Code: UKCAL-CWF-CON-EIA-RPT-00007-7017

Volume 7 Standalone Appendices

Appendix 19 Caledonia OWF Digital Aerial Surveys

Caledonia Offshore Wind Farm Ltd

5th Floor Atria One, 144 Morrison Street, Edinburgh, EH38EX

OW
OCEAN WINDS

Volume 7 Appendix 19 Caledonia OWF Digital Aerial Surveys

Code	UKCAL-CWF-CON-EIA-RPT-00007-7017
Revision	Issued
Date	18 October 2024

Ocean Winds Caledonia Offshore Wind Farm Digital Aerial Surveys

Ocean Winds UK Ltd

Final Report: May 2021 to April 2023

APEM Ref: P00006477

Issued March 2024

[redacted]

Client Contact:	[redacted]
Client:	Ocean Winds UK Ltd
Address:	Ocean Winds UK Ltd 5th Floor, Atria 1, 144 Morrison Street Edinburgh EH3 8EX
Project reference:	P00006477
Client reference:	Ocean Winds Caledonia OWF Aerial Surveys
Date of issue:	March 2024

Project Director:	[redacted]
Project Manager:	[redacted]
Key Contributors:	[redacted]

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 (2024). Final Report – Ocean Winds Caledonia OWF Digital Aerial Surveys, May 2021 to April 2023. APEM Scientific Report P6477. Ocean Winds UK Ltd, 14/03/2024, 718pp., v1.4

Revision and amendment register

Version Number	Date	Section(s)	Page(s)	Summary of Changes	Approved by
1.0	23/10/2023	All	All	Creation	MD
1.1	17/01/2024	All	All	Internal Review	JT/SY
1.2	19/01/2024	All	All	Edits after internal review	MD
1.3	28/02/2024	All	All	Edits after client's comments	MD, COM, AG, SY
1.4	07/03/2014	All	All	Edits after client's comments	MD

Contents

List of figures

List of tables

1. Executive summary

Ocean Winds Ltd. (Ocean Winds) contracted APEM Ltd. (APEM) to undertake 24 monthly baseline digital aerial surveys of the proposed Caledonia Offshore Wind Farm (OWF), commencing May 2021 and ending April 2023. Caledonia OWF was previously known as NE4 Proposed Development Area (PDA). Caledonia OWF plus a 4 kilometres (km) buffer will be hereafter referred to as the Survey Area. Surveys were carried out using APEM's high-resolution digital still camera system to assess the abundance and distribution of birds and marine mammals in the Survey Area.

A dividing border between the north and south of Caledonia OWF was established by Ocean Winds, subsequently defining two subdivisions within the Survey Area, hereafter referred as Caledonia North and Caledonia South (Figure 1). Ocean Winds contracted APEM to analyse the data for the two subdivisions and associated buffers in addition to the Survey Area. Each subdivision has a 4 km buffer (Figure 1).

Images from 24 surveys carried out between May 2021 and April 2023 have been analysed by APEM, and the outputs of this analysis are the subject of this report. Raw counts, design-based unapportioned abundance and density estimates of all species, apportioned abundance and density estimates of specific species and availability-corrected abundance estimates of guillemot, razorbill, puffin and harbour porpoise are presented. Incidental observations recorded during the surveys are also presented as well as information on species distribution and flight direction. The key findings within the Caledonia OWF, Caledonia North and Caledonia South carried out between May 2021 and April 2023, expressed as raw counts, are summarised below.

- **Survey 1 – May 2021**

Survey Area: Auks were the most frequently recorded species group recorded (n=2,402), followed by small gulls (n=195). In addition, fulmars (n=91), gannets (n=14), terns (n=13), auks and/or shearwaters (n=10), unidentified bird species (n=8), marine mammals (n=8), unidentified gulls (n=2), large gulls (n=1), skuas (n=1) and shearwaters (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=786), followed by small gulls (n=81). In addition, fulmars (n=61), gannets (n=8), auk / shearwater (n=6), terns (n=3), marine mammals (n=3), large gull (n=1), and skua (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=1,890), followed by small gulls (n=139). In addition, fulmars (n=46), terns (n=10), gannets (n=8), unidentified bird species (n=8), marine mammals (n=6), auk / shearwater species (n=5), unidentified gull (n=2) and shearwater (n=1) were also recorded.

- **Survey 2 – June 2021**

Survey Area: Auks were the most frequently recorded species group recorded (n=1,703), followed by small gulls (n=358). In addition, gannets (n=114), fulmars (n=105), shearwaters (n=15), auks and/or shearwaters (n=14), marine mammals (n=7), unidentified bird species (n=4), large gulls (n=2), skuas (n=1) and divers (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=542), followed by small gulls (n=80). In addition, fulmars (n=52), gannets (n=51), marine mammals (n=5), skua (n=2), unidentified bird species (n=2), large gull (n=1), shearwater (n=1) and auk / shearwater (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=1,389), followed by small gulls (n=311). In addition, gannets (n=79), fulmars (n=74), shearwaters (n=15), auk and/or shearwaters (n=14), marine mammal (n=4), unidentified bird species (n=3), skuas (n=2), large gull (n=1), and divers (n=1) were also recorded.

- **Survey 3 – July 2021**

Survey Area: Auks were the most frequently recorded species group (n=3,211), followed by small gulls (n=1,083). In addition, fulmars (n=790), gannets (n=34), large gulls (n=22), auks and/or shearwaters (n=13), marine mammals (n=13), skuas (n=10), shearwaters (n=3), terns (n=2), unidentified bird species (n=2) and unidentified gulls (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=1,200), followed by small gulls (n=513). In addition, fulmars (n=215), large gulls (n=22), gannets (n=9), auk / shearwaters (n=7), marine mammals (n=6), skuas (n=5), terns (n=2), unidentified gulls (n=1), shearwaters (n=1) and unidentified bird species (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=2,602), followed by small gulls (n=857). In addition, fulmars (n=673), gannets (n=29), auk / shearwater (n=10), marine mammals (n=9), skuas (n=5), shearwaters (n=2), unidentified bird species (n=2), and large gull (n=1) were also recorded.

- **Survey 4 – August 2021**

Survey Area: Auks were the most frequently recorded species group (n=1,329), followed by small gulls (n=294). In addition, fulmars (n=285), gannets (n=71), skuas (n=6), terns (n=5), large gulls (n=3), unidentified bird species (n=3), unidentified gulls (n=2) and marine mammals (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=565), followed by fulmars (n=179). In addition, small gulls (n=75), gannets (n=26), skuas (n=6), terns (n=5), large gulls (n=3), unidentified bird species (n=2), unidentified gull (n=1), and marine mammal (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=987), followed by small gulls (n=247). In addition, fulmars (n=178), gannets (n=57), terns (n=5), skuas (n=2), unidentified gulls (n=1) and unidentified bird species (n=1) were also recorded.

- **Survey 5 – September 2021**

Survey Area: Auks were the most frequently recorded species group (n=1,101), followed by small gulls (n=166). In addition, fulmars (n=113), gannets (n=101), large gulls (n=81), marine mammals (n=10), unidentified bird species (n=3), shearwaters (n=1) and skuas (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=225), followed by large gulls (n=81). In addition, gannets (n=62), fulmars (n=52), small gulls (n=17), marine mammals (n=7), and unidentified bird species (n=3) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=987), followed by small gulls (n=154). In addition, fulmars (n=93), gannets (n=47), large gulls (n=14), marine mammals (n=5), shearwaters (n=1), skuas (n=1) and unidentified bird species (n=1) were also recorded.

- **Survey 6 – October 2021**

Survey Area: Auks were the most frequently recorded species group (n=411), followed by gannets (n=125). In addition, small gulls (n=85), large gulls (n=58), marine mammals (n=24), fulmars (n=12) and unidentified bird species (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=119), followed by gannets (n=89). In addition, large gulls (n=58), small gulls (n=52), marine mammals (n=22), and fulmars (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=366), followed by gannets (n=82). In addition, small gulls (n=46), marine mammals (n=19), fulmars (n=11), large gulls (n=2) and unidentified bird species (n=1) were also recorded.

- **Survey 7 – November 2021**

Survey Area: Auks were the most frequently recorded species group (n=454), followed by large gulls (n=195). In addition, fulmars (n=180), small gulls (n=144), gannets (n=16), marine mammals (n=16) and divers (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=199), followed by small gulls (n=139). In addition, large gulls (n=101), fulmar (n=45), marine mammals (n=13) and gannets (n=6) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=354), followed by fulmars (n=136). In addition, large gulls (n=119), small gulls (n=61), gannets (n=14), marine mammals (n=13) and divers (n=1) were also recorded.

- **Survey 8 – December 2021**

Survey Area: Auks were the most frequently recorded species group (n=232), followed by fulmars (n=194). In addition, small gulls (n=27), large gulls (n=18), marine mammals (n=11), unidentified bird species (n=6), and gannets (n=4) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=96), followed by fulmars (n=87). In addition, small gulls (n=18), large gulls (n=11), unidentified bird species (n=3), gannets (n=2), and marine mammals (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=169), followed by fulmars (n=118). In addition, small gulls (n=17), marine mammals (n=11), large gulls (n=9), unidentified bird species (n=3), and gannets (n=2) were also recorded.

- **Survey 9 – January 2022**

Survey Area: Auks were the most frequently recorded species group (n=132), followed by fulmars (n=55). In addition, large gulls (n=50), small gulls (n=8), marine mammals (n=7), unidentified bird species (n=5), gannets (n=2) and sharks (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=62), followed by large gulls (n=38). In addition, fulmars (n=37), small gulls (n=7), unidentified bird species (n=2), and marine mammals (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=99), followed by fulmars (n=31). In addition, large gulls (n=27), marine mammals (n=6), small gulls (n=4), unidentified bird species (n=3), gannets (n=2) and sharks (n=1) were also recorded.

- **Survey 10 – February 2022**

Survey Area: Auks were the most frequently recorded species group (n=419) followed by fulmars (n=80). In addition, large gulls (n=50), small gulls (n=29), marine mammals (n=13), gannets (n=5), wildfowl (n=2), unidentified gulls (n=1) and unidentified bird species (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=198) followed by fulmars (n=37). In addition, large gulls (n=24), small gulls (n=21), marine mammals (n=13), unidentified gulls (n=1) and unidentified bird species (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=265) followed by fulmars (n=56). In addition, large gulls (n=37), small gulls (n=11), marine mammals (n=10), gannets (n=5), and wildfowl (n=2) were also recorded.

- **Survey 11 – March 2022**

Survey Area: Auks were the most frequently recorded species group (n=203) followed by small gulls (n=42). In addition, fulmars (n=28), marine mammals (n=11), large gulls (n=4), gannets (n=1) unidentified bird species (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=83) followed by small gulls (n=35). In addition, fulmars (n=22), marine mammals (n=5), large gulls (n=4), and unidentified bird species (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=161) followed by small gulls (n=15). In addition, fulmars (n=10), marine mammals (n=8), large gulls (n=2) and gannets (n=1) were also recorded.

- **Survey 12 – April 2022**

Survey Area: Auks were the most frequently recorded species group (n=861) followed by small gulls (n=100). In addition, fulmars (n=70), gannets (n=12), marine mammals (n=6), auks and/or shearwaters (n=2) and unidentified bird species (n=2) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=381) followed by small gulls (n=35). In addition, fulmars (n=24), marine mammals (n=5), gannets (n=4), and auks and/or shearwaters (n=2) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=651) followed by small gulls (n=80). In addition, fulmars (n=56), gannets (n=10), marine mammals (n=3) and unidentified bird species (n=2) were also recorded.

- **Survey 13 – May 2022**

Survey Area: Auks were the most frequently recorded species group (n=4,074) followed by small gulls (n=678). In addition, fulmars (n=54), gannets (n=22), marine mammals (n=14), auks and/or shearwaters (n=9), shearwaters (n=9), unidentified bird species (n=7), terns (n=6) and large gull (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=2,936) followed by small gulls (n=533). In addition, fulmars (n=32), gannets (n=7), terns (n=6), auk / shearwaters (n=6), marine mammals (n=4), shearwaters (n=3), unidentified bird species (n=3), and large gull (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=2,001) followed by small gulls (n=236). In addition, fulmars (n=34), gannets (n=17), marine mammals (n=11), shearwaters (n=8), auk / shearwaters (n=3), unidentified bird species (n=3) and terns (n=2) were also recorded.

- **Survey 14 – June 2022**

Survey Area: Auks were the most frequently recorded species group (n=2,417) followed by small gulls (n=813). In addition, gannets (n=267), fulmars (n=204), marine mammals (n=33), auks and/or shearwaters (n=5), unidentified bird species (n=5), large gulls (n=3), and wader species (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=1,195) followed by small gulls (n=300). In addition, fulmars (n=130), gannets (n=78), marine mammals (n=14), auk / shearwaters (n=4), large gulls (n=3), unidentified bird species (n=3) and wader species (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=1,644) followed by small gulls (n=680). In addition, gannets (n=228), fulmars (n=109), marine mammals (n=22), auk / shearwaters (n=4), unidentified bird species (n=4) and wader species (n=1) were also recorded.

- **Survey 15 – July 2022**

Survey Area: Auks were the most frequently recorded species group (n=3,073) followed by fulmars (n=1,634). In addition, small gulls (n=920), gannets (n=110), large gulls (n=47), marine mammals (n=22), unidentified bird species (n=13) and skuas (n=2) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=865) followed by fulmars (n=407). In addition, small gulls (n=316), gannets (n=50), marine mammals (n=14), large gulls (n=12), unidentified bird species (n=9), and skuas (n=2) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=2,655) followed by fulmars (n=1,442). In addition, small gulls (n=860), gannets (n=97), large gulls (n=46), marine mammals (n=17), unidentified bird species (n=6), and skuas (n=1) were also recorded.

- **Survey 16 – August 2022**

Survey Area: Auks were the most frequently recorded species group (n=401) followed by small gulls (n=146). In addition, fulmars (n=115), terns (n=14), gannets (n=12), marine mammals (n=12), unidentified bird species (n=6), gulls (n=3), skuas (n=2) and shearwater (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=113), followed by small gulls (n=75). In addition, fulmars (n=63), gannets (n=8), marine mammals (n=4), unidentified bird species (n=3), unidentified gulls (n=1), terns (n=1) and skuas (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=340), followed by small gulls (n=94). In addition, fulmars (n=76), terns (n=13), marine mammals (n=11), gannets (n=10), unidentified bird species (n=4), skuas (n=2), unidentified gulls (n=2), and shearwaters (n=1) were also recorded.

- **Survey 17 – September 2022**

Survey Area: Auks were the most frequently recorded species group (n=3,325) followed by gannets (n=105). In addition, auks and/or shearwaters (n=74), small gulls (n=50), fulmars (n=47), marine mammals (n=29), large gulls (n=12), shearwaters (n=2) and unidentified bird species (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=895) followed by gannets (n=46). In addition, small gulls (n=22), marine mammals (n=20), fulmars (n=19), large gulls (n=10), auk / shearwaters (n=1) and unidentified bird species (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=2,707) followed by gannets (n=87). In addition, auks and/or shearwaters (n=73), fulmars (n=38), small gulls (n=35), marine mammals (n=12), large gulls (n=4), and shearwaters (n=2) were also recorded.

- **Survey 18 – October 2022**

Survey Area: Passerine species were the most frequently recorded species group (n=367) followed by auks (n=214). In addition, marine mammals (n=54), gannets (n=47), large gulls (n=42), small gulls (n=32), fulmars (n=4), unidentified bird species (n=2) and divers (n=1) were also recorded.

Caledonia North Survey Area: Passerine species were the most frequently recorded species group (n=271) followed by auks (n=89). In addition, large gulls (n=24), marine mammals (n=13), gannets (n=10), small gulls (n=4), divers (n=1) and unidentified bird species (n=1) were also recorded.

Caledonia South Survey Area: Passerine species were the most frequently recorded species group (n=225) followed by auks (n=157). In addition, gannets (n=42), marine mammals (n=42), small gulls (n=31), large gulls (n=26), fulmar (n=4), divers (n=1), and unidentified bird species (n=1) were also recorded.

- **Survey 19 – November 2022**

Survey Area: Fulmars were the most frequently recorded species group (n=252) followed by auks (n=63). In addition, large gulls (n=23), small gulls (n=17), marine mammals (n=6), gannets (n=2), fulmar and/or gull species (n=2), sharks (n=1) and unidentified bird species (n=1) were also recorded.

Caledonia North Survey Area: Fulmars were the most frequently recorded species group (n=167) followed by auks (n=35). In addition, small gulls (n=13), large gulls (n=13), marine mammals (n=4), fulmar and/or gull species (n=1), and unidentified bird species (n=1) were also recorded.

Caledonia South Survey Area: Fulmars were the most frequently recorded species group (n=140) followed by auks (n=53). In addition, large gulls (n=18), small gulls (n=13), marine mammals (n=4), gannets (n=2), fulmar and/or gull species (n=1), and sharks (n=1) were also recorded.

- **Survey 20 – December 2022**

Survey Area: Auks were the most frequently recorded species group (n=118) followed by fulmars (n=87). In addition, large gulls (n=30), small gulls (n=10), gannets (n=5), marine mammals (n=5), gulls (n=2) and unidentified bird species (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=68) followed by fulmars (n=60). In addition, large gulls (n=21), small gulls (n=7), gannets (n=4), marine mammals (n=2), unidentified gulls (n=1), and unidentified bird species (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=75) followed by fulmars (n=52). In addition, large gulls (n=17), small gulls (n=6), gannets (n=4), marine mammals (n=3), and unidentified gulls (n=1) were also recorded.

- **Survey 21 – January 2023**

Survey Area: Auks were the most frequently recorded species group (n=179) followed by fulmars (n=53). In addition, large gulls (n=33), marine mammals (n=10), small gulls (n=5), gannets (n=3) and wildfowl (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=84) followed by fulmars (n=26). In addition, large gulls (n=22), marine mammals (n=6), small gulls (n=4), gannets (n=1) and wildfowl (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=132) followed by fulmars (n=36). In addition, large gulls (n=18), marine mammals (n=5), gannets (n=3), small gulls (n=2), and wildfowl (n=1) were also recorded.

- **Survey 22 – February 2023**

Survey Area: Auks were the most frequently recorded species group (n=559) followed by fulmars (n=37). In addition, small gulls (n=33), marine mammals (n=18), large gulls (n=17), and gannets (n=8) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=246) followed by fulmars (n=20). In addition, small gulls (n=15), large gulls (n=11), marine mammals (n=7) and gannets (n=6) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=418) followed by fulmars (n=22). In addition, small gulls (n=21), marine mammals (n=12), large gulls (n=11), and gannets (n=3) were also recorded.

- **Survey 23 – March 2023**

Survey Area: Auks were the most frequently recorded species group (n=650) followed by fulmars (n=96). In addition, small gulls (n=16), marine mammals (n=13), large gulls (n=6), auks and/or shearwaters (n=4), fulmar and/or gulls (n=1), and gannets (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=409) followed by fulmars (n=54). In addition, small gulls (n=8), marine mammals (n=6), large gulls (n=4), auks and/or shearwaters (n=2), and fulmar / gull species (n=1) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=455) followed by fulmars (n=54). In addition, small gulls (n=13), marine mammals (n=10), large gulls (n=3), auks and/or shearwaters (n=2), gannets (n=1), and fulmar / gull species (n=1) were also recorded.

- **Survey 24 – April 2023**

Survey Area: Auks were the most frequently recorded species group (n=640) followed by small gulls (n=129). In addition, fulmars (n=39), gannets (n=15), marine mammals (n=7), large gulls (n=1), and auks and/or shearwaters (n=1) were also recorded.

Caledonia North Survey Area: Auks were the most frequently recorded species group (n=159) followed by fulmars (n=27). In addition, small gulls (n=9) and marine mammals (n=4) were also recorded.

Caledonia South Survey Area: Auks were the most frequently recorded species group (n=560) followed by small gulls (n=123). In addition, gannets (n=15), fulmars (n=15), marine mammals (n=4), large gulls (n=1), and auks and/or shearwaters (n=1) were also recorded.

2. Introduction

2.1 Background

APEM has been contracted by Ocean Winds for the supply of a programme of 24 monthly digital aerial surveys, the main purpose of which is to provide baseline information on the distribution and abundance of seabirds and marine mammals within and around Caledonia OWF. Ocean Winds and APEM engaged with NatureScot and Marine Scotland Science (now Marine Directorate) on 22nd October 2020 to discuss the data collection and assessment methods. Method feedback was provided on 6th November 2021 and final feedback was provided on 16th December 2021.

Caledonia OWF (Figure 1) is a site within the Final Sectoral Marine Plan for Offshore Wind Energy. The water depth across Caledonia OWF is predominantly shallow (<60 metres [m]) throughout, with small areas of deeper water (60-100 m) in the south of the Plan Option (PO).

A desk study was undertaken to inform on the potential seabird species likely to be present within Caledonia OWF. The Sectoral Marine Plan Strategic Environmental Assessment (SEA) and Habitat Regulations Appraisal (HRA) identified Caledonia OWF as likely to be important as a foraging area for seabirds, in particular black-legged kittiwake, from multiple Special Protection Areas (SPAs).

2.2 Aim of the report

The report presents information on marine birds, mammals and other megafauna, derived from 24 consecutive months of digital aerial surveys (May 2021 to April 2023 inclusive) of a Survey Area consisting of Caledonia OWF plus a 4 km buffer (collectively referred to as the Survey Area) and its subdivisions, Caledonia North and Caledonia South, plus their respective 4 km buffer. The information that is presented within this report and its appendices includes the following:

- Summary of surveys
- Health and safety summary
- Unapportioned abundance and density estimate for all bird, marine mammal and shark species recorded per month within the Survey Area and its subdivisions, apportioned abundance and density estimates of specific species, and apportioned and availability-corrected abundance and density estimates for auk species and harbour porpoises
- Bird flight direction
- Spatial distribution maps of birds and marine mammals.

The aim of this report is to provide information on the 24 monthly site-specific baseline surveys, which will inform the offshore ornithology and marine mammal Environmental Impact Assessment (EIA) and HRA. The report has been prepared in advance of the final assessment to provide stakeholders with an early sight of the ornithology baseline derived from the digital aerial surveys. Whilst every care has been taken during the preparation and presentation of the baseline data included within this report, it should not be regarded as final. Whilst it is not expected to be required, any substantive changes that may be required between this report and the final assessment will be highlighted within the assessment.

2.3 Site description

Caledonia OWF is located off northeast Scotland, approximately 23.4 kilometres (km) south-east of the Wick coast at its closest point (Figure 1) and covers an area of approximately 427 kilometres squared (km^2). The Survey area, Caledonia OWF plus a 4 km buffer, covers an area of approximatively 884 km^2. This was the standard Survey Area for all months.

Caledonia OWF was subdivided in two smaller areas, Caledonia North and Caledonia South (Figure 1). Caledonia North Survey Area includes Caledonia North plus a 4 km buffer (of which some of the buffer overlaps Caledonia South) and covers an area of approximatively 557 km^2 while Caledonia South Survey Area includes Caledonia South plus a 4 km buffer (of which some of the buffer overlaps Caledonia North) and covers an area of approximatively 534 km^2 (Figure 1). Information regarding the transect lines included in the reporting regions of Caledonia OWF, Caledonia North and Caledonia South and their 2 km and 4 km buffers is shown in Table 1.

Table 1 Number of transects, survey line minimum / maximum lengths and total lengths of all survey lines in each reporting region within the Survey Area.

Region	No. transects	Minimum transect length (km)	Maximum transect length (km)	Total length of transects (km)
Caledonia OWF	9	4.52	30.68	163.39
Caledonia OWF plus 2 km buffer	11	6.06	35.59	246.14
Survey Area	13	5.46	39.70	338.25
Caledonia North	7	3.07	18.13	83.48
Caledonia North plus 2 km buffer	9	4.42	24.25	141.91
Caledonia North Survey Area	11	3.40	28.83	211.71
Caledonia South	8	4.61	12.55	80.39
Caledonia South plus 2 km buffer	10	6.11	16.67	139.66
Caledonia South Survey Area	12	5.46	20.87	205.95

2.4 Bird and marine mammal names

Throughout this report the bird species names used are those that are in common use among British ornithologists, and this corresponds to the "British (English) vernacular name 2012" column of the list of English and scientific names prepared by the British Ornithologist's Union (BOU, 2022).

Scientific names and taxonomy of birds and marine fauna are provided in Appendix 1 – Scientific Names and Taxonomy.

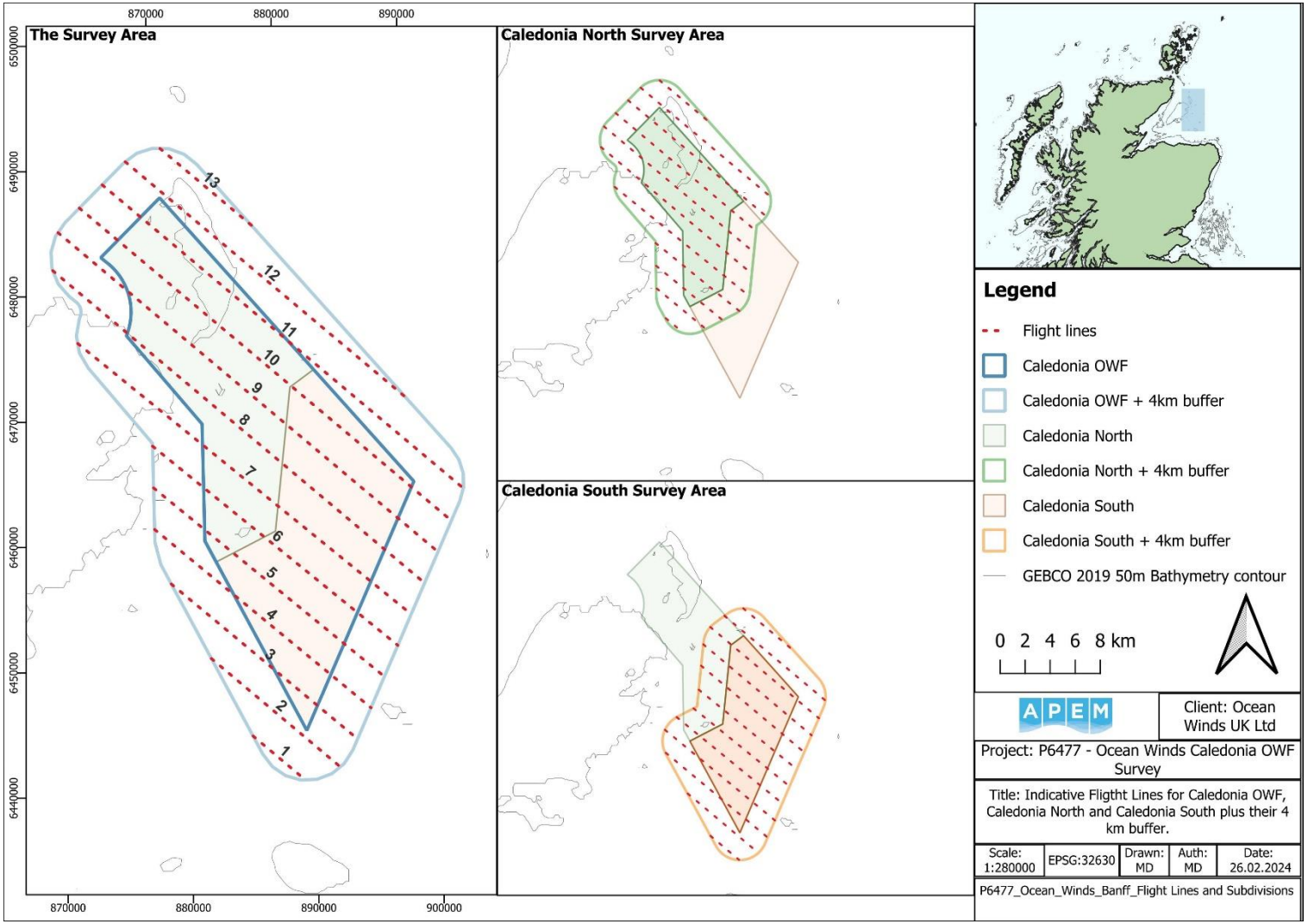


Figure 1 **Caledonia OWF, Caledonia North and Caledonia South plus their 4 km buffer with indicative flight lines**

3. Survey and analysis methodologies

3.1 Summary of digital aerial surveys

A programme of 24 digital aerial surveys took place on a monthly basis between May 2021 and April 2023 inclusive.

Surveys were conducted using APEM's bespoke camera system, termed "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 capture node is precisely defined, allowing the system to fire the camera exposures at exactly the right location. This ensures that each survey is flown with the same orientation and the camera is triggered at the same position within set tolerances. APEM's flight planning software enables tolerances along survey lines to be set, meaning the camera system would automatically abort data capture should the aircraft drift away from the planned flight line. APEM's on-board camera technician continually monitored the imagery as it was collected to ensure the data collected was fit for purpose. The 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.

The digital aerial surveys captured images at 1.5 cm ground sampling distance (GSD) along 13 transect lines spaced approximately 2.6 km apart within Survey Area (Figure 1).

Imagery was captured in raw format and post-processed to ensure optimal quality for the subsequent stage of image analysis, to extract information on marine fauna or other notable occurrences. When a survey was completed, data were checked to ensure the number of lines and the number of images collected was correct, and that the quality of the imagery was acceptable. Once the image analysis was completed, further QA processes took place (see Section 0).

No health or safety issues were reported during each of the surveys. The dates, number of flights needed to survey all transects (due to weather or technical issue), on task start and end times, are provided for each digital aerial survey in Table 2 with the corresponding weather conditions provided in Table 3.

Table 2 Survey date, flight number and start / end time (Coordinated Universal Time) of each survey flight during May 2021 to April 2023 survey period

Survey No.	Date	Flight Number	UTC Start Time (HH:MM)	UTC End Time (HH:MM)
1[1]	15-May-21	1	11:55	14:00
2[1]	10-Jun-21	1	15:56	18:11
3[1]	2-Jul-21	1	09:21	11:18
4[1]	1-Aug-21	1	17:41	19:48
5[1]	14-Sep-21[2]	1	09:43	11:50
6[1]	4-Oct-21	1	08:50	10:52
7	15-Nov-21	1	10:34	12:38
8	6-Dec-21	2[3]	13:04	14:21
9	9-Jan-22	1	10:22	12:19
10	13-Feb-22	1	11:16	13:18
11	2-Mar-22	1	09:34	11:36
12[1]	26-Apr-22	1	09:36	12:37
13[1]	14-May-22	1	10:41	12:40
14[1]	4-June-22	1	14:02	16:17
15[1]	5-July-22	1	15:57	18:05
16[1]	10-August-22	1	08:46	11:58
17[1]	11-Sep-22	1	09:01	11:02

Survey No.	Date	Flight Number	UTC Start Time (HH:MM)	UTC End Time (HH:MM)
18[1]	14-Oct-22	1	09:22	11:22
19	25-Nov-22	1	09:37	11:35
20	17-Dec-22	1	10:37	12:42
21	9-Jan-23[4]	2	09:40	11:54
22	13-Feb-23	1	11:49	14:30
23	10-Mar-23	1	14:41	16:50
24[1]	04-Apr-23	1	08:57	10:57

[1] UTC time is identical to GMT (i.e. surveys 7 to 11), but for surveys undertaken during BST (i.e. surveys 1 to 6, and 12), differs from UK time by -1 hour.

[2] Survey 13th of September 2021 aborted due to aircraft issue and re-flown on the 14th of September.

[3] Survey 6th of December 2021 was flown by two planes. The start time correspond to the time the first plane started recording and the end time correspond to the time the second plane finished recording.

[4] Survey 7th January 2023 aborted due to rain and re-flown on the 9thJanuary.

Table 3 Weather conditions recorded during each survey flight during the May 2021 to April 2023 survey period

Survey No.	Date	Douglas Sea State[1]	Turbidity[2]	Wind Speed (knots) / direction	Cloud Cover (%)[3]	Visibility (km)	Air Temp (°C)
1	15-May-21	1	1	3-13 / N-NNE	100	10+	5
2	10-Jun-21	2	0	21-29 / W	100	10+	18
3	2-Jul-21	1	1	5 / N	90	10+	10
4	1-Aug-21	2	0	15-18 / NNW	99	20+	8
5	14-Sep-21	3	2	5-10 / SSE	30-45	10+	12
6	4-Oct-21	2-3	1	14-22 / SW	20-30	10+	9
7	15-Nov-21	1	1	8-15 / W	20	10+	7-8
8	6-Dec-21	2	1-2	12-20 / S	100	30+	3
9	9-Jan-22	0	0	3-9 / S-W	5	30+	4
10	13-Feb-22	2	1	6-8 / W-SW	60-90	10+	5
11	2-Mar-22	2-4	1	24-29 / SE	10-40	10+	2-3
12	26-Apr-22	1	2	9-20 / NE-NNE	75	10+	4
13	14-May-22	2	2	18 / W	100	10+	9
14	4-June-22	2	2	6-10 / N	0	10+	13
15	5-July-22	3	3	3-7 / W- SE	35	20+	11
16	10-Aug-22	0.5 – 1.5	0.5 - 1	17 – 31 / SW	0-100	40+	18
17	11-Sep-22	2 - 3	0	13 – 18 / S	20 - 60	10+	13
18	14-Oct-22	3	2	18 / W - SW	10	10+	8
19	25-Nov-22	3	2	23 – 34 / S	10 - 80	20 - 30	7 - 8
20	17-Dec-22	3	2	22 – 29 / SW - W	80 - 95	20	3
21	9-Jan-23	1	1	19 / W	20	10+	5
22	13-Feb-23	1	1	7 – 13 / S - W	10	10+	6 - 7
23	10-Mar-23	1 - 2	0	5 – 26 / SW -W	50 - 70	10+	0
24	4-Apr-23	1 - 2	0	15 -17 / SW	80 -100	10+	6 -7

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

[2] 0 = Clear, 1 = Slightly Turbid, 2 = Moderately Turbid, 3 = Highly Turbid

[3] 0 = Clear, 1-10 = Few, 11-50 = Scattered, 51-95 = Broken, 96-100 = Overcast

Weather conditions during all surveys were conducive to collecting and analysing imagery for the purpose of providing data on the identification, distribution and abundance of bird species and marine fauna within the Survey Area. Favourable conditions for surveying are defined as a cloud base of at least 1,300 ft, visibility of >5 km, wind speed of <30 knots, and sea state of 4 (moderate) or less. For safety reasons, no surveying took place in icing conditions.

Measures were taken to minimise glint and glare, such as avoiding surveying when the sun angle has the greatest potential to impact image quality. Furthermore, additional imagery was collected through the survey, providing an alternative set of images for analysis to ensure that sufficient coverage is achieved in the case that imagery was affected strongly by glint or glare. The number of image nodes clipped to the Survey Area, coverage collected per survey within the Survey Area, and the analysed coverage per Site and Site plus 4 km buffer are presented in Table 4.

Table 4 Number of images and survey coverage collected for each monthly survey across the Survey Area, and analysed coverage per region during the May 2021 to April 2023 survey period

Survey No.	No. image nodes	Survey coverage (%)	Coverage analysed (%)					
			Caledonia OWF	Survey Area	Caledonia North	Caledonia North Survey Area	Caledonia South	Caledonia South Survey Area
1	2385	25.49	17.14	17.39	17.15	17.07	17.16	17.22
2	2384	25.48	17.02	17.23	16.92	16.89	17.18	17.19
3	2323	24.85	16.94	17.25	16.89	16.50	17.04	16.64
4	2383	25.47	17.26	17.51	17.26	17.21	17.31	17.37
5	2384	25.48	17.22	17.40	17.26	17.11	17.23	17.21
6	2481	26.52	17.08	17.34	17.14	17.10	17.06	17.21
7	2383	25.47	17.20	17.47	17.11	17.11	17.35	17.38
8	2383	25.47	17.22	17.45	17.26	17.16	17.22	17.28
9	2385	25.49	17.27	17.49	17.29	17.26	17.29	17.34
10	2372	25.35	18.50	18.64	18.57	18.16	18.46	18.41
11	2384	25.48	18.67	18.82	18.78	18.50	18.62	18.60
12	2384	25.43	17.36	17.62	17.41	17.36	17.35	17.43
13	2387	25.51	17.25	17.47	17.23	17.19	17.30	17.39
14	2385	25.49	17.39	17.44	17.56	17.29	17.25	17.25
15	2387	25.51	17.08	17.35	17.08	17.07	17.13	17.26
16	2382	25.43	17.33	17.47	17.34	17.45	17.37	17.43
17	2383	25.44	17.27	17.31	17.43	17.16	17.14	17.12
18	2388	25.47	17.12	17.15	17.27	17.02	17.00	17.01
19	2385	25.52	16.99	17.24	16.96	16.94	17.06	17.08
20	2384	25.49	17.07	17.12	17.21	16.95	16.96	16.96
21	2382	25.48	17.16	17.19	17.28	16.95	17.08	17.08
22	2376	25.39	17.40	17.49	17.35	17.30	17.50	17.32
23	2386	25.50	17.13	17.26	17.06	17.01	17.24	17.15
24	2384	25.48	17.63	17.62	17.73	17.44	17.57	17.46

3.2 Species identification

There are occasions when it is not possible to identify an individual in the digital aerial survey image to the species level and the individual is identified as belonging to a higher-level group e.g. 'small gulls' or 'dolphin/porpoise'. The possible groups and the individual species that are included in the groups are listed in Table 5 for birds and Table 6 for marine mammals.

Table 5 Individual and group level of bird species included in 'unidentified' groups during the May 2021 to April 2023 survey period

Species Level 1	Group Level 2	Group Level 3	Group Level 4	Group Level 5
Great northern diver	Diver species	-	-	-
Red-throated diver				
Kittiwake	Small gulls		Gull species	Fulmar / Gull species
Common Gull				
Great Black-backed Gull	Black-backed gulls	Large gulls		
Lesser Black-backed Gull				
Herring Gull				
Fulmar	-		-	
Common tern	'Commic' tern		Tern species	-
Arctic tern				-
Guillemots	Guillemots / Razorbill	Auk species		Auk / Shearwater species
Razorbill				
Black guillemot				
Puffin				
Sooty shearwater	-	Large shearwater species	Shearwater species	
Manx shearwater	-			

Table 6 Individual and group level of marine mammal and shark species included in 'unidentified' groups during the May 2021 to April 2023 survey period

Species Level 1	Group Level 2	Group Level 3	Group Level 4
Grey seal	Seal species		Unidentified marine mammal Species
Common dolphin	Dolphin Species	Dolphin / porpoise species	
White-beaked dolphin			
Bottlenose dolphin			
Risso's dolphin			
Harbour porpoise	Porpoise species		
Common minke whale	Whale species		
Basking shark	Shark species		-

The images were analysed to enumerate birds and marine mammals to species level, where possible. Targets identified from the images were 'snagged' (i.e. located within the images) and categorised. Yearly identification rates of species specific to Caledonia OWF surveys are presented in Table 7 and monthly identification rates are presented in Appendix 2 – Species identification rates. Unidentified bird species have not been included in the ID rate calculations due to the low number observed during the survey period (n=32 in year 1; n=36 in year 2) and the broadness of the grouping. Identification rate of an individual to the species level, from May 2021 to April 2023, specific to the Caledonia OWF project, are presented hereafter (Table 7). The ID rates were calculated from the raw counts of species observation in the Survey Area. In year 1, great skua, great northern diver, fulmar, gannet, white-beaked dolphin, harbour porpoise and common minke whale were all positively identified to species level and do not form part of the higher-level groupings. In year 2, pink-footed goose, great skua, Arctic skua, red-throated diver, gannet and basking shark were all positively identified to species level and do not form part of the higher-level groupings.

The species identification table represents a simple calculation of the proportion of each species recorded in the survey dataset. This approach provides a comparison of species frequencies without accounting for potential bias related to species rarity. It is important to acknowledge that less common species may appear to have lower identification percentages simply because they were less frequently captured in the imagery. This does not necessarily reflect a true identification rate but rather their relative abundance within the sampled population.

Table 7 Yearly average of identification rate of species recorded to species level from a higher taxonomic grouping, within the Survey Area during the May 2021 to April 2023 survey period

Species common name	ID Species Level 1 (%) – Year 1: May 21 to April 22	ID Species Level 1 (%) – Year 2: May 22 to Apr 23
Pink-footed goose	-	100%
Mallard	100%	-
Kittiwake	99.8%	99.8%
Common gull	64.3%	36.4%
Great black-backed gull	92.1%	94.3%
Herring gull	61.9%	83.9%
Lesser black-backed gull	8.1%	50%
Common tern	37.5%	-
Arctic tern	64.3%	42.9%
Great skua	100%	100%
Arctic skua	-	100%
Guillemot	78.4%	90%
Razorbill	31.3%	53.8%
Black guillemot	0.1%	0.1%
Puffin	76.5%	81.1%
Great northern diver	100%	-
Red-throated diver	-	100%
Fulmar	100%	99.9%
Sooty shearwater	2.5%	-
Manx shearwater	32.8%	8.5%
Gannet	100%	100%
Grey seal	81.8%	66.7%
Common dolphin	-	88.6%
White-beaked dolphin	100%	80.8%
Bottlenose dolphin	-	28.6%
Risso's dolphin	-	58.3%
Harbour porpoise	100%	95.5%
Common minke whale	100%	66.7%
Basking shark	-	100%

3.3 Summary of quality assurance

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 and marine mammals found were subject to internal QA to ensure that species identification was correct. Images containing no birds and/or marine mammals 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 the one who initially analysed the imagery.

3.4 Species abundance estimates

For each monthly digital aerial survey of the Survey Area, geo-referenced locations of birds or marine mammals contained within each individual digital still image were used to generate raw counts. Individual locations contained within the Survey Area were then extracted using QGIS, providing raw count data. These data are presented in this final report for all species recorded during both years of baseline surveys.

The raw counts were 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).

Measures of precision were calculated using a Poisson precision for the abundance estimates. This produced a CV (Coefficient of Variation) based on the relationship of the standard error to the mean (Thomas *et al.*, 2010). A target precision of ≤ 0.16 allows the detection of a population change of a factor as small as 2 (Bohlin, 1990).

All analysis and data manipulation carried out by APEM was conducted in the R programming language (R Development Core Team, 2021) and non-parametric 95% confidence intervals were generated using the 'boot' library of function (Canty & Ripley, 2022). This results in species-specific monthly abundance estimates being calculated from the raw count data, with upper and lower 95% confidence limits (Lower and Upper Confidence Limits, [LCL; UCL]). Where appropriate, a level of precision is also presented for each monthly abundance estimate. Dividing the monthly abundance estimates by the size of the Survey Area calculates the density (e.g. birds per km^2) for any given species. Abundance and density estimates presented in this report were calculated from the total raw count of individuals per species, recorded on a given month, regardless of the recorded behaviour (with the exception of deceased individuals, which were removed from the analysis, though these records are reported in Section 0).

3.5 Attribution and apportionment of unidentified individuals

Although the majority of individuals recorded from the surveys are identified to species level, a number remained identified to group level only. The abundance estimates with confidence limits within this annual report include attribution of unidentified individuals into the monthly abundance estimates and densities to account for these unidentified individuals. This is based on an apportionment of the group level identified individuals between those species within that group that were identified to species level within each individual monthly abundance estimate.

The number of unidentified individuals in a group is proportioned to the specific species that are contained within that group, based on the relative abundance of the positively identified species in that month's survey. Following the same methodology, confidence limits were also apportioned. For example, in the case of kittiwakes, the count consists of:

Positively identified kittiwake + proportion of group level identified small gulls estimated to be kittiwakes calculated from positively identified small gull species.

For instance, if 10 'small gull species' are recorded in June, and 20 kittiwakes and 20 common gulls are also recorded in June, the apportioning calculation will estimate that birds identified in June as 'small gull species are likely to consist of five kittiwakes and five common gulls.

In the 24 months surveys for the Survey Area, the individuals identified to group level contained within the dataset were:

Seabirds

- Wader species
- Black-backed gull species
- Large gull species
- Gull species
- 'Commic' tern
- Tern species
- Guillemot / razorbill
- Auk species
- Fulmar / gull species
- Small shearwater species
- Shearwater species
- Auk / shearwater species
- Thrush species
- Passerine species
- Bird species

Marine megafauna

- Seal species
- Dolphin species
- Dolphin / porpoise species
- Marine mammal species
- Shark species

Where no species-specific identification for common tern and Arctic tern is possible (size and plumage features are so similar that it is often difficult to separate them), they remain in the data as 'commic' tern. As a wide-ranging group, unidentified bird species counts (<0.01 % of the total of birds recorded across the two years in the Survey Area, n=54; Table 8) do not undergo apportionment.

In a given month, instances may have occurred when there were individuals only identified to group level rather than positively identified to species level. In such cases, apportionment of species abundance was undertaken, whereby individuals identified to group level were divided and assigned to month across the data, following a hierarchical approach using:

1. Same month, same year, same area (site or buffer only)
2. Same month, same year, same Survey Area (Site and Buffer)
3. Same month, same year, same Survey Area, larger buffer (if available)
4. Same bio-season/season, same year, same area (site or buffer only)
5. Same bio-season, same year, same Survey Area (Site and Buffer)
6. Same bio-season, same year, same Survey Area, larger buffer (if available)
7. Same month, different year, same area (site or buffer only)
8. Same month, different year, same Survey Area (Site and Buffer)
9. Same month, different year, same Survey Area, larger buffer (if available)
10. Same bio-season/season, different year, same area (site or buffer only)
11. Same bio-season/season, different year, same Survey Area (Site and Buffer)
12. Same bio-season/season, different year, same Survey Area, larger buffer (if available).

Bar plot diagrams created for key species (kittiwake, great black-backed gull, herring gull, great skua, guillemot, razorbill, puffin, fulmar, gannet) were created using where relevant, unapportioned, apportioned or apportioned and availability bias-corrected abundance estimates in the R programming language (R Development Core Team, 2021). Breeding and non-breeding seasons were also highlighted on the diagrams as per NatureScot (2024).

3.6 Availability bias

Diving birds, such as guillemots and razorbills, spend time foraging beneath the water surface. As a result of this, an unknown number of birds may go undetected due to the snapshot nature of aerial survey techniques (i.e. they are underwater, and therefore unavailable to be counted by the survey aircraft as it passes overhead). To account for this 'availability bias', a correction factor must be applied. This factor is applied to birds recorded on the sea only; birds in flight are assumed to be 100% available for detection and are therefore not included in these calculations.

The correction factors applied to guillemots and razorbills were based on that recommended by JNCC in a submission during the examination phase of the East Anglia ONE OWF, referred to by JNCC as Method C (JNCC, 2013). This applies a correction factor, on the basis of aerial surveys recording 76% of sitting guillemots and 83% of sitting razorbills, which assumes 24% and 17% of these species, respectively, will be underwater when aerial imagery is captured. The correction factor for puffins assumes 14% to be underwater at any time (Spencer, 2012). Therefore, to correct for availability bias the 'unavailable' birds are added to the bird totals on a monthly basis to create revised population estimates. The 'corrected' abundance estimates for guillemots and razorbills are presented in the relevant sections later in this report.

For marine mammals, it is possible from aerial imagery to capture individuals at the sea surface as well as underneath. Correction factors are applied to account for the availability bias of individuals which may be beneath the water surface at the moment an image is captured. For harbour porpoise, the seasonal correction factors from Voet *et al.* (2017) were applied to the total monthly abundance estimates (submerged and surfacing). The correction factors consider the probability of harbour porpoise being within the upper 2 m of the water column and therefore assumed to be detected by the aerial surveys (Teilmann *et al.*, 2013).

The average time spent at the water surface is not as well studied for other marine mammal species as it is for harbour porpoise, although some information does exist (e.g. grey seal, harbour seal, white-beaked dolphin bottlenose dolphin and Atlantic white-sided dolphin; see Voet *et al.*, 2017). Therefore, only abundance estimates for harbour porpoise were corrected for availability bias.

The corrected data for all species for which availability bias corrections were carried out are presented in the relevant species accounts in Section 4.

Specific text of the Method C for guillemot and razorbills, and puffin and harbour porpoises' correction factors are presented in the Appendix 3 – Correction factors.

3.7 Species distribution maps

Each individual identified within the digital still imagery is geo-referenced, allowing those locations to be related to the boundaries of the Survey Area, Caledonia North Survey Area, and Caledonia South Survey Area. The spatial distribution of each species within the Survey Area has been illustrated on a map, with the results presented in the Appendix 4 – Distribution maps.

3.8 Species flight direction rose diagrams

The flight direction of birds was recorded from all digital still images. Bearings of bird directions were plotted using the R programming language (R Development Core Team, 2021) to summarise overall directions of movement. The mean angle and mean vector are used to describe directional preferences and extent of 'agreement'. Length of the mean describes how the headings are clustered around the mean value and is graphically represented by a red arrow, with a vector (r) ranging value between 0 and 1. Arrow direction corresponds to the mean heading and the arrow length is proportional to its value. A Rayleigh test (Z) that assumes a null hypothesis of uniformity (i.e. scattered orientation in all directions) was used, where a significant test indicates directionality of movement. A larger value of r leads to a larger Z value, which would show that data is less likely to be normally (and uniformly) distributed. The critical value of the Rayleigh test of uniformity (Z) is graphically represented by a red circle. If the uniform distribution hypothesis is rejected ($p<0.05$), it will be graphically represented by the red arrow extending beyond the red circle. If the uniform distribution hypothesis is not rejected ($p>0.05$), i.e. there is no significant direction, it will be graphically represented by the red arrow falling within the red circle.

For each species, rose diagrams, where bird flight direction was significative ($p<0.05$), were presented in this report while rose diagrams, where bird flight direction was non-significative, were presented in Appendix 5 – Rose diagrams.

4. Species accounts

Across the 24 monthly surveys from May 2021 to April 2023, a total of 40,623 birds and 352 marine mammals and other megafauna were recorded in the Survey Area (Table 8, Table 11).

A total of 17,035 birds and 181 marine mammals and other megafauna were recorded during both years of baseline surveys in Caledonia North Survey Area (Table 9, Table 12).

A total of 30,317 birds and 249 marine mammals and other megafauna were recorded during both years of baseline surveys in Caledonia South Survey Area (Table 10, Table 13).

It should be noted that due to the spatial overlap between Caledonia North Survey Area and Caledonia South Survey Area, the total observations in each of these areas is greater than the total number of records made within the Survey Area.

The following species accounts present the raw counts, design-based abundance estimates, density estimates and distribution data from the twenty-four monthly digital aerial surveys in Caledonia OWF, Caledonia North and Caledonia South and respective buffers.

Table 8 Summary of total raw counts of bird species recorded within the Survey Area during the May 2021 to April 2023 survey period

Bird Species	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sep 22	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	Mar 23	Apr 23	Grand total
Pink-footed goose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Mallard	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Wader species	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Kittiwake	195	358	1,083	294	158	85	143	27	8	29	42	100	677	813	920	144	50	32	17	8	5	33	16	129	5,366
Common gull	-	-	-	-	8	-	1	-	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-	13
Great black-backed gull	-	-	-	3	76	46	163	15	48	43	2	-	-	-	-	-	12	38	19	22	33	15	5	-	540
Herring gull	1	1	16	-	1	7	14	3	1	7	1	-	-	1	29	-	-	3	3	8	-	2	1	-	99
Lesser black-backed gull	-	-	3	-	-	-	-	-	-	-	-	-	1	2	6	-	-	-	-	-	-	-	-	-	12
Black-backed gull species	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Large gull species	-	-	2	-	4	5	16	-	1	-	1	-	-	-	12	-	-	1	1	-	-	-	-	1	44
Gull species	1	-	1	2	-	-	-	-	-	1	-	-	-	-	-	3	-	-	-	2	-	-	-	-	10
Common tern	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Arctic tern	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	15
'Commic' tern	3	-	-	2	-	-	-	-	-	-	-	-	6	-	-	8	-	-	-	-	-	-	-	-	19
Tern species	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Great skua	1	2	10	6	1	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	22
Arctic skua	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
Guillemot	1,944	1,047	2,687	115	808	266	421	18	88	145	130	448	3,127	2,299	2,595	157	2,038	116	15	81	147	448	503	494	20,137
Razorbill	178	160	296	61	80	10	-	6	8	59	13	148	406	35	198	60	514	8	16	17	20	66	84	99	2,542
Guillemot / Razorbill	172	401	77	401	174	78	33	208	35	212	55	50	313	48	226	38	232	83	30	17	6	36	44	27	2,996
Black guillemot	-	1	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	4
Puffin	102	84	107	562	25	39	-	-	-	-	2	194	204	25	38	137	495	4	-	-	5	7	14	10	2,054
Auk species	6	10	44	190	12	16	-	-	1	3	3	19	24	8	16	8	46	3	2	3	1	2	5	10	432
Great northern diver	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Red-throated diver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Fulmar	91	105	790	285	113	12	180	187	55	80	28	70	54	204	1,634	115	47	4	252	87	53	37	96	39	4,618
Fulmar / Gull species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	3
Sooty shearwater	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Manx shearwater	1	15	3	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	28
Small shearwater species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	2
Shearwater species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Auk / shearwater species	10	14	13	-	-	-	-	-	-	-	-	2	9	5	-	1	74	-	-	-	-	-	4	1	133
Gannet	14	114	33	71	99	125	16	4	2	5	1	12	22	267	110	12	105	47	2	5	3	8	1	15	1,093
Thrush species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	289	-	-	-	-	-	-	289
Passerine species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78	-	-	-	-	-	-	78
Bird species	8	3	2	3	2	1	-	6	5	1	1	-	3	4	9	1	1	2	1	1	-	-	-	-	54
Grand Total	**2,737**	**2,316**	**5,170**	**1,998**	**1,562**	**690**	**990**	**474**	**252**	**587**	**279**	**1,044**	**4,855**	**3,714**	**5,795**	**695**	**3,616**	**709**	**360**	**253**	**274**	**654**	**774**	**825**	**40,623**

Table 9 Summary of total raw counts of bird species recorded within Caledonia North Survey Area during the May 2021 to April 2023 survey period

Bird Species	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sep 22	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	Mar 23	Apr 23	Grand total
Pink-footed goose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Mallard	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Wader species	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Kittiwake	81	81	513	75	15	52	138	18	7	21	35	35	532	300	317	73	22	4	13	5	4	15	8	9	2,373
Common gull	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-	7
Great black-backed gull	-	-	-	3	76	46	84	9	37	23	2	-	-	-	-	-	10	22	12	16	22	11	3	-	376
Herring gull	1	-	16	-	1	7	9	2	-	1	1	-	-	1	12	-	-	1	1	5	-	-	1	-	59
Lesser black-backed gull	-	-	3	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	6
Black-backed gull species	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Large gull species	-	-	2	-	4	5	7	-	1	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	21
Gull species	-	-	1	2	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	6
Common tern	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Arctic tern	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
'Commic' tern	-	-	-	2	-	-	-	-	-	-	-	-	6	-	-	1	-	-	-	-	-	-	-	-	9
Tern species	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Great skua	1	2	5	6	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	16
Arctic skua	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Guillemot	560	385	993	38	112	64	180	9	41	46	45	170	2,284	1,127	702	28	101	25	4	44	62	201	316	124	7,661
Razorbill	99	47	112	44	24	2	-	2	1	37	9	82	314	22	77	30	371	8	9	9	12	17	53	14	1,395
Guillemot / Razorbill	68	74	31	44	66	26	19	85	19	112	28	16	217	32	63	24	91	49	22	12	4	23	29	9	1,163
Black guillemot	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2
Puffin	59	38	46	418	14	16	-	-	-	-	-	104	105	11	18	29	302	4	-	-	5	4	8	4	1,185
Auk species	3	3	18	21	7	10	-	-	1	3	1	9	16	2	6	1	30	3	-	3	1	1	4	8	151
Great northern diver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Red-throated diver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Fulmar	62	53	215	179	54	1	45	87	37	37	22	24	30	130	405	62	19	-	167	60	26	21	55	27	1,818
Fulmar / Gull species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	2
Sooty shearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Manx shearwater	-	1	1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	5
Small shearwater species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Shearwater species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Auk / shearwater species	6	1	7	-	-	-	-	-	-	-	-	2	6	4	-	-	1	1	-	-	-	-	2	-	30
Gannet	8	51	9	26	60	89	6	2	-	-	-	4	7	74	25	7	46	10	-	3	1	6	-	1	435
Thrush species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	214	-	-	-	-	-	-	214
Passerine species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57	-	-	-	-	-	-	57
Bird species	-	2	1	2	2	-	-	3	2	1	1	-	3	2	6	1	1	1	1	1	-	-	-	-	30
Grand Total	**951**	**739**	**1,976**	**863**	**437**	**318**	**490**	**217**	**146**	**282**	**145**	**446**	**3,524**	**1,709**	**1,633**	**260**	**994**	**401**	**230**	**161**	**138**	**299**	**480**	**196**	**17,035**

Table 10 Summary of total raw counts of bird species recorded within Caledonia South Survey Area during the May 2021 to April 2023 survey period

Bird Species	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sep 22	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	Mar 23	Apr 23	Grand total
Pink-footed goose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Mallard	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**
Wader species	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	**1**
Kittiwake	139	312	857	247	148	46	61	17	4	11	15	80	236	680	861	92	35	31	13	5	2	21	13	123	**4,049**
Common gull	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-	**9**
Great black-backed gull	-	-	-	-	14	1	96	7	26	30	1	-	-	-	-	-	4	24	14	11	18	9	3	-	**258**
Herring gull	-	1	-	-	-	-	8	2	1	7	-	-	-	-	28	-	-	2	3	6	-	2	-	-	**60**
Lesser black-backed gull	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	**6**
Black-backed gull species	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Large gull species	-	-	1	-	-	1	14	-	-	-	1	-	-	-	12	-	-	-	1	-	-	-	-	1	**31**
Gull species	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	**4**
Common tern	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3**
Arctic tern	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**6**	-	-	-	-	-	-	-	-	**12**
'Commic' tern	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-	7	-	-	-	-	-	-	-	-	**14**
Tern species	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Great skua	-	2	5	2	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	**11**
Arctic skua	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	**2**
Guillemot	1,602	825	2,175	93	758	240	329	14	67	117	113	375	1,508	1,563	2,278	140	1,982	96	12	53	114	331	357	437	**15,579**
Razorbill	99	131	244	26	67	10	-	5	7	27	6	100	185	21	158	47	243	1	13	10	14	54	57	92	**1,617**
Guillemot / Razorbill	125	354	59	376	136	71	27	150	25	121	38	45	151	34	183	20	170	57	26	11	4	28	29	21	**2,261**
Black guillemot	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	**3**
Puffin	61	76	88	309	21	31	-	-	-	-	2	116	149	18	29	126	283	1	-	-	-	4	9	6	**1,329**
Auk species	3	8	37	183	7	12	-	-	-	-	2	13	10	7	13	7	29	2	2	1	-	1	3	4	**344**
Great northern diver	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**
Red-throated diver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	**1**
Fulmar	46	75	673	178	96	11	136	125	31	56	10	56	31	109	1,441	76	38	4	140	52	36	22	54	15	**3,511**
Fulmar / Gull species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	**2**
Sooty shearwater	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Manx shearwater	1	15	2	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	**26**
Small shearwater species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	**2**
Shearwater species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	**1**
Auk / shearwater species	5	14	10	-	-	-	-	-	-	-	-	-	3	4	-	-	73	-	-	-	-	-	2	1	**112**
Gannet	8	79	28	57	47	82	14	2	2	5	1	10	16	222	69	9	86	42	2	3	3	**3**	1	16	**807**
Thrush species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	188	-	-	-	-	-	-	**188**
Passerine species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37	-	-	-	-	-	-	**37**
Bird species	8	2	2	1	-	1	-	3	3	-	-	-	1	3	5	-	-	1	-	-	-	-	-	-	**30**
Grand Total	**2,108**	**1,896**	**4,181**	**1,478**	**1,302**	**506**	**687**	**325**	**166**	**376**	**189**	**796**	**2,300**	**2,663**	**5,084**	**536**	**2,945**	**487**	**227**	**154**	**191**	**475**	**529**	**716**	**30,317**

Table 11 Summary of total raw counts of marine mammal and shark species recorded within the Survey Area during the May 2021 to April 2023 survey period

Marine mammal and other megafauna Species	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sep 22	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	Mar 23	Apr 23	Grand total
Grey seal	-	1	-	-	3	2	2	-	1	-	-	-	-	2	-	2	1	4	1	1	2	2	2	-	26
Seal species	1	2	2	-	-	-	-	-	-	1	1	-	-	1	-	-	-	-	1	2	-	1	1	-	13
Common dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	-	-	-	-	-	-	39
White-beaked dolphin	-	-	-	-	2	2	8	7	3	8	-	-	-	-	-	-	14	9	-	-	5	6	-	-	64
Bottlenose dolphin	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
Risso's dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	5	-	-	-	-	-	-	-	7
Dolphin species	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	--	-	3
Harbour porpoise	3	2	2	-	3	12	-	4	-	2	8	6	10	22	19	8	9	-	4	1	3	9	10	4	141
Dolphin / porpoise species	4	1	3	-	2	8	6	-	1	2	2	-	1	4	-	-	-	2	-	-	-	-	-	3	39
Common minke whale	-	-	6	-	-	-	-	-	-	-	-	-	1	2	3	-	-	-	-	-	-	-	-	-	12
Marine mammal species	-	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	-	-	-	4
Basking shark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Shark species	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Grand Total	**8**	**7**	**13**	**1**	**10**	**24**	**16**	**11**	**8**	**13**	**11**	**6**	**14**	**33**	**22**	**12**	**29**	**54**	**7**	**5**	**10**	**18**	**13**	**7**	**352**

Table 12 Summary of total raw counts of marine mammal and shark species recorded within Caledonia North Survey Area during the May 2021 to April 2023 survey period

Marine mammal and other megafauna Species	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sep 22	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	Mar 23	Apr 23	Grand total
Grey seal	-	-	-	-	2	1	1	-	1	-	-	-	-	2	-	2	1	4	1	1	2	1	1	-	20
Seal species	1	2	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-	8
Common dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
White-beaked dolphin	-	-	-	-	-	2	8	-	-	8	-	-	-	-	-	-	8	9	-	-	2	6	-	-	43
Bottlenose dolphin	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
Risso's dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	5
Dolphin species	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Harbour porpoise	1	2	-	-	3	11	-	1	-	2	4	5	2	9	14	3	6	-	3	-	2	-	4	3	75
Dolphin / porpoise species	1	-	2	-	2	8	4	-	-	2	1	-	-	1	-	-	-	-	-	-	-	-	-	1	22
Common minke whale	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Marine mammal species	-	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	3
Basking shark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Shark species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Grand Total	**3**	**5**	**6**	**1**	**7**	**22**	**13**	**1**	**1**	**13**	**5**	**5**	**4**	**14**	**14**	**5**	**20**	**13**	**4**	**2**	**6**	**7**	**6**	**4**	**181**

Table 13 Summary of total raw counts of marine mammal and shark species recorded within Caledonia South Survey Area during the May 2021 to April 2023 survey period

Marine mammal and other megafauna Species	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21	Jan 22	Feb 22	Mar 22	Apr 22	May 22	Jun 22	Jul 22	Aug 22	Sep 22	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	Mar 23	Apr 23	Grand total
Grey seal	-	1	-	-	1	1	2	-	-	-	-	-	-	1	-	2	1	1	1	-	-	2	1	-	**14**
Seal species	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	1	1	-	1	1	-	**7**
Common dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	-	-	-	-	-	-	**39**
White-beaked dolphin	-	-	-	-	2	-	8	7	3	8	-	-	-	-	-	-	6	-	-	-	3	-	-	-	**37**
Bottlenose dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0**
Risso's dolphin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	**2**
Dolphin species	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**3**
Harbour porpoise	3	1	2	-	1	10	-	4	-	-	5	3	9	14	14	7	5	-	2	1	2	9	8	2	**102**
Dolphin / porpoise species	3	1	1	-	1	8	3	-	1	2	2	-	1	3	-	-	-	2	-	-	-	-	-	2	**30**
Common minke whale	-	-	5	-	-	-	-	-	-	-	-	-	1	2	3	-	-	-	-	-	-	-	-	-	**11**
Marine mammal species	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	**2**
Basking shark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	**1**
Shark species	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1**
Grand Total	**6**	**4**	**9**	**0**	**5**	**19**	**13**	**11**	**7**	**10**	**8**	**3**	**11**	**22**	**17**	**11**	**12**	**42**	**5**	**3**	**5**	**12**	**10**	**4**	**249**

4.1 Pink-footed goose

i. Abundance and density estimates

A pink-footed goose was recorded in the Survey Area in January 2023, specifically in Caledonia North (Table 8, Table 14 to Table 15). Abundance and density estimates are therefore very low (Table 14 to Table 15).

Table 14 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of pink-footed geese in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Jan-23	1	6	1	17	1.00	0.01	6	1	17	0.01
b) Caledonia OWF plus 2 km buffer										
Jan-23	1	6	1	17	1.00	0.01	6	1	17	0.01
c) Survey Area										
Jan-23	1	6	1	18	1.00	0.01	6	1	18	0.01

Table 15 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of pink-footed geese in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
Jan-23	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia North plus 2 km buffer										
Jan-23	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia North Survey Area										
Jan-23	1	6	1	17	1.00	0.01	6	1	18	0.01

Table 16 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of pink-footed geese in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
None recorded										
b) Caledonia South plus 2 km buffer										
None recorded										
c) Caledonia South Survey Area										
None recorded										

ii. Distribution and behaviour

The single pink-footed goose was recorded in January 2023 within Caledonia OWF, specifically in the south of Caledonia North, near the subdivision line with Caledonia South (Appendix 4, Figure A4.1).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.1).

4.2 Mallard

i. Abundance and density estimates

Two mallards were recorded in the Survey Area in February 2022 (Table 8, Table 17 to Table 29), specifically in Caledonia South (Table 17, Table 29). Abundance and density estimates are therefore very low (Table 17 to Table 29).

Table 17 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of mallards in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total, unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Feb-22	2	11	2	32	0.71	0.03	11	2	32	0.03
b) Caledonia OWF plus 2 km buffer										
Feb-22	2	11	2	32	0.71	0.02	11	2	32	0.02
c) Survey Area										
Feb-22	2	11	2	33	0.71	0.01	11	2	33	0.01

Table 18 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of mallards in Caledonia North, Caledonia North plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
None recorded										
b) Caledonia North plus 2 km buffer										
None recorded										
c) Caledonia North Survey Area										
None recorded										

Table 19 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of mallards in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Feb-22	2	11	2	32	0.71	0.05	11	2	32	0.05
b) Caledonia South plus 2 km buffer										
Feb-22	2	11	2	32	0.71	0.03	11	2	32	0.03
c) Caledonia South Survey Area										
Feb-22	2	11	2	32	0.71	0.02	11	2	33	0.02

ii. Distribution and behaviour

Mallards were recorded in Caledonia South near the south border of the subdivision (Appendix 4, Figure A4.2).

As only two birds were recorded as flying, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.2).

4.3 Unidentified wader species

i. Abundance and density estimates

A single wader species was recorded in the Survey Area during the second year of the baseline surveys. The wader species was recorded in June 2022, in Caledonia North Survey Area and Caledonia South Survey Area (Table 20 to Table 22). Abundance and density estimates are therefore very low (Table 20 to Table 22).

Table 20 Raw counts, unapportioned abundance and density estimates (birds per km^2) of wader species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
None recorded						
b) Caledonia OWF plus 2 km buffer						
None recorded						
c) Survey Area						
Jun-22	1	6	1	17	1.00	0.01

Table 21 Raw counts, unapportioned abundance and density estimates (birds per km^2) of wader species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
None recorded						
b) Caledonia North plus 2 km buffer						
None recorded						
c) Caledonia North Survey Area						
Jun-22	1	6	1	17	1.00	0.01

Table 22 Raw counts, unapportioned abundance and density estimates (birds per km^2) of wader species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
None recorded						
b) Caledonia South plus 2 km buffer						
None recorded						
c) Caledonia South Survey Area						
Jun-22	1	6	1	17	1.00	0.01

ii. Distribution and behaviour

A single wader species was recorded in the southeast of Caledonia North Buffer Zone (Appendix 4, Figure A4.3).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.3).

4.4 Kittiwake

i. Abundance and density estimates

Caledonia OWF

A total of 5,366 kittiwakes were recorded in the Survey Area during both years of baseline surveys (Table 8). Kittiwakes were recorded in every survey (Table 8, Table 23). Kittiwakes were the most abundant during the breeding season (April to August), with a peak of abundance in June 2022 in Caledonia OWF and Caledonia OWF plus 2 km buffer, and in July 2021 in the Survey Area (Table 23, Figure 2):

- 502 individuals were recorded in Caledonia OWF in June 2022, resulting in an unapportioned mean abundance estimate of 2,885 [1,109; 4,925] and an apportioned mean abundance estimate of 2,885 [868; 5,781] individuals. Both equated to a mean density estimate of 6.75 birds/km^2.
- 723 individuals were recorded in Caledonia OWF plus 2 km buffer in June 2022, resulting in an unapportioned mean abundance estimate of 4,142 [1,908; 6,761] and an apportioned mean abundance estimate of 4,142 [1,358; 8,005] individuals. These equated to mean density estimates of 6.44 (unapportioned) and 6.43 (apportioned) birds/km^2.
- 1,083 individuals were recorded in the Survey Area in July 2021, resulting in an unapportioned mean abundance estimate of 6,539 [1,787; 12,788] and apportioned mean abundance estimate of 6,545 [1,613; 12,890] individuals. Both equated to a mean density estimate of 7.40 birds/km^2.

In both breeding seasons covered by the baseline surveys, apportioned mean kittiwake abundances across the Survey Area grew steadily throughout the first half of the breeding season, with peaks observed in June (2022) or July (2021). This is likely associated at least in part with breeding adult birds carrying out foraging trips from nearby breeding colonies. Mean apportioned abundances were considerably lower in August 2021 and 2022 than the preceding months. This would be expected since this is the time at which birds tend to leave the seas close to breeding colonies, in order to spend the non-breeding season in more oceanic areas.

Reductions in mean apportioned abundance in the nine breeding season surveys, outside the survey month with the peak mean apportioned abundance (July 2021), varied from 8% to 93%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period.

Kittiwake abundance was the lowest during the non-breeding season (September to March) with a wintering peak of abundance in November 2021 in Caledonia OWF, and September 2021 in Caledonia OWF plus 2 km buffer and the Survey Area (Table 23, Figure 2):

- 74 individuals were recorded in Caledonia OWF in November 2021, resulting in an unapportioned mean abundance estimate of 430 [197; 685] and an apportioned mean abundance estimate of 430 [198; 708] individuals. Both equated to a mean density estimate of 1.01 birds/km^2.
- 129 individuals were recorded in Caledonia OWF plus 2 km buffer in September 2021, resulting in an unapportioned mean abundance estimate of 741 [129; 1,969] and an apportioned mean abundance estimate of 741 [144; 1,998] individuals. Both equated to a mean density estimate of 1.15 birds/km^2.
- 158 individuals were recorded in the Survey Area in September 2021, resulting in an unapportioned mean abundance estimate of 925 [187; 2,341] and an apportioned mean

abundance estimate of 925 [219; 2,329] individuals. Both equated to a mean density estimate of 1.05 birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, the trends observed in apportioned mean kittiwake abundance were characterised by relatively consistent and low apportioned mean abundances of birds across all reporting regions in the Survey Area. Apportioned mean abundances were lowest in the winter months across both survey years, with peak mean apportioned abundances occurring in the autumn. Most of the 13 surveys in the non-breeding season other than the peak month reported considerably lower mean apportioned abundances of birds than the peak month. Reductions in mean apportioned abundance relative to the peak were between 10% to 98%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording apportioned mean kittiwake abundances considerably lower than the peak mean apportioned abundance.

The 95% confidence intervals calculated for the mean abundances were often relatively high even for surveys where CV values were low (e.g. July 2021 for the Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia OWF), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precision were calculated for most survey months (CV ≤ 0.16; Table 23). This was particularly the case for months during the breeding season (April to August), which is when the majority of records of this species were made (Table 23). Within Caledonia OWF, a single survey during the breeding season had a precision value of CV > 0.16 (April 2022; 0.17; Table 23). Outside the breeding season, CV values of 0.2 to 0.4 for Caledonia OWF were more common (Table 23). For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 23).

Table 23 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of kittiwakes in Caledonia OWF, Caledonia OWF plus 2 km buffer, and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of kittiwake raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
May-21	134	781	227	1,656	0.09	1.83	782	236	1,820	1.83
Jun-21	175	1,027	340	2,178	0.08	2.4	1,027	381	2,325	2.4
Jul-21	307	1,811	425	3,320	0.06	4.24	1,817	457	3,734	4.25
Aug-21	62	359	255	492	0.13	0.84	359	232	498	0.84
Sep-21	12	70	35	99	0.29	0.16	70	36	110	0.16
Oct-21	35	205	99	322	0.17	0.48	204	98	322	0.48
Nov-21	74	430	197	685	0.12	1.01	430	198	708	1.01
Dec-21	10	58	17	104	0.32	0.14	58	18	104	0.14
Jan-22	7	41	17	69	0.38	0.1	41	12	69	0.1
Feb-22	14	76	22	135	0.27	0.18	76	18	146	0.18
Mar-22	14	75	27	134	0.27	0.18	75	29	139	0.18
Apr-22	36	207	138	288	0.17	0.48	207	133	288	0.48
May-22	326	1,889	771	2,978	0.06	4.42	1,889	736	3,181	4.42
Jun-22	502	2,885	1,109	4,925	0.04	6.75	2,885	868	5,781	6.75

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Jul-22	202	1,182	351	2,515	0.07	2.77	1,182	379	2,615	2.76
Aug-22	76	438	265	611	0.11	1.03	443	249	637	1.04
Sep-22	24	139	69	226	0.20	0.33	139	51	278	0.33
Oct-22	9	53	18	105	0.33	0.12	53	15	99	0.12
Nov-22	10	59	10	129	0.32	0.14	59	10	136	0.14
Dec-22	2	12	2	35	0.71	0.03	14	2	40	0.03
Jan-23	2	12	2	23	0.71	0.03	12	2	29	0.03
Feb-23	14	80	17	166	0.27	0.19	81	14	178	0.19
Mar-23	4	23	6	41	0.50	0.05	24	4	55	0.06
Apr-23	114	646	114	1,695	0.09	1.51	646	114	1,718	1.51
b)	Caledonia OWF plus 2 km buffer									
May-21	161	925	373	1,787	0.08	1.44	931	381	1,941	1.45
Jun-21	269	1,560	644	2,912	0.06	2.42	1,560	654	2,981	2.42
Jul-21	657	3,806	741	7,965	0.04	5.91	3,811	802	8,185	5.92
Aug-21	159	907	502	1,558	0.08	1.41	907	497	1,552	1.41
Sep-21	129	741	129	1,969	0.09	1.15	741	144	1,998	1.15
Oct-21	60	346	236	455	0.13	0.54	345	231	479	0.54
Nov-21	101	578	309	881	0.10	0.9	578	265	876	0.9
Dec-21	21	120	69	172	0.22	0.19	121	64	183	0.19
Jan-22	7	40	11	69	0.38	0.06	40	17	74	0.06
Feb-22	22	118	59	188	0.21	0.18	120	45	211	0.19
Mar-22	20	106	48	180	0.22	0.16	106	45	180	0.16
Apr-22	86	488	176	1,010	0.11	0.76	488	204	1,015	0.76
May-22	607	3,472	1,830	5,143	0.04	5.4	3,472	1,636	5,681	5.39
Jun-22	723	4,142	1,908	6,761	0.04	6.44	4,142	1,358	8,005	6.43
Jul-22	332	1,912	829	3,553	0.05	2.97	1,912	818	3,714	2.97
Aug-22	108	618	366	904	0.10	0.96	623	386	909	0.97
Sep-22	39	225	144	312	0.16	0.35	225	93	398	0.35
Oct-22	24	140	52	239	0.20	0.22	140	52	250	0.22
Nov-22	15	87	15	185	0.26	0.14	87	17	198	0.14
Dec-22	4	23	4	58	0.50	0.04	27	4	74	0.04
Jan-23	3	17	3	35	0.58	0.03	17	3	35	0.03
Feb-23	19	109	34	211	0.23	0.17	109	28	217	0.17
Mar-23	11	64	29	104	0.30	0.1	65	18	113	0.1
Apr-23	122	692	122	1,752	0.09	1.08	691	131	1,786	1.07
c)	Survey Area									
May-21	195	1,140	532	1,993	0.07	1.29	1,146	535	2,216	1.3
Jun-21	358	2,106	759	4,148	0.05	2.38	2,106	831	4,101	2.38
Jul-21	1,083	6,539	1,787	12,788	0.03	7.4	6,545	1,613	12,890	7.4
Aug-21	294	1,706	743	2,889	0.06	1.93	1,718	767	3,116	1.94
Sep-21	158	925	187	2,341	0.08	1.05	925	219	2,329	1.05
Oct-21	85	498	334	679	0.11	0.56	498	317	696	0.56
Nov-21	143	832	501	1,199	0.08	0.94	832	449	1,258	0.94
Dec-21	27	157	87	227	0.19	0.18	158	84	233	0.18
Jan-22	8	46	17	81	0.35	0.05	46	17	81	0.05
Feb-22	29	159	82	236	0.19	0.18	161	76	258	0.18
Mar-22	42	227	113	340	0.15	0.26	227	114	351	0.26
Apr-22	100	577	254	1,113	0.10	0.65	577	288	1,130	0.65
May-22	677	3,931	1,980	5,922	0.04	4.45	3,931	1,754	6,521	4.45
Jun-22	813	4,705	2,193	7,819	0.04	5.32	4,705	1,667	8,611	5.32
Jul-22	920	5,377	1,625	10,269	0.03	6.08	5,377	1,882	10,257	6.08

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Aug-22	144	827	511	1,189	0.08	0.94	833	493	1,315	0.94
Sep-22	50	292	204	385	0.14	0.33	292	135	472	0.33
Oct-22	32	188	88	300	0.18	0.21	188	77	323	0.21
Nov-22	17	100	18	200	0.24	0.11	101	23	209	0.11
Dec-22	8	47	12	88	0.35	0.05	49	8	113	0.06
Jan-23	5	29	6	59	0.45	0.03	29	6	59	0.03
Feb-23	33	191	93	301	0.17	0.22	191	69	347	0.22
Mar-23	16	94	53	141	0.25	0.11	95	35	161	0.11
Apr-23	129	740	143	1,802	0.09	0.84	740	153	1,848	0.84

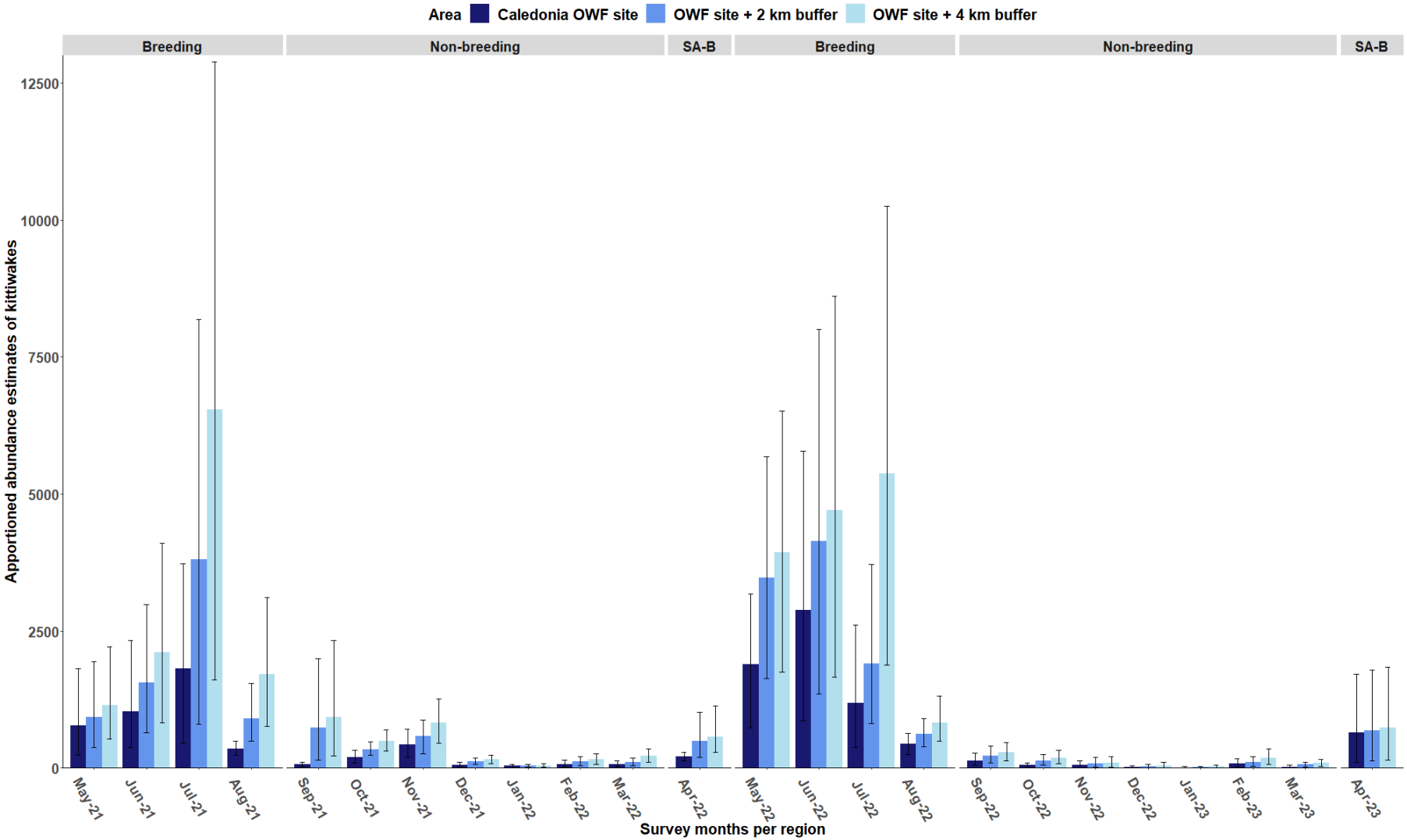


Figure 2 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total kittiwakes recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Kittiwake seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)

Caledonia North

A total of 2,373 kittiwakes were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Kittiwakes were recorded in every survey, except in December 2022 in Caledonia North (Table 24). Kittiwakes were the most abundant during kittiwake breeding season (April to August), with a peak of abundance in May 2022 (Table 24, Figure 3):

- 188 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 1,091 [337; 1,805] and an apportioned mean abundance estimate of 1,091 [383; 1,857] individuals. These equated to mean density estimates of 5.00 (unapportioned) and 4.99 (apportioned) birds/km^2.
- 465 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 2,648 [1,196; 4,134] and an apportioned mean abundance estimate of 2,648 [1,065; 4,584] individuals. These equated to mean density estimates of 7.06 (unapportioned) and 7.05 (apportioned) birds/km^2.
- 532 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 3,093 [1,372; 4,896] and an apportioned mean abundance estimate of 3,094 [1,245; 5,384] individuals. Both equated to a mean density estimate of 5.55birds/km^2.

Temporal patterns of kittiwake abundance in Caledonia North Survey Area varied considerably between the 2021 and 2022 breeding seasons. In 2021, low mean apportioned abundances of kittiwake occurred in every month with the exception of July, when an obvious peak occurred within Caledonia North Survey Area. Both Caledonia North and Caledonia North plus 2 km buffer recorded a lesser peak in the same month. In the 2022 breeding season, the peak mean apportioned abundance of kittiwake was recorded in May 2022 across all reporting regions, which was also the peak breeding season count for kittiwake in Caledonia North across the whole baseline survey programme. Mean apportioned kittiwake abundance reduced month by month thereafter. Both April and August surveys within the survey period recorded low mean apportioned abundances of kittiwake. The temporal variation within Caledonia North Survey Area during both breeding seasons is somewhat different to that recorded for both Caledonia South Survey Area, and the Survey Area as a whole.

Reductions in mean apportioned abundance in the eight breeding season surveys outside the peak survey month varied from 1% to 99%, with most surveys falling towards the upper extent of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording apportioned mean kittiwake abundances considerably lower than the peak mean apportioned abundance.

During both years of surveys, kittiwake abundance was the lowest during the non-breeding season (September to March) with a wintering peak of abundance in November 2021 (Table 24, Figure 3):

- 64 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 374 [216; 608] and an apportioned mean abundance estimate of 375 [205; 602] individuals. These equated to mean density estimates of 1.71 (unapportioned) and 1.72 (apportioned) birds/km^2.
- 96 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 548 [319; 804] and an apportioned mean abundance estimate of 548 [308; 850] individuals. Both equated to a mean density estimate of 1.46 birds/km^2.
- 138 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 806 [531; 1,133] and an apportioned mean abundance estimate of 806 [498; 1,180] individuals. Both equated to a mean density estimate of 1.45 birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, the trends observed in apportioned mean kittiwake abundance were characterised by relatively consistent and low apportioned mean abundances across all reporting regions within Caledonia North Survey Area. Apportioned mean abundances were lowest in the winter months across both survey years, with peak mean apportioned abundances occurring in the autumn. Most of the 13 surveys in the non-breeding season, other than the peak month (November 2021), reported considerably lower mean apportioned abundances of birds than the peak month. Reductions in mean apportioned abundance relative to the peak were between 62% to 98%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 24). This was particularly the case for months during the breeding season (April to August), which is when the majority of records were made (Table 24). Within Caledonia North, four out of ten surveys carried out during the breeding season had a precision value of CV ≤ 0.16, with a further three surveys reporting a precision value of ≤ 0.2 (Table 24). Outside the breeding season, CV values of 0.2 to 0.5 for Caledonia North were more common (Table 24). For Caldonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 24). The precision values for Caledonia North were generally higher than the equivalent values for Caledonia OWF, which is likely a product of a reduced number of records, coupled with lower transect numbers and lengths within these reporting regions relative to Caledonia OWF (Table 1, Table 23, Table 24). Despite this, confidence in the kittiwake abundance and density estimates for Caledonia North and Caledonia North plus buffers generated from the baseline survey data is still considered to be reasonably good, particularly for abundance and densities recorded during the breeding season (Table 24).

Table 24 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of kittiwakes in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of kittiwake raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
May-21	48	280	128	484	0.14	1.28	280	97	536	1.28
Jun-21	21	124	47	219	0.22	0.57	124	41	219	0.57
Jul-21	42	249	107	403	0.15	1.14	254	69	515	1.16
Aug-21	24	139	81	197	0.20	0.64	139	66	214	0.64
Sep-21	5	29	5	58	0.45	0.13	29	6	58	0.13
Oct-21	17	99	23	193	0.24	0.45	99	24	199	0.45
Nov-21	64	374	216	608	0.13	1.71	375	205	602	1.72
Dec-21	5	29	6	64	0.45	0.13	29	5	64	0.13
Jan-22	5	29	12	52	0.45	0.13	29	12	52	0.13
Feb-22	9	48	11	102	0.33	0.22	49	10	102	0.22
Mar-22	11	59	16	117	0.30	0.27	59	18	123	0.27
Apr-22	14	80	34	138	0.27	0.37	81	35	143	0.37
May-22	188	1,091	337	1,805	0.07	5.00	1,091	383	1,857	4.99
Jun-22	92	524	131	1,219	0.10	2.40	524	134	1,219	2.40
Jul-22	29	170	76	263	0.19	0.78	170	77	281	0.78
Aug-22	29	167	81	265	0.19	0.76	167	81	271	0.76

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Sep-22	10	57	11	138	0.32	0.26	57	11	138	0.26
Oct-22	2	12	2	23	0.71	0.05	12	2	34	0.05
Nov-22	6	35	6	83	0.41	0.16	36	8	82	0.16
Jan-23	1	6	1	17	1.00	0.03	6	1	17	0.03
Feb-23	8	46	8	115	0.35	0.21	46	8	115	0.21
Mar-23	2	12	2	29	0.71	0.05	12	2	36	0.05
Apr-23	7	39	11	73	0.38	0.18	39	11	73	0.18
b) Caledonia North plus 2 km buffer										
May-21	62	355	160	583	0.13	0.95	354	149	658	0.94
Jun-21	38	220	98	388	0.16	0.59	220	89	417	0.59
Jul-21	172	992	242	2,283	0.08	2.64	997	256	2,358	2.65
Aug-21	52	295	221	391	0.14	0.79	295	218	397	0.79
Sep-21	13	74	23	125	0.28	0.20	74	28	131	0.20
Oct-21	35	200	97	320	0.17	0.53	200	90	326	0.53
Nov-21	96	548	319	804	0.10	1.46	548	308	850	1.46
Dec-21	16	91	45	142	0.25	0.24	91	41	142	0.24
Jan-22	5	28	6	51	0.45	0.07	28	6	51	0.07
Feb-22	17	91	38	150	0.24	0.24	94	33	163	0.25
Mar-22	14	74	21	143	0.27	0.20	75	23	149	0.20
Apr-22	23	129	56	202	0.21	0.34	130	57	214	0.35
May-22	465	2,648	1,196	4,134	0.05	7.06	2,648	1,065	4,584	7.05
Jun-22	171	986	340	1,886	0.08	2.63	987	353	2,111	2.63
Jul-22	85	487	303	715	0.11	1.30	487	293	738	1.30
Aug-22	51	292	154	440	0.14	0.78	291	151	452	0.77
Sep-22	16	93	29	174	0.25	0.25	93	30	185	0.25
Oct-22	3	18	6	35	0.58	0.05	18	3	47	0.05
Nov-22	11	63	11	138	0.30	0.17	63	11	150	0.17
Dec-22	2	12	2	35	0.71	0.03	14	2	41	0.04
Jan-23	2	12	2	23	0.71	0.03	12	2	29	0.03
Feb-23	10	57	11	131	0.32	0.15	57	10	143	0.15
Mar-23	6	35	12	58	0.41	0.09	34	9	70	0.09
Apr-23	9	51	17	86	0.33	0.14	51	17	86	0.14
c) Caledonia North Survey Area										
May-21	81	474	269	743	0.11	0.85	474	241	767	0.85
Jun-21	81	479	195	810	0.11	0.86	479	186	810	0.86
Jul-21	513	3,107	563	6,504	0.04	5.58	3,113	849	6,182	5.58
Aug-21	75	435	325	569	0.12	0.78	447	298	615	0.80
Sep-21	15	88	35	146	0.26	0.16	88	36	158	0.16
Oct-21	52	304	129	508	0.14	0.55	304	134	502	0.55
Nov-21	138	806	531	1,133	0.09	1.45	806	498	1,180	1.45
Dec-21	18	105	47	169	0.24	0.19	105	48	168	0.19
Jan-22	7	41	12	69	0.38	0.07	41	12	69	0.07
Feb-22	21	116	61	176	0.22	0.21	119	56	206	0.21
Mar-22	35	189	86	302	0.17	0.34	189	81	318	0.34
Apr-22	35	201	115	282	0.17	0.36	202	122	288	0.36
May-22	532	3,093	1,372	4,896	0.04	5.55	3,094	1,245	5,384	5.55
Jun-22	300	1,734	901	2,658	0.06	3.11	1,733	735	3,028	3.11
Jul-22	317	1,855	562	4,173	0.06	3.33	1,855	618	4,191	3.33
Aug-22	73	418	235	618	0.12	0.75	418	204	687	0.75
Sep-22	22	128	52	215	0.21	0.23	128	37	233	0.23
Oct-22	4	23	6	41	0.50	0.04	24	4	53	0.04

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Nov-22	13	77	13	177	0.28	0.14	77	13	178	0.14
Dec-22	5	29	5	71	0.45	0.05	31	5	86	0.06
Jan-23	4	24	4	47	0.50	0.04	24	4	47	0.04
Feb-23	15	87	29	162	0.26	0.16	87	27	174	0.16
Mar-23	8	47	18	88	0.35	0.08	48	9	97	0.09
Apr-23	9	52	17	92	0.33	0.09	52	17	92	0.09

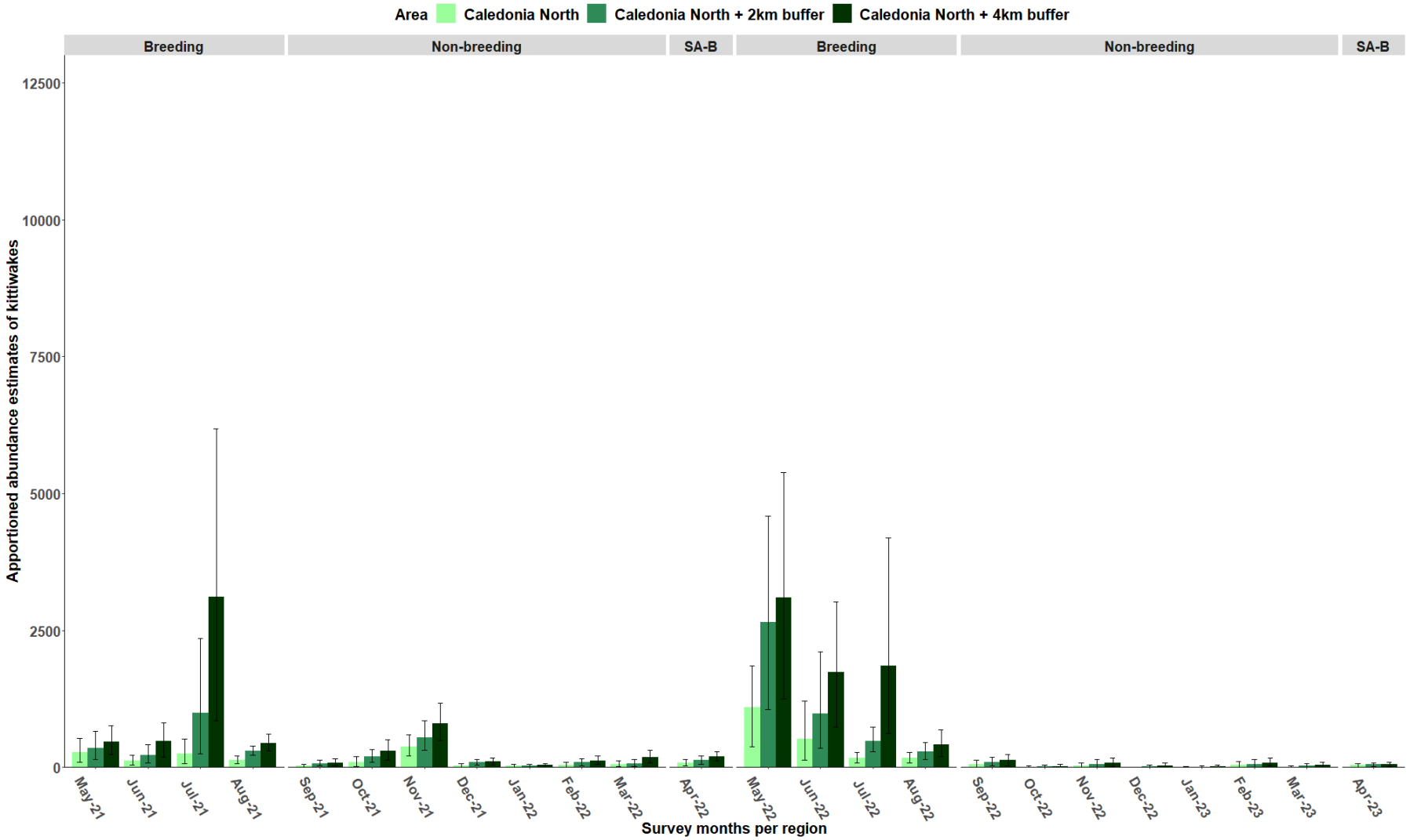


Figure 3 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total kittiwakes recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Kittiwake seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)

Caledonia South

A total of 4,049 kittiwakes were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Kittiwakes were recorded in every survey (Table 25). Kittiwakes were the most abundant during kittiwake breeding season, with a peak of abundance in June 2022 in Caledonia South and Caledonia South plus 2 km buffer, and in July 2022 in Caledonia South Survey Area (Table 25, Figure 4):

- 410 individuals were recorded in Caledonia South in June 2022, resulting in an unapportioned mean abundance estimate of 2,375 [1,071; 4,089] and an apportioned mean abundance estimate of 2,375 [718; 4,732] individuals. Both equated to a mean density estimate of 11.29 birds/km^2.
- 615 individuals were recorded in Caledonia South plus 2 km buffer in June 2022, resulting in an unapportioned mean abundance estimate of 3,491 [1,686; 5,484] and an apportioned mean abundance estimate of 3,492 [1,113; 6,359] individuals. Both equated to a mean density estimate of 9.71 birds/km^2.
- 861 individuals were recorded in Caledonia South Survey Area in July 2022, resulting in an unapportioned mean abundance estimate of 4,985 [1,233; 9,628] and an apportioned mean abundance estimate of 4,985 [1,439; 9,755] individuals. These equated to mean density estimates of 9.35 (unapportioned) and 9.34 (apportioned) birds/km^2. However, in July 2021, the unapportioned and apportioned mean abundance estimates were higher with 5,146 [1,358-1,489; 9,542-10,148] individuals, which equated to mean density estimates of 9.65 (unapportioned) and 9.64 (apportioned) birds/km^2.

In both breeding seasons covered by the baseline surveys, apportioned mean kittiwake abundances across Caledonia South Survey Area grew steadily throughout the first half of the breeding season, with peaks observed in June or July depending on the reporting region and year in question. This is likely associated, at least in part, with breeding adult birds carrying out foraging trips from nearby breeding colonies. Mean apportioned abundances were considerably lower in August 2021 and 2022 than the preceding months. This would be expected since this is the time at which birds tend to leave the seas close to breeding colonies, in order to spend the non-breeding season in more oceanic areas.

Reductions in mean apportioned abundance in the breeding season surveys outside the peak survey month varied from 0% to 95%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period.

During both years of surveys, kittiwake abundance was the lowest during the non-breeding season (September to March) with a wintering peak of abundance in October 2021 in Caledonia South and in September 2021 in Caledonia South plus buffers (Table 25; Figure 4):

- 18 individuals were recorded in Caledonia South in October 2021, resulting in an unapportioned mean abundance estimate of 105 [47; 187] and an apportioned mean abundance estimate of 106 [38; 199] individuals. Both equated to a mean density estimate of 0.50 birds/km^2.
- 122 individuals were recorded in Caledonia South plus 2 km buffer in September 2021, resulting in an unapportioned mean abundance estimate of 705 [122; 2,000] and an apportioned mean abundance estimate of 705 [122; 1,994] individuals. Both equated to a mean density estimate of 1.96 birds/km^2.
- 148 individuals were recorded Caledonia South Survey Area in September 2021, resulting in an unapportioned mean abundance estimate of 859 [148; 2,247] and an apportioned mean abundance estimate of 860 [170; 2,276] individuals. Both equated to a mean density estimate of 1.61 birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, the trends observed in apportioned mean kittiwake abundance were characterised by relatively consistent and low apportioned mean abundances across all reporting regions within Caledonia South Survey Area. Apportioned mean abundances were lowest in the winter months across both survey years, with peak mean apportioned abundances occurring in the autumn. Most of the 13 surveys in the non-breeding season other than the peak month reported considerably lower mean apportioned abundances of birds than the peak month. Reductions in mean apportioned abundance relative to the peak were between 24% to 99%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were quite variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording apportioned mean kittiwake abundances considerably lower than the peak mean apportioned abundance.

The 95% confidence intervals calculated for the mean abundances were often relatively high even for surveys where CV values were low (e.g. July 2021 and July 2022 for Caledonia South Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia South), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 25). This was particularly the case for months during the breeding season (April to August), which is when the majority of records were made (Table 25). Within Caledonia South, nine out of ten surveys carried out during the breeding season had a precision value of CV ≤ 0.16 (Table 25). Outside the breeding season, CV values of 0.2 to 0.5 for Caledonia South were more common, with small numbers of outliers (Table 25). For Caledonia South plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 25). The precision values for Caledonia South were generally higher (indicating lower precision) than the equivalent values for Caledonia OWF, which is likely a product of a reduced number of records, coupled with lower transect numbers and lengths within these reporting regions relative to Caledonia OWF (Table 1, Table 23, Table 25).

Table 25 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of kittiwakes in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of kittiwake raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
May-21	86	501	86	1,362	0.11	2.38	501	116	1,356	2.38
Jun-21	154	896	268	2,018	0.08	4.26	896	308	2,105	4.26
Jul-21	281	1,648	281	3,630	0.06	7.84	1,648	337	3,671	7.83
Aug-21	38	219	104	352	0.16	1.04	220	94	393	1.05
Sep-21	7	41	17	64	0.38	0.19	41	18	75	0.19
Oct-21	18	105	47	187	0.24	0.50	106	38	199	0.50
Nov-21	10	58	17	115	0.32	0.28	58	10	139	0.28
Dec-21	5	29	6	52	0.45	0.14	29	7	63	0.14
Jan-22	2	12	2	29	0.71	0.06	12	2	29	0.06
Feb-22	6	32	11	54	0.41	0.15	32	8	64	0.15
Mar-22	3	16	3	32	0.58	0.08	16	5	32	0.08

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Apr-22	22	127	86	167	0.21	0.60	127	86	167	0.60
May-22	138	797	138	1,900	0.09	3.79	797	179	1,900	3.79
Jun-22	410	2,375	1,071	4,089	0.05	11.29	2,375	718	4,732	11.29
Jul-22	173	1,009	239	2,438	0.08	4.80	1,009	272	2,391	4.79
Aug-22	47	270	132	426	0.15	1.28	275	128	435	1.31
Sep-22	14	82	41	122	0.27	0.39	81	22	169	0.38
Oct-22	7	41	7	88	0.38	0.19	41	14	88	0.19
Nov-22	4	23	4	70	0.50	0.11	24	4	71	0.12
Dec-22	2	12	2	35	0.71	0.06	14	2	42	0.07
Jan-23	1	6	1	18	1.00	0.03	6	1	18	0.03
Feb-23	6	34	17	57	0.41	0.16	34	8	63	0.16
Mar-23	2	12	2	23	0.71	0.06	12	2	29	0.06
Apr-23	107	609	107	1,678	0.10	2.90	608	107	1,683	2.89
b)	Caledonia South plus 2 km buffer									
May-21	111	641	150	1,520	0.09	1.78	648	195	1,589	1.80
Jun-21	239	1,386	476	2,743	0.06	3.86	1,386	514	2,859	3.85
Jul-21	598	3,479	599	7,529	0.04	9.68	3,480	676	7,488	9.67
Aug-21	121	694	264	1,370	0.09	1.93	694	235	1,359	1.93
Sep-21	122	705	122	2,000	0.09	1.96	705	122	1,994	1.96
Oct-21	28	162	93	249	0.19	0.45	162	90	272	0.45
Nov-21	31	177	74	298	0.18	0.49	177	77	304	0.49
Dec-21	10	58	17	109	0.32	0.16	58	13	121	0.16
Jan-22	2	11	2	29	0.71	0.03	11	2	29	0.03
Feb-22	6	32	11	53	0.41	0.09	32	8	64	0.09
Mar-22	8	42	21	69	0.35	0.12	42	17	79	0.12
Apr-22	72	412	120	921	0.12	1.15	412	154	933	1.15
May-22	202	1,159	258	2,358	0.07	3.22	1,159	303	2,444	3.22
Jun-22	615	3,491	1,686	5,484	0.04	9.71	3,492	1,113	6,359	9.71
Jul-22	285	1,649	602	3,252	0.06	4.59	1,649	583	3,402	4.58
Aug-22	71	406	223	600	0.12	1.13	411	222	638	1.14
Sep-22	26	149	80	217	0.20	0.41	149	45	292	0.41
Oct-22	24	138	58	242	0.20	0.38	138	50	254	0.38
Nov-22	9	52	9	122	0.33	0.14	52	9	125	0.15
Dec-22	4	23	4	58	0.50	0.06	25	6	68	0.07
Jan-23	1	6	1	17	1.00	0.02	6	1	17	0.02
Feb-23	10	57	29	91	0.32	0.16	57	20	97	0.16
Mar-23	7	40	7	81	0.38	0.11	41	10	83	0.11
Apr-23	115	644	115	1,697	0.09	1.79	644	115	1,703	1.79
c)	Caledonia South Survey Area									
May-21	139	806	249	1,706	0.08	1.51	812	273	1,838	1.52
Jun-21	312	1,813	570	3,807	0.06	3.40	1,814	635	3,743	3.40
Jul-21	857	5,146	1,489	9,542	0.03	9.65	5,146	1,358	10,148	9.64
Aug-21	247	1,421	454	2,703	0.06	2.66	1,427	462	2,858	2.67
Sep-21	148	859	148	2,247	0.08	1.61	860	170	2,276	1.61
Oct-21	46	267	180	366	0.15	0.50	267	168	371	0.50
Nov-21	61	351	178	512	0.13	0.66	351	166	529	0.66
Dec-21	17	98	40	168	0.24	0.18	99	37	174	0.19
Jan-22	4	23	6	40	0.50	0.04	23	6	40	0.04
Feb-22	11	60	22	109	0.30	0.11	60	16	114	0.11
Mar-22	15	81	43	113	0.26	0.15	81	34	134	0.15
Apr-22	80	459	155	997	0.11	0.86	458	189	992	0.86

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
May-22	236	1,356	385	2,857	0.07	2.54	1,356	396	2,805	2.54
Jun-22	680	3,938	1,946	6,382	0.04	7.38	3,938	1,489	7,384	7.38
Jul-22	**861**	**4,985**	**1,233**	**9,628**	**0.03**	**9.35**	**4,985**	**1,439**	**9,755**	**9.34**
Aug-22	92	527	287	797	0.10	0.99	533	288	824	1.00
Sep-22	35	204	128	280	0.17	0.38	204	82	362	0.38
Oct-22	31	182	88	294	0.18	0.34	182	81	323	0.34
Nov-22	13	76	13	170	0.28	0.14	76	13	165	0.14
Dec-22	5	29	5	65	0.45	0.05	32	5	76	0.06
Jan-23	2	12	2	29	0.71	0.02	12	2	29	0.02
Feb-23	21	121	58	196	0.22	0.23	121	41	231	0.23
Mar-23	13	76	35	122	0.28	0.14	77	23	132	0.14
Apr-23	123	704	123	1,803	0.09	1.32	705	123	1,798	1.32

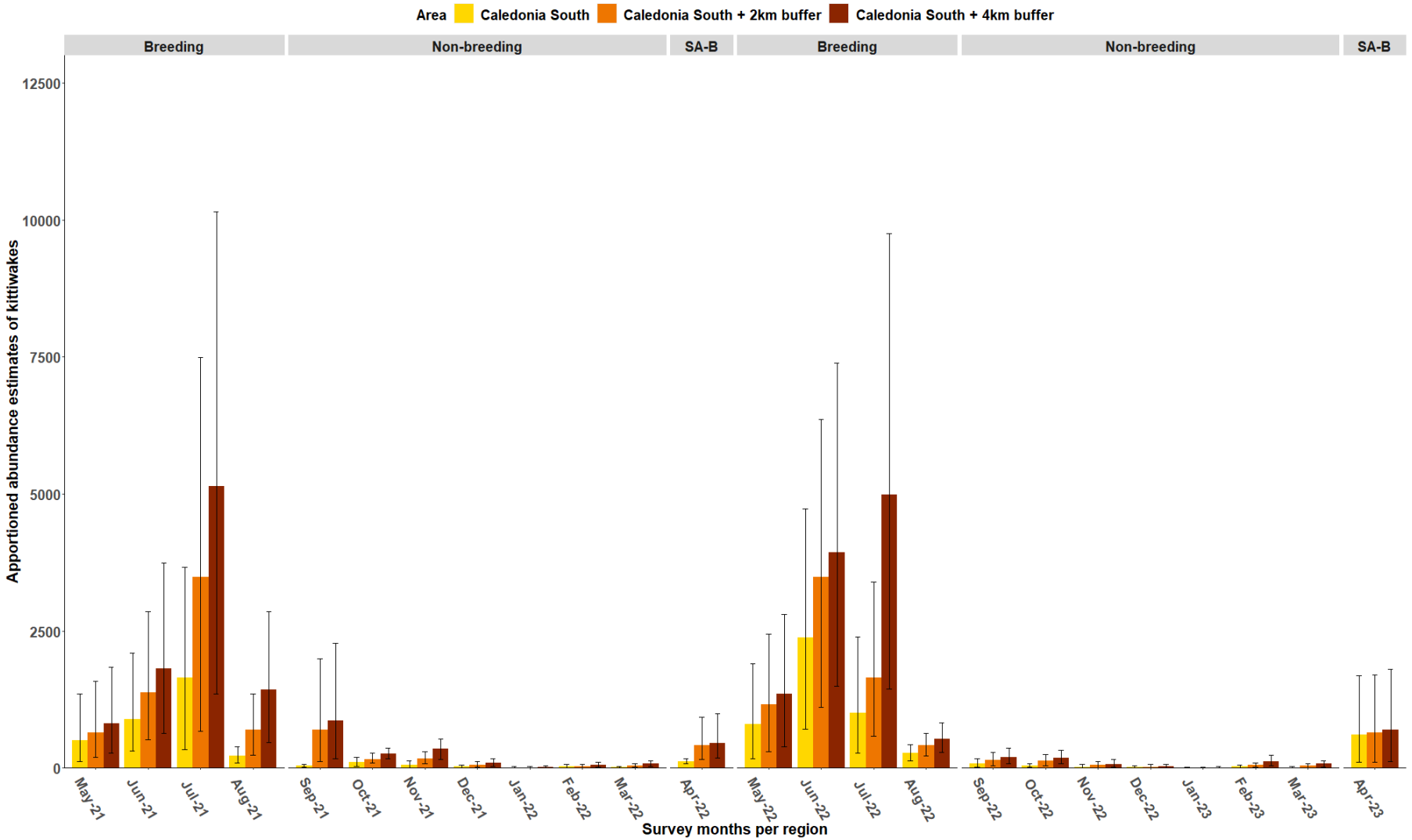


Figure 4 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total kittiwakes recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Kittiwake seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)

ii. Distribution and behaviour

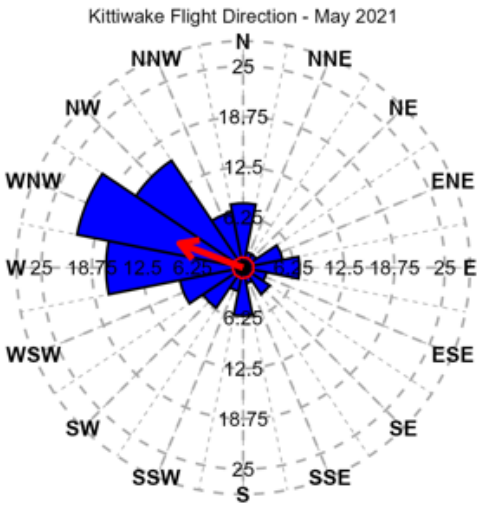
Maps of distribution are shown in Appendix 4: Figures A4.4-27. Kittiwakes were distributed throughout the Survey Area in May 2021 (Figure A4.4), October 2021 (Figure A4.9), December 2021 to June 2022 (Figure A4.11-17), August 2022 (Figure A4.19), and February 2023 (Figure A4.25). From June to September 2021, and in July and October 2022 and March 2023, their distribution was more concentrated in Caledonia South and Caledonia South Buffer Zone (Figure A4.5-8, 18, 21, 26). Most kittiwakes were recorded in the north and west of the Survey Area in November 2021 (Figure A4.10). In September 2022 and April 2023, kittiwakes were in the north and south of the Survey Area (Figure A4.20, 27). Most kittiwakes were recorded in the eastern side of the Survey Area near the subdivision line in November 2022 (Figure A4.22) and in the east of buffer and southwest corner of Caledonia South in December 2022 (Figure A4.23). In January 2023, they were recorded in the north of Caledonia North Buffer Zone, in the south of Caledonia North and in the south of Caledonia South (Figure A4.24).

Based on the location of key breeding colonies relative to Caledonia OWF, it could be inferred that the reason for the distribution that was observed during this period of the year was due to the presence of breeding adults from Troup, Pennan and Lion's Heads SPA, situated to the south of the Survey Area. However, it is recognised that there is potential connectivity between Caledonia OWF and other breeding kittiwake SPAs during the breeding season.

Significant predominant direction of flight was recorded in:

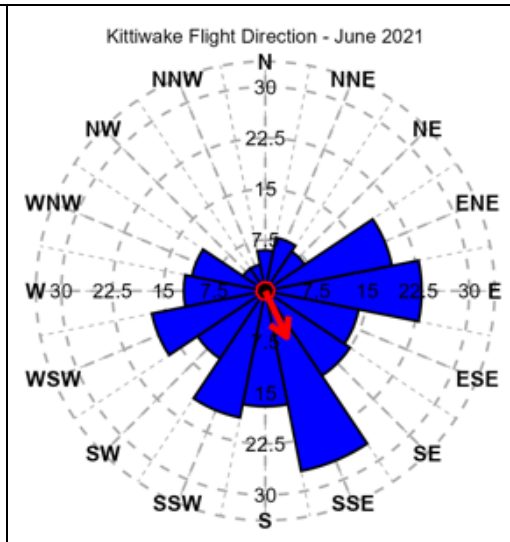
- **May**
  - 2021 west-northwest (Figure 5a)
  - 2022 west-southwest (Figure 5l)
- **June**
  - 2021 south-southeast (Figure 5b)
  - 2022 northeast (Figure 5m)
- **July**
  - 2021 south-southeast (Figure 5c)
  - 2022 south-southeast (Figure 5n)
- **August**
  - 2021 north-northwest (Figure 5d)
  - 2022 west-southwest (Figure 5o)
- **September**
  - 2021 west-southwest (Figure 5e)
  - 2022 west (Figure 5p)
- **October**
  - 2021 south-southwest (Figure 5f)
  - 2022 southwest (Figure 5q)
- **November**
  - 2021 southwest (Figure 5g)
  - 2022 south-southeast (Figure 5r)
- **December**
  - 2021 west-northwest (Figure 5h)
- **February**
  - 2023 east-southeast (Figure 5i)
- **March**
  - 2022 south-southeast (Figure 5j)
- **April**
  - 2022 east-southeast (Figure 5k)
  - 2023 south-southeast (Figure 5s)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.4).



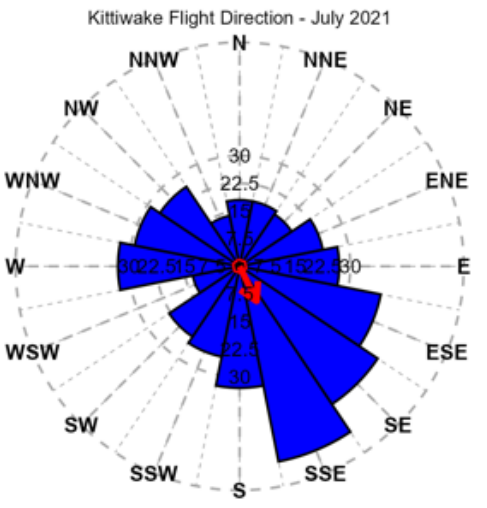
Number of Observations	117
Mean Vector (μ)	291.934
Length of Mean Vector (r)	0.402
Rayleigh Test (Z)	18.863
Rayleigh Test (p)	<0.001

a May 2021



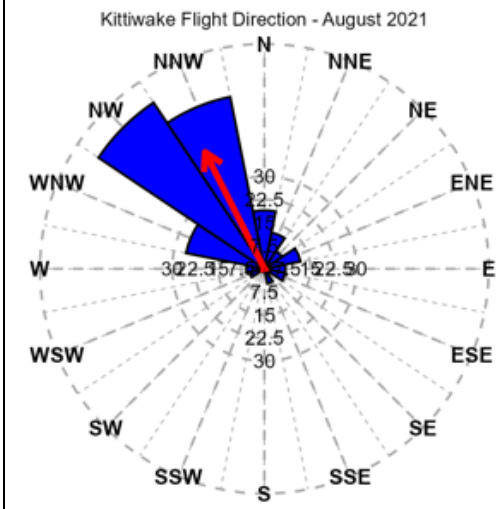
Number of Observations	215
Mean Vector (μ)	155.316
Length of Mean Vector (r)	0.276
Rayleigh Test (Z)	16.360
Rayleigh Test (p)	<0.001

b June 2021



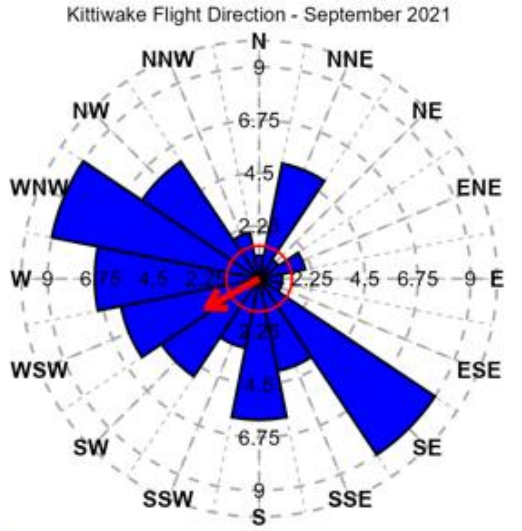
Number of Observations	437
Mean Vector (μ)	154.589
Length of Mean Vector (r)	0.194
Rayleigh Test (Z)	16.481
Rayleigh Test (p)	<0.001

c July 2021



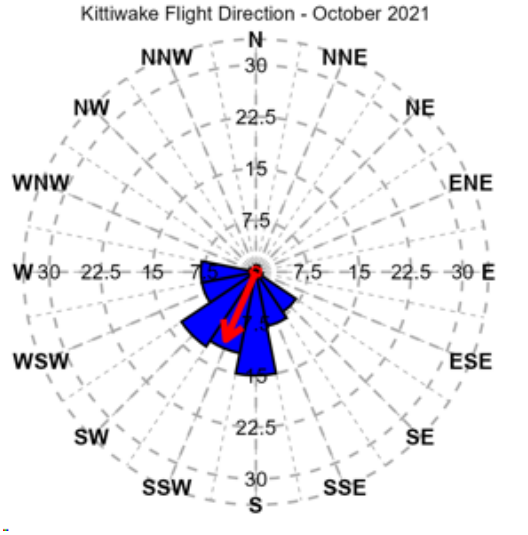
Number of Observations	232
Mean Vector (μ)	333.917
Length of Mean Vector (r)	0.655
Rayleigh Test (Z)	99.433
Rayleigh Test (p)	<0.001

d August 2021



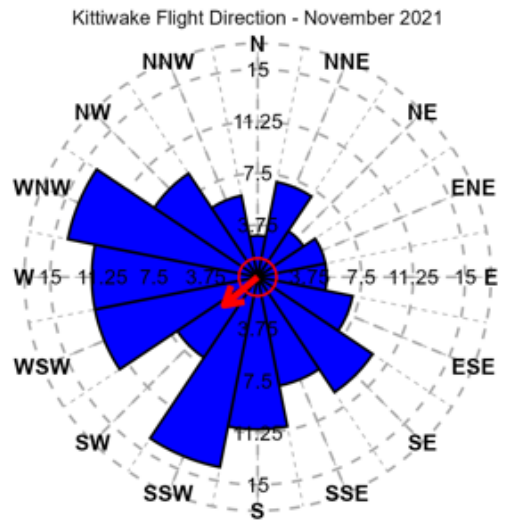
Number of Observations	68
Mean Vector (μ)	241.079
Length of Mean Vector (r)	0.282
Rayleigh Test (Z)	5.424
Rayleigh Test (p)	0.004

e September 2021



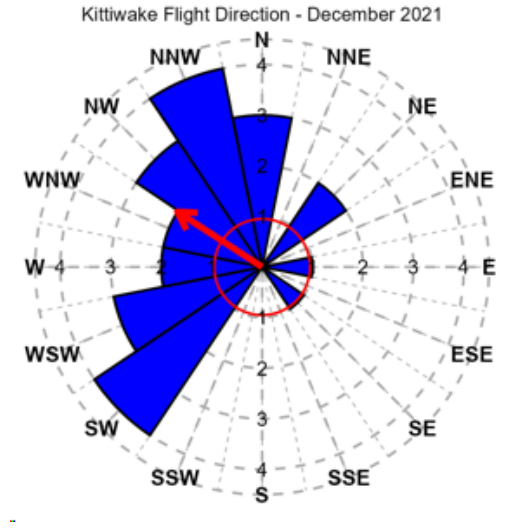
Number of Observations	75
Mean Vector (μ)	204.475
Length of Mean Vector (r)	0.717
Rayleigh Test (Z)	38.587
Rayleigh Test (p)	<0.001

f October 2021



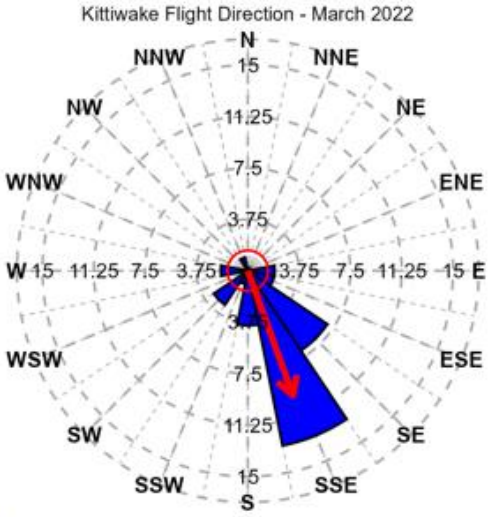
Number of Observations	134
Mean Vector (μ)	230.689
Length of Mean Vector (r)	0.227
Rayleigh Test (Z)	6.906
Rayleigh Test (p)	0.001

g November 2021



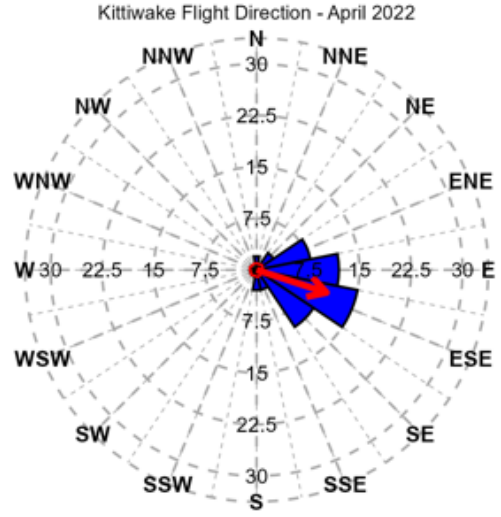
Number of Observations	25
Mean Vector (μ)	303.250
Length of Mean Vector (r)	0.501
Rayleigh Test (Z)	6.279
Rayleigh Test (p)	0.001

h December 2021



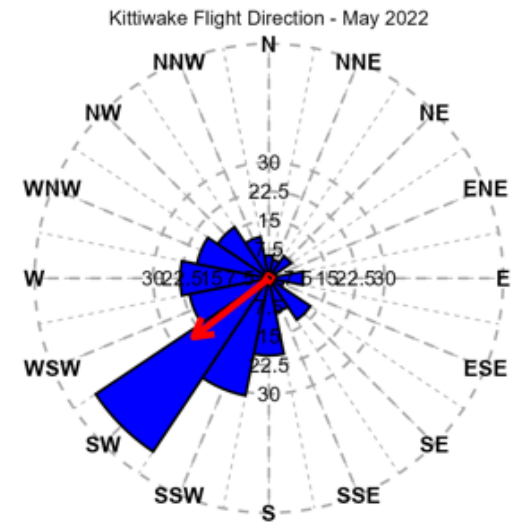
Number of Observations	35
Mean Vector (μ)	160.209
Length of Mean Vector (r)	0.743
Rayleigh Test (Z)	19.311
Rayleigh Test (p)	<0.001

i March 2022



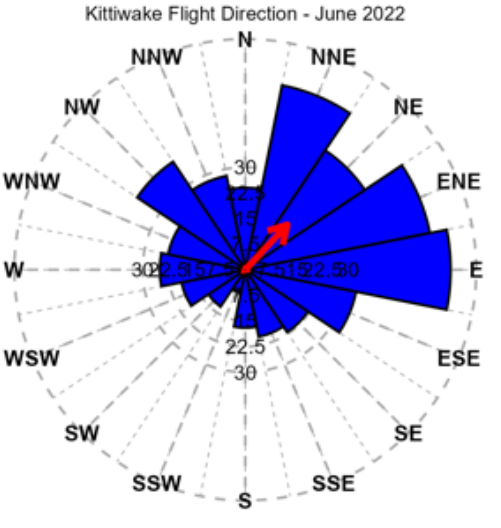
Number of Observations	60
Mean Vector (μ)	108.084
Length of Mean Vector (r)	0.714
Rayleigh Test (Z)	30.550
Rayleigh Test (p)	<0.001

j April 2022



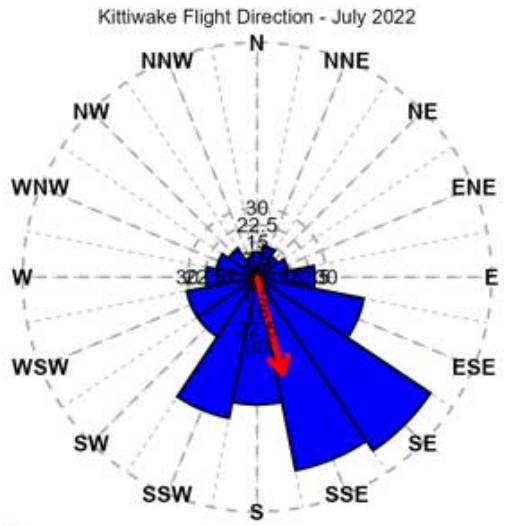
Number of Observations	250
Mean Vector (μ)	232.740
Length of Mean Vector (r)	0.458
Rayleigh Test (Z)	52.352
Rayleigh Test (p)	<0.001

k May 2022



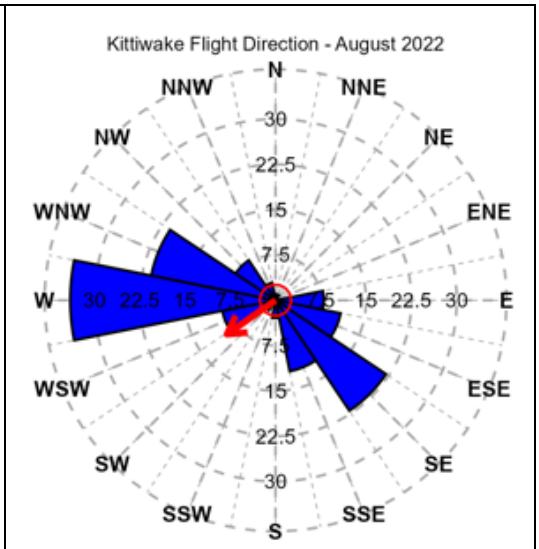
Number of Observations	481
Mean Vector (μ)	43.805
Length of Mean Vector (r)	0.299
Rayleigh Test (Z)	43.103
Rayleigh Test (p)	<0.001

l June 2022



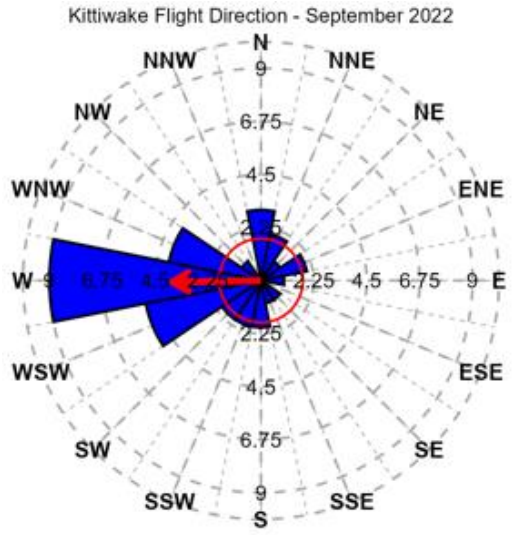
Number of Observations	540
Mean Vector (μ)	165.085
Length of Mean Vector (r)	0.477
Rayleigh Test (Z)	122.964
Rayleigh Test (p)	<0.001

m July 2022



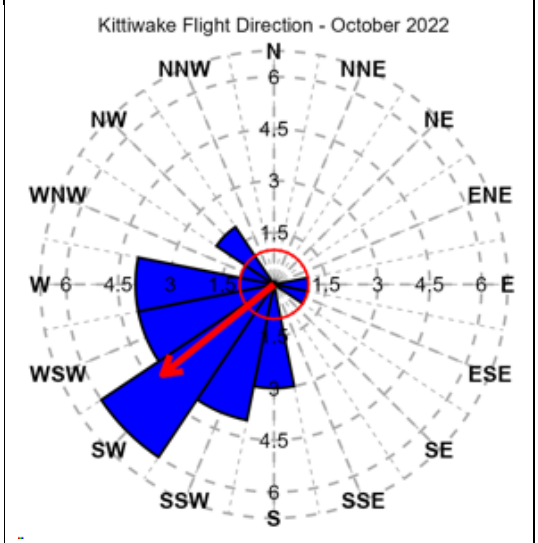
Number of Observations	135
Mean Vector (μ)	235.020
Length of Mean Vector (r)	0.288
Rayleigh Test (Z)	11.226
Rayleigh Test (p)	<0.001

n August 2022



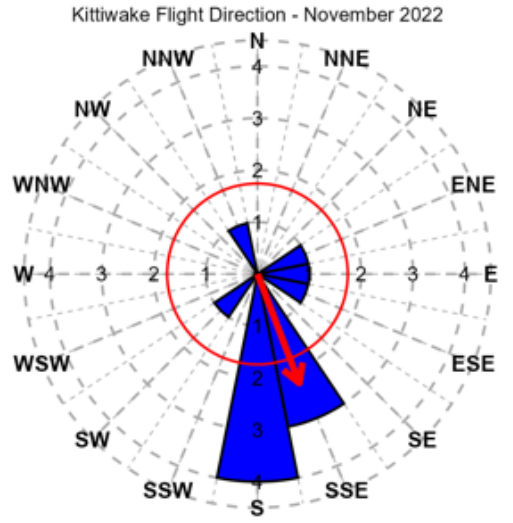
Number of Observations	36
Mean Vector (μ)	269.557
Length of Mean Vector (r)	0.418
Rayleigh Test (Z)	6.294
Rayleigh Test (p)	0.002

o September 2022



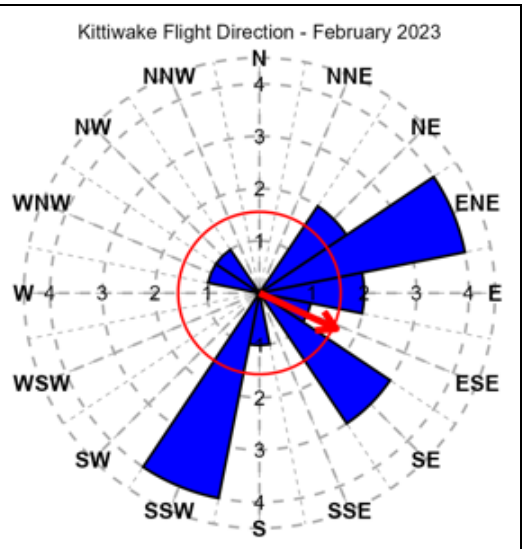
Number of Observations	26
Mean Vector (μ)	231.834
Length of Mean Vector (r)	0.690
Rayleigh Test (Z)	12.369
Rayleigh Test (p)	<0.001

p October 2022



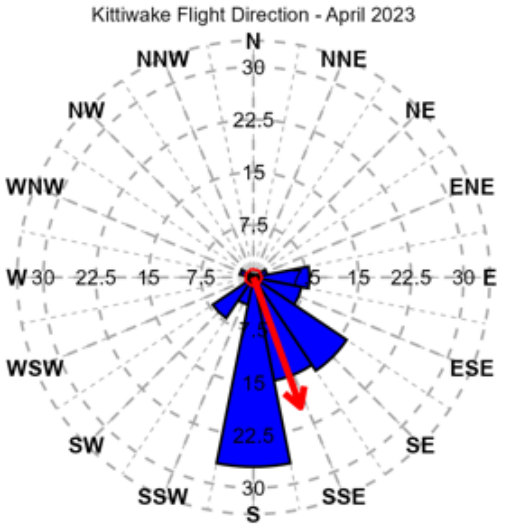
Number of Observations	12
Mean Vector (μ)	159.037
Length of Mean Vector (r)	0.563
Rayleigh Test (Z)	3.798
Rayleigh Test (p)	0.019

q November 2022



Number of Observations	19
Mean Vector (μ)	115.393
Length of Mean Vector (r)	0.404
Rayleigh Test (Z)	3.100
Rayleigh Test (p)	0.043

r February 2023



Number of Observations	91
Mean Vector (μ)	160.200
Length of Mean Vector (r)	0.728
Rayleigh Test (Z)	48.244
Rayleigh Test (p)	<0.001

s April 2023

Figure 5 Summary of flight direction of kittiwakes within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.5 Common gull

i. Abundance and density estimates

Caledonia OWF

A total of 13 common gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Common gulls were only recorded in August and December 2022 in Caledonia OWF both with two individuals, and subsequently low mean abundance and densities (Table 26). Eight common gulls were additionally recorded in September 2021 in Caledonia OWF plus 2 km (Table 26). This resulted in an estimated unapportioned and apportioned mean abundance of 46 [8, 115] individuals, which both equated to a mean density estimate of 0.07 birds/km^2 (Table 26).

In the Survey Area, common gulls were recorded in September, November 2021 and August and December 2022, with a peak of eight individuals in September 2021 (Table 26). This resulted in an estimated unapportioned and apportioned mean abundance of 47 [8, 129] individuals, which equated to a mean density estimate of 0.05 birds/km^2 (Table 26).

Common gulls were, therefore, mostly recorded during their non-breeding period (September to February), with only a couple of individuals recorded at the end of their breeding season (April to August). The baseline data indicates that the Survey Area is of limited importance to this species year round, but particularly during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 26).

Table 26 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of common gulls in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Aug-22	2	12	2	35	0.71	0.03	12	2	35	0.03
Dec-22	2	12	2	23	0.71	0.03	14	2	33	0.03
b) Caledonia OWF plus 2 km buffer										
Sep-21	8	46	8	115	0.35	0.07	46	8	115	0.07
Aug-22	2	11	2	34	0.71	0.02	11	2	34	0.02
Dec-22	2	12	2	29	0.71	0.02	13	2	31	0.02
c) Survey Area										
Sep-21	8	47	8	129	0.35	0.05	47	8	129	0.05
Nov-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Aug-22	2	11	2	34	0.71	0.01	11	2	34	0.01
Dec-22	2	12	2	29	0.71	0.01	12	2	31	0.01

Caledonia North

A total of seven common gulls were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). In Caledonia North, only three common gulls were recorded in August and December 2022, and subsequently low mean abundance and densities (Table 27). In Caledonia North plus 2 km buffer, two common gulls were additionally recorded in September 2021 (Table 27). This resulted in unapportioned and apportioned mean abundance estimate of 11 [2, 34] individuals, which both equated to a mean density estimate of 0.03 birds/km^2, in both September 2021 and August 2022 (Table 27).

In Caldonia North Survey Area, common gulls were recorded September, November 2021 and August and December 2022, with peaks in September 2021 and August 2022 (two individuals), resulting in an estimated unapportioned and apportioned mean abundance of 12 [2, 34-35] individuals. These equated to mean density estimates of 0.03 (unapportioned) and 0.02 (apportioned) birds/km^2 in both September 2021 and August 2022 (Table 27).

Common gulls were therefore mostly recorded during their non-breeding period, with the exception of August 2022. The baseline data indicates that the Caledonia North Survey Area is of limited importance to this species year-round, but particularly during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 27).

Table 27 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of common gulls in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
Aug-22	2	12	2	35	0.71	0.05	12	2	35	0.05
Dec-22	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia North plus 2 km buffer										
Sep-21	2	11	2	34	0.71	0.03	11	2	34	0.03
Aug-22	2	11	2	34	0.71	0.03	11	2	34	0.03
Dec-22	2	12	2	29	0.71	0.03	12	2	29	0.03
c) Caledonia North Survey Area										
Sep-21	2	12	2	35	0.71	0.03	12	2	35	0.02
Nov-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Aug-22	2	12	2	35	0.71	0.03	11	2	34	0.02
Dec-22	1	6	1	18	1.00	0.01	12	2	29	0.02

Caledonia South

A total of nine common gulls were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). In Caledonia South, a single common gull was recorded in December 2022 (Table 10), and subsequently very low abundance and densities. In Caledonia South plus 2 km buffer, six common gulls were additionally recorded in September 2021 (Table 28). This resulted in an unapportioned and apportioned mean abundance of 35 [6, 104] individuals, which both equated to a mean density estimate of 0.10 birds/km^2 (Table 28).

In Caledonia South Survey Area, common gulls were recorded in September 2021, August and December 2022, with a of six individuals in September 2021 (Table 28). This resulted in an unapportioned and apportioned mean abundance of 35 [6, 105] individuals, which both equated to a mean density estimate of 0.07 birds/km^2 (Table 28).

Common gulls were, therefore, mostly recorded during their non-breeding period, with the exception of August 2022. The baseline data indicates that the Survey Area is of limited importance to this species year-round, but particularly during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 28).

Table 28 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of common gulls in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Dec-22	1	6	1	18	1.00	0.03	7	1	22	0.03
b) Caledonia South plus 2 km buffer										
Sep-21	6	35	6	104	0.41	0.10	35	6	104	0.10
Dec-22	1	6	1	17	1.00	0.02	7	2	19	0.02
c) Caledonia South Survey Area										
Sep-21	6	35	6	105	0.41	0.07	35	6	105	0.07
Aug-22	2	11	2	34	0.71	0.02	11	2	34	0.02
Dec-22	1	6	1	18	1.00	0.01	6	1	20	0.01

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.28-32. In September 2021, common gulls were recorded in the west of Caledonia North Buffer Zone and the east of Caledonia South Buffer Zone (Figure A4.28). In November 2021, a single common gull was recorded in the northwest towards the outer Buffer Zone boundary of Caledonia North Survey Area (Figure A4.29). Common gulls were recorded in the centre of Caledonia North in May 2022 and in the south of Caledonia North in August 2022 (Figures A4.30-31). In December 2022, one common gull was recorded in the north of Caledonia North while a second individual was recorded in the north of Caledonia South, near the subdivision line with Caledonia North (Figure A4.32).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.5).

4.6 Great black-backed gull

i. Abundance and density estimates

Caledonia OWF

A total of 540 great black-backed gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Great black-backed gulls were most abundant during the non-breeding season (September to March) (Table 29, Figure 6). In Caledonia OWF, they were only recorded during this season, with the exception of August 2022 where an apportioned mean abundance of 1 [0, 3] individual was estimated (Table 29). In total, great black-backed gulls were recorded in 13, 17, and 17 of the 24 baseline surveys in Caledonia OWF, Caledonia OWF plus 2 km buffer, and the Survey Area, respectively. In August 2022 and April 2023, great black-backed gulls have been recorded after apportioning despite not being directly recorded during the relevant survey (Table 29). This represents apportioning of black-backed gulls and/or large gull species into the great black-backed gull category, following the hierarchy outlined in Section 3.5.

Peak numbers of great black-backed gull were recorded in November 2021 (Table 29, Figure 6):

- 73 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 424 [197; 755] and an apportioned mean abundance estimate of 473 [189; 923] individuals. These equated to mean density estimates of 0.99 (unapportioned) and 1.11 (apportioned) birds/km^2.

- 119 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 681 [383; 1,058] and an apportioned mean abundance estimate of 760 [372; 1,294] individuals. These equated to mean density estimates of 1.06 (unapportioned) and 1.18 (apportioned) birds/km^2.
- 163 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 949 [553; 1,444] and an apportioned mean abundance estimate of 1,046 [519; 1,745] individuals. These equated to mean density estimates of 1.07 (unapportioned) and 1.18 (apportioned) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned abundances of great black-backed gull within the Survey Area occurred in November 2021 and October 2022, with other months considerably lower in mean apportioned abundances than the overall peak for the two years of surveys (November 2021). In the 2021/22 non-breeding season, apportioned mean abundances were generally higher in the autumn than the winter period, with birds largely absent by the spring, presumably as birds move towards their breeding colonies. In the 2022/23 non-breeding season, mean apportioned abundances were comparable throughout most of the season. A key difference between the two non-breeding periods were the overall numbers of birds present, with the 2021/22 non-breeding season surveys recording larger numbers of birds than the 2022/23 non-breeding season surveys. Reductions in mean apportioned abundance relative to the peak were between 55% to 99%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period.

Great black-backed gulls were absent from Caledonia OWF during the breeding season (April to July) and in March during the breeding site attendance period (Table 29; Figure 6). However, low numbers of individuals (≤5) were recorded in both 2 km and 4 km Buffer Zones during the aforementioned periods (Table 29, Figure 6).

The 95% confidence intervals calculated for the mean abundances were sometimes relatively high even for surveys where CV values were low (e.g. September 2021 and November 2021 for the Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia OWF), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precisions were calculated for the survey months where larger numbers of great black-backed gulls were recorded (CV ≤ 0.16; Table 29). Outside these months, CV values of 0.2 to 0.6 for Caledonia OWF were more common, with larger values reported in surveys where fewer birds were observed. For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 29). This was likely a product of an increased number of records, coupled with higher transect numbers and lengths within these reporting regions relative to Caledonia OWF (Table 1).

Table 29 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of great black-backed gulls in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of great black-backed gull raw counts per season, with light yellow for the breeding season months (April to July) and light blue to royal blue (peak number) for the wintering months (September to March)

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Sep-21	12	70	12	197	0.29	0.16	81	14	215	0.19

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Oct-21	3	18	3	53	0.58	0.04	32	7	87	0.07
Nov-21	**73**	**424**	**197**	**755**	**0.12**	**0.99**	**473**	**189**	**923**	**1.11**
Dec-21	8	46	17	75	0.35	0.11	46	10	98	0.11
Jan-22	20	116	52	174	0.22	0.27	116	41	186	0.27
Feb-22	20	108	43	184	0.22	0.25	108	22	216	0.25
Aug-22	0	-	-	-	-	-	1	0	3	0.00
Sep-22	3	17	6	35	1.00	0.04	18	3	46	0.04
Oct-22	18	105	47	169	0.58	0.25	105	37	187	0.25
Nov-22	5	29	6	65	0.24	0.07	34	8	78	0.08
Dec-22	1	6	1	18	0.45	0.01	7	1	21	0.02
Jan-23	18	105	52	175	1.00	0.25	105	35	186	0.25
Feb-23	6	34	11	57	0.24	0.08	34	9	68	0.08
b) Caledonia OWF plus 2 km buffer										
Aug-21	3	17	3	51	0.58	0.03	17	3	51	0.03
Sep-21	41	235	46	465	0.16	0.37	253	55	556	0.39
Oct-21	23	133	23	311	0.21	0.21	159	28	369	0.25
Nov-21	**119**	**681**	**383**	**1,058**	**0.09**	**1.06**	**760**	**372**	**1,294**	**1.18**
Dec-21	11	63	29	97	0.30	0.1	63	16	120	0.1
Jan-22	37	211	114	303	0.16	0.33	217	105	348	0.34
Feb-22	34	182	96	284	0.17	0.28	185	72	319	0.29
Mar-22	1	5	1	16	1.00	0.01	0	1	16	0
Aug-22	0	-	-	-	-	-	6	1	17	0.01
Sep-22	8	46	12	92	0.35	0.07	47	10	104	0.07
Oct-22	27	157	99	227	0.19	0.24	162	71	265	0.25
Nov-22	16	93	64	116	0.25	0.14	98	47	193	0.15
Dec-22	8	47	18	88	0.35	0.07	51	14	99	0.08
Jan-23	24	139	58	238	0.20	0.22	140	40	256	0.22
Feb-23	10	57	29	86	0.32	0.09	58	17	103	0.09
Mar-23	3	17	3	35	0.58	0.03	18	3	41	0.03
Apr-23	0	-	-	-	-	-	4	1	10	0.01
c) Survey Area										
Aug-21	3	17	3	52	0.58	0.02	17	3	52	0.02
Sep-21	76	445	170	773	0.11	0.5	468	122	942	0.53
Oct-21	46	269	82	474	0.15	0.3	294	93	543	0.33
Nov-21	**163**	**949**	**553**	**1,444**	**0.08**	**1.07**	**1,046**	**519**	**1,745**	**1.18**
Dec-21	15	87	52	122	0.26	0.1	87	30	157	0.10
Jan-22	48	278	174	382	0.14	0.31	284	170	416	0.32
Feb-22	43	236	126	379	0.15	0.27	237	91	413	0.27
Mar-22	2	11	2	27	0.71	0.01	11	2	27	0.01
Aug-22	0	-	-	-	-	-	6	1	17	0.01
Sep-22	12	70	12	140	0.29	0.08	70	14	158	0.08
Oct-22	38	223	147	306	0.16	0.25	229	119	351	0.26
Nov-22	19	112	88	136	0.23	0.13	119	48	210	0.13
Dec-22	22	130	65	206	0.21	0.15	137	50	259	0.15
Jan-23	33	194	88	312	0.17	0.22	194	77	336	0.22
Feb-23	15	87	46	127	0.26	0.1	87	35	156	0.10
Mar-23	5	29	6	59	0.45	0.03	29	7	60	0.03
Apr-23	0	-	-	-	-	-	5	1	12	0.01

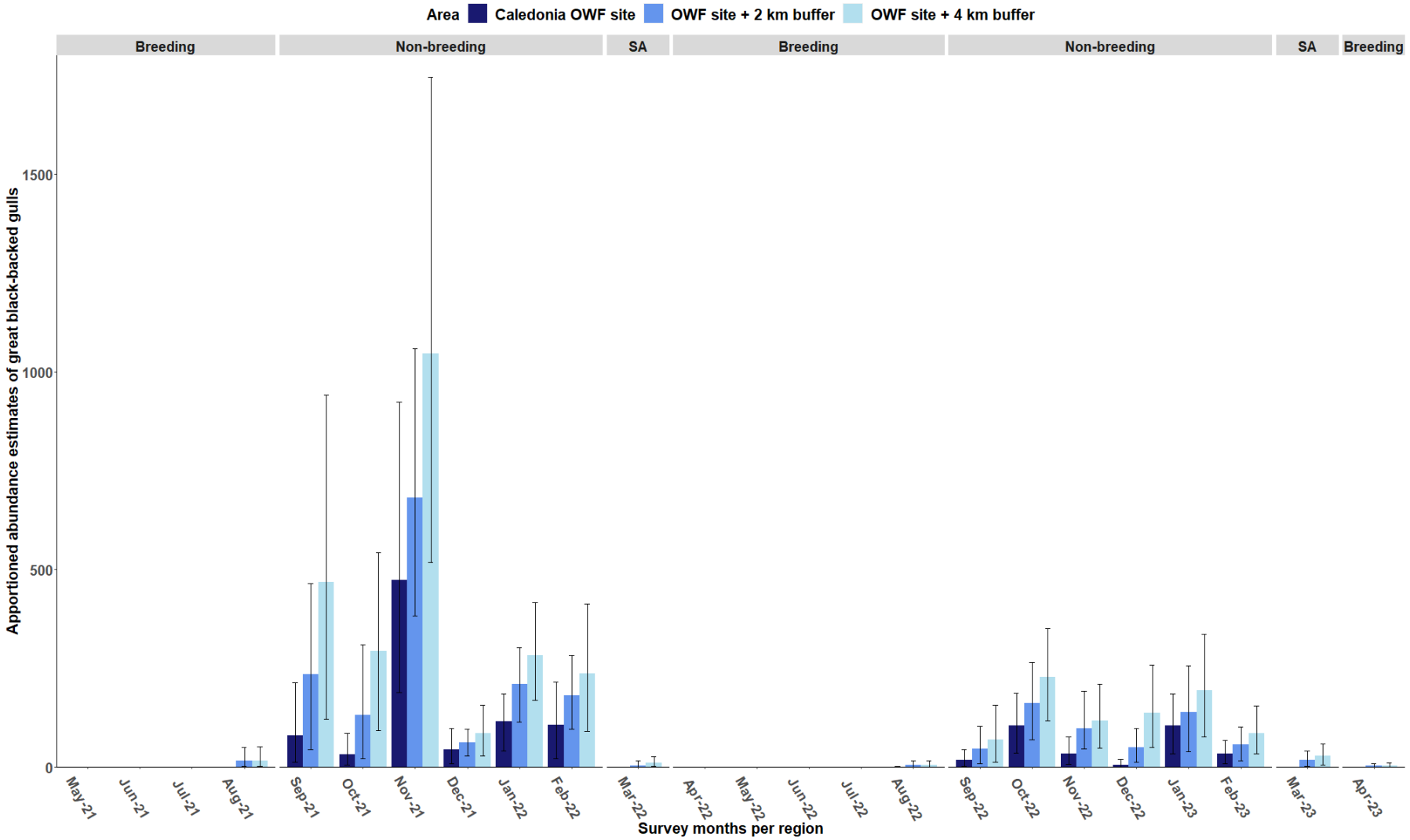


Figure 6 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of total great black-backed gulls recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Great black-backed gull seasonal periods are also displayed. SA stands for breeding site attendance

Caledonia North

A total of 376 great black-backed gulls were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Great black-backed gulls were most abundant in all reporting regions during the non-breeding season. They were recorded from September 2021 to February 2022 and September 2022 to February 2023 in Caledonia North (Table 9, Table 30, Figure 7) while they were additionally present in low numbers in August 2021, March 2022 and March 2023 in Caledonia North plus 2 km and 4 km buffers (Table 30). In August 2022, great black-backed gulls have been recorded after apportioning despite not being directly recorded during the relevant survey (Table 30). This represents apportioning of black-backed gulls and/or large gull species into the great black-backed gull category, following the hierarchy outlined in Section 3.5.

Peak numbers were recorded in November 2021 (Table 30, Figure 7):

- 15 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 88 [41; 134] and an apportioned mean abundance estimate of 93 [36; 155] individuals. These equated to mean density estimates of 0.40 (unapportioned) and 0.43 (apportioned) birds/km^2.
- 54 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 308 [154; 491] and an apportioned mean abundance estimate of 335 [140; 614] individuals. These equated to mean density estimates of 0.82 (unapportioned) and 0.89 (apportioned) birds/km^2.
- 84 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 490 [274; 747] and an apportioned mean abundance estimate of 533 [228; 976] individuals. These equated to mean density estimates of 0.88 (unapportioned) and 0.96 (apportioned) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned great black-backed gull abundances occurred within Caledonia North Survey Area in November 2021, October 2022 or January 2023 (depending on the reporting region), with other months considerably lower in mean apportioned abundances than the overall peak for the two years of surveys, in November 2021. In the 2021/22 non-breeding season, apportioned mean abundances were generally higher in the autumn than the winter period, with birds largely absent by the spring, presumably as birds move towards their breeding colonies. In the 2022/23 non-breeding season, mean apportioned abundances were comparable throughout most of the season. A key difference between the two non-breeding periods were the overall numbers of birds present, with the 2021/22 non-breeding season surveys recording larger numbers of birds than the 2022/23 non-breeding season surveys.

Reductions in mean apportioned abundance relative to the peak were between 12% to 99%, with most surveys reporting reductions closer to the upper limit. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording apportioned mean abundances for this species that were considerably lower than the peak mean apportioned abundance.

Great black-backed gulls were recorded absent from Caledonia North Survey Area during the breeding season (April to July). They were only recorded in low numbers in March during the breeding site attendance period in Caledonia North 2 km and 4 km Buffer Zones (Table 30, Figure 7).

The 95% confidence intervals calculated for the mean abundances were sometimes relatively high even for surveys where CV values were low (e.g. September 2021 and November 2021 for Caledonia North Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia North), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precisions were calculated for the survey months where larger numbers of great black-backed gulls were recorded (CV ≤ 0.16; Table 30). Outside these months, CV values of around 0.2 to 0.7 for Caledonia North were more common, with larger values reported in surveys where fewer birds were observed (Table 30). For Caledonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 30). This was likely a product of an increased number of records, coupled with higher transect numbers and lengths within these reporting regions relative to Caledonia North (Table 1).

Table 30 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of great black-backed gulls in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of great black-backed gull raw counts per season, with light yellow for the breeding season months (April to July) and light blue to royal blue (peak number) for the wintering months (September to March)**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a)	**Caledonia North**									
Sep-21	12	70	12	185	0.29	0.32	81	14	209	0.37
Oct-21	3	18	3	53	0.58	0.08	32	7	83	0.15
Nov-21	**15**	**88**	**41**	**134**	**0.26**	**0.40**	**93**	**36**	**155**	**0.43**
Dec-21	4	23	4	46	0.50	0.11	24	4	70	0.11
Jan-22	9	52	17	93	0.33	0.24	52	18	104	0.24
Feb-22	12	65	12	129	0.29	0.30	65	13	129	0.30
Sep-22	2	11	2	23	0.71	0.05	11	2	23	0.05
Oct-22	8	46	23	69	0.35	0.21	47	14	81	0.22
Nov-22	4	24	4	47	0.50	0.11	24	4	59	0.11
Dec-22	1	6	1	17	1.00	0.03	6	1	17	0.03
Jan-23	9	52	23	81	0.33	0.24	52	18	92	0.24
Feb-23	2	12	2	29	0.71	0.05	12	2	23	0.05
b)	**Caledonia North plus 2 km buffer**									
Aug-21	3	17	3	51	0.58	0.05	17	3	51	0.05
Sep-21	41	233	46	444	0.16	0.62	250	67	563	0.67
Oct-21	23	131	23	309	0.21	0.35	158	28	354	0.42
Nov-21	**54**	**308**	**154**	**491**	**0.14**	**0.82**	**335**	**140**	**614**	**0.89**
Dec-21	7	40	11	74	0.38	0.11	40	7	97	0.11
Jan-22	24	136	74	204	0.20	0.36	143	59	244	0.38
Feb-22	19	102	27	199	0.23	0.27	104	22	217	0.28
Mar-22	1	5	1	16	1.00	0.01	5	1	16	0.01
Aug-22	-	-	-	-	-	-	6	1	17	0.02
Sep-22	7	41	7	87	0.38	0.11	41	9	93	0.11
Oct-22	14	82	53	112	0.27	0.22	88	42	150	0.24
Nov-22	10	58	29	81	0.32	0.15	58	20	115	0.15
Dec-22	5	29	5	65	0.45	0.08	32	5	70	0.08
Jan-23	17	100	35	176	0.24	0.27	100	30	205	0.27
Feb-23	5	29	11	46	0.45	0.08	28	8	63	0.07
Mar-23	2	12	2	29	0.71	0.03	12	2	34	0.03
c)	**Caledonia North Survey Area**									
Aug-21	3	17	3	52	0.58	0.03	17	3	52	0.03
Sep-21	76	444	193	730	0.11	0.80	467	122	946	0.84
Oct-21	46	269	99	479	0.15	0.48	294	93	553	0.53
Nov-21	**84**	**490**	**274**	**747**	**0.11**	**0.88**	**533**	**228**	**976**	**0.96**
Dec-21	9	52	23	82	0.33	0.09	52	10	116	0.09

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jan-22	37	214	139	289	0.16	0.38	220	135	323	0.39
Feb-22	23	127	39	248	0.21	0.23	130	31	261	0.23
Mar-22	2	11	2	27	0.71	0.02	11	2	27	0.02
Aug-22	0	-	-	-	-	-	6	1	17	0.01
Sep-22	10	58	10	134	0.32	0.10	58	12	134	0.10
Oct-22	22	129	82	182	0.21	0.23	136	69	215	0.24
Nov-22	12	71	41	100	0.29	0.13	71	27	137	0.13
Dec-22	16	94	35	165	0.25	0.17	98	30	203	0.18
Jan-23	22	130	65	212	0.21	0.23	130	42	242	0.23
Feb-23	11	64	29	98	0.30	0.11	64	25	109	0.11
Mar-23	3	18	3	47	0.58	0.03	18	3	48	0.03

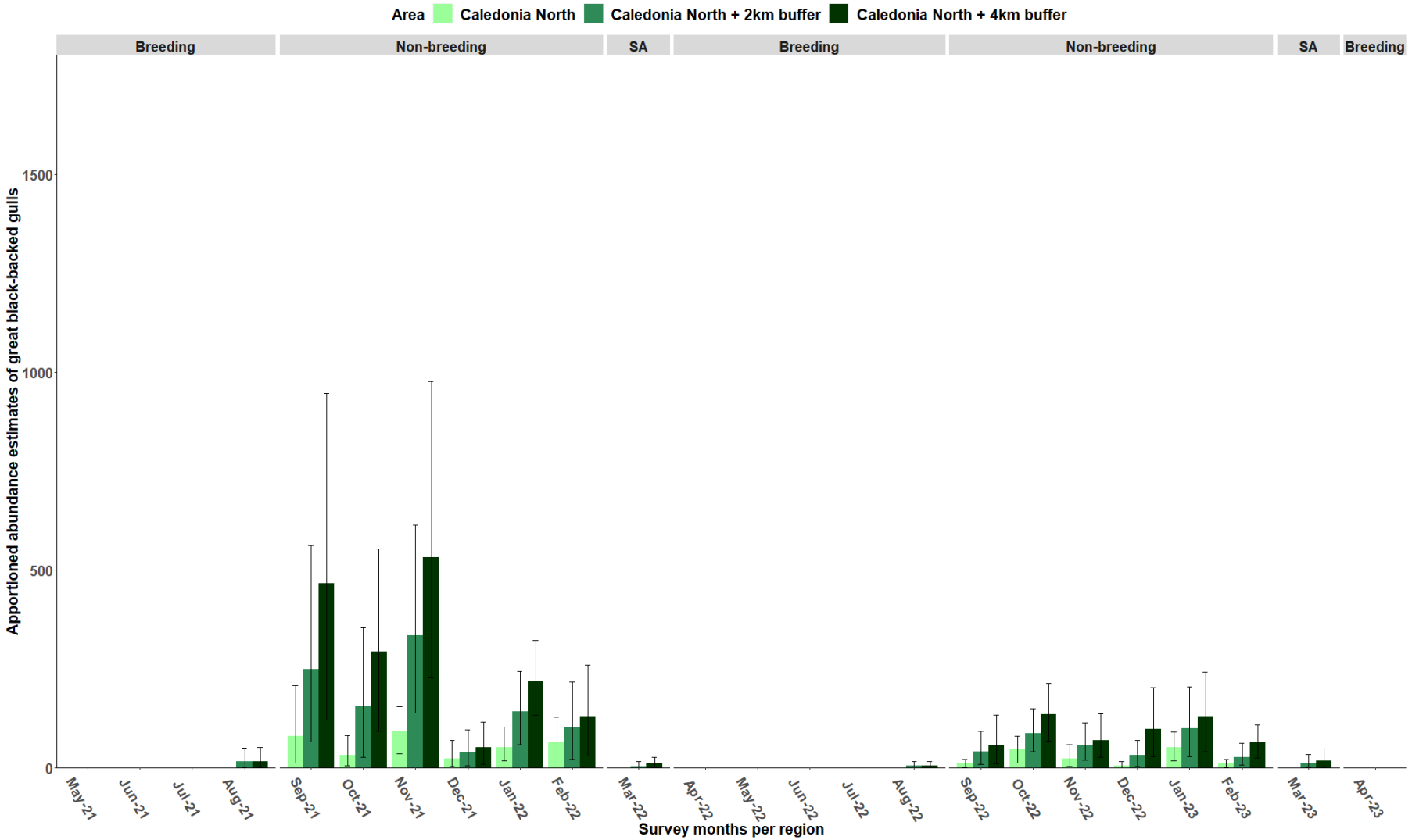


Figure 7 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total great-black back gulls recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Great black-backed gull seasonal periods are also displayed. SA stands for breeding site attendance

Caledonia South

A total of 258 great black-backed gulls were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Great black-backed gulls were only recorded from November 2021 to February 2022, September to November 2022 and January to February 2023 in Caledonia South (Table 31, Figure 8). They were additionally recorded in low numbers in March 2022 and March 2023 in Caledonia North plus 2 km buffer and additionally in April 2023 in Caledonia South Survey Area (Table 31). In April 2023, great black-backed gulls have been recorded, in Caledonia South plus 2 km buffer, after apportioning despite not being directly recorded during the relevant survey (Table 31). This represents apportioning of black-backed gulls and/or large gull species into the great black-backed gull category, following the hierarchy outlined in Section 3.5

Great black-backed gulls were the most abundant during the non-breeding season (September to February), with peak numbers in November 2021 (Table 31, Figure 8):

- 58 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 334 [127; 651] and an apportioned mean abundance estimate of 377 [129; 776] individuals. These equated to mean density estimates of 1.59 (unapportioned) and 1.79 (apportioned) birds/km^2.
- 74 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 424 [212; 739] and an apportioned mean abundance estimate of 481 [240; 892] individuals. These equated to mean density estimates of 1.18 (unapportioned) and 1.34 (apportioned) birds/km^2.
- 96 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 552 [259; 937], and an apportioned mean abundance estimate of 632 [278; 1,132] individuals. These equated to mean density estimates of 1.03 (unapportioned) and 1.18 (apportioned) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned abundances of great black-backed gull occurred in Caledonia South Survey Area in November 2021 and October 2022, with other months considerably lower in mean apportioned abundances than the overall peak for the two years of surveys, in November 2021. Other than this large peak mean abundance, mean apportioned abundances were comparable throughout most of the non-breeding season surveys covered by the baseline survey period.

Reductions in mean apportioned abundance relative to the peak were between 74% to 99%, indicating relatively low variability in mean apportioned abundances in non-breeding season surveys relative to the mean peak abundance.

Great black-backed gulls were mostly absent from Caledonia South Survey Area during the breeding season (April to July), with the exception of April 2023 where they were recorded in low numbers in Caledonia South 4 km Buffer Zone (Table 31). This led to small numbers of apportioned birds being allocated to this species within other regions within Caledonia South Survey Area.

The 95% confidence intervals calculated for the mean abundances were sometimes relatively high even for surveys where CV values were low (e.g. November 2021 for Caledonia North Survey Area). This is perhaps a consequence of the numbers of birds in single samples (i.e. images) being highly variable. Where reporting regions were smaller (e.g. Caledonia South), it is possible that there was lower variability between samples, resulting in tighter 95% confidence intervals about the mean abundance estimate.

Good measures of precision were calculated for the survey months where larger numbers of great black-backed gulls were recorded (CV ≤ 0.16; Table 31). Outside these months, CV values of around 0.2 to 0.5 for Caledonia South were more common, with larger values reported in surveys where fewer birds were observed (Table 31). For Caledonia South plus buffers, CV values were generally lower than

the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 31). This was likely a product of an increased number of records, coupled with higher transect numbers and lengths within these reporting regions relative to Caledonia South (Table 1).

Table 31 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of great black-backed gulls in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of great black-backed gull raw counts per season, with light yellow for the breeding season months (April to July) and light blue to royal blue (peak number) for the wintering months (September to March)**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a)	**Caledonia South**									
Nov-21	**58**	**334**	**127**	**651**	**0.13**	**1.59**	**377**	**129**	**776**	**1.79**
Dec-21	4	23	6	46	0.50	0.11	24	4	52	0.11
Jan-22	11	64	35	92	0.30	0.30	63	20	110	0.30
Feb-22	8	43	11	76	0.35	0.20	43	8	98	0.20
Sep-22	1	6	1	17	1.00	0.03	5	1	16	0.02
Oct-22	10	59	24	100	0.32	0.28	6	1	17	0.03
Nov-22	1	6	1	18	1.00	0.03	59	24	100	0.28
Jan-23	9	53	18	94	0.33	0.25	8	1	27	0.04
Feb-23	4	23	6	40	0.50	0.11	52	12	100	0.25
b)	**Caledonia South plus 2 km buffer**									
Oct-21	-	-	-	-	-	-	5	5	15	0.02
Nov-21	**74**	**424**	**212**	**739**	**0.12**	**1.18**	**481**	**240**	**892**	**1.34**
Dec-21	5	29	6	58	0.45	0.08	29	5	64	0.08
Jan-22	17	98	46	149	0.24	0.27	97	34	160	0.27
Feb-22	19	101	64	139	0.23	0.28	102	29	186	0.28
Mar-22	-	-	-	-	-	-	5	5	16	0.01
Sep-22	2	11	2	29	0.71	0.03	11	2	29	0.03
Oct-22	15	86	40	132	0.26	0.24	87	37	162	0.24
Nov-22	10	58	29	87	0.32	0.16	64	30	126	0.18
Dec-22	3	17	6	35	0.58	0.05	19	5	39	0.05
Jan-23	10	57	23	98	0.32	0.16	58	16	103	0.16
Feb-23	7	40	11	68	0.38	0.11	40	9	74	0.11
Mar-23	2	12	2	29	0.71	0.03	12	2	29	0.03
Apr-23	-	-	-	-	-	-	6	6	17	0.02
c)	**Caledonia South Survey Area**									
Sep-21	14	81	14	244	0.27	0.15	81	14	243	0.15
Oct-21	1	6	1	17	1.00	0.01	12	2	34	0.02
Nov-21	**96**	**552**	**259**	**937**	**0.10**	**1.03**	**632**	**278**	**1,132**	**1.18**
Dec-21	7	40	12	69	0.38	0.07	40	7	87	0.07
Jan-22	26	150	86	219	0.20	0.28	150	69	230	0.28
Feb-22	30	163	87	255	0.18	0.31	163	66	276	0.31
Mar-22	1	5	1	16	1.00	0.01	10	2	32	0.02
Sep-22	4	23	6	41	0.50	0.04	24	4	53	0.04
Oct-22	24	141	76	206	0.20	0.26	141	73	235	0.26
Nov-22	14	82	47	117	0.27	0.15	86	28	156	0.16
Dec-22	11	65	18	118	0.30	0.12	66	18	142	0.12
Jan-23	18	105	41	181	0.24	0.20	105	24	211	0.20
Feb-23	9	52	23	81	0.33	0.10	52	18	86	0.10
Mar-23	3	17	3	35	0.58	0.03	17	3	35	0.03
Apr-23	14	81	14	244	0.27	0.15	6	1	17	0.01

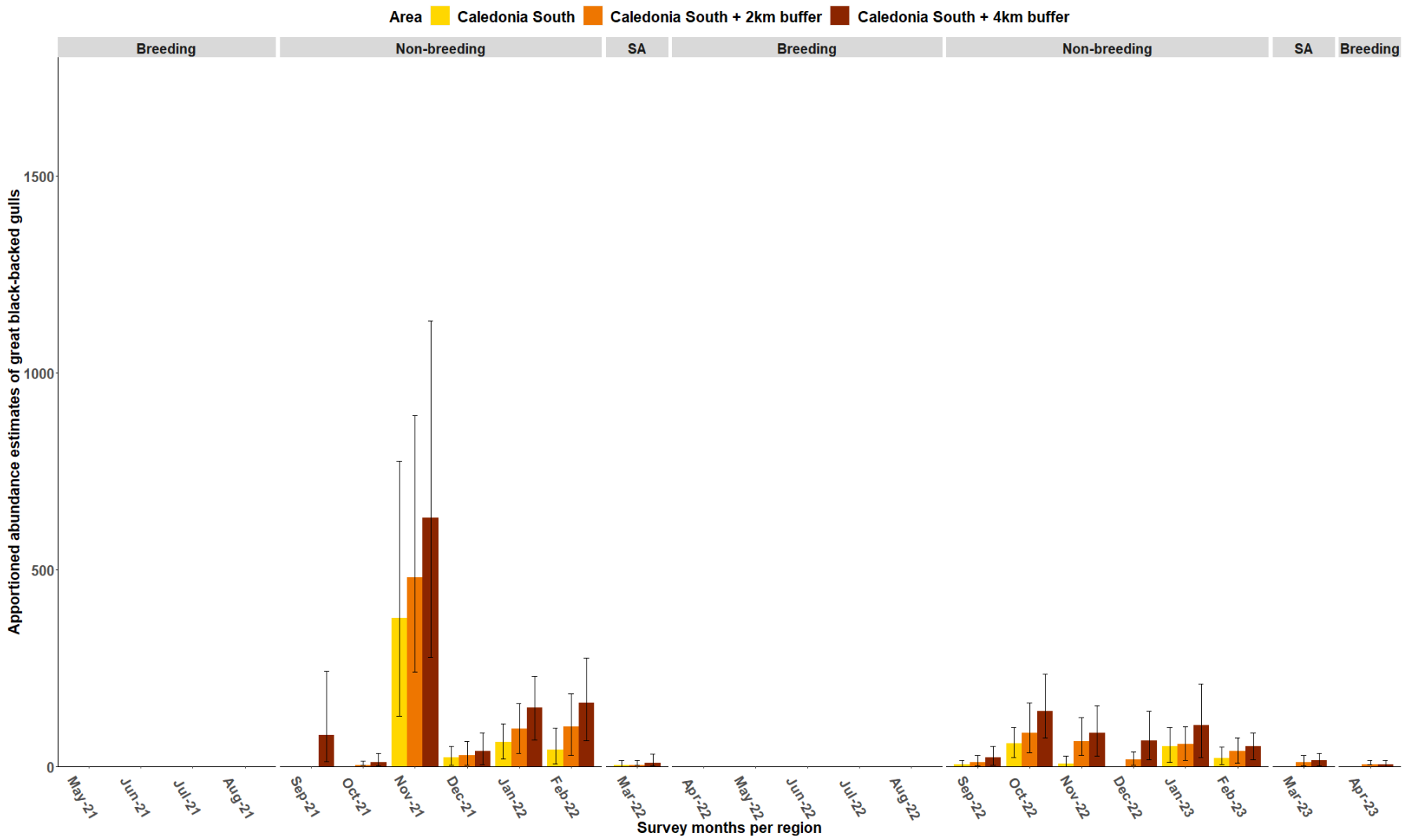


Figure 8 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total great-black back gulls recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Great-black back gull seasonal periods are also displayed. SA stands for breeding site attendance

ii. Distribution and behaviour

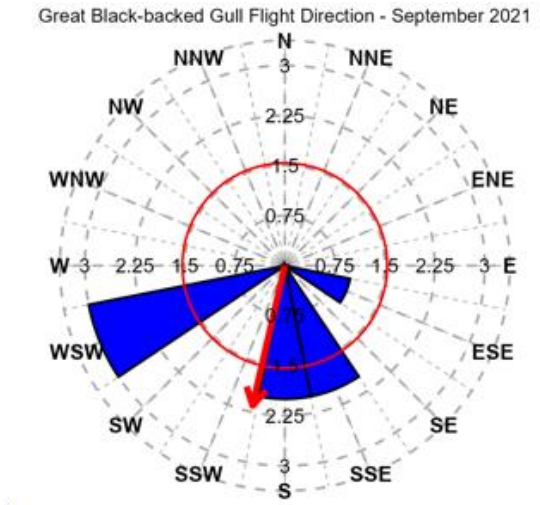
Maps of distribution are shown in Appendix 4: Figures A4.33-47. Great black-backed gulls were absent from the Survey Area during May to July 2021 surveys, which coincides with the migration-free breeding season for this species. This indicates that the Survey Area was of limited or no importance to nearby SPA breeding colonies of this species (e.g. East Caithness Cliffs SPA, Copinsay SPA and Hoy SPA).

In August, September and October 2021, and September 2022, great black-backed gulls were concentrated in the west of the Survey Area, predominantly within the Buffer Zone, in the vicinity of operational Moray East wind turbines (Figures A4.33-35, A4.41). In December 2021, they were distributed in the south and west of the Survey Area, with most individuals within the Buffer Zone (Figure A4.37). During the November 2021, January, February and October 2022 surveys, they were widely distributed throughout the Survey Area (Figures A4.36, 38-39, 42). The two individuals recorded in March 2022 were both within the Buffer Zone; one in Caledonia North Buffer Zone near the Caledonia North boundary and one in the northwest of Caledonia South Buffer Zone (Figure A4.40). In November 2022, great black-backed gulls were scattered throughout the Survey Area, with highest numbers along the subdivision line of Caledonia North and Caledonia South, and southern parts of Caledonia South Buffer Zone (Figure A4.43). In December 2022, individuals were predominantly recorded within the Survey Area Buffer Zone, with most of them recorded in the west and east of Caledonia North Buffer Zone (Figure A4.44). In January 2023, they were mainly recorded towards the centre of the Survey Area (Figure A4.45), while individuals occurred more scattered across the Survey Area in February and in the west of the Survey Area Buffer Zone in March 2023 (Figures A4.46-47).

Significant predominant direction of flight was recorded in:

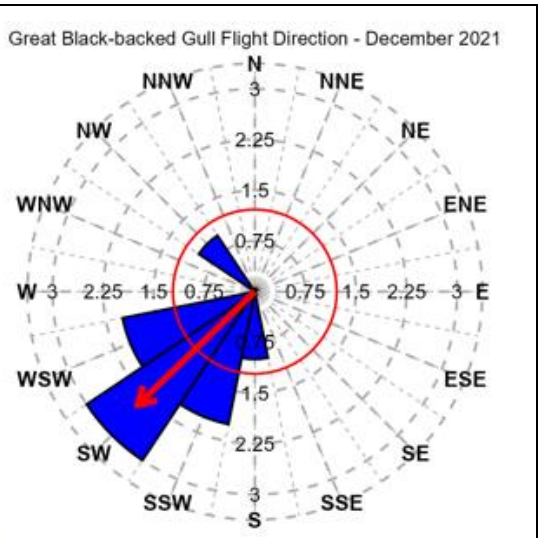
- **September**
  - 2021 south-southwest (Figure 9a)
- **December**
  - 2021 southwest (Figure 9b)
  - 2022 west (Figure 9f)
- **January**
  - 2022 west-southwest (Figure 9c)
  - 2023 south-southwest (Figure 9g)
- **February**
  - 2022 south (Figure 9d)
- **November**
  - 2022 south-southeast (Figure 9e)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.6).



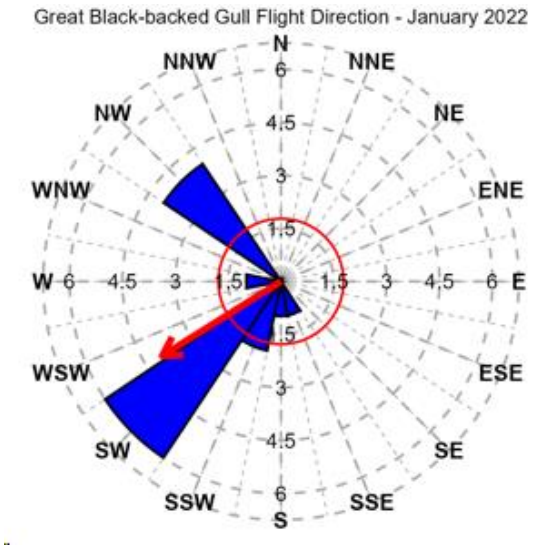
Number of Observations	8
Mean Vector (μ)	193.006
Length of Mean Vector (r)	0.718
Rayleigh Test (Z)	4.119
Rayleigh Test (p)	0.011

a September 2021



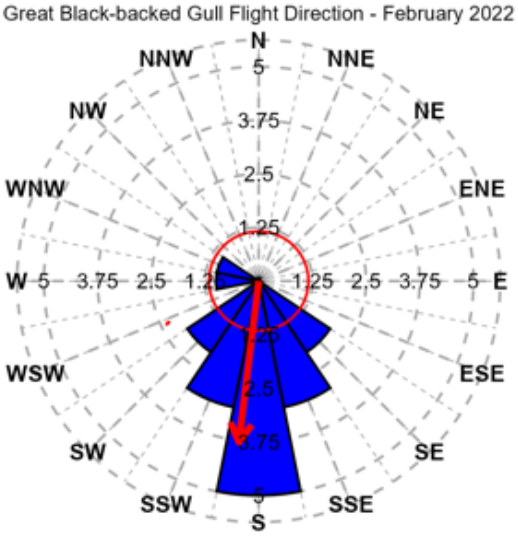
Number of Observations	9
Mean Vector (μ)	226.451
Length of Mean Vector (r)	0.807
Rayleigh Test (Z)	5.861
Rayleigh Test (p)	0.001

b December 2021



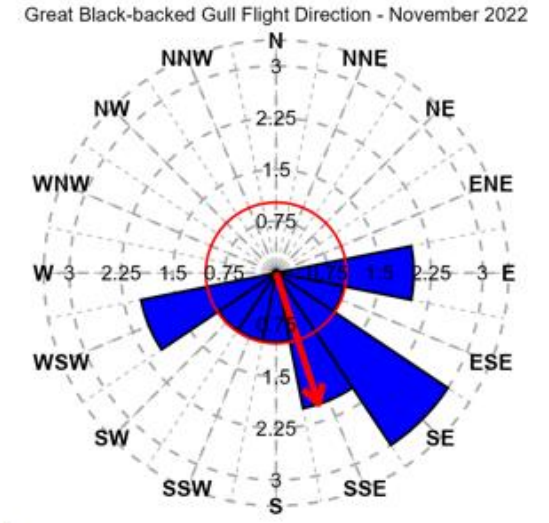
Number of Observations	15
Mean Vector (μ)	238.347
Length of Mean Vector (r)	0.662
Rayleigh Test (Z)	6.569
Rayleigh Test (p)	<0.001

c January 2022



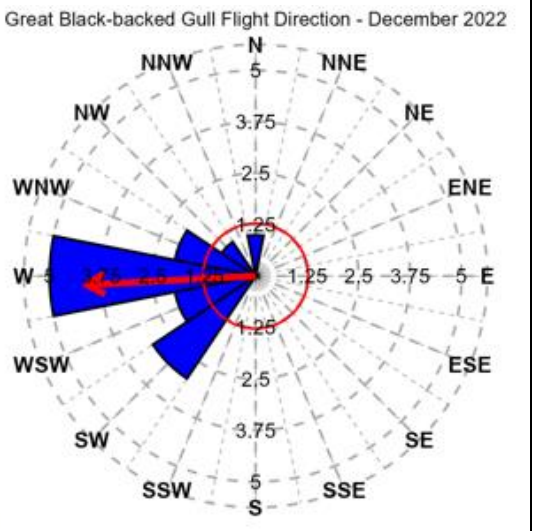
Number of Observations	17
Mean Vector (μ)	188.949
Length of Mean Vector (r)	0.756
Rayleigh Test (Z)	9.726
Rayleigh Test (p)	<0.001

d February 2022



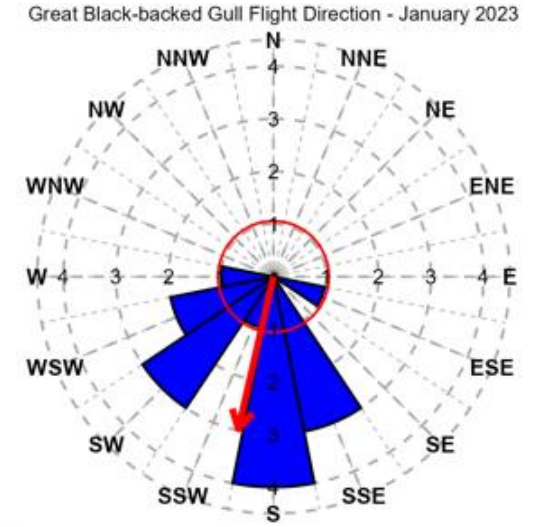
Number of Observations	13
Mean Vector (μ)	162.164
Length of Mean Vector (r)	0.664
Rayleigh Test (Z)	5.729
Rayleigh Test (p)	0.002

e November 2022



Number of Observations	14
Mean Vector (μ)	267.340
Length of Mean Vector (r)	0.821
Rayleigh Test (Z)	9.437
Rayleigh Test (p)	<0.001

f December 2022



Number of Observations	15
Mean Vector (μ)	193.113
Length of Mean Vector (r)	0.742
Rayleigh Test (Z)	8.260
Rayleigh Test (p)	<0.001

g January 2023

Figure 9 Summary of flight direction of great black-backed gulls, within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.7 Herring gull

i. Abundance and estimates

Caledonia OWF

A total of 99 herring gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Herring gulls were recorded in low numbers in all baseline surveys, except August 2021, April, May, August and September 2022, January and April 2023 (Table 8, Table 32, Figure 10). Herring gulls were the most abundant during the non-breeding season (September to March), with peak numbers recorded in November 2021 (Table 32, Figure 10):

- Seven individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 41 [7; 93], and an apportioned mean abundance estimate of 45 [7; 99] individuals. These equated to mean density estimates of 0.10 (unapportioned) and 0.11 (apportioned) birds/km^2.
- 14 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 80 [29; 137] and an apportioned mean abundance estimate of 87 [26; 176] individuals. These equated to mean density estimates of 0.12 (unapportioned) and 0.14 (apportioned) birds/km^2.
- 14 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 81 [29; 146] and an apportioned mean abundance estimate of 90 [27; 176] individuals. These equated to mean density estimates of 0.09 (unapportioned) and 0.10 (apportioned) birds/km^2.

During the non-breeding seasons covered by the baseline surveys, herring gull numbers peaked in November 2021 and December 2022, with numbers steadily growing each month prior to the peak. Both January to March periods covered by the baseline surveys recorded low numbers of birds. Whilst birds were present more consistently than the breeding season, it is still considered that Caledonia Survey Area is situated is of limited importance to this species during the non-breeding season.

Numbers of herring gulls recorded in the breeding season (April to August) were generally slightly lower than during the non-breeding season. The peak abundance was recorded in July 2022 (Table 32):

- Six individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 35 [6; 82], and an apportioned mean abundance estimate of 63 [11; 152] individuals. These equated to mean density estimates of 0.08 (unapportioned) and 0.15 (apportioned) birds/km^2.
- Seven individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 40 [7; 92] and an apportioned mean abundance estimate of 77 [20; 175] individuals. These equated to mean density estimates of 0.06 (unapportioned) and 0.12 (apportioned) birds/km^2.
- 29 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 169 [53; 310] and an apportioned mean abundance estimate of 219 [41; 494] individuals. These equated to mean density estimates of 0.19 (unapportioned) and 0.25 (apportioned) birds/km^2.

In March 2022 and 2023, during the breeding site attendance period, only a single individual was recorded in the Survey Area. In March 2022, an unapportioned mean abundance of 5 [1; 16] and an apportioned mean abundance of 10 [2; 32] individuals were estimated across all regions (Table 32). This equated to mean density estimates of 0.01 (unapportioned) and 0.02 (apportioned) birds/km^2 (Table 32).

In both breeding seasons covered by the baseline surveys, apportioned mean herring gull abundances across the Survey Area were very low in April to June (being almost completely absent between April to June 2022), with larger (though still modest) numbers of birds present in July. Birds were absent in August 2021 and 2022. This indicates that the area in which Caledonia Survey Area is situated is of limited importance to this species during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 32).

Table 32 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of herring gulls in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of herring gull raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
May-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jul-21	0	-	-	-	-	-	7	1	16	0.02
Sep-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Oct-21	3	18	3	41	0.58	0.04	27	5	66	0.06
Nov-21	**7**	**41**	**7**	**93**	**0.38**	**0.1**	**45**	**7**	**99**	**0.11**
Dec-21	2	12	2	29	0.71	0.03	12	2	29	0.03
Jan-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Feb-22	2	11	2	27	0.71	0.03	10	2	32	0.02
Mar-22	1	5	1	16	1.00	0.01	10	2	32	0.02
Jul-22	**6**	**35**	**6**	**82**	**0.41**	**0.08**	**63**	**11**	**152**	**0.15**
Oct-22	2	12	2	29	0.71	0.03	12	2	29	0.03
Nov-22	3	18	3	35	0.58	0.04	20	3	48	0.05
Dec-22	5	29	5	76	0.45	0.07	32	5	82	0.08
Feb-23	1	6	1	17	1.00	0.01	6	1	17	0.01
Mar-23	1	6	1	18	1.00	0.01	6	1	18	0.01
Apr-23	0	-	-	-	-	-	6	1	17	0.01
b) Caledonia OWF plus 2 km buffer										
May-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jul-21	0	-	-	-	-	-	12	2	16	0.02
Sep-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Oct-21	3	17	3	46	0.58	0.03	21	4	52	0.03
Nov-21	**14**	**80**	**29**	**137**	**0.27**	**0.12**	**87**	**26**	**176**	**0.14**
Dec-21	3	17	3	40	0.58	0.03	17	3	40	0.03
Jan-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Feb-22	2	11	2	27	0.71	0.02	10	2	33	0.02
Mar-22	1	5	1	16	1.00	0.01	10	2	32	0.02
Jul-22	**7**	**40**	**7**	**92**	**0.38**	**0.06**	**77**	**20**	**175**	**0.12**
Oct-22	2	12	2	29	0.71	0.02	13	2	31	0.02
Nov-22	3	17	3	35	0.58	0.03	19	3	52	0.03
Dec-22	6	35	6	93	0.41	0.05	39	7	113	0.06
Feb-23	2	11	2	29	0.71	0.02	11	2	29	0.02
Mar-23	1	6	1	17	1.00	0.01	6	1	17	0.01
Apr-23	0	-	-	-	-	-	2	0	7	0.00

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
c) Survey Area										
May-21	1	6	1	18	0.71	0.01	6	1	18	0.01
Jun-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jul-21	16	97	16	290	0.25	0.11	106	18	309	0.12
Sep-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Oct-21	7	41	12	76	0.38	0.05	45	14	90	0.05
Nov-21	**14**	**81**	**29**	**146**	**0.27**	**0.09**	**90**	**27**	**176**	**0.1**
Dec-21	3	17	3	47	0.58	0.02	17	3	47	0.02
Jan-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Feb-22	7	38	7	93	0.38	0.04	39	7	112	0.04
Mar-22	1	5	1	16	1.00	0.01	10	2	32	0.01
Jun-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Jul-22	**29**	**169**	**53**	**310**	**0.19**	**0.19**	**219**	**41**	**494**	**0.25**
Oct-22	3	18	3	35	0.58	0.02	18	3	49	0.02
Nov-22	3	18	3	35	0.58	0.02	19	3	51	0.02
Dec-22	8	47	8	106	0.35	0.05	50	8	115	0.06
Feb-23	2	12	2	29	0.71	0.01	12	2	29	0.01
Mar-23	1	6	1	18	1.00	0.01	6	1	18	0.01
Apr-23	0	-	-	-	-	-	1	0	5	0.00

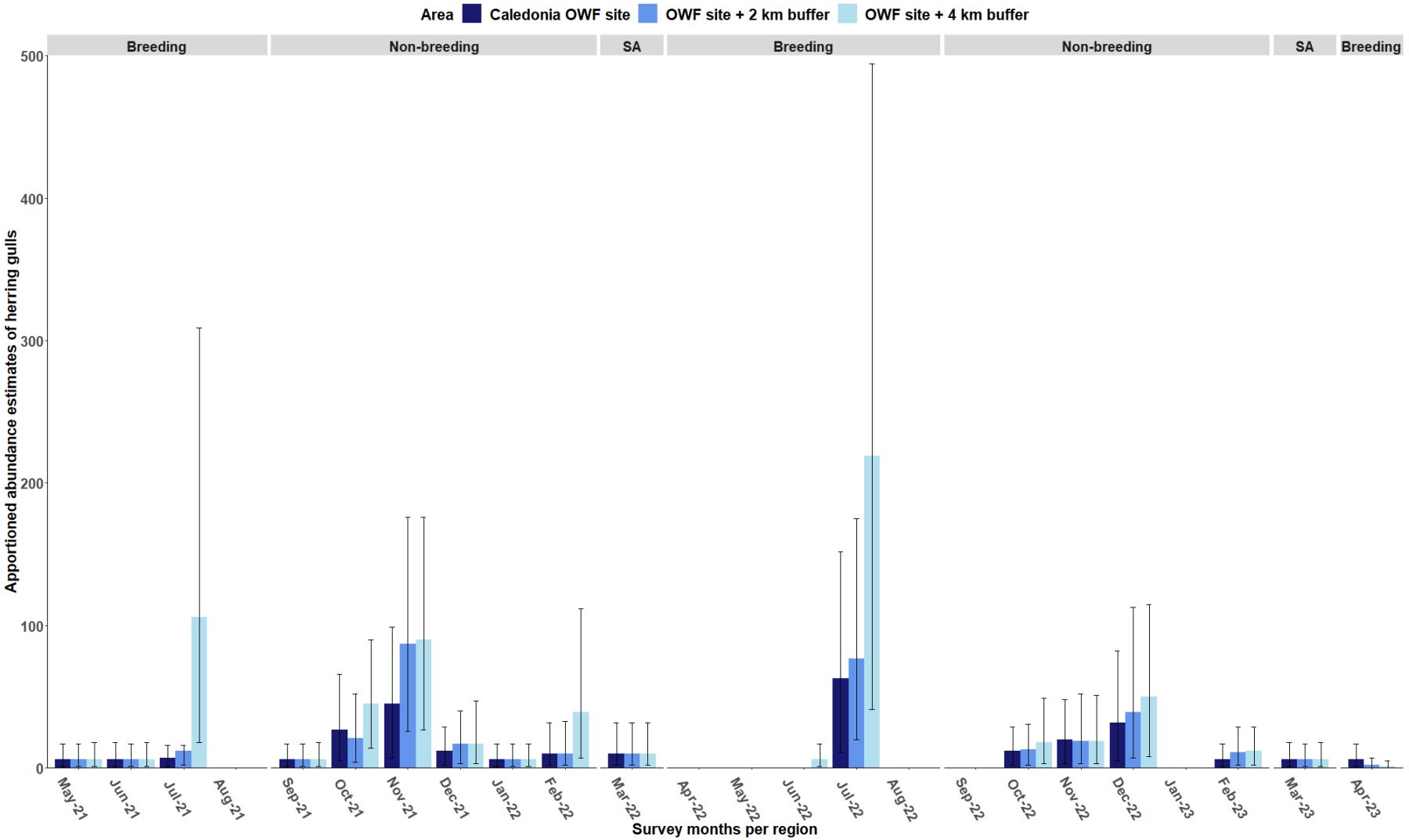


Figure 10 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of total herring gulls recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Herring gull seasonal periods are also displayed. SA stands for breeding site attendance

Caledonia North

A total of 59 herring gulls were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Herring gulls were recorded in low numbers in Caledonia North Survey Area in May, July, and September to December 2021, February, March, June, July, October to December 2022, and March 2023 (Table 9, Table 33, Figure 11). Herring gulls were the most abundant during the non-breeding season, with peak numbers recorded in October 2021 in Caledonia North, and November 2021 in Caledonia North plus 2 km buffer and Caledonia North Survey Area (Table 33, Figure 11):

- Three individuals were recorded in Caledonia North in October 2021, resulting in an unapportioned mean abundance estimate of 18 [3; 41] and an apportioned mean abundance estimate of 27 [5; 64] individuals. These equated to mean density estimates of 0.08 (unapportioned) and 0.12 (apportioned) birds/km^2.
- Eight individuals were recorded in Caledonia North plus 2 km buffer in November 2021, resulting in an unapportioned mean abundance estimate of 46 [8; 91] and an apportioned mean abundance estimate of 48 [11; 104] individuals. These equated to mean density estimates of 0.12 (unapportioned) and 0.13 (apportioned) birds/km^2.
- Nine individuals were recorded in Caledonia North Survey Area in November 2021, resulting in an unapportioned mean abundance estimate of 53 [12; 105] and an apportioned mean abundance estimate of 57 [12; 116] individuals. Both equated to a mean density estimate of 0.10 birds/km^2.

During the non-breeding seasons covered by the baseline surveys, herring gull numbers peaked in November 2021 and December 2022, with numbers steadily growing each month prior to the peak. Both January to March periods covered by the baseline surveys recorded very low numbers of birds. Birds were completely absent from the surveys on a number of occasions. It is considered that Caledonia North Survey Area is situated is of limited importance to this species during the non-breeding season.

Low numbers of herring gulls were recorded during the breeding season (April to August) in Caledonia North Survey Area. Peak counts were recorded in July 2022 in Caledonia North and Caledonia North plus 2 km buffer, and July 2021 in Caledonia North Survey Area (Table 33, Figure 11):

- Two individuals were recorded in Caledonia North in July 2022, resulting in an unapportioned and apportioned mean abundance estimate of 12 [2; 23] individuals. This equated to a mean density estimate of 0.05 birds/km^2.
- Three individuals were recorded in Caledonia North plus 2 km buffer in July 2022, resulting in an unapportioned mean abundance estimate of 17 [3; 34], and apportioned mean abundance estimate of 17 [6; 34] individuals. Both equated to a mean density estimate of 0.05 birds/km^2.
- 16 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 97 [16; 291] and an apportioned mean abundance estimate of 108 [18; 319] individuals. These equated to mean density estimates of 0.17 (unapportioned) and 0.19 (apportioned) birds/km^2.

In both breeding seasons covered by the baseline surveys, apportioned mean herring gull abundances across Caledonia North Survey Area were very low between April to June, with larger (though still modest) numbers of birds present in July. Birds were absent in August 2021 and 2022. This indicates that the area in which Caledonia Survey Area is situated is of limited importance to this species during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 33).

Table 33 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of herring gulls in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of herring gull raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
May-21	1	6	1	17	1.00	0.03	6	1	17	0.03
Jul-21	-	-	-	-	-	-	12	2	30	0.05
Sep-21	1	6	1	17	1.00	0.03	6	1	17	0.03
Oct-21	3	18	3	41	0.58	0.08	27	5	64	0.12
Nov-21	1	6	1	18	1.00	0.03	7	1	21	0.03
Dec-21	2	12	2	23	0.71	0.05	12	2	23	0.05
Feb-22	1	5	1	16	1.00	0.02	5	1	16	0.02
Mar-22	1	5	1	16	1.00	0.02	5	1	16	0.02
Jul-22	2	12	2	23	0.71	0.05	12	2	23	0.05
Oct-22	1	6	1	17	1.00	0.03	6	1	17	0.03
Dec-22	1	6	1	17	1.00	0.03	6	1	17	0.03
Mar-23	1	6	1	18	1.00	0.03	6	1	18	0.03
b) Caledonia North plus 2 km buffer										
May-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Jul-21	-	-	-	-	-	-	12	2	29	0.03
Sep-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Oct-21	3	17	3	40	0.58	0.05	20	4	52	0.05
Nov-21	8	46	8	91	0.35	0.12	48	11	104	0.13
Dec-21	2	11	2	28	0.71	0.03	11	2	28	0.03
Feb-22	1	5	1	16	1.00	0.01	5	1	17	0.01
Mar-22	1	5	1	16	1.00	0.01	5	1	16	0.01
Jul-22	3	17	3	34	0.58	0.05	17	6	34	0.05
Oct-22	1	6	1	18	1.00	0.02	7	1	21	0.02
Dec-22	4	24	4	59	0.50	0.06	27	5	73	0.07
Mar-23	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia North Survey Area										
May-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jul-21	16	97	16	291	0.25	0.17	108	18	319	0.19
Sep-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Oct-21	7	41	18	70	0.38	0.07	45	14	90	0.08
Nov-21	9	53	12	105	0.33	0.10	57	12	116	0.10
Dec-21	2	12	2	29	0.71	0.02	12	2	29	0.02
Feb-22	1	6	1	17	1.00	0.01	6	1	18	0.01
Mar-22	1	5	1	16	1.00	0.01	10	2	32	0.02
Jun-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Jul-22	12	70	12	181	0.29	0.13	71	15	193	0.13
Oct-22	1	6	1	18	1.00	0.01	6	1	20	0.01
Nov-22	1	6	1	18	1.00	0.01	6	1	18	0.01
Dec-22	5	29	5	71	0.45	0.05	32	5	76	0.06
Mar-23	1	6	1	18	1.00	0.01	6	1	18	0.01

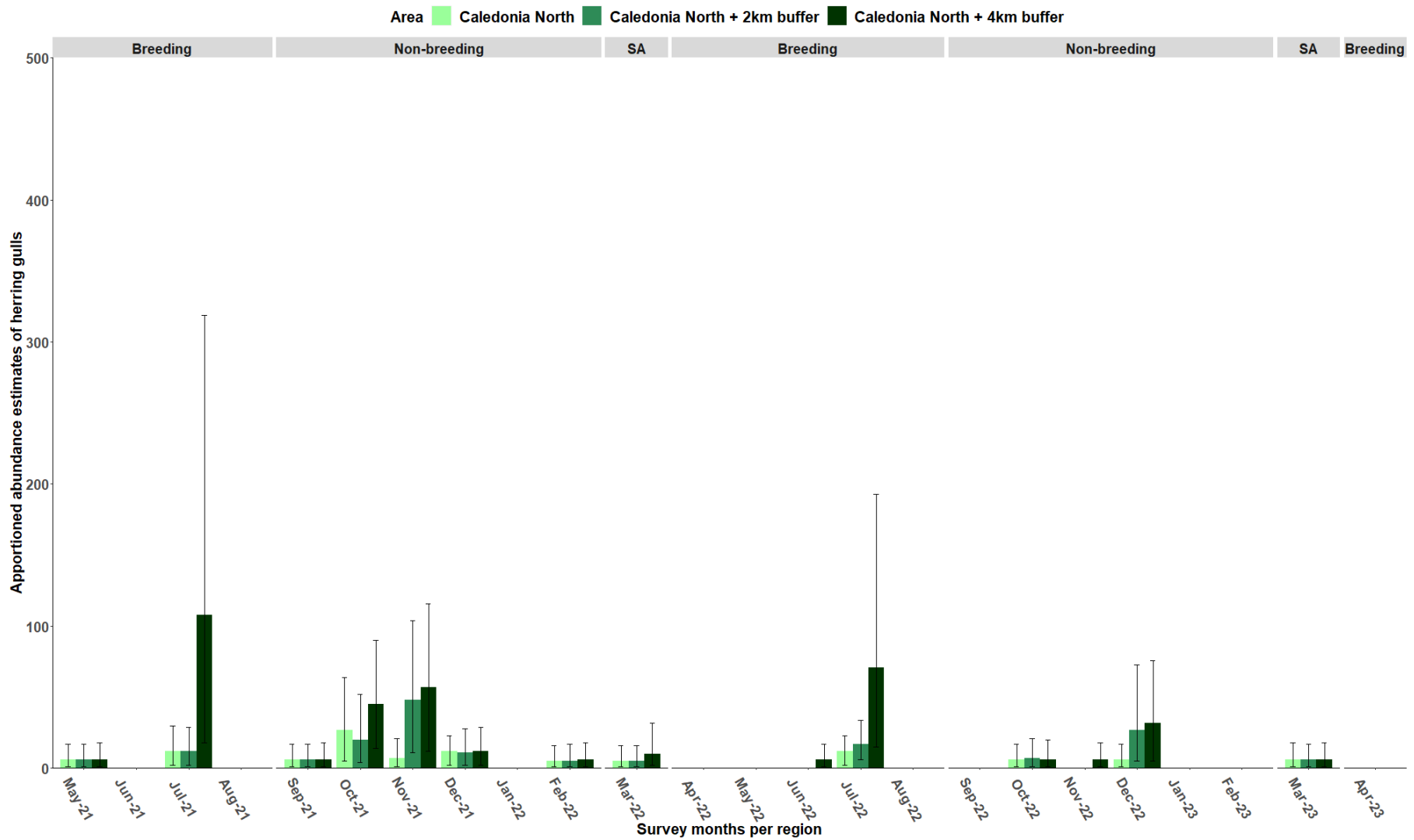


Figure 11 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total herring gulls recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Herring gull seasonal periods are also displayed. SA stands for breeding site attendance

Caledonia South

A total of 60 herring gulls were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Herring gulls were recorded in low numbers in Caledonia South Survey Area in June 2021, November 2021 to February 2022, July 2022, October to December 2022 and February 2023 (Table 10, Table 34, Figure 12). Herring gulls were the more abundant during the non-breeding season (Table 34). Peak numbers were recorded in November 2021 (Table 34, Figure 12):

- Six individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 35 [6; 81] and an apportioned mean abundance estimate of 39 [7; 93] individuals. These equated to mean density estimates of 0.17 (unapportioned) and 0.19 (apportioned) birds/km^2.
- Eight individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 46 [8; 97] and an apportioned mean abundance estimate of 51 [14; 121] individuals. These equated to mean density estimates of 0.13 (unapportioned) and 0.14 (apportioned) birds/km^2.
- Eight individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 46 [8; 98] and an apportioned mean abundance estimate of 51 [9; 120] individuals. These equated to mean density estimates of 0.09 (unapportioned) and 0.10 (apportioned) birds/km^2.

During the non-breeding seasons covered by the baseline surveys, herring gull numbers peaked in November 2021 and December 2022. Both January to March periods covered by the baseline surveys recorded very low numbers of birds. Birds were completely absent from the surveys on a number of occasions. It is considered that Caledonia South Survey Area is situated is of limited importance to this species during the non-breeding season.

Herring gulls were the most abundant during the breeding season in Caledonia South and Caledonia South plus 2 km buffer (n≤8) while a peak number was recorded in July 2022 in Caledonia South Survey Area (Table 34, Figure 11):

- Four individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 23 [4; 70] and an apportioned mean abundance estimate of 47 [8; 137] individuals. These equated to mean density estimates of 0.11 (unapportioned) and 0.22 (apportioned) birds/km^2.
- Six individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 35 [6; 87] and an apportioned mean abundance estimate of 70 [41; 168] individuals. These equated to mean density estimates of 0.10 (unapportioned) and 0.19 (apportioned) birds/km^2.
- 28 individuals in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 162 [41; 307] and an apportioned mean abundance estimate of 208 [36; 465] individuals. These equated to mean density estimates of 0.30 (unapportioned) and 0.39 (apportioned) birds/km^2.

In both breeding seasons covered by the baseline surveys, apportioned mean herring gull abundances across Caledonia South Survey Area were very low between April to June, with larger (though still modest) numbers of birds present in July 2022 (though not July 2021). Birds were absent in August 2021 and 2022. This indicates that the area in which Caledonia Survey Area is situated is of limited importance to this species during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 34).

Table 34 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of herring gulls in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of herring gull raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to August) and light blue to royal blue (peak number) for the wintering months (September to March)**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Jun-21	1	6	1	17	1.00	0.03	6	1	17	0.03
Nov-21	**6**	**35**	**6**	**81**	**0.41**	**0.17**	**39**	**7**	**93**	**0.19**
Jan-22	1	6	1	17	1.00	0.03	6	1	17	0.03
Feb-22	1	5	1	16	1.00	0.02	5	1	16	0.02
Jul-22	**4**	**23**	**4**	**70**	**0.50**	**0.11**	**47**	**8**	**137**	**0.22**
Oct-22	1	6	1	18	1.00	0.03	6	1	18	0.03
Nov-22	3	18	6	35	0.58	0.09	22	4	52	0.11
Dec-22	4	24	4	71	0.50	0.11	26	4	77	0.13
Feb-23	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia South plus 2 km buffer										
Jun-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Oct-21	-	-	-	-	-	-	1	1	2	0.00
Nov-21	**8**	**46**	**8**	**97**	**0.35**	**0.13**	**51**	**14**	**121**	**0.14**
Dec-21	2	12	2	29	0.71	0.03	12	2	29	0.03
Jan-22	1	6	1	17	1.00	0.02	6	1	17	0.02
Feb-22	1	5	1	16	1.00	0.01	5	1	16	0.01
Jul-22	**6**	**35**	**6**	**87**	**0.41**	**0.10**	**70**	**41**	**168**	**0.19**
Oct-22	2	12	2	29	0.71	0.03	12	2	34	0.03
Nov-22	3	17	3	35	0.58	0.05	19	4	44	0.05
Dec-22	5	29	5	87	0.45	0.08	31	7	93	0.09
Feb-23	2	11	2	29	0.71	0.03	11	2	29	0.03
c) Caledonia South Survey Area										
Jun-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jul-21	-	-	-	-	-	-	4	1	10	0.01
Nov-21	**8**	**46**	**8**	**98**	**0.35**	**0.09**	**51**	**9**	**120**	**0.10**
Dec-21	2	12	2	29	0.71	0.02	12	2	29	0.02
Jan-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Feb-22	7	38	7	98	0.38	0.07	38	7	103	0.07
Jul-22	**28**	**162**	**41**	**307**	**0.19**	**0.30**	**208**	**36**	**465**	**0.39**
Oct-22	2	12	2	23	0.71	0.02	12	2	36	0.02
Nov-22	3	18	3	35	0.58	0.03	19	3	52	0.04
Dec-22	6	35	6	94	0.41	0.07	38	6	106	0.07
Feb-23	2	12	2	29	0.71	0.02	12	2	29	0.02

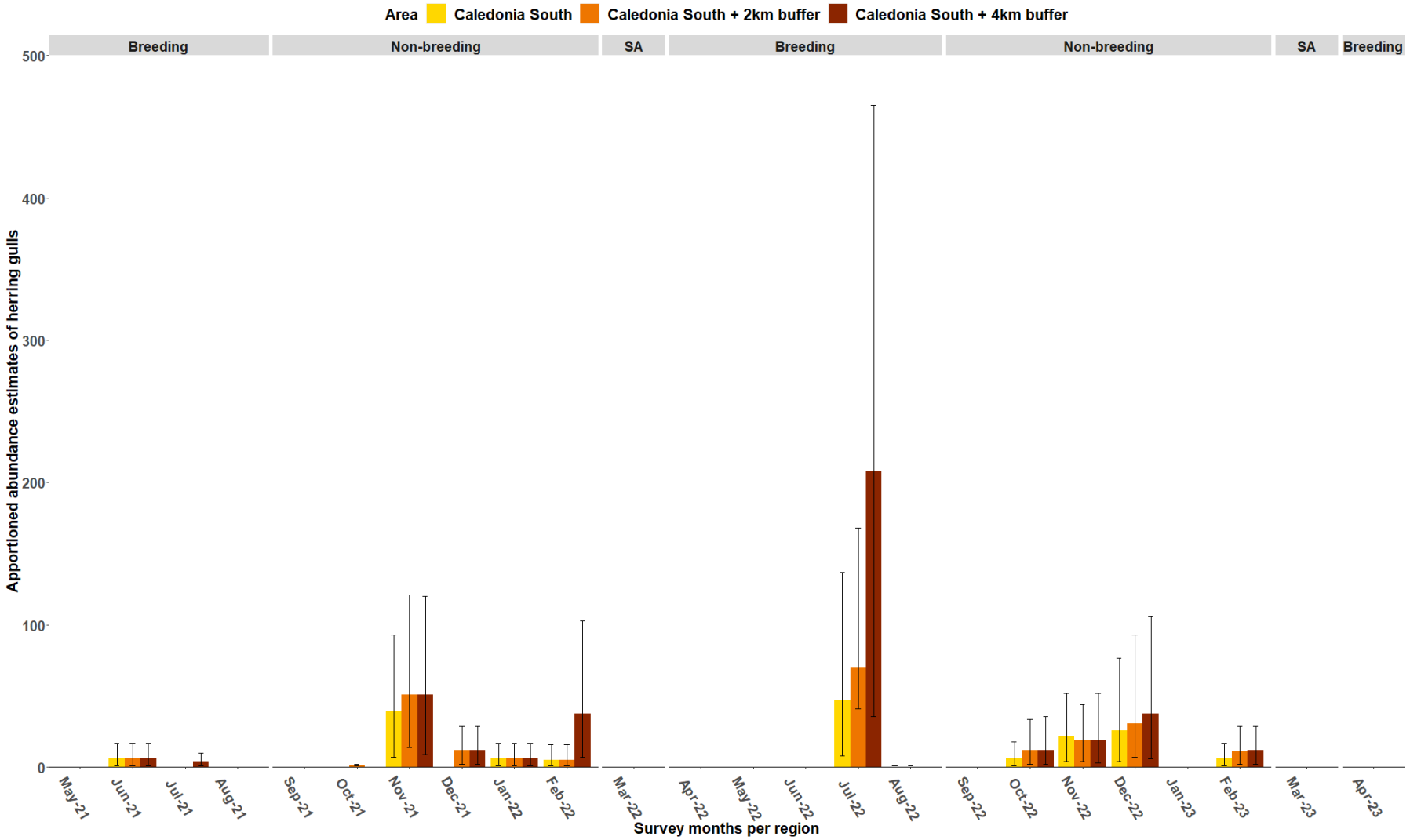


Figure 12 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total herring gulls recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Herring gull seasonal periods are also displayed. SA stands for breeding site attendance

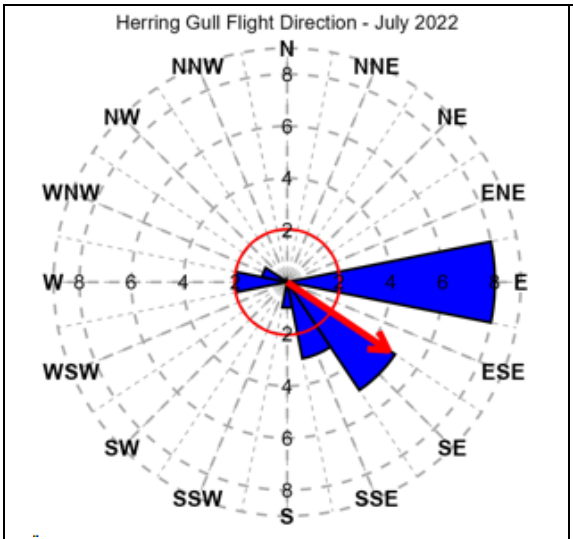
ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.48-64. Herring gulls were recorded in the north of Caledonia North in May 2021, March 2022 and 2023 (Figures A4.48, 57, 64) whereas they were recorded in Caledonia South in January 2022 (Figure A4.55). In June 2021, a single alive individual was recorded in Caledonia South and a deceased individual was recorded in Caledonia North (Figure A4.49). During July, September, and October 2021, and June 2022, they were concentrated in the west of Caledonia North, where individuals largely occurred within the Buffer Zone (Figures A4.50-52, 58). Herring gulls were loosely distributed across central parts of Caledonia OWF and Buffer Zone between November and December 2021 as well as December 2022 (Figures A4.53-54, 62). A more southern distribution was recorded in February 2022 and 2023, July, October, and November 2022 (Figure A4.56, 59-61, 63) (Figure A4.63).

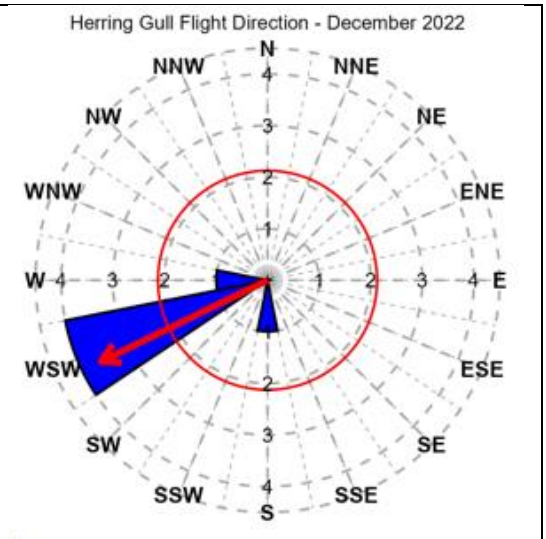
Significant predominant direction of flight was recorded in:

- **July**
  - 2022 southeast (Figure 13a)
- **December**
  - 2022 west-southwest (Figure 13b)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.7).



Number of Observations	20
Mean Vector (μ)	124.391
Length of Mean Vector (r)	0.586
Rayleigh Test (Z)	6.877
Rayleigh Test (p)	<0.001
a July 2022	



Number of Observations	6
Mean Vector (μ)	244.054
Length of Mean Vector (r)	0.897
Rayleigh Test (Z)	4.831
Rayleigh Test (p)	0.003
b December 2022	

Figure 13 Summary of flight direction of herring gulls within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.8 Lesser black-backed gull

i. Abundance and density estimates

A total of 12 lesser black-backed gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Individuals were only recorded during the breeding season (mid-March to August), in July 2021 and May to July 2022 (Table 35). Peak numbers were recorded in July 2022 across the Survey Area, with four individuals recorded in Caledonia OWF and Caledonia OWF plus 2 km buffer, and six individuals recorded in the Survey Area (Table 35). The latter resulted in an unapportioned mean abundance estimate of 35 [6; 94] and an apportioned mean abundance estimate of 56 [9; 184] individuals. These equated to mean density estimates of 0.04 (unapportioned) and 0.06 (apportioned) birds/km^2 (Table 35).

The very low number of lesser black-backed gulls recorded within the Survey Area in both years of surveys indicates a lack of connectivity between the area of sea, in which Caledonia OWF is situated, and the single SPA breeding colony of this species (Forth Islands SPA), which was identified by the HRA Screening Report (GoBe Consultants, 2022) as potentially having connectivity with Caledonia OWF during the breeding season.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 35).

Table 35 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of lesser black-backed gulls in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Jul-21	0	-	-	-	-	-	5	1	13	0.01
Jun-22	2	11	2	34	0.71	0.03	11	2	34	0.03
Jul-22	4	23	4	70	0.50	0.05	42	7	129	0.1
b) Caledonia OWF plus 2 km buffer										
Jul-21	0	-	-	-	-	-	4	1	13	0.01
Jun-22	2	11	2	34	0.71	0.02	11	2	34	0.02
Jul-22	4	23	4	69	0.50	0.04	44	7	141	0.07
c) Survey Area										
Jul-21	3	18	3	48	0.58	0.02	28	5	84	0.03
May-22	1	6	1	17	<1	0.01	6	1	17	0.01
Jun-22	2	12	2	35	0.71	0.01	12	2	35	0.01
Jul-22	6	35	6	94	0.41	0.04	56	9	184	0.06

Six lesser black-backed gulls were recorded in Caledonia North Survey Area (Table 9). In Caledonia North and Caledonia North plus 2 km buffer, two individuals were recorded in June 2022 (Table 36). However, peak numbers were recorded in July 2021 in Caledonia North Survey Area with three individuals recorded. The latter resulted in an unapportioned mean abundance estimate of 18 [3; 48] and an apportioned mean abundance estimate of 25 [4; 75] individuals, which equated to mean density estimates of 0.03 (unapportioned) and 0.05 (apportioned) birds/km^2 (Table 36).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 36 and Table 37).

Table 36 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of lesser black-backed gulls in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
Jun-22	2	11	2	34	0.71	0.05	11	2	34	0.05
b) Caledonia North plus 2 km buffer										
Jun-22	2	12	2	35	0.71	0.04	12	2	35	0.03
c) Caledonia North Survey Area										
Jul-21	3	18	3	48	0.58	0.03	25	4	75	0.05
May-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-22	2	12	2	35	0.71	0.02	12	2	35	0.02

Six lesser black-backed gulls were recorded in Caledonia South Survey Area (Table 10). In Caledonia South and Caledonia South plus 2 km buffer, four individuals were recorded in July 2022 (Table 37). However, peak numbers were recorded in July 2022 in Caledonia South Survey Area with six individuals recorded. The latter resulted in an unapportioned mean abundance estimate of 35 [6; 93] and an apportioned mean abundance estimate of 58 [10; 190] individuals, which equated to mean density estimates of 0.07 (unapportioned) and 0.11 (apportioned) birds/km^2 (Table 37).

Table 37 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of lesser black-backed gulls in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Jul-22	4	23	4	70	0.50	0.11	47	8	137	0.22
Aug-22	-	-	-	-	-	-	-	-	1	-
b) Caledonia South plus 2 km buffer										
Jul-22	4	23	4	69	0.50	0.06	46	27	144	0.13
Aug-22	-	-	-	-	-	-	-	-	1	-
c) Caledonia South Survey Area										
Jul-21	-	-	-	-	-	-	2	-	8	0.00
Jul-22	6	35	6	93	0.41	0.07	58	10	190	0.11

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figure A4.65-68. In July 2021, lesser black-backed gulls were recorded in the west of Caledonia North Buffer Zone, towards the southern end of the area occupied by Moray East wind turbines (Figure A4.65). A single individual occurred in the northeast of Caledonia North Buffer Zone in May 2022 (Figure A4.66), while two lesser black-backed gulls were recorded at the northern tip of Caledonia North in June 2022 (Figure A4.67). In contrast, individuals were concentrated in the southwest of the Survey Area, in southwest of Caledonia South and within the Buffer Zone (Figure A4.68).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.8).

4.9 Unidentified black-backed gull species

i. Abundance and density estimates

Three black-backed gulls that could not be identified to species level were recorded in the Survey Area during both years of baseline surveys, with two individuals in Caledonia North Survey Area and a single individual in Caledonia South (Table 8 to Table 10). Abundance and density estimates are therefore very low. Black-backed gull species have been used for apportioning to species level where possible.

Table 38 Raw counts, unapportioned abundance and density estimates (birds per km²) of black-backed gull species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia OWF						
Nov-21	1	6	1	17	<1	0.01
b) Caledonia OWF plus 2 km buffer						
Nov-21	2	11	2	29	0.71	0.02
c) Survey Area						
Jul-21	1	6	1	18	<1	0.01
Nov-21	2	12	2	29	0.71	0.01

Table 39 Raw counts, unapportioned abundance and density estimates (birds per km²) of black-backed gull species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
None recorded						
b) Caledonia North plus 2 km buffer						
Nov-21	1	6	1	17	<1	0.02
c) Caledonia North Survey Area						
Jul-21	1	6	1	18	<1	0.01
Nov-21	1	6	1	18	<1	0.01

Table 40 Raw counts, unapportioned abundance and density estimates (birds per km²) of black-backed gull species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
Nov-21	1	6	1	17	1.00	0.03
b) Caledonia South plus 2 km buffer						
Nov-21	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
Nov-21	1	6	1	17	1.00	0.01

ii. Distribution and behaviour

A single black-backed gull species was recorded in the west of the Survey Area towards the outer Buffer Zone boundary of Caledonia North Survey Area just north of the subdivision line during July 2021 (Appendix 4, Figure A4.69). In November 2021, one individual was recorded in the west of Caledonia North Buffer Zone near the Caledonia North boundary while the second individual was recorded in the east of Caledonia South (Appendix 4, Figure A4.70).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.9).

4.10 Unidentified large gull species

i. Abundance and density estimates

A total of 44 unidentified large gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Large gull species were recorded in the July, September to November 2021, January, March, July and October to November 2022, and April 2023 (Table 8, Table 41). The peak raw count was recorded in November 2021 in all reporting regions. In the Survey Area, 16 individuals were recorded in November 2021, resulting in an unapportioned mean abundance estimate of 93 individuals, which equated to a mean density estimate of 0.11 birds/km^2 (Table 41). Large gull species have been used for apportioning to species level where possible.

Measures of precisions were high, which is likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 41).

Table 41 Raw counts, unapportioned abundance and density estimates (birds per km^2) of large gull species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
Jul-21	2	12	2	29	0.71	0.03
Sep-21	2	12	2	29	0.71	0.03
Oct-21	4	23	4	47	0.50	0.05
Nov-21	8	46	8	93	0.35	0.11
Mar-22	1	5	1	16	<1	0.01
Jul-22	8	47	8	129	0.35	0.11
Nov-22	1	6	1	18	<1	0.01
Apr-23	1	6	1	17	<1	0.01
b) Caledonia OWF plus 2 km buffer						
Jul-21	2	12	2	29	0.71	0.02
Sep-21	3	17	3	34	0.58	0.03
Oct-21	5	29	6	58	0.45	0.05
Nov-21	12	69	17	126	0.29	0.11
Jan-22	1	6	1	17	<1	0.01
Mar-22	1	5	1	16	<1	0.01
Jul-22	10	58	10	167	0.32	0.09
Oct-22	1	6	1	17	<1	0.01
Nov-22	1	6	1	17	<1	0.01
Apr-23	1	6	1	17	<1	0.01
c) Survey Area						
Jul-21	2	12	2	30	0.71	0.01
Sep-21	4	23	6	41	0.50	0.03
Oct-21	5	29	6	59	0.45	0.03
Nov-21	16	93	47	151	0.25	0.11
Jan-22	1	6	1	17	<1	0.01
Mar-22	1	5	1	16	<1	0.01
Jul-22	12	70	12	205	0.29	0.08
Oct-22	1	6	1	18	<1	0.01
Nov-22	1	6	1	18	<1	0.01
Apr-23	1	6	1	17	<1	0.01

In Caledonia North Survey Area, large gulls were similarly recorded to the wider Survey Area, except in July and November 2022, and April 2023, where individuals were recorded in Caledonia South Survey Area (Table 9,Table 10). Large gulls were absent from Caledonia South Survey Area in September 2021, January and October 2022 (Table 9, Table 10).

Across Caledonia North Survey Area, peak numbers were recorded in October 2021, with four individuals in Caledonia North and five individuals in Caledonia North plus buffers (Table 42). In Caledonia North Survey Area, this resulted in an unapportioned mean abundance estimate of 29 [6; 41] individuals, which equated to a mean density estimate of 0.05 birds/km^2 (Table 42).

In Caledonia South, peak numbers were recorded in July 2022, with eight individuals, while a peak number of ten individuals was recorded in November 2021 and July 2022 in Caledonia South plus 2 km buffer (Table 43). In Caledonia South Survey Area, a peak number of 14 individuals was recorded in November 2021. This resulted in an unapportioned mean abundance estimate of 80 [34;144] individuals, which equated to a mean density estimate of 0.15 birds/km^2 (Table 43).

Table 42 Raw counts, unapportioned abundance and density estimates (birds per km^2) of large gull species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
Jul-21	2	12	2	30	0.71	0.05
Sep-21	2	12	2	23	0.71	0.05
Oct-21	4	23	6	47	0.50	0.11
Nov-21	1	6	1	18	<1	0.03
b) Caledonia North plus 2 km buffer						
Jul-21	2	12	2	23	0.71	0.03
Sep-21	3	17	6	34	0.58	0.05
Oct-21	5	29	6	51	0.45	0.08
Nov-21	4	23	4	57	0.50	0.06
Jan-22	1	6	1	17	<1	0.02
Oct-22	1	6	1	18	<1	0.02
c) Caledonia North Survey Area						
Jul-21	2	12	2	30	0.71	0.02
Sep-21	4	23	6	41	0.50	0.04
Oct-21	5	29	6	58	0.45	0.05
Nov-21	7	41	7	82	0.38	0.07
Jan-22	1	6	1	17	<1	0.01
Mar-22	1	5	1	16	<1	0.01
Oct-22	1	6	1	18	<1	0.01

Table 43 Raw counts, unapportioned abundance and density estimates (birds per km^2) of large gull species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
Nov-21	7	40	7	86	0.38	0.19
Mar-22	1	5	1	16	1.00	0.02
Jul-22	8	47	8	128	0.35	0.22
Nov-22	1	6	1	18	1.00	0.03
Apr-23	1	6	1	17	1.00	0.03
b) Caledonia South plus 2 km buffer						

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Oct-21	1	6	1	17	1.00	0.02
Nov-21	10	57	11	114	0.32	0.16
Mar-22	1	5	1	16	1.00	0.01
Jul-22	10	58	10	168	0.32	0.16
Nov-22	1	6	1	17	1.00	0.02
Apr-23	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
Jul-21	1	6	1	18	1.00	0.01
Oct-21	1	6	1	17	1.00	0.01
Nov-21	14	80	34	144	0.27	0.15
Mar-22	1	5	1	16	1.00	0.01
Jul-22	12	69	12	203	0.29	0.13
Nov-22	1	6	1	18	1.00	0.01
Apr-23	1	6	1	17	1.00	0.01

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.71-80. Unidentified large gulls were recorded in the north and south of Caledonia North in July 2021 (Figure A4.71), in the southwest of Caledonia North Buffer Zone in January and October 2022 (Figures A4.75, 78). They were recorded in towards the north of Caledonia North Survey Area in September 2021 (Figure A4.72) and in the centre and west of Caledonia North Survey Area in October 2021 (Figure A4.73). In November 2021, they were loosely distributed across the Survey Area, with most individuals recorded with Caledonia South Survey Area (Figure A4.74). In March 2022, the single individuals was recorded in the north of Caledonia South near the subdivision line (Figure A4.76). In July 2022, individuals were recorded in the southwest of Caledonia South Survey Area (Figure A4.77). In November 2022 and April 2023, individuals were recorded in the south of Caledonia South near the Buffer Zone boundary (Figures A4.79, 80)

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.10).

4.11 Unidentified gull species

i. Abundance and density estimates

A total of ten unidentified gulls were recorded in the Survey Area during both years of baseline surveys (Table 8). Unidentified gulls were recorded in very low numbers in May, July to August 2021, and in February, August and December 2022 (Table 8, Table 44). Abundance and density estimates were therefore very low (Table 44 to Table 46). Unidentified gulls have been used for apportioning to species level where possible.

Table 44 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified gull species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia OWF						
Jul-21	1	6	1	18	1.00	0.01
Aug-22	1	6	1	17	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01
b) Caledonia OWF plus 2 km buffer						
May-21	1	6	1	17	1.00	0.01
Jul-21	1	6	1	17	1.00	0.01

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Feb-22	1	5	1	16	1.00	0.01
Aug-22	2	11	2	29	0.71	0.02
Dec-22	2	11	2	29	0.71	0.02
c) Survey Area						
May-21	1	6	1	18	1.00	0.01
Jul-21	1	6	1	18	1.00	0.01
Aug-21	2	12	2	29	0.71	0.01
Feb-22	1	5	1	16	1.00	0.01
Aug-22	2	11	2	29	0.71	0.01
Dec-22	2	12	2	29	0.71	0.01

Table 45 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified gull species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
Jul-21	1	6	1	18	1.00	0.03
b) Caledonia North plus 2 km buffer						
Jul-21	1	6	1	17	1.00	0.02
Feb-22	1	5	1	16	1.00	0.01
Aug-22	1	6	1	17	1.00	0.02
Dec-22	1	6	1	18	1.00	0.02
c) Caledonia North Survey Area						
Jul-21	1	6	1	18	1.00	0.01
Aug-21	2	12	2	29	0.71	0.02
Feb-22	1	6	1	17	1.00	0.01
Aug-22	1	6	1	17	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01

Table 46 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified gull species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
Aug-22	1	6	1	17	1.00	0.03
Dec-22	1	6	1	18	1.00	0.03
b) Caledonia South plus 2 km buffer						
May-21	1	6	1	17	1.00	0.02
Aug-22	1	6	1	17	1.00	0.02
Dec-22	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
May-21	1	6	1	17	1.00	0.01
Aug-21	1	6	1	17	1.00	0.01
Aug-22	1	6	1	17	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.81-86. Overall, no apparent distributional pattern was discernible for unidentified gulls during the baseline survey period, with records scattered across the Survey Area.

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.11).

4.12 Common tern

i. Abundance and density estimates

Three common terns were recorded in the Survey Area during the first year of the baseline surveys, and none in the second year (Table 8). Common terns were recorded in the August 2021 survey only, specifically within Caledonia North (Table 47 to

Table 49). Abundance and density estimates were therefore very low (Table 47 to

Table 49). Although no common terns were definitively identified in August 2022, apportioning of ‘commic’ terns gave an abundance estimate of 6 [1; 17] in Caledonia OWF and all reporting region within Caledonia North Survey Area (Table 47 to

Table 49).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 47 to

Table 49).

Table 47 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of common terns in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Aug-21	3	17	3	52	0.58	0.04	29	5	87	0.07
Aug-22	0	-	-	-	-	-	6	1	17	0.01
b) Caledonia OWF plus 2 km buffer										
Aug-21	3	17	3	51	0.58	0.03	28	5	85	0.04
c) Survey Area										
Aug-21	3	17	3	52	0.58	0.02	29	5	87	0.03

Table 48 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of common terns in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
Aug-21	3	17	3	52	0.58	0.08	29	5	87	0.13
Aug-22	-	-	-	-	-	-	6	1	17	0.03
b) Caledonia North plus 2 km buffer										
Aug-21	3	17	3	51	0.58	0.05	28	5	85	0.07
Aug-22	-	-	-	-	-	-	6	1	17	0.02
c) Caledonia North Survey Area										
Aug-21	3	17	3	52	0.58	0.03	29	5	87	0.03
Aug-22	-	-	-	-	-	-	6	1	17	0.03

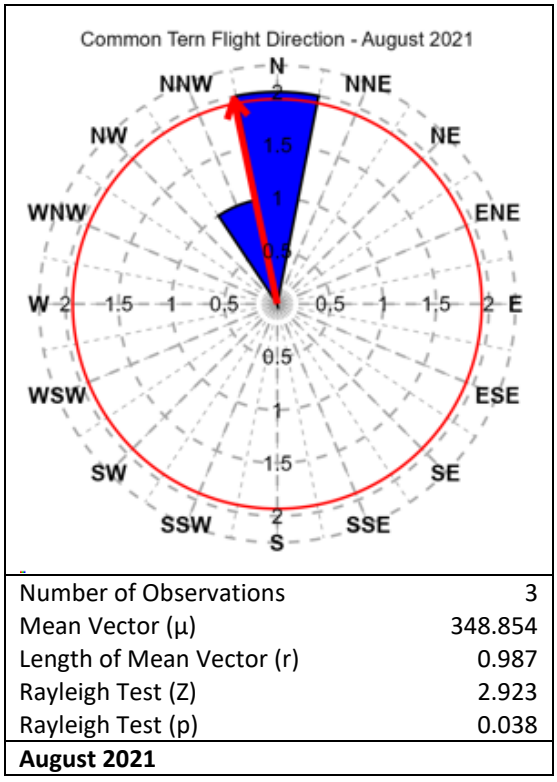
Table 49 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of common terns in Caledonia South, Caledonia South plus 2 km and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
None recorded										
b) Caledonia South plus 2 km buffer										
None recorded										
c) Caledonia South Survey Area										
Aug-21	3	17	3	52	0.58	0.03	29	5	87	0.05

ii. Distribution and behaviour

All common terns were recorded in the southwest of Caledonia North towards the boundary with the Buffer Zone (Appendix 4, Figure A4.87).

All common terns were recorded in flight, with a significant predominant direction of north-northwest (Figure 14).



Number of Observations	3
Mean Vector (μ)	348.854
Length of Mean Vector (r)	0.987
Rayleigh Test (Z)	2.923
Rayleigh Test (p)	0.038
August 2021	

Figure 14 Summary of flight direction of common terns within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.13 Arctic tern

i. Abundance and density estimates

A total of 15 Arctic terns were recorded in the Survey Area during the baseline surveys, three individuals in Caledonia North Survey Area and 12 individuals in Caledonia South Survey Area (Table 8 to Table 10). All records were made within the breeding season for this species (May to August), though the low numbers of birds recorded indicates that the Survey Area is of limited importance to this species. Arctic terns were recorded only in the 2 km and 4 km Buffer Zones, with none recorded in Caledonia OWF, and subsequently in Caledonia North and Caledonia South (Table 50 to Table 52). Despite this, some apportioned unidentified terns ('commic' tern and / or tern species) within Caledonia OWF mean that low abundances of Arctic tern were reported in Caledonia OWF during the May 2022 survey. Peak numbers of Arctic terns were recorded in May 2021 in the Survey Area, with 9 individuals, resulting in an unapportioned mean abundance estimate of 53 [12; 117] and an apportioned mean abundance estimate of 77 [16;188] individuals (Table 50). These equated to mean density estimates of 0.06 (unapportioned) and 0.09 (apportioned) birds/km^2 (Table 50).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 50).

Table 50 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of Arctic terns in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
May-22	0	-	-	-	-	-	12	2	35	0.03
b) Caledonia OWF plus 2 km buffer										
May-21	7	40	7	98	0.38	0.06	69	11	172	0.11
May-22	0	-	-	-	-	-	11	2	34	0.02
Aug-22	5	29	5	69	0.45	0.05	58	10	138	0.09
c) Survey Area										
May-21	9	53	12	117	0.33	0.06	77	16	188	0.09
May-22	0	-	-	-	-	-	12	2	35	0.01
Aug-22	6	34	6	75	0.41	0.04	80	17	167	0.09

A peak of three individuals was recorded in Caledonia North Survey Area (Table 51). This resulted in an unapportioned and apportioned mean abundance estimate of 18 [3; 41-47] individuals, which equated to a mean density estimate of 0.03 birds/km^2 (Table 51).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 51).

Table 51 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of Arctic terns in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
May-22	-	-	-	-	-	-	12	2	35	0.05
b) Caledonia North plus 2 km buffer										
May-21	1	6	1	17	1.00	0.02	6	1	17	0.02

May-22	-	-	-	-	-	-	11	2	34	0.03
c) Caledonia North Survey Area										
May-21	3	18	3	47	0.58	0.03	18	3	41	0.03
May-22	-	-	-	-	-	-	12	2	35	0.02

In Caledonia South Survey Area, six individuals were recorded in May 2021 and August 2022. In May 2021, this resulted in an unapportioned mean abundance estimate of 35 [6; 99] and apportioned mean abundance estimate of 58 [10; 162] individuals (Table 52). These equated to mean density estimates of 0.07 (unapportioned) and 0.11 (apportioned) birds/km^2 (Table 52). In August 2022, the six individuals resulted in an unapportioned mean abundance estimate of 34 [6; 75] and apportioned mean abundance estimate of 74 [13; 155] individuals (Table 52). These equated to mean density estimates of 0.06 (unapportioned) and 0.14 (apportioned) birds/km^2 (Table 52).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 52).

Table 52 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of Arctic terns in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

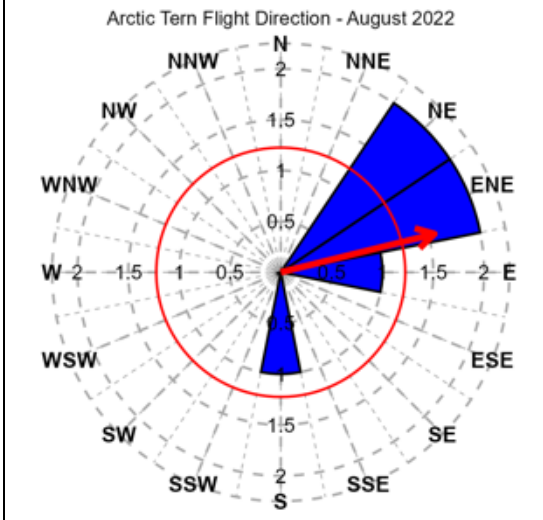
Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
None recorded										
b) Caledonia South plus 2 km buffer										
May-21	6	35	6	98	0.41	0.10	58	29	161	0.16
Aug-22	5	29	5	69	0.45	0.08	52	28	126	0.14
c) Caledonia South Survey Area										
May-21	6	35	6	99	0.41	0.07	58	10	162	0.11
Aug-22	6	34	6	75	0.41	0.06	74	13	155	0.14

ii. Distribution and behaviour

Arctic terns were recorded within the Survey Area Buffer Zone both in May 2021 and August 2022; they were recorded in the northeast and south of the Survey Area Buffer Zone in May whereas they were only in Caledonia South Buffer Zone in August, specifically in the east and south of the Buffer Zone (Appendix 4, Figure A4.88-89).

In August 2022, Arctic terns were recorded flying in a significant east-northeasterly direction (Figure 15).

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.12).



Number of Observations	6
Mean Vector (μ)	76.705
Length of Mean Vector (r)	0.778
Rayleigh Test (Z)	3.636
Rayleigh Test (p)	0.019
August 2022	

Figure 15 Summary of flight direction of Arctic terns within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.14 'Commic' tern

i. Abundance and density estimates

A total of 19 'commic' terns were recorded in the Survey Area during both years of baseline surveys (Table 8). 'Commic' terns were recorded in low numbers in May 2021, August 2021 and August 2022 (Table 53). In the Survey Area, a peak of eight individuals were recorded in August 2022, resulting in an unapportioned mean abundance estimate of 46 [11; 92] individuals (Table 53). This equated to a mean density estimate of 0.05 birds/km^2 (Table 53). 'Commic' terns have been used for apportioning to species level where possible.

Table 53 Raw counts, unapportioned abundance and density estimates (birds per km^2) of 'commic' terns in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
Aug-21	2	12	2	35	0.58	0.03
May-22	4	23	4	70	0.71	0.05
Aug-22	1	6	1	17	0.50	0.01
b) Caledonia OWF plus 2 km buffer						
May-21	3	17	3	52	0.58	0.03
Aug-21	2	11	2	34	0.71	0.02
May-22	4	23	4	69	0.50	0.04
Aug-22	5	29	5	74	0.45	0.05
c) Survey Area						
May-21	3	18	3	53	0.58	0.02
Aug-21	2	12	2	35	0.71	0.01
May-22	6	35	6	93	0.41	0.04

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Aug-22	8	46	11	92	0.35	0.05

In Caledonia North Survey Area, the peak number of 'commic' terns recorded was six individuals in May 2022, resulting in an unapportioned mean abundance estimate of 35 [6; 81] individuals (Table 54). This equated to a mean density estimate of 0.06 birds/km^2 (Table 54).

Table 54 Raw counts, unapportioned abundance and density estimates (birds per km^2) of 'commic' terns in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
Aug-21	2	12	2	35	0.71	0.05
May-22	4	23	4	70	0.50	0.11
Aug-22	1	6	1	17	<1	0.03
b) Caledonia North plus 2 km buffer						
Aug-21	2	11	2	34	0.71	0.03
May-22	4	23	4	68	0.50	0.06
Aug-22	1	6	1	17	<1	0.02
c) Caledonia North Survey Area						
Aug-21	2	12	2	35	0.71	0.02
May-22	6	35	6	81	0.41	0.06
Aug-22	1	6	1	17	<1	0.01

In Caledonia South Survey Area, a peak count of seven individuals was recorded in August 2022, resulting in an unapportioned mean abundance estimate of 40 [7; 86] individuals (Table 55). This equated to a mean density estimate of 0.07 birds/km^2 (Table 55).

Table 55 Raw counts, unapportioned abundance and density estimates (birds per km^2) of 'commic' terns in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
None recorded						
b) Caledonia South plus 2 km buffer						
May-21	3	17	3	52	0.58	0.05
Aug-22	4	23	4	57	0.50	0.06
c) Caledonia South Survey Area						
May-21	3	17	3	52	0.58	0.03
Aug-21	2	12	2	35	0.71	0.02
May-22	2	11	2	34	0.71	0.02
Aug-22	7	40	7	86	0.38	0.07

ii. Distribution and behaviour

Maps of 'commic' tern distribution are shown in Appendix 4: Figures A4.90-93. In May 2021, they were recorded in the south of Caledonia South Buffer Zone near Caledonia South boundary (Figure A4.90). In August 2021, they were recorded in the southwest of Caledonia North, close to the Buffer Zone boundary (Figure A4.91). In May 2022, they were recorded in the north of the Caledonia North and in the southeast of Caledonia North Buffer Zone (Figure A4.92). In August 2022, individuals were recorded in the north of Caledonia North and in the east, south and southwest of Caldonia South Buffer Zone (Figure A4.93).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.13).

4.15 Unidentified tern species

i. Abundance and density estimates

Three unidentified terns were recorded in the Survey Area during the first year of the baseline surveys, none were recorded during the second year of surveys (Table 8), or in Caledonia OWF during either year (Table 56). Unidentified tern species were recorded in low numbers in the May and July 2021 surveys (Table 56). In the Survey Area, a peak of two individuals was recorded in July 2021, resulting in an unapportioned mean abundance estimate of 12 [2; 36] individuals, which equated to a mean density estimate of 0.01 birds/km^2 (Table 56). Unidentified tern species have been used for apportioning to species level where possible.

Table 56 Raw counts, unapportioned abundance and density estimates (birds per km^2) of unidentified tern species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
None recorded						
b) Caledonia OWF plus 2 km buffer						
May-21	1	6	1	17	1.00	0.01
Jul-21	2	12	2	35	0.71	0.02
c) Survey Area						
May-21	1	6	1	18	1.00	0.01
Jul-21	2	12	2	36	0.71	0.01

In Caledonia North Survey Area, two individuals were recorded in the 2 km Buffer Zone in July 2021, resulting in an unapportioned mean abundance estimate of 12 [2; 36] individuals in the Caledonia North Survey Area (Table 57). This equated to a mean density estimate of 0.02 birds/km^2 (Table 57).

Table 57 Raw counts, unapportioned abundance and density estimates (birds per km^2) of unidentified tern species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
None recorded						
b) Caledonia North plus 2 km buffer						
Jul-21	2	12	2	35	0.71	0.03
c) Caledonia North Survey Area						
Jul-21	2	12	2	36	0.71	0.02

A single individual was recorded in the 2 km Buffer Zone in May 2021 (Table 58). This resulted in an unapportioned mean abundance estimate of 6 [1; 17] individuals in the Caledonia South Survey Area (Table 58). This equated to a mean density estimate of 0.01 birds/km^2 (Table 58).

Table 58 Raw counts, unapportioned abundance and density estimates (birds per km^2) of unidentified tern species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
None recorded						
b) Caledonia South plus 2 km buffer						
May-21	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
May-21	1	6	1	17	1.00	0.01

ii. Distribution and behaviour

Unidentified terns were recorded in south of the Survey Area, in Caledonia South Buffer Zone near the boundary with Caledonia South in May 2021 (Appendix 4, Figure A4.94) whereas they were they were recorded in northeast of Caledonia North Buffer Zone, near the boundary with Caledonia North in July 2021 (Appendix 4, Figure A4.95).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.14).

4.16 Great skua

i. Abundance and density estimates

Caledonia OWF

A total of 22 great skuas were recorded in the Survey Area during both years of baseline surveys (Table 8). Only two great skuas were recorded during the second year of surveys (Table 8). All records of great skuas were made during the breeding season (mid-April to mid-September) (

Table 59, Figure 16). Peak numbers were recorded in July 2021 (

Table 59, Figure 16):

- Four individuals were recorded in Caledonia OWF, resulting in an unapportioned and apportioned mean abundance estimates of 24 [4; 65-71] individuals. Both equated to a mean density estimate of 0.06 birds/km^2.
- Six birds were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned and apportioned mean abundance estimate of 35 [6; 93-99] individuals. Both equated to a mean density estimate of 0.05 birds/km^2.
- Ten individuals were recorded in the Survey Area, resulting in an unapportioned and apportioned mean abundance estimates of 60 [4; 65-71] individuals. Both equated to a mean density estimate of 0.07 birds/km^2.

Whilst present within the Survey Area during both breeding seasons, the trends observed for great skua abundance in this seasonal period were characterised by relatively consistent and low apportioned mean abundances across all reporting regions. Birds were recorded much more frequently in the 2021 breeding season than in the 2022 breeding season.

Great skuas were not recorded during the non-breeding season (mid-September to mid-April) (

Table 59, Figure 16).

Measures of precision were high in all surveys in which this species was recorded, which is likely related to the low numbers of individuals recorded in each region (CV > 0.16;

Table 59).

Table 59 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of great skuas in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. A colour gradient, light yellow to orange (peak number), follow the ascending order of great skua raw counts breeding season months (mid-April to mid-September)**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
May-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-21	2	12	2	29	0.71	0.03	12	2	36	0.03
Jul-21	**4**	**24**	**4**	**65**	**0.50**	**0.06**	**24**	**4**	**71**	**0.06**
Aug-21	**4**	**23**	**4**	**64**	**0.50**	**0.05**	**23**	**4**	**58**	**0.05**
Jul-22	2	12	2	35	0.71	0.03	12	2	36	0.03
b) Caledonia OWF plus 2 km buffer										
May-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-21	2	12	2	29	0.71	0.02	12	2	34	0.02
Jul-21	**6**	**35**	**6**	**93**	**0.41**	**0.05**	**35**	**6**	**99**	**0.05**
Aug-21	5	29	5	68	0.45	0.05	29	5	68	0.05
Jul-22	2	12	2	35	0.71	0.02	12	2	34	0.02
c) Survey Area										
May-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jun-21	2	12	2	29	0.71	0.01	12	2	36	0.01
Jul-21	**10**	**60**	**10**	**133**	**0.32**	**0.07**	**60**	**12**	**145**	**0.07**
Aug-21	6	35	6	81	0.41	0.04	35	6	75	0.04
Sep-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jul-22	2	12	2	35	0.71	0.01	12	2	36	0.01

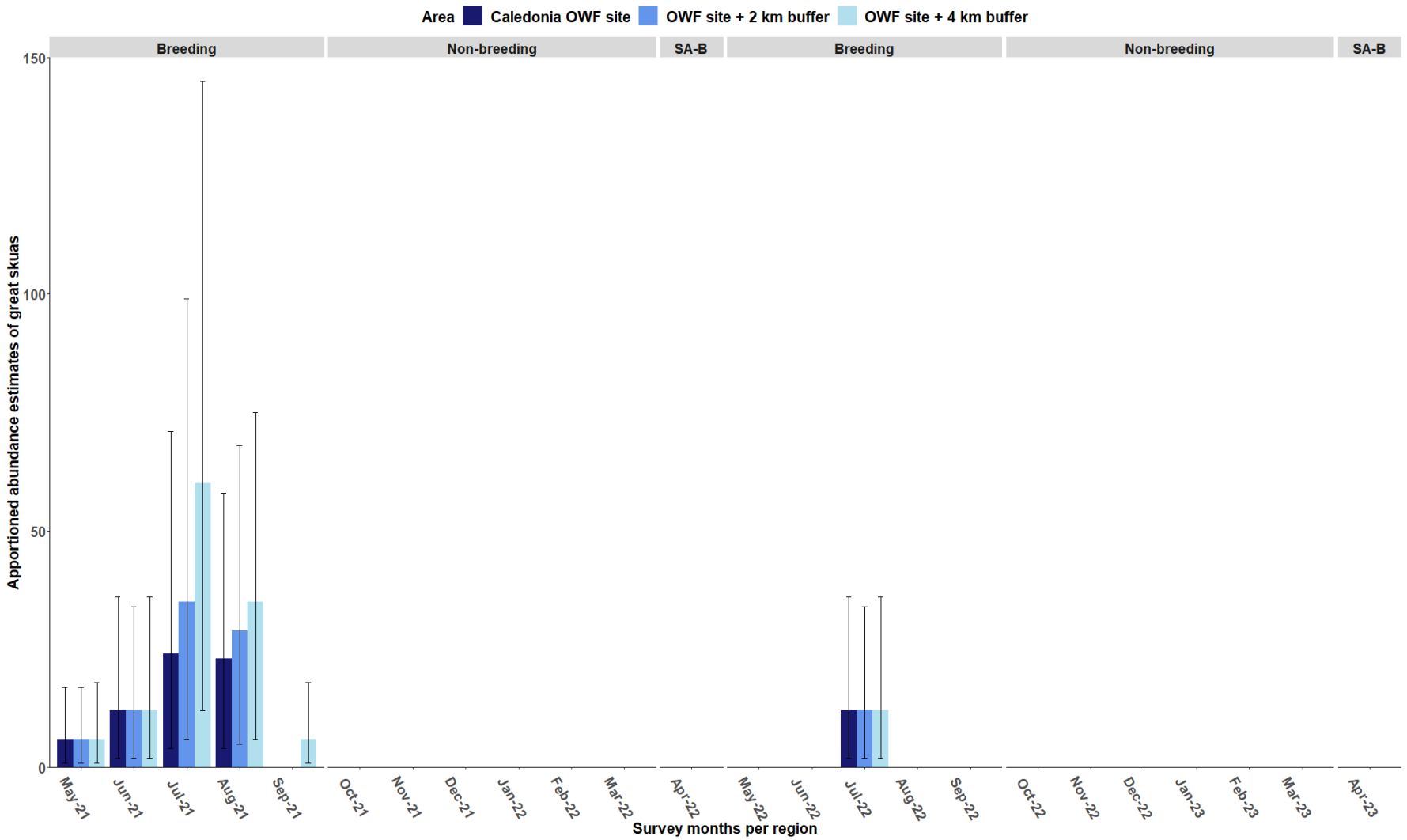


Figure 16 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total great skuas recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Great skua seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)

Caledonia North

A total of 16 great skuas were recorded in Caledonia North Survey Area during both years of baseline surveys, with only two of these being recorded during the second year of surveys (Table 9). The peak count was recorded in August 2021 (Table 60, Figure 17):

- Three individuals were recorded in Caledonia North, resulting in an unapportioned and apportioned mean abundance estimate of 17 [3; 41] individuals. Both equated to a mean density estimate of 0.08 birds/km^2.
- Four individuals were recorded in Caledonia North plus 2 km, resulting in an unapportioned and apportioned mean abundance estimate of 23 [4; 57] individuals. Both equated to a mean density estimate of 0.06 birds/km^2.
- Six individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned and apportioned mean abundance estimate of 35 [6; 75] individuals. Both equated to a mean density estimate of 0.06 birds/km^2.

Whilst present within Caledonia North Survey Area during both breeding seasons, the trends observed for great skua abundance in this seasonal period were characterised by relatively consistent and low apportioned mean abundances across all reporting regions. Great skuas were recorded much more frequently in the 2021 breeding season than in the 2022 breeding season.

Great skuas were absent during the non-breeding season (mid-September to mid-April) (Table 60, Figure 17).

Measures of precisions were high, which is likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 60).

Table 60 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of great skuas in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. A colour gradient, light yellow to orange (peak number), follow the ascending order of great skua raw counts breeding season months (mid-April to mid-September)

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
May-21	1	6	1	17	1.00	0.03	6	1	17	0.03
Jun-21	2	12	2	30	0.71	0.05	12	2	36	0.05
Jul-21	1	6	1	18	1.00	0.03	6	1	18	0.03
Aug-21	**3**	**17**	**3**	**41**	**0.58**	**0.08**	**17**	**3**	**41**	**0.08**
Jul-22	1	6	1	18	1.00	0.03	6	1	18	0.03
b) Caledonia North plus 2 km buffer										
May-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Jun-21	2	12	2	29	0.71	0.03	12	2	34	0.03
Jul-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Aug-21	**4**	**23**	**4**	**57**	**0.50**	**0.06**	**23**	**4**	**57**	**0.06**
Jul-22	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia North Survey Area										
May-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jun-21	2	12	2	30	0.71	0.02	12	2	36	0.02
Jul-21	5	30	5	73	0.45	0.05	30	5	72	0.05
Aug-21	**6**	**35**	**6**	**75**	**0.41**	**0.06**	**35**	**6**	**75**	**0.06**
Jul-22	2	12	2	35	0.71	0.02	12	2	36	0.02

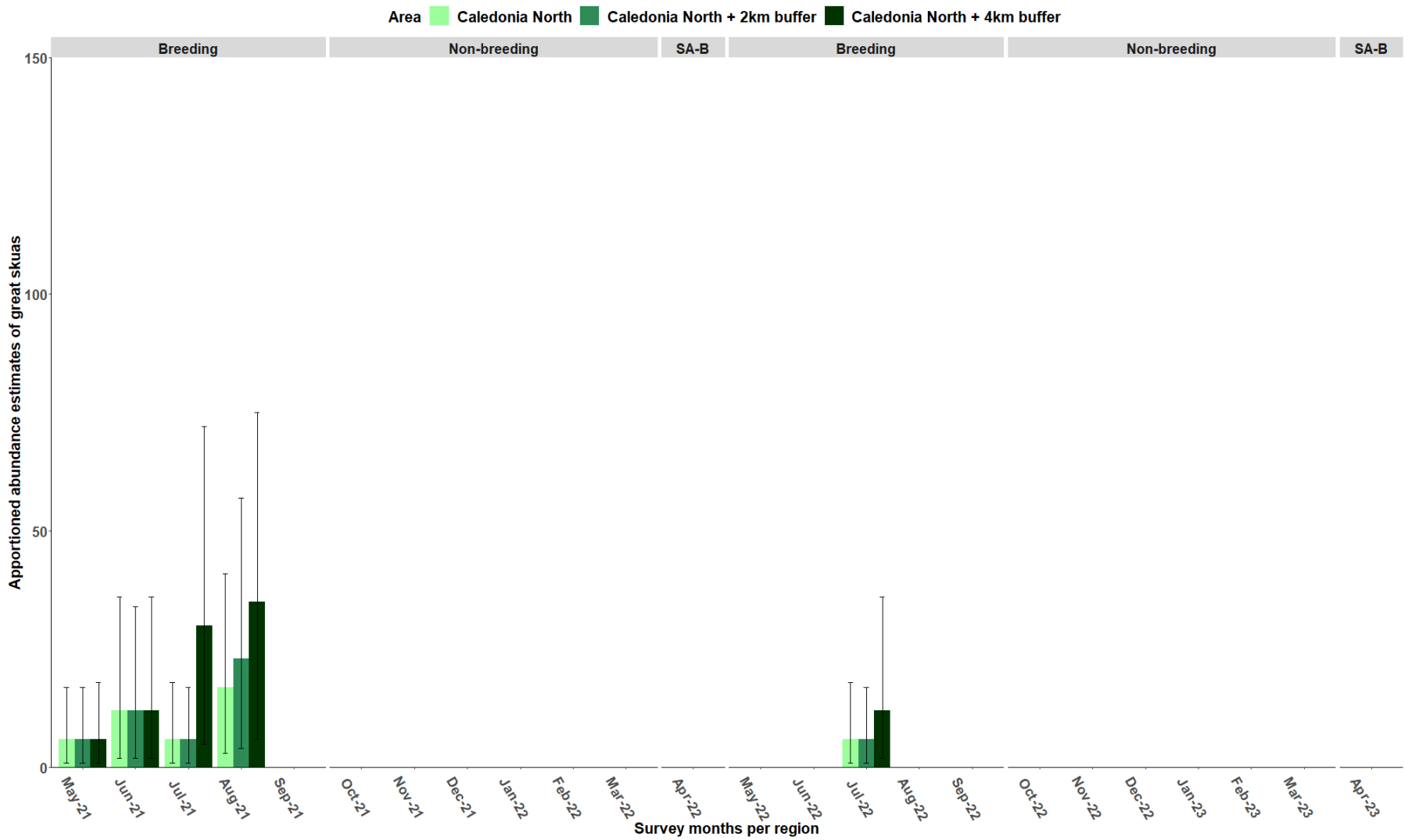


Figure 17 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total great skuas recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Great skua seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)

Caledonia South

A total of 11 great skuas were recorded in Caledonia South Survey Area during both years of baseline surveys, with a single individual recorded in 2022 (Figure 10). All records of great skuas were made, in low numbers, during the breeding season (between mid-April to mid-September) (Table 61, Figure 18). Peak numbers were recorded in July 2021 (Table 61, Figure 18):

- Three individuals were recorded in Caledonia South, resulting in an unapportioned and apportioned mean abundance estimate of 18 [3; 53] individuals. Both equated to a mean density estimate of 0.09 birds/km^2.
- Five individuals were recorded in Caledonia South plus 2 km, resulting in an unapportioned and apportioned mean abundance estimate of 30 [5; 90] individuals. Both equated to a mean density estimate of 0.08 birds/km^2.
- Five individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned and apportioned mean abundance estimate of 30 [5; 90] individuals. Both equated to a mean density estimate of 0.06 birds/km^2.

Whilst present within Caledonia South Survey Area during both breeding seasons, the trends observed for great skua abundance in this seasonal period were characterised by relatively consistent and low apportioned mean abundances across all reporting regions. Great skuas were recorded much more frequently in the 2021 breeding season than in the 2022 breeding season.

Great skuas were recorded absent during the non-breeding season (mid-September to mid-April) (Table 61, Figure 18).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 61).

Table 61 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of great skuas in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. A colour gradient, light yellow to orange (peak number), follow the ascending order of great skua raw counts breeding season months (mid-April to mid-September)

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Jul-21	**3**	**18**	**3**	**53**	**0.58**	**0.09**	**18**	**3**	**53**	**0.09**
Aug-21	1	6	1	17	1.00	0.03	6	1	17	0.03
Jul-22	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia South plus 2 km buffer										
Jun-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Jul-21	**5**	**29**	**5**	**87**	**0.45**	**0.08**	**29**	**5**	**87**	**0.08**
Aug-21	2	11	2	29	0.71	0.03	11	2	29	0.03
Jul-22	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia South Survey Area										
Jun-21	2	12	2	29	0.71	0.02	12	2	34	0.02
Jul-21	**5**	**30**	**5**	**90**	**0.45**	**0.06**	**30**	**5**	**90**	**0.06**
Aug-21	2	12	2	29	0.71	0.02	12	2	29	0.02
Sep-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jul-22	1	6	1	17	1.00	0.01	6	1	17	0.01

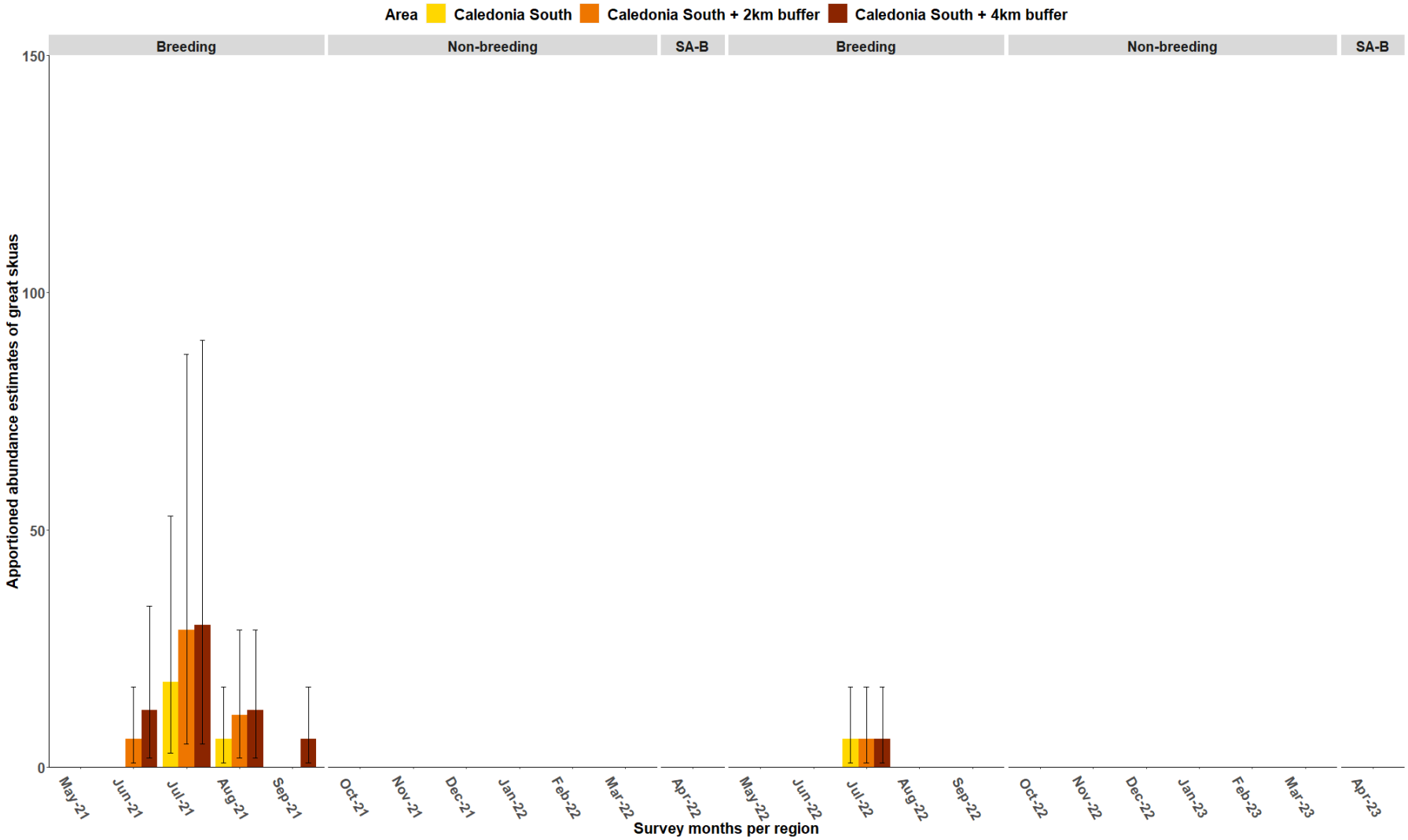
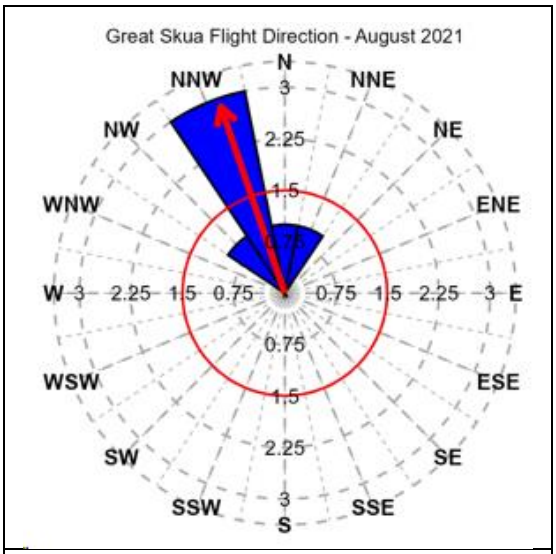


Figure 18 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total great skuas recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Great skua seasonal periods are also displayed. SA-B corresponds to month split between breeding site attendance (SA) and breeding (B)

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.96-101. In May and June 2021, great skuas were recorded within Caledonia North (Figure A4.96-97). They were recorded both in northern and southern parts of the Survey Area during July and August 2021 with highest numbers across Caledonia North Survey Area and generally more records within Caledonia North (Figure A4.98-99). In September 2021, a single great skua was recorded in the south of Caledonia South buffer (Figure A4.100). Two individuals were recorded in the centre of the Survey Area in July 2022, One within Caledonia North and one within Caledonia South (Figure A4.101).

In August 2021, great skua were recorded flying in a significantly north-northwest direction (Figure 19d). The number of great skuas recorded in flight in any other months were too low to determine a significant flight direction. (Appendix 5, Figure A5.15).



Number of Observations	6
Mean Vector (μ)	341.279
Length of Mean Vector (r)	0.957
Rayleigh Test (Z)	5.499
Rayleigh Test (p)	<0.001
August 2021	

Figure 19 Summary of flight direction of great skuas within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.17 Arctic skua

i. *Abundance and density estimates*

Two Arctic skuas were recorded in the Survey Area during the second year of the baseline surveys (Table 8). The two individuals were recorded in August 2022 during the breeding season (May to August) (Table 62). These led to unapportioned and apportioned mean abundance estimate of 11 [2; 29] individuals, which equated to a mean density estimate of 0.01 birds/km^2 (Table 62).

No Arctic skuas were recorded during the non-breeding season and site attendance period (Table 62).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16, Table 62).

Table 62 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of Arctic skuas in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Aug-22	1	6	1	17	1.00	0.01	6	1	17	0.01
b) Caledonia OWF plus 2 km buffer										
Aug-22	2	11	2	29	0.71	0.02	11	2	29	0.02
c) Survey Area										
Aug-22	2	11	2	29	0.71	0.01	11	2	29	0.01

A single individual was recorded in Caledonia North, resulting in very low abundance and density estimates (Table 63). No Arctic skuas were recorded in Caledonia South, however, two individuals were recorded in the 2 km Buffer Zone of Caledonia South (Table 64). These resulted in an unapportioned and apportioned abundance estimate of 11 [2; 29] individuals, which equated to a mean density estimate of 0.03 birds/km^2 (Table 64).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16, Table 63 and Table 64).

Table 63 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of Arctic skuas in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
Aug-22	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia North plus 2 km buffer										
Aug-22	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia North Survey Area										
Aug-22	1	6	1	17	1.00	0.01	6	1	17	0.01

Table 64 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of Arctic skuas in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
None recorded										
b) Caledonia South plus 2 km buffer										
Aug-22	2	11	2	29	0.71	0.03	11	2	29	0.03
c) Caledonia South Survey Area										
Aug-22	2	11	2	29	0.71	0.02	11	2	29	0.02

ii. *Distribution and behaviour*

Arctic skuas were only recorded in August 2022, with one individual recorded in the southern tip of Caledonia South Buffer Zone and one recorded in the south of Caledonia North, near the subdivision line with Caledonia South (Appendix 4, Figure A4.102).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.16).

4.18 Guillemot

i. Abundance and density estimates

Caledonia OWF

A total of 20,137 guillemots were recorded in the Survey Area during both years of baseline surveys (Table 8). Guillemots were recorded in every survey (Table 8, Table 65). Highest abundances were recorded during the breeding season (April to mid-August), with guillemots attending colonies from February onwards), especially from May to July, with a peak of abundance recorded in May 2022 (Table 65, Figure 20):

- 1,511 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 8,755 [5,464; 12,277], an apportioned mean abundance estimate of 9,643 [6,067; 13,857] and an apportioned and availability bias-corrected mean abundance estimate of 12,547 [7,909; 18,015] individuals. These equated to mean density estimates of 20.49 (unapportioned), 22.55 (apportioned) and 29.34 (apportioned and availability bias-corrected) birds/km^2.
- 2,388 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 13,660 [8,735; 18,866], an apportioned mean abundance estimate of 14,995 [9,648; 20,305] and an apportioned and availability bias-corrected mean abundance estimate of 19,546 [12,599; 26,440] individuals. These equated to mean density estimates of 21.23 (unapportioned), 23.28 (apportioned) and 30.35 (apportioned and availability bias-corrected) birds/km^2.
- 3,127 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 18,156 [11,792; 24,548], an apportioned mean abundance estimate of 19,915 [12,794; 27,330] and an apportioned and availability bias-corrected mean abundance estimate of 25,952 [16,690; 35,597] individuals. These equated to mean density estimates of 20.55 (unapportioned), 22.52 (apportioned) and 29.35 (apportioned and availability bias-corrected) birds/km^2.

In both breeding seasons covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances across the Survey Area were low at the beginning of the season (i.e. April), and rapidly increased thereafter. Peak abundances occurred either in July (2021) or May (2022), with mean abundances being consistently high throughout May to July in both survey years. Between July and August, apportioned and availability bias-corrected mean guillemot abundances dropped substantially in both breeding seasons covered by the baseline survey period, with low abundances observed in both August 2021 and August 2022. These temporal patterns are indicative of a rapid arrival and departure of birds from the Survey Area close to the start and end of the breeding season. The higher mean abundances in May to July indicate that the Survey Area is likely being used by breeding adults from nearby colonies. Apportioned and availability bias-corrected mean guillemot abundances across the breeding seasons of both 2021 and 2022 were relatively similar, with no obvious significant differences in apportioned and availability bias-corrected mean guillemot abundances between the two seasons.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month (May 2022) varied from 16% to 96%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

During both years of surveys, guillemots were also recorded during the non-breeding period (September to March), albeit in lower numbers than the breeding season, with a wintering peak of abundance in September 2022 (Table 65, Figure 20):

- 390 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 2,257 [1,302; 3,455], an apportioned mean abundance estimate of 2,701 [1,556; 4,119] and an apportioned and availability bias-corrected mean abundance estimate of 3,530 [2,037; 5,378] individuals. These equated to mean density estimates of 5.28 (apportioned), 6.32 (unapportioned) and 8.26 (apportioned and availability bias-corrected) birds/km^2.
- 1,303 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 7,520 [2,170; 17,222], an apportioned mean abundance estimate of 8,710 [2,608; 18,652] and an apportioned and availability bias-corrected mean abundance estimate of 11,408 [3,416; 24,432] individuals. These equated to mean density estimates of 11.69 (unapportioned), 13.52 (apportioned) and 17.71 (apportioned and availability bias-corrected) birds/km^2.
- 2,038 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 11,892 [4,476; 22,921], an apportioned mean abundance estimate of 13,436 [5,251; 26,308] and an apportioned and availability bias-corrected mean abundance estimate of 17,603 [6,882; 34,468] individuals. These equated to mean density estimates of 13.46 (unapportioned), 15.19 (apportioned) and 19.90 (apportioned and availability bias-corrected) birds/km^2.

During the breeding site attendance period (February and March), guillemots were also recorded in low numbers (lower than the rest of the non-breeding period), with peak numbers in March 2023 (Table 65, Figure 20):

- 289 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 1,686 [1,143; 2,223], an apportioned mean abundance estimate of 1,821 [1,209; 2,479] and an apportioned and availability bias-corrected mean abundance estimate of 2,342 [1,570; 3,169] individuals. These equated to mean density estimates of 3.95 (unapportioned), 4.26 (apportioned) and 5.48 (apportioned and availability bias-corrected) birds/km^2.
- 406 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 2,350 [1,528; 3,144], an apportioned mean abundance estimate of 2,568 [1,611; 3,511] and an apportioned and availability bias-corrected mean abundance estimate of 3,304 [2,093; 4,493] individuals. These equated to mean density estimates of 3.65 (unapportioned), 3.99 (apportioned) and 5.13 (apportioned and availability bias-corrected) birds/km^2.
- 503 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 2,953 [2,114; 3,840], an apportioned mean abundance estimate of 3,218 [2,131; 4,278] and an apportioned and availability bias-corrected mean abundance estimate of 4,146 [2,762; 5,487] individuals. These equated to mean density estimates of 3.34 (unapportioned), 3.64 (apportioned) and 4.69 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected guillemot abundances within the Survey Area occurred in September, with surveys in other non-breeding season months recording considerably lower equivalent abundances than the overall peak for the two years of surveys, in September 2022. The timing of the non-breeding season peak indicates that post-breeding aggregations of birds, likely from multiple colonies across the wider area, may occur in the Survey Area. Peak mean apportioned and availability bias-corrected guillemot abundances were generally low across the Survey Area during the winter months, with mean

abundances increasing slightly from February in both survey years included in the baseline survey period. This indicates that birds attending nearby breeding colonies prior to the breeding season may be using the Survey Area.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak for the non-breeding season were between 34% to 99%, with most surveys reporting reductions closer to the upper limit of the range. This indicates that the mean apportioned guillemot abundances were somewhat variable throughout the non-breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording mean abundances for this species that were considerably lower than the peak mean apportioned abundance for this seasonal period.

Very good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 65). Within Caledonia OWF, four surveys out of 24 had precision values of CV > 0.16, of which all were during the non-breeding season, when fewer records of this species were made (Table 65). For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 65).

Table 65 **Raw counts, unapportioned, apportioned and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of guillemots in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of guillemot raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to March). No colours were attributed to the breeding site attendance period (February to March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF														
May-21	852	4,968	3,265	6,781	0.03	11.63	5,340	3,299	7,543	12.49	6,903	4,302	9,691	16.14
Jun-21	481	2,823	2,143	3,604	0.05	6.61	3,476	2,251	4,944	8.13	4,390	2,869	6,220	10.27
Jul-21	1,243	7,331	3,326	13,364	0.03	17.16	7,612	3,210	14,571	17.8	9,684	4,074	18,626	22.65
Aug-21	45	260	162	353	0.15	0.61	493	246	837	1.15	628	315	1,067	1.47
Sep-21	168	975	627	1,346	0.08	2.28	1,344	883	1,836	3.14	1,756	1,157	2,393	4.11
Oct-21	93	544	386	725	0.10	1.27	743	392	1,190	1.74	943	509	1,486	2.2
Nov-21	158	918	743	1,115	0.08	2.15	1,045	794	1,348	2.44	1,349	1,036	1,720	3.15
Dec-21	9	52	23	81	0.33	0.12	346	235	445	0.81	454	308	584	1.06
Jan-22	43	249	87	399	0.15	0.58	370	149	650	0.86	474	194	820	1.11
Feb-22	62	335	221	443	0.13	0.78	741	527	974	1.73	968	690	1,268	2.26
Mar-22	78	417	235	626	0.11	0.98	551	244	885	1.29	620	284	981	1.45
Apr-22	167	961	541	1,480	0.08	2.25	1,064	470	1,731	2.49	1,235	563	1,984	2.89
May-22	**1,511**	**8,755**	**5,464**	**12,277**	**0.03**	**20.49**	**9,643**	**6,067**	**13,857**	**22.55**	**12,547**	**7,909**	**18,015**	**29.34**
Jun-22	1,057	6,074	3,517	9,471	0.03	14.22	6,237	3,436	9,757	14.59	8,026	4,447	12,511	18.77
Jul-22	834	4,878	3,170	6,551	0.03	11.42	5,357	3,089	7,912	12.53	6,758	3,889	9,958	15.8
Aug-22	50	288	92	553	0.14	0.67	338	104	639	0.79	441	137	833	1.03
Sep-22	**390**	**2,257**	**1,302**	**3,455**	**0.05**	**5.28**	**2,701**	**1,556**	**4,119**	**6.32**	**3,530**	**2,037**	**5,378**	**8.26**
Oct-22	27	158	76	251	0.19	0.37	345	85	835	0.81	392	101	930	0.92
Nov-22	2	12	2	24	0.71	0.03	55	11	119	0.13	72	14	156	0.17
Dec-22	35	205	117	293	0.17	0.48	266	139	403	0.62	349	183	529	0.82
Jan-23	68	396	250	547	0.12	0.93	421	227	634	0.98	539	293	806	1.26
Feb-23	242	1,389	809	1,940	0.06	3.25	1,503	719	2,488	3.51	1,674	816	2,762	3.92
Mar-23	289	1,686	1,143	2,223	0.06	3.95	1,821	1,209	2,479	4.26	2,342	1,570	3,169	5.48
Apr-23	317	1,797	782	3,367	0.06	4.21	1,898	585	4,057	4.44	2,363	727	5,062	5.53
b) Caledonia OWF plus 2 km buffer														
May-21	1,509	8,670	5,567	11,652	0.03	13.47	9,403	5,836	13,291	14.6	12,171	7,597	17,122	18.9

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jun-21	760	4,408	3,382	5,620	0.04	6.85	5,748	3,717	8,112	8.93	7,235	4,671	10,233	11.23
Jul-21	2,014	11,666	5,237	21,740	0.02	18.13	12,191	4,804	23,466	18.93	15,538	6,068	30,106	24.12
Aug-21	63	360	268	445	0.13	0.56	819	437	1,341	1.27	1,050	563	1,721	1.63
Sep-21	496	2,848	1,441	4,731	0.04	4.43	3,473	1,839	5,755	5.39	4,536	2,408	7,499	7.04
Oct-21	163	940	611	1,222	0.08	1.46	1,281	705	1,872	1.99	1,620	909	2,337	2.52
Nov-21	282	1,613	1,270	1,899	0.06	2.51	1,756	1,349	2,253	2.73	2,270	1,758	2,891	3.52
Dec-21	14	80	40	126	0.27	0.12	611	489	777	0.95	800	642	1,018	1.24
Jan-22	66	377	183	577	0.12	0.59	520	261	868	0.81	669	340	1,100	1.04
Feb-22	101	541	338	761	0.10	0.84	1,149	797	1,586	1.78	1,493	1,042	2,044	2.32
Mar-22	89	472	271	717	0.11	0.73	649	311	1,038	1.01	745	370	1,176	1.16
Apr-22	272	1,543	993	2,104	0.06	2.4	1,692	925	2,539	2.63	1,942	1,052	2,922	3.02
May-22	**2,388**	**13,660**	**8,735**	**18,866**	**0.02**	**21.23**	**14,995**	**9,648**	**20,305**	**23.28**	**19,546**	**12,599**	**26,440**	**30.35**
Jun-22	1,758	10,073	6,434	14,622	0.02	15.65	10,338	6,037	14,935	16.05	13,314	7,816	19,161	20.67
Jul-22	1,426	8,211	5,378	11,562	0.03	12.76	9,095	5,359	13,683	14.12	11,529	6,775	17,386	17.9
Aug-22	112	641	418	904	0.09	1	751	458	1,094	1.17	981	599	1,424	1.52
Sep-22	**1,303**	**7,520**	**2,170**	**17,222**	**0.03**	**11.69**	**8,710**	**2,608**	**18,652**	**13.52**	**11,408**	**3,416**	**24,432**	**17.71**
Oct-22	83	484	175	955	0.11	0.75	858	198	1,953	1.33	979	234	2,216	1.52
Nov-22	5	29	6	58	0.45	0.05	73	27	127	0.11	94	35	161	0.15
Dec-22	56	327	239	420	0.13	0.51	403	267	545	0.63	529	350	714	0.82
Jan-23	106	616	442	796	0.10	0.96	646	365	978	1	813	470	1,212	1.26
Feb-23	349	1,994	1,428	2,514	0.05	3.1	2,128	1,201	3,210	3.3	2,419	1,384	3,622	3.76
Mar-23	406	2,350	1,528	3,144	0.05	3.65	2,568	1,611	3,511	3.99	3,304	2,093	4,493	5.13
Apr-23	416	2,359	1,145	4,134	0.05	3.67	2,510	1,119	4,726	3.9	3,137	1,404	5,919	4.87
c) Survey Area														
May-21	1,944	11,361	7,463	15,207	0.02	12.86	12,364	7,794	17,028	13.98	15,984	10,122	21,907	18.07
Jun-21	1,047	6,160	4,507	8,290	0.03	6.97	8,289	4,992	12,180	9.37	10,325	6,235	15,104	11.67
Jul-21	2,687	16,223	7,656	29,307	0.02	18.36	16,935	6,934	30,203	19.15	21,670	8,828	38,770	24.5
Aug-21	115	667	545	801	0.09	0.75	2,229	1,136	3,440	2.52	2,886	1,471	4,455	3.26
Sep-21	808	4,729	2,400	7,474	0.04	5.35	5,717	2,989	9,335	6.46	7,470	3,915	12,182	8.45
Oct-21	266	1,557	1,036	2,107	0.06	1.76	2,079	1,215	3,066	2.35	2,650	1,575	3,866	3
Nov-21	421	2,451	1,839	3,010	0.05	2.77	2,643	1,938	3,388	2.99	3,427	2,528	4,373	3.88
Dec-21	18	105	58	163	0.24	0.12	1,026	804	1,324	1.16	1,330	1,052	1,692	1.5

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jan-22	88	510	267	771	0.11	0.58	705	373	1,100	0.8	906	486	1,393	1.02
Feb-22	145	796	478	1,109	0.08	0.9	1,616	1,038	2,269	1.83	2,099	1,356	2,932	2.37
Mar-22	130	702	438	1,010	0.09	0.79	963	477	1,493	1.09	1,127	571	1,734	1.27
Apr-22	448	2,583	1,586	3,880	0.05	2.92	2,781	1,511	4,163	3.15	3,110	1,685	4,663	3.52
May-22	3,127	18,156	11,792	24,548	0.02	20.55	19,915	12,794	27,330	22.52	25,952	16,690	35,597	29.35
Jun-22	2,299	13,305	8,502	18,497	0.02	15.06	13,652	8,091	19,710	15.44	17,522	10,446	25,198	19.81
Jul-22	2,595	15,167	9,088	22,823	0.02	17.16	16,462	8,689	25,204	18.61	21,055	11,048	32,308	23.81
Aug-22	157	902	586	1,241	0.08	1.02	1,086	683	1,547	1.23	1,420	895	2,018	1.61
Sep-22	2,038	11,892	4,476	22,921	0.02	13.46	13,436	5,251	26,308	15.19	17,603	6,882	34,468	19.9
Oct-22	116	682	259	1,252	0.09	0.77	1,184	249	2,487	1.34	1,369	296	2,870	1.55
Nov-22	15	88	35	153	0.26	0.1	180	85	308	0.2	229	110	390	0.26
Dec-22	81	478	318	637	0.11	0.54	576	366	782	0.65	755	480	1,025	0.85
Jan-23	147	864	582	1,153	0.08	0.98	900	548	1,346	1.02	1,140	704	1,688	1.29
Feb-23	448	2,594	1,673	3,492	0.05	2.94	2,782	1,595	4,203	3.15	3,176	1,844	4,762	3.59
Mar-23	503	2,953	2,114	3,840	0.04	3.34	3,218	2,131	4,278	3.64	4,146	2,762	5,487	4.69
Apr-23	494	2,835	1,561	4,758	0.04	3.21	3,011	1,536	5,333	3.4	3,739	1,901	6,642	4.23

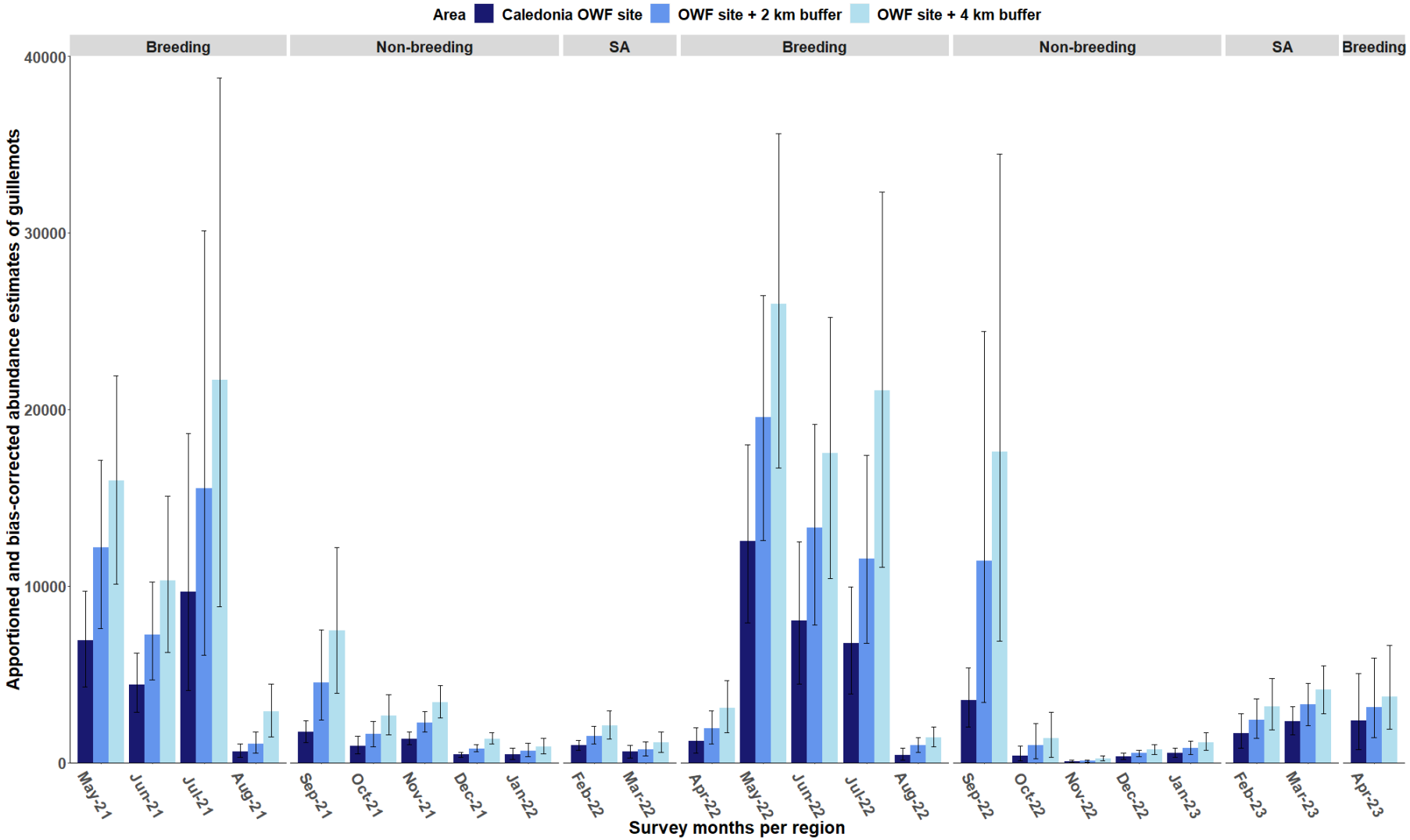


Figure 20 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total guillemots recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Guillemot seasonal periods are also displayed. SA stands for breeding site attendance

Caledonia North

A total of 7,661 guillemots were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Guillemots were recorded in every survey (Table 9, Table 66). Highest abundances were recorded during the breeding season (April to mid-August, with birds attending colonies from February onwards), especially from May to July, with a peak of abundance in May 2022 (Table 66, Figure 21):

- 852 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 4,944 [2,774; 7,515], an apportioned mean abundance estimate of 5,420 [2,764; 8,827] and an apportioned and availability bias-corrected mean abundance estimate of 7,019 [3,578; 11,441] individuals. These equated to mean density estimates of 22.64 (unapportioned), 24.81 (apportioned) and 32.12 (apportioned and availability bias-corrected) birds/km^2.
- 1,597 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 9,095 [5,888; 12,528], an apportioned mean abundance estimate of 9,965 [6,132; 14,072] and an apportioned and availability bias-corrected mean abundance estimate of 12,962 [7,988; 18,287] individuals. These equated to mean density estimates of 24.23 (unapportioned), 26.53 (apportioned) and 34.51 (apportioned and availability bias-corrected) birds/km^2.
- 2,284 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 13,280 [8,902; 18,176], an apportioned mean abundance estimate of 14,493 [9,513; 20,016] and an apportioned and availability bias-corrected mean abundance estimate of 18,859 [12,395; 26,032] individuals. These equated to mean density estimates of 23.84 (unapportioned), 26.00 (apportioned) and 33.83 (apportioned and availability bias-corrected) birds/km^2.

In both breeding seasons covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances across Caledonia North Survey Area were low at the beginning of the season (i.e. April), and rapidly increased thereafter. Peak abundances occurred either in July (2021) or May (2022). In 2021, mean abundances were relatively similar between May and July, whilst in 2022, a large peak was observed in May 2022, with relatively stable mean abundances being recorded across much of Caledonia North Survey Area in June and July 2022. Between July and August in both years covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances dropped substantially, with low abundances observed in both August 2021 and August 2022. These temporal patterns are indicative of a rapid arrival and departure of birds from Caledonia North Survey Area close to the start and end of the breeding season. The higher mean abundances in May to July indicate that Caledonia North Survey Area is likely being used by breeding adults from nearby colonies. Overall, excluding the overall peak for the breeding season apportioned and availability bias-corrected mean guillemot abundances in May 2022, abundances were relatively similar across the two breeding seasons covered by the baseline survey period.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 55% to 99%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

During both years of surveys, guillemots were recorded during the non-breeding period (September to March) in considerably lower numbers than the breeding season. Excluding the January to February period, where nest attendance commonly occurs in this species, the wintering peak abundance was recorded in November 2021 (Table 66, Figure 21):

- 62 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 362 [257; 479], an apportioned mean abundance estimate of 428 [268; 626] and an apportioned and availability bias-corrected mean abundance estimate of 552 [350; 797] individuals. These equated to mean density estimates of 1.66 (unapportioned), 1.96 (apportioned) and 2.53 (apportioned and availability bias-corrected) birds/km^2.
- 119 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 679 [411; 1,004], an apportioned mean abundance estimate of 752 [450; 1,169] and an apportioned and availability bias-corrected mean abundance estimate of 977 [588; 1,508] individuals. These equated to mean density estimates of 1.81 (unapportioned), 2.00 (apportioned) and 2.60 (apportioned and availability bias-corrected) birds/km^2.
- 180 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,051 [771; 1,390], an apportioned mean abundance estimate of 1,162 [796; 1,641] and an apportioned and availability bias-corrected mean abundance estimate of 1,509 [1,041; 2,117] individuals. These equated to mean density estimates of 1.89 (unapportioned), 2.08 (apportioned) and 2.71 (apportioned and availability bias-corrected) birds/km^2.

During the breeding site attendance period (February and March), guillemots were recorded in low numbers (though in higher peak numbers than the rest of the non-breeding season, in contrast to the Survey Area), with peak numbers in March 2023 (Table 66, Figure 21):

- 132 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 774 [522; 1,031], an apportioned mean abundance estimate of 866 [552; 1,212] and an apportioned and availability bias-corrected mean abundance estimate of 1,110 [718; 1,532] individuals. These equated to mean density estimates of 3.55 (unapportioned), 3.97 (apportioned) and 5.08 (apportioned and availability bias-corrected) birds/km^2.
- 232 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,345 [957; 1,780], an apportioned mean abundance estimate of 1,489 [1,032; 2,054] and an apportioned and availability bias-corrected mean abundance estimate of 1,918 [1,346; 2,615] individuals. These equated to mean density estimates of 3.58 (unapportioned), 3.97 (apportioned) and 5.11 (apportioned and availability bias-corrected) birds/km^2.
- 316 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,856 [1,339; 2,408], an apportioned mean abundance estimate of 2,033 [1,355; 2,783] and an apportioned and availability bias-corrected mean abundance estimate of 2,620 [1,759; 3,561] individuals. These equated to mean density estimates of 3.33 (unapportioned), 3.65 (apportioned) and 4.70 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, mean apportioned and availability bias-corrected guillemot abundances were consistently low within Caledonia North Survey Area, with the overall peak for this period occurring in November 2021, excluding the pre-breeding season colony attendance period. The autumnal peaks in mean apportioned and availability bias-corrected guillemot abundances observed within the Survey Area and Caledonia South Survey Area were not recorded to the same extent within Caledonia North Survey Area, indicating a possible lower importance of Caledonia North Survey Area to this species during the autumn. Peak mean apportioned

and availability bias-corrected guillemot abundances were generally low across Caledonia North Survey Area during the winter months, with mean abundances increasing slightly from February in both survey years included in the baseline survey period. This indicates that birds attending nearby breeding colonies prior to the breeding season may be using Caledonia North Survey Area.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 14% to 95%, with most surveys reporting reductions in the middle of the extremes of the range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 66). Within Caledonia North, 12 surveys out of 24 had precision values of CV ≤ 0.16, and most surveys during the breeding season (seven of ten) had CV values of ≤ 0.16. CV values during the non-breeding season were higher (more often in the region of 0.2 to 0.5), indicating lower levels of precision when compared with breeding season surveys (Table 66). For Caledonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 66).

