

London Array Ltd.

**LONDON ARRAY OFFSHORE WIND
FARM; AERIAL BIRD SURVEY
REPORT WINTER 2010 / 11 & 2011 /
12 (ZONES 1 & 2).**

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EXECUTIVE SUMMARY

1. The site of the London Array Offshore Wind Farm (OWF) was surveyed in total eight times, once a month between November and February, during the winters of 2010 / 11 and 2011 / 12, using digital high resolution still imagery.
2. Construction of Phase 1 of the London Array wind farm started in March 2011, Zone 1 was therefore under construction during the 2011 / 12 winter surveys.
3. One control Zone (Zone 2) was surveyed with the same frequency over the same period, to meet the requirements of the Marine Licence.
4. Surveys were conducted on a systematic grid of 500 m separation, with images at 3 cm GSD resolution. Average coverage of zones was 15%.
5. Comparison of results between years showed that overall there were more birds recorded in Zones 1 & 2 during the winter surveys 2010 / 11 (cumulative estimate over four months = 17,628) than there were recorded during the winter surveys 2011 / 12 (cumulative estimate over four months = 8,712).
6. Fewer divers were recorded in Zones 1 & 2 during the winter surveys 2011 / 12 than there were recorded during the winter surveys 2010 / 11.
7. Divers arrived at all Zones later during the winter 2011 / 12 (arrived in January / February) compared with winter 2010 / 11 (arrived in November / December).
8. During the winter surveys 2010 / 11, numbers of red-throated divers counted in Zones 1 & 2 were lowest in November, increased in December and decreased in January. In February numbers peaked with an estimated 9,103 divers in both zones (the peak estimate within the Zone 1 London Array OWF site also occurred in this month).
9. During the winter surveys 2011 / 12, numbers of red-throated divers counted in Zones 1 & 2 were very low through November and December 2011, increased in January 2012 and peaked in February 2012 with an estimated 2,697 divers in both zones (although peak estimates within the Zone 1 London Array OWF site occurred in January).
10. The peak number of divers was lower in Zone 1 in 2011 / 12 compared with 2010 / 11, although the peak was higher in Zone 2 in 2011 / 12 compared with the previous year.
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 in Phase 1 in the London Array OWF, etc.
12. Distribution of divers appeared to reflect shallow water areas. All divers in Zone 1 & 2 were recorded in water < 26 m in depth.

13. High concentrations of divers were recorded along the north-eastern border of Zone 1 in February 2011 and January 2012, the majority of these birds were outside of the Phase 1 development area. This distribution of divers in Zone 1 was similar to historical layout.
14. Other bird species / groups recorded included common scoters, fulmars, gannets, cormorants / shags, great crested grebes, great skuas, small gulls (including kittiwakes 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.
15. Peak abundance estimates increased for four species (seaduck species, fulmars, cormorants / shags and great black-backed gulls) during 2011 / 12 in comparison to 2010 / 11. For all other species, peak abundance estimates were lower during 2011 / 12 in comparison to 2010 / 11.
16. Marine mammals, likely harbour porpoises, were most abundant during February in Zone 1 during both winter 2010 / 11 and winter 2011 / 12, although the number of individuals estimated to be present was lower during 2011 / 12. In Zone 2 numbers also peaked in February during both survey years. Marine mammal abundance was relatively low across all other survey months during 2010 / 11 and 2011 / 12 in both zones. Across both years, marine mammals were thinly distributed in groups no bigger than two or three.

1 INTRODUCTION

This report summarises the findings of the winter 2010 / 11 and 2011 / 12 aerial surveys of the London Array Ltd Offshore Wind Farm (OWF) site, and associated control zone, for birds and marine mammals. The aerial surveys are designed to meet the requirements of the Marine Licence¹ granted in respect of the wind farm; in order to satisfy these requirements both pre and during construction monitoring for Phases 1 and 2 is required, necessitating aerial surveys of the London Array OWF site and a control zone. Aerial surveys that took place in 2010 / 11 were conducted pre-construction of the London Array OWF and the surveys in 2011 / 12 were conducted during construction of the wind farm in Phase 1. Construction of Phase 1 commenced in March 2011 and is due to be completed by the end of 2012.

