

Natural England

# **Ornithological and Marine Mammal Baseline Characterisation Surveys for the POSEIDON project**

**July-September (Seasonal) Report – South-West Celtic  
Sea**

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COMMERCIAL IN CONFIDENCE

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## 1. Executive Summary

This report constitutes the fourth seasonal (July to September 2023) report outlining results from digital aerial surveys conducted in September 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 across two days in September, with no technical or safety issues. A total of 993 observations were recorded in September 2023, of which 646 were observations of birds and 347 observations of marine megafauna.

## 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<sup>2</sup>). 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 fourth seasonal (July to September 2023) survey, undertaken in September 2023.

### 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.

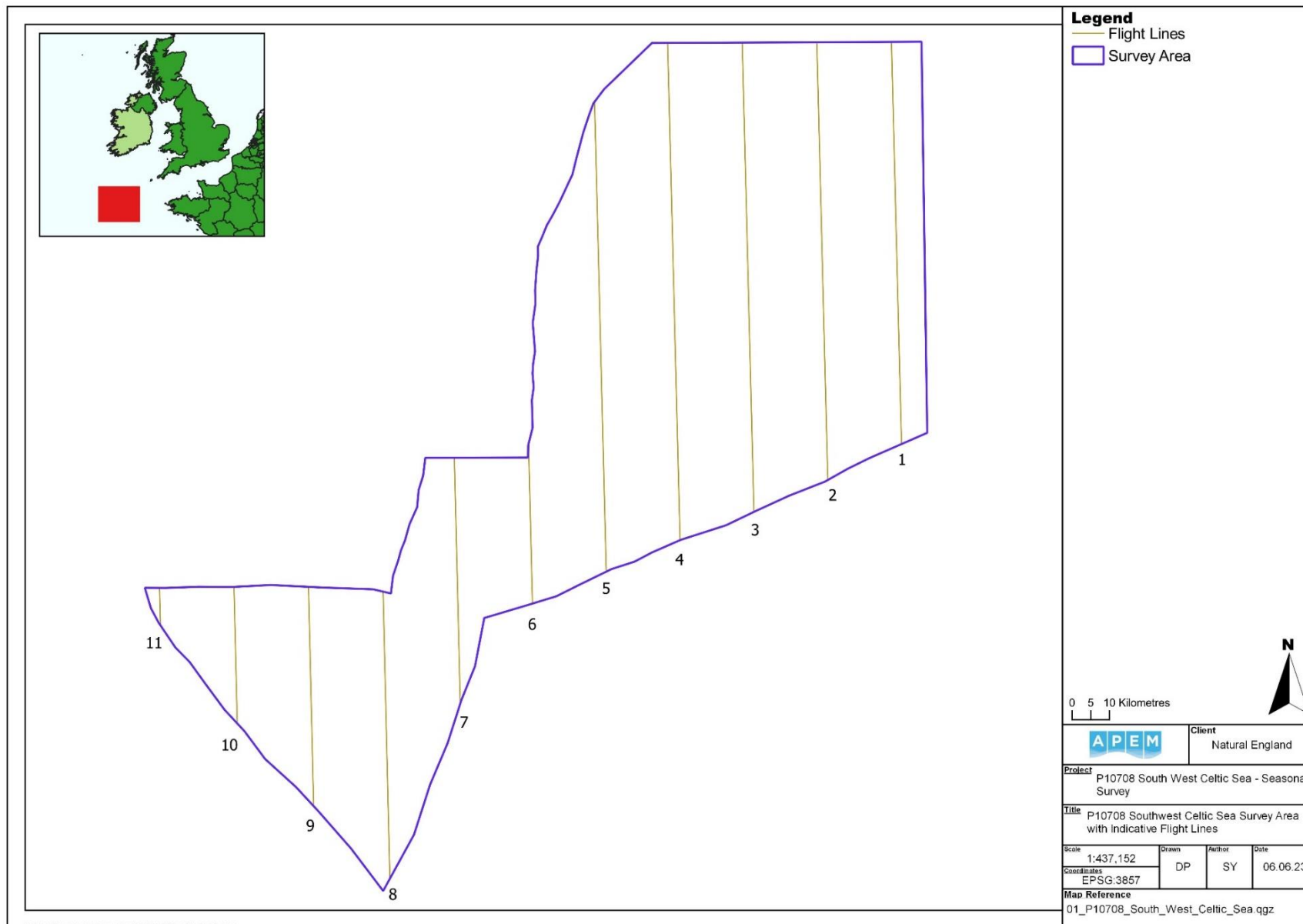


Figure 1 Location of the South-West Celtic Sea Survey Area with indicative flight lines

### 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 were 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 horizontal and vertical 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 from 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<sup>2</sup>. 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 6,398 nodes were initially captured. Of these, 6,301 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 6,398 image nodes. All planned nodes were successfully captured (**Table 2**). The target of 3% coverage was achieved, including a redundancy of an additional 0.40%, which is over 10% contingency with respect to the target coverage.

Effort data is calculated as the area (km<sup>2</sup>) 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 are 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 were 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.

