Natural England

Ornithological and Marine Mammal Baseline Characterisation Surveys for the POSEIDON project

January – March (Seasonal) Report – Central North Sea

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COMMERCIAL IN CONFIDENCE

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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 February 2023 within the Central North 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 February 2023 with no safety issues. A total of 7,986 observations were recorded during the survey in February 2023, of which 7,795 were observations of birds and 191 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 Central North 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 North Sea to the east of Fraserburgh in the North and Bridlington in the South, bounded to the south-east by the Dogger Bank, (**Figure 1**) and covers an area of 42,050 square kilometres (km^2). The survey method has been designed to optimise the data collection for all bird, marine mammal, and other marine megafauna species using a transect-based survey design at 1.5-centimetre (cm) resolution 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 February 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.

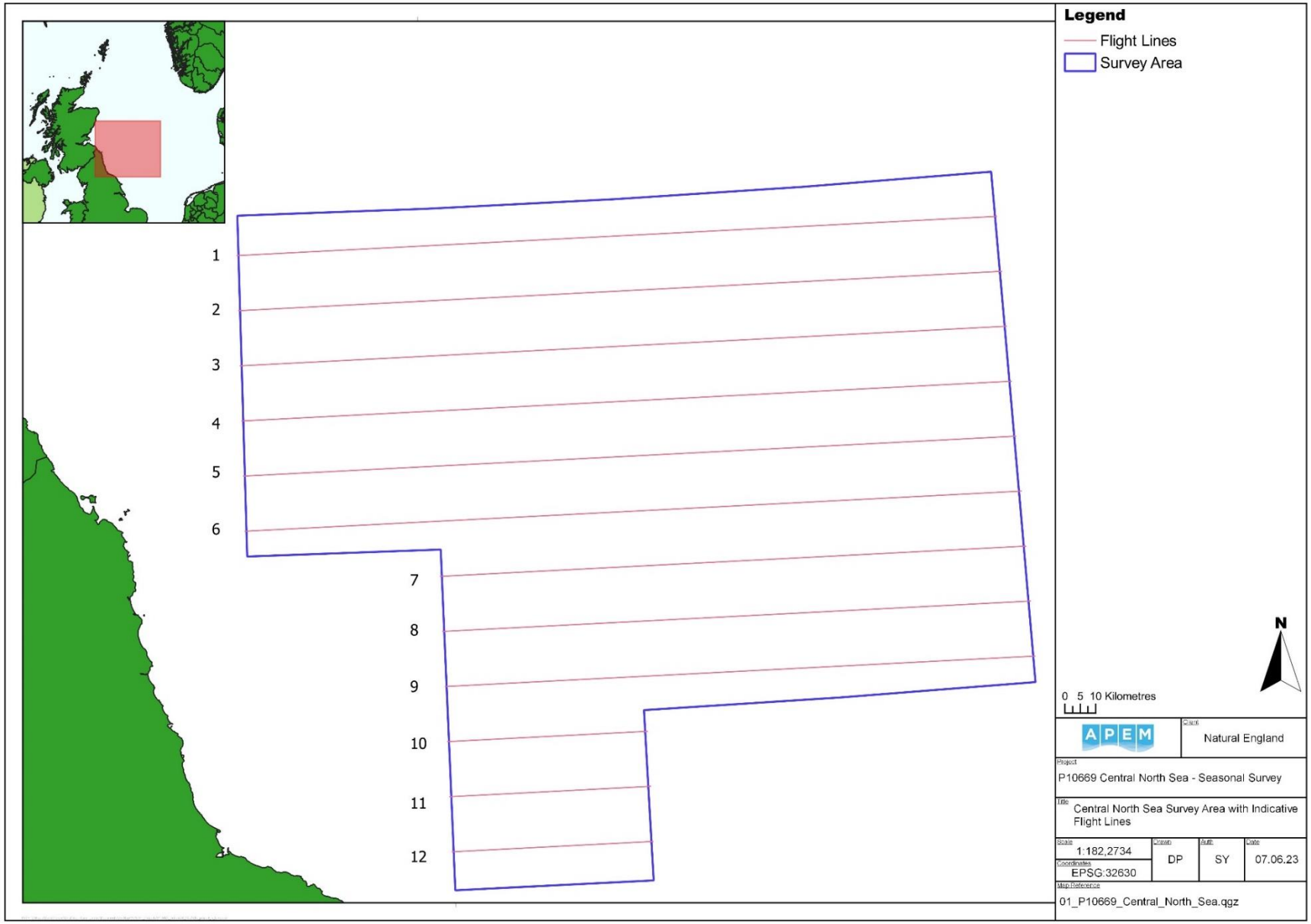

Figure 1 Location of Central North Sea survey area

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. An automatic cutout is installed to automatically stop imagery being taken should the aircraft stray further than a defined distance, either laterally or vertically, from the planned flight line (**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 flight plan tolerances and focus of the camera lenses ensures no discernible differences occur 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 flights occurred on the 26th and 27th of February. On 26th of February, two planes were used to survey lines 1 to 6, including a fuel stop by the aircraft (take off at 08:27 and 12:27, landing at 11:48 and 17:54), and 7 to 8 (take off at 10:15, landing at 13:05), respectively.

On 27th of February, one plane was used to survey lines 3 and 9 to 12 (take off at 10:41, landing at 15:46).

The camera system captured abutting imagery along 12 survey flight lines spaced approximately 18 km apart within the Survey Area (**Figure 1**). The total Survey Area was 42,050 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=12. A total of 15,951 nodes were initially captured. Of these, 15,842 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 3.56% retained images and 3.56% analysed, generated from 15,951 image nodes. Coverage of 3% was achieved including a redundancy of an additional 0.56%, 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 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 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 3.56%, thus exceeding the 3% coverage required, enabling sufficient coverage to be collected should images be affected by glint or glare. Glint or glare was present approximately 16% of images during this survey. Whilst the presence of glare may make target identification a slower process, only the most severe glare impacts ID rates.

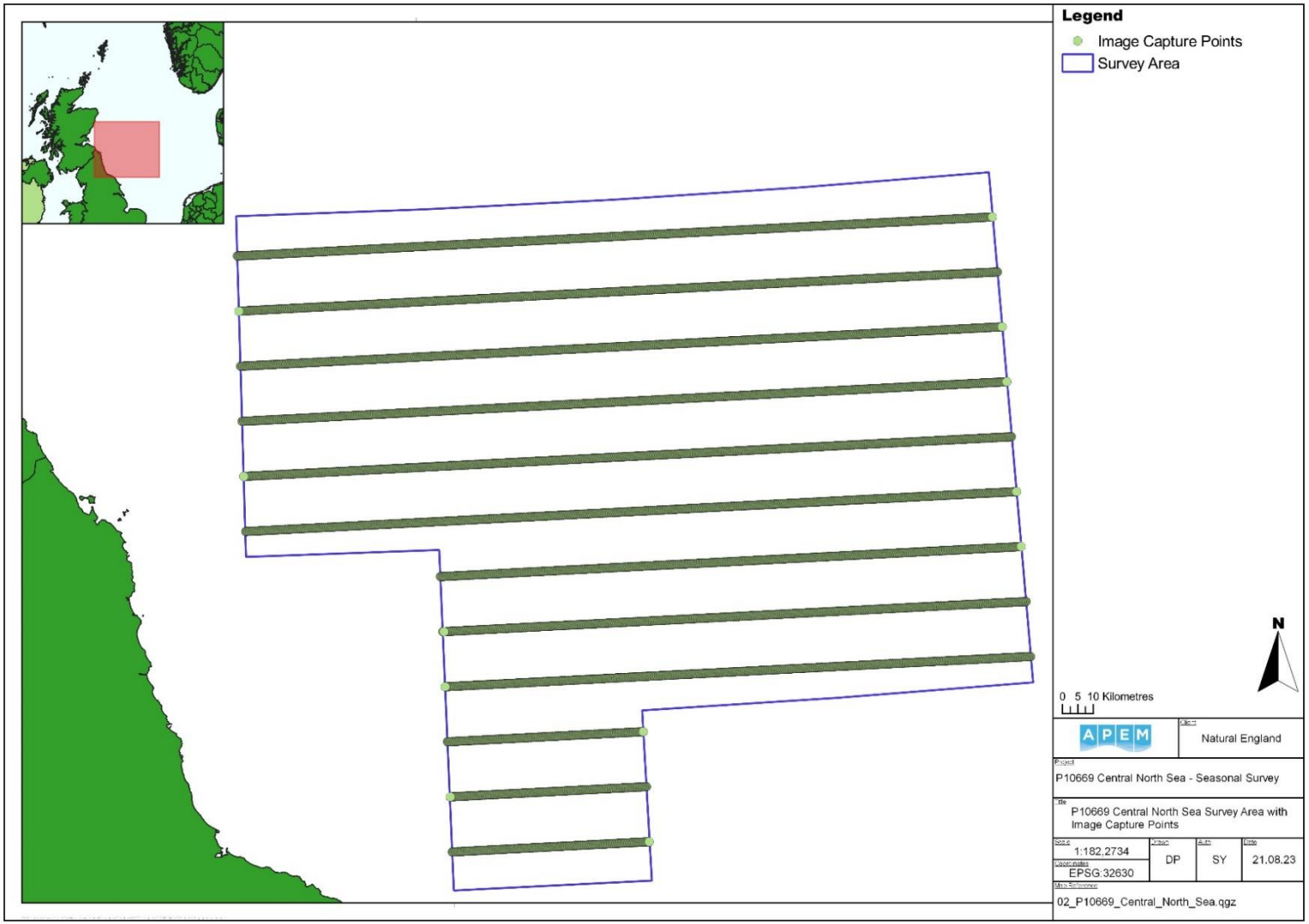

Figure 2 Individual image capture points during the January to March 2023 (February 2023) survey

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 (February 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	247.00	3	1,736	1,729	-	-	Two rigs nearby	-
2	248.14	3	1,744	1,737	-	-	-	-
3**	248.99	3	1,751	1,744	Space issue on drive, dark images	Rainbow in imagery	-	-
4	250.14	3	1,759	1,751	-	-	-	-
5	250.99	3	1,765	1,758	-	-	-	-
6	252.14	3	1,774	1,765	-	-	-	-
7	189.79	3	1,338	1,330	-	Occasional glare	-	-
8	190.78	3	1,343	1,336	-	-	-	-
9	191.34	3	1,348	1,341	-	-	-	-
10	64.05	3	475	449	-	-	-	-
11	64.19	3	459	450	-	-	-	-
12	64.49	3	459	452	-	-	-	-

*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.