Table 66 **Raw counts, unapportioned, apportioned and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of guillemots in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of guillemot raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to March). No colours were attributed to the breeding site attendance period (February to March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North														
May-21	276	1,609	787	2,956	0.06	7.37	1,748	797	3,150	8.00	2,228	1,025	4,013	10.2
Jun-21	179	1,058	786	1,342	0.07	4.85	1,245	835	1,639	5.70	1,564	1,056	2,052	7.16
Jul-21	317	1,877	1,006	3,836	0.06	8.60	1,968	970	3,137	9.01	2,362	1,173	3,744	10.81
Aug-21	11	64	29	104	0.30	0.29	78	32	129	0.36	89	38	146	0.41
Sep-21	37	214	156	284	0.16	0.98	326	192	512	1.49	422	251	656	1.93
Oct-21	16	93	41	152	0.25	0.43	172	56	347	0.79	202	69	395	0.93
Nov-21	62	362	257	479	0.13	1.66	428	268	626	1.96	552	350	797	2.53
Dec-21	5	29	12	46	0.45	0.13	136	57	215	0.62	178	74	281	0.81
Jan-22	7	40	12	75	0.38	0.18	93	22	219	0.43	111	27	255	0.51
Feb-22	23	124	43	205	0.21	0.57	288	106	458	1.32	376	139	595	1.72
Mar-22	24	128	69	197	0.20	0.59	172	54	341	0.79	201	67	393	0.92
Apr-22	79	454	281	666	0.11	2.08	476	160	847	2.18	526	183	925	2.41
May-22	852	4,944	2,774	7,515	0.03	22.64	5,420	2,764	8,827	24.81	7,019	3,578	11,441	32.12
Jun-22	325	1,851	826	3,121	0.06	8.48	1,890	833	3,282	8.65	2,378	1,067	4,095	10.88
Jul-22	217	1,271	1,013	1,557	0.07	5.82	1,424	998	1,855	6.52	1,752	1,253	2,251	8.02
Aug-22	5	29	6	58	0.45	0.13	39	10	76	0.18	51	13	100	0.24
Sep-22	53	304	161	453	0.14	1.39	390	205	579	1.78	511	269	759	2.34
Oct-22	2	12	2	23	0.71	0.05	21	4	60	0.10	26	4	73	0.12
Nov-22	1	6	1	18	1.00	0.03	34	6	89	0.15	44	7	116	0.2
Dec-22	14	81	41	151	0.27	0.37	106	46	215	0.49	139	60	282	0.64
Jan-23	27	156	75	243	0.19	0.71	170	62	299	0.78	221	81	386	1.01
Feb-23	116	669	311	1,066	0.09	3.06	717	286	1,205	3.28	768	315	1,281	3.51
Mar-23	132	774	522	1,031	0.09	3.55	866	552	1,212	3.97	1,110	718	1,532	5.08
Apr-23	26	147	90	203	0.20	0.67	170	61	336	0.78	205	75	402	0.94
b) Caledonia North plus 2 km buffer														
May-21	380	2,173	995	3,758	0.05	5.79	2,395	1,112	4,280	6.38	3,034	1,421	5,406	8.08

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jun-21	275	1,593	1,077	2,056	0.06	4.24	1,857	1,182	2,544	4.94	2,333	1,495	3,184	6.21
Jul-21	623	3,591	2,525	4,727	0.04	9.57	3,735	2,218	5,466	9.95	4,555	2,721	6,657	12.13
Aug-21	20	113	62	170	0.22	0.30	143	48	275	0.38	168	56	327	0.45
Sep-21	65	370	250	489	0.12	0.99	595	360	897	1.58	766	470	1,136	2.04
Oct-21	30	171	80	269	0.18	0.46	273	100	502	0.73	328	126	583	0.87
Nov-21	**119**	**679**	**411**	**1,004**	**0.09**	**1.81**	**752**	**450**	**1,169**	**2.00**	**977**	**588**	**1,508**	**2.6**
Dec-21	5	28	6	57	0.45	0.07	244	134	320	0.65	320	175	420	0.85
Jan-22	21	119	57	216	0.22	0.32	191	75	378	0.51	237	96	459	0.63
Feb-22	34	182	86	279	0.17	0.48	430	203	679	1.14	558	266	877	1.49
Mar-22	31	165	85	244	0.18	0.44	218	75	406	0.58	249	88	464	0.66
Apr-22	119	669	433	933	0.09	1.78	719	331	1,173	1.91	810	377	1,311	2.16
May-22	**1,597**	**9,095**	**5,888**	**12,528**	**0.03**	**24.23**	**9,965**	**6,132**	**14,072**	**26.53**	**12,962**	**7,988**	**18,287**	**34.51**
Jun-22	657	3,790	2,394	5,261	0.04	10.10	3,899	2,273	5,773	10.38	4,919	2,905	7,221	13.1
Jul-22	402	2,301	1,603	3,022	0.05	6.13	2,541	1,583	3,589	6.76	3,078	1,937	4,314	8.2
Aug-22	20	114	40	212	0.22	0.30	151	46	290	0.40	198	61	380	0.53
Sep-22	73	424	244	610	0.12	1.13	536	294	813	1.43	703	385	1,066	1.87
Oct-22	21	123	21	323	0.22	0.33	295	50	779	0.79	303	52	795	0.81
Nov-22	3	17	3	46	0.58	0.05	50	12	116	0.13	64	15	147	0.17
Dec-22	25	147	82	218	0.20	0.39	195	94	306	0.52	255	124	401	0.68
Jan-23	42	246	147	352	0.15	0.66	267	134	422	0.71	348	175	548	0.93
Feb-23	166	947	513	1,460	0.08	2.52	1,001	483	1,584	2.66	1,082	532	1,704	2.88
Mar-23	232	1,345	957	1,780	0.07	3.58	1,489	1,032	2,054	3.97	1,918	1,346	2,615	5.11
Apr-23	58	331	269	406	0.13	0.88	399	220	611	1.06	491	275	746	1.31
c) Caledonia North Survey Area														
May-21	560	3,278	1,879	5,104	0.04	5.88	3,659	1,987	5,772	6.56	4,635	2,536	7,272	8.31
Jun-21	385	2,277	1,485	3,052	0.05	4.09	2,686	1,654	3,756	4.82	3,357	2,075	4,683	6.02
Jul-21	993	6,013	3,730	9,077	0.03	10.79	6,305	3,380	10,219	11.31	7,833	4,214	12,743	14.05
Aug-21	38	221	122	314	0.16	0.40	312	164	458	0.56	380	201	557	0.68
Sep-21	112	654	508	800	0.09	1.17	1,004	688	1,374	1.80	1,296	899	1,749	2.32
Oct-21	64	374	210	573	0.13	0.67	568	257	1,008	1.02	698	327	1,216	1.25
Nov-21	**180**	**1,051**	**771**	**1,390**	**0.07**	**1.89**	**1,162**	**796**	**1,641**	**2.08**	**1,509**	**1,041**	**2,117**	**2.71**
Dec-21	9	52	29	76	0.33	0.09	463	304	647	0.83	592	396	804	1.06

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jan-22	41	237	139	336	0.16	0.43	351	158	599	0.63	445	204	746	0.8
Feb-22	46	253	127	407	0.15	0.45	577	281	910	1.03	741	366	1,160	1.33
Mar-22	45	243	140	367	0.15	0.44	349	147	600	0.63	407	177	691	0.73
Apr-22	170	979	599	1,370	0.08	1.76	1,048	510	1,626	1.88	1,193	582	1,846	2.14
May-22	2,284	13,280	8,902	18,176	0.02	23.84	14,493	9,513	20,016	26.00	18,859	12,395	26,032	33.83
Jun-22	1,127	6,512	4,172	8,985	0.03	11.69	6,727	3,720	9,986	12.07	8,516	4,773	12,509	15.27
Jul-22	702	4,109	2,967	5,256	0.04	7.38	4,462	2,684	6,462	8.00	5,493	3,312	7,953	9.85
Aug-22	28	160	63	269	0.19	0.29	230	92	402	0.41	301	120	527	0.54
Sep-22	101	588	326	874	0.10	1.06	724	367	1,087	1.30	947	481	1,419	1.7
Oct-22	25	147	25	352	0.20	0.26	435	80	1,011	0.78	452	84	1,041	0.81
Nov-22	4	24	4	53	0.50	0.04	61	16	117	0.11	78	20	145	0.14
Dec-22	44	259	147	389	0.15	0.46	333	167	511	0.60	436	219	669	0.78
Jan-23	62	366	212	531	0.13	0.66	389	187	621	0.70	500	242	794	0.9
Feb-23	201	1,161	555	1,750	0.07	2.08	1,287	565	2,174	2.31	1,408	633	2,348	2.53
Mar-23	316	1,856	1,339	2,408	0.06	3.33	2,033	1,355	2,783	3.65	2,620	1,759	3,561	4.7
Apr-23	124	710	470	974	0.09	1.27	795	432	1,206	1.43	959	523	1,449	1.72

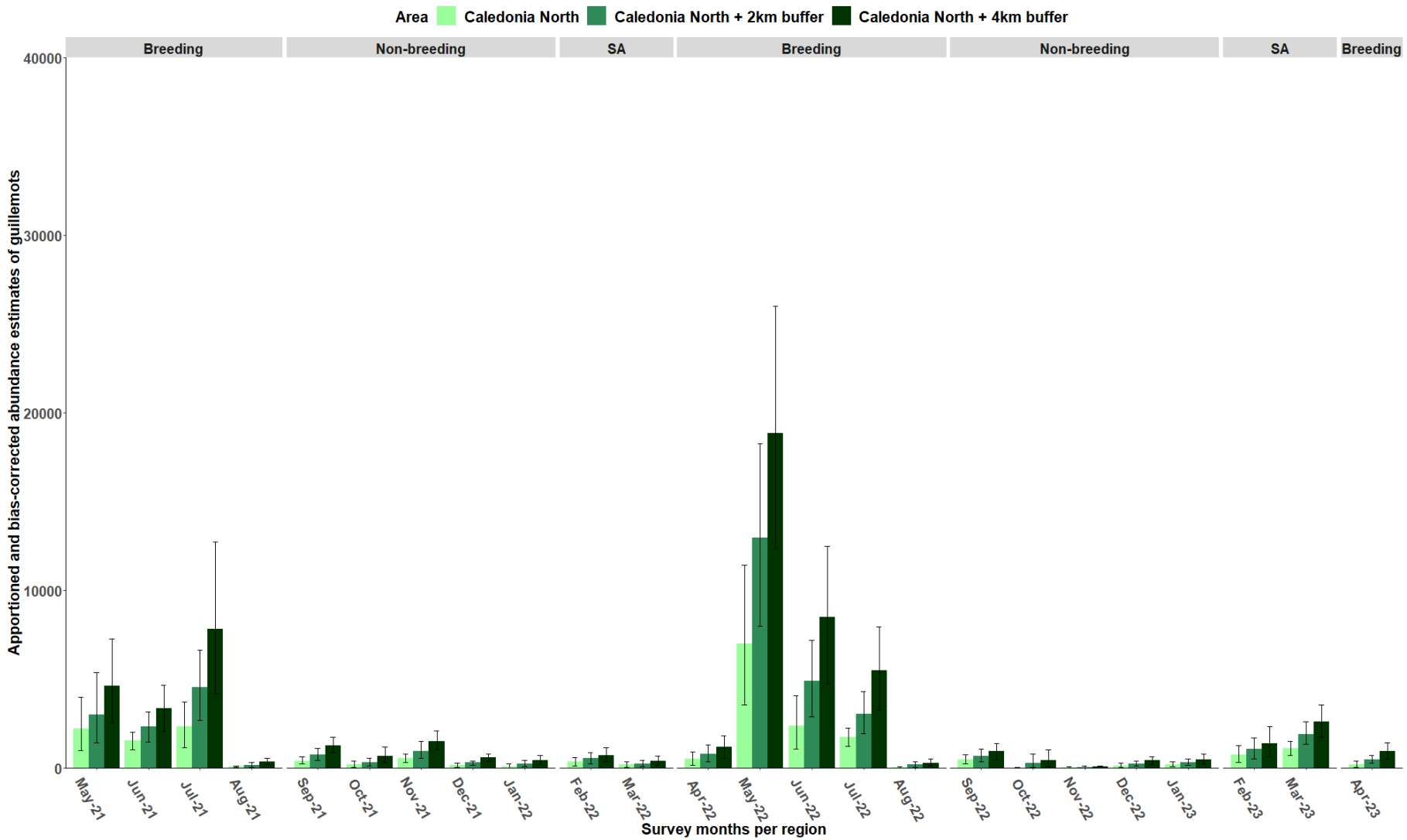


Figure 21 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total guillemots recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Guillemot seasonal periods are also displayed. SA stands for breeding site attendance

Caledonia South

A total of 15,579 guillemots were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Guillemots were recorded in every survey (Table 10, Table 67). Highest abundances were recorded during the breeding season (April to mid-August, with birds attending colonies from February onwards), especially from May to July, with a peak of abundance in July 2021 in Caledonia South and Caledonia South plus 2 km buffer, and in July 2022 for Caledonia South Survey Area (Table 67, Figure 22):

- 947 individuals were recorded in Caledonia South in July 2021, resulting in an unapportioned mean abundance estimate of 5,554 [1,771; 11,735], an apportioned mean abundance estimate of 5,748 [1,733; 12,403] and an apportioned and availability bias-corrected mean abundance estimate of 7,457 [2,224; 16,152] individuals. These equated to mean density estimates of 26.41 (unapportioned), 27.31 (apportioned) and 35.43 (apportioned and availability bias-corrected) birds/km^2.
- 1,563 individuals were recorded in Caledonia South plus 2 km buffer in July 2021, resulting in an unapportioned mean abundance estimate of 9,094 [2,868; 19,305], an apportioned mean abundance estimate of 9,525 [3,142; 20,132] and an apportioned and availability bias-corrected mean abundance estimate of 12,351 [4,037; 26,194] individuals. These equated to mean density estimates of 25.30 (unapportioned), 26.48 (apportioned) and 34.33 (apportioned and availability bias-corrected) birds/km^2.
- 2,278 individuals were recorded in Caledonia South Survey Area in July 2022, resulting in an unapportioned mean abundance estimate of 13,189 [6,924; 20,611], an apportioned mean abundance estimate of 14,246 [6,710; 23,854] and an apportioned and availability bias-corrected mean abundance estimate of 18,392 [8,622; 30,838] individuals. These equated to mean density estimates of 24.73 (unapportioned), 26.69 (apportioned) and 34.46 (apportioned and availability bias-corrected) birds/km^2.

In both breeding seasons covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances across Caledonia South Survey Area were low at the beginning of the season (i.e. April), and rapidly increased thereafter. Peak abundances occurred in July in both the 2021 and 2022 breeding seasons, though apportioned and availability bias-corrected mean guillemot abundances were consistently high throughout May, June and July in both survey years. Between July and August in both years covered by the baseline surveys, apportioned and availability bias-corrected mean guillemot abundances dropped substantially, with low abundances observed in both August 2021 and August 2022. These temporal patterns are indicative of a rapid arrival and departure of birds from Caledonia South Survey Area close to the start and end of the breeding season. The higher mean abundances in May to July indicate that Caledonia South Survey Area is likely being used by breeding adults from nearby colonies. Apportioned and availability bias-corrected mean guillemot abundances across the breeding seasons of both 2021 and 2022 were relatively similar, with no obvious significant differences in apportioned and availability bias-corrected mean guillemot abundances between the two seasons.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 4% to 95%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

During both years of surveys, guillemots were also recorded during the non-breeding period (September to March) in considerably lower numbers than during the breeding season. The wintering peak of abundance occurred in September 2022 (Table 67, Figure 22):

- 341 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 1,988 [1,084; 3,142], an apportioned mean abundance estimate of 2,282 [1,199; 3,515] and an apportioned and availability bias-corrected mean abundance estimate of 2,980 [1,567; 4,585] individuals. These equated to a mean density estimate of 9.45 (unapportioned), 10.85 (apportioned) and 14.16 (apportioned and availability bias-corrected) birds/km^2.
- 1,247 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 7,123 [1,868; 15,834], an apportioned mean abundance estimate of 8,150 [2,832; 17,259] and an apportioned and availability bias-corrected mean abundance estimate of 10,674 [3,709; 22,604] individuals. These equated to mean density estimates of 19.82 (unapportioned), 22.66 (apportioned) and 29.67 (apportioned and availability bias-corrected) birds/km^2.
- 1,982 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 11,565 [4,044; 22,092], an apportioned mean abundance estimate of 12,918 [4,500; 24,544] and an apportioned and availability bias-corrected mean abundance estimate of 16,924 [5,897; 32,156] individuals. These equated to mean density estimates of 21.68 (unapportioned), 24.20 (apportioned) and 31.71 (apportioned and availability bias-corrected) birds/km^2.

During the breeding site attendance period (February and March), guillemots were also recorded in low numbers (lower than other periods of the non-breeding season), with peak numbers in March 2023 (Table 67, Figure 22):

- 157 individuals were recorded in Caledonia South in March 2023, resulting in an unapportioned mean abundance estimate of 910 [499; 1,461], an apportioned mean abundance estimate of 954 [531; 1,568] and an apportioned and availability bias-corrected mean abundance estimate of 1,231 [693; 2,011] individuals. These equated to mean density estimates of 4.33 (unapportioned), 4.53 (apportioned) and 5.85 (apportioned and availability bias-corrected) birds/km^2.
- 239 individuals were recorded in Caledonia South plus 2 km buffer in March 2023, resulting in an unapportioned mean abundance estimate of 1,376 [916; 2,021], an apportioned mean abundance estimate of 1,497 [1,007; 2,246] and an apportioned and availability bias-corrected mean abundance estimate of 1,933 [1,312; 2,881] individuals. These equated to mean density estimates of 3.83 (unapportioned), 4.16 (apportioned) and 5.37 (apportioned and availability bias-corrected) birds/km^2.
- 357 individuals were recorded in Caledonia South Survey Area in March 2023, resulting in an unapportioned mean abundance estimate of 2,080 [1,434; 2,832], an apportioned mean abundance estimate of 2,251 [1,494; 3,151] and an apportioned and availability bias-corrected mean abundance estimate of 2,899 [1,940; 4,043] individuals. These equated to mean density estimates of 3.90 (unapportioned), 4.22 (apportioned) and 5.43 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected guillemot abundances within Caledonia South Survey Area occurred in September, with surveys in other non-breeding season months recording considerably lower equivalent abundances than the overall peak for the two years of surveys, in September 2022. The timing of the non-breeding season peak indicates that post-breeding aggregations of birds, likely from multiple colonies across the wider area, may occur in Caledonia South Survey Area. Peak mean apportioned and availability bias-corrected guillemot abundances were generally low across

Caledonia South Survey Area during the winter months, with mean abundances increasing from February in both survey years included in the baseline survey period. This indicates that birds attending nearby breeding colonies prior to the breeding season may be using Caledonia South Survey Area.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak for the non-breeding season were between 55% to 99%, with most surveys reporting reductions closer to the upper limit of the range. This indicates that the mean apportioned guillemot abundances were somewhat variable throughout the non-breeding season surveys when compared with the peak mean apportioned abundance for the baseline survey period, with many of the surveys recording mean abundances for this species that were considerably lower than the peak mean apportioned abundance for this seasonal period.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16; Table 67). Within Caledonia South, 18 surveys out of 24 had precision values of CV ≤ 0.16, and most surveys during the breeding season (nine of ten) had CV values of ≤ 0.16. CV values during the non-breeding season were higher (more often in the region of 0.2 to 0.5), indicating lower levels of precision when compared with breeding season surveys (Table 67). For Caledonia South plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 67).

Table 67 **Raw counts, unapportioned, apportioned and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of guillemots in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of guillemot raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to March). No colours were attributed to the breeding site attendance period (February to March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South														
May-21	577	3,359	2,230	4,424	0.04	15.97	3,590	2,254	5,109	17.06	4,672	2,949	6,614	22.2
Jun-21	312	1,815	1,111	2,809	0.06	8.63	2,280	1,211	3,800	10.83	2,873	1,545	4,770	13.65
Jul-21	**947**	**5,554**	**1,771**	**11,735**	**0.03**	**26.41**	**5,748**	**1,733**	**12,403**	**27.31**	**7,457**	**2,224**	**16,152**	**35.43**
Aug-21	34	196	115	283	0.17	0.93	466	187	853	2.21	605	244	1,106	2.87
Sep-21	131	760	429	1,131	0.09	3.61	1,015	589	1,472	4.82	1,328	772	1,924	6.31
Oct-21	77	451	322	597	0.11	2.14	570	358	846	2.71	740	468	1,087	3.52
Nov-21	96	553	409	691	0.10	2.63	617	433	830	2.93	796	565	1,058	3.78
Dec-21	4	23	6	41	0.50	0.11	202	119	292	0.96	265	156	383	1.26
Jan-22	36	208	75	364	0.17	0.99	277	102	462	1.32	364	134	606	1.73
Feb-22	39	211	97	336	0.16	1.00	444	262	679	2.11	581	343	885	2.76
Mar-22	55	295	140	510	0.13	1.40	390	137	691	1.85	433	154	759	2.06
Apr-22	88	507	219	956	0.11	2.41	595	250	1,081	2.83	719	316	1,268	3.41
May-22	664	3,834	2,483	5,336	0.04	18.23	4,248	2,652	6,001	20.19	5,561	3,475	7,851	26.42
Jun-22	732	4,239	2,236	6,284	0.04	20.16	4,364	2,263	6,534	20.74	5,671	2,942	8,486	26.95
Jul-22	622	3,628	1,972	5,489	0.04	17.25	3,950	1,903	6,321	18.77	5,028	2,406	8,058	23.89
Aug-22	45	259	81	483	0.15	1.23	294	92	545	1.40	383	121	710	1.82
Sep-22	**341**	**1,988**	**1,084**	**3,142**	**0.05**	**9.45**	**2,282**	**1,199**	**3,515**	**10.85**	**2,980**	**1,567**	**4,585**	**14.16**
Oct-22	25	147	65	241	0.20	0.70	318	82	787	1.51	358	97	865	1.7
Nov-22	1	6	1	18	1.00	0.03	22	4	54	0.10	28	5	71	0.13
Dec-22	21	124	59	206	0.22	0.59	160	77	264	0.76	210	101	346	1
Jan-23	42	246	140	386	0.15	1.17	257	125	406	1.22	324	162	505	1.54
Feb-23	126	719	405	1,125	0.09	3.42	789	331	1,398	3.75	910	378	1,630	4.32
Mar-23	157	910	499	1,461	0.08	4.33	954	531	1,568	4.53	1,231	693	2,011	5.85
Apr-23	291	1,655	700	3,242	0.06	7.87	1,734	481	3,746	8.24	2,165	602	4,688	10.29
b) Caledonia South plus 2 km buffer														
May-21	1,199	6,928	4,923	8,864	0.03	19.27	7,460	5,259	10,218	20.74	9,720	6,870	13,283	27.02

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jun-21	560	3,248	2,169	4,912	0.04	9.04	4,397	3,063	7,061	12.22	5,537	3,869	8,917	15.39
Jul-21	**1,563**	**9,094**	**2,868**	**19,305**	**0.03**	**25.30**	**9,525**	**3,142**	**20,132**	**26.48**	**12,351**	**4,037**	**26,194**	**34.33**
Aug-21	48	275	183	378	0.14	0.77	846	726	1,516	2.35	1,099	950	1,964	3.06
Sep-21	455	2,629	1,202	4,704	0.05	7.31	3,081	1,661	5,312	8.56	4,034	2,176	6,952	11.21
Oct-21	143	829	615	1,027	0.08	2.31	1,092	855	1,544	3.04	1,403	1,105	1,960	3.9
Nov-21	202	1,156	916	1,385	0.07	3.22	1,237	968	1,574	3.44	1,598	1,258	2,021	4.44
Dec-21	11	63	29	109	0.30	0.18	418	384	591	1.16	549	504	775	1.52
Jan-22	51	293	126	466	0.14	0.82	391	224	617	1.09	512	293	808	1.42
Feb-22	78	417	224	673	0.11	1.16	794	574	1,225	2.21	1,033	751	1,585	2.87
Mar-22	73	386	217	630	0.12	1.07	532	289	901	1.48	606	341	1,013	1.68
Apr-22	210	1,201	801	1,658	0.07	3.34	1,335	735	2,084	3.71	1,537	864	2,390	4.27
May-22	964	5,530	3,700	7,446	0.03	15.38	6,066	4,161	8,569	16.86	7,942	5,452	11,216	22.08
Jun-22	1,221	6,932	4,349	9,560	0.03	19.29	7,112	4,523	10,004	19.77	9,237	5,877	12,981	25.68
Jul-22	1,149	6,648	3,709	10,449	0.03	18.50	7,335	4,123	11,596	20.39	9,395	5,272	14,864	26.12
Aug-22	98	560	377	794	0.10	1.56	622	440	936	1.73	811	574	1,217	2.25
Sep-22	**1,247**	**7,123**	**1,868**	**15,834**	**0.03**	**19.82**	**8,150**	**2,832**	**17,259**	**22.66**	**10,674**	**3,709**	**22,604**	**29.67**
Oct-22	64	369	109	760	0.13	1.03	692	410	1,503	1.92	799	439	1,745	2.22
Nov-22	3	17	3	35	0.58	0.05	38	24	77	0.11	50	31	101	0.14
Dec-22	39	225	144	317	0.16	0.63	273	192	380	0.76	358	252	499	1
Jan-23	80	459	333	620	0.11	1.28	474	290	729	1.32	588	368	888	1.63
Feb-23	226	1,290	839	1,746	0.07	3.59	1,385	768	2,189	3.85	1,612	885	2,554	4.48
Mar-23	239	1,376	916	2,021	0.06	3.83	1,497	1,007	2,246	4.16	1,933	1,312	2,881	5.37
Apr-23	382	2,140	986	3,870	0.05	5.95	2,240	946	4,330	6.23	2,804	1,192	5,418	7.8
c) Caledonia South Survey Area														
May-21	1,602	9,295	6,353	12,091	0.02	17.43	10,018	6,512	13,810	18.77	13,014	8,492	17,894	24.38
Jun-21	825	4,795	3,022	6,858	0.03	8.99	6,640	3,386	10,826	12.44	8,271	4,239	13,398	15.5
Jul-21	2,175	13,061	4,966	24,453	0.02	24.49	13,623	4,566	25,544	25.52	17,676	5,884	33,226	33.12
Aug-21	93	535	391	702	0.10	1.00	2,376	981	3,829	4.45	3,094	1,281	4,981	5.8
Sep-21	758	4,402	2,038	7,247	0.04	8.25	5,163	2,549	8,681	9.67	6,762	3,341	11,366	12.67
Oct-21	240	1,393	1,004	1,805	0.06	2.61	1,852	1,142	2,686	3.47	2,374	1,487	3,393	4.45
Nov-21	329	1,892	1,420	2,426	0.06	3.55	2,046	1,404	2,743	3.83	2,654	1,829	3,546	4.97
Dec-21	14	81	35	145	0.27	0.15	720	513	956	1.35	944	673	1,253	1.77

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jan-22	67	386	190	570	0.12	0.72	519	269	813	0.97	676	352	1,055	1.27
Feb-22	117	635	380	961	0.09	1.19	1,162	703	1,712	2.18	1,512	920	2,217	2.83
Mar-22	113	607	381	913	0.09	1.14	803	395	1,263	1.50	932	464	1,457	1.75
Apr-22	375	2,150	1,347	3,044	0.05	4.03	2,331	1,277	3,489	4.37	2,618	1,426	3,926	4.9
May-22	1,508	8,667	5,972	10,989	0.03	16.25	9,500	6,322	12,302	17.80	12,401	8,267	16,033	23.23
Jun-22	1,563	9,051	5,687	12,682	0.03	16.97	9,310	5,396	12,860	17.44	12,061	6,979	16,661	22.6
Jul-22	**2,278**	**13,189**	**6,924**	**20,611**	**0.02**	**24.73**	**14,246**	**6,710**	**23,854**	**26.69**	**18,392**	**8,622**	**30,838**	**34.46**
Aug-22	140	803	504	1,129	0.08	1.51	910	516	1,335	1.71	1,189	676	1,740	2.23
Sep-22	**1,982**	**11,565**	**4,044**	**22,092**	**0.02**	**21.68**	**12,918**	**4,500**	**24,544**	**24.20**	**16,924**	**5,897**	**32,156**	**31.71**
Oct-22	96	564	170	1,169	0.10	1.06	911	194	1,971	1.71	1,084	236	2,341	2.03
Nov-22	12	70	18	129	0.29	0.13	151	57	299	0.28	193	74	378	0.36
Dec-22	53	312	200	418	0.14	0.58	372	244	504	0.70	487	319	660	0.91
Jan-23	114	667	450	901	0.09	1.25	689	408	1,041	1.29	865	523	1,287	1.62
Feb-23	331	1,910	1,102	2,833	0.05	3.58	2,052	933	3,295	3.84	2,358	1,081	3,781	4.42
Mar-23	357	2,080	1,434	2,832	0.05	3.90	2,251	1,494	3,151	4.22	2,899	1,940	4,043	5.43
Apr-23	437	2,502	1,254	4,448	0.05	4.69	2,622	1,141	4,962	4.91	3,277	1,437	6,198	6.14

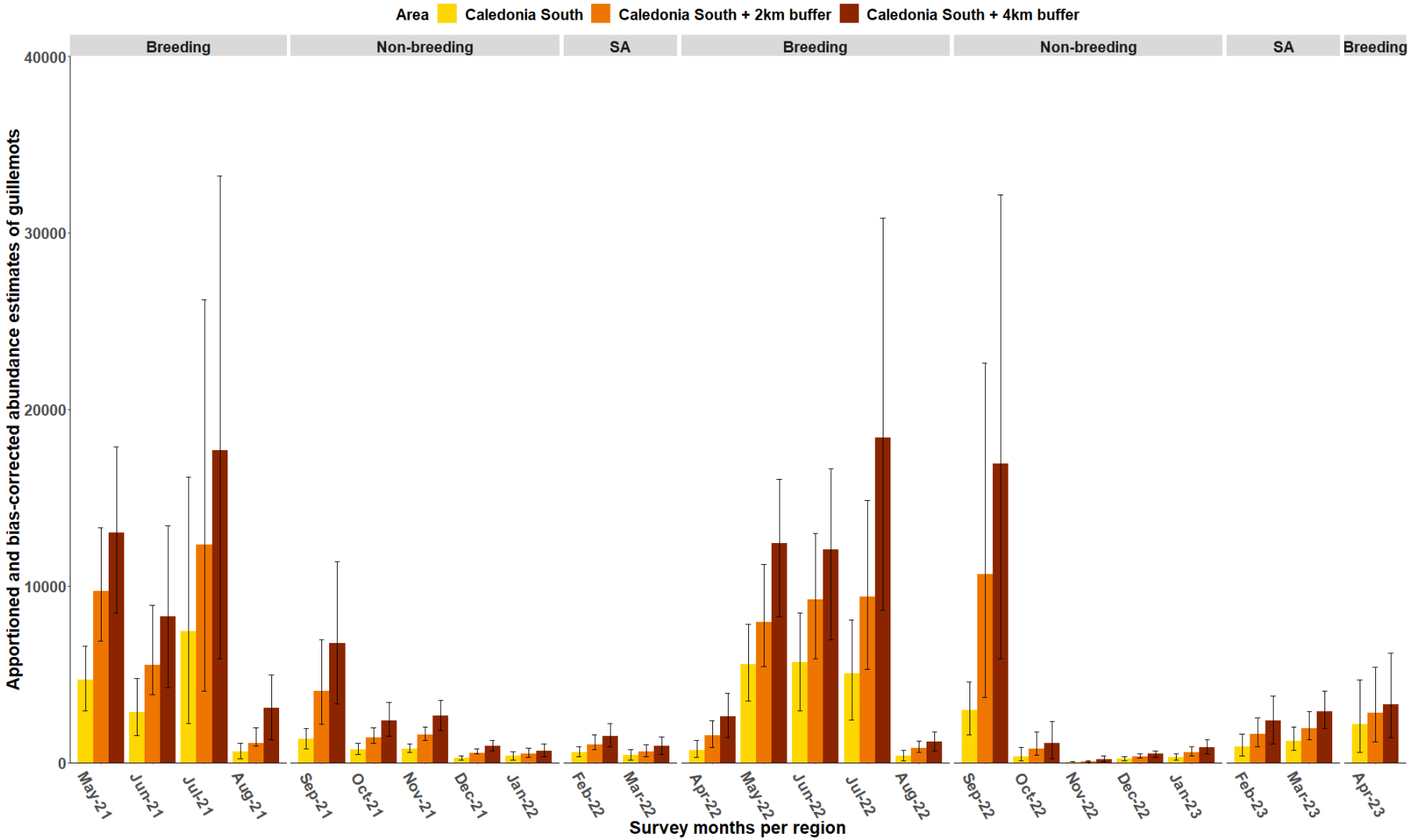


Figure 22 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total guillemots recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Guillemot seasonal periods are also displayed. SA stands for breeding site attendance

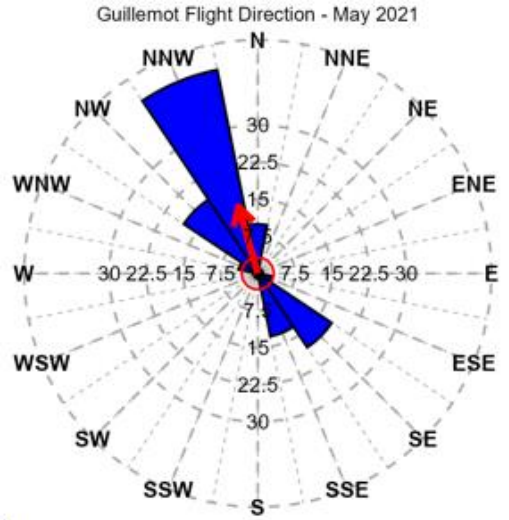
ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.103-126. In May to July 2021, November 2021, April to July 2022, December 2022, and in January and March 2023, guillemots were distributed throughout the Survey Area without any discernible distributional pattern (Figure A4.103-105, 109, 114-117, 122-123, 125). In August and October 2021, and January 2022, largest concentrations of guillemots occurred in the east to south of the Survey Area (Figure A4.106, 108, 111). In September 2021, February, March and August to November 2022, February and April 2023, most birds were located towards the south of the Survey Area (Figure A4.107, 112-113, 118-121, 124, 126). Higher numbers of birds to the south (and sometimes in the northwest) of the Survey Area may be linked to the proximity of these areas to breeding colonies (East Caithness Cliffs SPA to the west of the Survey Area, and Troup, Pennan and Lion's Heads SPA to the south of the Survey Area).

Significant predominant direction of flight was recorded in:

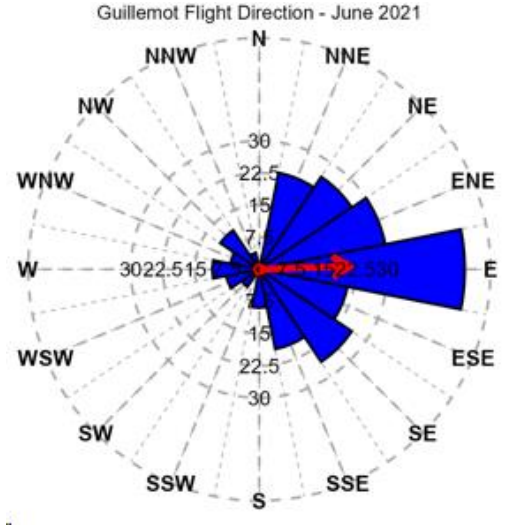
- **May**
  - 2021 north-northwest (Figure 23a)
- **June**
  - 2021 east (Figure 23b)
  - 2022 southeast (Figure 23e)
- **July**
  - 2022 southeast (Figure 23f)
- **October**
  - 2022 south-southeast (Figure 23g)
- **February**
  - 2023 northwest (Figure 23h)
- **March**
  - 2022 west-northwest (Figure 23c)
- **April**
  - 2022 northwest (Figure 23d)

As very few birds were recorded in flight in other surveys, and January, March and April 2023, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.17).



Number of Observations	114
Mean Vector (μ)	344.331
Length of Mean Vector (r)	0.334
Rayleigh Test (Z)	12.752
Rayleigh Test (p)	0.001

a May 2021

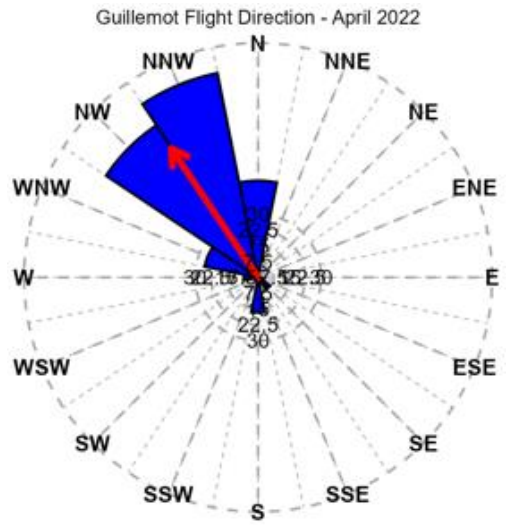


Number of Observations	250
Mean Vector (μ)	88.667
Length of Mean Vector (r)	0.443
Rayleigh Test (Z)	48.993
Rayleigh Test (p)	<0.001

b June 2021

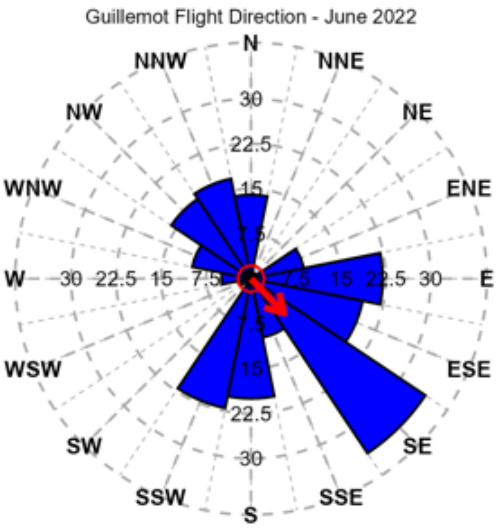
Number of Observations	76
Mean Vector (μ)	301.781
Length of Mean Vector (r)	0.777
Rayleigh Test (Z)	45.871
Rayleigh Test (p)	<0.001

c March 2022



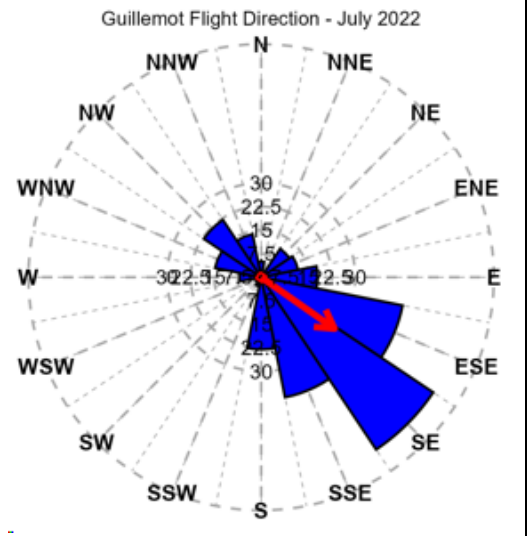
Number of Observations	296
Mean Vector (μ)	326.710
Length of Mean Vector (r)	0.747
Rayleigh Test (Z)	165.019
Rayleigh Test (p)	<0.001

d April 2022



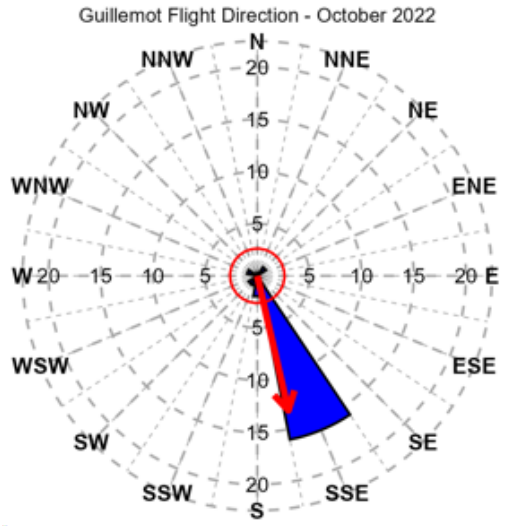
Number of Observations	204
Mean Vector (μ)	136.358
Length of Mean Vector (r)	0.229
Rayleigh Test (Z)	10.691
Rayleigh Test (p)	<0.001

e June 2022



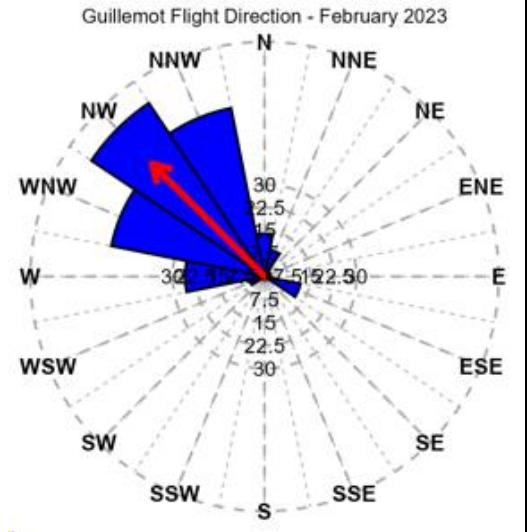
Number of Observations	285
Mean Vector (μ)	125.997
Length of Mean Vector (r)	0.432
Rayleigh Test (Z)	53.283
Rayleigh Test (p)	<0.001

f July 2022



Number of Observations	22
Mean Vector (μ)	167.081
Length of Mean Vector (r)	0.828
Rayleigh Test (Z)	15.072
Rayleigh Test (p)	<0.001

g October 2022



Number of Observations	247
Mean Vector (μ)	315.856
Length of Mean Vector (r)	0.764
Rayleigh Test (Z)	144.290
Rayleigh Test (p)	<0.001

h February 2023

Figure 23 Summary of flight direction of guillemots within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.19 Razorbill

i. Abundance and density estimates

Caledonia OWF

A total of 2,542 razorbills were recorded in the Survey Area during both years of baseline surveys (Table 8). Razorbills were recorded in every survey apart from November 2021 (Table 8, Table 68, Figure 24). In contrast to guillemot, highest abundances of razorbills were recorded during the non-breeding period (September to February). Peak abundances were recorded in September 2022 (Table 68, Figure 24):

- 250 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 1,447 [619; 2,361], an apportioned mean abundance estimate of 1,731 [805; 2,821] and an apportioned and availability bias-corrected mean abundance estimate of 2,093 [974; 3,408] individuals. These equated to mean density estimates of 3.39 (unapportioned), 4.05 (apportioned) and 4.90 (apportioned and availability bias-corrected) birds/km^2.
- 401 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 2,314 [1,437; 3,342], an apportioned mean abundance estimate of 2,682 [1,707; 3,857] and an apportioned and availability bias-corrected mean abundance estimate of 3,232 [2,065; 4,636] individuals. These equated to mean density estimates of 3.60 (unapportioned), 4.16 (apportioned) and 5.02 (apportioned and availability bias-corrected) birds/km^2.
- 514 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 2,999 [1,844; 4,231], an apportioned mean abundance estimate of 3,395 [2,092; 4,797] and an apportioned and availability bias-corrected mean abundance estimate of 4,094 [2,531; 5,772] individuals. These equated to mean density estimates of 3.39 (unapportioned), 3.84 (apportioned) and 4.63 (apportioned and availability bias-corrected) birds/km^2.

During the breeding site attendance period (March), razorbills were recorded in low numbers (considerably lower than the rest of the non-breeding season), with a peak abundance for the survey period recorded in March 2023: (Table 65; Figure 20):

- 48 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 280 [169; 379], an apportioned mean abundance estimate of 302 [166; 440] and an apportioned and availability bias-corrected mean abundance estimate of 360 [200; 521] individuals. These equated to mean density estimates of 0.66 (unapportioned), 0.71 (apportioned) and 0.84 (apportioned and availability bias-corrected) birds/km^2.
- 58 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 336 [191; 504], an apportioned mean abundance estimate of 366 [183; 590] and an apportioned and availability bias-corrected mean abundance estimate of 432 [220; 690] individuals. These equated to mean density estimates of 0.52 (unapportioned), 0.57 (apportioned) and 0.67 (apportioned and availability bias-corrected) birds/km^2.
- 84 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 493 [323; 646], an apportioned mean abundance estimate of 537 [307; 785] and an apportioned and availability bias-corrected mean abundance estimate of 634 [368; 919] individuals. These equated to mean density estimates of 0.56 (unapportioned), 0.61 (apportioned) and 0.72 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances within the Survey Area occurred in September and February/March. The largest overall peak was in September 2022, when mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species. During the winter months, relatively low mean apportioned and availability bias-corrected abundances occurred in both non-breeding seasons, with slightly higher abundances recorded in February 2022, February 2023 and March 2023. The timing of the non-breeding season peaks indicates that the Survey Area may be relatively important to post-breeding aggregations of birds (likely from a number of breeding colonies in the wider area), and birds attending colonies in the pre-breeding period.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 80% to >99.5%, reflecting the fact that the September 2022 peak was very large relative to the other mean apportioned and availability bias-corrected abundances recorded for razorbill in the Survey Area and reporting regions during the non-breeding season.

During the breeding season (April to mid-August), peak mean abundance was recorded in May 2022 (Table 68, Figure 24):

- 207 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 1,199 [591; 2,126], an apportioned mean abundance estimate of 1,323 [608; 2,417] and an apportioned and availability bias-corrected mean abundance estimate of 1,599 [735; 2,916] individuals. These equated to mean density estimates of 2.81 (unapportioned), 3.09 (apportioned) and 3.74 (apportioned and availability bias-corrected) birds/km^2.
- 290 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,659 [938; 2,626], an apportioned mean abundance estimate of 1,824 [1,002; 2,944] and an apportioned and availability bias-corrected mean abundance estimate of 2,205 [1,213; 3,355] individuals. These equated to mean density estimates of 2.58 (unapportioned), 2.83 (apportioned) and 3.42 (apportioned and availability bias-corrected) birds/km^2.
- 406 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 2,357 [1,260; 3,664], an apportioned mean abundance estimate of 2,590 [1,418; 4,061] and an apportioned and availability bias-corrected mean abundance estimate of 3,133 [1,716; 4,907] individuals. These equated to mean density estimates of 2.67 (unapportioned), 2.93 (apportioned) and 3.54 (apportioned and availability bias-corrected) birds/km^2.

In both breeding seasons covered by the baseline surveys, apportioned and availability bias-corrected mean razorbill abundances across the Survey Area were slightly lower at the beginning of the season (i.e. April) than other months in the breeding season. During the 2021 breeding season, abundances between May and August 2021 were relatively consistent, with the peak apportioned and availability bias-corrected mean razorbill abundance occurring in July 2021. During the 2022 breeding season, a large peak in apportioned and availability bias-corrected mean razorbill abundances (which was the overall breeding season peak month) was recorded in May 2022. Abundances were very low in June 2022, and also low in August 2022, with a larger apportioned and availability bias-corrected mean abundance in July 2022 across the Survey Area. The reasons for the differences in temporal patterns between the 2021 and 2022 breeding seasons within the Survey Area are unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 28% to 92%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

Precision values were quite variable for this species throughout the survey period (Table 68). CV values of ≤ 0.16 were reported in nine of 23 baseline surveys across Caledonia OWF, with lower precision values (i.e. higher levels of precision) coinciding with surveys where higher numbers of razorbills were recorded (Table 68). For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 68).

Table 68 **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of razorbills in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of razorbill raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to February). No colours were attributed to the breeding site attendance period (March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF														
May-21	63	367	245	478	0.13	0.86	396	257	528	0.93	479	312	639	1.12
Jun-21	53	311	188	452	0.14	0.73	383	210	612	0.9	458	253	729	1.07
Jul-21	126	743	419	1,168	0.09	1.74	775	436	1,243	1.81	938	528	1,505	2.19
Aug-21	35	203	116	307	0.17	0.48	435	182	785	1.02	527	221	951	1.23
Sep-21	24	139	70	215	0.20	0.33	193	100	301	0.45	231	121	358	0.54
Oct-21	6	35	18	53	0.41	0.08	44	21	68	0.1	53	25	83	0.12
Dec-21	4	23	4	46	0.50	0.05	153	61	286	0.36	185	74	346	0.43
Jan-22	3	17	3	41	0.58	0.04	23	5	55	0.05	28	6	67	0.07
Feb-22	23	124	59	194	0.21	0.29	279	140	414	0.65	338	170	502	0.79
Mar-22	5	27	5	48	0.45	0.06	47	9	100	0.11	55	11	117	0.13
Apr-22	57	328	144	581	0.13	0.77	391	150	717	0.91	471	181	861	1.1
May-22	207	1,199	591	2,126	0.07	2.81	1,323	608	2,417	3.09	1,599	735	2,916	3.74
Jun-22	17	98	57	144	0.24	0.23	101	53	149	0.24	122	64	181	0.29
Jul-22	65	380	246	509	0.12	0.89	425	263	584	0.99	514	319	707	1.2
Aug-22	20	115	58	184	0.22	0.27	135	65	218	0.32	164	79	264	0.38
Sep-22	250	1,447	619	2,361	0.06	3.39	1,731	805	2,821	4.05	2,093	974	3,408	4.9
Oct-22	1	6	1	18	<1	0.01	7	1	24	0.02	9	1	29	0.02
Nov-22	5	29	6	53	0.45	0.07	116	34	211	0.27	139	41	252	0.33
Dec-22	5	29	12	53	0.45	0.07	38	8	72	0.09	46	9	87	0.11
Jan-23	13	76	29	128	0.28	0.18	80	29	133	0.19	97	36	161	0.23
Feb-23	32	184	103	276	0.18	0.43	201	91	361	0.47	236	109	419	0.55
Mar-23	48	280	169	379	0.14	0.66	302	166	440	0.71	360	200	521	0.84
Apr-23	61	346	85	771	0.13	0.81	368	70	861	0.86	440	83	1,027	1.03
b) Caledonia OWF plus 2 km buffer														
May-21	129	741	511	971	0.09	1.15	804	516	1,089	1.25	974	625	1,319	1.51
Jun-21	96	557	331	800	0.10	0.87	739	391	1,206	1.15	886	473	1,440	1.38

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jul-21	195	1,130	620	1,894	0.07	1.76	1,187	661	1,909	1.84	1,437	800	2,312	2.23
Aug-21	51	291	171	405	0.14	0.45	760	359	1,313	1.18	921	435	1,590	1.43
Sep-21	53	304	195	431	0.14	0.47	372	239	510	0.58	449	289	612	0.7
Oct-21	8	46	23	69	0.35	0.07	60	28	93	0.09	72	34	112	0.11
Dec-21	6	34	11	57	0.41	0.05	259	135	351	0.4	314	163	425	0.49
Jan-22	7	40	11	69	0.38	0.06	52	14	92	0.08	63	17	112	0.1
Feb-22	44	236	155	306	0.15	0.37	518	393	623	0.8	627	476	754	0.97
Mar-22	8	42	21	64	0.35	0.07	77	33	131	0.12	93	39	155	0.14
Apr-22	95	539	261	941	0.10	0.84	645	281	1,126	1	774	340	1,349	1.2
May-22	290	1,659	938	2,626	0.06	2.58	1,824	1,002	2,944	2.83	2,205	1,213	3,555	3.42
Jun-22	24	138	86	183	0.20	0.21	142	94	189	0.22	172	113	229	0.27
Jul-22	140	806	553	1,088	0.08	1.25	905	568	1,261	1.41	1,094	687	1,521	1.7
Aug-22	55	315	200	440	0.13	0.49	366	221	551	0.57	444	268	667	0.69
Sep-22	401	2,314	1,437	3,342	0.05	3.6	2,682	1,707	3,857	4.16	3,232	2,065	4,636	5.02
Oct-22	7	41	7	111	0.38	0.06	45	7	128	0.07	54	9	155	0.08
Nov-22	10	58	17	110	0.32	0.09	159	52	295	0.25	191	63	354	0.3
Dec-22	13	76	35	123	0.28	0.12	94	33	166	0.15	114	40	201	0.18
Jan-23	17	99	46	169	0.24	0.15	104	47	176	0.16	126	56	213	0.19
Feb-23	46	263	149	383	0.15	0.41	283	133	463	0.44	334	160	542	0.52
Mar-23	58	336	191	504	0.13	0.52	366	183	590	0.57	432	220	690	0.67
Apr-23	82	465	125	924	0.11	0.72	501	130	1,032	0.78	600	156	1,233	0.93
c) Survey Area														
May-21	178	1,040	666	1,432	0.07	1.18	1,132	731	1,585	1.28	1,371	885	1,920	1.55
Jun-21	160	941	553	1,471	0.08	1.06	1,303	630	2,191	1.47	1,563	761	2,621	1.77
Jul-21	296	1,787	1,238	2,481	0.06	2.02	1,873	1,266	2,593	2.12	2,265	1,533	3,133	2.56
Aug-21	61	354	186	528	0.13	0.4	1,358	494	2,491	1.54	1,644	598	3,016	1.86
Sep-21	80	468	298	661	0.11	0.53	566	350	810	0.64	684	424	974	0.77
Oct-21	10	59	35	82	0.32	0.07	74	42	106	0.08	90	50	129	0.1
Dec-21	6	35	12	64	0.41	0.04	326	165	465	0.37	395	200	563	0.45
Jan-22	8	46	17	81	0.35	0.05	60	31	99	0.07	73	37	120	0.08
Feb-22	59	324	247	406	0.13	0.37	683	536	806	0.77	827	649	977	0.94
Mar-22	13	70	32	108	0.28	0.08	122	50	211	0.14	147	61	252	0.17

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Apr-22	148	853	473	1,361	0.08	0.97	1,019	540	1,665	1.15	1,223	652	1,991	1.38
May-22	**406**	**2,357**	**1,260**	**3,664**	**0.05**	**2.67**	**2,590**	**1,418**	**4,061**	**2.93**	**3,133**	**1,716**	**4,907**	**3.54**
Jun-22	35	203	122	289	0.17	0.23	208	114	304	0.24	250	138	361	0.28
Jul-22	198	1,157	748	1,677	0.07	1.31	1,264	797	1,819	1.43	1,525	964	2,194	1.72
Aug-22	60	345	184	523	0.13	0.39	413	216	638	0.47	501	262	773	0.57
Sep-22	**514**	**2,999**	**1,844**	**4,231**	**0.04**	**3.39**	**3,395**	**2,092**	**4,797**	**3.84**	**4,094**	**2,531**	**5,772**	**4.63**
Oct-22	8	47	8	123	0.35	0.05	51	8	133	0.06	61	10	161	0.07
Nov-22	16	94	29	177	0.25	0.11	192	52	358	0.22	231	63	427	0.26
Dec-22	17	100	53	153	0.24	0.11	120	61	184	0.14	146	74	223	0.16
Jan-23	20	118	53	194	0.22	0.13	123	60	200	0.14	149	72	242	0.17
Feb-23	66	382	243	515	0.12	0.43	416	230	624	0.47	494	276	738	0.56
Mar-23	84	493	323	646	0.11	0.56	537	307	785	0.61	634	368	919	0.72
Apr-23	99	568	201	1,062	0.10	0.64	609	191	1,167	0.69	725	230	1,386	0.82

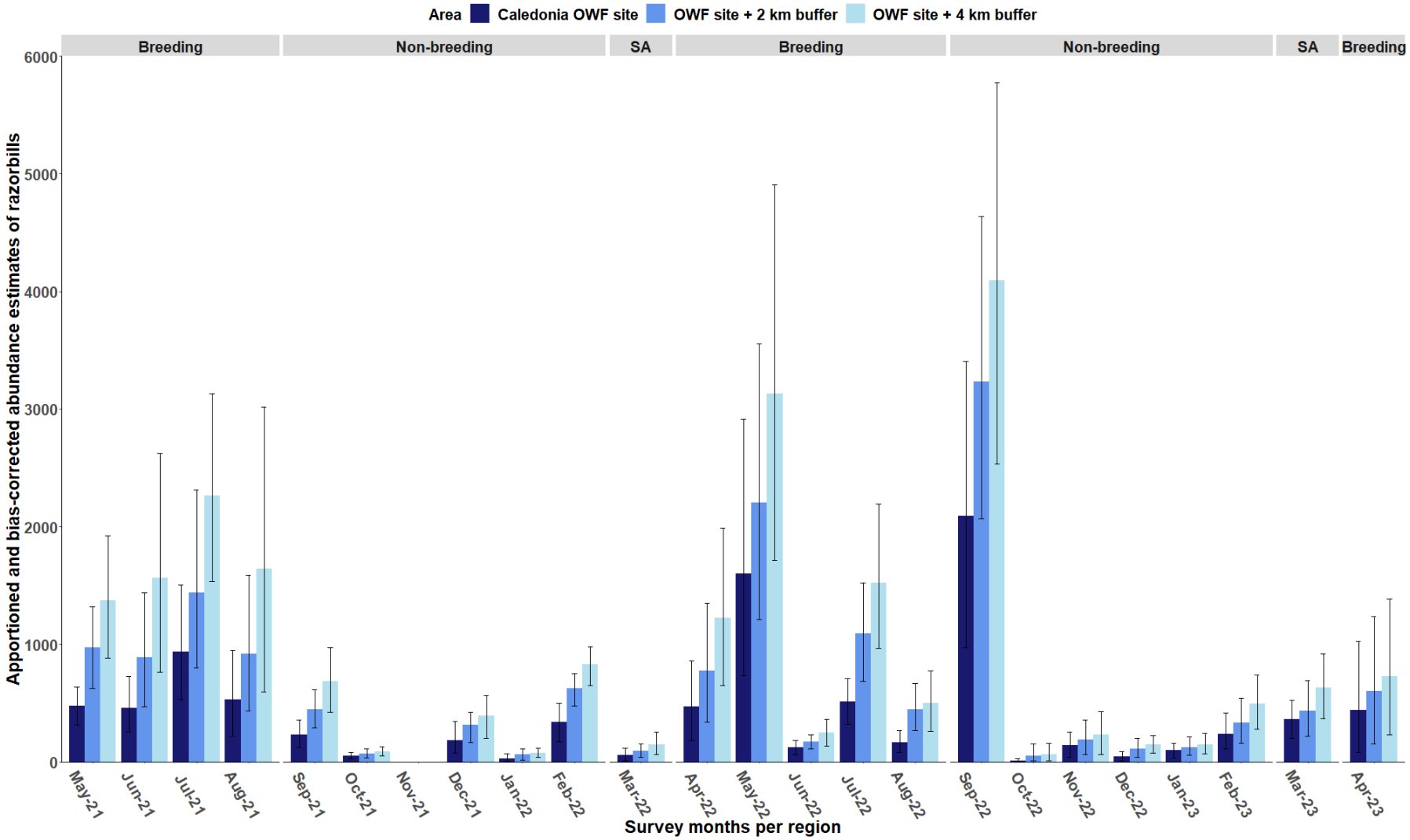


Figure 24 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total razorbills recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Razorbill seasonal periods are also displayed. SA stands for breeding site attendance.

Caledonia North

A total of 1,395 razorbills were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Razorbills were recorded in every survey apart from November 2021 (Table 9, Table 69, Figure 25). Highest abundances were recorded during the non-breeding period (September to February). Peak of abundance were recorded in September 2022 (Table 69, Figure 25):

- 171 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 981 [419; 1,584], an apportioned mean abundance estimate of 1,256 [506; 2,086] and an apportioned and availability bias-corrected mean abundance estimate of 1,519 [612; 2,522] individuals. These equated to mean density estimates of 4.49 (unapportioned), 5.75 (apportioned) and 6.95 (apportioned and availability bias-corrected) birds/km^2.
- 276 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,603 [865; 2,434], an apportioned mean abundance estimate of 2,021 [1,043; 3,201] and an apportioned and availability bias-corrected mean abundance estimate of 2,438 [1,262; 3,850] individuals. These equated to mean density estimates of 4.27 (unapportioned), 5.38 (apportioned) and 6.49 (apportioned and availability bias-corrected) birds/km^2.
- 371 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 2,161 [1,089; 3,227], an apportioned mean abundance estimate of 2,665 [1,314; 4,158] and an apportioned and availability bias-corrected mean abundance estimate of 3,215 [1,589; 5,006] individuals. These equated to mean density estimates of 3.88 (unapportioned), 4.78 (apportioned) and 5.77 (apportioned and availability bias-corrected) birds/km^2.

During the breeding site attendance period (March), razorbills were recorded in low numbers, with a peak number in March 2023: (Table 69, Figure 25):

- 18 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 105 [29; 199], an apportioned mean abundance estimate of 119 [34; 231] and an apportioned and availability bias-corrected mean abundance estimate of 141 [41; 273] individuals. These equated to mean density estimates of 0.48 (unapportioned), 0.54 (apportioned) and 0.65 (apportioned and availability bias-corrected) birds/km^2.
- 32 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 186 [70; 330], an apportioned mean abundance estimate of 204 [65; 372] and an apportioned and availability bias-corrected mean abundance estimate of 236 [77; 426] individuals. These equated to mean density estimates of 0.50 (unapportioned), 0.54 (apportioned) and 0.63 (apportioned and availability bias-corrected) birds/km^2.
- 53 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 311 [170; 458], an apportioned mean abundance estimate of 340 [157; 543] and an apportioned and availability bias-corrected mean abundance estimate of 399 [188; 630] individuals. These equated to mean density estimates of 0.56 (unapportioned), 0.61 (apportioned) and 0.72 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances of razorbills within Caledonia North Survey Area occurred in September and February/March. The largest overall peak was recorded in September 2022, when mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species. During the late autumn and winter months, mean apportioned and availability bias-corrected abundances of razorbills was consistently low in Caledonia North Survey Area reporting regions, with higher mean apportioned and availability

bias-corrected abundances of razorbills occurring in February 2022, and March 2023. The timing of the non-breeding season peaks indicates that the Survey Area may be relatively important to post-breeding aggregations of birds (likely from a number of breeding colonies in the wider area), and birds attending colonies in the pre-breeding period.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 81% to >99.5%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This is largely a reflection of the fact that the September 2022 peak was very large relative to the other mean apportioned and availability bias-corrected abundances recorded for razorbill in Caledonia North Survey Area and reporting regions during the non-breeding season.

During the breeding season (April to mid-August, with birds attending colonies from March onwards) Peak abundance was recorded in May 2022 (Table 69, Figure 25):

- 133 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 772 [395; 1,352], an apportioned mean abundance estimate of 850 [403; 1,548] and an apportioned and availability bias-corrected mean abundance estimate of 1,026 [488; 1,867] individuals. These equated to mean density estimates of 3.54 (unapportioned), 3.89 (apportioned) and 4.63 (apportioned and availability bias-corrected) birds/km^2.
- 214 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,219 [763; 1,822], an apportioned mean abundance estimate of 1,338 [804; 1,995] and an apportioned and availability bias-corrected mean abundance estimate of 1,618 [974; 2,409] individuals. These equated to mean density estimates of 3.25 (unapportioned), 3.56 (apportioned) and 4.31 (apportioned and availability bias-corrected) birds/km^2.
- 314 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,826 [988; 2,797], an apportioned mean abundance estimate of 1,998 [1,036; 3,092] and an apportioned and availability bias-corrected mean abundance estimate of 2,417 [1,254; 3,737] individuals. These equated to mean density estimates of 3.28 (unapportioned), 3.58 (apportioned) and 4.33 (apportioned and availability bias-corrected) birds/km^2.

During the 2021 breeding season, mean apportioned and availability bias-corrected razorbill abundance between May and August were relatively consistent, with Caledonia North Survey Area peak occurring in July 2021. During the 2022 breeding season, a large peak in apportioned and availability bias-corrected mean razorbill abundances (which was the overall breeding season peak month by a larger margin) was recorded in May 2022. Abundances were very low in June 2022 and in August 2022, with a larger apportioned and availability bias-corrected mean abundance in July 2022 across Caledonia North Survey Area. The reasons for the differences in temporal patterns between the 2021 and 2022 breeding seasons within Caledonia North Survey Area are unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 64% to 97%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season when compared with the peak mean apportioned abundance for this season during the baseline survey period.

Precision values were quite variable throughout the survey period (Table 69). CV values of ≤ 0.16 were reported in two of 22 baseline surveys across Caledonia North, with lower precision values (i.e. higher levels of precision) coinciding with surveys where higher numbers of razorbills were recorded (Table 69). For Caledonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 69).

Table 69 **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of razorbills in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of razorbill raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to February). No colours were attributed to the breeding site attendance period (March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North														
May-21	30	175	70	286	0.18	0.80	192	70	317	0.88	232	85	384	1.06
Jun-21	14	83	30	148	0.27	0.38	97	21	196	0.44	112	24	226	0.51
Jul-21	28	166	89	249	0.19	0.76	179	92	279	0.82	217	112	338	0.99
Aug-21	22	127	35	226	0.21	0.58	204	68	360	0.93	246	83	436	1.13
Sep-21	12	70	29	104	0.29	0.32	103	38	175	0.47	125	46	211	0.57
Oct-21	1	6	1	18	1.00	0.03	8	1	26	0.04	10	1	32	0.05
Dec-21	2	12	2	35	0.71	0.05	56	9	144	0.26	68	11	175	0.31
Feb-22	16	86	27	151	0.25	0.39	206	79	355	0.94	250	95	430	1.14
Mar-22	3	16	3	43	0.58	0.07	25	4	64	0.11	30	4	77	0.14
Apr-22	34	195	52	379	0.17	0.89	217	49	435	0.99	263	59	526	1.2
May-22	133	772	395	1,352	0.09	3.54	850	403	1,548	3.89	1,026	488	1,867	4.7
Jun-22	8	46	11	91	0.35	0.21	47	11	95	0.22	57	13	115	0.26
Jul-22	30	176	88	258	0.18	0.81	204	99	327	0.94	248	120	395	1.13
Aug-22	8	46	12	87	0.35	0.21	62	20	114	0.28	75	25	138	0.34
Sep-22	171	981	419	1,584	0.08	4.49	1,256	506	2,086	5.75	1,519	612	2,522	6.95
Oct-22	1	6	1	17	1.00	0.03	15	3	43	0.07	18	3	52	0.08
Nov-22	3	18	3	35	0.58	0.08	73	12	136	0.34	88	15	161	0.4
Dec-22	2	12	2	29	0.71	0.05	16	2	41	0.07	19	3	50	0.09
Jan-23	6	35	6	69	0.41	0.16	38	6	80	0.18	46	8	97	0.21
Feb-23	7	40	7	86	0.38	0.18	45	7	105	0.20	48	8	114	0.22
Mar-23	18	105	29	199	0.24	0.48	119	34	231	0.54	141	41	273	0.65
Apr-23	3	17	3	28	0.58	0.08	192	70	317	0.88	26	8	44	0.12
b) Caledonia North plus 2 km buffer														
May-21	61	349	229	475	0.13	0.93	384	240	509	1.02	465	290	617	1.24
Jun-21	31	180	93	278	0.18	0.48	210	96	352	0.56	246	115	407	0.66
Jul-21	56	323	231	438	0.13	0.86	341	244	456	0.91	413	296	552	1.1

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Aug-21	37	210	102	323	0.16	0.56	334	153	511	0.89	404	185	619	1.08
Sep-21	17	97	23	188	0.24	0.26	159	46	313	0.42	192	55	379	0.51
Oct-21	1	6	1	17	1.00	0.02	8	1	24	0.02	10	2	29	0.03
Dec-21	2	11	2	34	0.71	0.03	96	45	214	0.26	116	54	259	0.31
Jan-22	1	6	1	17	1.00	0.02	8	1	25	0.02	10	1	30	0.03
Feb-22	29	156	80	236	0.19	0.42	375	216	544	1.00	454	261	659	1.21
Mar-22	5	27	5	53	0.45	0.07	47	8	89	0.13	57	9	108	0.15
Apr-22	49	275	90	489	0.14	0.73	325	93	600	0.87	394	113	726	1.05
May-22	214	1,219	763	1,822	0.07	3.25	1,338	804	1,995	3.56	1,618	974	2,409	4.31
Jun-22	12	69	23	121	0.29	0.18	71	23	126	0.19	86	28	152	0.23
Jul-22	54	309	166	452	0.14	0.82	354	164	545	0.94	427	199	657	1.14
Aug-22	24	137	74	200	0.20	0.37	182	86	281	0.48	220	104	340	0.59
Sep-22	276	1,603	865	2,434	0.06	4.27	2,021	1,043	3,201	5.38	2,438	1,262	3,850	6.49
Oct-22	7	41	7	112	0.38	0.11	58	10	161	0.15	70	12	195	0.19
Nov-22	6	35	12	58	0.41	0.09	113	33	195	0.30	135	40	232	0.36
Dec-22	6	35	6	65	0.41	0.09	46	14	94	0.12	56	17	114	0.15
Jan-23	7	41	7	82	0.38	0.11	44	12	93	0.12	54	15	112	0.14
Feb-23	13	74	13	131	0.28	0.20	82	18	171	0.22	92	20	190	0.24
Mar-23	32	186	70	330	0.18	0.50	204	65	372	0.54	236	77	426	0.63
Apr-23	8	46	17	80	0.35	0.12	58	14	123	0.15	69	17	146	0.18
c) Caledonia North Survey Area														
May-21	99	579	369	819	0.10	1.04	646	411	900	1.16	782	497	1,090	1.4
Jun-21	47	278	142	432	0.15	0.50	329	170	532	0.59	390	204	621	0.7
Jul-21	112	678	491	902	0.09	1.22	719	521	972	1.29	868	631	1,169	1.56
Aug-21	44	255	99	406	0.15	0.46	436	204	693	0.78	528	246	840	0.95
Sep-21	24	140	70	239	0.20	0.25	212	88	392	0.38	257	107	475	0.46
Oct-21	2	12	2	29	0.71	0.02	15	2	37	0.03	18	3	45	0.03
Dec-21	2	12	2	35	0.71	0.02	96	20	233	0.17	116	25	283	0.21
Jan-22	1	6	1	17	1.00	0.01	8	1	25	0.01	10	1	30	0.02
Feb-22	37	204	110	297	0.16	0.37	514	303	736	0.92	623	366	892	1.12
Mar-22	9	49	22	86	0.33	0.09	99	29	182	0.18	120	35	221	0.22
Apr-22	82	472	236	771	0.11	0.85	535	241	904	0.96	643	291	1,082	1.15

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
May-22	**314**	**1,826**	**988**	**2,797**	**0.06**	**3.28**	**1,998**	**1,036**	**3,092**	**3.58**	**2,417**	**1,254**	**3,737**	**4.33**
Jun-22	22	127	58	196	0.21	0.23	132	61	216	0.24	158	74	254	0.28
Jul-22	77	451	293	603	0.11	0.81	501	309	705	0.90	604	374	847	1.08
Aug-22	30	172	86	252	0.18	0.31	247	122	377	0.44	299	148	456	0.54
Sep-22	**371**	**2,161**	**1,089**	**3,227**	**0.05**	**3.88**	**2,665**	**1,314**	**4,158**	**4.78**	**3,215**	**1,589**	**5,006**	**5.77**
Oct-22	8	47	8	117	0.35	0.08	61	10	159	0.11	74	12	193	0.13
Nov-22	9	53	12	100	0.33	0.10	146	39	284	0.26	174	47	338	0.31
Dec-22	9	53	18	94	0.33	0.10	68	22	125	0.12	82	27	152	0.15
Jan-23	12	71	24	118	0.29	0.13	76	25	138	0.14	92	30	167	0.17
Feb-23	17	98	40	168	0.24	0.18	111	39	204	0.20	125	45	227	0.22
Mar-23	53	311	170	458	0.14	0.56	340	157	543	0.61	399	188	630	0.72
Apr-23	14	80	34	137	0.27	0.14	91	30	163	0.16	105	36	188	0.19

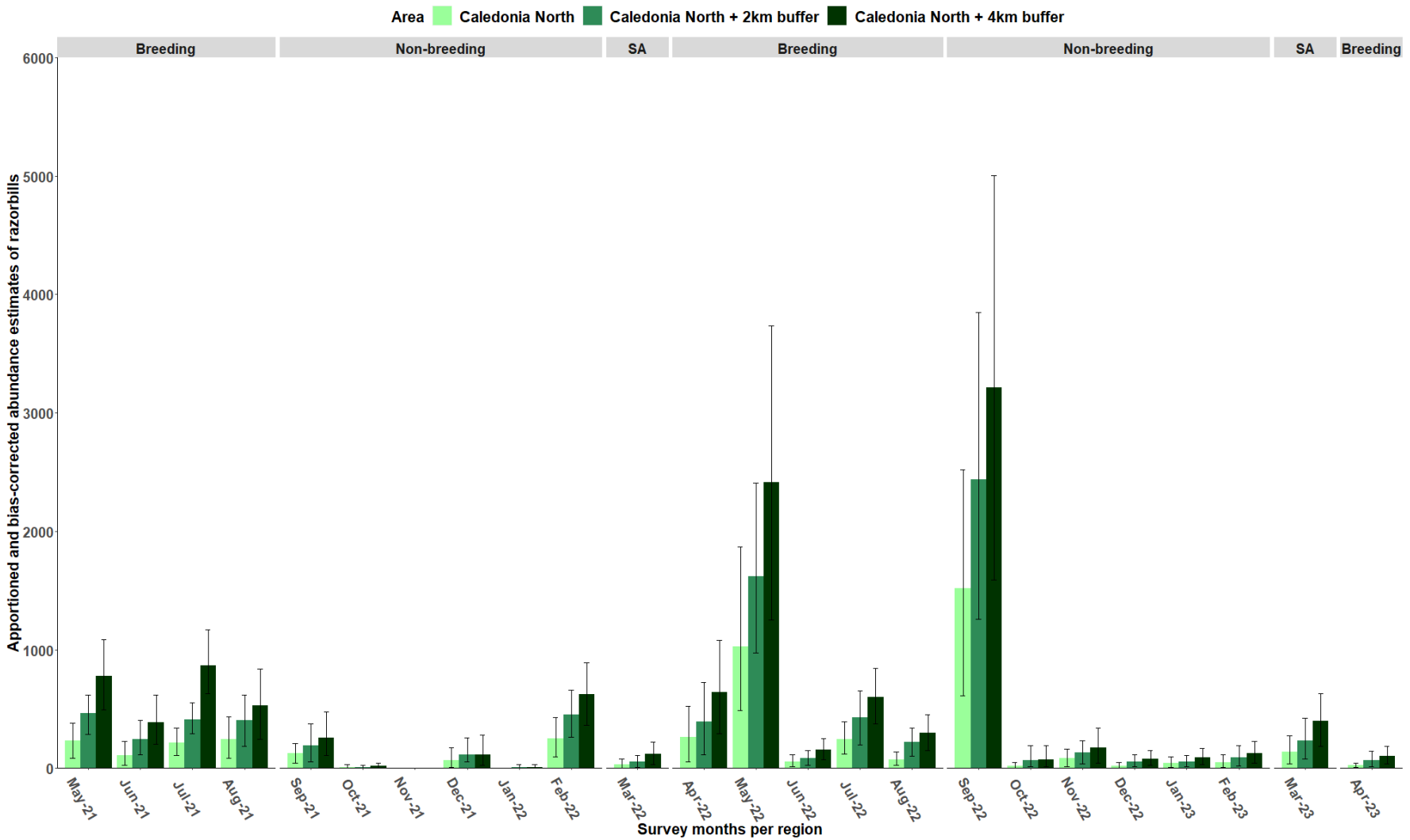


Figure 25 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total razorbills recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Razorbill seasonal periods are also displayed. SA stands for breeding site attendance.

Caledonia South

A total of 1,617 razorbills were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Razorbills were recorded in every survey apart from November 2021 (Table 70, Figure 26). In contrast to Caledonia North and the Survey Area, highest abundances of razorbills were recorded during the breeding season (April to mid-August, with birds attending colonies from March onwards). Peak breeding season abundances were recorded during in July 2021 (Table 70, Figure 26):

- 100 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 586 [270; 1,003], an apportioned mean abundance estimate of 607 [288; 1,023] and an apportioned and availability bias-corrected mean abundance estimate of 735 [348; 1,239] individuals. These equated to mean density estimates of 2.79 (unapportioned), 2.88 (apportioned) and 3.49 (apportioned and availability bias-corrected) birds/km^2.
- 157 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 913 [425; 1,699], an apportioned mean abundance estimate of 958 [481; 1,645] and an apportioned and availability bias-corrected mean abundance estimate of 1,160 [582; 1,993] individuals. These equated to mean density estimates of 2.54 (unapportioned), 2.66 (apportioned) and 3.22 (apportioned and availability bias-corrected) birds/km^2.
- 244 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,465 [895; 2,210], an apportioned mean abundance estimate of 1,530 [960; 2,320] and an apportioned and availability bias-corrected mean abundance estimate of 1,853 [1,163; 2,809] individuals. These equated to mean density estimates of 2.75 (unapportioned), 2.87 (apportioned) and 3.47 (apportioned and availability bias-corrected) birds/km^2.

During the 2021 breeding season, mean apportioned and availability bias-corrected razorbill abundance within Caledonia South Survey Area increased between May and July, with the breeding season peak for the baseline survey period occurring in July 2021. Razorbill mean apportioned and availability bias-corrected abundance declined between July 2021 and August 2021. During the 2022 breeding season, the temporal pattern observed was quite different to the 2021 breeding season, with low numbers of birds present in June 2022 and August 2022, and higher abundances recorded in April 2022, May 2022 and August 2022. The reasons for the differences in temporal patterns between the 2021 and 2022 breeding seasons within Caledonia South Survey Area are unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 22% to 93%, with most surveys falling somewhere in the middle of the two extremes of this range. This indicates that the mean apportioned abundances were somewhat variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

During the non-breeding period, peak numbers were recorded in September 2022 (Table 70, Figure 26):

- 79 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 461 [268; 665], an apportioned mean abundance estimate of 529 [288; 774] and an apportioned and availability bias-corrected mean abundance estimate of 639 [348; 932] individuals. These equated to mean density estimates of 2.19 (unapportioned), 2.51 (apportioned) and 3.04 (apportioned and availability bias-corrected) birds/km^2.
- 163 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 931 [674; 1,171], an apportioned mean abundance estimate of 1,067 [803; 1,382] and an apportioned and availability bias-corrected mean abundance estimate of 1,286 [970; 1,659] individuals. These equated to mean density

estimates of 2.59 (unapportioned), 2.96 (apportioned) and 3.57 (apportioned and availability bias-corrected) birds/km^2.

- 243 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,418 [1,120; 1,786], an apportioned mean abundance estimate of 1,586 [1,254; 1,983] and an apportioned and availability bias-corrected mean abundance estimate of 1,915 [1,517; 2,384] individuals. These equated to mean density estimates of 2.66 (unapportioned), 2.97 (apportioned) and 3.59 (apportioned and availability bias-corrected) birds/km^2.

During the breeding site attendance period (March), razorbills were recorded in low numbers in Caledonia South Survey Area, with a peak abundance in March 2023: (Table 70, Figure 26):

- 30 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 174 [104; 255], an apportioned mean abundance estimate of 182 [92; 288] and an apportioned and availability bias-corrected mean abundance estimate of 217 [110; 340] individuals. These equated to mean density estimates of 0.83 (unapportioned), 0.87 (apportioned) and 1.03 (apportioned and availability bias-corrected) birds/km^2.
- 35 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 202 [98; 311], an apportioned mean abundance estimate of 219 [102; 367] and an apportioned and availability bias-corrected mean abundance estimate of 261 [122; 435] individuals. These equated to mean density estimates of 0.56 (unapportioned), 0.61 (apportioned) and 0.73 (apportioned and availability bias-corrected) birds/km^2.
- 57 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 332 [221; 449], an apportioned mean abundance estimate of 360 [185; 534] and an apportioned and availability bias-corrected mean abundance estimate of 425 [222; 627] individuals. These equated to mean density estimates of 0.62 (unapportioned), 0.67 (apportioned) and 0.8 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances of razorbills occurred within Caledonia South Survey Area in September. The largest overall peak was in September 2022, when mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species. During the late autumn and winter months, mean apportioned and availability bias-corrected abundances of razorbills was generally low in Caledonia South Survey Area reporting regions (with the exception of December 2021), with higher mean apportioned and availability bias-corrected abundances of razorbills occurring in February 2022, February 2023, and March 2023.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 66% to >99.5%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This reflects the fact that the September 2022 peak was very large relative to the other peak mean apportioned and availability bias-corrected abundances recorded for razorbill during the non-breeding season.

Precision values were quite variable for this species throughout the survey period (Table 70). CV values of ≤ 0.16 were reported in five of 22 baseline surveys across Caledonia South, with lower precision values (i.e. higher levels of precision) coinciding with surveys where higher numbers of birds were recorded (Table 70). For Caledonia South plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 70).

Table 70 **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of razorbills in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of razorbill raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to February). No colours were attributed to the breeding site attendance period (March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South														
May-21	33	192	93	303	0.17	0.91	206	89	321	0.98	249	108	389	1.18
Jun-21	39	227	116	355	0.16	1.08	284	128	480	1.35	344	155	581	1.63
Jul-21	100	586	270	1,003	0.10	2.79	607	288	1,023	2.88	735	348	1,239	3.49
Aug-21	13	75	23	127	0.28	0.36	188	39	426	0.89	228	47	516	1.08
Sep-21	13	75	29	128	0.28	0.36	100	42	161	0.47	119	50	192	0.57
Oct-21	5	29	12	41	0.45	0.14	36	13	53	0.17	43	16	64	0.2
Dec-21	2	12	2	23	0.71	0.06	106	40	207	0.50	128	48	250	0.61
Jan-22	3	17	3	46	0.58	0.08	23	5	52	0.11	27	6	63	0.13
Feb-22	7	38	16	65	0.38	0.18	81	31	138	0.38	98	38	167	0.47
Mar-22	2	11	2	27	0.71	0.05	17	4	55	0.08	20	4	63	0.09
Apr-22	23	132	52	225	0.21	0.63	165	55	291	0.78	197	66	345	0.93
May-22	74	427	191	705	0.12	2.03	474	191	810	2.25	573	231	978	2.72
Jun-22	9	52	29	81	0.33	0.25	54	30	78	0.25	65	36	94	0.31
Jul-22	35	204	99	321	0.17	0.97	225	109	374	1.07	272	133	453	1.29
Aug-22	12	69	35	98	0.29	0.33	78	37	122	0.37	95	45	148	0.45
Sep-22	79	461	268	665	0.11	2.19	529	288	774	2.51	639	348	932	3.04
Nov-22	2	12	2	35	0.71	0.06	43	7	105	0.21	52	9	127	0.25
Dec-22	3	18	3	41	0.58	0.09	23	4	54	0.11	28	5	66	0.13
Jan-23	7	41	12	76	0.38	0.19	42	7	80	0.20	51	9	96	0.24
Feb-23	25	143	68	234	0.20	0.68	153	71	264	0.73	184	86	315	0.87
Mar-23	30	174	104	255	0.18	0.83	182	92	288	0.87	217	110	340	1.03
Apr-23	58	330	63	722	0.13	1.57	347	60	839	1.65	414	72	1,000	1.97
b) Caledonia South plus 2 km buffer														
May-21	73	422	260	578	0.12	1.17	455	287	654	1.27	551	348	792	1.53
Jun-21	70	406	215	661	0.12	1.13	564	368	965	1.57	682	445	1,164	1.9
Jul-21	157	913	425	1,699	0.08	2.54	958	481	1,645	2.66	1,160	582	1,993	3.22

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Aug-21	19	109	46	172	0.23	0.30	367	304	721	1.02	445	369	873	1.24
Sep-21	39	225	144	329	0.16	0.63	266	174	385	0.74	320	210	461	0.89
Oct-21	8	46	23	70	0.35	0.13	59	36	95	0.16	72	44	115	0.2
Dec-21	5	29	12	46	0.45	0.08	193	176	250	0.54	233	213	302	0.65
Jan-22	6	34	11	63	0.41	0.09	45	22	84	0.13	55	27	102	0.15
Feb-22	19	101	64	144	0.23	0.28	199	157	266	0.55	241	190	322	0.67
Mar-22	4	21	5	37	0.50	0.06	38	21	79	0.11	45	25	92	0.13
Apr-22	51	292	126	492	0.14	0.81	355	184	624	0.99	422	220	741	1.17
May-22	109	625	327	952	0.10	1.74	687	389	1,063	1.91	830	470	1,284	2.31
Jun-22	12	68	40	97	0.29	0.19	70	42	94	0.19	84	50	114	0.23
Jul-22	99	573	301	897	0.10	1.59	638	355	1,048	1.77	771	430	1,266	2.14
Aug-22	39	223	97	366	0.16	0.62	245	125	429	0.68	297	152	519	0.83
Sep-22	163	931	674	1,171	0.08	2.59	1,067	803	1,382	2.96	1,286	970	1,659	3.57
Oct-22	1	6	1	17	1.00	0.02	6	1	18	0.02	8	1	22	0.02
Nov-22	6	35	6	76	0.41	0.10	78	49	168	0.22	95	59	203	0.26
Dec-22	8	46	12	87	0.35	0.13	56	22	99	0.16	68	26	120	0.19
Jan-23	11	63	11	132	0.30	0.18	65	13	132	0.18	78	15	160	0.22
Feb-23	34	194	91	308	0.17	0.54	207	105	350	0.57	249	127	420	0.69
Mar-23	35	202	98	311	0.17	0.56	219	102	367	0.61	261	122	435	0.73
Apr-23	77	431	90	874	0.11	1.20	455	107	1,024	1.26	545	128	1,223	1.51
c) Caledonia South Survey Area														
May-21	99	574	342	812	0.10	1.08	621	348	921	1.16	751	421	1,115	1.41
Jun-21	131	761	384	1,273	0.09	1.43	1,091	447	1,990	2.04	1,312	540	2,389	2.46
Jul-21	244	1,465	895	2,210	0.06	2.75	1,530	960	2,320	2.87	1,853	1,163	2,809	3.47
Aug-21	26	150	69	224	0.20	0.28	743	218	1,345	1.39	899	264	1,629	1.69
Sep-21	67	389	238	575	0.12	0.73	457	278	689	0.86	552	337	830	1.03
Oct-21	10	58	35	81	0.32	0.11	73	41	105	0.14	88	50	128	0.16
Dec-21	5	29	12	46	0.45	0.05	258	176	316	0.48	312	213	383	0.58
Jan-22	7	40	12	69	0.38	0.07	52	16	98	0.10	64	19	119	0.12
Feb-22	27	147	92	206	0.19	0.28	277	183	373	0.52	335	222	452	0.63
Mar-22	6	32	6	64	0.41	0.06	51	11	121	0.10	60	13	143	0.11
Apr-22	100	573	344	831	0.10	1.07	699	360	1,088	1.31	838	434	1,301	1.57

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
May-22	185	1,063	644	1,529	0.07	1.99	1,166	653	1,728	2.18	1,408	790	2,082	2.64
Jun-22	21	122	75	174	0.22	0.23	125	76	180	0.23	152	92	219	0.28
Jul-22	158	915	533	1,471	0.08	1.72	992	559	1,550	1.86	1,199	677	1,871	2.25
Aug-22	47	269	109	476	0.15	0.50	303	111	519	0.57	367	135	629	0.69
Sep-22	**243**	**1,418**	**1,120**	**1,786**	**0.06**	**2.66**	**1,586**	**1,254**	**1,983**	**2.97**	**1,915**	**1,517**	**2,384**	**3.59**
Oct-22	1	6	1	18	1.00	0.01	6	1	19	0.01	8	1	23	0.01
Nov-22	13	76	18	146	0.28	0.14	159	54	274	0.30	192	65	332	0.36
Dec-22	10	59	24	100	0.32	0.11	70	28	120	0.13	85	34	146	0.16
Jan-23	14	82	29	152	0.27	0.15	84	29	152	0.16	102	35	184	0.19
Feb-23	54	312	179	444	0.14	0.58	337	190	512	0.63	405	230	614	0.76
Mar-23	57	332	221	449	0.13	0.62	360	185	534	0.67	425	222	627	0.8
Apr-23	92	527	155	1,059	0.10	0.99	555	150	1,121	1.04	661	179	1,328	1.24

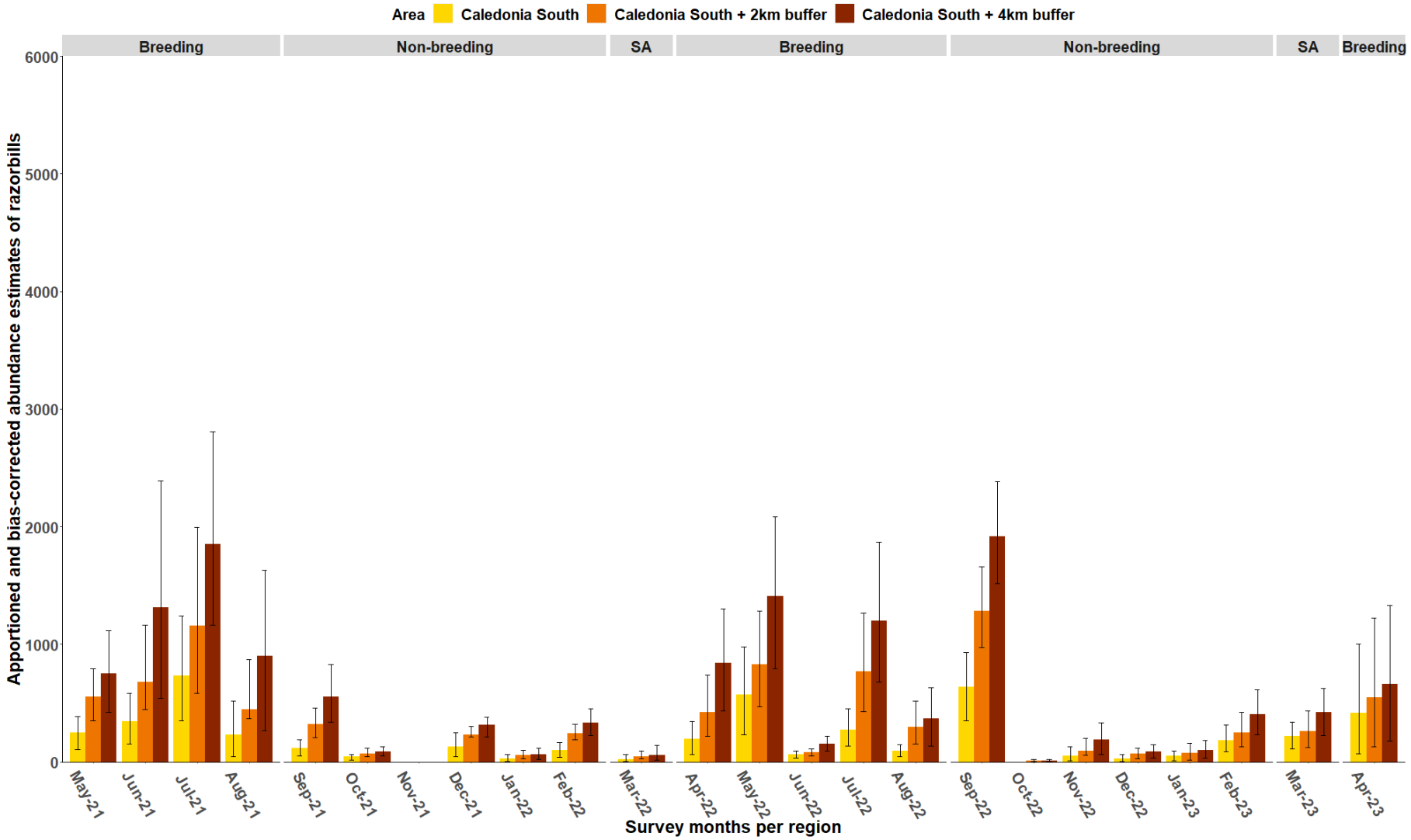


Figure 26 Bar plot of the monthly apportioned abundances estimates (with 95% confidence intervals) of total razorbills recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Razorbill seasonal periods are also displayed. SA stands for breeding site attendance.

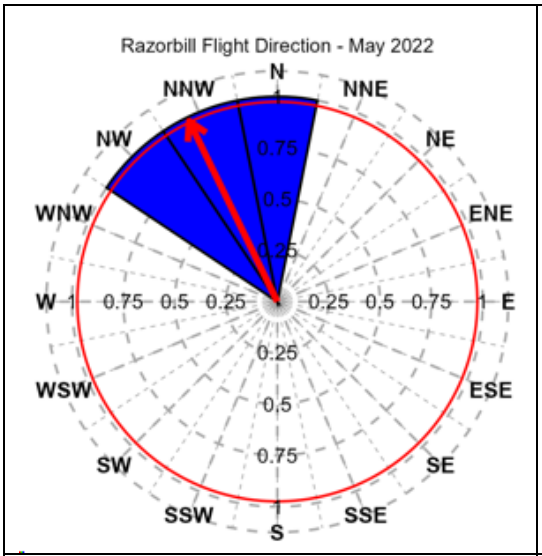
ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.127-149. Razorbills were recorded throughout the Survey Area without any discernible distribution pattern in July to September and December 2021, March to April, June, August, November, and December 2022, and in January and March 2023 (Figures A4.129-131, 133, 136-137, 139, 141, 144-146, 148). During May and June 2021, razorbills occurred throughout the majority of the Survey Area with lower numbers towards the northeast and highest numbers in the northwest and south (Figures A4.127-128). Razorbills appeared exclusively in Caledonia South and its Buffer Zone in October 2021, and also displayed higher numbers therein during January, February and July 2022, and in February and April 2023 (Figures A4.132, 134-135, 140, 147, 149). In contrast, May and September 2022 recorded the majority of birds in Caledonia North (Figure A4.138, 142). Higher numbers of razorbills to the south (and to a lesser extent in the northwest) of the Survey Area indicate connectivity of these areas to breeding colonies within foraging range of these areas (East Caithness Cliffs SPA to the west of the Survey Area, and Troup, Pennan and Lion's Heads SPA to the south of the Survey Area).

Significant predominant direction of flight was recorded in:

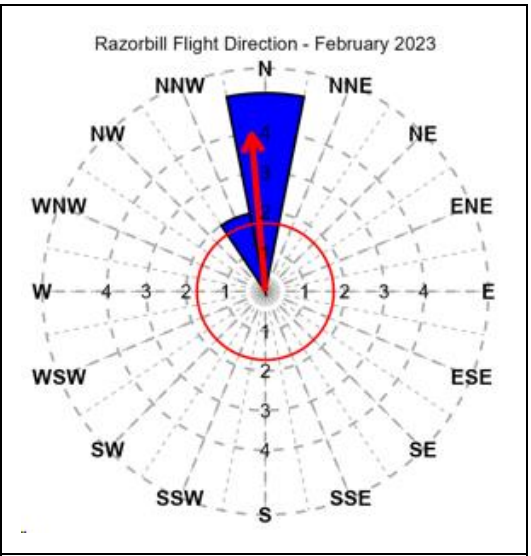
- **May**
  - 2022 north-northwest (Figure 27a)
- **February**
  - 2023 north (Figure 27b)
- **March**
  - 2023 east-southeast (Figure 27c)

As very few birds were recorded in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.18).



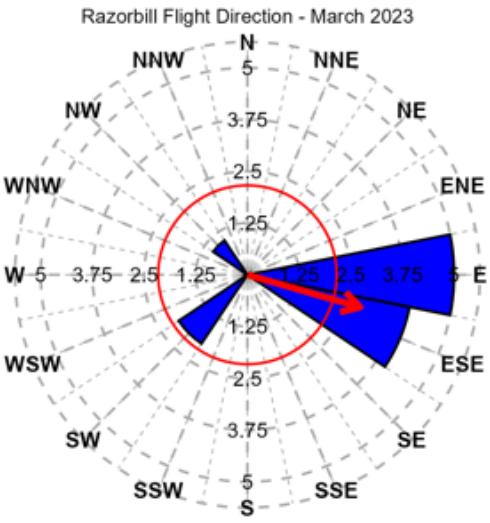
Number of Observations	3
Mean Vector (μ)	334.718
Length of Mean Vector (r)	0.979
Rayleigh Test (Z)	2.874
Rayleigh Test (p)	0.041

a May 2022



Number of Observations	7
Mean Vector (μ)	355.524
Length of Mean Vector (r)	0.991
Rayleigh Test (Z)	6.868
Rayleigh Test (p)	<0.001

b February 2023



Number of Observations	12
Mean Vector (μ)	106.401
Length of Mean Vector (r)	0.567
Rayleigh Test (Z)	3.861
Rayleigh Test (p)	0.018
c March 2023	

Figure 27 Summary of flight direction of razorbills within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.20 Guillemot and / or razorbill

i. Abundance and density estimates

Caledonia OWF

A total of 2,996 unidentified guillemots and / or razorbills were recorded in the Survey Area during both years of baseline surveys (Table 8). Guillemots and / or razorbills were recorded in every survey (Table 8). Guillemots and / or razorbills have been used for apportioning to species level where possible.

Highest abundances were recorded during the breeding season, especially from May to July, with a peak of abundance in May 2022 (

Table 71):

- 155 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 898 [562; 1,338] individuals. This equated to a mean density estimate of 2.1 birds/km^2.
- 235 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,344 [881; 1,819] individuals. This equated to a mean density estimate of 2.09 birds/km^2.
- 312 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 1,812 [1,126; 2,514] individuals. This equated to a mean density estimate of 2.05 birds/km^2.

Table 71 **Raw counts, unapportioned abundance and density estimates (birds per km^2) of guillemots and / or razorbills in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
May-21	64	373	163	653	0.13	0.87
Jun-21	117	687	429	1,045	0.09	1.61
Jul-21	28	165	65	283	0.19	0.39
Aug-21	72	417	150	828	0.12	0.98
Sep-21	70	406	278	551	0.12	0.95
Oct-21	27	158	76	252	0.19	0.37
Nov-21	22	128	64	192	0.21	0.3
Dec-21	73	424	273	592	0.12	0.99
Jan-22	21	122	75	174	0.22	0.29
Feb-22	103	556	405	708	0.10	1.30
Mar-22	26	139	102	177	0.20	0.33
Apr-22	24	138	81	201	0.20	0.32
May-22	155	898	562	1,338	0.08	2.1
Jun-22	24	138	52	253	0.20	0.32
Jul-22	80	468	187	836	0.11	1.1
Aug-22	10	58	17	110	0.32	0.14
Sep-22	107	619	440	781	0.10	1.45
Oct-22	30	175	30	484	0.18	0.41
Nov-22	21	123	41	223	0.22	0.29
Dec-22	11	64	35	105	0.30	0.15
Jan-23	4	23	4	52	0.50	0.05
Feb-23	22	126	63	207	0.21	0.29
Mar-23	23	134	70	193	0.21	0.31
Apr-23	20	113	20	289	0.22	0.26
b) Caledonia OWF plus 2 km buffer						
May-21	129	741	373	1,270	0.09	1.15
Jun-21	243	1,409	777	2,355	0.06	2.19
Jul-21	53	307	139	533	0.14	0.48
Aug-21	146	833	377	1,581	0.08	1.29
Sep-21	112	643	477	827	0.09	1.00
Oct-21	50	288	133	455	0.14	0.45
Nov-21	25	143	63	234	0.20	0.22
Dec-21	132	756	578	950	0.09	1.17
Jan-22	26	149	74	234	0.20	0.23
Feb-22	163	874	713	1,029	0.08	1.36
Mar-22	37	196	133	260	0.16	0.30
Apr-22	38	216	96	352	0.16	0.34
May-22	235	1,344	881	1,819	0.07	2.09
Jun-22	36	206	97	350	0.17	0.32
Jul-22	156	898	512	1,347	0.08	1.40
Aug-22	22	126	51	212	0.21	0.20
Sep-22	175	1,010	727	1,327	0.08	1.57
Oct-22	63	367	63	804	0.13	0.57
Nov-22	24	139	52	238	0.20	0.22
Dec-22	13	76	35	134	0.28	0.12

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Jan-23	5	29	6	52	0.45	0.05
Feb-23	26	149	80	246	0.20	0.23
Mar-23	38	220	139	295	0.16	0.34
Apr-23	25	142	40	312	0.20	0.22
c) Survey Area						
May-21	172	1,005	555	1,601	0.08	1.14
Jun-21	401	2,359	1,230	3,648	0.05	2.67
Jul-21	77	465	235	755	0.11	0.53
Aug-21	401	2,326	934	4,073	0.05	2.63
Sep-21	174	1,018	650	1,516	0.08	1.15
Oct-21	78	457	205	749	0.11	0.52
Nov-21	33	192	81	314	0.17	0.22
Dec-21	208	1,212	897	1,532	0.07	1.37
Jan-22	35	203	122	290	0.17	0.23
Feb-22	212	1,164	845	1,444	0.07	1.32
Mar-22	55	297	189	421	0.13	0.34
Apr-22	50	288	121	473	0.14	0.33
May-22	312	1,812	1,126	2,514	0.06	2.05
Jun-22	48	278	133	434	0.14	0.31
Jul-22	224	1,309	719	1,975	0.07	1.48
Aug-22	38	218	126	322	0.16	0.25
Sep-22	232	1,354	975	1,745	0.07	1.53
Oct-22	83	488	112	976	0.11	0.55
Nov-22	30	177	88	259	0.18	0.20
Dec-22	17	100	53	159	0.24	0.11
Jan-23	6	35	12	65	0.41	0.04
Feb-23	36	208	110	330	0.17	0.24
Mar-23	44	258	164	341	0.15	0.29
Apr-23	27	155	46	339	0.19	0.18

Caledonia North

A total of 2,996 unidentified guillemots and / or razorbills were recorded in the Survey Area during both years of baseline surveys (Table 9). Guillemots and / or razorbills were recorded in every survey (Table 9). Guillemot and / or razorbills have been used for apportioning to species level where possible.

Highest abundances were recorded during the breeding season, especially from May to July, with a peak of abundance in May 2022 (

Table 71):

- 83 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 482 [174; 836] individuals. This equated to a mean density estimate of 2.21 birds/km^2.
- 156 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 888 [569; 1,236] individuals. This equated to a mean density estimate of 2.37 birds/km^2.
- 217 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,262 [762; 1,756] individuals. This equated to a mean density estimate of 2.27 birds/km^2.

Table 72 **Raw counts, unapportioned abundance and density estimates (birds per km^2) of guillemots and / or razorbills in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
May-21	24	140	70	204	0.20	0.64
Jun-21	31	183	130	231	0.18	0.84
Jul-21	7	41	12	71	0.38	0.19
Aug-21	15	87	35	139	0.26	0.40
Sep-21	24	139	58	220	0.20	0.64
Oct-21	12	70	18	134	0.29	0.32
Nov-21	11	64	12	129	0.30	0.29
Dec-21	26	151	58	278	0.20	0.69
Jan-22	8	46	8	98	0.35	0.21
Feb-22	52	280	113	431	0.14	1.28
Mar-22	9	48	11	91	0.33	0.22
Apr-22	6	34	6	75	0.41	0.16
May-22	83	482	174	836	0.11	2.21
Jun-22	6	34	6	91	0.41	0.16
Jul-22	28	164	53	299	0.19	0.75
Aug-22	4	23	12	35	0.50	0.11
Sep-22	52	298	143	448	0.14	1.36
Oct-22	1	6	1	17	1.00	0.03
Nov-22	14	83	18	165	0.27	0.38
Dec-22	5	29	5	76	0.45	0.13
Jan-23	2	12	2	35	0.71	0.05
Feb-23	8	46	12	86	0.35	0.21
Mar-23	14	82	47	111	0.27	0.38
Apr-23	5	28	6	56	0.45	0.13
b) Caledonia North plus 2 km buffer						
May-21	41	235	154	315	0.16	0.63
Jun-21	48	278	185	359	0.14	0.74
Jul-21	11	63	29	98	0.30	0.17
Aug-21	25	142	62	233	0.20	0.38
Sep-21	46	262	165	381	0.15	0.70
Oct-21	13	74	23	143	0.28	0.20
Nov-21	13	74	23	137	0.28	0.20
Dec-21	53	301	176	466	0.14	0.80
Jan-22	12	68	12	136	0.29	0.18
Feb-22	84	451	247	660	0.11	1.20
Mar-22	13	69	21	122	0.28	0.18
Apr-22	14	79	17	140	0.27	0.21
May-22	156	888	569	1,236	0.08	2.37
Jun-22	14	81	29	138	0.27	0.22
Jul-22	44	252	120	418	0.15	0.67
Aug-22	13	74	17	149	0.28	0.20
Sep-22	74	430	192	668	0.12	1.15
Oct-22	30	176	30	482	0.18	0.47
Nov-22	19	110	35	196	0.23	0.29
Dec-22	8	47	18	94	0.35	0.13
Jan-23	3	18	3	41	0.58	0.05
Feb-23	10	57	17	108	0.32	0.15

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Mar-23	24	139	81	197	0.20	0.37
Apr-23	8	46	23	69	0.35	0.12
c) Caledonia North Survey Area						
May-21	68	398	269	527	0.12	0.71
Jun-21	74	438	266	603	0.12	0.79
Jul-21	31	188	85	333	0.18	0.34
Aug-21	44	255	151	360	0.15	0.46
Sep-21	66	385	210	590	0.12	0.69
Oct-21	26	152	58	263	0.20	0.27
Nov-21	19	111	53	187	0.23	0.20
Dec-21	85	495	291	751	0.11	0.89
Jan-22	19	110	35	185	0.23	0.20
Feb-22	112	616	325	897	0.09	1.11
Mar-22	28	151	76	254	0.19	0.27
Apr-22	16	92	29	167	0.25	0.17
May-22	217	1,262	762	1,756	0.07	2.27
Jun-22	32	185	75	306	0.18	0.33
Jul-22	63	369	211	550	0.13	0.66
Aug-22	24	137	46	235	0.20	0.25
Sep-22	91	530	256	850	0.10	0.95
Oct-22	49	288	49	675	0.14	0.52
Nov-22	22	130	53	218	0.21	0.23
Dec-22	12	71	29	118	0.29	0.13
Jan-23	4	24	4	47	0.50	0.04
Feb-23	23	133	46	225	0.21	0.24
Mar-23	29	170	100	241	0.19	0.31
Apr-23	9	52	23	80	0.33	0.09

Caledonia South

A total of 2,261 unidentified guillemots and / or razorbills were recorded in the Survey Area during both years of baseline surveys (Table 10). Guillemots and / or razorbills were recorded in every survey (Table 10). Guillemot and / or razorbills have been used for apportioning to species level where possible.

Highest abundances were recorded during the breeding season, especially from May to July, with a peak of abundance in June 2021 (Table 73):

- 86 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 500 [227; 855] individuals. This equated to a mean density estimate of 2.38 birds/km^2.
- 209 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,212 [534; 2,012] individuals. This equated to a mean density estimate of 3.37 birds/km^2.
- 354 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 2,058 [965; 3,482] individuals. This equated to a mean density estimate of 3.86 birds/km^2.

Table 73 **Raw counts, unapportioned abundance and density estimates (birds per km^2) of guillemots and / or razorbills in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
May-21	40	233	47	489	0.16	1.11
Jun-21	86	500	227	855	0.11	2.38
Jul-21	22	129	22	246	0.21	0.61
Aug-21	57	329	75	756	0.13	1.56
Sep-21	46	267	186	360	0.15	1.27
Oct-21	15	88	41	141	0.26	0.42
Nov-21	11	63	35	104	0.30	0.30
Dec-21	47	273	157	435	0.15	1.30
Jan-22	13	75	40	116	0.28	0.36
Feb-22	51	276	189	400	0.14	1.31
Mar-22	17	91	43	140	0.24	0.43
Apr-22	18	104	75	138	0.24	0.49
May-22	72	416	243	629	0.12	1.98
Jun-22	18	104	41	168	0.24	0.49
Jul-22	52	303	52	671	0.14	1.44
Aug-22	6	35	6	69	0.41	0.17
Sep-22	55	321	187	449	0.13	1.53
Oct-22	29	170	29	476	0.19	0.81
Nov-22	7	41	7	88	0.38	0.19
Dec-22	6	35	12	59	0.41	0.17
Jan-23	2	12	2	29	0.71	0.06
Feb-23	14	80	17	160	0.27	0.38
Mar-23	9	52	12	104	0.33	0.25
Apr-23	15	85	15	233	0.26	0.40
b) Caledonia South plus 2 km buffer						
May-21	92	532	191	1,057	0.10	1.48
Jun-21	209	1,212	534	2,012	0.07	3.37
Jul-21	45	262	81	500	0.15	0.73
Aug-21	128	734	287	1,496	0.09	2.04
Sep-21	81	468	324	647	0.11	1.30
Oct-21	39	226	104	360	0.16	0.63
Nov-21	14	80	40	137	0.27	0.22
Dec-21	90	519	363	686	0.11	1.44
Jan-22	19	109	46	184	0.23	0.30
Feb-22	89	475	342	620	0.11	1.32
Mar-22	29	153	101	201	0.19	0.43
Apr-22	30	172	80	269	0.18	0.48
May-22	94	539	316	820	0.10	1.50
Jun-22	24	136	68	216	0.20	0.38
Jul-22	119	689	249	1,180	0.09	1.92
Aug-22	10	57	23	97	0.32	0.16
Sep-22	120	685	491	880	0.09	1.91
Oct-22	56	323	56	708	0.13	0.90
Nov-22	10	58	17	111	0.32	0.16
Dec-22	9	52	35	69	0.33	0.14
Jan-23	3	17	6	34	0.58	0.05
Feb-23	19	108	40	200	0.23	0.30

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Mar-23	22	127	75	190	0.21	0.35
Apr-23	18	101	18	252	0.24	0.28
c) Caledonia South Survey Area						
May-21	125	725	319	1,300	0.09	1.36
Jun-21	354	2,058	965	3,482	0.05	3.86
Jul-21	59	354	150	619	0.13	0.66
Aug-21	376	2,163	742	3,779	0.05	4.06
Sep-21	136	790	476	1,254	0.09	1.48
Oct-21	71	412	180	697	0.12	0.77
Nov-21	27	155	92	241	0.19	0.29
Dec-21	150	868	642	1,099	0.08	1.63
Jan-22	25	144	81	225	0.20	0.27
Feb-22	121	657	445	858	0.09	1.23
Mar-22	38	204	140	274	0.16	0.38
Apr-22	45	258	109	407	0.15	0.48
May-22	151	868	500	1,305	0.08	1.63
Jun-22	34	197	87	324	0.17	0.37
Jul-22	183	1,060	463	1,737	0.07	1.99
Aug-22	20	115	46	201	0.22	0.22
Sep-22	170	992	683	1,278	0.08	1.86
Oct-22	57	335	57	758	0.13	0.63
Nov-22	26	152	82	234	0.20	0.28
Dec-22	11	65	41	94	0.30	0.12
Jan-23	4	23	6	41	0.50	0.04
Feb-23	28	162	87	265	0.19	0.30
Mar-23	29	169	93	245	0.19	0.32
Apr-23	21	120	29	280	0.22	0.22

ii. Distribution and behaviour

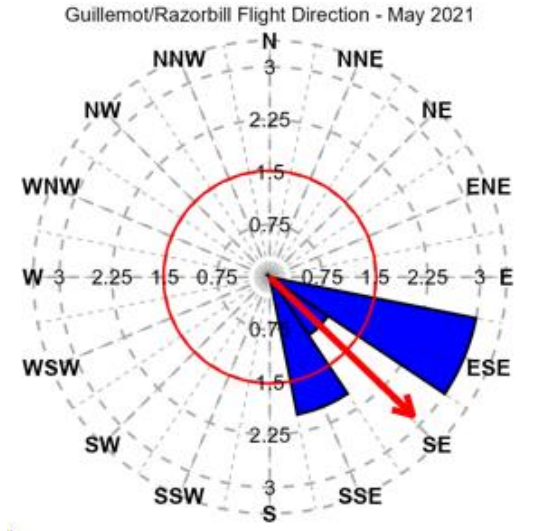
Maps of distribution are shown in Appendix 4: Figures A4.150-173. Guillemot and / or razorbills were distributed throughout the Survey Area with highest numbers in Caledonia South and its Buffer Zone during June to December 2021, March, April and July 2022 (Figure A4.151-157, 160-161, 164). During the remaining months of the survey period, guillemot and / or razorbills were loosely distributed throughout the Survey Area (Figures A4.150, 158-159, 162-163, 165-173).

Significant predominant direction of flight was recorded in:

- **May**
  - 2021 southeast (Figure 28a)
- **June**
  - 2021 east (Figure 28b)
- **October**
  - 2021 south (Figure 28c)
  - 2022 south (Figure 28f)
- **December**
  - 2021 northwest (Figure 28d)
- **January**
  - 2022 south (Figure 28e)
- **February**
  - 2023 northwest (Figure 28g)

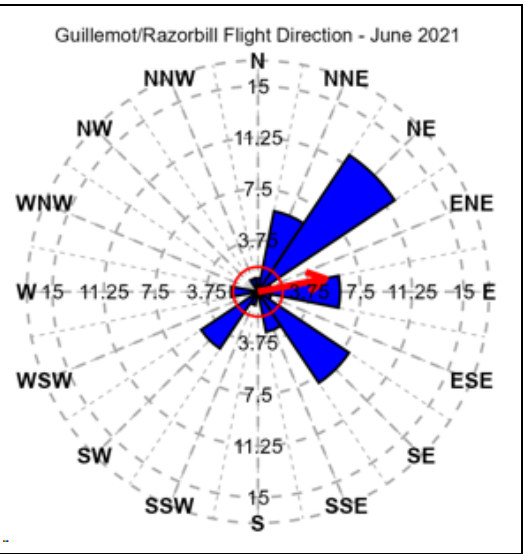
- **March**
  - 2022 west-southwest (Figure 28h)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.19).



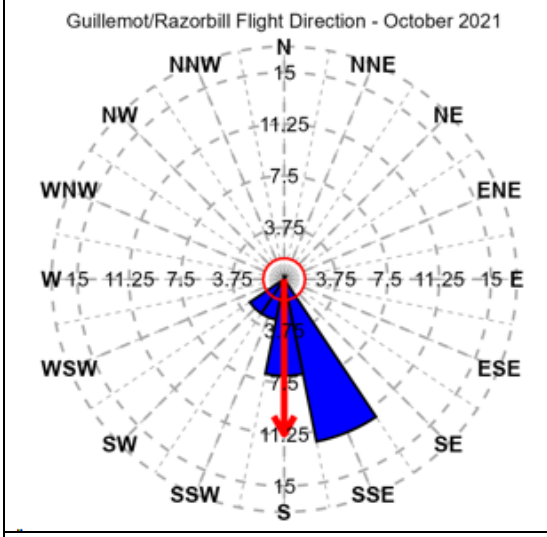
Number of Observations	6
Mean Vector (μ)	134.765
Length of Mean Vector (r)	0.943
Rayleigh Test (Z)	5.336
Rayleigh Test (p)	<0.001

a May 2021



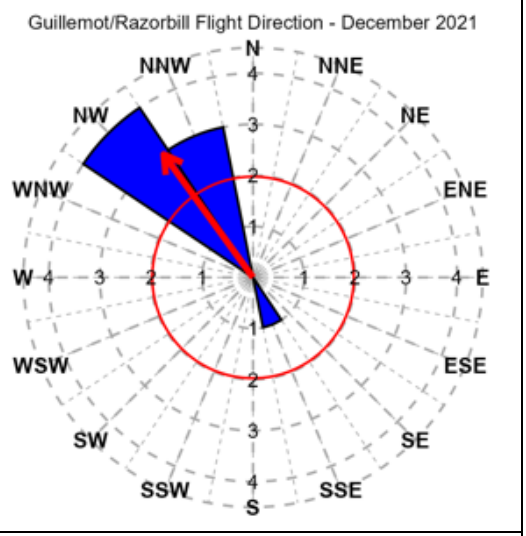
Number of Observations	47
Mean Vector (μ)	79.002
Length of Mean Vector (r)	0.417
Rayleigh Test (Z)	8.171
Rayleigh Test (p)	<0.001

b June 2021



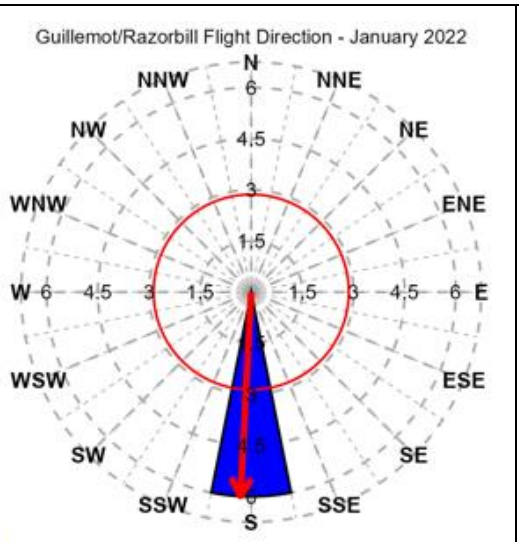
Number of Observations	25
Mean Vector (μ)	180.986
Length of Mean Vector (r)	0.936
Rayleigh Test (Z)	21.926
Rayleigh Test (p)	<0.001

c October 2021



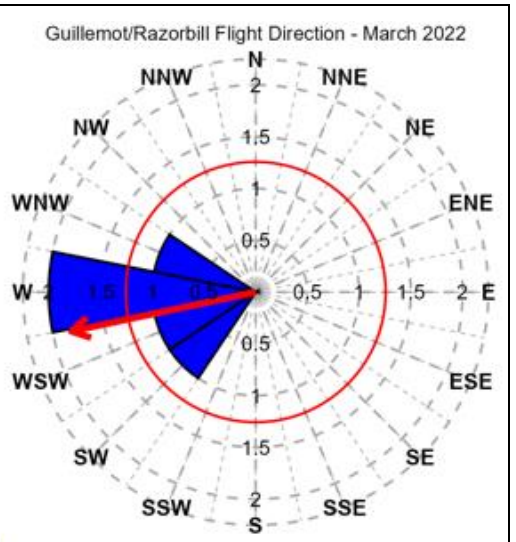
Number of Observations	8
Mean Vector (μ)	324.827
Length of Mean Vector (r)	0.744
Rayleigh Test (Z)	4.431
Rayleigh Test (p)	0.007

d December 2021



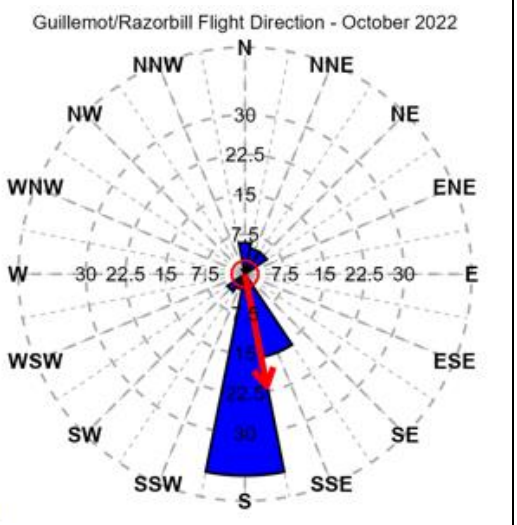
Number of Observations	6
Mean Vector (μ)	183.797
Length of Mean Vector (r)	0.999
Rayleigh Test (Z)	5.987
Rayleigh Test (p)	<0.001

e January 2022



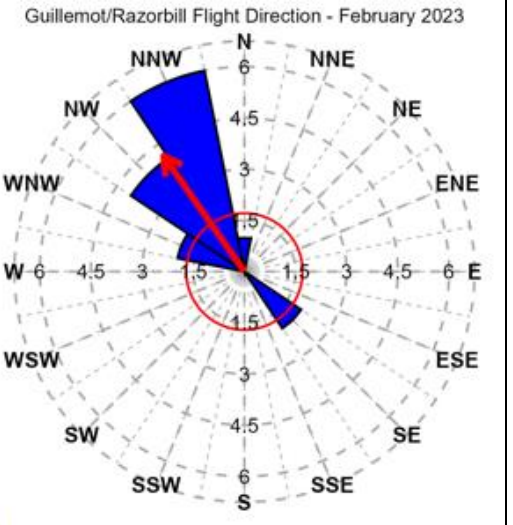
Number of Observations	5
Mean Vector (μ)	258.854
Length Mean Vector (r)	0.911
Rayleigh Test (Z)	4.145
Rayleigh Test (p)	0.008

f March 2022



Number of Observations	78
Mean Vector (μ)	169.596
Length of Mean Vector (r)	0.567
Rayleigh Test (Z)	25.034
Rayleigh Test (p)	<0.001

g October 2022



Number of Observations	15
Mean Vector (μ)	325.430
Length of Mean Vector (r)	0.688
Rayleigh Test (Z)	7.102
Rayleigh Test (p)	<0.001

h February 2023

Figure 28 Summary of flight direction of guillemots and /or razorbills within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.21 Black guillemot

i. Abundance and density estimates

A total of four black guillemots were recorded in the Survey Area during both years of baseline surveys (Table 8), specifically in June 2021, April and June 2022. In these months, peak numbers were recorded in June 2022, with two individuals, resulting in an unapportioned and apportioned mean abundance of 12 [2; 29] individuals, which equated to a mean density estimate of 0.01 birds/km^2 (Table 74).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 74).

Table 74 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of black guillemots in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Jun-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jun-22	1	6	1	17	1.00	0.01	6	1	17	0.01
b) Caledonia OWF plus 2 km buffer										
Jun-21	1	6	1	17	1.00	0.01	6	1	18	0.01
Apr-22	1	6	1	17	1.00	0.01	6	1	18	0.01
Jun-22	2	11	2	29	0.71	0.02	11	2	29	0.02
c) Survey Area										
Jun-21	1	6	1	18	1.00	0.01	6	1	19	0.01
Apr-22	1	6	1	17	1.00	0.01	6	1	18	0.01
Jun-22	2	12	2	29	0.71	0.01	12	2	29	0.01

In Caledonia North Survey Area, an individual was recorded in both June 2021 and 2022, therefore, resulting in low abundance and density estimates (Table 75). Similarly, in Caledonia South Survey Area, a single individual was recorded in June 2022, April and June 2022, which therefore also resulted in low abundance and density estimates (Table 76).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 75 and Table 76).

Table 75 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of black guillemots in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
Jun-22	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia North plus 2 km buffer										
Jun-22	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia North Survey Area										
Jun-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jun-22	1	6	1	17	1.00	0.01	6	1	17	0.01

Table 76 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of black guillemots in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Jun-21	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia South plus 2 km buffer										
Jun-21	1	6	1	17	1.00	0.02	6	1	18	0.02
Apr-22	1	6	1	17	1.00	0.02	6	1	18	0.02
Jun-22	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia South Survey Area										
Jun-21	1	6	1	17	1.00	0.01	6	1	18	0.01
Apr-22	1	6	1	17	1.00	0.01	6	1	18	0.01
Jun-22	1	6	1	17	1.00	0.01	6	1	17	0.01

ii. Distribution and behaviour

The single black guillemot recorded in June 2021 was located in the centre of Caledonia South (Appendix 4, Figure A4.174), while the individual recorded in April 2022 was recorded at the southern boundary of Caledonia South (Appendix 4, Figure A4.175). In June 2022, one individual was recorded in the north of Caledonia North while the other was recorded in the south of Caledonia South Buffer Zone (Appendix 4, Figure A4.176).

4.22 Puffin

i. Abundance and density estimates

Caledonia OWF

A total of 2,054 puffins were recorded in the Survey Area during both years of baseline surveys (Table 8). Puffins were recorded in every survey except November 2021 to February 2022 and November to December 2022 (Table 8). Puffins were the most abundant during the breeding season (April to mid-August, with birds attending colonies from mid-March onwards). Peak of abundance was recorded in August 2021 (Table 77, Figure 29):

- 370 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 2,142 [1,042; 3,438], an apportioned mean abundance estimate of 2,390 [1,099; 3,951] and an apportioned and availability bias-corrected mean abundance estimate of 2,784 [1,280; 4,603] individuals. These equated to mean density estimates of 5.01 (unapportioned), 5.59 (apportioned) and 6.51 (apportioned and availability bias-corrected) birds/km^2.
- 462 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 2,636 [1,381; 4,246], an apportioned mean abundance estimate of 3,076 [1,539; 4,976] and an apportioned and availability bias-corrected mean abundance estimate of 3,583 [1,793; 5,797] individuals. These equated to mean density estimates of 4.10 (unapportioned), 4.78 (apportioned) and 5.56 (apportioned and availability bias-corrected) birds/km^2.
- 562 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 3,260 [1,949; 4,891], an apportioned mean abundance estimate of 4,123 [2,188; 6,363] and an apportioned and availability bias-corrected mean abundance estimate of 4,803 [2,548; 7,413] individuals. These equated to mean density estimates of 3.69

(unapportioned), 4.66 (apportioned) and 5.43 (apportioned and availability bias-corrected) birds/km^2.

During the 2021 breeding season, mean apportioned and availability bias-corrected puffin abundances in the Survey Area and reporting regions between May and July were very consistent. In August 2021, a large peak in mean abundance was observed, which was also the peak breeding season abundance for all reporting regions across the baseline survey period. It is anticipated that rather than a peak of breeding adult birds, the timing of this peak, and the size of the abundances recorded relative to other breeding season surveys, may indicate a post-breeding peak of birds, likely originating from multiple breeding colonies across the wider region. What could be considered to be an equivalent peak occurred in September 2022 (i.e. outside the breeding season). During the 2022 breeding season, mean abundances were consistent across April and May (and higher than the corresponding abundances recorded in the same months in 2021. In June and July 2022, abundances were considerably lower, with higher abundances reported during August 2022. The reason for the different temporal patterns in the 2021 and 2022 breeding seasons is unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 70% to 99%, with most surveys falling somewhere in the middle of the two extremes of this range. This is indicative of the overall breeding season peak for being considerably higher than the abundance estimates recorded for all other surveys during this season. This is perhaps related to the presence of a post-breeding season peak in August 2021, which happened to fall inside the breeding season.

During the non-breeding season (September to mid-March), puffins were only recorded in September to October 2021, September 2022 and January to March 2023, with a peak in September 2022 (Table 77, Figure 29):

- 213 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 1,233 [602; 1,921], an apportioned mean abundance estimate of 1,269 [627; 2,031] and an apportioned and availability bias-corrected mean abundance estimate of 1,477 [730; 2,360] individuals. These equated to mean density estimates of 2.89 (unapportioned), 2.97 (apportioned) and 3.45 (apportioned and availability bias-corrected) birds/km^2.
- 342 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,974 [1,281; 2,782], an apportioned mean abundance estimate of 2,084 [1,266; 2,990] and an apportioned and availability bias-corrected mean abundance estimate of 2,426 [1,475; 3,477] individuals. These equated to mean density estimates of 3.07 (unapportioned), 3.24 (apportioned) and 3.77 (apportioned and availability bias-corrected) birds/km^2.
- 495 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 2,888 [1,727; 4,277], an apportioned mean abundance estimate of 3,001 [1,745; 4,345] and an apportioned and availability bias-corrected mean abundance estimate of 3,492 [2,032; 5,051] individuals. These equated to mean density estimates of 3.27 (unapportioned), 3.39 (apportioned) and 3.95 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances occurred within the Survey Area and reporting regions in September 2022. The timing of this peak is indicative of a post-breeding season aggregation of birds (likely consisting of birds from multiple breeding colonies across the region). A peak abundance estimate in August 2021 (i.e. within the breeding season) is also considered likely to be a post-breeding aggregation of birds, which arguably could be considered a non-breeding count, despite the earlier timing in 2021. The September 2022 mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species

within the Survey Area and reporting regions. Puffin were absent from the surveys carried out between November 2021 and February 2022, and October to December 2022, in keeping with the general understand of the seasonal movements of this species. Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 86% to >99.5%, reflecting the fact that the September 2022 peak was very large relative to the other mean apportioned and availability bias-corrected abundances recorded for puffin during the non-breeding season.

During the breeding site attendance period (March), puffins were recorded in low numbers, with peak numbers in March 2023 (Table 77, Figure 29):

- Nine individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 53 [18; 88], an apportioned mean abundance estimate of 54 [18; 95] and an apportioned and availability bias-corrected mean abundance estimate of 63 [21; 111] individuals. These equated to mean density estimates of 0.12 (unapportioned), 0.13 (apportioned) and 0.15 (apportioned and availability bias-corrected) birds/km^2.
- 11 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 64 [23; 110], an apportioned mean abundance estimate of 65 [17; 112] and an apportioned and availability bias-corrected mean abundance estimate of 75 [20; 131] individuals. These equated to mean density estimates of 0.10 (unapportioned), 0.10 (apportioned) and 0.12 (apportioned and availability bias-corrected) birds/km^2.
- 14 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 82 [29; 141], an apportioned mean abundance estimate of 83 [35; 139] and an apportioned and availability bias-corrected mean abundance estimate of 97 [41; 161] individuals. These equated to mean density estimates of 0.09 (unapportioned), 0.09 (apportioned) and 0.11 (apportioned and availability bias-corrected) birds/km^2.

Measures of precisions were variable for puffin across the survey period (Table 77). During eight of 16 surveys in which the species was recorded within Caledonia OWF, CV values were ≤ 0.16, indicating higher levels of precision (Table 77). Seven of these eight surveys were within the breeding season, which meant that seven of 10 breeding season surveys had a CV value of ≤ 0.16 (Table 77). Higher levels of precision coincided with higher numbers of puffins being recorded (Table 77). Outside the breeding season, when lower numbers of puffins were recorded, CV values were typically calculated to be between 0.2 to 0.6, indicating lower levels of precision (Table 77). For Caledonia OWF plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia OWF, indicating higher precision within these reporting regions (Table 77).

Table 77 **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of puffins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of puffin raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to mid-March). No colours were attributed to the breeding site attendance period (March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF														
May-21	43	251	122	414	0.15	0.59	252	122	412	0.59	294	142	480	0.69
Jun-21	37	217	82	399	0.16	0.51	220	77	413	0.51	255	90	478	0.6
Jul-21	46	271	106	478	0.15	0.63	277	111	510	0.65	320	129	586	0.75
Aug-21	370	2,142	1,042	3,438	0.05	5.01	2,390	1,099	3,951	5.59	2,784	1,280	4,603	6.51
Sep-21	13	75	46	110	0.28	0.18	76	41	113	0.18	89	48	132	0.21
Oct-21	28	164	70	281	0.19	0.38	179	73	297	0.42	208	85	346	0.49
Apr-22	88	507	253	858	0.11	1.19	523	245	891	1.22	610	285	1,038	1.43
May-22	107	620	365	863	0.10	1.45	627	397	876	1.47	731	463	1,020	1.71
Jun-22	10	57	11	126	0.32	0.13	58	10	139	0.14	67	12	159	0.16
Jul-22	27	158	99	228	0.19	0.37	160	90	243	0.37	185	104	281	0.43
Aug-22	59	340	208	473	0.13	0.8	351	210	497	0.82	408	245	578	0.96
Sep-22	213	1,233	602	1,921	0.07	2.89	1,269	627	2,031	2.97	1,477	730	2,360	3.45
Jan-23	3	17	3	52	0.58	0.04	17	3	53	0.04	20	4	62	0.05
Feb-23	5	29	6	52	0.45	0.07	29	6	53	0.07	34	7	62	0.08
Mar-23	9	53	18	88	0.33	0.12	54	18	95	0.13	63	21	111	0.15
Apr-23	5	28	6	57	0.45	0.07	28	5	58	0.07	33	6	67	0.08
b) Caledonia OWF plus 2 km buffer														
May-21	73	419	276	586	0.12	0.65	421	282	592	0.65	491	329	689	0.76
Jun-21	53	307	116	505	0.14	0.48	315	108	555	0.49	364	125	641	0.56
Jul-21	77	446	261	684	0.11	0.69	456	254	703	0.71	527	295	809	0.82
Aug-21	462	2,636	1,381	4,246	0.05	4.1	3,076	1,539	4,976	4.78	3,583	1,793	5,797	5.56
Sep-21	18	103	46	172	0.24	0.16	105	52	175	0.16	122	61	204	0.19
Oct-21	34	196	92	323	0.17	0.3	211	85	353	0.33	245	99	411	0.38
Mar-22	2	11	2	32	0.71	0.02	12	2	36	0.02	14	2	42	0.02
Apr-22	140	794	431	1,259	0.08	1.23	821	441	1,286	1.28	957	514	1,498	1.49
May-22	157	898	555	1,230	0.08	1.4	907	576	1,222	1.41	1,057	671	1,424	1.64

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jun-22	15	86	29	160	0.26	0.13	87	30	179	0.13	100	35	205	0.15
Jul-22	27	155	81	242	0.19	0.24	158	77	250	0.24	183	89	288	0.28
Aug-22	95	543	332	784	0.10	0.84	560	336	786	0.87	652	392	916	1.01
Sep-22	**342**	**1,974**	**1,281**	**2,782**	**0.05**	**3.07**	**2,084**	**1,266**	**2,990**	**3.24**	**2,426**	**1,475**	**3,477**	**3.77**
Jan-23	3	17	3	52	0.58	0.03	17	3	53	0.03	20	4	62	0.03
Feb-23	7	40	11	69	0.38	0.06	40	11	70	0.06	47	13	81	0.07
Mar-23	11	64	23	110	0.30	0.10	65	17	112	0.10	75	20	131	0.12
Apr-23	8	45	11	79	0.35	0.07	46	17	81	0.07	53	20	94	0.08
c) Survey Area														
May-21	102	596	392	818	0.10	0.67	599	393	850	0.68	698	457	990	0.79
Jun-21	84	494	271	735	0.11	0.56	506	261	782	0.57	585	303	905	0.66
Jul-21	107	646	423	906	0.10	0.73	658	418	946	0.74	763	487	1,092	0.86
Aug-21	**562**	**3,260**	**1,949**	**4,891**	**0.04**	**3.69**	**4,123**	**2,188**	**6,363**	**4.66**	**4,803**	**2,548**	**7,413**	**5.43**
Sep-21	25	146	94	205	0.20	0.17	148	95	214	0.17	172	110	250	0.19
Oct-21	39	228	100	375	0.16	0.26	240	103	393	0.27	280	120	458	0.32
Mar-22	2	11	2	32	0.71	0.01	11	2	34	0.01	13	2	40	0.02
Apr-22	194	1,119	646	1,661	0.07	1.27	1,165	689	1,702	1.32	1,358	803	1,982	1.54
May-22	204	1,184	708	1,707	0.07	1.34	1,195	666	1,684	1.35	1,392	776	1,962	1.57
Jun-22	25	145	58	237	0.20	0.16	146	59	250	0.16	169	69	288	0.19
Jul-22	38	222	140	321	0.16	0.25	223	142	330	0.25	259	165	382	0.29
Aug-22	137	787	460	1,201	0.09	0.89	805	458	1,226	0.91	938	534	1,428	1.06
Sep-22	**495**	**2,888**	**1,727**	**4,277**	**0.04**	**3.27**	**3,001**	**1,745**	**4,345**	**3.39**	**3,492**	**2,032**	**5,051**	**3.95**
Oct-22	4	24	6	41	0.50	0.03	25	6	42	0.03	29	7	49	0.03
Jan-23	5	29	5	71	0.45	0.03	29	5	77	0.03	34	6	90	0.04
Feb-23	7	41	12	69	0.38	0.05	41	12	76	0.05	48	14	89	0.05
Mar-23	14	82	29	141	0.27	0.09	83	35	139	0.09	97	41	161	0.11
Apr-23	10	57	23	98	0.32	0.06	58	23	100	0.07	68	27	117	0.08

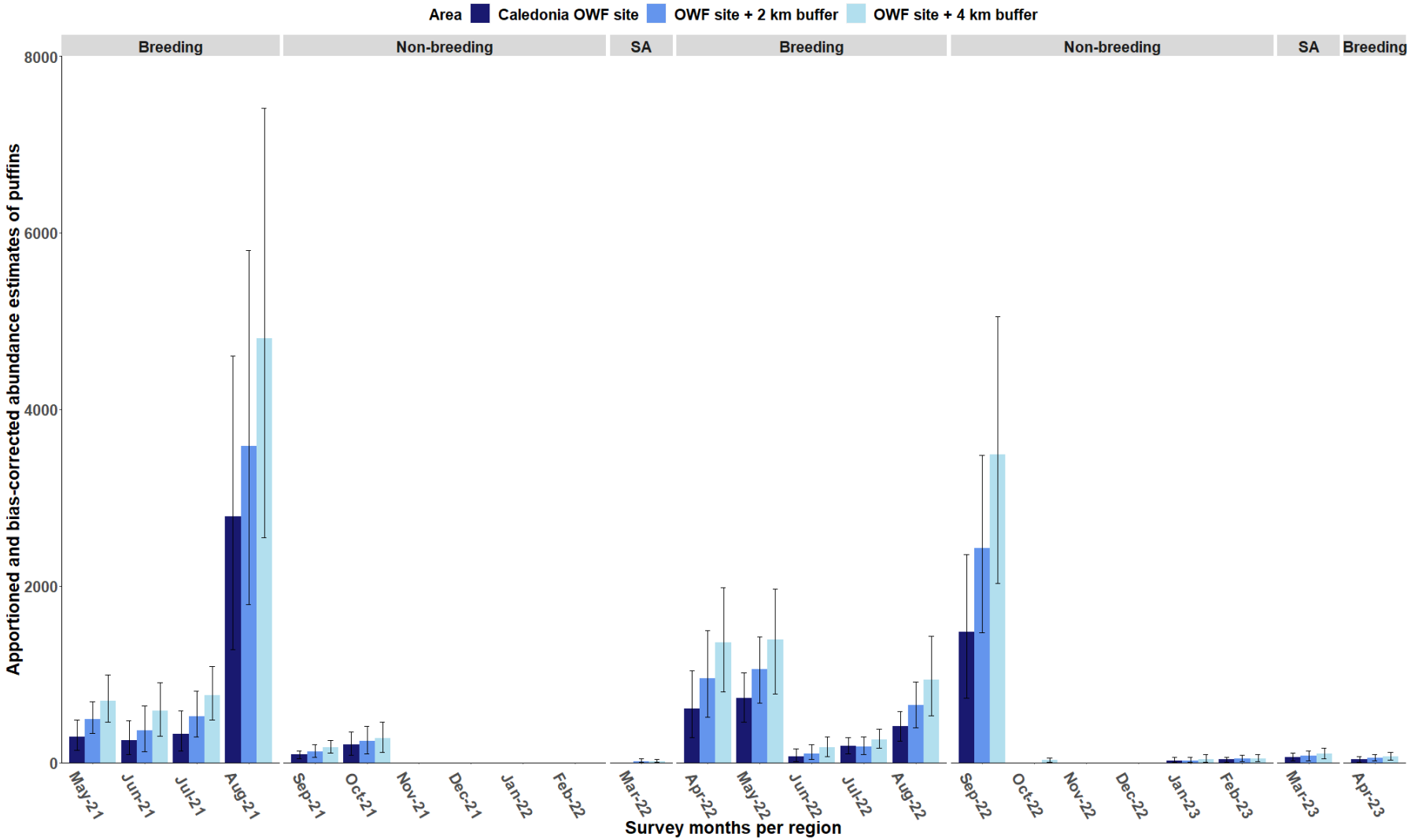


Figure 29 Bar plot of the monthly apportioned and availability bias-corrected abundances estimates (with 95% confidence intervals) of total puffins recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Puffin seasonal periods are also displayed. SA stands for breeding site attendance

Caledonia North

A total of 1,185 puffins were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Puffins were recorded in every survey except November 2021 to March 2022 and November to December 2022 (Table 9). Puffin were the most abundant during the breeding season (April to mid-August, with birds attending colonies from mid-March onwards). Peak of abundance was recorded in August 2021 (Table 78, Figure 30):

- 195 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 1,130 [463; 1,796], an apportioned mean abundance estimate of 1,156 [467; 1,811] and an apportioned and availability bias-corrected mean abundance estimate of 1,346 [545; 2,109] individuals. These equated to mean density estimates of 5.18 (unapportioned), 5.29 (apportioned) and 6.16 (apportioned and availability bias-corrected) birds/km^2.
- 345 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,957 [823; 3,211], an apportioned mean abundance estimate of 2,047 [856; 3,383] and an apportioned and availability bias-corrected mean abundance estimate of 2,385 [997; 3,942] individuals. These equated to mean density estimates of 5.21 (unapportioned), 5.45 (apportioned) and 6.35 (apportioned and availability bias-corrected) birds/km^2.
- 418 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 2,427 [1,115; 3,959], an apportioned mean abundance estimate of 2,532 [1,098; 4,231] and an apportioned and availability bias-corrected mean abundance estimate of 2,950 [1,279; 4,929] individuals. These equated to mean density estimates of 4.36 (unapportioned), 4.54 (apportioned) and 5.29 (apportioned and availability bias-corrected) birds/km^2.

During the 2021 breeding season, mean apportioned and availability bias-corrected puffin abundances in Caledonia North Survey Area and reporting regions between May and July were relatively consistent, with the peak occurring in May 2021. In August 2021, a large peak in abundance was observed, which was also the peak breeding season mean apportioned and availability bias-corrected abundance for all reporting regions across the baseline survey period. It is anticipated that rather than a peak of breeding adult birds, the timing of this peak, and the size of the abundances recorded relative to other breeding season surveys, may indicate a post-breeding peak of birds, likely originating from multiple breeding colonies across the wider region. What could be considered to be an equivalent peak occurred in September 2022 (i.e. outside the breeding season). During the 2022 breeding season, abundances were consistent across April and May (and higher than the corresponding abundances recorded in the same months in 2021. In June and July 2022, abundances were considerably lower, with slightly higher mean abundances reported during August 2022. The reason for the different temporal patterns in the 2021 and 2022 breeding seasons is unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 75% to 99%, with most surveys falling somewhere in the middle of the two extremes of this range. This is indicative of the overall breeding season peak for the baseline survey period being considerably higher than the abundance estimates recorded for all other surveys during this season across both of the breeding seasons within the survey period. This is perhaps related to the presence of a post-breeding season peak in August 2021 (i.e. inside the breeding season).

During the non-breeding season (September to mid-March), puffins were only recorded in September to October 2021, September 2022 and January to March 2023, with a peak recorded in September 2022 (Table 77, Figure 29):

- 107 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 614 [321; 930], an apportioned mean abundance estimate of 644 [327; 978] and an apportioned and availability bias-corrected mean abundance estimate of 750 [381; 1,139] individuals. These equated to mean density estimates of 2.81 (unapportioned), 2.95 (apportioned) and 3.43 (apportioned and availability bias-corrected) birds/km^2.
- 193 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,121 [691; 1,475], an apportioned mean abundance estimate of 1,178 [769; 1,620] and an apportioned and availability bias-corrected mean abundance estimate of 1,372 [896; 1,887] individuals. These equated to mean density estimates of 2.99 (unapportioned), 3.14 (apportioned) and 3.65 (apportioned and availability bias-corrected) birds/km^2.
- 302 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 1,759 [920; 2,673], an apportioned mean abundance estimate of 1,829 [978; 2,913] and an apportioned and availability bias-corrected mean abundance estimate of 2,128 [1,139; 3,385] individuals. These equated to mean density estimates of 3.16 (unapportioned), 3.28 (apportioned) and 3.82 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances of puffin within Caledonia North Survey Area and reporting regions occurred in September 2022. The timing of this peak is indicative of a post-breeding season aggregation of birds (likely consisting of birds from multiple breeding colonies across the region). A peak abundance estimate in August 2021 (i.e. within the breeding season) is also considered likely to be a post-breeding aggregation of birds, which arguably could be considered a non-breeding count, despite the earlier timing in 2021. The September 2022 mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species within Caledonia North Survey Area and reporting regions. Puffin were absent from the surveys carried out between November 2021 and March 2022, and either absent or recorded in very low numbers between October 2022 to April 2023. Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 91% to 99%, reflecting the fact that the September 2022 peak was very large relative to the other mean apportioned and availability bias-corrected abundances recorded for puffin during the non-breeding season.

During the breeding site attendance period (March), puffins were recorded absent in March 2022 and in low numbers in March 2023, which is when the peak was recorded (Table 77, Figure 29):

- Six individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 35 [6; 70], an apportioned mean abundance estimate of 36 [6; 80] and an apportioned and availability bias-corrected mean abundance estimate of 42 [7; 93] individuals. These equated to mean density estimates of 0.16 (unapportioned), 0.16 (apportioned) and 0.19 (apportioned and availability bias-corrected) birds/km^2.
- Seven individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 41 [7; 87], an apportioned mean abundance estimate of 42 [7; 90] and an apportioned and availability bias-corrected mean abundance estimate of 49 [8; 105] individuals. These equated to mean density estimates of 0.11 (unapportioned), 0.11 (apportioned) and 0.153 (apportioned and availability bias-corrected) birds/km^2.

- Eight individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 47 [12; 94], an apportioned mean abundance estimate of 48 [12; 103] and an apportioned and availability bias-corrected mean abundance estimate of 56 [14; 120] individuals. These equated to mean density estimates of 0.08 (unapportioned), 0.09 (apportioned) and 0.10 (apportioned and availability bias-corrected) birds/km^2.

Measures of precisions were variable for puffin across the survey period (Table 78). During three of 16 surveys in which the species was recorded within Caledonia North, CV values were ≤ 0.16, indicating higher levels of precision (Table 78). The three surveys were within the breeding season, which meant that three of 10 breeding season surveys had a CV value of ≤ 0.16 (Table 78). Higher levels of precision coincided with higher numbers of puffins being recorded (Table 78). Outside the breeding season, when lower numbers of puffins were recorded, CV values were typically calculated to be between 0.2 to 0.6, indicating lower levels of precision (Table 78). For Caledonia North plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia North, indicating higher precision within these reporting regions (Table 78).

Table 78 **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of puffins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of puffin raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to mid-March). No colours were attributed to the breeding site attendance period (March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North														
May-21	24	140	29	280	0.20	0.64	141	35	284	0.65	165	41	330	0.75
Jun-21	7	41	7	89	0.38	0.19	42	7	104	0.19	47	8	118	0.22
Jul-21	12	71	24	142	0.29	0.33	73	15	155	0.34	83	17	173	0.38
Aug-21	195	1,130	463	1,796	0.07	5.18	1,156	467	1,811	5.29	1,346	545	2,109	6.16
Sep-21	5	29	6	52	0.45	0.13	30	12	54	0.14	34	14	63	0.16
Oct-21	9	53	12	99	0.33	0.24	60	13	117	0.28	70	15	137	0.32
Apr-22	49	281	98	517	0.14	1.29	289	93	544	1.32	336	109	634	1.54
May-22	44	255	122	389	0.15	1.17	258	129	389	1.18	301	150	453	1.38
Jun-22	4	23	6	34	0.50	0.11	23	7	51	0.11	26	8	57	0.12
Jul-22	10	59	12	123	0.32	0.27	60	12	120	0.27	70	14	140	0.32
Aug-22	10	58	17	104	0.32	0.27	61	17	111	0.28	71	20	129	0.32
Sep-22	107	614	321	930	0.10	2.81	644	327	978	2.95	750	381	1,139	3.43
Jan-23	3	17	3	52	0.58	0.08	18	3	54	0.08	20	4	63	0.09
Feb-23	3	17	3	40	0.58	0.08	18	3	43	0.08	21	4	50	0.09
Mar-23	6	35	6	70	0.41	0.16	36	6	80	0.16	42	7	93	0.19
Apr-23	1	6	1	17	1.00	0.03	6	1	17	0.03	7	1	20	0.03
b) Caledonia North plus 2 km buffer														
May-21	41	235	97	400	0.16	0.63	237	92	387	0.63	276	107	450	0.73
Jun-21	20	116	20	255	0.22	0.31	117	24	258	0.31	135	28	298	0.36
Jul-21	27	156	52	271	0.19	0.42	160	44	287	0.43	183	50	327	0.49
Aug-21	345	1,957	823	3,211	0.05	5.21	2,047	856	3,383	5.45	2,385	997	3,942	6.35
Sep-21	7	40	7	85	0.38	0.11	42	11	91	0.11	49	13	107	0.13
Oct-21	13	74	13	154	0.28	0.20	91	16	183	0.24	105	18	213	0.28
Apr-22	77	433	174	747	0.11	1.15	451	157	790	1.20	526	183	920	1.4
May-22	80	456	279	666	0.11	1.22	461	269	658	1.23	537	314	767	1.43
Jun-22	5	29	12	46	0.45	0.08	29	7	58	0.08	33	8	65	0.09

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jul-22	10	57	11	120	0.32	0.15	58	11	123	0.15	68	13	144	0.18
Aug-22	22	126	69	200	0.21	0.34	130	70	205	0.35	151	81	239	0.4
Sep-22	193	1,121	691	1,475	0.07	2.99	1,178	769	1,620	3.14	1,372	896	1,887	3.65
Jan-23	3	18	3	53	0.58	0.05	18	3	55	0.05	21	4	64	0.06
Feb-23	4	23	4	46	0.50	0.06	23	6	48	0.06	27	7	56	0.07
Mar-23	7	41	7	87	0.38	0.11	42	7	90	0.11	49	8	105	0.13
Apr-23	2	11	2	29	0.71	0.03	12	2	27	0.03	14	2	31	0.04
c) Caledonia North Survey Area														
May-21	59	345	205	503	0.13	0.62	348	193	528	0.62	405	225	615	0.73
Jun-21	38	225	95	384	0.16	0.40	227	84	420	0.41	263	98	486	0.47
Jul-21	46	279	121	466	0.15	0.50	285	120	508	0.51	329	139	585	0.59
Aug-21	418	2,427	1,115	3,959	0.05	4.36	2,532	1,098	4,231	4.54	2,950	1,279	4,929	5.29
Sep-21	14	82	35	134	0.27	0.15	86	36	137	0.15	100	42	159	0.18
Oct-21	16	94	18	187	0.25	0.17	107	20	205	0.19	124	23	239	0.22
Apr-22	104	599	282	967	0.10	1.08	623	287	1,022	1.12	726	335	1,190	1.3
May-22	105	611	378	831	0.10	1.10	616	386	853	1.11	718	449	993	1.29
Jun-22	11	64	17	121	0.30	0.11	64	13	134	0.12	74	15	153	0.13
Jul-22	18	105	53	164	0.24	0.19	106	47	172	0.19	124	55	201	0.22
Aug-22	29	166	80	269	0.19	0.30	170	75	281	0.30	198	87	327	0.36
Sep-22	302	1,759	920	2,673	0.06	3.16	1,829	978	2,913	3.28	2,128	1,139	3,385	3.82
Oct-22	4	23	6	41	0.50	0.04	27	7	49	0.05	31	8	58	0.06
Jan-23	5	29	5	71	0.45	0.05	29	5	73	0.05	34	6	85	0.06
Feb-23	4	23	4	52	0.50	0.04	23	4	47	0.04	27	5	55	0.05
Mar-23	8	47	12	94	0.35	0.08	48	12	103	0.09	56	14	120	0.1
Apr-23	4	23	4	52	0.50	0.04	25	4	57	0.04	29	5	67	0.05

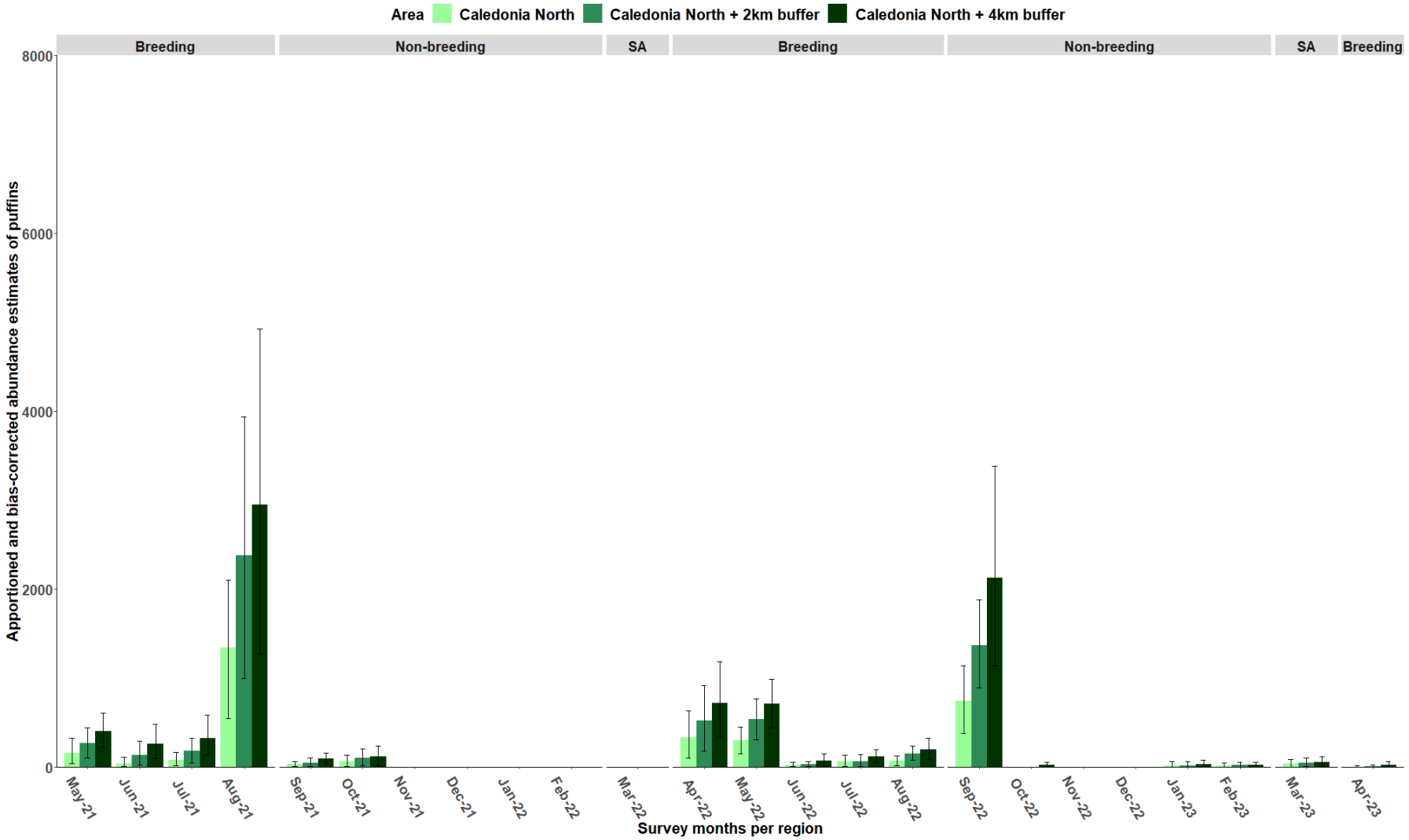


Figure 30 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total puffins recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Puffin seasonal periods are also displayed. SA stands for breeding site attendance

Caledonia South

A total of 1,329 puffins were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Puffins were recorded in every survey except November 2021 to February 2022 and November 2022 to January 2023 (Table 10). During the breeding season (April to mid-August, with birds attending colonies from mid-March onwards). Puffin were the most abundant during the breeding season (April to August), with a peak in August 2021 (Table 79, Figure 31):

- 175 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 1,010 [433; 1,605], an apportioned mean abundance estimate of 1,223 [494; 2,139] and an apportioned and availability bias-corrected mean abundance estimate of 1,424 [576; 2,491] individuals. These equated to mean density estimates of 4.80 (unapportioned), 5.81 (apportioned) and 6.77 (apportioned and availability bias-corrected) birds/km^2.
- 246 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,410 [803; 2,190], an apportioned mean abundance estimate of 1,796 [1,217; 2,935] and an apportioned and availability bias-corrected mean abundance estimate of 2,093 [1,418; 3,420] individuals. These equated to mean density estimates of 3.92 (unapportioned), 4.99 (apportioned) and 5.82 (apportioned and availability bias-corrected) birds/km^2.
- 309 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,777 [1,162; 2,537], an apportioned mean abundance estimate of 2,559 [1,441; 3,960] and an apportioned and availability bias-corrected mean abundance estimate of 2,981 [1,678; 4,614] individuals. These equated to mean density estimates of 3.33 (unapportioned), 4.79 (apportioned) and 5.59 (apportioned and availability bias-corrected) birds/km^2.

During the 2021 breeding season, mean apportioned and availability bias-corrected puffin abundances within Caledonia South Survey Area and reporting regions between May and July were very consistent. In August 2021, a large peak in abundance was observed, which was also the peak breeding season mean apportioned and availability bias-corrected abundance for all reporting regions across the baseline survey period. It is anticipated that rather than a peak of breeding adult birds, the timing of this peak, and the size of the abundances recorded relative to other breeding season surveys, may indicate a post-breeding peak of birds, likely originating from multiple breeding colonies across the wider region. What could be considered to be an equivalent peak occurred in September 2022 (i.e. outside the breeding season). During the 2022 breeding season, abundances were consistent across April and May (and higher than the corresponding abundances recorded in the same months in 2021. In June and July 2022, abundances were considerably lower, with higher mean abundances comparable to April and May 2022 reported during August 2022. The reason for the different temporal patterns in the 2021 and 2022 breeding seasons is unclear.

Reductions in mean apportioned and availability bias-corrected abundance in the breeding season surveys outside the peak survey month varied from 66% to 99%, with most surveys falling somewhere in the middle of the two extremes of this range. This is indicative of the overall breeding season peak for the baseline survey period being considerably higher than the abundance estimates recorded for all other surveys during this season across both of the breeding seasons within the survey period. This is perhaps related to the presence of a post-breeding season peak in August 2021 (i.e. inside the breeding season).

During the non-breeding season (September to mid-March), puffins were only recorded present in September to October 2021, September 2022 and January to March 2023, with a peak in September 2022 (Table 79, Figure 31):

- 106 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 618 [326; 985], an apportioned mean abundance estimate of 628 [336; 1,015] and an apportioned and availability bias-corrected mean abundance estimate of 730 [391; 1,177] individuals. These equated to mean density estimates of 2.94 (unapportioned), 2.99 (apportioned) and 3.47 (apportioned and availability bias-corrected) birds/km^2.
- 193 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,102 [777; 1,468], an apportioned mean abundance estimate of 1,372 [838; 1,591] and an apportioned and availability bias-corrected mean abundance estimate of 1,358 [976; 1,848] individuals. These equated to mean density estimates of 3.07 (unapportioned), 3.24 (apportioned) and 3.77 (apportioned and availability bias-corrected) birds/km^2.
- 283 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,651 [1,190; 2,101], an apportioned mean abundance estimate of 1,717 [1,216; 2,295] and an apportioned and availability bias-corrected mean abundance estimate of 1,996 [1,416; 2,662] individuals. These equated to mean density estimates of 3.1 (unapportioned), 3.22 (apportioned) and 3.74 (apportioned and availability bias-corrected) birds/km^2.

During the two non-breeding seasons covered by the baseline surveys, peak mean apportioned and availability bias-corrected abundances of puffin within Caledonia South Survey Area and reporting regions occurred in September 2022. The timing of this peak is indicative of a post-breeding season aggregation of birds (likely consisting of birds from multiple breeding colonies across the region). A peak abundance estimate in August 2021 (i.e. within the breeding season) is also considered likely to be a post-breeding aggregation of birds, which arguably could be considered a non-breeding count, despite the earlier timing in 2021. The September 2022 mean apportioned and availability bias-corrected abundances were considerably larger than in any other survey during the non-breeding season for this species, and puffin were absent from the surveys carried out between November 2021 and February 2022, and either absent or recorded in very low numbers between October 2022 to April 2023. Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 81% to >99.5%, reflecting the fact that the September 2022 peak was very large relative to the other peak mean apportioned and availability bias-corrected abundances recorded for puffin during the non-breeding season.

During the breeding site attendance period (March), puffins were recorded in low numbers, with peak numbers in March 2023 (Table 79, Figure 31):

- Three individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 17 [6; 35], an apportioned mean abundance estimate of 17 [3; 35] and an apportioned and availability bias-corrected mean abundance estimate of 20 [3; 41] individuals. These equated to mean density estimates of 0.08 (unapportioned), 0.08 (apportioned) and 0.09 (apportioned and availability bias-corrected) birds/km^2.
- Five individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned and apportioned mean abundance estimate of 29 [5; 58-64], and an apportioned and availability bias-corrected mean abundance estimate of 34 [6; 75] individuals. These equated to mean density estimates of 0.08 (unapportioned and apportioned) and 0.09 (apportioned and availability bias-corrected) birds/km^2.
- Nine individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 52 [23; 87], an apportioned mean abundance estimate of 53 [23; 89], and an apportioned and availability bias-corrected mean abundance estimate of 61

[27; 103] individuals. These equated to mean density estimates of 0.10 (unapportioned), 0.1 (apportioned) and 0.11 (apportioned and availability bias-corrected) birds/km^2.

Measures of precisions were variable for puffin across the survey period (Table 79). During four of 15 surveys in which the species was recorded within Caledonia South, CV values were ≤ 0.16, indicating higher levels of precision (Table 79). The four surveys were within the breeding season, which meant that four of 10 breeding season surveys had a CV value of ≤ 0.16 (Table 79). Higher levels of precision coincided with higher numbers of puffins being recorded (Table 79). Outside the breeding season, when lower numbers of puffins were recorded, CV values were typically calculated to be between 0.2 to 0.7, indicating lower levels of precision (Table 79). For Caledonia South plus buffer regions, CV values were generally lower than the corresponding CV values for Caledonia South, indicating higher precision within these reporting regions (Table 79).

Table 79 **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (birds per km^2) of puffins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of puffin raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-August) and light blue to royal blue (peak number) for the wintering months (September to mid-March). No colours were attributed to the breeding site attendance period (March)**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South														
May-21	19	111	70	151	0.23	0.53	111	64	152	0.53	130	75	177	0.62
Jun-21	31	180	76	320	0.18	0.86	182	70	320	0.87	212	82	373	1.01
Jul-21	34	199	70	352	0.17	0.95	202	59	356	0.96	235	69	415	1.12
Aug-21	**175**	**1,010**	**433**	**1,605**	**0.08**	**4.80**	**1,223**	**494**	**2,139**	**5.81**	**1,424**	**576**	**2,491**	**6.77**
Sep-21	8	46	23	81	0.35	0.22	47	23	77	0.22	54	27	89	0.26
Oct-21	19	111	53	182	0.23	0.53	120	42	203	0.57	140	49	236	0.66
Apr-22	39	225	86	380	0.16	1.07	233	87	390	1.11	271	102	454	1.29
May-22	63	364	219	502	0.13	1.73	368	215	509	1.75	428	250	594	2.04
Jun-22	6	35	6	93	0.41	0.17	35	6	94	0.17	41	7	109	0.19
Jul-22	17	99	52	152	0.24	0.47	100	48	159	0.48	116	56	182	0.55
Aug-22	49	282	161	408	0.14	1.34	290	152	437	1.38	338	177	509	1.61
Sep-22	**106**	**618**	**326**	**985**	**0.10**	**2.94**	**628**	**336**	**1,015**	**2.99**	**730**	**391**	**1,177**	**3.47**
Feb-23	2	11	2	29	0.71	0.05	11	2	23	0.05	13	2	27	0.06
Mar-23	3	17	6	35	0.58	0.08	17	3	35	0.08	20	3	41	0.09
Apr-23	4	23	6	46	0.50	0.11	23	6	46	0.11	27	7	54	0.13
b) Caledonia South plus 2 km buffer														
May-21	45	260	173	376	0.15	0.72	261	169	374	0.73	304	197	435	0.85
Jun-21	48	278	110	470	0.14	0.77	286	115	506	0.80	331	134	584	0.92
Jul-21	61	355	169	570	0.13	0.99	363	178	599	1.01	421	207	694	1.17
Aug-21	**246**	**1,410**	**803**	**2,190**	**0.06**	**3.92**	**1,796**	**1,217**	**2,935**	**4.99**	**2,093**	**1,418**	**3,420**	**5.82**
Sep-21	13	75	35	127	0.28	0.21	76	36	122	0.21	88	41	142	0.24
Oct-21	25	145	64	226	0.20	0.40	154	79	252	0.43	179	92	293	0.5
Mar-22	2	11	2	32	0.71	0.03	12	3	36	0.03	14	3	42	0.04
Apr-22	73	417	200	669	0.12	1.16	431	191	699	1.20	502	222	814	1.4
May-22	94	539	321	774	0.10	1.50	544	303	772	1.51	634	353	900	1.76
Jun-22	12	68	23	131	0.29	0.19	68	17	132	0.19	80	20	154	0.22

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Jul-22	19	110	52	174	0.23	0.31	111	54	181	0.31	128	63	208	0.36
Aug-22	85	486	280	726	0.11	1.35	499	287	744	1.39	581	334	866	1.62
Sep-22	193	1,102	777	1,468	0.07	3.07	1,167	838	1,591	3.24	1,358	976	1,848	3.77
Feb-23	4	23	6	46	0.50	0.06	23	4	51	0.06	27	5	59	0.07
Mar-23	5	29	5	58	0.45	0.08	29	5	64	0.08	34	6	75	0.09
Apr-23	6	34	6	67	0.41	0.09	34	6	63	0.10	40	7	73	0.11
c) Caledonia South Survey Area														
May-21	61	354	215	534	0.13	0.66	356	209	539	0.67	414	244	628	0.78
Jun-21	76	442	232	680	0.11	0.83	452	217	739	0.85	522	251	854	0.98
Jul-21	88	528	348	745	0.11	0.99	538	358	771	1.01	626	417	895	1.17
Aug-21	309	1,777	1,162	2,537	0.06	3.33	2,559	1,441	3,960	4.79	2,981	1,678	4,614	5.59
Sep-21	21	122	64	186	0.22	0.23	123	70	188	0.23	143	82	219	0.27
Oct-21	31	180	81	290	0.18	0.34	188	83	314	0.35	219	97	366	0.41
Mar-22	2	11	2	32	0.71	0.02	11	2	34	0.02	13	2	40	0.02
Apr-22	116	665	344	1,032	0.09	1.25	691	343	1,104	1.29	805	400	1,286	1.51
May-22	149	856	517	1,190	0.08	1.60	862	514	1,225	1.62	1,004	599	1,427	1.88
Jun-22	18	104	41	180	0.24	0.19	105	41	187	0.20	122	48	218	0.23
Jul-22	29	168	104	237	0.19	0.31	169	106	238	0.32	196	123	275	0.37
Aug-22	126	722	390	1,135	0.09	1.35	736	388	1,132	1.38	857	452	1,319	1.61
Sep-22	283	1,651	1,190	2,101	0.06	3.10	1,717	1,216	2,295	3.22	1,996	1,416	2,662	3.74
Oct-22	1	6	1	18	1.00	0.01	6	1	19	0.01	7	1	22	0.01
Feb-23	4	23	4	46	0.50	0.04	23	4	52	0.04	27	5	61	0.05
Mar-23	9	52	23	87	0.33	0.10	53	23	89	0.10	61	27	103	0.11
Apr-23	6	34	6	63	0.41	0.06	34	6	70	0.06	40	7	82	0.08

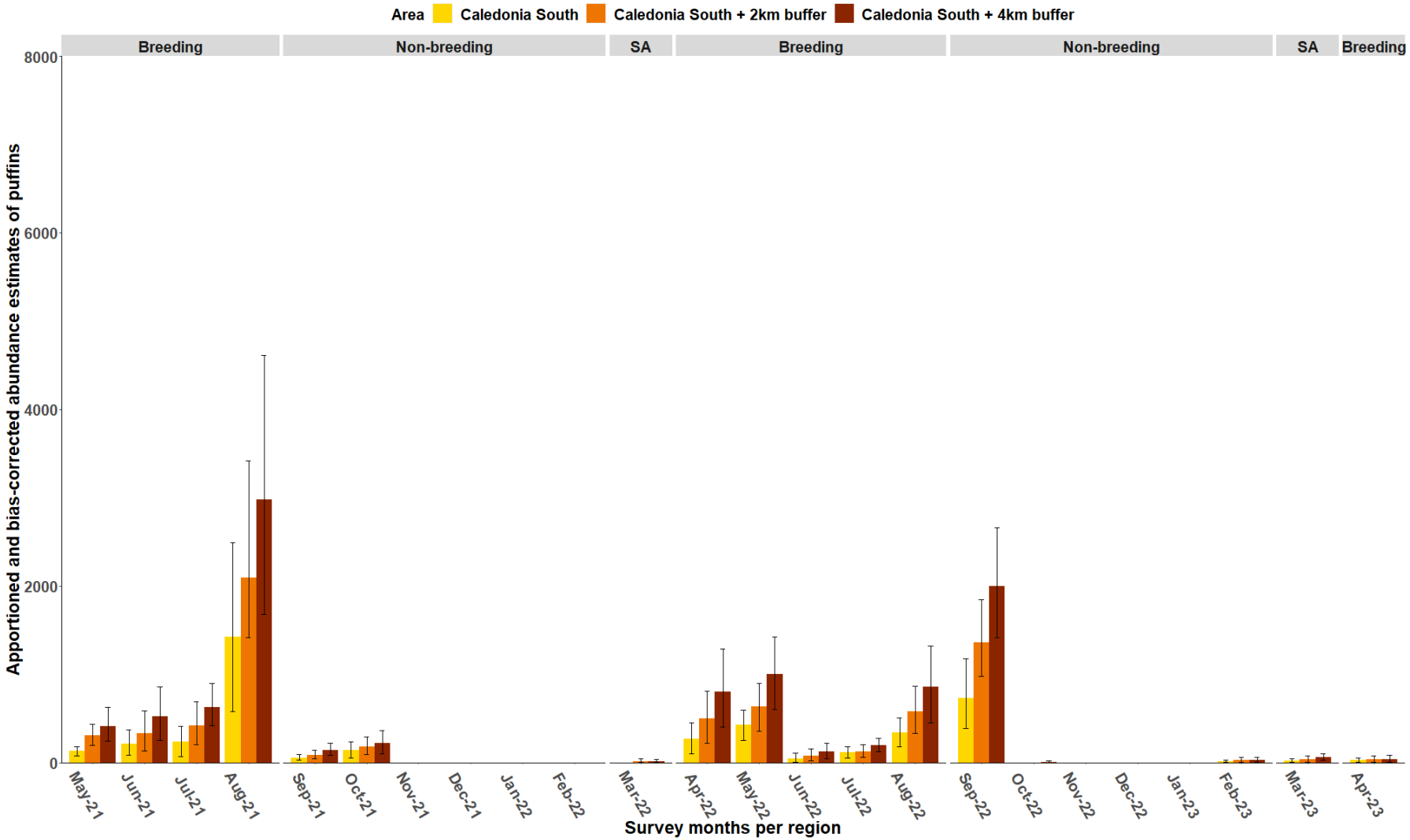


Figure 31 Bar plot of the monthly apportioned and availability bias-corrected abundance estimates (with 95% confidence intervals) of total puffins recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Puffin seasonal periods are also displayed. SA stands for breeding site attendance.

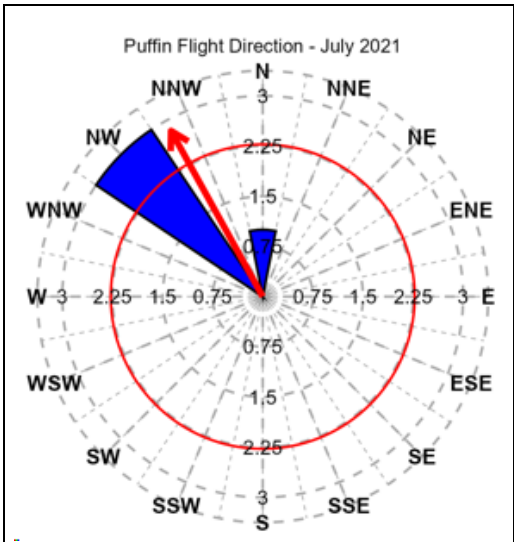
ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.177-194. While puffins were mostly loosely distributed across the Survey Area, higher numbers of records were made in Caledonia South and its Buffer Zone in June, July, September, and October 2021 and in August 2022 (Figures A4.178-179, 181-182, 188). In August 2021, October 2022 and January 2023, the opposite pattern was observed with individuals largely recorded in the north of the Survey Area (Figure A4.180, 190-191). The two individuals recorded in March 2022 were both located in the southwest of Caledonia South Buffer Zone (Figure A4.183).

Significant predominant direction of flight was recorded in:

- **July**
  - 2021 north-northwest (Figure 32a)
- **September**
  - 2022 west (Figure 32b)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.20).



Number of Observations	4	Number of Observations	5
Mean Vector (μ)	331.121	Mean Vector (μ)	279.888
Length of Mean Vector (r)	0.943	Length of Mean Vector (r)	0.907
Rayleigh Test (Z)	3.558	Rayleigh Test (Z)	4.112
Rayleigh Test (p)	0.016	Rayleigh Test (p)	0.008
a July 2021		**b September 2022**	

Figure 32 Summary of flight direction of puffins within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.23 Unidentified auk species

i. Abundance and density estimates

A total of 432 unidentified auks were recorded in the Survey Area during both years of baseline surveys (Table 8). Auk species were recorded in every survey except November and December 2021 (Table 8). Peak numbers were recorded in August 2021, when 190 unidentified auks were recorded in the Survey Area (Table 80). This resulted in an unapportioned mean abundance estimate of 1,102 [354; 1,903] individuals and a mean density estimate of 1.25 birds/km^2 (Table 80). Auk species have been used for apportioning to species level where possible.

Table 80 Raw counts, unapportioned abundance and density estimates (birds per km^2) of auk species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
May-21	3	17	3	41	0.58	0.04
Jun-21	4	23	6	47	0.50	0.05
Jul-21	19	112	59	165	0.23	0.26
Aug-21	51	295	98	596	0.14	0.69
Sep-21	3	17	3	46	0.58	0.04
Oct-21	11	64	23	117	0.30	0.15
Jan-22	1	6	1	17	1.00	0.01
Feb-22	1	5	1	16	1.00	0.01
Mar-22	3	16	3	43	0.58	0.04
Apr-22	6	35	12	63	0.41	0.08
May-22	15	87	35	156	0.26	0.2
Jun-22	3	17	3	40	0.58	0.04
Jul-22	10	58	23	94	0.32	0.14
Aug-22	4	23	6	52	0.50	0.05
Sep-22	24	139	29	295	0.20	0.33
Oct-22	2	12	2	35	0.71	0.03
Nov-22	1	6	1	18	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01
Jan-23	1	6	1	17	1.00	0.01
Feb-23	1	6	1	17	1.00	0.01
Mar-23	2	12	2	29	0.71	0.03
Apr-23	1	6	1	17	1.00	0.01
b) Caledonia plus 2 km buffer						
May-21	5	29	5	57	0.45	0.05
Jun-21	7	41	7	87	0.38	0.06
Jul-21	37	214	116	330	0.16	0.33
Aug-21	94	536	194	964	0.10	0.83
Sep-21	9	52	9	98	0.33	0.08
Oct-21	14	81	29	144	0.27	0.13
Jan-22	1	6	1	17	1.00	0.01
Feb-22	3	16	3	38	0.58	0.02
Mar-22	3	16	3	42	0.58	0.02
Apr-22	11	62	23	108	0.30	0.1
May-22	20	114	57	183	0.22	0.18
Jun-22	7	40	7	80	0.38	0.06
Jul-22	15	86	35	150	0.26	0.13
Aug-22	8	46	17	74	0.35	0.07

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Sep-22	40	231	110	375	0.16	0.36
Oct-22	2	12	2	35	0.71	0.02
Nov-22	1	6	1	17	1.00	0.01
Dec-22	3	18	3	35	0.58	0.03
Jan-23	1	6	1	17	1.00	0.01
Feb-23	1	6	1	17	1.00	0.01
Mar-23	2	12	2	29	0.71	0.02
Apr-23	7	40	7	85	0.38	0.06
c) Survey Area						
May-21	6	35	6	76	0.41	0.04
Jun-21	10	59	18	106	0.32	0.07
Jul-21	44	266	163	398	0.15	0.3
Aug-21	190	1,102	354	1,903	0.07	1.25
Sep-21	12	70	23	129	0.29	0.08
Oct-21	16	94	35	158	0.25	0.11
Jan-22	1	6	1	17	1.00	0.01
Feb-22	3	16	3	44	0.58	0.02
Mar-22	3	16	3	38	0.58	0.02
Apr-22	19	110	52	167	0.23	0.12
May-22	24	139	58	226	0.20	0.16
Jun-22	8	46	8	98	0.35	0.05
Jul-22	16	94	41	158	0.25	0.11
Aug-22	8	46	17	80	0.35	0.05
Sep-22	46	268	123	420	0.15	0.3
Oct-22	3	18	3	47	0.58	0.02
Nov-22	2	12	2	29	0.71	0.01
Dec-22	3	18	3	35	0.58	0.02
Jan-23	1	6	1	18	1.00	0.01
Feb-23	2	12	2	35	0.71	0.01
Mar-23	5	29	6	59	0.45	0.03
Apr-23	10	57	23	98	0.32	0.06

In Caledonia North Survey Area, peak numbers were recorded in September 2022, with 30 individuals recorded (Table 81). This resulted in an unapportioned mean abundance estimate of 175 [64; 297] individuals, which equated to a mean density estimate of 0.31 birds/km² (Table 81).

Table 81 Raw counts, unapportioned abundance and density estimates (birds per km²) of auk species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
May-21	3	17	3	47	0.58	0.08
Jun-21	2	12	2	35	0.71	0.05
Jul-21	8	47	8	101	0.35	0.22
Aug-21	5	29	5	64	0.45	0.13
Sep-21	1	6	1	17	1.00	0.03
Oct-21	3	18	3	41	0.58	0.08
Jan-22	1	6	1	17	1.00	0.03
Feb-22	1	5	1	16	1.00	0.02
Mar-22	1	5	1	16	1.00	0.02
Apr-22	2	11	2	29	0.71	0.05

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
May-22	9	52	12	110	0.33	0.24
Jul-22	3	18	6	35	0.58	0.08
Aug-22	1	6	1	17	1.00	0.03
Sep-22	15	86	15	184	0.26	0.39
Oct-22	2	12	2	35	0.71	0.05
Jan-23	1	6	1	17	1.00	0.03
Feb-23	1	6	1	17	1.00	0.03
Mar-23	2	12	2	29	0.71	0.05
b) Caledonia North plus 2 km buffer						
May-21	3	17	3	40	0.58	0.05
Jun-21	2	12	2	35	0.71	0.03
Jul-21	14	81	29	144	0.27	0.22
Aug-21	18	102	18	272	0.24	0.27
Sep-21	5	28	5	57	0.45	0.07
Oct-21	8	46	17	80	0.35	0.12
Jan-22	1	6	1	17	1.00	0.02
Feb-22	3	16	3	43	0.58	0.04
Mar-22	1	5	1	16	1.00	0.01
Apr-22	6	34	6	62	0.41	0.09
May-22	13	74	28	131	0.28	0.20
Jun-22	2	12	2	29	0.71	0.03
Jul-22	6	34	6	69	0.41	0.09
Aug-22	1	6	1	17	1.00	0.02
Sep-22	26	151	64	256	0.20	0.40
Oct-22	2	12	2	35	0.71	0.03
Dec-22	2	12	2	29	0.71	0.03
Jan-23	1	6	1	18	1.00	0.02
Feb-23	1	6	1	17	1.00	0.02
Mar-23	2	12	2	29	0.71	0.03
Apr-23	6	34	6	69	0.41	0.09
c) Caledonia North Survey Area						
May-21	3	18	3	47	0.58	0.03
Jun-21	3	18	3	41	0.58	0.03
Jul-21	18	109	48	176	0.24	0.20
Aug-21	21	122	21	331	0.22	0.22
Sep-21	7	41	12	76	0.38	0.07
Oct-21	10	58	23	99	0.32	0.10
Jan-22	1	6	1	17	1.00	0.01
Feb-22	3	17	3	44	0.58	0.03
Mar-22	1	5	1	16	1.00	0.01
Apr-22	9	52	17	92	0.33	0.09
May-22	16	93	35	163	0.25	0.17
Jun-22	2	12	2	29	0.71	0.02
Jul-22	6	35	6	76	0.41	0.06
Aug-22	1	6	1	17	1.00	0.01
Sep-22	30	175	64	297	0.18	0.31
Oct-22	3	18	3	41	0.58	0.03
Dec-22	3	18	3	35	0.58	0.03
Jan-23	1	6	1	18	1.00	0.01
Feb-23	1	6	1	17	1.00	0.01
Mar-23	4	23	6	53	0.50	0.04

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Apr-23	8	46	17	80	0.35	0.08

In Caledonia South Survey Area, peak numbers were recorded in August 2021, with 183 individuals recorded (Table 82). This resulted in an unapportioned mean abundance estimate of 1,053 [299; 1,869] individuals, which equated to a mean density estimate of 1.97 birds/km² (Table 82).

Table 82 Raw counts, unapportioned abundance and density estimates (birds per km²) of auk species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
Jun-21	2	12	2	29	0.71	0.06
Jul-21	11	65	23	111	0.30	0.31
Aug-21	46	266	58	577	0.15	1.26
Sep-21	2	12	2	29	0.71	0.06
Oct-21	8	47	12	100	0.35	0.22
Mar-22	2	11	2	32	0.71	0.05
Apr-22	4	23	4	46	0.50	0.11
May-22	6	35	12	69	0.41	0.17
Jun-22	3	17	3	41	0.58	0.08
Jul-22	7	41	12	76	0.38	0.19
Aug-22	3	17	3	40	0.58	0.08
Sep-22	9	52	9	111	0.33	0.25
Nov-22	1	6	1	18	1.00	0.03
Dec-22	1	6	1	18	1.00	0.03
Apr-23	1	6	1	17	1.00	0.03
b) Caledonia South plus 2 km buffer						
May-21	2	12	2	35	0.71	0.03
Jun-21	5	29	5	70	0.45	0.08
Jul-21	29	169	81	273	0.19	0.47
Aug-21	84	482	161	912	0.11	1.34
Sep-21	4	23	6	40	0.50	0.06
Oct-21	10	58	12	110	0.32	0.16
Mar-22	2	11	2	32	0.71	0.03
Apr-22	7	40	11	86	0.38	0.11
May-22	8	46	11	86	0.35	0.13
Jun-22	5	28	5	74	0.45	0.08
Jul-22	11	64	29	104	0.30	0.18
Aug-22	7	40	11	69	0.38	0.11
Sep-22	22	126	51	211	0.21	0.35
Nov-22	1	6	1	17	1.00	0.02
Dec-22	1	6	1	17	1.00	0.02
Mar-23	1	6	1	17	1.00	0.02
Apr-23	3	17	3	45	0.58	0.05
c) Caledonia South Survey Area						
May-21	3	17	3	41	0.58	0.03
Jun-21	8	46	8	99	0.35	0.09
Jul-21	37	222	120	336	0.16	0.42
Aug-21	183	1,053	299	1,869	0.07	1.97
Sep-21	7	41	7	93	0.38	0.08
Oct-21	12	70	23	122	0.29	0.13

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
Mar-22	2	11	2	32	0.71	0.02
Apr-22	13	75	23	138	0.28	0.14
May-22	10	57	23	98	0.32	0.11
Jun-22	7	41	7	98	0.38	0.08
Jul-22	13	75	35	122	0.28	0.14
Aug-22	7	40	11	75	0.38	0.07
Sep-22	29	169	88	251	0.19	0.32
Oct-22	2	12	2	35	0.71	0.02
Nov-22	2	12	2	29	0.71	0.02
Dec-22	1	6	1	18	1.00	0.01
Feb-23	1	6	1	17	1.00	0.01
Mar-23	3	17	3	35	0.58	0.03
Apr-23	4	23	4	52	0.50	0.04

ii. Distribution and behaviour

Maps of distribution of unidentified auks are shown in Appendix 4: Figures A4.195-216. Unidentified auks were recorded in the north and the southeast of the Survey Area in May 2021 (Figure A4.195) and largely in the east to southeast in June 2021 (Figure A4.196). Individuals were loosely distributed throughout the Survey Area in July, September, October 2021 and April, May, and September 2022 (Figure A4.197, 199-200, 204-204, 209). Highest numbers in the south of the Survey Area were recorded in August 2021 (Figure A4.198). In January, February, and October 2022, and in April 2023, unidentified auks were mainly recorded in Caledonia North and its Buffer Zone (Figure A4.201-202, 210, 216). Few records scattered across the Survey Area were made in November 2022 and March 2023 (Figure A4.211-215).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.21).

4.24 Great northern diver

i. Abundance and density estimates

Two great northern divers were recorded in the Survey Area during the first year of the baseline surveys, and none were recorded the second year of surveys (Table 8 to Table 10). They were only recorded in Caledonia South (Table 83 to Table 85). A single great northern diver was recorded in each of the June and November 2021 surveys, therefore, abundance and density estimates were very low (Table 83, Table 85).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 83 to Table 85).

Table 83 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of great northern divers in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Jun-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Nov-21	1	6	1	17	1.00	0.01	6	1	17	0.01
b) Caledonia OWF plus 2 km buffer										
Jun-21	1	6	1	17	1.00	0.01	6	1	17	0.01

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Nov-21	1	6	1	17	1.00	0.01	6	1	17	0.01
c) Survey Area										
Jun-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Nov-21	1	6	1	17	1.00	0.01	6	1	17	0.01

Table 84 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of red-throated divers in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia North										
None recorded										
b) Caledonia North plus 2 km buffer										
None recorded										
c) Caledonia North Survey Area										
None recorded										

Table 85 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of great northern divers in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia South										
Jun-21	1	6	1	17	1.00	0.03	6	1	17	0.03
Nov-21	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia South plus 2 km buffer										
Jun-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Nov-21	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia South Survey Area										
Jun-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Nov-21	1	6	1	17	1.00	0.01	6	1	17	0.01

ii. Distribution and behaviour

Great northern divers were only recorded within Caledonia South (Appendix 4, Figures A4.217-218). Both great northern divers were recorded along the boundary between Caledonia South and its Buffer Zone, with the single individual recorded in the southwest in June 2021 and in the west in November 2021 (Appendix 4, Figure A4.217-218).

4.25 Red-throated diver

i. Abundance and density estimates

A single red-throated diver was recorded in the Survey Area during the second year of the baseline surveys (Table 8). The individual was recorded in October 2022 in Caledonia South (Table 86 to Table 88). The abundance and density estimates were therefore very low (Table 86 to Table 88).

Measures of precisions were high, which was likely related to the low numbers of individuals recorded in each region (CV > 0.16; Table 86 to Table 88).

Table 86 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of red-throated divers in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Oct-22	1	6	1	18	1.00	0.01	6	1	18	0.01
b) Caledonia OWF plus 2 km buffer										
Oct-22	1	6	1	17	1.00	0.01	6	1	17	0.01
c) Survey Area										
Oct-22	1	6	1	18	1.00	0.01	6	1	18	0.01

Table 87 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of red-throated divers in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
None recorded										
b) Caledonia North plus 2 km buffer										
None recorded										
c) Caledonia North Survey Area										
Oct-22	1	6	1	18	1.00	0.01	6	1	18	0.01

Table 88 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of red-throated divers in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Oct-22	1	6	1	18	1.00	0.03	6	1	18	0.03
b) Caledonia South plus 2 km buffer										
Oct-22	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia South Survey Area										
Oct-22	1	6	1	18	1.00	0.01	6	1	18	0.01

ii. Distribution and behaviour

In October 2022, the single red-throated diver was recorded in the north of Caledonia South, near the border with Caledonia North (Appendix 4, Figure A4.219).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5. 22).

4.26 Fulmar

i. Abundance and density estimates

Caledonia OWF

A total of 4,618 fulmars were recorded in the Survey Area during both years of baseline surveys (Table 8). Fulmars were recorded in every survey (Table 8). Fulmars were the most abundant during the breeding season (April to mid-September). A peak of abundance was recorded in July 2022 (Table 89, Figure 33):

- 705 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 4,124 [2,351; 6,147] and an apportioned abundance estimate of 4,123 [1,896; 6,732] individuals. These equated to mean density estimates of 9.65 (unapportioned) and 9.64 (apportioned) birds/km^2.
- 1,096 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 6,311 [3,783; 9,270] and an apportioned abundance estimate of 6,310 [3,484; 10,358] individuals. These equated to mean density estimates of 9.81 (unapportioned) and 9.80 (apportioned) birds/km^2.
- 1,631 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 9,532 [4,342; 15,617] and an apportioned abundance estimate of 9,533 [3,887; 16,136] individuals. These equated to mean density estimates of 10.79 (unapportioned) and 10.78 (apportioned) birds/km^2.

During the breeding seasons covered by the baseline surveys, very obvious peaks in fulmar abundance were recorded in July 2021 and 2022, with relatively consistent, and considerably lower numbers, recorded in other breeding season surveys. The peak mean abundance of fulmar within Caledonia OWF and its reporting regions was around 30% to 50% (depending on the reporting region considered) greater than the next highest mean abundance recorded, in July 2021. Mean abundances in the ten other surveys during the breeding seasons covered were 93% to 98% lower than the peak mean abundance. The data indicate that whilst larger numbers of fulmar were present within the Survey Area at a specific time within both breeding seasons covered by the baseline surveys (i.e. July), they were present in much lower numbers during the remainder of the breeding seasons covered by the baseline surveys.

During the non-breeding season (mid-September to March), fulmars were recorded in highest numbers in November, with a peak in November 2022 (Table 89, Figure 33):

- 125 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 735 [512; 1,000] and apportioned abundance estimate of 740 [480; 1,044] individuals. These equated to mean density estimates of 1.72 (unapportioned) and 1.73 (apportioned) birds/km^2.
- 196 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean unapportioned abundance estimate of 1,136 [840; 1,472] and apportioned abundance estimate of 1,141 [824; 1,510] individuals. Both equated to a mean density estimate of 1.77 birds/km^2.
- 252 individuals were recorded in the Survey Area, resulting in a mean unapportioned abundance estimate of 1,486 [1,032; 1,922] and apportioned abundance estimate of 1,497 [998; 1,988] individuals. These equated to mean density estimates of 1.68 (unapportioned) and 1.69 (apportioned) birds/km^2.

As with breeding season mean abundances, the data indicates that during a specific period within both non-breeding seasons covered by the surveys (i.e. November, which recorded similar abundances in both survey years), fulmar were present in larger numbers than the rest of the non-breeding season. In the ten other non-breeding season months covered by the baseline surveys, mean abundances in this were 76% to 98% lower, with mean abundances for most surveys being closer to the higher end of these reductions.

Very good measures of precisions were calculated for most survey months (CV ≤ 0.16), with 19 of the 24 baseline surveys for Caledonia OWF reporting CV values of ≤ 0.16 (Table 89). The five exceptions, all occurring during the winter months, coincided with lower numbers of birds being recorded (Table 89).

Table 89 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of fulmars in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of fulmar raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-September) and light blue to royal blue (peak number) for the wintering months (mid-September to March)

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia OWF										
May-21	43	251	181	315	0.15	0.59	251	164	350	0.59
Jun-21	40	235	141	346	0.16	0.55	234	124	358	0.55
Jul-21	466	2,748	714	6,511	0.05	6.43	2,748	683	6,517	6.43
Aug-21	138	799	602	1,030	0.09	1.87	798	561	1,071	1.87
Sep-21	50	290	203	383	0.14	0.68	290	162	435	0.68
Oct-21	3	18	3	47	0.58	0.04	18	3	47	0.04
Nov-21	122	709	122	1,847	0.09	1.66	709	150	1,830	1.66
Dec-21	85	493	296	720	0.11	1.15	493	290	719	1.15
Jan-22	25	145	87	203	0.20	0.34	145	64	237	0.34
Feb-22	36	194	113	297	0.17	0.45	194	92	297	0.45
Mar-22	8	43	16	75	0.35	0.1	43	13	81	0.10
Apr-22	48	276	48	530	0.14	0.65	277	61	582	0.65
May-22	20	116	75	162	0.22	0.27	116	58	197	0.27
Jun-22	96	552	276	862	0.10	1.29	551	264	902	1.29
Jul-22	705	4,124	2,351	6,147	0.04	9.65	4,123	1,896	6,732	9.64
Aug-22	44	254	150	363	0.15	0.59	254	131	369	0.59
Sep-22	18	104	52	162	0.24	0.24	104	35	185	0.24
Nov-22	125	735	512	1,000	0.09	1.72	740	480	1,044	1.73
Dec-22	41	240	100	410	0.16	0.56	240	102	427	0.56
Jan-23	14	82	47	134	0.27	0.19	82	31	157	0.19
Feb-23	15	86	52	121	0.26	0.2	86	41	138	0.20
Mar-23	49	286	158	420	0.14	0.67	292	147	460	0.68
Apr-23	13	74	34	119	0.28	0.17	74	17	147	0.17
b) Caledonia OWF plus 2 km buffer										
May-21	76	437	345	534	0.11	0.68	436	293	598	0.68
Jun-21	68	394	249	563	0.12	0.61	395	243	574	0.61
Jul-21	629	3,644	1,170	8,058	0.04	5.66	3,643	1,066	8,266	5.66
Aug-21	220	1,255	896	1,586	0.07	1.95	1,255	873	1,626	1.95
Sep-21	65	373	270	477	0.12	0.58	374	224	545	0.58
Oct-21	7	40	7	81	0.38	0.06	41	7	92	0.06
Nov-21	155	886	206	1,985	0.08	1.38	886	236	2,081	1.38
Dec-21	129	739	447	1,088	0.09	1.15	739	441	1,134	1.15

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Jan-22	47	269	171	371	0.15	0.42	269	139	429	0.42
Feb-22	56	300	198	407	0.13	0.47	300	177	439	0.47
Mar-22	13	69	32	106	0.28	0.11	69	29	117	0.11
Apr-22	61	346	125	607	0.13	0.54	346	113	641	0.54
May-22	45	257	149	412	0.15	0.4	258	115	452	0.40
Jun-22	149	854	493	1,243	0.08	1.33	853	429	1,318	1.32
Jul-22	1,096	6,311	3,783	9,270	0.03	9.81	6,310	3,484	10,358	9.80
Aug-22	71	406	275	555	0.12	0.63	406	189	670	0.63
Sep-22	34	196	110	294	0.17	0.3	196	80	329	0.30
Nov-22	196	1,136	840	1,472	0.07	1.77	1,141	824	1,510	1.77
Dec-22	63	368	198	607	0.13	0.57	368	175	618	0.57
Jan-23	25	145	93	209	0.20	0.23	145	79	221	0.23
Feb-23	22	126	74	177	0.21	0.2	126	66	183	0.20
Mar-23	67	388	197	591	0.12	0.6	393	198	638	0.61
Apr-23	24	136	51	244	0.20	0.21	136	34	272	0.21
c)	Survey Area									
May-21	91	532	392	672	0.10	0.6	531	339	748	0.60
Jun-21	105	618	429	818	0.10	0.7	618	406	847	0.70
Jul-21	790	4,770	1,678	9,890	0.04	5.4	4,770	1,510	10,035	5.39
Aug-21	285	1,653	1,149	2,147	0.06	1.87	1,653	1,126	2,141	1.87
Sep-21	113	661	509	837	0.09	0.75	661	416	942	0.75
Oct-21	12	70	12	146	0.29	0.08	71	12	158	0.08
Nov-21	180	1,048	297	2,235	0.07	1.19	1,048	288	2,247	1.19
Dec-21	187	1,090	740	1,509	0.07	1.23	1,090	728	1,538	1.23
Jan-22	55	319	203	435	0.13	0.36	319	177	487	0.36
Feb-22	80	439	296	604	0.11	0.5	439	269	615	0.50
Mar-22	28	151	86	227	0.19	0.17	152	75	227	0.17
Apr-22	70	404	179	669	0.12	0.46	404	150	721	0.46
May-22	51	296	157	482	0.14	0.33	297	127	517	0.34
Jun-22	204	1,181	677	1,765	0.07	1.34	1,180	665	1,782	1.33
Jul-22	1,631	9,532	4,342	15,617	0.02	10.79	9,533	3,887	16,136	10.78
Aug-22	114	655	465	850	0.09	0.74	655	356	1,011	0.74
Sep-22	47	274	169	391	0.15	0.31	274	140	420	0.31
Oct-22	4	24	4	59	0.50	0.03	24	4	70	0.03
Nov-22	252	1,486	1,032	1,922	0.06	1.68	1,497	998	1,988	1.69
Dec-22	87	513	295	761	0.11	0.58	513	277	802	0.58
Jan-23	53	312	194	470	0.14	0.35	312	164	476	0.35
Feb-23	37	214	145	278	0.16	0.24	215	134	295	0.24
Mar-23	96	564	317	834	0.10	0.64	569	288	877	0.64
Apr-23	39	224	121	344	0.16	0.25	224	97	396	0.25

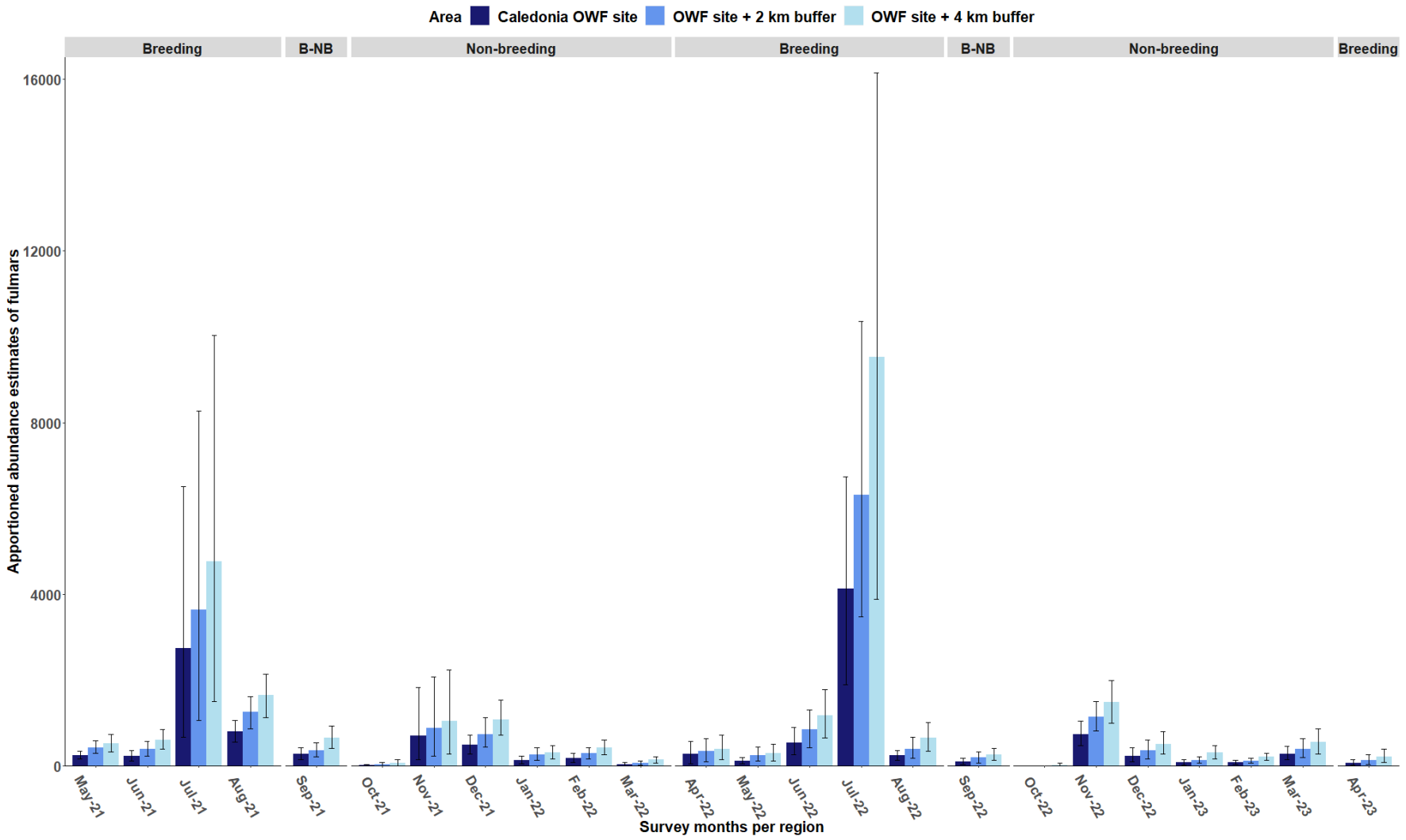


Figure 33 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total fulmars recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Fulmar seasonal periods are also displayed. B-NB corresponds to month split between breeding (B) and non-breeding (NB)

Caledonia North

A total of 1,818 fulmars were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Fulmar were recorded in every survey, except October 2022 (Table 9). Fulmars were the most abundant during the breeding season (April to mid-September). A peak of abundance was recorded in July 2022 (Table 90, Figure 34):

- 179 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 1,048 [427; 1,762] and an apportioned mean abundance estimate of 1,048 [409; 1,815] individuals. Both equated to a mean density estimate of 4.80 birds/km^2.
- 287 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,643 [876; 2,444] and an apportioned mean abundance estimate of 1,642 [807; 2,513] individuals. These equated to mean density estimates of 4.38 (unapportioned) and 4.37 (apportioned) birds/km^2
- 405 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 2,370 [1,598; 3,260] and an apportioned mean abundance estimate of 2,370 [1,551; 3,289] individuals. Both equated to mean density estimate of 4.25 birds/km^2.

During the breeding seasons in Caledonia North Survey Area covered by the baseline surveys, relatively subtle peaks in fulmar abundance were recorded in July 2021 and 2022 (when the overall baseline survey seasonal peak was observed), with consistently low numbers recorded in most other breeding season surveys. Mean abundances in the other surveys during the breeding seasons covered were 45% to 97% lower than the peak mean abundance, with the average reduction located towards the upper end of the range.

During the non-breeding season (mid-September to March), fulmars were only recorded in higher numbers in November, with a peak in November 2022 (Table 90, Figure 34):

- 70 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimate of 413 [230; 637] and apportioned abundance estimate of 412 [219; 636] individuals. Both equated to a mean density estimate of 1.89 birds/km^2.
- 119 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 686 [421; 980] individuals, which equated to a mean density estimate of 1.83 birds/km^2.
- 167 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 985 [655; 1,333] and apportioned abundance estimate of 990 [621; 1,384] individuals. Both equated to mean density estimates of 1.77 (unapportioned) and 1.78 (apportioned) birds/km^2.

The data indicates that during the non-breeding season, fulmar abundance in Caledonia North Survey Area was generally very low, with small peaks recorded In December 2021 and November 2022. In the other non-breeding season months covered by the baseline surveys, mean abundances in this were 45% to 99% lower than the peak mean abundance, with mean abundances for most surveys being closer to the higher end of these reductions.

Good measures of precisions were calculated for some, but not all, survey months (CV ≤ 0.16), with six of the 23 baseline surveys in which fulmar was recorded within Caledonia North reporting CV values of ≤ 0.16 (Table 90). The vast majority of other surveys reported CV values of ≤ 0.50, with higher values (i.e. lower precision) occurring in surveys where fewer birds were recorded (Table 90). Corresponding values for Caledonia North plus buffer regions were generally lower (i.e. higher precision), which is anticipated to relate to the number of birds recorded (Table 90).

Table 90 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of fulmars in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of fulmar raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-September) and light blue to royal blue (peak number) for the wintering months (mid-September to March)**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a)	Caledonia North									
May-21	25	146	82	210	0.20	0.67	146	69	221	0.67
Jun-21	21	124	53	201	0.22	0.57	124	36	213	0.57
Jul-21	78	462	343	622	0.11	2.12	462	290	669	2.11
Aug-21	69	400	238	556	0.12	1.83	399	250	561	1.83
Sep-21	24	139	81	209	0.20	0.64	139	48	255	0.64
Oct-21	1	6	1	18	1.00	0.03	6	1	18	0.03
Nov-21	10	58	10	123	0.32	0.27	59	10	129	0.27
Dec-21	39	226	52	440	0.16	1.04	226	39	464	1.03
Jan-22	12	69	12	133	0.29	0.32	69	15	162	0.32
Feb-22	12	65	32	92	0.29	0.30	65	22	113	0.30
Mar-22	6	32	16	48	0.41	0.15	32	17	53	0.15
Apr-22	9	52	17	92	0.33	0.24	52	17	92	0.24
May-22	10	58	29	87	0.32	0.27	58	18	93	0.27
Jun-22	44	251	120	382	0.15	1.15	250	120	399	1.14
Jul-22	179	1,048	427	1,762	0.07	4.80	1,048	409	1,815	4.80
Aug-22	25	144	75	231	0.20	0.66	144	72	236	0.66
Sep-22	11	63	40	92	0.30	0.29	63	12	121	0.29
Nov-22	70	413	230	637	0.12	1.89	412	219	636	1.89
Dec-22	22	128	23	256	0.21	0.59	128	22	256	0.59
Jan-23	9	52	17	104	0.33	0.24	52	13	121	0.24
Feb-23	6	35	17	52	0.41	0.16	35	13	69	0.16
Mar-23	24	141	53	234	0.20	0.65	141	55	246	0.65
Apr-23	5	28	6	56	0.45	0.13	28	5	62	0.13
b)	Caledonia North plus 2 km buffer									
May-21	44	252	154	337	0.15	0.67	252	138	360	0.67
Jun-21	36	208	104	324	0.17	0.55	209	104	336	0.56
Jul-21	141	813	588	1,026	0.08	2.17	813	524	1,119	2.16
Aug-21	123	698	459	976	0.09	1.86	698	459	970	1.86
Sep-21	29	165	97	250	0.19	0.44	165	74	279	0.44
Oct-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Nov-21	28	160	29	354	0.19	0.43	159	28	382	0.42
Dec-21	61	347	119	648	0.13	0.92	347	111	637	0.92
Jan-22	27	153	51	267	0.19	0.41	154	49	306	0.41
Feb-22	23	123	75	172	0.21	0.33	124	54	209	0.33
Mar-22	8	43	11	74	0.35	0.11	42	17	80	0.11
Apr-22	20	112	56	191	0.22	0.30	112	47	202	0.30
May-22	21	120	63	182	0.22	0.32	120	51	194	0.32
Jun-22	84	485	242	756	0.11	1.29	485	208	854	1.29
Jul-22	287	1,643	876	2,444	0.06	4.38	1,642	807	2,513	4.37
Aug-22	40	229	126	372	0.16	0.61	229	119	384	0.61
Sep-22	15	87	52	139	0.26	0.23	87	24	168	0.23
Nov-22	119	686	421	980	0.09	1.83	686	424	998	1.83

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Dec-22	36	212	65	417	0.17	0.56	212	49	400	0.56
Jan-23	16	94	41	158	0.25	0.25	94	30	176	0.25
Feb-23	13	74	40	108	0.28	0.20	74	32	125	0.20
Mar-23	32	186	70	319	0.18	0.50	186	69	330	0.50
Apr-23	13	74	23	154	0.28	0.20	74	17	154	0.20
c)	**Caledonia North Survey Area**									
May-21	62	363	217	509	0.13	0.65	363	199	545	0.65
Jun-21	53	314	201	450	0.14	0.56	314	196	450	0.56
Jul-21	215	1,302	1,042	1,581	0.07	2.34	1,302	914	1,660	2.34
Aug-21	179	1,039	702	1,388	0.07	1.87	1,039	685	1,434	1.86
Sep-21	54	315	199	473	0.14	0.57	315	164	520	0.57
Oct-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Nov-21	45	263	45	596	0.15	0.47	263	48	613	0.47
Dec-21	87	507	239	897	0.11	0.91	507	216	868	0.91
Jan-22	37	214	116	313	0.16	0.38	214	104	365	0.38
Feb-22	37	204	116	303	0.16	0.37	204	94	325	0.37
Mar-22	22	119	59	194	0.21	0.21	119	52	199	0.21
Apr-22	24	138	69	224	0.20	0.25	138	66	231	0.25
May-22	30	174	76	297	0.18	0.31	174	64	320	0.31
Jun-22	130	751	387	1,133	0.09	1.35	751	341	1260	1.35
Jul-22	**405**	**2,370**	**1,598**	**3,260**	**0.05**	**4.25**	**2,370**	**1,551**	**3,289**	**4.25**
Aug-22	62	355	229	515	0.13	0.64	355	217	527	0.64
Sep-22	19	111	52	169	0.23	0.20	111	34	198	0.20
Nov-22	**167**	**985**	**655**	**1,333**	**0.08**	**1.77**	**990**	**621**	**1,384**	**1.78**
Dec-22	60	354	147	578	0.13	0.64	354	145	601	0.63
Jan-23	26	153	65	271	0.20	0.27	154	50	277	0.28
Feb-23	21	121	75	173	0.22	0.22	121	61	185	0.22
Mar-23	55	323	123	540	0.13	0.58	328	130	566	0.59
Apr-23	27	155	80	258	0.19	0.28	154	63	258	0.28

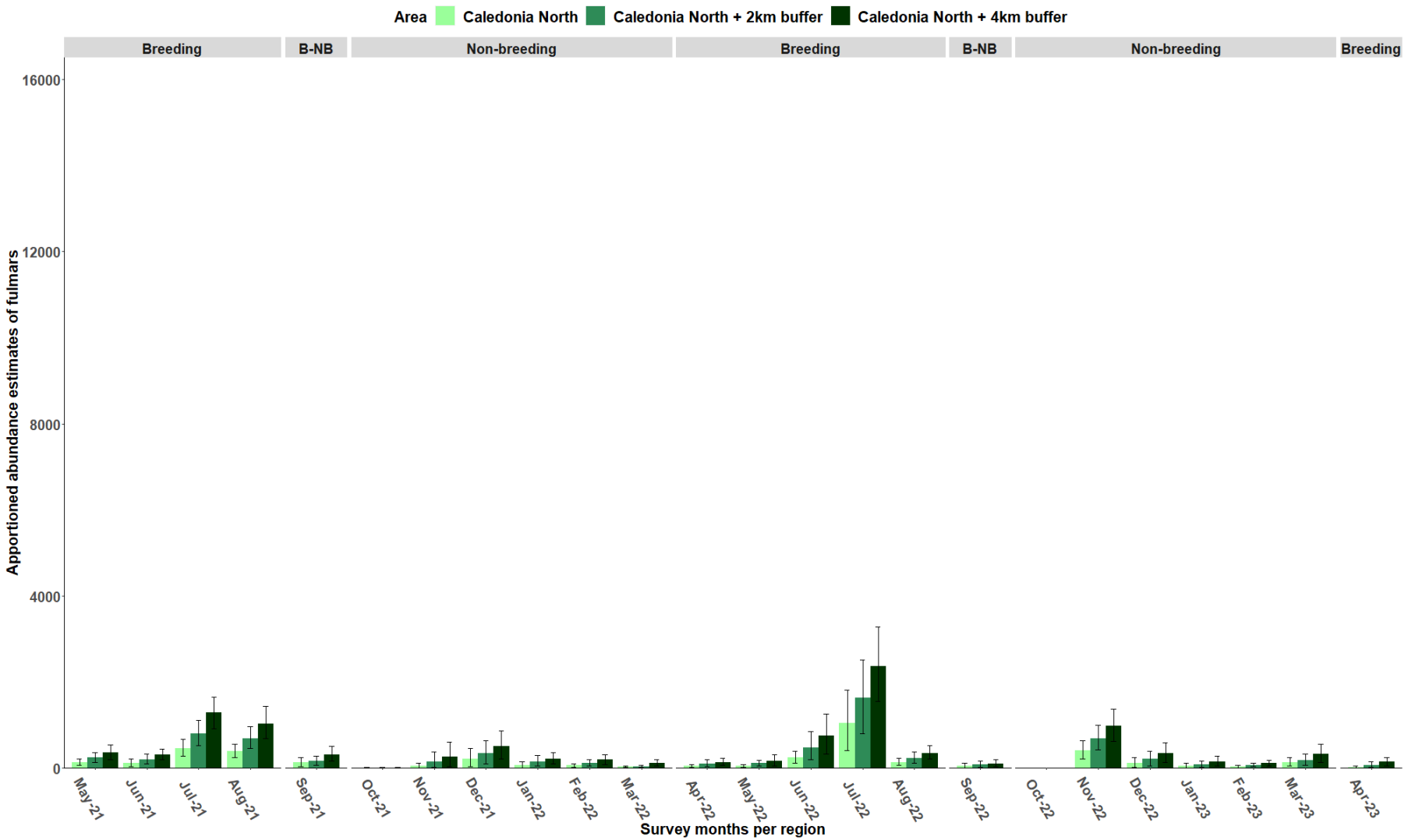


Figure 34 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total fulmars recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Fulmar seasonal periods are also displayed. B-NB corresponds to month split between breeding (B) and non-breeding (NB)

Caledonia South

A total of 3,511 fulmars were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Fulmar were recorded in all months (Table 10). Fulmars were the most abundant during the breeding season (April to mid-September). Peak of abundance was recorded in July 2022 (Table 91, Figure 35):

- 526 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 3,068 [1,342; 5,191] and an apportioned mean abundance estimate of 3,068 [1,219; 5,640] individuals. These equated to mean density estimates of 14.59 (unapportioned) and 14.58 (apportioned) birds/km^2.
- 888 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 5,138 [2,291; 8,615] and an apportioned abundance estimate of 5,138 [2,100; 8,713] individuals. These equated to mean density estimates of 14.29 (unapportioned) and 14.28 (apportioned) birds/km^2.
- 1,441 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 8,343 [3,300; 14,144] and an apportioned abundance estimate of 8,343 [2,976; 14,590] individuals. These equated to mean density estimates of 15.64 (unapportioned) and 15.63 (apportioned) birds/km^2.

During the breeding seasons covered by the baseline surveys, very obvious peaks in fulmar abundance were recorded in July 2021 and 2022, with relatively consistent, and considerably lower numbers, recorded in other breeding season surveys. The peak mean abundance of fulmar across Caledonia South Survey Area was around 30% to 50% (depending on the reporting region considered) greater than the next highest mean abundance recorded, in July 2021. Mean abundances in the ten other surveys during the breeding seasons covered were 86% to 99% lower than the peak mean abundance. The data indicate that whilst larger numbers of fulmar were present within the Caledonia South Survey Area at a specific time within both breeding seasons covered by the baseline surveys (i.e. July), they were present in much lower numbers during the remainder of the breeding seasons covered by the baseline surveys.

During the non-breeding season (mid-September to March), fulmars were only recorded in higher numbers in November, with a peak in November 2021 in Caledonia South and Caledonia South plus 2 km buffer and in November 2022 in Caledonia South Survey Area (Table 91, Figure 35):

- 112 individuals were recorded in Caledonia South in November 2021, resulting in an unapportioned mean abundance estimate of 645 [112; 1,722] and apportioned abundance estimate of 646 [112; 1,722] individuals. Both equated to a mean density estimate of 3.07 birds/km^2.
- 127 individuals were recorded in Caledonia South plus 2 km buffer in November 2021, resulting in an unapportioned mean abundance estimate of 727 [127; 1,826] and apportioned abundance estimate of 727 [163; 1,849] individuals. Both equated to a mean density estimate of 2.02 birds/km^2.
- 140 individuals were recorded in Caledonia South Survey Area in November 2022, resulting in an unapportioned mean abundance estimate of 819 [602; 988] and apportioned abundance estimate of 824 [576; 1,044] individuals. Both equated to a mean density estimate of 1.54 birds/km^2.

As with breeding season mean abundances, the data indicates that during a specific period within both non-breeding seasons covered by the surveys (i.e. November, which recorded similar abundances in both survey years), fulmar were present in larger numbers than the rest of the non-breeding season, though the peaks were modest. Fulmar were present in most non-breeding season surveys in low numbers.

Good measures of precisions were calculated for most survey months (CV ≤ 0.16), with eight of the 23 baseline surveys in which fulmar was recorded within Caledonia South reporting CV values of ≤ 0.16 (Table 91). The other surveys reported CV values of ≤ 0.50, with higher values (i.e. lower precision) occurring in surveys where fewer birds were recorded (Table 91). Corresponding values for Caledonia South plus buffer regions were generally lower (i.e. higher precision), which is anticipated to relate to the number of birds recorded (Table 91).

Table 91 **Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of fulmars in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of fulmar raw counts per season, with light yellow to orange (peak number) for the breeding season months (April to mid-September) and light blue to royal blue (peak number) for the wintering months (mid-September to March)**

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a)	Caledonia South									
May-21	18	105	52	157	0.24	0.50	105	47	181	0.50
Jun-21	19	111	64	157	0.23	0.53	111	47	175	0.53
Jul-21	388	2,275	388	5,953	0.05	10.82	2,276	431	5,971	10.81
Aug-21	69	398	312	473	0.12	1.89	398	293	520	1.89
Sep-21	26	151	87	209	0.20	0.72	150	63	232	0.71
Oct-21	2	12	2	29	0.71	0.06	12	2	29	0.06
Nov-21	112	645	112	1,722	0.09	3.07	646	112	1,722	3.07
Dec-21	46	267	174	342	0.15	1.27	267	182	348	1.27
Jan-22	13	75	40	116	0.28	0.36	75	26	138	0.36
Feb-22	24	130	54	222	0.20	0.62	130	43	232	0.62
Mar-22	2	11	2	32	0.71	0.05	10	2	32	0.05
Apr-22	39	225	39	495	0.16	1.07	225	39	513	1.07
May-22	10	58	17	110	0.32	0.28	57	13	133	0.27
Jun-22	52	301	156	486	0.14	1.43	301	145	498	1.43
Jul-22	526	3,068	1,342	5,191	0.04	14.59	3,068	1,219	5,640	14.58
Aug-22	19	109	69	150	0.23	0.52	110	59	167	0.52
Sep-22	7	41	12	76	0.38	0.19	41	7	87	0.19
Nov-22	57	334	293	381	0.13	1.59	339	272	425	1.61
Dec-22	19	112	47	189	0.23	0.53	112	49	188	0.53
Jan-23	5	29	12	41	0.45	0.14	29	7	59	0.14
Feb-23	9	51	17	91	0.33	0.24	51	17	91	0.24
Mar-23	25	145	81	214	0.20	0.69	151	59	272	0.72
Apr-23	8	46	11	80	0.35	0.22	46	10	108	0.22
b)	Caledonia South plus 2 km buffer									
May-21	36	208	150	260	0.17	0.58	208	115	312	0.58
Jun-21	40	232	151	313	0.16	0.65	232	139	336	0.64
Jul-21	535	3,113	593	7,639	0.04	8.66	3,112	675	7,634	8.65
Aug-21	124	711	562	837	0.09	1.98	711	551	866	1.98
Sep-21	43	249	173	324	0.15	0.69	249	150	353	0.69
Oct-21	6	35	6	70	0.41	0.10	35	6	81	0.10
Nov-21	127	727	127	1,826	0.09	2.02	727	163	1,849	2.02
Dec-21	77	444	340	553	0.11	1.24	444	323	576	1.23
Jan-22	23	132	69	195	0.21	0.37	132	52	218	0.37
Feb-22	39	208	117	320	0.16	0.58	208	101	332	0.58
Mar-22	6	32	6	63	0.41	0.09	31	6	64	0.09
Apr-22	48	275	74	520	0.14	0.77	274	73	572	0.76

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
May-22	27	155	63	287	0.19	0.43	155	49	304	0.43
Jun-22	77	437	250	664	0.11	1.22	437	244	681	1.21
Jul-22	888	5,138	2,291	8,615	0.03	14.29	5,138	2,100	8,713	14.28
Aug-22	40	229	166	309	0.16	0.64	228	97	394	0.63
Sep-22	26	149	74	246	0.20	0.41	148	66	257	0.41
Nov-22	104	606	530	670	0.10	1.69	611	495	730	1.70
Dec-22	32	185	121	277	0.18	0.51	185	108	271	0.51
Jan-23	12	69	40	98	0.29	0.19	68	31	115	0.19
Feb-23	13	74	29	120	0.28	0.21	74	30	131	0.21
Mar-23	42	242	132	334	0.15	0.67	247	132	376	0.69
Apr-23	12	67	34	101	0.29	0.19	68	12	129	0.19
c)	Caledonia South Survey Area									
May-21	46	267	186	342	0.15	0.50	267	150	388	0.50
Jun-21	75	436	314	593	0.12	0.82	436	262	634	0.82
Jul-21	673	4,042	1,051	8,804	0.04	7.58	4,042	973	8,900	7.57
Aug-21	178	1,024	765	1,237	0.07	1.92	1,024	759	1,259	1.92
Sep-21	96	557	412	714	0.10	1.04	557	331	790	1.04
Oct-21	11	64	12	128	0.30	0.12	64	13	139	0.12
Nov-21	136	782	161	1,880	0.09	1.47	782	169	1,909	1.47
Dec-21	125	723	521	920	0.09	1.36	723	497	925	1.35
Jan-22	31	179	92	265	0.18	0.34	179	81	294	0.34
Feb-22	56	304	190	440	0.13	0.57	304	163	462	0.57
Mar-22	10	54	27	91	0.32	0.10	54	18	97	0.10
Apr-22	56	321	109	590	0.13	0.60	321	105	596	0.60
May-22	31	178	86	310	0.18	0.33	178	63	327	0.33
Jun-22	109	631	405	886	0.10	1.18	632	383	898	1.18
Jul-22	1,441	8,343	3,300	14,144	0.03	15.64	8,343	2,976	14,590	15.63
Aug-22	76	436	310	585	0.11	0.82	436	235	677	0.82
Sep-22	38	222	117	344	0.16	0.42	222	105	362	0.42
Oct-22	4	23	4	59	0.50	0.04	24	4	70	0.04
Nov-22	140	819	602	988	0.08	1.54	824	576	1,044	1.54
Dec-22	52	306	194	460	0.14	0.57	306	183	460	0.57
Jan-23	36	211	135	304	0.17	0.40	211	111	310	0.40
Feb-23	22	127	69	196	0.21	0.24	127	58	214	0.24
Mar-23	54	315	181	455	0.14	0.59	320	165	491	0.60
Apr-23	15	86	40	137	0.26	0.16	86	18	166	0.16

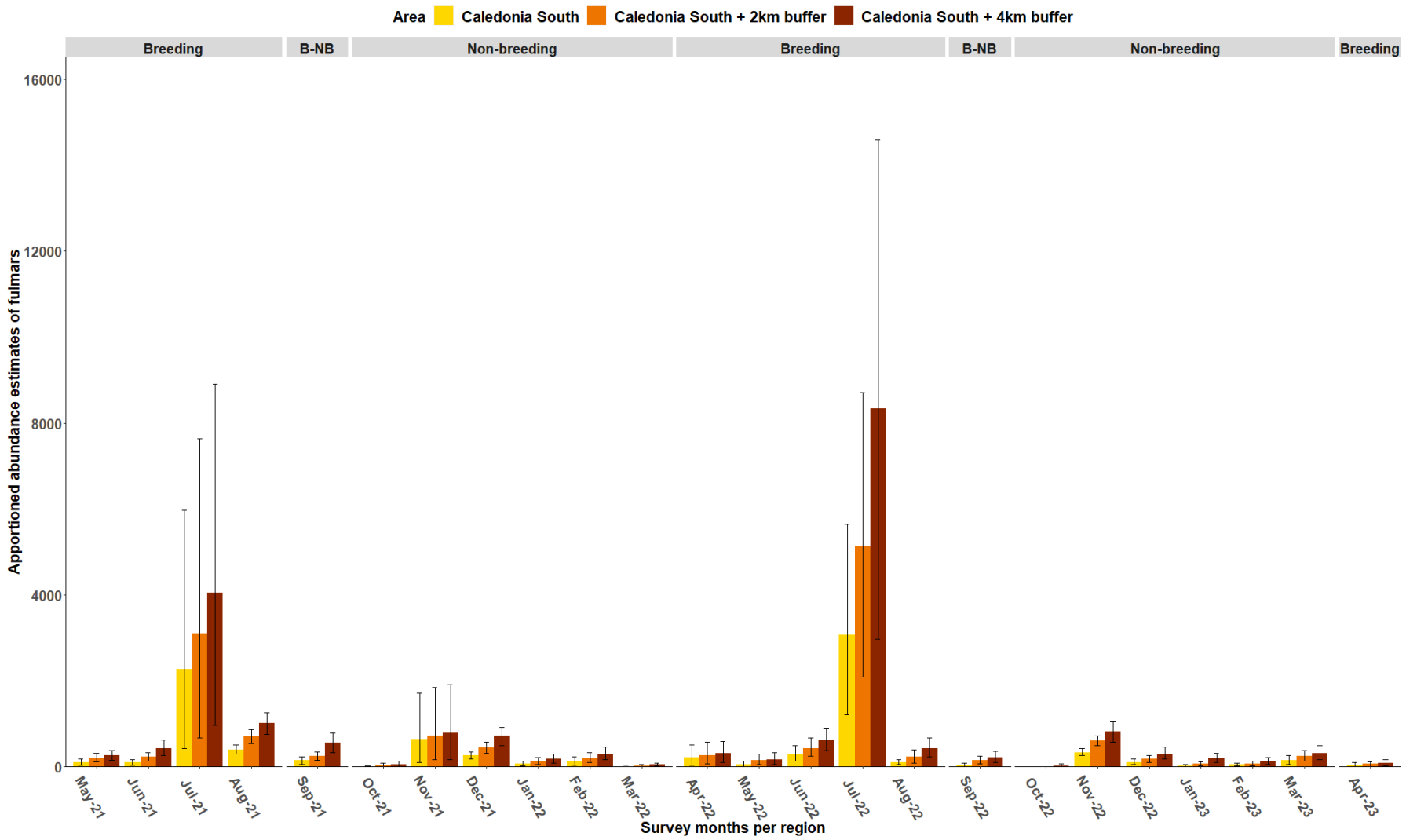


Figure 35 Bar plot of monthly apportioned abundance estimates (with 95% confidence intervals) of the total fulmars recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Fulmar seasonal periods are also displayed. B-NB corresponds to month split between breeding (B) and non-breeding (NB)

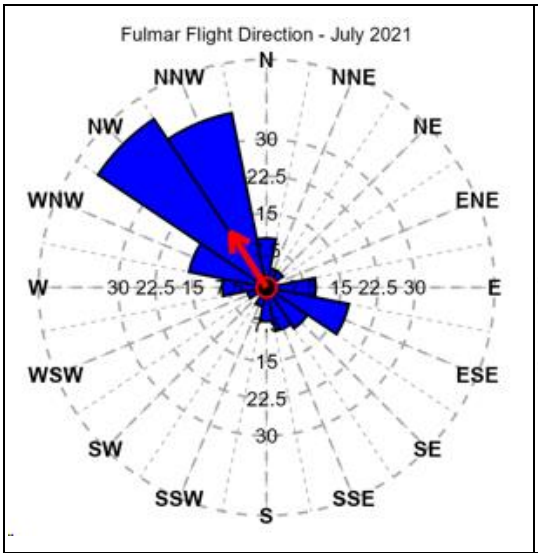
ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.220-243. Overall, fulmars displayed no discernible distribution pattern. However, they were predominantly recorded in the southeast of the Survey Area in October 2021 (Figure A4.225) and displayed hotspots in the north and the southeast of the Survey Area in November 2021 (Figure A4.226). Only two individuals were recorded in October 2022, both in the southeast of Caledonia South Buffer Zone towards its outer boundary (Figure A4.237).

Significant predominant direction of flight was recorded in:

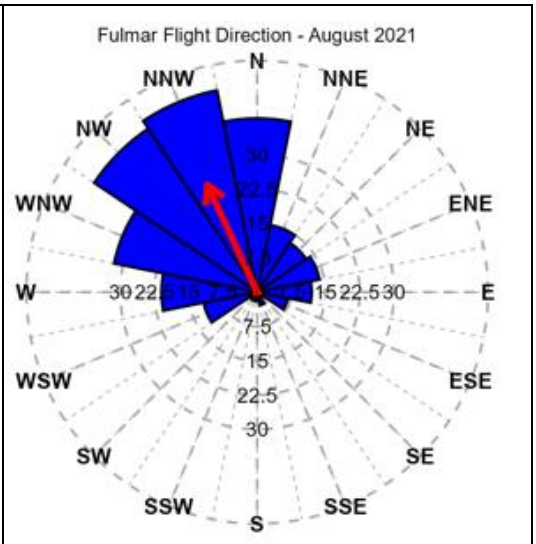
- **June**
  - 2022 north-northeast (Figure 36h)
- **July**
  - 2021 northwest (Figure 36a)
  - 2022 south-southeast (Figure 36i)
- **August**
  - 2021 north-northwest (Figure 36b)
  - 2022 south (Figure 36j)
- **November**
  - 2022 southeast (Figure 36k)
- **December**
  - 2021 south (Figure 36c)
  - 2022 south (Figure 36l)
- **January**
  - 2022 west-southwest (Figure 36d)
  - 2023 south-southeast (Figure 36m)
- **February**
  - 2022 southeast (Figure 36e)
  - 2023 east (Figure 36n)
- **March**
  - 2022 east-northeast (Figure 36f)
  - 2023 north-northeast (Figure 36o)
- **April**
  - 2022 northeast (Figure 36g)
  - 2023 east-southeast (Figure 36p)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.23).



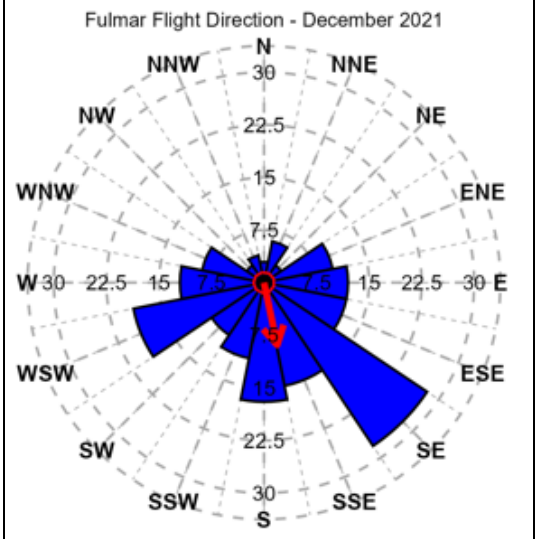
Number of Observations	185
Mean Vector (μ)	327.768
Length of Mean Vector (r)	0.319
Rayleigh Test (Z)	18.823
Rayleigh Test (p)	<0.001

a July 2021



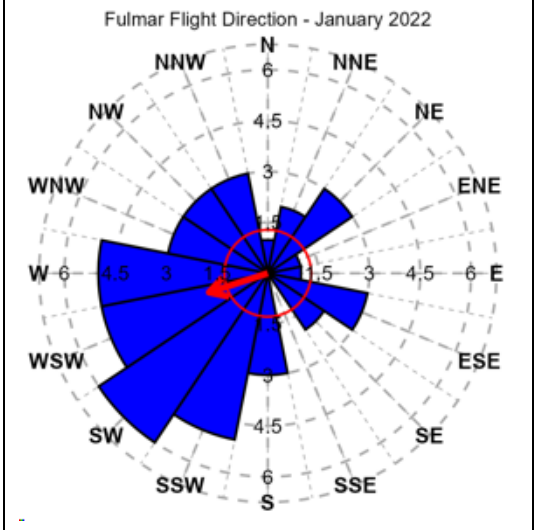
Number of Observations	262
Mean Vector (μ)	335.478
Length of Mean Vector (r)	0.574
Rayleigh Test (Z)	86.434
Rayleigh Test (p)	<0.001

b August 2021



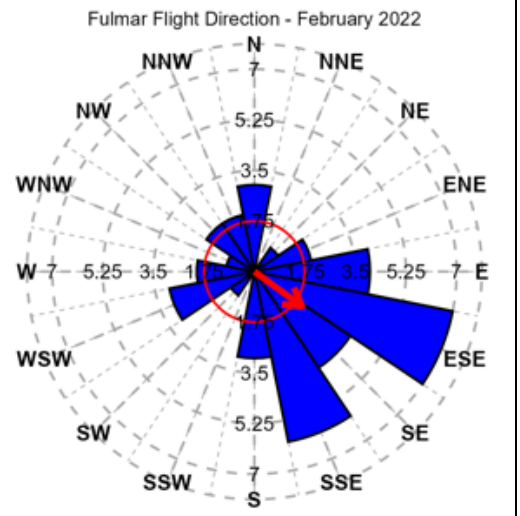
Number of Observations	173
Mean Vector (μ)	168.743
Length of Mean Vector (r)	0.324
Rayleigh Test (Z)	18.139
Rayleigh Test (p)	<0.001

c December 2021



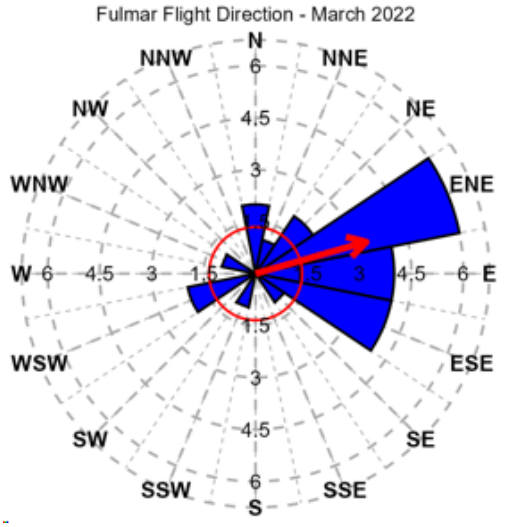
Number of Observations	46
Mean Vector (μ)	252.731
Length of Mean Vector (r)	0.303
Rayleigh Test (Z)	4.224
Rayleigh Test (p)	0.014

d January 2022



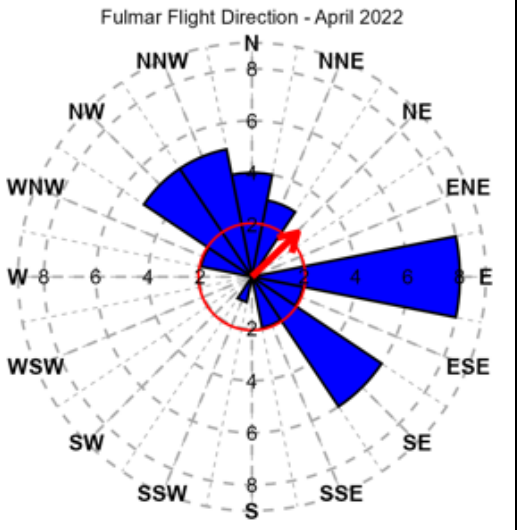
Number of Observations	41
Mean Vector (μ)	126.390
Length of Mean Vector (r)	0.291
Rayleigh Test (Z)	3.480
Rayleigh Test (p)	0.030

e February 2022



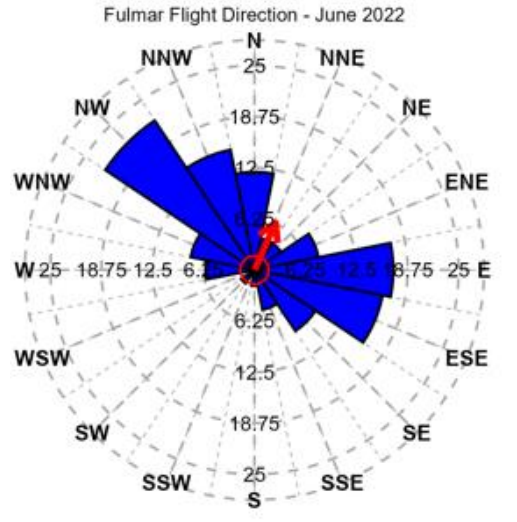
Number of Observations	24
Mean Vector (μ)	74.892
Length of Mean Vector (r)	0.554
Rayleigh Test (Z)	7.353
Rayleigh Test (p)	<0.001

f March 2022



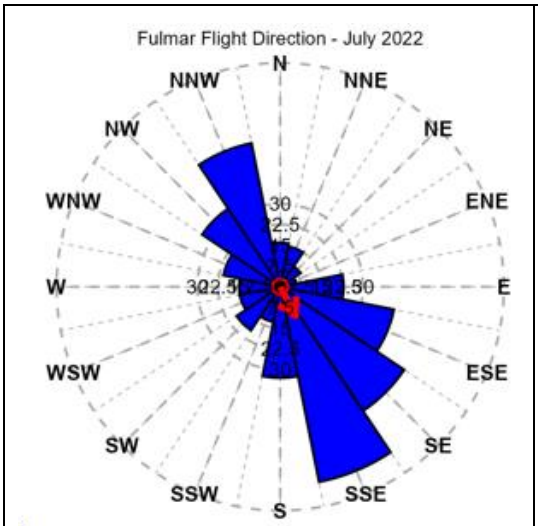
Number of Observations	38
Mean Vector (μ)	46.196
Length of Mean Vector (r)	0.305
Rayleigh Test (Z)	3.530
Rayleigh Test (p)	0.028

g April 2022



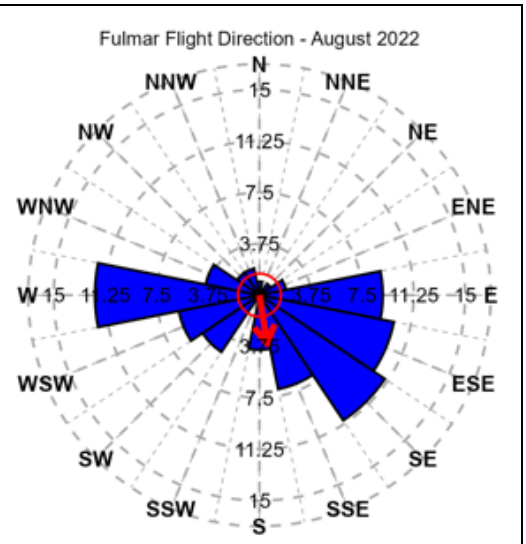
Number of Observations	130
Mean Vector (μ)	24.238
Length of Mean Vector (r)	0.287
Rayleigh Test (Z)	10.740
Rayleigh Test (p)	<0.001

h June 2022



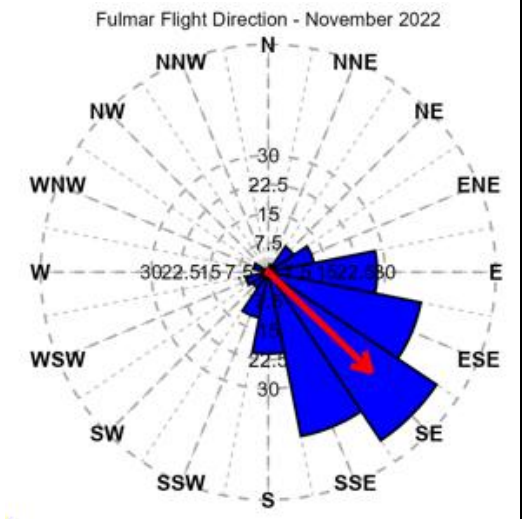
Number of Observations	440
Mean Vector (μ)	152.648
Length of Mean Vector (r)	0.165
Rayleigh Test (Z)	11.968
Rayleigh Test (p)	<0.001

i July 2022



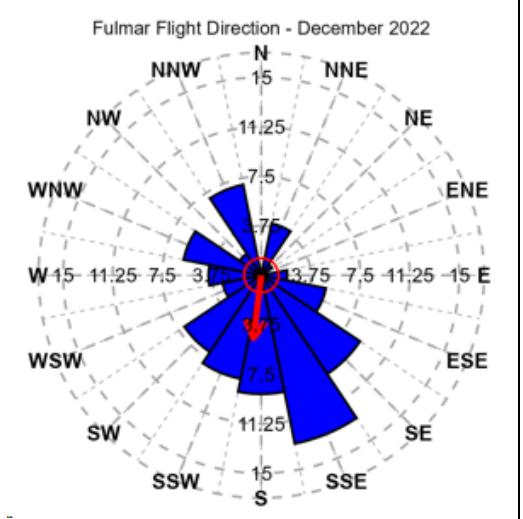
Number of Observations	76
Mean Vector (μ)	171.359
Length of Mean Vector (r)	0.298
Rayleigh Test (Z)	6.765
Rayleigh Test (p)	0.001

j August 2022



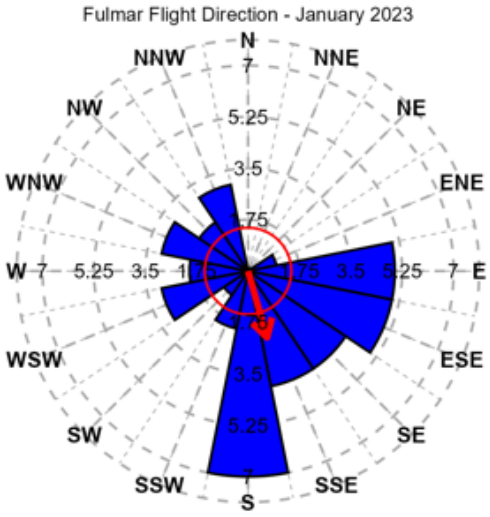
Number of Observations	234
Mean Vector (μ)	134.555
Length of Mean Vector (r)	0.702
Rayleigh Test (Z)	115.160
Rayleigh Test (p)	<0.001

k November 2022



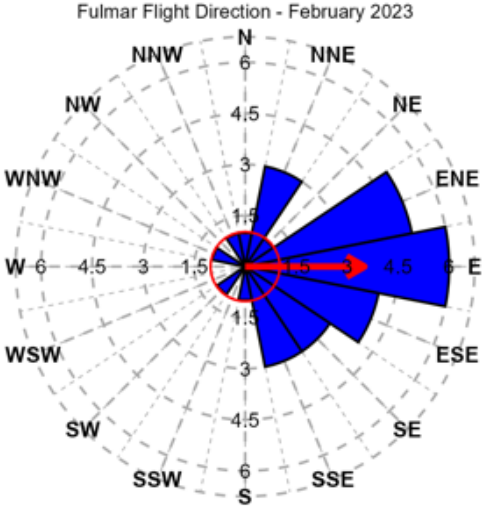
Number of Observations	80
Mean Vector (μ)	187.842
Length of Mean Vector (r)	0.368
Rayleigh Test (Z)	10.814
Rayleigh Test (p)	<0.001

l December 2022



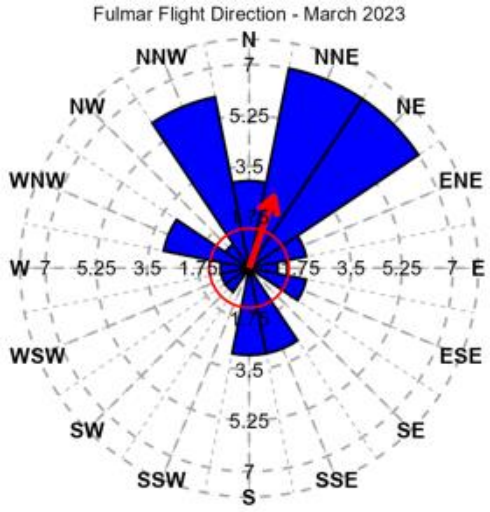
Number of Observations	42
Mean Vector (μ)	164.798
Length of Mean Vector (r)	0.336
Rayleigh Test (Z)	4.752
Rayleigh Test (p)	0.008

m January 2023



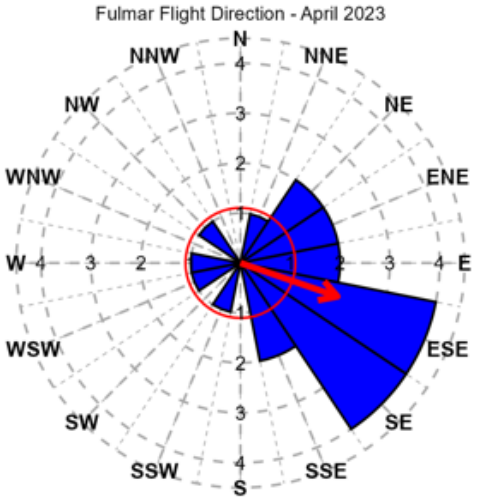
Number of Observations	30
Mean Vector (μ)	90.965
Length of Mean Vector (r)	0.584
Rayleigh Test (Z)	10.239
Rayleigh Test (p)	<0.001

n February 2023



Number of Observations	41
Mean Vector (μ)	19.539
Length of Mean Vector (r)	0.372
Rayleigh Test (Z)	5.674
Rayleigh Test (p)	0.003

o March 2023



Number of Observations	21
Mean Vector (μ)	109.590
Length of Mean Vector (r)	0.515
Rayleigh Test (Z)	5.560
Rayleigh Test (p)	0.003

p April 2023

Figure 36 Summary of flight direction of fulmars within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.27 Unidentified fulmar and / or gull species

i. Abundance and density estimates

Three unidentified fulmar and / or gulls were recorded in the Survey Area during the second year of the baseline surveys, two in November 2022 and a single individual in March 2023 (Table 8, Table 92). Two were recorded in Caledonia North Survey Area, a single individual in each month of November 2022 and March 2023 (Table 93). Two individuals were also recorded in Caledonia South, a single individual recorded in each month of November 2022 and March 2023 (Table 94). Abundance and density estimates were therefore low in all reporting regions (Table 92 to Table 94).

Table 92 Raw counts, unapportioned abundance and density estimates (birds per km²) of fulmar and / or gull species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia OWF						
Nov-22	1	6	1	18	1.00	0.01
Mar-23	1	6	1	18	1.00	0.01
b) Caledonia OWF plus 2 km buffer						
Nov-22	1	6	1	17	1.00	0.01
Mar-23	1	6	1	17	1.00	0.01
c) Survey Area						
Nov-22	2	12	2	29	0.71	0.01
Mar-23	1	6	1	18	1.00	0.01

Table 93 Raw counts, unapportioned abundance and density estimates (birds per km²) of fulmar and / or gull species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
None recorded						
b) Caledonia North plus 2 km buffer						
None recorded						
c) Caledonia North Survey Area						
Nov-22	1	6	1	18	1.00	0.01
Mar-23	1	6	1	18	1.00	0.01

Table 94 Raw counts, unapportioned abundance and density estimates (birds per km²) of fulmar and / or gull species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
Nov-23	1	6	1	18	1.00	0.03
Mar-23	1	6	1	17	1.00	0.03
b) Caledonia South plus 2 km buffer						
Nov-22	1	6	1	17	1.00	0.02
Mar-23	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
Nov-22	1	6	1	18	1.00	0.01
Mar-23	1	6	1	17	1.00	0.01

ii. Distribution and behaviour

Fulmar and / or gulls were sporadically recorded (Appendix 4, Figure A4.244-245). In November 2022, one individual was recorded in the north of Caledonia North Buffer Zone while the other was recorded in the centre of Caledonia South (Figure A4.244). In March 2023, the individual was recorded in the western parts of Caledonia South towards the western boundary with its Buffer Zone (Figure A4.245).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.24).

4.28 Sooty shearwater

i. Abundance and density estimates

A single sooty shearwater was recorded in Caledonia OWF in September, specifically in Caledonia South, which resulted in very low abundance and density estimates (Table 8, Table 95 to Table 97).

Measures of precisions were high, which is likely related to the low numbers of individuals recorded in each region (Table 95 to Table 97). The low precision is reflected in the wide 95% confidence intervals for this species.

Table 95 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of sooty shearwaters in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Sep-21	1	6	1	17	1.00	0.01	6	1	17	0.01
b) Caledonia OWF plus 2 km buffer										
Sep-21	1	6	1	17	1.00	0.01	6	1	17	0.01
c) Survey Area										
Sep-21	1	6	1	18	1.00	0.01	6	1	18	0.01

Table 96 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of sooty shearwaters in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
None recorded										
b) Caledonia North plus 2 km buffer										
None recorded										
c) Caledonia North Survey Area										
None recorded										

Table 97 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of sooty shearwaters in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Sep-21	1	6	1	17	1.00	0.03	6	1	17	0.03

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
b) Caledonia South plus 2 km buffer										
Sep-21	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia South Survey Area										
Sep-21	1	6	1	17	1.00	0.01	6	1	17	0.01

ii. Distribution and behaviour

As only a single sooty shearwater was recorded in Caledonia South in September 2021 (Appendix 4, Figure A4.246).

As only one bird was recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.25).

4.29 Manx shearwater

i. Abundance and density estimates

A total of 28 Manx shearwaters were recorded in the Survey Area during both years of baseline surveys (Table 8). Manx shearwaters were recorded in May to July 2021, and May 2022 (Table 8, Table 98). In the Survey Area, a peak of 15 Manx shearwaters were recorded in June 2021, which resulted in an unapportioned mean abundance estimate of 88 [15; 235] and an apportioned mean abundance estimate of 89 [15; 239] individuals (Table 98). Both equated to a mean density estimate of 0.10 birds/km² (Table 98).

Manx shearwaters were only recorded during the breeding season (April to mid-October).

CV values were high, indicating low precision in the mean abundance estimates (Table 98). This is likely related to the low numbers of individuals recorded in each region (Table 98). This is reflected in the wide 95% confidence intervals recorded for this species (Table 98).

Table 98 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km²) of Manx shearwaters in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia OWF										
Jun-21	2	12	2	29	0.71	0.03	12	2	30	0.03
Jul-21	2	12	2	29	0.71	0.03	12	2	29	0.03
May-22	8	46	8	116	0.35	0.11	47	8	133	0.11
b) Caledonia OWF plus 2 km buffer										
Jun-21	9	52	9	122	0.33	0.08	54	9	149	0.08
Jul-21	3	17	6	35	0.58	0.03	17	6	35	0.03
May-22	8	46	8	120	0.35	0.07	45	8	132	0.07
c) Survey Area										
May-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jun-21	15	88	15	235	0.26	0.10	89	15	239	0.10
Jul-21	3	18	6	36	0.58	0.02	18	3	36	0.02
May-22	9	52	9	134	0.33	0.06	52	9	140	0.06

In Caledonia North Survey Area, numbers recorded were low, therefore abundance and density estimates were low (Table 99). In Caledonia South Survey Area, a peak of 15 Manx shearwaters was recorded in June 2021 (Table 99). This resulted in an unapportioned mean abundance estimate of 87 [15; 232] and an apportioned mean abundance estimate of 88 [15; 242] individuals (Table 100). Both equated to a mean density estimate of 0.16 birds/km^2 (Table 100).

CV values were high, indicating low precision in the mean abundance estimates (Table 99, Table 100). This is likely related to the low numbers of individuals recorded in each region (Table 99, Table 100). This is reflected in the wide 95% confidence intervals recorded for this species (Table 99, Table 100).

Table 99 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of Manx shearwaters in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
Jul-21	1	6	1	18	1.00	0.03	6	1	18	0.03
May-22	2	12	2	23	0.71	0.05	12	2	23	0.05
b) Caledonia North plus 2 km buffer										
Jul-21	1	6	1	17	1.00	0.02	6	1	17	0.02
May-22	2	11	2	28	0.71	0.03	11	2	28	0.03
c) Caledonia North Survey Area										
Jun-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Jul-21	1	6	1	18	1.00	0.01	6	1	18	0.01
May-22	3	17	6	35	0.58	0.03	17	3	35	0.03

Table 100 Raw counts, unapportioned and apportioned abundance and density estimates (birds per km^2) of Manx shearwaters in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

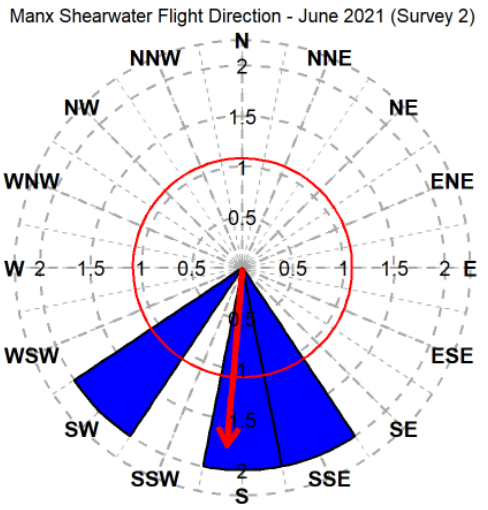
Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Jun-21	2	12	2	29	0.71	0.06	12	2	29	0.06
Jul-21	1	6	1	18	1.00	0.03	6	1	18	0.03
May-22	6	35	6	104	0.41	0.17	35	6	104	0.17
Aug-22	-	-	-	-	-	-	6	1	17	0.03
b) Caledonia South plus 2 km buffer										
Jun-21	9	52	9	122	0.33	0.14	54	10	149	0.15
Jul-21	2	12	2	29	0.71	0.03	12	2	29	0.03
May-22	6	34	6	103	0.41	0.09	34	6	103	0.09
Aug-22	-	-	-	-	-	-	6	6	17	0.02
c) Caledonia South Survey Area										
May-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-21	15	87	15	232	0.26	0.16	88	15	242	0.16
Jul-21	2	12	2	30	0.71	0.02	12	2	30	0.02
May-22	8	46	8	115	0.35	0.09	45	8	132	0.08
Aug-22	-	-	-	-	-	-	6	1	17	0.01

ii. Distribution and behaviour

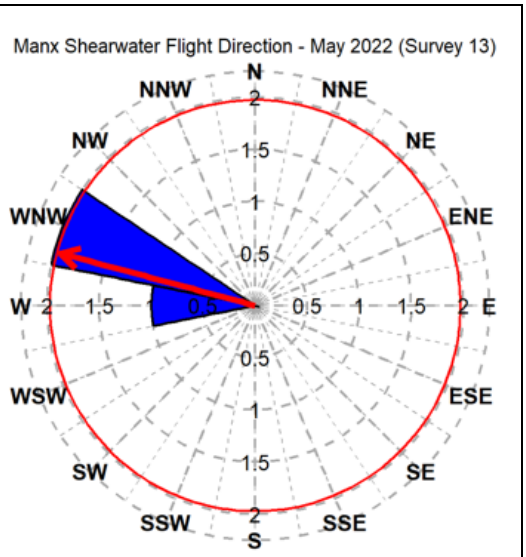
Maps of distribution are shown in Appendix 4: Figure A4.247-250. A single Manx shearwater was recorded at the southern tip of Caledonia South Buffer Zone in May 2021 (Figure A4.247). Similarly, they also largely occurred in the south of the Survey Area in June (Figure A4.248). In July 2021 and May 2022, however, they were more loosely scattered across the Survey Area (Figure A4.249-250).

All Manx shearwaters recorded in flight, were flying with significant predominant direction of flight in:

- **June**
  - 2021 south (Figure 37a)
- **May**
  - 2022 west-northwest (Figure 37b)



Number of Observations	6
Mean Vector (μ)	185.650
Length of Mean Vector (r)	0.881
Rayleigh Test (Z)	4.658
Rayleigh Test (p)	0.004
a June 2021	



Number of Observations	3
Mean Vector (μ)	285.782
Length of Mean Vector (r)	0.966
Rayleigh Test (Z)	2.802
Rayleigh Test (p)	0.046
b May 2022	

Figure 37 Summary of flight direction of Manx shearwaters within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.30 Unidentified small shearwater species

i. Abundance and density estimates

Two small shearwaters were recorded in the Survey Area, specifically in Caledonia South Survey Area, during the second year of the baseline surveys (Table 8 to Table 10). A single individual was recorded in each of August and September 2022. Abundance and density estimates were therefore very low (Table 101 and Table 103). No records of small shearwater species were made across Caledonia North Survey Area (Table 102). Small shearwater species have been used for apportioning to species level where possible.

Table 101 Raw counts, unapportioned abundance and density estimates (birds per km^2) of small shearwater species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
Aug-22	1	6	1	17	1.00	0.01
b) Caledonia OWF plus 2 km buffer						
Aug-22	1	6	1	17	1.00	0.01
Sep-22	1	6	1	17	1.00	0.01
c) Survey Area						
Aug-22	1	6	1	17	1.00	0.01
Sep-22	1	6	1	18	1.00	0.01

Table 102 Raw counts, unapportioned abundance and density estimates (birds per km^2) of small shearwater species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
None recorded						
b) Caledonia North plus 2 km buffer						
None recorded						
c) Caledonia North Survey Area						
None recorded						

Table 103 Raw counts, unapportioned abundance and density estimates (birds per km^2) of small shearwater species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
Aug-22	1	6	1	17	1.00	0.03
b) Caledonia South plus 2 km buffer						
Aug-22	1	6	1	17	1.00	0.02
Sep-22	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
Aug-22	1	6	1	17	1.00	0.01
Sep-22	1	6	1	18	1.00	0.01

ii. Distribution and behaviour

Both small shearwater species were recorded in Caledonia South, with the individual recorded in August 2022 located in the west, near the boundary with the Buffer Zone (Appendix 4, Figure A4.251). In September 2022, the individual was recorded in the southwest of Caledonia South 4 km buffer (Appendix 4, Figure A4.252).

As only one bird was recorded in flight each survey, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.26).

4.31 Unidentified shearwater species

i. Abundance and density estimates

A single shearwater species was recorded in the Survey Area, specifically in Caledonia South Survey Area, during the second year of the baseline surveys (Table 8 to Table 10). The single individual was recorded in September 2022, and therefore, the abundance and density estimates were very low (Table 104, Table 106). No records of shearwater species were made across Caledonia North Survey Area (Table 105). Shearwater species have been used for apportioning to species level where possible.

Table 104 Raw counts, unapportioned abundance and density estimates (birds per km²) of shearwater species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia OWF						
None recorded						
b) Caledonia OWF plus 2 km buffer						
Sep-22	1	6	1	17	1.00	0.01
c) Survey Area						
Sep-22	1	6	1	18	1.00	0.01

Table 105 Raw counts, unapportioned abundance and density estimates (birds per km²) of shearwater species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
None recorded						
b) Caledonia North plus 2 km buffer						
None recorded						
c) Caledonia North Survey Area						
None recorded						

Table 106 Raw counts, unapportioned abundance and density estimates (birds per km²) of shearwater species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
None recorded						
b) Caledonia South plus 2 km buffer						
Sep-22	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
Sep-22	1	6	1	18	1.00	0.01

ii. Distribution and behaviour

A single shearwater species was recorded in September 2022 at the southern tip of Caledonia South Buffer Zone (Appendix 4, Figure A4.253).

4.32 Unidentified auk and / or shearwater species

i. Abundance and density estimates

A total of 133 unidentified auk and / or shearwaters were recorded in the Survey Area during both years of baseline surveys (Table 8). Auk and / or shearwaters were only recorded in months of April to July and September (Table 8). Peak numbers were recorded in September 2022 across the Survey Area, with 74 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 432 [74; 1,290] individuals, which equated to a mean density estimate of 0.49 birds/km^2 (Table 107). Auk and / or shearwaters have been used for apportioning to species level where possible.

Table 107 Raw counts, unapportioned abundance and density estimates (birds per km^2) of auk and / or shearwater species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
May-21	2	12	2	35	0.71	0.03
Jun-21	3	18	3	41	0.58	0.04
Jul-21	7	41	7	88	0.38	0.1
Apr-22	1	6	1	17	1.00	0.01
May-22	6	35	12	64	0.41	0.08
Jun-22	2	11	2	29	0.71	0.03
Sep-22	1	6	1	17	1.00	0.01
Mar-23	2	12	2	35	0.71	0.03
Apr-23	1	6	1	17	1.00	0.01
b) Caledonia OWF plus 2 km buffer						
May-21	5	29	5	69	0.45	0.05
Jun-21	14	81	14	174	0.27	0.13
Jul-21	12	70	12	151	0.29	0.11
Apr-22	1	6	1	17	1.00	0.01
May-22	9	51	23	92	0.33	0.08
Jun-22	4	23	4	52	0.50	0.04
Aug-22	1	6	1	17	1.00	0.01
Sep-22	74	427	74	1,275	0.12	0.66
Mar-23	3	17	3	46	0.58	0.03
Apr-23	1	6	1	17	1.00	0.01
c) Survey Area						
May-21	10	58	18	111	0.32	0.07
Jun-21	14	82	14	171	0.27	0.09
Jul-21	13	78	18	169	0.28	0.09
Apr-22	2	12	2	29	0.71	0.01
May-22	9	52	23	93	0.33	0.06
Jun-22	5	29	6	58	0.45	0.03
Aug-22	1	6	1	17	1.00	0.01
Sep-22	74	432	74	1,290	0.12	0.49
Mar-23	4	23	4	53	0.50	0.03
Apr-23	1	6	1	17	1.00	0.01

In Caledonia North Survey Area, peak numbers of auk and / or shearwaters were recorded in July 2021, with seven individuals recorded (Table 108). This resulted in an unapportioned mean abundance estimate of 42 [12; 73] individuals, which equated to a mean density estimate of 0.08 birds/km^2 (Table 108).

Table 108 Raw counts, unapportioned abundance and density estimates (birds per km^2) of auk and / or shearwater species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
Jun-21	1	6	1	18	1.00	0.03
Jul-21	3	18	6	36	0.58	0.08
Apr-22	1	6	1	17	1.00	0.03
May-22	4	23	4	46	0.50	0.11
Jun-22	1	6	1	17	1.00	0.03
Sep-22	1	6	1	17	1.00	0.03
Mar-23	2	12	2	35	0.71	0.05
b) Caledonia North plus 2 km buffer						
May-21	1	6	1	17	1.00	0.02
Jun-21	1	6	1	17	1.00	0.02
Jul-21	4	23	4	46	0.50	0.06
Apr-22	1	6	1	17	1.00	0.02
May-22	6	34	6	74	0.41	0.09
Jun-22	3	17	3	40	0.58	0.05
Aug-22	1	6	1	17	1.00	0.02
Sep-22	1	6	1	17	1.00	0.02
Mar-23	2	12	2	35	0.71	0.03
c) Caledonia North Survey Area						
May-21	6	35	12	64	0.41	0.06
Jun-21	1	6	1	18	1.00	0.01
Jul-21	7	42	12	73	0.38	0.08
Apr-22	2	12	2	29	0.71	0.02
May-22	6	35	6	76	0.41	0.06
Jun-22	4	23	4	46	0.50	0.04
Aug-22	1	6	1	17	1.00	0.01
Sep-22	1	6	1	17	1.00	0.01
Mar-23	2	12	2	35	0.71	0.02

In Caledonia South Survey Area, peak numbers of auk and / or shearwaters were recorded in September 2022, with 73 individuals recorded (Table 109). This resulted in a mean abundance estimate of 426 [73; 1,278] individuals, which equated to a mean density estimate of 0.80 birds/km^2 (Table 109).

Table 109 Raw counts, unapportioned abundance and density estimates (birds per km^2) of auk and / or shearwater species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
May-21	2	12	2	35	0.71	0.06
Jun-21	2	12	2	35	0.71	0.06
Jul-21	4	23	4	65	0.50	0.11
May-22	2	12	2	23	0.71	0.06
Jun-22	1	6	1	17	1.00	0.03
Apr-23	1	6	1	17	1.00	0.03
b) Caledonia South plus 2 km buffer						
May-21	4	23	4	64	0.50	0.06
Jun-21	13	75	13	168	0.28	0.21

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
Jul-21	9	52	9	128	0.33	0.14
May-22	3	17	3	34	0.58	0.05
Jun-22	3	17	3	40	0.58	0.05
Sep-22	73	417	73	1,251	0.12	1.16
Mar-23	1	6	1	17	1.00	0.02
Apr-23	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
May-21	5	29	5	87	0.45	0.05
Jun-21	14	81	14	174	0.27	0.15
Jul-21	10	60	12	132	0.32	0.11
May-22	3	17	3	34	0.58	0.03
Jun-22	4	23	4	46	0.50	0.04
Sep-22	73	426	73	1,278	0.12	0.80
Mar-23	2	12	2	29	0.71	0.02
Apr-23	1	6	1	17	1.00	0.01

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figure A4.254-263. Auk and / or shearwaters were recorded in the north and east to south of the Survey Area during May 2021, September 2022, and March 2023 (Figure A4.254, 261-262). In June 2021, they were recorded in the centre and south of the Survey Area (Figure A4.255) whereas they were more loosely distributed during July 2021, and May to June 2022 (Figure A4.256, 258-259). In April and August 2022, individuals were recorded in the northwest of the Survey Area (Figure A4.257, 260). A single individual was recorded in the northwest of Caledonia North Buffer Zone in August 2022 (Figure A4.135) while it was recorded in the east of Caledonia South in April 2023 (Figure A4.263).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.27).

4.33 Gannet

i. Abundance and density estimates

Caledonia OWF

A total of 1,093 gannets were recorded in the Survey Area during both years of baseline surveys (Table 8). Gannets were recorded throughout the year, being recorded in Caledonia OWF in 23 of 24 baseline surveys, and Caledonia OWF plus buffers in every survey (Table 110, Figure 38). Gannets were the most abundant during the breeding season (mid-March to September). Peak of abundance was recorded in June 2022 (Table 110, Figure 38):

- 173 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 994 [224; 1,977] individuals, which equated to a mean density estimate of 2.33 birds/km^2.
- 225 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,289 [487; 2,212] individuals, which equated to a mean density estimate of 2.00 birds/km^2.
- 258 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 1,493 [666; 2,448] individuals, which equated to a mean density estimate of 1.69 birds/km^2.

The two breeding seasons covered by the baseline survey period displayed some similarities in temporal variation in mean unapportioned gannet abundance within the Survey Area. Abundances were relatively low in the early breeding season months (April and May), with peak mean unapportioned gannet abundance occurring in June for both breeding seasons. A key difference between the 2021 and 2022 breeding seasons was the size of the June mean unapportioned abundance peak, which was considerably larger in 2022 than 2021. The following two months (July and August) recorded lower mean unapportioned gannet abundances in both 2021 and 2022, though higher than the early breeding season. In 2021, the August mean unapportioned gannet abundances were higher than July, and vice versa in 2022. Both September 2021 and September 2022 saw increases in mean unapportioned gannet abundance compared with previous months. The timing of this increased mean unapportioned abundance peak, and its continuation into the early part of the non-breeding season, suggests that the Survey Area may be a location used by post-breeding aggregations of this species, before birds leave the wider area for the non-breeding season.

The peak abundance of gannets during the breeding season (June 2022) was considerably higher than other months, with over twice the number of birds recorded in Caledonia OWF reporting regions when compared with the next most abundant month. Reductions in mean unapportioned abundance relative to the peak were between 55% to >99.5%.

During the non-breeding season (October to mid-February), gannets were particularly abundant in October 2021, which is when the peak was recorded (Table 110, Figure 38):

- 66 individuals were recorded in Caledonia OWF, resulting in an unapportioned mean abundance estimate of 386 [252; 527] individuals, which equated to a mean density estimate of 0.90 birds/km^2.
- 91 individuals were recorded in Caledonia OWF plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 525 [375; 692] individuals, which equated to a mean density estimate of 0.82 birds/km^2.
- 125 individuals were recorded in the Survey Area, resulting in an unapportioned mean abundance estimate of 732 [486; 977] individuals, which equated to a mean density estimate of 0.83 birds/km^2.

In both non-breeding seasons covered by the baseline survey period, the only month where substantial numbers of gannets were recorded in the Survey Area was October. It is considered a reasonable assumption, based on the timing of this peak, and its relative size compared with unapportioned mean abundances in other non-breeding season surveys, that these peak mean unapportioned abundances represent post-breeding aggregations of birds (likely from multiple breeding colonies across the region). Low abundances of birds were recorded in all reporting regions for the remainder of the non-breeding season surveys. It is noteworthy that the October 2021 peak was considerably larger than the October 2022 peak.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 62% to 99%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This reflects the fact that the October 2021 peak (which was the overall peak mean unapportioned abundance for gannet in the non-breeding season across the baseline survey period) was very large relative to the other mean unapportioned abundances recorded for gannet during the non-breeding season in the Survey Area and reporting regions. Relatively good measures of precisions (CV ≤ 0.16) were calculated for survey month where raw counts of individuals where higher, and measures of precisions were high when raw counts of individual were low (CV > 0.16; Table 110).

This means that CV values were lowest during the middle part of the breeding season, and the late breeding season and autumn dispersal periods (Table 110). CV values were > 0.16 for the most part, with only five, seven and eight surveys of Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area respectively having CV values of ≤ 0.16 (Table 110). This indicates lower precision for the abundance and densities calculated for this species compared to some of the more numerous species recorded during the baseline surveys. This is reflected by the relatively large 95% confidence intervals around the mean abundance estimates for this species (Table 110).

Table 110 Raw counts, unapportioned abundance and density estimates (birds per km²) of gannets in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of gannet raw counts per season, with light yellow to orange (peak number) for the breeding season months (mid-March to September) and light blue to royal blue (peak number) for the wintering months (October to mid-February). No colours were attributed to the breeding site attendance period (mid-February - mid-March)

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia OWF						
May-21	3	17	3	35	0.58	0.04
Jun-21	68	399	217	663	0.12	0.93
Jul-21	18	106	18	271	0.24	0.25
Aug-21	27	156	93	237	0.19	0.37
Sep-21	40	232	99	383	0.16	0.54
Oct-21	**66**	**386**	**252**	**527**	**0.12**	**0.9**
Nov-21	9	52	23	81	0.33	0.12
Dec-21	4	23	4	46	0.50	0.05
Jan-22	2	12	2	29	0.71	0.03
Feb-22	2	11	2	32	0.71	0.03
Mar-22	1	5	1	16	1.00	0.01
Apr-22	4	23	6	40	0.50	0.05
May-22	13	75	13	191	0.28	0.18
Jun-22	**173**	**994**	**224**	**1,977**	**0.08**	**2.33**
Jul-22	30	175	105	269	0.18	0.41
Aug-22	7	40	12	75	0.38	0.09
Sep-22	52	301	145	475	0.14	0.7
Oct-22	10	58	10	123	0.32	0.14
Nov-22	1	6	1	18	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01
Jan-23	1	6	1	17	1.00	0.01
Feb-23	3	17	3	34	0.58	0.04
Apr-23	14	79	14	227	0.27	0.18
b) Caledonia OWF plus 2 km buffer						
May-21	11	63	34	98	0.30	0.1
Jun-21	91	528	273	835	0.10	0.82
Jul-21	21	122	21	266	0.22	0.19
Aug-21	49	280	171	394	0.14	0.44
Sep-21	66	379	230	545	0.12	0.59
Oct-21	**91**	**525**	**375**	**692**	**0.10**	**0.82**
Nov-21	13	74	34	114	0.28	0.11
Dec-21	4	23	4	52	0.50	0.04
Jan-22	2	11	2	29	0.71	0.02
Feb-22	4	21	4	64	0.5	0.03

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Mar-22	1	5	1	16	1.00	0.01
Apr-22	5	28	11	45	0.45	0.04
May-22	17	97	23	212	0.24	0.15
Jun-22	225	1,289	487	2,212	0.07	2.00
Jul-22	44	253	127	403	0.15	0.39
Aug-22	11	63	34	97	0.30	0.1
Sep-22	85	491	317	646	0.11	0.76
Oct-22	18	105	29	210	0.24	0.16
Nov-22	1	6	1	17	1.00	0.01
Dec-22	3	18	3	35	0.58	0.03
Jan-23	2	12	2	29	0.71	0.02
Feb-23	6	34	11	63	0.41	0.05
Mar-23	1	6	1	17	1.00	0.01
Apr-23	14	79	14	232	0.27	0.12
c) Survey Area						
May-21	14	82	35	140	0.27	0.09
Jun-21	114	671	353	1,065	0.09	0.76
Jul-21	33	199	78	362	0.17	0.23
Aug-21	71	412	267	557	0.12	0.47
Sep-21	99	579	398	784	0.10	0.66
Oct-21	125	732	486	977	0.09	0.83
Nov-21	16	93	41	151	0.25	0.11
Dec-21	4	23	4	52	0.50	0.03
Jan-22	2	12	2	29	0.71	0.01
Feb-22	5	27	5	71	0.45	0.03
Mar-22	1	5	1	16	1.00	0.01
Apr-22	12	69	17	156	0.29	0.08
May-22	21	122	41	238	0.22	0.14
Jun-22	258	1,493	666	2,448	0.06	1.69
Jul-22	72	421	210	660	0.12	0.48
Aug-22	11	63	29	103	0.30	0.07
Sep-22	104	607	379	829	0.10	0.69
Oct-22	47	276	76	600	0.15	0.31
Nov-22	2	12	2	29	0.71	0.01
Dec-22	4	24	4	53	0.50	0.03
Jan-23	3	18	3	35	0.58	0.02
Feb-23	8	46	17	75	0.35	0.05
Mar-23	1	6	1	18	1.00	0.01
Apr-23	15	86	15	235	0.26	0.1

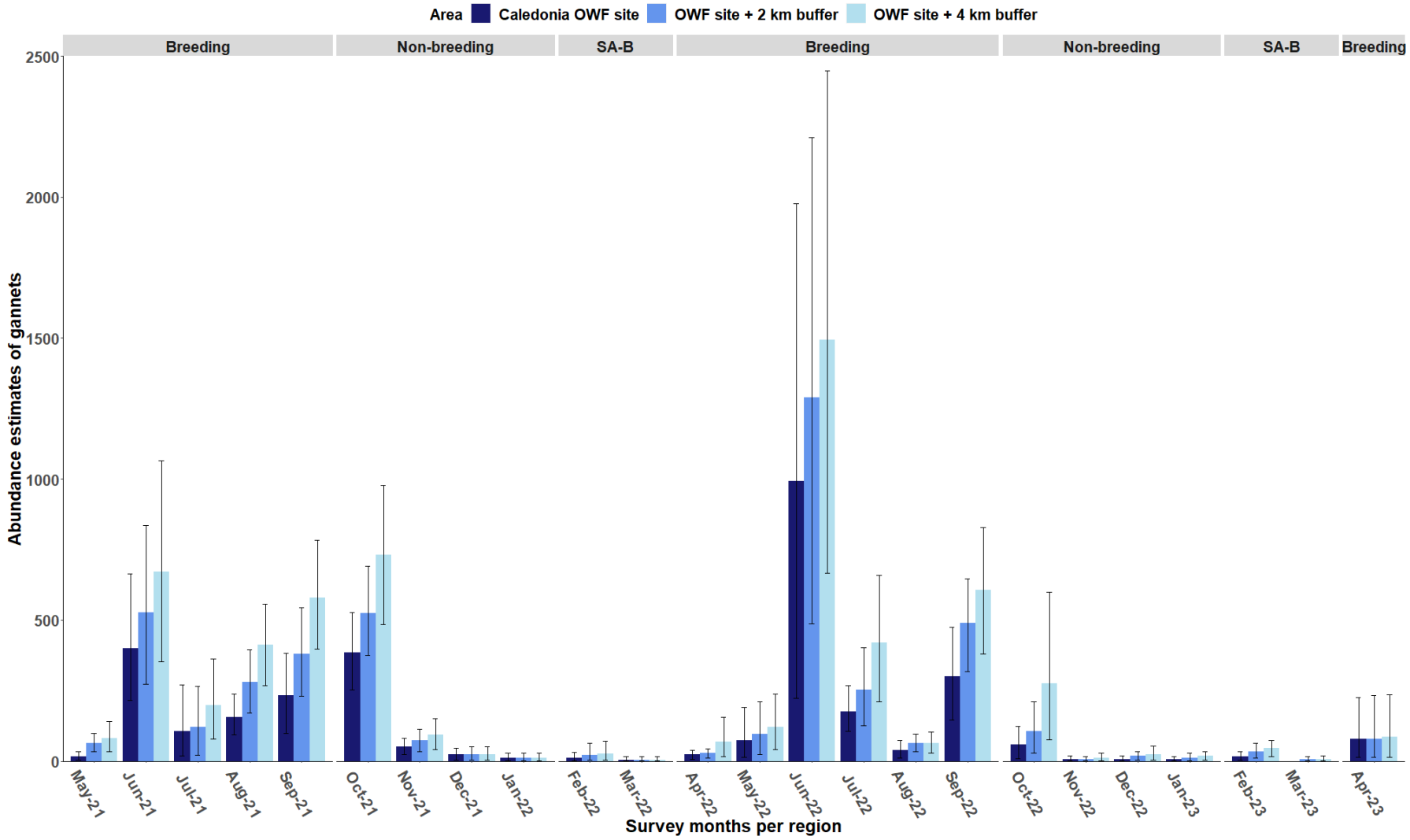


Figure 38 Bar plot of the monthly abundance estimates (with 95% confidence intervals) of total gannets recorded in each reporting region of the Survey Area, during the May 2021 to April 2023 survey period. Gannet seasonal periods are also displayed. SA stands for breeding site attendance and SA-B corresponds to month split between SA and breeding (B)

Caledonia North

A total of 435 gannets were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 9). Gannets were recorded throughout the year, except January to March 2022, November 2022, and March 2023 (Table 111, Figure 39). Within Caledonia North, Caledonia North plus 2 km buffer, and Caledonia North Survey Area, they were recorded in 16, 18 and 19 of the 24 baseline surveys respectively. Gannets were the most abundant during the non-breeding season (October to mid-March) across Caledonia North Survey Area, except in Caledonia North, where they were the most abundant during the breeding season (mid-March to September) (Table 111, Figure 39).

During the non-breeding season, peak abundance was recorded in October 2021 (Table 111, Figure 39):

- 37 individuals were recorded in Caledonia North, resulting in an unapportioned mean abundance estimates of 216 [99; 333] individuals, which equated to a mean density estimate of 0.99 birds/km^2.
- 61 individuals were recorded in Caledonia North plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 349 [206; 497] individuals, which equated to a mean density estimate of 0.93 birds/km^2.
- 89 individuals were recorded in Caledonia North Survey Area, resulting in an unapportioned mean abundance estimate of 520 [316; 754] individuals, which equated to a mean density estimate of 0.93 birds/km^2.

In both non-breeding seasons covered by the baseline survey period, the only month where substantial numbers of gannets were recorded in Caledonia North Survey Area was October. It is considered a reasonable assumption, based on the timing of this peak, and its relative size compared with unapportioned mean abundances in other non-breeding season surveys, that these peak mean unapportioned abundances represent post-breeding aggregations of birds (likely from multiple breeding colonies across the region). Low abundances of birds were recorded in all reporting regions for the remainder of the non-breeding season surveys. It is noteworthy that the October 2021 peak was considerably larger than the October 2022 peak.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 84% to 99%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This reflects the fact that the October 2021 peak (which was the overall peak mean unapportioned abundance for gannet in the non-breeding season across the baseline survey period) was very large relative to the other mean unapportioned abundances recorded for gannet during the non-breeding season in Caledonia North Survey Area and reporting regions.

During the breeding season (mid-March to September), gannet peak abundances were recorded in June 2021 in Caledonia North and Caledonia North plus 2 km buffer, and June 2022 in Caledonia North Survey Area (Table 111, Figure 39):

- 42 individuals were recorded in Caledonia North in June 2021, resulting in an unapportioned mean abundance estimate of 248 [89; 497] individuals, which equated to a mean density estimate of 1.14 birds/km^2.
- 47 individuals were recorded in Caledonia North plus 2 km buffer in June 2021, resulting in an unapportioned mean abundance estimate of 272 [81; 521] individuals, which equated to a mean density estimate of 0.72 birds/km^2.
- 74 individuals were recorded in Caledonia North Survey Area in June 2022, resulting in an unapportioned mean abundance estimate of 428 [260; 630] individuals, which equated to a mean density estimate of 0.77 birds/km^2.

The two breeding seasons covered by the baseline survey period displayed some similarities in temporal variation in mean unapportioned gannet abundance within Caledonia North Survey Area. Abundances were relatively low in the early breeding season months (April and May), with peak mean unapportioned gannet abundance occurring in June for both breeding seasons. The following two months (July and August) recorded lower mean unapportioned gannet abundances, though higher than the early breeding season. In 2021, the August mean unapportioned gannet abundances were higher than July, and vice versa in 2022. Both September 2021 and September 2022 saw increases in mean unapportioned gannet abundance compared with previous months. The timing of this increased mean unapportioned abundance peak, and its continuation into the early part of the non-breeding season (in the 2021 breeding season in particular), suggests that Caledonia North Survey Area may be a location used by post-breeding aggregations of this species, before birds leave the wider area for the non-breeding season.

Reductions in mean unapportioned abundance relative to the peak were between 14% to 99%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This indicates that the mean apportioned abundances were highly variable throughout the breeding season surveys when compared with the peak mean apportioned abundance for this season during the baseline survey period.

CV values were high, which is likely related to the relatively low numbers of individuals recorded in each region (CV > 0.16; Table 111). CV values were generally lowest during the middle part of the breeding season, and the late breeding season and autumn dispersal periods (Table 111). CV values were > 0.16 for the most part, with two of 16, three of 18, and five of 19 surveys in Caledonia North, Caledonia North plus 2 km buffer, and Caledonia North Survey Area respectively falling below this value (Table 111). This indicates lower precision for the abundance and densities calculated for this species compared to some of the more numerous species recorded during the baseline surveys. This is reflected by the relatively large 95% confidence intervals around the mean abundance estimates for this species (Table 111).

Table 111 Raw counts, unapportioned abundance and density estimates (birds per km^2) of gannets in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of gannet raw counts per season, with light yellow to orange (peak number) for the breeding season months (mid-March to September) and light blue to royal blue (peak number) for the wintering months (October to mid-February). No colours were attributed to the breeding site attendance period (mid-February - mid-March)

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
May-21	1	6	1	17	1.00	0.03
Jun-21	42	248	89	497	0.15	1.14
Jul-21	3	18	3	53	0.58	0.08
Aug-21	12	70	29	116	0.29	0.32
Sep-21	25	145	35	267	0.20	0.66
Oct-21	37	216	99	333	0.16	0.99
Nov-21	4	23	6	47	0.50	0.11
Dec-21	2	12	2	23	0.71	0.05
Apr-22	3	17	6	34	0.58	0.08
May-22	1	6	1	17	1.00	0.03
Jun-22	21	120	74	171	0.22	0.55
Jul-22	5	29	6	59	0.45	0.13
Aug-22	2	12	2	23	0.71	0.05
Sep-22	12	69	23	138	0.29	0.32

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
Oct-22	6	35	6	93	0.41	0.16
Feb-23	2	12	2	29	0.71	0.05
b) Caledonia North plus 2 km buffer						
May-21	7	40	11	74	0.38	0.11
Jun-21	47	272	81	521	0.15	0.72
Jul-21	5	29	6	63	0.45	0.08
Aug-21	20	113	34	204	0.22	0.30
Sep-21	41	233	97	398	0.16	0.62
Oct-21	61	349	206	497	0.13	0.93
Nov-21	5	29	6	57	0.45	0.08
Dec-21	2	11	2	28	0.71	0.03
Apr-22	3	17	3	34	0.58	0.05
May-22	4	23	4	46	0.50	0.06
Jun-22	36	208	121	294	0.17	0.55
Jul-22	13	74	34	120	0.28	0.20
Aug-22	6	34	6	69	0.41	0.09
Sep-22	28	163	99	227	0.19	0.43
Oct-22	7	41	7	100	0.38	0.11
Dec-22	1	6	1	18	1.00	0.02
Jan-23	1	6	1	18	1.00	0.02
Feb-23	5	29	6	51	0.45	0.08
c) Caledonia North Survey Area						
May-21	8	47	12	82	0.35	0.08
Jun-21	51	302	101	586	0.14	0.54
Jul-21	9	55	18	97	0.33	0.10
Aug-21	26	151	70	255	0.20	0.27
Sep-21	60	350	187	532	0.13	0.63
Oct-21	89	520	316	754	0.11	0.93
Nov-21	6	35	6	70	0.41	0.06
Dec-21	2	12	2	29	0.71	0.02
Apr-22	4	23	6	40	0.50	0.04
May-22	7	41	12	81	0.38	0.07
Jun-22	74	428	260	630	0.12	0.77
Jul-22	25	146	59	263	0.20	0.26
Aug-22	7	40	11	74	0.38	0.07
Sep-22	46	268	151	402	0.15	0.48
Oct-22	10	59	18	123	0.32	0.11
Dec-22	3	18	3	35	0.58	0.03
Jan-23	1	6	1	18	1.00	0.01
Feb-23	6	35	12	64	0.41	0.06
Apr-23	1	6	1	17	1.00	0.01

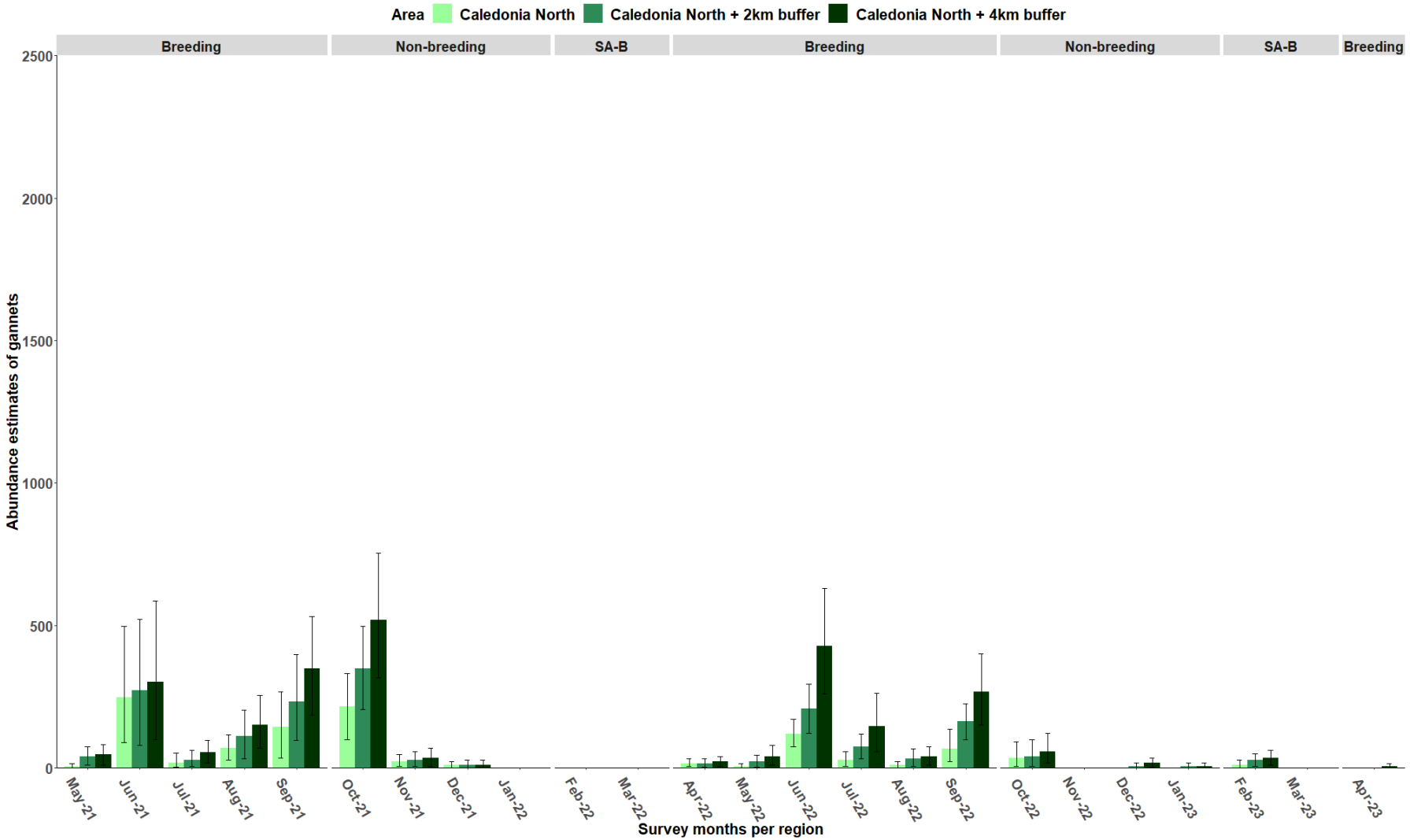


Figure 39 Bar plot of the monthly abundance estimates (with 95% confidence intervals) of total gannets recorded in each reporting region of Caledonia North Survey Area, during the May 2021 to April 2023 survey period. Gannet seasonal periods are also displayed. SA stands for breeding site attendance and SA-B corresponds to month split between SA and breeding (B)

Caledonia South

A total of 807 gannets were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 10). Gannets were recorded throughout the year, being recorded in Caledonia South in 23 of 24 baseline surveys, and Caledonia South plus buffers in every survey (Table 112, Figure 40). Gannets were the most abundant during the breeding season (mid-March to September). Peak of abundance was recorded in June 2022 (Table 112, Figure 40):

- 152 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 880 [185; 1,807] individuals, which equated to a mean density estimate of 4.18 birds/km^2.
- 196 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 1,113 [324; 2,066] individuals, which equated to a mean density estimate of 3.10 birds/km^2.
- 222 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 1,286 [492; 2,253] individuals, which equated to a mean density estimate of 2.41 birds/km^2.

The two breeding seasons covered by the baseline survey period displayed some similarities in temporal variation in mean unapportioned gannet abundance. Abundances were relatively low in the early breeding season months (April and May), with peak mean unapportioned gannet abundance occurring in June for both breeding seasons. The most striking difference between unapportioned mean abundances in the 2021 and 2022 breeding seasons is the size of the peak in June, with the 2022 peak being very large relative to other months around it (as well as other months in the 2021 breeding season). The peak abundance of gannets during the breeding season (June 2022) was considerably higher than other months, with over twice the number of birds recorded in Caledonia South reporting regions when compared with the next most abundant month across the baseline survey period.

The following two months of each breeding season (July and August) recorded lower mean unapportioned gannet abundances than June. In 2021, the August mean unapportioned gannet abundances were higher than July, and vice versa in 2022 (when mean unapportioned abundances were particularly low). Abundances remained at a similar level in September 2021 compared with the previous month, and actually increased substantially between August 2021 and September 2022. This, coupled with the continued use of the area into October in both years, suggests that Caledonia South Survey Area may be a location used by post-breeding aggregations of this species.

During the non-breeding season (October to mid-March), gannets were particularly abundant in October 2021, which is when the peak was recorded (Table 112, Figure 40):

- 29 individuals were recorded in Caledonia South, resulting in an unapportioned mean abundance estimate of 170 [105; 228] individuals, which equated to a mean density estimate of 0.81 birds/km^2.
- 46 individuals were recorded in Caledonia South plus 2 km buffer, resulting in an unapportioned mean abundance estimate of 267 [186; 354] individuals, which equated to a mean density estimate of 0.74 birds/km^2.
- 82 individuals were recorded in Caledonia South Survey Area, resulting in an unapportioned mean abundance estimate of 476 [366; 598] individuals, which equated to a mean density estimate of 0.89 birds/km^2.

In both non-breeding seasons covered by the baseline survey period, the only month where substantial numbers of gannets were recorded in Caledonia South Survey Area was October. It is considered a reasonable assumption, based on the timing of this peak, and its relative size compared with unapportioned mean abundances in other non-breeding season surveys, that these peak mean unapportioned abundances represent post-breeding aggregations of birds (likely from multiple

breeding colonies across the region). Low abundances of birds were recorded in all reporting regions for the remainder of the non-breeding season surveys. It is noteworthy that the October 2021 peak was considerably larger than the October 2022 peak.

Reductions in mean apportioned and availability bias-corrected abundance relative to the peak were between 63% to 98%, with many of the surveys recording reductions in mean abundances at the upper end of this range when compared with the peak month. This reflects the fact that the October 2021 peak (which was the overall peak mean unapportioned abundance for gannet in the non-breeding season across the baseline survey period) was very large relative to the other mean unapportioned abundances recorded for gannet during the non-breeding season in Caledonia South Survey Area and reporting regions.

Relatively good measures of precisions (CV ≤ 0.16) were calculated for survey month where raw counts of individuals where higher, and measures of precisions were high when raw counts of individual were low (CV > 0.16; Table 112). CV values were generally lowest during the middle part of the breeding season, and the late breeding season and autumn dispersal periods (Table 112). CV values were > 0.16 for the most part, with two of 23, six of 24, and eight of 24 surveys in Caledonia South, Caledonia South plus 2 km buffer, and Caledonia South Survey Area respectively falling below this value (Table 112). This indicates lower precision for the abundance and densities calculated for this species compared to some of the more numerous species recorded during the baseline surveys. This is reflected by the relatively large 95% confidence intervals around the mean abundance estimates for this species (Table 112).