The aim of these surveys was 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 of Phase 1 of the London Array 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 these surveys were to:

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

1.1 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 (potential 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

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

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). Estimates for the Outer Thames SPA based on standard visual aerial surveys, place the wintering total at 6,466 individuals, or 38% of the GB estimate (O'Brien *et al.* 2008). The SPA covers over 379,311 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).

2 METHODS

2.1 Survey design

High definition digital aerial surveys were undertaken using either a Vulcanair P68 Observer twin engine survey aircraft or a Britten-Norman Islander survey aircraft. Aerial surveys were carried out over four months during the winter (November – February) in two years including 2010 / 11 and 2011 / 12. In total, eight surveys of Zone 1 (containing the London Array OWF Phase 1 & 2 development sites plus the rest of the site not currently under construction) and Zone 2 (control zone) were completed, with one survey conducted each month in each year (see section 2.2).

To ensure comparability between years, each survey was flown on a 500 m grid at a 3 cm ground sampling distance (GSD) resolution (for detailed rationale on this methodology, see APEM (2010)). The primary aim of APEM's grid survey methodology is to derive sufficient independent estimates of bird density (and distribution) to reach a target level of precision around the population estimates, measured by the Coefficient of Variation (CV'). The CV' is a measure of the precision about a mean estimate. A $CV' \leq 0.16$ relates to a precision level able to detect a doubling or halving of the population (Bohlin, 1990). The coarseness (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.

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

Zone 1: area encompassing the London Array Limited OWF site.

This zone contains the London Array OWF Phase 1 & 2 development sites plus the rest of the OWF site that is not currently under construction. The zone also includes an area to the north-east of the OWF footprint, encompassing an aggregate site and the whole of the Long Sand bar. A 1 km buffer is also included in this zone to examine bird density in surrounding shipping lanes.

Zone 2: control zone to south west of London Array OWF site.

This zone is 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.