**There were space issues on the camera drive on the initial line 3 survey attempt, and the drive was changed. There were two attempts on the 26th of February, but the line was not completed and had dark images. The issue was resolved, and due to incoming bad weather, the line was resurveyed to ensure coverage on the following day (27th of February). All details for line 3 within this report refer to the successful resurvey.

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

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	26/02/2023	09:01 / 10:06	122	20-45	20	3	18	35°	3	2
2	26/02/2023	10:12 / 11:16	122	20	20	3	21	30°	3	2
3	27/02/2023	11:18 / 12:04	124	99	10	3	17	30°	2-3	2
4	26/02/2023	15:10 / 16:12	128	40-80	20	2	15	45°	2-3	2-3
5	26/02/2023	14:00 / 15:04	123	35-80	20-25	3	17	20°	3	2-3
6	26/02/2023	12:49 / 13:55	120	20-85	20	3	19	30°	2-3	2
7	26/02/2023	10:48 / 11:37	125	0-10	25+	4	15	20°	2	1-2
8	26/02/2023	11:44 / 12:33	125	0-50	25+	4	19	20°	1	1
9	27/02/2023	12:51 / 13:40	118	80-90	10	4	10	30°	3	2-3
10	27/02/2023	13:45 / 14:02	137	85-90	10	3	20	40°	3	2-3
11	27/02/2023	14:07 / 14:24	132	65	10	4	17	30°	2-3	2-3
12	27/02/2023	14:29 / 14:46	120	65	10	4	17	45°	3	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	*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 higher-level taxonomic groups for the January to March 2023 seasonal survey period (February 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="3" rowspan="2">Small Gull species</td><td rowspan="11">Unidentified Bird species</td></tr>
<tr><td>Common Gull</td></tr>
<tr><td>Great Black-backed Gull</td><td rowspan="2">Black-backed Gull species</td><td rowspan="3">Large Gull species</td><td rowspan="3">Gull species</td></tr>
<tr><td>Lesser Black-backed Gull</td></tr>
<tr><td>Herring Gull</td><td colspan="2"></td></tr>
<tr><td>Guillemot</td><td rowspan="2">Guillemot and / or Razorbill</td><td rowspan="3">Auk species</td><td rowspan="4">Diver species</td></tr>
<tr><td>Razorbill</td></tr>
<tr><td>Puffin</td><td colspan="2"></td></tr>
<tr><td>Great Northern Diver</td><td colspan="3"></td></tr>
<tr><td>Fulmar</td><td colspan="3">Fulmar / Gull species</td></tr>
<tr><td>Gannet</td><td colspan="4"></td></tr>
</table>

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

Species	Group Level 1	Group Level 2	Group Level 3	Group Level 4
Grey Seal	Seal species			Unidentified Marine Mammal species
White-beaked Dolphin	Dolphin species		Dolphin / Porpoise species	
Harbour Porpoise				

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 a 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 90%. 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. Prior to QA, a total of 8,587 snags were identified.

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 bird measurements (based on reference lengths taken from the literature), 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

[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.

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 7,795 birds were recorded in the Survey Area during the January – March 2023 seasonal (February 2023) survey. Of those, 5,851 were sitting on the water, 1,940 were in flight and 4 were deceased (**Table 7).** A total of 191 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 (February 2023)

Species Group	Species	Flying	Sitting	Deceased	Total
Gulls	Kittiwake	592	327	-	919
	Common Gull	1	-	-	1
	Small Gull species	-	1	-	1
	Great Black-backed Gull	30	38	-	68
	Herring Gull	3	6	-	9
	Large Gull species	1	10	-	11
	Lesser Black-backed Gull	1	3	-	4
	Black-backed Gull species	-	2	-	2
	Gull species	1	-	-	1
Auk	Guillemot	262	3,716	-	3,978
	Guillemot / Razorbill	7	362	-	369
	Razorbill	65	278	-	343
	Puffin	1	257	-	258
	Auk species	1	63	-	64
Diver	Great Northern Diver	-	2	-	2
Great Northern / White-billed Diver	Great Northern / White-billed Diver	-	1	-	1
Fulmar	Fulmar	926	710	-	1,636
Fulmar / Gull	Fulmar / Gull species	2	33	1	36
Gannet	Gannet	46	36	1	83
Unidentified Bird species	Unidentified Bird species	1	6	2	9
Total		**1,940**	**5,851**	**4**	**7,795**

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

Species Group	Species	Submerged	Surfacing	Deceased	Total
Seal	Grey Seal	9	22	-	31
	Seal species	5	5	-	10
Dolphin / Porpoise	Dolphin / Porpoise	15	-	-	15
Dolphin	White-beaked Dolphin	28	2	-	30
Porpoise	Harbour Porpoise	71	31	-	102
Marine Mammal species	Marine Mammal species	1	2	-	3
Total		**129**	**62**	**0**	**191**

4.2 Spatial Distribution

Figure 3 and **Figure 4** show the location of birds and marine megafauna, respectively, recorded in the Survey Area. Birds were recorded across the Survey Area, although with lower numbers observed in the south. Marine megafauna species were also recorded throughout the Survey Area, but with lower numbers in the north-east. **Figure 5** to **Figure 14** show distributions of more abundant birds by species, whilst **Figure 15** shows the distribution of less frequently recorded bird species**. Figure 16** and **Figure 17** show the distribution of grey seals and harbour porpoise, respectively, within the Survey Area, and **Figure 18** shows distributions of less frequently recorded marine megafauna by species.

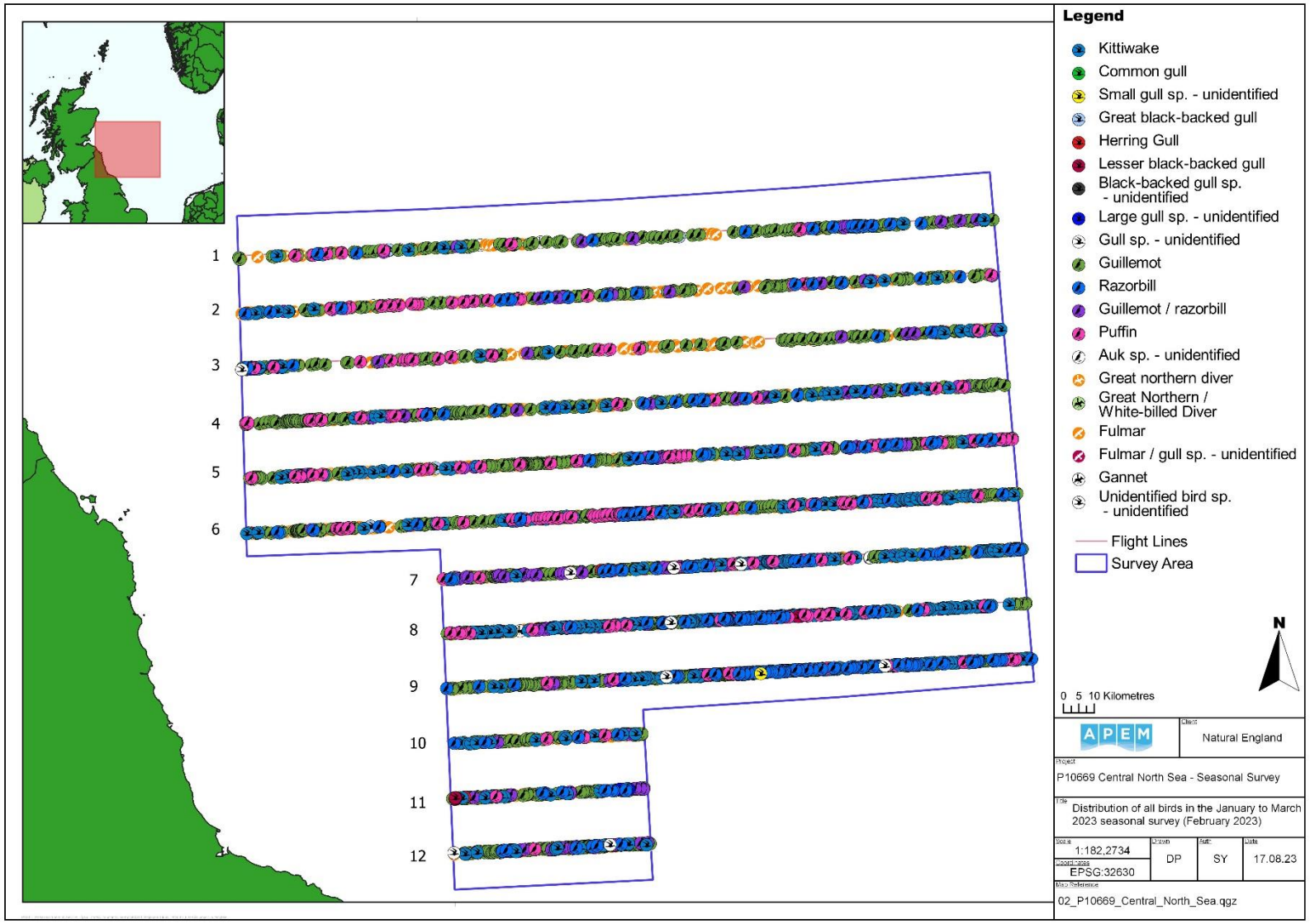

Figure 3 Distribution of all birds recorded in the January to March 2023 seasonal survey (February 2023).