Table 112 Raw counts, unapportioned abundance and density estimates (birds per km^2) of gannets in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period. Colour gradients follow the ascending order of gannet raw counts per season, with light yellow to orange (peak number) for the breeding season months (mid-March to September) and light blue to royal blue (peak number) for the wintering months (October to mid-February). No colours were attributed to the breeding site attendance period (mid-February - mid-March)

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
May-21	2	12	2	29	0.71	0.06
Jun-21	26	151	81	262	0.20	0.72
Jul-21	15	88	15	229	0.26	0.42
Aug-21	15	87	46	144	0.26	0.41
Sep-21	15	87	23	162	0.26	0.41
Oct-21	29	170	105	228	0.19	0.81
Nov-21	5	29	6	52	0.45	0.14
Dec-21	2	12	2	35	0.71	0.06
Jan-22	2	12	2	29	0.71	0.06
Feb-22	2	11	2	32	0.71	0.05
Mar-22	1	5	1	16	1.00	0.02
Apr-22	1	6	1	17	1.00	0.03
May-22	12	69	12	185	0.29	0.33
Jun-22	152	880	185	1,807	0.08	4.18
Jul-22	25	146	70	239	0.20	0.69
Aug-22	5	29	6	52	0.45	0.14
Sep-22	41	239	122	350	0.16	1.14
Oct-22	4	24	4	47	0.50	0.11
Nov-22	1	6	1	18	1.00	0.03
Dec-22	1	6	1	18	1.00	0.03
Jan-23	1	6	1	18	1.00	0.03

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
Feb-23	1	6	1	17	1.00	0.03
Apr-23	14	80	14	228	0.27	0.38
b) Caledonia South plus 2 km buffer						
May-21	5	29	6	52	0.45	0.08
Jun-21	52	302	157	487	0.14	0.84
Jul-21	16	93	16	233	0.25	0.26
Aug-21	37	212	155	275	0.16	0.59
Sep-21	26	150	87	231	0.20	0.42
Oct-21	46	267	186	354	0.15	0.74
Nov-21	9	52	17	92	0.33	0.14
Dec-21	2	12	2	35	0.71	0.03
Jan-22	2	11	2	29	0.71	0.03
Feb-22	4	21	4	64	0.50	0.06
Mar-22	1	5	1	16	1.00	0.01
Apr-22	3	17	6	34	0.58	0.05
May-22	13	75	13	189	0.28	0.21
Jun-22	196	1,113	324	2,066	0.07	3.10
Jul-22	38	220	87	382	0.16	0.61
Aug-22	9	51	29	74	0.33	0.14
Sep-22	68	388	234	548	0.12	1.08
Oct-22	17	98	23	225	0.24	0.27
Nov-22	1	6	1	17	1.00	0.02
Dec-22	2	12	2	29	0.71	0.03
Jan-23	2	11	2	29	0.71	0.03
Feb-23	2	11	2	29	0.71	0.03
Mar-23	1	6	1	17	1.00	0.02
Apr-23	14	78	14	230	0.27	0.22
c) Caledonia South Survey Area						
May-21	8	46	17	75	0.35	0.09
Jun-21	79	459	250	750	0.11	0.86
Jul-21	28	168	54	336	0.19	0.31
Aug-21	57	328	224	443	0.13	0.61
Sep-21	47	273	145	436	0.15	0.51
Oct-21	82	476	366	598	0.11	0.89
Nov-21	14	80	29	138	0.27	0.15
Dec-21	2	12	2	35	0.71	0.02
Jan-22	2	12	2	29	0.71	0.02
Feb-22	5	27	5	71	0.45	0.05
Mar-22	1	5	1	16	1.00	0.01
Apr-22	10	57	10	138	0.32	0.11
May-22	16	92	23	213	0.25	0.17
Jun-22	222	1,286	492	2,253	0.07	2.41
Jul-22	69	399	162	654	0.12	0.75
Aug-22	9	52	23	80	0.33	0.10
Sep-22	86	502	274	718	0.11	0.94
Oct-22	42	247	65	564	0.15	0.46
Nov-22	2	12	2	29	0.71	0.02
Dec-22	3	18	3	41	0.58	0.03
Jan-23	3	18	3	35	0.58	0.03
Feb-23	3	17	3	35	0.58	0.03
Mar-23	1	6	1	17	1.00	0.01
Apr-23	16	92	16	246	0.25	0.17

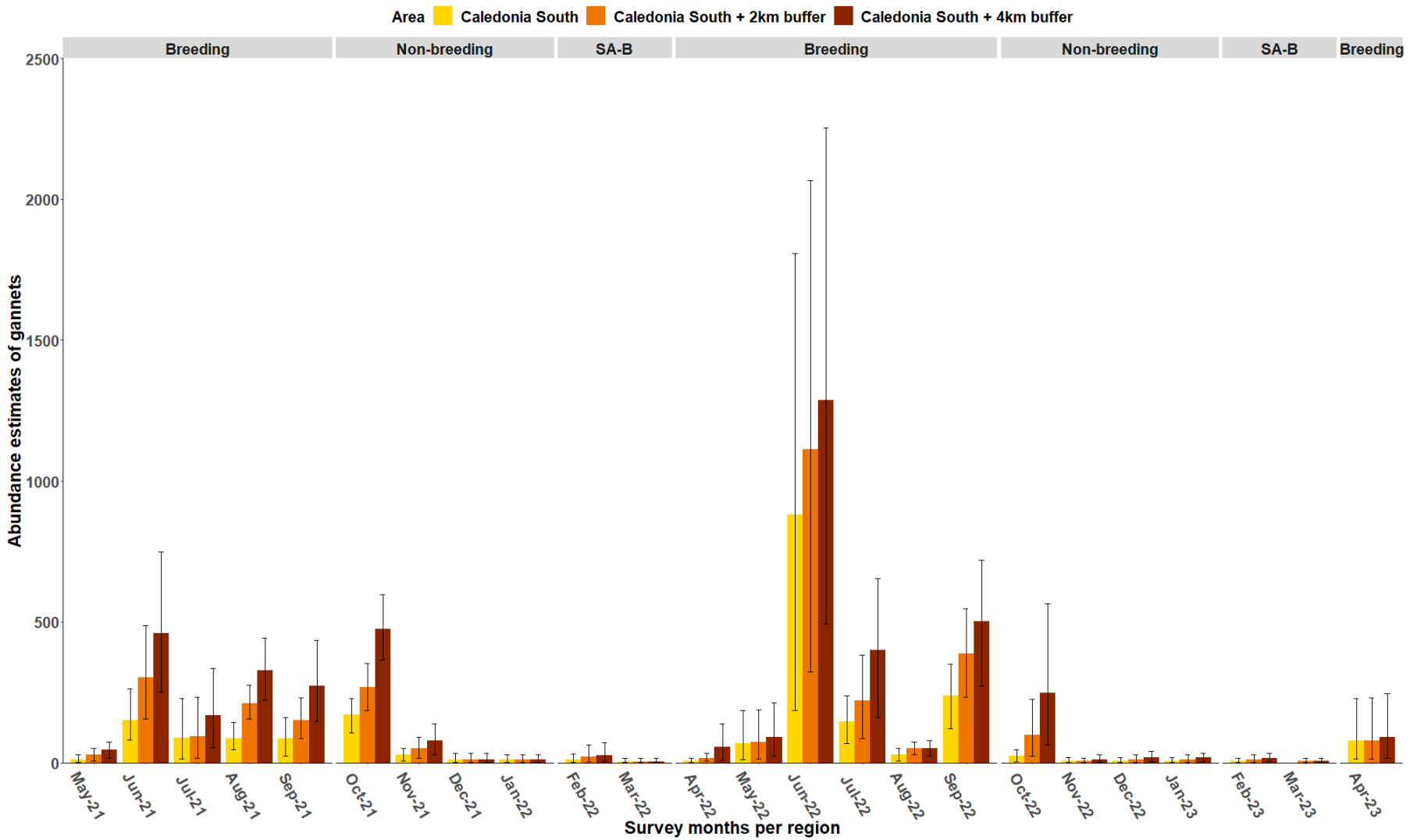


Figure 40 Bar plot of the monthly abundance estimates (with 95% confidence intervals) of total gannets recorded in each reporting region of Caledonia South Survey Area, during the May 2021 to April 2023 survey period. Gannet seasonal periods are also displayed. SA stands for breeding site attendance and SA-B corresponds to month split between SA and breeding (B)

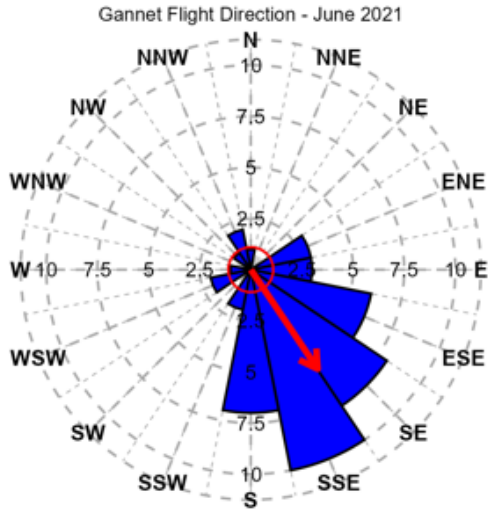
ii. Distribution and behaviour

Distribution maps are shown in Appendix 4: Figure A4.264-287. Overall, gannets were recorded throughout the Survey Area. In July and August 2021, they were mostly in the south of the Survey Area (Figure A4.266-267), while most individuals in September 2021 were in the northwest and the south (Figure A4.268). Between January and March 2022, a small number of gannets were recorded in Caledonia South and its Buffer Zone (Figures A4.272-274). In June 2002, the highest numbers of gannets were recorded in the western half of the Survey Area (Figure A4.277). Between July 2022 and January 2023, gannets occurred throughout the Survey Area, although the highest numbers were seen in Caledonia South (Figures A4.278-284). In other months, they were more loosely distributed across the Survey Area (Figures A4. 264-264, 269-271, 275-26, 285-287). Distribution during the breeding season appeared more skewed towards the southern half of the Survey Area, indicating that birds could have originated from the Troup, Pennan and Lion's Heads SPA, which supports a breeding colony of gannets (though the species is not a qualifying feature of the SPA).

Significant predominant direction of flight was recorded in:

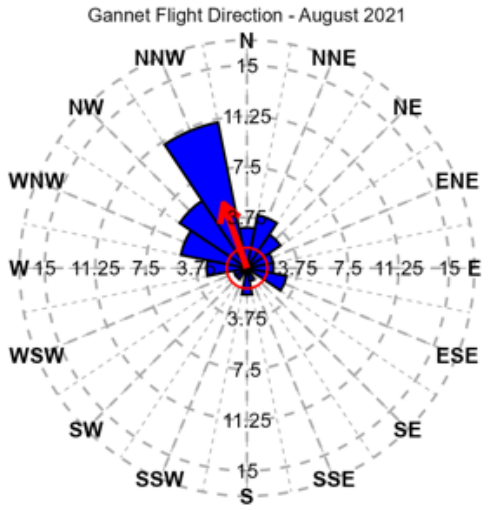
- **June**
  - 2021 southeast (Figure 41a)
  - 2022 east-northeast (Figure 41e)
- **July**
  - 2022 east-southeast (Figure 41f)
- **August**
  - 2021 north-northwest (Figure 41b)
- **September**
  - 2022 southeast (Figure 41g)
- **October**
  - 2021 southeast (Figure 41c)
  - 2022 south-southwest (Figure 41h)
- **November**
  - 2021 east-southeast (Figure 41d)
- **February**
  - 2023 east (Figure 41i)

As very few birds were recorded in flight in other surveys, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.23).



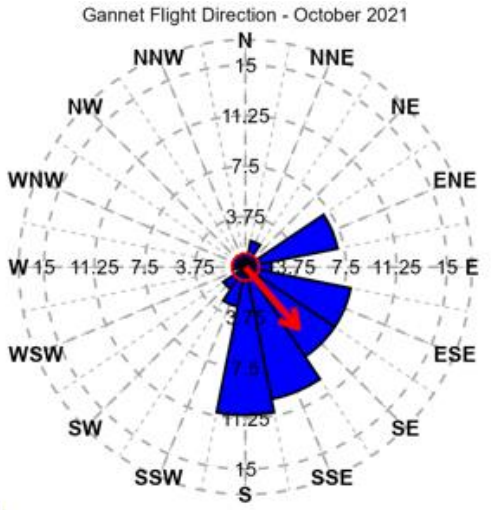
Number of Observations	46
Mean Vector (μ)	146.023
Length of Mean Vector (r)	0.585
Rayleigh Test (Z)	15.733
Rayleigh Test (p)	<0.001

a June 2021



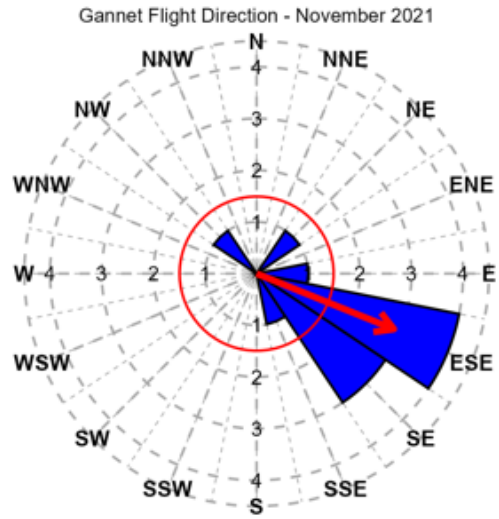
Number of Observations	47
Mean Vector (μ)	340.832
Length of Mean Vector (r)	0.459
Rayleigh Test (Z)	9.892
Rayleigh Test (p)	<0.001

b August 2021



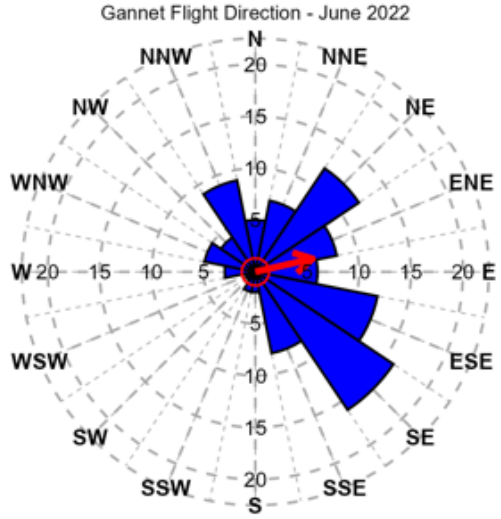
Number of Observations	59
Mean Vector (μ)	139.938
Length of Mean Vector (r)	0.541
Rayleigh Test (Z)	17.261
Rayleigh Test (p)	<0.001

c October 2021



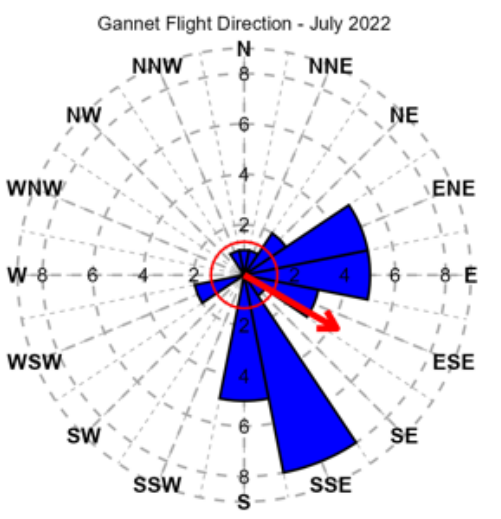
Number of Observations	11
Mean Vector (μ)	112.987
Length of Mean Vector (r)	0.717
Rayleigh Test (Z)	5.648
Rayleigh Test (p)	0.002

d November 2021



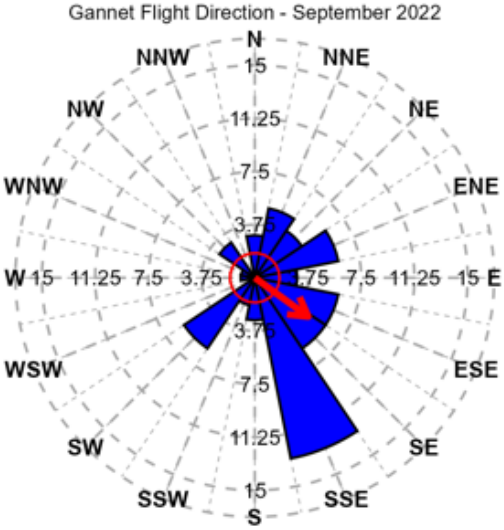
Number of Observations	101
Mean Vector (μ)	77.505
Length of Mean Vector (r)	0.353
Rayleigh Test (Z)	12.553
Rayleigh Test (p)	<0.001

e June 2022



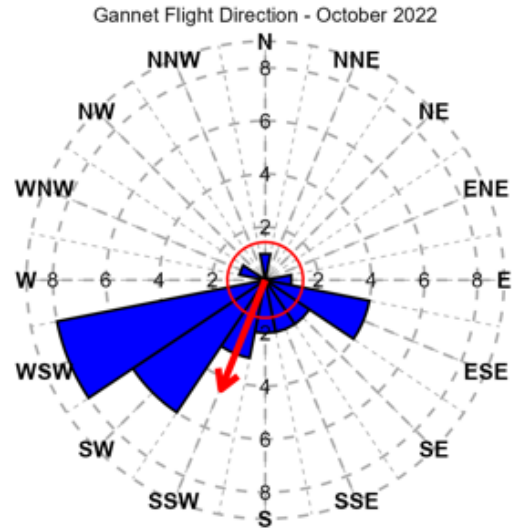
Number of Observations	34
Mean Vector (μ)	120.057
Length of Mean Vector (r)	0.531
Rayleigh Test (Z)	9.575
Rayleigh Test (p)	<0.001

f July 2022



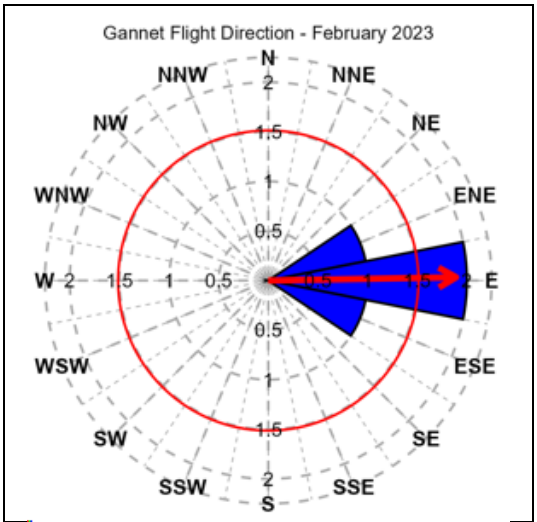
Number of Observations	62
Mean Vector (μ)	126.594
Length of Mean Vector (r)	0.358
Rayleigh Test (Z)	7.947
Rayleigh Test (p)	<0.001

g September 2022



Number of Observations	30
Mean Vector (μ)	202.354
Length of Mean Vector (r)	0.555
Rayleigh Test (Z)	9.250
Rayleigh Test (p)	<0.001

h October 2022



Number of Observations	4
Mean Vector (μ)	89.122
Length of Mean Vector (r)	0.945
Rayleigh Test (Z)	3.574
Rayleigh Test (p)	0.016
i February 2023	

Figure 41 Summary of flight direction of gannets within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.34 Unidentified thrush species

i. Abundance and density estimates

A total of 289 unidentified thrushes were recorded in the Survey Area in October 2022 (Table 8, Table 113). This resulted in an unapportioned mean abundance estimate of 1,699 [382; 3,321] individuals, which equated in a mean density estimate of 1.92 birds/km^2 (Table 113). It is reasonable to assume, given the timing of the records and the group to which these records were assigned, that these were birds on migration.

Table 113 Raw counts, unapportioned abundance and density estimates (birds per km^2) of unidentified thrush species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
Oct-22	17	99	18	245	0.24	0.23
b) Caledonia OWF plus 2 km buffer						
Oct-22	114	664	114	1,736	0.09	1.03
c) Survey Area						
Oct-22	289	1,699	382	3,321	0.06	1.92

In Caledonia North Survey Area, a total of 214 unidentified thrushes were recorded in October 2022 (Table 9). This resulted in an unapportioned mean abundance estimate of 1,257 [317; 2,460] individuals, which equated to a mean density estimate of 2.26 birds/km^2 (

Table 114).

Table 114 Raw counts, unapportioned abundance and density estimates (birds per km^2) of unidentified thrush species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
Oct-22	4	23	4	58	0.50	0.11
b) Caledonia North plus 2 km buffer						
Oct-22	105	617	105	1,733	0.10	1.64
c) Caledonia North Survey Area						
Oct-22	214	1,257	317	2,460	0.07	2.26

In Caledonia South Survey Area, a total of 188 unidentified thrushes were recorded in October 2022 (Table 10). This resulted in an unapportioned mean abundance estimate of 1,104 [188; 2,350] individuals, which equated to a mean density estimate of 2.07 birds/km^2 (Table 115).

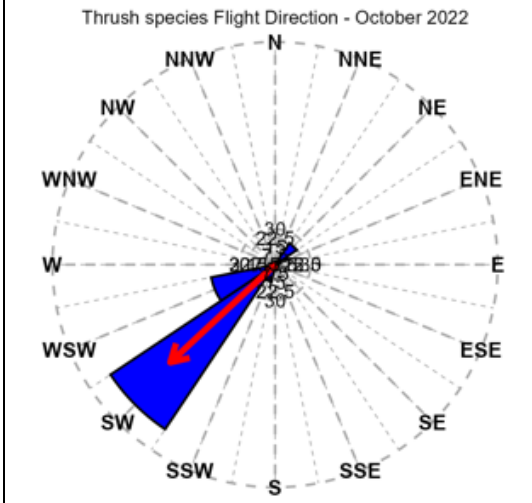
Table 115 Raw counts, unapportioned abundance and density estimates (birds per km^2) of unidentified thrush species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
Oct-22	13	76	13	217	0.28	0.36
b) Caledonia South plus 2 km buffer						
Oct-22	62	357	62	1,048	0.13	0.99
c) Caledonia South Survey Area						
Oct-22	188	1,104	188	2,350	0.07	2.07

ii. Distribution and behaviour

Unidentified thrushes were only recorded in October 2022, scattered across the Survey Area, however, with most records in Caledonia North Survey Area (Appendix 4, Figure A4.288).

All unidentified thrushes were recorded flying in a significant south-westerly direction in October 2022.



Number of Observations	289
Mean Vector (μ)	227.364
Length of Mean Vector (r)	0.724
Rayleigh Test (Z)	151.365
Rayleigh Test (p)	<0.001
October 2022	

Figure 42 Summary of flight direction of thrush species within surveys where a significant flight direction was recorded during the May 2021 to April 2023 survey period

4.35 Unidentified passerine species

i. Abundance and density estimates

A total of 78 unidentified passerines were recorded in the Survey Area in October 2022 (Table 8, Table 116). This resulted in an unapportioned mean abundance estimate of 459 [78; 894] individuals, which equated to a mean density estimate of 0.52 birds/km^2 (Table 116). It is reasonable to assume, given the timing of the records and the group to which these records were assigned, that these were birds on migration.

Table 116 Raw counts, unapportioned abundance and density estimates (birds per km^2) of passerine species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
Oct-22	16	93	16	257	0.25	0.22
b) Caledonia OWF plus 2 km buffer						
Oct-22	17	99	17	274	0.24	0.15
c) Survey Area						
Oct-22	78	459	78	894	0.11	0.52

A total of 57 unidentified passerines recorded in Caledonia North Survey Area in October 2022 (Table 9, Table 117). This resulted in an unapportioned mean abundance estimate of 335 [57; 693] individuals, which equated to a mean density estimate of 0.60 birds/km^2 (Table 117).

Table 117 Raw counts, unapportioned abundance and density estimates (birds per km²) of passerine species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
Oct-22	14	81	14	243	0.27	0.37
b) Caledonia North plus 2 km buffer						
Oct-22	17	100	17	276	0.24	0.27
c) Caledonia North Survey Area						
Oct-22	57	335	57	693	0.13	0.60

A total of 37 unidentified passerines were recorded in Caledonia South Survey Area in October 2022 (Table 10, Table 118). This resulted in an unapportioned mean abundance of estimate 217 [37; 441] individuals, which equated to a mean density estimate of 0.41 birds/km^2 (Table 118).

Table 118 Raw counts, unapportioned abundance and density estimates (birds per km²) of passerine species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
Oct-22	2	12	2	35	0.71	0.06
b) Caledonia South plus 2 km buffer						
Oct-22	2	12	2	35	0.71	0.03
c) Caledonia South Survey Area						
Oct-22	37	217	37	441	0.16	0.41

ii. Distribution and behaviour

Unidentified passerines were largely recorded in the northeast of the Survey Area, across both Caledonia North and South in October 2022 (Appendix 4, Figure A4.289).

All unidentified passerines recorded were flying with no significant preference in flight direction (Appendix 5, Figure A5.29).

4.36 Unidentified bird species

i. Abundance and density estimates

A total of 54 unidentified birds were recorded in the Survey Area during both years of baseline surveys (Table 8). Unidentified birds were not apportioned to species as it is a too broad group to attribute to species. Unidentified birds were recorded in every survey, except in November 2021, April 2022, January to April 2023 (Table 8). Peak numbers were recorded in July 2022, with nine individuals recorded in the Survey Area, resulting in a mean abundance estimate of 53 [23; 82] individuals, which equated to a mean density estimate of 0.06 birds/km^2 (Table 119). The peak mean abundance estimate in Caledonia OWF was of 23 unidentified birds in July 2022, while in Caledonia plus 2 km buffer, a peak mean abundance estimate of 46 individuals were recorded in May 2021 (Table 119).

Table 119 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified bird species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia OWF						
May-21	1	6	1	17	1.00	0.01

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Jun-21	3	18	3	35	0.58	0.04
Aug-21	3	17	3	46	0.58	0.04
Sep-21	1	6	1	17	1.00	0.01
Dec-21	3	17	3	41	0.58	0.04
Jan-22	2	12	2	29	0.71	0.03
May-22	2	12	2	29	0.71	0.03
Jun-22	1	6	1	17	1.00	0.01
Jul-22	4	23	4	53	0.5	0.05
Sep-22	1	6	1	17	1.00	0.01
Nov-22	1	6	1	18	1.00	0.01
b) Caledonia OWF plus 2 km buffer						
May-21	8	46	8	126	0.35	0.07
Jun-21	3	17	3	35	0.58	0.03
Jul-21	1	6	1	17	1.00	0.01
Aug-21	3	17	3	46	0.58	0.03
Sep-21	2	11	2	29	0.71	0.02
Oct-21	1	6	1	17	1.00	0.01
Dec-21	4	23	4	46	0.50	0.04
Jan-22	2	11	2	29	0.71	0.02
Feb-22	1	5	1	16	1.00	0.01
May-22	2	11	2	29	0.71	0.02
Jun-22	3	17	3	40	0.58	0.03
Jul-22	6	35	12	58	0.41	0.05
Aug-22	1	6	1	17	1.00	0.01
Sep-22	1	6	1	17	1.00	0.01
Nov-22	1	6	1	17	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01
c) Survey Area						
May-21	8	47	8	134	0.35	0.05
Jun-21	3	18	3	35	0.58	0.02
Jul-21	2	12	2	30	0.71	0.01
Aug-21	3	17	3	46	0.58	0.02
Sep-21	2	12	2	29	0.71	0.01
Oct-21	1	6	1	18	1.00	0.01
Dec-21	6	35	12	64	0.41	0.04
Jan-22	5	29	12	46	0.45	0.03
Feb-22	1	5	1	16	1.00	0.01
Mar-22	1	5	1	16	1.00	0.01
May-22	3	17	3	35	0.58	0.02
Jun-22	4	23	4	52	0.50	0.03
Jul-22	9	53	23	82	0.33	0.06
Aug-22	1	6	1	17	1.00	0.01
Sep-22	1	6	1	18	1.00	0.01
Oct-22	2	12	2	29	0.71	0.01
Nov-22	1	6	1	18	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01

In Caledonia North Survey Area, peak numbers were recorded in July 2022, with 6 individuals recorded (Table 120). This resulted in a mean abundance estimate of 35 [6; 64] individuals, which equated to a mean density estimate of 0.06 birds/km^2 (Table 120).

Table 120 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified bird species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
Jun-21	1	6	1	18	1.00	0.03
Aug-21	2	12	2	35	0.71	0.05
Sep-21	1	6	1	17	1.00	0.03
Dec-21	1	6	1	17	1.00	0.03
Jan-22	1	6	1	17	1.00	0.03
May-22	2	12	2	29	0.71	0.05
Jun-22	1	6	1	17	1.00	0.03
Jul-22	3	18	3	41	0.58	0.08
Aug-22	1	6	1	17	1.00	0.03
Sep-22	1	6	1	17	1.00	0.03
Nov-22	1	6	1	18	1.00	0.03
b) Caledonia North plus 2 km buffer						
Jun-21	2	12	2	29	0.71	0.03
Aug-21	2	11	2	34	0.71	0.03
Sep-21	2	11	2	28	0.71	0.03
Dec-21	2	11	2	28	0.71	0.03
Jan-22	1	6	1	17	1.00	0.02
Feb-22	1	5	1	16	1.00	0.01
May-22	2	11	2	28	0.71	0.03
Jun-22	1	6	1	17	1.00	0.02
Jul-22	4	23	4	52	0.50	0.06
Aug-22	1	6	1	17	1.00	0.02
Sep-22	1	6	1	17	1.00	0.02
Nov-22	1	6	1	17	1.00	0.02
Dec-22	1	6	1	18	1.00	0.02
c) Caledonia North Survey Area						
Jun-21	2	12	2	30	0.71	0.02
Jul-21	1	6	1	18	1.00	0.01
Aug-21	2	12	2	35	0.71	0.02
Sep-21	2	12	2	29	0.71	0.02
Dec-21	3	17	3	35	0.58	0.03
Jan-22	2	12	2	29	0.71	0.02
Feb-22	1	6	1	17	1.00	0.01
Mar-22	1	5	1	16	1.00	0.01
May-22	3	17	3	35	0.58	0.03
Jun-22	2	12	2	29	0.71	0.02
Jul-22	6	35	6	64	0.41	0.06
Aug-22	1	6	1	17	1.00	0.01
Sep-22	1	6	1	17	1.00	0.01
Oct-22	1	6	1	18	1.00	0.01
Nov-22	1	6	1	18	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01

In Caledonia South Survey Area, peak numbers were recorded in May 2021, with 8 individuals recorded (Table 121). This resulted in a mean abundance estimate of 46 [8; 128] individuals, which equated to a mean density estimate of 0.09 birds/km² (Table 121).

Table 121 Raw counts, unapportioned abundance and density estimates (birds per km²) of unidentified bird species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
May-21	1	6	1	17	1.00	0.03
Jun-21	2	12	2	23	0.71	0.06
Aug-21	1	6	1	17	1.00	0.03
Dec-21	2	12	2	35	0.71	0.06
Jan-22	1	6	1	17	1.00	0.03
Jul-22	1	6	1	17	1.00	0.03
b) Caledonia South plus 2 km buffer						
May-21	8	46	8	127	0.35	0.13
Jun-21	2	12	2	29	0.71	0.03
Jul-21	1	6	1	17	1.00	0.02
Aug-21	1	6	1	17	1.00	0.02
Oct-21	1	6	1	17	1.00	0.02
Dec-21	2	12	2	35	0.71	0.03
Jan-22	1	6	1	17	1.00	0.02
Jun-22	2	11	2	34	0.71	0.03
Jul-22	2	12	2	29	0.71	0.03
c) Caledonia South Survey Area						
May-21	8	46	8	128	0.35	0.09
Jun-21	2	12	2	29	0.71	0.02
Jul-21	2	12	2	30	0.71	0.02
Aug-21	1	6	1	17	1.00	0.01
Oct-21	1	6	1	17	1.00	0.01
Dec-21	3	17	3	46	0.58	0.03
Jan-22	3	17	3	35	0.58	0.03
May-22	1	6	1	17	1.00	0.01
Jun-22	3	17	3	41	0.58	0.03
Jul-22	5	29	6	58	0.45	0.05
Oct-22	1	6	1	18	1.00	0.01

ii. Distribution and behaviour

Distribution maps are shown in Appendix 4: Figure A4.290-308. Unidentified birds were loosely distributed across Caledonia South and its Buffer Zone in May to July 2021 and in April 2022 (Figures A4.290-292, 300), whereas they occurred largely in Caledonia North in August and September 2021 (Figure A4.293-294). In December 2021, January 2022 and May to August 2022, unidentified birds were loosely scattered across the Survey Area (Figures A4.296-297, 301-304). In October 2021, and in February and March 2022, sporadic records were made Zone in the east and west of the Survey Area Buffer (Figures A4.295, 298-299). From September to December 2022, unidentified bird species were found in very low numbers across the Survey Area (Figure A4.305-308).

As very few birds were recorded in flight, they were too infrequent to determine any preference in flight direction (Appendix 5, Figure A5.30).

4.37 Deceased birds

Within the Survey Area, 91 deceased birds were recorded during both years of baseline surveys (Table 122). They were recorded in the May to July and September to October 2021, April to September and December 2022 surveys (Table 122).

Whilst it is not uncommon for small numbers of records of deceased birds to be made during surveys of this nature, it is noteworthy that higher numbers of deceased gannets were recorded in the June 2022 and July 2022 surveys (Table 122). It is reasonable to assume that many of these records would have been associated with the outbreak of Highly Pathogenic Avian Influenza (HPAI) reported across many colonies during the 2022 breeding season.

Table 122 Raw counts of deceased bird species recorded within the Survey Area during the May 2021 to April 2023 survey period

Survey	Common gull	Herring gull	Gull species	Guillemot / Razorbill	Fulmar	Gannet	Unidentified bird species	Total
May-21	-	-	1	-	-	-	-	**1**
Jun-21	-	1	-	-	-	-	1	**2**
Jul-21	-	-	-	-	-	1	-	**1**
Sep-21	-	-	-	2	-	2	1	**5**
Oct-21	-	-	-	2	-	-	-	**2**
Apr-22	-	-	-	1	-	-	2	**3**
May-22	1	-	-	1	3	1	4	**10**
Jun-22	-	-	-	-	-	9	1	**10**
Jul-22	-	-	-	2	3	38	4	**47**
Aug-22	-	-	1	-	1	1	5	**8**
Sep-22	-	-	-	-	-	1	-	**1**
Dec-22	-	-	-	-	-	1	-	**1**
Total	**1**	**1**	**2**	**8**	**7**	**54**	**18**	**91**

4.38 Grey seal

i. Abundance and density estimates

A total of 26 grey seals were recorded in the Survey Area during both years of baseline surveys (Table 11). Grey seals were recorded in low numbers (≤4) in June 2021, September to November 2021, January 2022, June 2022, and from August 2022 to March 2023 (Table 123). Peak abundance was recorded in October 2022, with 4 individuals resulting in an unapportioned mean abundance estimate of 24 [6; 53] and an apportioned mean abundance estimate of 24 [4; 59] individuals (Table 123). Both equated to a mean density estimate of 0.03 mammals/km^2 (Table 123).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 123).

Table 123 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of grey seals in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Oct-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Nov-21	2	12	2	29	0.71	0.03	12	2	29	0.03
Jun-22	1	6	1	17	1.00	0.01	13	2	37	0.03
Aug-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Sep-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Oct-22	2	12	2	29	0.71	0.03	12	2	36	0.03
Nov-22	0	-	-	-	-	-	6	1	18	0.01
Dec-22	1	6	1	18	1.00	0.01	18	3	47	0.04
Jan-23	1	6	1	17	1.00	0.01	6	1	17	0.01
Feb-23	1	6	1	17	1.00	0.01	6	1	17	0.01
Mar-23	1	6	1	18	1.00	0.01	6	1	18	0.01
b) Caledonia OWF plus 2 km buffer										
Jun-21	1	6	1	17	1.00	0.01	6	2	34	0.01
Jul-21	0	-	-	-	-	-	-	1	17	-
Oct-21	2	12	2	29	0.71	0.02	12	2	29	0.02
Nov-21	2	11	2	29	0.71	0.02	11	2	29	0.02
Jan-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-22	1	6	1	17	1.00	0.01	12	2	36	0.02
Aug-22	2	11	2	29	0.71	0.02	12	2	34	0.02
Sep-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Oct-22	2	12	2	29	0.71	0.02	12	2	34	0.02
Nov-22	0	-	-	-	-	-	6	1	17	0.01
Dec-22	1	6	1	18	1.00	0.01	18	3	47	0.03
Jan-23	1	6	1	17	1.00	0.01	6	1	17	0.01
Feb-23	1	6	1	17	1.00	0.01	6	1	17	0.01
Mar-23	2	12	2	29	0.71	0.02	12	2	29	0.02
c) Survey Area										
May-21	0	-	-	-	-	-	6	1	18	0.01
Jun-21	1	6	1	18	1.00	0.01	18	3	54	0.02
Jul-21	0	-	-	-	-	-	12	2	36	0.01
Sep-21	3	18	3	47	0.58	0.02	18	3	47	0.02
Oct-21	2	12	2	29	0.71	0.01	12	2	29	0.01
Nov-21	2	12	2	29	0.71	0.01	12	2	29	0.01

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Jan-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-22	2	12	2	29	0.71	0.01	19	3	53	0.02
Aug-22	2	11	2	29	0.71	0.01	12	2	34	0.01
Sep-22	1	6	1	18	1.00	0.01	6	1	18	0.01
Oct-22	4	24	6	53	0.50	0.03	24	4	59	0.03
Nov-22	1	6	1	18	1.00	0.01	12	2	36	0.01
Dec-22	1	6	1	18	1.00	0.01	18	3	47	0.02
Jan-23	2	12	2	29	0.71	0.01	12	2	29	0.01
Feb-23	2	12	2	29	0.71	0.01	18	3	46	0.02
Mar-23	2	12	2	29	0.71	0.01	18	3	47	0.02

A total of 20 grey seals were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 12). Peak abundance was recorded in October 2022 with 4 individuals, resulting in an unapportioned mean abundance estimate of 23 [4; 47] and an apportioned mean abundance estimate of 24 [4; 59] individuals (Table 124). Both equated to a mean density estimate of 0.04 mammals/km^2 (Table 124).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 124).

Table 124 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of grey seals in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia North										
Oct-21	1	6	1	18	1.00	0.03	6	1	18	0.03
Oct-22	2	12	2	23	0.71	0.05	12	2	34	0.05
Dec-22	1	6	1	17	1.00	0.03	12	2	34	0.05
Jan-23	1	6	1	17	1.00	0.03	6	1	17	0.03
Feb-23	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia North plus 2 km buffer										
Jun-21	0	-	-	-	-	-	6	1	17	0.02
Jul-21	0	-	-	-	-	-	6	1	17	0.02
Oct-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Jan-22	1	6	1	17	1.00	0.02	6	1	17	0.02
Aug-22	2	11	2	29	0.71	0.03	12	2	34	0.03
Oct-22	2	12	2	29	0.71	0.03	12	2	36	0.03
Dec-22	1	6	1	18	1.00	0.02	12	2	36	0.03
Jan-23	1	6	1	18	1.00	0.02	6	1	19	0.02
Feb-23	1	6	1	17	1.00	0.02	6	1	17	0.02
Mar-23	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia North Survey Area										
May-21	0	-	-	-	-	-	6	1	18	0.01
Jun-21	0	-	-	-	-	-	12	2	36	0.02
Jul-21	0	-	-	-	-	-	12	2	36	0.02
Sep-21	2	12	2	35	0.71	0.02	12	2	36	0.02
Oct-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Nov-21	1	6	1	18	1.00	0.01	6	1	18	0.01

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Jan-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-22	2	12	2	29	0.71	0.02	13	2	39	0.02
Aug-22	2	11	2	29	0.71	0.02	12	2	34	0.02
Sep-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Oct-22	4	23	4	47	0.50	0.04	24	4	59	0.04
Nov-22	1	6	1	18	1.00	0.01	6	1	18	0.01
Dec-22	1	6	1	18	1.00	0.01	12	2	36	0.02
Jan-23	2	12	2	29	0.71	0.02	12	2	29	0.02
Feb-23	1	6	1	17	1.00	0.01	6	1	17	0.01
Mar-23	1	6	1	18	1.00	0.01	12	2	36	0.02

A total of 14 grey seals were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 13). They were recorded in low numbers (≤2), therefore, abundance and density estimates were low (Table 125).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 125).

Table 125 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km²) of grey seals in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia South										
Nov-21	2	12	2	29	0.71	0.06	12	2	29	0.06
Jun-22	1	6	1	17	1.00	0.03	12	2	34	0.06
Aug-22	1	6	1	17	1.00	0.03	6	1	17	0.03
Sep-22	1	6	1	17	1.00	0.03	6	1	17	0.03
Nov-22	0	-	-	-	-	-	6	1	17	0.03
Mar-23	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia South plus 2 km buffer										
Jun-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Jul-21	0	-	-	-	-	-	6	1	17	0.02
Oct-21	1	6	1	17	1.00	0.02	6	1	17	0.02
Nov-21	2	11	2	29	0.71	0.03	11	2	29	0.03
Jun-22	1	6	1	17	1.00	0.02	12	7	34	0.03
Aug-22	2	11	2	29	0.71	0.03	12	2	34	0.03
Sep-22	1	6	1	17	1.00	0.02	6	1	17	0.02
Nov-22	0	-	-	-	-	-	6	6	17	0.02
Mar-23	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia South Survey Area										
Jun-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Jul-21	0	-	-	-	-	-	6	1	18	0.01
Sep-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Oct-21	1	6	1	17	1.00	0.01	6	1	17	0.01
Nov-21	2	11	2	29	0.71	0.02	11	2	29	0.02
Jun-22	1	6	1	17	1.00	0.01	12	2	36	0.02
Aug-22	2	11	2	29	0.71	0.02	12	2	34	0.02
Sep-22	1	6	1	18	1.00	0.01	6	1	18	0.01

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Oct-22	1	6	1	18	1.00	0.01	6	1	18	0.01
Nov-22	1	6	1	18	1.00	0.01	12	2	36	0.02
Dec-22	0	-	-	-	-	-	6	1	18	0.01
Feb-23	2	12	2	29	0.71	0.02	18	3	46	0.03
Mar-23	1	6	1	17	1.00	0.01	12	2	34	0.02

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figure A4.309-322. Grey seals were recorded in the Survey Area Buffer Zone in June and September 2021 and January 2022, with records during June in the southeast (Figure A4.309), during September in the northeast and southeast (Figure A4.310), and during January in the northeast (Figure A4.313). In October 2021, grey seals were recorded in the central and southern parts of the Survey Area (Figure A4.311), whereas they were in Caledonia South during November 2021, and September and November 2022 (Figures A4.312, 316, 318) and in Caledonia North during October and December 2022 and January 2023 (Figure A4.317, 319-320). In August 2022, two individuals were recorded in the northeast close to the subdivision line between Caledonia North and South (Figure A4.315). Grey seals were recorded in the northeast and southwest in February 2023 and in the north and southeast in March 2023 (Figure A4.321-322).

4.39 Unidentified seal species

i. Abundance and density estimates

A total of 13 unidentified seals were recorded in the Survey Area during both years of baseline surveys (Table 11). They were recorded in low numbers (≤2), therefore, abundance and density estimates were very low (Table 126).

Table 126 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of seal species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
Mar-22	1	5	1	16	1.00	0.01
Jun-22	1	6	1	17	1.00	0.01
Nov-22	1	6	1	18	1.00	0.01
Dec-22	2	12	2	29	0.71	0.03
b) Caledonia OWF plus 2 km						
Jun-21	1	6	1	17	1.00	0.01
Jul-21	1	6	1	17	1.00	0.01
Feb-22	1	5	1	16	1.00	0.01
Mar-22	1	5	1	16	1.00	0.01
Jun-22	1	6	1	17	1.00	0.01
Nov-22	1	6	1	17	1.00	0.01
Dec-22	2	12	2	29	0.71	0.02
c) Survey Area						
May-21	1	6	1	18	1.00	0.01
Jun-21	2	12	2	29	0.71	0.01
Jul-21	2	12	2	30	0.71	0.01
Feb-22	1	5	1	16	1.00	0.01
Mar-22	1	5	1	16	1.00	0.01
Jun-22	1	6	1	17	1.00	0.01

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Nov-22	1	6	1	18	1.00	0.01
Dec-22	2	12	2	29	0.71	0.01
Feb-23	1	6	1	17	1.00	0.01
Mar-23	1	6	1	18	1.00	0.01

A total of eight unidentified seals were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 12). They were recorded in low numbers (≤2), therefore, abundance estimates were very low (**Error! Not a valid bookmark self-reference.**).

Table 127 Raw counts, unapportioned abundance and density estimates (mammals per km²) of seal species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
Dec-22	1	6	1	17	1.00	0.03
b) Caledonia North plus 2 km buffer						
Jun-21	1	6	1	17	1.00	0.02
Jul-21	1	6	1	17	1.00	0.02
Feb-22	1	5	1	16	1.00	0.01
Dec-22	1	6	1	18	1.00	0.02
c) Caledonia North Survey Area						
May-21	1	6	1	18	1.00	0.01
Jun-21	2	12	2	30	0.71	0.02
Jul-21	2	12	2	30	0.71	0.02
Feb-22	1	6	1	17	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01
Mar-23	1	6	1	18	1.00	0.01

A total of seven unidentified seals were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 13). They were recorded in low numbers (≤1), therefore, abundance and density estimates were very low (**Error! Not a valid bookmark self-reference.**).

Table 128 Raw counts, unapportioned abundance and density estimates (mammals per km²) of seal species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia South						
Mar-22	1	5	1	16	1.00	0.02
Jun-22	1	6	1	17	1.00	0.03
Nov-22	1	6	1	18	1.00	0.03
Dec-22	1	6	1	18	1.00	0.03
b) Caledonia South plus 2 km buffer						
Jul-21	1	6	1	17	1.00	0.02
Mar-22	1	5	1	16	1.00	0.01
Jun-22	1	6	1	17	1.00	0.02
Nov-22	1	6	1	17	1.00	0.02
Dec-22	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
Jul-21	1	6	1	18	1.00	0.01
Mar-22	1	5	1	16	1.00	0.01
Jun-22	1	6	1	17	1.00	0.01

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Nov-22	1	6	1	18	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01
Feb-23	1	6	1	17	1.00	0.01
Mar-23	1	6	1	17	1.00	0.01

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.323-332. From May to July 2021, seal species occurred only in Caledonia North Buffer Zone, with most individuals in the northeast (Figures A4.323-325). The individual in February 2022 was located close to the most southerly turbine of the Moray East offshore wind farm within Caledonia North, close to the 4 km buffer of Caledonia South (Figure A4.326). In March, June, November, December 2022, and in February and March 2023, the majority of individuals were recorded in Caledonia South though one individual during December 2022 occurred in Caledonia North (Figure A4.327-332).

4.40 Common dolphin

i. Abundance and density estimates

A total of 39 common dolphins were recorded in the Survey Area in October 2022 (Table 11, Table 129). They were only recorded in the 4 km Buffer Zone of the Survey Area, specifically in Caledonia South Buffer Zone (Table 129, Table 131). This resulted in an unapportioned mean abundance estimate of 229 [39; 687-688] and an apportioned mean abundance of 238 [41; 715-723] individuals in the Survey Area and Caledonia South Survey Area (Table 129, Table 131). These equated to mean density estimates of 0.26 (unapportioned) and 0.27 (apportioned) mammals/km^2 in the Survey Area and 0.43 (unapportioned) and 0.45 (apportioned) mammals/km^2 in Caledonia South Survey Area (Table 129, Table 131). No records of common dolphins were recorded in Caledonia North Survey Area (Table 12, Table 130).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 129 to Table 131).

Table 129 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of common dolphins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia OWF										
None recorded										
b) Caledonia OWF plus 2 km buffer										
None recorded										
c) Survey Area										
Oct-22	39	229	39	688	0.16	0.26	238	41	715	0.27

Table 130 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of common dolphins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
None recorded										
b) Caledonia North plus 2 km buffer										
None recorded										
c) Caledonia North Survey Area										
None recorded										

Table 131 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of common dolphins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
None recorded										
b) Caledonia South plus 2 km buffer										
Oct-22	6	35	6	104	0.41	0.10	41	12	121	0.11
c) Caledonia South Survey Area										
Oct-22	39	229	39	687	0.16	0.43	241	41	723	0.45

ii. Distribution and behaviour

Common dolphins were only recorded during October 2022, when they were recorded in the southwest of the Survey Area within Caledonia South Buffer Zone (Appendix 4, Figure A4.333).

4.41 White-beaked dolphin

i. Abundance and density estimates

A total of 64 white-beaked dolphins were recorded in the Survey Area during both years of baseline surveys (Table 11). White-beaked dolphins were recorded from September 2021 to February 2022, September and October 2022 and January and February 2023 (Table 11, Table 132). In the Survey Area, a peak of 14 white-beaked dolphins were recorded in September 2022, resulting in an unapportioned mean abundance estimate of 82 [14; 175] and an apportioned mean abundance estimate of 81 [14; 187] individuals (Table 132). Both equated to a mean density estimate of 0.09 mammals/km^2 (Table 132).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 132).

Table 132 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of white-beaked dolphins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a)	**Caledonia OWF**									
Oct-21	2	12	2	35	0.71	0.03	20	3	65	0.05
Nov-21	8	46	8	116	0.35	0.11	52	9	127	0.12
Dec-21	7	41	7	122	0.38	0.10	41	7	122	0.1
Jan-22	0	-	-	-	-	-	18	3	52	0.04
Feb-22	4	22	4	65	0.50	0.05	32	6	97	0.07
Sep-22	14	81	14	162	0.27	0.19	81	16	174	0.19
Oct-22	2	12	2	35	0.71	0.03	18	3	53	0.04
Jan-23	2	12	2	35	0.71	0.03	12	2	35	0.03
Feb-23	6	34	6	103	0.41	0.08	34	6	103	0.08
b)	**Caledonia OWF plus 2 km buffer**									
Oct-21	2	12	2	35	0.71	0.02	20	3	63	0.03
Nov-21	8	46	8	109	0.35	0.07	63	11	155	0.1
Dec-21	7	40	7	120	0.38	0.06	40	7	120	0.06
Jan-22	0	-	-	-	-	-	14	3	43	0.02
Feb-22	4	21	4	64	0.50	0.03	32	6	96	0.05
Sep-22	14	81	23	173	0.27	0.13	81	16	179	0.13
Oct-22	2	12	2	35	0.71	0.02	18	3	52	0.03
Dec-22	0	-	-	-	-	-	3	0	10	-
Jan-23	2	12	2	35	0.71	0.02	12	2	35	0.02
Feb-23	6	34	6	103	0.41	0.05	34	6	103	0.05
c)	**Survey Area**									
Sep-21	2	12	2	35	0.71	0.01	20	3	54	0.02
Oct-21	2	12	2	35	0.71	0.01	20	3	64	0.02
Nov-21	8	47	8	116	0.35	0.05	82	14	198	0.09
Dec-21	7	41	7	122	0.38	0.05	41	7	122	0.05
Jan-22	3	17	3	52	0.58	0.02	36	6	104	0.04
Feb-22	8	44	8	110	0.35	0.05	53	10	137	0.06
Sep-22	14	82	14	175	0.27	0.09	81	14	187	0.09
Oct-22	9	53	9	135	0.33	0.06	56	9	155	0.06
Dec-22	0	-	-	-	-	-	6	1	18	0.01
Jan-23	5	29	5	59	0.45	0.03	30	5	82	0.03
Feb-23	6	35	6	104	0.41	0.04	35	6	104	0.04

A total of 43 white-beaked dolphins were recorded in Caledonia North Survey Area during both years of baseline surveys (Table 12). Peak abundance was recorded in October 2022, with 9 individuals recorded (Table 133). This resulted in an unapportioned and apportioned mean abundance estimate of 53 [9; 135] individuals, which both equated to a mean density estimate of 0.10 mammals/km^2 (Table 133).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 133).

Table 133 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of white-beaked dolphins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
Oct-21	2	12	2	35	0.71	0.05	36	6	105	0.16
Nov-21	3	18	3	53	0.58	0.08	18	3	53	0.08
Sep-22	8	46	8	92	0.35	0.21	46	8	109	0.21
Oct-22	2	12	2	35	0.71	0.05	12	2	35	0.05
Jan-23	2	12	2	35	0.71	0.05	12	2	35	0.05
Feb-23	6	35	6	104	0.41	0.16	35	6	104	0.16
b) Caledonia North plus 2 km buffer										
Oct-21	2	11	2	34	0.71	0.03	29	5	97	0.08
Nov-21	3	17	3	51	0.58	0.05	23	4	68	0.06
Feb-22	4	21	4	64	0.50	0.06	21	4	64	0.06
Sep-22	8	46	8	116	0.35	0.12	46	8	111	0.12
Oct-22	2	12	2	35	0.71	0.03	12	2	35	0.03
Jan-23	2	12	2	35	0.71	0.03	12	2	35	0.03
Feb-23	6	34	6	103	0.41	0.09	34	6	103	0.09
c) Caledonia North Survey Area										
Oct-21	2	12	2	35	0.71	0.02	21	3	64	0.04
Nov-21	8	47	8	111	0.35	0.08	70	12	181	0.13
Feb-22	8	44	8	110	0.35	0.08	55	10	139	0.10
Sep-22	8	47	8	116	0.35	0.08	46	8	117	0.08
Oct-22	9	53	9	135	0.33	0.10	53	9	135	0.10
Jan-23	2	12	2	35	0.71	0.02	12	2	35	0.02
Feb-23	6	35	6	104	0.41	0.06	35	6	104	0.06

A total of 37 white-beaked dolphins were recorded in Caledonia South Survey Area during both years of baseline surveys (Table 13). Peak abundance was recorded in November 2021 and February 2022, both with 8 individuals recorded. This resulted in an unapportioned mean abundance estimate of 46 [8; 121] and an apportioned mean abundance estimate of 63 [11; 161] individuals in In November 2021 (Table 134), which equated to mean density estimates of 0.09 (unapportioned) and 0.12 (apportioned) mammals/km^2 (Table 134). In February, the eight individuals recorded resulted in an unapportioned mean abundance estimate of 43 [8; 109] and apportioned mean abundance estimate of 54 [10; 141] individuals (Table 134). These equated to mean density estimates of 0.08 (unapportioned) and 0.10 (apportioned) mammals/km^2 (Table 134).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 134).

Table 134 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of white-beaked dolphins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Nov-21	5	29	5	86	0.45	0.14	35	6	103	0.17
Dec-21	7	41	7	122	0.38	0.19	41	7	122	0.19

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Jan-22	-	-	-	-	-	-	18	3	52	0.09
Feb-22	4	22	4	65	0.50	0.10	32	6	97	0.15
Sep-22	6	35	6	105	0.41	0.17	35	6	104	0.17
Oct-22	-	-	-	-	-	-	4	1	12	0.02
b) Caledonia South plus 2 km buffer										
Sep-21	-	-	-	-	-	-	3	3	10	0.01
Nov-21	8	46	8	114	0.35	0.13	63	25	155	0.18
Dec-21	7	40	7	121	0.38	0.11	40	7	121	0.11
Jan-22	-	-	-	-	-	-	17	17	51	0.05
Feb-22	4	21	4	64	0.50	0.06	32	15	96	0.09
Sep-22	6	34	6	103	0.41	0.09	35	6	103	0.10
c) Caledonia South Survey Area										
Sep-21	2	12	2	35	0.71	0.02	18	3	52	0.03
Nov-21	8	46	8	121	0.35	0.09	63	11	161	0.12
Dec-21	7	40	7	121	0.38	0.07	40	7	121	0.07
Jan-22	3	17	3	52	0.58	0.03	36	6	104	0.07
Feb-22	8	43	8	109	0.35	0.08	54	10	141	0.10
Sep-22	6	35	6	105	0.41	0.07	35	6	106	0.07
Jan-23	3	18	3	41	0.58	0.03	18	3	41	0.03

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.334-343. White-beaked dolphins were overall loosely scattered across the Survey Area with a higher number of records in Caledonia South. They were recorded in the southeast during September 2021 (Figure A4.334), in central and southwestern areas close to the subdivision boundary between Caledonia North and South in October and November 2021, and February and September 2022 (Figures A4.335-336, 339-340), in the south in December 2021 (Figure A4.337), in the northeast to east in January and October 2022 (Figure A4.338, 341), and north in February 2023 (Figure A4.343). Individuals were more loosely distributed across both northern and southern parts of the Survey Area in January 2023 (Figure A4.342).

4.42 Bottlenose dolphin

i. Abundance and density estimates

Two bottlenose dolphins were recorded in Caledonia OWF in May 2022, specifically in Caledonia North (Table 11, Table 12, Table 135, Table 136). The abundance and density estimates were therefore very low (Table 135 to Table 136). No records of bottlenose dolphins in Caledonia South Survey Area were made (Table 137).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 135 to Table 137).

Table 135 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km²) of bottlenose dolphins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia OWF										
May-22	2	12	2	35	0.71	0.03	14	2	42	0.03

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
b) Caledonia OWF plus 2 km buffer										
May-22	2	11	2	34	0.71	0.02	12	2	40	0.02
c) Survey Area										
May-22	2	12	2	35	0.71	0.01	13	2	40	0.02

Table 136 Raw counts, unapportioned abundance and density estimates (mammals per km²) of bottlenose dolphins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia North										
May-22	2	12	2	35	0.71	0.05	12	2	35	0.05
b) Caledonia North plus 2 km buffer										
May-22	2	11	2	34	0.71	0.03	11	2	34	0.03
c) Caledonia North Survey Area										
May-22	2	12	2	35	0.71	0.02	12	2	35	0.05

Table 137 Raw counts, unapportioned abundance and density estimates (mammals per km²) of bottlenose dolphins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia South										
None recorded										
b) Caledonia South plus 2 km buffer										
None recorded										
c) Caledonia South Survey Area										
None recorded										

ii. Distribution and behaviour

Two bottlenose dolphins were recorded in May 2022 within the northwest of the Survey Area towards the western border between Caledonia North and its Buffer Zone (Appendix 4, Figure A4.344).

4.43 Risso's dolphin

i. Abundance and density estimates

A total of seven Risso's dolphins were recorded in the Survey Area during the second year of the baseline surveys (Table 11). Risso's dolphins were recorded in August and September 2022 (Table 11, Table 138). Specifically, two individuals were recorded in August 2022, in Caledonia South and five individuals were recorded in September 2022 in Caledonia North plus 2 km buffer (Table 11 to Table 13, Table 138 to Table 140). Abundance and density estimates were therefore very low in august 2022 (Table 138 to Table 139). In the Survey Area and Caledonia North Survey Area, the September 2022 peak of five Risso's dolphins resulted in an unapportioned and apportioned mean abundance estimate of 29 [5; 87-88] individuals, which equated to mean density estimates of 0.03 mammals/km² in the Survey Area and 0.5 mammals/km² in Caledonia North Survey Area (Table 138 to Table 140).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16; Table 138 to Table 140).

Table 138 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of Risso's dolphins in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF										
Jun-21	0	-	-	-	-	-	6	1	18	0.01
Aug-22	2	12	2	35	0.71	0.03	12	2	34	0.03
b) Caledonia OWF plus 2 km buffer										
Jun-21	0	-	-	-	-	-	6	1	17	0.01
Aug-22	2	11	2	34	0.71	0.02	12	2	34	0.02
Sep-22	5	29	5	87	0.45	0.05	29	5	87	0.05
c) Survey Area										
Jun-21	0	-	-	-	-	-	6	1	18	0.01
Aug-22	2	11	2	34	0.71	0.01	12	2	34	0.01
Sep-22	5	29	5	88	0.45	0.03	29	5	88	0.03

Table 139 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of Risso's dolphins in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North										
None recorded										
b) Caledonia North plus 2 km buffer										
Sep-22	5	29	5	87	0.45	0.08	29	5	87	0.08
c) Caledonia North Survey Area										
Sep-22	5	29	5	87	0.45	0.05	29	5	87	0.05

Table 140 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of Risso's dolphins in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South										
Aug-22	2	12	2	35	0.71	0.06	12	2	34	0.06
b) Caledonia South plus 2 km buffer										
Jun-21	-	-	-	-	-	-	6	6	17	0.02
Aug-22	2	11	2	34	0.71	0.03	12	2	34	0.03
c) Caledonia South Survey Area										
Jun-21	-	-	-	-	-	-	6	1	17	0.01
Aug-22	2	11	2	34	0.71	0.02	12	2	34	0.02

ii. Distribution and behaviour

Risso's dolphins were recorded in the southeast of the Survey Area within Caledonia South during August 2022 (Appendix 4, Figure A4.345), while individuals recorded in September 2022 occurred in the northwest of Caledonia North Buffer Zone close to the boundary with the Caledonia North (Appendix 4, Figure A4.346).

4.44 Unidentified dolphin species

i. Abundance and density estimates

Three unidentified dolphins were recorded in the Survey Area during the first year of surveys, none were recorded the second year of surveys (Table 11). A single unidentified dolphin was recorded in June 2021 in Caledonia North, while two individuals were recorded in January 2022 in Caledonia South (Table 141 to Table 143). In both months, abundance and density estimates were therefore very low (Table 141 to Table 143). Unidentified dolphins have been used for apportioning to species level where possible.

Table 141 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of dolphin species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
Jun-21	1	6	1	18	1.00	0.01
Jan-22	2	12	2	35	0.71	0.03
b) Caledonia OWF plus 2 km buffer						
Jun-21	1	6	1	17	1.00	0.01
Jan-22	2	11	2	34	0.71	0.02
c) Survey Area						
Jun-21	1	6	1	18	1.00	0.01
Jan-22	2	12	2	35	0.71	0.01

Table 142 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of dolphin species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
Jun-21	1	6	1	18	1.00	0.03
b) Caledonia North plus 2 km buffer						
Jun-21	1	6	1	17	1.00	0.02
c) Caledonia North Survey Area						
Jun-21	1	6	1	18	1.00	0.01

Table 143 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of dolphin species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
Jan-22	2	12	2	35	0.71	0.06
b) Caledonia South plus 2 km buffer						
Jun-21	1	6	1	17	1.00	0.02
Jan-22	2	11	2	34	0.71	0.03
c) Caledonia South Survey Area						
Jun-21	1	6	1	17	1.00	0.01
Jan-22	2	12	2	35	0.71	0.02

ii. Distribution and behaviour

Unidentified dolphins were recorded in the southern part of Caledonia North in June 2021 (Appendix 4, Figure A4.347) and in the east of Caledonia South in January 2022 (Appendix 4, Figure A4.348).

4.45 Harbour porpoise

i. Abundance and density estimates

A total of 141 harbour porpoises were recorded in the Survey Area during both years of baseline surveys (Table 11). Harbour porpoises were recorded throughout the year, except in August and November 2021, January and October 2022 (Table 11, Table 144). They were most abundant in October 2021 in Caledonia OWF, in July 2022 in Caledonia plus 2 km buffer and in June 2022 in the Survey area (Table 144):

- 12 individuals were recorded in Caledonia OWF in October 2021, resulting in an unapportioned mean abundance estimate of 70 [12; 158], an apportioned mean abundance estimate of 110 [21; 268] and an apportioned and availability bias-corrected mean abundance estimate of 242 [46; 589] individuals. These equated to mean density estimates of 0.16 (unapportioned), 0.26 (apportioned) and 0.57 (apportioned and availability bias-corrected) mammals/km^2.
- 15 individuals were recorded in Caledonia OWF plus 2 km buffer in July 2022, resulting in an unapportioned mean abundance estimate of 86 [23; 173], an apportioned mean abundance estimate of 87 [18; 190] and an apportioned and availability bias-corrected mean abundance estimate of 159 [33; 347] individuals. These equated to mean density estimates of 0.13 (unapportioned), 0.14 (apportioned) and 0.25 (apportioned and availability bias-corrected) mammals/km^2.
- 22 individuals were recorded in the Survey Area in June 2022, resulting in an unapportioned mean abundance estimate of 127 [75; 185], an apportioned mean abundance estimate of 160 [61; 278] and an apportioned and availability bias-corrected mean abundance estimate of 293 [111; 508] individuals. These equated to mean density estimates of 0.14 (unapportioned), 0.18 (apportioned) and 0.33 (apportioned and availability bias-corrected) mammals/km^2.

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16, Table 144).

Table 144 Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (mammals per km^2) of harbour porpoises in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia OWF														
May-21	1	6	1	17	1.00	0.01	23	4	69	0.05	40	7	121	0.09
Jun-21	2	12	2	29	0.71	0.03	18	3	41	0.04	33	5	75	0.08
Jul-21	0	-	-	-	-	-	6	1	18	0.01	11	2	33	0.03
Sep-21	1	6	1	17	1.00	0.01	12	2	34	0.03	26	4	75	0.06
Oct-21	12	70	12	158	0.29	0.16	110	21	268	0.26	242	46	589	0.57
Dec-21	1	6	1	17	1.00	0.01	6	1	17	0.01	13	2	36	0.03
Mar-22	6	32	6	70	0.41	0.07	43	8	97	0.1	75	14	170	0.18
Apr-22	5	29	5	58	0.45	0.07	29	5	75	0.07	51	9	131	0.12
May-22	5	29	6	52	0.45	0.07	33	7	62	0.08	58	12	109	0.14
Jun-22	7	40	11	80	0.38	0.09	68	14	133	0.16	124	25	243	0.29
Jul-22	10	58	12	111	0.32	0.14	59	13	117	0.14	108	24	214	0.25
Aug-22	4	23	4	52	0.50	0.05	23	4	46	0.05	42	7	84	0.1
Sep-22	7	41	12	69	0.38	0.1	40	7	99	0.09	88	15	218	0.21
Nov-22	1	6	1	18	1.00	0.01	6	1	18	0.01	13	2	40	0.03
Jan-23	2	12	2	29	0.71	0.03	12	2	29	0.03	25	4	61	0.06
Feb-23	4	23	4	57	0.50	0.05	23	4	57	0.05	49	8	121	0.11
Mar-23	3	18	3	35	0.58	0.04	18	3	47	0.04	32	5	82	0.07
Apr-23	1	6	1	17	1.00	0.01	12	2	34	0.03	21	4	60	0.05
b) Caledonia OWF plus 2 km buffer														
May-21	3	17	3	46	0.58	0.03	34	6	98	0.05	60	11	172	0.09
Jun-21	2	12	2	23	0.71	0.02	12	3	46	0.02	33	5	84	0.05
Jul-21	1	6	1	17	1.00	0.01	6	3	46	0.01	33	5	84	0.05
Aug-21	0	-	-	-	-	-	2	0	6	-	4	1	11	0.01
Sep-21	1	6	1	17	1.00	0.01	17	3	46	0.03	37	7	101	0.06
Oct-21	12	69	12	156	0.29	0.11	108	21	277	0.17	238	46	609	0.37
Dec-21	4	23	4	52	0.50	0.04	23	4	57	0.04	49	8	121	0.08
Jan-22	0	-	-	-	-	-	-	1	9	-	13	1	18	0.02
Feb-22	1	5	1	16	1.00	0.01	5	1	16	0.01	11	2	34	0.02

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Mar-22	7	37	7	74	0.38	0.06	48	9	107	0.07	84	16	187	0.13
Apr-22	6	34	11	62	0.41	0.05	34	6	90	0.05	60	11	158	0.09
May-22	9	51	23	92	0.33	0.08	56	14	109	0.09	98	24	192	0.15
Jun-22	14	80	40	120	0.27	0.12	108	32	203	0.17	198	58	371	0.31
Jul-22	15	86	23	173	0.26	0.13	87	18	190	0.14	159	33	347	0.25
Aug-22	8	46	17	74	0.35	0.07	46	23	74	0.07	84	42	135	0.13
Sep-22	7	40	12	75	0.38	0.06	40	7	104	0.06	88	15	229	0.14
Nov-22	3	17	3	35	0.58	0.03	18	3	46	0.03	40	7	101	0.06
Dec-22	0	-	-	-	-	-	3	1	8	0.01	7	1	17	0.01
Jan-23	3	17	6	35	0.58	0.03	17	6	35	0.03	36	13	74	0.06
Feb-23	7	40	7	86	0.38	0.06	40	7	86	0.06	85	15	182	0.13
Mar-23	7	41	12	75	0.38	0.06	40	7	99	0.06	70	12	173	0.11
Apr-23	3	17	3	40	0.58	0.03	28	5	68	0.04	49	9	119	0.08
c) Survey Area														
May-21	3	18	3	47	0.58	0.02	41	7	117	0.05	72	12	205	0.08
Jun-21	2	12	2	29	0.71	0.01	18	3	47	0.02	33	5	86	0.04
Jul-21	2	12	2	30	0.71	0.01	30	5	66	0.03	55	9	121	0.06
Aug-21	0	-	-	-	-	-	3	1	9	0.00	5	1	16	0.01
Sep-21	3	18	3	35	0.58	0.02	22	4	57	0.02	48	8	125	0.05
Oct-21	12	70	12	158	0.29	0.08	110	19	275	0.12	242	41	605	0.27
Dec-21	4	23	4	52	0.50	0.03	23	4	64	0.03	49	8	136	0.06
Feb-22	2	11	2	27	0.71	0.01	11	2	37	0.01	24	5	78	0.03
Mar-22	8	43	16	86	0.35	0.05	54	14	113	0.06	95	25	198	0.11
Apr-22	6	35	6	69	0.41	0.04	34	6	92	0.04	60	11	161	0.07
May-22	10	58	17	105	0.32	0.07	63	16	133	0.07	110	28	232	0.12
Jun-22	22	127	75	185	0.21	0.14	160	61	278	0.18	293	111	508	0.33
Jul-22	19	111	47	193	0.23	0.13	111	36	205	0.13	203	66	375	0.23
Aug-22	8	46	17	75	0.35	0.05	46	17	75	0.05	84	31	137	0.1
Sep-22	9	53	12	93	0.33	0.06	52	9	117	0.06	114	20	257	0.13
Nov-22	4	24	6	41	0.50	0.03	24	4	58	0.03	53	9	127	0.06
Dec-22	1	6	1	18	1.00	0.01	6	1	18	0.01	13	2	38	0.01
Jan-23	3	18	6	35	0.58	0.02	18	3	35	0.02	38	6	74	0.04
Feb-23	9	52	12	93	0.33	0.06	52	12	98	0.06	110	25	208	0.12

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
Mar-23	10	59	23	112	0.32	0.07	58	10	140	0.07	102	18	245	0.11
Apr-23	4	23	4	52	0.50	0.03	40	7	80	0.05	70	12	140	0.08

A total of 75 harbour porpoises were recorded in Caledonia North Survey Area and 102 in Caledonia South Survey Area during both years of baseline surveys (Table 12, Table 13). Harbour porpoises were mostly recorded low numbers (≤8) in Caledonia North and Caledonia South plus 2 km buffer. In Caledonia North Survey Area, peak numbers reached 14 individuals in July 2022 (Table 145). This resulted in an unapportioned and apportioned mean abundance estimates of 82 [23; 164-170] and an apportioned and availability bias-corrected mean abundance estimate of 150 [42; 311] individuals (Table 145). These equated to mean density estimates of 0.15 (unapportioned), 0.15 (apportioned) and 0.27 (apportioned and availability bias-corrected) mammals/km^2 (Table 145).

Similarly, harbour porpoises were mostly recorded low numbers (≤10) in Caledonia South and Caledonia plus 2 km buffer while they were recorded in higher number in Caledonia South Survey Area, where peak numbers reached 14 individuals in June and July 2022 (Table 146). In June 2022, this resulted in an estimated unapportioned mean abundance of 81 [41; 116], an apportioned mean abundance of 103 [41; 197] and an apportioned and availability bias-corrected mean abundance of 188 [75; 360] individuals (Table 146). These equated to mean density estimates of 0.15 (unapportioned), 0.19 (apportioned) and 0.35 (apportioned and availability bias-corrected) mammals/km^2 (Table 146). In July 2022, the peak of 14 individuals resulted in an estimated unapportioned mean abundance estimate of 81 [35; 127], an apportioned mean abundance estimate of 81 [30; 139] and an apportioned and availability bias-corrected mean abundance estimate of 148 [55; 254] individuals (Table 146). These equated to mean density estimates of 0.15 (unapportioned), 0.15 (apportioned) and 0.28 (apportioned and availability bias-corrected) mammals/km^2 (Table 146).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16, Table 145 and Table 146).

Table 145 **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (mammals per km^2) of harbour porpoises in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia North														
May-21	1	6	1	17	1.00	0.03	6	1	17	0.03	11	2	30	0.02
Jun-21	2	12	2	30	0.71	0.05	12	2	30	0.05	22	4	55	0.04
Aug-21	0	-	-	-	-	-	6	1	17	0.03	11	2	31	0.02
Sep-21	1	6	1	17	1.00	0.03	6	1	17	0.03	13	2	37	0.02
Oct-21	3	18	3	53	0.58	0.08	42	7	123	0.19	91	15	270	0.16
Mar-22	3	16	3	37	0.58	0.07	16	3	37	0.07	28	5	65	0.05
Apr-22	4	23	6	46	0.50	0.11	23	4	57	0.11	40	7	100	0.07
May-22	2	12	2	23	0.71	0.05	12	2	23	0.05	21	4	40	0.04
Jun-22	1	6	1	17	1.00	0.03	18	3	51	0.08	33	5	93	0.06
Jul-22	5	29	5	76	0.45	0.13	29	5	76	0.13	53	9	139	0.1
Aug-22	1	6	1	17	1.00	0.03	6	1	17	0.03	11	2	31	0.02
Sep-22	3	17	3	40	0.58	0.08	17	3	51	0.08	37	7	112	0.07
Nov-22	1	6	1	18	1.00	0.03	6	1	18	0.03	13	2	40	0.02
Jan-23	1	6	1	17	1.00	0.03	6	1	17	0.03	13	2	36	0.02
Mar-23	1	6	1	18	1.00	0.03	6	1	18	0.03	11	2	32	0.02
Apr-23	2	11	2	23	0.71	0.05	11	2	23	0.05	19	4	40	0.03
b) Caledonia North plus 2 km buffer														
May-21	1	6	1	17	1.00	0.02	6	1	17	0.02	11	2	30	0.03
Jun-21	2	12	2	23	0.71	0.03	12	2	29	0.03	22	4	53	0.06
Jul-21	0	-	-	-	-	-	6	1	17	0.02	11	2	31	0.03
Aug-21	0	-	-	-	-	-	6	1	17	0.02	11	2	31	0.03
Sep-21	1	6	1	17	1.00	0.02	17	3	45	0.05	37	7	99	0.10
Oct-21	4	23	4	57	0.50	0.06	51	9	131	0.14	112	19	288	0.30
Dec-21	1	6	1	17	1.00	0.02	6	1	17	0.02	13	2	36	0.03
Feb-22	1	5	1	16	1.00	0.01	5	1	16	0.01	11	2	34	0.03
Mar-22	3	16	3	37	0.58	0.04	21	4	59	0.06	37	7	103	0.10
Apr-22	5	28	6	51	0.45	0.07	28	5	67	0.07	49	9	117	0.13

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
May-22	2	11	2	28	0.71	0.03	11	2	28	0.03	19	4	49	0.05
Jun-22	5	29	6	63	0.45	0.08	41	7	97	0.11	75	13	177	0.20
Jul-22	8	46	8	126	0.35	0.12	46	8	132	0.12	84	15	241	0.22
Aug-22	2	11	2	29	0.71	0.03	11	2	29	0.03	20	4	53	0.05
Sep-22	3	17	3	41	0.58	0.05	18	3	52	0.05	40	7	114	0.11
Nov-22	3	17	6	35	0.58	0.05	18	3	46	0.05	40	7	101	0.11
Jan-23	2	12	2	29	0.71	0.03	12	2	23	0.03	25	4	49	0.07
Mar-23	3	17	3	41	0.58	0.05	18	3	52	0.05	32	5	91	0.08
Apr-23	3	17	6	34	0.58	0.05	23	7	51	0.06	40	12	89	0.11
c) Caledonia North Survey Area														
May-21	1	6	1	18	1.00	0.01	12	2	36	0.02	21	4	63	0.04
Jun-21	2	12	2	30	0.71	0.02	12	2	30	0.02	22	4	55	0.04
Jul-21	0	-	-	-	-	-	12	2	30	0.02	22	4	55	0.04
Aug-21	0	-	-	-	-	-	6	1	17	0.01	11	2	31	0.02
Sep-21	3	18	3	35	0.58	0.03	30	5	76	0.05	66	11	167	0.12
Oct-21	11	64	11	152	0.30	0.11	103	18	274	0.19	227	39	602	0.41
Dec-21	1	6	1	17	1.00	0.01	6	1	17	0.01	13	2	36	0.02
Feb-22	2	11	2	28	0.71	0.02	13	2	39	0.02	29	5	83	0.05
Mar-22	4	22	4	43	0.50	0.04	27	5	65	0.05	47	9	114	0.08
Apr-22	5	29	6	52	0.45	0.05	29	5	75	0.05	51	9	131	0.09
May-22	2	12	2	29	0.71	0.02	12	2	29	0.02	21	4	51	0.04
Jun-22	9	52	17	87	0.33	0.09	69	16	145	0.12	125	29	266	0.22
Jul-22	14	82	23	164	0.27	0.15	82	23	170	0.15	150	42	311	0.27
Aug-22	3	17	3	34	0.58	0.03	17	3	34	0.03	31	5	62	0.06
Sep-22	6	35	6	64	0.41	0.06	35	6	81	0.06	77	13	178	0.14
Nov-22	3	18	3	35	0.58	0.03	18	3	47	0.03	40	7	103	0.07
Jan-23	2	12	2	29	0.71	0.02	12	2	29	0.02	25	4	61	0.05
Mar-23	4	23	4	59	0.50	0.04	24	4	71	0.04	42	7	124	0.08
Apr-23	3	17	3	34	0.58	0.03	23	7	51	0.04	40	12	89	0.07

Table 146 **Raw counts, unapportioned, apportioned, and apportioned and availability bias-corrected abundance and density estimates (mammals per km^2) of harbour porpoises in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period**

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
a) Caledonia South														
May-21	0	-	-	-	-	-	17	3	52	0.08	30	5	91	0.14
Jun-21	0	-	-	-	-	-	6	1	17	0.03	11	2	31	0.05
Jul-21	0	-	-	-	-	-	6	1	18	0.03	11	2	33	0.05
Sep-21	0	-	-	-	-	-	6	1	17	0.03	13	2	37	0.06
Oct-21	9	53	9	135	0.33	0.25	53	9	141	0.25	116	20	310	0.55
Dec-21	1	6	1	17	1.00	0.03	6	1	17	0.03	13	2	36	0.06
Mar-22	3	16	3	38	0.58	0.08	27	5	70	0.13	47	9	123	0.22
Apr-22	1	6	1	17	1.00	0.03	6	1	17	0.03	11	2	30	0.05
May-22	3	17	6	35	0.58	0.08	23	4	52	0.11	40	7	91	0.19
Jun-22	6	35	6	75	0.41	0.17	52	9	116	0.25	95	16	212	0.45
Jul-22	5	29	5	64	0.45	0.14	29	5	75	0.14	53	9	137	0.25
Aug-22	3	17	3	40	0.58	0.08	17	3	46	0.08	31	5	84	0.15
Sep-22	4	23	4	47	0.50	0.11	23	4	58	0.11	51	9	127	0.24
Oct-22	-	-	-	-	-	-	2	-	6	0.01	5	1	13	0.02
Jan-23	1	6	1	18	1.00	0.03	6	1	18	0.03	13	2	38	0.06
Feb-23	4	23	4	63	0.50	0.11	23	4	57	0.11	49	8	121	0.23
Mar-23	2	12	2	29	0.71	0.06	12	2	29	0.06	21	4	51	0.1
Apr-23	-	-	-	-	-	-	6	1	17	0.03	11	2	30	0.05
b) Caledonia South plus 2 km buffer														
May-21	2	12	2	29	0.71	0.03	29	19	86	0.08	51	33	151	0.14
Jun-21	1	6	1	17	1.00	0.02	12	7	34	0.03	22	13	62	0.06
Jul-21	1	6	1	17	1.00	0.02	12	7	34	0.03	22	13	62	0.06
Sep-22	0	-	-	-	-	-	3	3	7	0.01	6	6	15	0.02
Oct-21	10	58	10	139	0.32	0.16	58	10	145	0.16	127	22	319	0.35
Dec-21	4	23	6	46	0.50	0.06	23	4	63	0.06	49	8	133	0.14
Mar-22	4	21	5	48	0.50	0.06	32	15	74	0.09	56	26	130	0.16
Apr-22	2	11	2	34	0.71	0.03	11	2	34	0.03	19	4	60	0.05

Survey	Raw count	Total unapportioned					Total apportioned				Total apportioned and bias-corrected			
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)	Abundance	LCL	UCL	Density (km^2)	Abundance	LCL	UCL	Density (km^2)
May-22	7	40	17	63	0.38	0.11	46	19	92	0.13	81	33	161	0.22
Jun-22	10	57	23	91	0.32	0.16	73	30	153	0.20	133	55	280	0.37
Jul-22	9	52	17	98	0.33	0.14	52	13	98	0.14	95	24	179	0.26
Aug-22	7	40	11	69	0.38	0.11	40	11	69	0.11	73	20	126	0.2
Sep-22	5	29	5	63	0.45	0.08	29	5	74	0.08	64	11	163	0.18
Nov-22	1	6	1	17	1.00	0.02	6	1	17	0.02	13	2	37	0.04
Dec-22	0	-	-	-	-	-	6	6	17	0.02	13	13	36	0.04
Jan-23	1	6	1	17	1.00	0.02	6	1	17	0.02	13	2	36	0.04
Feb-23	7	40	7	86	0.38	0.11	40	7	86	0.11	85	15	182	0.24
Mar-23	4	23	6	40	0.50	0.06	24	4	52	0.07	42	7	91	0.12
Apr-23	1	6	1	17	1.00	0.02	12	7	34	0.03	21	12	60	0.06
c) Caledonia South Survey Area														
May-21	3	17	3	46	0.58	0.03	35	6	98	0.07	61	11	172	0.11
Jun-21	1	6	1	17	1.00	0.01	12	2	34	0.02	22	4	62	0.04
Jul-21	2	12	2	30	0.71	0.02	18	3	48	0.03	33	5	88	0.06
Sep-21	1	6	1	17	1.00	0.01	6	1	17	0.01	13	2	37	0.02
Oct-21	10	58	10	145	0.32	0.11	104	18	284	0.19	229	40	624	0.43
Dec-21	4	23	4	46	0.50	0.04	23	4	63	0.04	49	8	133	0.09
Mar-22	5	27	5	54	0.45	0.05	37	8	81	0.07	65	14	142	0.12
Apr-22	3	17	3	46	0.58	0.03	17	3	51	0.03	30	5	89	0.06
May-22	9	52	17	103	0.33	0.10	57	15	120	0.11	100	26	210	0.19
Jun-22	14	81	41	116	0.27	0.15	103	41	197	0.19	188	75	360	0.35
Jul-22	14	81	35	127	0.27	0.15	81	30	139	0.15	148	55	254	0.28
Aug-22	7	40	11	69	0.38	0.07	40	11	69	0.07	73	20	126	0.14
Sep-22	5	29	5	58	0.45	0.05	29	5	76	0.05	64	11	167	0.12
Nov-22	2	12	2	29	0.71	0.02	12	2	36	0.02	26	4	79	0.05
Dec-22	1	6	1	18	1.00	0.01	12	2	36	0.02	25	4	76	0.05
Jan-23	2	12	2	29	0.71	0.02	12	2	29	0.02	25	4	61	0.05
Feb-23	9	52	12	92	0.33	0.10	52	12	98	0.10	110	25	208	0.21
Mar-23	0	-	-	-	-	-	46	8	111	0.09	81	14	194	0.15
Apr-23	0	-	-	-	-	-	22	4	58	0.04	39	7	102	0.07

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.349-368. Harbour porpoises overall did not show any specific distributional pattern and were scattered across the Survey Area. They were recorded in central and eastern parts of the Survey Area during May 2021 and November 2022 (Figures A4.349, 363), whereas the individuals in June and October 2021 were recorded in the central west (Figures A4.350, 353). They were recorded in the central parts of the Survey Area, in the south of Caledonia North Survey Area in September 2021 (Figures A4.352). Individuals were recorded in the south in December 2022 (Figure A4.364), and individuals in January 2023 were recorded in the central west and south (Figure A4.365). In July 2021, harbour porpoises were recorded in the southwest and northeast of Caledonia South Buffer Zone (Figure A4.351). More loose distribution was observed between December 2021 and June 2022, and in September 2022 and April 2023, with records stretching from the northwest to south and east of the Survey Area (Figures A4.354-359, 362, 368). While distribution remained scattered, most records during July and August 2022, and during February and March 2023 were in the southern half of the Survey Area (Figures A4.360-361, 366-367).

4.46 Unidentified dolphin and / or porpoise species

i. Abundance and density estimates

A total of 39 unidentified dolphins and / or porpoises were recorded in the Survey Area during both years of baseline surveys (Table 11). Dolphins and / or porpoises were recorded in the Survey Area in every survey, except in August and December 2021, April 2022, from July to September 2022 and from November 2022 to March2023 (Table 11, Table 147). In the Survey Area, a peak of eight individuals were recorded in October 2021, resulting in an unapportioned abundance estimate of 47 [8; 140] individuals, which equated to a mean density estimate of 0.05 mammals/km^2 (Table 147). Unidentified dolphin and / or porpoises have been used for apportioning to species level where possible.

Table 147 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of unidentified dolphin and / or porpoise species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
May-21	3	17	3	52	0.58	0.04
Jun-21	1	6	1	18	<1	0.01
Jul-21	1	6	1	18	<1	0.01
Sep-21	1	6	1	17	<1	0.01
Oct-21	8	47	8	140	0.35	0.11
Nov-21	1	6	1	17	<1	0.01
Jan-22	1	6	1	17	<1	0.01
Feb-22	2	11	2	32	0.71	0.03
Mar-22	2	11	2	27	0.71	0.03
May-22	1	6	1	17	<1	0.01
Jun-22	4	23	4	46	0.50	0.05
Oct-22	1	6	1	18	<1	0.01
Apr-23	1	6	1	17	<1	0.01
b) Caledonia OWF plus 2 km						
May-21	3	17	3	52	0.58	0.03
Jun-21	1	6	1	17	<1	0.01
Jul-21	2	12	2	29	0.71	0.02
Sep-21	2	11	2	29	0.71	0.02

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
Oct-21	8	46	8	138	0.35	0.07
Nov-21	3	17	3	46	0.58	0.03
Jan-22	1	6	1	17	<1	0.01
Feb-22	2	11	2	32	0.71	0.02
Mar-22	2	11	2	27	0.71	0.02
May-22	1	6	1	17	<1	0.01
Jun-22	4	23	4	46	0.50	0.04
Oct-22	1	6	1	17	<1	0.01
Apr-23	2	11	2	28	0.71	0.02
c) Survey Area						
May-21	4	23	4	70	0.50	0.03
Jun-21	1	6	1	18	<1	0.01
Jul-21	3	18	6	36	0.58	0.02
Sep-21	2	12	2	29	0.71	0.01
Oct-21	8	47	8	140	0.35	0.05
Nov-21	6	35	6	76	0.41	0.04
Jan-22	1	6	1	17	<1	0.01
Feb-22	2	11	2	33	0.71	0.01
Mar-22	2	11	2	27	0.71	0.01
May-22	1	6	1	17	<1	0.01
Jun-22	4	23	4	52	0.50	0.03
Oct-22	2	12	2	35	0.71	0.01
Apr-23	3	17	3	34	0.58	0.02

A total of 22 unidentified dolphins and / or porpoises were recorded in Caledonia North Survey Area, in May, July and from September to November 2021, February, March and June 2022 (Table 12). In the Caledonia North Survey Area, a peak of eight individuals were recorded in October 2021, resulting in an unapportioned abundance estimate of 47 [8; 140] individuals, which equated to a mean density estimate of 0.08 mammals/km^2 (Table 148).

Table 148 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of unidentified dolphin and / or porpoise species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia North						
Oct-21	8	47	8	140	0.35	0.22
Jun-22	1	6	1	17	1.00	0.03
b) Caledonia North plus 2 km buffer						
Jul-21	1	6	1	17	1.00	0.02
Sep-21	2	11	2	28	0.71	0.03
Oct-21	8	46	8	137	0.35	0.12
Nov-21	1	6	1	17	1.00	0.02
Mar-22	1	5	1	16	1.00	0.01
Jun-22	1	6	1	17	1.00	0.02
Apr-23	1	6	1	17	1.00	0.02
c) Caledonia North Survey Area						
May-21	1	6	1	18	1.00	0.01
Jul-21	2	12	2	30	0.71	0.02
Sep-21	2	12	2	29	0.71	0.02
Oct-21	8	47	8	140	0.35	0.08
Nov-21	4	23	4	58	0.50	0.04

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
Feb-22	2	11	2	33	0.71	0.02
Mar-22	1	5	1	16	1.00	0.01
Jun-22	1	6	1	17	1.00	0.01
Apr-23	1	6	1	17	1.00	0.01

A total of 30 unidentified dolphins / porpoise species were recorded in Caledonia South Survey Area, from May to July and from September to November 2021, from January to March, and in May, June and October 2022, and April 2023 (Table 13). In the Caledonia South Survey Area, a peak of eight individuals were recorded in October 2021, resulting in an unapportioned abundance estimate of 46 [8; 139] individuals, which equated to a mean density estimate of 0.09 mammals/km^2 (Table 149).

Table 149 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of unidentified dolphin and / or porpoise species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Toal unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
May-21	3	17	3	52	0.58	0.08
Jun-21	1	6	1	17	1.00	0.03
Jul-21	1	6	1	18	1.00	0.03
Sep-21	1	6	1	17	1.00	0.03
Nov-21	1	6	1	17	1.00	0.03
Jan-22	1	6	1	17	1.00	0.03
Feb-22	2	11	2	32	0.71	0.05
Mar-22	2	11	2	27	0.71	0.05
May-22	1	6	1	17	1.00	0.03
Jun-22	3	17	3	41	0.58	0.08
Oct-22	1	6	1	18	1.00	0.03
Apr-23	1	6	1	17	1.00	0.03
b) Caledonia South plus 2 km buffer						
May-21	3	17	3	52	0.58	0.05
Jun-21	1	6	1	17	1.00	0.02
Jul-21	1	6	1	17	1.00	0.02
Sep-21	1	6	1	17	1.00	0.02
Nov-21	3	17	3	46	0.58	0.05
Jan-22	1	6	1	17	1.00	0.02
Feb-22	2	11	2	32	0.71	0.03
Mar-22	2	11	2	26	0.71	0.03
May-22	1	6	1	17	1.00	0.02
Jun-22	3	17	3	40	0.58	0.05
Oct-22	1	6	1	17	1.00	0.02
Apr-23	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
May-21	3	17	3	52	0.58	0.03
Jun-21	1	6	1	17	1.00	0.01
Jul-21	1	6	1	18	1.00	0.01
Sep-21	1	6	1	17	1.00	0.01
Oct-21	8	46	8	139	0.35	0.09
Nov-21	3	17	3	46	0.58	0.03
Jan-22	1	6	1	17	1.00	0.01
Feb-22	2	11	2	33	0.71	0.02
Mar-22	2	11	2	27	0.71	0.02

Survey	Raw count	Toal unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
May-22	1	6	1	17	1.00	0.01
Jun-22	3	17	3	41	0.58	0.03
Oct-22	2	12	2	35	0.71	0.02
Apr-23	2	11	2	29	0.71	0.02

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figures A4.369-381. Unidentified dolphins and / or porpoises were recorded in Caledonia South and its Buffer zone in June 2021, January to March, and May 2022, and October 2022 (Figures A4.370, 375-378, 380), whereas they were only recorded in Caledonia North in October 2021 (Figure A4.373). They were recorded scattered across both northern and southern parts of the Survey Area in other months, specifically, in the northwest of Caledonia North Buffer Zone and the northeast of Caledonia South in May 2021 (Figure A4.369), in the west and northeast of Caledonia North Buffer Zone and the east of Caledonia South in July 2021 (Figure A4.371), in the northeast of Caledonia North Buffer Zone and west of Caledonia South in September 2021 (Figure A4.372), in the southwest of Caledonia North Buffer Zone, central north of Caledonia South and the southeast of its Buffer Zone in November 2021 (Figure A4.374), in the centre of Caledonia North and the southeast to south of Caledonia South in June 2022 (Figure A4.379), and in the west of Caledonia North Buffer Zone, and the east and west of Caledonia South in April 2023 (Figure A4.381).

4.47 Common minke whale

i. Abundance and density estimates

A total of 12 common minke whale were recorded in the Survey Area during both years of baseline surveys (Table 11). Common minke whales were recorded in the July 2021 and May to July 2022 (Table 11, Table 150). In the Survey Area, a peak of six common minke whales were recorded in July 2021, resulting in an unapportioned mean abundance estimate of 36 [6; 66] and an apportioned mean abundance estimate of 36 [8; 78] individuals (Table 150). Both equated to a mean density estimate of 0.04 mammals/km^2 (Table 150).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16, Table 150).

Table 150 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km^2) of common minke whales in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia OWF										
Jul-21	1	6	1	18	1.00	0.01	6	1	18	0.01
Aug-21	0	-	-	-	-	-	6	1	17	0.01
Jun-22	1	6	1	17	1.00	0.01	7	1	20	0.02
b) Caledonia OWF plus 2 km buffer										
Jul-21	4	23	4	46	0.5	0.04	24	4	58	0.04
Aug-21	0	-	-	-	-	-	4	1	11	0.01
May-22	1	6	1	17	1	0.01	6	1	17	0.01
Jun-22	1	6	1	17	1	0.01	6	1	19	0.01
Jul-22	1	6	1	17	1	0.01	6	1	17	0.01
c) Survey Area										

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
Jul-21	6	36	6	66	0.41	0.04	36	8	78	0.04
May-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-22	2	12	2	29	0.71	0.01	13	2	33	0.01
Jul-22	3	18	3	35	0.58	0.02	18	3	35	0.02

In Caledonia North Survey Area, two common minke whales were recorded in July 2021 (Table 12, Table 151). Abundance and density estimates were therefore very low (Table 151).

Table 151 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km²) of common minke whales in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia North										
None recorded										
b) Caledonia North plus 2 km buffer										
Jul-21	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia North Survey Area										
Jul-21	2	12	2	30	0.71	0.02	12	2	30	0.02

A total of 11 common minke whales were recorded in Caledonia South Survey Area in July 2021 and May to July 2022 (Table 13, Table 152). In Caledonia South Survey Area, a peak of five common minke whales were recorded in July 2021, resulting in an unapportioned and apportioned mean abundance estimate of 30 [5-6; 54-66] individuals and a mean density estimate of 0.06 mammals/km² (Table 152).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each reporting region during each survey (CV > 0.16, Table 152).

Table 152 Raw counts, unapportioned and apportioned abundance and density estimates (mammals per km²) of common minke whales in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia South										
Jul-21	1	6	1	18	1.00	0.03	6	1	18	0.03
Jun-22	1	6	1	17	1.00	0.03	6	1	17	0.03
b) Caledonia South plus 2 km buffer										
Jul-21	4	23	4	47	0.50	0.06	24	4	58	0.07
May-22	1	6	1	17	1.00	0.02	6	1	17	0.02
Jun-22	1	6	1	17	1.00	0.02	6	1	17	0.02
Jul-22	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia South Survey Area										
Jul-21	5	30	6	54	0.45	0.06	30	5	66	0.06
May-22	1	6	1	17	1.00	0.01	6	1	17	0.01
Jun-22	2	12	2	29	0.71	0.02	13	2	32	0.02
Jul-22	3	17	3	35	0.58	0.03	17	6	35	0.03

ii. Distribution and behaviour

Maps of distribution are shown in Appendix 4: Figure A4.382-385. Common minke whales were largely recorded in Caledonia South and its Buffer Zone, though sporadic records further north were also made. They occurred in proximity to Moray East wind turbines in the west and in the south of the Survey Area in July 2021 (Figure A4.382). The single individual in May 2022 was recorded in the northeast of Caledonia South Buffer Zone (Figure A4.383). In June and July 2022, records were more loosely scattered in comparison, but both months included individuals close to the Moray East wind turbines in the west of the Survey Area and individuals further south (Figures A4.384-385).

4.48 Unidentified marine mammal species

i. Abundance and density estimates

A total of four unidentified marine mammals were recorded in the Survey Area during both years of baseline surveys (Table 11). In both August 2021 and December 2022, a single marine mammal was recorded in Caledonia North Survey Area and Caledonia South Survey Area (Table 11 to Table 13, Table 153 to Table 155). The peak abundance was recorded in June 2022, with two individuals recorded in Caledonia North Survey Area (Table 154 to Table 155). The abundance and density estimates were therefore very low (Table 153 to Table 155). Unidentified marine mammal species have been used for apportioning to species level where possible.

Table 153 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of marine mammal species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia OWF						
Aug-21	1	6	1	17	1.00	0.01
Jun-22	1	6	1	17	1.00	0.01
b) Caledonia OWF plus 2 km buffer						
Aug-21	1	6	1	17	1.00	0.01
Jun-22	1	6	1	17	1.00	0.01
Dec-22	1	6	1	18	1.00	0.01
c) Survey Area						
Aug-21	1	6	1	17	1.00	0.01
Jun-22	2	12	2	29	0.71	0.01
Dec-22	1	6	1	18	1.00	0.01

Table 154 Raw counts, unapportioned abundance and density estimates (mammals per km^2) of marine mammal species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
Aug-21	1	6	1	17	1.00	0.03
Jun-22	1	6	1	17	1.00	0.03
b) Caledonia North plus 2 km buffer						
Aug-21	1	6	1	17	1.00	0.02
Jun-22	1	6	1	17	1.00	0.02
c) Caledonia North Survey Area						
Aug-21	1	6	1	17	1.00	0.01
Jun-22	2	12	2	29	0.71	0.02

Table 155 Raw counts, unapportioned abundance and density estimates (mammals per km²) of marine mammal species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km2)
a) Caledonia South						
None recorded						
b) Caledonia South plus 2 km buffer						
Dec-22	1	6	1	17	1.00	0.02
c) Caledonia South Survey Area						
Jun-22	**1**	**6**	1	17	1.00	0.01
Dec-22	**1**	**6**	1	18	1.00	0.01

ii. Distribution and behaviour

A single unidentified marine mammal was recorded in the northeast of Caledonia North in August 2021 (Appendix 4, Figure A4.386), while the individual recorded in December 2022 was located in the southeast of Caledonia South Buffer Zone towards the other end of the Survey Area (Appendix 4, Figure A4.388). In June 2022, the two records were made in northwest of Caledonia North Buffer Zone and the southwest of Caledonia North (Appendix 4, Figure A4.387).

4.49 Basking shark

i. Abundance and density estimates

A single basking shark was recorded in the Survey Area during the second year of the baseline surveys (Table 11, Table 13). The individual was recorded in the November 2022, within Caledonia OWF, specifically in Caledonia South (Table 156 to Table 158). The abundance and density estimates were therefore very low (Table 156 to Table 158).

Measures of precisions were high (indicating lower levels of precision), which is likely related to the low numbers of individuals recorded in each region (CV > 0.16, Table 156 to Table 158).

Table 156 Raw counts, unapportioned and apportioned abundance and density estimates (individuals per km²) of basking sharks in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia OWF										
Nov-22	1	6	1.00	18	1	0.01	6	1	18	0.01
b) Caledonia OWF plus 2 km buffer										
Nov-22	1	6	1.00	17	1	0.01	6	1	17	0.01
c) Survey Area										
Nov-22	1	6	1.00	18	1	0.01	6	1	17	0.01

Table 157 Raw counts, unapportioned and apportioned abundance and density estimates (individuals per km²) of basking shark in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia North										
None recorded										

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
b) Caledonia North plus 2 km buffer										
None recorded										
c) Caledonia North Survey Area										
None recorded										

Table 158 Raw counts, unapportioned and apportioned abundance and density estimates (individuals per km²) of basking shark in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned					Total apportioned			
		Abundance	LCL	UCL	Precision (CV)	Density (km²)	Abundance	LCL	UCL	Density (km²)
a) Caledonia South										
Nov-22	1	6	1	18	1.00	0.03	6	1	18	0.03
b) Caledonia South plus 2 km buffer										
Nov-22	1	6	1	17	1.00	0.02	6	1	17	0.02
c) Caledonia South Survey Area										
Nov-22	1	6	1	18	1.00	0.01	6	1	18	0.01

ii. Distribution and behaviour

The only basking shark recorded, in November 2022, was located in the southwest of Caledonia South (Appendix 4, Figure A4.389).

4.50 Unidentified shark species

i. Abundance and density estimates

A single unidentified shark species was recorded in the Survey Area during the second year of the baseline surveys (Table 11). The individual was recorded in the January 2022 in the 4 km Buffer Zone of the Survey Area, specifically within Caledonia South 4 km buffer (Table 159 to Table 161). The abundance and density estimates were therefore very low (Table 159 to Table 161).

Table 159 Raw counts, unapportioned abundance and density estimates (individuals per km²) of shark species in Caledonia OWF, Caledonia OWF plus 2 km buffer and the Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km²)
a) Caledonia OWF						
None recorded						
b) Caledonia OWF plus 2 km buffer						
None recorded						
c) Survey Area						
Jan-22	1	6	1	17	<1	0.01

Table 160 Raw counts, unapportioned abundance and density estimates (individuals per km^2) of shark species in Caledonia North, Caledonia North plus 2 km buffer and Caledonia North Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia North						
None recorded						
b) Caledonia North plus 2 km buffer						
None recorded						
c) Caledonia North Survey Area						
None recorded						

Table 161 Raw counts, unapportioned abundance and density estimates (individuals per km^2) of shark species in Caledonia South, Caledonia South plus 2 km buffer and Caledonia South Survey Area during the May 2021 to April 2023 survey period

Survey	Raw count	Total unapportioned				
		Abundance	LCL	UCL	Precision (CV)	Density (km^2)
a) Caledonia South						
None recorded						
b) Caledonia South plus 2 km buffer						
None recorded						
c) Caledonia South Survey Area						
Jan-22	1	6	1	17	1.00	0.01

i. Distribution and behaviour

The single unidentified shark was recorded in the east of Caledonia South Buffer Zone towards its outer border (Appendix 4, Figure A4.390).

5. Anecdotal observations

Anecdotal observations visually recorded from the aircraft during the 24 months of surveys with respect to anthropogenic activities within the Survey Area are presented in Table 162. Anthropogenic observations recorded in the imagery during the 24 months of surveys within the Survey Area are presented in Table 163.

Table 162 Summary of anthropogenic activities visually recorded from the aircraft during each survey flight of the May 2021 to April 2023 survey period

Survey No.	Date	No. observations	Anthropogenic structure	Time of record	Heading direction
1	15-May-21	1	Tanker	14:24	WNW
2	10-Jun-21	1	Cargo vessel	18:25	W
3	2-Jul-21	1	Transport crew vessel	11:33	Unidentified
4	1-Aug-21	5	4 fishing vessels 1 unspecified red boat	19:17, 19:18, 19:31 19:14	Unidentified
5	14-Sep-21	6	3 fishing vessels 2 small rig boats 1 pleasure boat	11:08, 11:42, 12:39 11:47 11:42	Unidentified
6	4-Oct-21	0	-	-	-
7	15-Nov-21	0	-	-	-
8	6-Dec-21	0	-	-	-
9	9-Jan-22	0	-	-	-
10	13-Feb-22	2	Small fishing vessels	12:18	ESE
11	2-Mar-22	1	Wind farm service vessel	10:33	Stationary (working)
12	26-Apr-22	1	Small fishing vessel	12:47	NNE
13	14-May-22	0	-	-	-
14	4-Jun-22	0	-	-	-
15	5-Jul-22	3	Speed boat Small rig boat Rig boat	17:23 17:34 18:33	E N N
16	10-Aug-22	1	Wind Cat	08:59	Stationary
17	11-Sep-22	0	-	-	-
18	14-Oct-22	3	2 Trawlers 1 Fishing vessel	11:32, 11:54 12:03	E, W ESE
19	25-Nov-22	1	Large red vessel working around turbines	10:34	W
20	17-Dec-22	0	-	-	-
21	9-Jan-23	0	-	-	-
22	13-Feb-23	0	-	-	-
23	10-Mar-23	1	Possibly a Royal National Lifeboat Institution (RNLI) vessel	16:13	NW
24	04-Apr-23	1	Research vessel	11:08	S

Table 163 Summary of anthropogenic structures recorded in the imagery of the Survey Area during each monthly survey of the May 2021 to April 2023 survey period

Survey No.	Date	No. observations	Fixed structure	Vessel
1	15-May-21	10	1 Buoy 2 Wind turbines 6 Wind turbine bases	1 Cargo ship (13:28)
2	10-Jun-21	8	1 Buoy 5 Wind turbines 2 Wind turbine bases	
3	2-Jul-21	12	1 Buoy 9 Wind turbines	1 Supply vessel (10:52) 1 Wind carrier (10:52)
4	1-Aug-21	10	1 Buoy 9 Wind turbines	
5	14-Sep-21	12	1 Buoy 8 Wind turbines	1 Fishing vessel (9:58) 1 Passenger vessel (11:09) 1 Sailing boat (10:39)
6	4-Oct-21	9	1 Buoy 8 Wind turbines	
7	15-Nov-21	8	1 Buoys 7 Wind turbines	
8	6-Dec-21	9	1 Buoy 8 Wind turbines	
9	9-Jan-22	9	1 Buoy 8 Wind turbines	
10	13-Feb-22	9	1 Buoy 8 Wind turbines	
11	2-Mar-22	9	1 Buoy 8 Wind turbines	
12	26-Apr-22	10	1 Buoy 8 Wind turbines	1 Fishing vessel (12:07)
13	14-May-22	9	8 Wind turbines	1 Fishing vessel (11:00)
14	4-Jun-22	8	7 Wind turbines	1 Supply vessel (15:35)
15	5-Jul-22	9	8 Wind turbines	1 Supply vessel (16:53)
16	10-Aug-22	8	8 Wind turbines	
17	11-Sep-22	7	7 Wind turbines	
18	14-Oct-22	8	7 Wind turbines	1 Miscellaneous vessel (10:50)
19	25-Nov-22	8	8 Wind turbines	
20	17-Dec-22	7	7 Wind turbines	
21	9-Jan-23	8	7 Wind turbines	1 Miscellaneous vessel (10:00)
22	13-Feb-23	7	7 Wind turbines	
23	10-Mar-23	9	8 Wind turbines	1 Supply vessel (16:13)
24	04-Apr-23	7	7 Wind turbines	

6. References

Bohlin, T., Heggberget, T.G., Strange, C., 1990. Estimation of population parameters using electric fishing: aspects of the sampling design with emphasis on salmonids in streams. *Fishing with Electricity*. Fishing News Books, Oxford, pp. 156-173.

British Ornithologists' Union, 2022. The British List: A Checklist of Birds of Britain (10th edition). *Ibis*, 164, pp. 860-910.

Canty, A. and Ripley, B., 2022. Boot: Bootstrap R (S-Plus) Functions. R package version 1.3-28.1.

Efron, B. and Tibshirani, R.J., 1993. An introduction to the bootstrap. *Chapman & Hall, London*.

Joint Nature Conservation Committee, 2013. *JNCC Expert Statement on Ornithological Issues for Written Representations in Respect of East Anglia ONE Offshore Windfarm by Dr Sophy Alle*n. Joint Nature Conservation Committee, Aberdeen

NatureScot, 2024. Guidance note - Seasonal Periods for Birds in the Scottish Marine Environment. Available at: https://www.nature.scot/sites/default/files/2020-10/Guidance%20note%20-%20Seasonal%20definitions%20for%20birds%20in%20the%20Scottish%20Marine%20Environment.pdf (Accessed: 10/01/2024).

R Development Core Team, 2021. R: A language and environment for statistical computing. *R Foundation for Statistical Computing, Vienna, Austria*.

Spencer, S.M. (2012). Diving behaviour and identification of sex of breeding Atlantic puffins (Fratercula arctica), and nest-site characteristics of Alcids on Petit Manan Island, Maine. MSc Thesis submitted to University of Massachusetts Amherst in May 2012.

Teilmann, J., Christiansen, C.T., Kjellerup, S., Dietz, R., Nachman, G., 2013. Geographic, seasonal and diurnal surface behaviour of harbour porpoise. *Marine Mammal Science* 29(2): E60-E76.

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. and Burnham, K.P., 2010, Distance software: design and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology* vol. 47(1), pp. 5-14.

Voet, H., Rehfisch, M., McGovern, S., Sweeney, S., 2017. Marine Mammal Correction Factor for Availability Bias in Aerial Digital Still Surveys. Case Study: Harbour Porpoise (*Phocoena phocoena*) in the Southern North Sea. APEM Ltd.

Appendix 1 - Scientific names and taxonomy

Common Name	Scientific Name	Family	Class
Pink-footed goose	*Anser brachyrhynchus*	Anatidae	Aves
Mallard	*Anas platyrhynchos*	Anatidae	Aves
Kittiwake	*Rissa tridactyla*	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
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
Great northern diver	*Gavia immer*	Gaviidae	Aves
Red-throated diver	*Gavia stellata*	Gaviidae	Aves
Fulmar	*Fulmarus glacialis*	Procellariidae	Aves
Sooty shearwater	*Ardenna grisea*	Procellariidae	Aves
Manx shearwater	*Puffinus puffinus*	Procellariidae	Aves
Gannet	*Morus bassanus*	Sulidae	Aves
Grey seal	*Halichoerus grypus*	Phocidae	Mammalia
Common dolphin	*Delphinus delphis*	Delphinidae	Mammalia
White-beaked dolphin	*Lagenorhynchus albirostris*	Delphinidae	Mammalia
Bottlenose dolphin	*Tursiops truncatus*	Delphinidae	Mammalia
Risso's dolphin	*Grampus griseus*	Delphinidae	Mammalia
Harbour porpoise	*Phocoena phocoena*	Phocoenidae	Mammalia
Common minke whale	*Balaenoptera acutorostrata*	Balaenopteridae	Mammalia
Basking shark	*Cetorhinus maximus*	Cetorhinidae	Chondrichthyes

Appendix 2 - Species identification rates

Identification (ID) rates are provided according to groups presented in Table 5 for birds and Table 6 for marine mammals (reiterated below: Table A2.1, Table A2.2). Unidentified bird species have not been included in the ID rate calculations due to the low number observed during the survey period (n=32 in year 1; n=36 in year 2) and the broadness of the grouping. Identification rate of an individual to the species level, from May 2021 to April 2022 and from May 2022 to April 2023, specific to Caledonia OWF project, are presented hereafter (Table A2.3, Table A2.4). The ID rates were calculated from the raw counts of species observation in Caledonia Survey Area. Species positively identified to species level, i.e. recorded 100% to species level (level 1), do not form part of the higher-level groupings.

Table A2.1 Individual bird species and grouping levels, these are shown in 5 levels of groupings

<table>
<tr><th>Species Level 1</th><th>Group Level 2</th><th>Group Level 3</th><th>Group Level 4</th><th>Group Level 5</th></tr>
<tr><td>Great northern diver</td><td rowspan="2">Diver species</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>Red-throated diver</td></tr>
<tr><td>Kittiwake</td><td colspan="2" rowspan="2">Small gulls</td><td rowspan="5">Gull species</td><td rowspan="6">Fulmar / Gull species</td></tr>
<tr><td>Common Gull</td></tr>
<tr><td>Great Black-backed Gull</td><td rowspan="2">Black-backed gulls</td><td rowspan="3">Large gulls</td></tr>
<tr><td>Lesser Black-backed Gull</td></tr>
<tr><td>Herring Gull</td><td colspan="2"></td></tr>
<tr><td>Fulmar</td><td colspan="2">-</td><td>-</td></tr>
<tr><td>Common tern</td><td colspan="2" rowspan="2">‘Commic’ tern</td><td rowspan="2">Tern species</td><td>-</td></tr>
<tr><td>Arctic tern</td><td>-</td></tr>
<tr><td>Guillemots</td><td rowspan="3">Guillemots / Razorbill</td><td colspan="2" rowspan="3">Auk species</td><td rowspan="5">Auk / Shearwater species</td></tr>
<tr><td>Razorbill</td></tr>
<tr><td>Black guillemot</td></tr>
<tr><td>Puffin</td><td colspan="3"></td></tr>
<tr><td>Sooty shearwater</td><td>-</td><td>Large shearwater species</td><td>Shearwater species</td></tr>
<tr><td>Manx shearwater</td><td>-</td></tr>
</table>

Table A2.2 Individual marine mammal species and their grouping levels, these are shown in 4 levels of groupings

<table>
<tr><th>Species Level 1</th><th>Group Level 2</th><th>Group Level 3</th><th>Group Level 4</th></tr>
<tr><td>Grey seal</td><td colspan="2">Seal species</td><td rowspan="6">Unidentified marine mammal Species</td></tr>
<tr><td>Common dolphin</td><td rowspan="4">Dolphin Species</td><td rowspan="5">Dolphin / porpoise species</td></tr>
<tr><td>White-beaked dolphin</td></tr>
<tr><td>Bottlenose dolphin</td></tr>
<tr><td>Risso’s dolphin</td></tr>
<tr><td>Harbour porpoise</td><td>Porpoise species</td></tr>
<tr><td>Common minke whale</td><td colspan="2">Whale species</td></tr>
<tr><td>Basking shark</td><td colspan="2">Shark species</td><td>-</td></tr>
</table>

Table A2.3 Monthly identification rates of species recorded across year 1 (May 2021 to April 2022)

Common Name	May 21	Jun 21	Jul 21	Aug 21	Sep 21	Oct 21	Nov 21	Dec 21	Jan 22	Feb 22	Mar 22	Apr 22
	ID Species Level 1 (%)											
Mallard	-	-	-	-	-	-	-	-	-	100	-	-
Kittiwake	99.5	100	99.9	99.3	100	100	100	100	100	96.7	100	100
Common gull	-	-	-	-	100	-	100	-	-	-	-	-
Great black-backed gull	-	-	-	60	95	90.2	90.1	100	98	97.7	66.7	-
Lesser black-backed gull	-	-	42.9	-	-	-	-	-	-	-	-	-
Herring gull	50	100	84.2		20	58.3	46.7	100	50	87.5	50	-
Common tern	-	-	-	60	-	-	-	-	-	-	-	-
Arctic tern	69.2	-	-	-	-	-	-	-	-	-	-	-
Great skua	100	100	100	-	100	-	-	-	-	-	-	-
Guillemot	91.2	71.1	95.2	16.3	81.3	73.9	92.7	8	71	40.3	69.1	86.3
Razorbill	48.6	27.4	68.8	9.4	30.1	9.6	-	2.8	18.2	21.5	18.3	67.6
Black guillemot	-	0.2	-	-	-	-	-	-	-	-	-	1.4
Puffin	86.4	77.8	65.2	74.7	67.6	70.9	-	-	-	-	40	90.2
Great northern diver	-	100	-	-	-	-	100	-	-	-	-	-
Fulmar	100	100	100	100	100	100	100	100	100	100	100	100
Manx shearwater	9.1	51.7	18.8	-	-	-	-	-	-	-	-	-
Sooty shearwater	-	-	-	-	100	-	-	-	-	-	-	-
Gannet	100	100	100	100	100	100	100	100	100	100	100	100
Grey seal	-	33.3	-	-	100	100	100	-	100	-	-	-
White-beaked dolphin	-	-	-	-	50	20	57.1	100	50	80	-	-
Harbour porpoise	42.9	66.7	40	-	60	60	-	100	-	50	80	100
Common minke whale	-	-	100	-	-	-	-	-	-	-	-	-

Table A2.4 Monthly identification rates of species recorded across year 2 (May 2022 to April 2023)

Common Name	May 22	Jun 22	Jul 22	Aug 22	Sep 22	Oct 22	Nov 22	Dec 22	Jan 23	Feb 23	Mar 23	Apr 23
	ID Species Level 1 (%)											
Pink-footed goose	-	-	-	-	-	-	-	-	100	-	-	-
Kittiwake	100	100	100	99.1	100	100	89.5	80	100	100	94.1	100
Common gull	-	-	-	50	-	-	-	50	-	-	-	-
Great black-backed gull	-	-	-	60	100	97.4	86.4	92	100	100	83.3	-
Lesser black-backed gull	100	100	33.3	-	-	-	-	-	-	-	-	-
Herring gull	-	100	70.7	-	-	75	50	80	-	100	50	-
Common tern	-	-	-	-	-	-	-	-	-	-	-	-
Arctic tern	-	-	-	42.9	-	-	-	-	-	-	-	-
Great skua	-	-	100	-	-	-	-	-	-	-	-	-
Arctic skua	-	-	-	100	-	-	-	-	-	-	-	-
Guillemot	90.1	97.4	91.4	77.2	85.1	57.4	31.9	80.2	95.5	92.2	90.5	92.9
Razorbill	54.4	36.5	45.7	60.8	59.1	-	33.3	45.9	74.1	63.5	61.3	72.3
Black guillemot	-	3.2	-	-	-	-	-	-	-	-	-	-
Puffin	86.3	65.8	70.9	93.3	80.5	57.1	-	-	83.3	77.8	60.9	47.6
Red-throated diver	-	-	-	-	-	100	-	-	-	-	-	-
Fulmar	100	100	100	100	100	100	99.2	100	100	100	99	100
Manx shearwater	50	-	-	-	-	-	-	-	-	-	-	-
Gannet	100	100	100	100	100	100	100	100	100	100	100	100
Grey seal	-	40	-	100	100	100	50	25	100	66.7	66.7	-
Common dolphin	-	-	-	-	-	95.1	-	-		-	-	-
Bottlenose dolphin	66.7	-	-	-	-	-	-	-		-	-	-
Risso's dolphin	-	-	-	100	100	-	-	-	-	-	-	-
White-beaked dolphin	-	-	-	-	100	81.8	-	-	100	100	-	-
Harbour porpoise	90.9	78.6	100	100	100	-	100	50	100	100	100	57.1
Common minke whale	100	50	100	-	-	-	-	-	-	-	-	-
Basking shark	-	-	-	-	-	-	100	-	-	-	-	-

Appendix 3 – Correction factors

Diving birds, and marine mammals spend time foraging beneath the water surface. As a result of this, an unknown number of birds and marine mammals may go undetected due to the snapshot nature of aerial survey techniques. Consequently, abundance and density estimates were adjusted to account for these unobserved individuals with species-specific correction factors.

Guillemot and razorbill

The correction factor applied to each relevant species is based on that recommended by JNCC in a submission during the examination phase of the East Anglia ONE OWF, referred to by JNCC as Method C[1]. A copy of the text on Method C is provided below. This has been taken from Paragraph 5.6.5 of this document:

> METHOD C
>
> Guillemots
>
> Underwater (1.9h) / [Sea surface (5.1h) + Diving activity (2.9h)] = 0.2375
>
> Therefore, for **guillemot availability** JNCC would calculate ***g(0)* = 0.7625**
>
> Razorbills
>
> Underwater (0.8h) / [Sea surface (3.1h) + Diving activity (1.5h)] = 0.1739
>
> Therefore, for **razorbill availability** JNCC would calculate ***g(0)* = 0.8261**
>
> This works on the following assumptions:
>
> 1. That all birds observed on the water in the project area are undertaking a foraging trip (in most cases this seems appropriate);
> 2. That 'birds in flight' are adequately characterised within the 'birds in flight' quotion of the Thaxter et al. (2010) figures (i.e. that portion which has been removed from the Correction Factor calculation;
> 3. That the proportions of time spent foraging underwater are representative of behaviour throughout the year (i.e. not just the breeding season – the period in which this proportional data was calculated from by Thaxter et al. 2010), should the Correction Factor be applied to annual abundance estimates.

Puffin

The correction factor applied to puffins is 1.165, which is based on the assumption that 14% puffins are assumed to be underwater at any time[2].

[1] Joint Nature Conservation Committee, 2013. JNCC Expert Statement on Ornithological Issues for Written Representations in Respect of East Anglia ONE Offshore Windfarm by Dr Sophy Allen. *Joint Nature Conservation Committee, Aberdeen*.

[2] Spencer, S.M. (2012). Diving behaviour and identification of sex of breeding Atlantic puffins (Fratercula arctica), and nest-site characteristics of Alcids on Petit Manan Island, Maine. MSc Thesis submitted to University of Massachusetts Amherst in May 2012.

Harbour porpoise

Aerial digital surveys are commonly used to capture marine mammals for baseline characterisation of offshore wind farm sites in the UK. The benefit of this method includes the permanent record, which allows for third party corroboration on species identification as well as allowing for group size and behaviour to be re-examined, if required.

The correction factors, which were applied to harbour porpoise monthly abundance estimates, are described in Voet *et al.* (2017)[3]. This was based on a study by Teilmann *et al.* (2013)[4], which tagged 35 harbour porpoises in the waters around Denmark using satellite transmitters. The satellite tags collected data on average for 135 days (minimum was 25 days and maximum was 349 days). Amongst other variables studied, the percentage of time spent in the upper 2 metres (m) of the water column was recorded and analysed. No significant difference in time spent in the upper 2m between sex or geographical location of tagging was found. There was also no significant correlation between the length of the harbour porpoise and time spent at 0-2m. However, the variable month was identified as having a significant effect, which varied between seasons. Therefore, correction factors were applied to the total abundance (surfacing and submerged individuals) as per Teilmann *et al.* (2013) recommendation. The correction factors applied are provided in Table A3.164.

Table A3.164 Seasonal harbour porpoise correction factors

Season	Correction Factor
Spring (Mar-May)	0.571
Summer (Jun-Aug)	0.547
Autumn (Sep-Nov)	0.455
Winter (Dec-Feb)	0.472

[3] Voet H., Rehfisch M., McGovern S. and Sweeney S. (2017) Marine Mammal Correction Factor for Availability Bias in Aerial Digital Still surveys. Case Study: Harbour porpoise (*Phocoena phocoena*) in the Southern North Sea. APEM Ltd.

[4] Teilmann J, Christiansen CT, Kjellerup S, Dietz R and Nachman G (2013) 'Geographic, seasonal and diurnal surface behaviour of harbour porpoise'. Marine Mammal Science 29(2): E60-E76.

Appendix 4 – Distribution maps

List of figures

Pink-footed goose

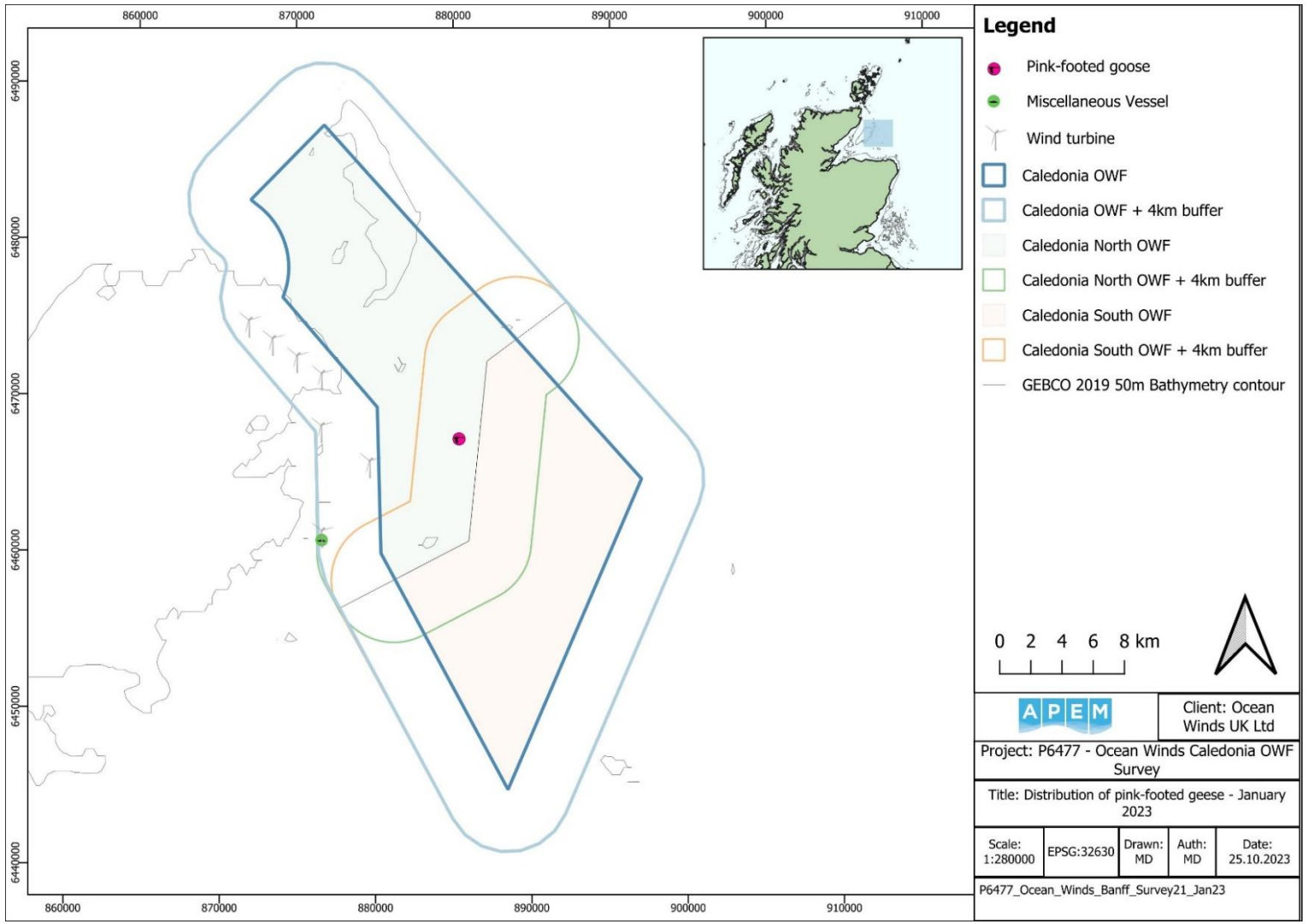


Figure A4.43 Distribution of pink-footed geese recorded in the Survey Area in January 2023

Mallard

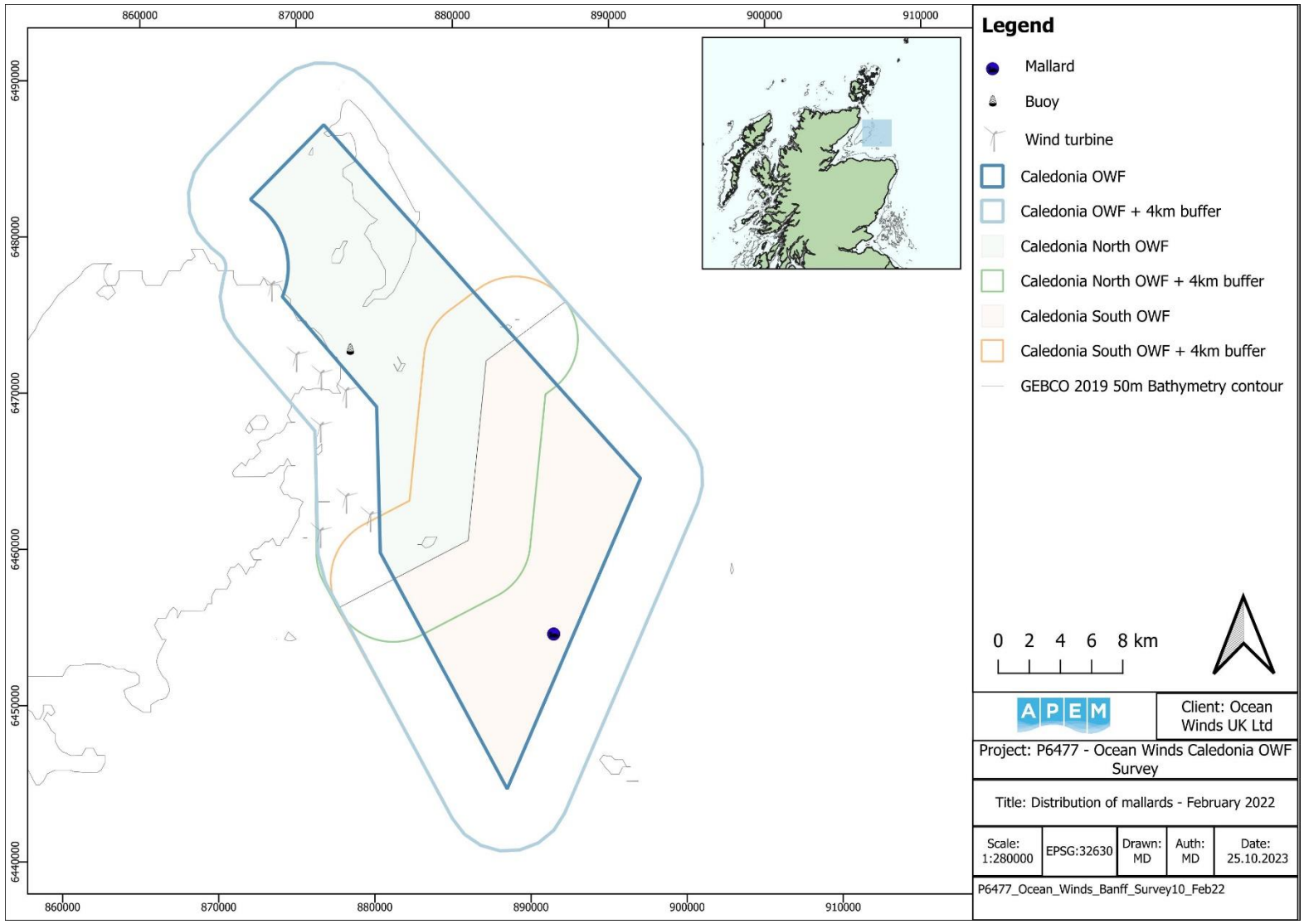


Figure A4.44 Distribution of mallard recorded in the Survey Area in February 2022

Unidentified wader species

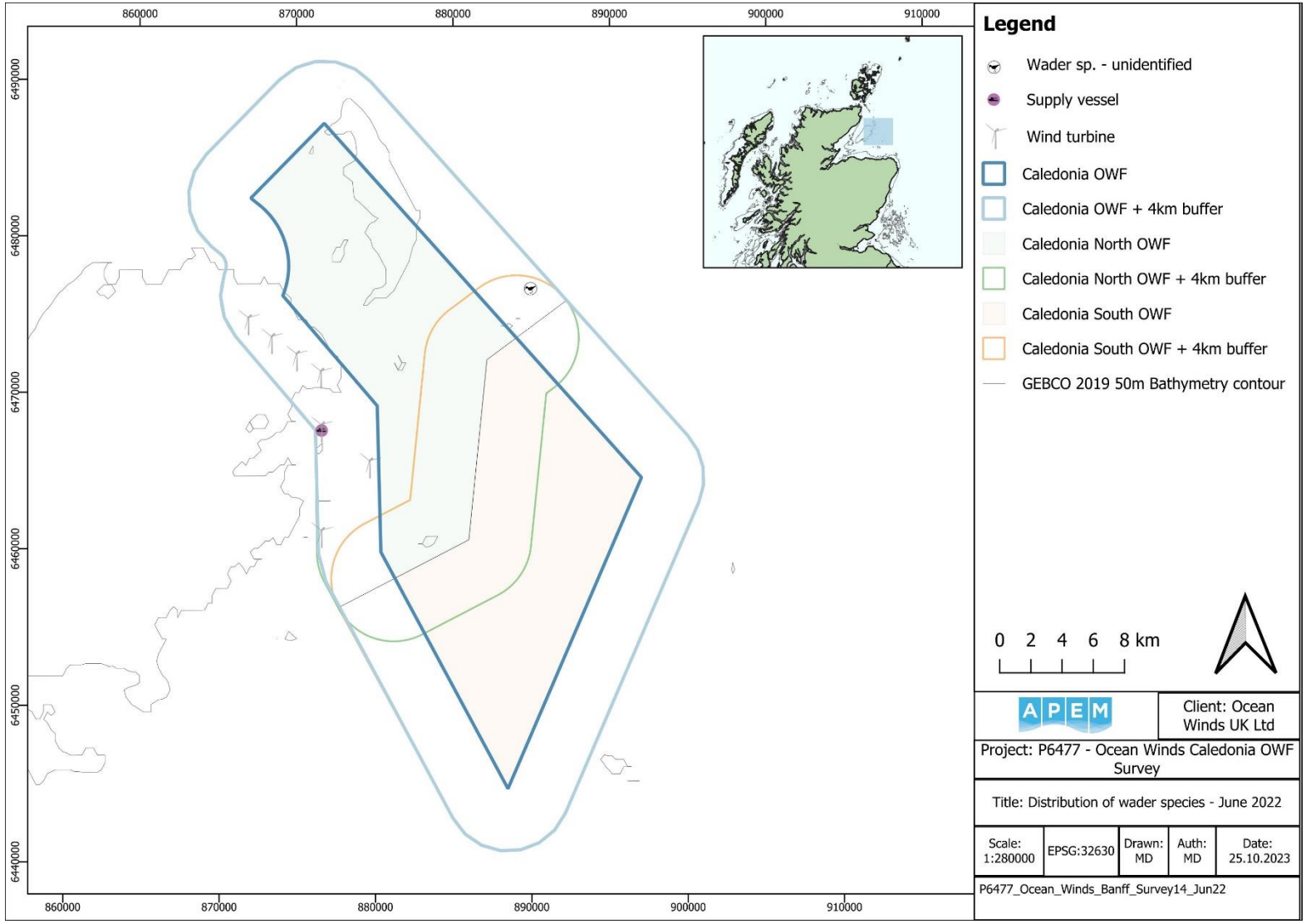


Figure A4.45 Distribution of wader species recorded in the Survey Area in June 2022

Kittiwake

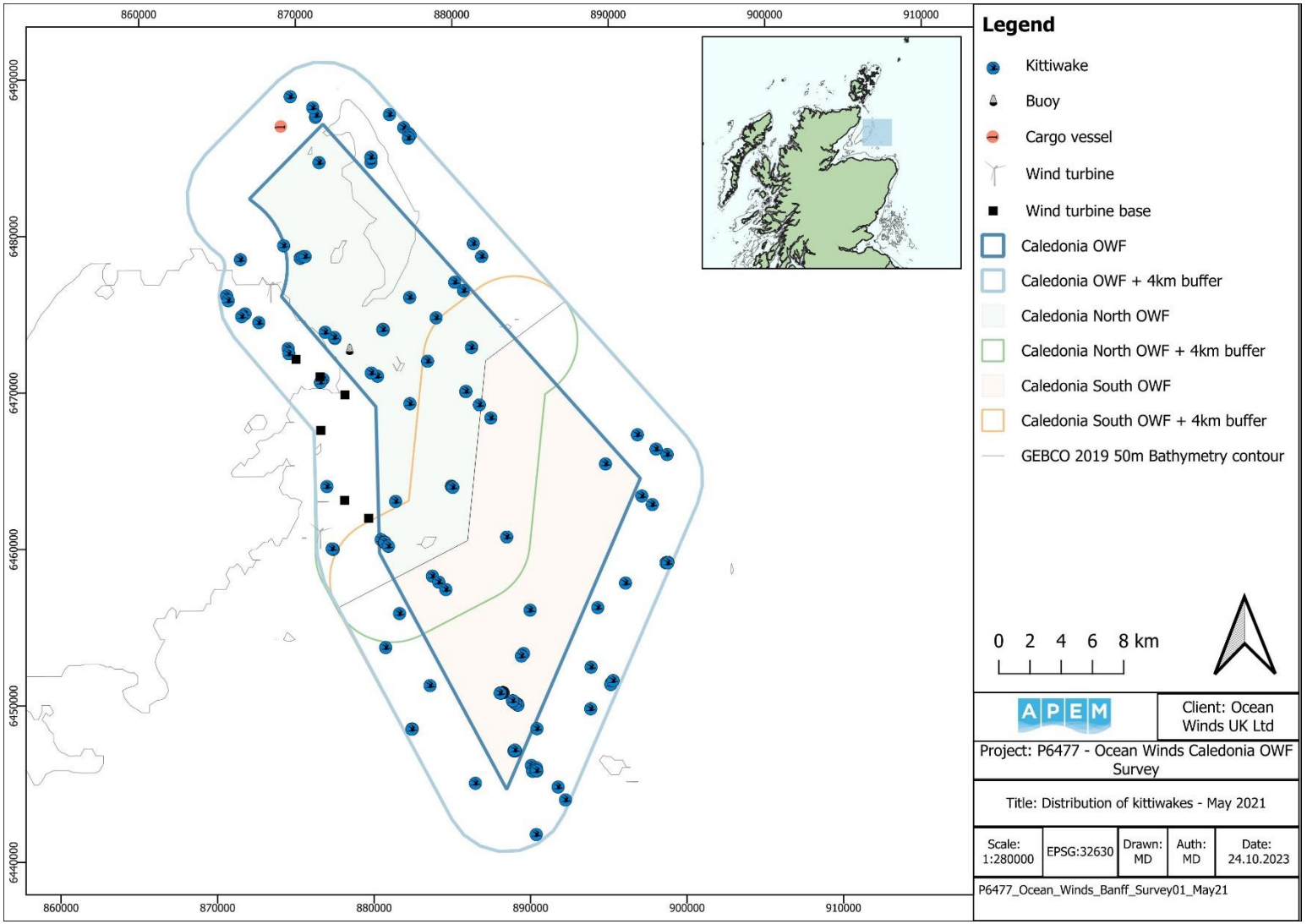


Figure A4.46 Distribution of kittiwakes recorded in the Survey Area in May 2021

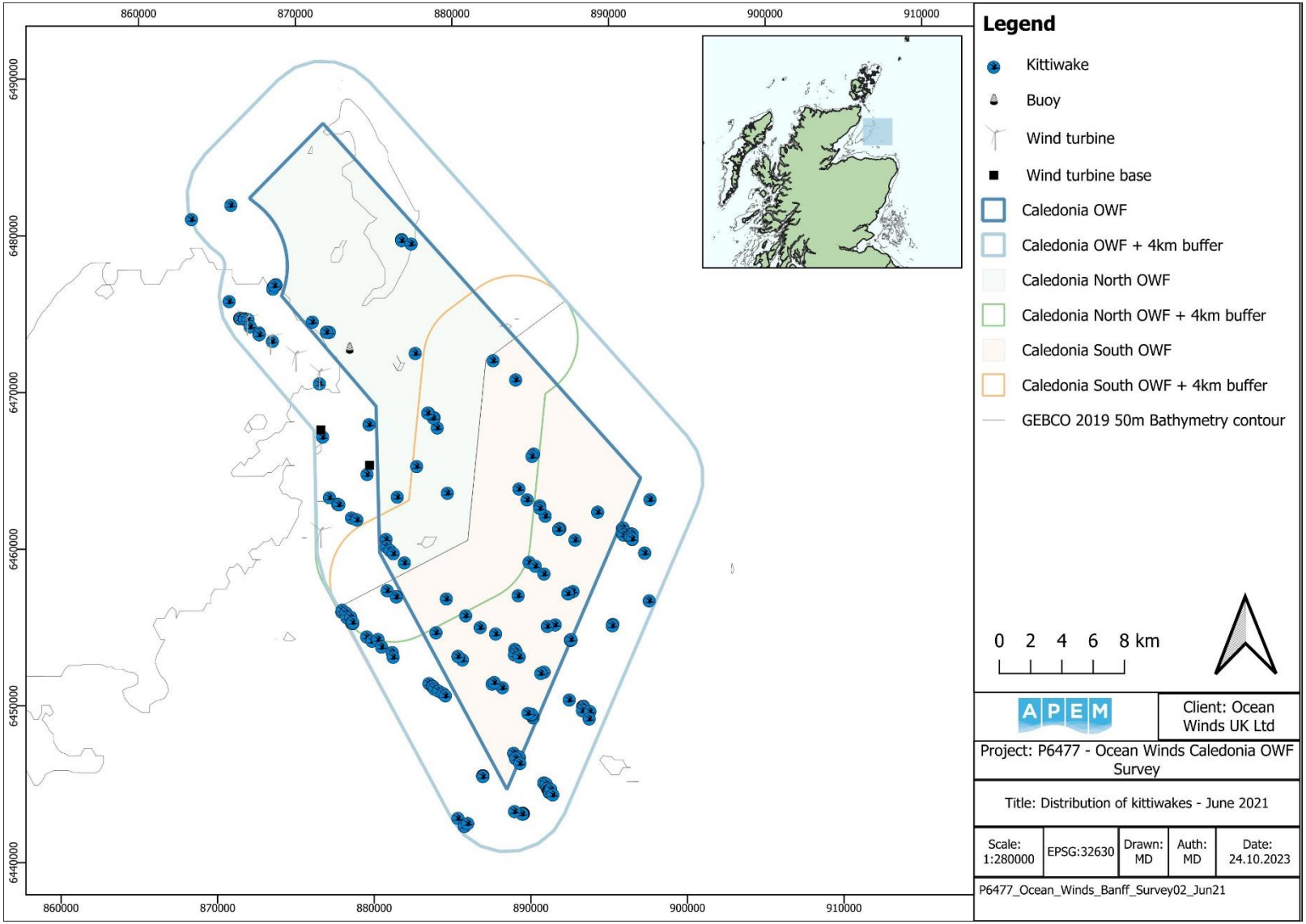


Figure A4.47 Distribution of kittiwakes recorded in the Survey Area in June 2021

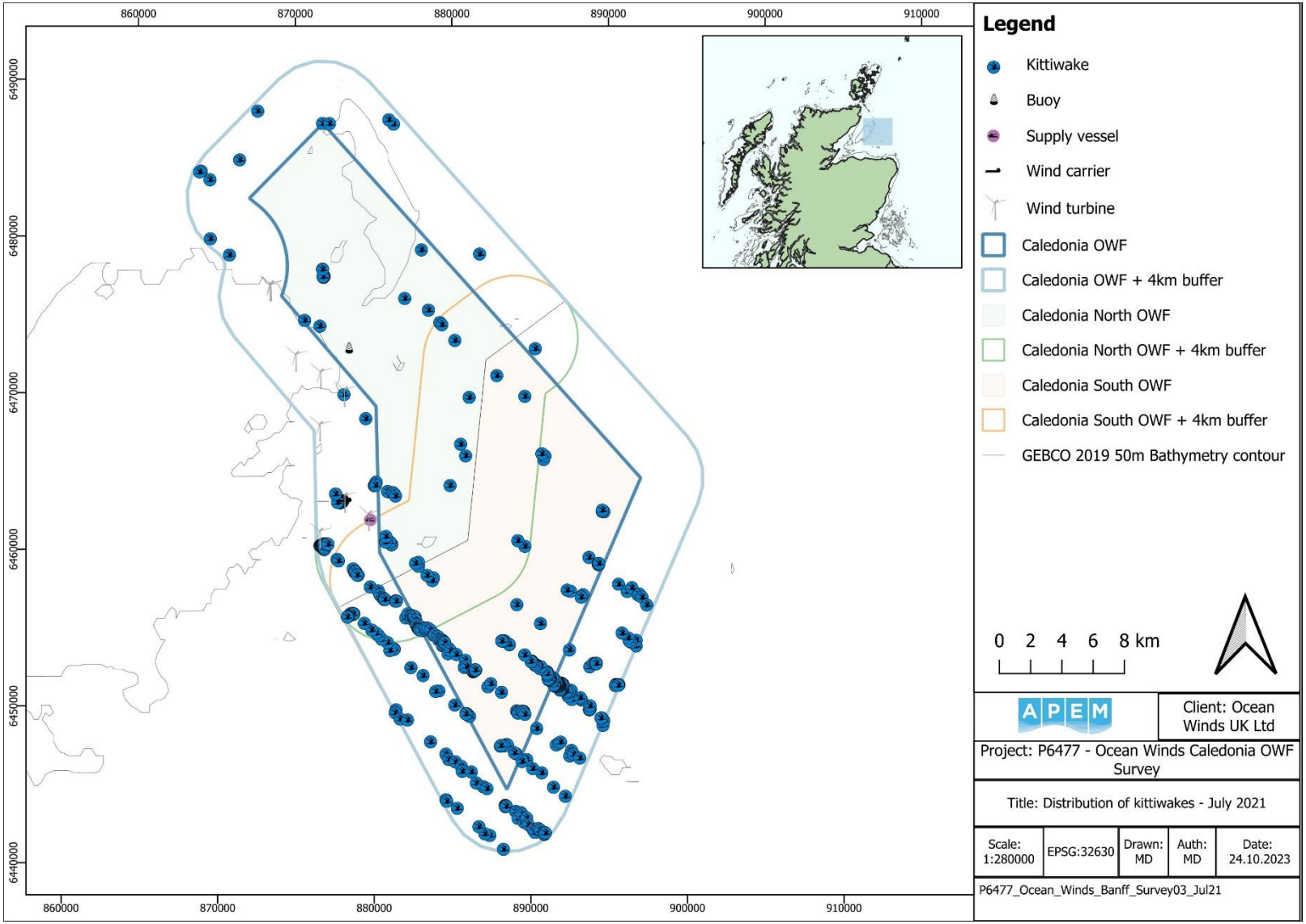


Figure A4.48 Distribution of kittiwakes recorded in the Survey Area in July 2021

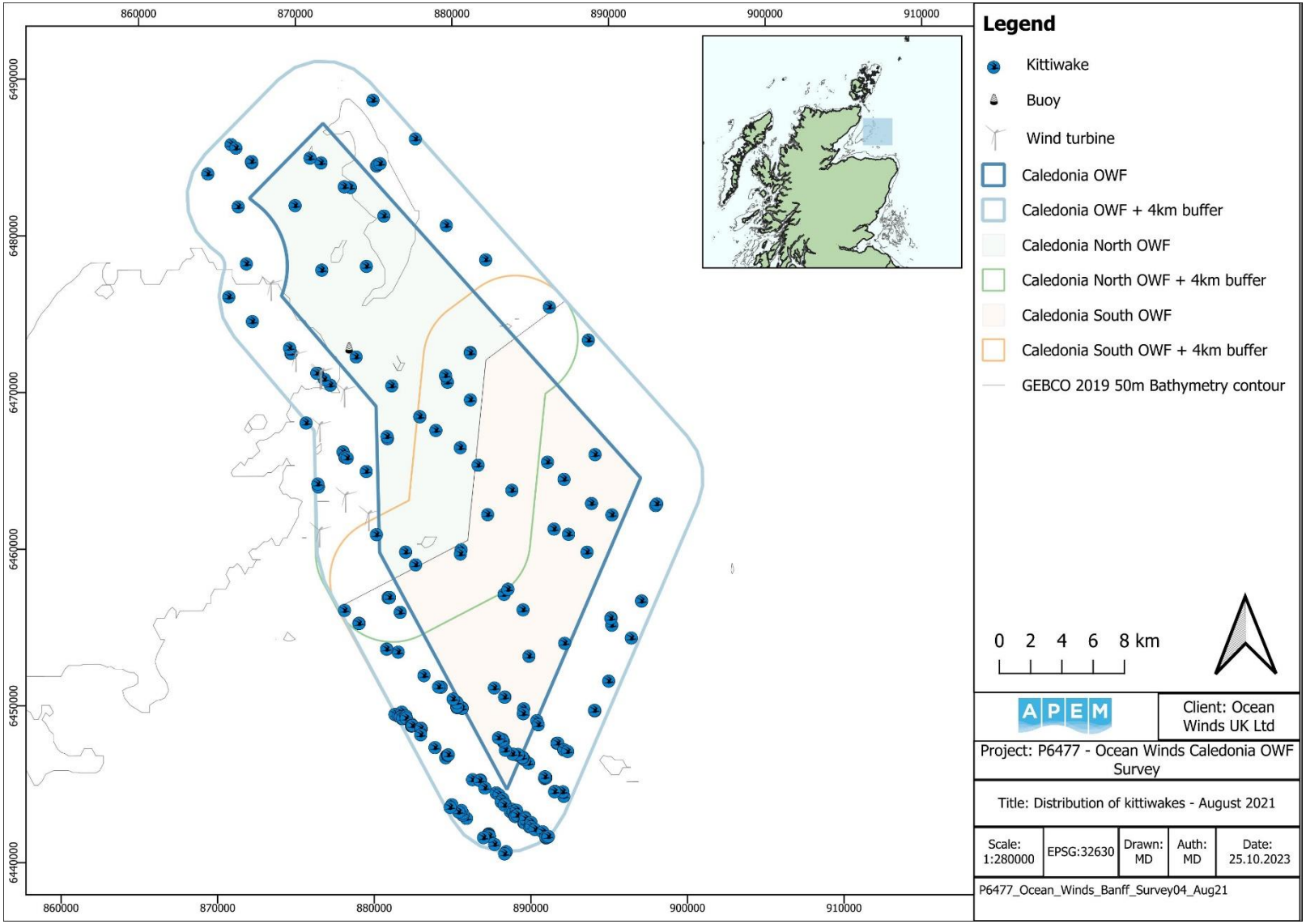


Figure A4.49 Distribution of kittiwakes recorded in the Survey Area in August 2021

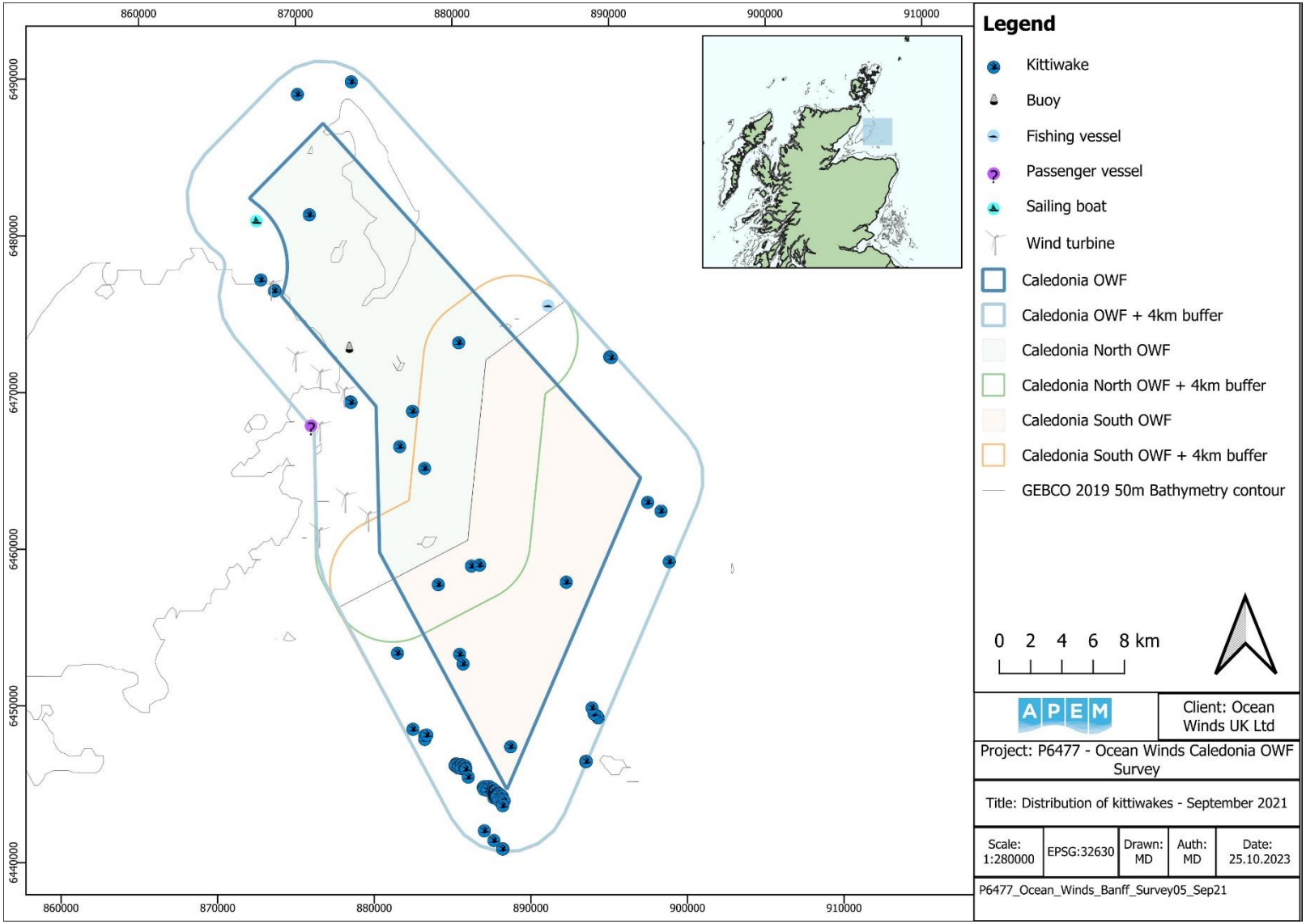


Figure A4.50 Distribution of kittiwakes recorded in the Survey Area in September 2021

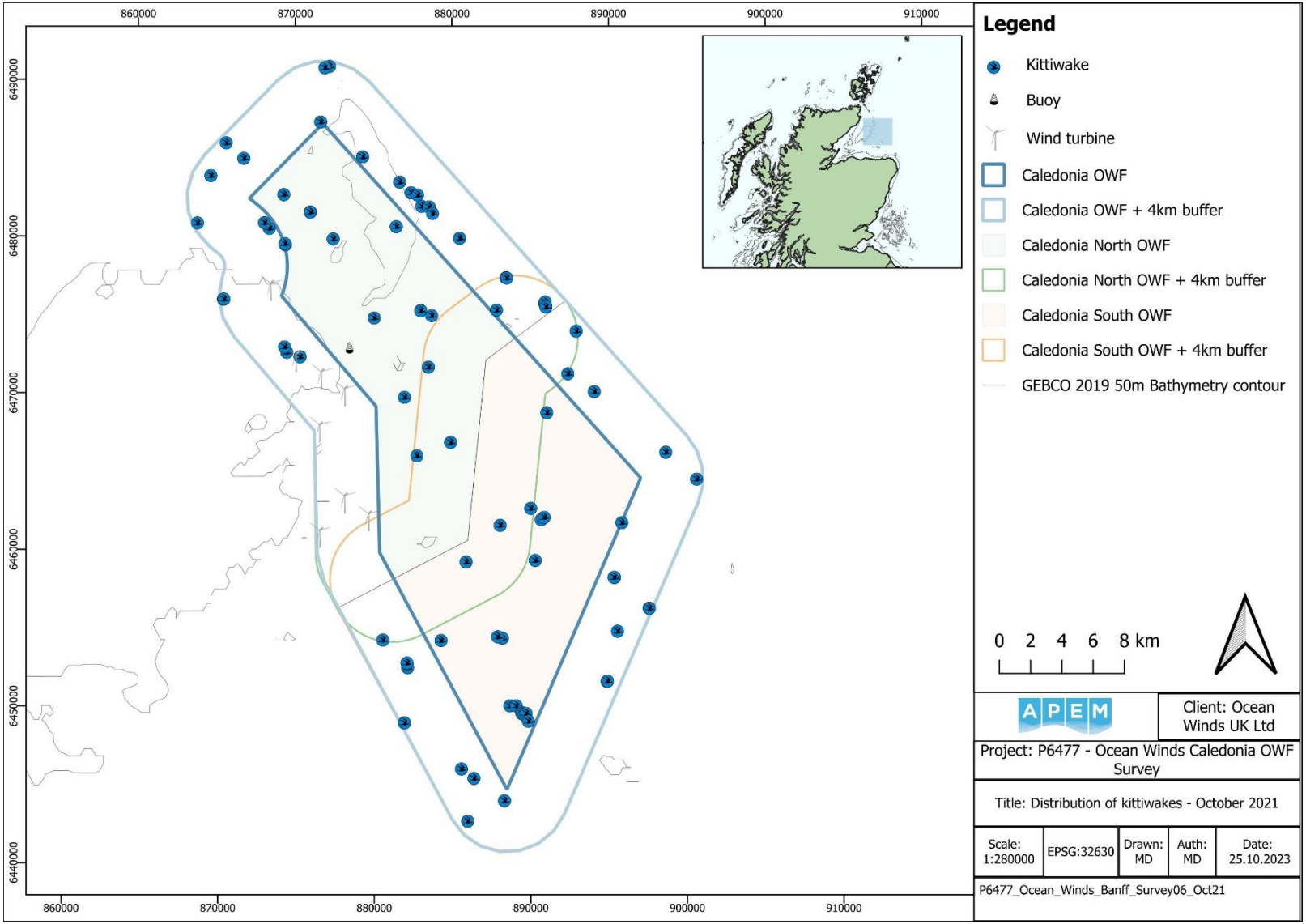


Figure A4.51 Distribution of kittiwakes recorded in the Survey Area in October 2021

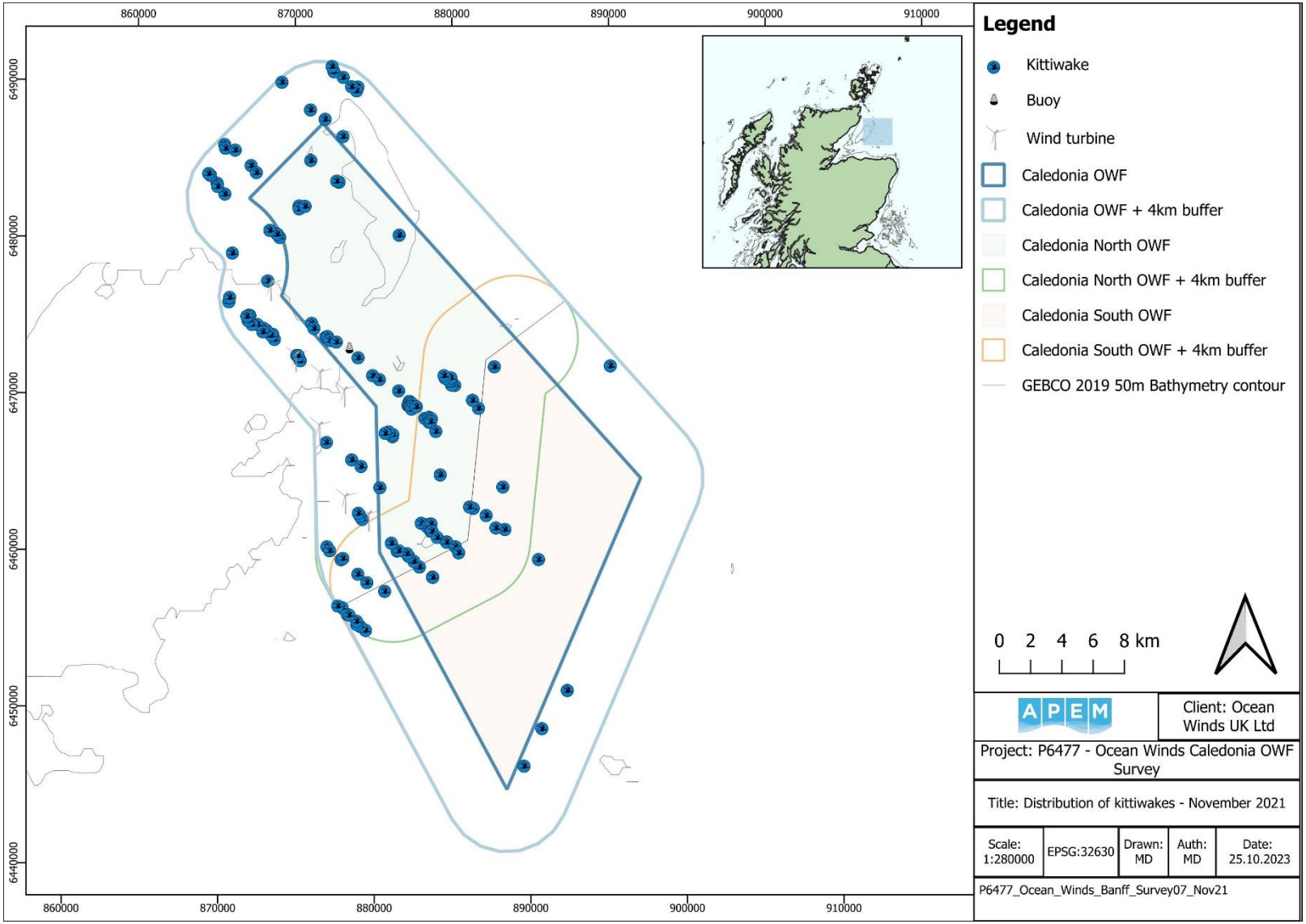


Figure A4.52 Distribution of kittiwakes recorded in the Survey Area in November 2021

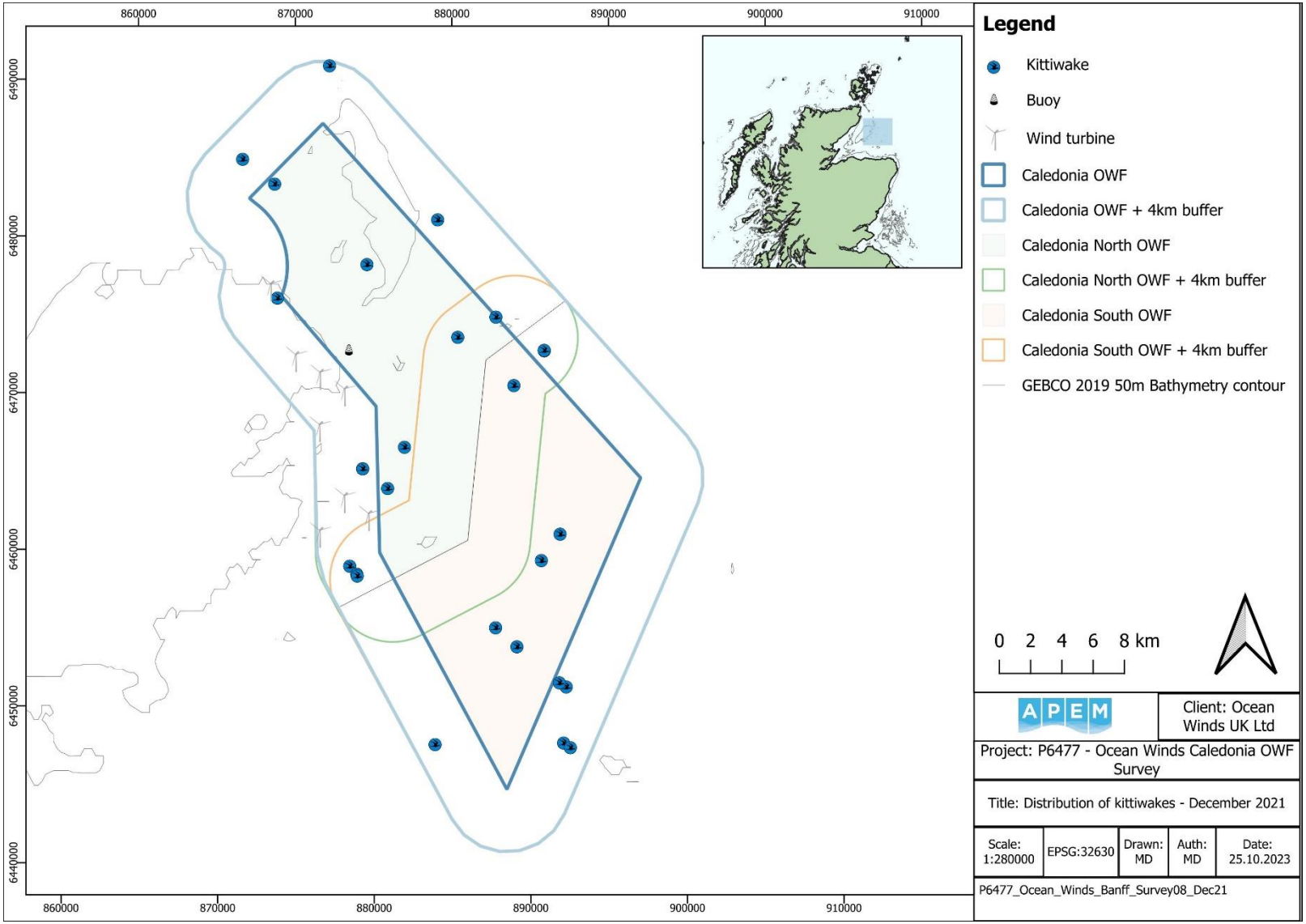


Figure A4.53 Distribution of kittiwakes recorded in the Survey Area in December 2021

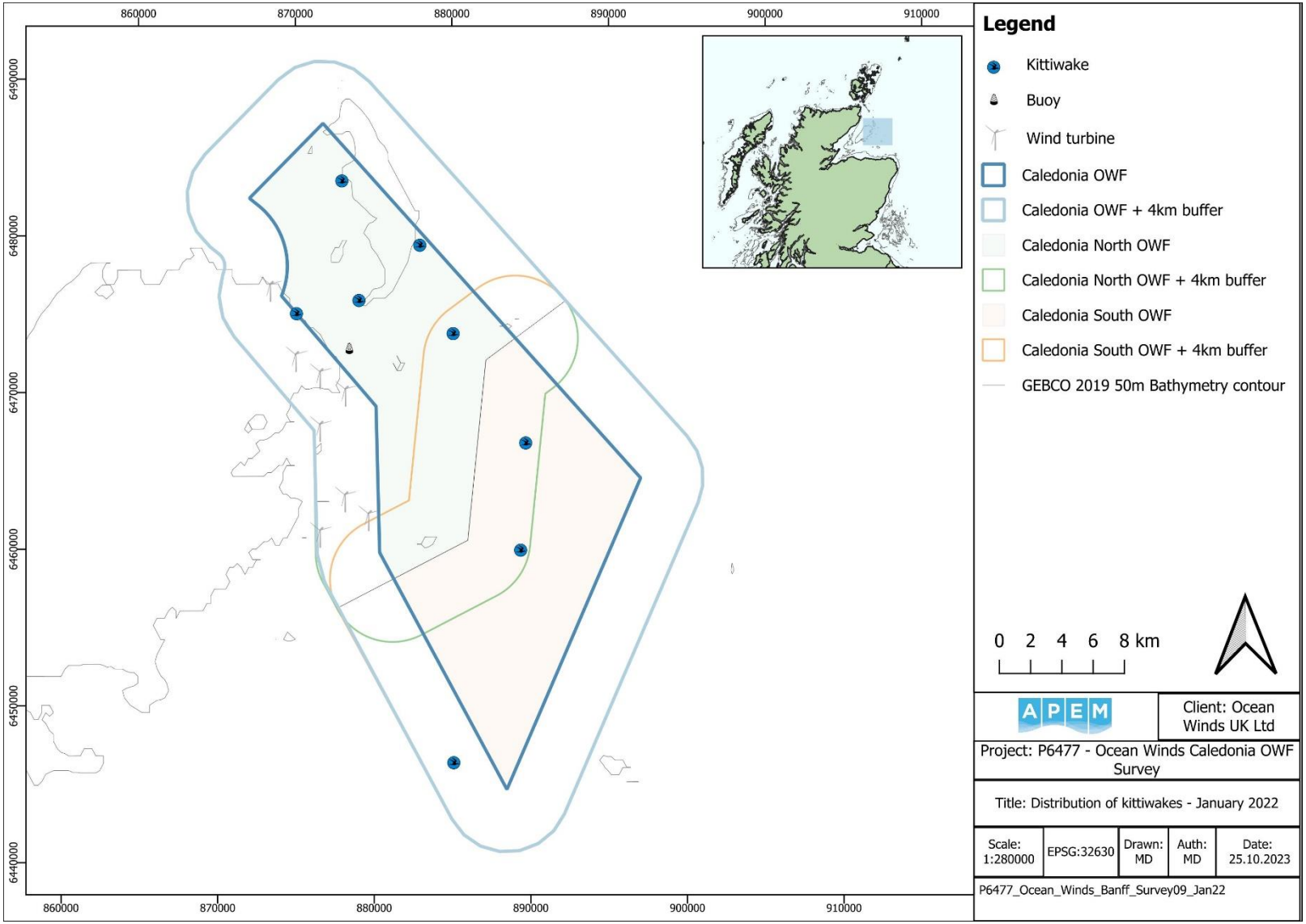


Figure A4.54 Distribution of kittiwakes recorded in the Survey Area in January 2022

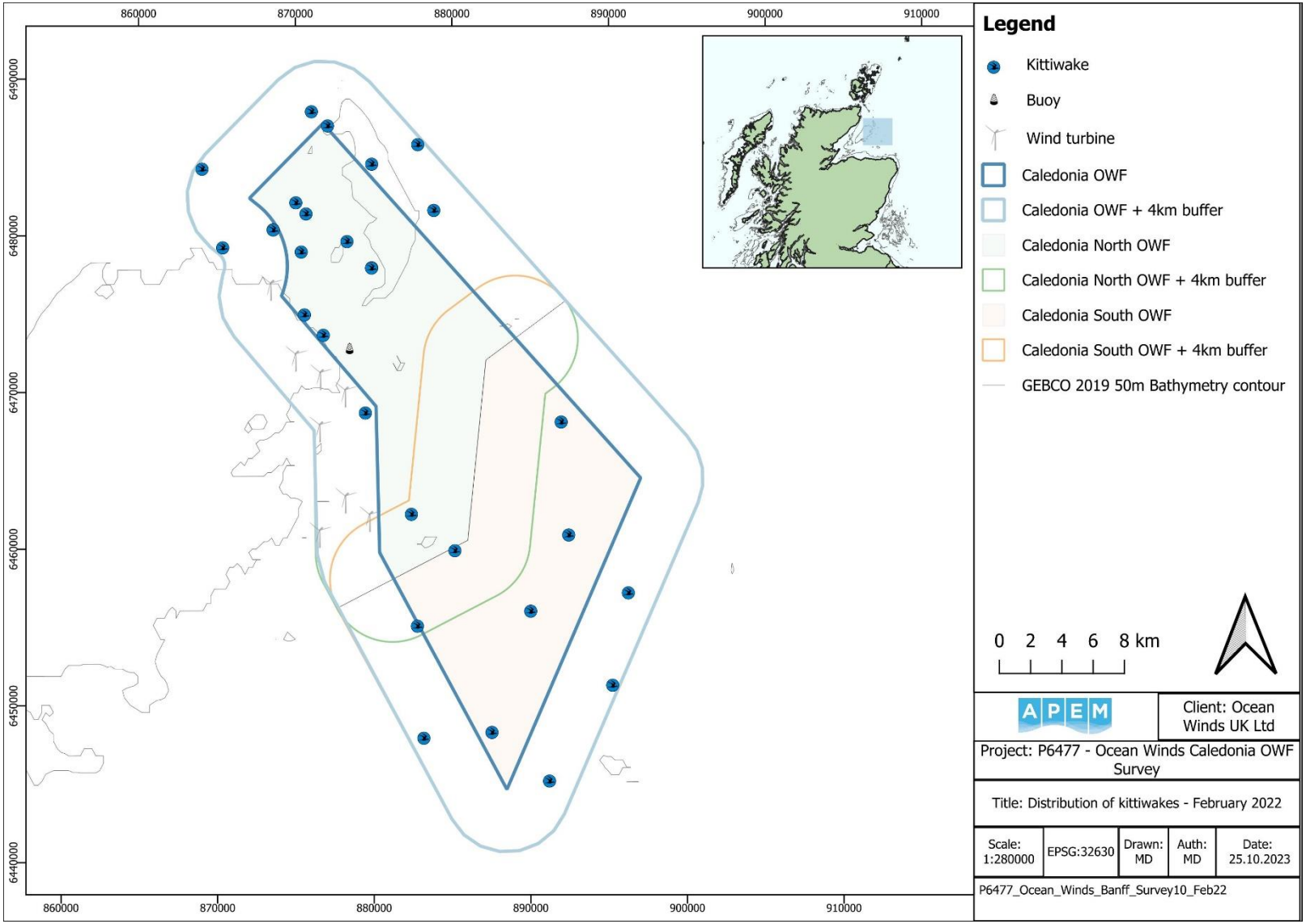


Figure A4.55 Distribution of kittiwakes recorded in the Survey Area in February 2022

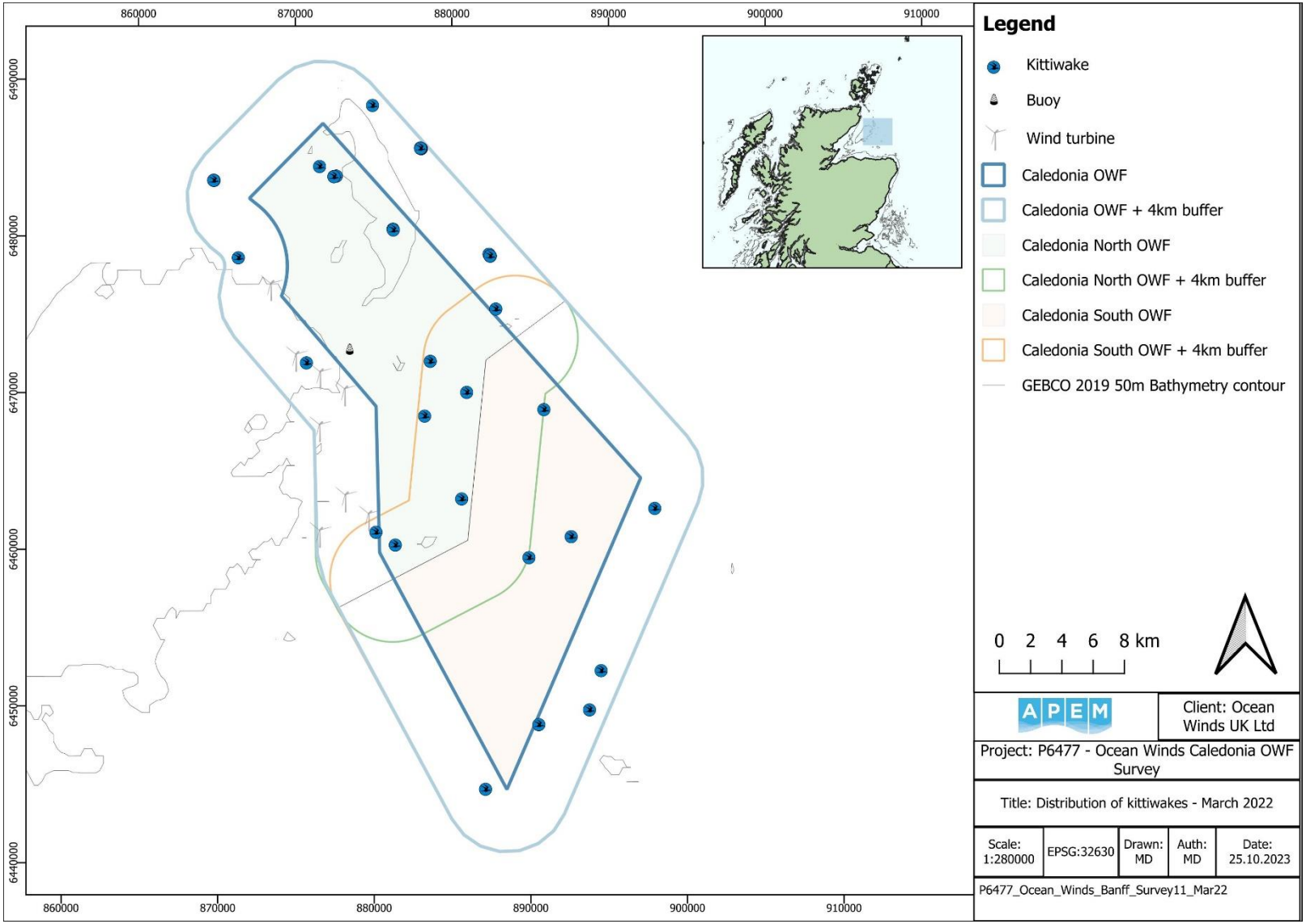


Figure A4.56 Distribution of kittiwakes recorded in the Survey Area in March 2022

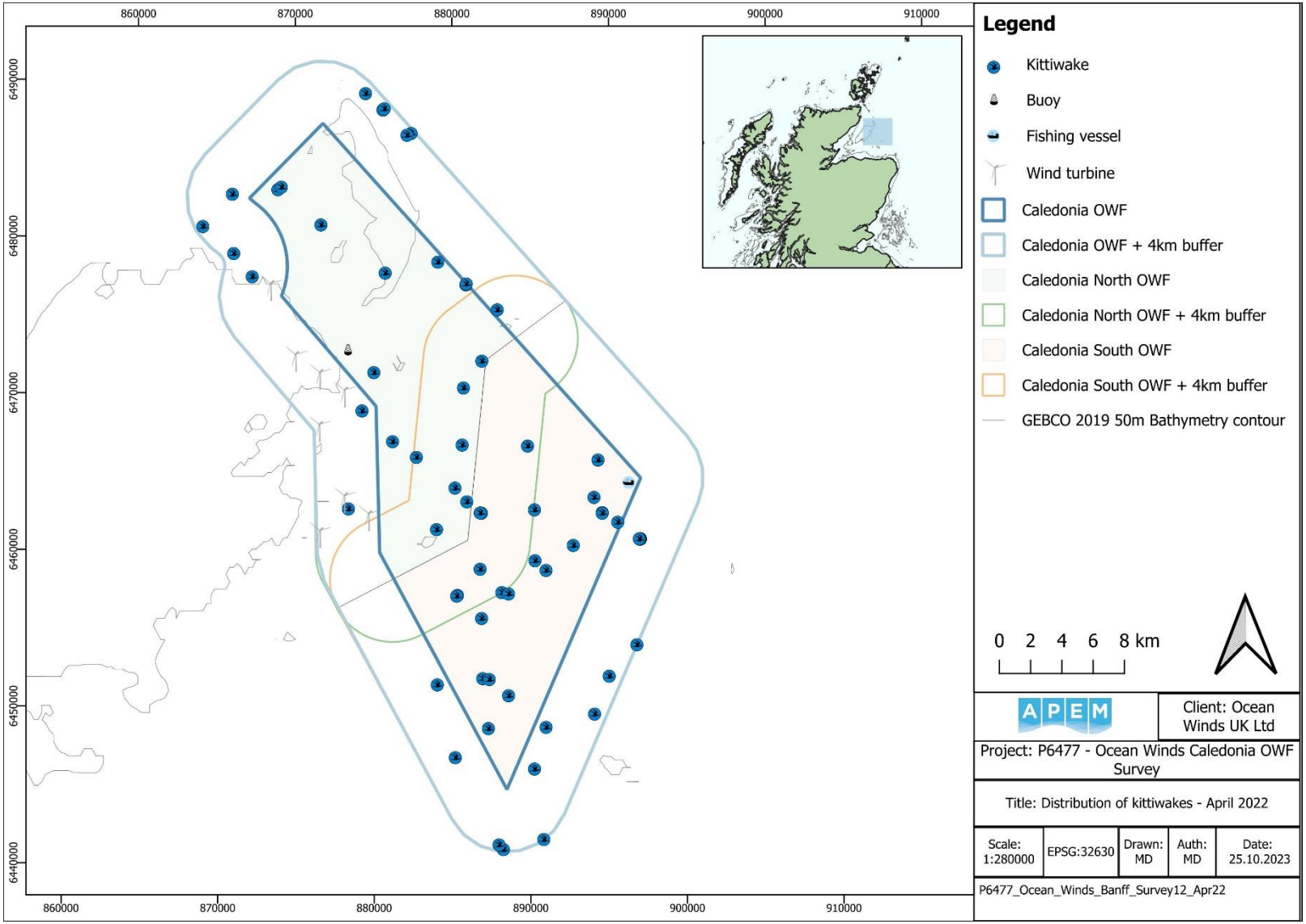


Figure A4.57 Distribution of kittiwakes recorded in the Survey Area in April 2022

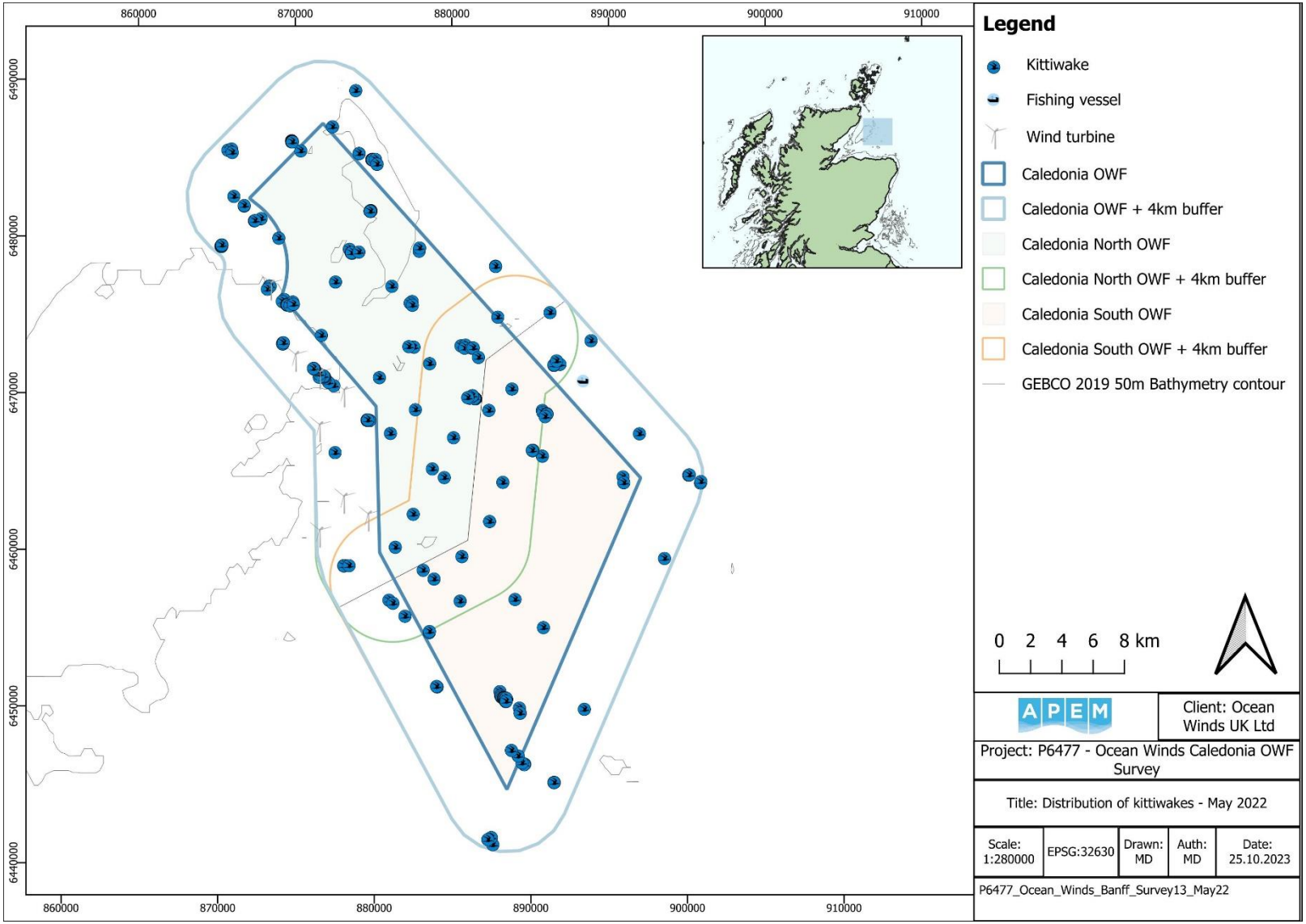


Figure A4.58 Distribution of kittiwakes recorded in the Survey Area in May 2022

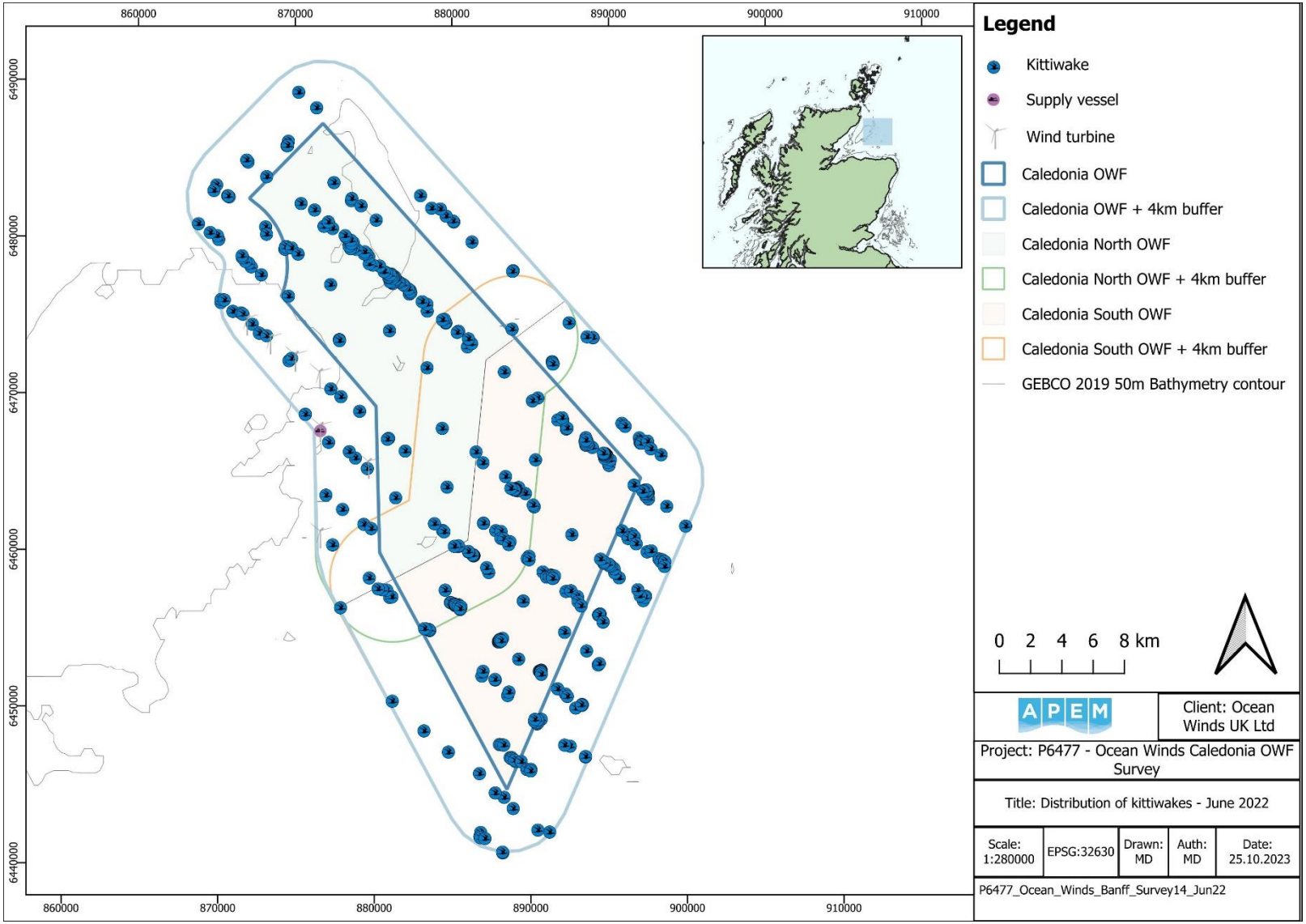


Figure A4.59 Distribution of kittiwakes recorded in the Survey Area in June 2022

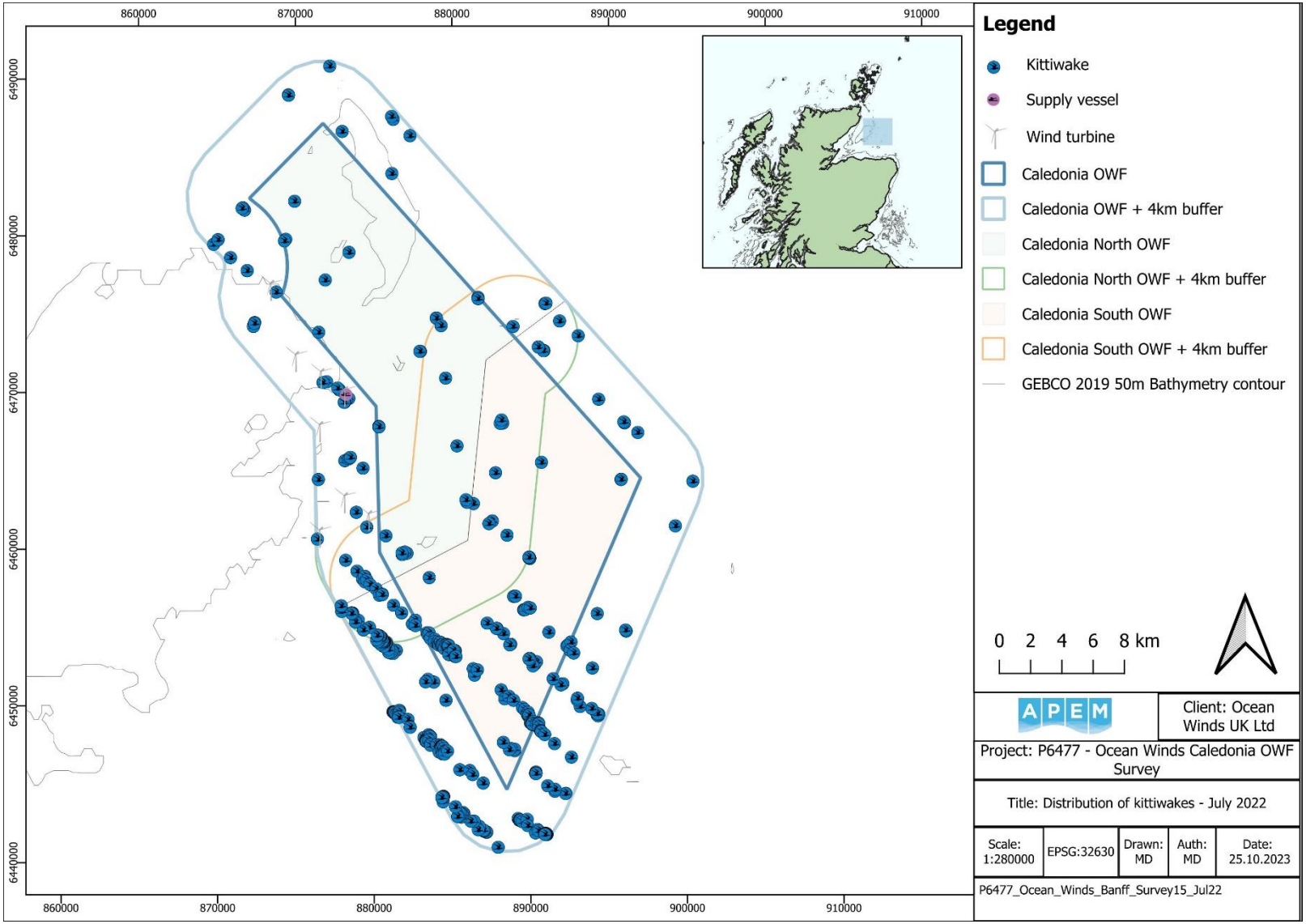


Figure A4.60 Distribution of kittiwakes recorded in the Survey Area in July 2022

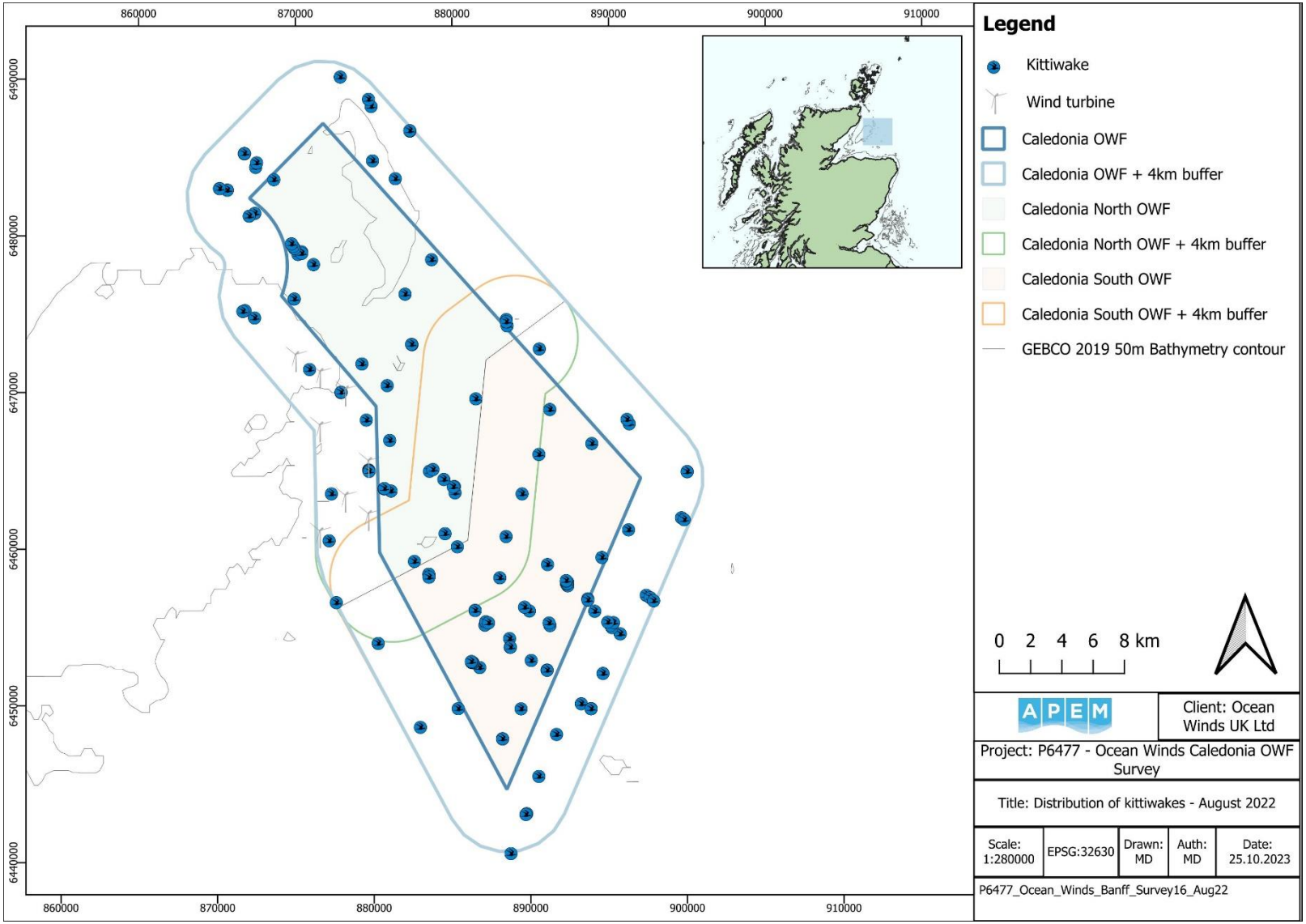


Figure A4.61 Distribution of kittiwakes recorded in the Survey Area in August 2022

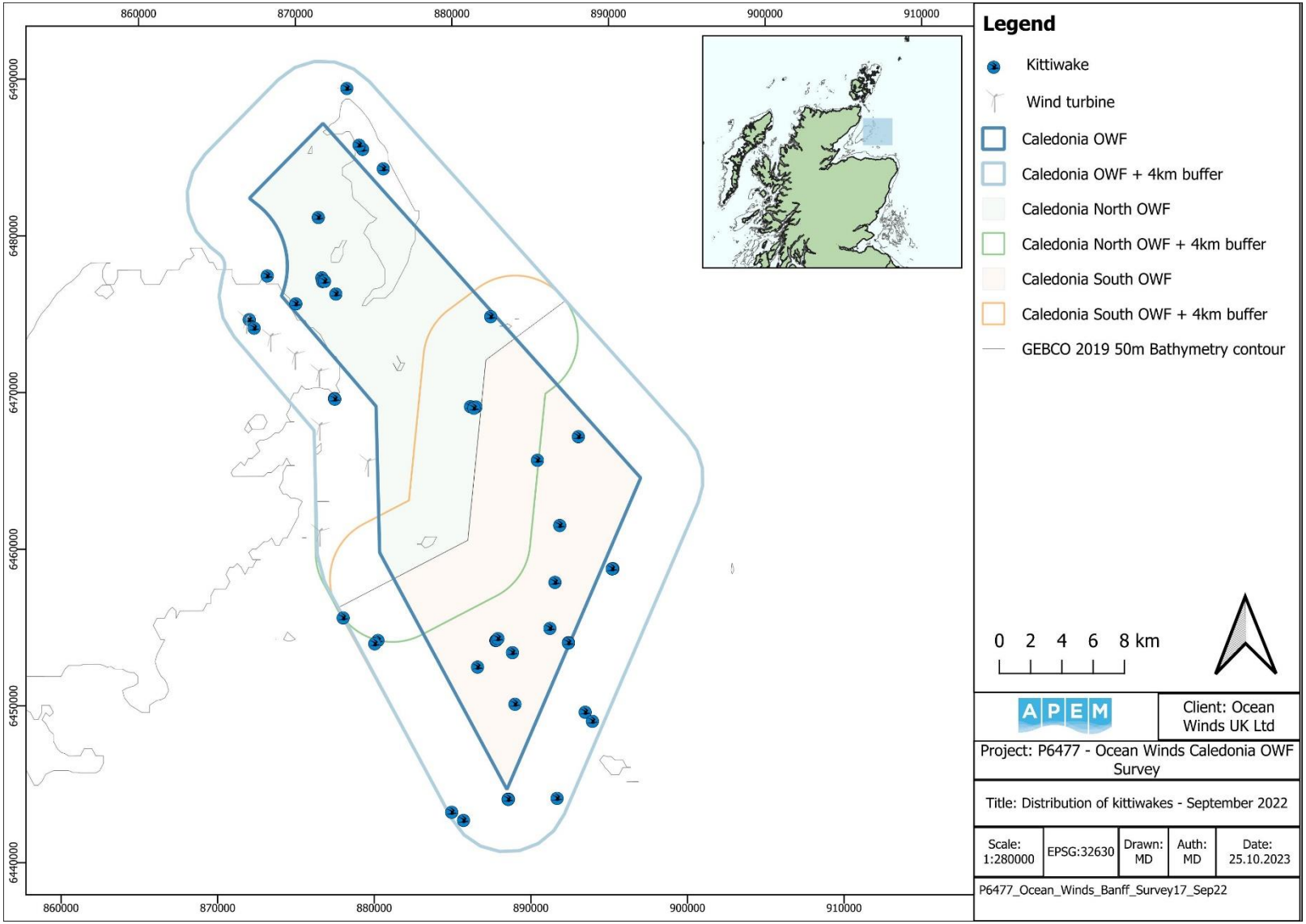


Figure A4.62 Distribution of kittiwakes recorded in the Survey Area in September 2022

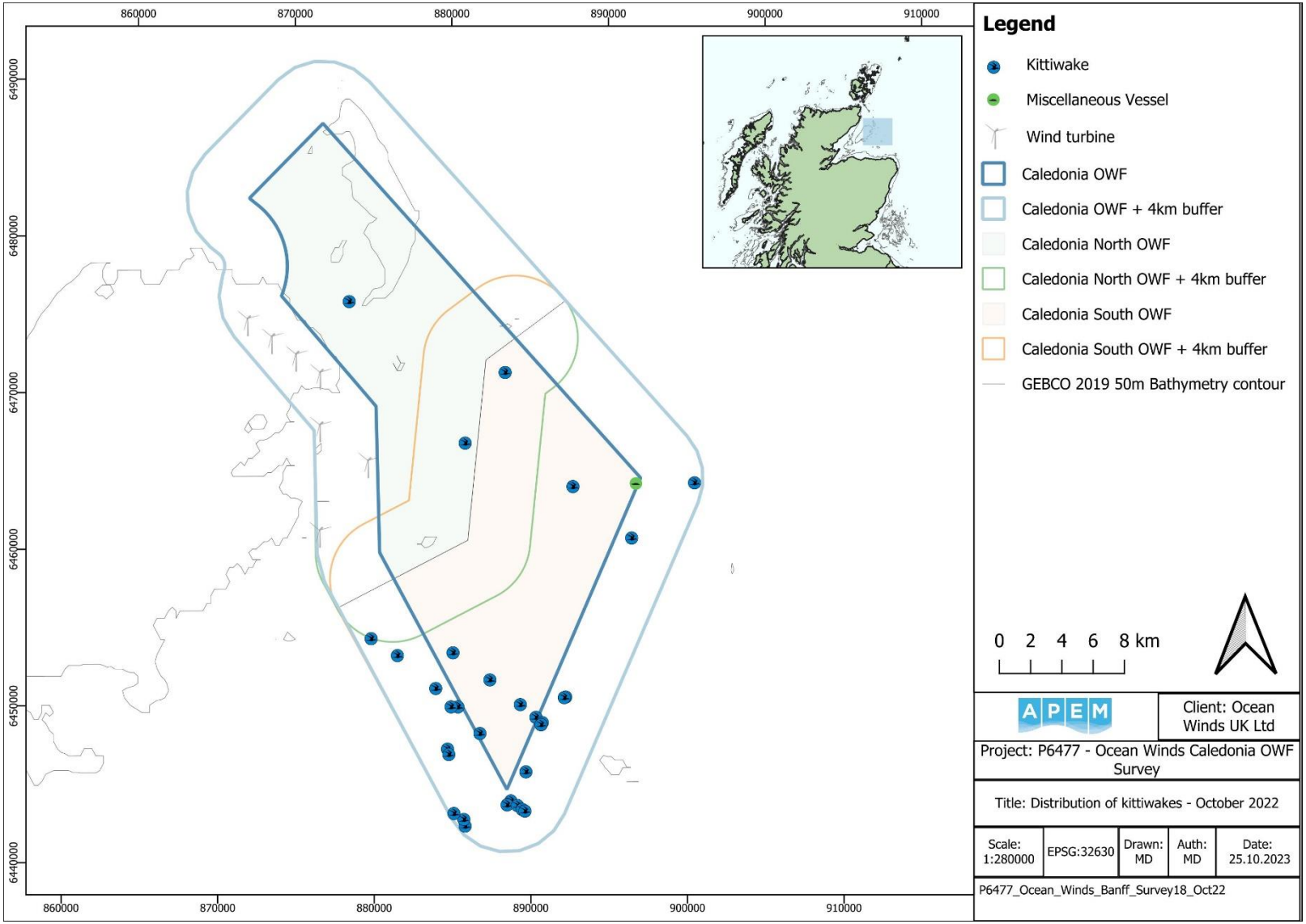


Figure A4.63 Distribution of kittiwakes recorded in the Survey Area in October 2022

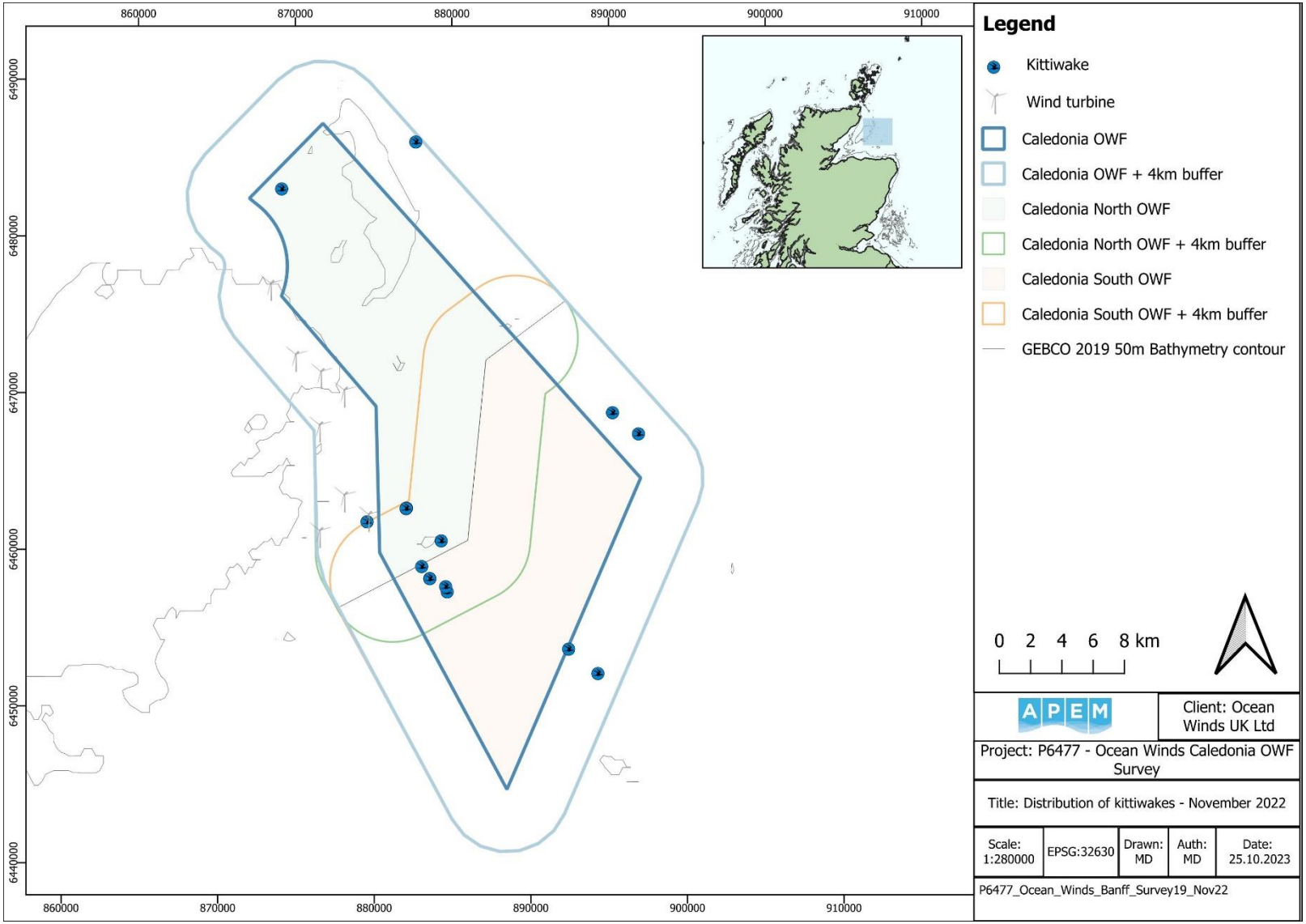


Figure A4.64 Distribution of kittiwakes recorded in the Survey Area in November 2022

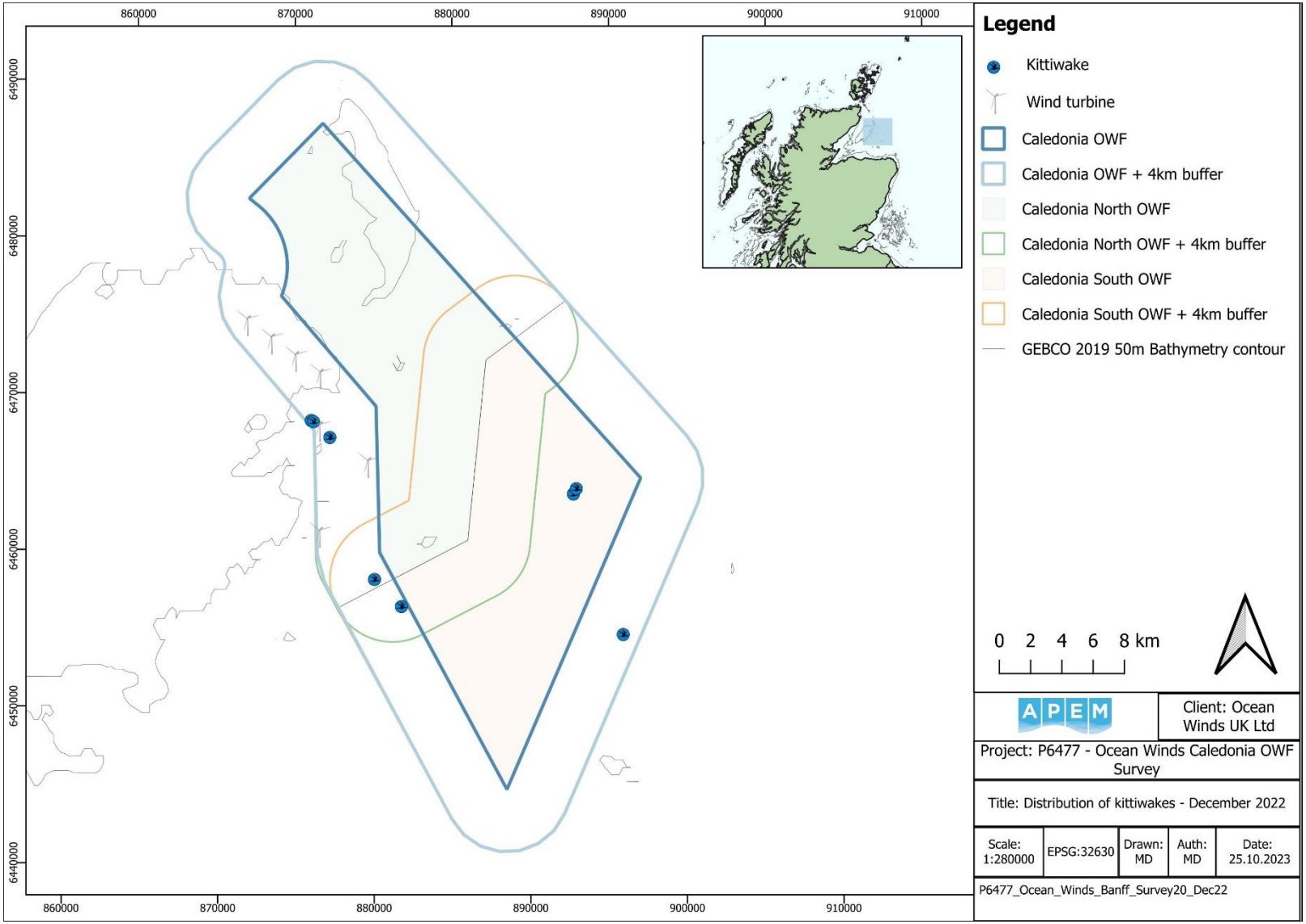


Figure A4.65 Distribution of kittiwakes recorded in the Survey Area in December 2022

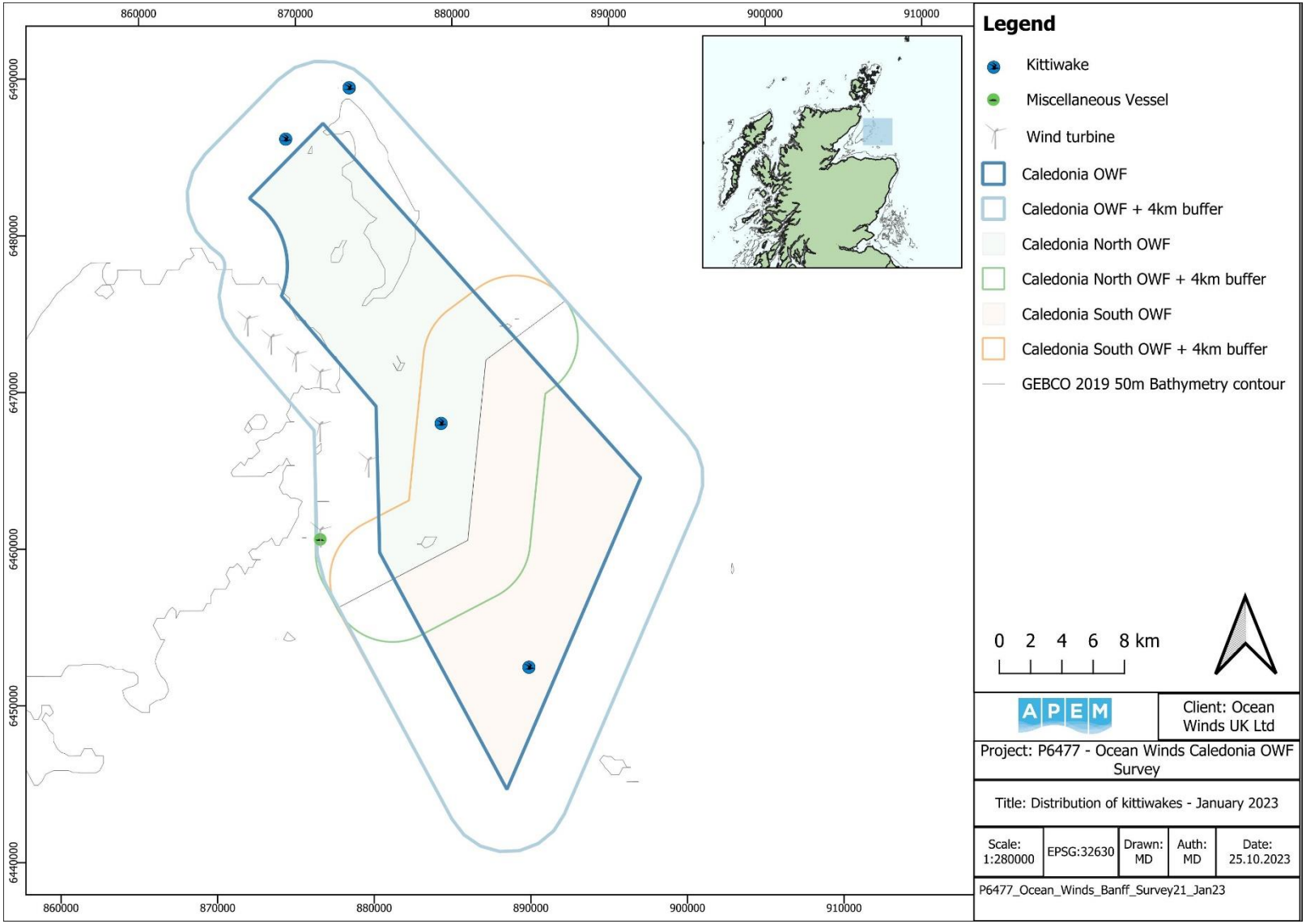


Figure A4.66 Distribution of kittiwakes recorded in the Survey Area in January 2023

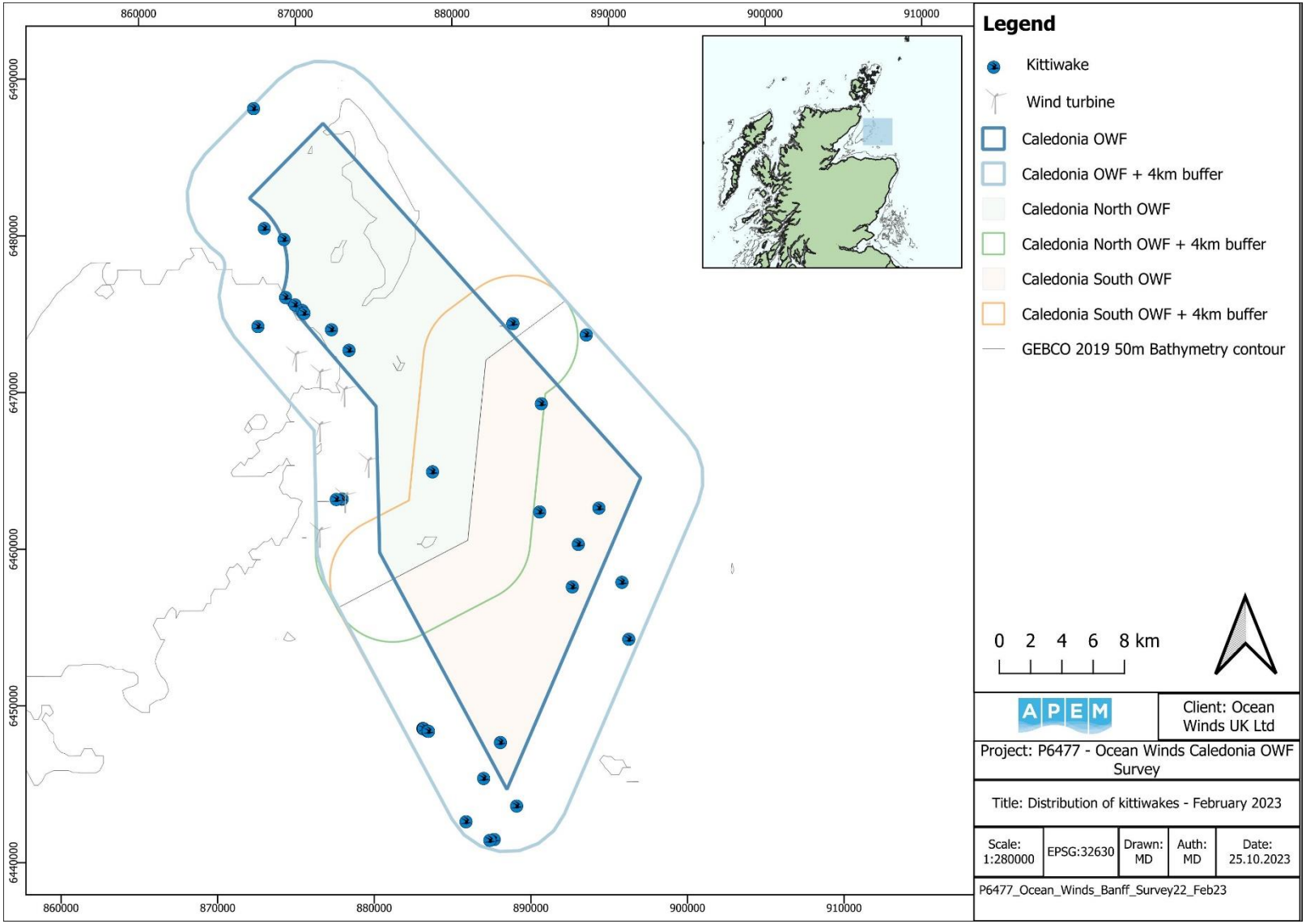


Figure A4.67 Distribution of kittiwakes recorded in the Survey Area in February 2023

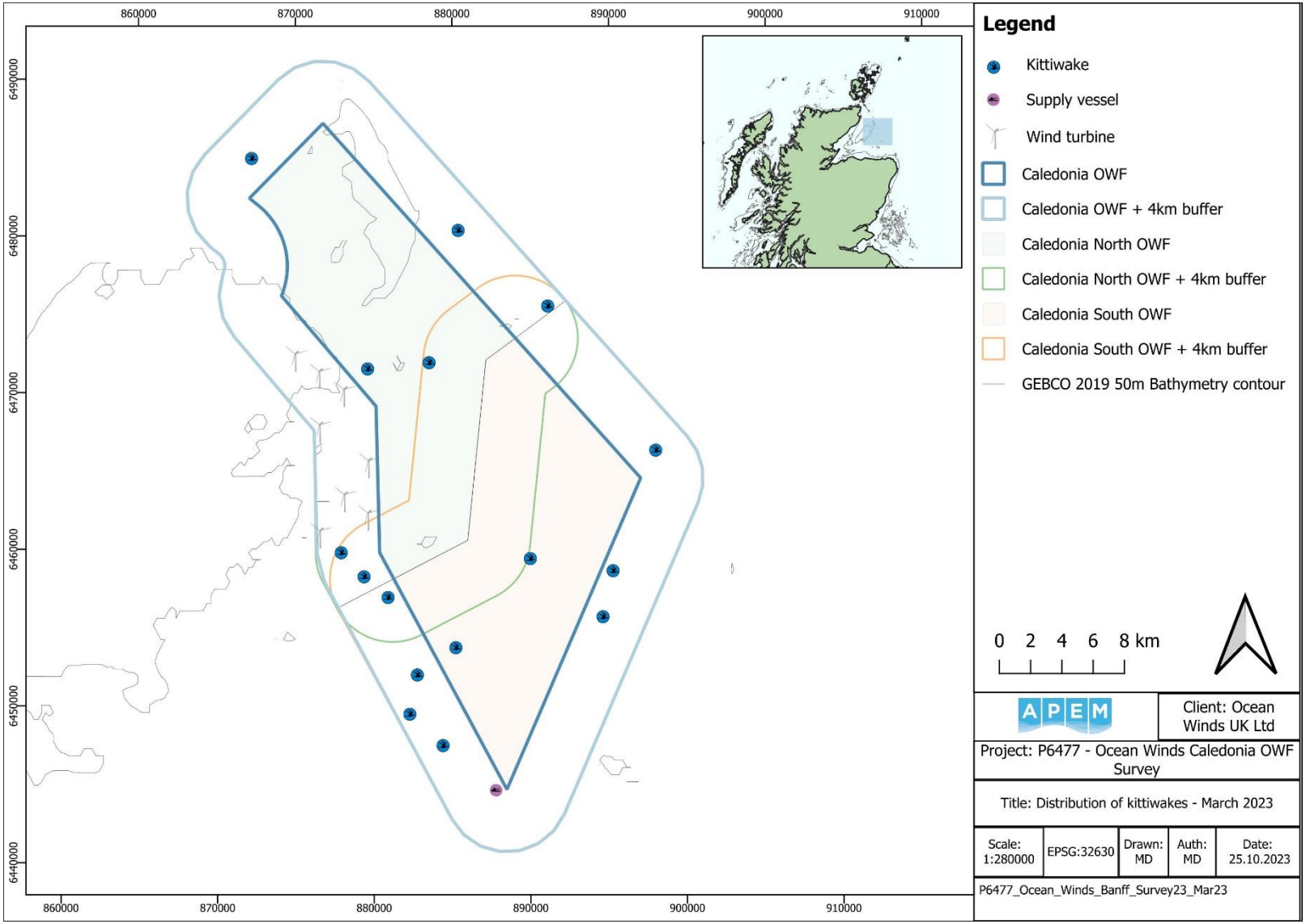


Figure A4.68 Distribution of kittiwakes recorded in the Survey Area in March 2023

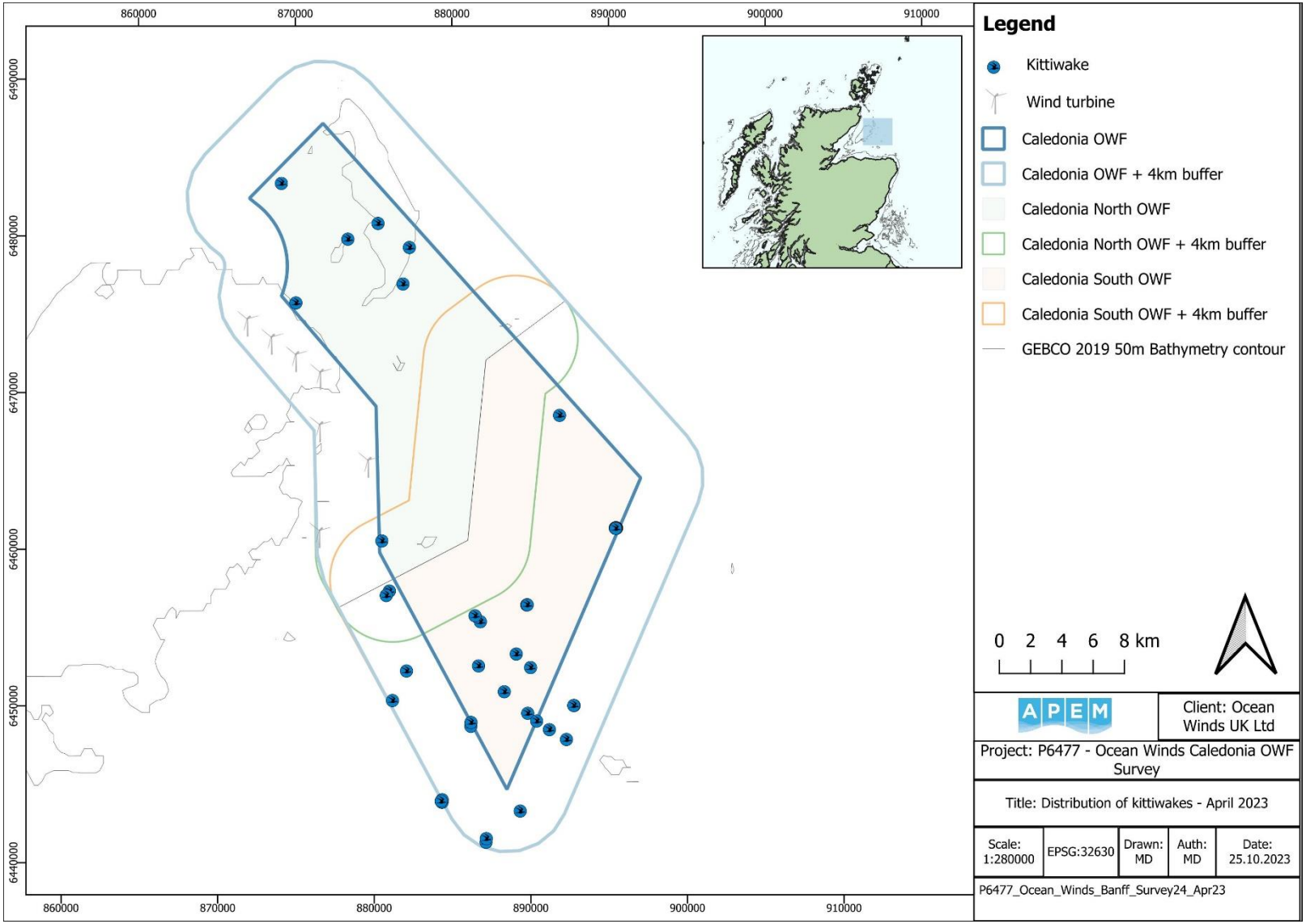


Figure A4.69 Distribution of kittiwakes recorded in the Survey Area in April 2023

Common gull

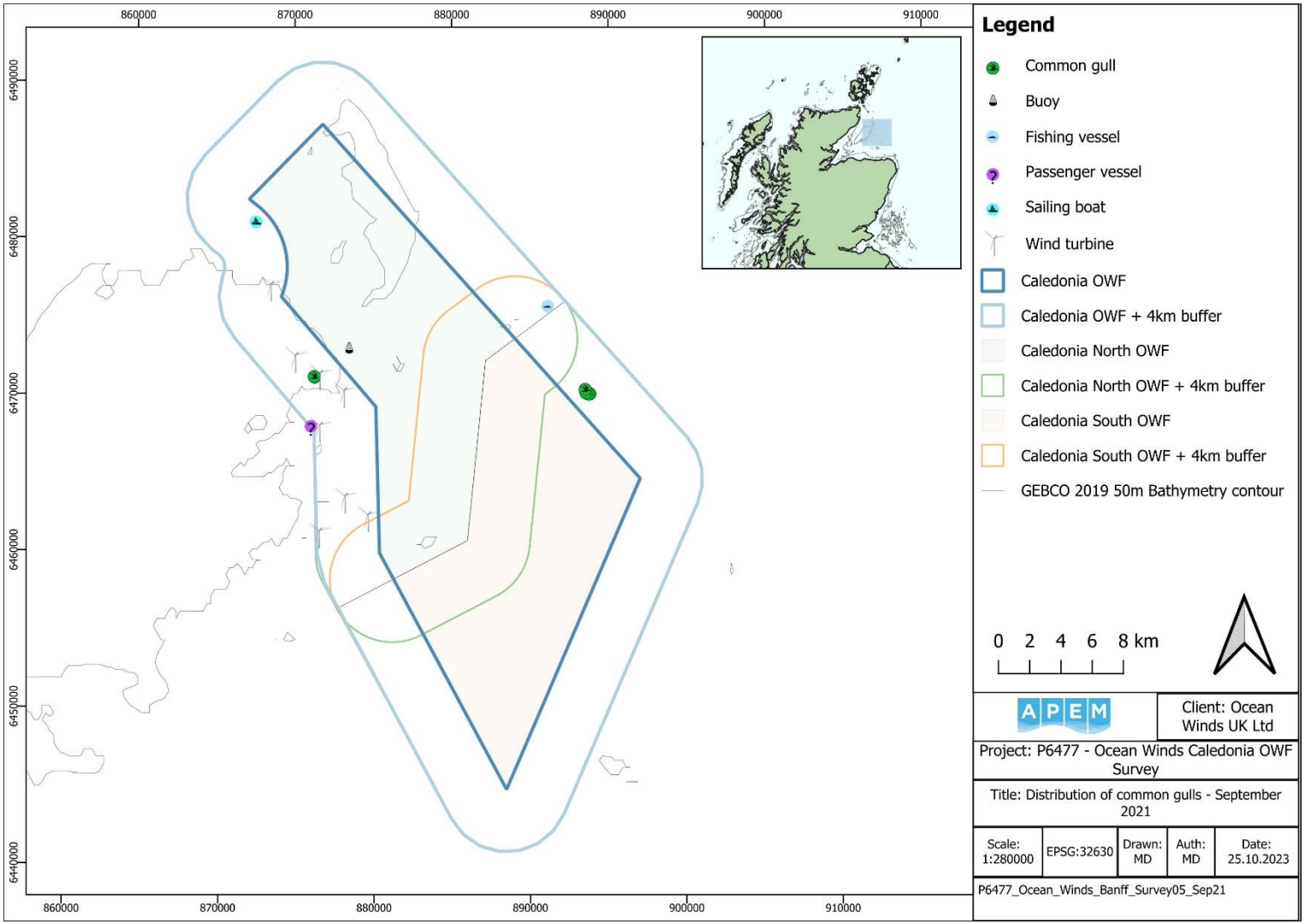


Figure A4.70 Distribution of common gulls recorded in the Survey Area in September 2021

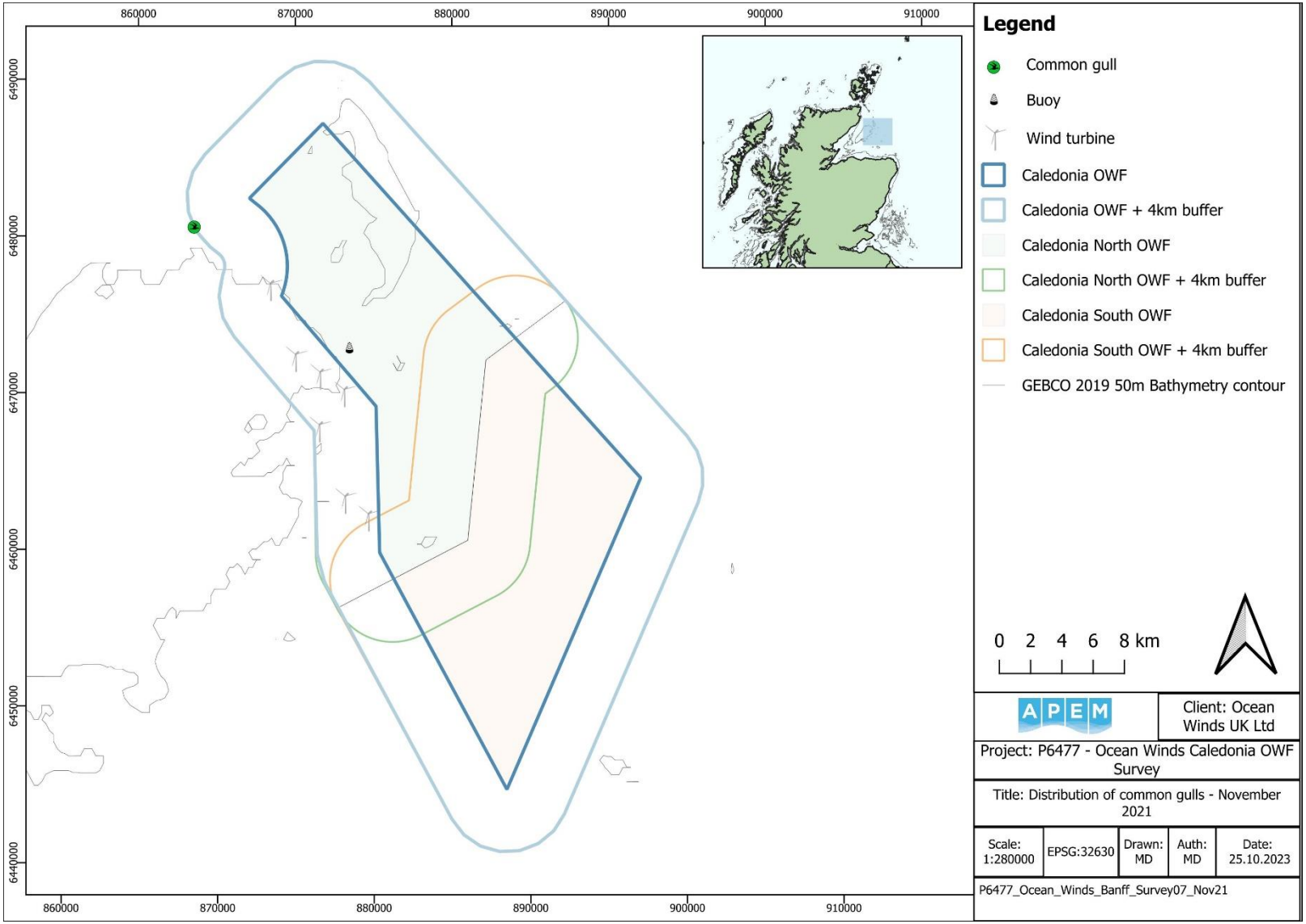


Figure A4.71 Distribution of common gulls recorded in the Survey Area in November 2021

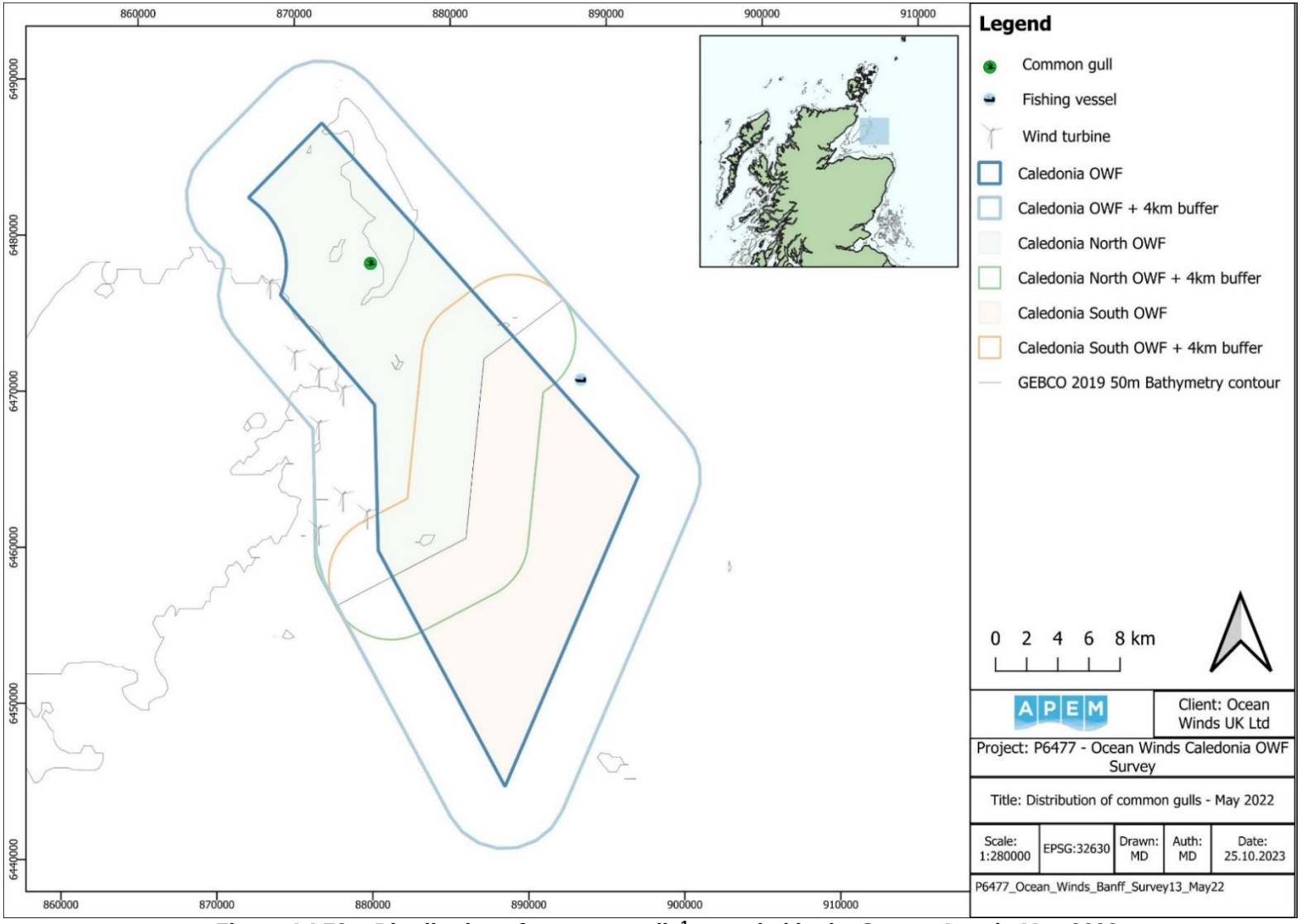


Figure A4.72 Distribution of common gulls[1] recorded in the Survey Area in May 2022

[1]deceased individual

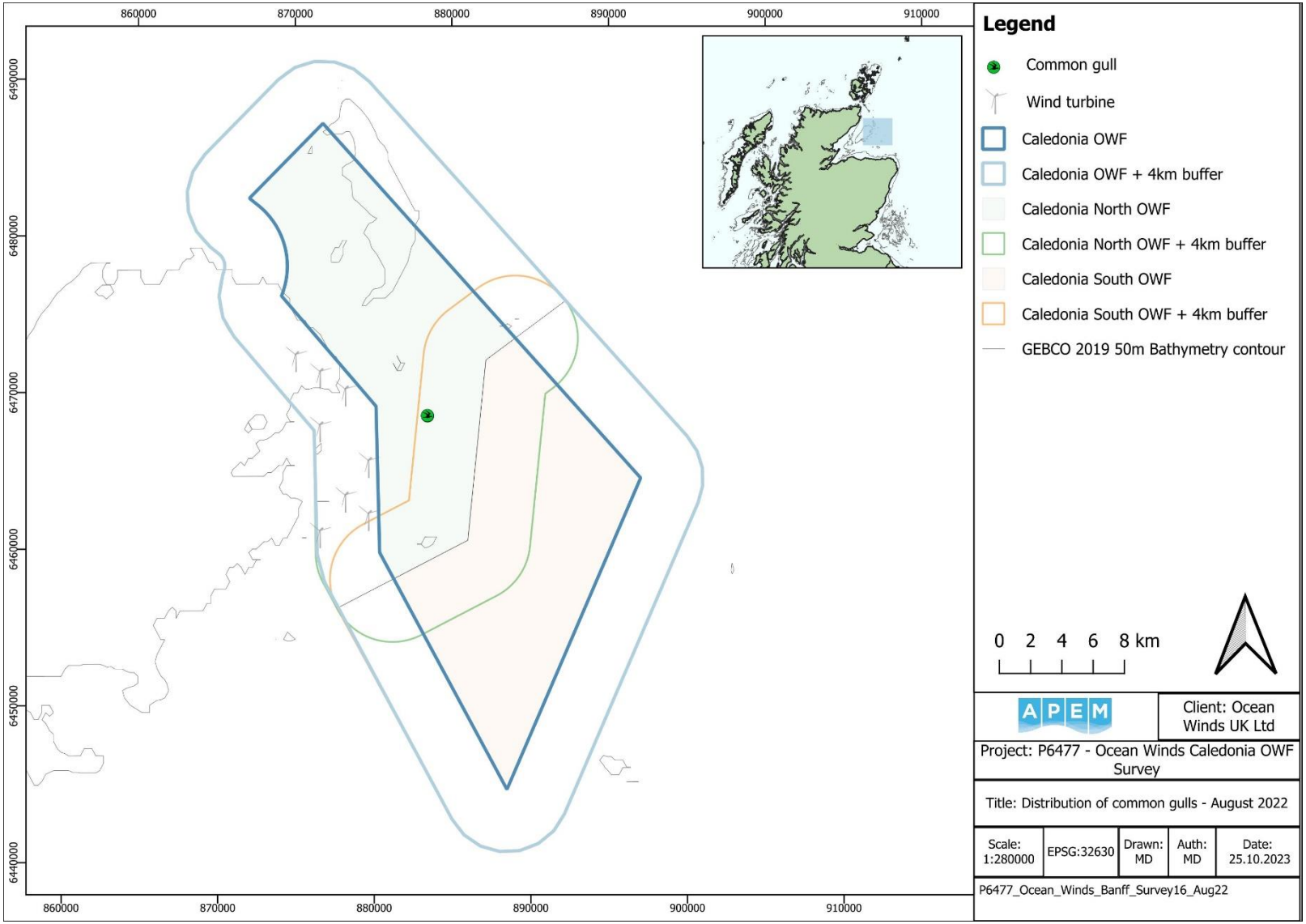


Figure A4.73 Distribution of common gulls recorded in the Survey Area in August 2022

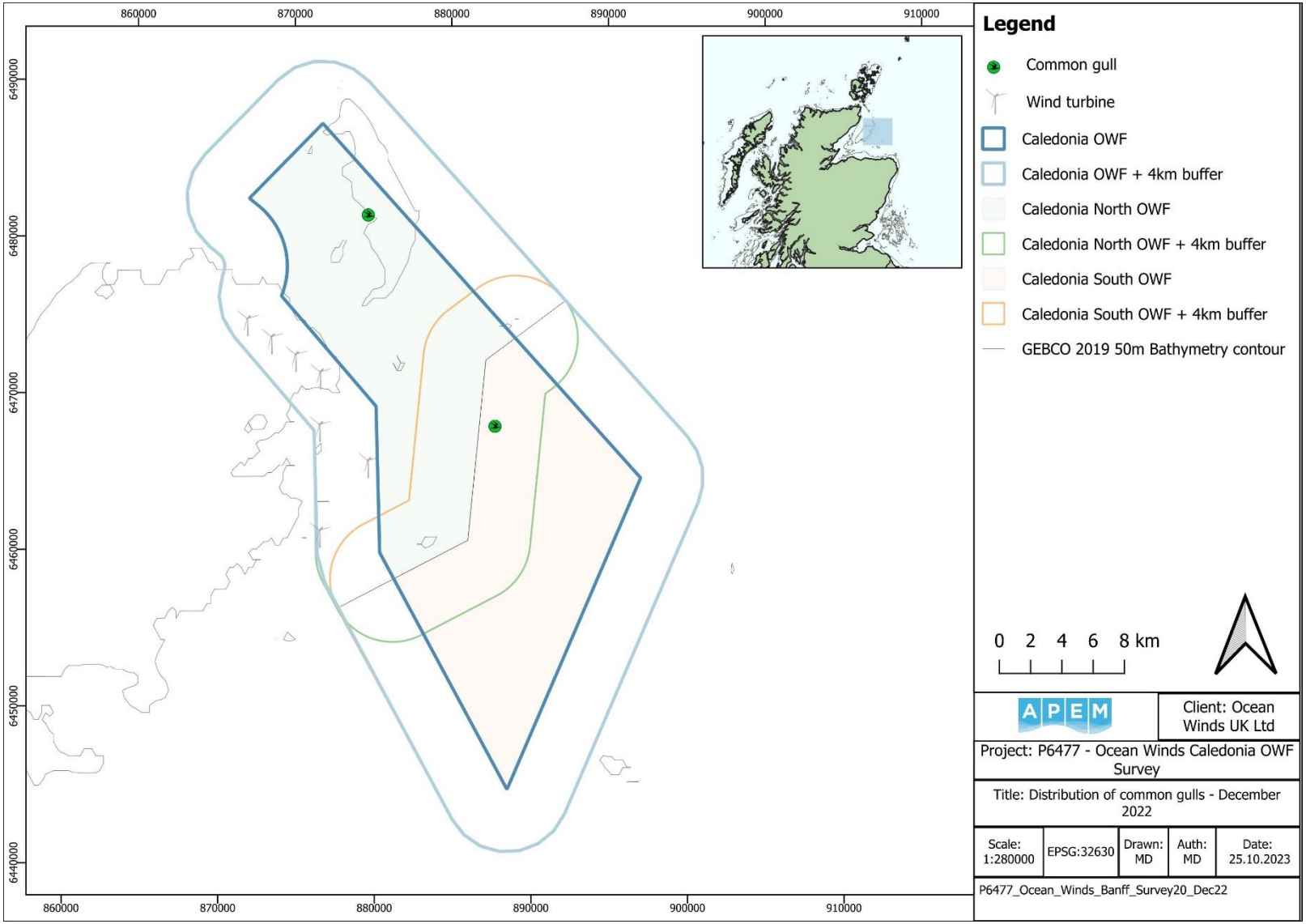


Figure A4.74 Distribution of common gulls recorded in the Survey Area in December 2022

Great black-backed gull

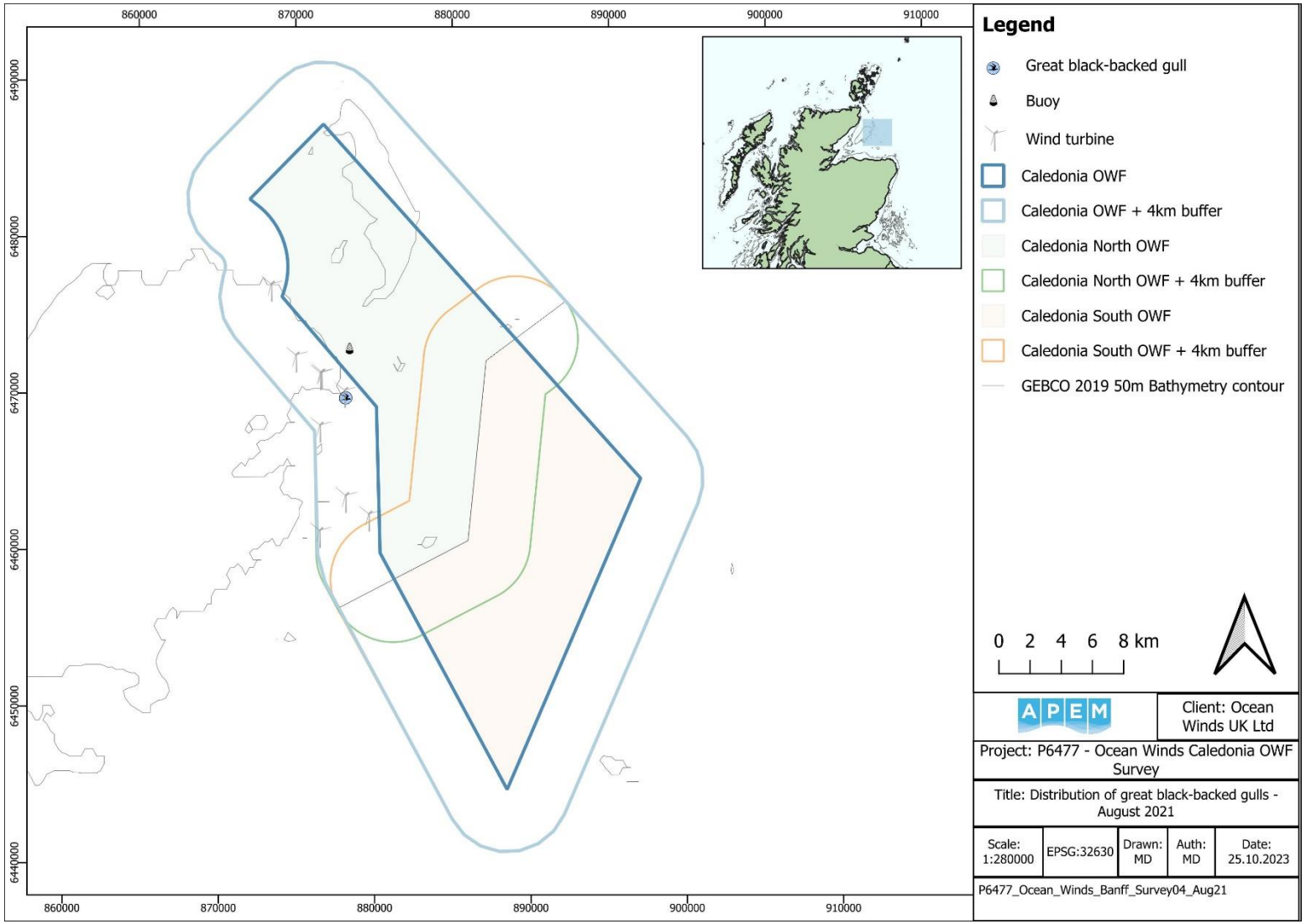


Figure A4.75 Distribution of great black-backed gulls recorded in the Survey Area in August 2021

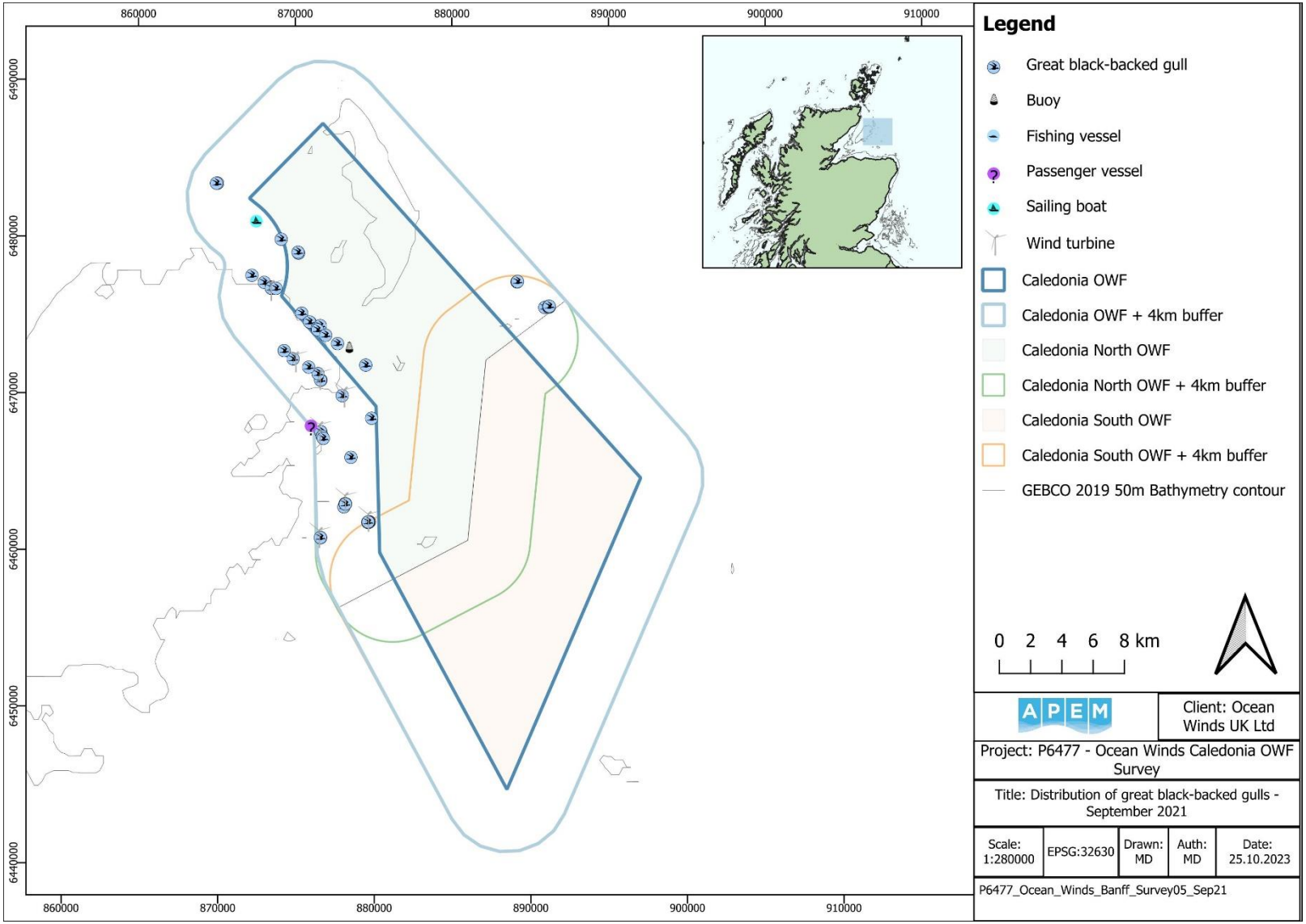


Figure A4.76 Distribution of great black-backed gulls recorded in the Survey Area in September 2021

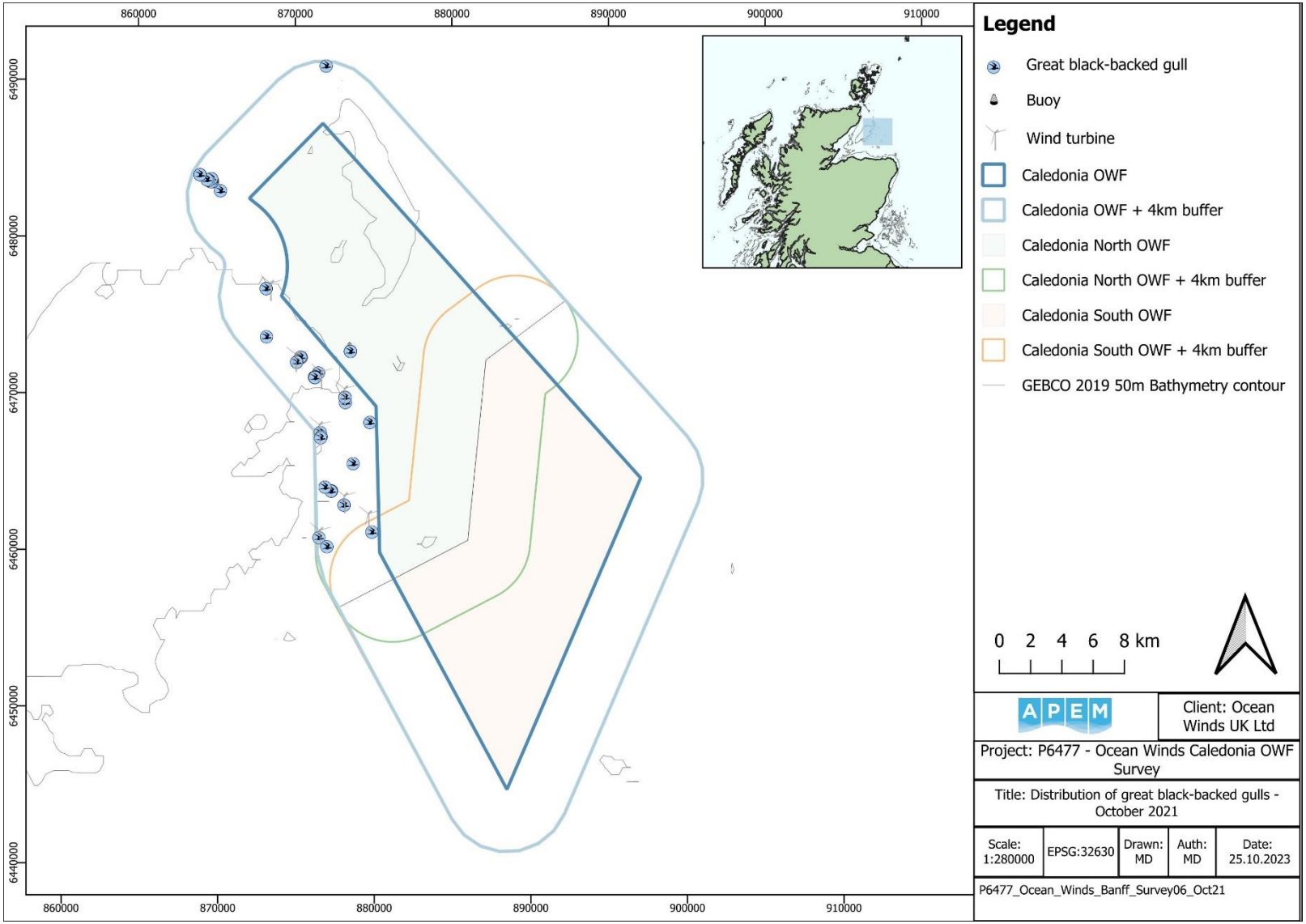


Figure A4.77 Distribution of great black-backed gulls recorded in the Survey Area in October 2021

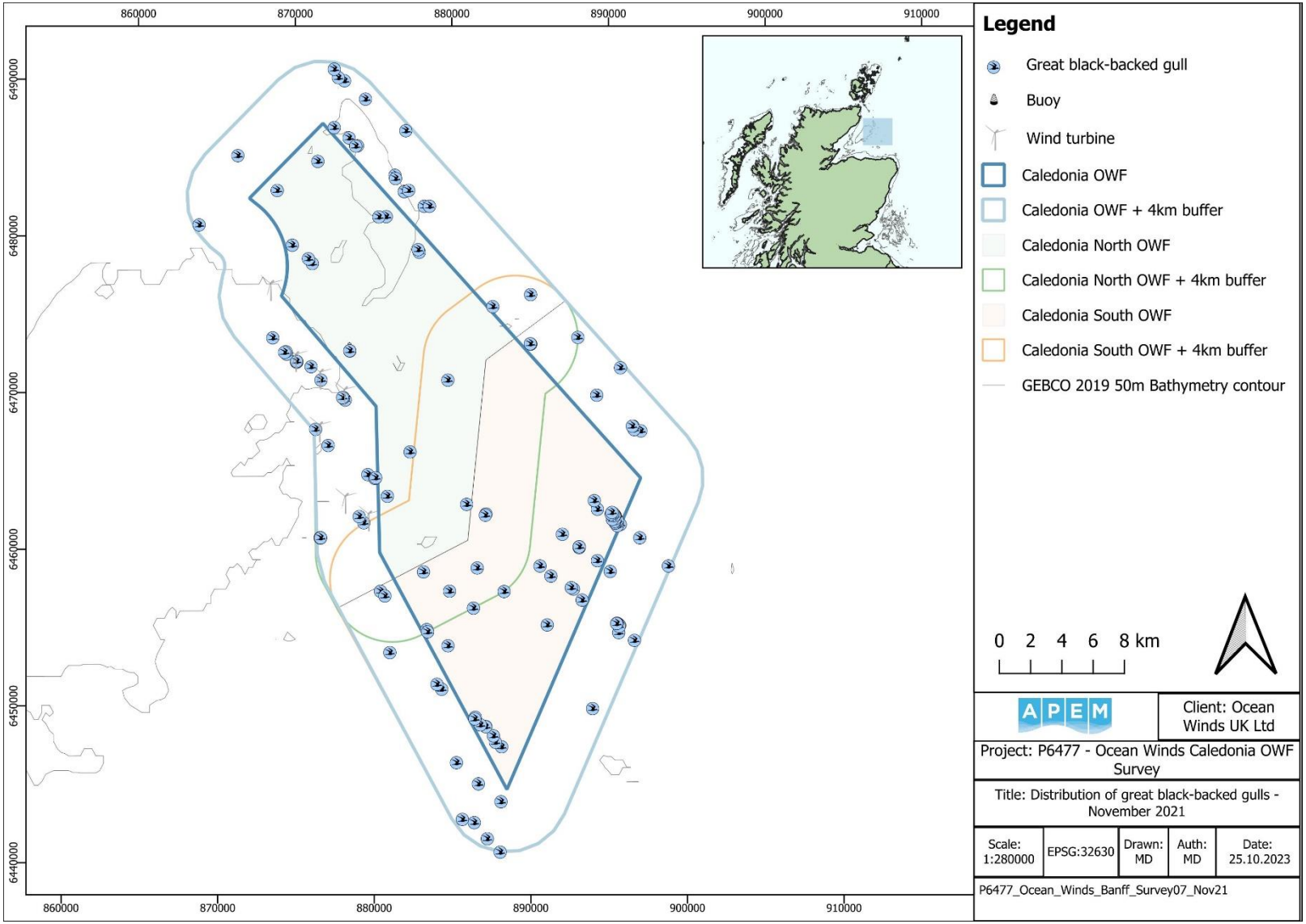


Figure A4.78 Distribution of great black-backed gulls recorded in the Survey Area in November 2021

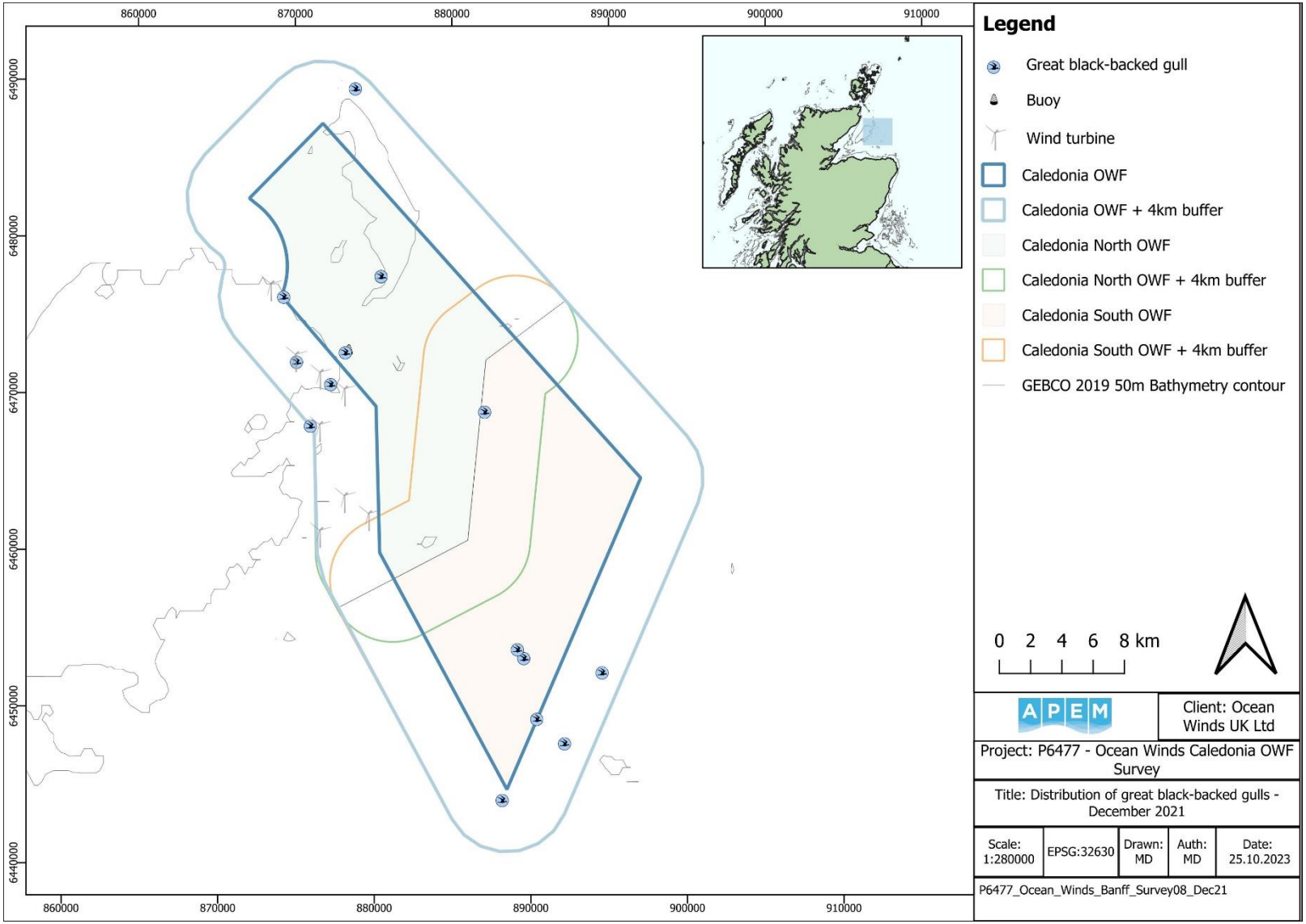


Figure A4.79 Distribution of great black-backed gulls recorded in the Survey Area in December 2021

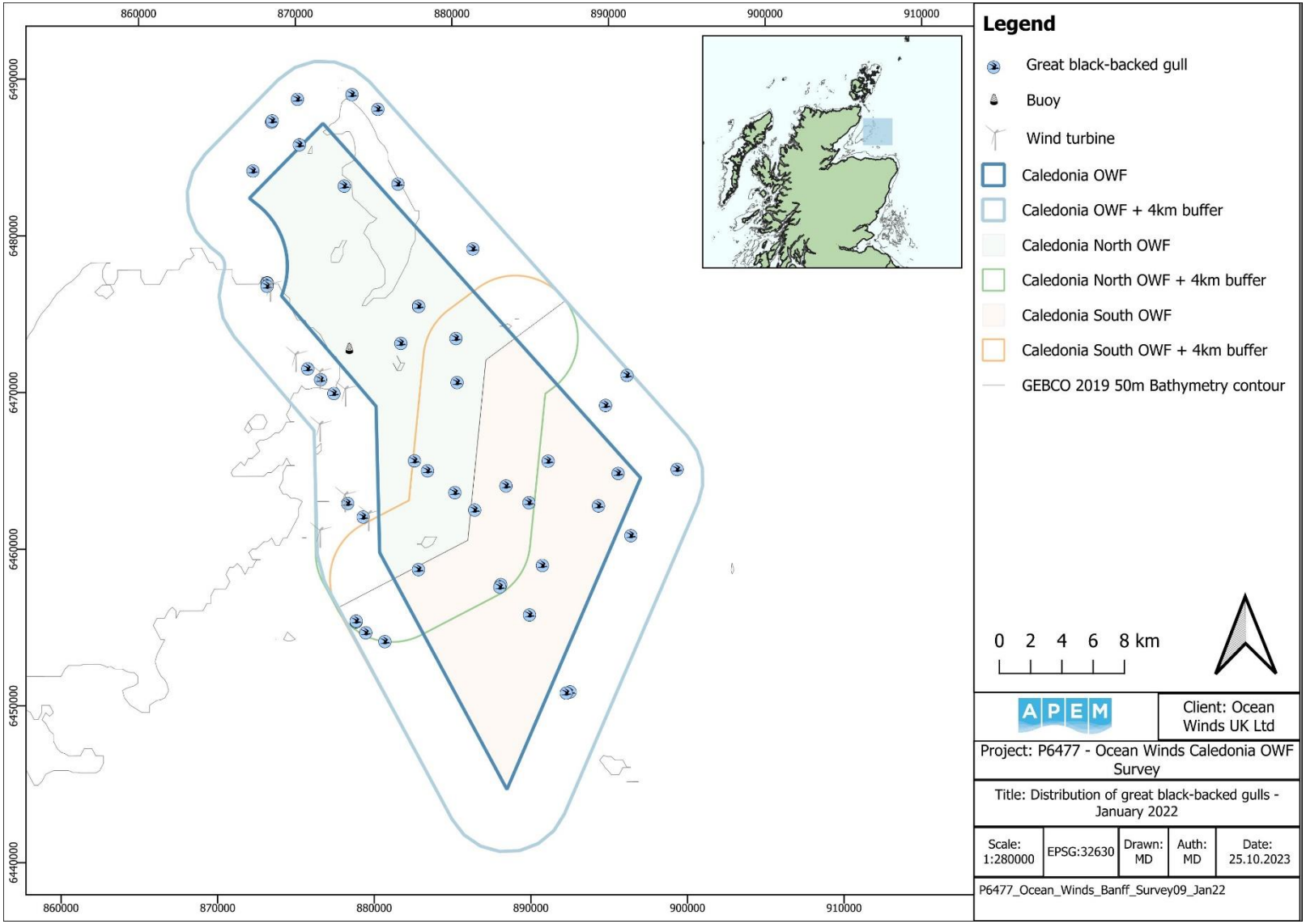


Figure A4.80 Distribution of great black-backed gulls recorded in the Survey Area in January 2022

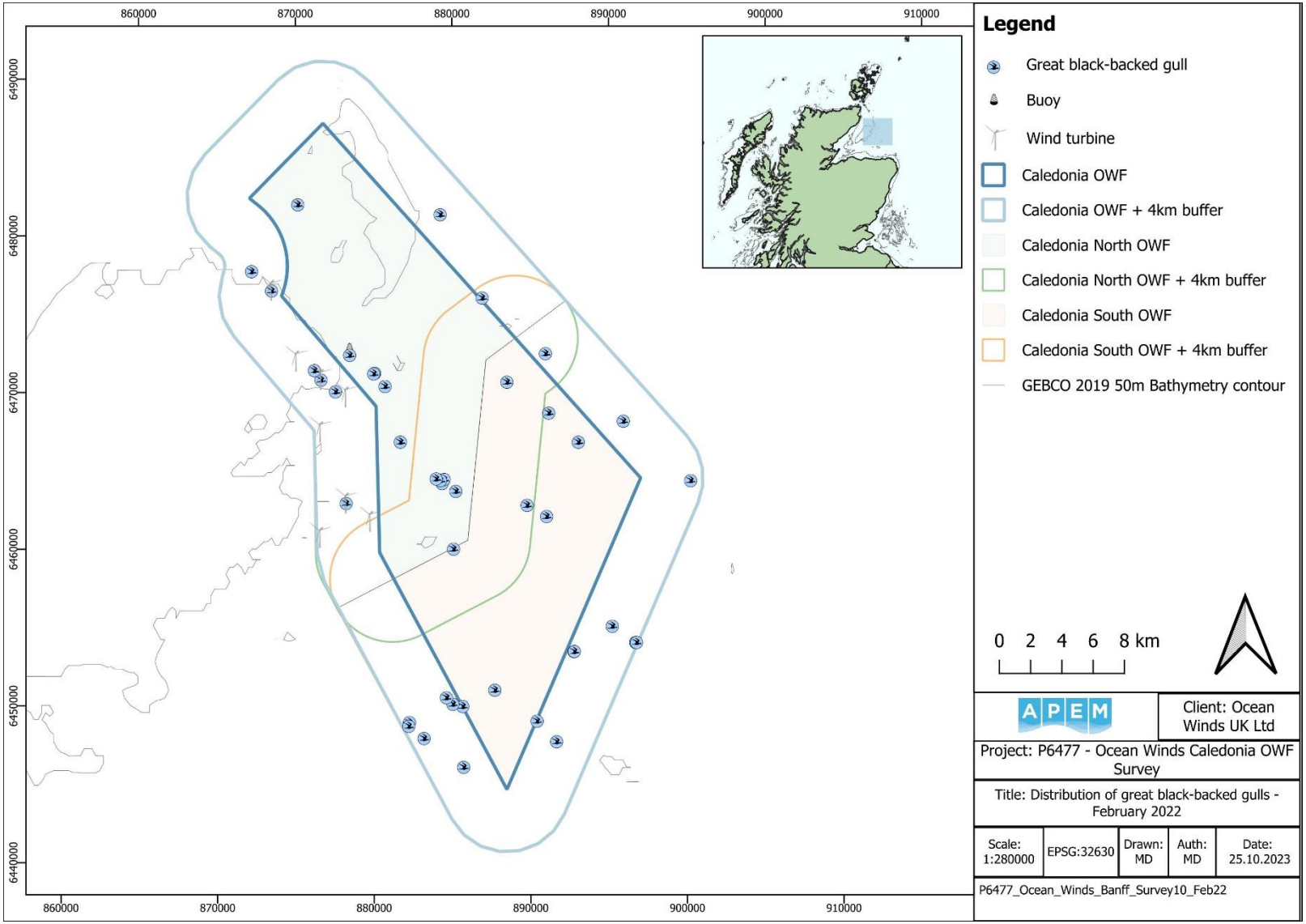


Figure A4.81 Distribution of great black-backed gulls recorded in the Survey Area in February 2022

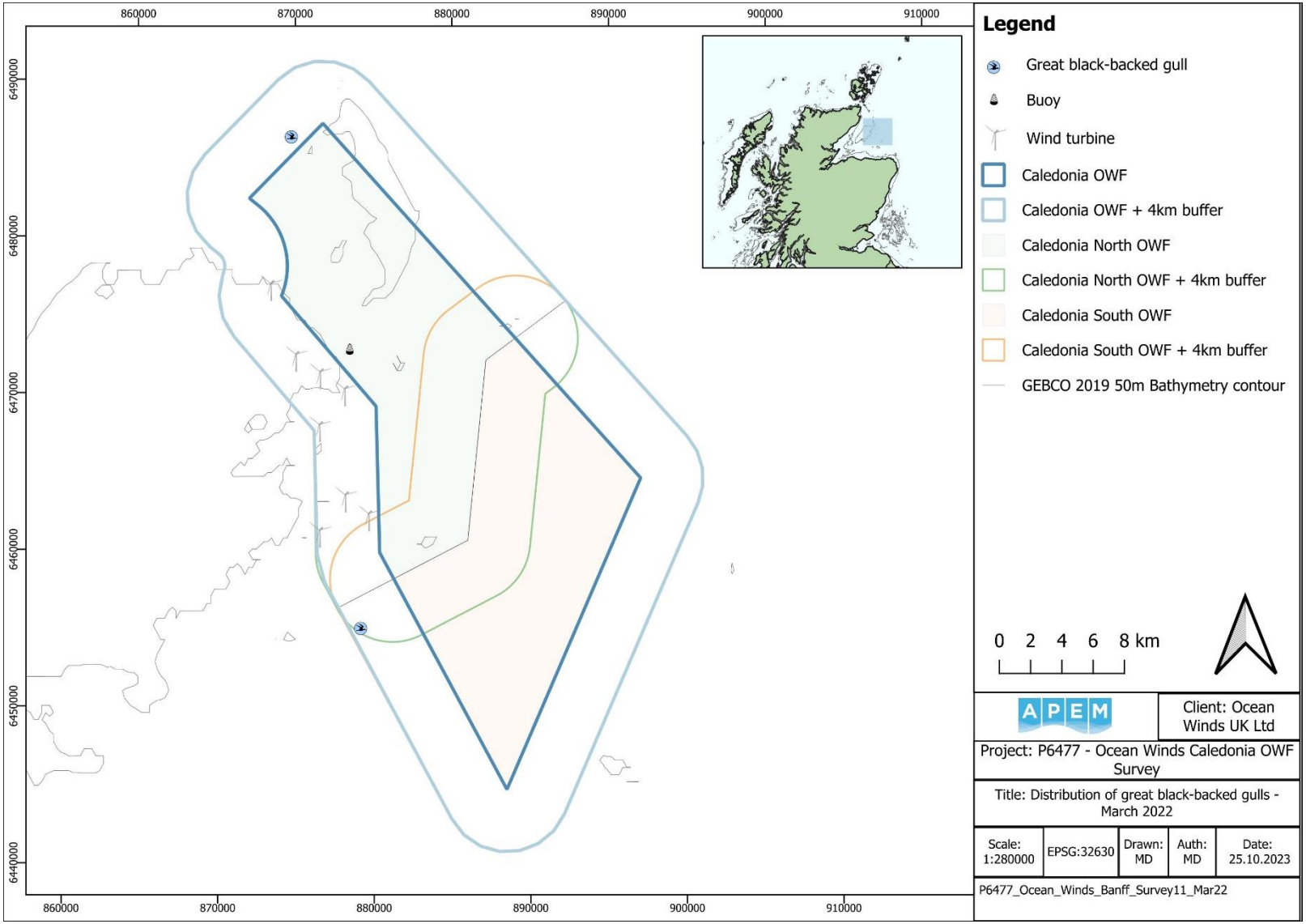


Figure A4.82 Distribution of great black-backed gulls recorded in the Survey Area in March 2022

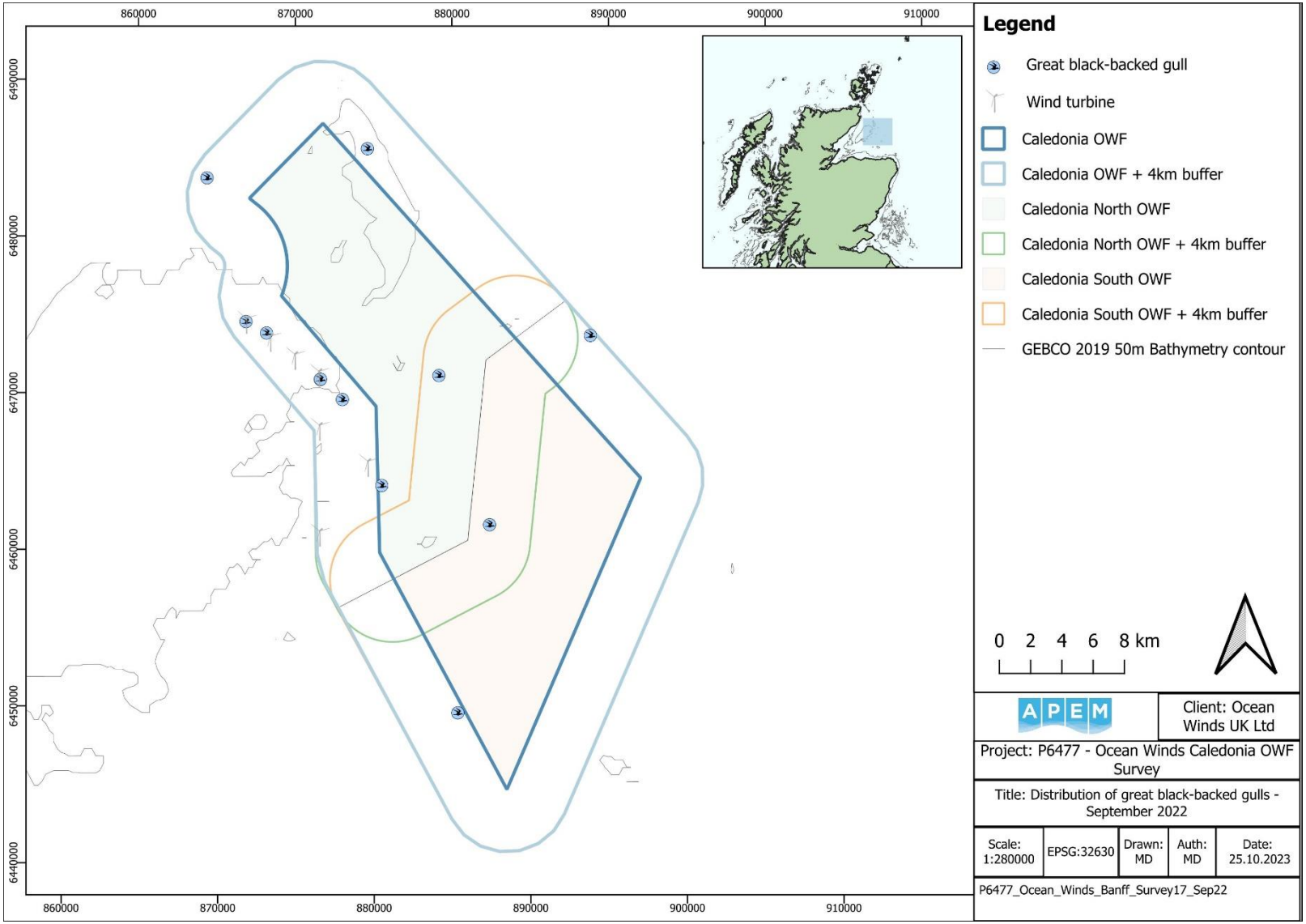


Figure A4.83 Distribution of great black-backed gulls recorded in the Survey Area in September 2022

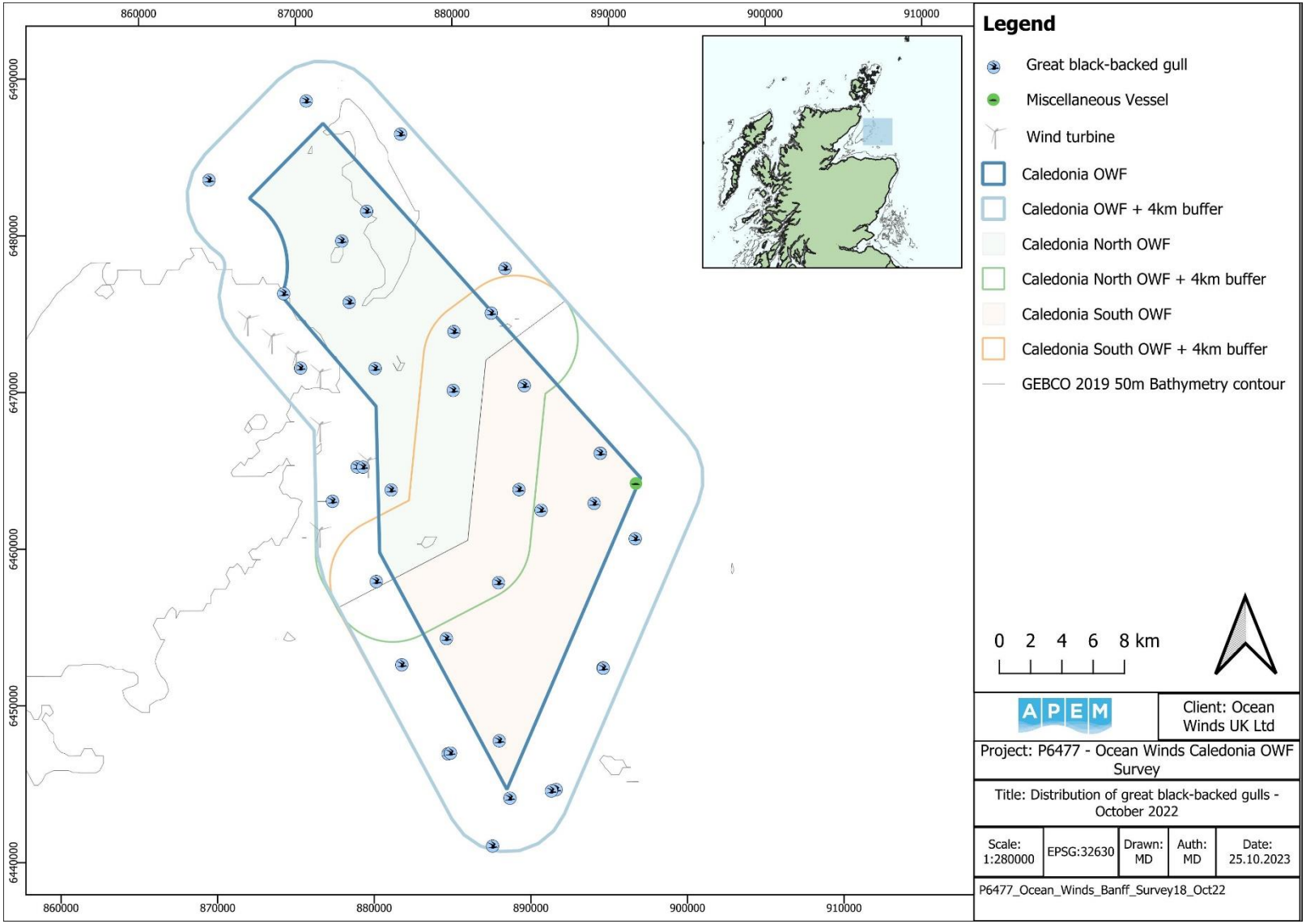


Figure A4.84 Distribution of great black-backed gulls recorded in the Survey Area in October 2022

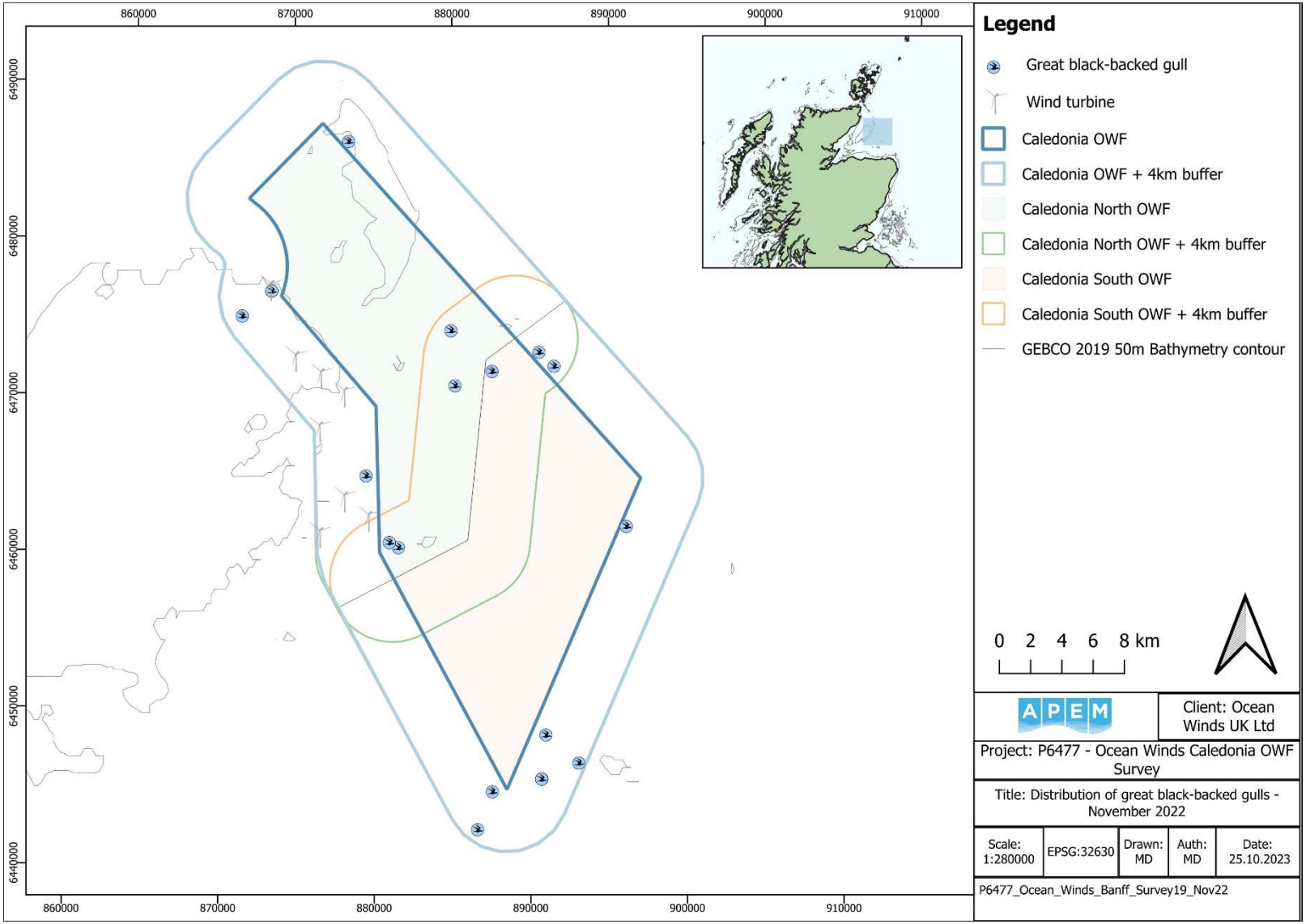


Figure A4.85 Distribution of great black-backed gulls recorded in the Survey Area in November 2022

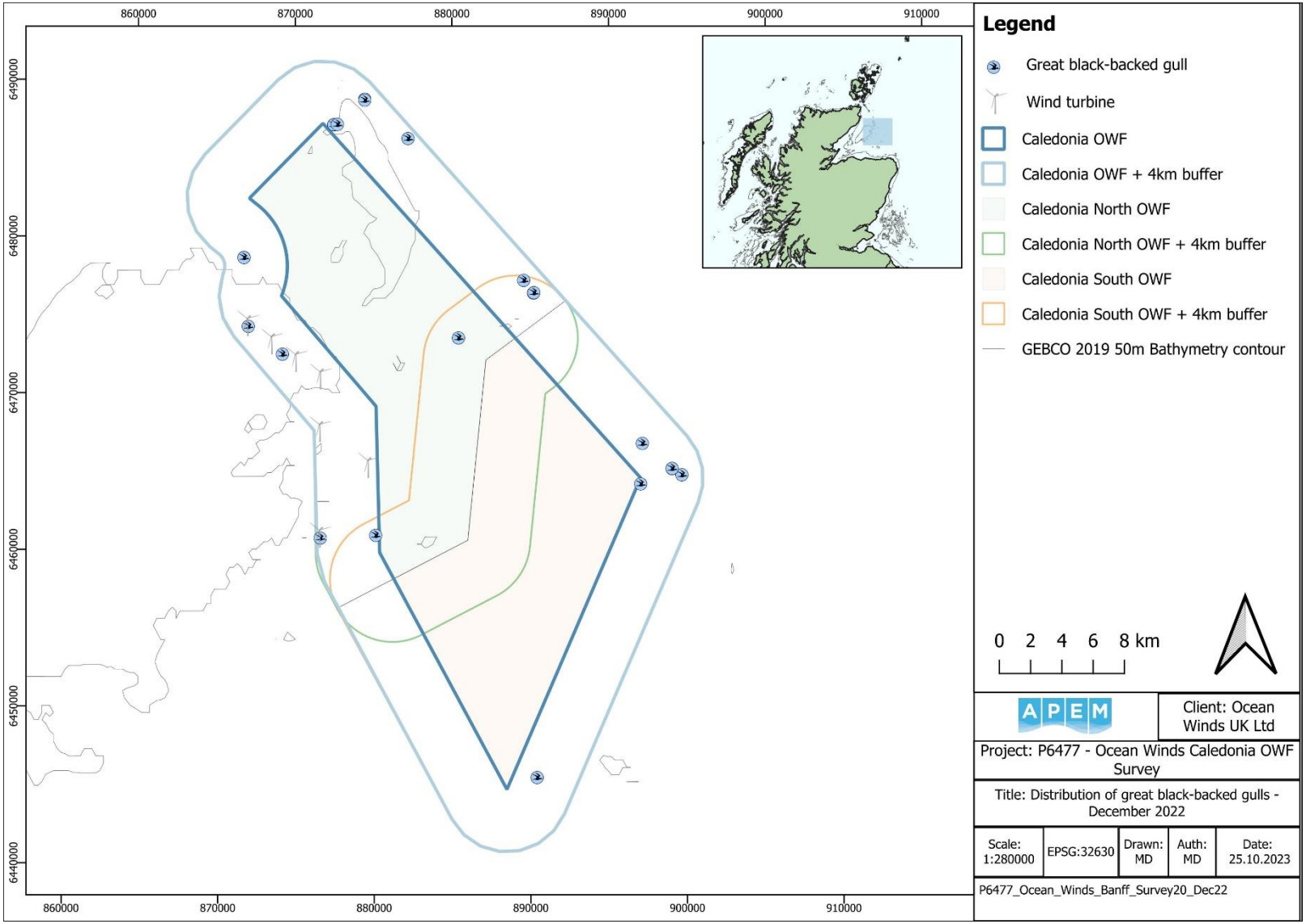


Figure A4.86 Distribution of great black-backed gulls recorded in the Survey Area in December 2022

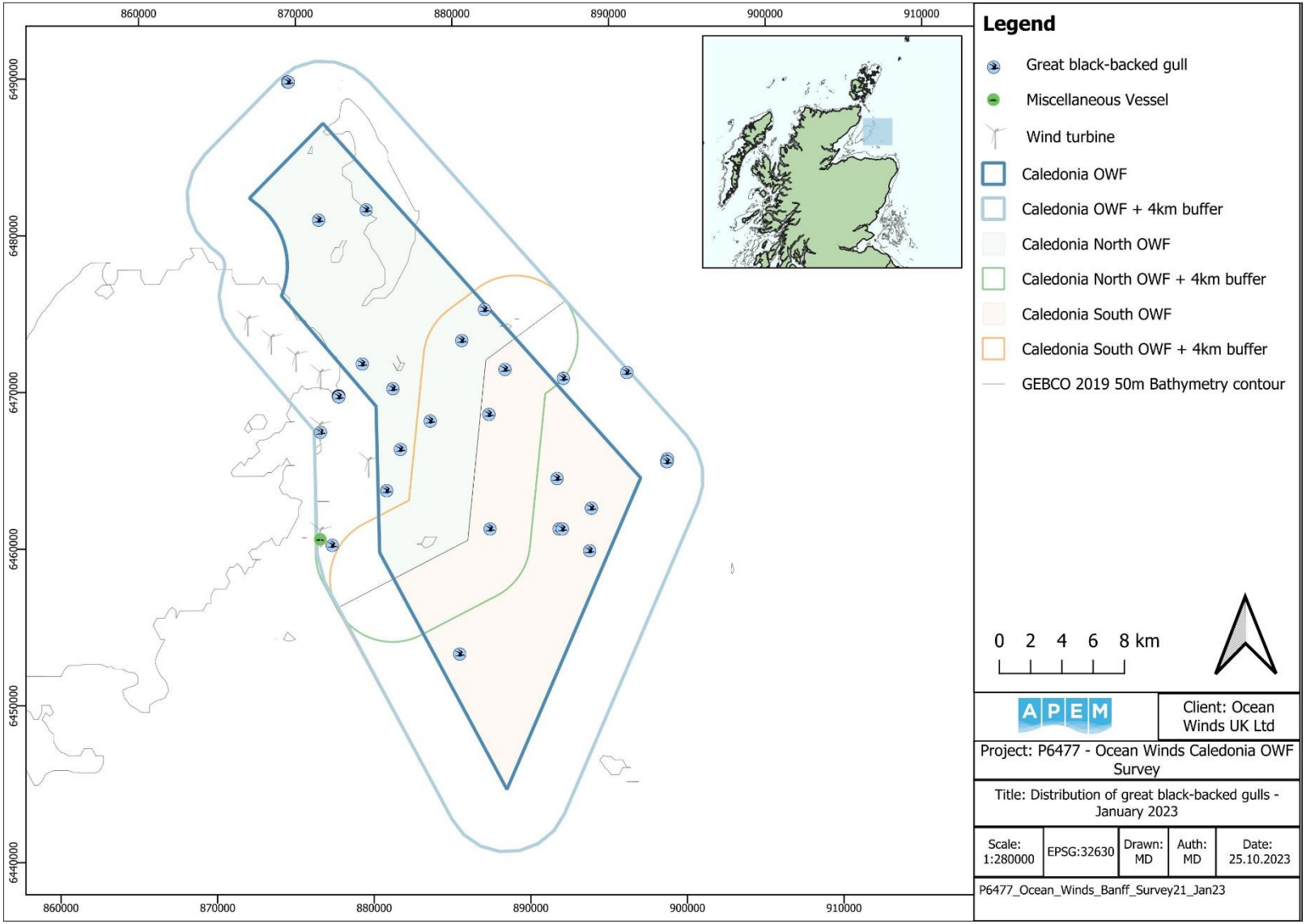


Figure A4.87 Distribution of great black-backed gulls recorded in the Survey Area in January 2023

