Natural England

Ornithological and Marine Mammal Baseline Characterisation Surveys for the POSEIDON project

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

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1. Executive Summary

This report constitutes the third year two seasonal (April to June 2024) report outlining results from digital aerial surveys conducted in June 2024 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 June 2024, with no technical or safety issues. A total of 263 observations were recorded in June 2024, of which 147 were observations of birds and 116 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, year two seasonal digital aerial surveys within the South-West Celtic Sea, commencing from April 2023. The programme of work repeats the four seasonal surveys of the Survey Area completed by APEM from 2022-2023. 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 (April to June 2024) survey, undertaken in June 2024 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.

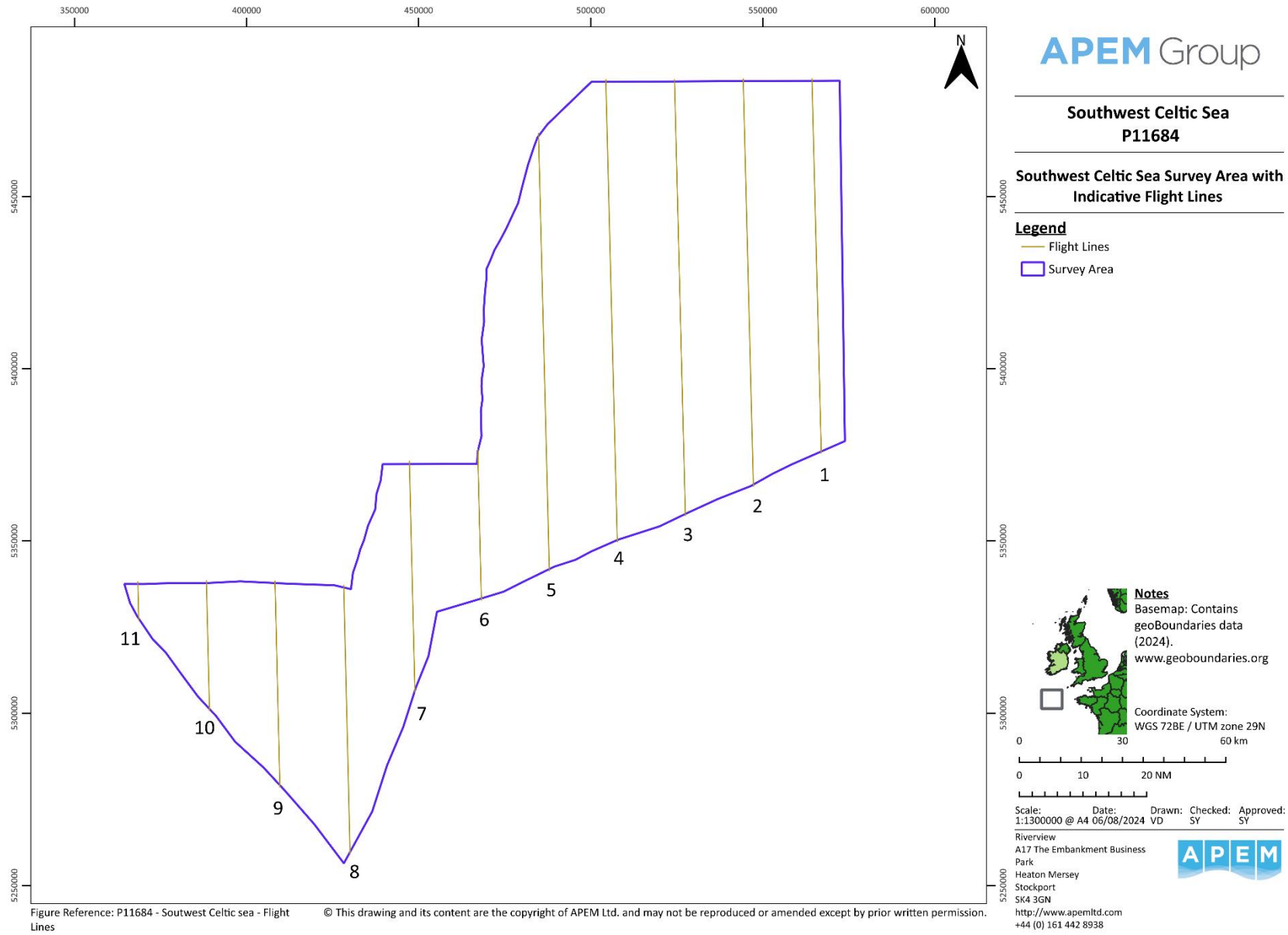

Figure 1 Location of the South-West Celtic Sea Survey Area with indicative flight lines and line numbers.

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. 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. 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. A total of 6,402 nodes were initially captured. Of these, 6,301 were used for analysis. The difference reflects nodes removed during clipping to the boundary area. Total coverage was calculated to be 3.43% generated from 6,301 image nodes (**Table 2**). The target coverage of 3% was achieved including a redundancy of an additional 0.43%, which is 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. The 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. Summing analysed footprints and comparing against the entire survey area gives the percentage analysed.

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 the survey were conducive to collecting and analysing imagery for the purposes of providing data on the identification, distribution, and abundance of bird species and marine fauna within the Survey Area. Whilst strong winds (close to the standard limit of 30 knots during which condition are considered favourable for surveys) were noted during some lines, they did not constitute a health and safety risk.

On the 2nd of June, two planes were used to survey lines 3-5 (take off at 12:25, landing at 17:49), and 6-11 (take off at 11:51, landing at 17:45), respectively. It was not possible to continue the survey on this date due to low cloud in the south of the Survey Area.

On the 5th of June, lines 1-2 were surveyed (take off at 12:00, landing at 16:07). Initial analysis of imagery from 2nd June indicated lines 6-7 and 9-11 were obscured by low cloud. A second plane therefore resurveyed the affected lines (take off at 07:17, landing at 12:35). Therefore, images to be used in analysis were taken on 2nd June for lines 3, 4, 5 and 8, and were taken on 5th June for all other lines (**Table 2**).

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 3.43%, thus exceeding the 3% coverage required, enabling sufficient coverage to be collected should images be affected by glint or glare.

