

Natural England

Ornithological and Marine Mammal Baseline Characterisation Surveys for the POSEIDON project

July-September (Seasonal) Report – Central North Sea

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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 August 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 August 2023. A total of 9,315 observations were recorded during the survey in August 2023, of which 8,928 were observations of birds and 387 were 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 (km²). 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 (July to September 2023) survey, undertaken in August 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.

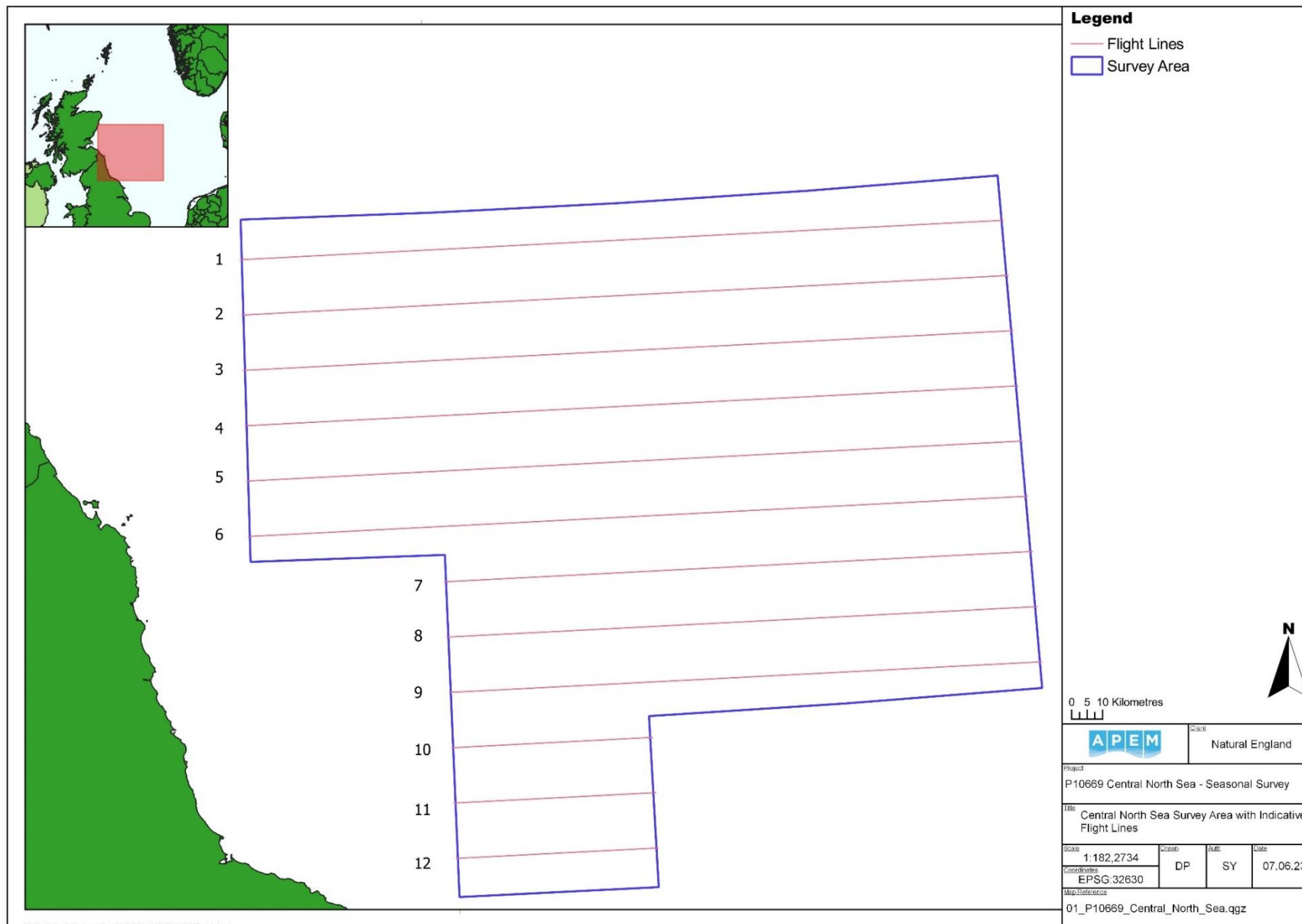


Figure 1 Location of Central North Sea survey area

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 (**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.

Flights occurred on the 21st and 22nd of August. On the 21st of August, two aircraft were used to survey lines 1 to 2 (take-off at 11:41, landing at 16:26), and lines 10 to 12 (take-off at 11:42, landing at 15:03), respectively. On the 22nd of August, the two aircraft surveyed lines 3 to 5 (one aircraft across two flights, take-off and landing at 08:37 and 11:55, and again at 13:42 and 16:50), and lines 6 to 9 (one aircraft across two flights, take-off and landing at 08:35 and 11:50, and again at 13:44 and 17:03), respectively.

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 km². 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 15,926 nodes were initially captured. Of these, 15,834 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 3.64% analysed, generated from 15,926 image nodes (**Table 2**). The target coverage of 3% was achieved including a redundancy of an additional 0.64%, 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 purposes 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 3.64%, thus exceeding the 3% coverage required, enabling sufficient coverage to be collected should images be affected by glint or glare.

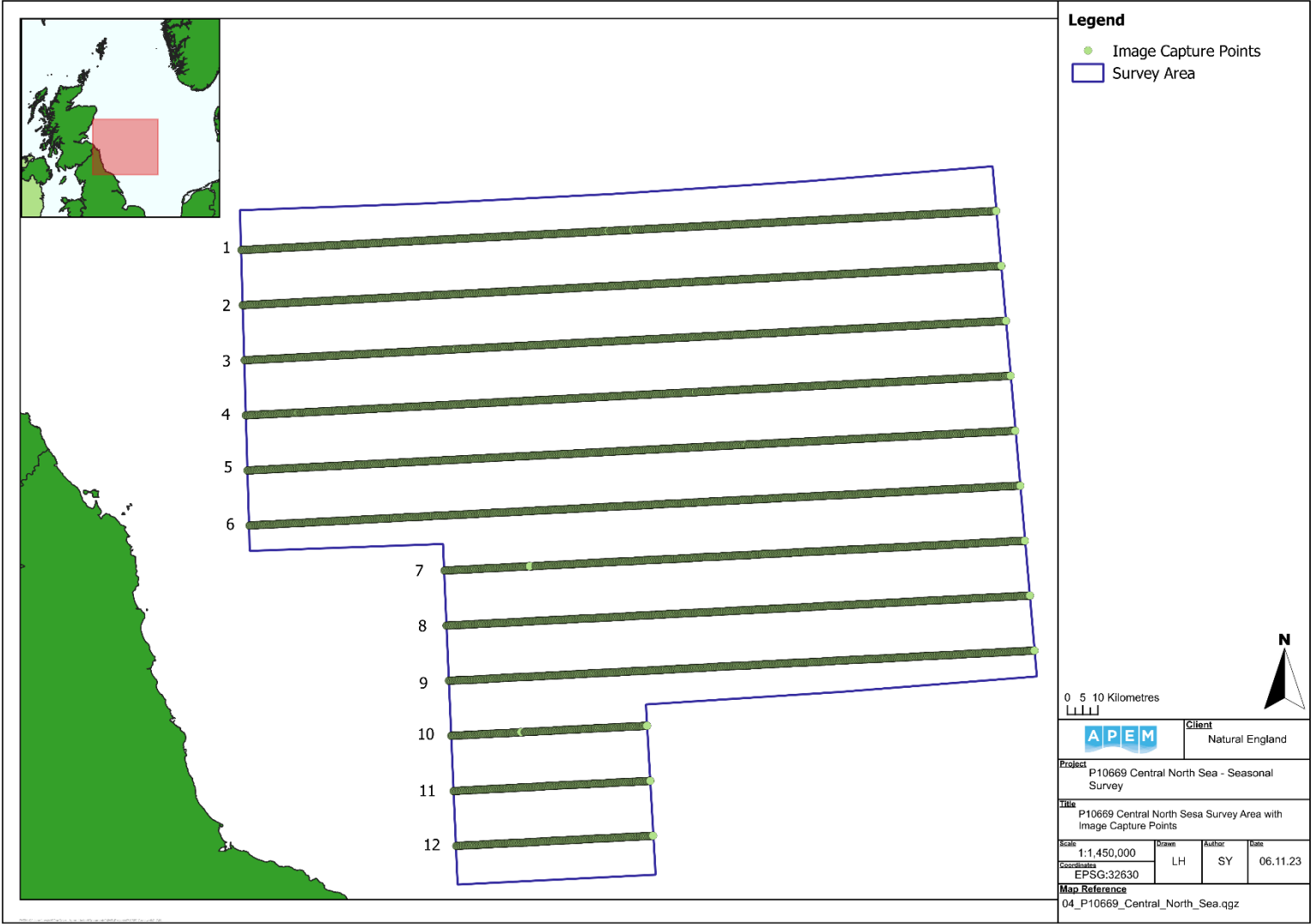


Figure 2 Individual image capture points during the July to September 2023 (August 2023) survey

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>		Warning	Cutout	
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 (August 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	247.18	3	1,735	1,726	1 missing image	-	-	-
2	248.32	3	1,744	1,737	-	-	-	-
3	249.32	3	1,751	1,743	-	-	-	-
4	250.45	3	1,758	1,751	1 missing image	-	-	-
5	251.31	3	1,764	1,757	1 missing image	-	-	-
6	252.59	3	1,774	1,765	-	-	-	-
7	190.44	3	1,335	1,329	-	-	-	Nodes initially captured inside restricted/danger area before it was active, line aborted and re-flown at end of survey
8	191.15	3	1,343	1,336	-	-	-	-
9	191.86	3	1,348	1,341	-	-	-	-
10	64.98	3	456	447	1 missing image	-	-	-
11	64.26	3	459	451	-	-	-	-
12	64.26	3	459	451	-	-	-	-

