

Natural England

Ornithological and Marine Mammal Baseline Characterisation Surveys for the POSEIDON project

**October-December (Seasonal) Report – Central North
Sea**

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1. Executive Summary

This report constitutes the first seasonal (October to December 2022) report outlining results from digital aerial surveys conducted in January 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 three days in January 2023 with no safety issues. Due to weather delays, it was not possible to carry out the survey by the end of December 2022. A total of 3,634 observations were recorded during the survey in January 2023, of which 3,835 were observations of birds and 81 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 (October to December 2022) survey, undertaken in January 2023 due to weather delays throughout December, 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.

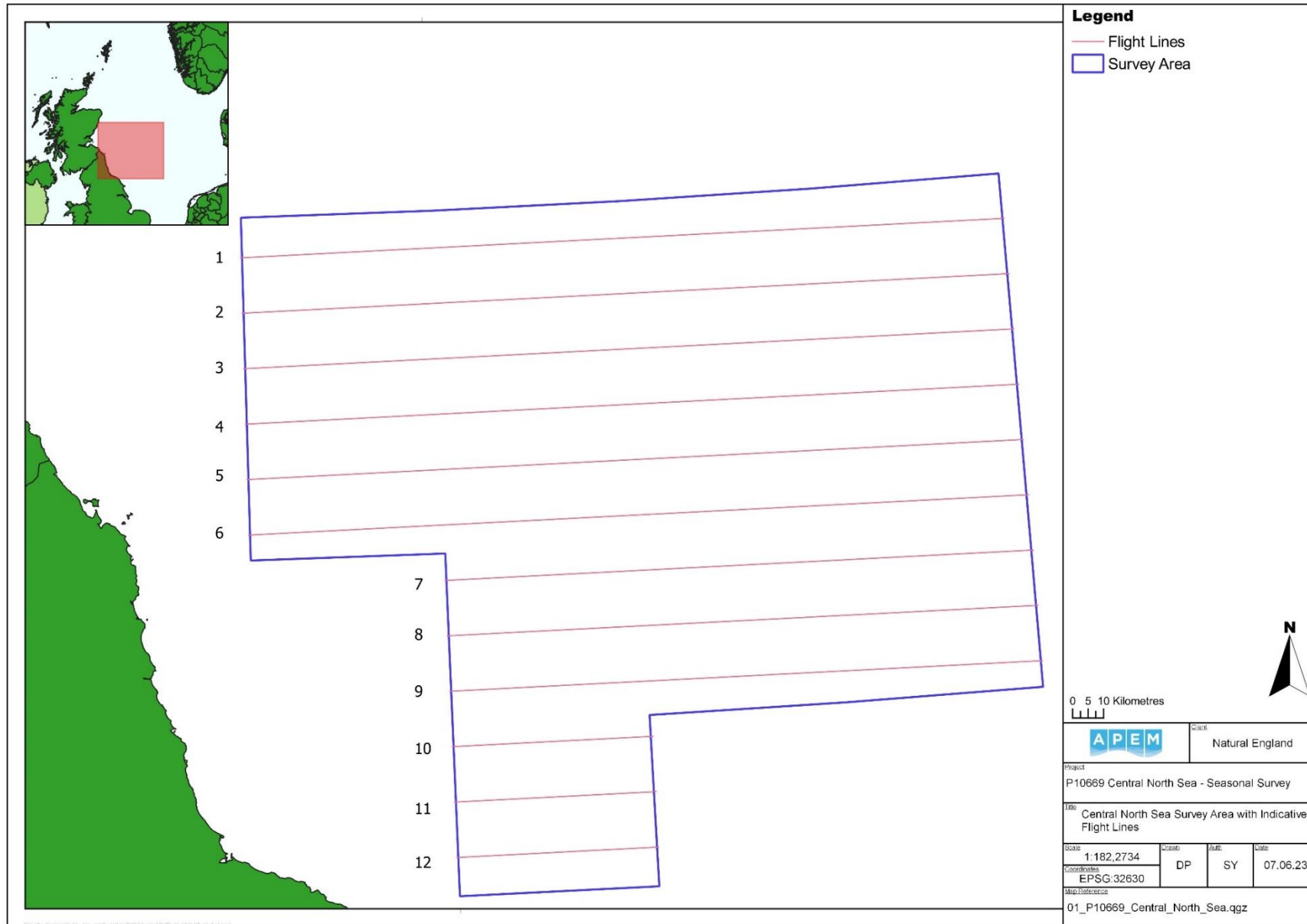


Figure 1 Location of Central North Sea survey area

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.

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. Images were collected in a continuous transect-based design 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.

Due to weather delays, flights occurred on the 20th, 21st and 22nd of January. On 20th January, two planes were used to survey lines 5 and 6 (take off at 10:10, landing at 14:13), and 7 to 10 (take off at 10:00, landing at 15:38), respectively.

On 21st January, two planes were used to survey lines 1 and 2 (take off at 12:13, landing at 15:57), and 3 and 4 (take off at 12:20, landing at 15:49), respectively.

Before all lines were completed on 21st January, the angle of the sun prevented photos of sufficient quality for analysis being taken. Therefore, on 22nd January, a single plane surveyed lines 11 and 12. Take off occurred at 10:12 and landing occurred at 10:48.

The camera system captured abutting imagery along 12 survey flight lines spaced approximately 2.6 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. For analysis purposes each transect should be treated as a single sample, therefore for the current survey design, $n=12$. Total coverage was calculated to be 3.56% captured and 3.35% analysed, generated from 6,323 image nodes. On lines 1 and 2, images were captured on two out of three cameras due to corrupted data on the hard drive; however, the target coverage of 3% was achieved including a redundancy of an additional 0.28%, which is almost 10% contingency with respect to the target coverage.

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**. Whilst strong winds (close to the standard limit of 30 knots during which conditions are considered favourable for surveys) were noted during some lines, they did not constitute a health and safety risk. 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 3.35%, thus exceeding the 3% coverage required, enabling sufficient coverage to be collected should images be affected by glint or glare.

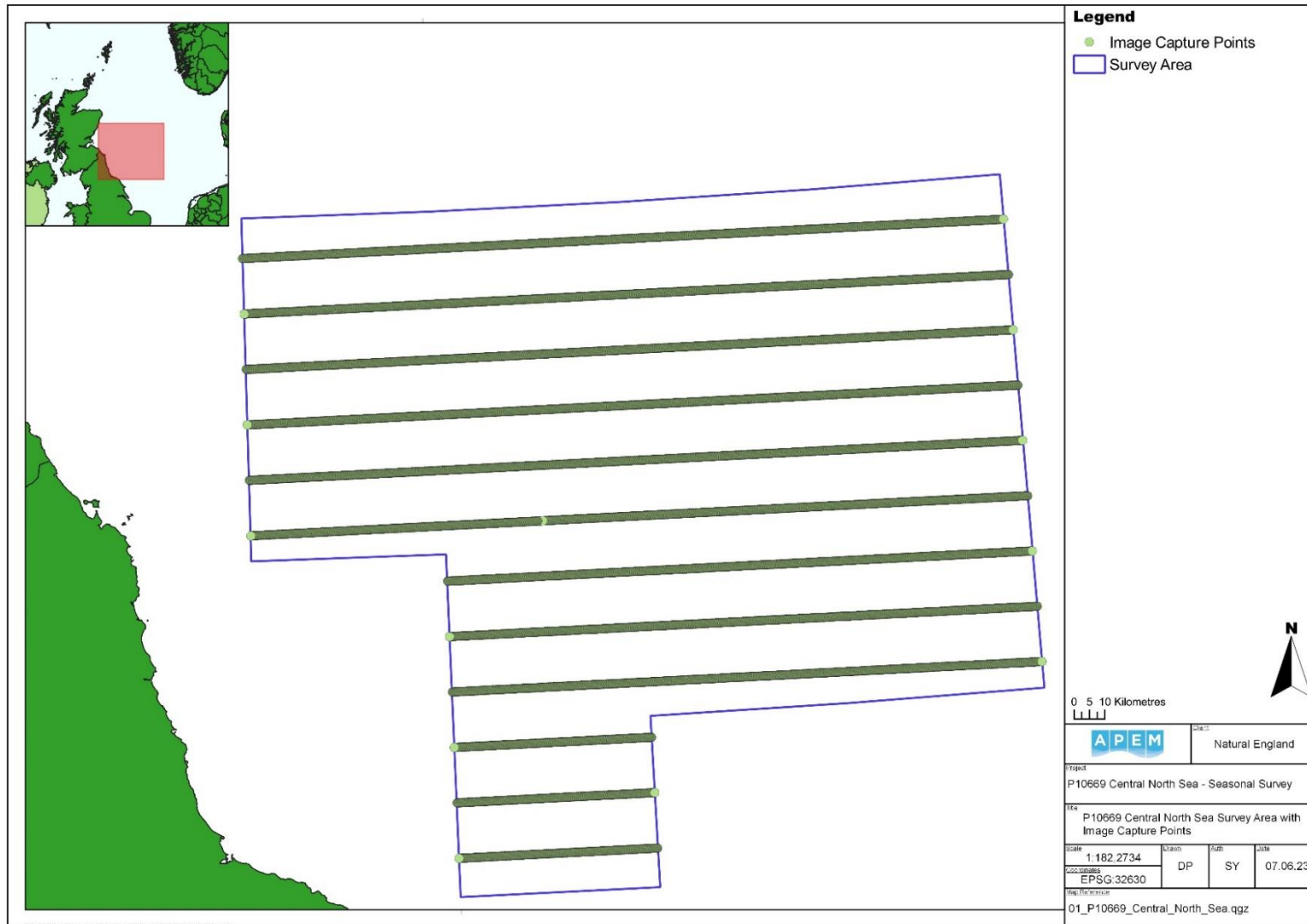


Figure 2 Individual image capture points during the October to December 2022 (January 2023) survey

Table 1 Lateral and vertical camera tolerances (m)

<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 October to December 2022 seasonal survey (January 2023).