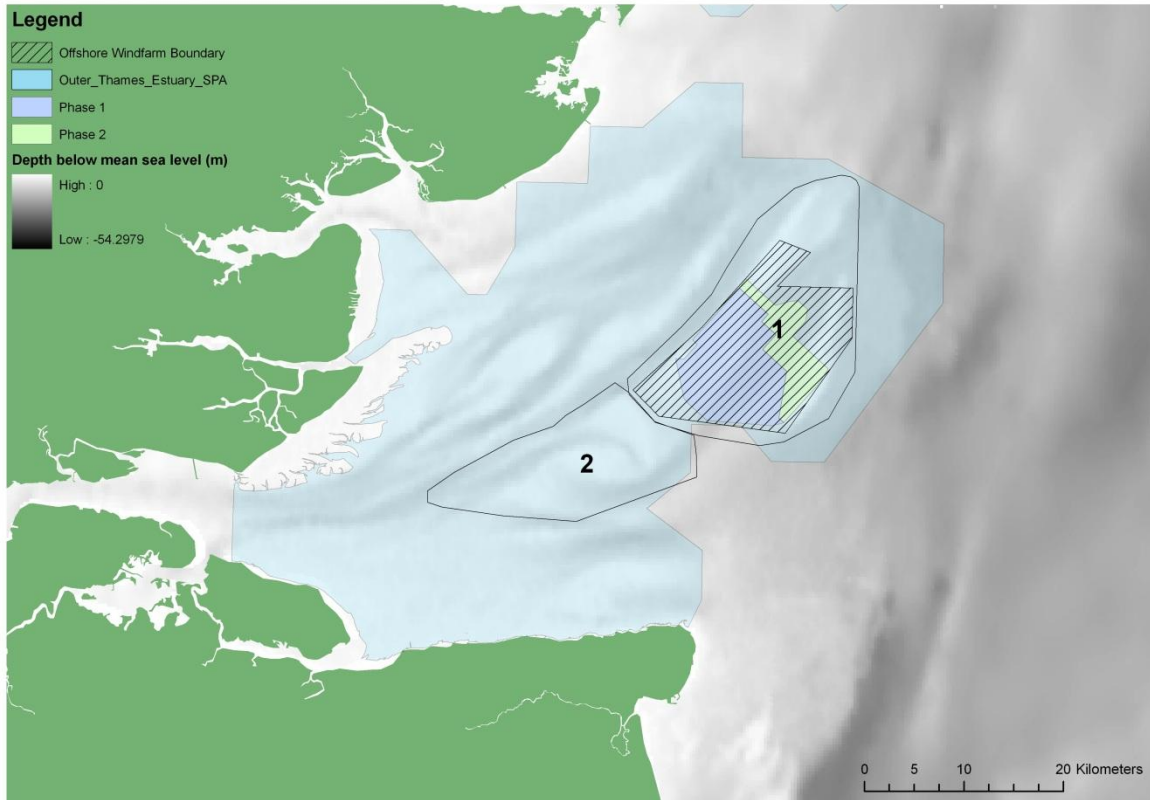


Figure 2.1 Layout of Zone 1 and 2 survey areas. Zone 1 contains the London Array OWF site (lined area) with Phase 1 (blue) and Phase 2 (green) development sites. Zone 2 is the control zone. The Outer Thames Estuary SPA (light blue area), designated for wintering red-throated divers, is also shown.

2.2 Survey information

2.2.1 Winter 2010 / 11 (November – February)

Survey 1: The first survey was undertaken between the 23rd and 24th November 2010. Zone 1 was surveyed on the 23rd and Zone 2 was completed on the 24th.

Survey 2: The second survey was undertaken on the 9th December 2010 when both Zone 1 and Zone 2 were surveyed.

Survey 3: The third survey was undertaken between the 10th and 18th January 2011, although between the 12th to 15th weather conditions were unsuitable for completing the surveys. Zone 1 was surveyed on the 10th and 11th and Zone 2 was surveyed on the 18th.

Survey 4: The fourth survey was undertaken between the 14th and 15th February 2011. Zone 1 was surveyed on the 14th and Zone 2 was surveyed on the 15th.

2.2.2 Winter 2011 / 12 (November – February)

Survey 5: The fifth survey was undertaken between the 2nd and 4th November 2011. Zone 1 was completed on the 4th and Zone 2 was surveyed on the 2nd and 3rd.

Survey 6: The sixth survey was undertaken between the 2nd and 3rd December 2011. Zone 1 was completed on the 2nd and Zone 2 was surveyed on the 3rd.

Survey 7: The seventh survey was undertaken between the 16th and 17th January 2012. Zone 1 was surveyed on the 17th and Zone 2 was completed on the 16th.

Survey 8: The eighth survey was undertaken between the 7th and 8th February 2012. Zone 1 was surveyed on the 8th and Zone 2 was completed the 7th.

2.2.3 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 cetacean 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 cetacean 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

Both internal and external Quality Assurance (QA) is carried out on each survey. Each bird image is reviewed and checked by APEM's own dedicated QA manager, ensuring that 100% of birds found are 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 are assessed in batches with a different staff member responsible for each batch. Images containing no birds are removed and kept separately for further QA. Of these 'blank' images, 20% are randomly selected for QA by an independent reviewer. If there is less than 90% agreement, the entire batch of fifty images is re-analysed.

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

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

2.5 Data analysis

2.5.1 Population estimates

Population estimates were derived from the grid data for all the monthly surveys undertaken each year. For each monthly aerial survey of Zones 1 & 2, geo-referenced locations of birds contained within each individual digital still image were used to generate raw counts. Those bird locations contained within the boundaries of each zone were then extracted using ArcGIS, leaving raw count data for images obtained from each zone.

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

$$N = i A$$

Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. The statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values taken as the variability of the statistic over the population (Efron & Tibshirani 1993).

Measures of precision were calculated using a negative binomial estimator, suitable for a pseudo-Poisson over-dispersed distribution (Elliott 1977). This produced a CV' (Coefficient of Variation) based on the relationship of the standard error to the mean. A target precision of ≤ 0.16 allows the detection of a population change of a factor as small as 2 (Bohlin 1990).

All analysis and data manipulation was 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).

It is also possible to estimate population abundance and distribution using a Density Surface Modelling (DSM) approach which involves the use of Generalised Additive Models (GAMs) to produce density surface smoothed maps across a study area using a Geographic Information System (GIS). As GAMs are based on environmental covariates (e.g. bathymetry, fishing data, benthic data etc.), they allow a more informed density estimate to be made for areas that were not covered by the images taken during the aerial survey. In addition to the covariates (and in place of the covariates if none are available), GAMs can also be based on static surrogates (distance from shore, distance from SPA, etc.). This offers a very powerful technique, and as the data are collected on a grid, they are entirely suitable for this approach. GAM modelling was not undertaken for this report, but this form of modelling can be subsequently undertaken if required.