*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 (August 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	21/08/2023	13:26 / 14:30	130	10	>10	16	26	210°	1	1
2	21/08/2023	14:37 / 15:45	115	0	>10	15	21	210°	1	1
3	22/03/2023	14:12 / 15:16	125	50	>10	15	19	270°	1	0
4	22/03/2023	10:09 / 11:23	120	10-80	>10	16	19	250°	1	1
5	22/03/2023	09:00 / 10:03	130	20-60	>10	15	27	250°	1	1
6	22/03/2023	09:01 / 10:07	117	10	>10	15	23	250°	2	0
7*	22/03/2023	14:13 / 14:21	124	90	>10	16	18	260°	2	0
7*	22/03/2023	15:29 / 16:12	120	10	>10	16	16	260°	2	0
8	22/03/2023	14:33 / 15:23	120	80	>10	16	22	260°	1	0
9	22/03/2023	10:26 / 11:17	120	10	>10	15	14	270°	2	0
10	21/08/2023	13:45 / 14:07	120	20	>10	17	25	210°	3	0
11	21/08/2023	13:20 / 13:38	118	40	>10	17	25	210°	1	0
12	21/08/2023	12:54 / 13:14	120	70	>10	17	25	210°	1	1

*Weather conditions have been recorded separately for the two surveys on line 7. Nodes were initially captured inside a restricted/danger area before it was active. Upon activation, the line was temporarily aborted and re-flown at end of survey.

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 > 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 higher-level taxonomic groups for the July to September 2023 seasonal survey period (August 2023)

Species	Group Level 1	Group Level 2	Group Level 3	Group Level 4
Common Scoter	Duck species		Wildfowl species	Unidentified Bird species
Curlew	Wader species			
Kittiwake	Small Gull species		Gull species	
Little Gull				
Greater Black-backed Gull	Black-backed Gull species	Large Gull species		
Great Skua	Skua species			
Arctic Skua				
Guillemot	Guillemot or Razorbill	Auk species		
Razorbill				
Puffin				
European Storm Petrel	Storm Petrel species			
Leach’s Storm Petrel				
Fulmar	Fulmar / Gull species			
Manx Shearwater	Small Shearwater species	Shearwater species		
Gannet				

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

Species	Group Level 1	Group Level 2	Group Level 3	Group Level 4
Grey Seal	Seal species		Unidentified Marine Mammal species	Unidentified Marine Organism
Common Minke Whale	Whale species			
White-beaked Dolphin	Dolphin species	Dolphin / Porpoise		
Harbour Porpoise				
Atlantic Bluefin Tuna	Fish species			
Basking Shark	Shark species			

3.3 Summary of Quality Assurance

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

The first step in the QA process, referred to as Blank QA, reviewed percentage agreement between images identified as positive (containing at least one target of interest) and those identified as blank (not containing any targets of interest). A random sample of 20% of survey imagery were subjected to a QA audit review, in which agreement in positive images should reach 90% agreement versus the main analysis of the whole survey. Where 90% agreement was not reached, a complete re-analysis of the survey data was undertaken. This consisted of analysing each image from the survey again, and extra positives from the re-analysis and QA audit are included in the data. For the current survey, the initial agreement was 95%. 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 Height

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 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

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

the 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 8,928 birds were recorded in the Survey Area during the July – September 2023 seasonal (August 2023) survey. Of those, 8,506 were sitting on the water, 407 were in flight and 15 were deceased (**Table 7**).

A total of 387 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 July to September 2023 seasonal survey period (August 2023)

Species Group	Species	Flying	Sitting	Deceased	Total
Wildfowl	Common Scoter	2	-	-	2
Waders	Curlew	1	-	-	1
	Wader species	19	-	-	19
Gulls	Kittiwake	23	17	-	40
	Little Gull	2	-	-	2
	Great Black-backed Gull	5	-	-	5
Skuas	Great Skua	3	1	-	4
	Arctic Skua	2	-	-	2
	Skua species	1	-	-	1
Auk	Guillemot	1	7,237	-	7,238
	Razorbill	-	100	-	100
	Guillemot / Razorbill	-	232	7	239
	Puffin	1	19	-	20
	Auk species	-	11	-	11
Storm Petrels	Storm Petrel species	6	-	-	6
Fulmar	Fulmar	143	774	2	919
Shearwaters	Manx Shearwater	-	1	-	1
Gannet	Gannet	197	109	1	307
Unidentified Bird species	Unidentified Bird species	1	5	5	11
Total		407	8,506	15	<u>8,928</u>

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

Species Group	Species	Submerged	Surfacing	Deceased	Total
Seal	Grey Seal	15	18	-	33
	Seal species	1	-	-	1
Whale	Common Minke Whale	1	-	-	1
	Whale species	1	-	-	1
Dolphin	White-beaked Dolphin	62	5	-	67
Porpoise	Harbour Porpoise	227	45	-	272
Dolphin / Porpoise	Dolphin / Porpoise species	3	-	-	3
Marine Mammal species	Marine Mammal species	2	-	-	2
Fish	Atlantic Bluefin Tuna	5	-	-	5
Shark	Basking Shark	2	-	-	2
Total		319	68	0	387

4.2 Spatial Distribution

Figure 3 and **Figure 4** show the locations of all birds and marine megafauna, respectively, recorded in the Survey Area. Birds were recorded across the Survey Area, with the greatest concentrations found throughout the northeast round to the west of the Survey Area. Marine megafauna species were also recorded throughout the Survey Area and showed a scattered distribution. **Figure 5** to **Figure 11** show distributions of more abundant birds by species, whilst **Figure 12** shows the distribution of less frequently recorded bird species. **Figure 13** to **Figure 15** shows the distributions of more abundant marine megafauna species within the Survey Area and **Figure 16** shows distributions of less frequently recorded marine megafauna by species. **Figure 17** shows distribution of vessels and abiotic structures in the Survey Area.

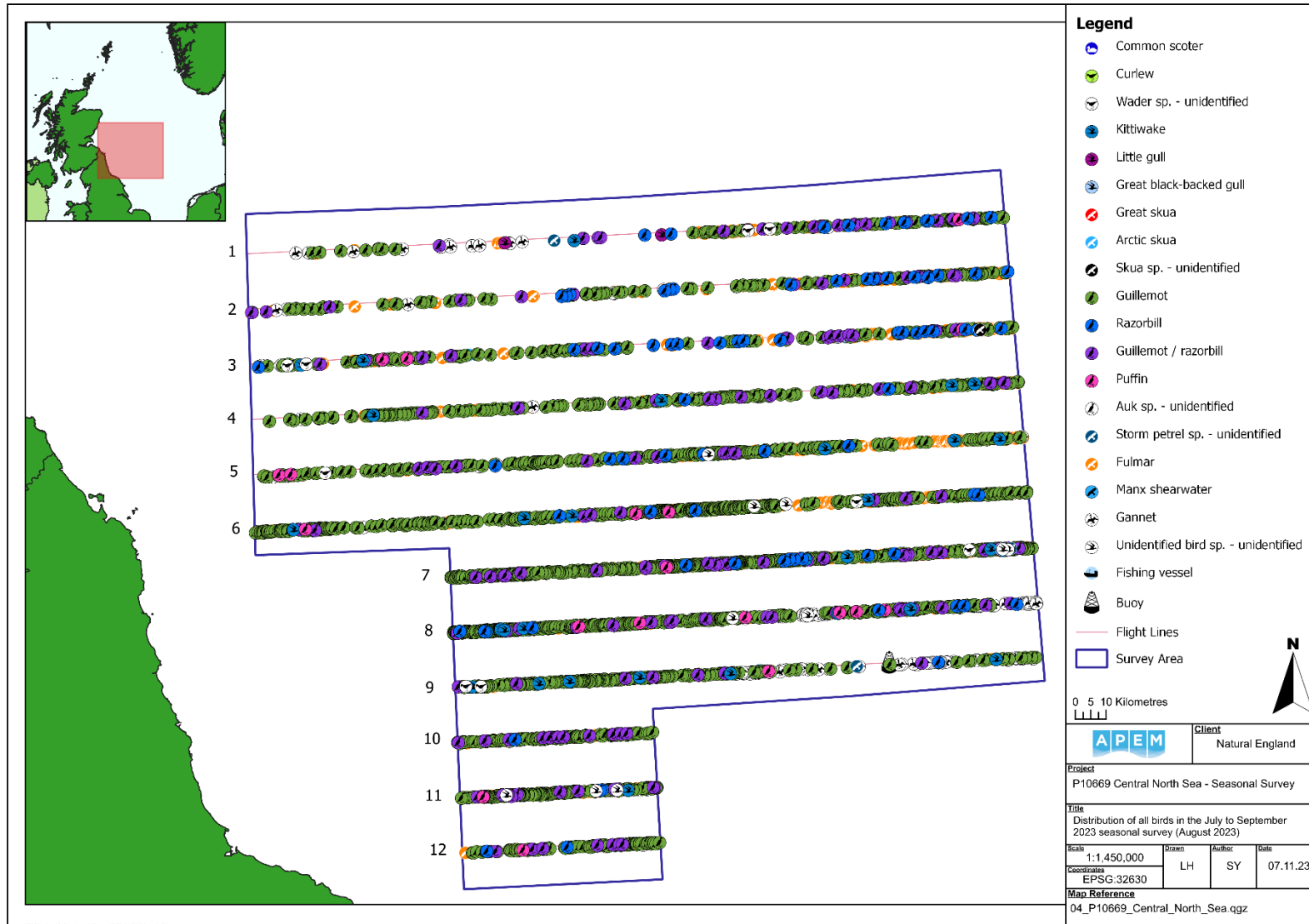


Figure 3 Distribution of all birds recorded in the July to September 2023 seasonal survey (August 2023)

