Appendix 11-2:
Ornithological and Marine Megafauna Aerial Survey Results

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

rps
A TETRA TECH COMPANY

PARK WIND
JERA GROUP

ESB
Energy for generations

ORIEL WIND FARM PROJECT

Environmental Impact Assessment Report
Appendix 11-2: Ornithological and Marine Megafauna Aerial Survey Results

MDR1502B
A1 C01
EIAR - Appendix 11-2
March 2024

Ornithological and Marine Megafauna Aerial Survey Results of Oriel Offshore Wind Farm

Oriel Windfarm Limited

April - September 2020

APEM Ref: P00004972

Issued December 2020

Dr Stephanie McGovern, Dr Kate Rogerson, Anya Wicikowski,

Client:	**Parkwind**
Address:	**Digital Office Centre Balheary Road Swords, Co. Dublin Ireland**
Project reference:	**P00004972**
Date of issue:	**December 2020**

Project Director:	**Dr Stuart Clough**
Project Manager:	**Stephanie McGovern**
Key Contributors:	**Simon Warford, Anya Wicikowski, Kate Rogerson**

APEM Ltd
Aviation Park
Hawarden Airport
Flint Road
Saltney Ferry
Chester
Ch4 0GZ

Tel: 01244 520 460
Fax: 01244 533 741

Registered in England No. 2530851

This report should be cited as;

APEM (2020). Oriel Offshore: April – September 2020 - Aerial Bird & Marine Megafauna Survey. APEM Scientific Report P4972. Oriel Windfarm Limited, 18/12/2020, V3, 132 pp.

Revision and Amendment Register

Version Number	Date	Section(s)	Page(s)	Summary of Changes	Approved by
1.0	06/11/2020	All	All	First draft	KR
2.0	23/11/2020	All	All	Inclusion of August data	KR
3.0	16/12/2020	All	All	Inclusion of September data	KR
Final	21/12/2020	All	All	Internal Review	AW

Contents

List of Figures

List of Tables

1. Executive Summary

A program of six monthly aerial digital surveys of the Oriel offshore wind farm area and offshore cable corridor in the Irish Sea were undertaken between April and September 2020. Surveys were carried out using APEM Ltd.'s high-resolution camera system to capture digital still imagery, to assess the abundance and distribution of birds and marine megafauna of the Oriel Survey Area. Raw counts and design-based abundance estimates of all species and incidental observations recorded during the surveys are presented here as well as information on species distribution, flight height, and flight direction. The key findings from each of the monthly aerial digital surveys are summarised below.

- Survey 1 – April 2020
    - The total number of birds recorded during the April Survey was 3,082. The most abundant species recorded was common scoter (n= 2,005), followed by great northern diver (n=285), guillemot (n=247), guillemot / razorbill (n=217), gannet (n=73), black guillemot (n=59), great black-backed gull (n=43), kittiwake (n=41), razorbill (n=36), auk species (n=24), red-throated diver (n=15), common gull (n=6), diver species (n=6), Manx shearwater (n=6), sandwich tern (n=3), duck species (n=3), black-headed gull (n=2), herring gull (n=2), puffin (n=2), cormorant / shag (n=2), commic tern (n=2), cormorant (n=1), fulmar (n=1), small gull species (n=1).

    - A total of 18 marine mammals were recorded in the Survey Area during the April survey, these were all recorded as dolphin / porpoise (n=18). No other marine megafauna was recorded during the April survey.

- Survey 2 – May 2020
    - A total of 1,485 birds were recorded in the Survey Area during the May survey. The most abundant species recorded was Manx shearwater (n=547) followed by guillemot (n=529), gannet (n=127), guillemot / razorbill (n=91), razorbill (n=67), great black-backed gull (n=35), kittiwake (n=31), herring gull (n=17), auk species (n=12), great northern diver (n=9), small gull species (n=6), sandwich tern (n=2), commic tern (n=2), lesser black-backed gull (n=2), gull species (n=2), cormorant / shag (n=2), black guillemot (n=1), puffin (n=1), common gull (n=1) and great shearwater (n=1).

    - A total of nine marine mammals were recorded in the Survey Area during the April survey, these were recorded as dolphin / porpoise (n=5) and phocids (n=4). No other marine megafauna was recorded during the April survey.

- Survey 3 – June 2020
    - A total of 963 birds were recorded in the Survey Area during the June survey. The most abundant species recorded was razorbill (n=295), followed by guillemot / razorbill (n=245), guillemot (n=207), Manx shearwater (n=90), gannet (n=41), black guillemot (n=38), cormorant (n=9), auk species (n=7), puffin (n=7), commic / roseate tern (n=5), commic tern (n=4), great northern diver (n=4), diver species (n=3), sandwich tern (n=3), kittiwake (n=2), curlew (n=1), great black-backed gull (n=1) and herring gull (n=1).

    - A total of eight marine mammals were recorded in the Survey Area during the June survey, these were recorded as phocids (n=7), harbour porpoise (n=1). One other marine megafauna was recorded during the June survey, it was identified as shark species (n=1).

- Survey 4 – July 2020
    - A total of 4,640 birds were recorded in the Survey Area during the July survey. The most abundant species recorded was guillemot (n=3,235), followed by guillemot / razorbill (n=808), Manx shearwater (n=280), gannet (n=156), black guillemot (n=38), razorbill (n=31), herring gull (n=24), kittiwake (n=15), auk species (n=10), great black-backed gull (n=10), puffin (n=7), commic tern (n=5), common scoter (n=4), cormorant (n=4), great northern diver (n=4), commic / roseate tern (n=3), common gull (n=2), great skua (n=1), lesser black-backed gull (n=1), roseate tern (n=1) and sandwich tern (n=1).

    - A total of three marine mammals were recorded in the Survey Area during the July survey, these were recorded as phocids (n=3). No other marine megafauna was recorded during the July survey.

- Survey 5 – August 2020
    - A total of 4,965 birds were recorded in the Survey Area during the August survey. The most abundant species recorded was guillemot (n=3,077), followed by Manx shearwater (n=1,317), black guillemot (n=224), gannet (n=145), razorbill (n=66), guillemot / razorbill (n=54), great black-backed gull (n=37), kittiwake (n=18), puffin (n=10), commic tern (n=7), small gull species (n=3), gull species (n=2), auk species (n=1), cormorant (n=1), fulmar (n=1), herring gull (n=1) and sandwich tern (n=1).

    - A total of 20 marine mammals were recorded in the Survey Area during the August survey, these were recorded as dolphin / porpoise (n=15), grey seal (n=2), harbour porpoise (n=2) and phocids (n=1).

- Survey 6 – September 2020
    - A total of 8,652 birds were recorded in the Survey Area during the September. The most abundant species recorded was guillemot (n=6,163), followed by razorbill (n=1,064), guillemot / razorbill (n=796), black guillemot (n=217), gannet (n=141), Manx shearwater (n=137), common scoter (n=29), kittiwake (n=24), puffin (n=24), great black-backed gull (n=16), auk species (n=7), common tern (n=7), commic tern (n=5), red-throated diver (n=4), commic / roseate tern (n=3), sandwich tern (n=3), arctic skua (n=2), cormorant / shag (n=2), gull species (n=2), cormorant (n=1), herring gull (n=1), large gull species (n=1), lesser black-backed gull (n=1), little gull (n=1) and small gull species (n=1).

    - A total of 22 marine mammals were recorded in the Survey Area during the September survey, these were recorded as dolphin / porpoise (n=7), dolphin species (n=3), harbour porpoise (n=3), phocids (n=3), grey seal (n=2), marine mammal species (n=2), baleen whale species (n=1) and common minke whale (n=1). One other marine megafauna was recorded during the September survey, it was identified as leatherback turtle (n=1).

2. Introduction

Parkwind, as investors in Oriel Windfarm Limited, requested APEM Ltd (APEM) to undertake monthly aerial digital surveys of Oriel Offshore Windfarm Ornithology Study area. The primary objective of the work was to assess the abundance and distribution of birds present in the area and to gather information on other marine megafauna, such as marine mammals. This data will meet the aims and objectives of the work required by Oriel Windfarm Limited to inform future environmental impact assessment work for the proposed wind farm development.

The Ornithology Study area is located, in the west of the Irish Sea, off the east coast of Ireland (**Figure 1**). Surveys commenced in April 2020 and were continued for six months. The survey method was designed to complement the pre-existing boat-based surveys which had already been undertaken, with the same aims and objects as this digital aerial survey.

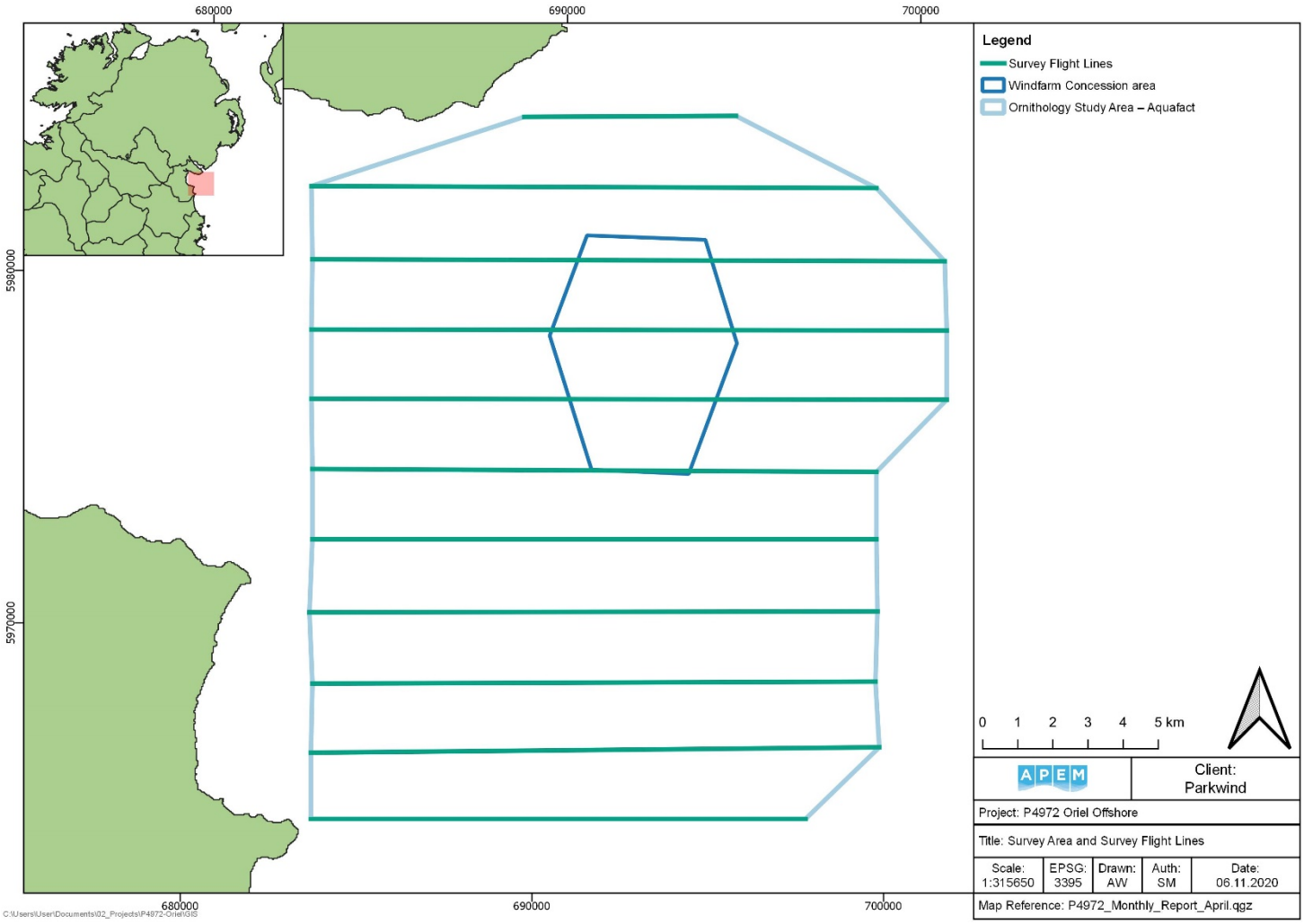


Figure 1 Location of the Oriel Offshore Ornithology Study area, with survey flight lines.

This report summarises the information collected following the completion of the six monthly aerial digital surveys of the Ornithology Study area between April 2020 and September 2020.

The following information is provided in Section 3:

- The number of surveys conducted;
- The dates, start and end times, and weather conditions;
- Survey and analysis methodology; and
- Health and safety notes.

The following information is provided in Section 4:

- Raw counts of observations across surveys from April 2020 to September 2020;

The following information is provided in Section 5:

- Design-based abundances and densities for each bird species / taxonomic group;
- Flight direction information;
- Flight height information; and
- Maps showing the locations of each bird species / taxonomic group.

Anecdotal observations, for example shipping information recorded visually from the aircraft or captured in the imagery, is provided in Section 6.

3. Survey and Analysis Methodologies

3.1 Summary of Aerial Digital Surveys

APEM has a bespoke camera system called “Shearwater IV” customised by in-house specialists for surveying the offshore environment. The camera system is integrated with custom flight planning software that allows each survey transect to be accurately mapped out before the aircraft leaves the ground. Each image node is precisely defined, allowing the system to capture imagery at exactly the right location. The flight planning software ensures that each survey is flown with the same transect orientation and the camera is triggered at the same position along each transect within set tolerances. APEM’s planning systems enable tolerances on flight path along survey lines to be set, automatically aborting survey lines that drift away from the aircraft’s planned flight line.

APEM’s on-board camera technician continually monitored the imagery as it was collected to ensure the data collected was fit for purpose. Both the pilot and camera technician would make the decision to cease data collection should the conditions become unsuitable for surveying and / or data collection. Subsequently, the survey would then be resumed at the next earliest opportunity.

APEM’s bespoke camera system was fitted into a twin-engine aircraft, data collected were 1.5 centimetre (cm) ground sample distance (GSD) digital still images, using a GPS-linked bespoke flight management system to ensure the tracks were flown with a high degree of accuracy at least 25% coverage of the sea surface was collected to be analysed. The camera system captured abutting still imagery along 11 survey lines spaced approximately two kilometres (km) between-track, perpendicular to the coastline. The aircraft collected the data at an altitude of approximately 395 meters (m), and a speed of approximately 120 knots. The aircraft’s internal Global Positioning System (GPS) and inertial measurement unit (IMU) systems record to an accuracy of +/- 3 to 5 m as standard.

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 is completed, the data are checked to ensure the number of lines and the number of images collected is correct, and that the quality of the imagery is acceptable. Once the image analysis is completed, further Quality Control (QC) processes take place (see **3.2 Summary of Quality Control**).

No health or safety issues were reported during the surveys.

The date(s), and start and end times are provided for each aerial digital survey in **Table 1** with the corresponding weather conditions provided in **Table 2**.

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 Ornithology Study area. Favourable conditions for surveying are defined as a cloud base of > 518 m, visibility of >5 km, wind speed of <30 knots, and sea state of 4 (moderate) or less on the Beaufort scale . For safety reasons, no surveying takes place in icing conditions.

Table 1 Date and start / end time (Coordinated Universal Time) for each flight for the April 2020 to September 2020 monthly surveys

Survey No.	Date	Flight Number	UTC Start Time (HH:MM)	UTC End Time (HH:MM)
1	24-04-2020	1	08:00	10:09
2	02-06-2020	1	12:04	13:58
3	21-06-2020	1	16:21	17:48
4	18-07-2020	1	16:07	17:31
5	08-08-2020	1	13:41	14:55
6	03-09-2020	1	07:45	09:19

Table 2 Weather conditions recorded for completed surveys: April 2019 to March 2020

Survey No.	Date	Douglas Sea State[1]	Wind Speed (knots) / Direction	Cloud Cover (%)[2]	Visibility (km)	Air Temp (°C)
1	24-04-2020	1	10 - 15 / W	50	> 10 km	18
2	02-06-2020	1	10 / NE	50	> 10 km	19
3	21-06-2020	3	15 - 20 / W	25-50	> 10 km	15
4	18-07-2020	2	10 / NW	50-95	> 10 km	15
5	08-08-2020	1	10 / NE	0-80	> 10 km	16-18
6	03-09-2020	3	20 / W	50-100	> 10 km	16-17

[1] 0 = Calm (Glassy); 1 = Calm (Rippled); 2 = Smooth; 3 = Slightly Moderate; 4 = Moderate

[2] 0 = Clear; 1-10 = Few; 11-50 = Scattered; 51-95 = Broken; 96-100 = Overcast

3.2 Summary of Quality Control

Internal QA was carried out on the data collected from each of the surveys. Images were assessed in batches with a different staff member responsible for each batch. Each image containing birds was reviewed and checked by APEM's dedicated QA Manager, ensuring that 100% of birds found were subject to internal QA to ensure that species identification was correct. Images containing no birds, marine megafauna or anthropological objects of interest were removed and kept separately for further internal QA. Of these 'blank' images, 10% were randomly selected for QA. If there was less than 90% agreement, the entire batch was re-analysed independently by a different staff member than who initially analysed the imagery.

3.3 Species Abundance Estimates

For each monthly aerial digital survey of the Ornithology Study area, geo-referenced locations of marine fauna, contained within each individual digital still image, were used to generate raw counts. Marine fauna locations contained within the boundaries of the two areas: the Ornithology Study area (which contains the Windfarm Concession area), and the Windfarm Concession area alone were then extracted using QGIS, providing raw count data. These data are presented in this annual report for all species.

The raw counts were then divided by the number of images collected to give the mean number of animals per image (*i*). Population estimates (N) for each survey month were then generated by multiplying the mean number of animals per image by the total number of images required to cover the entire study area (A):

$N = i\,A$

Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. The

statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values were taken as the variability of the statistic over the population (Efron & Tibshirani, 1993).

A measure of precision was calculated using a Poisson estimator, suitable for a pseudo-Poisson over-dispersed distribution. This produced a CV based on the relationship of the standard error to the mean.

All analyses and data manipulation carried out by APEM were conducted in the R programming language (R Core Team, 2020) and non-parametric 95% confidence intervals were generated using the 'boot' library of function (Canty & Ripley, 2010). This results in species-specific monthly abundance estimates being calculated from the raw count data, with upper and lower confidence limits. Where appropriate, a level of precision is also presented for each monthly abundance estimate. Dividing the monthly abundance estimates by the size of the area covered (Ornithology Study area or Windfarm Concession area) calculates the associated density (e.g. bird per km^2) for any given species.

3.4 Species Distribution Maps

Each individual located by the surveys is geo-referenced and this allows those locations to be related to the boundary of the Ornithology Study area. Distribution maps were produced for each species using QGIS (version 3.10.7) by separating each individual species recorded in all surveys and then representing these individuals as a symbol 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 a differentiation across the board between species that use the same icon.

3.5 Species Flight Direction Rose Diagrams

The flight direction of birds was recorded from all digital still images. Bearings of bird directions were plotted using Oriana to summarise overall directions of movement. The mean angle and mean vector is used to describe directional preferences and extent of 'agreement'. A Rayleigh test that assumes a null hypothesis of uniformity (i.e. scattered orientation in all directions) was used, where a significant test indicates directionality of movement.

3.6 Avian Flight Altitudes

Bird flight altitude was estimated from the digital still images. It was determined using bespoke APEM software that applies a set of rules developed in-house as well as trigonometry to provide an estimate of flight height above mean sea level (MSL). Flight height boxplot graphs were produced for each species, where possible, by combining the suitable flight height data collected from the survey programme. The 'box' is the interquartile range, with the middle bold line representing the median of the data. The 'whiskers' are the largest and smallest non-outliers. The range of the entire data includes the outliers represented by circles.

4. Raw counts of bird and marine megafauna

A total of 23,787 birds were recorded in the Survey Area during the April 2020, May 2020, June 2020, July 2020, August 2020 and September 2020 surveys (**Table 3**). The most abundant species recorded was guillemot (n=13,458), followed by Manx shearwater (n=2,377), guillemot / razorbill (n=2211), common scoter (n=2,038), razorbill (n=1,559), gannet (n=683), black guillemot (n=577), great northern diver (n=302), great black-backed gull (n=142), kittiwake (n=131), auk species (n=61), puffin (n=51), herring gull (n=46), commic tern (n=25), red-throated diver (n=19), cormorant (n=16), sandwich tern (n=13), commic / roseate tern (n=11), small gull species (n=11), common gull (n=9), diver species (n=9), common tern (n=7), cormorant / shag (n=6), gull species (n=6), lesser black-backed gull (n=4), duck species (n=3), arctic skua (n=2), black-headed gull (n=2), fulmar (n=2), curlew (n=1), great shearwater (n=1), great skua (n=1), large gull species (n=1), little gull (n=1) and roseate tern (n=1).

A total of 80 marine mammals were recorded in the Survey Area during the April 2020, May 2020, June 2020, July 2020, August 2020 and September 2020 surveys (**Table 4**), these were recorded as dolphin / porpoise (n=45), phocids (n=18), harbour porpoise (n=6), grey seal (n=4), dolphin species (n=3), marine mammal species (n=2), baleen whale species (n=1), common minke whale (n=1). Two other marine megafauna were recorded, these were identified as shark species (n=1) and leatherback turtle (n=1;**Table 4**).

Species distribution maps for each survey are included in **Appendix II**.

The total number of birds recorded during the April Survey was 3,082. The most abundant species recorded was common scoter (n= 2,005), followed by great northern diver (n=285), guillemot (n=247), guillemot / razorbill (n=217), gannet (n=73), black guillemot (n=59), great black-backed gull (n=43), kittiwake (n=41), razorbill (n=36), auk species (n=24), red-throated diver (n=15), common gull (n=6), diver species (n=6), Manx shearwater (n=6), sandwich tern (n=3), duck species (n=3), black-headed gull (n=2), herring gull (n=2), puffin (n=2), cormorant / shag (n=2), commic tern (n=2), cormorant (n=1), fulmar (n=1) and small gull species (n=1).

A total of 18 marine mammals were recorded during the April survey, these were all recorded as dolphin / porpoise (n=18). No other marine megafauna was recorded during the April survey.

A total of 1,485 birds were recorded during the May survey. The most abundant species recorded was Manx shearwater (n=547) followed by guillemot (n=529), gannet (n=127), guillemot / razorbill (n=91), razorbill (n=67), great black-backed gull (n=35), kittiwake (n=31), herring gull (n=17), auk species (n=12), great northern diver (n=9), small gull species (n=6), sandwich tern (n=2), commic tern (n=2), lesser black-backed gull (n=2), gull species (n=2), cormorant / shag (n=2), black guillemot (n=1), puffin (n=1), common gull (n=1) and great shearwater (n=1).

A total of nine marine mammals were recorded during the April survey, these were recorded as dolphin / porpoise (n=5) and phocids (n=4). No other marine megafauna was recorded during the April survey.

A total of 963 birds were recorded during the June survey. The most abundant species recorded was razorbill (n=295), followed by guillemot / razorbill (n=245), guillemot (n=207), Manx shearwater (n=90), gannet (n=41), black guillemot (n=38), cormorant (n=9), auk species (n=7), puffin (n=7), commic / roseate tern (n=5), commic tern (n=4), great northern diver (n=4), diver species (n=3), sandwich tern (n=3), kittiwake (n=2), curlew (n=1), great black-backed gull (n=1) and herring gull (n=1).

A total of eight marine mammals were recorded during the June survey, these were recorded as phocids (n=7), harbour porpoise (n=1). One other marine megafauna was recorded during the June survey, it was identified as shark species (n=1).

A total of 4,640 birds were recorded during the July survey. The most abundant species recorded was guillemot (n=3,235), followed by guillemot / razorbill (n=808), Manx shearwater (n=280), gannet (n=156), black guillemot (n=38), razorbill (n=31), herring gull (n=24), kittiwake (n=15), auk species (n=10), great black-backed gull (n=10), puffin (n=7), commic tern (n=5), common scoter (n=4), cormorant (n=4), great northern diver (n=4), commic / roseate tern (n=3), common gull (n=2), great skua (n=1), lesser black-backed gull (n=1), roseate tern (n=1) and sandwich tern (n=1).

A total of three marine mammals were recorded during the July survey, these were recorded as phocids (n=3). No other marine megafauna was recorded during the July survey.

A total of 4,965 birds were recorded in the Survey Area during the August survey. The most abundant species recorded was guillemot (n=3,077), followed by Manx shearwater (n=1,317), black guillemot (n=224), gannet (n=145), razorbill (n=66), guillemot / razorbill (n=54), great black-backed gull (n=37), kittiwake (n=18), puffin (n=10), commic tern (n=7), small gull species (n=3), gull species (n=2), auk species (n=1), cormorant (n=1), fulmar (n=1), herring gull (n=1) and sandwich tern (n=1).

A total of 20 marine mammals were recorded in the Survey Area during the August survey, these were recorded as dolphin / porpoise (n=15), grey seal (n=2), harbour porpoise (n=2) and phocids (n=1).

A total of 8,652 birds were recorded in the Survey Area during the September. The most abundant species recorded was guillemot (n=6,163), followed by razorbill (n=1,064), guillemot / razorbill (n=796), black guillemot (n=217), gannet (n=141), Manx shearwater (n=137), common scoter (n=29), kittiwake (n=24), puffin (n=24), great black-backed gull (n=16), auk species (n=7), common tern (n=7), commic tern (n=5), red-throated diver (n=4), commic / roseate tern (n=3), sandwich tern (n=3), arctic skua (n=2), cormorant / shag (n=2), gull species (n=2), cormorant (n=1), herring gull (n=1), large gull species (n=1), lesser black-backed gull (n=1), little gull (n=1) and small gull species (n=1).

A total of 22 marine mammals were recorded in the Survey Area during the September survey, these were recorded as dolphin / porpoise (n=7), dolphin species (n=3), harbour porpoise (n=3), phocids (n=3), grey seal (n=2), marine mammal species (n=2), baleen whale species (n=1) and common minke whale (n=1). One other marine mega fauna was recorded during the September survey, it was identified as leatherback turtle (n=1).

Table 3 Raw counts of avian species (in taxonomic order) recorded during the April 2020, May 2020, June 2020, July 2020, August 2020 and September 2020 surveys.

Family	Species	Flying	Sitting	Perched	Total
Ducks and Waterfowl	Common Scoter	7	2031	-	2038
	Duck Species	-	3	-	3
Waders	Curlew	1	-	-	1
Gulls and Terns	Kittiwake	84	47	-	131
	Black-headed Gull	2	-	-	2
	Little Gull	1	-	-	1
	Common Gull	7	2	-	9
	Great Black-backed Gull	27	115	-	142
	Herring Gull	23	23	-	46
	Lesser Black-backed Gull	2	2	-	4
	Small Gull Species	2	9	-	11
	Large Gull Species	-	1	-	1
	Gull Species	1	5	-	6
	Sandwich Tern	13	-	-	13
	Roseate Tern	1	-	-	1
	Common Tern	7	-	-	7
	Commic[1] Tern	25	-	-	25
	Commic[1] / Roseate Tern	11	-	-	11
Skua	Great Skua	1	-	-	1
	Arctic Skua	1	1	-	2
Auks	Guillemot	150	13308	-	13458
	Razorbill	32	1527	-	1559
	Black Guillemot	4	573	-	577
	Guillemot / Razorbill	17	2194	-	2211
	Puffin	-	51	-	51
	Auk Species	-	61	-	61
Divers	Red-throated Diver	2	17	-	19
	Great Northern Diver	-	302	-	302
	Diver Species	-	9	-	9
Fulmars and Shearwaters	Fulmar	1	1	-	2
	Great Shearwater	-	1	-	1
	Manx Shearwater	1370	1007	-	2377
Gannet	Gannet	342	341	-	683
Cormorants and Shags	Cormorant	6	10	-	16
	Cormorant / Shag	4	-	2	6
Total Avian Species		***2144***	***21641***	***2***	***23787***

[1] Includes arctic tern and common tern.

Table 4 Raw counts of marine megafauna species recorded during the April 2020, May 2020, June 2020, July 2020, August 2020 and September 2020 surveys.

Species	Submerged	Surfacing	Total
Grey Seal	3	1	4
Phocids	9	9	18
Dolphin Speices	2	1	3
Harbour Porpoise	3	3	6
Dolphin / Porpoise	40	5	45
Common Minke Whale	1	-	1
Baleen Whale species	1	-	1
Marine Mammal species	2	-	2
Total Marine Mammals	***61***	***19***	***80***
Shark Species	1	-	1
Total Shark Species	***1***	***0***	***1***
Leatherback Turtle	-	1	1
Total Turtle Species	***0***	***1***	***1***

5. Species Accounts

The following species accounts present the raw counts, design-based abundance estimates, density estimates, behavioural and peak month distribution data of the six-month programme of aerial digital surveys of the Ornithology Study area. The density estimates provide the number of individuals per square kilometre (km^2). Abundance estimates have been provided for the Ornithology Study Area and Windfarm Concession Area separately, for each of the two areas the abundance are likely to differ due to the abundance estimates being calculated independently based on the numbers of recorded targets per location and the area covered by said locations. Scientific names and taxonomy of birds and marine fauna are provided in **Appendix I**.

5.1 Common Scoter

Overall 2,038 common scoter were identified during the surveys, 2,005 in April 2020, four in July 2020 and 29 in September 2020. Common scoter were not recorded in the May, June and August 2020 surveys.

Common scoter were recorded in the Ornithology Study Area in July and September, with a peak raw count of seven resulting in an abundance estimate of 20 (**Table 5**).

In April 2020, flying common scoter were significantly orientated around the mean of 162° (Rayleigh test, p=<0.05, **Figure 2**). In July 2020, flying common scoter were significantly orientated around the mean of 216° (Rayleigh test, p=<0.05, **Figure 2**).

Common scoter were recorded in a large single group west of the Windfarm Concession Area in April 2019, not within the Windfarm Concession Area (**Figure 3**). Common scoter were observed in the north-west corner of the Ornithology Study area. No common scoter were located in the Windfarm Concession area.

Table 5 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of common scoter in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
July-2020	4	11	4	34	0.5	0.03
September -2020	7	20	7	53	0.37796	0.06

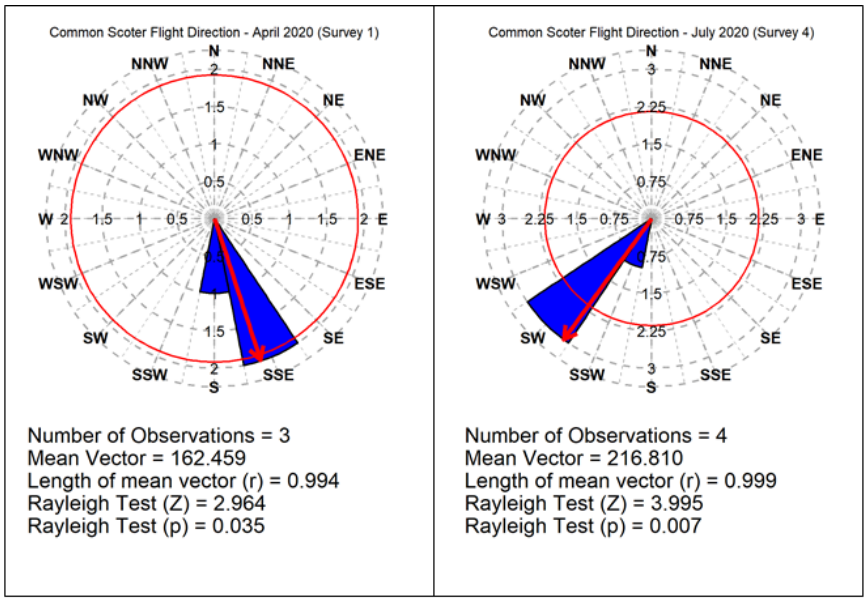


Figure 2 Summary of flight direction of common scoter during the April and July 2020 surveys

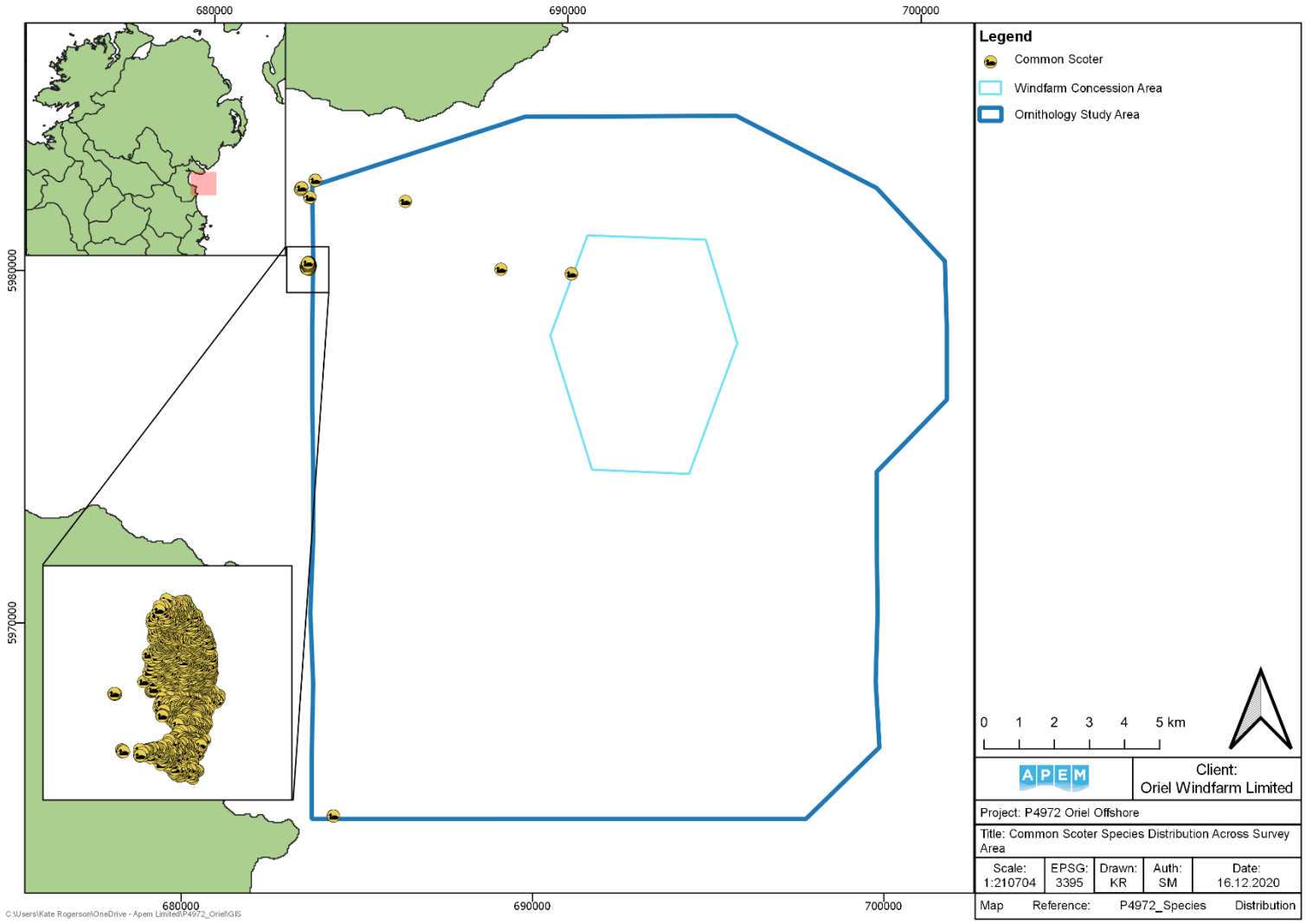


Figure 3 Distribution of common scoter recorded across the Ornithology Study Area

5.2 Duck Species – unidentified

During the April 2020 survey, three unidentified duck species were identified. Unidentified duck species were not recorded in the May 2020, June 2020, July 2020, August 2020 and September 2020 surveys.

The total raw count of three individuals in April 2020 resulted in an abundance estimate of nine for the Ornithology Study Area (**Table 6**).

Unidentified duck species were recorded in a single group to the west of the Windfarm Concession area in April 2020 (**Figure 4**). No unidentified duck species were located in the Windfarm Concession area.

Table 6 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of unidentified duck species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	3	9	3	26	0.57735	0.03

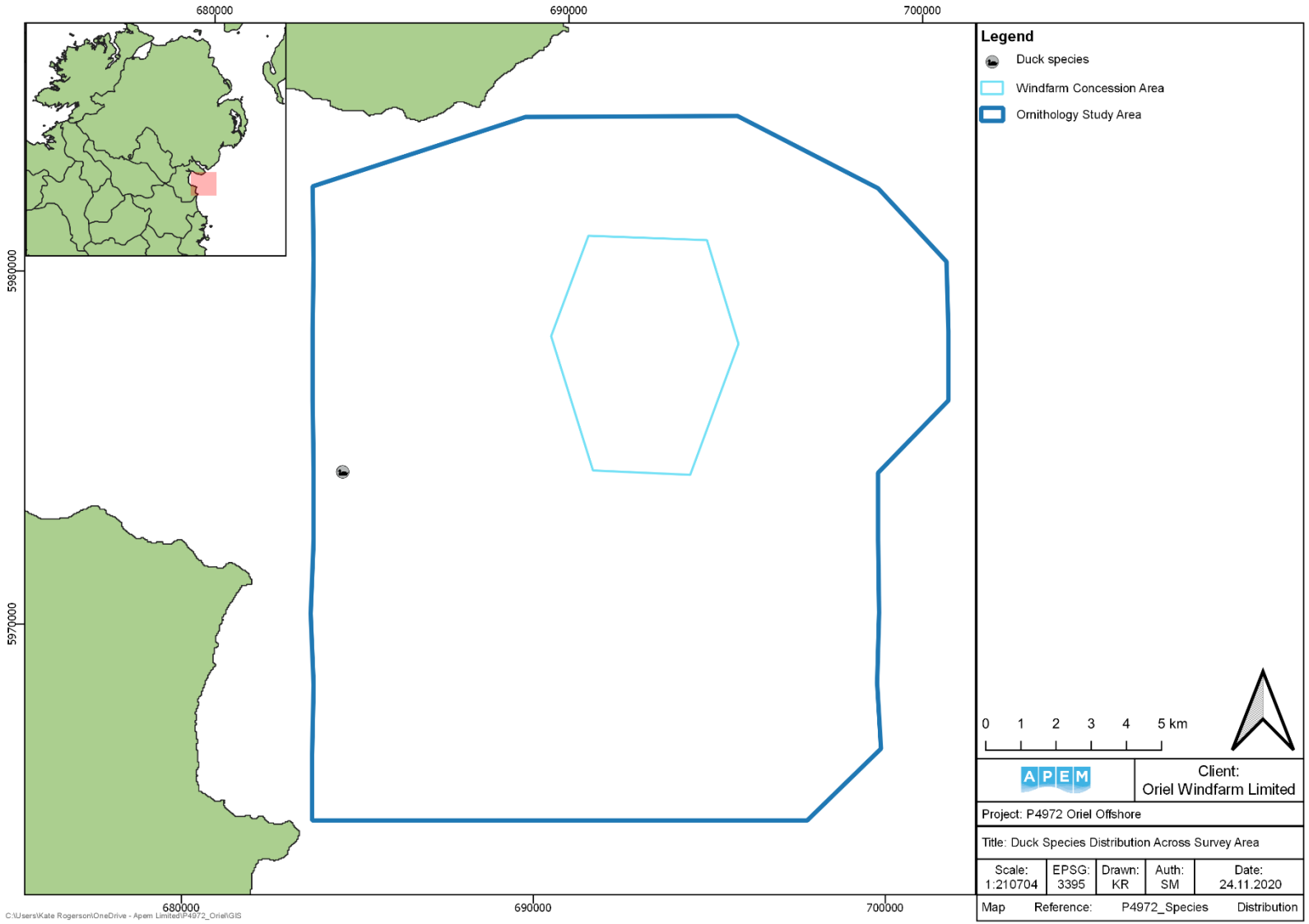


Figure 4 Distribution of duck species recorded across the Ornithology Study Area

5.3 Curlew

During the June 2020 survey, one curlew was identified. Curlew were not recorded in the April 2020, May 2020, July 2020, August 2020 and September surveys.

The raw count of one individual resulted in an abundance estimate of three for the Ornithology Study area (**Table 7**).

In June 2020, the curlew was recorded as flying and orientated towards 209° (Rayleigh test, p=>0.05, **Figure 5**).

In June 2020 the curlew was located on the western edge of the Ornithology Study area (**Figure 6**). No curlew were located in the Windfarm Concession area.

Table 7 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of curlew in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	1	3	1	9	1	0.01

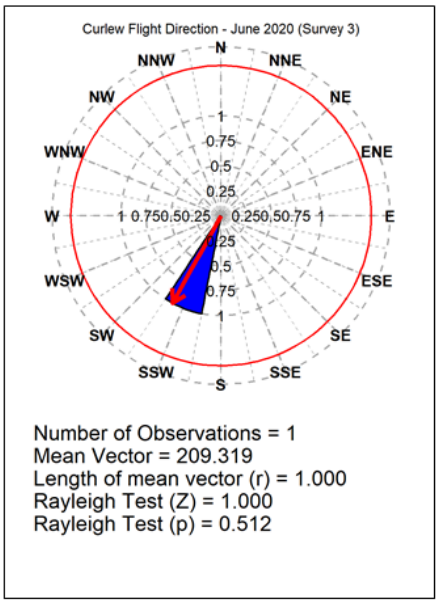


Figure 5 Summary of flight direction of curlew during the June 2020 survey

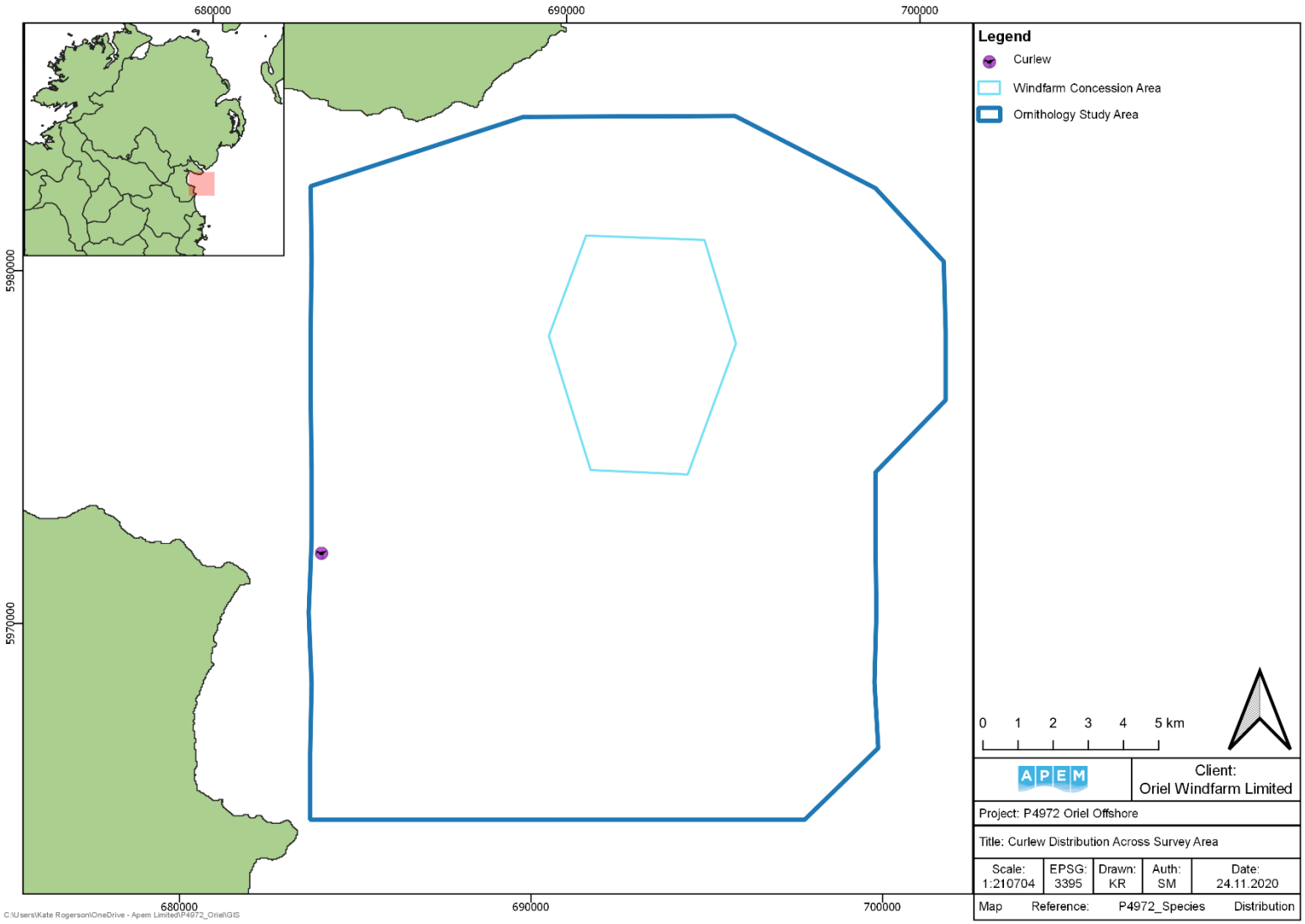


Figure 6 Peak distribution of curlew recorded across the Ornithology Study Area

5.4 Kittiwake

Overall 131 kittiwake were identified across the surveys, 41 in April 2020, 31 in May 2020, two in June 2020, 15 in July 2020, 18 in August 2020 and 24 in September 2020 surveys.