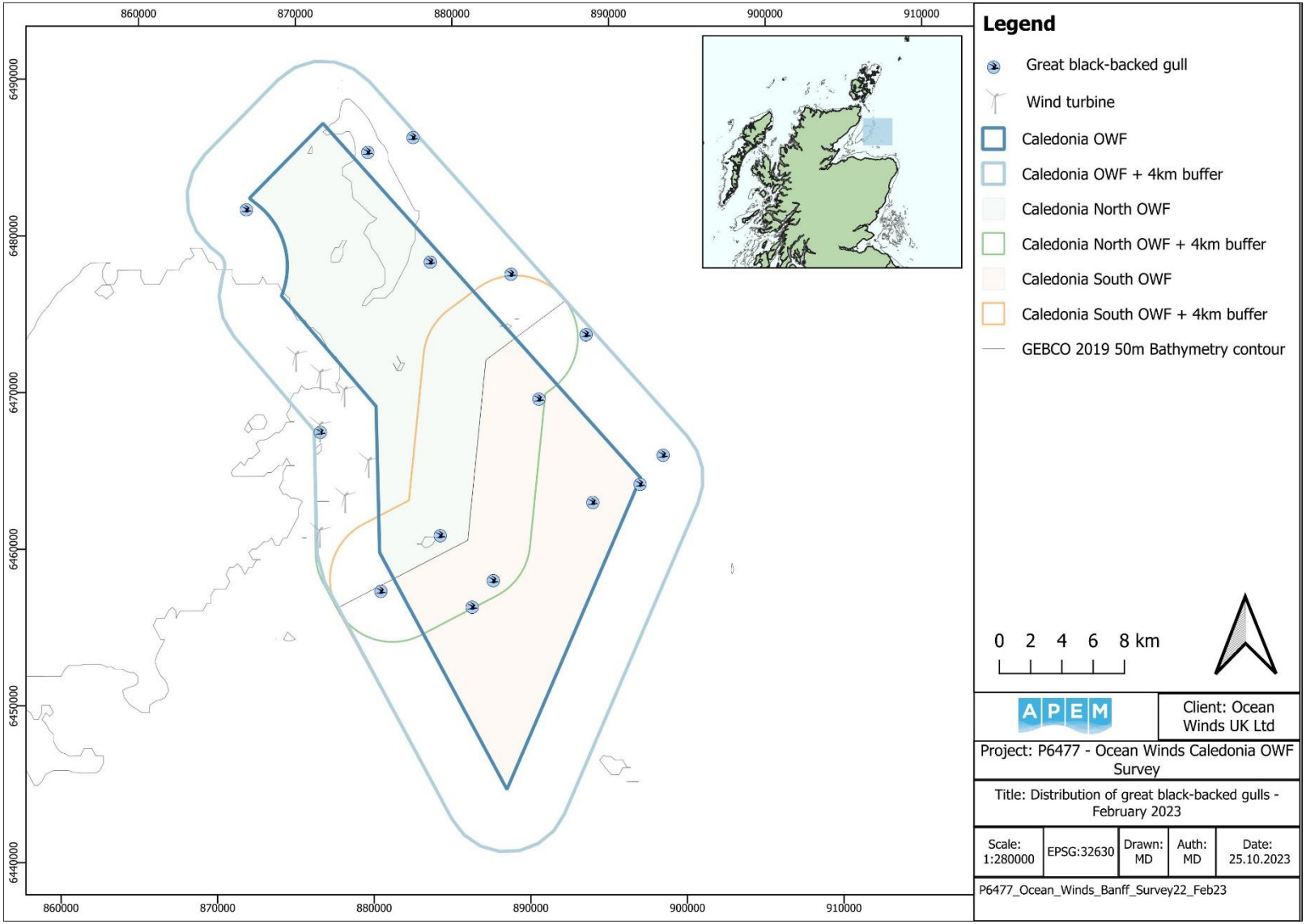


Figure A4.88 Distribution of great black-backed gulls recorded in the Survey Area in February 2023

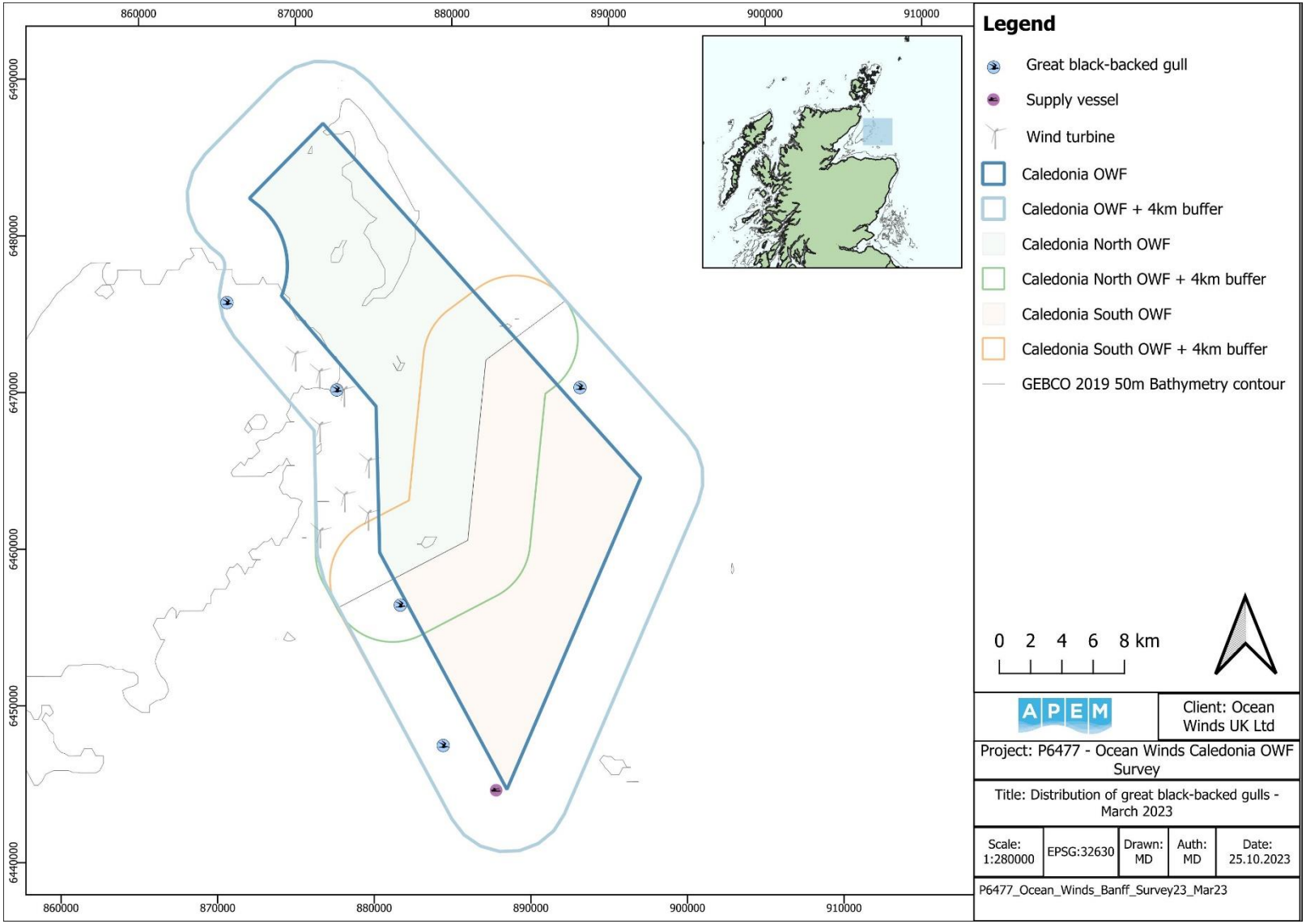


Figure A4.89 Distribution of great black-backed gulls recorded in the Survey Area in March 2023

Herring gull

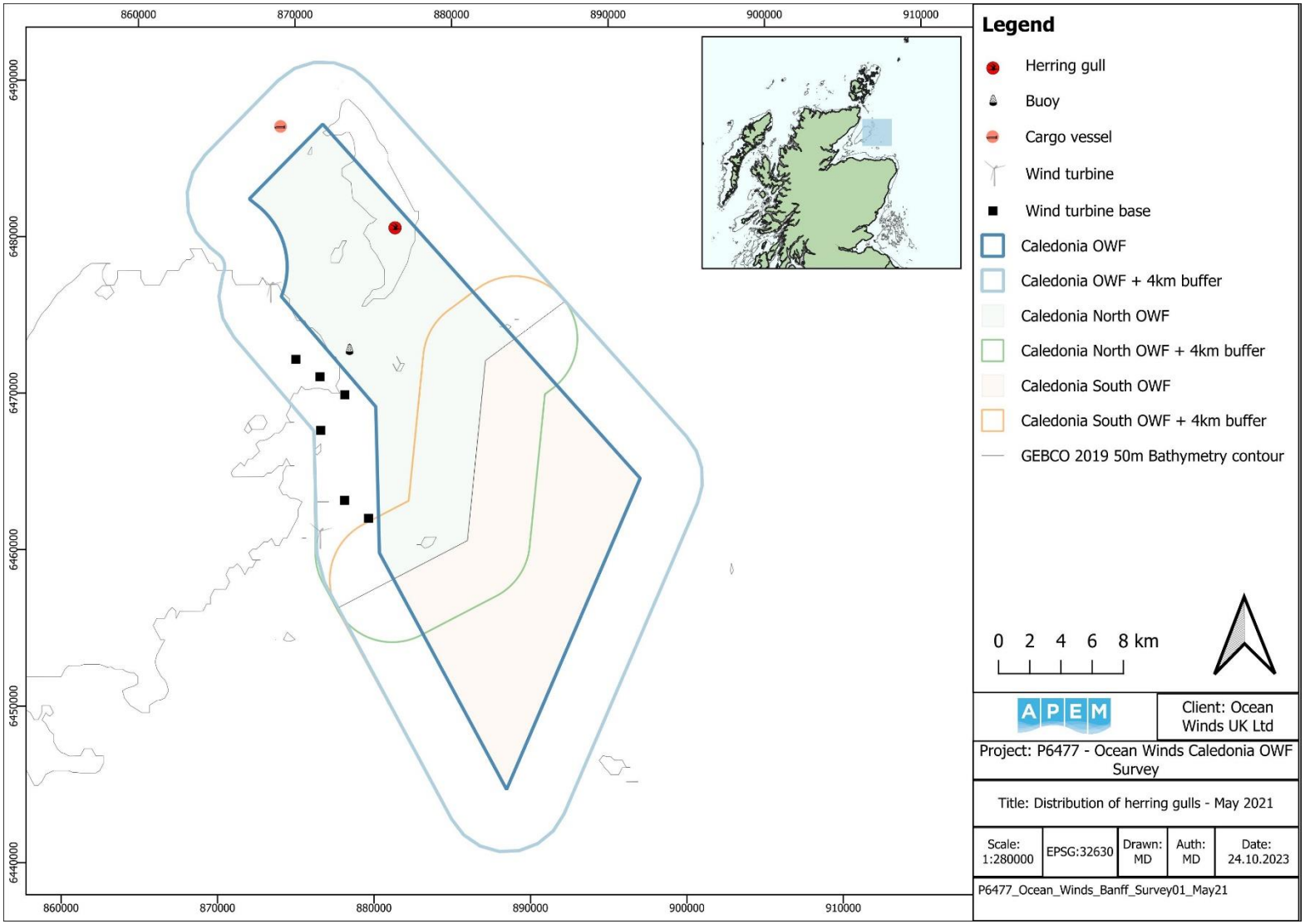


Figure A4.90 Distribution of herring gulls recorded in the Survey Area in May 2021

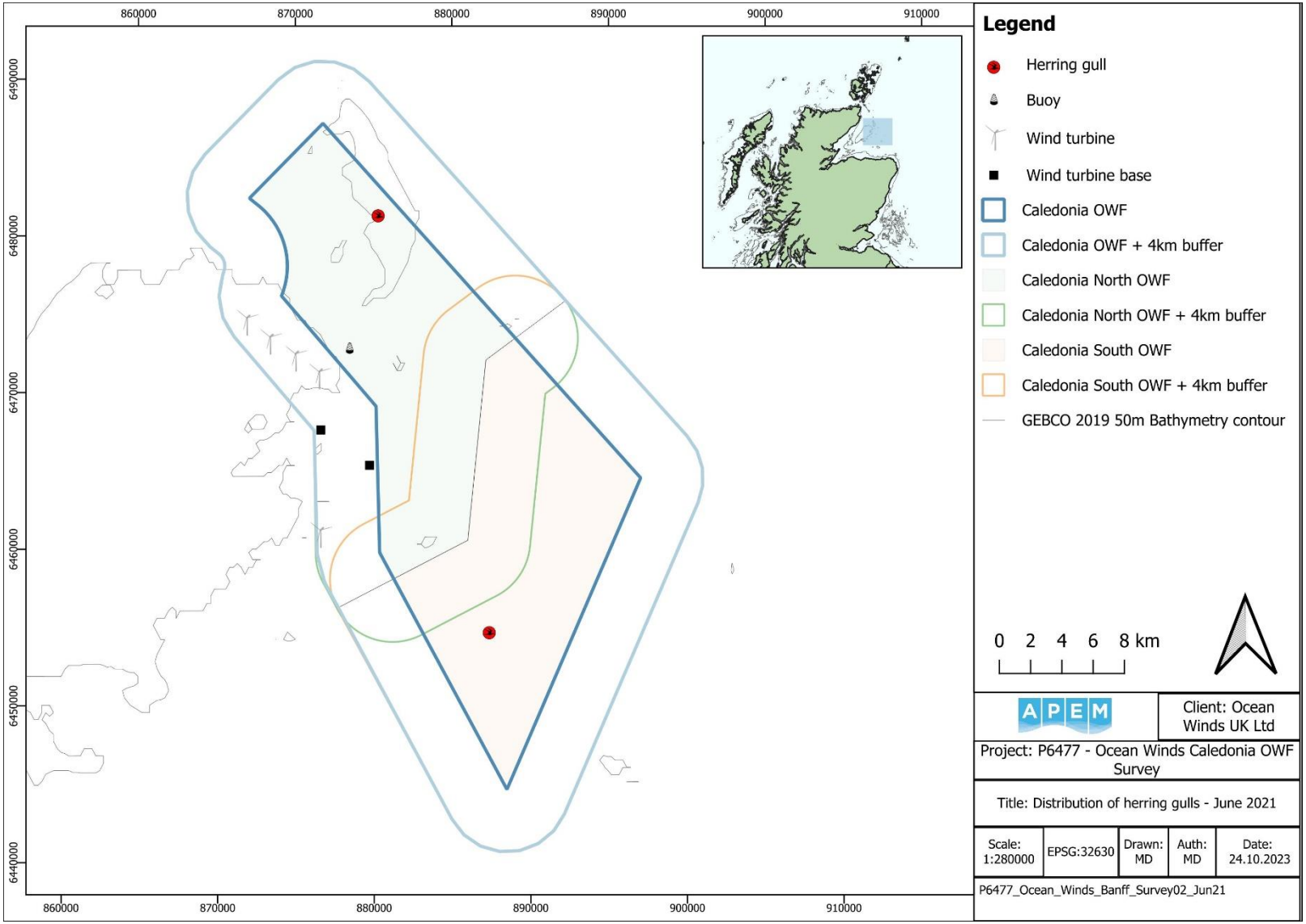


Figure A4.91 Distribution of herring gulls recorded in the Survey Area in June 2021

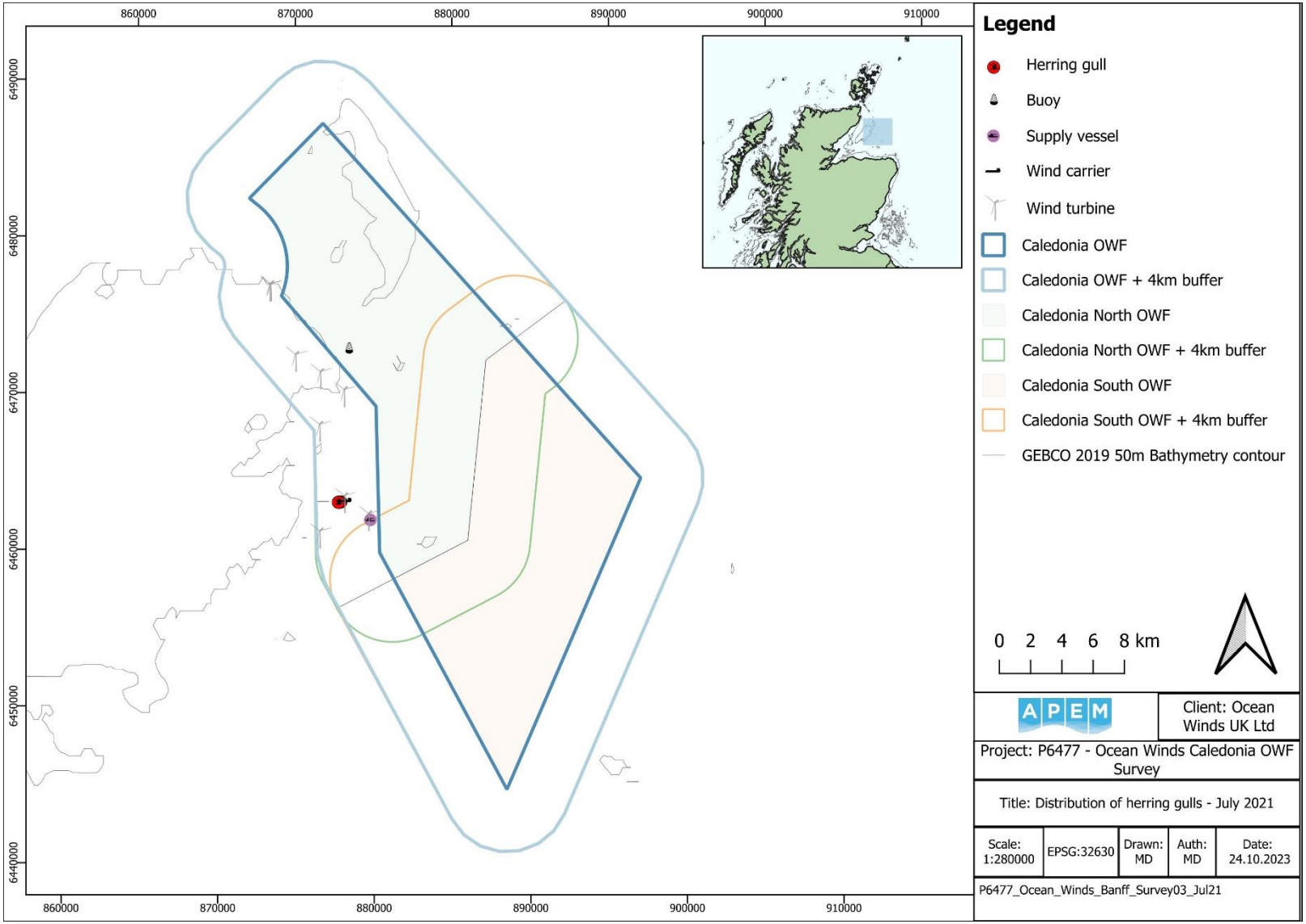


Figure A4.92 Distribution of herring gulls recorded in the Survey Area in July 2021

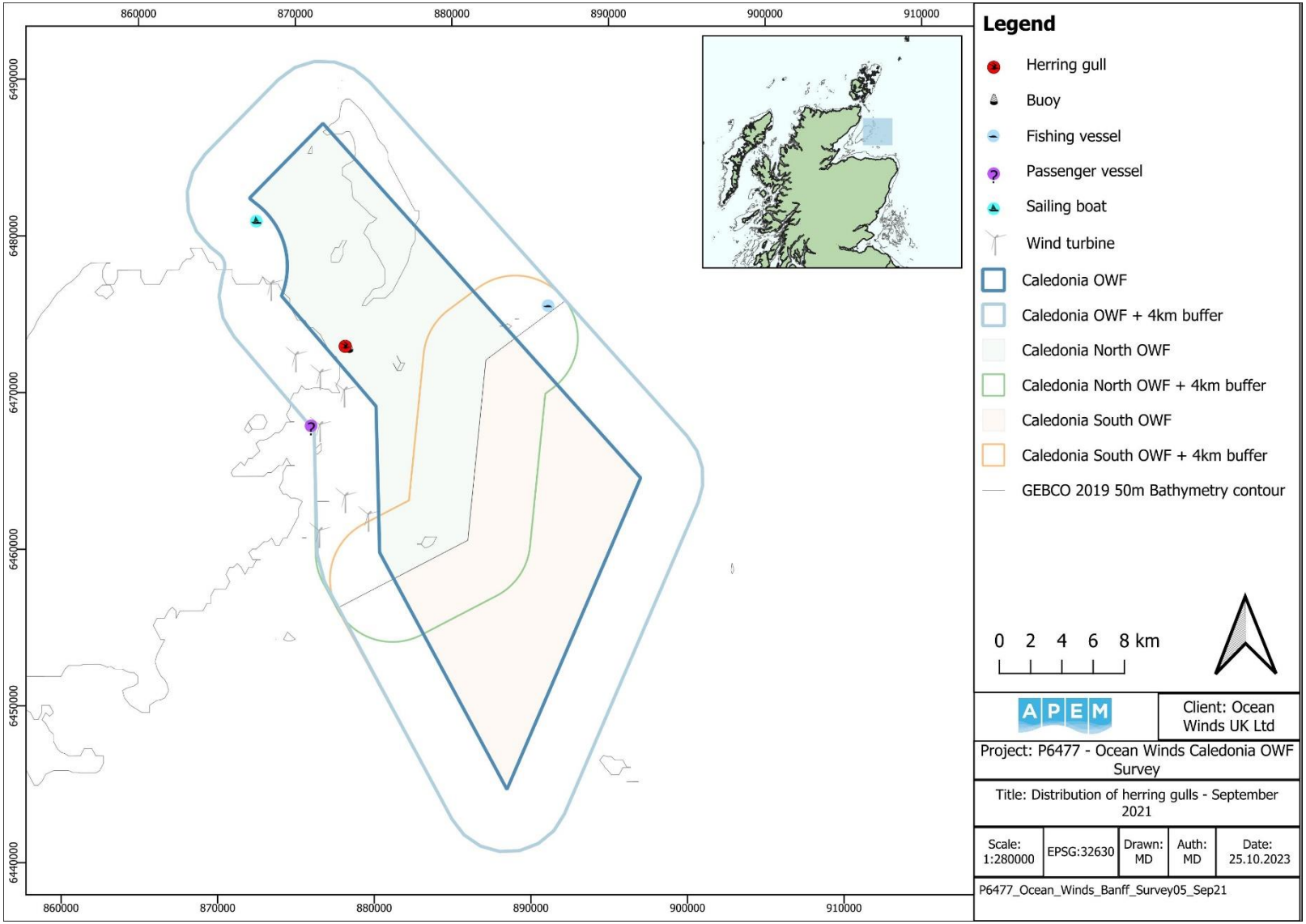


Figure A4.93 Distribution of herring gulls recorded in the Survey Area in September 2021

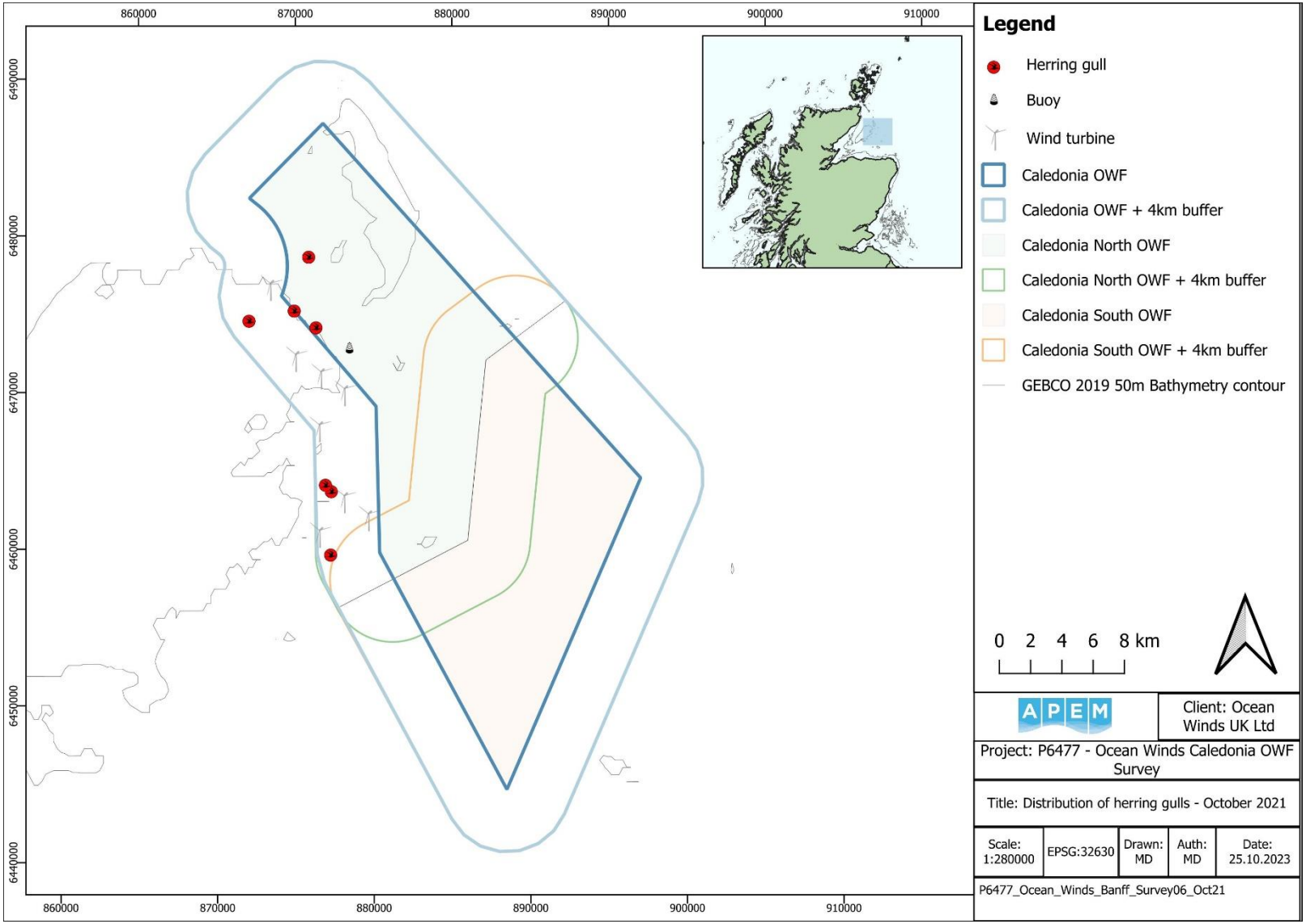


Figure A4.94 Distribution of herring gulls recorded in the Survey Area in October 2021

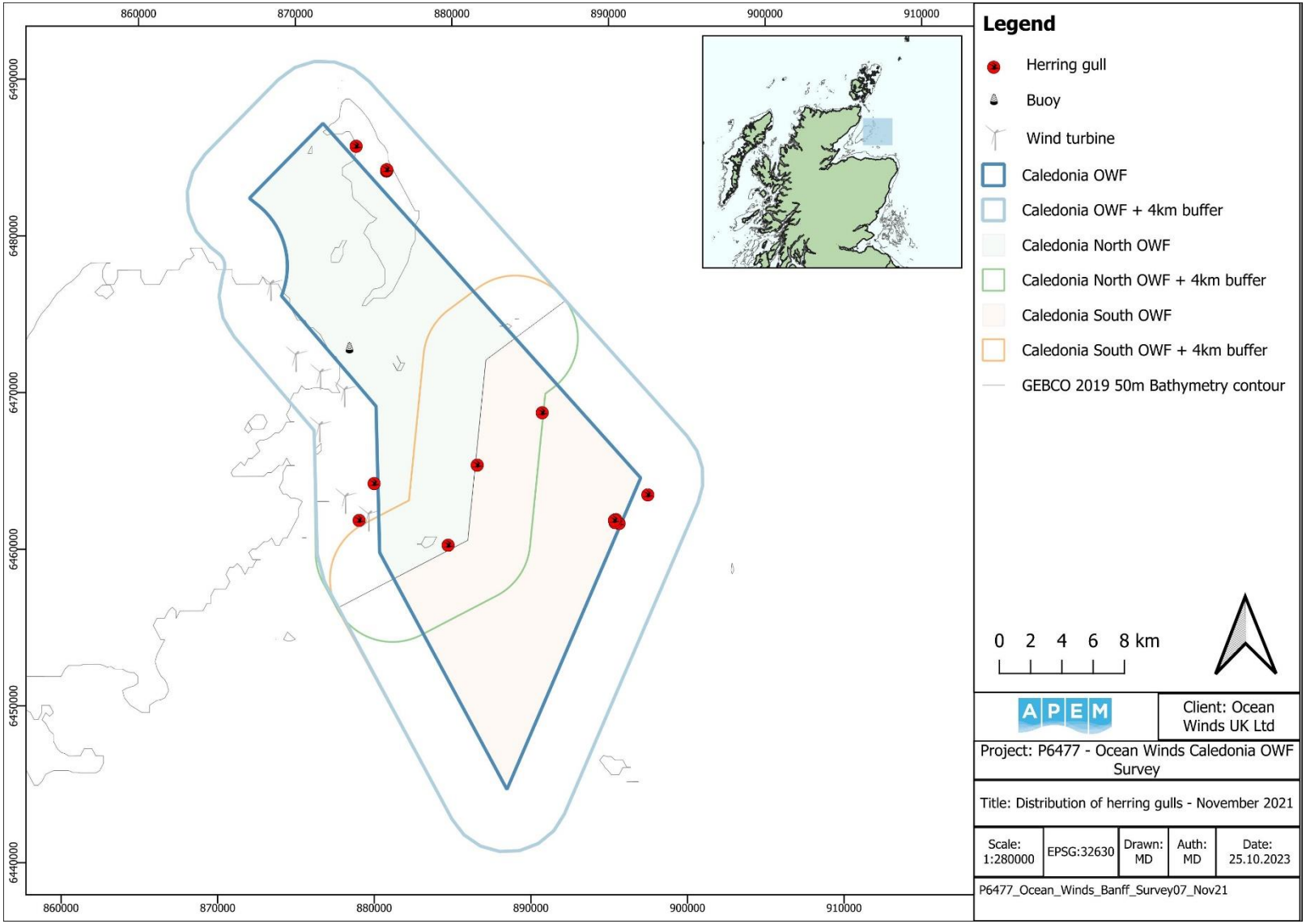


Figure A4.95 Distribution of herring gulls recorded in the Survey Area in November 2021

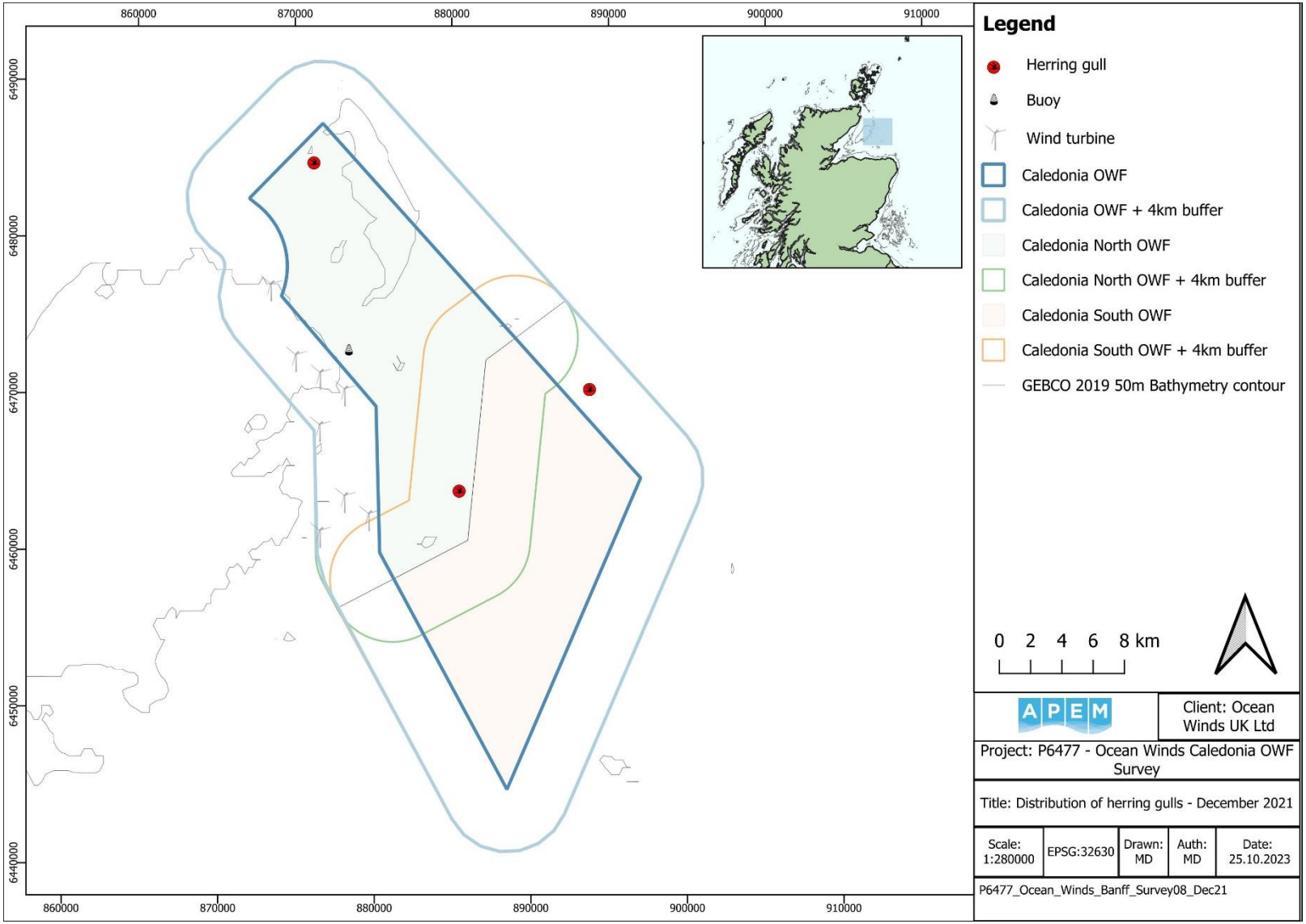


Figure A4.96 Distribution of herring gulls recorded in the Survey Area in December 2021

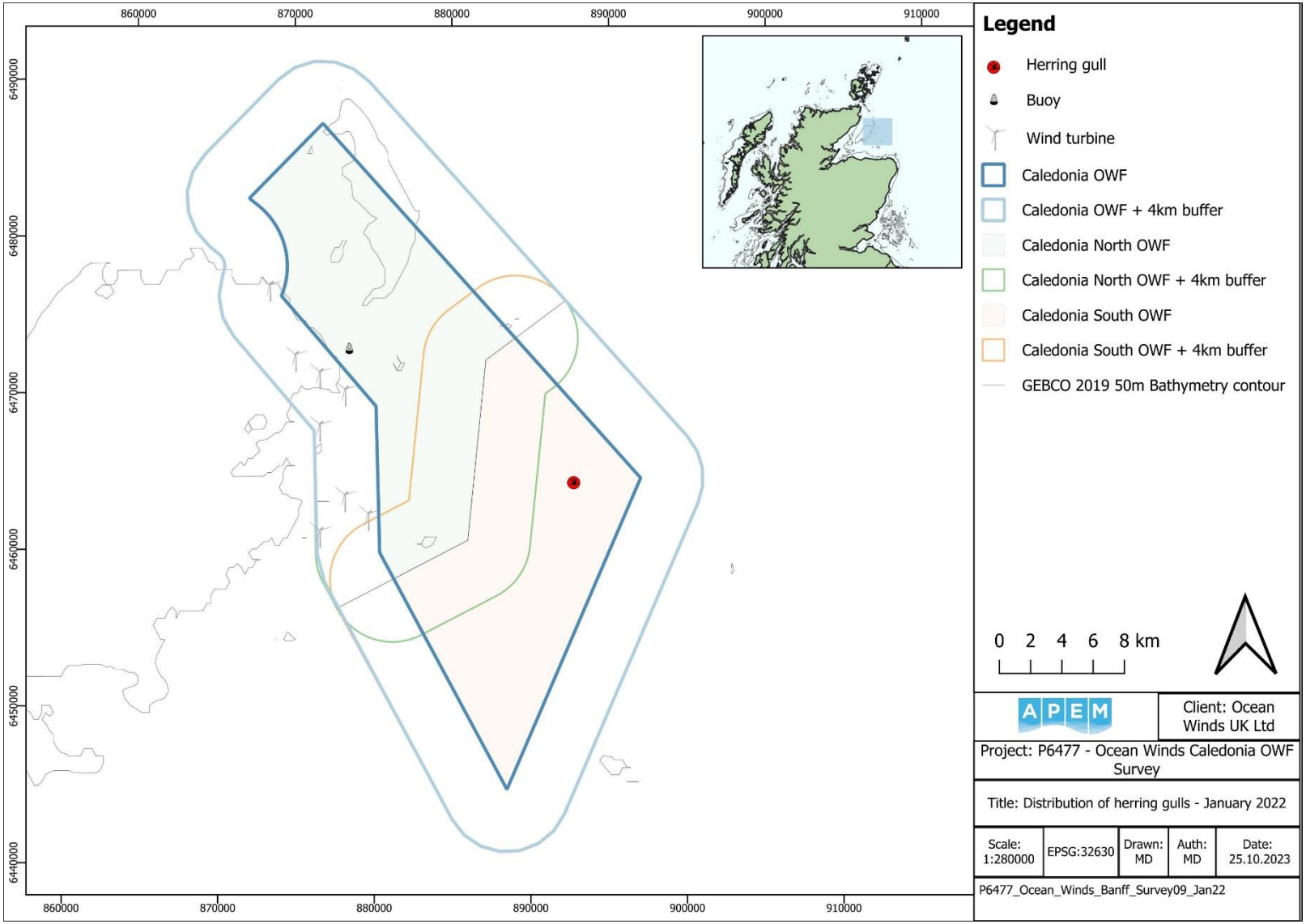


Figure A4.97 Distribution of herring gulls recorded in the Survey Area in January 2022

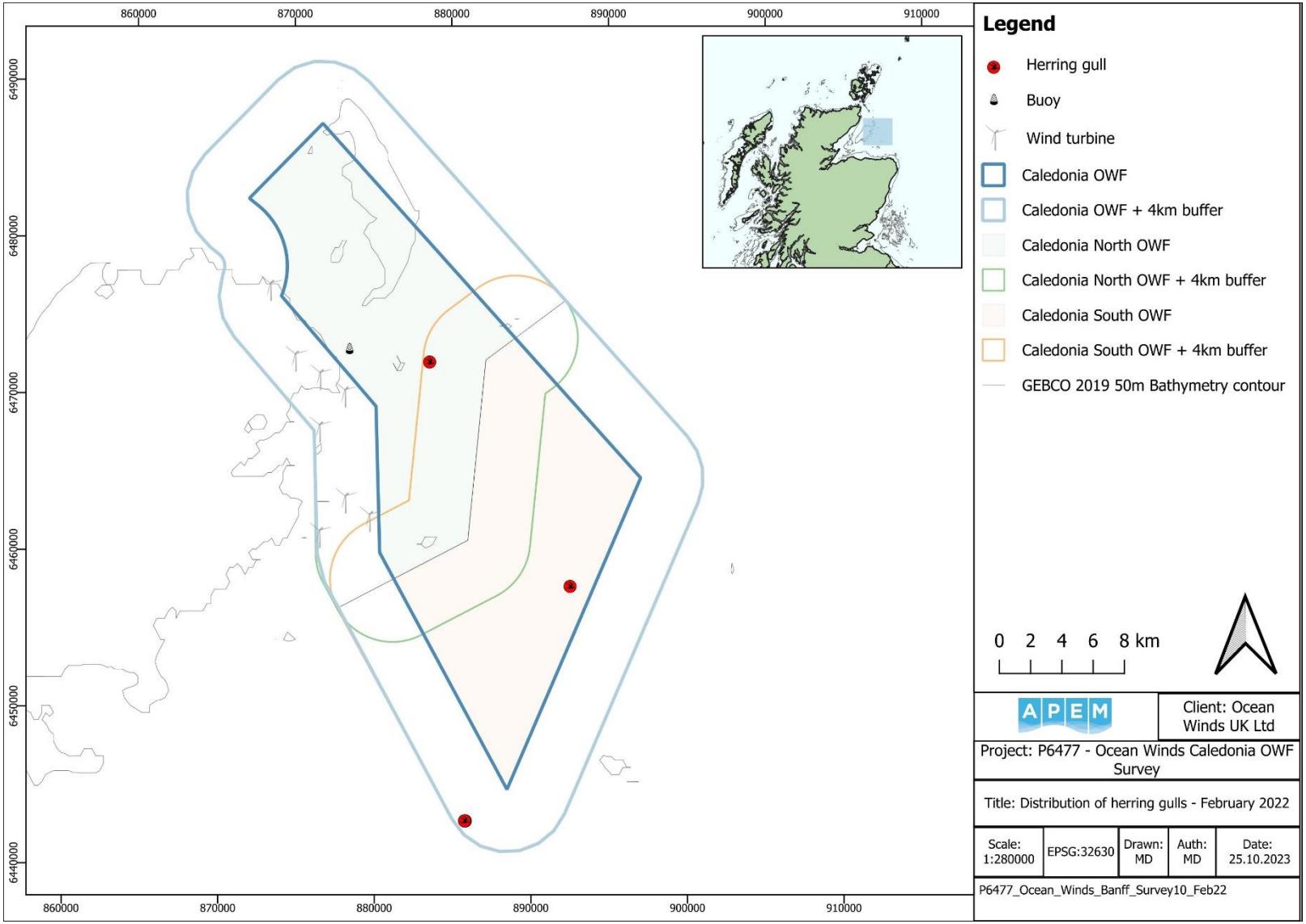


Figure A4.98 Distribution of herring gulls recorded in the Survey Area in February 2022

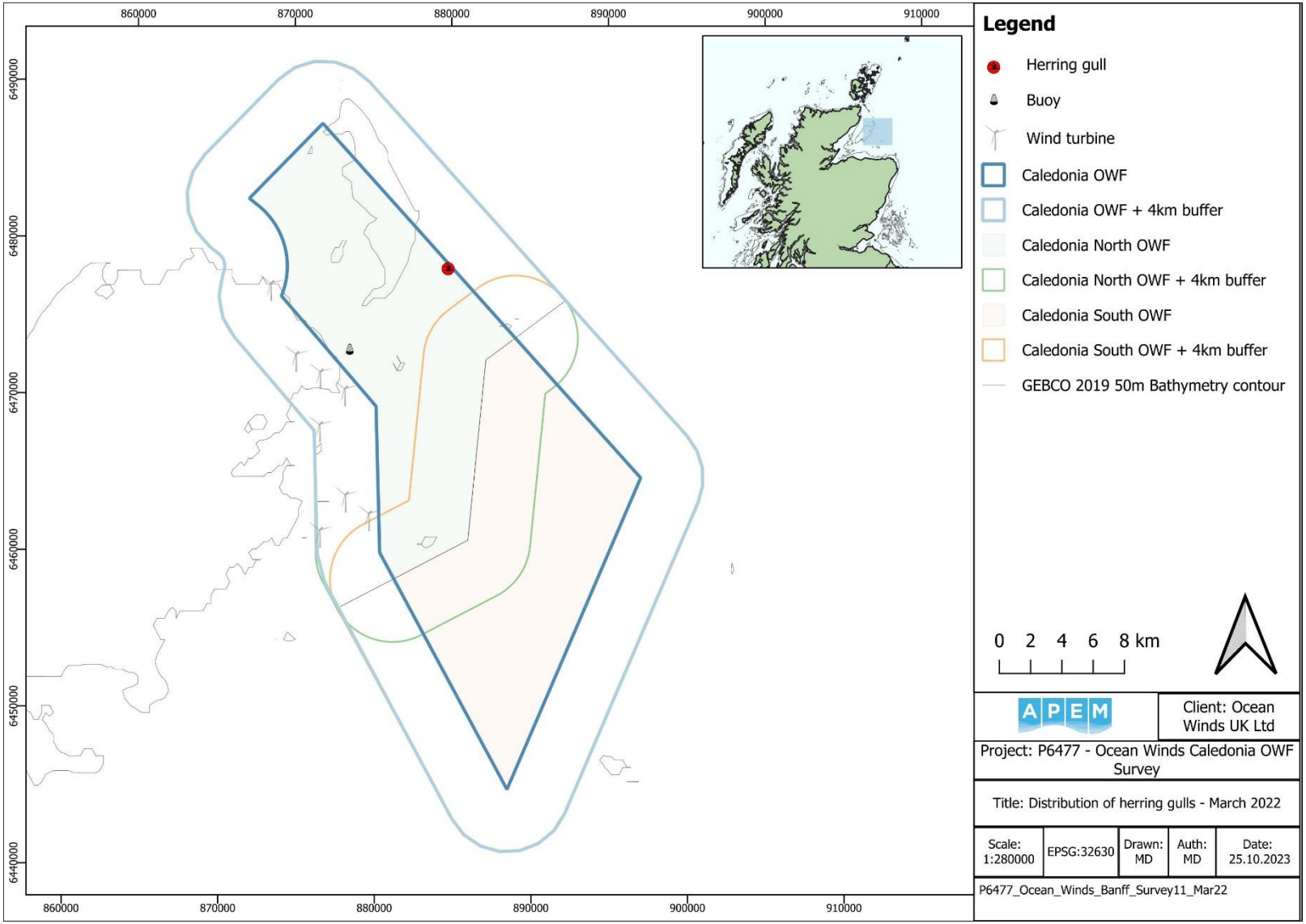


Figure A4.99 Distribution of herring gulls recorded in the Survey Area in March 2022

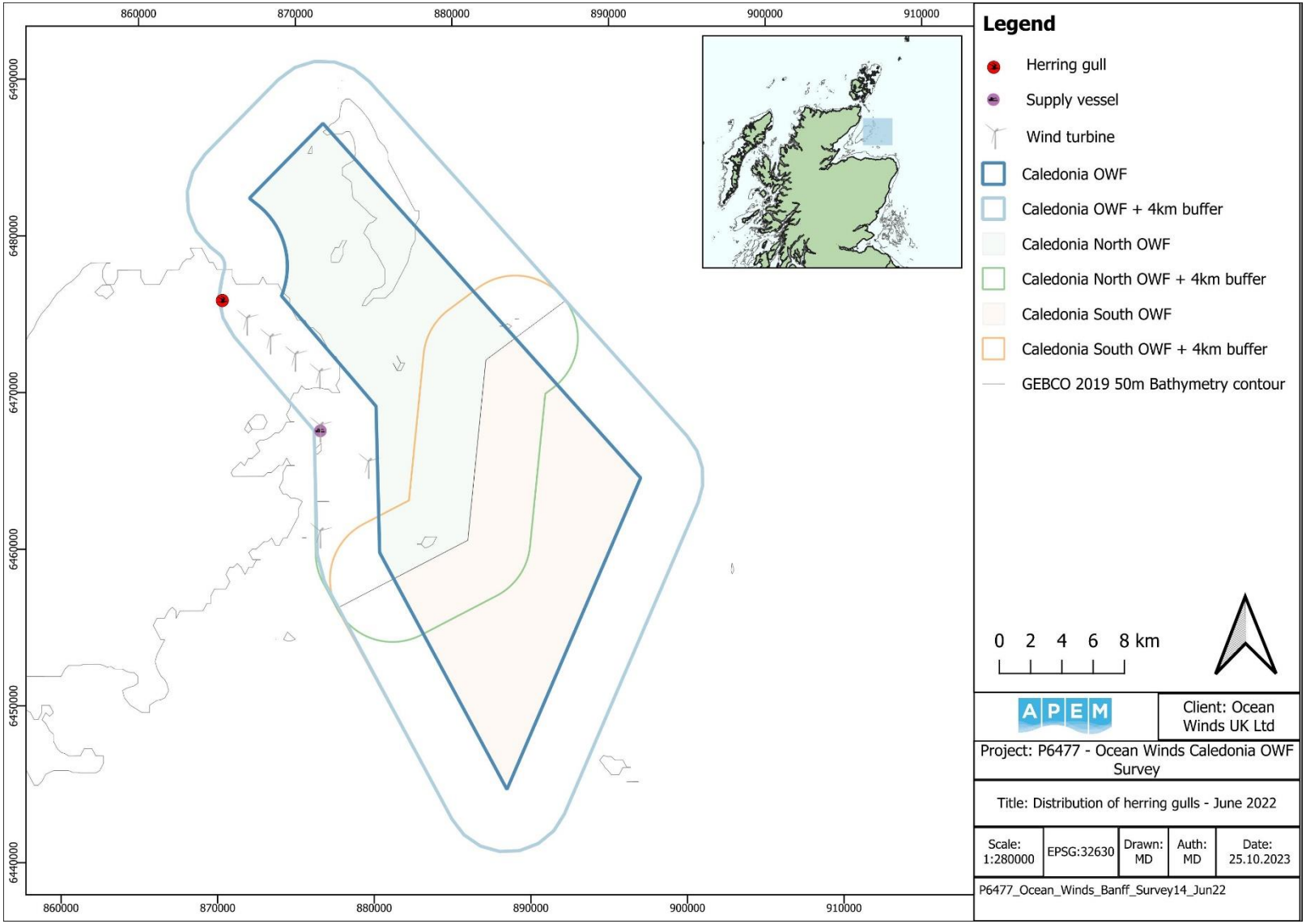


Figure A4.100 Distribution of herring gulls recorded in the Survey Area in June 2022

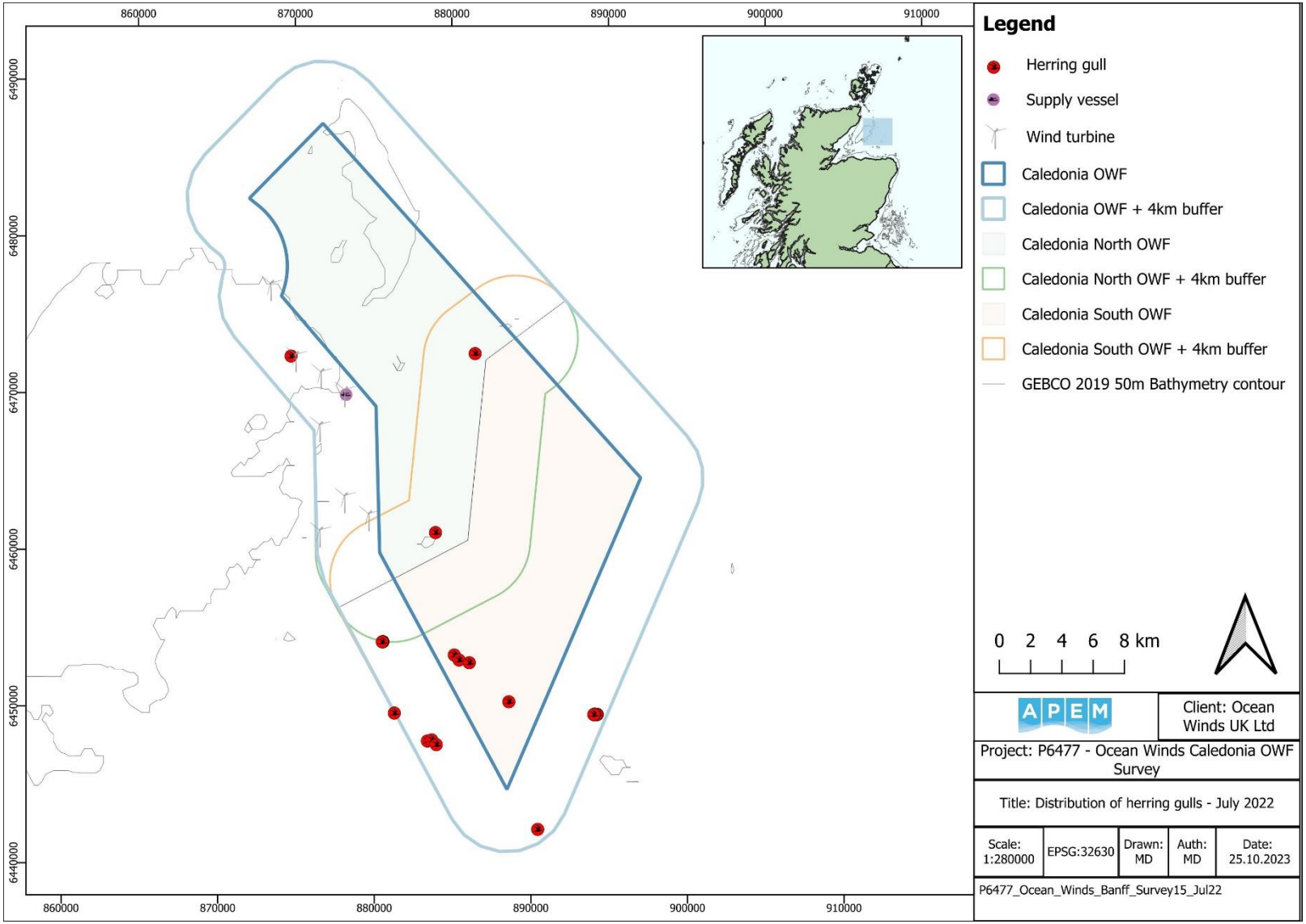


Figure A4.101 Distribution of herring gulls recorded in the Survey Area in July 2022

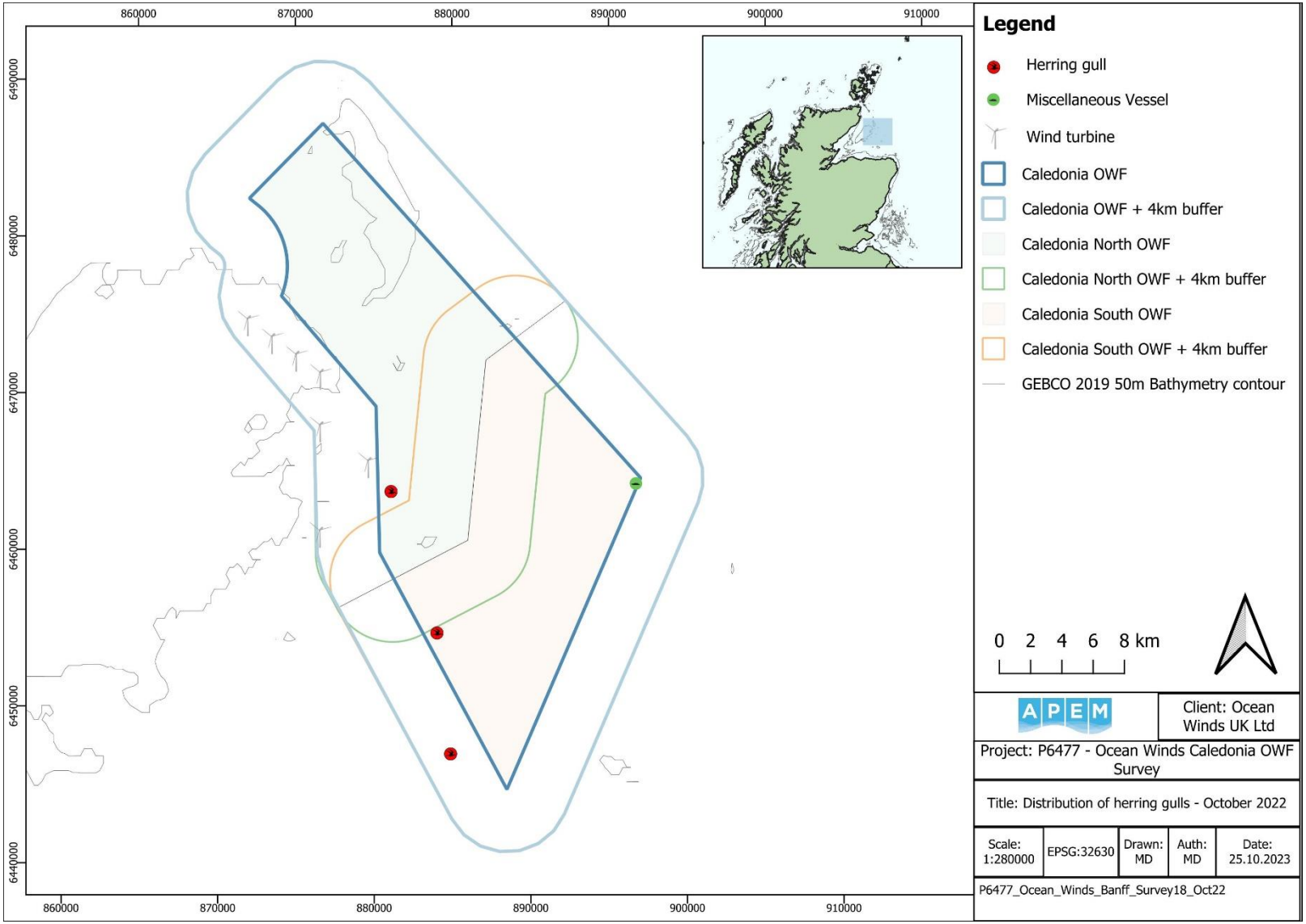


Figure A4.102 Distribution of herring gulls recorded in the Survey Area in October 2022

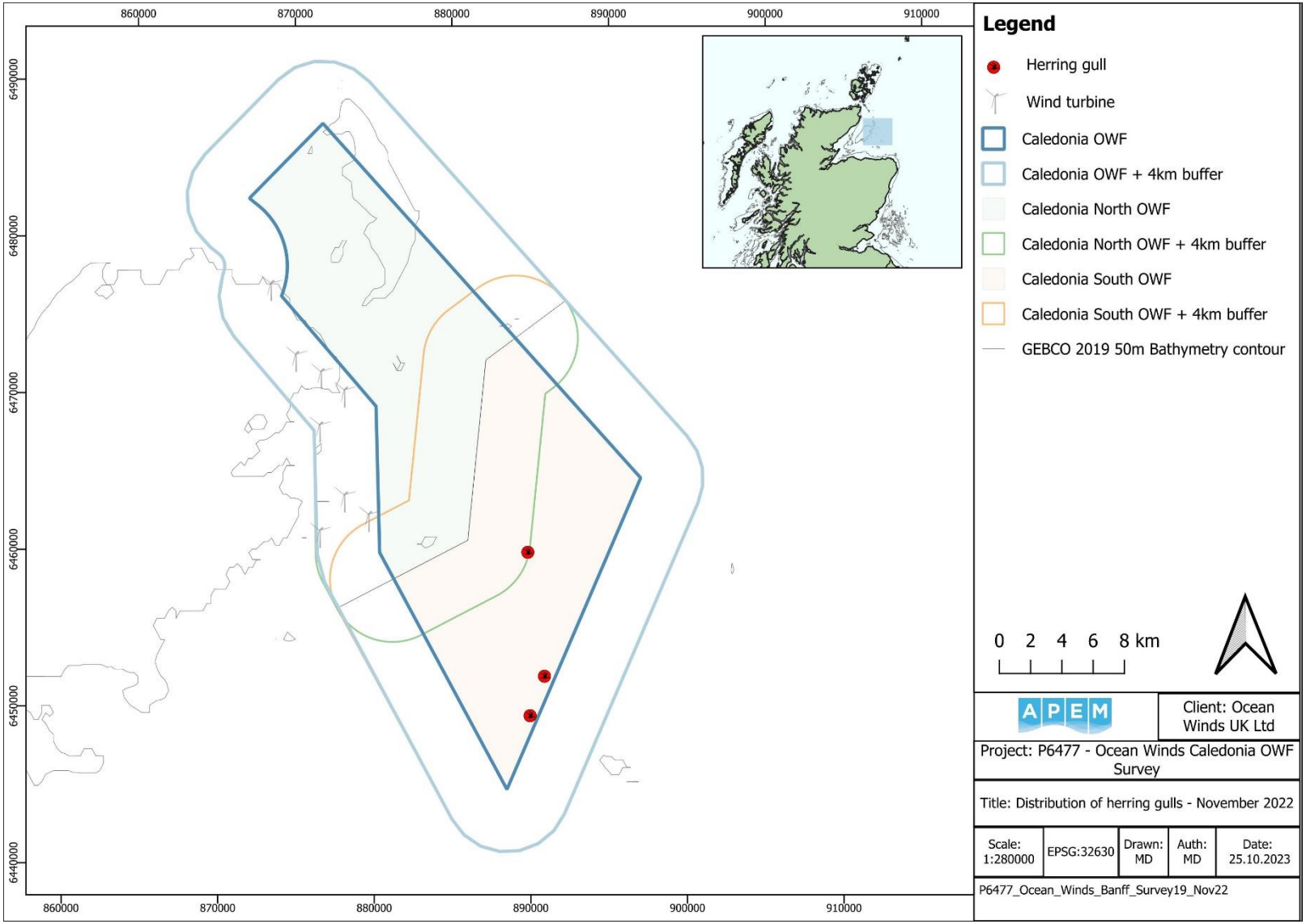


Figure A4.103 Distribution of herring gulls recorded in the Survey Area in November 2022

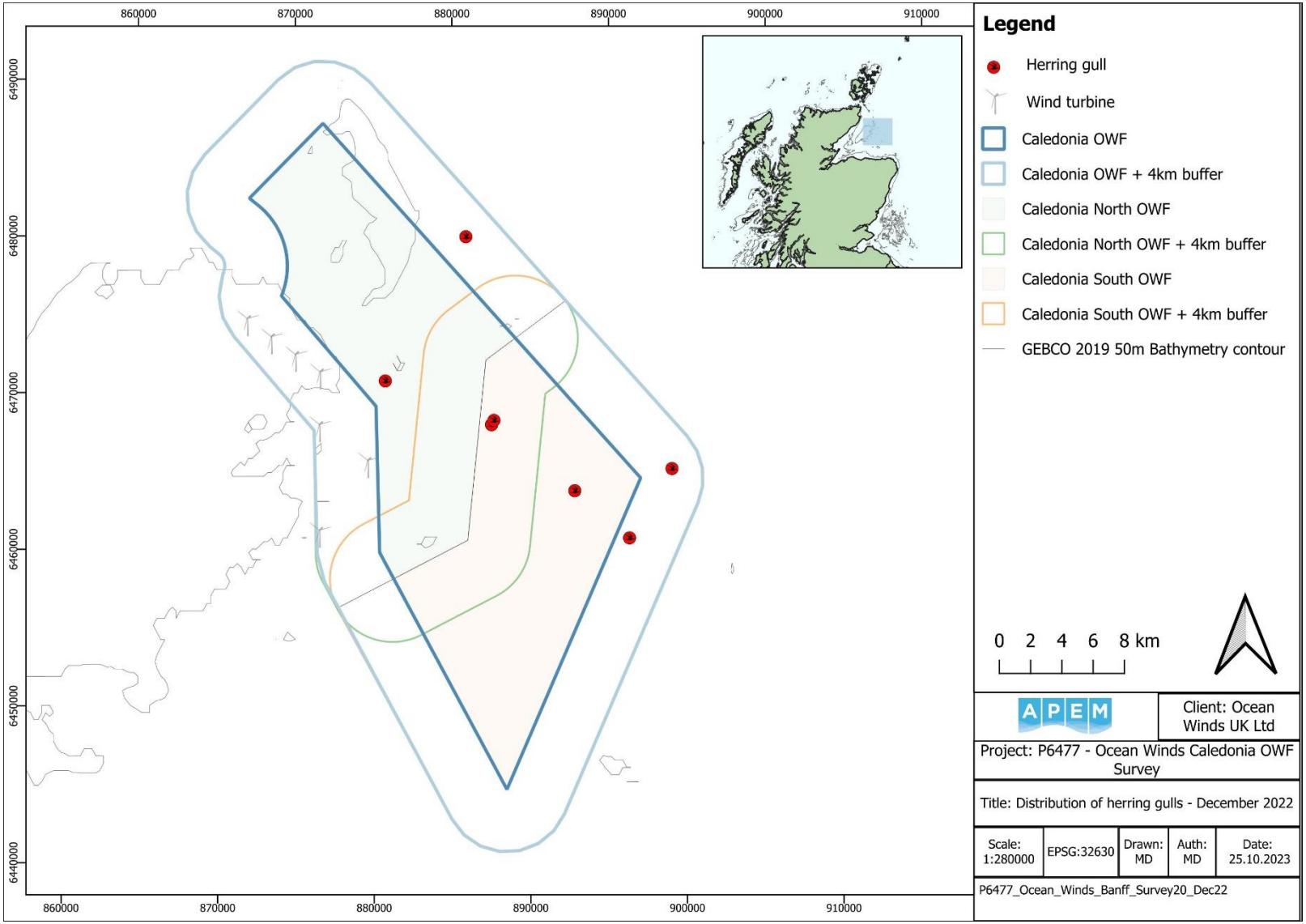


Figure A4.104 Distribution of herring gulls recorded in the Survey Area in December 2022

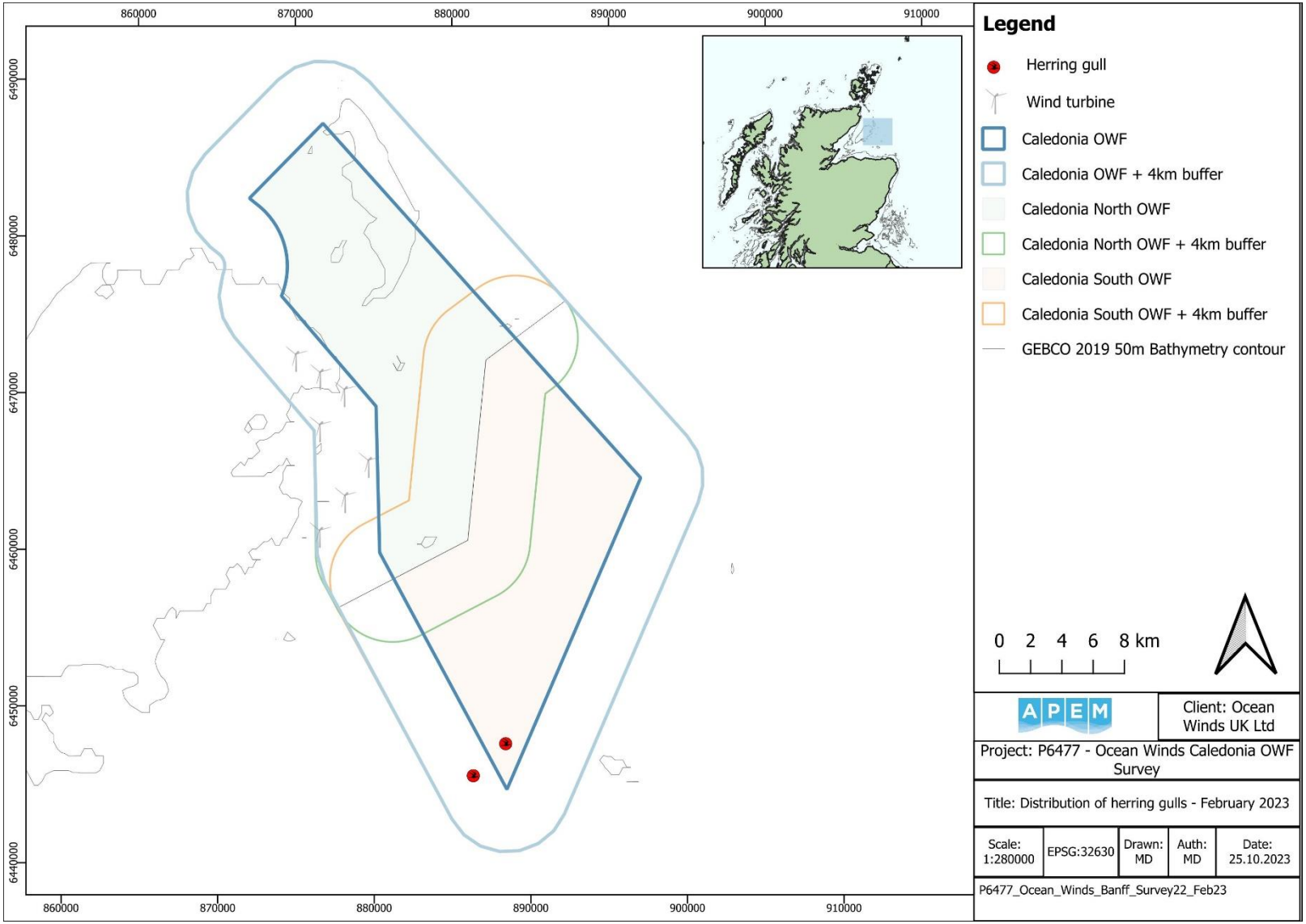


Figure A4.105 Distribution of herring gulls recorded in the Survey Area in February 2023

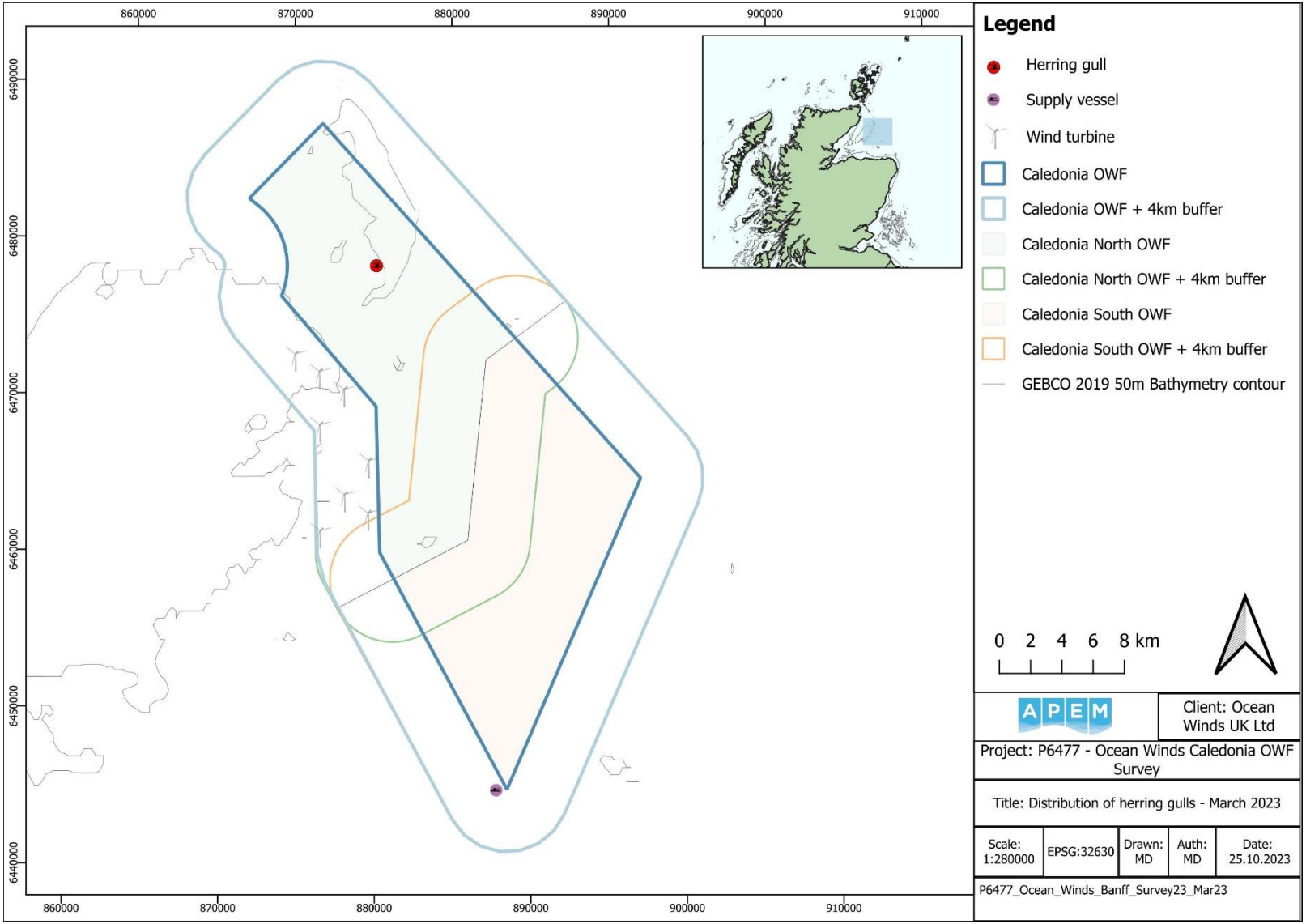


Figure A4.106 Distribution of herring gulls recorded in the Survey Area in March 2023

Lesser black-backed gull

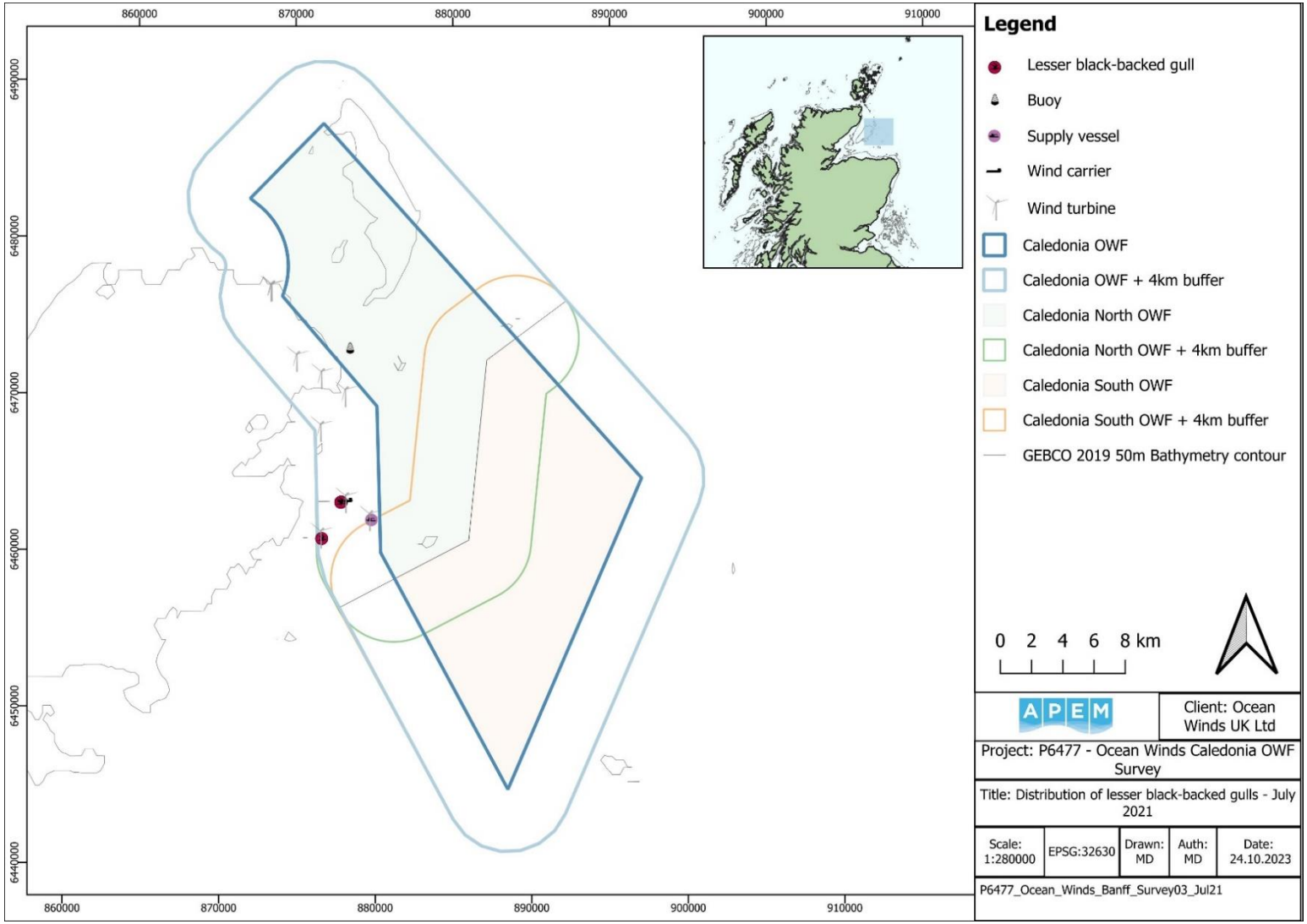


Figure A4.107 Distribution of lesser black-backed gulls recorded in the Survey Area in July 2021

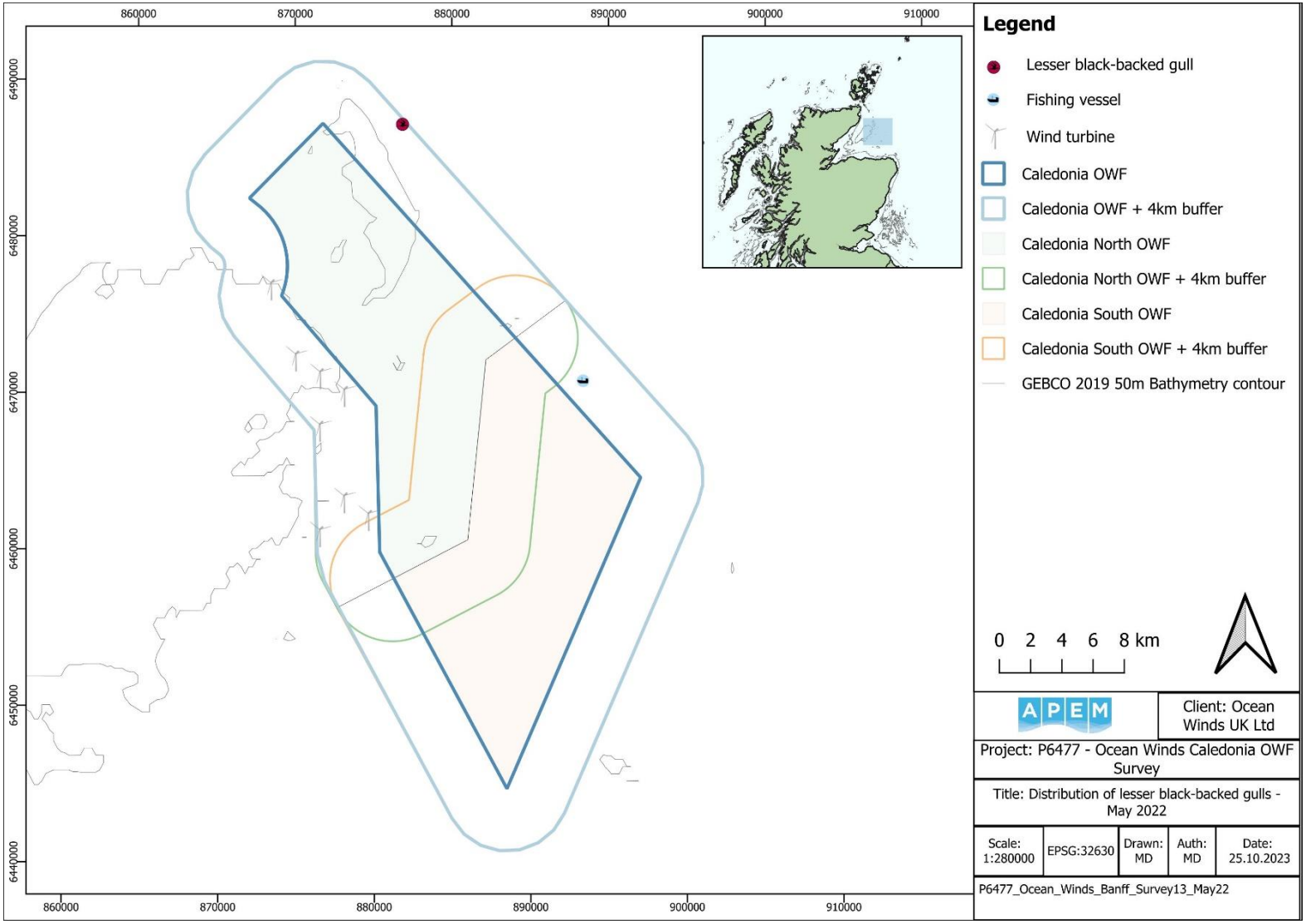


Figure A4.108 Distribution of lesser black-backed gulls recorded in the Survey Area in May 2022

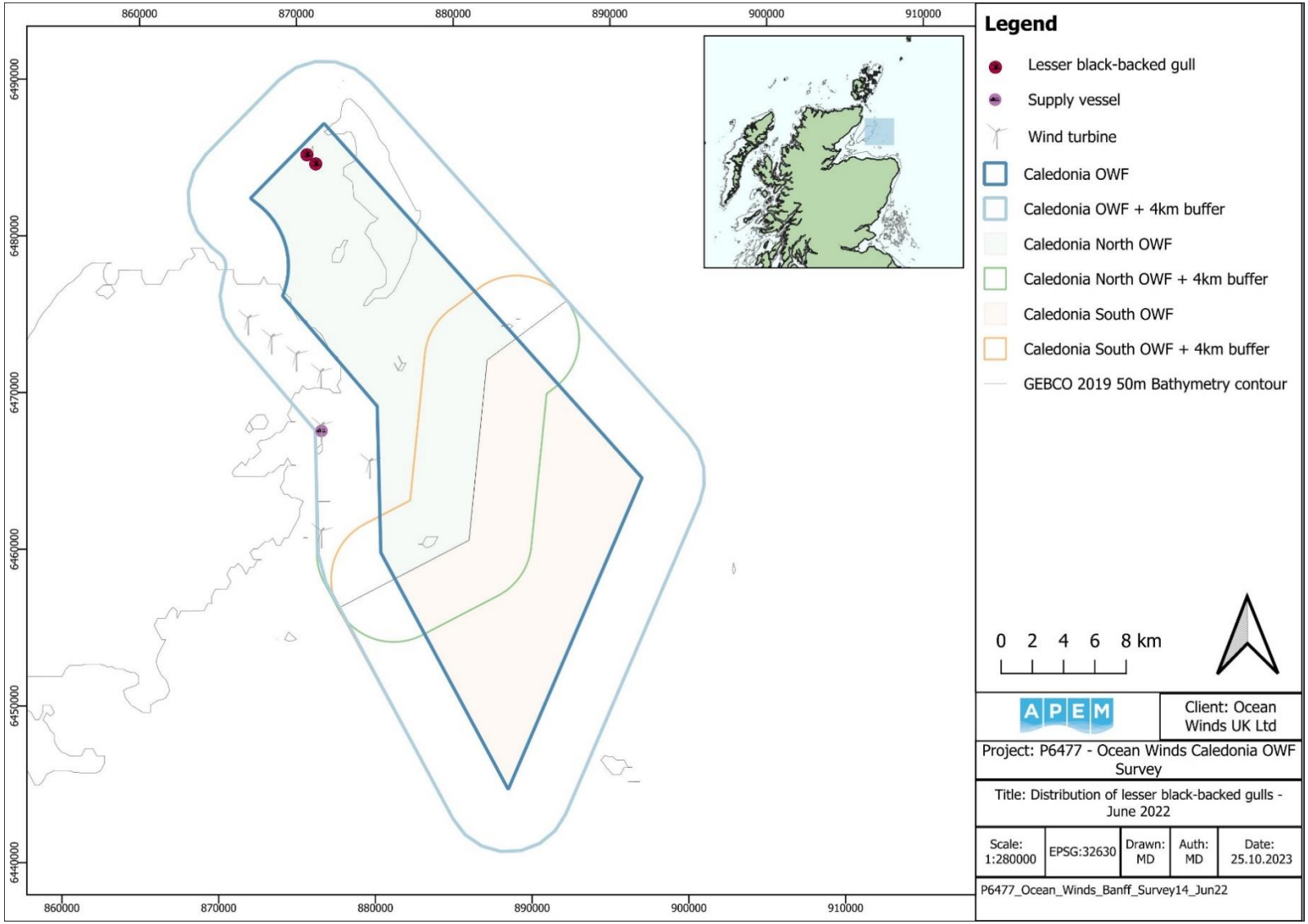


Figure A4.109 Distribution of lesser black-backed gulls recorded in the Survey Area in June 2022

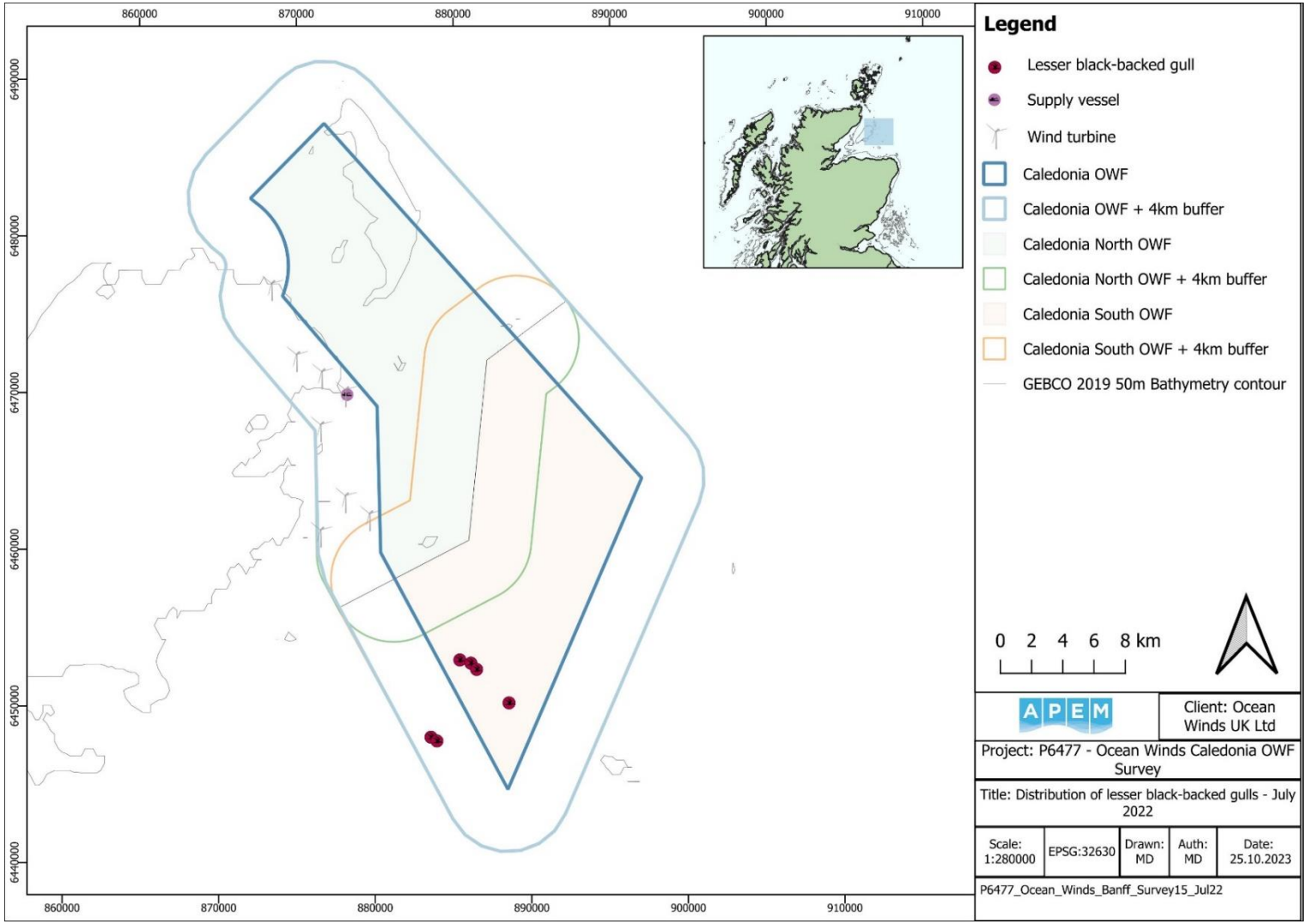


Figure A4.110 Distribution of lesser black-backed gulls recorded in the Survey Area in July 2022

Unidentified black-backed gull species

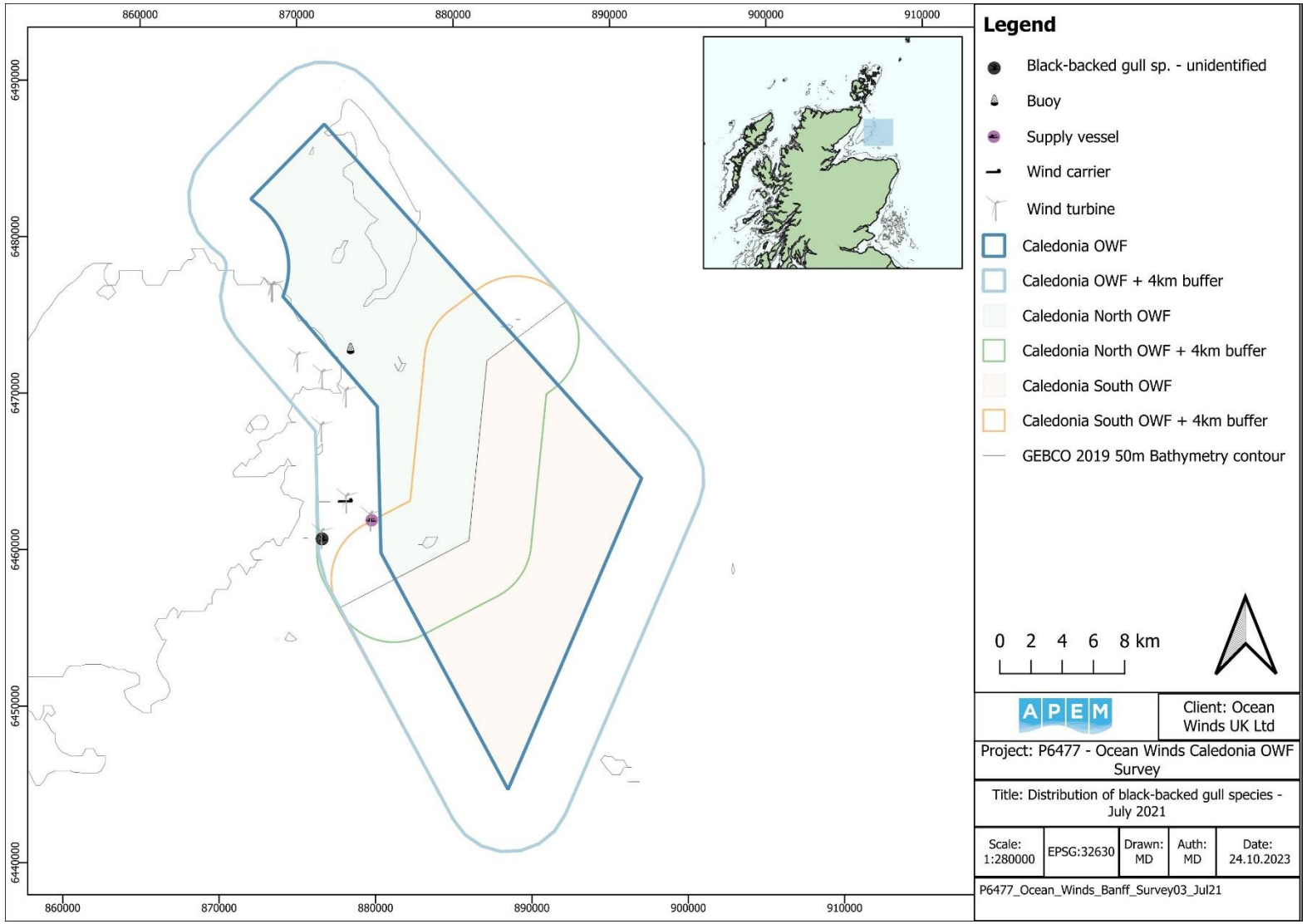


Figure A4.111 Distribution of black-backed gull species recorded in the Survey Area in July 2021

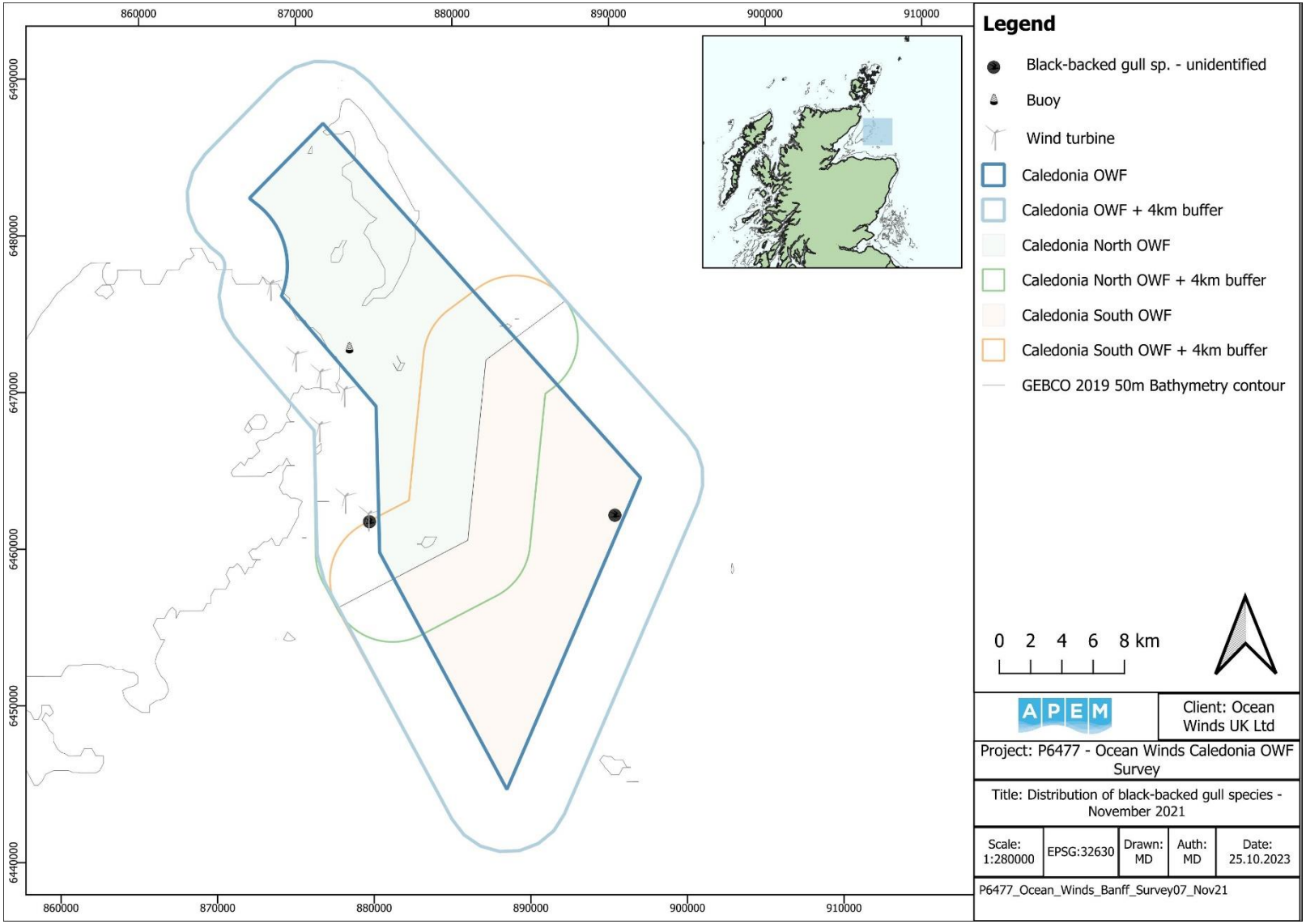


Figure A4.112 Distribution of black-backed gull species recorded in the Survey Area in November 2021

Unidentified large gull species

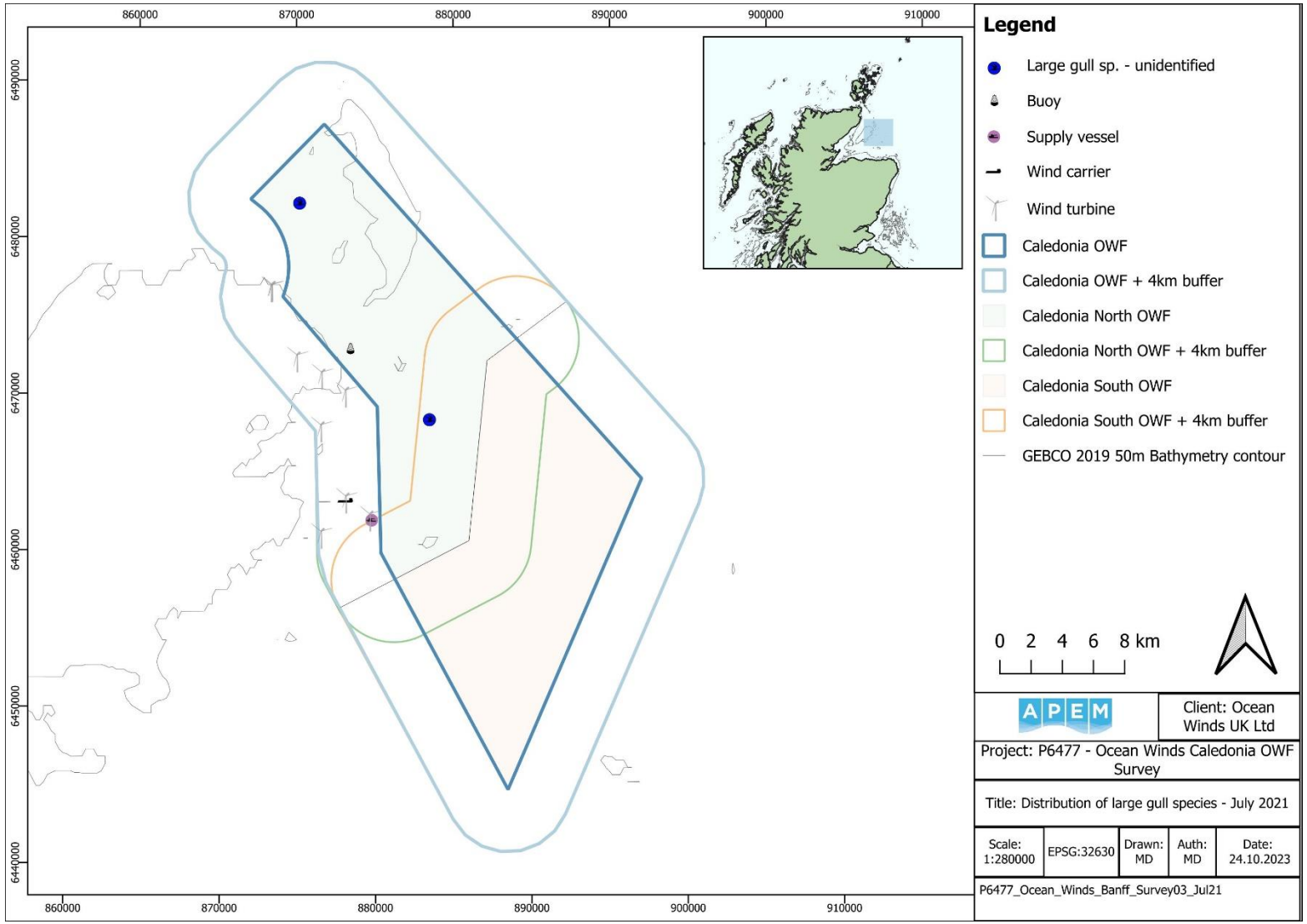


Figure A4.113 Distribution of large gull species recorded in the Survey Area in July 2021

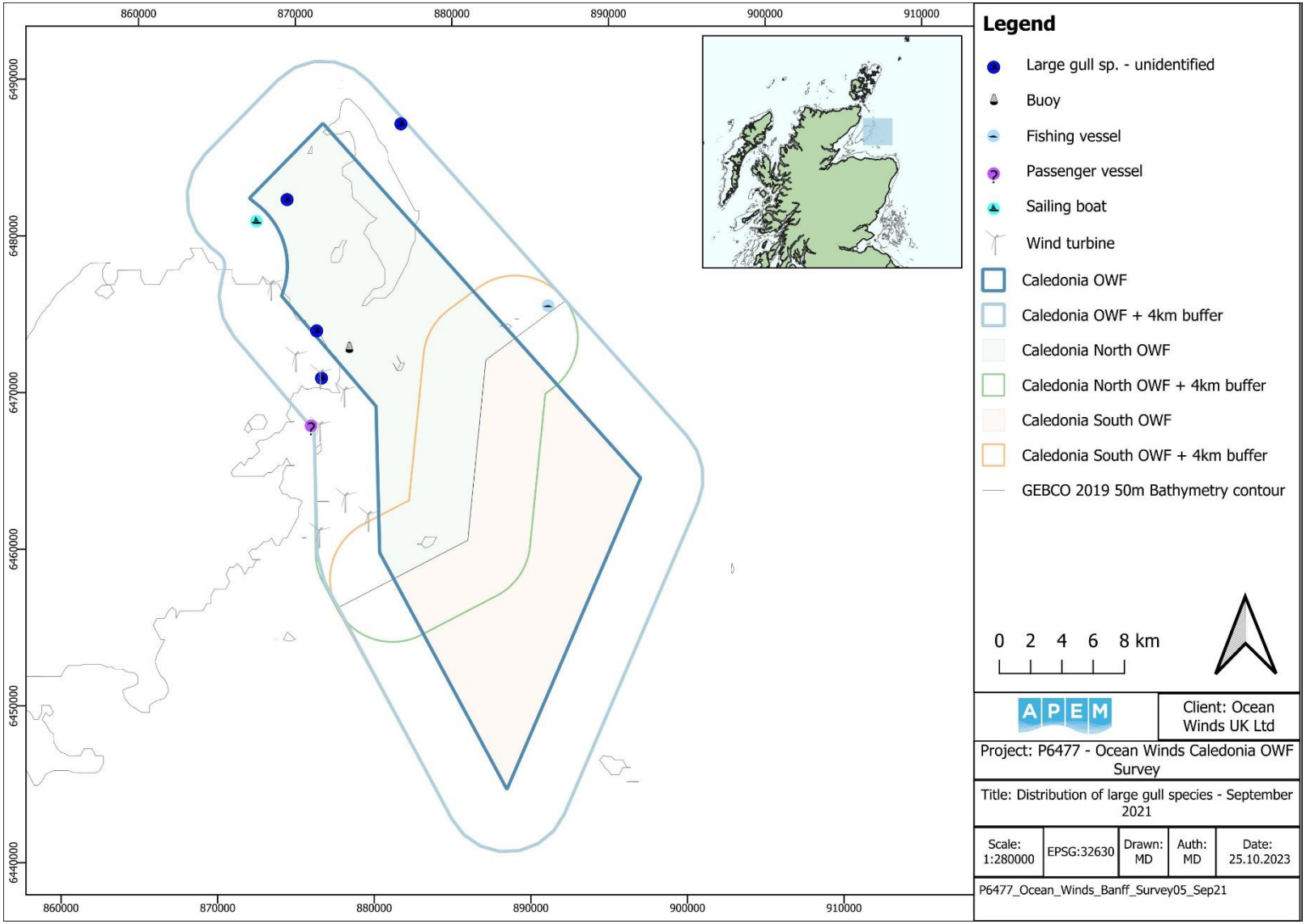


Figure A4.114 Distribution of large gull species recorded in the Survey Area in September 2021

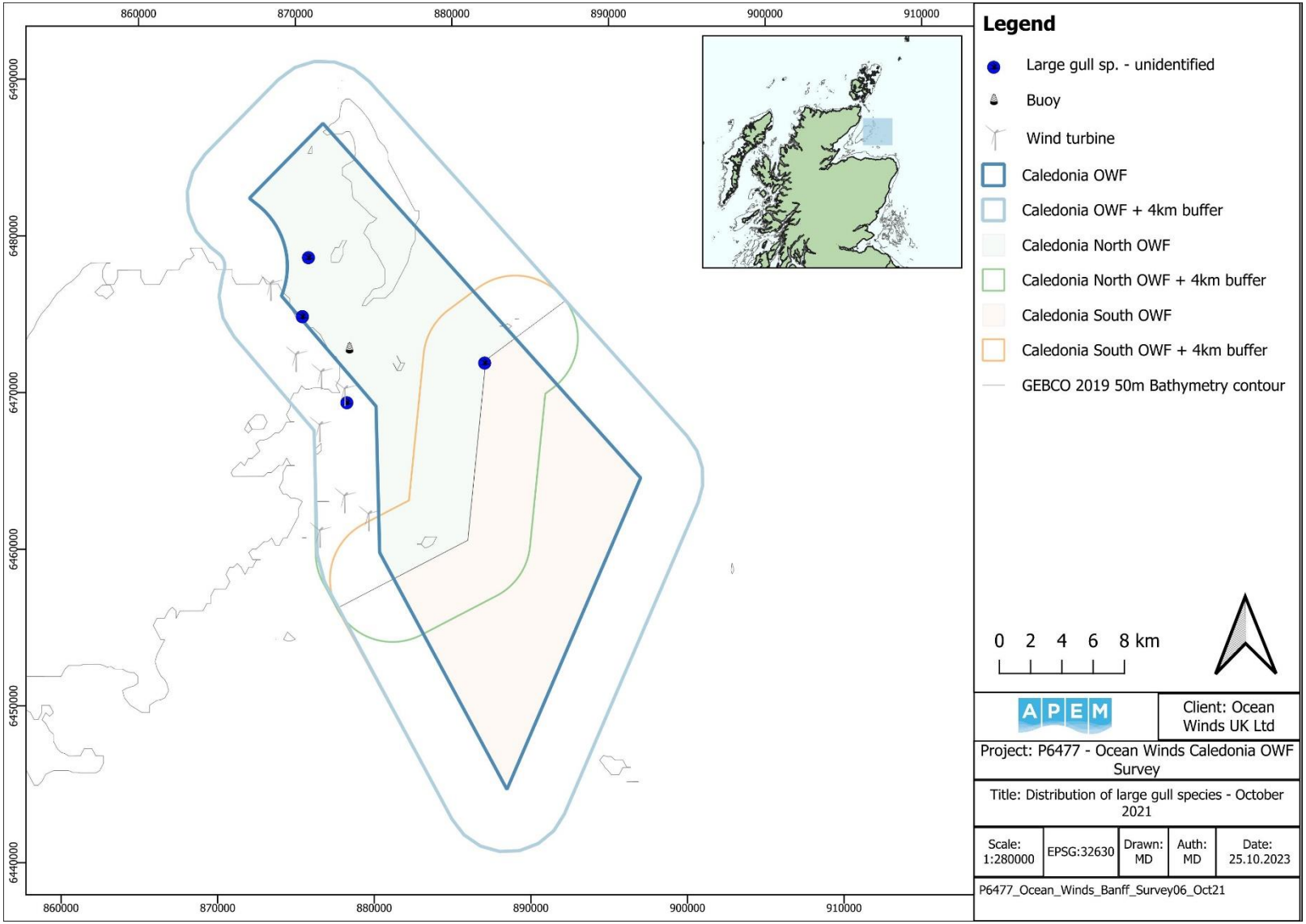


Figure A4.115 Distribution of large gull species recorded in the Survey Area in October 2021

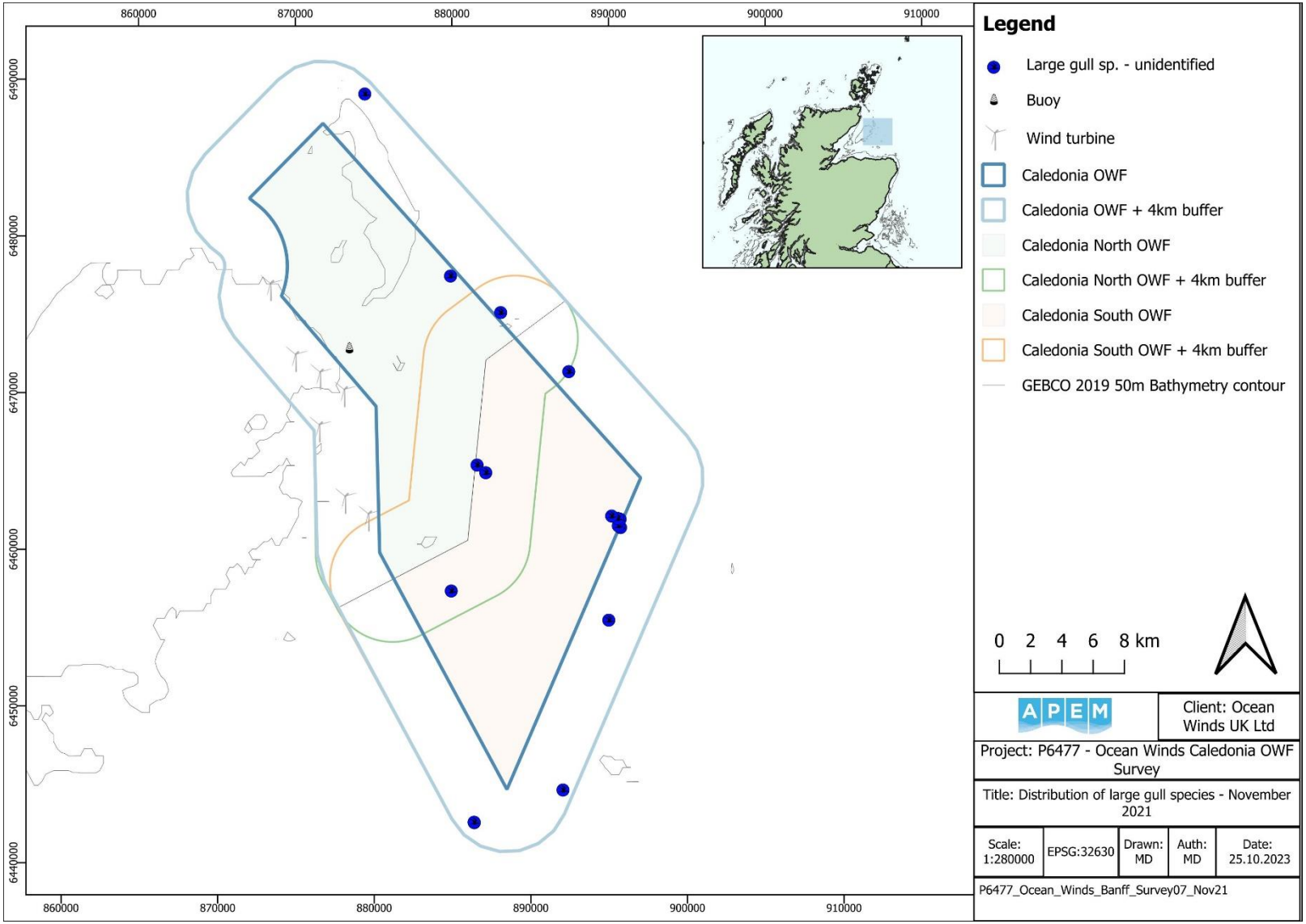


Figure A4.116 Distribution of large gull species recorded in the Survey Area in November 2021

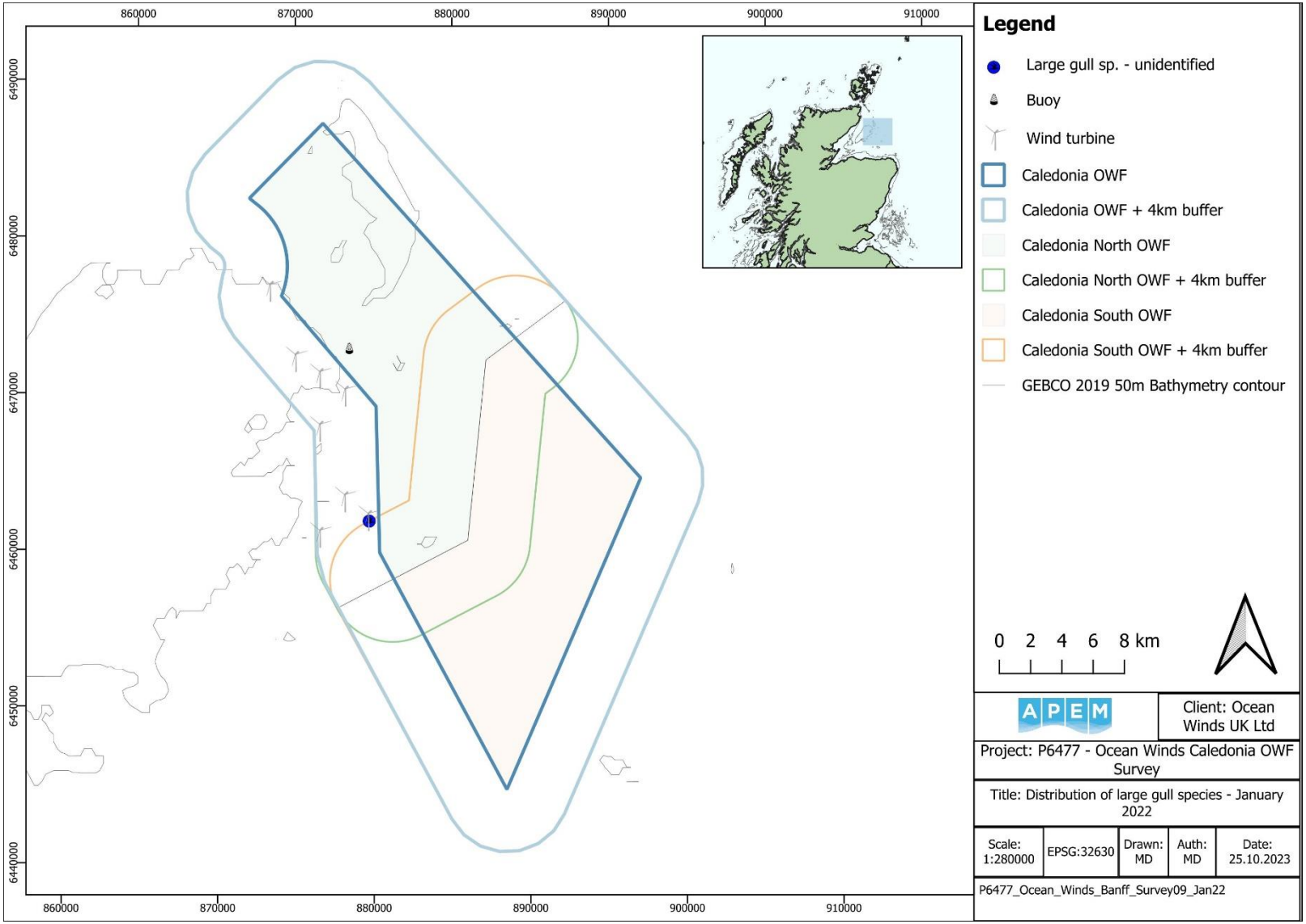


Figure A4.117 Distribution of large gull species recorded in the Survey Area in January 2022

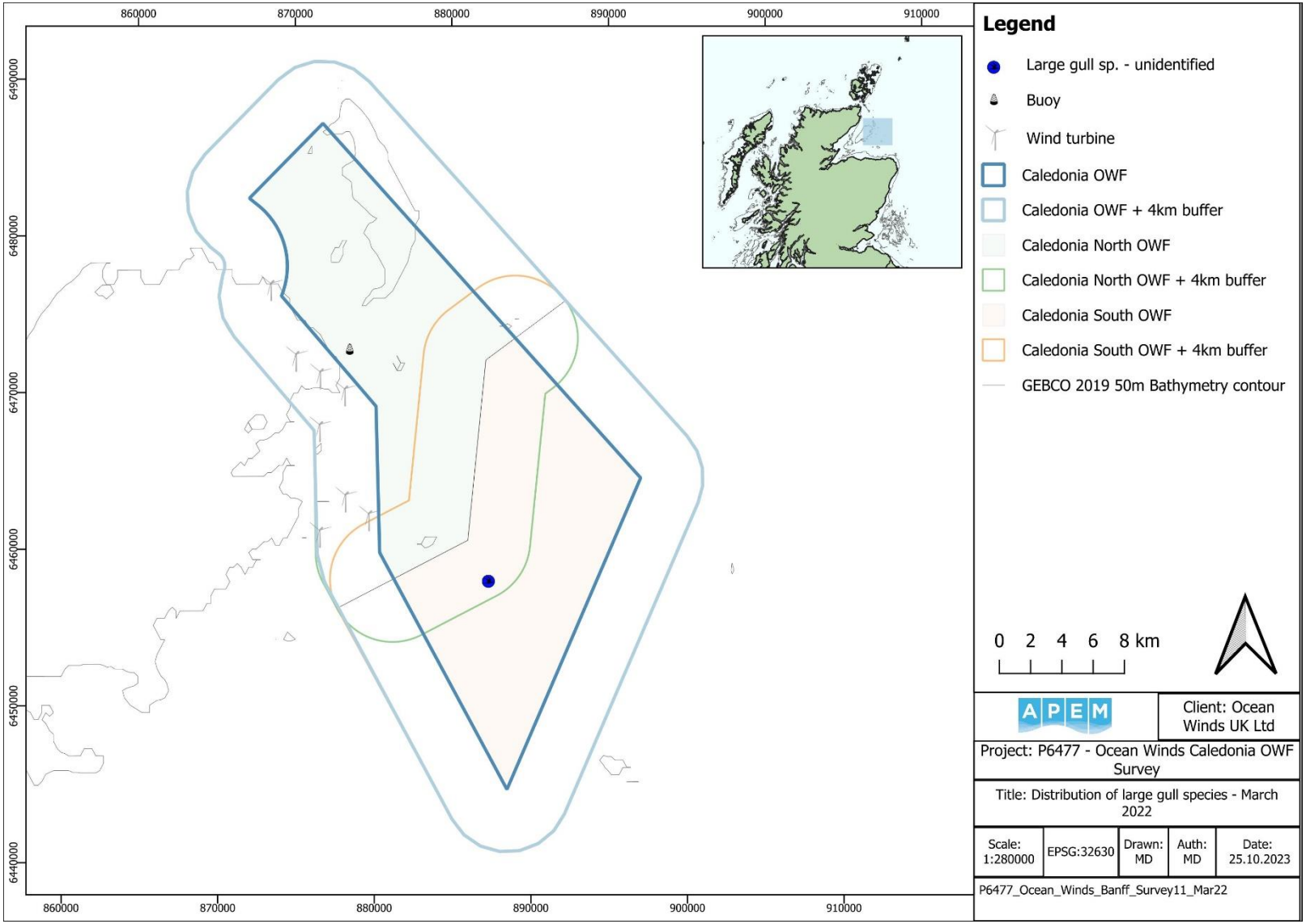


Figure A4.118 Distribution of large gull species recorded in the Survey Area in March 2022

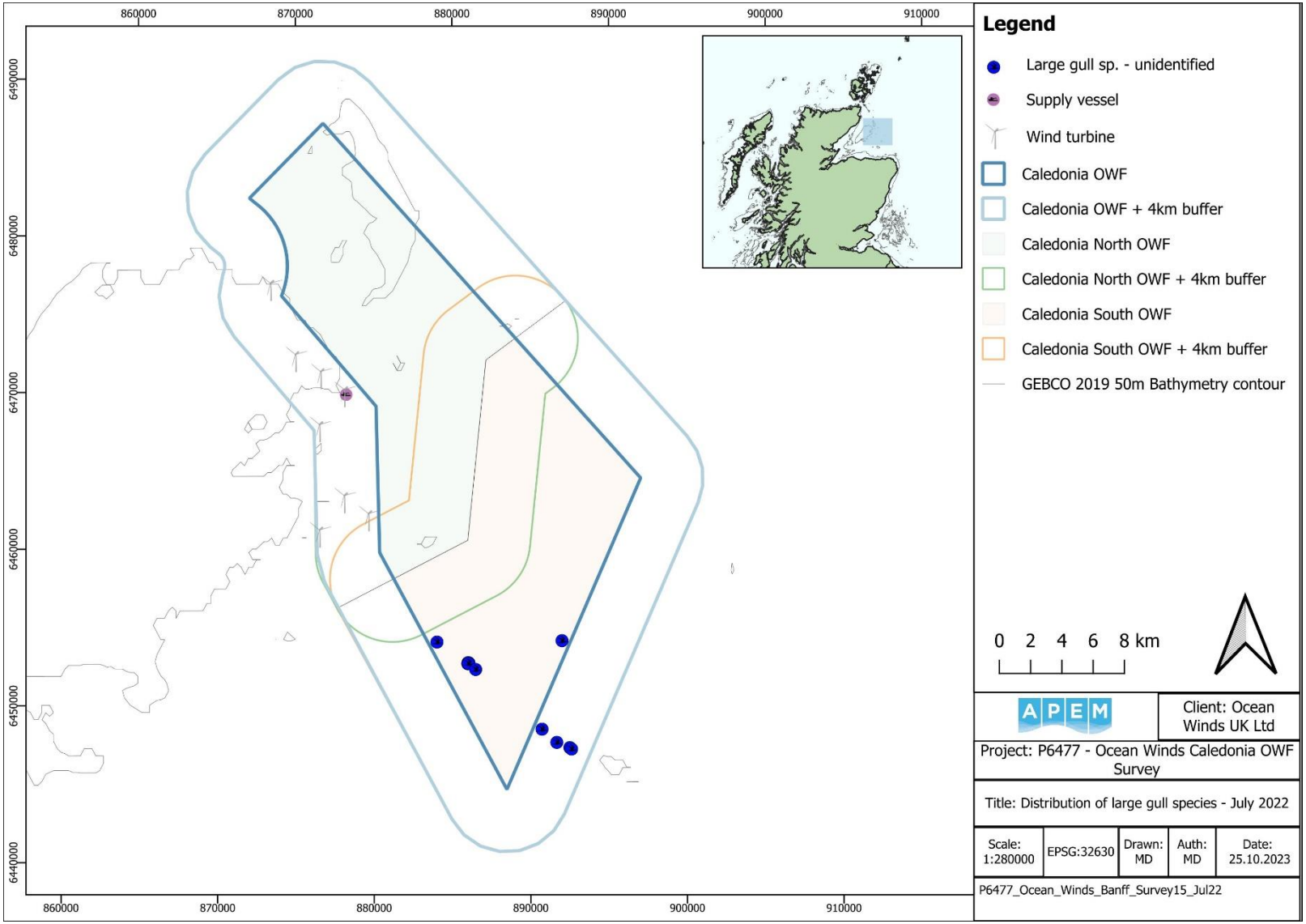


Figure A4.119 Distribution of large gull species recorded in the Survey Area in July 2022

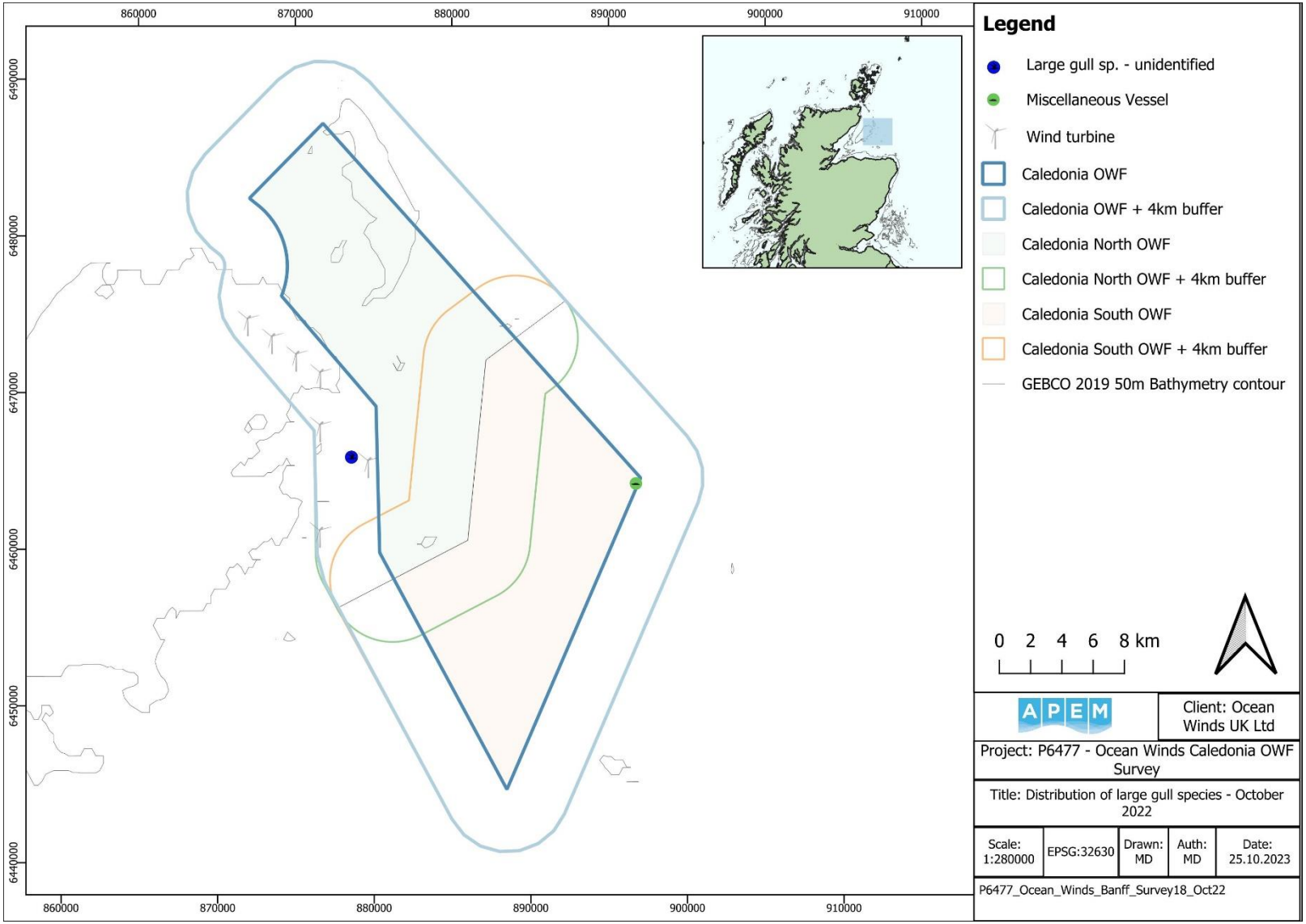


Figure A4.120 Distribution of large gull species recorded in the Survey Area in October 2022

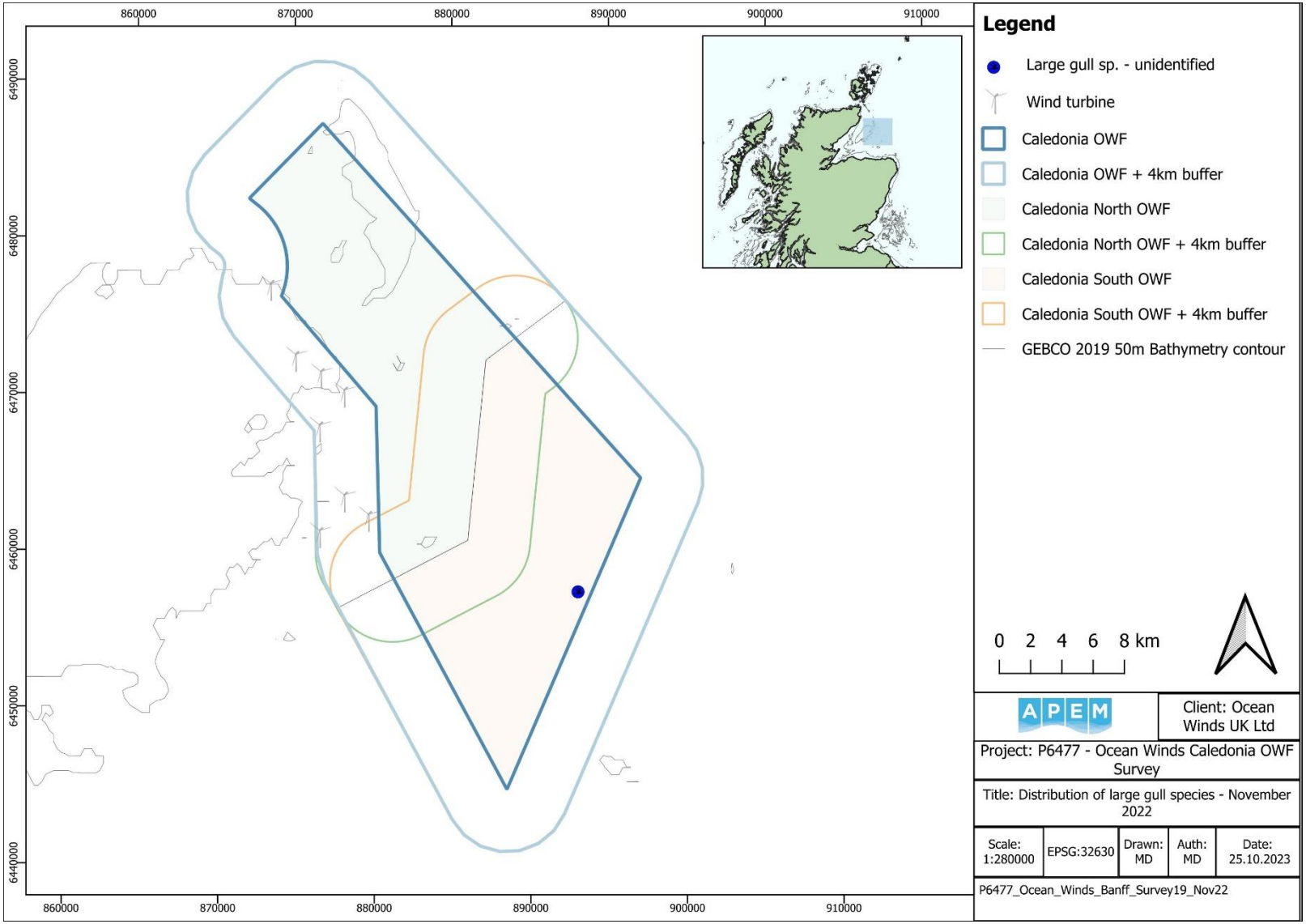


Figure A4.121 Distribution of large gull species recorded in the Survey Area in November 2022

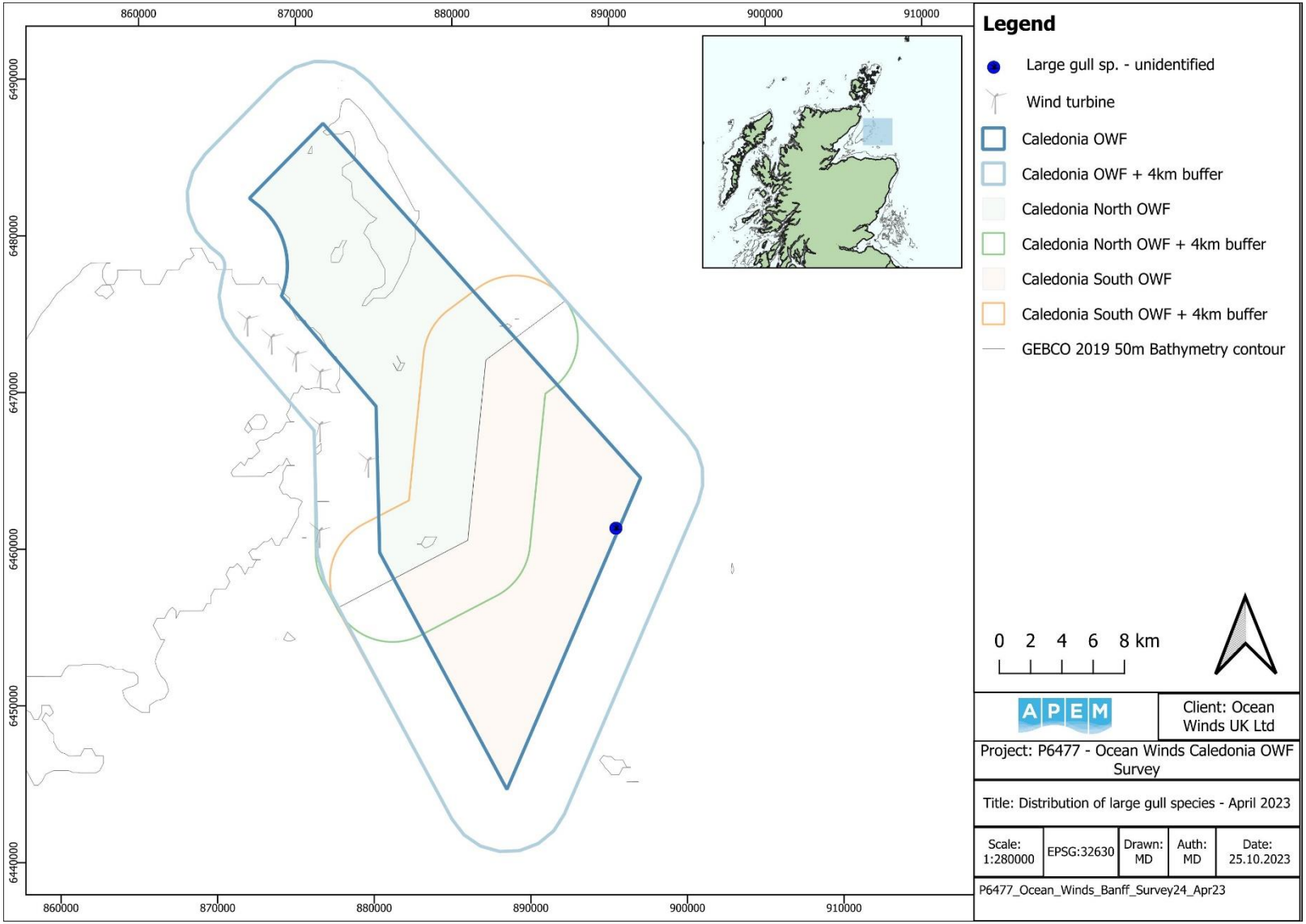


Figure A4.122 Distribution of large gull species recorded in the Survey Area in April 2023

Unidentified gull species

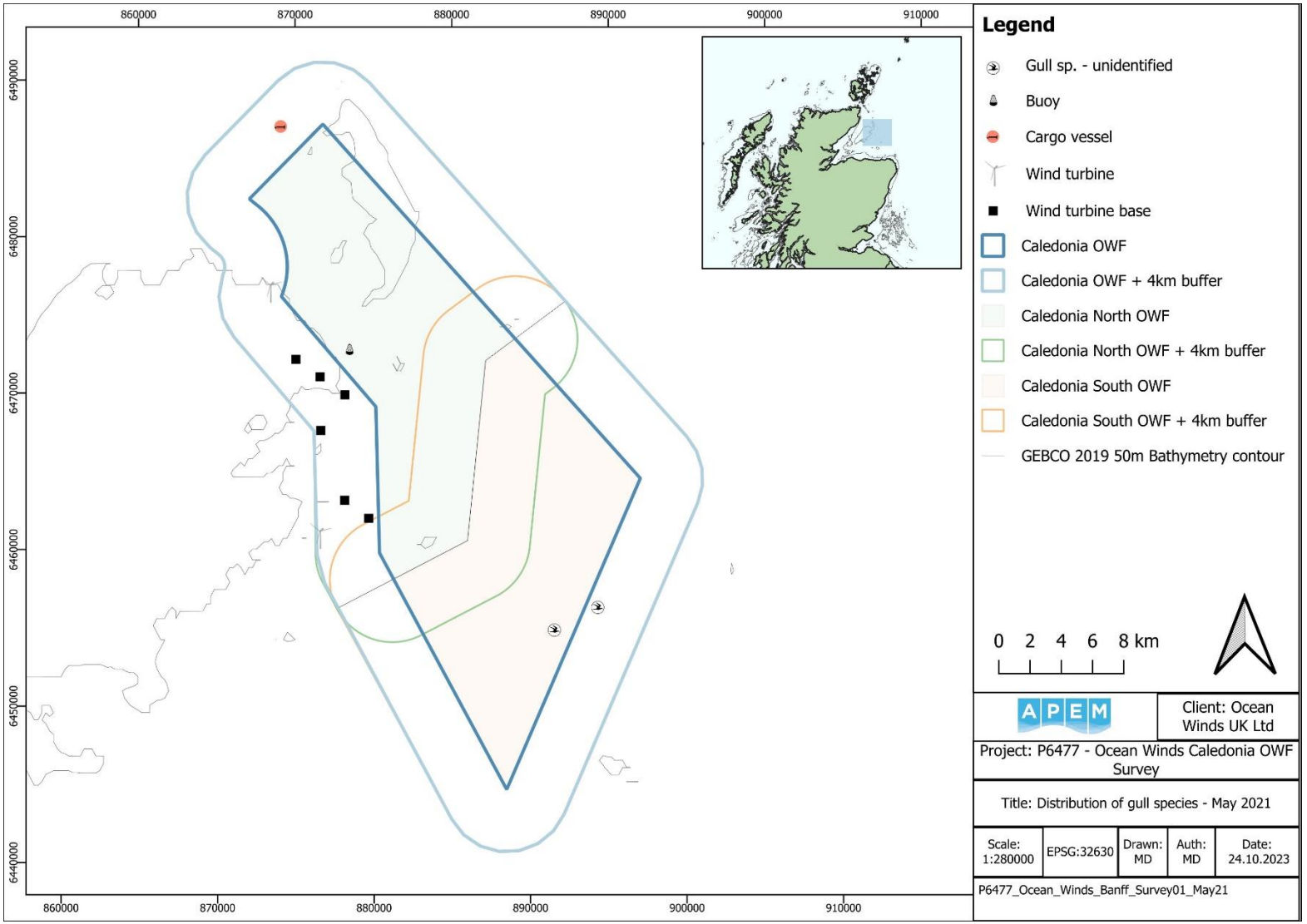


Figure A4.123 Distribution of gull species recorded in the Survey Area in May 2021

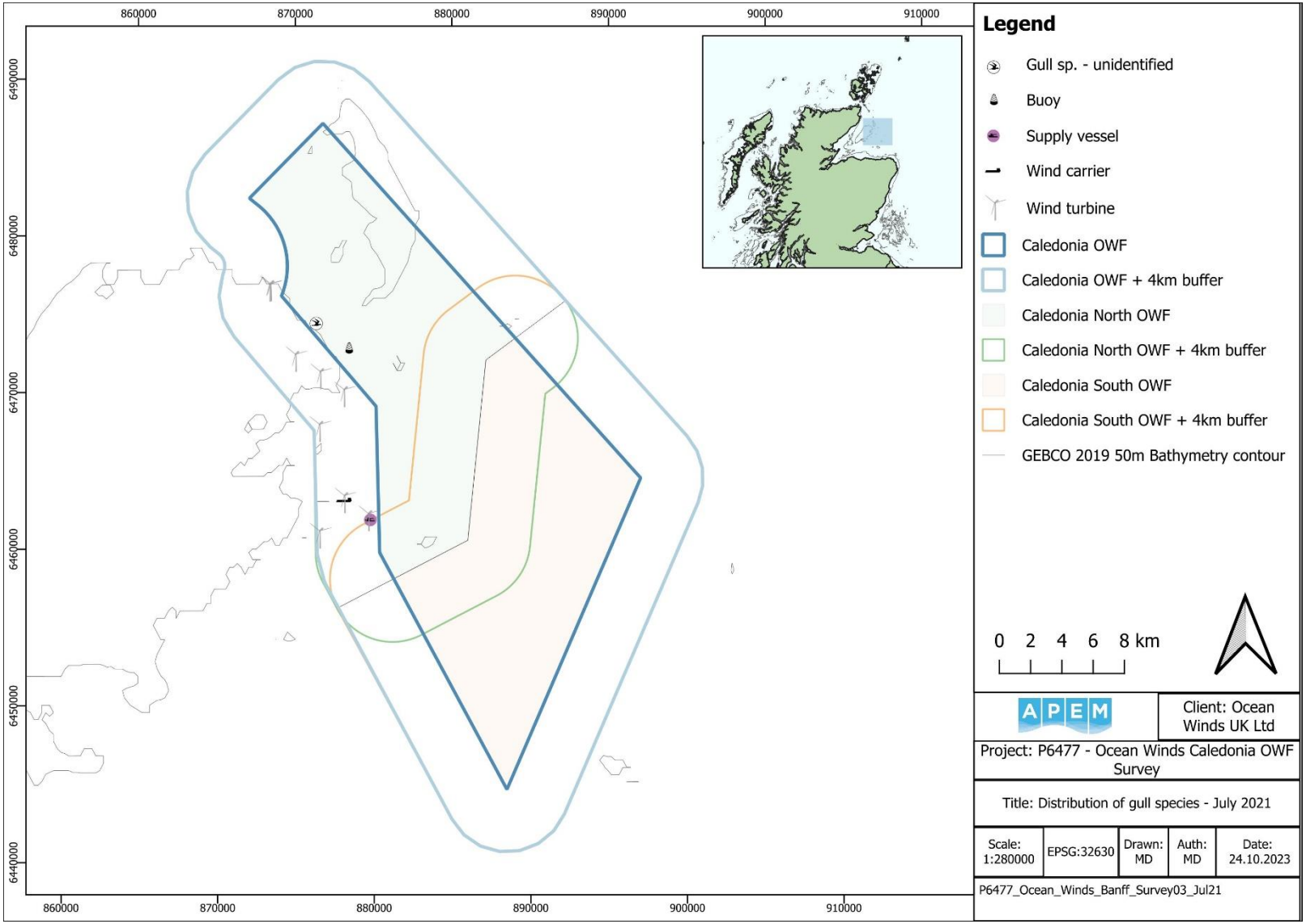


Figure A4.124 Distribution of gull species recorded in the Survey Area in July 2021

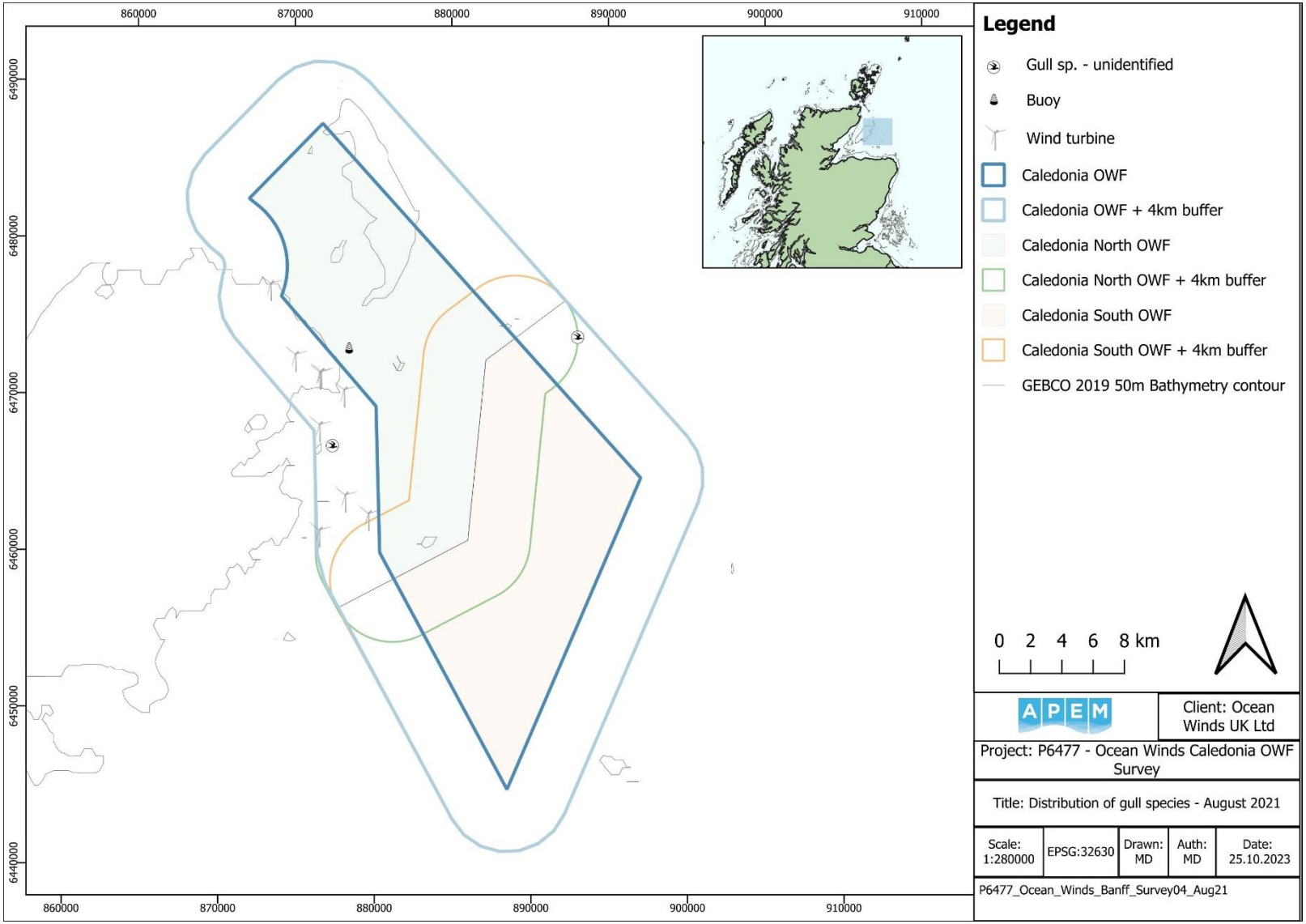


Figure A4.125 Distribution of gull species recorded in the Survey Area in August 2021

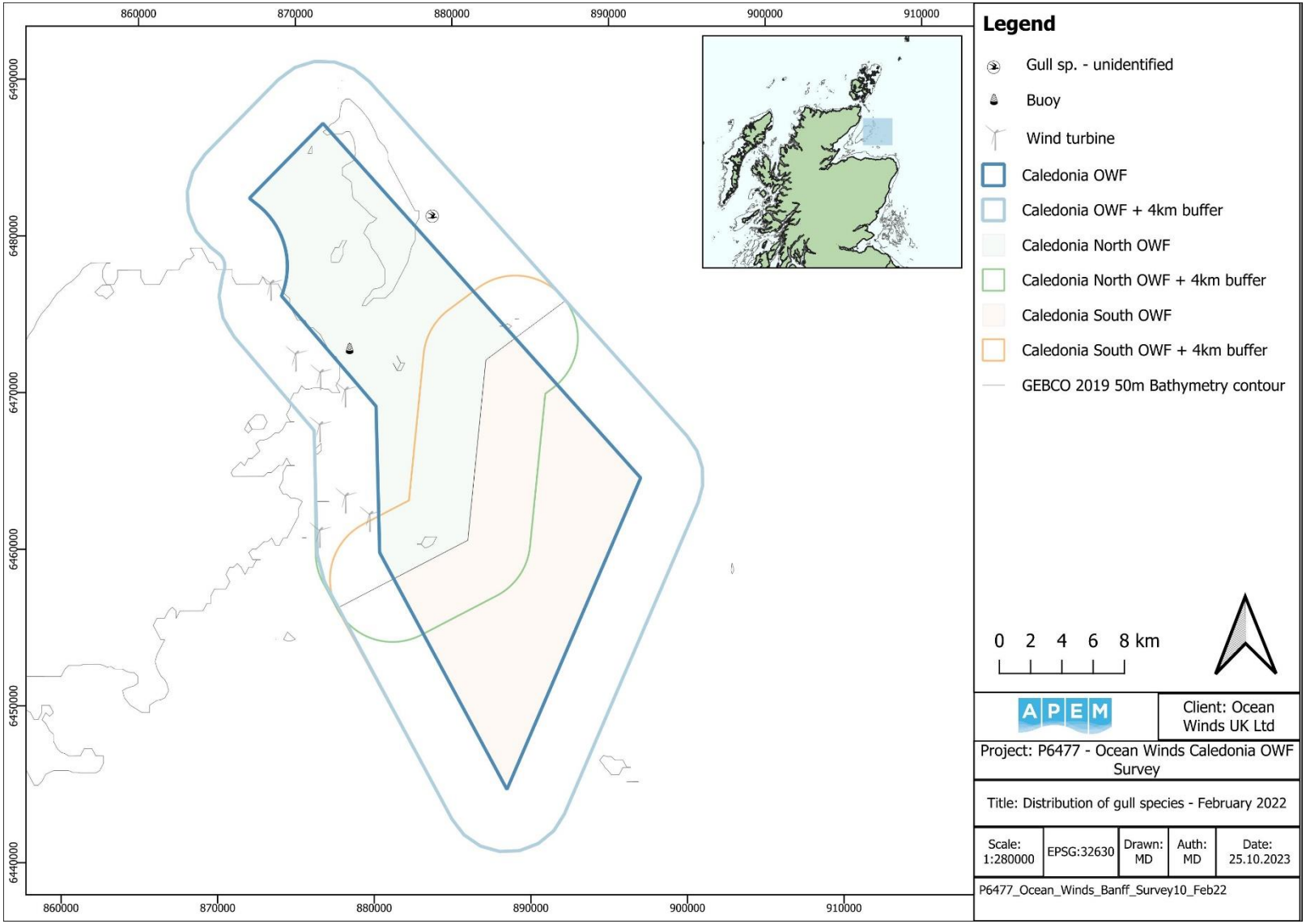


Figure A4.126 Distribution of gull species recorded in the Survey Area in February 2022

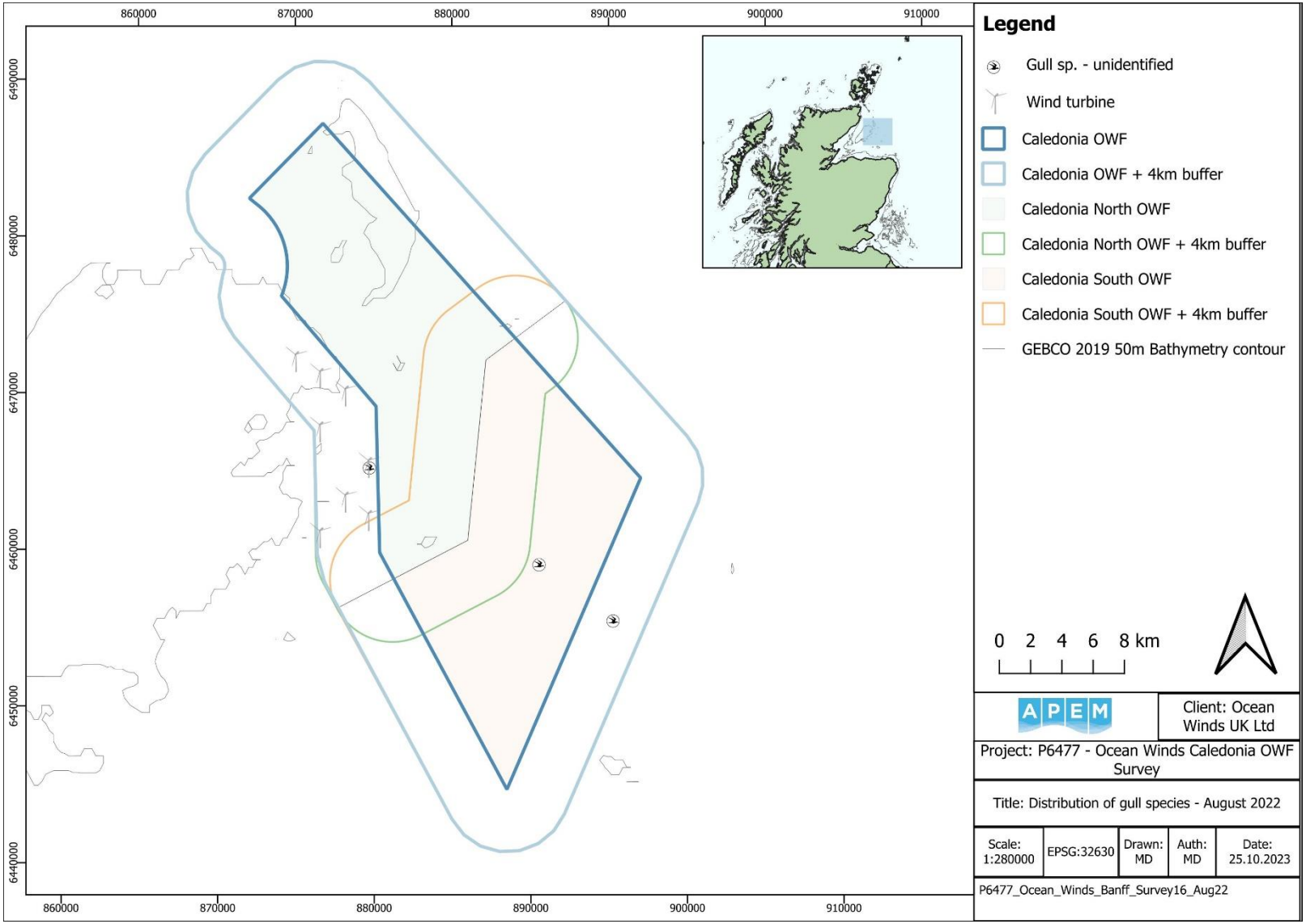


Figure A4.127 Distribution of gull species recorded in the Survey Area in August 2022

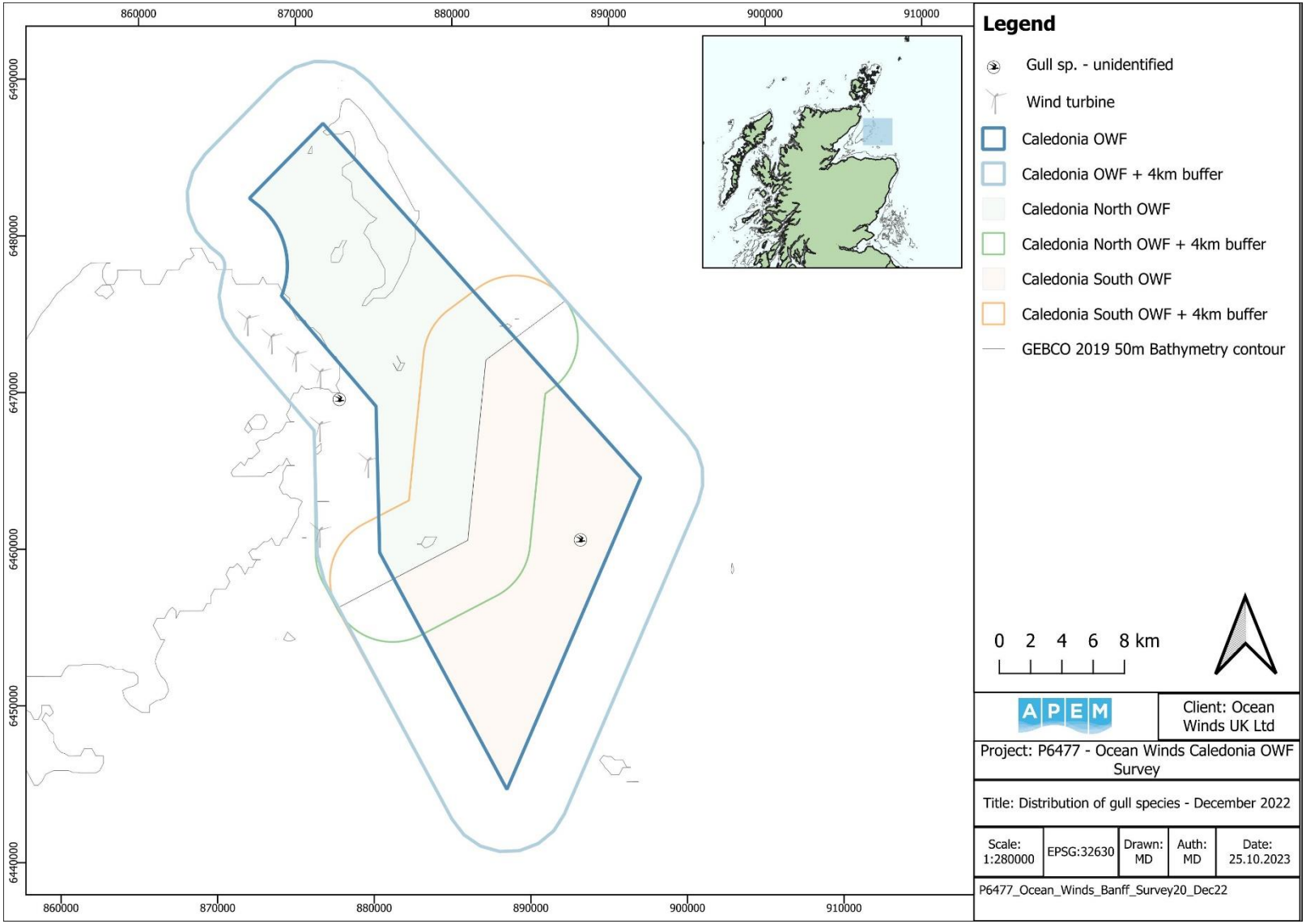


Figure A4.128 Distribution of gull species recorded in the Survey Area in December 2022

Common tern

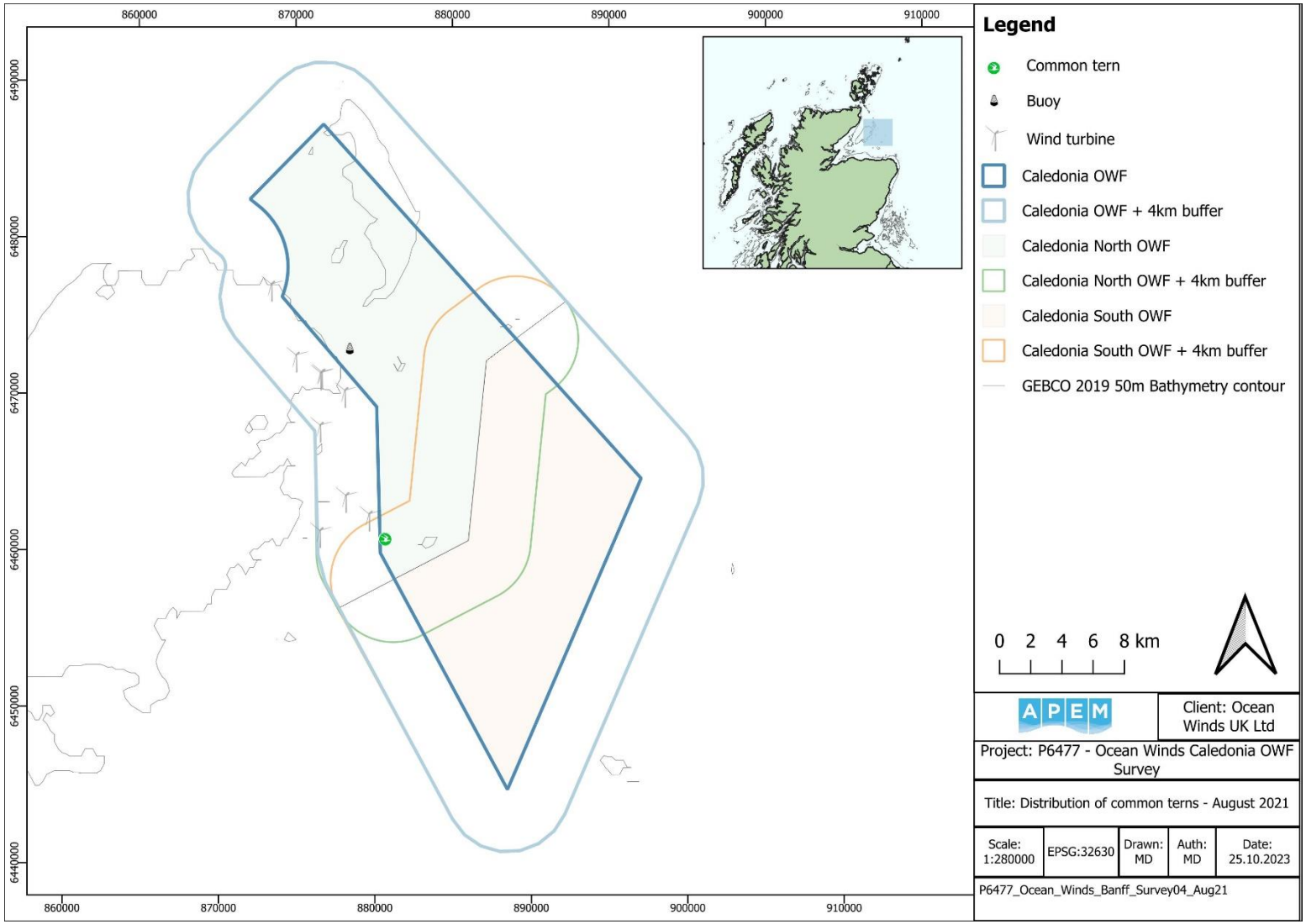


Figure A4.129 Distribution of common terns recorded in the Survey Area in August 2021

Arctic tern

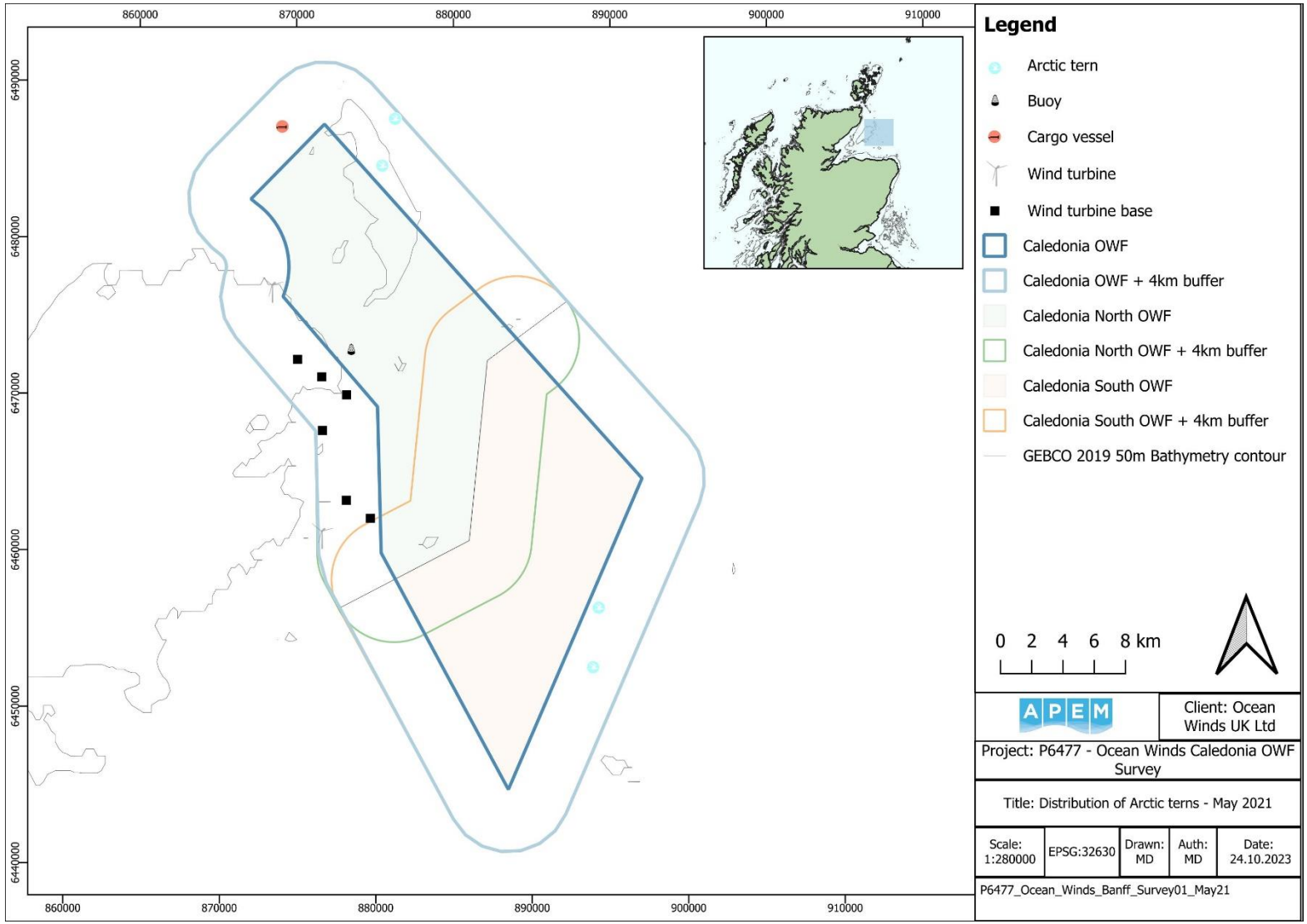


Figure A4.130 Distribution of Arctic terns recorded in the Survey Area in May 2021

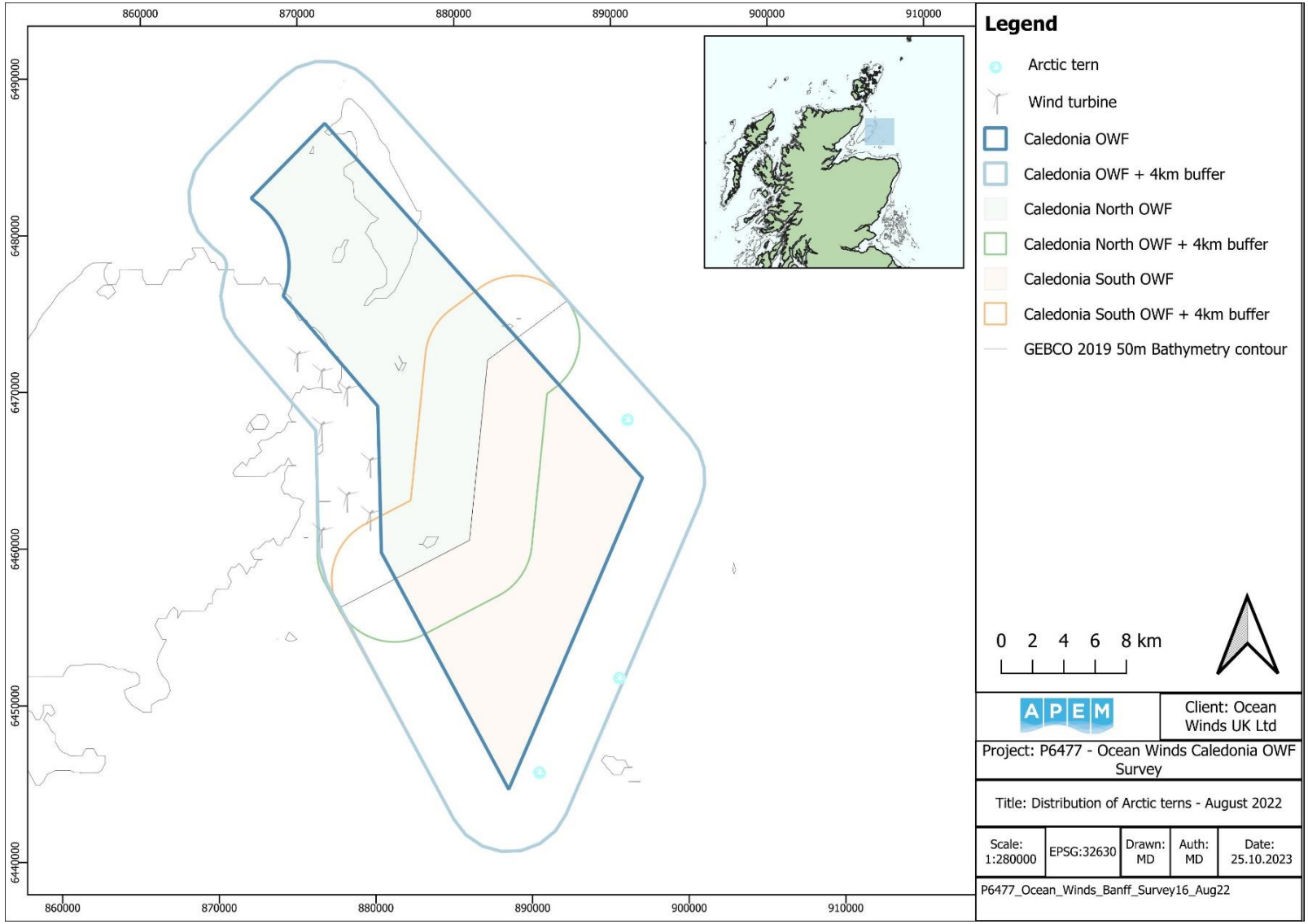


Figure A4.131 Distribution of Arctic terns recorded in the Survey Area in August 2022

'Commic' tern

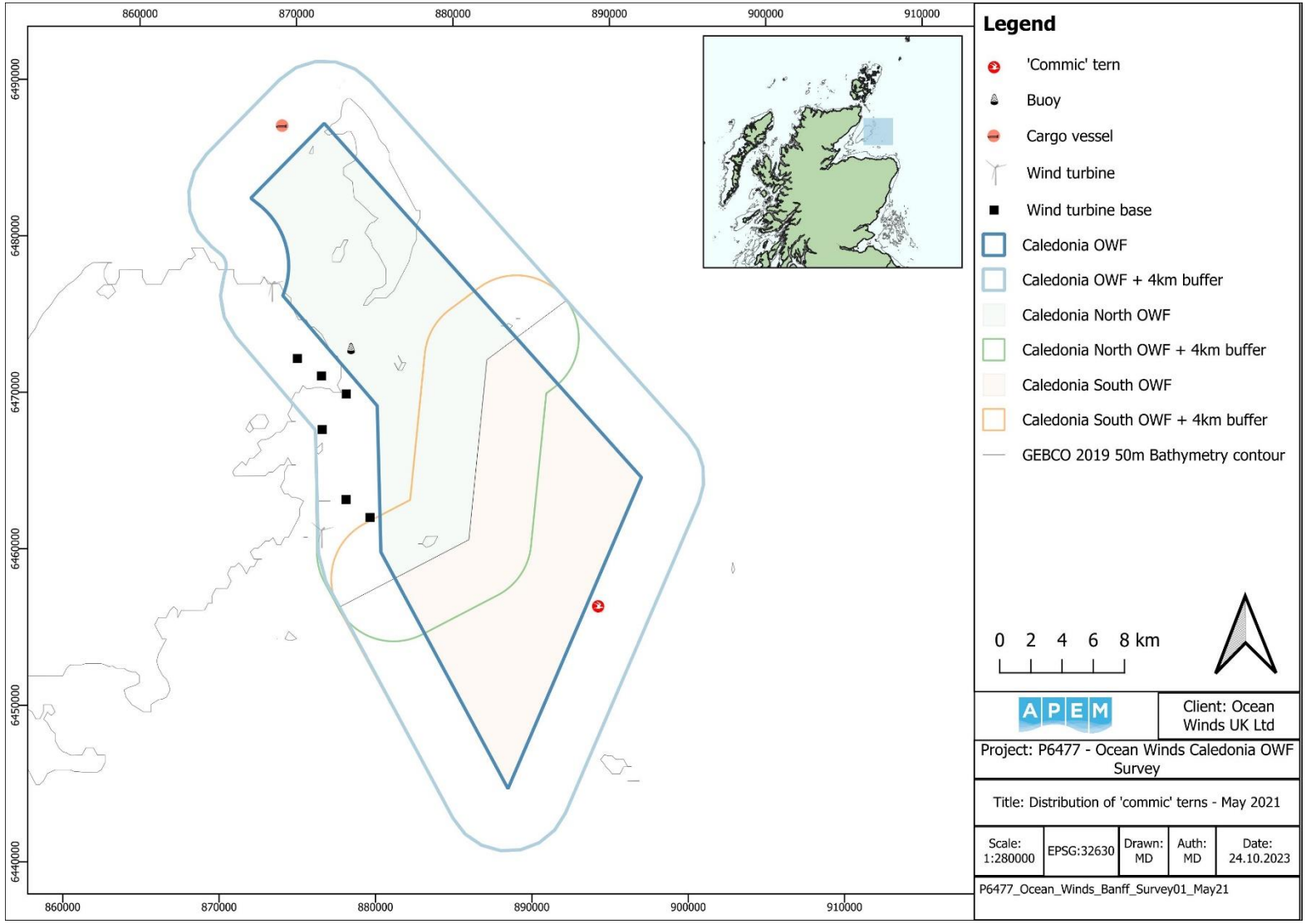


Figure A4.132 Distribution of 'commic' terns recorded in the Survey Area in May 2021

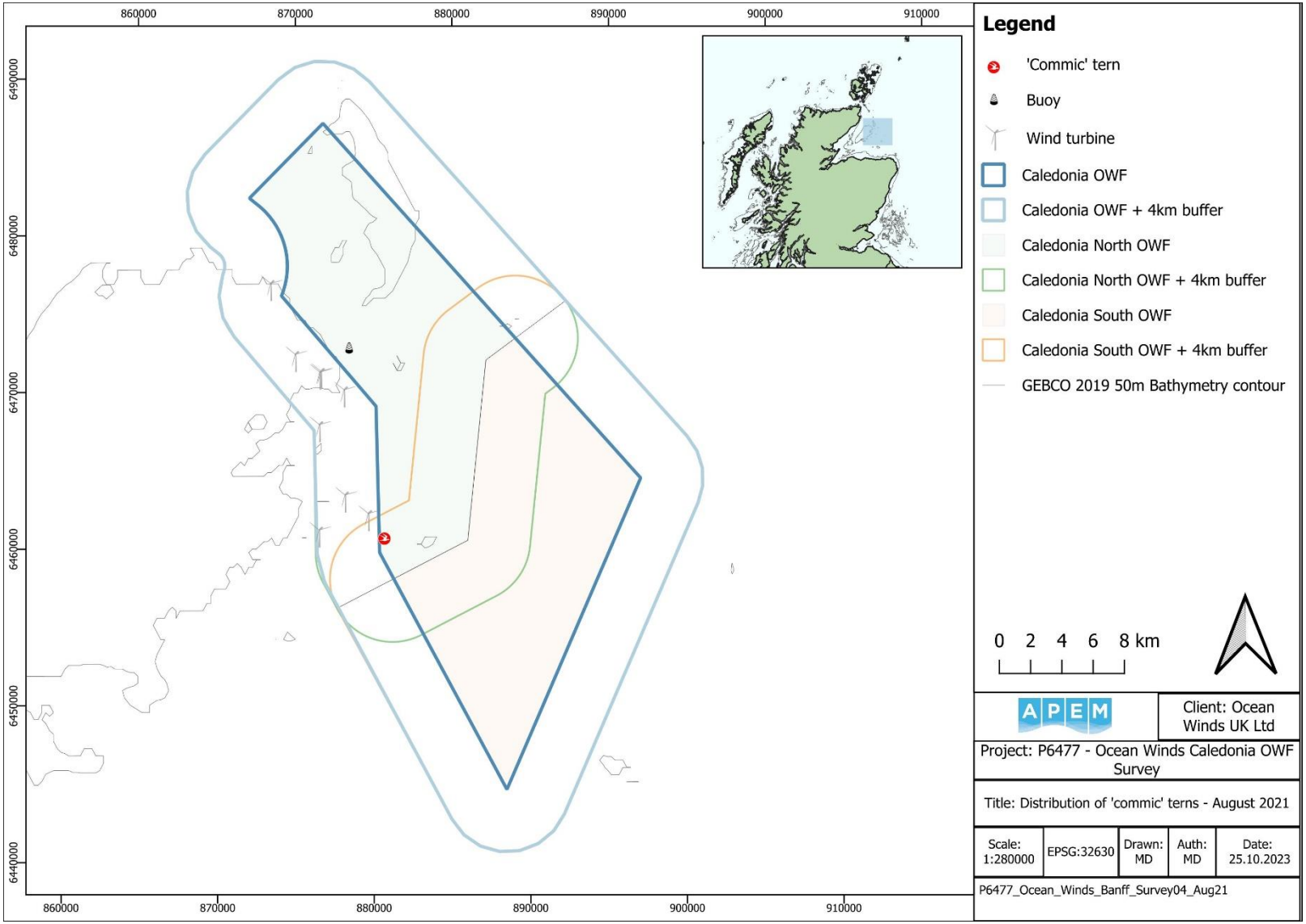


Figure A4.133 Distribution of 'commic' terns recorded in the Survey Area in August 2021

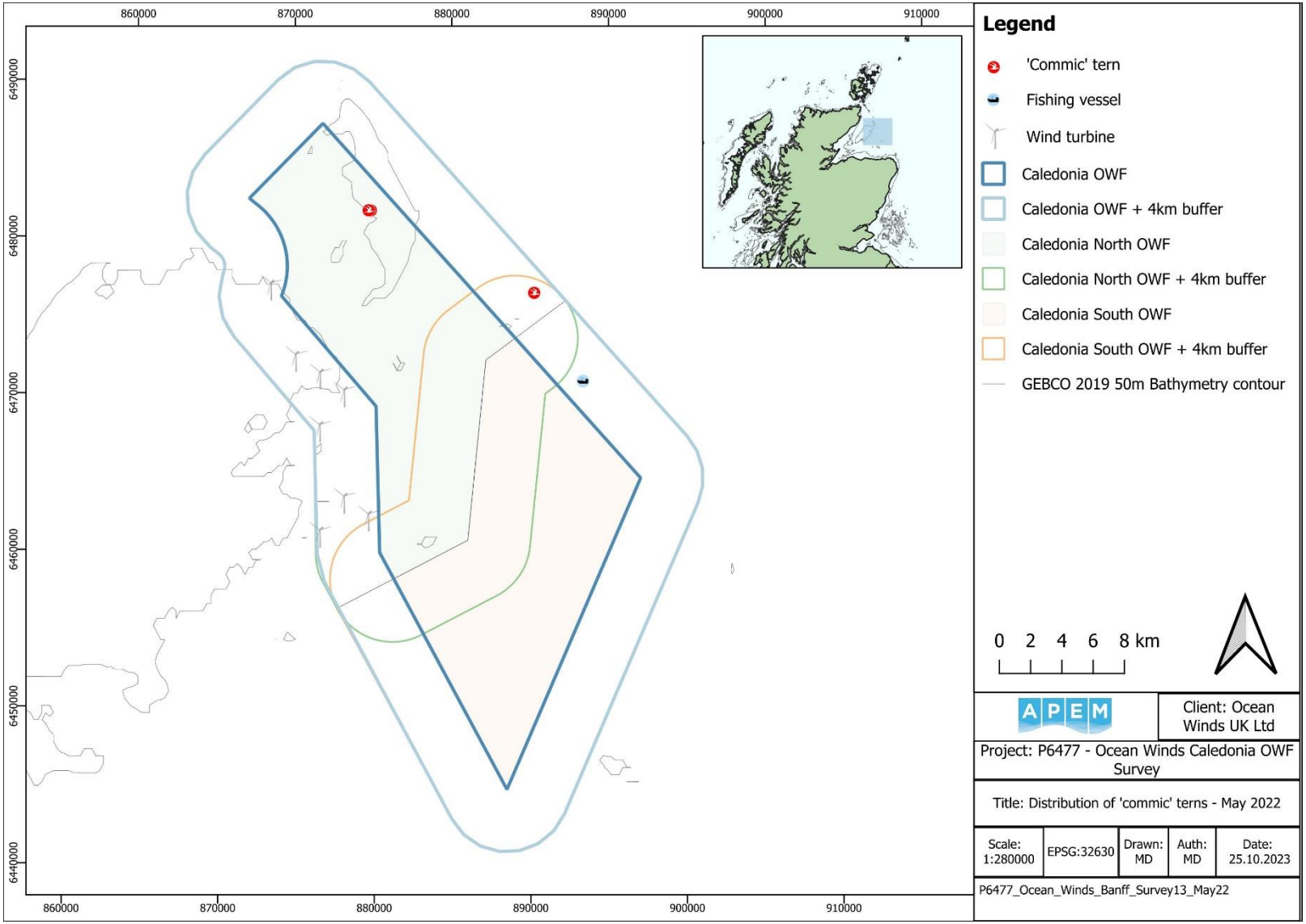


Figure A4.134 Distribution of 'commic' terns recorded in the Survey Area in May 2022

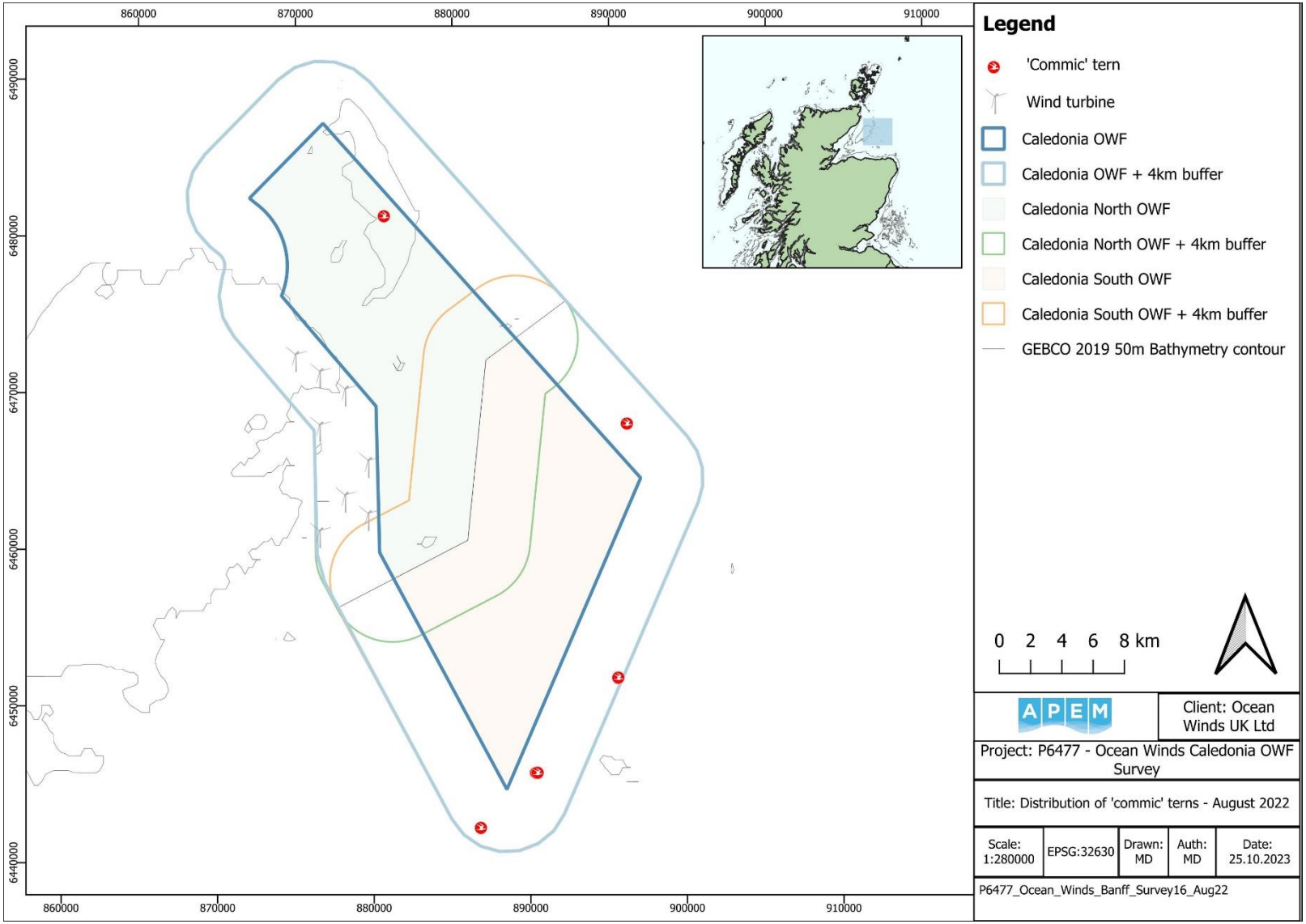


Figure A4.135 Distribution of 'commic' terns recorded in the Survey Area in August 2022

Unidentified tern species

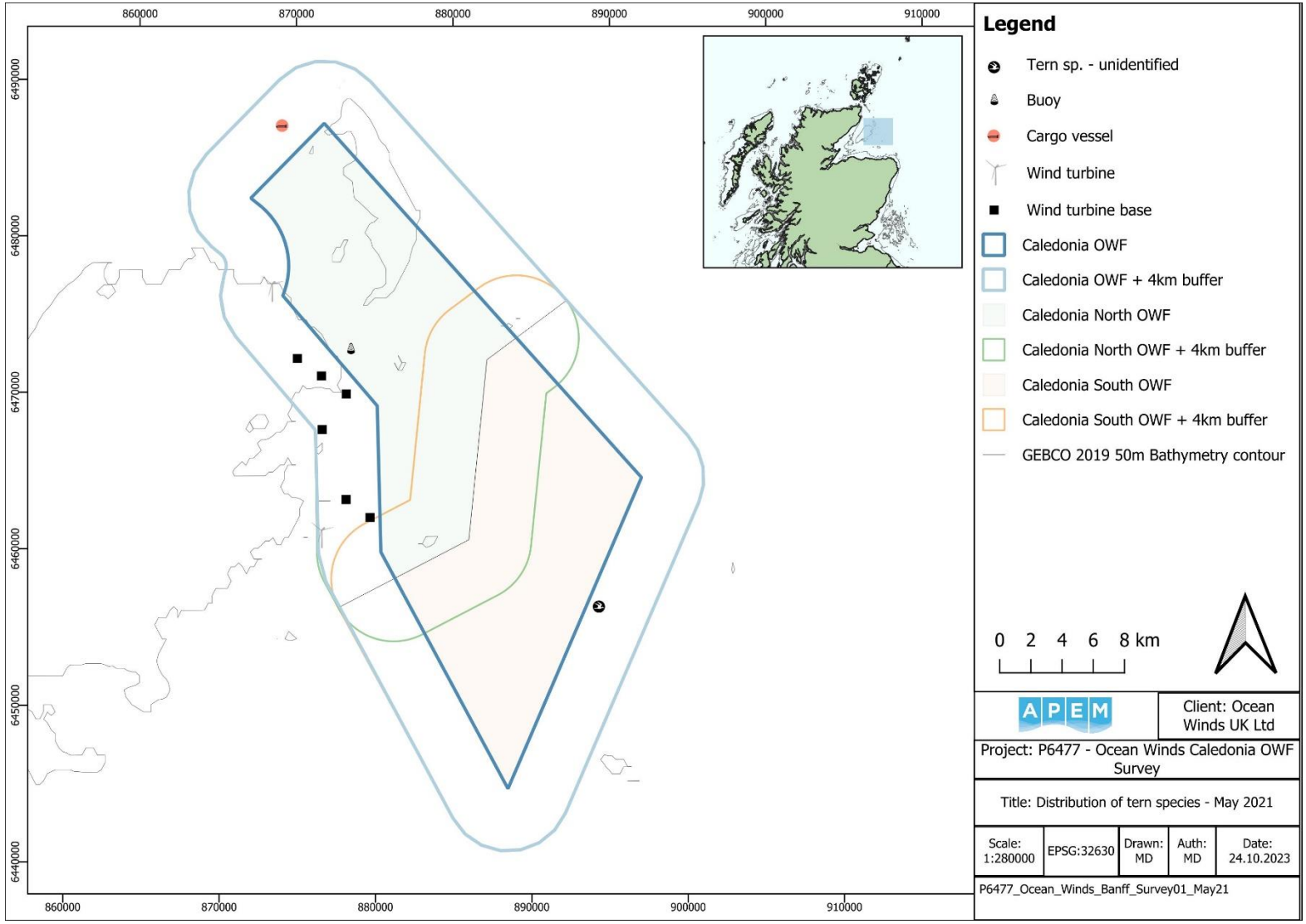


Figure A4.136 Distribution of tern species recorded in the Survey Area in May 2021

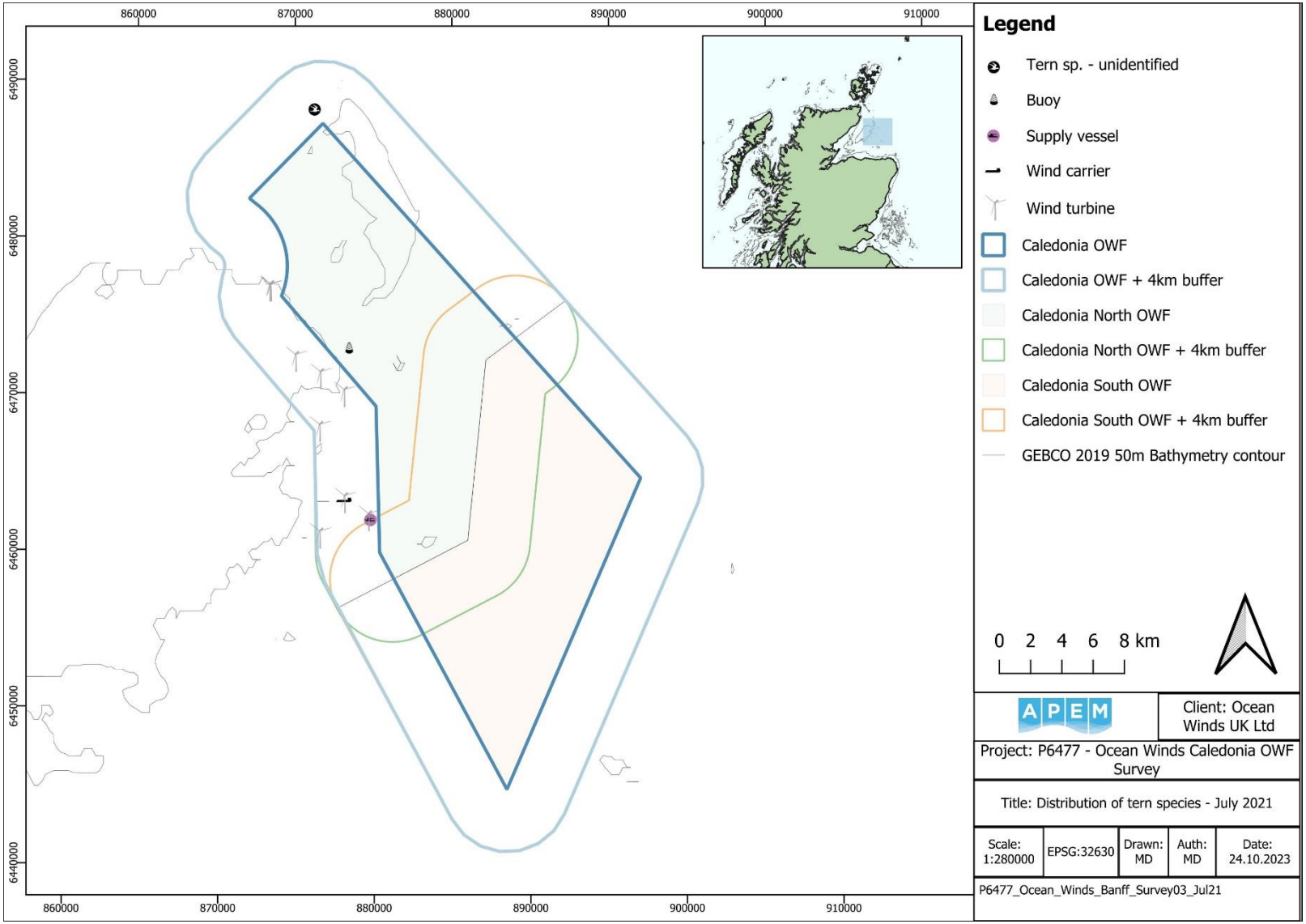


Figure A4.137 Distribution of tern species recorded in the Survey Area in July 2021

Great skua

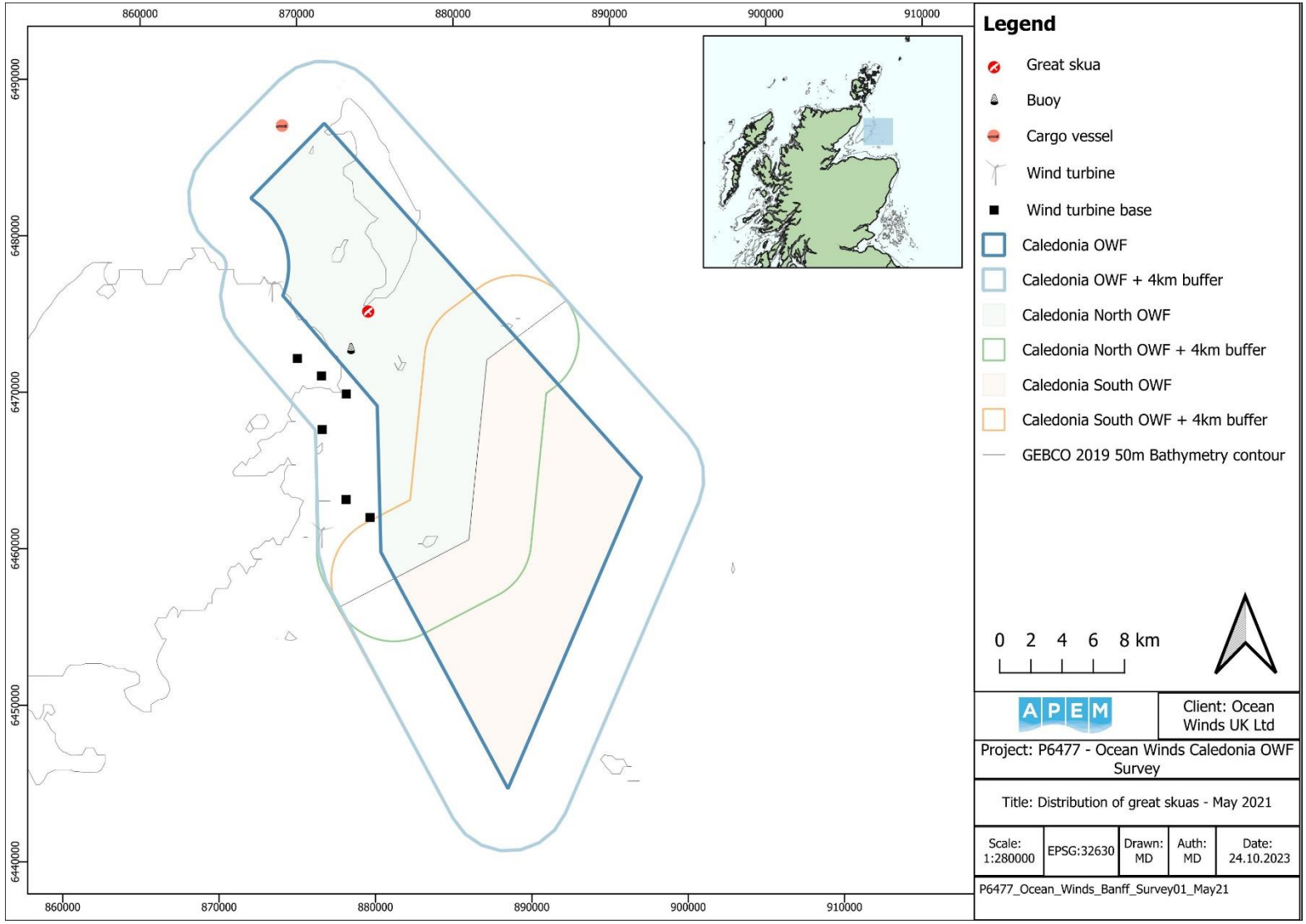


Figure A4.138 Distribution of great skuas recorded in the Survey Area in May 2021

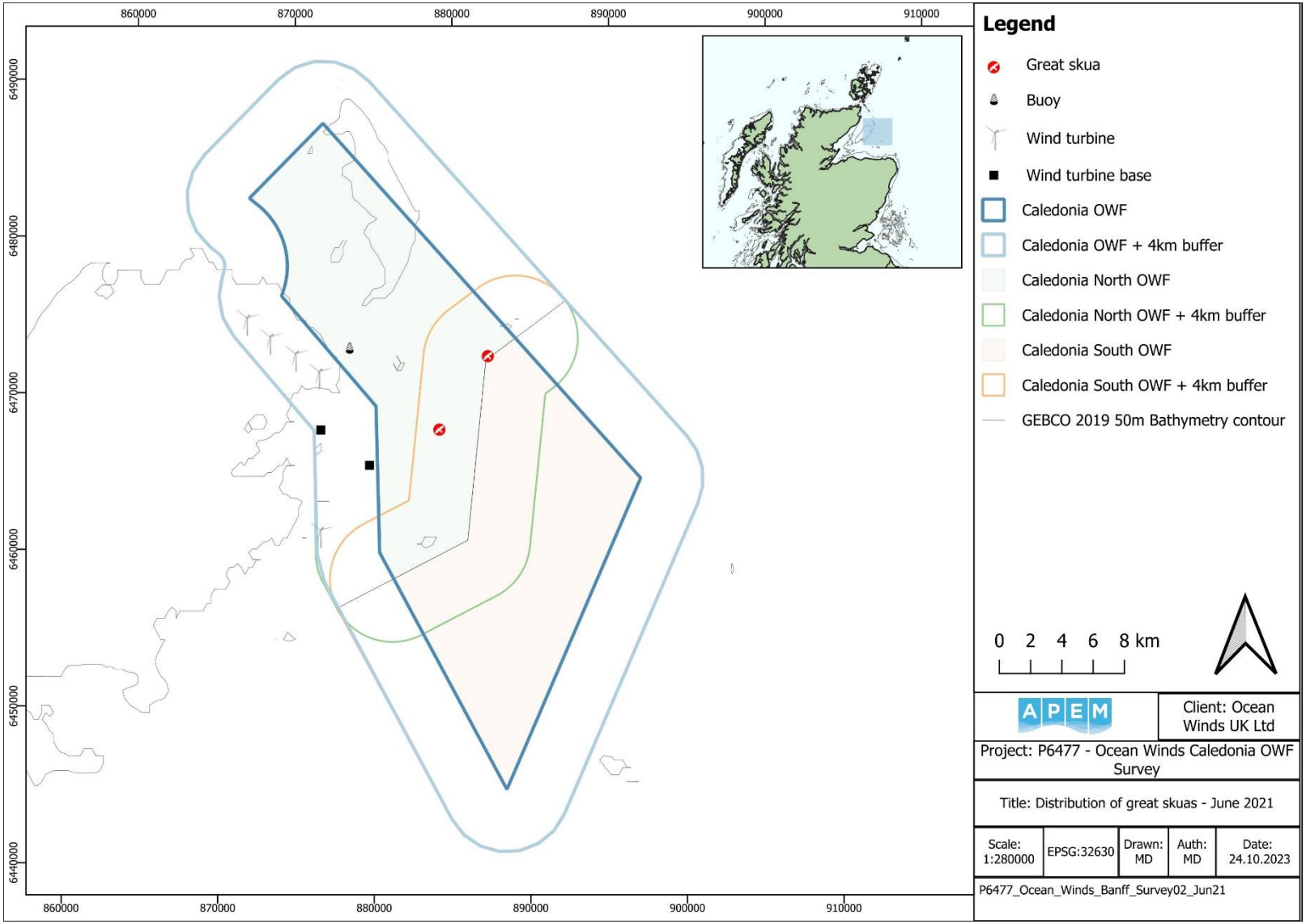


Figure A4.139 Distribution of great skuas recorded in the Survey Area in June 2021

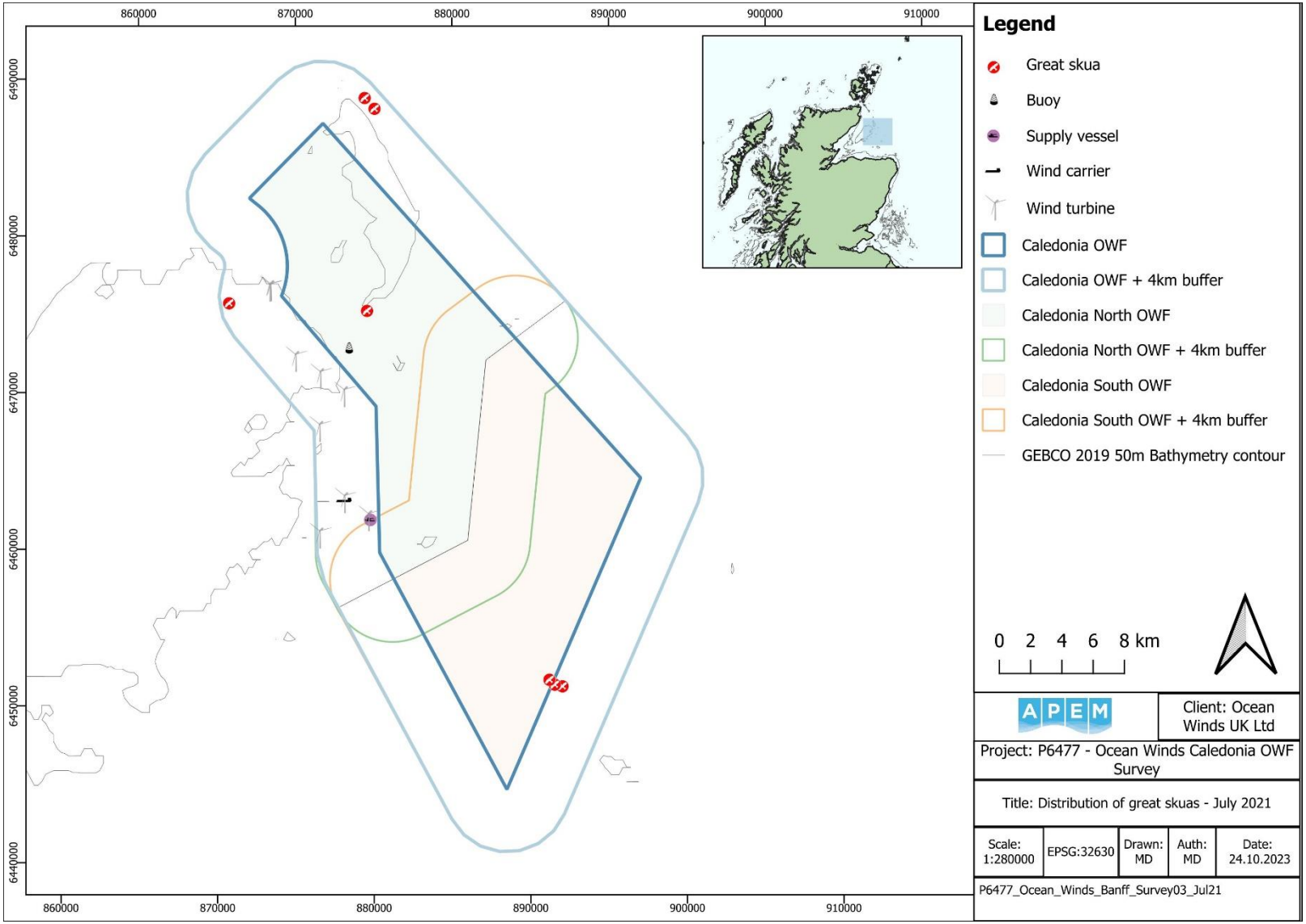


Figure A4.140 Distribution of great skuas recorded in the Survey Area in July 2021

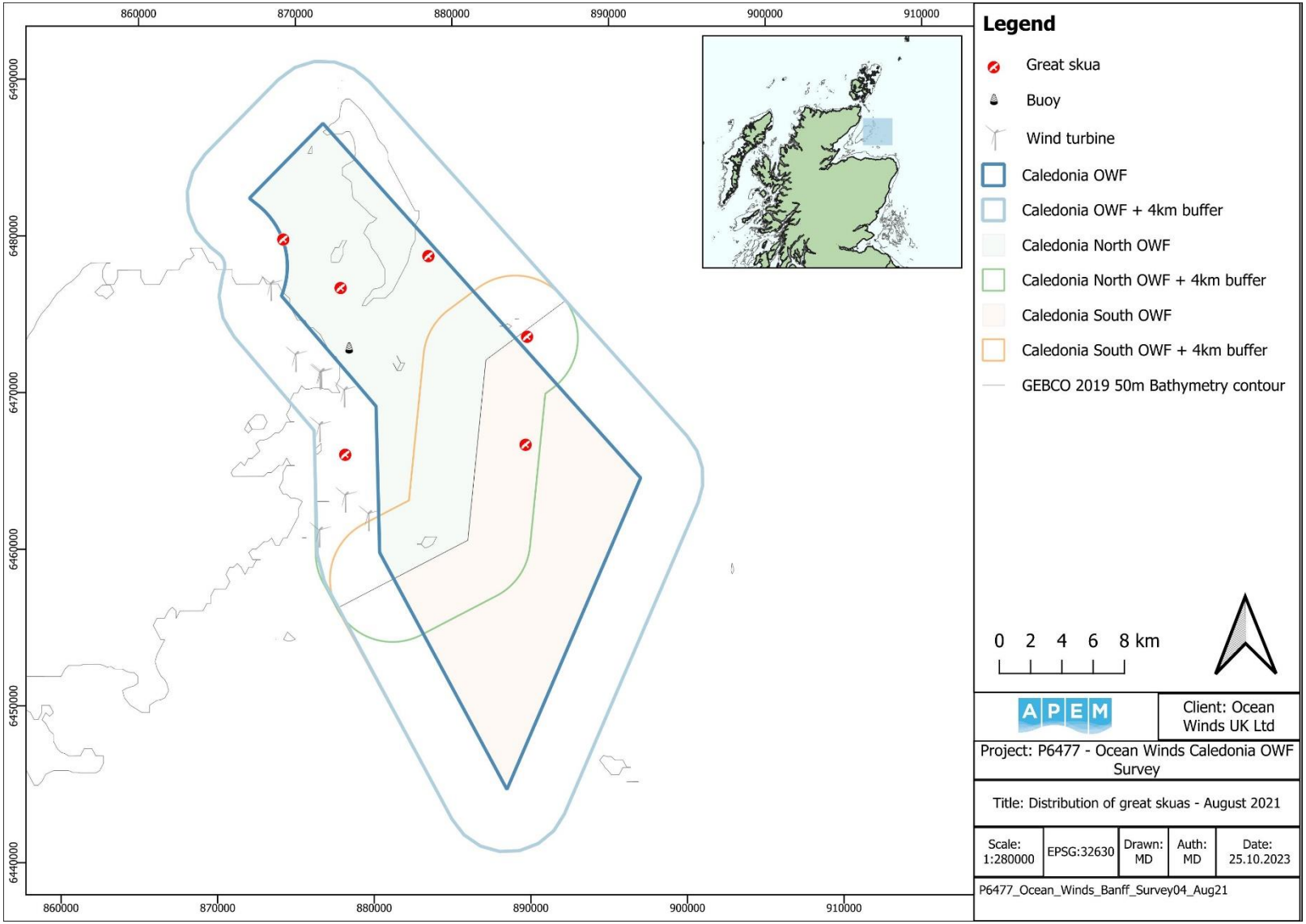


Figure A4.141 Distribution of great skuas recorded in the Survey Area in August 2021

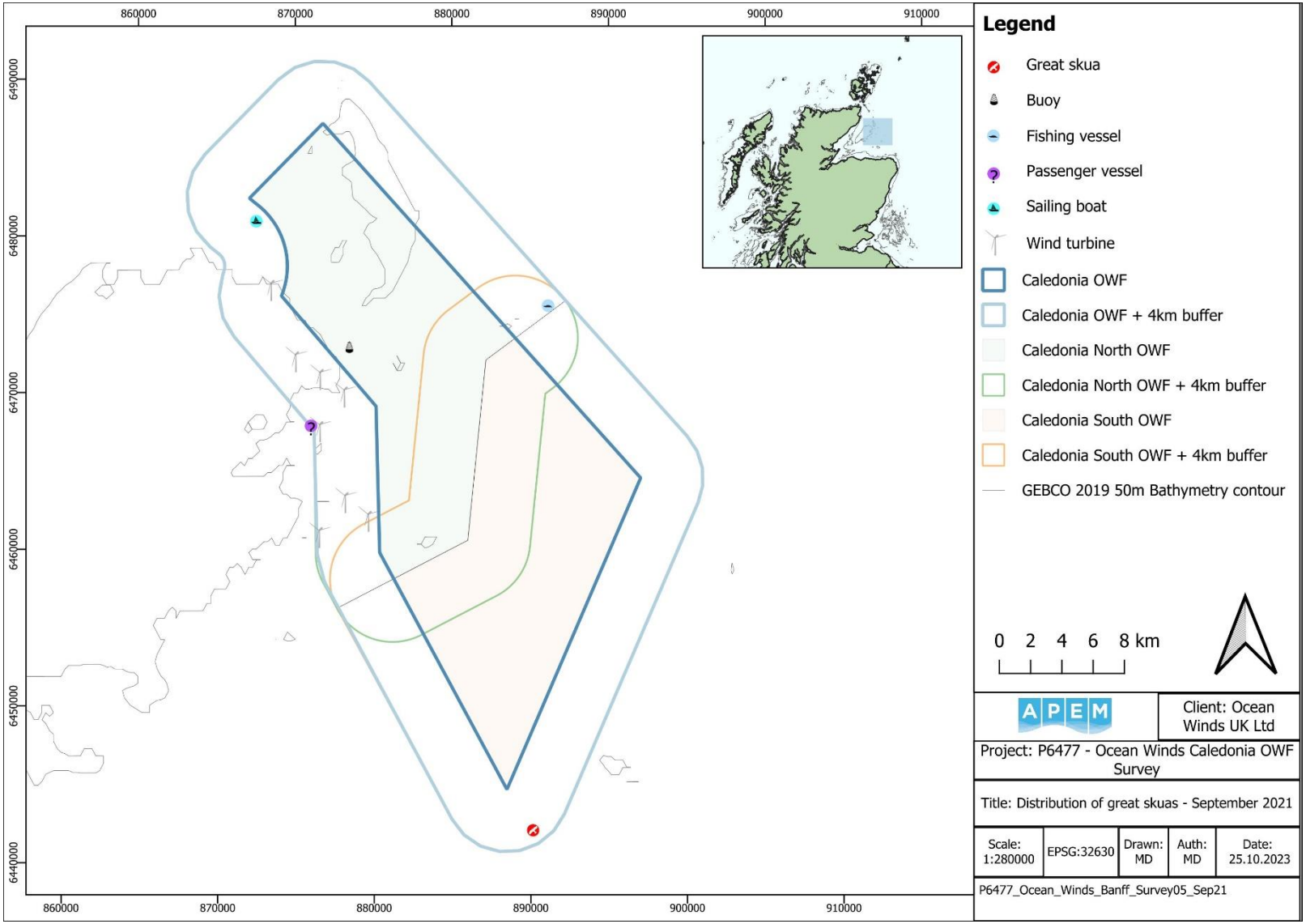


Figure A4.142 Distribution of great skuas recorded in the Survey Area in September 2021

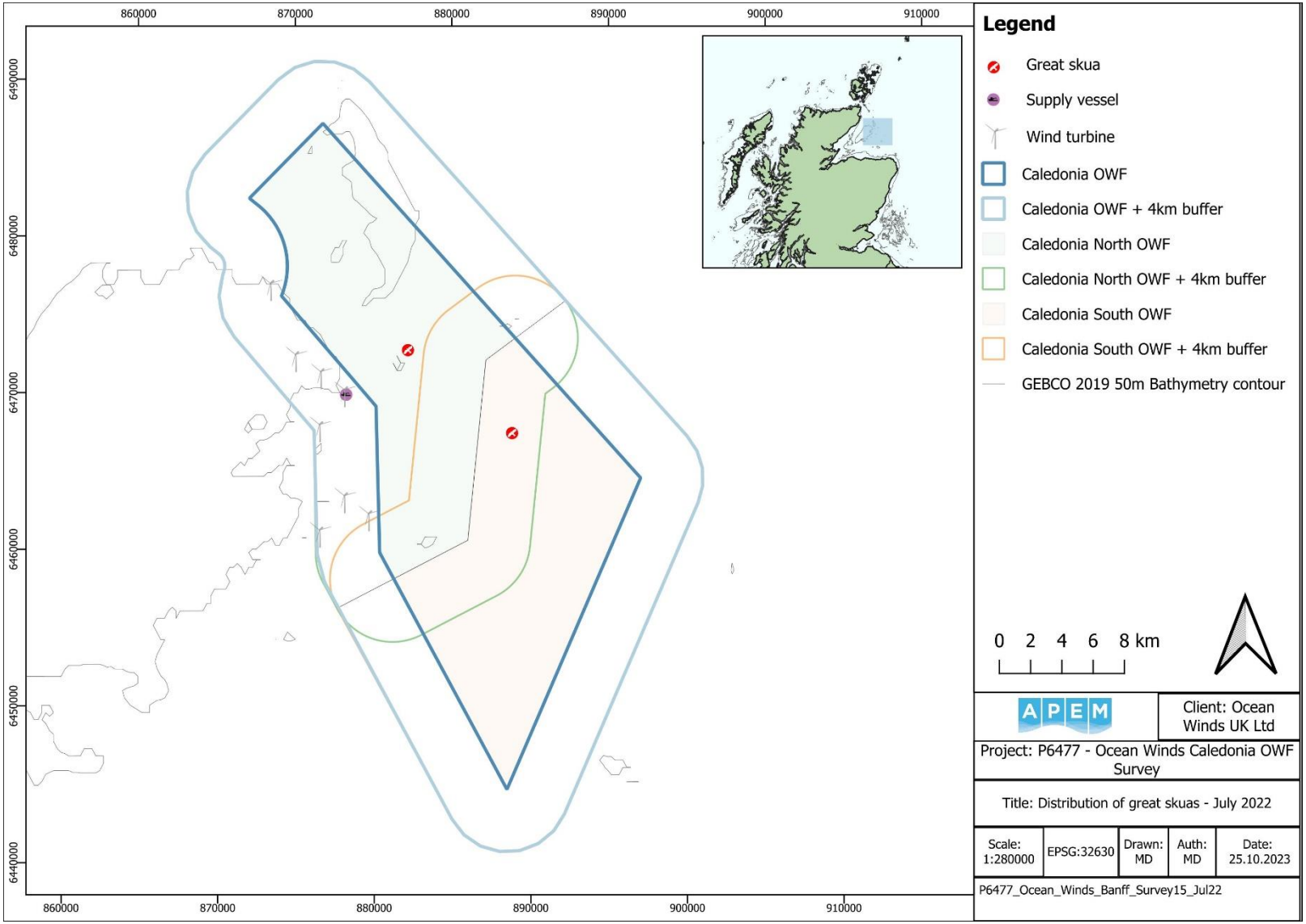


Figure A4.143 Distribution of great skuas recorded in the Survey Area in July 2022

Arctic skua

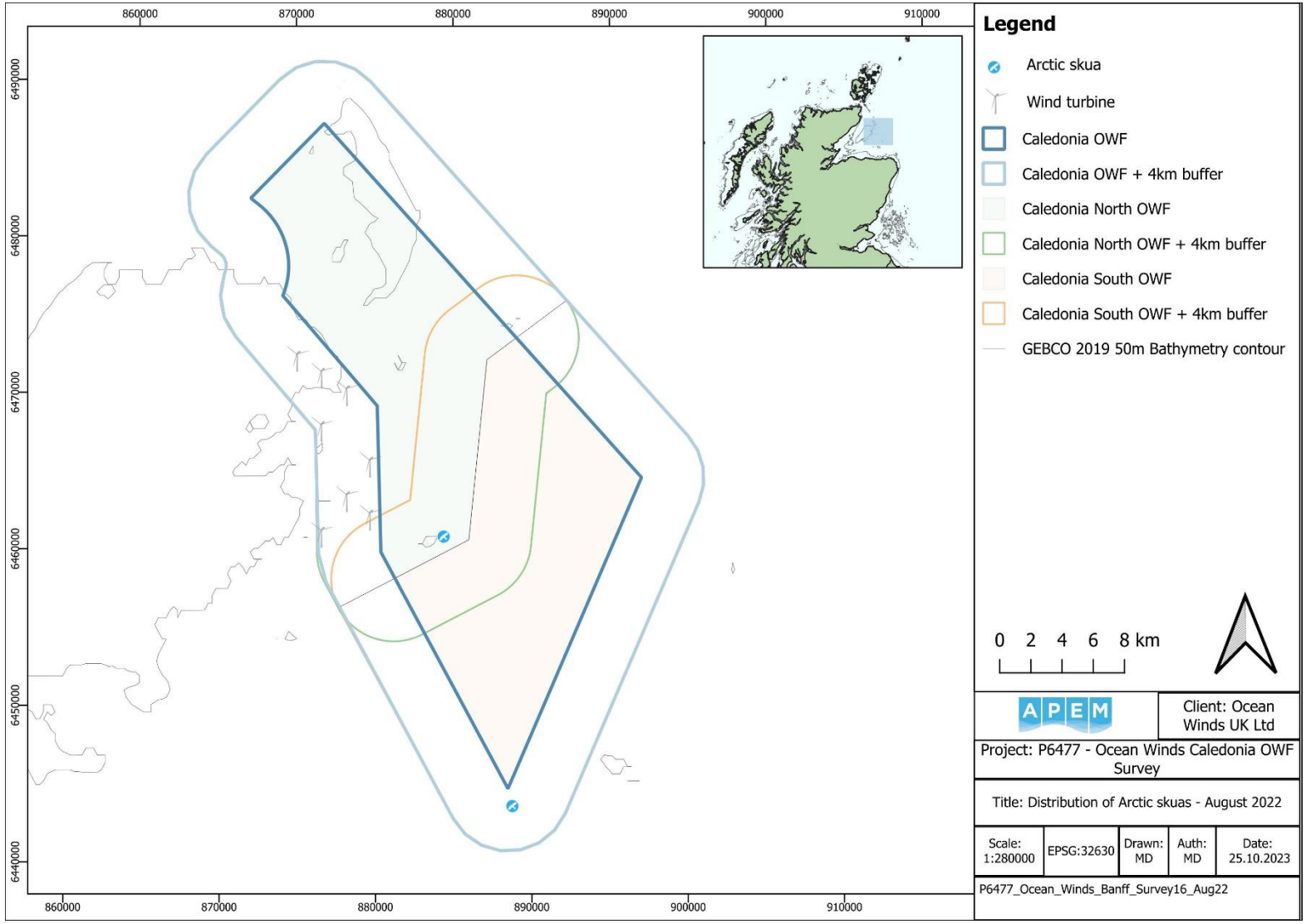


Figure A4.144 Distribution of Arctic skuas recorded in the Survey Area in August 2022

Guillemot

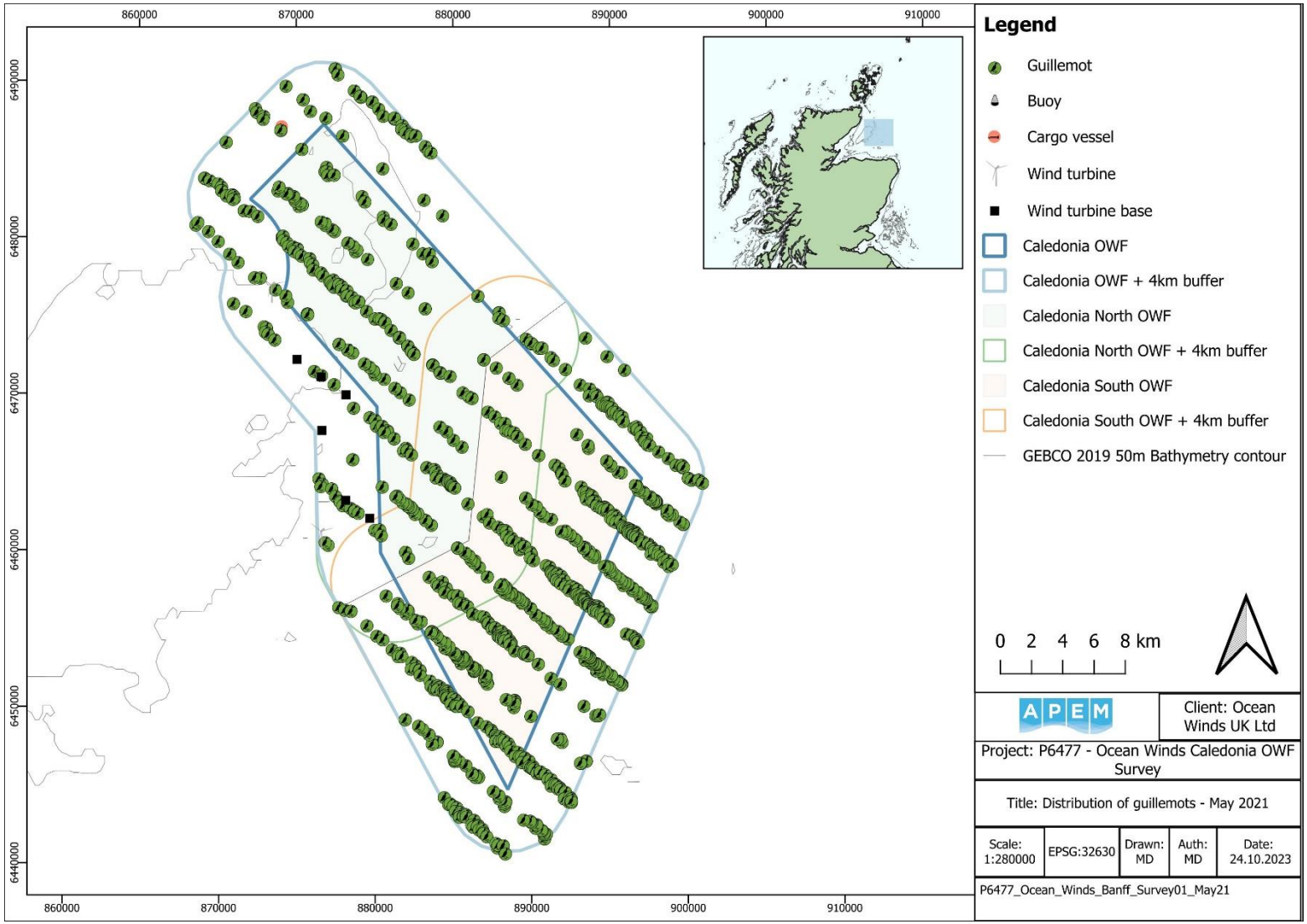


Figure A4.145 Distribution of guillemots recorded in the Survey Area in May 2021

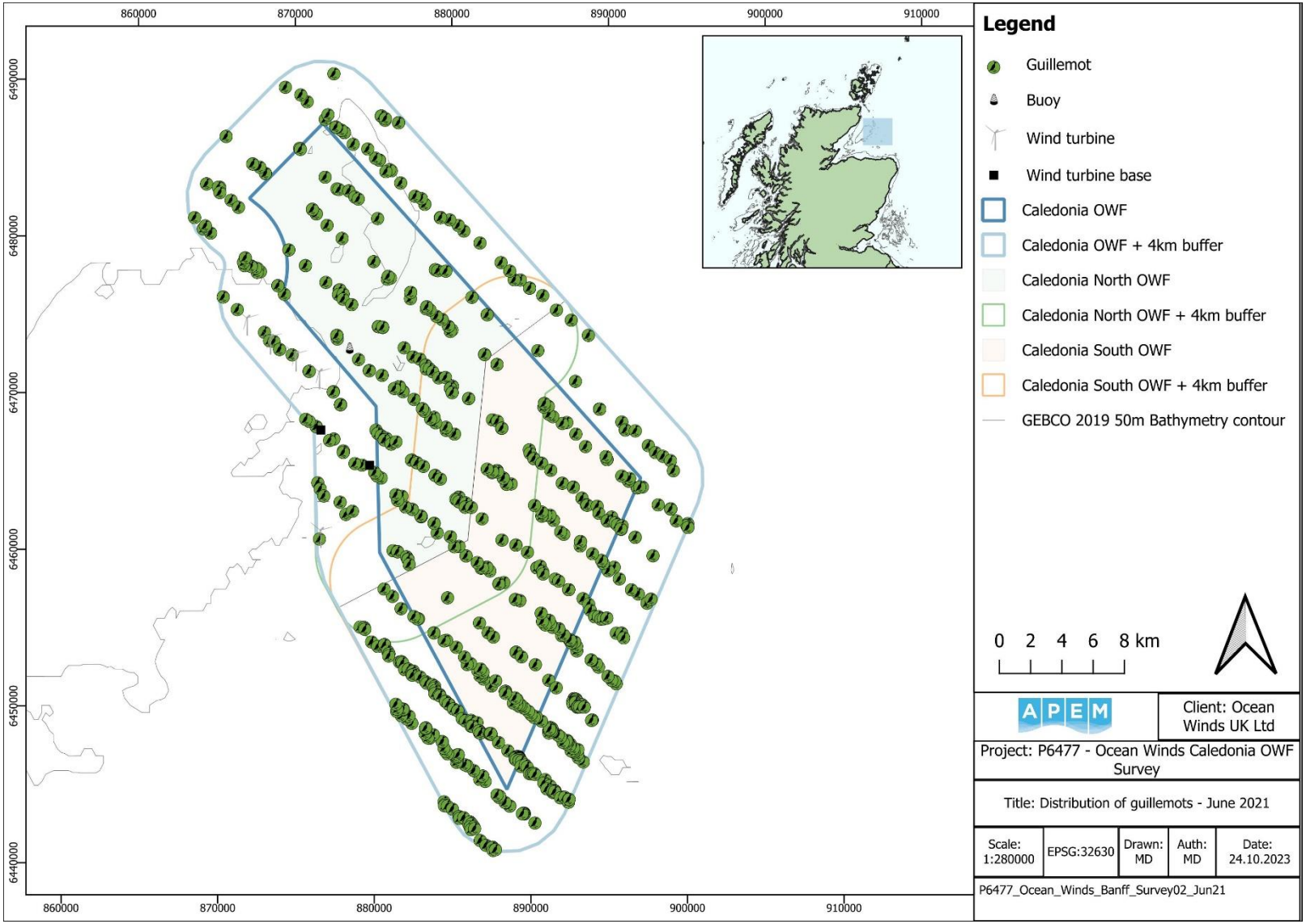


Figure A4.146 Distribution of guillemots recorded in the Survey Area in June 2021

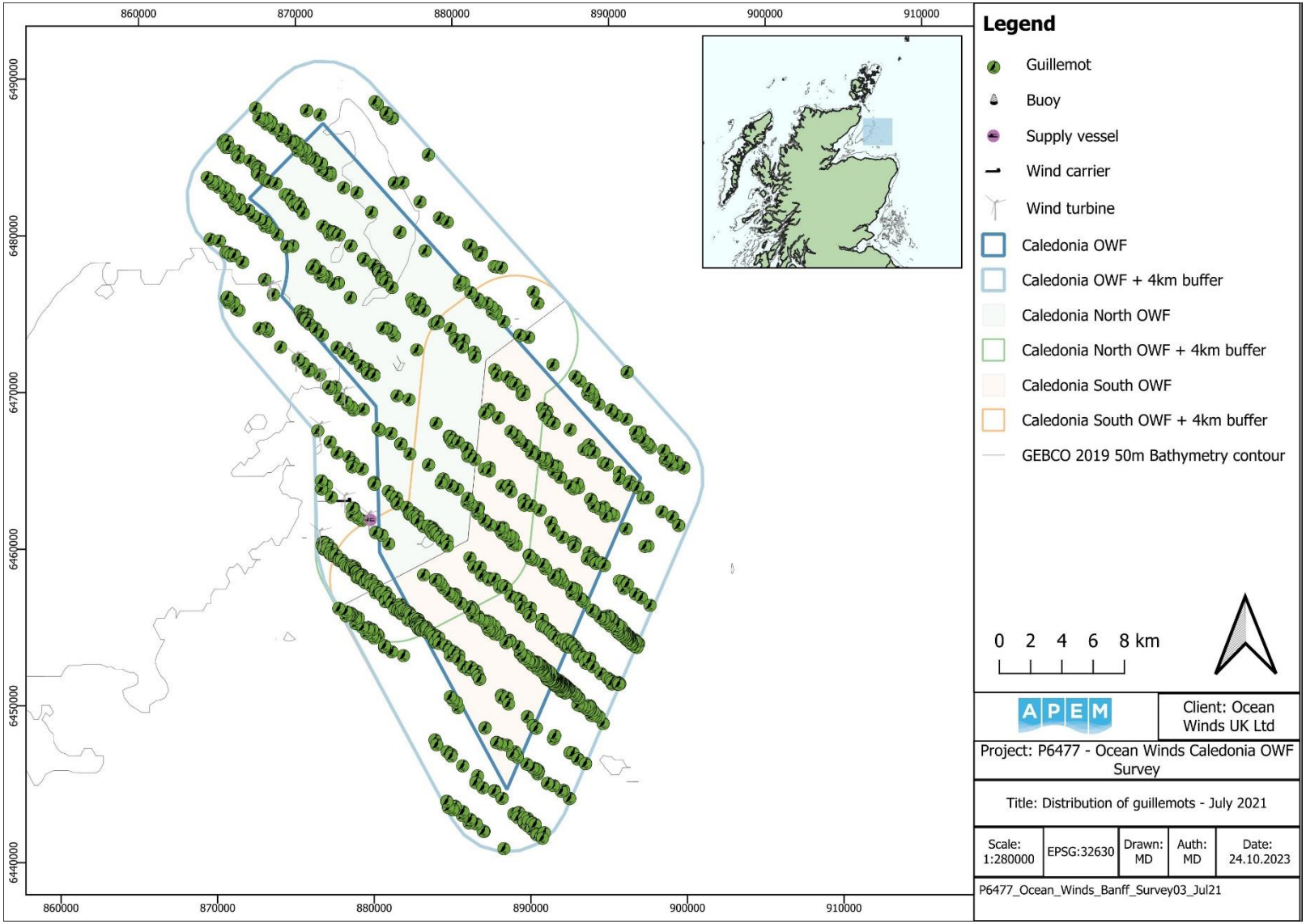


Figure A4.147 Distribution of guillemots recorded in the Survey Area in July 2021

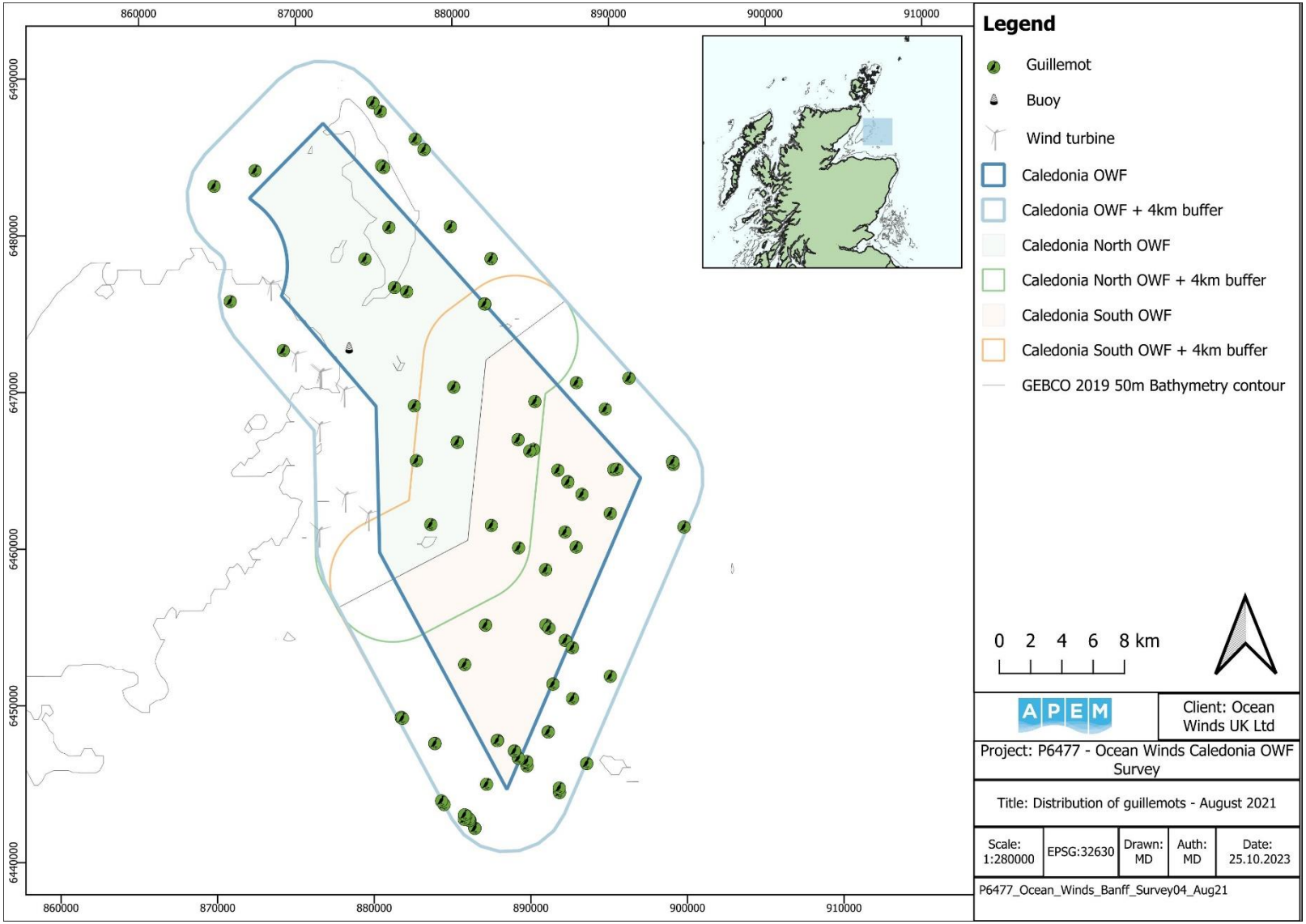


Figure A4.148 Distribution of guillemots recorded in the Survey Area in August 2021

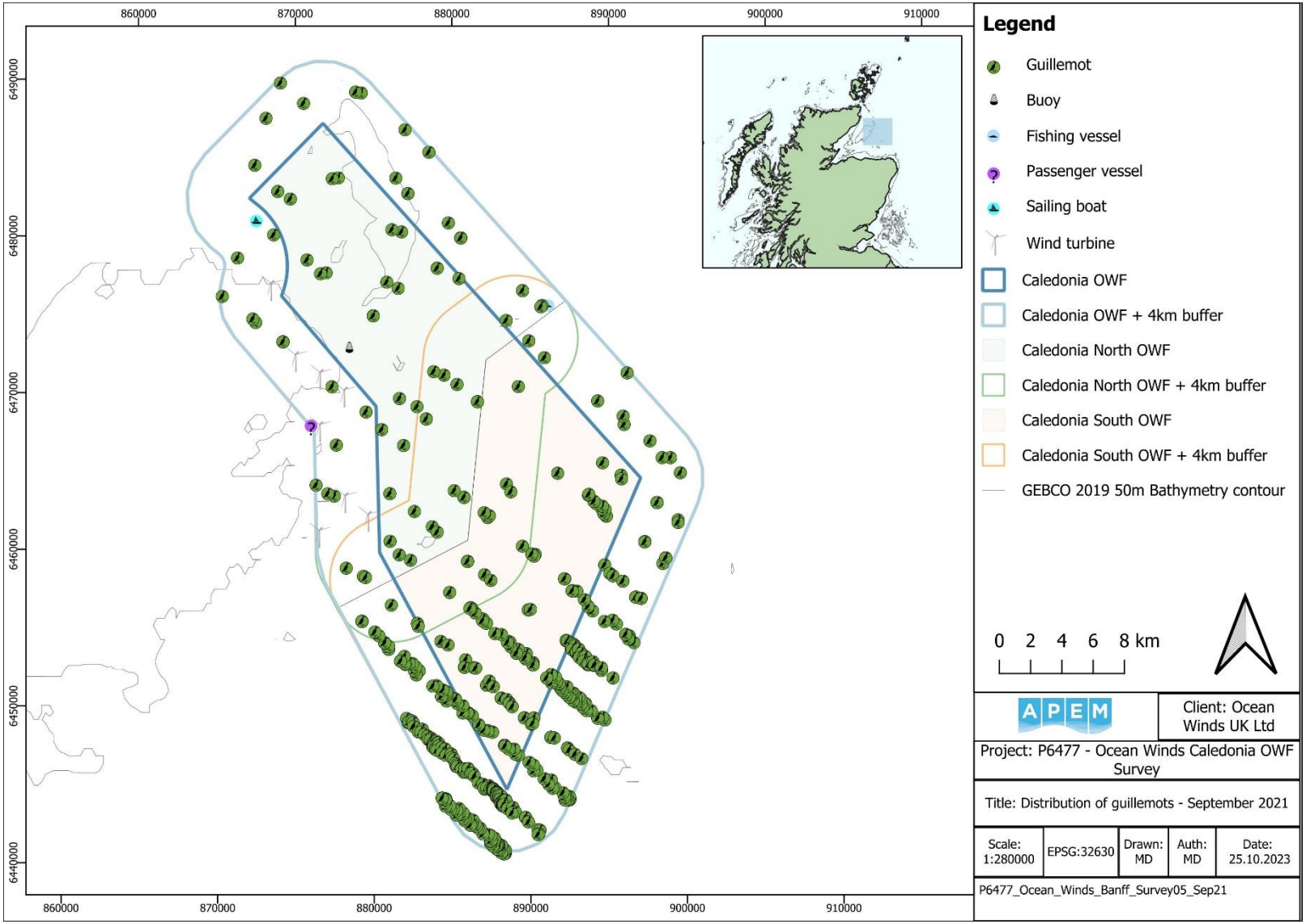


Figure A4.149 Distribution of guillemots recorded in the Survey Area in September 2021

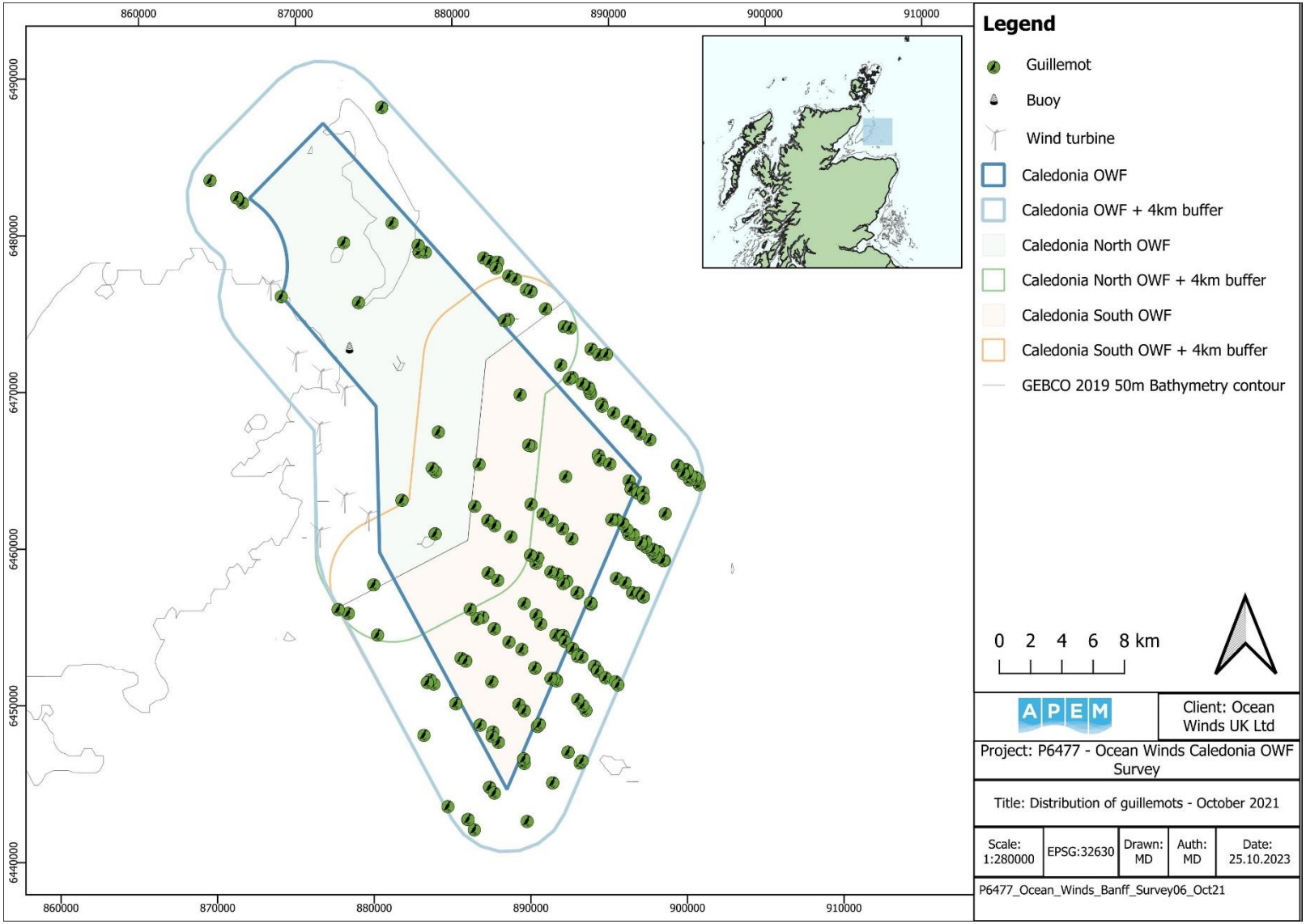


Figure A4.150 Distribution of guillemots recorded in the Survey Area in October 2021

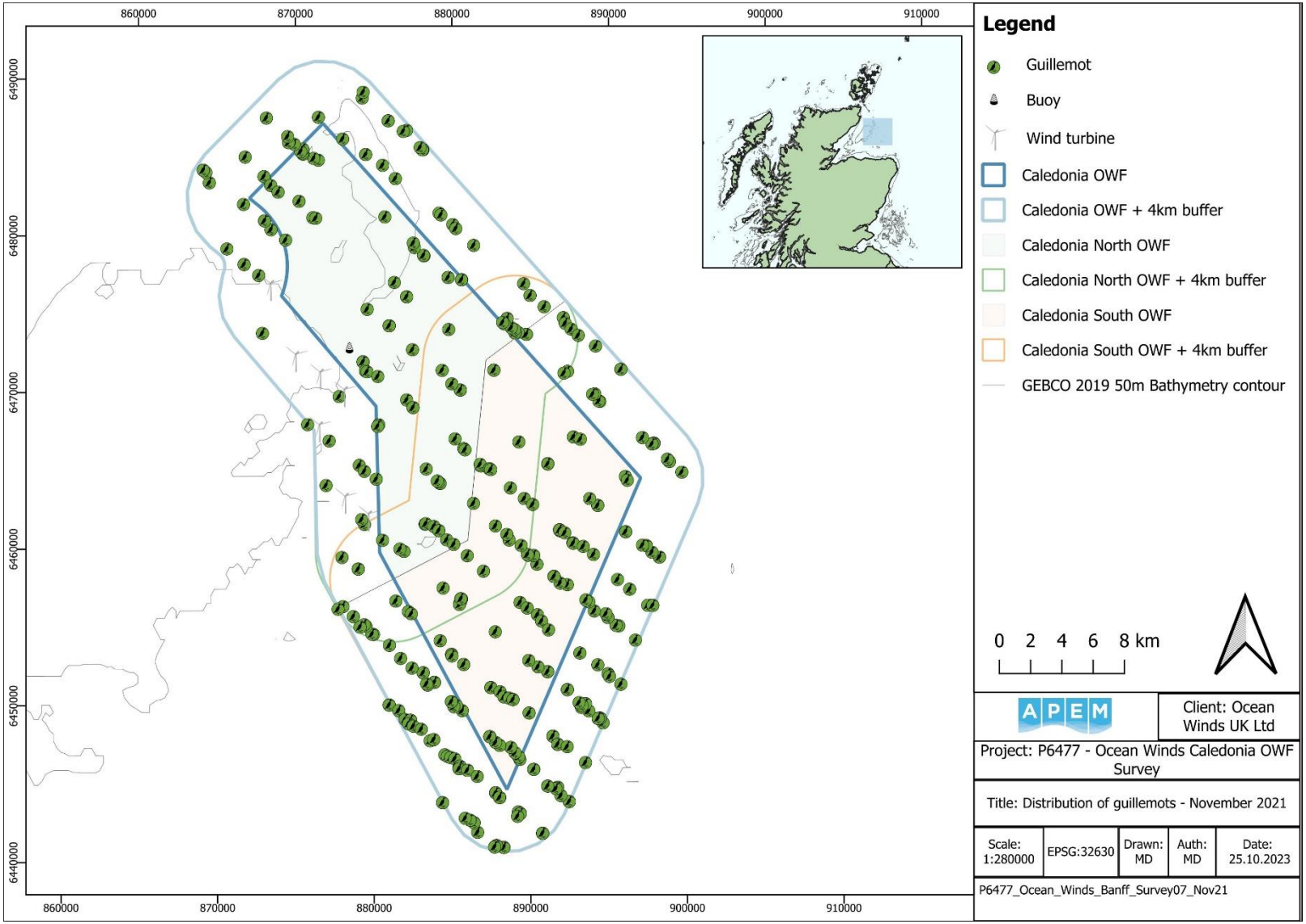


Figure A4.151 Distribution of guillemots recorded in the Survey Area in November 2021

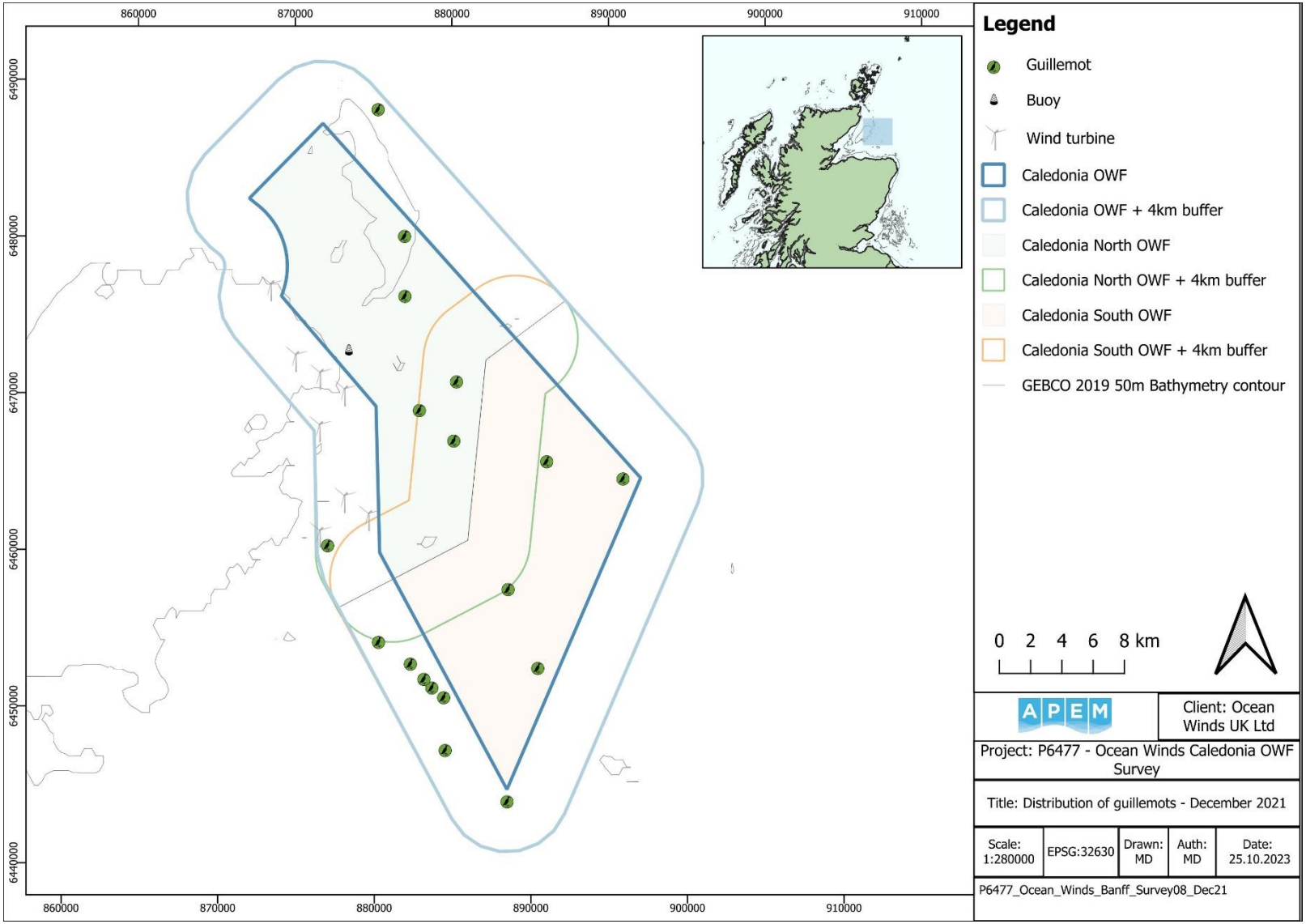


Figure A4.152 Distribution of guillemots recorded in the Survey Area in December 2021

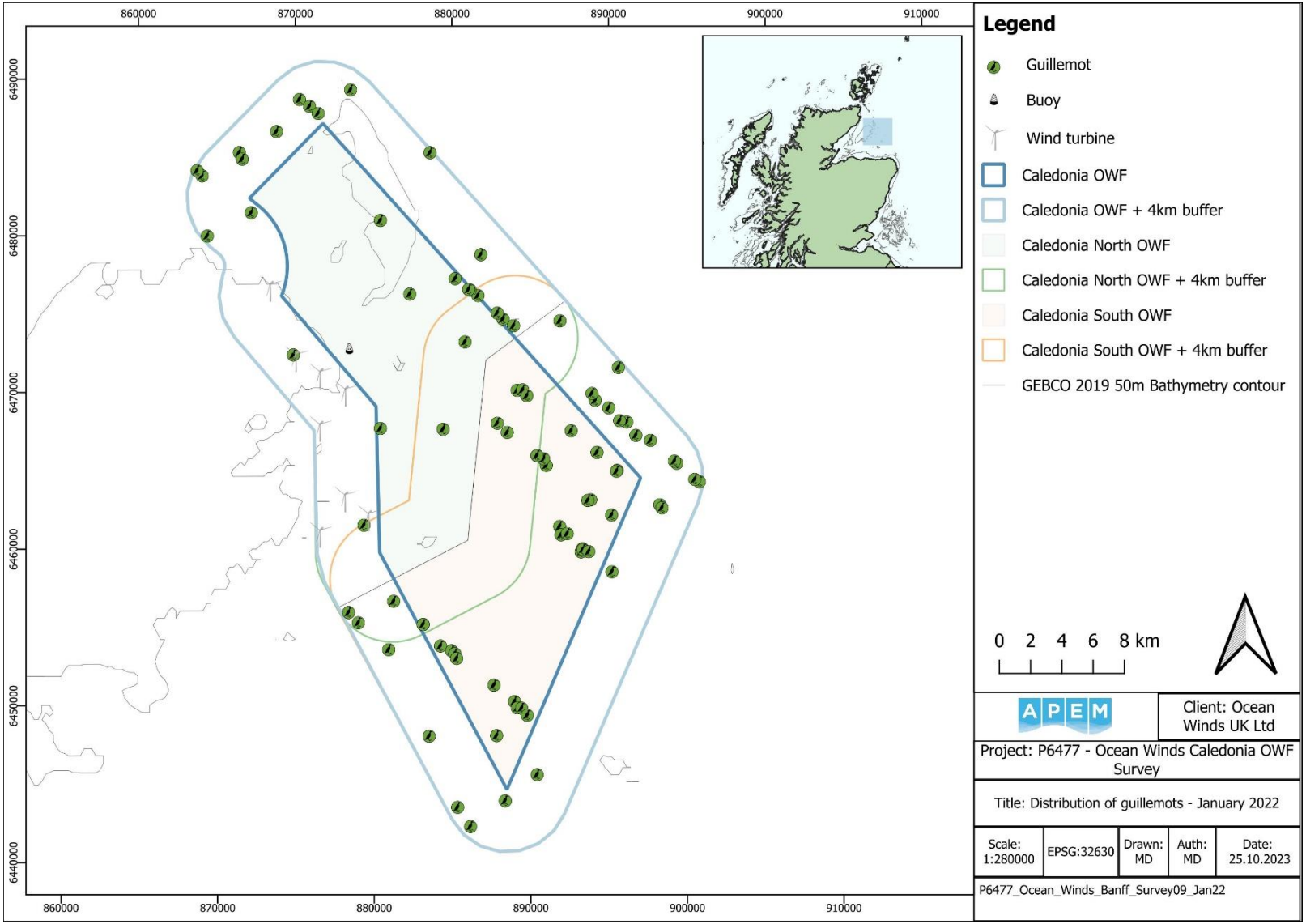


Figure A4.153 Distribution of guillemots recorded in the Survey Area in January 2022

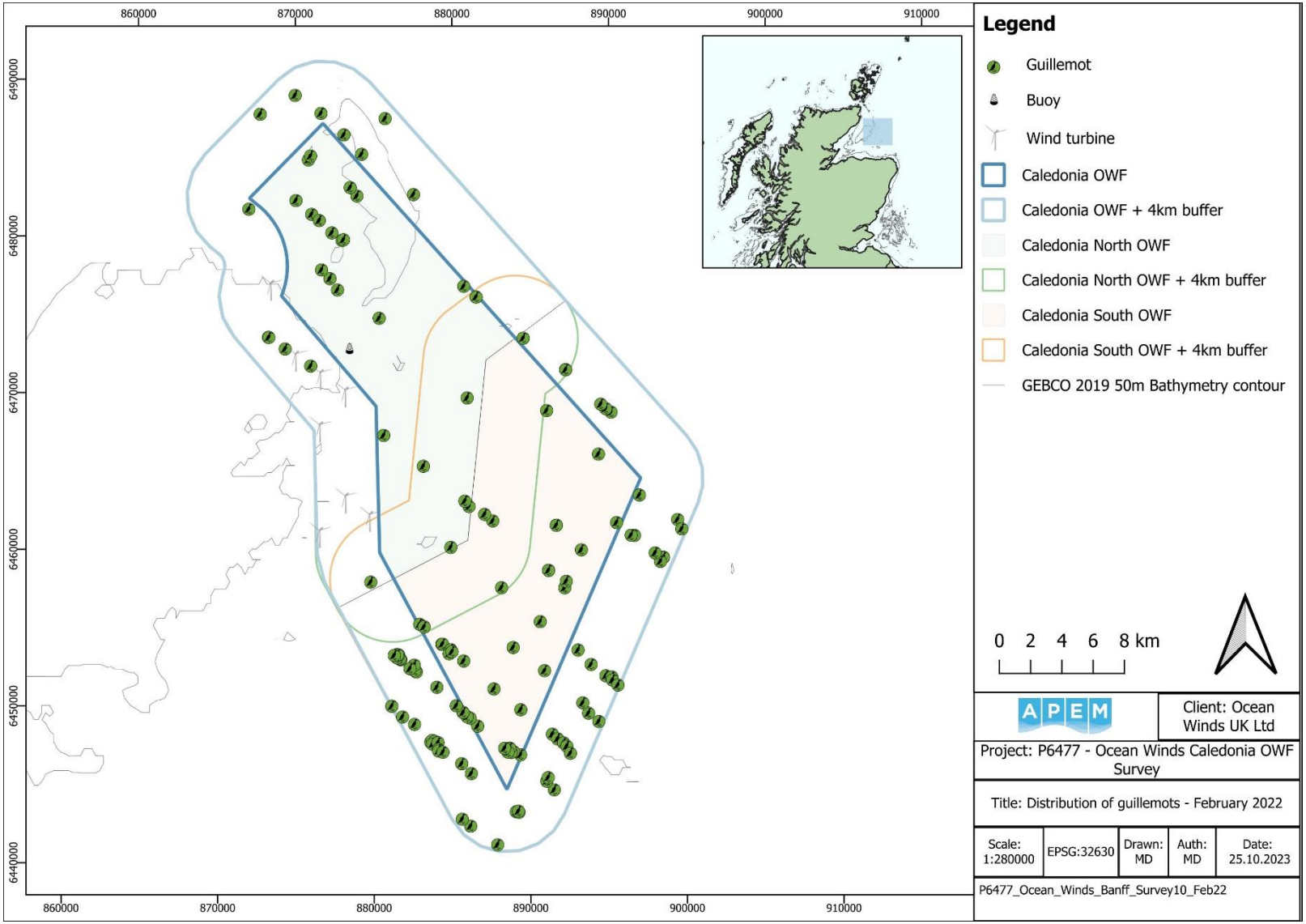


Figure A4.154 Distribution of guillemots recorded in the Survey Area in February 2022

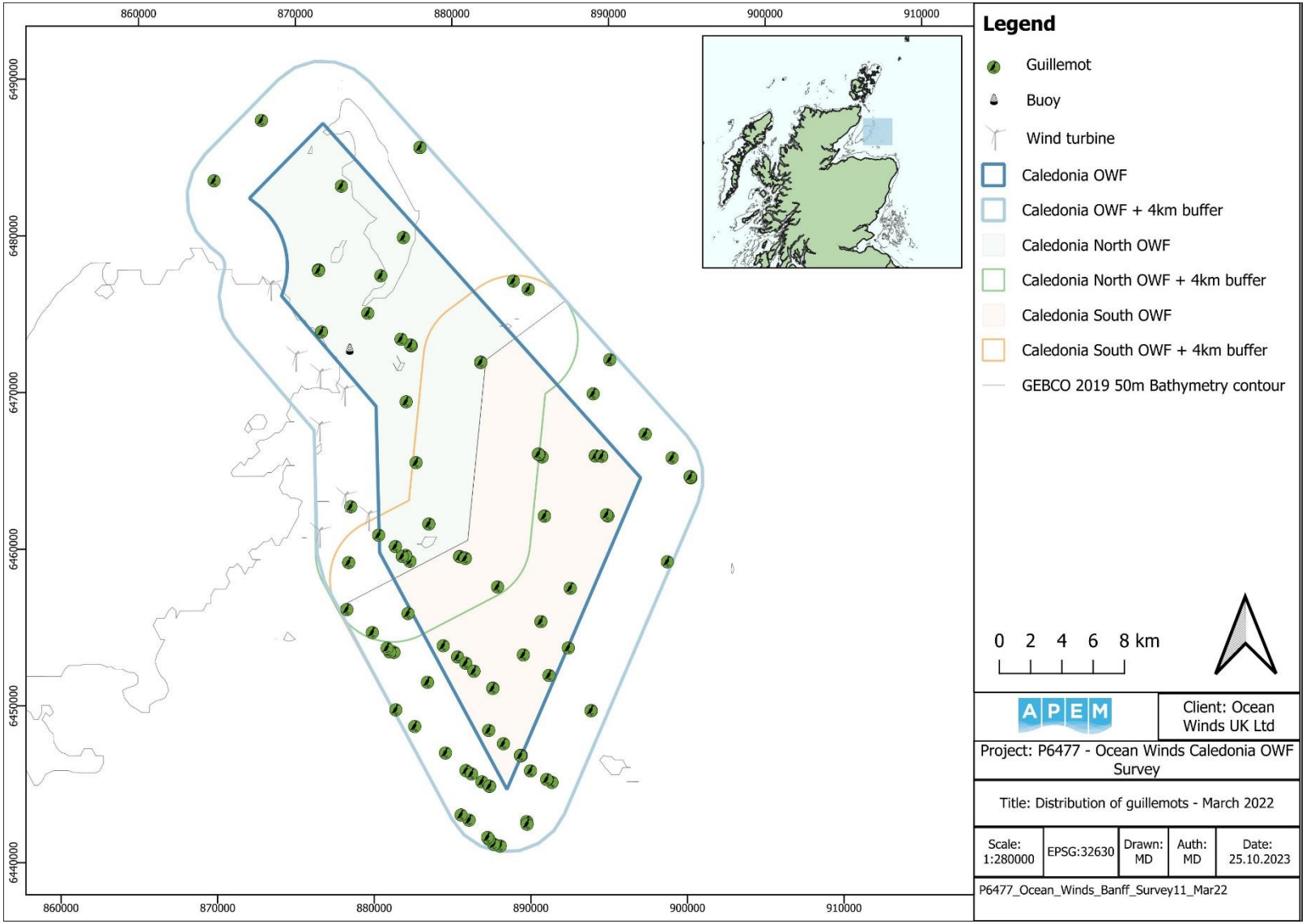


Figure A4.155 Distribution of guillemots recorded in the Survey Area in March 2022

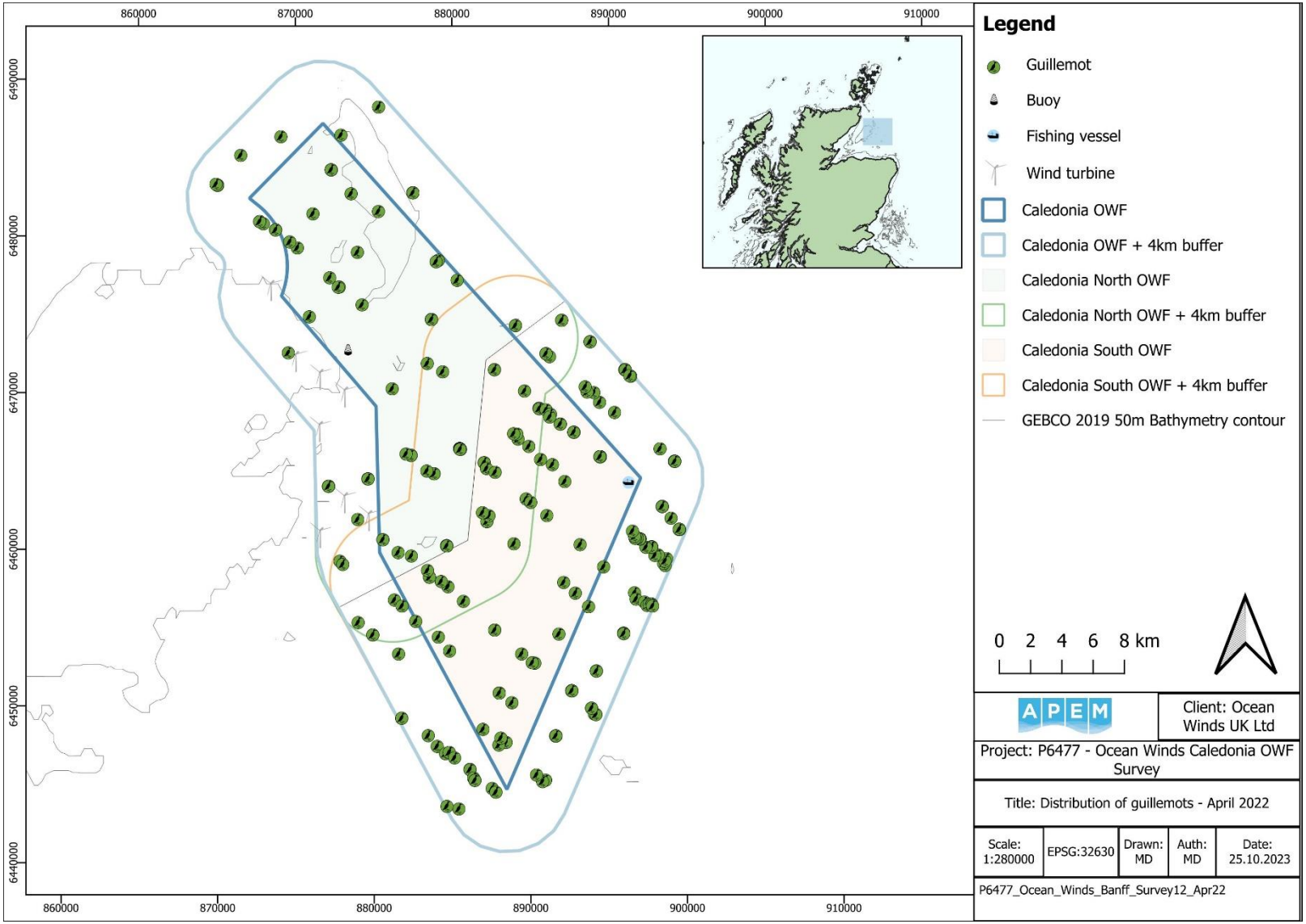


Figure A4.156 Distribution of guillemots recorded in the Survey Area in April 2022

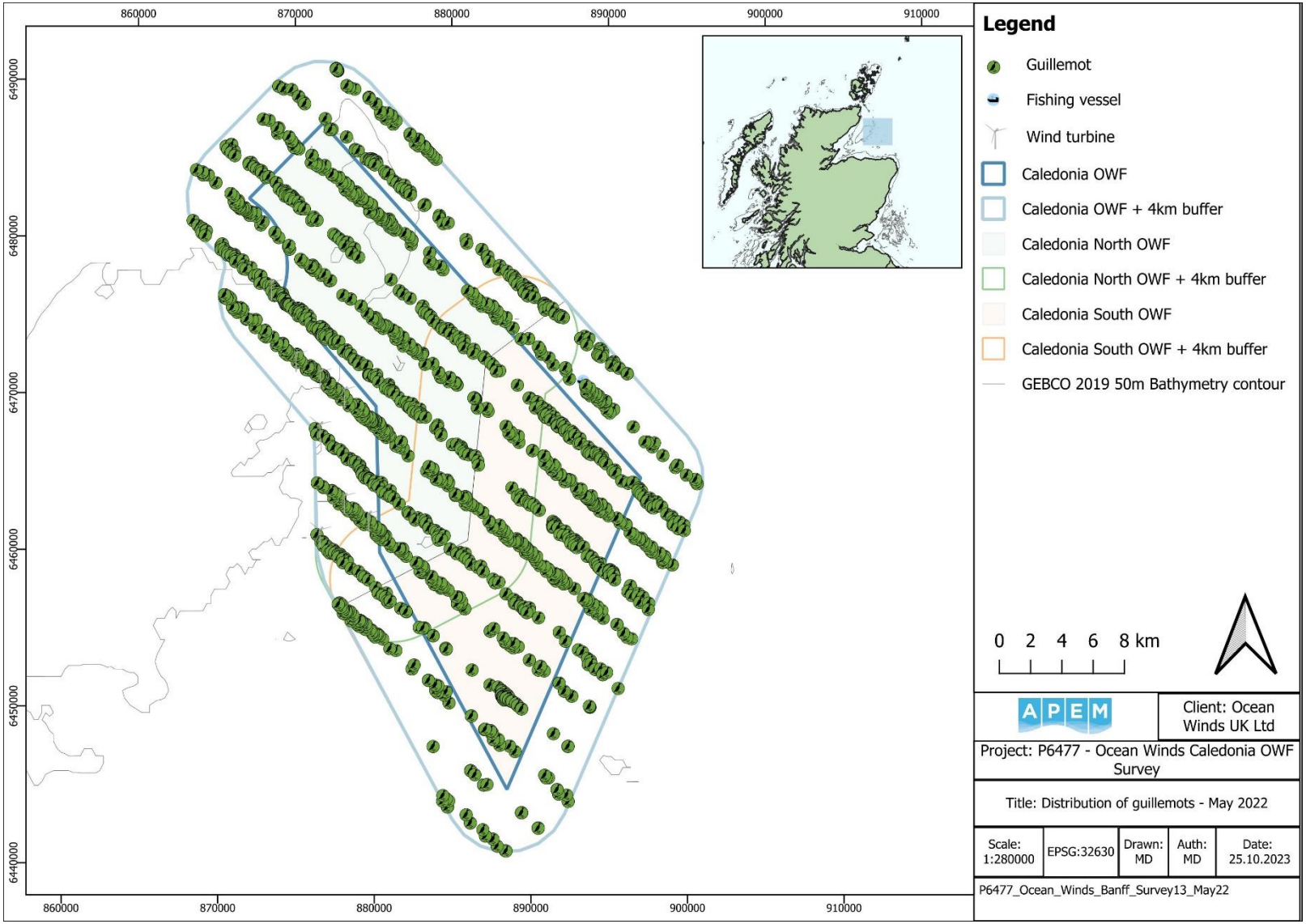


Figure A4.157 Distribution of guillemots recorded in the Survey Area in May 2022

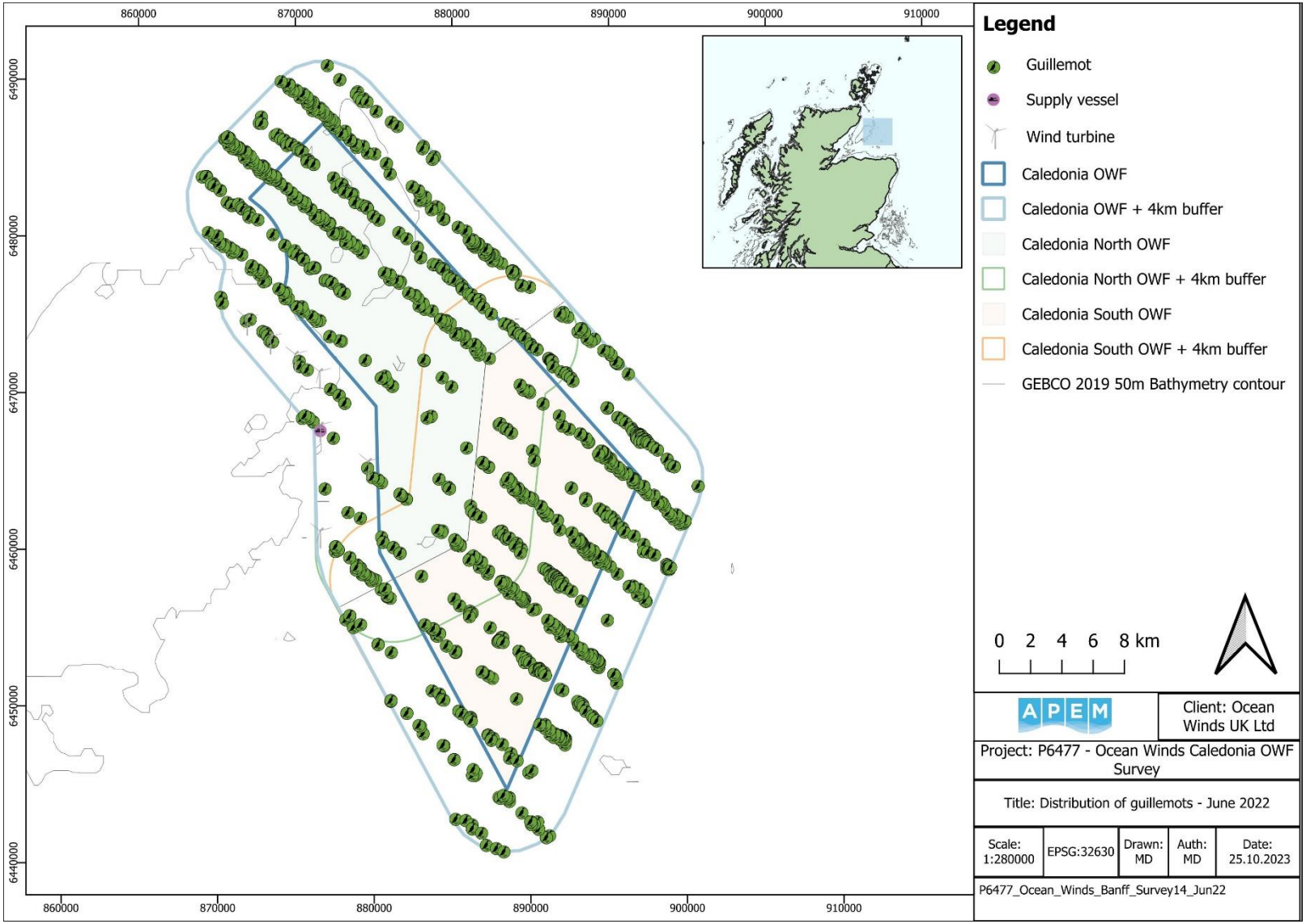


Figure A4.158 Distribution of guillemots recorded in the Survey Area in June 2022

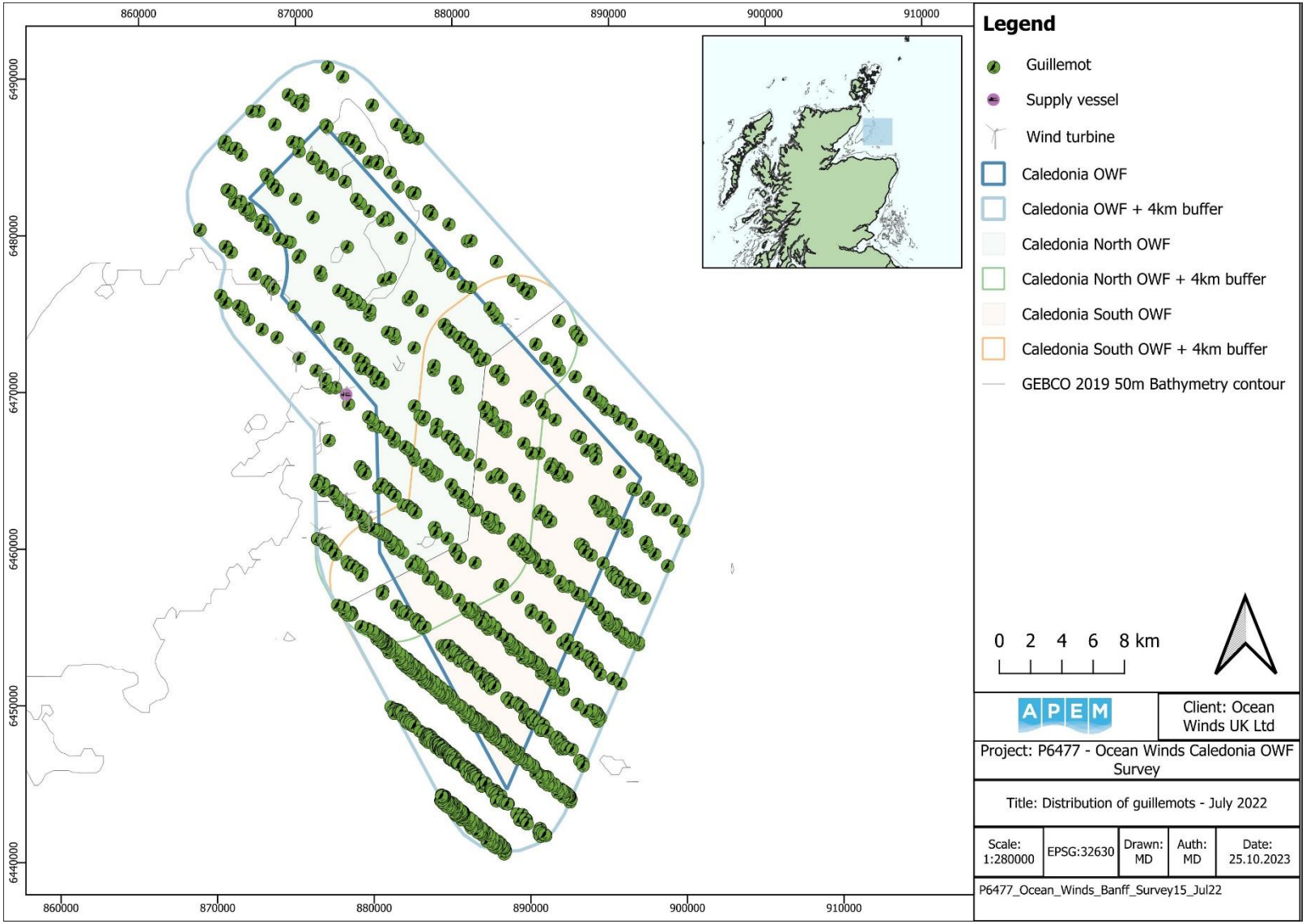


Figure A4.159 Distribution of guillemots recorded in the Survey Area in July 2022

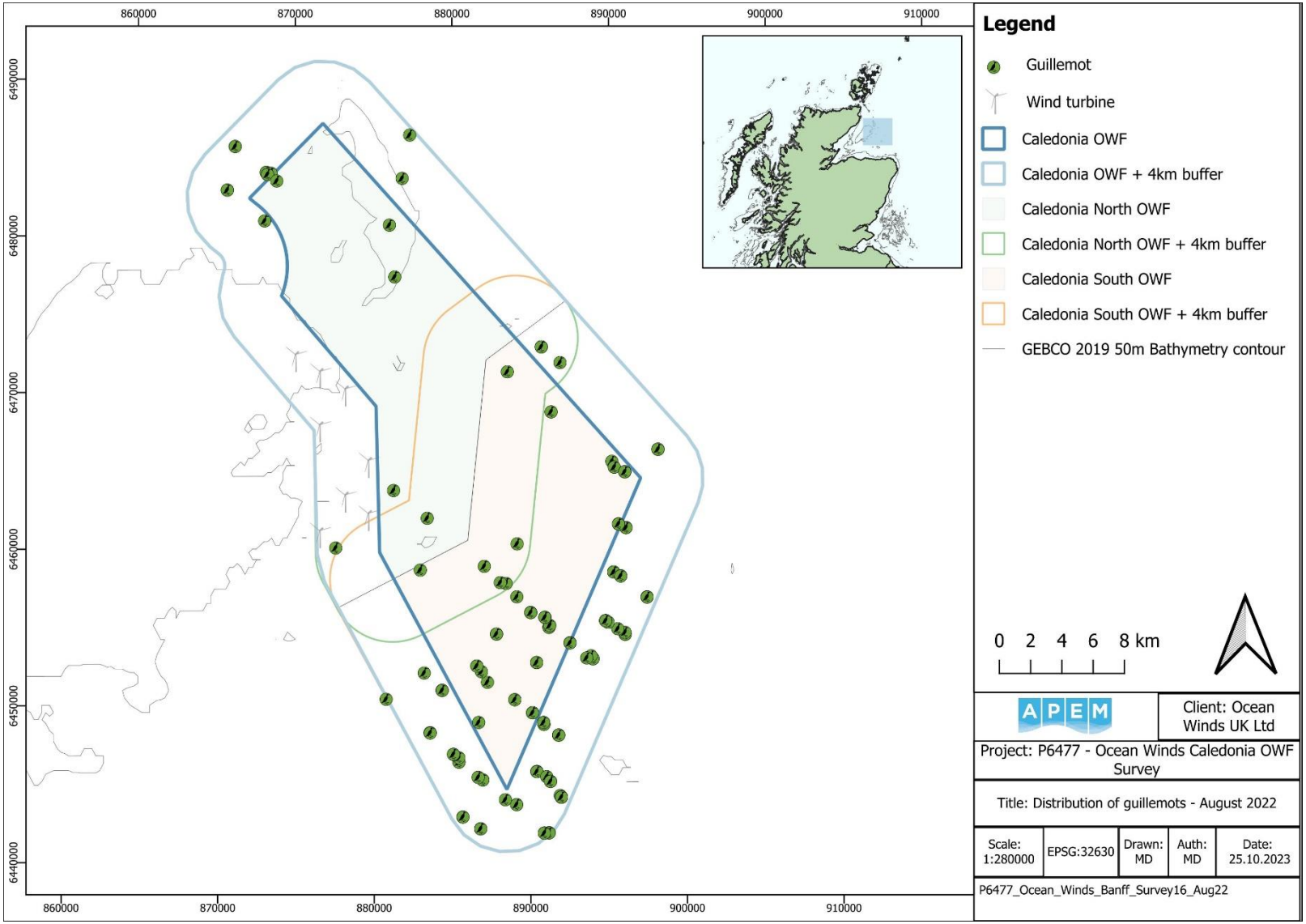


Figure A4.160 Distribution of guillemots recorded in the Survey Area in August 2022

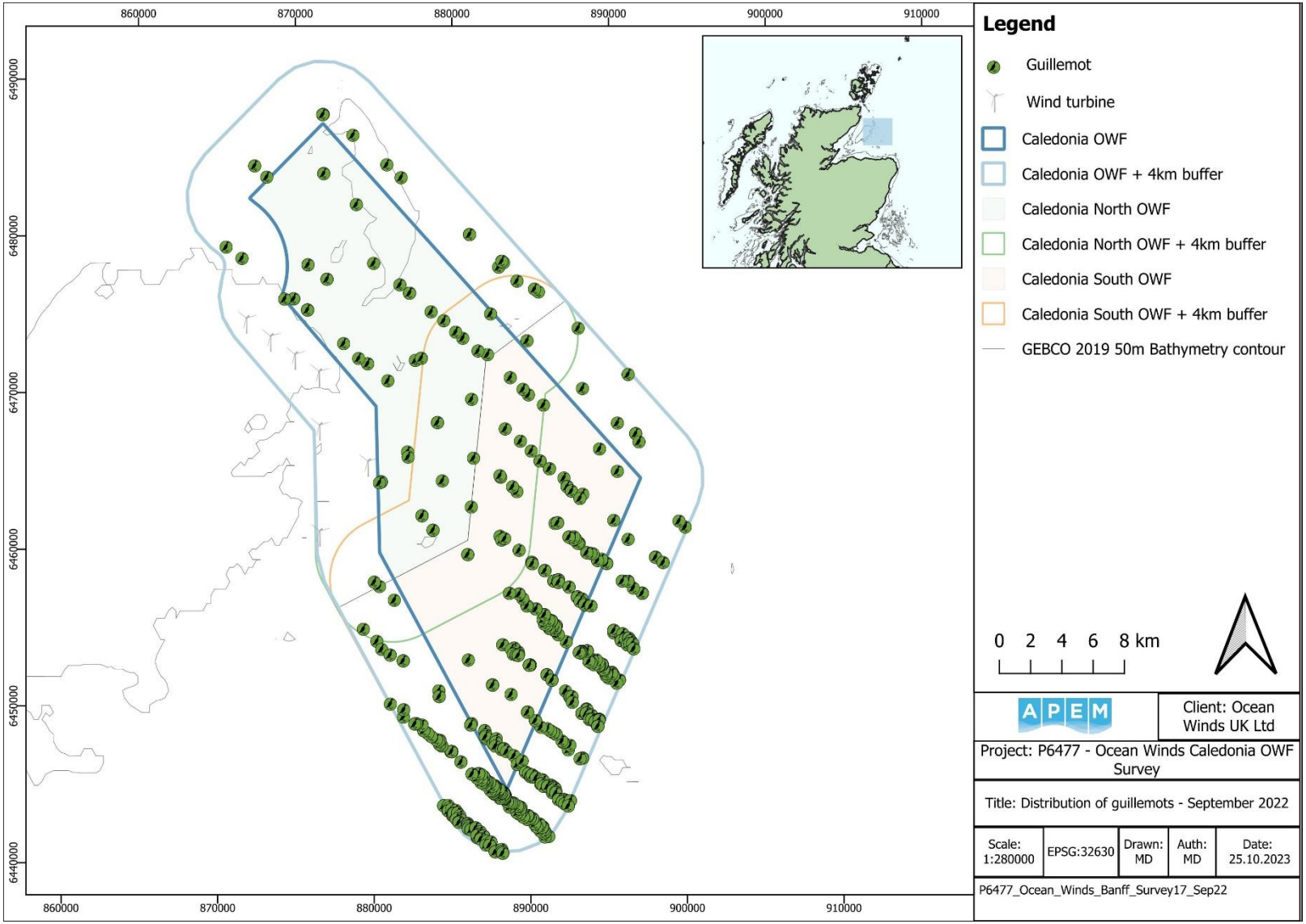


Figure A4.161 Distribution of guillemots recorded in the Survey Area in September 2022

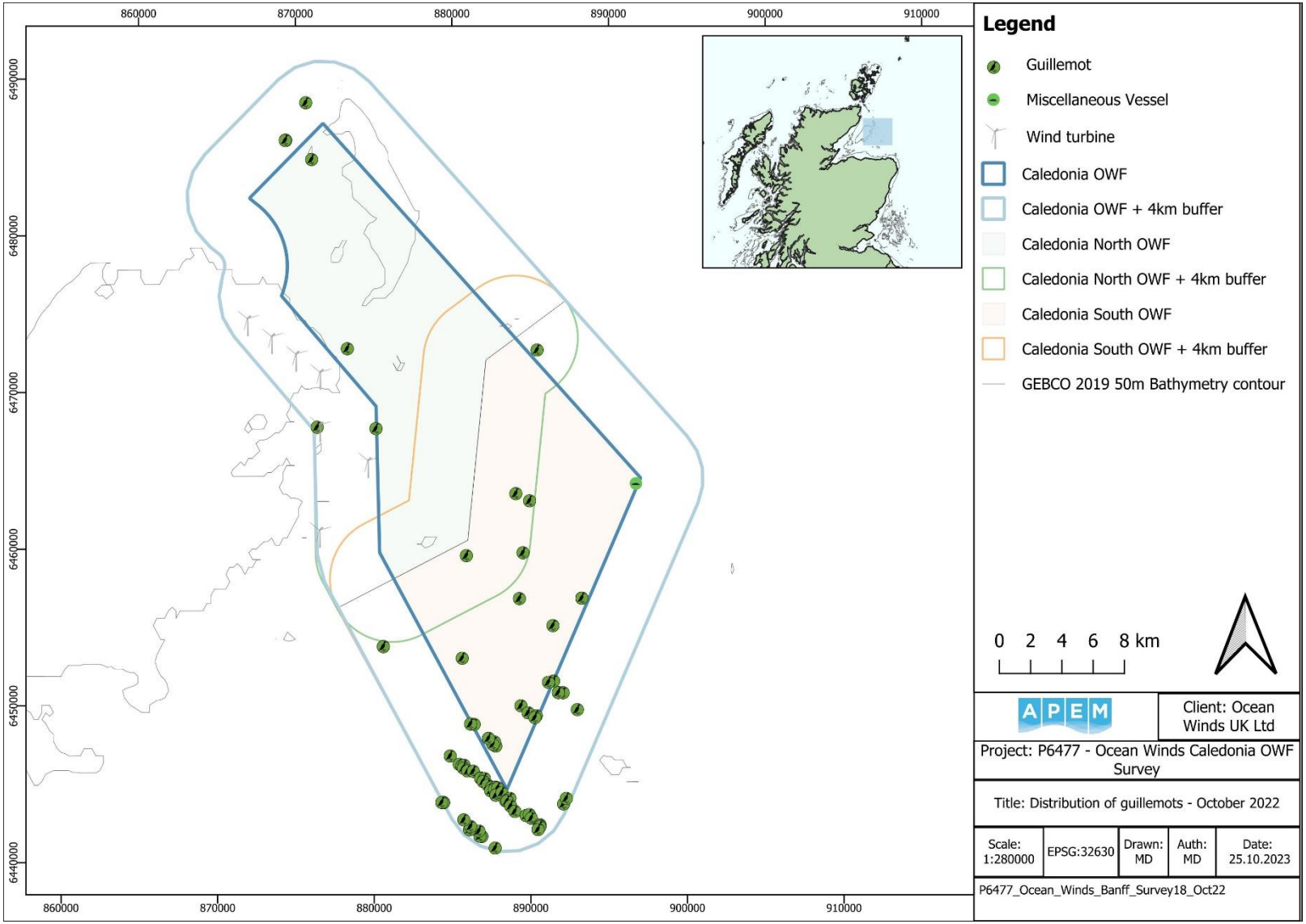


Figure A4.162 Distribution of guillemots recorded in the Survey Area in October 2022

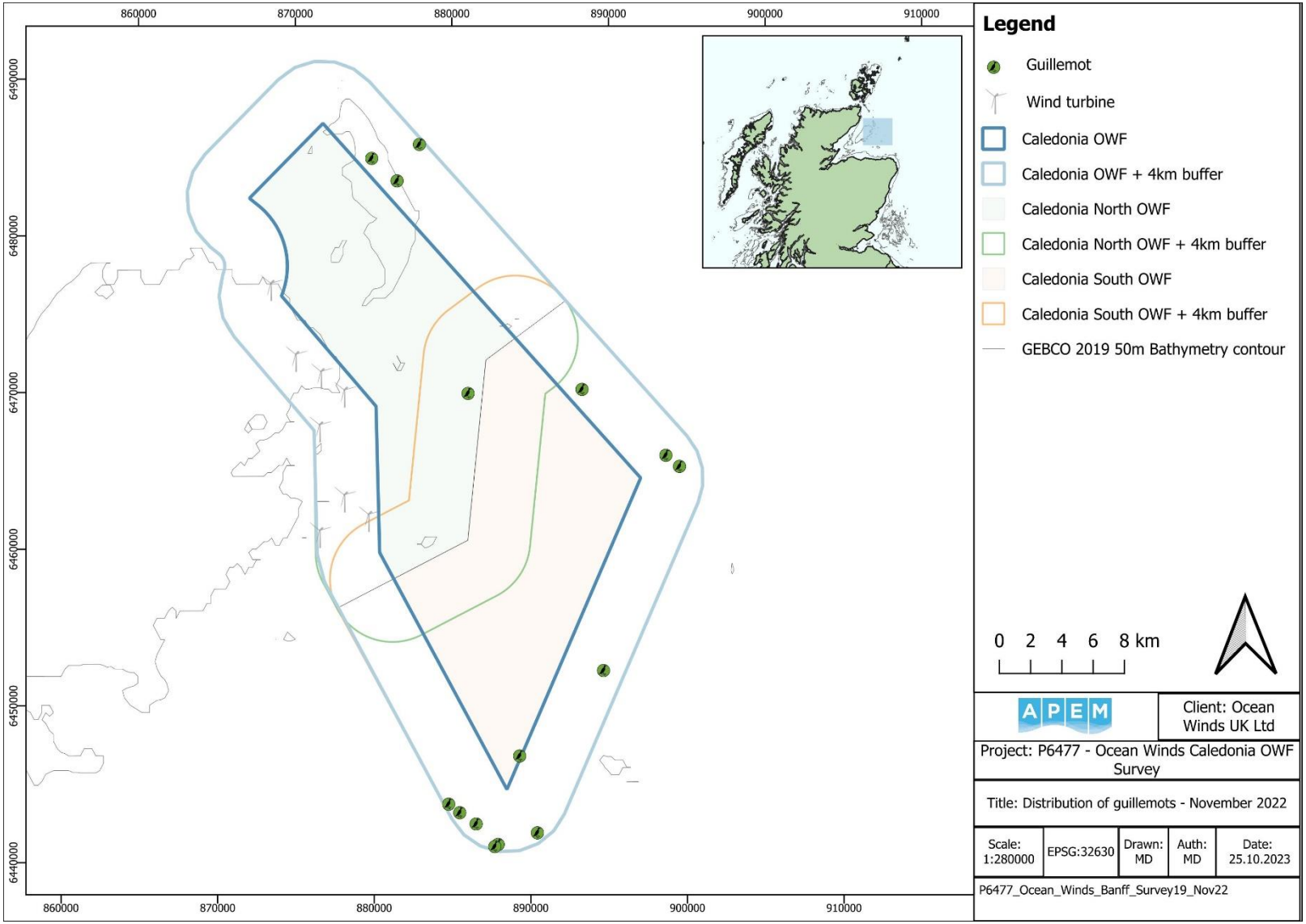


Figure A4.163 Distribution of guillemots recorded in the Survey Area in November 2022