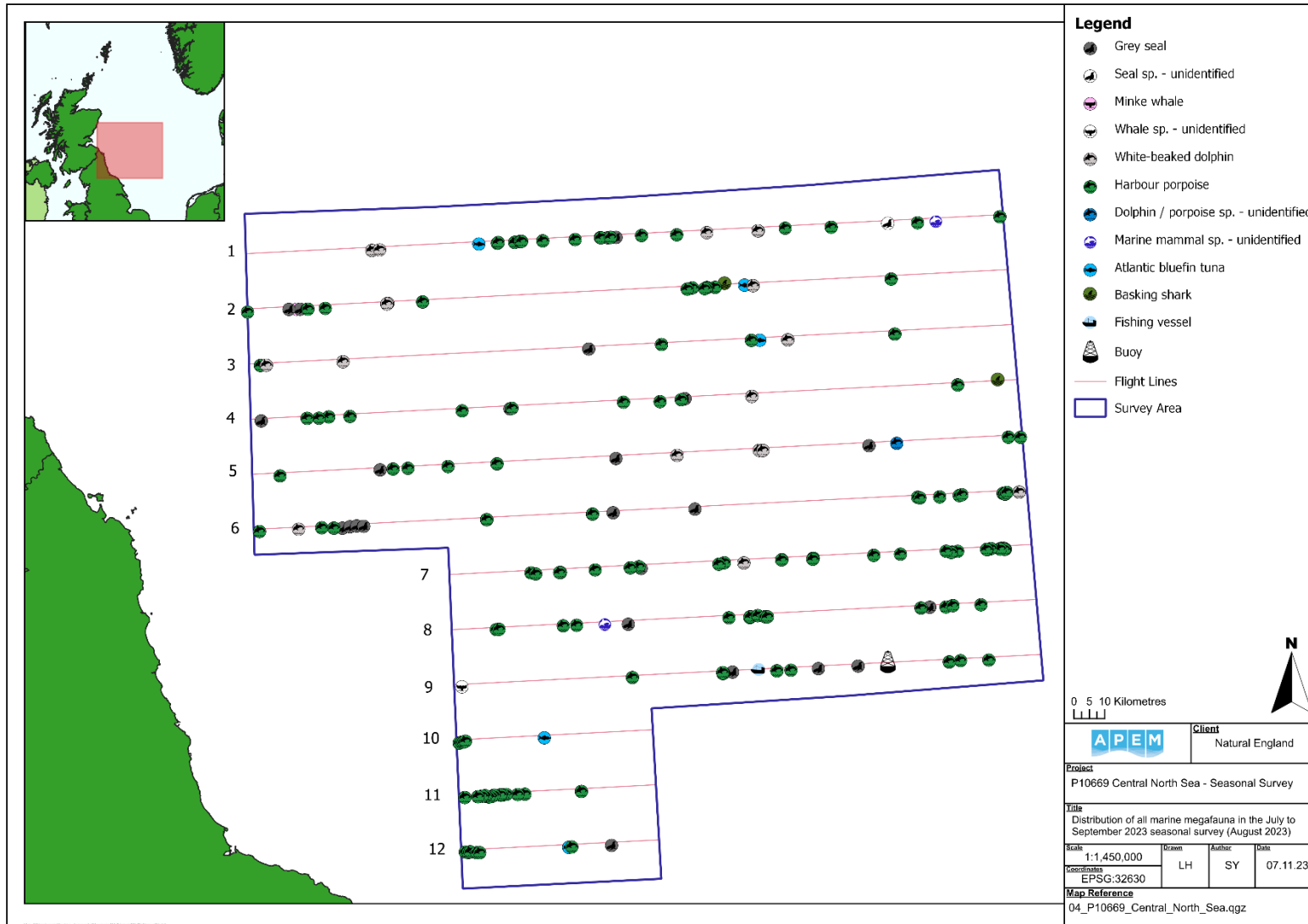


Figure 4 Distribution of all marine megafauna recorded in the July to September 2023 seasonal survey (August 2023)

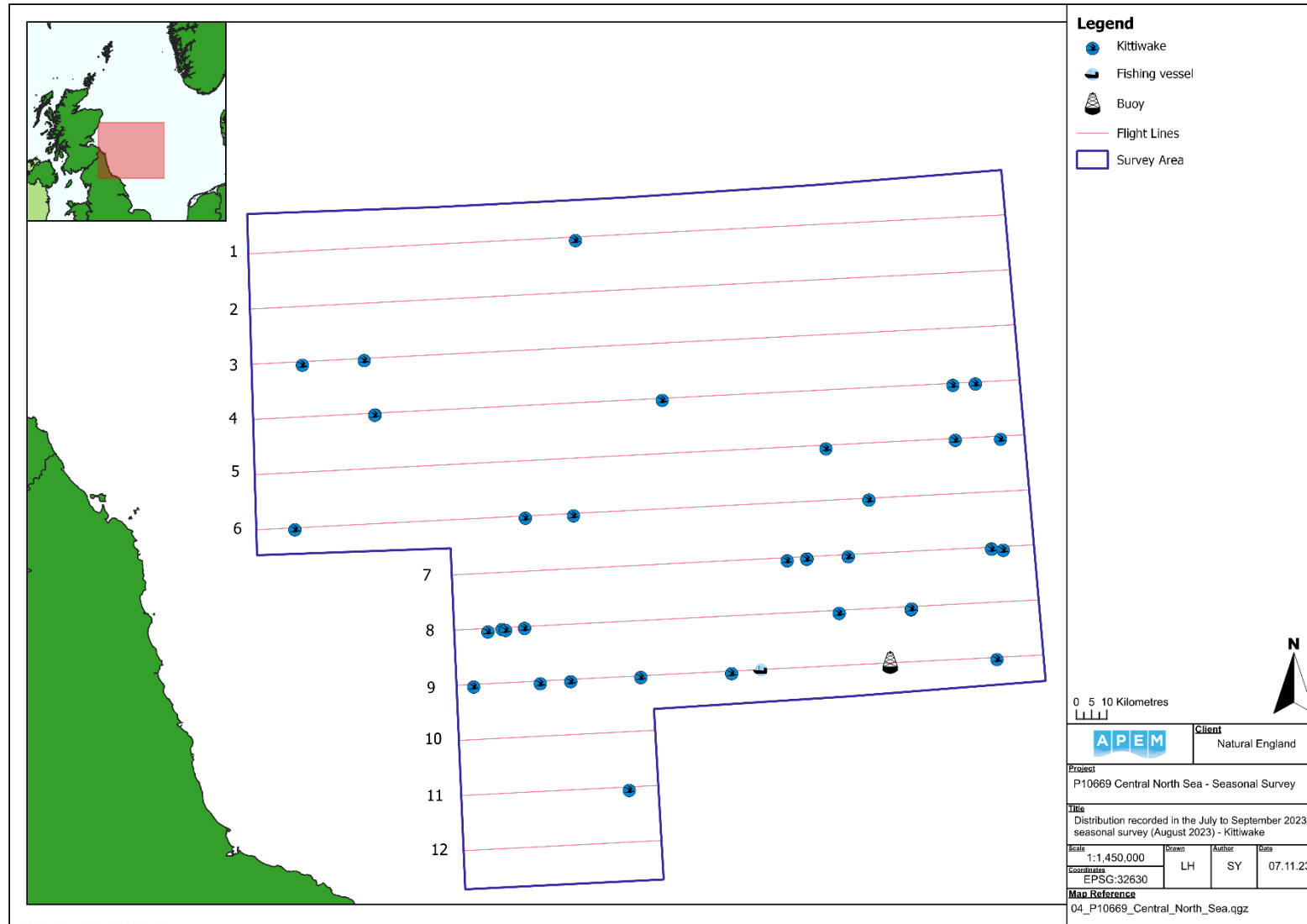


Figure 5 Kittiwake distribution recorded in the July to September 2023 seasonal survey (August 2023)

