

**London Array Ltd.**

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**London Array Offshore Wind Farm:  
Ornithology Aerial Survey Report 2012  
/ 2013**

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**CLIENT:** London Array Ltd.

**ADDRESS:** 7<sup>th</sup> Floor  
50 Broadway  
St. James's Park  
London.  
SW1H 0RG

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**PROJECT DIRECTOR:** Dr Stuart Clough

**PROJECT MANAGER:** Dr Nicola Goodship

**REPORT AUTHORS:** Dr Nicola Goodship, Natasha Rowland & Dr Emily Barlow.

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APEM LTD  
Riverview, A17 Embankment Business Park,  
Heaton Mersey, Stockport SK4 3GN  
Tel: 0161 442 8938 Fax: 0161432 6083  
Registered in England No. 2530851  
Website: [www.apemltd.co.uk](http://www.apemltd.co.uk)

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## EXECUTIVE SUMMARY

1. The site of the London Array Offshore Wind Farm plus a buffer around the wind farm (total = 'zone 1') in the Outer Thames estuary was surveyed four times (once per month in November, December, January and February) during the winter of 2012 / 13, using digital high resolution still imagery.
2. A control zone ('zone 2') was surveyed with the same frequency over the same period, to satisfy Marine Licence conditions. An additional four control zones (zone 3, 5, 6 & 7) were also surveyed in order to provide information for the wider Ornithological Review Panel process.
3. Offshore construction for the Phase 1 area of the London Array OWF site commenced in March 2011 and turbines were installed between January to December 2012. Low level activity construction works in Phase 1 are ongoing.
4. The 2012 / 13 aerial surveys were carried during the second winter of during-construction in Phase 1 London Array OWF site.
5. Surveys were conducted on a systematic grid of 500 m separation, with images at 3 cm GSD resolution. Average coverage of zones was 18%.
6. The majority of divers recorded were red-throated divers (97.3%); the remainder were recorded as black-throated divers and great northern divers. The total diver population estimated across all London Array survey zones (zone 1, 2, 3, 5, 6 & 7) was low in November and December 2012, increased in January 2013 and peaked in February 2013 with 5,004 (3,940 – 6,359) estimated divers present.
7. Distribution of divers appeared to reflect shallow water areas. Approximately 97% of all divers were in water depths of < 20 m.
8. High concentrations of divers were recorded in the northern part of zone 1 as well as along the north-east border of zone 1 in January and February 2013. This distribution of divers in zone 1 was similar to historical pattern.
9. Diver abundance and distribution between zones 1, 2 and 3 has changed over the past three years of winter aerial surveys (2010 / 11, 2011 / 12 & 2012 / 13). Peak diver population estimates in zone 1 containing Phase 1 London Array wind farm fell between 2010 / 11 to 2011 / 12 and started to rise again in 2012 / 13, while concurrently peak diver numbers in control zones 2 & 3 increased between 2010 / 11 and 2011 / 12 and then fell again in 2012 / 13 (Table Exec 1, Figure 4.5).

Table Exec 1 Monthly raw counts of red-throated divers in Zone 1 showing clear increase in numbers following placement of last turbine in December 2012.

Date	2010/11	2011/12	2012/13
November	18	2	27
December	184	2	9
January	144	181	193
February	1,257	155	665

10. It would appear that the major increase in red-throated diver numbers that occurred in January 2013 and especially in February 2013 in zone 1 (Table Exec 1) follows the putting in place of the last phase 1 turbine in December 2012. This appears to imply that red-throated divers may rapidly make use of an area once wind farm turbine placement has ceased. Further post-construction surveys would show whether divers continue to increase in zone. Were that to be the case it would be sound evidence that red-throated divers may be less affected by wind farms than previously thought with important implications for consenting.
11. Large inter-annual variation in recorded diver numbers is common. Reasons for this variation could include effects of weather, natural variation, diurnal distribution, effects of construction etc.
12. Other bird species / groups recorded in the 2012 / 13 aerial survey included scaup, common scoters, fulmars, gannets, cormorants/shags, grebes, oystercatchers, pomarine skuas, great skuas, small gulls (including kittiwakes, black-headed gulls, little gulls and common gulls), large gulls (including lesser black-backed gulls, herring gulls and great black-backed gulls) and auks (including guillemots, razorbills, little auks and puffins). Gulls were the most abundant species group after divers.
13. The majority of marine mammals recorded across all zones during the 2012 / 13 aerial survey were cetaceans (77% of total marine mammals); of these, 70% were recorded as dolphins / porpoises with the remainder identified as harbour porpoises. Dolphins / porpoises were most abundant in zone 1 in February 2013 with little use of other zones in other months.

# 1 INTRODUCTION

## 1.1 Aerial surveys

This report summarises the findings of the second winter (2012 / 13) during construction aerial surveys over London Array Ltd. Offshore Wind Farm (OWF) site (hereby referred to as London Array OWF site), and associated control zones (Figure 2.1), for birds and marine mammals. The London Array OWF site consists of Phases 1 & 2 development areas as well as two other areas not currently under consideration for development (one to the south of phase 1 and the other to the north of phase 2, see Figure 2.1). Pre-construction aerial surveys were carried out over the winters of 2009 / 10 and 2010 / 11. The London Array OWF is being constructed in two phases. Offshore construction for the Phase 1 area of the London Array OWF site commenced in March 2011 and the first of 175 turbines was installed in January 2012. The first year of during construction aerial surveys were carried out over the winter of 2011 / 12. The final turbine was installed in December 2012 and Phase 1 of the project was fully operational by spring 2013, although low level construction works are currently still on going. The date when Phase 2 construction will commence has yet to be announced.

London Array Ltd. has commissioned APEM Ltd. to collect high definition digital aerial images over London Array OWF site and associated control zones over the winter months (November, December, January & February) since 2009. During the winter of 2009 / 10 two control zones were surveyed as well as the London Array OWF. In the winter of 2010 / 11, five control zones were surveyed as well as the London Array OWF site plus an extra buffer around the wind farm; since the 2010 / 11 surveys the survey area has remained the same for the 2011 / 12 and 2012 / 13 surveys.

The aerial surveys were designed to meet the requirements of the Marine Licence<sup>1</sup> granted in respect of the wind farm, and to satisfy the wider Ornithological Review Panel (ORP) process. The ORP was set up prior to award of consent as an expert panel comprising representatives from London Array, Natural England and Royal Society for Protection of Birds. The aim of the ORP was to discuss and agree the scope of the ornithological monitoring required under the phased approach in the London Array Marine Licence, and to agree an interaction figure that would not have an adverse effect on integrity of the Outer Thames Estuary SPA. In order to satisfy Marine Licence conditions, pre-, during and post-construction monitoring for each phase of the wind farm is required, necessitating aerial surveys of the London Array OWF site plus a buffer around the site (zone 1) and a control zone (zone 2). Aerial surveys designed to fulfil the ORP process cover further control zones (zone 3, 5, 6 & 7).

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<sup>1</sup> The Marine Licence, issued in August 2012 replaces and combines the previous FEPA and CPA licences.

## 1.2 Importance of the Outer Thames Estuary for red-throated divers

During the non-breeding season, red-throated divers aggregate in often large groups in offshore areas. The Outer Thames Estuary SPA (Special Protection Area) has been identified by Natural England using data collected from aerial surveys during the period from January 1989 to winters of 2005 / 06 and 2006 / 07 and analysed by the Joint Nature Conservation Committee (JNCC) Seabirds and Cetaceans Team. These data show that the Outer Thames Estuary SPA regularly supports numbers of wintering red-throated diver that are of European importance, exceeding 1% of the Great Britain (GB) population of 17,000 birds. The red-throated diver is listed under Annex I of the EU Birds Directive (79/409/EEC) as being a rare or vulnerable species, meaning that EU member states are obligated to identify and designate key areas of habitat used by the species as SPAs. Sites supporting 1% or more of the GB population of an Annex I species are automatically considered for SPA designation (Stroud *et al.* 2001). Visual aerial survey estimates for the Outer Thames SPA place the wintering total at 6,466 individuals or 38% of the GB estimate (O'Brien *et al.* 2008). The SPA covers over 379,268 ha of offshore habitat between Kent and Norfolk. Over the wider Greater Thames area, estimates of 8,130 red-throated divers have been made, representing 47% of the national estimate (O'Brien *et al.* 2008).

## 1.3 Aim and objectives

The aim of this project is to provide information about the response of and risks to bird species (predominantly, but not exclusively, red-throated diver *Gavia stellata*), arising from the construction and operation of the wind farm. The red-throated diver is listed under Annex I of the EU Birds Directive (79/409/EEC) as being a rare or vulnerable species, meaning that EU member states are obligated to identify and designate key areas of habitat used by the species as Special Protection Areas (SPAs). Sites supporting 1% or more of the Great Britain population of an Annex I species are automatically considered for SPA designation (Stroud *et al.* 2001).

The defined objectives of the project are to:

1. Provide baseline surveys of Phase 1 pre-, during and post-construction in the London Array OWF site;
2. Provide baseline surveys of Phase 2 and the rest of the OWF not currently under construction;
3. Provide pre-, during and post-construction baseline surveys of control zones for the OWF site;
4. Describe temporal and spatial variation in bird numbers across the OWF and control zones;
5. Produce population estimates, with a given level of precision, for birds across the OWF and control zones;
6. Produce updated estimates of red-throated diver abundance and distribution within the OWF and control zones, with respect to the Special Protection Area (SPA) in the Outer Thames Estuary.



## 2 METHODS

### 2.1 Survey design

High definition digital aerial surveys were conducted during the winter period between November 2012 and February 2013. Four surveys of six zones were completed in total, with one survey conducted each month.

Each survey was flown on a 500 m grid at a 3 cm ground sampling distance (GSD) resolution to ensure comparability with the 2010 / 11 and 2011 / 12 pre- / during-construction surveys (for detailed rationale, see APEM 2010). The primary aim of APEM's grid survey methodology is to derive sufficient independent estimates of bird density (and distribution) to target a predefined level of precision around population estimates. The spacing of the grid (an image is collected at each grid internode) is determined by the predicted number of samples required to achieve the predefined level of confidence ( $CV < 0.16$ ).

Aerial surveys were undertaken using either a Vulcanair P68 Observer twin engine survey aircraft or a Britten-Norman Islander survey aircraft.

Surveys were flown in the following areas (Figure 2.1; for detailed rationale, see APEM 2011):

#### *Marine Licence condition areas*

**Zone 1: area encompassing the London Array Ltd OWF including Phase 1 and Phase 2 development sites plus a buffer surrounding the OWF site.** As per 2010 / 11 and 2011 / 12 surveys. After the 2009 / 10 aerial surveys, an additional area to the northeast of the London Array OWF footprint was added to zone 1, encompassing an aggregate site and the whole of the Long Sand sandbar. A 1 km buffer surrounding zone 1 was also added to examine bird density in surrounding shipping lanes after the 2009 / 10 surveys.

**Zone 2: control zone to south west of London Array OWF site.** As per 2010 / 11 and 2011 / 12 surveys. This zone was used to detect displacement of red-throated divers, as it contains sea bed mostly < 20 m deep and is largely devoid of shipping traffic, making it a likely suitable replacement habitat for any divers avoiding the wind farm area. An additional 1 km buffer surrounding zone 2 was added to examine bird density in surrounding shipping lanes after the 2009 / 10 surveys.

#### *Wider ORP process areas*

**Zone 3: control zone encompassing Kentish Flats OWF.** As per 2010 / 11 and 2011 / 12 surveys.

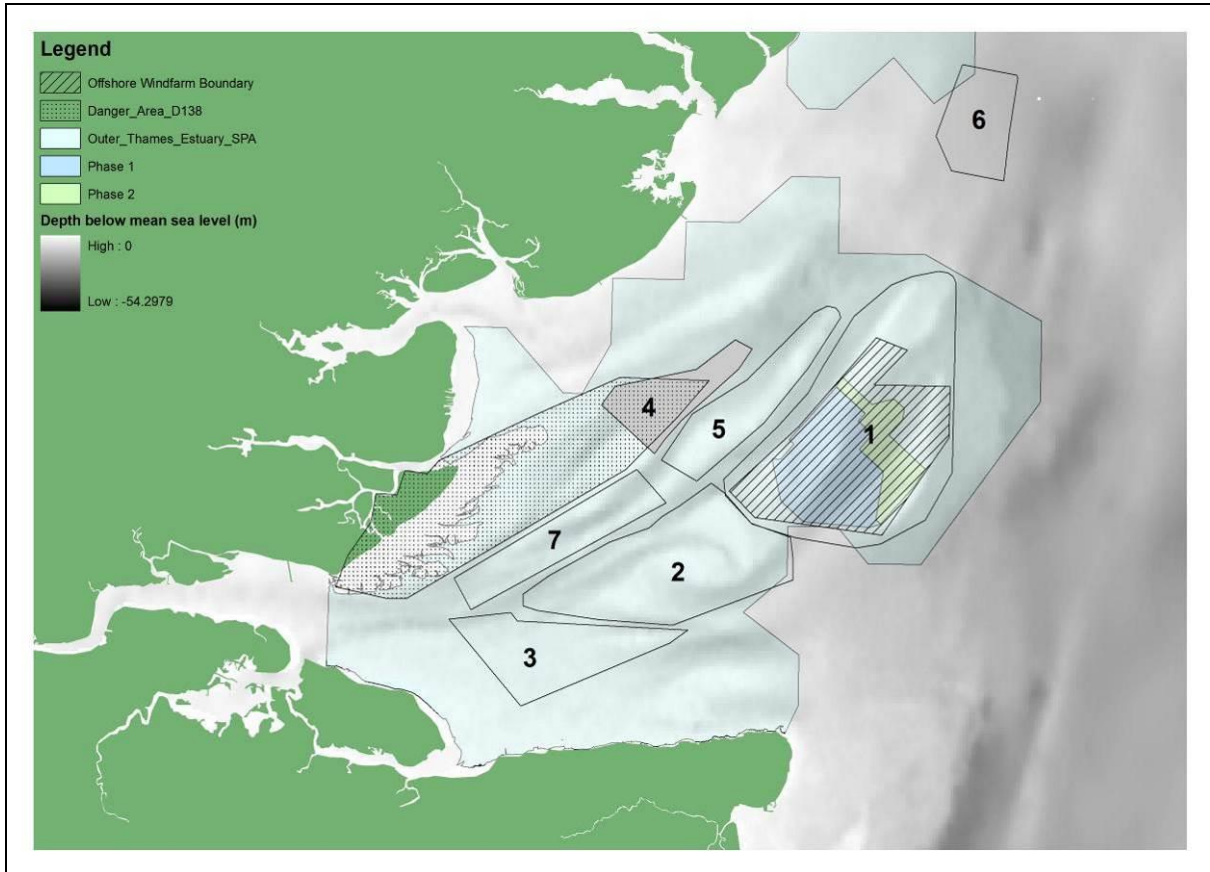
**Zone 5: control zone.** As per 2010 / 11 and 2011 / 12 surveys. This zone was used to detect effects of displacement from the London Array OWF. As for zone 2, this area contains sand bar habitat considered to be favoured by red-throated divers (i.e. sea bed <20 m) and is undisturbed by shipping. Although the sand bar extends to the south west, surveying was

restricted to the area north of the shipping lane, as this area is closest to the London Array OWF site, and thus the nearest available suitable habitat should displacement occur.

**Zone 6: control zone.** As per 2010 / 11 and 2011 / 12 surveys. This zone was included to confirm the presence or absence of red-throated divers in deeper waters surrounding the London Array OWF, as advised by JNCC. Displacement is considered unlikely to this area. The zone lies 6.1 km to the west of the western edge of the Greater Gabbard OWF, approximately double the buffer zone distance used for boat-based baseline data collection for that wind farm area (Banks *et al.* 2006).

**Zone 7: control zone.** As per 2010 / 11 and 2011 / 12 surveys. This zone was used during the 2010 / 11 pre-construction aerial surveys to replace control zone 4. Zone 7 is slightly different in shape to zone 4, but no more prone to shipping disturbance. The shape of zone 7 is largely dictated by the presence of the sand bank, which was one of the reasons it was selected to replace zone 4.

Zone 4 was discontinued during the 2009 / 10 aerial surveys, in agreement with London Array Ltd and the ORP group, as it overlaps the MoD firing range at Foulness / Shoeburyness (area D138), which is active from 0900-1700 every weekday, and involves both firing and unmanned air vehicles. The range is 'cold' before 0845 each day and at weekends leaving little scope for advance planning and carries an obligation to leave the airspace with no notice at all when it becomes active. Operationally therefore, activity would be restricted to early mornings and weekends, adding to the significant constraints of weather and light on winter surveys.



**Figure 2.1:** Layout of 2012 / 13 survey areas (zones 1, 2, 3, 5, 6 and 7). Zone 1 contains the London Array OWF site (lined area). The London Array OWF site contains Phase 1 (lined blue area) and Phase 2 (lined green area) development sites as well as two uncoloured areas that are not currently being considered for development. Zone 2 is the Marine Licence control zone, zones 3, 5, 6 and 7 are the ORP control zones. Zone 4 (grey) was not surveyed (see section 2.1) due to proximity of MOD area D138 (dotted area). The Outer Thames Estuary SPA (light blue area), designated for wintering red-throated divers, is also shown.

## 2.2 Survey information

Each survey zone was completed within a day. Therefore, the order in which the zones were surveyed depended on the length of time available to complete each zone within a day.

### 2.2.1 Survey One – November 2012

The first survey was undertaken between the 13<sup>th</sup> and 18<sup>th</sup> November 2012. Zones 5 and 7 were surveyed on the 13<sup>th</sup> November and zone 3 on the 14<sup>th</sup> November. Due to poor weather over the following three days, zones 1, 2 and 6 were completed on the 18<sup>th</sup> November.

### 2.2.2 Survey Two – December 2012

The second survey was undertaken between the 4<sup>th</sup> and 6<sup>th</sup> December 2012. Zones 3, 5 and 7 were surveyed on the 4<sup>th</sup> December, zone 2 and 6 on the 5<sup>th</sup> December and zone 1 on the 6<sup>th</sup> December.

### 2.2.3 Survey Three – January 2013

The third survey was undertaken between the 2<sup>nd</sup> and 8<sup>th</sup> January 2013. Zones 2 and 5 were surveyed on the 2<sup>nd</sup> January, zone 6 on the 3<sup>rd</sup> January, Zone 3 and 7 on the 4<sup>th</sup> January and zone 1 on the 8<sup>th</sup> January.

### 2.2.4 Survey Four – February 2013

The fourth survey was undertaken between the 2<sup>nd</sup> and 3<sup>rd</sup> February 2013. Zones 1, 3, 5 and 7 were surveyed on the 2<sup>nd</sup> February followed by zones 2 and 6 on the 3<sup>rd</sup> February.

### 2.2.5 Weather Conditions

A breakdown of the weather conditions on each survey and any other significant information can be found in Appendix I.

## 2.3 Data collection

Flight planning software defines the required flying altitude and speed according to the camera, lens and required pixel resolution. Digital still images were collected with a 3 cm ground sampling distance (GSD) resolution.

Survey data are analysed to produce maps showing bird and marine mammal distribution and density in a GIS format. Photographs are imported as geo-referenced images (WGS 84 projection) into ArcView 9.2 (ESRI) and the following data are recorded:

- Count (number of individuals of diver species, other bird species and marine mammal species);
- Behaviour (flying / sitting);
- Position (easting, northing);
- Date and time stamp of image collection.

Data on flight height are not considered essential, as the main species of interest are red-throated divers. Divers typically fly close to the sea surface (Blomdahl *et al*, 2003), making collision with turbine rotors unlikely. However, such data can be derived from digital still images if subsequently required.

## 2.4 Quality Assurance procedure

A standard internal and external Quality Assurance (QA) procedure was carried out on each survey.

For the internal QA, images were assessed in batches with a different staff member responsible for each batch. Each bird image was reviewed and checked by APEM's own dedicated QA manager, ensuring that 100% of birds found in the images were subject to internal QA. The QA manager, an experienced ornithologist, is responsible for maintaining and updating the image library and also provides advice and guidance to the image processing staff. Images containing no birds were removed and kept separately for further QA. Of these 'blank' images, 20% were randomly selected for QA by the QA manager. If there was less than 90% agreement, the entire batch of images was re-analysed.

Upon completion of the internal QA, 20% of the birds located in each survey were subject to external QA by an independent organisation. The appointed auditors for seabirds are the British Trust for Ornithology (BTO). The images for external QA were selected at random using a random number generator. The selected images were provided to the BTO along with information on measured body lengths and wingspans of the birds. All identifications were conducted 'blind' by the external analyst. Upon completion, a matrix was created to show the proportion of agreement and identify areas of potential misidentification. It has been previously established that at least 90% agreement between BTO and APEM is required. Any disagreements were reviewed and if the 90% threshold was still not reached then a further 20% of images were assessed by the BTO. If 90% agreement was not achieved after secondary assessment, then the entire batch of images would be required to be reassessed and the QA process repeated.

For marine mammals, all images containing such animals were sent for external ID. The appointed auditors for marine mammals are the Sea Mammal Research Unit (SMRU Ltd). Upon return of the SMRU identifications, the data was updated accordingly with any improvements on the level of identification already achieved by the image analysts and ornithologists at APEM.

## 2.5 Data analysis

### 2.5.1 Design-based abundance estimates

Design-based estimates of bird and marine mammal abundance with confidence limits (CL) and associated precision of estimates were calculated for each zone. All analysis and data manipulation were conducted in the R programming language (R Development Core Team 2010) and non-parametric 95% confidence intervals were generated using the ‘boot’ library of functions (Canty & Ripley 2010).

#### 2.5.1.1 Population estimates

To calculate population estimates, it is necessary to know the total number of images required to cover the survey area. This was done by calculating the average size of an image footprint. An average image footprint was calculated by dividing the sum of the image areas contained within the survey area by the number of images that were wholly or partially within the survey area. The mean footprint size across all seven surveys presented in this report was 41,126 m<sup>2</sup>. The total number of images required to cover the study area was then calculated, excluding land.

Relative population estimates for the near shore and wider area strata were generated by adding up the raw counts from geo-referenced images and dividing this number by the total number of images to give the mean number of birds per image (*i*). Relative population estimates (*N*) for each survey month were then calculated by multiplying the mean number of birds per image by the total number of images required to cover the entire study area (*A*). This is analogous to abundance estimation outlined in Borchers *et al.* (2002).

$$N = i A$$

Population estimates were derived from the grid data for all the monthly surveys undertaken during the winter 2012 / 13 surveys. For each monthly aerial survey of each zone, geo-referenced locations of birds and marine mammals contained within each individual digital still image were used to generate raw counts. Bird and mammal locations contained within the boundaries of each zone were then extracted using ArcGIS, leaving raw count data for images obtained from each zone. Where an image fell across the survey boundary, only the part of the image that fell within the survey area was included in the analysis.

#### 2.5.1.2 Confidence limits

Confidence limits (CL) showing the extent of variability surrounding the relative population estimate were calculated using a non-parametric bootstrap method. APEM routinely use bootstrap methods to calculate CL as this statistical method is considered to be a very robust way of assigning measures of accuracy (Borchers *et al.* 2002). For the bootstrap simulation, a sub-sample of images within strata were re-sampled 999 times with replacement from image data (i.e. 999 subsamples of the raw counts were used to produce 999 new ‘total raw count’ values). Each of the 999 bootstrap values were then used to produce relative

population estimates within each stratum as described in section 4.6.1.1. The upper and lower 95% confidence intervals (+CL and –CL respectively) of all the bootstrapped population estimates was taken as the variability of the statistic over the population (Efron & Tibshirani 1993).

### **2.5.1.3 Precision**

For every population estimate, APEM calculates a  $CV'$  (coefficient of variation) to provide a measure of precision about the mean population estimate, i.e. to provide a measure of how good the estimates are of the relative population. As aerial survey grid data normally contain a high proportion of images with zero counts (as animals are not normally evenly distributed across the survey area), measures of precision were calculated from the raw count data using a negative binomial estimator which is suitable for data that have a pseudo-Poisson over-dispersed distribution caused by a large number of zero counts (Elliott 1977). This produced a  $CV'$  based on the relationship of the standard error (SE) to the mean ( $\mu$ ).

$$CV' = SE / \mu$$

Effectively, this statistic is used to determine whether the sampling regime is sufficient to estimate the population with a given level of precision. A  $CV' \leq 0.16$  relates to a precision level able to detect a doubling or halving of the population (Bohlin, 1990), although at very low densities, it is not always mathematically possible to obtain a  $CV'$  of 0.16, even if 99% of the area is covered.

### **2.5.2 Relative density distribution maps for divers**

Bird and mammal observations comprised individual points for each recorded individual, geo-referenced to actual spatial location at the time of survey. Relative density distribution maps were produced for total divers using ArcGIS (version 9.2) by summing the number of divers recorded in each image and then representing this sum of divers as a dot on a map that was proportional to the number of divers in that image; i.e. large numbers of divers per image were represented by larger dots than smaller numbers of divers per image.

### 3 RESULTS

#### 3.1 Abundance estimates

**Table 3.1:** Peak counts, estimates, confidence limits and precision for all bird species recorded across the survey area during winter 2012 / 13 (a comparable table for winter 2010 / 11 and 2011 / 12 can be found in Appendix III). Estimates within the target precision of 0.16 are in red italic text.

Species / group	Zone	Month	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
Total diver species	1	February	<i>665</i>	<i>3,153</i>	<i>2,276</i>	<i>4,281</i>	<i>0.04</i>
Red-throated diver	1	February	<i>651</i>	<i>3,086</i>	<i>2,238</i>	<i>4,419</i>	<i>0.04</i>
Black-throated diver	1	February	9	43	14	71	0.33
Great northern diver	1	February	5	24	5	47	0.45
Scaup	2	January	14	114	14	341	0.27
Common scoter	7	February	<i>58</i>	<i>267</i>	<i>58</i>	<i>802</i>	<i>0.13</i>
Fulmar	1	November	6	47	16	86	0.41
Gannet	1	February	<i>158</i>	<i>749</i>	<i>322</i>	<i>1,460</i>	<i>0.08</i>
Total cormorant & shag	2	January	<i>40</i>	<i>325</i>	<i>40</i>	<i>966</i>	<i>0.16</i>
Grebe species	7	January	3	24	3	57	0.57
Oystercatcher	3	January	1	5	1	14	>1.00
Pomarine skua	1	November	1	8	1	24	>1.00
Great skua	2	February	1	5	1	19	>1.00
Total small gull species	1	January	<i>74</i>	<i>415</i>	<i>95</i>	<i>898</i>	<i>0.12</i>
Kittiwake	1	January	<i>67</i>	<i>376</i>	<i>84</i>	<i>881</i>	<i>0.12</i>
Black-headed gull	3	January	11	51	11	107	0.30
Little gull	1	November	5	39	8	86	0.45
Common gull	2	February	18	85	28	152	0.24
Total large gull species	2	February	<i>94</i>	<i>446</i>	<i>128</i>	<i>964</i>	<i>0.10</i>
Lesser black-backed gull	3	February	10	80	16	185	0.32
Herring gull	2	February	<i>75</i>	<i>356</i>	<i>75</i>	<i>812</i>	<i>0.12</i>
Great black-backed gull	1	November	28	220	94	392	0.19
Guillemot / razorbill	1	January	<i>102</i>	<i>573</i>	<i>432</i>	<i>724</i>	<i>0.10</i>
Guillemot	1	January	10	78	16	157	0.32
Razorbill	1	November	11	86	24	165	0.30
Little auk	1	November	4	31	8	71	0.50
Puffin	1	February	12	57	14	109	0.29



### 3.1.1 Divers

#### 3.1.1.1 Total diver species

Data presented in Table 3.2 refer to total divers (including red-throated divers, black-throated divers, great northern dives and divers not identified to species) recorded during the winter 2012 / 13 surveys. Divers were recorded in all zones in all survey months and generally diver numbers increased in the study area between November 2012 and February 2013. In four of the survey zones (zone 1, 2, 5 and 6), numbers of divers peaked in February with the highest peak recorded in zone 1 at an estimated 3,153 (2,276 – 4,281) individuals. In the remaining two zones (zone 3 and 7), numbers of divers peaked in January. The proportions of divers identified to species level are presented in Table 3.3. The majority of divers were identified as red-throated divers (average 97.3% of total divers). Only one diver was not identified to species. This unidentified diver species is likely to have been a red-throated diver since measurements were not consistent with great northern diver, and black-throated divers which are the main confusion species are comparatively scarce (average 2.8% total divers were recorded as black-throated divers) in the Outer Thames Estuary (O'Brien *et al.* 2008). Population estimates for divers that were identified to species are provided in subsequent sections.

**Table 3.2:** Monthly counts, estimates, confidence limits and precision for total divers in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	27	212	133	306	0.19
	Zone 2	23	106	60	161	0.21
	Zone 3	11	51	18	92	0.30
	Zone 5	5	23	5	55	0.45
	Zone 6	17	80	42	122	0.25
	Zone 7	5	23	5	45	0.44
December 2012	Zone 1	9	160	71	302	0.33
	Zone 2	24	193	113	274	0.20
	Zone 3	20	93	51	140	0.22
	Zone 5	12	55	28	87	0.28
	Zone 6	11	50	23	86	0.30
	Zone 7	3	14	3	32	0.57
January 2013	Zone 1	<i>193</i>	<i>1,084</i>	<i>808</i>	<i>1,364</i>	<i>0.07</i>
	Zone 2	<i>94</i>	<i>763</i>	<i>585</i>	<i>958</i>	<i>0.10</i>
	Zone 3	<i>63</i>	<i>294</i>	<i>201</i>	<i>411</i>	<i>0.13</i>
	Zone 5	21	168	96	248	0.23
	Zone 6	1	8	1	24	>1.00
	Zone 7	25	202	121	291	0.20
February 2013	Zone 1	<i>665</i>	<i>3,153</i>	<i>2,276</i>	<i>4,281</i>	<i>0.04</i>
	Zone 2	<i>241</i>	<i>1,144</i>	<i>912</i>	<i>1,410</i>	<i>0.07</i>
	Zone 3	27	217	129	305	0.20
	Zone 5	<i>63</i>	<i>288</i>	<i>215</i>	<i>370</i>	<i>0.13</i>
	Zone 6	18	82	46	128	0.24
	Zone 7	23	106	60	157	0.21

**Table 3.3:** Percentages of diver species recorded in each survey month between November 2012 and February 2013.

	Red-throated divers	Black-throated divers	Great northern divers	Unidentified diver
November 2012	87.4	4.6	8.0	0.0
December 2012	93.7	3.8	1.3	1.3
January 2013	98.7	1.0	0.3	0.0
February 2013	98.0	1.6	0.6	0.0

### 3.1.1.2 Red-throated divers

Data presented in Table 3.4 refer to red-throated divers recorded during the winter 2012 / 13 surveys. The majority of divers recorded were red-throated divers and these were recorded in all zones in all survey months. In four of the zones (zone 1, 2, 5 and 6), red-throated diver numbers peaked in February with the highest peak recorded in zone 1 at an estimated 3,086 (2,238 – 4,419) individuals. In the remaining two zones (zone 3 and 7), numbers of divers peaked in January.

**Table 3.4:** Monthly counts, estimates, confidence limits and precision for red-throated divers in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	23	181	110	259	0.21
	Zone 2	21	97	51	152	0.22
	Zone 3	10	46	14	87	0.32
	Zone 5	5	23	5	55	0.45
	Zone 6	12	56	28	89	0.28
	Zone 7	5	23	5	45	0.44
December 2012	Zone 1	8	142	53	267	0.35
	Zone 2	22	177	97	266	0.21
	Zone 3	18	84	47	126	0.24
	Zone 5	12	55	28	87	0.28
	Zone 6	11	50	23	86	0.30
	Zone 7	3	14	3	32	0.57
January 2013	Zone 1	<i>190</i>	<i>1,067</i>	<i>803</i>	<i>1,359</i>	<i>0.07</i>
	Zone 2	<i>93</i>	<i>755</i>	<i>585</i>	<i>942</i>	<i>0.11</i>
	Zone 3	<i>63</i>	<i>294</i>	<i>201</i>	<i>411</i>	<i>0.13</i>
	Zone 5	21	168	96	248	0.23
	Zone 6	1	8	1	24	>1.00
	Zone 7	24	194	113	283	0.21
February 2013	Zone 1	<i>651</i>	<i>3,086</i>	<i>2,238</i>	<i>4,419</i>	<i>0.04</i>
	Zone 2	<i>240</i>	<i>1,139</i>	<i>907</i>	<i>1,410</i>	<i>0.07</i>
	Zone 3	25	201	129	289	0.20
	Zone 5	<i>60</i>	<i>274</i>	<i>196</i>	<i>361</i>	<i>0.14</i>
	Zone 6	18	82	46	128	0.24
	Zone 7	22	101	55	157	0.21

### 3.1.1.3 Black-throated divers

Data presented in Table 3.5 refer to black-throated divers recorded during the winter 2012 / 13 surveys. Small numbers of black-throated divers were recorded in each survey month within different zones. The peak black-throated diver population was recorded in zone 1 in February 2013 at an estimated 43 (14 – 71) birds.

**Table 3.5:** Monthly counts, estimates, confidence limits and precision for black-throated divers in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	1	8	1	24	>1.00
	Zone 2	1	5	1	14	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	2	9	2	24	0.70
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	1	8	1	24	>1.00
	Zone 3	2	9	2	23	0.70
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	2	11	2	28	0.71
	Zone 2	1	8	1	24	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	1	8	1	24	>1.00
February 2013	Zone 1	9	43	14	71	0.33
	Zone 2	0	0	0	0	N/A
	Zone 3	4	32	4	129	0.50
	Zone 5	3	14	3	32	0.57
	Zone 6	0	0	0	0	N/A
	Zone 7	1	5	1	14	>1.00

### 3.1.1.4 Great northern divers

Data presented in Table 3.6 refer to great northern divers recorded during the winter 2012 / 13 surveys. Small numbers of great northern divers were recorded in each survey month with the peak recorded in zone 1 in February 2013 at an estimated 24 (5 – 47) birds.

**Table 3.6:** Monthly counts, estimates, confidence limits and precision for great northern divers in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	2	16	2	39	0.71
	Zone 2	1	5	1	14	>1.00
	Zone 3	1	5	1	14	>1.00
	Zone 5	0	0	0	0	N/A
	Zone 6	3	14	3	33	0.57
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	1	18	1	71	>1.00
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	1	6	1	17	>1.00
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	5	24	5	47	0.45
	Zone 2	1	5	1	14	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

### 3.1.2 Other bird species (excluding divers)

#### 3.1.2.1 Scaup

Data presented in Table 3.7 refer to scaup recorded during the winter 2012 / 13 surveys. Small numbers of scaup were recorded in zone 3 during the November 2012 survey and peak numbers were recorded in zone 2 during the January 2013 at an estimated 114 (14 – 341) birds.