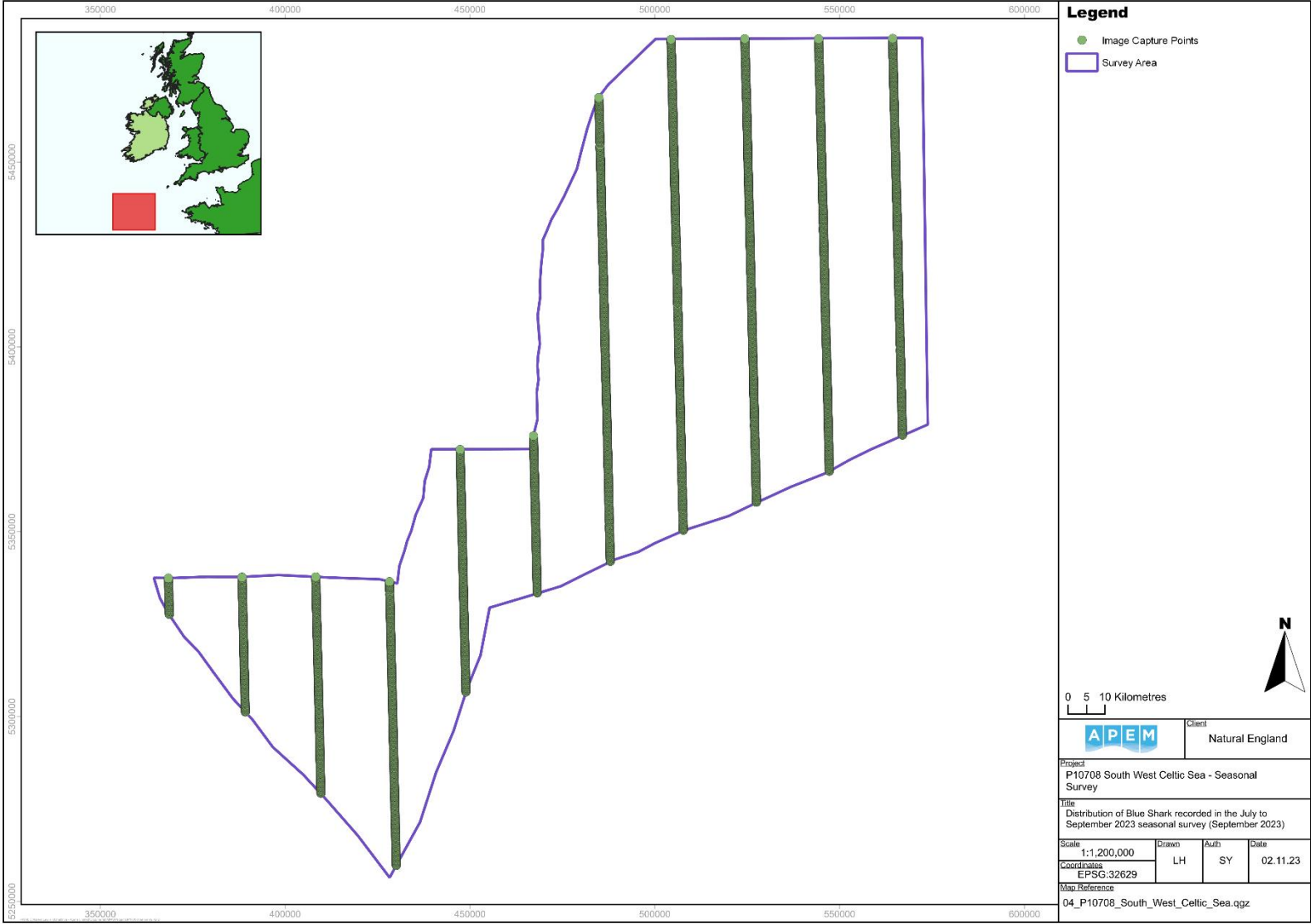


Figure 2 Individual image capture points during the July to September 2023 (September 2023) survey

**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.**

<u>Survey Tolerances</u>	<b>Warning</b>	<b>Cutout</b>	
Lateral Tolerance	30	60	m
Vertical tolerance	15	30 (No auto cutout)	m

**Table 2 Image capture and other observations during the July to September 2023 seasonal survey (September 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	107.41	3	762	753	-	-	Six nodes with cloud	-
2	117.11	3	829	821	-	-	3-4 pods of dolphins spotted off line	-
3	125.51	3	888	880	-	1	-	-
4	132.89	3	941	931	-	-	Whale spotted	-
5	125.57	3	888	878	-	-	-	-
6	45.48	3	308	299	-	-	-	-
7	65.69	3	471	461	-	Trawler spotted not on line	-	-
8	76.93	3	547	539	-	-	-	-
9	58.53	3	420	412	-	-	-	-
10	36.48	3	265	257	-	-	-	-
11	9.83	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 July to September 2023 seasonal survey (September 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	03/09/2023	08:59	09:30	30-60	>10	14	22	070°	2	0
2	03/09/2023	09:38	10:11	30-50	>10	14	13	060°	2	0
3	03/09/2023	10:21	10:57	30-50	>10	14	26	070°	2	0
4	03/09/2023	14:49	15:25	20-60	>10	14	11	060°	2	0
5	03/09/2023	15:33	16:07	20-60	>10	14	30	080°	2	0
6	02/09/2023	08:18	08:30	30	25	15	15	300°	1	2
7	02/09/2023	08:39	08:57	30-35	25	15	15	300°	1	2
8	02/09/2023	09:08	09:31	30-35	25	15	16	300°	1	2
9	02/09/2023	09:39	09:56	30	25	15	16	300°	1	2
10	02/09/2023	14:35	15:07	40	20	15	16	060°	1	2
11	02/09/2023	15:16	15:18	40	20	15	16	060°	1	2

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	<i>Surveys not typically flown at sea states &gt; 3.</i>			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 July to September 2023 seasonal survey period (September 2023)**

Species	Group Level 1	Group Level 2	Group Level 3	Group Level 4
Grey Phalarope	Wader species			Unidentified bird species
Kittiwake	Small Gull species		Gull species	
Great Black-backed Gull	Black-backed Gull species	Large Gull species		
Lesser Black-backed Gull				
Arctic Tern	'Commic' Tern		Tern species	
Common Tern				
European Storm Petrel	Storm Petrel species			
Leach's Storm Petrel				
Guillemot	Guillemot / Razorbill	Auk species	Auk and / or shearwater species	
Razorbill				
Puffin				
Cory's Shearwater	Large Shearwater species	Shearwater species		
Sooty Shearwater				
Great Shearwater				
Manx Shearwater	Small Shearwater species			
Balearic Shearwater				
Fulmar	Fulmar			
Gannet	Gannet			

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

Species	Group Level 1	Group Level 2	Group Level 3	Group Level 4
Common Minke Whale	Whale species			
Fin Whale				
Atlantic white-sided	Dolphin species	Dolphin / Porpoise species	Cetacean species	Marine Mammal species
Risso's Dolphin				
Bottlenose Dolphin				
Common Dolphin				
Striped 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  $\pm$  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)<sup>1</sup>. 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 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

<sup>1</sup>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.

body length measurement. Such birds are removed from the sample used to calculate flight heights. Flight height data are included within the separate raw data files.

## 4. Abundance and distribution

### 4.1 Abundance

A total of 646 birds were recorded in the Survey Area during the July – September 2023 seasonal (September 2023) survey. Of those, 403 were in flight and 243 were sitting on the water (**Table 7**). A total of 347 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 individual birds by species or species group recorded during the July to September 2023 seasonal survey period (September 2023)**