Survey line	Transect length (km)	N cameras capturing image	N image nodes	Camera issues	Shipping observations	Anecdotal observations	Health and Safety
1	247.00	2	1,157	Corrupted data on one camera	Two fishing vessels	More vessels in area	-
2	248.14	2	1,163	Corrupted data on one camera	-	More vessels in area	-
3	248.99	3	1,751	-	-	-	-
4	250.14	3	1,759	-	-	-	-
5	250.99	3	1,765	-	-	-	-
6	252.14	3	1,774	-	-	-	-
7*	189.79	3	1,338	-	-	-	-
8	190.78	3	1,343	-	-	-	-
9	191.34	3	1,348	-	-	-	-
10	64.05	3	457	-	-	-	-
11	64.19	3	459	-	-	-	-
12	64.49	3	459	-	-	-	-

*The GPS unit reported an error on the initial line 7 survey attempt. The issue was resolved, and the line resurveyed to ensure coverage. All details for line 7 within this report refer to the successful resurvey.

Table 3 Survey conditions during the October to December 2022 seasonal survey (January 2023)

Survey line	Date	Time on line (Start / End)	Ground speed (knots)	Cloud cover (%)	Visibility (km)	Outside temperature (°C)	Wind speed (knots)	Wind direction	Sea state (Douglas)	Turbidity
1	21/01/2023	12:53 / 13:59	113	30	10+	4	27	190°	1 – 3	1
2	21/01/2023	14:05 / 15:12	126	45	10+	3	11	160°	1 – 2	1
3	21/01/2023	12:51 / 14:05	115	30	10+	3	8 – 21	180°	1 – 2	1
4	21/01/2023	14:05 / 15:12	119	50	10+	3	8 – 25	180°	1 – 2	0 - 1
5	20/01/2023	11:31 / 12:42	120	80	10+	6	7	300°	3	0
6	20/01/2023	12:47 / 13:53	130	20	10+	4	10	90°	3	0
7	20/01/2023	11:36 / 12:27	124	40	10+	5	16	360°	2	1
8	20/01/2023	12:33 / 13:25	122	45	10+	5	16	360°	2	1
9	20/01/2023	13:31 / 14:23	118	45	10+	5	16	360°	2	1
10	20/01/2023	14:58 / 15:06	137	45	10+	5	16	360°	2	1
11	22/01/2023	10:48 / 11:04	132	10	10+	4	18	190°	1 – 2	1
12	22/01/2023	11:11 / 11:29	120	10	10+	4	18	190°	1 – 2	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	<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 October to December 2022 seasonal survey period (January 2023)

Species	Group Level 1	Group Level 2	Group Level 3	Group Level 4
Golden Plover	Wader species			Unidentified Bird species
Grey Phalarope				
Kittiwake	Small Gull species		Gull species	
Great Black-backed Gull	Black-backed Gull species	Large Gull species		
Lesser Black-backed Gull				
Herring Gull				
Common Tern	'Commic' Tern		Tern species	
Arctic Tern				
Great Skua	Skua species			
Arctic Skua				
European Storm Petrel	Storm Petrel species			
Leach's Storm Petrel				
Guillemot	Guillemot and / or 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			

Table 6 Marine mammal species included within higher-level taxonomic groups for the October to December 2022 seasonal survey period (January 2023)

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

3.3 Summary of Quality Assurance

Internal QA was carried out on the data collected during the survey. A random sample of 20% of survey imagery were subjected to a QA audit review, in which agreement in positive images (those containing any target of interest) 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 and extra positives from the re-analysis and QA audit are included in the data. For the current survey, the initial agreement was 77%. After re-analysis, agreement of 95% was attained.

In addition, identifications of targets (snags) are reviewed by our dedicated QA team. 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.

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)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 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 3,835 birds were recorded in the Survey Area during the October – December 2022 seasonal (January 2023) survey. Of those, 2,794 were sitting on the water, 1,039 were in flight and 2 were deceased (Table 7). A total of 68 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 October to December 2022 seasonal survey period (January 2023)

Species Group	Species	Flying	Sitting	Deceased	Total
Gulls	Kittiwake	274	65	-	339
	Common Gull	9	-	-	9
	Great Black-backed Gull	26	28	-	54
	Herring Gull	9	-	-	9
	Large Gull species	1	2	-	3
	Small Gull species	1	-	-	1
Auk	Little Auk	-	1	-	1
	Guillemot	199	1,778	-	1,977
	Guillemot / Razorbill	6	257	-	263
	Razorbill	2	137	-	139
	Puffin	-	184	-	184
	Auk species	-	39	-	39
Diver	Red-throated Diver	1	-	-	1
Fulmar	Fulmar	494	290	-	784
Fulmar / Gull	Gannet	14	7	-	21
Gannet	Fulmar / Gull species	2	1	1	4
Unidentified Bird species	Unidentified Bird species	1	5	1	7
Total		1,039	2,794	2	3,835

Table 8 Total number of individuals of marine megafauna by species or species group recorded during the October to December 2022 seasonal survey period (January 2023)

Species Group	Species	Submerged	Surfacing	Total
Seal	Grey Seal	6	7	13
Dolphin	White-beaked Dolphin	16	2	18
Porpoise	Dolphin / Porpoise	4	-	4
Dolphin/Porpoise	Harbour Porpoise	25	17	42
Marine Mammal species	Marine Mammal species	3	1	4
Total		54	27	81

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 12** show distributions of more abundant birds by species, whilst **Figure 13** shows the distribution of less frequently recorded bird species. **Figure 14** shows the distribution of Harbour porpoise within the Survey Area and **Figure 15** shows distributions of less frequently recorded marine megafauna by species. **Figure 16** shows distribution of vessels in the Survey Area.

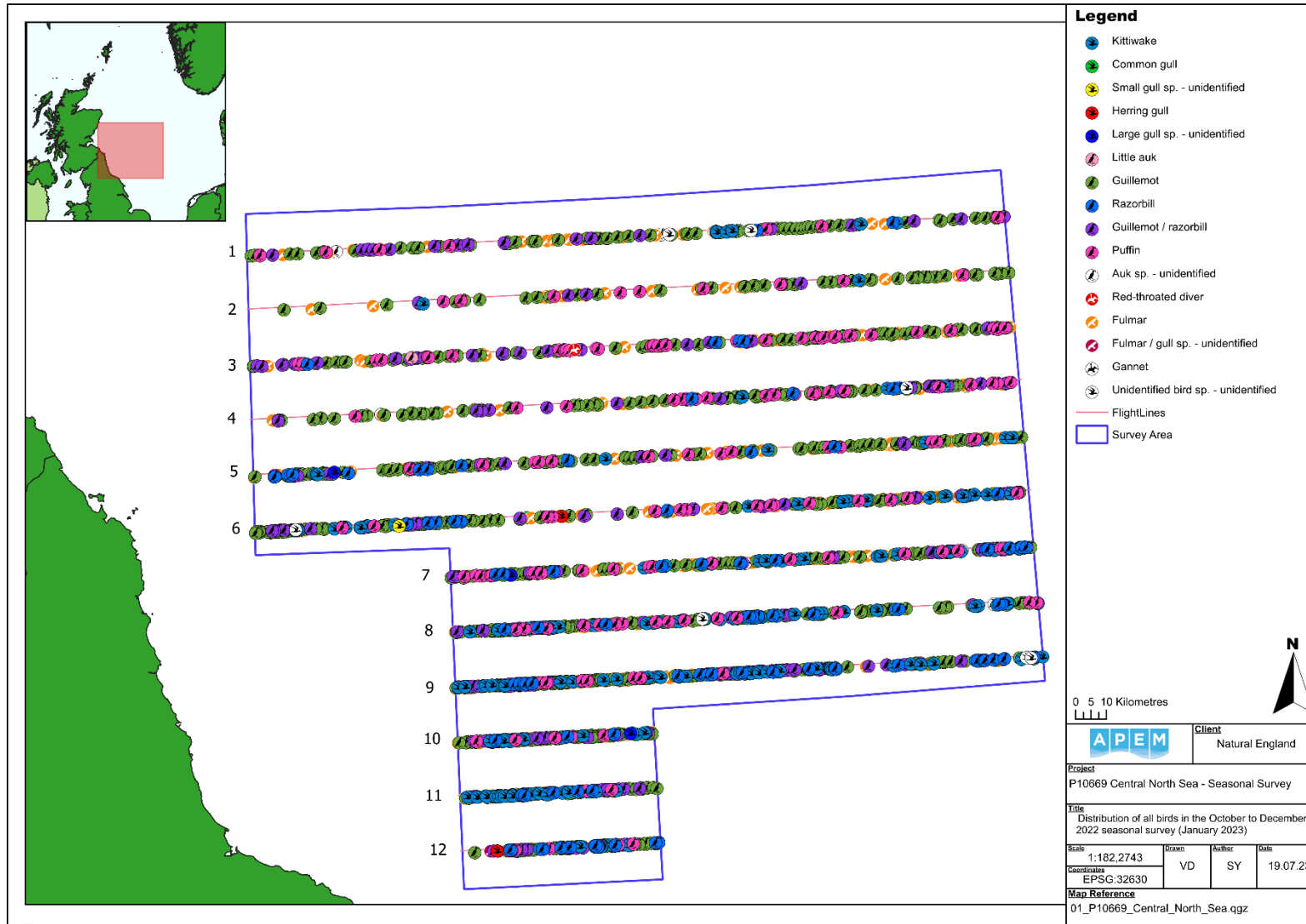


Figure 3 Distribution of all birds recorded in the October to December 2022 seasonal survey (January 2023).