**Table 3.7:** Monthly counts, estimates, confidence limits and precision for scaup in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	3	14	3	41	0.58
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	1	5	1	14	>1.00
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	14	114	14	341	0.27
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

### 3.1.2.2 Common scoters

Data presented in Table 3.8 refer to common scoter recorded during the winter 2012 / 13 surveys. Small numbers of common scoter were recorded during November 2012 and February 2013, with the peak recorded in zone 7 in February 2013 at an estimated 267 (58 – 802) birds.

**Table 3.8:** Monthly counts, estimates, confidence limits and precision for common scoters in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	2	16	2	47	0.71
	Zone 2	6	28	6	83	0.41
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	4	19	4	47	0.50
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	<i>58</i>	<i>267</i>	<i>58</i>	<i>802</i>	<i>0.13</i>

### 3.1.2.3 Fulmars

Data presented in Table 3.9 refer to fulmars recorded during the winter 2012 / 13 surveys. During winter 2012 / 13, fulmars were recorded in November and February with the peak population of fulmars recorded in zone 1 in November 2012 with an estimated 47 (16 – 86) birds.

**Table 3.9:** Monthly counts, estimates, confidence limits and precision for fulmars in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	6	47	16	86	0.41
	Zone 2	6	28	6	83	0.41
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	1	5	1	14	>1.00
	Zone 7	1	5	1	14	>1.00
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	1	5	1	14	>1.00
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

**3.1.2.4 Gannets**

Data presented in Table 3.10 refer to gannets recorded during the winter 2012 / 13 surveys. Gannets were recorded in each survey month, except December 2012. Peak numbers of gannets were present within zone 1 in February 2013 when an estimated 749 (322 – 1,460) gannets were recorded.

**Table 3.10:** Monthly counts, estimates, confidence limits and precision for gannets in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	4	31	8	63	0.50
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	1	5	1	14	>1.00
	Zone 6	2	9	2	24	0.70
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	1	8	1	24	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	1	8	1	24	>1.00
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	<i>158</i>	<i>749</i>	<i>322</i>	<i>1,460</i>	<i>0.08</i>
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	1	5	1	14	>1.00
	Zone 7	0	0	0	0	N/A



**3.1.2.5 Total cormorants & shags**

The data presented in Table 3.11 refer to all cormorants & shags recorded, including cormorants and those that were not identified to species. Cormorants and shags were present in all survey months, except November 2012. The peak number of cormorants and shags was present within zone 2 in January 2013, with an estimated 325 (40 – 966) birds. The majority of cormorants and shags were identified as cormorants. Only one cormorant / shag was not identified to species level within zone 3 in January 2013. The proportions of cormorants / shags identified to species level are presented in Table 3.12.

**Table 3.11:** Monthly counts, estimates, confidence limits and precision for total cormorants & shags in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	1	18	1	71	>1.00
	Zone 2	1	8	1	24	>1.00
	Zone 3	16	75	16	237	0.25
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	<i>40</i>	<i>325</i>	<i>40</i>	<i>966</i>	<i>0.16</i>
	Zone 3	5	23	5	93	0.45
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	16	76	16	214	0.25
	Zone 3	1	8	1	24	>1.00
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

**Table 3.12:** Percentages of cormorant / shag species recorded in each survey month between November 2012 and February 2013.

	Cormorants	Unidentified cormorant / shag
November 2012	N/A	N/A
December 2012	100	0
January 2013	98	2
February 2013	100	0

**3.1.2.6 Total grebes**

Data presented in Table 3.13 refer to all grebes including great-crested grebes and grebes not identified to species recorded during the winter 2012 / 13 surveys. All grebes were identified as great crested grebes with the exception of two birds recorded in zone 5 in December 2012 which were identified as grebe species. The proportions of grebes identified to species level are presented in Table 3.14. Great-crested grebes peaked in zone 7 in January 2013 at a population estimate of 24 (3 - 57) individuals.

**Table 3.13:** Monthly counts, estimates, confidence limits and precision for total grebes in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	0	0	0	0	N/A
	Zone 2	1	5	1	14	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	2	9	2	23	0.70
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	2	11	2	28	0.71
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	3	24	3	57	0.57
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	1	5	1	14	>1.00

**Table 3.14:** Percentages of grebe species recorded in each survey month between November 2012 and February 2013.

	Great-crested grebes	Unidentified grebes
November 2012	100	0
December 2012	0	100
January 2013	100	0
February 2013	100	0

**3.1.2.7 Oystercatchers**

Data presented in Table 3.15 refer to oystercatchers recorded during the winter 2012 / 13 surveys. Oystercatchers were present in zone 3 during January 2013 when an estimated 5 (1 – 14) birds were recorded. Oystercatchers were not recorded in any other zone in any other survey month.

**Table 3.15:** Monthly counts, estimates, confidence limits and precision for oystercatchers in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	1	5	1	14	>1.00
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

### 3.1.2.8 Pomarine skuas

Data presented in Table 3.16 refer to pomarine skuas recorded during the winter 2012 / 13 surveys. One pomarine skua was recorded in zone 1 during the November 2012 survey when an estimated 8 (1 – 24) birds were estimated to be present. Pomarine skuas were not recorded in any other zones in any other survey month.

**Table 3.16:** Monthly counts, estimates, confidence limits and precision for pomarine skuas in each zone at 500 m resolution.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	1	8	1	24	>1.00
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

### 3.1.2.9 Great skuas

Data presented in Table 3.17 refer to great skuas recorded during the winter 2012 / 13 surveys. One great skua was recorded within zone 2 during the February survey 2013 when 5 (1 – 19) birds were estimated to be present in total. Great skuas were not recorded in any other zone in any other month.

**Table 3.17:** Monthly counts, estimates, confidence limits and precision for great skuas in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	1	5	1	19	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

**3.1.2.10 Total small gulls**

Data presented in Table 3.18 refer to total small gulls (including kittiwakes, black-headed gulls, little gulls, common gulls and gulls not identified to species) recorded during the winter 2012 / 13 surveys. Small gulls were recorded in all zones with the exception of zone 5 during November 2012 and zone 6 during the February 2013 survey. Peak numbers of small gulls were recorded in zone 1 in November 2012 at an estimated 471 (243 - 777) birds. The proportions of small gulls identified to species level are presented in Table 3.19. The majority of small gulls (59% of total small gulls) were identified as kittiwakes. Unidentified small gulls were likely to have been either kittiwakes or common gulls. Population estimates for small gulls that were identified to species are provided in subsequent sections.

**Table 3.18:** Monthly counts, estimates, confidence limits and precision for all total small gull species (identified to group and species levels) in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	<i>60</i>	<i>471</i>	<i>243</i>	<i>777</i>	<i>0.13</i>
	Zone 2	3	14	3	32	0.58
	Zone 3	18	83	18	207	0.24
	Zone 5	0	0	0	0	N/A
	Zone 6	13	61	24	108	0.28
	Zone 7	8	36	9	68	0.35
	December 2012	Zone 1	3	53	3	124
Zone 2		6	48	6	113	0.41
Zone 3		6	28	6	70	0.41
Zone 5		4	18	5	37	0.50
Zone 6		7	32	9	59	0.38
Zone 7		3	14	3	28	0.57
January 2013	Zone 1	<i>74</i>	<i>415</i>	<i>95</i>	<i>898</i>	<i>0.12</i>
	Zone 2	11	89	32	162	0.30
	Zone 3	24	112	47	201	0.20
	Zone 5	3	24	3	64	0.58
	Zone 6	2	16	2	40	0.70
	Zone 7	12	97	48	154	0.28
February 2013	Zone 1	34	161	90	251	0.17
	Zone 2	29	138	71	214	0.19
	Zone 3	17	137	32	257	0.24
	Zone 5	7	32	9	59	0.38
	Zone 6	0	0	0	0	N/A
	Zone 7	17	78	23	166	0.24

**Table 3.19:** Percentages of small gull species recorded in each survey month between November 2012 and February 2013.

	Kittiwakes	Black-headed gulls	Little gulls	Common gulls	Unidentified small gulls
November 2012	69	3	8	13	7
December 2012	38	14	7	34	7
January 2013	78	12	0	5	5
February 2013	50	4	0	43	3

**3.1.2.11 Kittiwakes**

Data presented in Table 3.20 refer to kittiwakes recorded during the winter 2012 / 13 surveys. The highest number of kittiwakes was recorded in the January 2013 survey, when estimates peaked in zones 1, 2 and 7. Kittiwake numbers peaked at an estimated 376 (84 - 881) individuals in zone 1 during the January 2013 survey.

**Table 3.20:** Monthly counts, estimates, confidence limits and precision for kittiwake in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	<i>41</i>	<i>322</i>	<i>118</i>	<i>612</i>	<i>0.16</i>
	Zone 2	2	9	2	23	0.71
	Zone 3	14	64	14	184	0.27
	Zone 5	0	0	0	0	N/A
	Zone 6	10	47	14	89	0.32
	Zone 7	4	18	4	41	0.50
December 2012	Zone 1	3	53	3	124	0.57
	Zone 2	0	0	0	0	N/A
	Zone 3	2	9	2	23	0.70
	Zone 5	0	0	0	0	N/A
	Zone 6	3	14	3	27	0.57
	Zone 7	3	14	3	28	0.57
January 2013	Zone 1	<i>67</i>	<i>376</i>	<i>84</i>	<i>881</i>	<i>0.12</i>
	Zone 2	7	57	16	106	0.38
	Zone 3	12	56	14	131	0.29
	Zone 5	2	16	2	48	0.71
	Zone 6	2	16	2	40	0.70
	Zone 7	8	65	24	113	0.35
February 2013	Zone 1	32	152	85	242	0.18
	Zone 2	10	47	19	76	0.31
	Zone 3	1	8	1	24	>1.00
	Zone 5	4	18	5	37	0.50
	Zone 6	0	0	0	0	N/A
	Zone 7	5	23	5	46	0.44

**3.1.2.12 Black-headed gulls**

Data presented in Table 3.21 refer to black-headed gulls recorded during the winter 2012 / 13 surveys. Small numbers of black-headed gulls were recorded in some months within different zones. The peak number of black-headed gulls was recorded in zone 3 in January 2013 at an estimated 51 (11 – 107) birds.

**Table 3.21:** Monthly counts, estimates, confidence limits and precision for black-headed gulls in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	3	24	3	55	0.58
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	4	32	4	89	0.50
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	2	16	2	49	0.71
	Zone 3	11	51	11	107	0.30
	Zone 5	1	8	1	24	>1.00
	Zone 6	0	0	0	0	N/A
	Zone 7	1	8	1	24	>1.00
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	4	32	4	129	0.50
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A



### 3.1.2.13 *Little gulls*

Data presented in Table 3.22 refer to little gulls recorded during the winter 2012 / 13 surveys. Small numbers of little gulls were recorded during the November and December 2012 surveys with the peak population recorded within zone 1 in November 2012 at an estimated 39 (8 – 86) birds.

**Table 3.22:** Monthly counts, estimates, confidence limits and precision for little gulls in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	5	39	8	86	0.45
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	3	14	3	38	0.58
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	2	16	2	48	0.71
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

### 3.1.2.14 Common gulls

The data presented in Table 3.23 refer to common gulls recorded during the winter 2012 / 13 surveys. The majority of common gulls were recorded during the February 2013 survey, when birds were recorded in all surveyed zones except zone 6. Common gulls peaked at an estimated 85 (28 – 152) individuals in zone 2 in the February 2013 survey.

**Table 3.23: Monthly counts, estimates, confidence limits and precision for common gull in each zone at 500 m resolution.**

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	9	71	24	126	0.33
	Zone 2	0	0	0	0	N/A
	Zone 3	3	14	3	32	0.57
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	1	5	1	14	>1.00
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	4	19	4	51	0.50
	Zone 5	3	14	3	32	0.57
	Zone 6	3	14	3	36	0.58
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	5	28	5	79	0.45
	Zone 2	1	8	1	24	>1.00
	Zone 3	1	5	1	14	>1.00
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	2	9	2	24	0.71
	Zone 2	18	85	28	152	0.24
	Zone 3	10	80	16	177	0.32
	Zone 5	3	14	3	37	0.58
	Zone 6	0	0	0	0	N/A
	Zone 7	12	55	12	138	0.29

**3.1.2.15 Total large gulls**

Data presented in Table 3.24 refer to total large gulls (including lesser black-backed gulls, herring gulls, great black-backed gulls and large gulls not identified to species) recorded during the winter 2012 / 13 surveys. Large gulls were recorded in all zones with the exception of zone 6 in January 2013. Peak numbers of large gulls were recorded in zone 2 in the February 2013 survey at an estimated 446 (128 – 964) birds. The proportions of large gulls identified to species level are presented in Table 3.25. The majority of large gulls (55% of total large gulls) were identified as herring gulls. Population estimates for large gulls that were identified to species are provided in subsequent sections.

**Table 3.24:** Monthly counts, estimates, confidence limits and precision for total large gull species (identified to group and species levels) in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	<i>41</i>	<i>322</i>	<i>118</i>	<i>651</i>	<i>0.16</i>
	Zone 2	<i>38</i>	<i>175</i>	<i>46</i>	<i>383</i>	<i>0.16</i>
	Zone 3	18	83	18	189	0.24
	Zone 5	3	14	3	32	0.57
	Zone 6	1	5	1	14	>1.00
	Zone 7	11	50	23	86	0.30
	December 2012	Zone 1	2	36	2	89
Zone 2		3	24	3	56	0.58
Zone 3		12	56	12	163	0.29
Zone 5		1	5	1	14	>1.00
Zone 6		1	5	1	14	>1.00
Zone 7		1	5	1	14	>1.00
January 2013		Zone 1	34	191	107	298
	Zone 2	35	284	89	625	0.17
	Zone 3	36	168	70	299	0.17
	Zone 5	5	40	8	88	0.45
	Zone 6	0	0	0	0	N/A
	Zone 7	12	97	32	170	0.29
	February 2013	Zone 1	<i>42</i>	<i>199</i>	<i>52</i>	<i>474</i>
Zone 2		<i>94</i>	<i>446</i>	<i>128</i>	<i>964</i>	<i>0.10</i>
Zone 3		33	265	129	426	0.17
Zone 5		9	41	18	73	0.33
Zone 6		1	5	1	14	>1.00
Zone 7		19	88	23	184	0.23

**Table 3.25:** Percentages of large gull species recorded in each survey month between November 2012 and February 2013.

	Lesser black-backed gulls	Herring gulls	Great black-backed gulls	Unidentified large gulls
November 2012	17	38	44	1
December 2012	0	60	40	0
January 2013	3	67	30	0
February 2013	14	56	30	0

### 3.1.2.16 *Lesser black-backed gulls*

Data presented in Table 3.26 refer to lesser black-backed gulls recorded during the winter 2012 / 13 surveys. Small numbers of lesser black-backed gulls were recorded in all survey months except December 2013. Peak numbers of lesser black-backed gulls were recorded in zone 3 in the February 2013 survey at 80 (16 - 185) birds and also in zone 1 in the November 2012 survey at 78 (10 – 188) birds.

**Table 3.26:** Monthly counts, estimates, confidence limits and precision for lesser black-backed gulls in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	10	78	10	188	0.32
	Zone 2	1	5	1	14	>1.00
	Zone 3	5	23	5	55	0.45
	Zone 5	0	0	0	0	N/A
	Zone 6	1	5	1	14	>1.00
	Zone 7	2	9	2	23	0.70
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	2	16	2	41	N/A
	Zone 3	1	5	1	14	>1.00
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	1	8	1	24	>1.00
February 2013	Zone 1	7	33	9	62	0.38
	Zone 2	3	14	3	33	0.58
	Zone 3	10	80	16	185	0.32
	Zone 5	2	9	2	23	0.70
	Zone 6	0	0	0	0	N/A
	Zone 7	5	23	5	55	0.45

### 3.1.2.17 *Herring gulls*

The data presented in Table 3.27 refer to herring gulls recorded during the winter 2012 / 13 surveys. Herring gulls were recorded in some zones in all survey months. Peak numbers of herring gulls were recorded in within zone 2 during the February 2013 survey, when an estimated 356 (75 – 812) birds were present.

**Table 3.27:** Monthly counts, estimates, confidence limits and precision for herring gulls in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	3	24	3	55	0.58
	Zone 2	29	134	29	309	0.19
	Zone 3	6	28	6	83	0.41
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	5	23	5	45	0.44
December 2012	Zone 1	1	18	1	53	>1.00
	Zone 2	0	0	0	0	N/A
	Zone 3	11	51	11	205	0.30
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	19	107	51	174	0.23
	Zone 2	20	162	20	487	0.22
	Zone 3	30	140	56	247	0.18
	Zone 5	3	24	3	56	0.57
	Zone 6	0	0	0	0	N/A
	Zone 7	9	73	16	137	0.33
February 2013	Zone 1	12	57	12	161	0.29
	Zone 2	<i>75</i>	<i>356</i>	<i>75</i>	<i>812</i>	<i>0.12</i>
	Zone 3	12	96	32	177	0.29
	Zone 5	2	9	2	23	0.70
	Zone 6	0	0	0	0	N/A
	Zone 7	11	51	11	129	0.30

### 3.1.2.18 *Great black-backed gulls*

Data presented in Table 3.28 refer to great black-backed gulls recorded during the winter 2012 / 13 surveys. Great black-backed gulls were recorded in all zones except zone 6 in November 2012 and February 2013. Great black-backed gull numbers peaked in zone 1 during November 2012, with an estimated 220 (94 – 392) individuals present.

**Table 3.28:** Monthly counts, estimates, confidence limits and precision for great black-backed gulls in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	28	220	94	392	0.19
	Zone 2	8	37	14	65	0.35
	Zone 3	7	32	7	69	0.38
	Zone 5	3	14	3	32	0.57
	Zone 6	0	0	0	0	N/A
	Zone 7	3	14	3	32	0.57
December 2012	Zone 1	1	18	1	53	>1.00
	Zone 2	3	24	3	56	0.58
	Zone 3	1	5	1	14	>1.00
	Zone 5	1	5	1	14	>1.00
	Zone 6	1	5	1	14	>1.00
	Zone 7	1	5	1	14	>1.00
January 2013	Zone 1	15	84	28	152	0.26
	Zone 2	13	106	57	171	0.28
	Zone 3	5	23	5	51	0.45
	Zone 5	2	16	2	40	0.70
	Zone 6	0	0	0	0	N/A
	Zone 7	2	16	2	40	0.70
February 2013	Zone 1	23	109	23	275	0.21
	Zone 2	16	76	28	138	0.25
	Zone 3	11	88	24	169	0.30
	Zone 5	5	23	5	41	0.44
	Zone 6	1	5	1	14	>1.00
	Zone 7	3	14	3	32	0.57

### 3.1.2.19 Total auks

Data presented in Table 3.29 refer to total auks (including guillemots, razorbills, little auks, puffins and auks not identified to species) recorded during the winter 2012 / 13 surveys. Auks were recorded in all zones in all survey months. Peak numbers of auks were recorded in zone 1 during the November 2012 survey at an estimated 738 (526 – 1,005) birds. The proportions of auks identified to species level are presented in Table 3.30. The majority of auks were identified as guillemots or razorbills and those that were not identified to species are likely to have been one of these two species. Population estimates for auks that were identified to species are provided in subsequent sections.

**Table 3.29:** Monthly counts, estimates, confidence limits and precision for total auks (identified to group and species levels) in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	<i>94</i>	<i>738</i>	<i>526</i>	<i>1,005</i>	<i>0.10</i>
	Zone 2	6	28	9	51	0.41
	Zone 3	2	9	2	23	0.70
	Zone 5	3	14	3	42	0.58
	Zone 6	<i>42</i>	<i>197</i>	<i>122</i>	<i>282</i>	<i>0.16</i>
	Zone 7	5	23	5	45	0.44
December 2012	Zone 1	14	249	124	391	0.26
	Zone 2	18	145	72	234	0.24
	Zone 3	10	47	19	79	0.31
	Zone 5	21	97	51	143	0.22
	Zone 6	38	172	118	236	0.17
	Zone 7	5	23	5	51	0.45
January 2013	Zone 1	<i>109</i>	<i>612</i>	<i>483</i>	<i>769</i>	<i>0.10</i>
	Zone 2	35	284	187	382	0.17
	Zone 3	7	33	9	61	0.38
	Zone 5	10	80	32	128	0.31
	Zone 6	6	48	8	103	0.41
	Zone 7	15	121	65	194	0.26
February 2013	Zone 1	<i>98</i>	<i>465</i>	<i>341</i>	<i>593</i>	<i>0.10</i>
	Zone 2	<i>50</i>	<i>237</i>	<i>157</i>	<i>323</i>	<i>0.14</i>
	Zone 3	11	88	40	153	0.30
	Zone 5	13	59	27	96	0.28
	Zone 6	8	36	9	77	0.35
	Zone 7	8	37	9	74	0.35

**Table 3.30:** Percentages of auks recorded in each survey month between November 2012 and February 2013.

	Guillemots or Razorbills	Guillemots	Razorbills	Little auks	Puffins	Unidentified auks
November 2012	74	15	8	2	1	0
December 2012	96	0	2	1	1	0
January 2013	92	0	0	3	5	0
February 2013	88	0	0	2	10	0

### 3.1.2.20 *Guillemots / razorbills*

Data presented in Table 3.31 refer to guillemots or razorbills group recorded during the winter 2012 / 13 surveys. Guillemots / razorbills were recorded in all zones except zone 5 during November 2012. Peak numbers of guillemots / razorbills were recorded in zone 1 in the January 2013 survey window at an estimated 573 (432 – 724) birds.

**Table 3.31:** Monthly counts, estimates, confidence limits and precision for guillemots / razorbills in each zone at 500 m resolution. Estimates within the target precision of 0.16 in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	<i>68</i>	<i>534</i>	<i>369</i>	<i>746</i>	<i>0.12</i>
	Zone 2	3	14	3	32	0.58
	Zone 3	2	9	2	23	0.70
	Zone 5	0	0	0	0	N/A
	Zone 6	35	165	94	249	0.17
	Zone 7	4	18	5	36	0.50
December 2012	Zone 1	13	231	124	355	0.27
	Zone 2	17	137	64	234	0.24
	Zone 3	8	37	14	65	0.35
	Zone 5	21	97	51	143	0.22
	Zone 6	38	172	118	236	0.17
	Zone 7	5	23	5	51	0.45
January 2013	Zone 1	<i>102</i>	<i>573</i>	<i>432</i>	<i>724</i>	<i>0.10</i>
	Zone 2	33	268	179	365	0.17
	Zone 3	7	33	9	61	0.38
	Zone 5	10	80	32	128	0.31
	Zone 6	6	48	8	103	0.41
	Zone 7	13	105	48	170	0.28
February 2013	Zone 1	<i>84</i>	<i>398</i>	<i>294</i>	<i>507</i>	<i>0.11</i>
	Zone 2	<i>47</i>	<i>223</i>	<i>152</i>	<i>299</i>	<i>0.15</i>
	Zone 3	9	72	32	129	0.33
	Zone 5	11	50	18	82	0.30
	Zone 6	8	36	9	77	0.35
	Zone 7	7	32	7	69	0.38



### 3.1.2.21 *Guillemots*

Data presented in Table 3.32 refer to guillemots recorded during the winter 2012 / 13 surveys. Small numbers of guillemots were identified within zones 1, 2, 5, 6 and 7 during the November 2012 survey; with the peak estimate recorded in zone 1 at an estimated 78 (16 – 157) birds. No guillemots were recorded in the December 2012, January 2013 and February 2013 surveys.

**Table 3.32:** Monthly counts, estimates, confidence limits and precision for guillemots in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	10	78	16	157	0.32
	Zone 2	2	9	2	23	0.71
	Zone 3	0	0	0	0	N/A
	Zone 5	3	14	3	42	0.58
	Zone 6	7	33	9	66	0.38
	Zone 7	1	5	1	18	>1.00
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

### 3.1.2.22 *Razorbills*

Data presented in Table 3.33 refer to razorbills recorded during the winter 2012 / 13 surveys. Small numbers of razorbills were recorded in zone 1 and 2 during the November 2012 survey and also in zone 3 during the December 2012 survey. Peak numbers of razorbills were recorded in zone 1 in November 2012 when an estimated 86 (24 - 165) birds were recorded.

**Table 3.33:** Monthly counts, estimates, confidence limits and precision for razorbills in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	11	86	24	165	0.30
	Zone 2	1	5	1	14	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	2	9	2	23	0.70
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

**3.1.2.23 Little auks**

Data presented in Table 3.34 refer to little auks recorded during the winter 2012 / 13 surveys. Small numbers of little auks were recorded in each survey month. The peak number of little auks were recorded within zone 1 in November 2012 at an estimated 31 (8 - 71) birds.

**Table 3.34:** Monthly counts, estimates, confidence limits and precision for little auks in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	4	31	8	71	0.50
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	1	8	1	24	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	2	11	2	34	0.71
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	2	9	2	28	0.71
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	1	5	1	14	>1.00
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

**3.1.2.24 Puffins**

Data presented in Table 3.35 refer to puffins recorded during the winter 2012 / 13 surveys. Puffins were identified in all survey months. The peak puffin population was recorded within zone 1 in February 2013 with an estimated 57 (14 – 109) birds.

**Table 3.35:** Monthly counts, estimates, confidence limits and precision for puffins in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	1	8	1	24	>1.00
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	1	18	1	53	>1.00
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	5	28	6	62	0.45
	Zone 2	2	16	2	41	0.71
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	2	16	2	40	0.70
February 2013	Zone 1	12	57	14	109	0.29
	Zone 2	3	14	3	38	0.58
	Zone 3	2	16	2	40	0.70
	Zone 5	1	5	1	14	>1.00
	Zone 6	0	0	0	0	N/A
	Zone 7	1	5	1	14	>1.00

### 3.1.3 Marine mammals

#### 3.1.3.1 Total dolphin & porpoise

Data presented in Table 3.36 refer to total dolphin & porpoises (including harbour porpoises and dolphins or porpoises not identified to species) recorded during the winter 2012 / 13 surveys. Dolphins and porpoises were recorded in all survey months although the majority were recorded in February. Peak numbers of dolphins / porpoises were recorded in zone 1 during the February 2013 survey, with an estimated 90 (52 – 142) individuals present.

**Table 3.36:** Monthly counts, estimates, confidence limits and precision for total dolphin / porpoises in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	0	0	0	0	N/A
	Zone 2	1	5	1	14	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	2	9	2	24	0.70
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	1	8	1	24	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	1	5	1	14	>1.00
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	3	17	3	45	0.58
	Zone 2	1	8	1	24	>1.00
	Zone 3	1	5	1	14	>1.00
	Zone 5	3	24	3	72	0.58
	Zone 6	1	8	1	24	>1.00
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	19	90	52	142	0.23
	Zone 2	3	14	3	33	0.58
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	3	14	3	32	0.57
	Zone 7	0	0	0	0	N/A

### 3.1.3.2 Harbour porpoises

Data presented in Table 3.37 refer to harbour porpoises recorded during the winter 2012 / 13 surveys. Harbour porpoises were recorded in all survey months except December 2012. The peak number of harbour porpoises were recorded in zone 5 during the January 2013 survey when an estimated 16 (2 – 48) individuals were recorded.

**Table 3.37:** Monthly counts, estimates, confidence limits and precision for harbour porpoises in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	1	5	1	14	>1.00
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	2	16	2	48	0.71
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	3	14	3	33	0.58
	Zone 2	3	14	3	33	0.58
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	1	5	1	14	>1.00
	Zone 7	0	0	0	0	N/A

**3.1.3.3 Phocids**

Data presented in Table 3.38 refer to phocids (seals) recorded during the winter 2012 / 13 surveys. Phocids were recorded during the November 2012 and February 2013 surveys. During February 2013, the peak estimate was recorded in zone 1 with 38 (8 – 114) phocids present.

**Table 3.38:** Monthly counts, estimates, confidence limits and precision for phocids in each zone at 500 m resolution. Estimates within the target precision of 0.16 are in red italic text.

		Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November 2012	Zone 1	0	0	0	0	N/A
	Zone 2	1	5	1	14	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
December 2012	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
January 2013	Zone 1	0	0	0	0	N/A
	Zone 2	0	0	0	0	N/A
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A
February 2013	Zone 1	8	38	8	114	0.35
	Zone 2	1	5	1	14	>1.00
	Zone 3	0	0	0	0	N/A
	Zone 5	0	0	0	0	N/A
	Zone 6	0	0	0	0	N/A
	Zone 7	0	0	0	0	N/A

## 3.2 Distribution

### 3.2.1 Distribution of divers

#### 3.2.1.1 November 2012

The relative distribution of divers recorded in all zones during November 2012 is shown in Figure 3.1: A. The distribution of each individual diver recorded in this survey is also shown in Figure 3.2: A to F.

Relatively few divers were recorded in images taken across all zones during the November 2012 survey.

In zone 1, 27 divers were recorded; with the majority located in the north of the site and in the north west of the London Array OWF site. Individual divers were loosely scattered throughout the London Array OWF site in the south of the survey area, with one individual recorded on the southern boundary in the west of the zone. The bathymetry data indicates that these individuals were located in areas approximately 5-20 m water depth and were generally located around the edges of the shallowest areas (i.e. sand banks; Figure 3.1: A). Data on tide height at the nearest point to the London Array OWF site (Whitaker Beacon) indicate that the tide was incoming at the time of the survey (Appendix II).

A total of 23 divers were located within zone 2 during the November 2012 survey. The majority of divers were located in the centre and to the east of the centre of the site with individuals recorded along the south western border of the zone. Additionally, an individual diver was recorded in the far north of the site and a small group of divers were recorded to the west of the centre of the zone along the border of a region of shallow sand bank areas (Figure 3.1: A). Data on tide height indicate that the tide was outgoing for the first half an hour of the survey and then incoming for the remainder of the survey (Appendix II).

Within zone 3 a total of 11 divers were recorded. Of these birds, no divers were observed within the Kentish Flats wind farm site. The majority of divers were observed to the west of the Kentish Flats wind farm site and along the western boundary; although individual divers were also recorded to the east of the Kentish Flats wind farm development and in the far east corner of the zone. (Figure 3.1: A). Data on tide height indicate that the tide was outgoing at the time of the survey (Appendix II).

Within zone 5, a total of five divers were recorded; one towards the south western corner of the site near the edge of a shallow sand bank area with the remaining four divers recorded close to the northern boundary over deeper water. (Figure 3.1: A). Data on tide height indicate that the tide was outgoing at the time of survey (Appendix II).

A total of 18 divers were recorded within zone 6 (Figure 3.1: A). The majority of divers were recorded in the north west of the site close to the western boundary. Divers were also recorded in the south and centre of the survey area. These divers were all in areas approximately 20-30 m water depth (Figure 3.1: A). Data on tide height indicate that the tide was incoming at the time of survey (Appendix II).



Five divers were recorded within zone 7 during the November 2012 survey distributed along the northern and southern boundaries in the centre and north of the site close to the edges of shallow sand bank areas (Figure 3.1: A). Data on tide height indicate that the tide was outgoing at the time of survey (Appendix II).

### ***3.2.1.2 December 2012***

The relative distribution of divers recorded in all zones in the images from the December 2012 survey is shown in Figure 3.1: B. The distribution of each individual diver recorded in this survey is also shown in Figure 3.2: A to F).

Similar to November relatively few divers were recorded in images taken across all zones during the December 2012 survey.

In zone 1, large numbers of divers were recorded throughout the survey area and the London Array OWF site. The majority of divers were recorded in the north east of the survey area, above the London Array OWF wind farm site and along the eastern boundary. Clusters of three and seven individuals were recorded in the far north of the site with a further cluster of six individuals recorded close to the north eastern boundary of the London Array OWF site. These individuals were recorded near to the edge of shallow sand bank areas, approximately 5-20 m water depth (Figure 3.1: B). Data on tide height at the nearest point to the London Array OWF site (Whitaker Beacon) indicate that the tide was outgoing at the start of the survey then incoming for the most of the survey (Appendix II).

A total of 24 divers were recorded in zone 2, during the December 2012 survey. These individuals were recorded across the zone near the edge of shallow sand bank areas, with the majority located in shallow areas of 2-10 m water depth (Figure 3.1:B). Data on tide height indicate that the tide was incoming during the survey (Appendix II).

In zone 3, a further 20 divers were recorded in the centre and to the east of the site, with the majority of divers located to the south of the Kentish Flats wind farm site with one individual recorded in the north-west corner of the zone. No divers were recorded within the Kentish Flats wind farm site. Divers were observed in areas of 5-10 m water depth around the edges of shallow sand banks (Figure 3.1: B). Data on tide height indicate that the tide was incoming during the survey (Appendix II).

Within zone 5, 12 divers were recorded in total. Of these, the majority were observed in the south of the site, with individuals located along the northern and southern boundaries, with one individual located outside of the northern boundary in the centre of the site. All birds were found in shallow areas of approximately 5-10 m water depth and along the edges of shallow sand bank areas (Figure 3.1: B). Data on tide height indicate that the tide was incoming during the entire survey (Appendix II).

In zone 6, a further 11 divers were loosely distributed throughout the eastern half of the survey area with individuals also observed in the north west of the site. These divers were all in areas approximately 20-30 m water depth (Figure 3.1: B). Data on tide height indicate that the tide was incoming during the entire survey (Appendix II).

In zone 7, three divers were recorded along the northern boundary of the site in shallow areas >5 m water depth (Figure 3.1:B). Data on tide height indicate that the tide was incoming at the time of surveying (Appendix II).

### **3.2.1.3 January 2013**

The relative distribution of divers recorded in all zones in the images from the January 2013 survey is shown in Figure 3.1: C. The distribution of each individual diver recorded in this survey is also shown in Figure 3.2: A to F.

Moderately large numbers of divers were recorded in images taken across all zones during the January 2013 survey. No divers were recorded in zone 6 during the survey.

Approximately half of the divers recorded during the January 2013 survey were located within zone 1 (n=193; 49%). These individuals were mainly recorded in the north of the site towards the eastern and northern boundaries of the zone, with lower numbers observed within the London Array OWF site (n=29). The remaining divers were located along the south east and southern borders of the zone (Figure 3.1: C). Birds were largely located on the borders of shallower areas (approximately 10-20 m water depth) with some birds recorded in shallow areas (approximately 2-10 m water depth). Data on tide height at Whitaker Beacon indicate that the tide was outgoing at the time of the survey (Appendix II).