A peak raw count of 40 in April resulted in an abundance estimate of 115 for the Ornithology Study area (**Table 8**).

Flying kittiwake were recorded in all six surveys; in April 2020, flying kittiwake were significantly orientated around the mean of 28°; in July 2020, flying kittiwake were significantly orientated around the mean of 316°; in September 2020, flying kittiwake were significantly orientated around the mean of 260° (Rayleigh test, p=<0.05, **Figure 7**).

In April, May, June, July, August and September 2020; two, five, one, three, 10 and seven flying kittiwakes deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 43.95 m above MSL (**Figure 8**).

Kittiwake were recorded across the Ornithology Study area (**Figure 9**).

Table 8 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of kittiwake in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	7	19	7	40	0.37796	0.69
May-2020	15	41	15	96	0.2582	1.48
July-2020	4	11	4	33	0.5	0.4
September-2020	6	17	6	50	0.40825	0.61
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	40	115	43	205	0.15811	0.36
May-2020	29	84	29	168	0.1857	0.26
June-2020	1	3	1	9	1	0.01
July-2020	13	37	13	66	0.27735	0.12
August-2020	18	52	32	72	0.2357	0.16
September-2020	20	58	29	96	0.22361	0.18

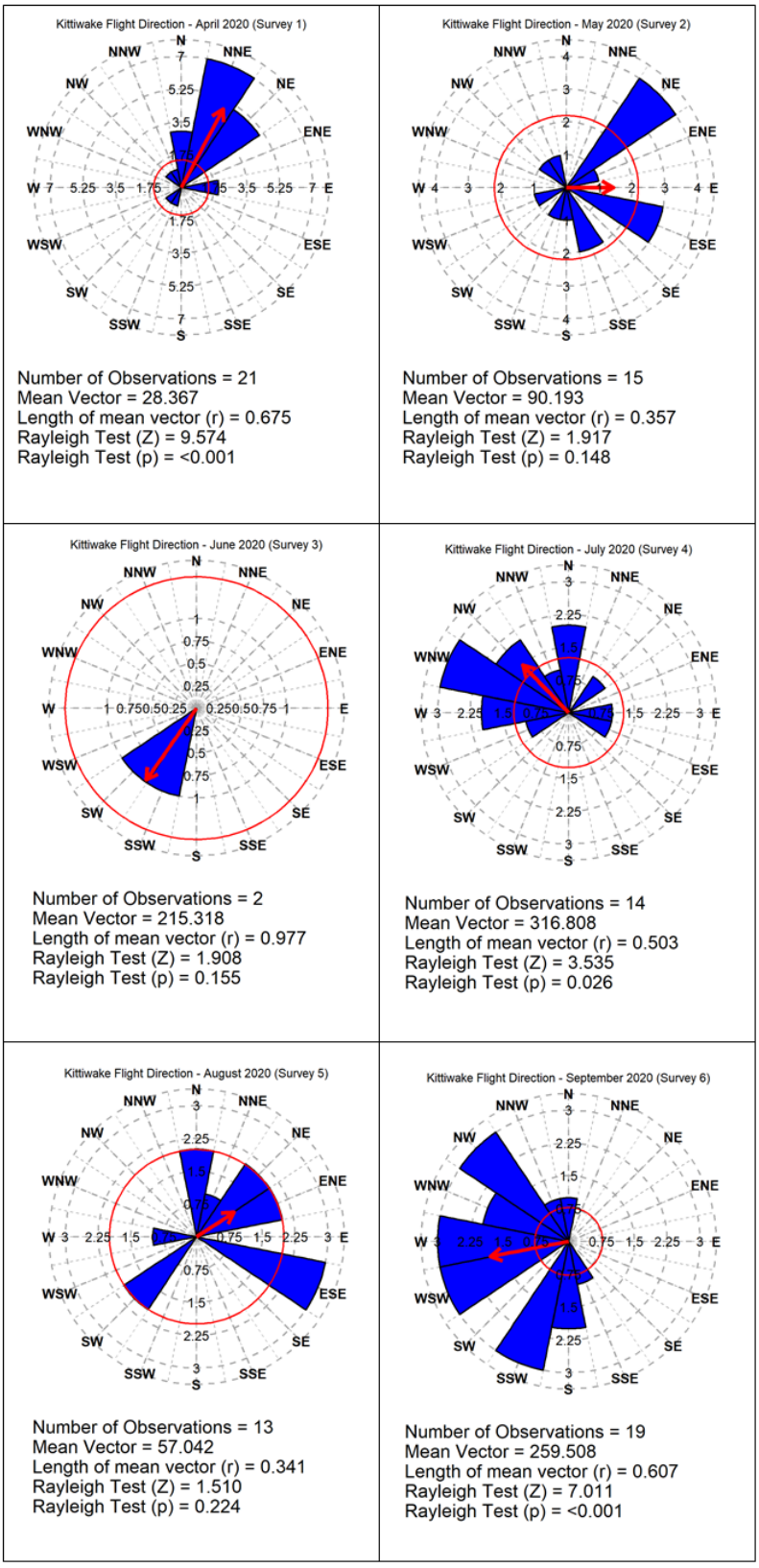


Figure 7 Summary of flight direction of kittiwake for all six surveys

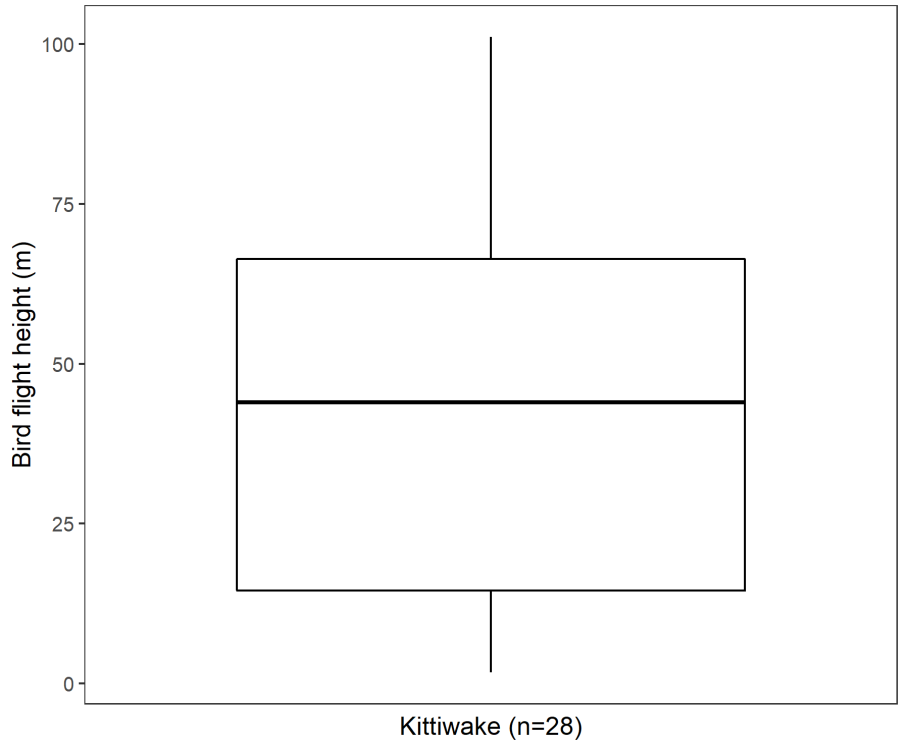


Figure 8 Flight heights of kittiwake (n=28) recorded in the Ornithology Study area

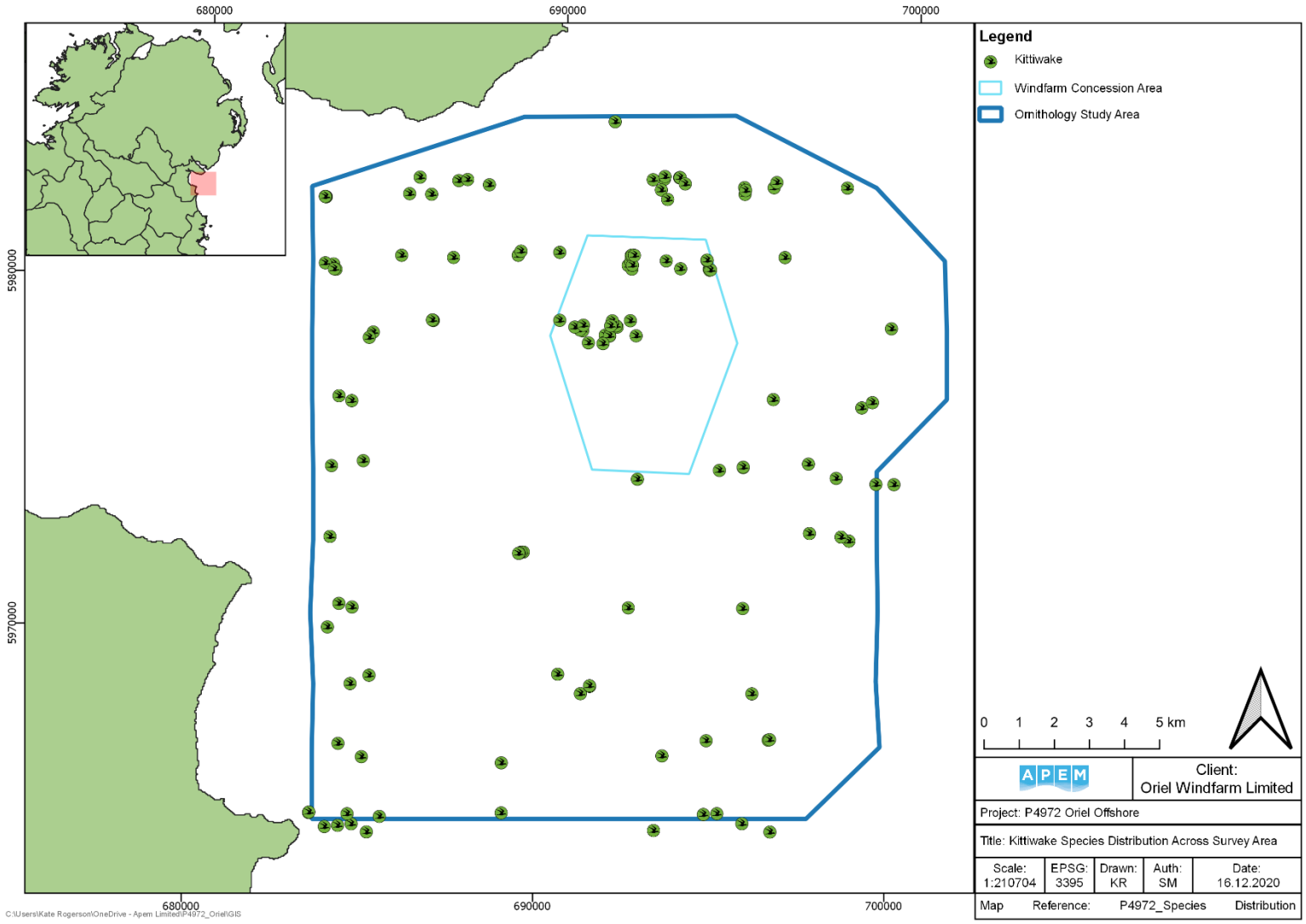


Figure 9 Peak distribution of kittiwake recorded across the Ornithology Study Area

5.5 Black-headed Gull

During the April 2020 survey, two black-headed gull were identified. Black-headed Gull were not recorded in the May 2020, June 2020, July 2020, August 2020 and September surveys.

The peak count of two black-headed gulls resulted in an abundance estimate of five for the Windfarm Concession area and wider Ornithology Study area (**Table 9**).

The black-headed gulls were recorded flying in a northerly direction (**Figure 10**).

The black-headed gulls were recorded in the northeast of the Windfarm Concession area (**Figure 11**).

Table 9 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of black-headed gull in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	2	5	2	16	0.70711	0.18
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	2	6	2	17	0.70711	0.02

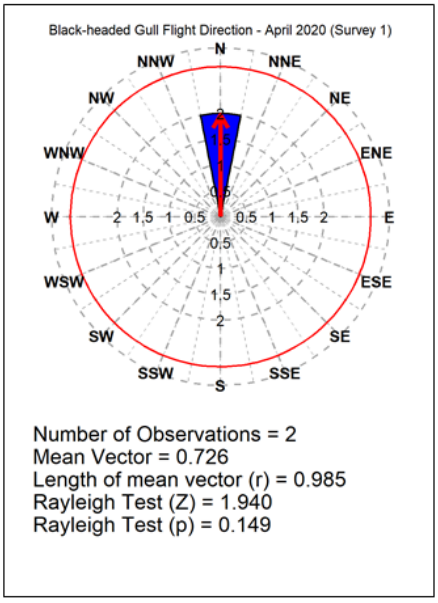


Figure 10 Summary of flight direction of black-headed gulls for April 2020 survey

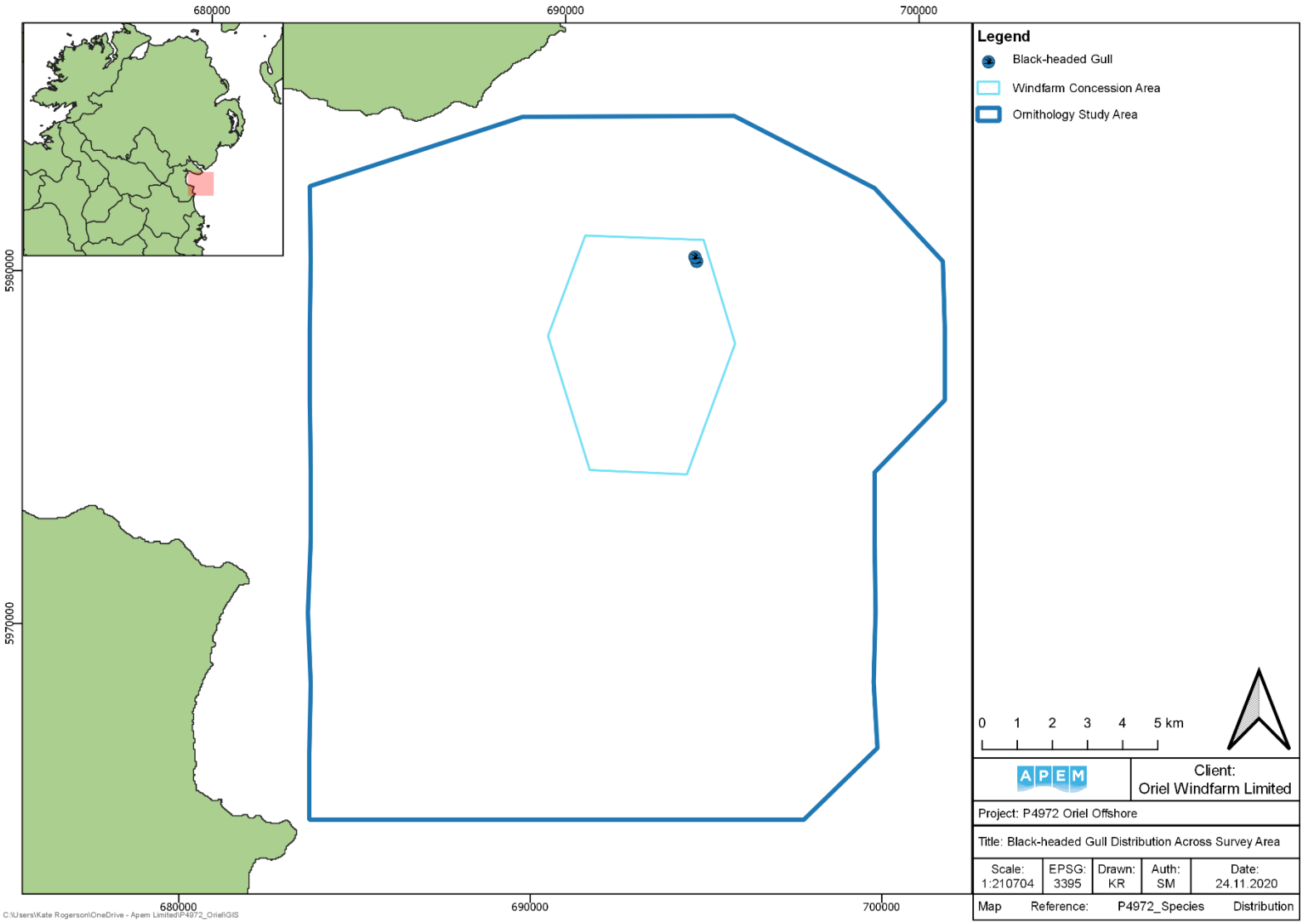


Figure 11 Location of black-headed gulls recorded in the Ornithology Study Area

5.6 Little Gull

During the September 2020 survey, one little gull was identified. Little gull were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The count of one little gull resulted in an abundance estimate of three for the Ornithology Study area (**Table 10**).

The little gull was recorded flying in a south-westerly direction (**Figure 12**).

The one flying little gull deemed suitable for flight height determination was recorded, with an altitude of 60.2 m above MSL.

The little gull was recorded on the western edge of the Ornithology Study area (**Figure 13**) .

Table 10 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of little gull in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
September -2020	1	3	1	9	1	0.01

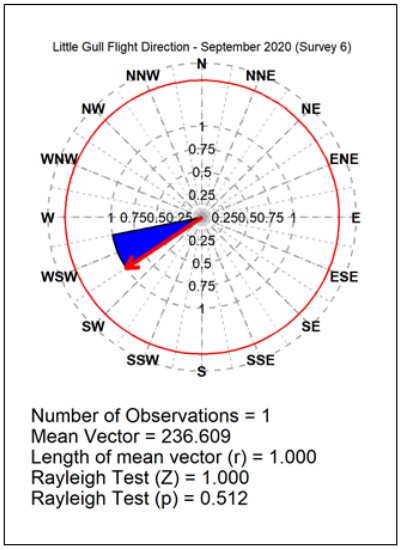


Figure 12 Summary of flight direction of little gull for the September 2020 surveys.

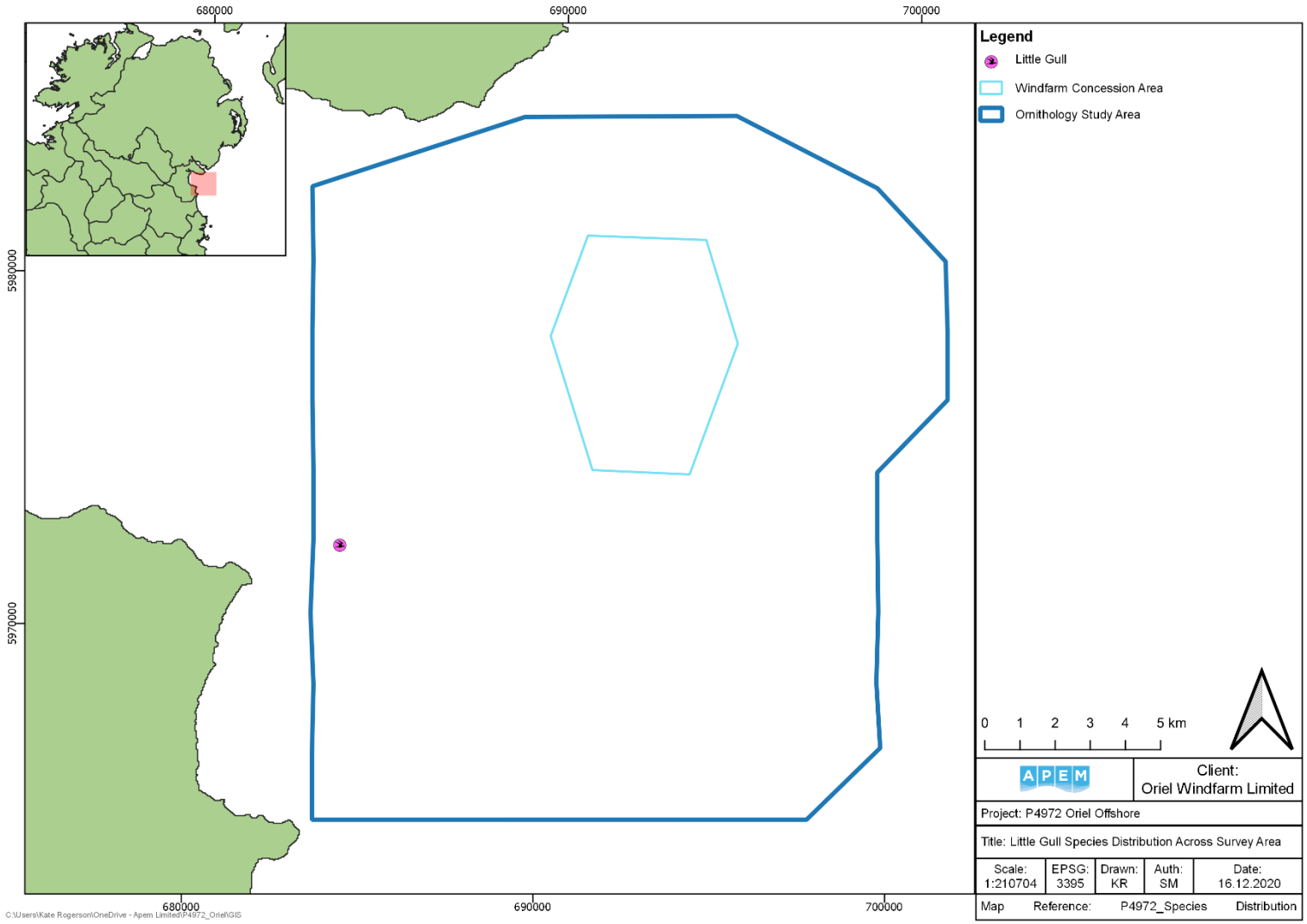


Figure 13 Location of little gull recorded in the Ornithology Study Area

5.7 Common Gull

Overall 9 common gull were identified, six in April 2020, two in May 2020, one in July 2020 surveys. Common gull were not recorded in the August 2020 and September survey.

A peak raw count of three were recorded in the Ornithology Study area in April 2020 resulting in an abundance estimate of nine for the Ornithology Study Area (**Table 11**).

Flying common gull were recorded in April, May and July surveys although no significant orientations were identified (Rayleigh test, p=>0.05, **Figure 14**).

Common gulls were recorded across the western side of the Ornithology Study area. No common gulls were recorded in the Windfarm Concession area (**Figure 15**).

Table 11 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of common gull in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	3	9	3	26	0.57735	0.03
July-2020	2	6	2	14	0.70711	0.02

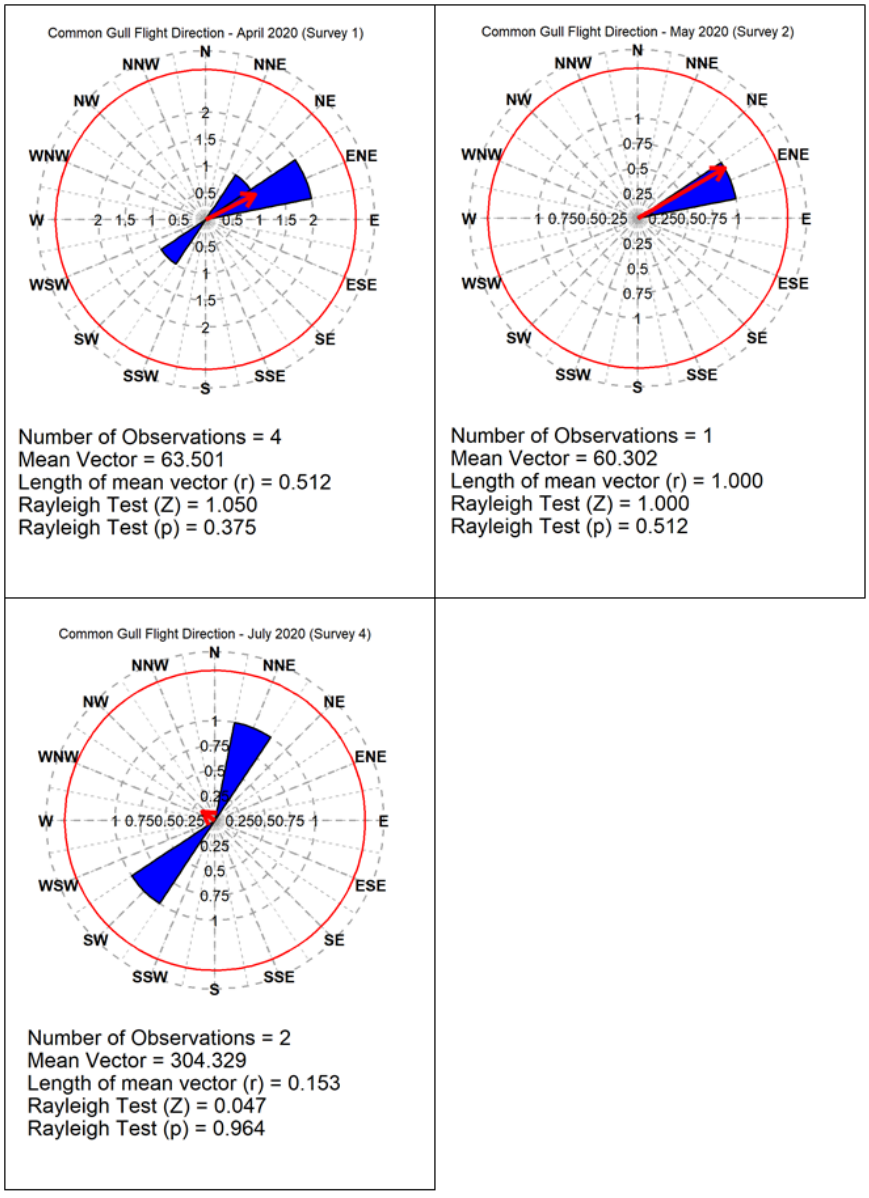


Figure 14 Summary of flight direction of common gull for the April, May and July 2020 surveys

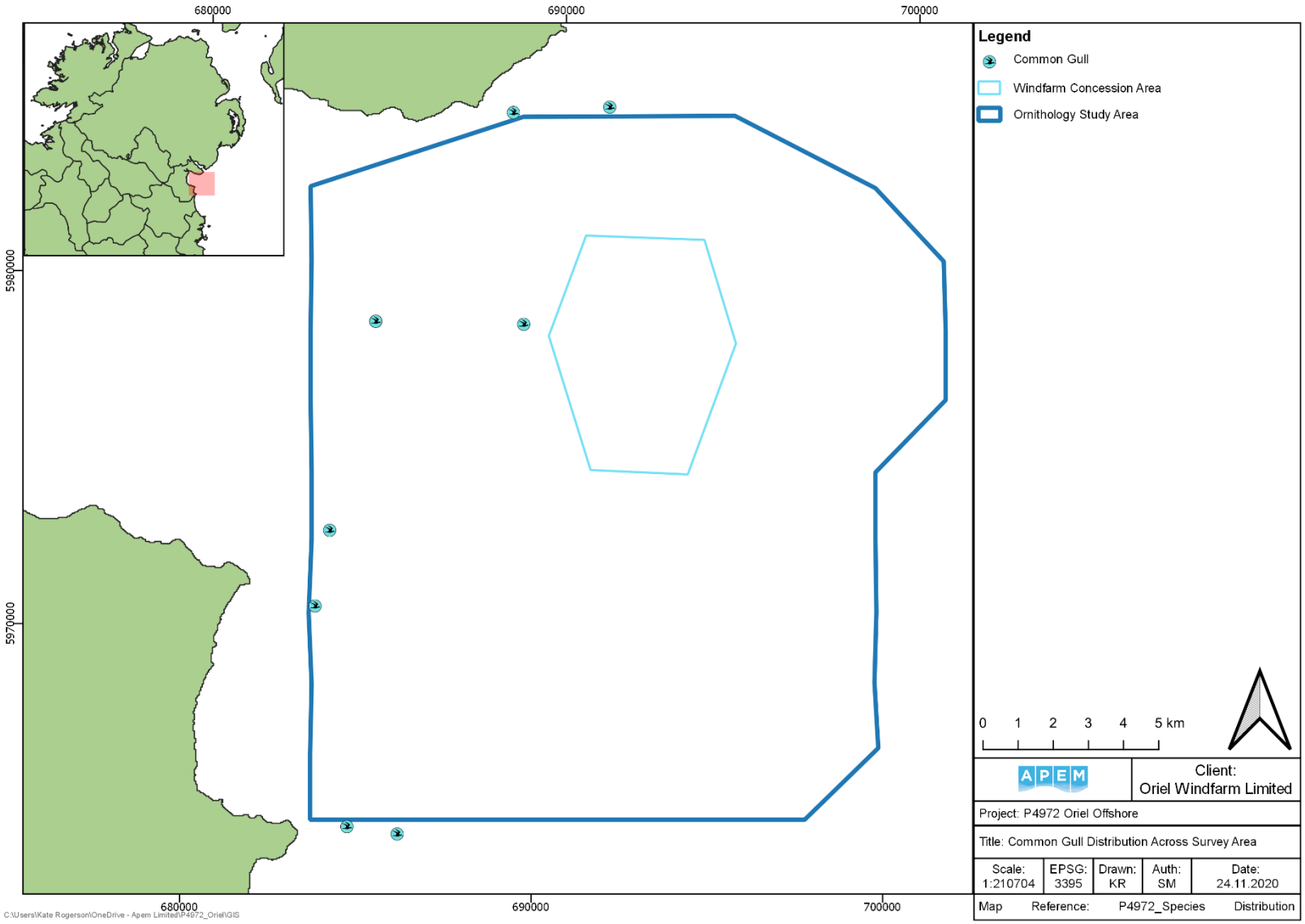


Figure 15 Distribution of common gulls recorded across the Ornithology Study Area

5.8 Great Black-backed Gull

Overall 142 great black-backed gull were identified, 43 in April 2020, 35 in May 2020, one in June 2020, 10 in July 2020, 37 in August 2020 and 16 in September 2020 surveys.

A peak count of 42 great black-backed gulls were recorded in April 2020 resulting in an abundance estimate of 121 for the Ornithology Study Area. A raw count of seven black-backed gulls recorded in the Windfarm Concession area in April 2020 resulting in an abundance estimate of 19 (**Table 12**).

Flying great black-backed gulls were recorded in April, May, June , August and September surveys. Significant orientations were recorded: in April 2020, flying great black-backed gulls were significantly orientated around the mean of 62°; in May 2020, flying kittiwake were significantly orientated around the mean of 94°; in September 2020, flying kittiwake were significantly orientated around the mean of 204° (Rayleigh test, p=<0.05, **Figure 16**).

One flying great black-backed gull deemed suitable for flight height determination was recorded, with an altitude of 4.5 m above MSL.

Great black-backed gulls were distributed across the Ornithology Study area (**Figure 17**).

Table 12 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of great black-backed gull in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	7	19	7	48	0.37796	0.69
August-2020	34	93	34	278	0.1715	3.36
September-2020	11	30	11	91	0.30151	1.08
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	42	121	42	228	0.1543	0.38
May-2020	32	93	32	235	0.17678	0.29
June-2020	1	3	1	9	1	0.01
July-2020	7	20	7	55	0.37796	0.06
August-2020	36	103	36	299	0.16667	0.32
September-2020	15	44	15	108	0.2582	0.14

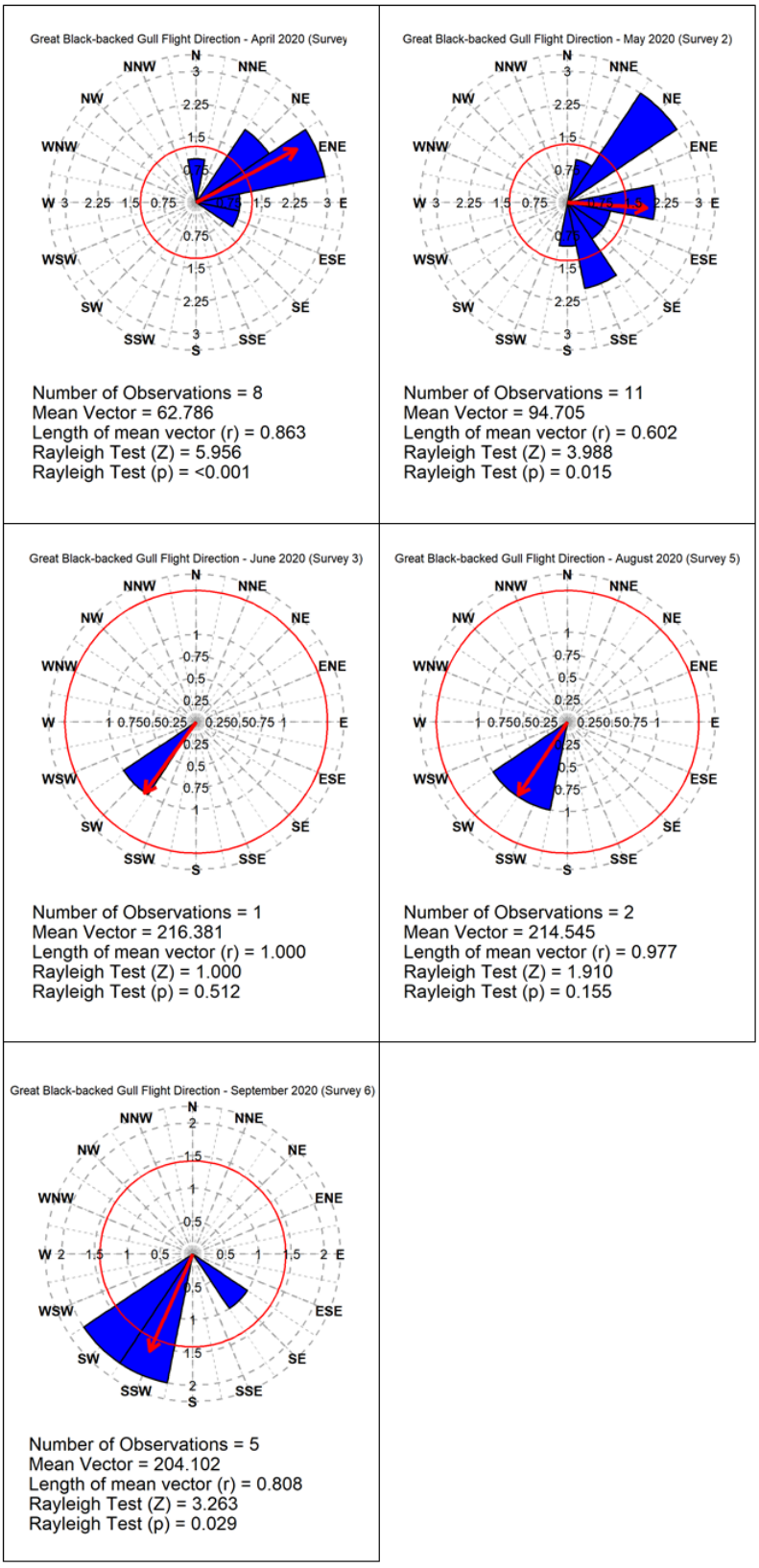


Figure 16 Summary of flight direction of great black-backed gull for the April, May, June, August and September 2020 surveys

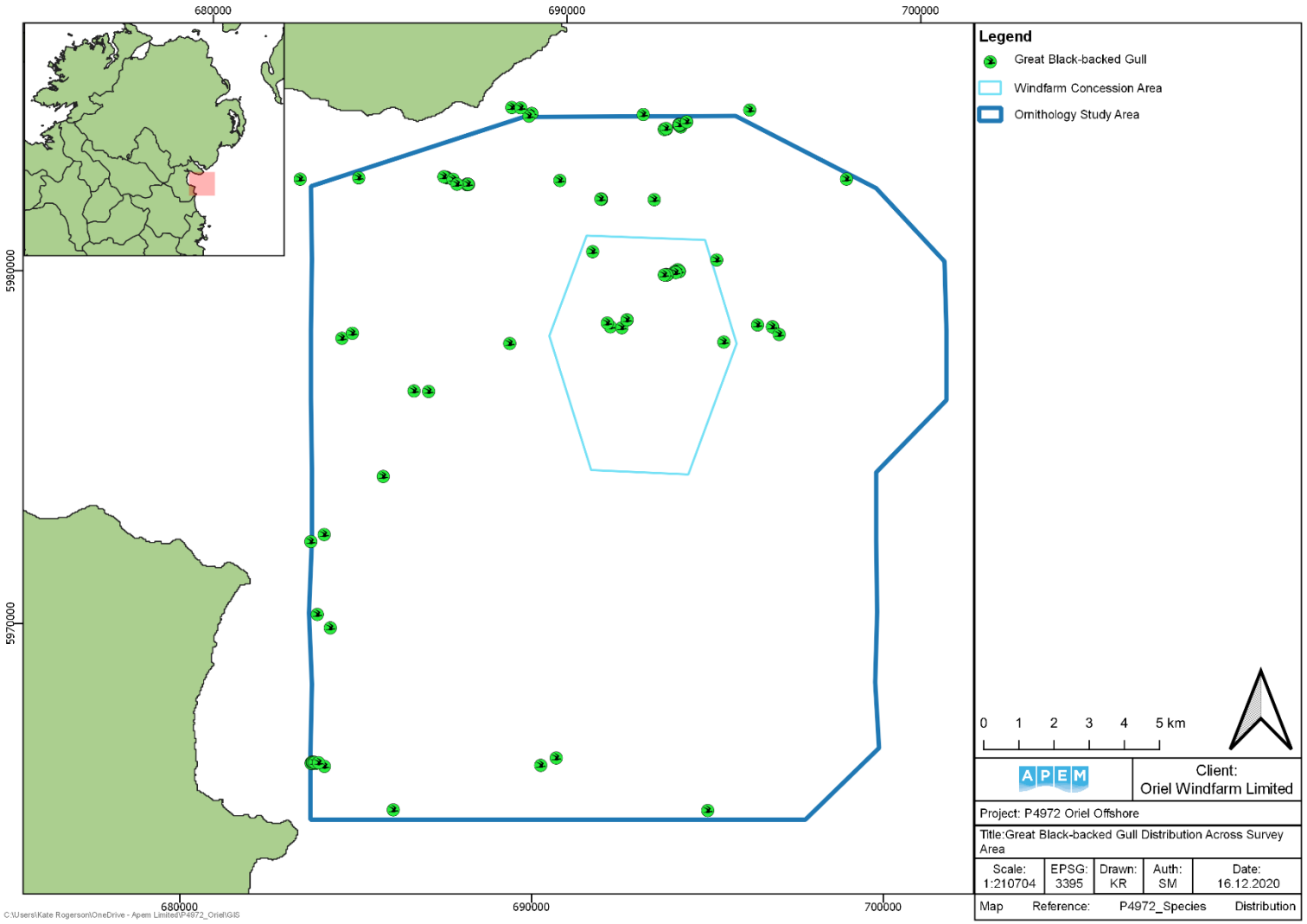


Figure 17 Distribution of great black-backed gull recorded across the Ornithology Study Area

5.9 Herring Gull

Overall 46 herring gull were identified, two in April 2020, 17 in May 2020, one in June 2020, 24 in July 2020, one in August 2020 and one in September 2020 surveys.

A peak raw count of 19 herring gulls in July 2020 resulted in an abundance estimate of 55 for the Ornithology Study area (**Table 13**).

Flying herring gulls were found to have no significant direction of flight in any of the six surveys (**Figure 18**).

In May and July 2020; two and one flying herring gull deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 46 m above MSL (**Figure 19**).

Herring gulls showed no overall distribution pattern, and were distributed across the Ornithology Study area; only one herring gull was located within the Windfarm Concession area (**Figure 20**).