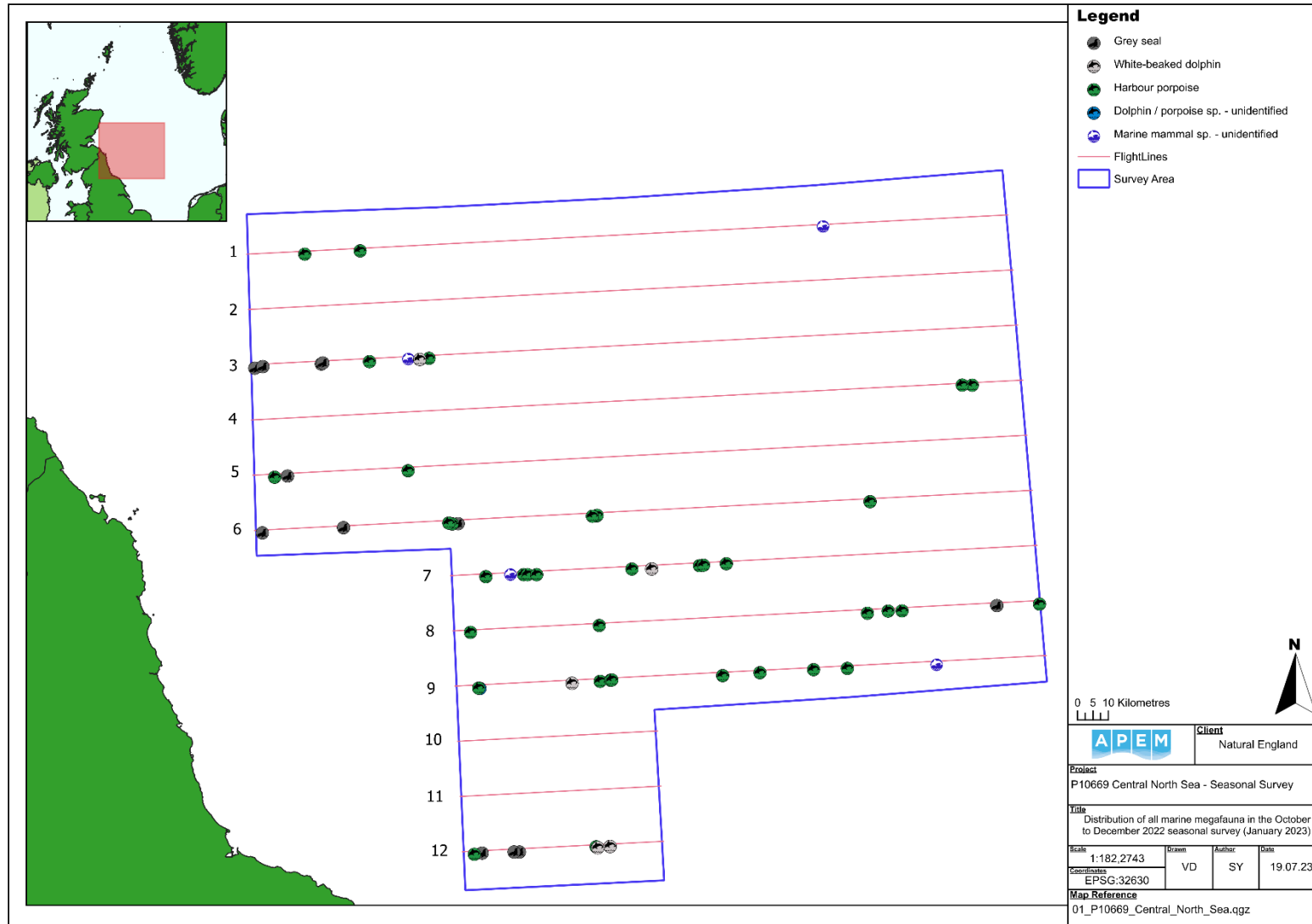


Figure 4 Distribution of all marine megafauna recorded in the October to December 2022 seasonal survey (January 2023).

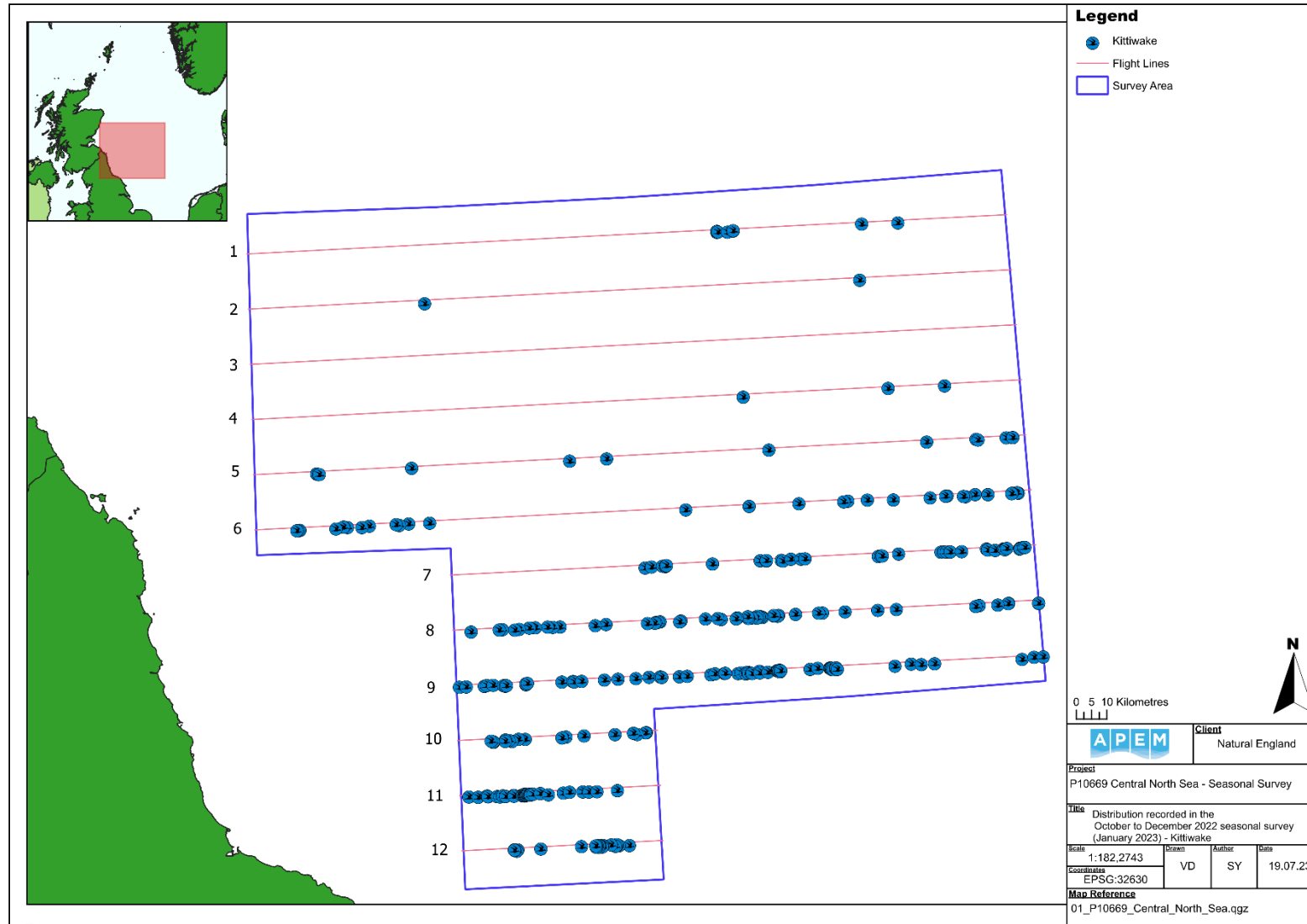


Figure 5 Kittiwake distribution recorded in the October to December 2022 seasonal survey (January 2023).