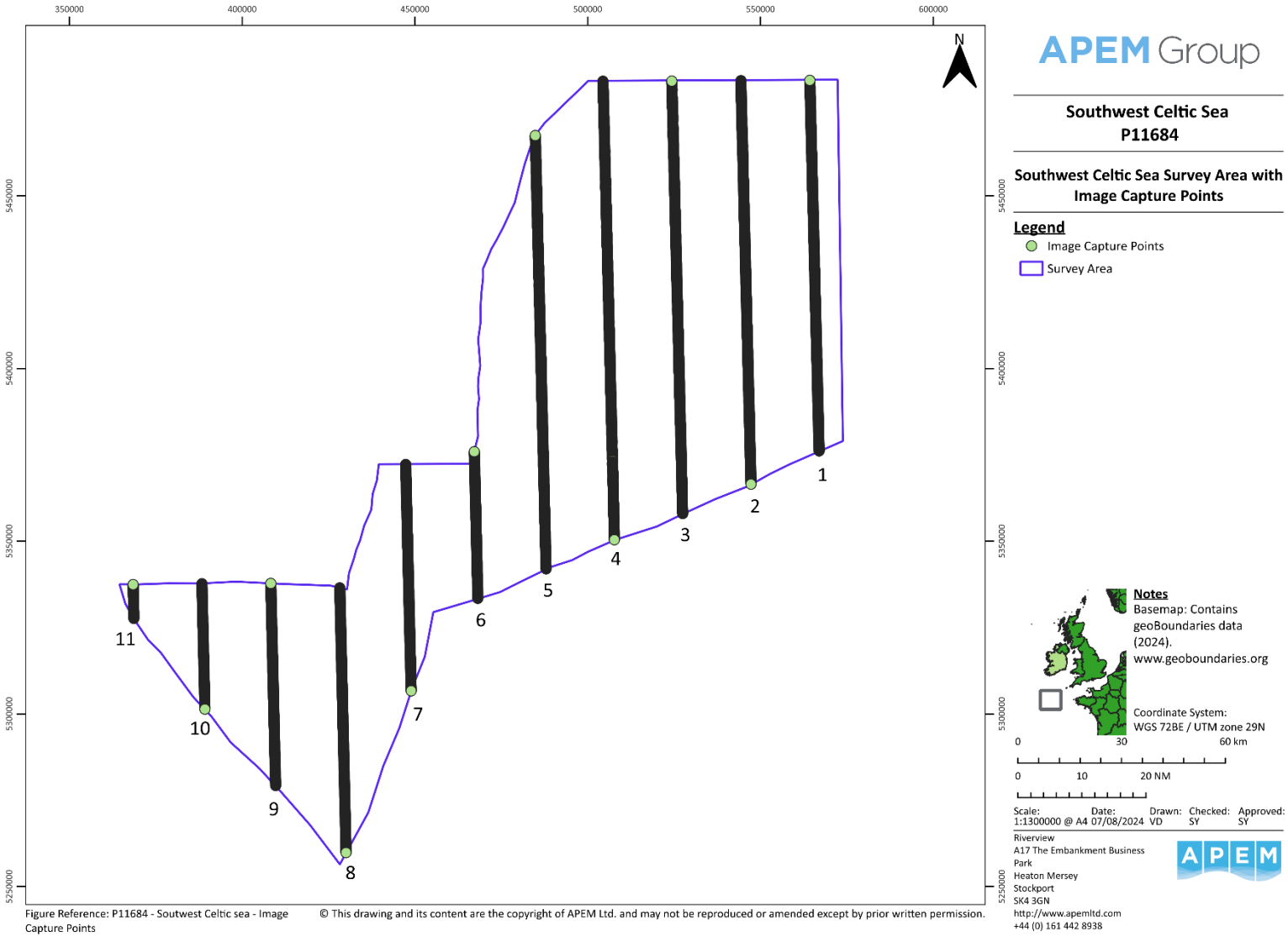

Figure 2 Individual image capture points during the April to June 2024 (June 2024) survey.

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 2024 seasonal survey (June 2024).

Survey line	Transect length (km)	N cameras capturing images	N image nodes (captured)	N images nodes (analysed)	Camera issues*	Shipping observations	Anecdotal observations	Health and Safety
1	107.41	3	762	753	-	-	-	-
2	116.96	3	829	820	-	-	-	-
3**	125.36	3	889	879	Cloud on the line. Flight system crashed and issues with the GPS. Affected line was re-flown.	-	Cloud on the line. Flown at 1,200 ft.	-
4	132.89	3	940	931	Flight system crashed and 2 nodes missed.	-	Some glint	-
5	125.57	3	891	881	-	-	Some glint	-
6***	42.51	3	308	299	-	-	-	-
7***	65.62	3	471	461	-	-	-	-
8	76.74	3	547	539	-	-	-	-
9***	58.61	3	421	412	-	-	-	-
10***	36.35	3	265	256	-	-	-	-
11***	9.85	3	79	70	-	-	-	-
Total	**897.87**	**3**	**6,402**	**6,301**	**N/A**			

*Due to the vast number of capture points collected during a 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.

**The system went offline on the initial line 3 survey attempt. The issue was resolved, and the line immediately resurveyed to ensure coverage. All details for line 3 within this report refer to the successful resurvey.

***Low cloud cover affected images on lines 6, 7, 9, 10 and 11 on the initial survey attempts on 2nd June. Each of these lines was resurveyed on 5th June. All details for lines 6, 7, 9, 10 and 11 within this report refer to the successful resurvey.

Table 3 Survey conditions during the April to June 2024 seasonal survey (June 2024).

Survey line	Date	Time on line (UTC) (Start / End)	Ground speed (knots)	Cloud cover (%)	Visibility (km)	Outside temperature (°C)	Wind speed (knots)	Wind direction	Sea state (Douglas)	Turbidity
1	05/06/2024	14:12 / 14:42	121	30	7	10	10	20°	2	0
2	05/06/2024	13:27 / 14:05	120	70	8	10	19	60°	2	0
3	02/06/2024	16:28 / 17:01	120	25	>10	12	23	30°	2	2
4	02/06/2024	15:35 / 16:16	118	0	>10	12	29	70°	2	2
5	02/06/2024	14:52 / 15:26	123	0	>10	13	23	45°	2	2
6	05/06/2024	10:44/ 10:56	125	75	>10	10	13	35°	3	1
7	05/06/2024	10:20 / 10:38	125	75	>10	10	10	45°	3	1
8	02/06/2024	14:42 / 15:03	120	60	7	13	17	80°	2	0
9	05/06/2024	09:51 / 10:06	125	75	>10	10	13	45°	3	1
10	05/06/2024	09:35 / 09:45	120	75	>10	10	10	45°	3	1
11	05/06/2024	09:21 / 09:24	125	75	>10	10	13	30°	3	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.*			96-100	Overcast		
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 2024 seasonal survey period (June 2024).

<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="7">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>Fulmar</td><td colspan="2"></td><td>Fulmar / Gull species</td></tr>
<tr><td>Sooty Shearwater</td><td>Large Shearwater species</td><td rowspan="2">Shearwater species</td><td rowspan="2">Auk and / or Shearwater species</td></tr>
<tr><td>Manx Shearwater</td><td>Small Shearwater species</td></tr>
<tr><td>Gannet</td><td colspan="3"></td></tr>
<tr><td>Collared Dove</td><td colspan="3">Passerine species</td></tr>
</table>

Table 6 Marine megafauna species included within higher-level taxonomic groups for the April to June 2024 seasonal survey period (June 2024).

Species	Group Level 1	Group Level 2	Group Level 3	Group Level 4
Common Dolphin	Dolphin species		Dolphin / Porpoise species	Unidentified Marine Mammal species
Bottlenose Dolphin				
Harbour Porpoise				
Unidentified Whale species	Whale species			
Ocean Sunfish	Bony Fish species			Unidentified Fish species
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 (Image Screening QA), reviewed percentage agreement between two sets of analysts for 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 the 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 consists 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 83%. After re-analysis, an agreement of 97% was attained. The initial target agreement rate was 76% and following re-analysis, an agreement rate of 95% was achieved.

Prior to the second step in the QA process, the tagged data underwent initial data checks, which are a series of discretionary sense checks carried out by QA Analysts. No fixed metrics are associated with these checks, this step provides an additional layer of checks to ensure the tagged data is as accurate as possible. This process involves sense checking tagged images for missed targets such as images or areas containing large aggregations of birds, pods of marine mammals and anthropogenic structures. A selection of images was checked for accuracy in target duplication and a sample of blank images were also checked for potential missed targets around busy areas of the survey.

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. As the current standard, 100% of the identifications were checked to ensure data accuracy. All data underwent a final review by a Technical Specialist. For the current survey, the identification agreement rate was 96.58% for all snags recorded. Additional checks on behaviour, age, sex and flight height suitability were also reviewed.

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 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.

[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.