Table 13 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of herring gull in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	9	1	0.01
May-2020	13	38	13	78	0.27735	0.12
June-2020	1	3	1	9	1	0.01
July-2020	19	55	19	106	0.22942	0.17
August-2020	1	3	1	9	1	0.01
September-2020	1	3	1	9	1	0.01

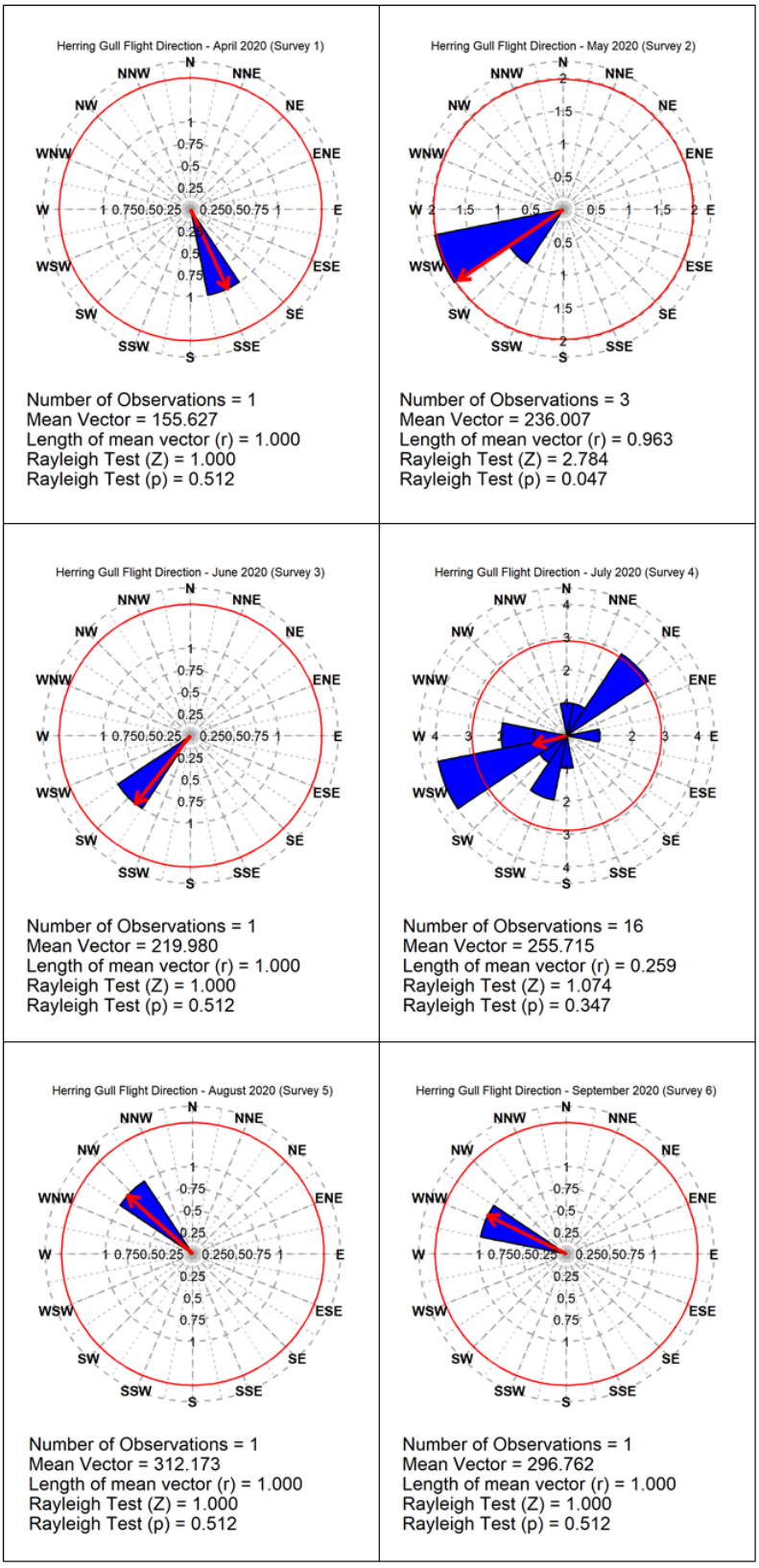


Figure 18 Summary of flight direction of herring gull during the six surveys

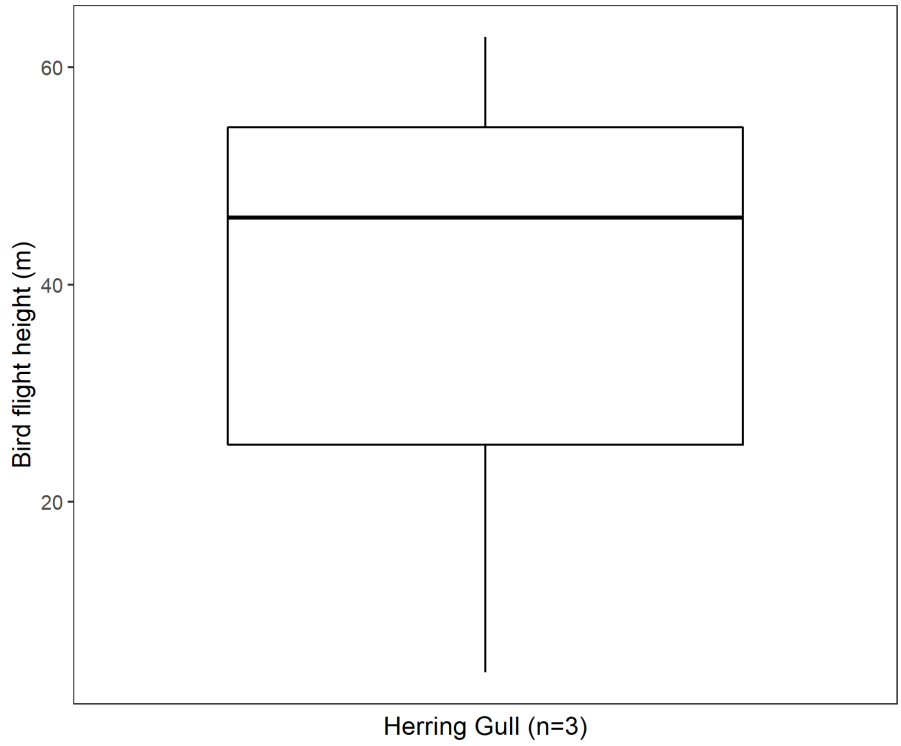


Figure 19 Flight heights of herring gull (n=3) recorded in the Ornithology Study area

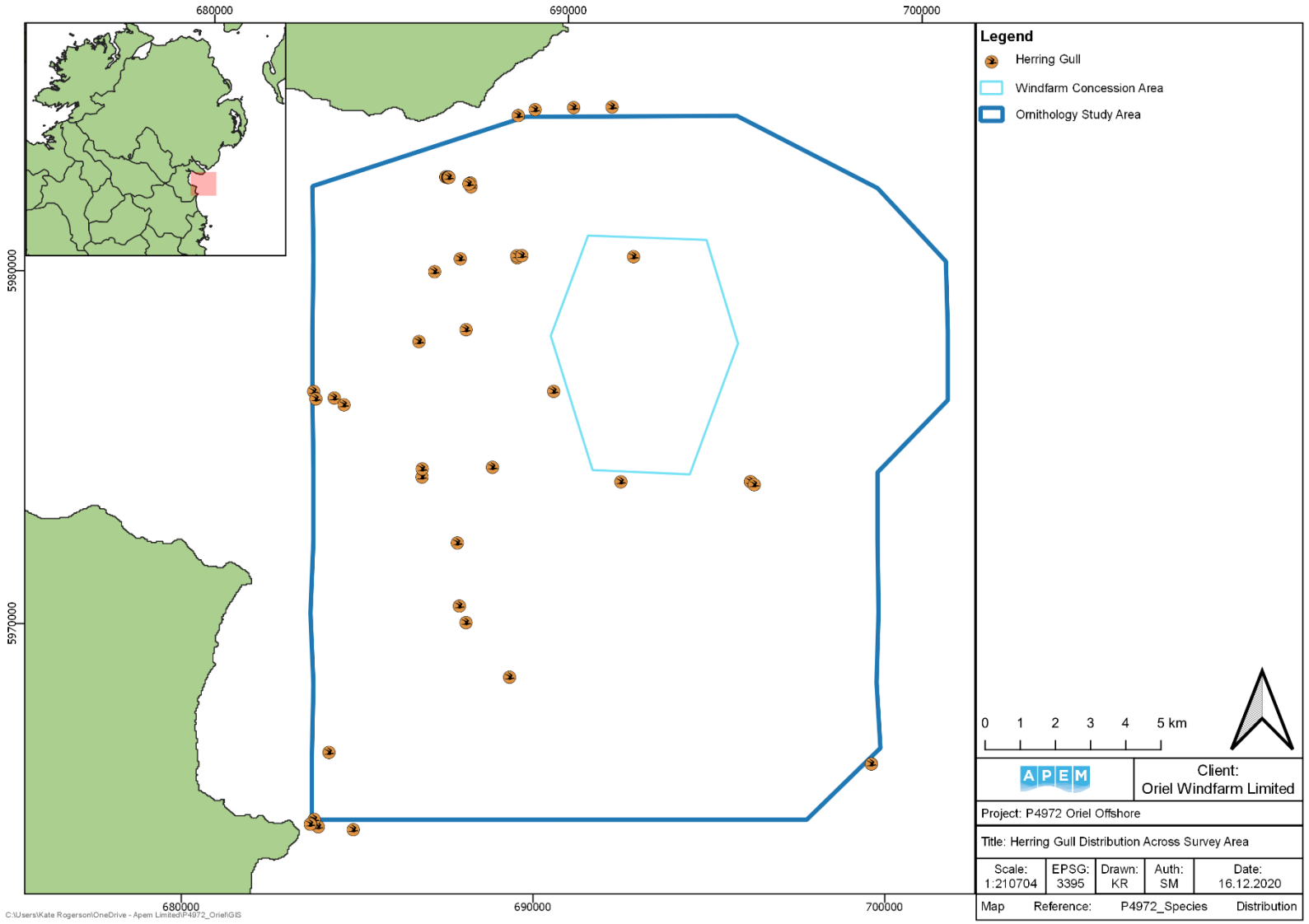


Figure 20 Distribution of herring gull recorded across the Ornithology Study Area

5.10 Lesser Black-backed Gull

Overall four lesser black-backed gull were identified, two in the May 2020, one in the July 2020 and one in the September 2020 surveys. Lesser black-backed gulls were not recorded in the June and August surveys.

The peak count of two lesser black-backed gulls in May 2020 resulted in an abundance estimate of 6 for the Ornithology Study area (**Table 14**).

Two lesser black-backed gulls were recorded as flying in the May 2020 survey, although there was not a significant orientation (**Figure 21**).

In May 2020, one flying lesser black-backed gull deemed suitable for flight height determination was recorded, with an altitude of 13 m above MSL.

The lesser black-backed gulls were located in the western side of the Ornithology Study area (**Figure 22**). No lesser black-backed gulls were located in the Windfarm Concession area.

Table 14 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of lesser black-backed gull in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	2	6	2	14	0.71	0.02
July-2020	1	3	1	9	1	0.01
September -2020	1	3	1	9	1	0.01

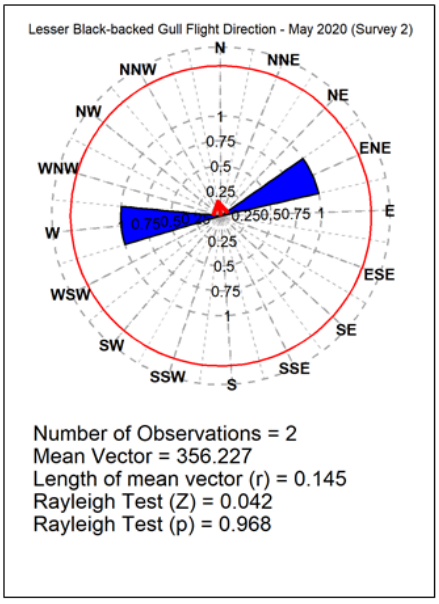


Figure 21 Summary of flight direction of lesser black-backed gull during the May 2020 survey

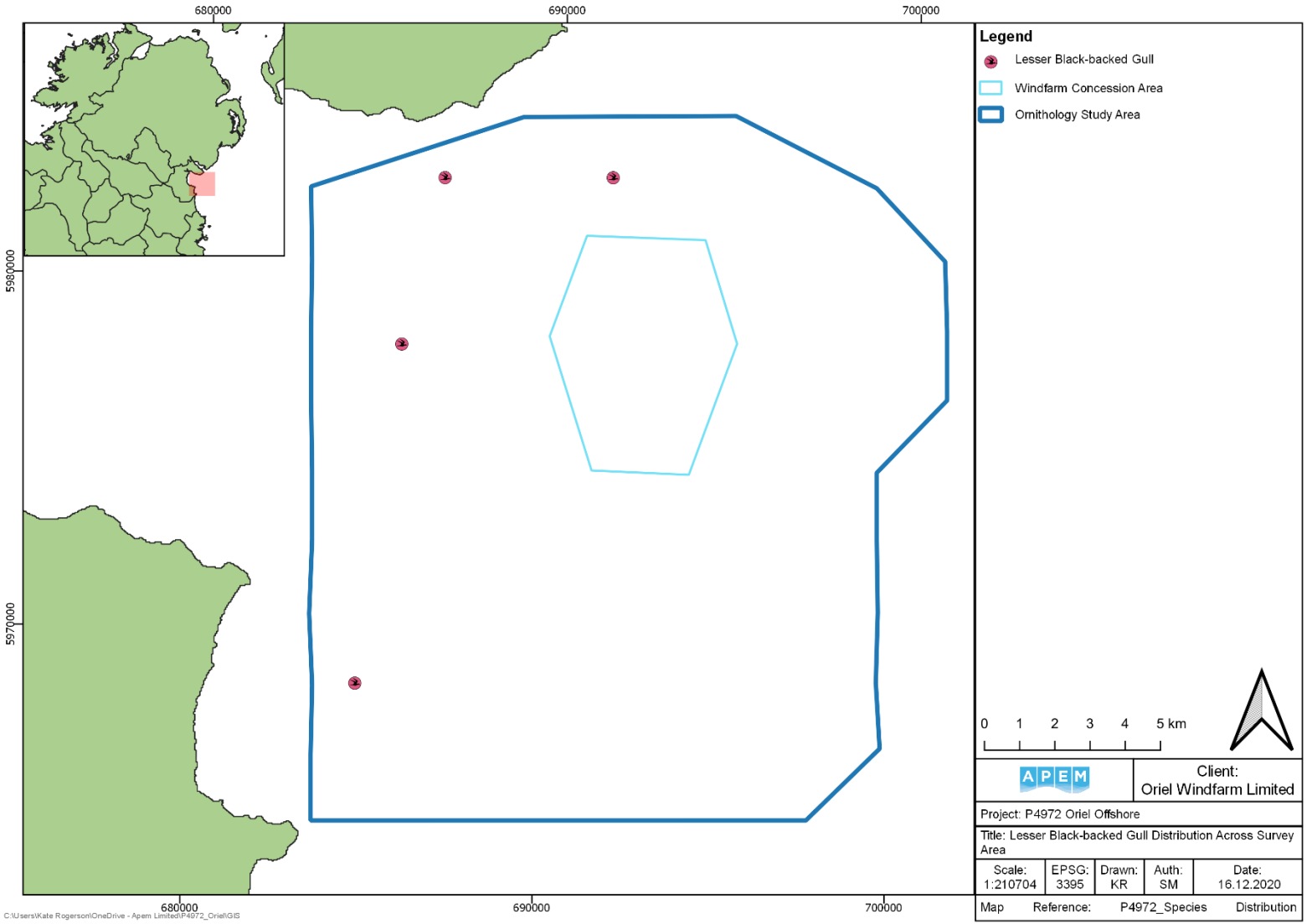


Figure 22 Location of lesser black-backed gulls across the Ornithology Study area

5.11 Gull species – unidentified

Overall, six unidentified gull species were recorded, two during the May 2020, two in the August 2020 and two in the September surveys. Unidentified gull species were not recorded in the April 2020, June 2020 and July 2020 surveys.

A peak raw count of two unidentified gull species resulted in an abundance estimate of six for the Ornithology Study area (**Table 15**).

One unidentified gull species individual was recorded as flying in a northwest direction (**Figure 23**).

During the May survey, the two unidentified gull species were recorded along the northern edge of the Ornithology Study area; during the August survey one was recorded in the north while the other was recorded to the southwest of the Windfarm Concession area; during the September survey the gulls were recorded to the west and south of the Windfarm Concession area. No unidentified gull species were recorded in the Windfarm Concession area (**Figure 24**).

Table 15 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of gull species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	1	3	1	9	1	0.01
August-2020	2	6	2	14	0.70711	0.02
September-2020	2	6	2	15	0.70711	0.02

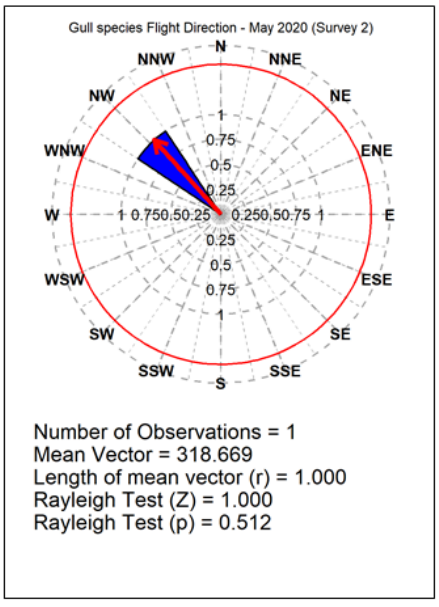


Figure 23 Summary of flight direction of unidentified gull species during the May 2020 survey

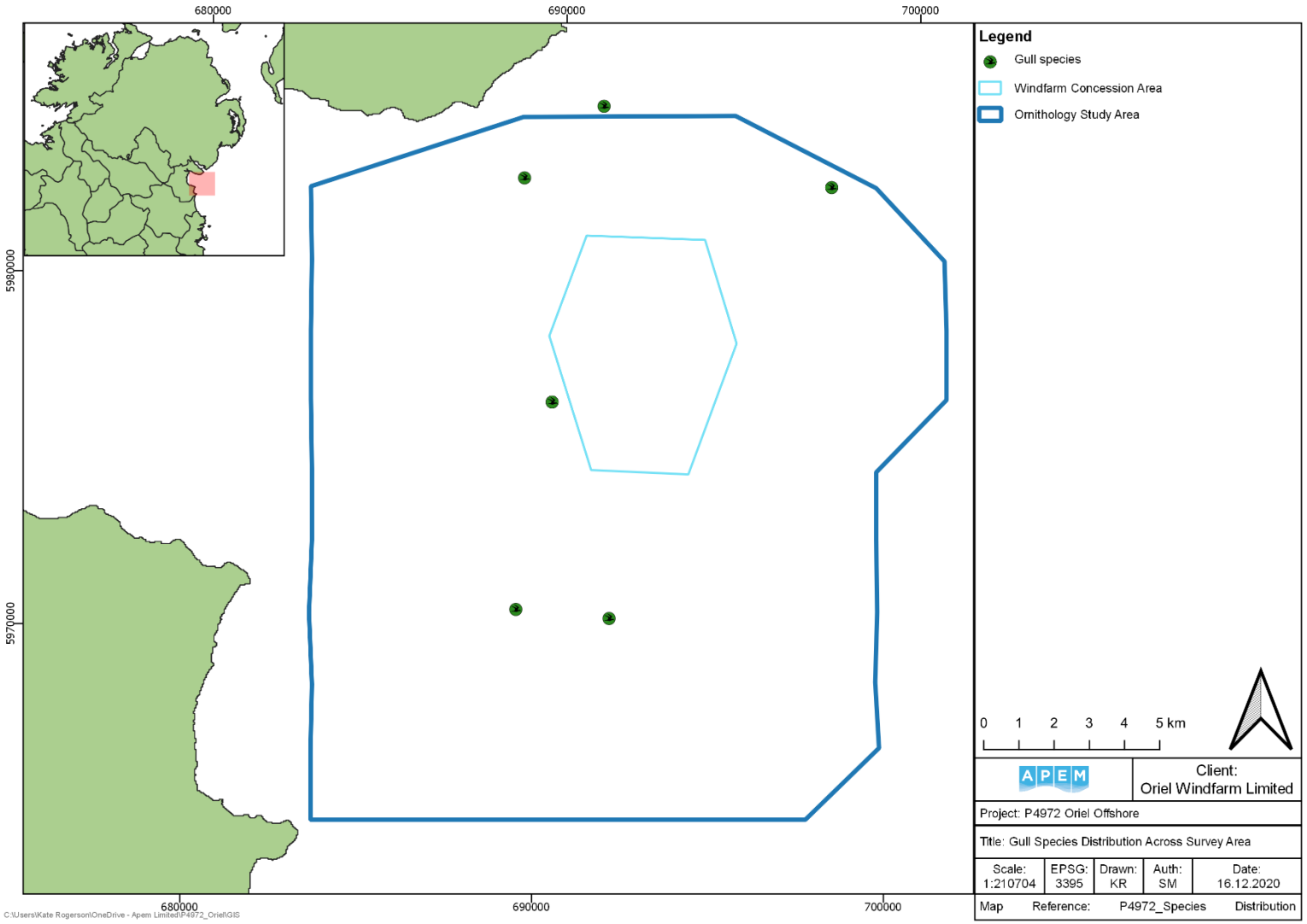


Figure 24 Location of unidentified gull species across the Ornithology Study area

5.12 Small Gull Species – unidentified

Overall 11 unidentified small gull species were identified, one in April 2020, six in May 2020, three in August 2020 and one in September 2020 surveys.

The peak count of six unidentified small gull species in May 2020 resulted in an abundance estimate of 17 for the Ornithology Study Area (**Table 16**).

In April, one unidentified small gull species was recorded as flying, the orientation was northerly, while in September, one flying unidentified small gull species was recorded as flying in a southerly direction (**Figure 25**).

Unidentified small gull species showed no overall distribution pattern, and were distributed across the Ornithology Study area (**Figure 26**).

Table 16 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of small gull species in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	2	5	2	11	0.70711	0.18
September-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	9	1	0.01
May-2020	6	17	9	26	0.40825	0.05
August-2020	3	9	3	20	0.57735	0.03
September-2020	1	3	1	9	1	0.01

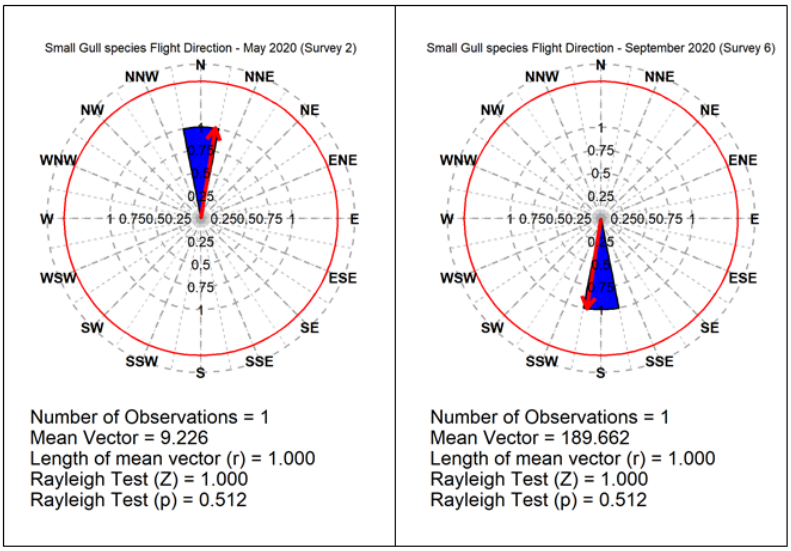


Figure 25 Summary of flight direction of unidentified small gull species during the May and September 2020 survey

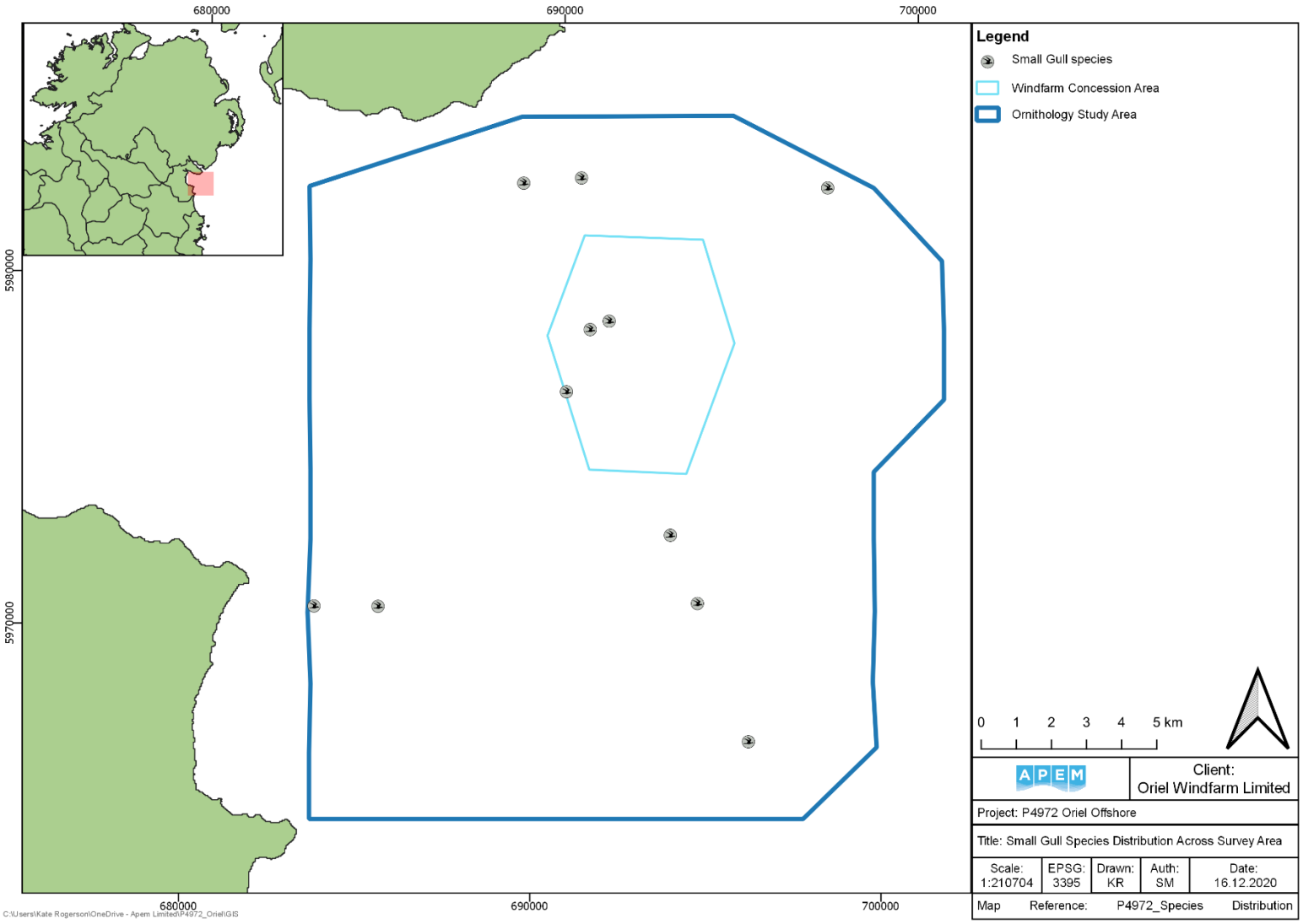


Figure 26 Distribution of unidentified small gull species across the Ornithology Study Area

5.13 Large Gull Species – unidentified

During the September 2020 survey, one unidentified large gull species was recorded. Unidentified large gull species were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The peak count of one unidentified large gull species in September 2020 resulted in an abundance estimate of three for the Ornithology Study Area (**Table 17**).

The large gull species was recorded in the southeast of the Ornithology Study Area (**Figure 27**).

Table 17 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of unidentified large gull species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	1	3	1	9	1	0.01

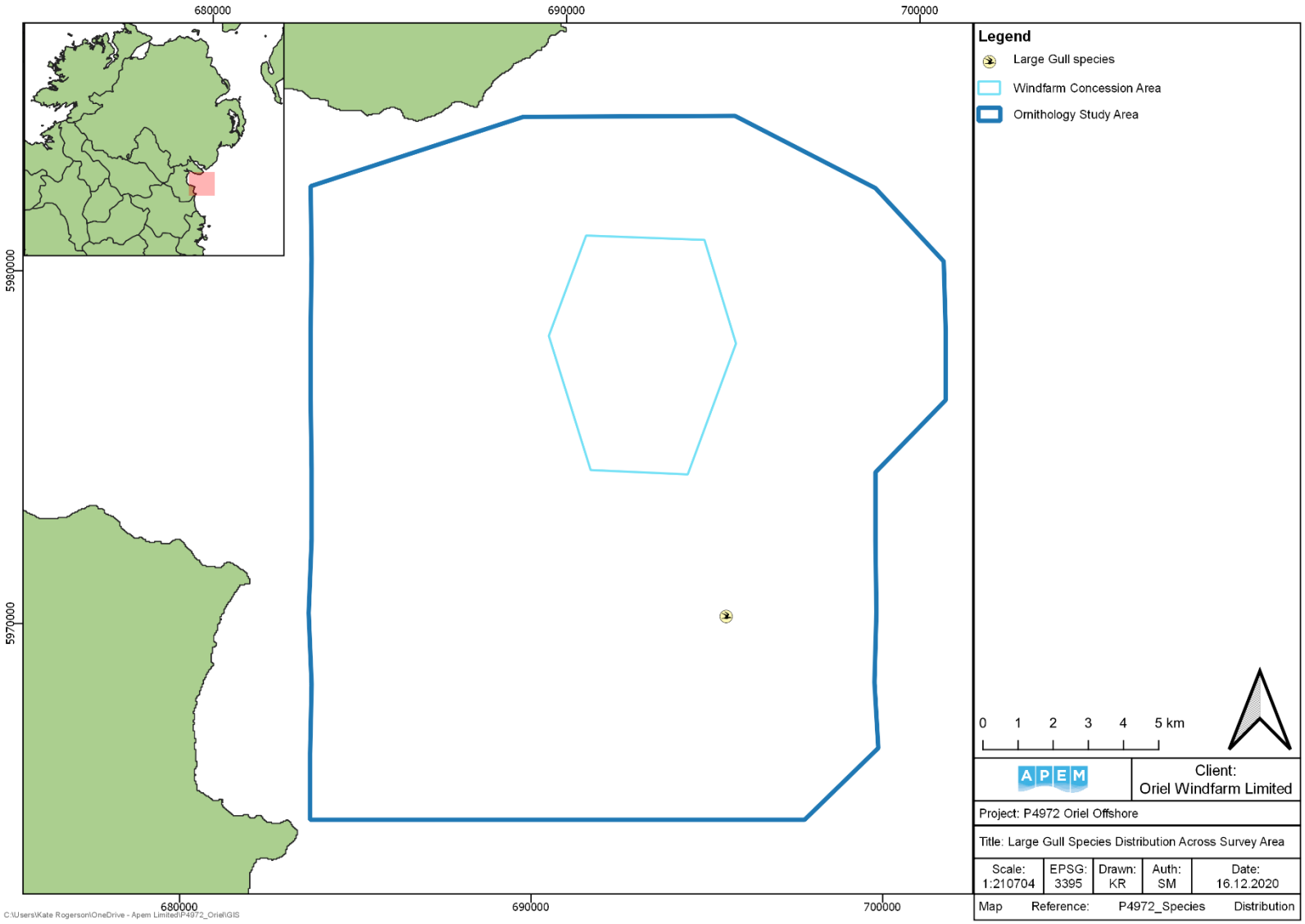


Figure 27 Location of unidentified large gull species across the Ornithology Study area

5.14 Sandwich Tern

Overall 13 sandwich tern were identified across the surveys, three in April 2020, two in May 2020, three in June 2020, one in July 2020, one in August 2020 and three in the September surveys.

The peak count of three sandwich terns in April 2020 resulted in an abundance estimate of nine for the Ornithology Study Area (**Table 18**).

Flying sandwich terns were recorded in all six of the surveys although there was not a significant orientation (**Figure 28**).

In April and September 2020, one and one flying sandwich tern deemed suitable for flight height determination were recorded respectively, the altitude was 60 m above MSL in April and 7 m in September.

Sandwich terns were recorded along in the western edge of the Ornithology area and in the northwest corner of the Ornithology study area (**Figure 29**). One sandwich tern was recorded in the Windfarm Concession area during the September 2020 survey.

Table 18 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of sandwich tern in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
September-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	3	9	3	23	0.57735	0.03
May-2020	1	3	1	9	1	0.01
June-2020	1	3	1	9	1	0.01
July-2020	1	3	1	9	1	0.01
September-2020	3	9	3	18	0.57735	0.03

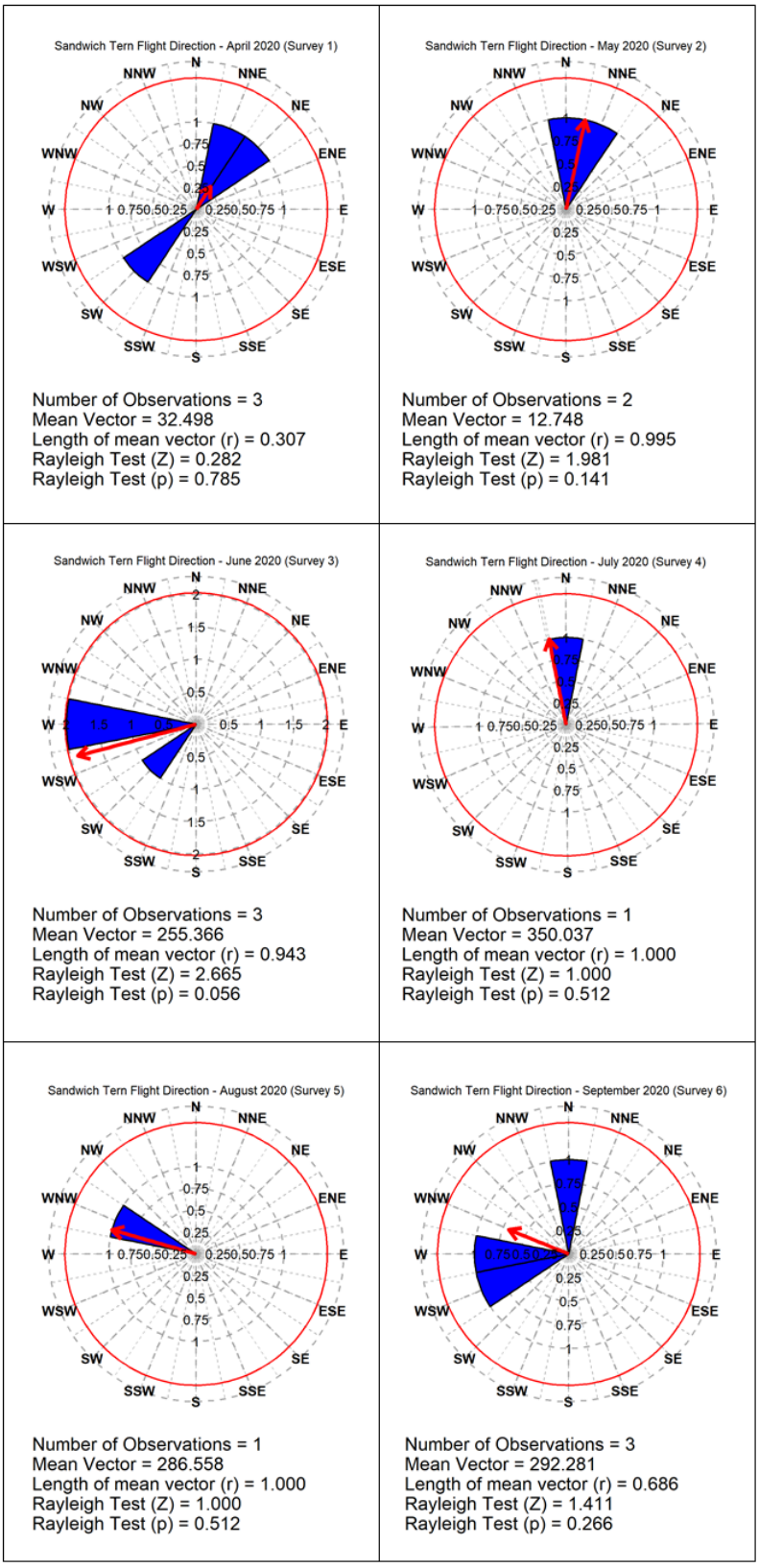


Figure 28 Summary of flight direction of sandwich tern during the six surveys

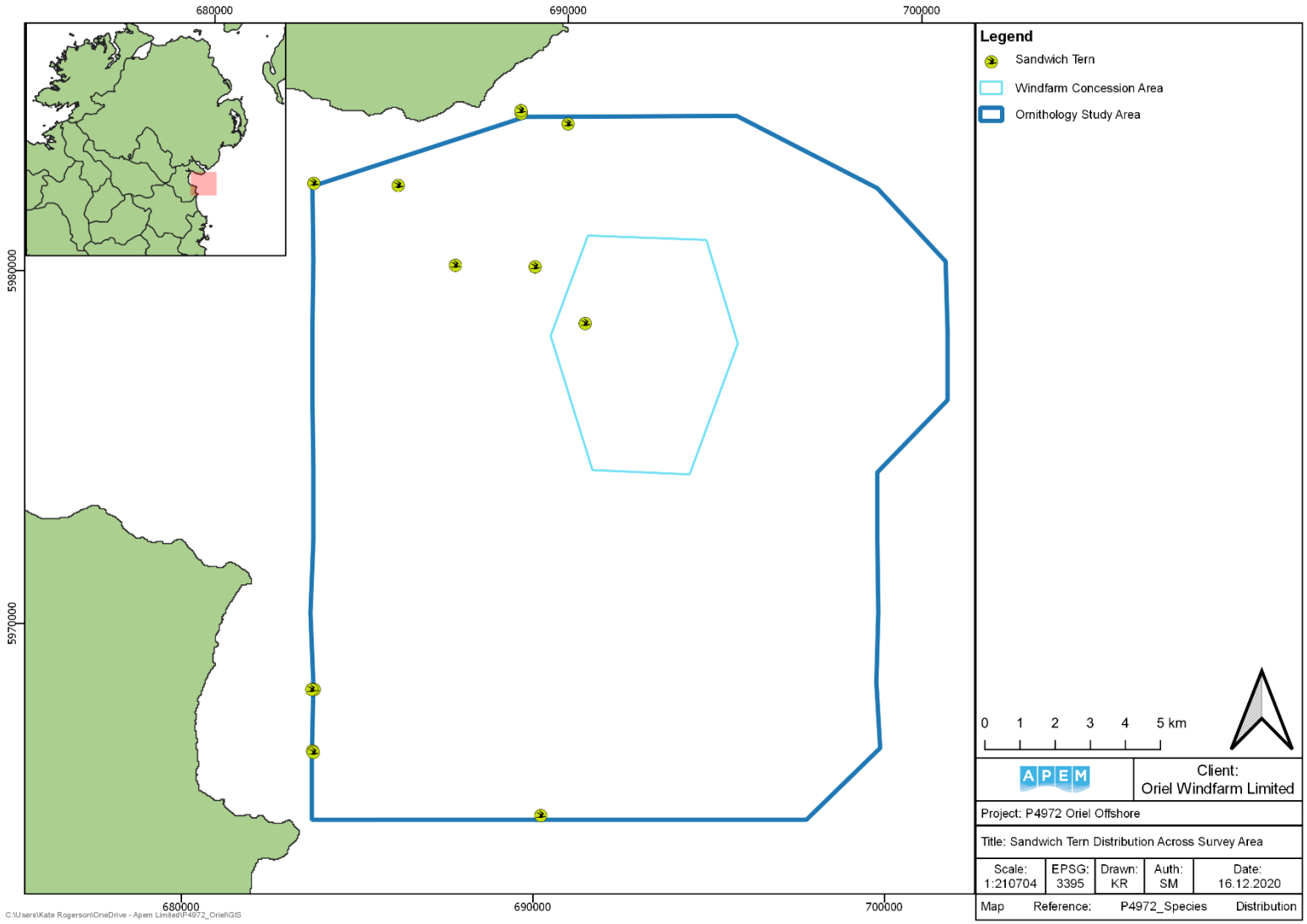


Figure 29 Distribution of sandwich tern recorded across the Ornithology Study area

5.15 Roseate Tern

During the July 2020 survey, one roseate tern were identified. Roseate tern were not recorded in the April 2020, May 2020, June 2020, August 2020 and September 2020 surveys.

The peak count of one roseate tern produced an abundance estimate of three for the Ornithology Study Area (**Table 19**).

The roseate tern was recorded as flying in an easterly direction (**Figure 30**).

The roseate tern was recorded along the southern edge of the Ornithology Study area. No roseate terns were recorded in the Windfarm Concession area (**Figure 31**).

Table 19 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of roseate tern in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
July-2020	1	3	1	9	1	0.01

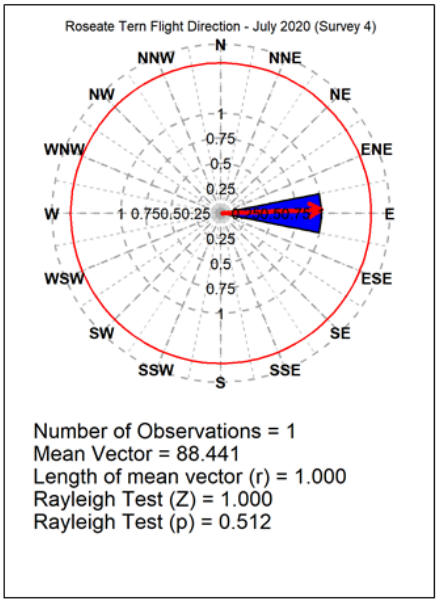


Figure 30 Summary of flight direction of roseate tern during the July survey

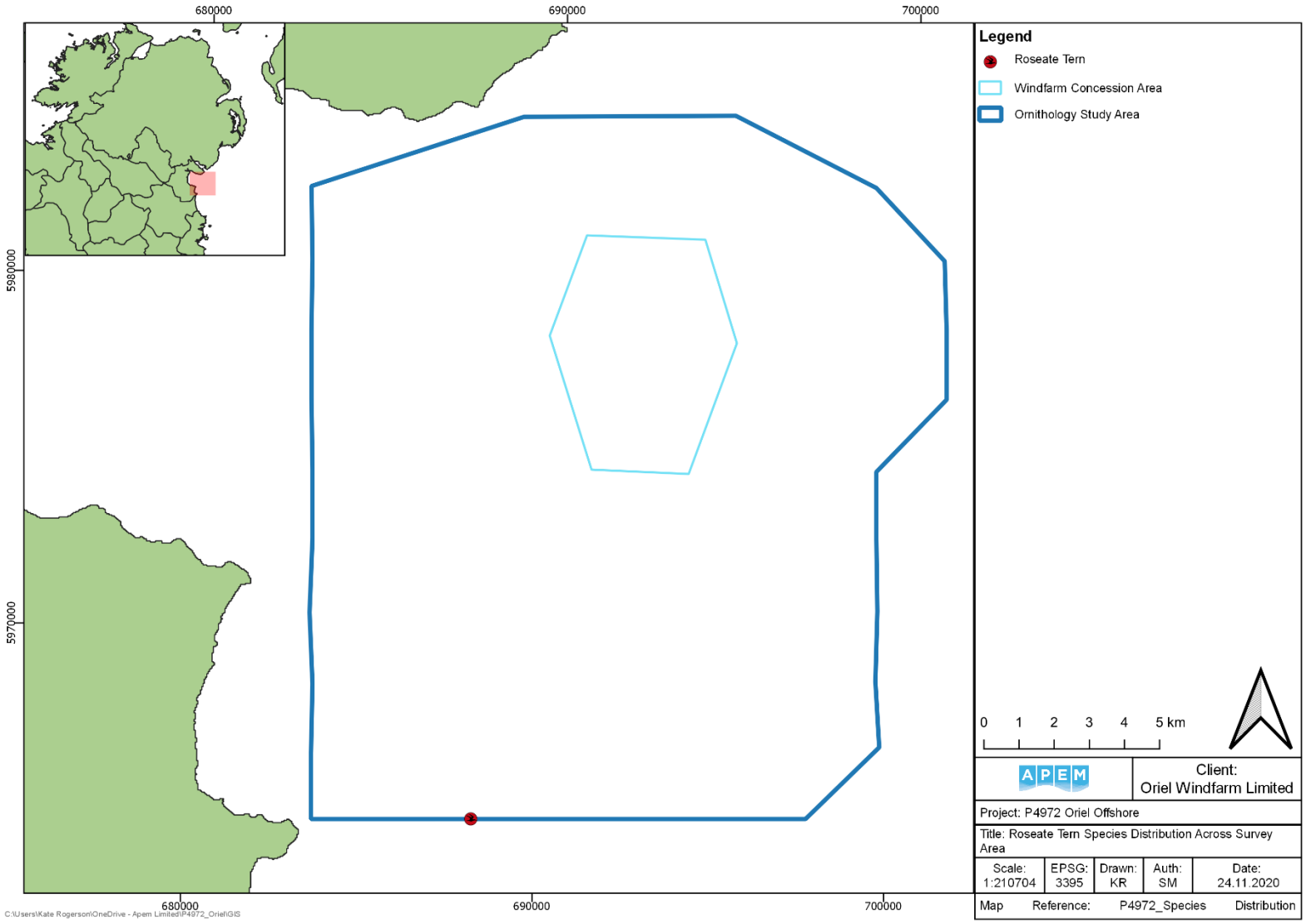


Figure 31 Location of roseate tern recorded in Ornithology Study area

5.16 Common Tern

During the September 2020 survey, seven common tern were identified. Common tern were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The peak count of five common terns resulted in an abundance estimate of 15 for the Ornithology Study area (**Table 20**).