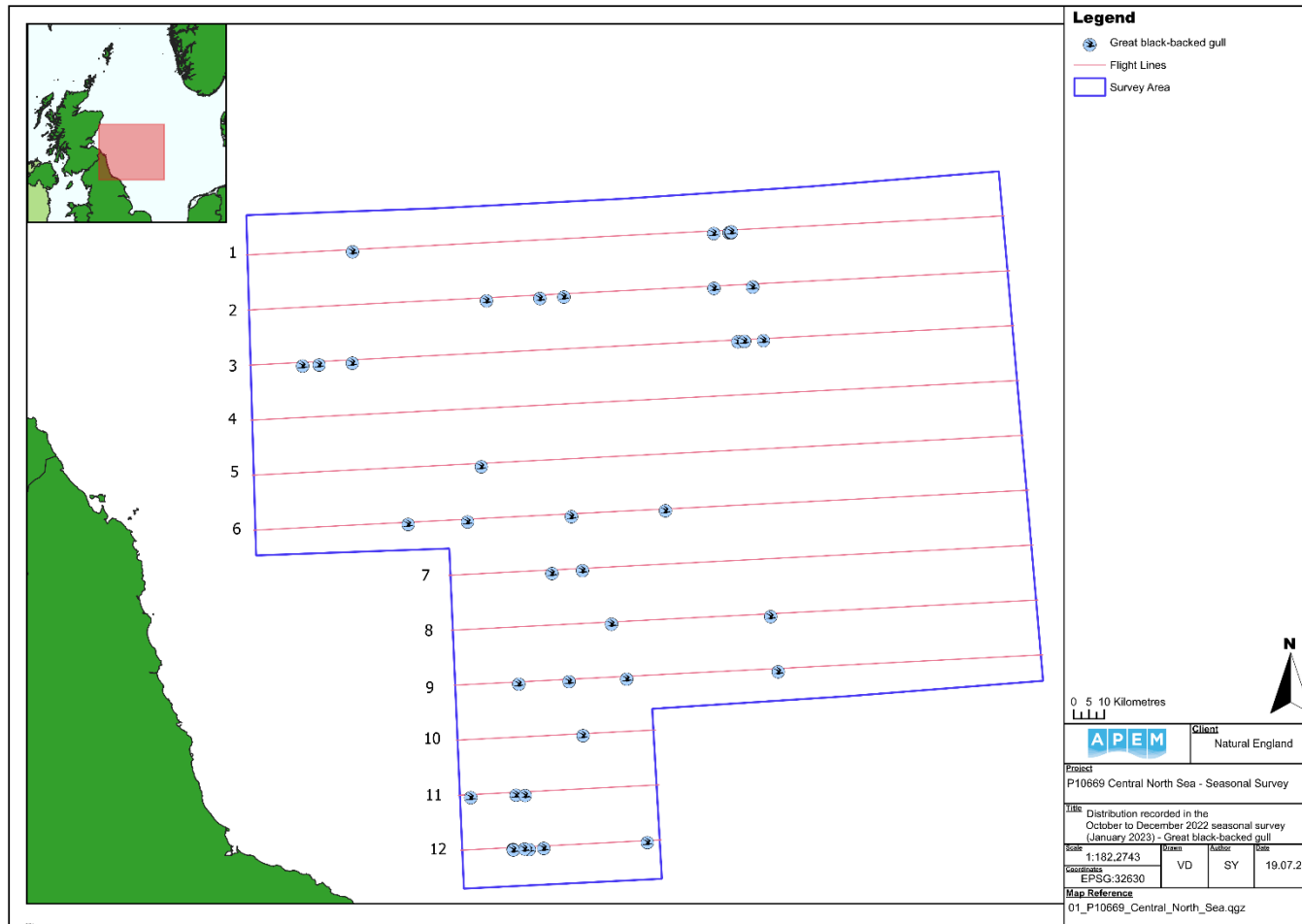


Figure 6 Great black-backed gull distribution recorded in the October to December 2022 seasonal survey (January 2023).

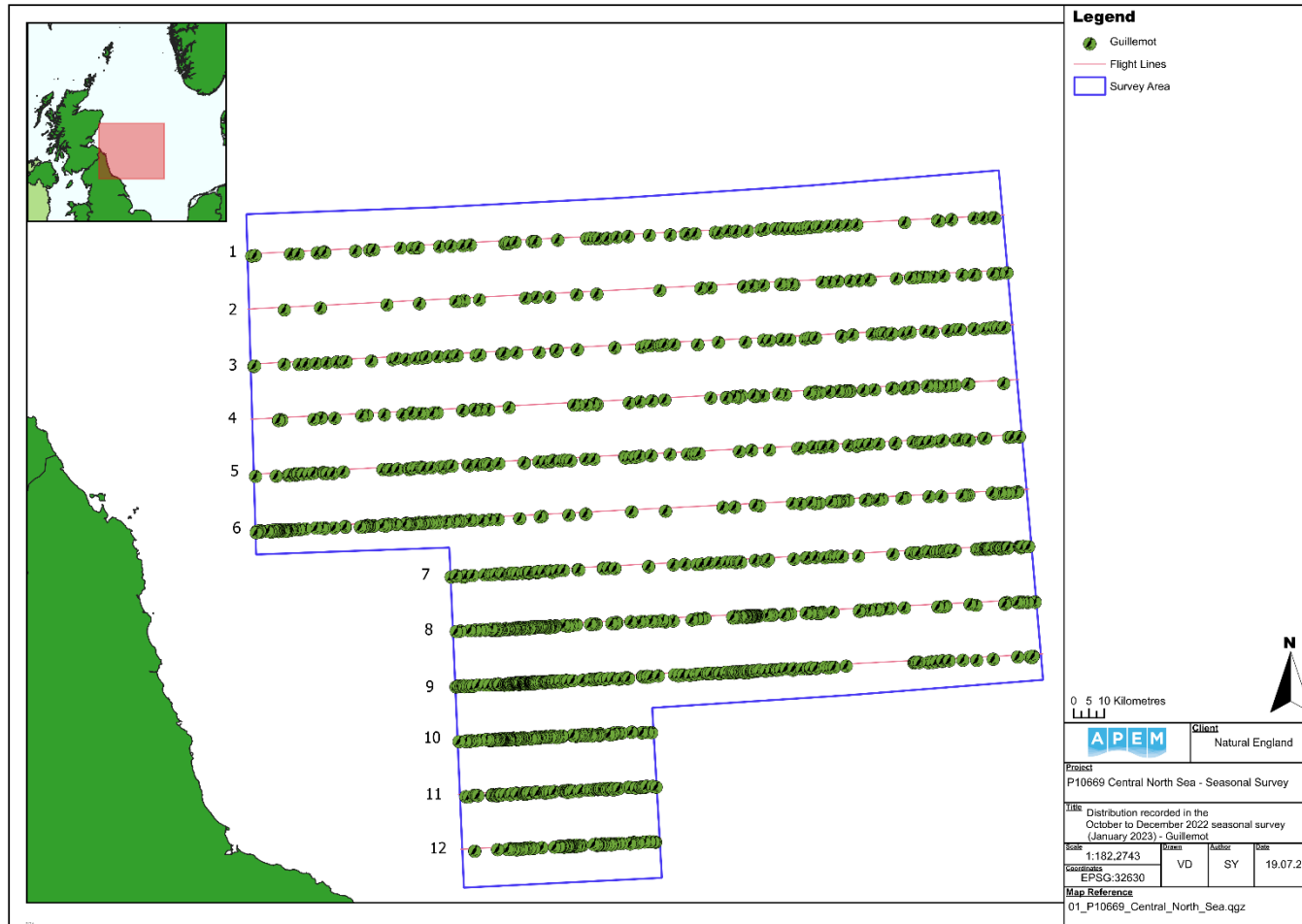


Figure 7 Guillemot distribution recorded in the October to December 2022 seasonal survey (January 2023).