4. Abundance and distribution

4.1 Abundance

A total of 147 birds were recorded in the Survey Area during the April to June 2024 seasonal (June 2024) survey. Of those, 64 were sitting on the water and 81 were in flight (**Table 7**).

A total of 116 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 2024 seasonal survey period (June 2024).

Species Group	Species	Flying	Sitting	Perched	Diving	Taking off	Deceased	Total
Gull	Kittiwake	1	-	-	-	-	-	**1**
	Lesser Black-backed gull	1	-	-	-	-	-	**1**
Fulmar	Fulmar	14	4	-	-	-	-	**18**
Shearwaters	Sooty shearwater	2	-	-	-	-	-	**2**
	Manx shearwater	6	-	-	-	-	-	**6**
	Small shearwater species	2	-	-	-	-	-	**2**
Auk / shearwater	Auk / shearwater species	-	2	-	-	-	-	**2**
Gannet	Gannet	54	58	-	-	-	2	**114**
Passerines	Collared dove	1	-	-	-	-	-	**1**
Total		**81**	**64**	**-**	**-**	**-**	**2**	**147**

Table 8 Total number of individuals of marine megafauna by species or species group recorded during the April to June 2024 seasonal survey period (June 2024).

Species Group	Species	Deeply Submerged*	Submerged**	Surfacing	Bottling***	Hauled Out	Deceased	Total
Dolphin	Common dolphin	5	62	5	-	-	-	**72**
	Bottlenose dolphin	-	7	1	-	-	-	**8**
	Dolphin species	-	2	-	-	-	-	**2**
Porpoise	Harbour porpoise	-	4	-	-	-	-	**4**
Dolphin / porpoise	Dolphin / porpoise	-	4	-	-	-	-	**4**
Whale	Whale species	-	-	1	-	-	-	**1**
Bony fish	Ocean sunfish	-	11	-	-	-	-	**11**
Shark	Blue shark	-	14	-	-	-	-	**14**
Total		**5**	**104**	**7**	-	-	**-**	**116**

*The target is far beneath the surface so that many features are difficult to distinguish. Deeply submerged targets may be difficult to identify to species level.

**The target is wholly underwater, within the first few metres of the surface. Features use to aid identification are usually visible.

*** Applies to seals, where the head is positioned above the surface and the rest of the body is submerged vertically.

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** and **Figure 6** show the locations of the most abundant birds by species (fulmar and gannet, respectively) within the Survey Area. **Figure 7** shows the aggregated distribution of less abundant bird species recorded in the Survey Area. **Figure 8** to **Figure 10** shows the locations of the most abundant non-avian megafauna species (common dolphin, ocean sunfish and blue shark, respectively) within the Survey Area. Lastly, **Figure 11** shows the aggregated distribution of less abundant marine megafauna recorded in the Survey Area. There were no vessels or abiotic structures recorded during this survey period. Birds were evenly distributed across the Survey Area. Marine megafauna species were also distributed throughout the Survey Area, although with higher numbers recorded in the east of the Survey Area.

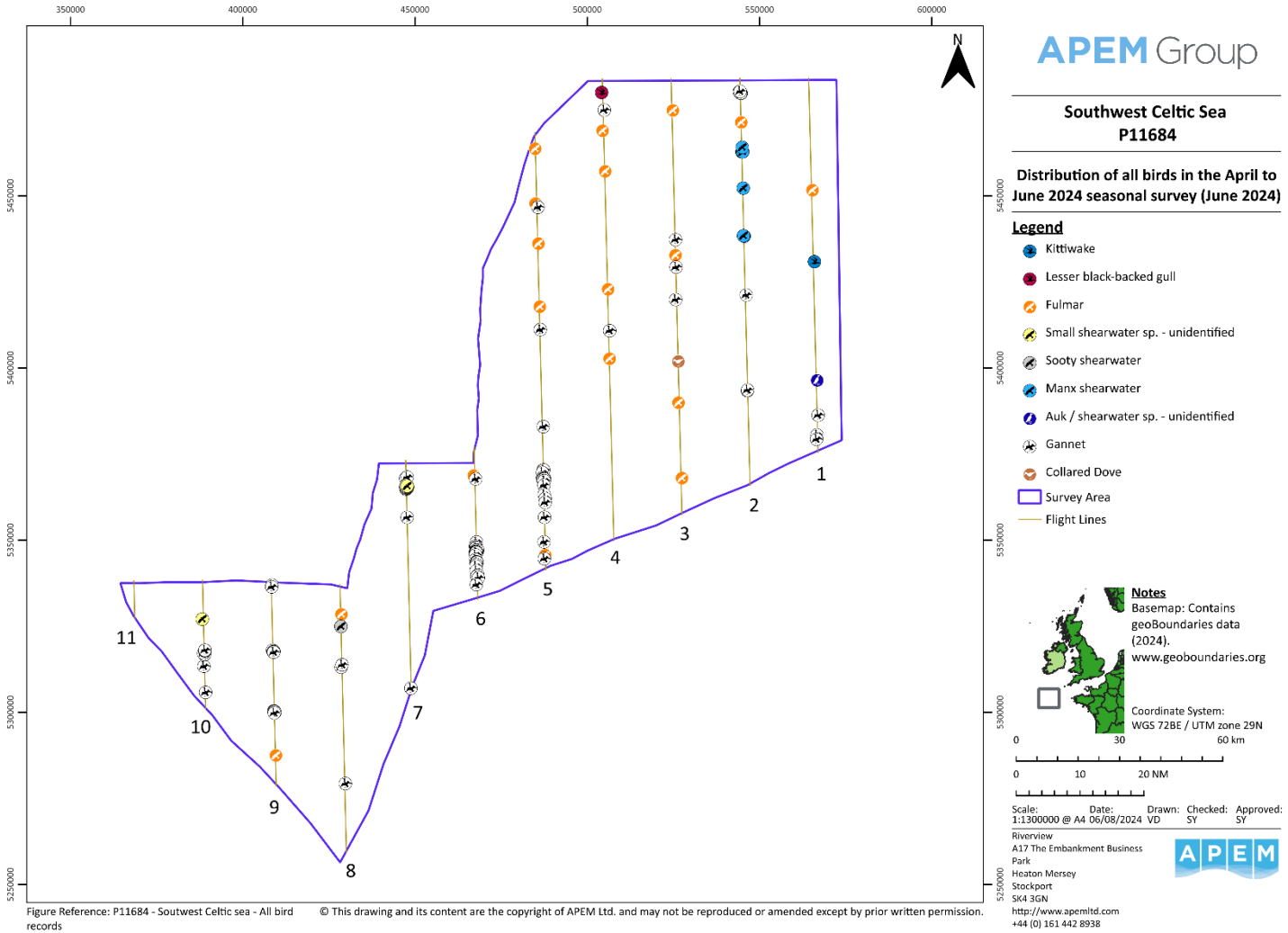

Figure 3 Distribution of all birds recorded in the April to June 2024 seasonal survey (June 2024).