The common terns were recorded as flying, although there was not a significant orientation (**Figure 32**).

In September 2020 two flying common tern deemed suitable for flight height determination were recorded, with heights of 32 and 105 m above MSL.

Common tern were located within the Windfarm Concession Area and on the western boundary of the Ornithology Study Area (**Figure 33**).

Table 20 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of common tern in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
September-2020	2	6	2	17	0.70711	0.22
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
September-2020	5	15	5	32	0.44721	0.05

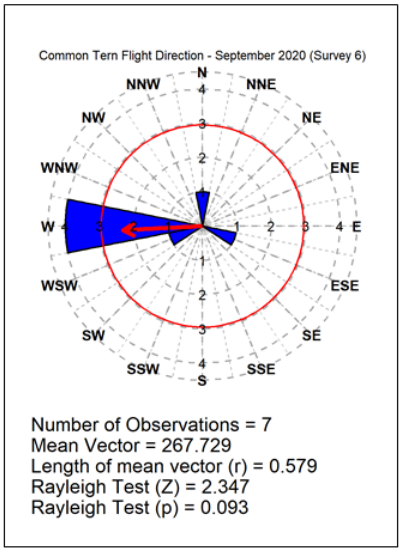


Figure 32 Summary of flight direction of common tern during the September 2020 survey.

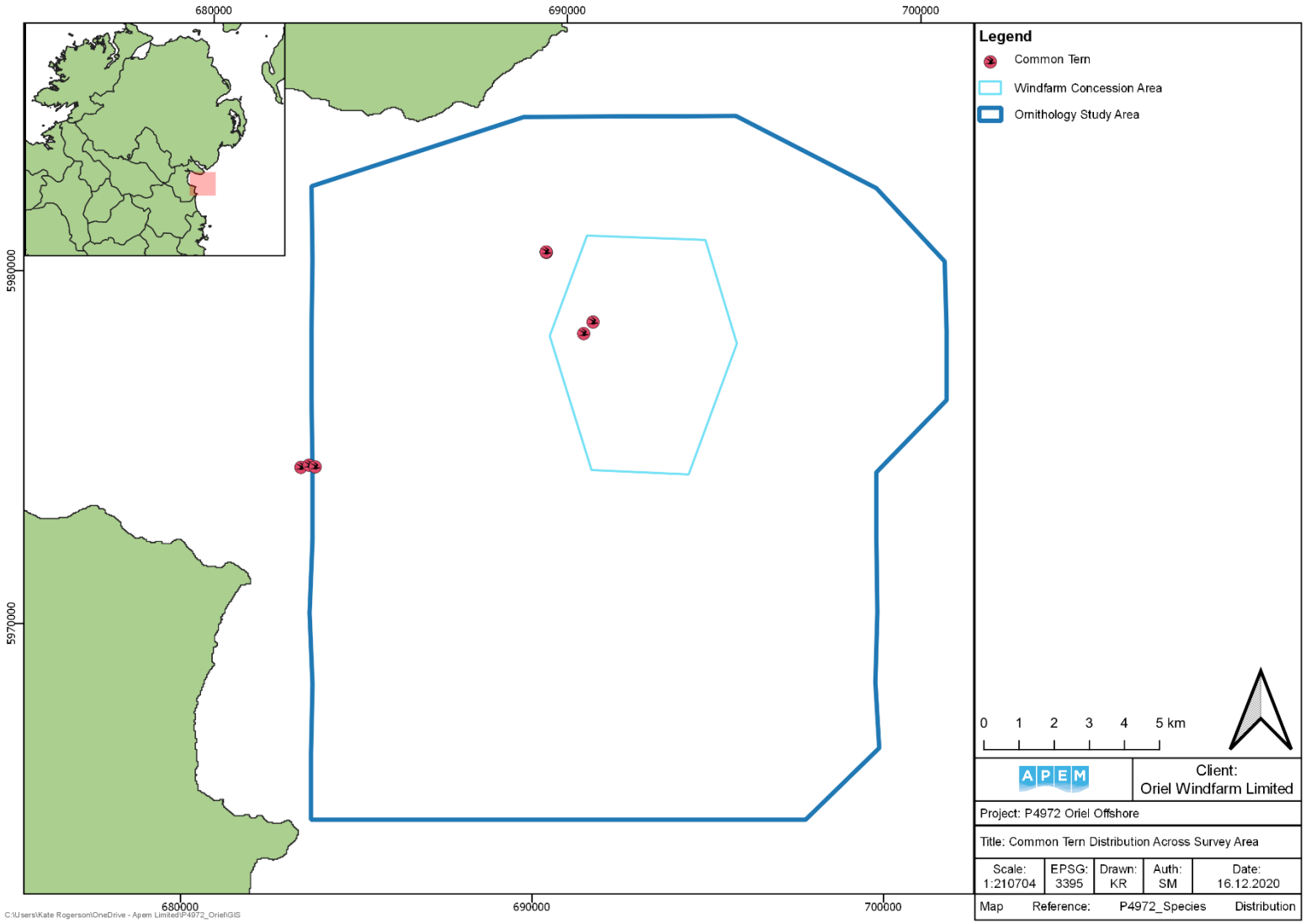


Figure 33 Distribution of common tern across the Ornithology Study Area.

5.17 Commic / Roseate Tern

Overall 11 commic / roseate tern were identified, five in June 2020, three in July 2020 and three in the September 2020 surveys. Commic / roseate tern were not recorded in the April 2020, May 2020 and August 2020 surveys.

The peak count of five commic / roseate terns resulted in an abundance estimate of 14 for the Ornithology Study area (**Table 21**).

Five flying comic / roseate terns were recorded in the June 2020 survey with a significant orientation around the mean of 188° (Rayleigh test, p=<0.05, **Figure 34**). No significant direction of flying commic / roseate terns was recorded in July and September.

Commic / roseate tern showed no overall distribution pattern and were distributed across the Ornithology Study area (**Figure 35**), although there was a concentration of commic / roseate terns east of the Windfarm Concession area.

Table 21 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of commic / roseate tern in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
July-2020	1	3	1	8	1	0.11
September-2020	2	6	2	17	0.70711	0.22
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	5	14	5	43	0.44721	0.04
July-2020	3	9	3	17	0.57735	0.03
September-2020	2	6	2	18	0.70711	0.02

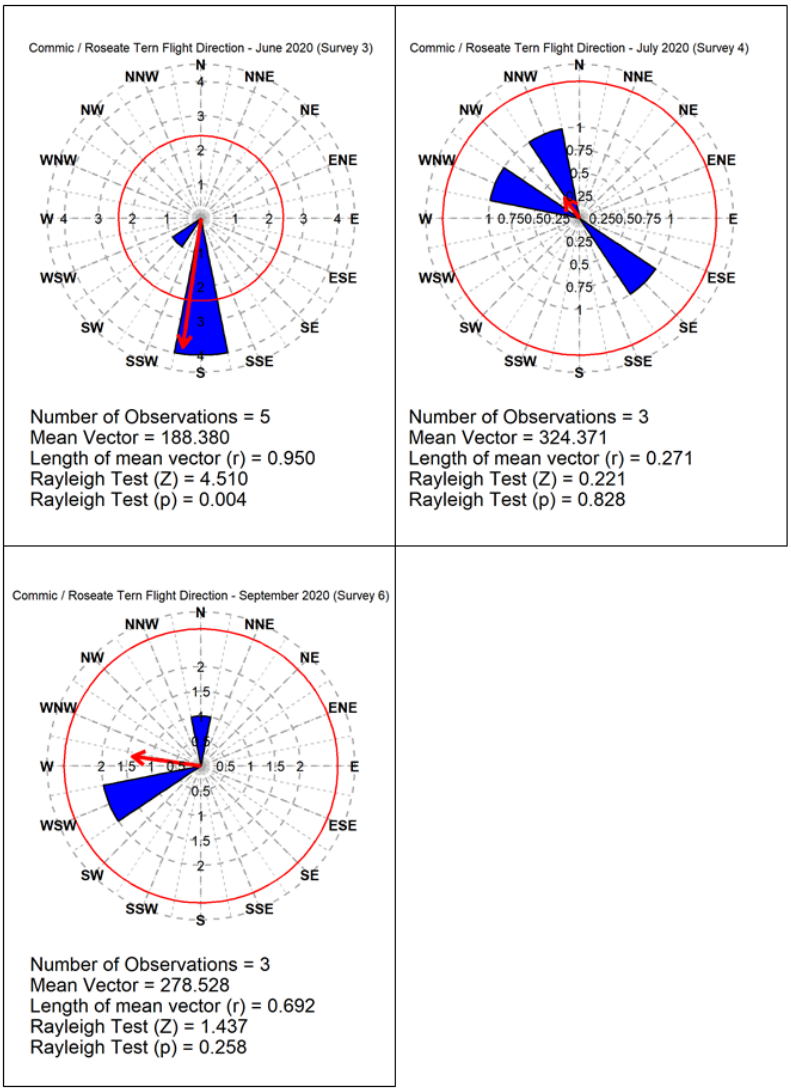


Figure 34 Summary of flight direction of commic / roseate tern during the June, July and September 2020 surveys

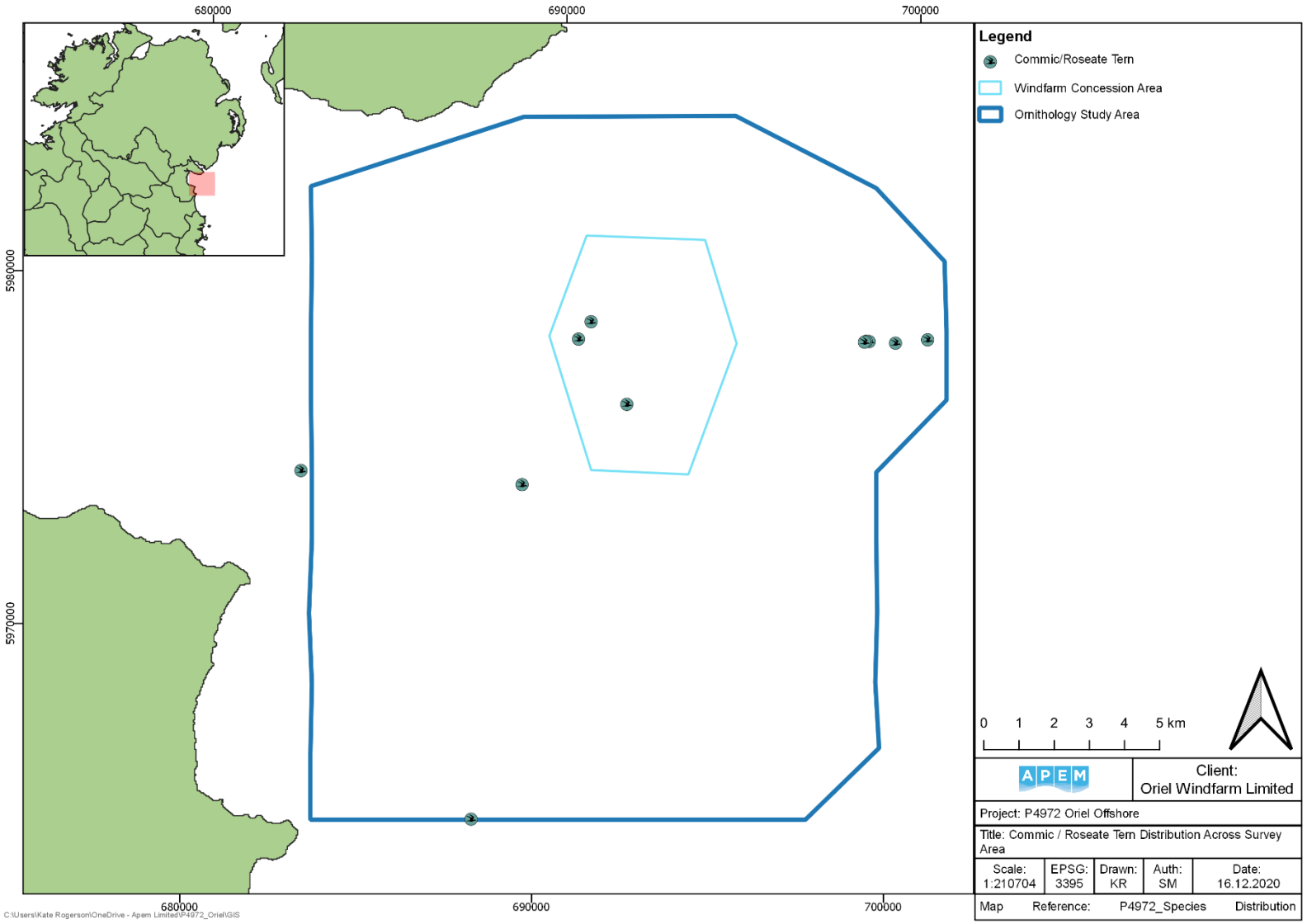


Figure 35 Distribution of commic / roseate tern across the Ornithology Study area

5.18 Commic Tern

Overall 25 commic terns were identified, two in April 2020, two in May 2020, four in June 2020, five in July 2020, seven in August 2020 and five in September 2020 surveys.

The peak raw count of seven commic terns in August resulted in an abundance estimate of 20 commic terns for the Ornithology Study Area (**Table 22**).

Flying commic terns recorded in all six surveys, a significant orientation was recorded in the July survey with birds flying around a mean orientation of 133°; in August survey with birds flying around a mean orientation of 187°; in September survey with birds flying around a mean orientation of 271° (Raleigh test, p=<0.05, **Figure 36**).

In May, June and August 2020, one, one and two flying common gull deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 18 m above MSL (**Figure 37**).

Commic tern showed no overall distribution pattern and were distributed across the Ornithology Study area (**Figure 38**).

Table 22 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of commic tern in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	8	1	0.11
August-2020	4	11	4	33	0.5	0.4
September-2020	4	11	4	33	0.5	0.4
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	9	1	0.01
May-2020	1	3	1	9	1	0.01
June-2020	3	9	3	20	0.57735	0.03
July-2020	5	14	5	34	0.44721	0.04
August-2020	7	20	7	52	0.37796	0.06
September-2020	5	15	5	38	0.44721	0.05

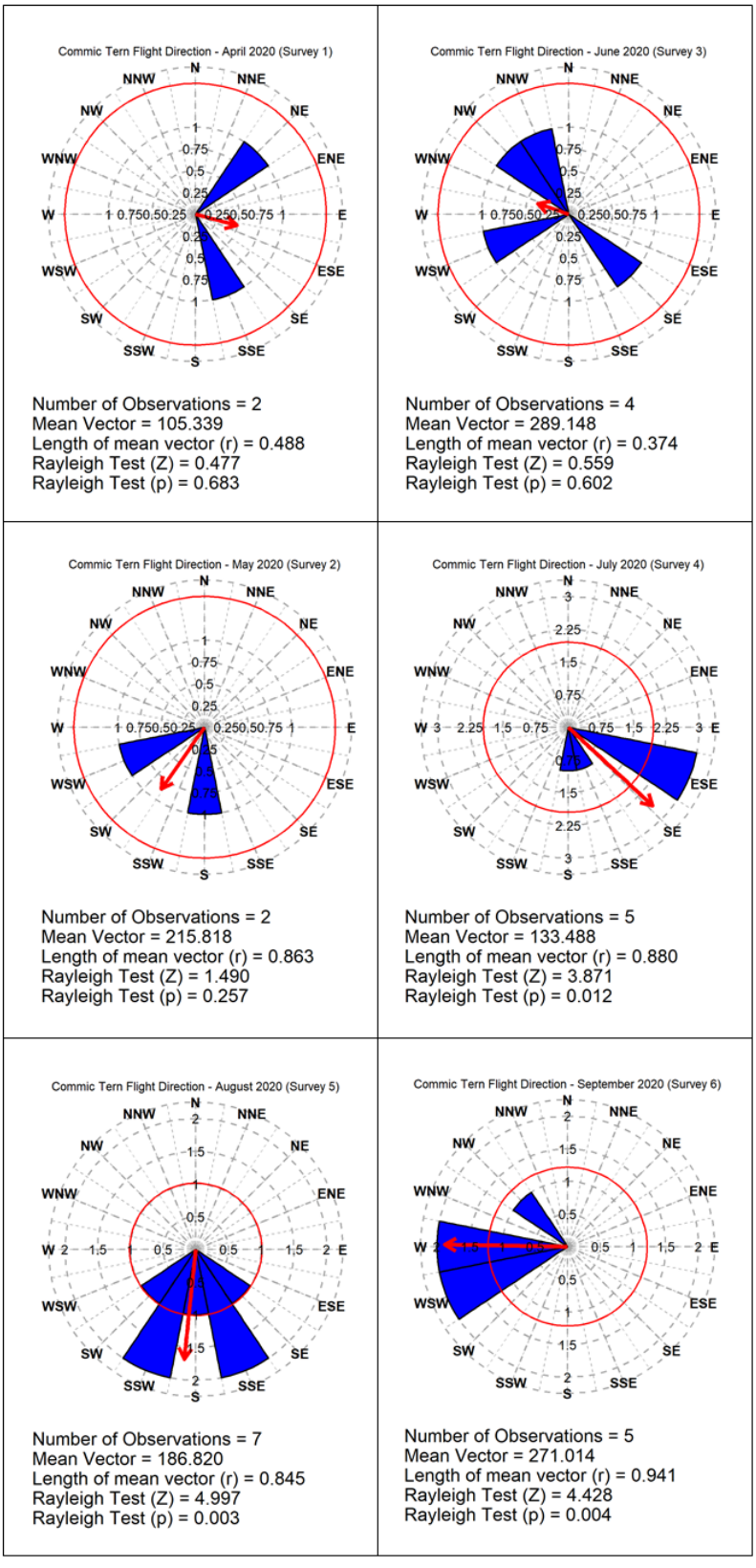


Figure 36 Summary of flight direction of commic tern during the six surveys

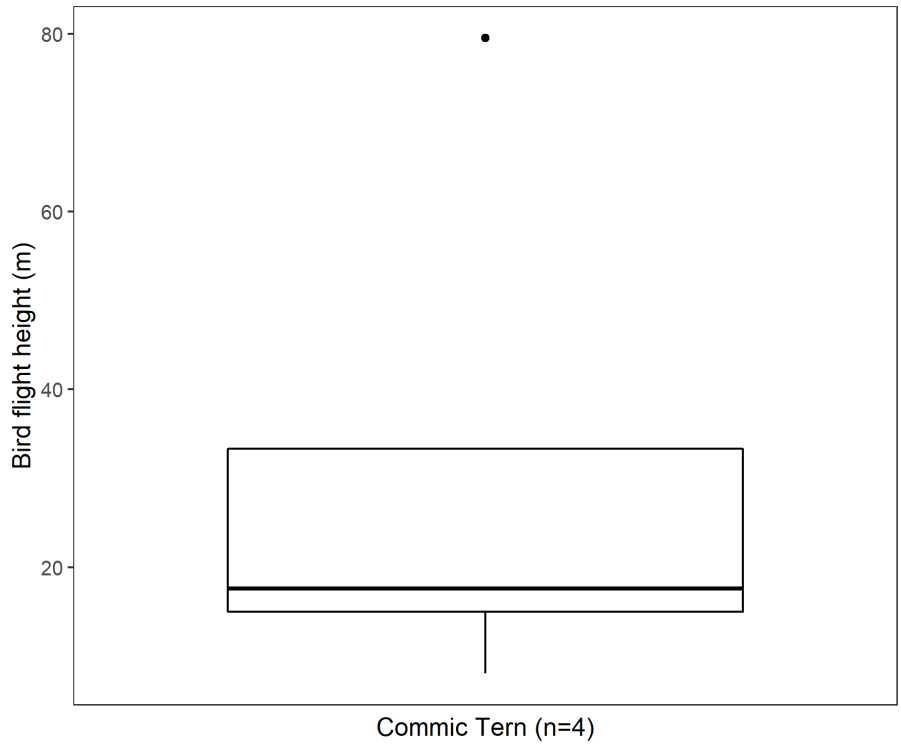


Figure 37 Flight heights of commic tern (n=4) recorded in the Ornithology Study area

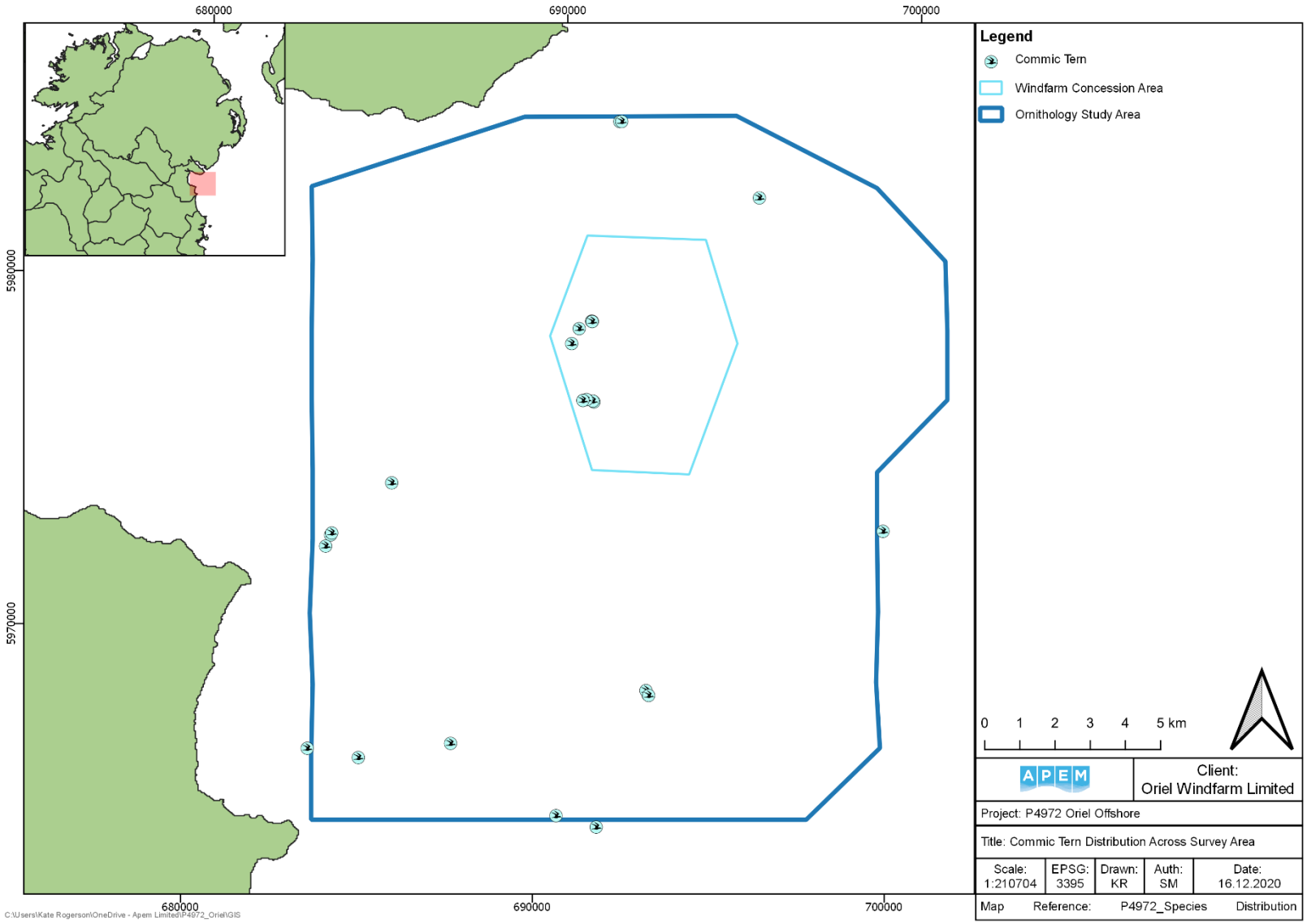


Figure 38 Distribution of commic tern recorded across the ornithology Study area

5.19 Great Skua

During the July 2020 survey, one great skua was identified. Great Skua were not recorded in the April 2020, May 2020, June 2020, August 2020 and September 2020 surveys.

The great skua resulted in an abundance estimate of three for the Ornithology Study area (**Table 23**).

The great skua was recorded flying in a northerly direction (**Figure 39**).

The great skua was located southeast of the Windfarm Concession area. No great skua were recorded in the Windfarm Concessions area (**Figure 40**).

Table 23 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of great skua in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
July-2020	1	3	1	9	1	0.01

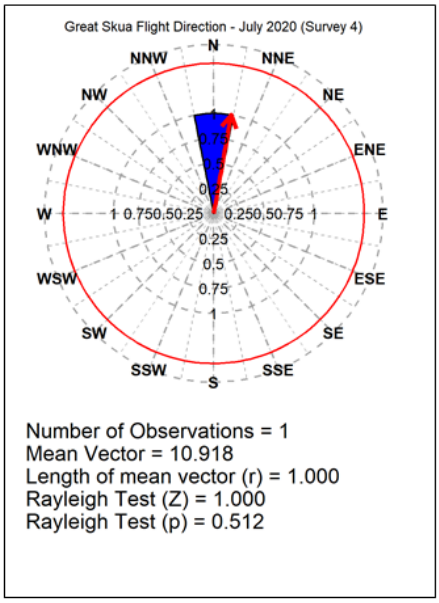


Figure 39 Summary of flight direction of great skua during the July survey

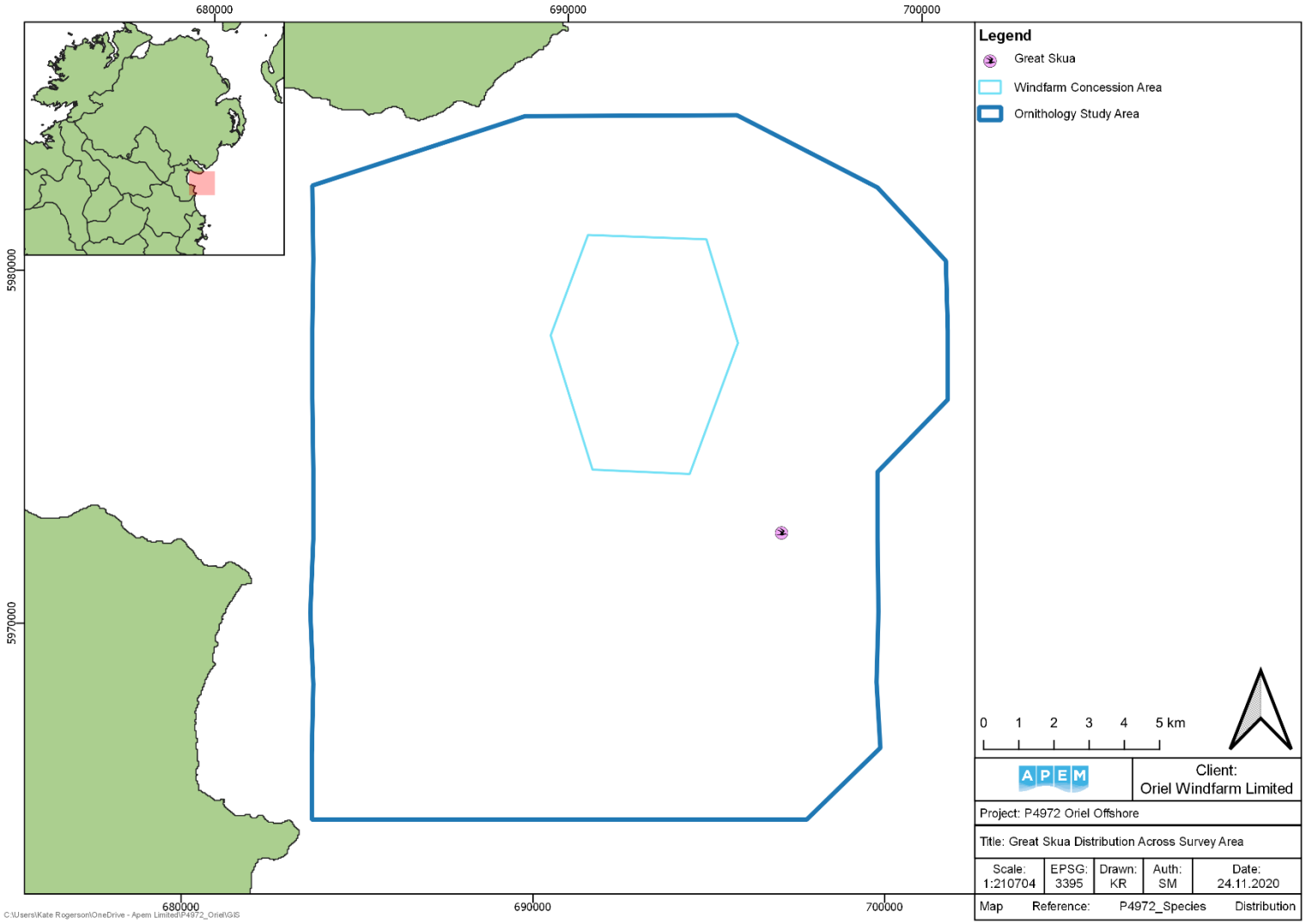


Figure 40 Location of great skua in the Ornithology Study area

5.20 Arctic Skua

During the September 2020 survey, two arctic skua were recorded. Arctic skua were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The peak count of two arctic skua resulted in an abundance estimate of six for the Ornithology Study area (**Table 24**).

One arctic skua was recorded flying in a south-westerly direction (**Figure 41**).

The flying arctic skua recorded in September 2020 was deemed suitable for flight height determination, and an altitude of 9 m above MSL was recorded.

One arctic skua was located in the northwest of the Ornithology Study Area, while the other was in the southeast corner of the Ornithology Study Area (**Figure 42**).

Table 24 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of arctic skua in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	2	6	2	12	0.70	0.02

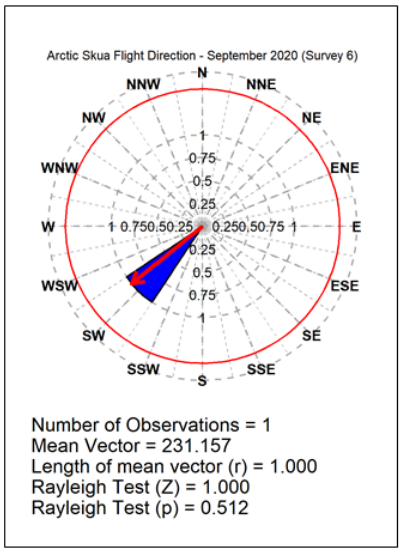


Figure 41 Summary of flight direction of arctic skua during the September 2020 survey

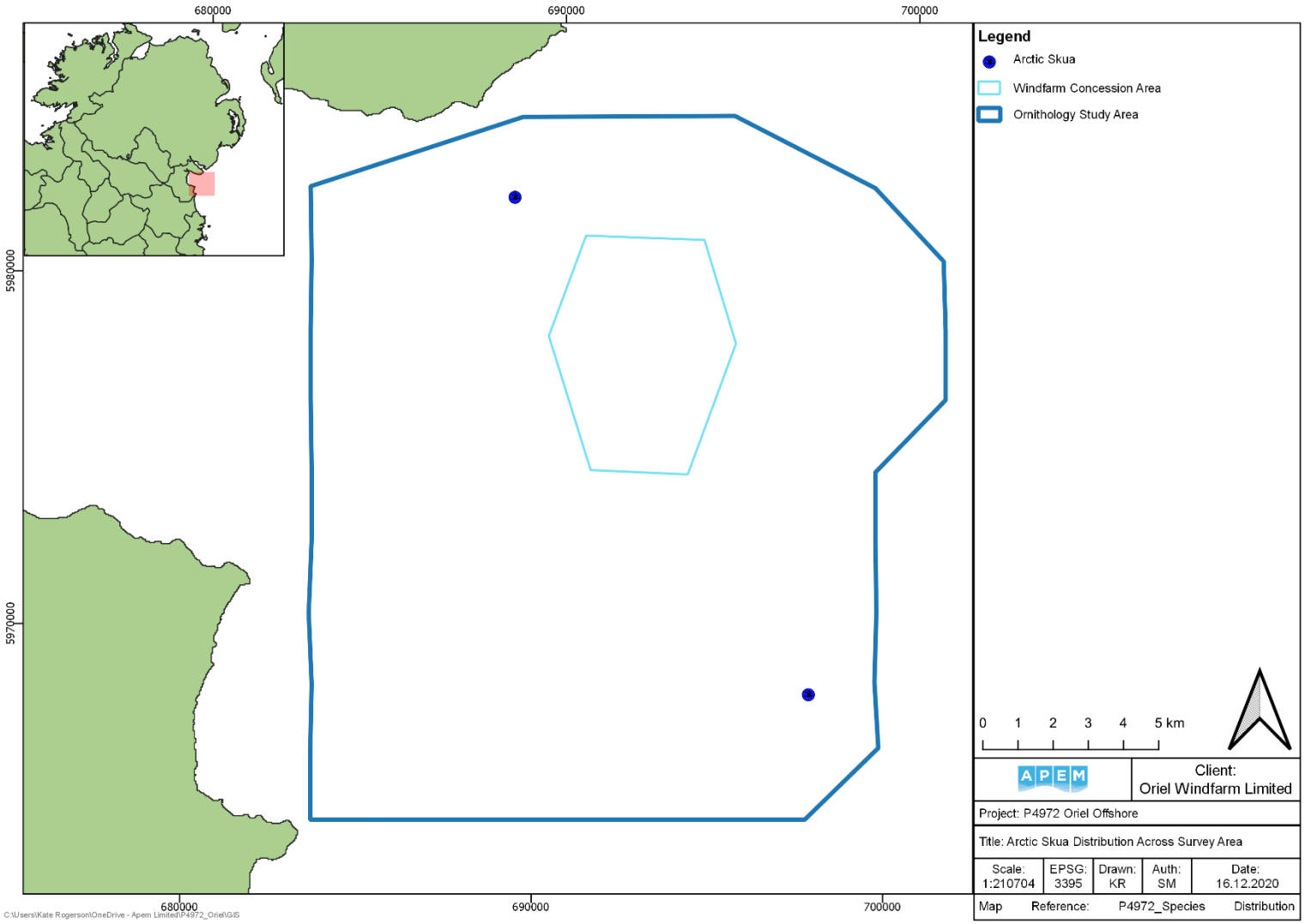


Figure 42 Location of arctic skua in the Ornithology Study Area.

5.21 Guillemot

Overall 13,458 guillemot were identified across the surveys, 247 in the April 2020, 529 in May 2020, 207 in June 2020, 3,235 in July 2020, 3,077 in August 2020 and 6,163 in September 2020 surveys.

A peak count of 5,562 guillemot in the September 2020 survey resulted in an abundance estimate of 16,228 across the Ornithology Study area (**Table 25**). In the same month a raw count of 430 guillemot in the Windfarm concession area resulted in an abundance estimate of 1,185 for the Windfarm Concession area.

Flying guillemot were recorded in May, June and July surveys. In June guillemot flew in a significant orientation around the mean of 193° and in September guillemot flew in a significant orientation around the mean of 255° (Raleigh test, p=<0.05, **Figure 43**).

In April, May, June and July 2020; five, three, seven and two flying guillemot deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 17 m above MSL (**Figure 44**).

Guillemot were distributed across the Ornithology Study area with the largest concentrations of individuals in the south to southeast of the area (**Figure 45**).

Table 25 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of guillemot in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	36	96	36	176	0.16667	3.46
May-2020	143	393	143	874	0.08362	14.18
June-2020	29	79	29	149	0.1857	2.85
July-2020	72	199	105	313	0.11785	7.18
August-2020	99	270	125	414	0.1005	9.74
September-2020	430	1185	780	1475	0.04822	42.76
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	218	629	456	791	0.06773	1.97
May-2020	492	1426	742	2122	0.04508	4.46
June-2020	182	523	345	706	0.07412	1.64
July-2020	2636	7565	4687	10518	0.01948	23.65
August-2020	2742	7877	4588	11236	0.0191	24.63
September-2020	5562	16228	11913	19866	0.01341	50.74

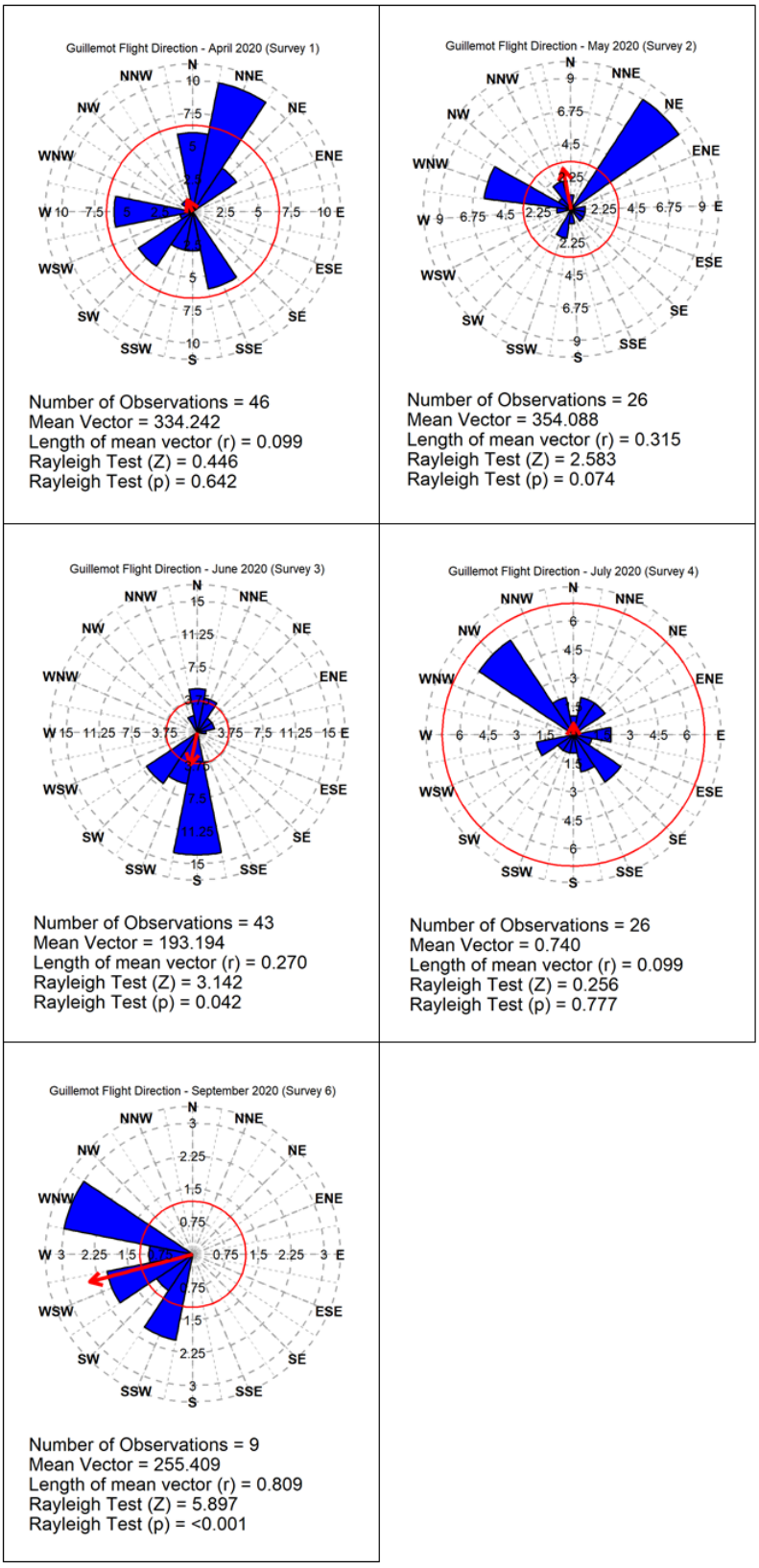


Figure 43 Summary of flight direction of guillemot during the April, May, June, July and September 2020 surveys

Figure 44 Flight heights of guillemot (n=17) recorded in the Ornithology Study area

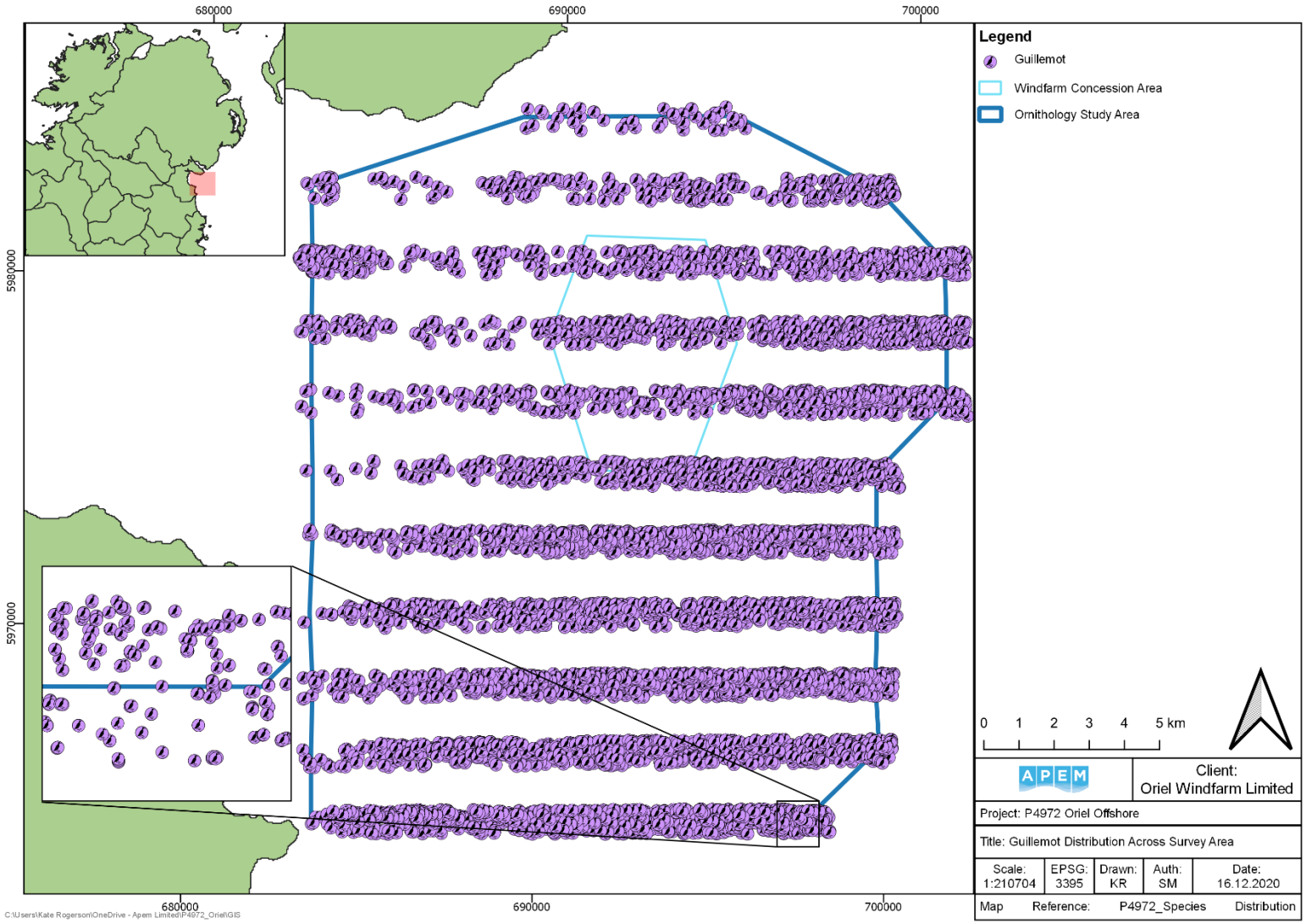


Figure 45 Distribution of guillemot recorded across the Ornithology Study area

5.22 Razorbill

Overall 1,559 razorbill were identified, 36 in the April 2020, 67 in May 2020, 295 in June 2020, 31 in July 2020, 66 in August 2020 and 1,064 in September 2020 surveys.