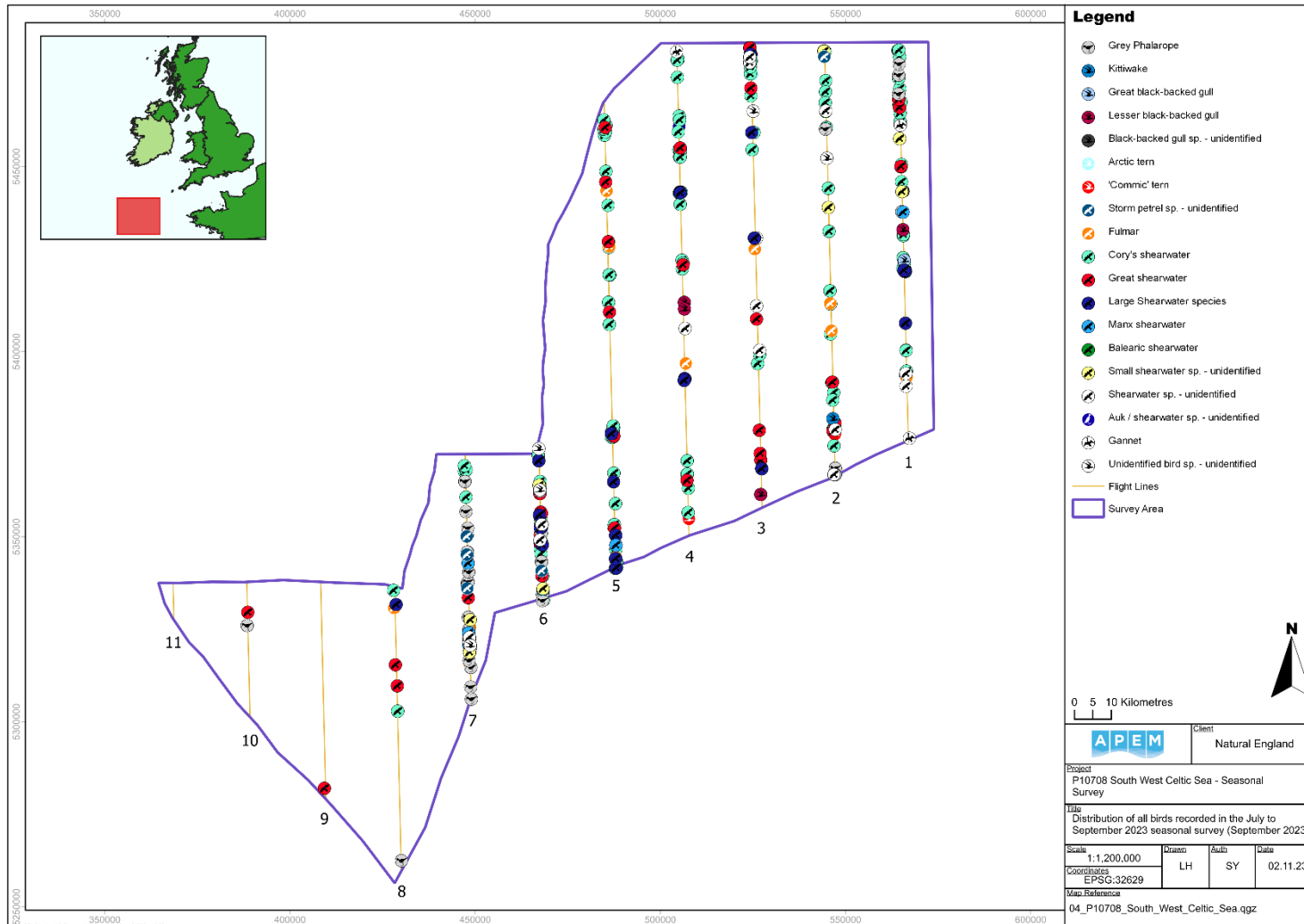
Species Group	Species	Flying	Sitting	Deceased	Total
Waders	Grey Phalarope	52	3	-	<b>55</b>
Large Gulls	Great Black-backed Gull	1	-	-	<b>1</b>
	Lesser Black-backed Gull	5	-	-	<b>5</b>
	Black-backed Gull species	2	-	-	<b>2</b>
Small Gulls	Kittiwake	1	-	-	<b>1</b>
Terns	Arctic Tern	6	-	-	<b>6</b>
	'Commic' Tern	5	-	-	<b>5</b>
Petrels	Storm Petrel species	17	-	-	<b>17</b>
Fulmars	Fulmar	1	11	-	<b>12</b>
Shearwaters	Cory's Shearwater	225	91	-	<b>316</b>
	Great Shearwater	41	36	-	<b>77</b>
	Large Shearwater species	15	81	-	<b>96</b>
	Manx Shearwater	5	8	-	<b>13</b>
	Balearic Shearwater	1	-	-	<b>1</b>
	Small Shearwater species	7	1	-	<b>8</b>
	Shearwater species	11	8	-	<b>19</b>
Auk / Shearwaters	Auk / Shearwater species	-	1	-	<b>1</b>
Gannets	Gannet	4	1	-	<b>5</b>
Birds	Unidentified Bird species	4	2	-	<b>6</b>
<b>Total</b>		<b>403</b>	<b>243</b>	<b>0</b>	<b>646</b>

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

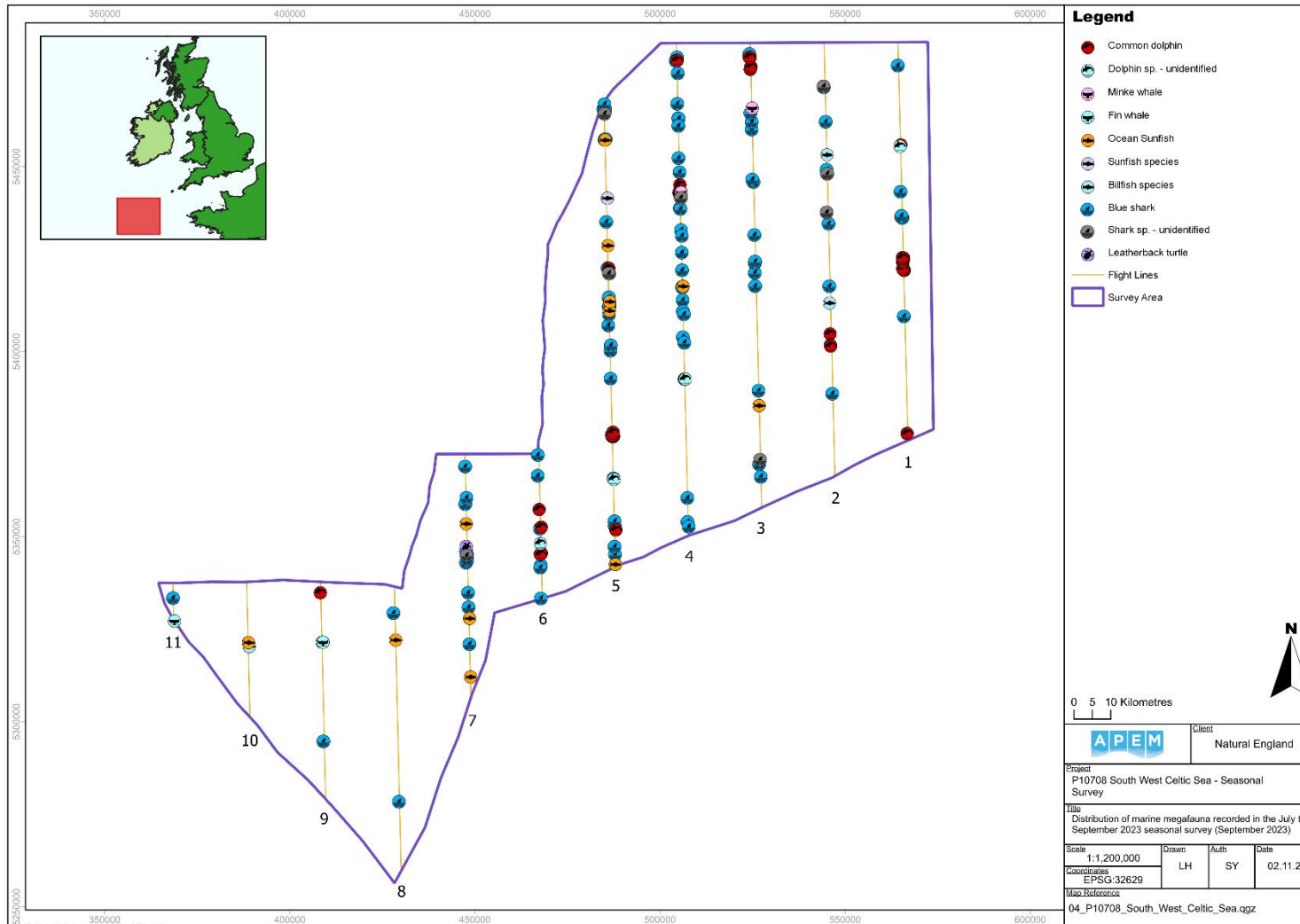
Species Group	Species	Submerged	Surfacing	Deceased	Total
Dolphins	Common Dolphin	182	28	-	<b>210</b>
	Dolphin species	4	-	-	<b>4</b>
Whales	Common Minke Whale	1	1	-	<b>2</b>
	Fin Whale	2	1	-	<b>3</b>
Fishes	Ocean Sunfish	13	-	-	<b>13</b>
	Sunfish species	1	-	-	<b>1</b>
	Billfish species	4	-	-	<b>4</b>
Sharks	Blue Shark	101	-	-	<b>101</b>
	Shark species	8	-	-	<b>8</b>
Turtles	Leatherback Turtle	-	1	-	<b>1</b>
<b>Total</b>		<b>316</b>	<b>31</b>	<b>0</b>	<b>347</b>