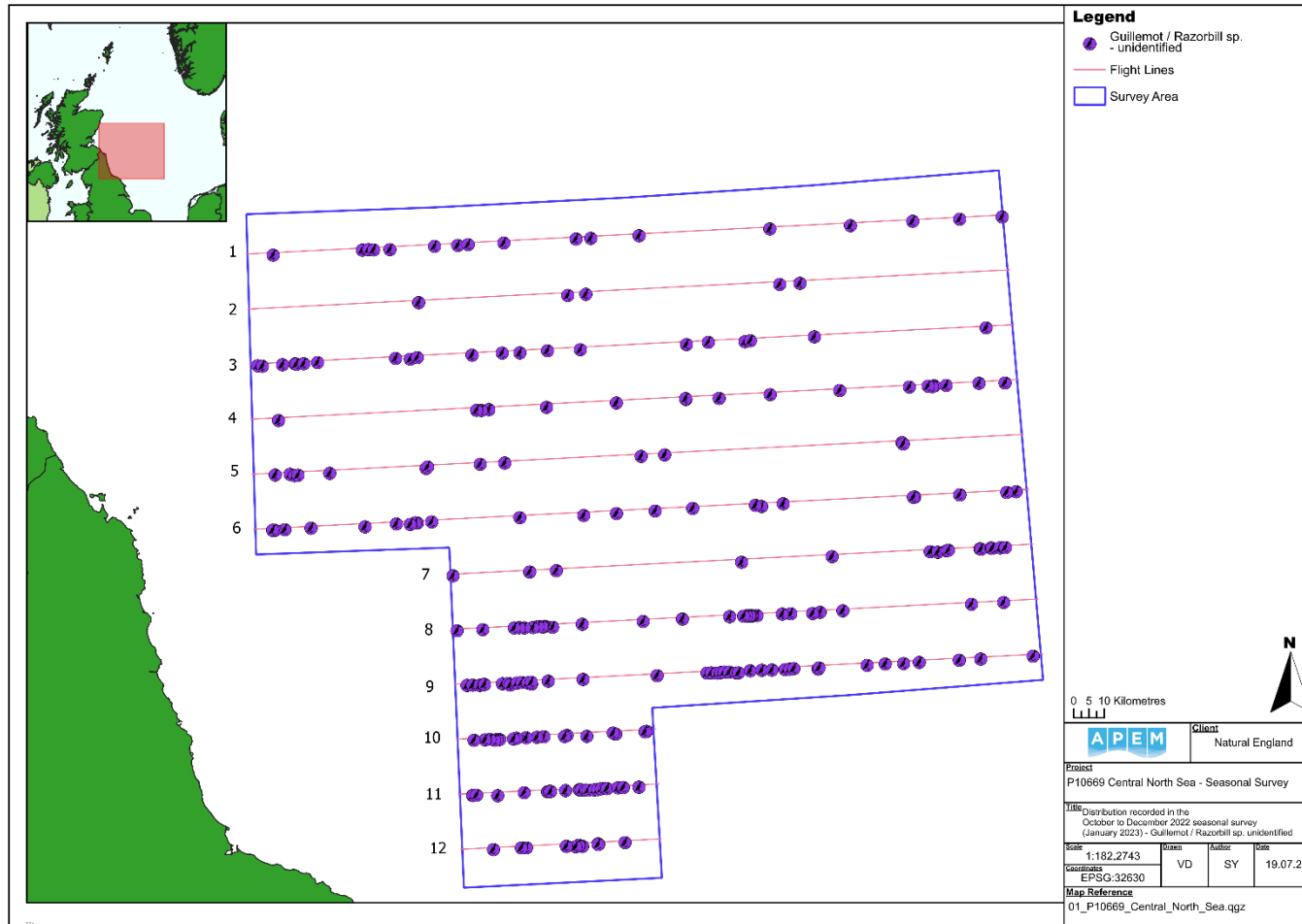


Figure 8 Guillemot / Razorbill distribution recorded in the October to December 2022 seasonal survey (January 2023).

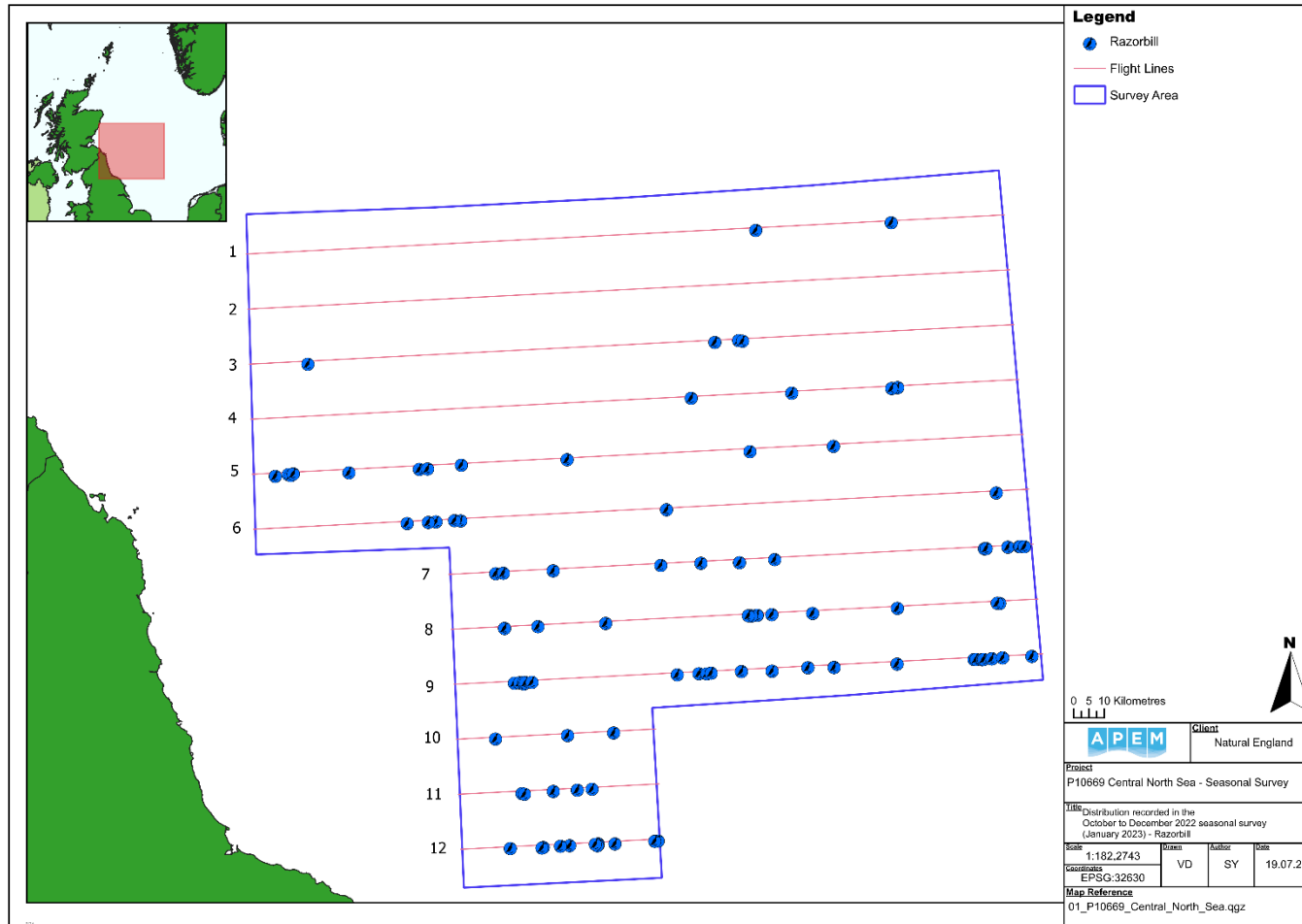


Figure 9 Razorbill distribution recorded in the October to December 2022 seasonal survey (January 2023).

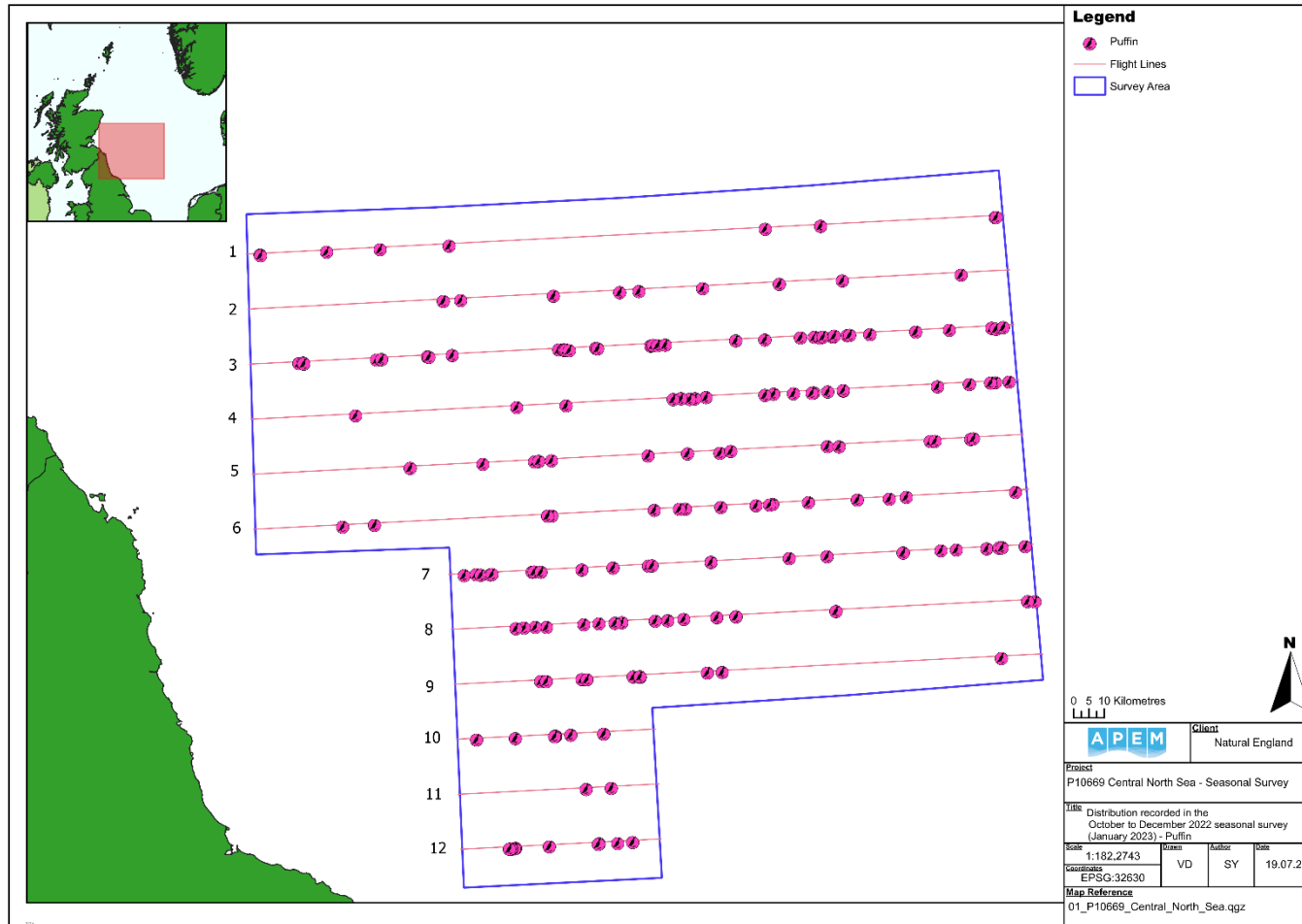


Figure 10 Puffin distribution recorded in the October to December 2022 seasonal survey (January 2023).