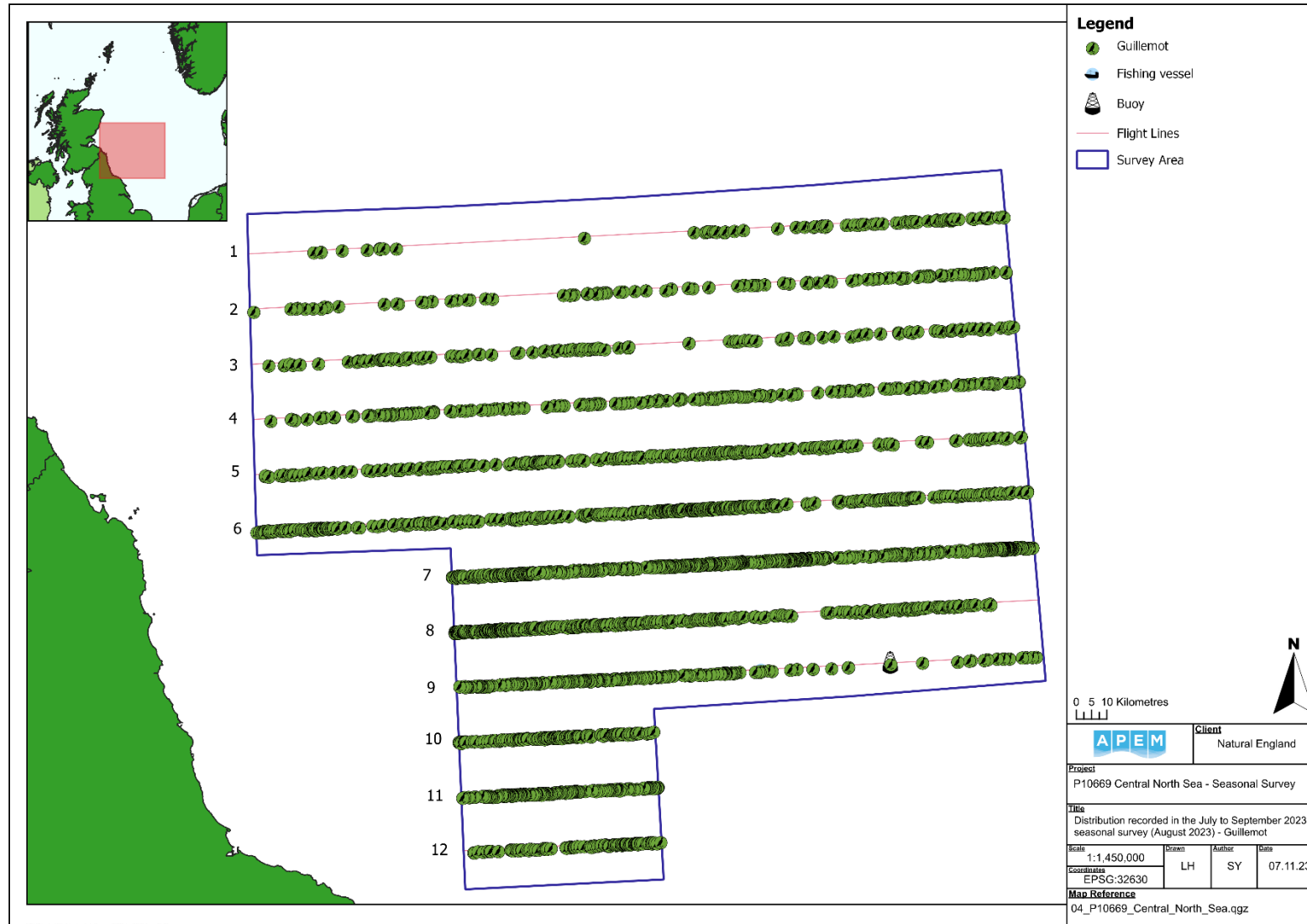


Figure 6 Guillemot distribution recorded in the July to September 2023 seasonal survey (August 2023)

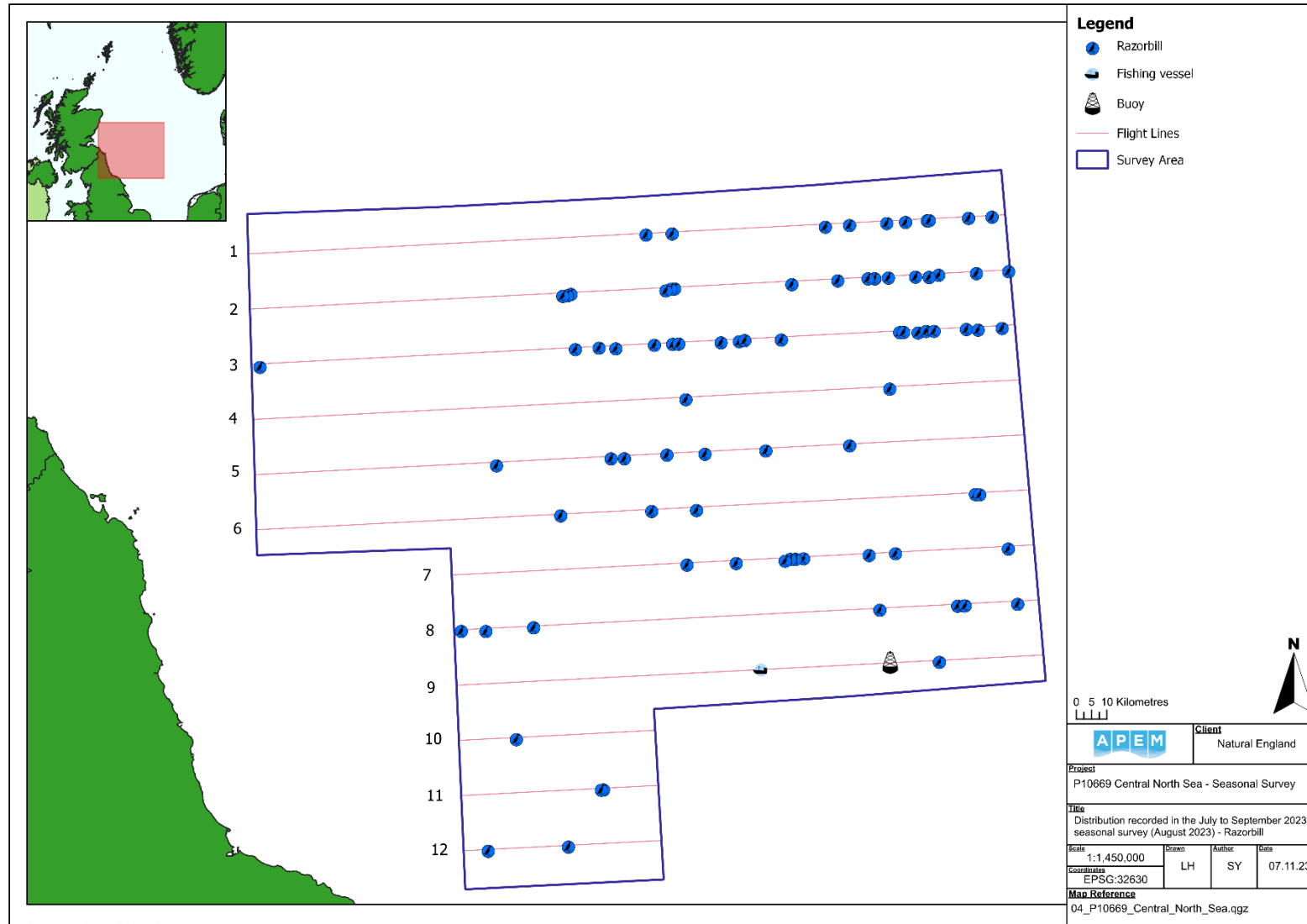


Figure 7 Razorbill distribution recorded in the July to September 2023 seasonal survey (August 2023)

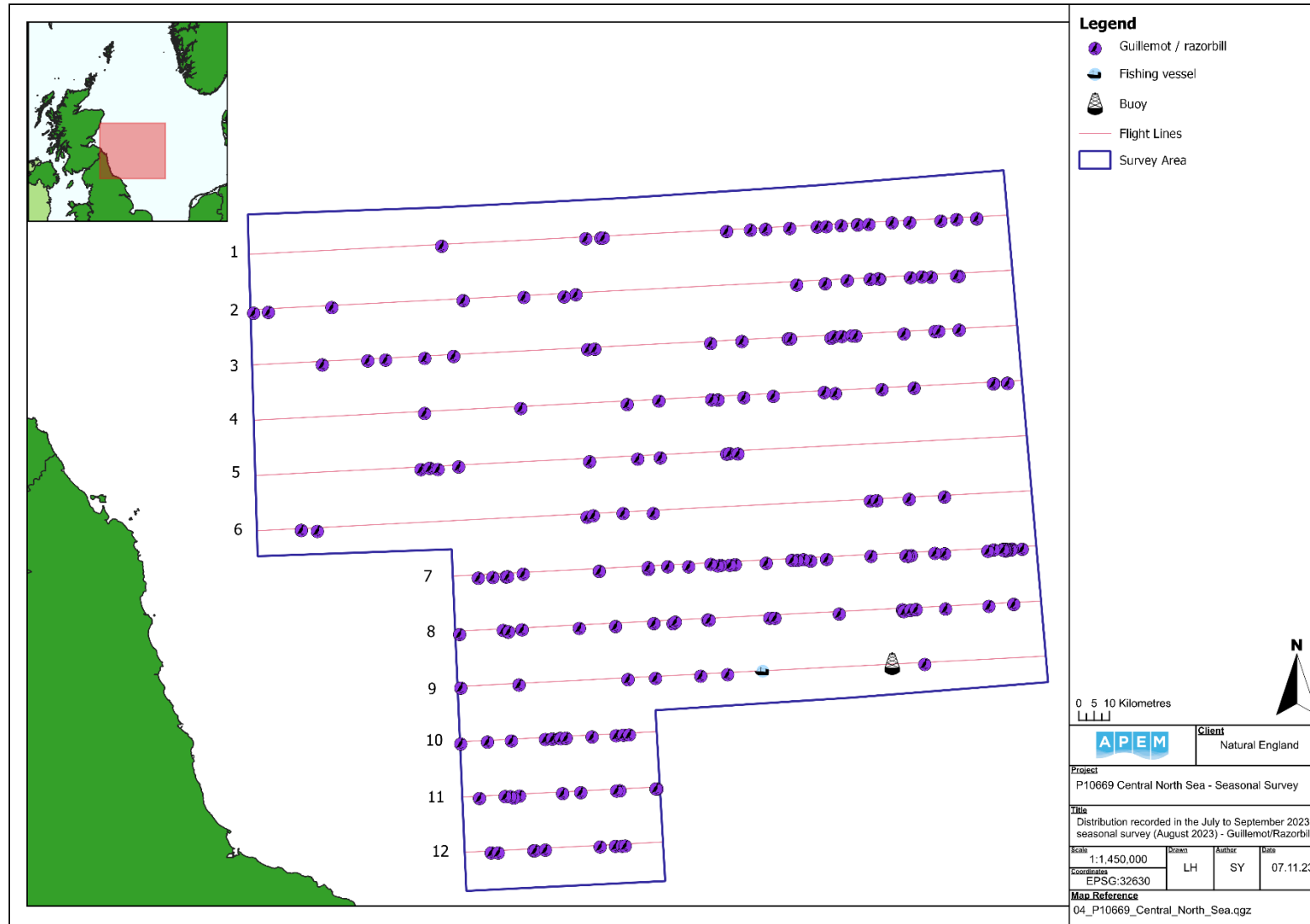


Figure 8 Guillemot / Razorbill distribution recorded in the July to September 2023 seasonal survey (August 2023)