## 4.2 Spatial Distribution

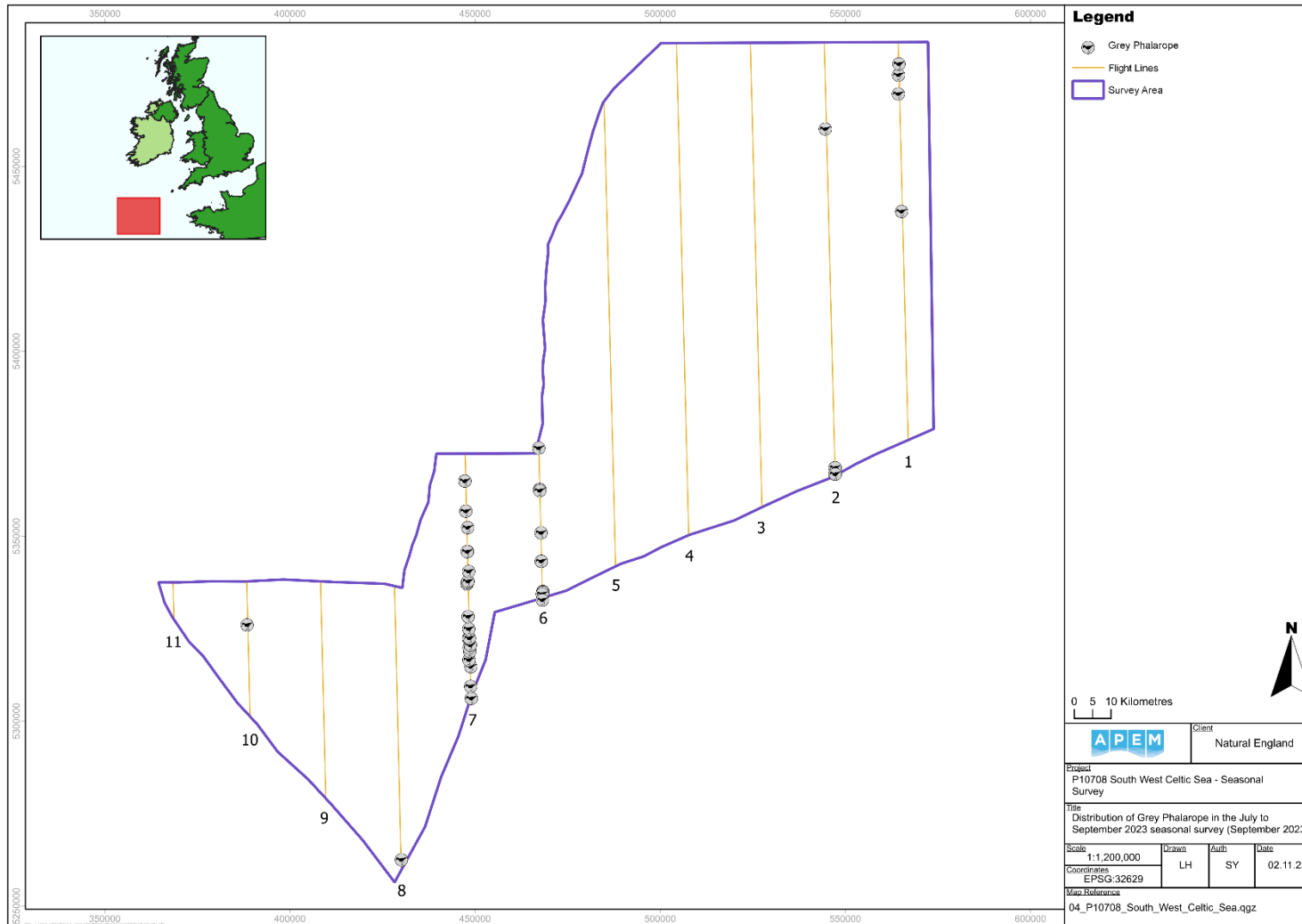
**Figure 3** and **Figure 4** detail the locations of all birds and other marine megafauna, respectively, recorded in the Survey Area. **Figure 5** to **Figure 8** shows the locations of the most abundant birds by species within the Survey Area. **Figure 9** displays the aggregated distribution of less abundant bird species recorded in the Survey Area. **Figure 10** to **Figure 11** show the locations of the most abundant marine megafauna by species within the Survey Area and **Figure 12** displays the aggregated distribution of less abundant marine megafauna recorded in the Survey Area. Birds were found throughout the Survey Area, with greater concentrations in the centre and the northeast. Marine megafauna species were also found throughout the Survey Area, with the greatest concentrations found in the centre and the more north-westerly sections.



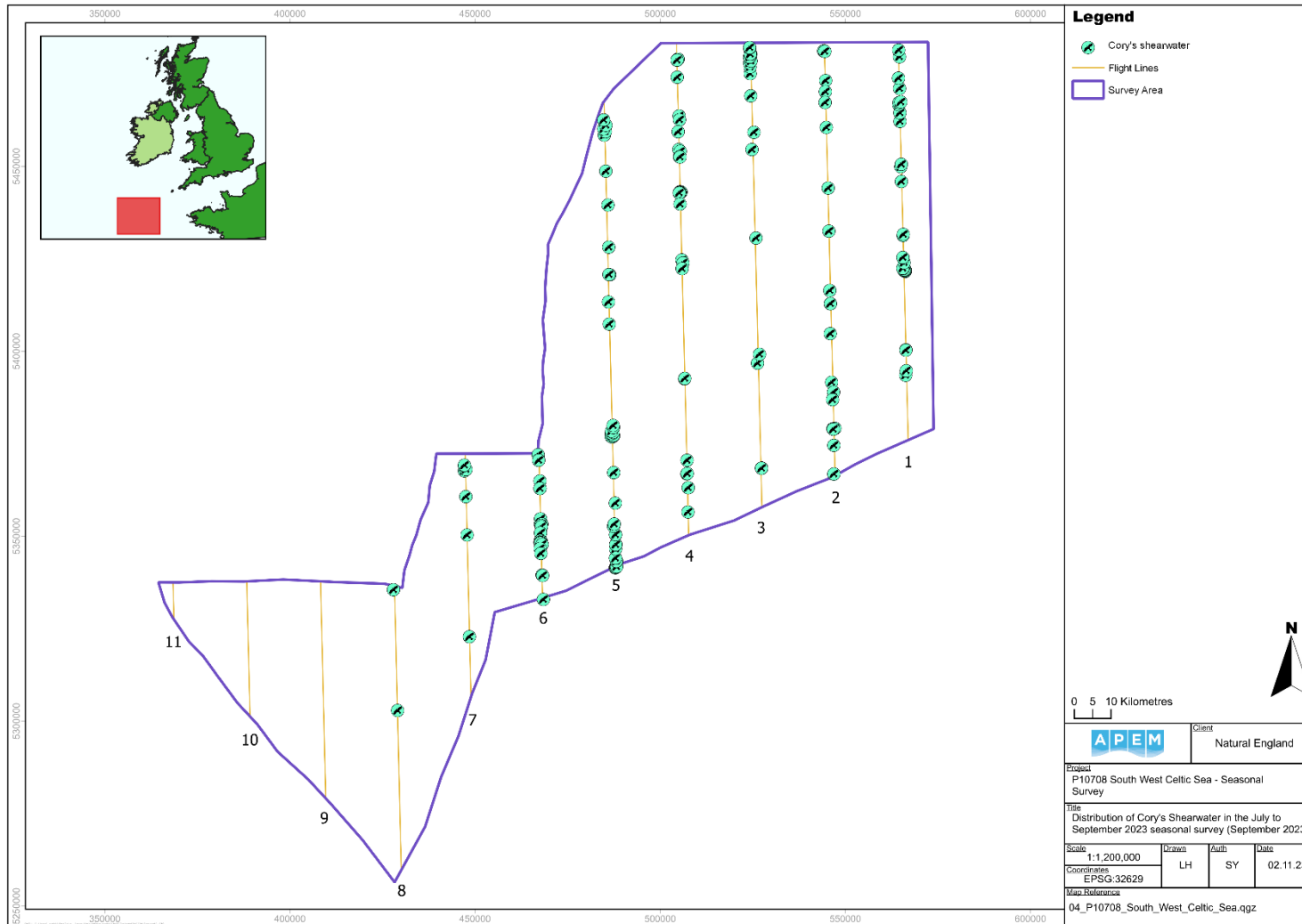
**Figure 3** Distribution of all birds recorded in the July to September 2023 seasonal survey (September 2023)