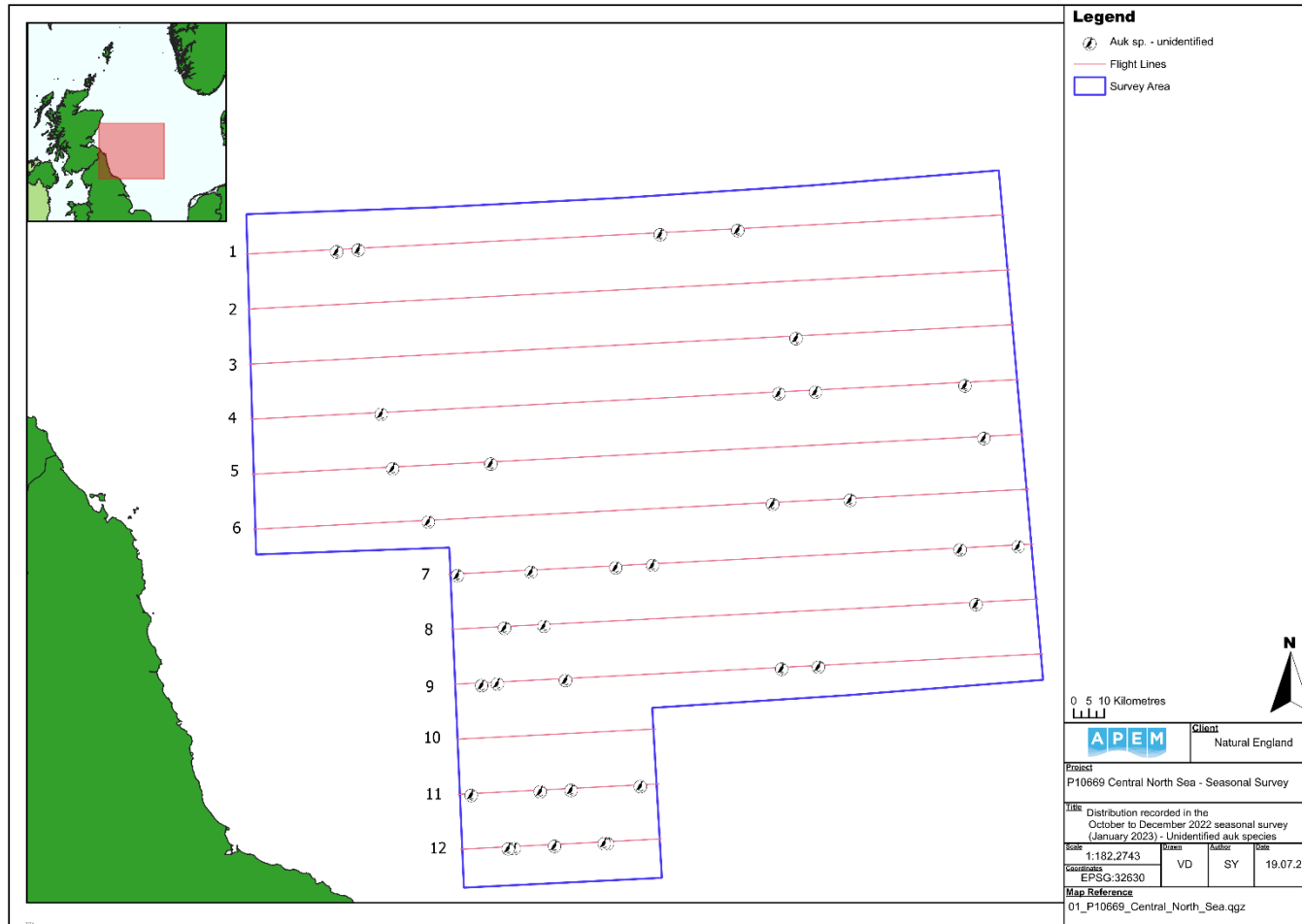


Figure 11 Auk species distribution recorded in the October to December 2022 seasonal survey (January 2023).

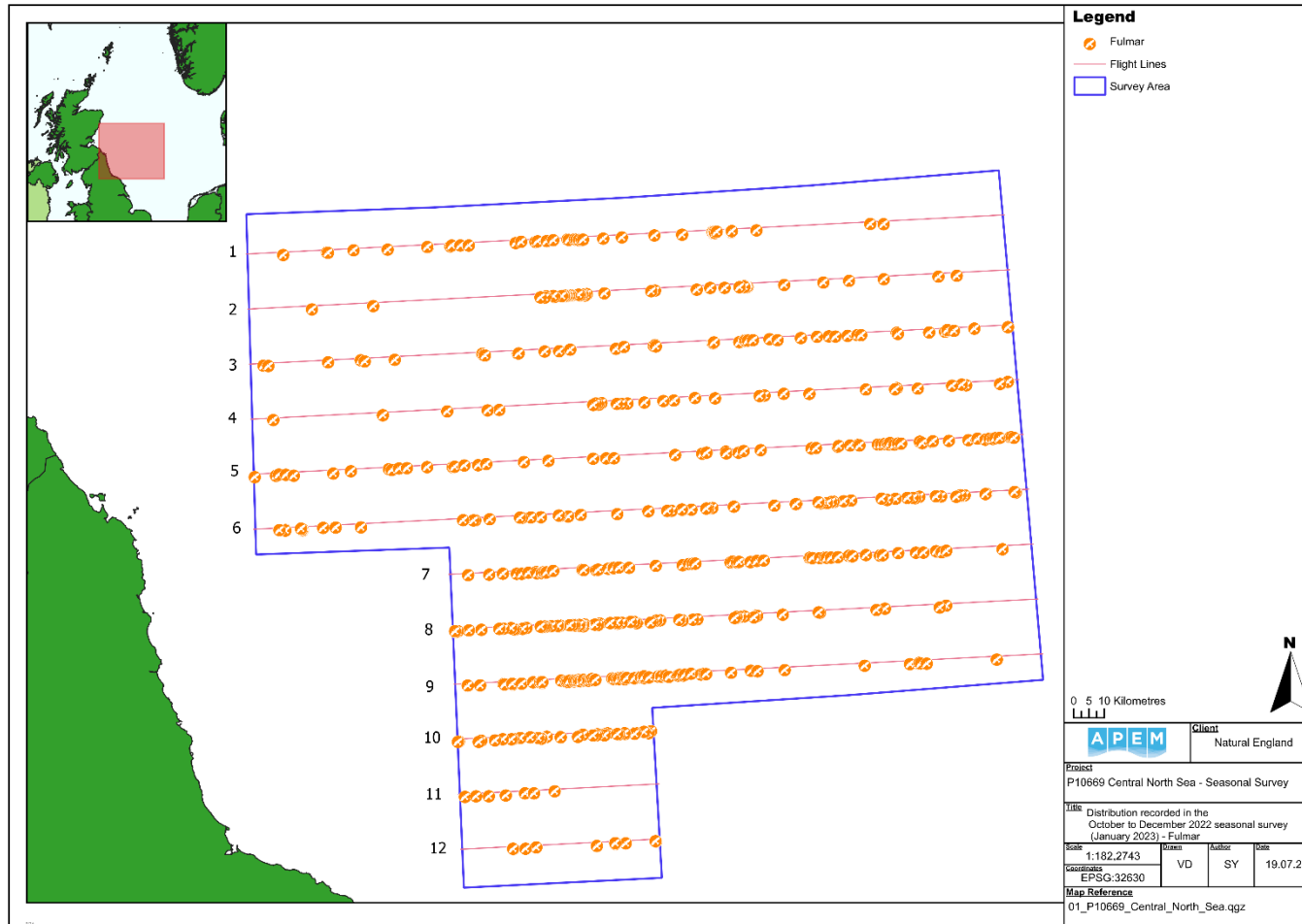


Figure 12 Fulmar distribution recorded in the October to December 2022 seasonal survey (January 2023).