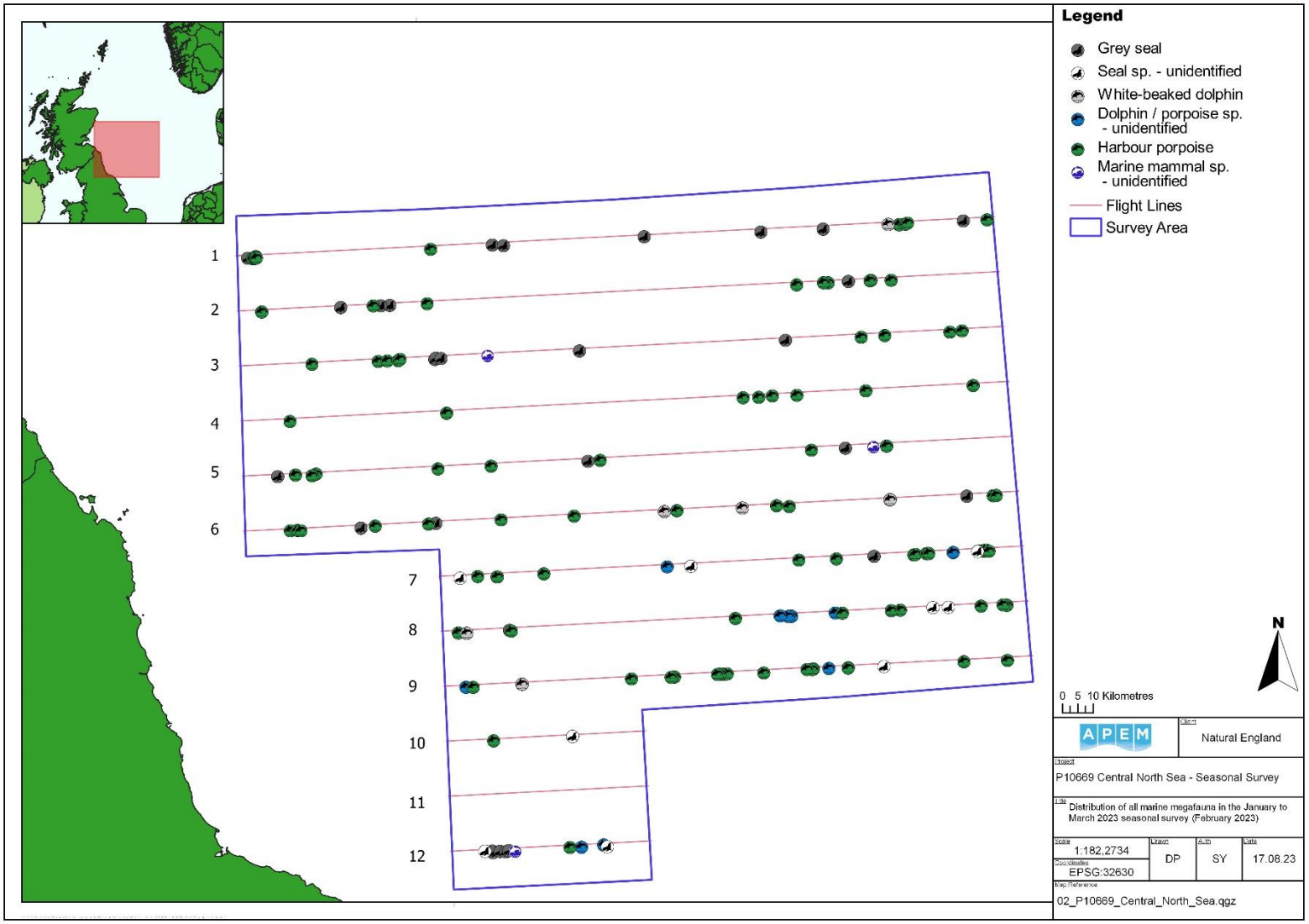

Figure 4 Distribution of all marine megafauna recorded in the January to March 2023 seasonal survey (February 2023).

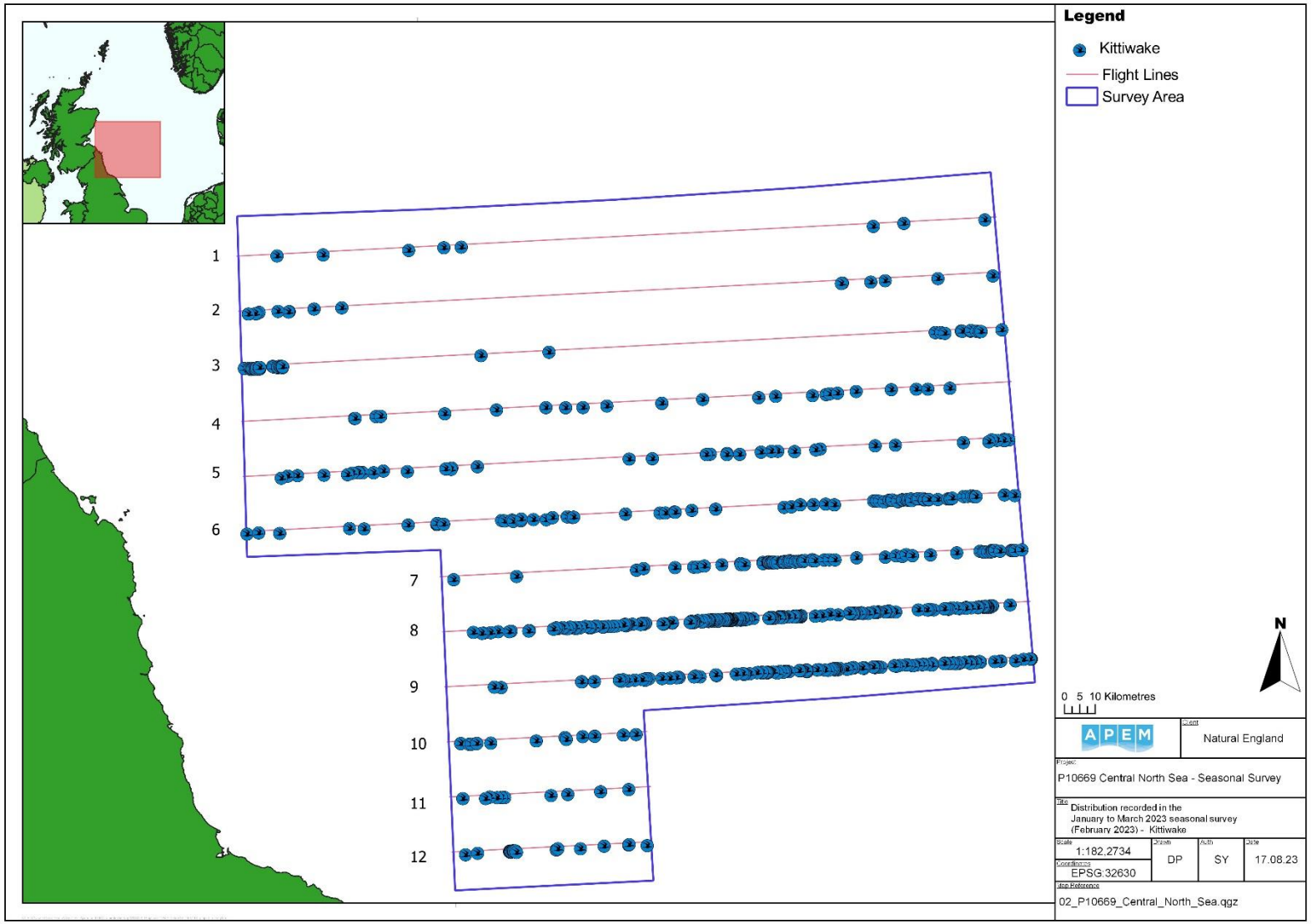

Figure 5 Kittiwake distribution recorded in the January to March 2023 seasonal survey (February 2023).

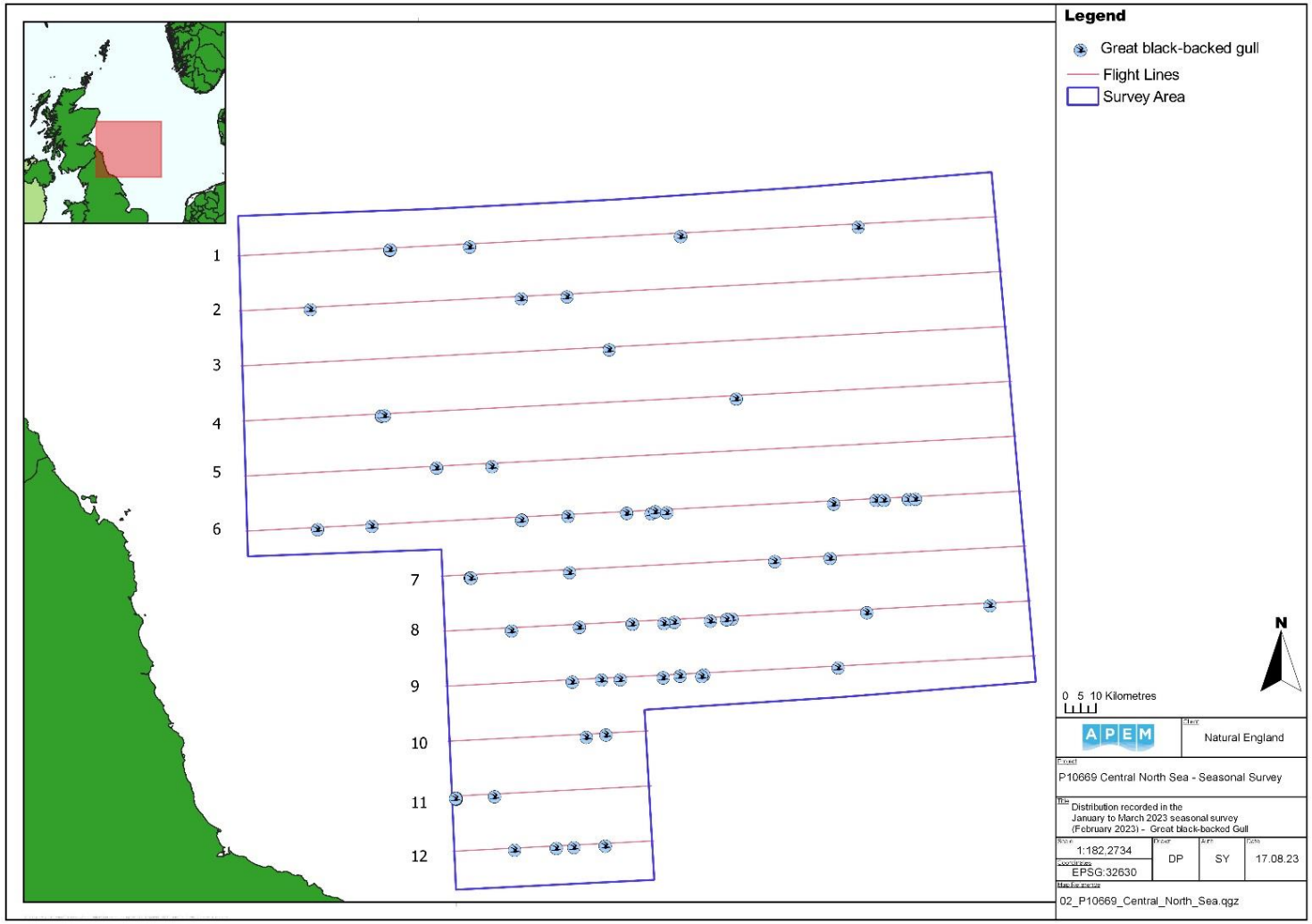

Figure 6 Great black-backed Gull distribution recorded in the January to March 2023 seasonal survey (February 2023).