A large proportion of divers were also located within zone 2 during the January 2013 survey (n=94; 24%). Divers were distributed throughout zone 2 excluding the far east of the zone. All individuals were recorded on the borders of shallow sand bank areas up to 20 m water depth (Figure 3.1: C). Data on tide height at Whitaker Beacon indicate that the tide was incoming at the time of the survey (Appendix II).

Within zone 3, no divers were recorded in the Kentish Flats wind farm site, with large concentrations of birds located along the western boundary of the site and in the north-eastern corner of the zone, with the majority of birds recorded in shallow areas of approximately 0-10 m water depth (Figure 3.1: C). Smaller concentrations of divers were also located north of the Kentish Flats wind farm site and close to the southern boundary of zone 3 (Figure 3.1: C). Data on tide height at Whitaker Beacon indicate that the tide was outgoing at the time of surveying (Appendix II).

The number of divers recorded in zone 5 was lower in comparison to those recorded in zones 1, 2 and 3 and 7. A total of 21 divers were located within zone 5 in shallow areas (5-10m water depth) loosely scattered throughout the zone, with the majority located in the southern half of the survey area (Figure 3.1: C). Data on tide height at Whitaker Beacon indicate that the tide was incoming at the time of surveying (Appendix II).

One diver was located in the north east section of zone 6 during the January 2013 survey.

In total 25 divers were present throughout zone 7, with fewer individuals recorded towards the south west. These individuals were all located in shallow areas of approximately 5-20 m water depth (Figure 3.1: C). Data on tide height at Whitaker Beacon indicate that the tide was incoming at the time of surveying (Appendix II).

### 3.2.1.4 February 2013

The relative distribution of divers recorded in all zones in the images from the February 2013 survey is shown in Figure 3.1: D. The distribution of each individual diver recorded in this survey is shown in Figure 3.2: A to F.

Large numbers of divers were recorded in images taken across all zones during the February 2011 survey.

Similarly to the January 2013 survey, the highest number of divers recorded during the February 2013 survey were located within zone 1 (n=665; 64%).

Within zone 1, a total of 665 divers were present, again concentrated in the north of the site and along the eastern side of the zone. Most of these individuals were just to the north of the London Array OWF site with 206 individuals located within it, also mainly in the north of the London Array OWF site and along the eastern boundary. The remaining divers were thinly dispersed across much of the rest of zone 1, with lower numbers observed in the south west of the site. Divers within zone 1 were largely located on the edges of shallow sand bank areas of approximately 5-10 m water depth, although small numbers of birds were recorded in areas of up to approximately 20 m water depth (Figure 3.1: D). Data on tide height at Whitaker Beacon indicate that the tide was outgoing for the first hour, then incoming for the remainder of the survey (Appendix II).

Within zone 2, a total of 241 divers were recorded. Large concentrations of divers were located the east and west of the centre of zone 2 during the February 2013 survey, in the shallowest areas of the zone (approximately 0-10 m). Smaller numbers of divers were recorded throughout much of the rest of the zone in deeper areas (up to 22 m water depth; Figure 3.1: D). Data on tide height at Whitaker Beacon indicate that the tide was outgoing until half way through survey then incoming (Appendix II).

In comparison to zones 1 and 2, a relatively small number of divers were recorded within zone 3 during the survey (n=27; 3%). Two individuals were recorded in the north west of the Kentish Flats wind farm site towards the northern border, with the remaining individuals located in the north east of the survey area and to the west of the Kentish Flats wind farm site. All of the birds recorded were in shallow sand bank areas of up to 10 m water depth (Figure 3.1: D). Data on tide height at Whitaker Beacon indicate that the tide was incoming throughout the survey (Appendix II).

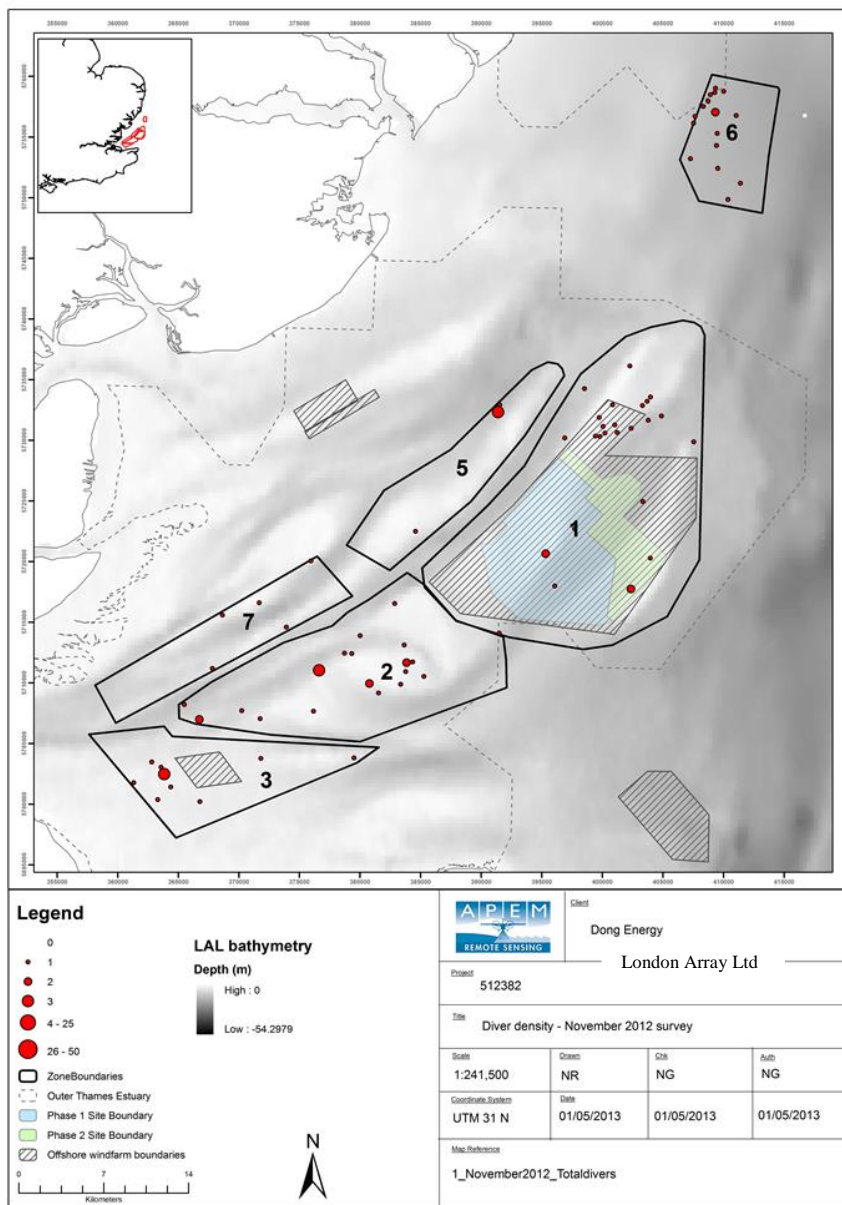
In zone 5, a total of 63 divers were largely distributed in or around the edges of the shallowest sand bank areas (up to approximately 10 m water depth) that run through the centre of the zone. The majority of divers were recorded in the centre of the zone towards the southern boundary, with divers loosely scattered in the southern and northern ends of the site (Figure 3.1: D). Data on tide height at Whitaker Beacon indicate that the tide was outgoing, ending on low tide at the time of survey (Appendix II).

The smallest number of divers was recorded within zone 6; 18 divers (2%) were located within the zone, with 11 of these individuals recorded in the north west of the area with the

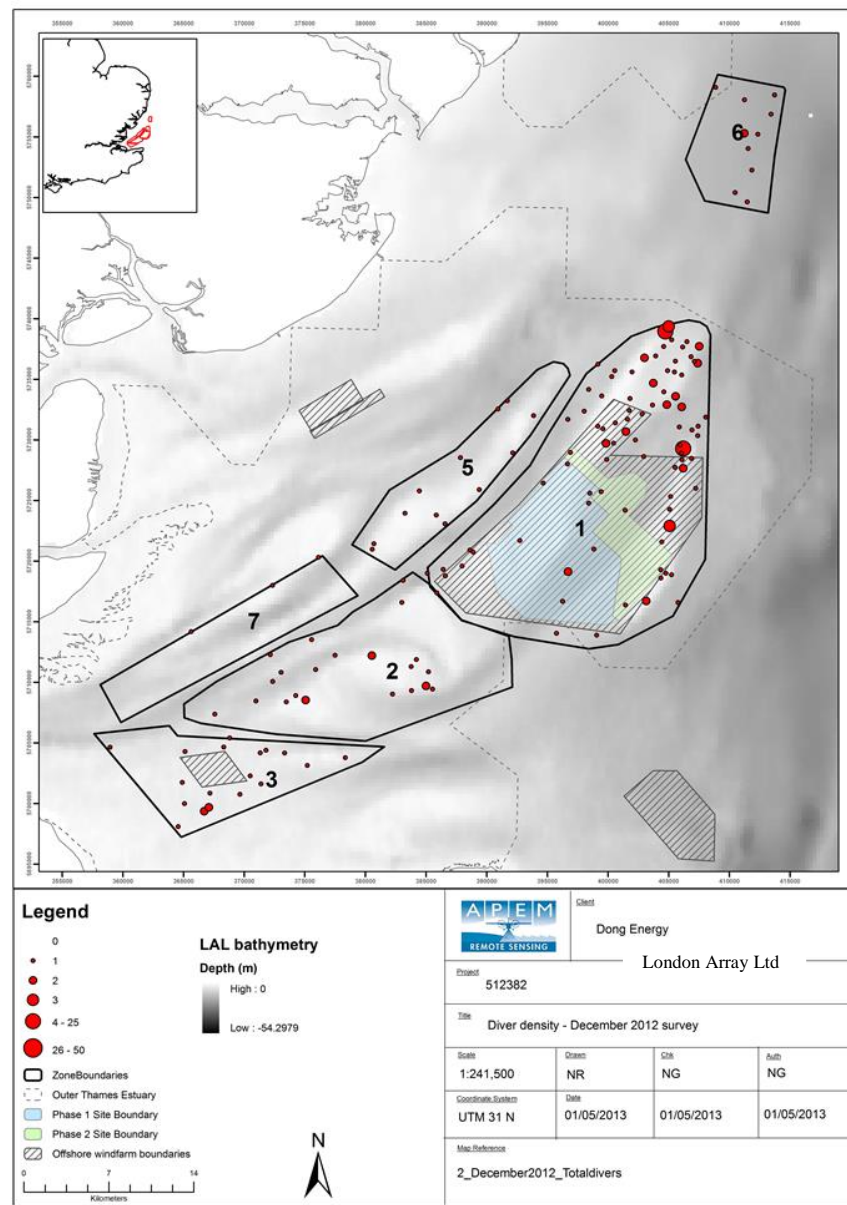
remainder scattered across the southern end of the site. Two divers were recorded outside of the zone boundary, on the north west corner and outside the western border in the north west of the site. All five divers were present in areas of approximately 25-30 m water depth (Figure 3.1: D). Data on tide height at Whitaker Beacon indicate that the tide was outgoing at the time of survey (Appendix II).

Twenty-three divers were distributed throughout much of zone 7, with no divers recorded in the southernmost end of the site. In the south west of the site the majority of divers were observed towards the southern border in shallow sand bank areas of up to 10 m water depth whereas in the north of the site divers were located in the centre of the site over deeper water up to approximately 20 m water depth.(Figure 3.1: D). Data on tide height at Whitaker Beacon indicate that the tide was incoming at the time of survey (Appendix II).

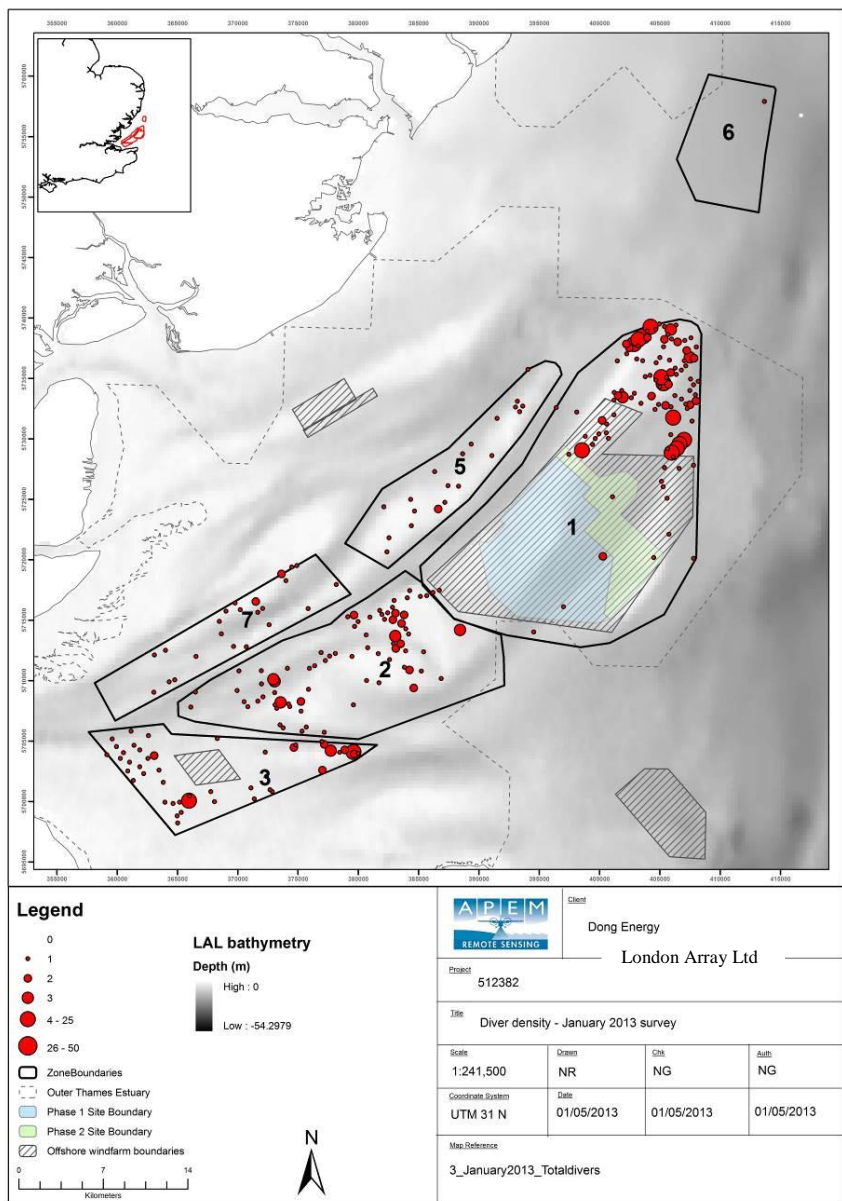
**Figure 3.1:** Relative distribution of divers recorded in each zone in each survey month. London Array Phase 1 (hatched blue area) and Phase 2 (hatched green area) are shown inside the hatched area of London Array OWF. Other hatched areas also show the Kentish Flats OWF (inside zone 3), Gunfleet Sands OWF (north-west of zone 5) and Thanet OWF (south of zone 1).



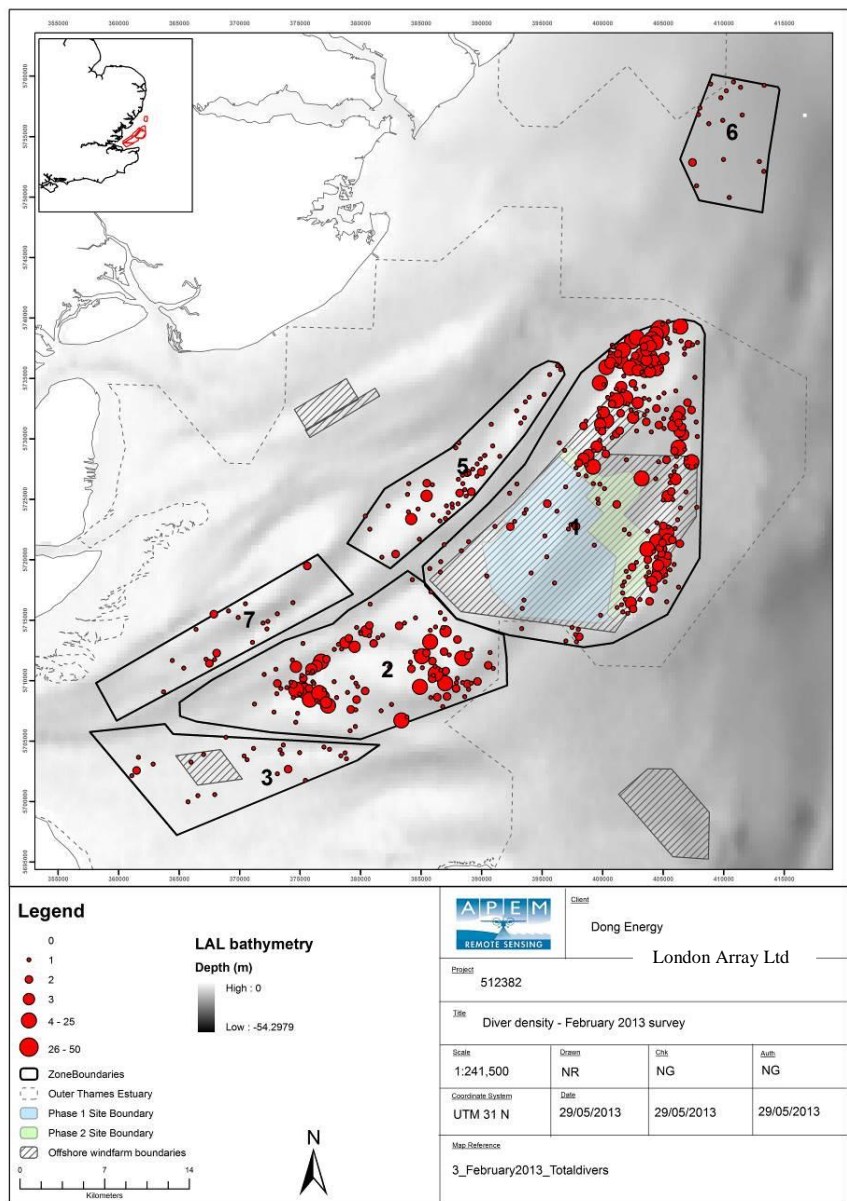
**A:** November 2012



**B:** December 2012



**C:** January 2013



**D:** February 2013

### 3.2.2 *Distribution of other bird species and marine mammals*

#### 3.1.2.2 *November 2012*

The distribution of each individual bird (including divers) and marine mammal recorded in the November 2012 survey is shown in Figure 3.2: A-F. This section describes the distribution of all the other bird species / groups recorded in the November 2012 survey, as diver distribution is described in Section 3.2.1 above.

In zone 1, bird species / groups recorded during the November 2012 survey were mainly distributed in the north east of the site, with birds located along the eastern boundary and towards the centre of the zone. No birds were recorded in the far south west corner of the site. Seaducks were concentrated in the centre of the zone within the Phase 1 site boundary. During the survey, fulmars were mainly recorded within the London Array OWF site, along the south eastern boundary and towards the centre of the site, with one individual located south of the London Array OWF site in the south east of the survey area. Gannets were also recorded in the south east of zone 1 within the Phase 2 site boundary and south of the London Array OWF site. A single skua was recorded in the south east of the survey area, below the London Array OWF site. Both small gulls and large gulls were generally located throughout the southern half of zone 1, with individual large gulls located along the eastern boundary to the north of the London Array OWF site. The majority of auks were located towards the north of zone 1, with a concentration along the eastern boundary, north of the London Array OWF site. (Figure 3.2: A).

Birds recorded within zone 2 during the November 2012 survey were generally located towards the centre and in the eastern half of the zone, with a cluster of birds recorded in the south west corner of the site. Seaducks were concentrated in the south east of the zone towards the southern boundary. The six fulmars observed during the November 2012 survey were recorded together in the south west corner of zone 2, close to the southern boundary. A single cormorant / shag was located just outside of the northern boundary in the western half of the survey area and a single grebe was recorded in the north west of zone 2, close to the northern boundary. The four small gulls recorded during the survey were located in four separate locations; one in the south east of the site, one south of the centre of zone 2 towards the southern boundary, one in the south west of the site close to the southern boundary and the remaining small gull was observed just outside the northern boundary in the west of the survey area. Large gulls were largely located in the centre and to the east of the centre of the site, with individual large gulls observed along the south western border, although individuals were also recorded along the northern border in the centre of the zone. Auks were loosely distributed throughout zone, with individuals located in the north east and south east corners of the zone. Auks were also observed in the centre of the site and towards the southern border, and towards the north west corner of the site, with one individual located just outside of the northern border, in the far west of the survey area. (Figure 3.2: B).

Three seaducks were recorded on the northern boundary above the Kentish Flats wind farm development within zone 3. The majority of both small gulls and large gulls were located along the northern boundary of the site and just outside of zone 3 in the area bordering zone 2, with individual gulls scattered in the west of the site. Three auks were recorded in the north

east of the site. No birds were recorded within the Kentish Flats wind farm site (Figure 3.2: C).

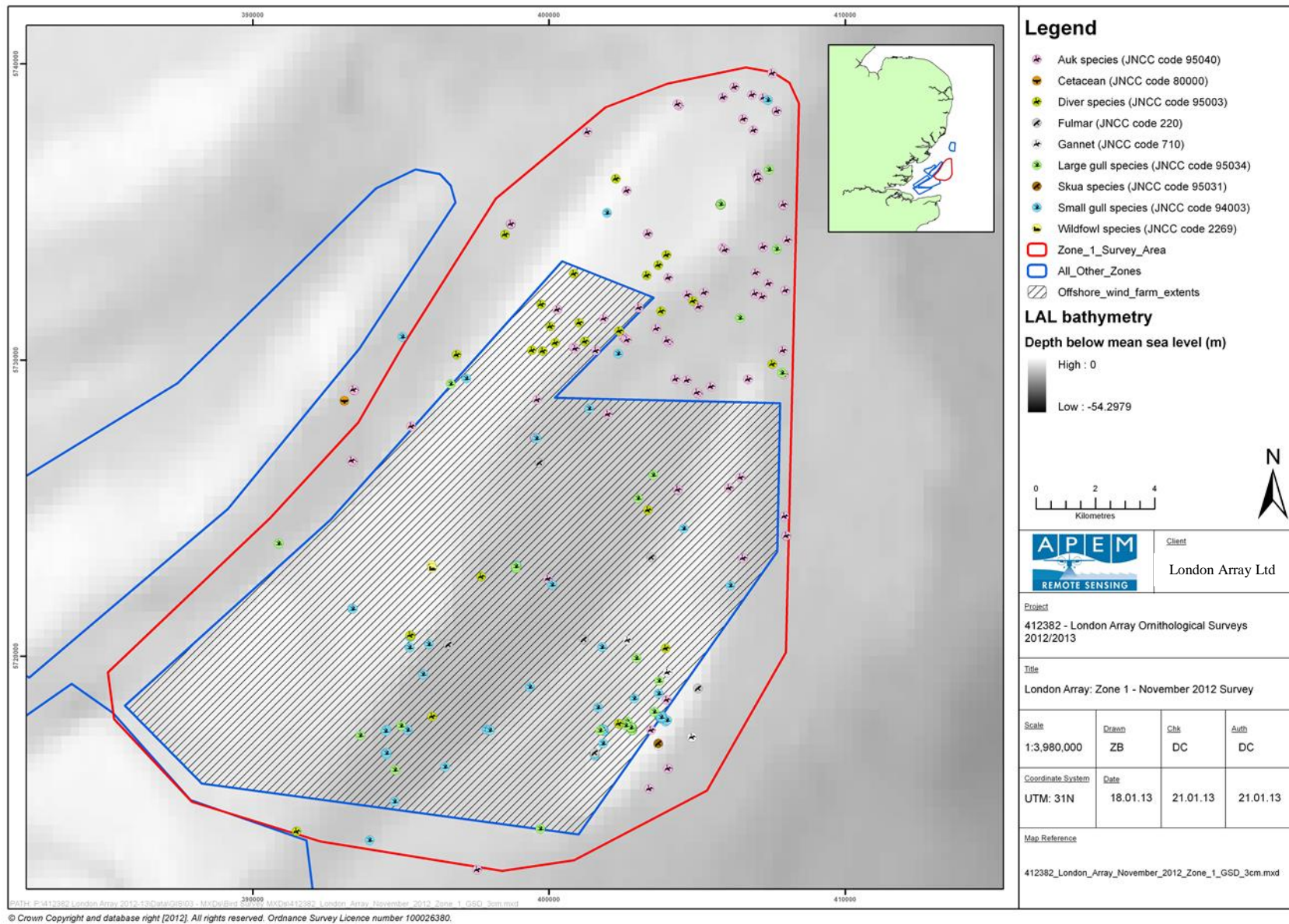
In zone 5, birds were recorded in a cluster in the south west of the zone and in the north of the site. A single gannet was recorded in the south west of the site over a shallow sandbank area. Large gulls were mainly distributed in the south west of the site, along the southern boundary in shallow sandbanks areas, with one individual recorded towards the centre of the site. Three auks were recorded together in the far north of zone 5 (Figure 3.2: D).

Few birds were recorded towards the north east of zone 6 in November 2012. A single fulmar was recorded south of the centre of the site, towards the southern boundary. Of the three gannets recorded during the survey; two were observed in the south east corner of the site with one individual located outside of the zone. The remaining gannet was observed to the west of the centre of the site outside of the zone 6 boundary. Small gulls were mainly located in the southern half of zone 6, although a single small gull was the only species to be recorded in the north east corner of the site. A single large gull was recorded in the south west of the area, towards the western boundary. Auks were dispersed throughout much of the zone, with the majority of auks recorded in the western half of the survey area (Figure 3.2: E).

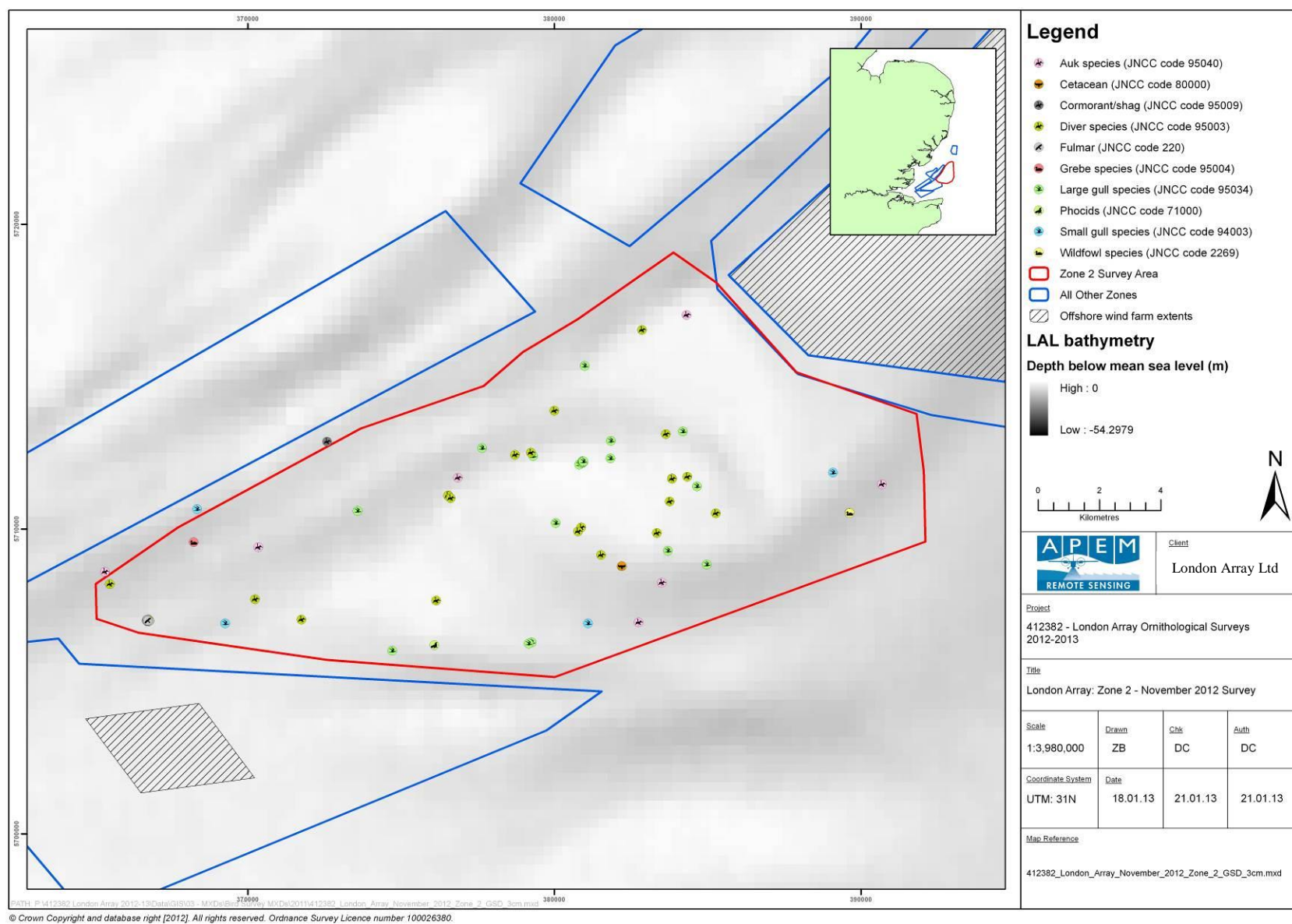
All of the other birds recorded within Zone 7 were distributed along the northern and southern boundaries of the zone over shallow sandbank areas, with no birds recorded in the south west corner of the site. A single seaduck was recorded in the east of the site, close to the southern boundary. Two fulmars were observed during the November survey; one outside of the zone in the north west corner of the survey area with the remaining fulmar recorded south of the centre of the site, close to the southern boundary. Small gulls and large gulls were concentrated towards the west of the zone, with individual small gulls and large gulls also located in the east of the zone towards the northern and southern boundaries. Of the six auks recorded during the November 2012 survey, one was observed in the north west corner of the zone, one was recorded in the centre of the site close to the southern boundary, two were located towards the south east of the site with the remaining two auks observed outside of the northern boundary in the west of zone 7 (Figure 3.2: F).

Of the three cetaceans recorded during the November 2013 survey, one dolphin / porpoise was observed to the south of the centre of zone 2 (Figure 3.2:B). The remaining two cetaceans (one dolphin / porpoise and one harbour porpoise) were recorded to the east of the centre of the site, along the zone 6 eastern boundary (Figure 3.2: E). Additionally, a single phocid was observed within zone 2, in the south west of the site along the southern boundary (Figure 3.2: B).

**Figure 3.2:** Distribution of bird and marine mammal species / groups recorded in each zone in the November 2012 survey at 500 m resolution.