2.5.2 Relative density distribution maps for divers

Bird 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 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 Zones 1 and 2 during winter 2010 / 11 and winter 2011 / 12. Estimates within the target precision of 0.16 are in red italic text.

Species / group	Year	Month	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
Diver species	2010 / 11	Feb	1	<i>1,257</i>	<i>8,194</i>	<i>6,727</i>	<i>9,830</i>	<i>0.03</i>
	2011 / 12	Feb	2	<i>433</i>	<i>1,980</i>	<i>1,536</i>	<i>2,469</i>	<i>0.05</i>
Great northern diver	2010 / 11	-	-	-	-	-	-	-
	2011 / 12	Feb	2	29	133	78	197	0.19
Seaduck species	2010 / 11	Jan	1	4	26	4	71	0.50
	2011 / 12	Nov	2	28	250	28	741	0.19
Fulmar	2010 / 11	Jan	1	1	6	1	19	>1.00
	2011 / 12	Jan	1	6	49	8	106	0.41
Shearwater species	2010 / 11	Jan	1	17	110	45	187	0.24
	2011 / 12	-	-	-	-	-	-	-
Gannet	2010 / 11	Feb	1	<i>91</i>	<i>593</i>	<i>398</i>	<i>815</i>	<i>0.10</i>
	2011 / 12	Dec	1	3	25	3	57	0.58
Cormorant / shag	2010 / 11	Nov/Dec	1	1	8	1	31	>1.00
	2011 / 12	Feb	2	23	105	23	315	0.21
Grebe species	2010 / 11	Dec	1	4	31	4	78	0.50
	2011 / 12	Jan	1	1	8	1	24	>1.00
Skua species	2010 / 11	-	-	-	-	-	-	-
	2011 / 12	Nov	1	1	8	1	24	>1.00
Small gull species	2010 / 11	Feb	1	<i>113</i>	<i>737</i>	<i>417</i>	<i>1,134</i>	<i>0.09</i>
	2011 / 12	Jan	1	3	24	3	57	0.58
Kittiwake	2010 / 11	Feb	1	<i>45</i>	<i>293</i>	<i>196</i>	<i>398</i>	<i>0.15</i>
	2011 / 12	Feb	2	<i>50</i>	<i>229</i>	<i>69</i>	<i>466</i>	<i>0.14</i>
Black-headed gull	2010 / 11	Feb	2	10	63	25	101	0.31
	2011 / 12	-	-	-	-	-	-	-
Common gull	2010 / 11	Feb	2	26	164	95	246	0.20
	2011 / 12	Feb	2	7	32	7	82	0.38
Large gull species	2010 / 11	Feb	2	12	76	13	170	0.29
	2011 / 12	Feb	1	3	14	3	32	0.58
Lesser black-backed gull	2010 / 11	Nov	1	7	54	7	147	0.38
	2011 / 12	Dec	1	2	16	2	49	0.71
Herring gull	2010 / 11	Feb	2	5	32	6	69	0.45
	2011 / 12	Dec	2	24	196	24	554	0.20

Species / group	Year	Month	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
Great black-backed gull	2010 / 11	Nov	2	8	61	15	129	0.35
	2011 / 12	Nov	1	22	179	73	302	0.21
Auk species	2010 / 11	Jan	1	50	323	194	484	0.14
	2011 / 12	Feb	1	4	19	4	51	0.50
Guillemot / razorbill	2010 / 11	-	-	-	-	-	-	-
	2011 / 12	Jan	1	60	489	342	644	0.13
Guillemot	2010 / 11	-	-	-	-	-	-	-
	2011 / 12	Jan	7	1	9	1	27	>1.00
Razorbill	2010 / 11	-	-	-	-	-	-	-
	2011 / 12	Dec	1	1	8	1	9	>1.00
Little auk	2010 / 11	-	-	-	-	-	-	-
	2011 / 12	Jan	2	1	8	1	33	>1.00
Puffin	2010 / 11	-	-	-	-	-	-	-
	2011 / 12	Jan	1	5	41	8	81	0.45

3.1.1 Diver species

Data presented in Table 3.2 refer to ‘divers’, including all red-throated divers plus all divers not identified to species level recorded during the winter 2010 / 11 and winter 2011 / 12 surveys. In all likelihood, the vast majority of divers not identified to species will have been red-throated divers, as the main confusion species, black-throated divers, are comparatively scarce in the Outer Thames Estuary. Divers identified as great northern divers are recorded separately below. Divers were recorded in all surveys except Zone 2 during December 2011.