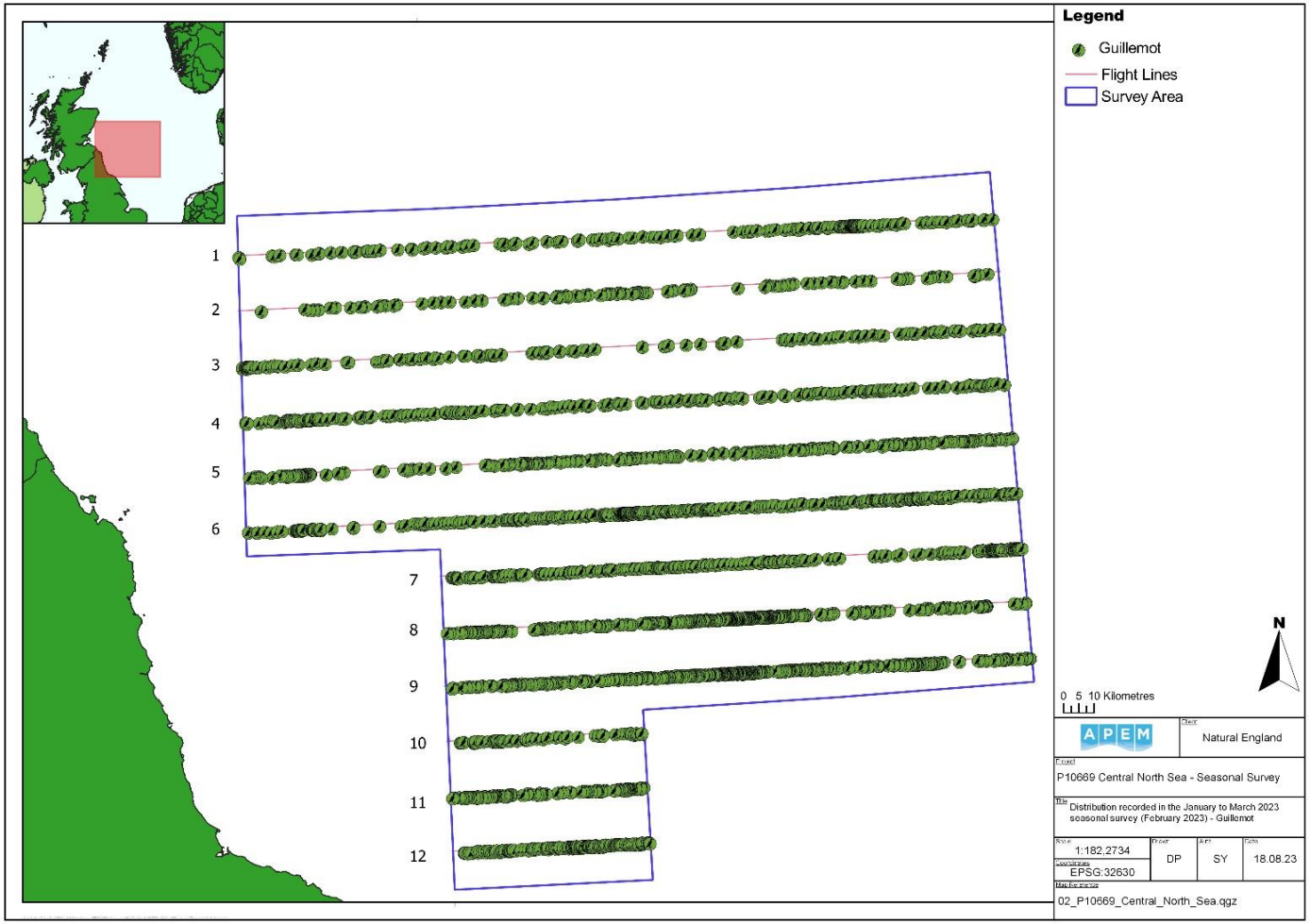

Figure 7 Guillemot distribution recorded in the January to March 2023 seasonal survey (February 2023).

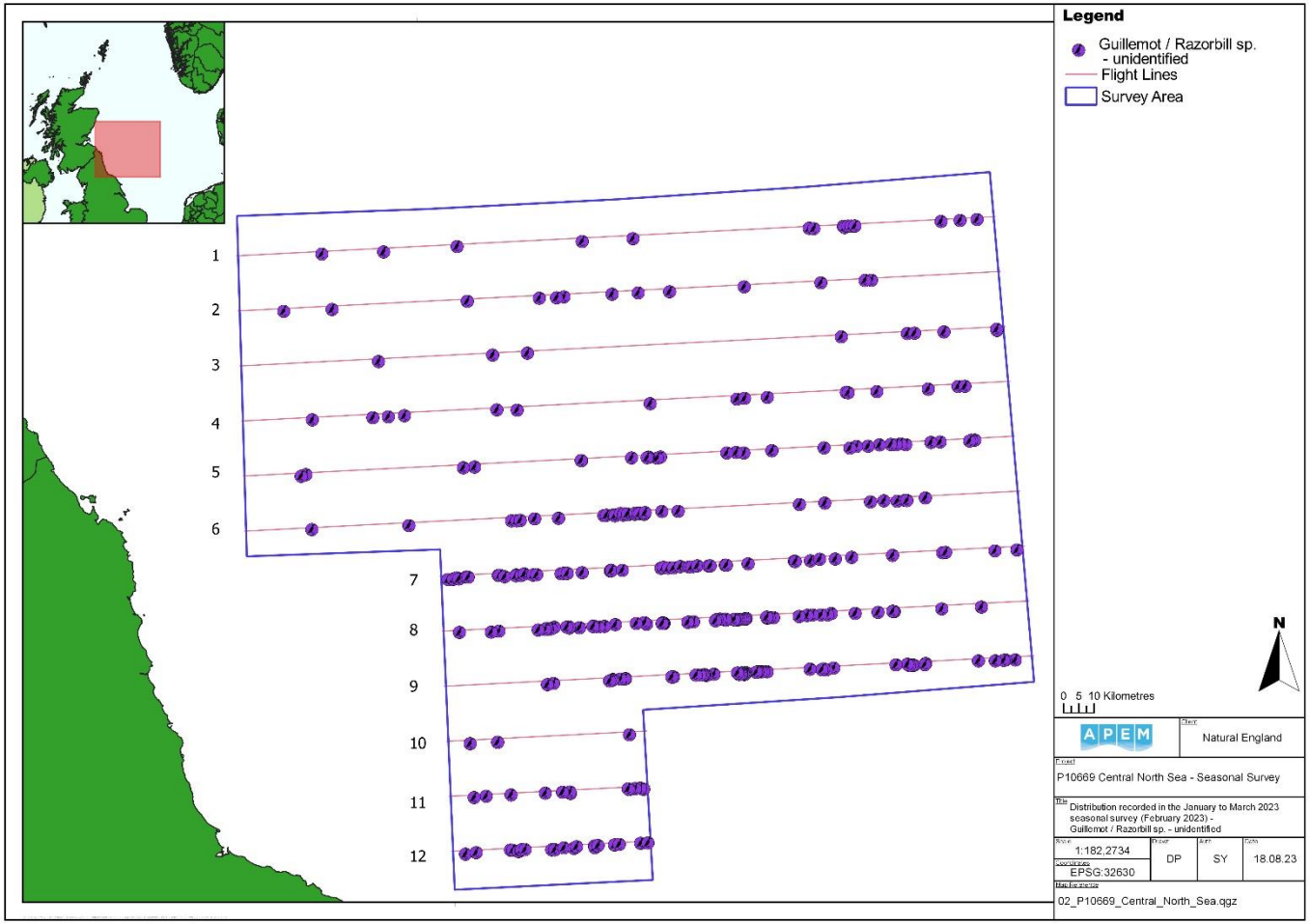

Figure 8 Unidentified guillemot / razorbill distribution recorded in the January to March 2023 seasonal survey (February 2023).

