sitting on the water and 214 were in flight (**Table 7**). A total of 406 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 April to June 2023 seasonal survey period (June 2023)

Species Group	Species	Flying	Sitting	Deceased	Total
Gulls	Great Black-backed Gull	2	-	-	2
Petrels	Storm Petrel species	57	-	-	57
Fulmar	Fulmar	16	161	-	177
Shearwaters	Cory's Shearwater	102	85	-	187
	Great Shearwater	5	3	-	8
	Large Shearwater species	3	5	-	8
	Shearwater species	1	-	-	1
Auk / Shearwaters	Auk / Shearwater species	-	2	-	2
Gannets	Gannet	28	46	-	74
Birds	Unidentified Bird species	-	4	-	4
Total		**214**	**306**	**0**	**520**

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

Species Group	Species	Submerged	Surfacing	Deceased	Total
Dolphin	Common Dolphin	184	7	-	191
	Risso's Dolphin	2	1	-	3
	Bottlenose Dolphin	34	3	-	37
	Dolphin species	7	-	-	7
Dolphin/Porpoise	Dolphin / Porpoise	2	-	-	2
Whale	Pilot whale	3	1	-	4
	Pygmy sperm whale	1	5	-	6
Cetacean	Cetacean species	4	-	-	4
Marine Mammal	Marine mammal species	1	-	-	1
Fish	Ocean Sunfish	30	-	-	30
	Billfish species	5	-	-	5
	Fish species	6	-	-	6
	Blue Shark	78	-	-	78
	Shark species	31	-	-	31
Marine Organism	Marine organism species	1	-	-	1
Total		**389**	**17**	**0**	**406**

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** shows 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** to **Figure 14** show the locations of the most abundant marine megafauna by species within the Survey Area and **Figure 15** 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.

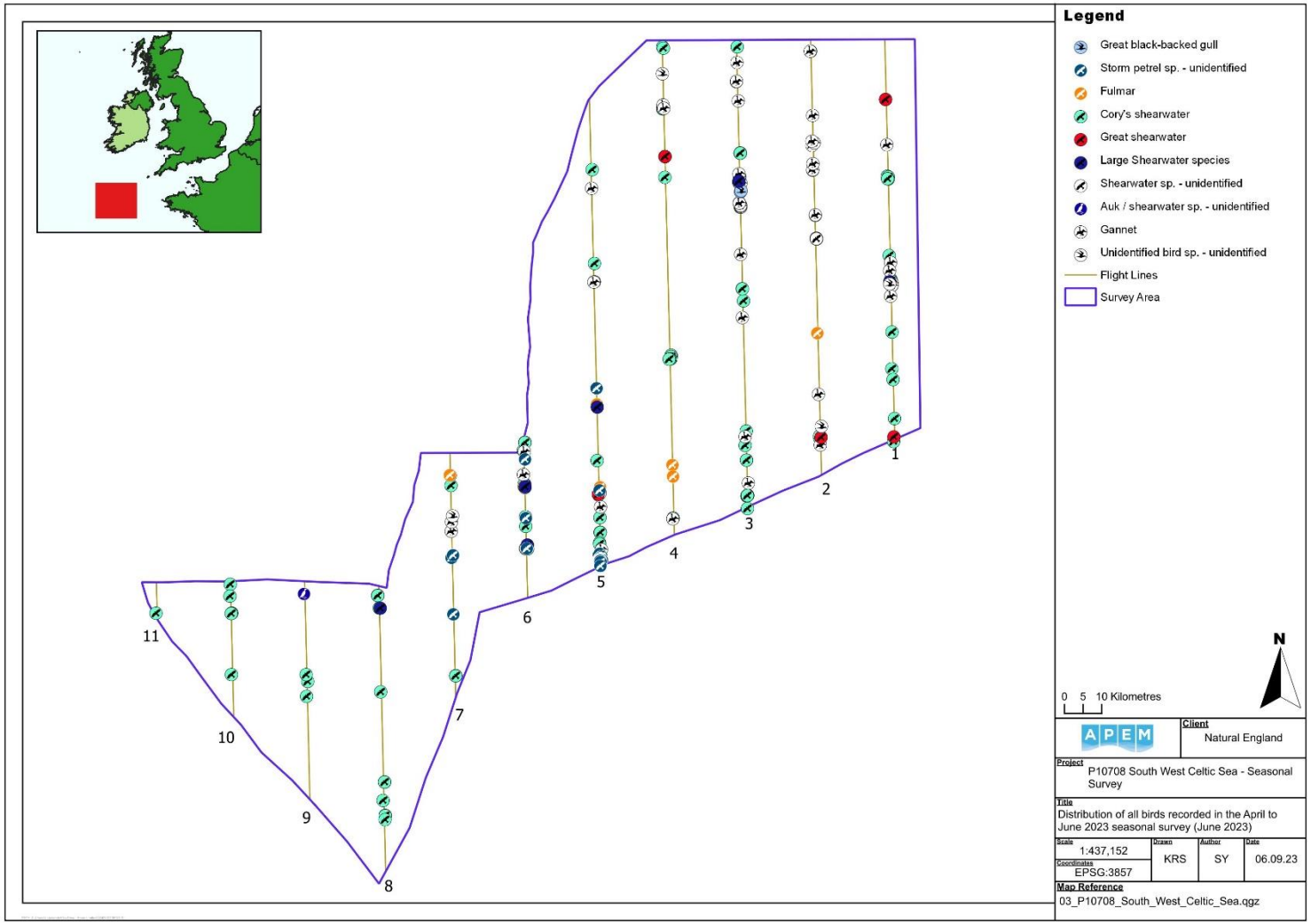

Figure 3 Distribution of all birds recorded in the April to June 2023 seasonal survey (June 2023).