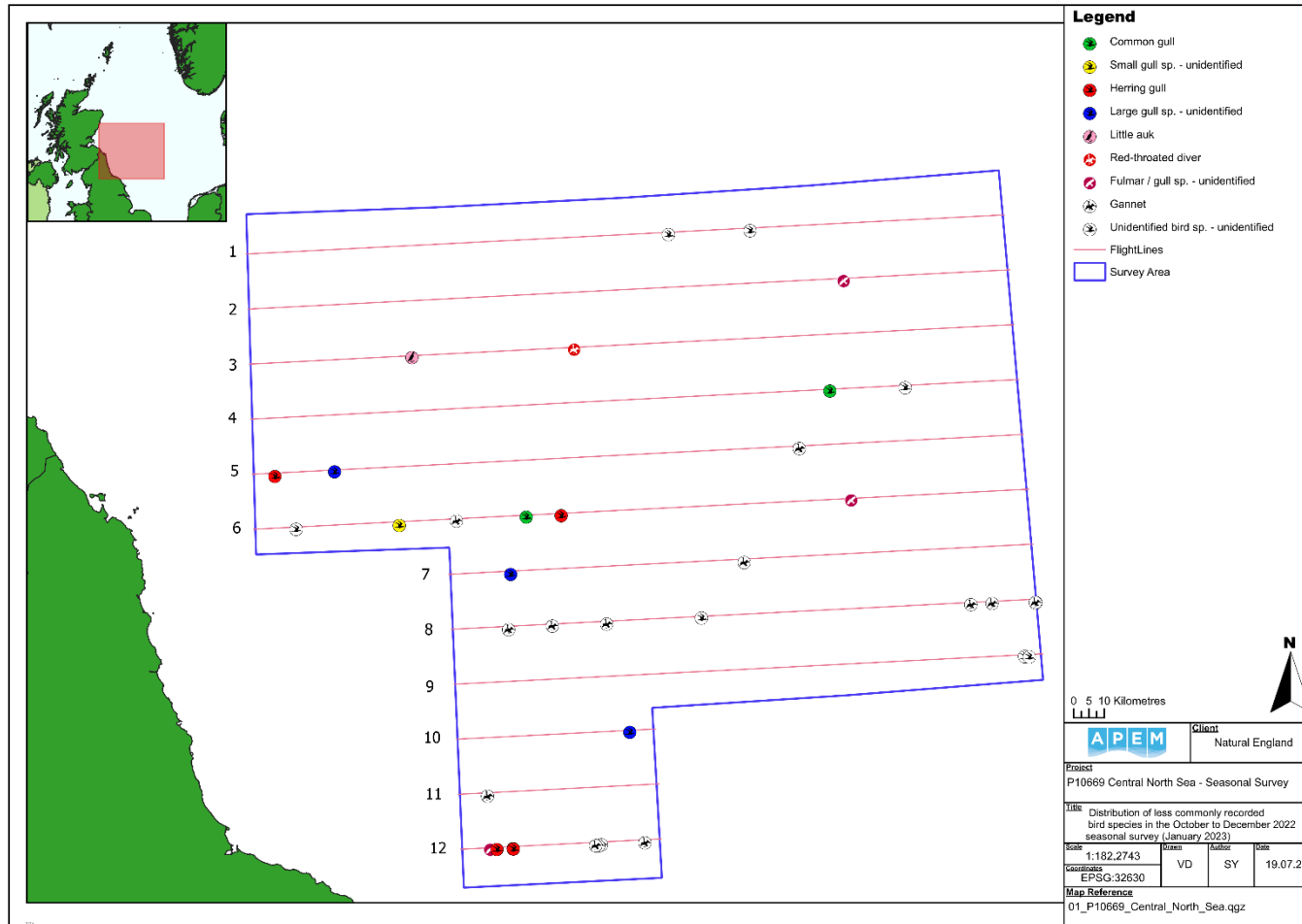


Figure 13 Distribution of less abundant bird species recorded in the October to December 2022 seasonal survey (January 2023).

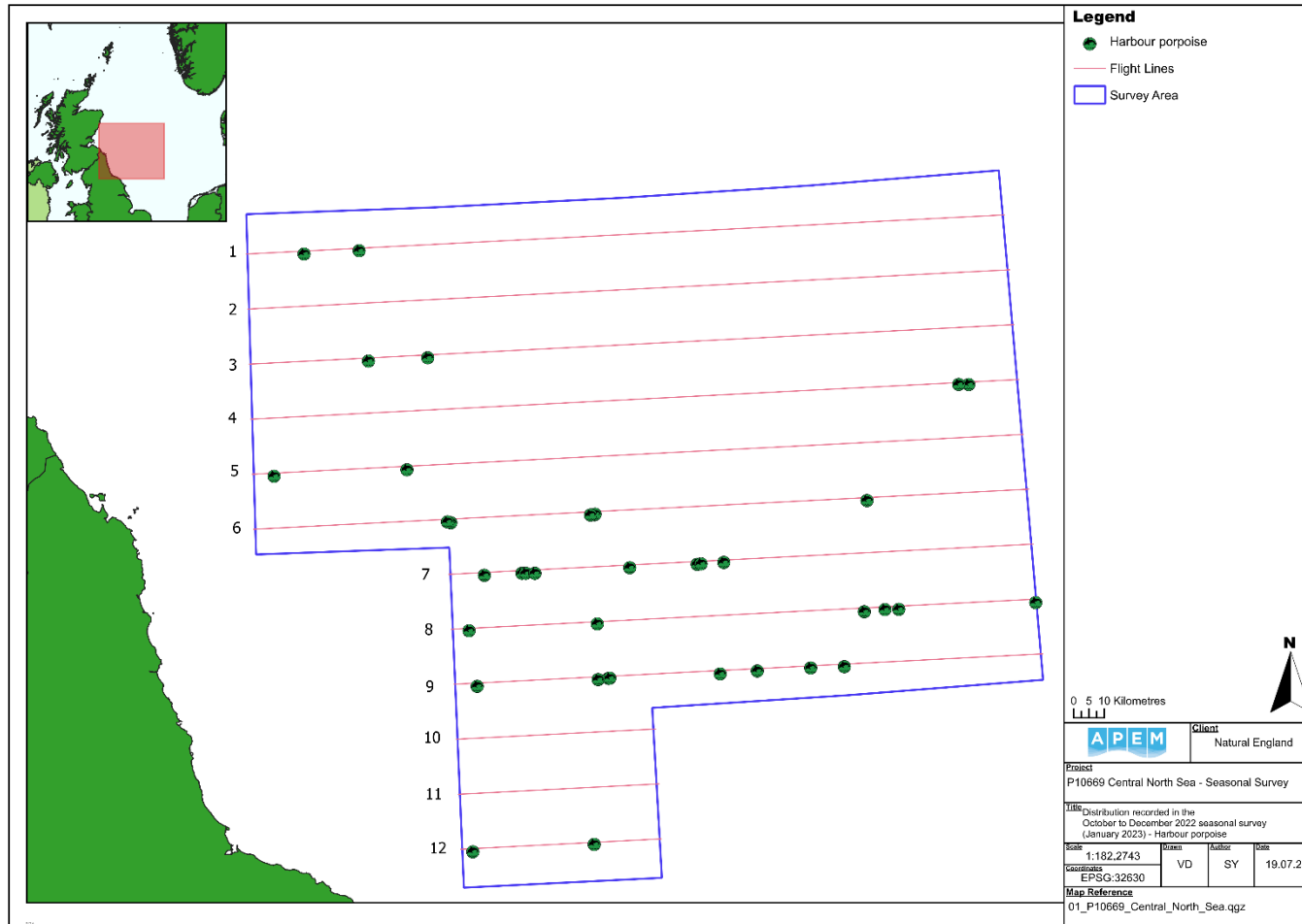


Figure 14 Harbour porpoise distribution recorded in the October to December 2022 seasonal survey (January 2023).

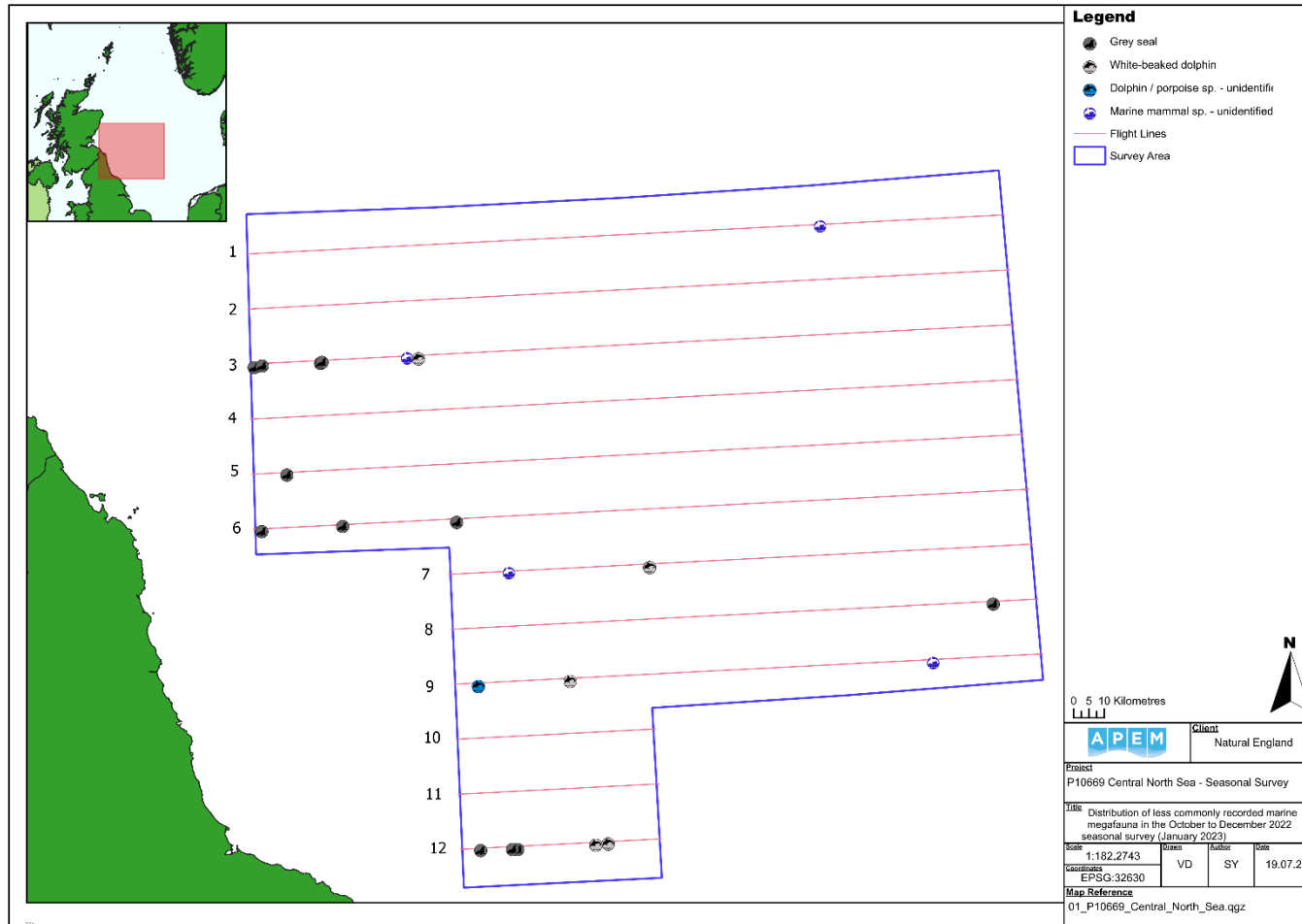


Figure 15 Distribution of less abundant marine megafauna recorded in the October to December 2022 seasonal survey (January 2023).