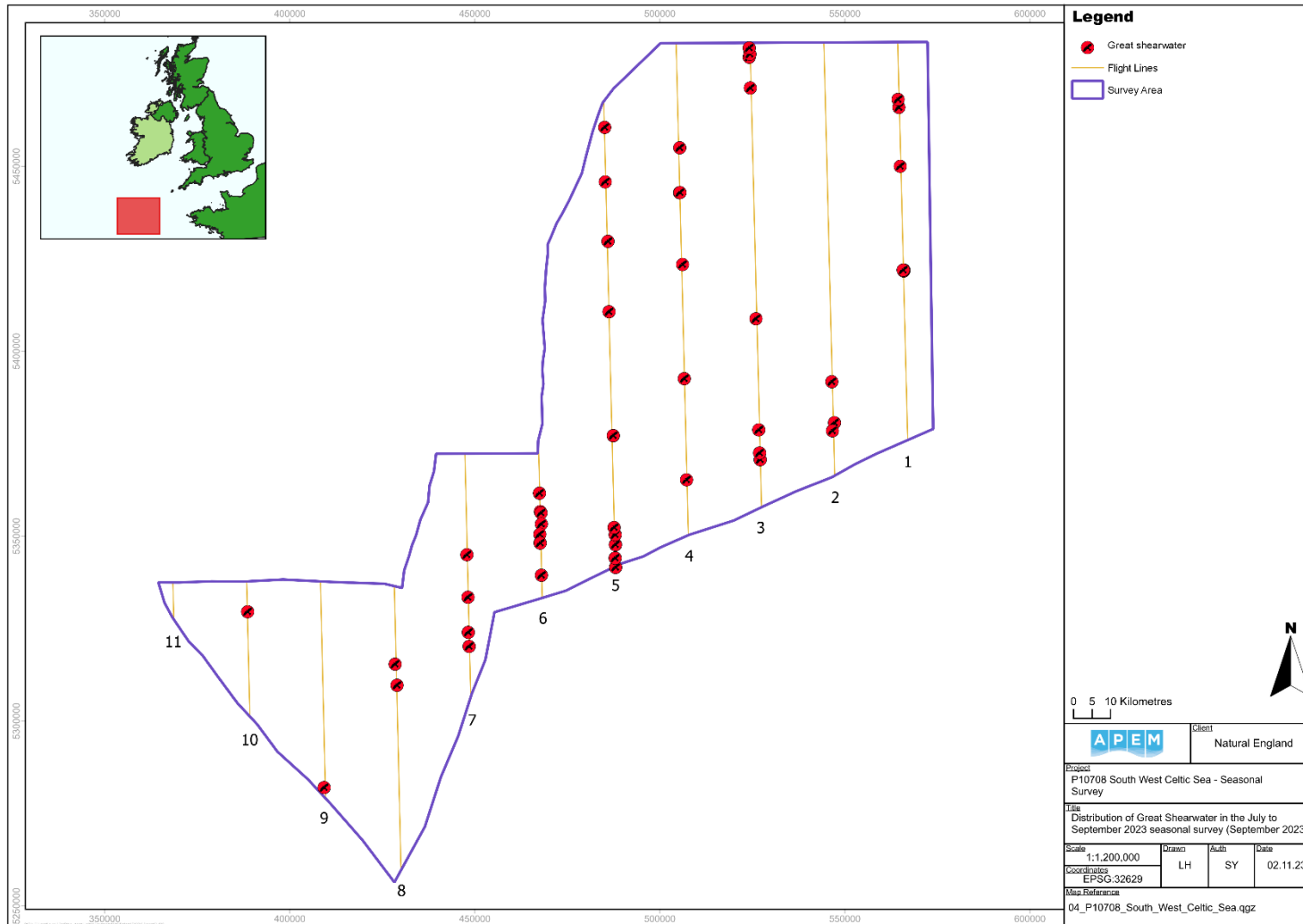
**Figure 4** Distribution of all marine megafauna recorded in the July to September 2023 seasonal survey (September 2023)