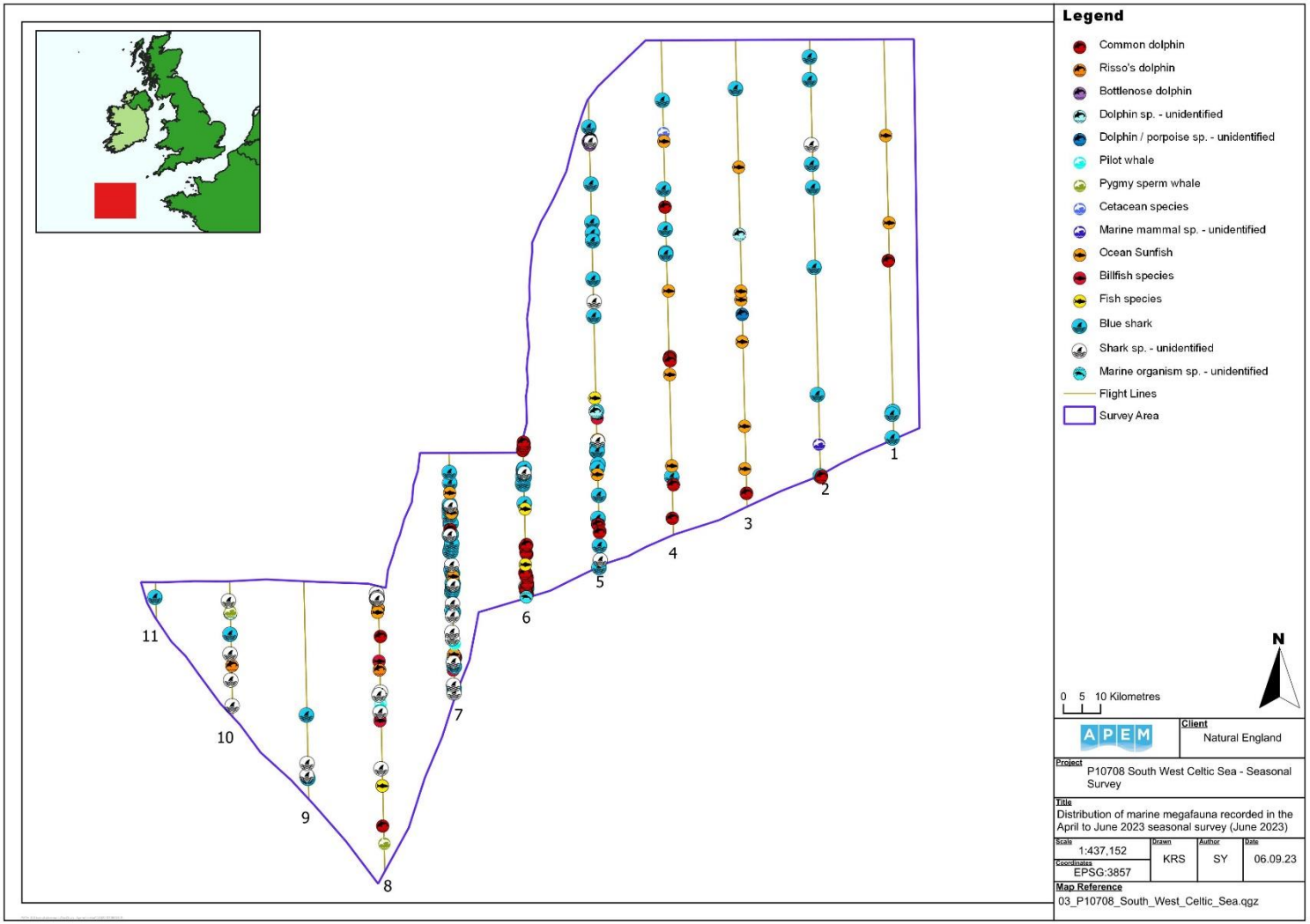

Figure 4 Distribution of all marine megafauna recorded in the April to June 2023 seasonal survey (June 2023)

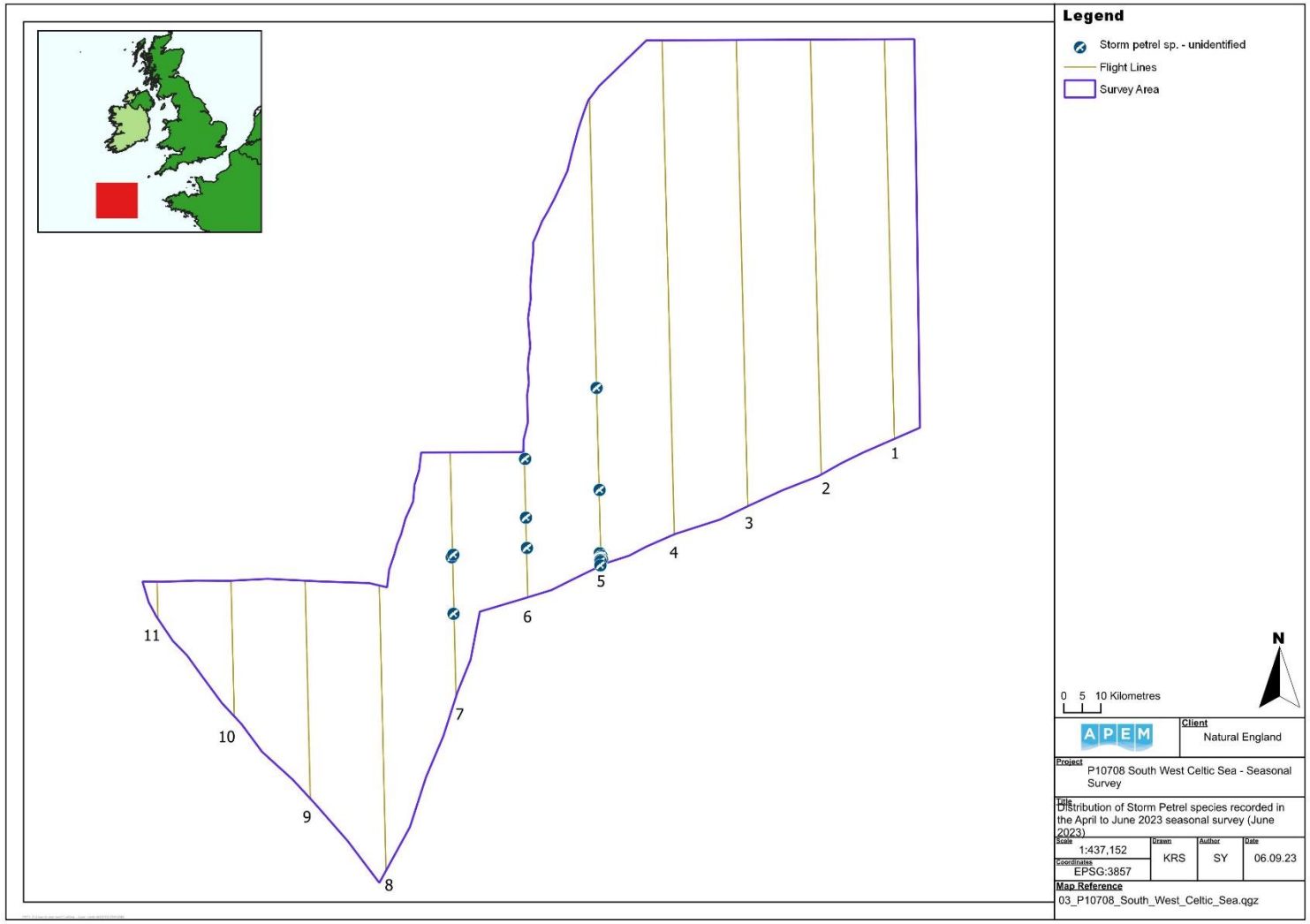

Figure 5 Storm petrel species distribution recorded in the April to June 2023 seasonal survey (June 2023).