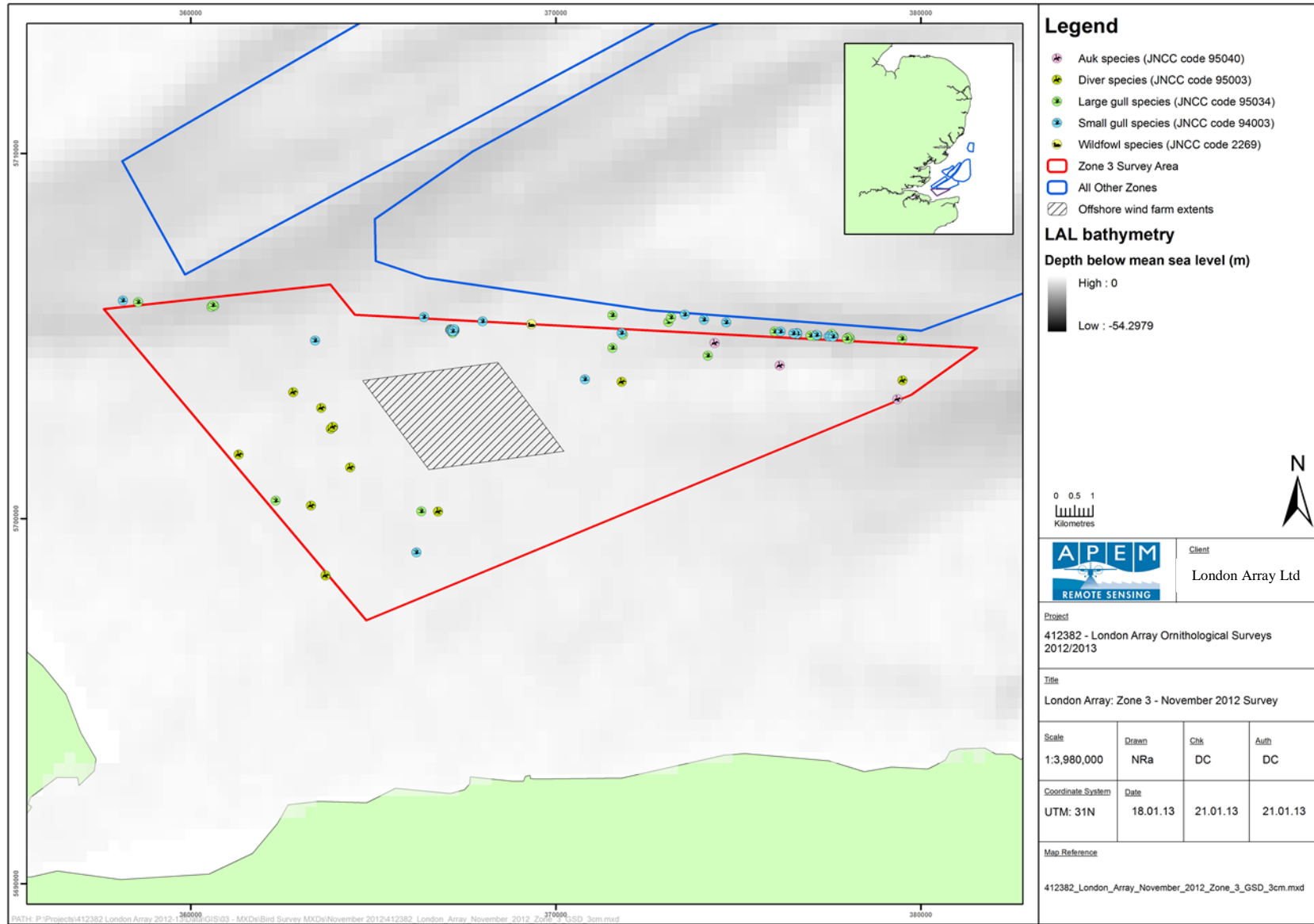
A: Zone 1



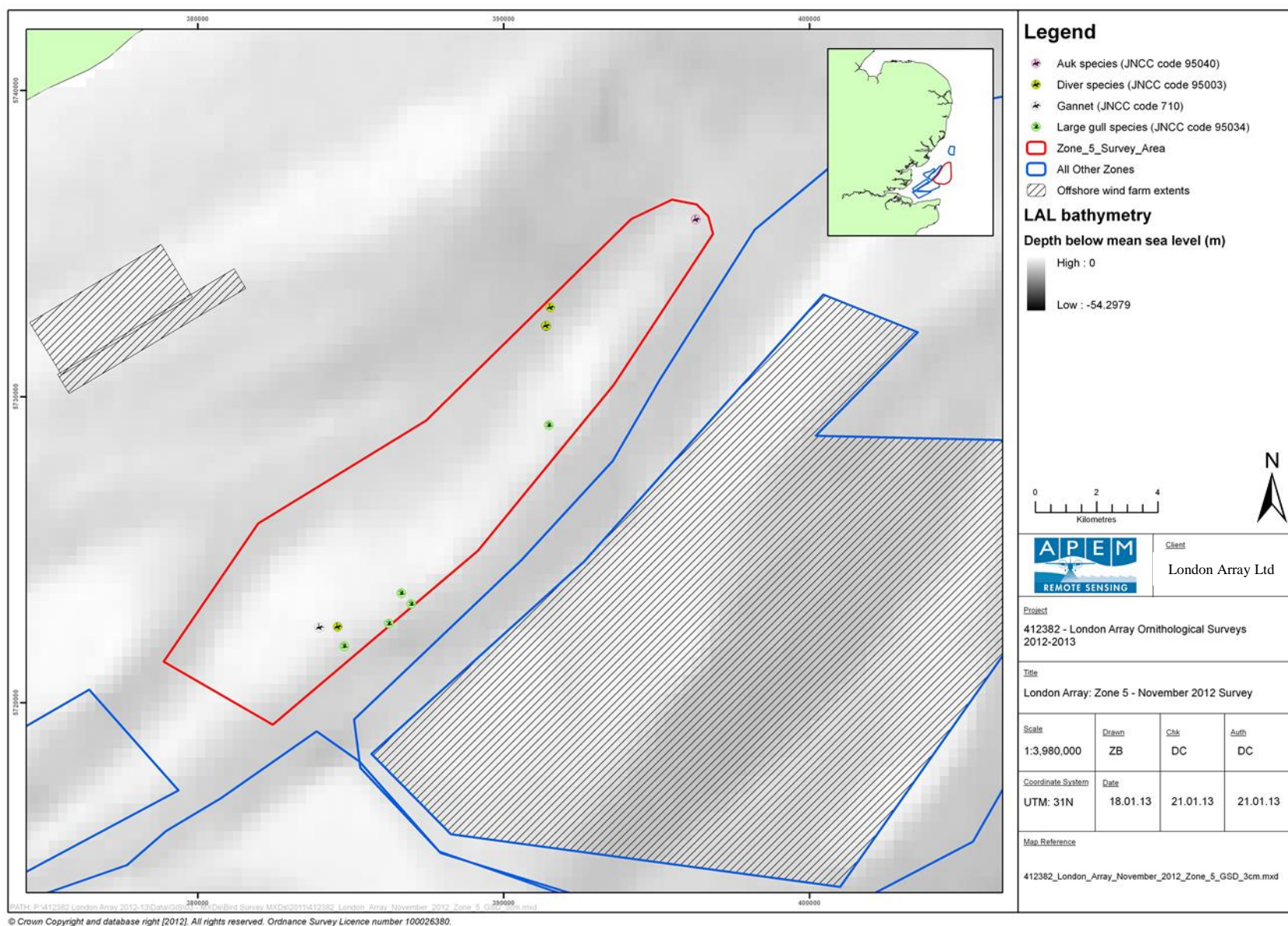
B: Zone 2



**Continued:** Distribution of bird and marine mammal species / groups recorded in each zone in the November 2012 survey at 500 m resolution.

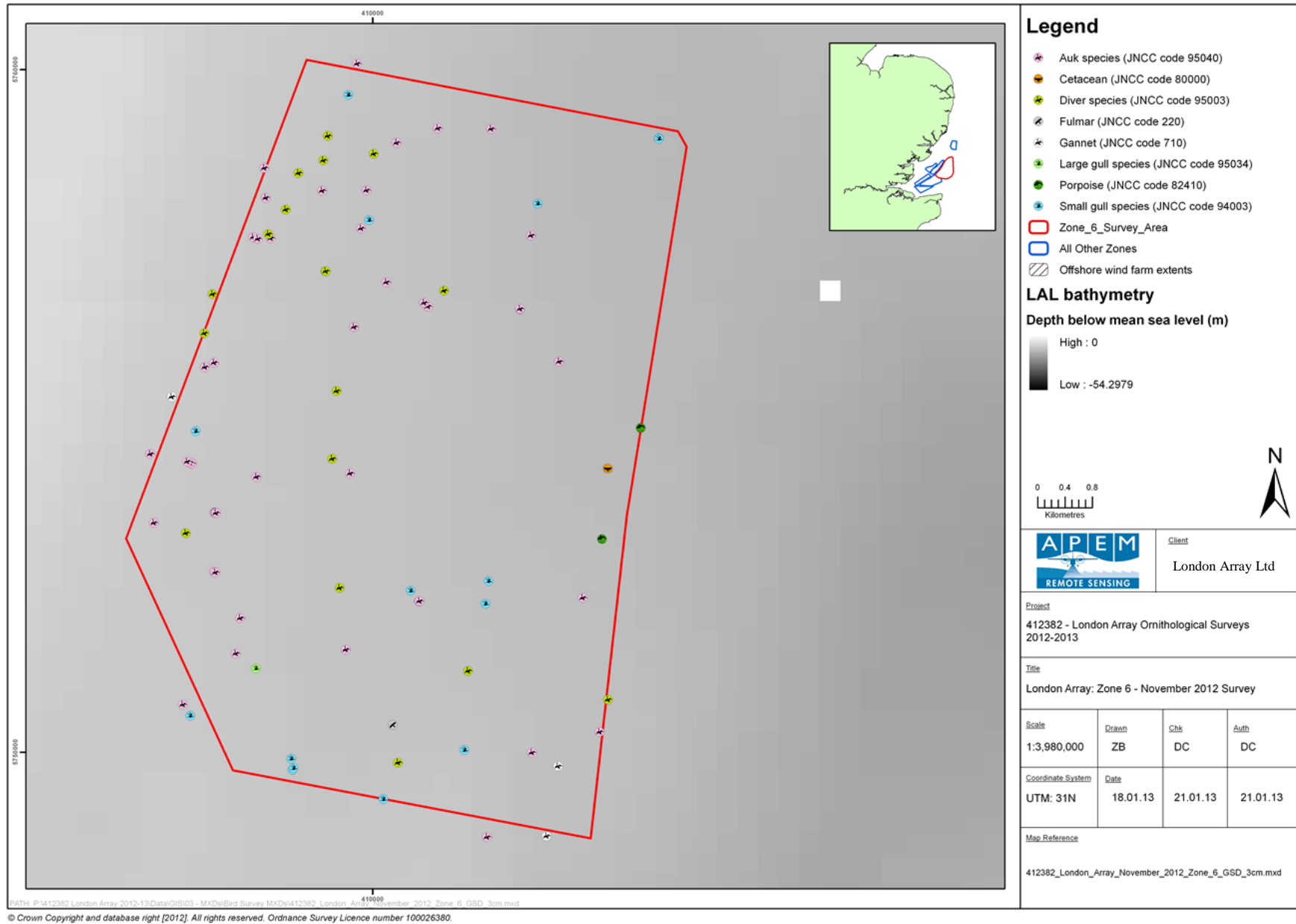


**C: Zone 3**

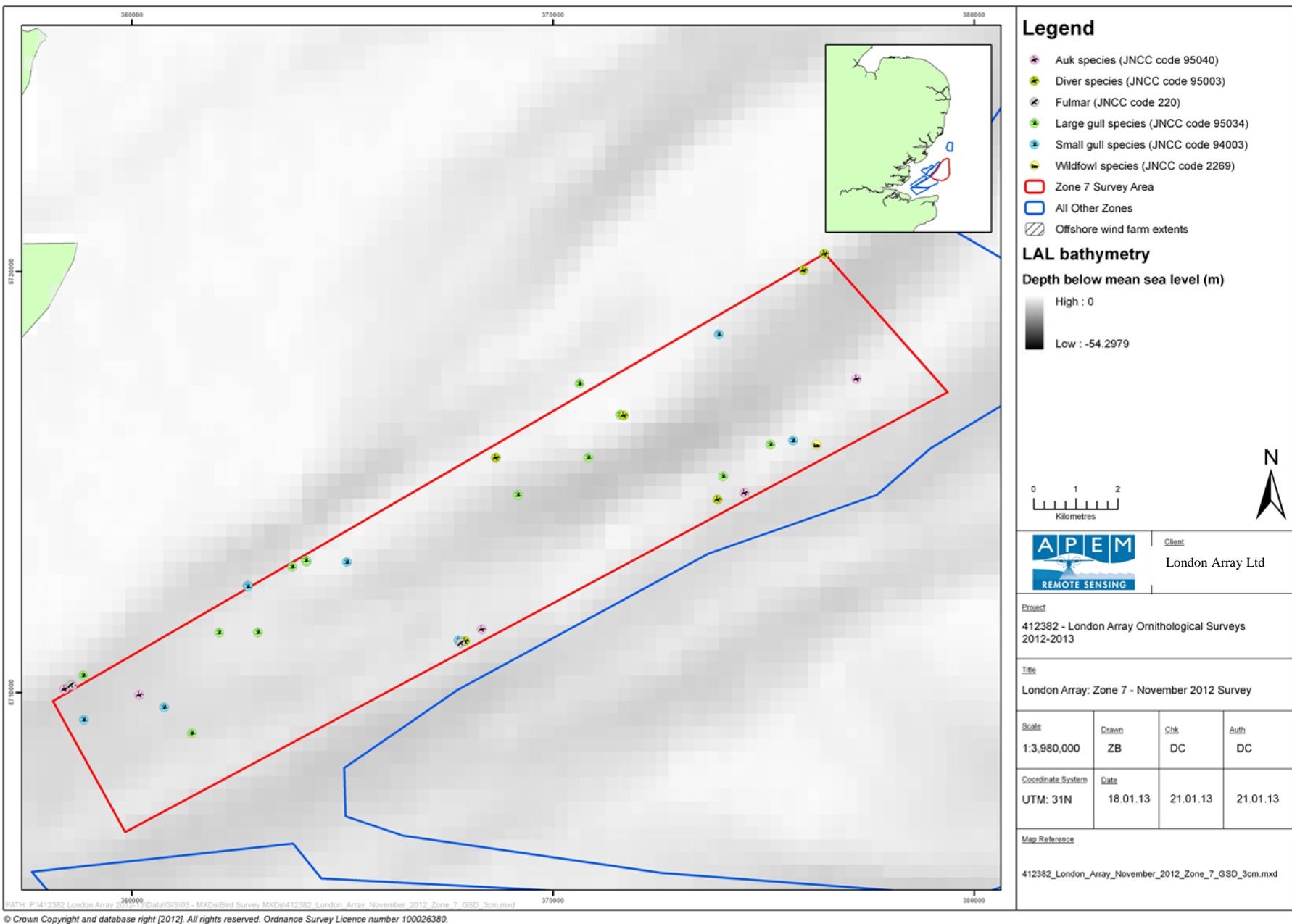


**D: Zone 5**

**Continued:** Distribution of bird and marine mammal species / groups recorded in each zone in the November 2012 survey at 500 m resolution.



**E: Zone 6**



**F: Zone 7**

### 3.1.2.3 December 2012

The distribution of each individual bird (including divers) recorded in this survey is shown in Figure 3.3: A-F. This section will describe the distribution of all the other bird species / groups recorded during the December 2012 survey, as diver distribution is described in Section 3.2.1 above.

Of the other birds recorded within zone 1, a single fulmar was observed to the north of the London Array OWF site, towards the eastern boundary of the site. Of the two cormorants / shags observed; one was located on the north eastern boundary of the London Array OWF site and the remaining cormorant / shag was recorded to the west of the centre of the site, just outside the western boundary of the London OWF site. The majority of small gulls were recorded within the London Array OWF site, with further individuals observed towards the north east and south west of the buffer. The majority of large gulls were also recorded throughout the London Array OWF site, with further individuals in the buffer areas; north of the site, in the south east, outside the London Array OWF site in the south west of the site and to the west of the centre of the zone 1. Auks were distributed throughout much of the zone, with the majority of individuals recorded in the north of the site towards the eastern boundary of the zone (Figure 3.3: A)

Within zone 2 a single cormorant / shag was recorded in the far south west corner of zone 2, close to the southern boundary. Small gulls were recorded within the lower half of the zone in a band running from east to west. Of the three large gulls recorded during the December 2012 survey of zone 2, two were observed in the north east of the site towards the northern and eastern boundaries over a shallow area and the remaining large gull was located in the south west of the zone towards the southern boundary. Auks were thinly dispersed across much of the site, with the majority recorded in the south east of the zone (Figure 3.3: B).

In zone 3 no birds were found within the Kentish Flats wind farm site. Cormorants / shags were mainly located together in the north west corner of the site, with individuals recorded in the north east and towards the southern boundary below the Kentish Flats wind farm site. Small gulls were located along the northern boundary and just outside of the zone, with one individual observed south of the centre of the site. The majority of large gulls were recorded in the north west of the zone 3, both within and just outside of the northern boundary. The remaining large gulls were observed in the north east of the site. Auks were recorded throughout the site, with the majority of auks observed in the north west of the zone (Figure 3.3: C).

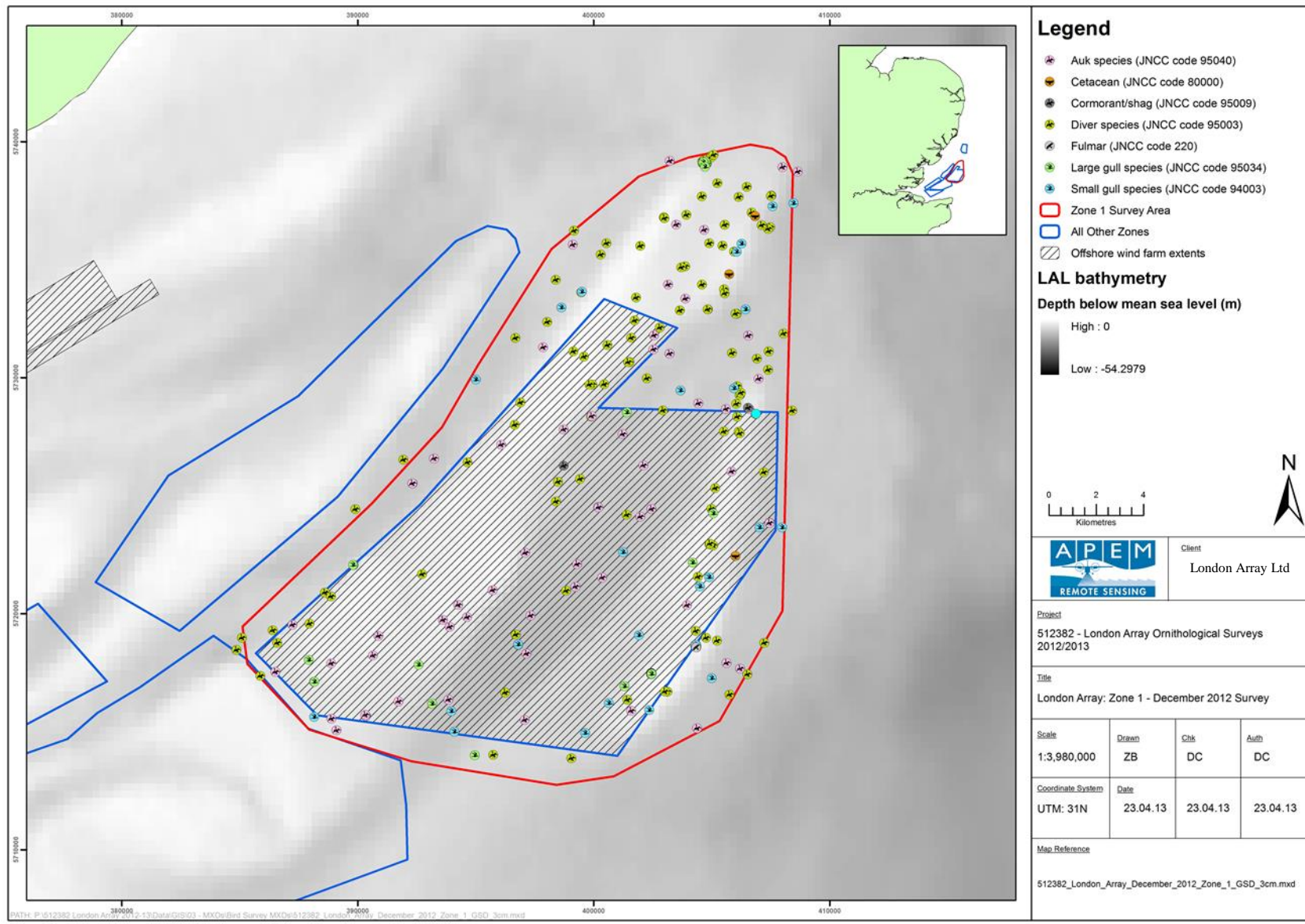
Within zone 5 other birds were concentrated towards the south western end of the zone and along the northern boundary. Two grebes were recorded close to the northern boundary in the north and in the centre of the zone. Small gulls were recorded in the southern half and centre of the survey area with one individual recorded outside of the zone close to the northern boundary. The large gull recorded during the December survey was located in the south of the site, towards the southern boundary over an area of shallow sandbanks. Auks were recorded along the northern boundary running from east to west and in the southern half of the survey area (Figure 3.3: D).

Few birds were recorded in the eastern half of the survey area in zone 6 during the December 2012 survey. Small gulls were recorded in the eastern half of the zone, with the majority recorded in the north of the site, with individuals observed outside of the zone in the north east and south east of the survey area. A single large gull species was recorded in the centre of the site, along the eastern boundary. Auks were thinly distributed across the zone, with the majority recorded in the south east of the survey area. Three auks were observed outside of the northern boundary in the north west of the zone (Figure 3.3: E).

Few birds were recorded during the December 2012 survey of zone 7, with three small gulls recorded in the north of the site, in the centre and in the south west corner of the zone. A single large gull was observed in the north east corner of the site on the boundary of a shallow sandbank area. Auks were recorded along the northern boundary of the zone, with individuals also recorded in the centre of the site over deeper water. (Figure 3.3: F).

Two dolphin / porpoises were recorded during the December 2012 survey. One was located within zone 2 in the north west of the site towards the northern boundary (Figure 3.3: B) whilst the other dolphin / porpoise was recorded in zone 6 in the south east corner of the site (Figure 3.3: E).

**Figure 3.3:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the December 2012 survey at 500 m resolution.

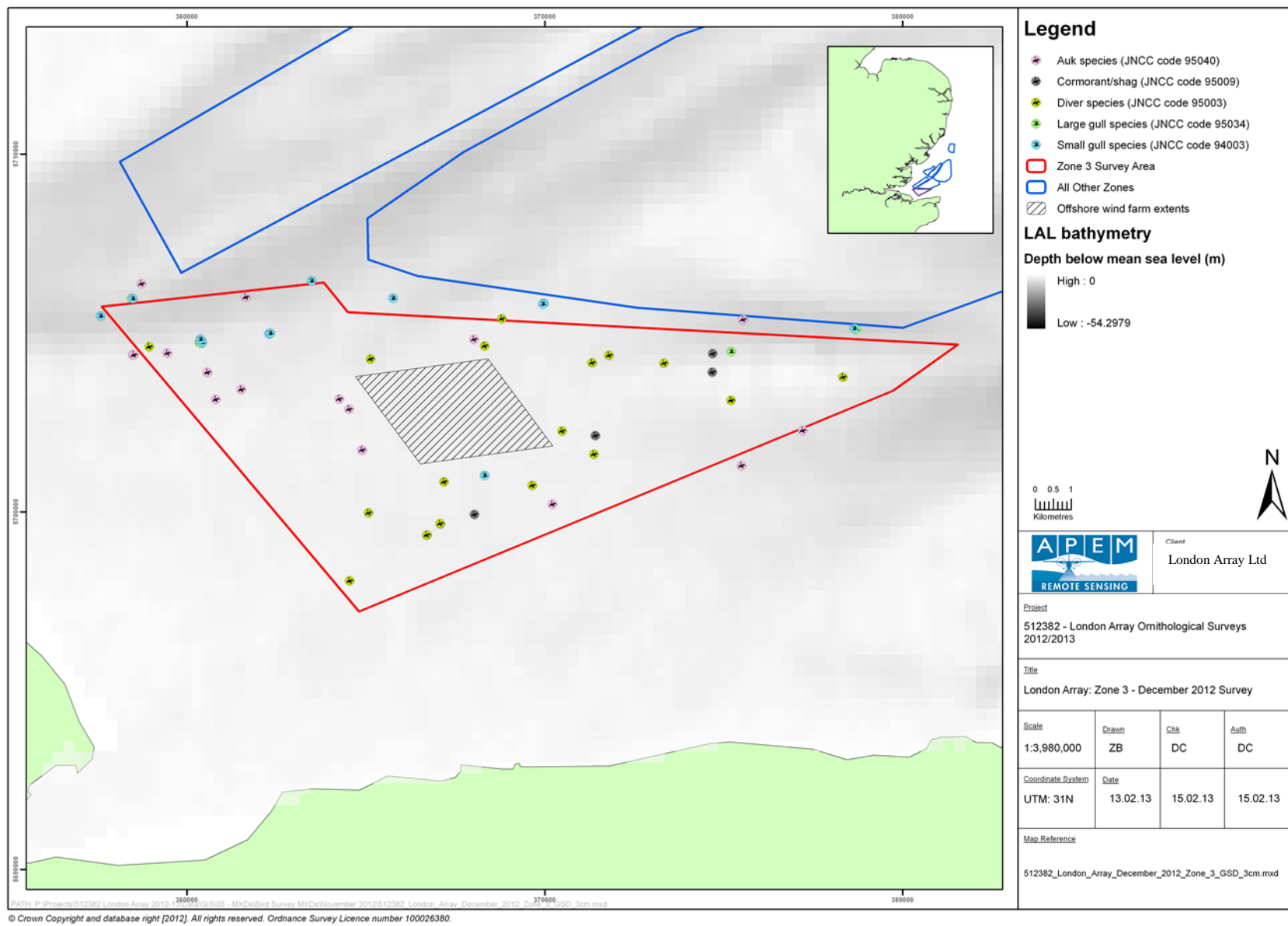


**A:** Zone 1

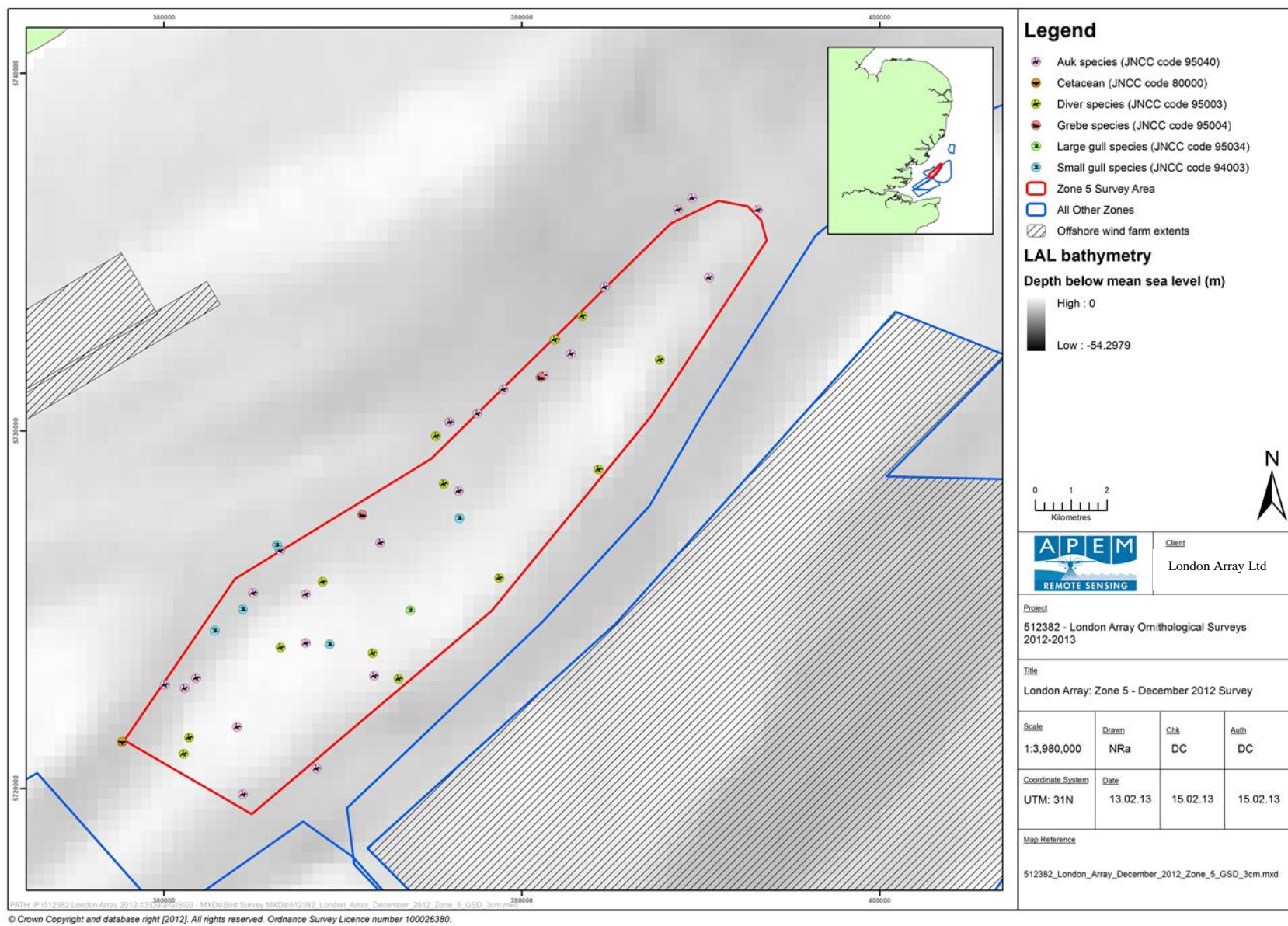


**B:** Zone 2

**Continued:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the December 2012 survey at 500 m resolution.

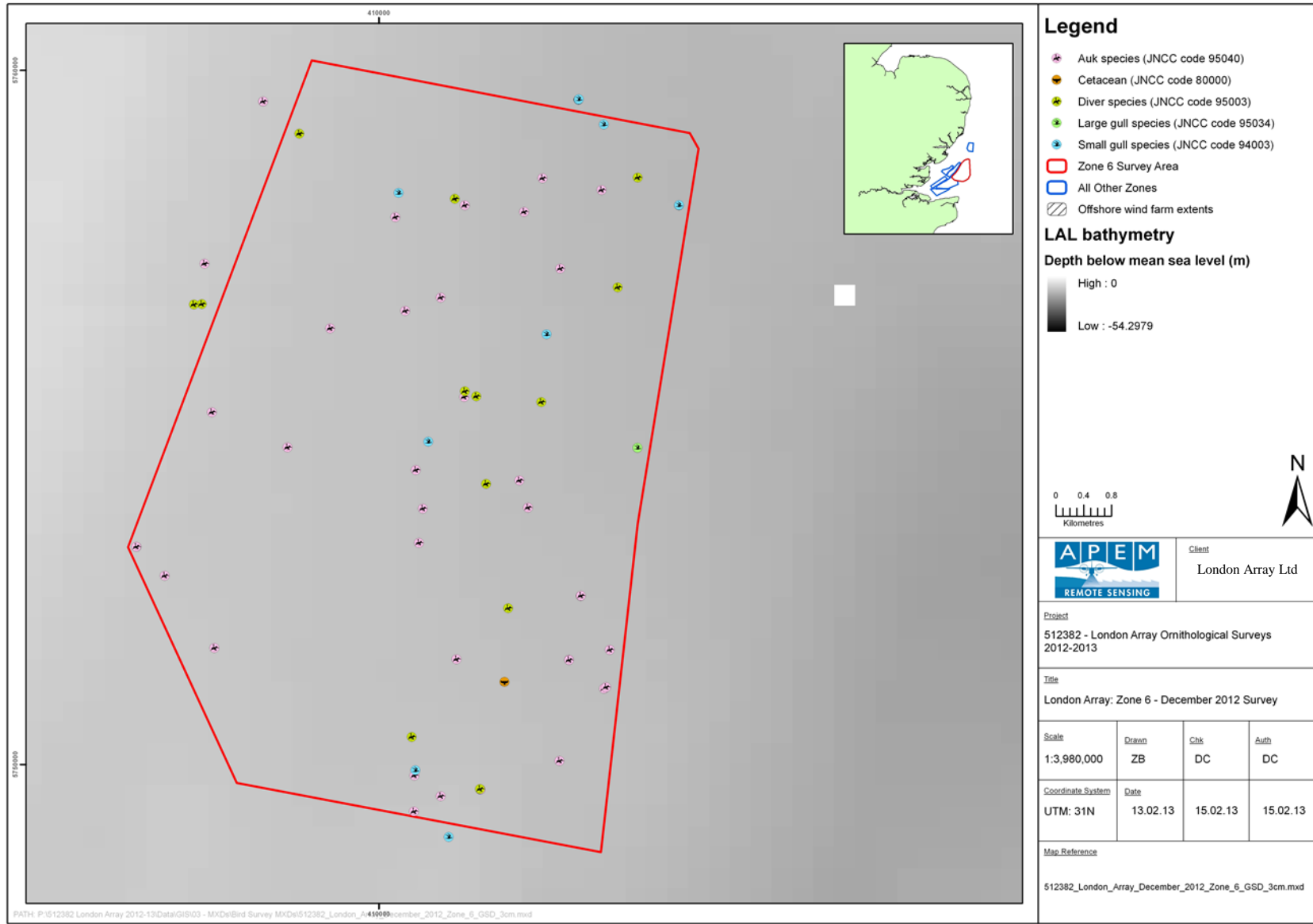


C: Zone 3

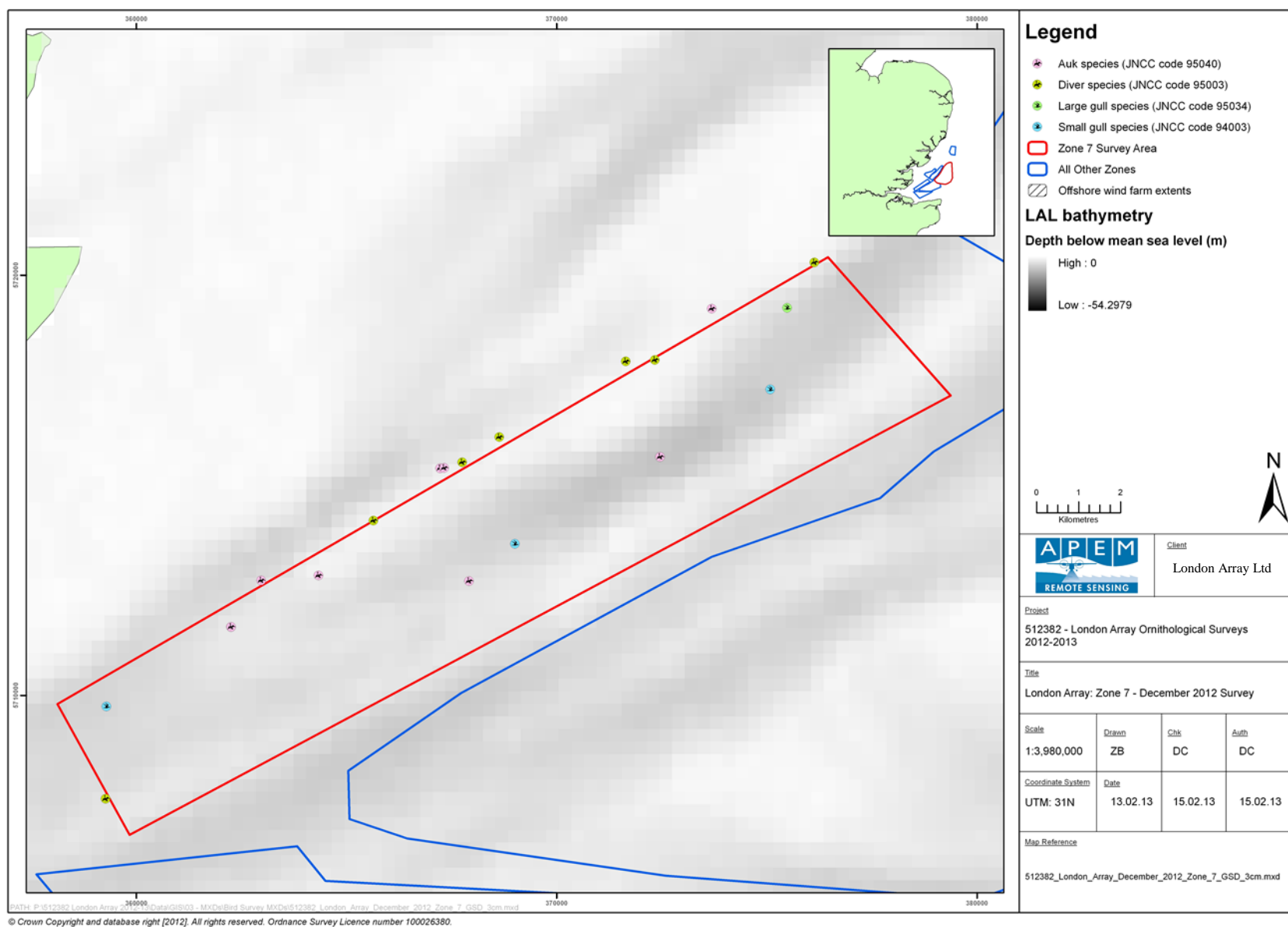


D: Zone 5

**Continued:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the December 2012 survey at 500 m resolution.



**E: Zone 6**



**F: Zone 7**

### 3.1.2.4 January 2013

The distribution of each individual bird (including divers) recorded in this survey is shown in Figure 3.4: A-F. This section will describe the distribution of all the other bird species / groups recorded in the January 2013 survey, as diver distribution is described in Section 3.2.1 above.