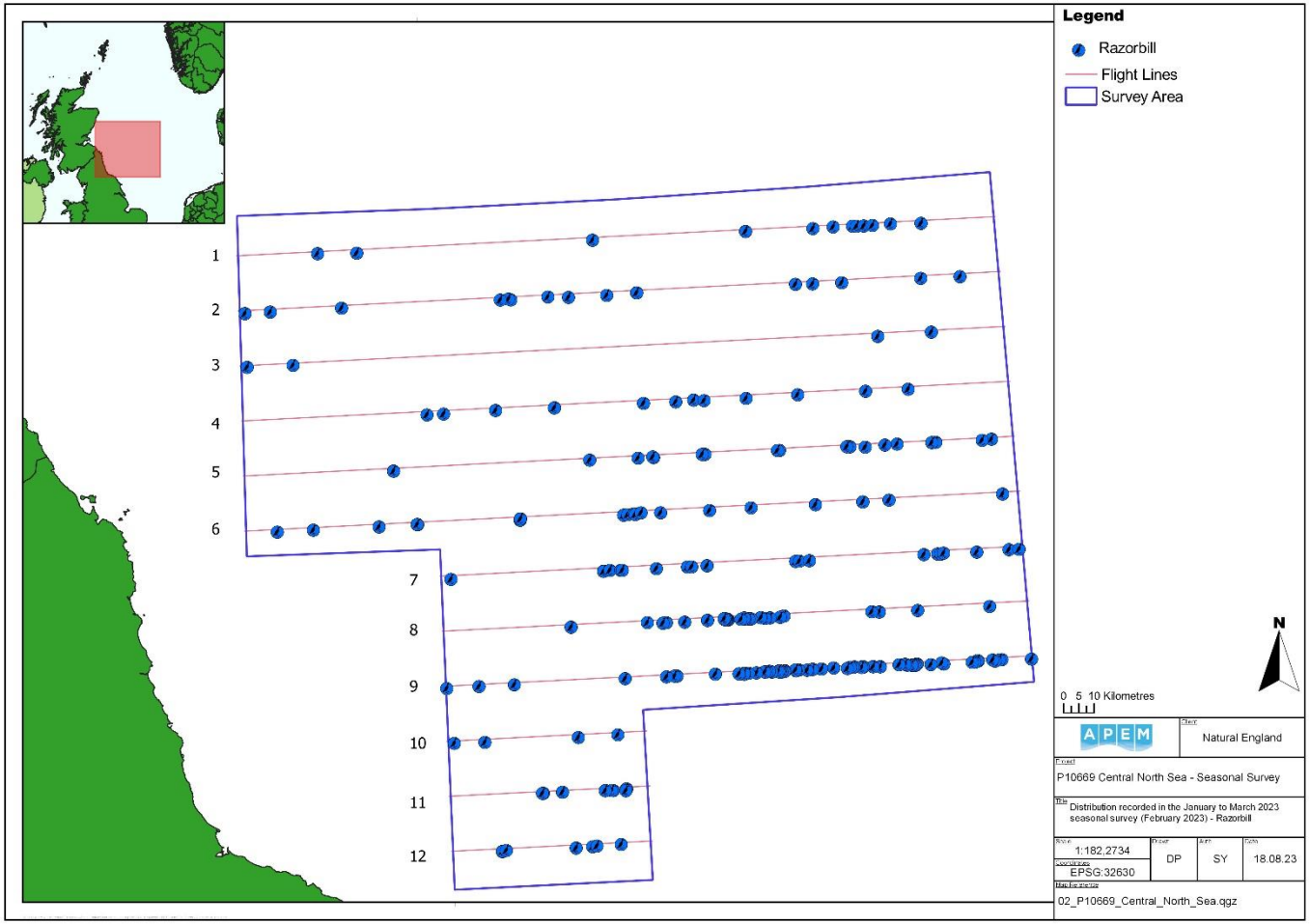

Figure 9 Razorbill distribution recorded in the January to March 2023 seasonal survey (February 2023).

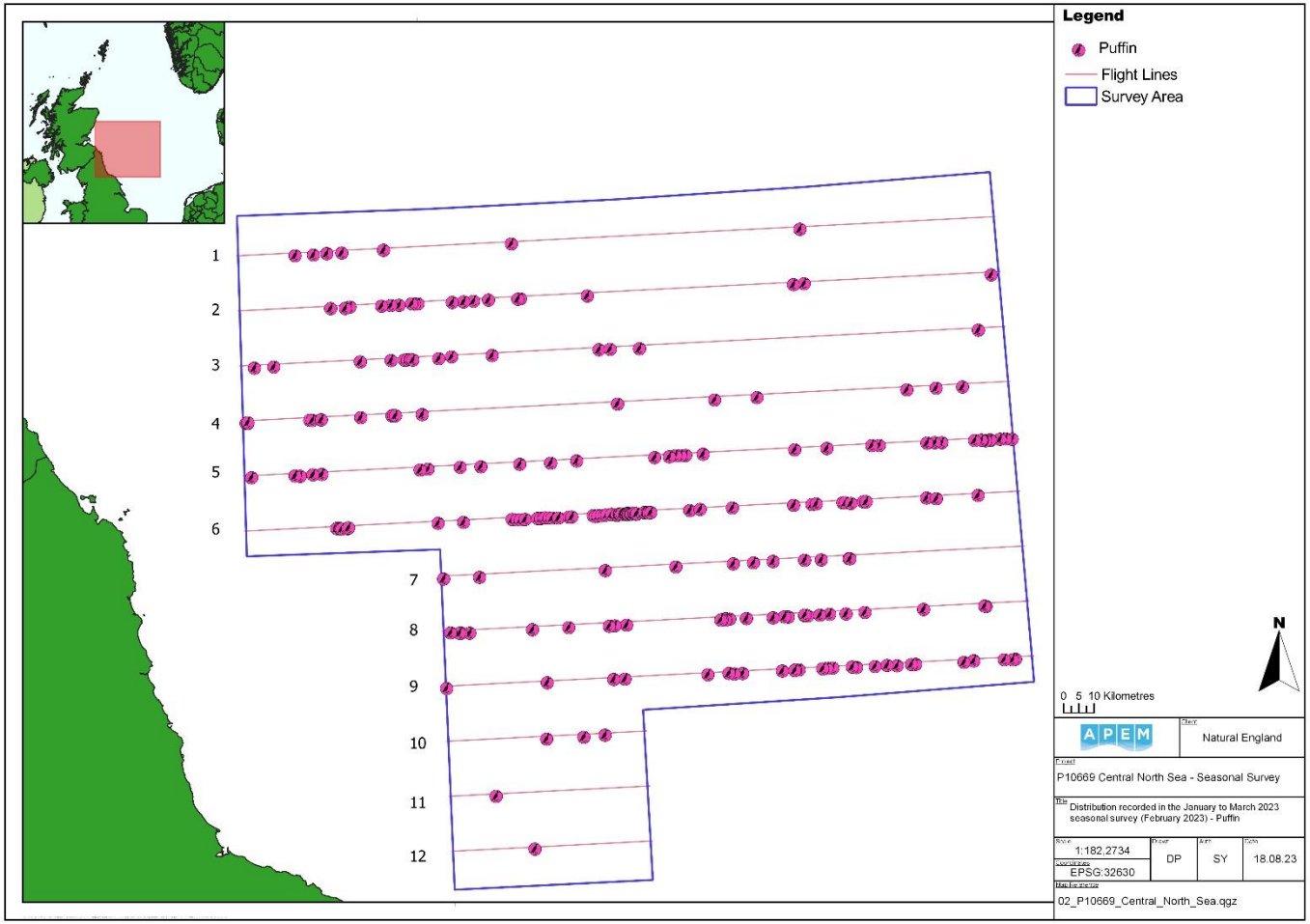

Figure 10 Puffin distribution recorded in the January to March 2023 seasonal survey (February 2023).

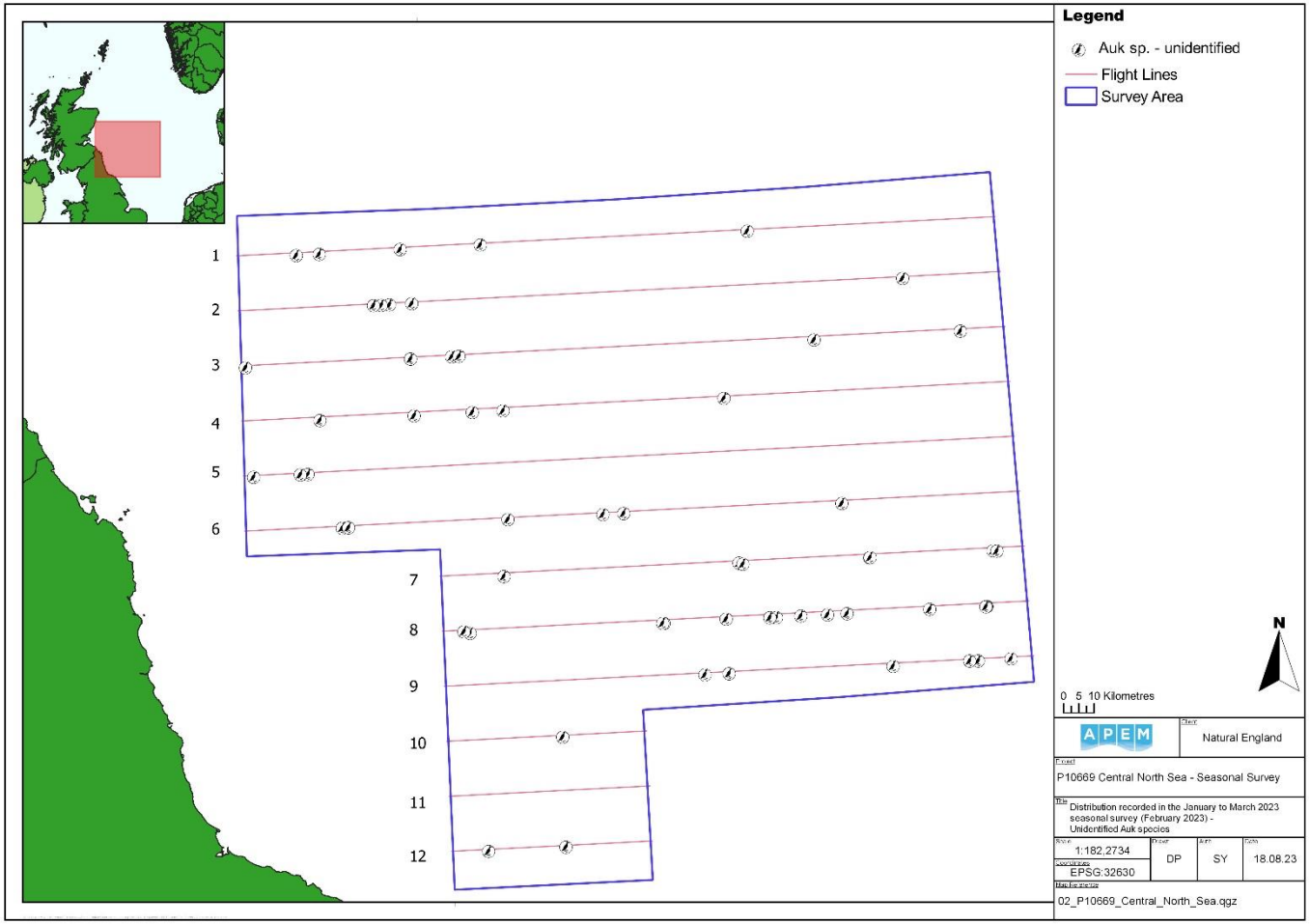

Figure 11 Unidentified auk species distribution recorded in the January to March 2023 seasonal survey (February 2023).