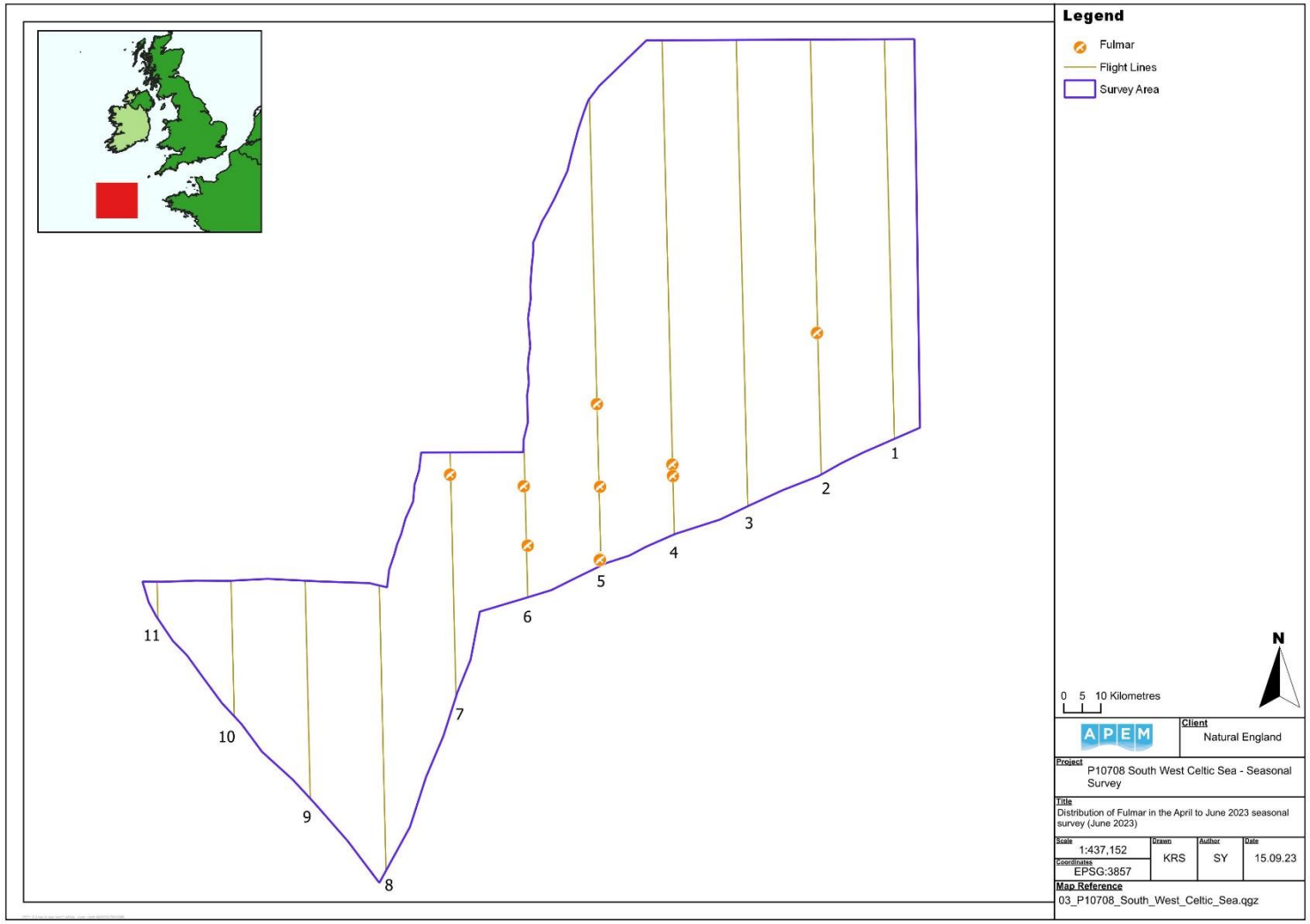

Figure 6 Fulmar distribution recorded in the April to June 2023 seasonal survey (June 2023).

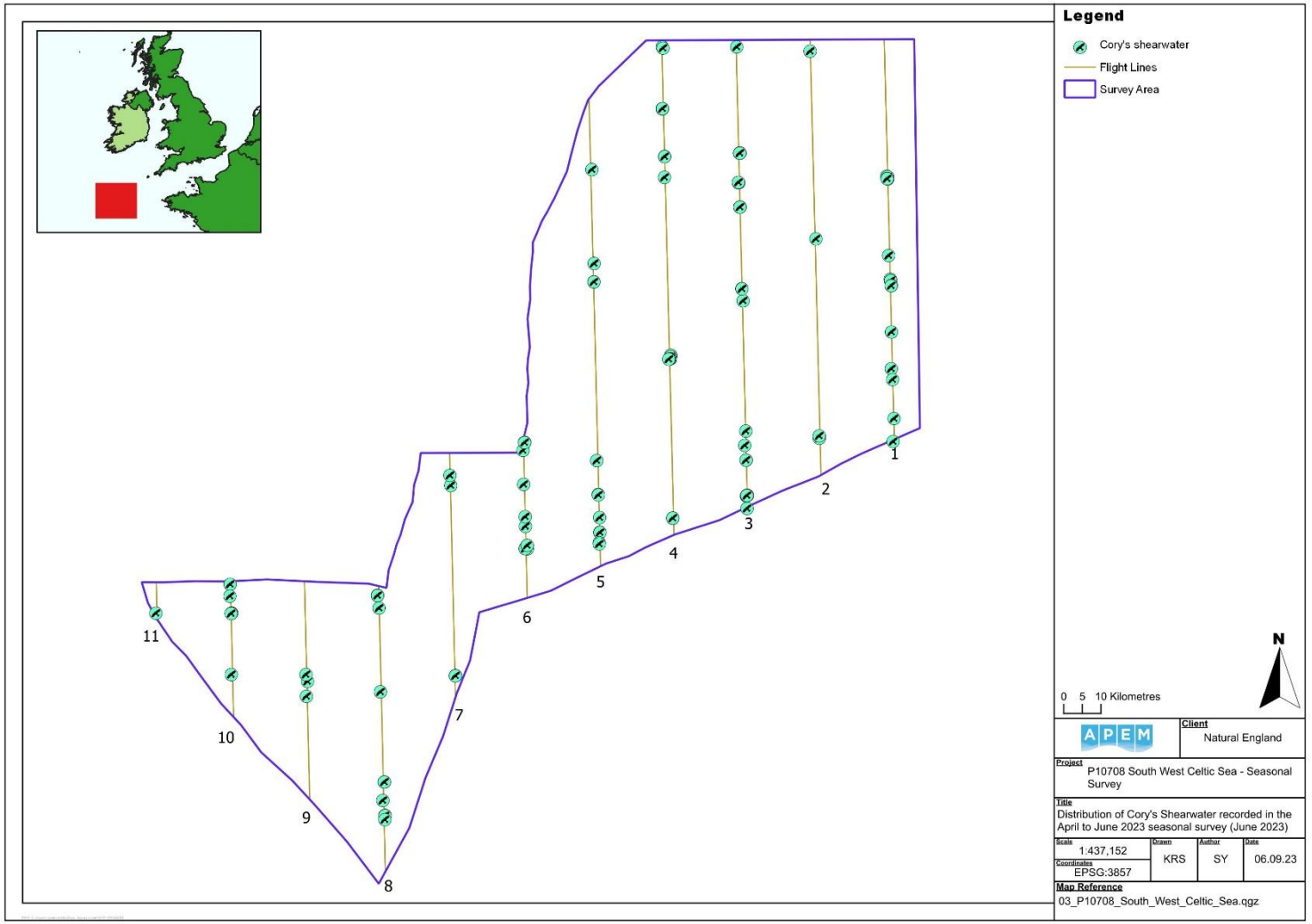

Figure 7 Cory's shearwater distribution recorded in the April to June 2023 seasonal survey (June 2023).