Many of the other bird species / groups recorded within zone 1 were located in the north east corner of the zone, north of the London Array OWF site and along the eastern edge of the site, with birds also located along the southern and western edges of the survey area. Two grebes were recorded during the survey; one in the north west of the London Array OWF site and one just outside the western boundary in the centre of the site. Small gulls were loosely distributed throughout much of zone 1; with the majority recorded in the eastern half of the site. Clusters of small gulls were located north of the London Array OWF site in the north east of the zone and within the Phase 1 Site boundary in the south west of the London Array OWF site. Large gulls were mainly concentrated in the south of the site within the Phase 1 Site boundary and south of the London Array OWF site. Individual large gulls were recorded in the north east and south west of the London Array OWF site with smaller numbers of also observed in the north and south west of the buffer. Auks were observed across zone 1 with the majority recorded in the north of the site and towards the eastern boundary of the survey area (Figure 3.4: A).

In zone 2, a small group of seaducks were recorded south of the centre of the site and a single fulmar was observed just outside of the south eastern boarder of zone 2. One gannet was recorded on the northern boundary in the eastern half of the site. Small gulls were mainly distributed along the south western boarder of the zone, with individuals located in the north west of the site close to the northern border. A further small gull was recorded in the north east of the site near a group of divers. Large gulls were loosely distributed throughout the survey area with a cluster recorded in the south west corner of the zone, close to the southern boundary. Auks were also recorded within zone 2 and were dispersed across much of the area, with fewer individuals in the far western and eastern ends of the zone (Figure 3.4: B).

In January 2013 one large gull was recorded within the Kentish Flats wind farm site with the remaining birds distributed throughout zone 3. Five cormorants / shags were located in a cluster towards the north east corner of the zone and one wader was also recorded in the same locality amongst a mixture of small gulls and large gulls. The majority of small gulls and all large gulls observed were recorded in groups along the northern Zonal boundary towards the north west and north east of the survey area. A further two small gulls and three large gulls were noted in the south of the zone. Auks were loosely scattered across the site; in the north east and north west of the zone with one individual located in the south of the site towards the southern boundary (Figure 3.4: C).

All other birds recorded in zone 5 were thinly dispersed across the zone. A single gannet was recorded in the north east of the site close to the southern boundary over an area of shallow sandbank. Three small gulls were recorded during the January 2013 survey, in the north and south of the site towards the northern and western boundaries. Of the seven large gulls recorded, five were observed just outside of the zone in the north west of the site. The



remaining two large gulls were recorded in the south of the site towards the northern boundary. The majority of auks were recorded in the north of the site, with individuals loosely scattered along the northern boundary of zone 5. Three auks were located just outside of the northern boundary in the north of the site. (Figure 3.4: D).

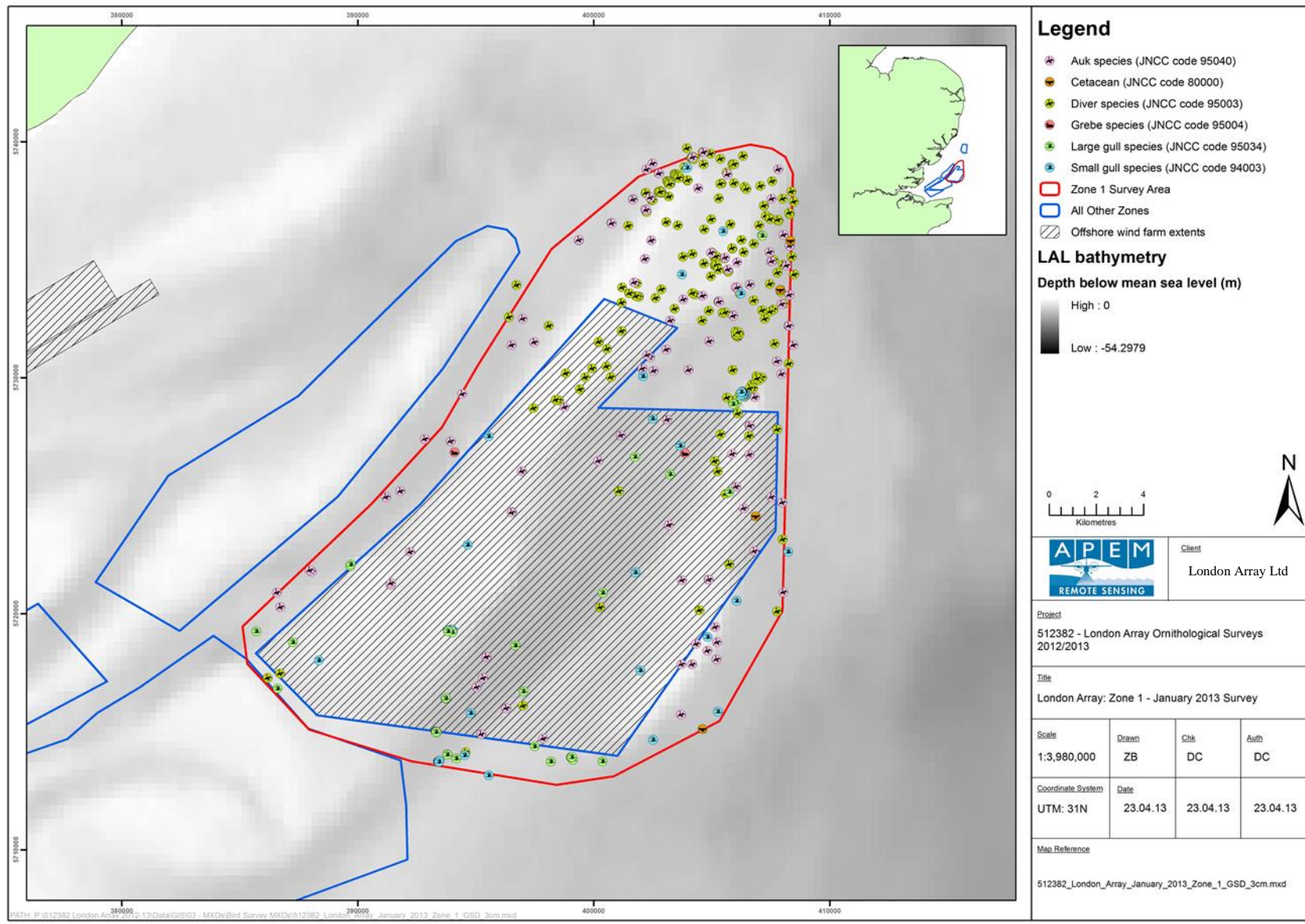
Relatively few birds were recorded within zone 6 during the January 2013 survey and those birds which were recorded were mainly in the east of the zone. Seven auks were recorded during the January 2012 survey within zone 6. Of these, two were located in the centre of the site, along the western and eastern boundaries and four were observed close to the southern boundary with one individual observed just outside of the southern boundary of the zone (Figure 3.4: E).

In zone 7 a higher concentration of birds were recorded in the centre and north of the zone. Of the three grebes recorded, one was observed towards the northern boundary in the centre of the site over shallow water. The remaining two grebes were located in the north of the site; towards the centre of the zone over deeper water and in the south east of the site over a shallow sandbank area. Small gulls were concentrated in the centre and north of the site, with a small number of individuals recorded in the south west corner of the zone. Of the 30 large gulls recorded during the January 2013 survey, the majority were observed in the north of the zone with a group of 16 individuals located just outside of the northern boundary in the north of the site. Individual large gulls were located along the southern boundary and outside of the southern boundary in the south-west of the site. Similarly to large gulls auks were mainly present in the north of the site with a single auk recorded in the south of the survey area, close to the western boundary (Figure 3.4: F).

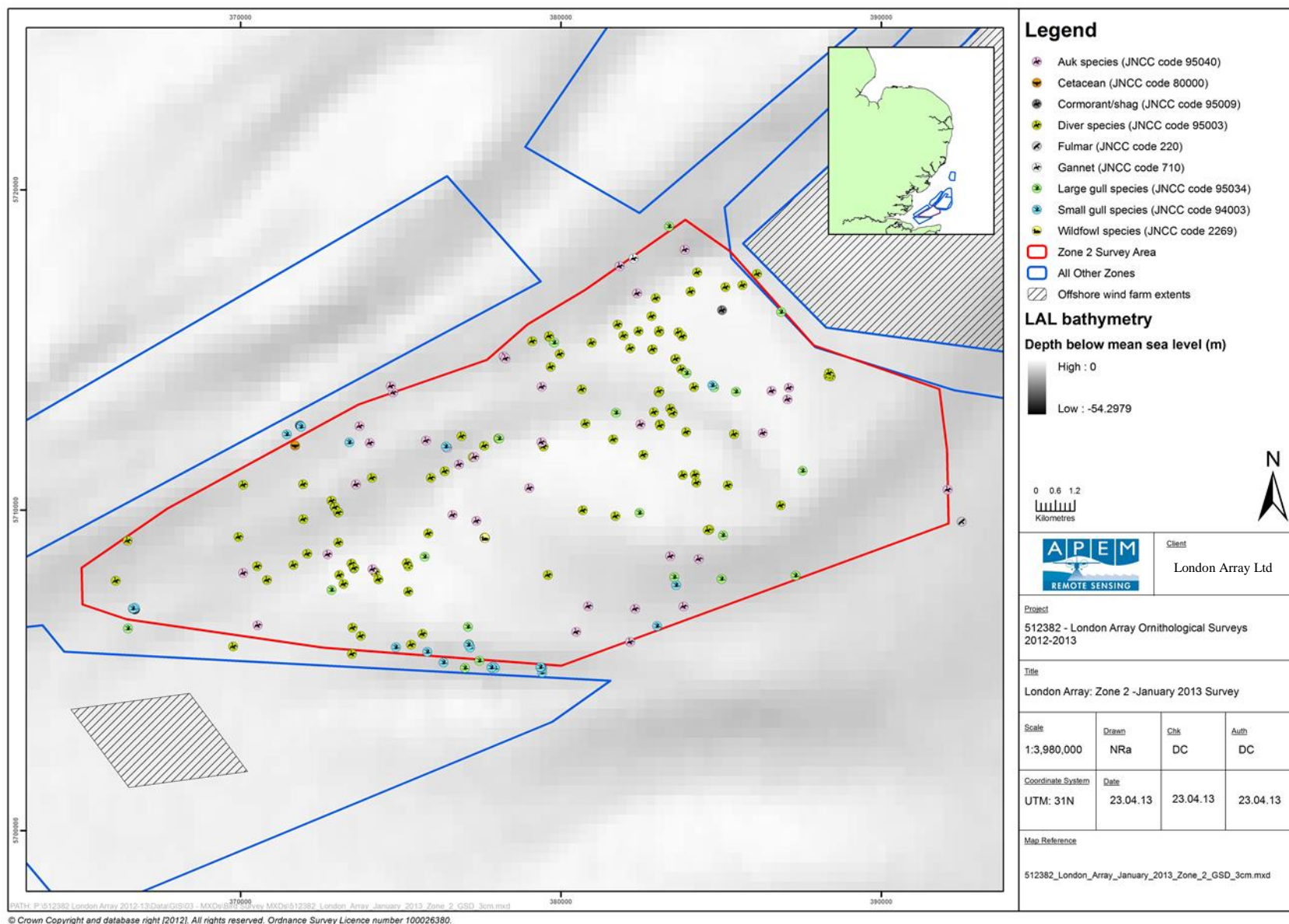
Cetaceans were recorded within zones 1, 2, 3, 5 and 6 during the January 2013 surveys. The majority of the cetaceans recorded were identified as dolphins / porpoises with two harbour porpoises recorded in zone 5. No cetaceans were recorded in zone 7.

Three cetaceans (dolphins / porpoises) were recorded within zone 1 during the January 2013 survey; two were recorded in the north of the site close to the eastern border with the remaining individual recorded in the north east of the London Array OWF site. (Figure 3.4: A). Within zone 2 a single dolphin / porpoise was recorded in the west of the site, close to the northern boundary (Figure 3.4: B). Within zone 3 a single dolphin / porpoise was located south of the Kentish Flats wind farm site in the centre of the zone (Figure 3.4:C). Both harbour porpoises were recorded together in the western half of the site close to the northern border and the dolphin / porpoise was recorded in the southernmost corner of the zone (Figure 3.4:D). An additional dolphin / porpoise was recorded within zone 6 close to the eastern boundary in the centre of the site (Figure 3.4 E).

**Figure 3.4:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the January 2013 survey at 500 m resolution.

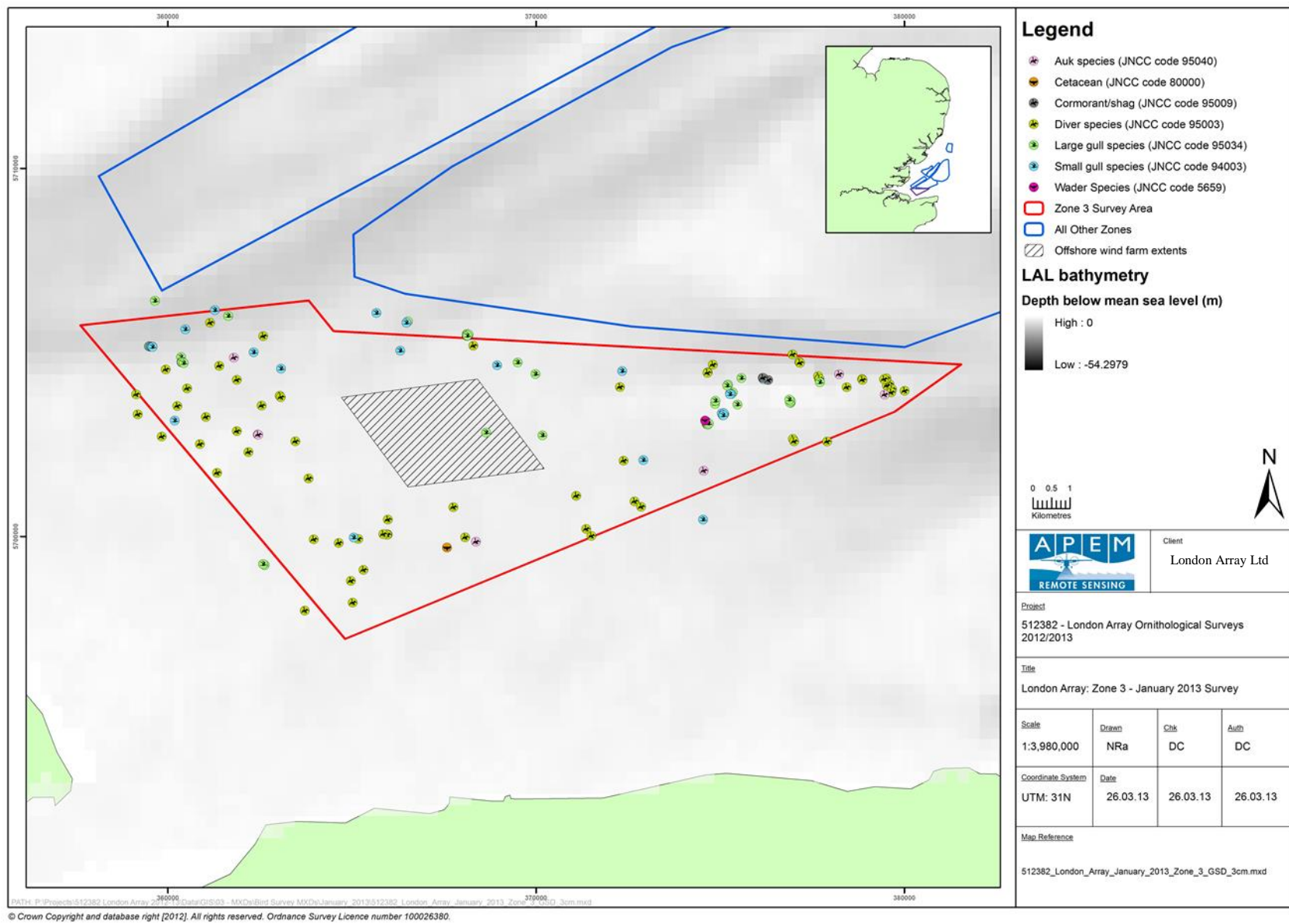


**A:** Zone 1

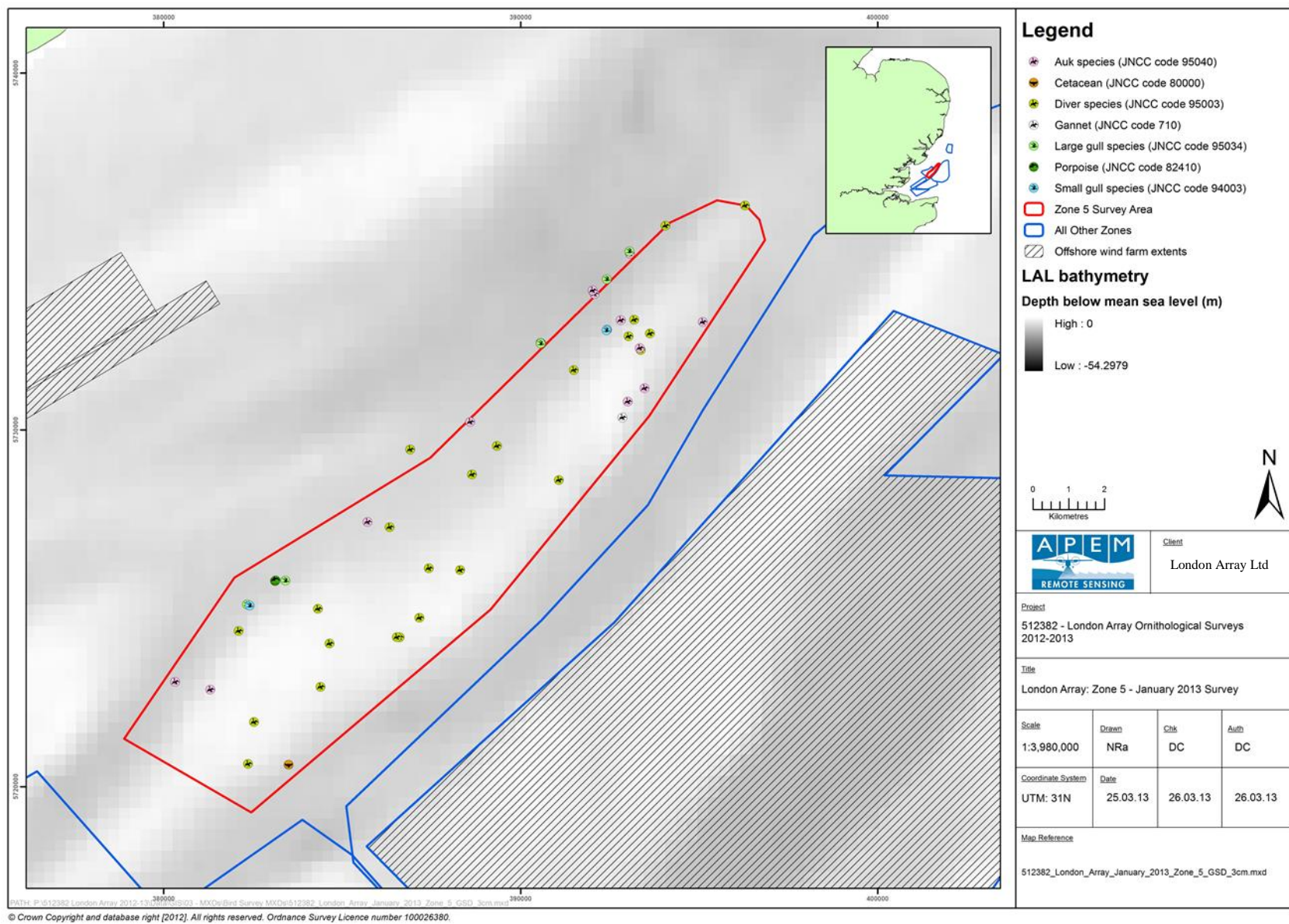


**B:** Zone 2

**Continued:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the January 2013 survey at 500 m resolution.

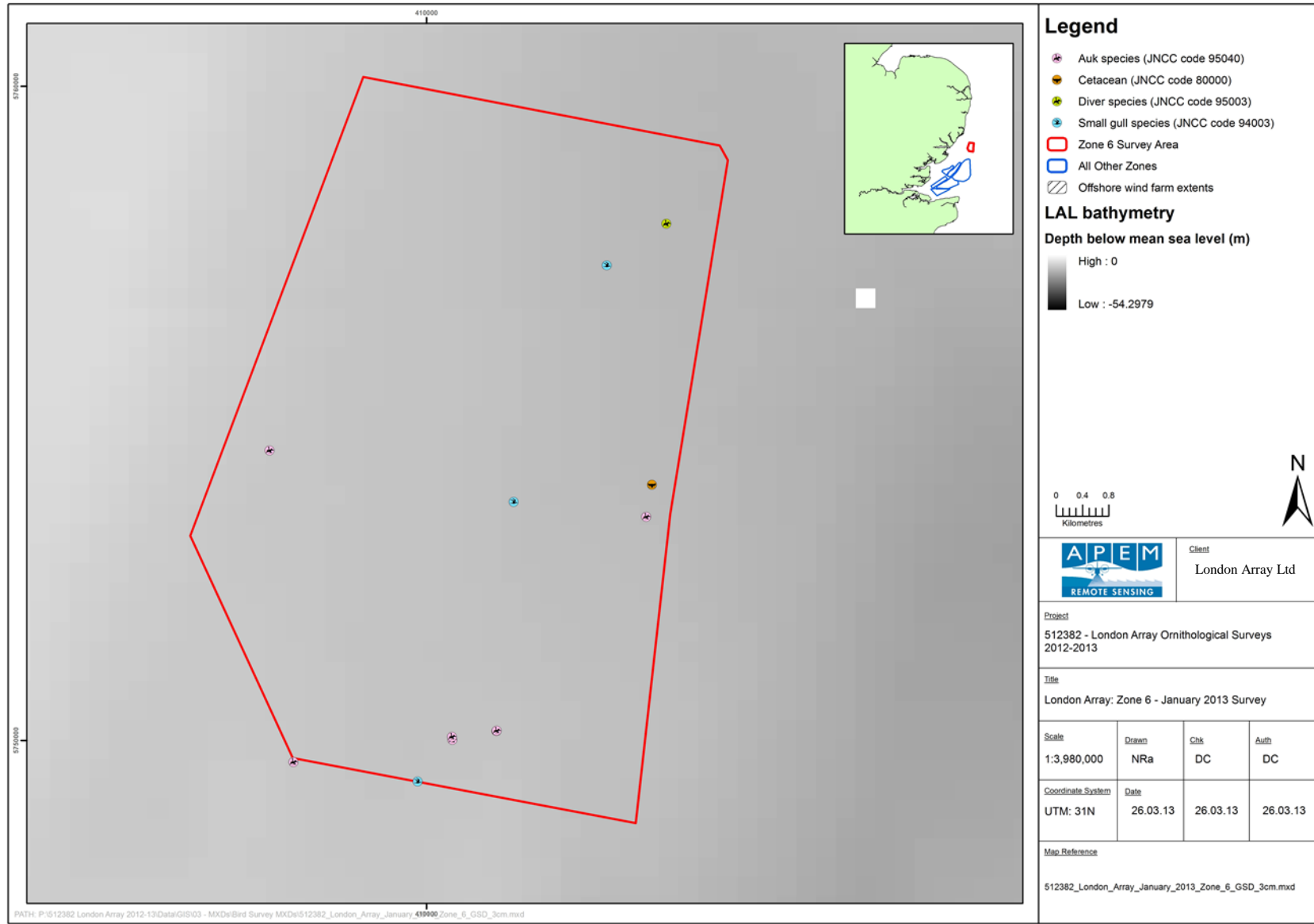


C: Zone 3

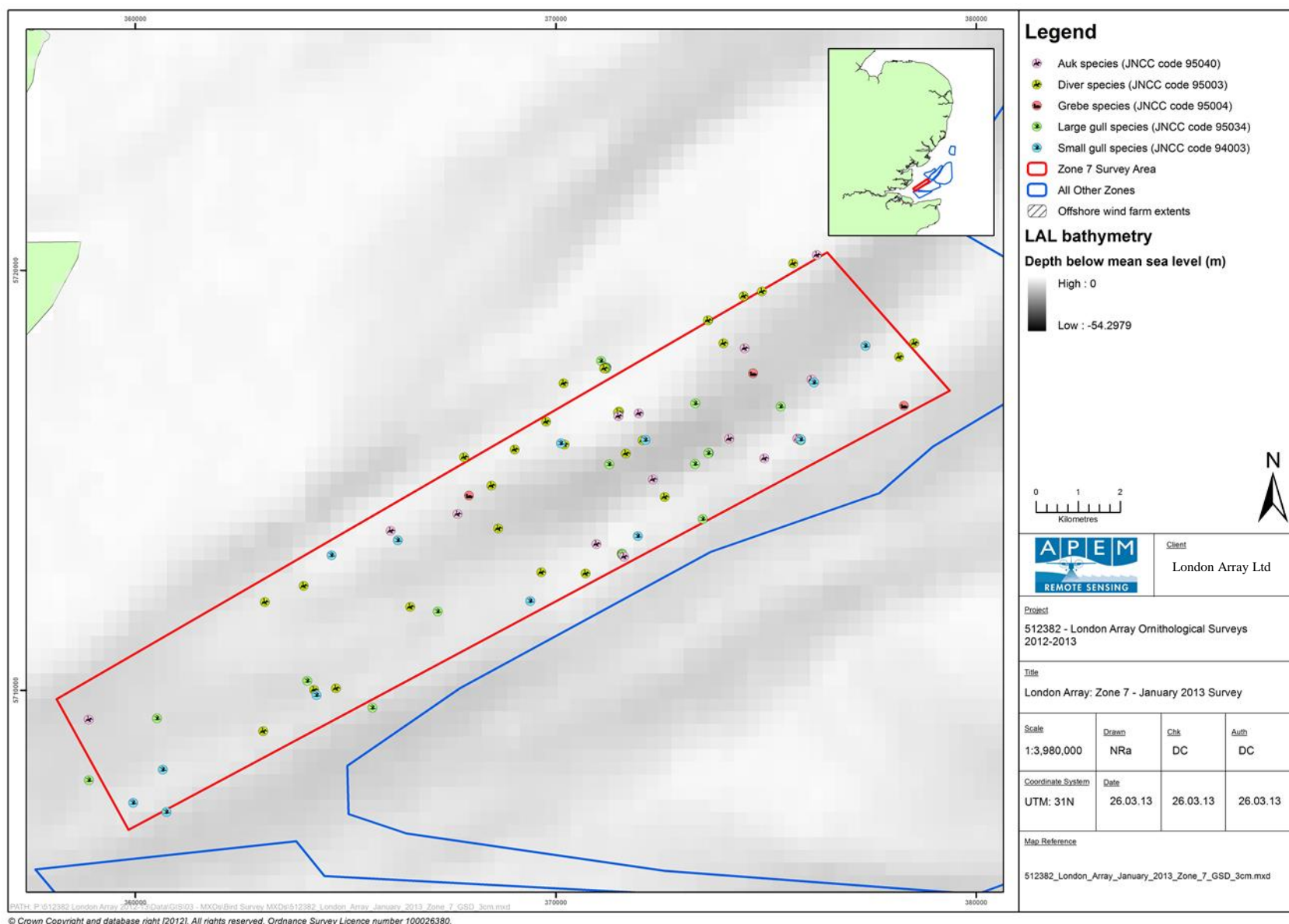


D: Zone 5

**Continued:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the January 2013 survey at 500 m resolution.



**E: Zone 6**



**F: Zone 7**

### 3.1.2.5 February 2013

The distribution of each individual bird (including divers) recorded in this survey is shown in Figure 3.5: A-F. This section will describe the distribution of all the other bird species / groups recorded in the February 2013 survey, as diver distribution is described in Section 3.2.1 above.

Other birds were generally scattered throughout much of zone 1, including the London Array OWF site, with the majority observed in the north of the site and along the eastern boundary. A single cormorant was located just outside of the zone 1 survey area, to the east of the centre of the site. Two fulmars were recorded during the February 2013 survey; one outside the eastern border of zone 1 in the centre of the site and one in the north west of the survey area above the London Array OWF site. The majority of gannets recorded were observed in the far north of the site and along the eastern boundary of the survey area, with large clusters observed in the north east corner of the London Array OWF site, in the south east of the zone along the eastern London Array OWF boundary and in the far north of the site. A single gannet was also recorded in the north west of the zone. Small gulls were loosely scattered across the site, with the majority observed in the south east of the survey area and along the eastern boundary of the London Array OWF site. No small gulls were recorded in the south west of the zone. Large gulls were scattered thinly across the zone, with higher numbers observed in the south of the site with a cluster of 25 large gulls located in the south-east of the London Array OWF site close to a group of seals. Auks were concentrated in in the north west of the zone in a band running along the western area boundary and in the south east of the survey area, with individual auks scattered across the London Array OWF site (Figure 3.5: A).

The most predominant of the other bird species / groups recorded in zone 2 were large gulls, which were concentrated mainly in the centre and within the western half of the survey area. Of the four common scoter recorded, two were observed in the centre of the site and two were recorded to the east of the centre of the site. A single fulmar was recorded just outside of the southern boundary, south of the centre of the site. A total of 16 cormorants were also recorded in three locations across the site; a large group of 14 cormorants were observed in the south west corner of the zone with individuals observed in the centre of the site and towards the south east corner of the zone. A single great skua was observed in the north east of the site whilst small gulls were mainly observed in the western half the zone, although one individual was observed outside of the site boundary in the east of the survey area. Auks were mainly concentrated in the south west of the zone with clusters of scattered individuals recorded in the east of the site and along the eastern and northern boundaries. (Figure 3.5: B).

A greater number of birds were located within the Kentish Flats wind farm site during February 2013 compared to the previous month's surveys, including a single cormorant and two auks located in the north of the Kentish Flats wind farm site. The majority of small gulls and large gulls were located in a cluster in the north east of the site, with individuals distributed in the north west of the zone close to the western and northern boundaries. Individual small gulls were also observed south of the Kentish Flats Wind farm site and individual large gulls were recorded outside of the survey area in the north east and north west of the survey area. Auks were loosely scattered in a band running east to west across the

northern half of the site, with two auks located outside of the northern boundary in the centre and north west of the site. A single auk was also recorded just outside of the south eastern boundary (Figure 3.5: C).

The majority of other birds recorded within zone 5 were located towards the centre and the south western end of the zone. Small gulls were mainly observed in the south of the site towards the north western boundary with individual small gulls located in the north of the site, close to the north eastern boundary and just outside of the northern boundary in the centre of the site. Similarly to small gulls, the majority of large gulls were recorded in the south of the site towards the north western boundary and towards the southernmost tip of the site. Individual large gulls were recorded in the centre of the site within the northern half of the survey area. Auks were scattered across the north east of the site with two individuals located in the far south of the site. No other bird species were observed during the February 2012 survey of zone 5 (Figure 3.5: D).

Birds were loosely scattered across the zone 6 survey area, with fewer birds located towards the eastern boundary of the site. In addition to divers 11 birds were recorded within zone 6, including a single gannet located south of the centre of the site, towards the southern survey boundary and a single large gull observed in the centre of the site towards the western survey area boundary. Of the nine auks recorded, six were located in the southern half of the survey area; towards the southern boundary, in the north east of the site and just outside of the western survey area boundary. A single auk was observed in the centre of the site towards the eastern boundary and the remaining two auks were located north of the centre of the site (Figure 3.5: E).

In zone 7, a group of 58 common scoters were recorded on the northern survey area boundary in the north east of the site. A single grebe was located on the boundary of a shallow sand banked area in the east of the site towards the southern survey area boundary. Small gulls were scattered across the survey area, with the majority located in the northernmost half of the site. Of the 25 large gulls recorded, 12 were located in a cluster on the boundary in the north west of the site. The remaining large gulls were loosely scattered in the north east of the site with two individuals located in the southernmost end of the site towards the southern survey boundary. The majority of auks were recorded in the north east of the survey area, with a single auk recorded on the border of the zone in the south west of the site close to a pair of auks also recorded in the south west of the site towards the northern boundary (Figure 3.5: F)

Cetaceans were recorded within zones 1, 2, 6 during the February 2013 surveys. The majority of cetaceans were positively identified as harbour porpoise with two dolphins / porpoises recorded within zone 6. No cetaceans were recorded in zones 3, 5 and 7.