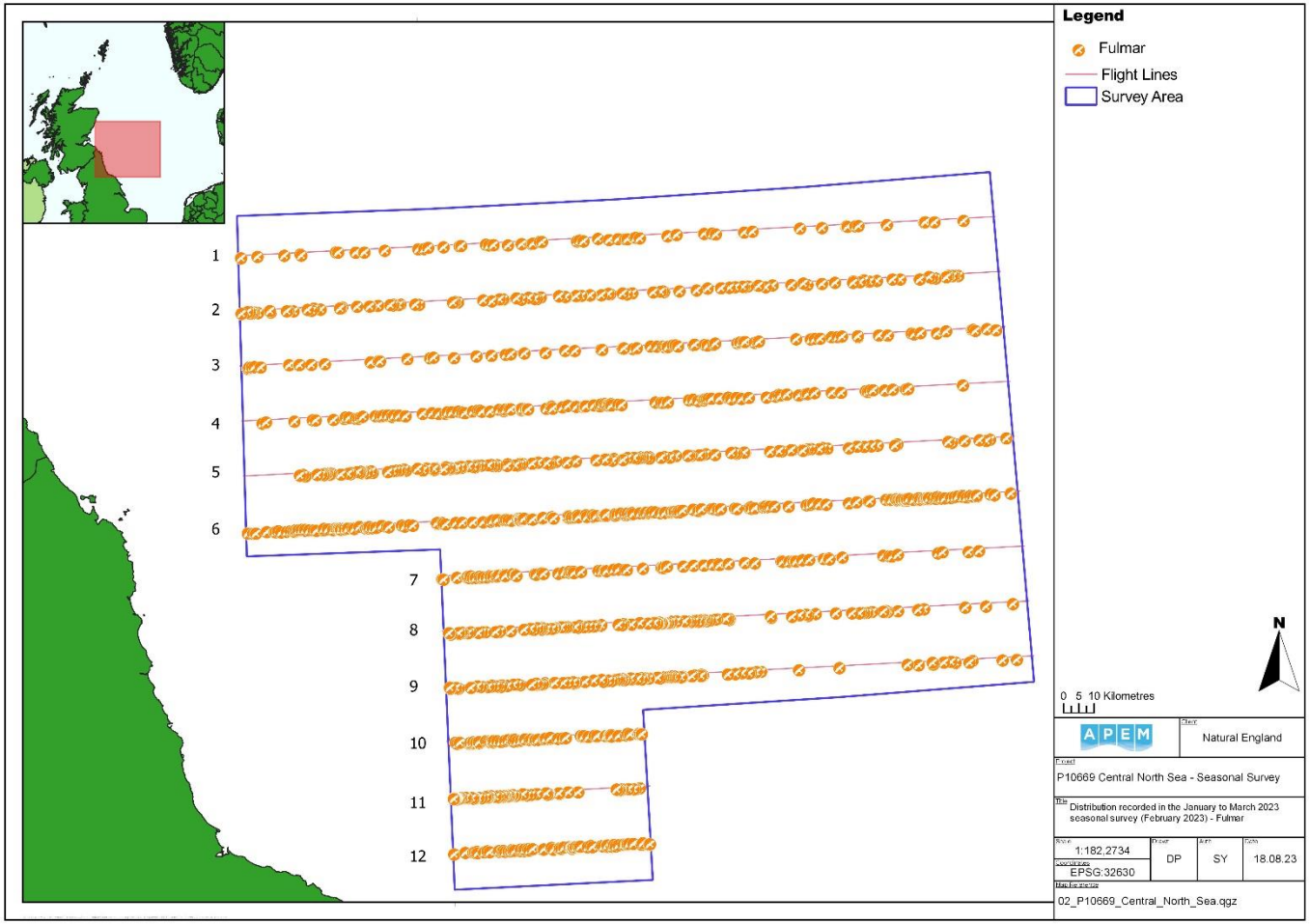

Figure 12 Fulmar distribution recorded in the January to March 2023 seasonal survey (February 2023).

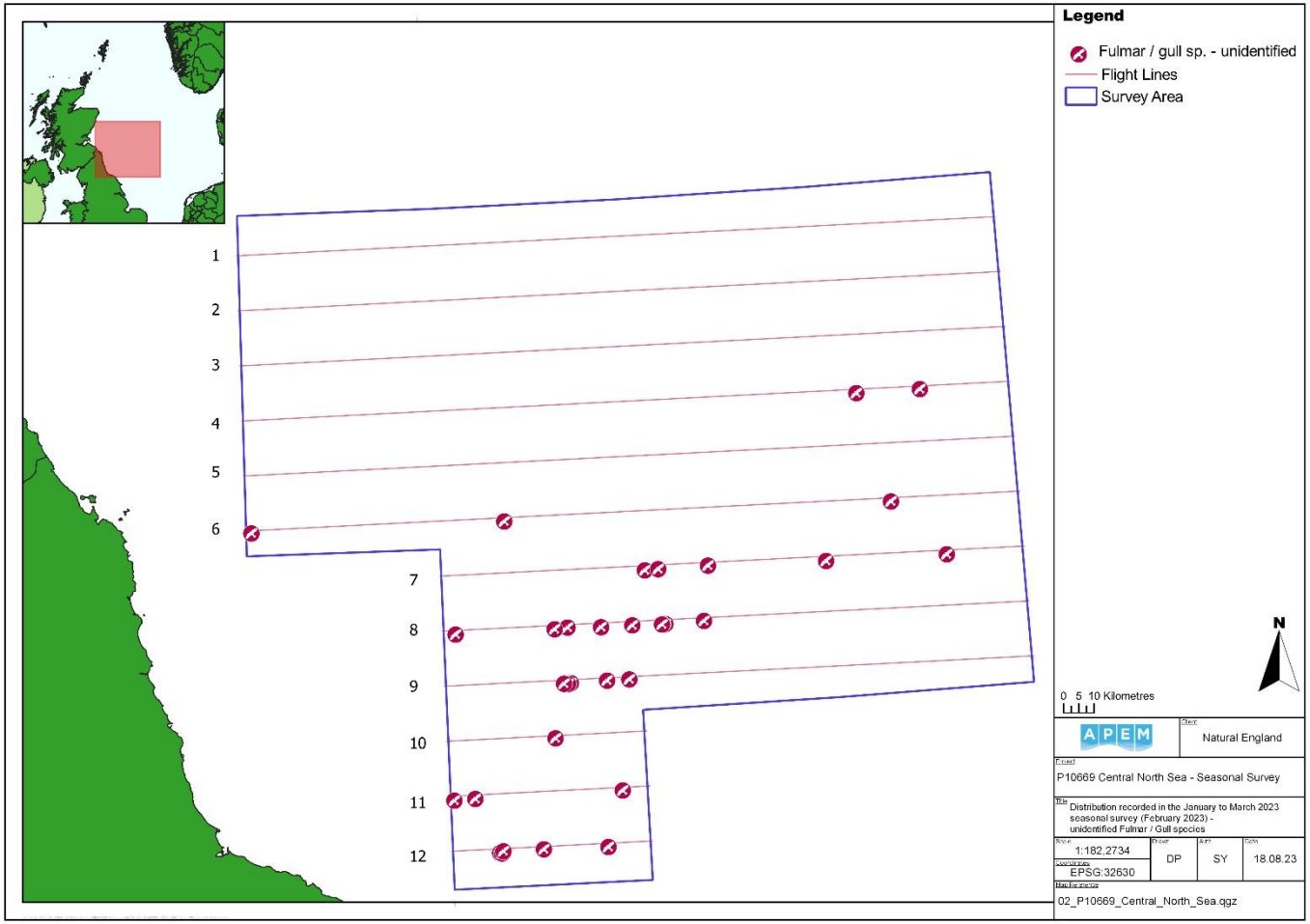

Figure 13 Unidentified fulmar / gull species distribution recorded in the January to March 2023 seasonal survey (February 2023).

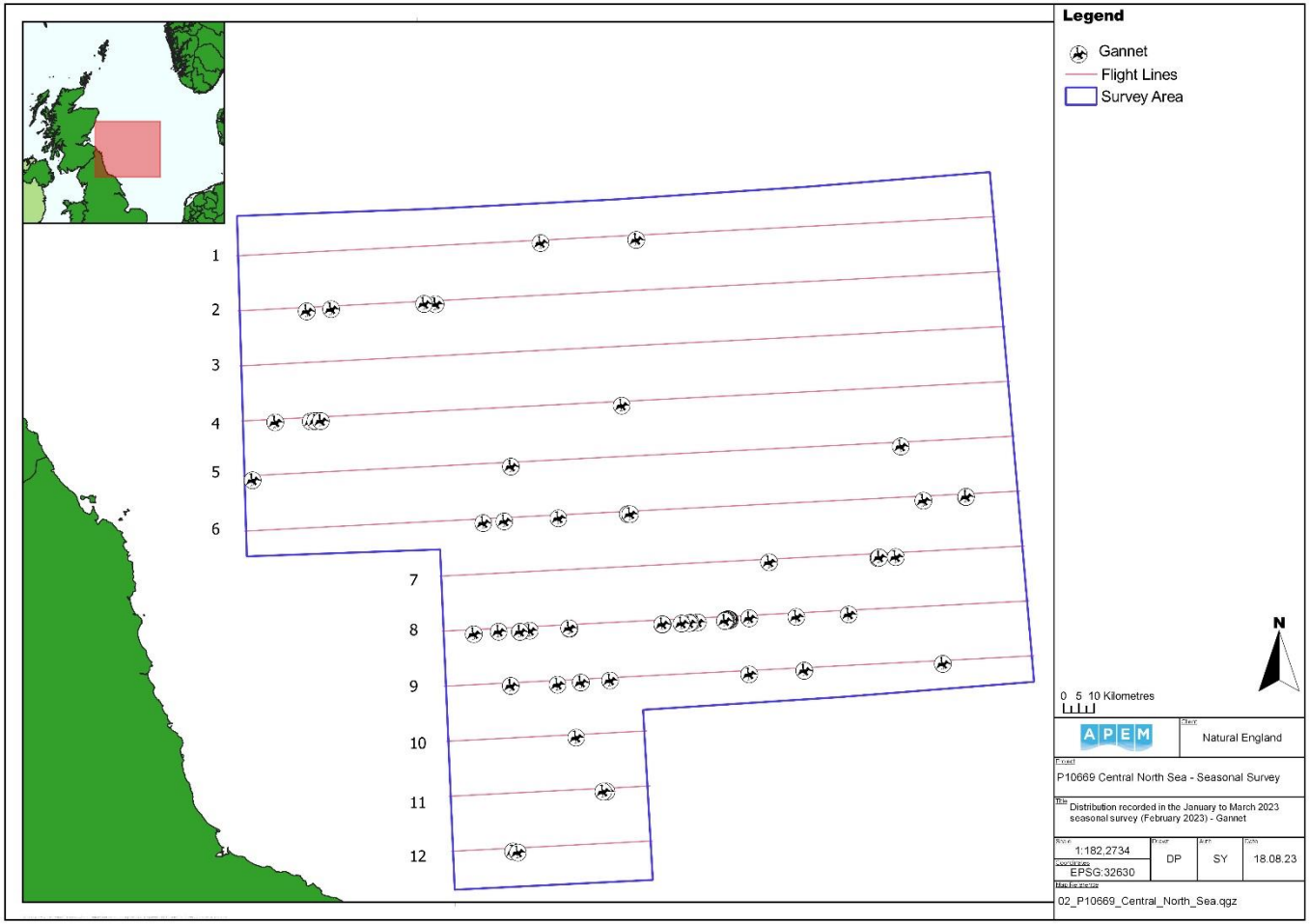

Figure 14 Gannet distribution recorded in the January to March 2023 seasonal survey (February 2023).