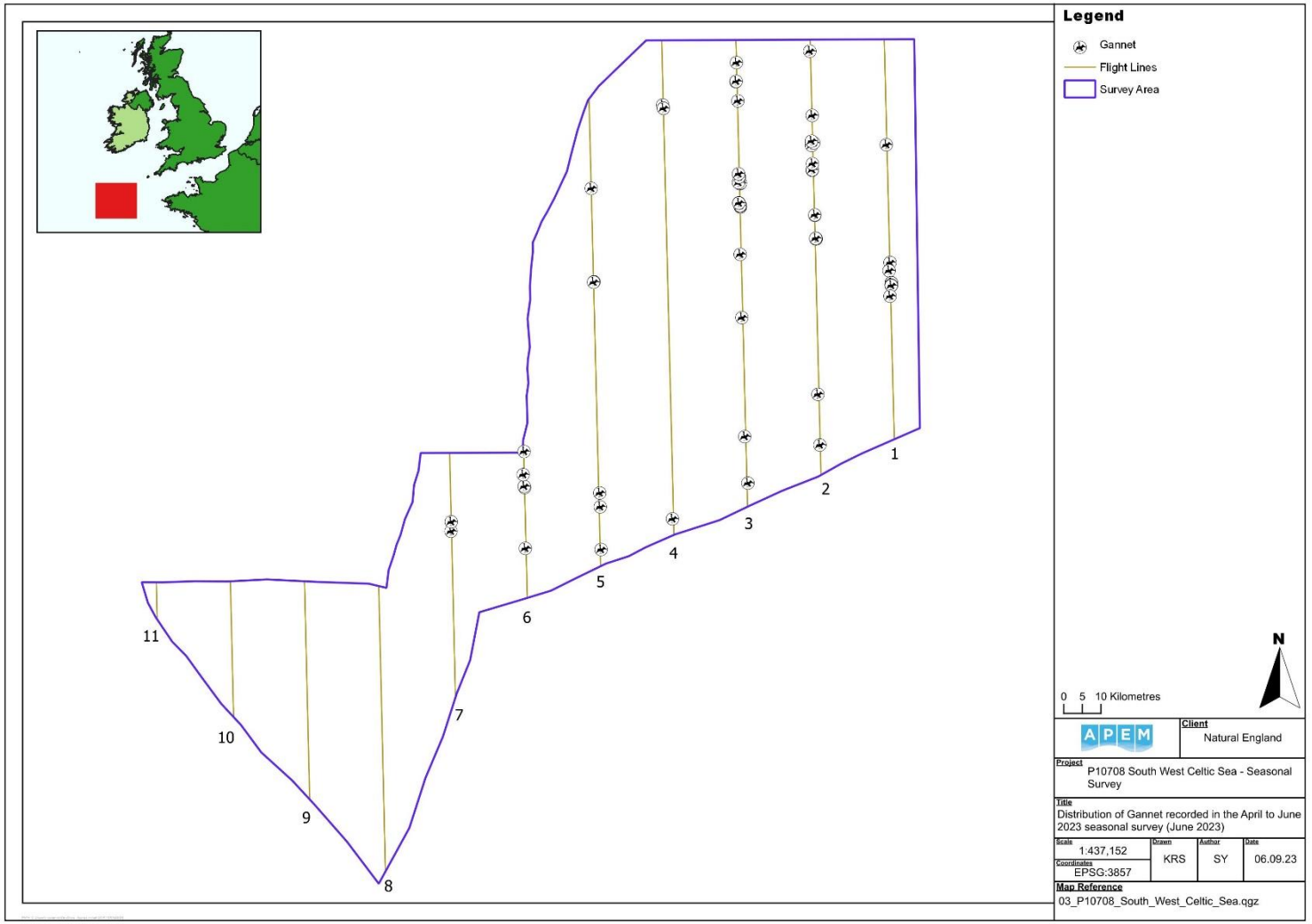

Figure 8 Gannet distribution recorded in the April to June 2023 seasonal survey (June 2023).

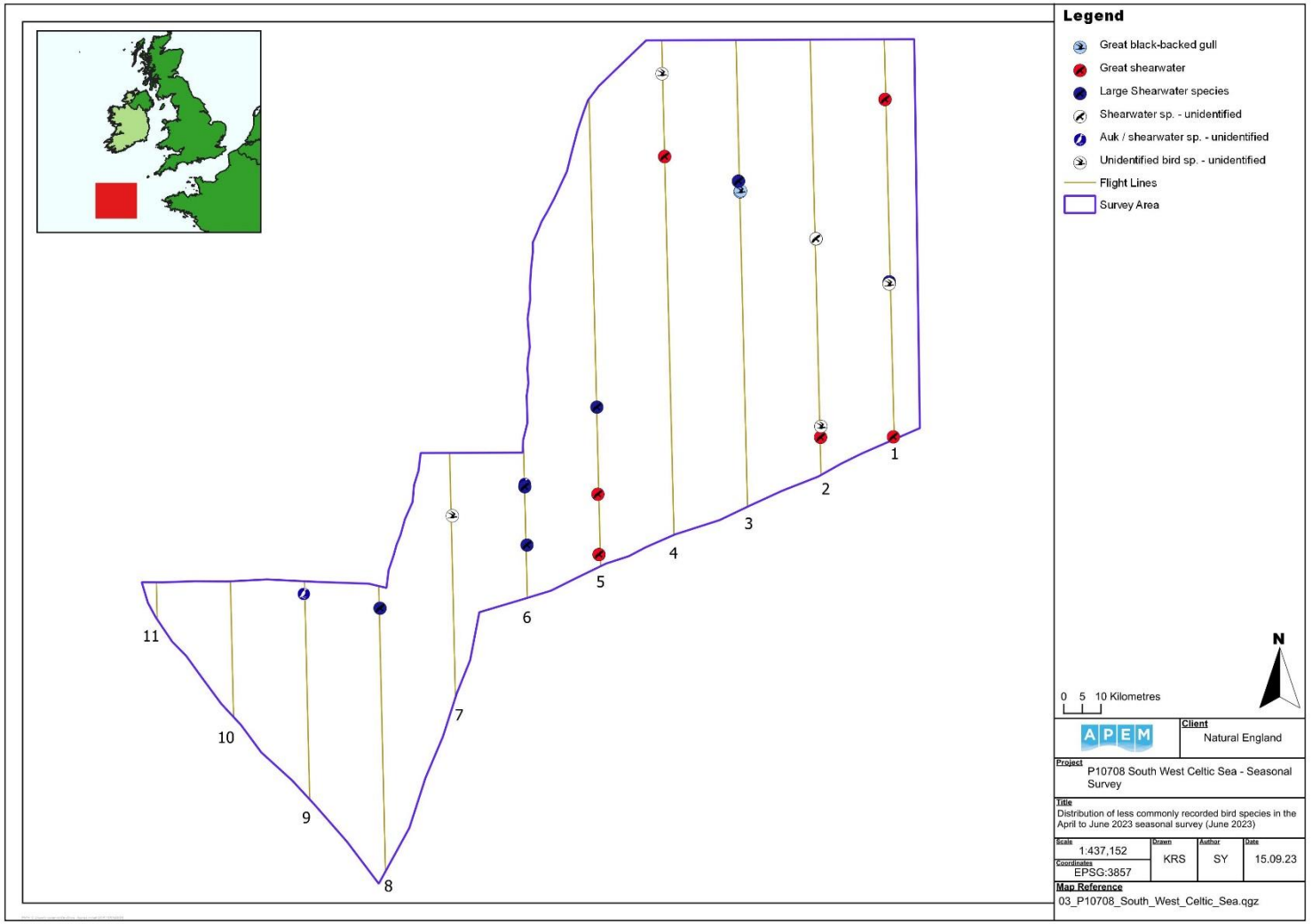

Figure 9 Distribution of less abundant bird species recorded in the April to June 2023 seasonal survey (June 2023).