During the winter 2010 / 11 surveys, numbers peaked during February 2011 in Zones 1 and 2 with an estimated 8,194 and 909 divers present, respectively. During the winter 2011 / 12 surveys, diver numbers peaked in January 2012 in Zone 1 with an estimated 1,474 divers present, and in Zone 2 numbers peaked during February 2012 when 1,980 divers were present.

During the winter 2010 / 11 surveys, of the divers recorded in February 2011, 56 of the divers in Zone 1 and two of the divers in Zone 2 were identified as red-throated divers. During the winter 2011 / 12 surveys, 159 of the divers recorded in Zone 1 during January 2012 were identified as red-throated divers and 178 of the divers recorded in Zone 2 during February 2012 were identified as red-throated divers. The remaining divers present in Zones 1 and 2 across all months could not be identified to species level. However, it is likely that the majority of these individuals were red-throated divers since measurements are not consistent with great northern diver, and black-throated divers are comparatively scarce in the Outer Thames Estuary (O’Brien *et al.* 2008).

Table 3.2 Monthly counts, estimates, confidence limits and precision for all divers in Zones 1 and 2. Estimates within the target precision of 0.16 are in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	18	139	70	225	0.24
		Zone 2	8	61	23	106	0.35
	2011	Zone 1	2	16	2	41	0.71
		Zone 2	1	9	1	27	>1.00
December	2010	Zone 1	<i>184</i>	<i>1,429</i>	<i>1,165</i>	<i>1,732</i>	<i>0.07</i>
		Zone 2	31	227	139	323	0.18
	2011	Zone 1	2	16	2	41	0.71
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	<i>144</i>	<i>930</i>	<i>691</i>	<i>1,195</i>	<i>0.08</i>
		Zone 2	7	53	15	105	0.38
	2012	Zone 1	<i>181</i>	<i>1,474</i>	<i>1,108</i>	<i>1,906</i>	<i>0.07</i>
		Zone 2	<i>87</i>	<i>711</i>	<i>523</i>	<i>899</i>	<i>0.11</i>
February	2011	Zone 1	<i>1,257</i>	<i>8,194</i>	<i>6,727</i>	<i>9,830</i>	<i>0.03</i>
		Zone 2	<i>144</i>	<i>909</i>	<i>682</i>	<i>1,174</i>	<i>0.08</i>
	2012	Zone 1	<i>155</i>	<i>717</i>	<i>551</i>	<i>921</i>	<i>0.08</i>
		Zone 2	<i>433</i>	<i>1,980</i>	<i>1,536</i>	<i>2,469</i>	<i>0.05</i>

3.1.1.1 *Great northern divers*

Data presented in Table 3.3 refer to great northern divers. No great northern divers were present during the winter 2010 / 11 surveys. During the winter 2011 / 12 surveys, great northern divers were present in Zones 1 and 2 in February 2012, with an estimated 19 and 133 individuals present, respectively.

Table 3.3 Monthly counts, estimates, confidence limits and precision for great northern divers in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	4	19	5	42	0.50
		Zone 2	29	133	78	197	0.19

3.1.2 Other bird species

3.1.2.1 Seaduck species

Data presented in Table 3.4 refer to seaduck species, including common scoters plus all seaducks not identified to species level during the winter 2010 / 11 and winter 2011 / 12 surveys. During the winter 2010 / 11 surveys, seaducks peaked in Zone 1 during January 2011 with an estimated 26 individuals present and in Zone 2 during February 2011 with an estimated 13 individuals present. During the winter 2011 / 12 surveys, seaducks (all of which were identified as common scoters) peaked in Zones 1 and 2 during November 2011 with an estimated 90 and 250 individuals present, respectively.