**Figure 5** Grey phalarope distribution recorded in the July to September 2023 seasonal survey (September 2023)



**Figure 6** Cory's shearwater distribution recorded in the July to September 2023 seasonal survey (September 2023)



**Figure 7** Great shearwater distribution recorded in the July to September 2023 seasonal survey (September 2023)

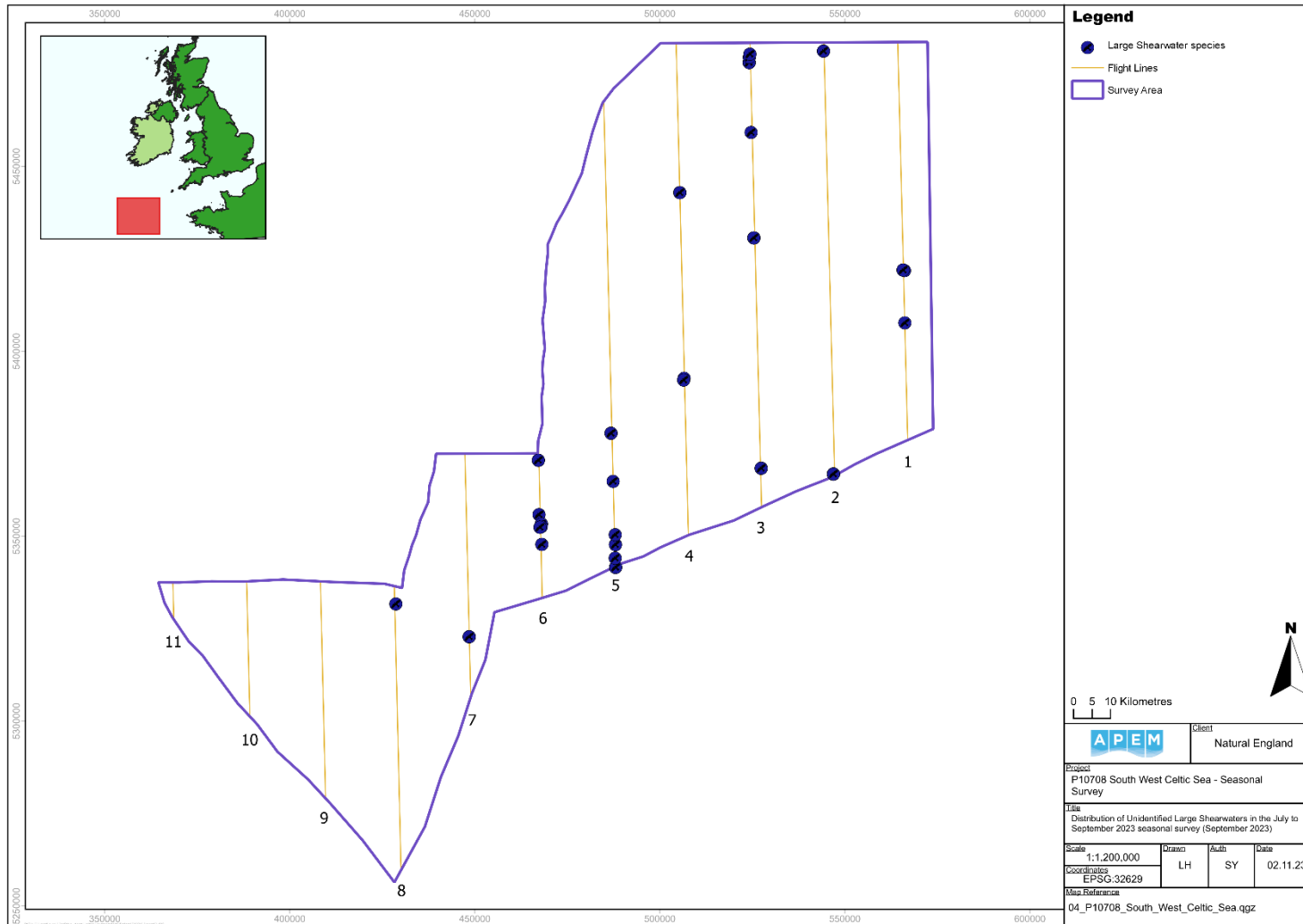


Figure 8 Unidentified large shearwater distribution recorded in the July to September 2023 seasonal survey (September 2023)