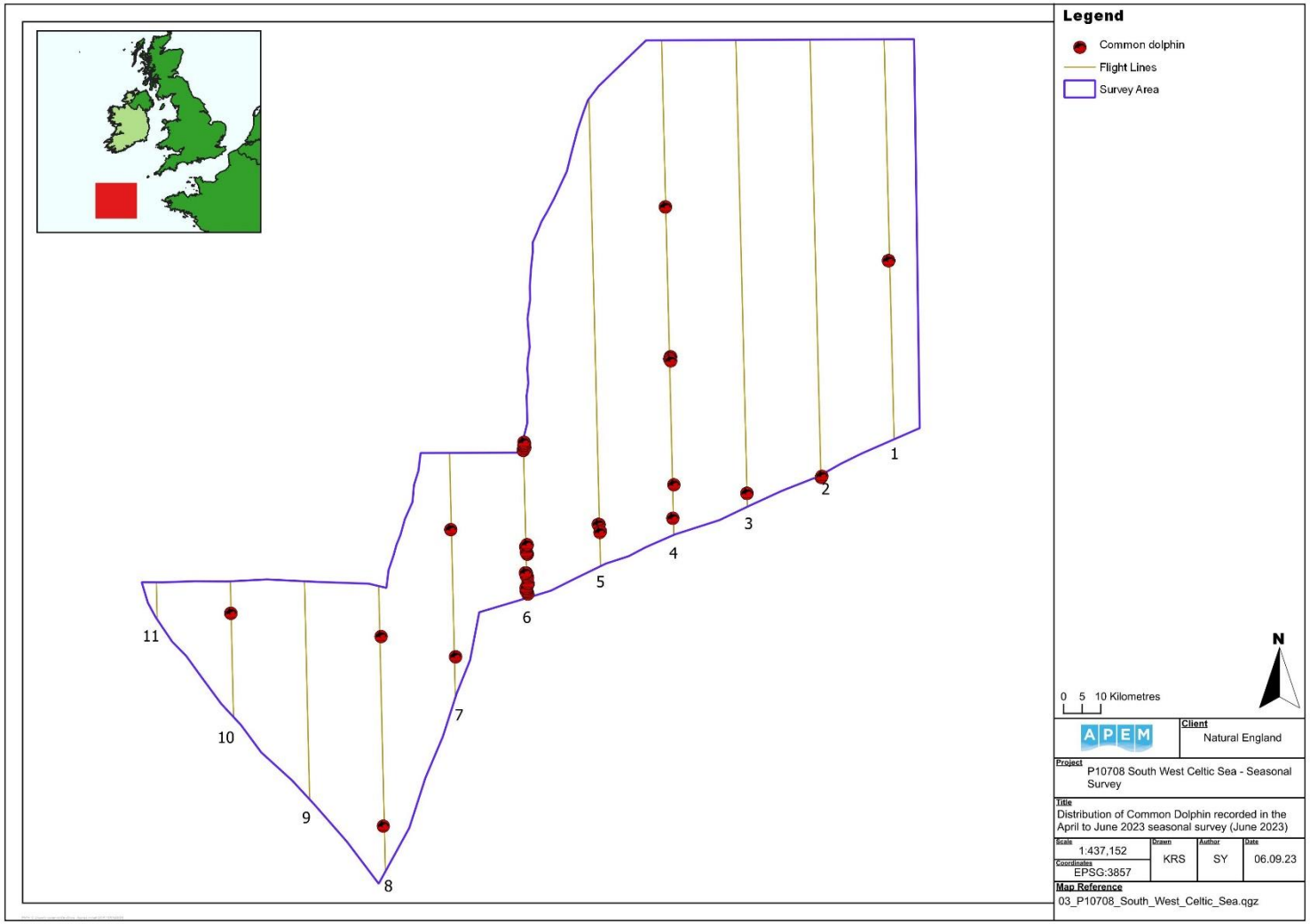

Figure 10 Common dolphin distribution recorded in the April to June 2023 seasonal survey (June 2023).

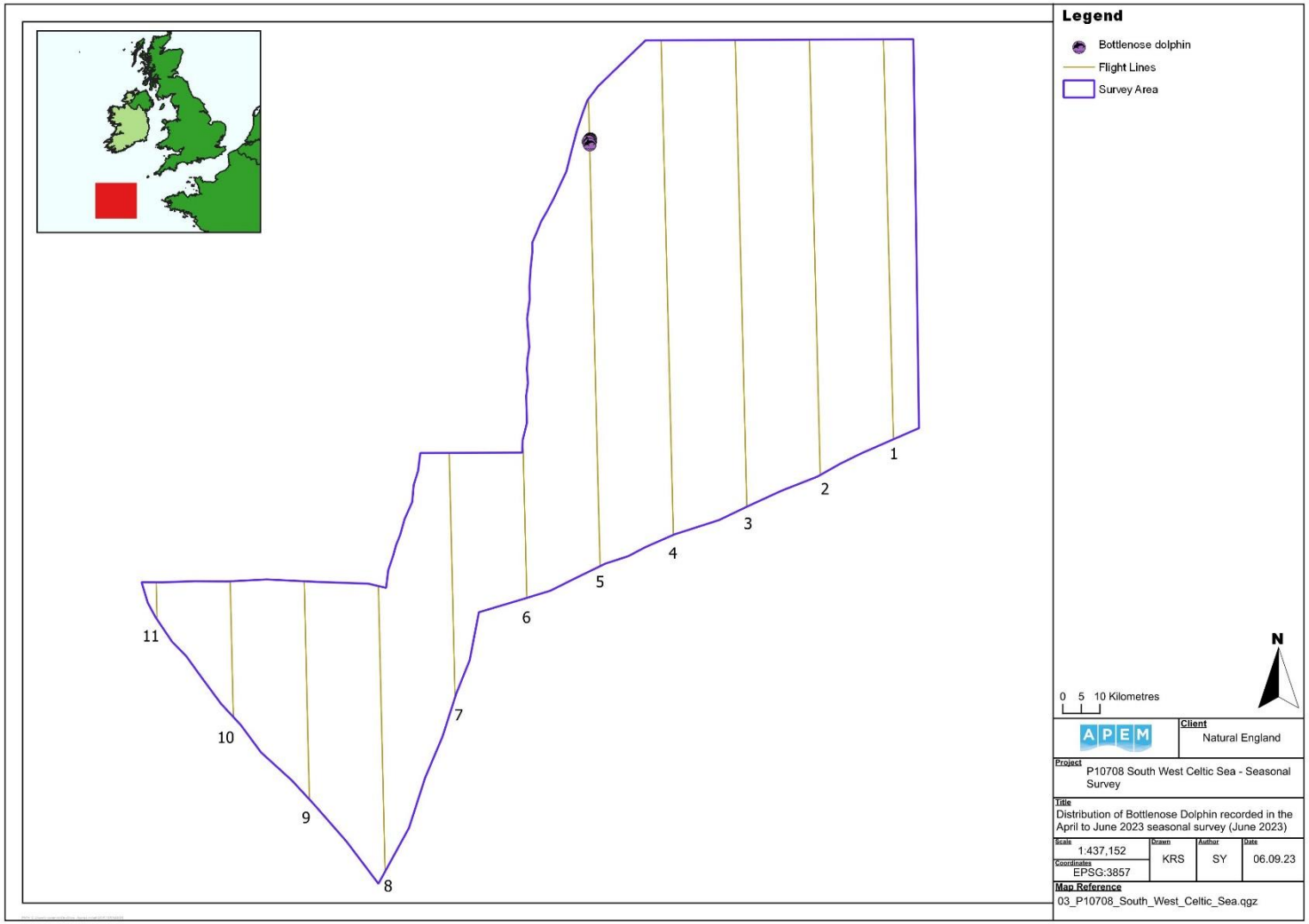

Figure 11 Bottlenose dolphin distribution recorded in the April to June 2023 seasonal survey (June 2023).