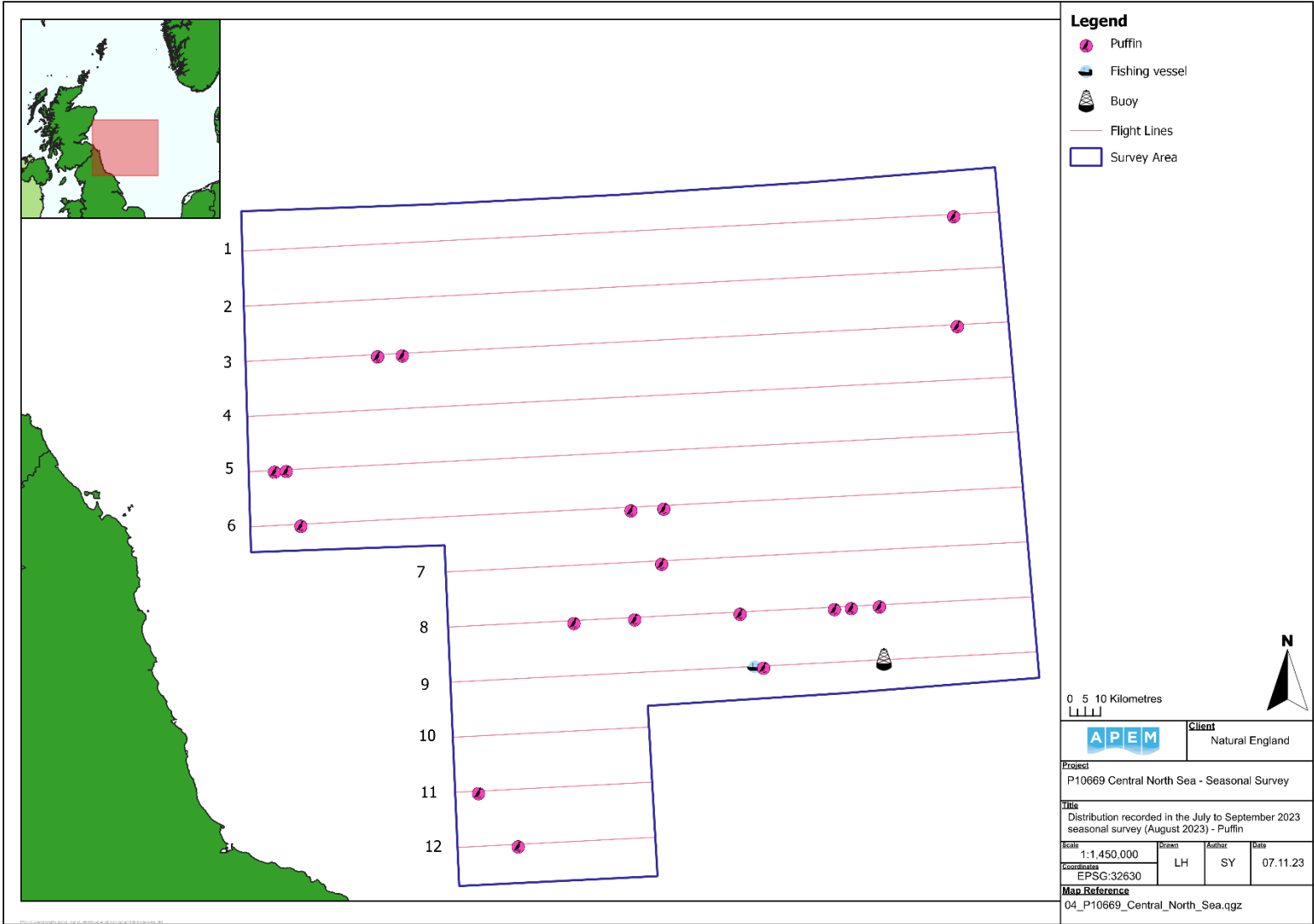


Figure 9 Puffin distribution recorded in the July to September 2023 seasonal survey (August 2023)

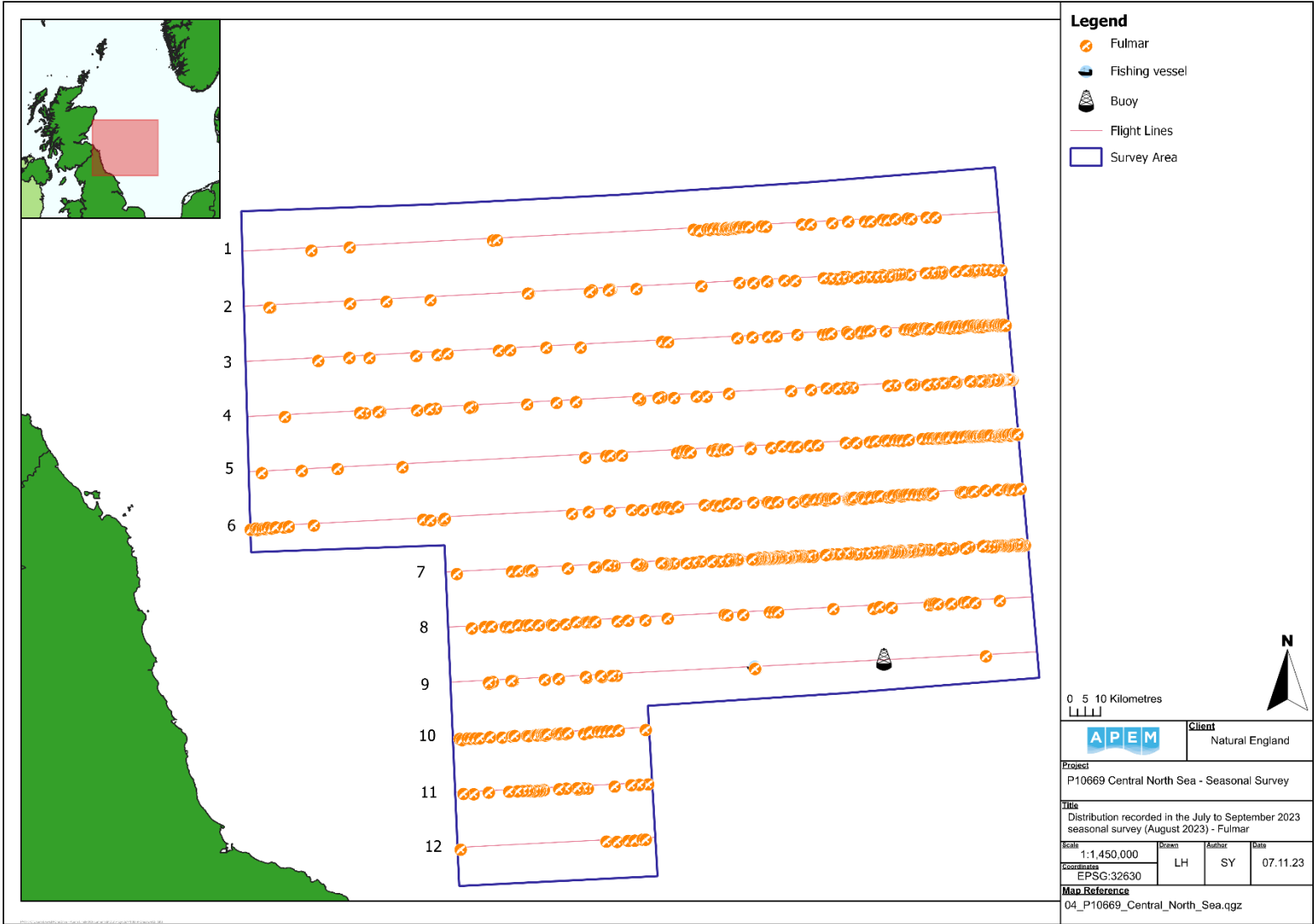


Figure 10 Fulmar distribution recorded in the July to September 2023 seasonal survey (August 2023)