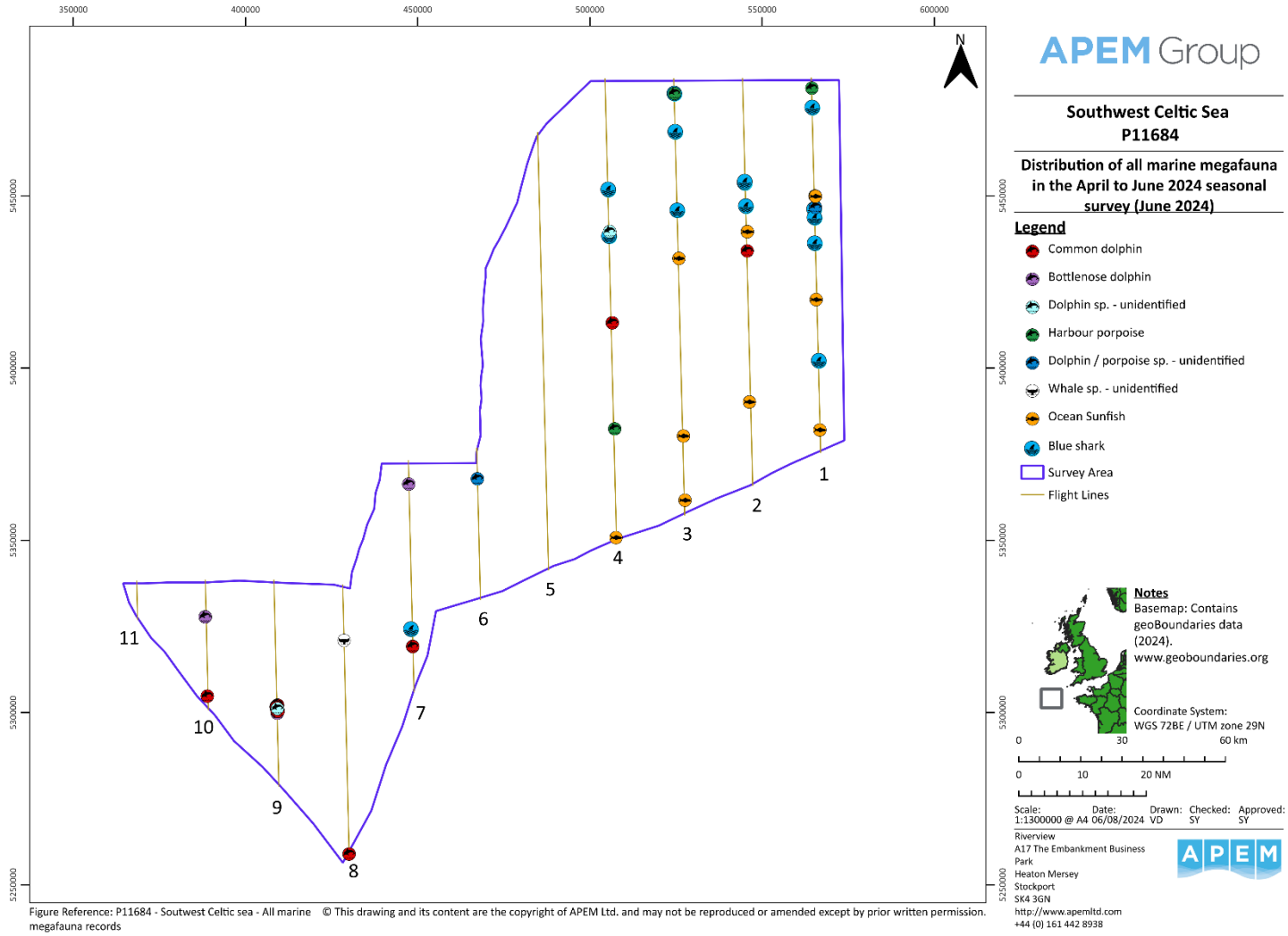

Figure 4 Distribution of all marine megafauna recorded in the April to June 2024 seasonal survey (June 2024).

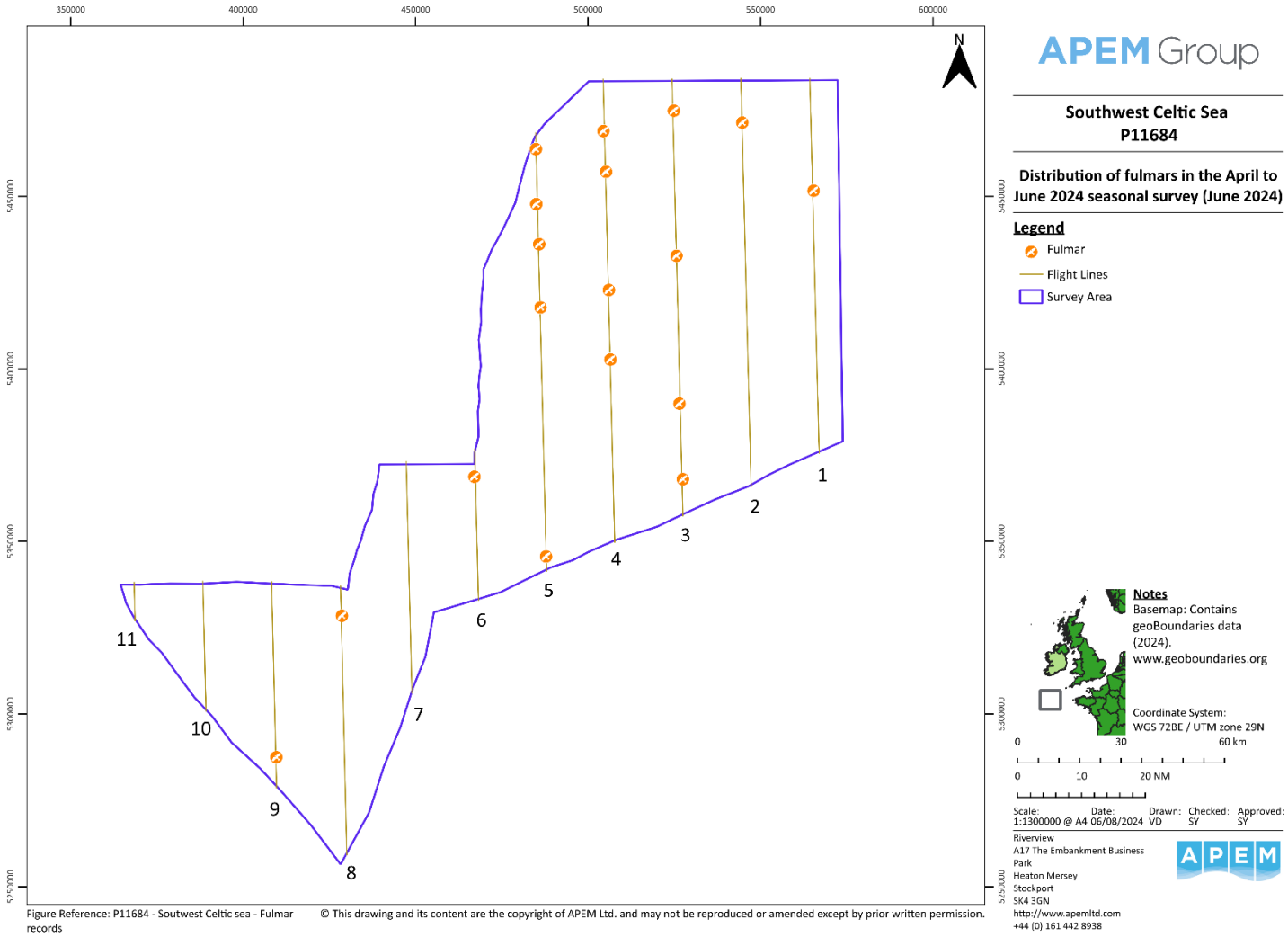

Figure 5 Fulmar distribution recorded in the April to June 2024 seasonal survey (June 2024).