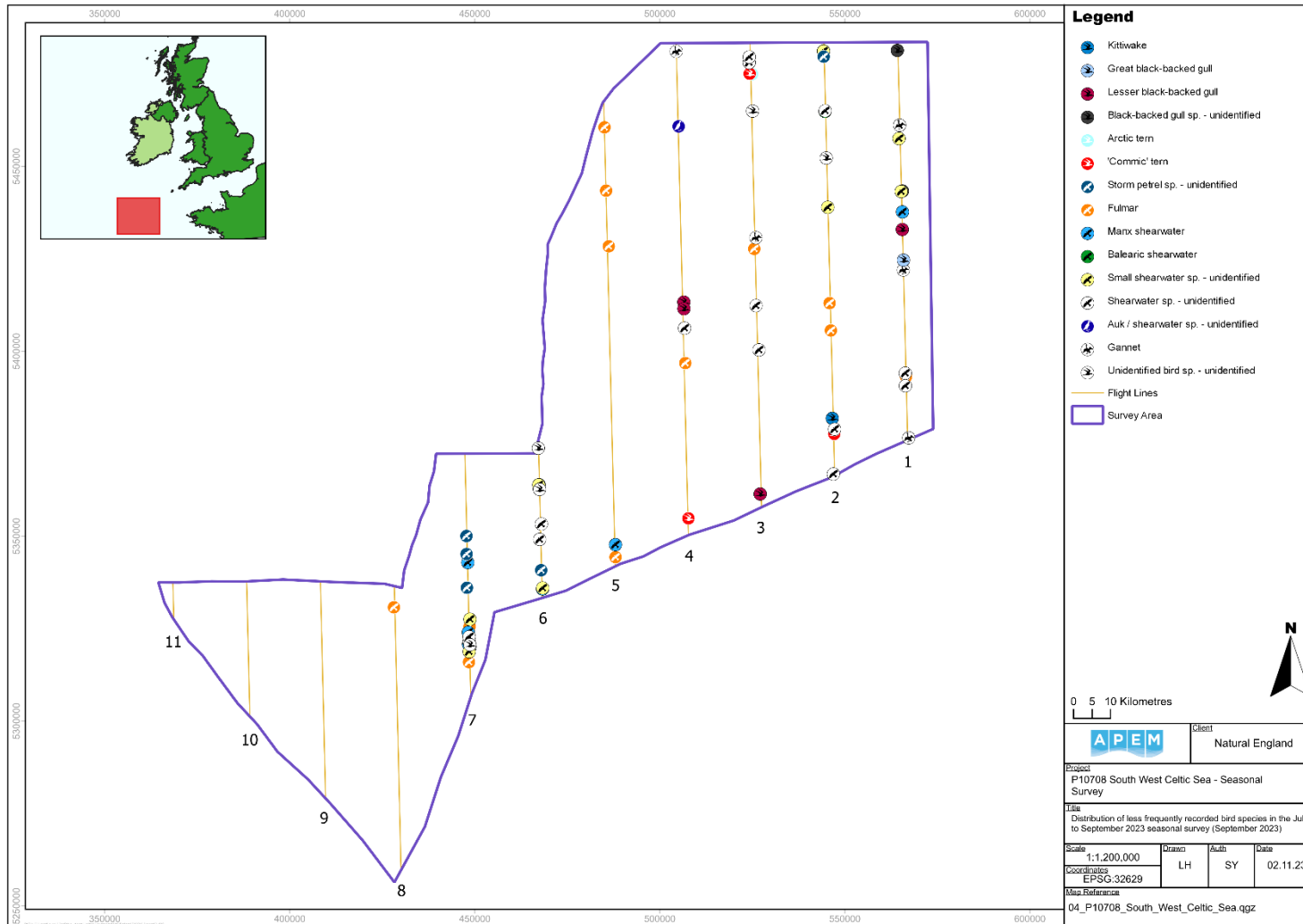
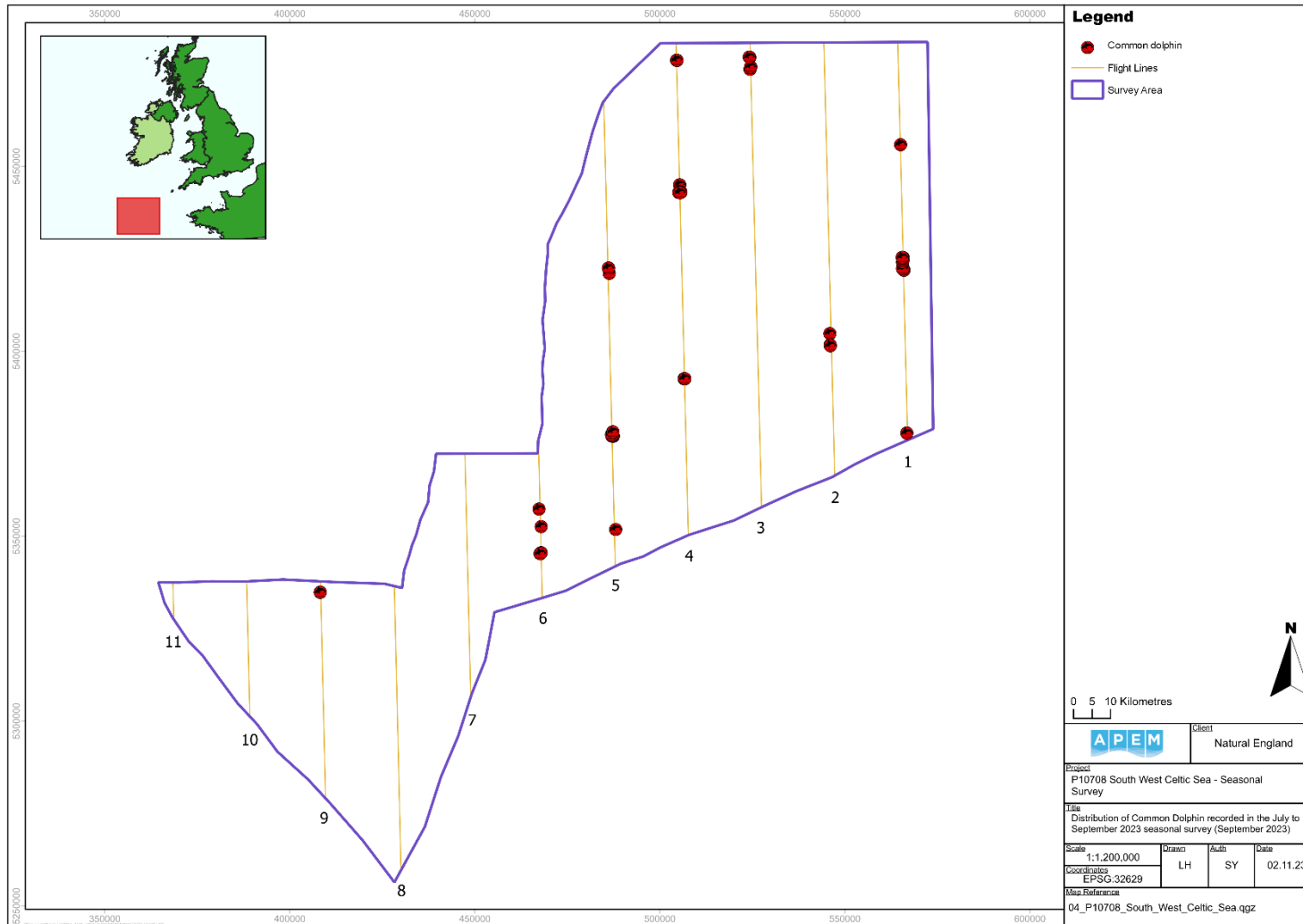
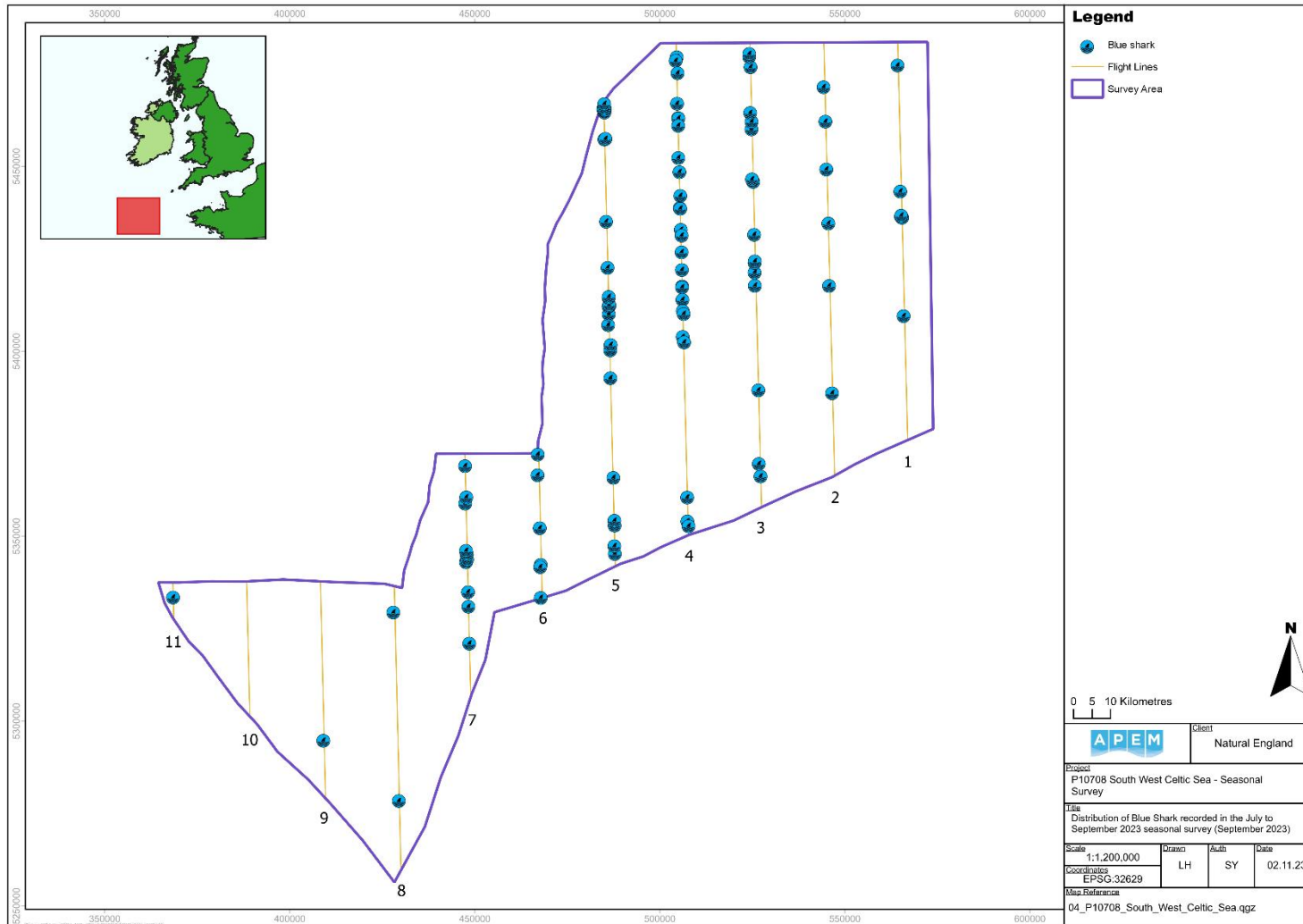


Figure 9 Distribution of less abundant bird species recorded in the July to September 2023 seasonal survey (September 2023)