Table 3.4 Monthly counts, estimates, confidence limits and precision for seaduck species in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	11	90	11	269	0.30
		Zone 2	28	250	28	741	0.19
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	4	26	4	71	0.50
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	1	7	1	20	>1.00
		Zone 2	2	13	2	38	0.71
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A

3.1.2.2 *Fulmars*

Data presented in Table 3.5 refer to all fulmars. During the winter 2010 / 11 surveys, fulmars peaked in Zone 1 during January 2011 with an estimated six individuals present. No fulmars were recorded in Zone 2 in any survey month during 2010 / 11. During the winter 2011 / 2012 surveys, fulmars peaked in Zone 1 during January 2012 when an estimated 49 individuals were present and in Zone 2 during February 2012 when an estimated five individuals were present.

Table 3.5 Monthly counts, estimates, confidence limits and precision for fulmars in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	2	16	2	41	0.71
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	1	6	1	19	>1.00
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	6	49	8	106	0.41
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	1	5	1	18	>1.00

3.1.2.3 Gannets

Data presented in Table 3.6 refer to gannets. During winter 2010 / 11, gannets peaked in Zones 1 and during February 2011 with estimated population sizes of 593 and 69 individuals, respectively. During the winter 2011 / 12 surveys, gannets peaked in Zone 1 during December 2011 when an estimated 25 individuals were present. No gannets were recorded in Zone 2 during 2011 / 12.

Table 3.6 Monthly counts, estimates, confidence limits and precision for gannets in Zones 1 and 2. Estimates within the target precision of 0.16 are in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	3	25	3	57	0.58
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	1	6	1	19	>1.00
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	<i>91</i>	<i>593</i>	<i>398</i>	<i>815</i>	<i>0.10</i>
		Zone 2	11	69	25	120	0.30
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A

3.1.2.4 *Cormorants / shags*

Data presented in Table 3.7 refer to cormorants / shags (including cormorants, shags and individuals recorded as cormorants or shags). During winter 2010 / 11, cormorants / shags (all identified as shags) peaked at an estimated eight individuals in Zone 1 during both November 2010 and December 2010. No cormorants / shags were recorded in Zone 2 in any month during the 2010 / 2011 surveys. During the 2011 / 12 surveys, cormorants / shags peaked in Zones 1 and 2 during February 2011 with an estimated 19 and 105 individuals present, respectively.

Table 3.7 Monthly counts, estimates, confidence limits and precision for cormorants / shags in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	1	8	1	31	>1.00
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	1	8	1	23	>1.00
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	1	6	1	19	>1.00
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	4	19	4	51	0.50
		Zone 2	23	105	23	315	0.21

3.1.2.5 Grebe species

Data present in Table 3.8 refer to all grebe species (including great crested grebes and those grebes not identified to species level). During the winter 2010 / 11 surveys, grebes peaked in Zone 1 during December 2010 when an estimated 31 individuals were present and in Zone 2 during November 2010 when eight grebes were estimated to be present. During the winter 2011 / 12 surveys, grebe species peaked in Zone 1 during January 2012 when an estimated eight individuals were present and in Zone 2 during February 2012 when five grebes were estimated to be present.

Table 3.8 Monthly counts, estimates, confidence limits and precision for grebes in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	1	8	1	23	>1.00
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	4	31	4	78	0.50
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	1	8	1	24	>1.00
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	2	13	2	33	0.71
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	1	5	1	14	>1.00

3.1.2.6 *Skua species*

Data presented in Table 3.9 refer to skua species (including great skuas and skuas not identified to species level). No skuas were recorded during the winter 2010 / 11 surveys. During the winter 2011 / 12 surveys, skuas peaked in Zone 1 during November 2011 when an estimated eight individuals were present. No skuas were recorded in Zone 2 in any month during winter 2011 / 12.

Table 3.9 Monthly counts, estimates, confidence limits and precision for skuas in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	1	8	1	24	>1.00
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A

3.1.2.7 *Total small gull species*

Data presented in Table 3.10 refer to all small gulls (including kittiwakes, black-headed gulls, common gulls and small gulls not identified to species level). During the winter 2010 / 11 surveys, small gulls peaked during February 2011 in both Zones 1 and 2 when an estimated 1,121 and 1,137 small gulls were present, respectively. During the winter 2011 / 12 surveys, small gulls peaked in Zone 1 during January 2012 with an estimated 106 individuals present, and in Zone 2 during February 2012 when an estimated 261 individuals were present.