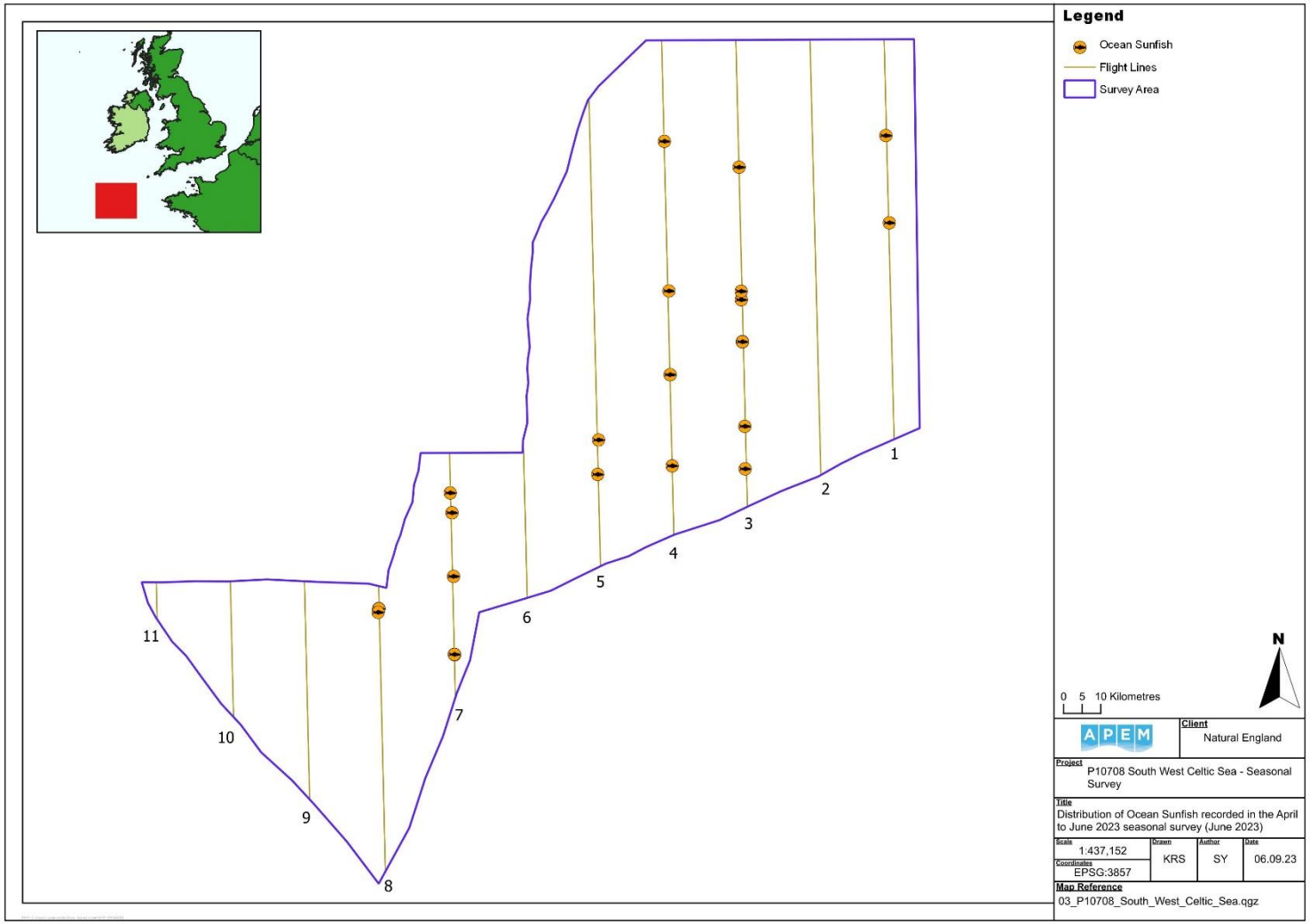

Figure 12 Ocean sunfish distribution recorded in the April to June 2023 seasonal survey (June 2023).

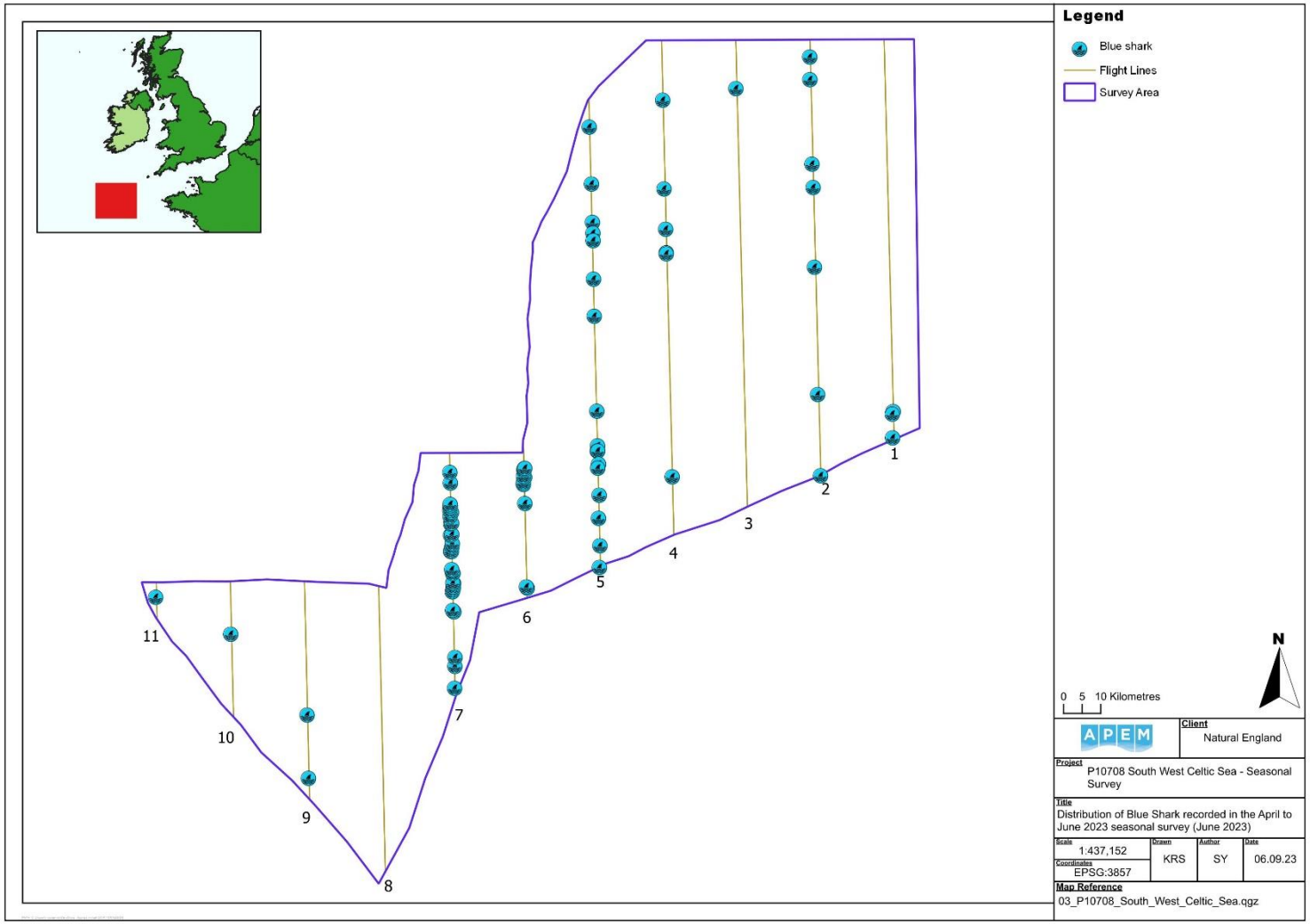

Figure 13 Blue shark distribution recorded in the April to June 2023 seasonal survey (June 2023).