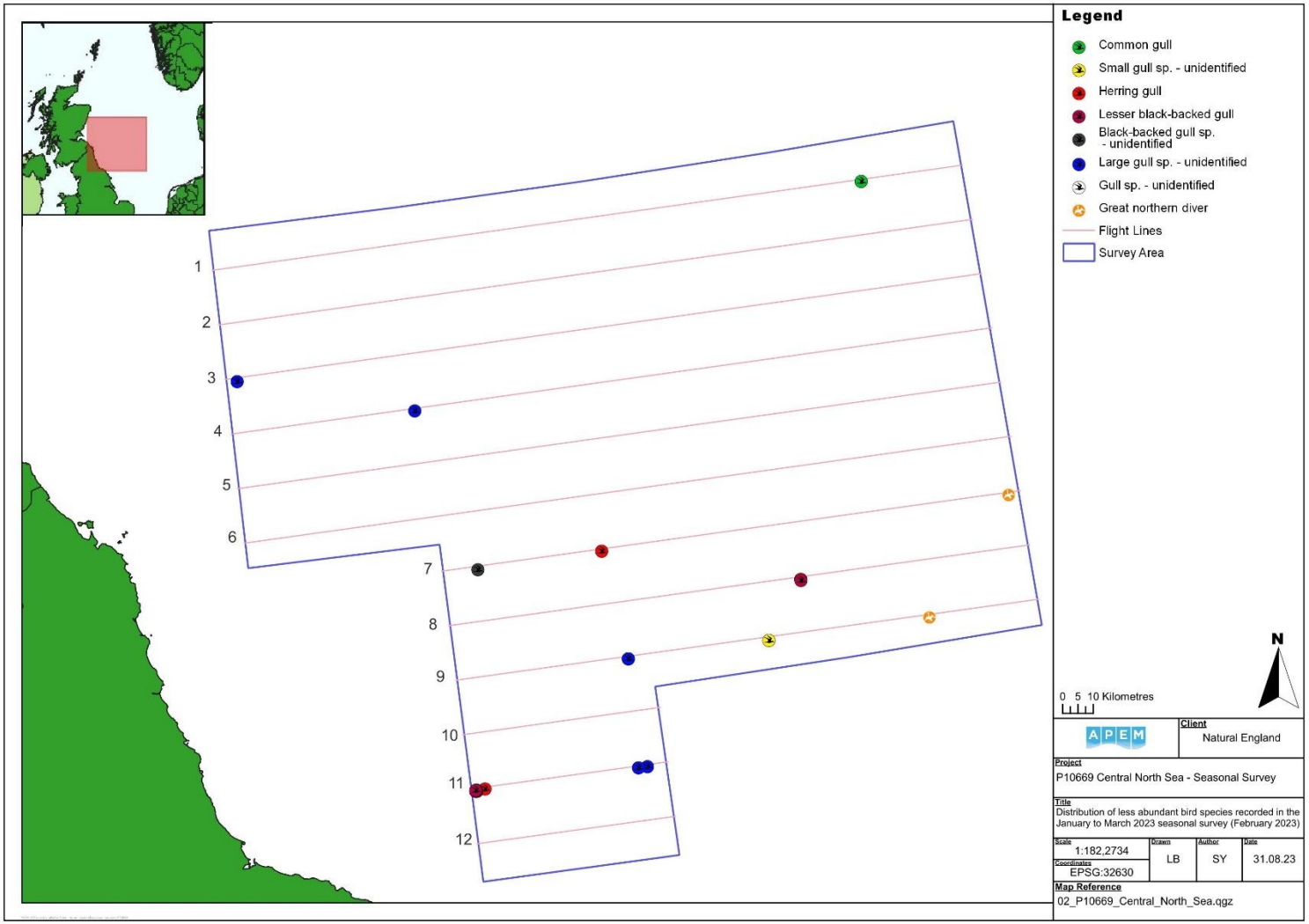

Figure 15 Distribution of less abundant bird species recorded in the January to March 2023 seasonal survey (February 2023).

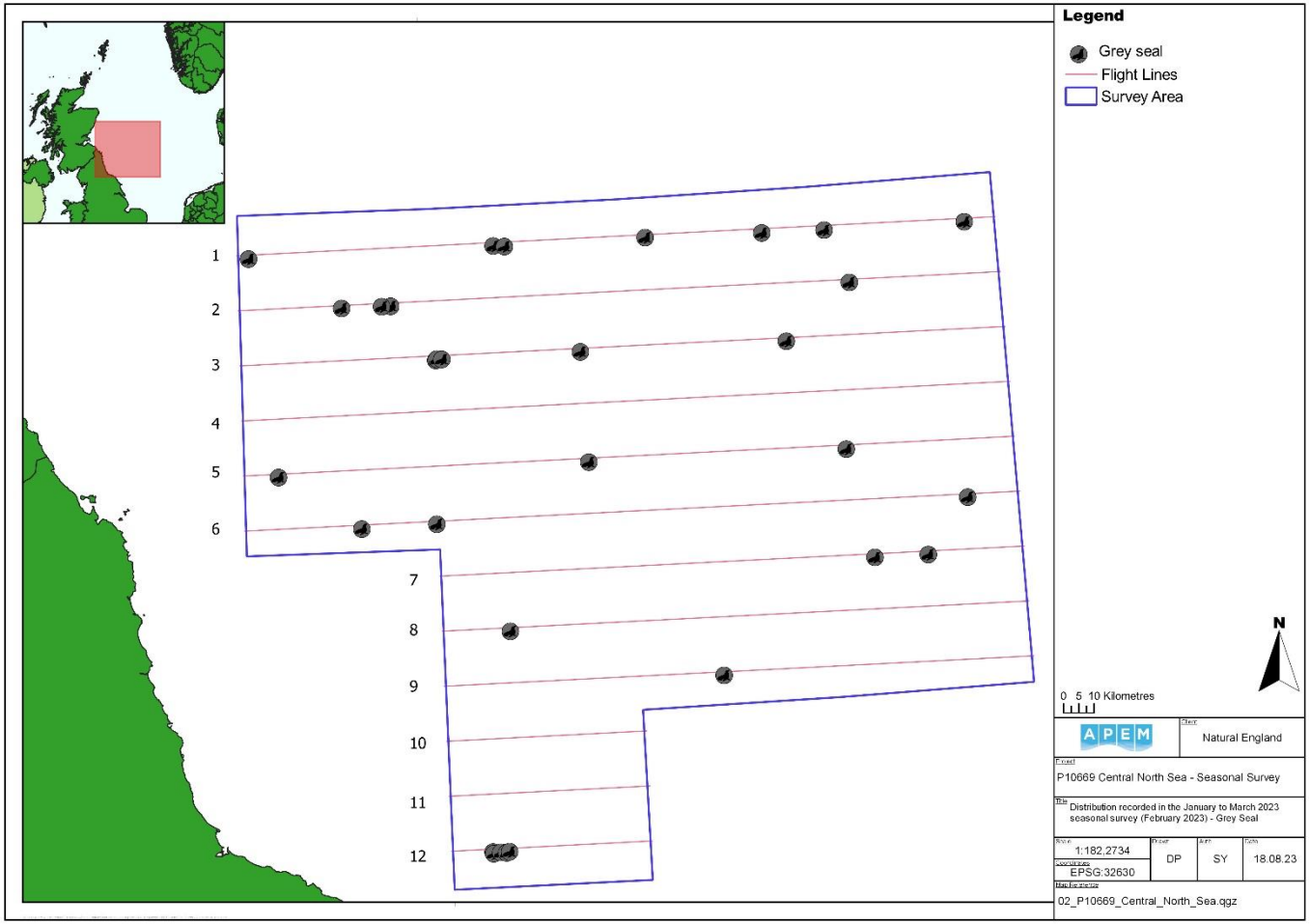

Figure 16 Grey Seal distribution recorded in the January to March 2023 seasonal survey (February 2023).