Table 3.10 Monthly counts, estimates, confidence limits and precision for all small gull species (identified to group and species levels) in Zones 1 and 2. Estimates within the target precision of 0.16 are in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	14	108	54	178	0.27
		Zone 2	3	23	3	61	0.58
	2011	Zone 1	3	24	3	57	0.58
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	1	8	1	23	>1
		Zone 2	11	80	15	183	0.30
	2011	Zone 1	5	41	8	90	0.45
		Zone 2	5	41	5	106	0.45
January	2011	Zone 1	13	84	32	149	0.28
		Zone 2	<i>47</i>	<i>354</i>	<i>241</i>	<i>498</i>	<i>0.15</i>
	2012	Zone 1	13	106	49	171	0.28
		Zone 2	5	41	8	82	0.45
February	2011	Zone 1	<i>172</i>	<i>1,121</i>	<i>769</i>	<i>1,545</i>	<i>0.08</i>
		Zone 2	<i>180</i>	<i>1,137</i>	<i>878</i>	<i>1,421</i>	<i>0.08</i>
	2012	Zone 1	9	42	14	74	0.33
		Zone 2	<i>57</i>	<i>261</i>	<i>78</i>	<i>544</i>	<i>0.13</i>

3.1.2.8 *Small gull species*

Data presented in Table 3.11 refer to all small gulls that were not identified to species level. Those small gulls identified beyond group level appear separately below. During the winter 2010 / 11 surveys, small gulls peaked in Zones 1 and 2 during February 2011 with an estimated 737 and 619 individuals present, respectively. During the winter 2011 / 12 survey, small gulls peaked in Zones 1 and 2 during January 2012 with an estimated 24 and eight individuals present, respectively.

Table 3.11 Monthly counts, estimates, confidence limits and precision for small gulls in Zones 1 and 2. Estimates within the target precision of 0.16 are in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	14	108	54	170	0.27
		Zone 2	3	23	3	61	0.58
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	1	8	1	23	>1.00
		Zone 2	10	73	10	161	0.32
	2011	Zone 1	2	16	2	41	0.71
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	13	84	32	149	0.28
		Zone 2	<i>39</i>	<i>294</i>	<i>181</i>	<i>422</i>	<i>0.16</i>
	2012	Zone 1	3	24	3	57	0.58
		Zone 2	1	8	1	25	>1.00
February	2011	Zone 1	<i>133</i>	<i>737</i>	<i>417</i>	<i>1,134</i>	<i>0.09</i>
		Zone 2	<i>98</i>	<i>619</i>	<i>429</i>	<i>833</i>	<i>0.10</i>
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A

3.1.2.9 Kittiwakes

Data presented in Table 3.12 refer to kittiwakes. During the winter 2010 / 11 surveys, kittiwakes peaked in Zones 1 and 2 during February 2011 when an estimated 293 and 290 individuals were present. During the winter 2011 / 12 surveys, small gulls peaked in Zone 1 during January 2012 when an estimated 73 individuals were present and in Zone 2 during February 2012 when an estimated 229 individuals were present.

Table 3.12 Monthly counts, estimates, confidence limits and precision for kittiwakes in Zones 1 and 2. Estimates within the target precision of 0.16 are in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	3	24	3	57	0.58
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	1	7	1	22	>1.00
	2011	Zone 1	3	25	3	57	0.58
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	2	15	2	45	0.71
	2012	Zone 1	9	73	33	130	0.33
		Zone 2	4	33	8	65	0.50
February	2011	Zone 1	<i>45</i>	<i>293</i>	<i>196</i>	<i>398</i>	<i>0.15</i>
		Zone 2	<i>46</i>	<i>290</i>	<i>202</i>	<i>398</i>	<i>0.15</i>
	2012	Zone 1	8	37	14	65	0.35
		Zone 2	<i>50</i>	<i>229</i>	<i>69</i>	<i>466</i>	<i>0.14</i>

3.1.2.10 *Black-headed gulls*

Data presented in Table 3.13 refer to black-headed gulls. During the winter 2010 / 11 surveys, black-headed gulls peaked in Zones 1 and 2 during February 2011 when an estimated 46 and 63 individuals were present, respectively. No black-headed gulls were identified in Zones 1 and 2 during the 2011 / 2012 winter surveys.