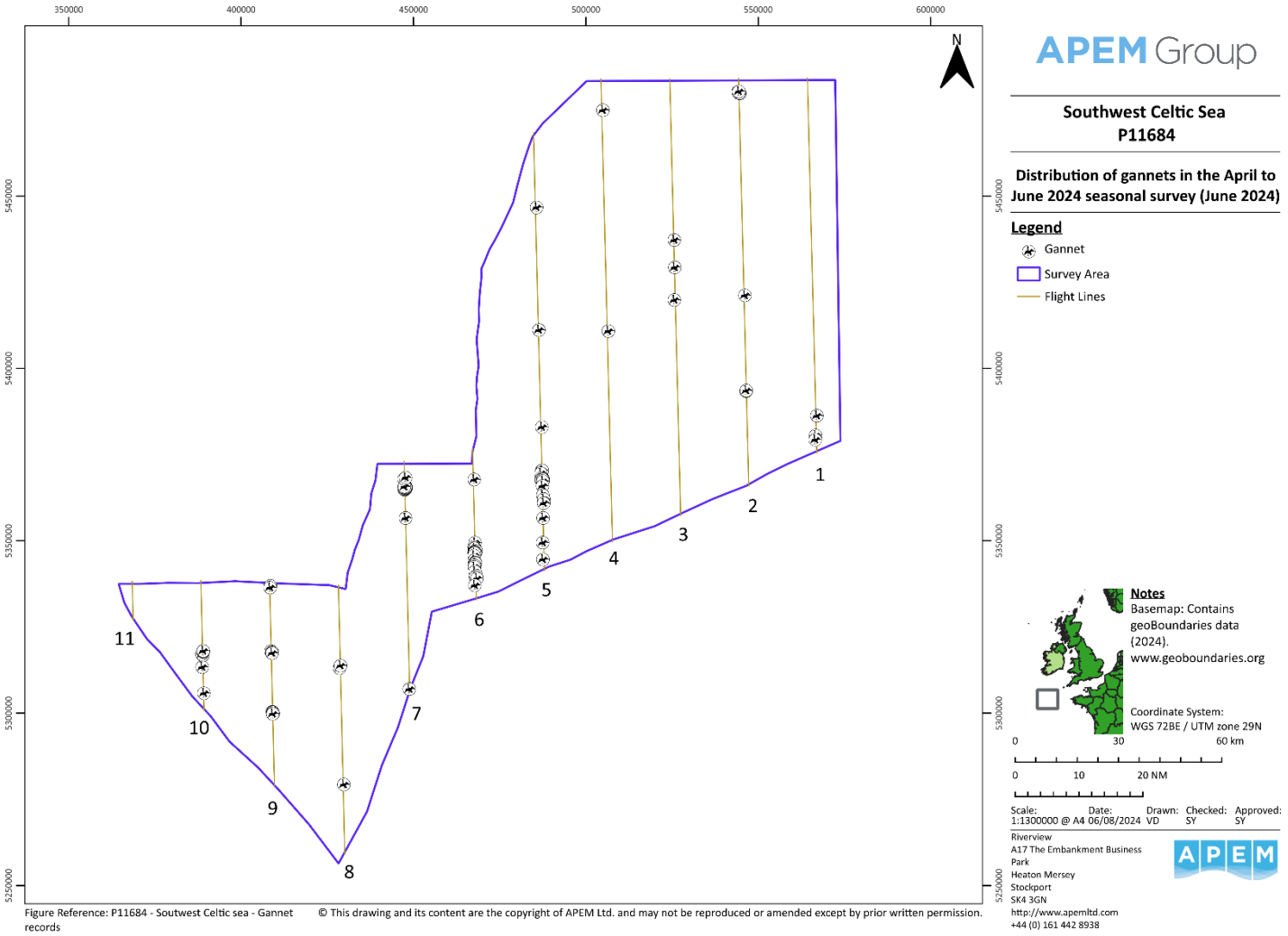

Figure 6 Gannet distribution recorded in the April to June 2024 seasonal survey (June 2024).

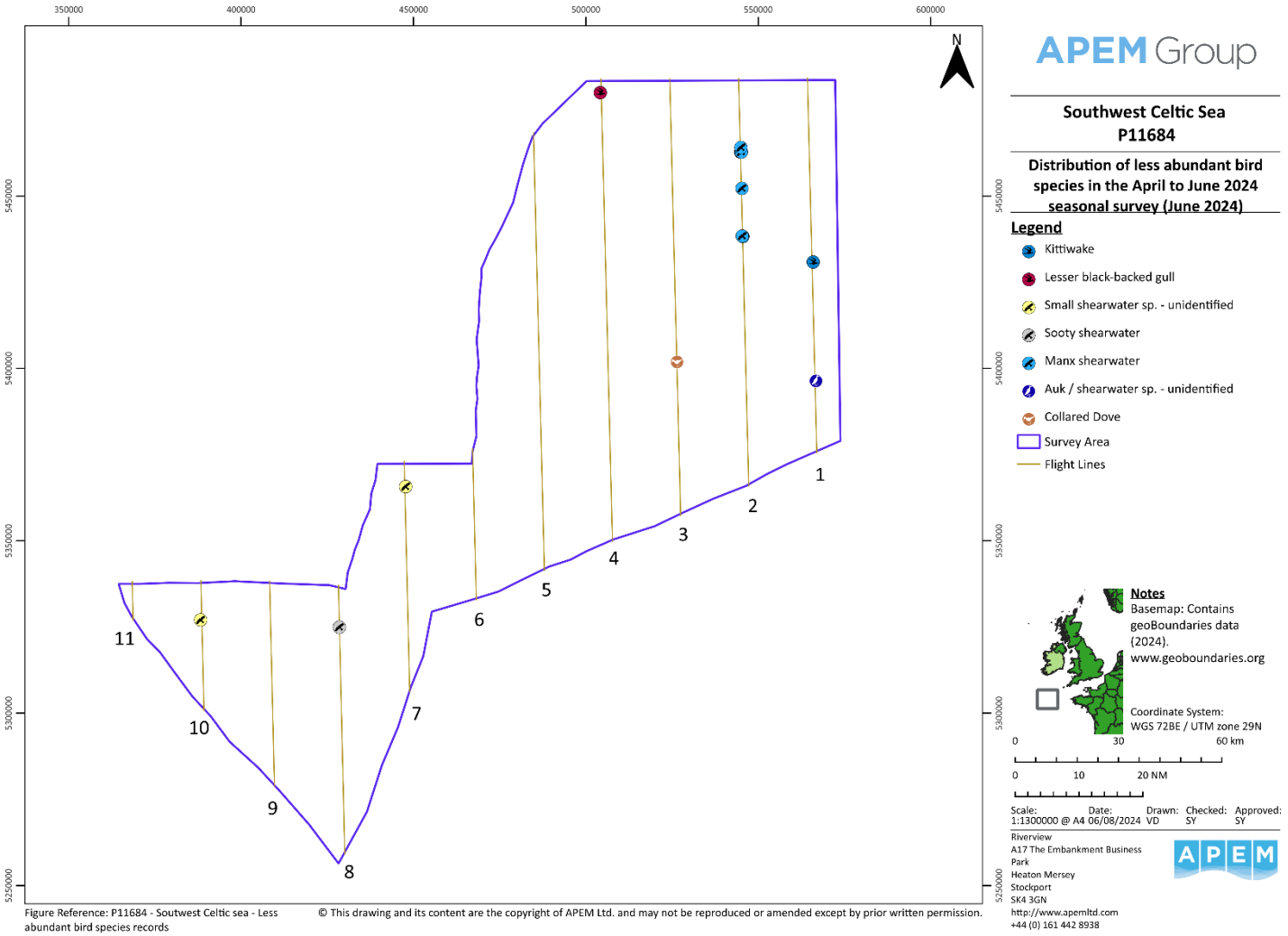

Figure 7 Distribution of less abundant bird species recorded in the April to June 2024 seasonal survey (June 2024).