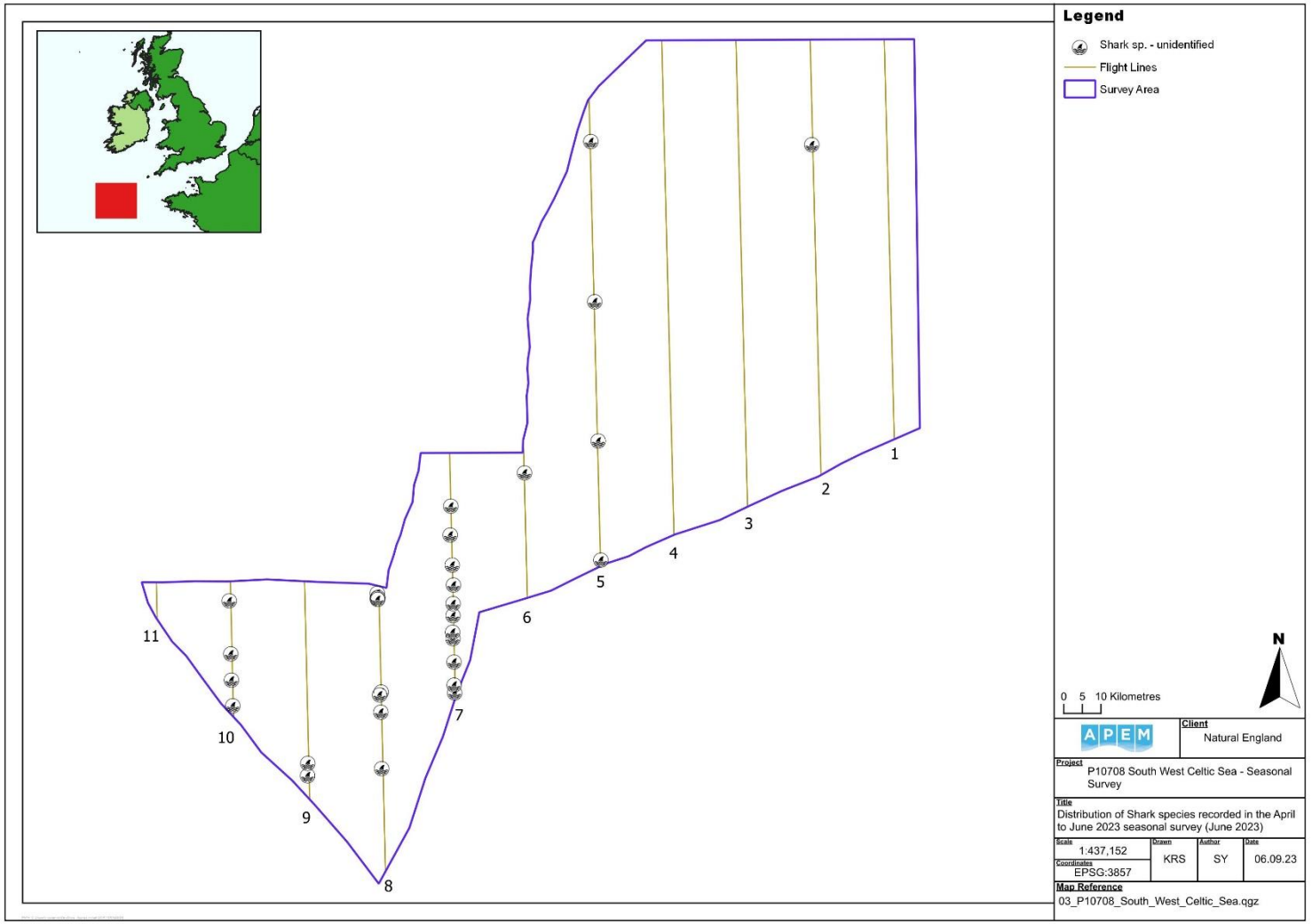

Figure 14 Shark species distribution recorded in the April to June 2023 seasonal survey (June 2023).