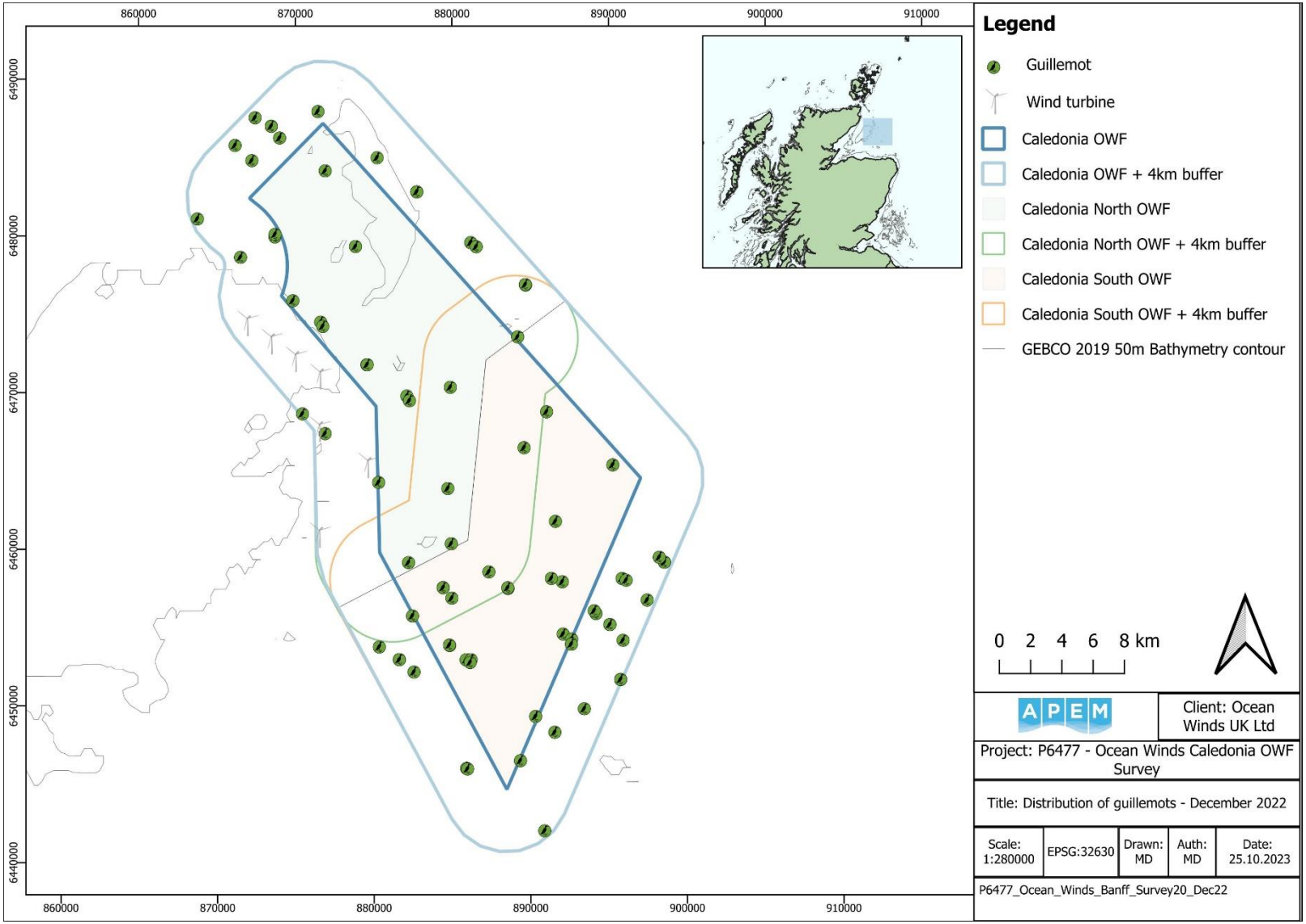


Figure A4.164 Distribution of guillemots recorded in the Survey Area in December 2022

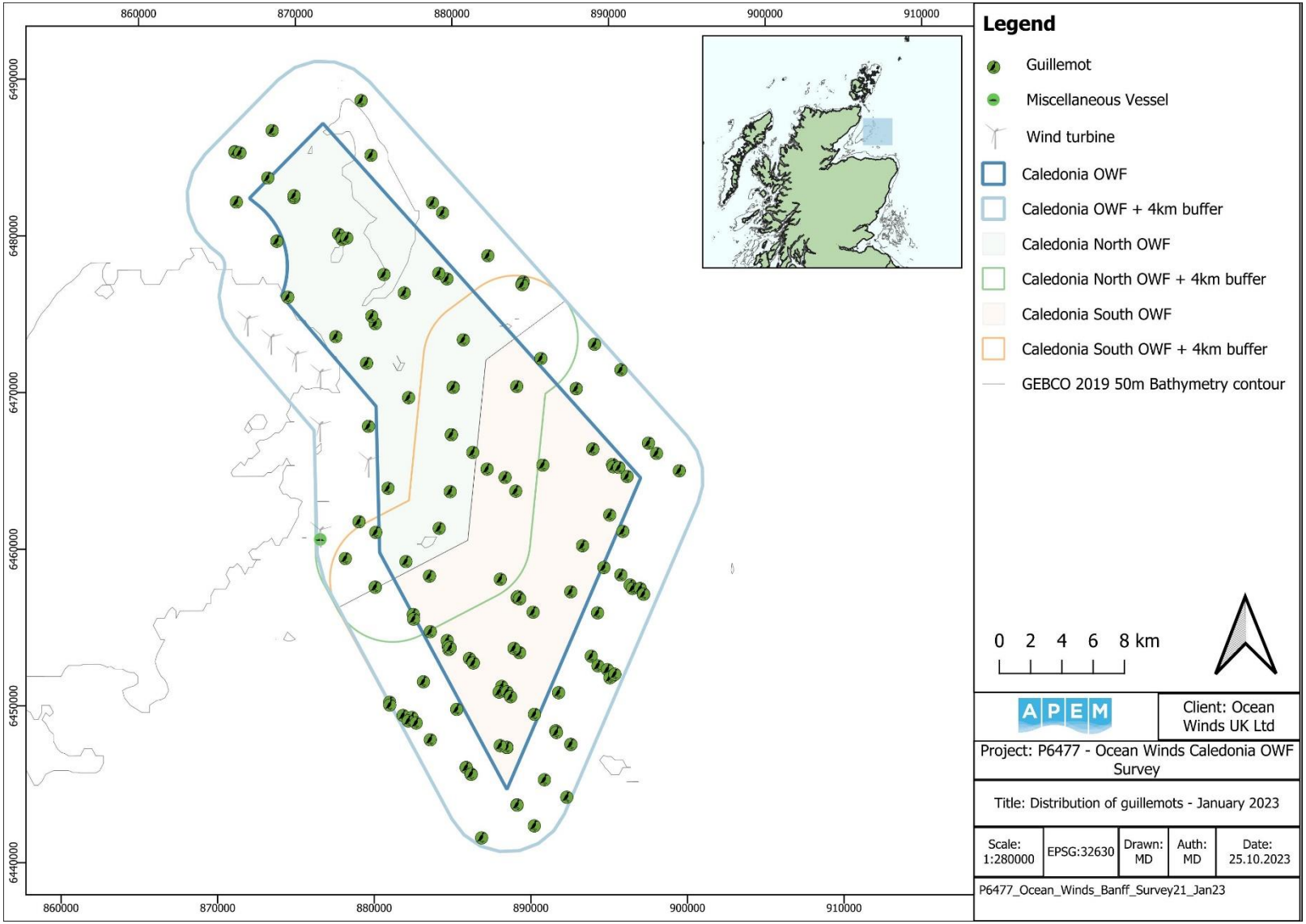


Figure A4.165 Distribution of guillemots recorded in the Survey Area in January 2023

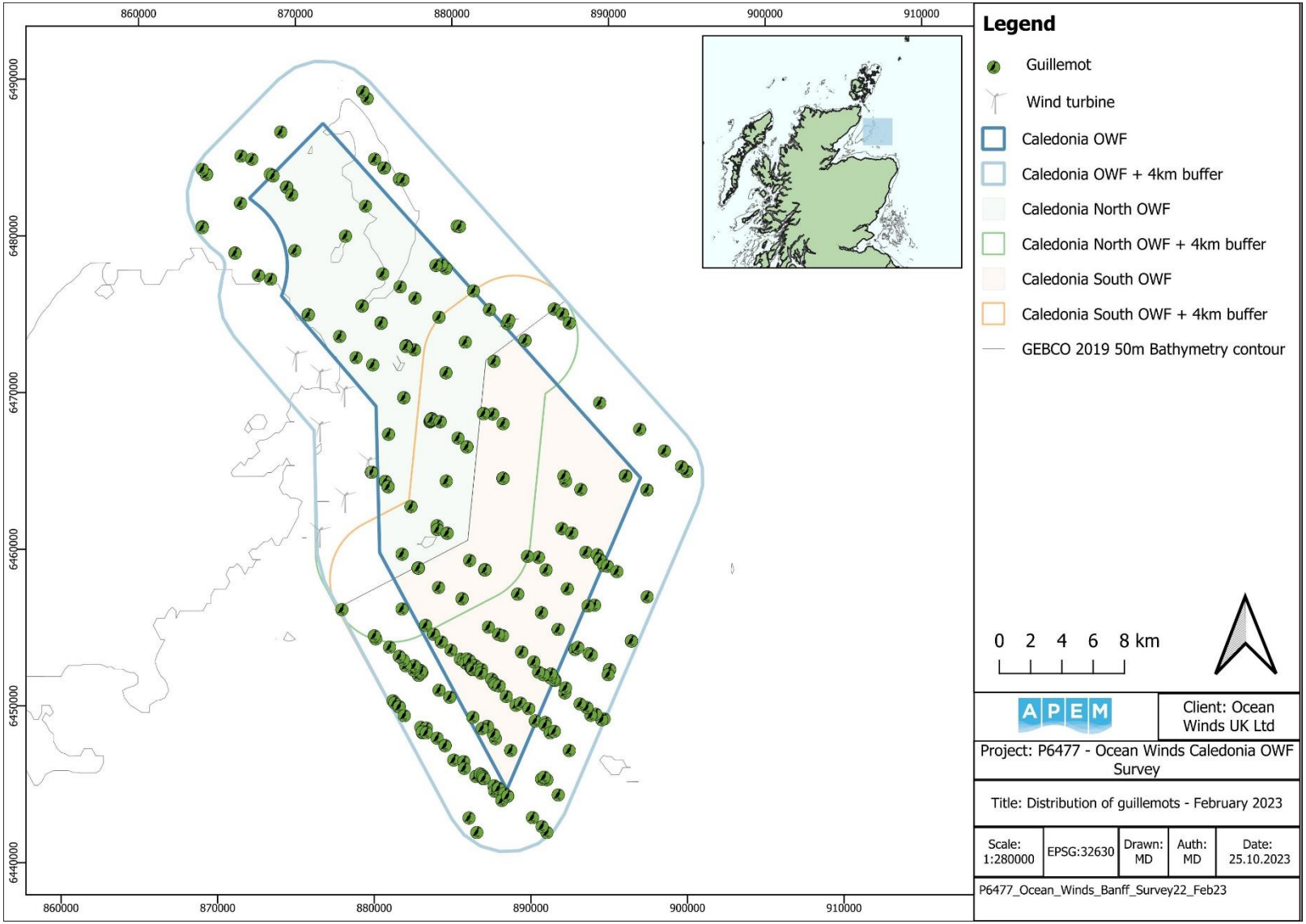


Figure A4.166 Distribution of guillemots recorded in the Survey Area in February 2023

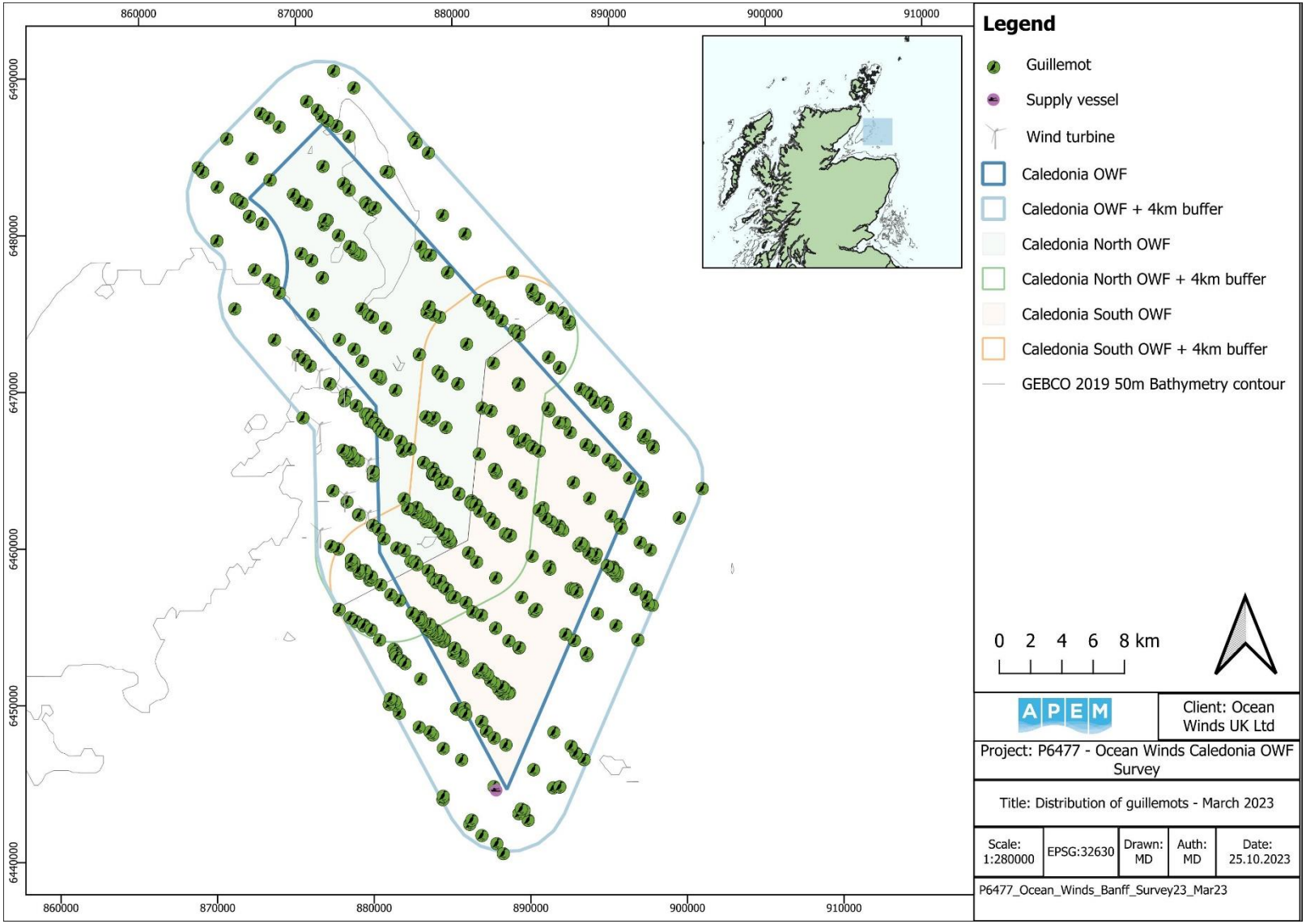


Figure A4.167 Distribution of guillemots recorded in the Survey Area in March 2023

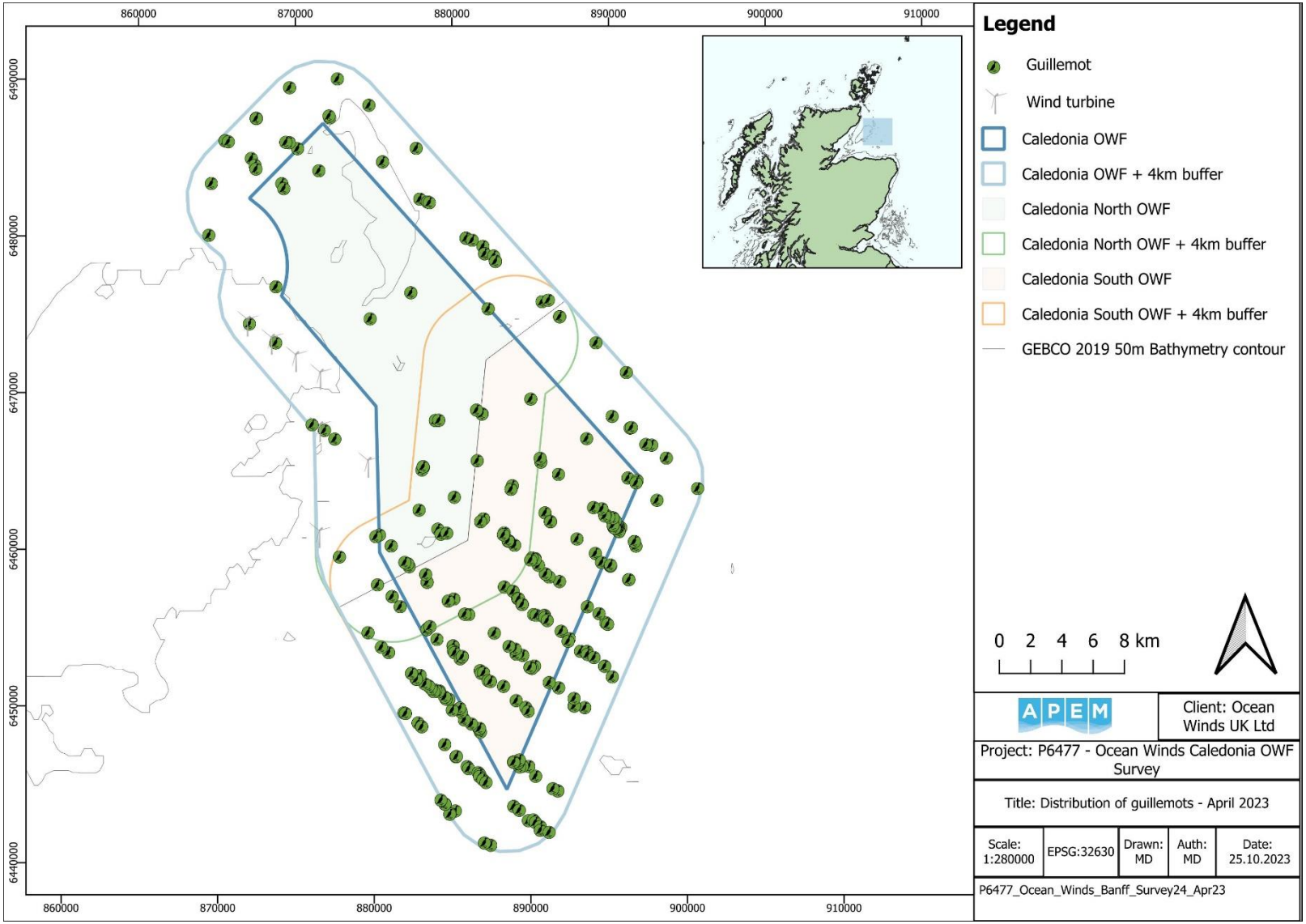


Figure A4.168 Distribution of guillemots recorded in the Survey Area in April 2023

Razorbill

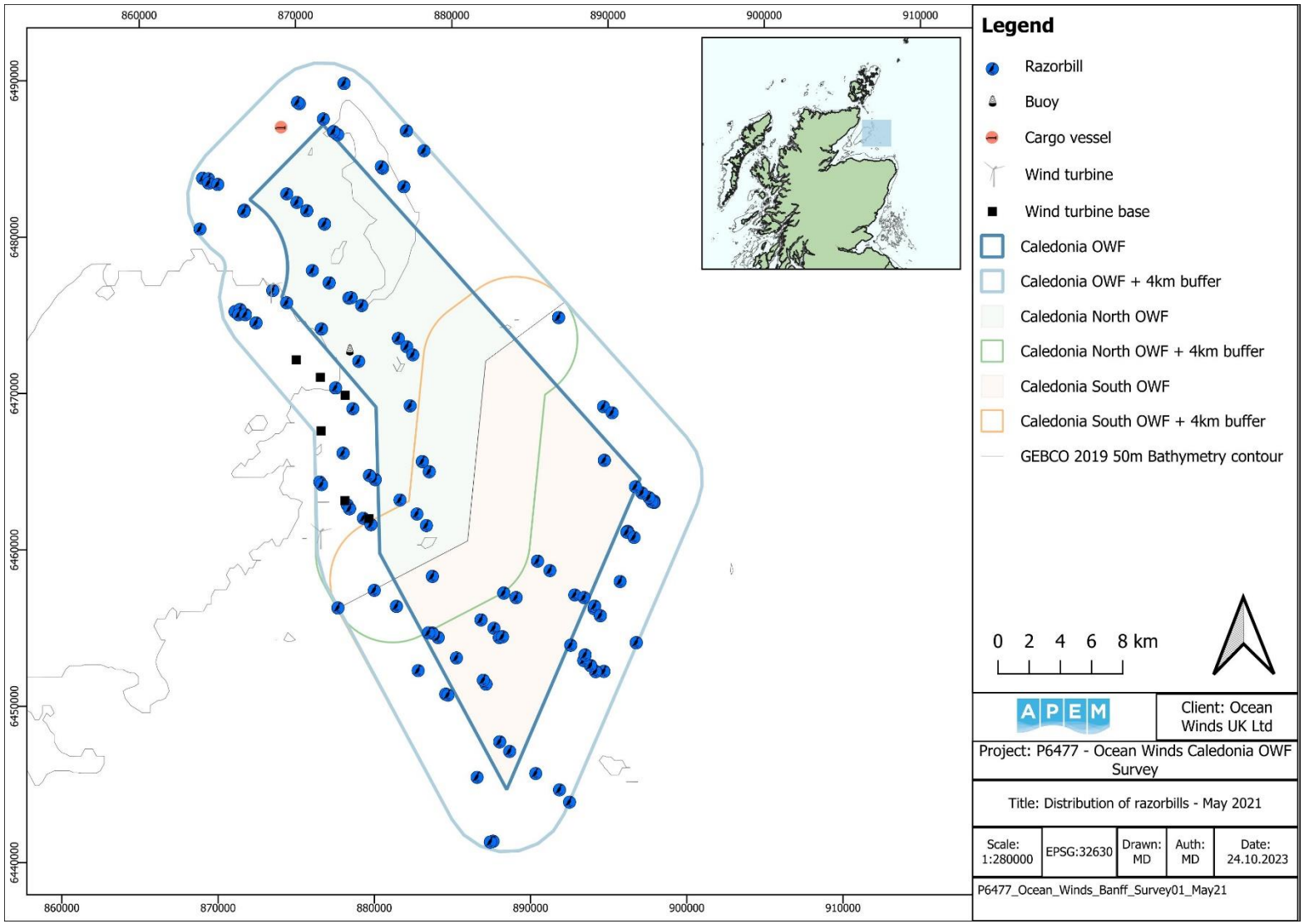


Figure A4.169 Distribution of razorbills recorded in the Survey Area in May 2021

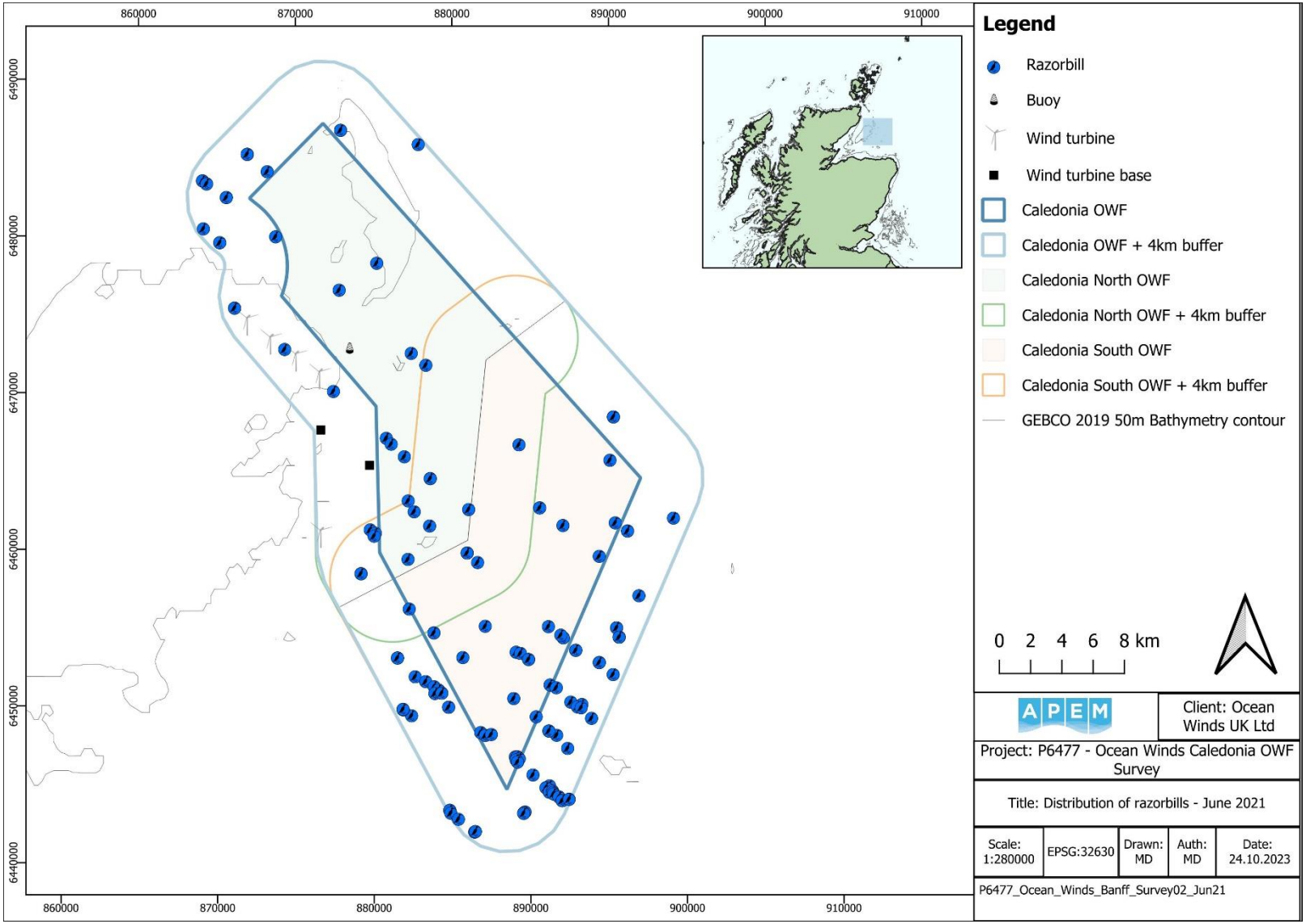


Figure A4.170 Distribution of razorbills recorded in the Survey Area in June 2021

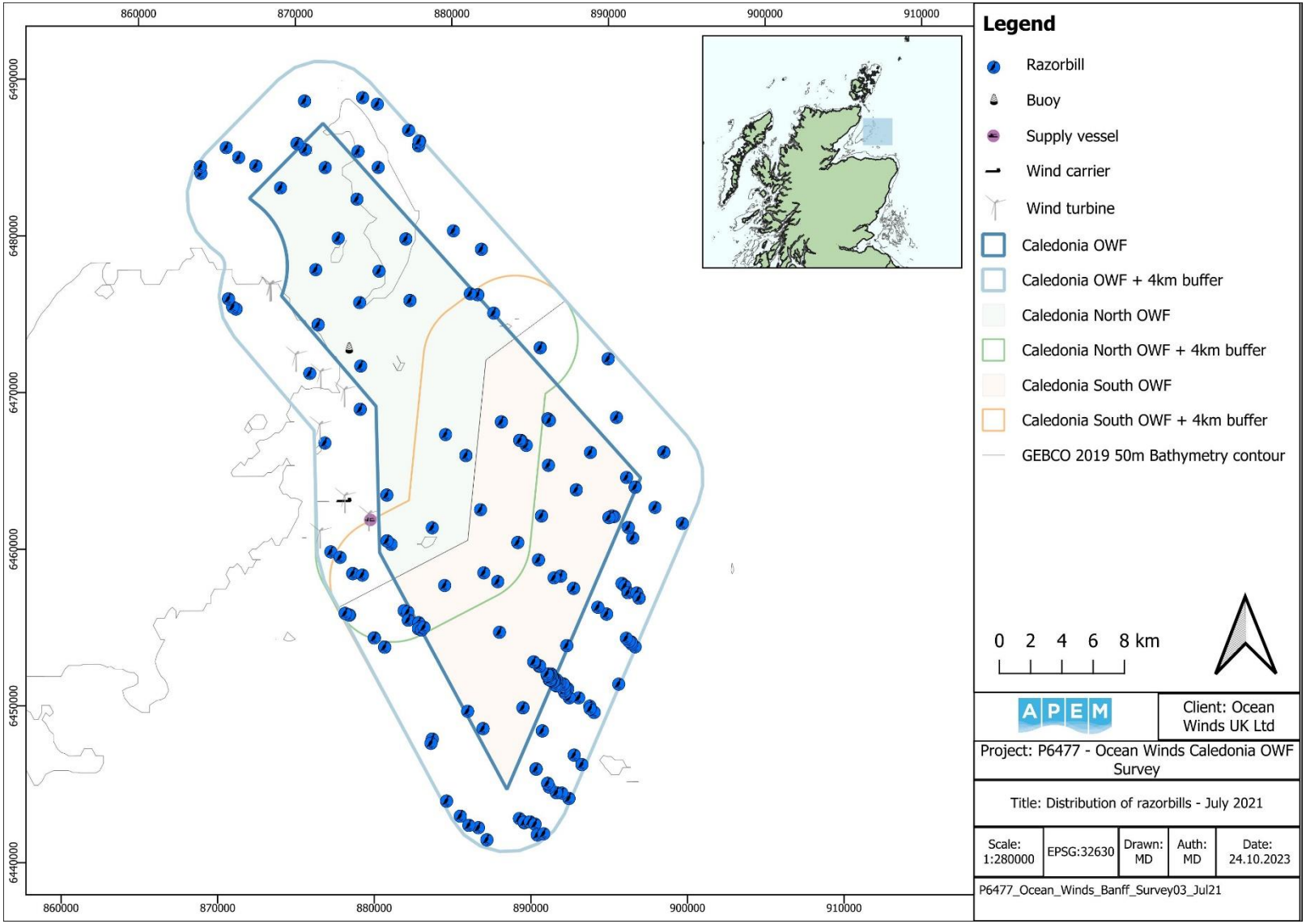


Figure A4.171 Distribution of razorbills recorded in the Survey Area in July 2021

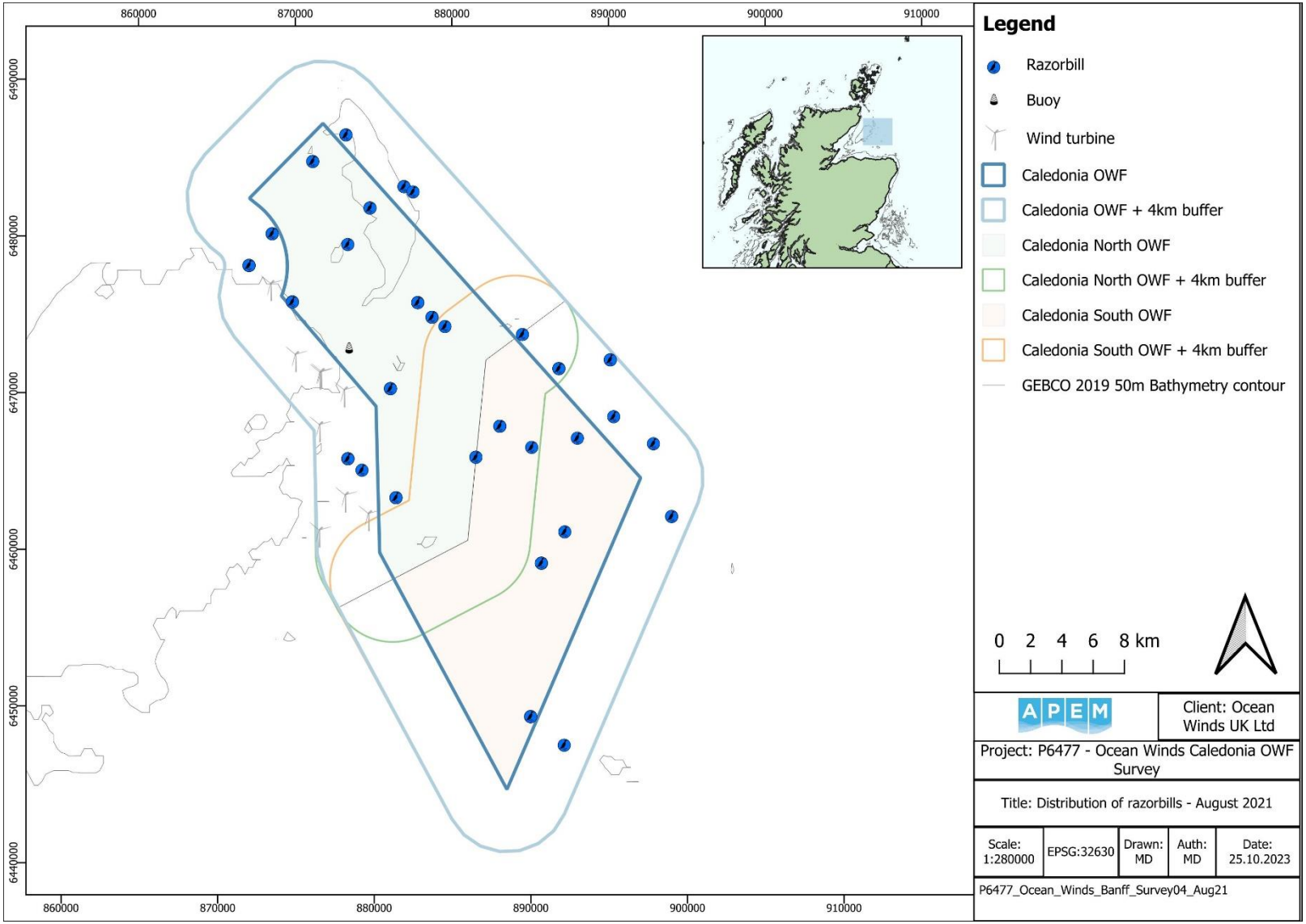


Figure A4.172 Distribution of razorbills recorded in the Survey Area in August 2021

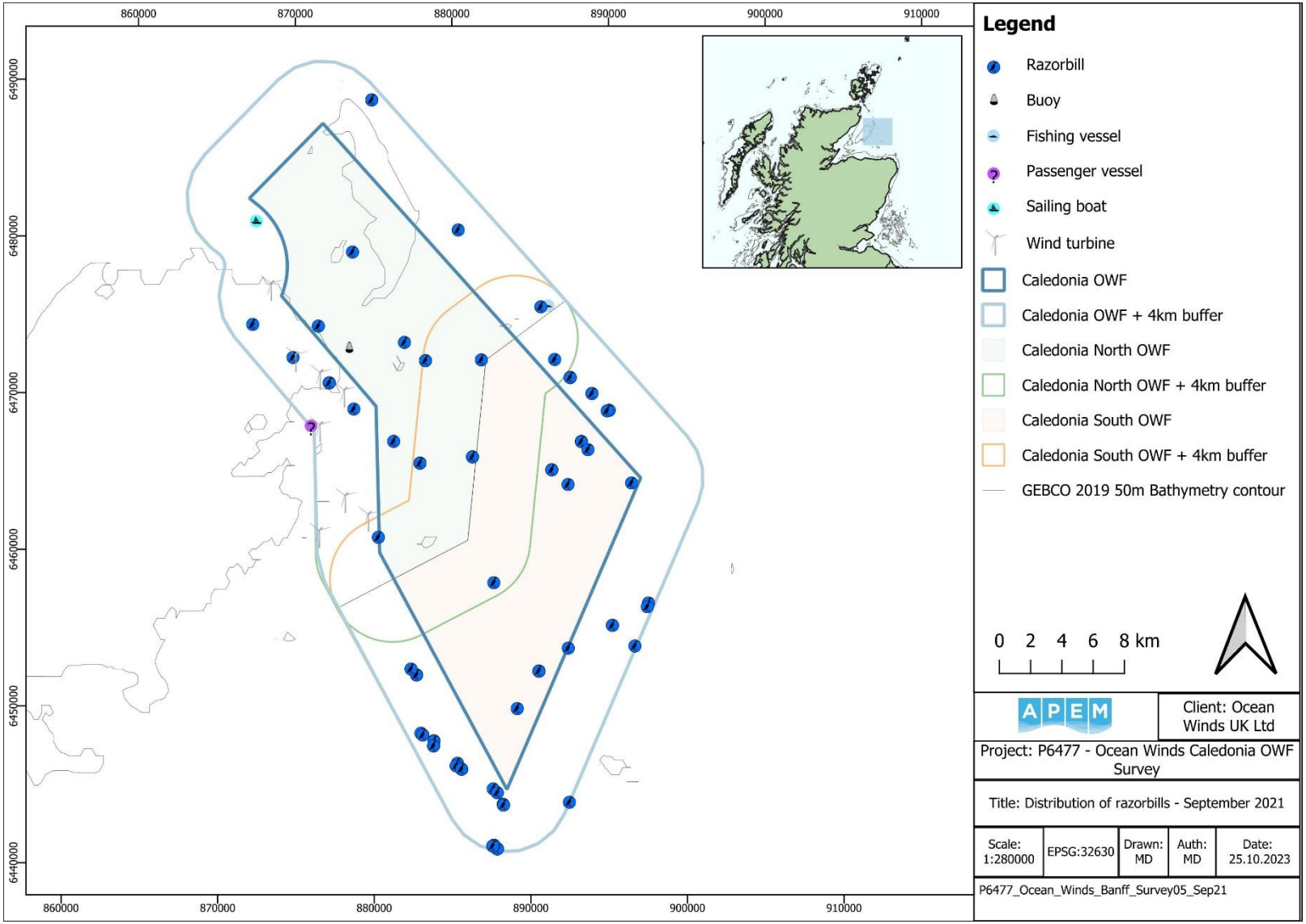


Figure A4.173 Distribution of razorbills recorded in the Survey Area in September 2021

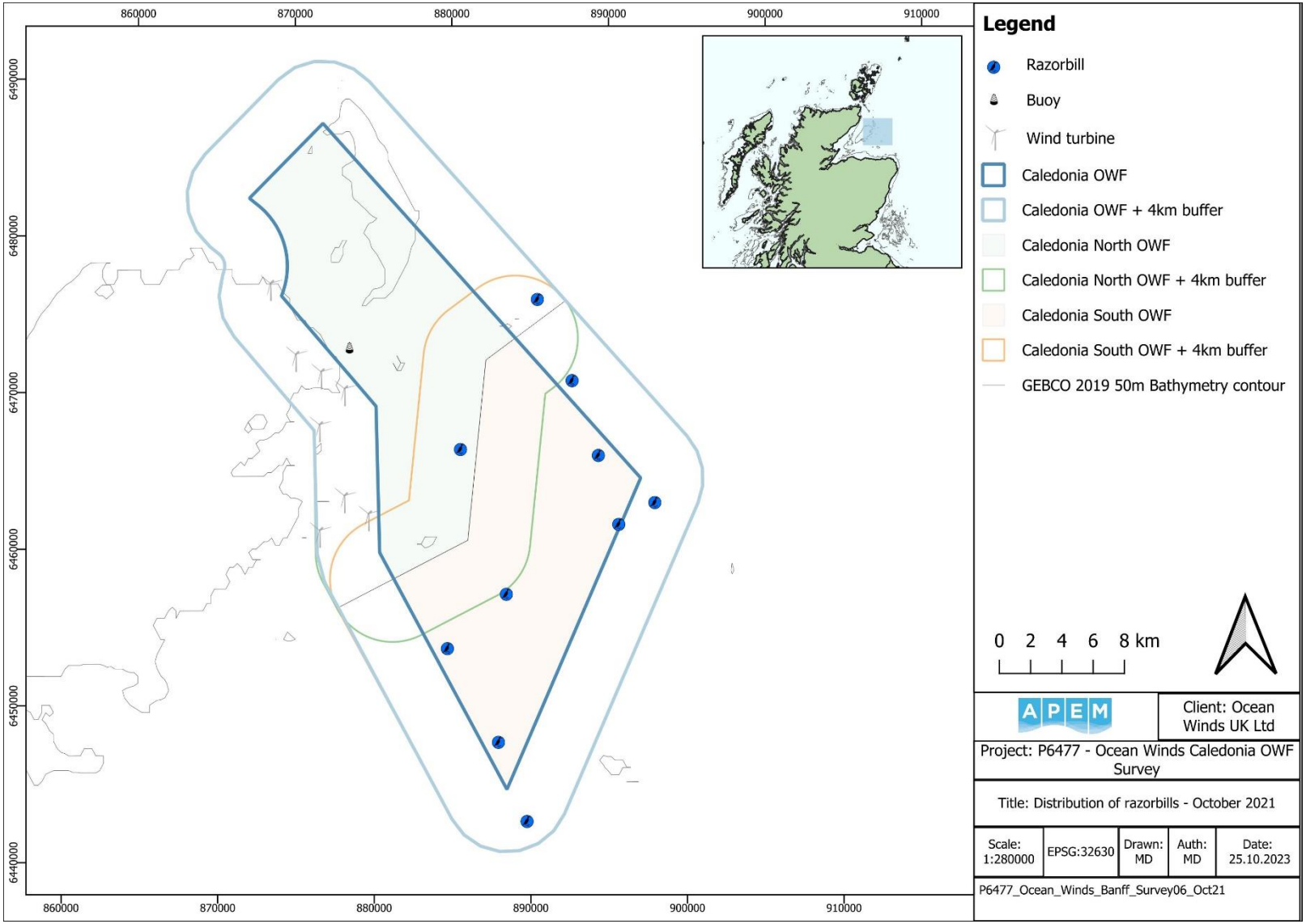


Figure A4.174 Distribution of razorbills recorded in the Survey Area in October 2021

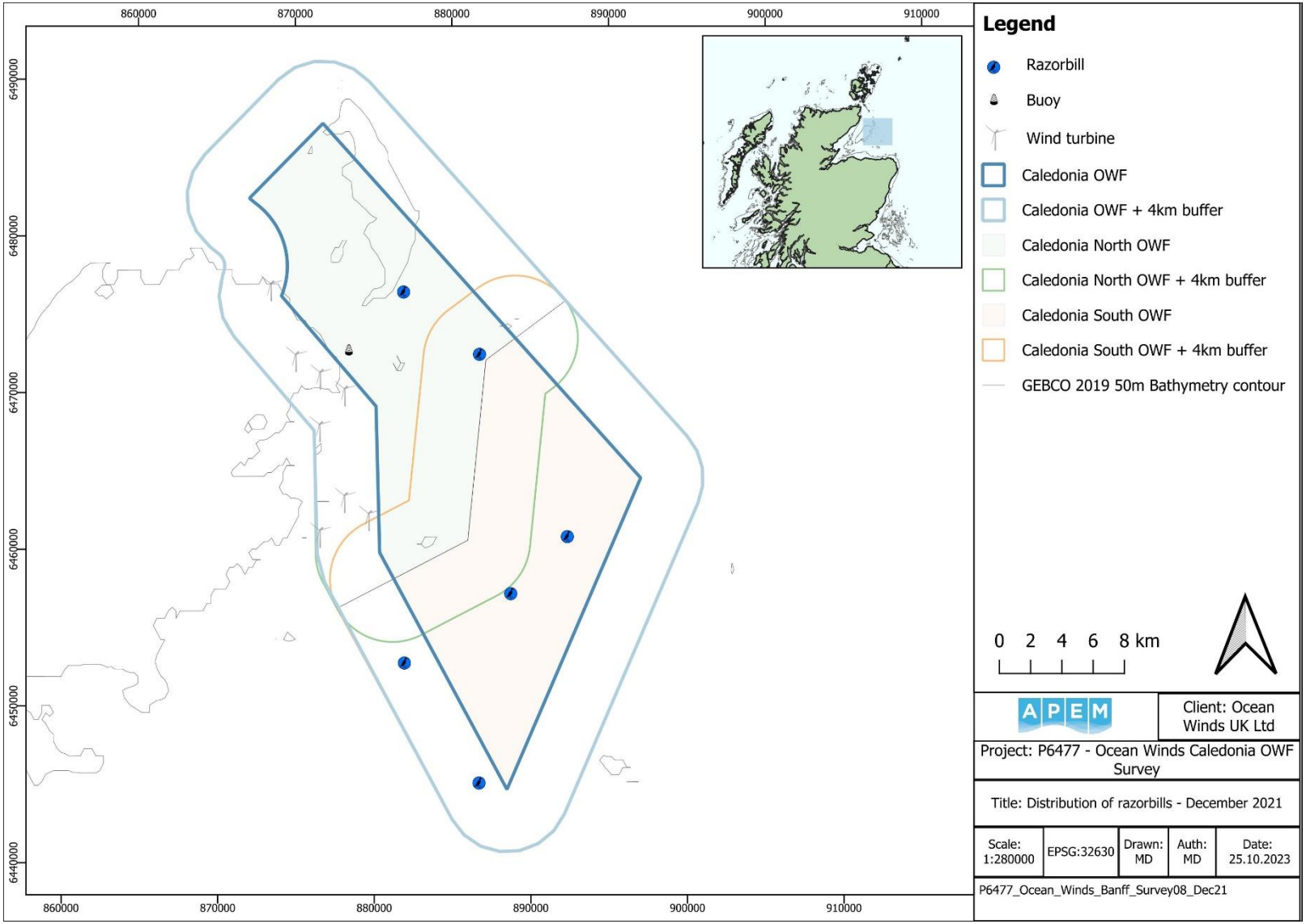


Figure A4.175 Distribution of razorbills recorded in the Survey Area in December 2021

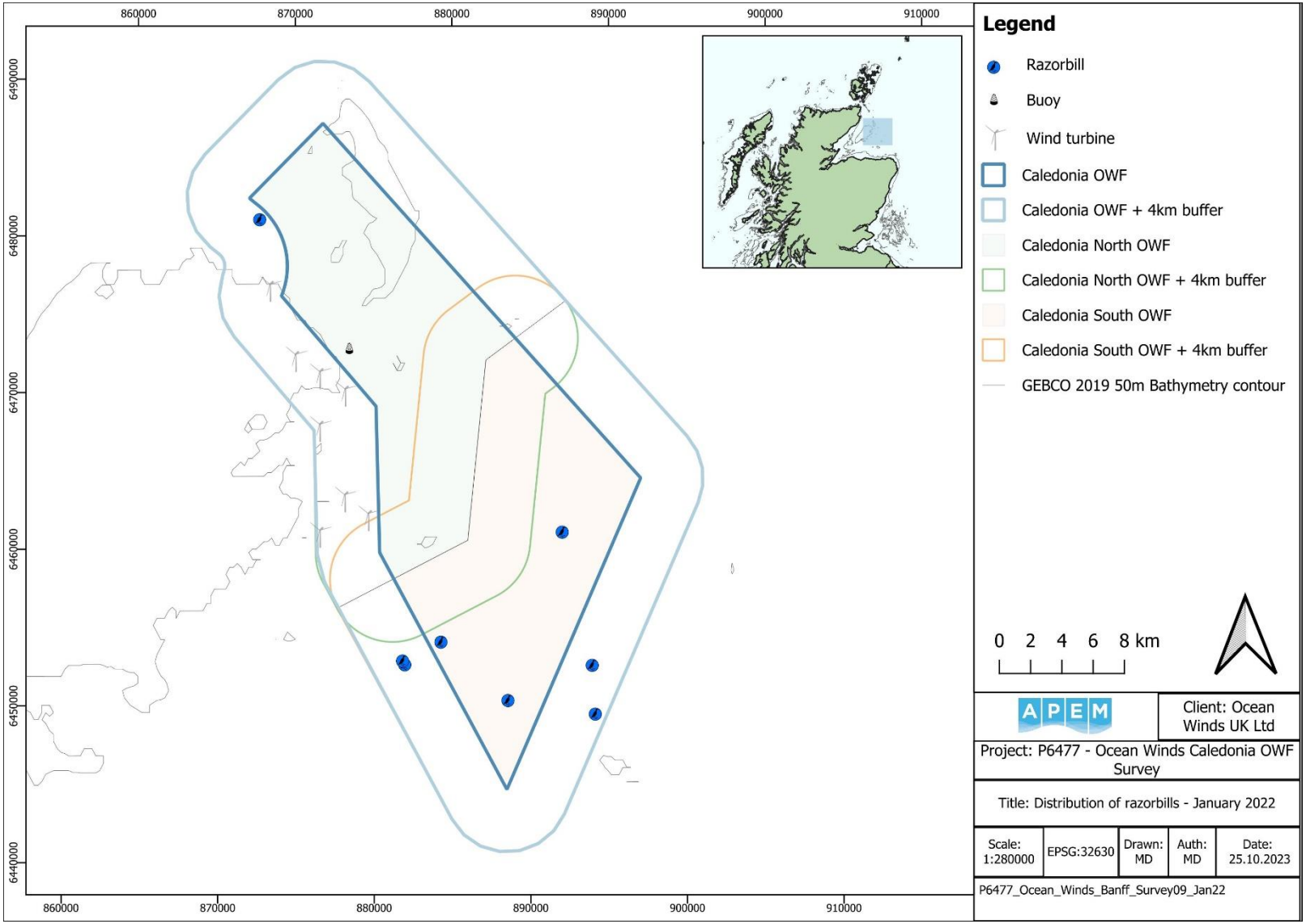


Figure A4.176 Distribution of razorbills recorded in the Survey Area in January 2022

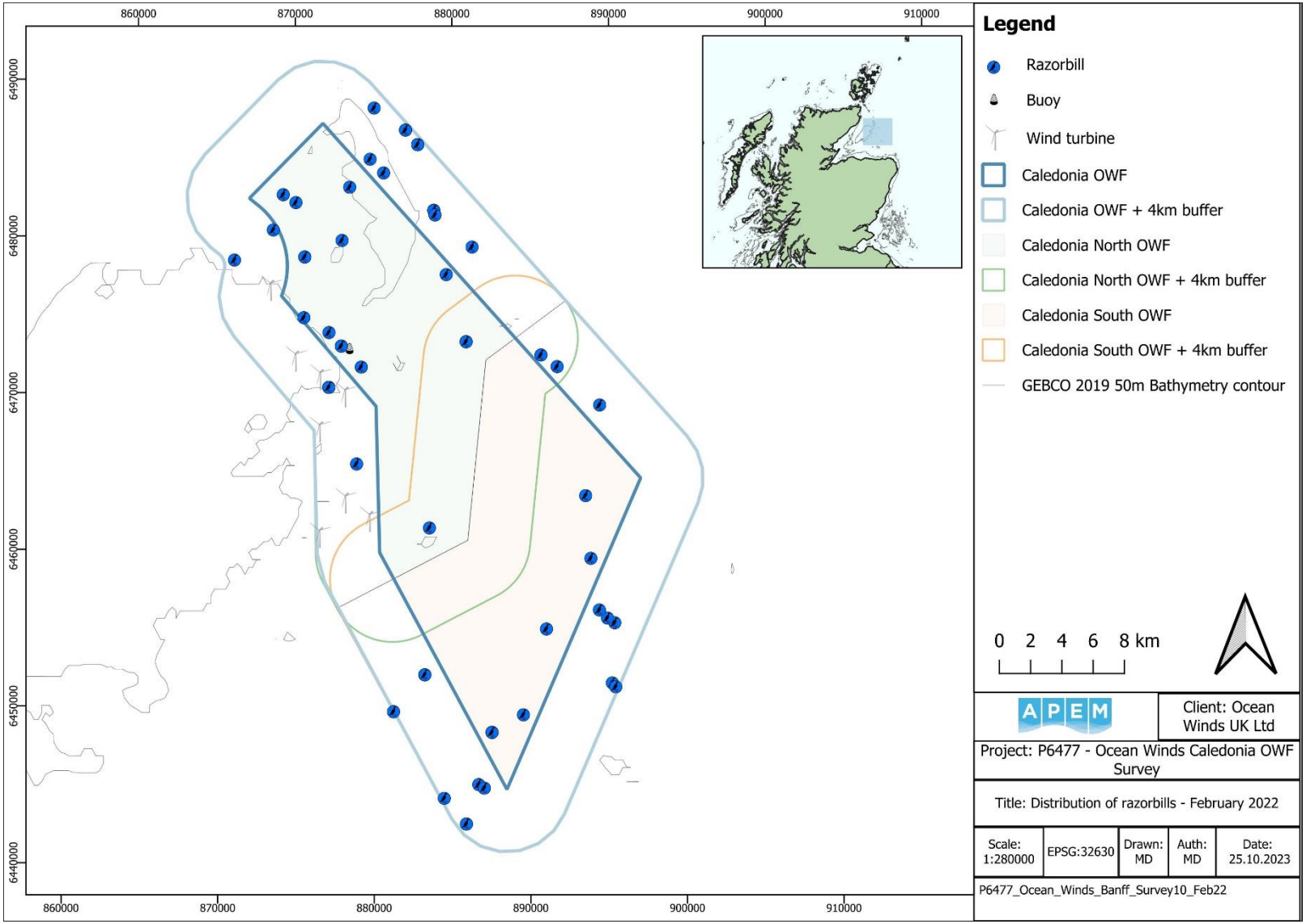


Figure A4.177 Distribution of razorbills recorded in the Survey Area in February 2022

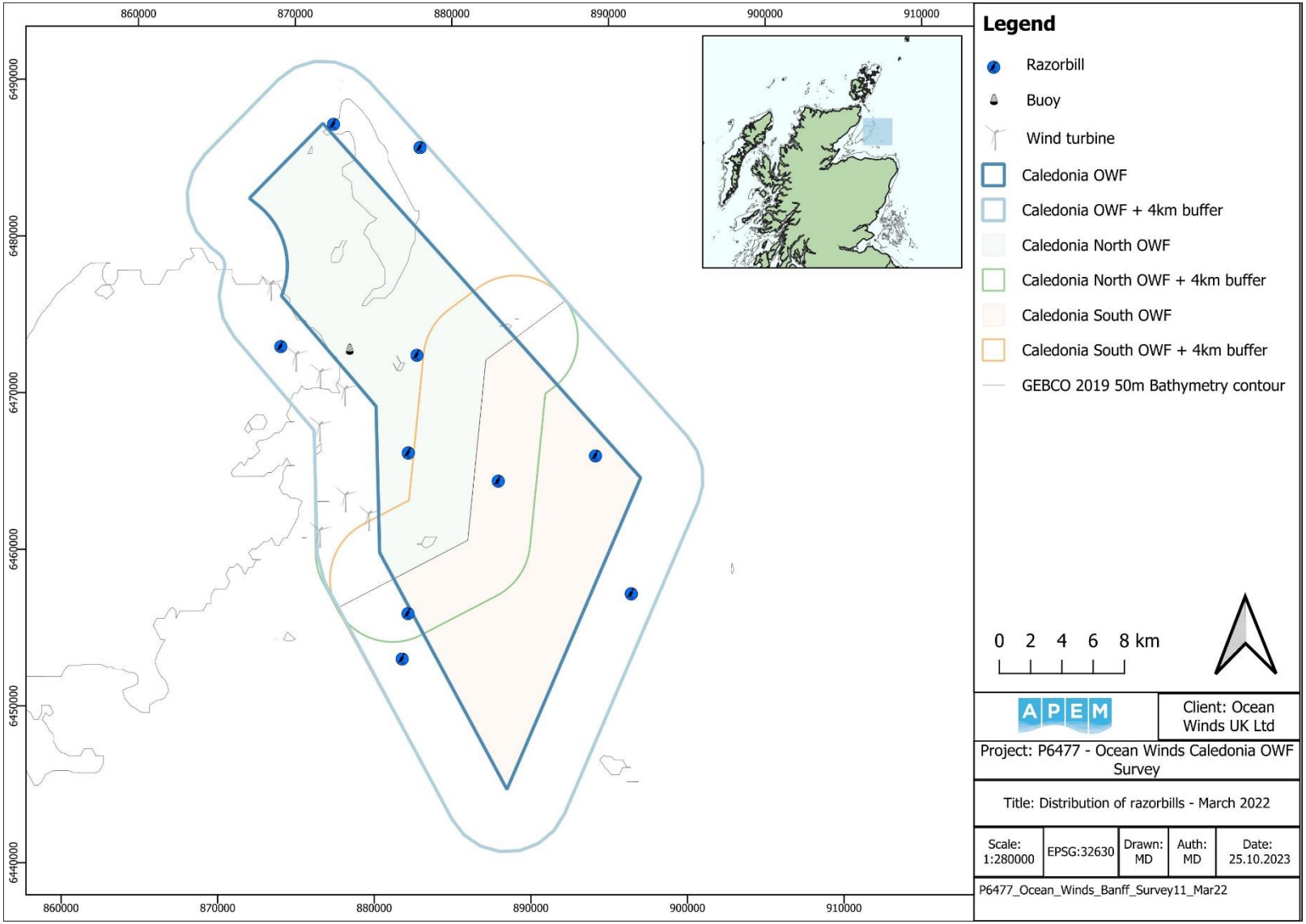


Figure A4.178 Distribution of razorbills recorded in the Survey Area in March 2022

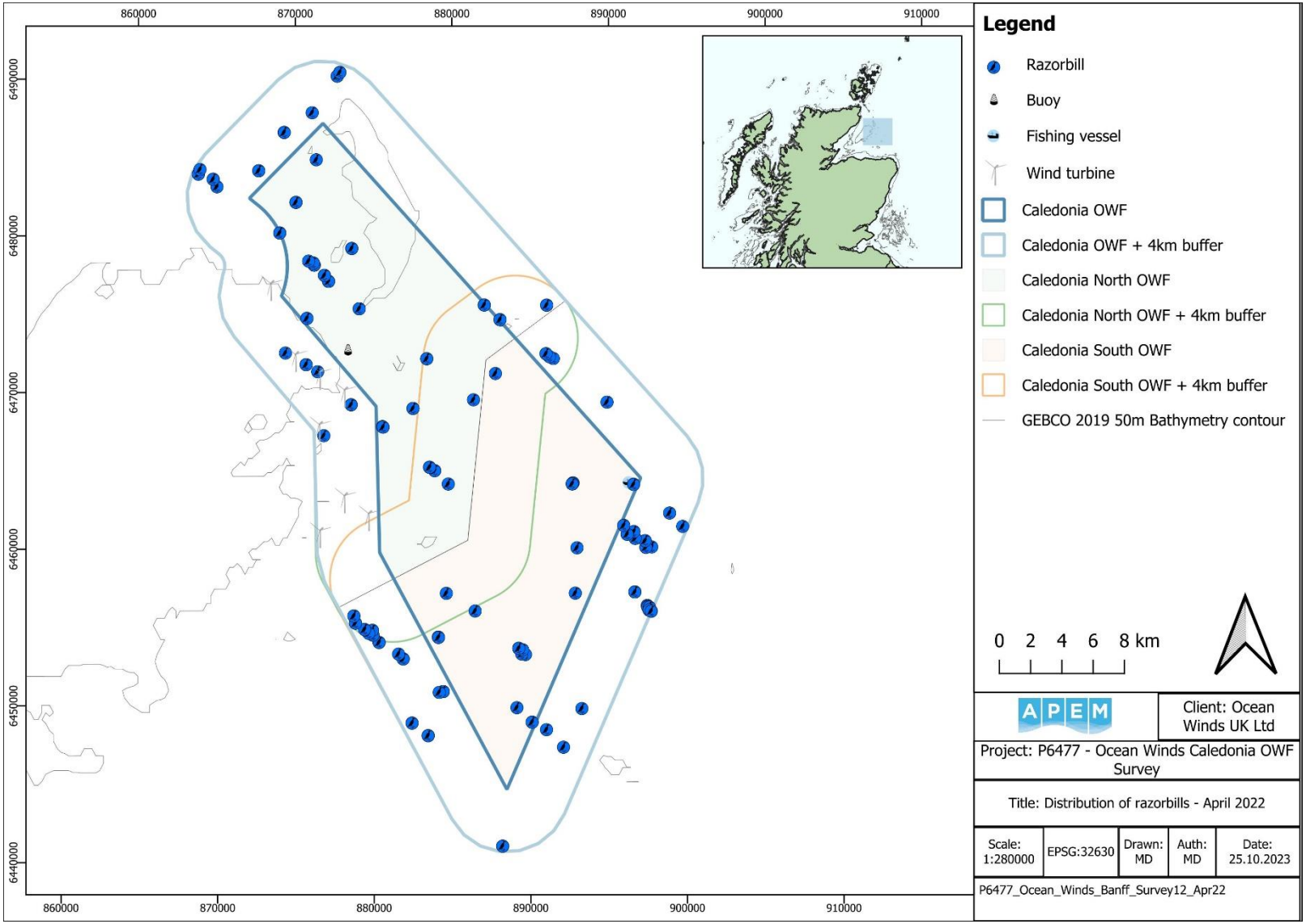


Figure A4.179 Distribution of razorbills recorded in the Survey Area in April 2022

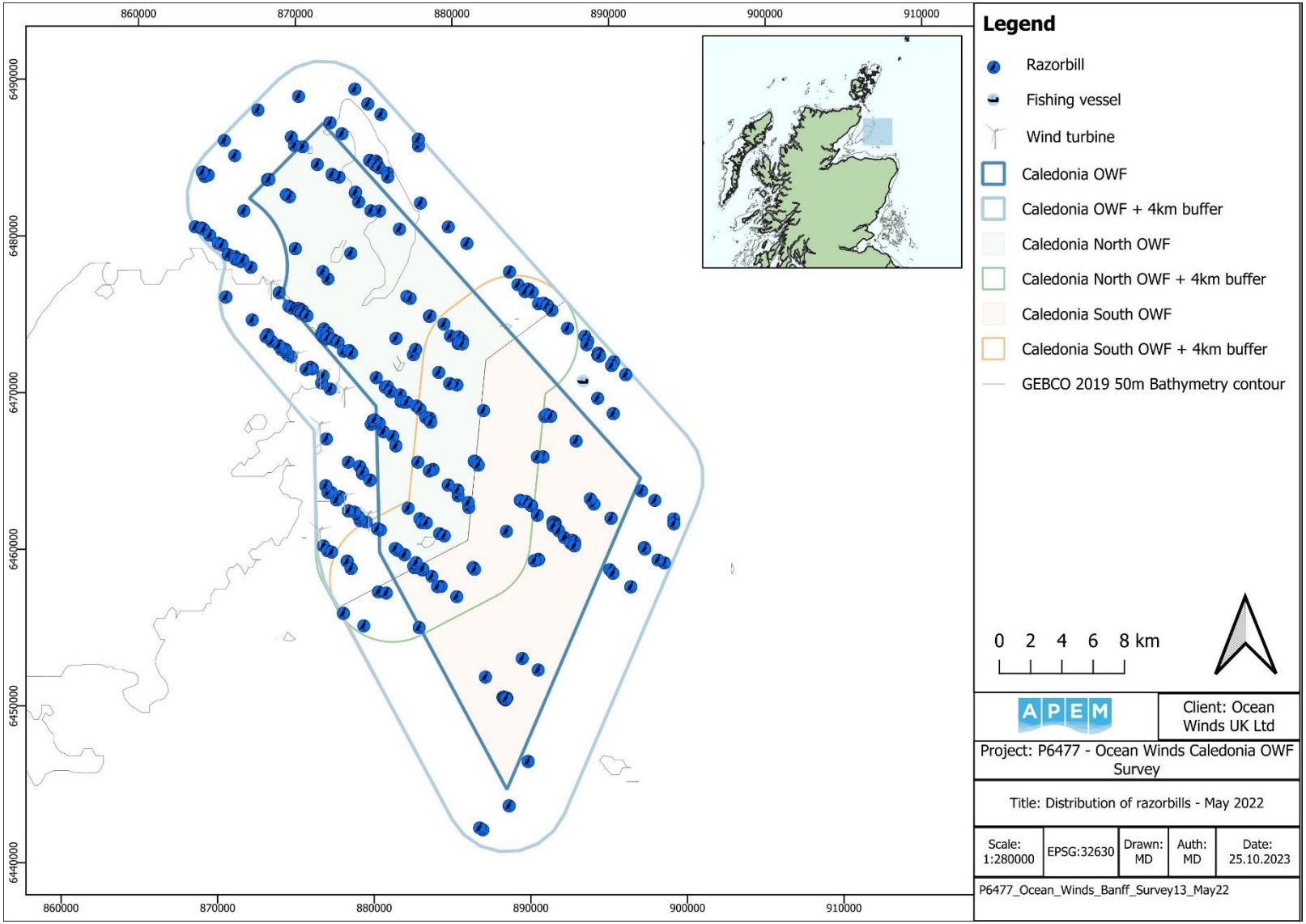


Figure A4.180 Distribution of razorbills recorded in the Survey Area in May 2022

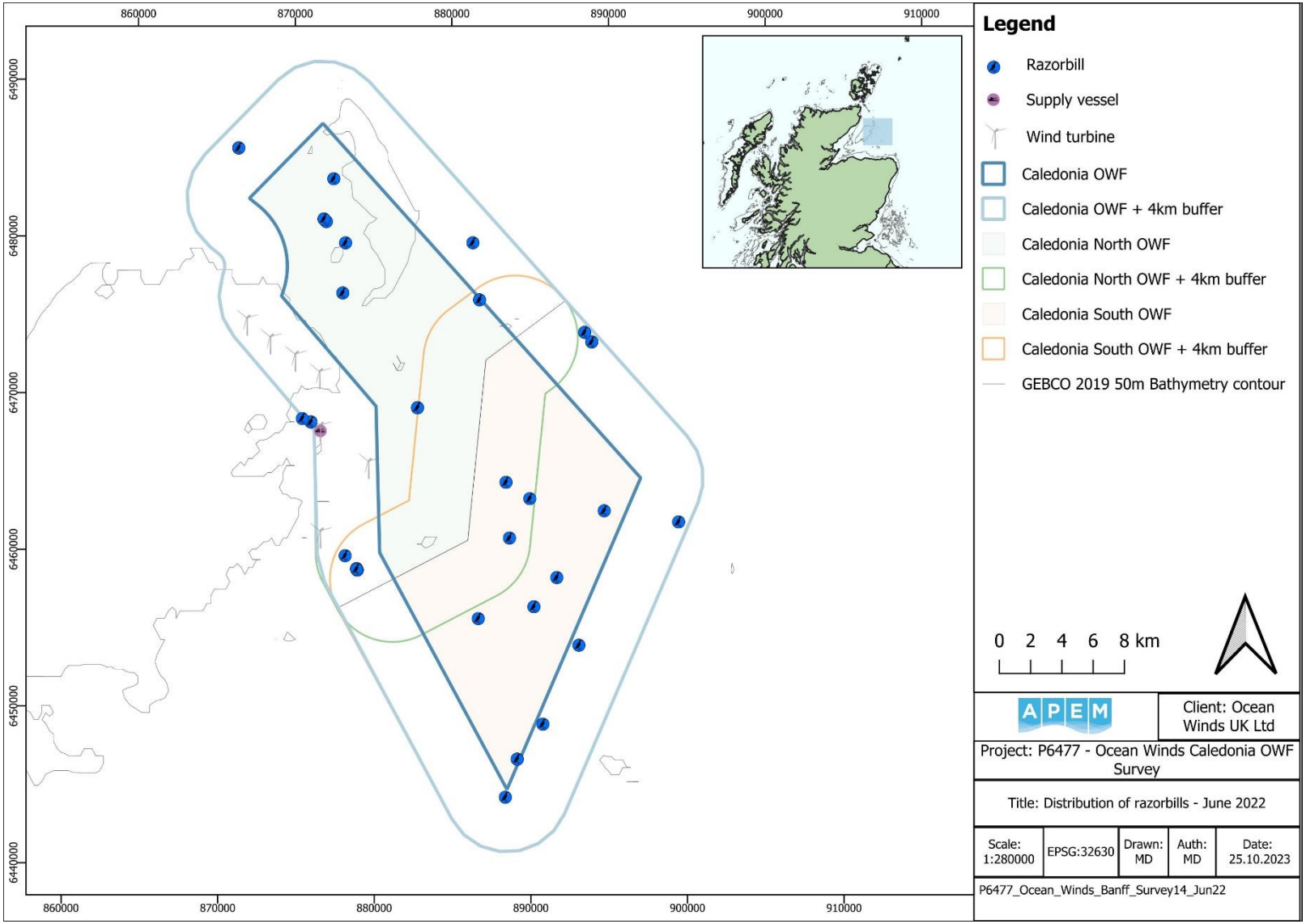


Figure A4.181 Distribution of razorbills recorded in the Survey Area in June 2022

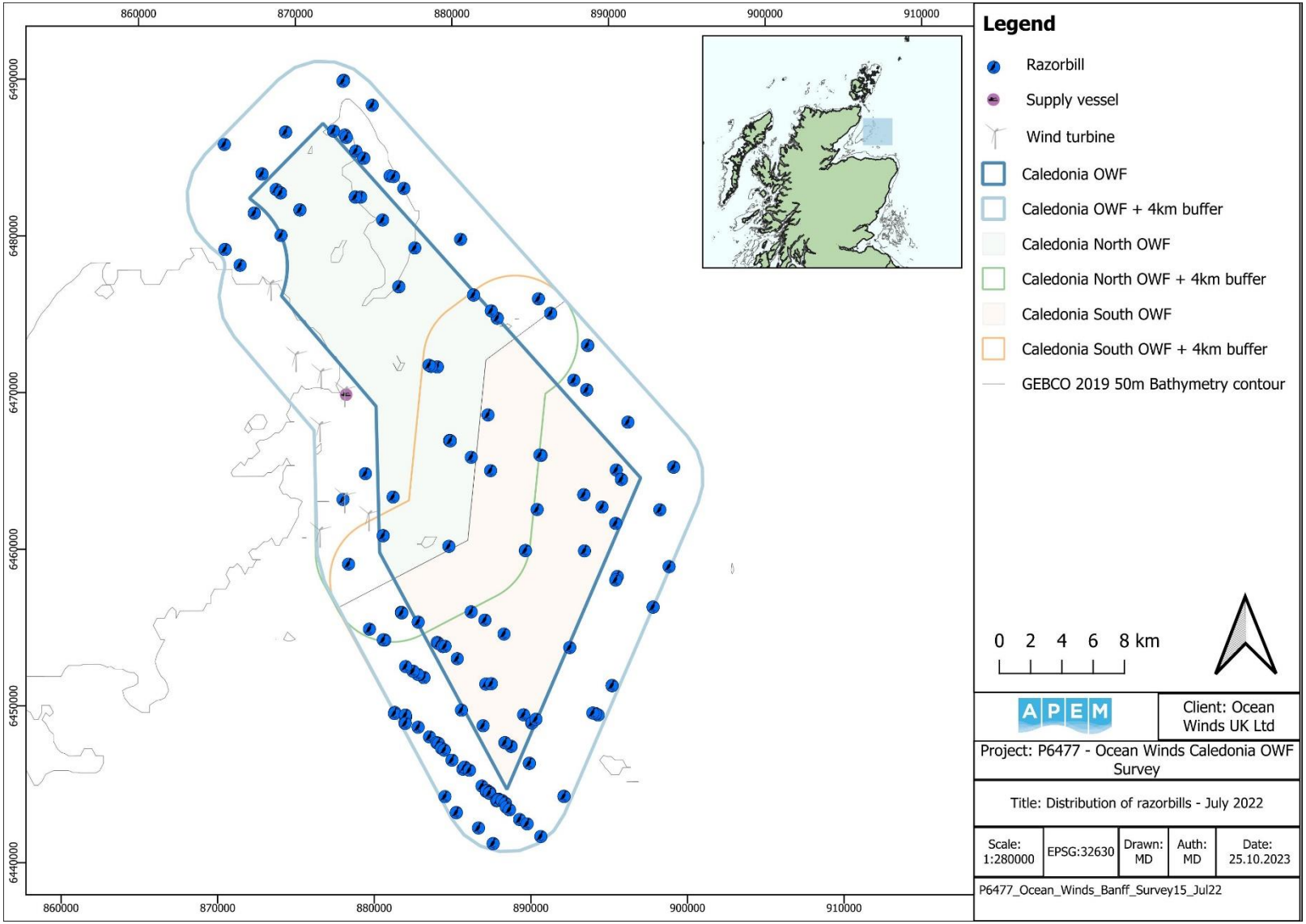


Figure A4.182 Distribution of razorbills recorded in the Survey Area in July 2022

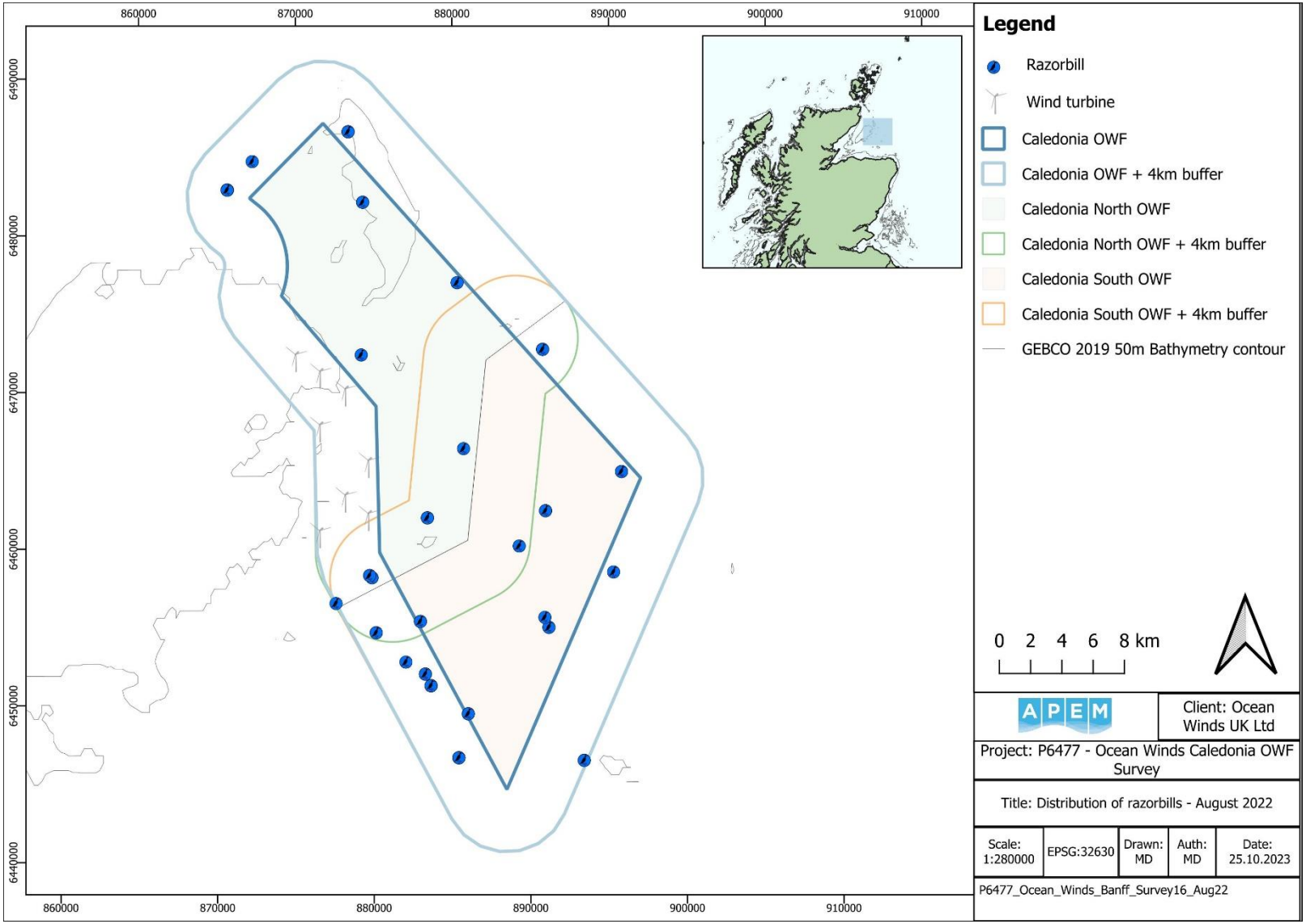


Figure A4.183 Distribution of razorbills recorded in the Survey Area in August 2022

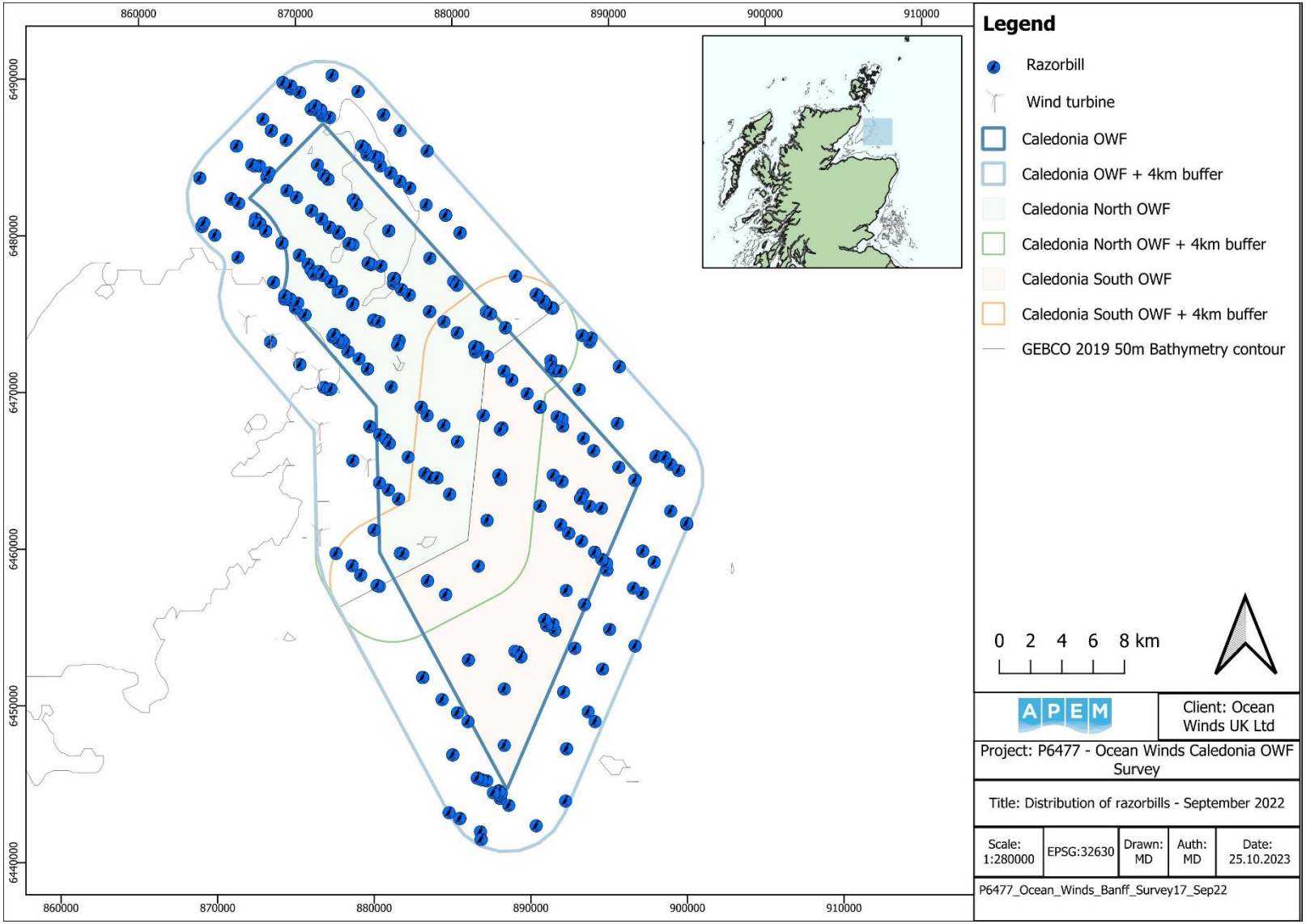


Figure A4.184 Distribution of razorbills recorded in the Survey Area in September 2022

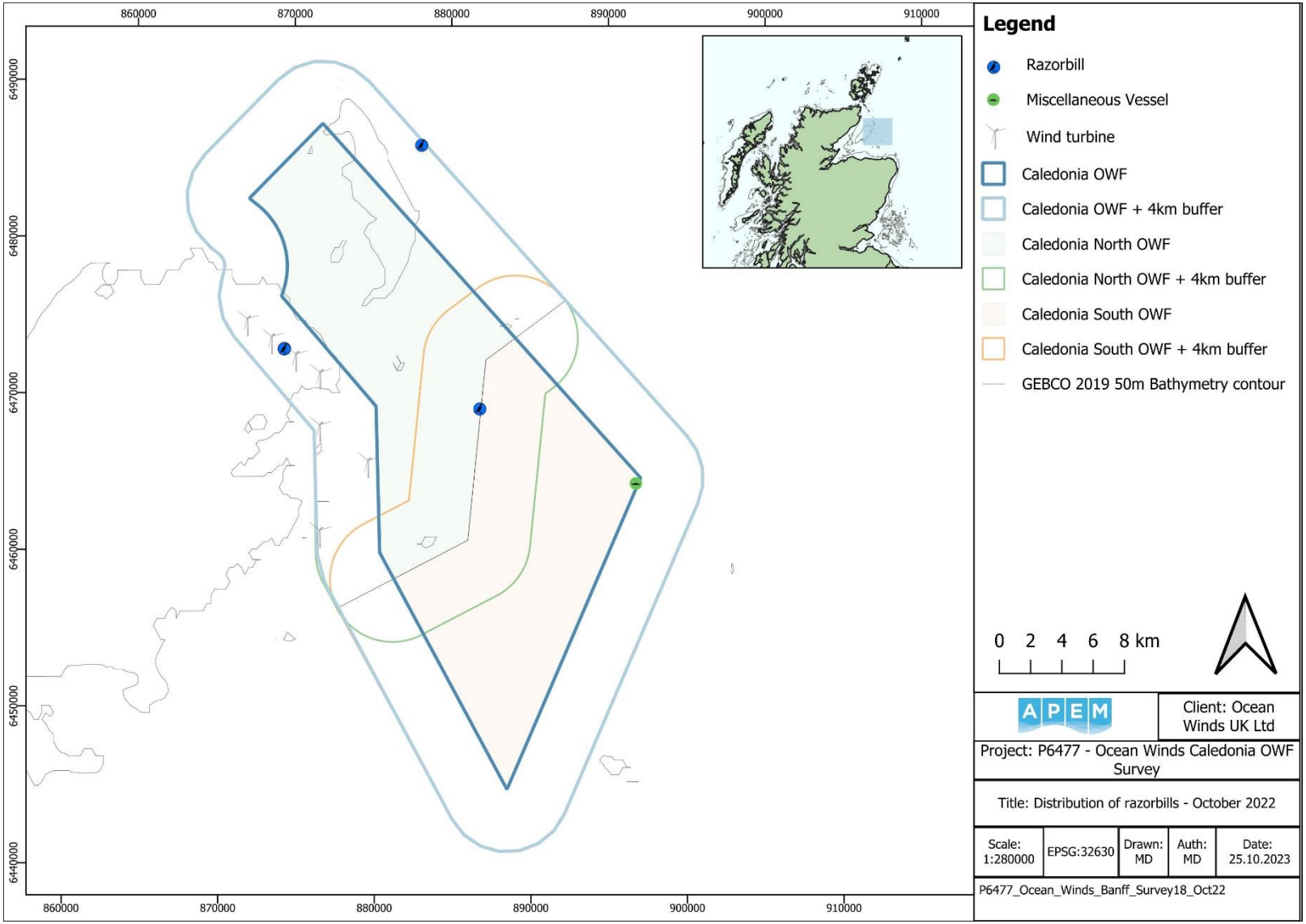


Figure A4.185 Distribution of razorbills recorded in the Survey Area in October 2022

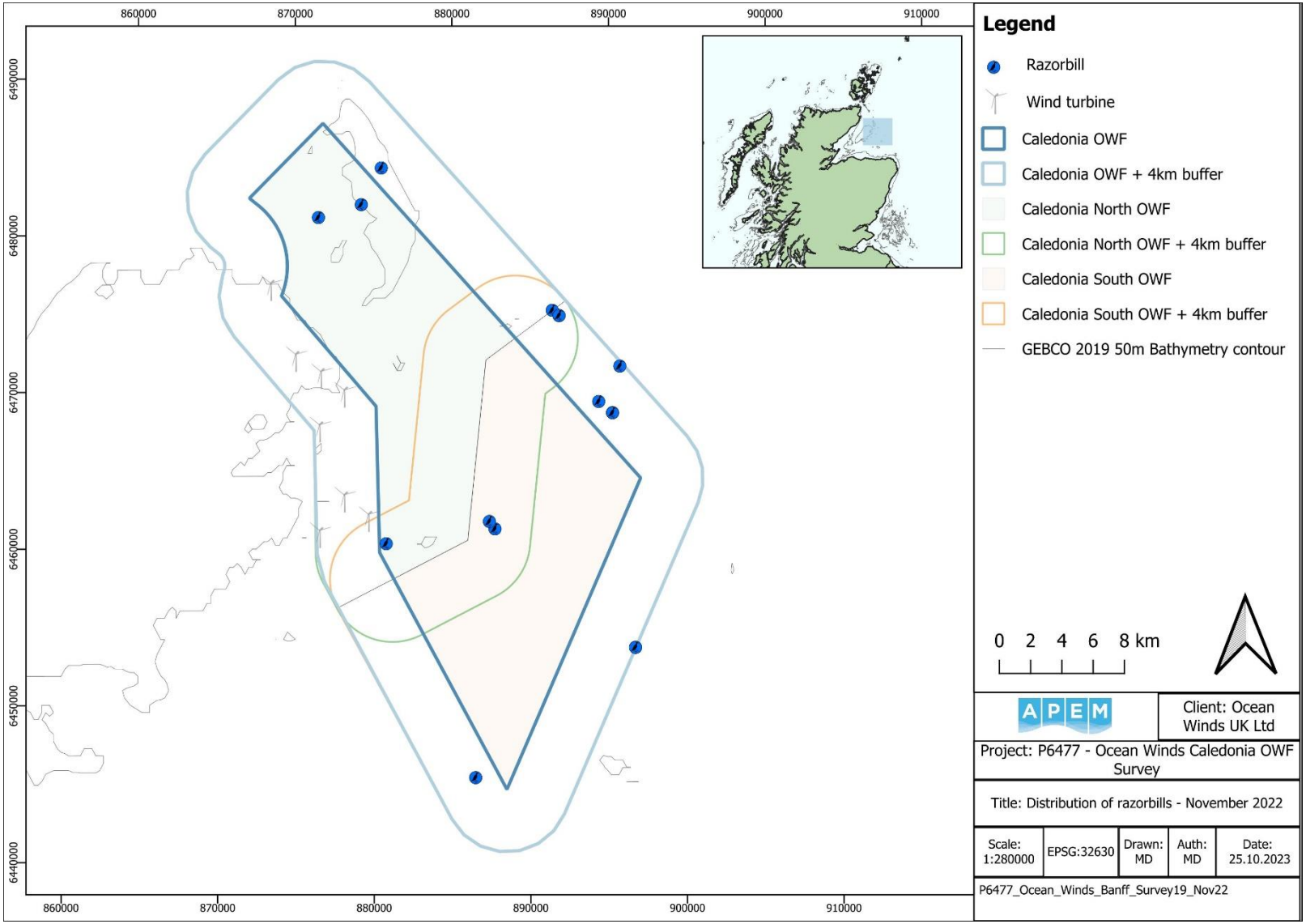


Figure A4.186 Distribution of razorbills recorded in the Survey Area in November 2022

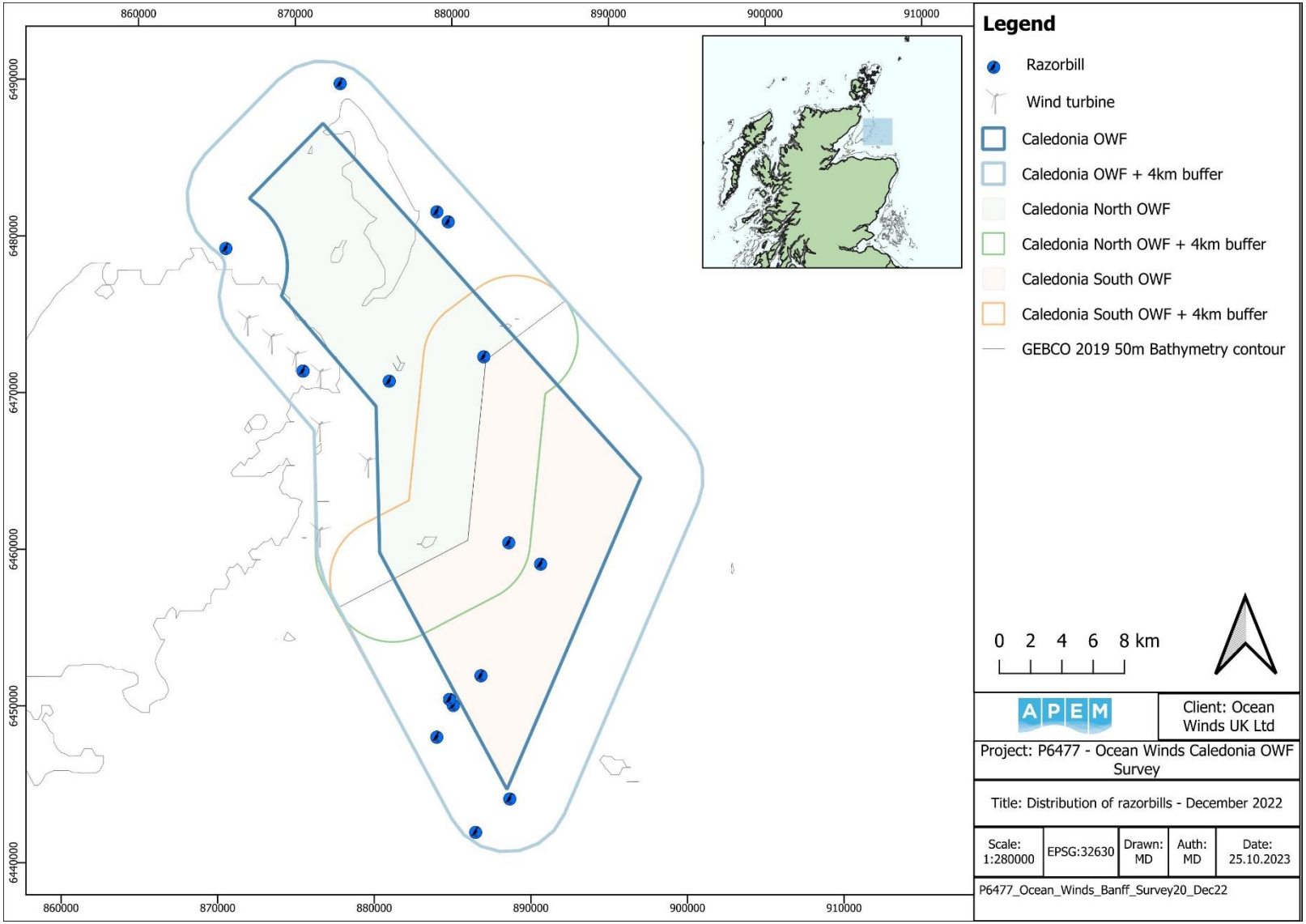


Figure A4.187 Distribution of razorbills recorded in the Survey Area in December 2022

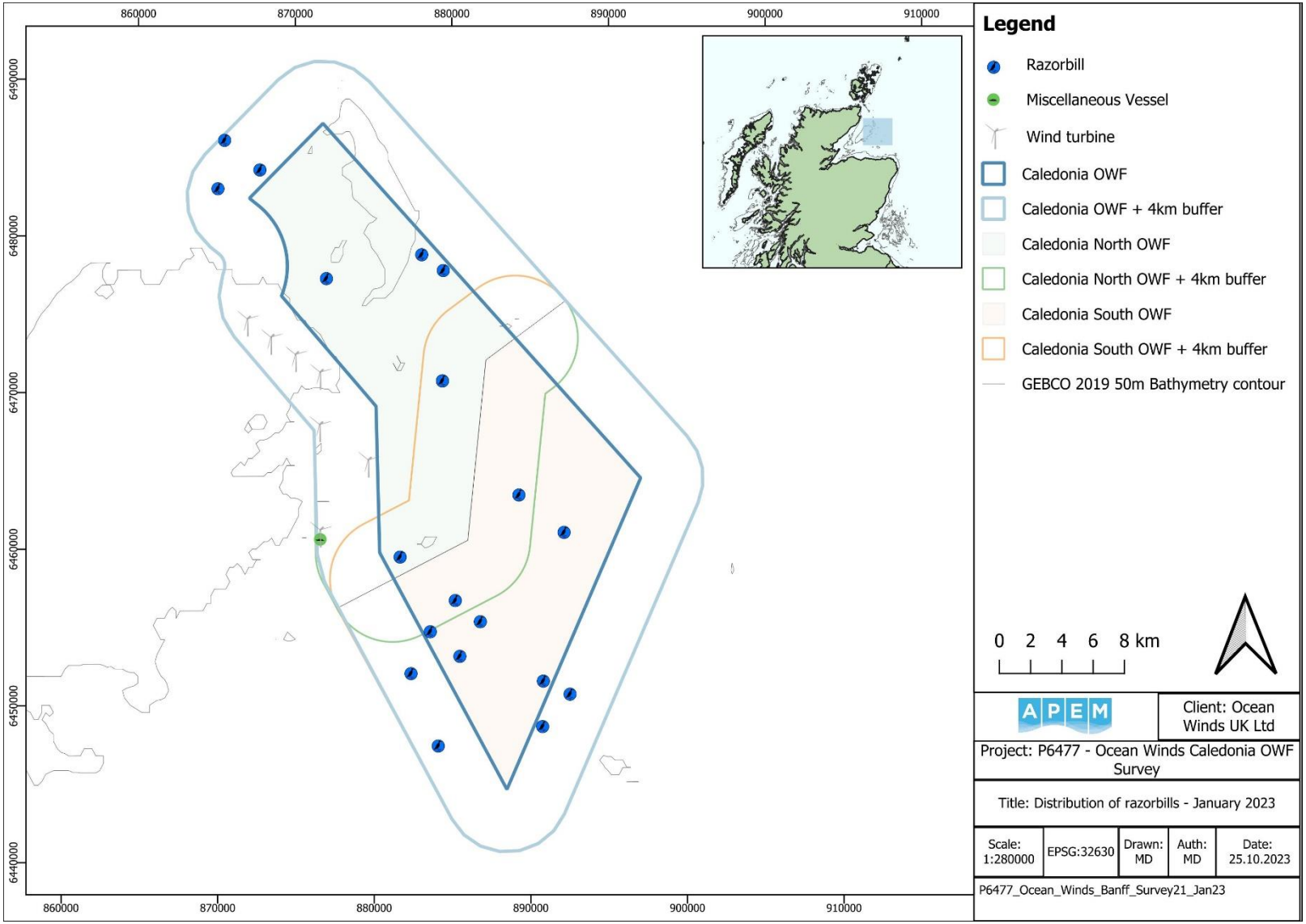


Figure A4.188 Distribution of razorbills recorded in the Survey Area in January 2023

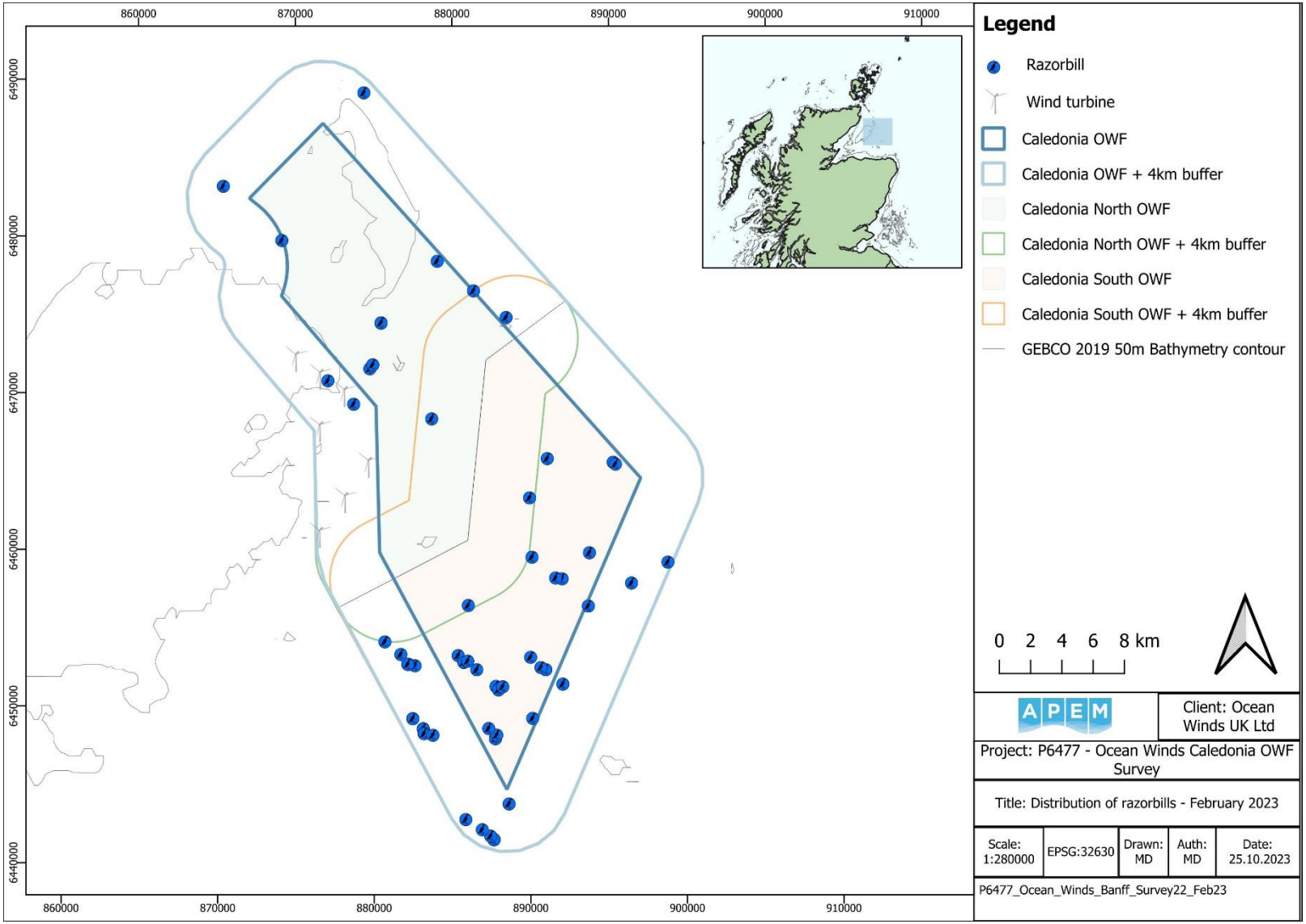


Figure A4.189 Distribution of razorbills recorded in the Survey Area in February 2023

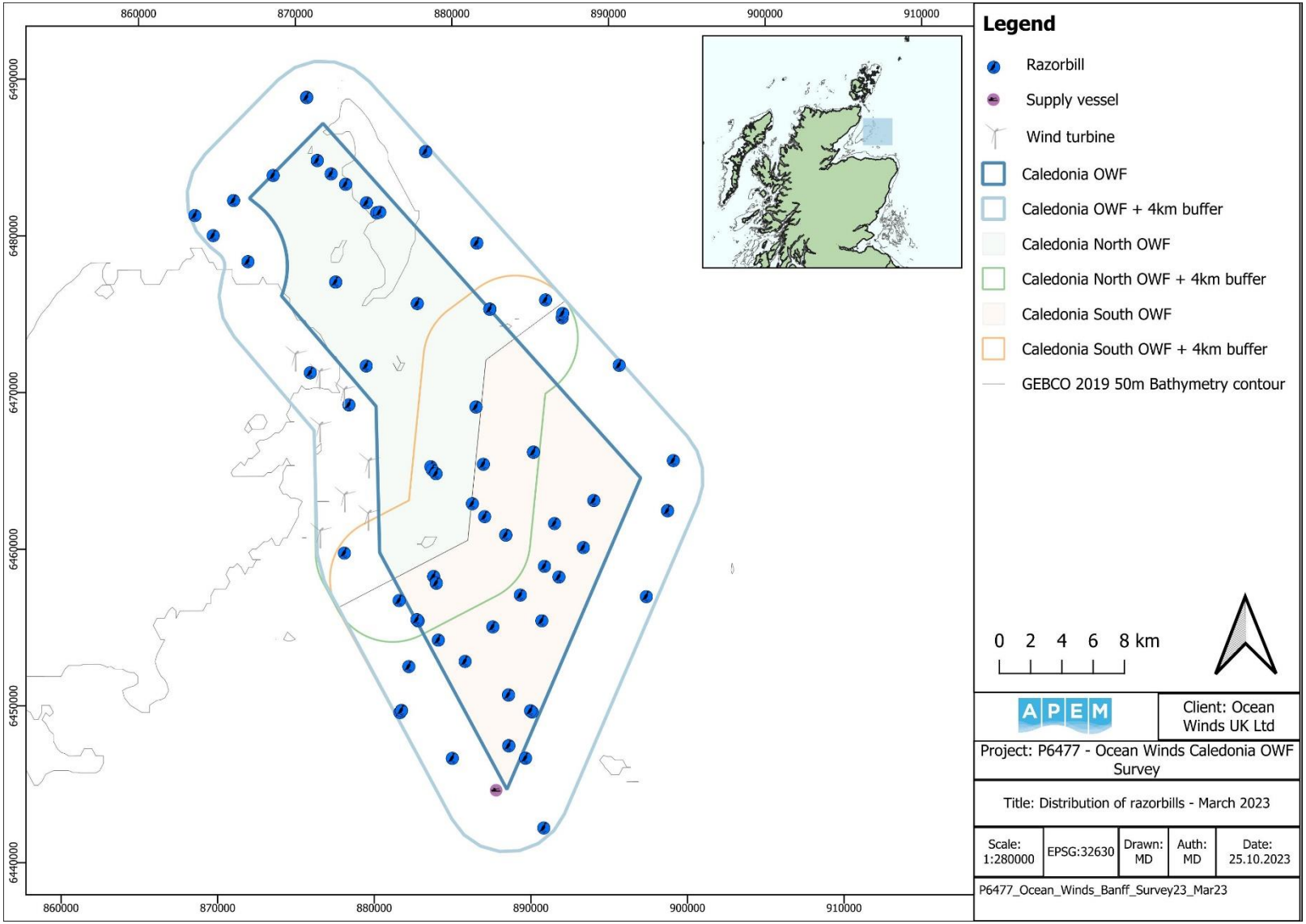


Figure A4.190 Distribution of razorbills recorded in the Survey Area in March 2023

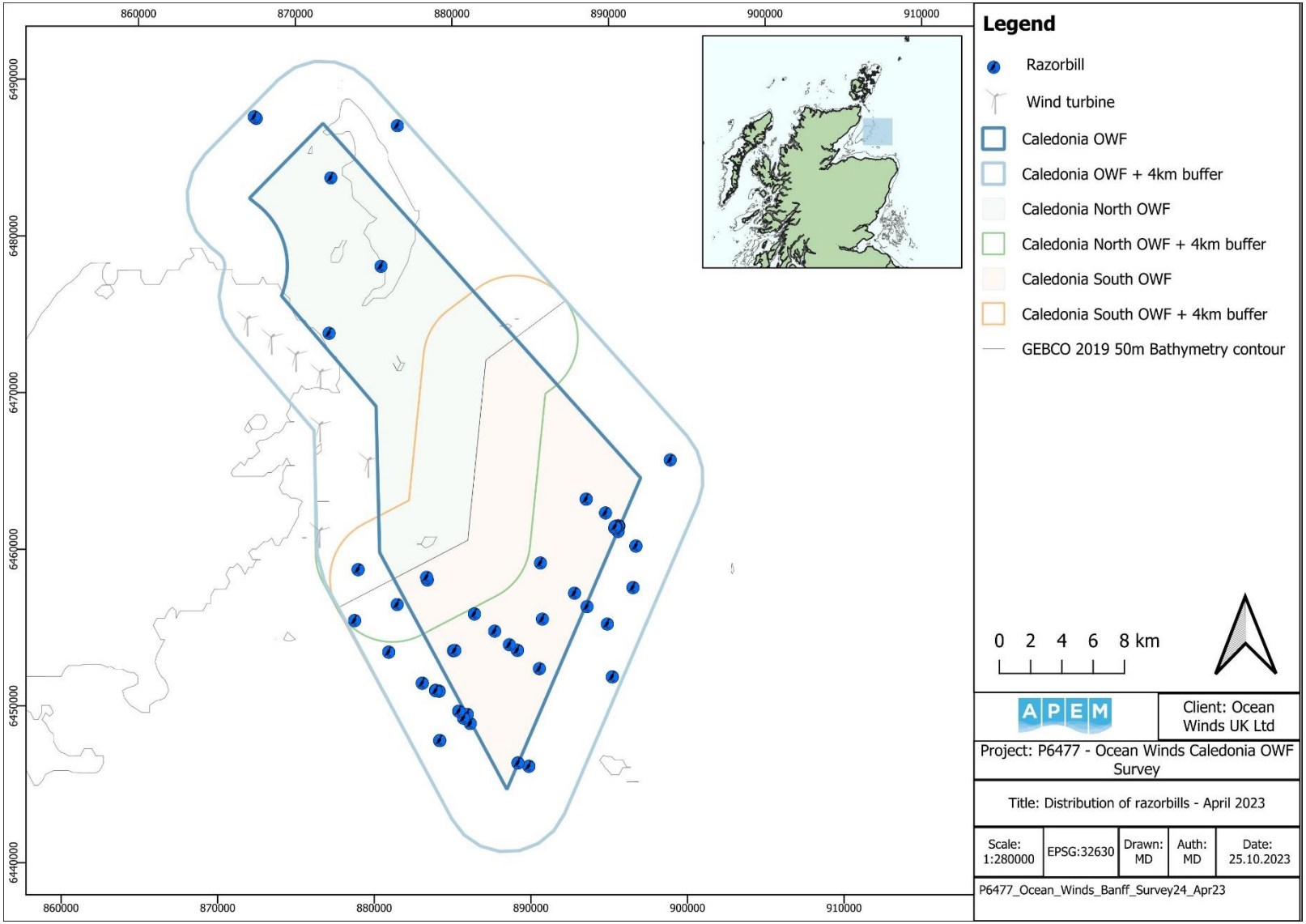


Figure A4.191 Distribution of razorbills recorded in the Survey Area in April 2023

Guillemot and / or razorbills

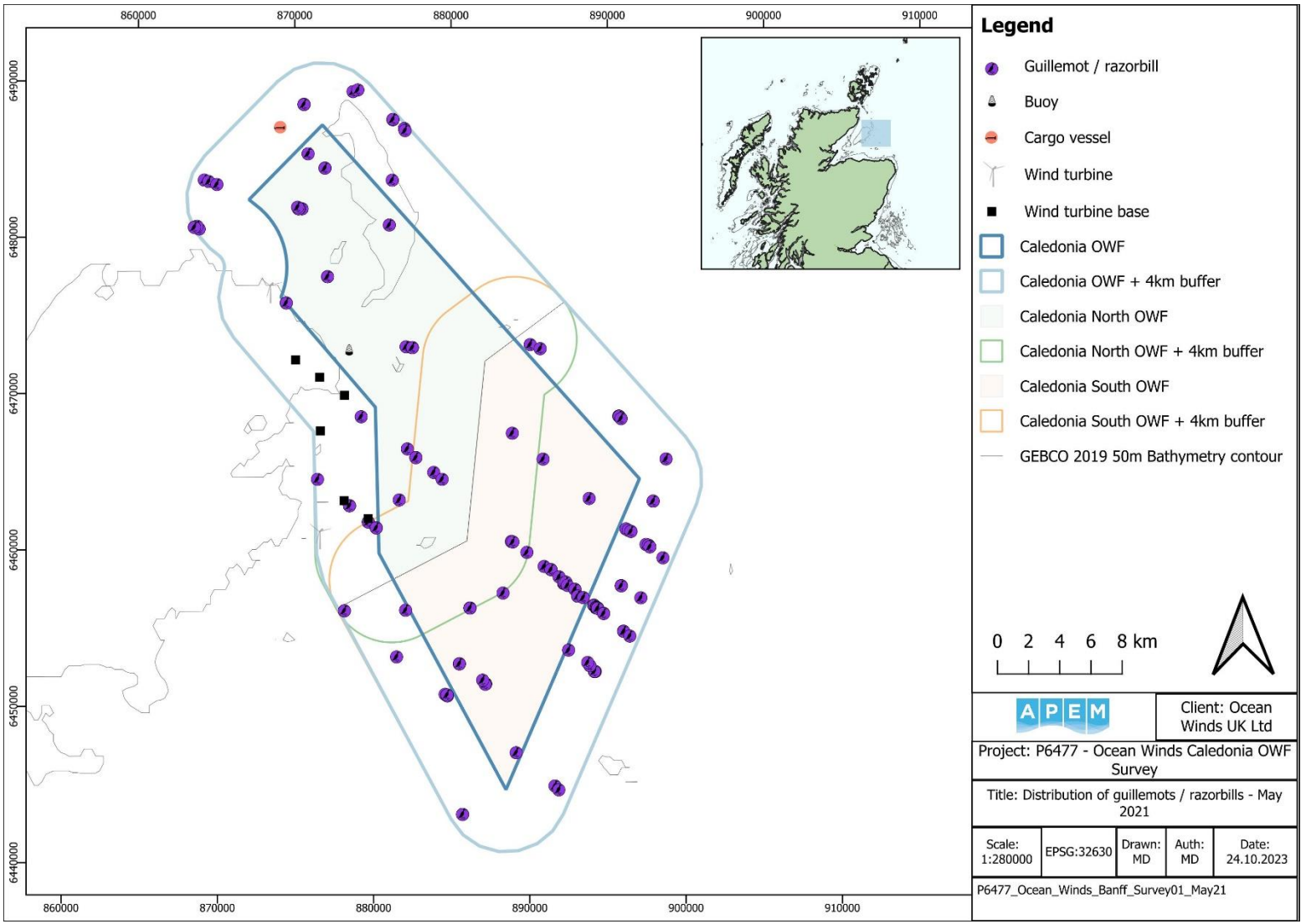


Figure A4.192 Distribution of guillemots / razorbills recorded in the Survey Area in May 2021

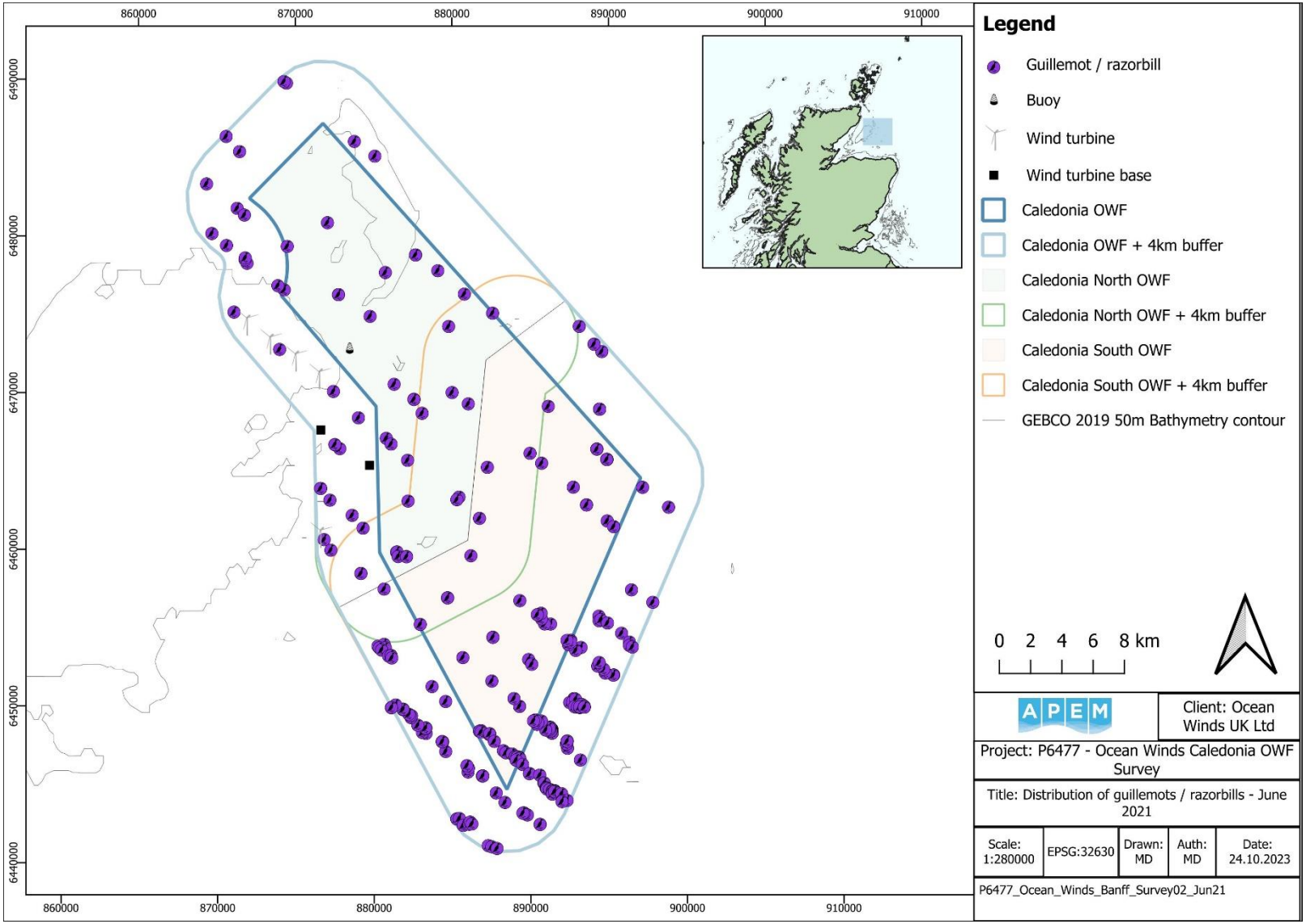


Figure A4.193 Distribution of guillemots / razorbills recorded in the Survey Area in June 2021

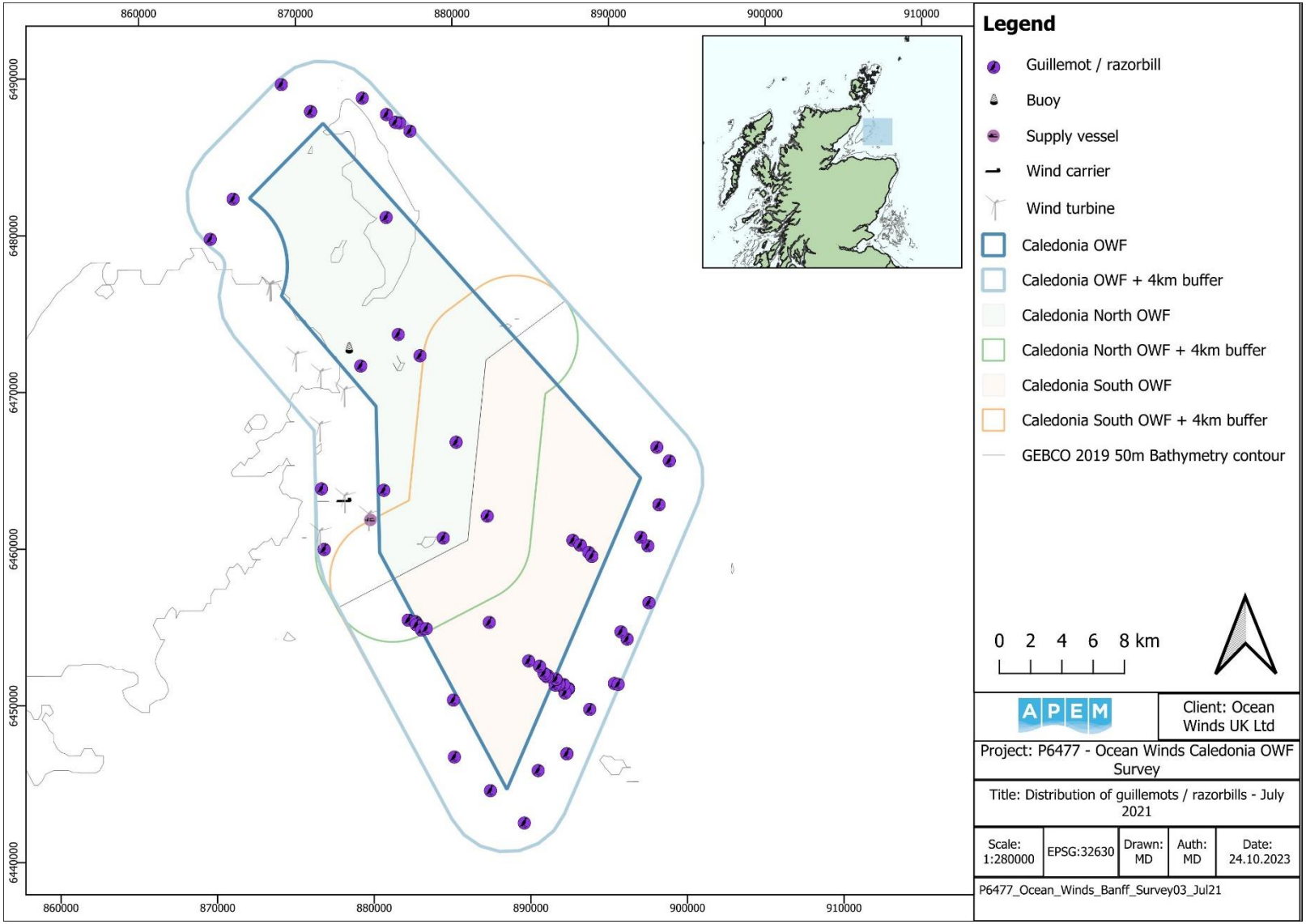


Figure A4.194 Distribution of guillemots / razorbills recorded in the Survey Area in July 2021

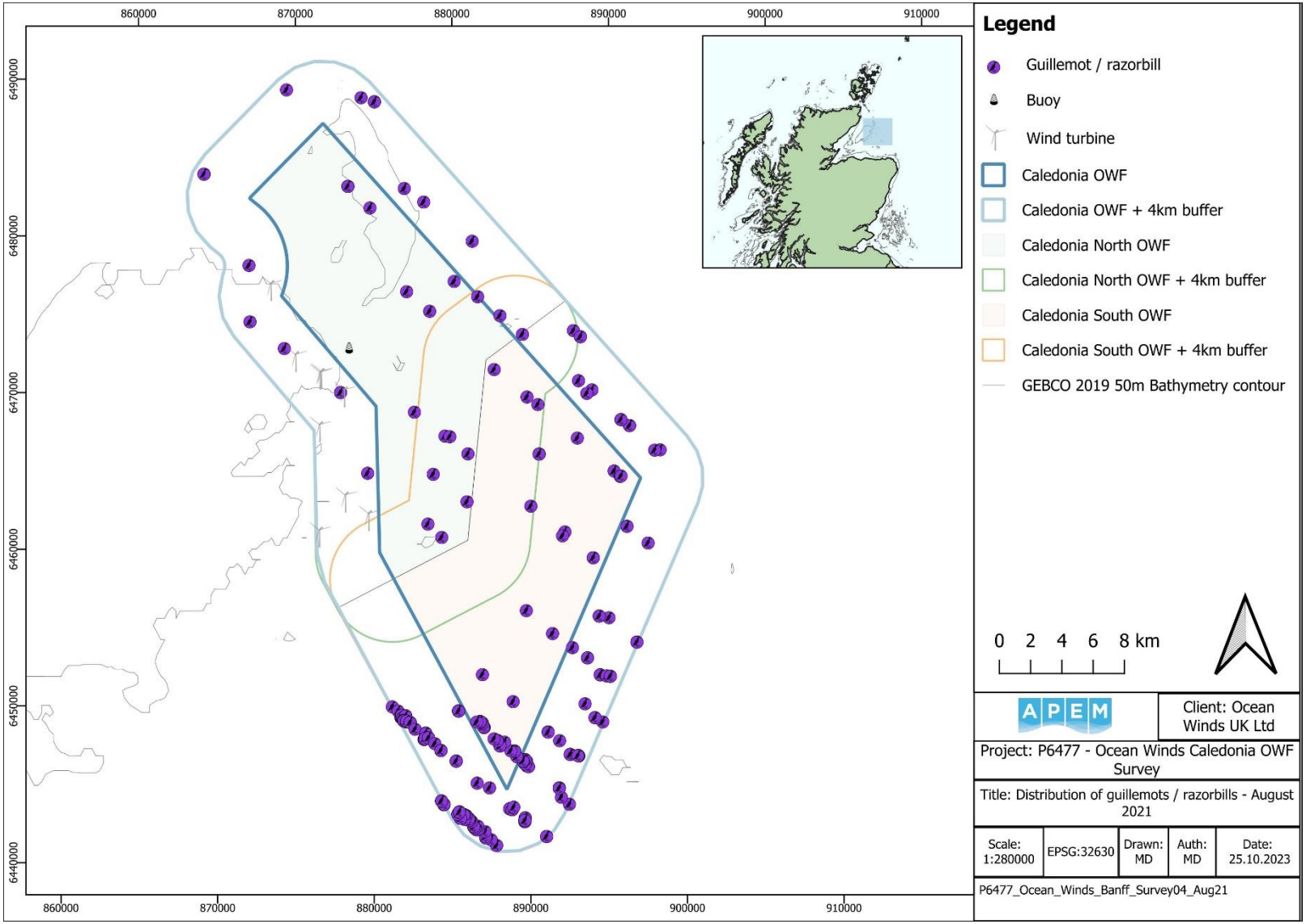


Figure A4.195 Distribution of guillemots / razorbills recorded in the Survey Area in August 2021

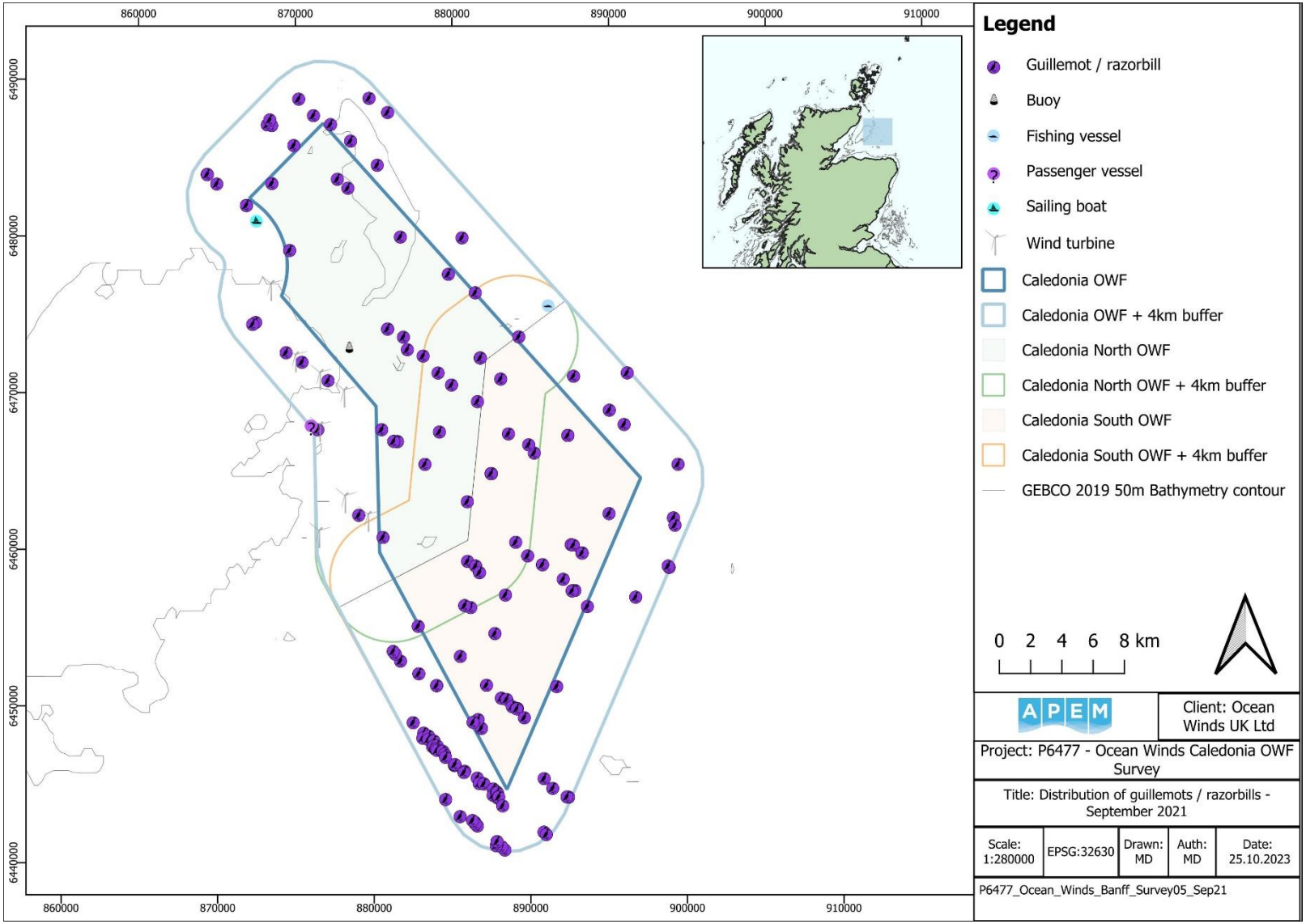


Figure A4.196 Distribution of guillemots / razorbills recorded in the Survey Area in September 2021

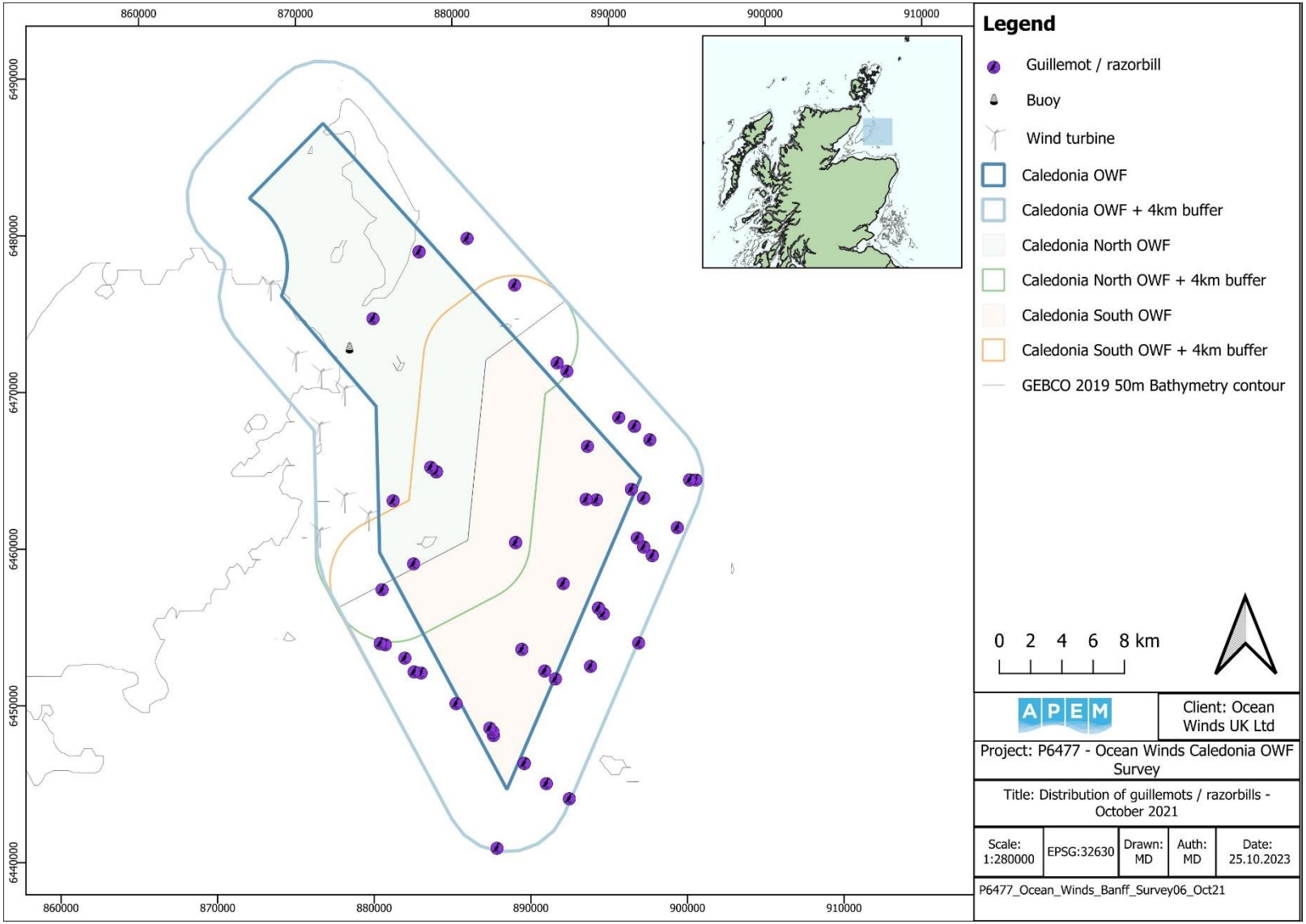


Figure A4.197 Distribution of guillemots / razorbills recorded in the Survey Area in October 2021

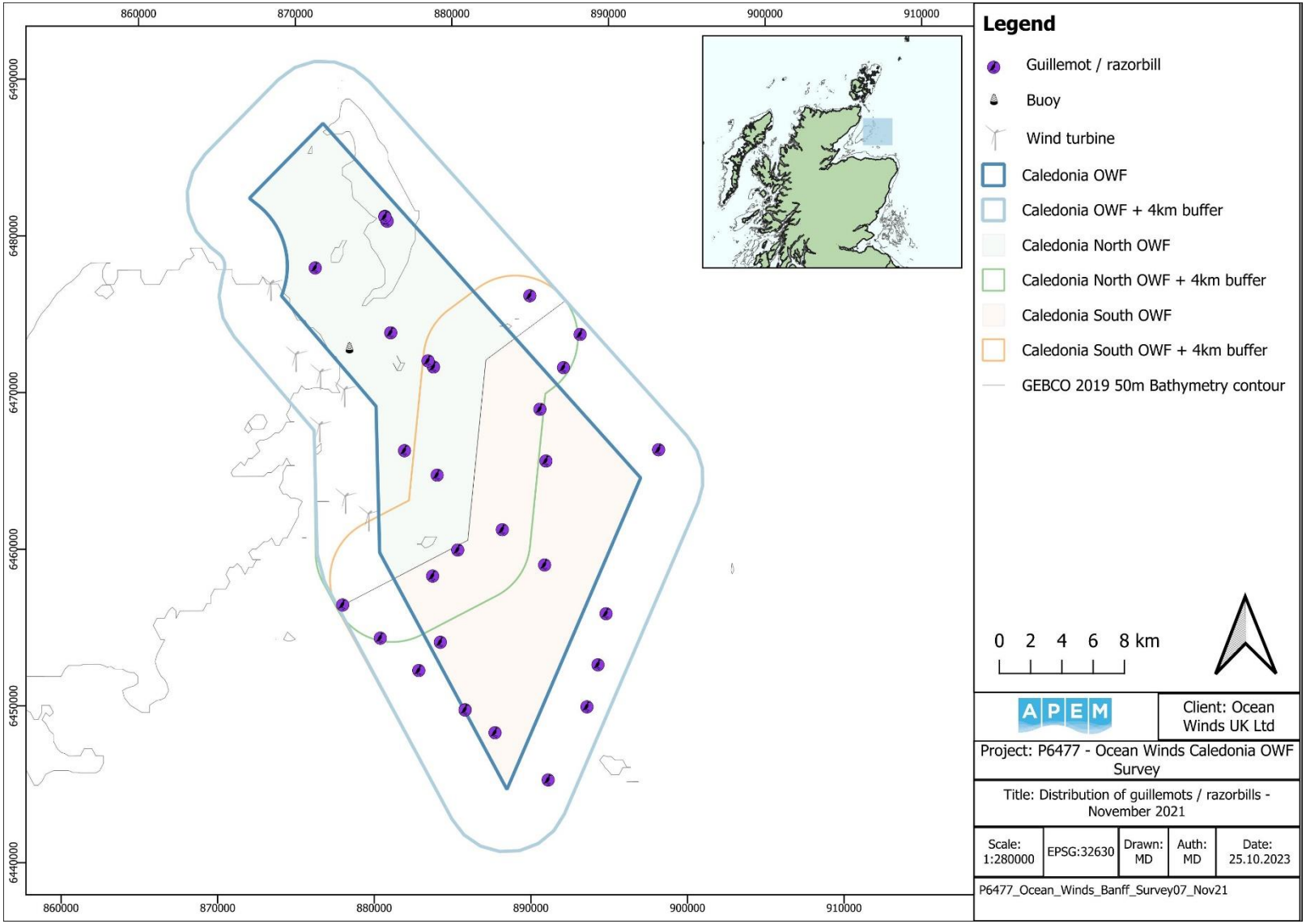


Figure A4.198 Distribution of guillemots / razorbills recorded in the Survey Area in November 2021

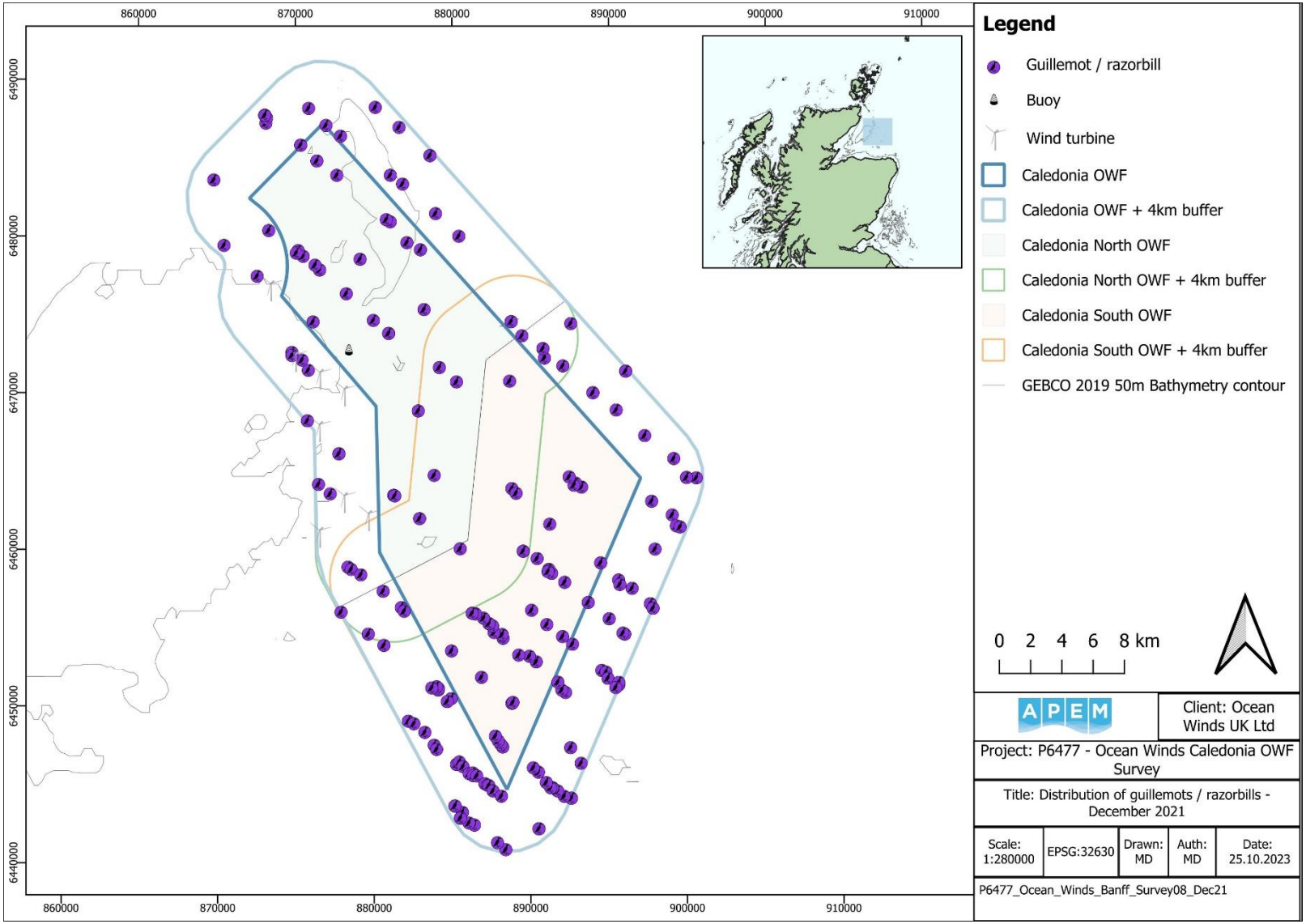


Figure A4.199 Distribution of guillemots / razorbills recorded in the Survey Area in December 2021

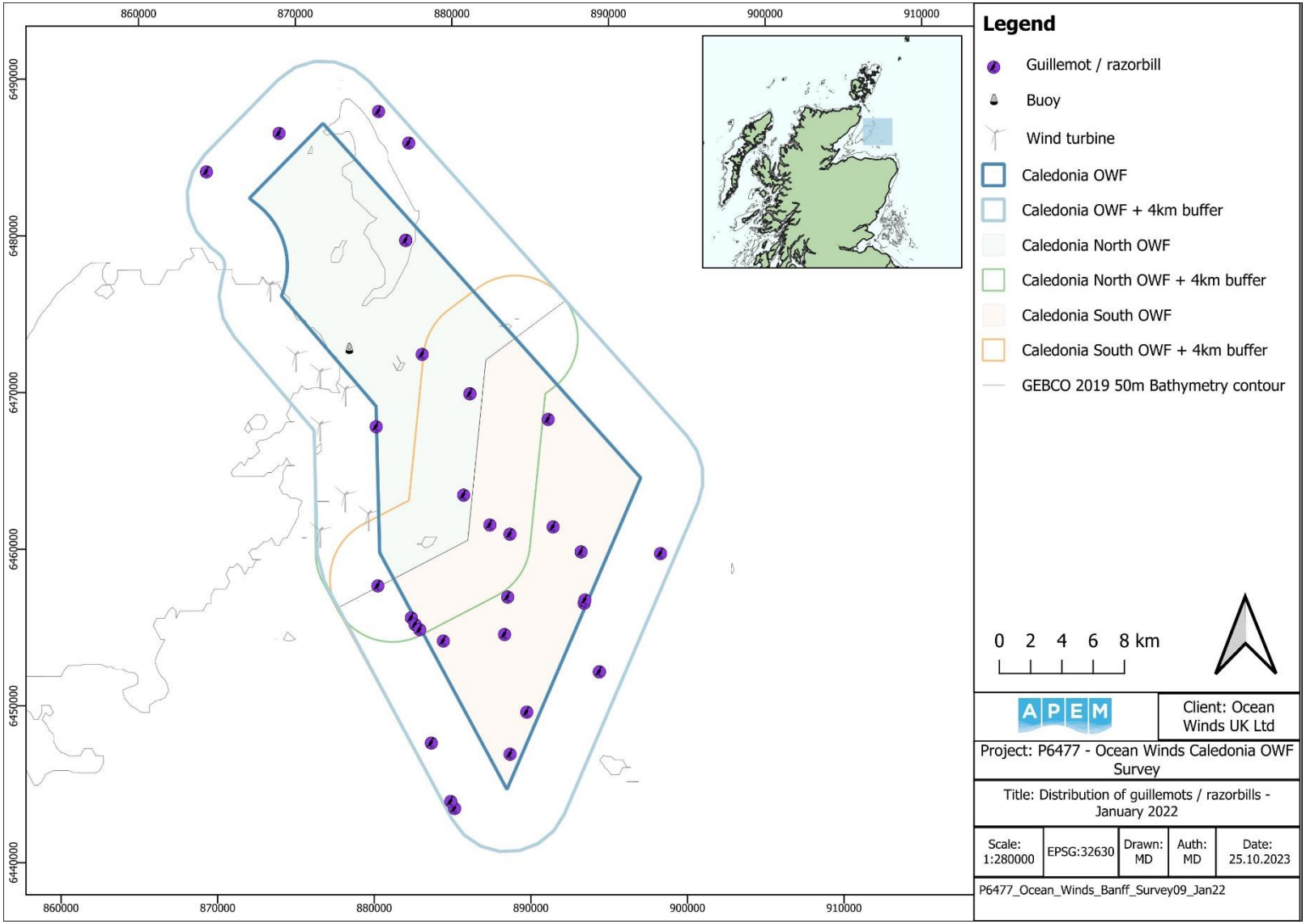


Figure A4.200 Distribution of guillemots / razorbills recorded in the Survey Area in January 2022

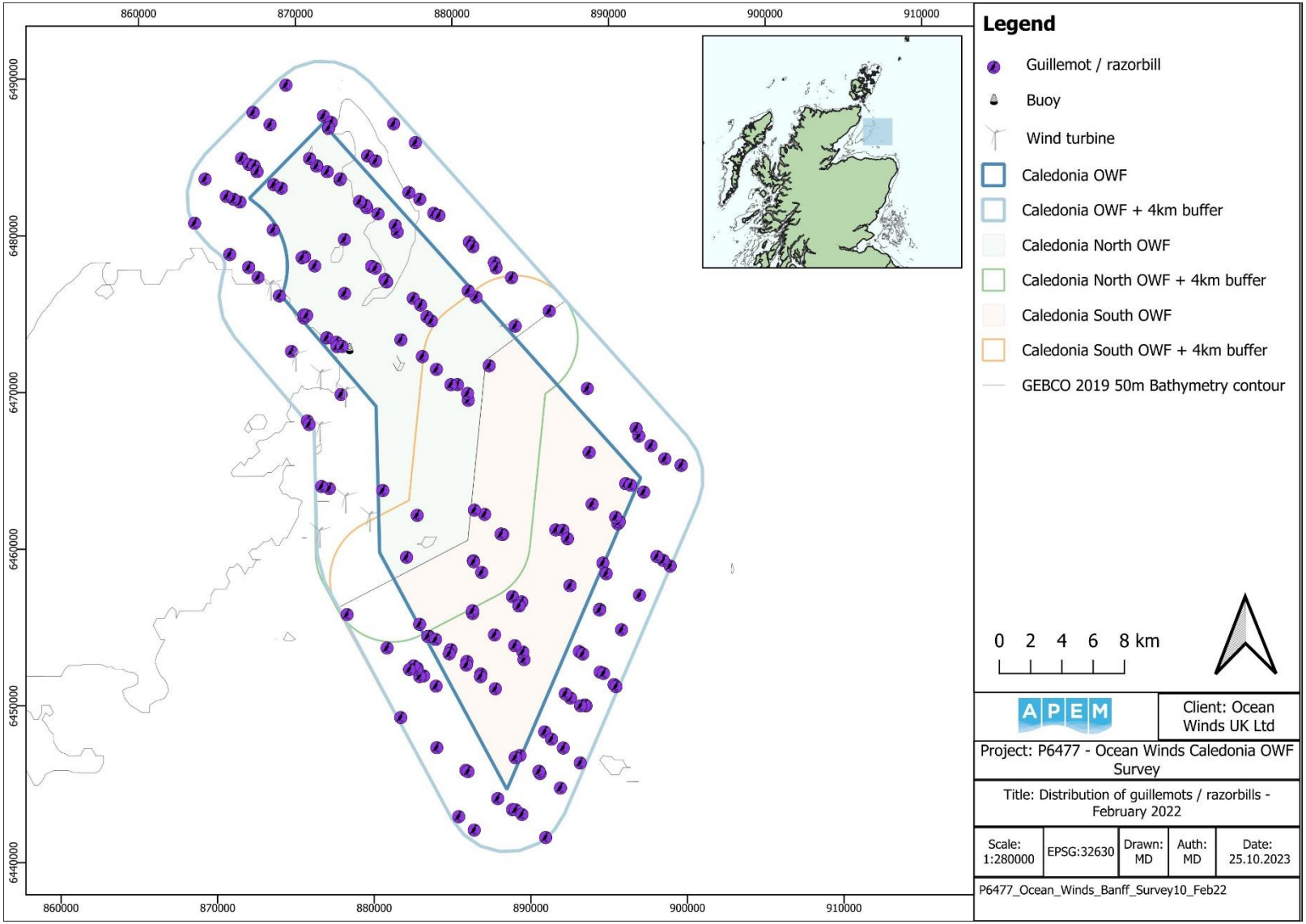


Figure A4.201 Distribution of guillemots / razorbills recorded in the Survey Area in February 2022

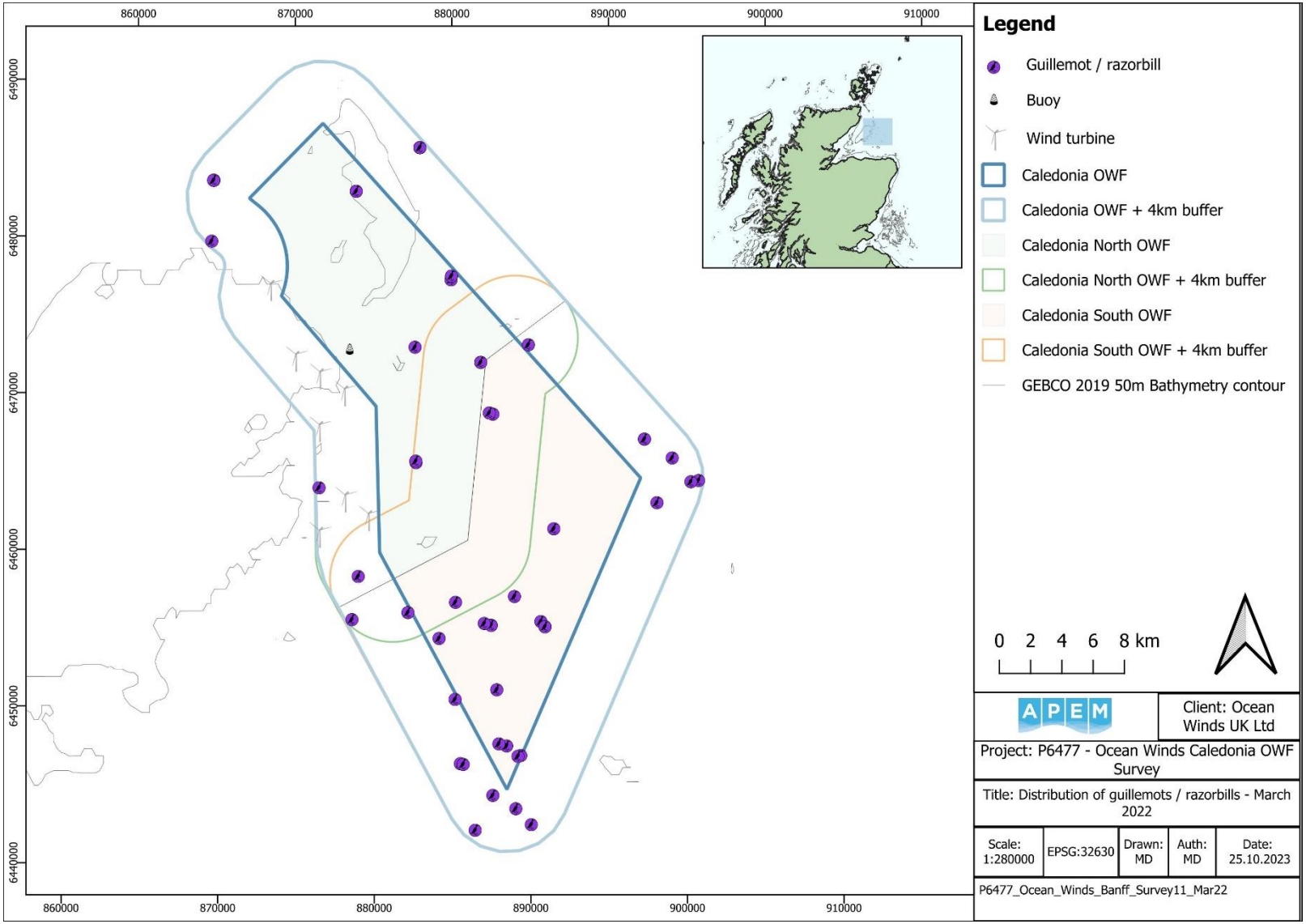


Figure A4.202 Distribution of guillemots / razorbills recorded in the Survey Area in March 2022

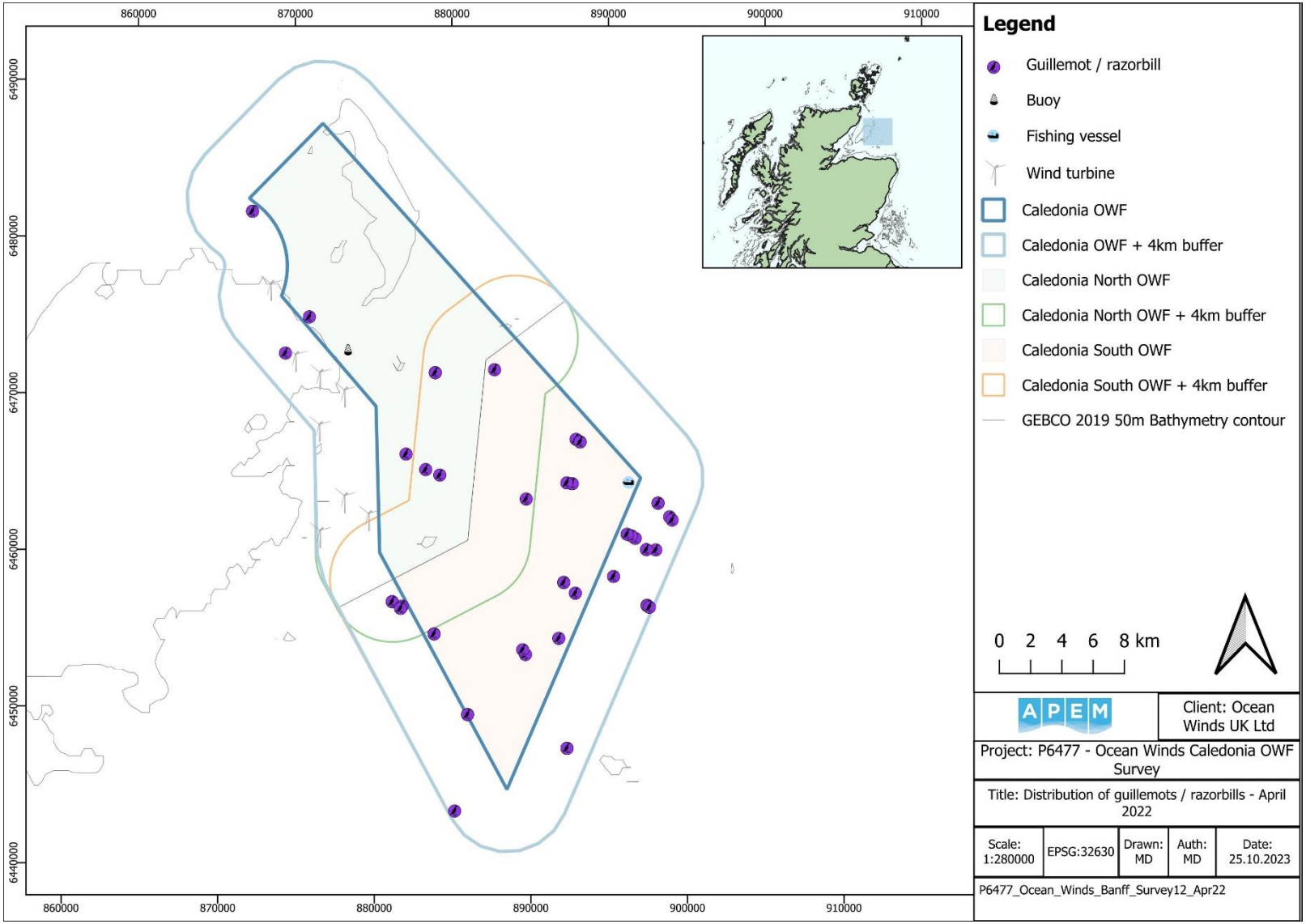


Figure A4.203 Distribution of guillemots / razorbills recorded in the Survey Area in April 2022

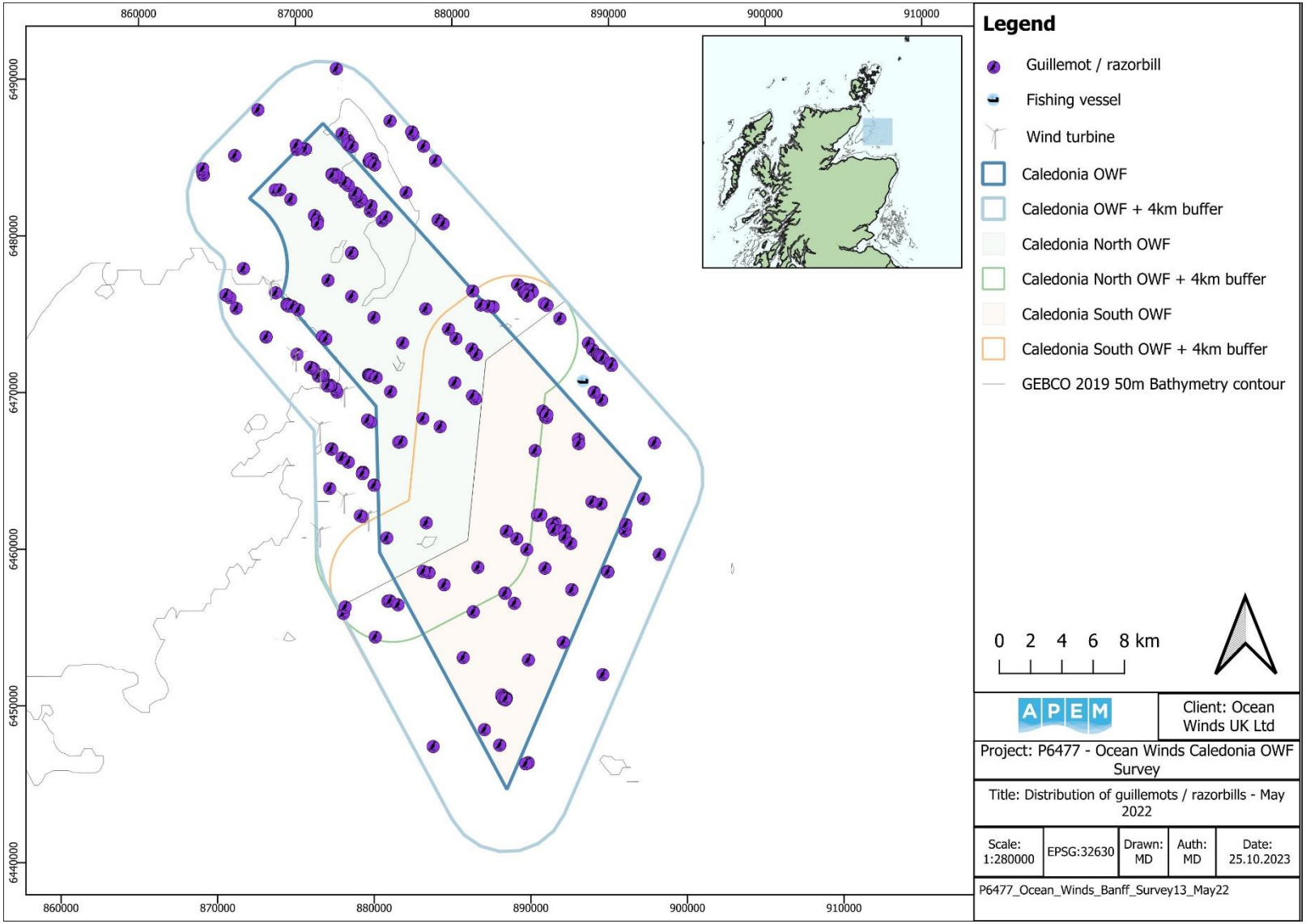


Figure A4.204 Distribution of guillemots / razorbills recorded in the Survey Area in May 2022

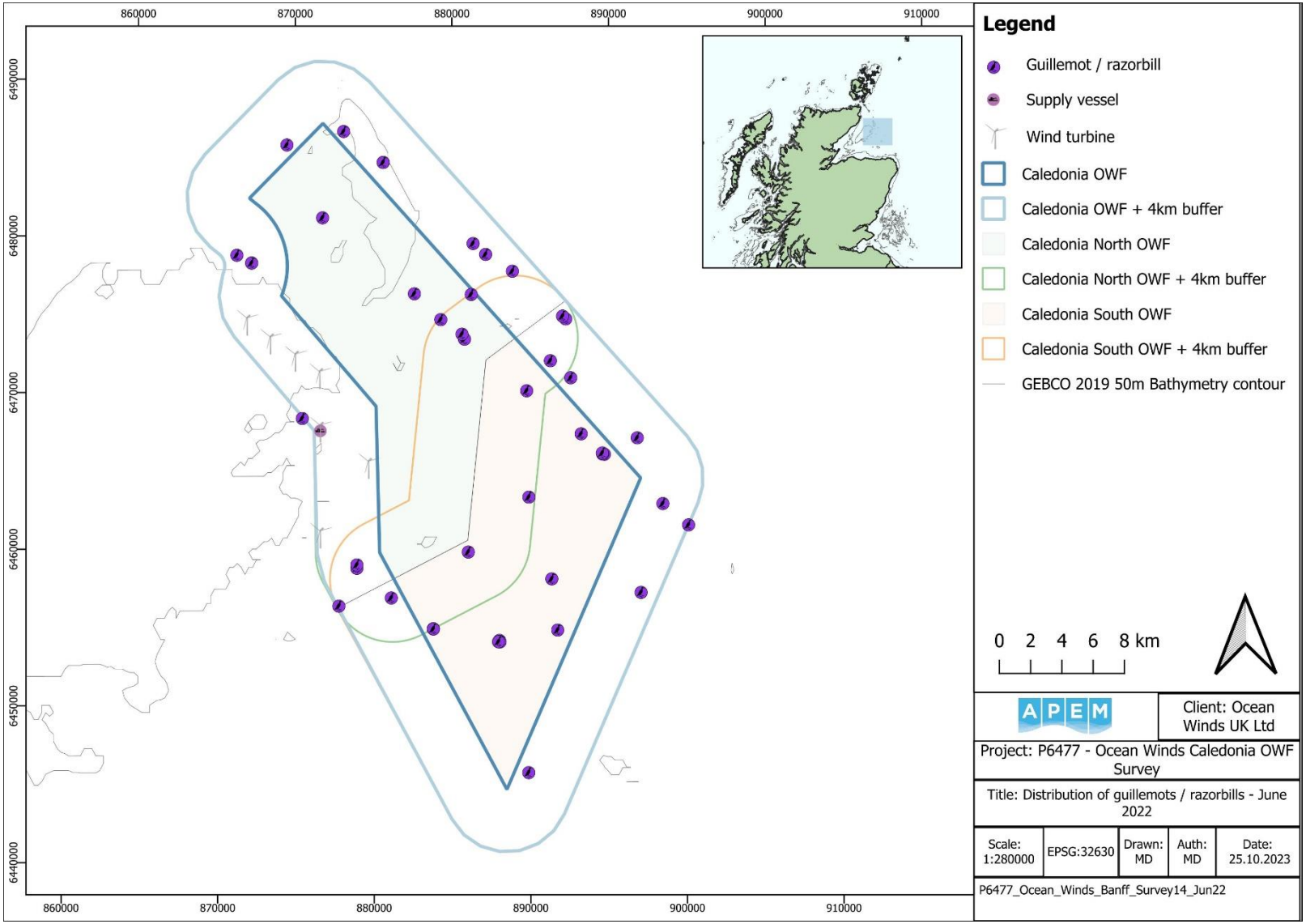


Figure A4.205 Distribution of guillemots / razorbills recorded in the Survey Area in June 2022

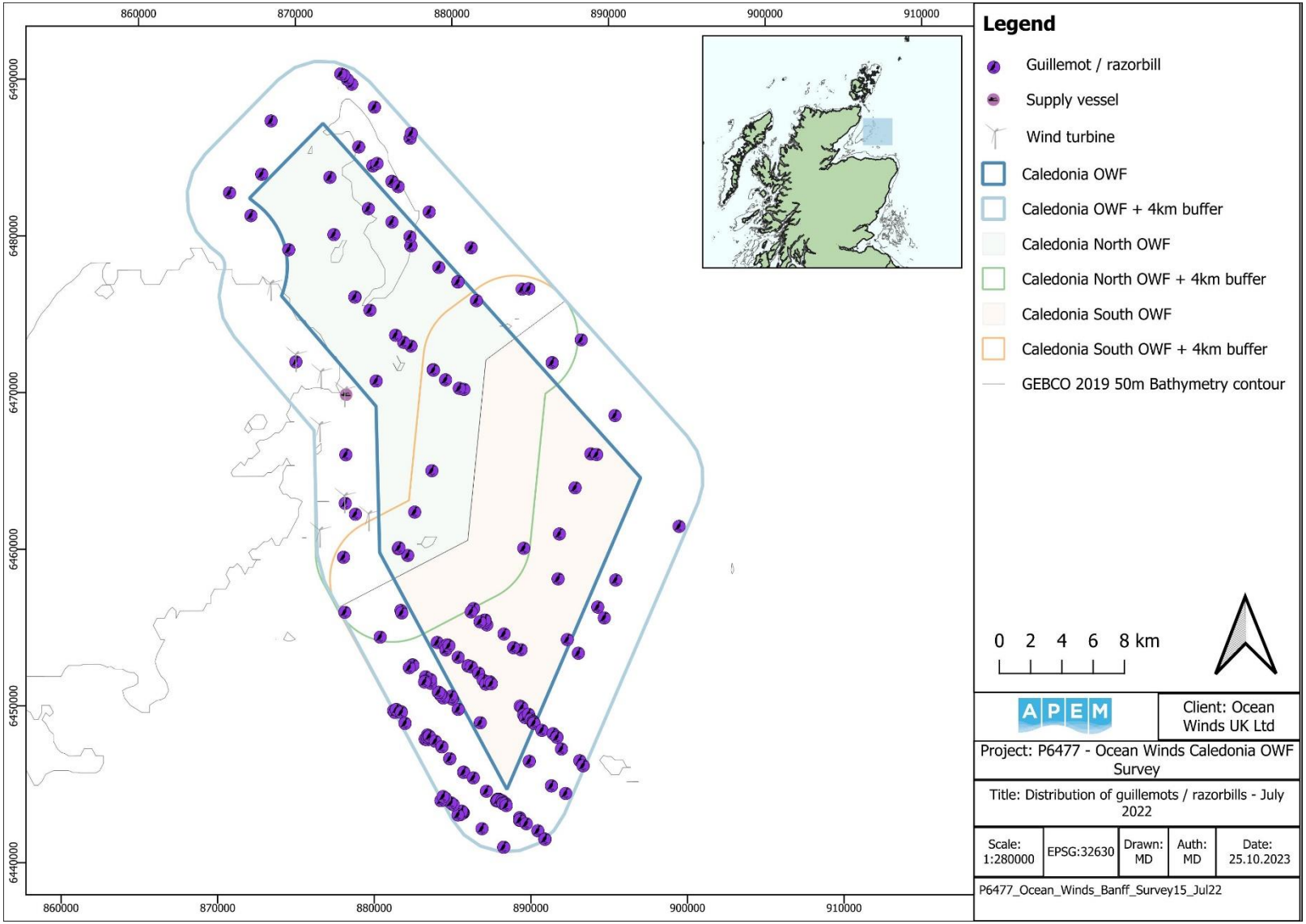


Figure A4.206 Distribution of guillemots / razorbills recorded in the Survey Area in July 2022

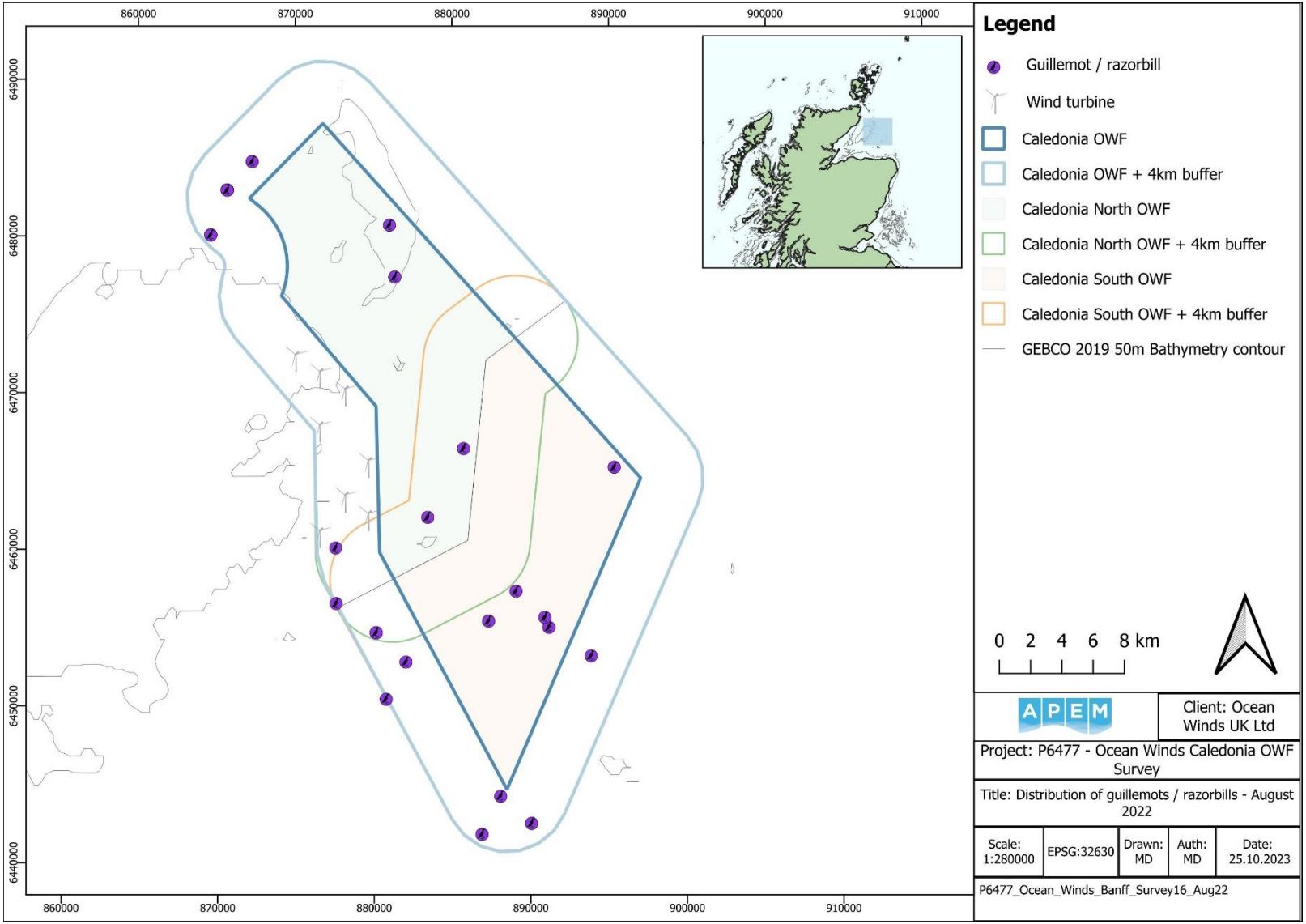


Figure A4.207 Distribution of guillemots / razorbills recorded in the Survey Area in August 2022

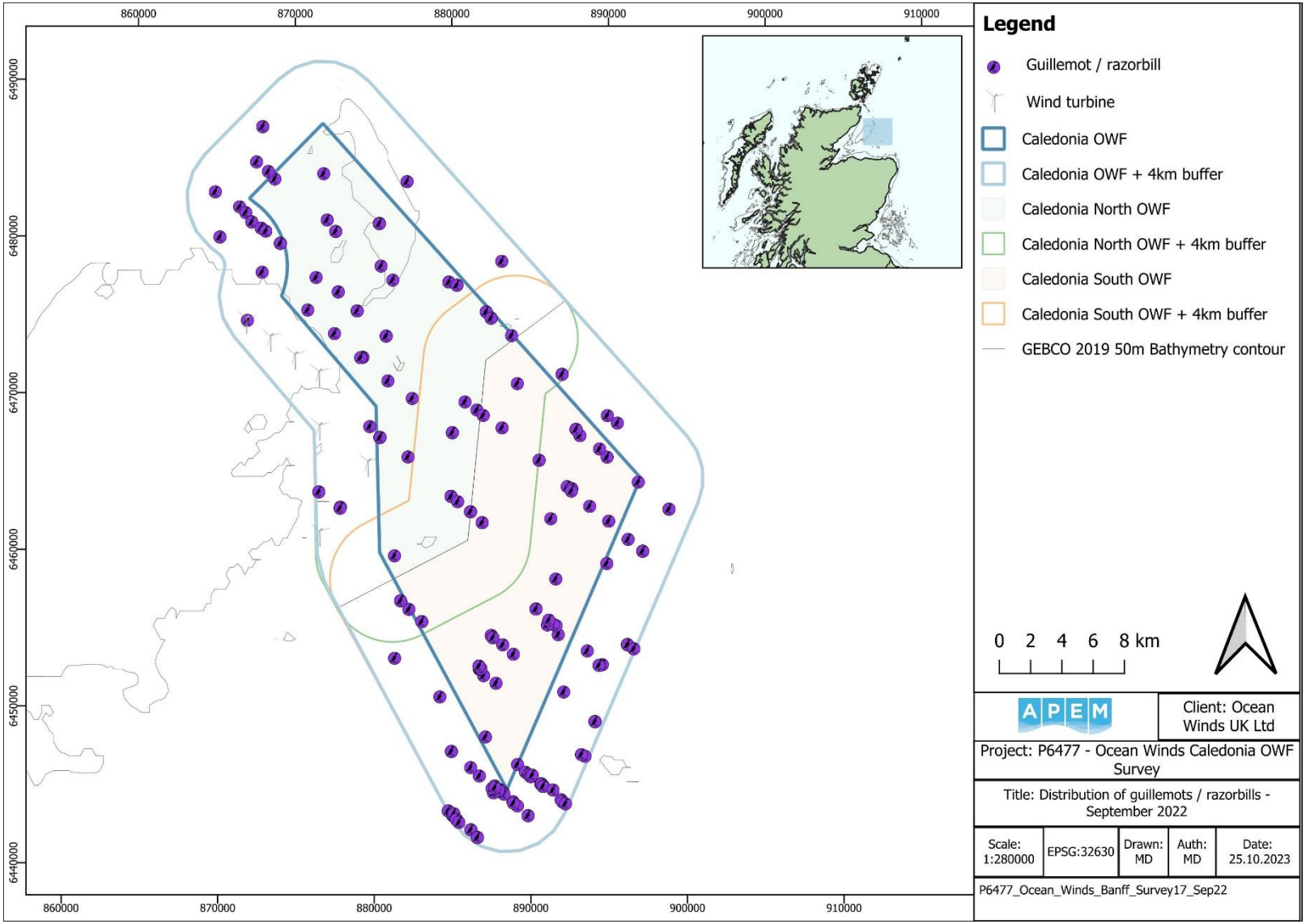


Figure A4.208 Distribution of guillemots / razorbills recorded in the Survey Area in September 2022

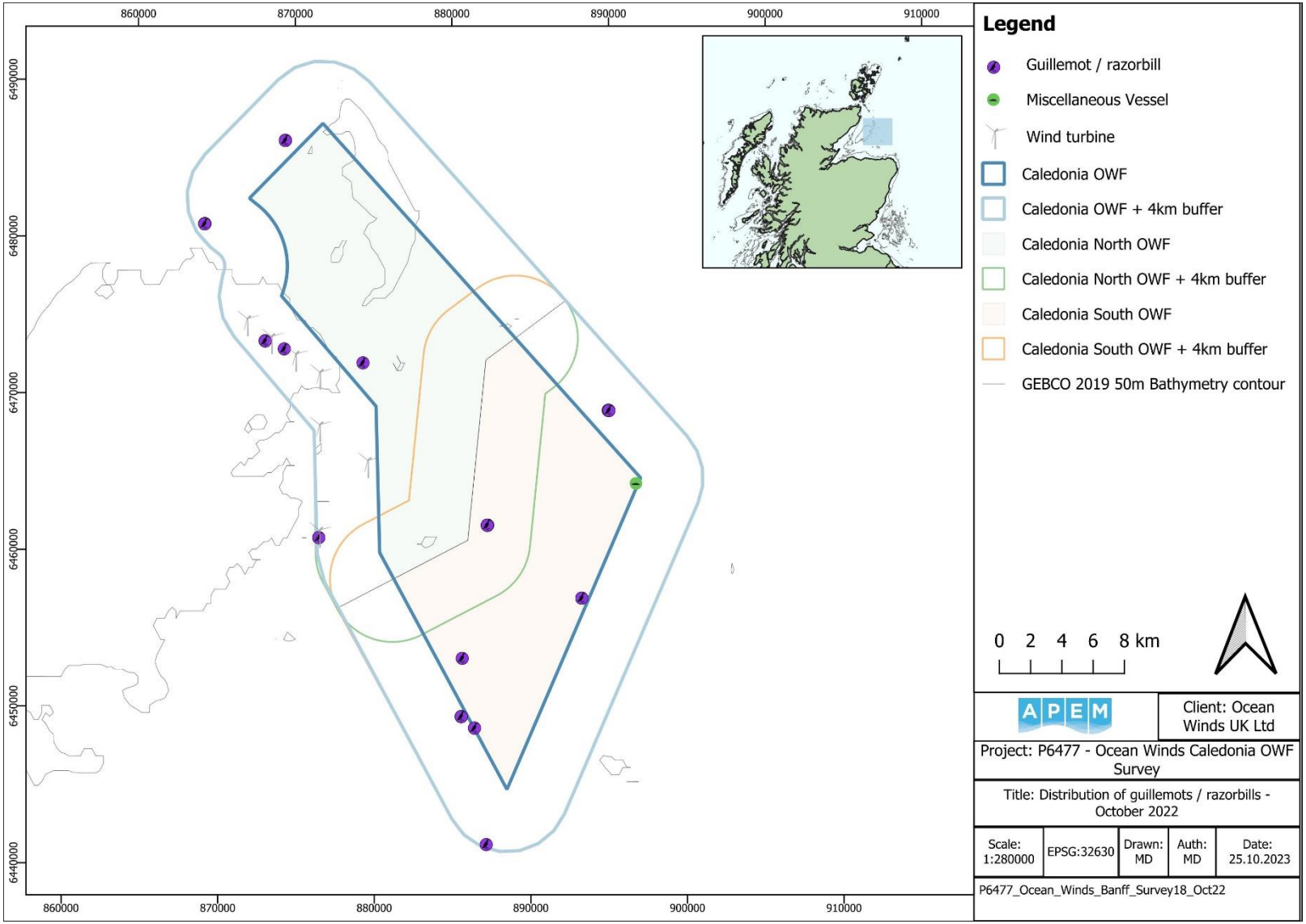


Figure A4.209 Distribution of guillemots / razorbills recorded in the Survey Area in October 2022

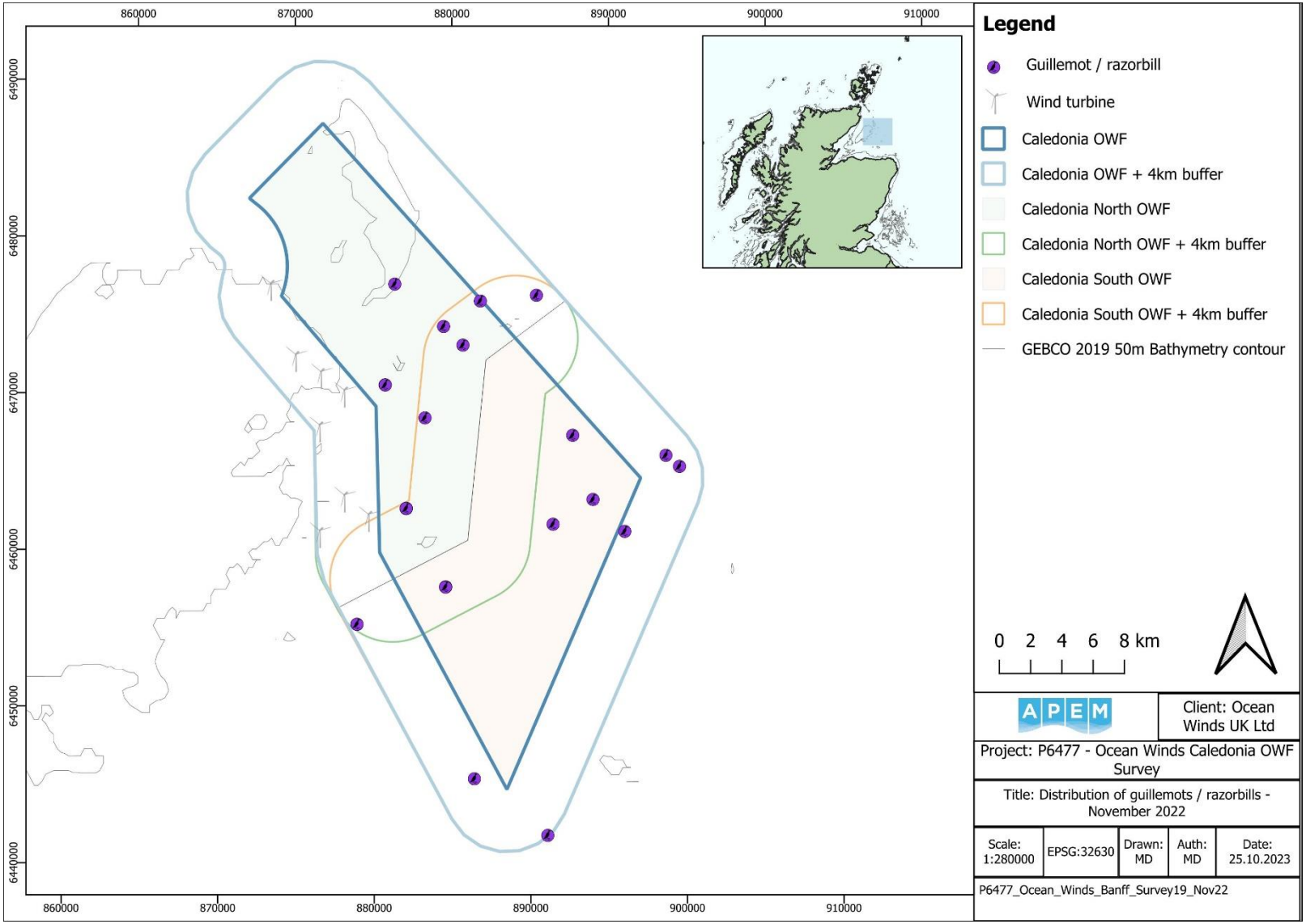


Figure A4.210 Distribution of guillemots / razorbills recorded in the Survey Area in November 2022

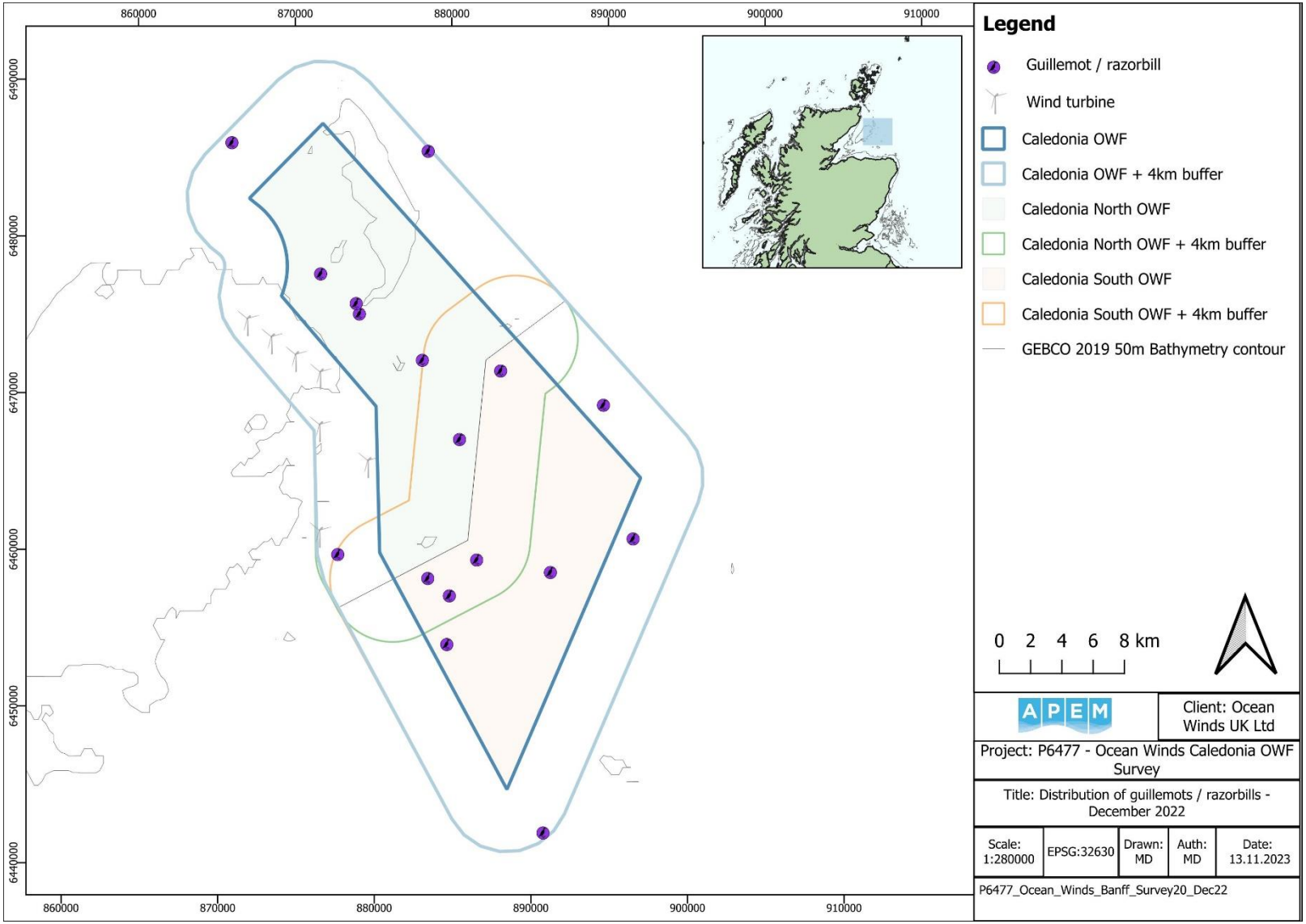


Figure A4.211 Distribution of guillemots / razorbills recorded in the Survey Area in December 2022

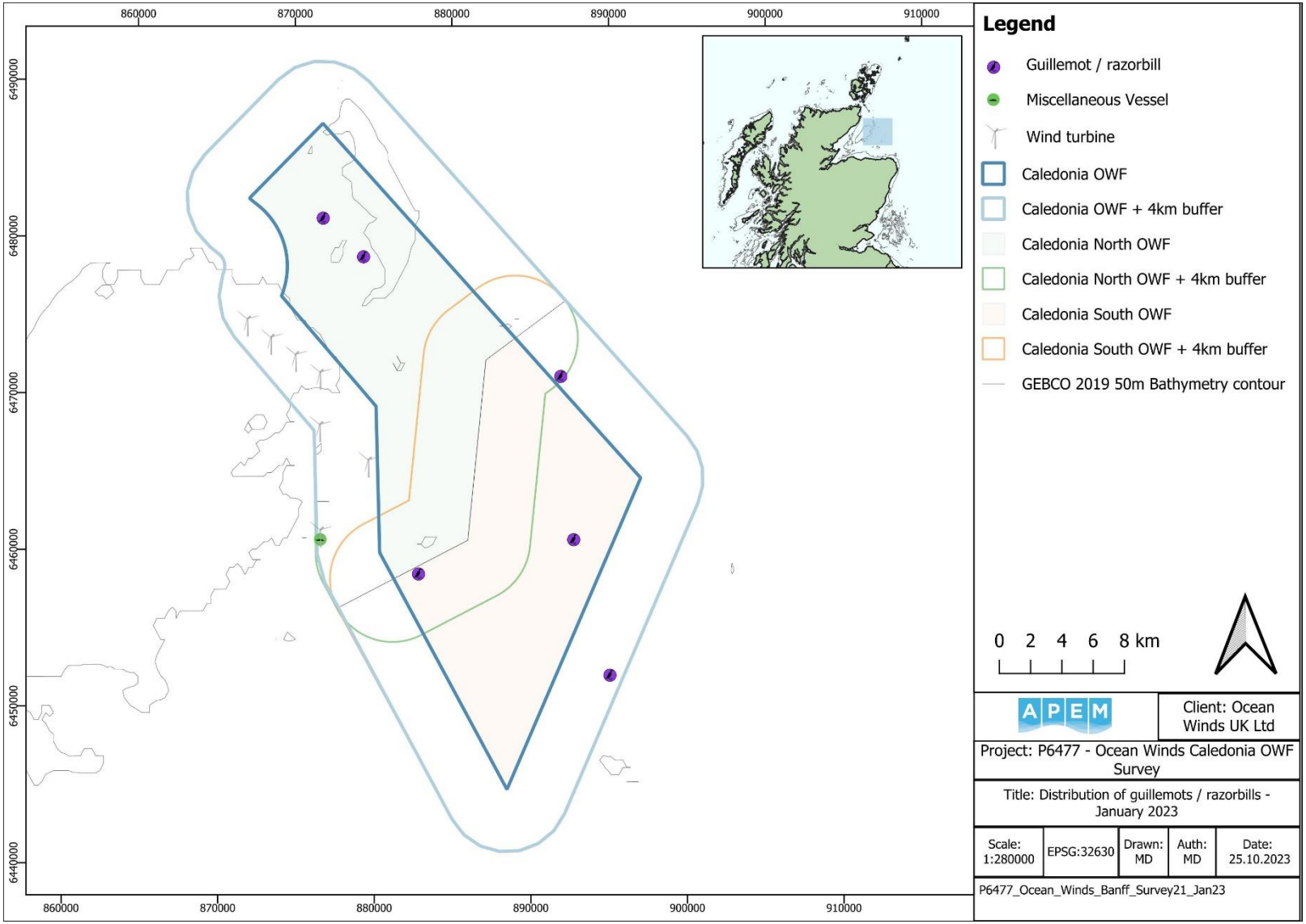


Figure A4.212 Distribution of guillemots / razorbills recorded in the Survey Area in January 2023

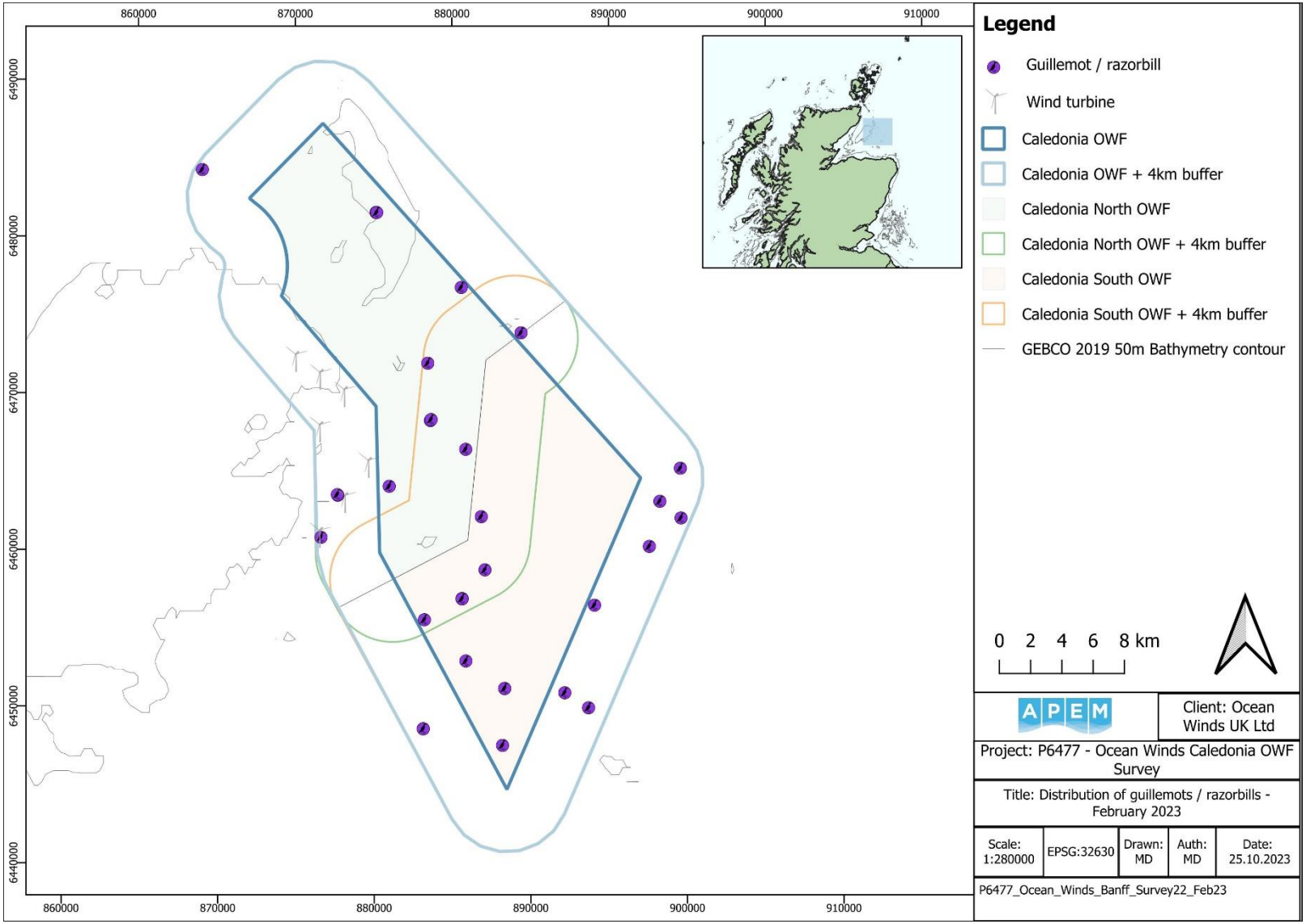


Figure A4.213 Distribution of guillemots / razorbills recorded in the Survey Area in February 2023

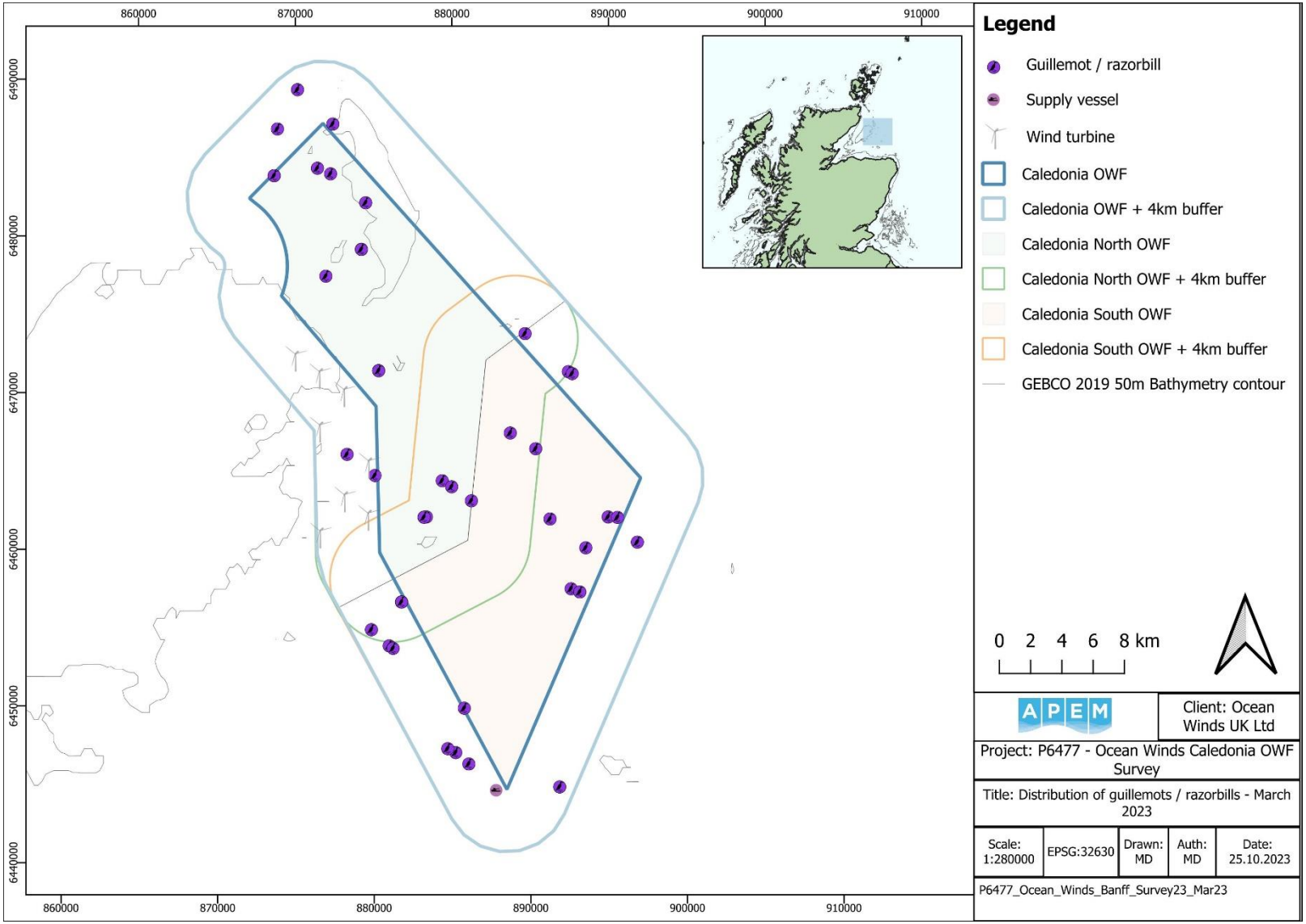


Figure A4.214 Distribution of guillemots / razorbills recorded in the Survey Area in March 2023

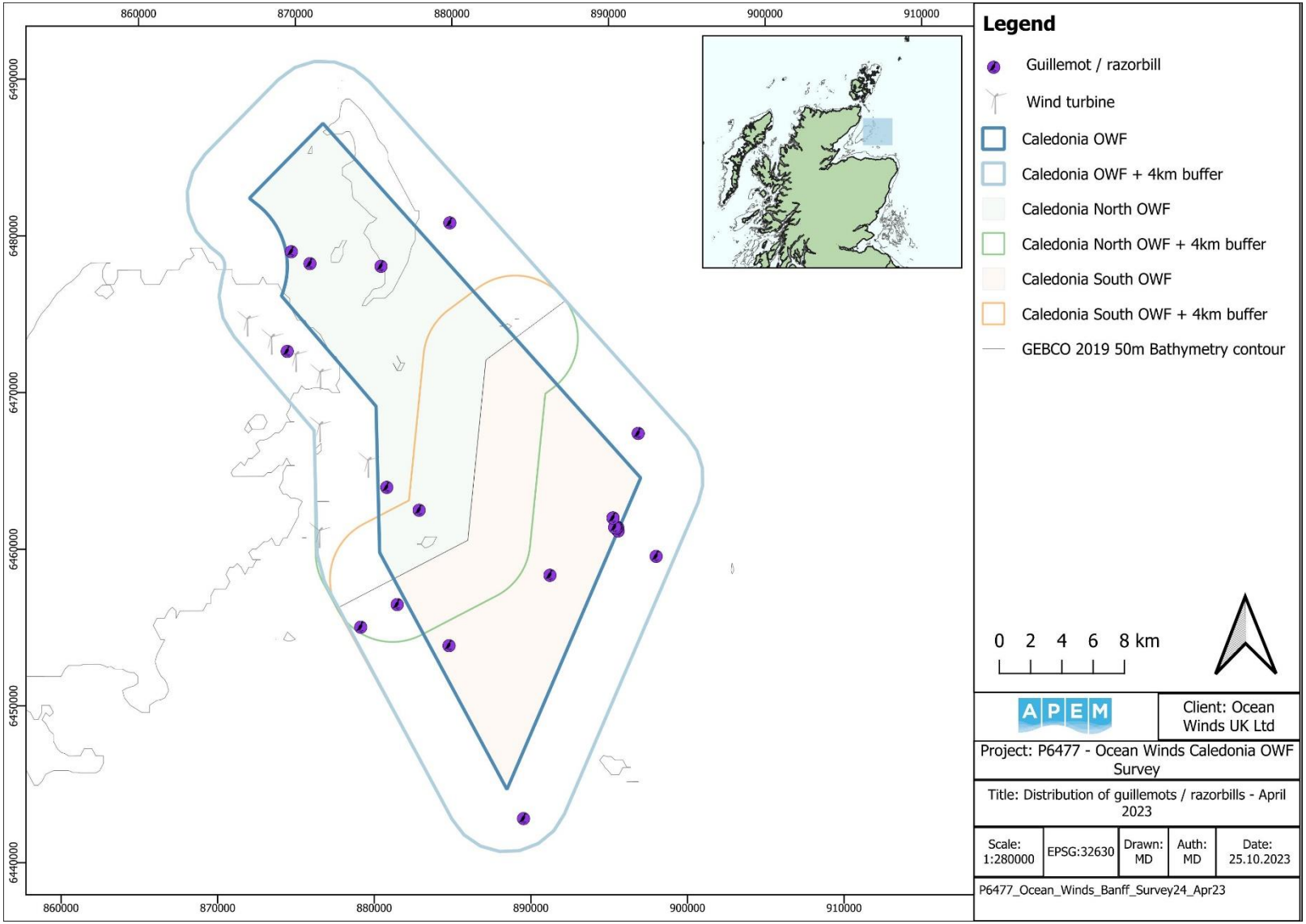


Figure A4.215 Distribution of guillemots / razorbills recorded in the Survey Area in April 2023

Black guillemot

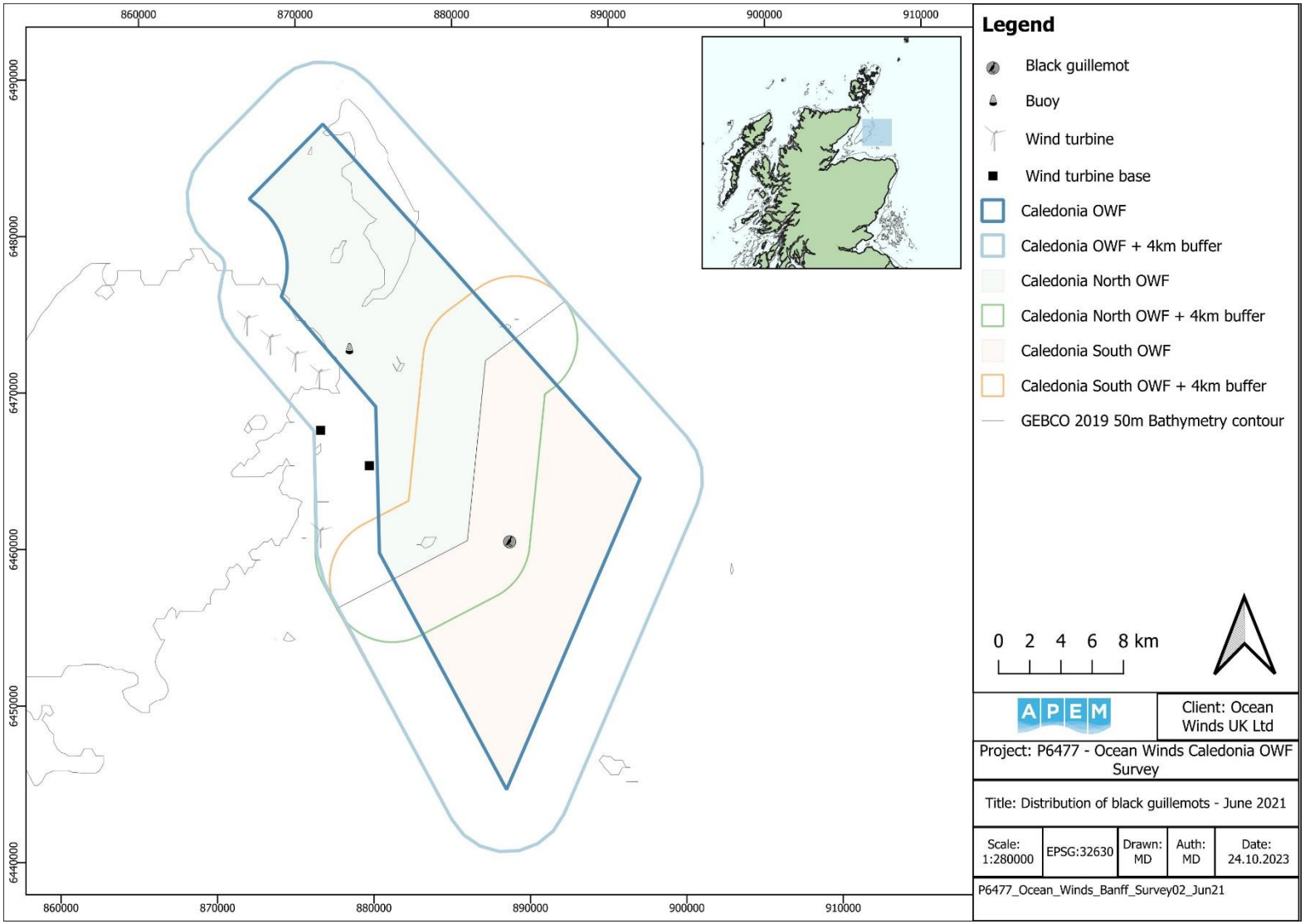


Figure A4.216 Distribution of black guillemots recorded in the Survey Area in June 2021

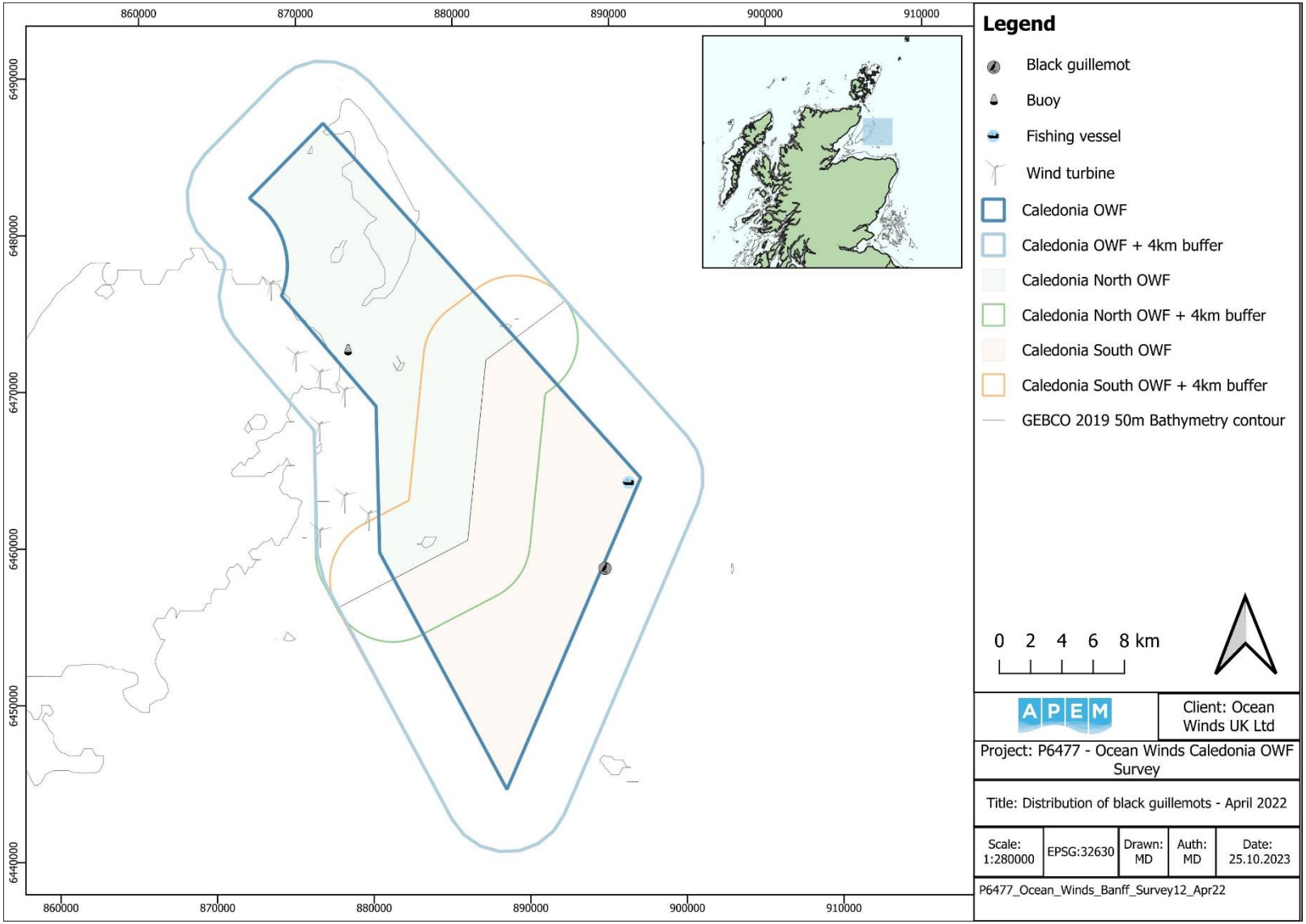


Figure A4.217 Distribution of black guillemots recorded in the Survey Area in April 2022

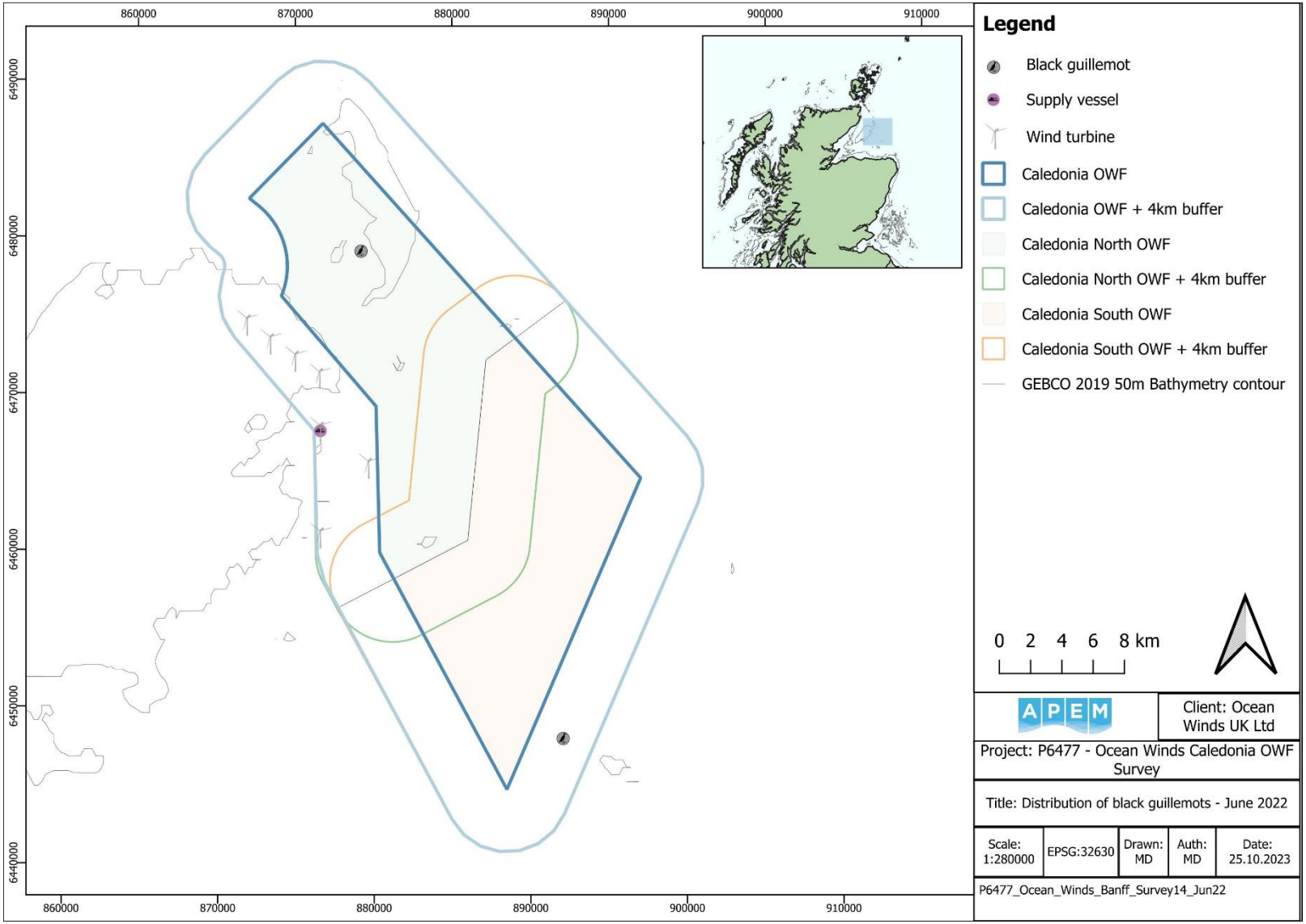


Figure A4.218 Distribution of black guillemots recorded in the Survey Area in June 2022

Puffin

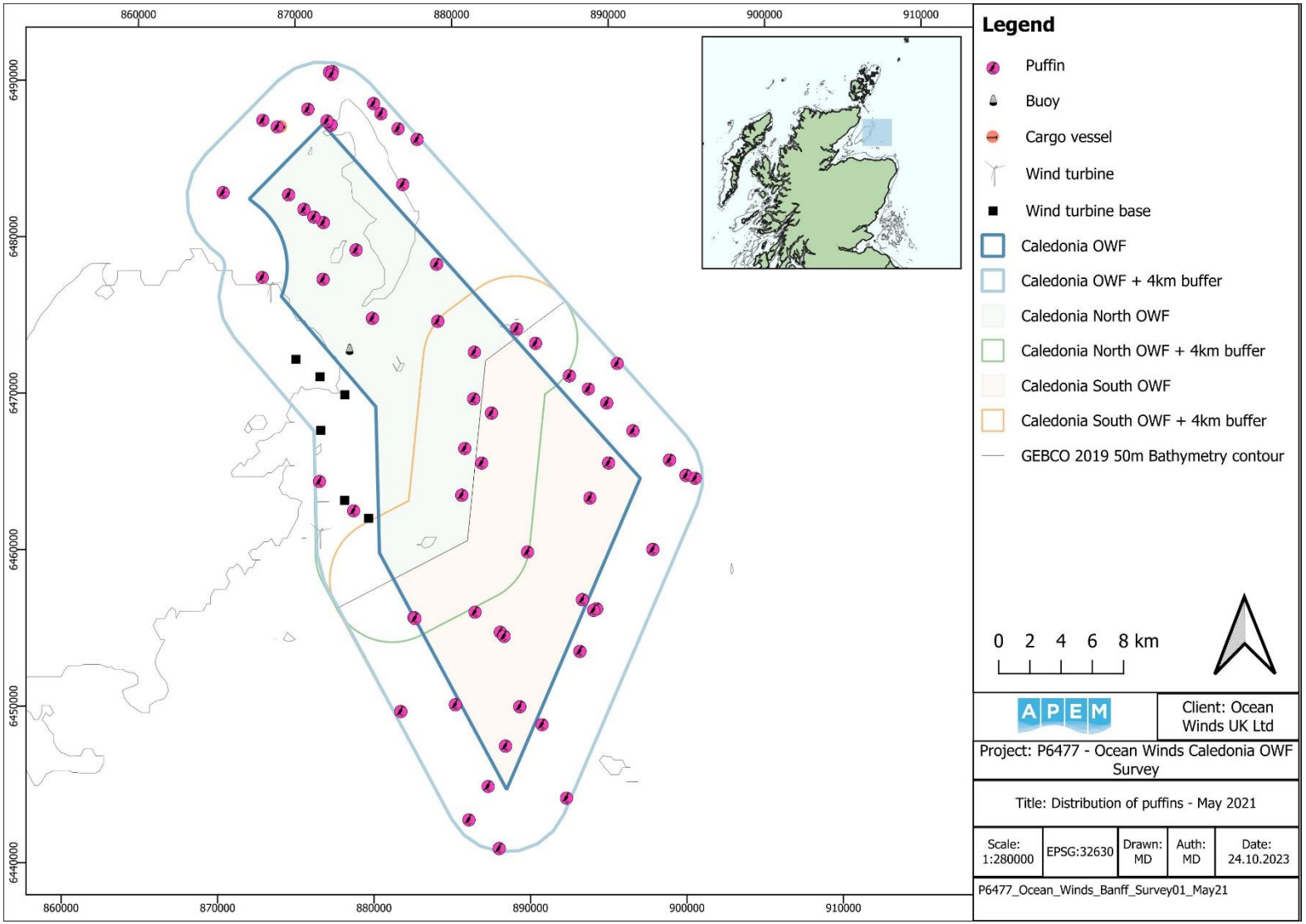


Figure A4.219 Distribution of puffins recorded in the Survey Area in May 2021

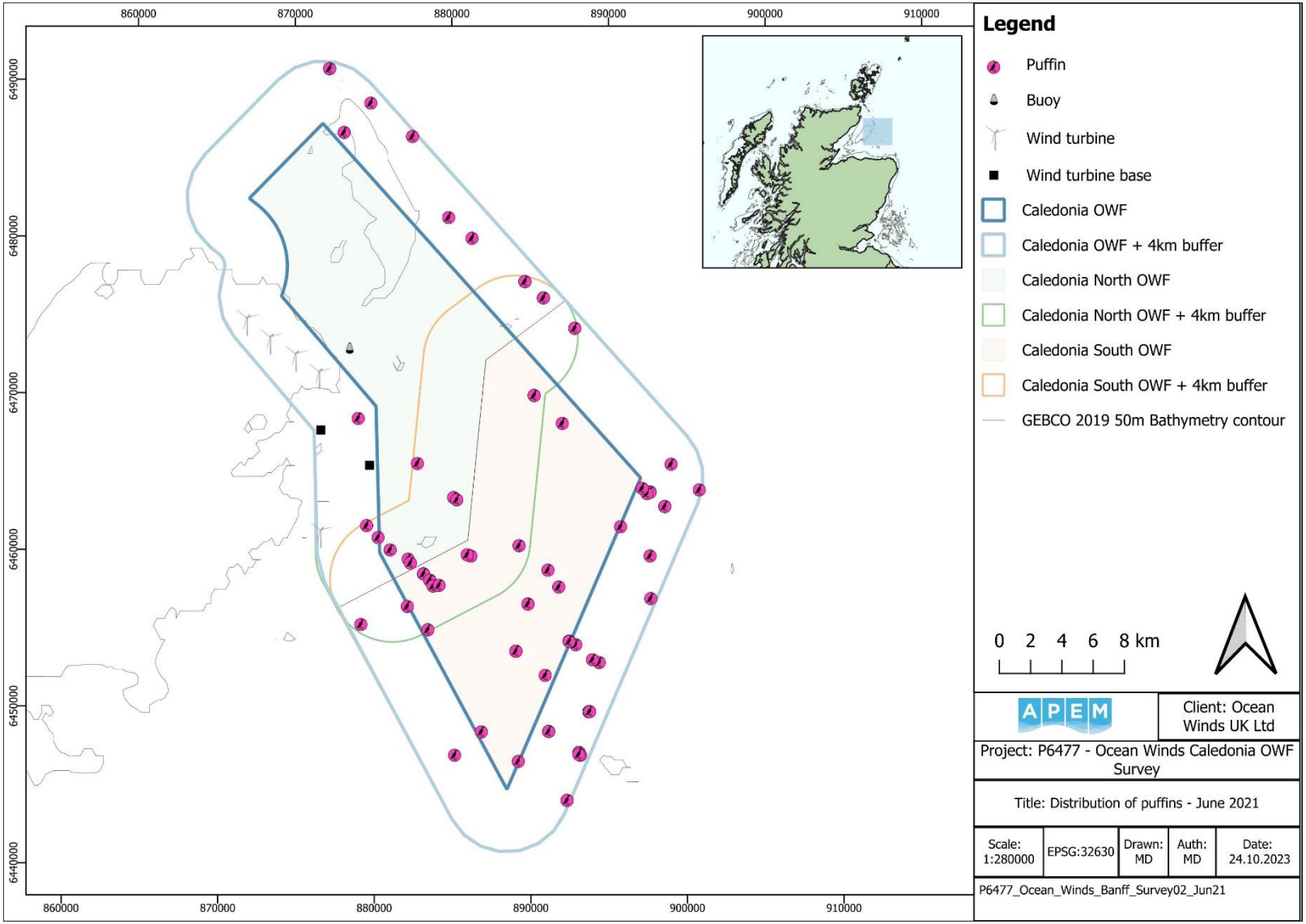


Figure A4.220 Distribution of puffins recorded in the Survey Area in June 2021

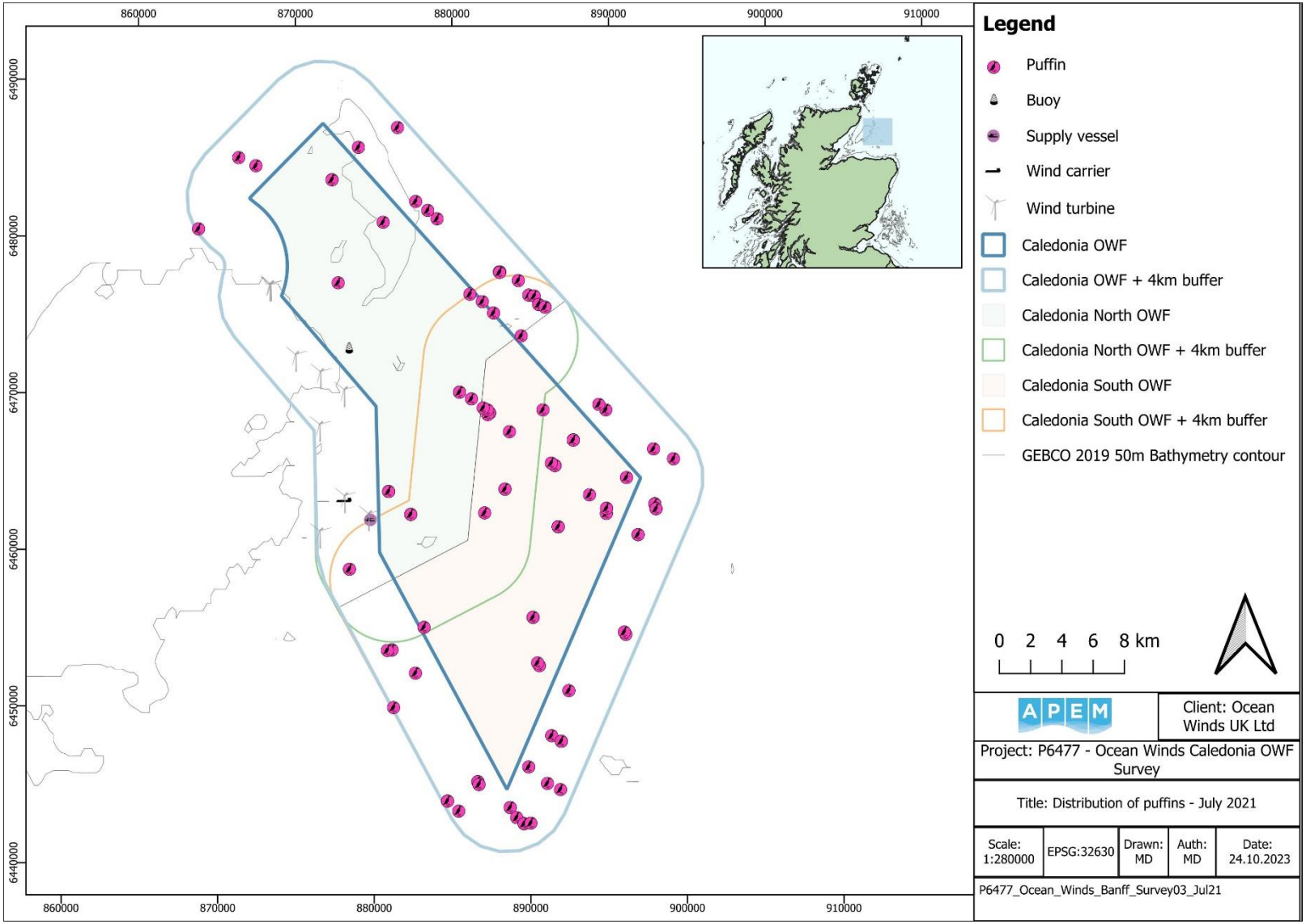


Figure A4.221 Distribution of puffins recorded in the Survey Area in July 2021

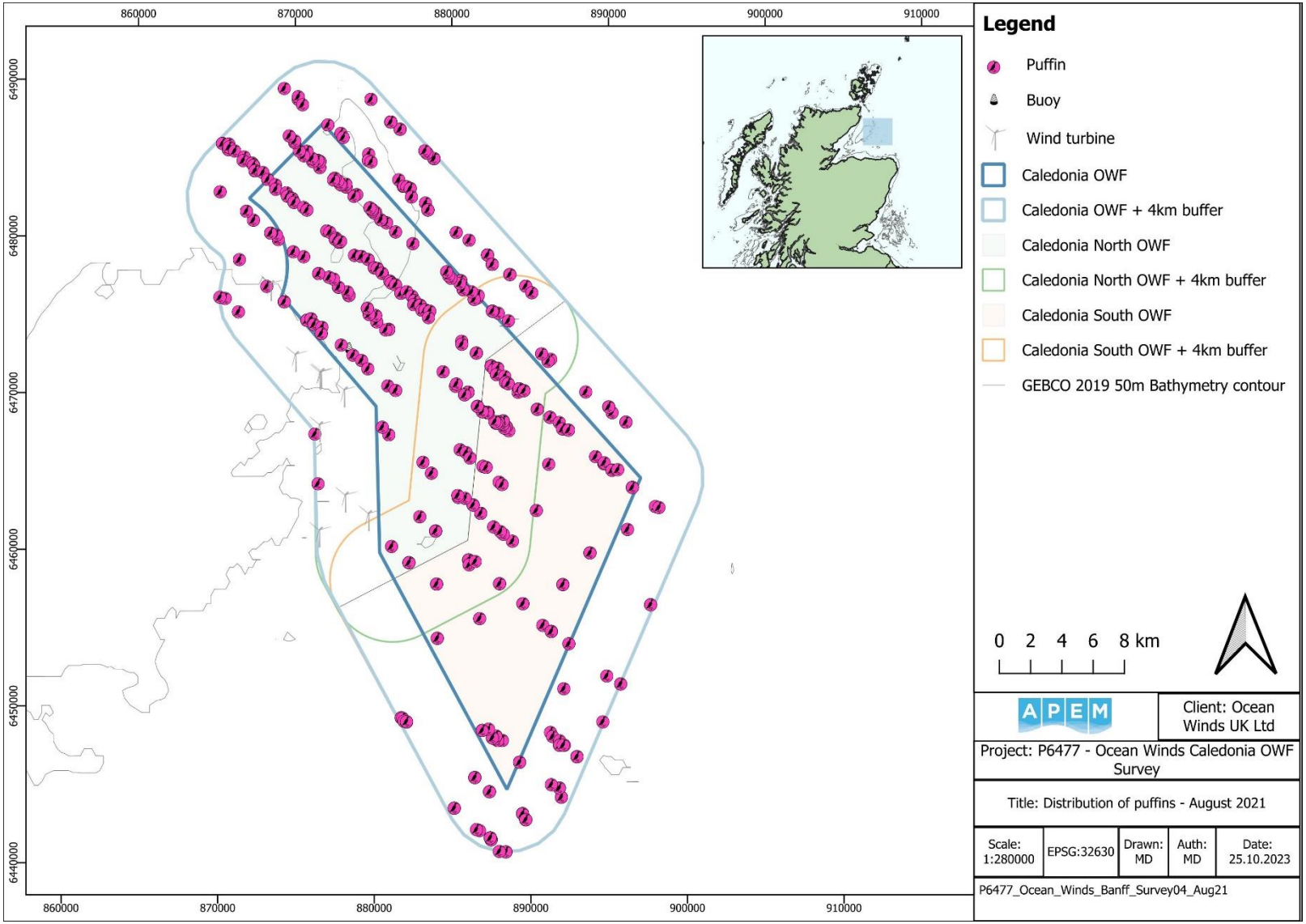


Figure A4.222 Distribution of puffins recorded in the Survey Area in August 2021

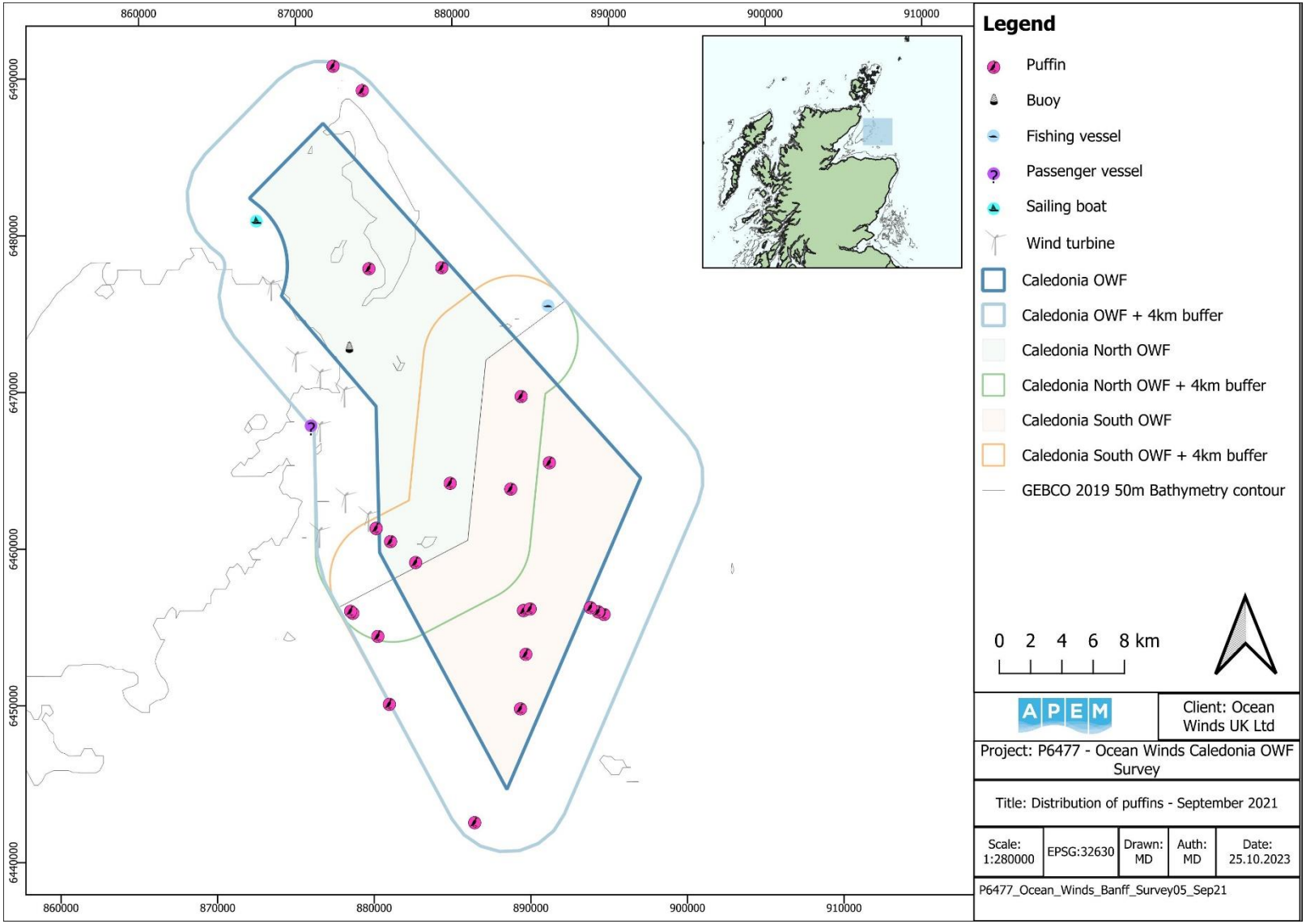


Figure A4.223 Distribution of puffins recorded in the Survey Area in September 2021

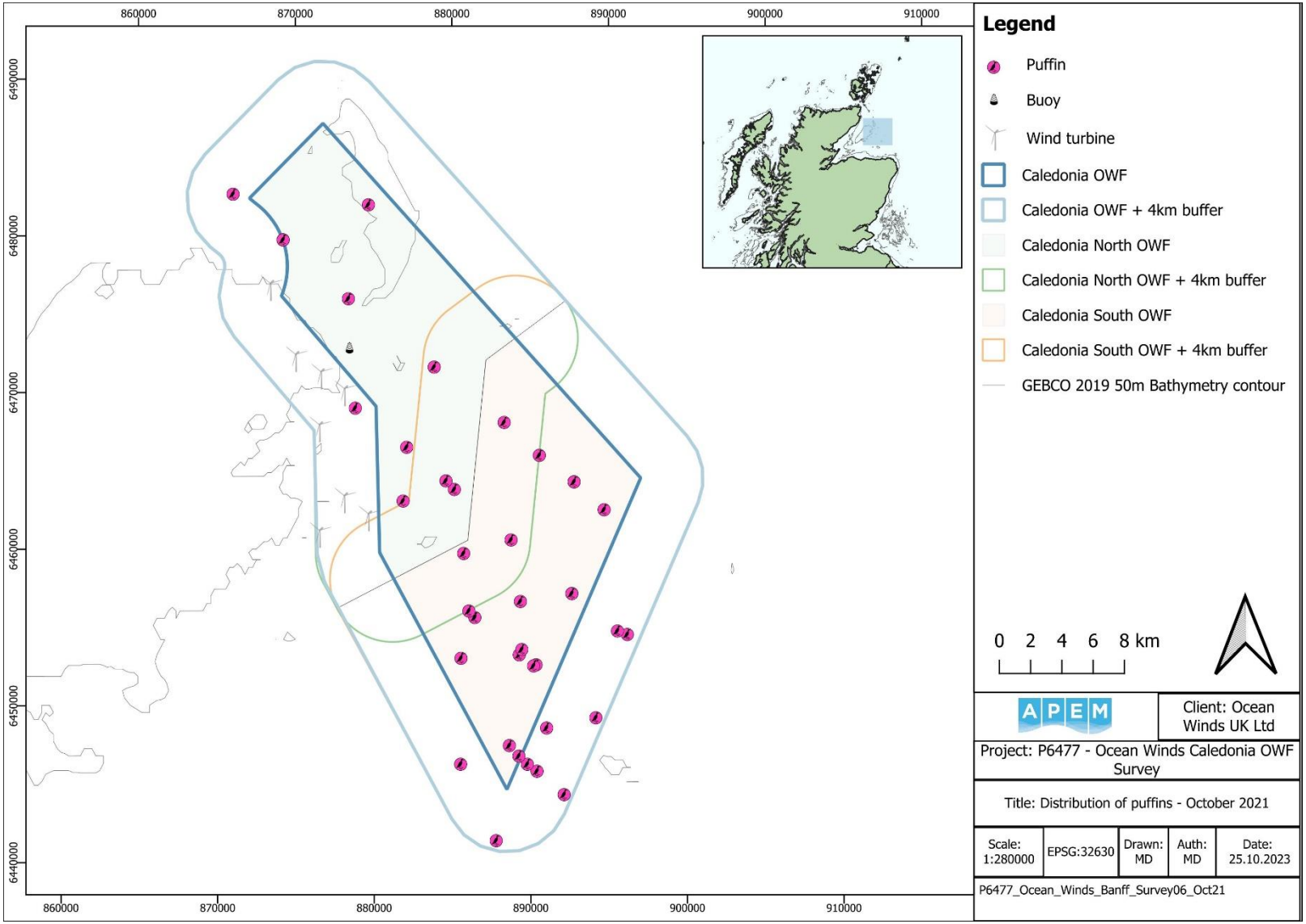


Figure A4.224 Distribution of puffins recorded in the Survey Area in October 2021

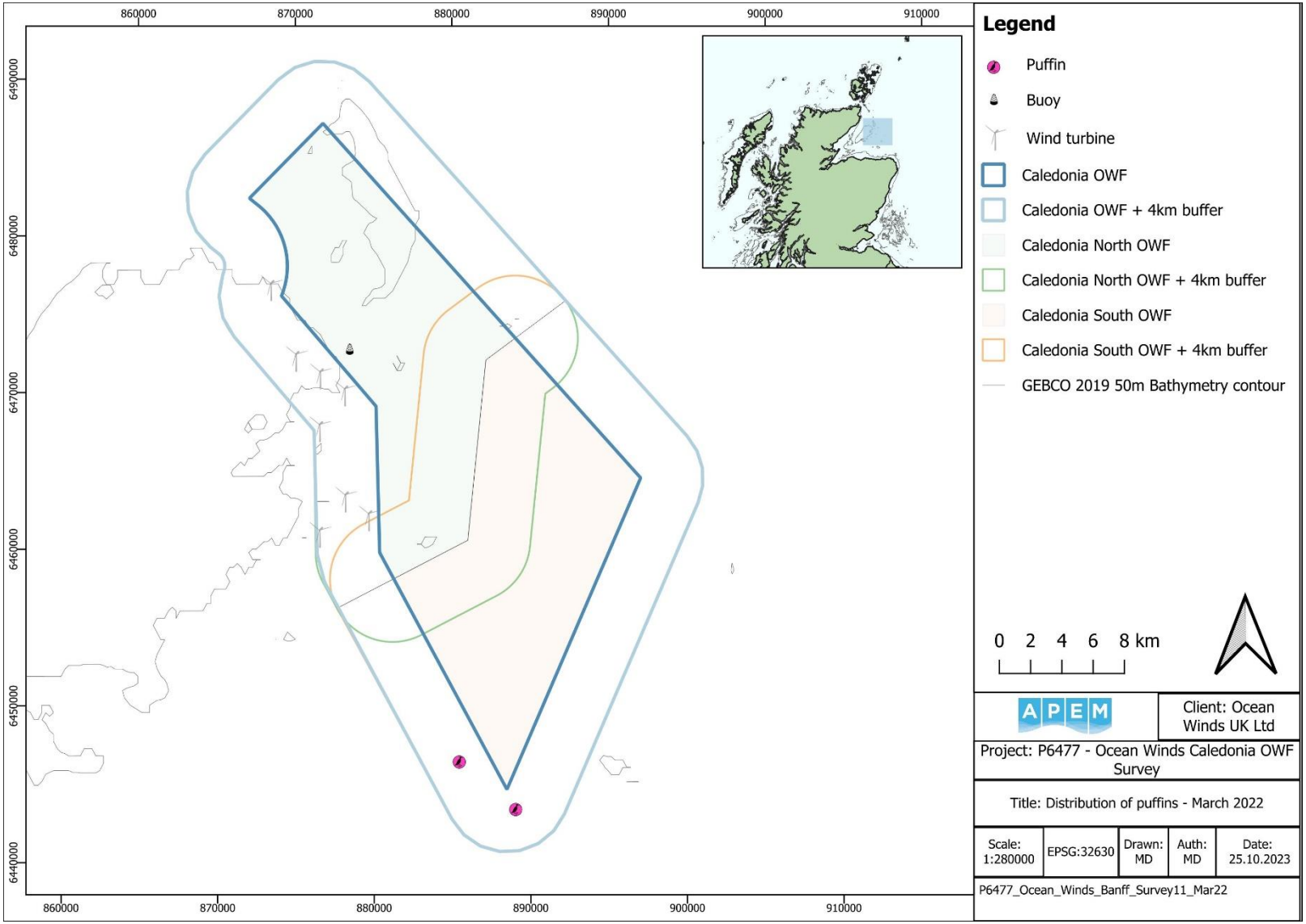


Figure A4.225 Distribution of puffins recorded in the Survey Area in March 2022

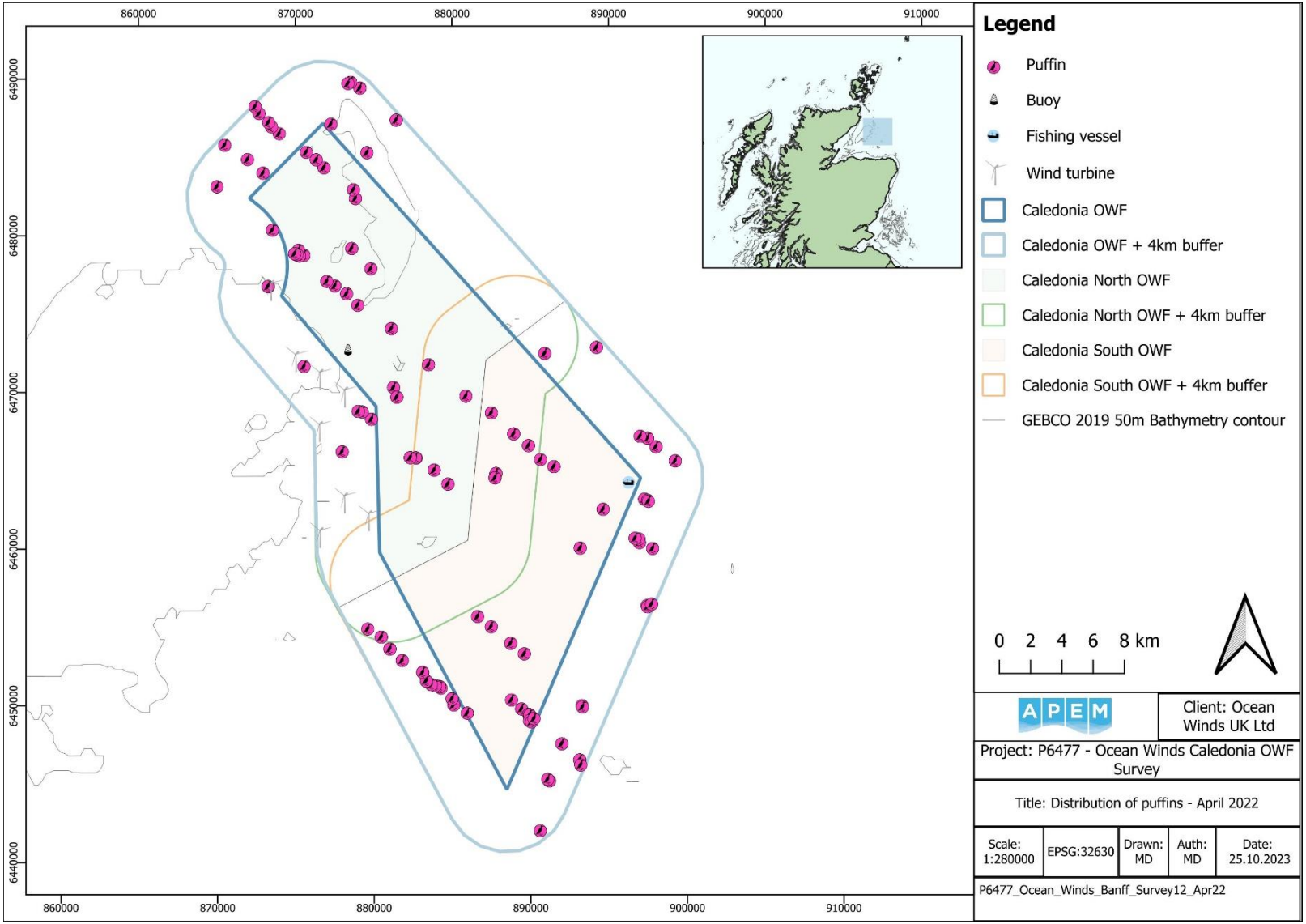


Figure A4.226 Distribution of puffins recorded in the Survey Area in April 2022

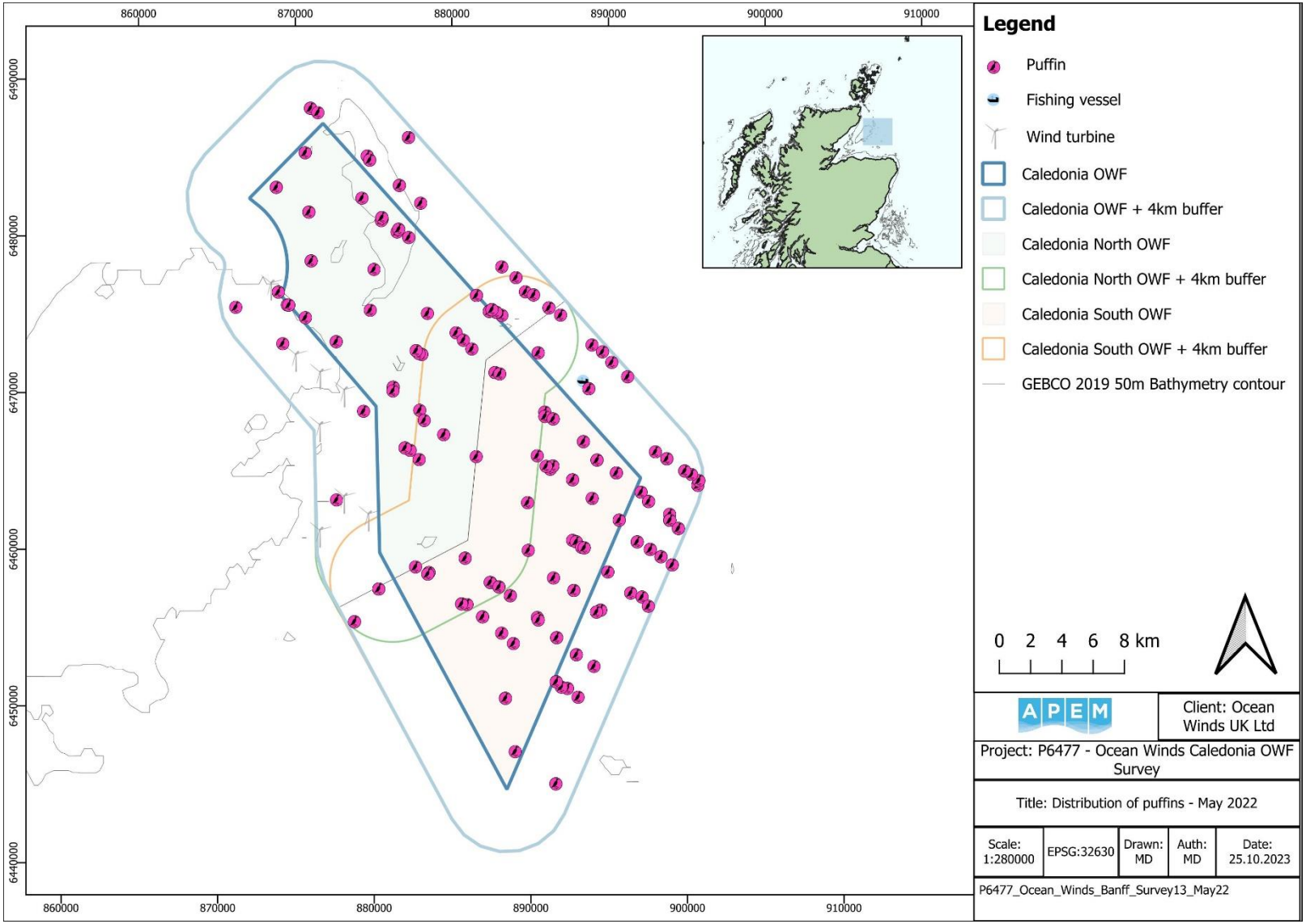


Figure A4.227 Distribution of puffins recorded in the Survey Area in May 2022

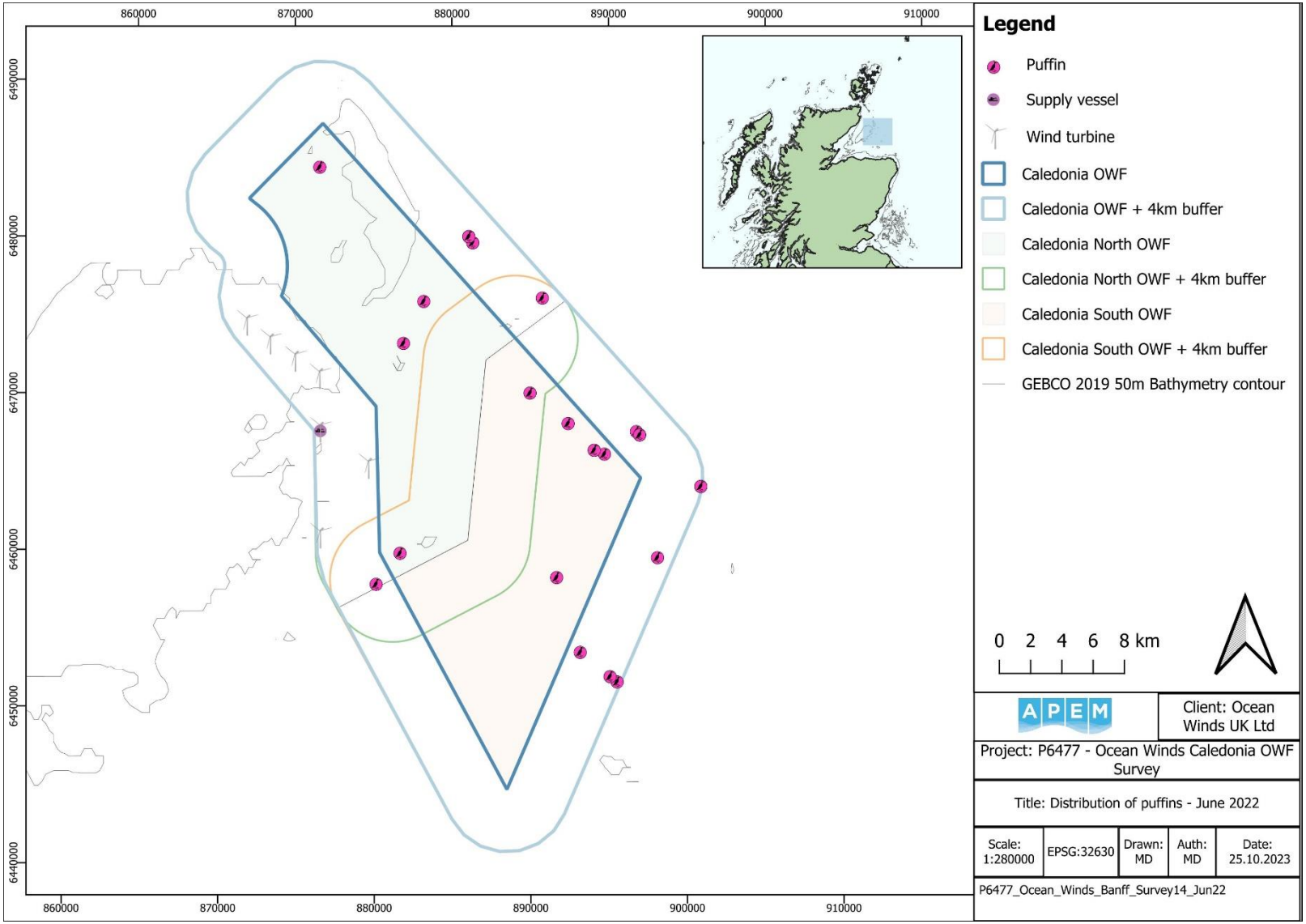


Figure A4.228 Distribution of puffins recorded in the Survey Area in June 2022

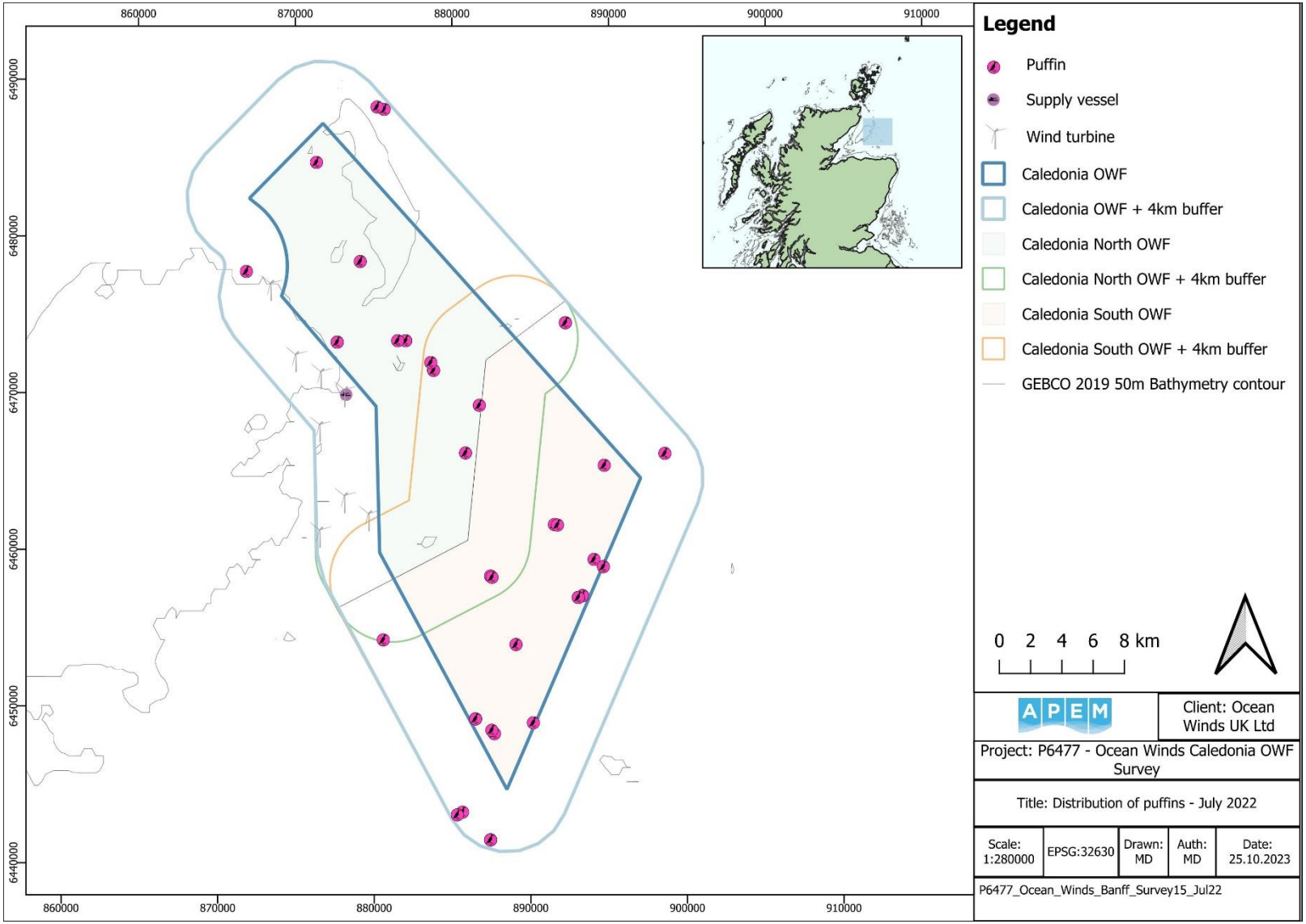


Figure A4.229 Distribution of puffins recorded in the Survey Area in July 2022

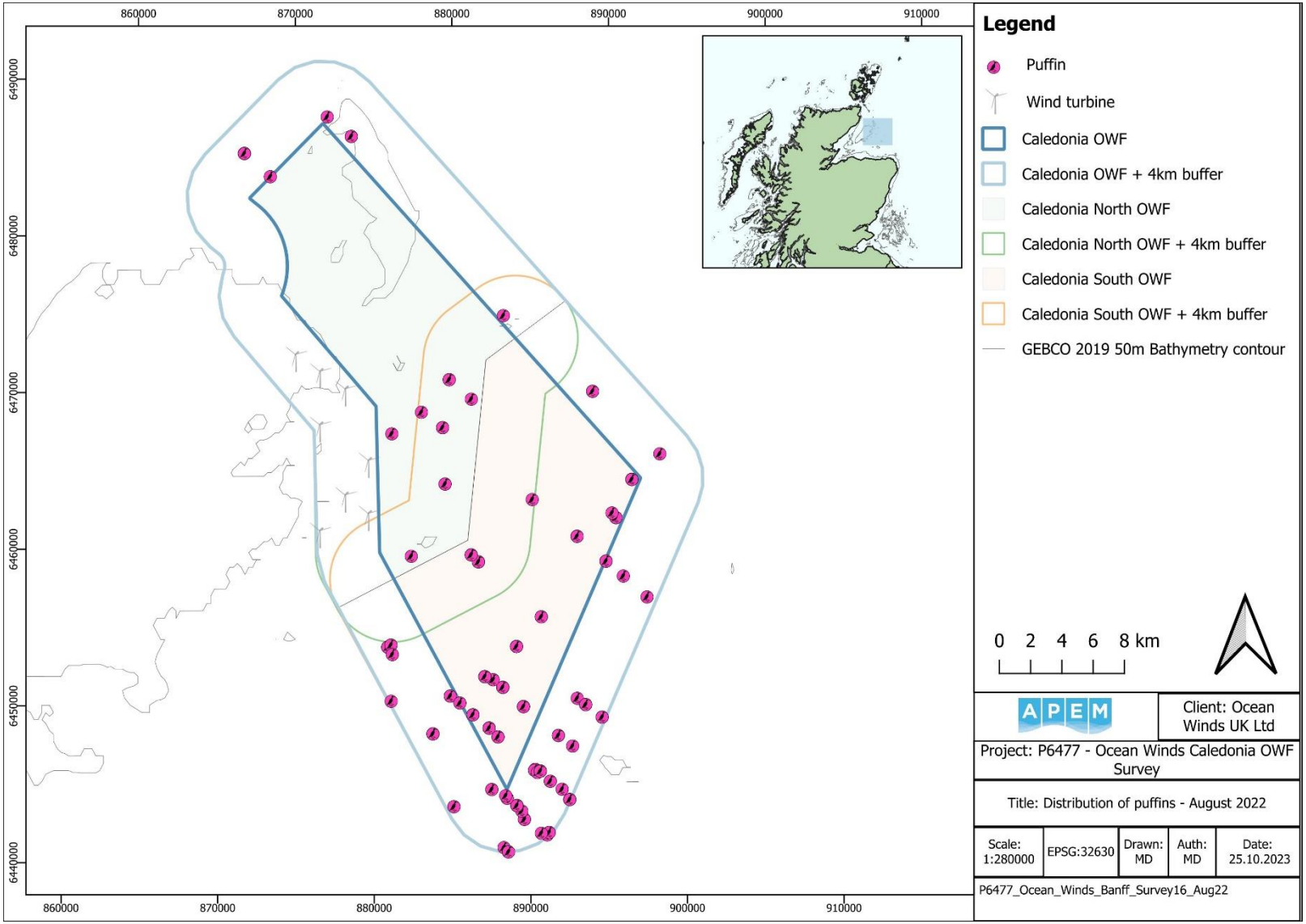


Figure A4.230 Distribution of puffins recorded in the Survey Area in August 2022

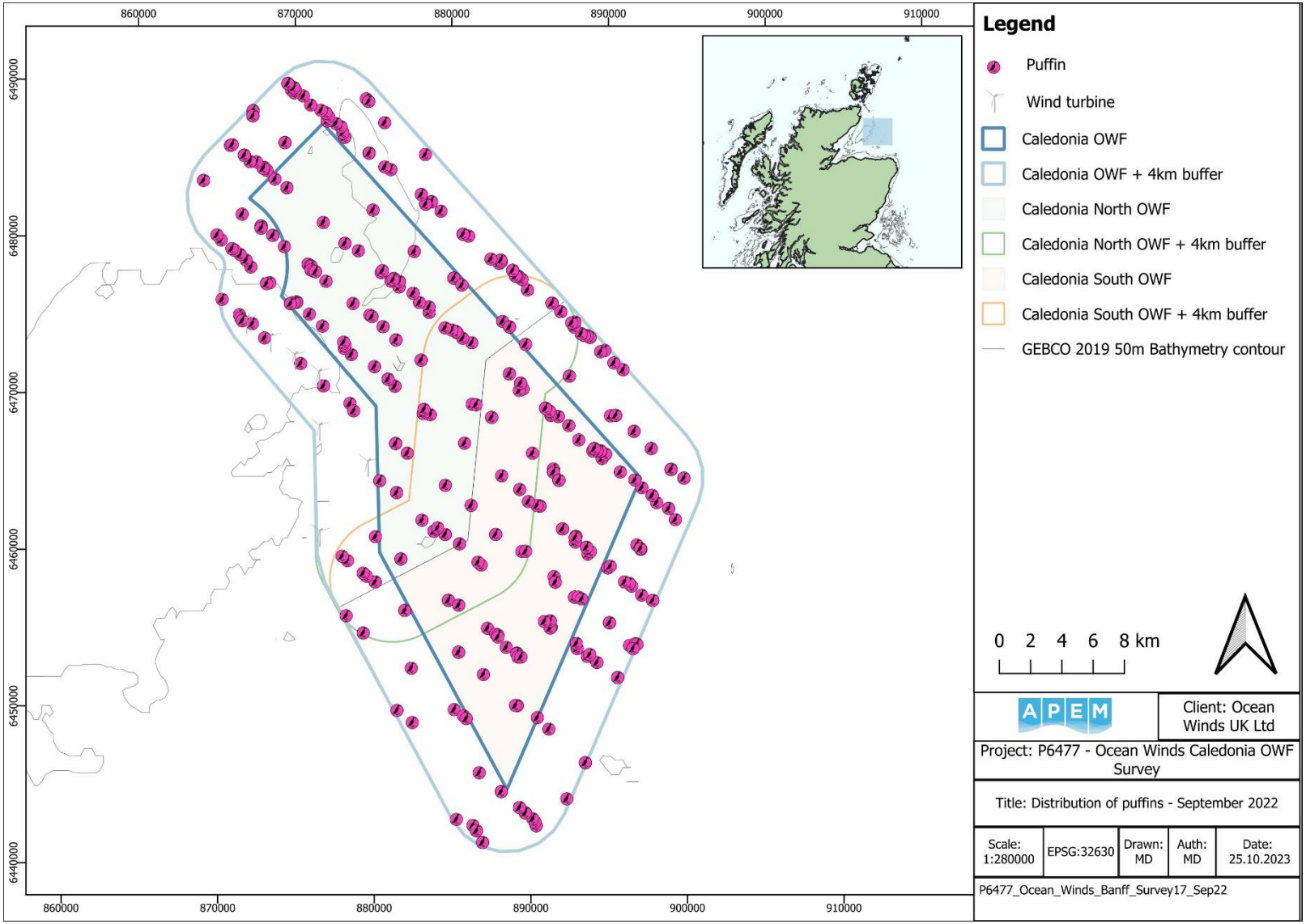


Figure A4.231 Distribution of puffins recorded in the Survey Area in September 2022

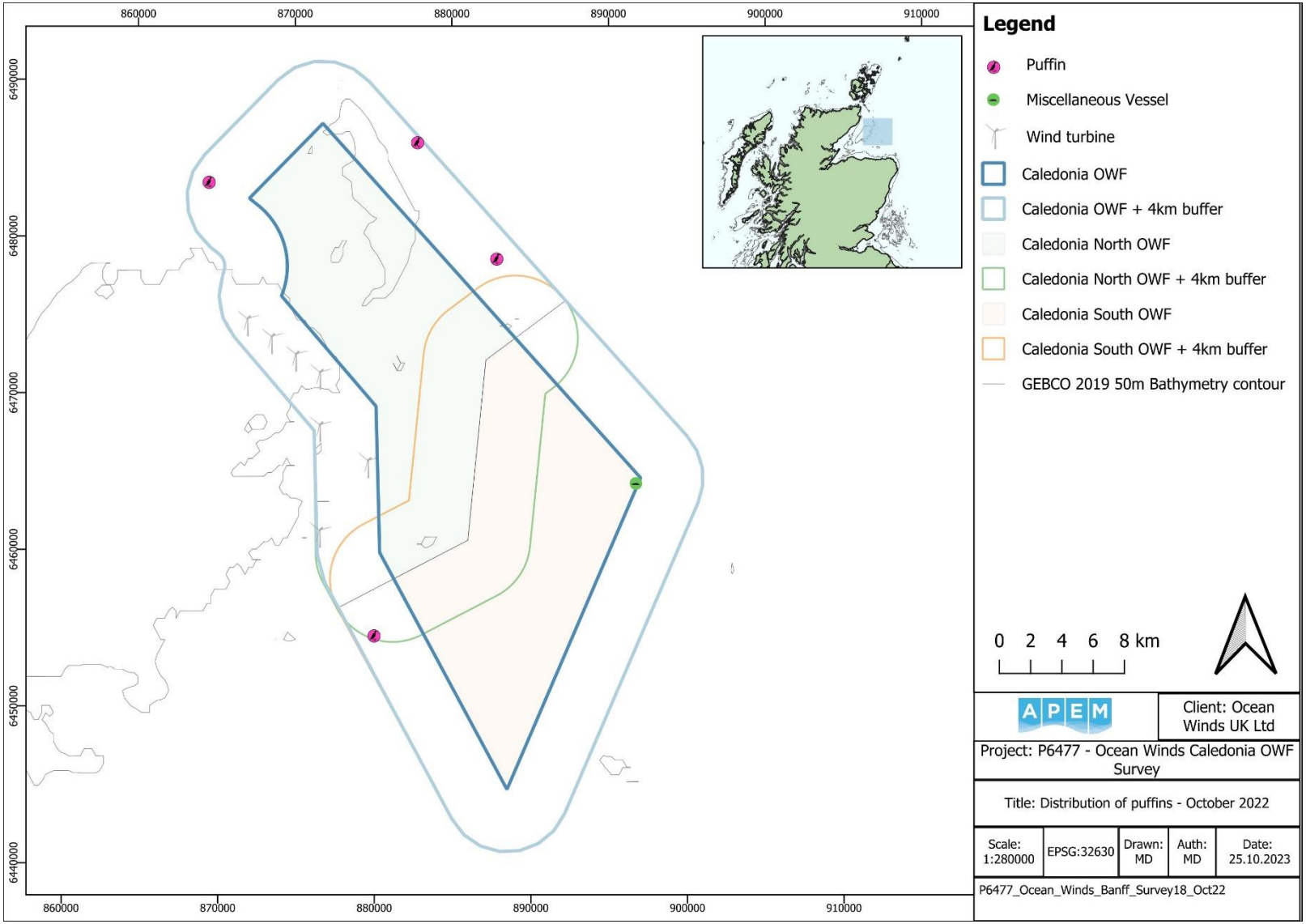


Figure A4.232 Distribution of puffins recorded in the Survey Area in October 2022

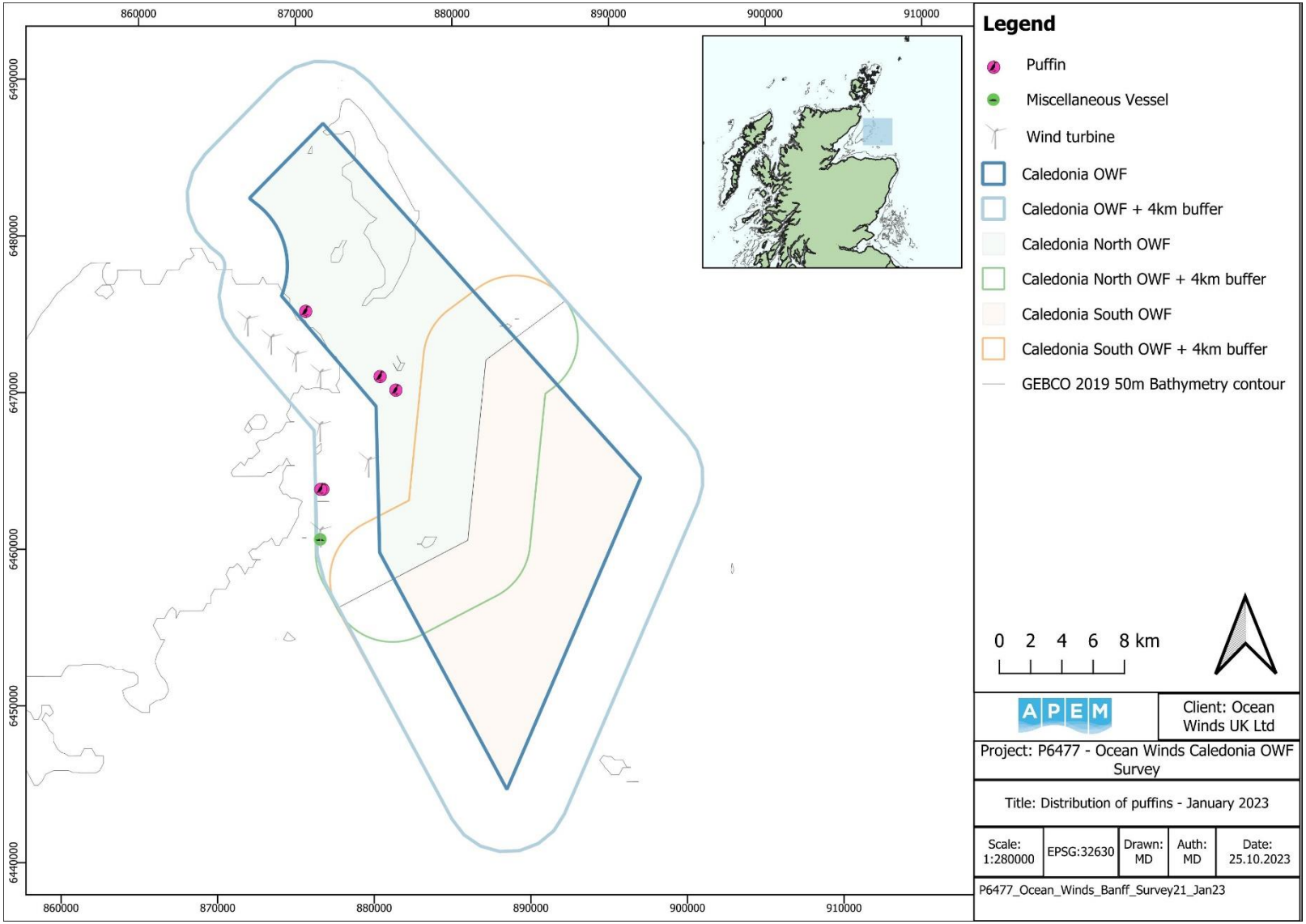


Figure A4.233 Distribution of puffins recorded in the Survey Area in January 2023

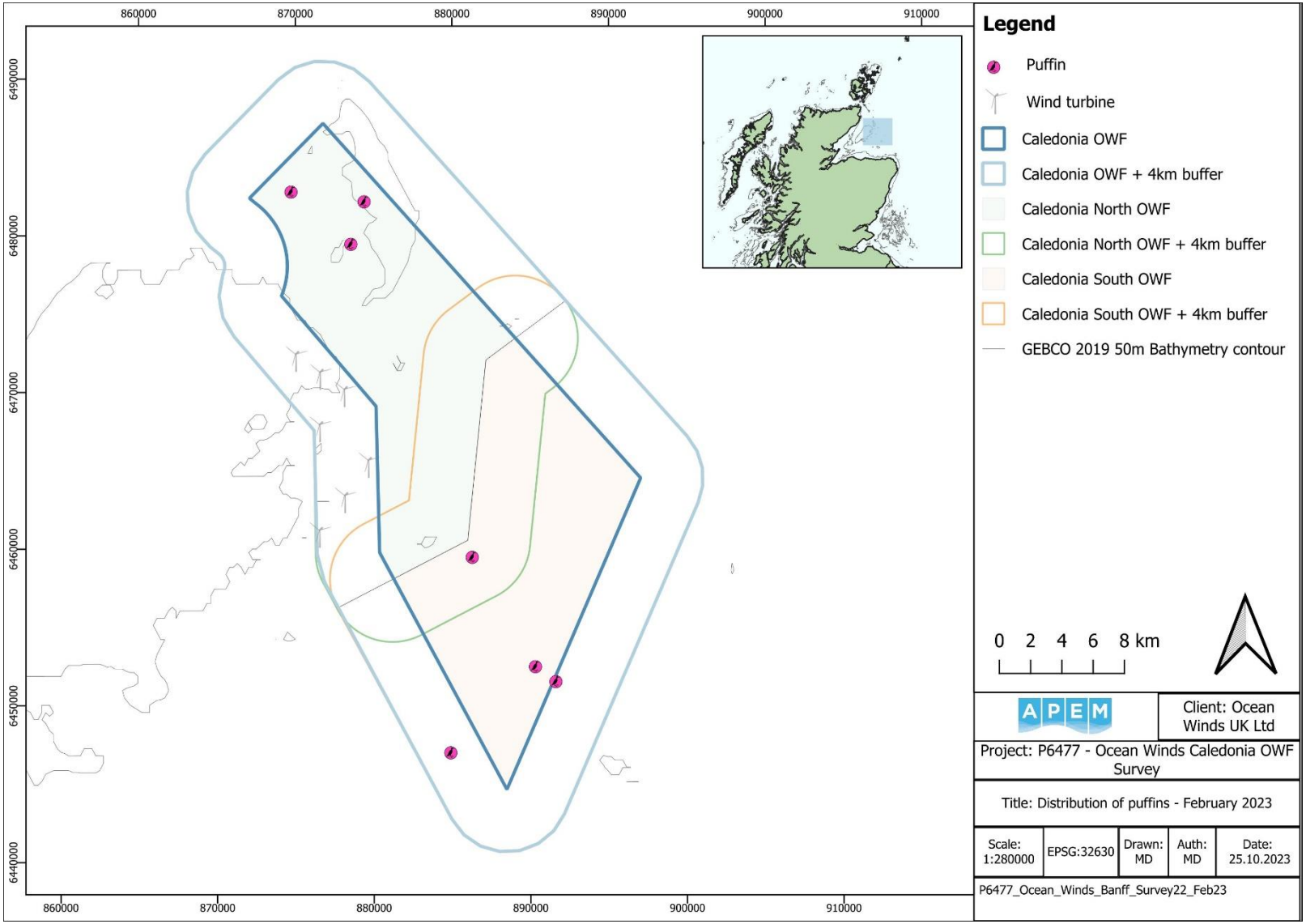


Figure A4.234 Distribution of puffins recorded in the Survey Area in February 2023

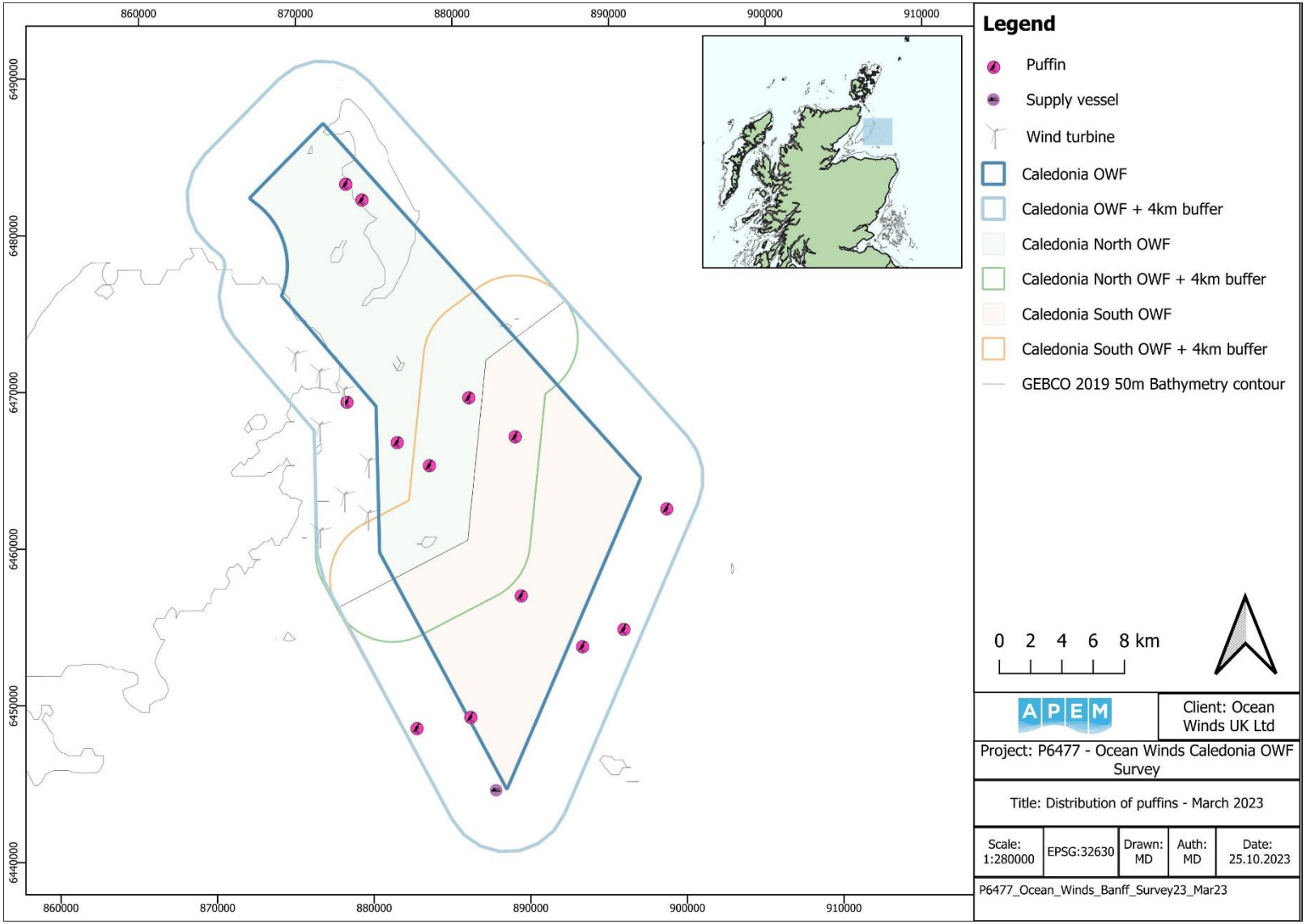


Figure A4.235 Distribution of puffins recorded in the Survey Area in March 2023

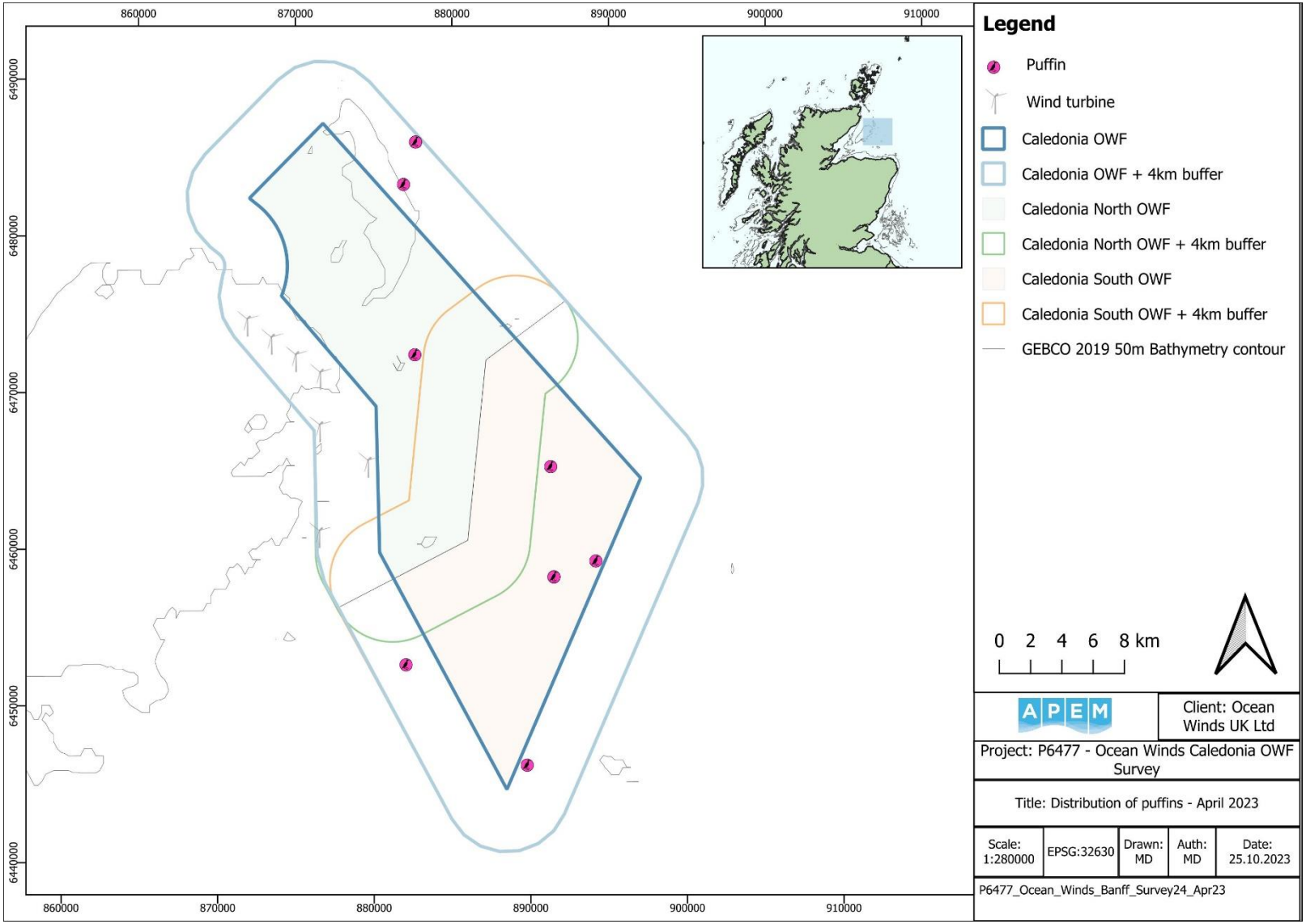


Figure A4.236 Distribution of puffins recorded in the Survey Area in April 2023

Unidentified auk species

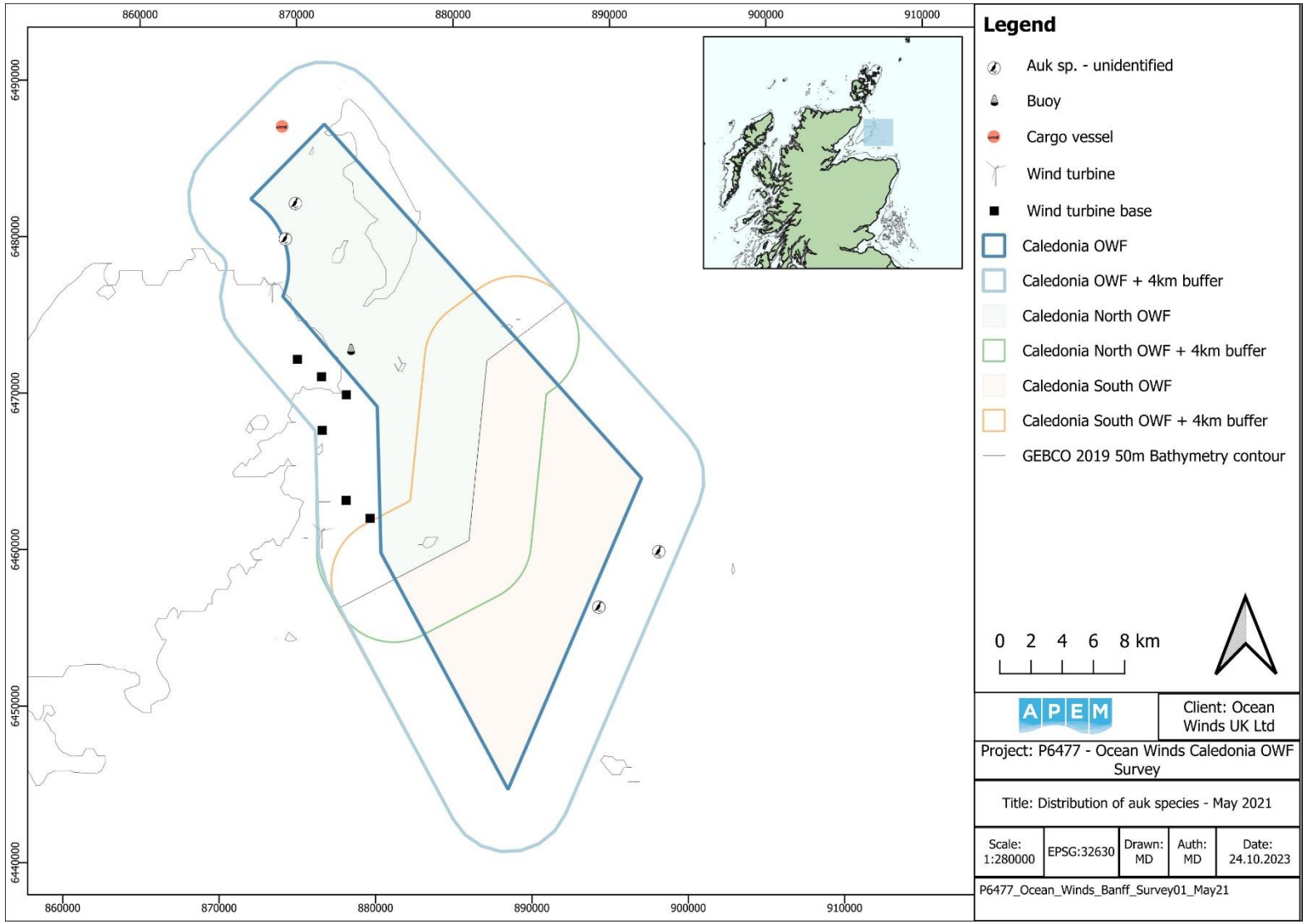


Figure A4.237 Distribution of auk species recorded in the Survey Area in May 2021

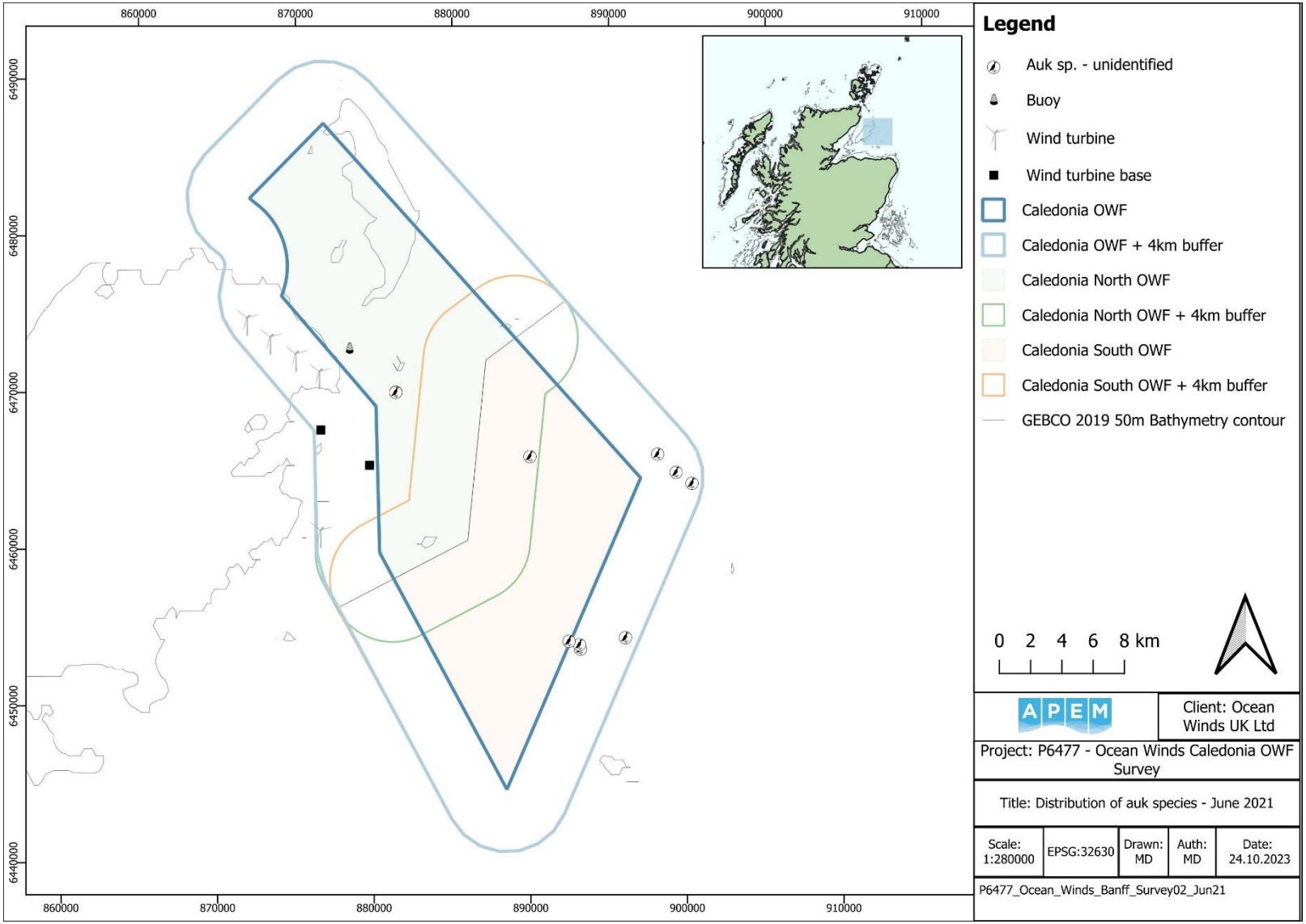


Figure A4.238 Distribution of auk species recorded in the Survey Area in June 2021

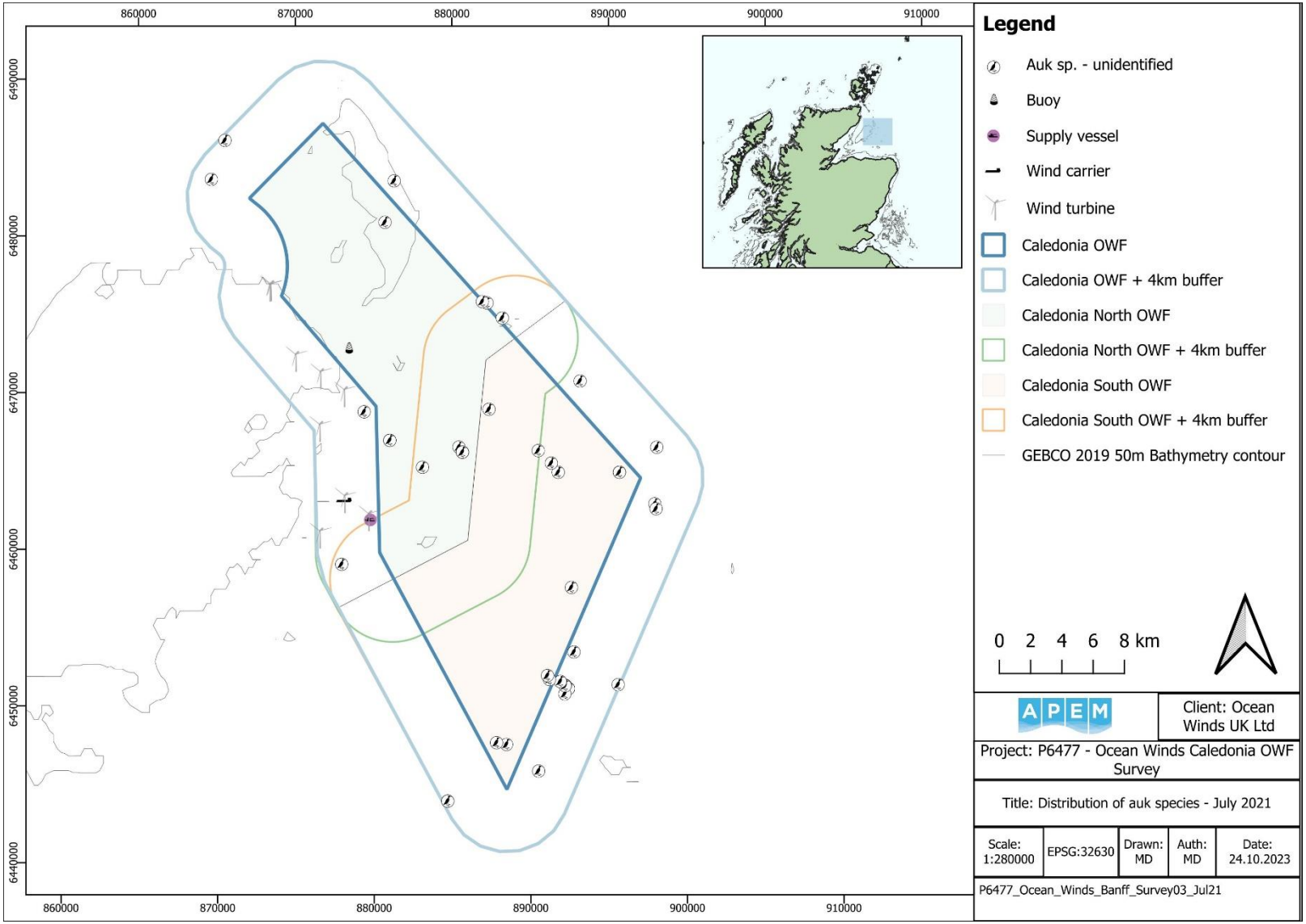


Figure A4.239 Distribution of auk species recorded in the Survey Area in July 2021

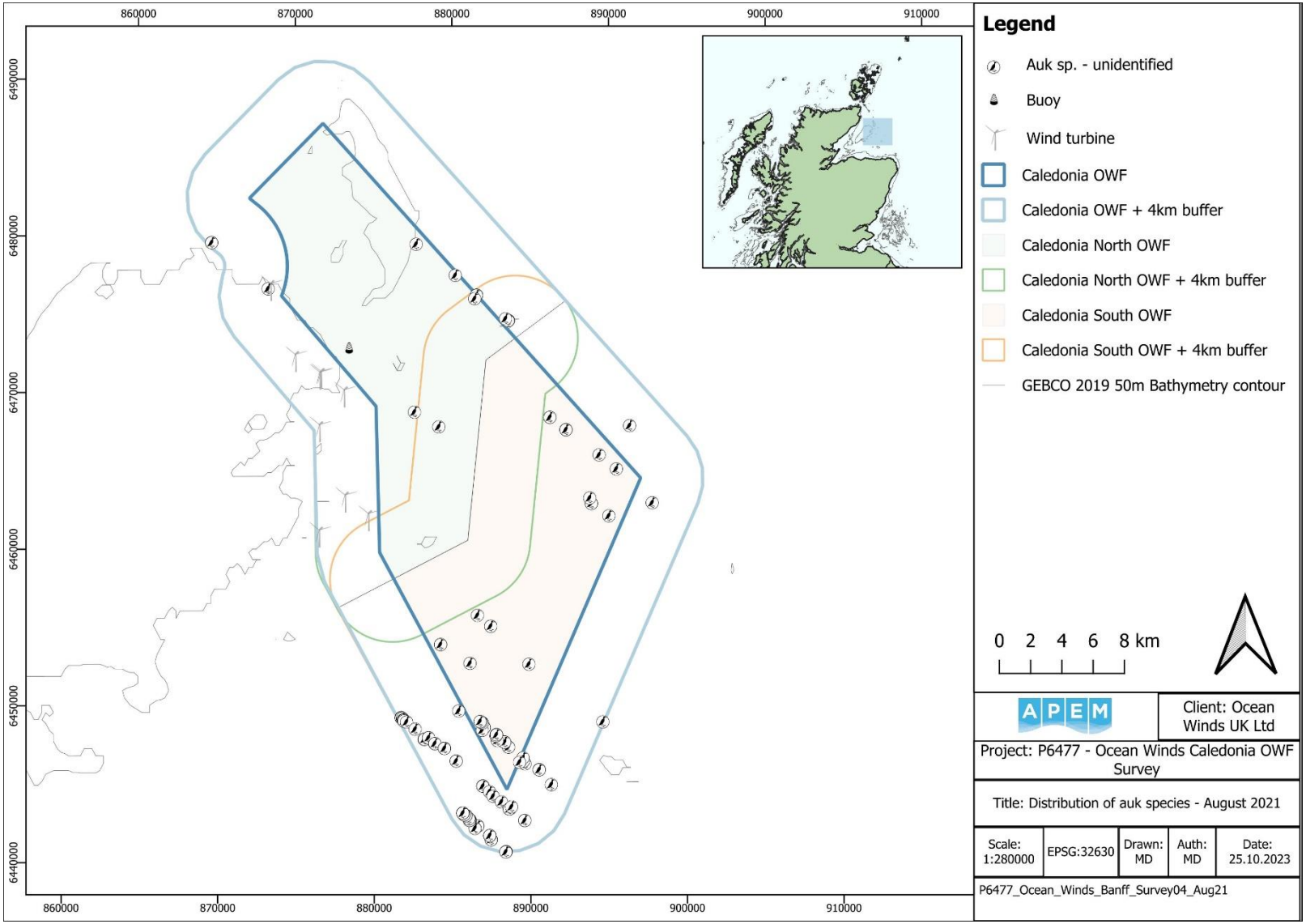


Figure A4.240 Distribution of auk species recorded in the Survey Area in August 2021