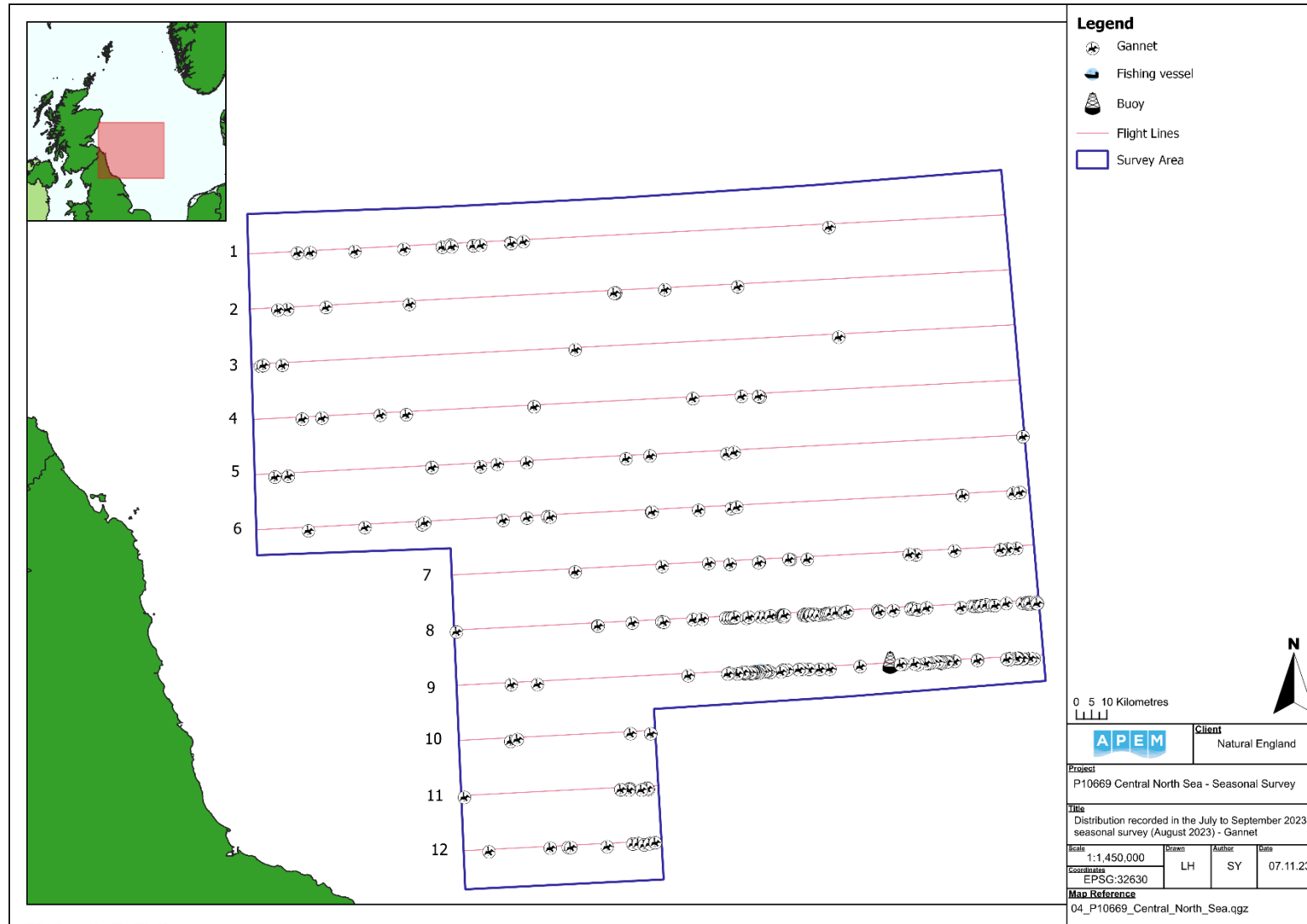


Figure 11 Gannet distribution recorded in the July to September 2023 seasonal survey (August 2023)

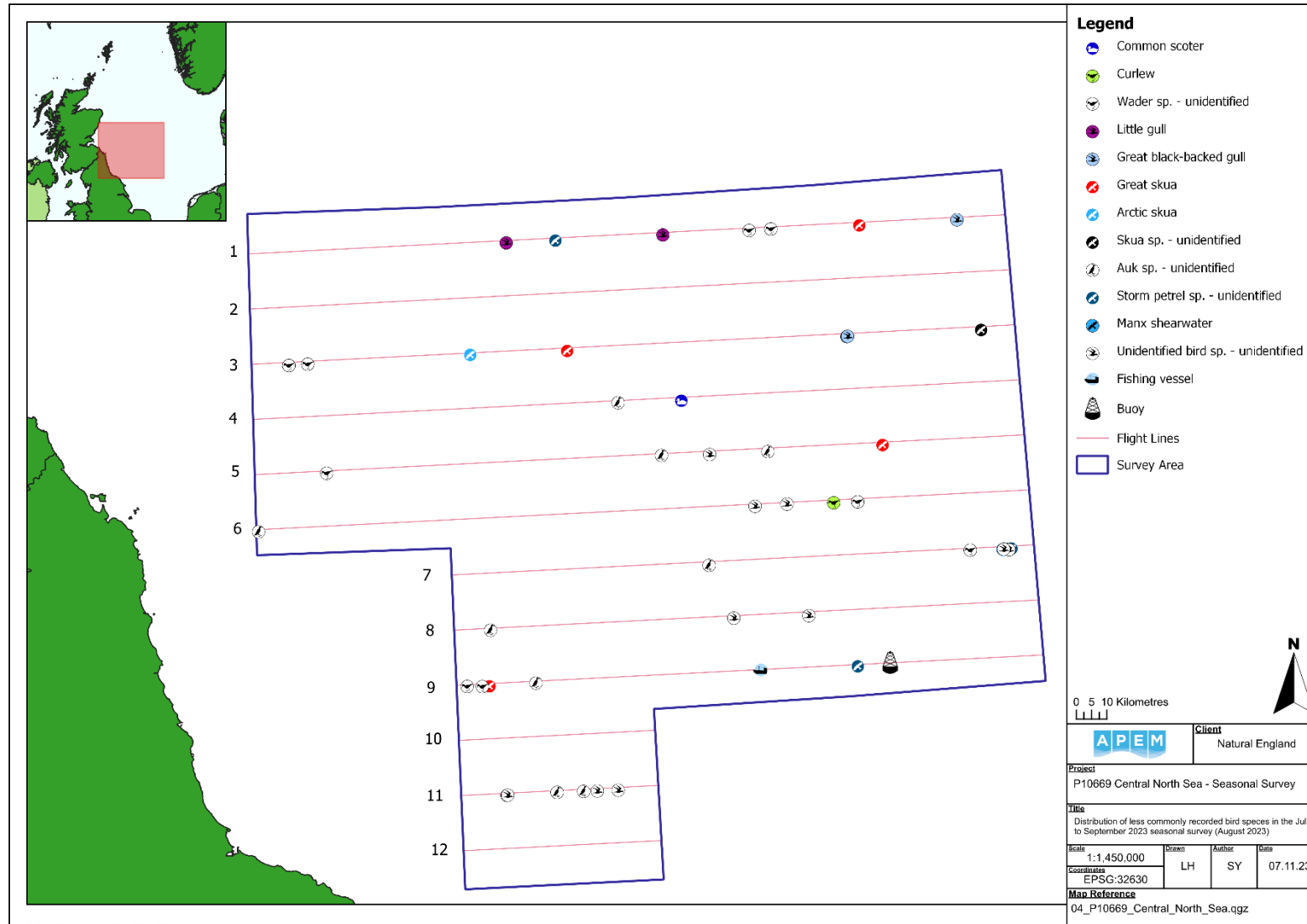


Figure 12 Distribution of less abundant bird species recorded in the July to September 2023 seasonal survey (August 2023)

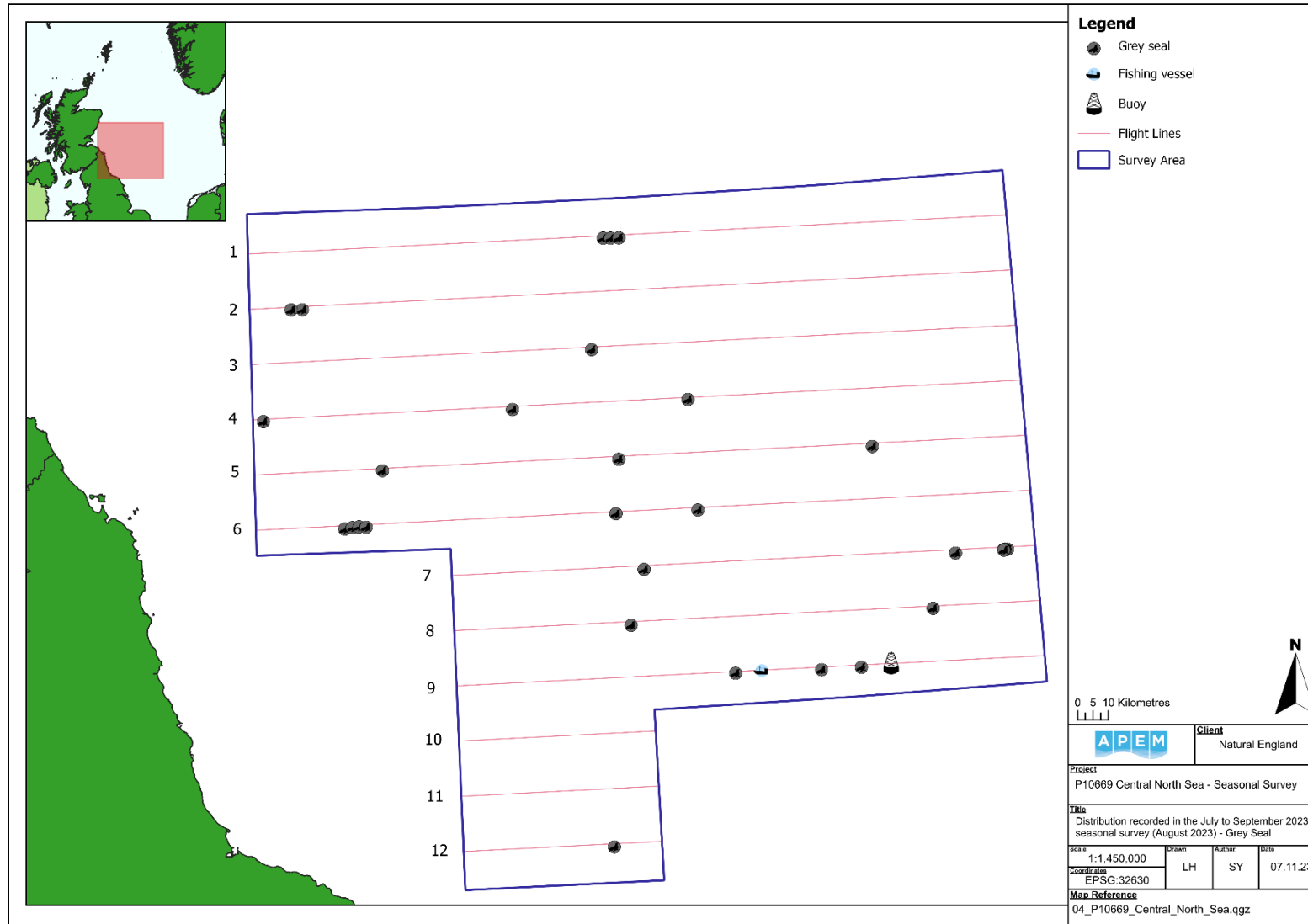


Figure 13 Grey seal distribution recorded in the July to September 2023 seasonal survey (August 2023)