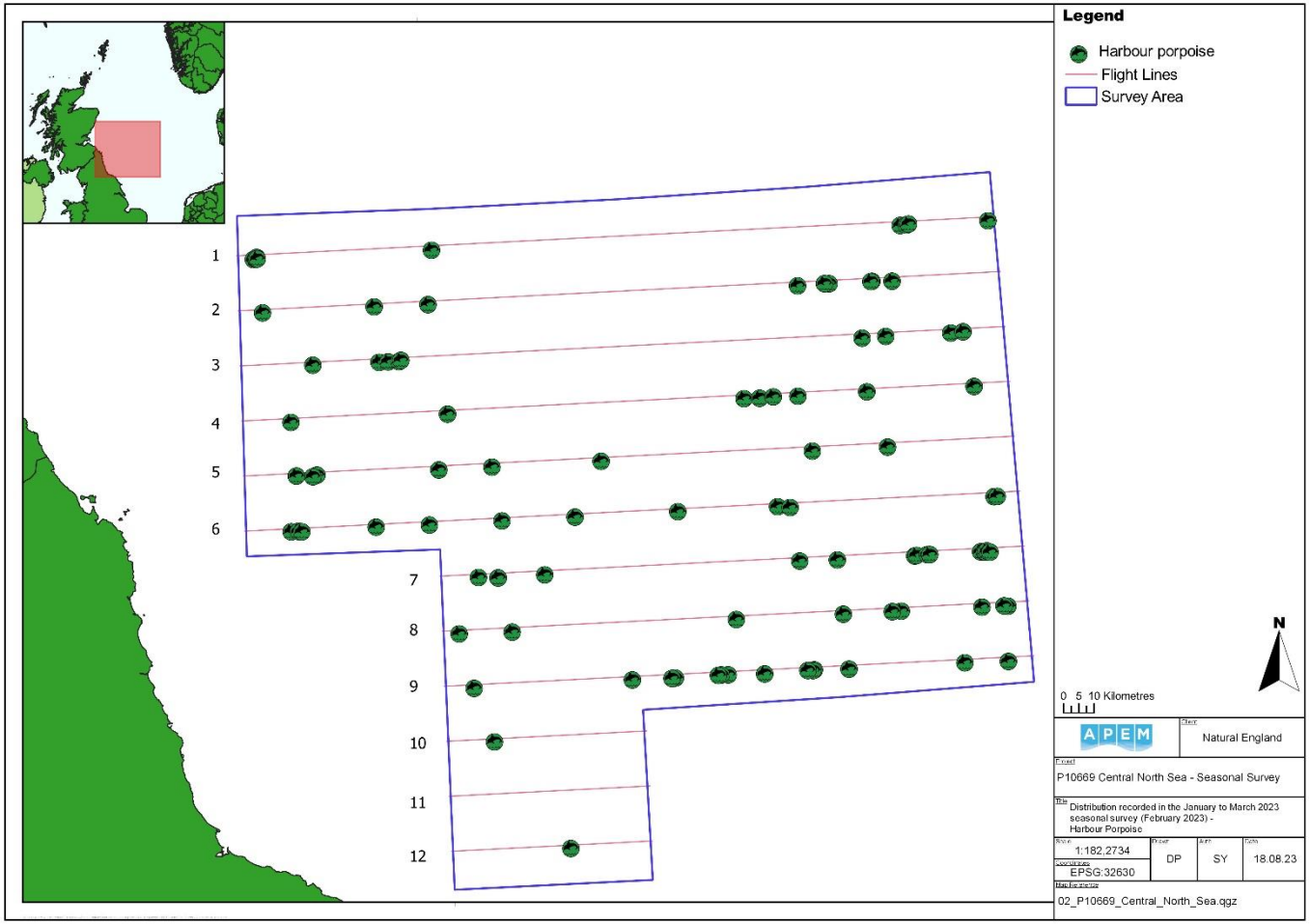

Figure 17 Harbour Porpoise distribution recorded in the January to March 2023 seasonal survey (February 2023).

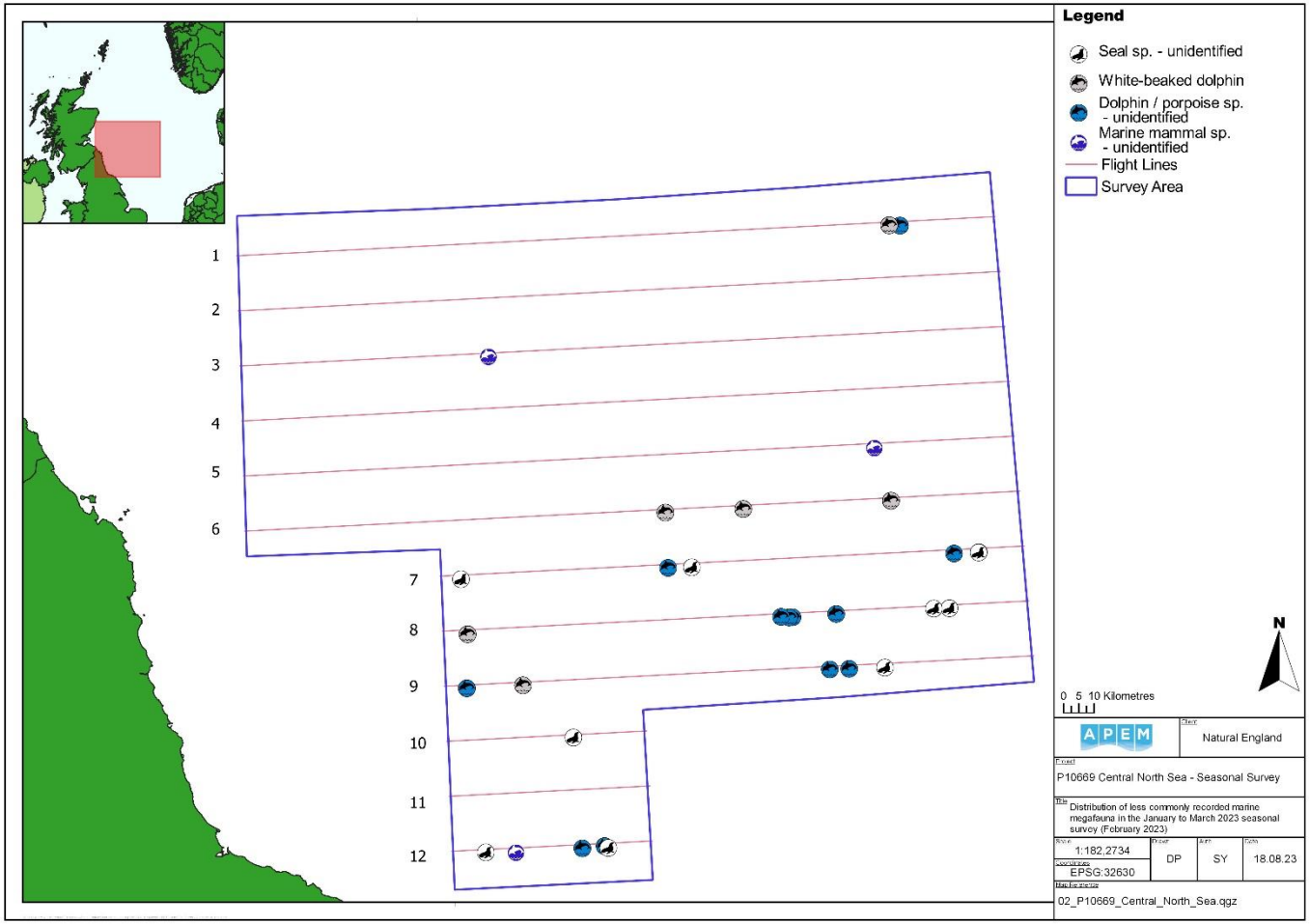

Figure 18 Distribution of less abundant marine megafauna recorded in the January to March 2023 seasonal survey (February 2023).

5. Abiotic Structures and Observations

Two rigs were seen nearby while flying line 1 on 26th of February.

Appendix I Scientific Names and Taxonomy

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

Species	Scientific.Name
Kittiwake	*Rissa tridactyla*
Common Gull	*Larus canus*
Great Black-backed Gull	*Larus marinus*
Herring Gull	*Larus argentatus*
Lesser Black-backed Gull	*Larus fuscus*
Guillemot	*Uria aalge*
Razorbill	*Alca torda*
Puffin	*Fratercula arctica*
Great Northern Diver	*Gavia immer*
Fulmar	*Fulmarus glacialis*
Gannet	*Morus bassanus*
Grey Seal	*Halichoerus grypus*
White-beaked Dolphin	*Lagenorhynchus albirostris*
Harbour Porpoise	*Phocoena phocoena*

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.

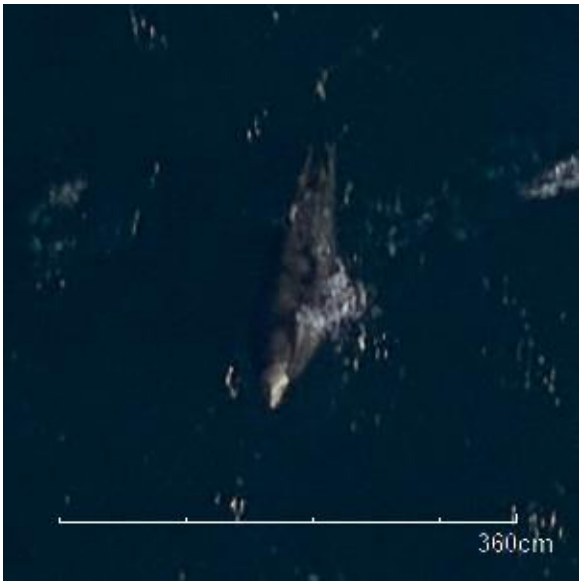

Figure 19 Grey Seal

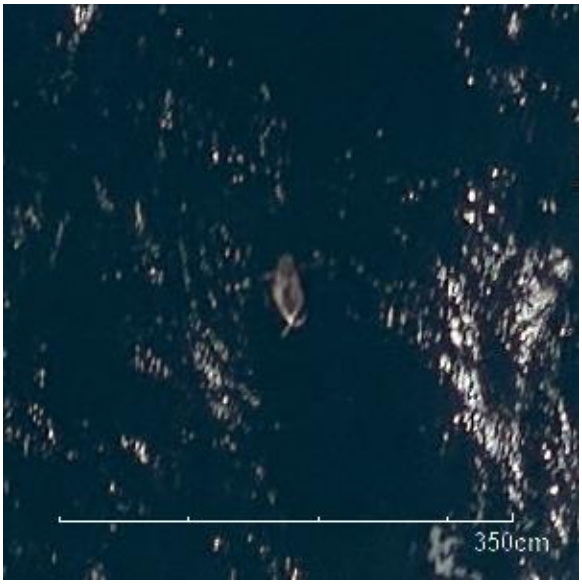

Figure 20 Great Northern Diver

Figure 21 Fulmar in flight

Figure 22 Gannet in flight

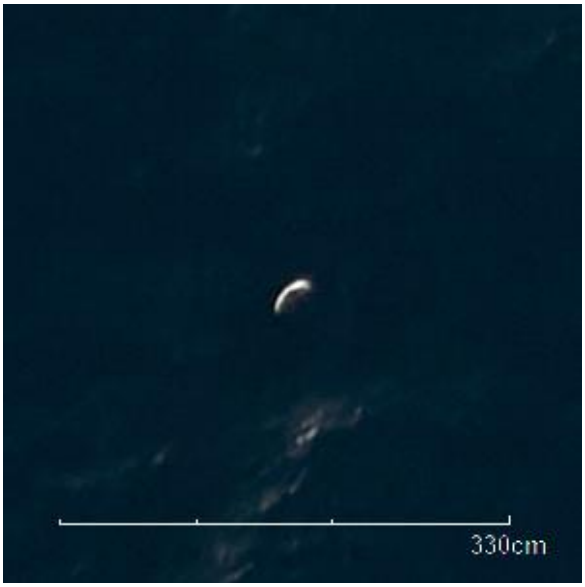

Figure 23 Guillemot

Figure 24 Kittiwake in flight