A peak raw count of 952 in September 2020 resulted in an abundance estimate of 2,778 for the Ornithology Study area (**Table 26**).

Flying herring gulls were found to have a significant direction of flight for in the April 2020 survey. Flying razorbill were significantly orientated around the mean of 348° (Rayleigh test, p=<0.05, **Figure 46**).

Herring gulls showed no predominant pattern of distribution, due to occurring throughout the extent of the Ornithology Study area across the survey period (**Figure 47**). Although there were higher concentrations of razorbill along the western side of the Ornithology Study are.

Table 26 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of razorbill in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	8	1	0.11
May-2020	7	19	7	30	0.37796	0.69
June-2020	32	87	60	125	0.17678	3.14
July-2020	2	6	2	17	0.70711	0.22
September-2020	72	198	99	298	0.11785	7.15
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	23	66	23	121	0.20851	0.21
May-2020	49	142	70	226	0.14286	0.44
June-2020	267	767	422	1223	0.0612	2.4
July-2020	26	75	43	106	0.19612	0.23
August-2020	54	155	95	218	0.13608	0.48
September-2020	952	2778	2107	3376	0.03241	8.69

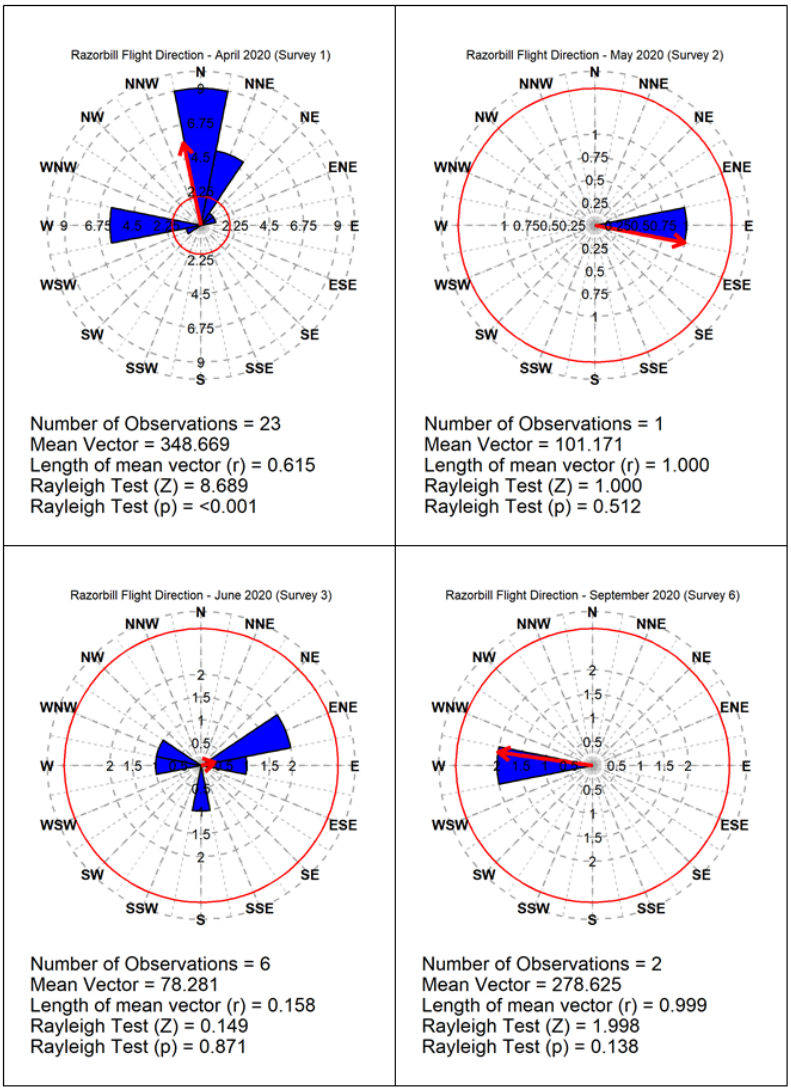


Figure 46 Summary of flight direction of razorbill during the April, May, June and September 2020 surveys.

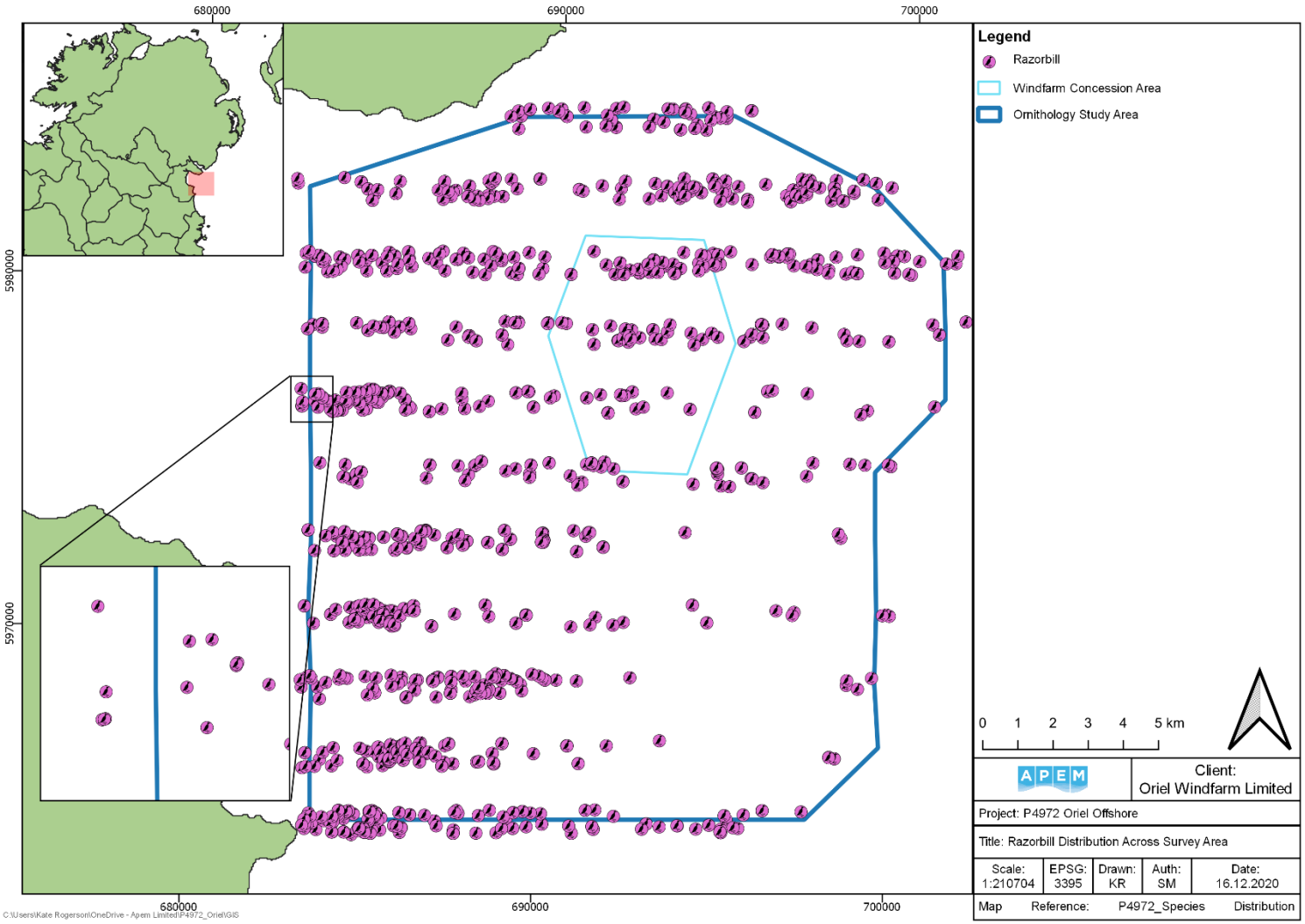


Figure 47 Distribution of razorbill recorded across the Ornithology Study area

5.23 Black Guillemot

Overall 577 black guillemot were identified across the survey period; 59 in the April 2020, one in May 2020, 38 in June 2020, 38 in July 2020, 224 in August 2020 and 217 in September 2020 surveys.

A peak raw count of 201 in September 2020 resulted in an abundance estimate of 586 for the Ornithology Study Area (**Table 27**).

Flying black guillemot were recorded in April 2020 and July 2020 and were found to have no significant direction of flight (**Figure 48**).

In August 2020, one flying guillemot deemed suitable for flight height determination was recorded, with an altitude of 3 m above MSL.

Black guillemot were concentrated to the east to northeast of the Windfarm Concession area (**Figure 49**).

Table 27 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of black guillemot in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	8	1	0.11
June-2020	2	5	2	16	0.70711	0.18
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	57	165	61	294	0.13245	0.52
May-2020	1	3	1	9	1	0.01
June-2020	36	103	36	190	0.16667	0.32
July-2020	37	106	37	221	0.1644	0.33
August-2020	184	529	184	971	0.07372	1.65
September-2020	201	586	201	1284	0.07053	1.83

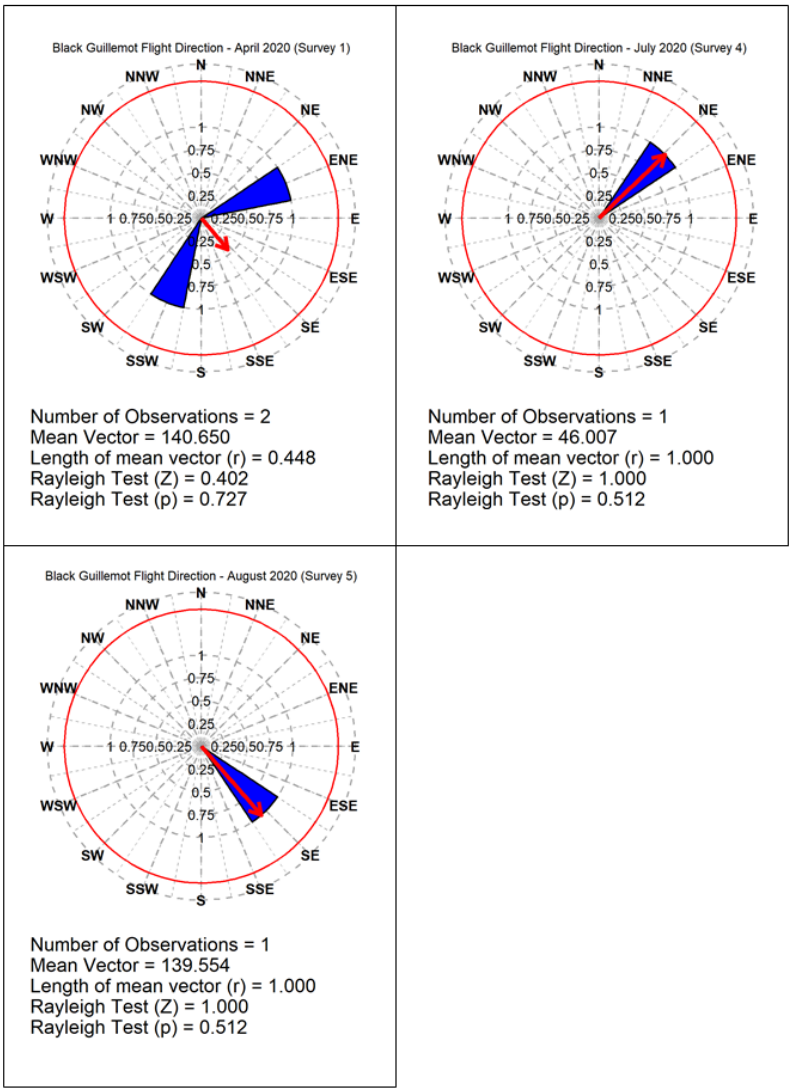


Figure 48 Summary of flight direction of black guillemot during the April, July and August 2020 surveys

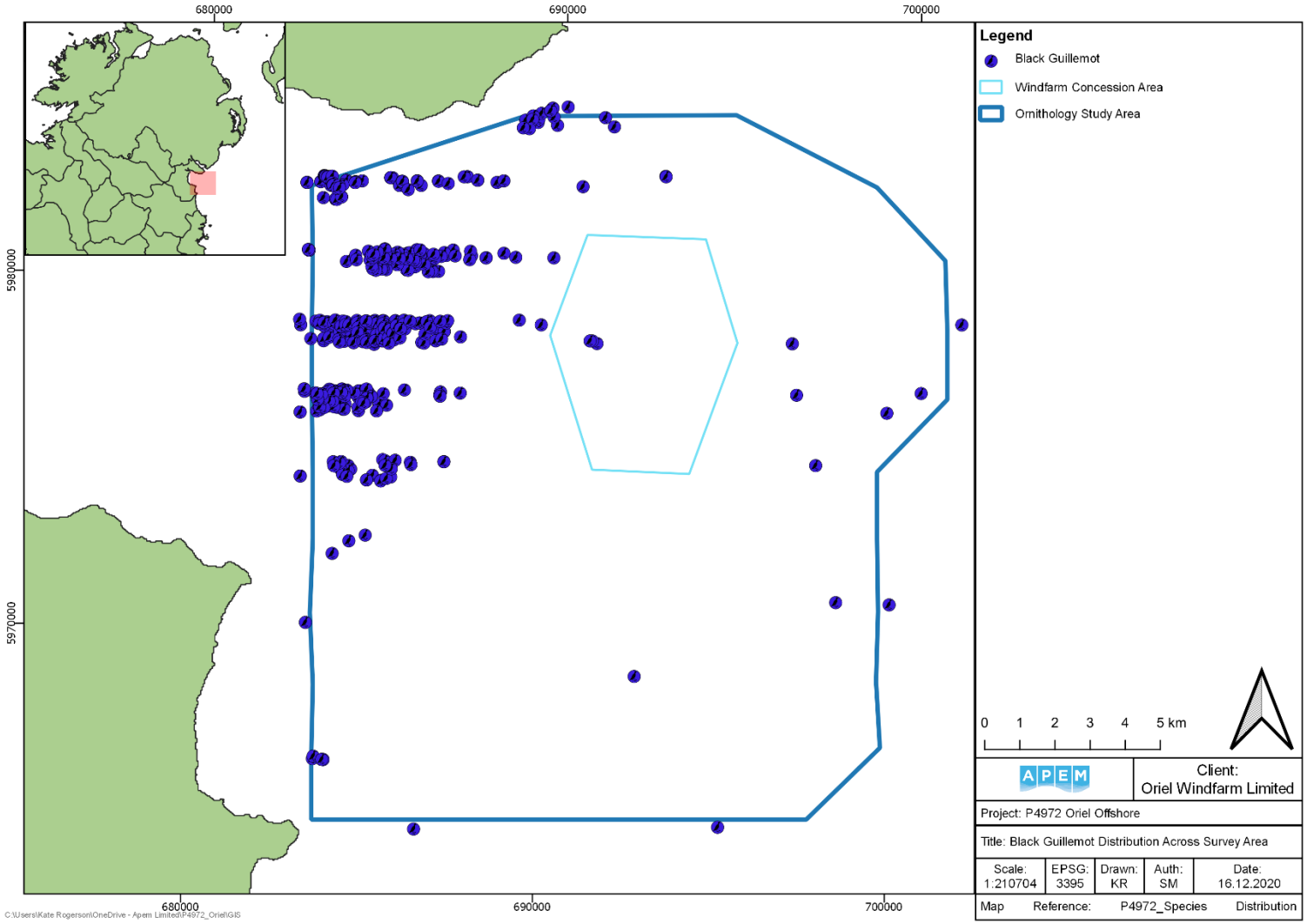


Figure 49 Distribution of black guillemot recorded across the Ornithology Study area

5.24 Guillemot / Razorbill

Overall 2,211 guillemot / razorbill were identified across the Surveys; 217 in April 2020, 91 in May 2020, 245 in June 2020, 808 in July 2020, 54 in August 2020 and 796 in September 2020 surveys.

A peak raw count of 758 in July resulted in an abundance estimate of 2,175 for the Ornithology Study area (**Table 28**).

Flying guillemot / razorbill were recorded in April, June, July and September although none showed a significant predominant direction of flight (Rayleigh test, p=>0.05, **Figure 50**).

In June 2020, two flying guillemot / razorbill deemed suitable for flight height determination were recorded, altitude of 33 and 59 m above MSL were recorded.

Guillemot / razorbill showed no predominant pattern of distribution and occurred throughout the extent of the Ornithology Study area (**Figure 51**).

Table 28 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of guillemot / razorbill in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	75	200	75	396	0.11547	7.22
May-2020	23	63	23	126	0.20851	2.27
June-2020	27	73	27	212	0.19245	2.63
July-2020	70	194	152	257	0.11952	7
September-2020	52	143	52	229	0.13868	5.16
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	194	560	283	886	0.0718	1.75
May-2020	85	246	148	357	0.10847	0.77
June-2020	217	623	333	970	0.06788	1.95
July-2020	758	2175	1421	2856	0.03632	6.8
August-2020	49	141	57	253	0.14286	0.44
September-2020	658	1920	1187	2693	0.03898	6

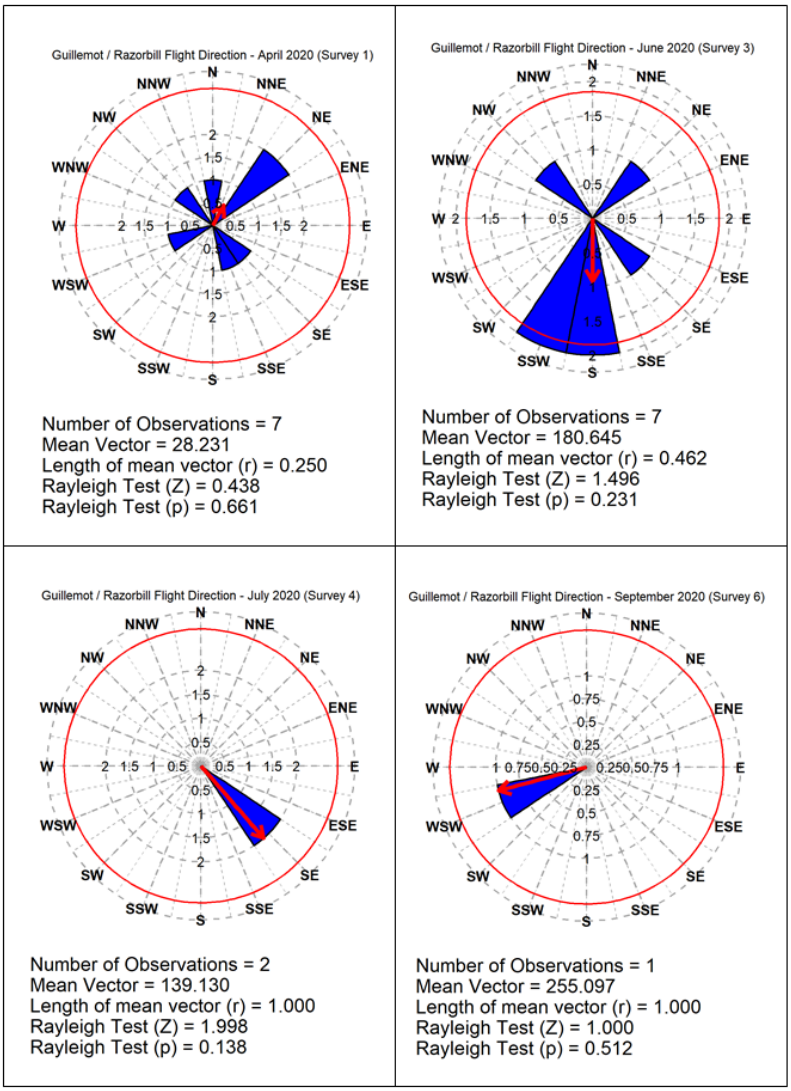


Figure 50 Summary of flight direction of guillemot / razorbill during the April, June, July and September 2020 surveys

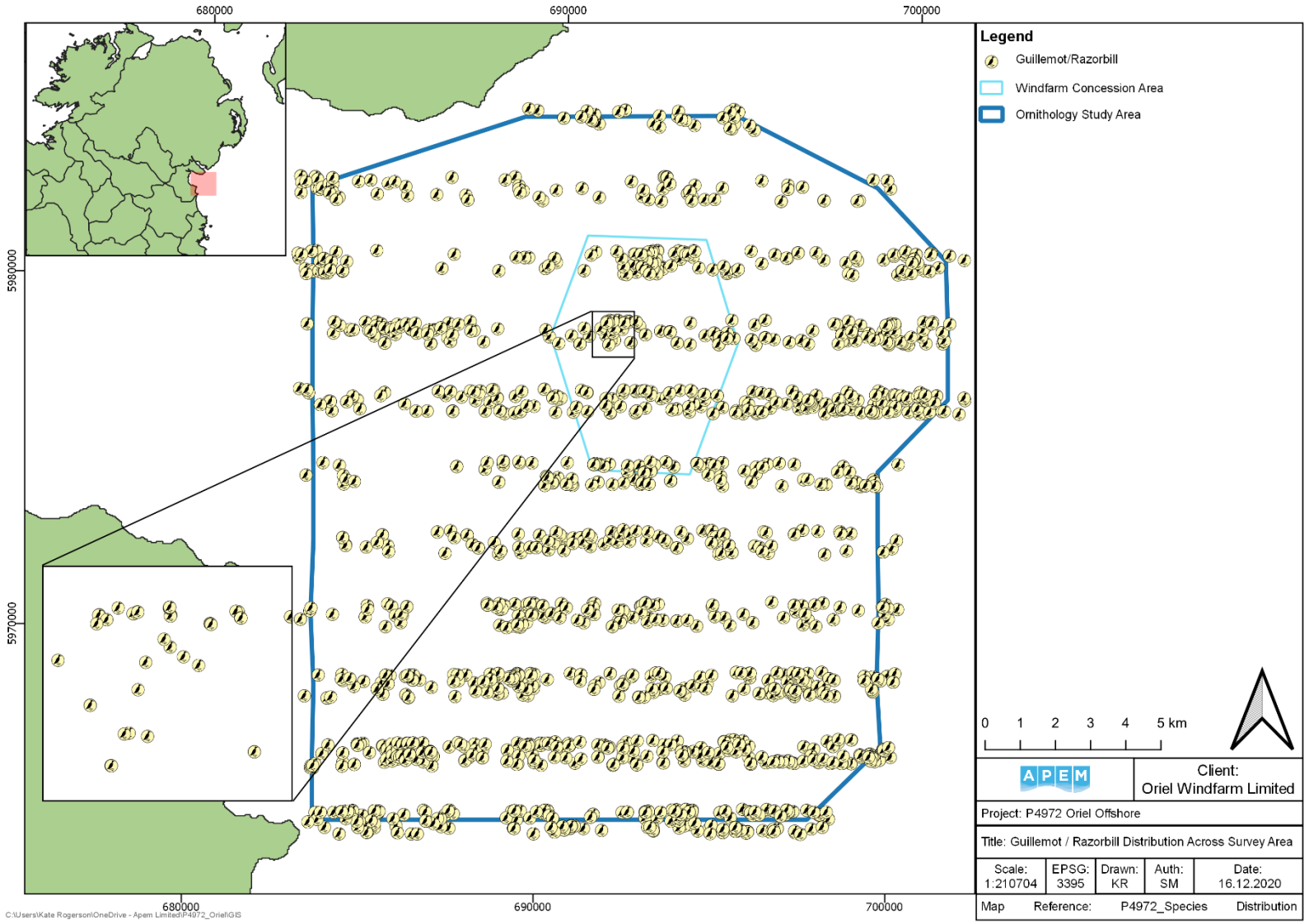


Figure 51 Distribution of guillemot / razorbill recorded across the Ornithology Study area

5.25 Puffin

Overall 51 puffin were identified across the surveys, two in the April 2020, one in May 2020 seven in June 2020, seven in July 2020, 10 in August 2020 and 24 in September 2020 surveys.

A peak raw count of 21 in September 2020 resulted in an abundance estimate of 61 for the Ornithology Study area (**Table 29**).

No flying puffin were recorded during the surveys.

There was no spatial distribution pattern in the locations for puffin across the Ornithology Study area (**Figure 52**).

Table 29 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of puffin in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	8	1	0.11
August-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	9	1	0.01
May-2020	1	3	1	9	1	0.01
June-2020	4	11	4	20	0.5	0.03
July-2020	7	20	7	46	0.37796	0.06
August-2020	9	26	9	55	0.33333	0.08
September-2020	21	61	21	117	0.21822	0.19

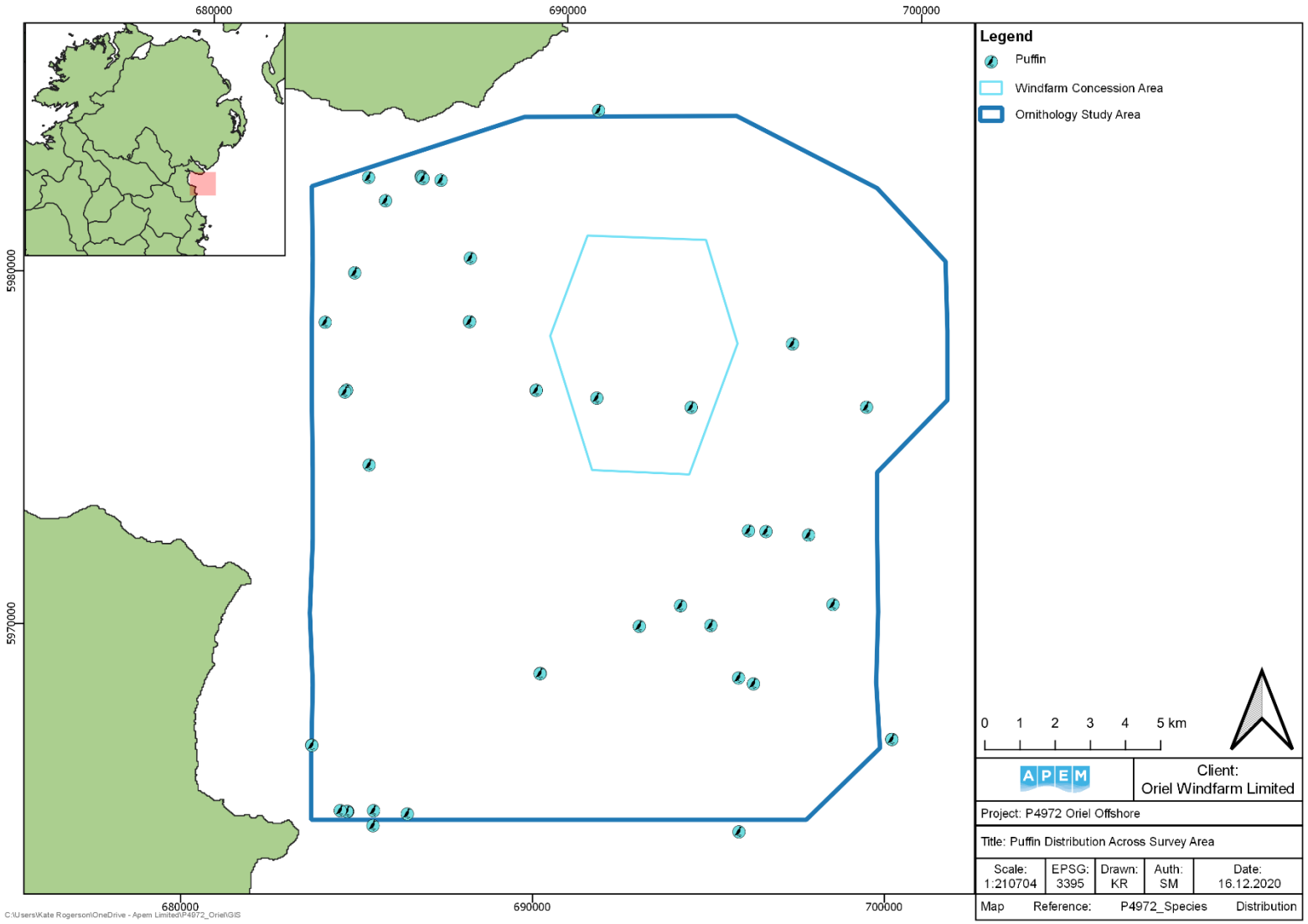


Figure 52 Distribution of puffin recorded across the Ornithology Study area

5.26 Auk Species - unidentified

Overall 61 unidentified auk species were recorded on the surveys; 24 in April 2020,12 in May 2020, seven in June 2020, ten in July 2020, one in August 2020 and seven in September 2020 surveys.

A peak raw count of 24 in April 2020 resulted in an abundance estimate of 69 for the Ornithology Study area (**Table 30**).

No flying unidentified auk species were recorded.

Unidentified auk species were recorded throughout the Ornithology Study area (**Figure 53**).

Table 30 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of auk species in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	4	11	4	24	0.5	0.4
May-2020	2	5	2	11	0.70711	0.18
June-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	24	69	29	121	0.20412	0.22
May-2020	12	35	12	58	0.28868	0.11
June-2020	7	20	7	52	0.37796	0.06
July-2020	10	29	10	66	0.31623	0.09
September-2020	7	20	7	47	0.37796	0.06

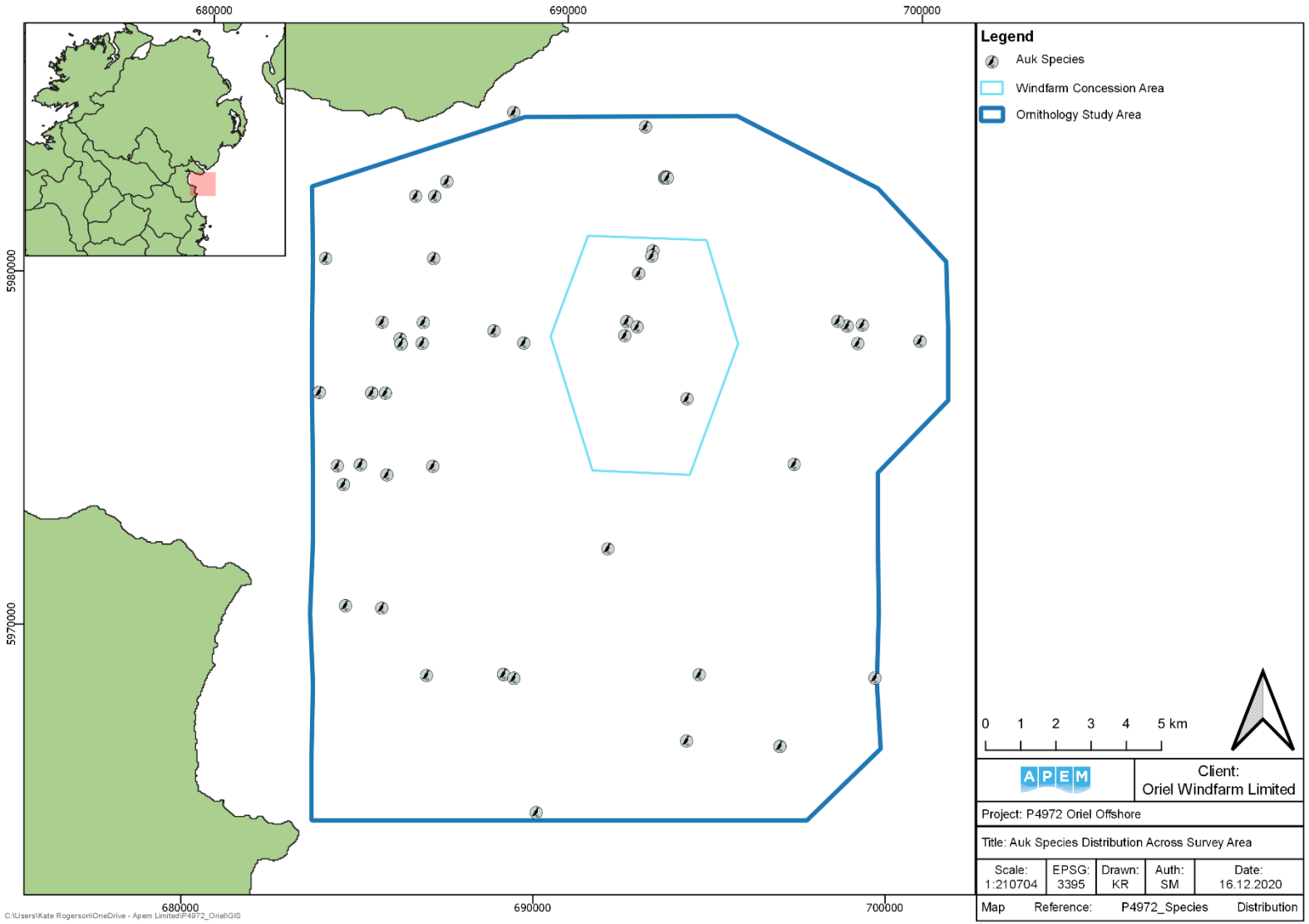


Figure 53 Distribution of unidentified auk species recorded across the Ornithology Study area

5.27 Red-throated Diver

Overall 19 red-throated diver were recorded, 15 in April 2020 and four in September 2020 surveys. Red-throated diver were not recorded in the May 2020, June 2020, July 2020 and August 2020 surveys.

A peak raw count of ten red-throated diver resulted in an abundance estimate of 29 for the Ornithology Study area (**Table 31**).

One red-throated diver was recorded flying in a north-easterly direction in the April survey and one red-throated diver was recorded flying in a south-westerly direction in the September survey (**Figure 54**).

The red-throated diver were mainly distributed along the western side of the Ornithology Study area (**Figure 55**), with only two located in the south eastern area. No red-throated diver were recorded in the Windfarm Concession area.

Table 31 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of red-throated diver in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	10	29	20	38	0.31623	0.09
September-2020	4	12	4	23	0.5	0.04

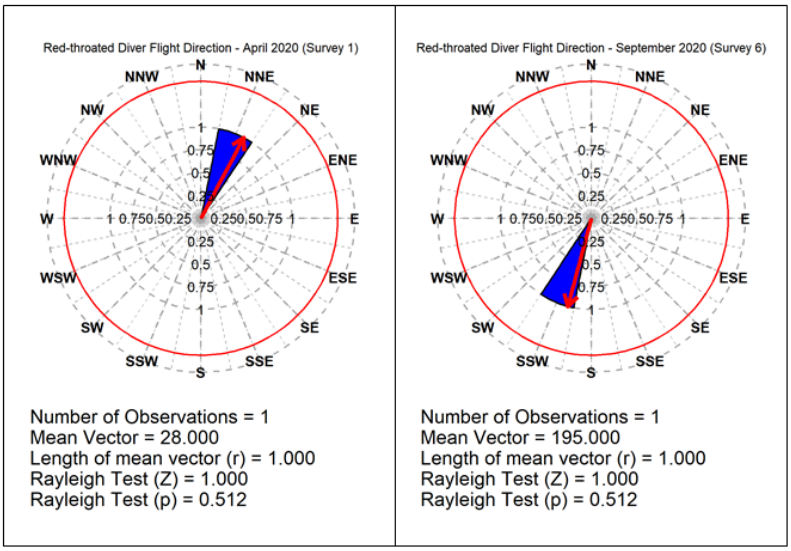


Figure 54 Summary of flight direction of red-throated diver during the April and September 2020 survey

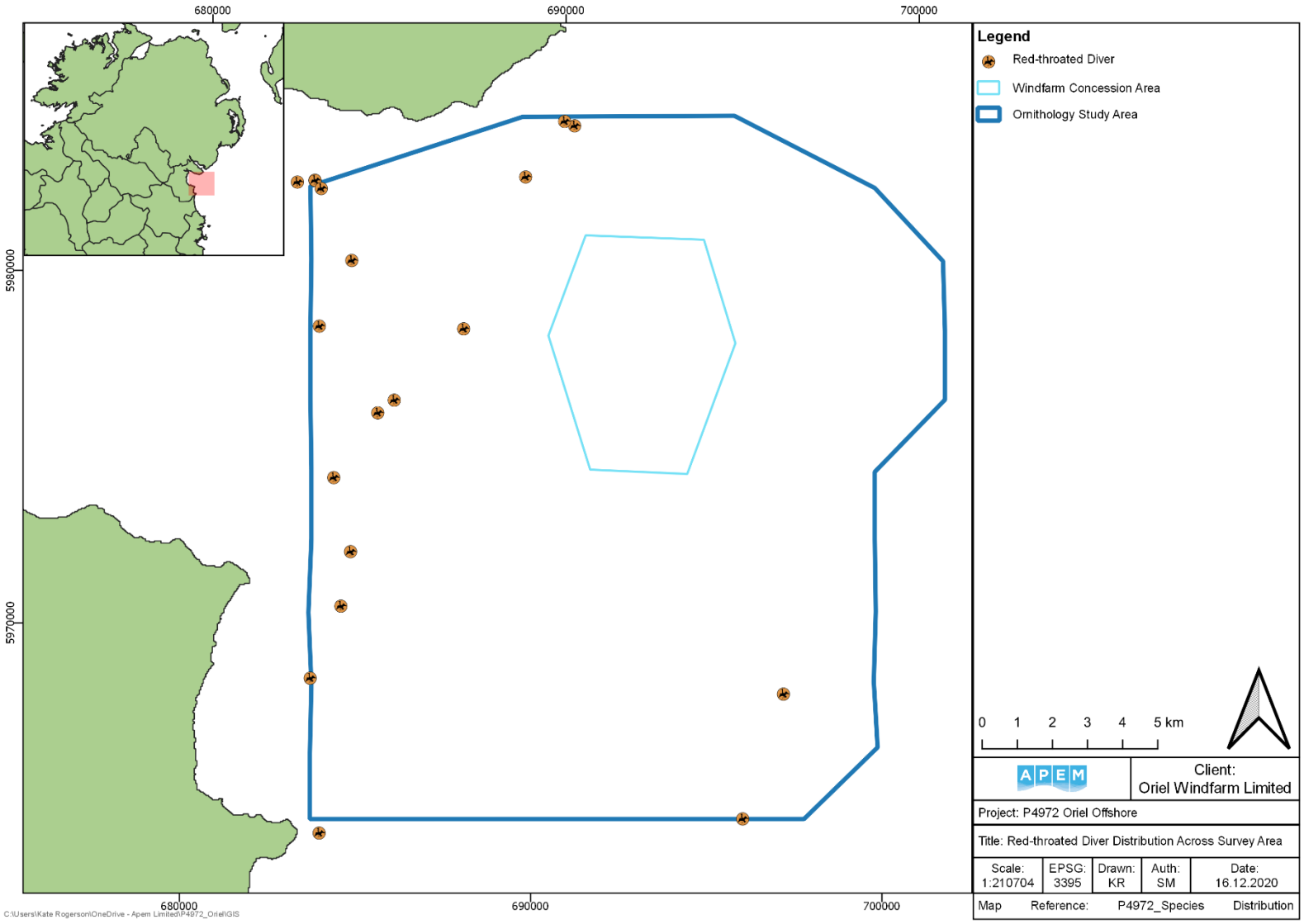


Figure 55 Distribution of red-throated diver recorded across the Ornithology Study area

5.28 Great Northern Diver

Overall 302 great northern diver were identified, 285 in April 2020, 9 in May 2020, 4 in June 2020 and 4 in July 2020 surveys. Great northern divers were not recorded in the August 2020 and September 2020 surveys.

A peak count of 268 great northern diver was recorded in April 2020 and resulted in an abundance estimate of 774 in the Ornithology Study area (**Table 32**).

The great northern divers were concentrated in the east to north of the Ornithology Study area. No great northern divers were recorded in the southwest of the Study area (**Figure 56**).