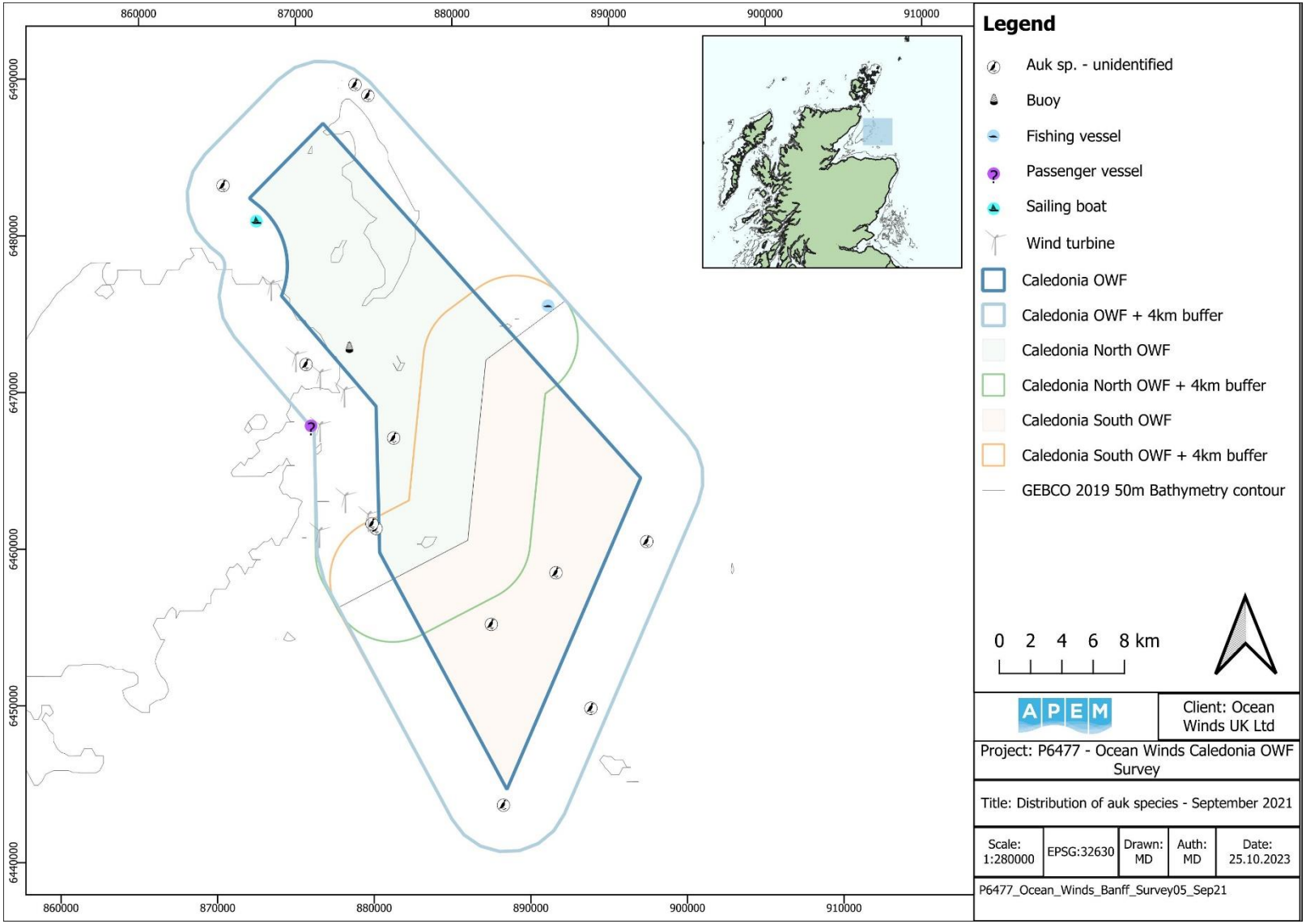


Figure A4.241 Distribution of auk species recorded in the Survey Area in September 2021

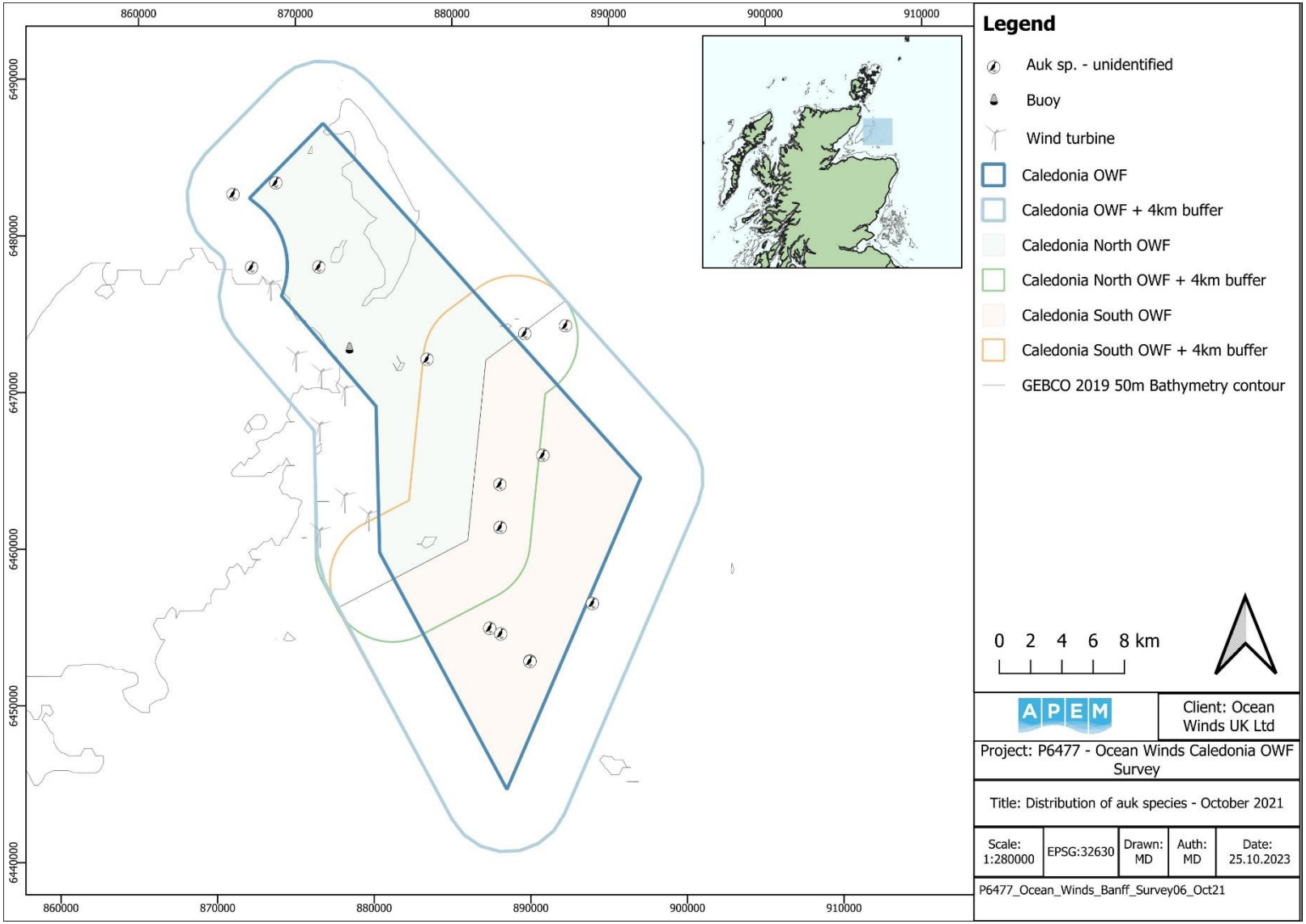


Figure A4.242 Distribution of auk species recorded in the Survey Area in October 2021

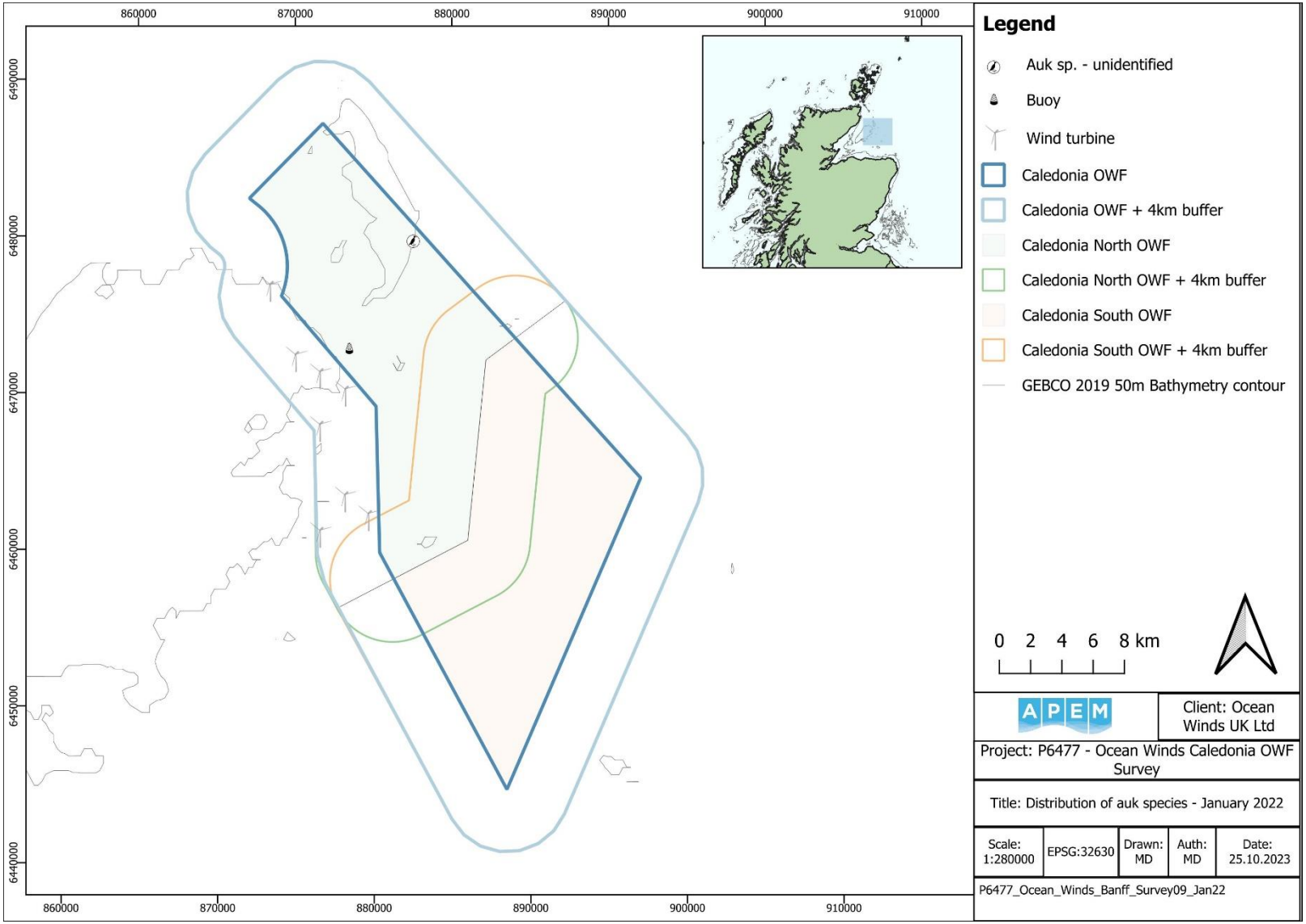


Figure A4.243 Distribution of auk species recorded in the Survey Area in January 2022

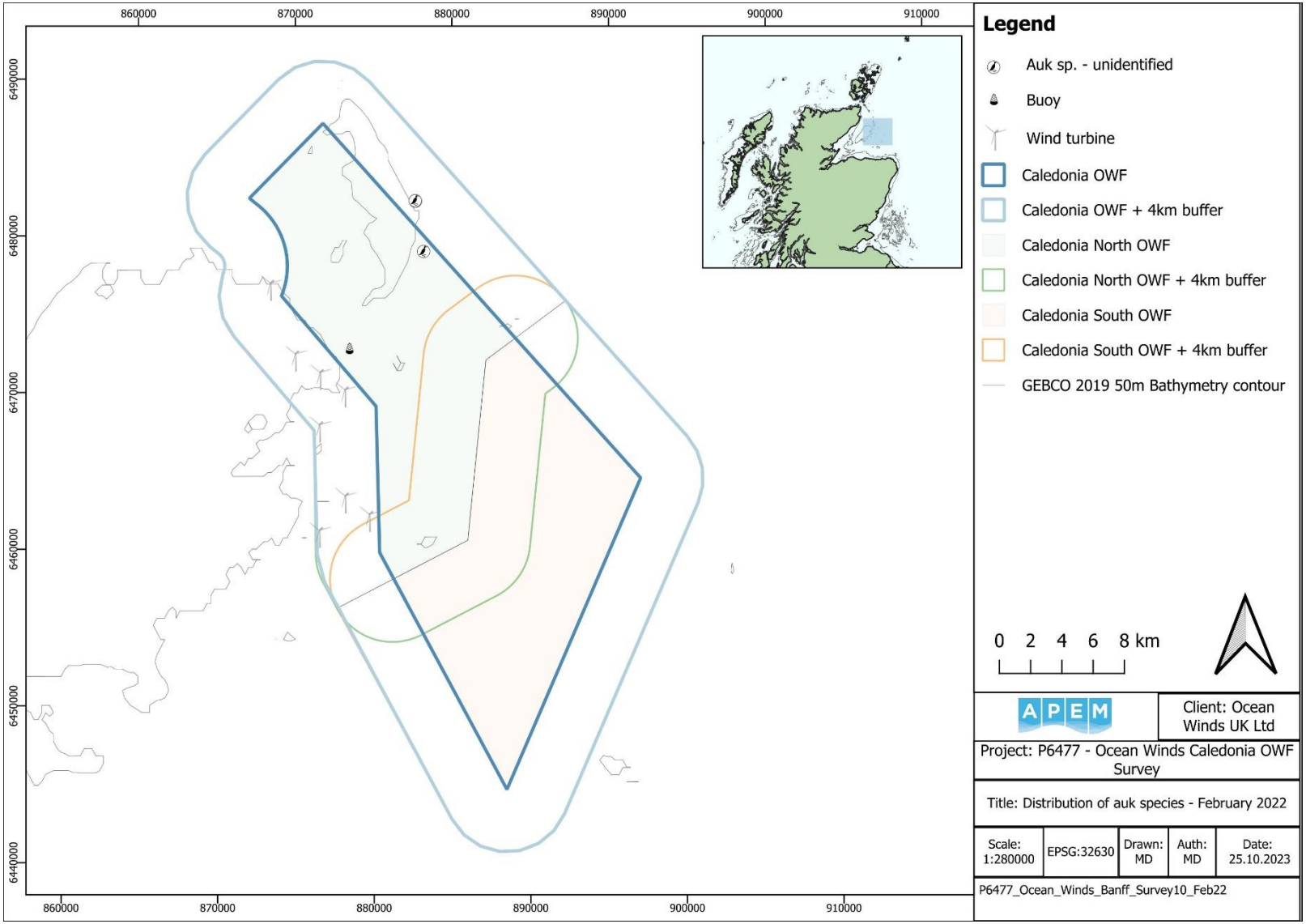


Figure A4.244 Distribution of auk species recorded in the Survey Area in February 2022

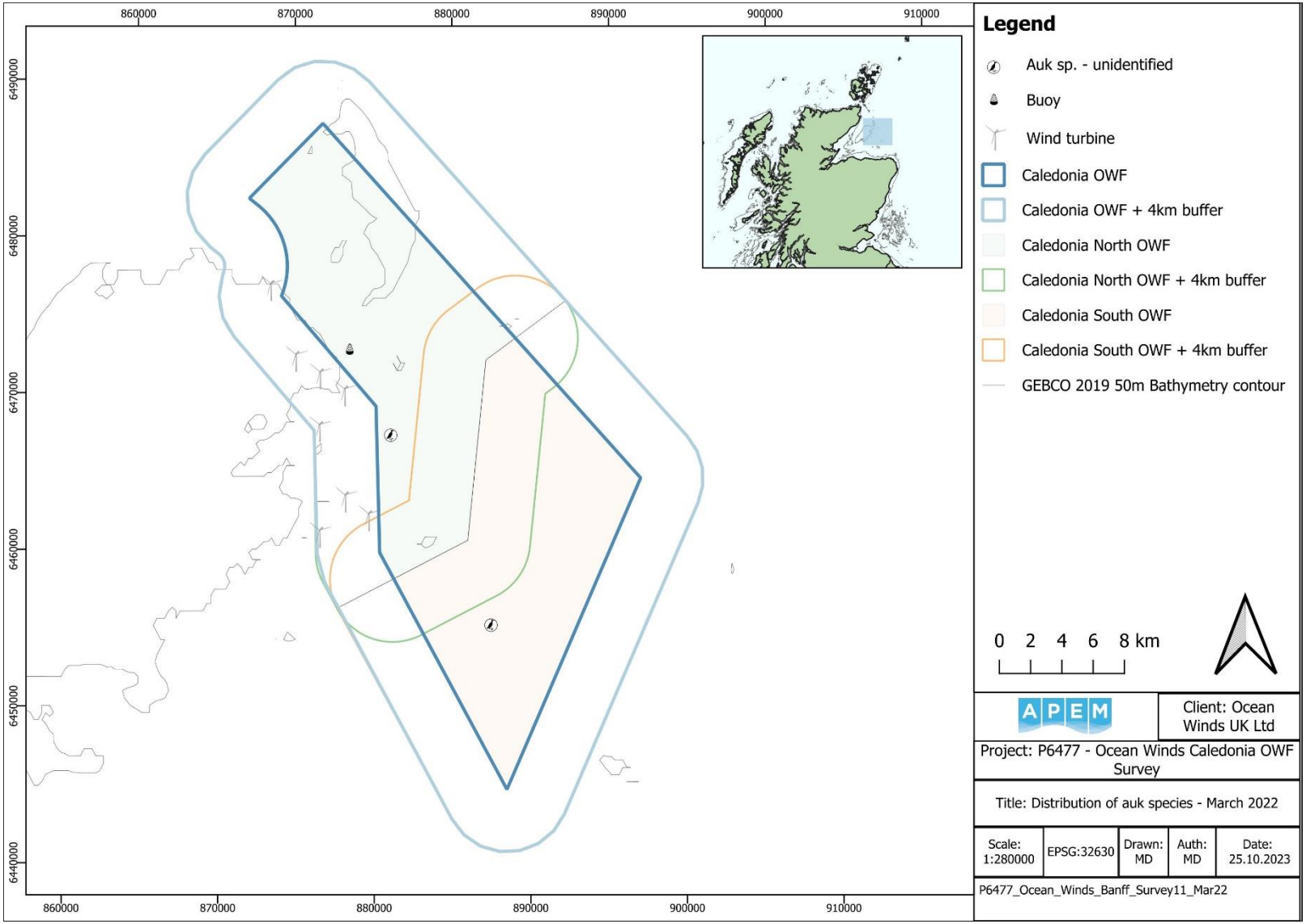


Figure A4.245 Distribution of auk species recorded in the Survey Area in March 2022

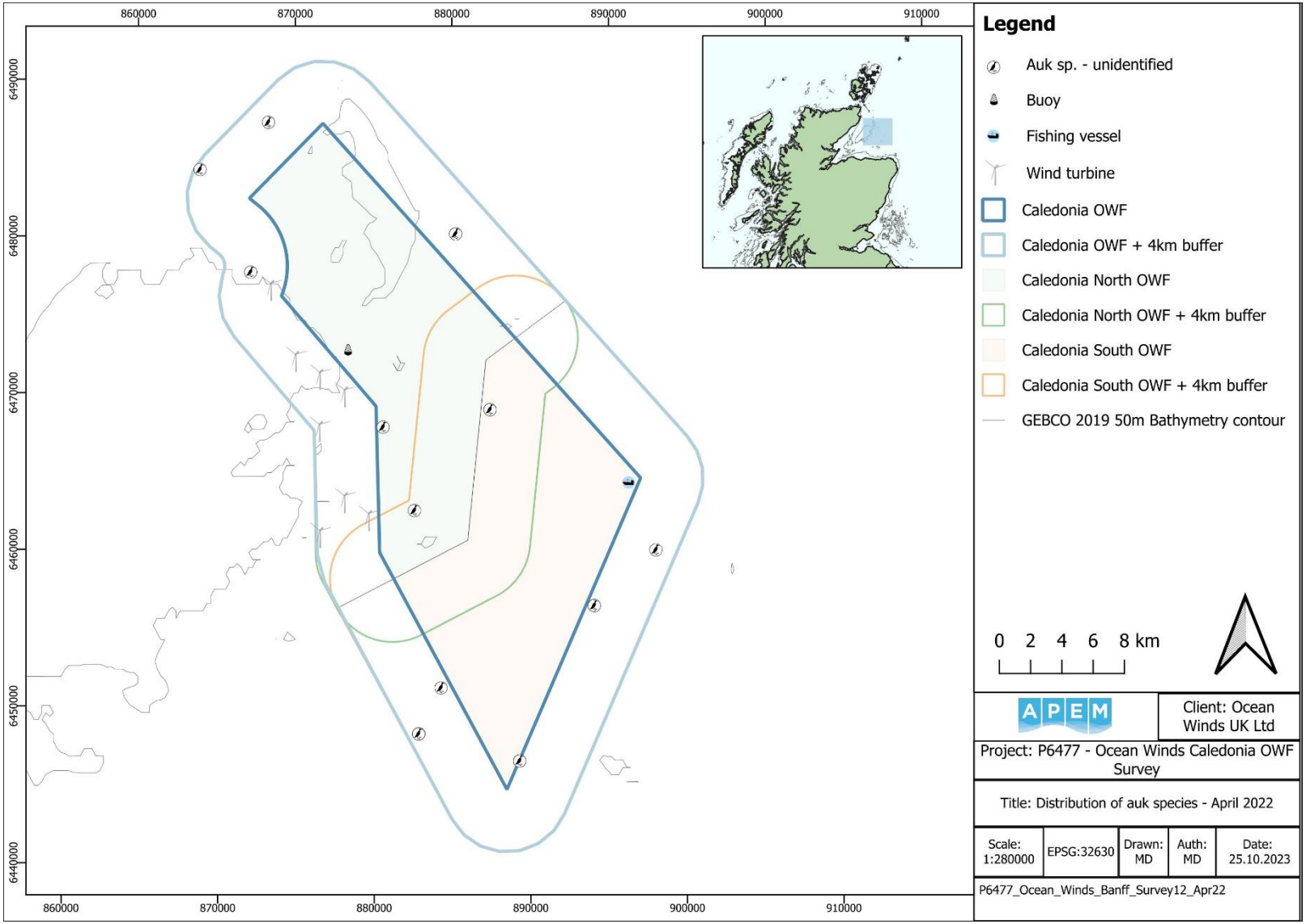


Figure A4.246 Distribution of auk species recorded in the Survey Area in April 2022

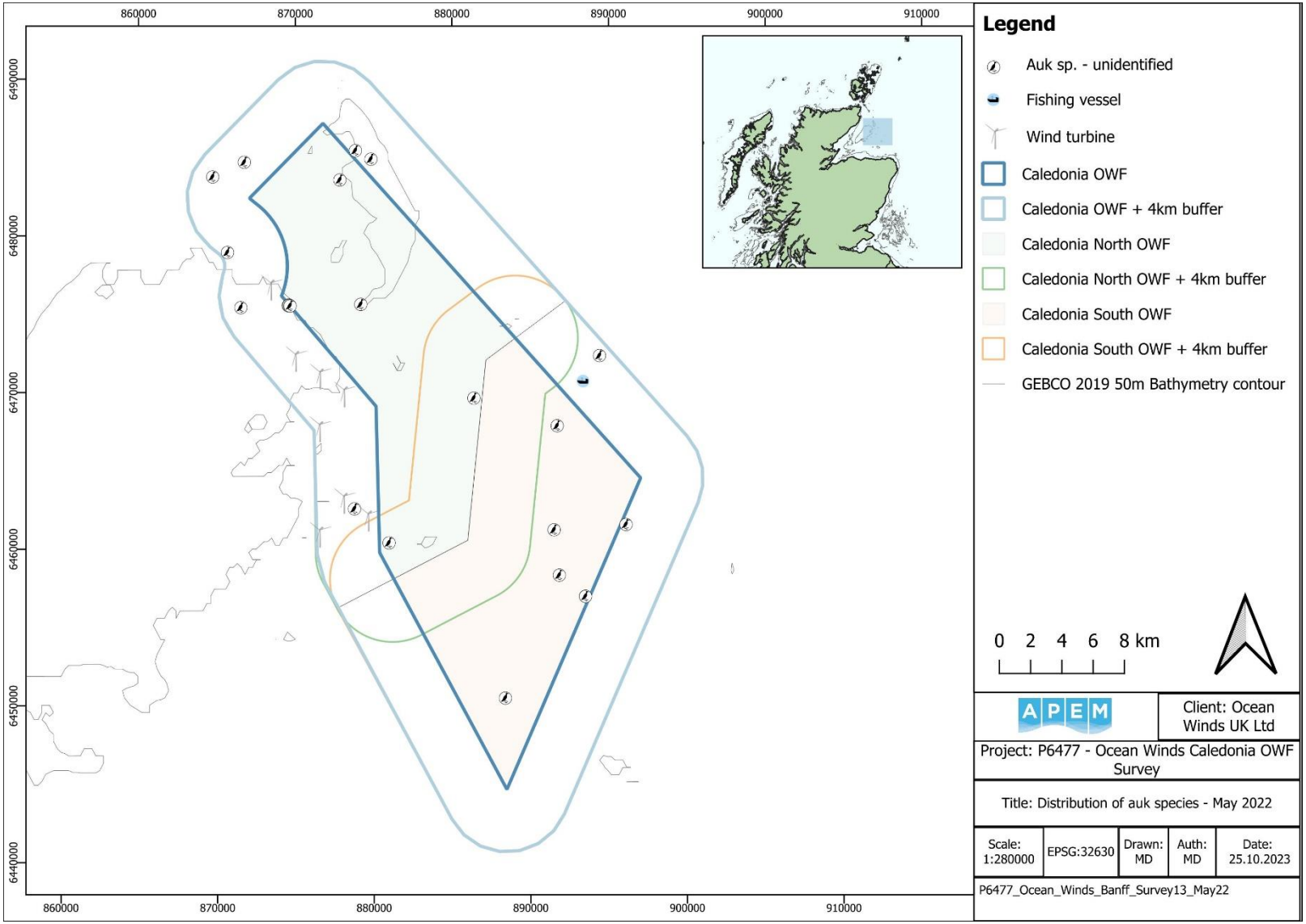


Figure A4.247 Distribution of auk species recorded in the Survey Area in May 2022

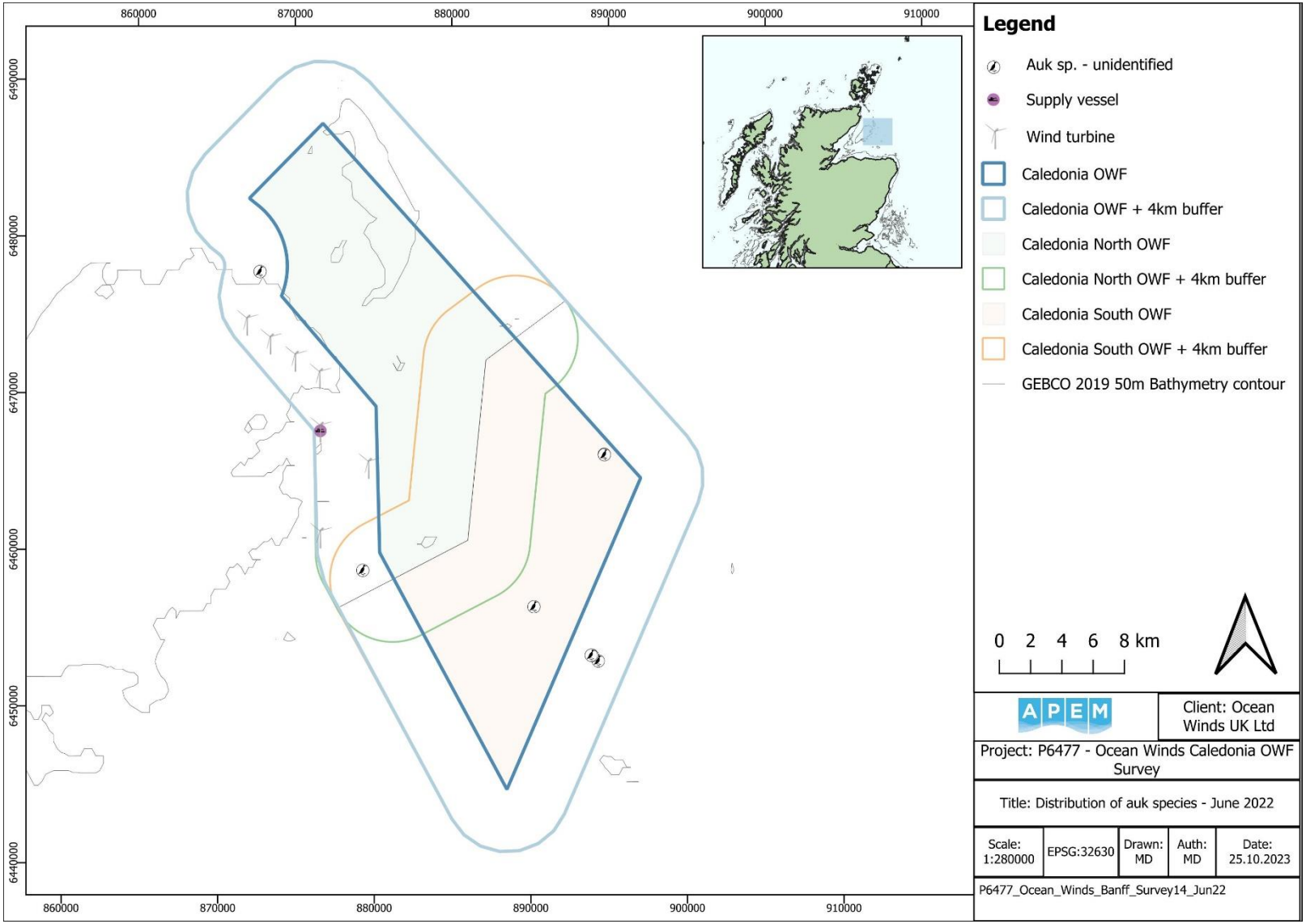


Figure A4.248 Distribution of auk species recorded in the Survey Area in June 2022

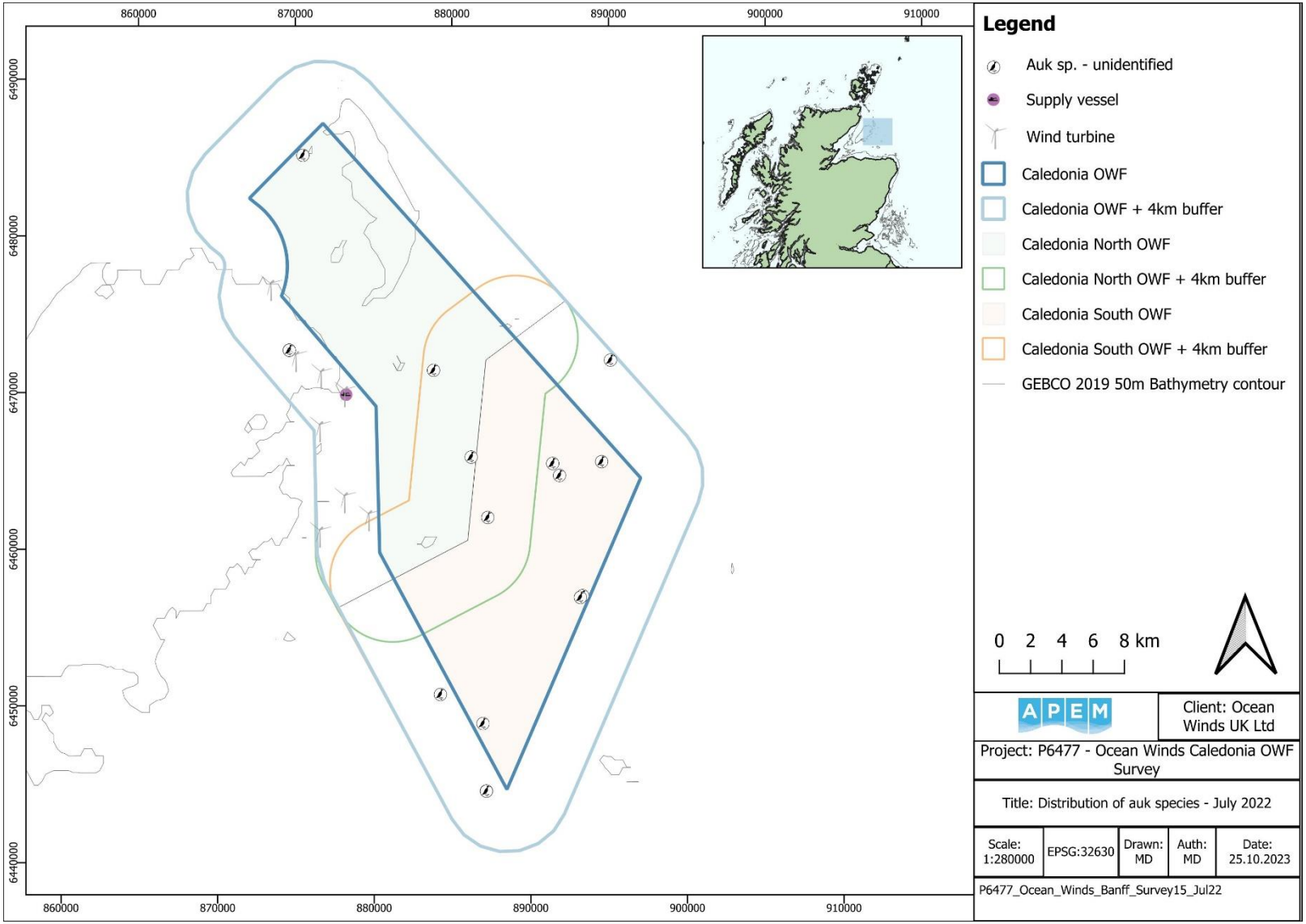


Figure A4.249 Distribution of auk species recorded in the Survey Area in July 2022

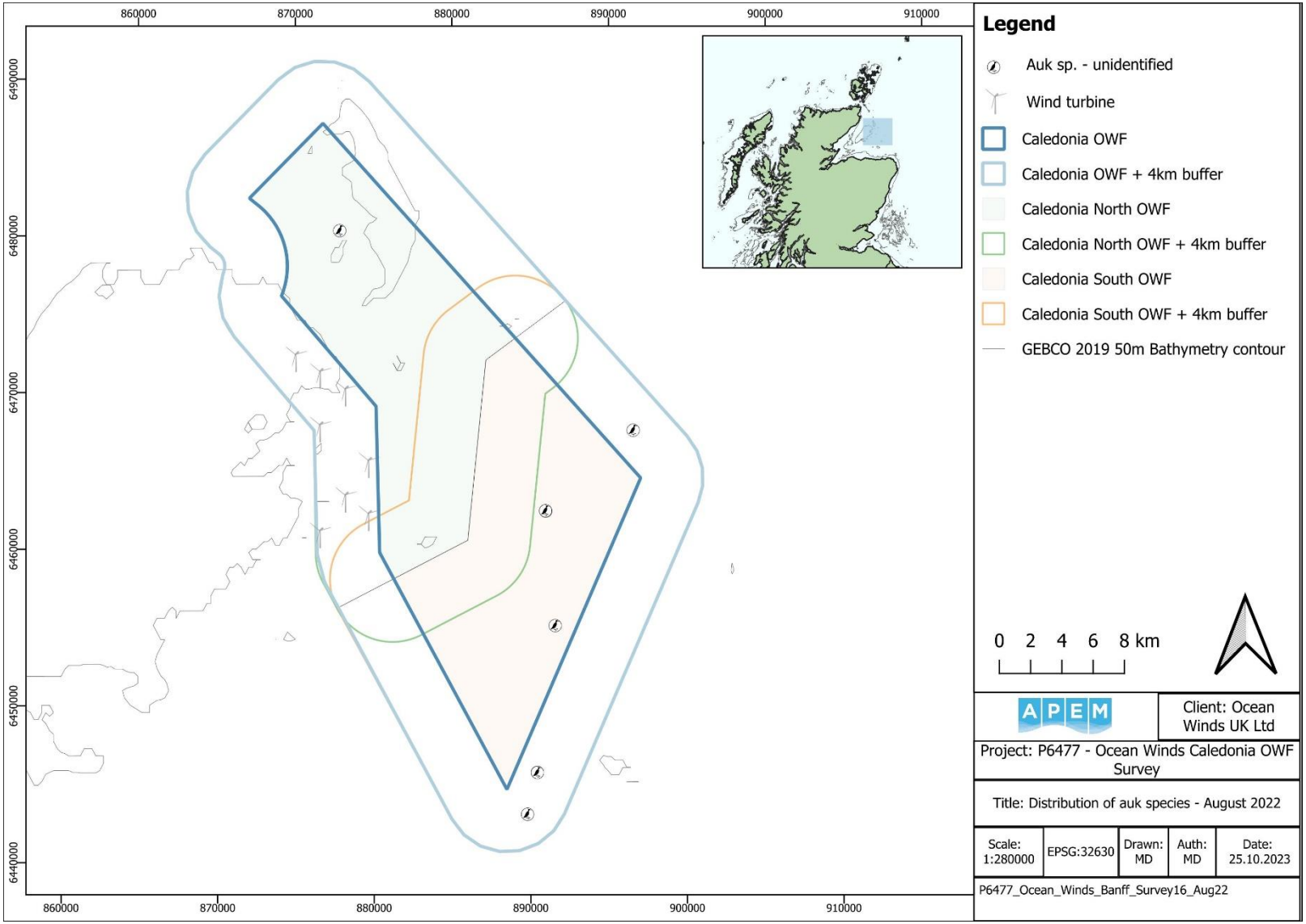


Figure A4.250 Distribution of auk species recorded in the Survey Area in August 2022

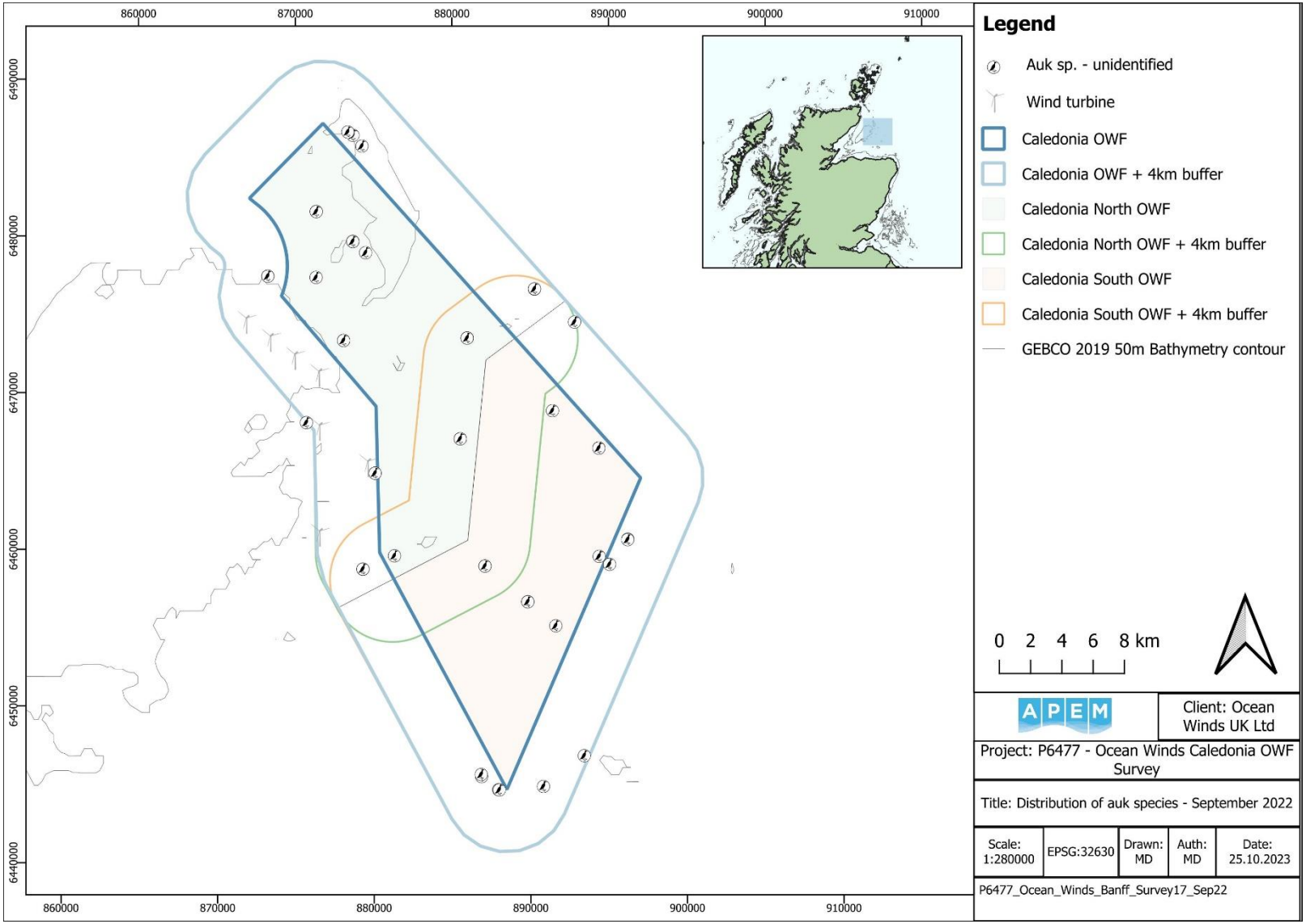


Figure A4.251 Distribution of auk species recorded in the Survey Area in September 2022

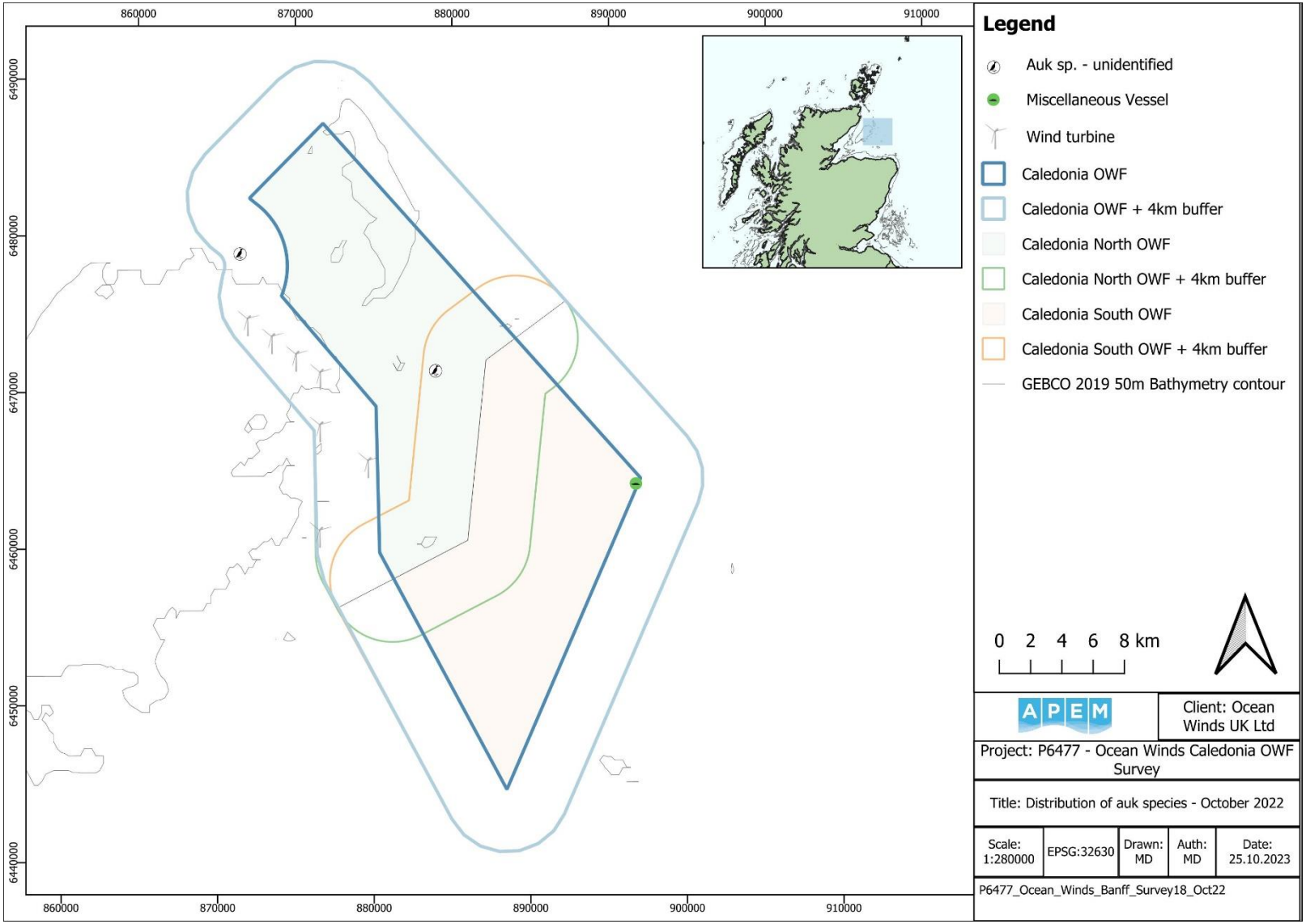


Figure A4.252 Distribution of auk species recorded in the Survey Area in October 2022

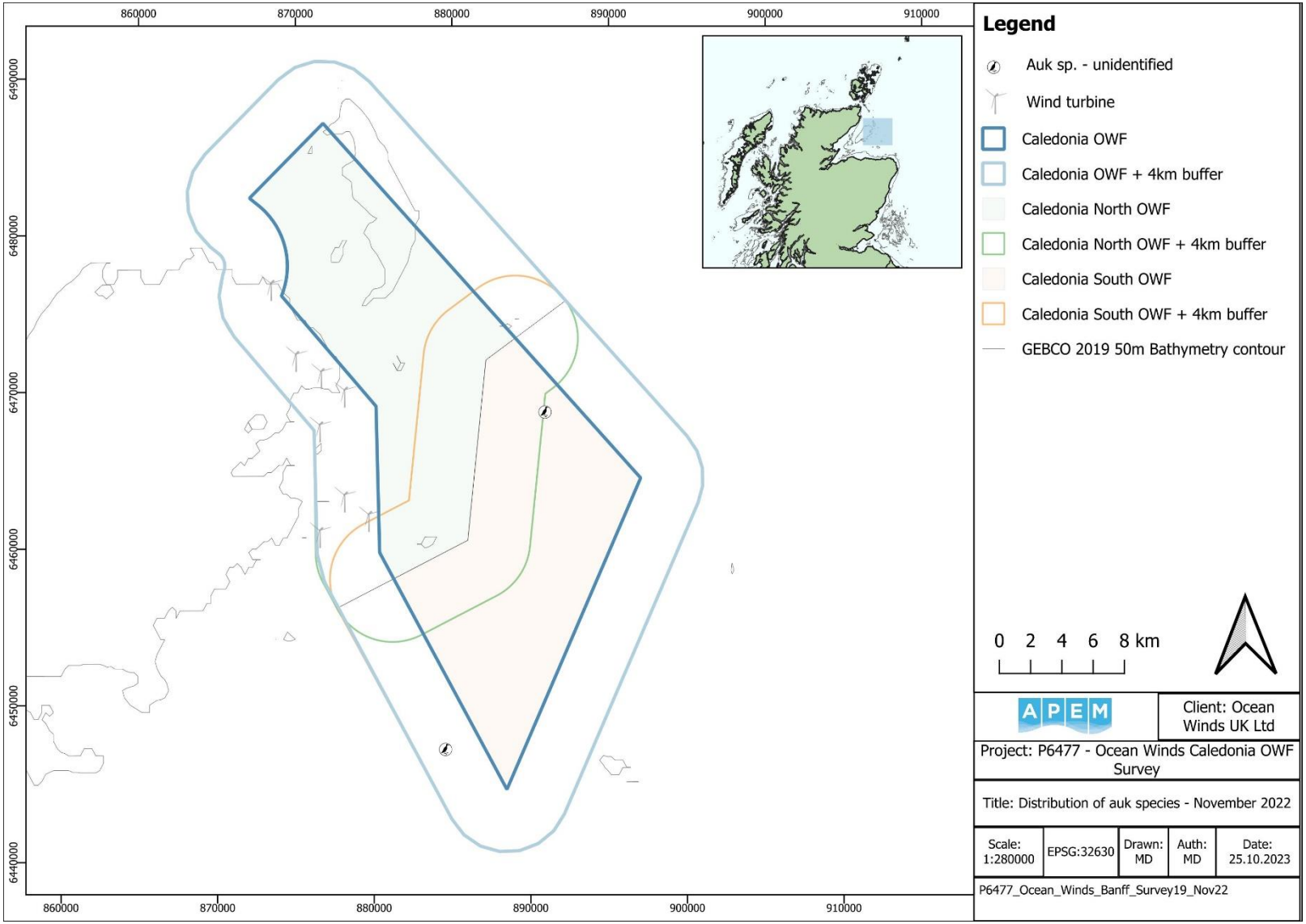


Figure A4.253 Distribution of auk species recorded in the Survey Area in November 2022

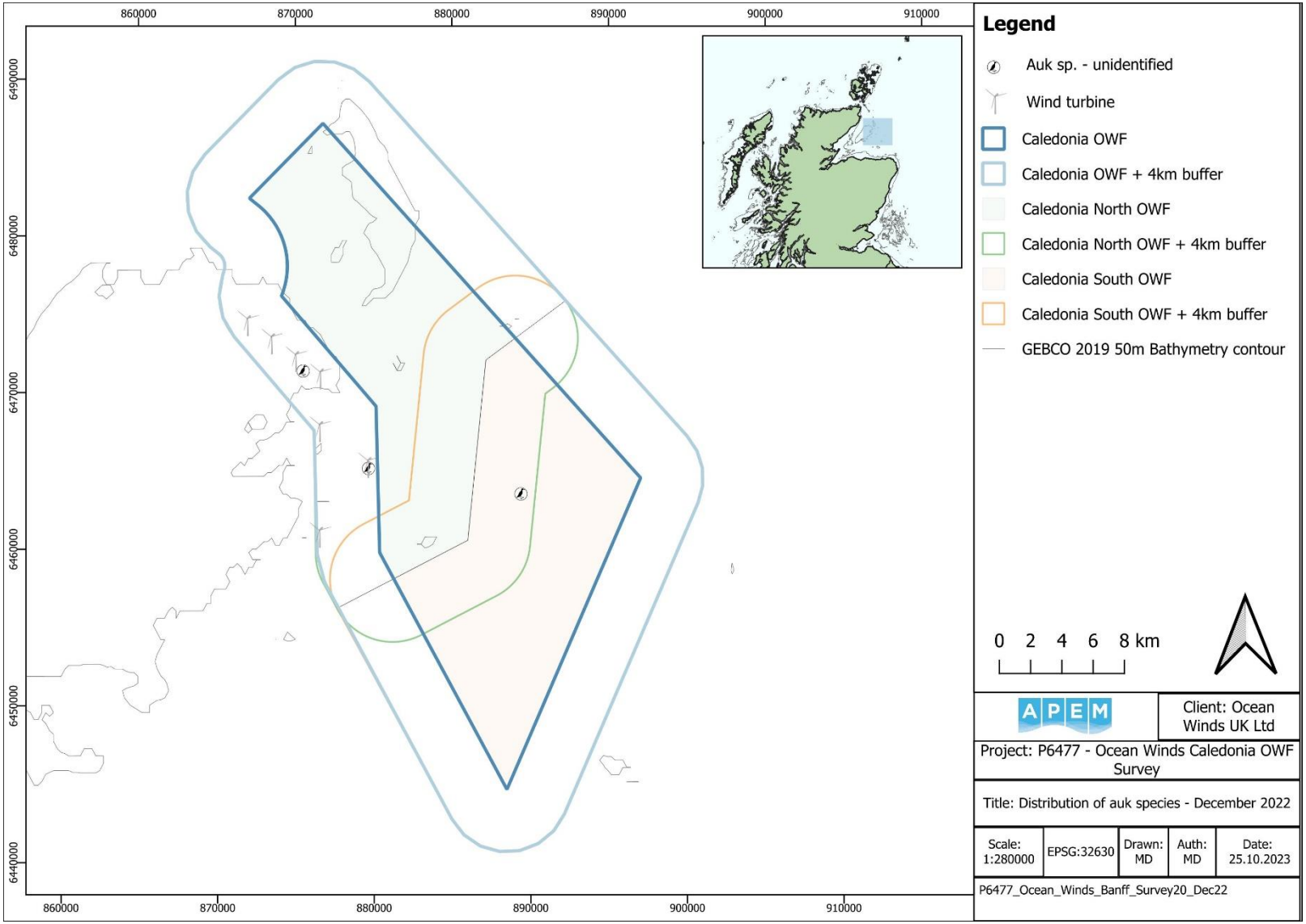


Figure A4.254 Distribution of auk species recorded in the Survey Area in December 2022

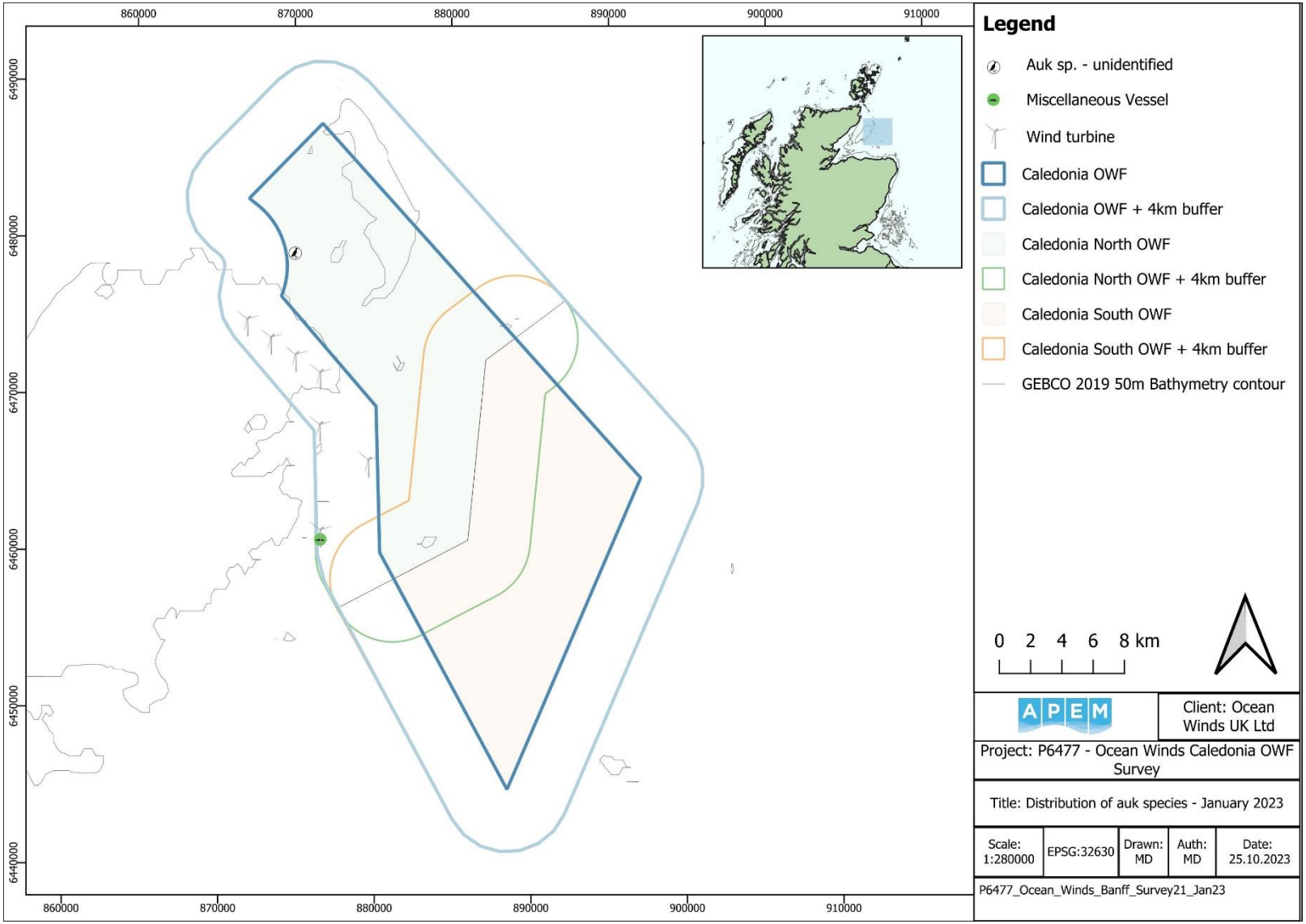


Figure A4.255 Distribution of auk species recorded in the Survey Area in January 2023

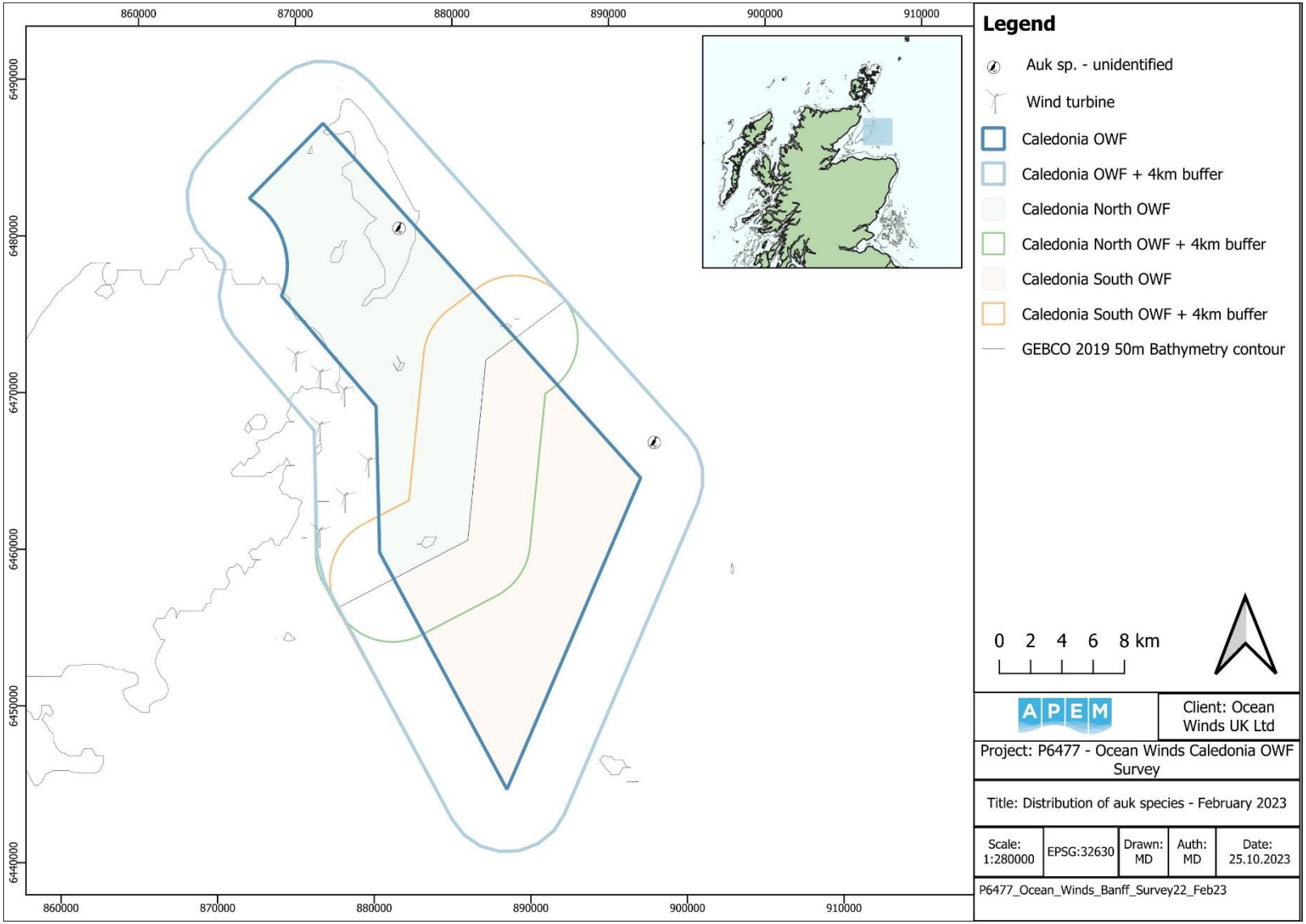


Figure A4.256 Distribution of auk species recorded in the Survey Area in February 2023

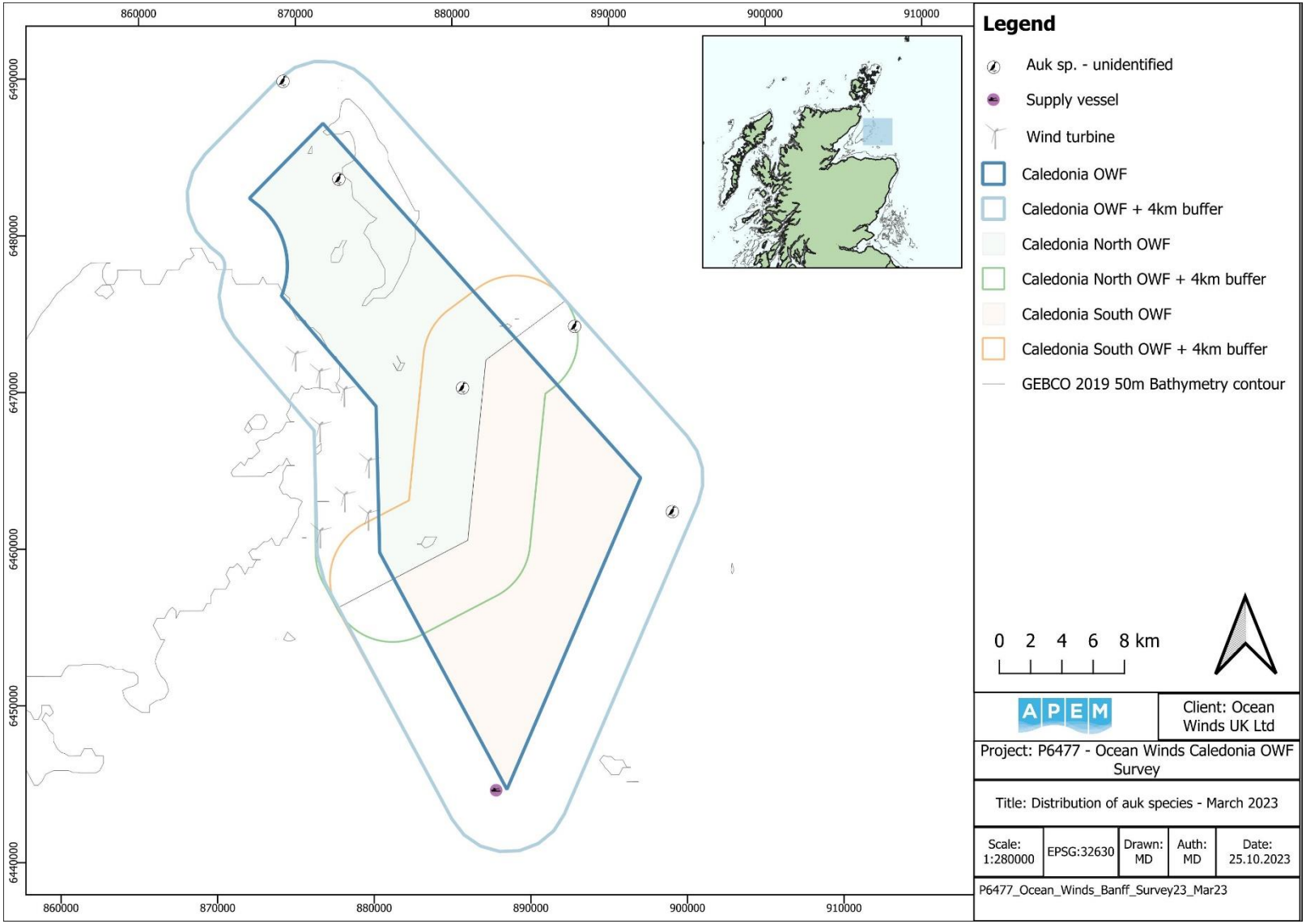


Figure A4.257 Distribution of auk species recorded in the Survey Area in March 2023

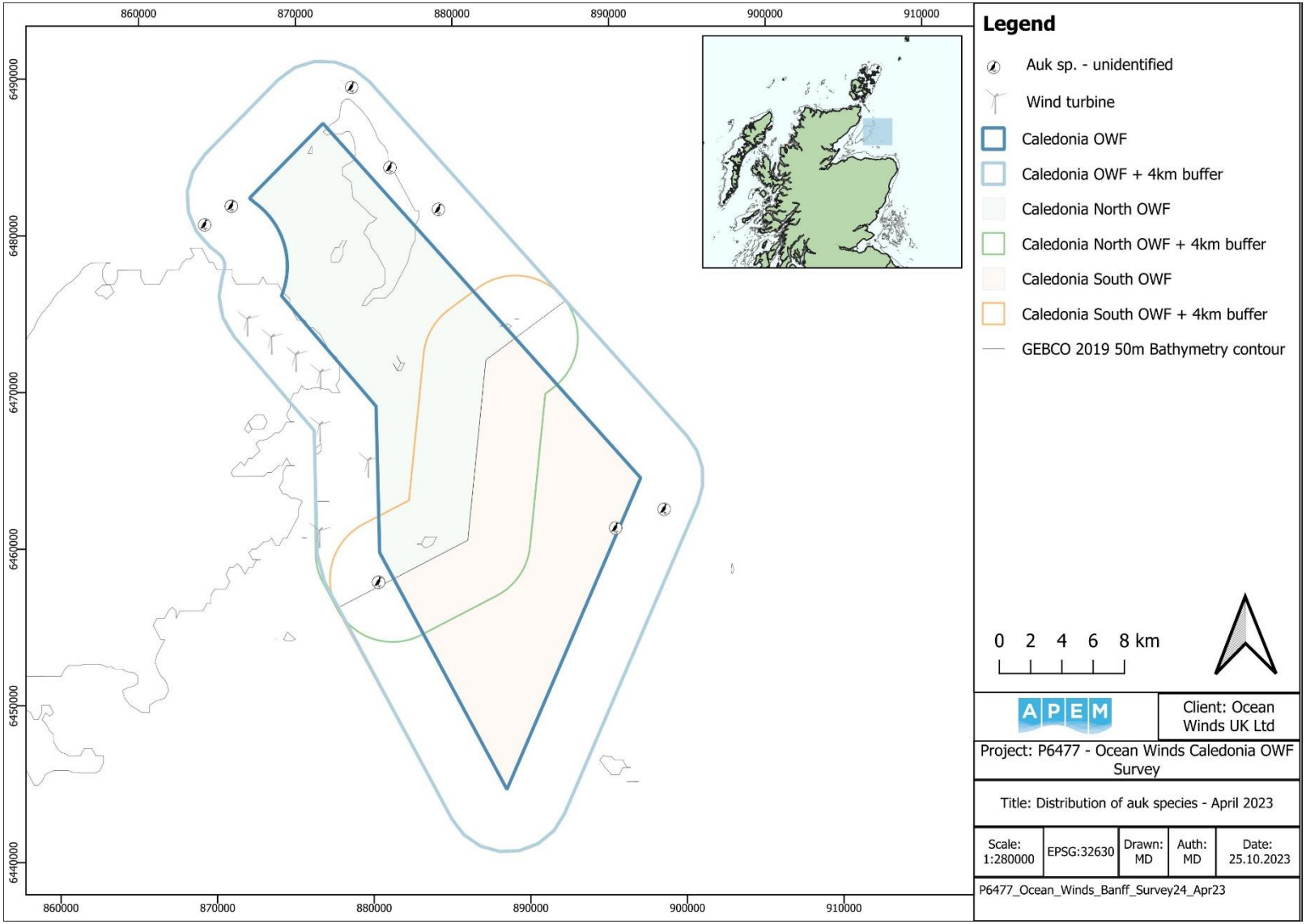


Figure A4.258 Distribution of auk species recorded in the Survey Area in April 2023

Great northern diver

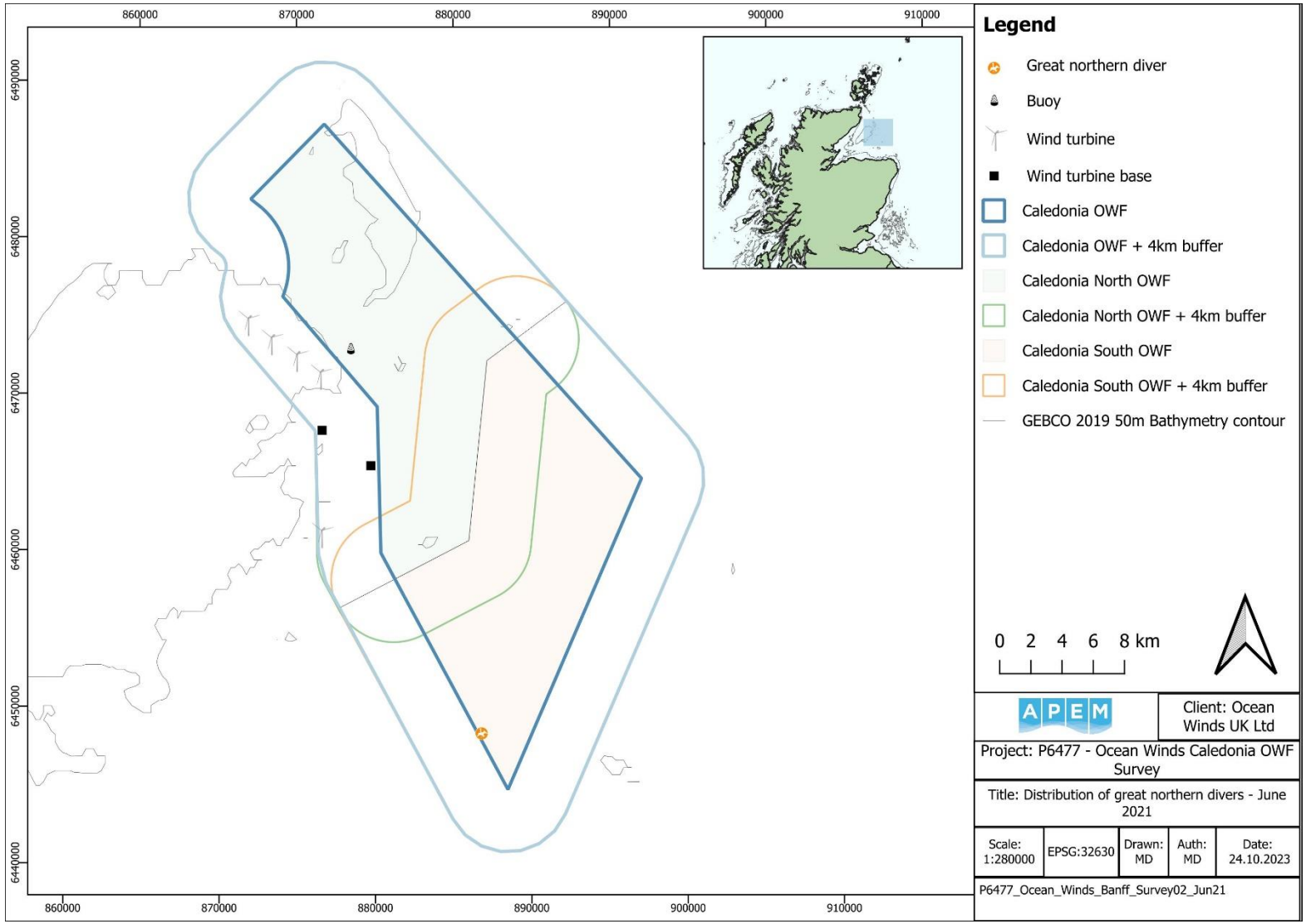


Figure A4.259 Distribution of great northern divers recorded in the Survey Area in June 2021

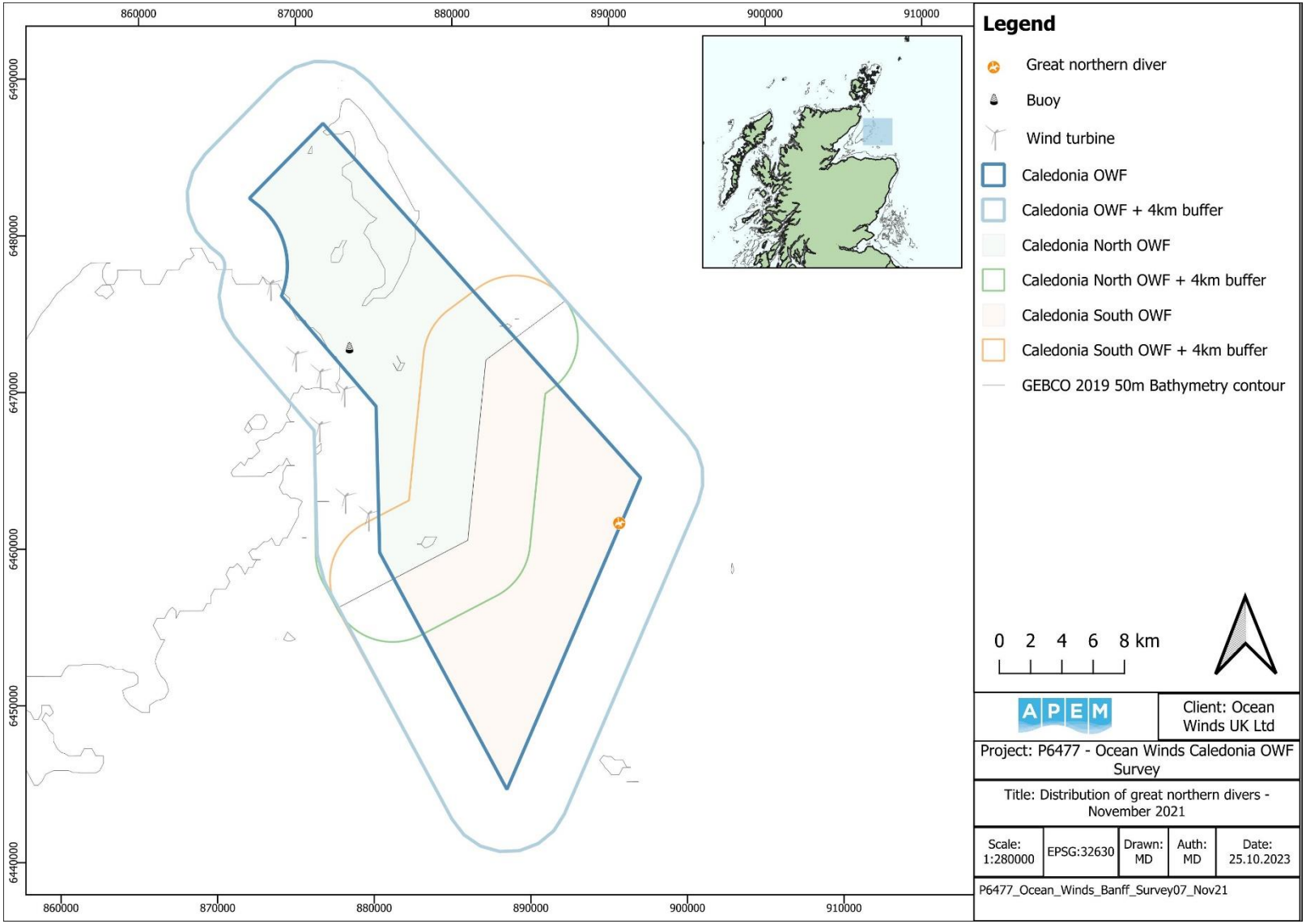


Figure A4.260 Distribution of great northern divers recorded in the Survey Area in November 2021

Red-throated diver

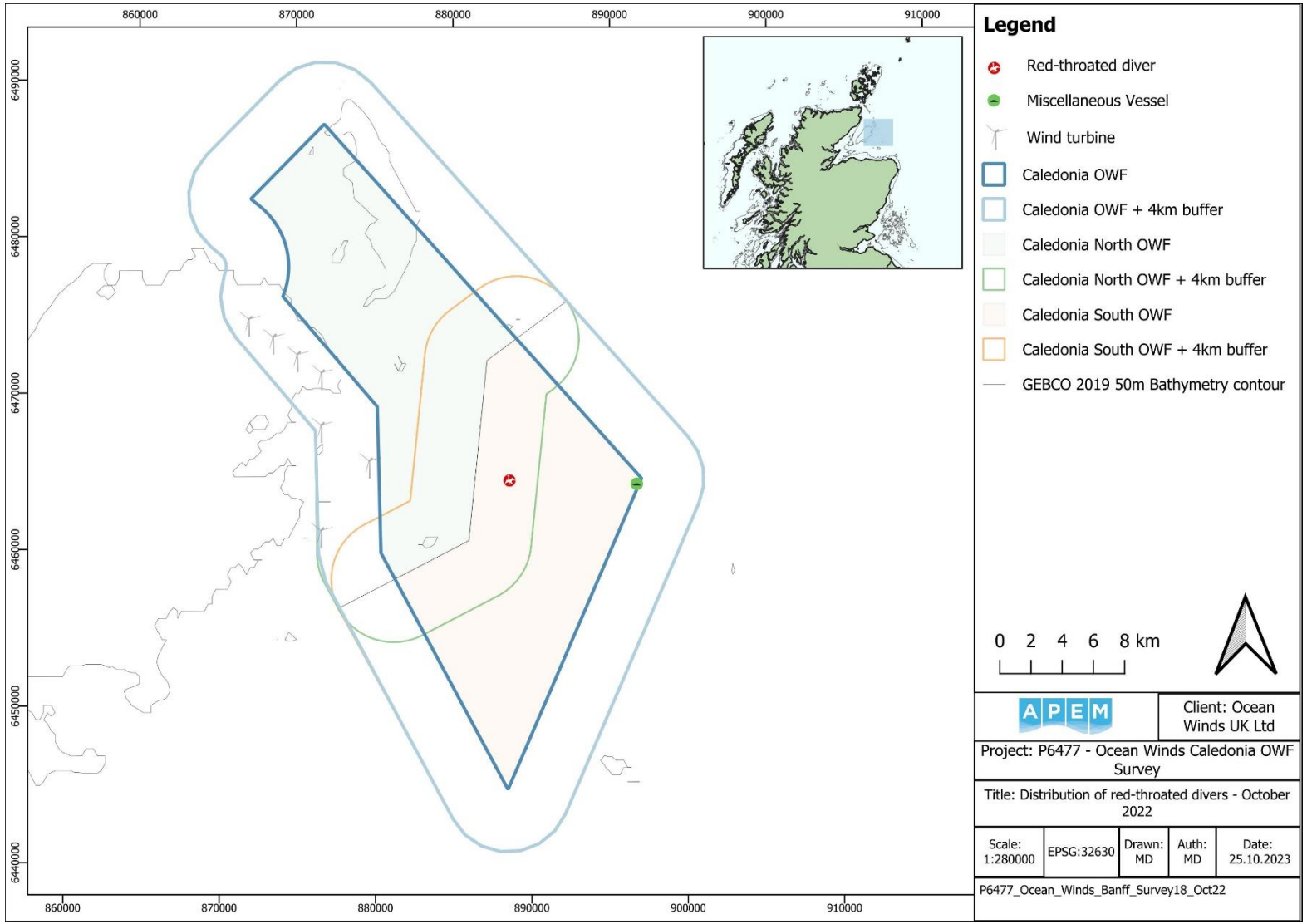


Figure A4.261 Distribution of red-throated divers recorded in the Survey Area in October 2022

Fulmar

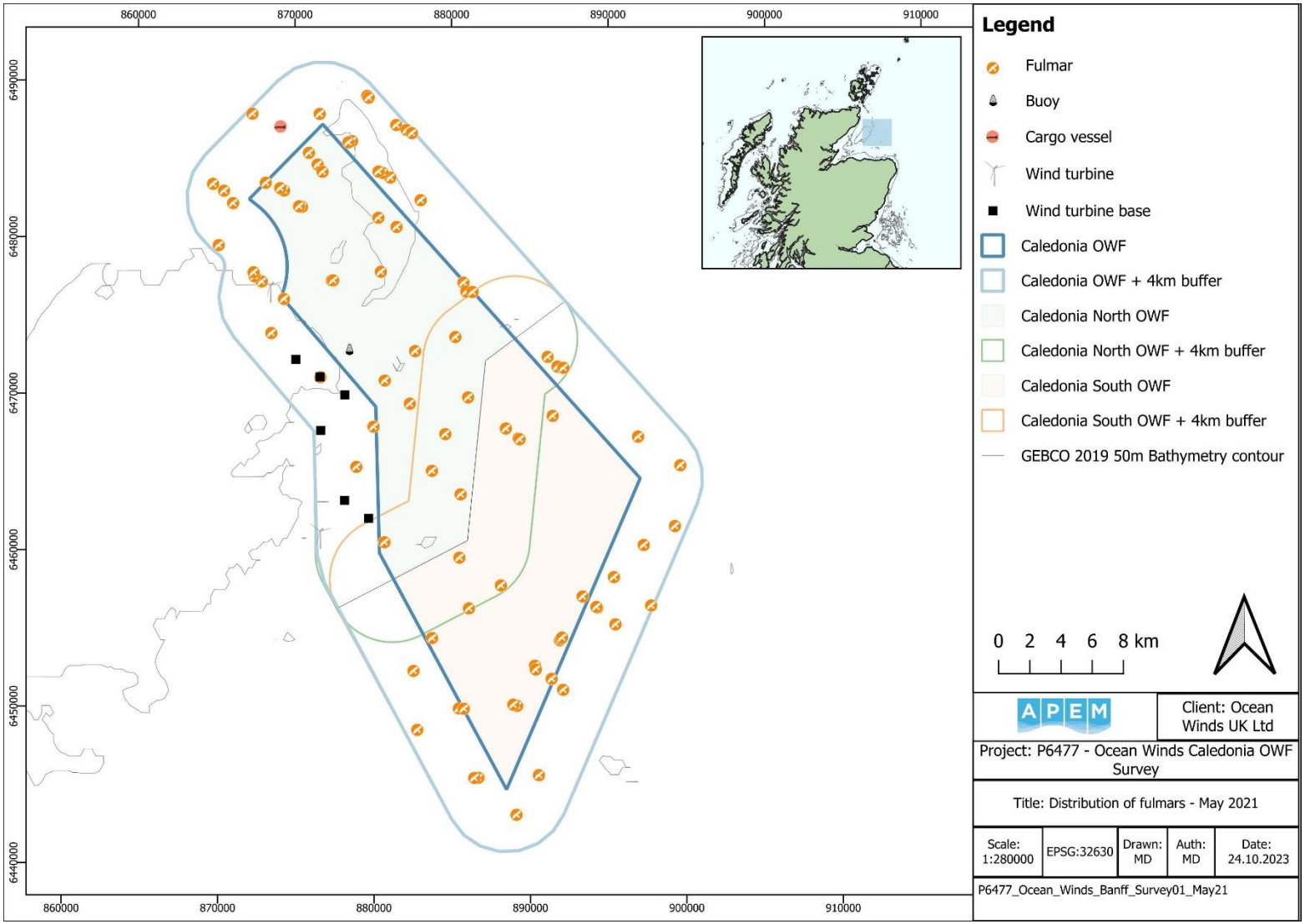


Figure A4.262 Distribution of fulmars recorded in the Survey Area in May 2021

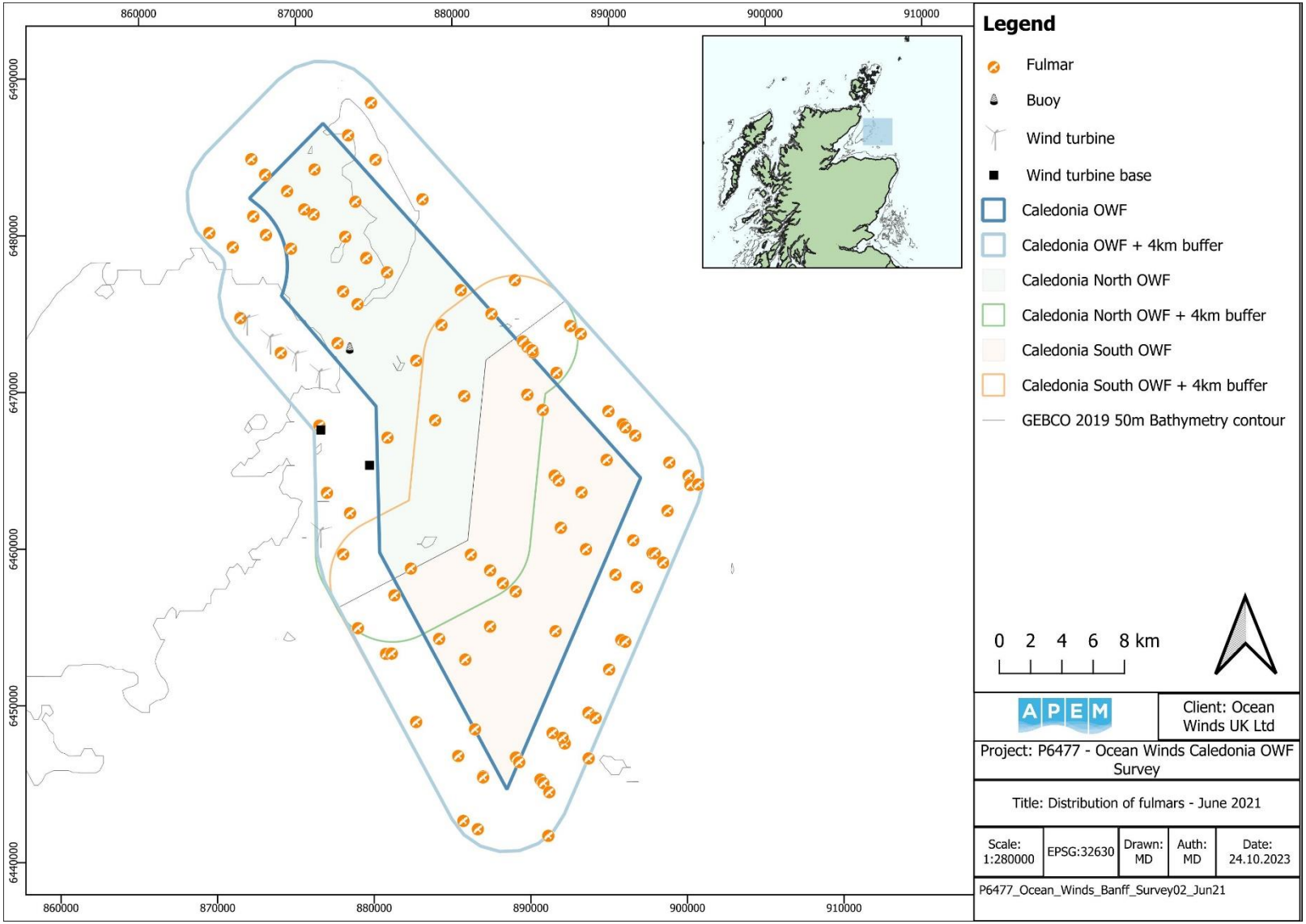


Figure A4.263 Distribution of fulmars recorded in the Survey Area in June 2021

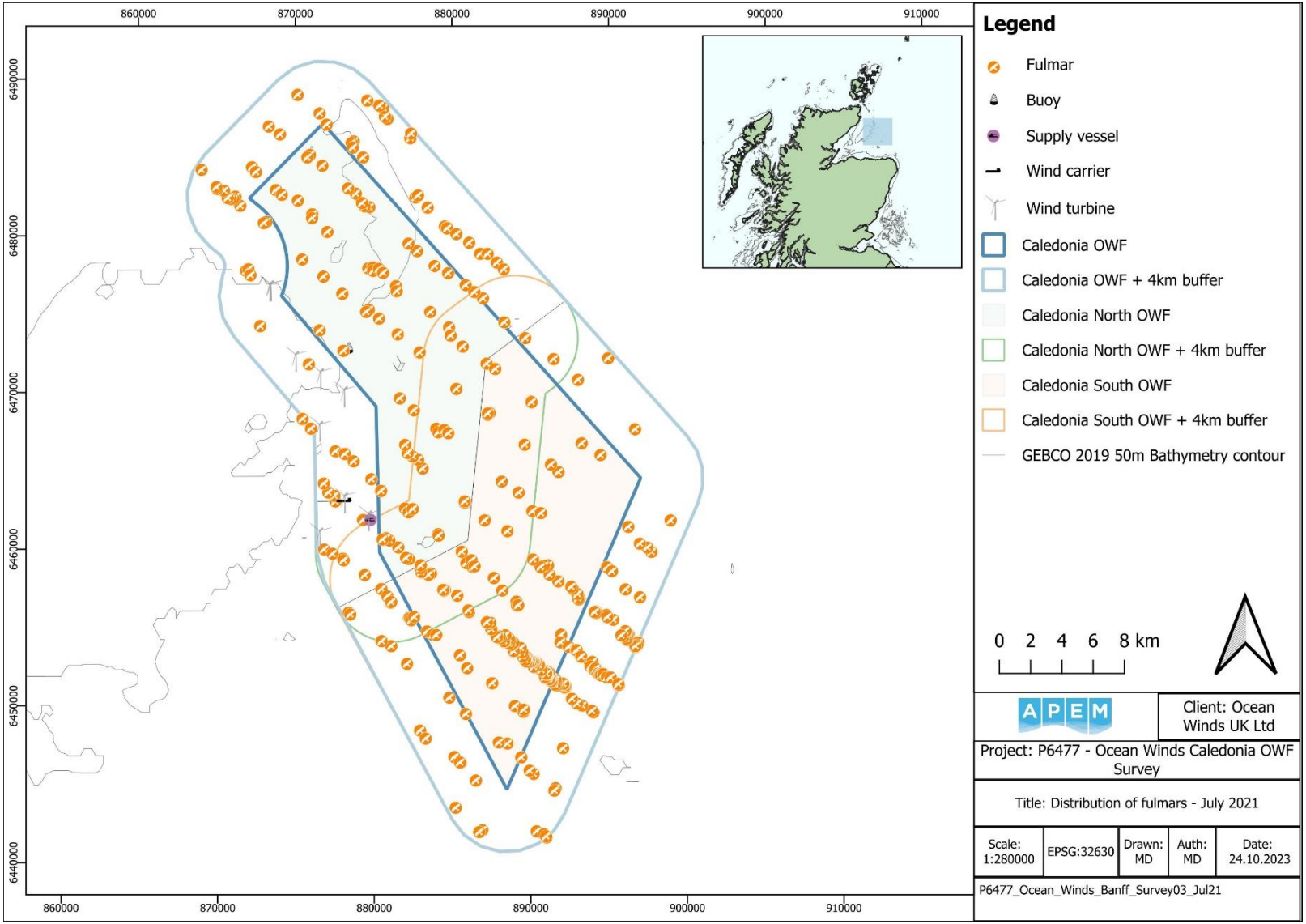


Figure A4.264 Distribution of fulmars recorded in the Survey Area in July 2021

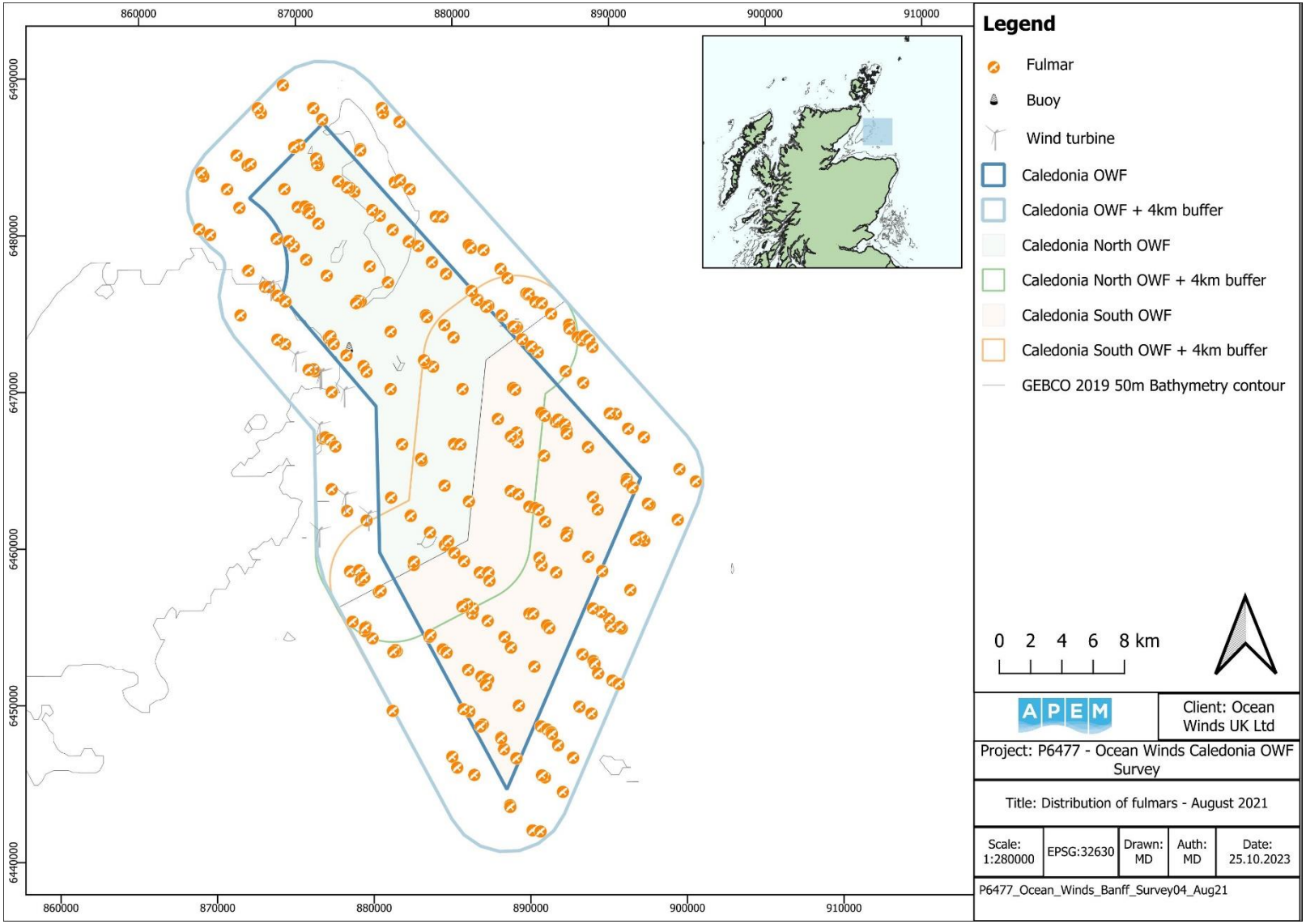


Figure A4.265 Distribution of fulmars recorded in the Survey Area in August 2021

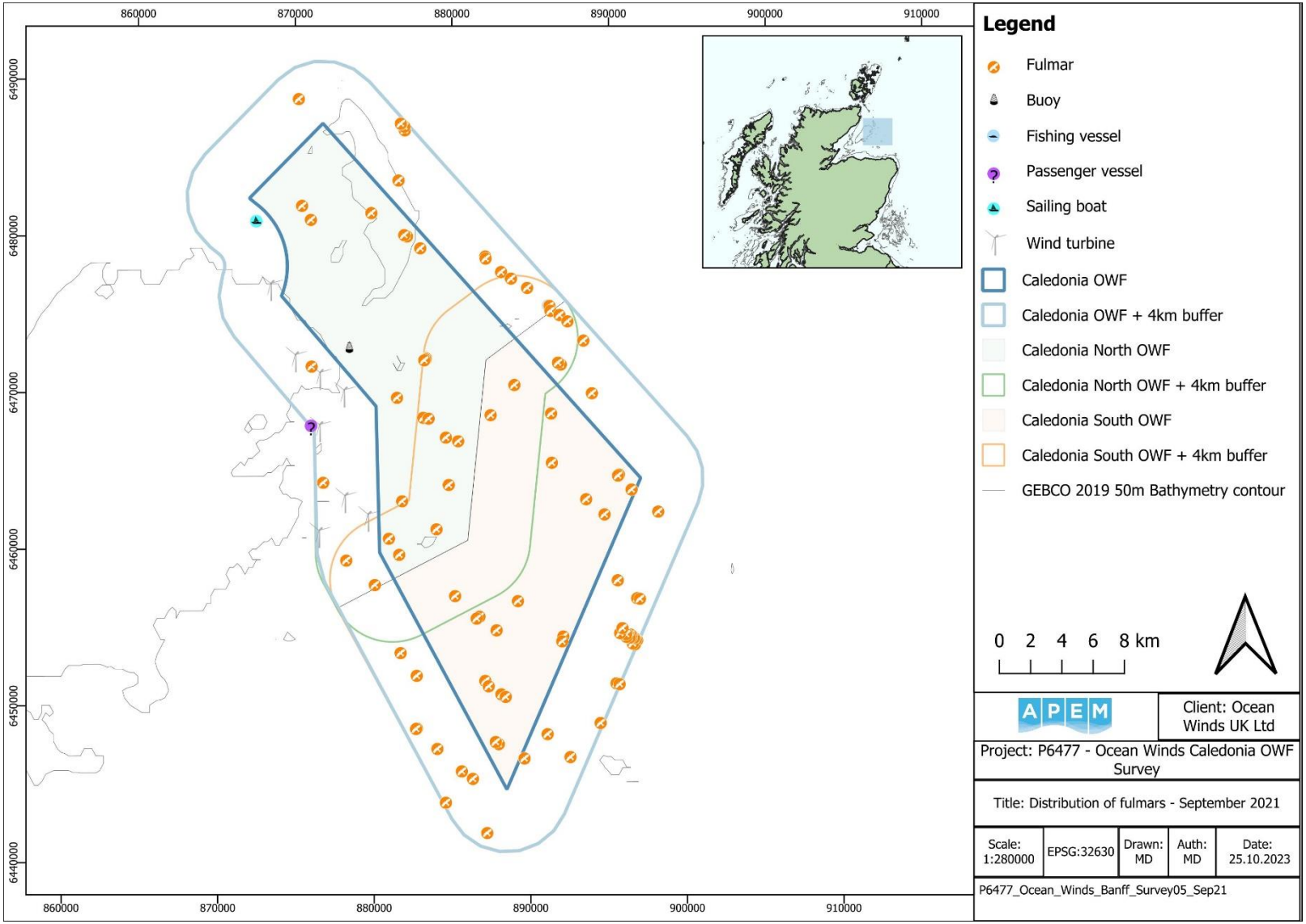


Figure A4.266 Distribution of fulmars recorded in the Survey Area in September 2021

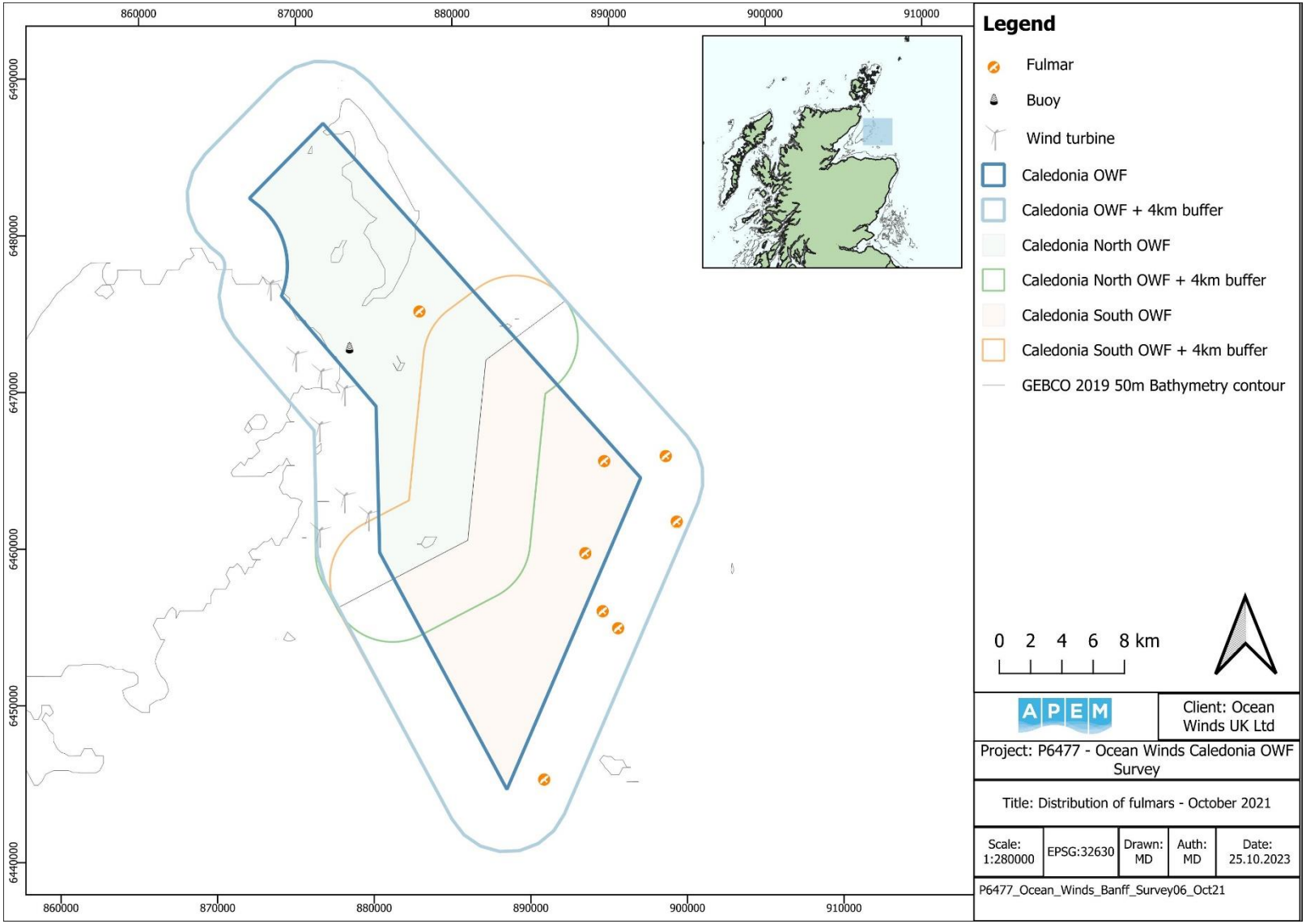


Figure A4.267 Distribution of fulmars recorded in the Survey Area in October 2021

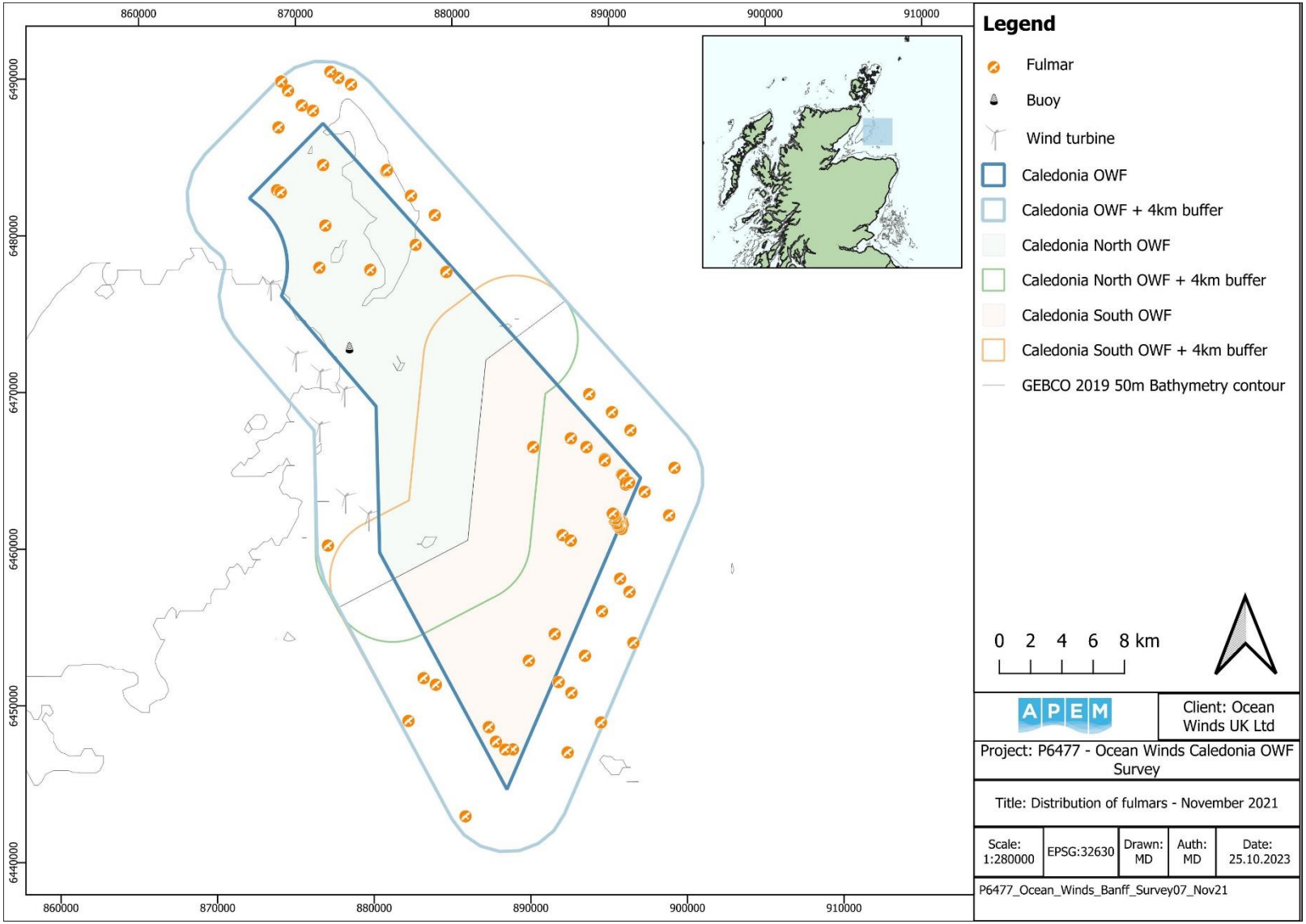


Figure A4.268 Distribution of fulmars recorded in the Survey Area in November 2021

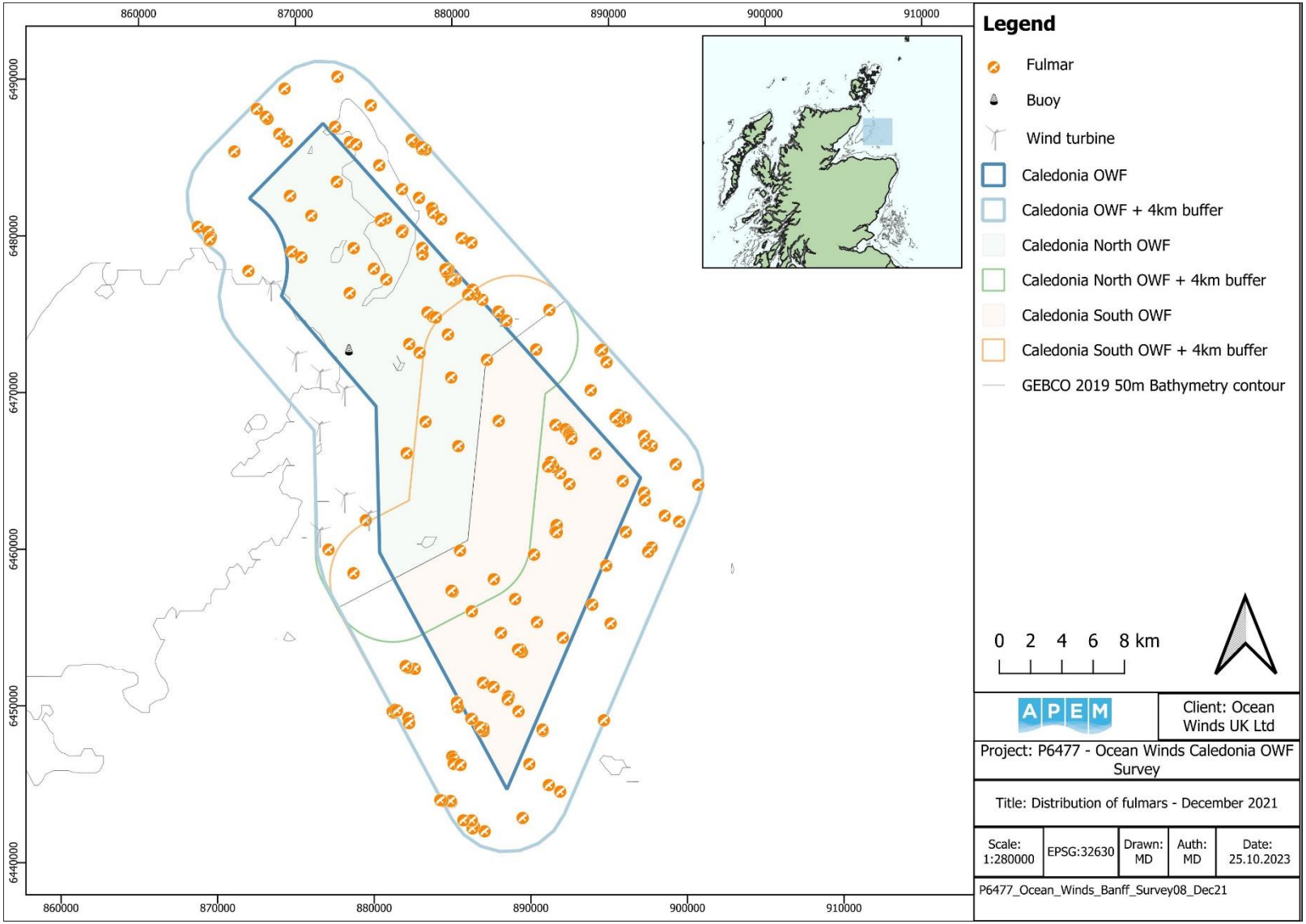


Figure A4.269 Distribution of fulmars recorded in the Survey Area in December 2021

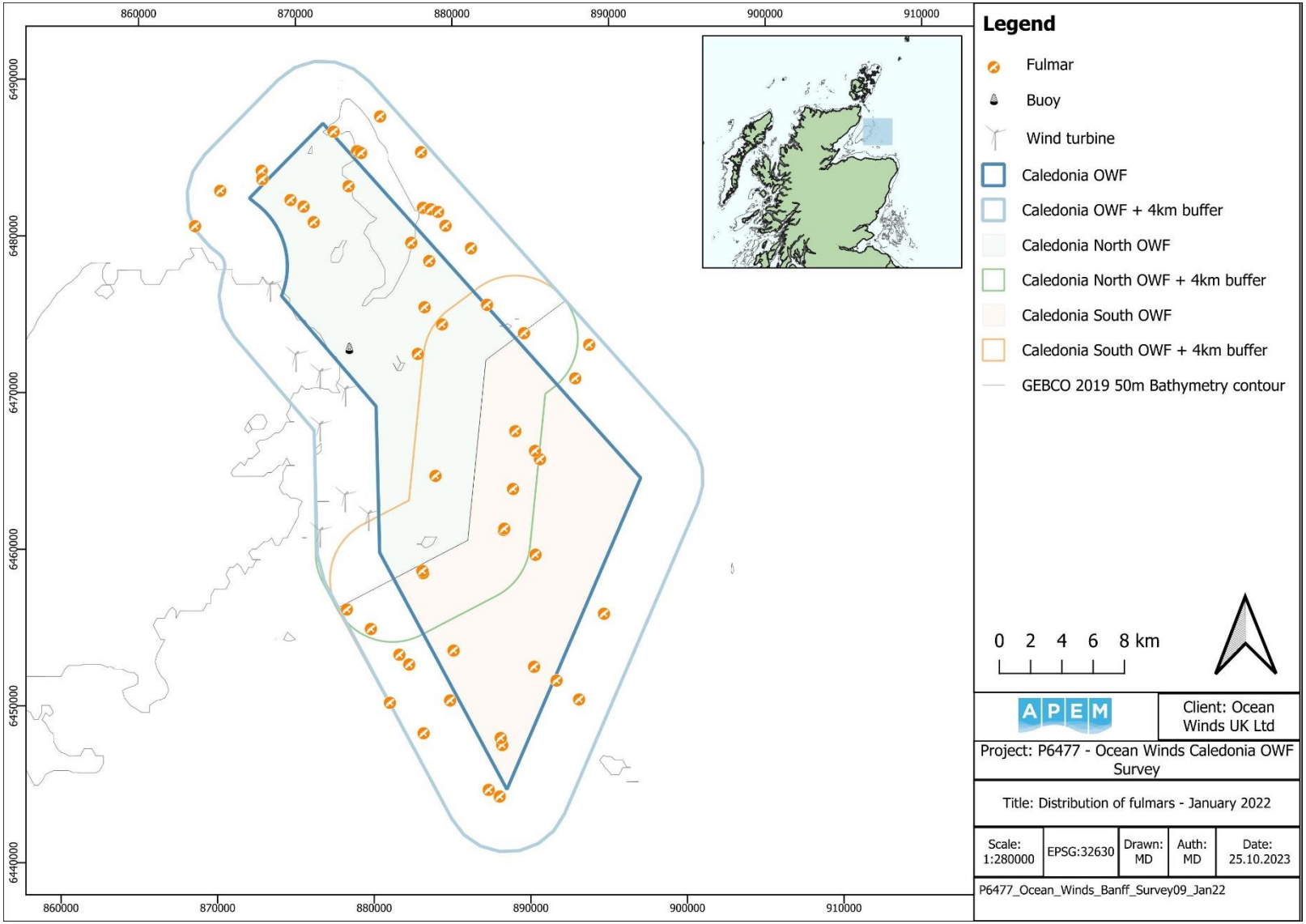


Figure A4.270 Distribution of fulmars recorded in the Survey Area in January 2022

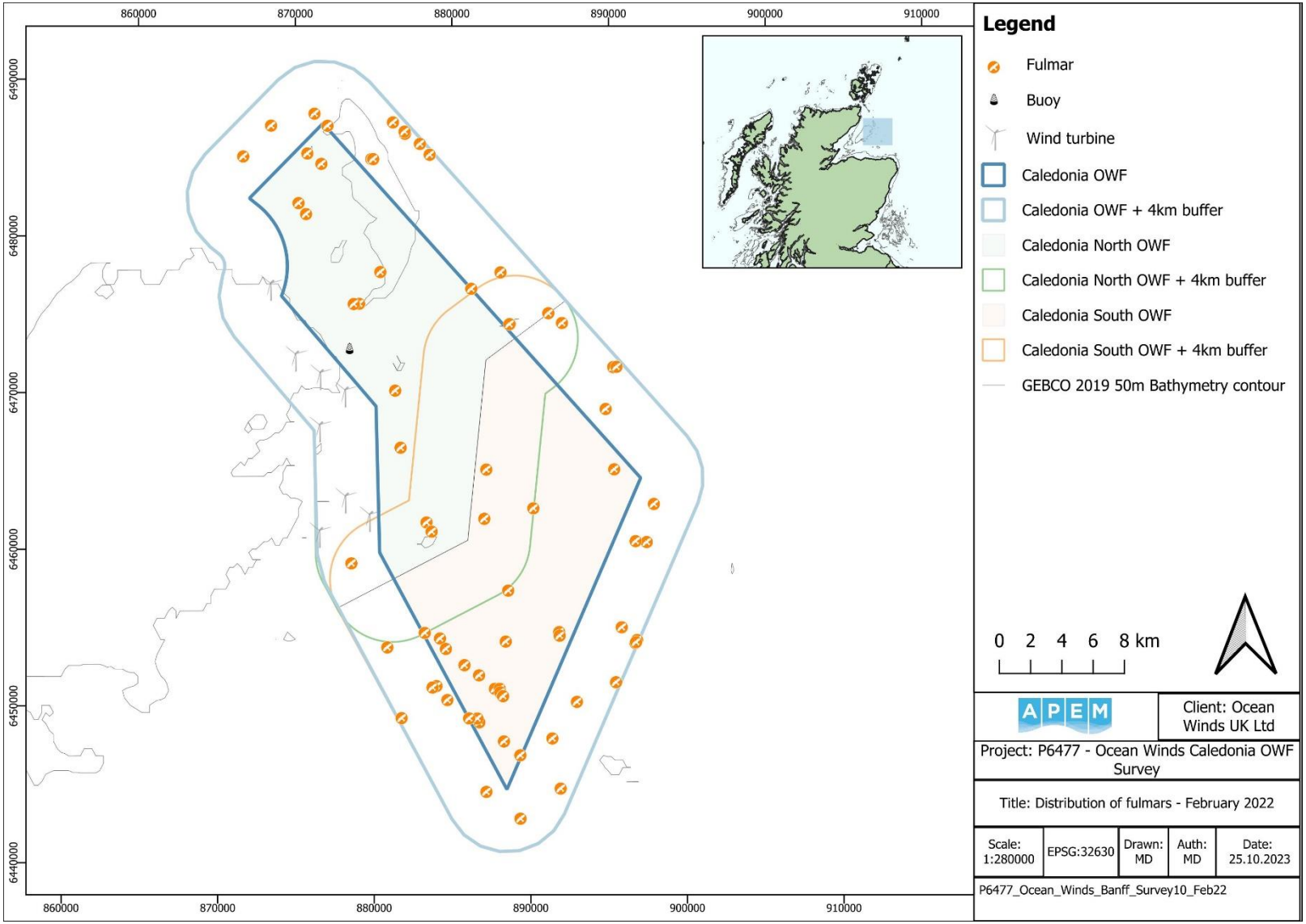


Figure A4.271 Distribution of fulmars recorded in the Survey Area in February 2022

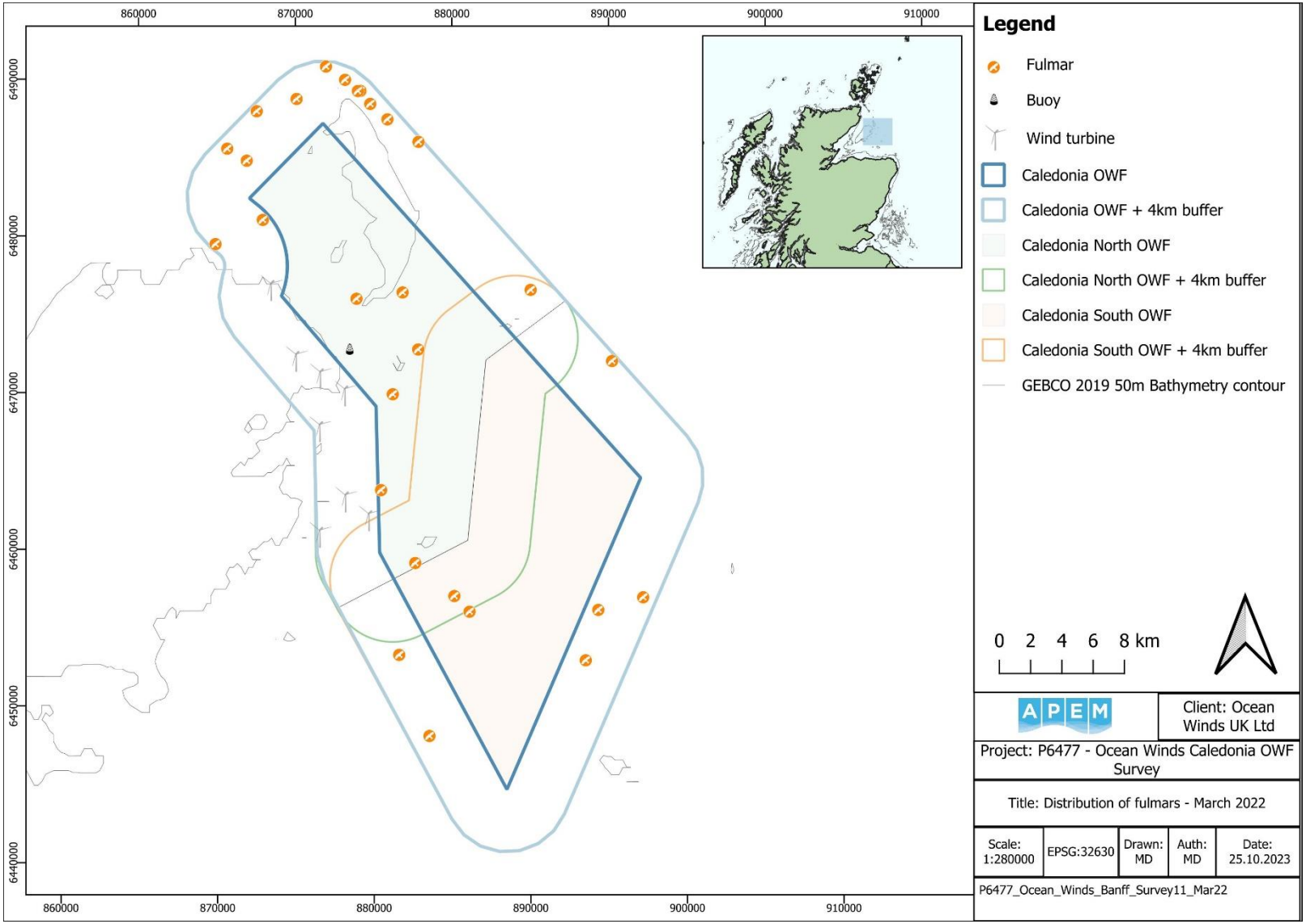


Figure A4.272 Distribution of fulmars recorded in the Survey Area in March 2022

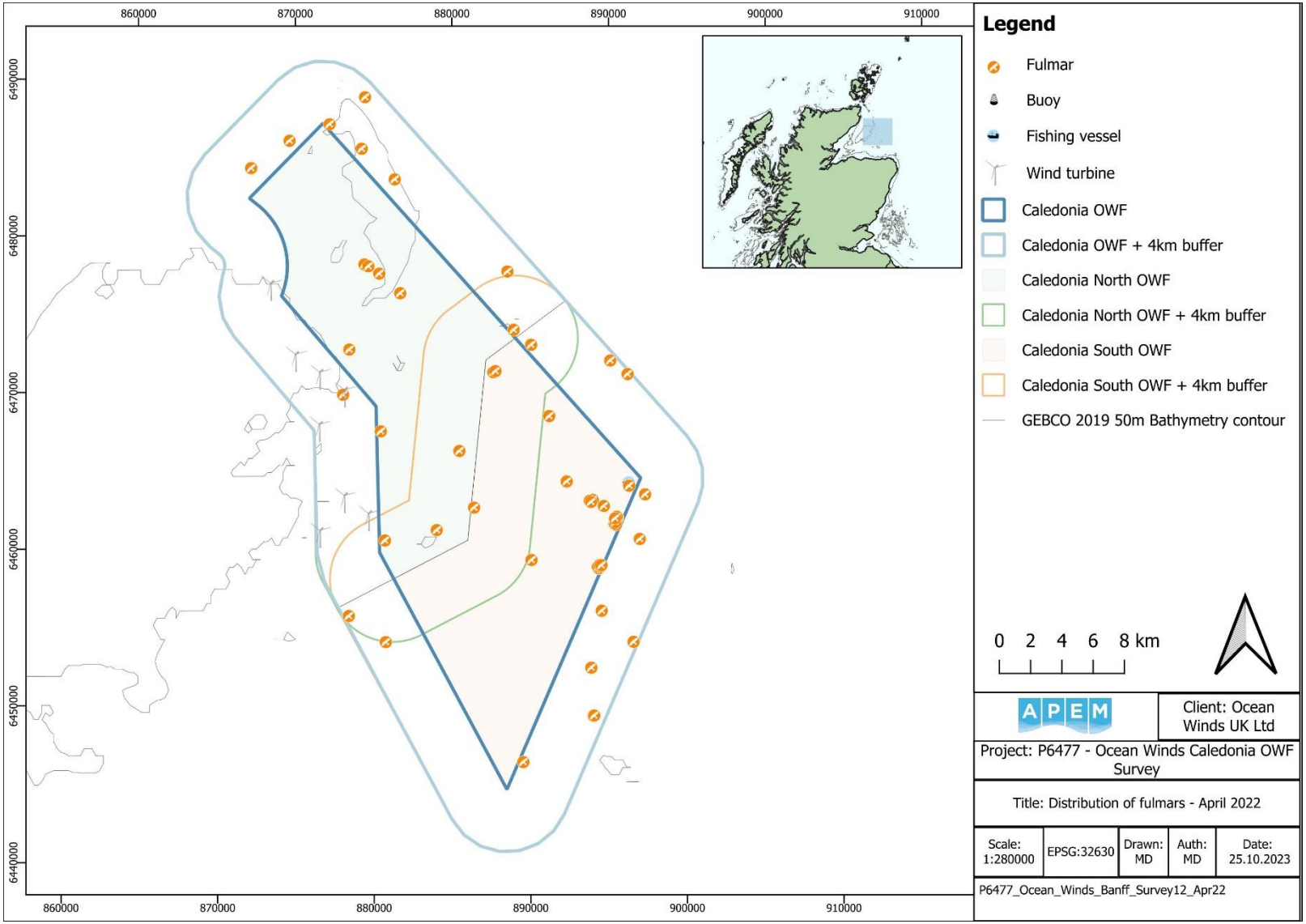


Figure A4.273 Distribution of fulmars recorded in the Survey Area in April 2022

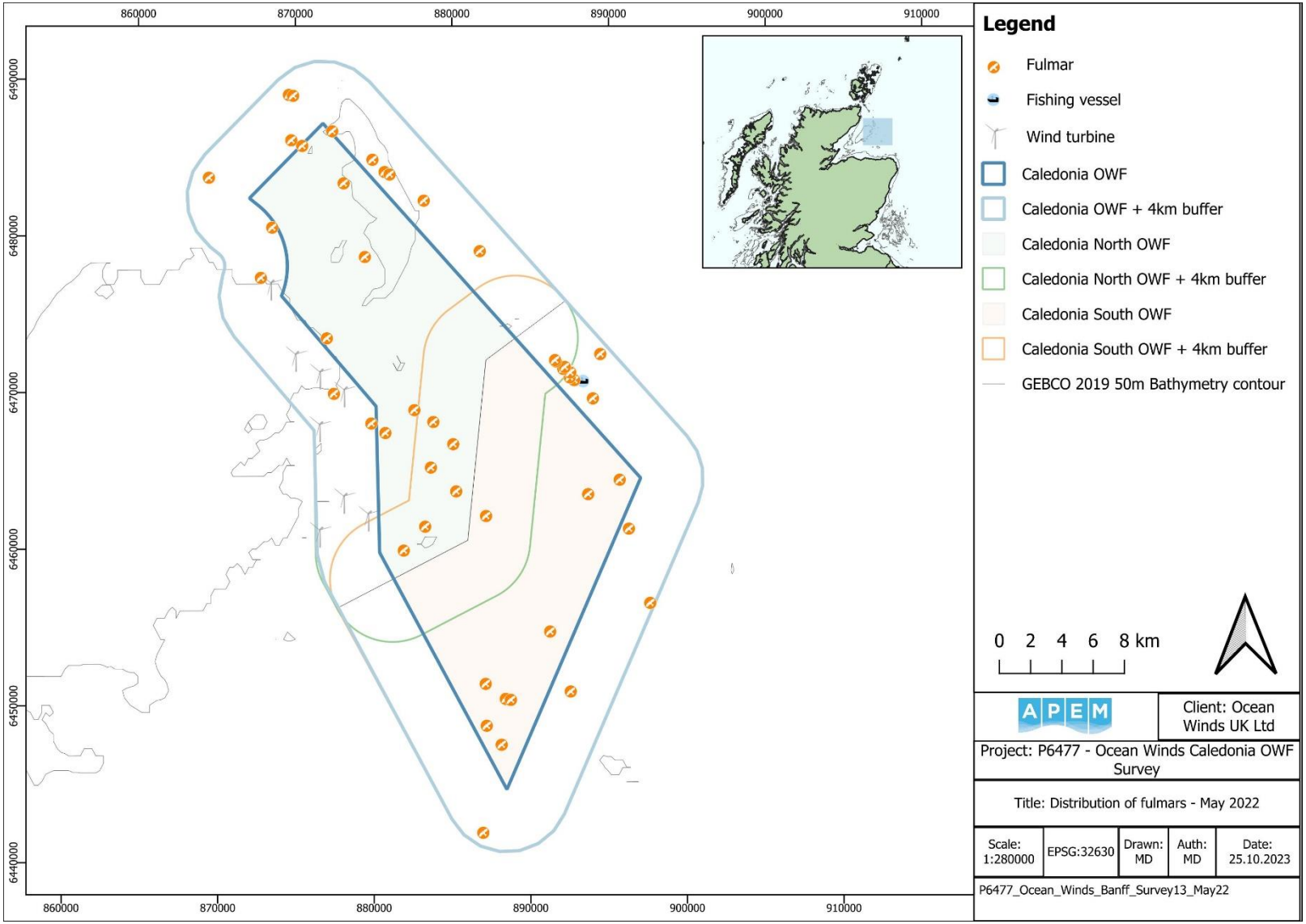


Figure A4.274 Distribution of fulmars recorded in the Survey Area in May 2022

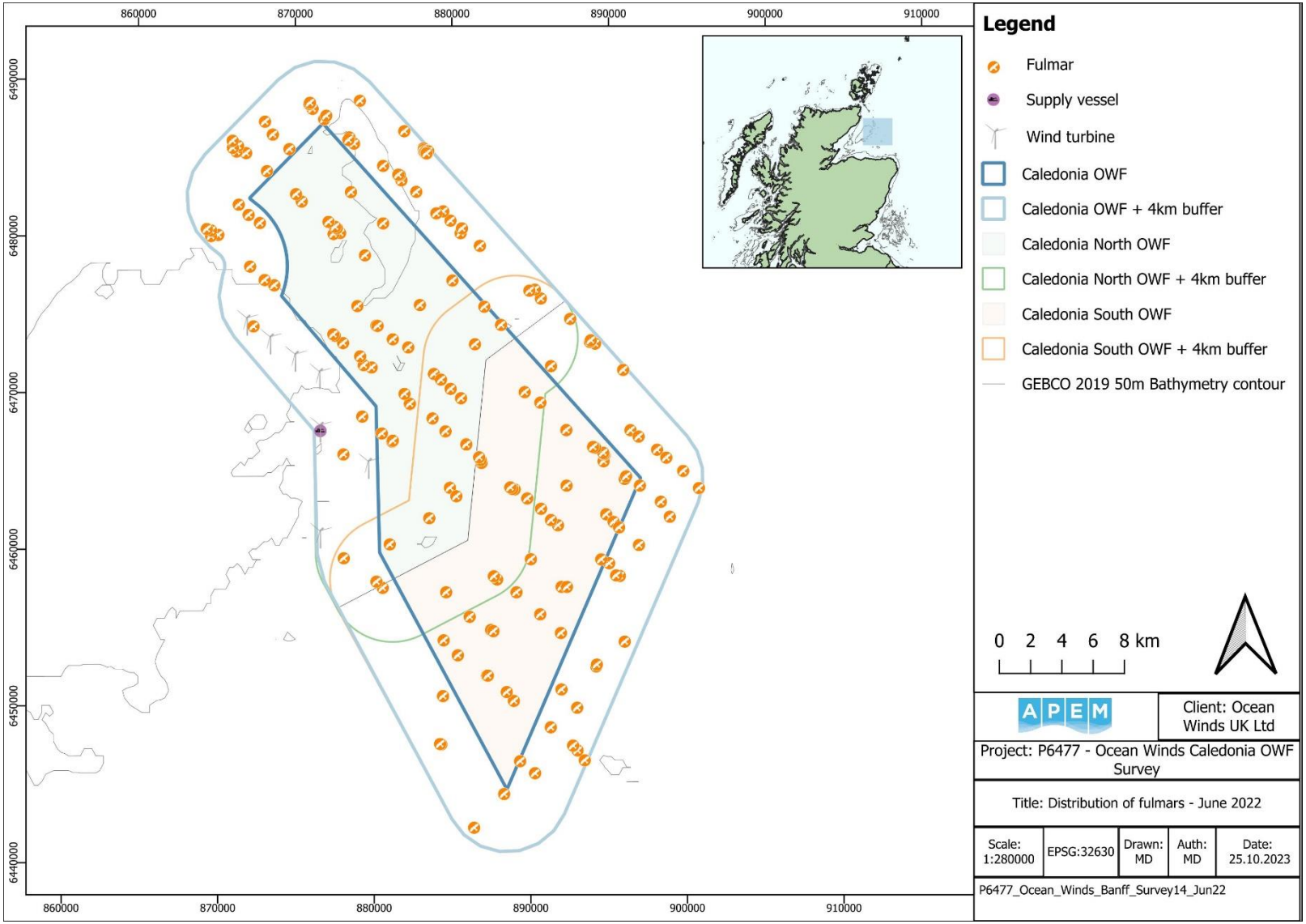


Figure A4.275 Distribution of fulmars recorded in the Survey Area in June 2022

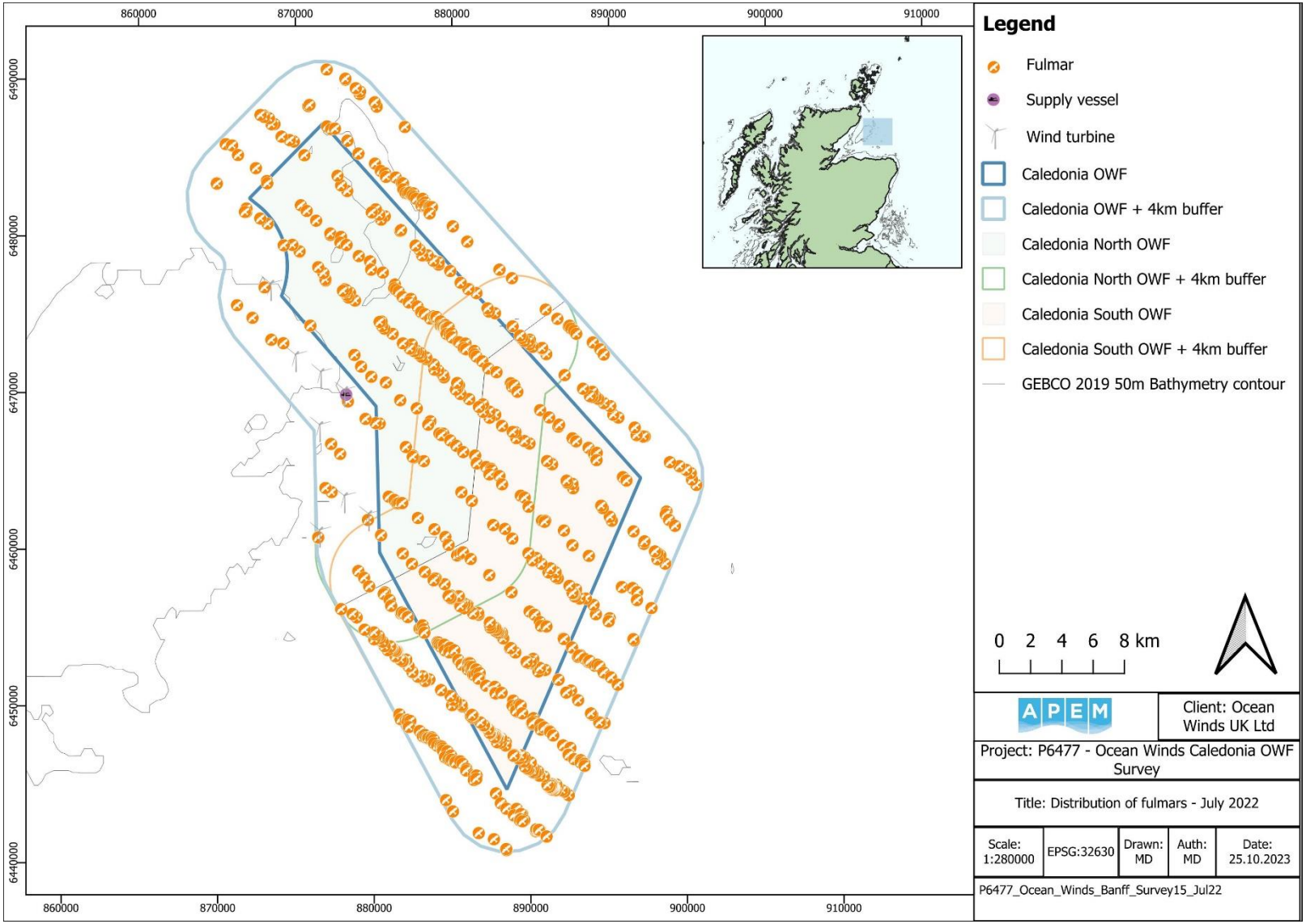


Figure A4.276 Distribution of fulmars recorded in the Survey Area in July 2022

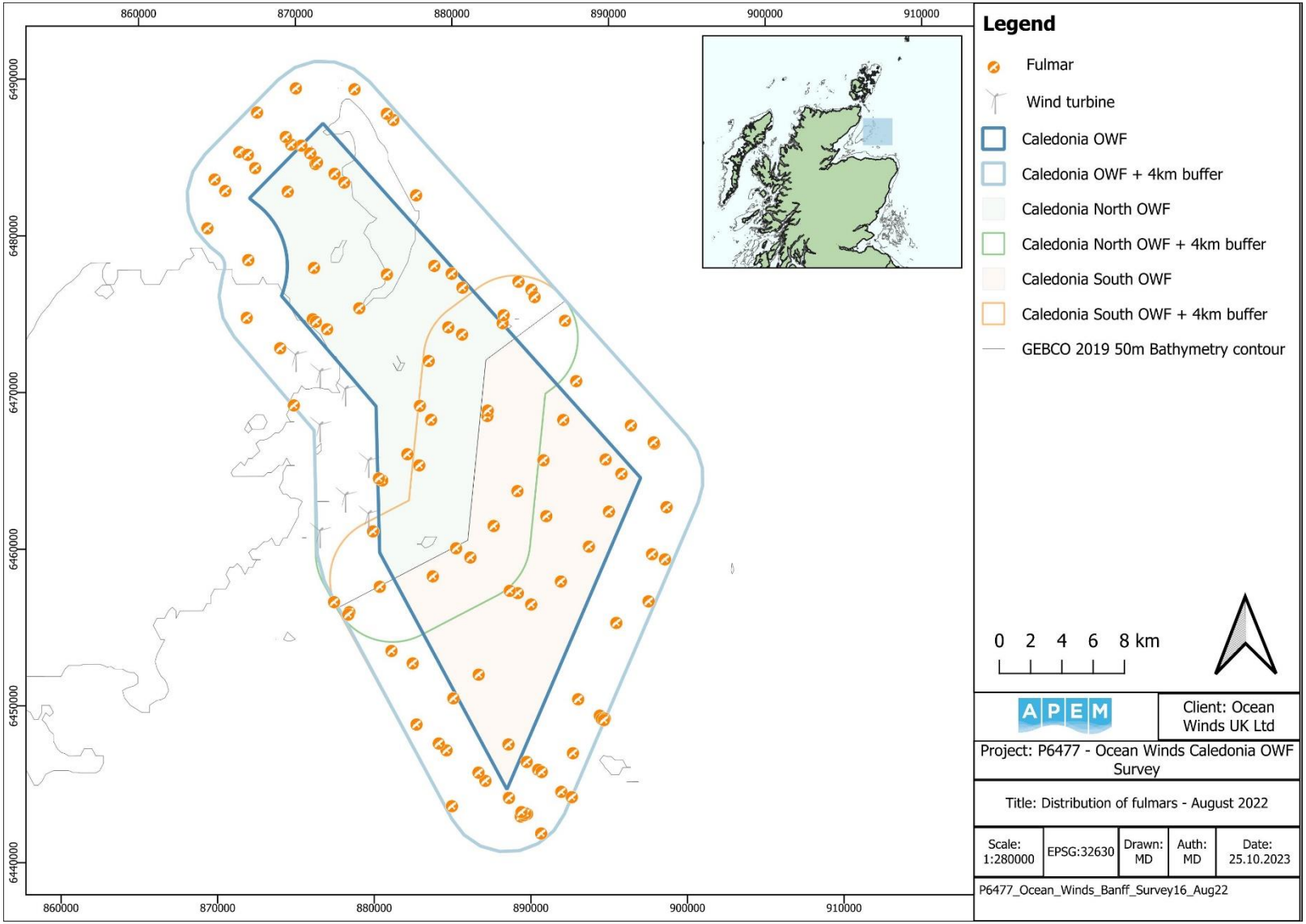


Figure A4.277 Distribution of fulmars recorded in the Survey Area in August 2022

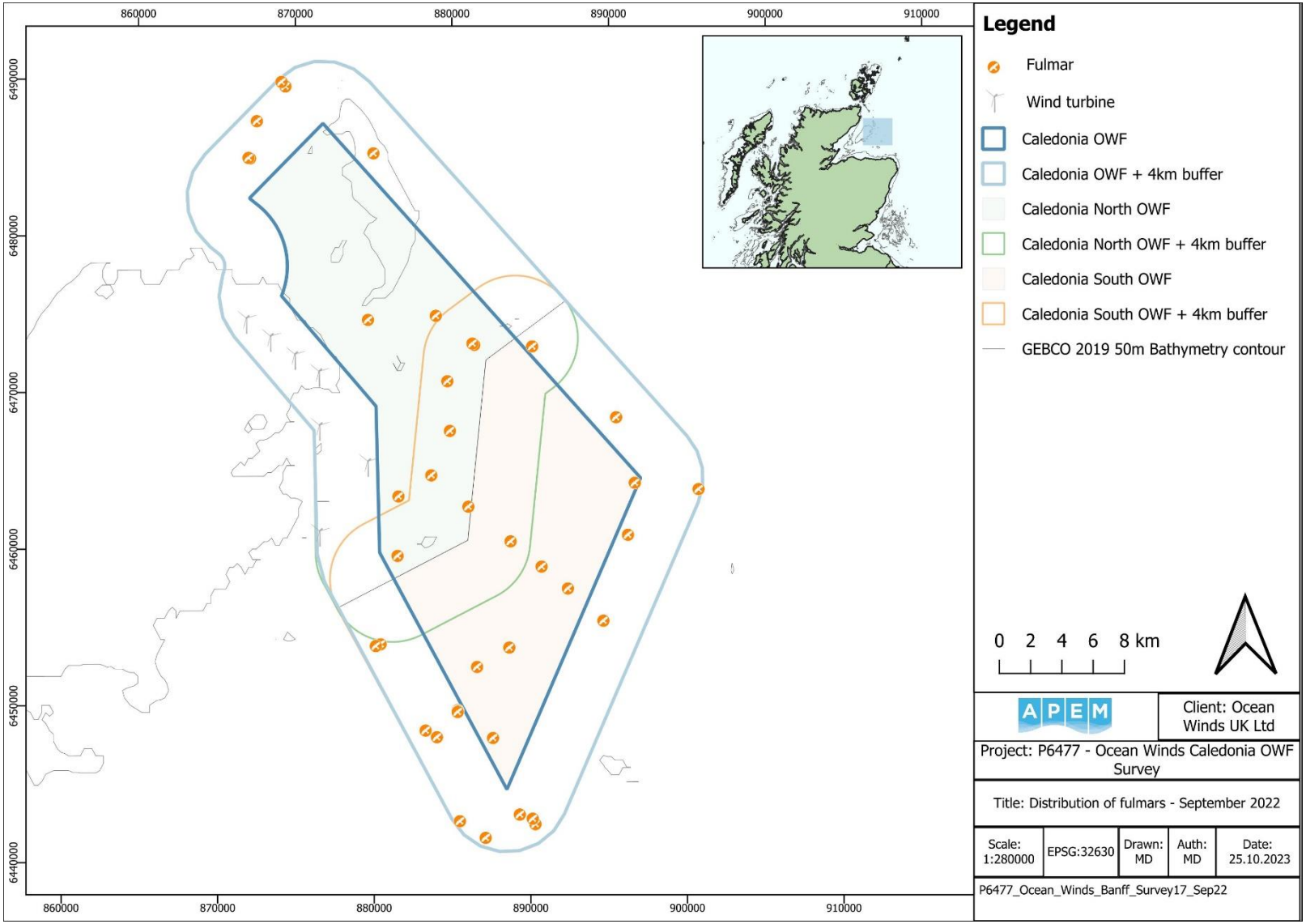


Figure A4.278 Distribution of fulmars recorded in the Survey Area in September 2022

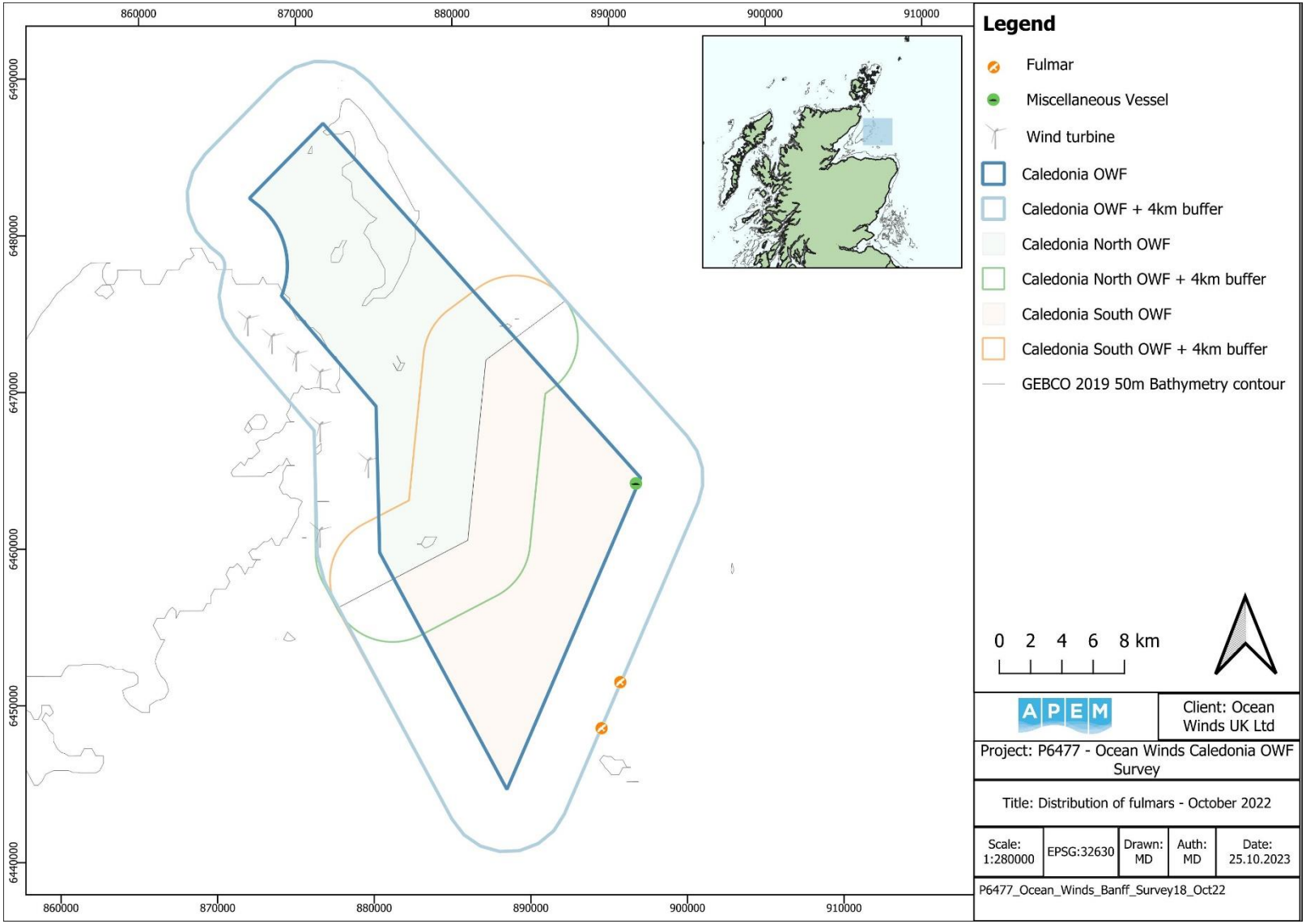


Figure A4.279 Distribution of fulmars recorded in the Survey Area in October 2022

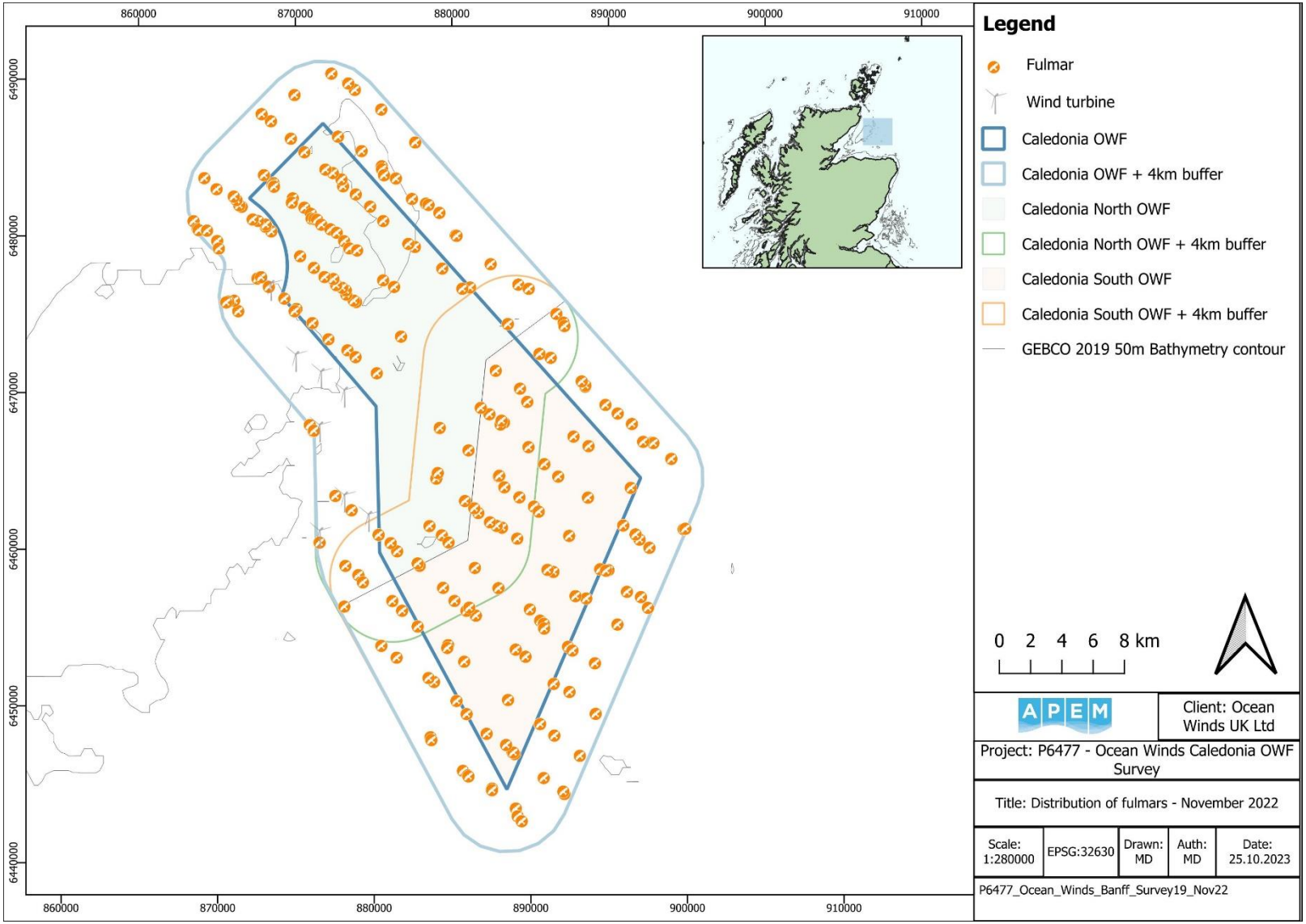


Figure A4.280 Distribution of fulmars recorded in the Survey Area in November 2022

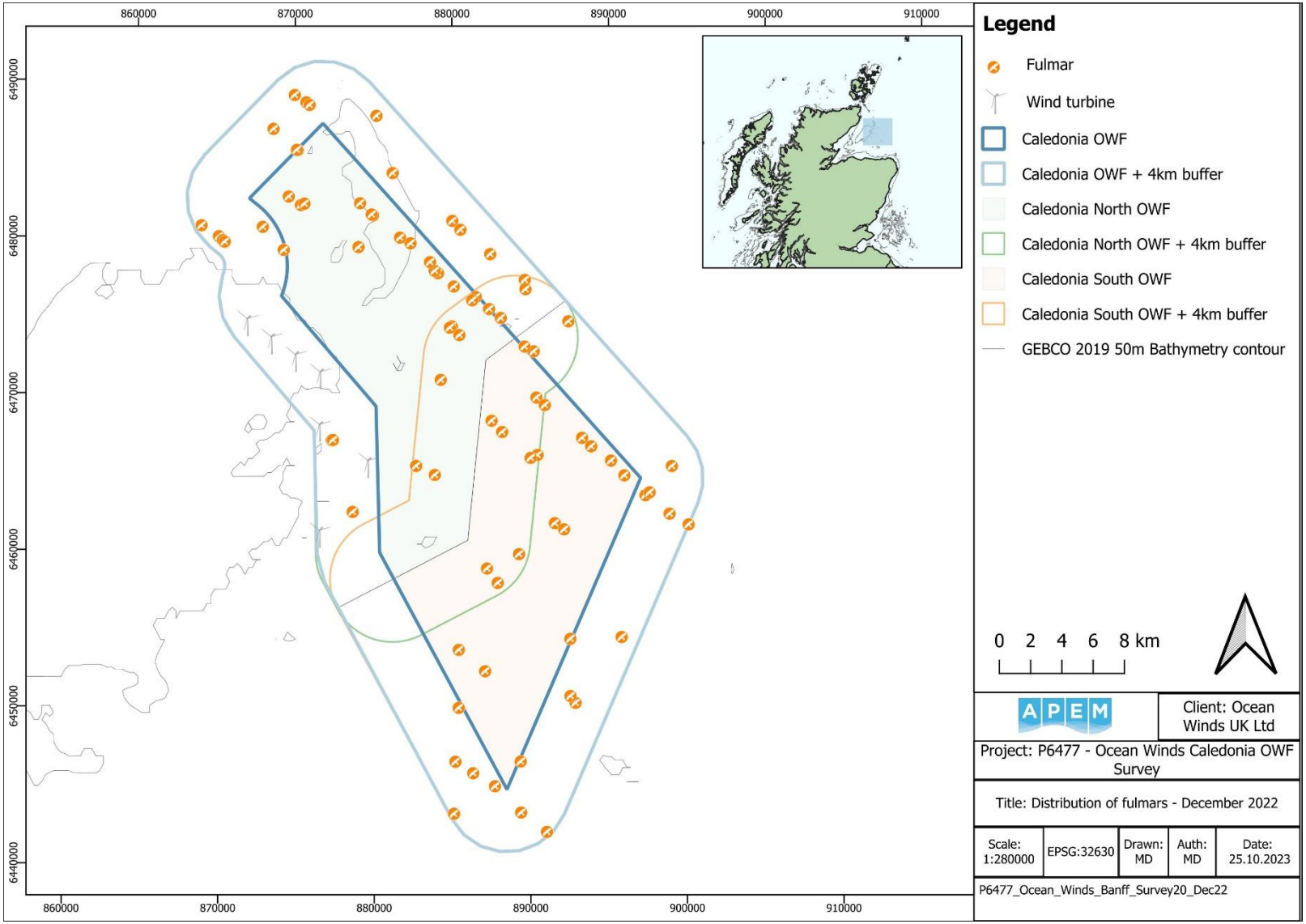


Figure A4.281 Distribution of fulmars recorded in the Survey Area in December 2022

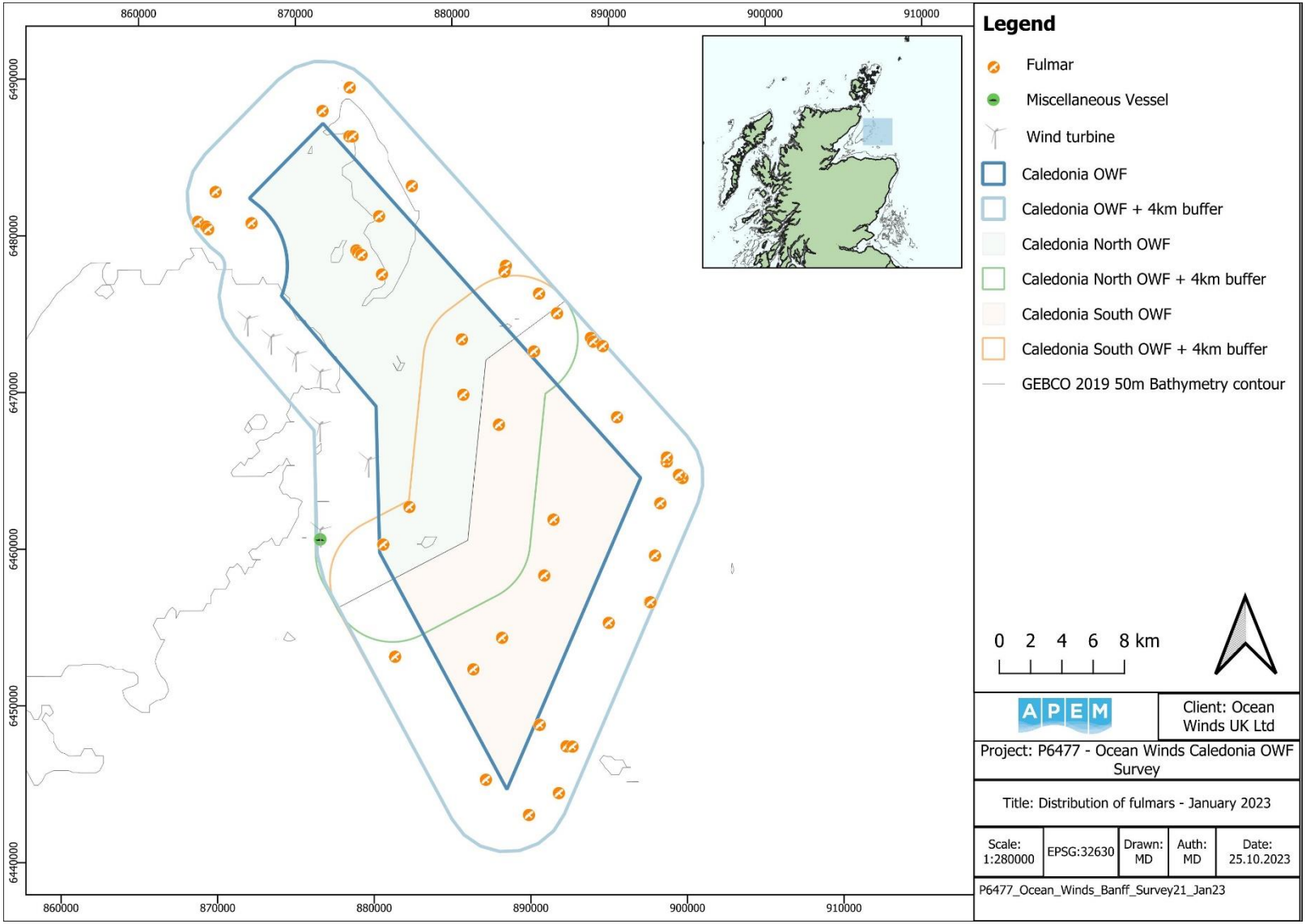


Figure A4.282 Distribution of fulmars recorded in the Survey Area in January 2023

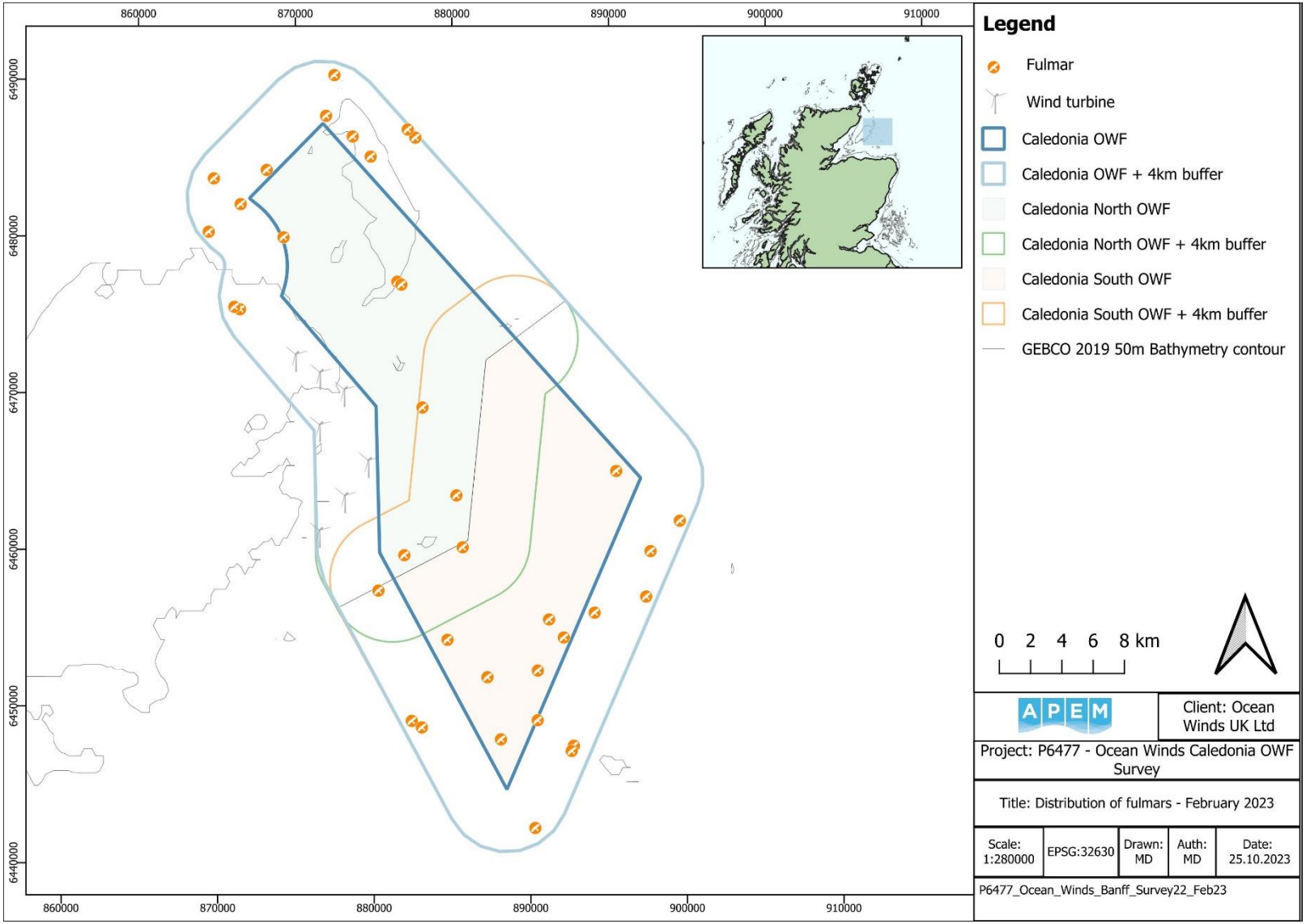


Figure A4.283 Distribution of fulmars recorded in the Survey Area in February 2023

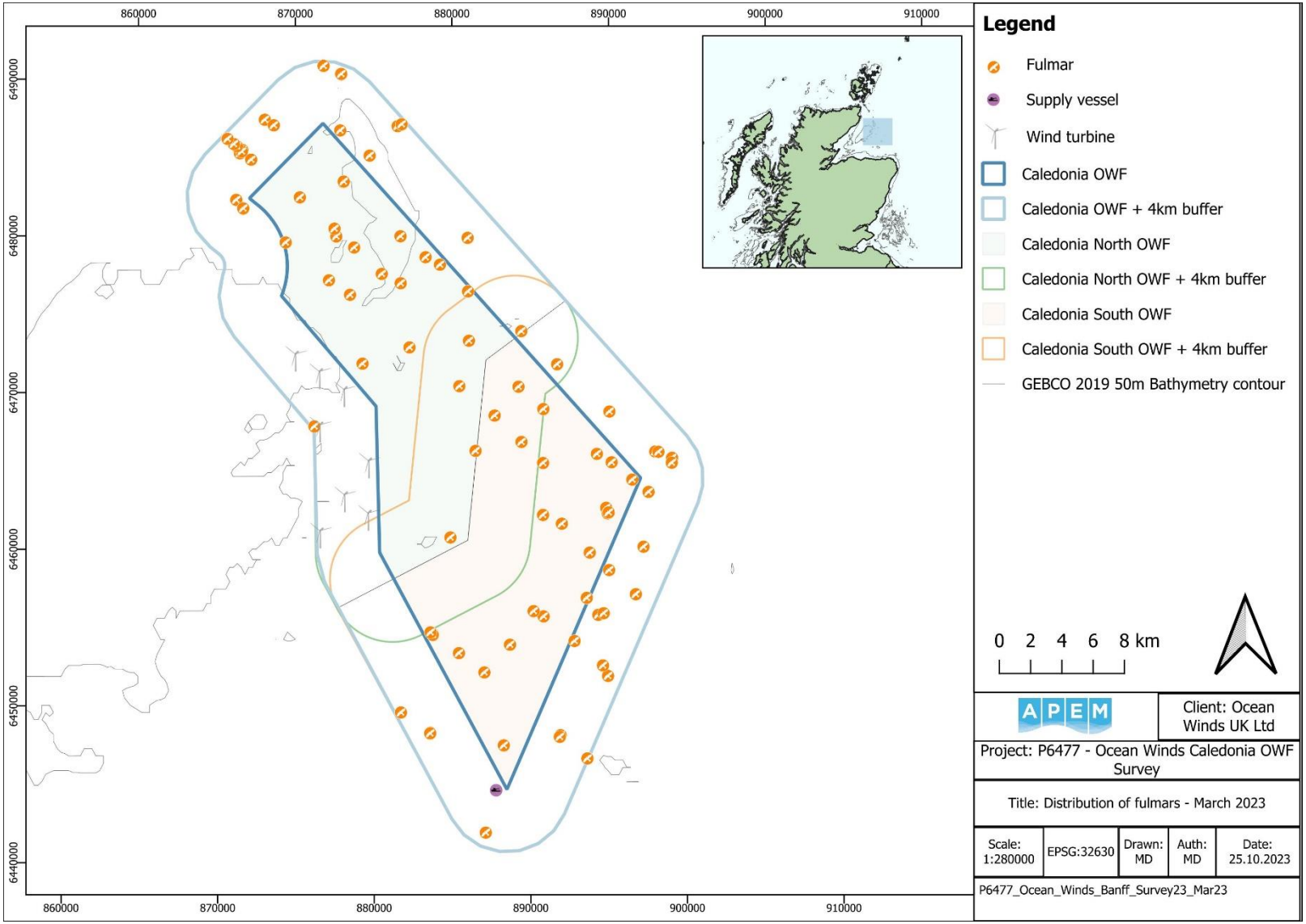


Figure A4.284 Distribution of fulmars recorded in the Survey Area in March 2023

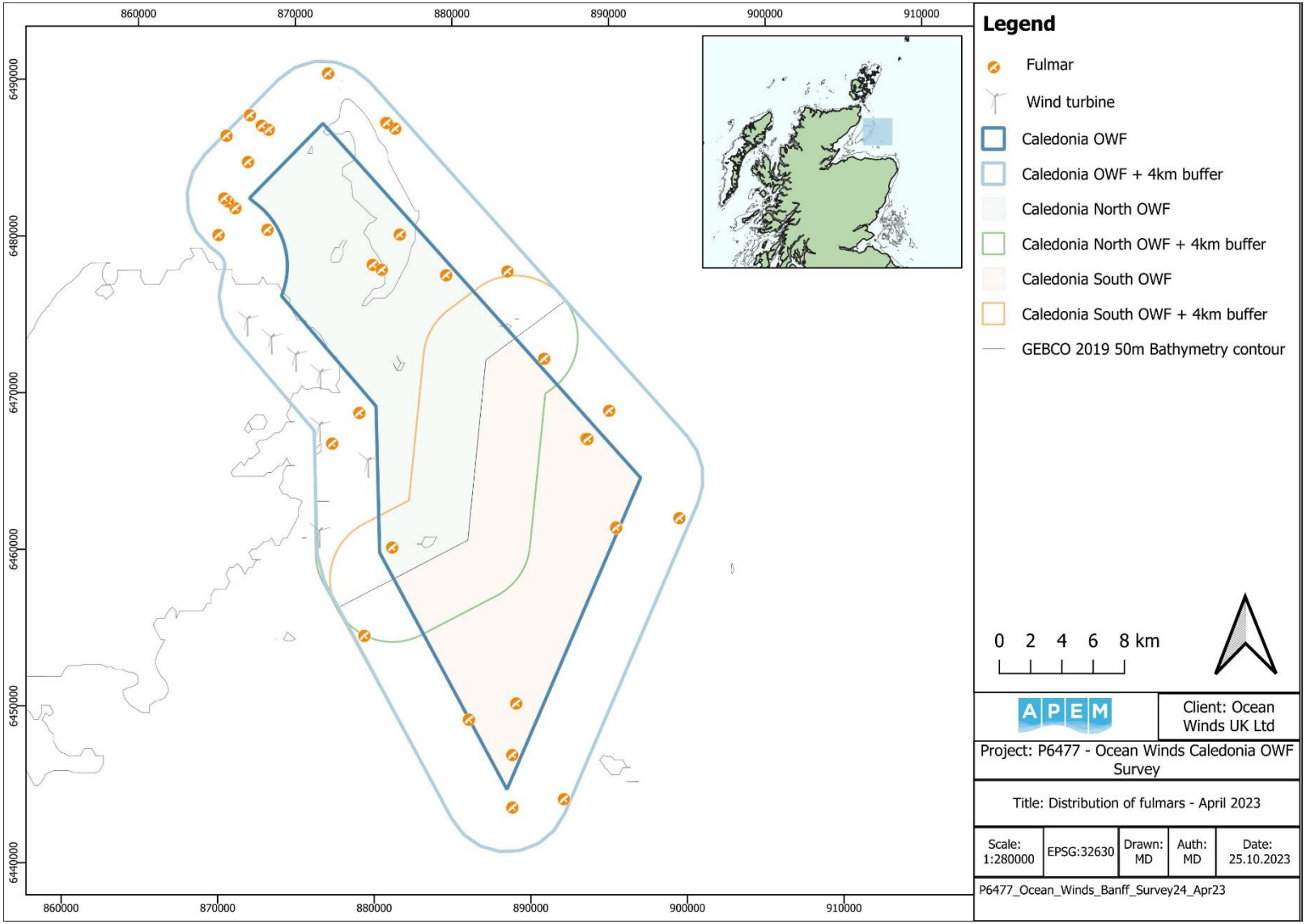


Figure A4.285 Distribution of fulmars recorded in the Survey Area in April 2023

Unidentified fulmar and / or gull species

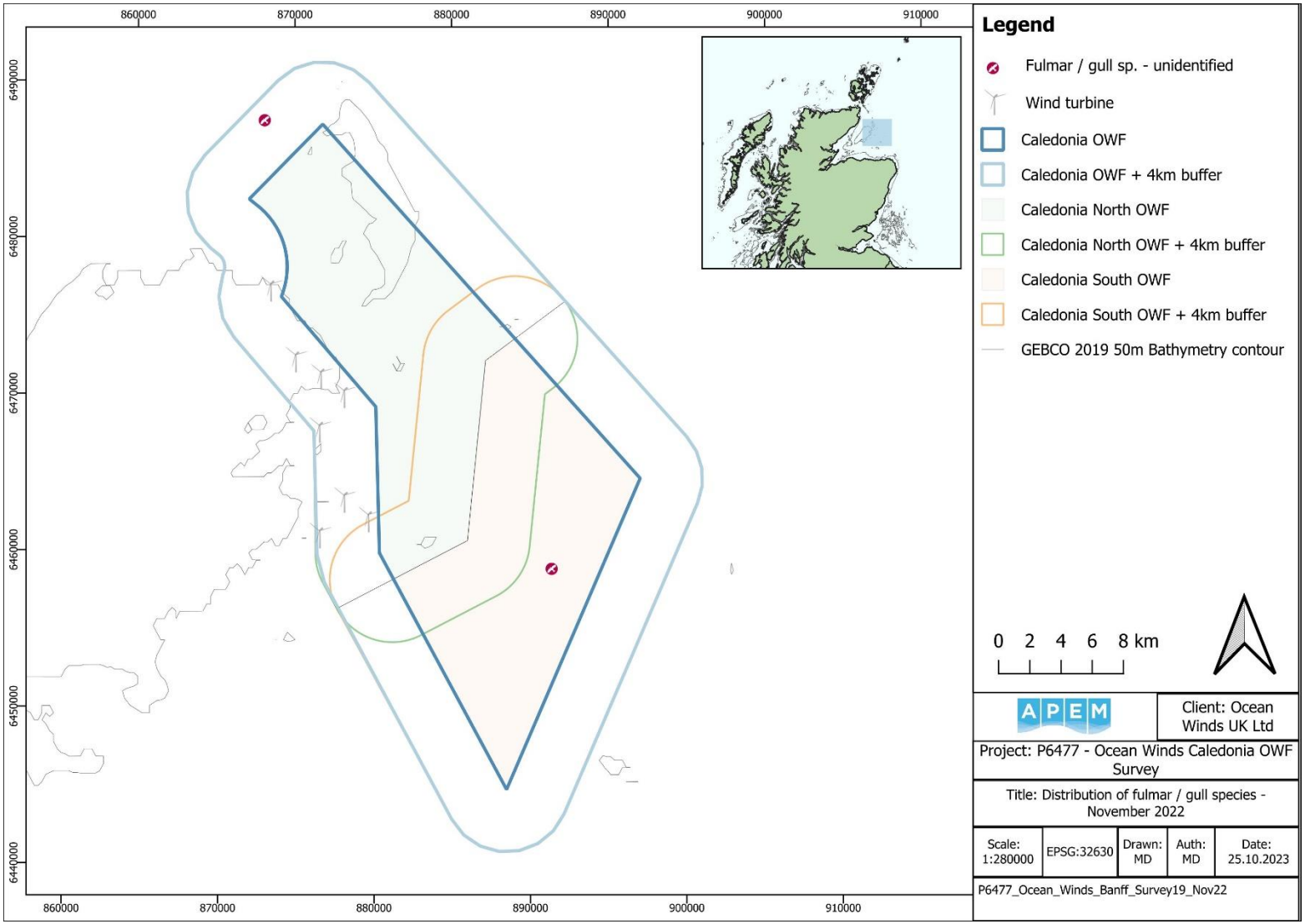


Figure A4.286 Distribution of fulmar / gull species recorded in the Survey Area in November 2022

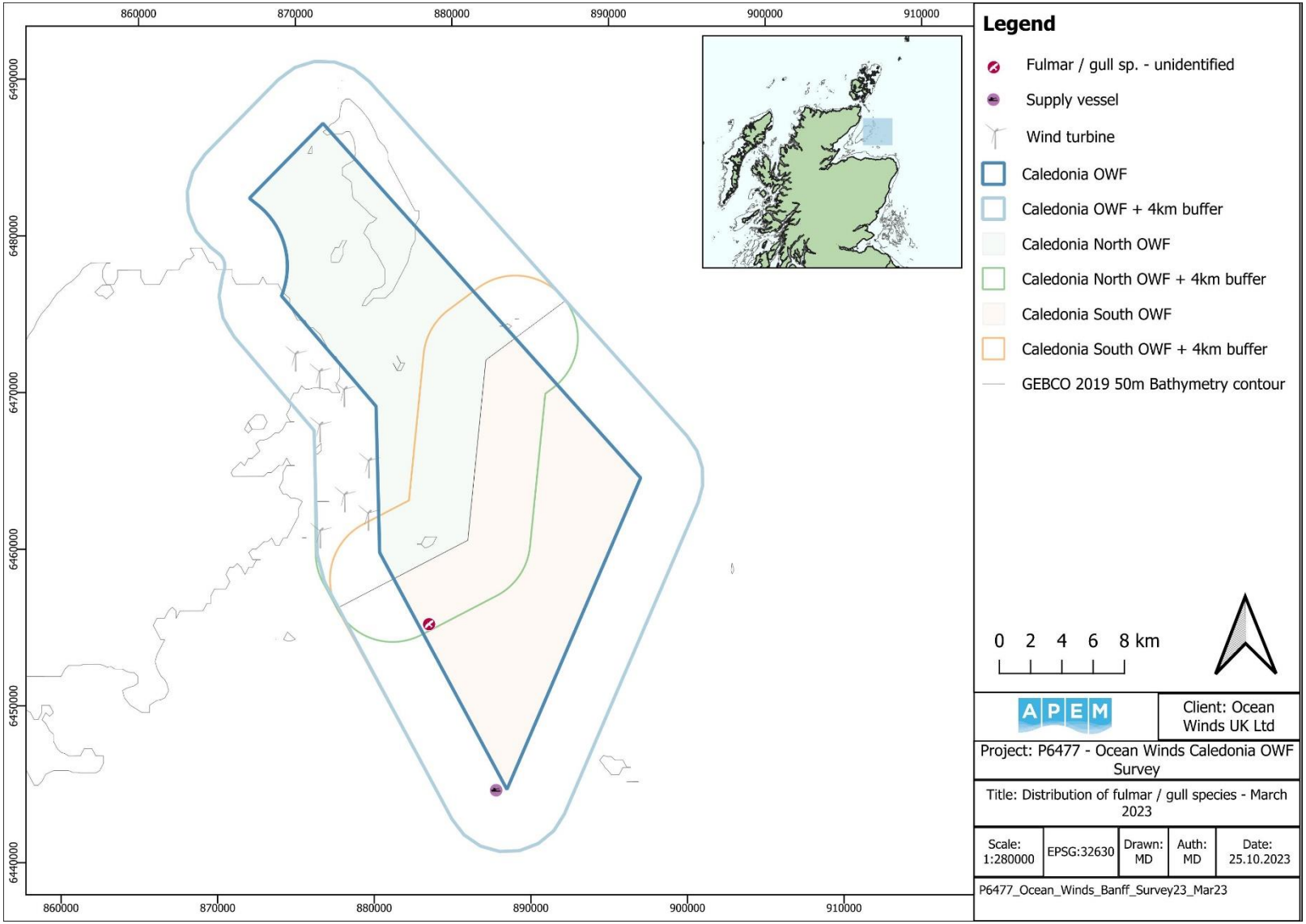


Figure A4.287 Distribution of fulmar / gull species recorded in the Survey Area in March 2023

Sooty shearwater

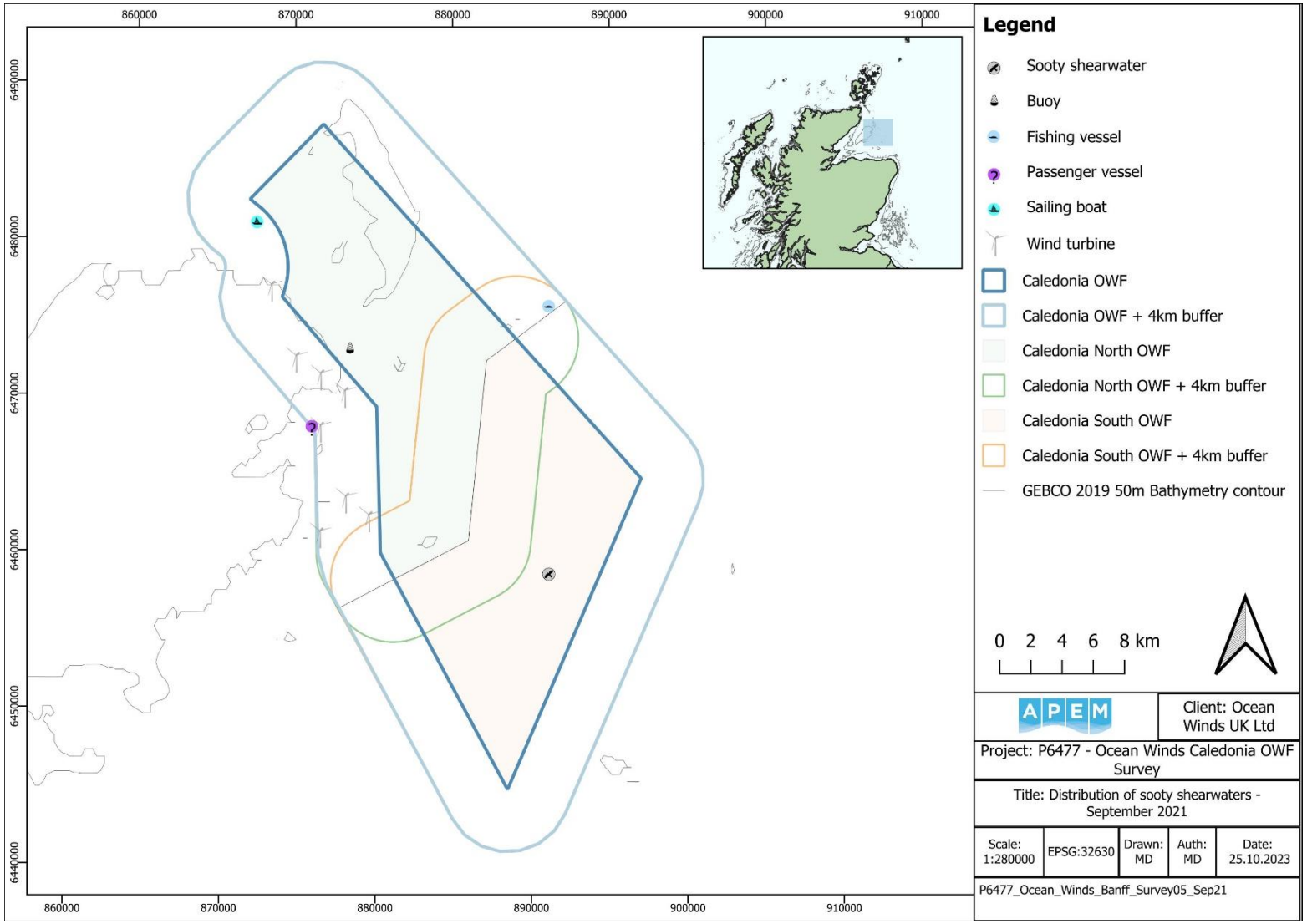


Figure A4.288 Distribution of sooty shearwaters recorded in the Survey Area in September 2021

Manx shearwater

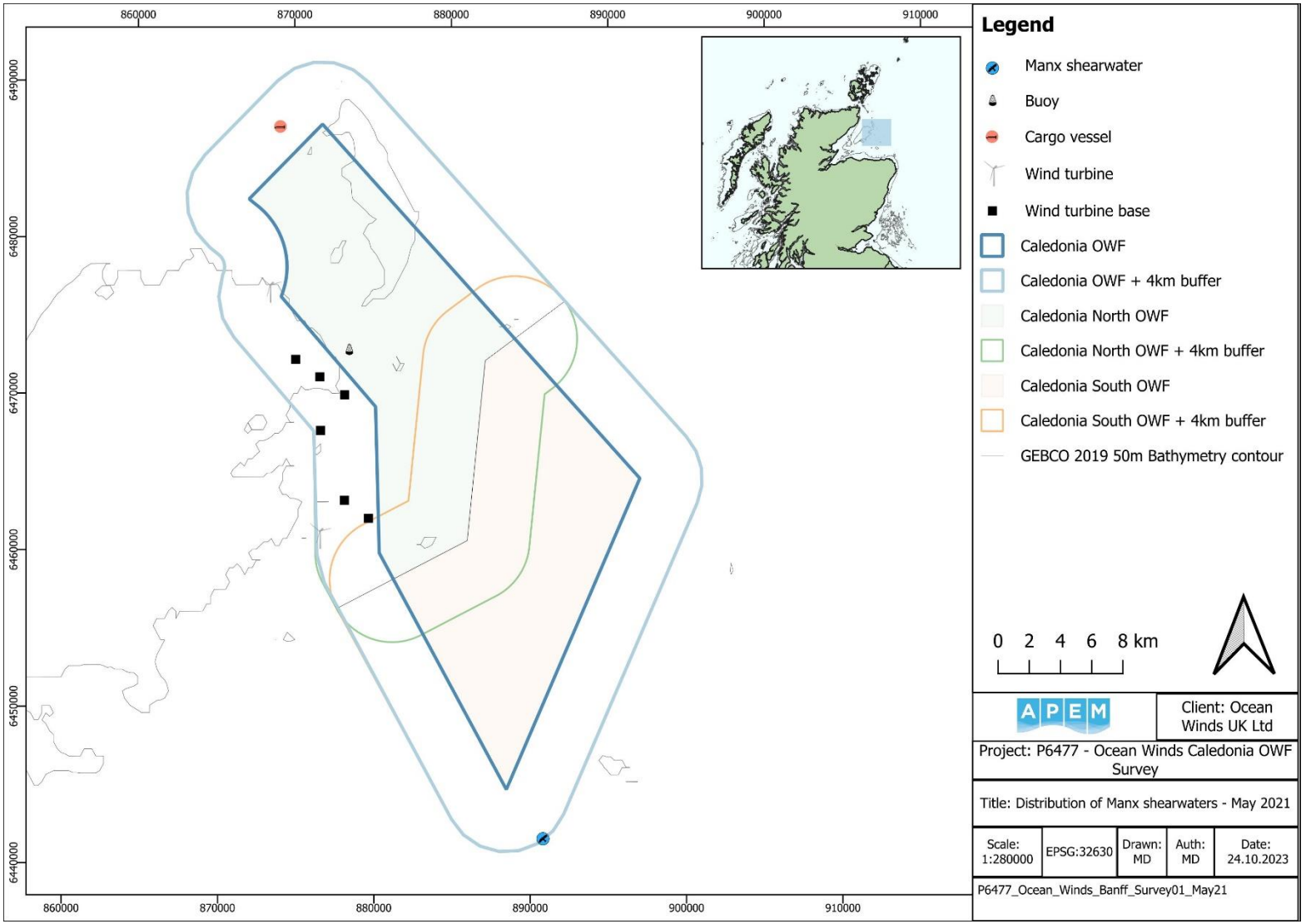


Figure A4.289 Distribution of Manx shearwaters recorded in the Survey Area in May 2021

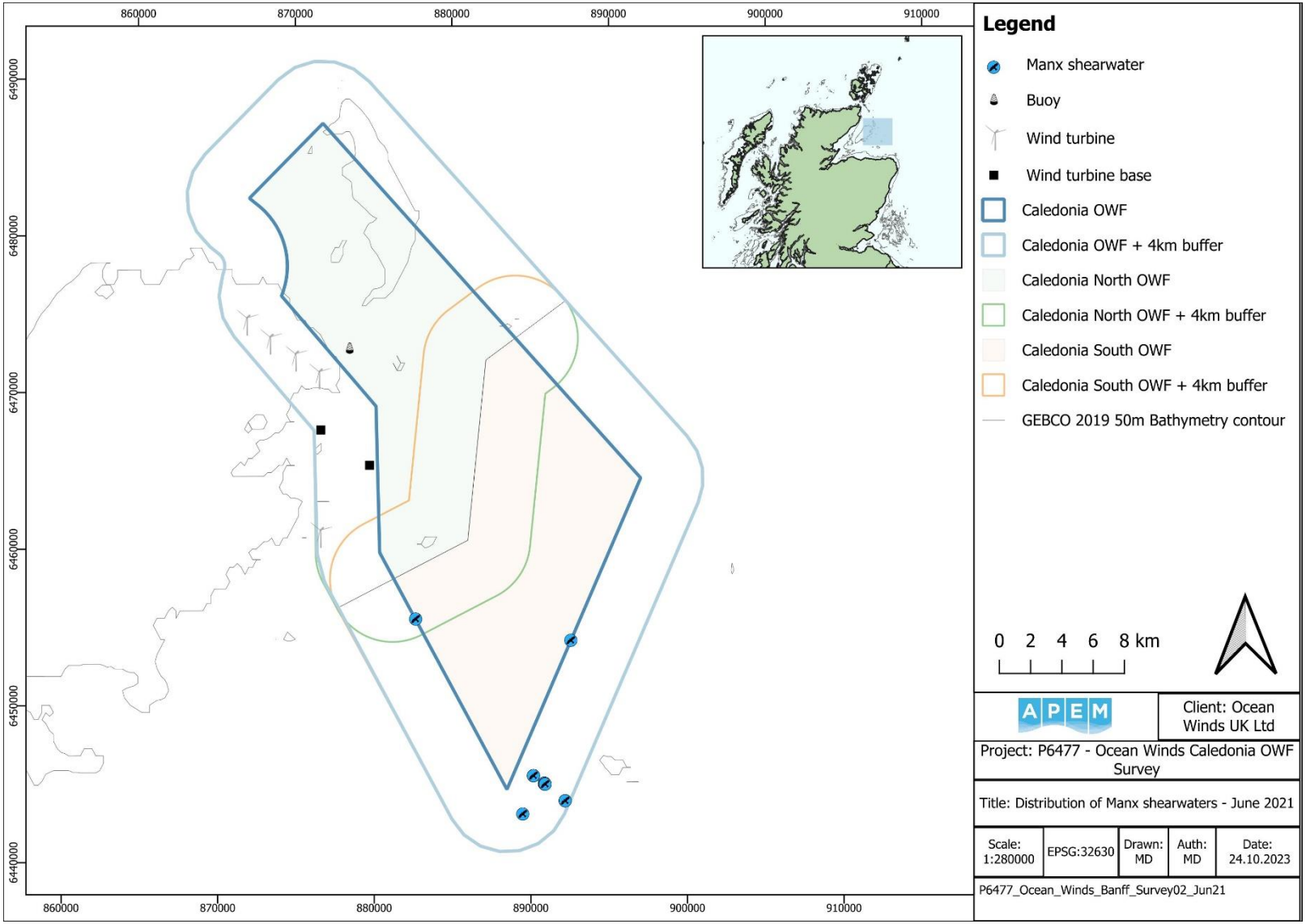


Figure A4.290 Distribution of Manx shearwaters recorded in the Survey Area in June 2021

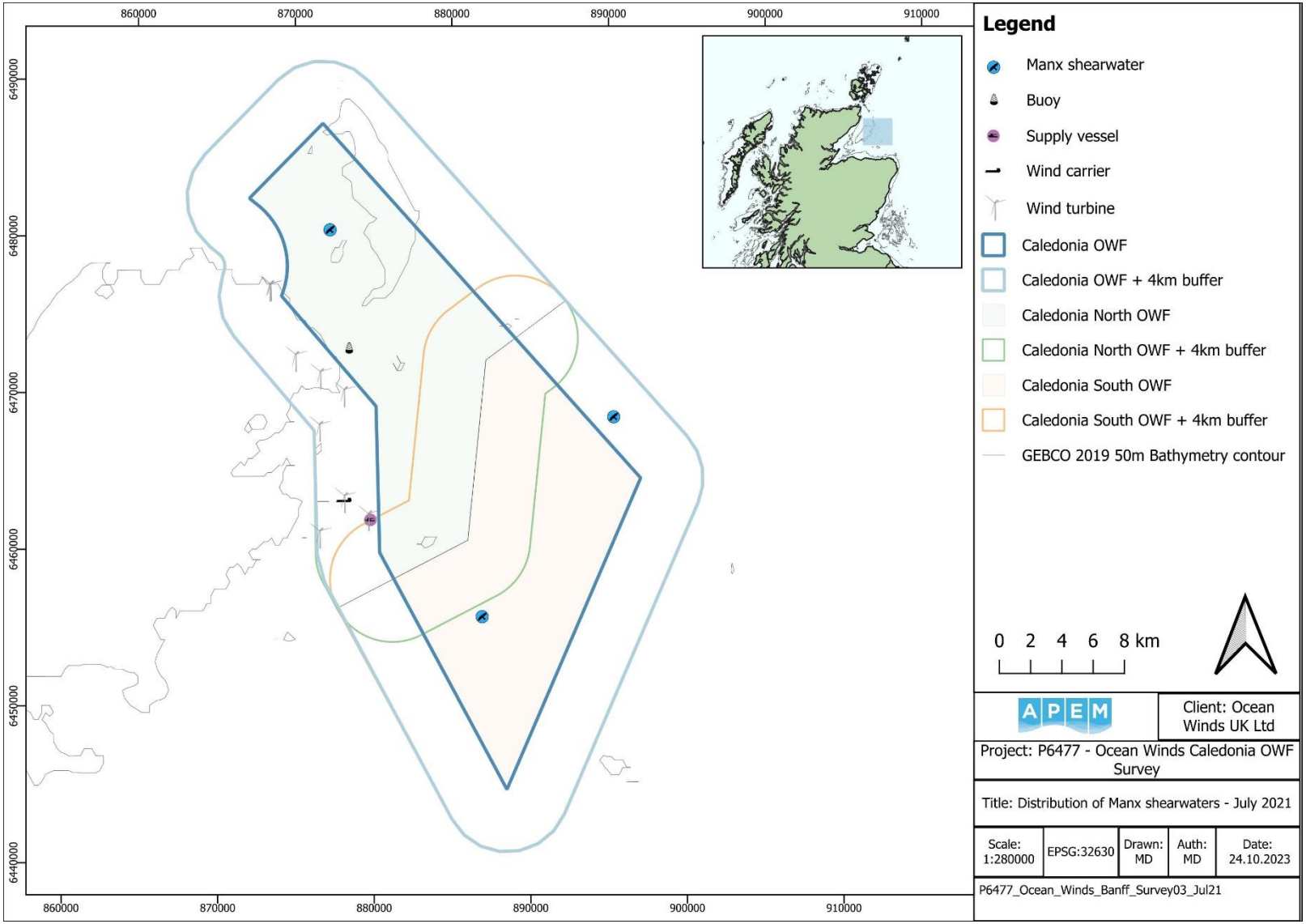


Figure A4.291 Distribution of Manx shearwaters recorded in the Survey Area in July 2021

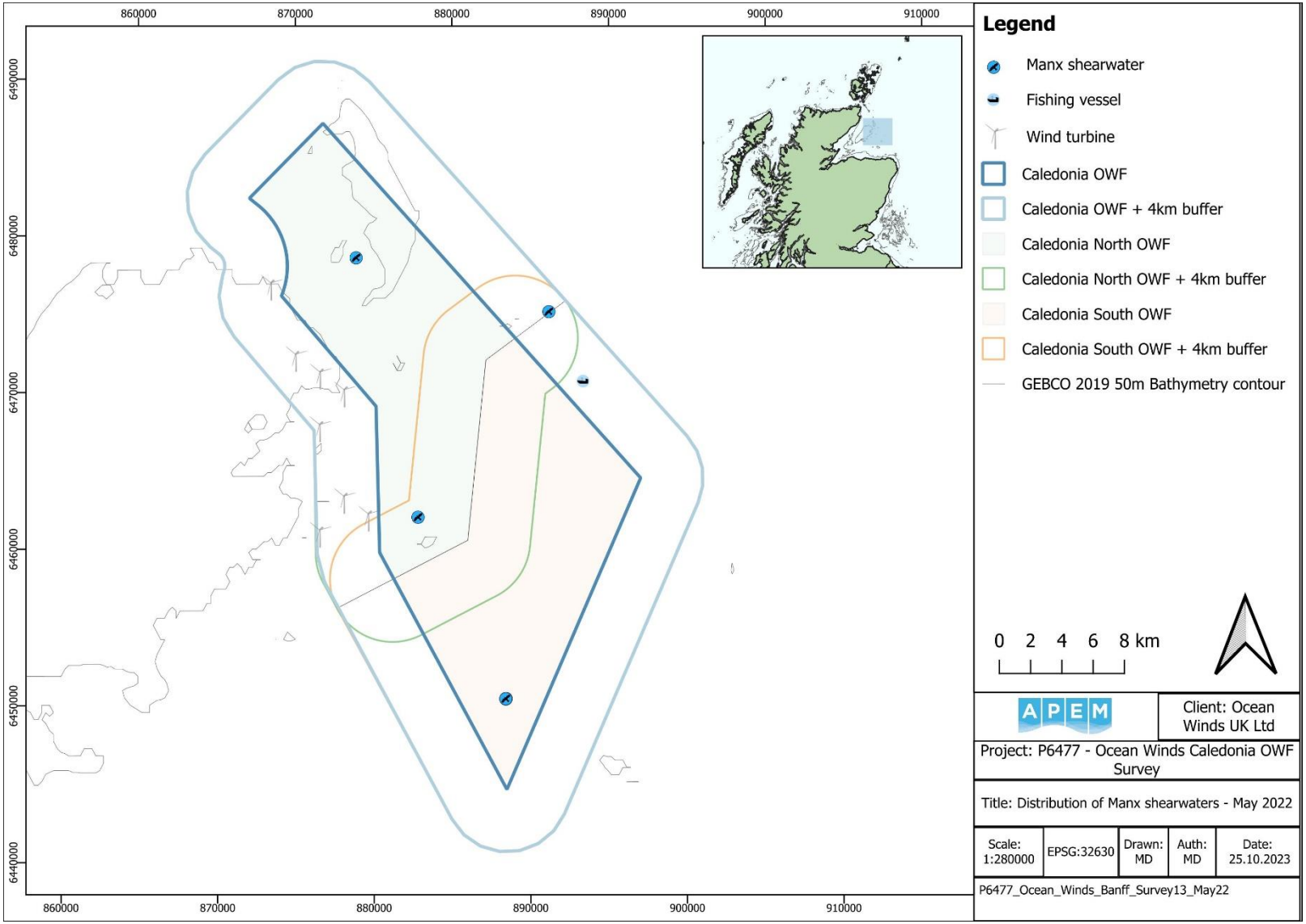


Figure A4.292 Distribution of Manx shearwaters recorded in the Survey Area in May 2022

Unidentified small shearwaters species

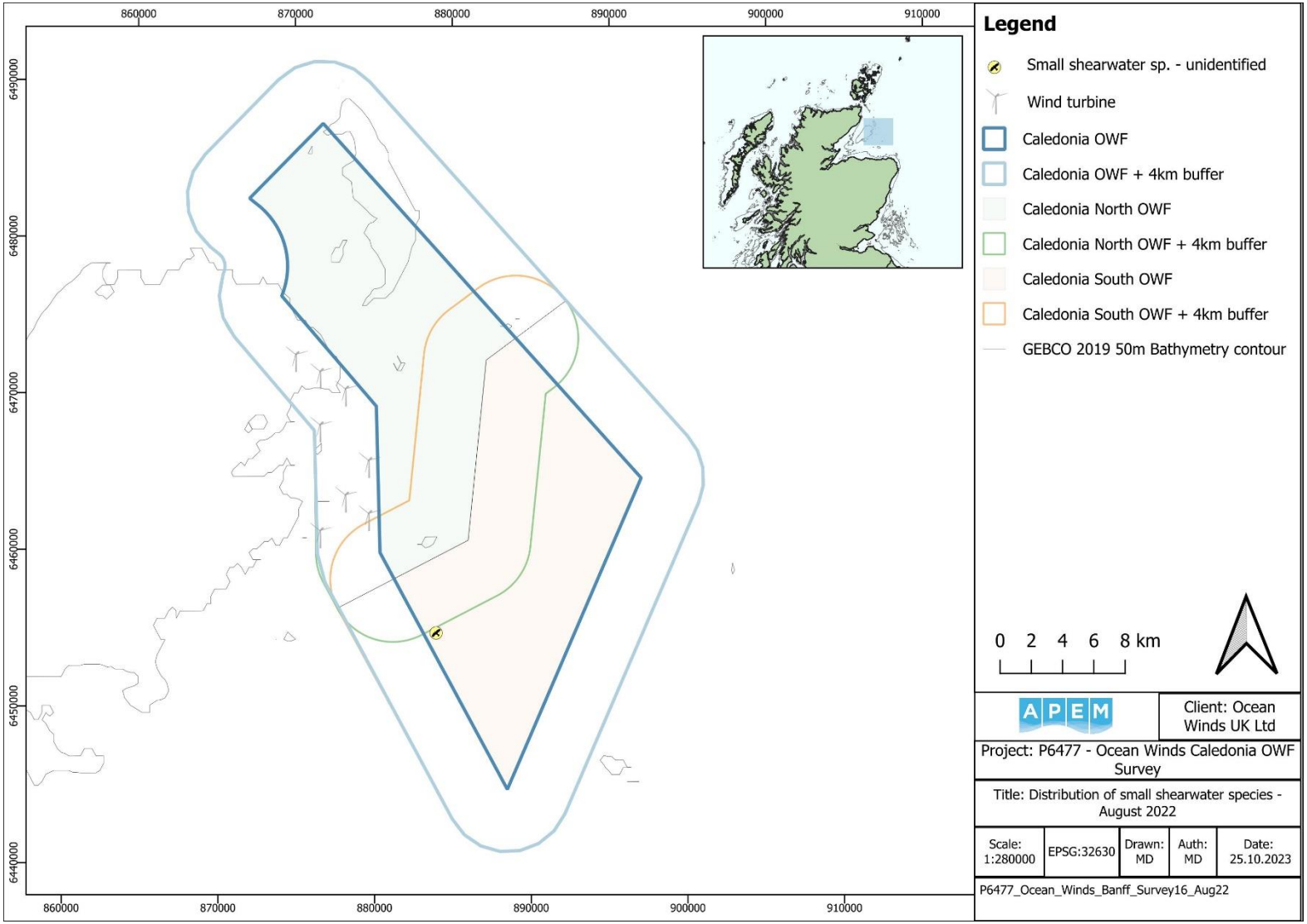


Figure A4.293 Distribution of small shearwater species recorded in the Survey Area in August 2022

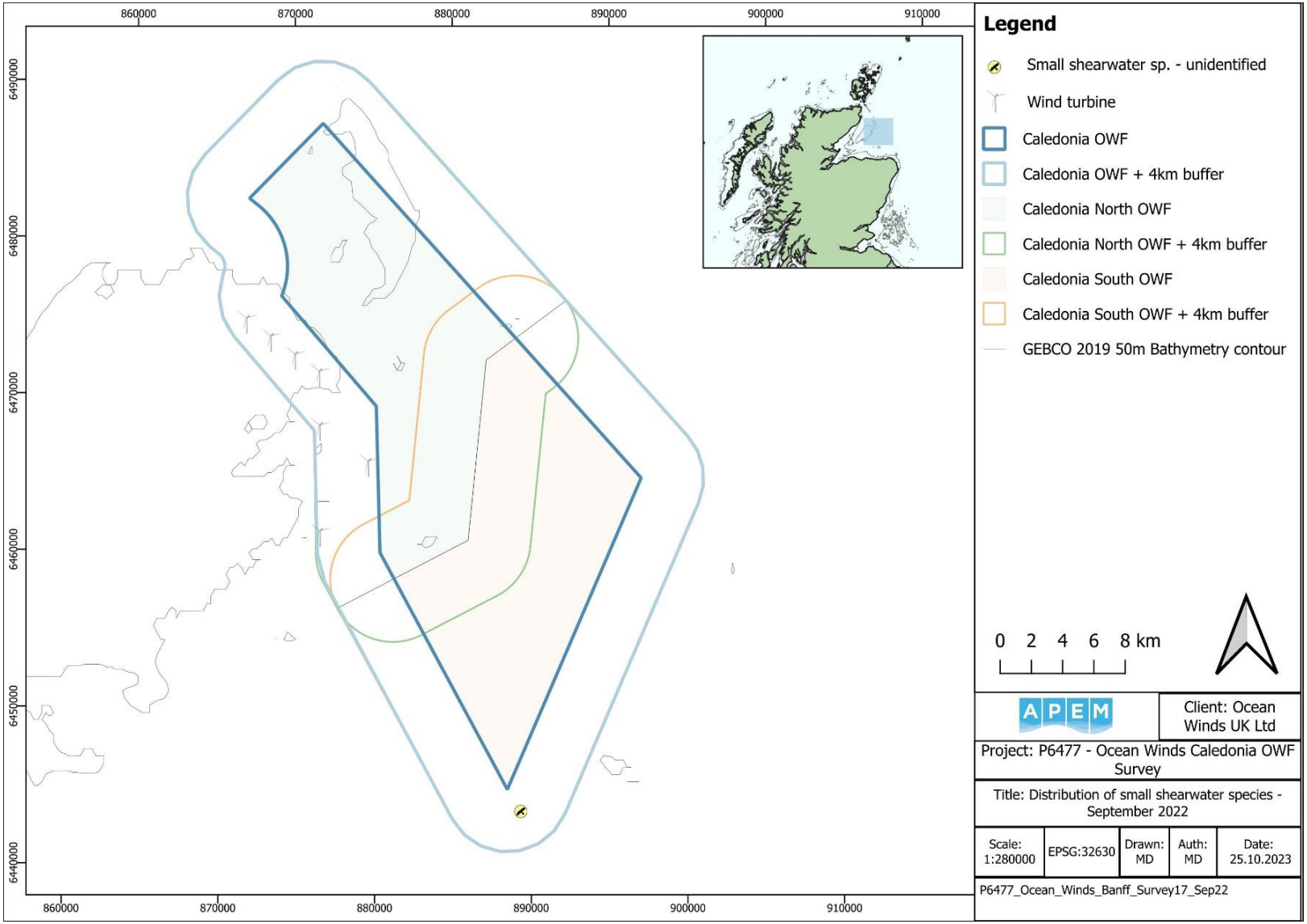


Figure A4.294 Distribution of small shearwater species recorded in the Survey Area in September 2022

Unidentified shearwaters species

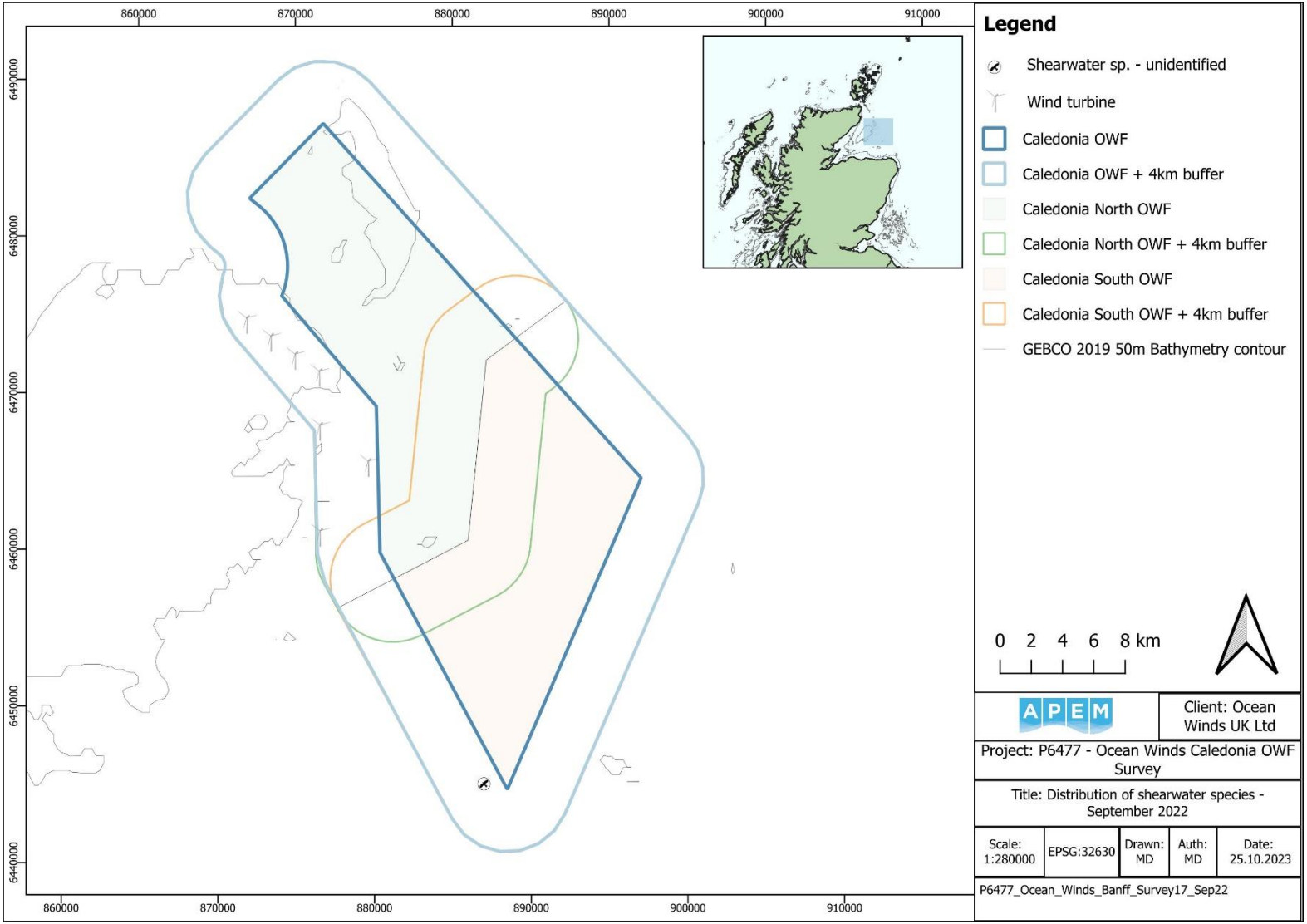


Figure A4.295 Distribution of shearwater species recorded in the Survey Area in September 2022

Unidentified auk and / or shearwaters species

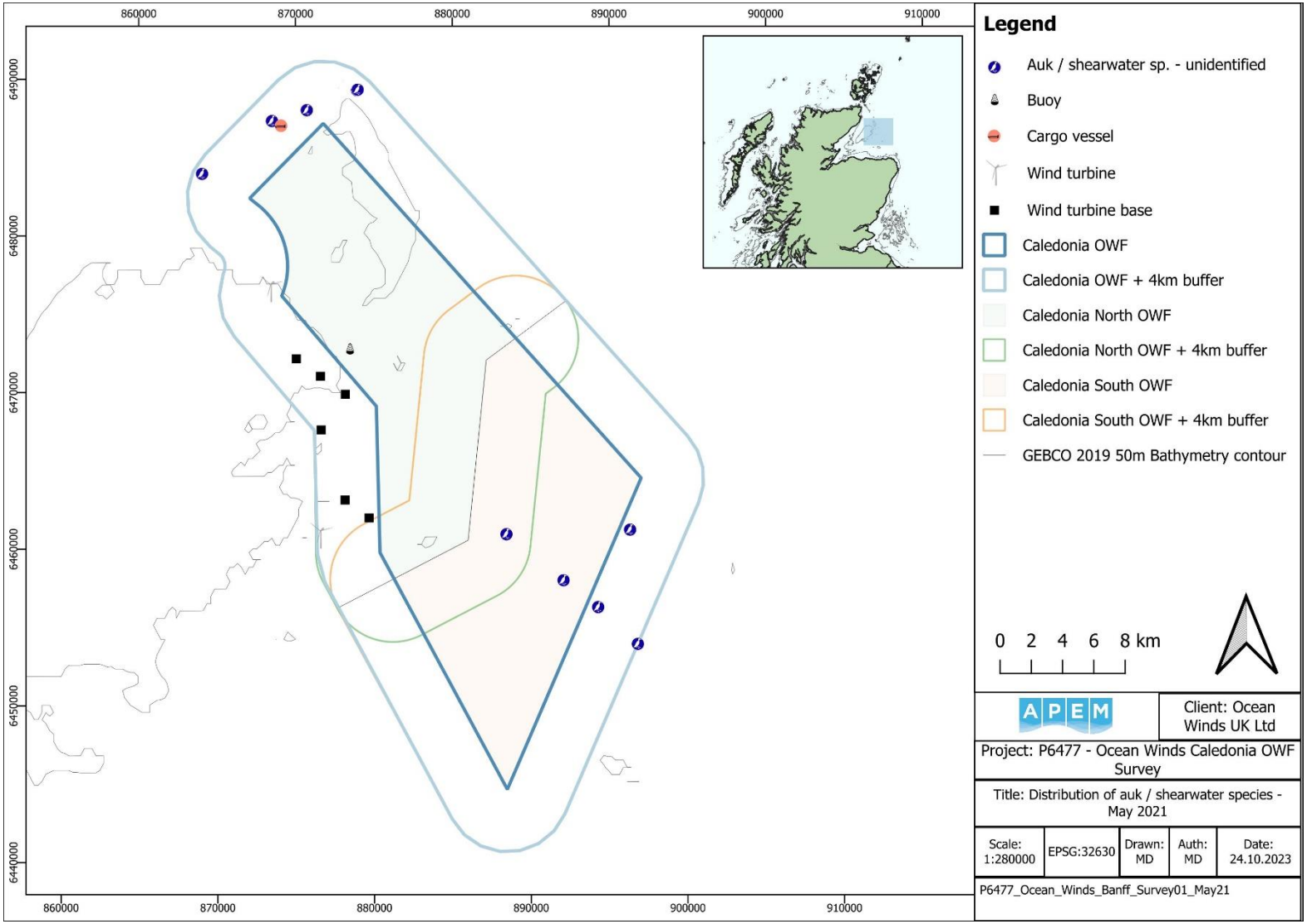


Figure A4.296 Distribution of auk / shearwater species recorded in the Survey Area in May 2021

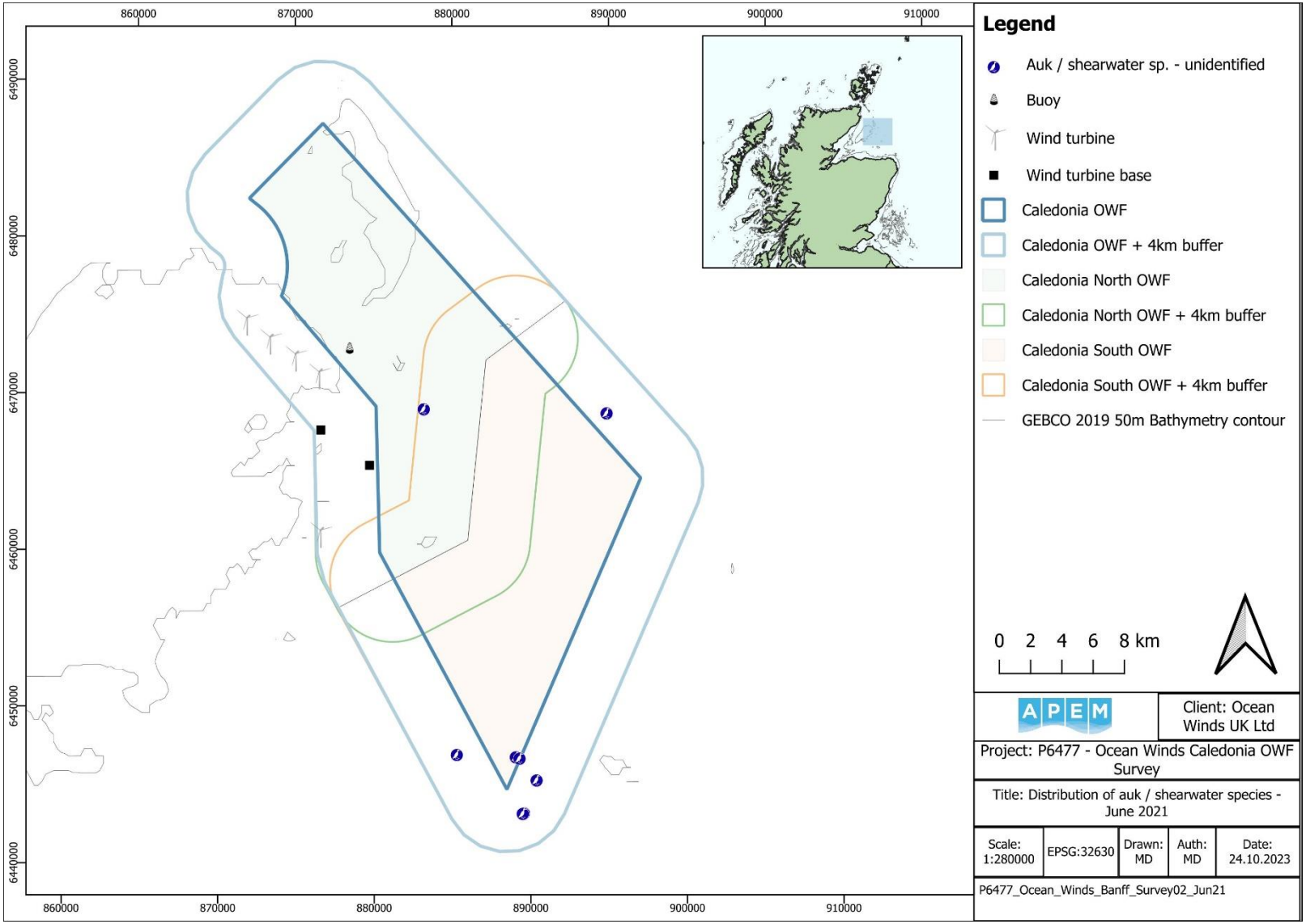


Figure A4.297 Distribution of auk / shearwater species recorded in the Survey Area in June 2021

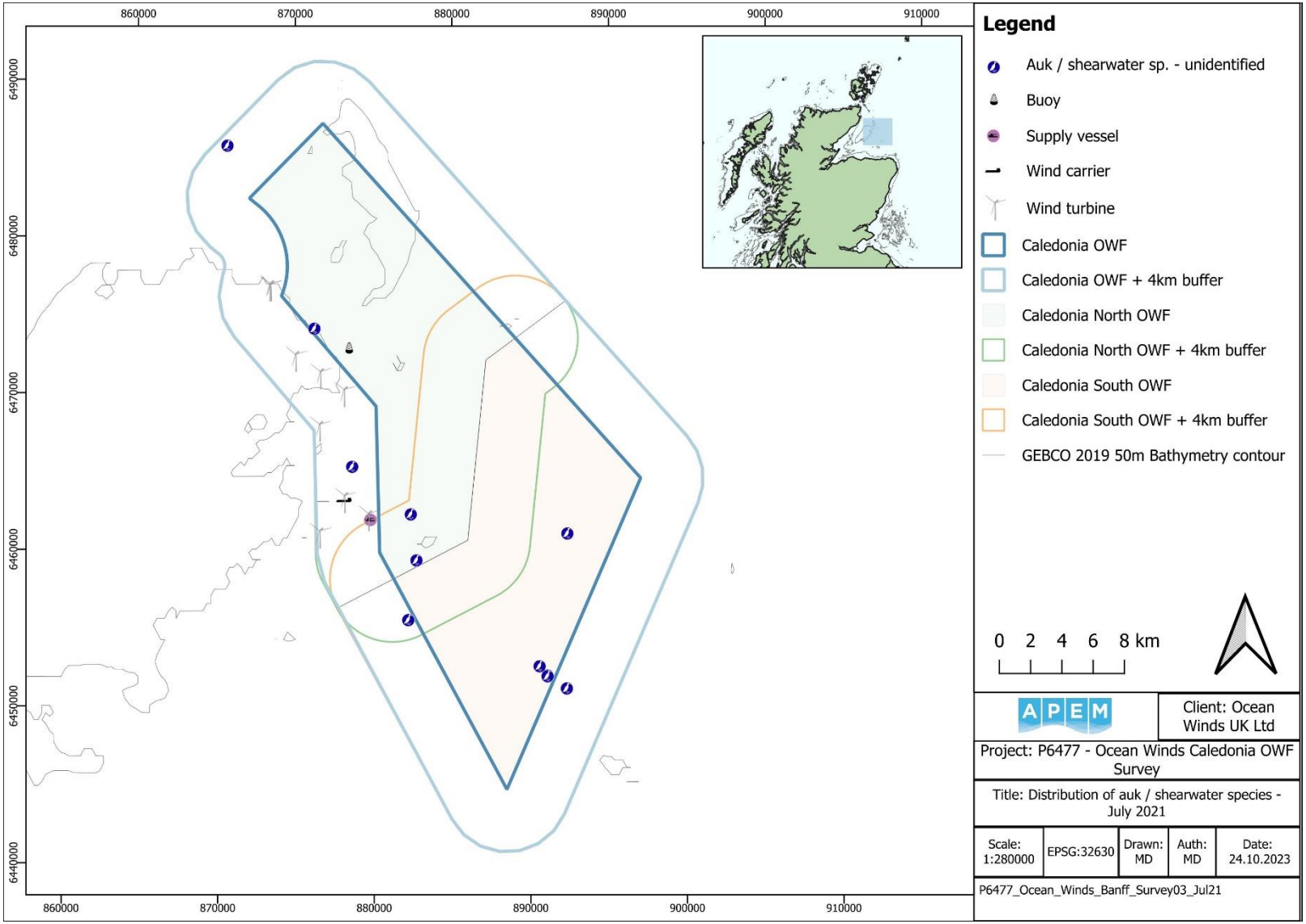


Figure A4.298 Distribution of auk / shearwater species recorded in the Survey Area in July 2021

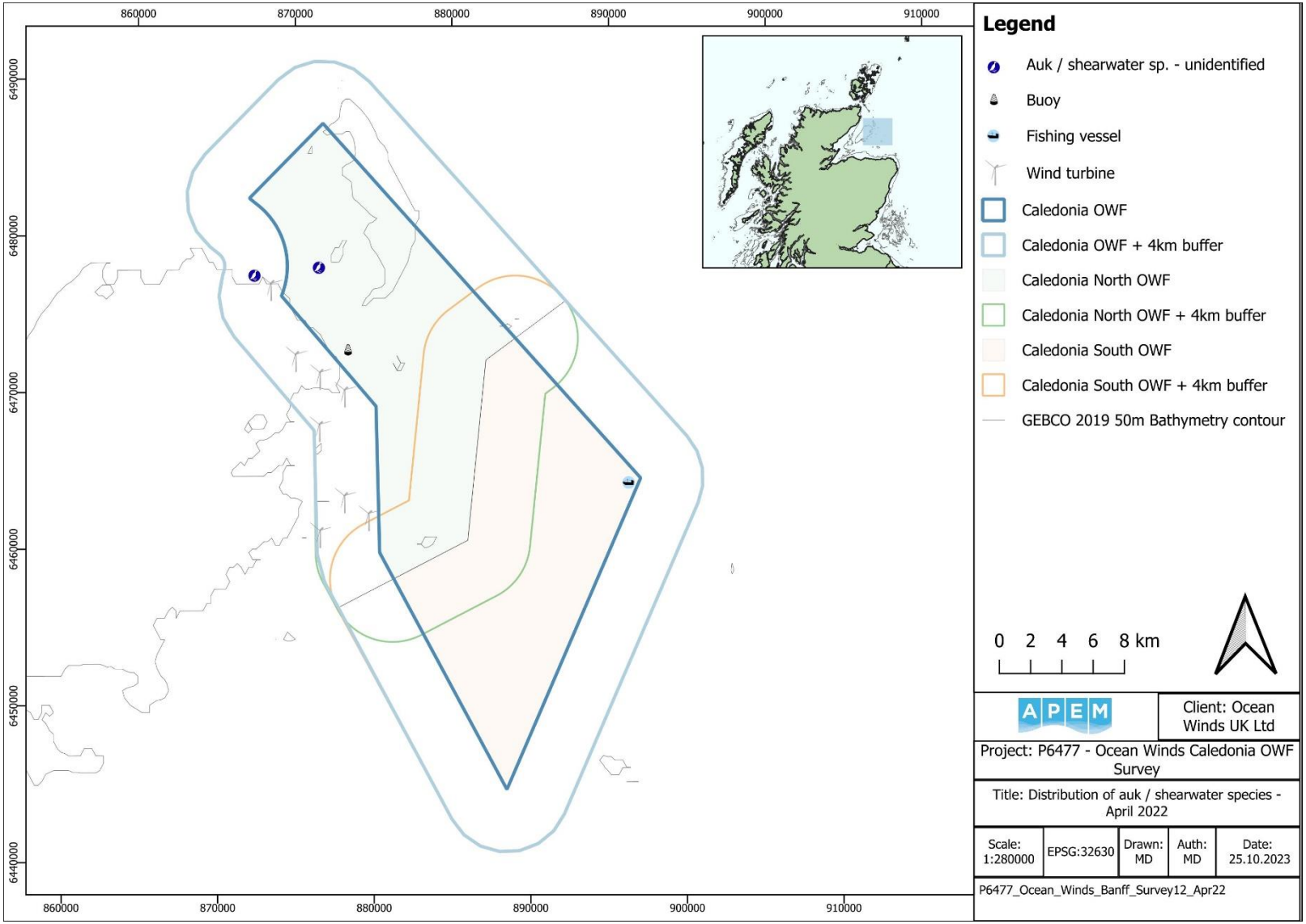


Figure A4.299 Distribution of auk / shearwater species recorded in the Survey Area in April 2022

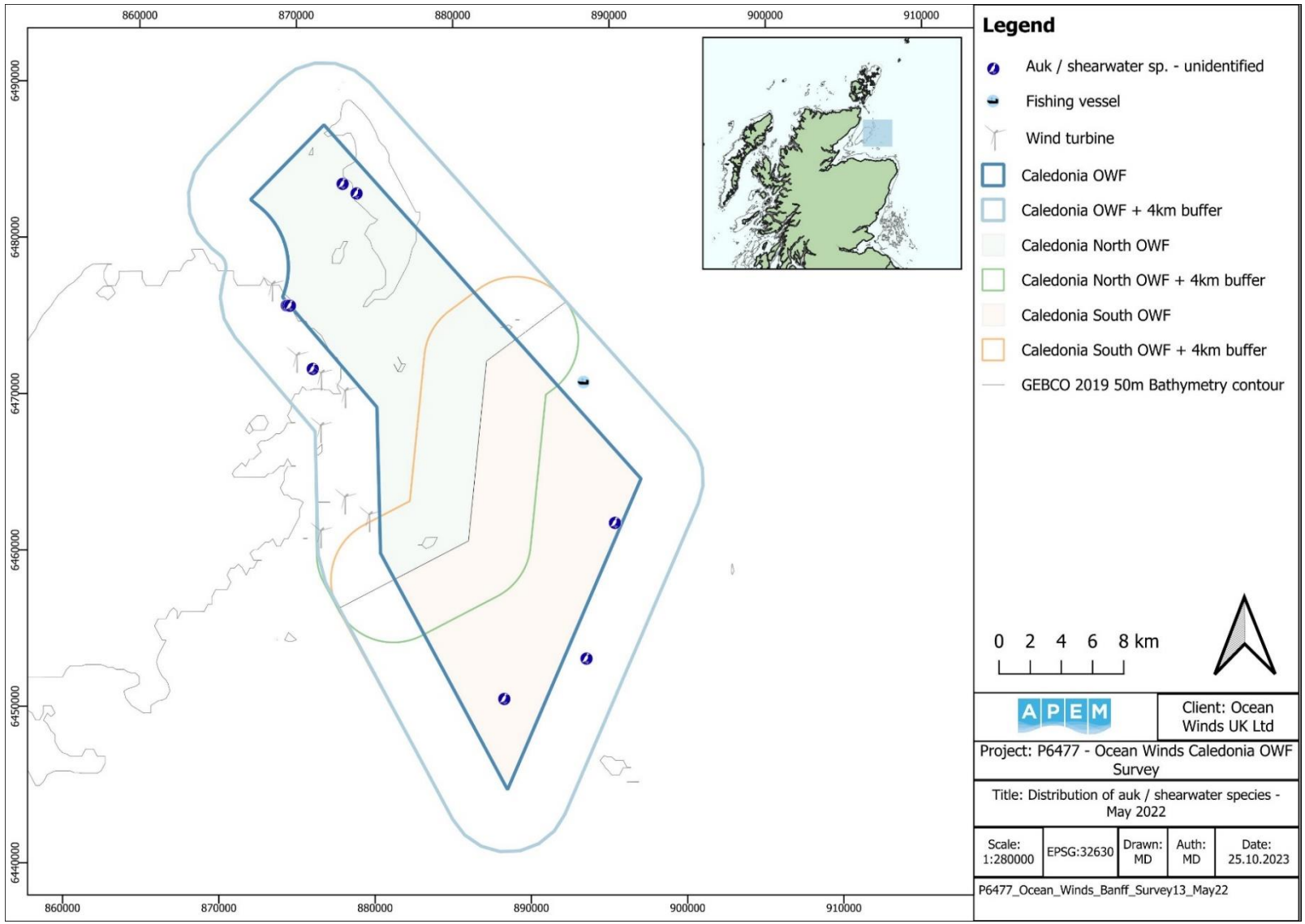


Figure A4.300 Distribution of auk / shearwater species recorded in the Survey Area in May 2022

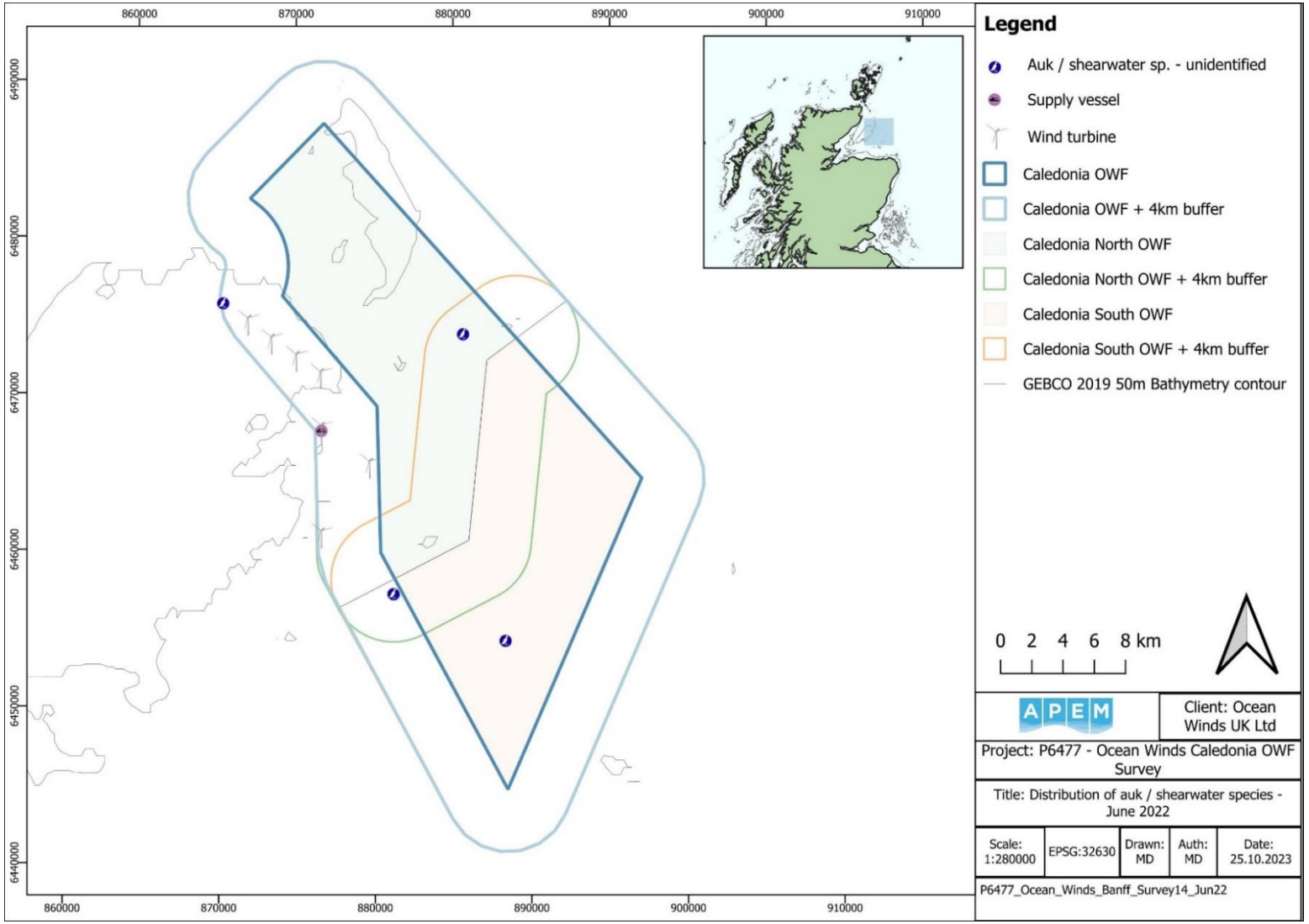


Figure A4.301 Distribution of auk / shearwater species recorded in the Survey Area in June 2022

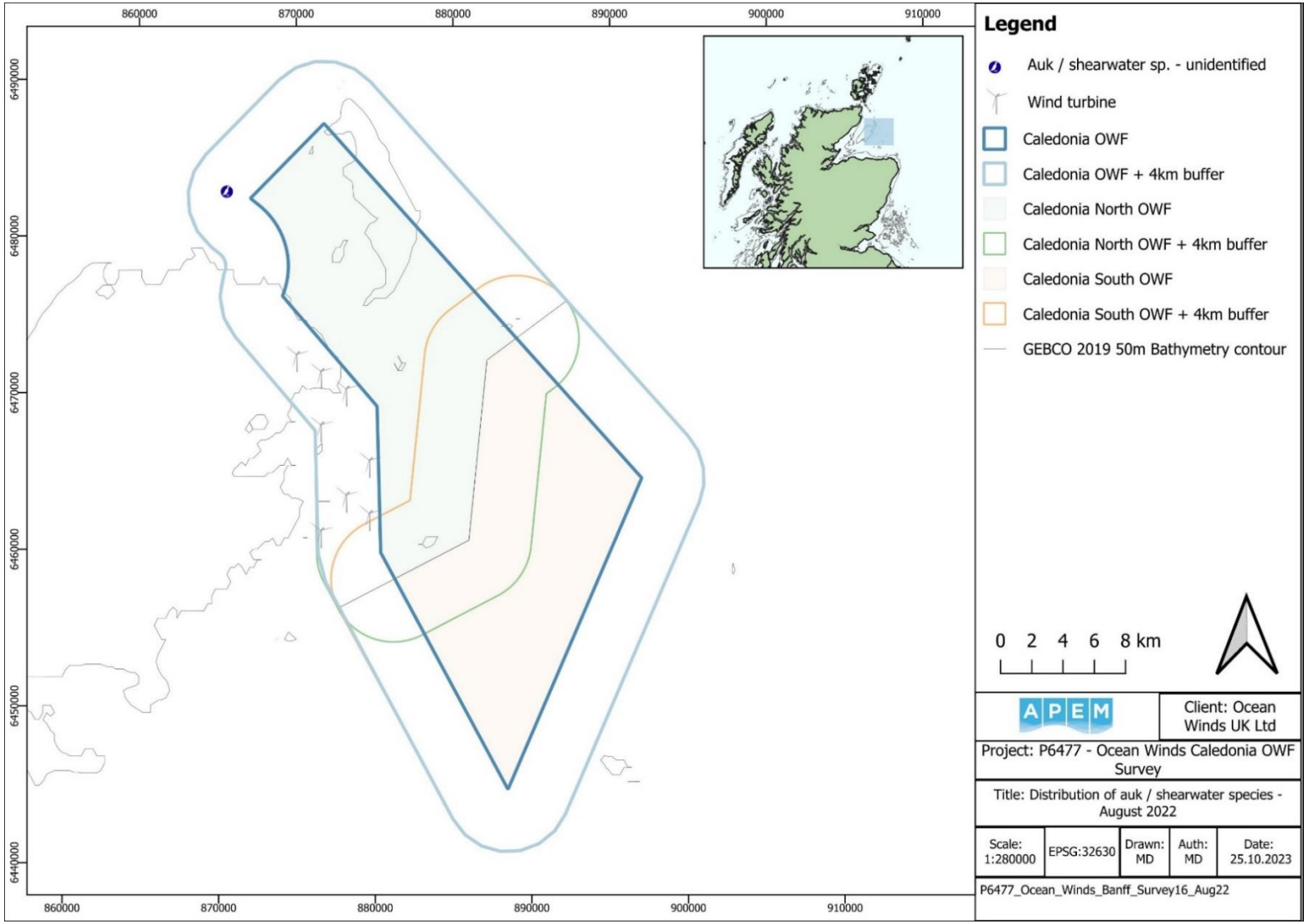


Figure A4.302 Distribution of auk / shearwater species recorded in the Survey Area in August 2022

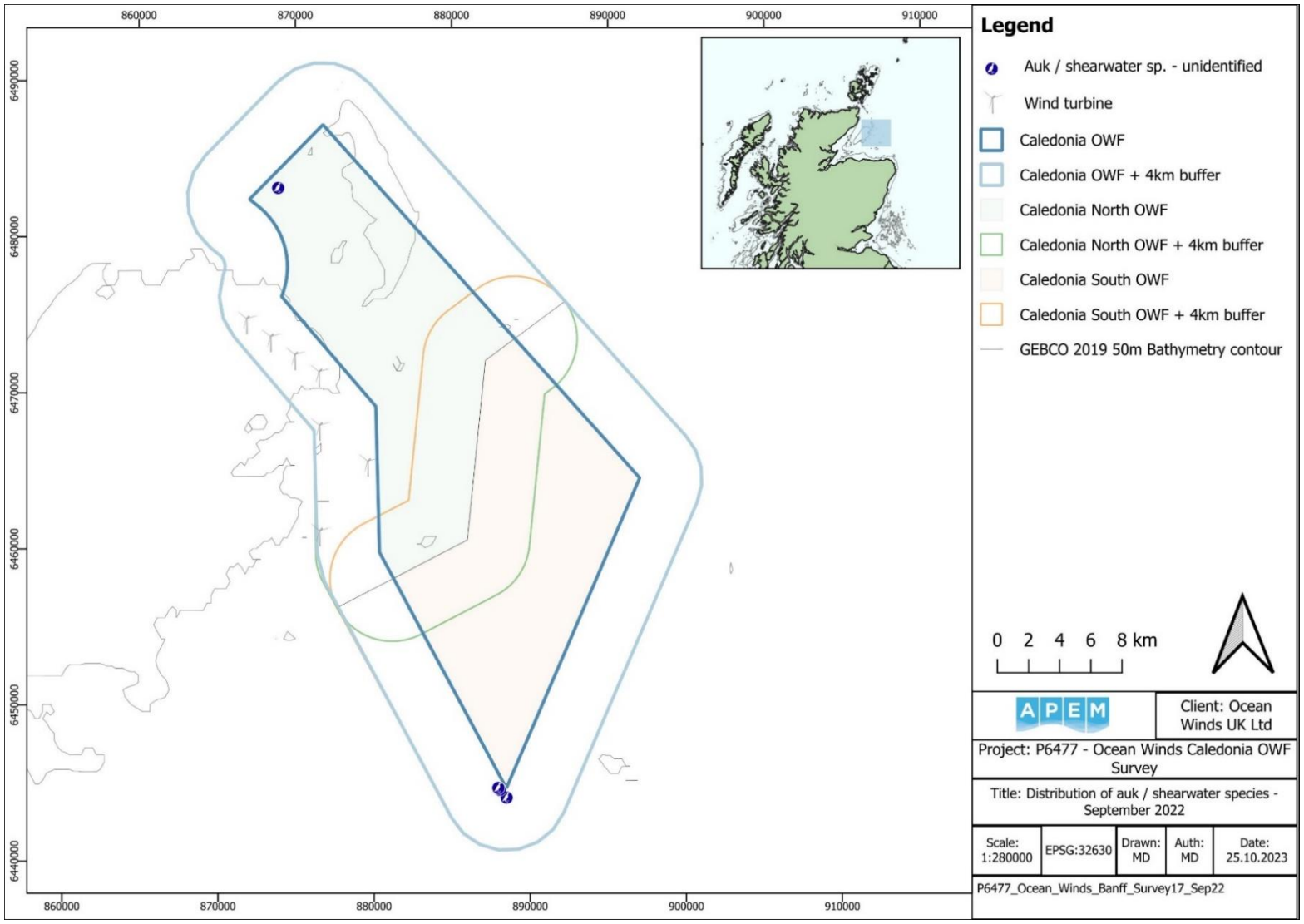


Figure A4.303 Distribution of auk / shearwater species recorded in the Survey Area in September 2022

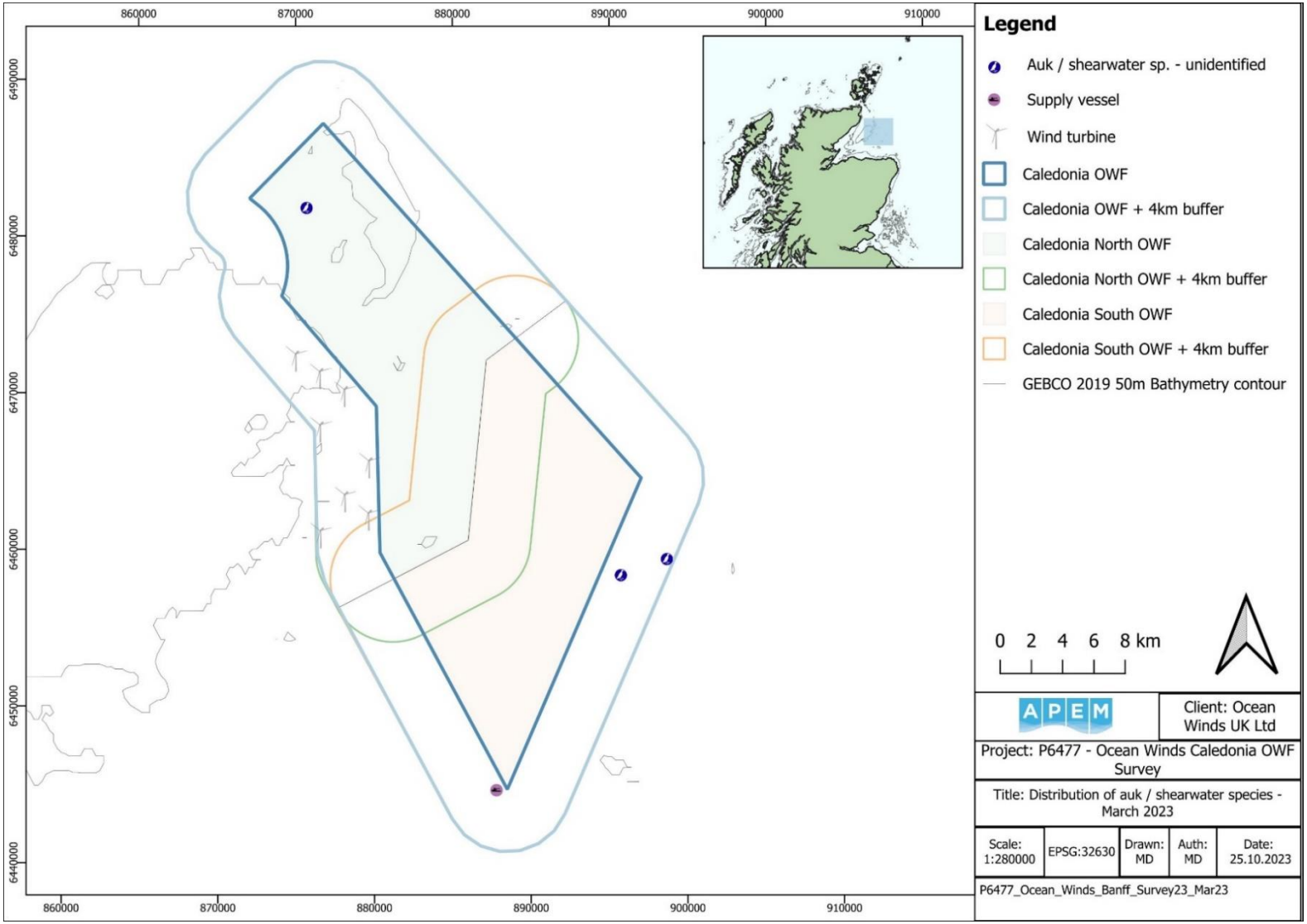


Figure A4.304 Distribution of auk / shearwater species recorded in the Survey Area in March 2023

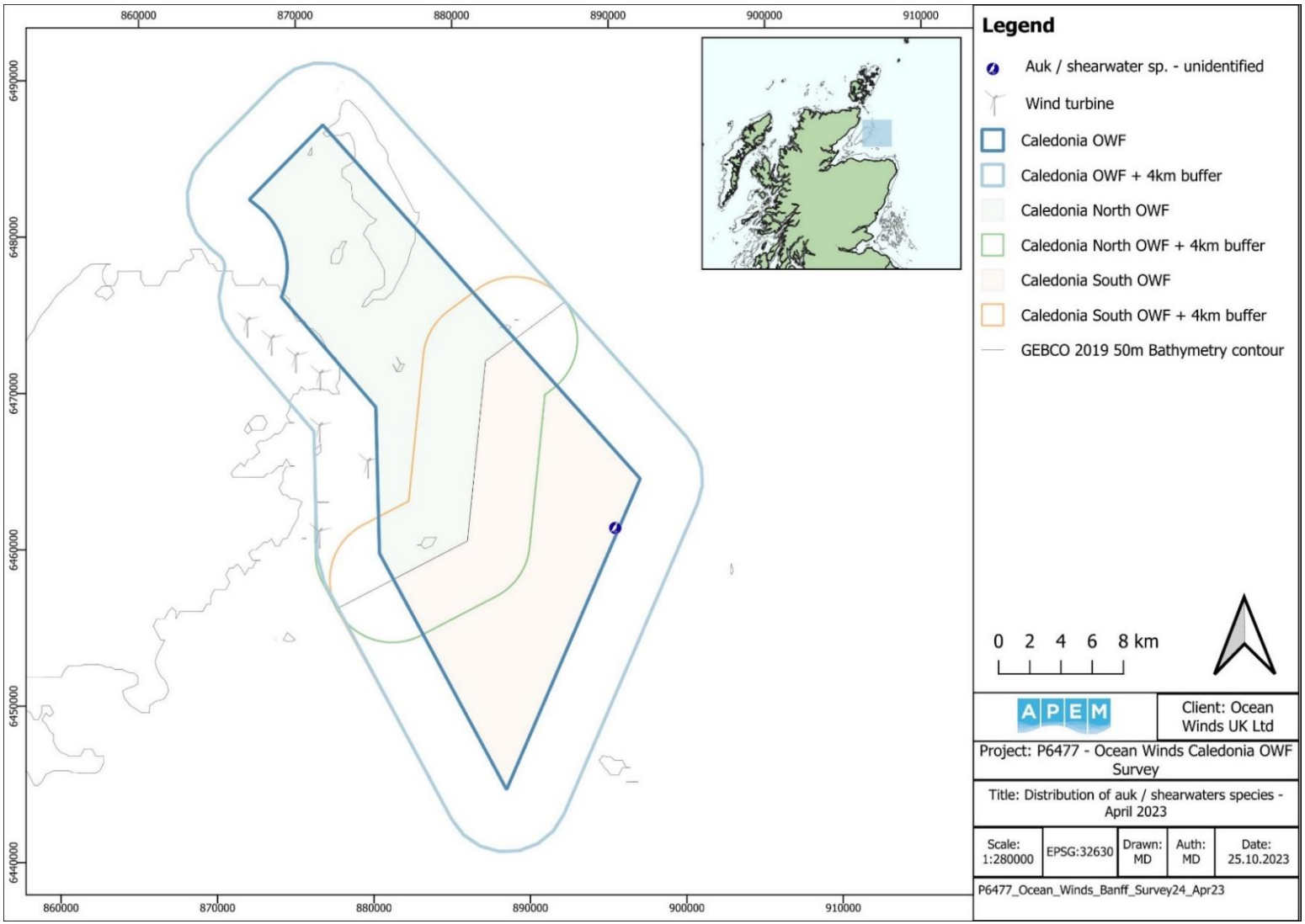


Figure A4.305 Distribution of auk / shearwater species recorded in the Survey Area in April 2023

Gannet

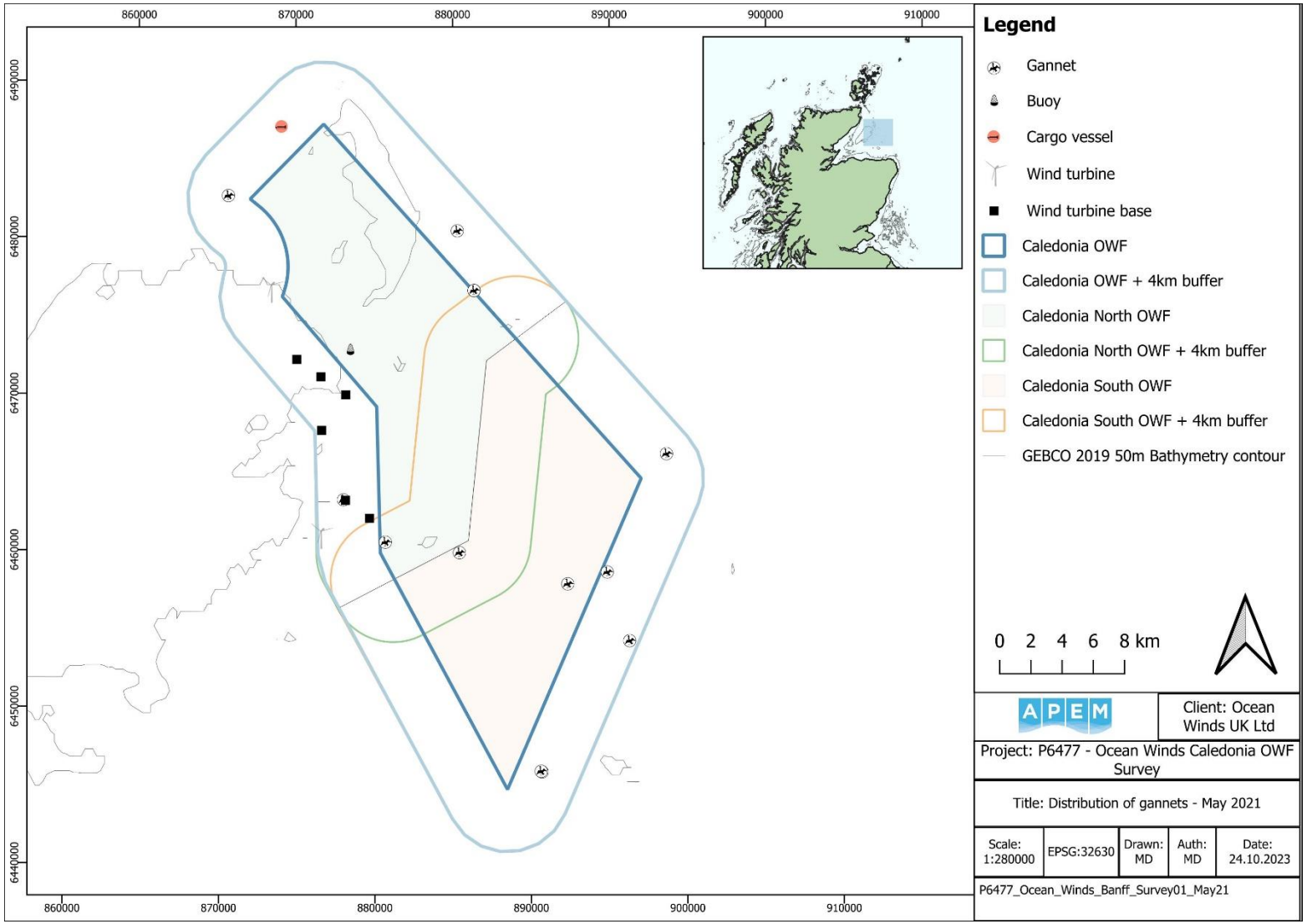


Figure A4.306 Distribution of gannets recorded in the Survey Area in May 2021

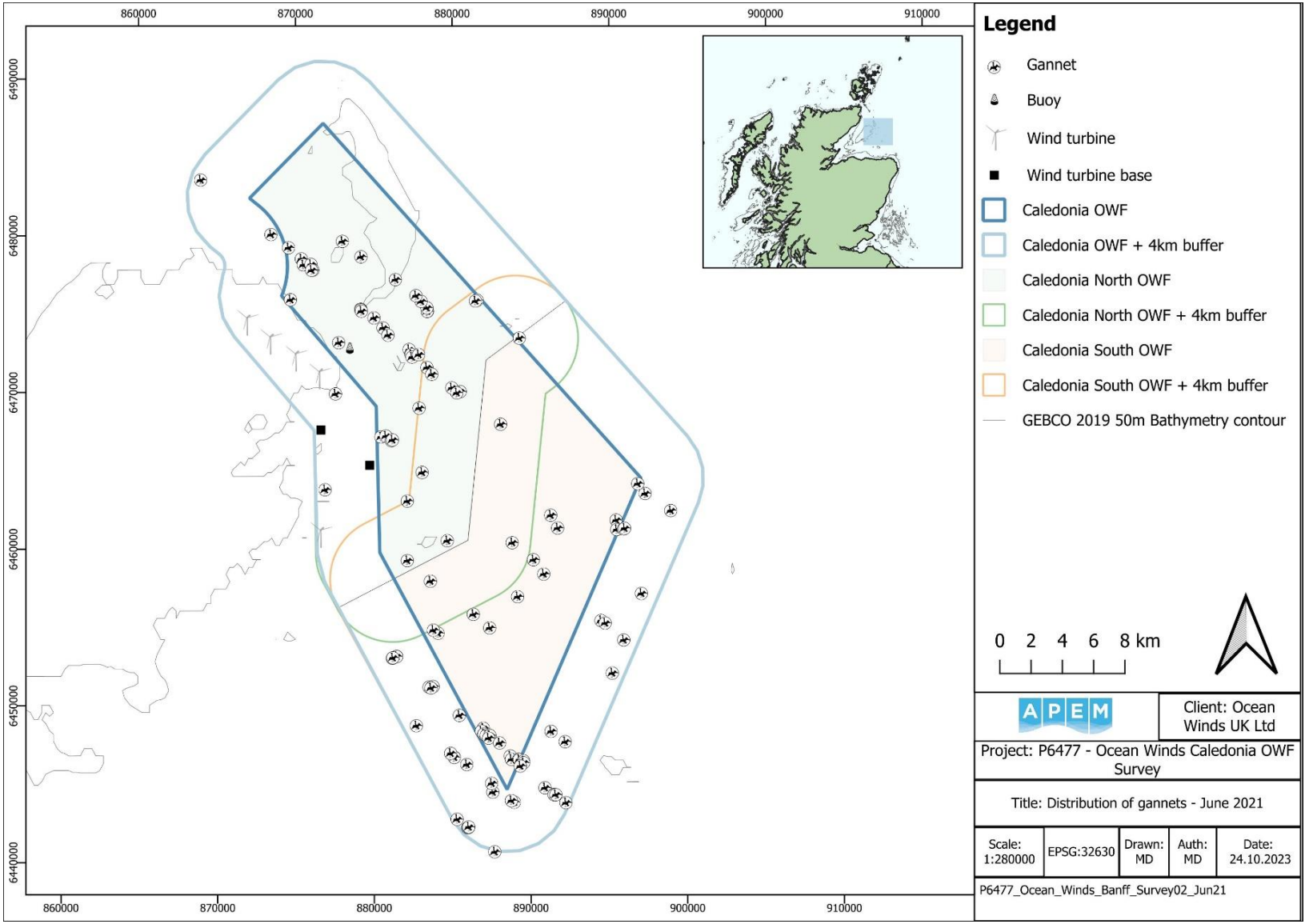


Figure A4.307 Distribution of gannets recorded in the Survey Area in June 2021

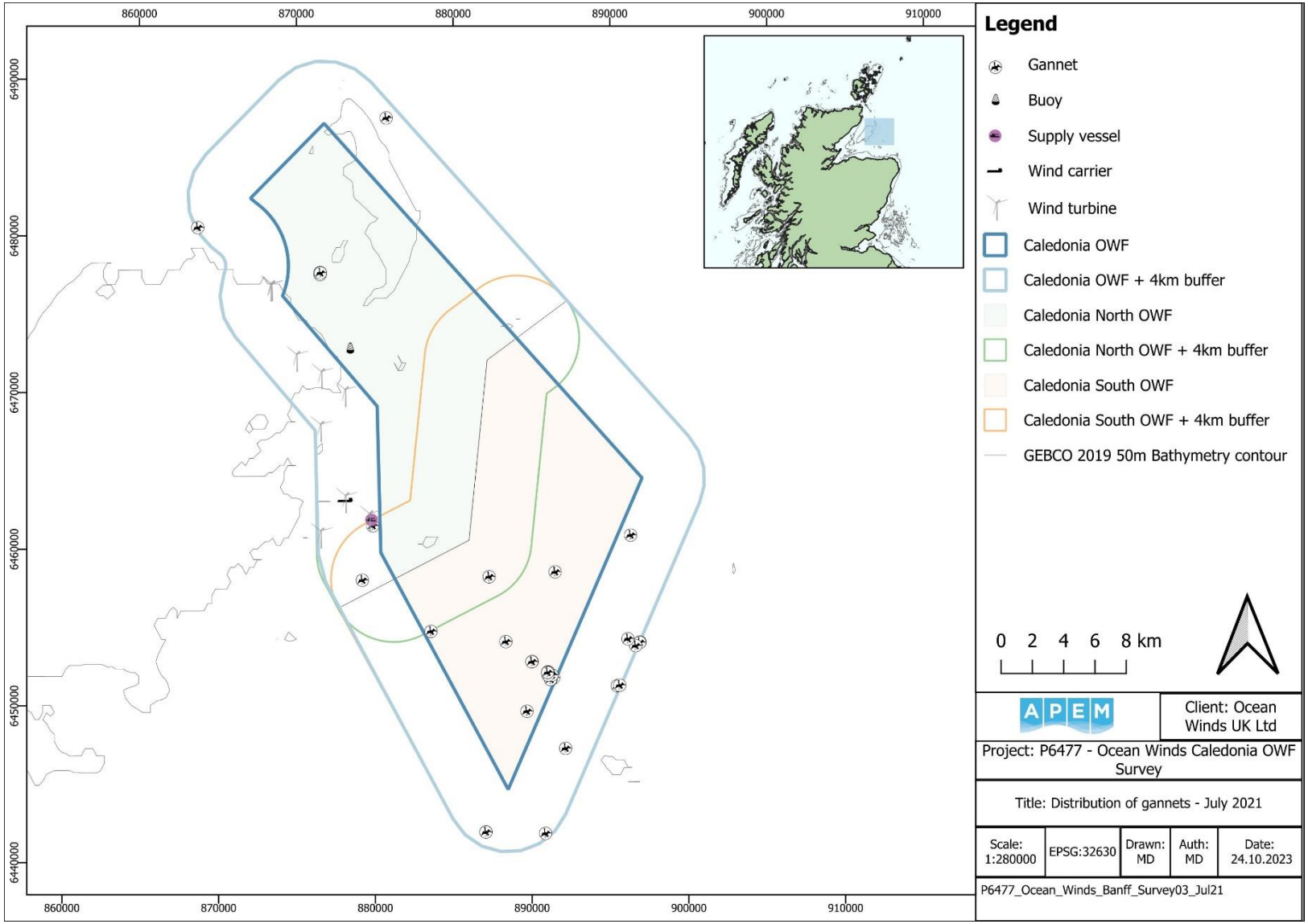


Figure A4.308 Distribution of gannets recorded in the Survey Area in July 2021

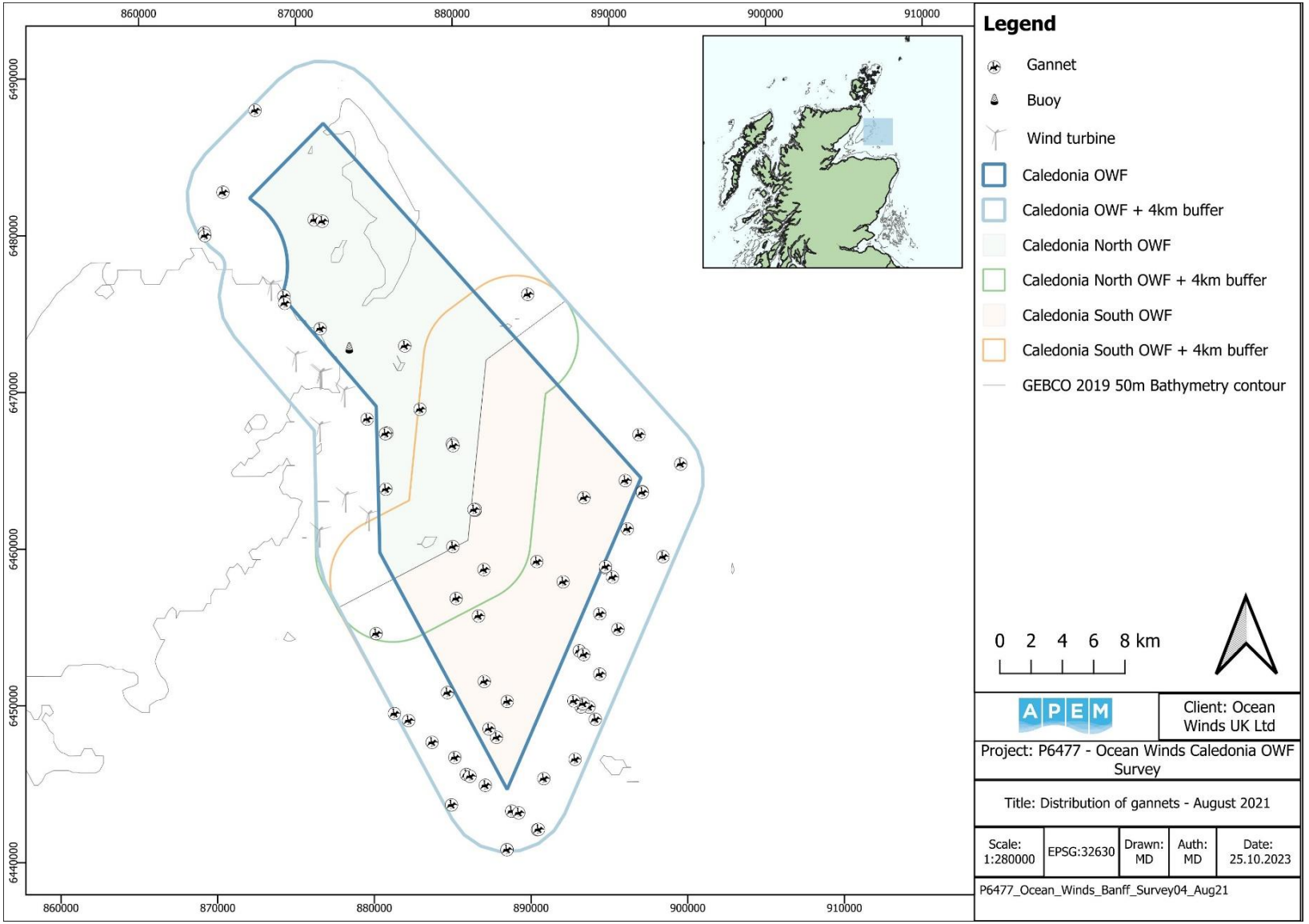


Figure A4.309 Distribution of gannets recorded in the Survey Area in August 2021

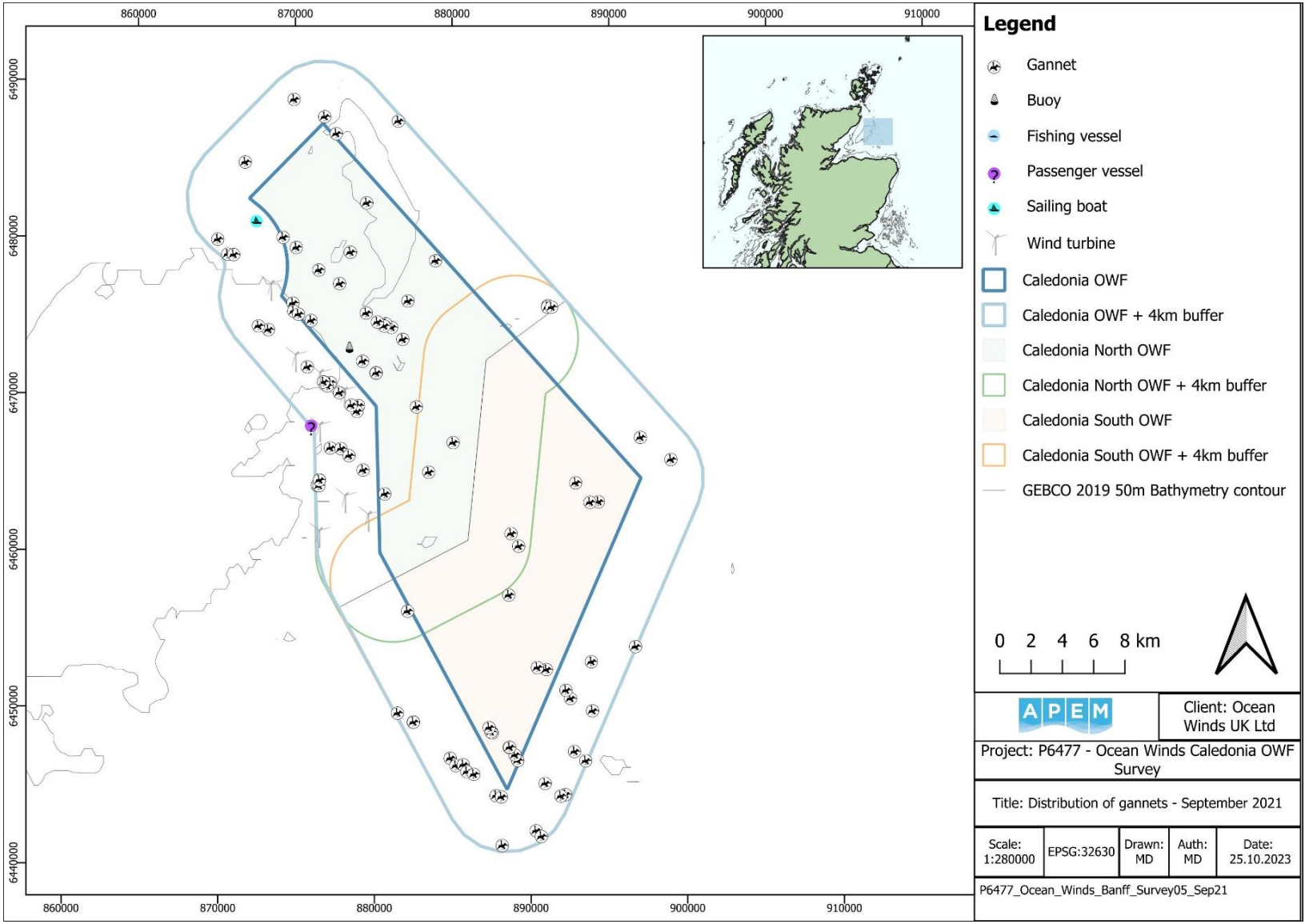


Figure A4.310 Distribution of gannets recorded in the Survey Area in September 2021

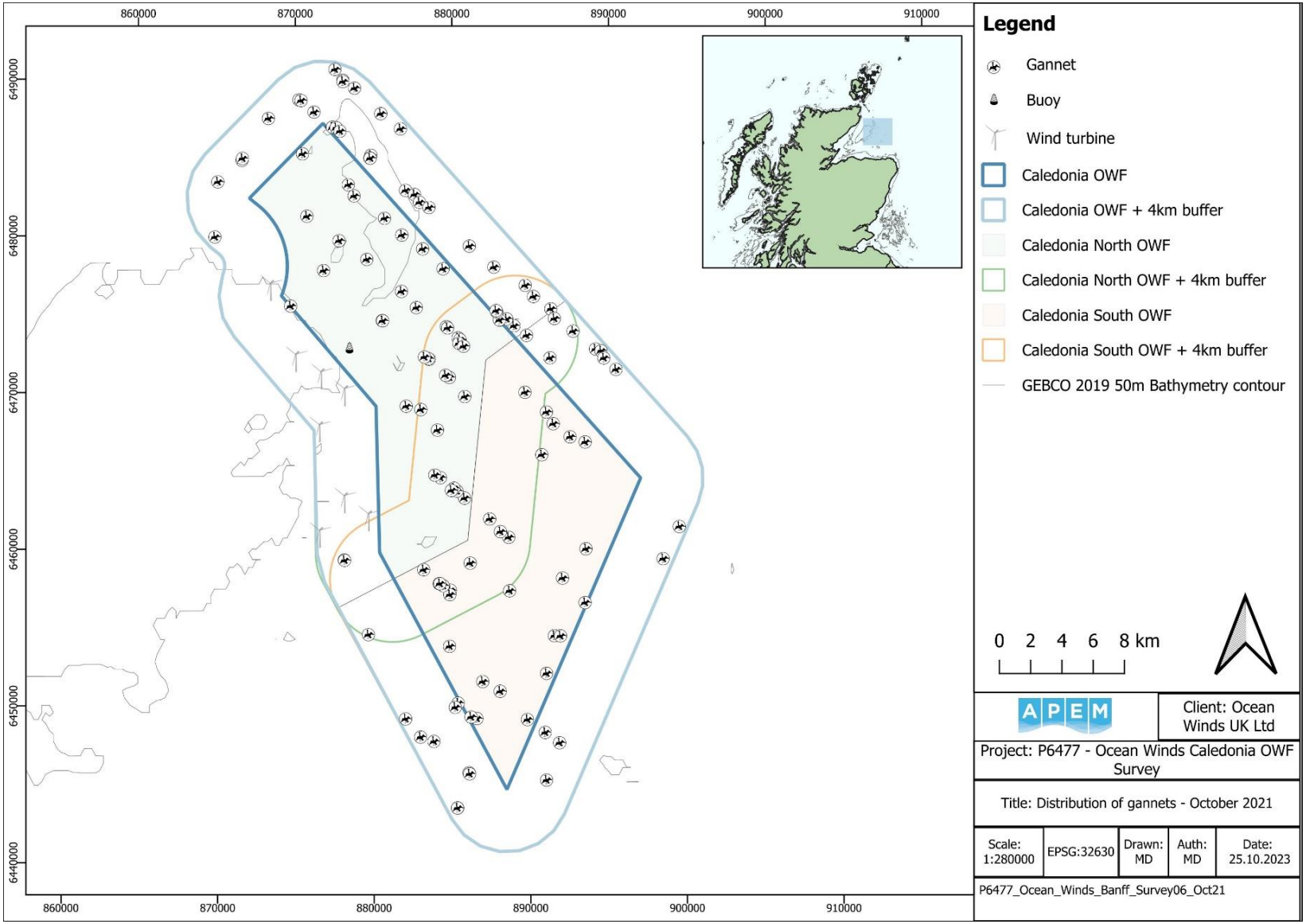


Figure A4.311 Distribution of gannets recorded in the Survey Area in October 2021

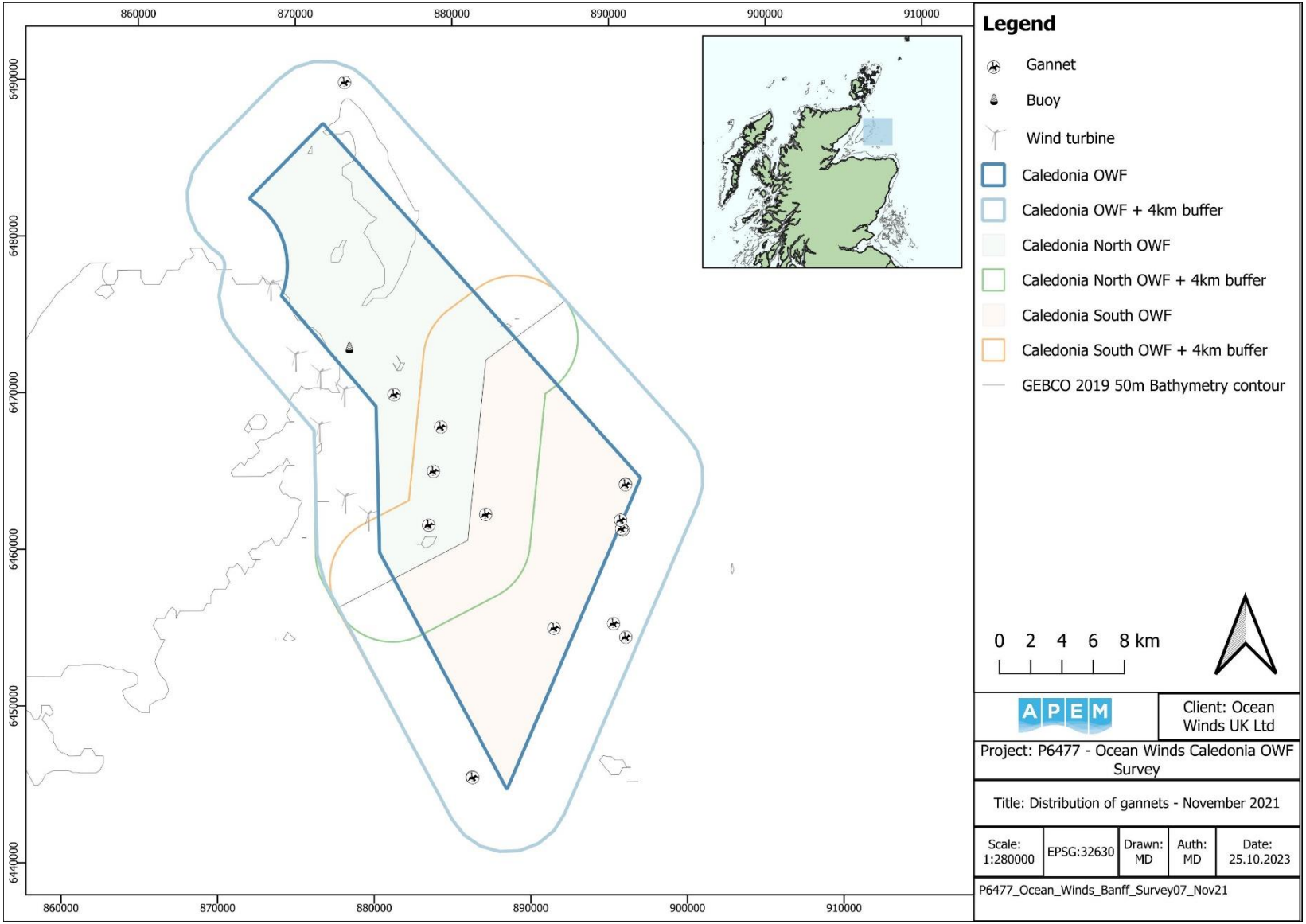


Figure A4.312 Distribution of gannets recorded in the Survey Area in November 2021

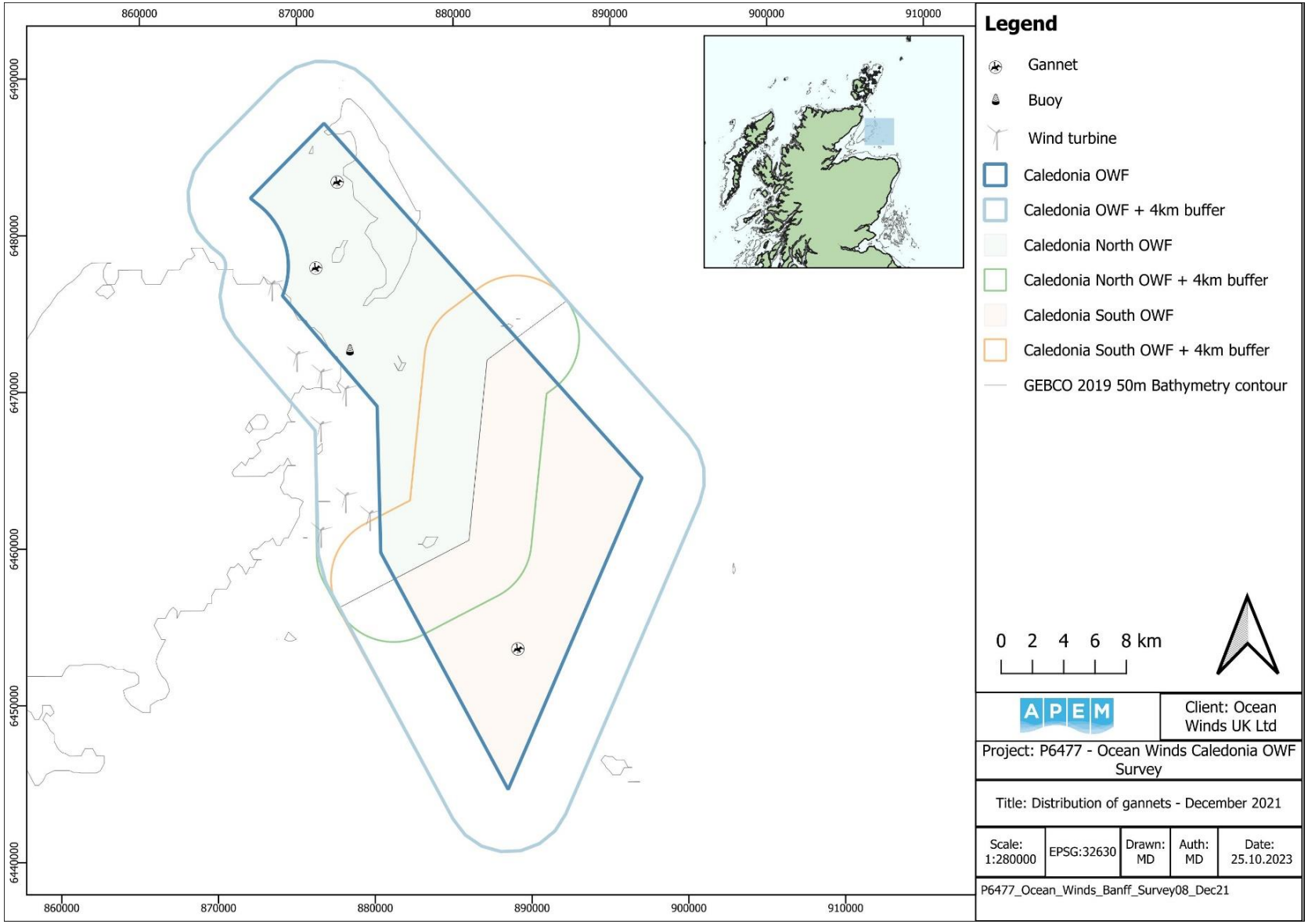


Figure A4.313 Distribution of gannets recorded in the Survey Area in December 2021

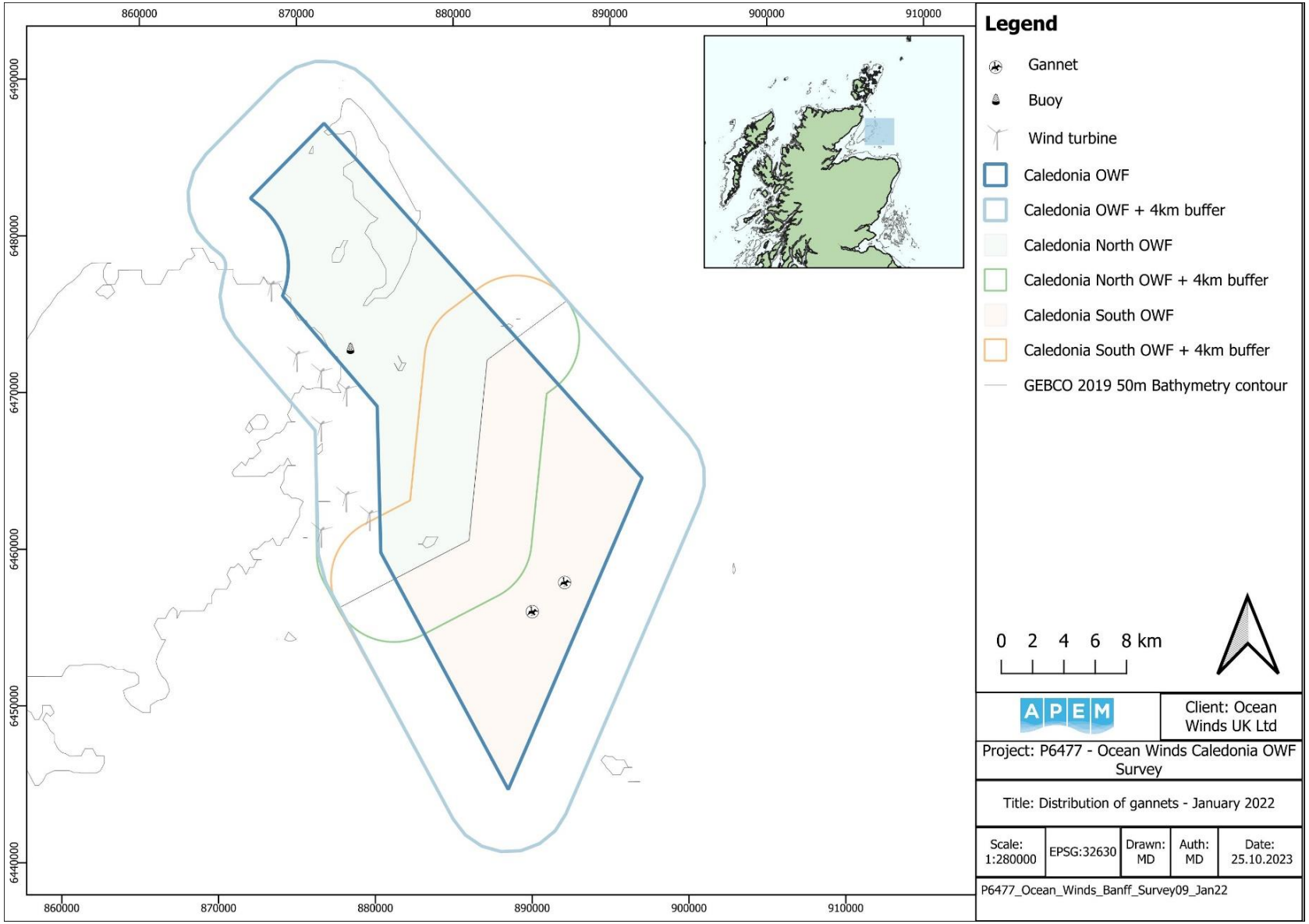


Figure A4.314 Distribution of gannets recorded in the Survey Area in January 2022

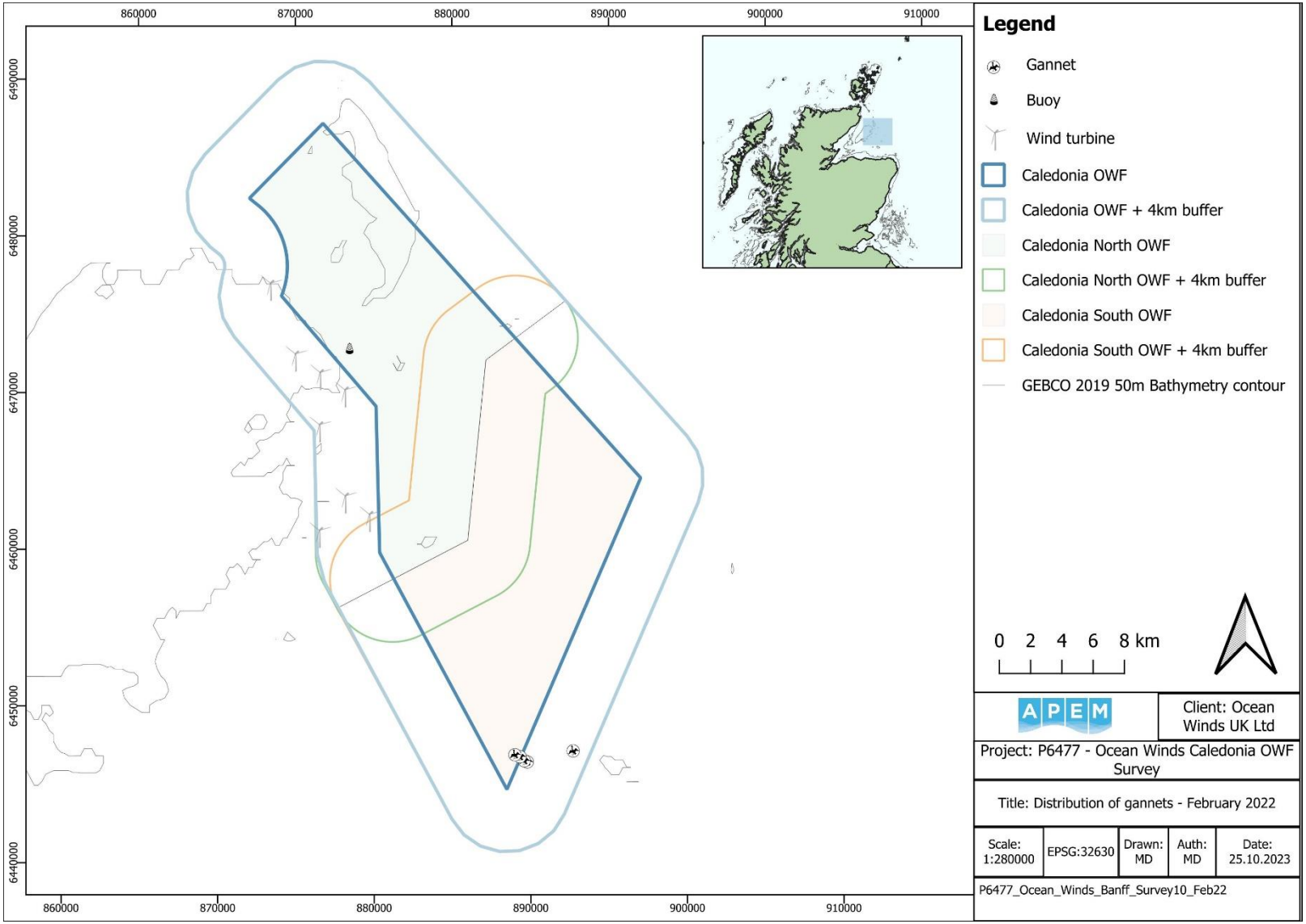


Figure A4.315 Distribution of gannets recorded in the Survey Area in February 2022