**Figure 10** Common dolphin distribution recorded in the July to September 2023 seasonal survey (September 2023)



**Figure 11 Blue shark distribution recorded in the July to September 2023 seasonal survey (September 2023)**

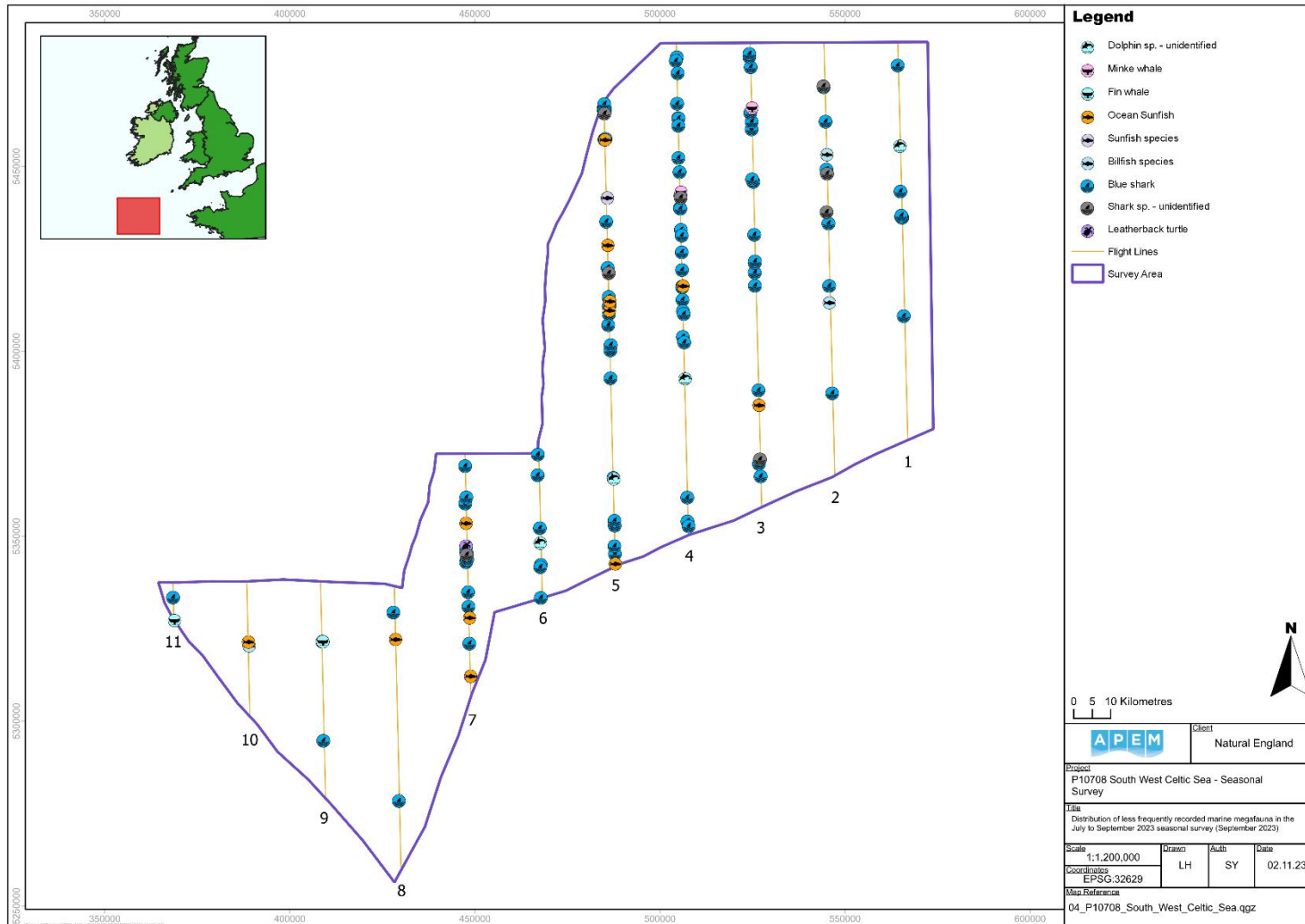


Figure 12 Distribution of less abundant marine megafauna recorded in the July to September 2023 seasonal survey (September 2023)

## 5. Abiotic Structures and Observations

The following abiotic structures were observed during the survey period:

A fishing trawler was observed by the flight-team to the side of line eight on the 2<sup>nd</sup> of September, bearing east to west.

## Appendix I Scientific Names and Taxonomy

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

Species	Scientific Name
Grey Phalarope	<i>Phalaropus fulicarius</i>
Kittiwake	<i>Rissa tridactyla</i>
Great Black-backed Gull	<i>Larus marinus</i>
Lesser Black-backed Gull	<i>Larus fuscus</i>
Arctic Tern	<i>Sterna paradisaea</i>
Fulmar	<i>Fulmarus glacialis</i>
Cory's Shearwater	<i>Calonectris borealis</i>
Great Shearwater	<i>Ardenna gravis</i>
Manx Shearwater	<i>Puffinus puffinus</i>
Balearic Shearwater	<i>Puffinus mauretanicus</i>
Gannet	<i>Morus bassanus</i>
Common Minke Whale	<i>Balaenoptera acutorostrata</i>
Fin Whale	<i>Balaenoptera physalus</i>
Common Dolphin	<i>Delphinus delphis</i>
Ocean Sunfish	<i>Mola mola</i>
Blue Shark	<i>Prionace glauca</i>
Leatherback Turtle	<i>Dermochelys coriacea</i>

## 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 Arctic tern in flight



Figure 14 Balearic shearwater in flight

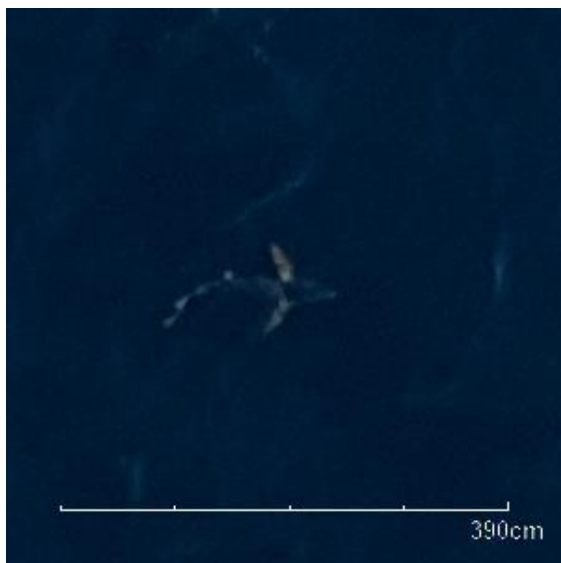


Figure 15 Blue shark

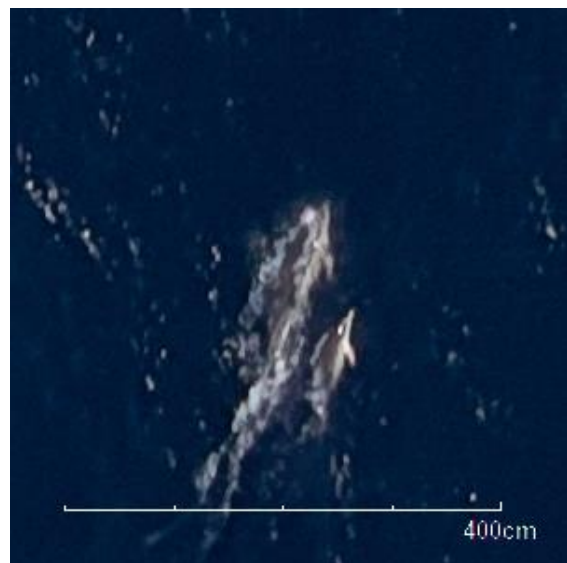
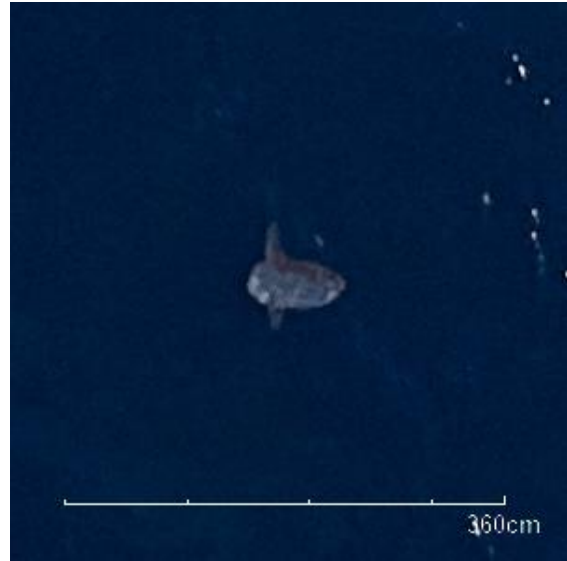


Figure 16 Common dolphin, with calf



**Figure 17** A fin whale, surfacing, with the blow (top left) and characteristic dorsal chevrons visible



**Figure 18** Ocean sunfish, laying characteristically horizontal near the water's surface