Table 32 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of great northern diver in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	38	102	38	144	0.16222	3.68
May-2020	2	5	2	16	0.70711	0.18
July-2020	2	6	2	11	0.70711	0.22
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	268	774	390	1221	0.06108	2.42
May-2020	9	26	9	55	0.33333	0.08
June-2020	3	9	3	23	0.57735	0.03
July-2020	4	11	4	26	0.5	0.03

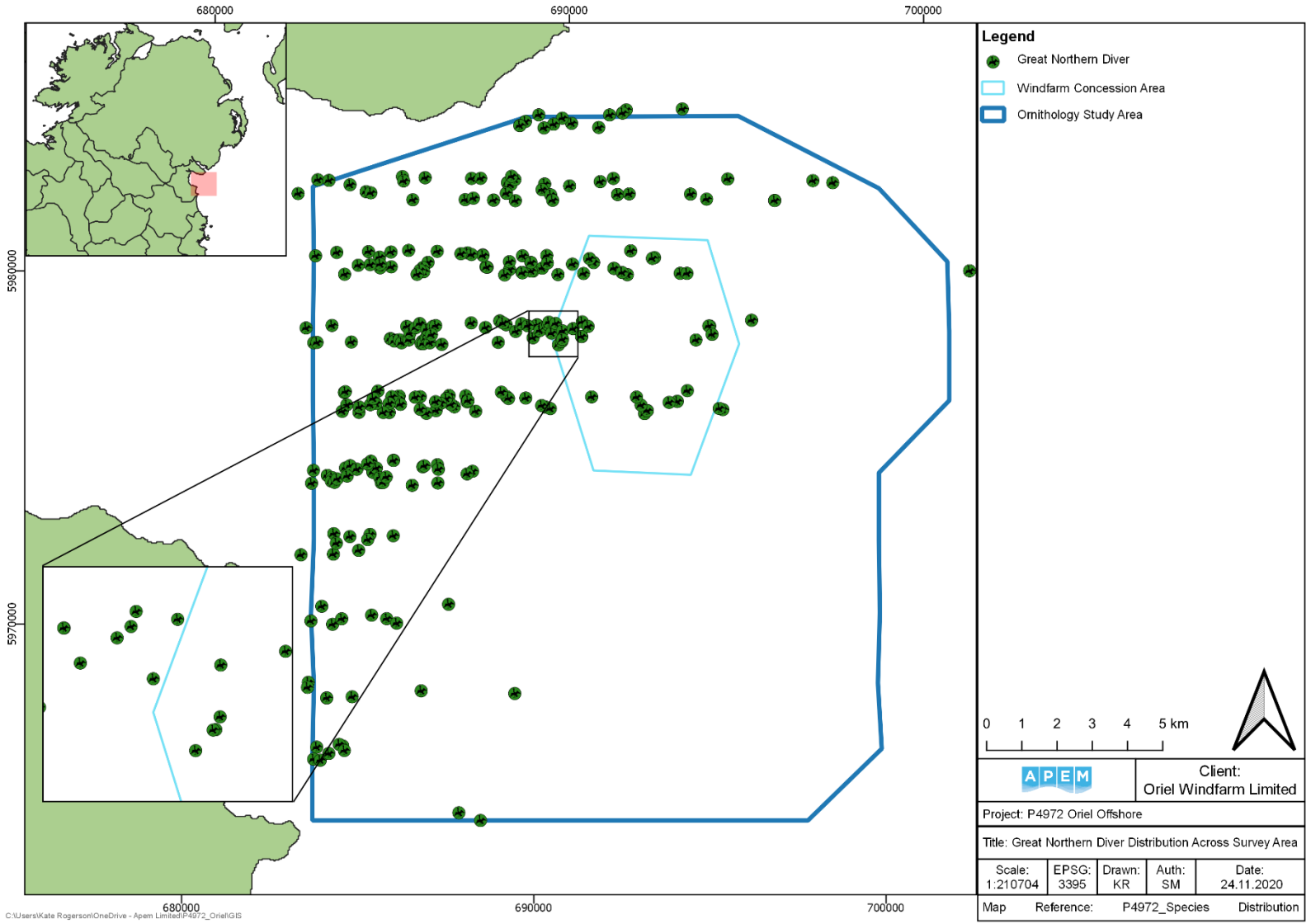


Figure 56 Distribution of great northern diver recorded across the Ornithology Study area

5.29 Diver species – unidentified

Overall nine unidentified diver species were identified, six in April 2020 and three in June 2020 surveys. Unidentified diver species were not recorded in May 2020, July 2020, August 2020 and September 2020 surveys.

A peak raw count of five resulted in an abundance estimate of nine for the Ornithology Study area (**Table 33**).

Unidentified diver species were located throughout the western side of the Ornithology Study area. One identified diver species was recorded in the Windfarm Concession area (**Figure 57**).

Table 33 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of diver species in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	5	14	5	29	0.44721	0.04
June-2020	3	9	3	17	0.57735	0.03

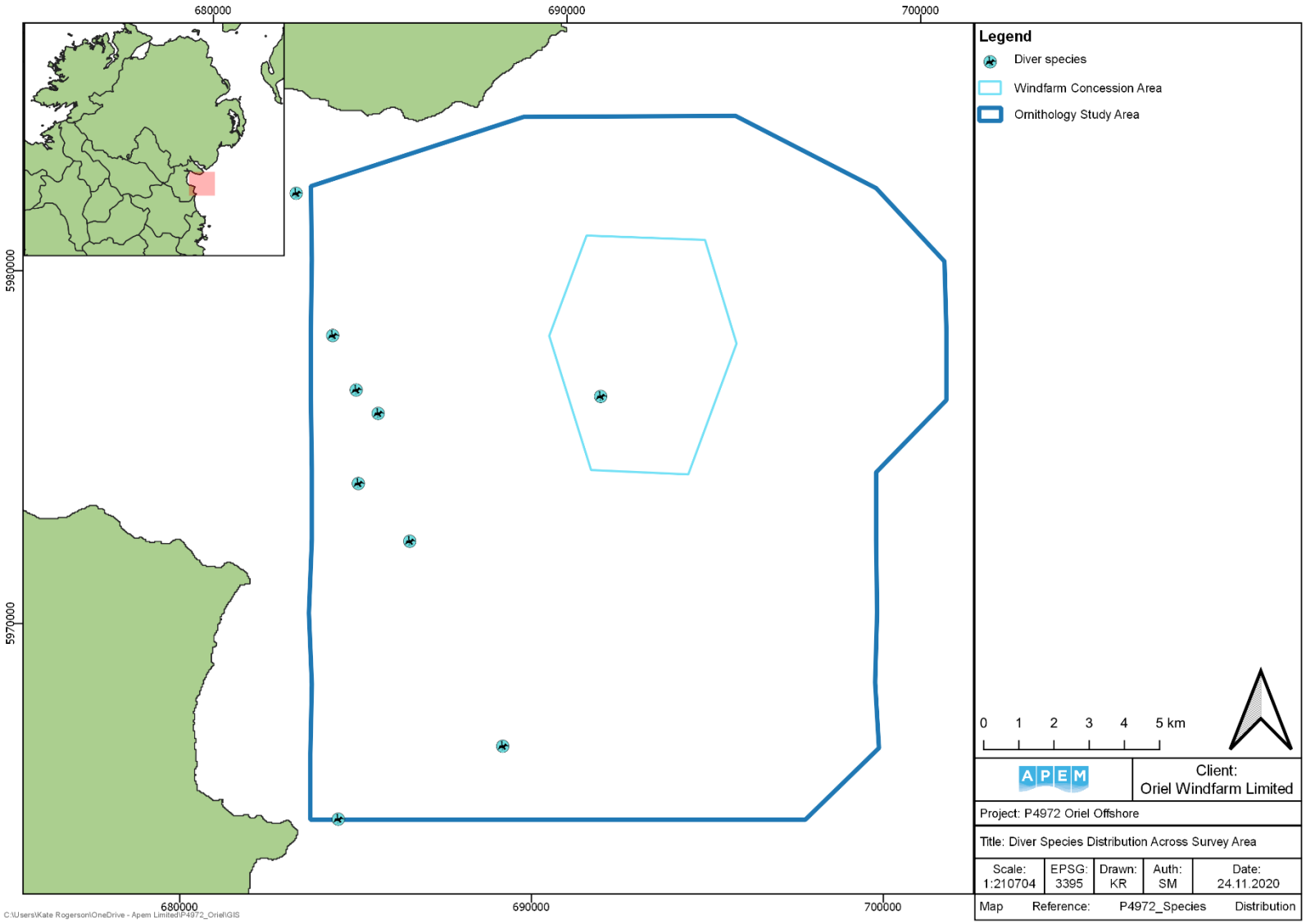


Figure 57 Distribution of unidentified diver species recorded across the Ornithology Study area

5.30 Fulmar

Overall two fulmar were identified, one each during the April 2020 and August 2020 surveys. Fulmar were not recorded in the May 2020, June 2020, July 2020 and September 2020 surveys.

The counts of one fulmar resulted in an abundance estimate of three for the Ornithology Study area (**Table 34**).

One fulmar was recorded flying in a westerly direction during the August survey (**Figure 58**).

The fulmar individuals were located to the east and west of the Windfarm Concession area (**Figure 59**). No fulmar were recorded in the Windfarm Concession area.

Table 34 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of fulmar in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
April-2020	1	3	1	9	1	0.01
August-2020	1	3	1	9	1	0.01

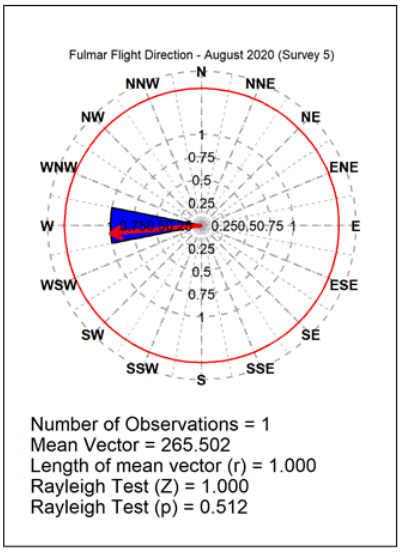


Figure 58 Summary of flight direction of fulmar during the August survey

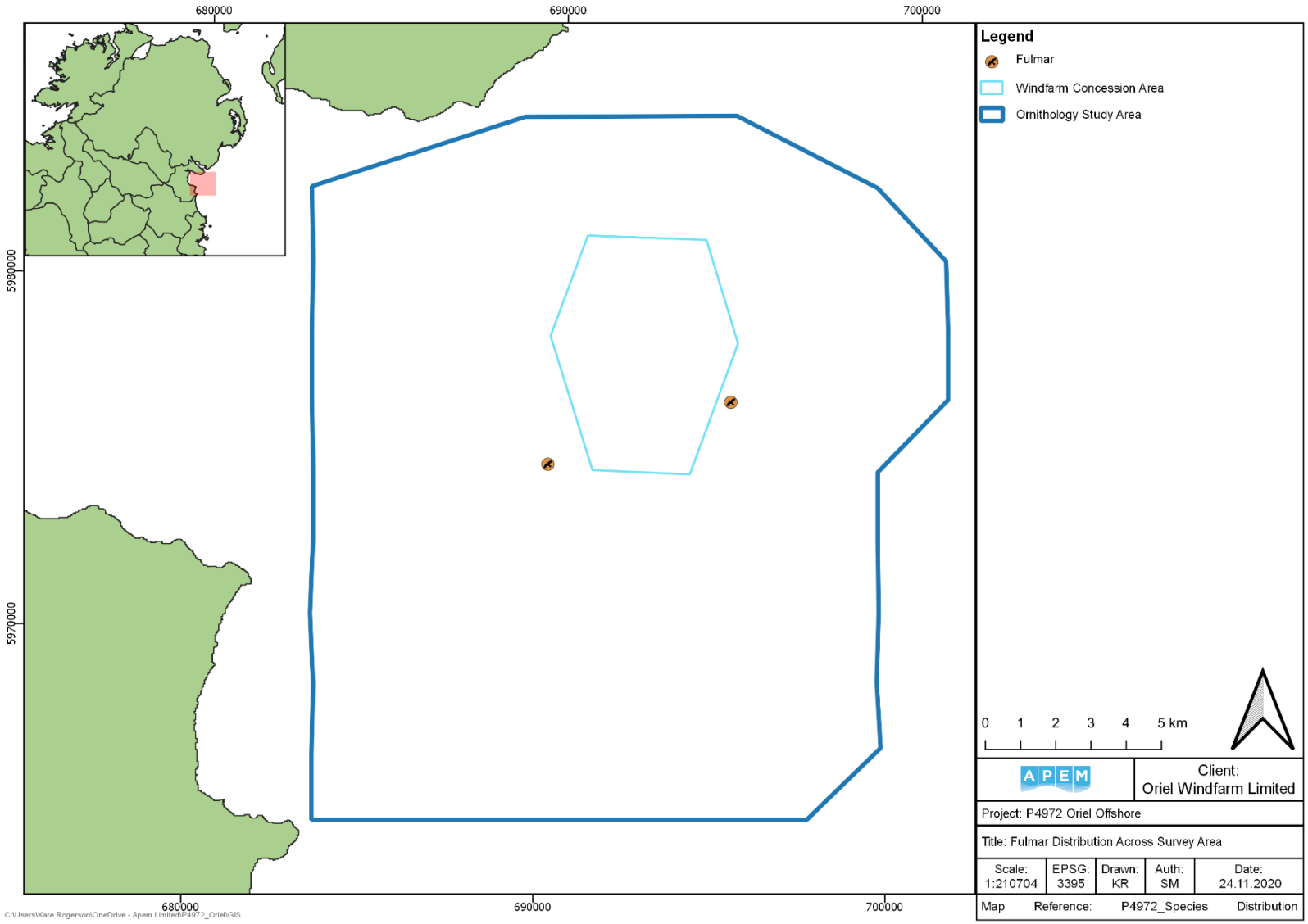


Figure 59 Location of fulmar recorded across the Ornithology Study area

5.31 Great Shearwater

During the May 2020 survey, one great shearwater were identified. Great Shearwater were not recorded in the April 2020, June 2020, July 2020, August 2020 and September 2020 surveys.

The single count resulted in resulted in an abundance estimate of three for the Ornithology Study area (**Table 35**).

The great shearwater was located on the western edge of the Ornithology Study area to the west of the Windfarm Concession area (**Figure 60**).

Table 35 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of great shearwater in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	1	3	1	9	1	0.01

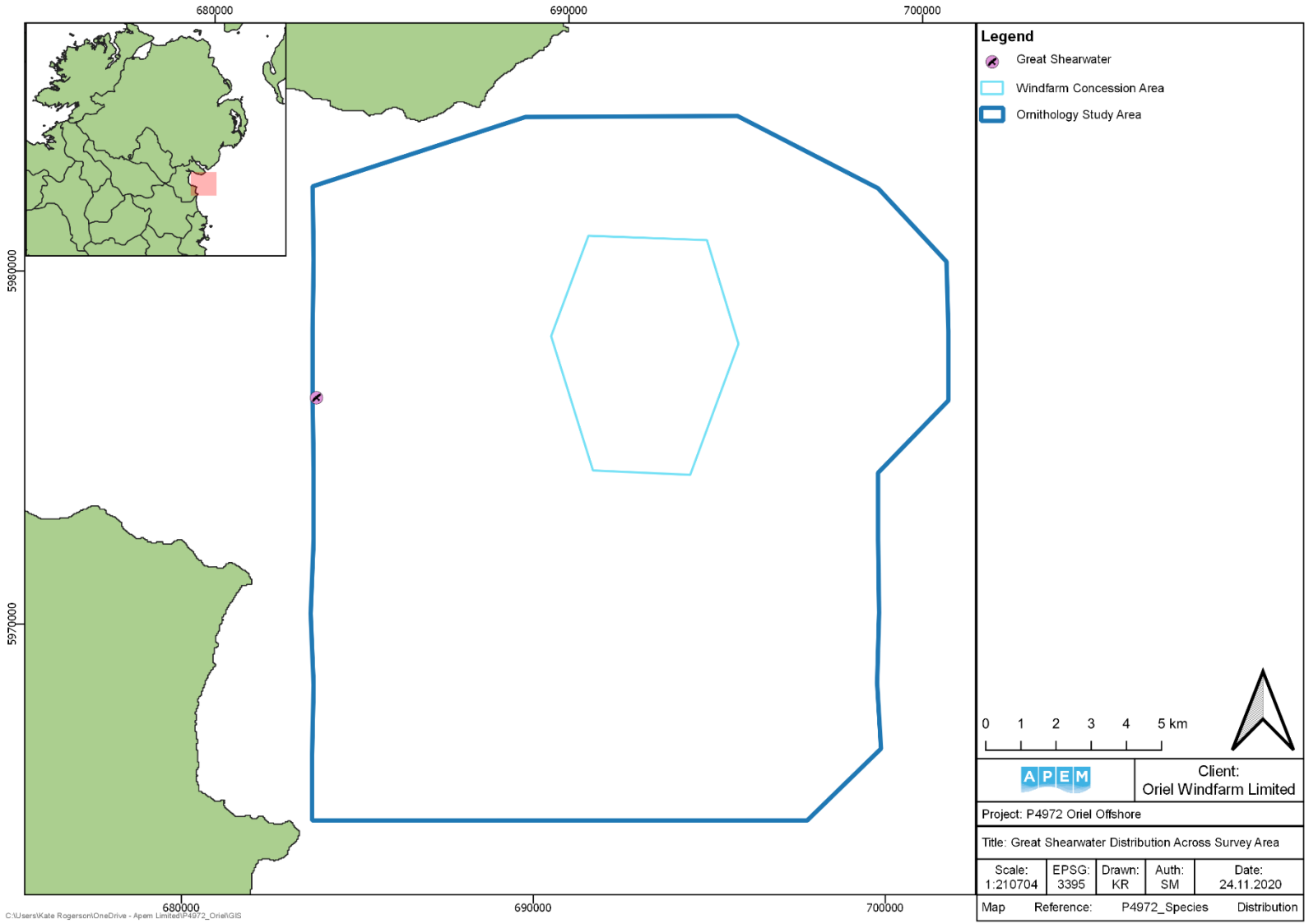


Figure 60 Location of great shearwater recorded across the Ornithology Study area

5.32 Manx Shearwater

Overall 2,377 Manx shearwater were identified, six in April 2020, 547 in May 2020, 90 in June 2020, 280 in July 2020, 1,317 in August 2020 and 137 in September 2020 surveys

The peak raw count of 1,245 Manx shearwater in August 2020 resulted in an abundance estimate of 3,577 in the Ornithology Study area (**Table 36**).

Flying Manx shearwaters were recorded in all six surveys with significant orientations recorded in five surveys. The flying Manx shearwater were significantly orientated around the mean of 126° in May 2020, 221° in June 2020, 112° in July 2020, 32° in August 2020 and 267° in September 2020 (Rayleigh test, p=<0.05, **Figure 61**).

In May, June, July, August and September 2020; 35, nine, five, 80 and four flying Manx shearwater deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 17 m above MSL (**Figure 62**).

Manx shearwater were observed across the Ornithology Study area, there were larger concentrations in the east to southeast of the area (**Figure 63**).

Table 36 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of Manx shearwater in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	1	3	1	8	1	0.11
May-2020	19	52	19	104	0.22942	1.88
June-2020	6	16	6	41	0.40825	0.58
July-2020	2	6	2	17	0.70711	0.22
August-2020	24	65	35	85	0.20412	2.35
September-2020	4	11	4	25	0.5	0.4
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	5	14	5	26	0.44721	0.04
May-2020	484	1403	484	2873	0.04545	4.39
June-2020	73	210	106	356	0.11704	0.66
July-2020	112	321	118	594	0.09449	1
August-2020	1245	3577	1640	5665	0.02834	11.18
September-2020	88	257	117	408	0.1066	0.8

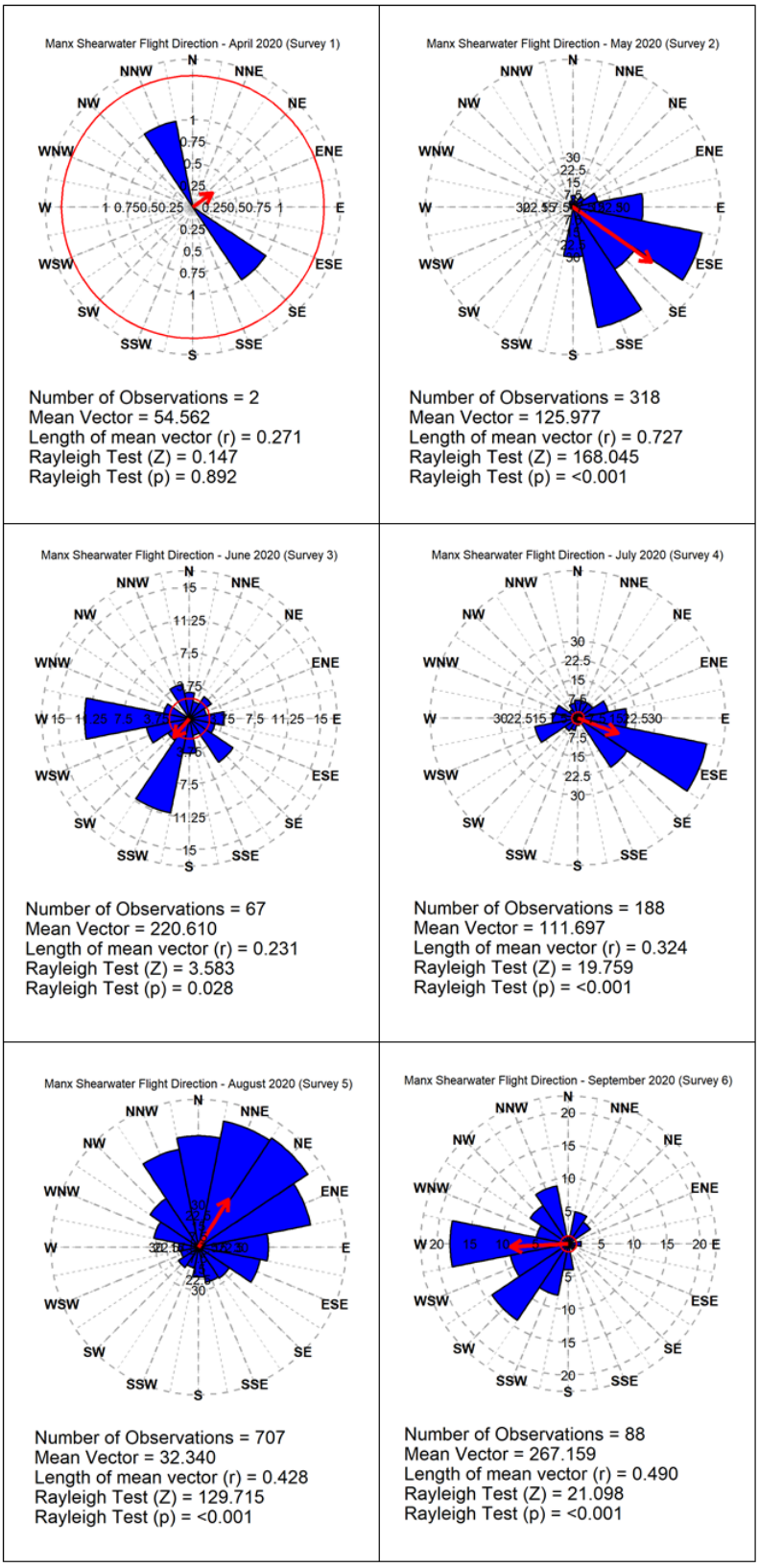


Figure 61 Summary of flight direction of Manx shearwater during the six surveys

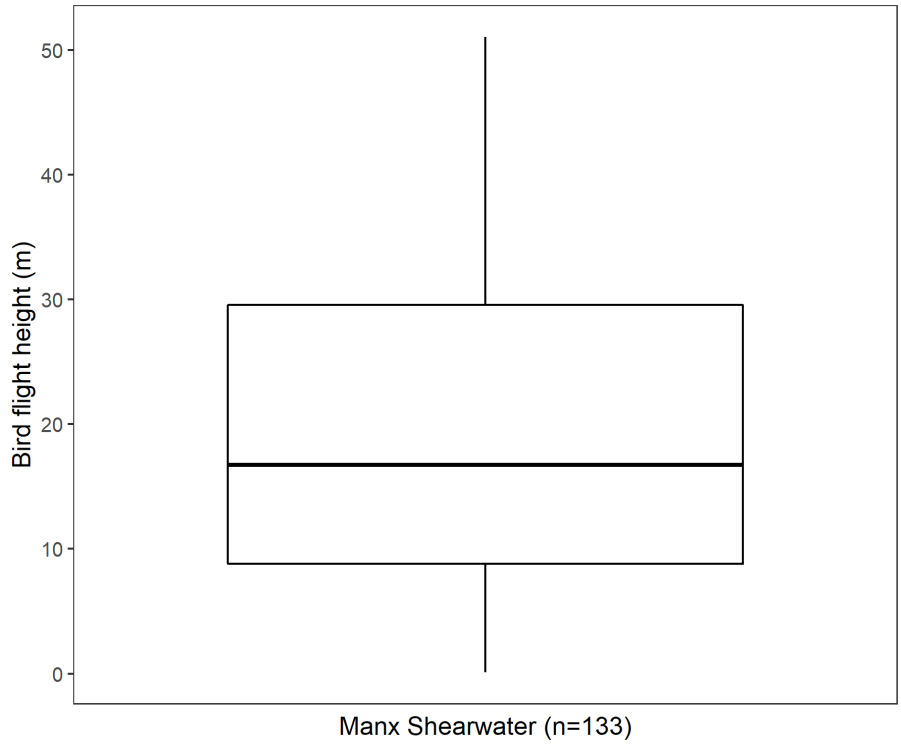


Figure 62 Flight heights of Manx shearwater (n=133) recorded in the Ornithology Study area

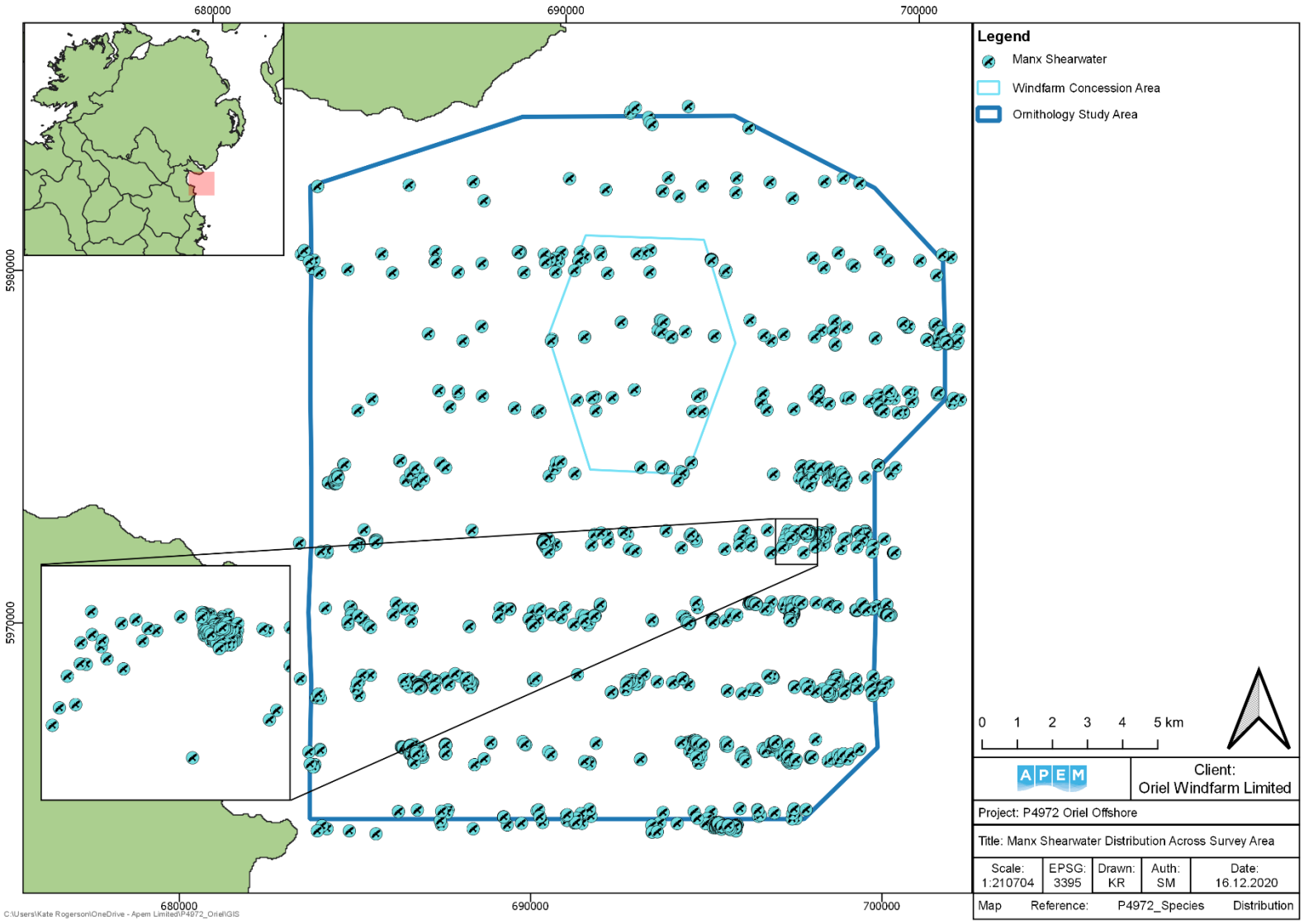


Figure 63 Distribution of Manx shearwater recorded across the Ornithology Study area

5.33 Gannet

Overall 683 gannet were identified, 73 in April 2020, 127 in May 2020, 41 in June 2020, 156 in July 2020, 145 in August 2020 and 141 in September 2020 surveys.

A peak count of 144 in July 2020 resulted in an abundance estimate of 413 for the Ornithology Study area (**Table 37**).

Flying gannet were recorded in all six surveys, and a significant orientation was observed in four of the surveys. The flying gannet were significantly orientated around the mean of 99° in April 2020, 108° in May 2020, 225° in June 2020, 88° in August 2020 and 233° in September 2020 (Rayleigh test, p=<0.05, **Figure 64**).

In April, May, June, July, August and September 2020; five, 13, eight, five, 19 and 14 flying gannet deemed suitable for flight height determination were recorded respectively, resulting in a median altitude of 21 m above MSL (**Figure 65**).

There is no spatial distribution pattern in the locations of gannet, with gannet observed across the Ornithology Study area (**Figure 66**).

Table 37 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of gannet in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	5	13	5	27	0.44721	0.47
May-2020	49	135	49	300	0.14286	4.87
June-2020	1	3	1	8	1	0.11
July-2020	20	55	33	77	0.22361	1.98
August-2020	12	33	12	55	0.28868	1.19
September-2020	12	33	12	77	0.28868	1.19
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	64	185	66	326	0.125	0.58
May-2020	122	354	148	641	0.09054	1.11
June-2020	33	95	52	135	0.17408	0.3
July-2020	144	413	238	583	0.08333	1.29
August-2020	120	345	221	477	0.09129	1.08
September-2020	124	362	175	627	0.0898	1.13

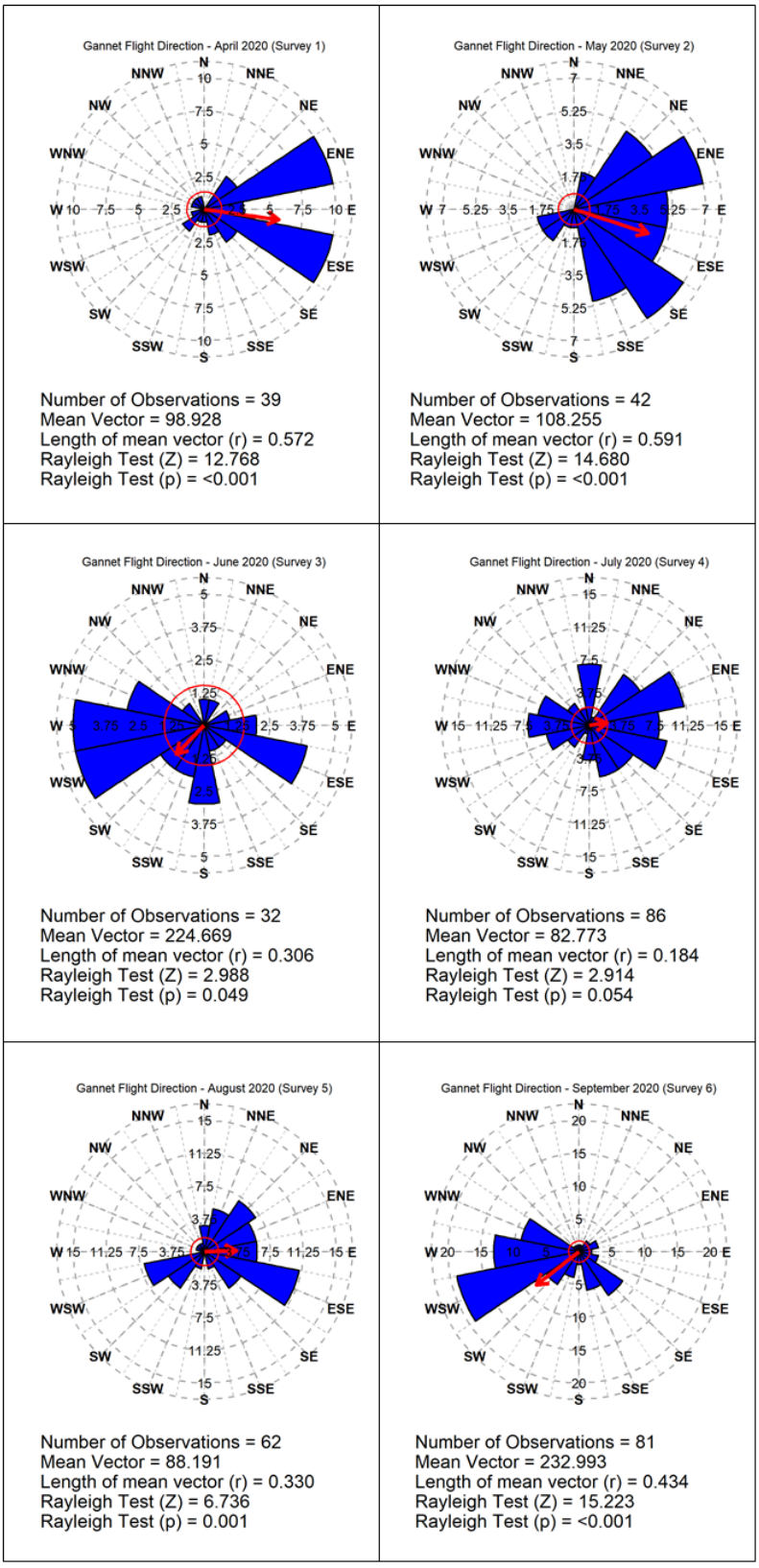


Figure 64 Summary of flight direction of gannet during the six surveys

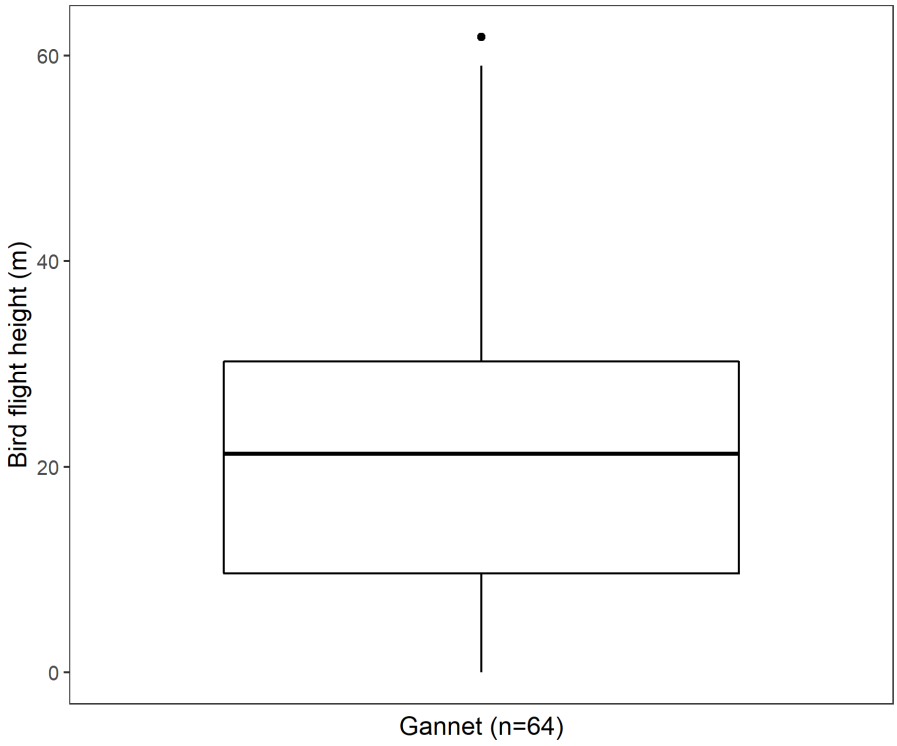


Figure 65 Flight heights of gannets (n=64) recorded in the Ornithology Study area

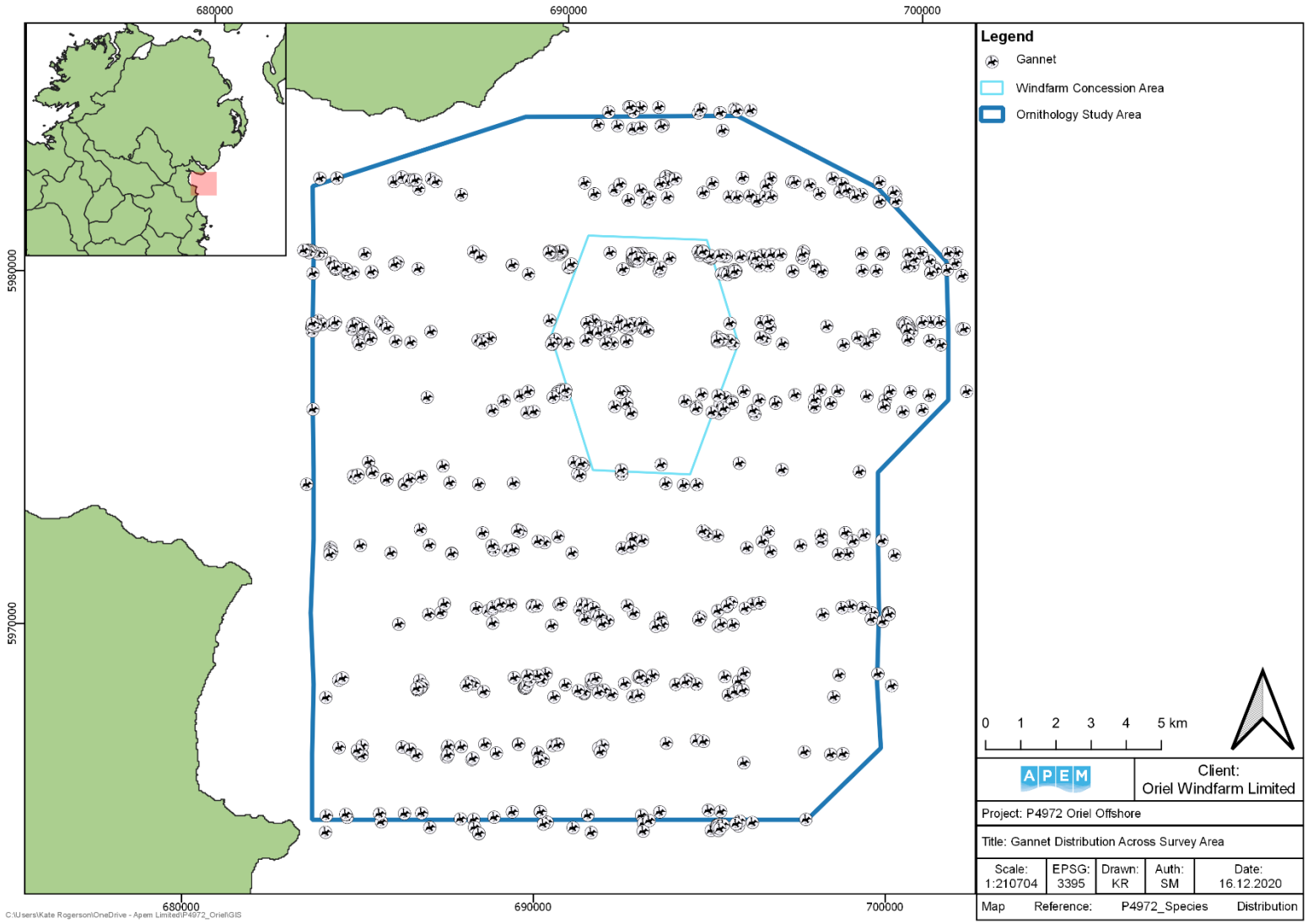


Figure 66 Distribution of gannet recorded across the Ornithology Study area

5.34 Cormorant

Overall 16 cormorant were identified in the surveys, one in April 2020, nine in June 2020, four in July 2020, one in August 2020 and one in September 2020 surveys. Cormorant were not identified in May 2020 survey.

A peak count of nine cormorants in June 2020 resulted in an abundance estimate of 26 for the Ornithology Study area (**Table 38**).

Flying cormorants were observed in June, July and September surveys. In June 2020 the flying gannets were significantly orientated around a mean of 205° (Rayleigh test, p=<0.05, **Figure 67**)

The cormorants were loosely located across the Ornithology Study area (**Figure 68**).