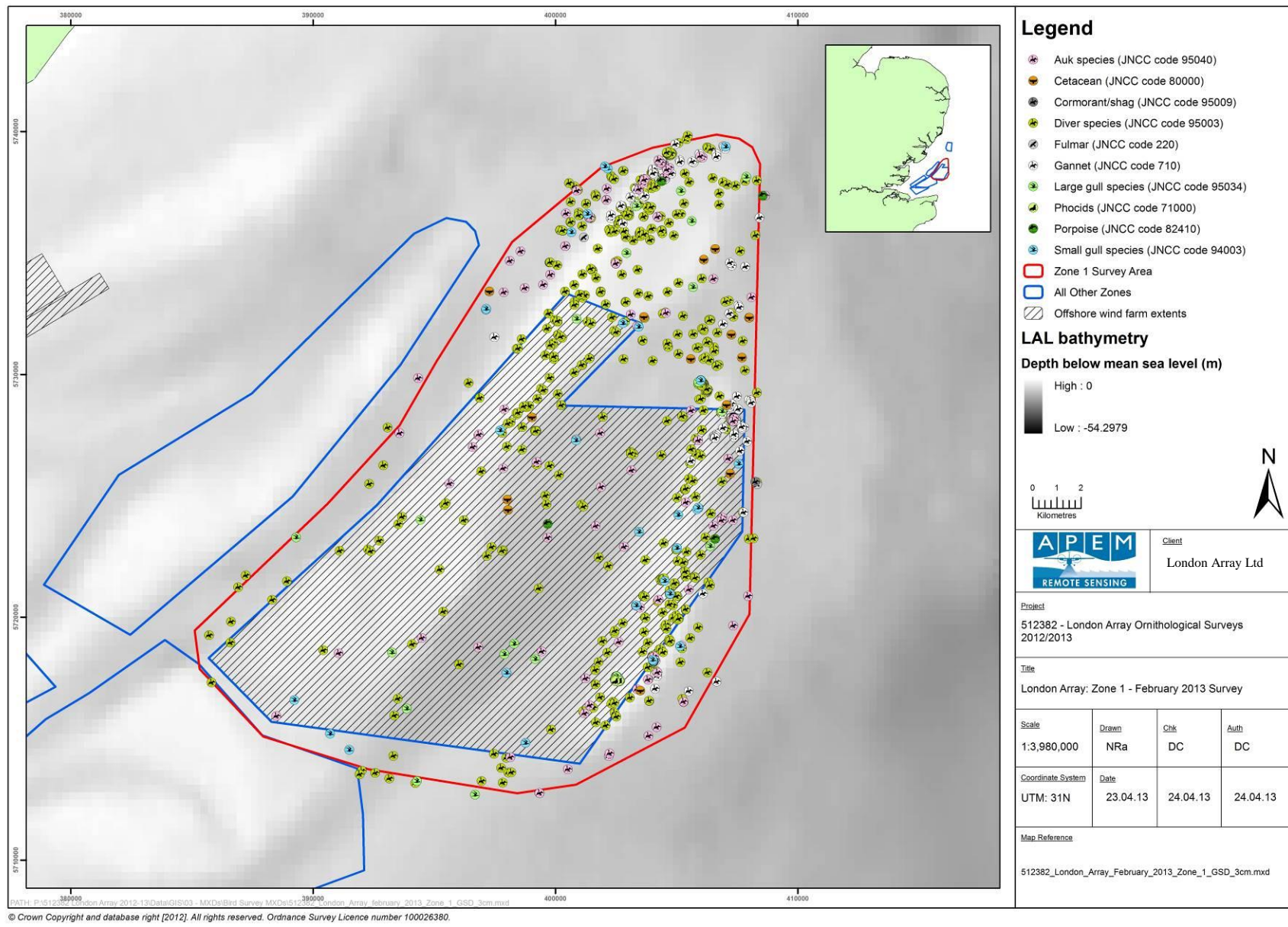
Phocid species were also recorded within zones 1 and 2, with no phocids recorded in the other zones.

A total of 19 cetaceans were distributed across zone 1, largely along the north eastern boundary of the zone, with a total of seven individuals recorded within the London Array OWF site (Figure 3.5: A). Of the three positively identified harbour porpoises recorded within zone 2, two were located in the centre of the site with one individual observed close to the southern boundary in the east of the site (Figure 3.5: B). Within Zone 6 two dolphins /

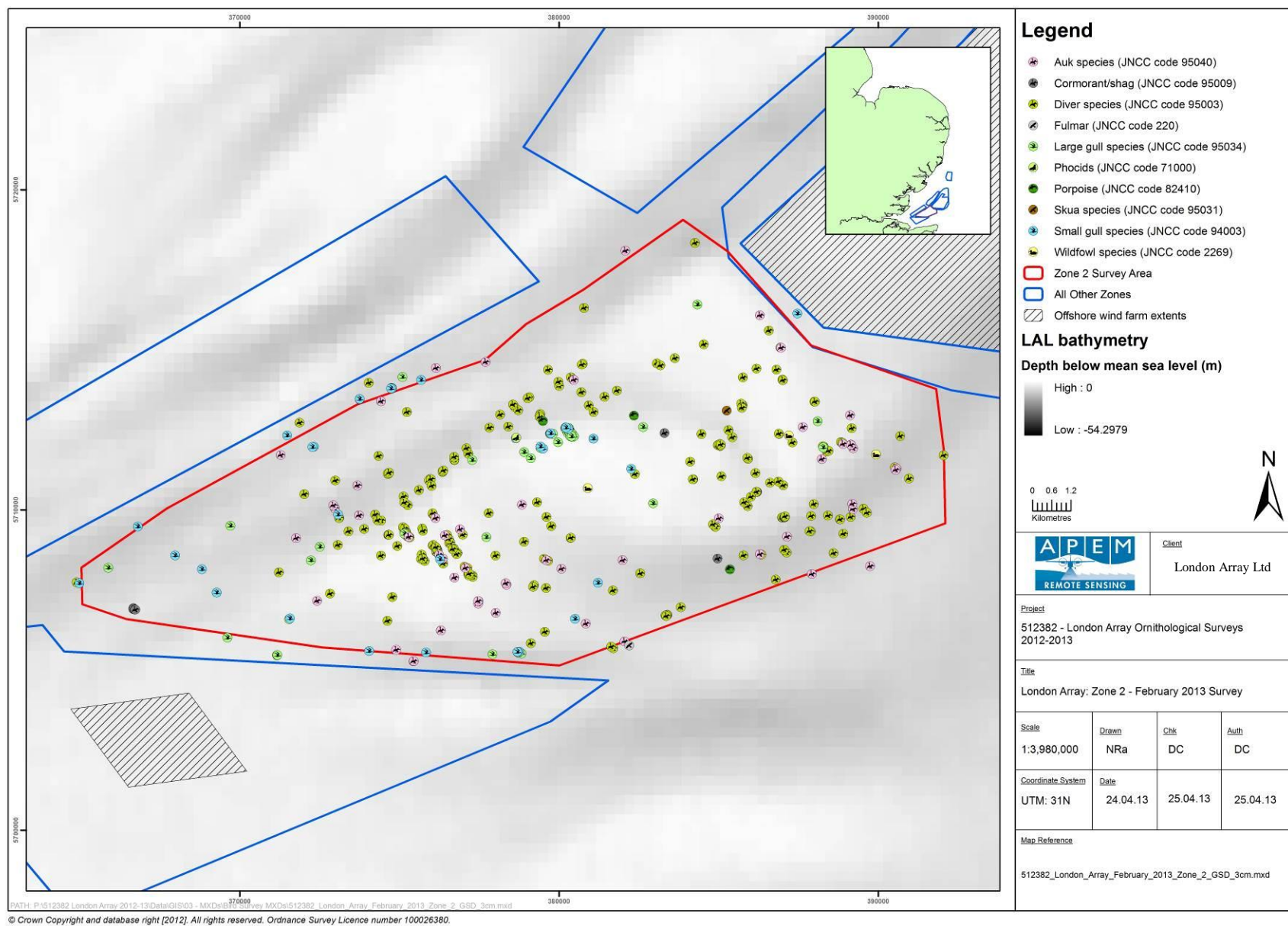
porpoises were recorded in the south of the site; one close to the western boundary and one in the centre of the site. (Figure 3.5: E). A single harbour porpoise was also recorded within zone 6 in the north west of the survey area (Figure 3.5: E).

A group of eight phocids were located in the south east of the London Array OWF site within zone 1 (Figure 3.5: A). Additionally within zone 2, a single phocid was observed in the centre of the site, towards the northern boundary (Figure 3.5: B).

**Figure 3.5:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the February 2013 survey at 500 m resolution.



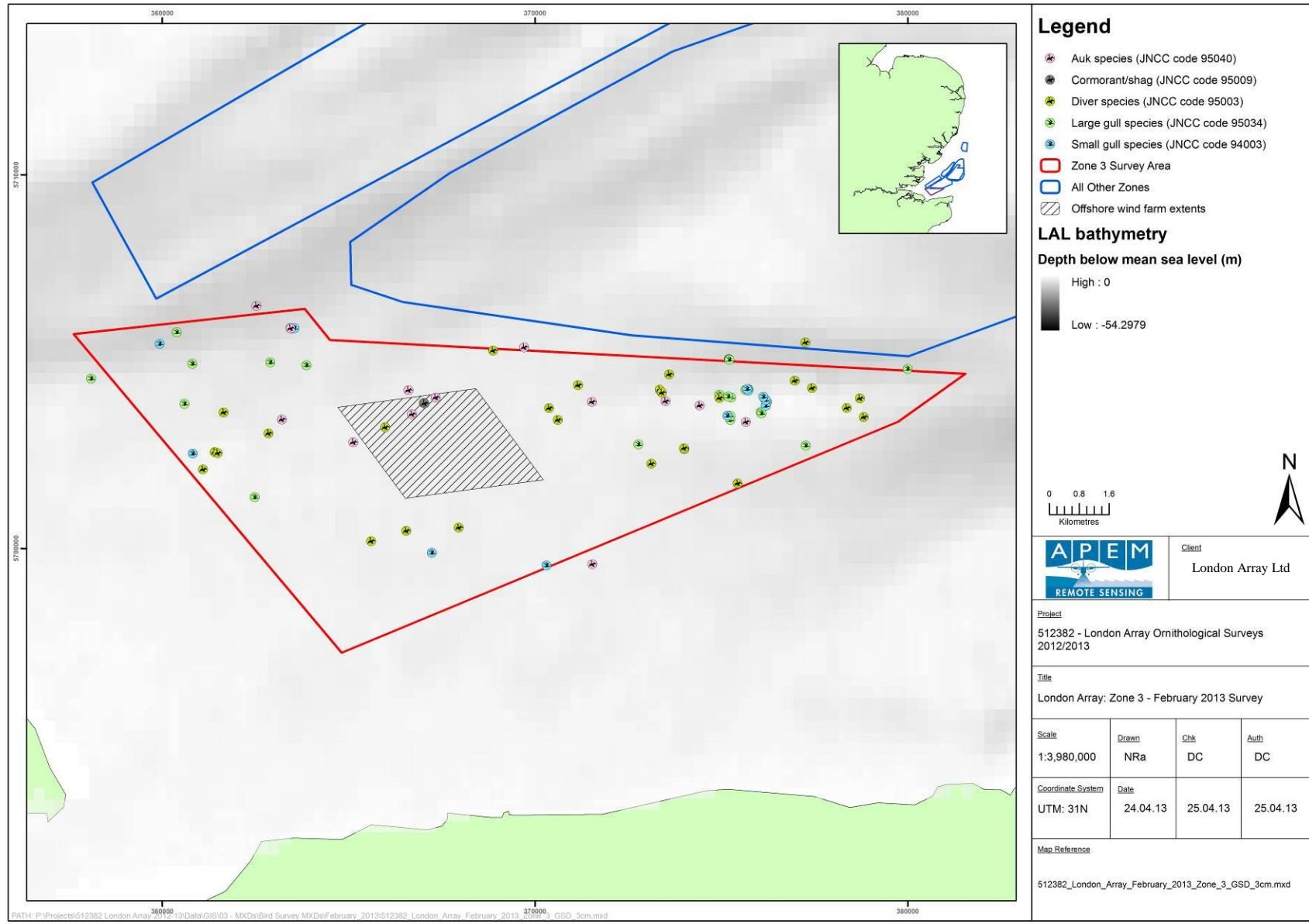
**A: Zone 1**



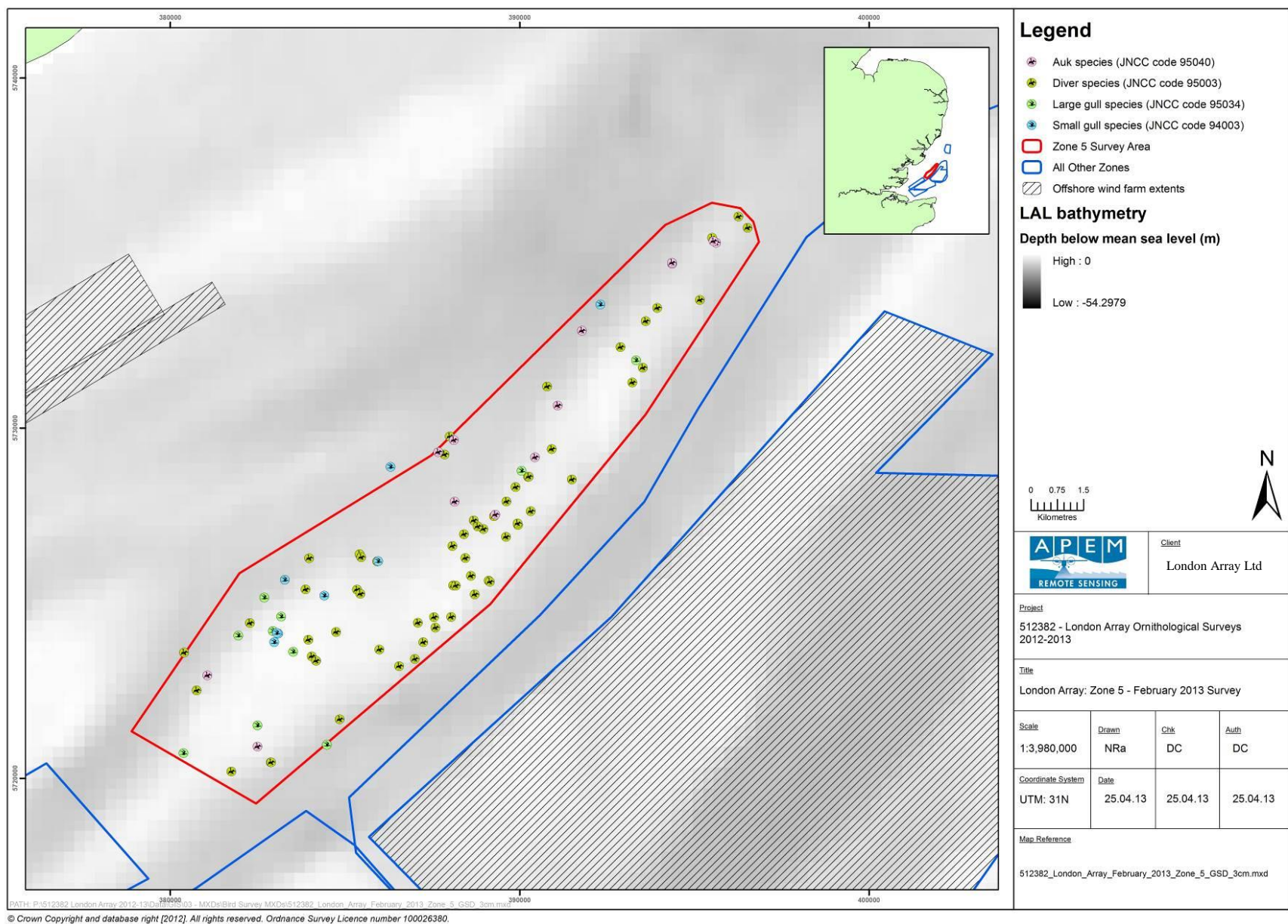
**B: Zone 2**



**Continued Figure 3.5:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the February 2013 survey at 500 m resolution.

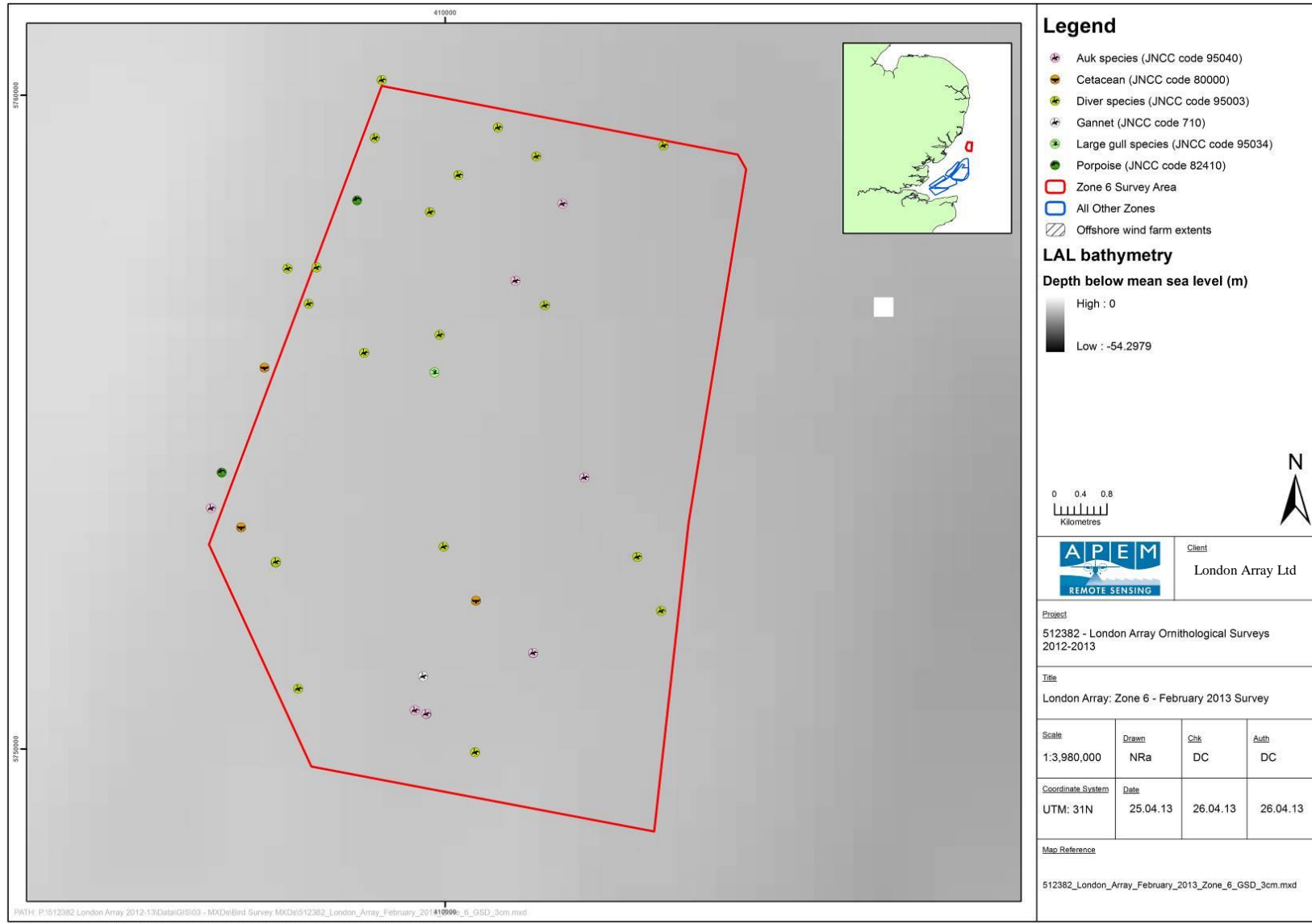


**C: Zone 3**

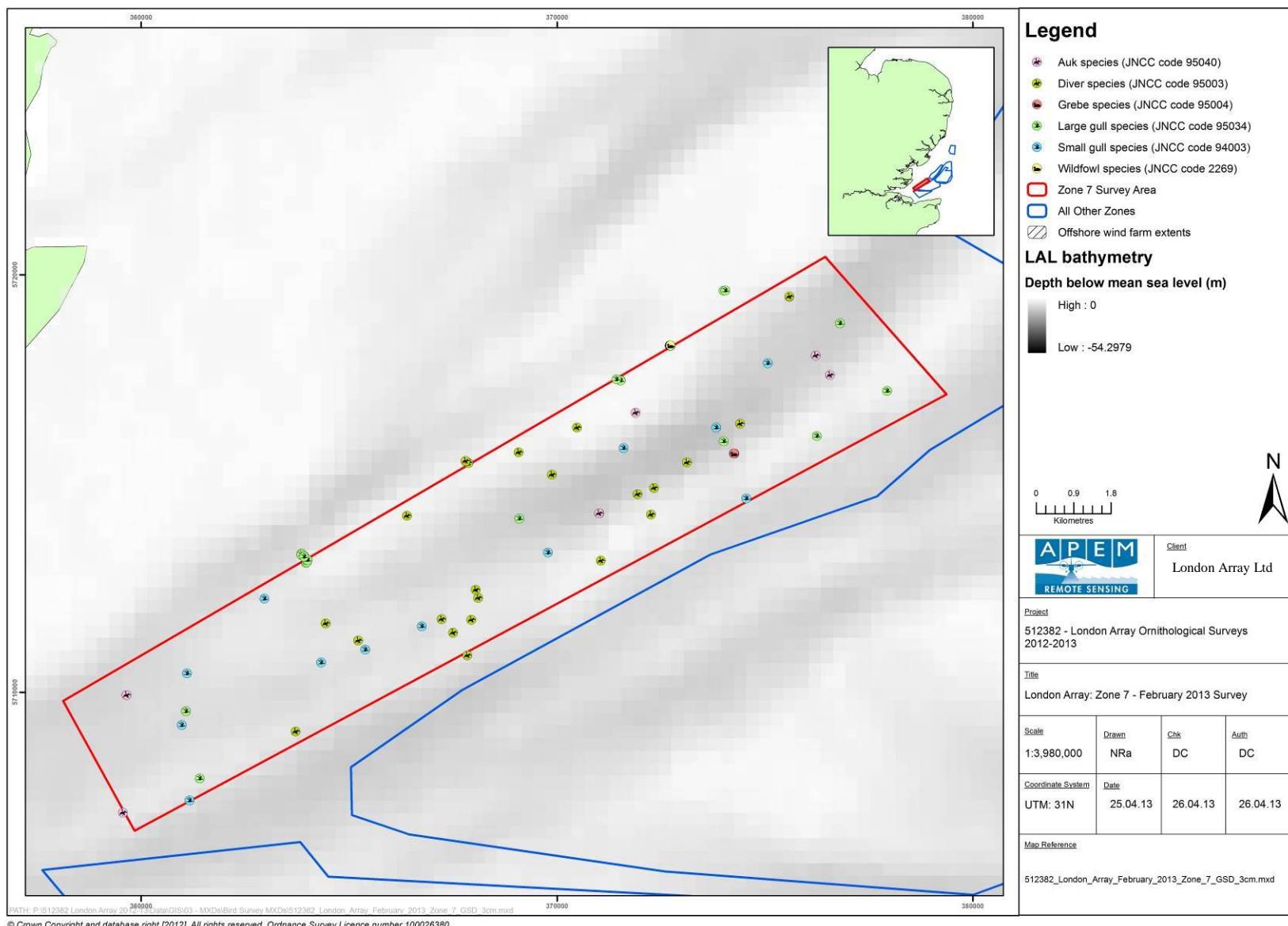


**D: Zone 5**

**Continued Figure 3.5:** Distribution of bird and marine mammal species / groups and marine mammals recorded in each zone in the February 2013 survey at 500 m resolution.



**E: Zone 6**



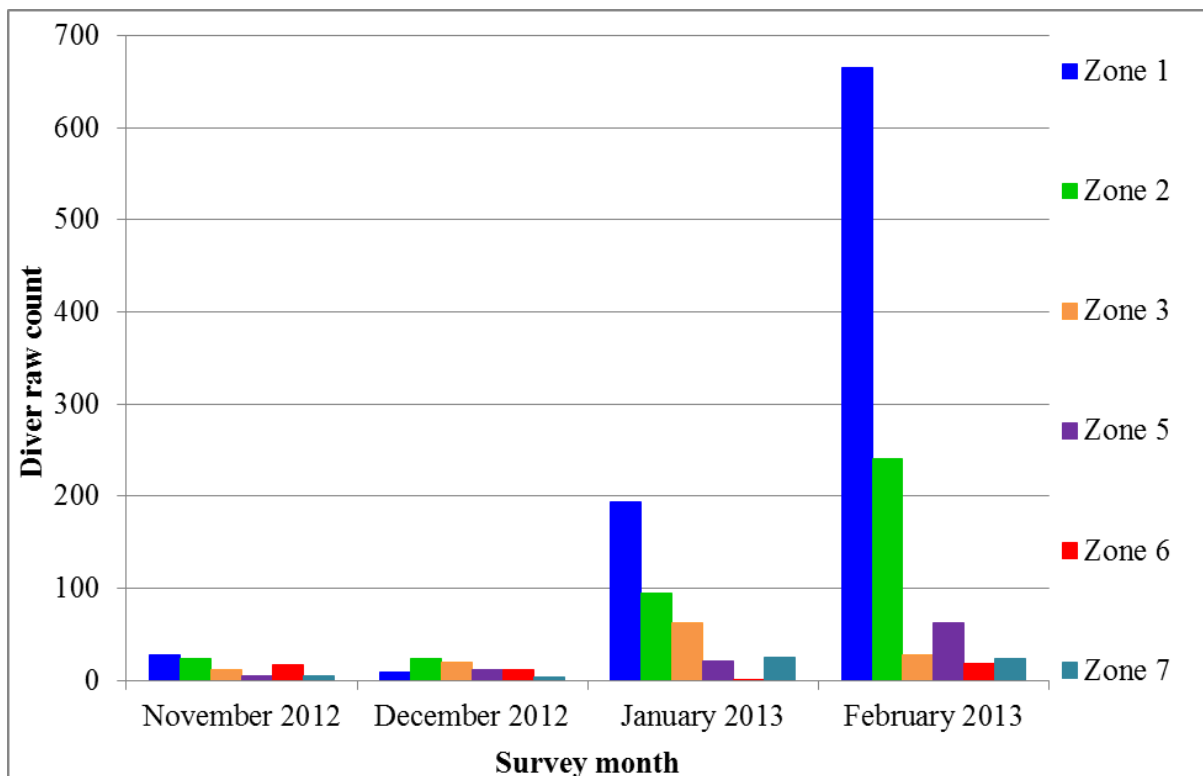
**F: Zone 7**

## 4 DISCUSSION

### 4.1 Diver abundance and distribution during the winter 2012 / 13

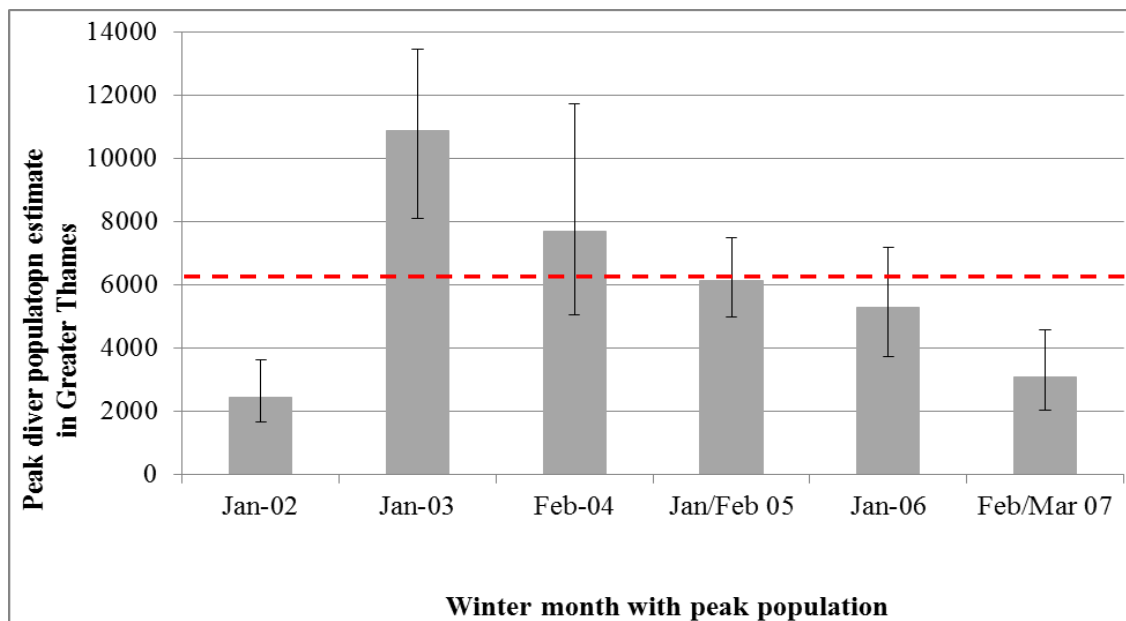
The total number of divers (including zones 1, 2, 3, 5, 6 & 7) recorded each month during the 2012 / 13 aerial surveys increased through the winter (Figure 4.1). Relatively low numbers of divers were recorded in November (total raw count = 88) and December 2012 (total raw count = 79) whilst the highest numbers of divers were observed during January (total raw count = 397) and February 2013 (total raw count = 1,037). This pattern is to be expected since January and February have previously been identified as peak months for red-throated divers wintering in the Greater Thames estuary (Webb *et al.* 2009). The large numbers of divers observed during this period may represent pre-migration aggregations of birds; pairs return to territories from the UK typically in March and April (Wernham *et al.* 2002). The highest numbers of divers were recorded in zone 1 (containing the London Array OWF with Phase 1 & Phase 2) & zone 2 (a control zone); the peak diver count per zone was recorded in zone 1 in February 2013. There was little increase in the number of divers recorded between November 2012 – February 2013 in zones 3, 5 & 7. Diver numbers recorded in the deep water zone 6 were consistently low throughout the winter and did not increase in February.

**Figure 4.1:** Total raw count of divers recorded in each zone in each month during the 2012 / 13 surveys.



The Outer Thames Estuary SPA has been designated for a total of 6,466 divers with a total of 8,130 individuals estimated across the wider Greater Thames estuary (O'Brien *et al.* 2008; Webb *et al.* 2009). In the February 2013 aerial survey, diver abundance across all zones, (including zone 6 which largely lies outside the SPA boundary but had a low diver abundance), peaked at a total of 5,004 (3,940 – 6,359) individuals; which is over three quarters of the designated SPA population (though note the February 2013 population estimate may include some temporal variation as the survey spanned two days). Aerial surveys over the past 10 years in the Greater Thames area (Figure 4.2) have shown a wide variation in peak population estimates for divers, ranging from 2,460 divers in January 2002 to 10,884 in January 2003 (Webb *et al.* 2009); the peak diver population estimate recorded during the February 2013 survey therefore falls within the range of these recent past surveys.

**Figure 4.2:** Peak seasonal population estimates for divers recorded by aerial surveys in the Greater Thames area between January 2002 – February / March 2007 (Webb *et al.* 2009; it should be noted that numbers are not comparable in all months due to differing levels of coverage). The red dashed line shows the SPA designated total of 6,466 individuals. Error bars represent confidence limits.



There are a range of factors that may explain the inter-annual variation of diver abundance and distribution in the Outer Thames Estuary over the last decade. These factors include environmental variables such as changes in weather patterns (e.g. varying conditions on wintering grounds and summer nesting sites), diurnal variation of diver movement affecting the numbers of divers recorded during the time of each survey, possible (combined) effects of construction in the area or a possible combination of all of these factors. Across all zones, the distribution of divers was generally indicative of habitat preferences; approximately 97% of all divers were recorded in water depths of less than 20 m which were associated with sand bank regions (Skov & Prins 2001).

Diver abundance and distribution are influenced on a diurnal basis according to the state of the tide. Tide data from the nearest available point to the London Array site (Whitaker Beacon: Appendix II) suggest that on the majority of occasions, divers appeared to be

distributed over sand bank areas when the tide was at or near its highest level (i.e. sand banks fully submerged). At times where the tide was at or near its lowest, the birds appeared to be distributed around the edges of the now exposed sand bank areas; at these times (ebb tide) modelling predicts the lowest availability of suitable habitat (Skov *et al.* 2010). Sand banks may provide feeding habitat for divers since herring and sprat are known to use sand banks as nursery and feeding grounds (Natural England & JNCC 2010). In addition, diver distribution may be related to hydrographic variables since eddies and current speed are significant response variables explaining diver density at London Array (Skov *et al.* 2010).

#### **4.2 Comparison of diver abundance and distribution of 2012 / 13 survey with 2011 / 12 and 2010 / 11**

By comparing peak diver abundance (i.e. the highest diver abundance recorded in any one survey month between November to February) over the winter surveys of 2010 / 11, 2011 / 12 and 2012 / 13 (Figures 4.3, Table 4.1, Figure 4.4, Figure 4.5), it can be seen that there have been changes in diver abundance and distribution over the last three years. Figure 4.3 shows that the peak diver population estimated to be present in all zones (zone 1 + 2 + 3 + 5 + 6 + 7) during the 2010 / 11 aerial survey was significantly higher than both the peak estimates recorded in the 2011 / 12 ( $\chi^2 = 79.54$ , d.f. = 1,  $p < 0.001$ ) and 2012 / 13 ( $\chi^2 = 69.01$ , d.f. = 1,  $p < 0.001$ ) aerial surveys, although peak diver estimates between years 2011 / 12 and 2012 / 13 were not significantly different ( $\chi^2 = 1.43$ , d.f. = 1,  $p = 0.23$ ). This significant difference in the peak diver populations between the 2010 / 11 survey compared with the latter two years is largely reflected in the number of divers recorded in zone 1 (Table 4.1; Figure 4.4: A). A large diver population was estimated for zone 1 during the peak survey in 2010 / 11; this population fell by 82% by the time of the peak survey of 2011 / 12 but then increased by 53% between 2011 / 12 and the 2012 / 13 peak survey. The distribution of divers within zone 1 has also changed over the last three years (Figure 4.5). Large numbers of divers were concentrated in the northern area and eastern edge of zone 1 as well as all through Phase 1 & 2 within zone 1 during the 2010 / 11 surveys, while in 2011 / 12, very few divers were located in Phase 1 & 2 and in the northern area of zone 1 and a much smaller concentration was located on the eastern edge of the zone. In the latest 2012 / 13 aerial survey, the majority of divers were concentrated in the northern area of zone 1 as well as along the eastern edge; small numbers of divers were also distributed throughout Phase 1 & 2.