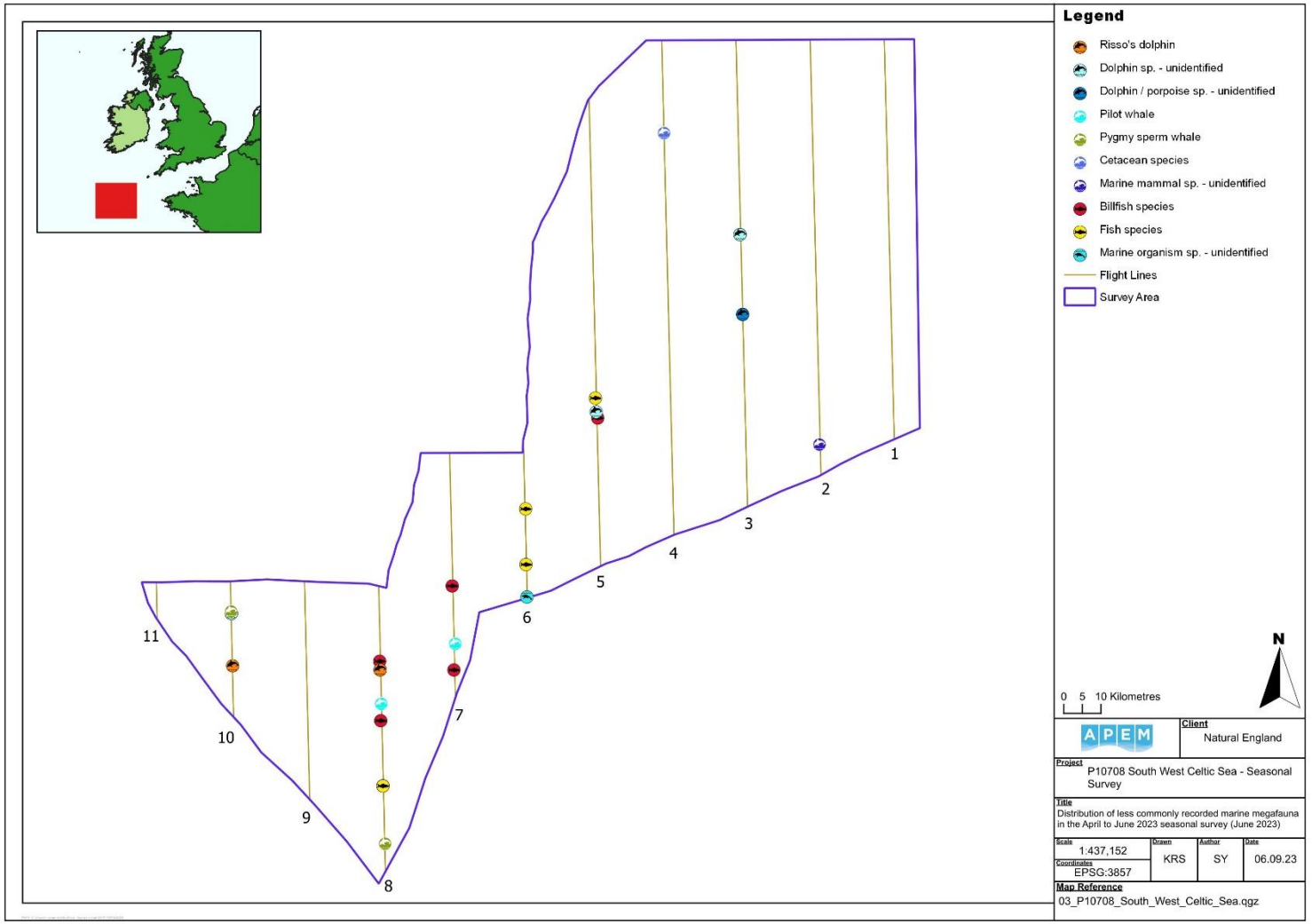

Figure 15 Distribution of less abundant marine megafauna recorded in the April to June 2023 seasonal survey (June 2023).

5. Abiotic Structures and Observations

The following abiotic structures were observed during the survey period:

Two tankers were observed from the aircraft on 21st June. One was observed when the survey aircraft was transiting between lines three and four. The other was observed- along line seven, heading in a southerly direction. No vessels were recorded in the imagery.

Appendix I Scientific Names and Taxonomy

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

Species	Scientific.Name
Great Black-backed Gull	*Larus marinus*
Fulmar	*Fulmarus glacialis*
Cory's Shearwater	*Calonectris borealis*
Great Shearwater	*Ardenna gravis*
Gannet	*Morus bassanus*
Pilot Whale	*Globicephala melas*
Pygmy Sperm Whale	*Kogia breviceps*
Common Dolphin	*Delphinus delphis*
Risso's Dolphin	*Grampus griseus*
.Bottlenose Dolphin	*Tursiops truncatus*
Ocean Sunfish	*Mola mola*
Blue Shark	*Prionace glauca*

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.

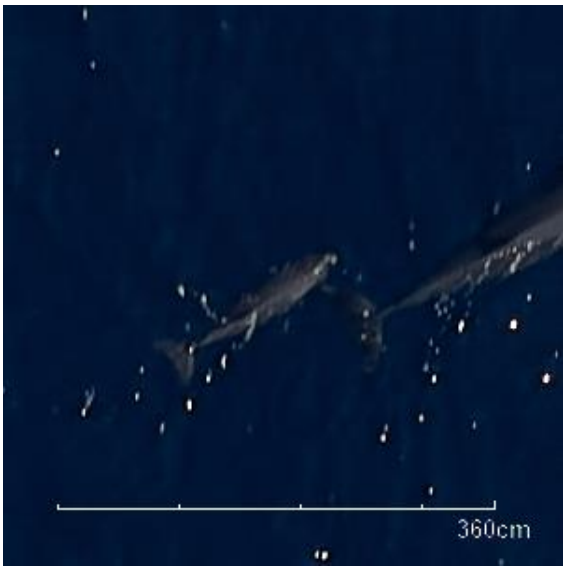

Figure 16 Pygmy sperm whale, with calf

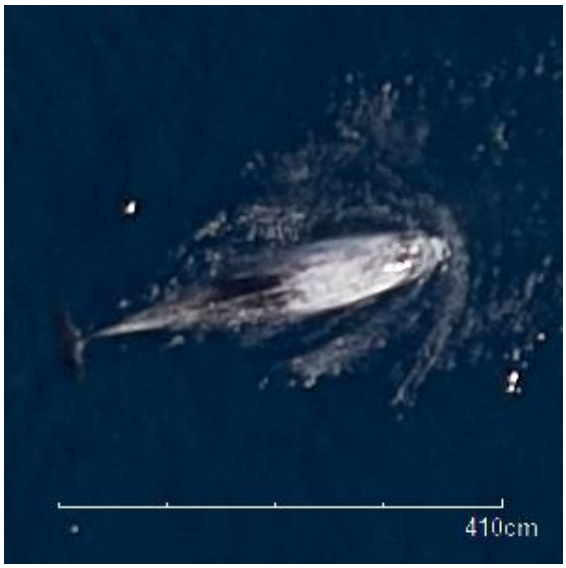

Figure 17 Risso's dolphin, surfacing

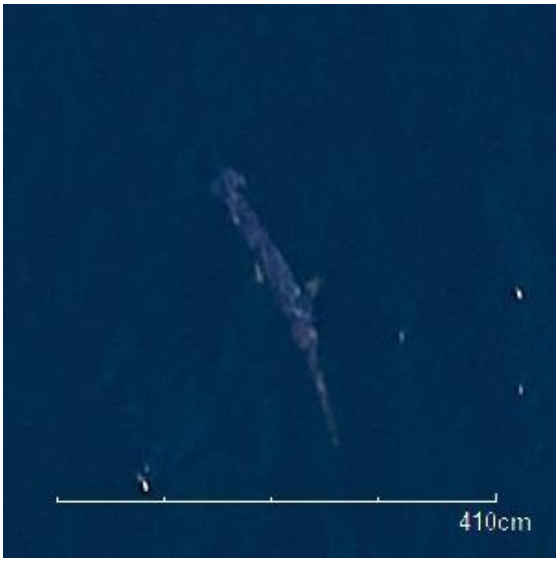

Figure 18 Billfish species, submerged but still identifiable to family level

Figure 19 Gannet in flight

Figure 20 Fulmar, taking off

Figure 21 Sitting Cory's shearwater

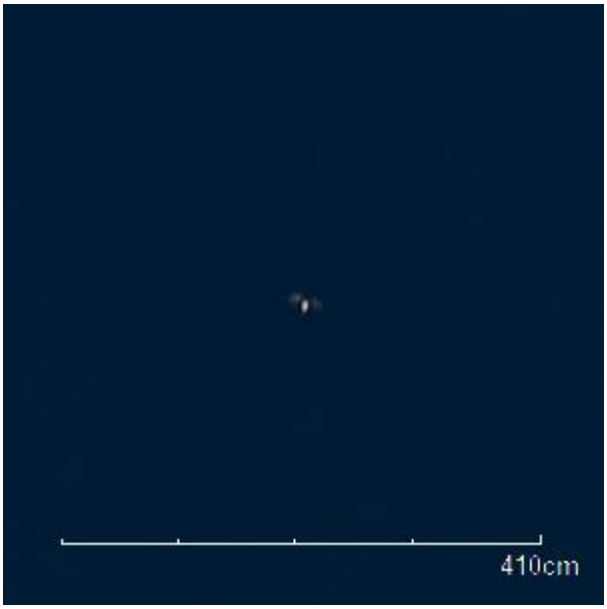

Figure 22 Storm petrel