Table 38 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of cormorant in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
July-2020	2	6	2	17	0.70711	0.22
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	9	26	9	55	0.33333	0.08
July-2020	3	9	3	26	0.57735	0.03
August-2020	1	3	1	9	1	0.01
September-2020	1	3	1	9	1	0.01

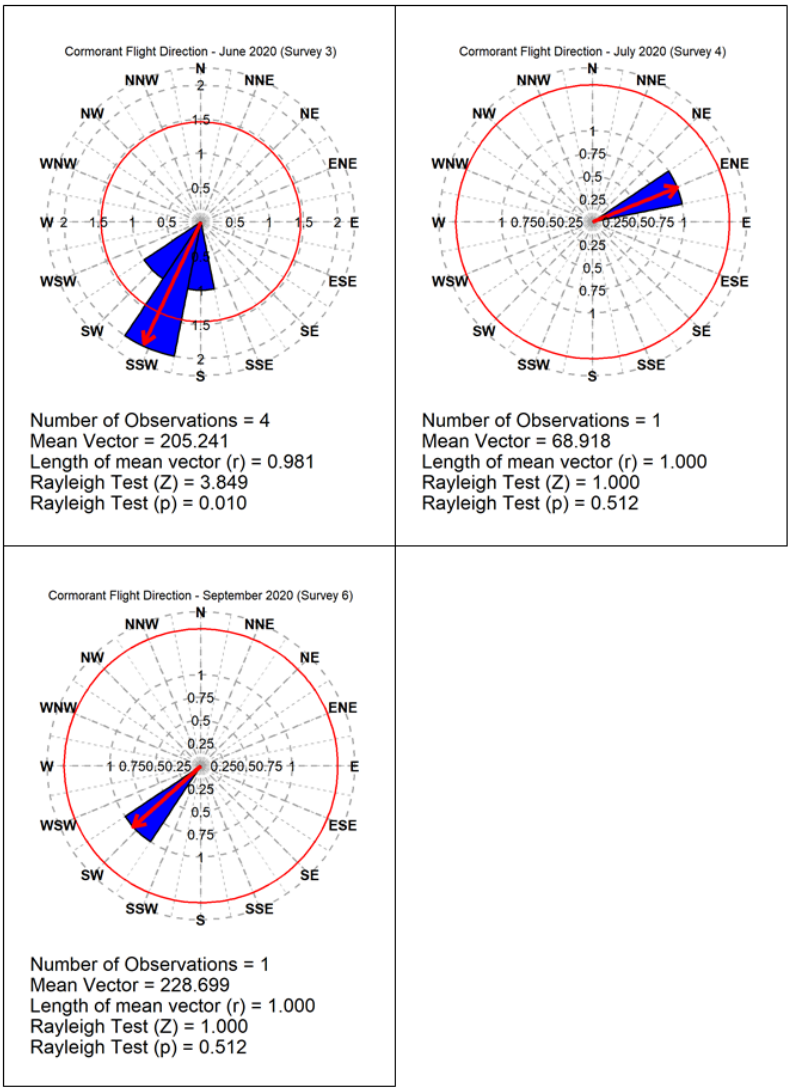


Figure 67 Summary of flight direction of cormorant during the June, July and September 2020 surveys

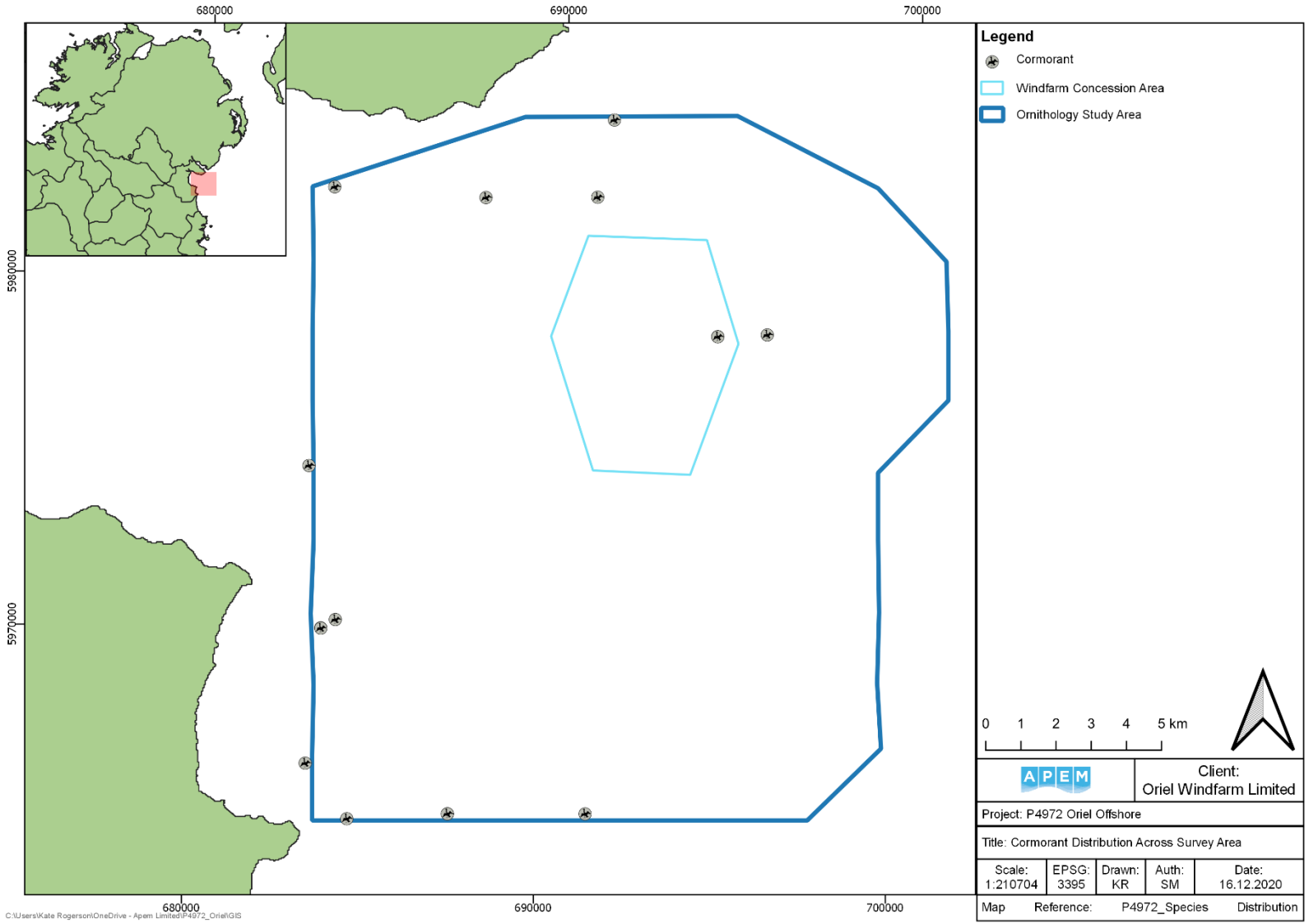


Figure 68 Distribution of cormorant recorded across the Ornithology Study area

5.35 Cormorant / Shag

Overall six cormorant / shag were identified, two in April 2020, two in May 2020 and two in September 2020 surveys. Cormorant / shag were not recorded in June, July and August 2020 surveys.

A peak raw count of two in May 2020 resulted in abundance estimates of six in the Ornithology Study area (**Table 39**).

Flying cormorant / shag were recorded in the April and September surveys. In the April 2020 survey, one flew in a west- northwest direction and the second flew in a south-southeast direction. In September, the two flying birds flew in a southern-westerly direction (**Figure 69**).

The cormorant / shag individuals were located in pairs, one pair in the southwest corner of the Ornithology Study area, just outside the boundary in April 2020 and the other two pairs located to the northwest of the Windfarm Concession area (**Figure 70**). No cormorant / shag individuals were recorded in the Windfarm Concession area.

Table 39 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of cormorant / shag in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	2	6	2	17	0.70711	0.02
September	2	6	2	18	0.70711	0.02

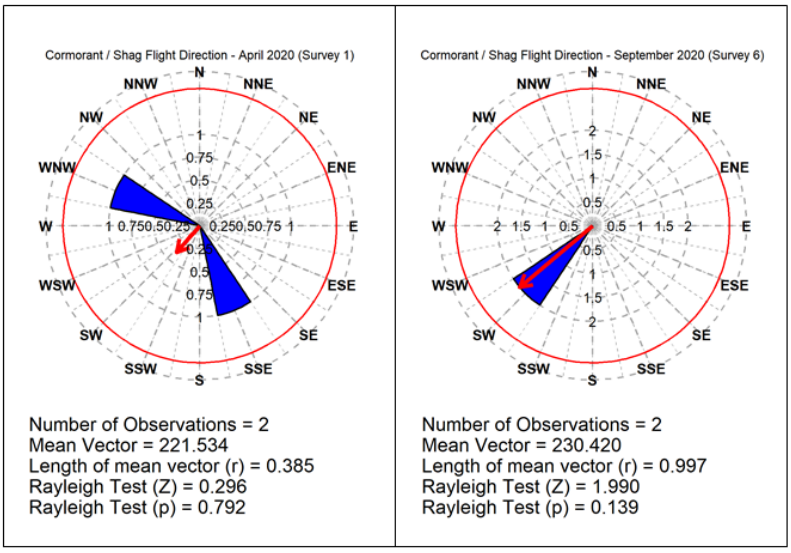


Figure 69 Summary of flight direction of cormorant / shag during the April and September 2020 survey

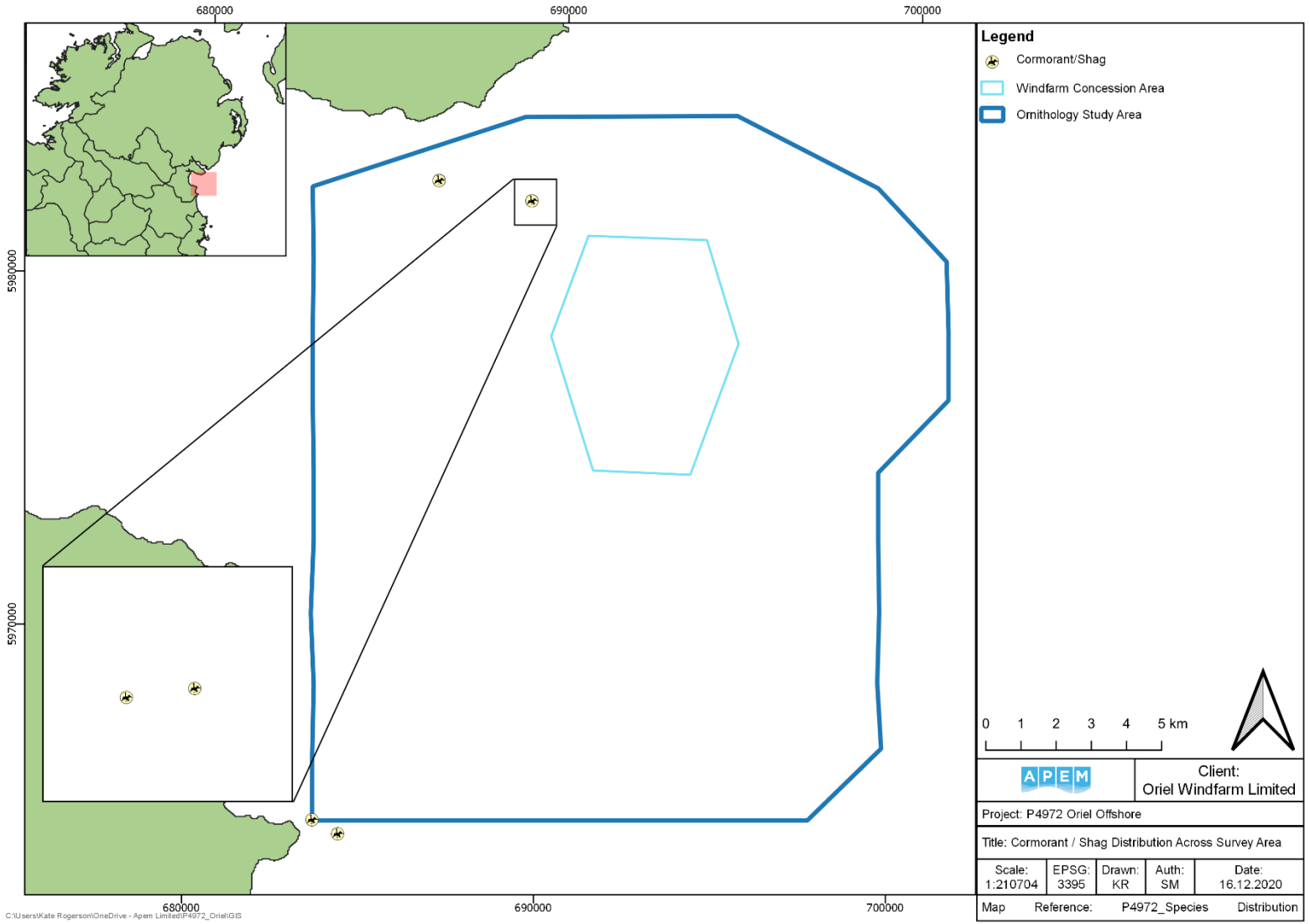


Figure 70 Location of cormorant / shag recorded across the Ornithology Study area

5.36 Grey Seal

Overall four grey seal were identified in the surveys, two in the August 2020 and two in September 2020 Surveys. Grey seal were not recorded in the April 2020, May 2020, June 2020 and July 2020 surveys.

A peak count of two grey seal in August 2020 resulted in an abundance estimate of six for the Ornithology Study area (**Table 40**).

Grey seal were recorded in the north east of the Ornithology Study area (**Figure 71**). No grey seal were recorded in the Windfarm Concession area.

Table 40 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of grey seal in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
August-2020	2	6	2	14	0.70711	0.02
September-2020	2	6	2	18	0.70711	0.02

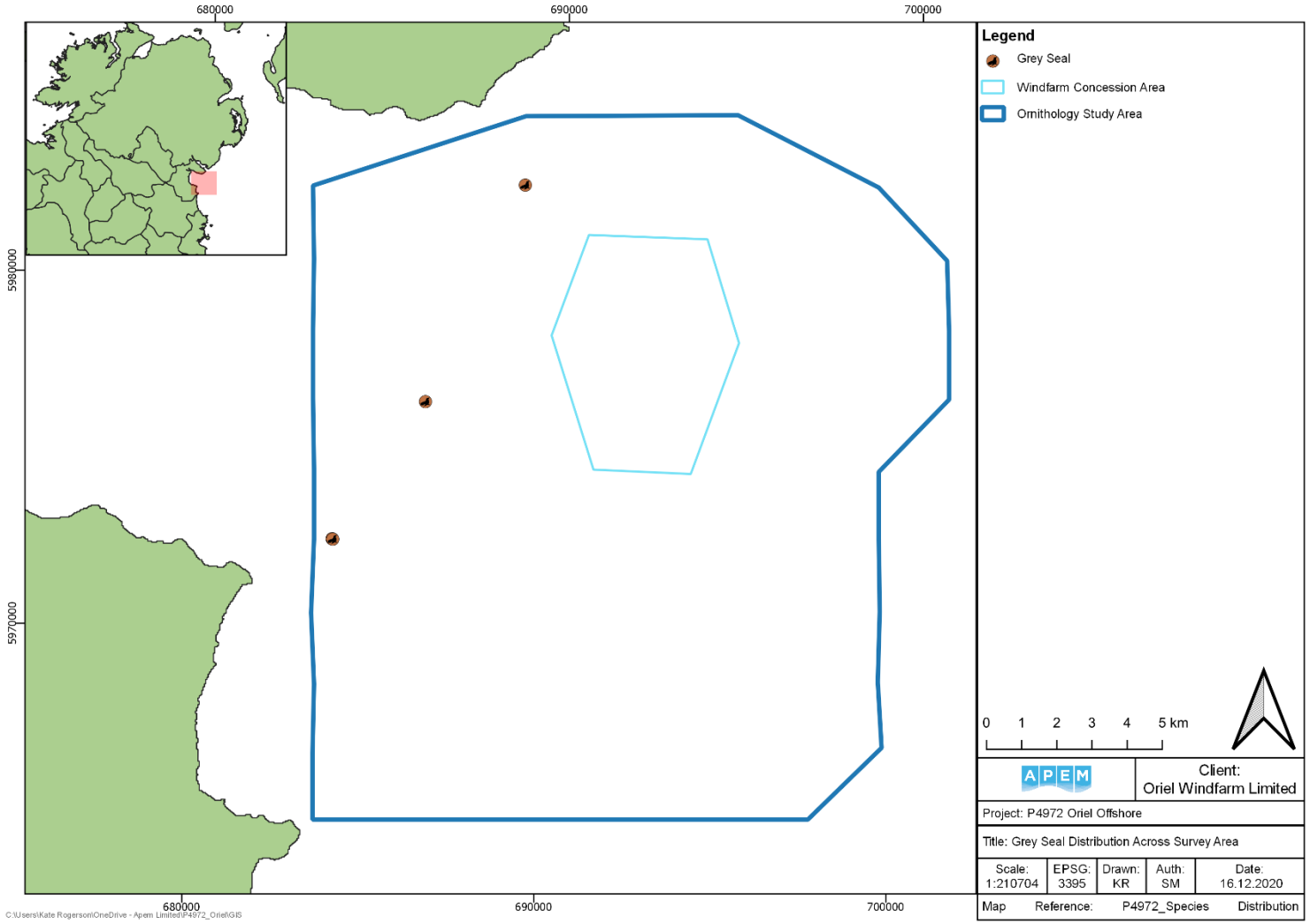


Figure 71 Distribution of grey seal recorded across the Ornithology Study area

5.37 Phocids – unidentified

Overall 18 phocids were identified in the surveys, four in May 2020, seven in June 2020, three in July 2020, one in August 2020 and three in September 2020 surveys. Phocids were not recorded in the April 2020 survey.

A peak count of seven phocids in June 2020 resulted in an abundance estimate of 20 for the Ornithology Study area (**Table 41**).

Phocids showed no spatial distribution pattern and were recorded across the Ornithology Study area (**Figure 72**).

Table 41 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of phocids in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	3	8	3	16	0.57735	0.29
September-2020	1	3	1	8	1	0.11
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
May-2020	3	9	3	17	0.57735	0.03
June-2020	7	20	7	34	0.37796	0.06
July-2020	2	6	2	14	0.70711	0.02
September-2020	2	6	2	15	0.70711	0.02

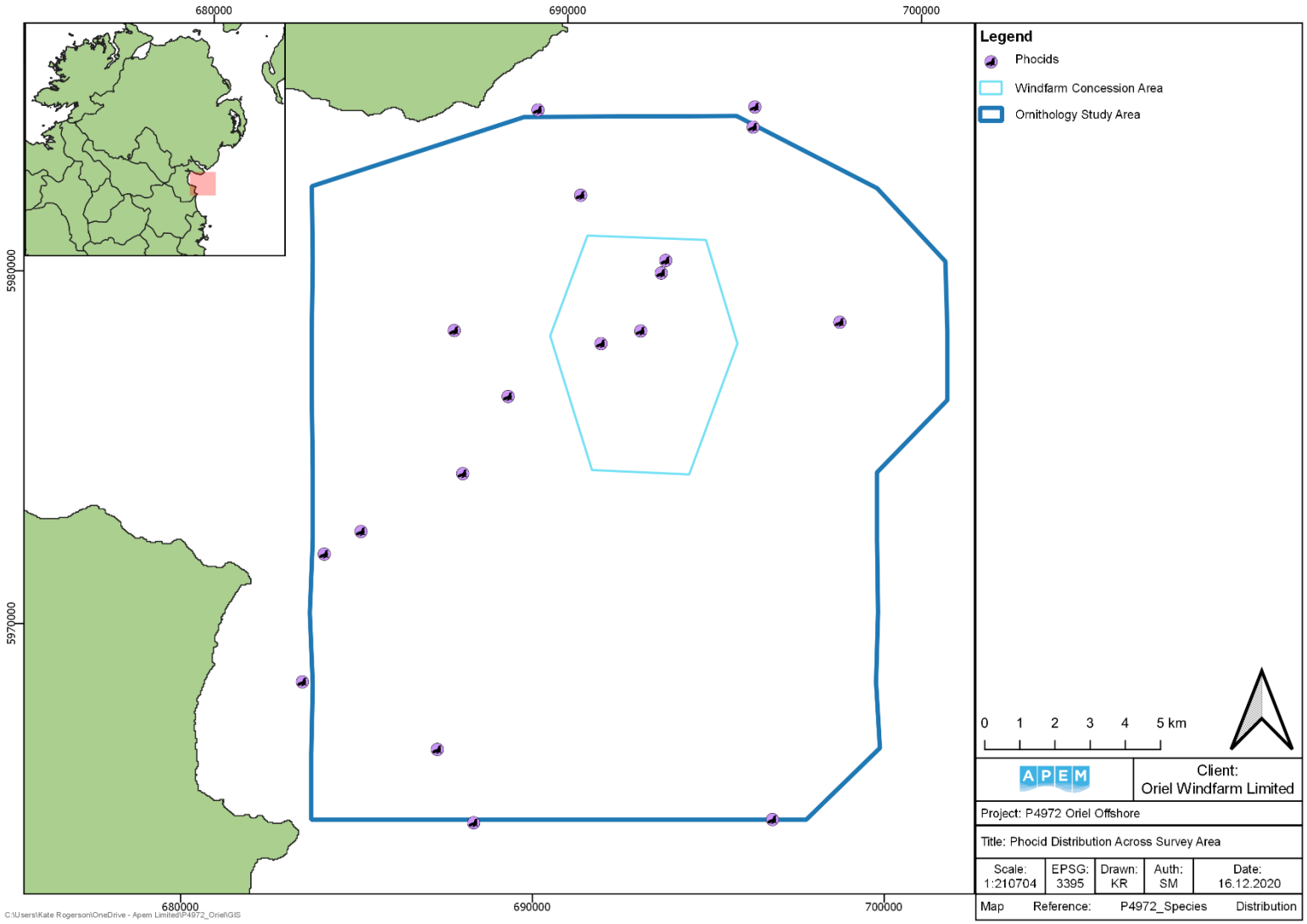


Figure 72 Distribution of phocids recorded across the Ornithology Study area

5.38 Dolphin Species – unidentified

During the September 2020 survey, three unidentified dolphin species were recorded. Dolphin species were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

A peak count of two unidentified dolphin species in September 2020 resulted in an abundance estimate of six for the Ornithology Study area (**Table 42**).

Unidentified dolphin species were located across the south of the Ornithology Study area (**Figure 73**).

Table 42 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of harbour porpoise in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	2	6	2	18	0.70711	0.02

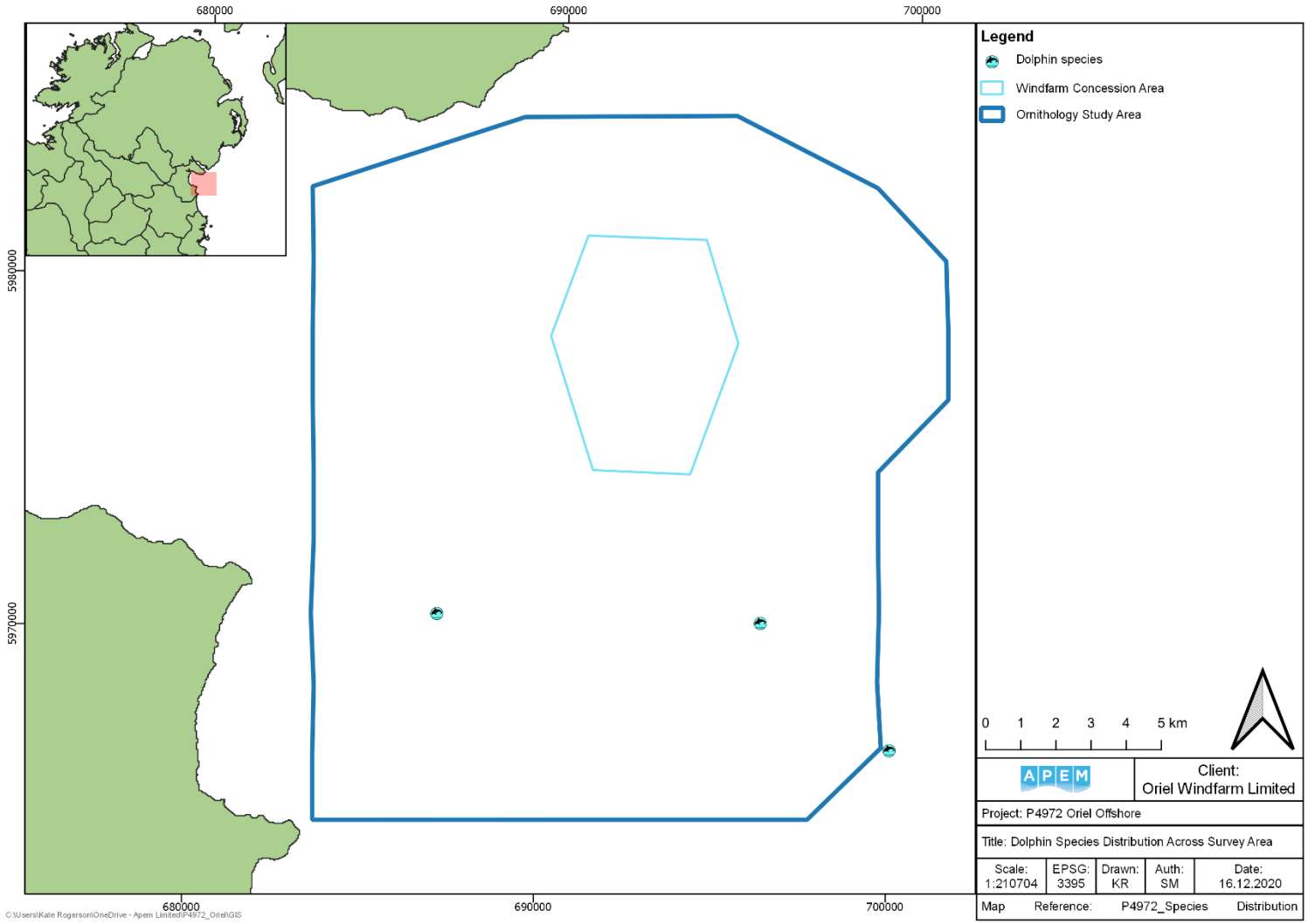


Figure 73 Location of unidentified dolphin species recorded in the Ornithology Study area

5.39 Harbour Porpoise

Overall six harbour porpoise were identified, one in the June 2020, two in the August 2020 and three in September 2020 surveys. Harbour Porpoise were not recorded in the April 2020, May 2020 and July 2020 surveys.

A peak count of three harbour porpoise in September 2020 resulted in an abundance estimate of nine for the Ornithology Study area (**Table 43**).

The harbour porpoise recorded in June and one recorded in August were both outside of the boundary for the Ornithology Study area along the southern edge (**Figure 74**), while the second to be recorded in August was observed in the west of the Ornithology Study area and the three recorded in September were observed in the centre-south of the Ornithology Study area.

Table 43 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of harbour porpoise in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
August-2020	1	3	1	9	1	0.01
September-2020	3	9	3	18	0.57735	0.03

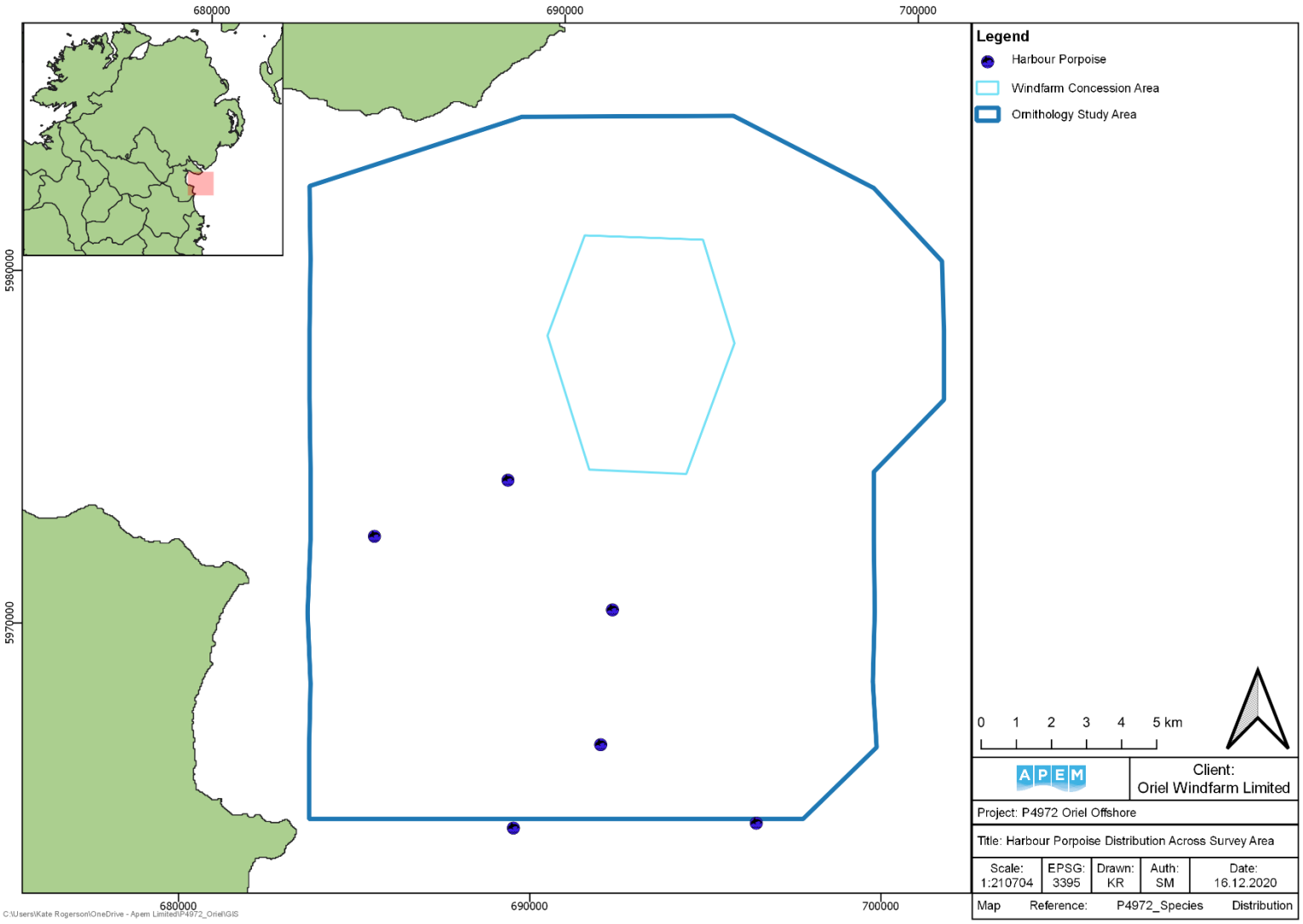


Figure 74 Location of harbour porpoise recorded in the Ornithology Study area

5.40 Dolphin / Porpoise Species – unidentified

Overall 45 dolphin / porpoise were identified, 18 in April 2020, five in May 2020, 15 August 2020 and seven in September 2020 surveys.

The peak count of 16 dolphin / porpoise in April 2020 resulted in an abundance estimate of 46 for the Ornithology Study area (**Table 44**).

Dolphin / porpoise were observed across the Ornithology Study area (**Figure 75**).

Table 44 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of dolphin / porpoise in: a) Windfarm Concession area; and b) Ornithology Study area**

a) Windfarm Concession area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	9	24	9	64	0.33333	0.87
May-2020	3	8	3	16	0.57735	0.29
b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
April-2020	16	46	16	95	0.25	0.14
May -2020	5	14	5	29	0.44721	0.04
August-2020	15	43	15	83	0.2582	0.13
September-2020	6	18	6	32	0.40825	0.06

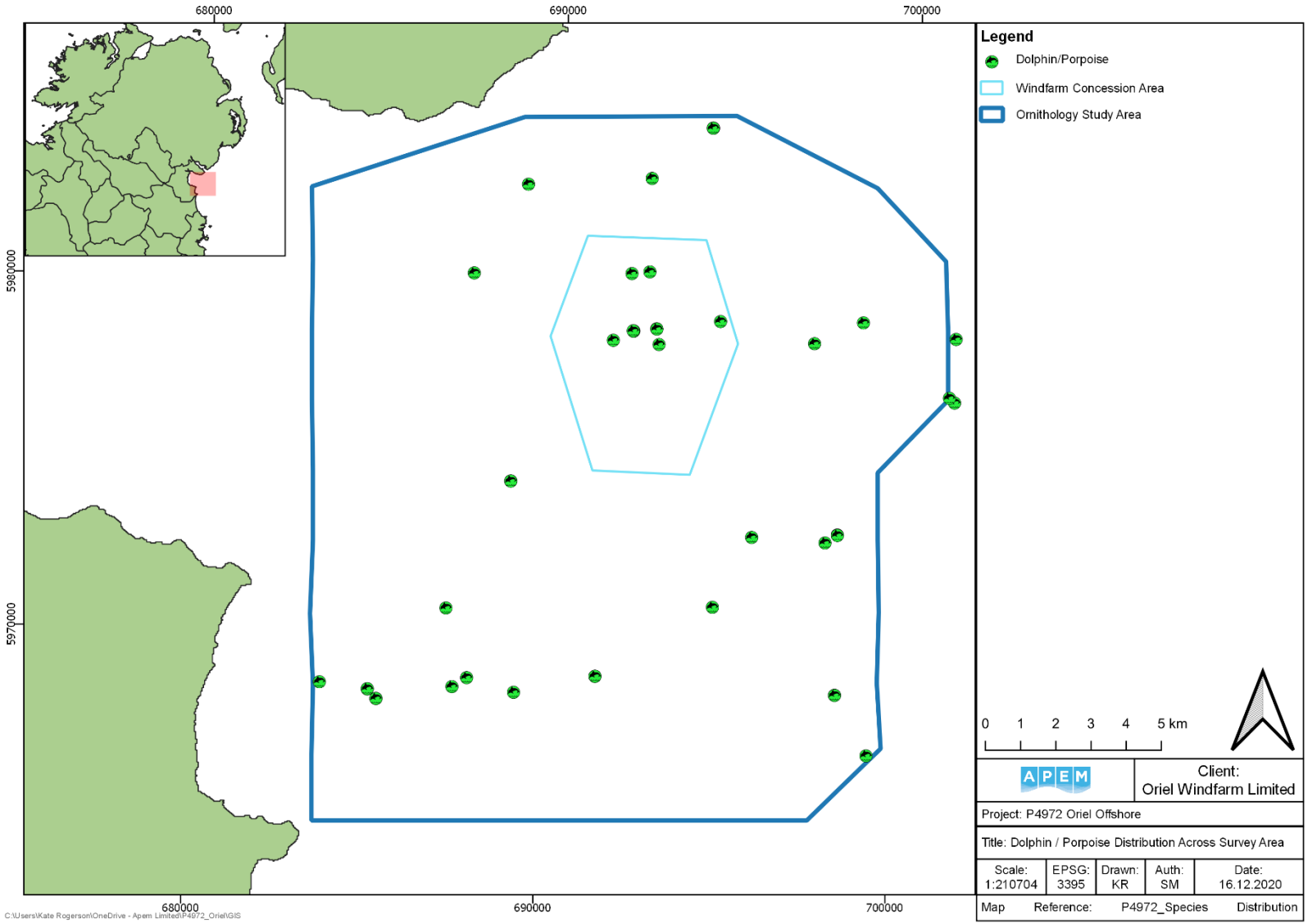


Figure 75 Distribution of dolphin / porpoise recorded in the Ornithology Study area

5.41 Common Minke Whale

During the September 2020 survey, one common minke whale were identified. No common minke whale were recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The single count resulted in an abundance estimate of three for the Ornithology Study area (**Table 45**).

The common minke whale was observed on the southwest tip of the Windfarm Concession Area (**Figure 76**).

Table 45 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of shark species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	1	3	1	9	1	0.01

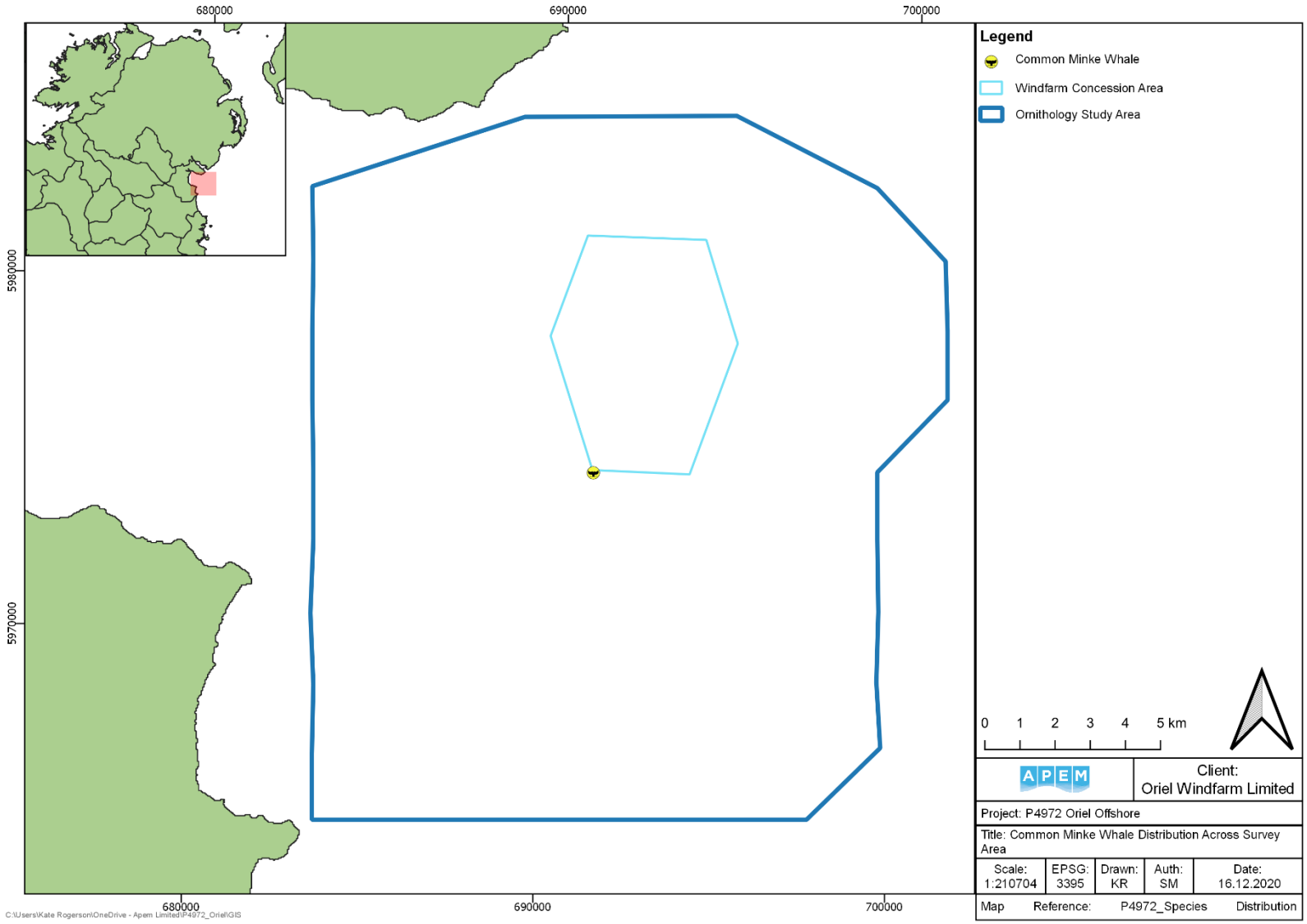


Figure 76 Location of common minke whale in the Ornithology Survey area.

5.42 Baleen Whale Species – unidentified

During the September 2020 survey, one unidentified baleen whale species was recorded. Baleen Whale species were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The single count resulted in an abundance estimate of three for the Ornithology Study area (**Table 46**).

The unidentified baleen whale was located in the southeast of the Ornithology Study area (**Figure 77**).

Table 46 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of shark species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
September-2020	1	3	1	9	1	0.01

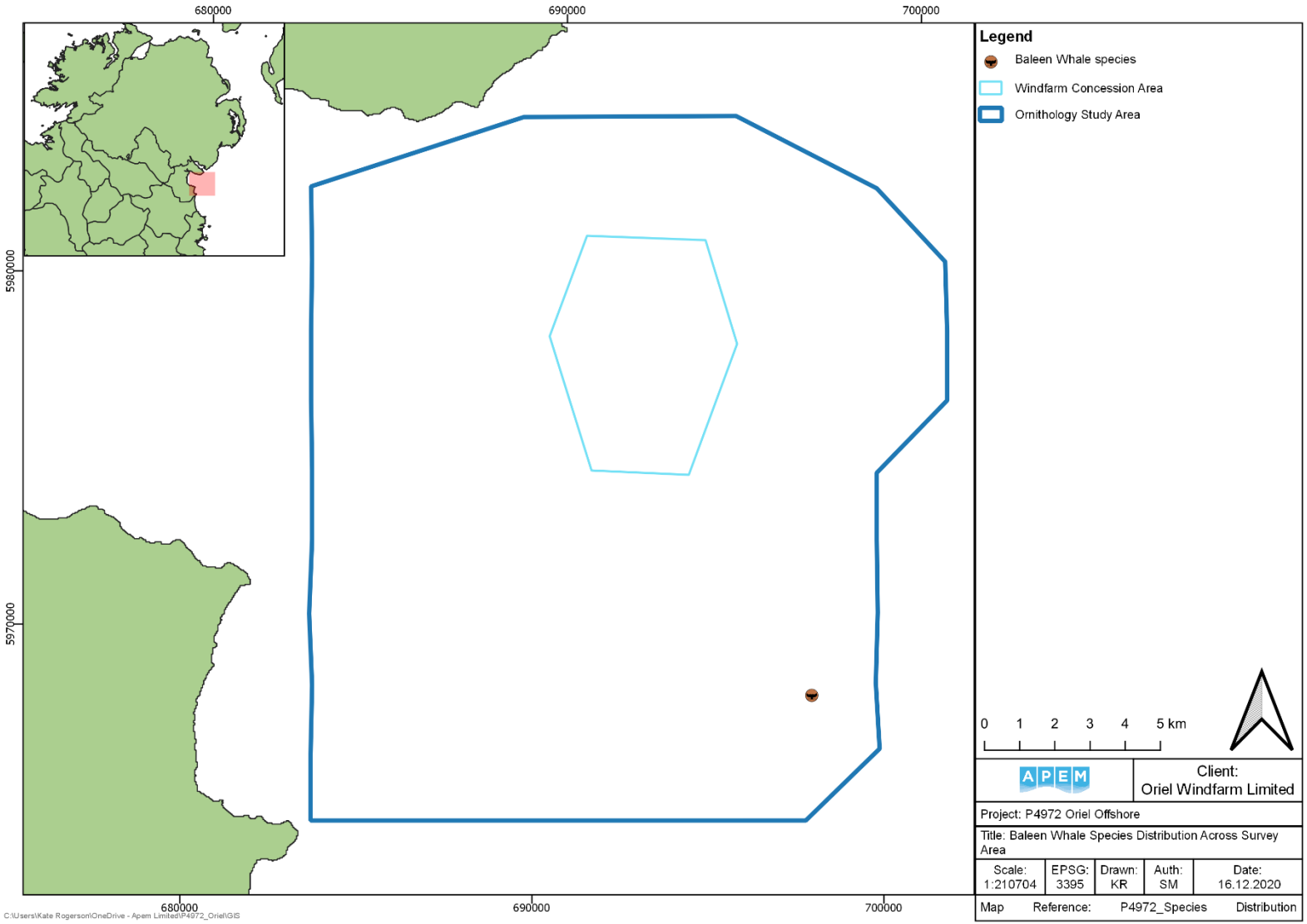


Figure 77 Location of unidentified baleen whale in the Ornithology Survey area.

5.43 Marine Mammal Species – unidentified

During the September 2020 survey, two unidentified marine mammal species were recorded. Marine Mammal species were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The single count resulted in an abundance estimate of three for the Ornithology Study area (**Table 47**).

The unidentified marine mammals were located to the east of the Windfarm Concession Area and in the southwest of the Ornithology Study area (**Figure 78**).