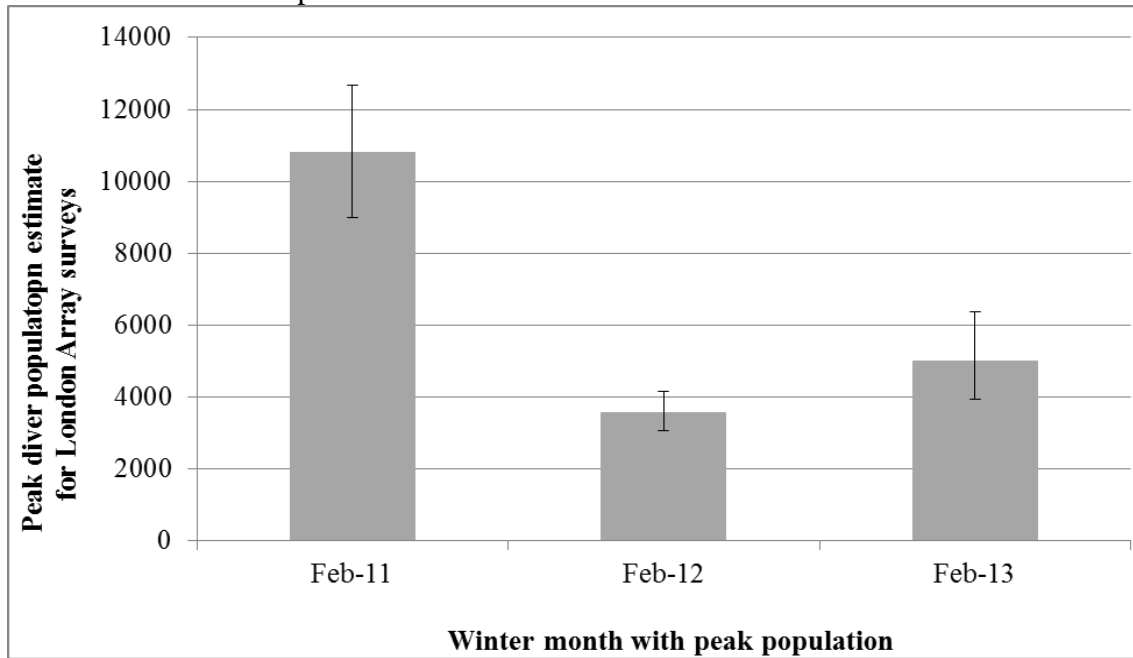
Compared with zone 1, an opposite pattern of peak diver abundance was recorded within the control zones. In control zone 2 (Figure 4.4: B), diver abundance rose by 44% between the peak survey of 2010 / 11 and 2011 / 12 and then fell by 67% between the peak survey of 2011 / 12 and 2012 / 13. To a lesser extent, a similar pattern was recorded in zone 3 (Figure 4.4: C) with peak estimates of divers rising in the 2011 / 12 survey and falling in the 2012 / 13 survey. In control zones 5, 6 and 7 peak diver population estimates did not fluctuate greatly between the three winter surveys. The distribution of divers also changed notably in zone 2 over the last three years (Figure 4.5). In 2010 / 11 the majority of divers were located down the centre of zone 2 in a north-south orientation, while in 2011 / 12 a far larger number of divers were situated in the northern part of zone 2 on the boundary of zone 1. In 2012 / 13, divers were again located down the centre and in the northern part of zone 2 but few divers were located along the boundary of zone 1. Generally, over all three winter surveys the majority of divers occurred mainly in areas of less than 20 m water depth which were

associated with sand bank regions (Skov & Prins 2001). Few divers have been located in the deeper waters of zone 6 in all three years.

Such changes in abundance and distribution between zones 1, 2 and 3 indicate that something has affected diver occurrence between these London Array zones over the last three years. One possible cause may be the result of shipping activity around the Phase 1 site due to the London Array OWF construction. Construction of Phase 1 commenced in March 2011 after the 2010 / 11 winter surveys had finished. Turbines were installed between January to December 2012 and low activity construction works are currently still on going. As there is some evidence that divers may be sensitive to shipping disturbance (Camphuysen *et al.* 2004, Schwemmer *et al.* 2011), it is possible that the increased level of shipping activity inside Phase 1 during construction disturbed some divers in the area. The peak diver estimate in zone 1 fell between the pre-construction surveys in 2010 / 11 and the first year of during-construction surveys in 2011 / 12, while at the same time the number of divers present in control zones 2 & 3 increased. This may indicate that some divers shifted their distribution out of zone 1 and into the control zones, in particular into zone 2, during the construction of the wind farm. However, it is important to note that the peak diver estimate rose again in the second year of construction in 2012 / 13 while in control zones 2 & 3 diver numbers fell. Therefore, if the construction of the wind farm did initially have an affect on the diver distribution in 2011 / 12, the latest survey results may indicate that divers are now moving back into zone 1 from the nearby control zones. It is also important to note that some of the divers have been recorded within the wind farm area, and quite high numbers within one kilometre of the turbines. The concentration of divers recorded in the north-eastern corner of zone 1 during the 2010 / 11 and 2012 / 13 aerial surveys was similar to previous historical aerial surveys in 2003 / 04 and 2004 / 05 (see APEM 2011 for review). Further winter aerial surveys over London Array between 2013 / 14 and 2015 / 16 will provide more information on whether diver numbers continue to rise in zone 1 which includes the London Array OWF, both Phases 1 & 2.

Disturbance caused by the construction of the Phase 1 London Array wind farm is certainly not the only possible cause of changes in diver abundance and distribution in the London Array area. Fluctuations in abundance and distribution may reflect inter-annual variation of environmental conditions; the winter of 2010 / 11 was exceptionally cold throughout much of northern Europe and these weather patterns may have led to inflated numbers of divers utilising the Outer Thames estuary during this time. In contrast the winters of 2011 / 12 and 2012 / 13 were much milder and may have given rise to a wider dispersion of divers outside of the study zones. As previously mentioned, diurnal variation between surveys in different years may have influenced the number of divers recorded. It is also possible that patterns of distribution were also partly determined by hydrodynamic variables that varied between surveys (Skov *et al.* 2010). It is likely that a combination of all these environmental variables as well as the possible displacement effects of construction have influenced diver distribution over the last three years.

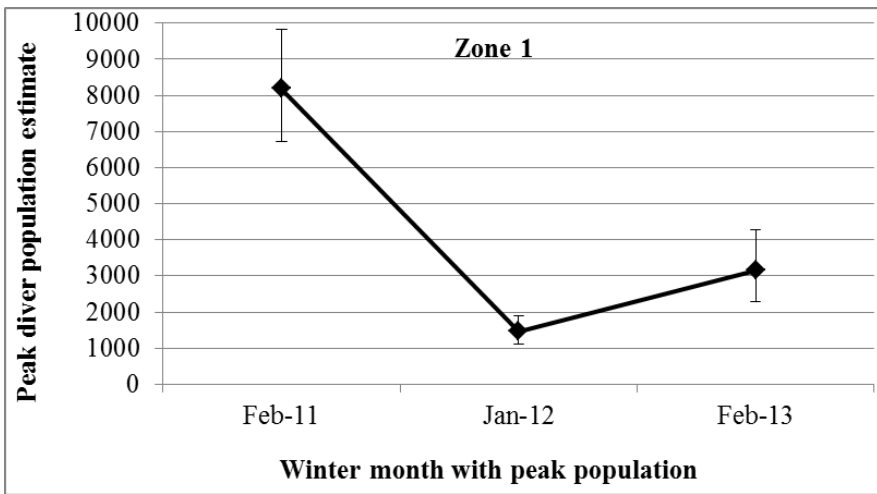
**Figure 4.3:** Peak population estimates for total divers recorded by the London Array aerial surveys (including zones 1 + 2 + 3 + 5 + 6 + 7) over three winters between 2010/11 and 2012/13. Error bars represent confidence limits.



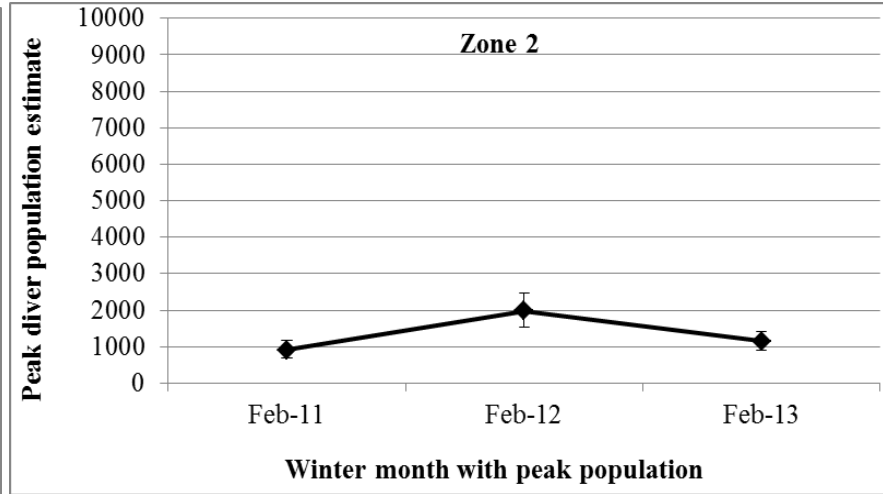
**Table 4.1:** Peak population estimates for divers recorded by the London Array aerial surveys in zone 1, 2, 3, 5, 6 & 7 over three winters in 2010/11, 2011/12 and 2012/13. These data are graphically represented in Figure 3.10. Error bars represent confidence limits.

Zone	Year	Month	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
1	2011	February	1,257	8,194	6,727	9,830	0.03
	2012	January	181	1,474	1,108	1,906	0.07
	2013	February	665	3,153	2,276	4,281	0.04
2	2011	February	144	909	682	1,174	0.08
	2012	February	433	1,980	1,536	2,469	0.05
	2013	February	241	1,144	912	1,410	0.07
3	2011	January	30	175	93	274	0.18
	2012	January	63	534	364	720	0.13
	2013	January	63	294	201	411	0.13
5	2011	February	53	312	200	448	0.14
	2012	February	83	391	255	575	0.11
	2013	February	63	288	215	370	0.13
6	2011	December	9	68	23	121	0.33
	2012	November	5	23	5	42	0.44
	2013	February	18	82	46	128	0.24
7	2011	February	61	367	253	499	0.13
	2012	February	63	286	163	444	0.13
	2013	January	25	202	121	291	0.20

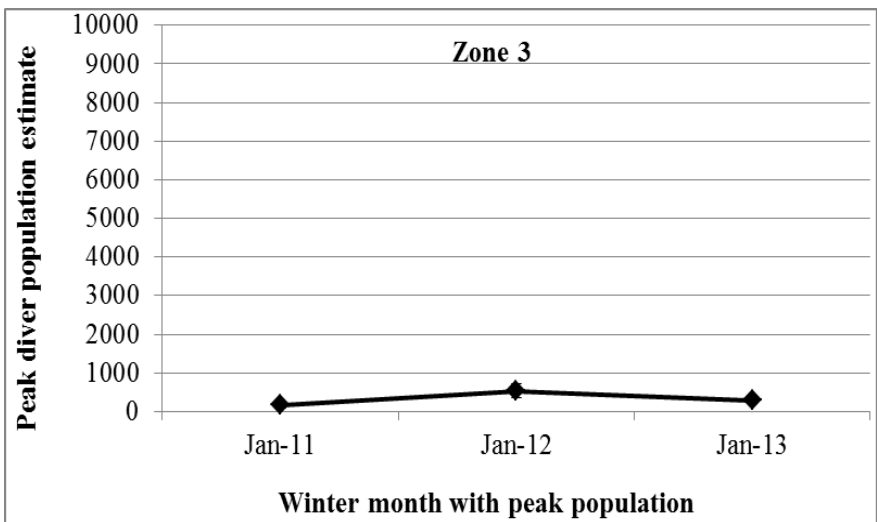
**Figure 4.4:** Peak population estimates for divers recorded by the London Array aerial surveys in zone 1, 2, 3, 5, 6 & 7 over three winters between 2010/11 and 2012/13. Error bars represent confidence limits.



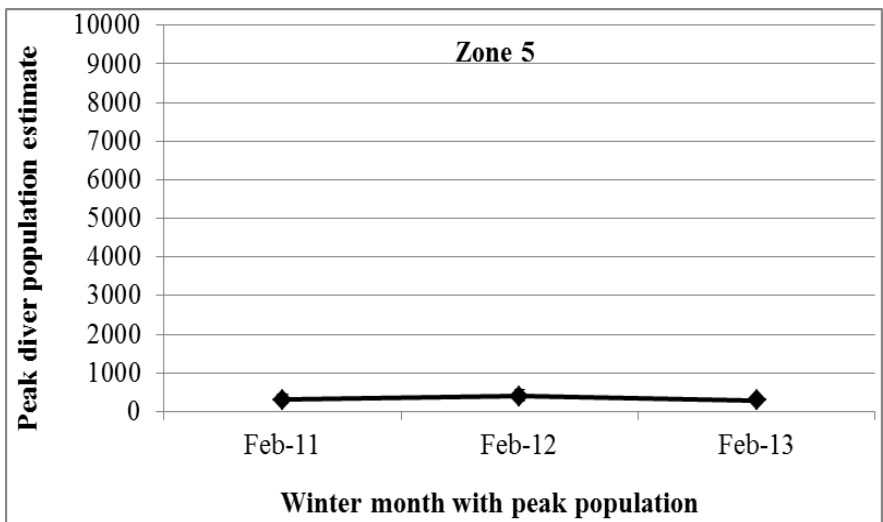
A: Zone 1



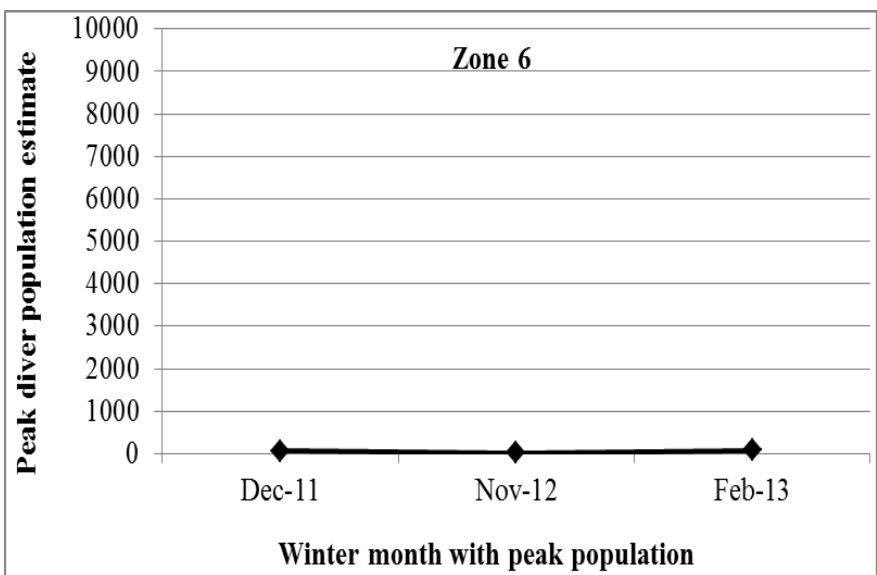
B: Zone 2



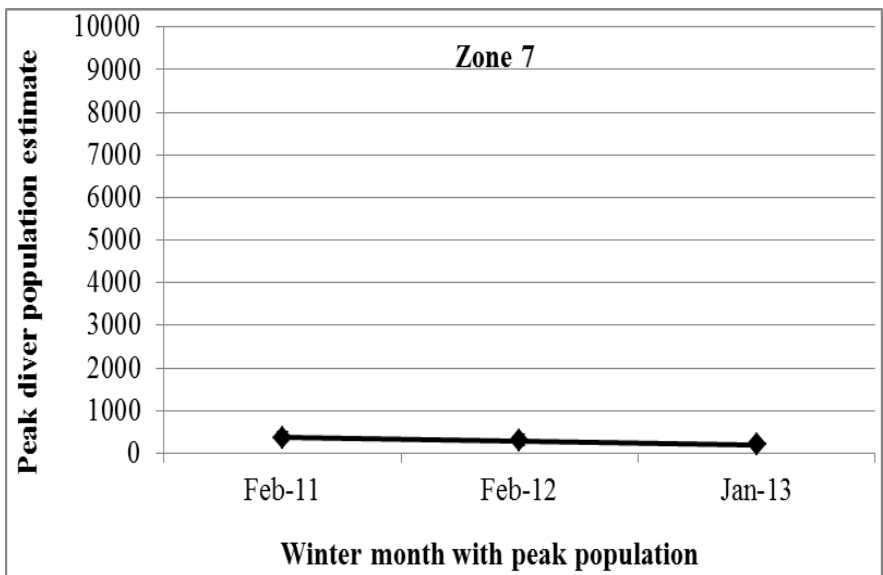
C: Zone 3



D: Zone 5



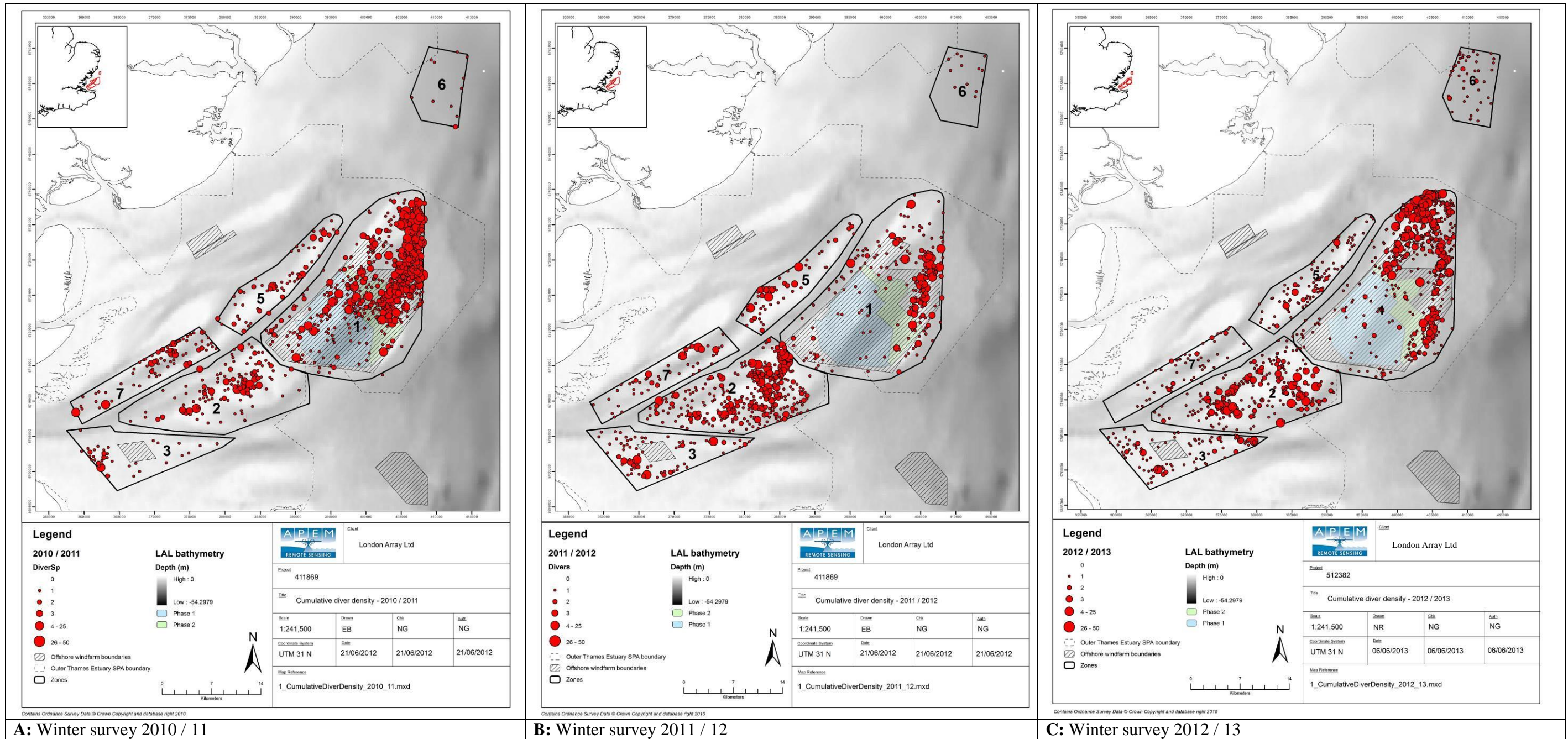
E: Zone 6



F: Zone 7



**Figure 4.5:** Cumulative distribution of divers in all zones during the winter of A) 2010 / 11 pre-construction, B) 2011 / 12 (during construction) and C) 2012 / 13 (end of construction in December 2012). These maps illustrate that there were generally fewer divers across all zones in 2011-12 compared with the previous year.



### 4.3 Comparison of other bird species abundance and distribution of 2012 / 13 survey with 2011 / 12 and 2010 / 11

In addition to divers, a range of bird species were recorded during the winter of 2012 / 13 across all zones.

Scaup peaked in January 2013 at an estimated 114 individuals across zone 2; this species was also present in the Outer Thames estuary in November 2012 when lower numbers were recorded in zones 1 and 3. In the UK, scaup are sparsely but widely distributed in areas of soft-shore coastline during the winter (Kirby *et al.* 1993), so such fluctuations in abundance are to be expected.

Like scaup, common scoters are known to winter around much of the UK shoreline during the winter months preferring shallow offshore areas with sandy sea beds (Lack 1986). Common scoters peaked at an estimated 267 individuals in zone 7 during February 2013 with lower numbers recorded in zone 2 during the same month. Across the UK, common scoter numbers build in January and February before individuals depart to their breeding grounds in northern Scotland, Iceland and Fennoscandia (Wernham *et al.* 2002; Cramp & Simmons 2004).

Relatively low numbers of fulmars were recorded during the winter 2012 / 13 surveys, with numbers peaking at an estimated 47 individuals during November within zone 1. Fulmars are known to be widely distributed throughout the North Sea following dispersal from their breeding colonies during September (Stone *et al.* 1995). Therefore, low numbers of this species within the Outer Thames estuary are to be expected. Indeed, low numbers of fulmars were also recorded across the area during the winters of 2010 / 11 and 2011 / 12.

Gannets peaked in February 2013 in zone 1 at an estimated 749 individuals; timing may reflect the passage of gannets through the North Sea from wintering quarters to more northerly breeding grounds (Wernham *et al.* 2002).

Cormorants and shags were present in some zones during all 2012 / 13 winter surveys, with the exception of November 2012. Numbers peaked at an estimated 325 individuals in zone 2 during January 2013. Since cormorants and shags show a coastal distribution year-round (Cramp & Simmons 2004), and zone 2 lies less than 20 km from land, high numbers in this area are to be expected.

A peak of 24 estimated grebes were present within zone 7 during January 2013. These were most likely great crested grebes as this species is known to shift to coastal areas during the non-breeding period, particularly shallow coastal areas and estuaries along the east coast (Lack 1986).

Oystercatchers are abundant in the UK during winter with 45% of the European breeding population present in Great Britain during this time (Stroud *et al.* 2001; Wernham *et al.* 2002). In winter, oystercatchers are concentrated on estuaries, particularly those which are associated with high shellfish productivity such as those surrounding the Outer Thames (Goss-Custard 1996). The presence of this species within zone 3 during January 2013 is therefore unsurprising; the birds were most likely flying between feeding areas.

During November 2012, an estimated eight pomarine skuas were located within zone 1. These individuals are likely to reflect autumn passage to wintering grounds off West Africa (Tasker *et al.* 1987; Cramp & Simmons 2004). Five great skuas were estimated to be present in zone 2 during February 2013 which is likely to reflect return spring passage from their wintering grounds off the coasts of Spain and Africa to their northern breeding colonies (Cramp & Simmons 2004).

A high percentage of small gulls (>90%) were identified to species level during winter 2012 / 13 due to improvements made in identification techniques as well as calm weather conditions during the survey flight. Kittiwake numbers peaked at an estimated 376 individuals across zone 1 in January 2013; as with other bird species, kittiwakes are known to move in response to atmospheric depressions at sea (Wernham *et al.* 2002), which may have caused an influx of kittiwakes into the estuary at this time. A smaller number of black-headed gulls were also recorded in January 2013 but further into the estuary in zone 3. Black-headed gulls spend much of their time over land as well as in tidal inshore waters showing a preference for inlets or estuaries with sandy or muddy beaches (Snow & Perrins 1998). These habitat preferences may have led to the low numbers recorded. An estimated 39 little gulls were recorded in November 2012 within zone 1; little gulls are known to arrive back in the North Sea as early as July and spend the autumn period in British waters before continuing their migration to south-west Europe (Olsen & Larsson 2003). Common gull numbers peaked later than the other small gull species; an estimated 85 individuals were present in zone 2 during February 2013. Common gulls are found in high densities around coastal parts of estuaries and bays in winter (Stone *et al.* 1995), and there is some evidence of movement of common gulls between Denmark and the UK during winter, sometimes peaking in January and suggesting a gradual westwards shift through the winter (Wernham *et al.* 2002).

As for the 2011 / 12 aerial surveys, herring gulls were the most numerous large gull species, peaking at an estimated 356 individuals in zone 2 during February 2013. Fewer lesser black-backed and great black-backed gulls were recorded. The distribution of great black-backed gulls is known to extend further out to sea following the end of their breeding season (Stone *et al.* 1995); it may be that the peak of 220 estimated great black-backed gulls recorded in zone 1 in November 2012 reflected a movement offshore.

Auk numbers peaked in November 2012 with 738 estimated individuals across zone 1; this zone was estimated to hold at least 200 auks in each month of survey. Guillemots and razorbills were the most abundant auk species, constituting more than 80% of auks during all survey months. Auks are generally widespread in marine areas in winter, and numbers can fluctuate at a given site (Stone *et al.* 1995).

#### 4.4 Marine mammals 2012 / 13

The majority of marine mammals recorded in the Outer Thames Estuary were cetaceans (77%); of these, 70% were recorded as dolphins / porpoises with the remainder identified as harbour porpoises. It is likely that the majority of individuals recorded as dolphins / porpoises were also harbour porpoises since this species is most often seen between January and April in the south-eastern North Sea (Reid *et al.* 2003). Other species of cetacean, such as bottlenose and white-beaked dolphins, have been recorded in the Thames Estuary, but sightings occur largely in the summer, between June and October (Kowalik *et al.* 2008). Phocid (seal) species peaked in February 2013 with 14 estimated individuals in zone 1 and a further 14 estimated individuals in zone 2. These phocids may have been either common or grey seal as both species are frequently recorded in the Thames Estuary (Kowalik *et al.* 2008).

## 5 CONCLUSIONS

- The total diver population estimated across all London Array survey zones (zone 1, 2, 3, 5, 6 & 7) was low in November and December 2012, increased in January 2013 and peaked in February 2013 with over 5,000 estimated divers.
- The majority of divers were identified as red-throated divers (97.3%); other species recorded included black-throated divers (1.7%) and great northern divers (0.9%). Only one diver was not identified to species level.
- Distribution of divers appeared to reflect shallow water areas over sand banks. Approximately 97% of divers were in water depths of < 20 m.
- The majority of divers were concentrated in the northern area and eastern edge of zone 1 during the January and February 2013 aerial surveys. This distribution was similar to historical surveys of the area in 2010/11, 2003/05 and 2004/05.
- Changes in diver abundance and distribution between zones 1, 2 and 3 over the past three years of winter aerial surveys (2010/11, 2011/12 & 2012/13) indicate that something has affected diver occurrence between these London Array zones. Peak diver population estimates in zone 1 containing Phase 1 London Array wind farm fell between 2010/11 to 2011/12 and started to rise again in 2012/13, while concurrently peak diver numbers in control zones 2 & 3 increased between 2010/11 and 2011/12 and then fell again in 2012/13.
- As the drop in diver numbers in zone 1 in 2011 / 12 coincided with the construction of the Phase 1 wind farm, it may be possible that the disturbance caused by the construction shipping (it has been suggested that divers are sensitive to shipping disturbance) resulted in some divers shifting their distribution out of zone 1 and into the nearby control zones. However, diver numbers recorded in zone 1 increased rapidly from January 2013 onwards following the placing of the last of the turbines. This increase suggests that some of the divers that used the area pre-construction in 2010 / 11 have moved back into zone 1 after initial displacement. Future aerial surveys of the London Array zones will show whether diver numbers continue to rise in zone 1 during the post-construction years.
- The construction of the Phase 1 wind farm is certainly not the only reason why diver abundance and distribution may have changed in the last three years. Historic data in the Greater Thames area has shown that diver numbers can fluctuate widely; possible causes may be changes in environmental patterns, diurnal movements, hydrodynamic variables as well as effects of construction. It is likely that divers are influenced by a combination of all these effects.
- Several other bird species / groups were recorded on the surveys, the most abundant of which were gulls (including herring gulls, kittiwakes and great black-backed gulls).
- The majority of marine mammals recorded across all zones were cetaceans (77% of total marine mammals); of these, 70% were recorded as dolphins / porpoises with the remainder identified as harbour porpoises. Dolphins / porpoises were most abundant in zone 1 in February 2013 with little use of other zones in other months.

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**APPENDIX I: SURVEY WEATHER CONDITIONS**

<b>Date surveys undertaken</b>	<b>Zone(s) surveyed</b>	<b>State of seas*</b>	<b>Wind speed / direction</b>	<b>Visibility</b>	<b>Other significant information</b>
November 13 <sup>th</sup> 2012	5, 7	0 - 1	7 knots / SE	Cloud cover scattered above 2000 feet with > 10 km visibility	
November 14 <sup>th</sup> 2012	3	0 - 1	7 knots / SE	Cloud cover scattered above 2000 feet with > 10 km visibility	
November 18 <sup>th</sup> 2012	1, 2, 6	0 - 1	2 – 6 knots / NNW / NNE	Cloud cover scattered above 2000 feet with > 10 km visibility	Between the 15 <sup>th</sup> and 18 <sup>th</sup> of November, the local weather was not suitable for survey. The remaining zones were therefore surveyed on the 18 <sup>th</sup> of November.
December 4 <sup>th</sup> 2012	1	1	11 / SW	Cloud cover scattered above 3000 feet with > 10 km visibility	
December 5 <sup>th</sup> 2012	2, 6	1 - 2	15 knots / NW	AM overcast with cloud becoming scattered by early PM. Visibility > 10 km all day.	
December 6 <sup>th</sup> 2012	1	1 - 2	16 knots / SW	AM cloud cover scattered above 2000 feet, becoming overcast by early PM. Visibility > 10 km all day	
January 2 <sup>nd</sup> 2013	2, 5	1	5 knots / NW	Scattered cloud cover with > 10 km visibility	
January 3 <sup>rd</sup> 2013	6	1	15 knots / SW	Cloud cover broken at 3500 feet with > 10 km visibility	
January 4 <sup>th</sup> 2013	3, 7	1 - 2	20 knots / NW	Scattered cloud cover with > 10 km visibility	
January 8 <sup>th</sup> 2013	1	3	24 knots / SW	Cloud scattered above 5000 feet with > 10 km visibility	
February 2 <sup>nd</sup> 2013	1, 3, 5, 7	2 - 3	16 knots / N	Cloud cover scattered at 1500 feet with > 10 km visibility	
February 3 <sup>rd</sup> 2013	2, 6	3 - 4	25 knots / NW	AM cloud cover broken becoming scattered by early PM, > 10 km visibility all day	



## APPENDIX II: TIDE INFORMATION FROM WHITAKER BEACON



Figure II.1 Location of Whitaker Beacon tide monitoring site

**Table II.1** Information on survey times and tide height and state during surveys at Whitaker Beacon site

Survey	Date	Zone	Survey time	Tide height at Whitaker Beacon	State of tide
November 2012	18/11/2012	1	10:40 – 12:31	08:58: 0.1m 15:17: 4.9m	Incoming
	18/11/2012	2	08:29 – 12:05	08:58: 0.1m 15:17: 4.9m	Incoming
	14/11/2011	3	13:03 – 14:42	12:02: 5.3m 18:10: -0.0	Outgoing
	13/11/2011	5	13:12 – 14:18	11:13: 5.1m 17:22: 0.1m	Outgoing
	18/11/2011	6	10:58 – 11:53	08:58: 0.1m 15:17: 4.9m	Incoming
	13/11/2011	7	14:19 – 15:15	11:13: 5.1m 17:22: 0.1m	Outgoing
December 2012	06/12/2012	1	09:12 – 13:18	10:44: 0.8 m 17:07: 4.0m	Outgoing at start then incoming
	05/12/2012	2	12:05 – 14:32	09:55: 0.7m 16:15: 4.1m	Incoming
	04/12/2012	3	12:19 – 13:59	09:13: 0.6m 15:31:4.3m	Incoming
	04/12/2011	5	12:33 – 13:38	09:13: 0.6m 15:31:4.3m	Incoming
	05/12/2011	6	12:25 – 13:19	09:55: 0.70m 16:15: 4.1m	Incoming
	04/12/2011	7	13:48 – 14:50	09:13: 0.6m 15:31:4.3m	Incoming
January 2013	08/01/2013	1	09:41 – 13:40	08:18: 4.1m 14:35: 0.9m	Outgoing
	02/01/2013	2	12:13 – 14:53	08:55: 0.4m 15:12: 4.6m	Incoming
	04/01/2013	3	10:20 – 12:02	10:19: 0.6m 16:39: 4.3m	Incoming
	02/01/2013	5	09:42 – 11:04	08:55: 0.4m 15:12: 4.6m	Incoming
	03/01/2013	6	09:56 – 10:52	09:35: 0.4m 15:53: 4.5m	Incoming
	04/01/2013	7	12:59 – 14:25	10:19: 0.6m 16:39: 4.3m	Incoming
February 2012	02/02/2013	1	08:53 – 15:34	09:57: 0.4m 16:14: 4.6m	Outgoing for first hour then incoming
	03/02/2013	2	08:56 – 11:41	04:32: 4.5m 10:45: 0.6m	Outgoing until half way through survey then incoming
	02/02/2013	3	11:19 – 13:05	09:57 0.4m 16:14: 4.6m	Incoming
	02/02/2013	5	08:23 – 10:06	03:46: 4.8m 09:57: 0.4m	Outgoing ending on low tide
	03/02/2013	6	08:51 – 09:58	04:32: 4.5m 10:45: 0.6m	Outgoing
	02/02/2013	7	10:12 – 11:15	09:57: 0.4m 16:14: 4.6m	Incoming

**APPENDIX III: PEAK COUNTS IN 2011 / 12 & 2010 / 11.****Table III.1:** Peak counts, estimates, confidence limits and precision for all bird species recorded across the survey area during winter 2011 / 12.

Species / group	Zone	Month	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
Diver species	2	February	433	1,980	1,536	2,469	0.05
Great northern divers	2	February	29	133	78	197	0.19
Seaduck species	2	November	28	250	28	741	0.19
Fulmar	1	January	6	49	8	106	0.41
Gannet	1	December	3	25	3	57	0.58
Cormorant / shag	3	January	56	475	56	1,899	0.13
Grebe species	1	January	1	8	1	24	>1.00
Skua species	1	November	1	8	1	24	>1.00
Small gull species	1	January	3	24	3	57	0.58
Kittiwake	2	February	50	229	69	466	0.14
Common gull	3	January	5	42	5	110	0.45
Large gull species	1	February	3	14	3	32	0.58
Lesser black-backed gull	7	January	3	27	3	82	0.58
Herring gull	3	January	50	424	59	966	0.14
Great black-backed gull	1	November	22	179	73	302	0.21
Auk species	7	December	3	27	3	64	0.57
Guillemot / razorbill	1	January	60	489	342	644	0.13
Guillemot	7	January	1	9	1	27	>1.00
Razorbill	1	December	1	8	1	9	>1.00
Little auk	2	January	1	8	1	33	>1.00
Puffin	1	January	5	41	8	81	0.45

**Table III.2:** Peak counts, estimates, confidence limits and precision for all bird species recorded across the survey area during winter 2010 / 11.