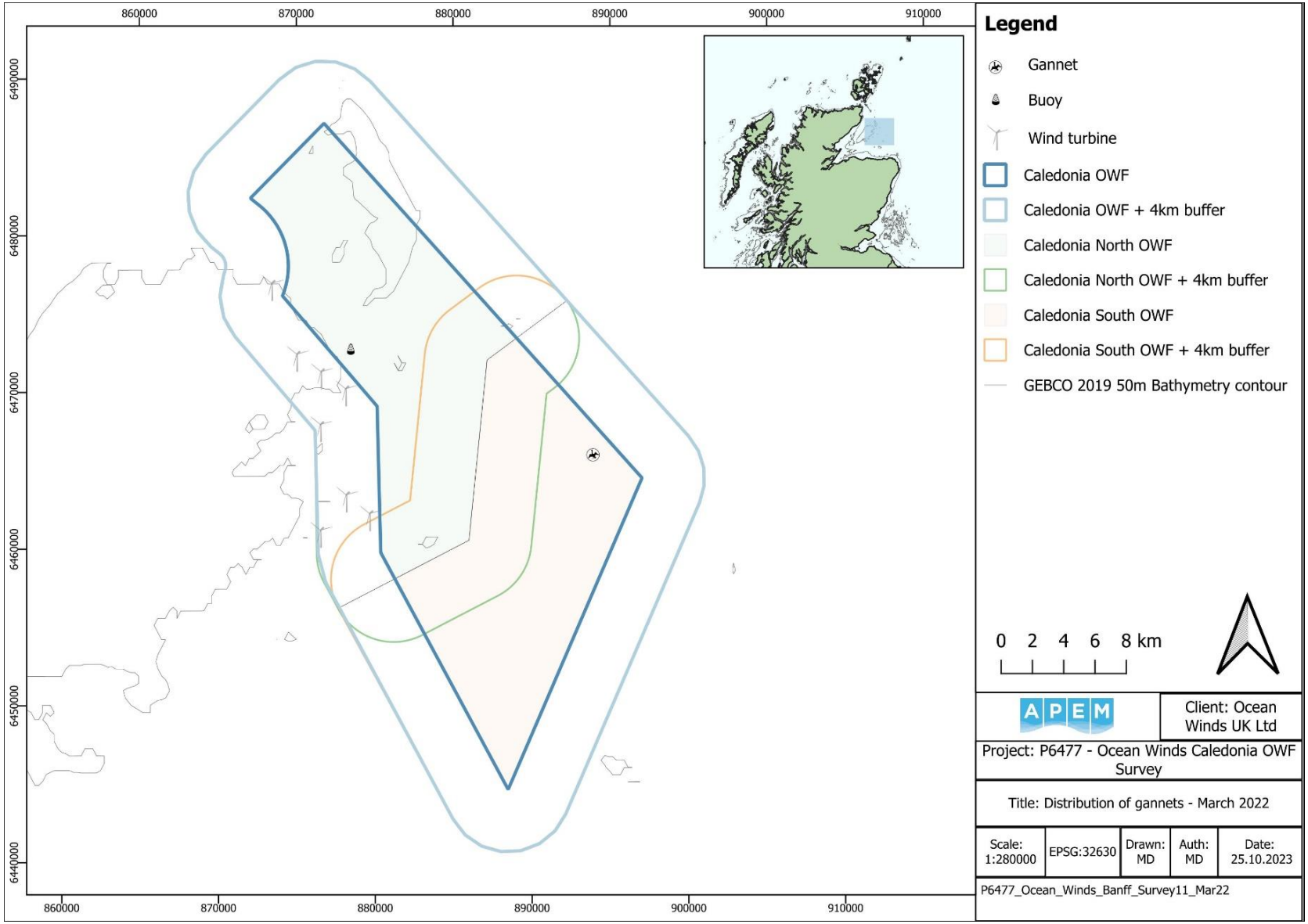


Figure A4.316 Distribution of gannets recorded in the Survey Area in March 2022

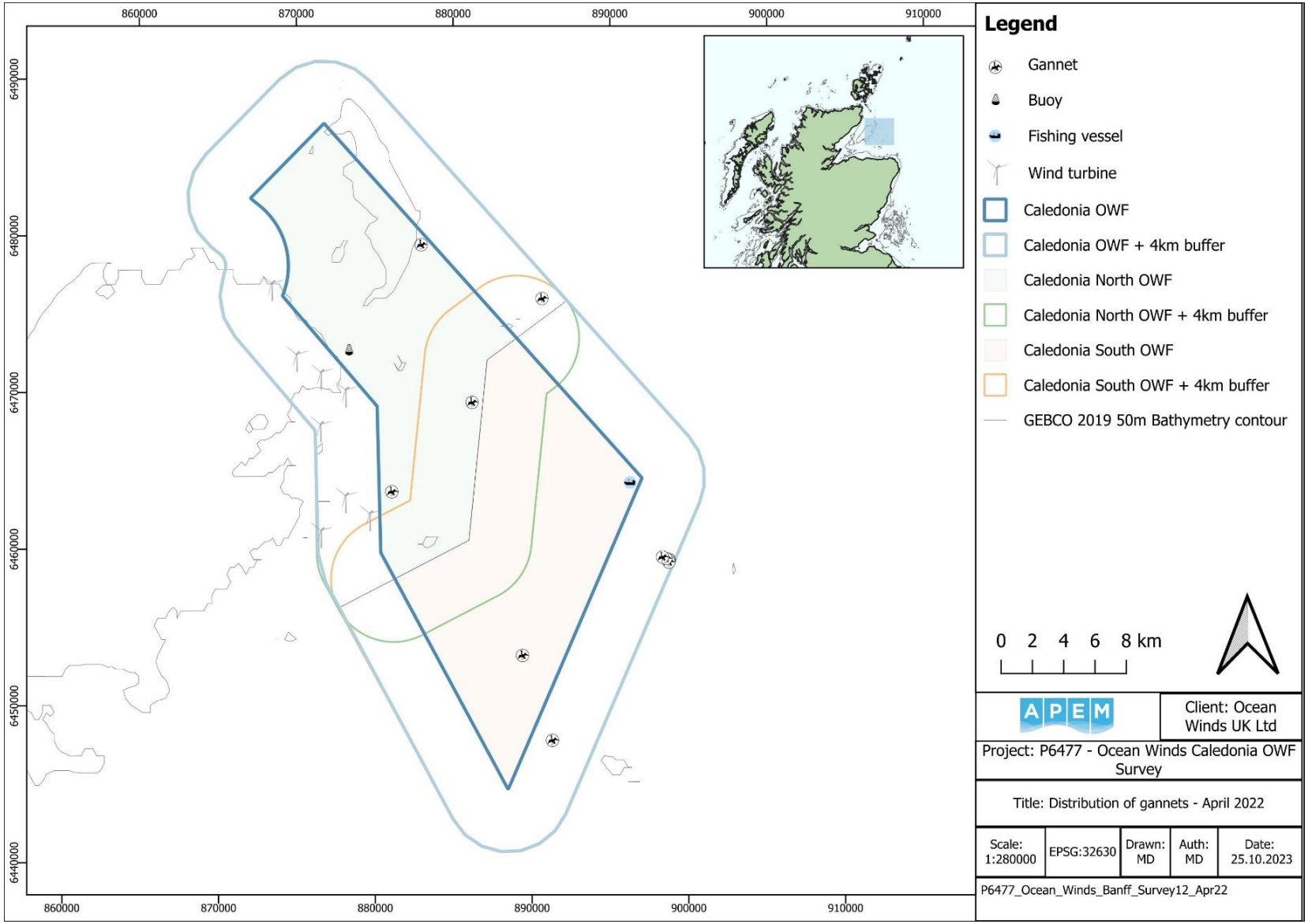


Figure A4.317 Distribution of gannets recorded in the Survey Area in April 2022

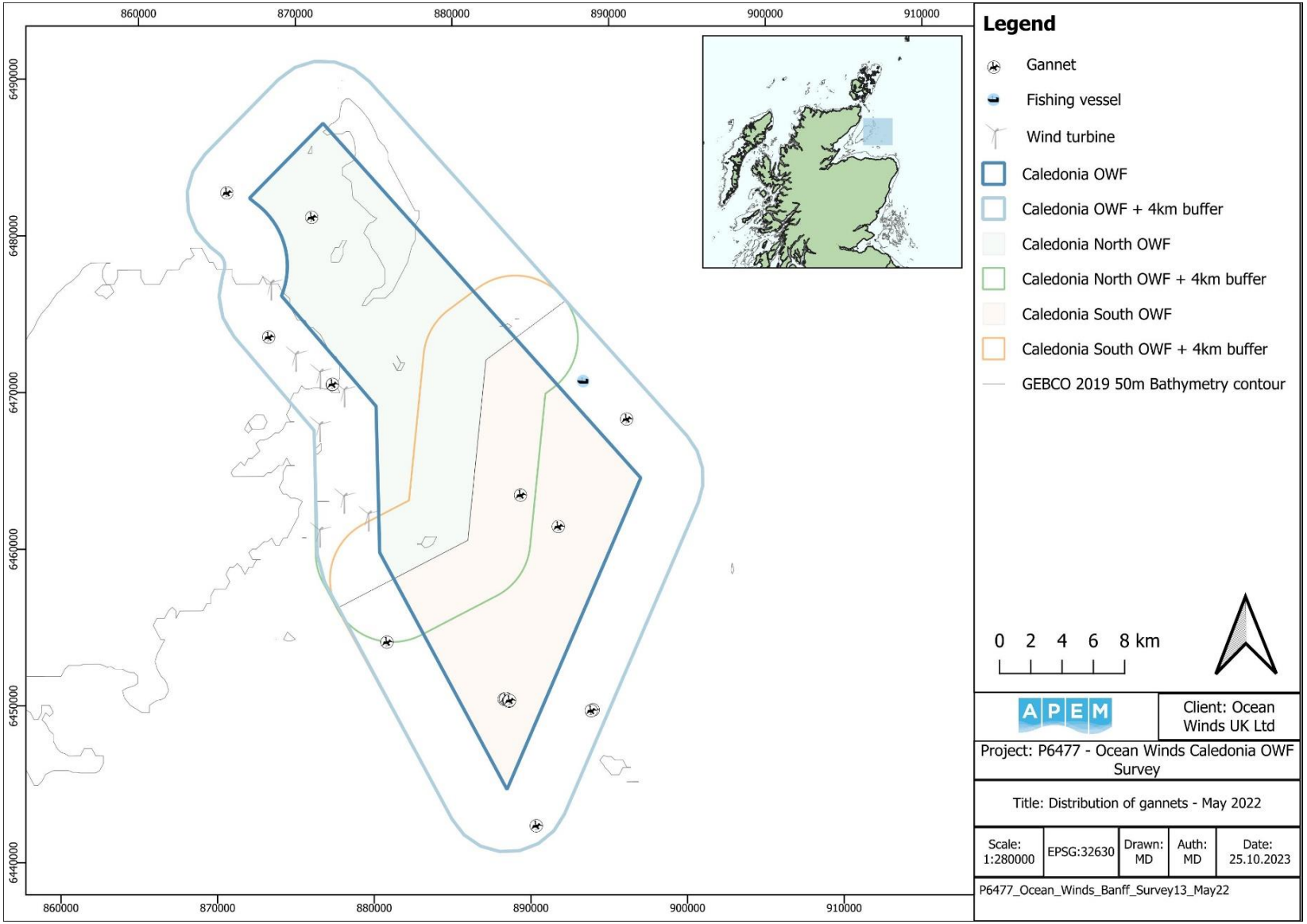


Figure A4.318 Distribution of gannets recorded in the Survey Area in May 2022

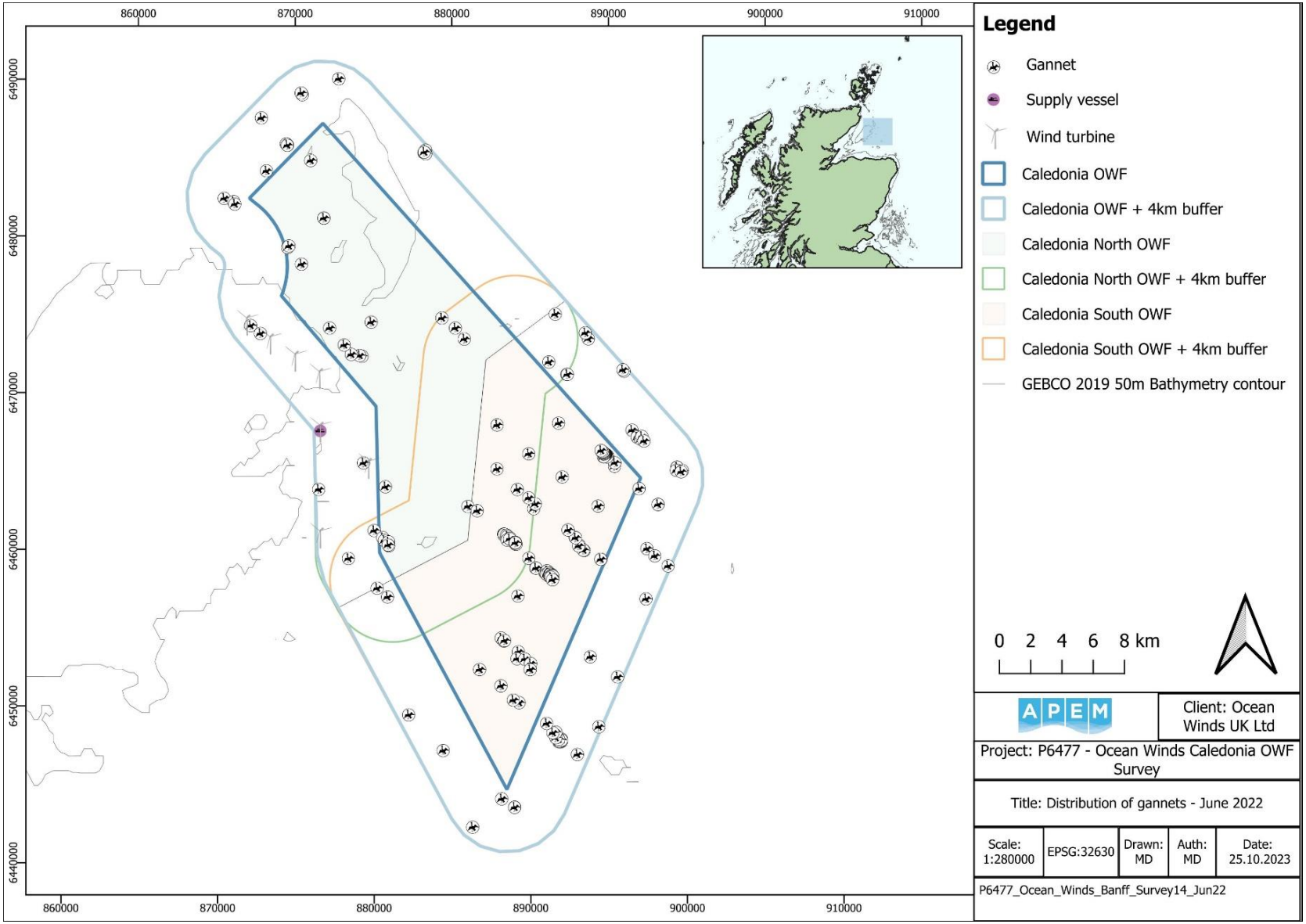


Figure A4.319 Distribution of gannets recorded in the Survey Area in June 2022

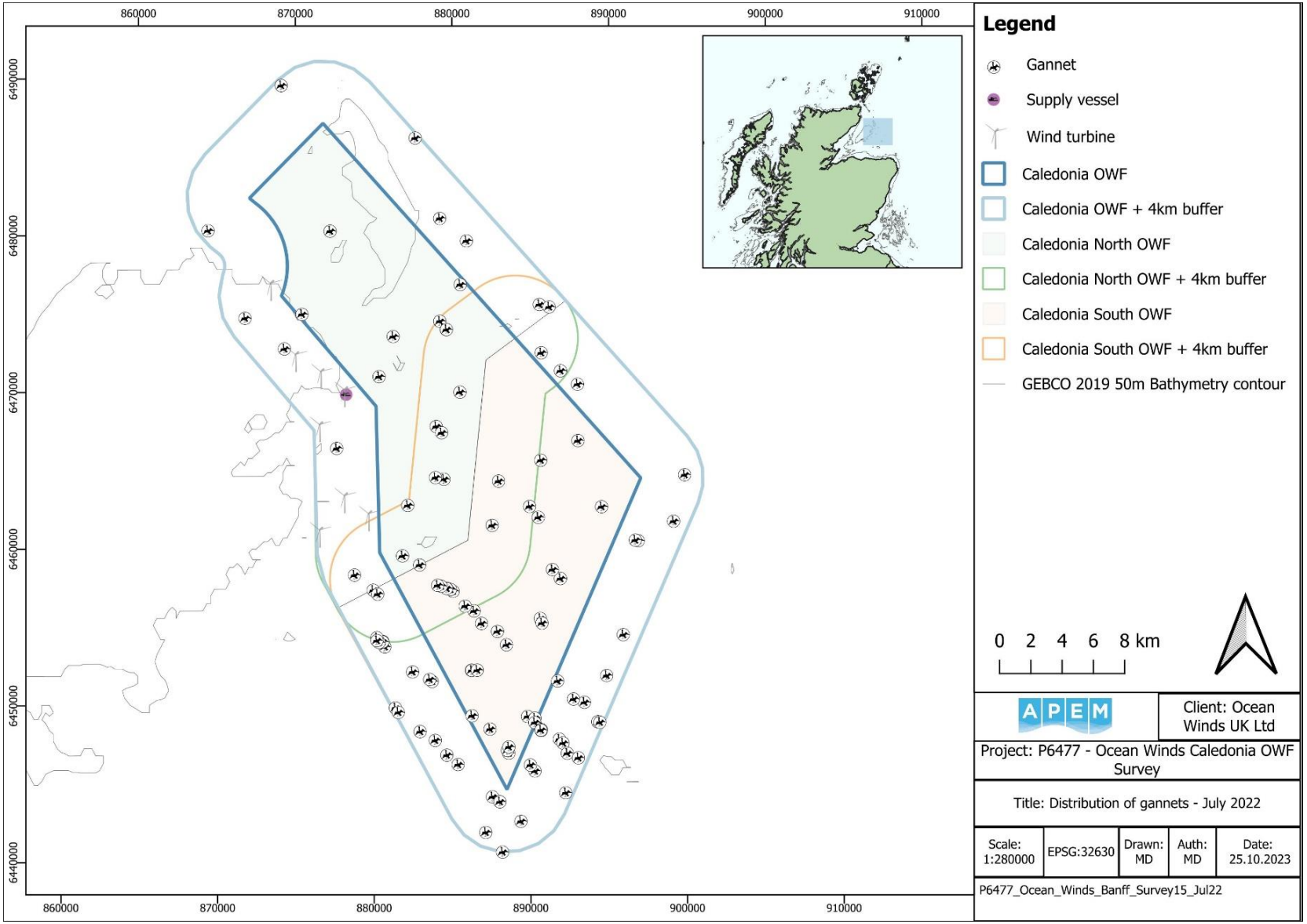


Figure A4.320 Distribution of gannets recorded in the Survey Area in July 2022

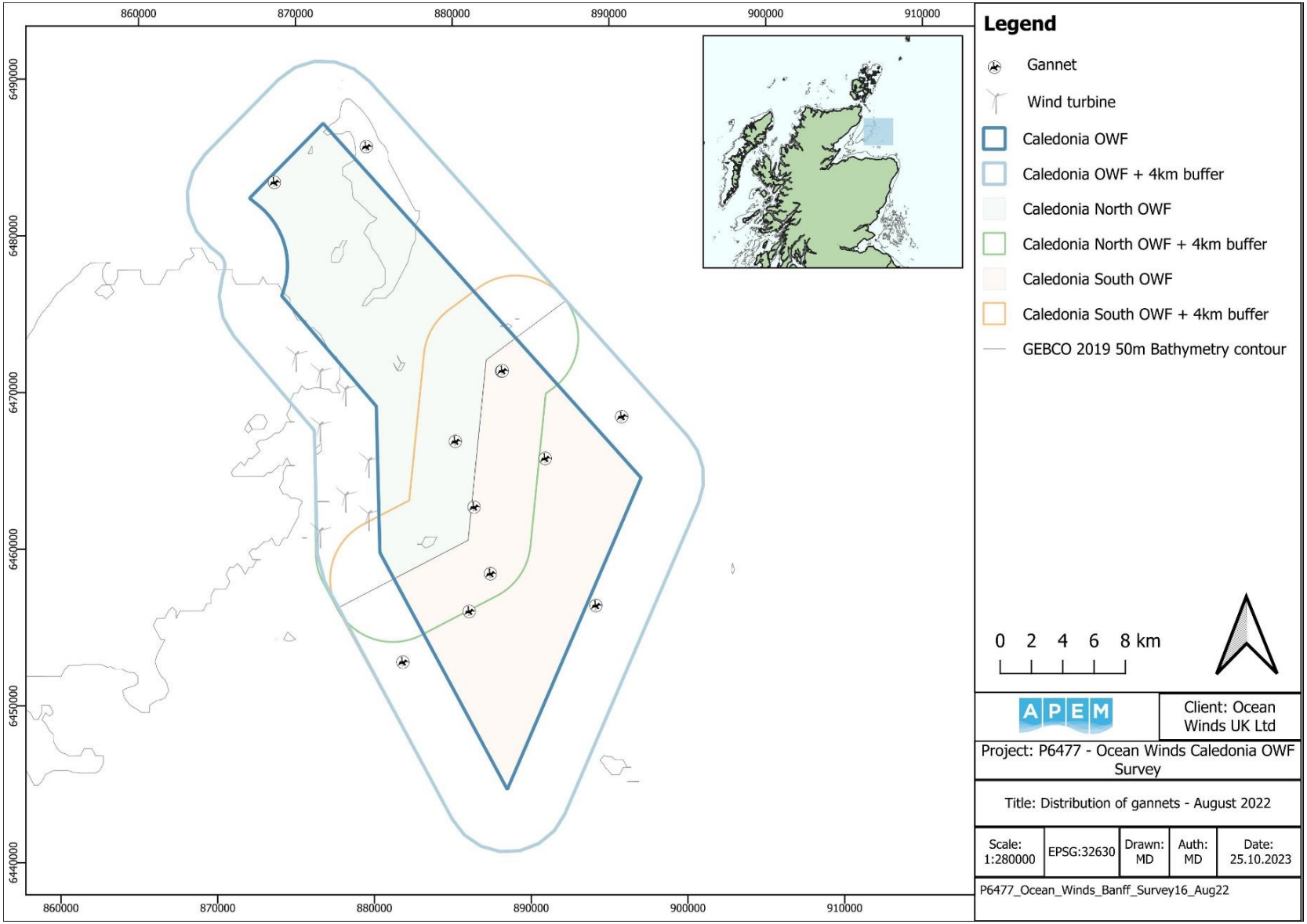


Figure A4.321 Distribution of gannets recorded in the Survey Area in August 2022

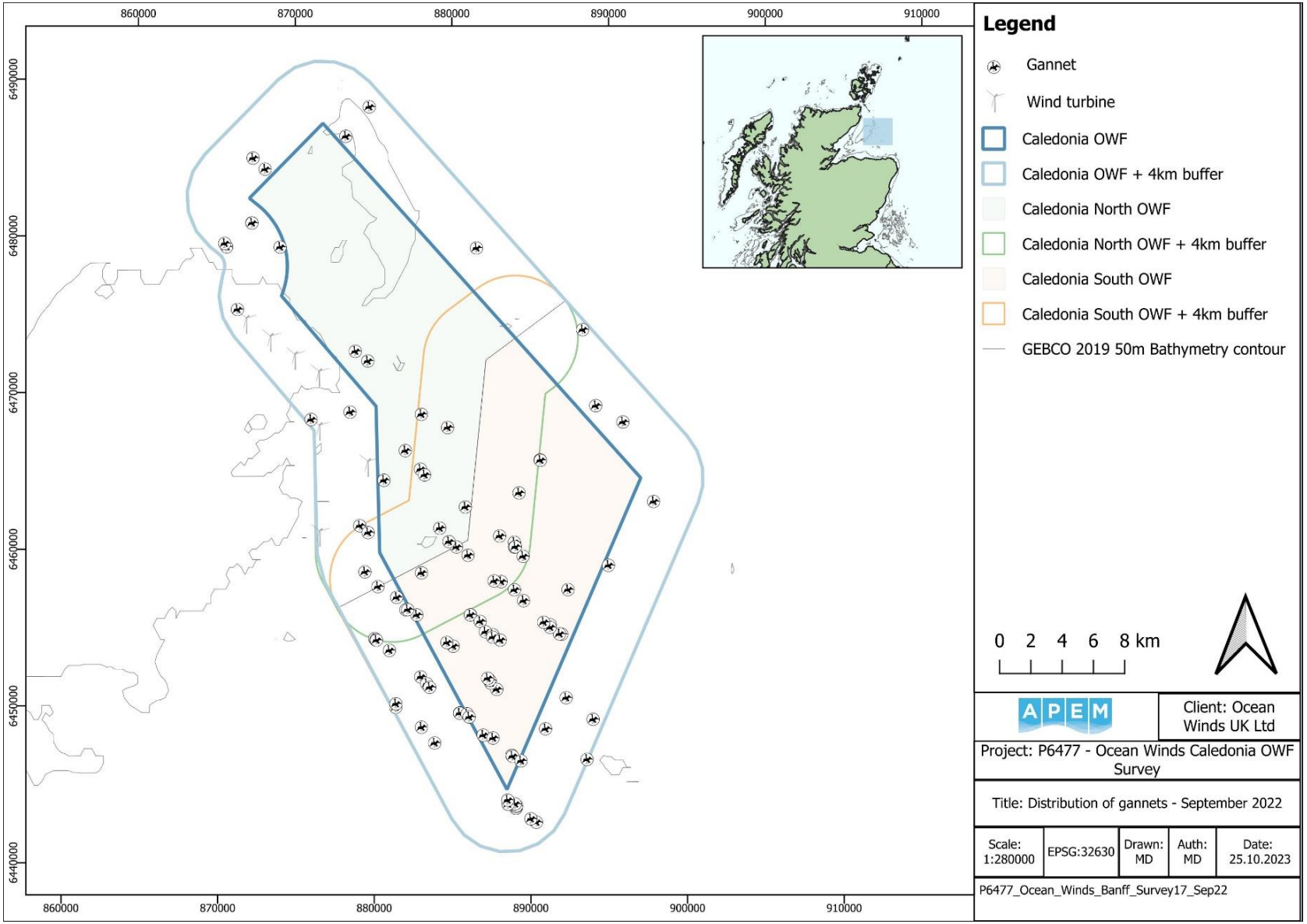


Figure A4.322 Distribution of gannets recorded in the Survey Area in September 2022

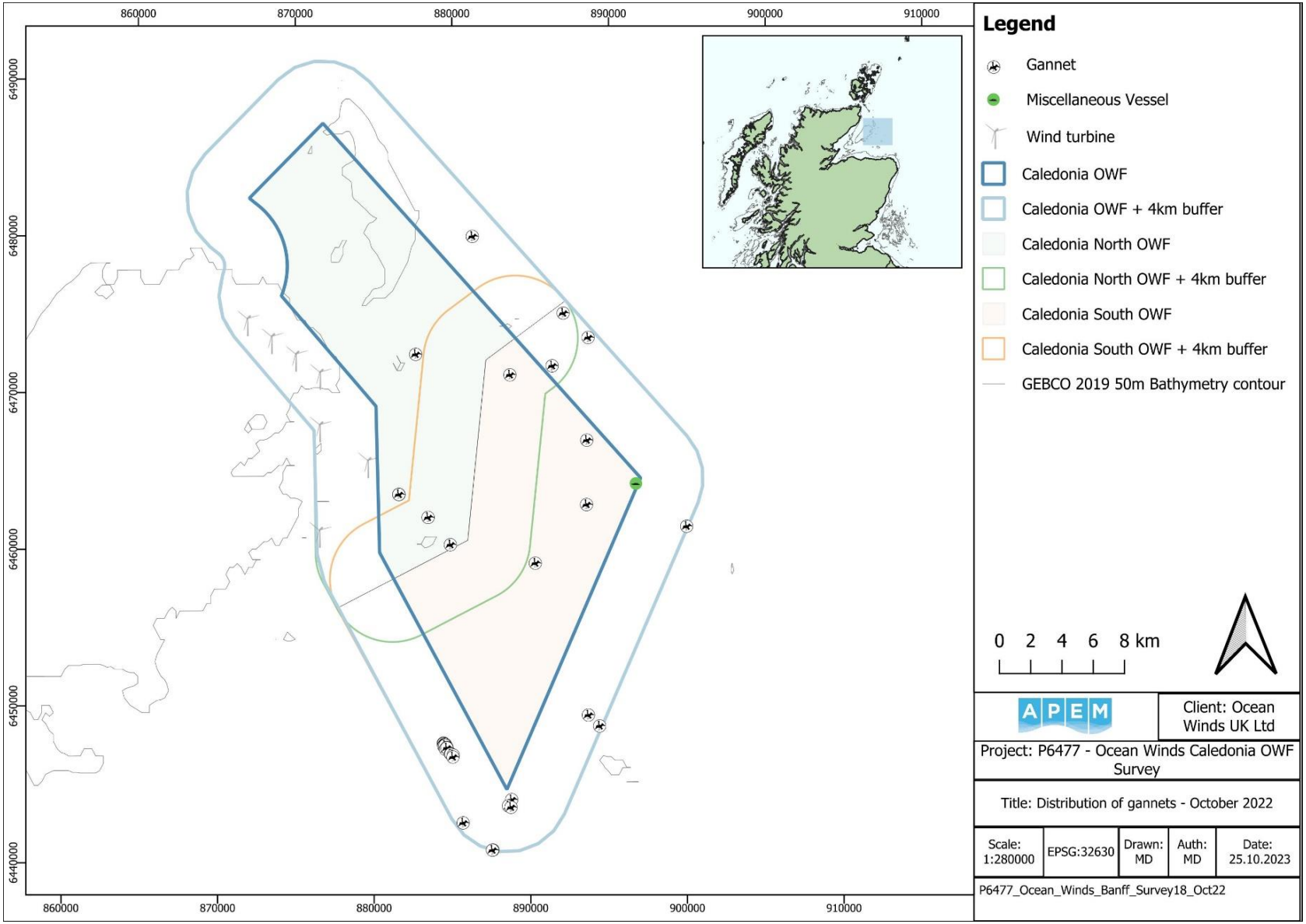


Figure A4.323 Distribution of gannets recorded in the Survey Area in October 2022

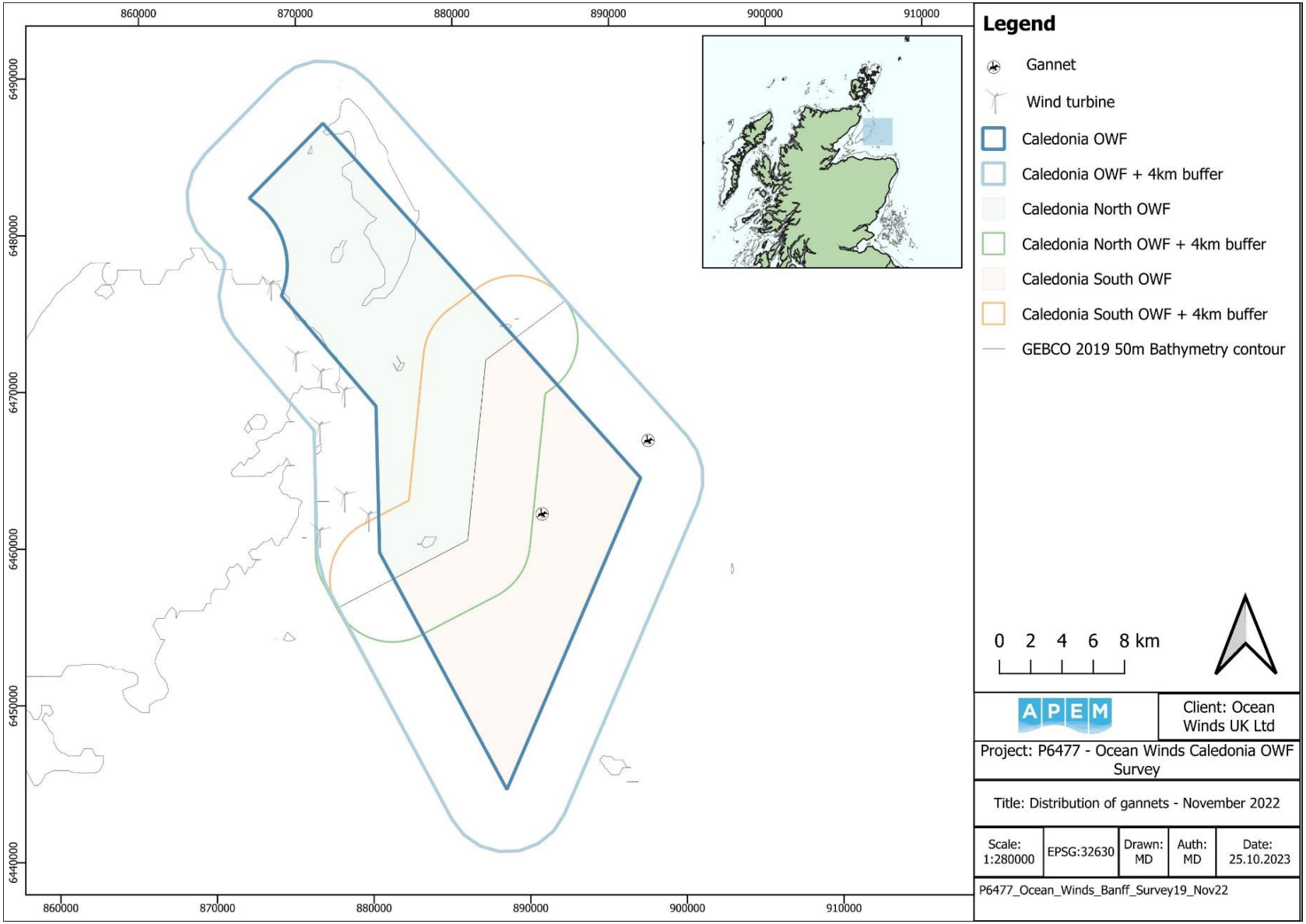


Figure A4.324 Distribution of gannets recorded in the Survey Area in November 2022

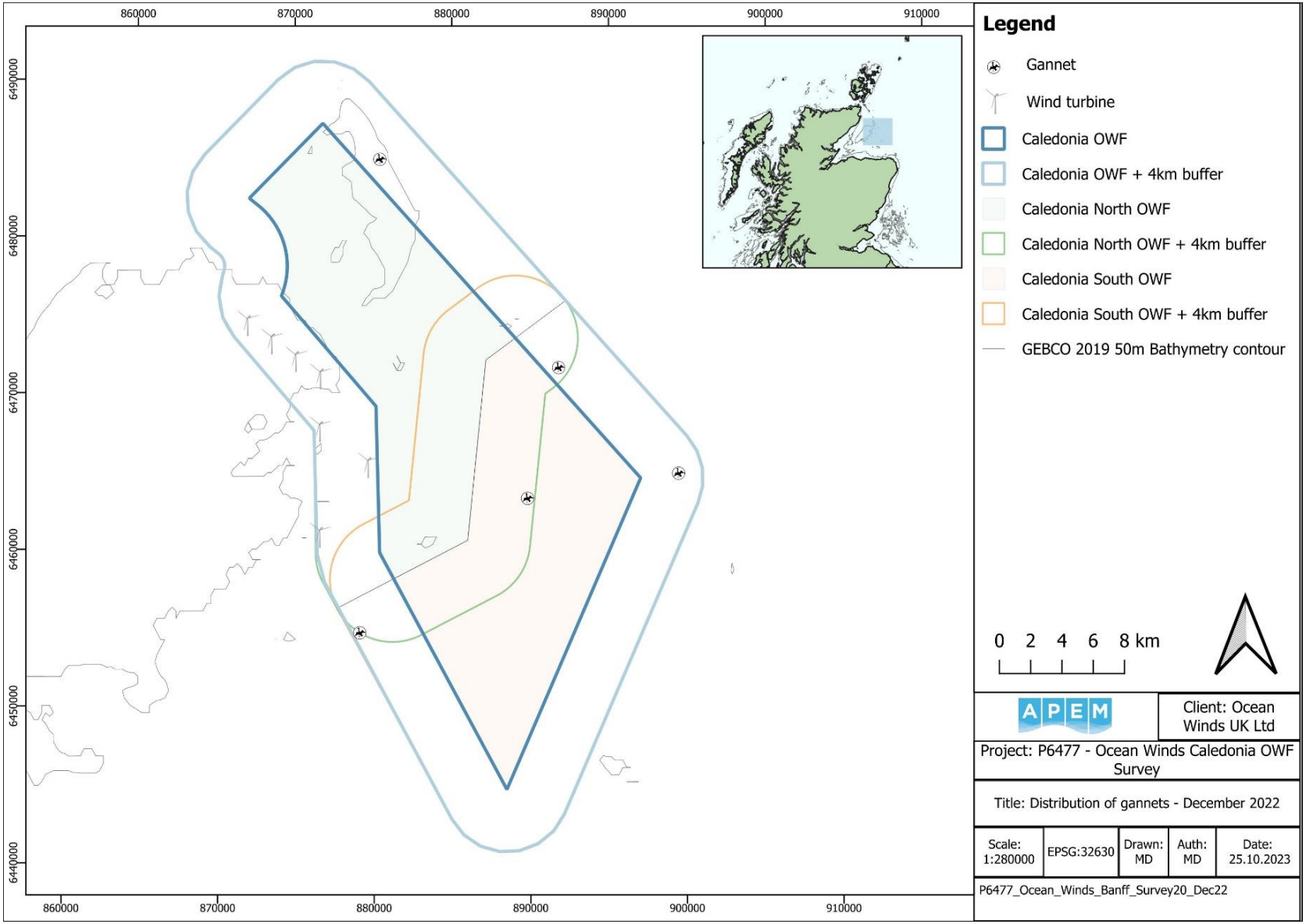


Figure A4.325 Distribution of gannets recorded in the Survey Area in December 2022

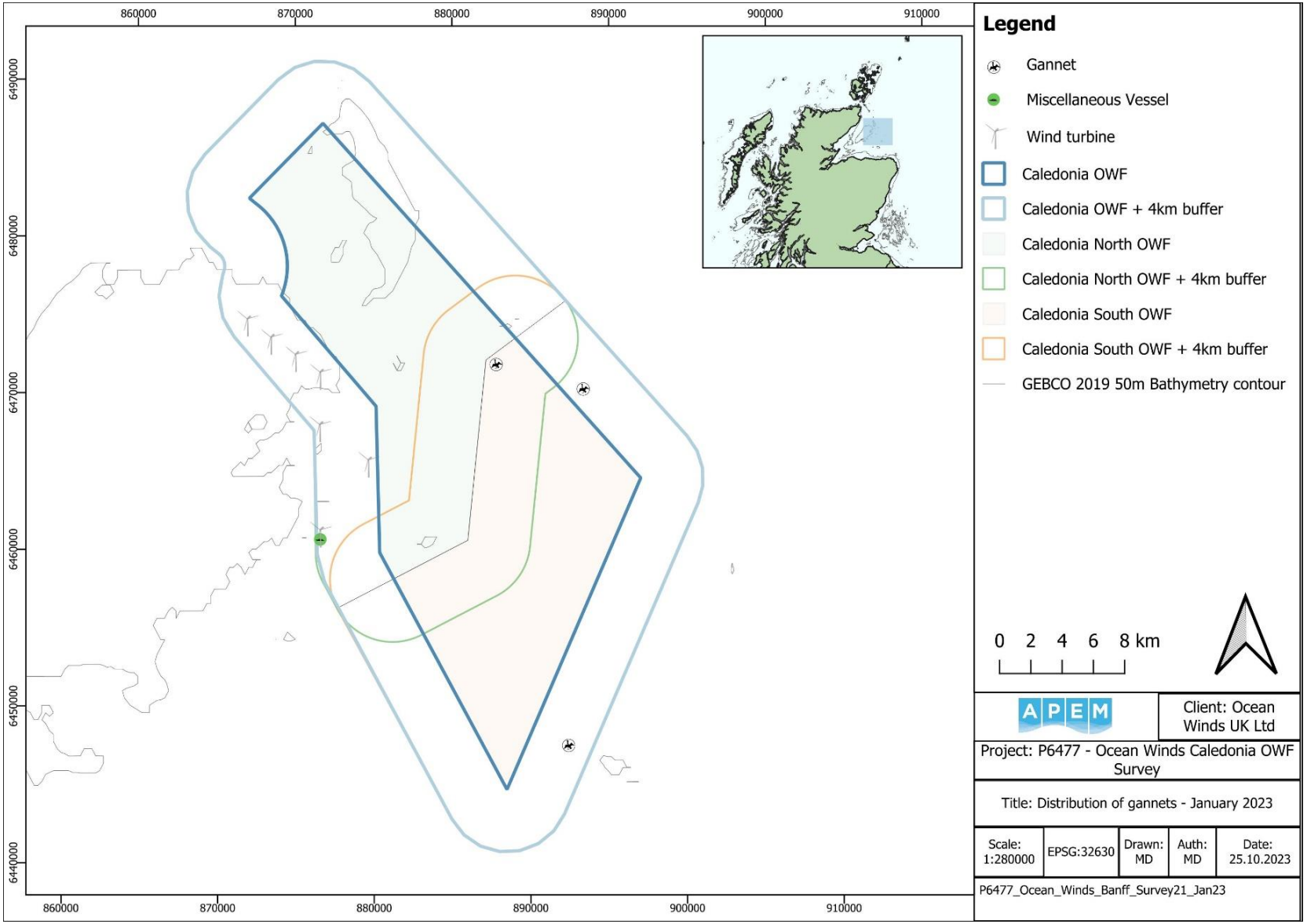


Figure A4.326 Distribution of gannets recorded in the Survey Area in January 2023

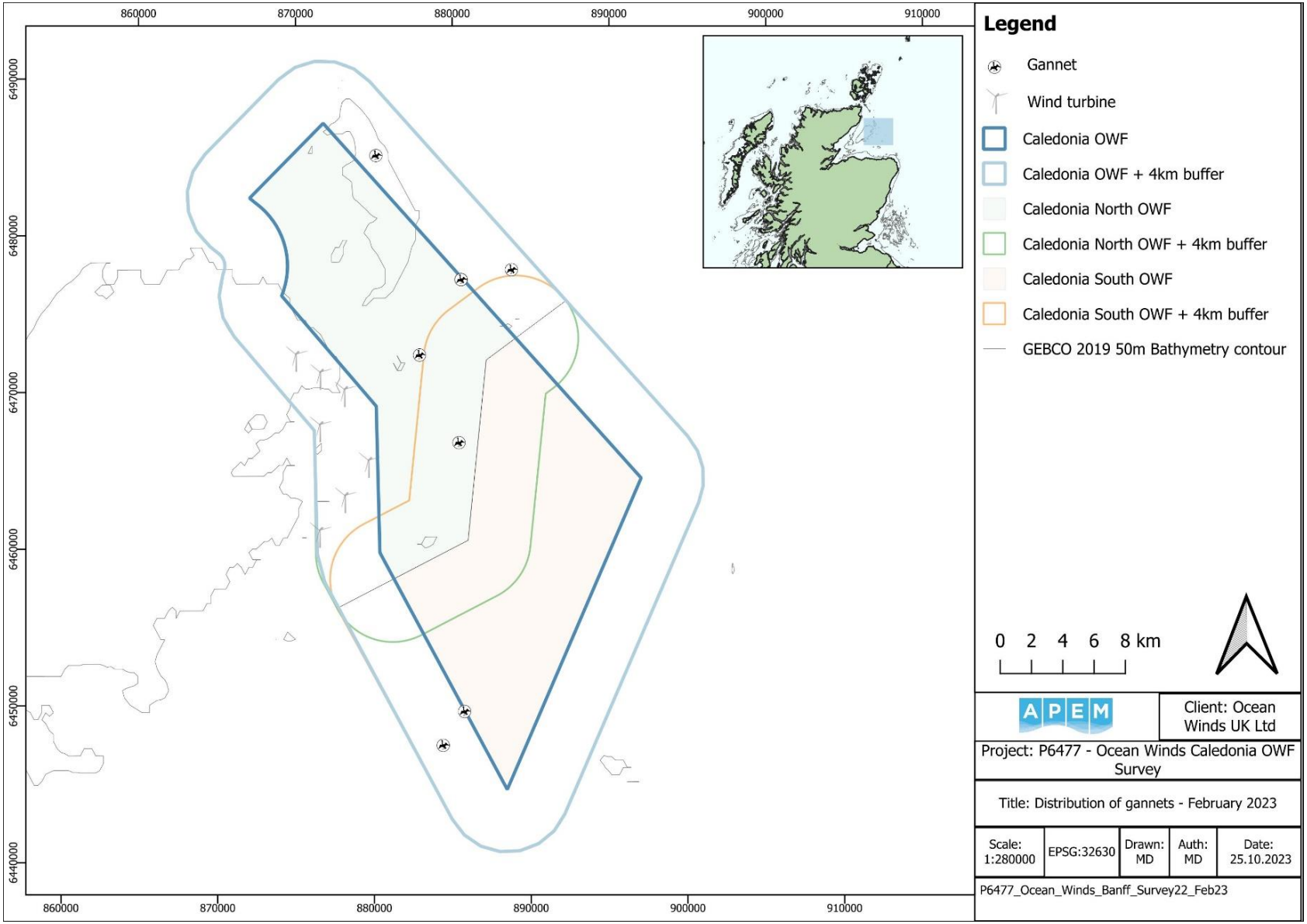


Figure A4.327 Distribution of gannets recorded in the Survey Area in February 2023

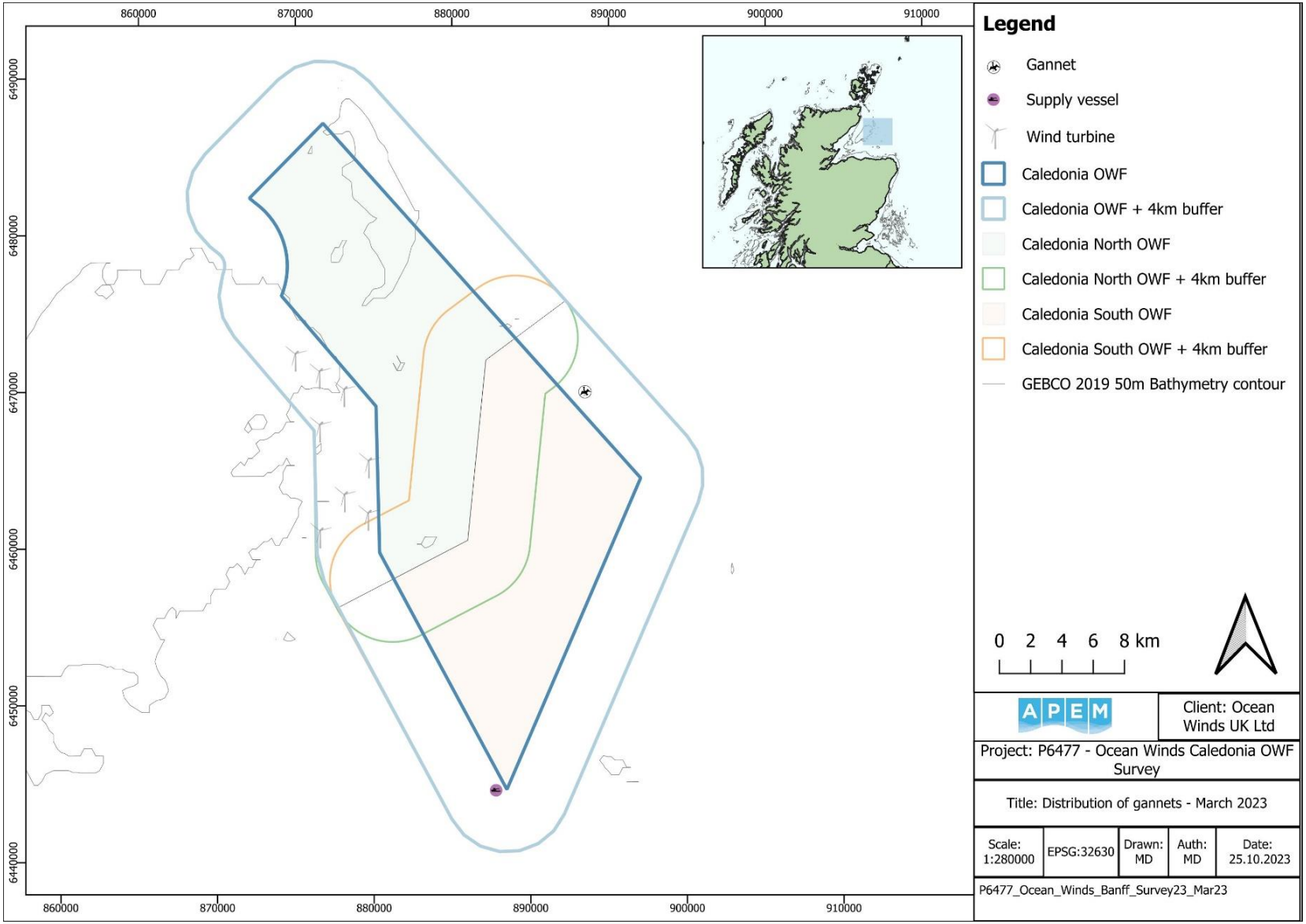


Figure A4.328 Distribution of gannets recorded in the Survey Area in March 2023

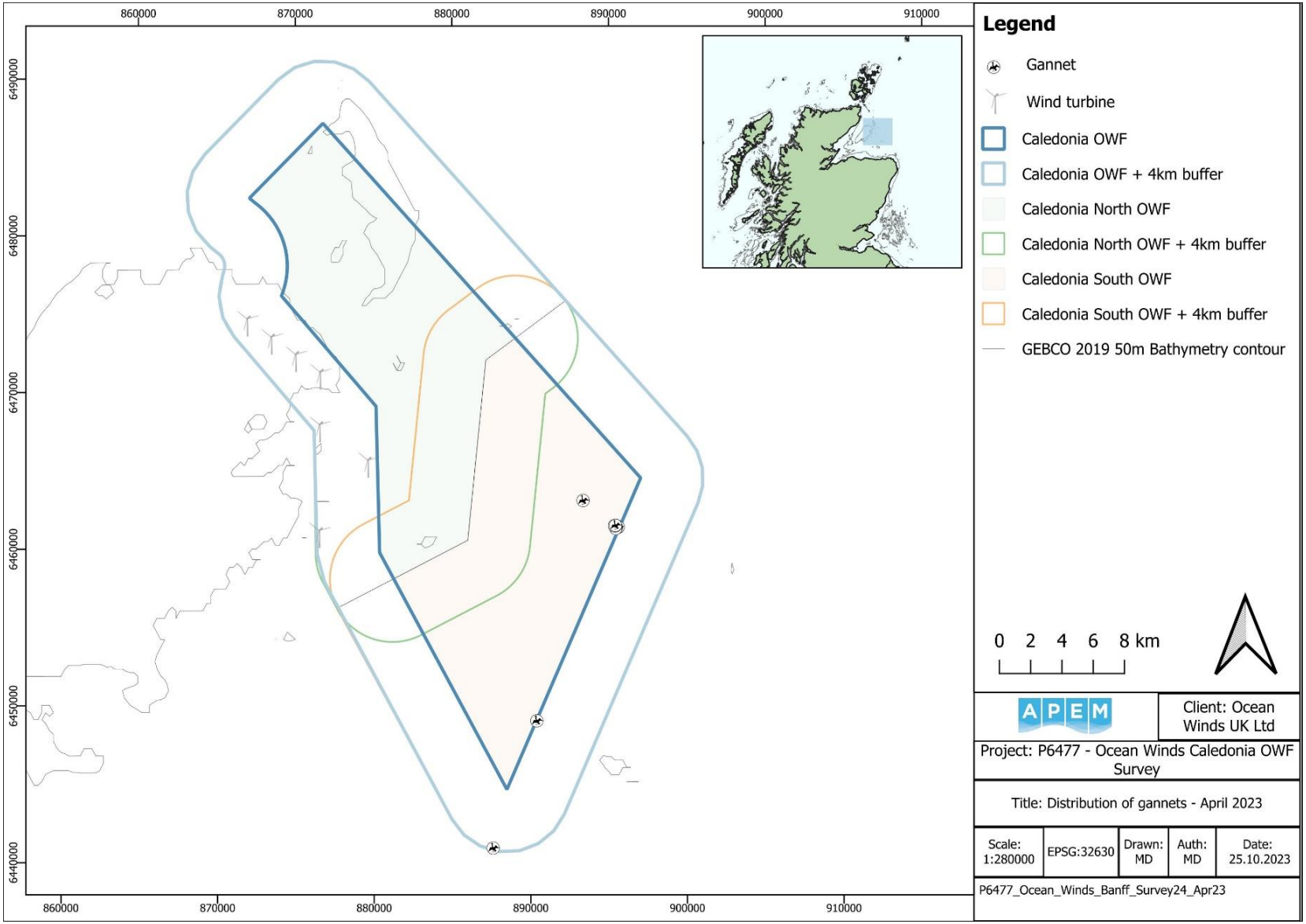


Figure A4.329 Distribution of gannets recorded in the Survey Area in April 2023

Unidentified thrush species

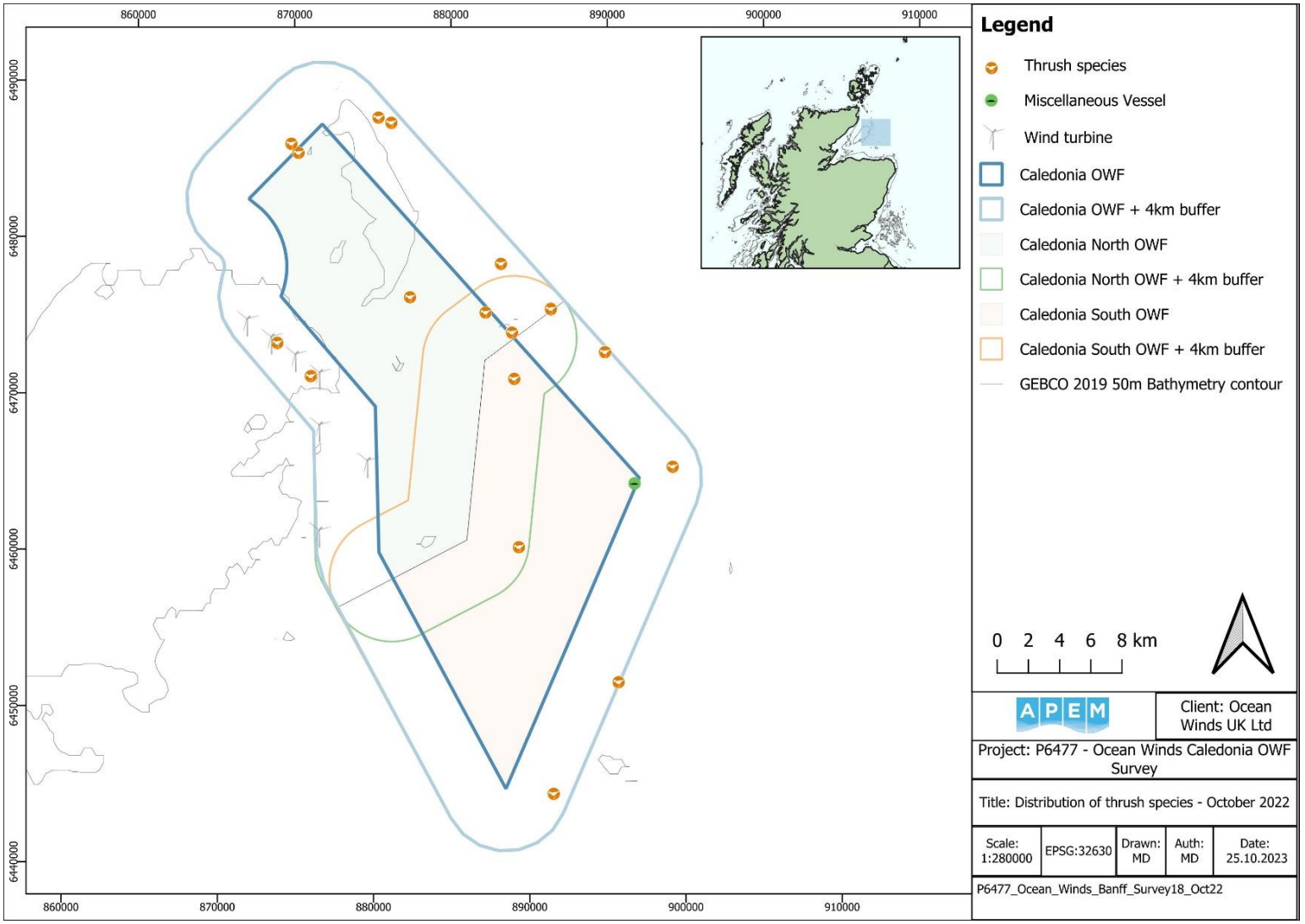


Figure A4.330 Distribution of thrush species recorded in the Survey Area in October 2022

Unidentified passerine species

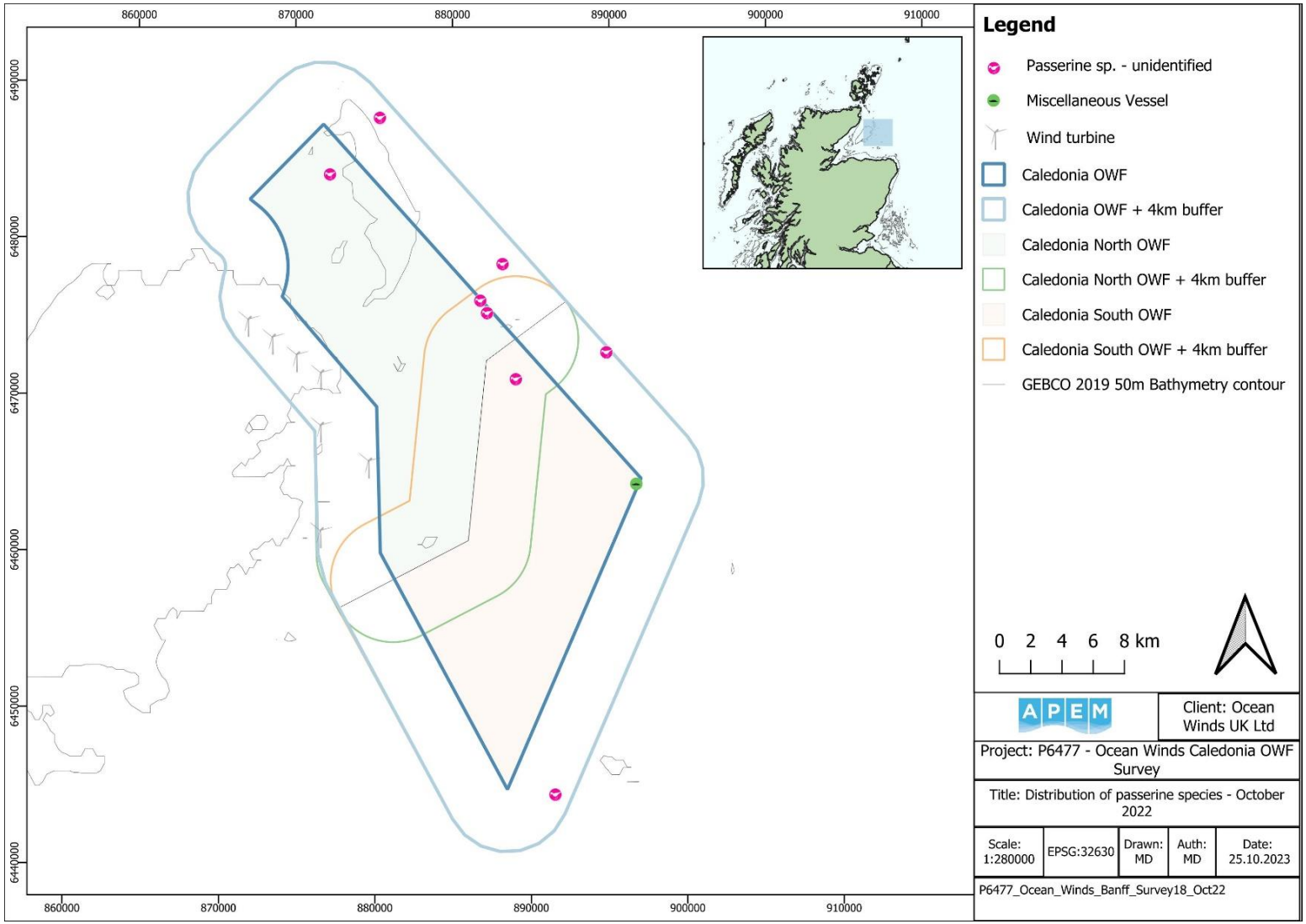


Figure A4.331 Distribution of passerine species recorded in the Survey Area in October 2022

Unidentified bird species

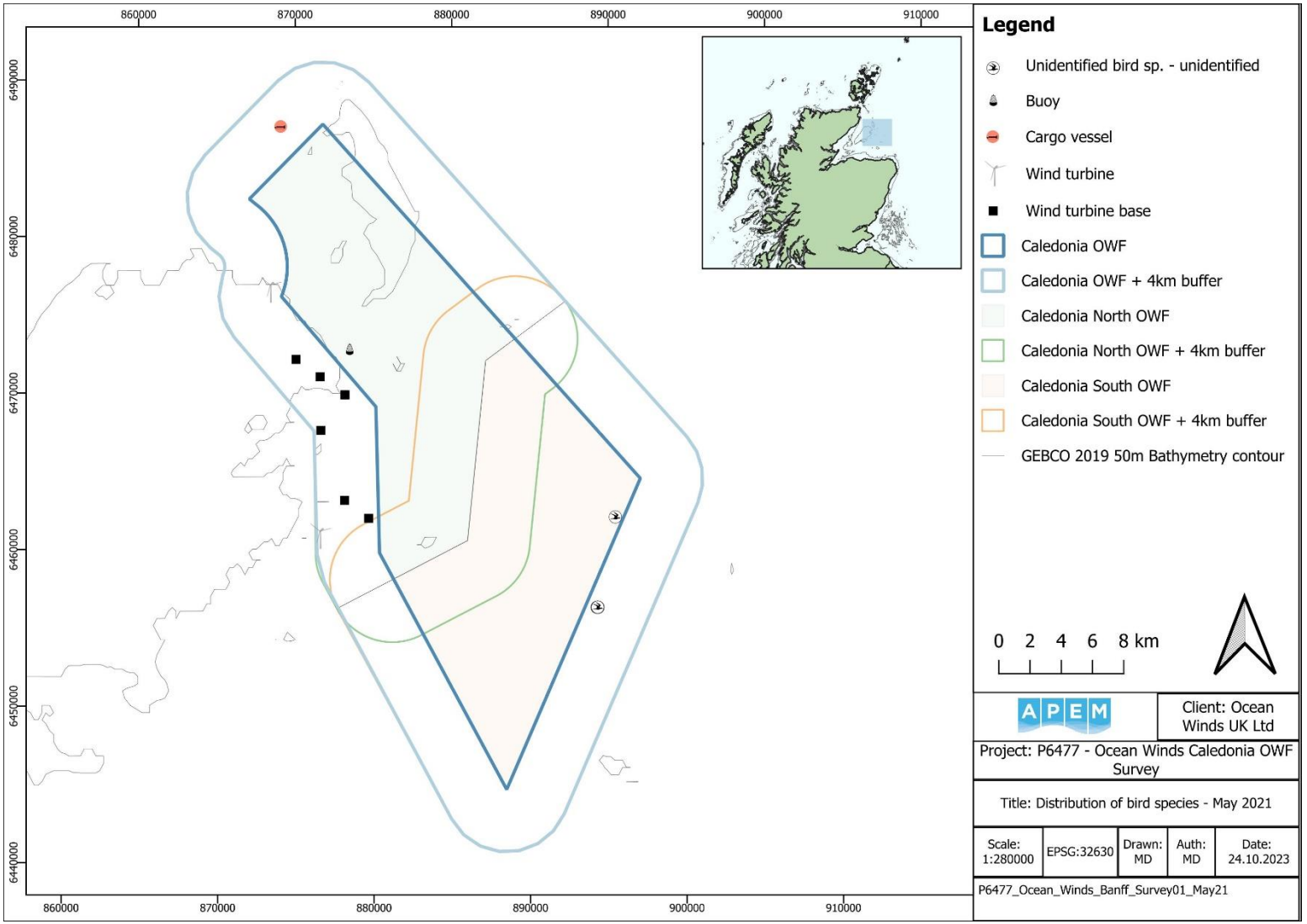


Figure A4.332 Distribution of unidentified bird species recorded in the Survey Area in May 2021

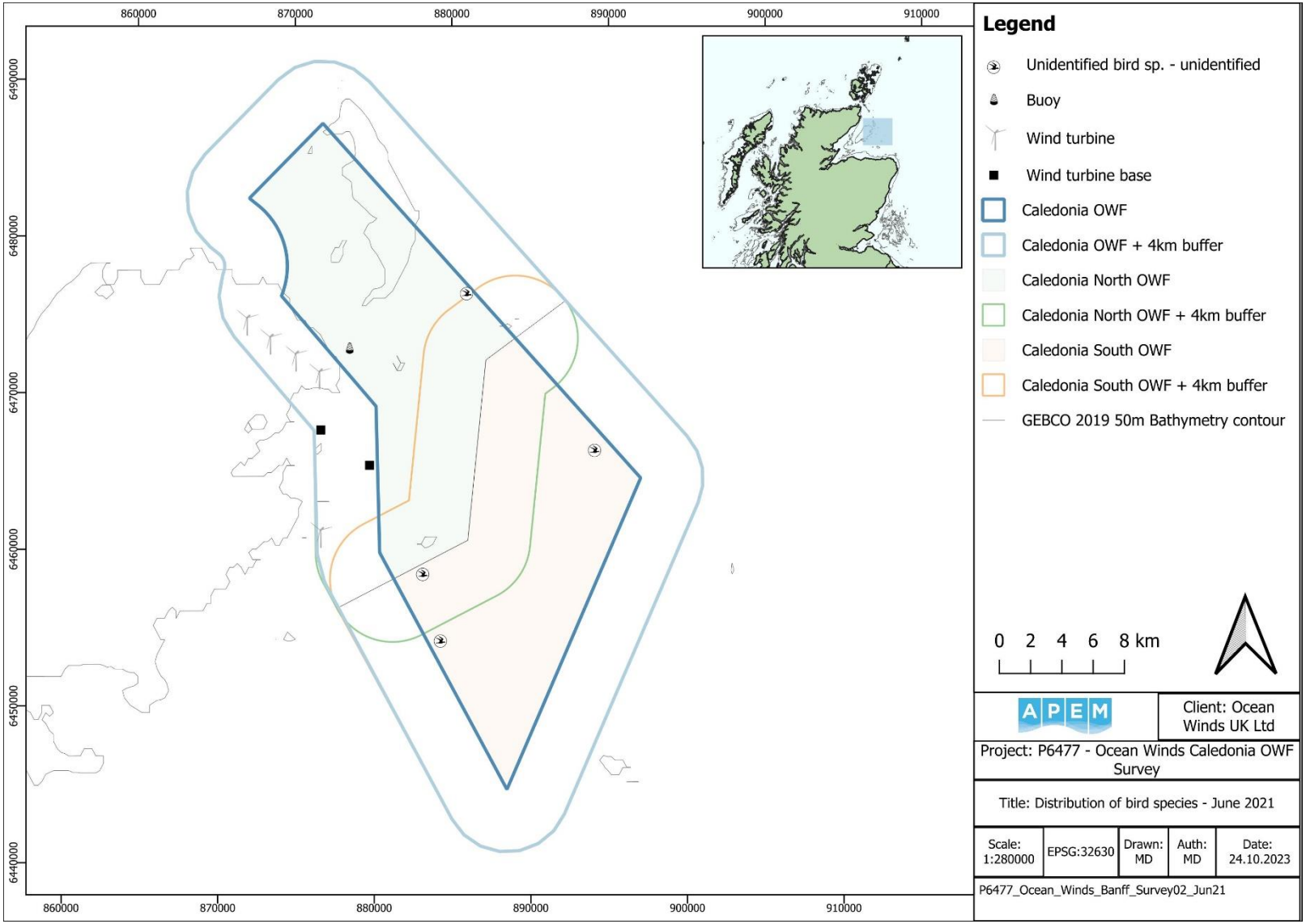


Figure A4.333 Distribution of unidentified bird species recorded in the Survey Area in June 2021

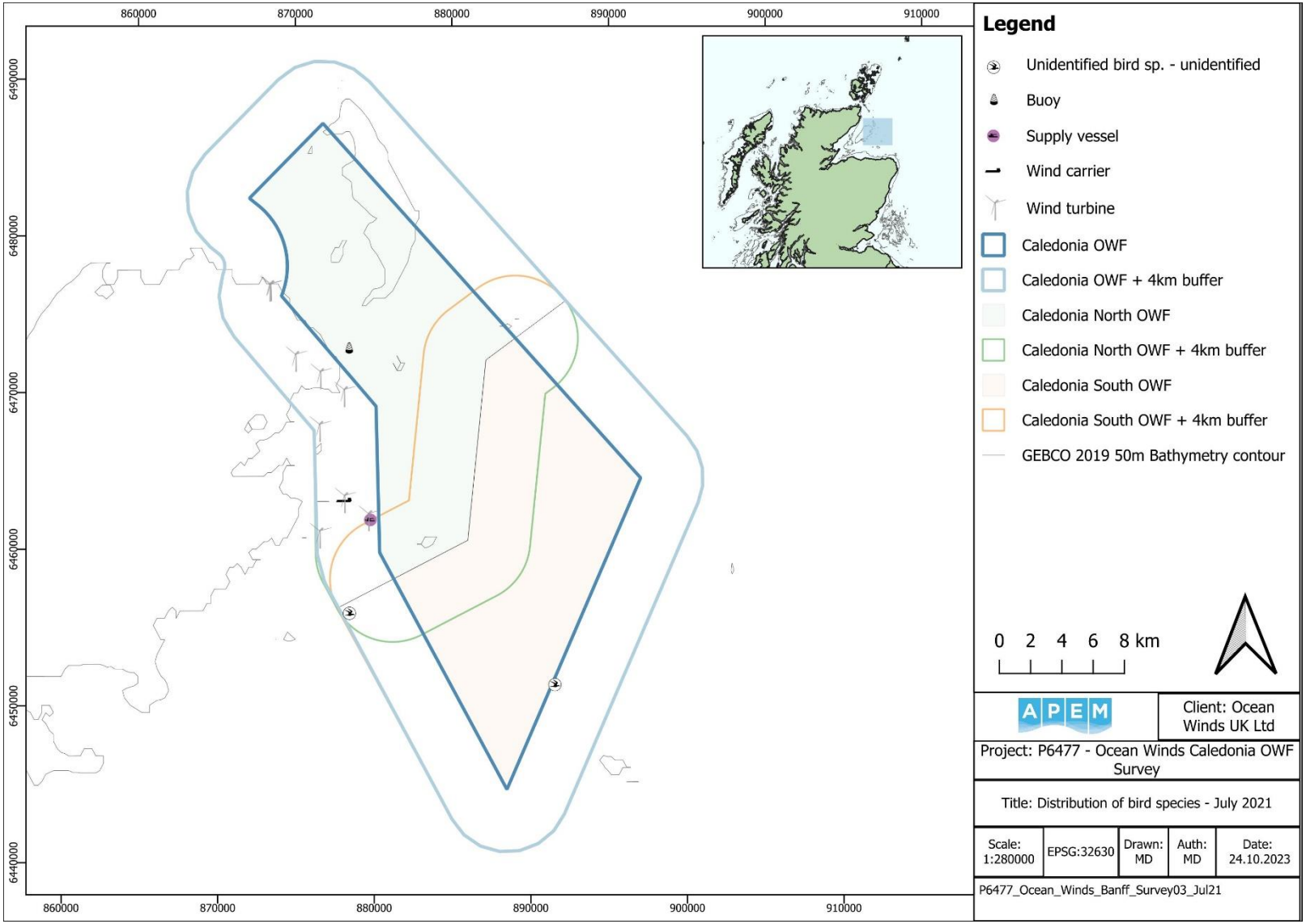


Figure A4.334 Distribution of unidentified bird species recorded in the Survey Area in July 2021

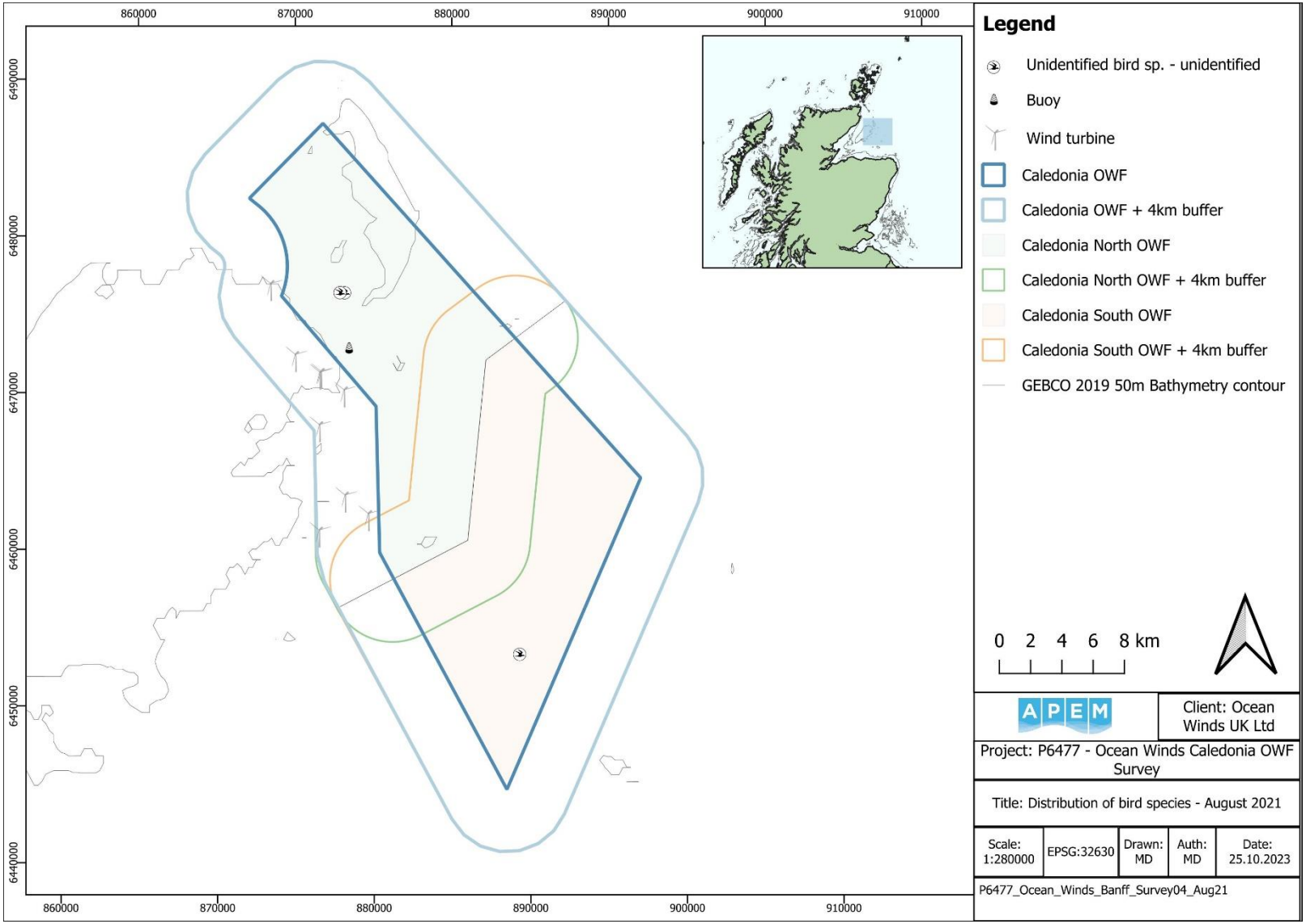


Figure A4.335 Distribution of unidentified bird species recorded in the Survey Area in August 2021

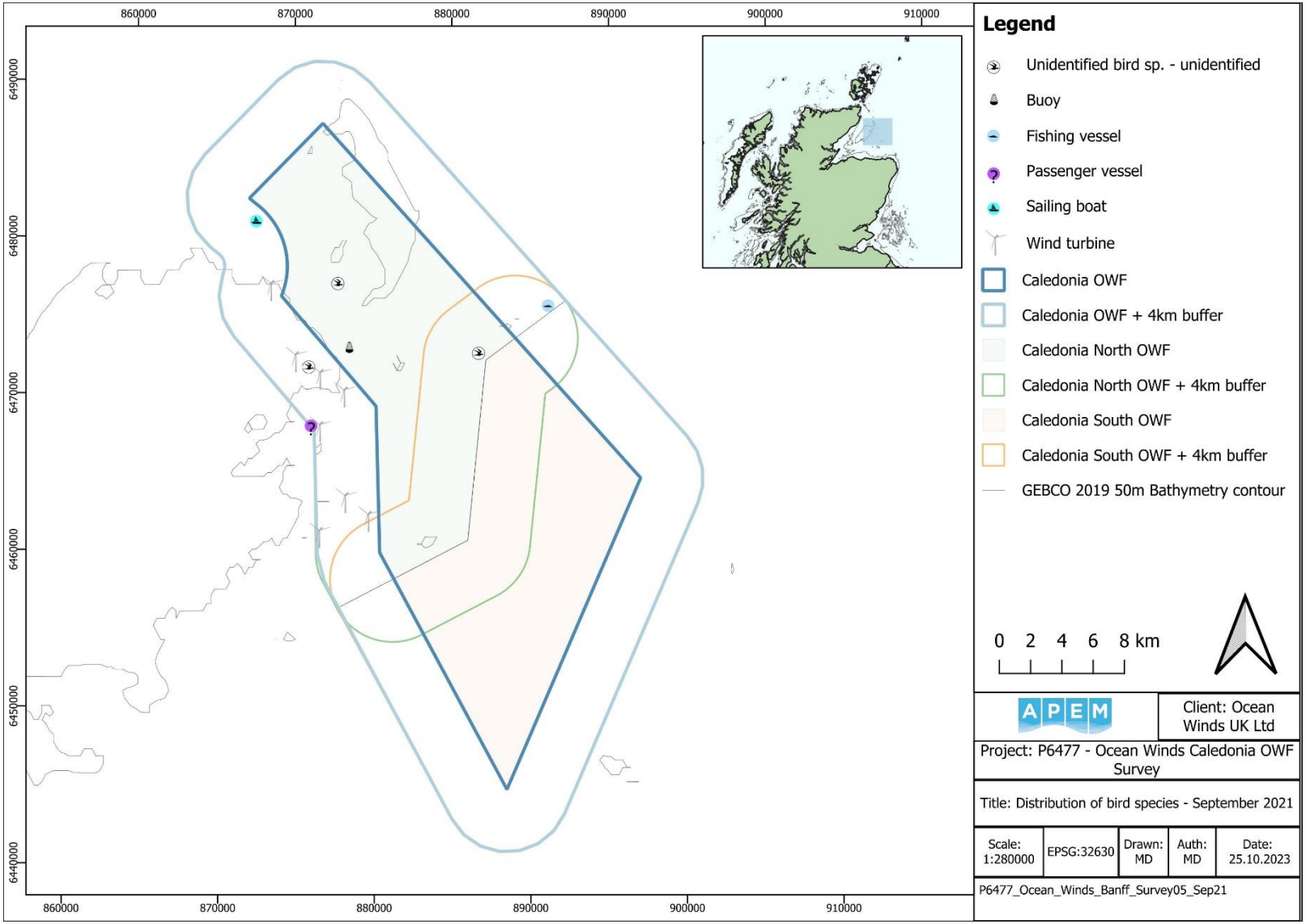


Figure A4.336 Distribution of unidentified bird species recorded in the Survey Area in September 2021

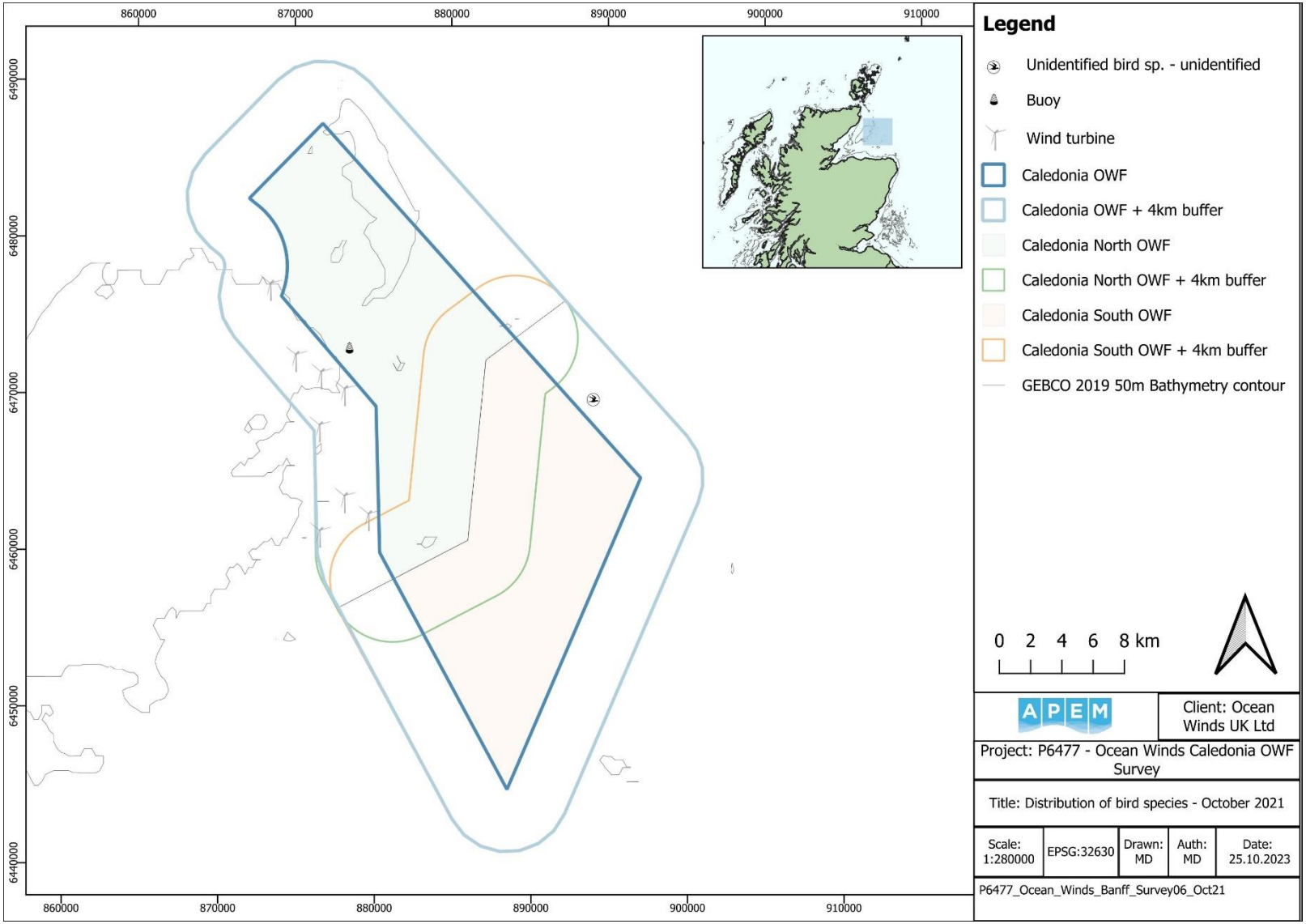


Figure A4.337 Distribution of unidentified bird species recorded in the Survey Area in October 2021

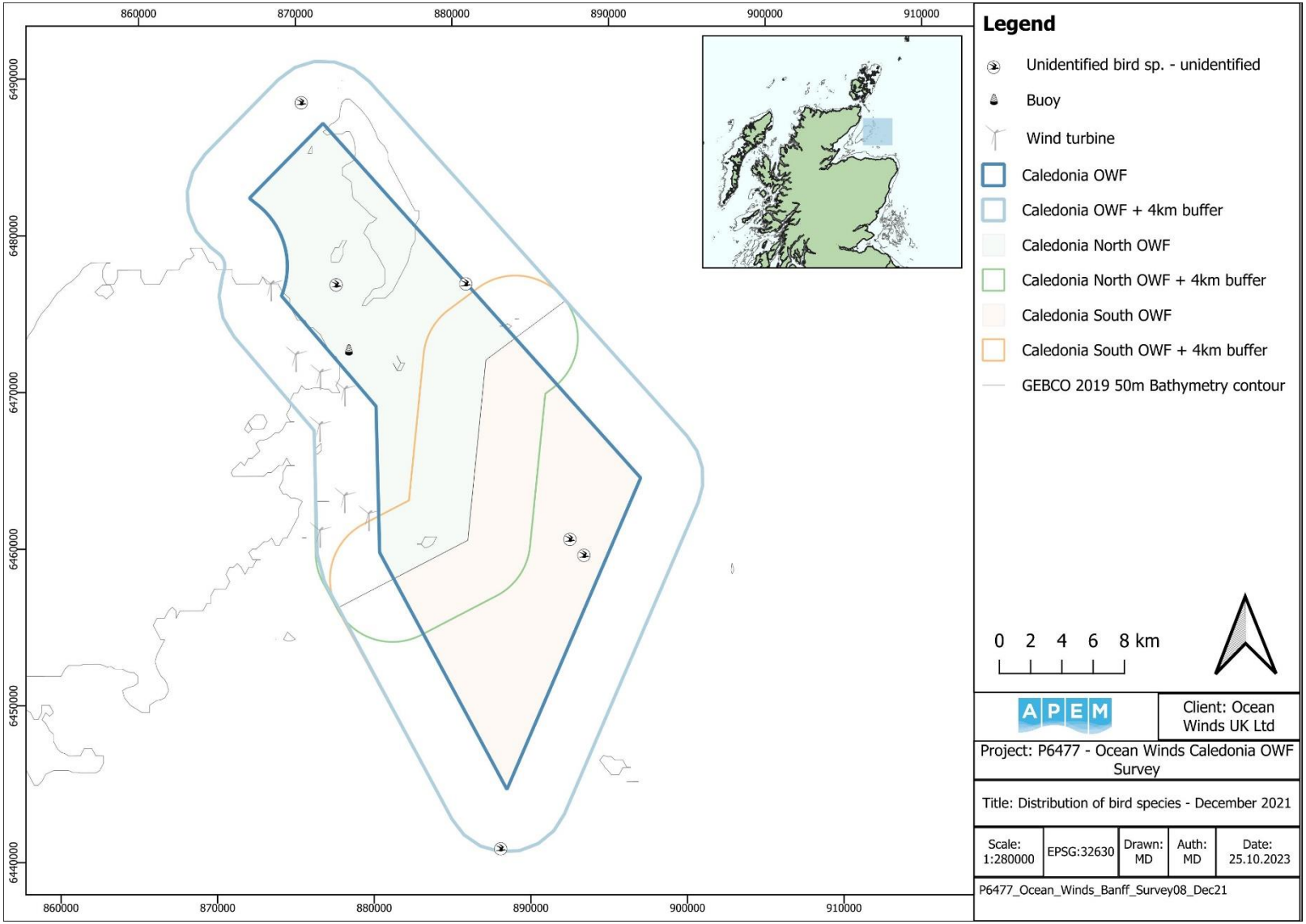


Figure A4.338 Distribution of unidentified bird species recorded in the Survey Area in December 2021

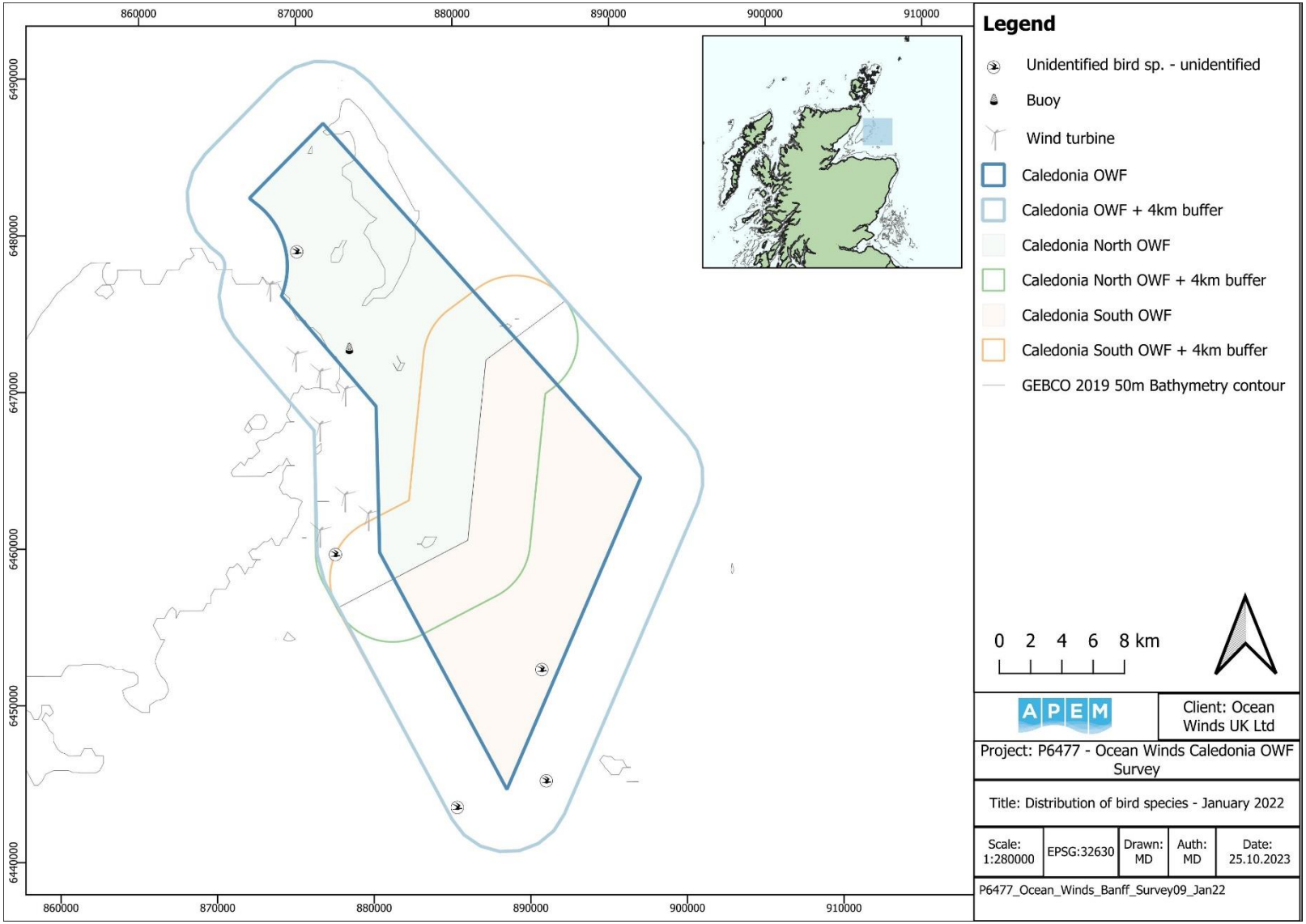


Figure A4.339 Distribution of unidentified bird species recorded in the Survey Area in January 2022

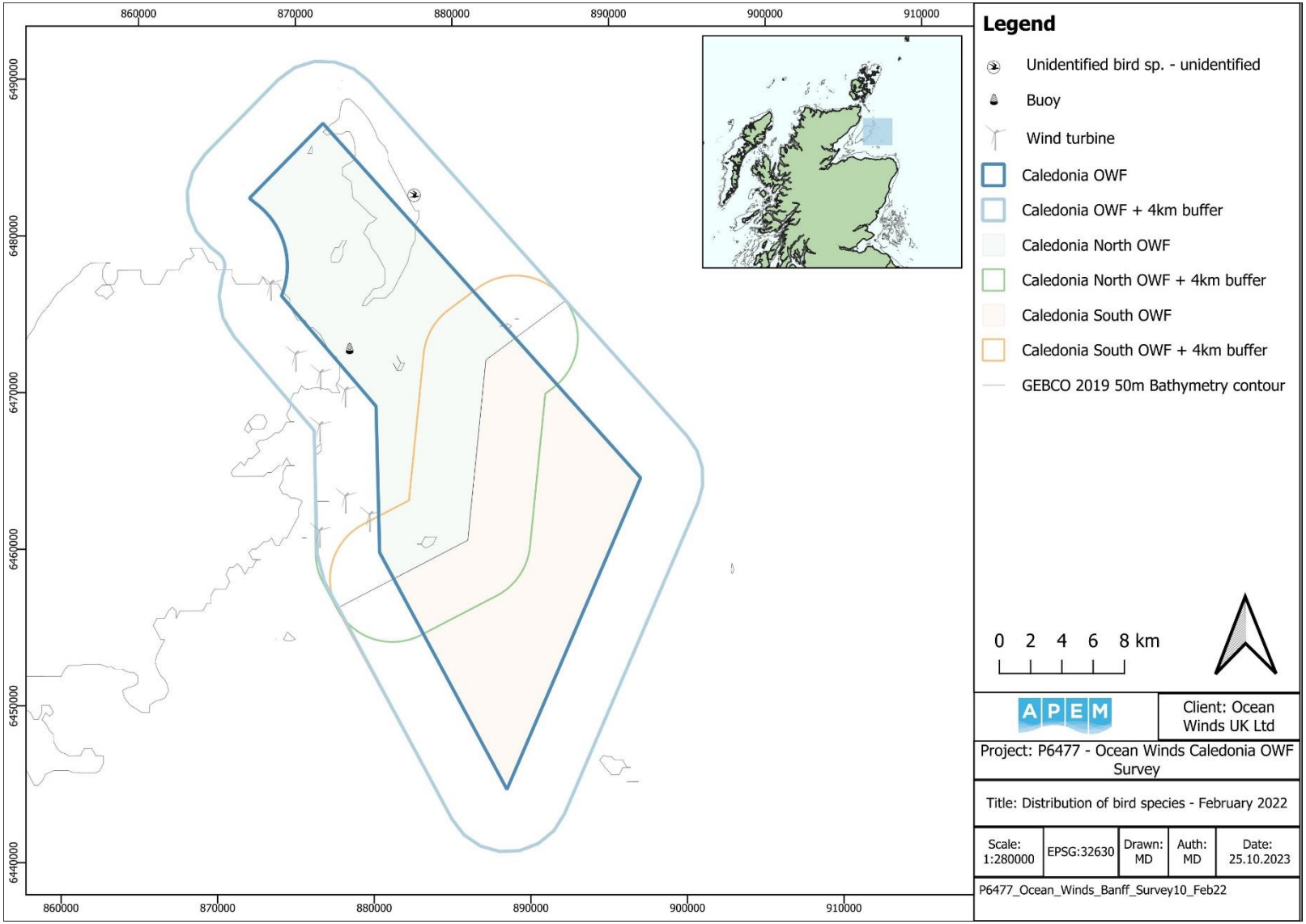


Figure A4.340 Distribution of unidentified bird species recorded in the Survey Area in February 2022

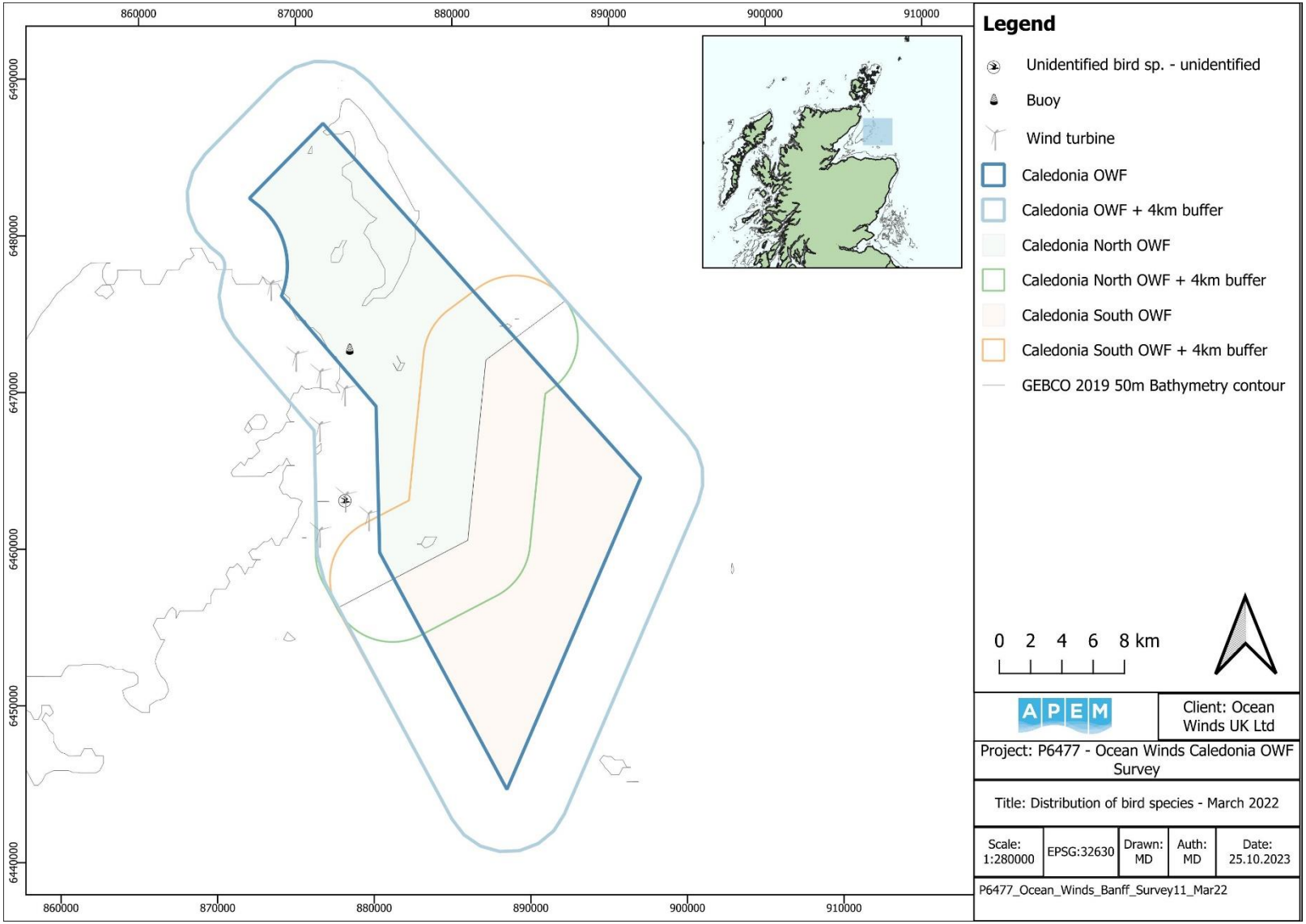


Figure A4.341 Distribution of unidentified bird species recorded in the Survey Area in March 2022

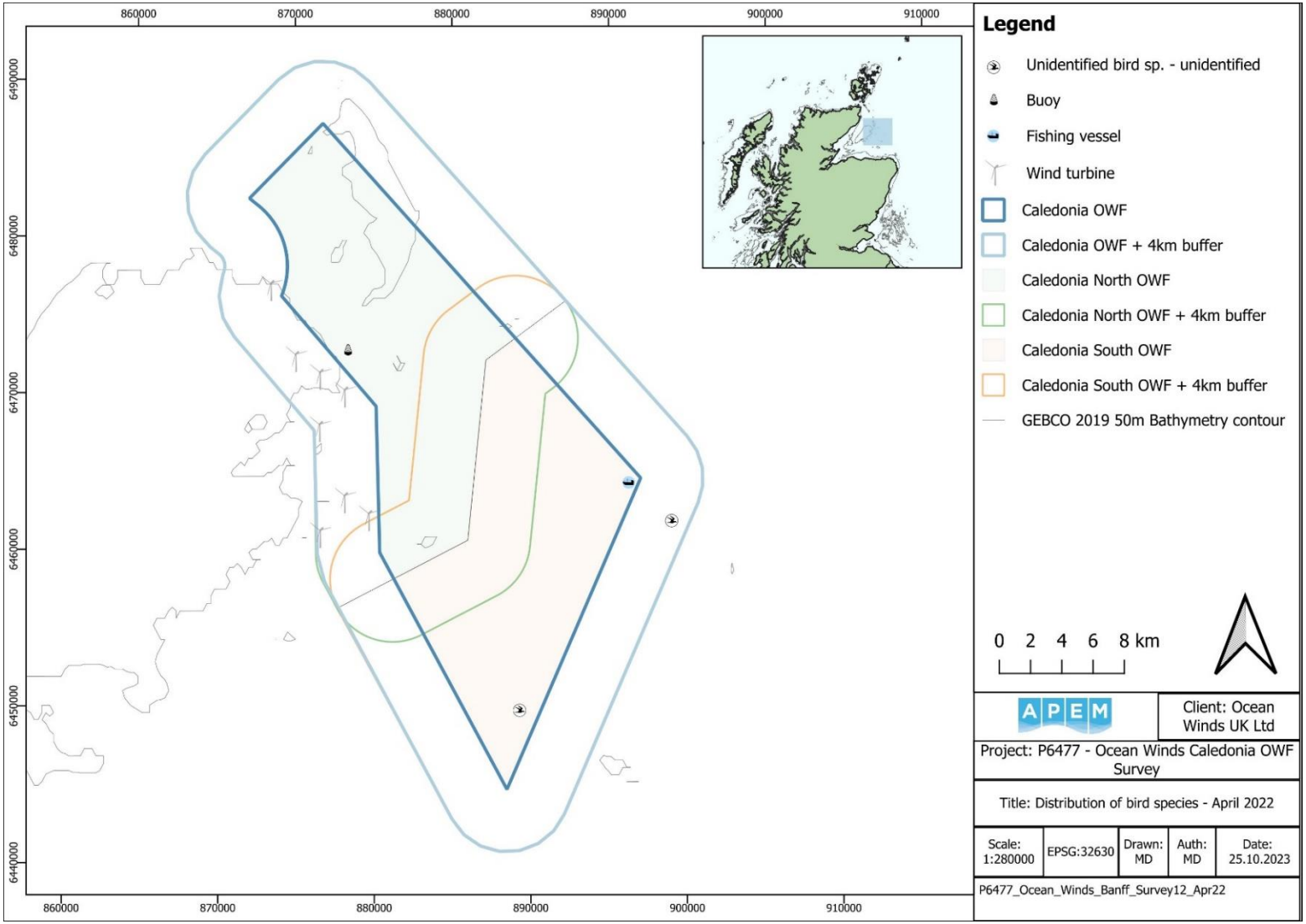


Figure A4.342 Distribution of unidentified bird species[1] recorded in the Survey Area in April 2022

[1]deceased individuals

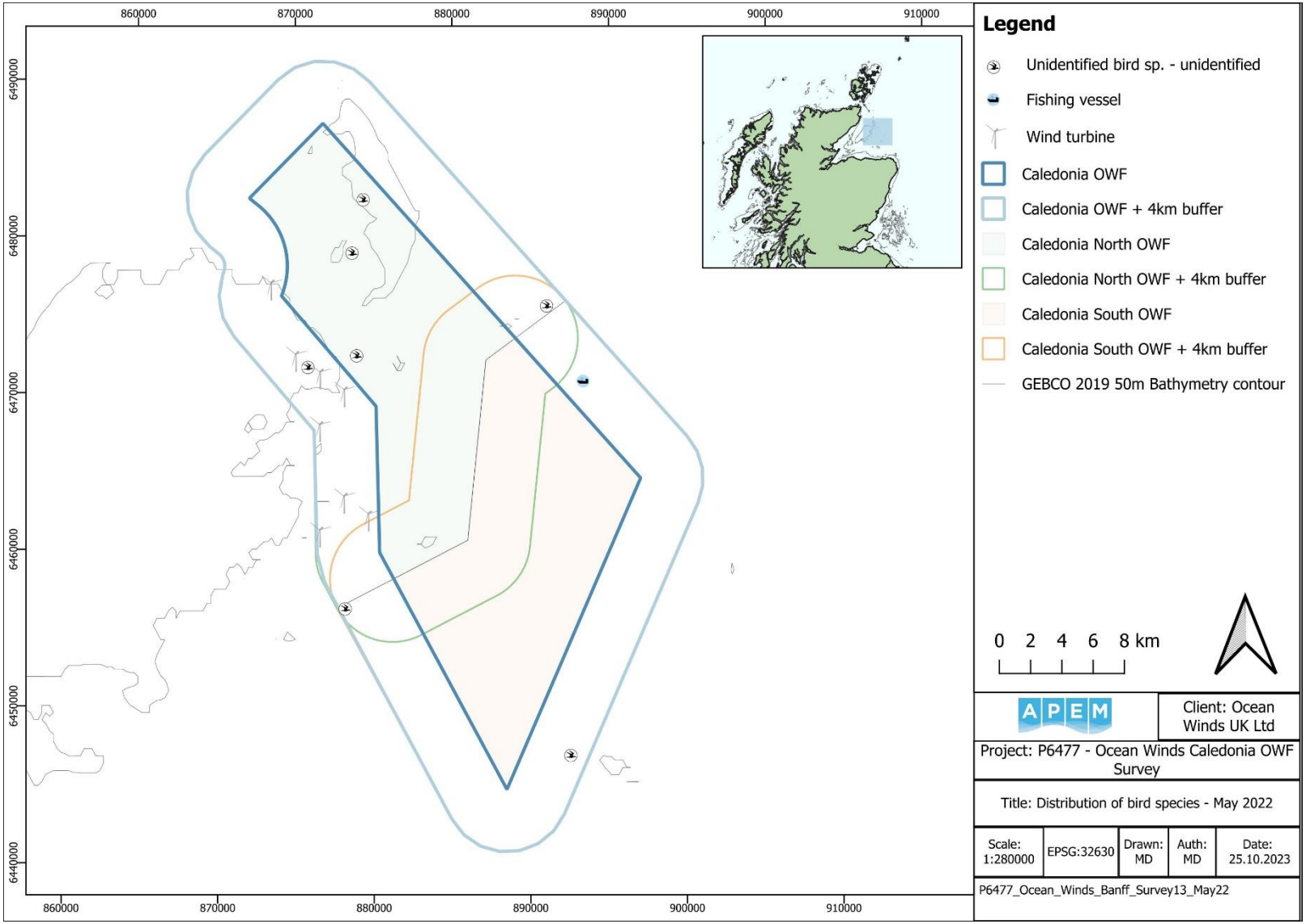


Figure A4.343 Distribution of unidentified bird species recorded in the Survey Area in May 2022

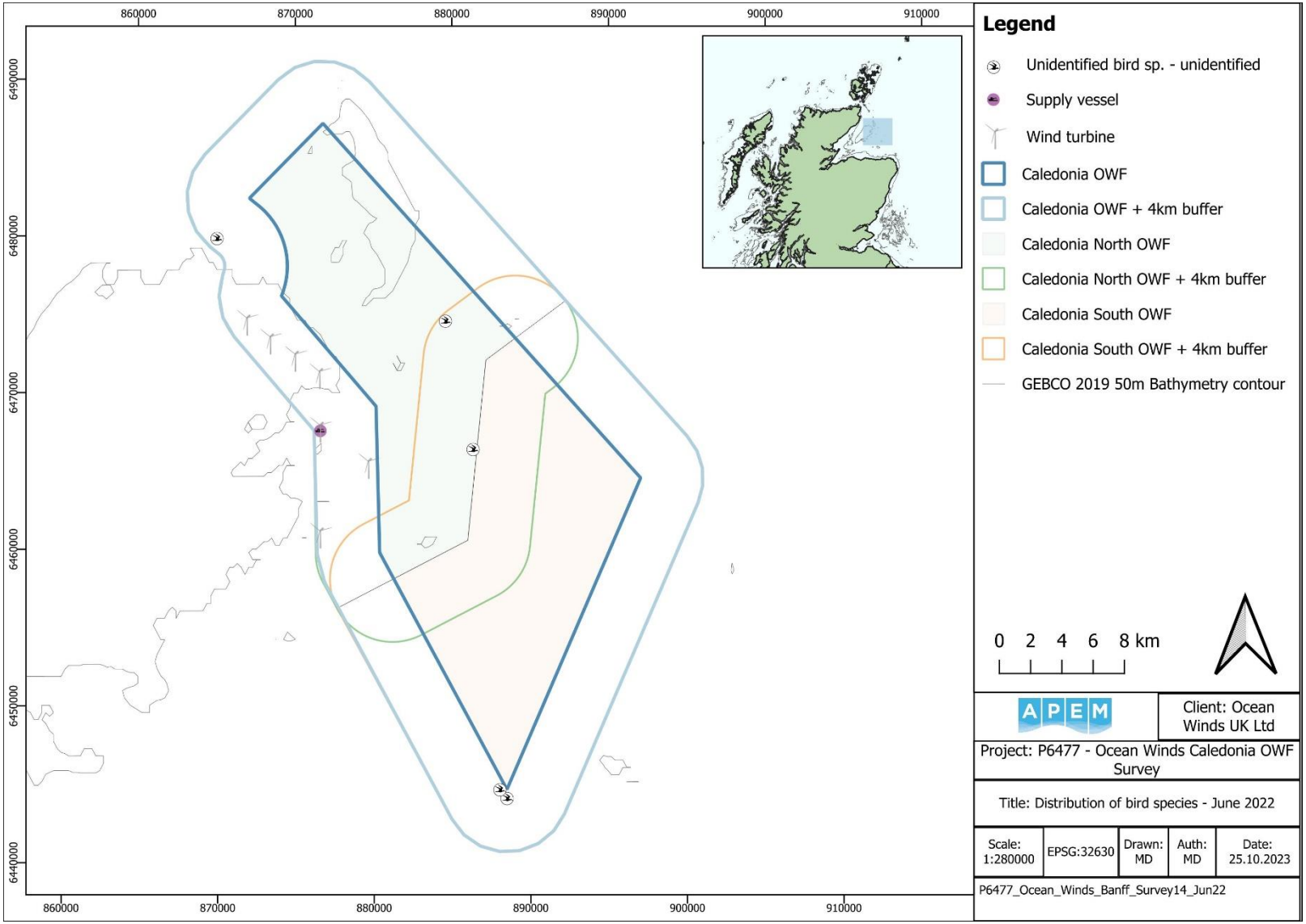


Figure A4.344 Distribution of unidentified bird species recorded in the Survey Area in June 2022

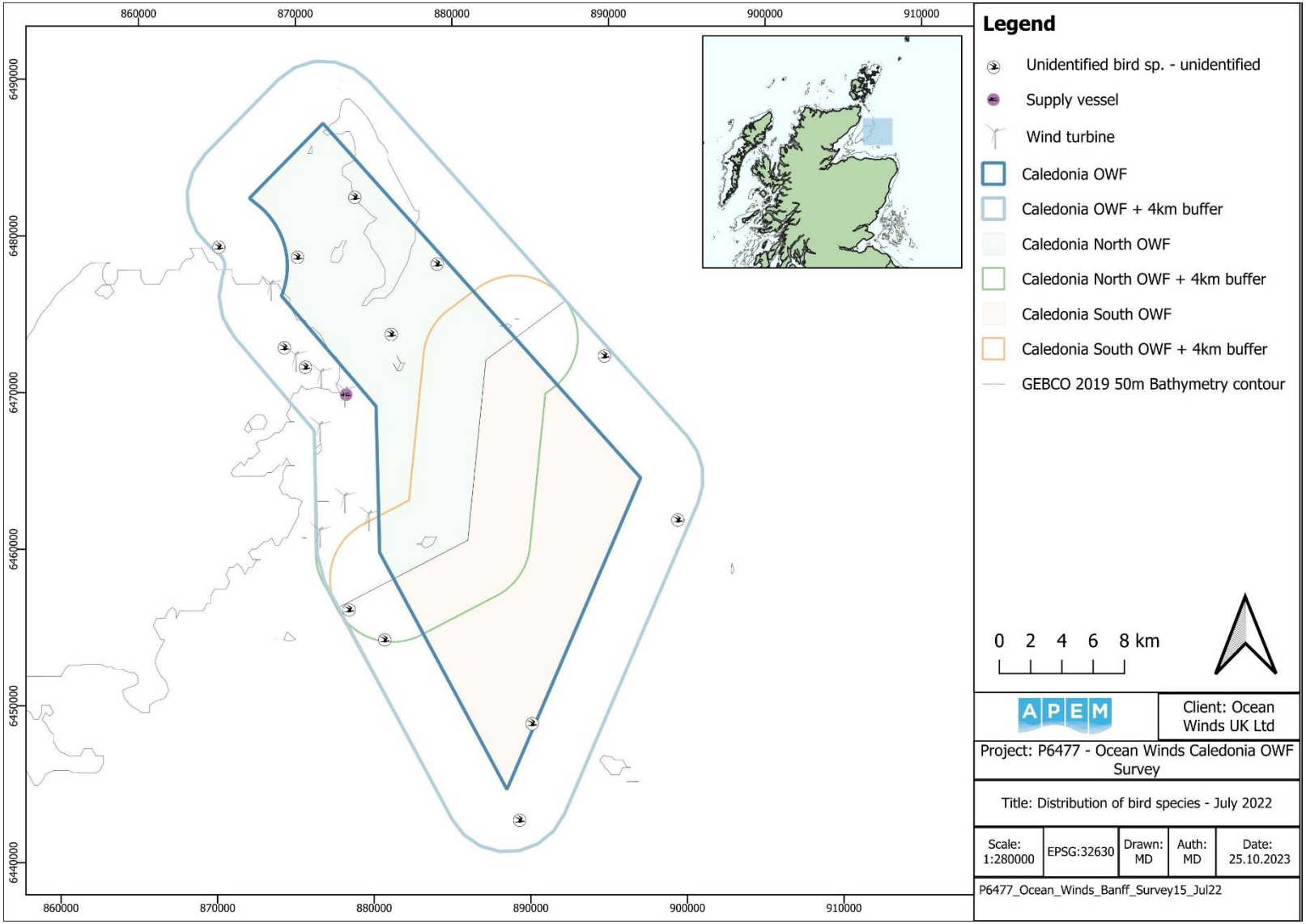


Figure A4.345 Distribution of unidentified bird species recorded in the Survey Area in July 2022

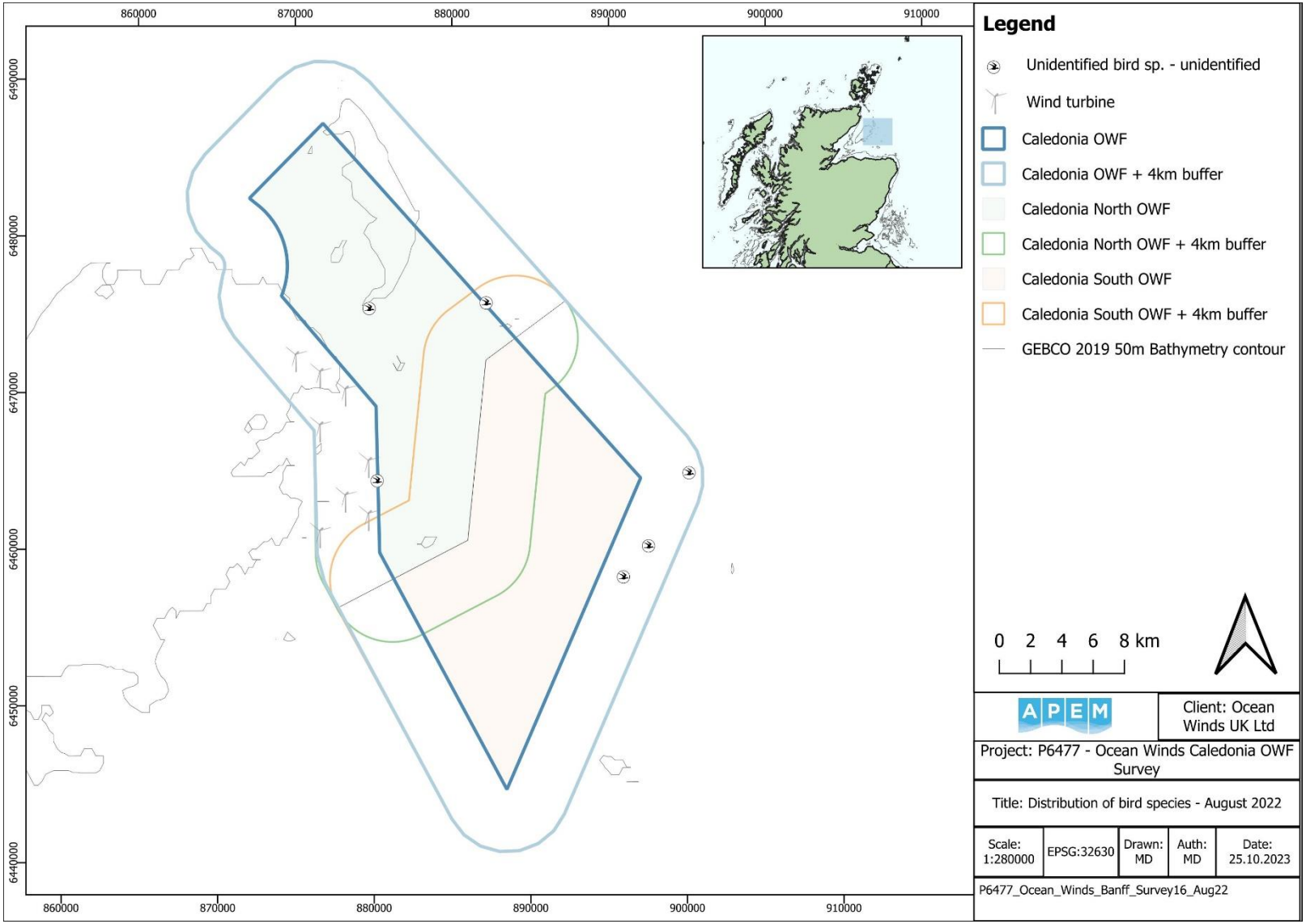


Figure A4.346 Distribution of unidentified bird species recorded in the Survey Area in August 2022

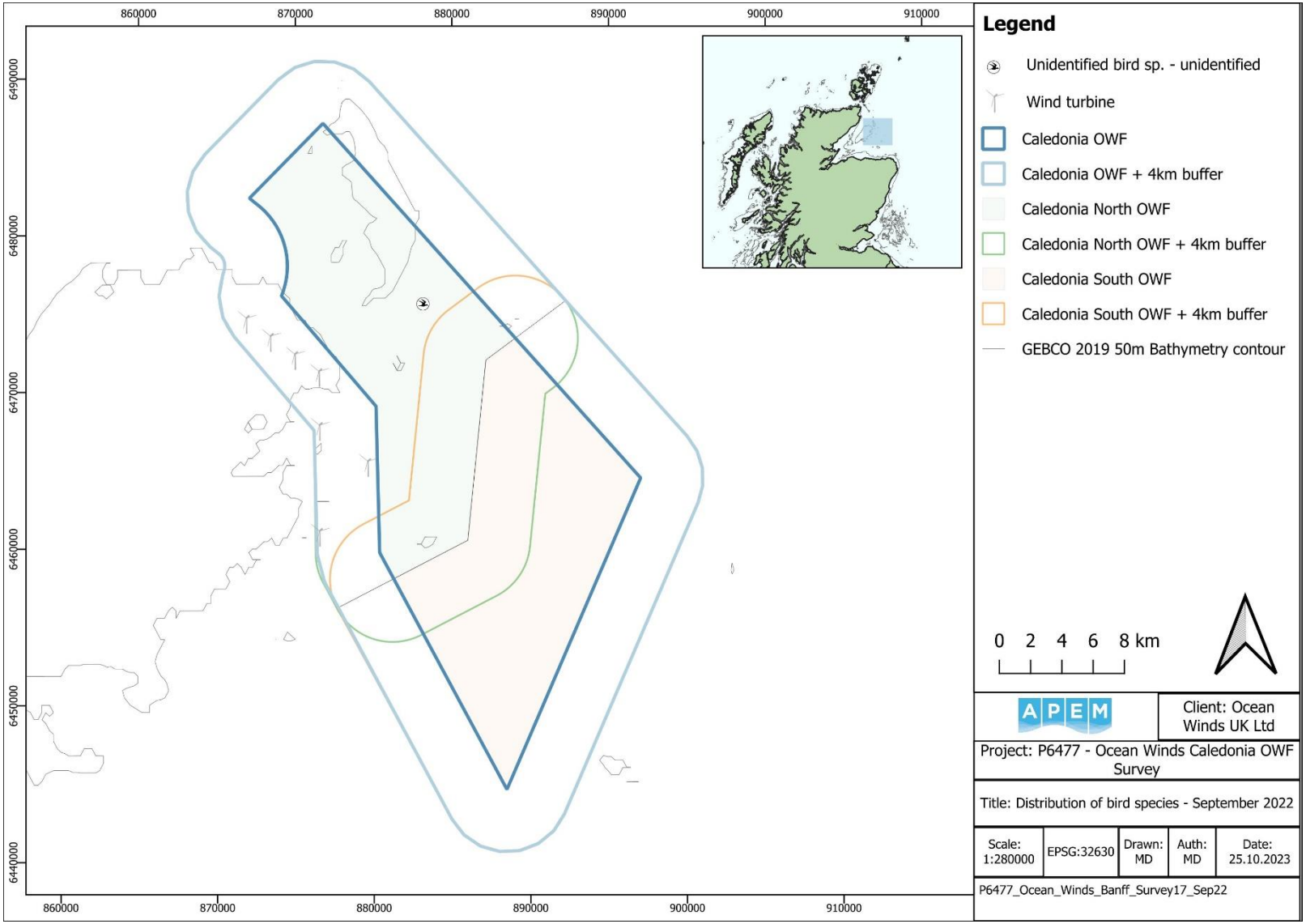


Figure A4.347 Distribution of unidentified bird species recorded in the Survey Area in September 2022

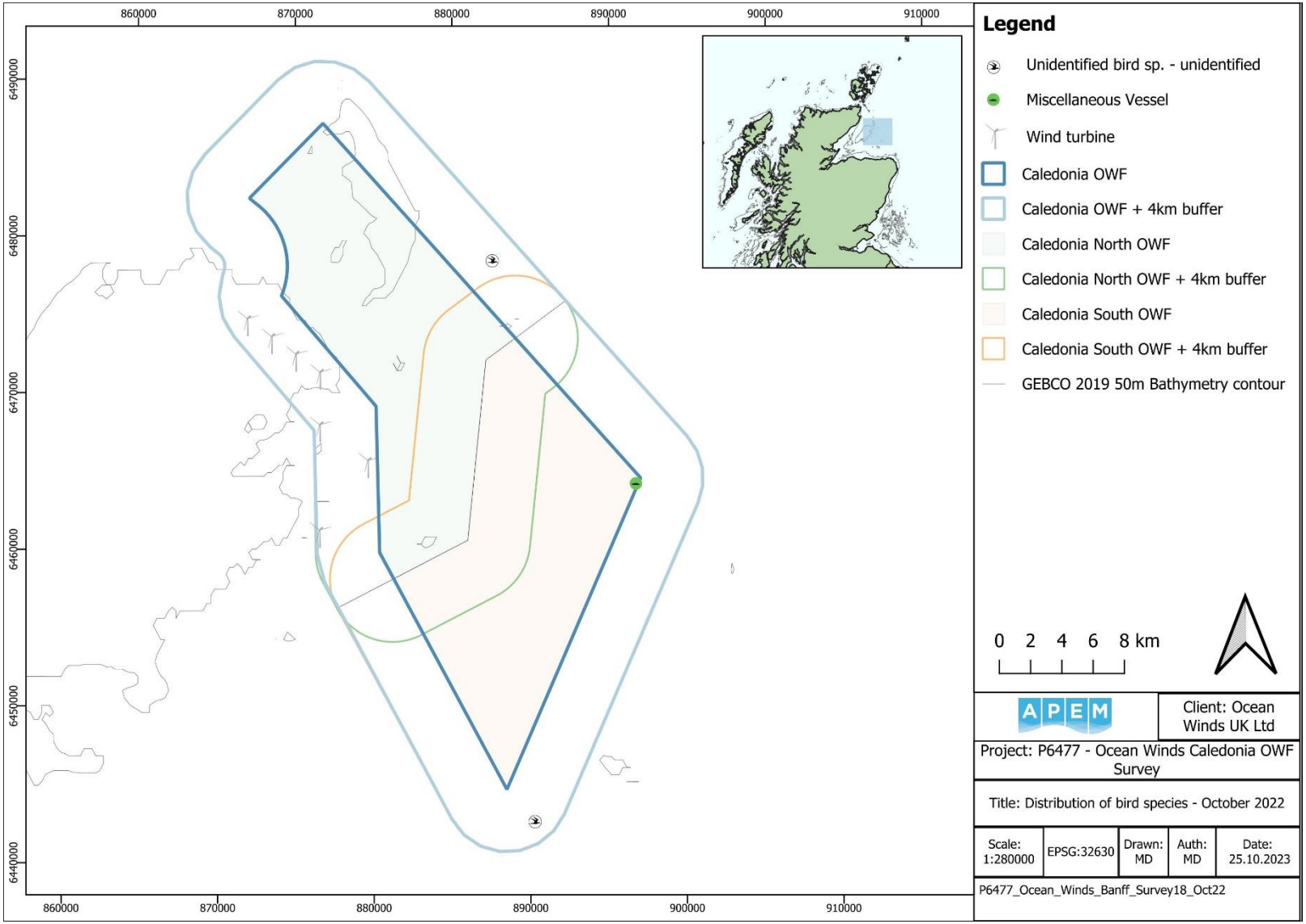


Figure A4.348 Distribution of unidentified bird species recorded in the Survey Area in October 2022

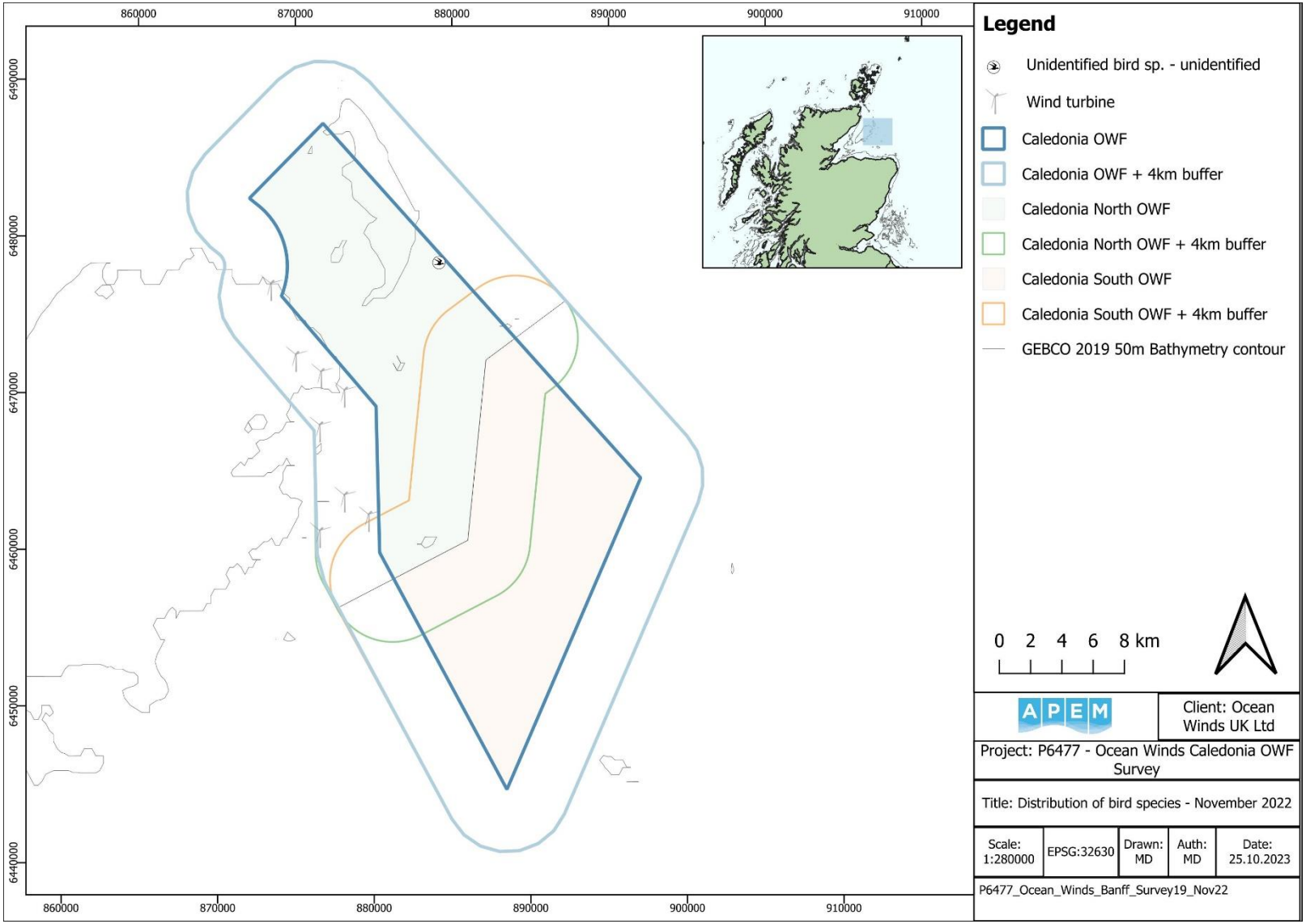


Figure A4.349 Distribution of unidentified bird species recorded in the Survey Area in November 2022

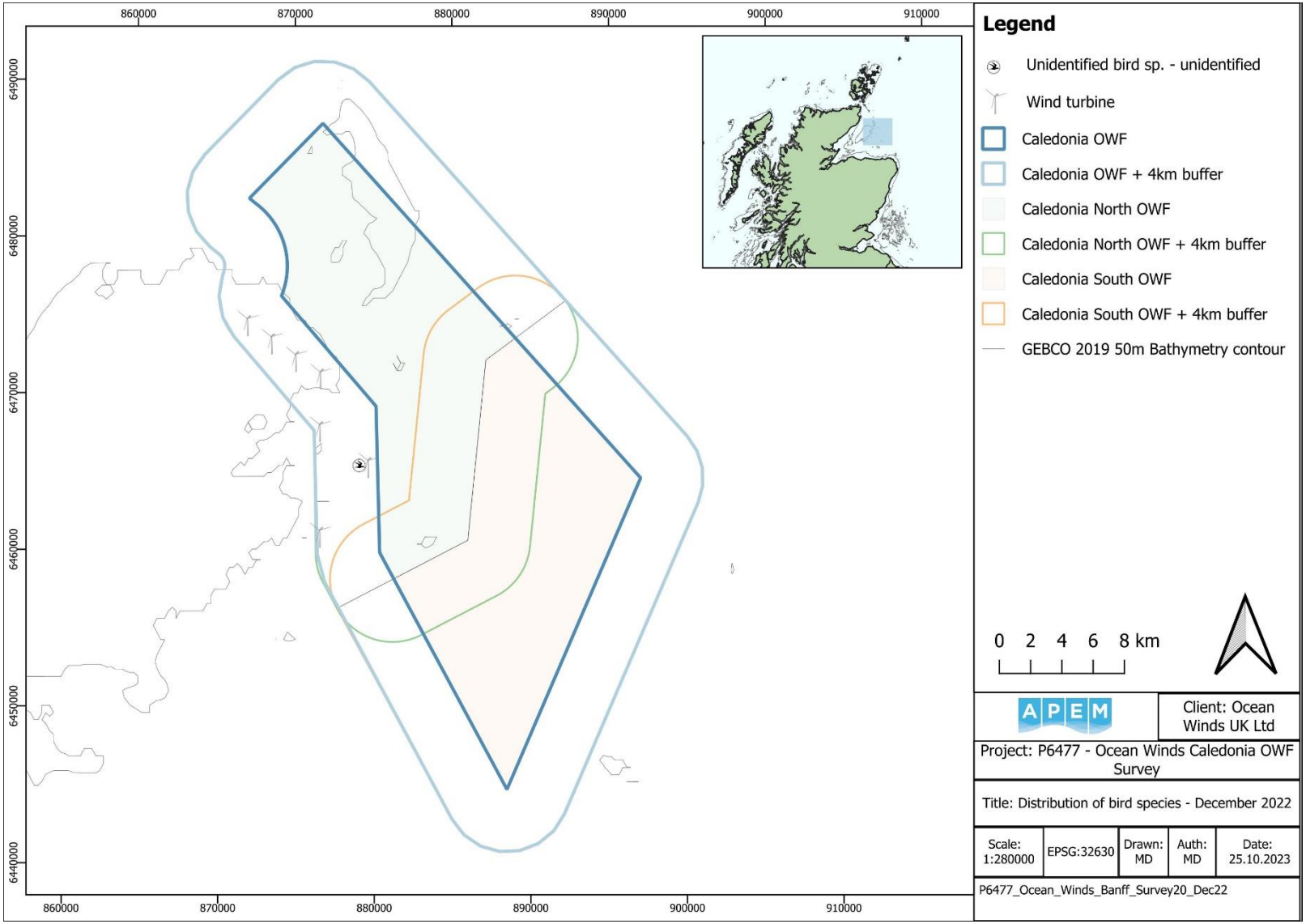


Figure A4.350 Distribution of unidentified bird species recorded in the Survey Area in December 2022

Grey seal

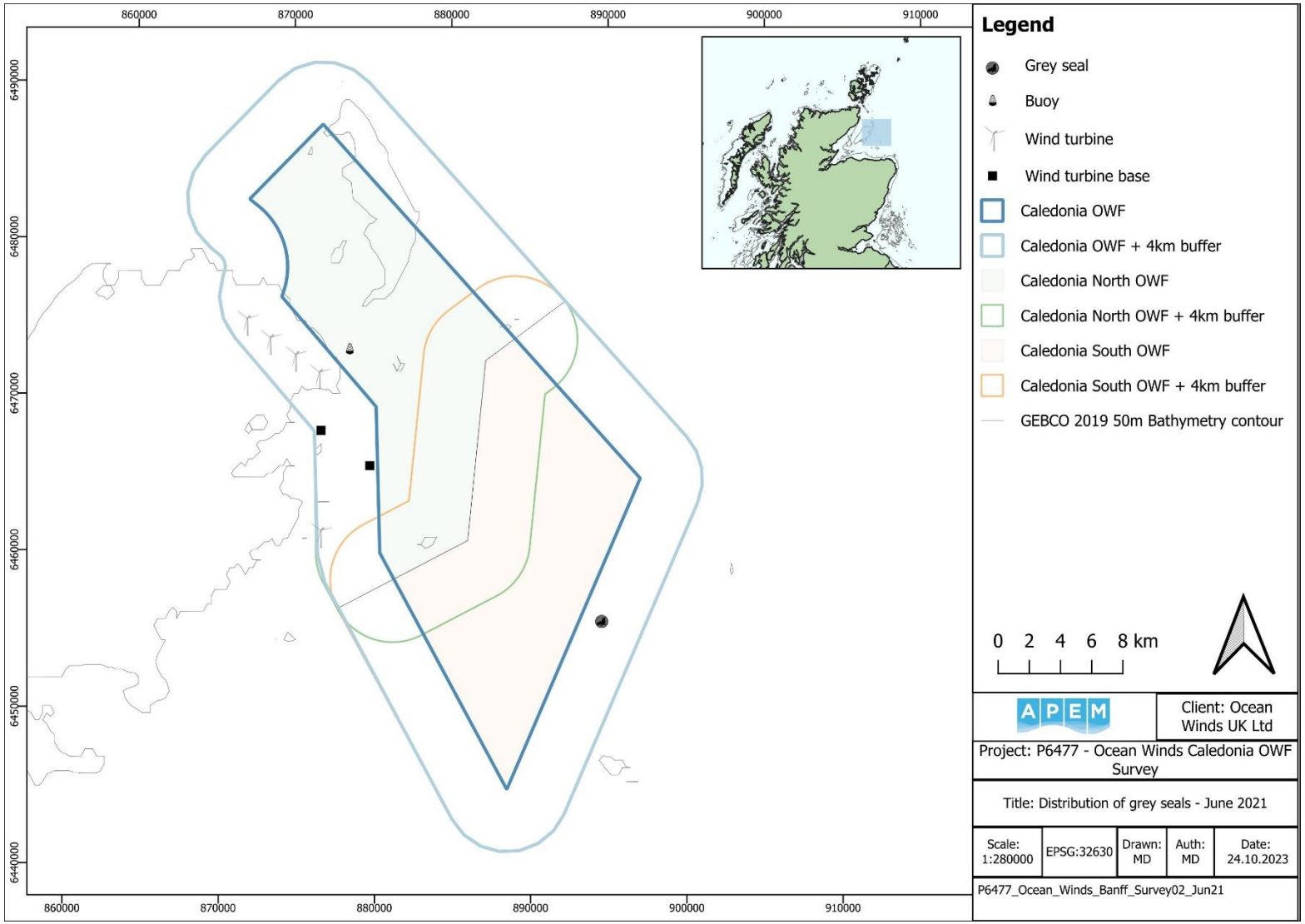


Figure A4.351 Distribution of grey seals recorded in the Survey Area in June 2021

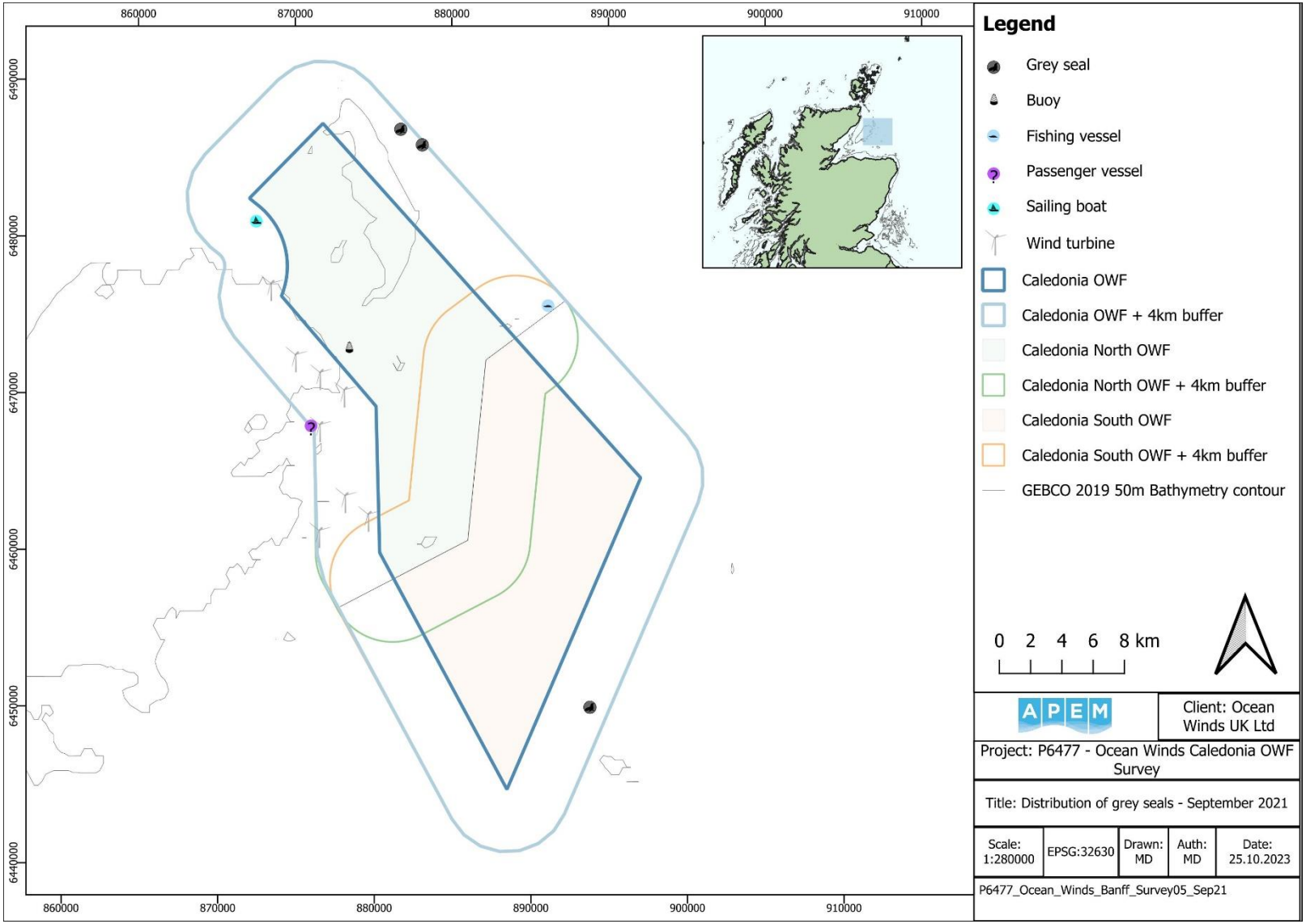


Figure A4.352 Distribution of grey seals recorded in the Survey Area in September 2021

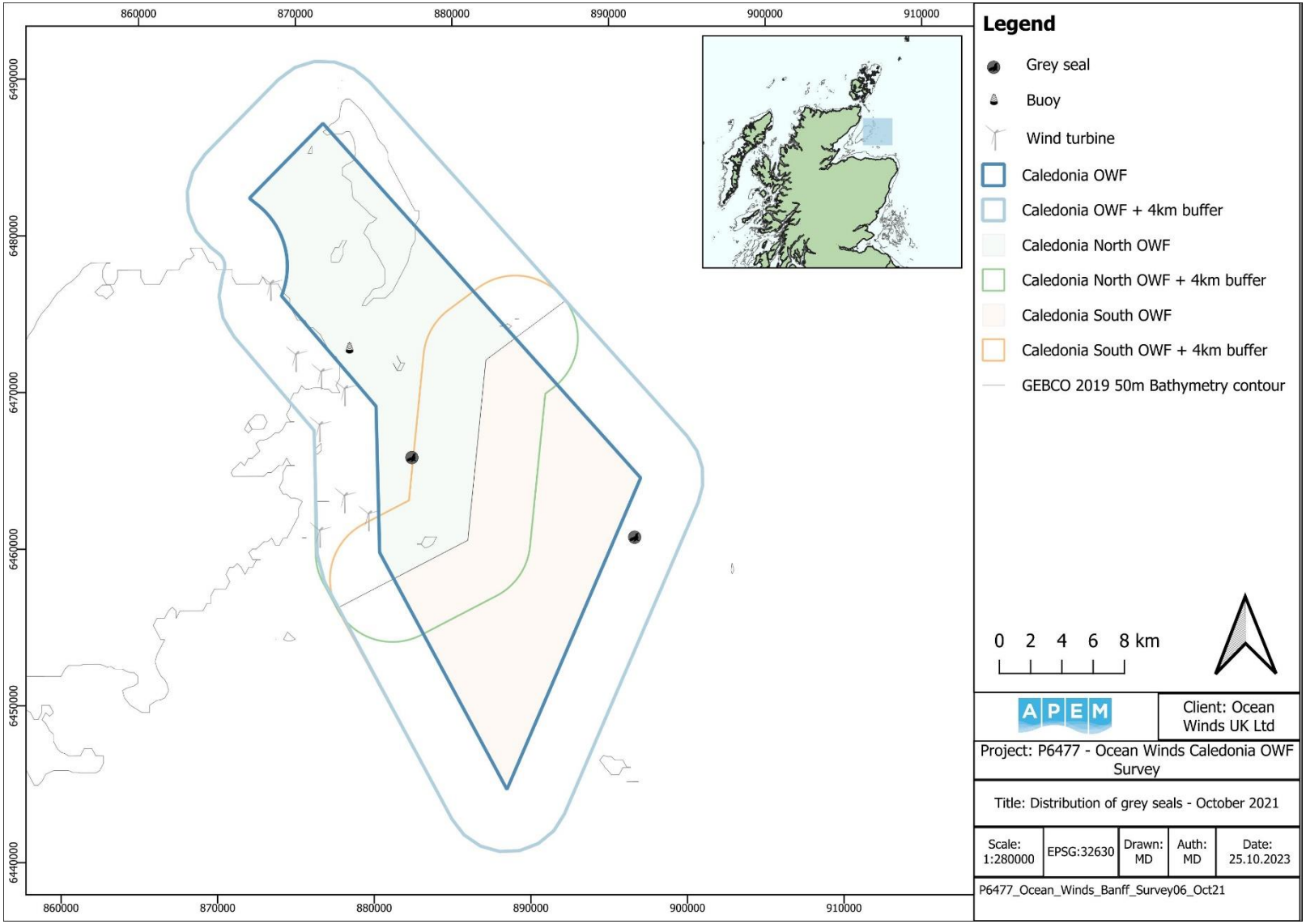


Figure A4.353 Distribution of grey seals recorded in the Survey Area in October 2021

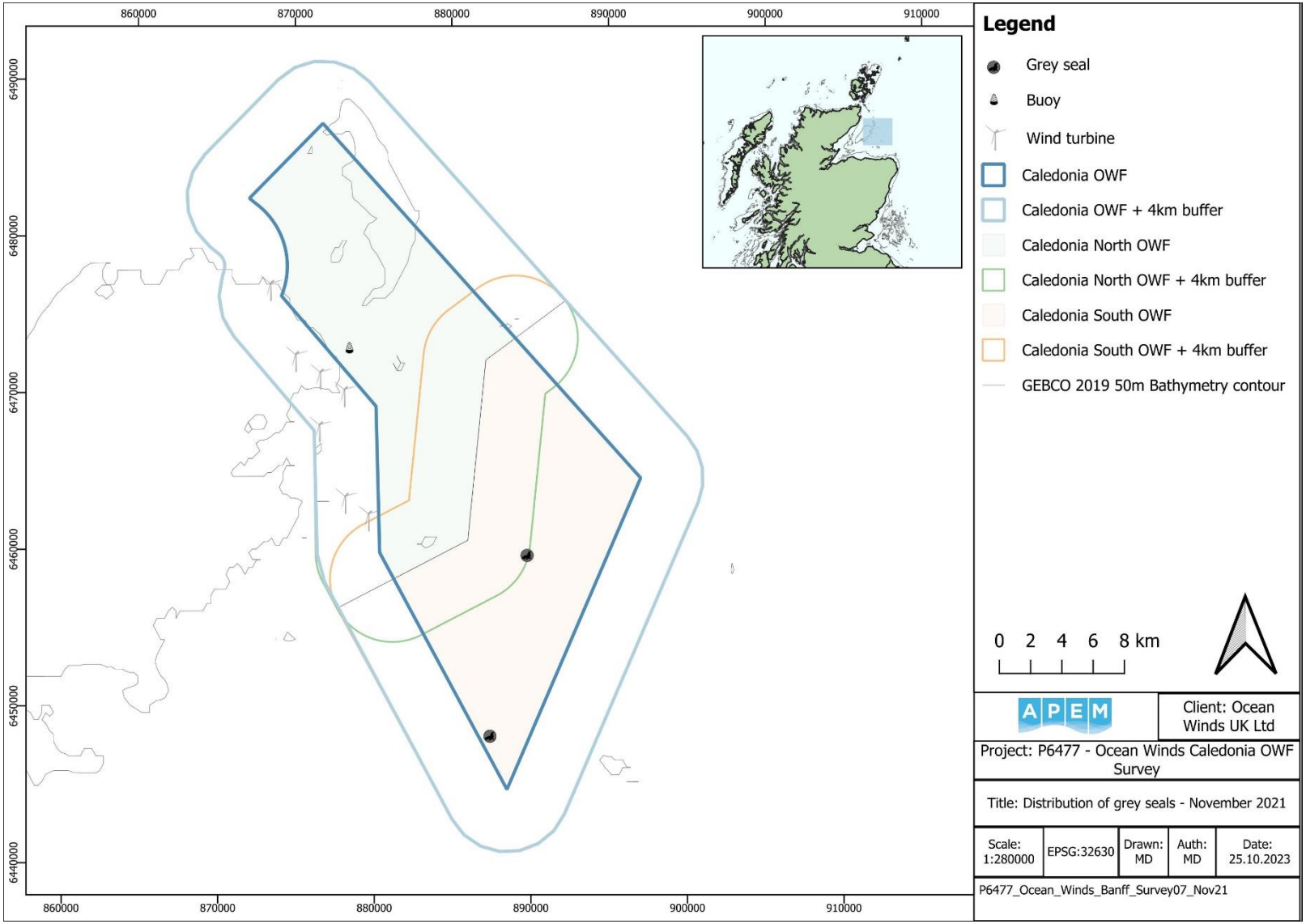


Figure A4.354 Distribution of grey seals recorded in the Survey Area in November 2021

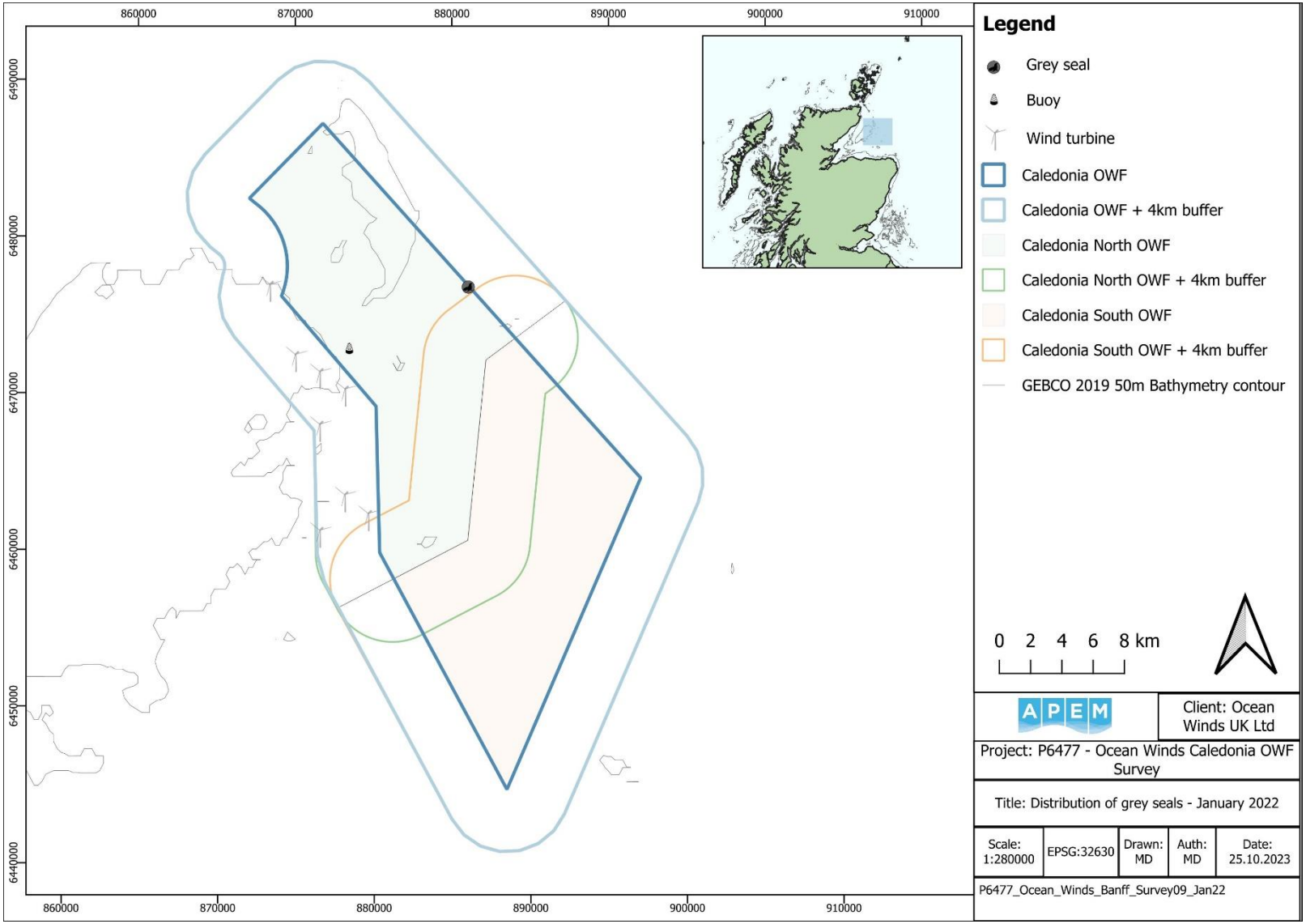


Figure A4.355 Distribution of grey seals recorded in the Survey Area in January 2022

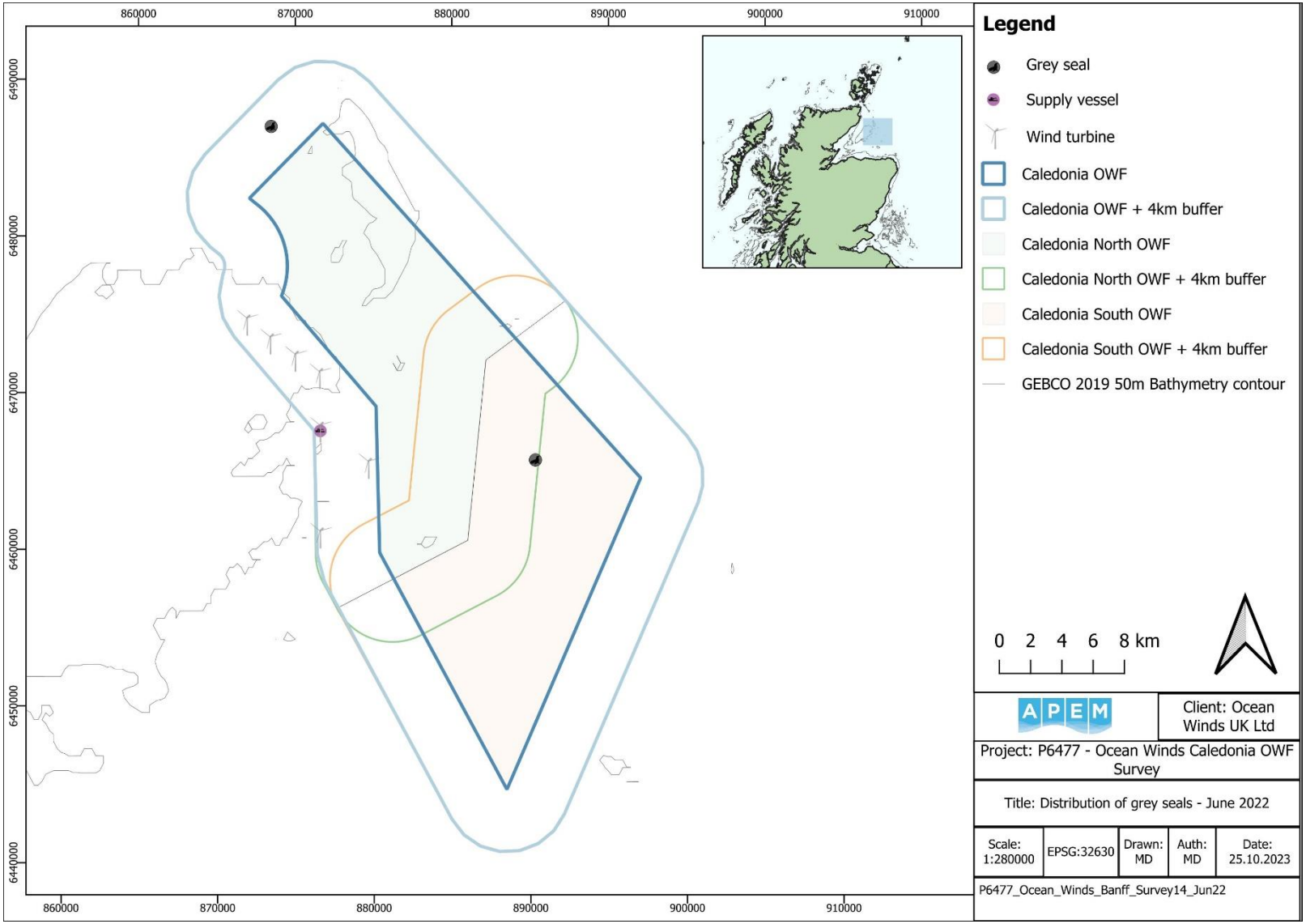


Figure A4.356 Distribution of grey seals recorded in the Survey Area in June 2022

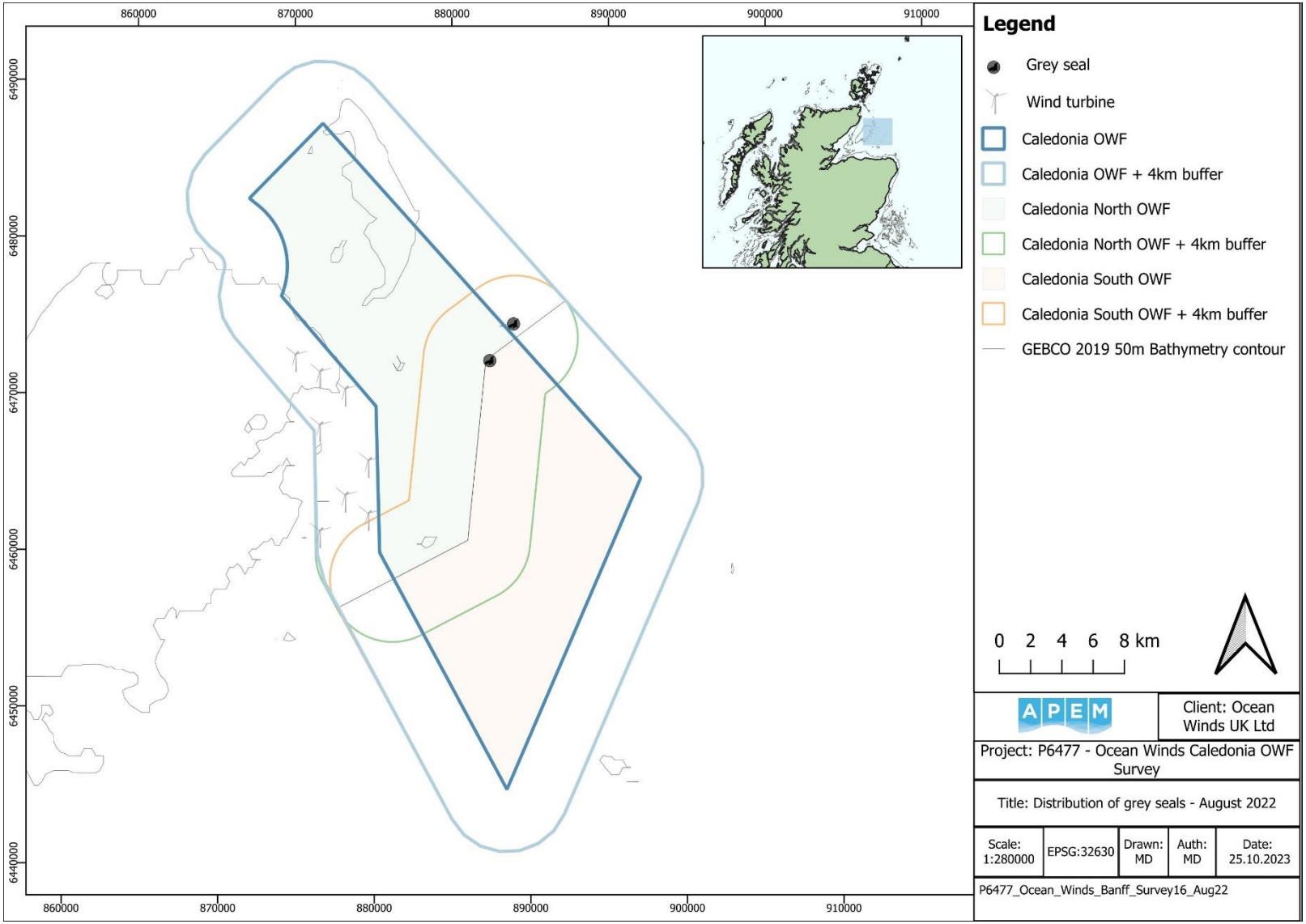


Figure A4.357 Distribution of grey seals recorded in the Survey Area in August 2022

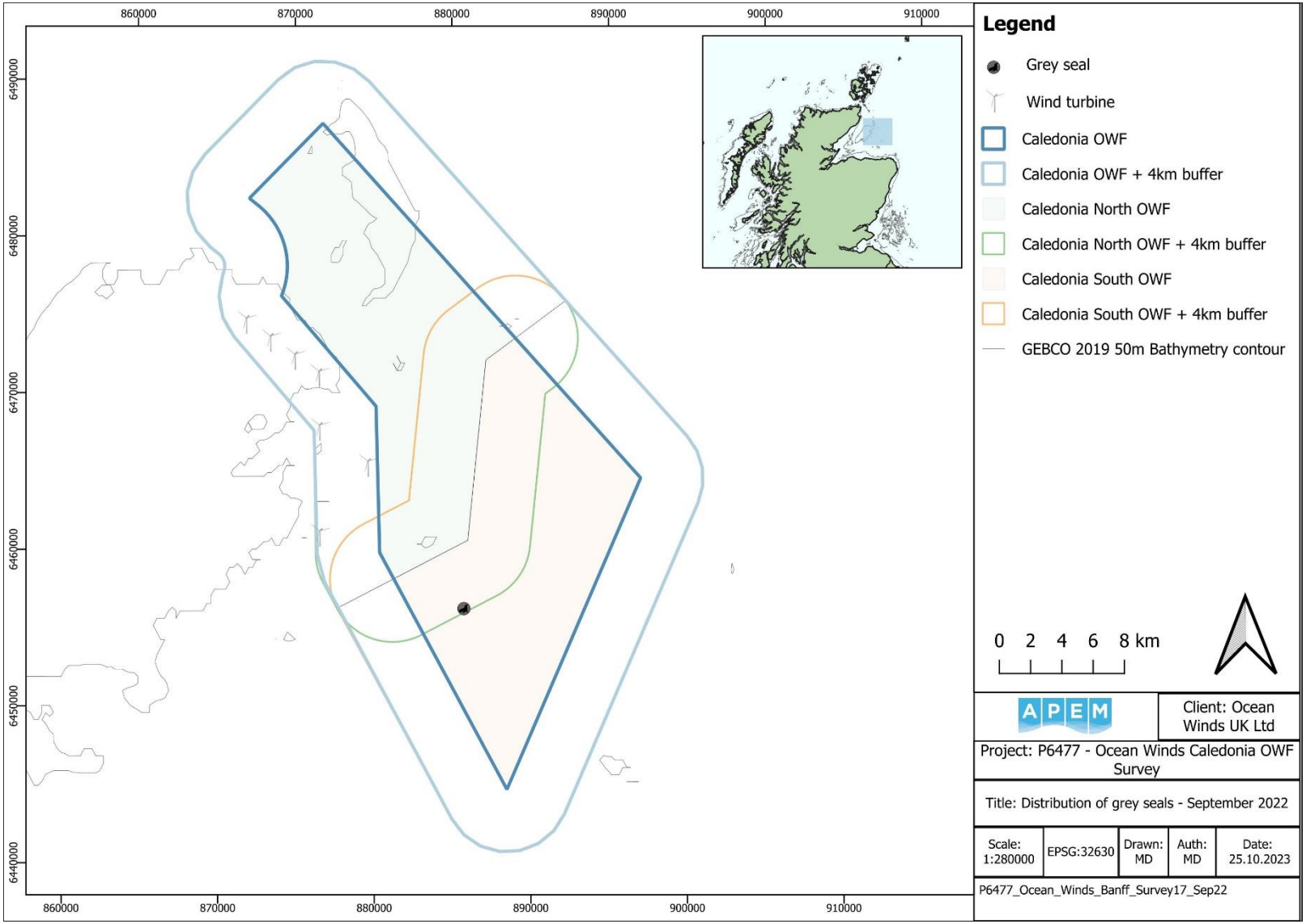


Figure A4.358 Distribution of grey seals recorded in the Survey Area in September 2022

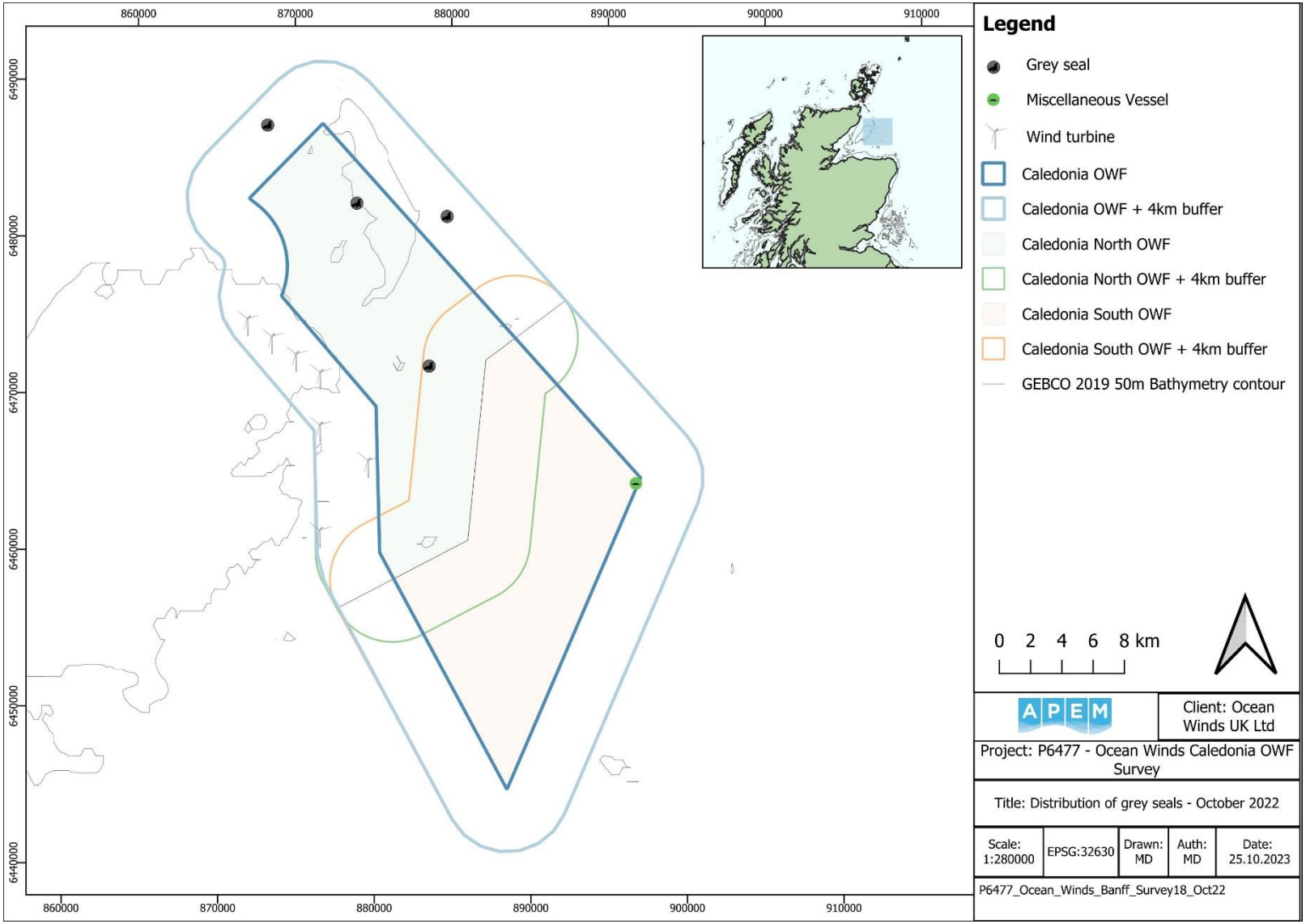


Figure A4.359 Distribution of grey seals recorded in the Survey Area in October 2022

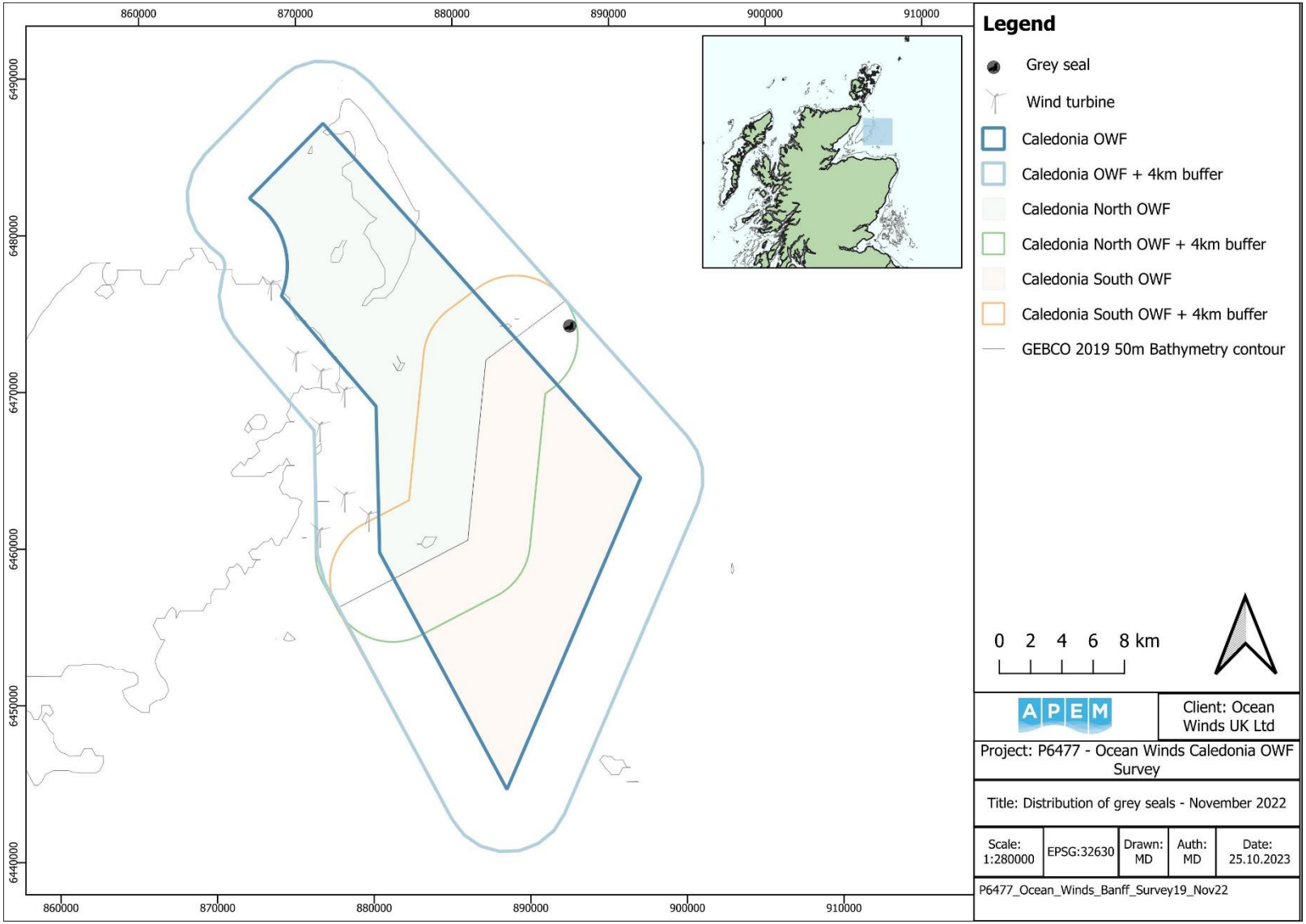


Figure A4.360 Distribution of grey seals recorded in the Survey Area in November 2022

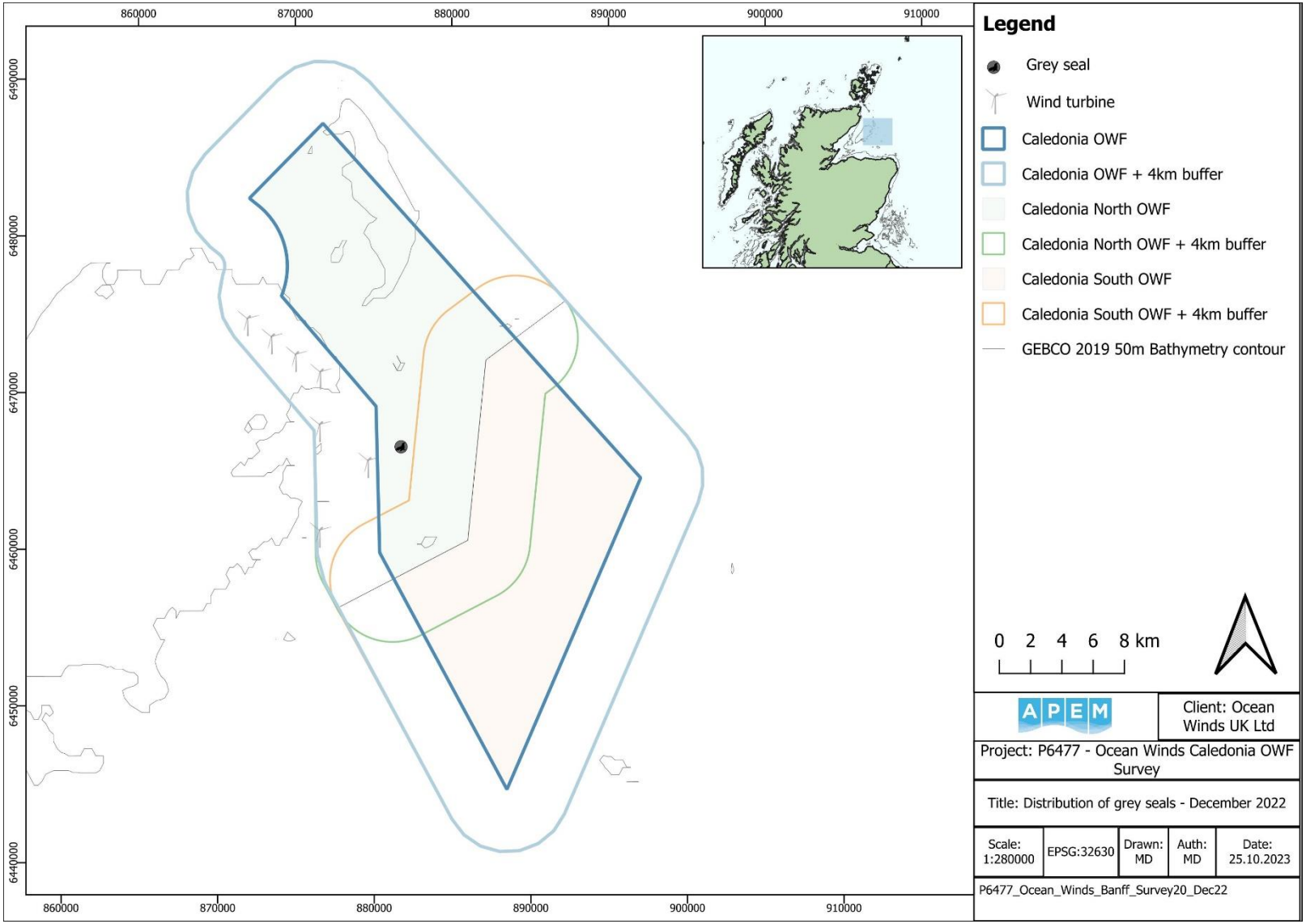


Figure A4.361 Distribution of grey seals recorded in the Survey Area in December 2022

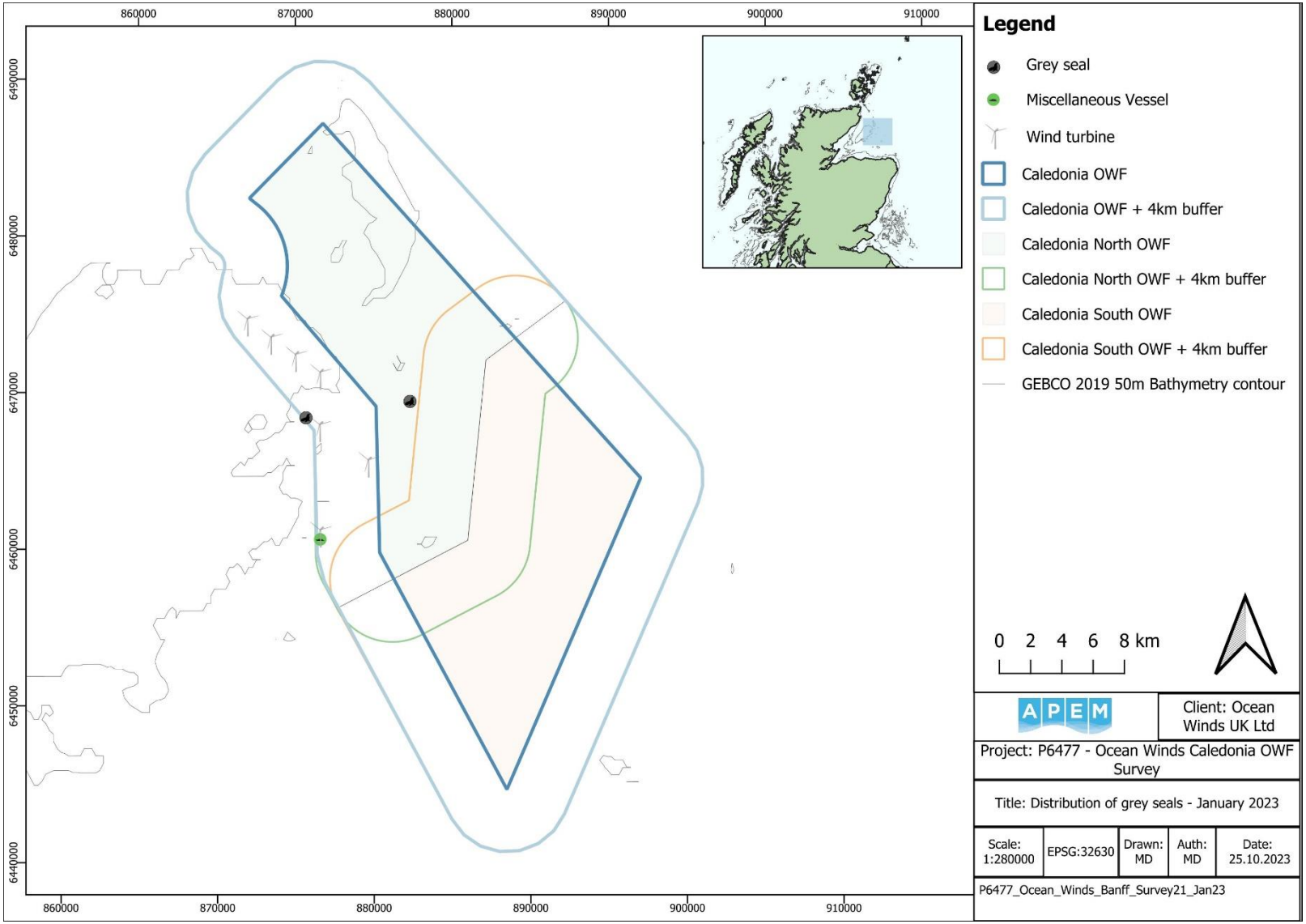


Figure A4.362 Distribution of grey seals recorded in the Survey Area in January 2023

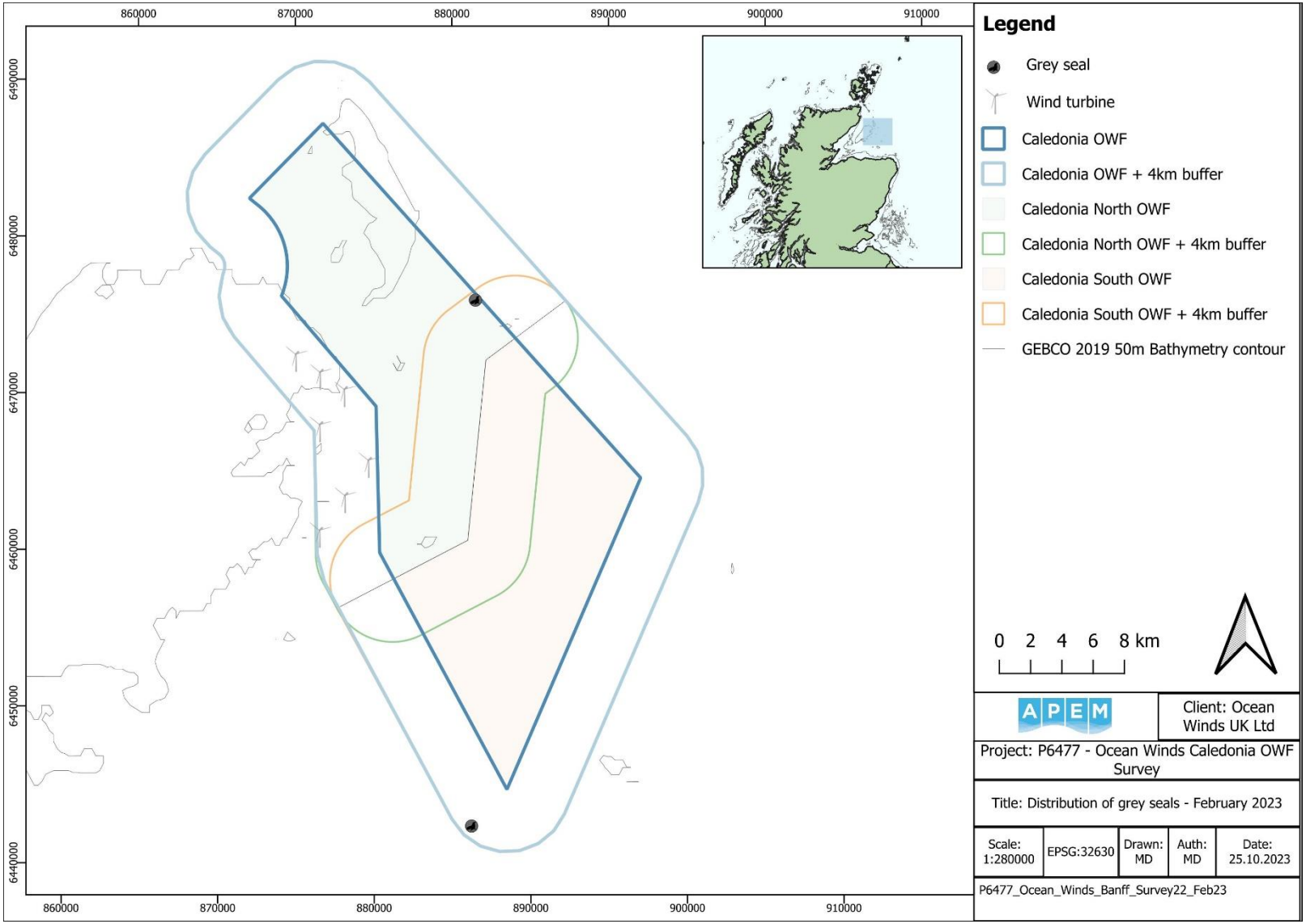


Figure A4.363 Distribution of grey seals recorded in the Survey Area in February 2023

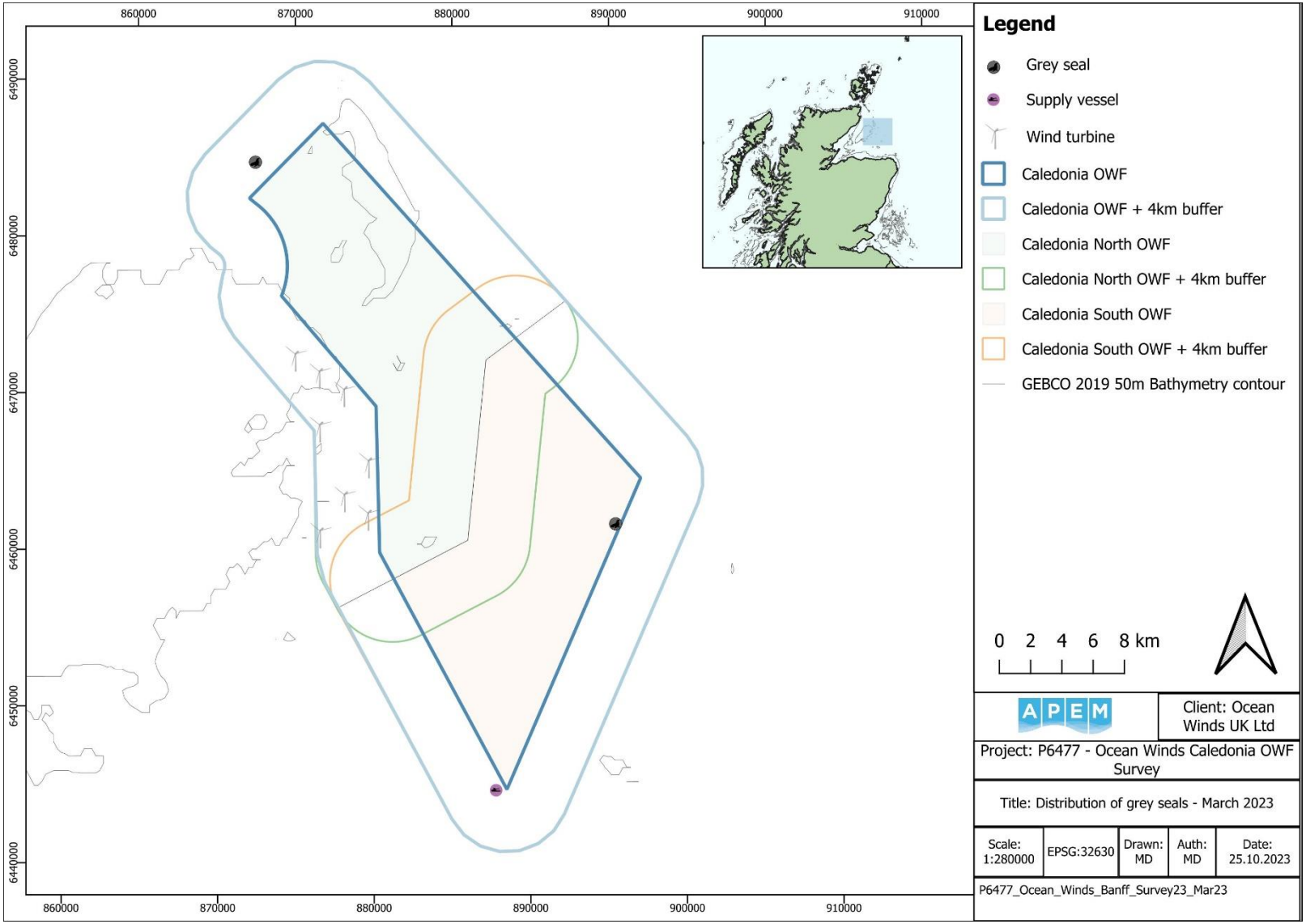


Figure A4.364 Distribution of grey seals recorded in the Survey Area in March 2023

Unidentified seal species

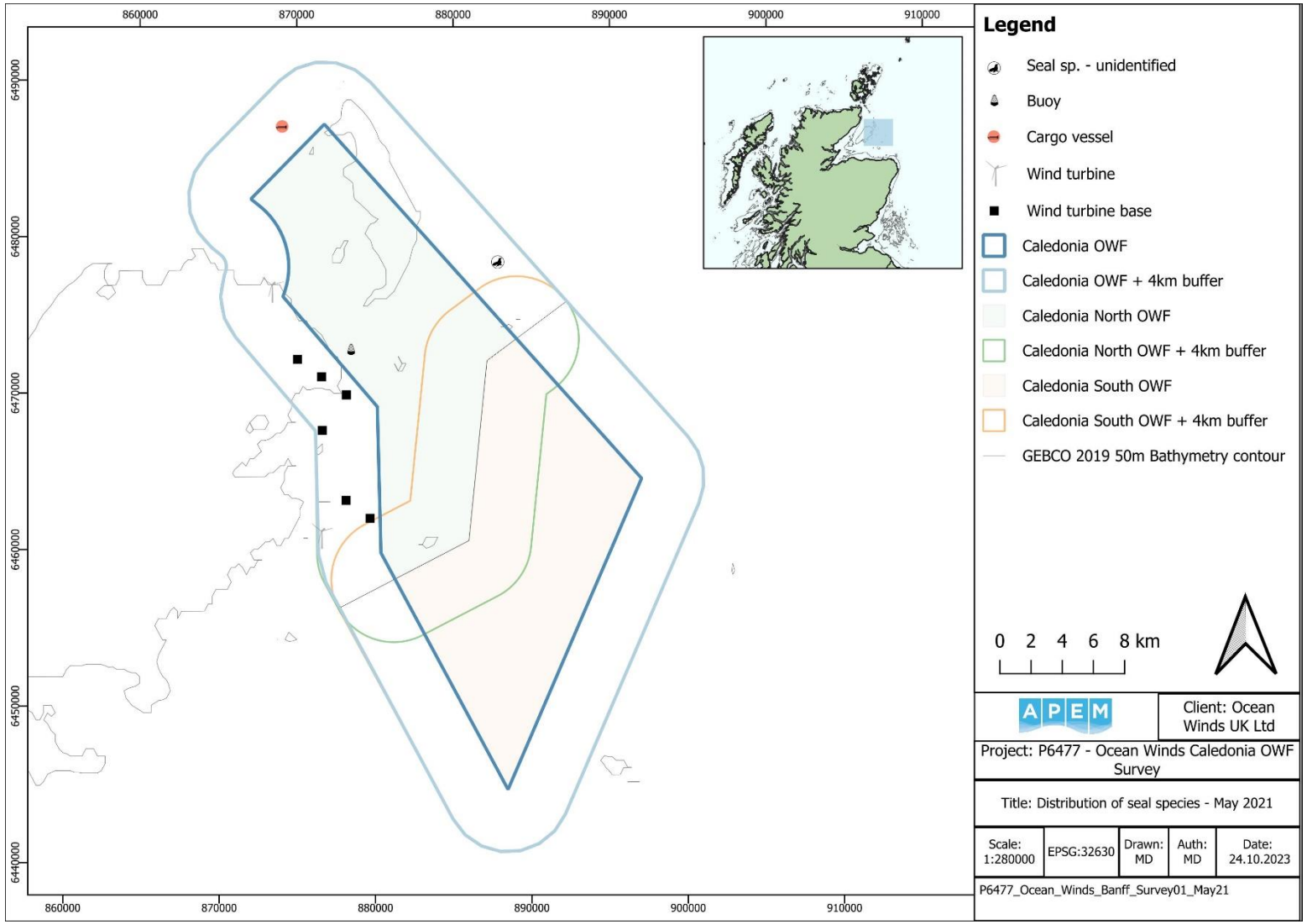


Figure A4.365 Distribution of unidentified seal species recorded in the Survey Area in May 2021

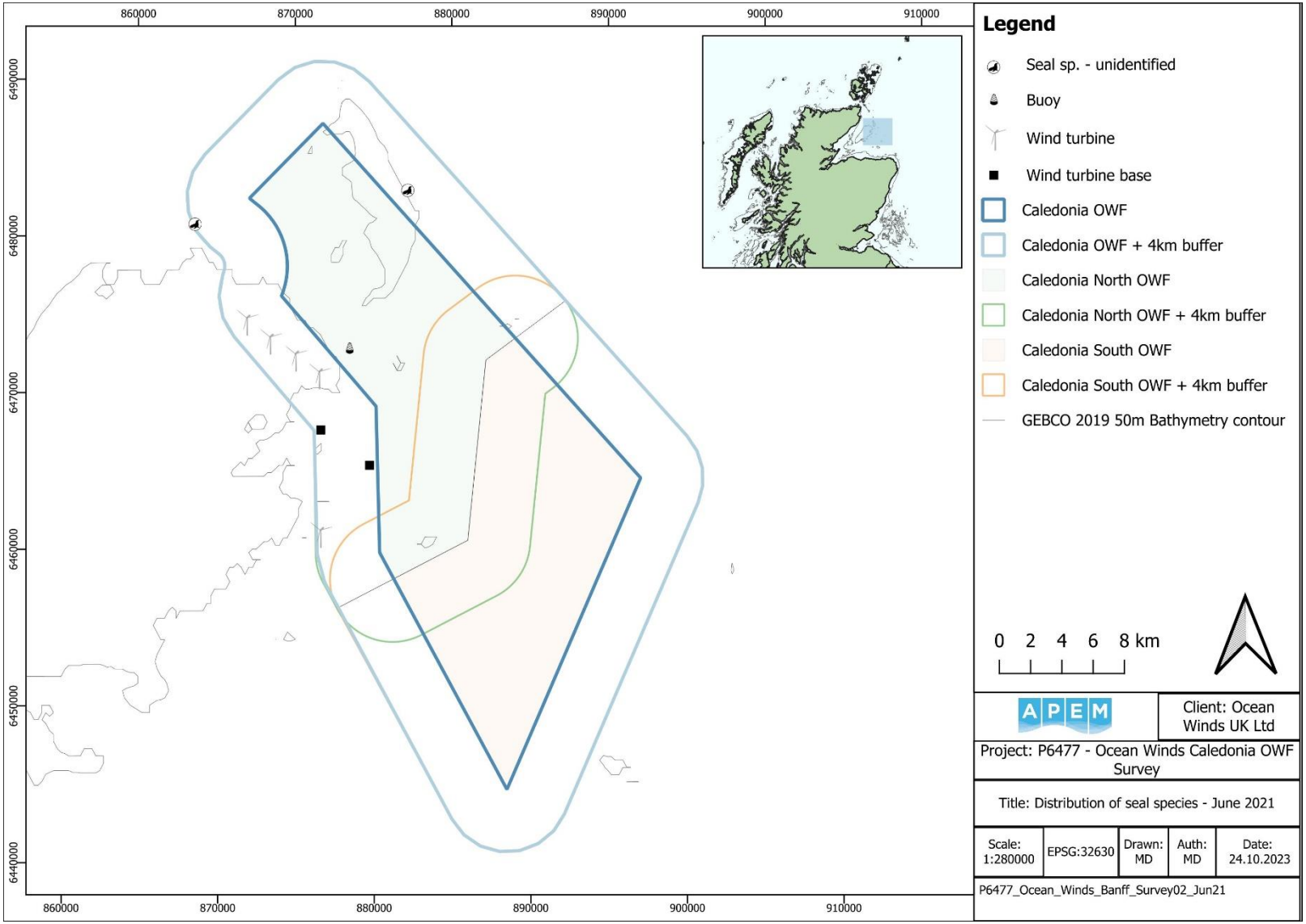


Figure A4.366 Distribution of unidentified seal species recorded in the Survey Area in June 2021

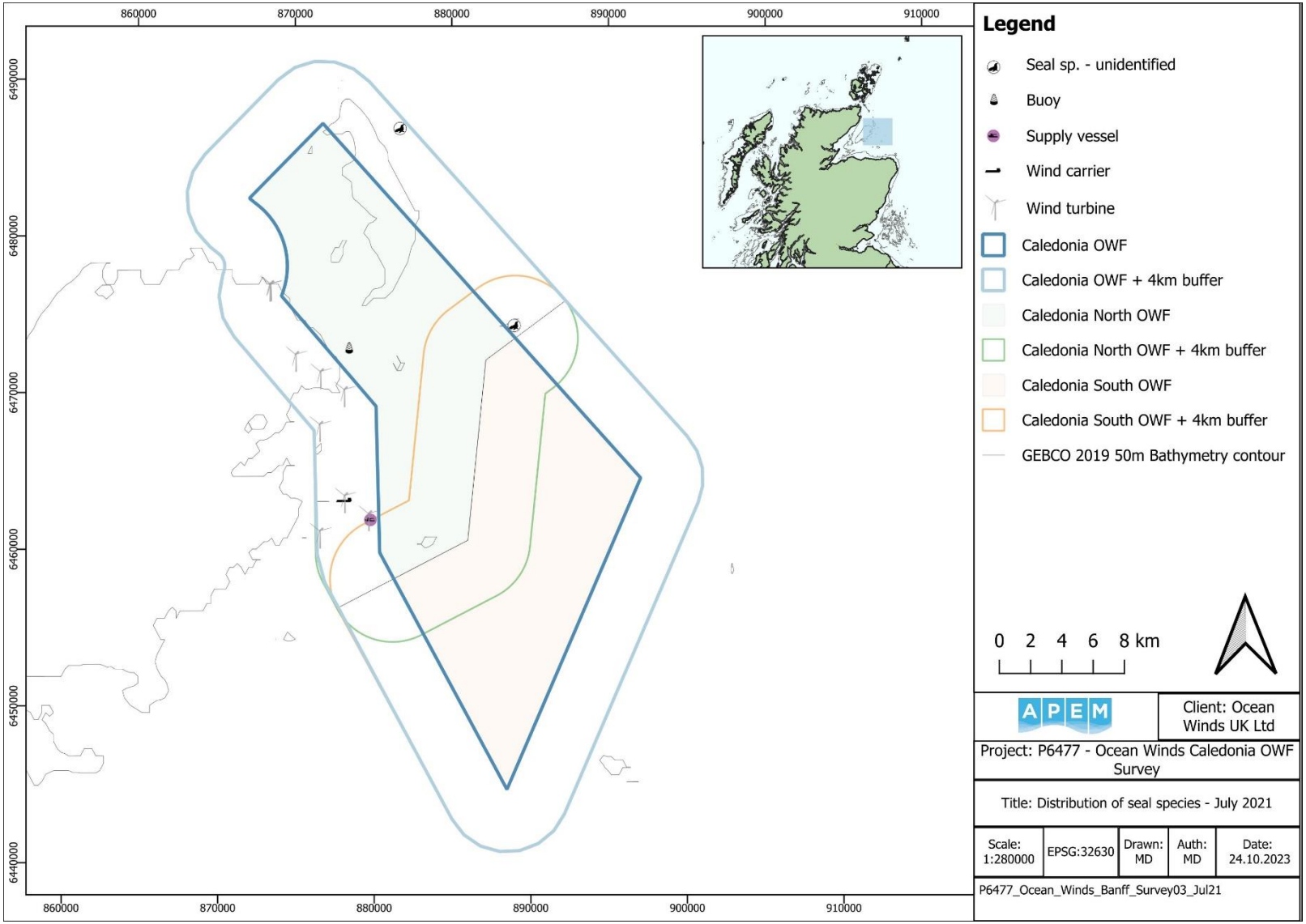


Figure A4.367 Distribution of unidentified seal species recorded in the Survey Area in July 2021

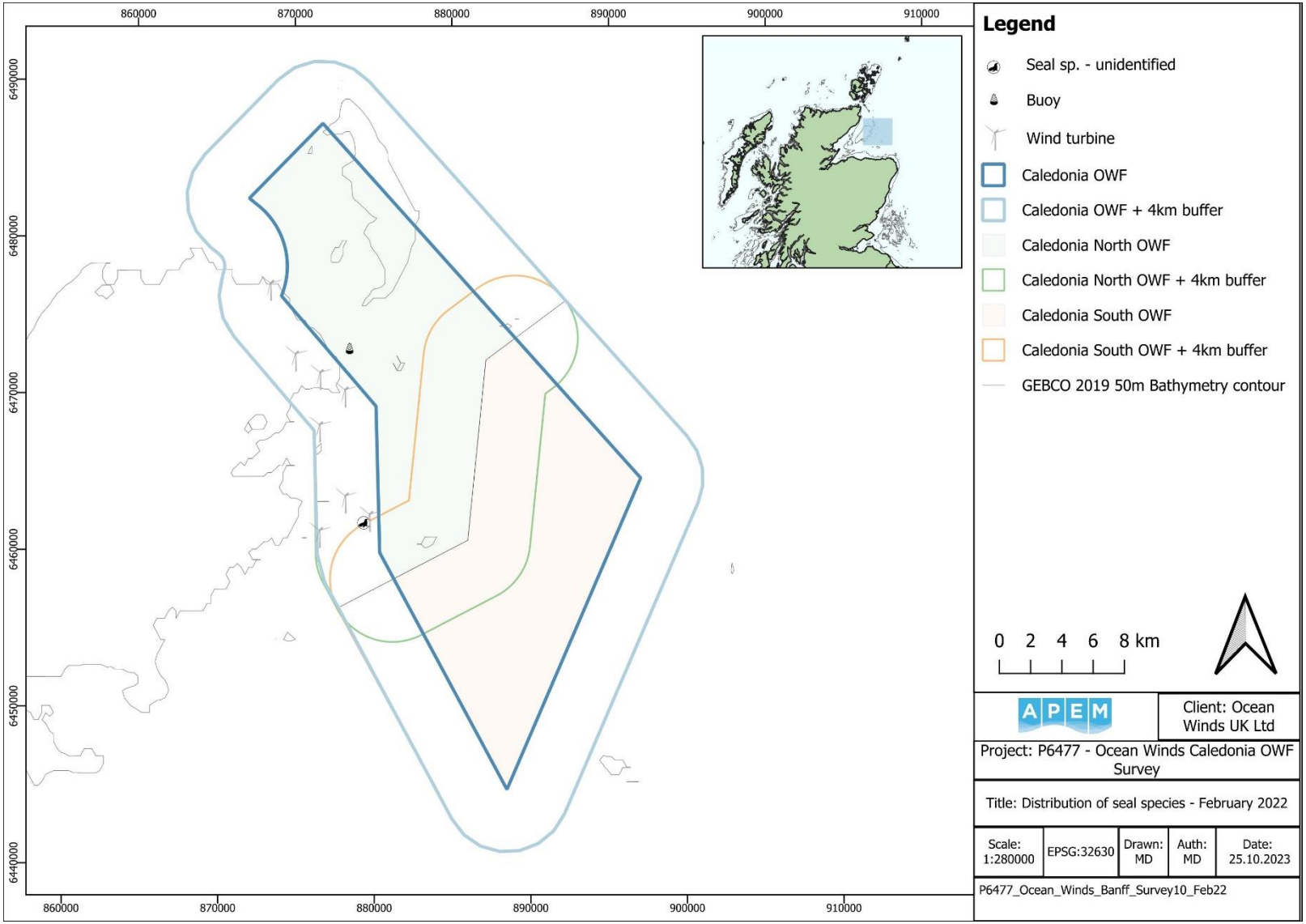


Figure A4.368 Distribution of unidentified seal species recorded in the Survey Area in February 2022

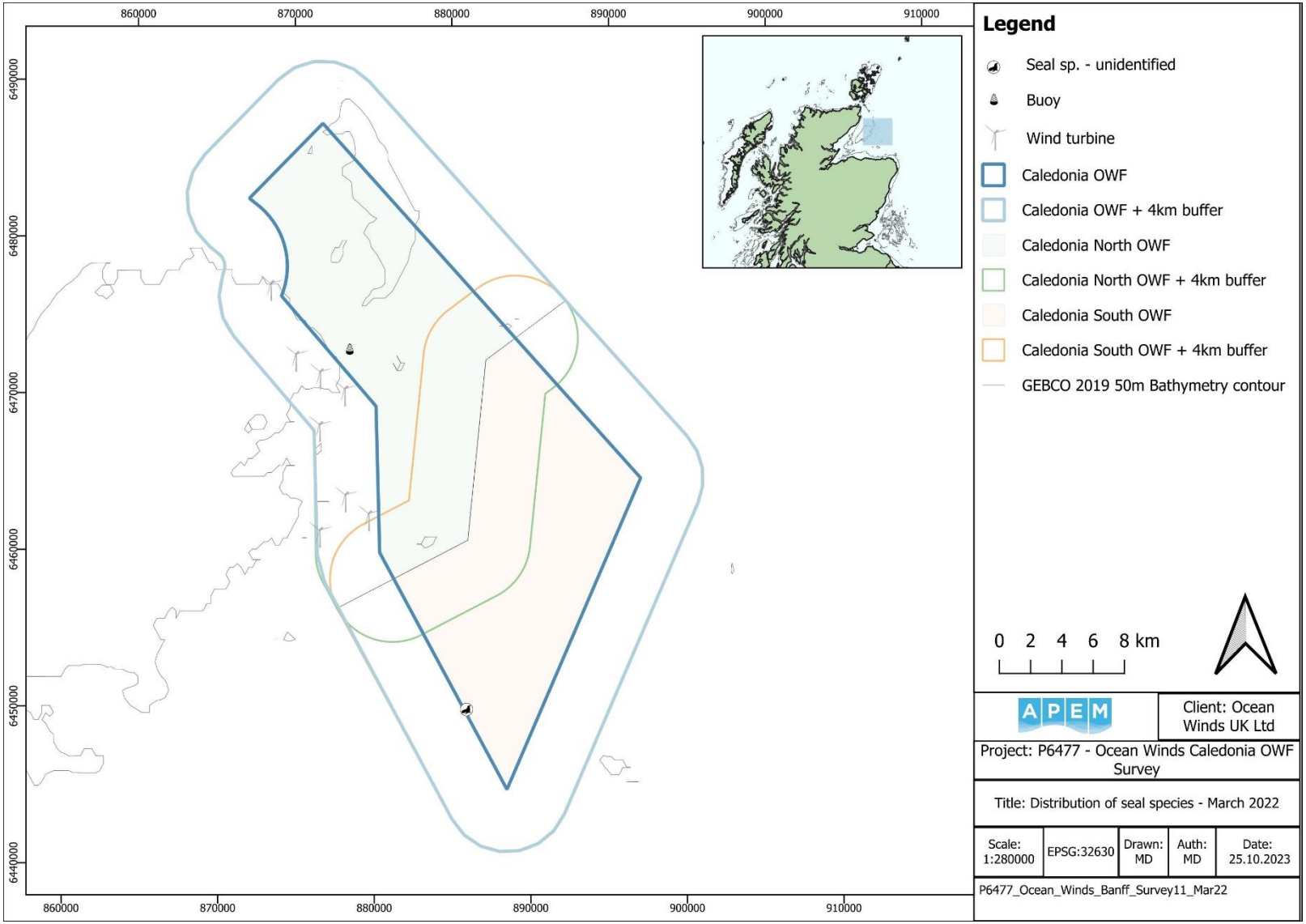


Figure A4.369 Distribution of unidentified seal species recorded in the Survey Area in March 2022

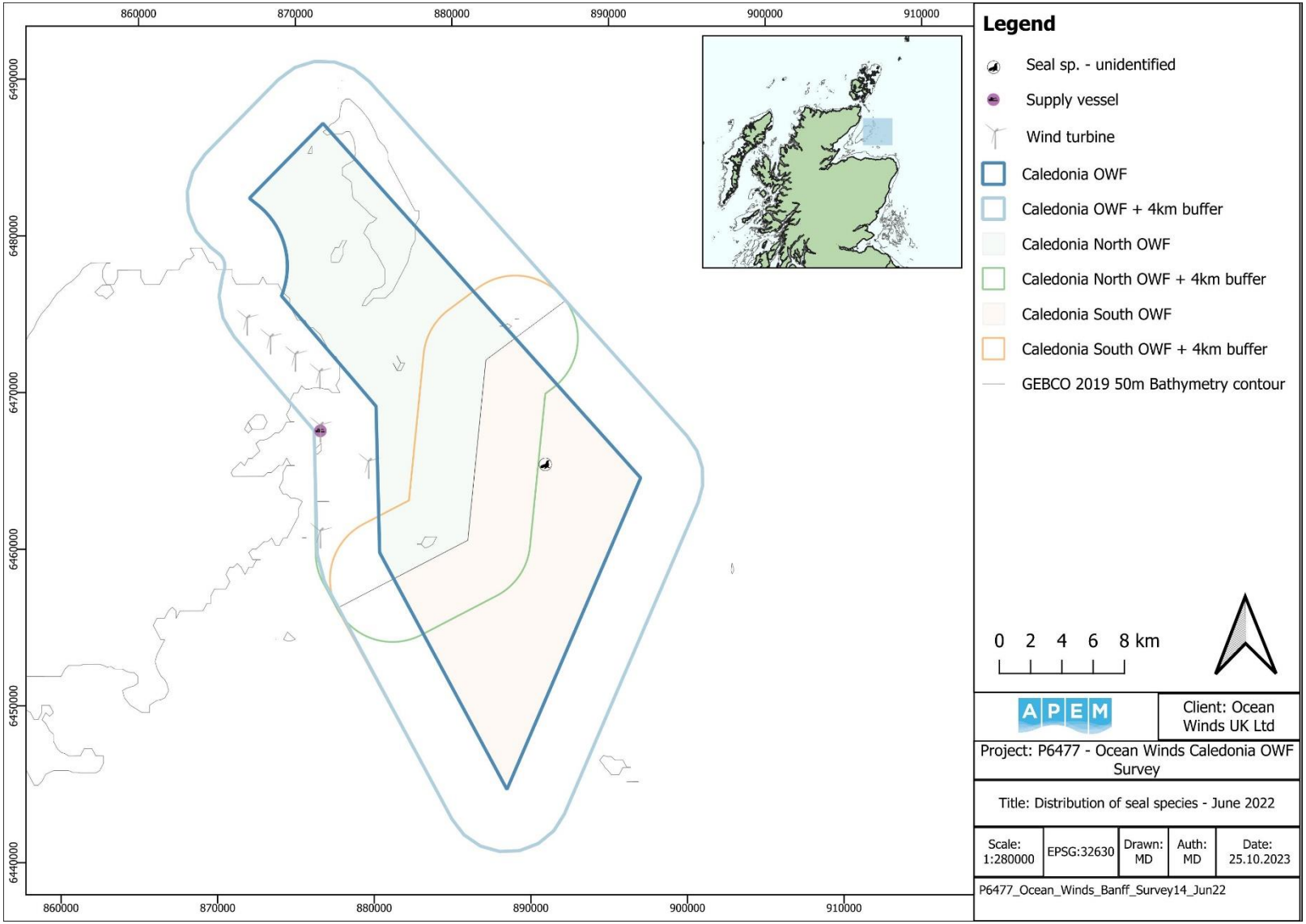


Figure A4.370 Distribution of unidentified seal species recorded in the Survey Area in June 2022

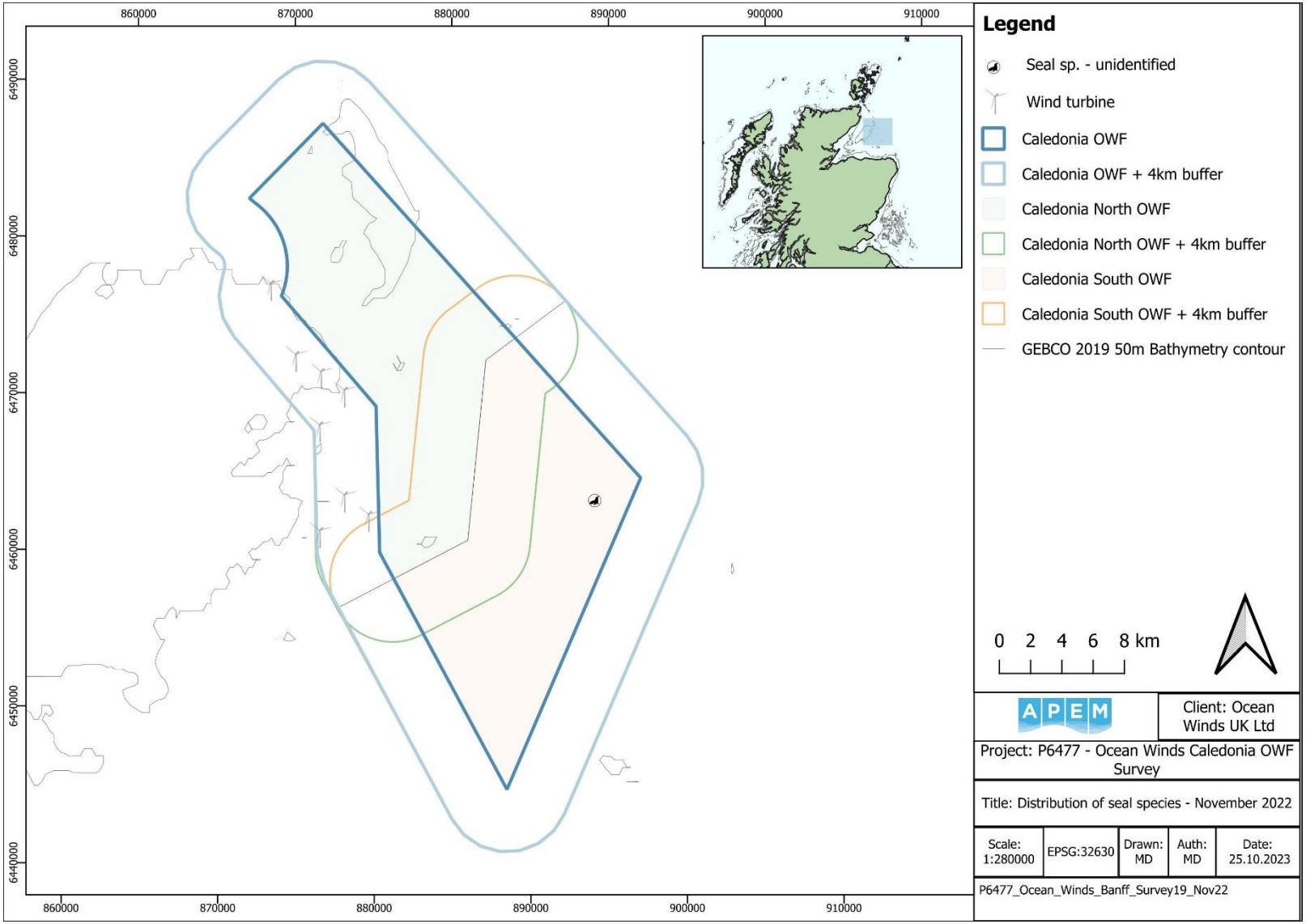


Figure A4.371 Distribution of unidentified seal species recorded in the Survey Area in November 2022

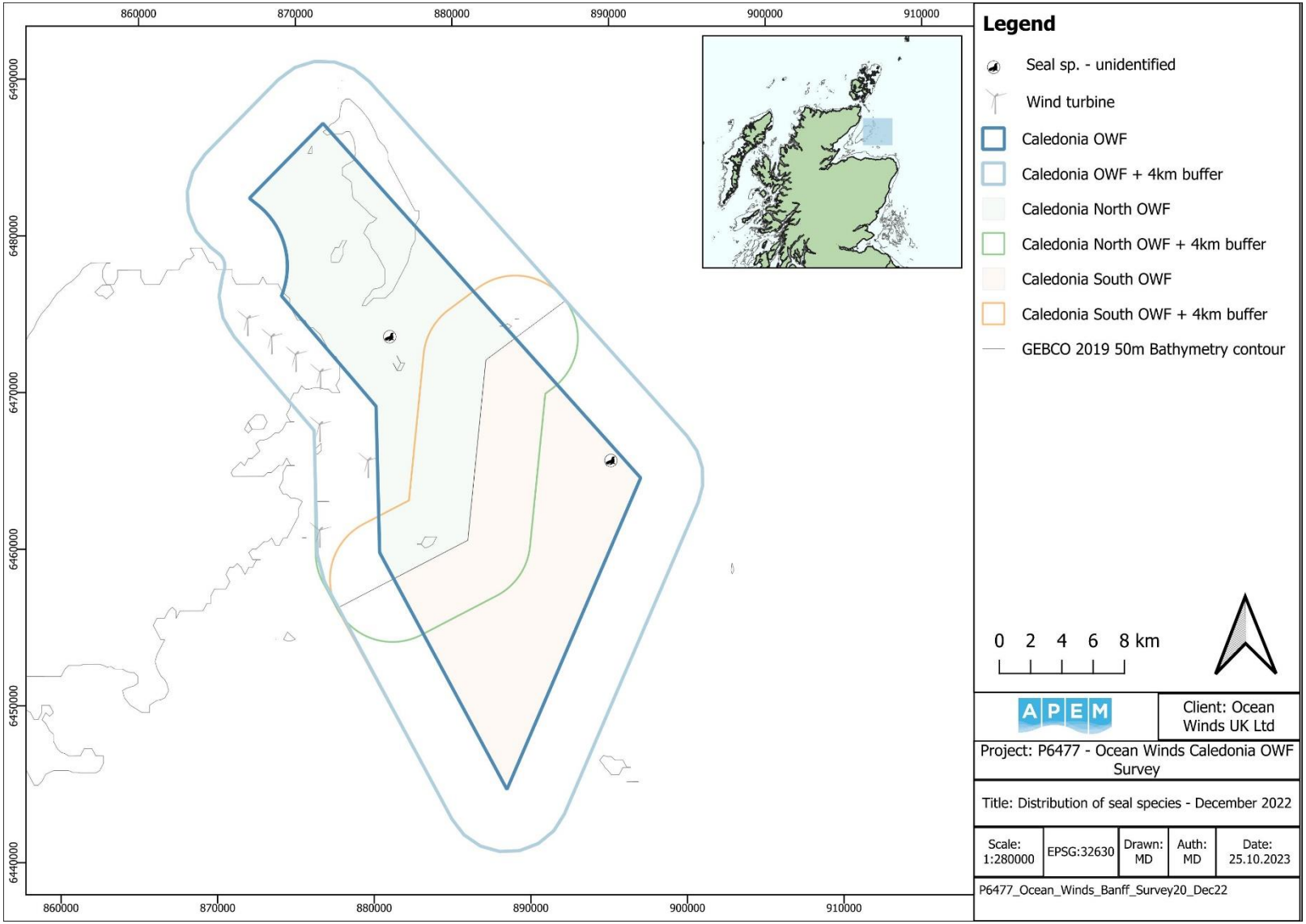


Figure A4.372 Distribution of unidentified seal species recorded in the Survey Area in December 2022

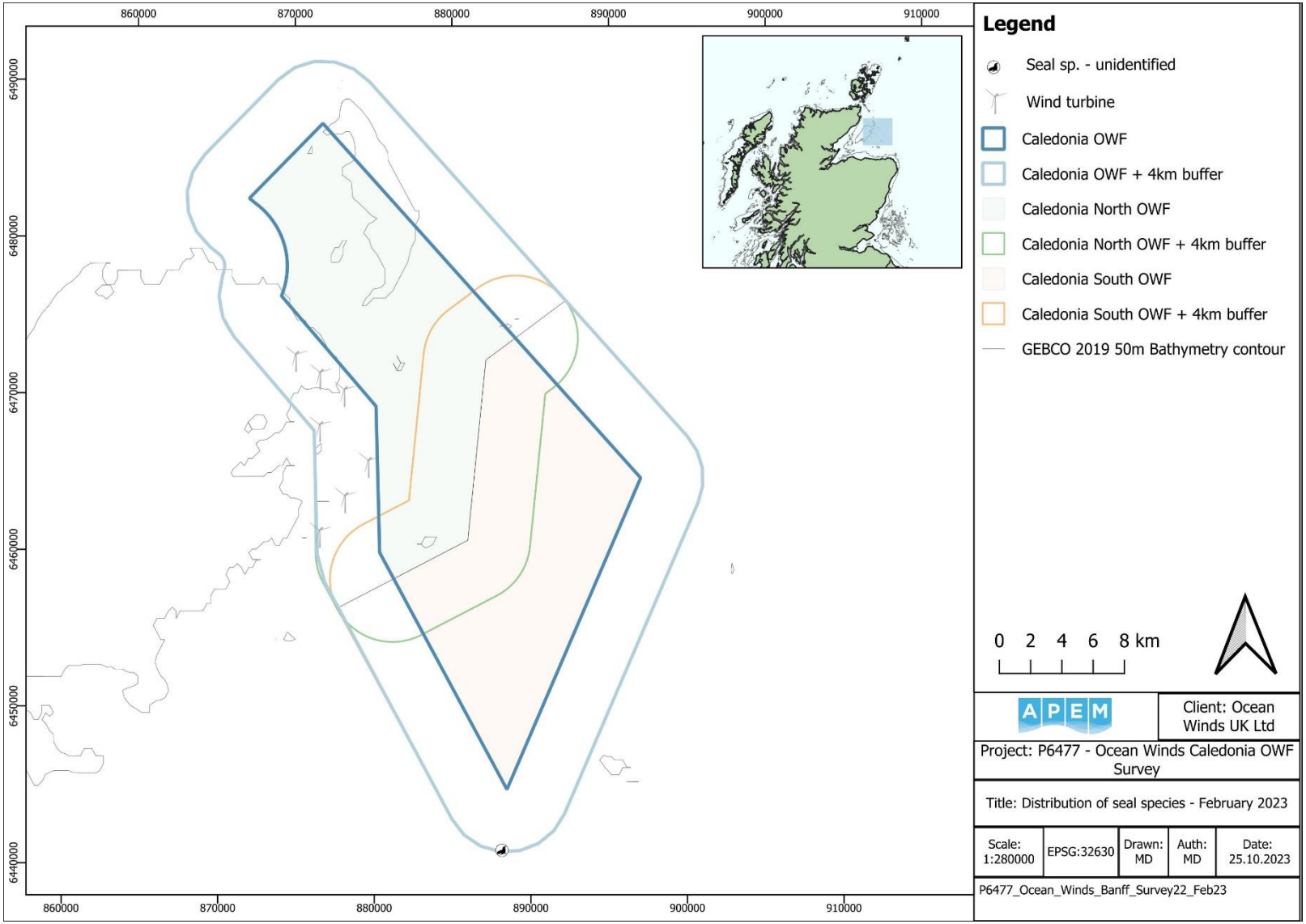


Figure A4.373 Distribution of unidentified seal species recorded in the Survey Area in February 2023

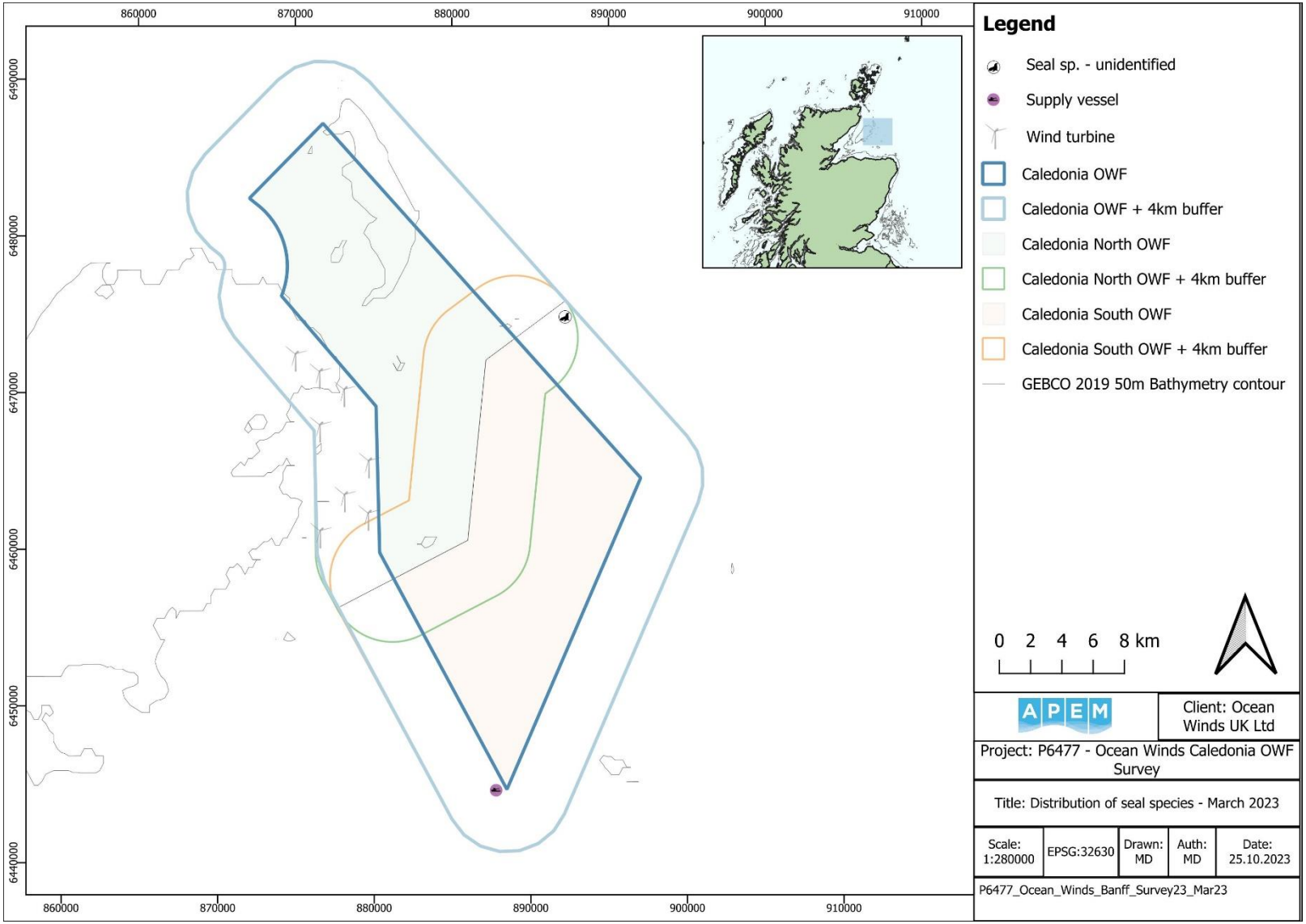


Figure A4.374 Distribution of unidentified seal species recorded in the Survey Area in March 2023

Common dolphin

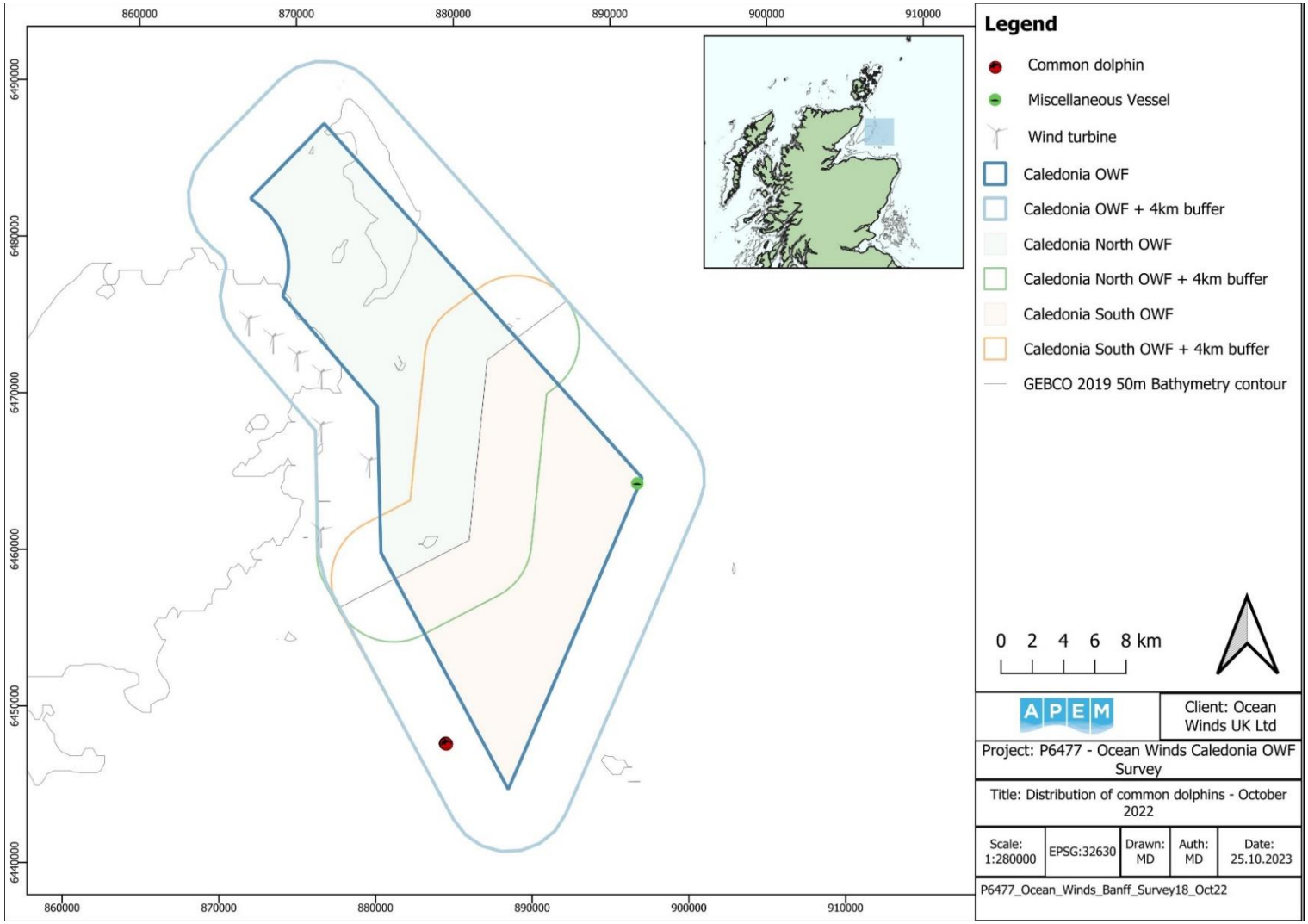


Figure A4.375 Distribution of common dolphins recorded in the Survey Area in October 2022

White-beaked dolphin

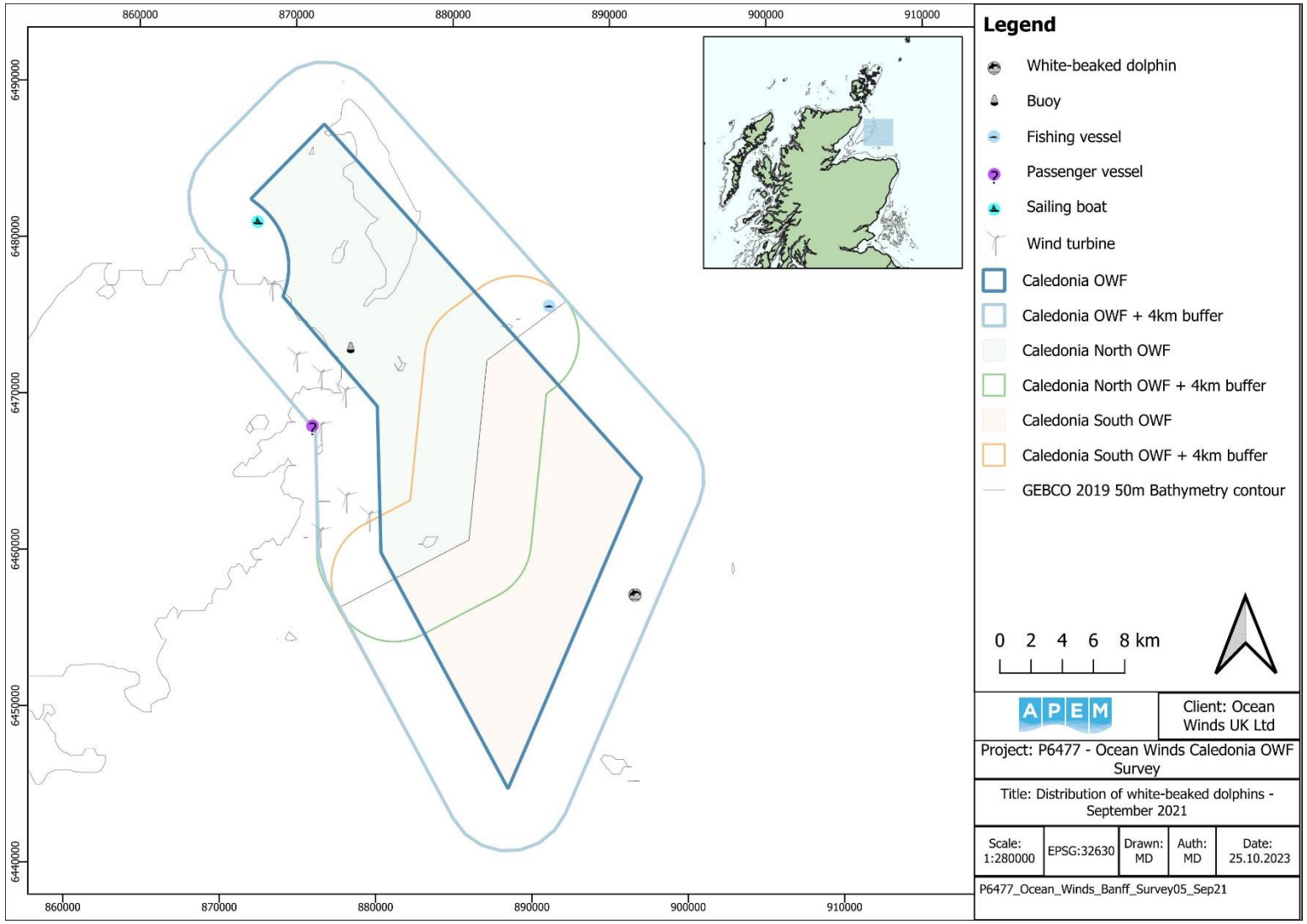


Figure A4.376 Distribution of white-beaked dolphins recorded in the Survey Area in September 2021

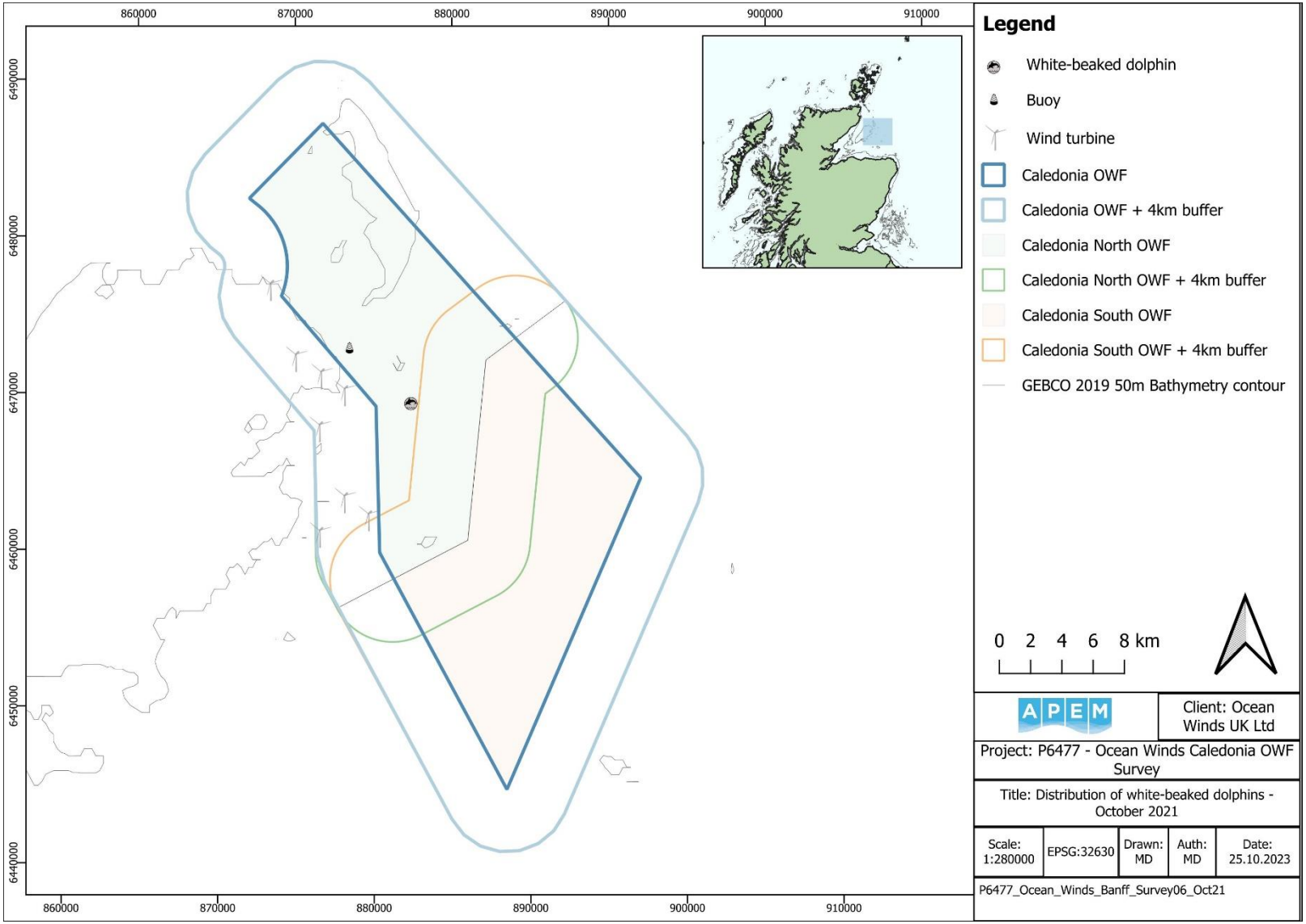


Figure A4.377 Distribution of white-beaked dolphins recorded in the Survey Area in October 2021

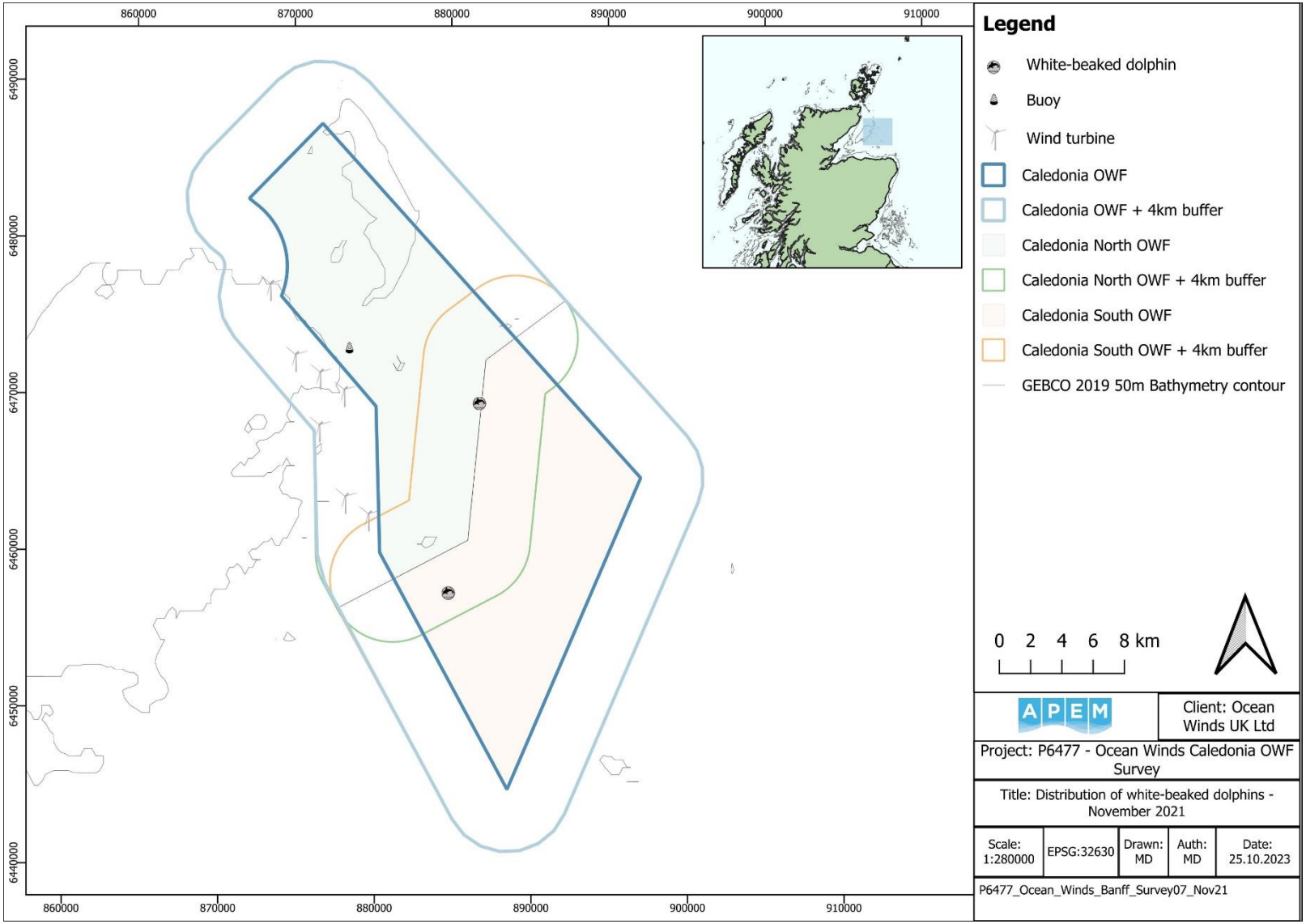


Figure A4.378 Distribution of white-beaked dolphins recorded in the Survey Area in November 2021

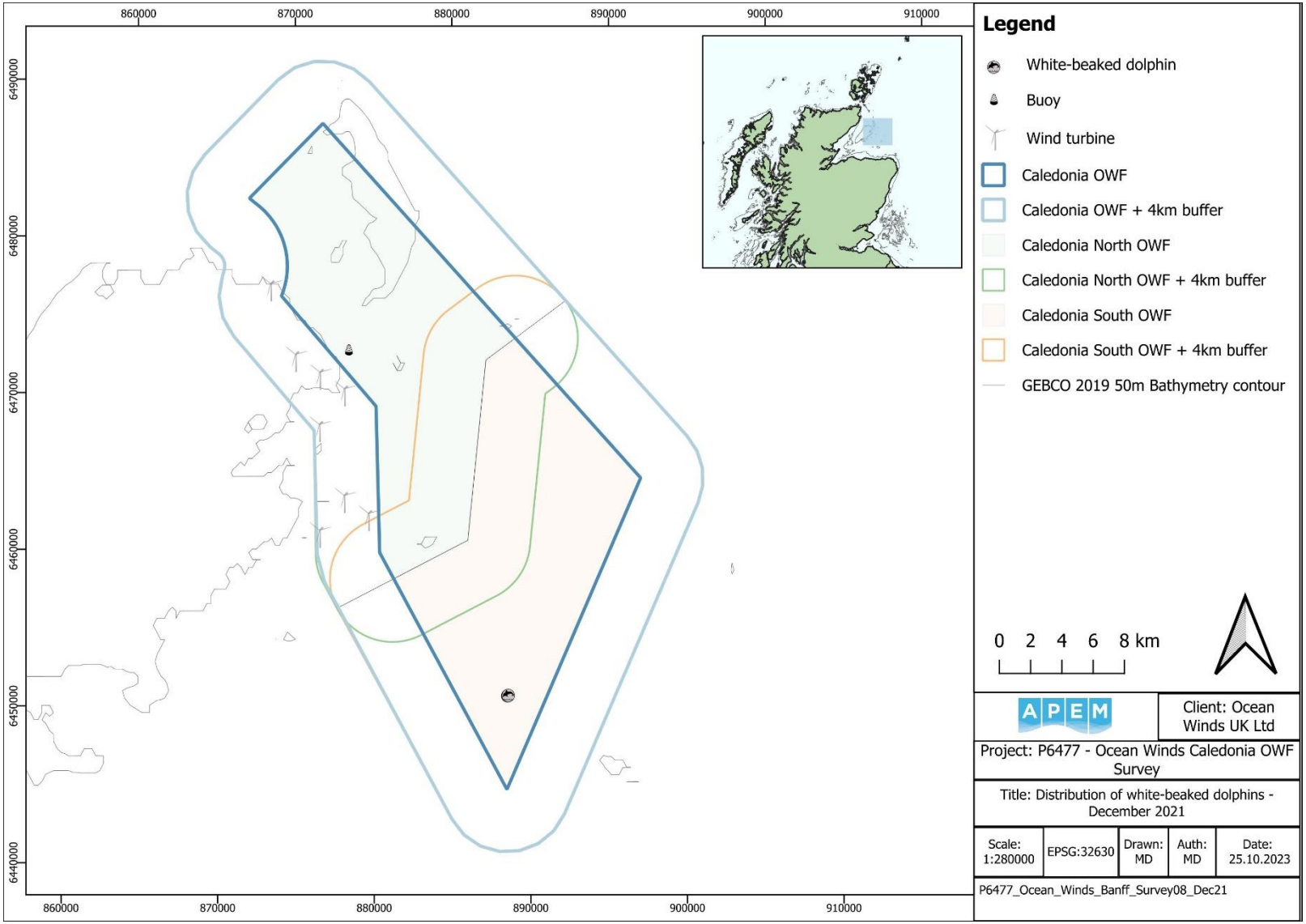


Figure A4.379 Distribution of white-beaked dolphins recorded in the Survey Area in December 2021

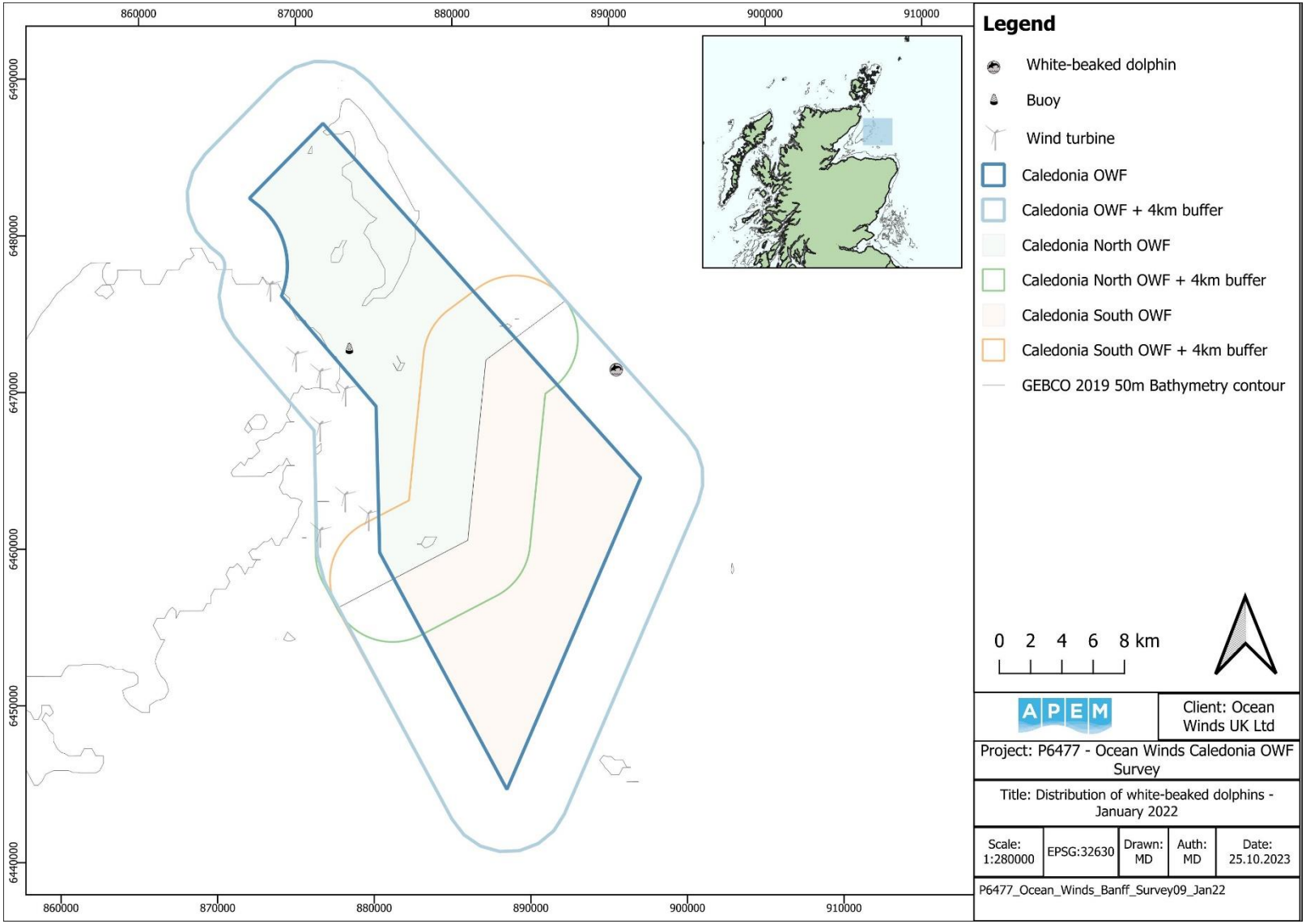


Figure A4.380 Distribution of white-beaked dolphins recorded in the Survey Area in January 2022

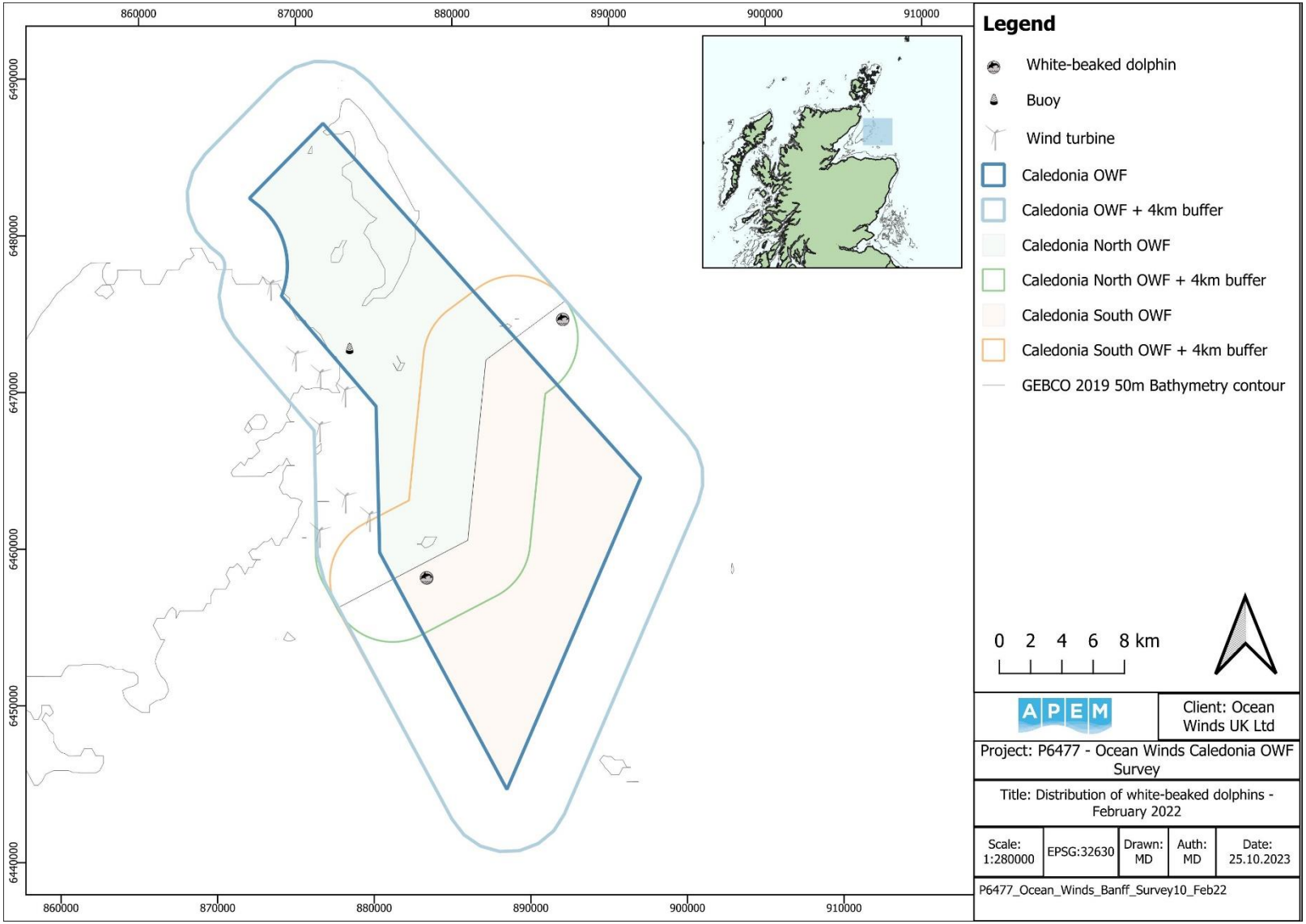


Figure A4.381 Distribution of white-beaked dolphins recorded in the Survey Area in February 2022

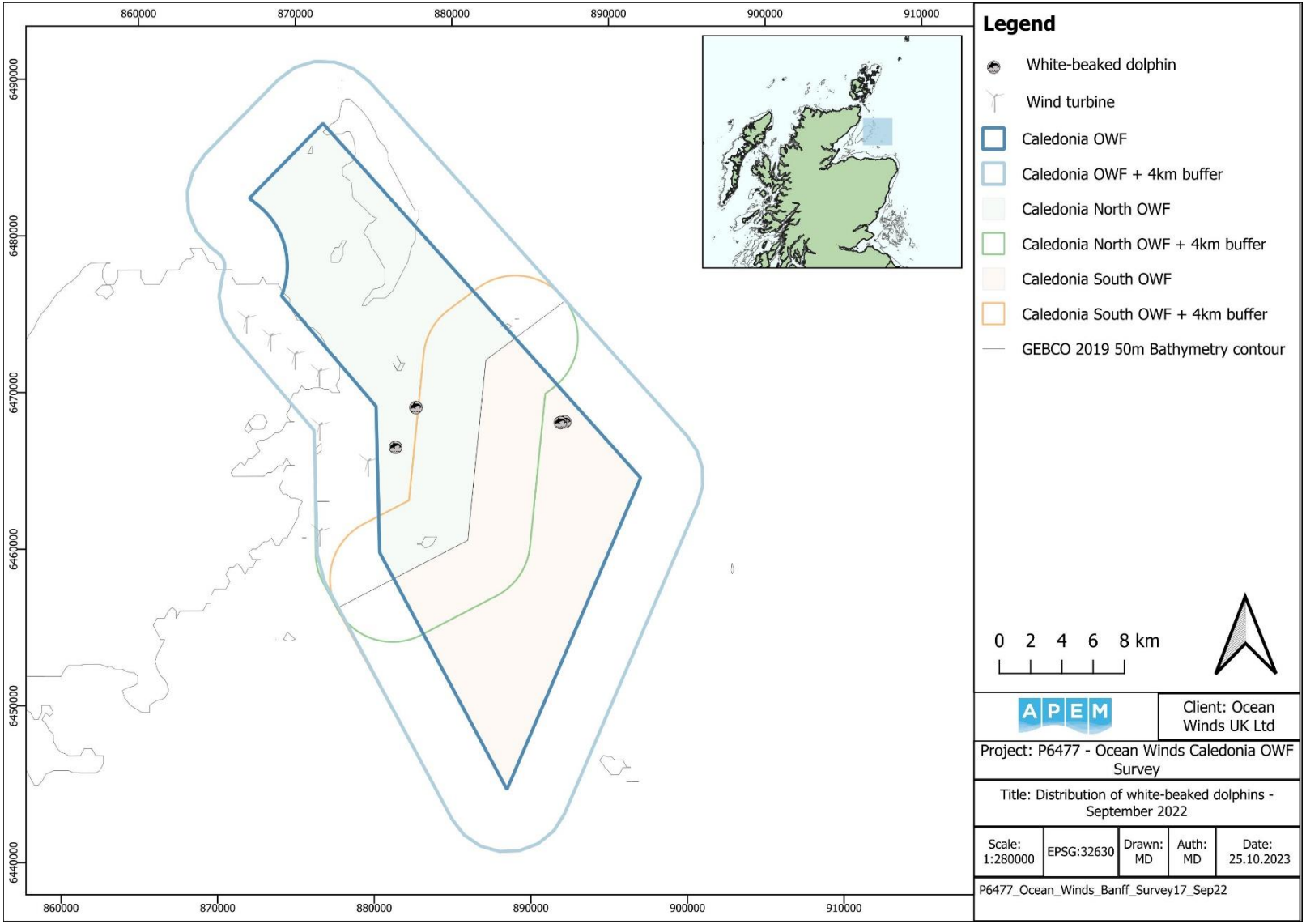


Figure A4.382 Distribution of white-beaked dolphins recorded in the Survey Area in September 2022

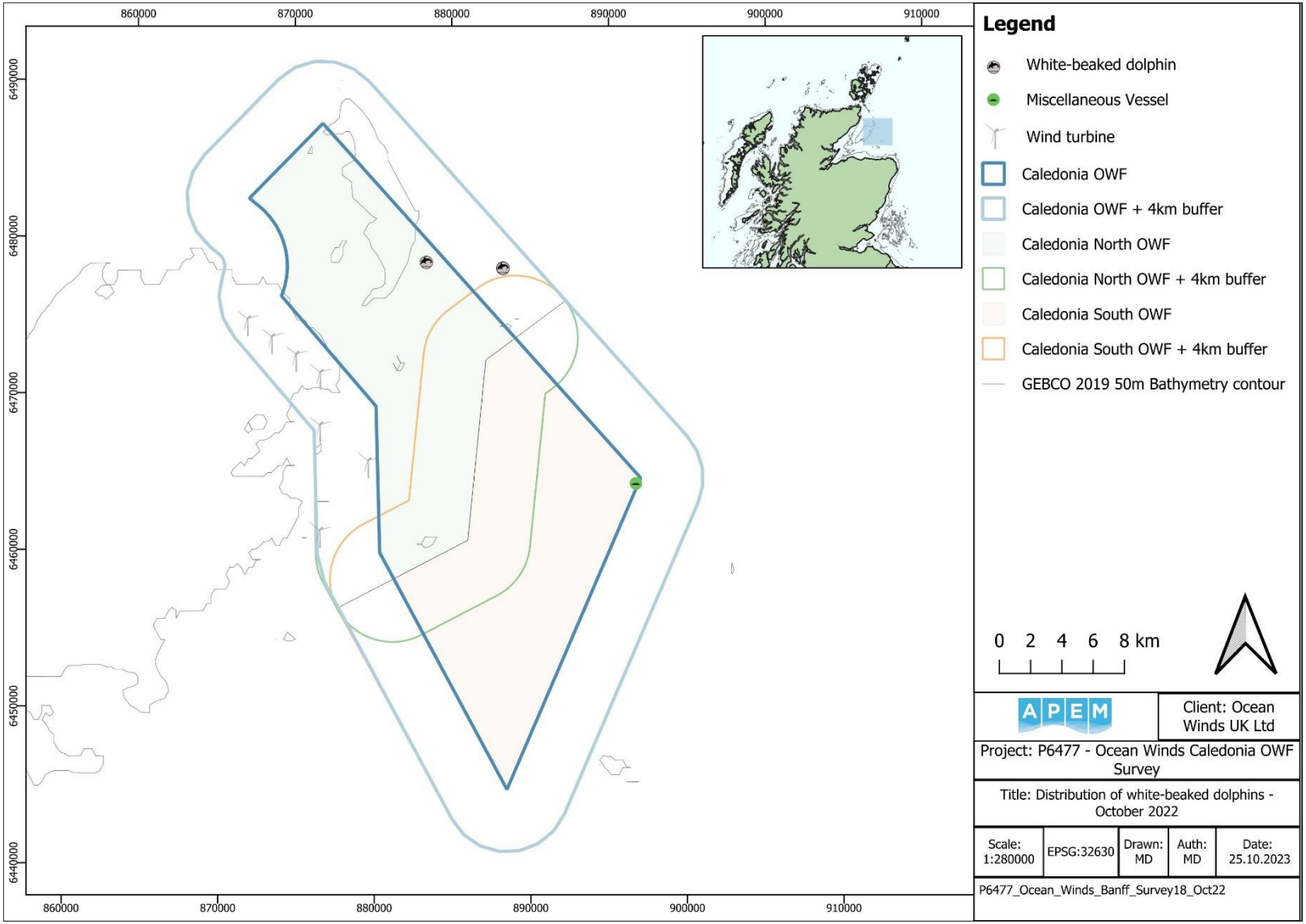


Figure A4.383 Distribution of white-beaked dolphins recorded in the Survey Area in October 2022

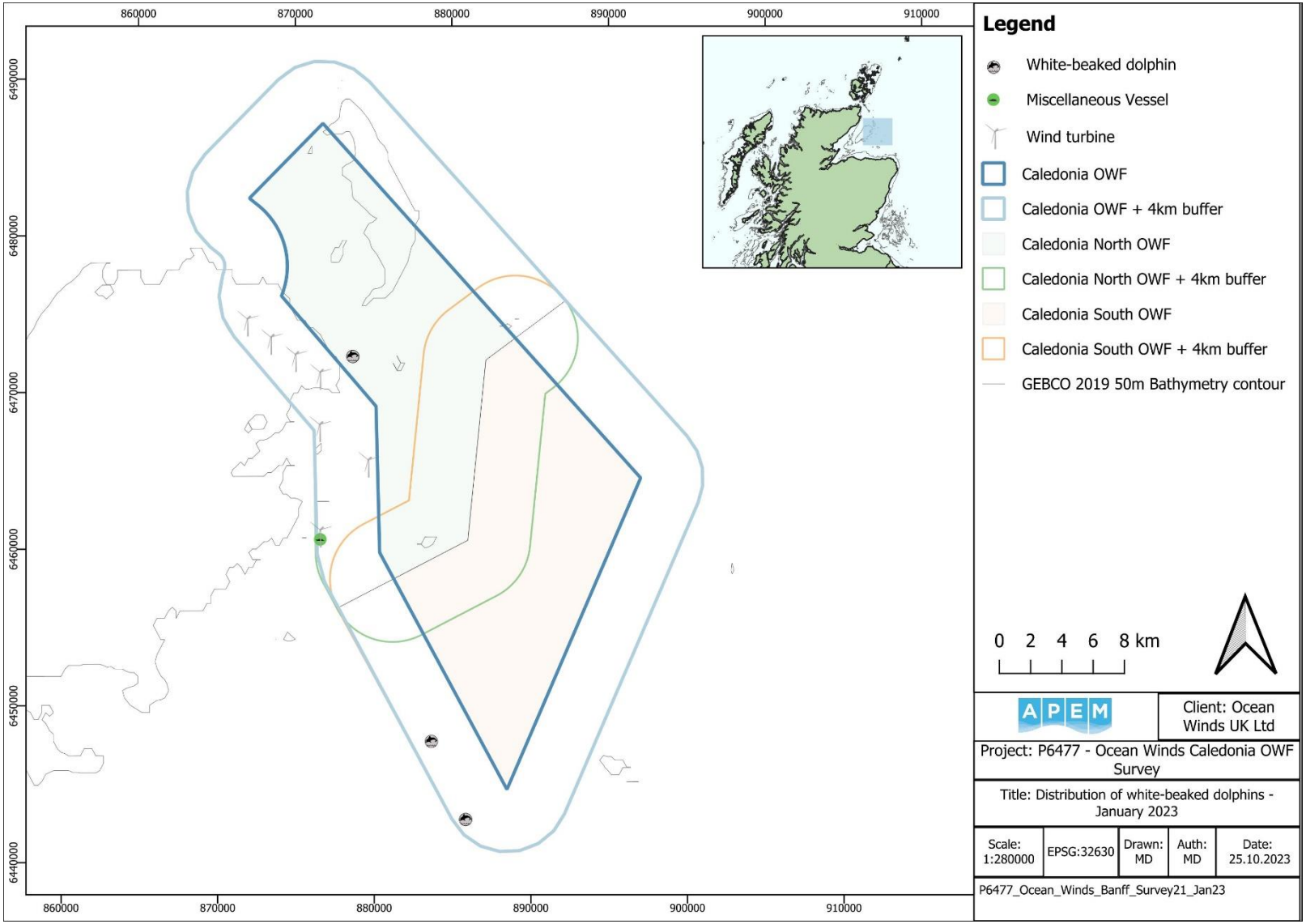


Figure A4.384 Distribution of white-beaked dolphins recorded in the Survey Area in January 2023

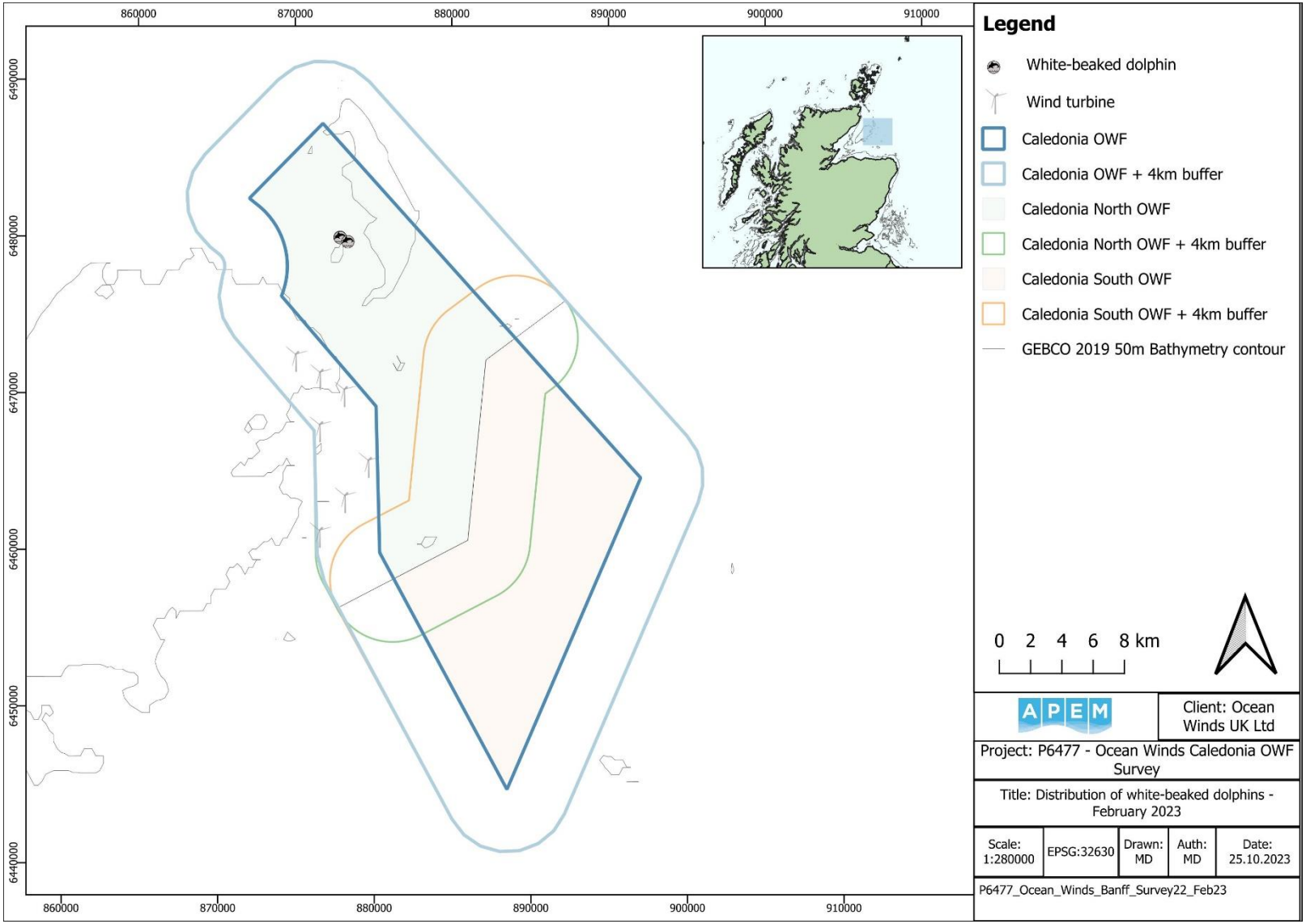


Figure A4.385 Distribution of white-beaked dolphins recorded in the Survey Area in February 2023

Bottlenose dolphin

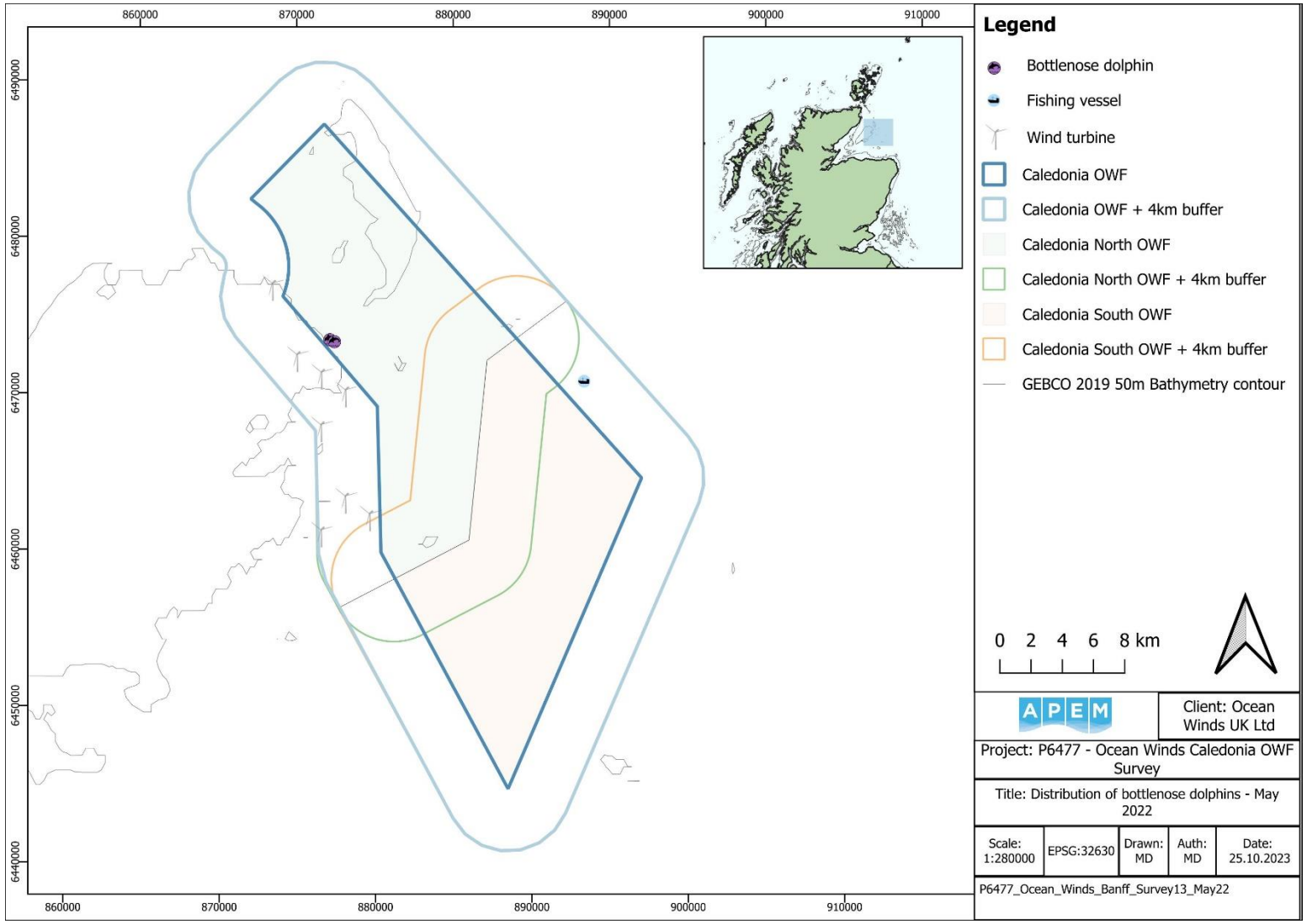


Figure A4.386 Distribution of bottlenose dolphins recorded in the Survey Area in May 2022

Risso's dolphin

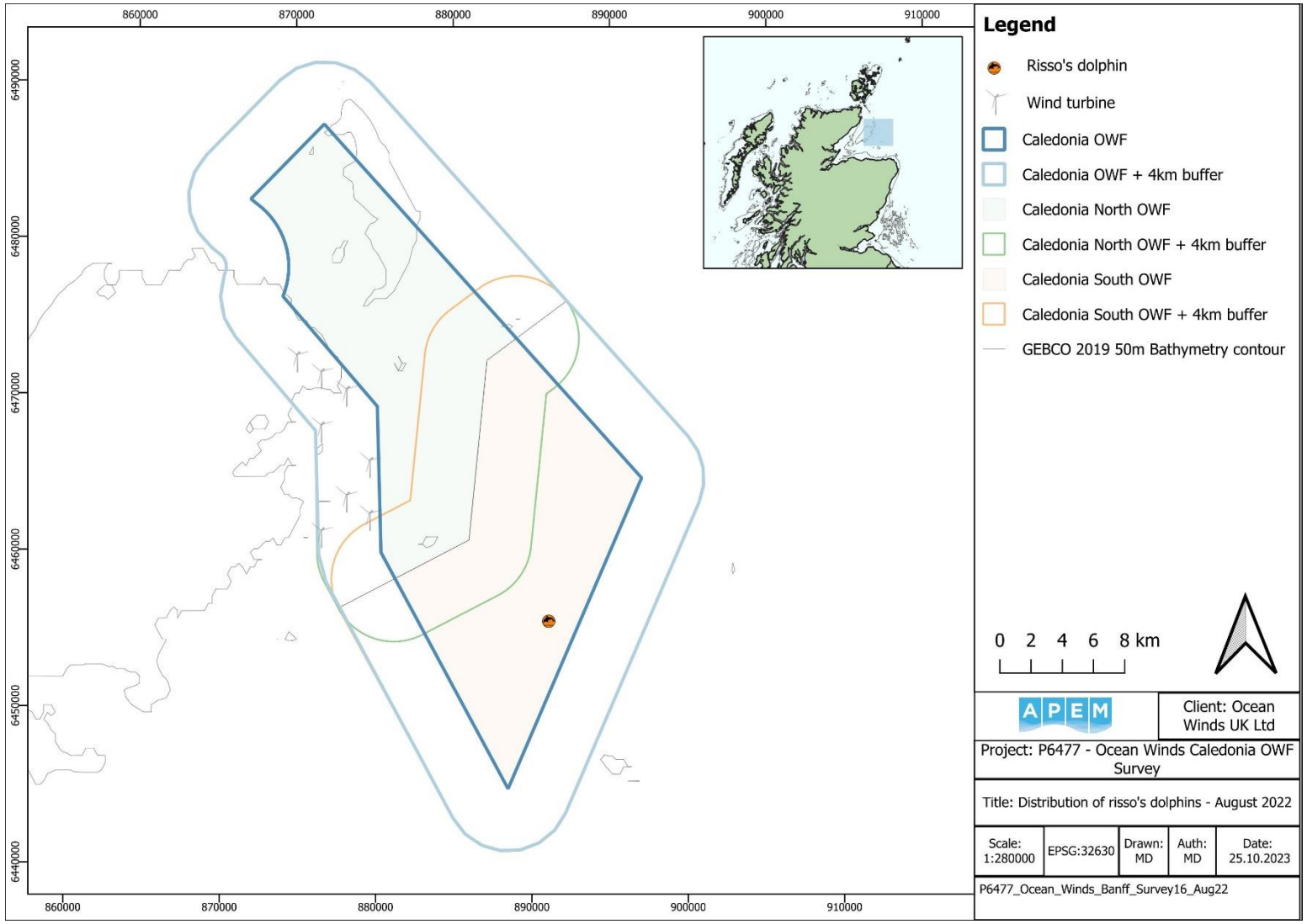


Figure A4.387 Distribution of Risso's dolphins recorded in the Survey Area in August 2022

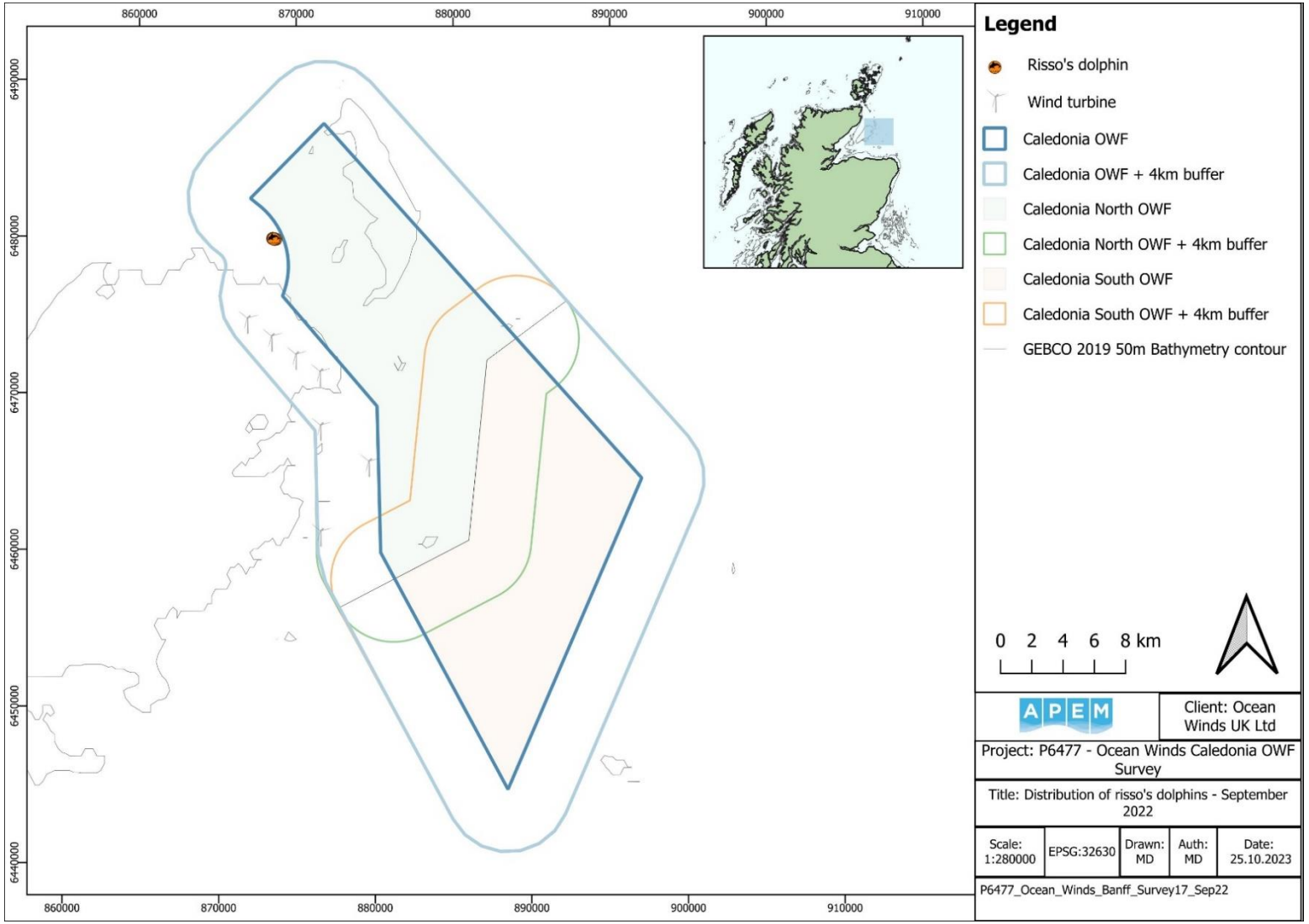


Figure A4.388 Distribution of Risso's dolphins recorded in the Survey Area in September 2022

Unidentified dolphin species

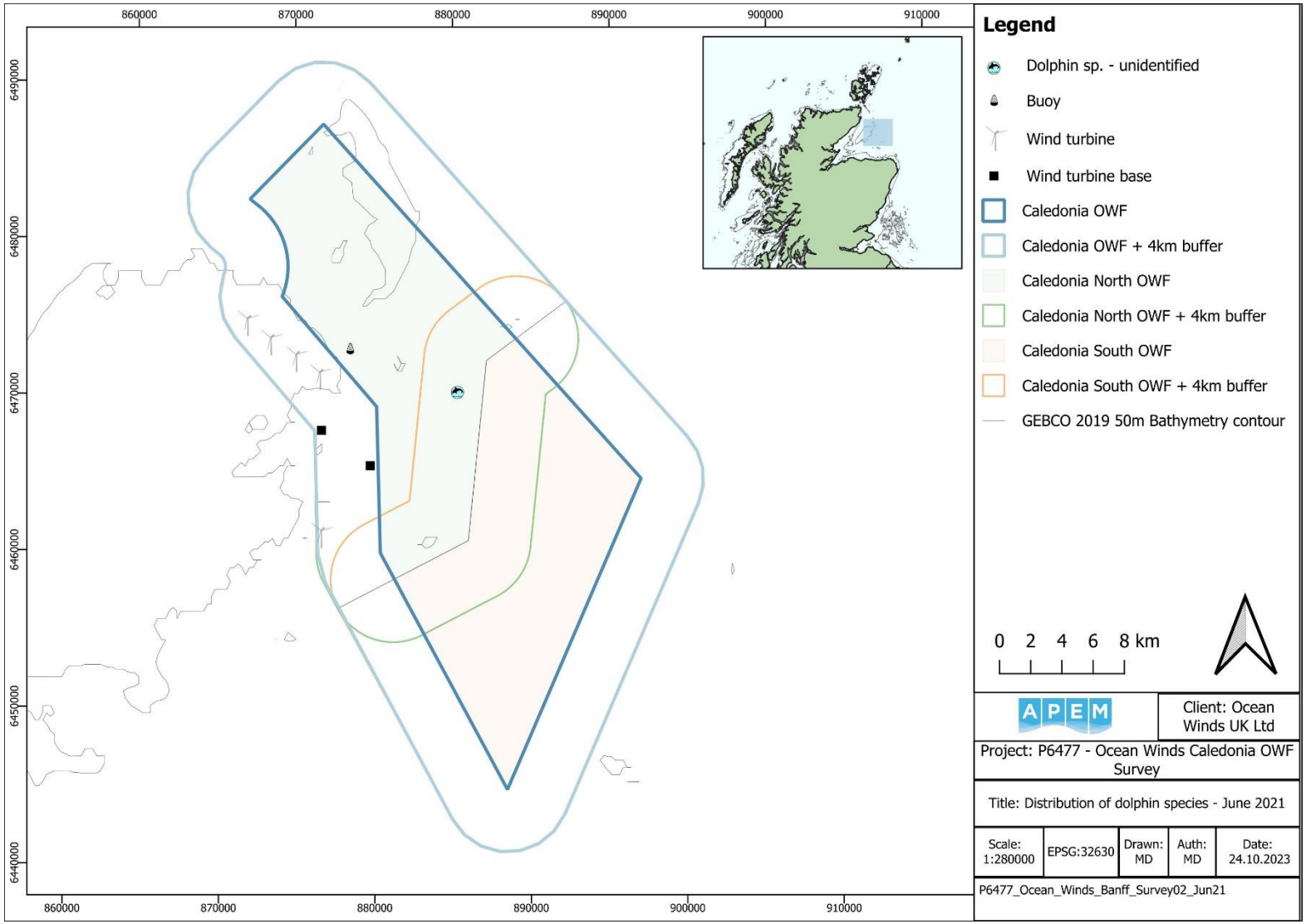


Figure A4.389 Distribution of unidentified dolphin species recorded in the Survey Area in June 2021

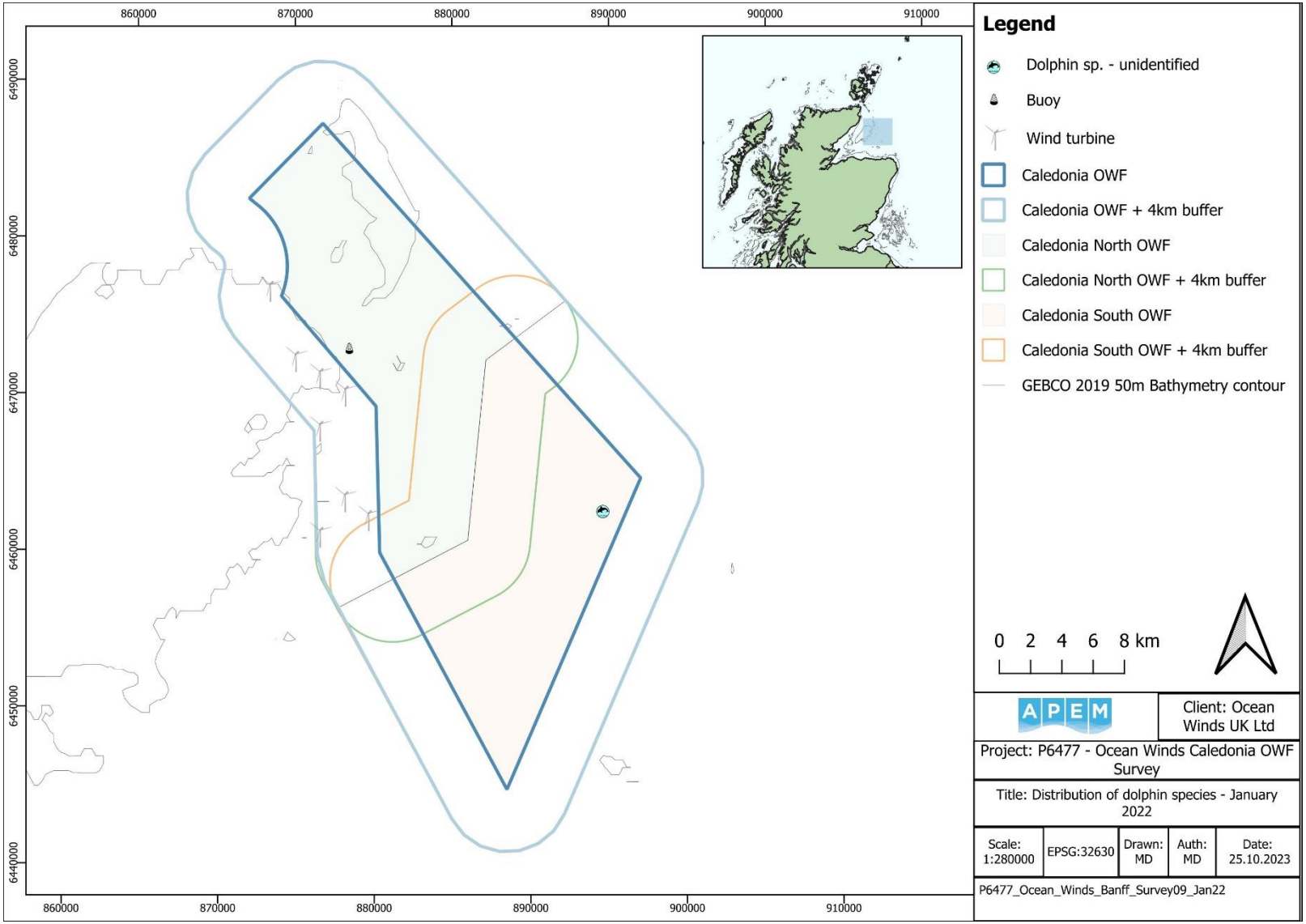


Figure A4.390 Distribution of unidentified dolphin species recorded in the Survey Area in January 2022

Harbour porpoise

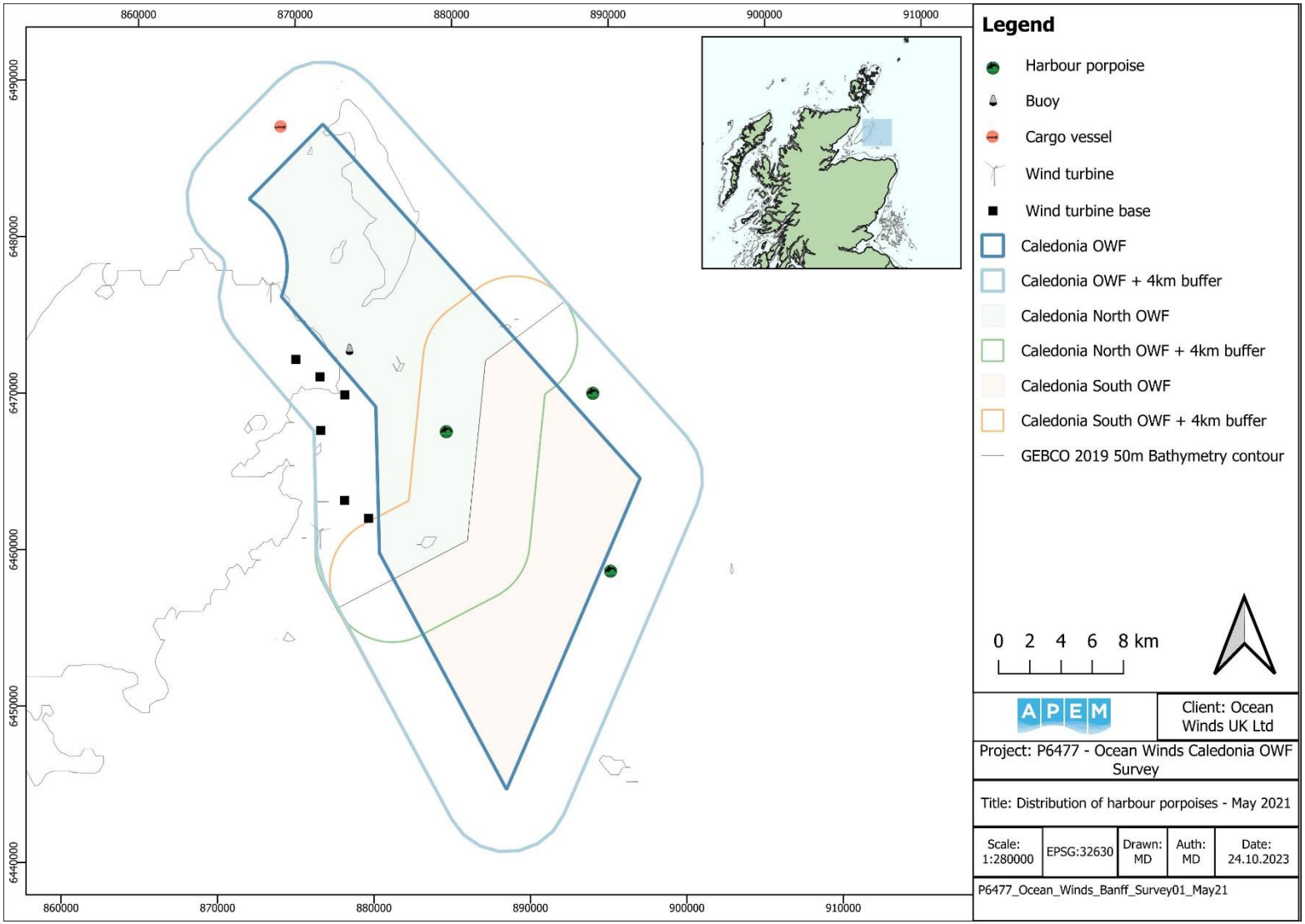


Figure A4.391 Distribution of harbour porpoises recorded in the Survey Area in May 2021

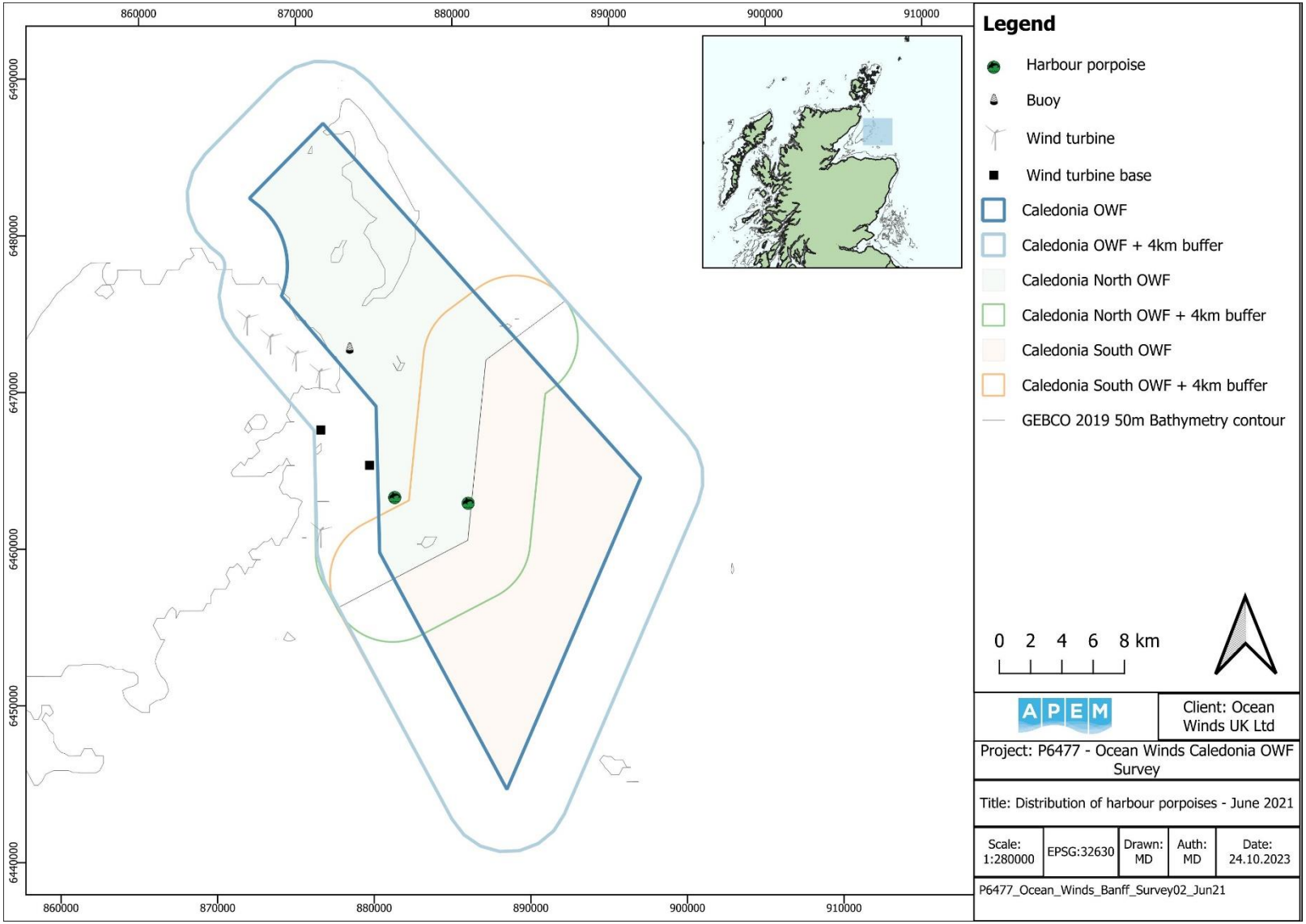


Figure A4.392 Distribution of harbour porpoises recorded in the Survey Area in June 2021

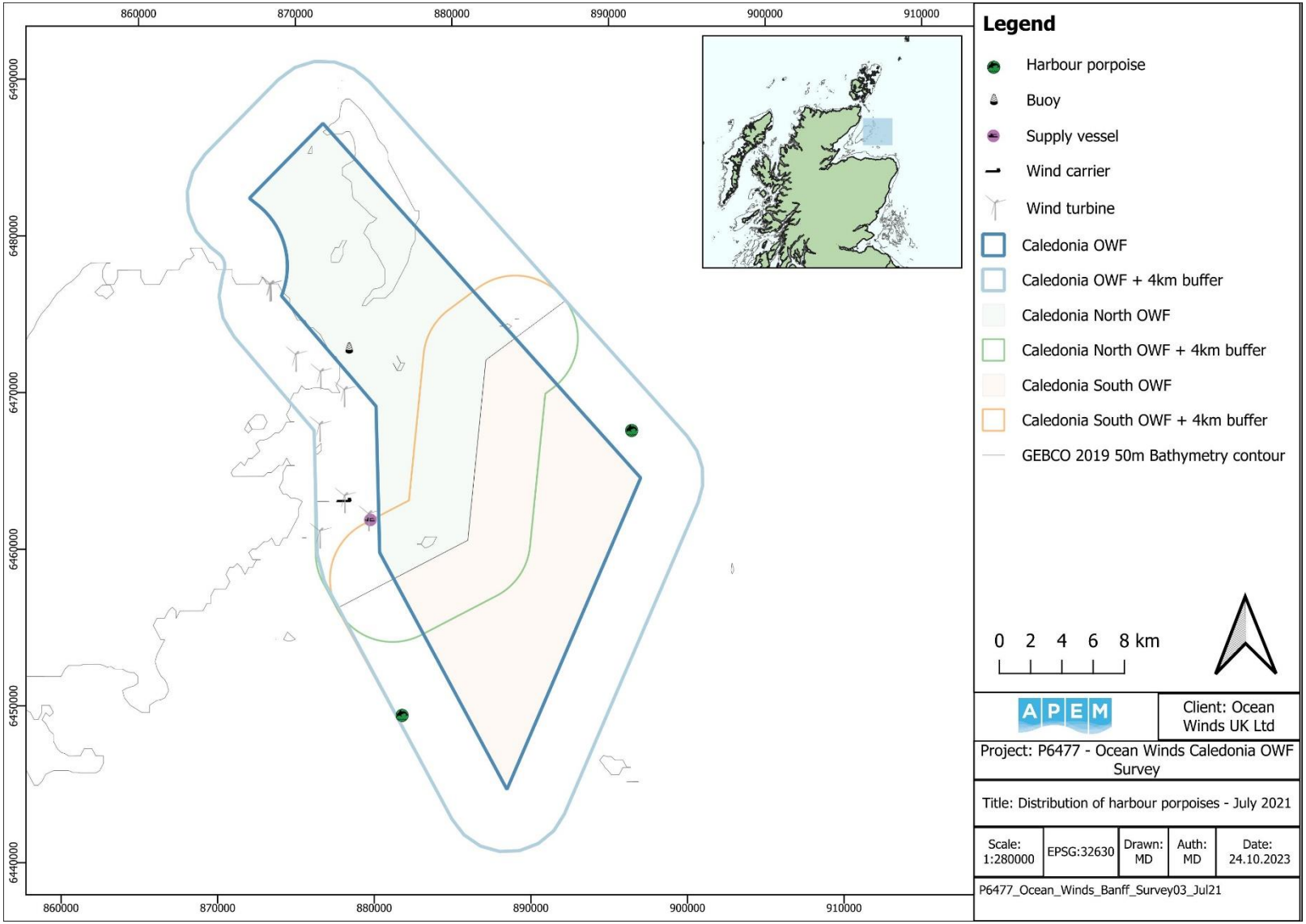


Figure A4.393 Distribution of harbour porpoises recorded in the Survey Area in July 2021