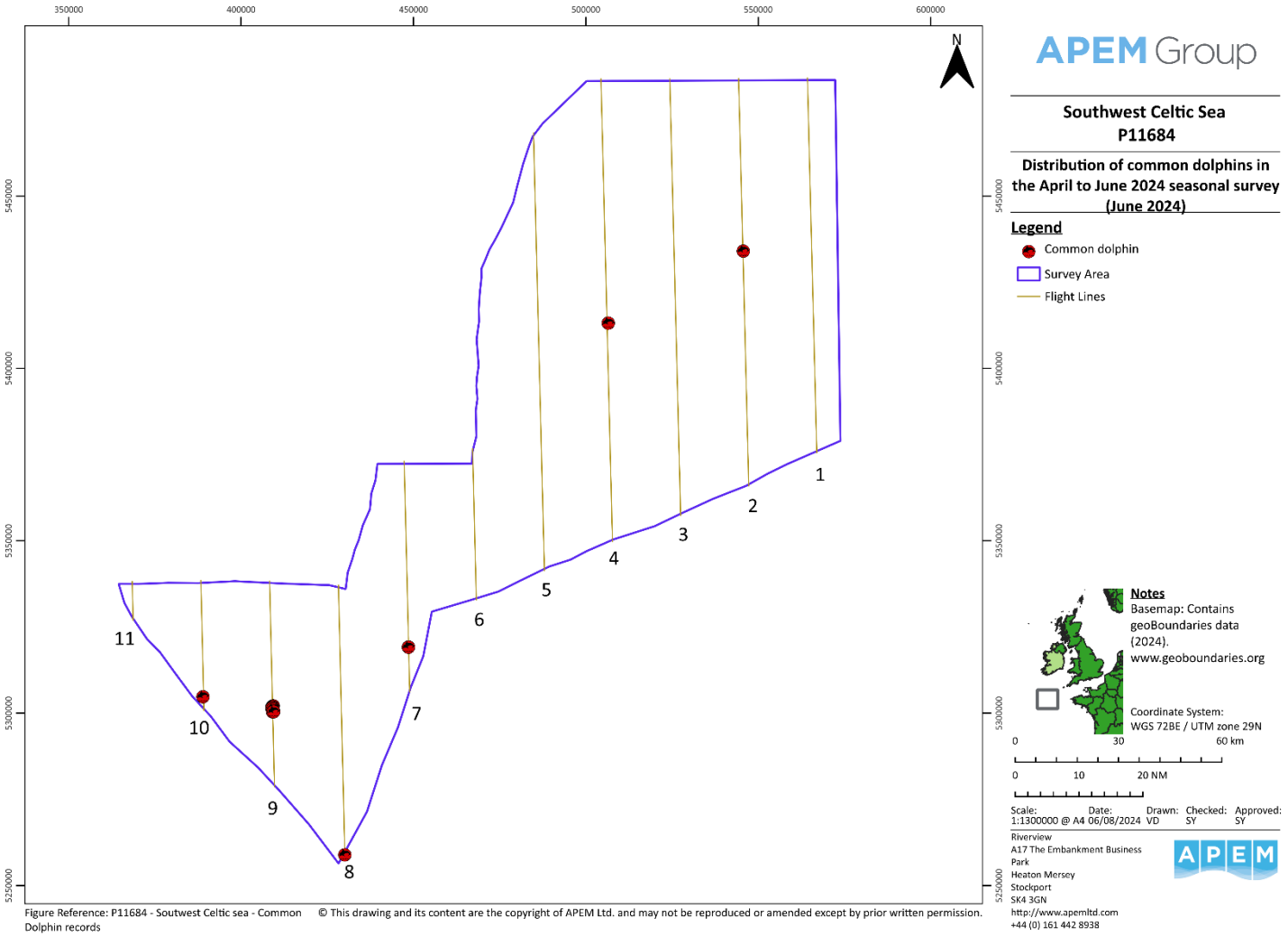

Figure 8 Common dolphin distribution recorded in the April to June 2024 seasonal survey (June 2024).

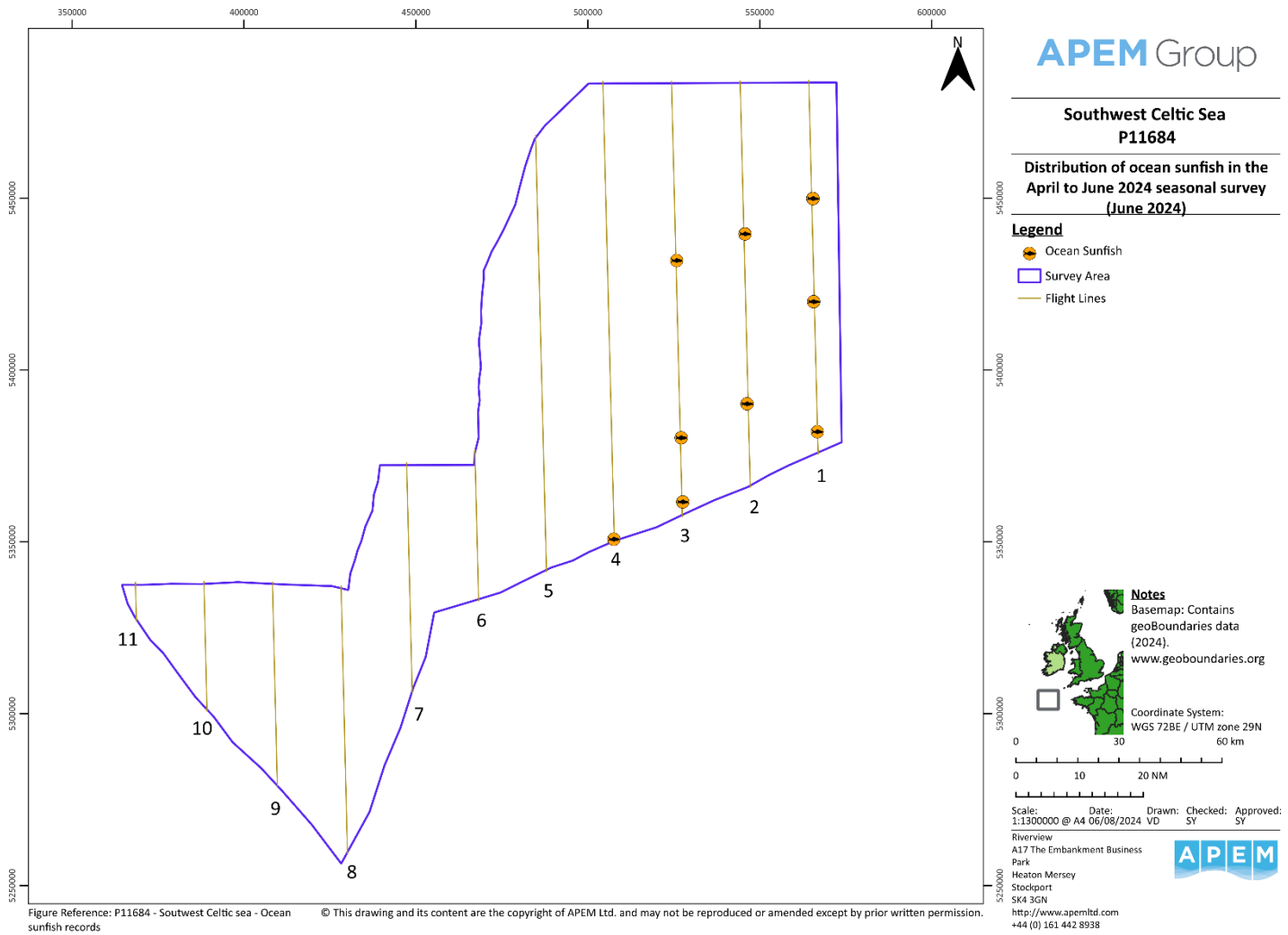

Figure 9 Ocean sunfish distribution recorded in the April to June 2024 seasonal survey (June 2024).