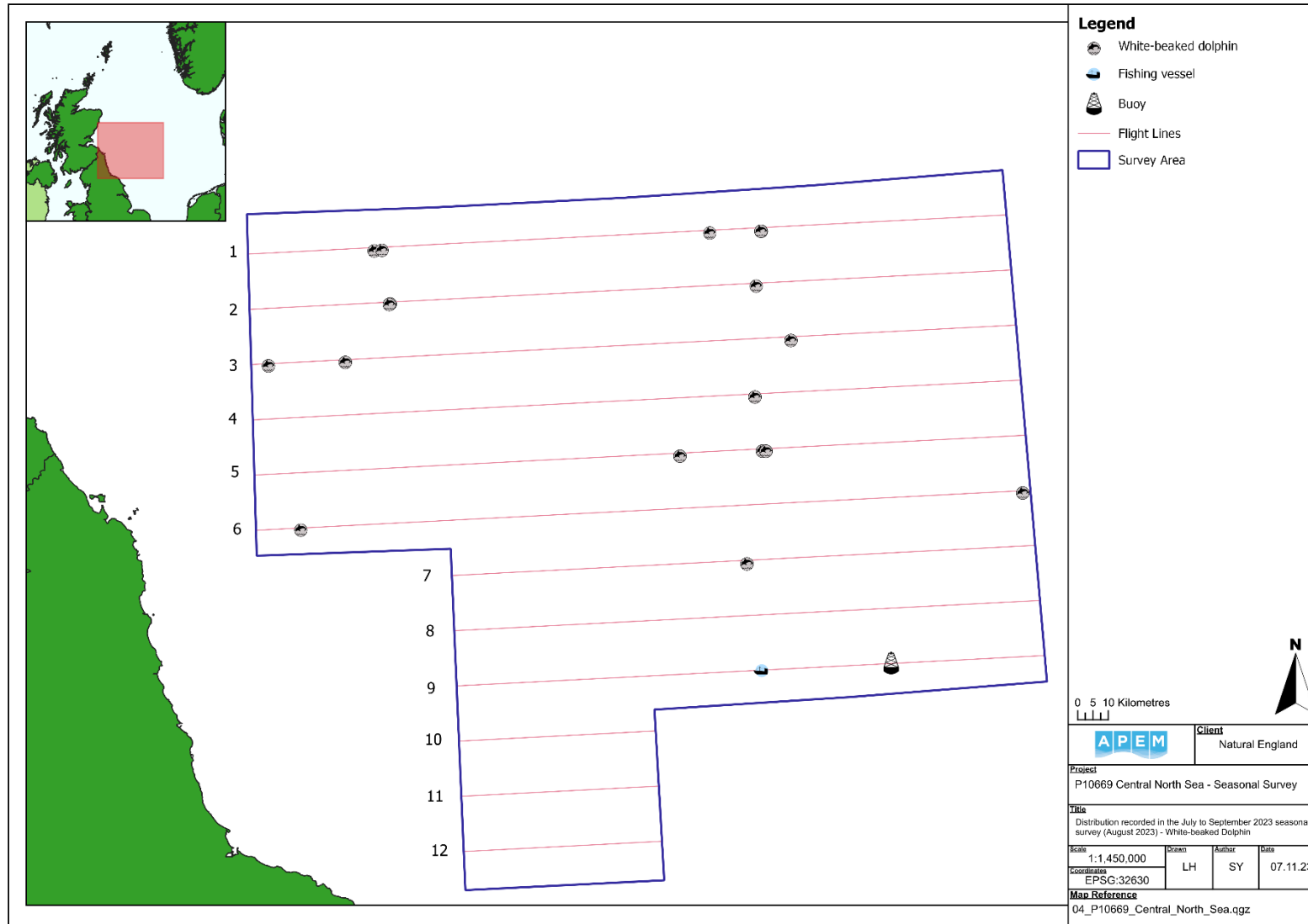


Figure 14 White-beaked dolphin distribution recorded in the July to September 2023 seasonal survey (August 2023)

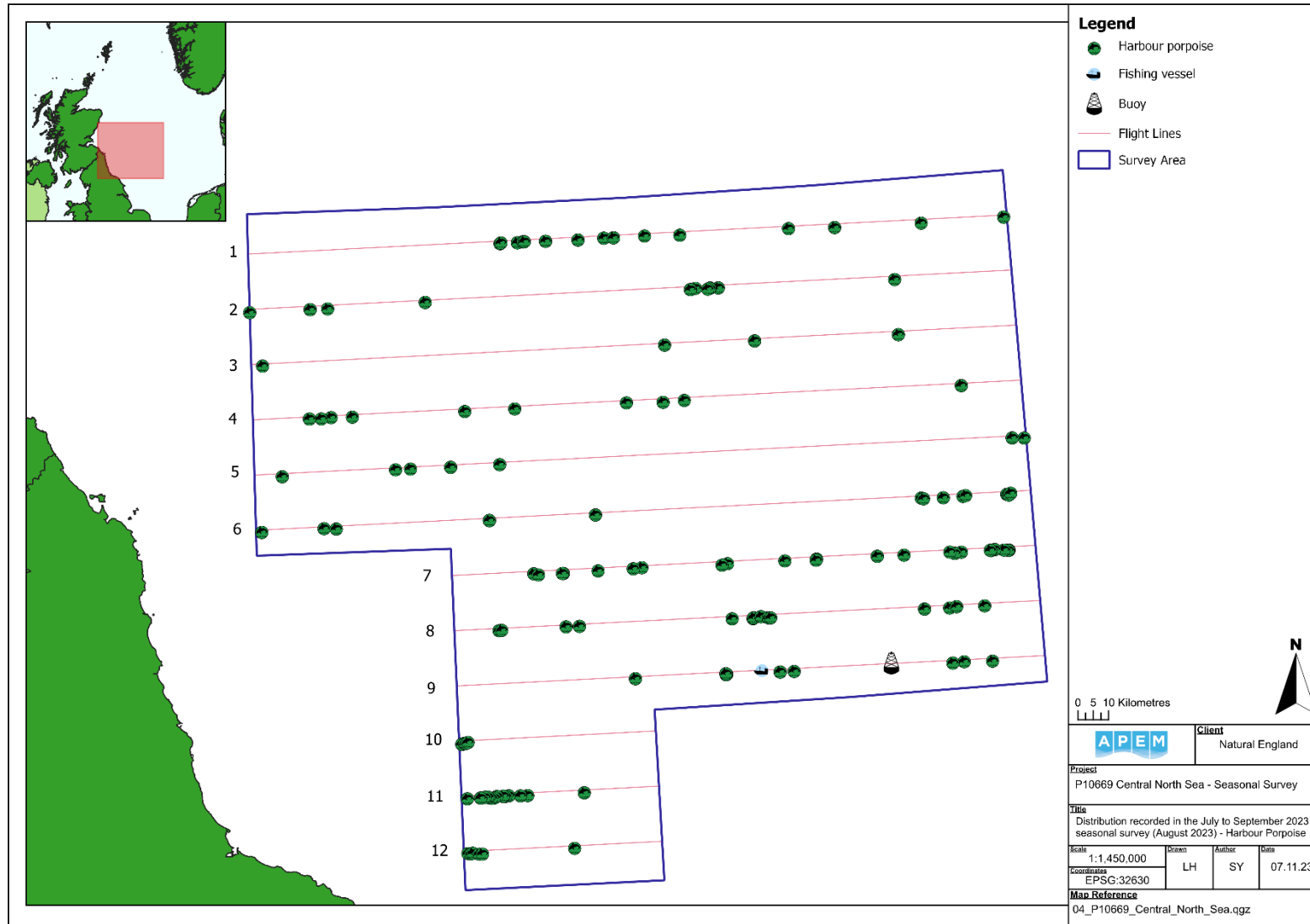


Figure 15 Harbour porpoise distribution recorded in the July to September 2023 seasonal survey (August 2023).