Table 47 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of marine mammal species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	1	3	1	9	1	0.01

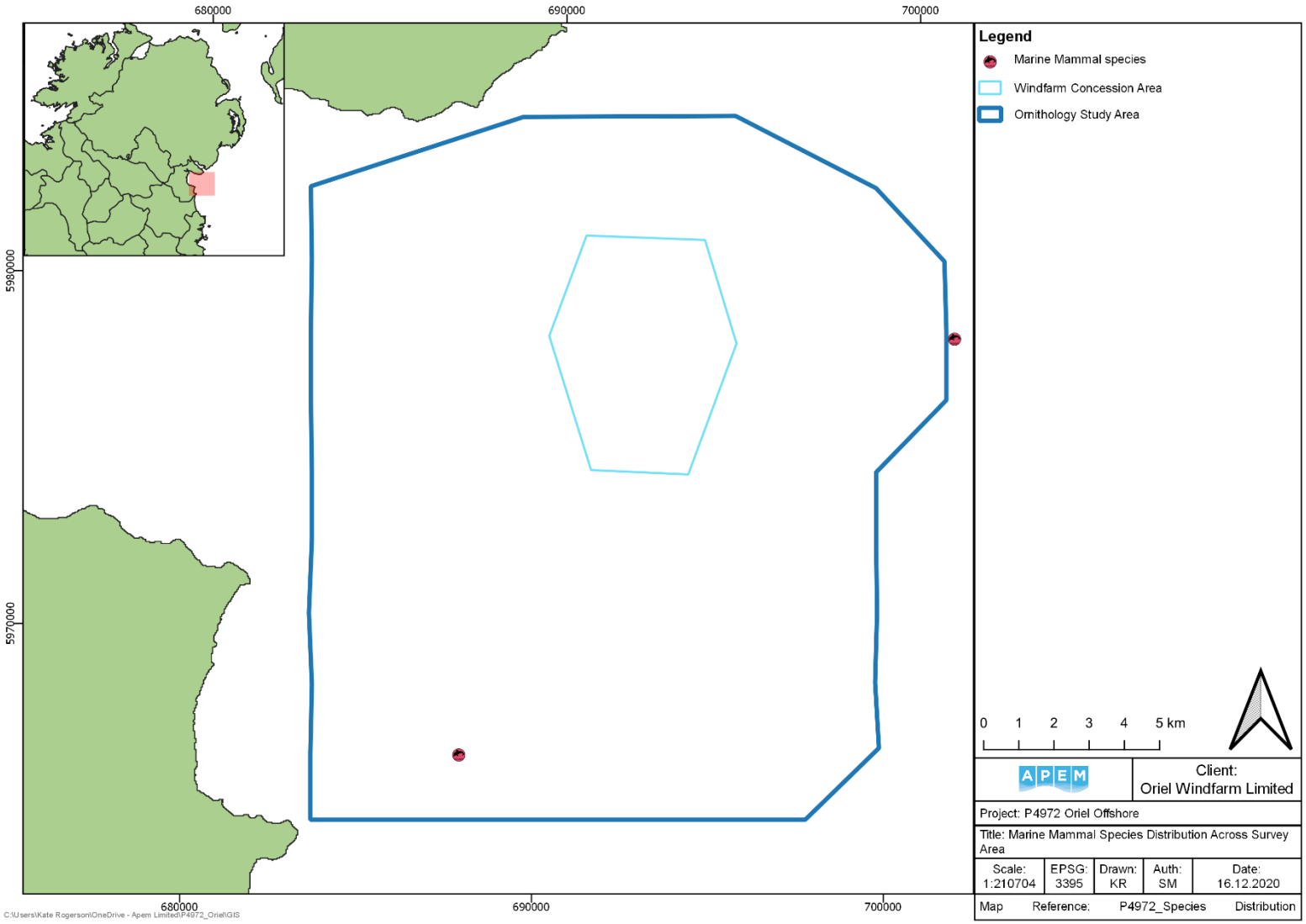


Figure 78 Location of unidentified marine mammal species in the Ornithology Survey area.

5.44 Shark Species – unidentified

One unidentified shark species was observed in the June 2020 survey. No unidentified shark species were recorded in the April, May or July surveys.

The single count resulted in an abundance estimate of three for the Ornithology Study area (**Table 48**).

The unidentified shark species was located to the west of the Windfarm Concession area (**Figure 79**).

Table 48 **Raw counts and abundance and density estimates (No. estimated individuals per km2) of shark species in: a) Windfarm Concession area; and b) Ornithology Study area**

b) Ornithology Study area						
Survey	**Raw Count**	**Abundance**	**Lower CI**	**Upper CI**	**Precision**	**Density**
June-2020	1	3	1	9	1	0.01

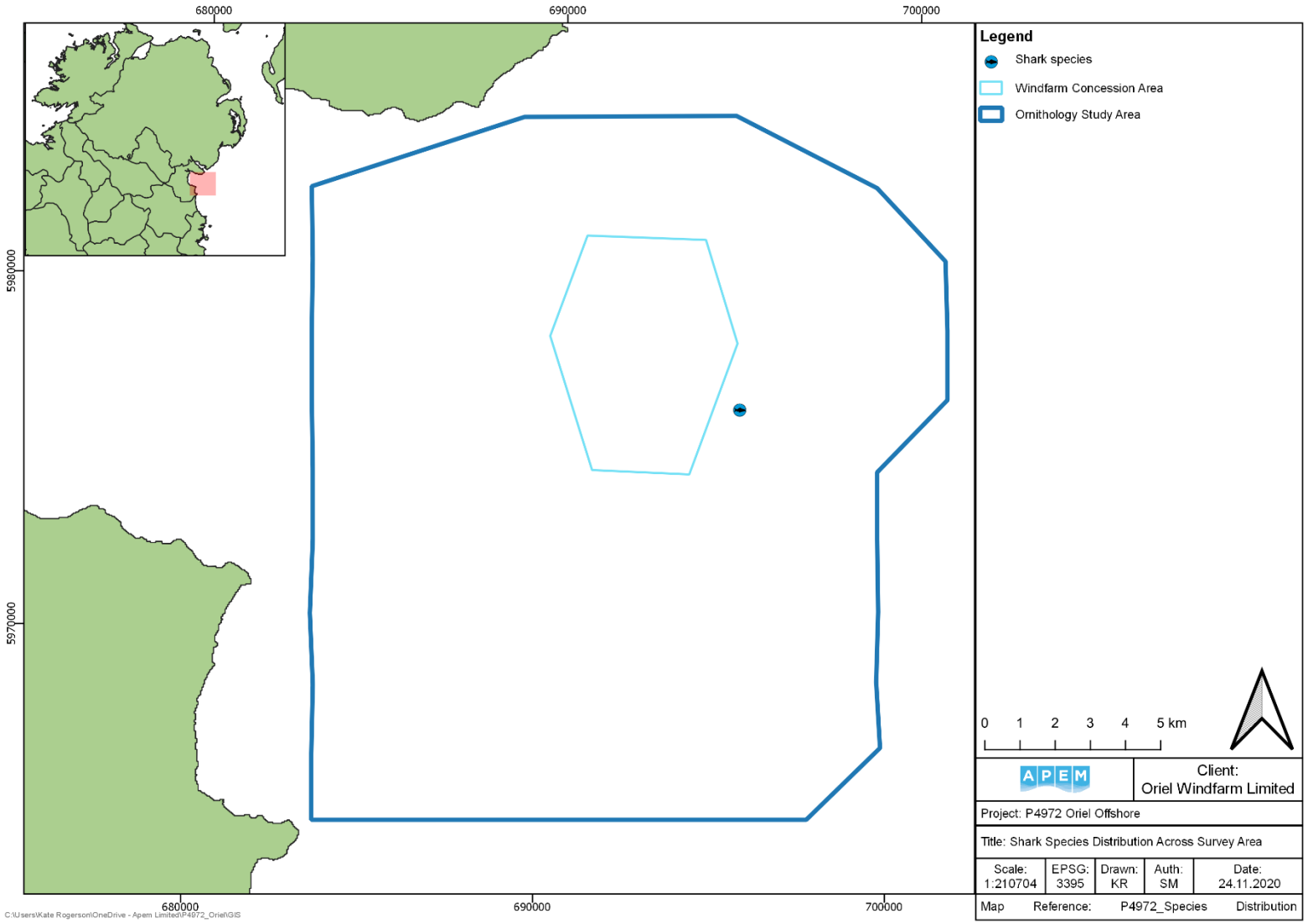


Figure 79 Location of unidentified shark species recorded across the Ornithology Study area

5.45 Leatherback Turtle

During the September 2020 survey, one leatherback turtle was recorded. Leatherback turtles were not recorded in the April 2020, May 2020, June 2020, July 2020 and August 2020 surveys.

The leatherback turtle was located outside the northern boundary of the Ornithology Study area (**Figure 80**).

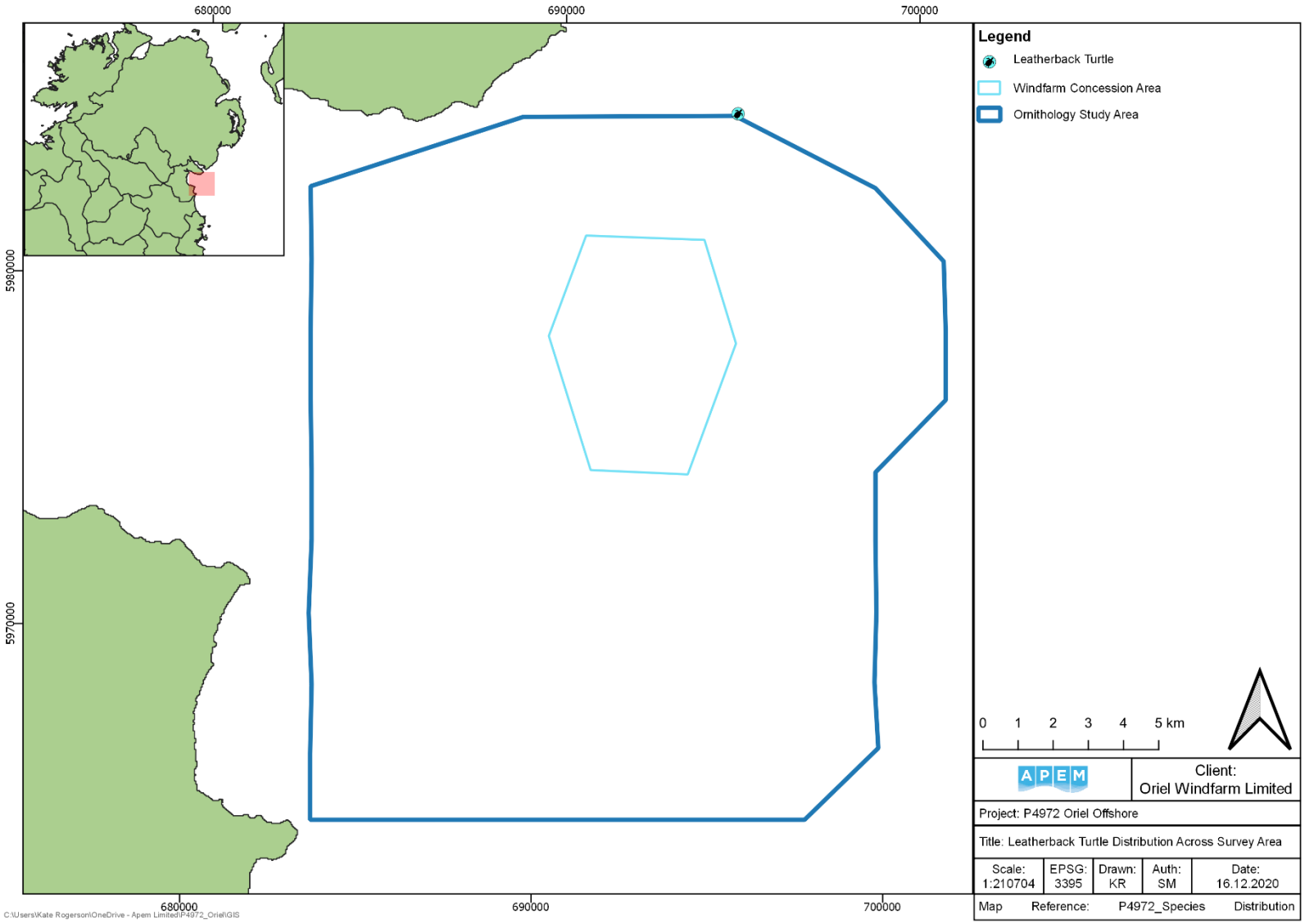


Figure 80 Location of leatherback turtle in the Ornithology Study area

6. Observations of Abiotic Structures

In April 2020, a total of seven anthropogenic objects were recorded in the Ornithology Study area. These were recorded sailing boats (n=3), fishing vessel (n=2), buoy (n=2). No vessels were recorded visually from the aircraft.

In May 2020, a total of seven anthropogenic objects were recorded in the Ornithology Study area, these were recorded as sailing boat (n=3), fishing vessel (n=2) and buoy (n=2). No vessels were recorded in the imagery. One fishing trawler (with an easterly bearing) was recorded visually from the aircraft.

In June 2020, two anthropogenic objects were recorded in the imagery. These were recorded as buoy (n=2) . No vessels were recorded visually from the aircraft.

In July 2020, one anthropogenic object was recorded in the imagery. This was recorded as buoy (n=1) No vessels were recorded visually from the aircraft.

In August 2020, nine anthropogenic objects were recorded in the imagery, these were recorded as recreational fishing vessel (n=4), fishing vessel (n=3) and buoy (n=2). A sailing boat (with a southerly bearing) was recorded visually from the aircraft.

In September 2020, three anthropogenic objects were recorded in the imagery, there were recorded as fishing vessel (n=2) and buoy (n=1). A fishing vessel (with a northerly bearing) was recorded visually from the aircraft.

7. References

Canty, A. & Ripley, B. 2010. *boot: bootstrap R (S-Plus) functions*. R package version 1.2-42.

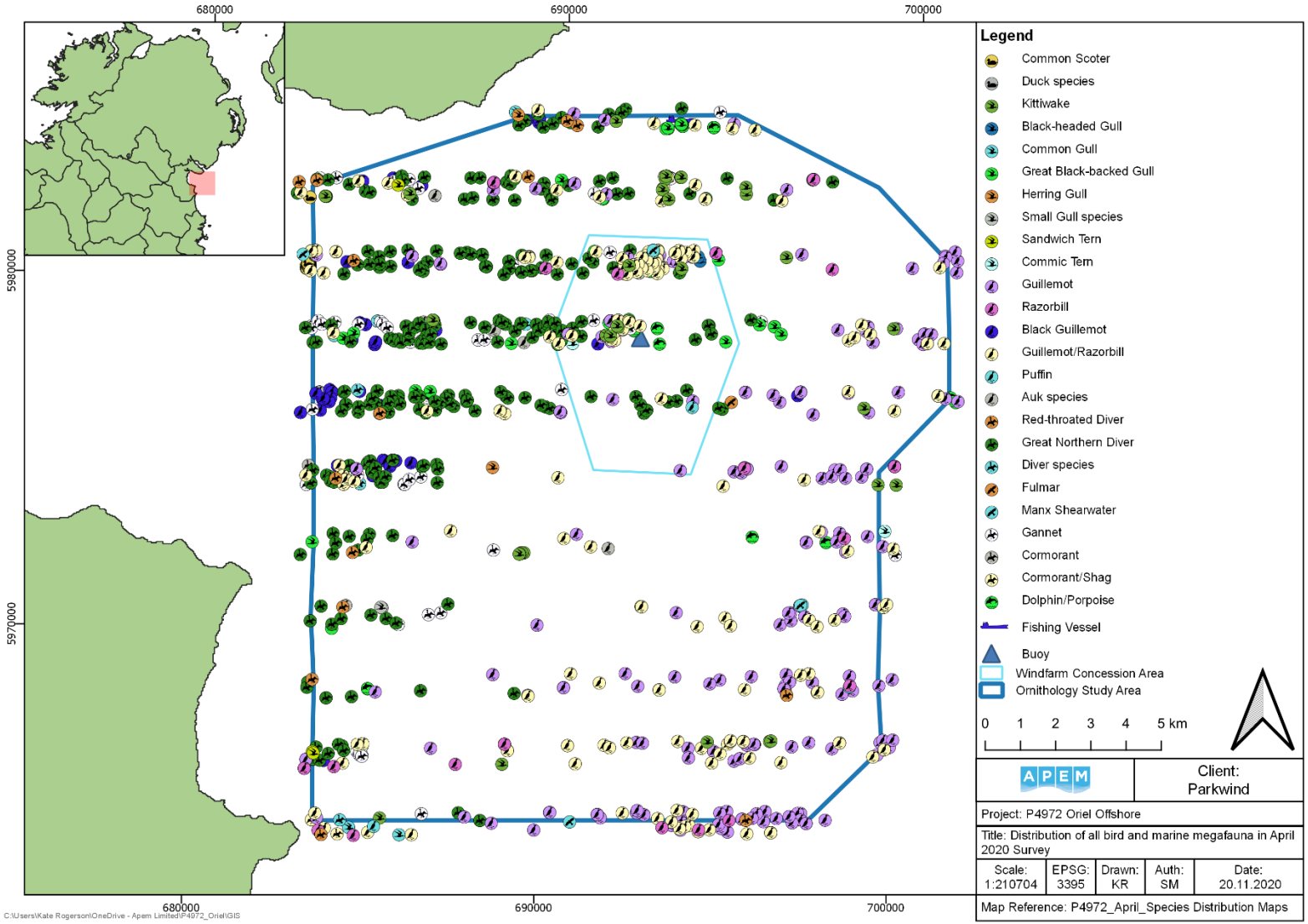
Efron, B. & Tibshirani, R.J. 1993. *An introduction to the bootstrap*. Chapman & Hall, London.
R Development Core Team (2012). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, http://www.R-project.org/.

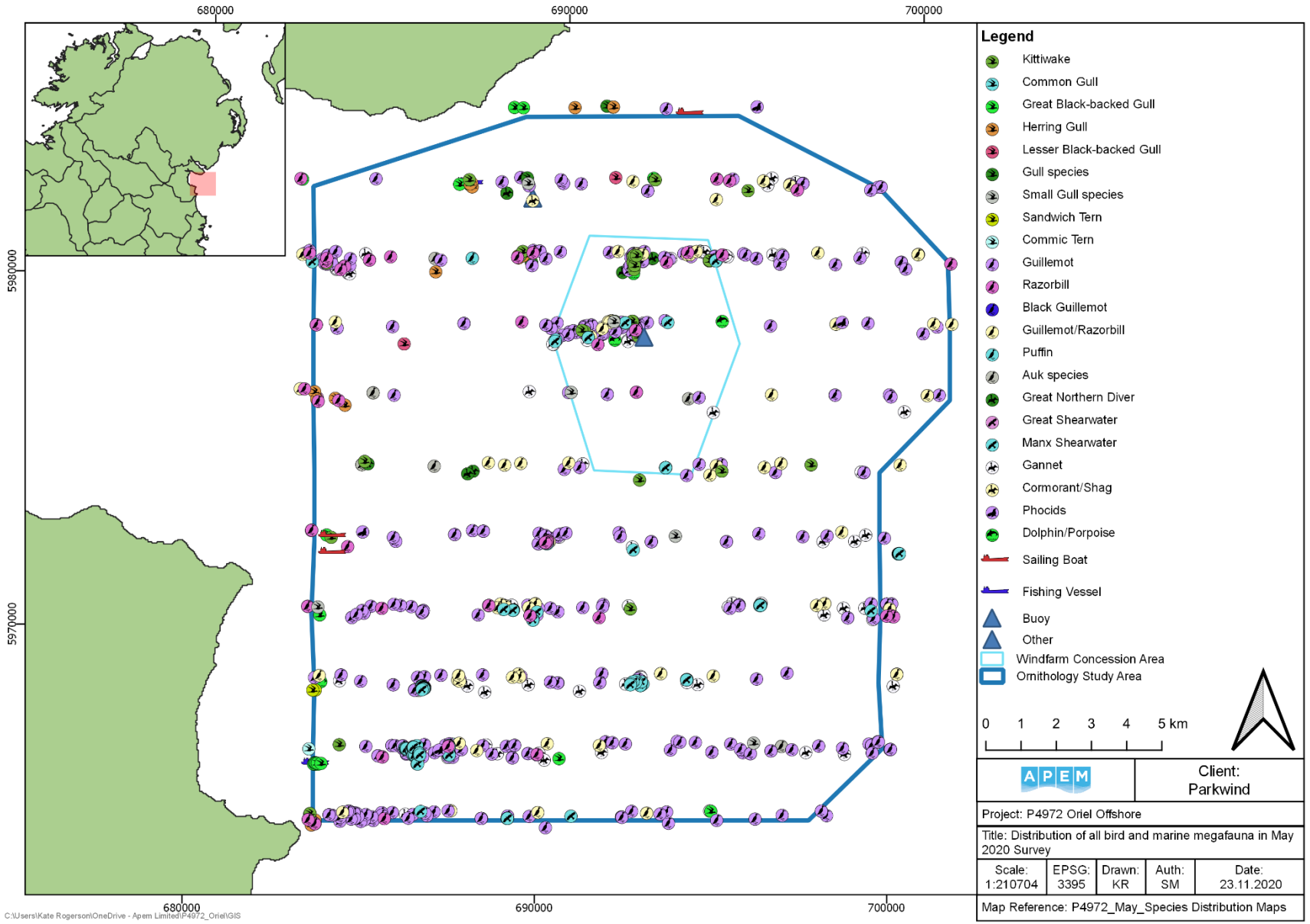
R Core Team, 2020. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

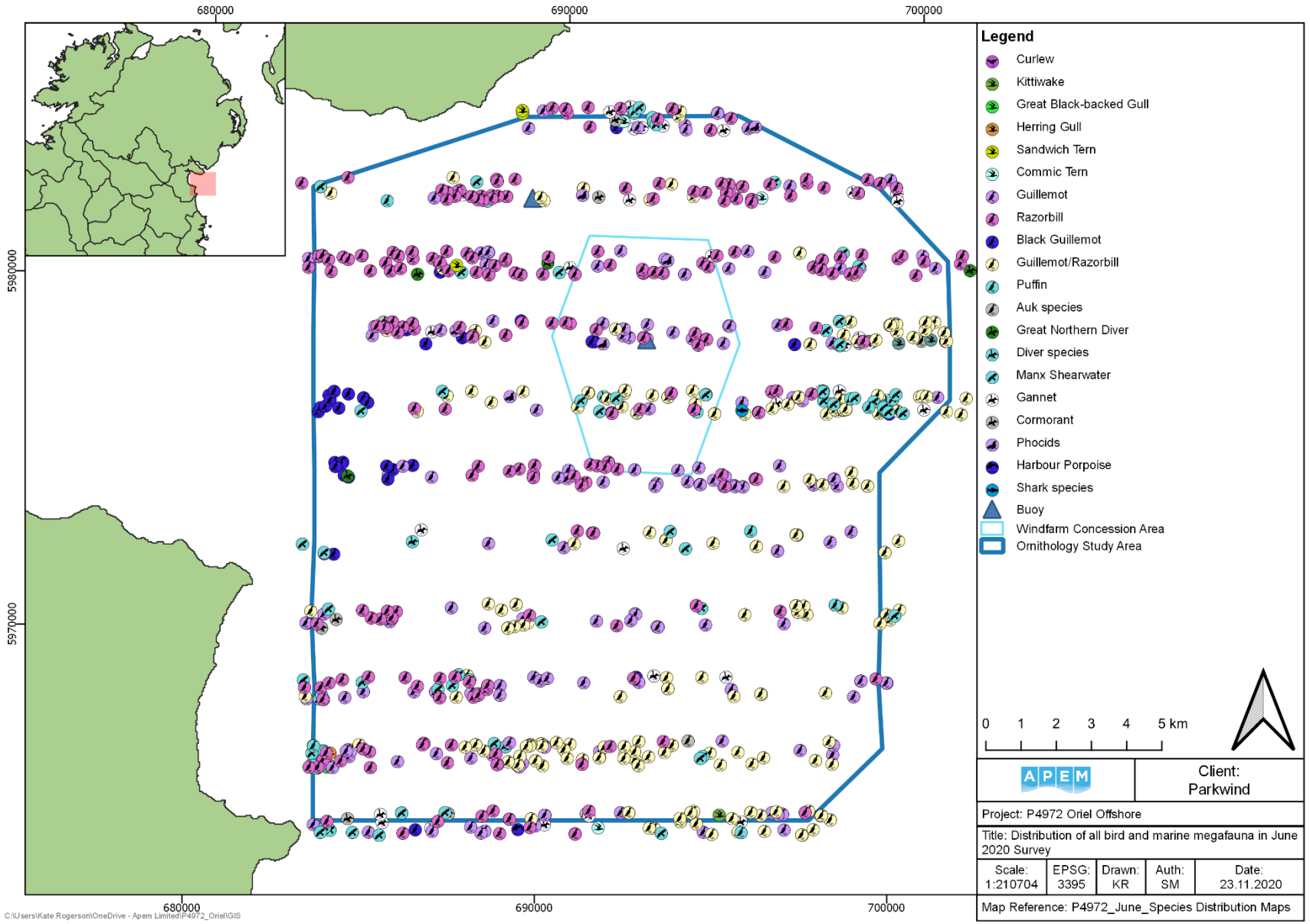
Appendix I Scientific Names and Taxonomy

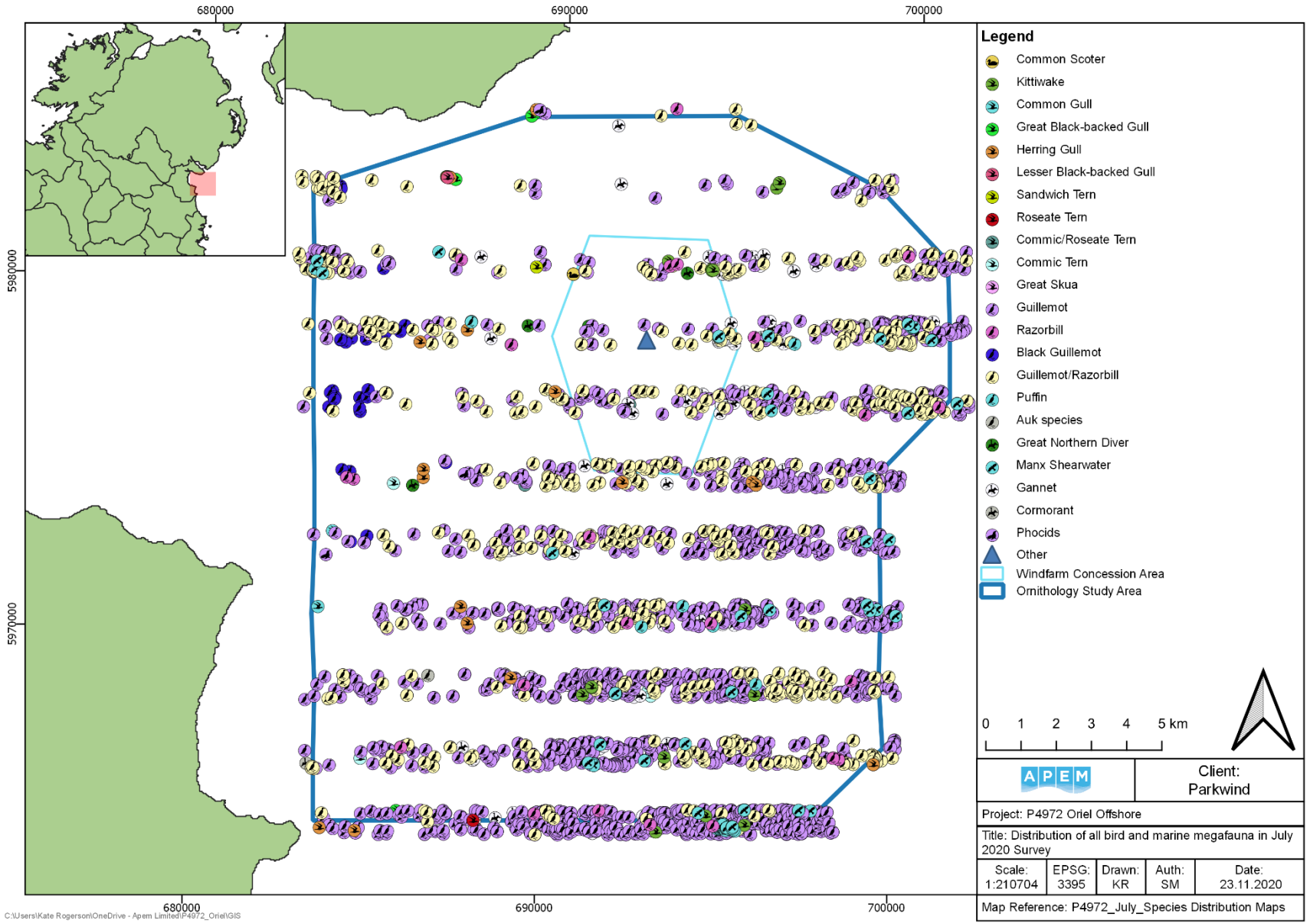
Common Name	Scientific Name	Family	Class
Common Scoter	*Melanitta nigra*	Anatidae	Aves
Curlew	*Numenius arquata*	Scolopacidae	Aves
Kittiwake	*Rissa tridactyla*	Laridae	Aves
Black-headed Gull	*Chroicocephalus ridibundus*	Laridae	Aves
Little Gull	*Hydrocoloeus minutus*	Laridae	Aves
Common Gull	*Larus canus*	Laridae	Aves
Great Black-backed Gull	*Larus marinus*	Laridae	Aves
Herring Gull	*Larus argentatus*	Laridae	Aves
Lesser Black-backed Gull	*Larus fuscus*	Laridae	Aves
Sandwich Tern	*Thalasseus sandvicensis*	Laridae	Aves
Roseate Tern	*Sterna dougallii*	Laridae	Aves
Common Tern	*Sterna hirundo*	Laridae	Aves
Arctic Tern	*Sterna paradisaea*	Laridae	Aves
Great Skua	*Stercorarius skua*	Stercorariidae	Aves
Arctic Skua	*Stercorarius parasiticus*	Stercorariidae	Aves
Guillemot	*Uria aalge*	Alcidae	Aves
Razorbill	*Alca torda*	Alcidae	Aves
Black Guillemot	*Cepphus grylle*	Alcidae	Aves
Puffin	*Fratercula arctica*	Alcidae	Aves
Red-throated Diver	*Gavia stellata*	Gaviidae	Aves
Great Northern Diver	*Gavia immer*	Gaviidae	Aves
Fulmar	*Fulmarus glacialis*	Procellariidae	Aves
Great Shearwater	*Ardenna gravis*	Procellariidae	Aves
Manx Shearwater	*Puffinus puffinus*	Procellariidae	Aves
Gannet	*Morus bassanus*	Sulidae	Aves
Shag	*Phalacrocorax aristotelis*	Phalacrocoracidae	Aves
Cormorant	*Phalacrocorax carbo*	Phalacrocoracidae	Aves
Grey Seal	*Halichoerus grypus*	Phocidae	Mammalia
Common Dolphin	*Delphinus delphis*	Delphinidae	Mammalia
Harbour Porpoise	*Phocoena phocoena*	Phocoenidae	Mammalia
Common Minke Whale	*Balaenoptera acutorostrata*	Balaenopteridae	Mammalia
Leatherback Turtle	*Dermochelys coriacea*	Dermochelyidae	Reptilia

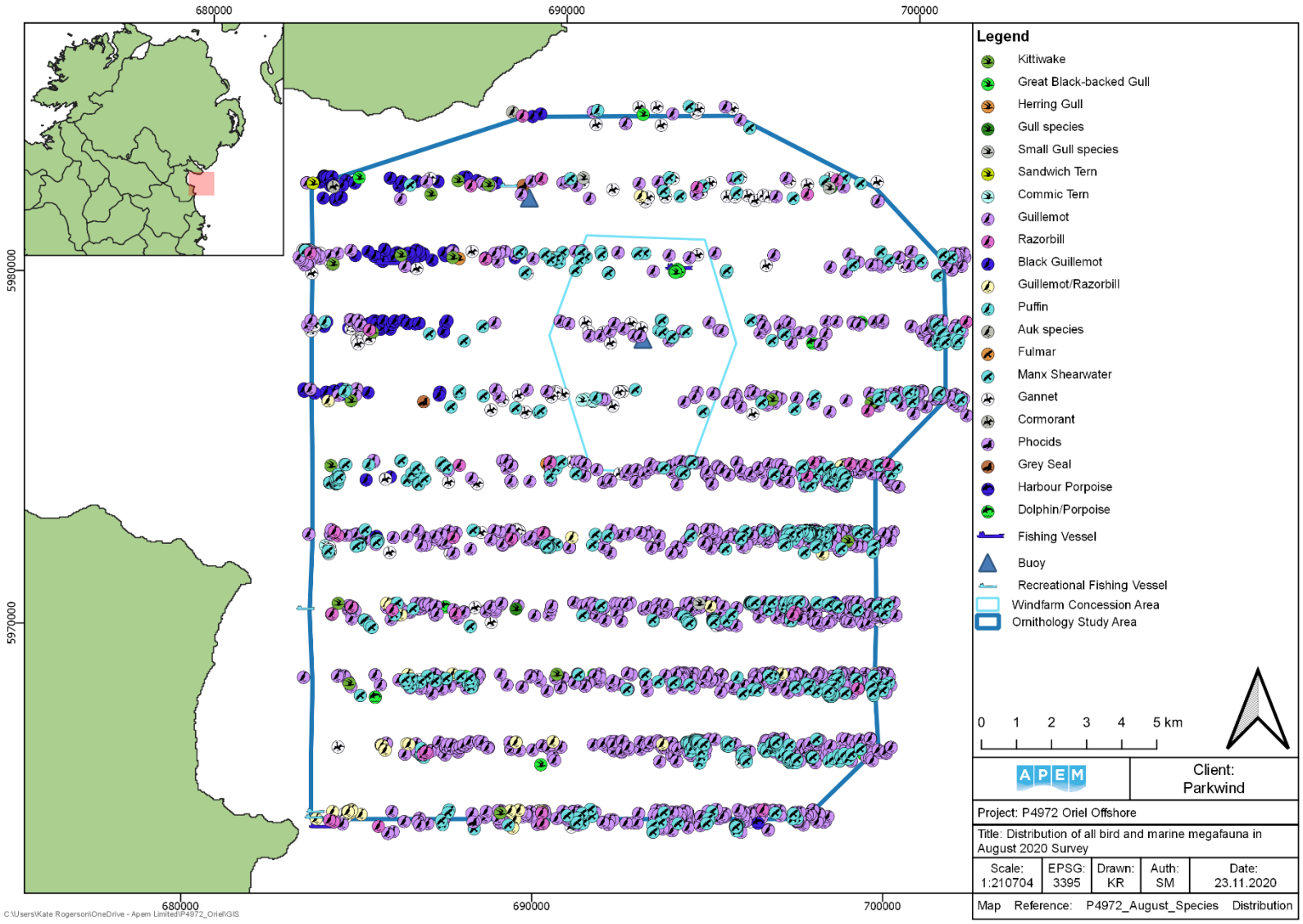
Appendix II Species distribution Maps per survey

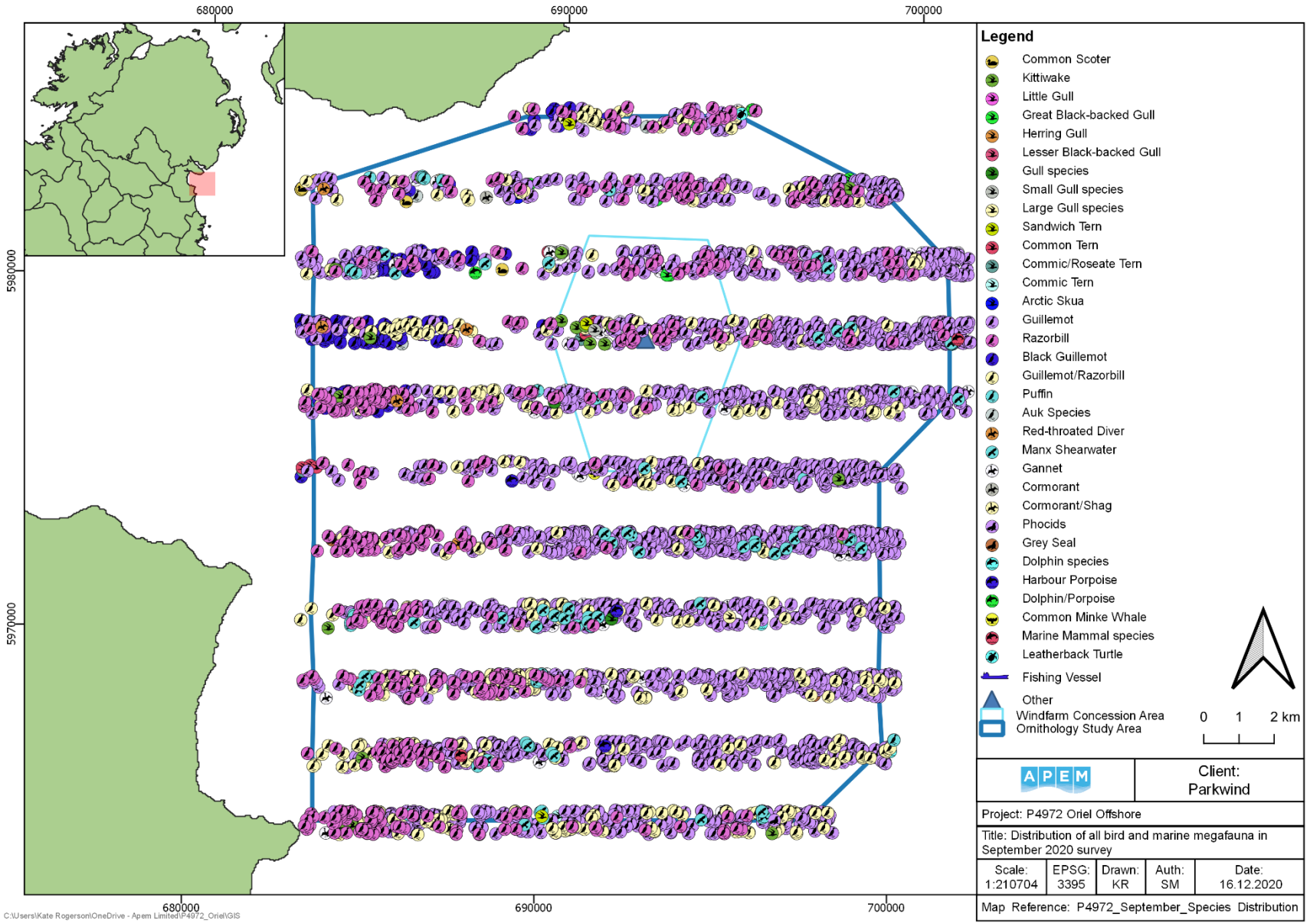



680000
690000
700000
5980000
5970000
Legend
Kittiwake
Common Gull
Great Black-backed Gull
Herring Gull
Lesser Black-backed Gull
Gull species
Small Gull species
Sandwich Tern
Commic Tern
Guillemot
Razorbill
Black Guillemot
Guillemot/Razorbill
Puffin
Auk species
Great Northern Diver
Great Shearwater
Manx Shearwater
Gannet
Cormorant/Shag
Phocids
Dolphin/Porpoise
Sailing Boat
Fishing Vessel
Buoy
Other
Windfarm Concession Area
Ornithology Study Area
0 1 2 3 4 5 km
APEM
Client: Parkwind
Project: P4972 Oriel Offshore
Title: Distribution of all bird and marine megafauna in May 2020 Survey
Scale: 1:210704
EPSG: 3395
Drawn: KR
Auth: SM
Date: 23.11.2020
Map Reference: P4972_May_Species Distribution Maps
C:\Users\Kate Rogerson\OneDrive - Apem Limited\P4972_Oriel\GIS


680000
690000
700000
5980000
5970000
Legend
Curlew
Kittiwake
Great Black-backed Gull
Herring Gull
Sandwich Tern
Commic Tern
Guillemot
Razorbill
Black Guillemot
Guillemot/Razorbill
Puffin
Auk species
Great Northern Diver
Diver species
Manx Shearwater
Gannet
Cormorant
Phocids
Harbour Porpoise
Shark species
Buoy
Windfarm Concession Area
Ornithology Study Area
0 1 2 3 4 5 km
APEM
Client: Parkwind
Project: P4972 Oriel Offshore
Title: Distribution of all bird and marine megafauna in June 2020 Survey
Scale: 1:210704
EPSG: 3395
Drawn: KR
Auth: SM
Date: 23.11.2020
Map Reference: P4972_June_Species Distribution Maps
C:\Users\Kate Rogerson\OneDrive - Apem Limited\P4972_Oriel\GIS


680000
690000
700000
5980000
5970000
Legend
Common Scoter
Kittiwake
Common Gull
Great Black-backed Gull
Herring Gull
Lesser Black-backed Gull
Sandwich Tern
Roseate Tern
Commic/Roseate Tern
Commic Tern
Great Skua
Guillemot
Razorbill
Black Guillemot
Guillemot/Razorbill
Puffin
Auk species
Great Northern Diver
Manx Shearwater
Gannet
Cormorant
Phocids
Other
Windfarm Concession Area
Ornithology Study Area
0 1 2 3 4 5 km
APEM
Client: Parkwind
Project: P4972 Oriel Offshore
Title: Distribution of all bird and marine megafauna in July 2020 Survey
Scale: 1:210704
EPSG: 3395
Drawn: KR
Auth: SM
Date: 23.11.2020
Map Reference: P4972_July_Species Distribution Maps
C:\Users\Kate Rogerson\OneDrive - Apem Limited\P4972_Oriel\GIS


680000
690000
700000
5980000
5970000
Legend
Kittiwake
Great Black-backed Gull
Herring Gull
Gull species
Small Gull species
Sandwich Tern
Commic Tern
Guillemot
Razorbill
Black Guillemot
Guillemot/Razorbill
Puffin
Auk species
Fulmar
Manx Shearwater
Gannet
Cormorant
Phocids
Grey Seal
Harbour Porpoise
Dolphin/Porpoise
Fishing Vessel
Buoy
Recreational Fishing Vessel
Windfarm Concession Area
Ornithology Study Area
0 1 2 3 4 5 km
APEM
Client: Parkwind
Project: P4972 Oriel Offshore
Title: Distribution of all bird and marine megafauna in August 2020 Survey
Scale: 1:210704
EPSG: 3395
Drawn: KR
Auth: SM
Date: 23.11.2020
Map Reference: P4972_August_Species Distribution
C:\Users\Kate Rogerson\OneDrive - Apem Limited\P4972_Oriel\GIS


680000
690000
700000
5980000
5970000
Legend
Common Scoter
Kittiwake
Little Gull
Great Black-backed Gull
Herring Gull
Lesser Black-backed Gull
Gull species
Small Gull species
Large Gull species
Sandwich Tern
Common Tern
Commic/Roseate Tern
Commic Tern
Arctic Skua
Guillemot
Razorbill
Black Guillemot
Guillemot/Razorbill
Puffin
Auk Species
Red-throated Diver
Manx Shearwater
Gannet
Cormorant
Cormorant/Shag
Phocids
Grey Seal
Dolphin species
Harbour Porpoise
Dolphin/Porpoise
Common Minke Whale
Marine Mammal species
Leatherback Turtle
Fishing Vessel
Other
Windfarm Concession Area
Ornithology Study Area
0 1 2 km
APEM
Client: Parkwind
Project: P4972 Oriel Offshore
Title: Distribution of all bird and marine megafauna in September 2020 survey
Scale: 1:210704
EPSG: 3395
Drawn: KR
Auth: SM
Date: 16.12.2020
Map Reference: P4972_September_Species Distribution
C:\Users\Kate Rogerson\OneDrive - Apem Limited\P4972_Oriel\GIS