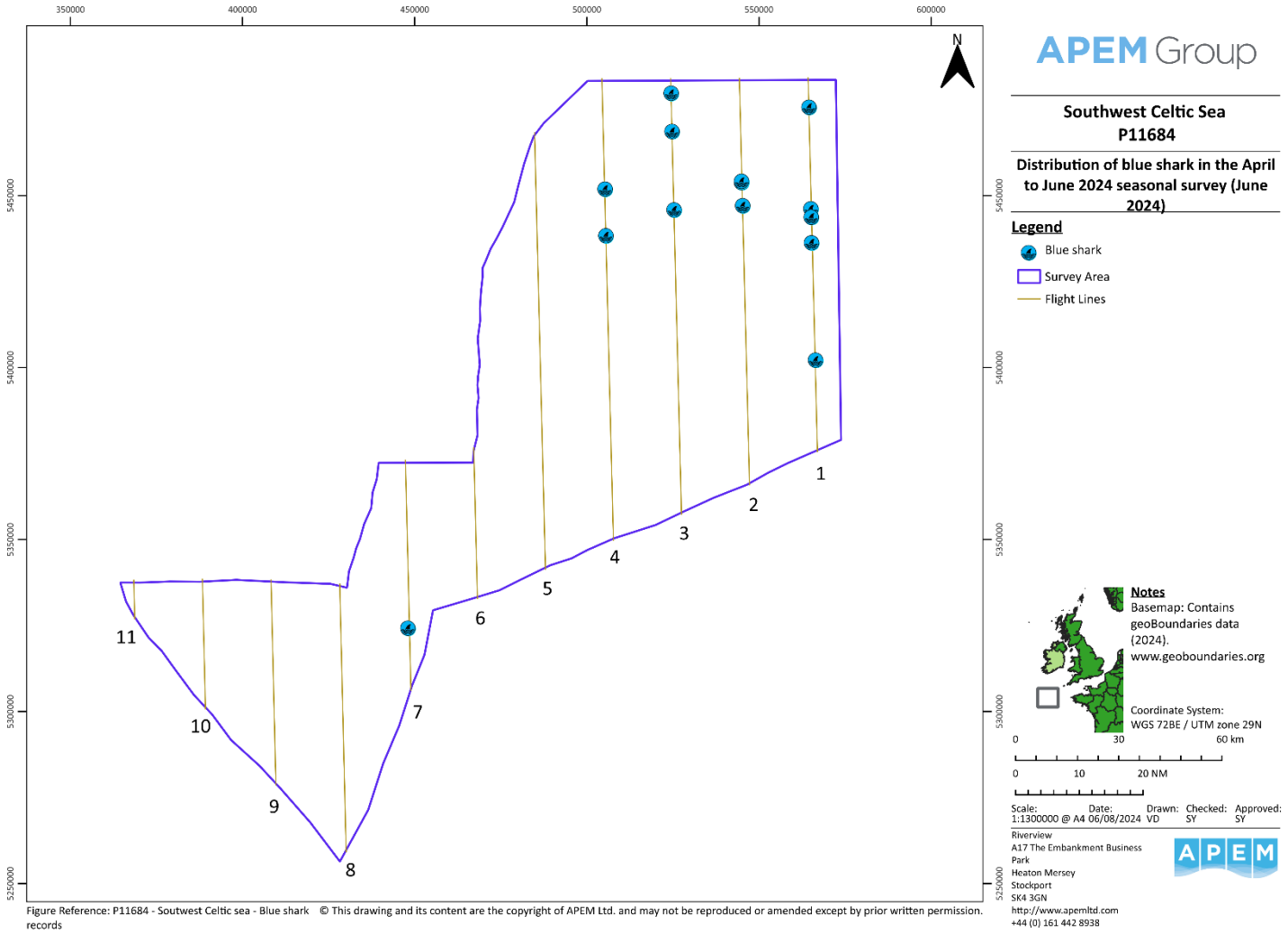

Figure 10 Blue shark distribution recorded in the April to June 2024 seasonal survey (June 2024).