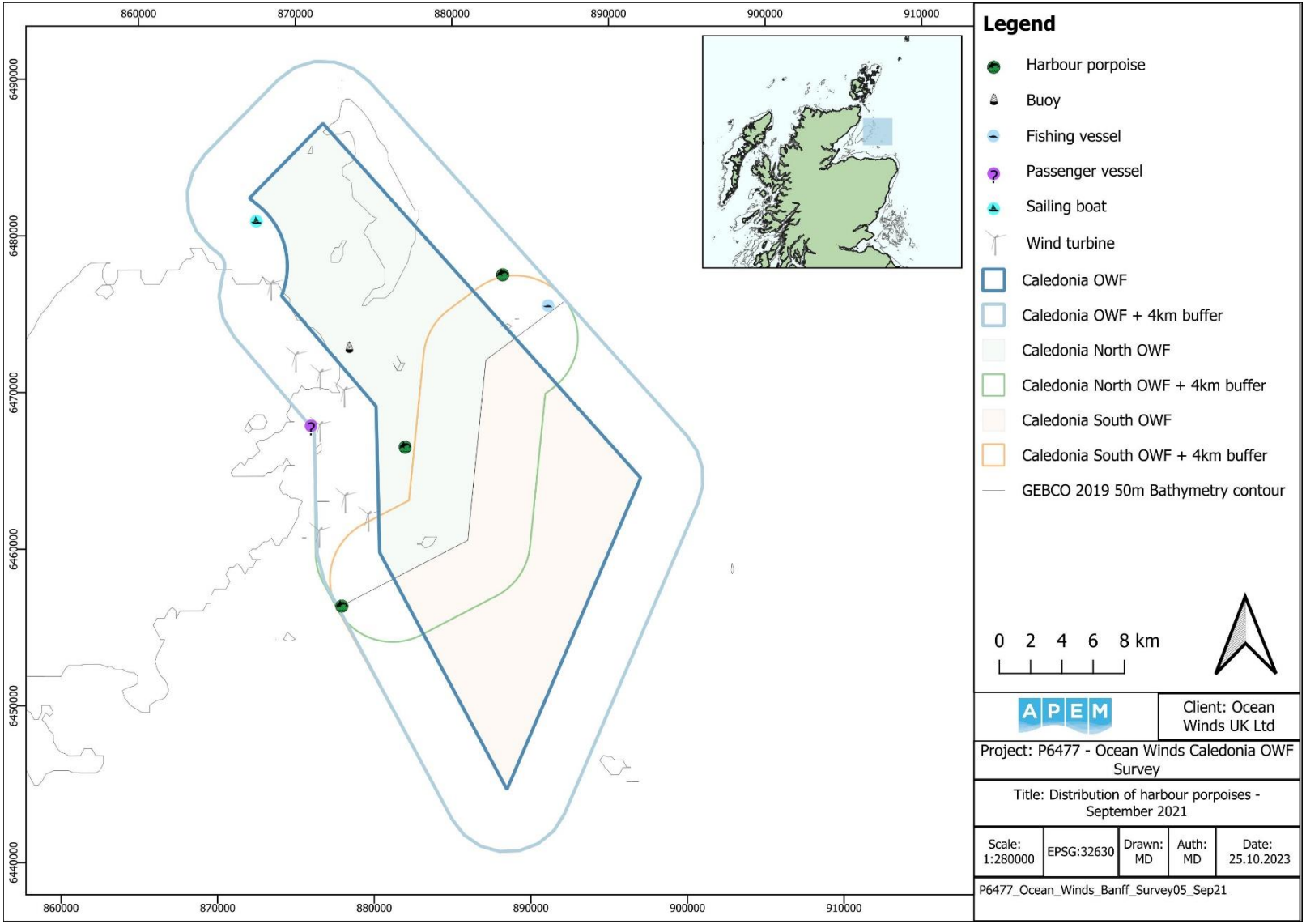


Figure A4.394 Distribution of harbour porpoises recorded in the Survey Area in September 2021

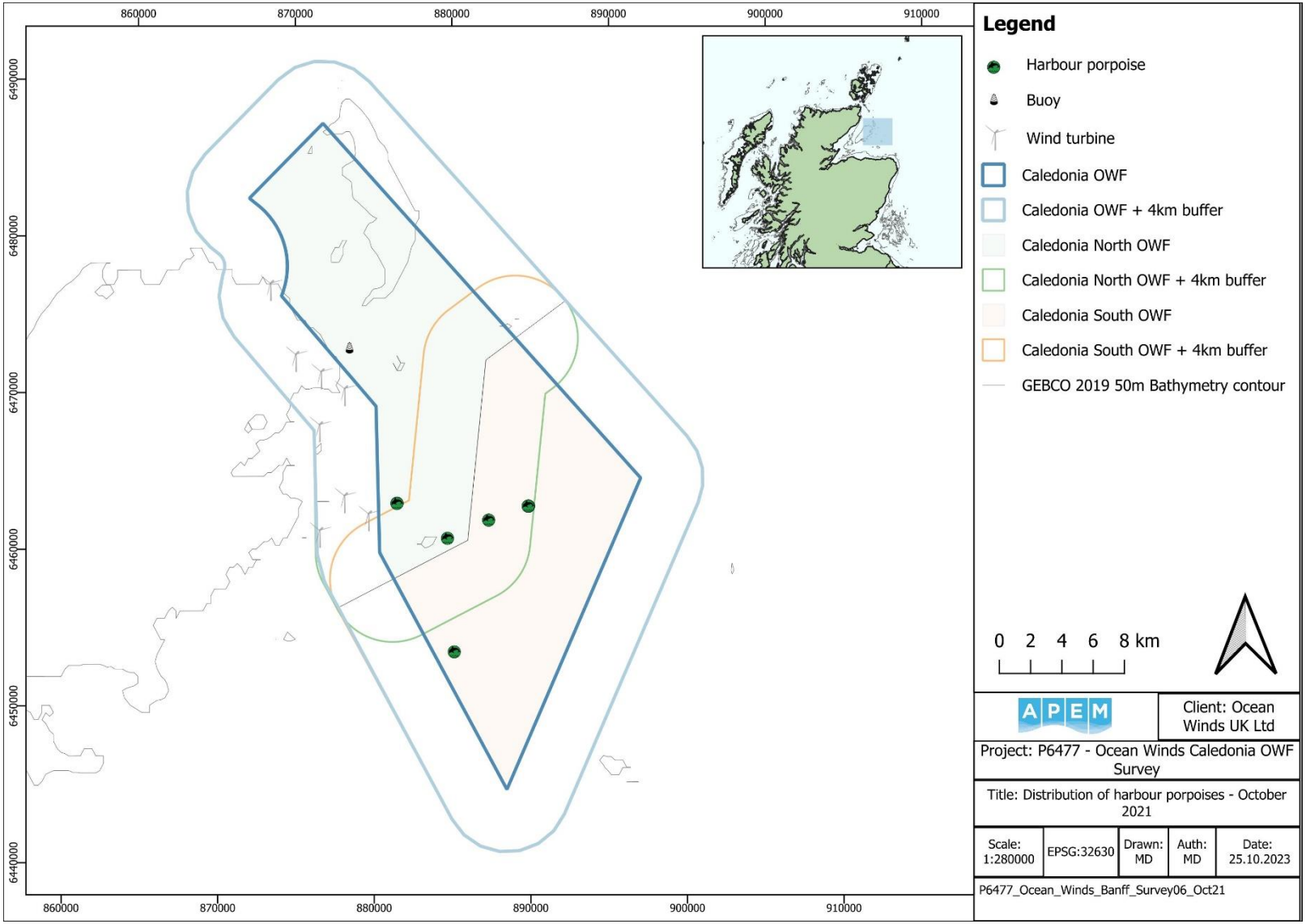


Figure A4.395 Distribution of harbour porpoises recorded in the Survey Area in October 2021

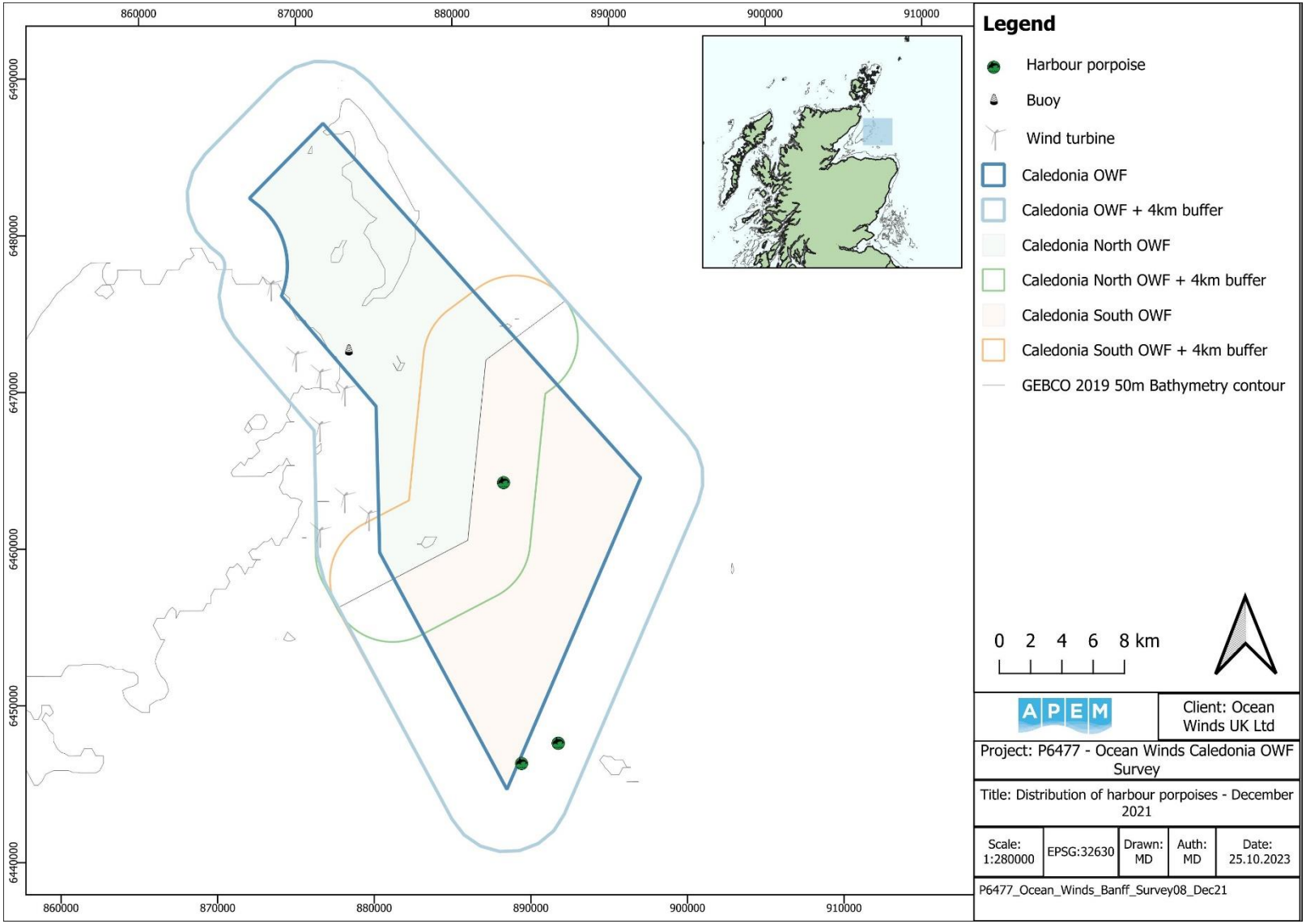


Figure A4.396 Distribution of harbour porpoises recorded in the Survey Area in December 2021

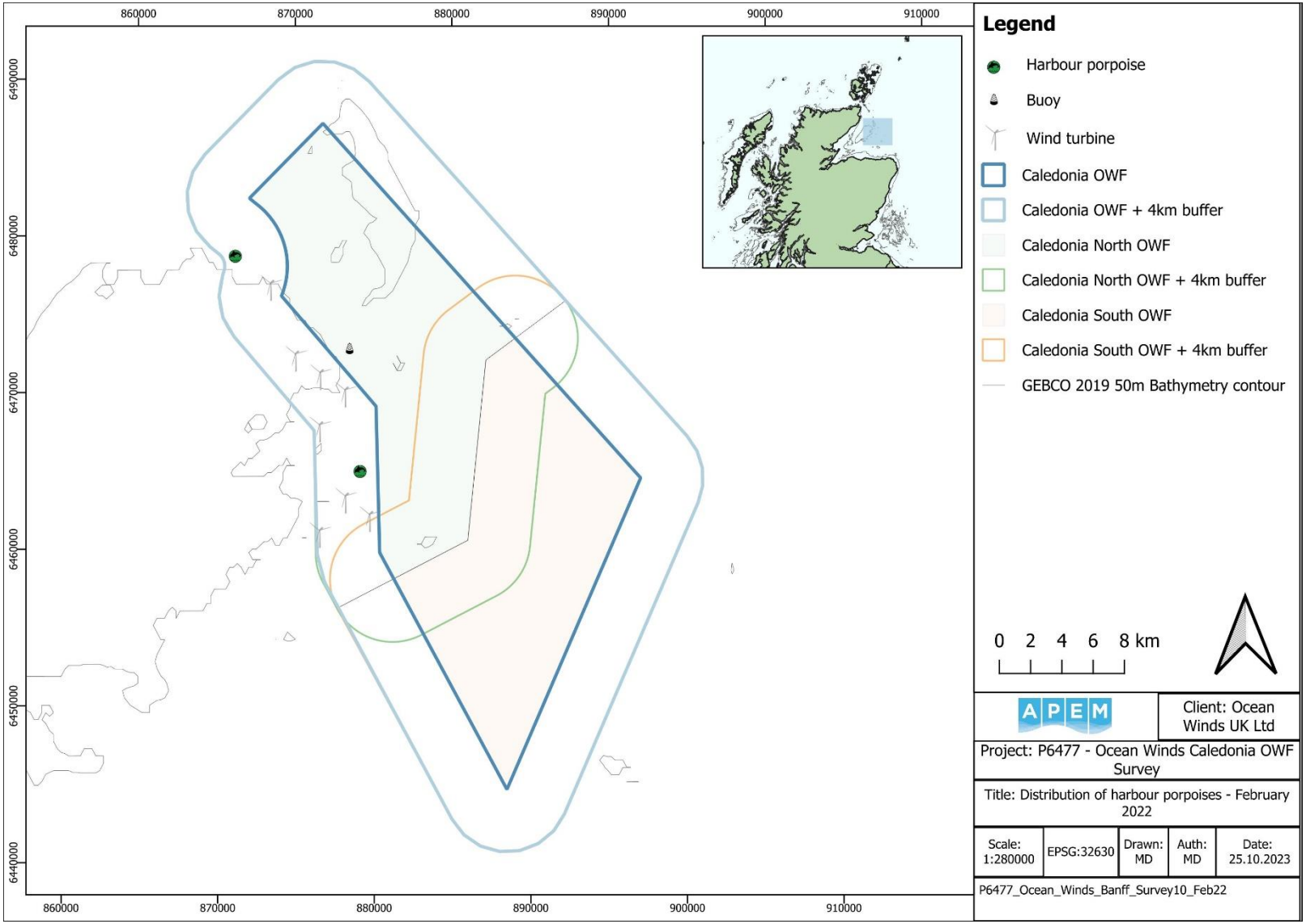


Figure A4.397 Distribution of harbour porpoises recorded in the Survey Area in February 2022

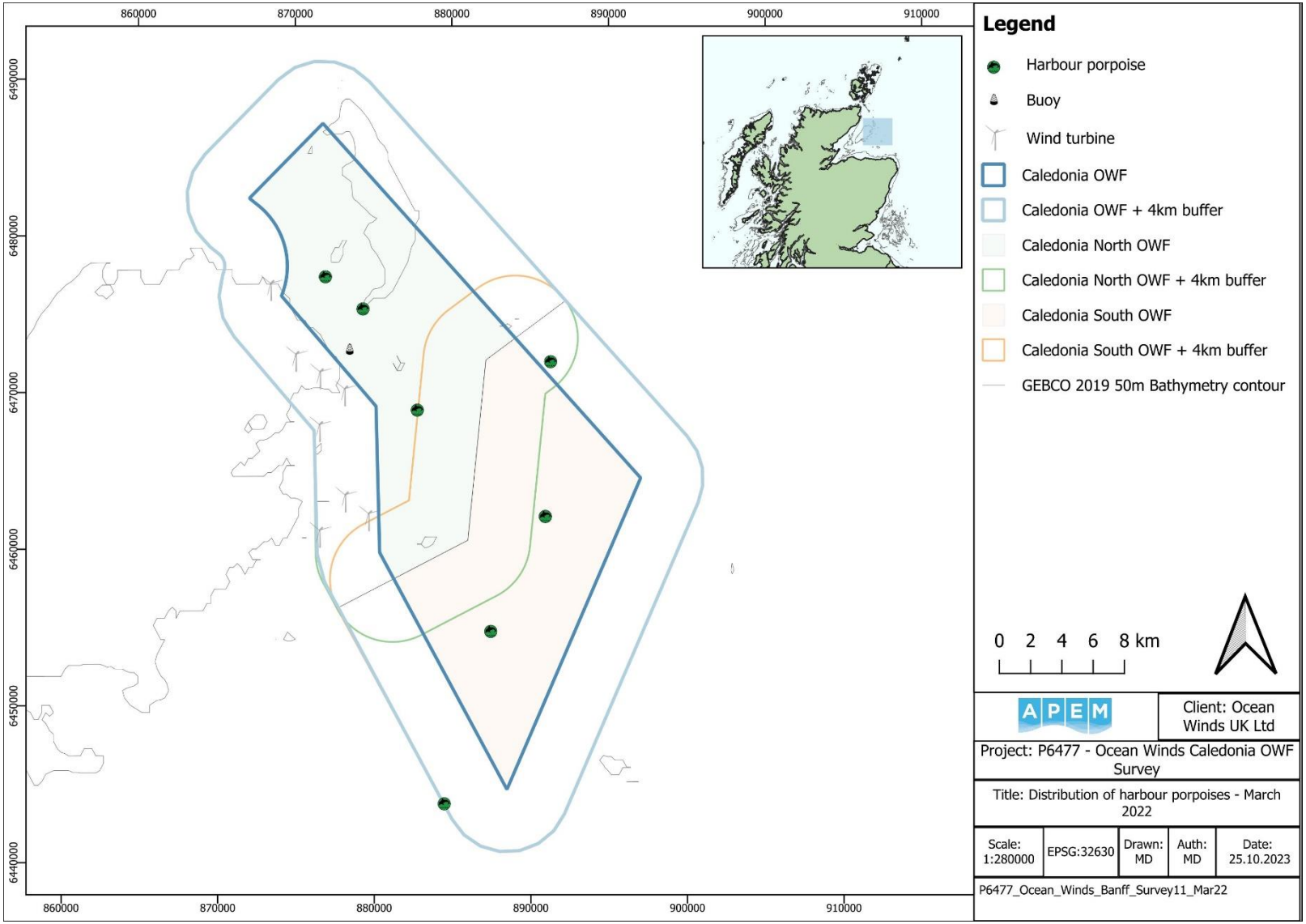


Figure A4.398 Distribution of harbour porpoises recorded in the Survey Area in March 2022

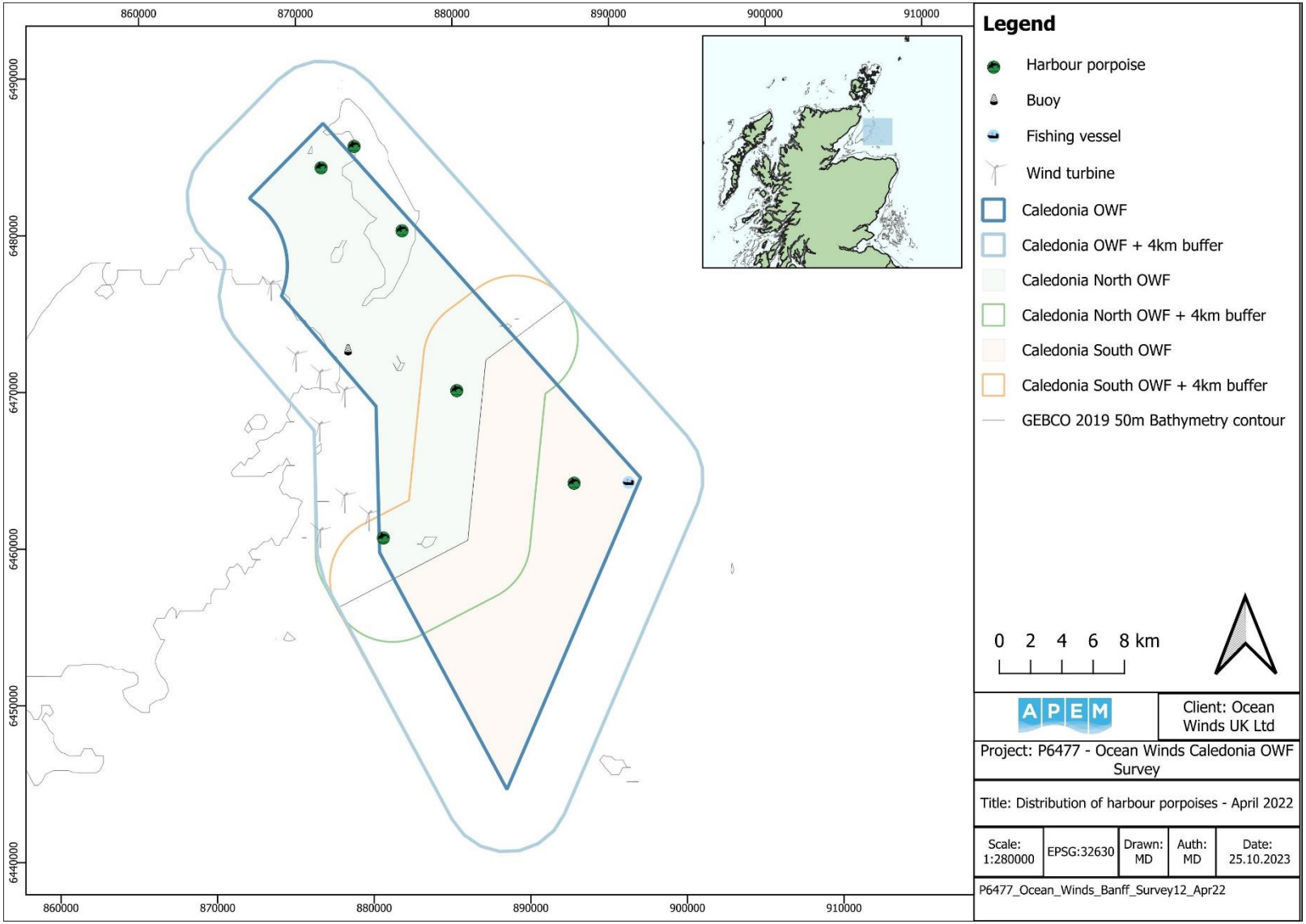


Figure A4.399 Distribution of harbour porpoises recorded in the Survey Area in April 2022

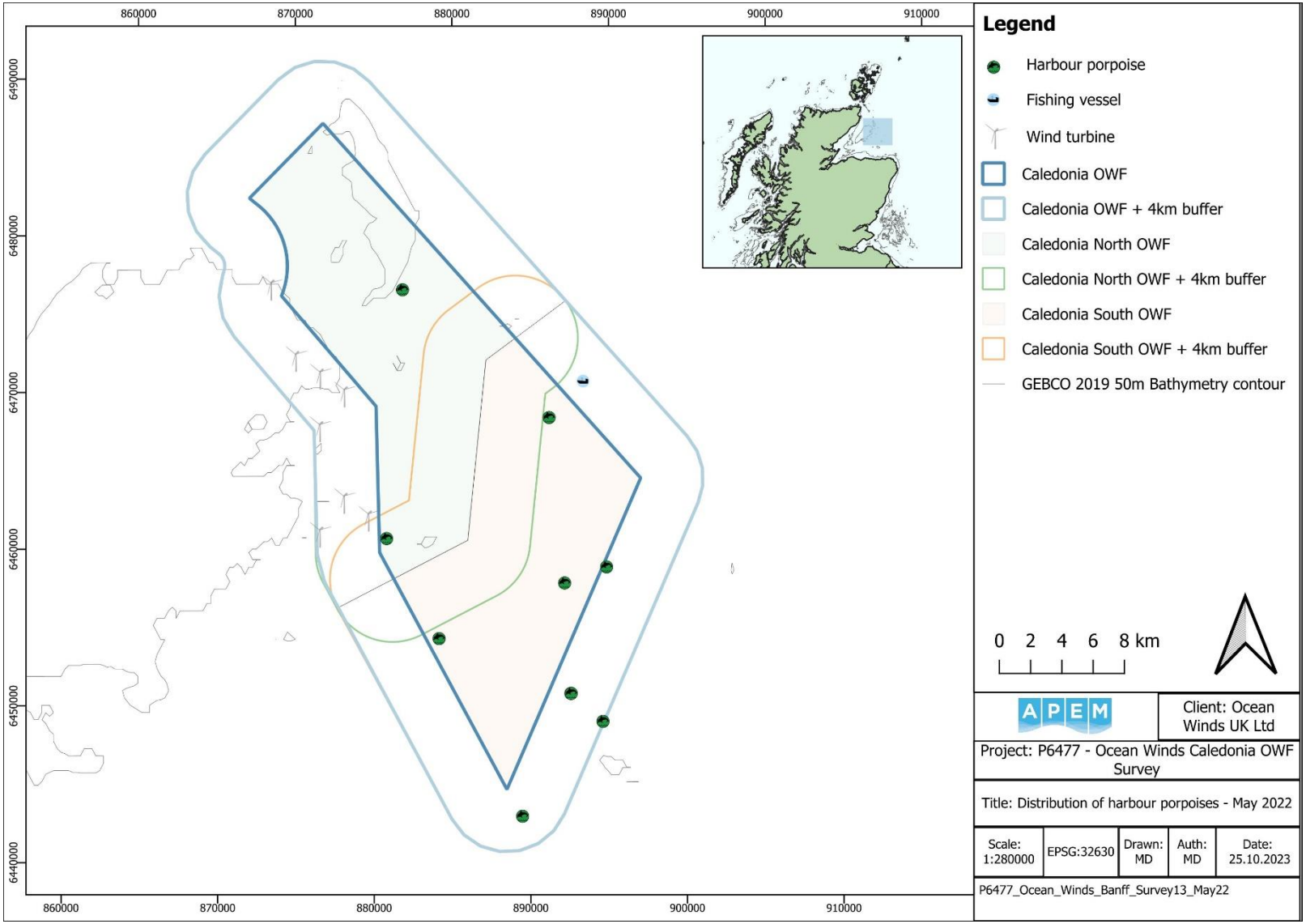


Figure A4.400 Distribution of harbour porpoises recorded in the Survey Area in May 2022

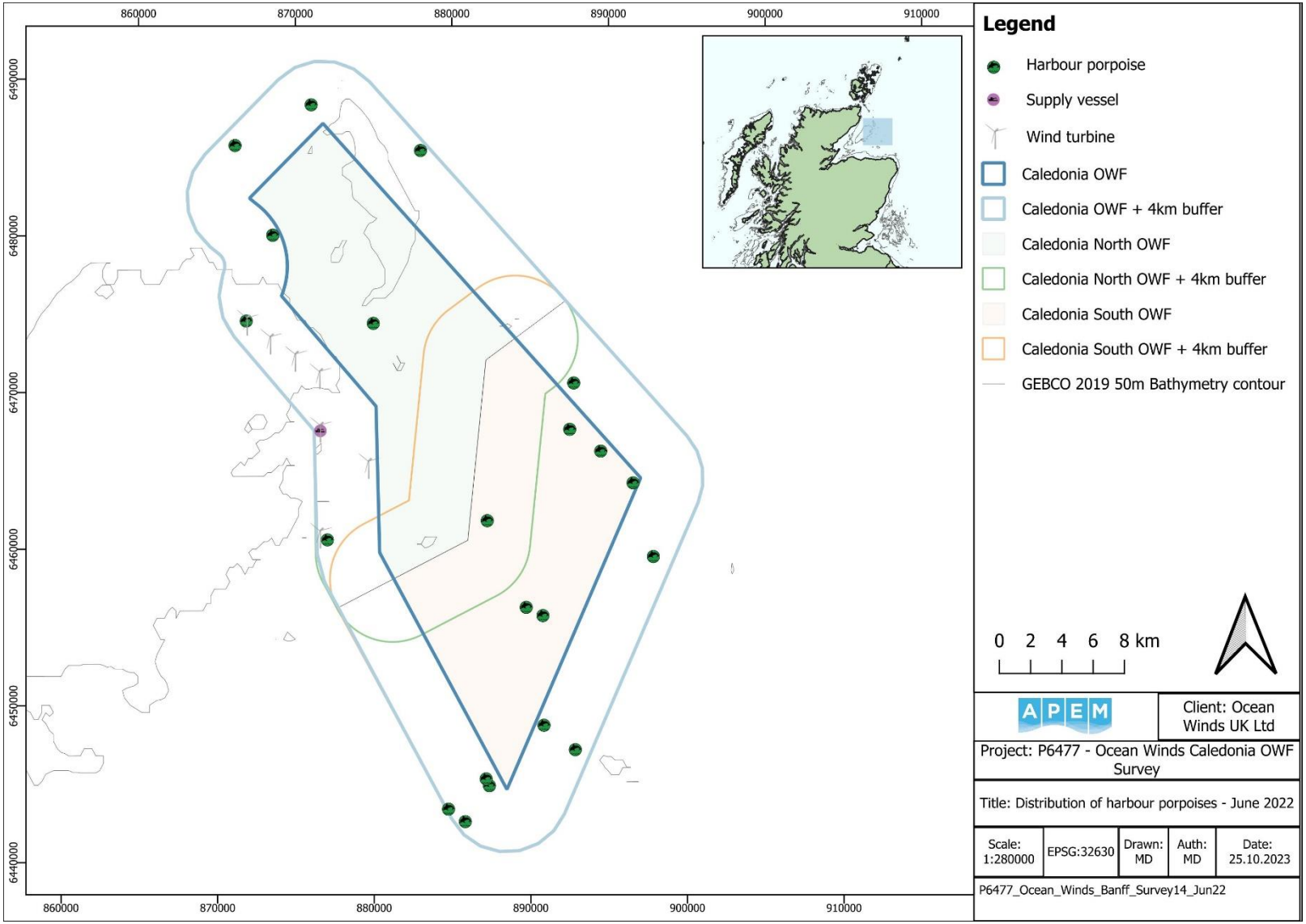


Figure A4.401 Distribution of harbour porpoises recorded in the Survey Area in June 2022

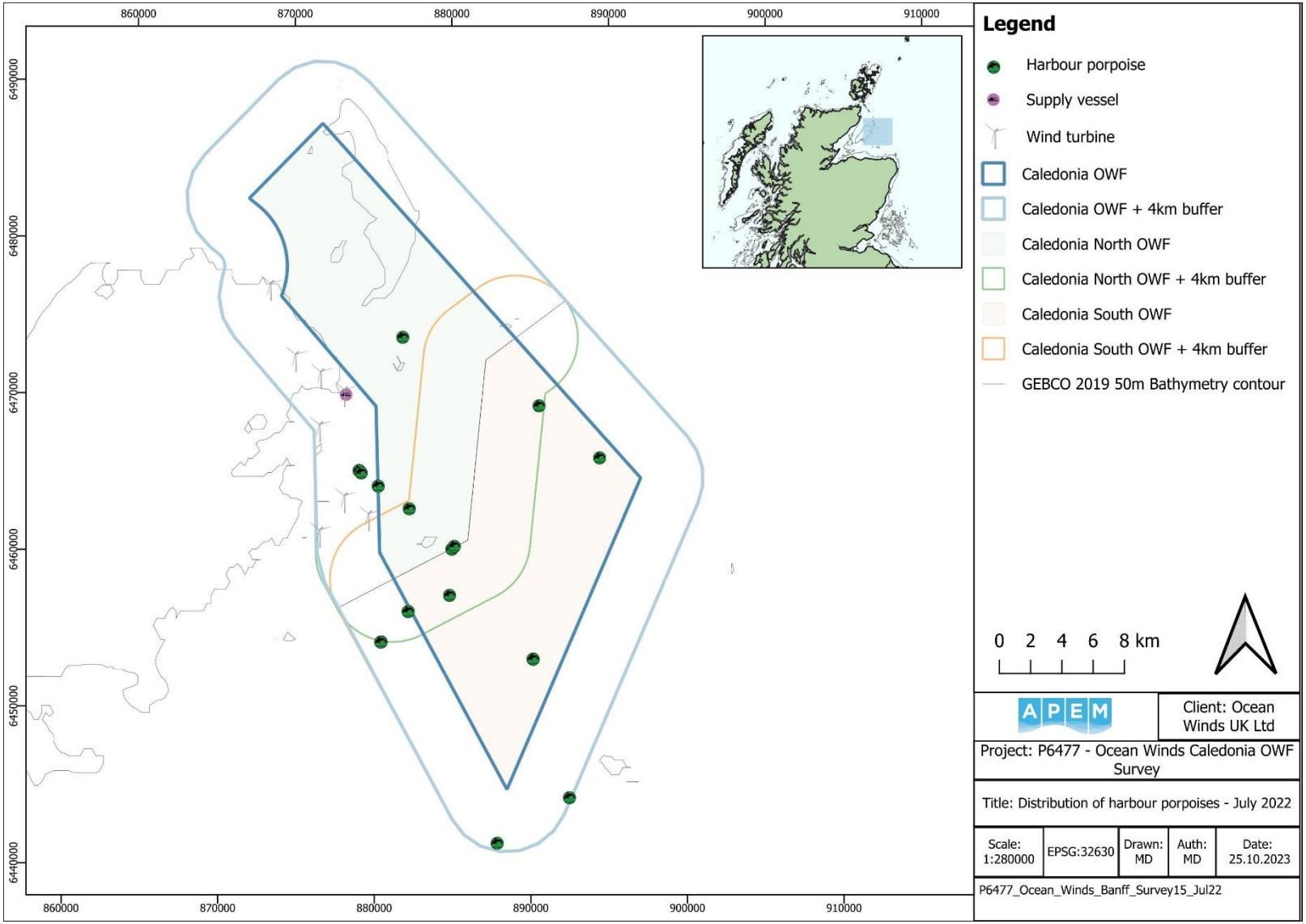


Figure A4.402 Distribution of harbour porpoises recorded in the Survey Area in July 2022

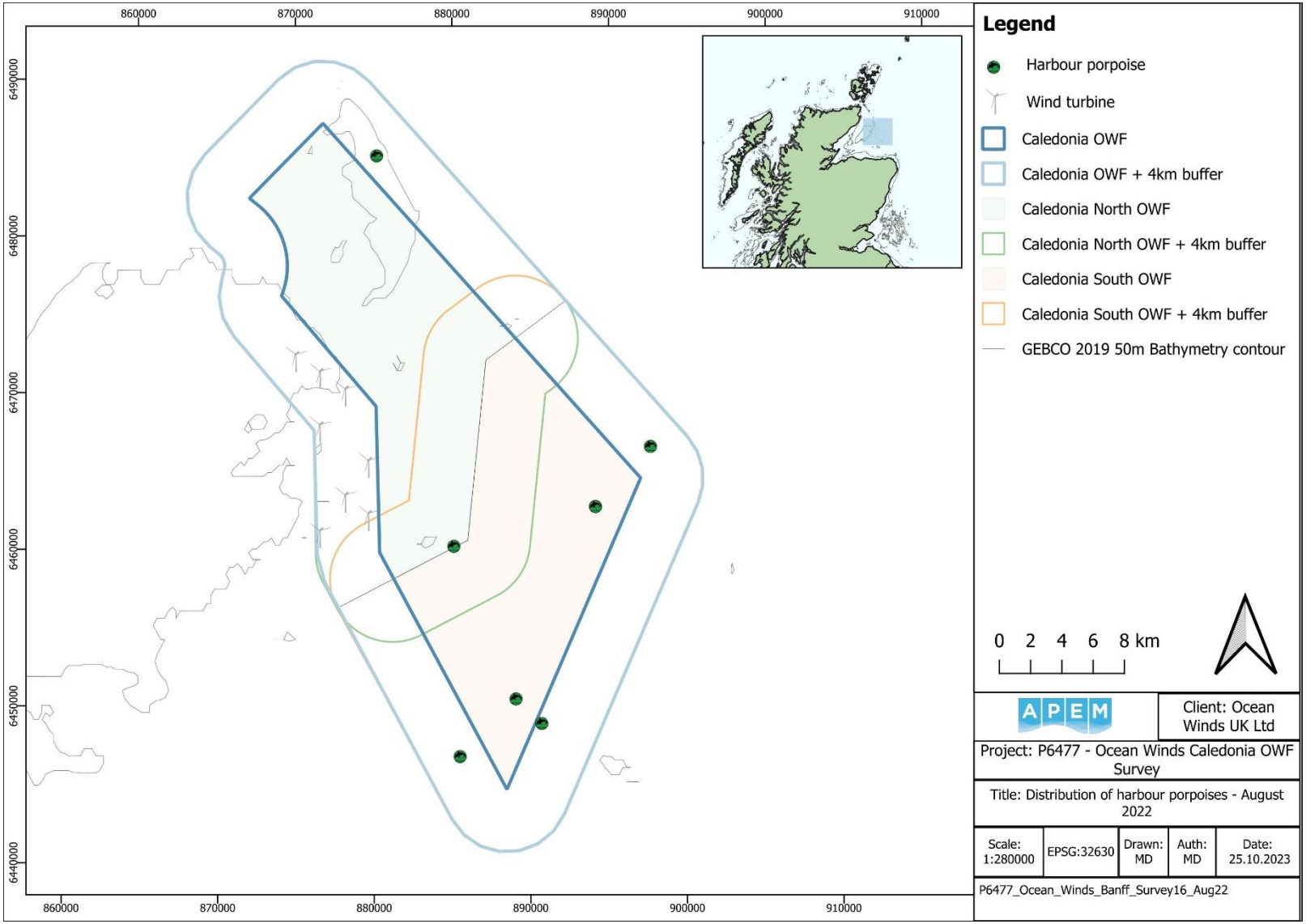


Figure A4.403 Distribution of harbour porpoises recorded in the Survey Area in August 2022

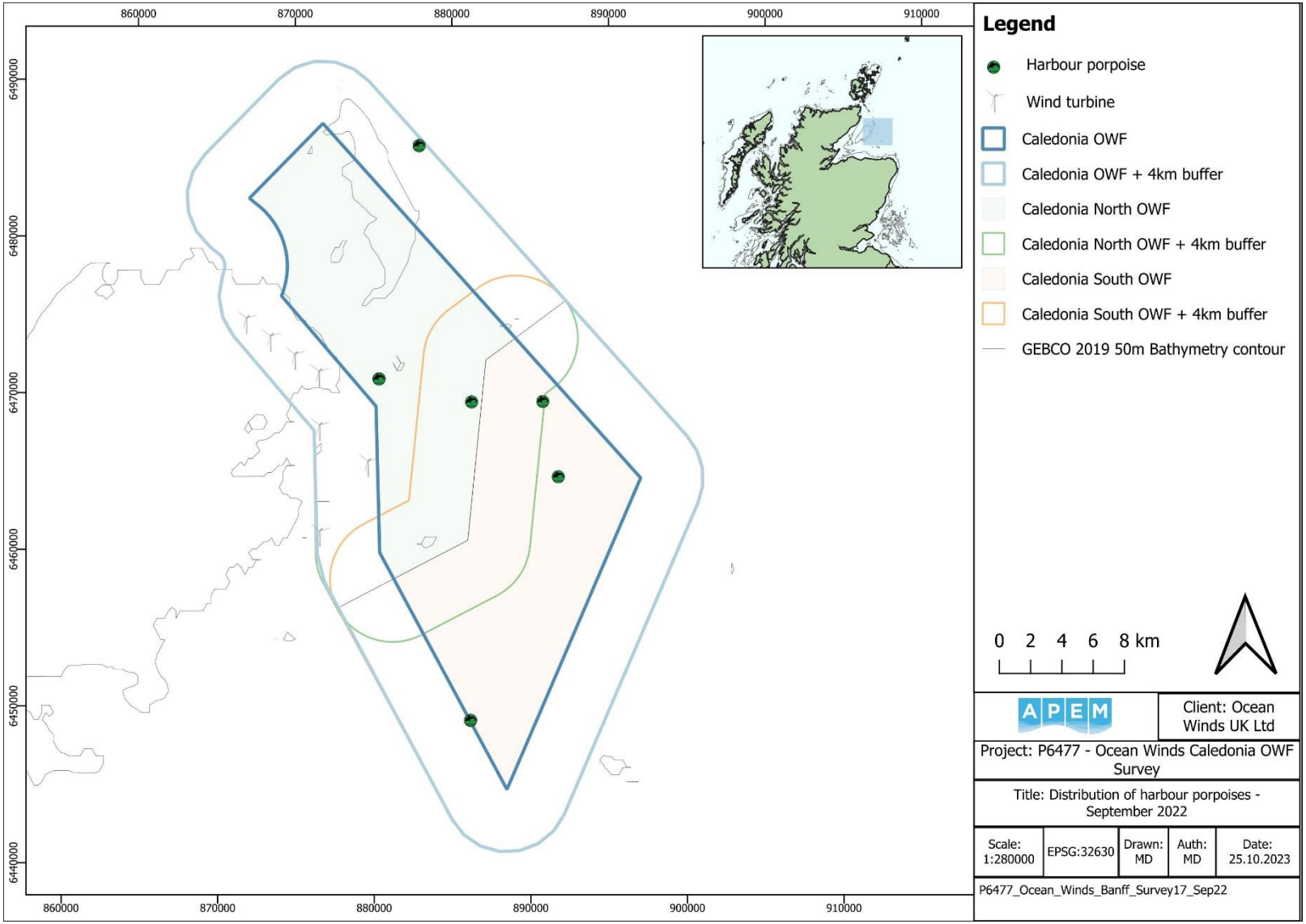


Figure A4.404 Distribution of harbour porpoises recorded in the Survey Area in September 2022

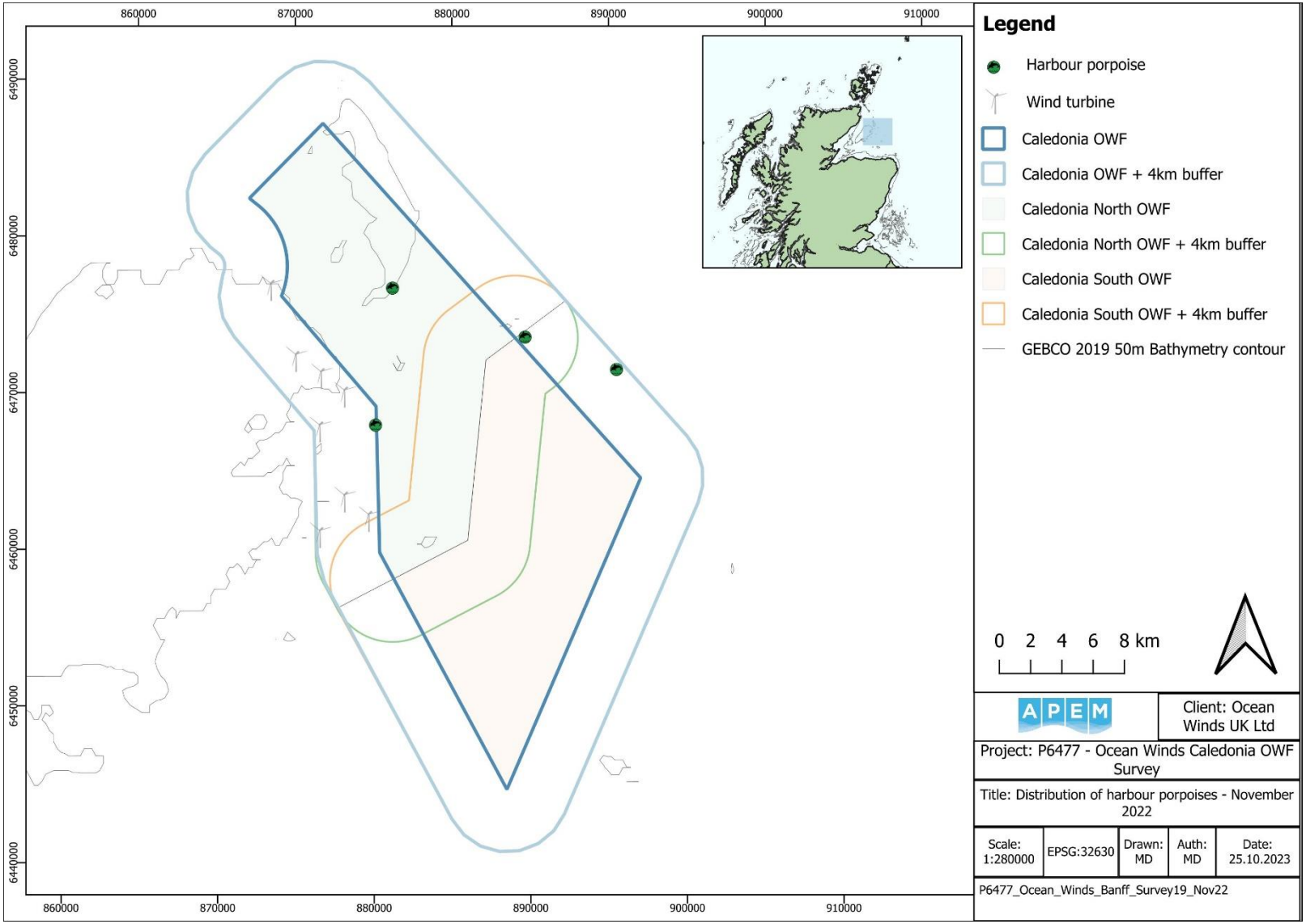


Figure A4.405 Distribution of harbour porpoises recorded in the Survey Area in November 2022

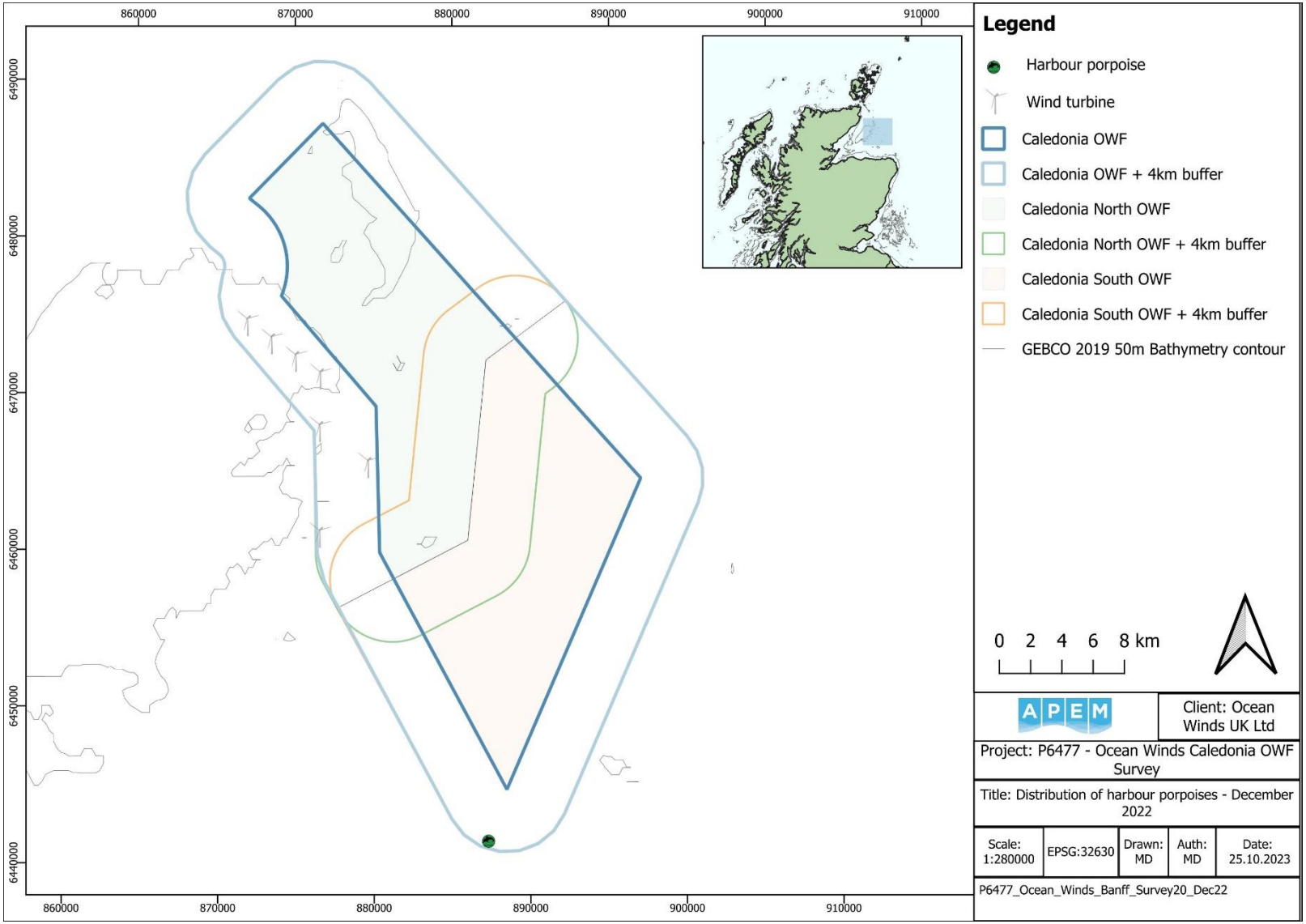


Figure A4.406 Distribution of harbour porpoises recorded in the Survey Area in December 2022

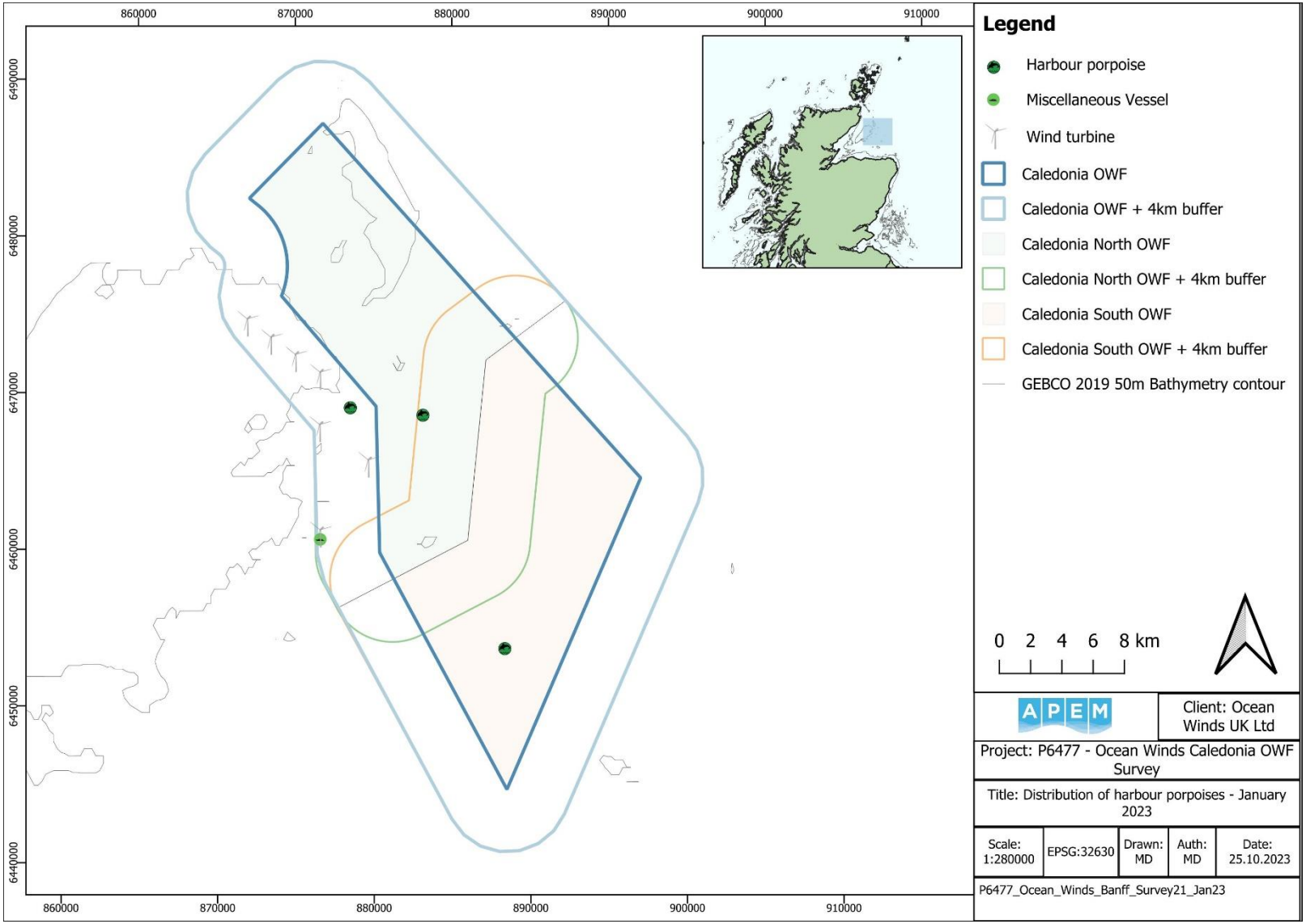


Figure A4.407 Distribution of harbour porpoises recorded in the Survey Area in January 2023

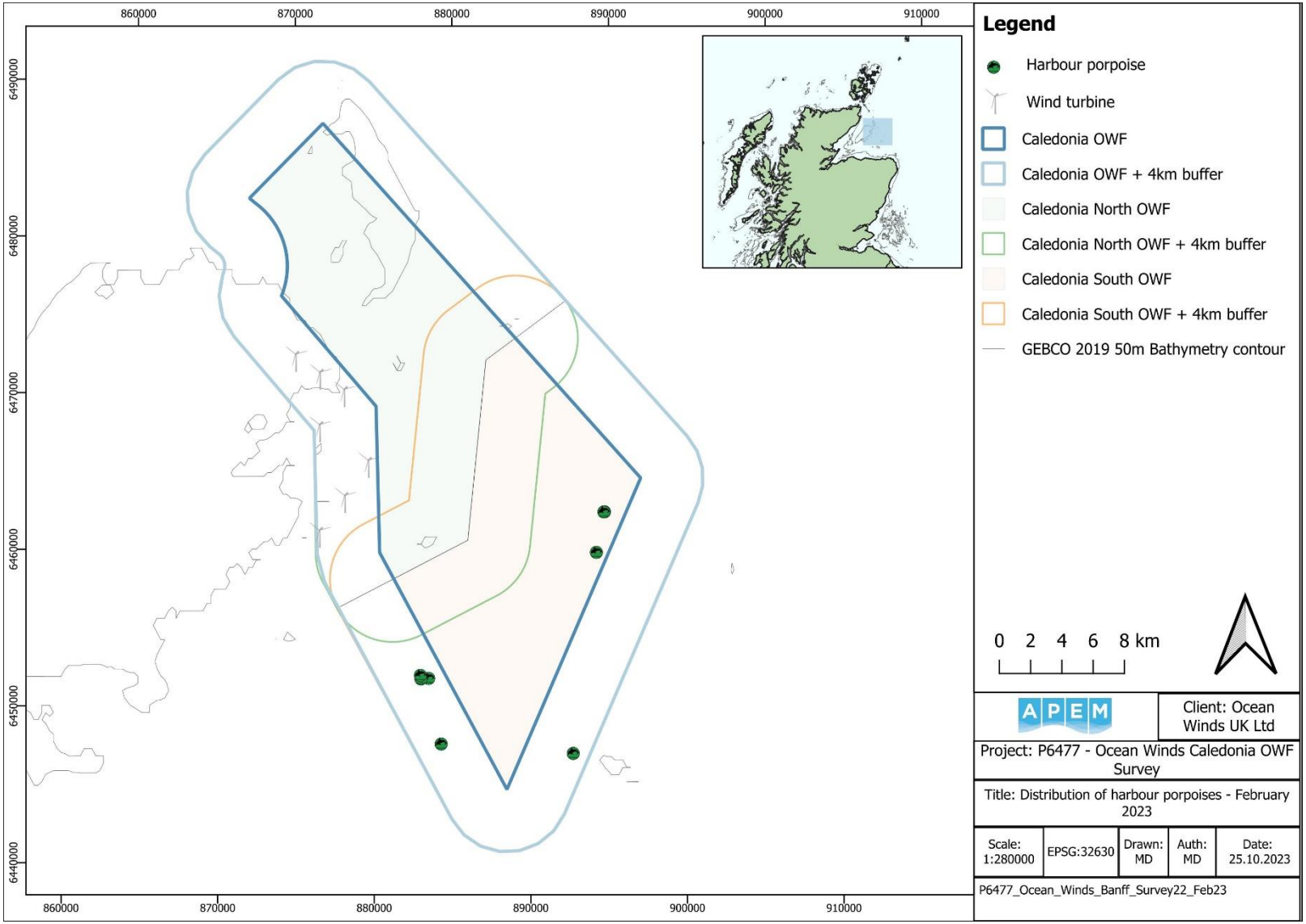


Figure A4.408 Distribution of harbour porpoises recorded in the Survey Area in February 2023

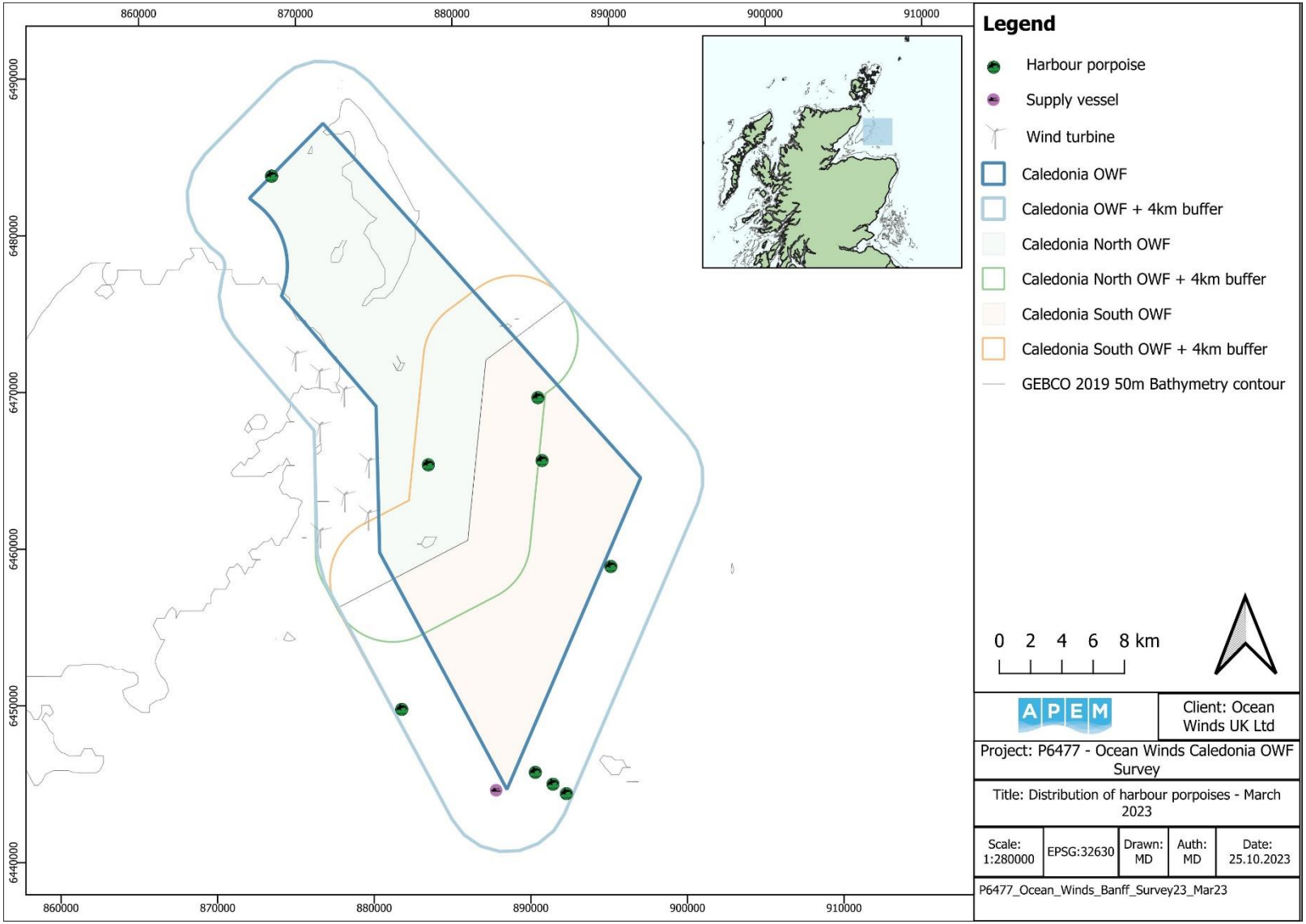


Figure A4.409 Distribution of harbour porpoises recorded in the Survey Area in March 2023

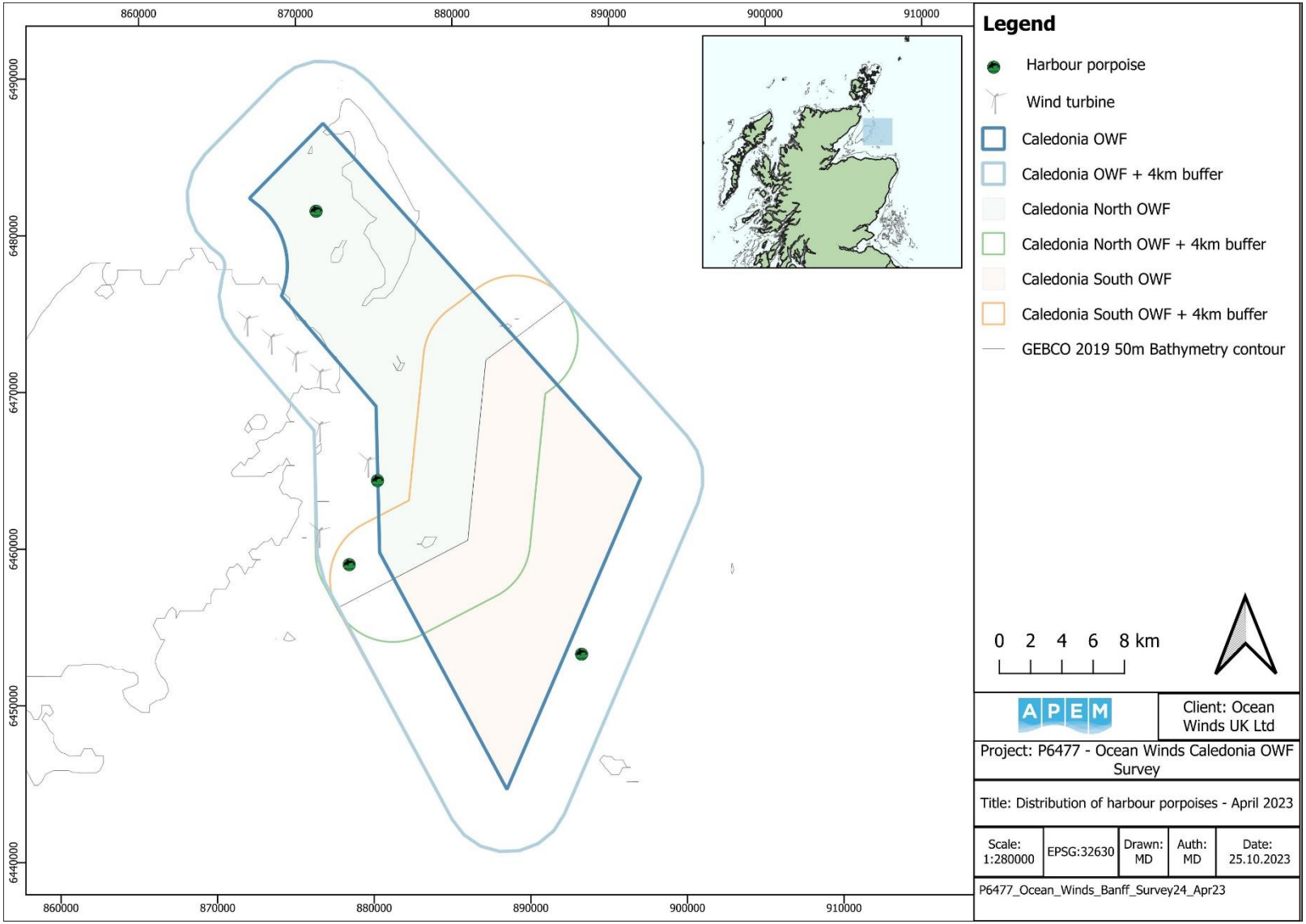


Figure A4.410 Distribution of harbour porpoises recorded in the Survey Area in April 2023

Unidentified dolphin and / or porpoise species

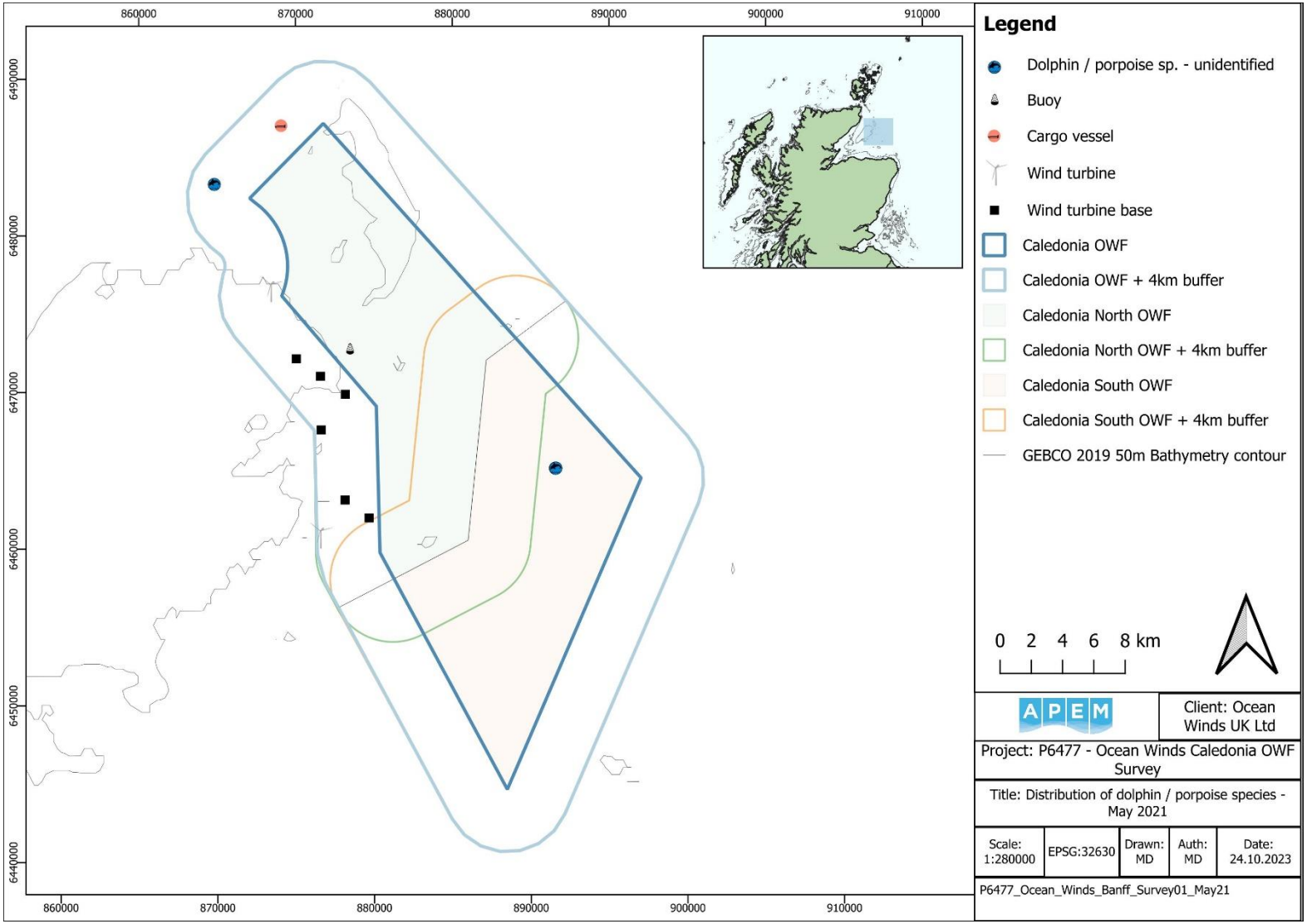


Figure A4.411 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in May 2021

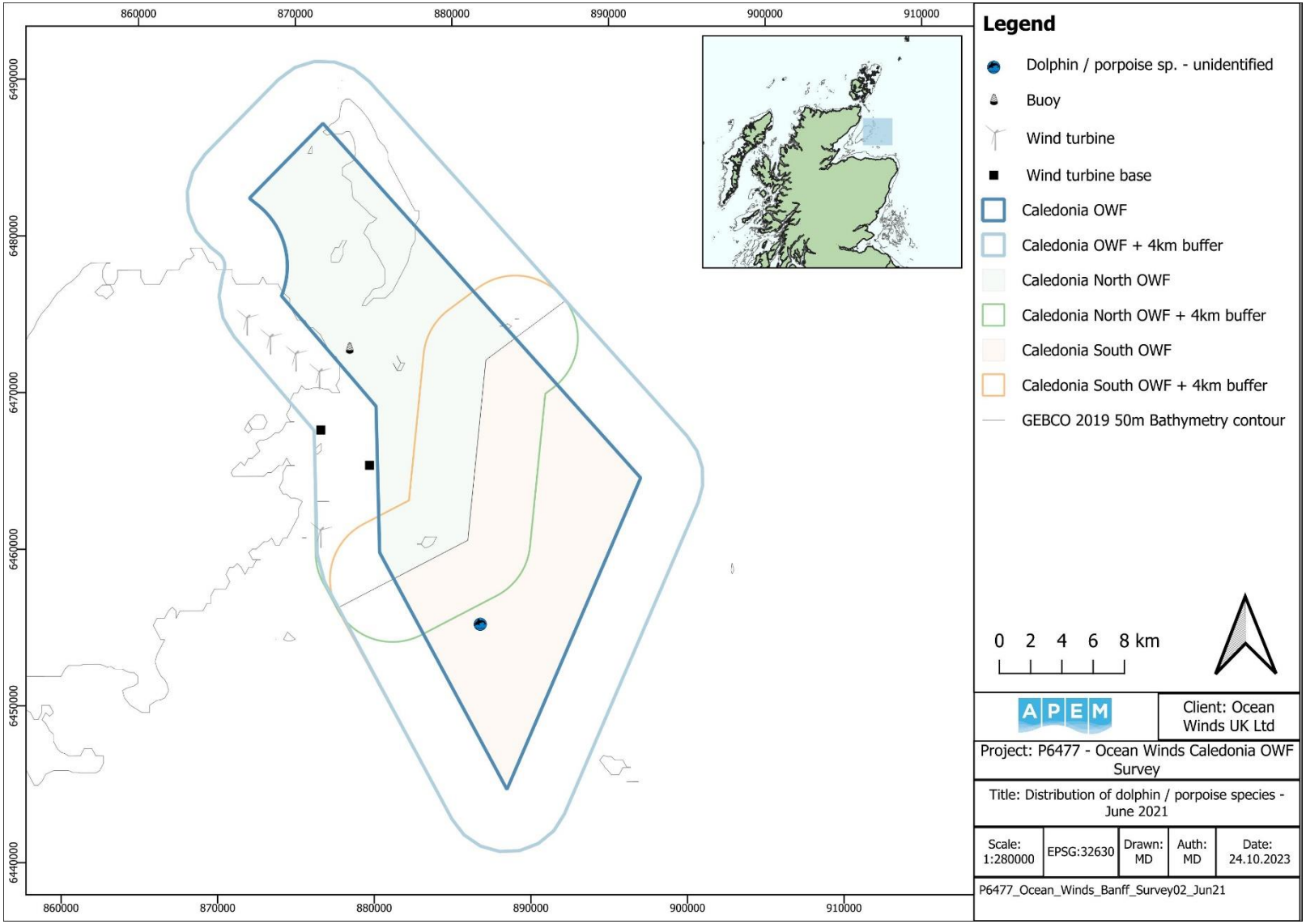


Figure A4.412 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in June 2021

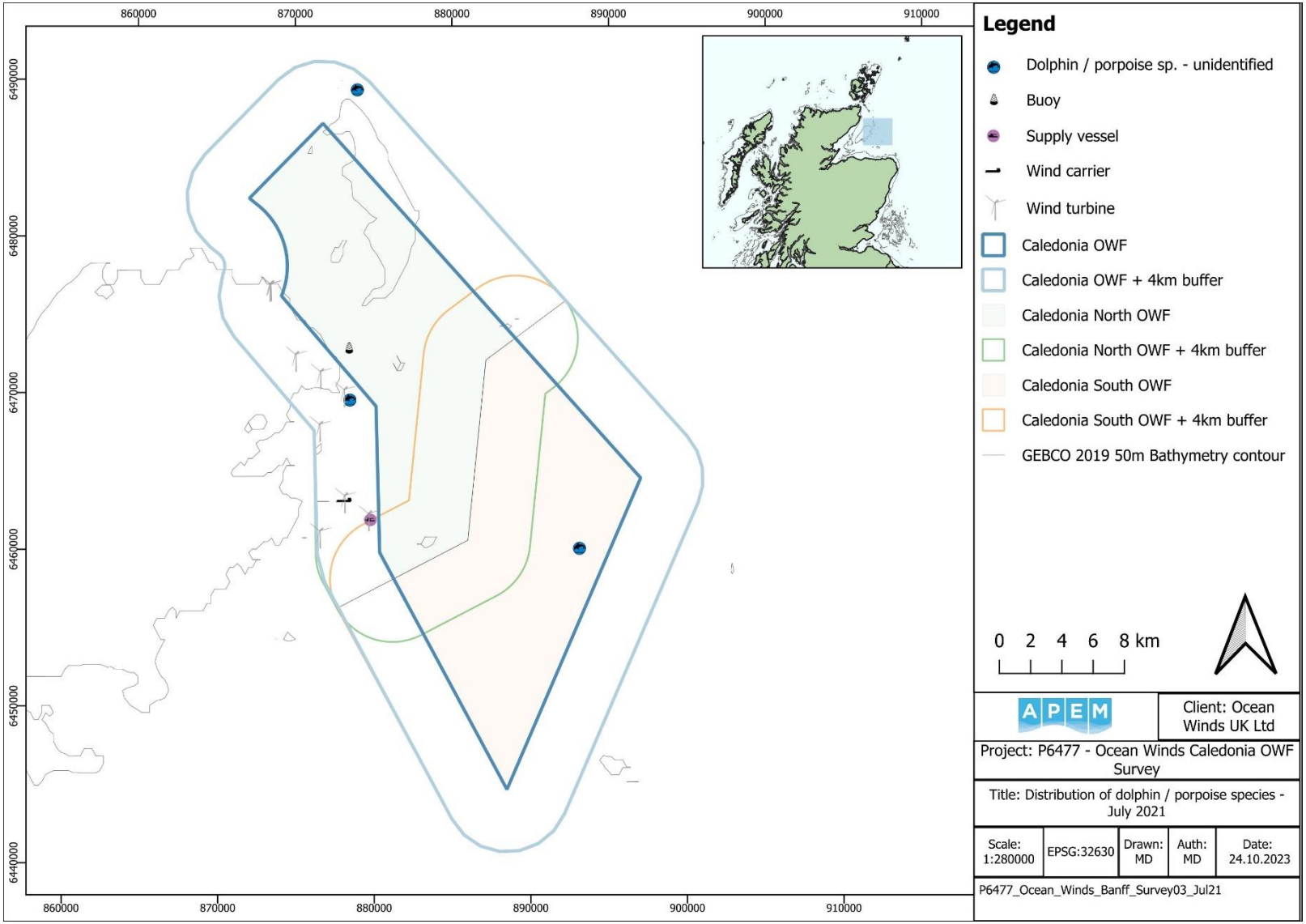


Figure A4.413 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in July 2021

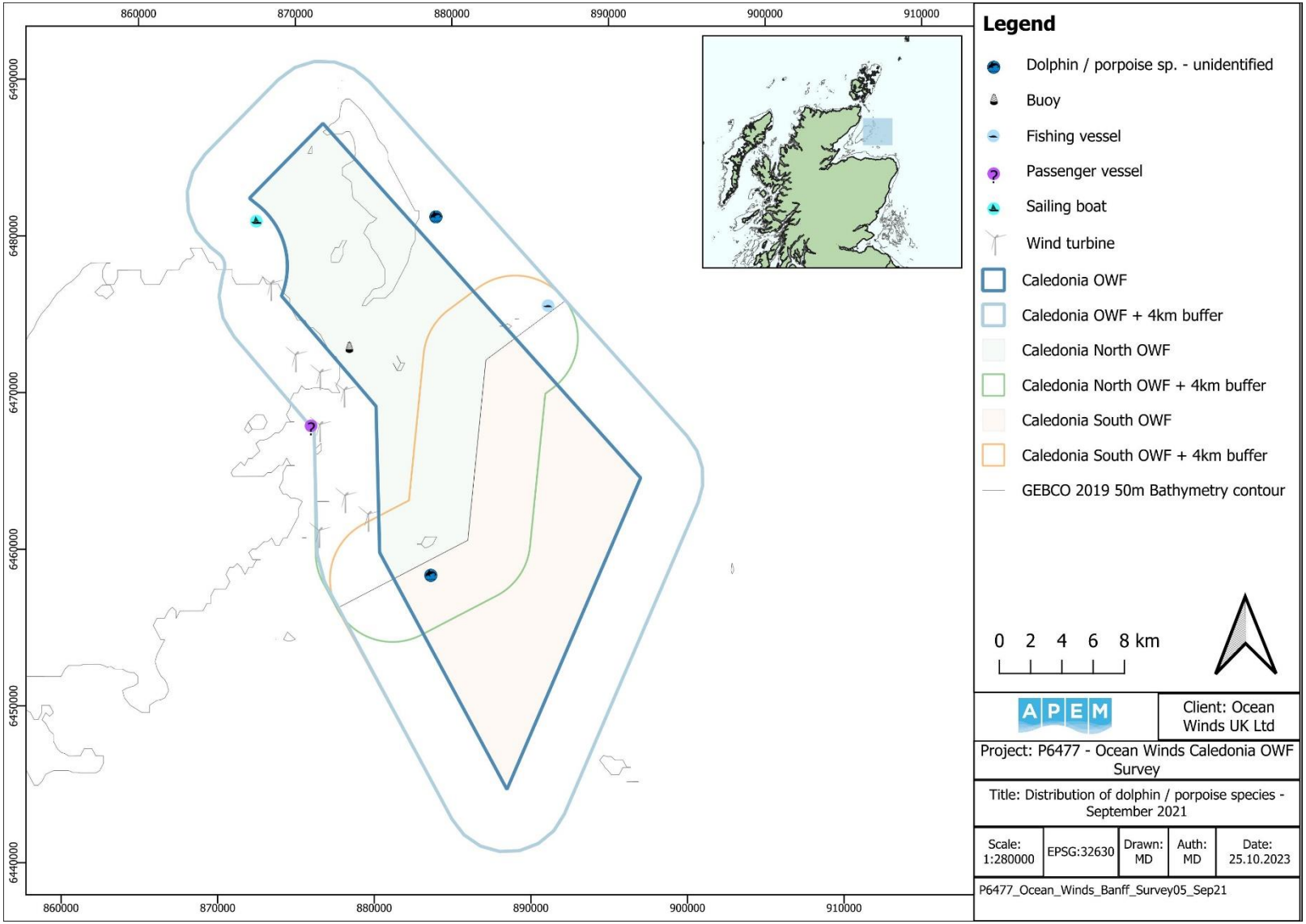


Figure A4.414 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in September 2021

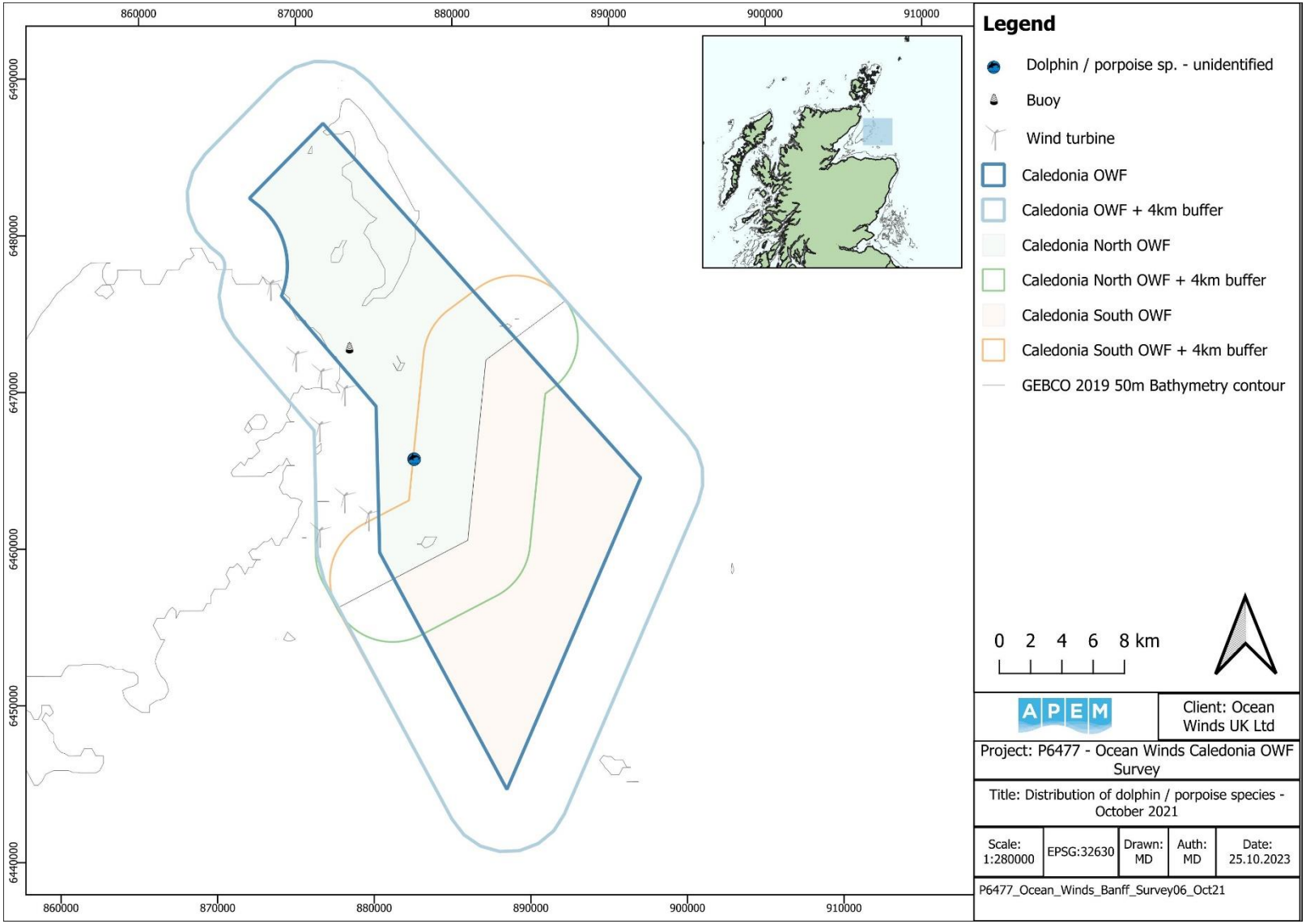


Figure A4.415 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in October 2021

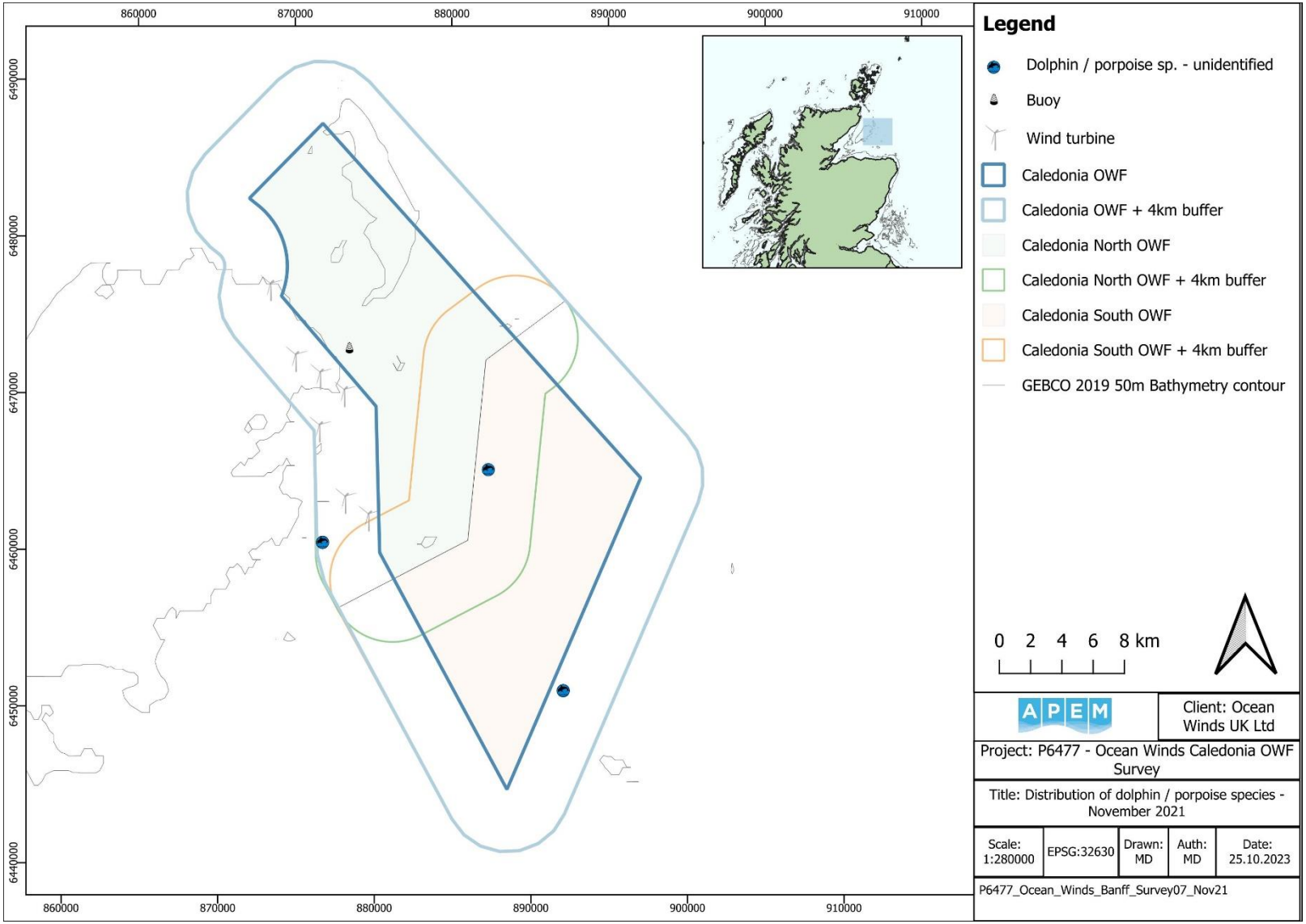


Figure A4.416 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in November 2021

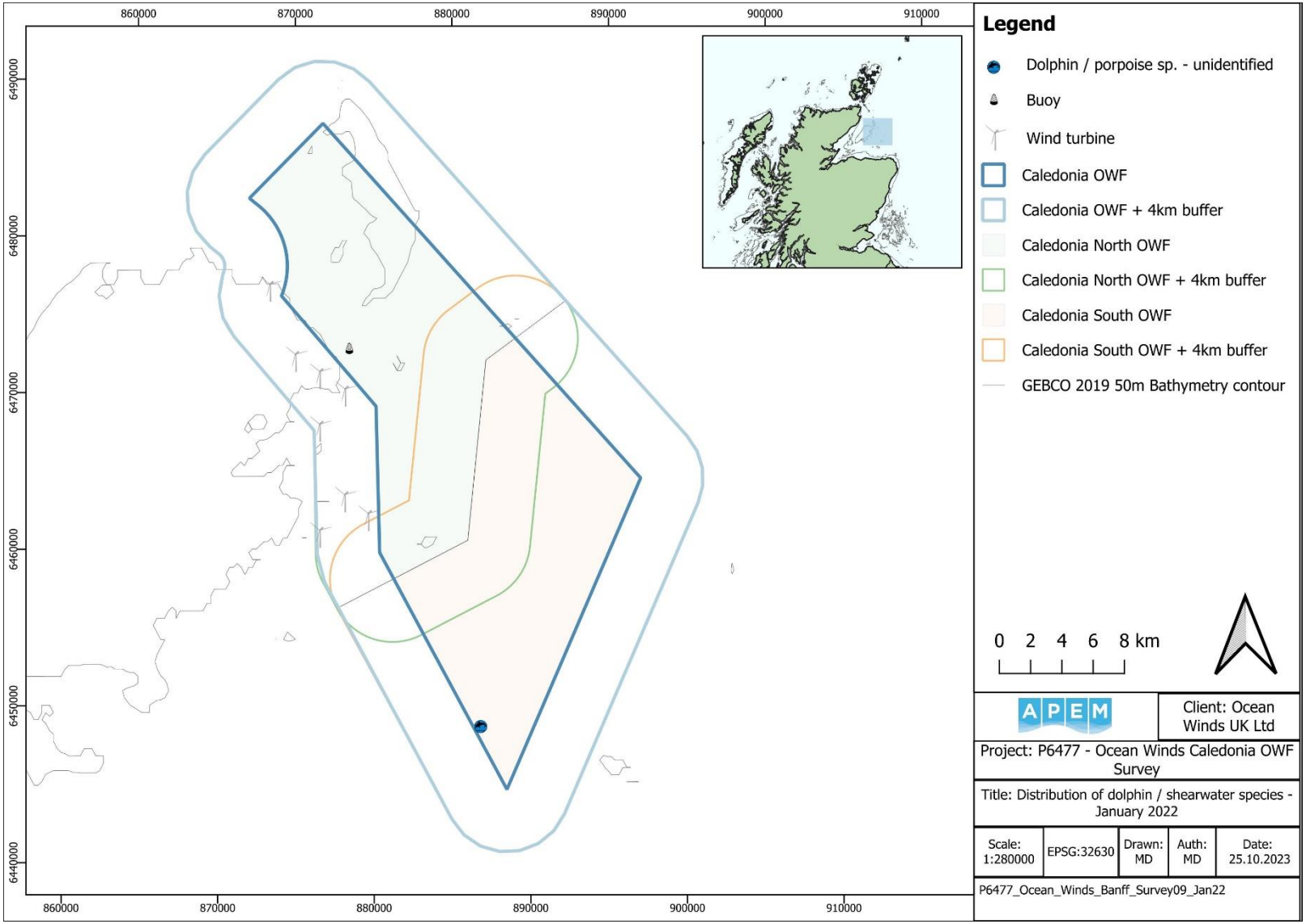


Figure A4.417 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in January 2022

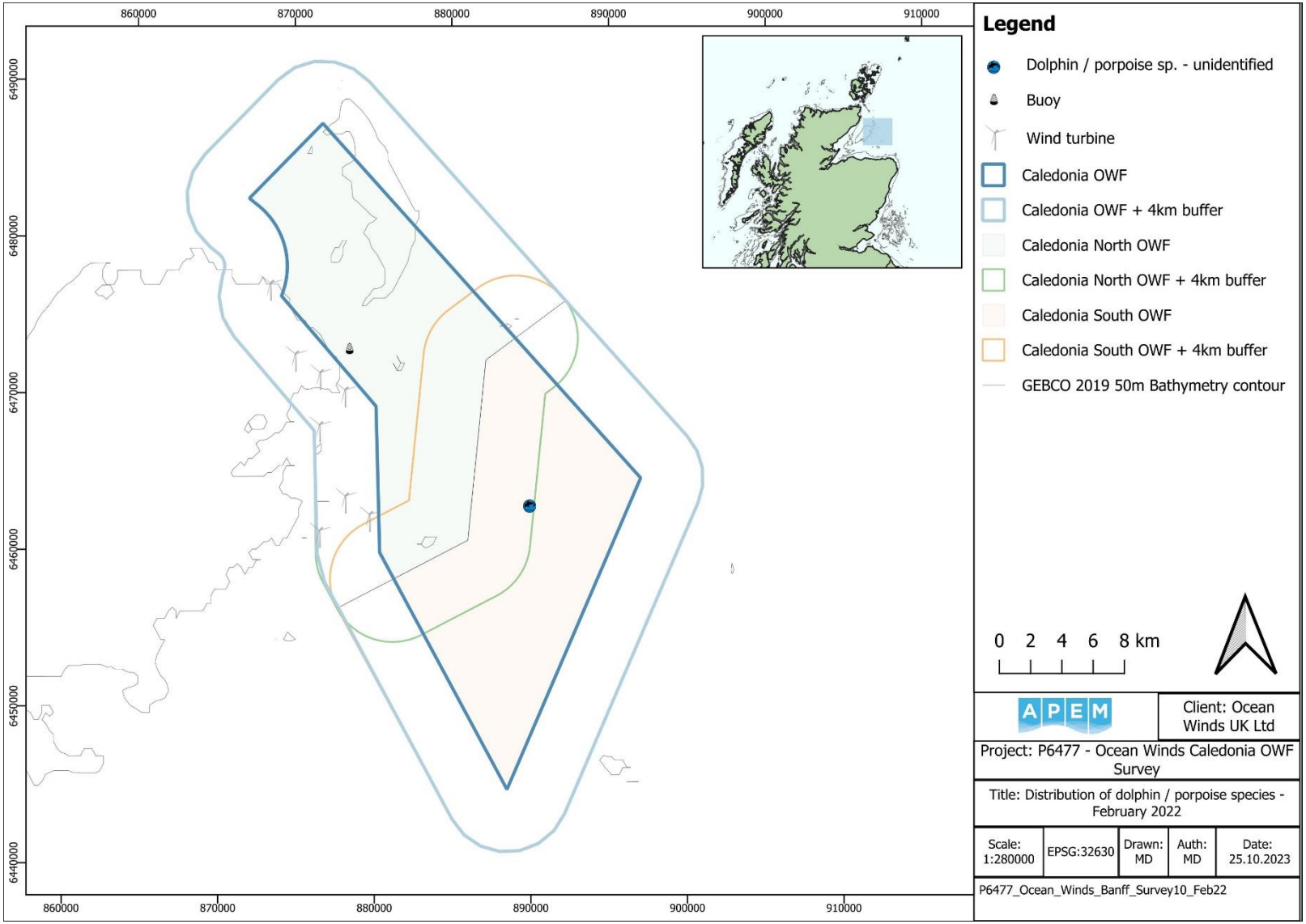


Figure A4.418 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in February 2022

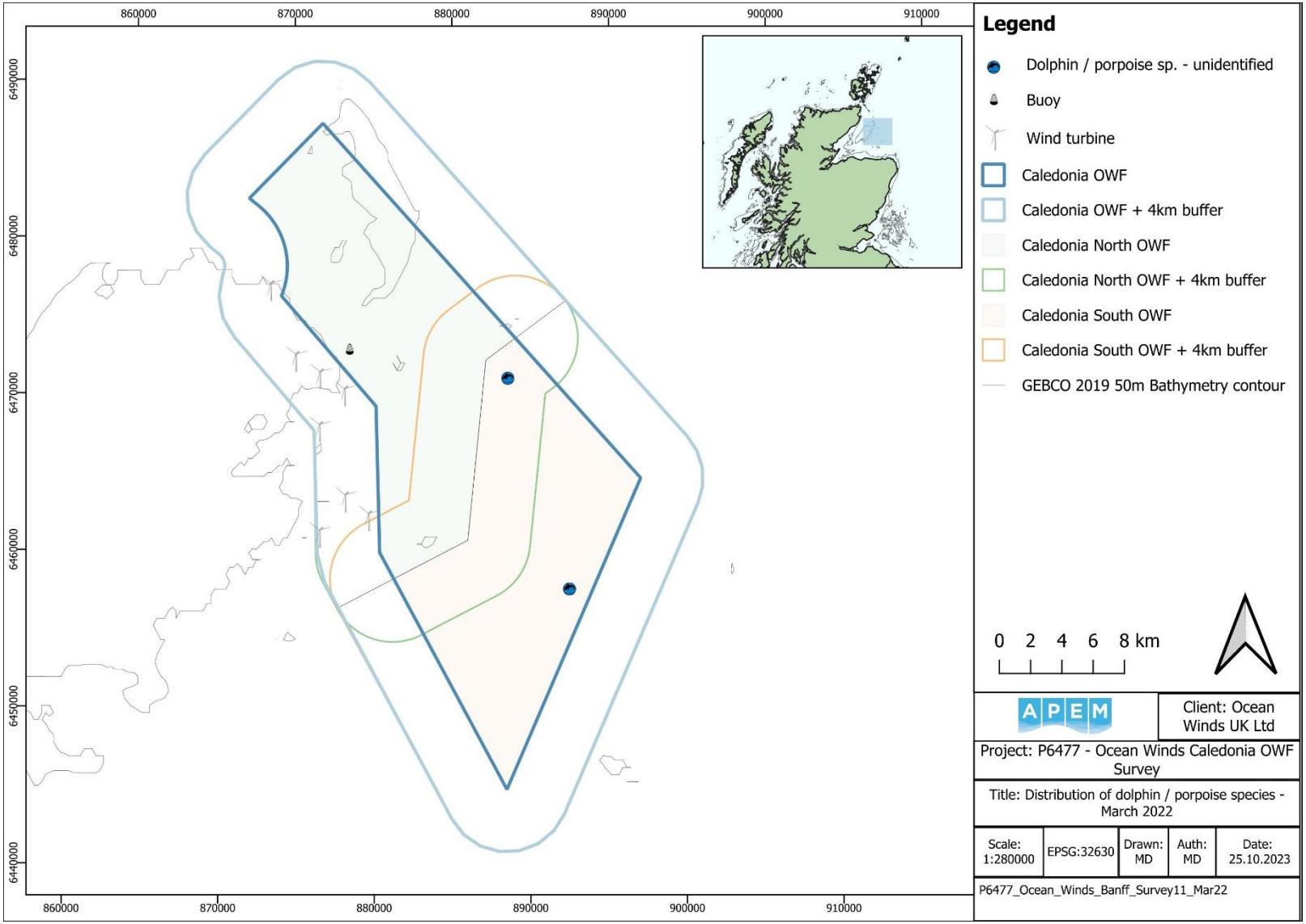


Figure A4.419 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in March 2022

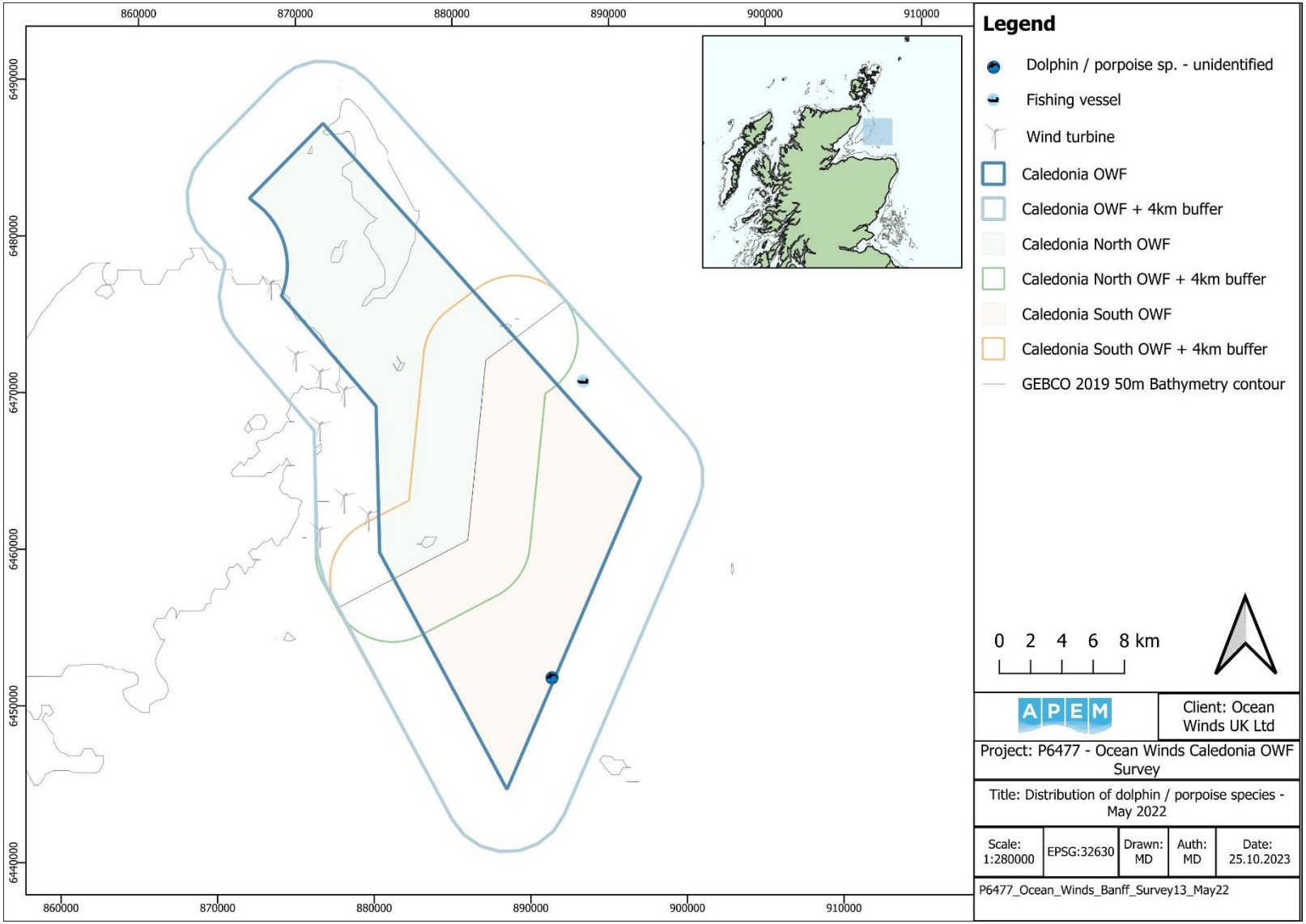


Figure A4.420 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in May 2022

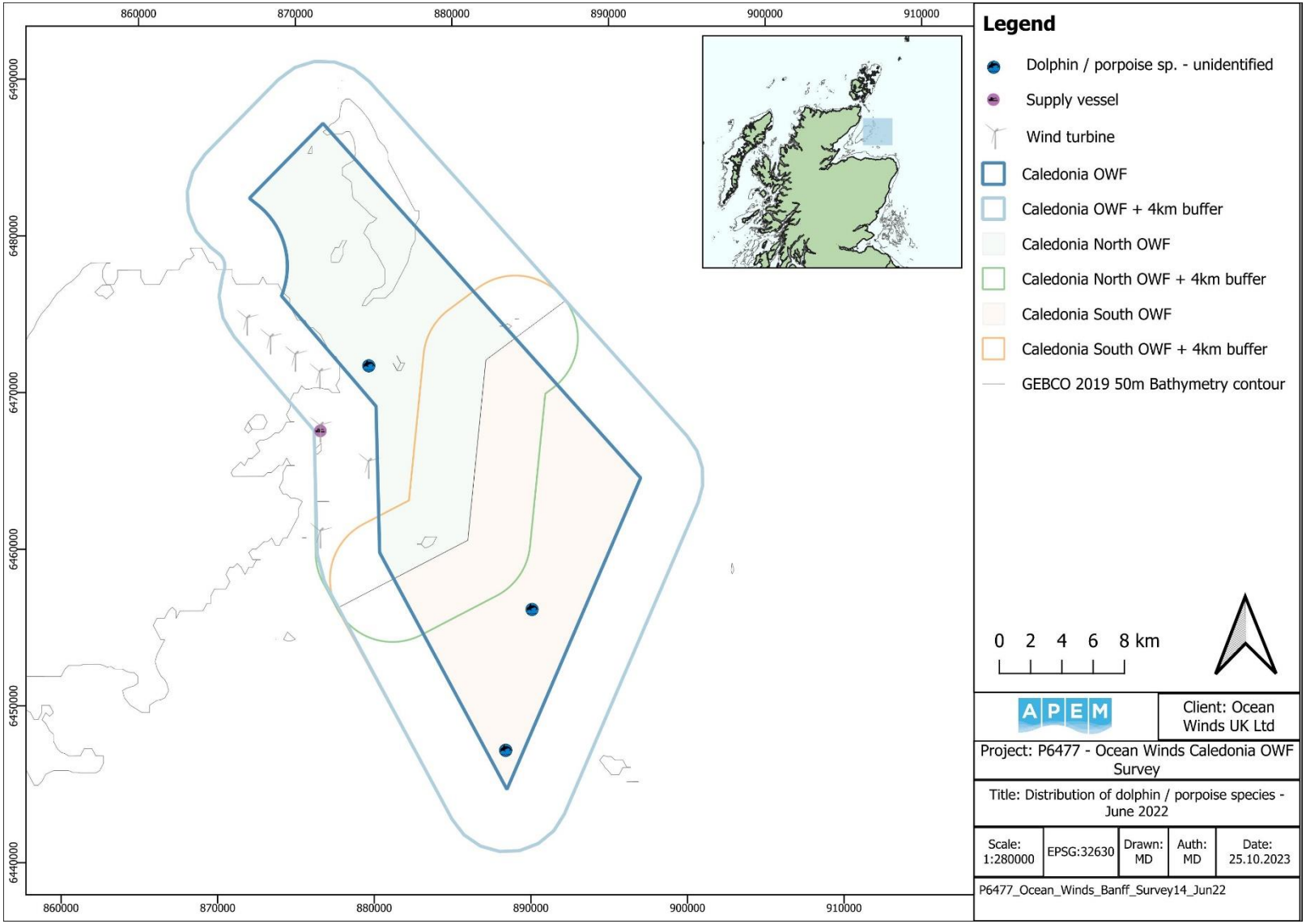


Figure A4.421 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in June 2022

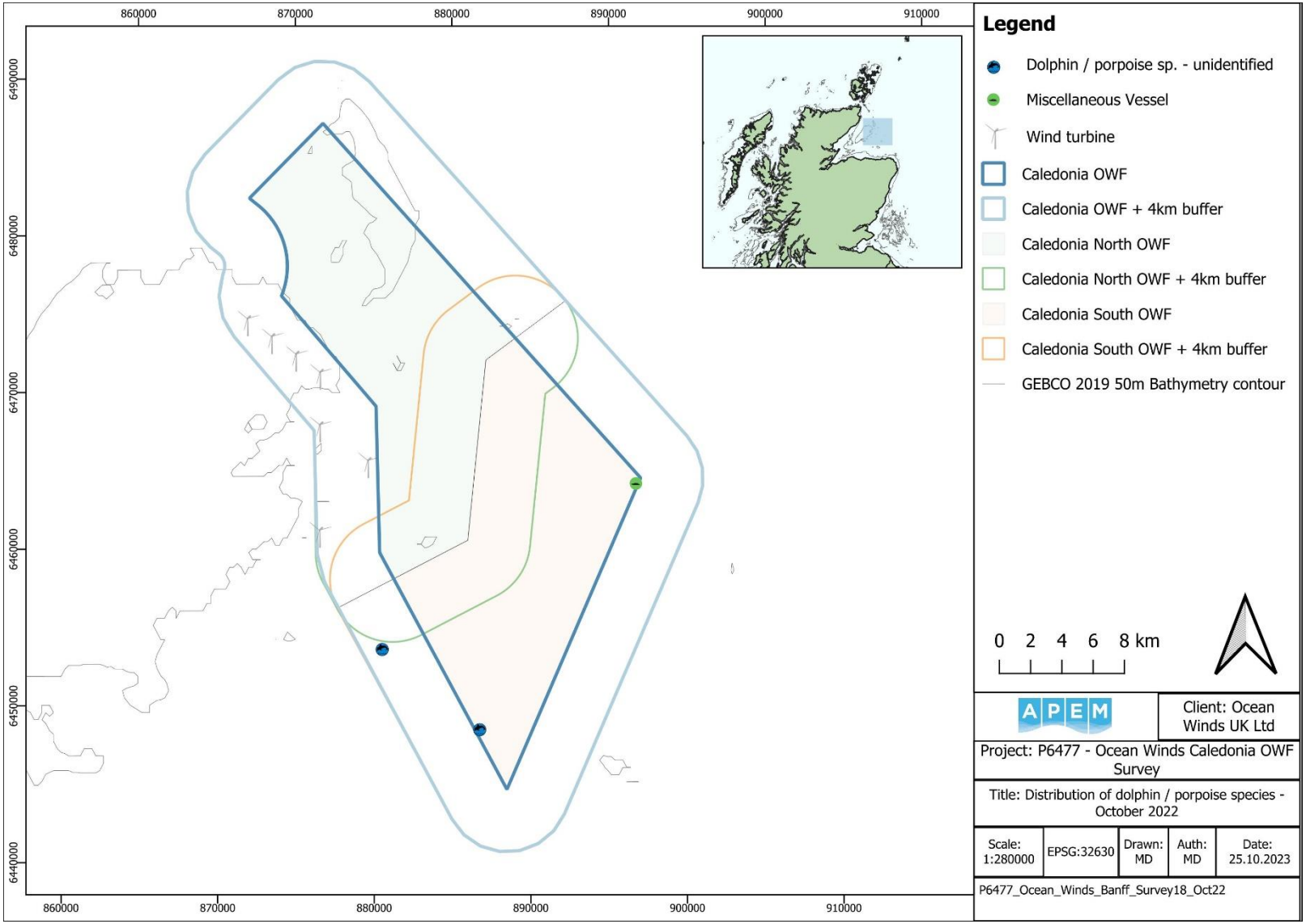


Figure A4.422 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in October 2022

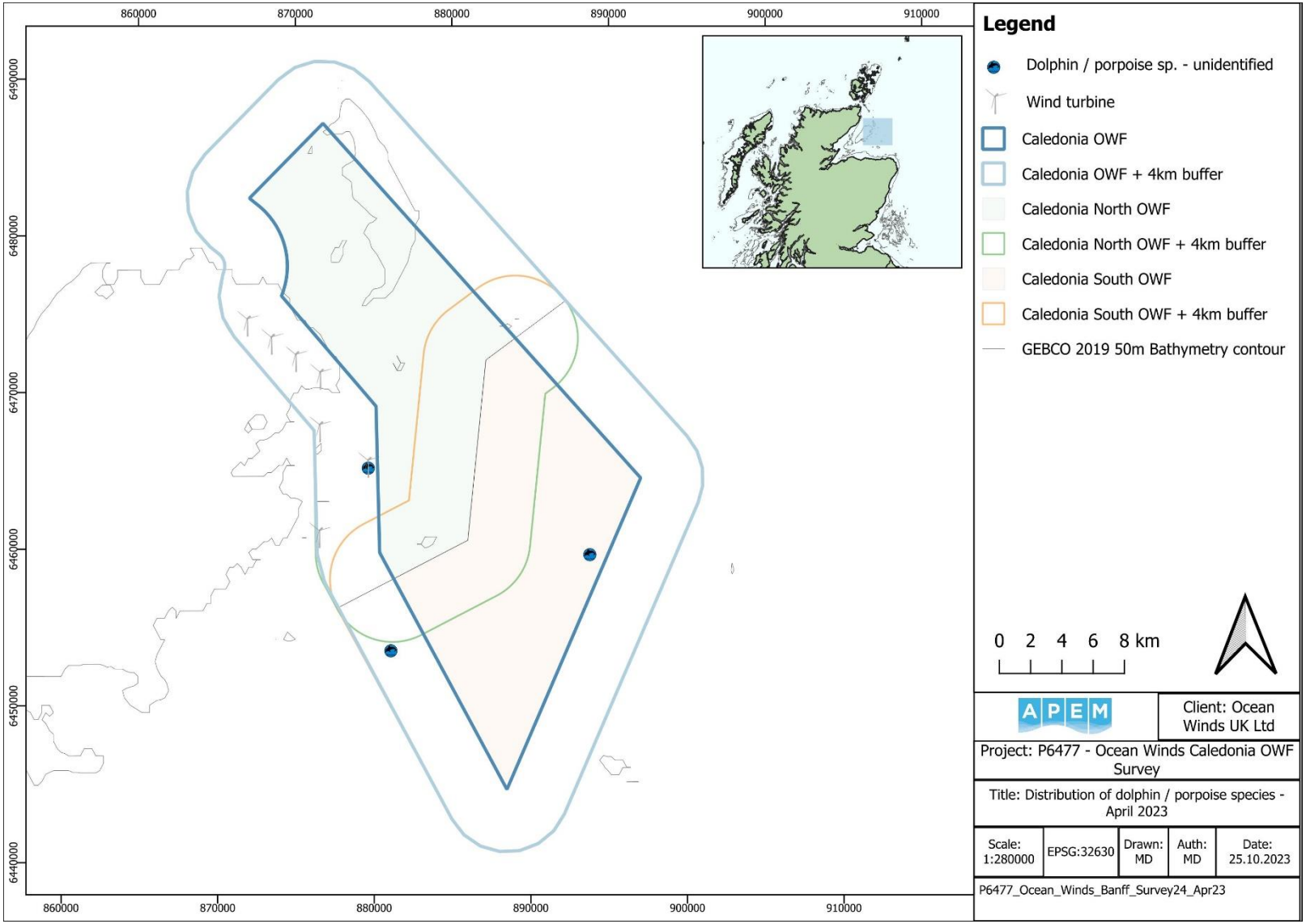


Figure A4.423 Distribution of unidentified dolphin / porpoise species recorded in the Survey Area in April 2023

Common minke whale

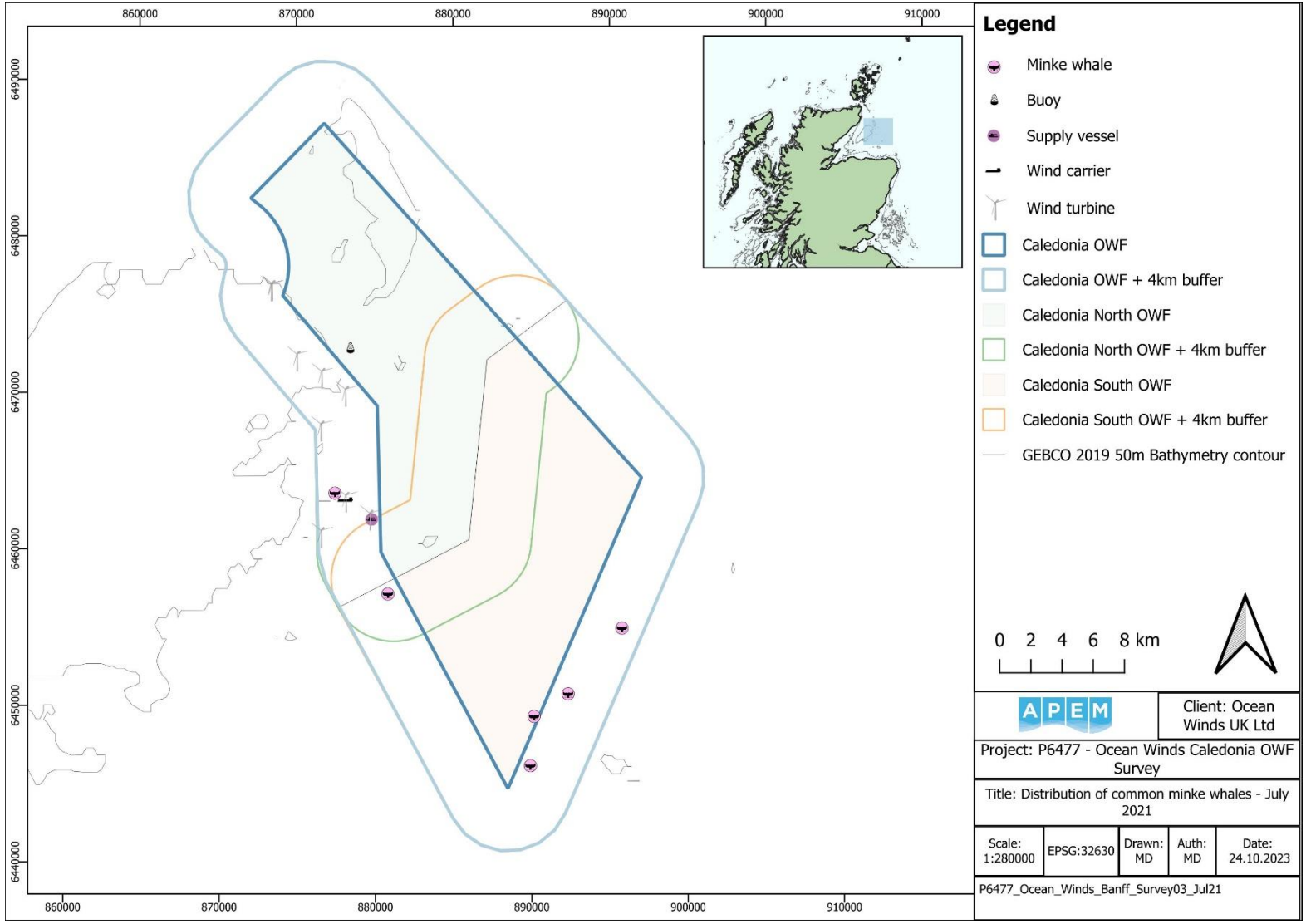


Figure A4.424 Distribution of common minke whales recorded in the Survey Area in July 2021

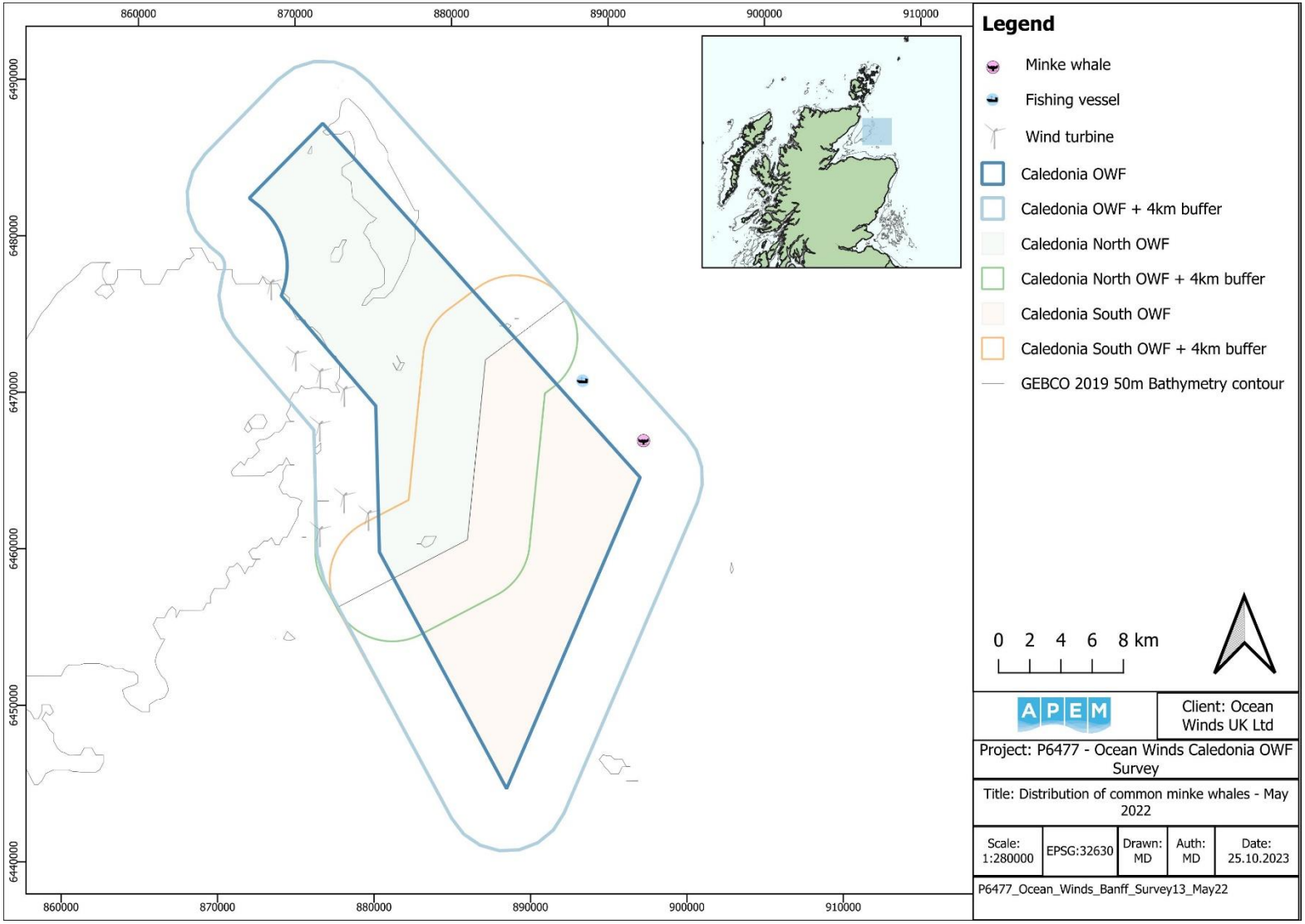


Figure A4.425 Distribution of common minke whales recorded in the Survey Area in May 2022

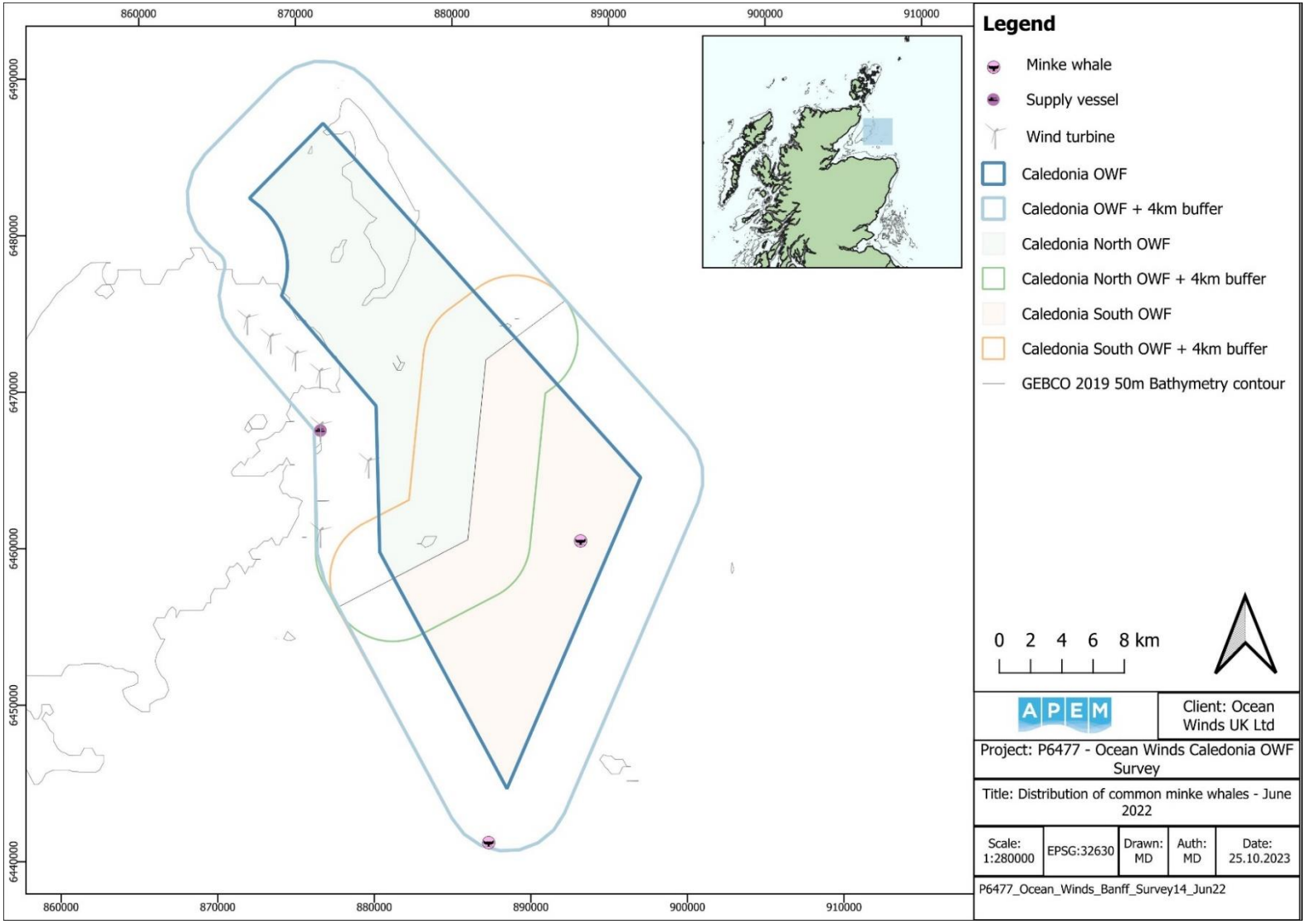


Figure A4.426 Distribution of common minke whales recorded in the Survey Area in June 2022

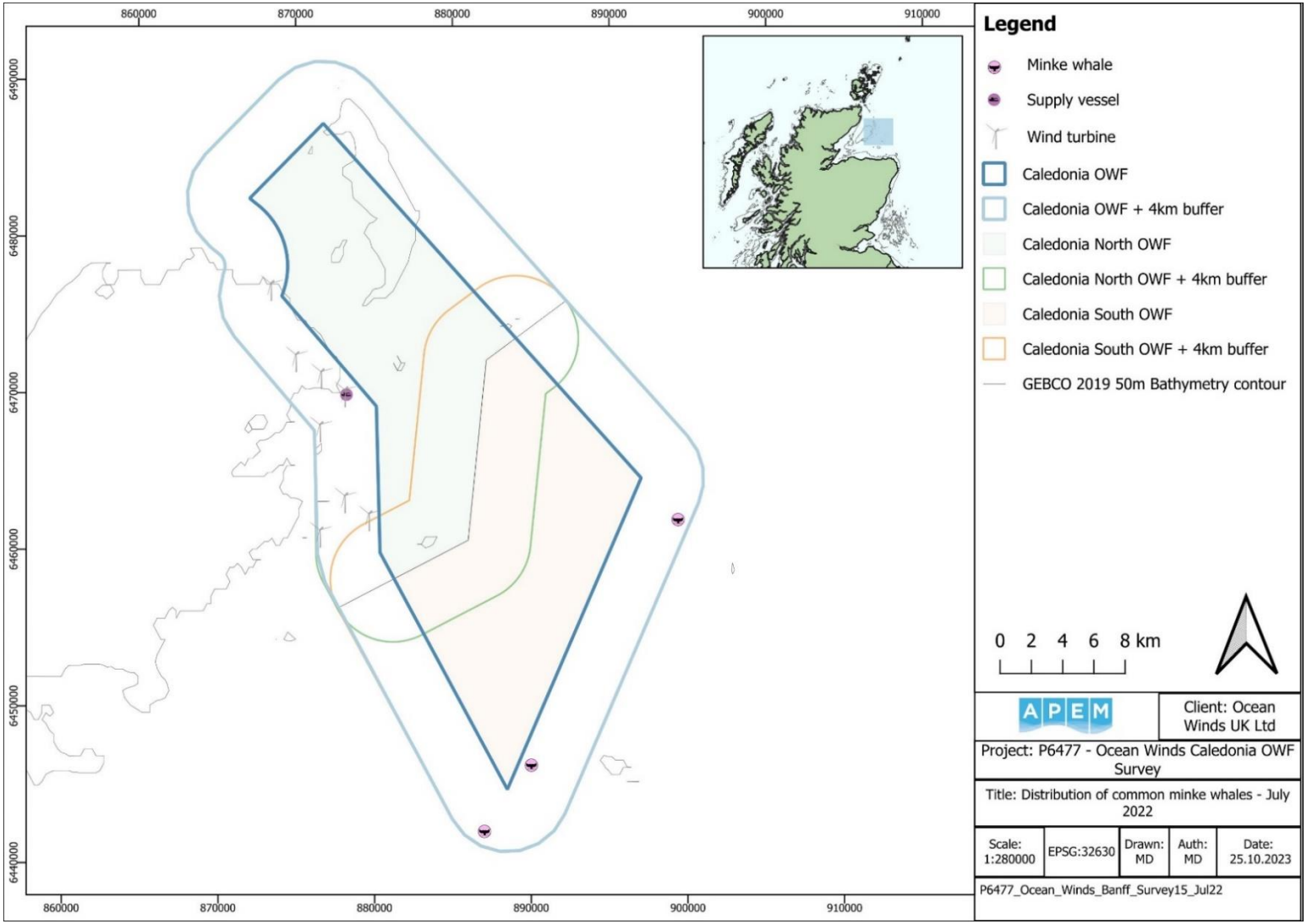


Figure A4.427 Distribution of common minke whales recorded in the Survey Area in July 2022

Unidentified marine mammal species

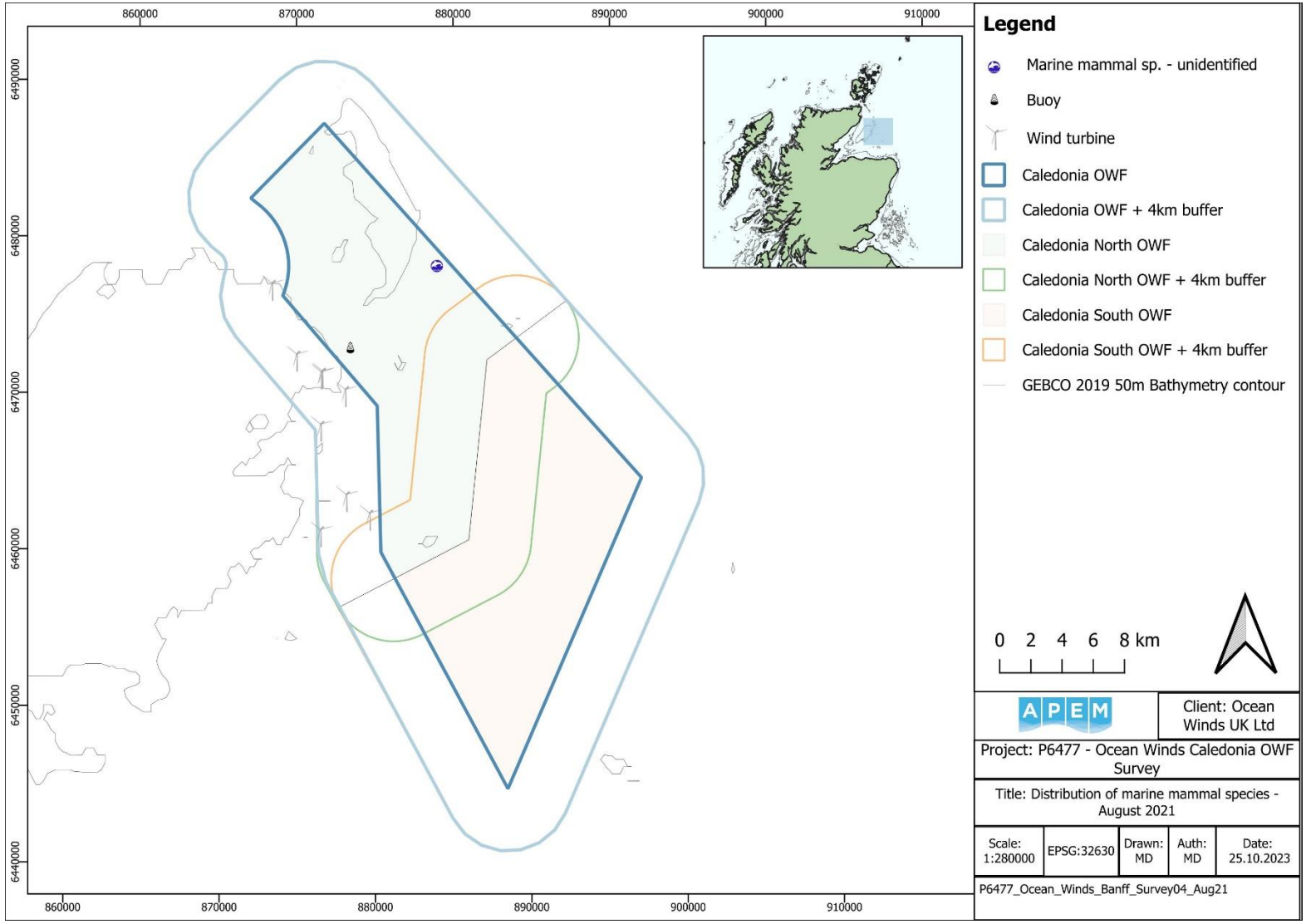


Figure A4.428 Distribution of unidentified marine mammal species recorded in the Survey Area in August 2021

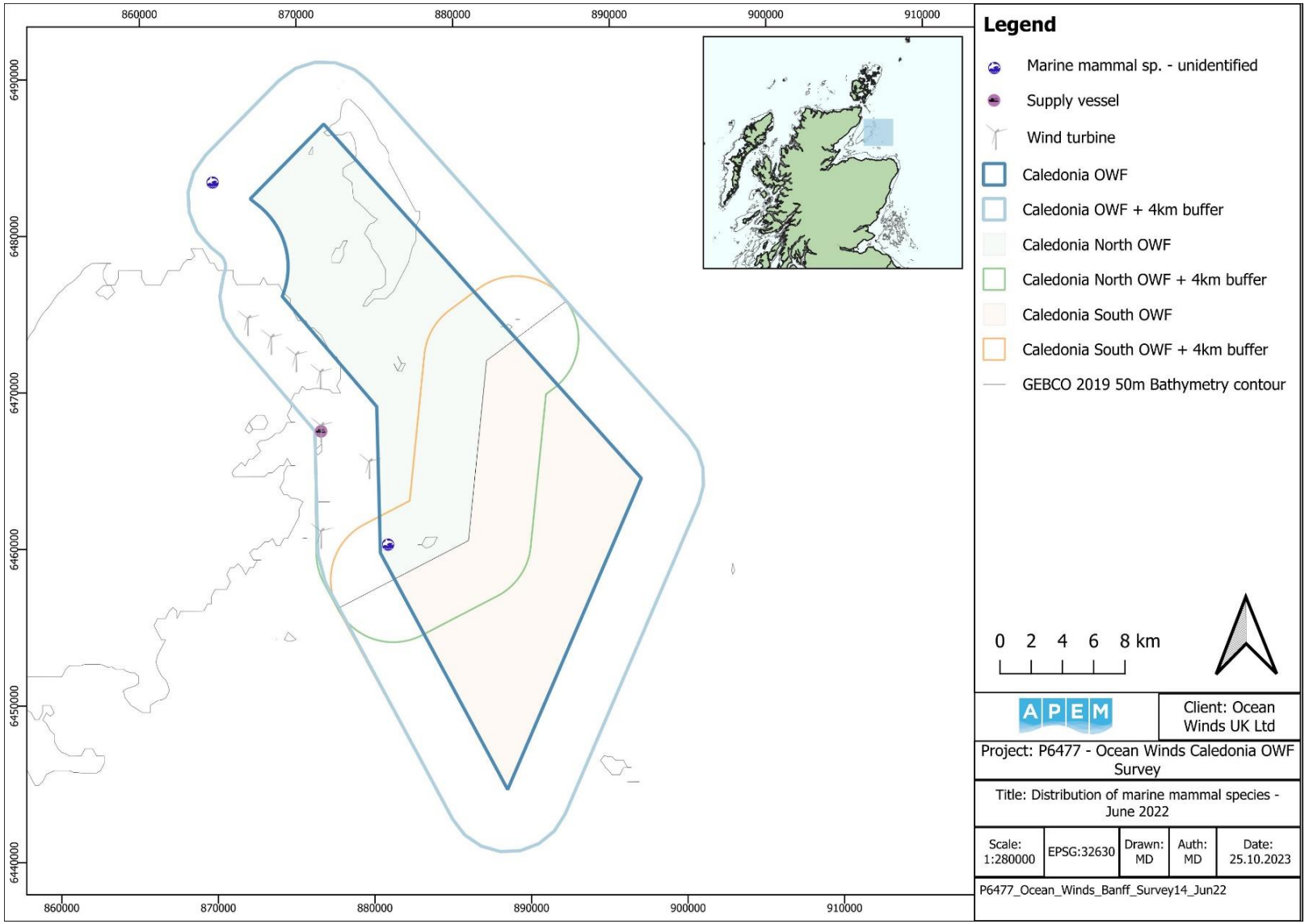


Figure A4.429 Distribution of unidentified marine mammal species recorded in the Survey Area in June 2022

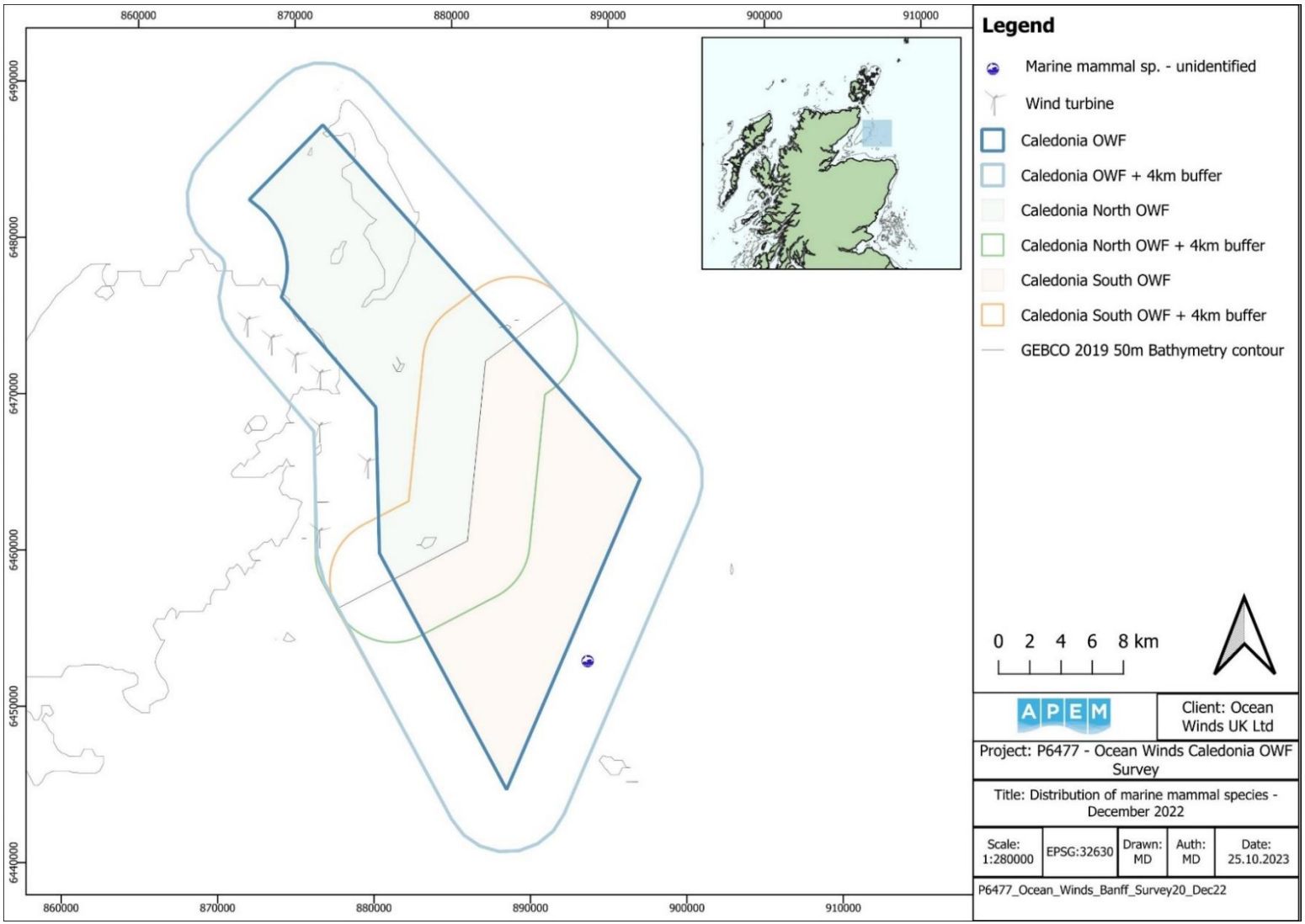


Figure A4.430 Distribution of unidentified marine mammal species recorded in the Survey Area in December 2022

Basking shark

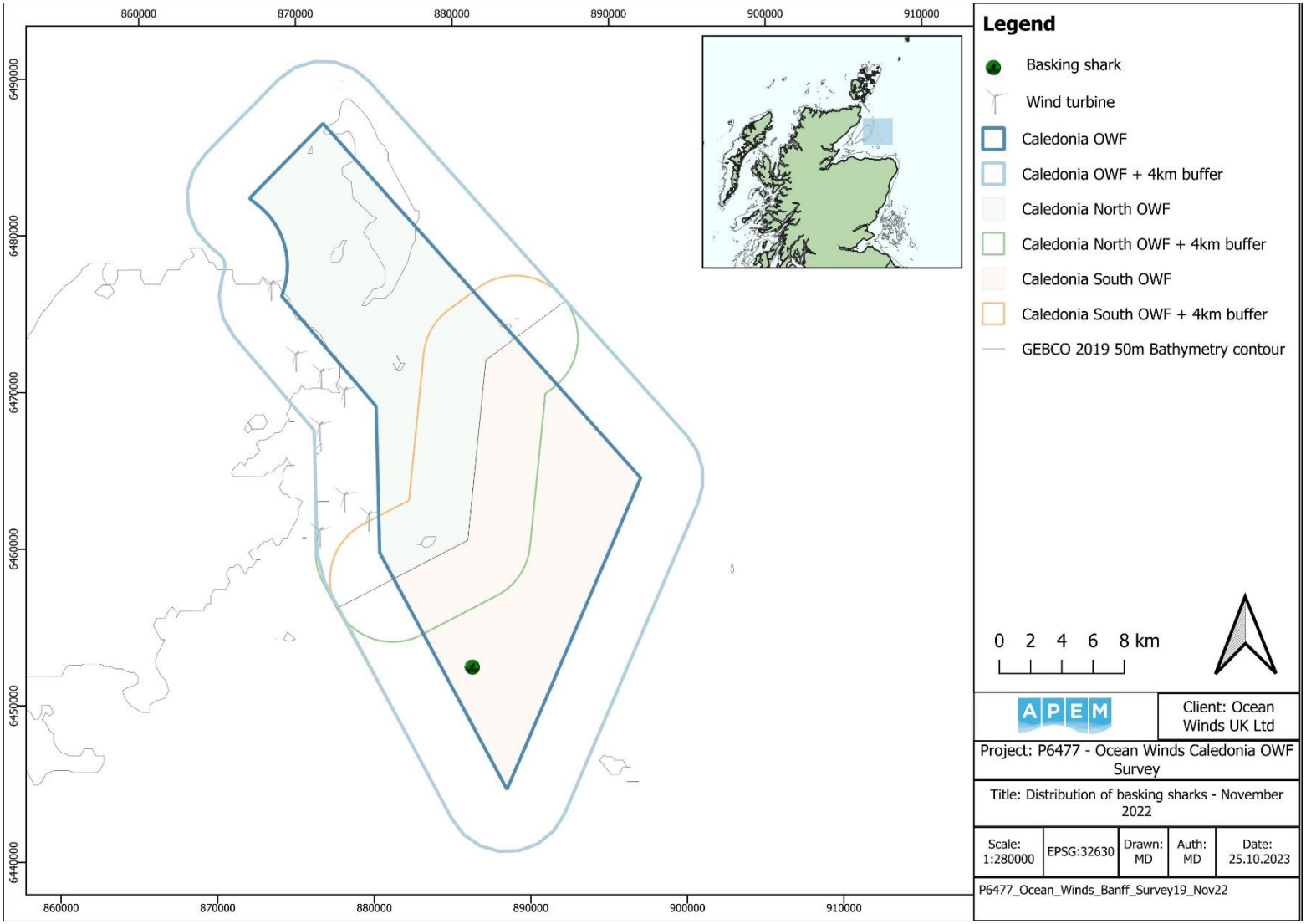


Figure A4.431 Distribution of basking sharks recorded in the Survey Area in November 2022

Unidentified shark species

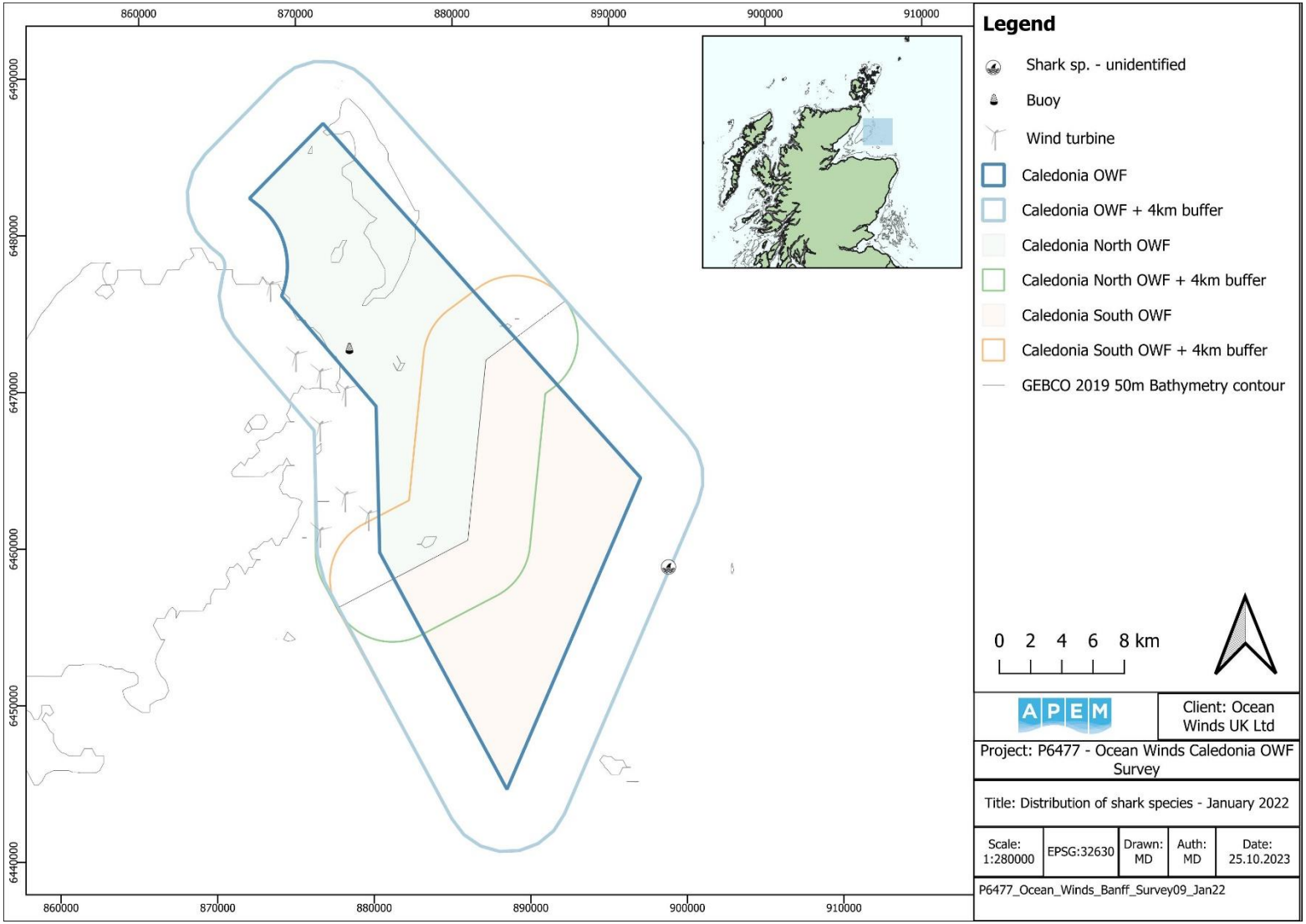
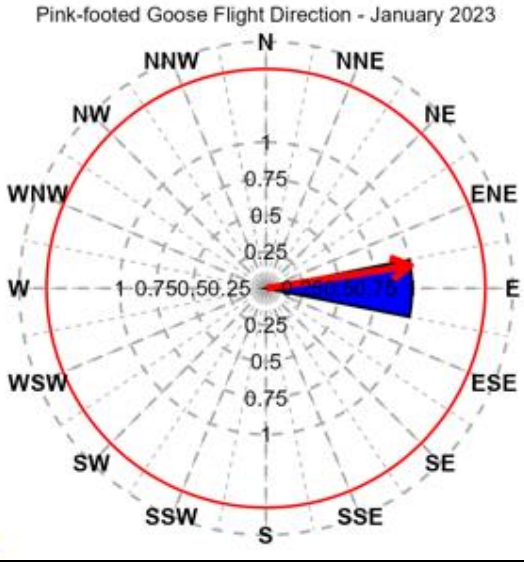


Figure A4.432 Distribution of shark species recorded in the Survey Area in January 2022

Appendix 5 – Rose diagrams

List of figures

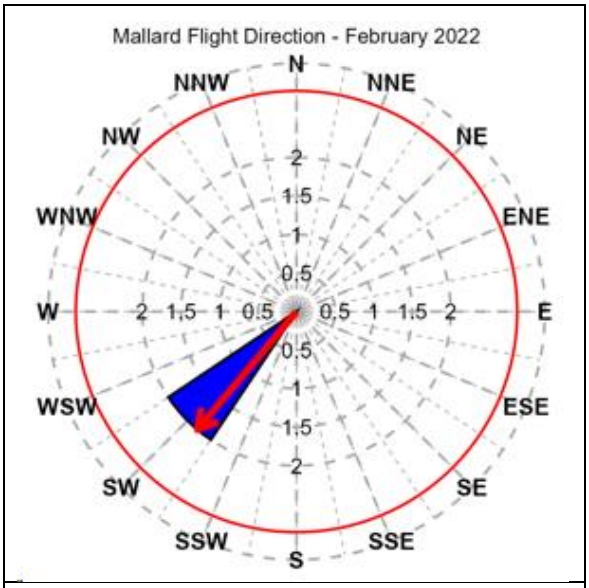
Pink-footed goose



Number of Observations	1
Mean Vector (μ)	81.699
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
January 2023	

Figure A5.433 Flight direction of pink-footed geese during the survey period

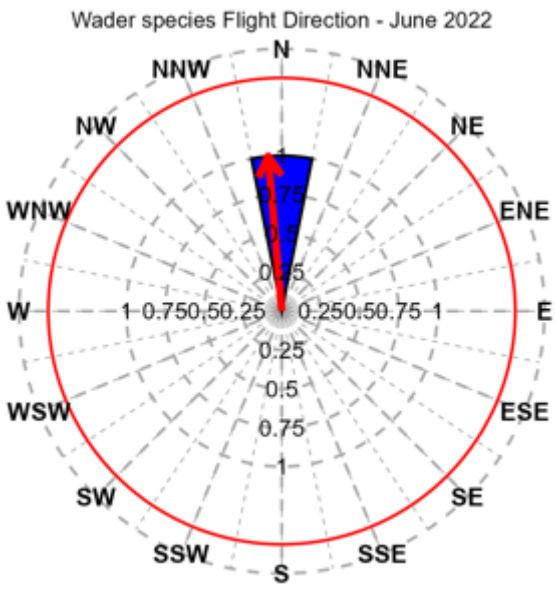
Mallard



Number of Observations	2
Mean Vector (μ)	220.585
Length of Mean Vector (r)	0.999
Rayleigh Test (Z)	1.996
Rayleigh Test (p)	0.138
February 2022	

Figure A5.434 Flight direction of mallards during the survey period

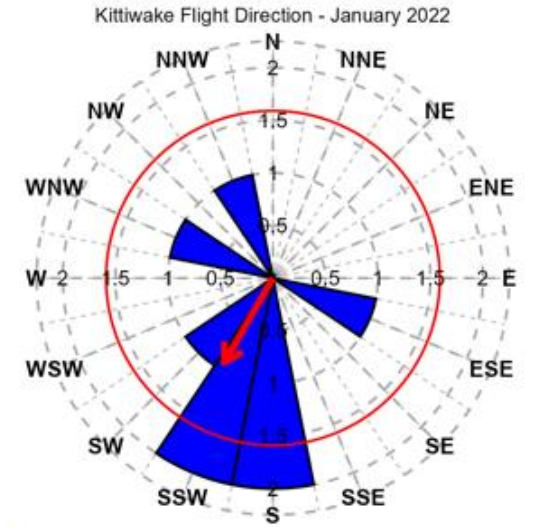
Wader species



Number of Observations	1
Mean Vector (μ)	355.343
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
June 2022	

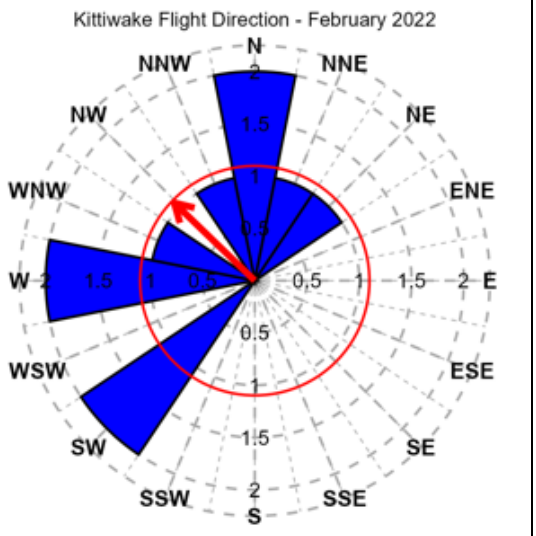
Figure A5.435 Flight direction of wader species during the survey period

Kittiwake



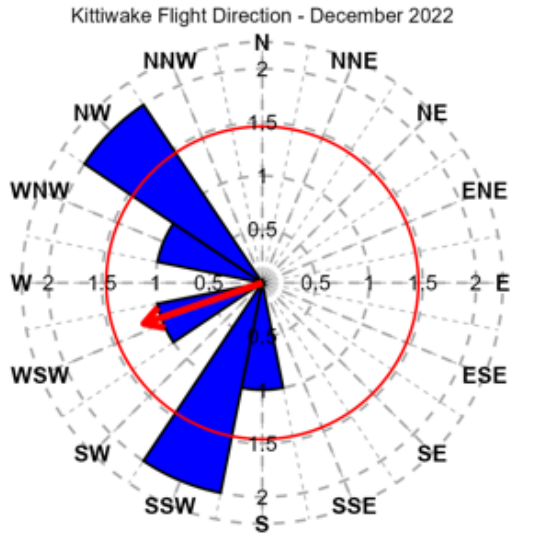
Number of Observations	8
Mean Vector (μ)	210.895
Length of Mean Vector (r)	0.463
Rayleigh Test (Z)	1.712
Rayleigh Test (p)	0.184

a January 2022



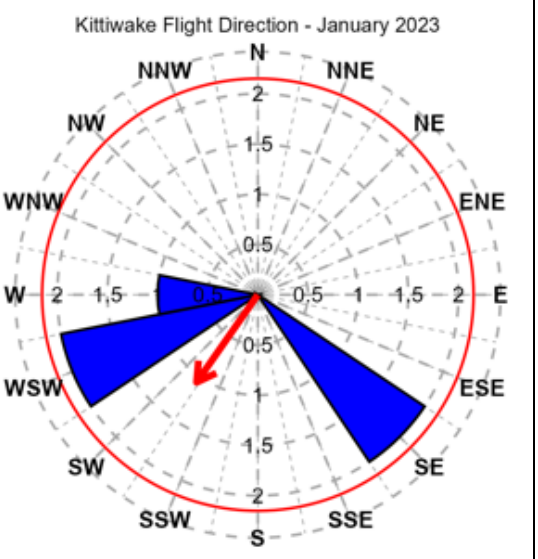
Number of Observations	10
Mean Vector (μ)	314.472
Length of Mean Vector (r)	0.536
Rayleigh Test (Z)	2.872
Rayleigh Test (p)	0.053

b February 2022



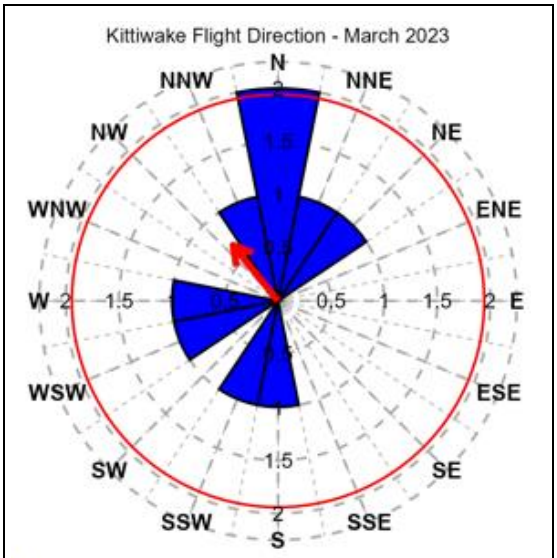
Number of Observations	7
Mean Vector (μ)	251.984
Length of Mean Vector (r)	0.585
Rayleigh Test (Z)	2.396
Rayleigh Test (p)	0.088

c December 2022



Number of Observations	5
Mean Vector (μ)	215.638
Length of Mean Vector (r)	0.532
Rayleigh Test (Z)	1.415
Rayleigh Test (p)	0.255

d January 2023

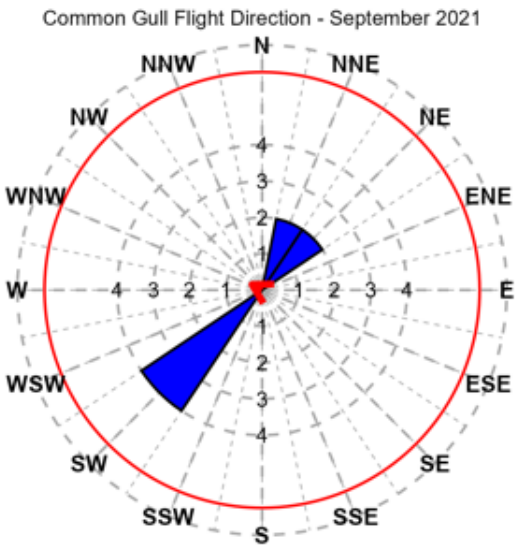


Number of Observations	9
Mean Vector (μ)	321.313
Length of Mean Vector (r)	0.336
Rayleigh Test (Z)	1.019
Rayleigh Test (p)	0.372

e March 2023

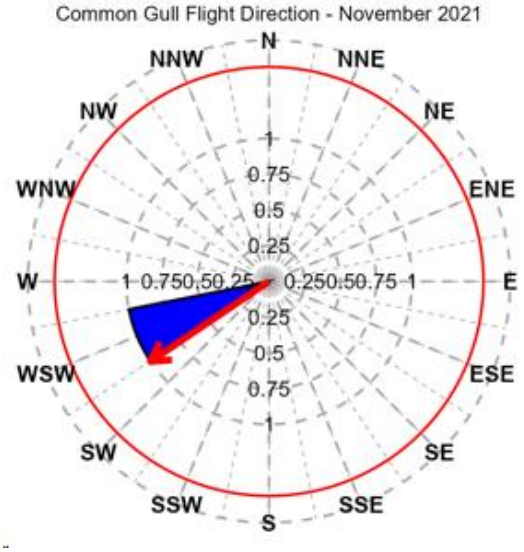
Figure A5.436 Flight direction of kittiwakes during the survey period

Common gull



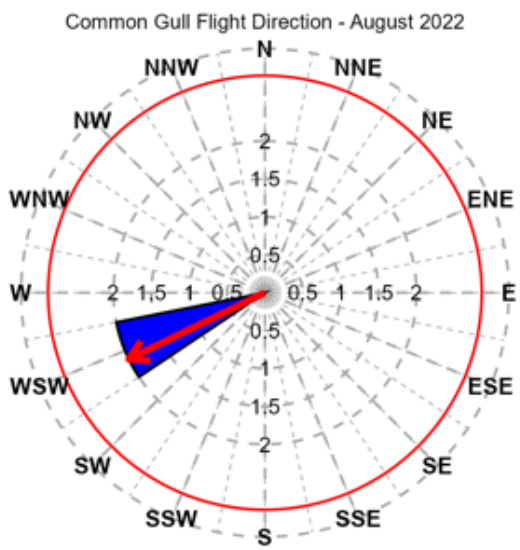
Number of Observations	8
Mean Vector (μ)	299.408
Length of Mean Vector (r)	0.078
Rayleigh Test (Z)	0.9
Rayleigh Test (p)	0.955

a September 2021



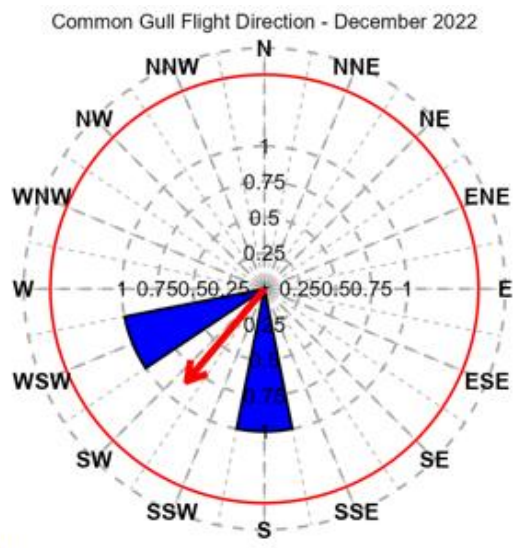
Number of Observations	1
Mean Vector (μ)	236.974
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

b November 2021



Number of Observations	2
Mean Vector (μ)	244.259
Length of Mean Vector (r)	0.999
Rayleigh Test (Z)	1.997
Rayleigh Test (p)	0.138

c August 2022

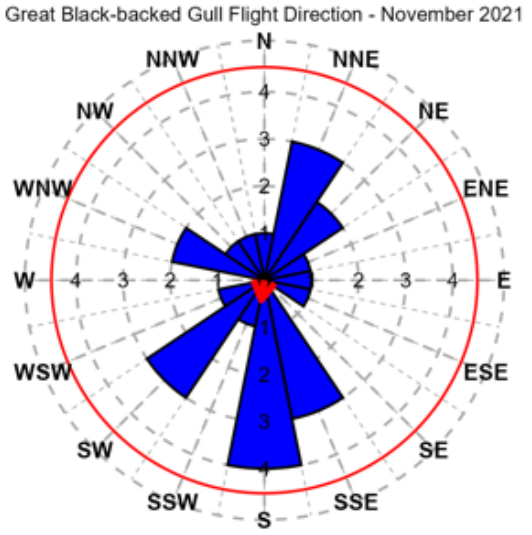


Number of Observations	2
Mean Vector (μ)	220.183
Length of Mean Vector (r)	0.844
Rayleigh Test (Z)	1.425
Rayleigh Test (p)	0.276

d December 2022

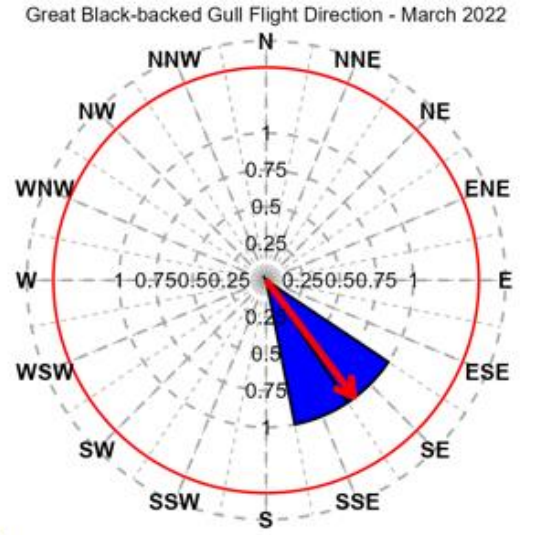
Figure A5.437 Flight direction of common gulls during the survey period

Great black-backed gull



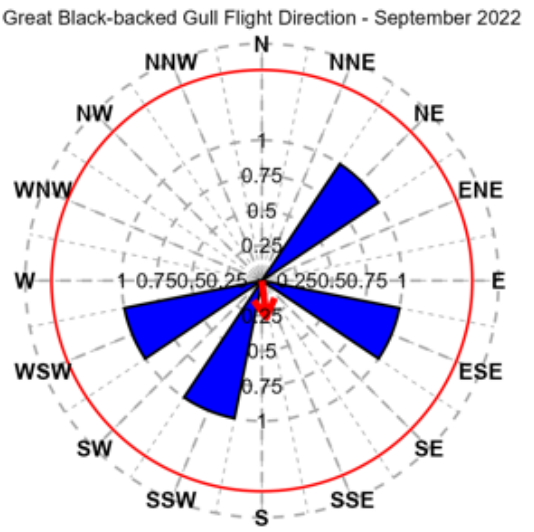
Number of Observations	25
Mean Vector (μ)	189.626
Length of Mean Vector (r)	0.105
Rayleigh Test (Z)	0.278
Rayleigh Test (p)	0.761

a November 2021



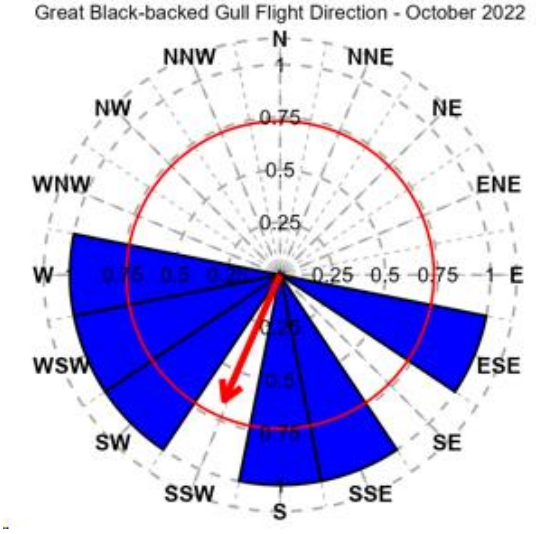
Number of Observations	2
Mean Vector (μ)	143.938
Length of Mean Vector (r)	0.989
Rayleigh Test (Z)	1.995
Rayleigh Test (p)	0.146

b March 2022



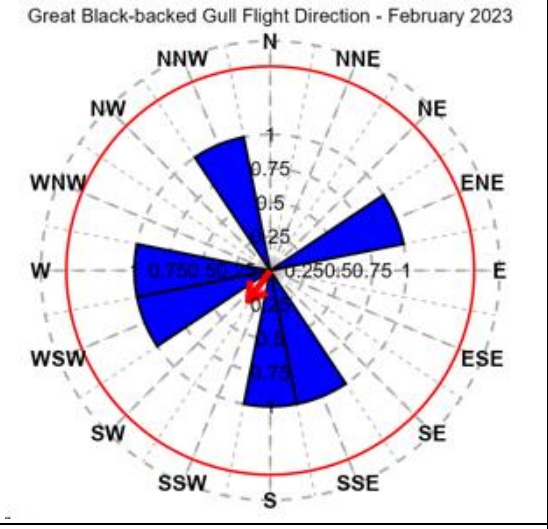
Number of Observations	4
Mean Vector (μ)	173.550
Length of Mean Vector (r)	0.264
Rayleigh Test (Z)	0.279
Rayleigh Test (p)	0.780

c September 2022



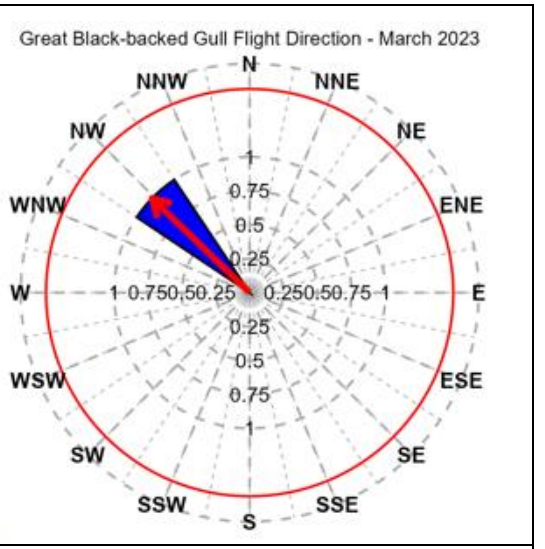
Number of Observations	6
Mean Vector (μ)	204.158
Length of Mean Vector (r)	0.652
Rayleigh Test (Z)	2.548
Rayleigh Test (p)	0.073

d October 2022



Number of Observations	6
Mean Vector (μ)	216.380
Length of Mean Vector (r)	0.276
Rayleigh Test (Z)	0.458
Rayleigh Test (p)	0.652

e February 2023

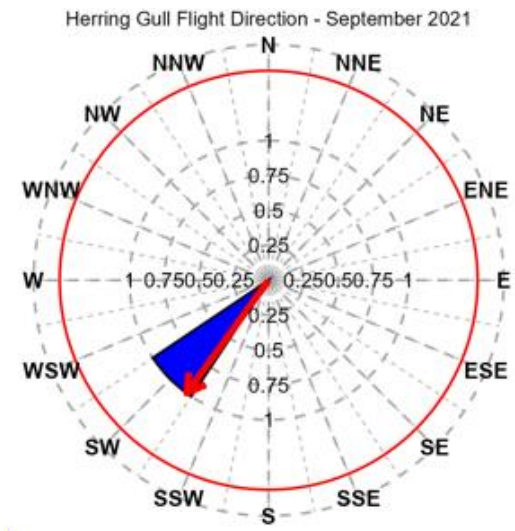


Number of Observations	1
Mean Vector (μ)	314.195
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

f March 2023

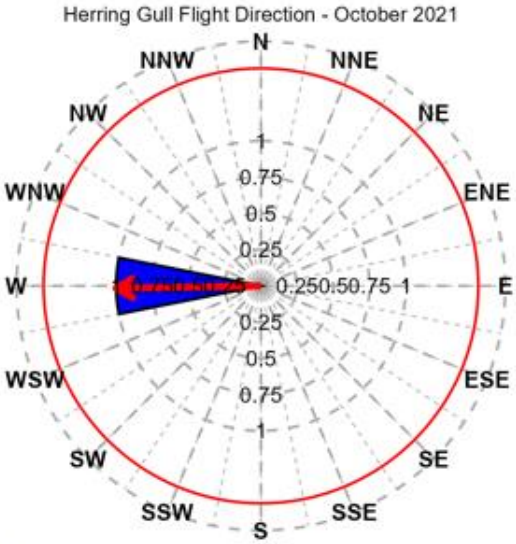
Figure A5.438 Flight direction of great black-backed gulls during the survey period

Herring gull



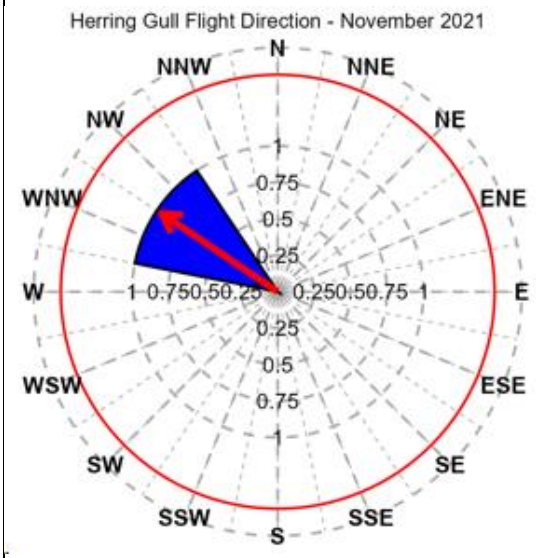
Number of Observations	1
Mean Vector (μ)	216.702
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

a September 2021



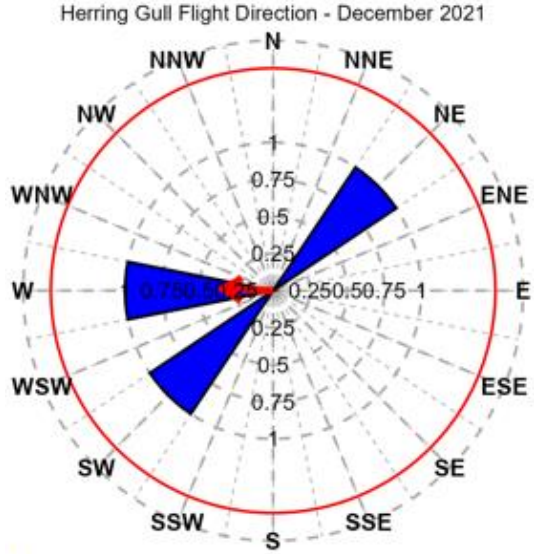
Number of Observations	1
Mean Vector (μ)	269.184
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

b October 2021



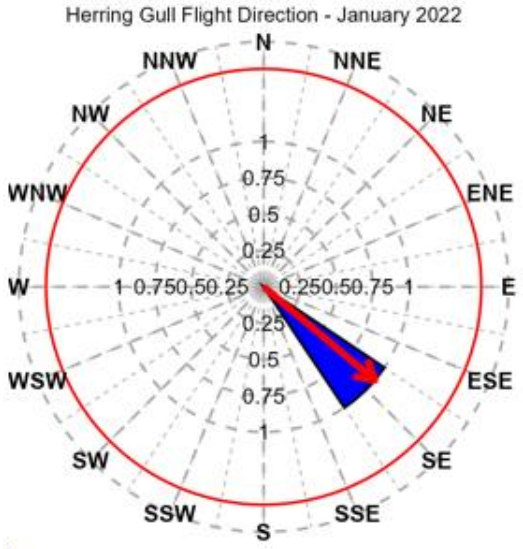
Number of Observations	2
Mean Vector (μ)	304.130
Length of Mean Vector (r)	0.961
Rayleigh Test (Z)	1.846
Rayleigh Test (p)	0.168

c November 2021



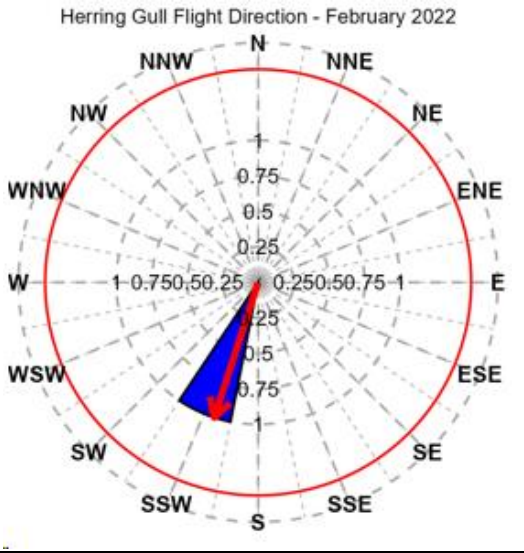
Number of Observations	3
Mean Vector (μ)	272.152
Length of Mean Vector (r)	0.343
Rayleigh Test (Z)	0.354
Rayleigh Test (p)	0.737

d December 2021



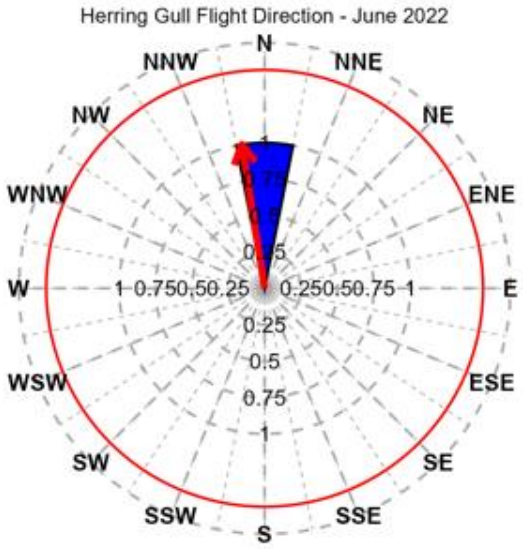
Number of Observations	1
Mean Vector (μ)	130.886
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

e January 2022



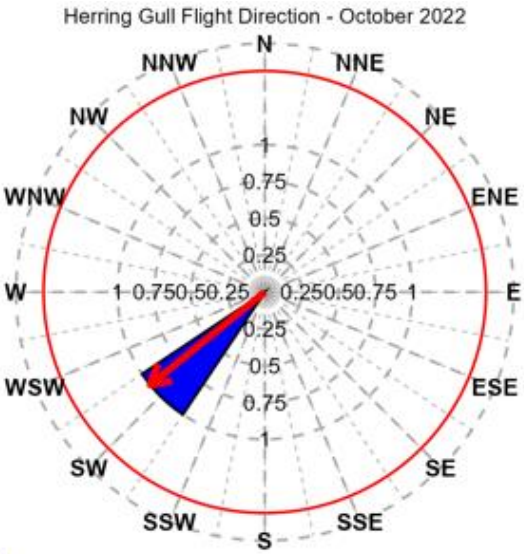
Number of Observations	1
Mean Vector (μ)	198.056
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

f February 2022



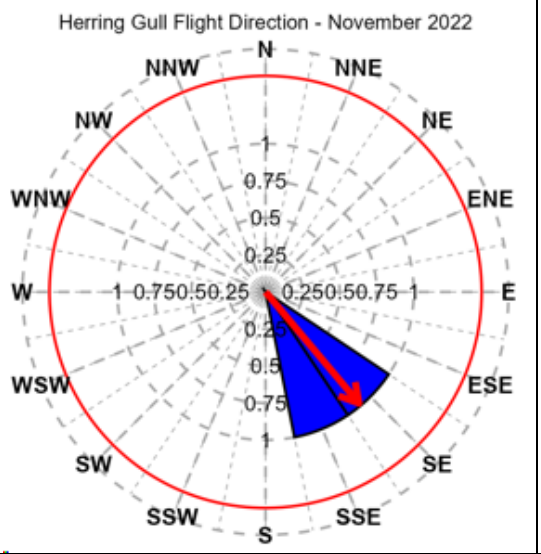
Number of Observations	1
Mean Vector (μ)	351.371
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

g June 2022



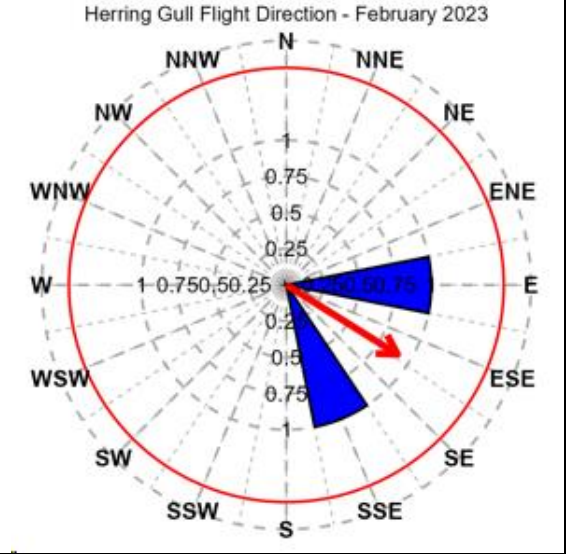
Number of Observations	1
Mean Vector (μ)	231.440
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

h October 2022



Number of Observations	2
Mean Vector (μ)	140.560
Length of Mean Vector (r)	0.981
Rayleigh Test (Z)	1.924
Rayleigh Test (p)	0.152

i November 2022

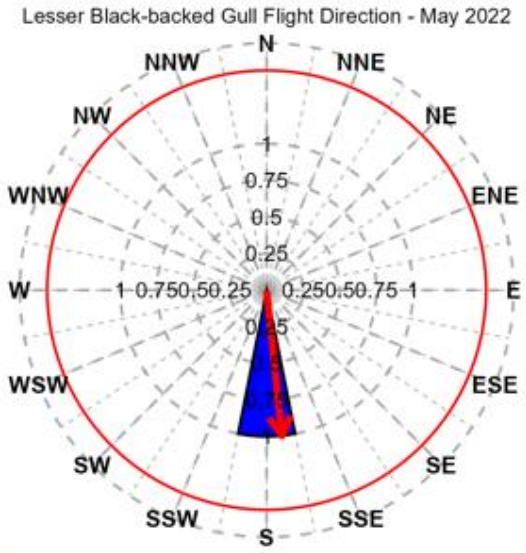


Number of Observations	2
Mean Vector (μ)	122.846
Length of Mean Vector (r)	0.904
Rayleigh Test (Z)	1.634
Rayleigh Test (p)	0.217

j February 2023

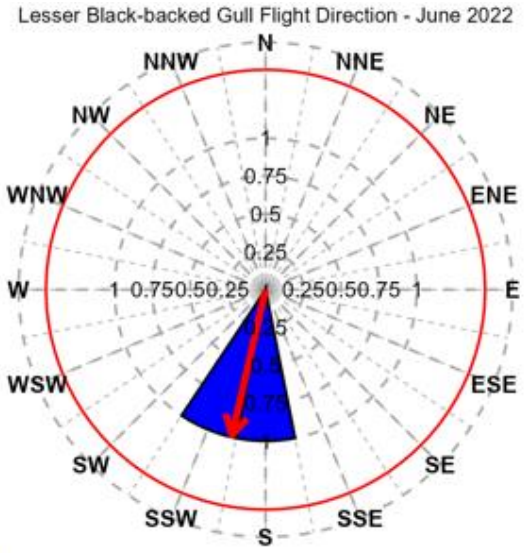
Figure A5.439 Flight direction of herring gulls during the survey period

Lesser black-backed gull



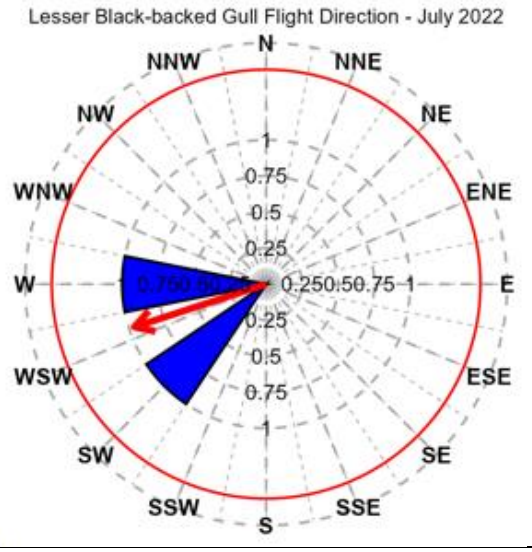
Number of Observations	1
Mean Vector (μ)	174.117
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

a May 2022



Number of Observations	2
Mean Vector (μ)	193.852
Length of Mean Vector (r)	0.985
Rayleigh Test (Z)	1.939
Rayleigh Test (p)	0.149

b June 2022

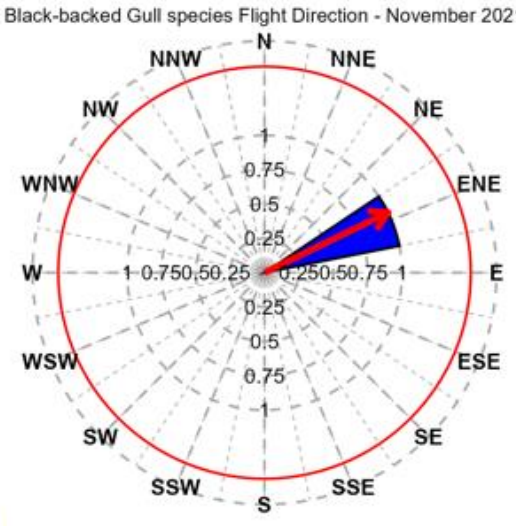


Number of Observations	2
Mean Vector (μ)	252.014
Length of Mean Vector (r)	0.961
Rayleigh Test (Z)	1.848
Rayleigh Test (p)	0.167

c July 2022

Figure A5.440 Flight direction of lesser black-backed gulls during the survey period

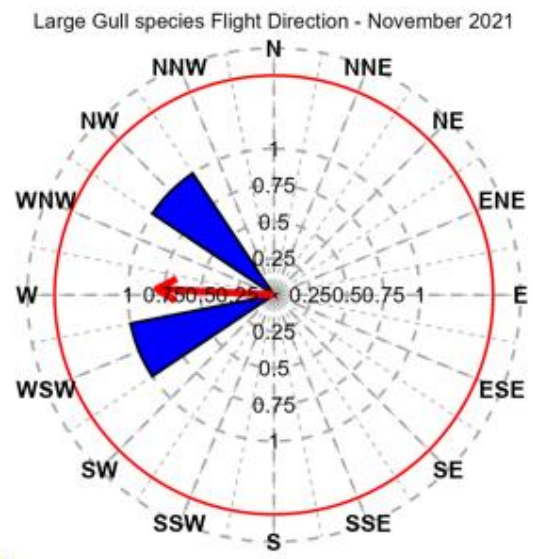
Black-backed gull species



Number of Observations	1
Mean Vector (μ)	64.895
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
November 2021	

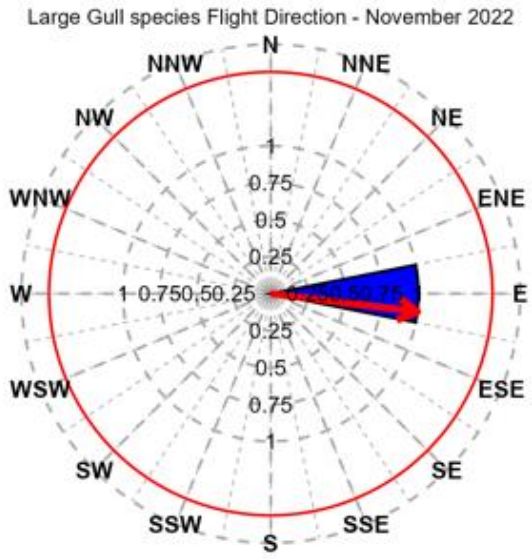
Figure A5.441 Flight direction of black-backed gull species during the survey period

Unidentified large gull species



Number of Observations	2
Mean Vector (μ)	273.891
Length of Mean Vector (r)	0.801
Rayleigh Test (Z)	1.282
Rayleigh Test (p)	0.322

a November 2021

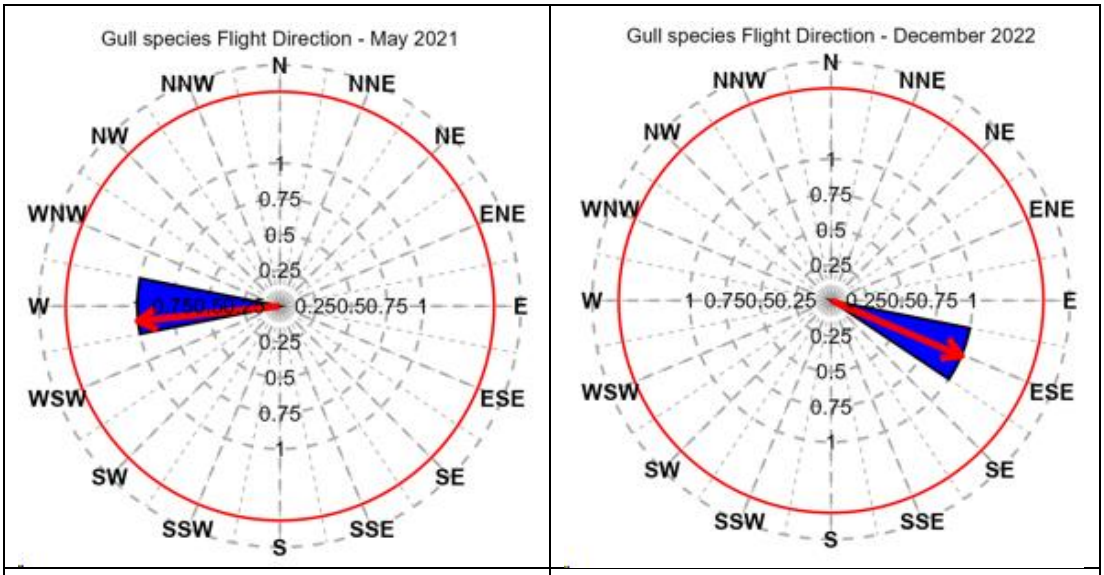


Number of Observations	1
Mean Vector (μ)	97.595
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

b November 2022

Figure A5.442 Flight direction of large gull species during the survey period

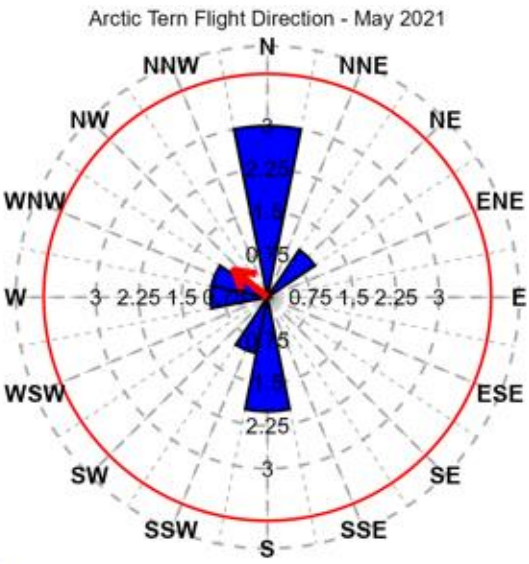
Unidentified gull species



Number of Observations	1	Number of Observations	1
Mean Vector (μ)	264.922	Mean Vector (μ)	113.564
Length of Mean Vector (r)	1.000	Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000	Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512	Rayleigh Test (p)	0.512
a May 2021		**b December 2022**	

Figure A5.443 Flight direction of gull species during the survey period

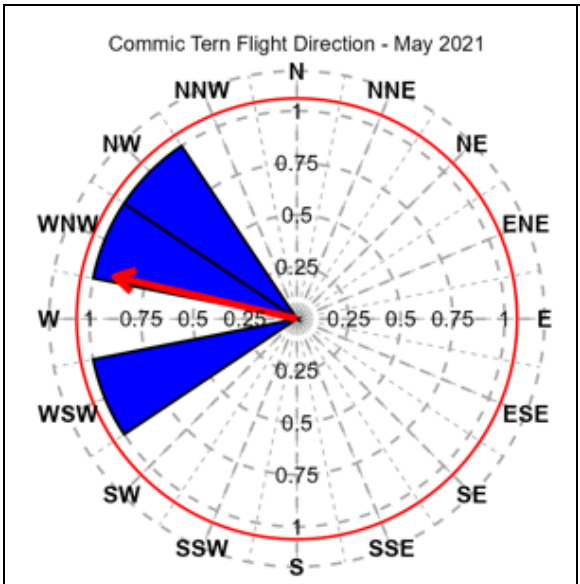
Arctic tern



Number of Observations	9
Mean Vector (μ)	309.774
Length of Mean Vector (r)	0.251
Rayleigh Test (Z)	0.565
Rayleigh Test (p)	0.582
May 2021	

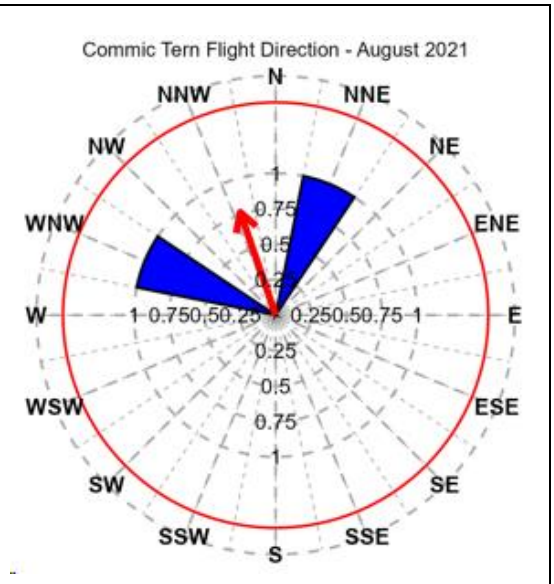
Figure A5.444 Flight direction of Arctic terns during the survey period

'Commic' tern



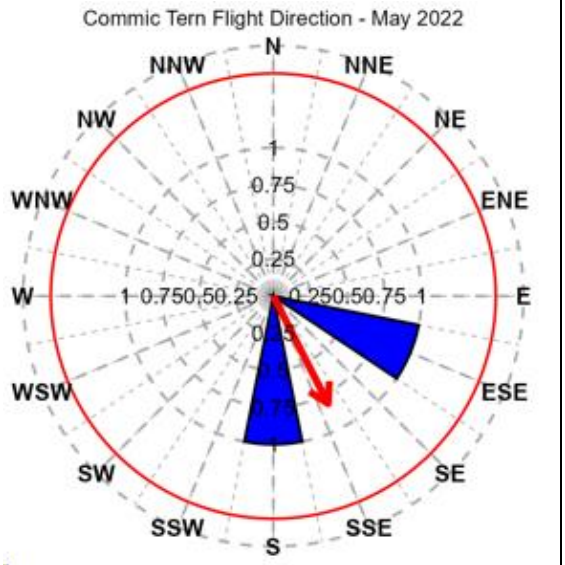
Number of Observations	3
Mean Vector (μ)	283.725
Length of Mean Vector (r)	0.899
Rayleigh Test (Z)	2.426
Rayleigh Test (p)	0.079

a May 2021



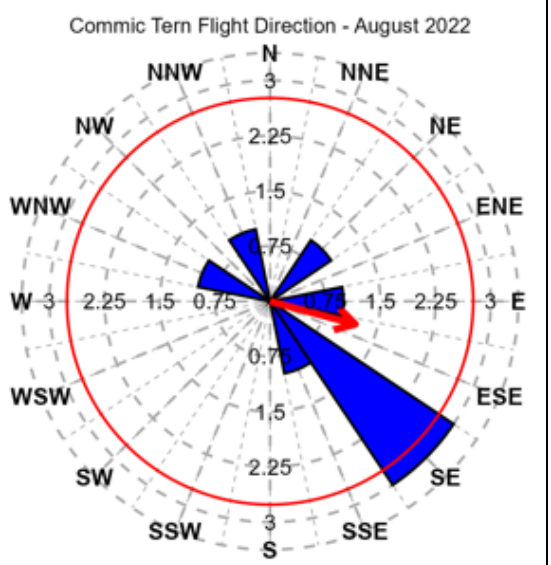
Number of Observations	2
Mean Vector (μ)	341.460
Length of Mean Vector (r)	0.767
Rayleigh Test (Z)	1.177
Rayleigh Test (p)	0.358

b August 2021



Number of Observations	2
Mean Vector (μ)	153.744
Length of Mean Vector (r)	0.814
Rayleigh Test (Z)	1.325
Rayleigh Test (p)	0.307

c May 2022

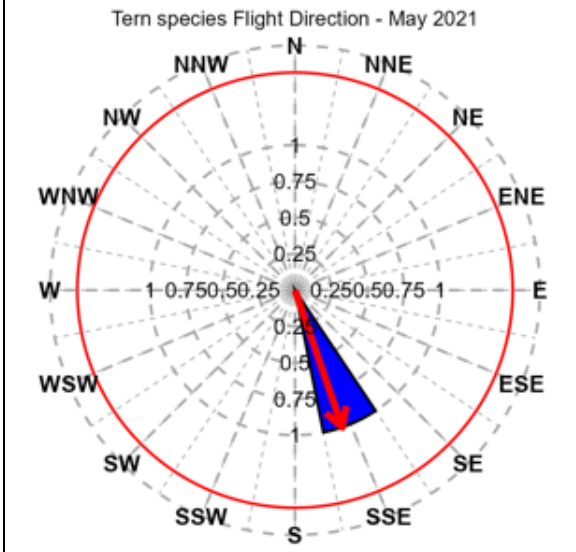


Number of Observations	8
Mean Vector (μ)	105.622
Length of Mean Vector (r)	0.399
Rayleigh Test (Z)	1.276
Rayleigh Test (p)	0.288

d August 2022

Figure A5.445 Flight direction of 'commic' terns during the survey period

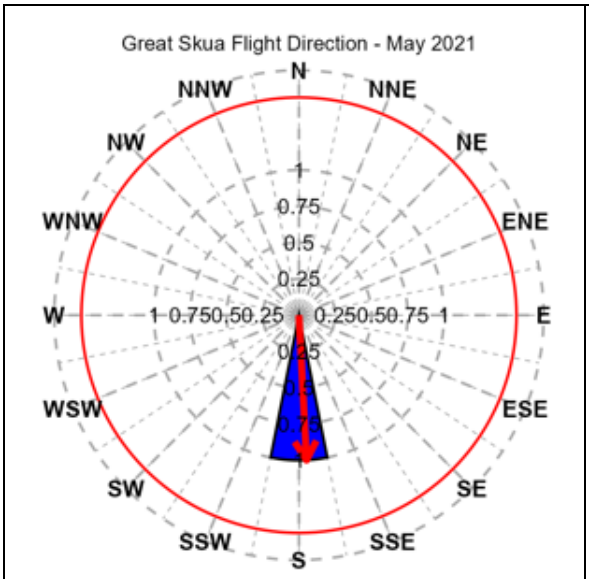
Unidentified tern species



Number of Observations	1
Mean Vector (μ)	161.193
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
May 2021	

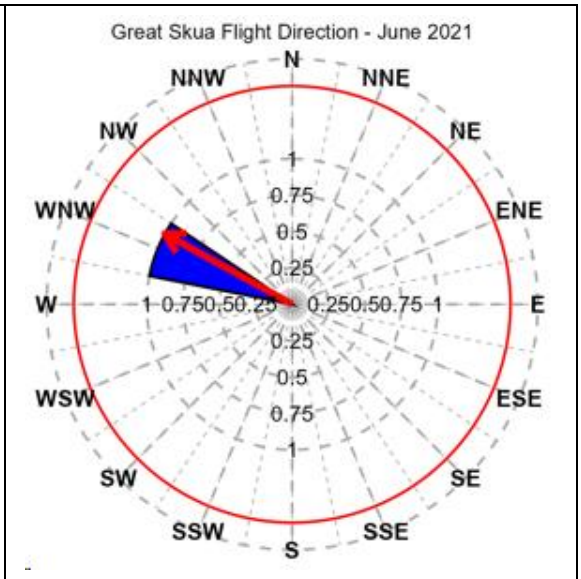
Figure A5.446 Flight direction of tern species during the survey period

Great skua



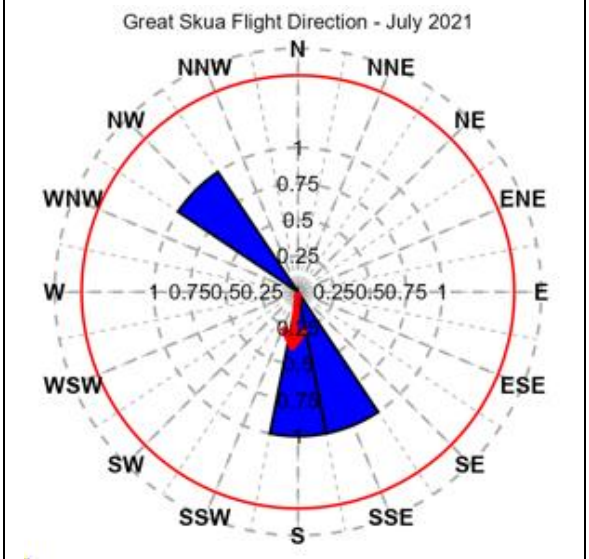
Number of Observations	1
Mean Vector (μ)	177.119
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

a May 2021



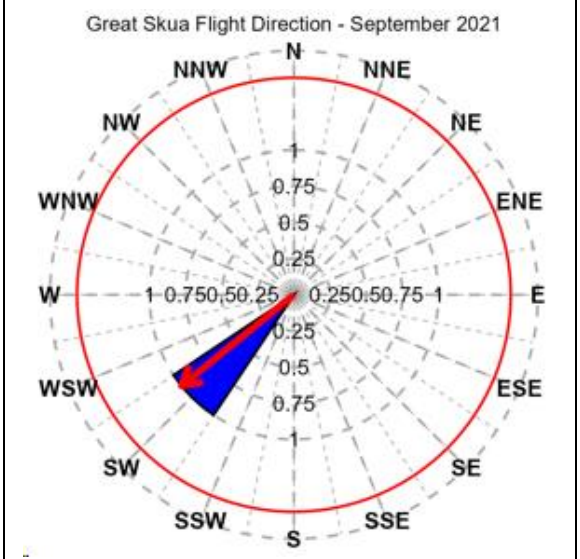
Number of Observations	1
Mean Vector (μ)	299.891
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

b June 2021



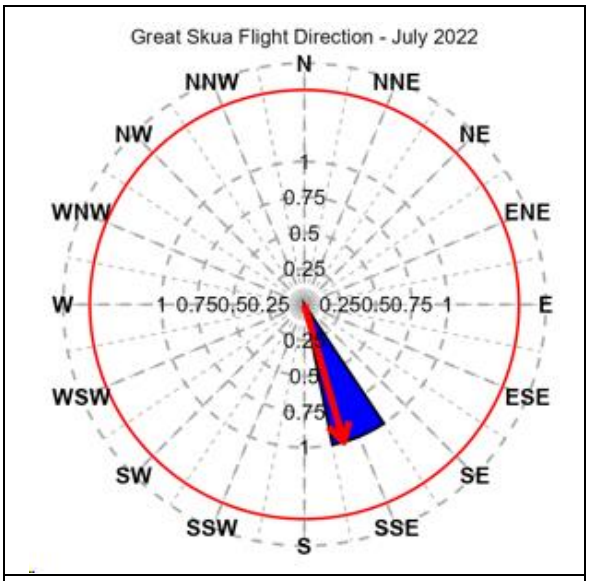
Number of Observations	3
Mean Vector (μ)	186.812
Length of Mean Vector (r)	0.383
Rayleigh Test (Z)	0.440
Rayleigh Test (p)	0.683

c July 2021



Number of Observations	1
Mean Vector (μ)	231.099
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

d September 2021

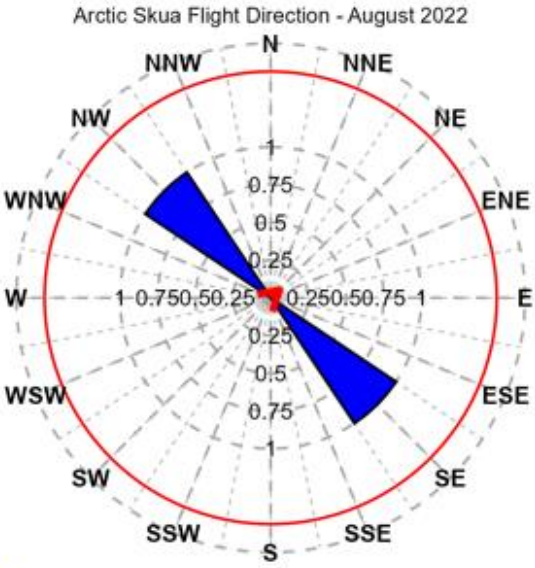


Number of Observations	1
Mean Vector (μ)	164.806
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

e July 2022

Figure A5.447 Flight direction of great skuas during the survey period

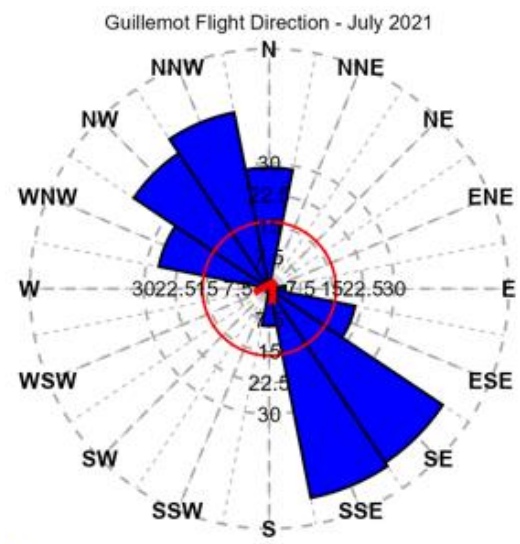
Artic skua



Number of Observations	2
Mean Vector (μ)	48.748
Length of Mean Vector (r)	0.079
Rayleigh Test (Z)	0.012
Rayleigh Test (p)	0.991
August 2022	

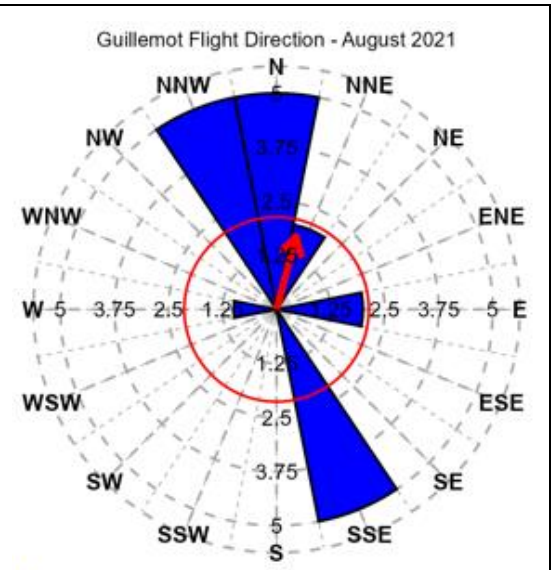
Figure A5.448 Flight direction of Arctic skuas during the survey period

Guillemot



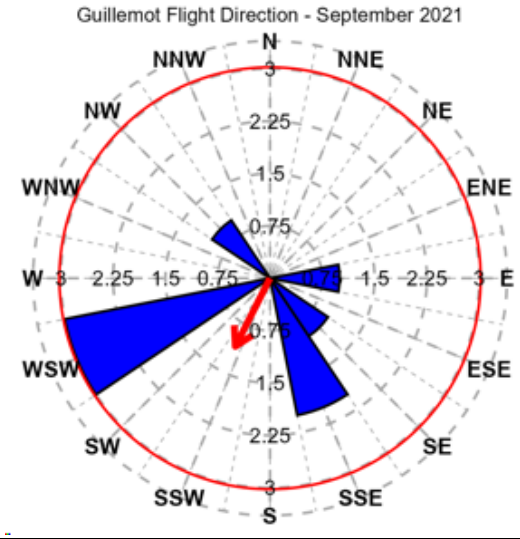
Number of Observations	282
Mean Vector (μ)	27.189
Length of Mean Vector (r)	0.035
Rayleigh Test (Z)	0.348
Rayleigh Test (p)	0.706

a July 2021



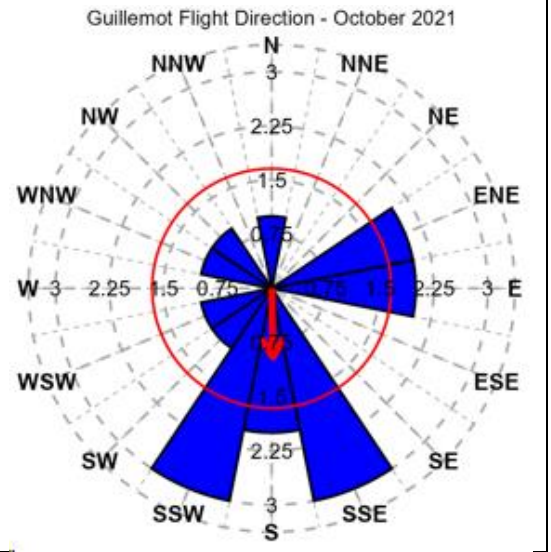
Number of Observations	20
Mean Vector (μ)	15.040
Length of Mean Vector (r)	0.349
Rayleigh Test (Z)	2.436
Rayleigh Test (p)	0.086

b August 2021



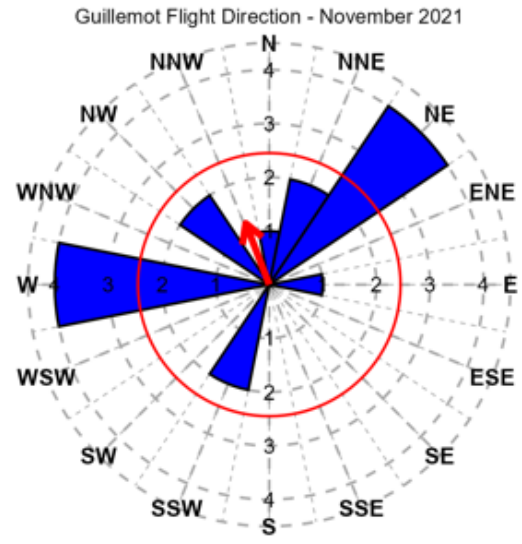
Number of Observations	8
Mean Vector (μ)	207.633
Length of Mean Vector (r)	0.365
Rayleigh Test (Z)	1.066
Rayleigh Test (p)	0.356

c September 2021



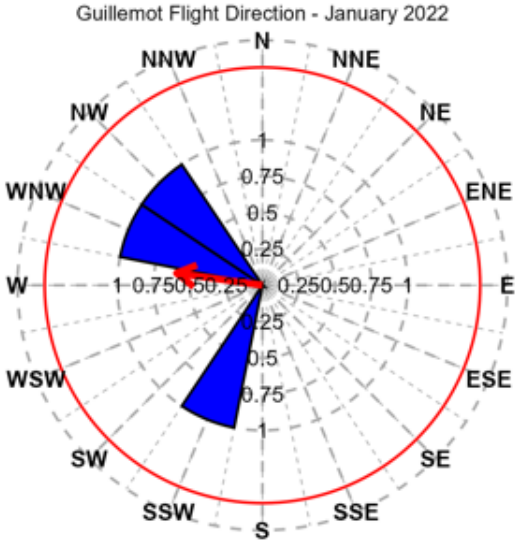
Number of Observations	17
Mean Vector (μ)	179.999
Length Mean Vector (r)	0.317
Rayleigh Test (Z)	1.710
Rayleigh Test (p)	0.182

d October 2021



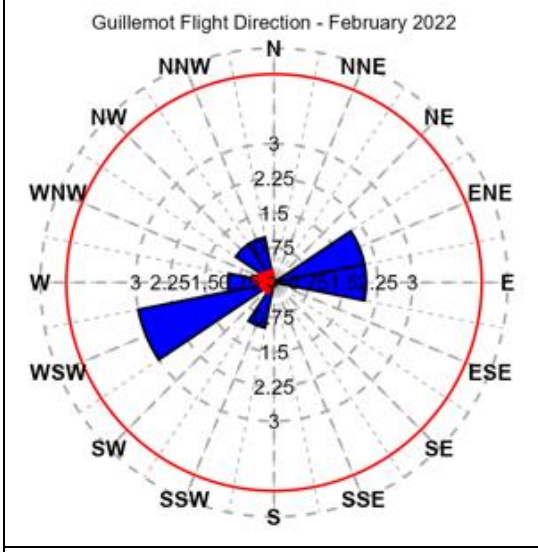
Number of Observations	16
Mean Vector (μ)	339.394
Length of Mean Vector (r)	0.305
Rayleigh Test (Z)	1.490
Rayleigh Test (p)	0.228

e November 2021



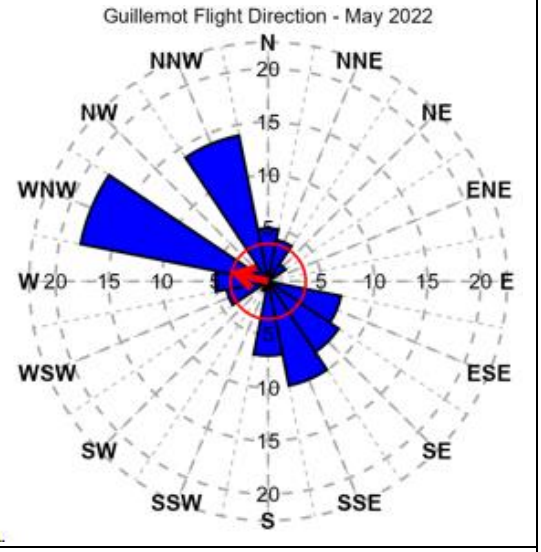
Number of Observations	3
Mean Vector (μ)	278.407
Length of Mean Vector (r)	0.597
Rayleigh Test (Z)	1.068
Rayleigh Test (p)	0.378

f January 2022



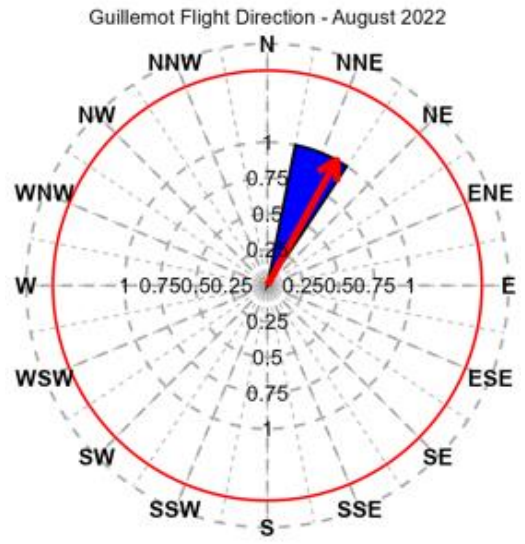
Number of Observations	11
Mean Vector (μ)	282.578
Length of Mean Vector (r)	0.144
Rayleigh Test (Z)	0.229
Rayleigh Test (p)	0.803

g February 2022



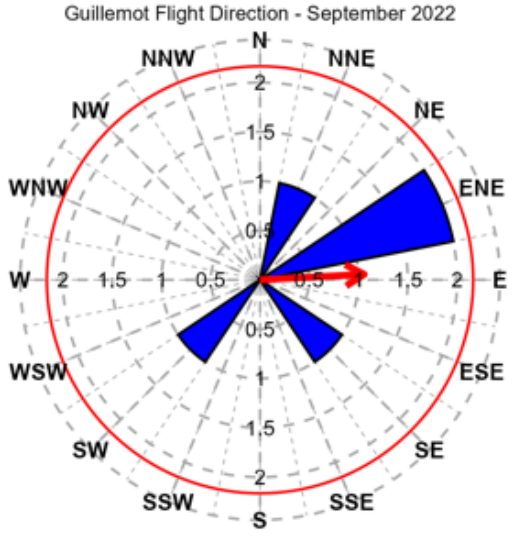
Number of Observations	87
Mean Vector (μ)	284.052
Length of Mean Vector (r)	0.174
Rayleigh Test (Z)	2.627
Rayleigh Test (p)	0.072

h May 2022



Number of Observations	1
Mean Vector (μ)	29.346
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

i August 2022

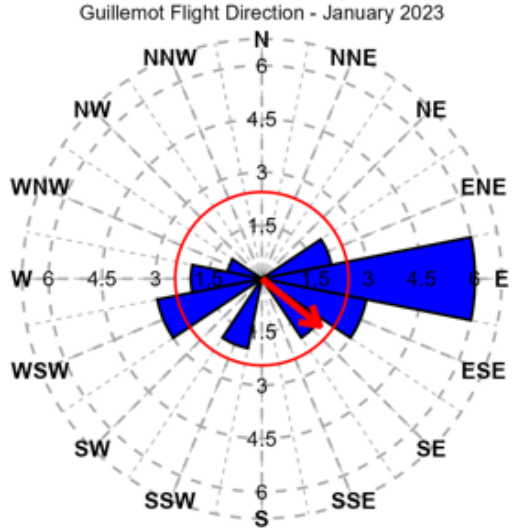


Number of Observations	5
Mean Vector (μ)	87.235
Length of Mean Vector (r)	0.529
Rayleigh Test (Z)	1.398
Rayleigh Test (p)	0.259

j September 2022

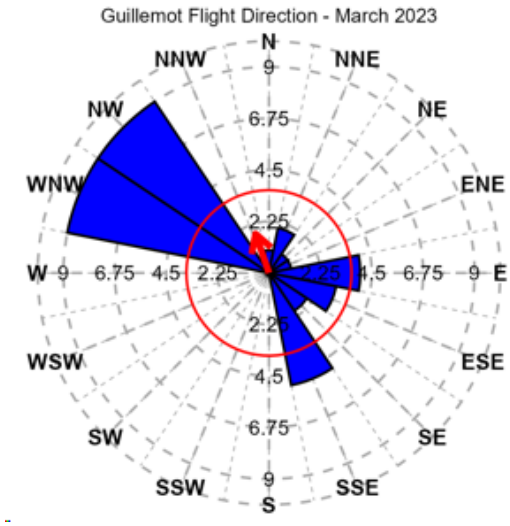
Number of Observations	2
Mean Vector (μ)	49.300
Length of Mean Vector (r)	0.247
Rayleigh Test (Z)	0.122
Rayleigh Test (p)	0.910

k November 2022

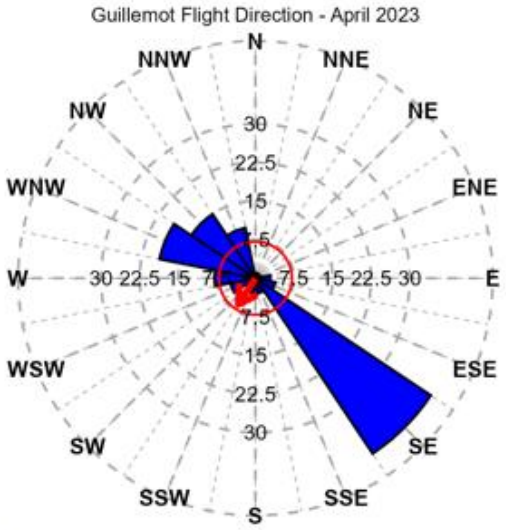


Number of Observations	21
Mean Vector (μ)	129.092
Length of Mean Vector (r)	0.349
Rayleigh Test (Z)	2.557
Rayleigh Test (p)	0.076

l January 2023



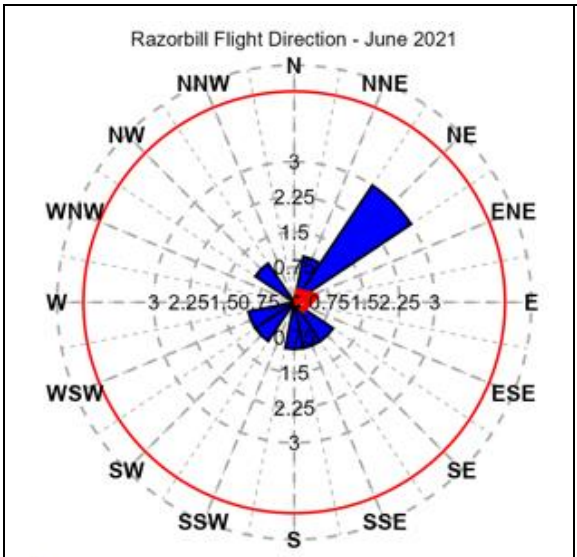
Number of Observations	37
Mean Vector (μ)	341.517
Length of Mean Vector (r)	0.201
Rayleigh Test (Z)	1.488
Rayleigh Test (p)	0.227
m March 2023	



Number of Observations	116
Mean Vector (μ)	213.427
Length of Mean Vector (r)	0.148
Rayleigh Test (Z)	2.557
Rayleigh Test (p)	0.078
n April 2023	

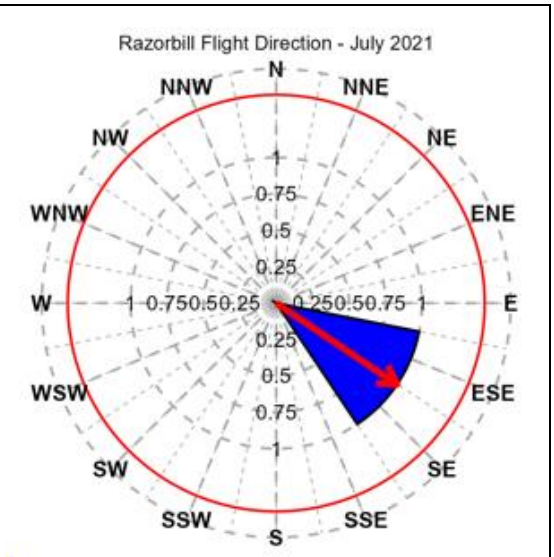
Figure A5.449 Flight direction of guillemots during the survey period

Razorbill



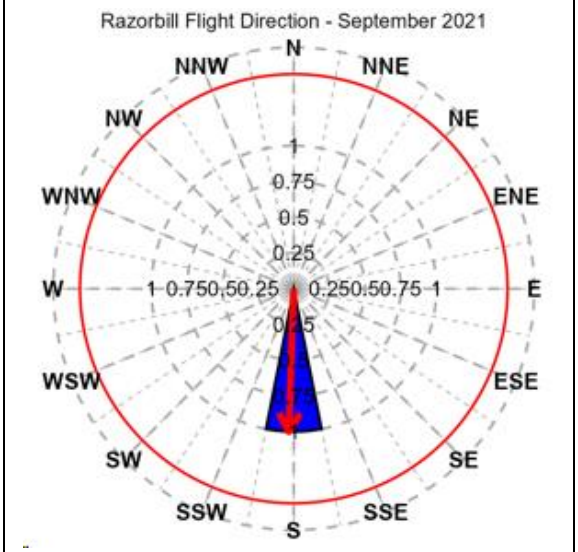
Number of Observations	10
Mean Vector (μ)	74.904
Length of Mean Vector (r)	0.157
Rayleigh Test (Z)	0.248
Rayleigh Test (p)	0.789

a June 2021



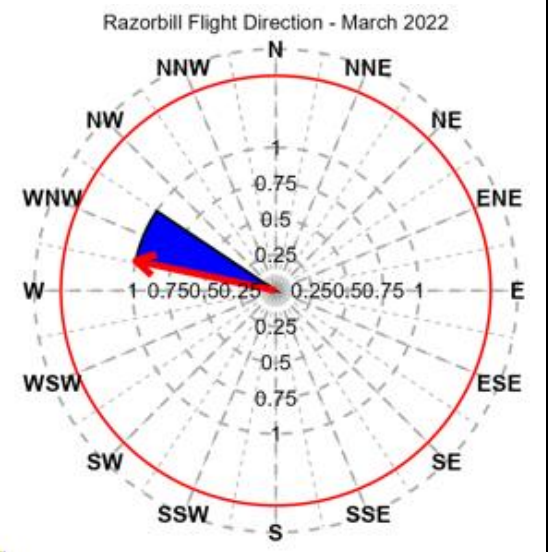
Number of Observations	2
Mean Vector (μ)	124.390
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.998
Rayleigh Test (p)	0.138

b July 2021



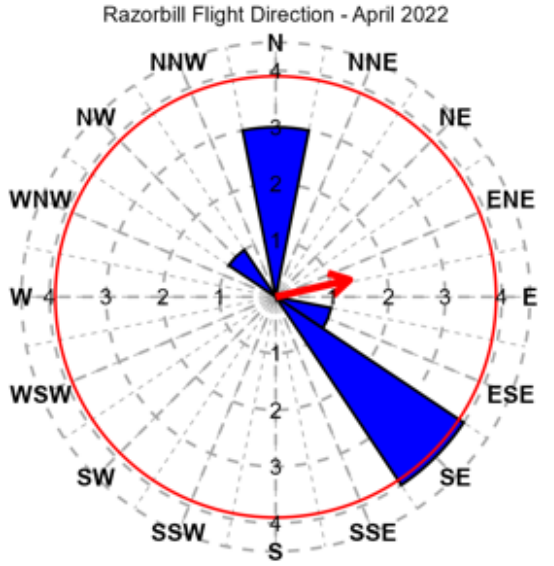
Number of Observations	1
Mean Vector (μ)	182.028
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

c September 2021



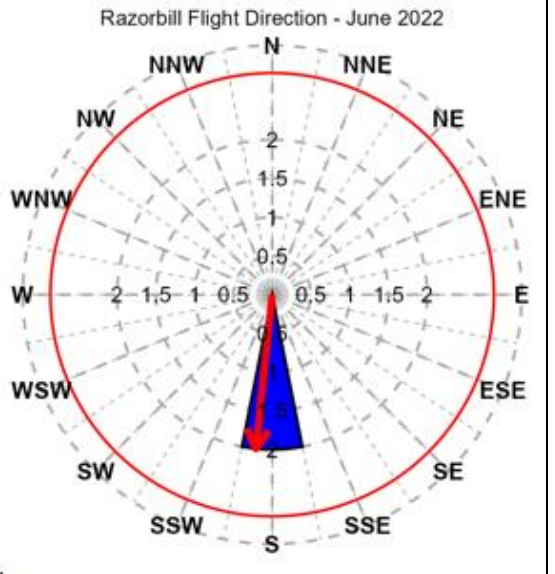
Number of Observations	1
Mean Vector (μ)	282.277
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

d March 2022



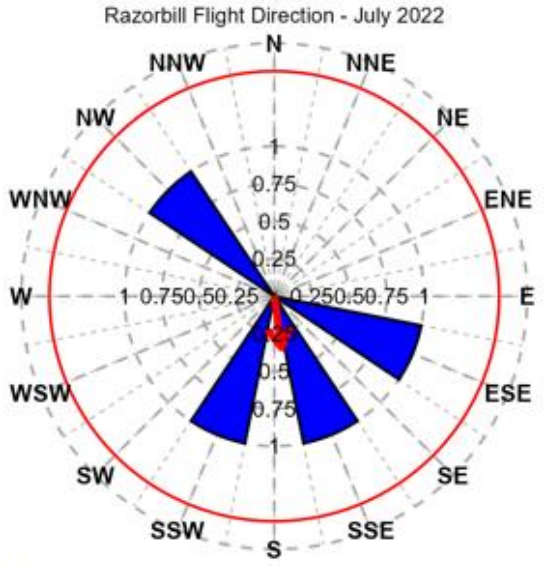
Number of Observations	9
Mean Vector (μ)	77.947
Length of Mean Vector (r)	0.335
Rayleigh Test (Z)	1.010
Rayleigh Test (p)	0.375

e April 2022



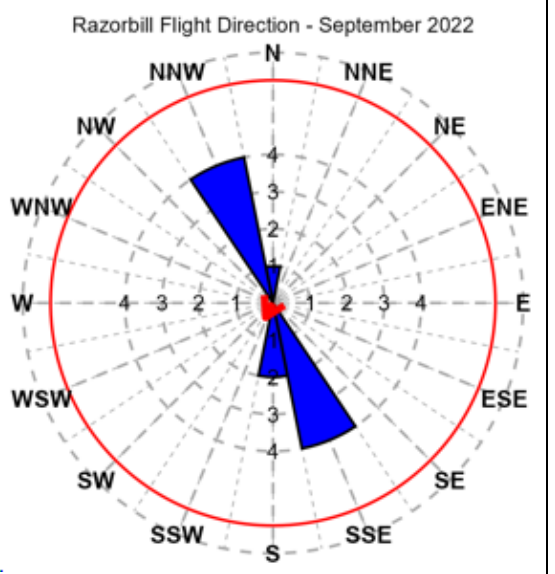
Number of Observations	2
Mean Vector (μ)	186.893
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.999
Rayleigh Test (p)	0.127

f June 2022



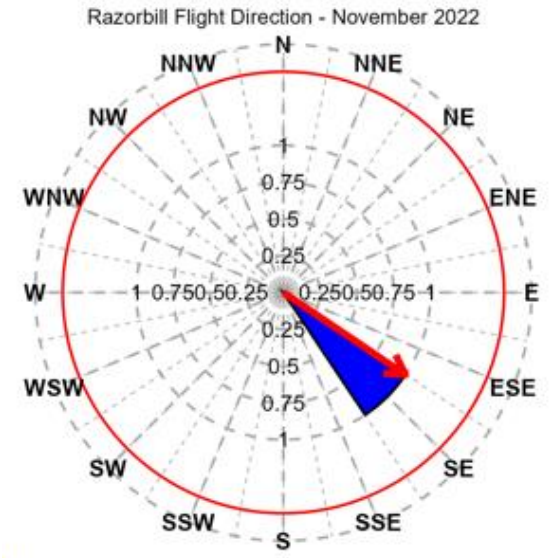
Number of Observations	4
Mean Vector (μ)	172.231
Length of Mean Vector (r)	0.347
Rayleigh Test (Z)	0.480
Rayleigh Test (p)	0.648

g July 2022



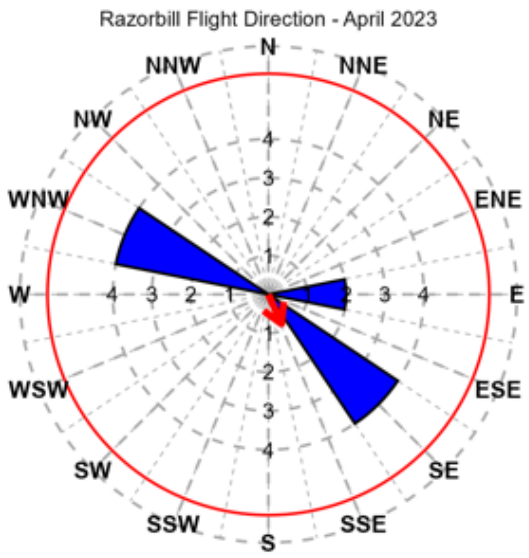
Number of Observations	11
Mean Vector (μ)	207.993
Length of Mean Vector (r)	0.111
Rayleigh Test (Z)	0.134
Rayleigh Test (p)	0.879

h September 2022



Number of Observations	1
Mean Vector (μ)	124.396
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

i November 2022

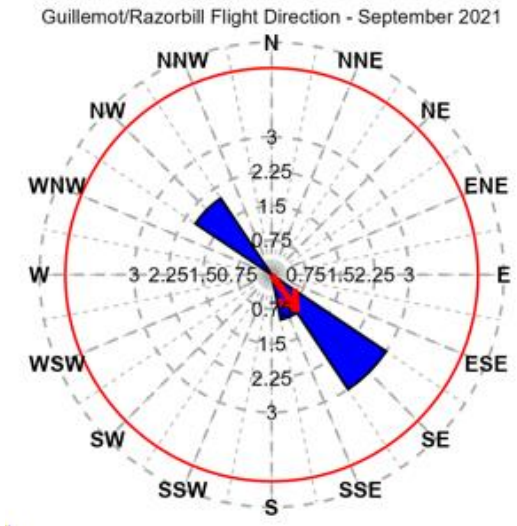


Number of Observations	10
Mean Vector (μ)	156.623
Length of Mean Vector (r)	0.207
Rayleigh Test (Z)	0.429
Rayleigh Test (p)	0.663

j April 2023

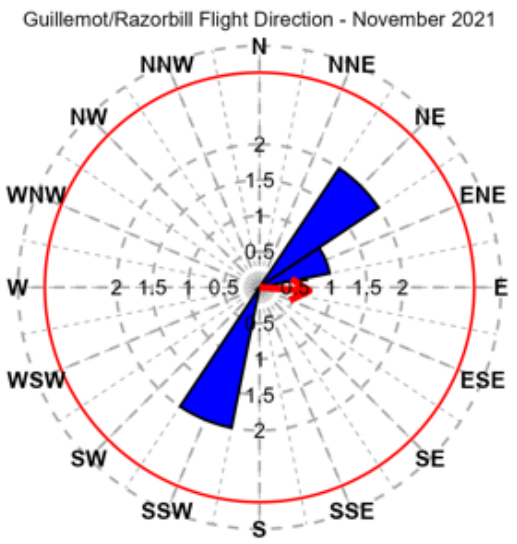
Figure A5.450 Flight direction of razorbills during the survey period

Unidentified guillemot / razorbill



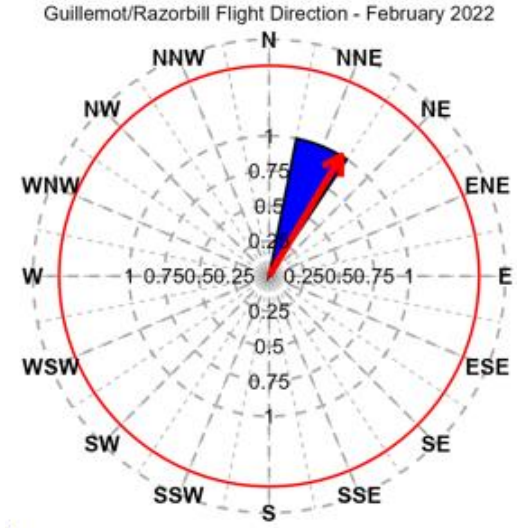
Number of Observations	6
Mean Vector (μ)	144.993
Length of Mean Vector (r)	0.311
Rayleigh Test (Z)	0.579
Rayleigh Test (p)	0.581

a September 2021



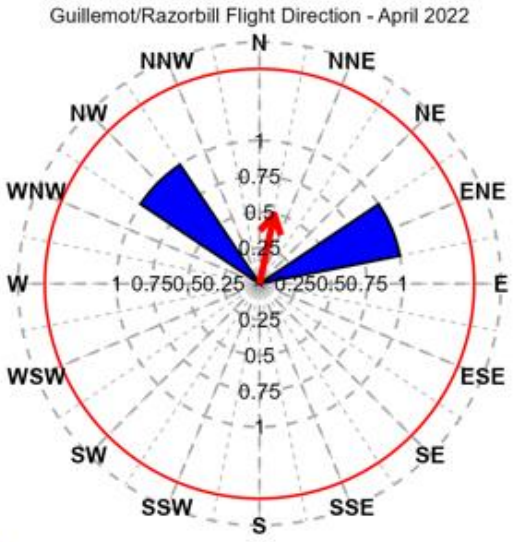
Number of Observations	5
Mean Vector (μ)	94.959
Length of Mean Vector (r)	0.347
Rayleigh Test (Z)	0.604
Rayleigh Test (p)	0.571

b November 2021



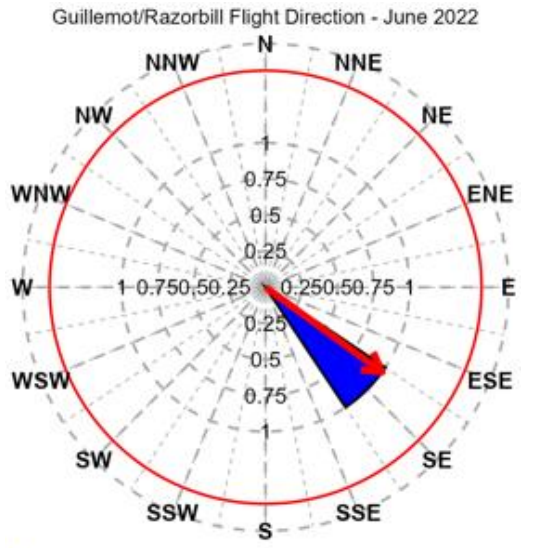
Number of Observations	1
Mean Vector (μ)	31.239
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

c February 2022



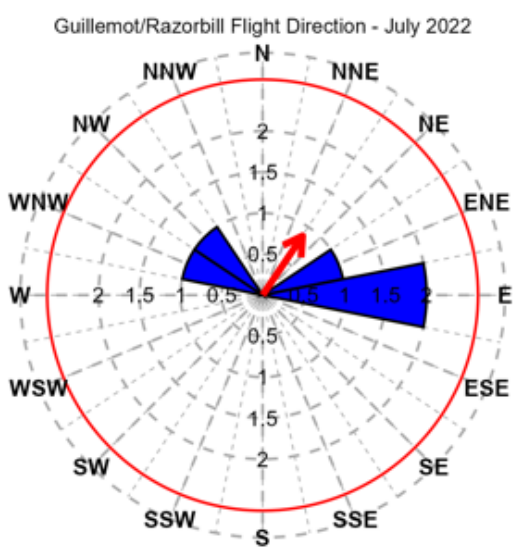
Number of Observations	2
Mean Vector (μ)	12.010
Length Mean Vector (r)	0.493
Rayleigh Test (Z)	0.486
Rayleigh Test (p)	0.678

d April 2022



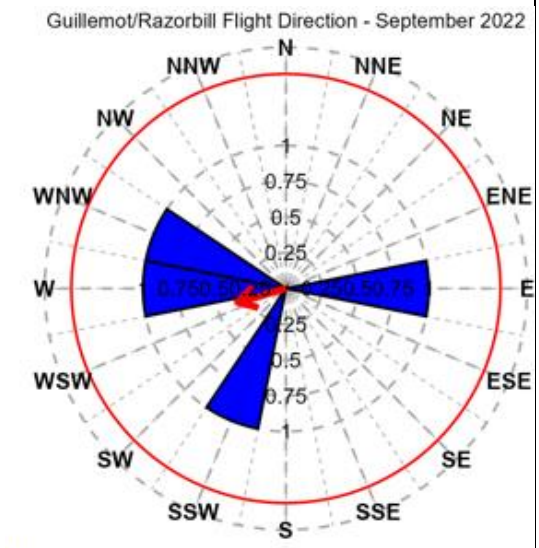
Number of Observations	1
Mean Vector (μ)	126.891
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

e June 2022



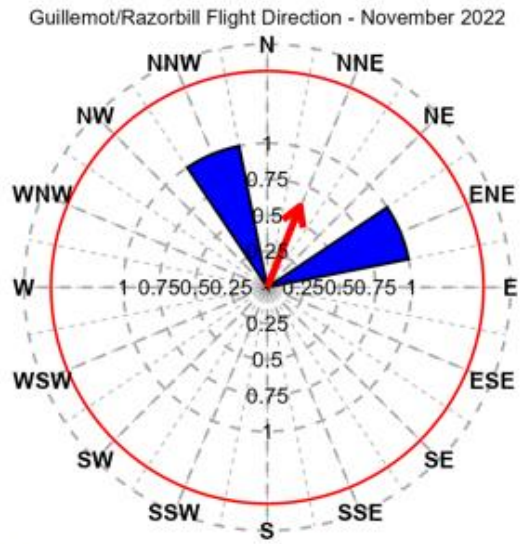
Number of Observations	5
Mean Vector (μ)	34.587
Length of Mean Vector (r)	0.435
Rayleigh Test (Z)	0.948
Rayleigh Test (p)	0.409

f July 2022



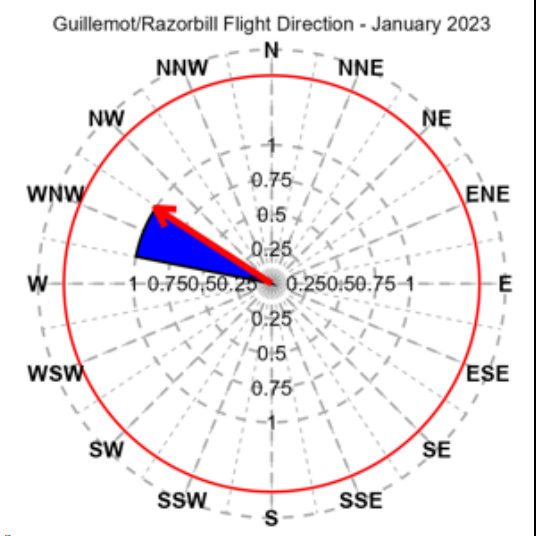
Number of Observations	4
Mean Vector (μ)	254.556
Length of Mean Vector (r)	0.351
Rayleigh Test (Z)	0.494
Rayleigh Test (p)	0.640

g September 2022



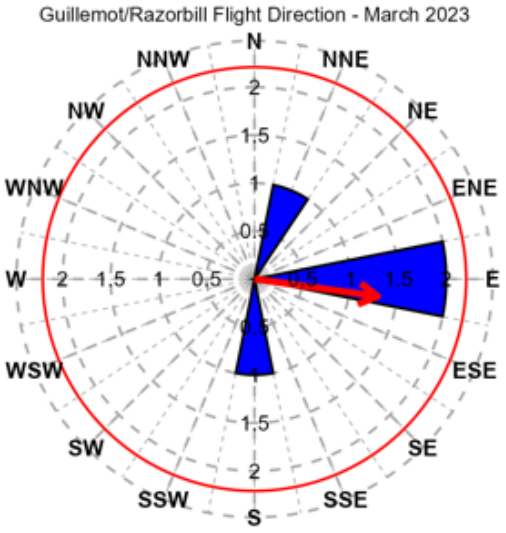
Number of Observations	2
Mean Vector (μ)	22.000
Length of Mean Vector (r)	0.606
Rayleigh Test (Z)	0.735
Rayleigh Test (p)	0.546

h November 2022



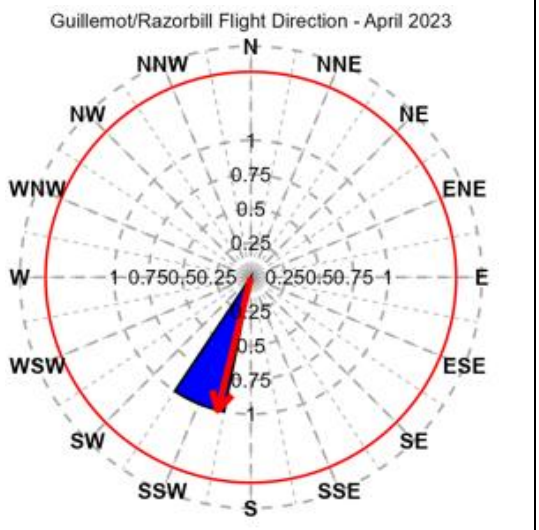
Number of Observations	1
Mean Vector (μ)	303.412
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

i January 2023



Number of Observations	4
Mean Vector (μ)	98.762
Length of Mean Vector (r)	0.648
Rayleigh Test (Z)	1.678
Rayleigh Test (p)	0.195

j March 2023

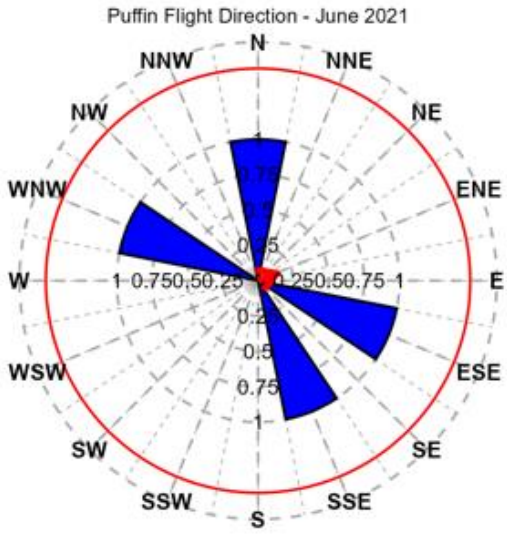


Number of Observations	1
Mean Vector (μ)	194.116
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

k April 2023

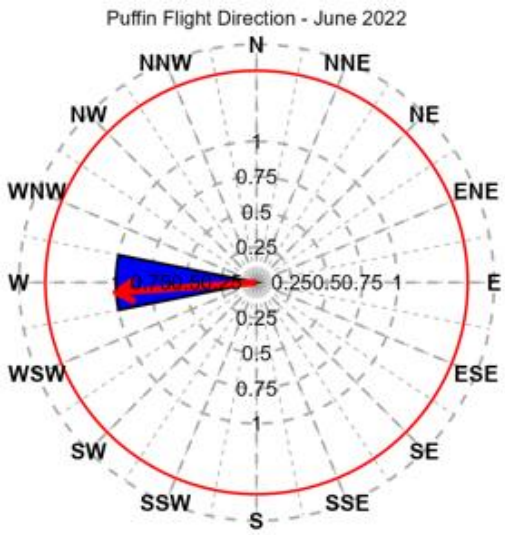
Figure A5.451 Flight direction of guillemots / razorbills during the survey period

Puffin



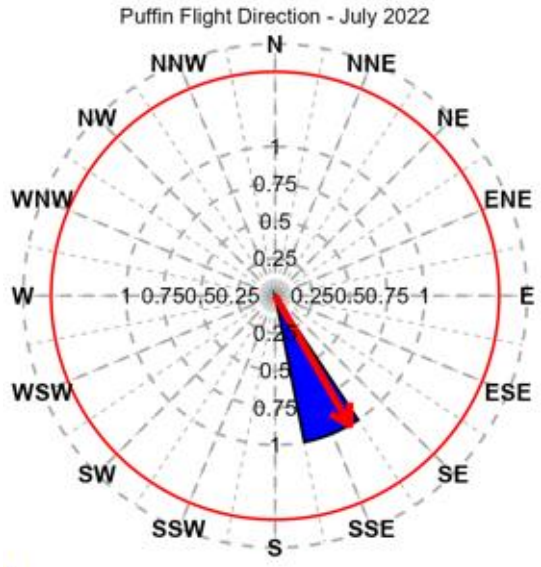
Number of Observations	4
Mean Vector (μ)	69.758
Length of Mean Vector (r)	0.143
Rayleigh Test (Z)	0.081
Rayleigh Test (p)	0.931

a June 2021



Number of Observations	1
Mean Vector (μ)	266.650
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

b June 2022

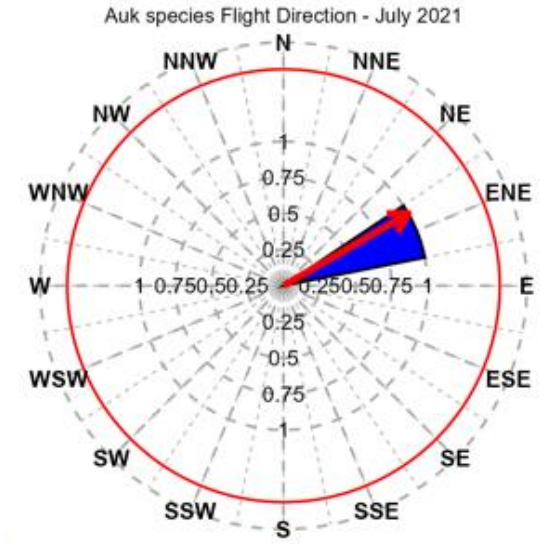


Number of Observations	1
Mean Vector (μ)	150.955
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

c July 2022

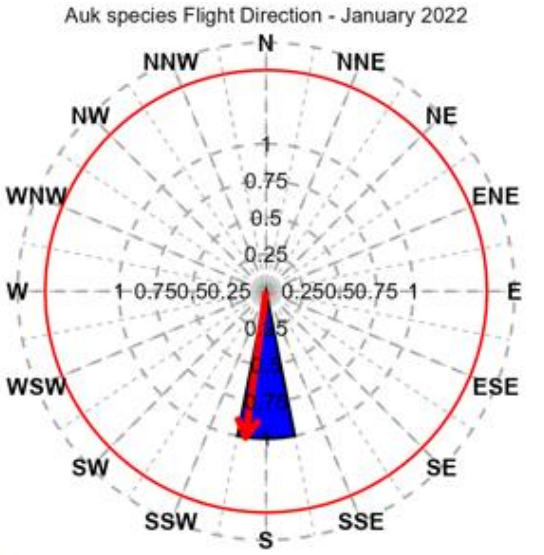
Figure A5.452 Flight direction of puffins during the survey period

Unidentified auk species



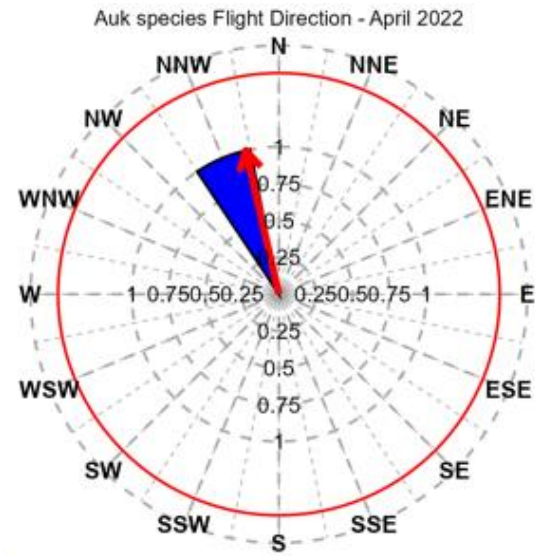
Number of Observations	1
Mean Vector (μ)	60.266
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

a July 2021



Number of Observations	1
Mean Vector (μ)	188.949
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

b January 2022



Number of Observations	1
Mean Vector (μ)	347.143
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

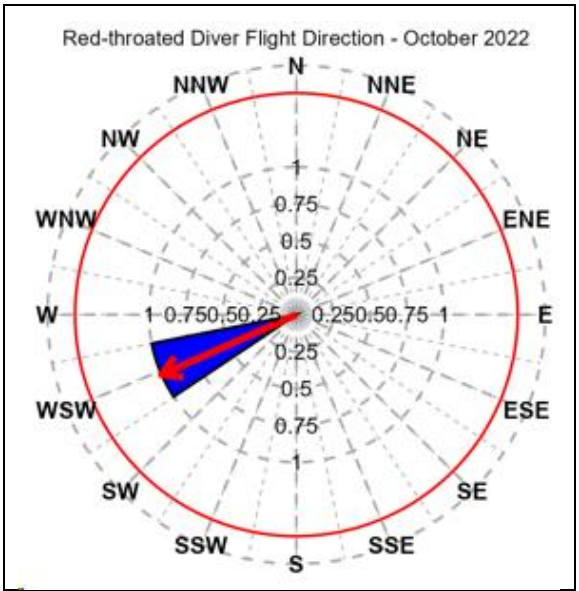
c April 2022

Number of Observations	1
Mean Vector (μ)	348.629
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

d August 2022

Figure A5.453 Flight direction of auk species during the survey period

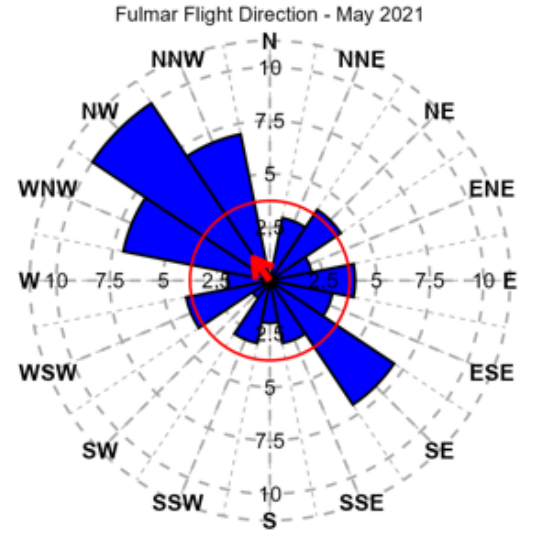
Red-throated diver



Number of Observations	1
Mean Vector (μ)	246.841
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
October 2022	

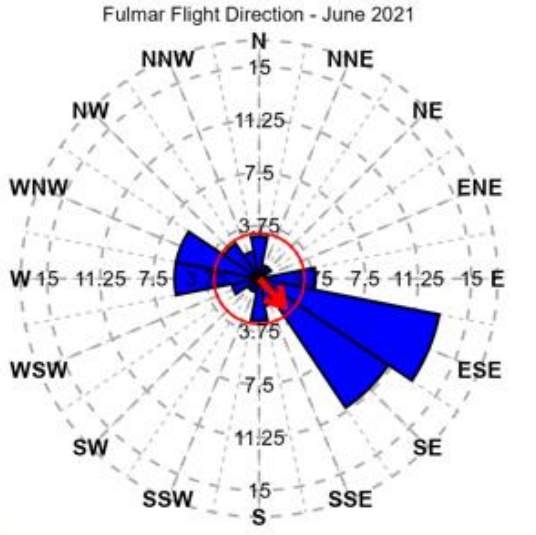
Figure A5.454 Flight direction of red-throated divers during the survey period

Fulmar



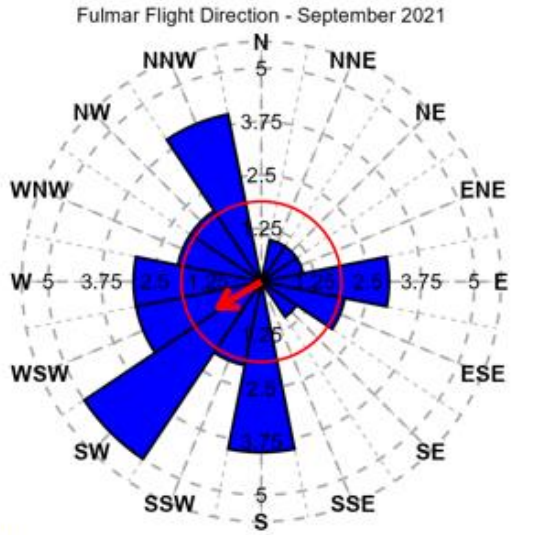
Number of Observations	62
Mean Vector (μ)	324.076
Length of Mean Vector (r)	0.129
Rayleigh Test (Z)	1.030
Rayleigh Test (p)	0.357

a May 2021



Number of Observations	59
Mean Vector (μ)	138.992
Length of Mean Vector (r)	0.205
Rayleigh Test (Z)	2.477
Rayleigh Test (p)	0.084

b June 2021

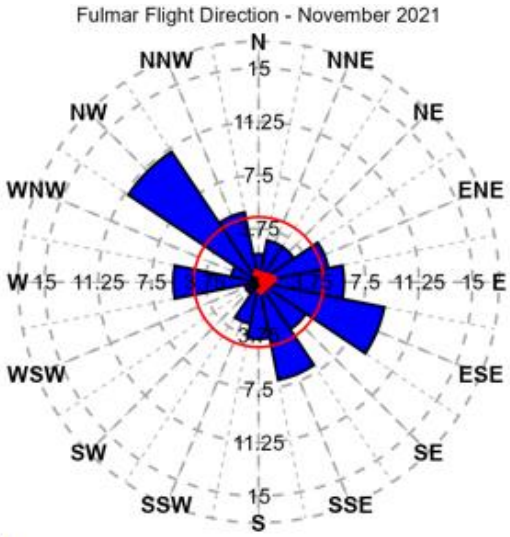


Number of Observations	34
Mean Vector (μ)	239.508
Length of Mean Vector (r)	0.233
Rayleigh Test (Z)	1.846
Rayleigh Test (p)	0.158

c September 2021

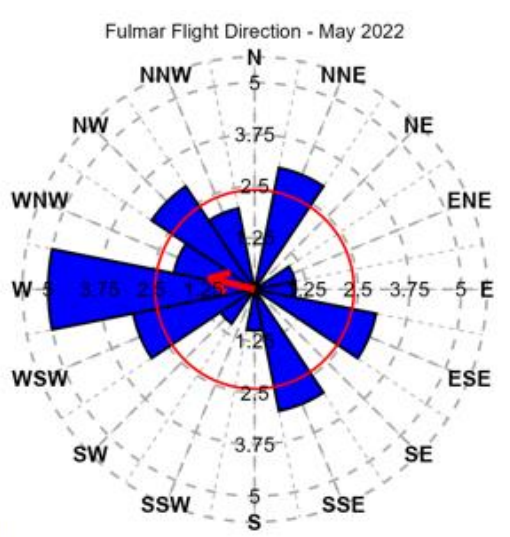
Number of Observations	2
Mean Vector (μ)	167.714
Length of Mean Vector (r)	0.855
Rayleigh Test (Z)	1.462
Rayleigh Test (p)	0.265

d October 2021



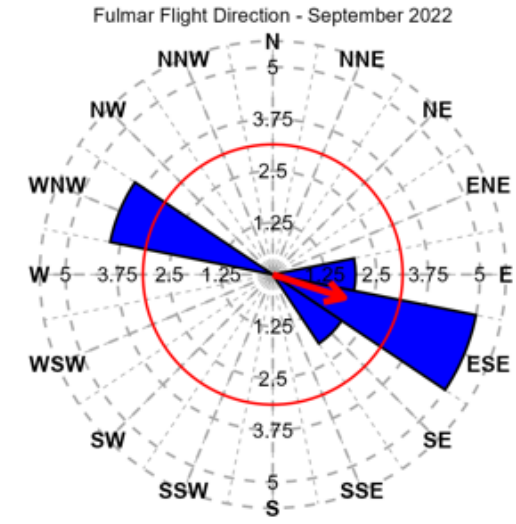
Number of Observations	72
Mean Vector (μ)	77.905
Length of Mean Vector (r)	0.100
Rayleigh Test (Z)	0.723
Rayleigh Test (p)	0.485

e November 2021



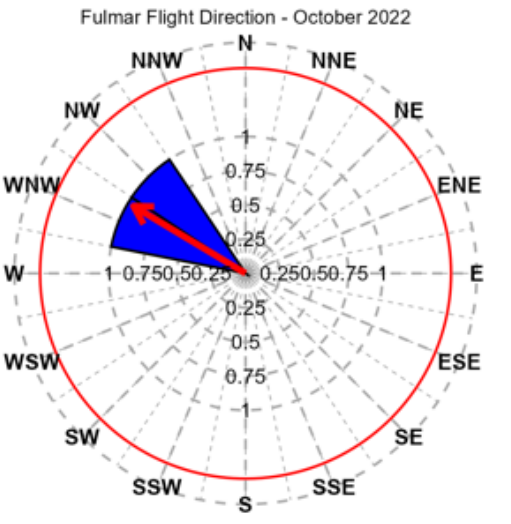
Number of Observations	28
Mean Vector (μ)	284.858
Length of Mean Vector (r)	0.221
Rayleigh Test (Z)	1.370
Rayleigh Test (p)	0.256

f May 2022



Number of Observations	13
Mean Vector (μ)	108.158
Length of Mean Vector (r)	0.361
Rayleigh Test (Z)	1.694
Rayleigh Test (p)	0.186

g September 2022

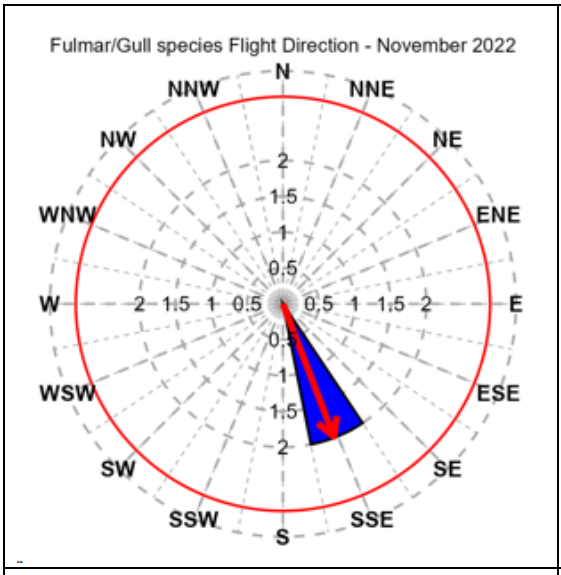


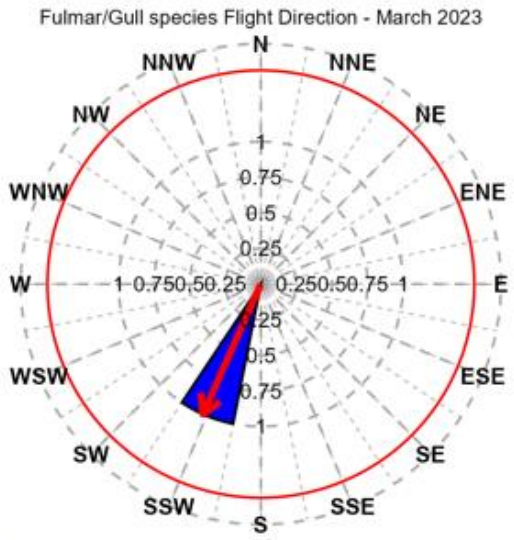
Number of Observations	2
Mean Vector (μ)	301.874
Length of Mean Vector (r)	0.954
Rayleigh Test (Z)	1.819
Rayleigh Test (p)	0.174

h October 2022

Figure A5.455 Flight direction of fulmars during the survey period

Unidentified fulmar / gull species

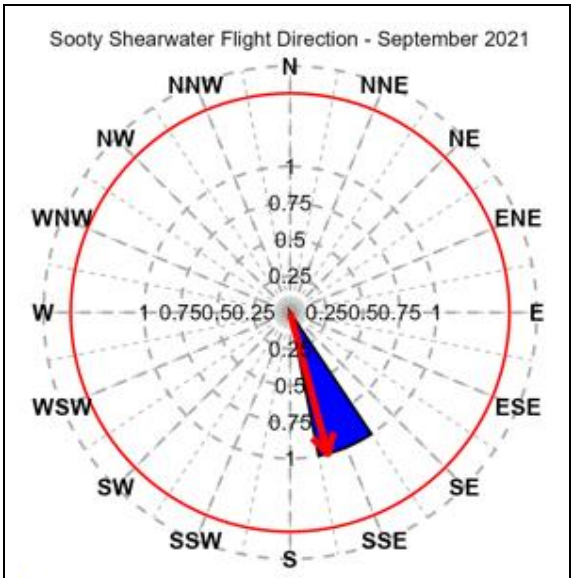




Number of Observations	2	Number of Observations	1
Mean Vector (μ)	159.288	Mean Vector (μ)	204.009
Length of Mean Vector (r)	0.990	Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.961	Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.145	Rayleigh Test (p)	0.512
a November 2022		**b March 2023**	

Figure A5.456 Flight direction of fulmar / gull species during the survey period

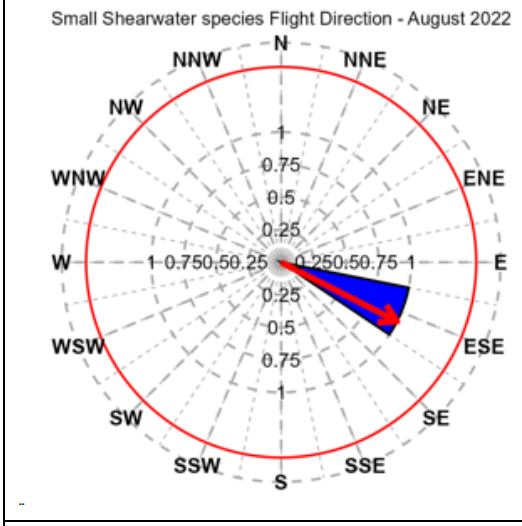
Sooty shearwater



Number of Observations	1
Mean Vector (μ)	165.403
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512
September 2021	

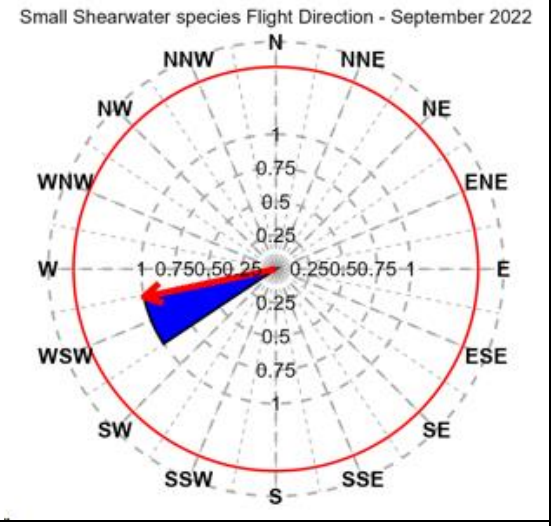
Figure A5.457 Flight direction of sooty shearwaters during the survey period

Unidentified small shearwater species



Number of Observations	1
Mean Vector (μ)	117.181
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

a August 2022

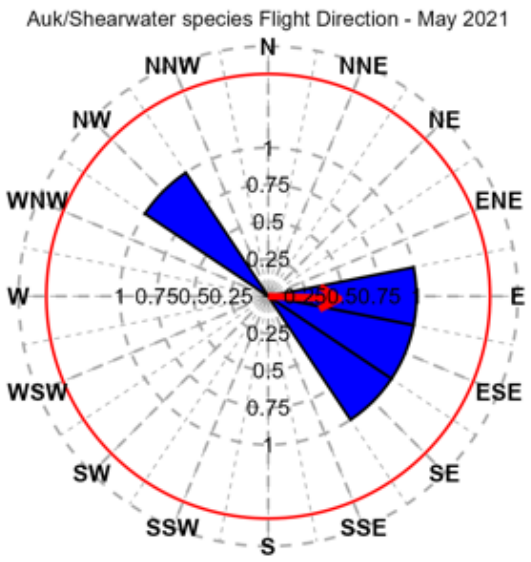


Number of Observations	1
Mean Vector (μ)	258.500
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

b September 2022

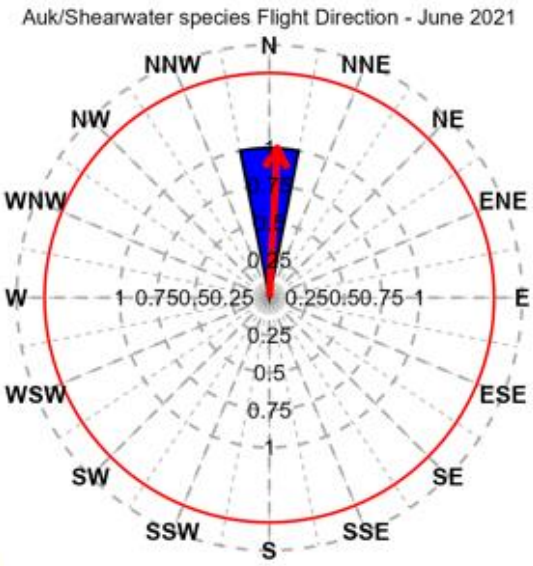
Figure A5.458 Flight direction of small shearwater species during the survey period

Unidentified auk / shearwater species



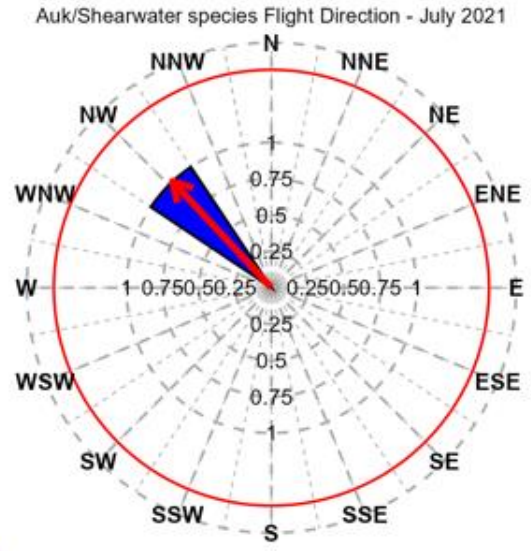
Number of Observations	4
Mean Vector (μ)	92.190
Length of Mean Vector (r)	0.478
Rayleigh Test (Z)	0.914
Rayleigh Test (p)	0.429

a May 2021



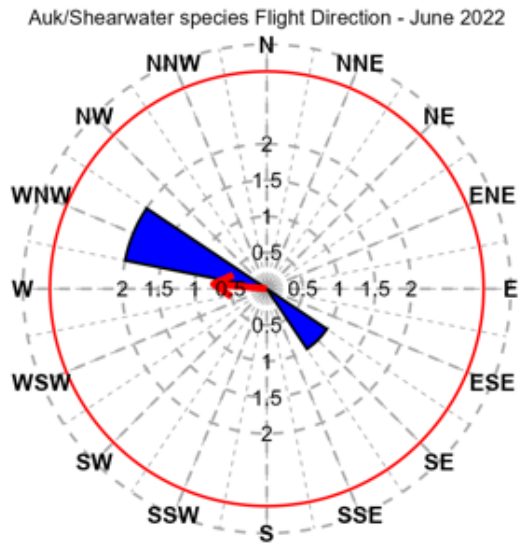
Number of Observations	1
Mean Vector (μ)	3.363
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

b June 2021



Number of Observations	1
Mean Vector (μ)	317.825
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

c July 2021

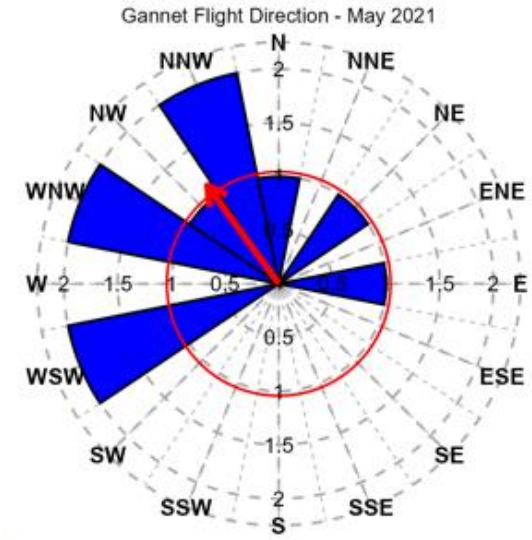


Number of Observations	3
Mean Vector (μ)	275.338
Length of Mean Vector (r)	0.369
Rayleigh Test (Z)	0.409
Rayleigh Test (p)	0.702

d June 2022

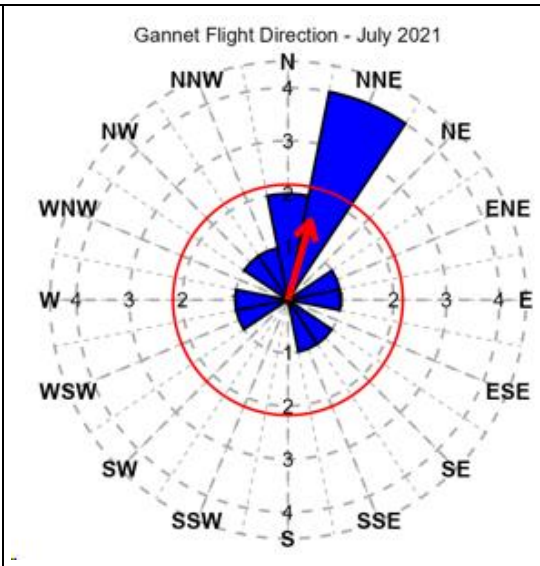
Figure A5.459 Flight direction of auk / shearwater species during the survey period

Gannet



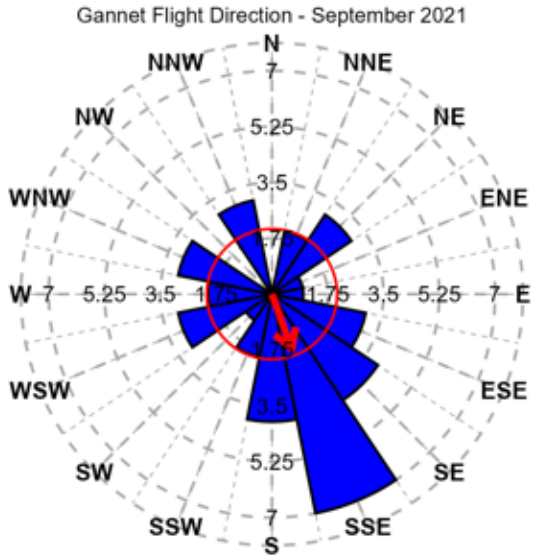
Number of Observations	10
Mean Vector (μ)	324.946
Length of Mean Vector (r)	0.564
Rayleigh Test (Z)	3.180
Rayleigh Test (p)	0.037

a May 2021



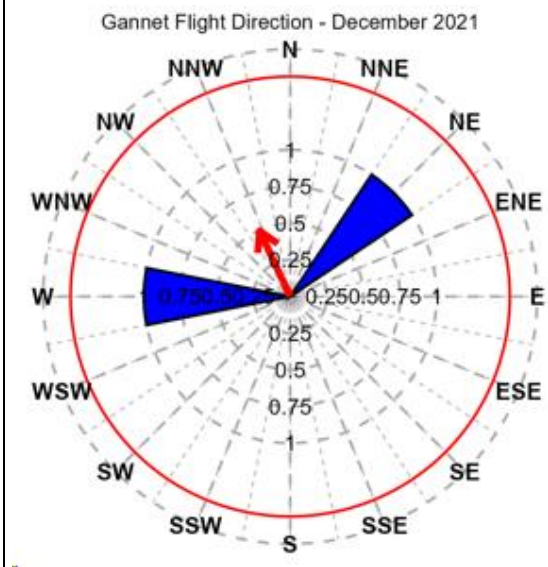
Number of Observations	14
Mean Vector (μ)	16.946
Length of Mean Vector (r)	0.386
Rayleigh Test (Z)	2.091
Rayleigh Test (p)	0.123

b July 2021



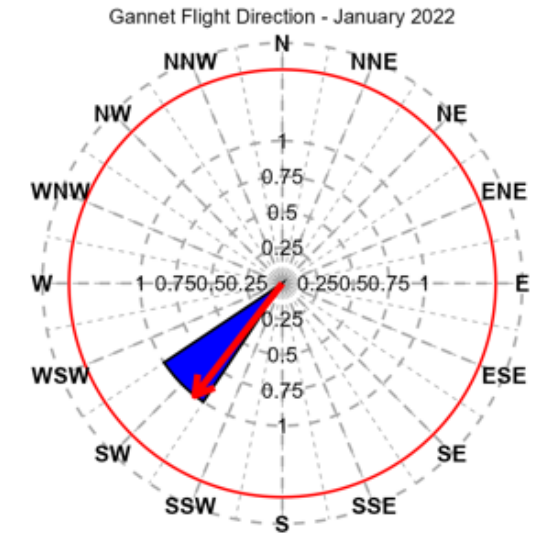
Number of Observations	39
Mean Vector (μ)	160.079
Length of Mean Vector (r)	0.261
Rayleigh Test (Z)	2.667
Rayleigh Test (p)	0.069

c September 2021



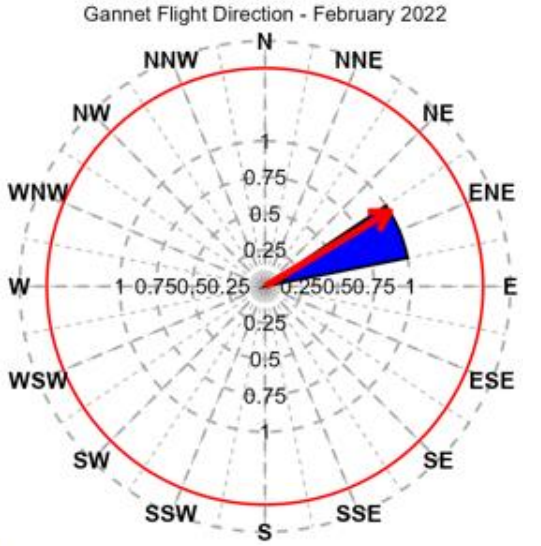
Number of Observations	2
Mean Vector (μ)	335.309
Length of Mean Vector (r)	0.493
Rayleigh Test (Z)	0.486
Rayleigh Test (p)	0.678

d December 2021



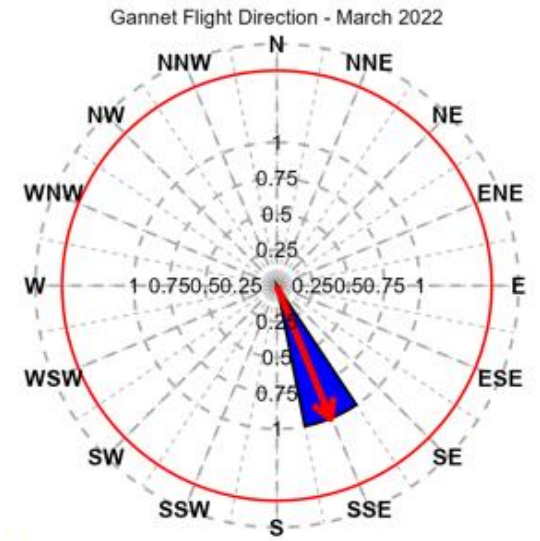
Number of Observations	1
Mean Vector (μ)	218.251
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

e January 2022



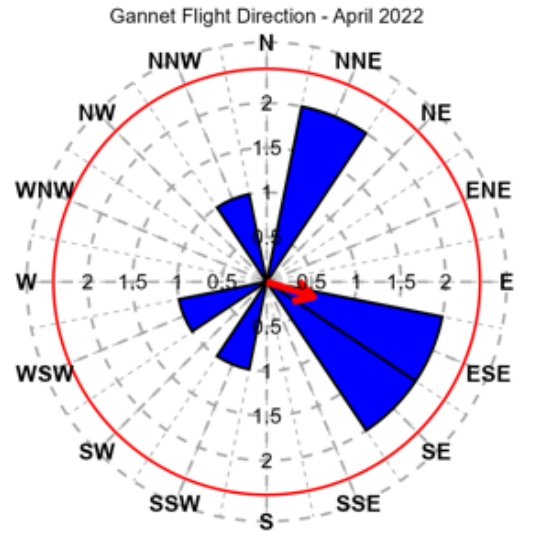
Number of Observations	1
Mean Vector (μ)	59.462
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

f February 2022



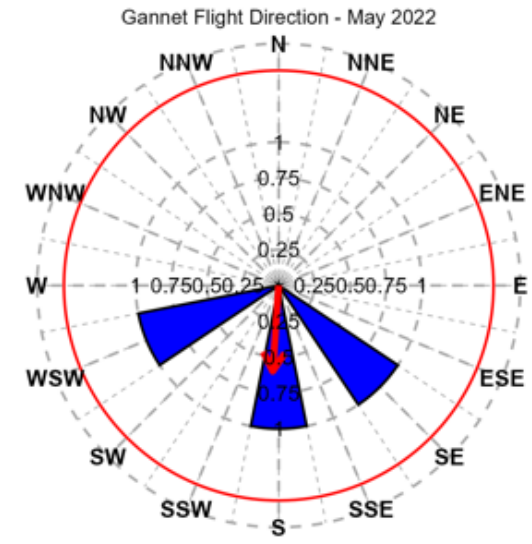
Number of Observations	1
Mean Vector (μ)	158.760
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

g March 2022



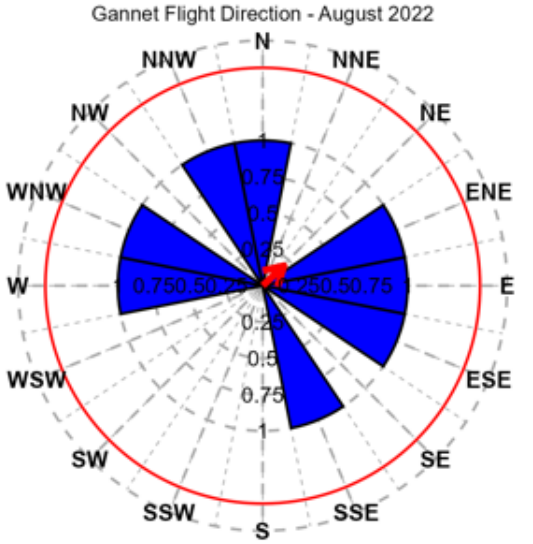
Number of Observations	9
Mean Vector (μ)	108.765
Length of Mean Vector (r)	0.274
Rayleigh Test (Z)	0.677
Rayleigh Test (p)	0.521

h April 2022



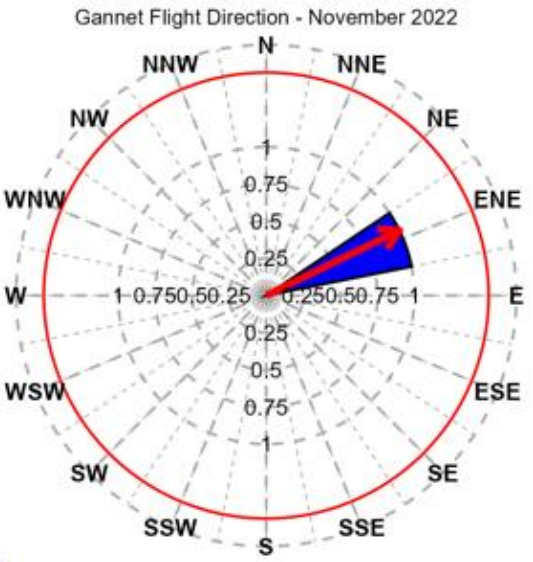
Number of Observations	3
Mean Vector (μ)	184.150
Length of Mean Vector (r)	0.599
Rayleigh Test (Z)	1.077
Rayleigh Test (p)	0.375

i May 2022



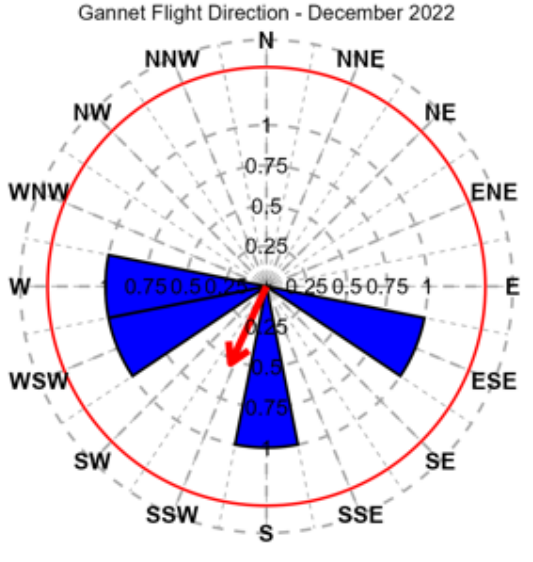
Number of Observations	8
Mean Vector (μ)	47.195
Length of Mean Vector (r)	0.201
Rayleigh Test (Z)	0.322
Rayleigh Test (p)	0.737

j August 2022



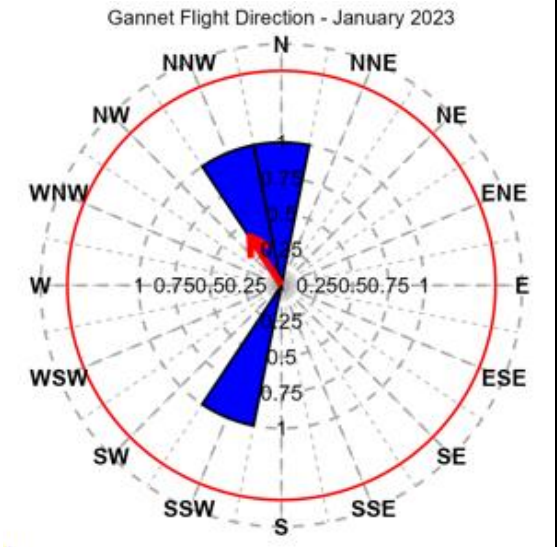
Number of Observations	1
Mean Vector (μ)	64.341
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

k November 2022



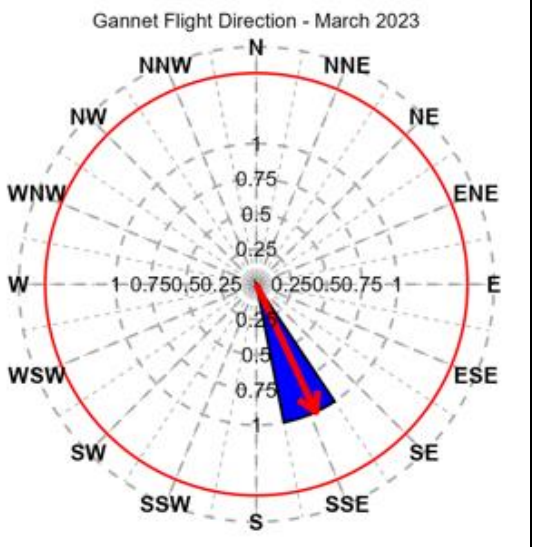
Number of Observations	4
Mean Vector (μ)	205.578
Length of Mean Vector (r)	0.526
Rayleigh Test (Z)	1.107
Rayleigh Test (p)	0.354

l December 2022



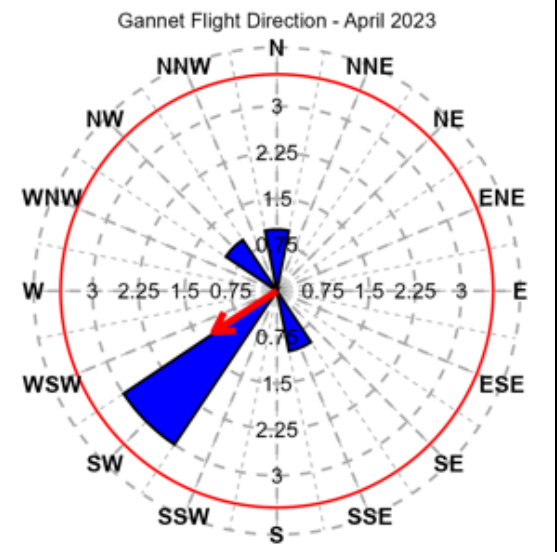
Number of Observations	3
Mean Vector (μ)	327.160
Length of Mean Vector (r)	0.407
Rayleigh Test (Z)	0.496
Rayleigh Test (p)	0.650

m January 2023



Number of Observations	1
Mean Vector (μ)	155.027
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

n March 2023

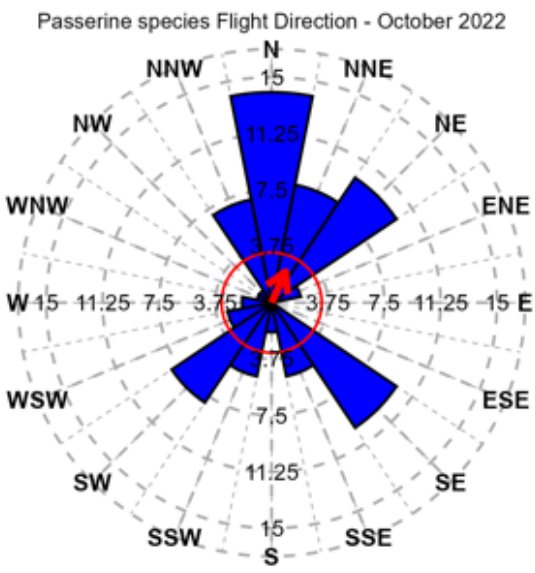


Number of Observations	6
Mean Vector (μ)	237.237
Length of Mean Vector (r)	0.407
Rayleigh Test (Z)	0.992
Rayleigh Test (p)	0.388

o April 2023

Figure A5.460 Flight direction of gannets during the survey period

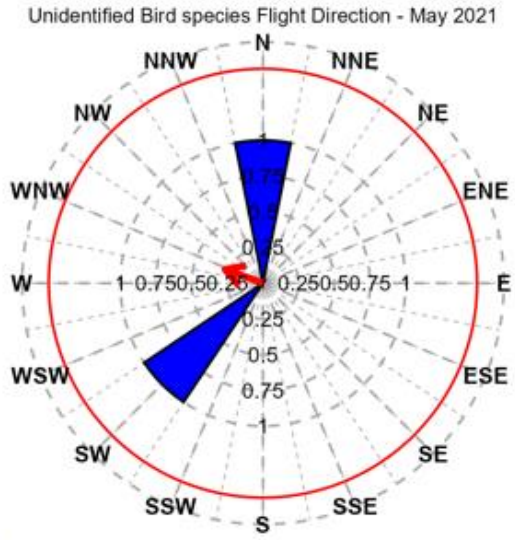
Unidentified passerine species



Number of Observations	78
Mean Vector (μ)	24.499
Length of Mean Vector (r)	0.161
Rayleigh Test (Z)	2.017
Rayleigh Test (p)	0.133
October 2022	

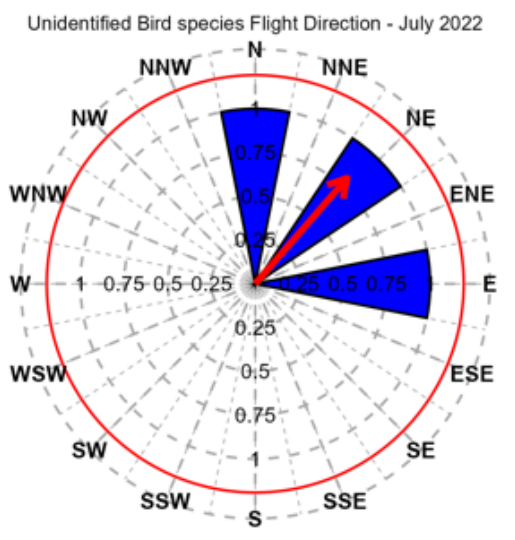
Figure A5.461 Flight direction of passerine species during the survey period

Unidentified bird species



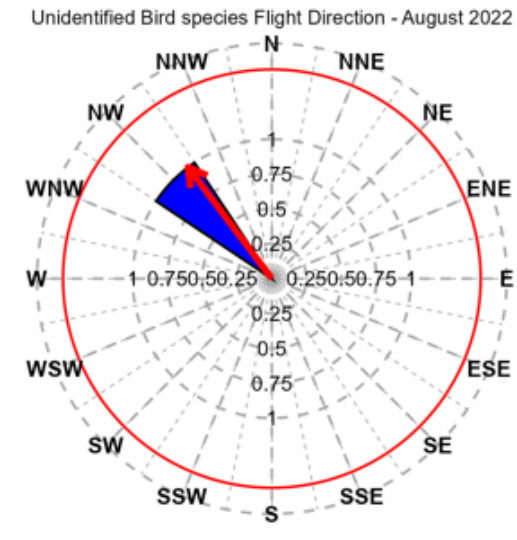
Number of Observations	2
Mean Vector (μ)	290.667
Length of Mean Vector (r)	0.283
Rayleigh Test (Z)	0.160
Rayleigh Test (p)	0.883

a May 2021



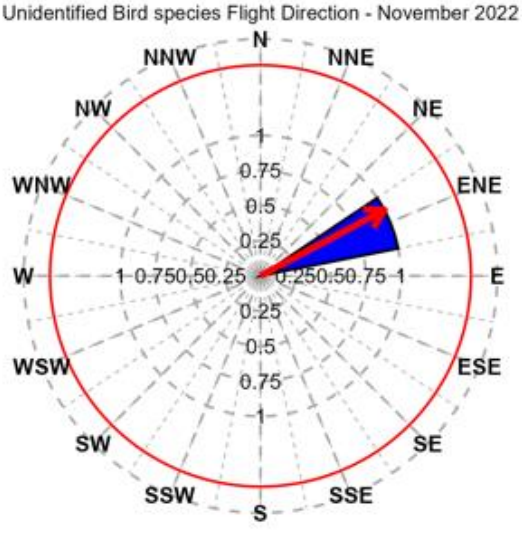
Number of Observations	3
Mean Vector (μ)	41.215
Length of Mean Vector (r)	0.800
Rayleigh Test (Z)	1.919
Rayleigh Test (p)	0.150

b July 2022



Number of Observations	1
Mean Vector (μ)	323.890
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

c August 2022



Number of Observations	1
Mean Vector (μ)	62.902
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

d November 2022

Figure A5.462 Flight direction of bird species during the survey period

Caledonia Offshore Wind Farm
5th Floor, Atria One
144 Morrison Street
Edinburgh
EH3 8EX

www.caledoniaoffshorewind.com

OCEAN WINDS