Species / group	Zone	Month	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
Diver species	1	February	8,194	6,727	9,830	0.03
Seaduck species	1	January	26	4	71	0.50
Fulmar	1	January	6	1	19	>1.00
Gannet	1	February	593	398	815	0.10
Cormorant / shag	7	November	7	1	22	>1.00
Grebe species	1	December	31	4	78	0.50
Shearwater species	1	January	110	45	187	0.24
Small gull species	3	January	2,731	1,514	4,292	0.05
Kittiwake	1	February	293	196	398	0.15
Black-headed gull	3	February	192	99	314	0.17
Common gull	3	February	536	408	658	0.11
Large gull species	3	December	99	38	182	0.28
Lesser black-backed gull	7	February	84	14	247	0.27
Herring gull	3	November	129	17	516	0.24
Great black-backed gull	7	February	84	14	247	0.27
Auk species	1	January	323	194	484	0.14

APPENDIX IV: BIRD DISTRIBUTION IN WINTER 2011 / 12

Figure IV.1 Distribution of birds and marine mammals during November 2011

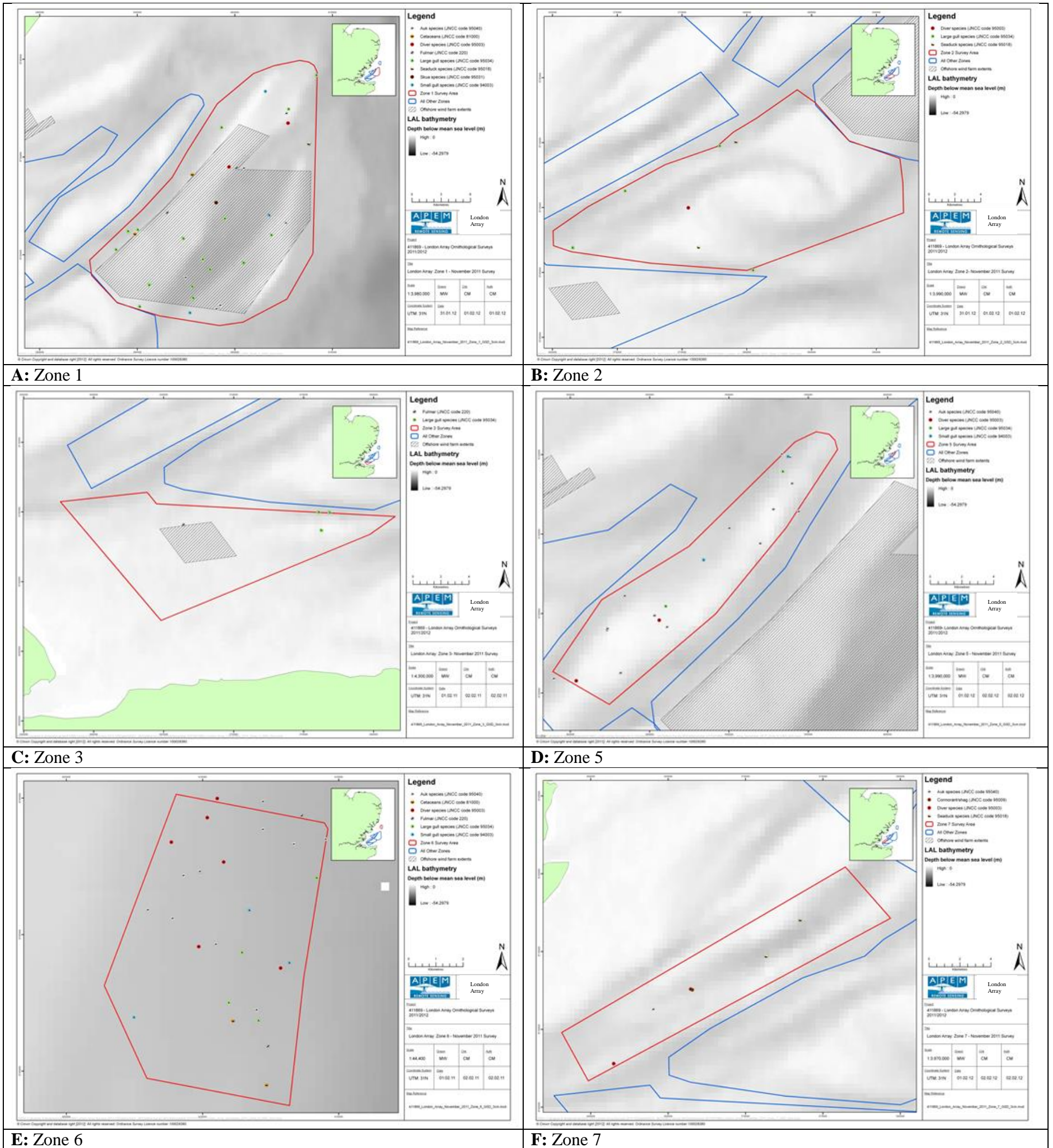


Figure IV.2 Distribution of birds and marine mammals during December 2011

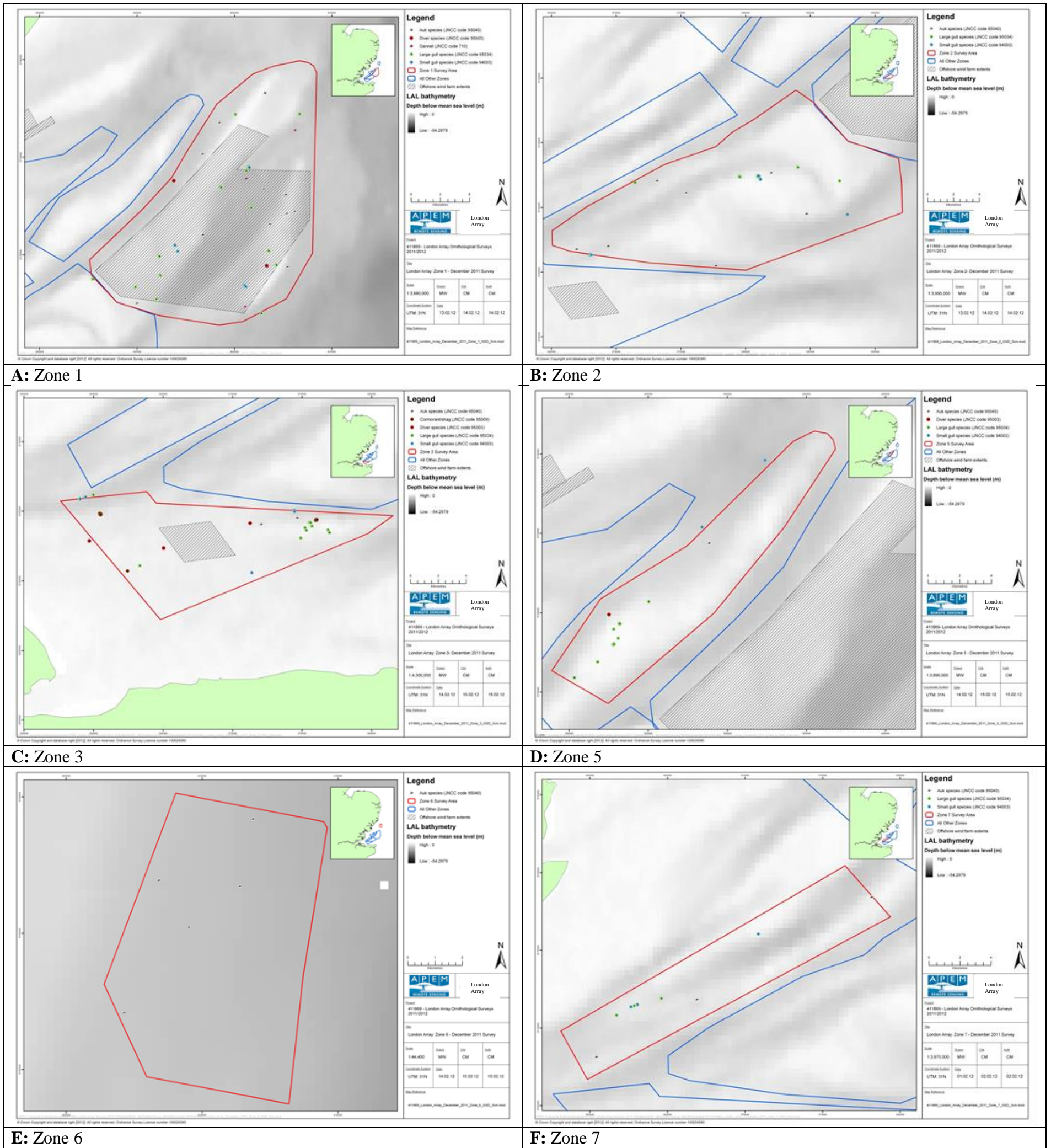


Figure IV.3 Distribution of birds and marine mammals during January 2012

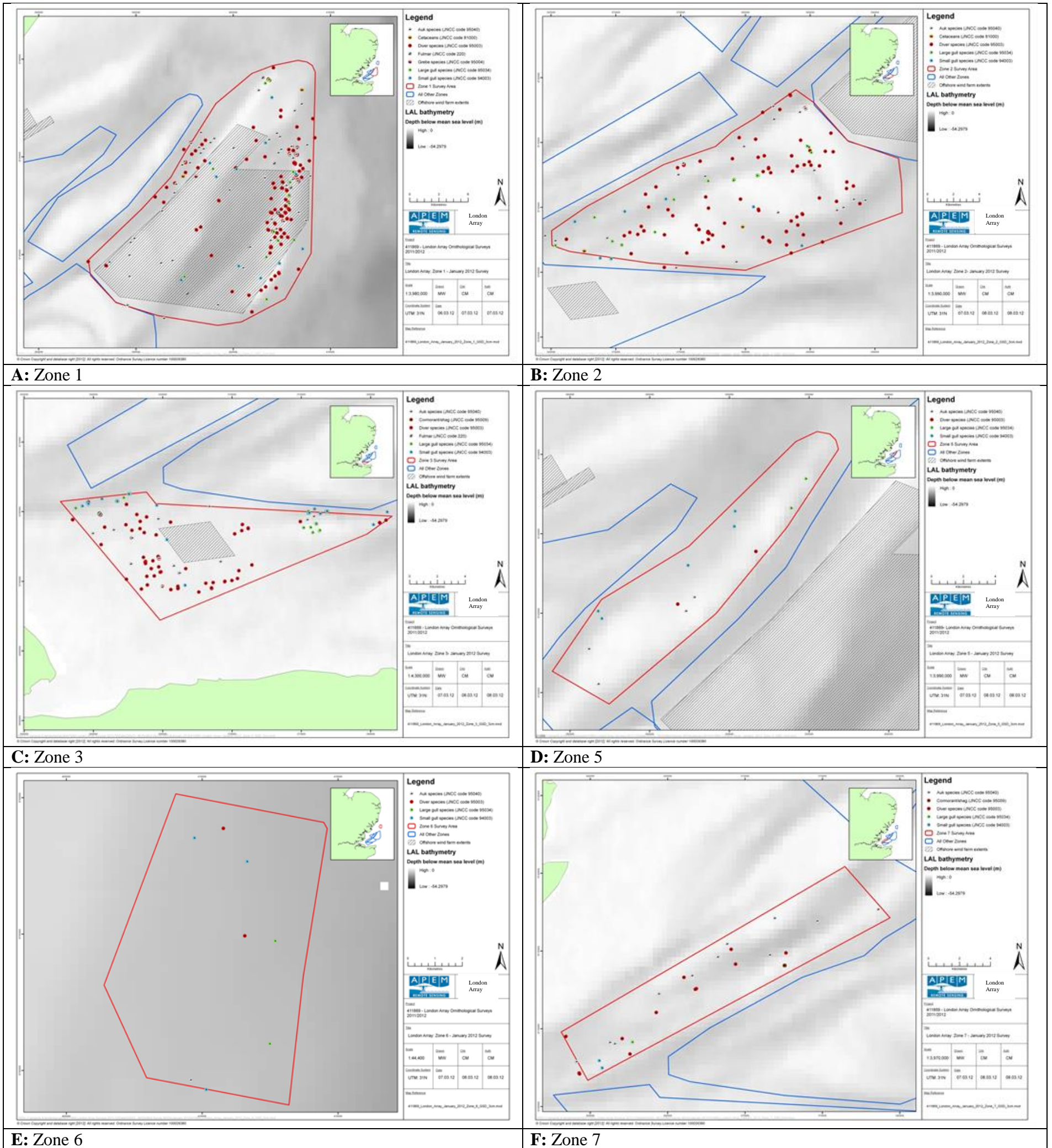
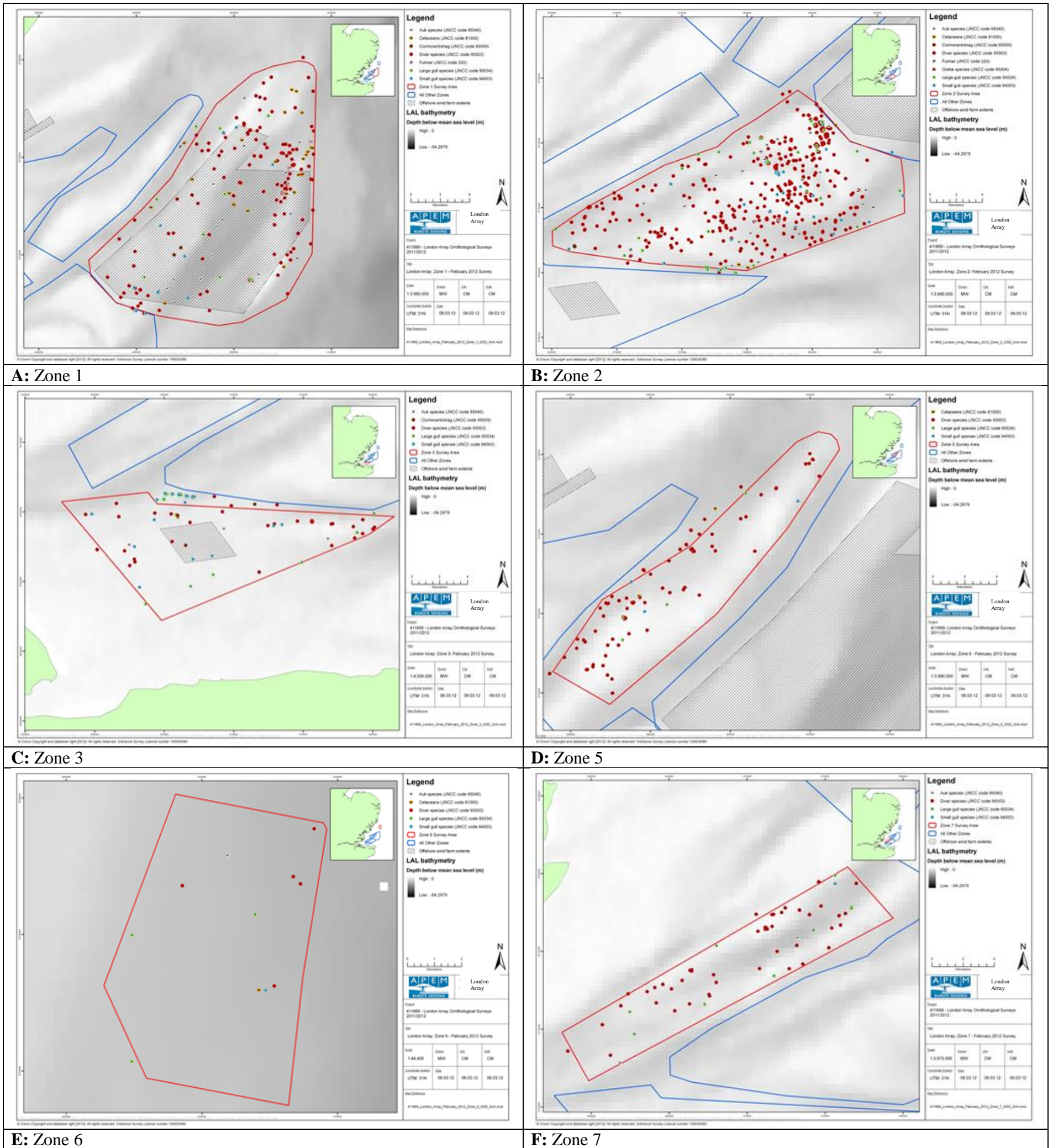


Figure IV.4 Distribution of birds and marine mammals during February 2012





APPENDIX V: BIRD DISTRIBUTION IN WINTER 2010 / 11

Figure V.1 Distribution of birds and marine mammals during November 2010

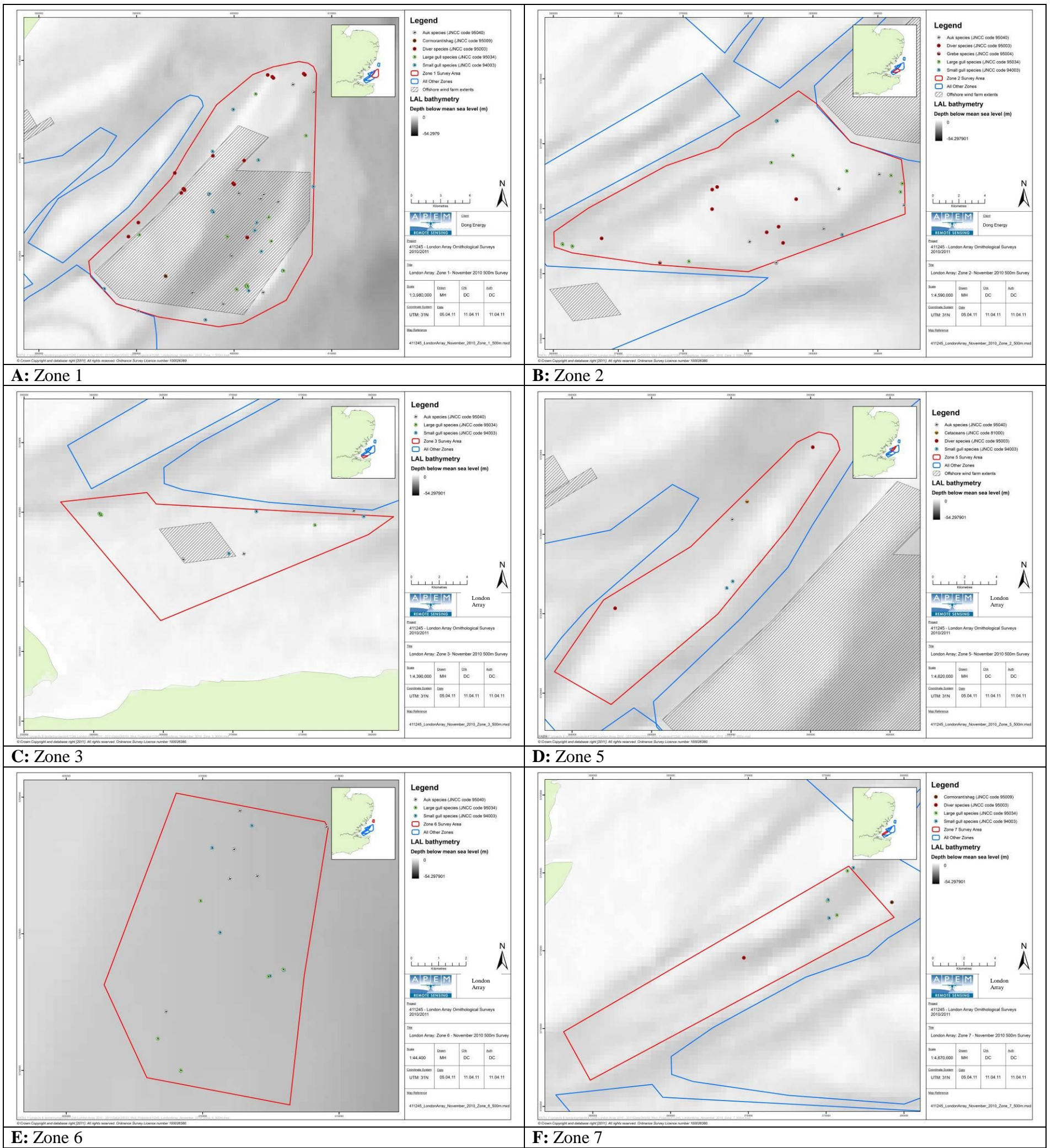


Figure V.2 Distribution of birds and marine mammals during December 2010

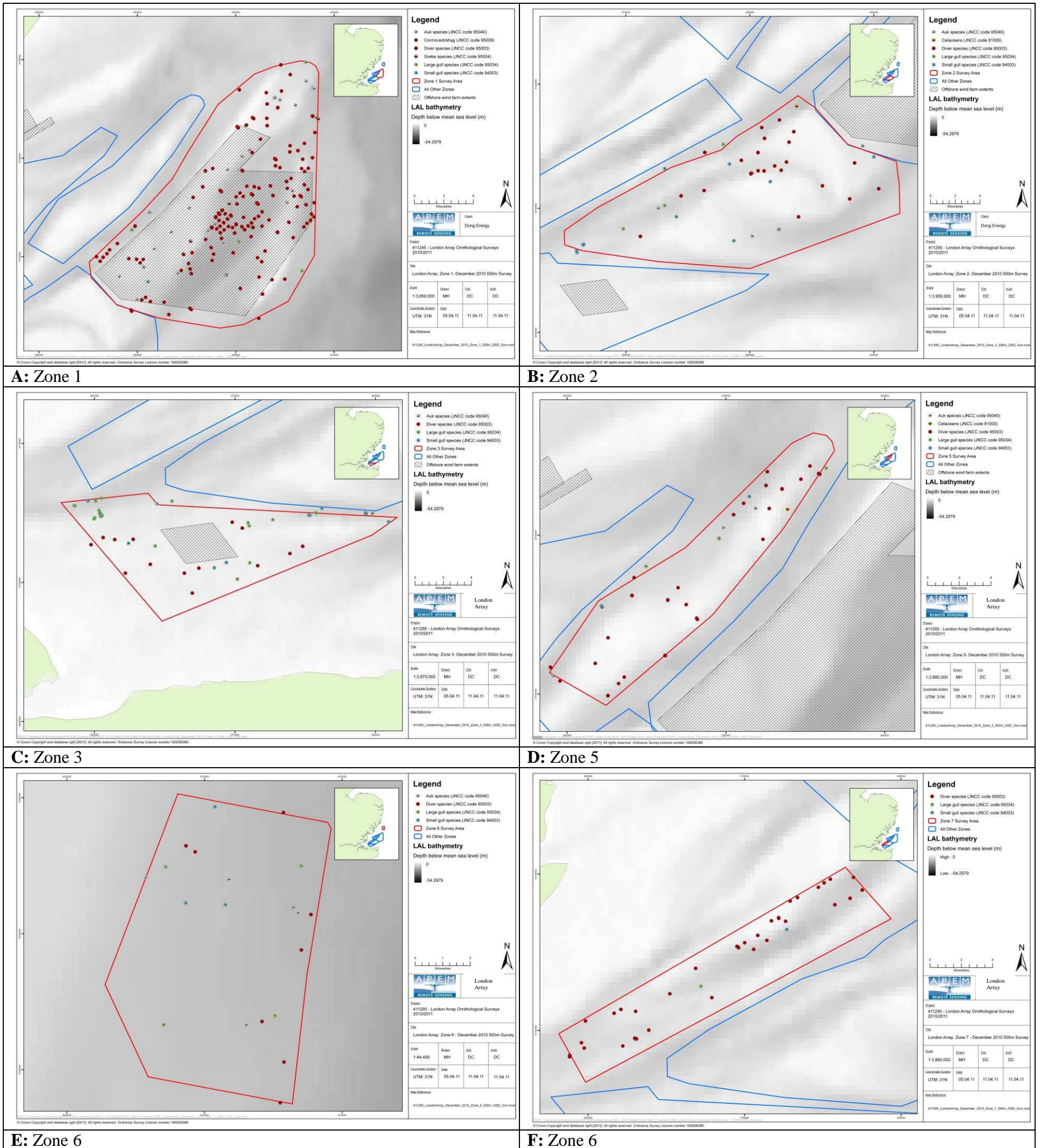


Figure V.3 Distribution of birds and marine mammals during January 2011

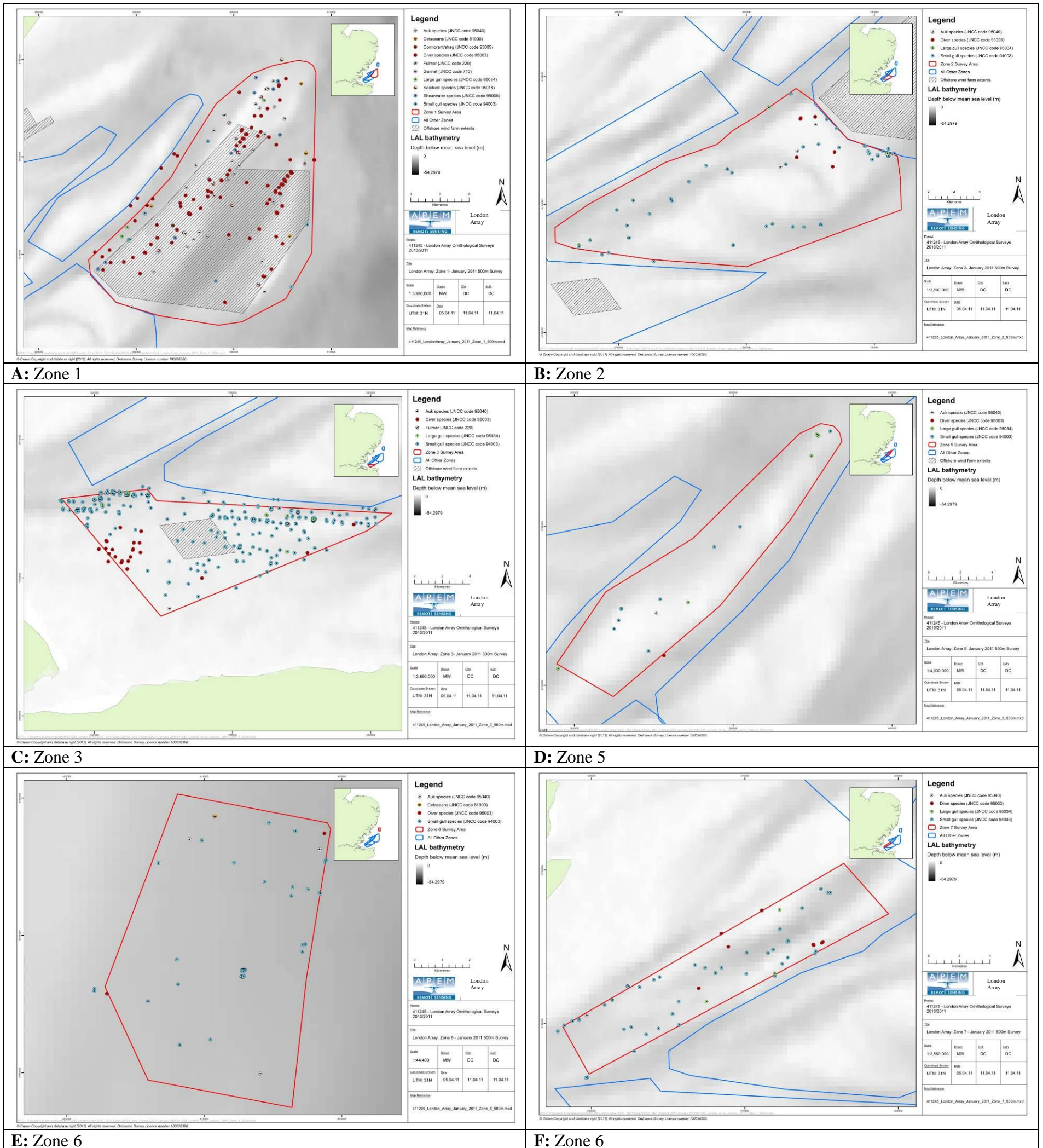
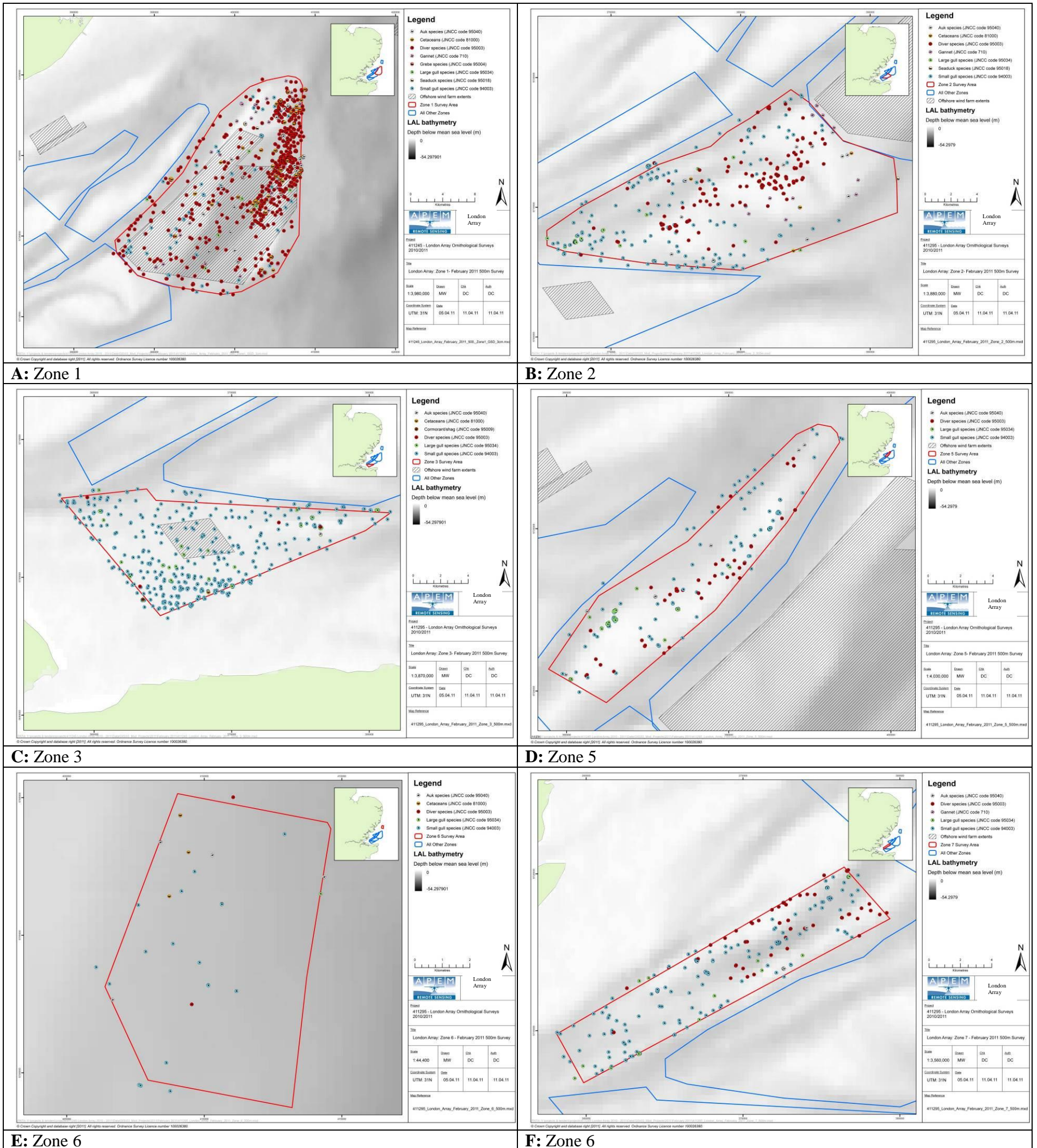


Figure V.4 Distribution of birds and marine mammals during February 2011



**APPENDIX VI: JNCC BIRD & MARINE MAMMAL GROUPS**

<b>JNCC Code</b>	<b>Grouping</b>	<b>Species Code</b>	<b>Species</b>
95018	Seaduck species	2040	Scaup
		2130	Common scoter
95003	Diver species	20	Red-throated diver
		30	Black-throated diver
		40	Great Northern diver
220	Fulmar	220	Fulmar
710	Gannet	710	Gannet
95009	Cormorant / shag	720	Cormorant
		800	Shag
95004	Grebe species	90	Great crested grebe
5659	Wader species	4500	Oystercatcher
95031	Skua species	5690	Great skua
94003	Small Gull species	6020	Kittiwake
		5820	Black headed gull
		5780	Little gull
		5900	Common gull
95034	Large Gull species	5910	Lesser black-backed gull
		5920	Herring gull
		6000	Great black-backed gull
95040	Auk species	6470	Little auk
		6340	Guillemot
		6540	Puffin
		6360	Razorbill
71000	All Phocids (e.g. seals)	n/a	
80000	All Cetaceans (whales, dolphins)	n/a	

**APPENDIX VII: LATIN NAMES OF BIRD SPECIES**

<b>Common name</b>	<b>Latin name</b>
Scaup	<i>Aythya marila</i>
Common scoter	<i>Melanitta nigra</i>
Red-throated diver	<i>Gavia stellata</i>
Black-throated diver	<i>Gavia arctica</i>
Great northern diver	<i>Gavia immer</i>
Fulmar	<i>Fulmarus glacialis</i>
Gannet	<i>Morus bassanus</i>
Cormorant	<i>Phalacrocorax carbo</i>
Shag	<i>Phalacrocorax aristotelis</i>
Great crested grebe	<i>Podiceps cristatus</i>
Oystercatcher	<i>Haematopus ostralegus</i>
Great skua	<i>Stercorarius skua</i>
Kittiwake	<i>Rissa tridactyla</i>
Black-headed gull	<i>Chroicocephalus ridibundus</i>
Common gull	<i>Larus canus</i>
Lesser black-backed gull	<i>Larus fuscus</i>
Herring gull	<i>Larus argentatus</i>
Great black-backed gull	<i>Larus marinus</i>
Guillemot	<i>Uria aalge</i>
Razorbill	<i>Alca torda</i>
Little auk	<i>Alle alle</i>
Puffin	<i>Fratercula arctica</i>