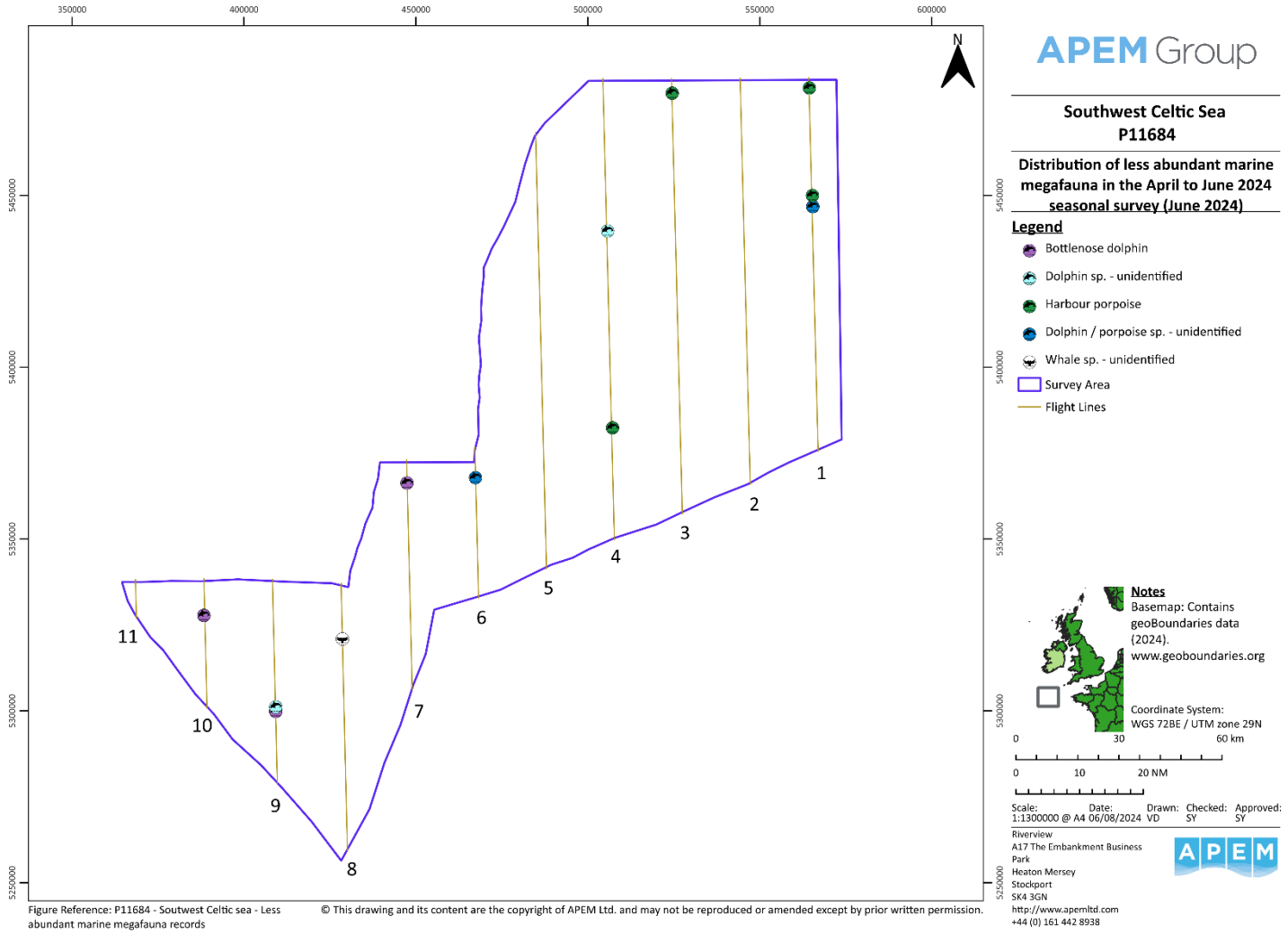

Figure 11 Distribution of less abundant marine megafauna recorded in the April to June 2024 seasonal survey (June 2024).

5. Abiotic Structures and Observations

No anthropogenic structures or vessels were observed from the aircraft or in the analysed imagery during the April to June 2024 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*
Fulmar	*Fulmarus glacialis*
Sooty Shearwater	*Ardenna grisea*
Manx Shearwater	*Puffinus puffinus*
Gannet	*Morus bassanus*
Collared Dove	*Streptopelia decaocto*
Common Dolphin	*Delphinus delphis*
Bottlenose Dolphin	*Tursiops truncatus*
Harbour Porpoise	*Phocoena phocoena*
Blue Shark	*Prionace glauca*
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.

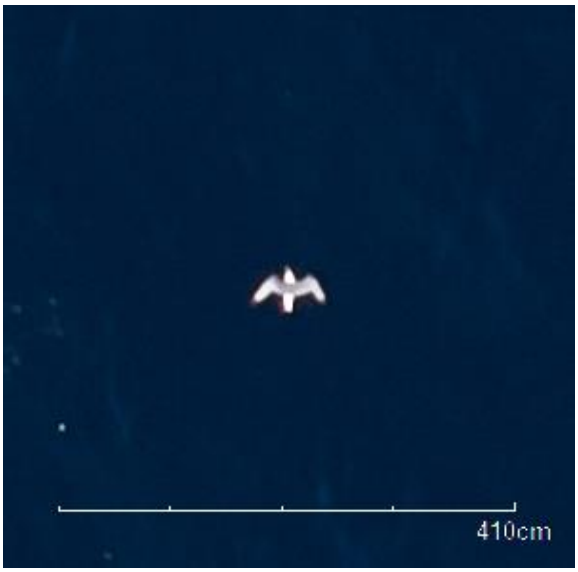

Figure 12 Kittiwake in flight.

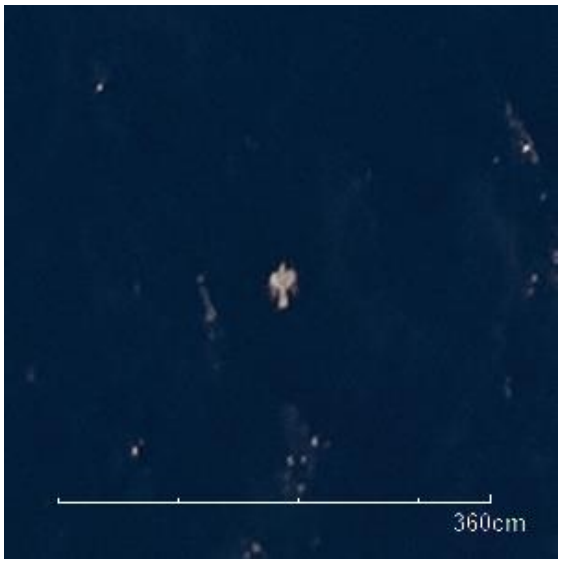

Figure 13 Collared dove in flight with wings folded against body.

Figure 14 Bottlenose dolphin surfacing.

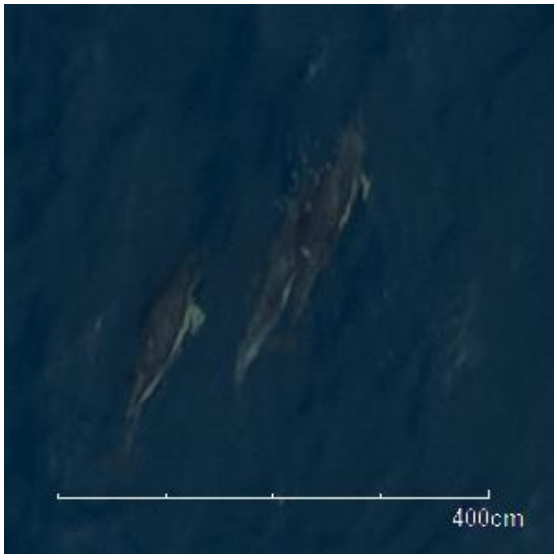

Figure 15 Small pod of common dolphins.

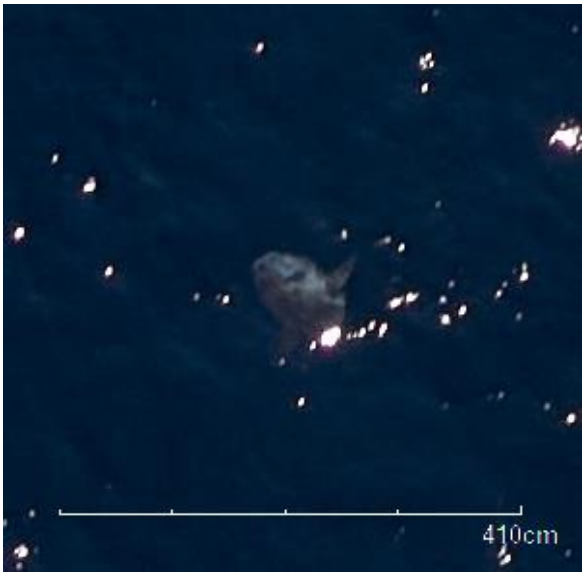

Figure 16 Submerged ocean sunfish with visible dorsal and anal fins.

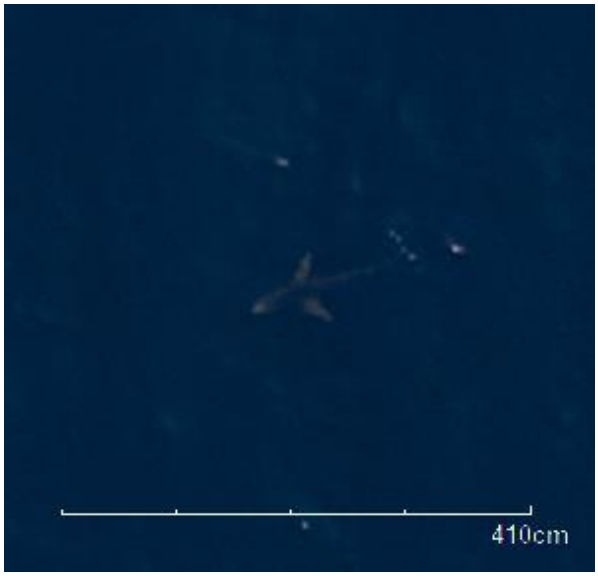

Figure 17 Blue shark in calm sea state.