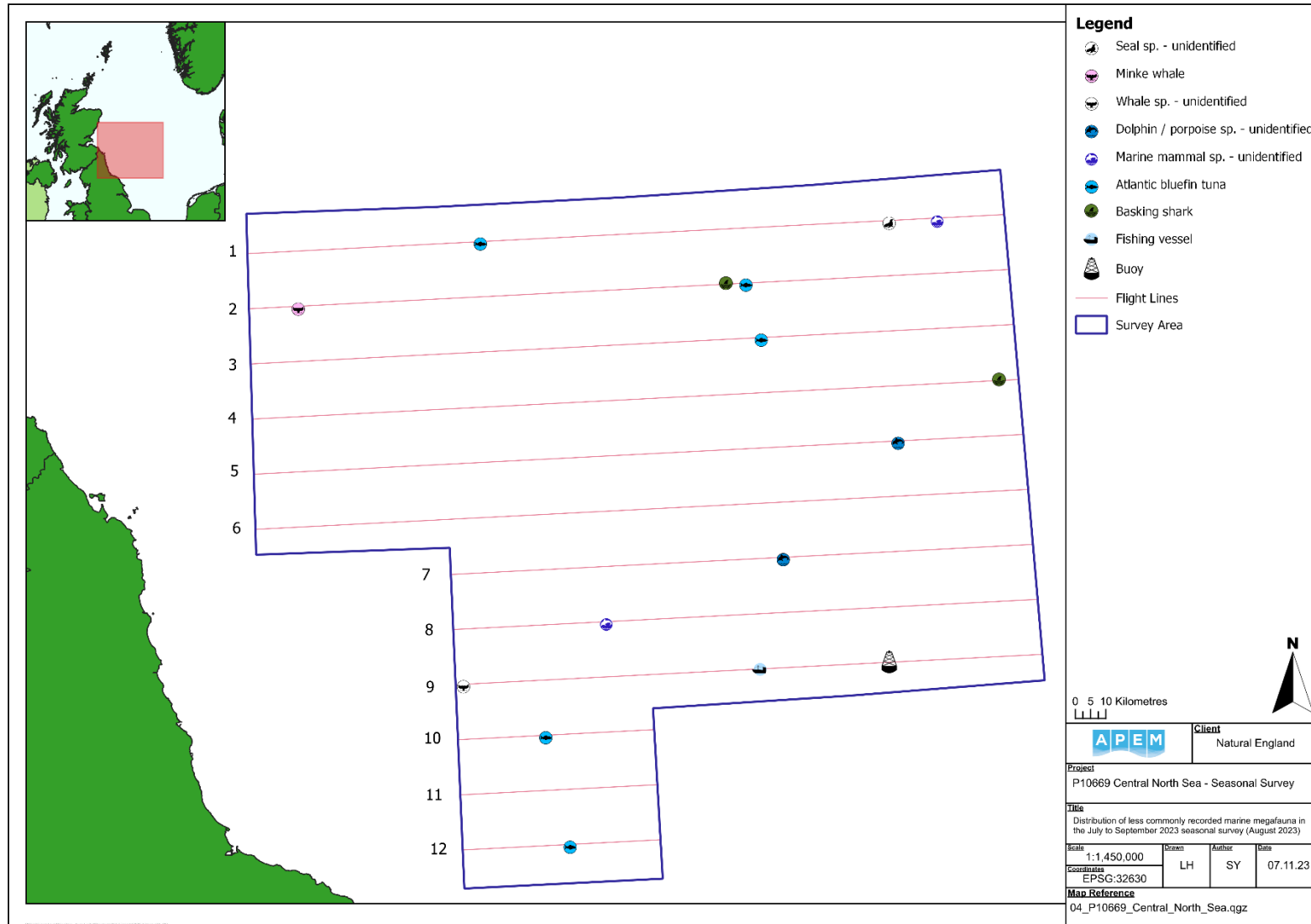


Figure 16 Distribution of less abundant marine megafauna in the July to September 2023 seasonal survey (August 2023)

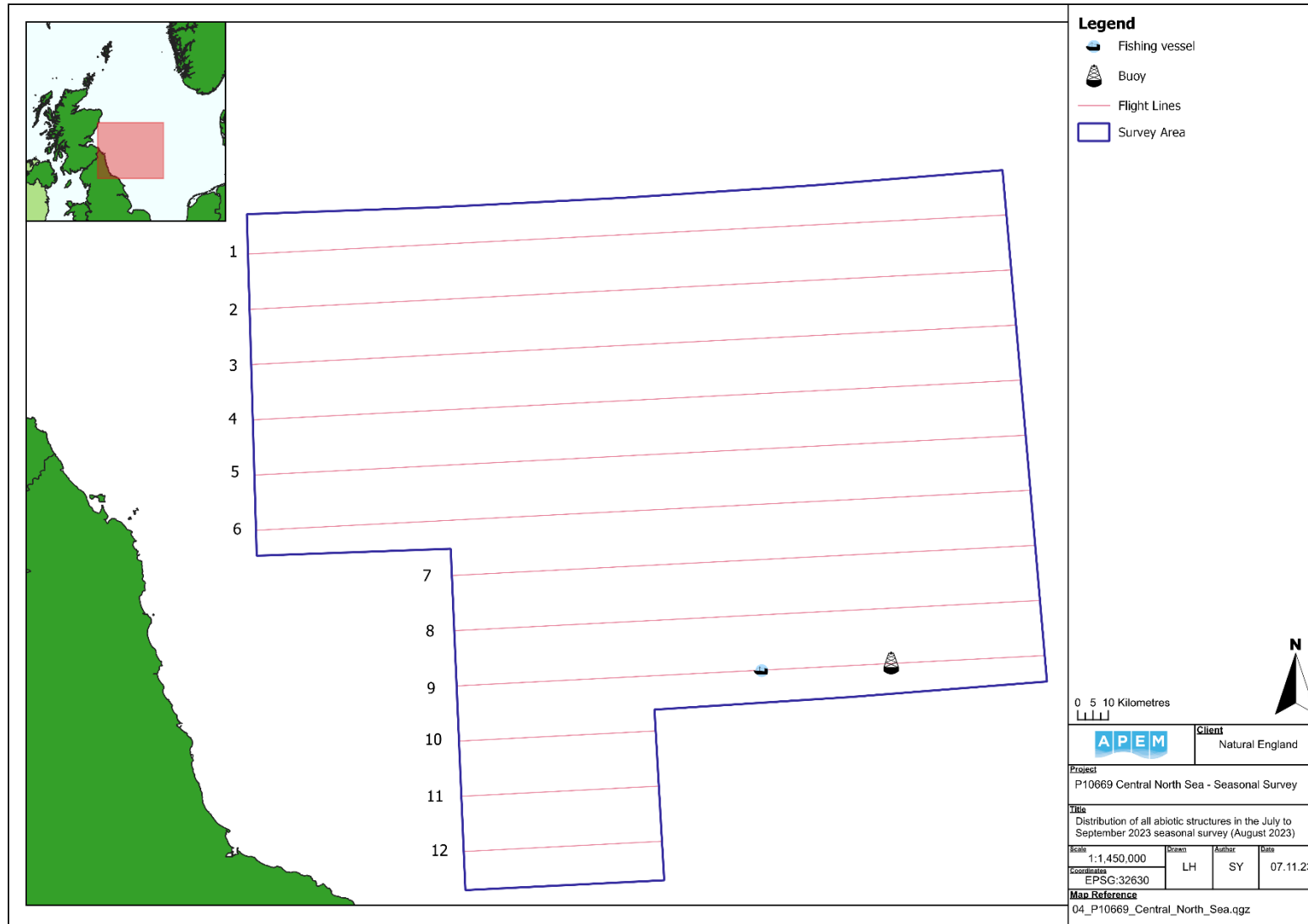


Figure 17 Distribution of abiotic structures and vessels recorded in the July to September 2023 seasonal survey (August 2023)

5. Abiotic Structures and Observations

The following abiotic structures were observed during the survey period:

A buoy and fishing vessel were present on line 9 when it was surveyed on the 22nd of August. The fishing vessel was observed heading toward the west-southwest.

Appendix I Scientific Names and Taxonomy

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

Species	Scientific Name
Common Scoter	<i>Melanitta nigra</i>
Curlew	<i>Numenius arquata</i>
Kittiwake	<i>Rissa tridactyla</i>
Little Gull	<i>Larus minutus</i>
Great Black-backed Gull	<i>Larus marinus</i>
Great Skua	<i>Stercorarius skua</i>
Arctic Skua	<i>Stercorarius parasiticus</i>
Guillemot	<i>Uria aalge</i>
Razorbill	<i>Alca torda</i>
Puffin	<i>Fratercula arctica</i>
Manx Shearwater	<i>Puffinus puffinus</i>
Fulmar	<i>Fulmarus glacialis</i>
Gannet	<i>Morus bassanus</i>
Grey Seal	<i>Halichoerus grypus</i>
Common Minke Whale	<i>Balaenoptera acutorostrata</i>
White-beaked Dolphin	<i>Lagenorhynchus albirostris</i>
Harbour Porpoise	<i>Phocoena phocoena</i>
Atlantic Bluefin Tuna	<i>Thunnus thynnus</i>
Basking Shark	<i>Cetorhinus maximus</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 18 **Grey seal**



Figure 19 **Arctic skua in flight**



Figure 20 **Fulmar in flight**



Figure 21 **Gannet in flight**

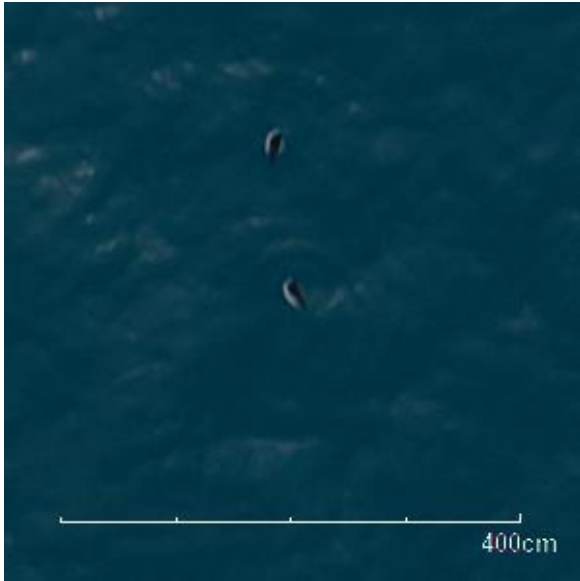


Figure 22 **Razorbill**

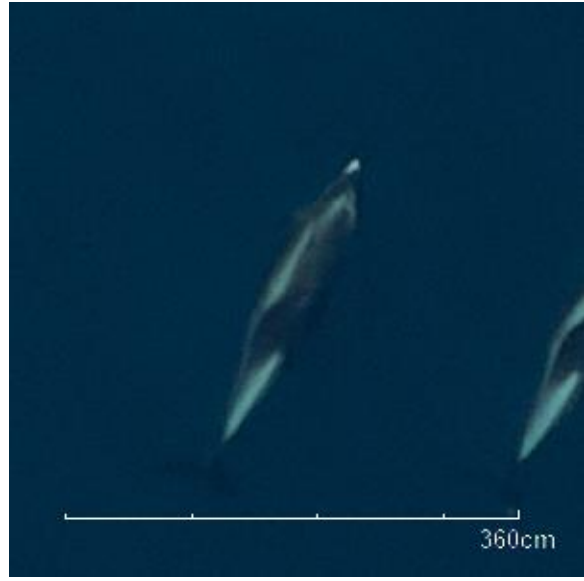


Figure 23 **White-beaked dolphin**