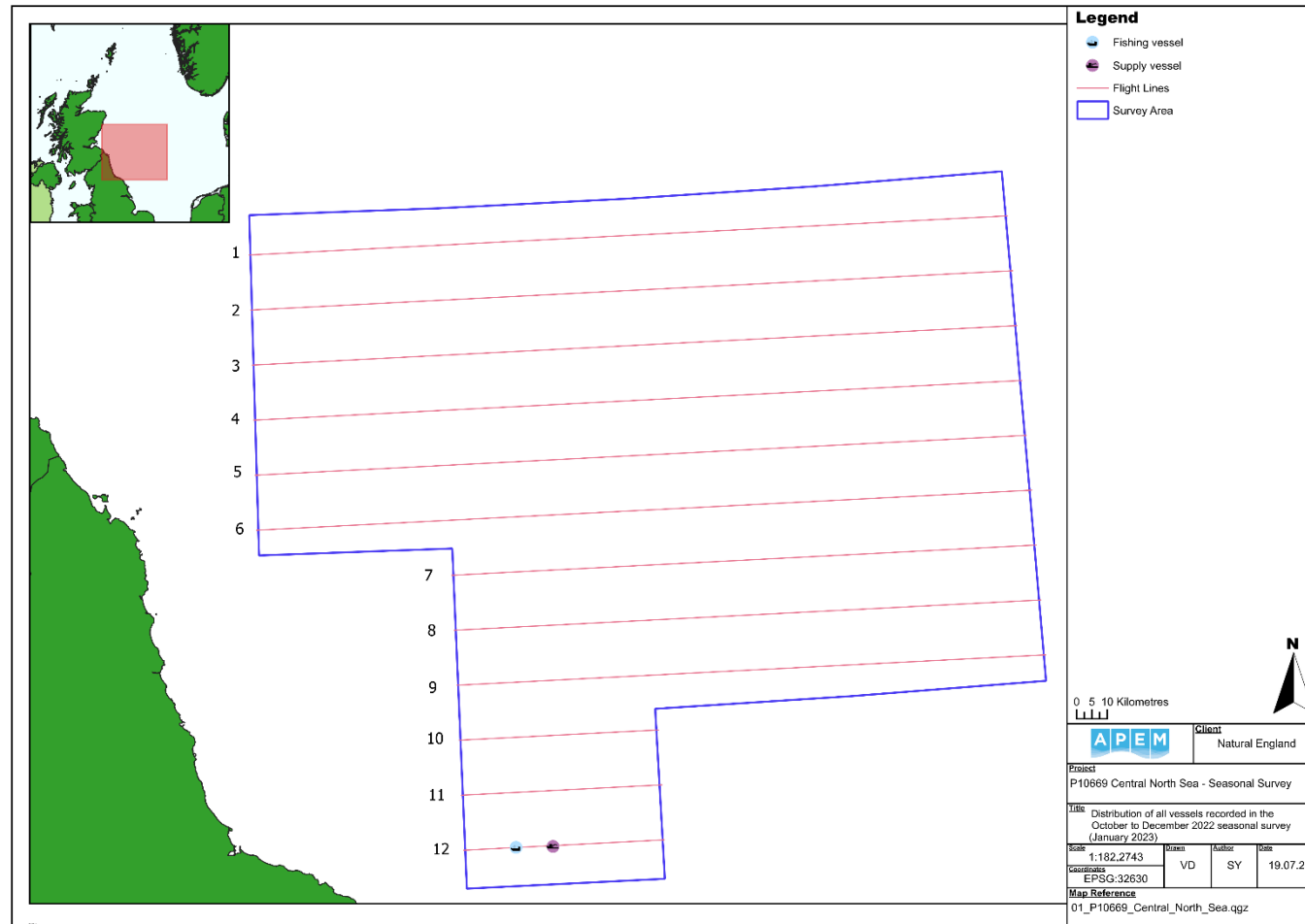


Figure 16 Distribution of vessels recorded in the October to December 2022 seasonal survey (January 2023).

5. Abiotic Structures and Observations

The following abiotic structures were observed during the survey period:

Two fishing vessels were observed from the aircraft. Both vessels were recorded along survey line number 1 on 21st of January, heading in a northerly direction. In addition to the two fishing vessels recorded, many other fishing vessels were seen in the general area on 21st of January.

Appendix I Scientific Names and Taxonomy

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

Species	Scientific.Name
Kittiwake	<i>Rissa tridactyla</i>
Common Gull	<i>Larus canus</i>
Great Black-backed Gull	<i>Larus marinus</i>
Herring Gull	<i>Larus argentatus</i>
Little Auk	<i>Alle alle</i>
Guillemot	<i>Uria aalge</i>
Razorbill	<i>Alca torda</i>
Puffin	<i>Fratercula arctica</i>
Red-throated Diver	<i>Gavia stellata</i>
Fulmar	<i>Fulmarus glacialis</i>
Gannet	<i>Morus bassanus</i>
Grey Seal	<i>Halichoerus grypus</i>
White-beaked Dolphin	<i>Lagenorhynchus albirostris</i>
Harbour Porpoise	<i>Phocoena phocoena</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.

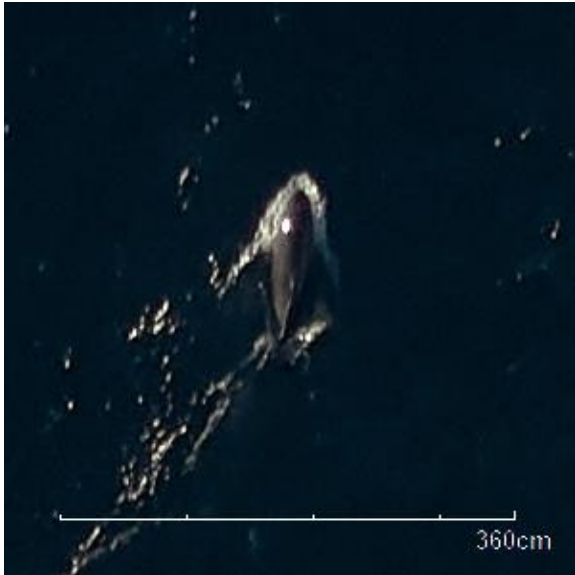


Figure 17 Harbour porpoise

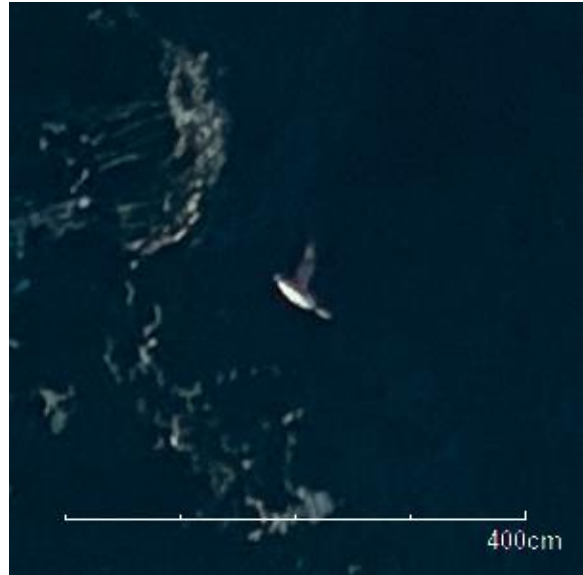


Figure 18 Red-throated diver in flight



Figure 19 Fulmar in flight



Figure 20 Gannet in flight



Figure 21 Herring gull in flight

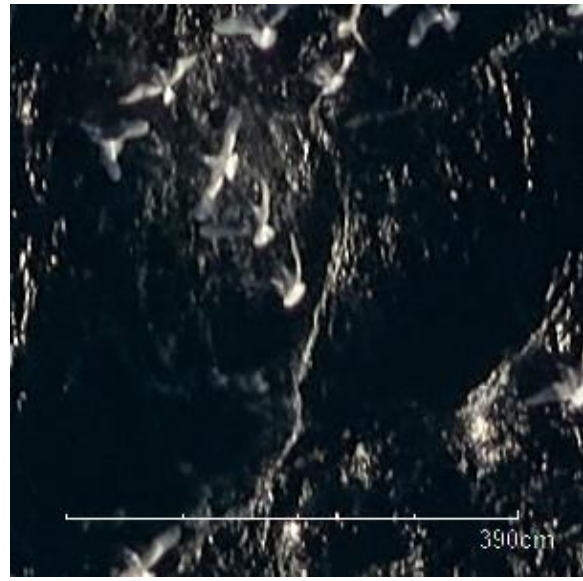


Figure 22 Small group of kittiwakes in flight over foamy sea