Table 3.13 Monthly counts, estimates, confidence limits and precision for black-headed gulls in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	2	15	2	38	0.71
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	7	46	13	85	0.38
		Zone 2	10	63	25	101	0.31
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A

3.1.2.11 *Common gulls*

Data presented in Table 3.14 refer to common gulls. During the winter 2010 / 11 surveys, common gulls peaked in Zones 1 and 2 during February 2011 when 46 and 164 individuals were present respectively. During the winter 2011 / 12 surveys, common gulls peaked in Zone 1 during January 2012 when eight individuals were estimated to be present. In Zone 2 during the 2011 / 12 surveys, common gulls peaked in December 2011 when an estimated 41 individuals were present.

Table 3.14 Monthly counts, estimates, confidence limits and precision for common gulls in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	5	41	5	106	0.45
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	4	30	8	60	0.50
	2012	Zone 1	1	8	1	24	>1.00
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	7	46	13	78	0.38
		Zone 2	26	164	95	246	0.20
	2012	Zone 1	1	5	1	19	>1.00
		Zone 2	7	32	7	82	0.38

3.1.2.12 Total large gulls

Data presented in Table 3.15 refer to all large gulls recorded (including lesser black-backed gulls, herring gulls, great black-backed gulls and those that were not identified to species level). During the winter 2010 / 11 surveys, large gulls peaked in Zones 1 and 2 during February 2011 when an estimated 137 and 152 individuals were present. During the winter 2011 / 12 surveys, large gulls peaked in Zone 1 during November 2011 when an estimated 204 individuals were present. In Zone 2 during the 2011 / 12 surveys, large gulls peaked at an estimated 277 individuals during December 2011.

Table 3.15 Monthly counts, estimates, confidence limits and precision for all large gulls (identified to group and species levels) in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	14	109	31	202	0.27
		Zone 2	13	99	30	182	0.28
	2011	Zone 1	25	204	90	334	0.20
		Zone 2	7	62	7	161	0.38
December	2010	Zone 1	5	39	8	78	0.45
		Zone 2	3	22	3	44	0.58
	2011	Zone 1	15	123	49	197	0.26
		Zone 2	34	277	34	799	0.17
January	2011	Zone 1	6	39	13	71	0.41
		Zone 2	3	23	3	53	0.58
	2012	Zone 1	17	138	65	228	0.24
		Zone 2	24	196	65	384	0.20
February	2011	Zone 1	21	137	59	241	0.22
		Zone 2	24	152	69	259	0.20
	2012	Zone 1	9	42	14	74	0.33
		Zone 2	32	146	87	210	0.18

3.1.2.13 Large gull species

Data presented in Table 3.16 refer to all large gulls that were not identified to species level. Those identified beyond group level appear separately below. During the winter 2010 / 11 surveys, large gulls peaked at an estimated 23 individuals in Zone 1 during December 2010 and at an estimated 76 individuals in Zone 2 during February 2011. During the winter 2011 / 12 surveys, large gulls peaked during February 2012 in Zones 1 and 2 at an estimated 14 and five individuals, respectively.

Table 3.16 Monthly counts, estimates, confidence limits and precision for large gull species in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	2	15	2	39	0.71
		Zone 2	3	23	3	46	0.58
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	3	23	3	54	0.58
		Zone 2	3	22	3	51	0.58
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	2	13	2	32	0.71
		Zone 2	2	15	2	38	0.71
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	2	13	2	33	0.71
		Zone 2	12	76	13	170	0.29
	2012	Zone 1	3	14	3	32	0.58
		Zone 2	1	5	1	14	>1.00

3.1.2.14 *Black-backed gull species*

Data presented in Table 3.17 refers to black-backed gulls identified to group level (lesser black-backed gulls or great black-backed gulls). Those individuals identified to species level also appear separately below. During the winter 2010 / 11 surveys, black-backed gulls peaked in Zones 1 and 2 during February 2011 with an estimated 52 and six individuals present, respectively. During the winter 2011 / 12 surveys, black-backed gulls estimated to be present in Zones 1 and 2 also peaked in February with 14 and five individuals, respectively.

Table 3.17 Monthly counts, estimates, confidence limits and precision for black-backed gull species in Zone 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	2	15	2	39	0.71
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	1	8	1	24	>1.00
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	8	52	8	137	0.35
		Zone 2	1	6	1	19	>1.00
	2012	Zone 1	3	14	3	32	0.58
		Zone 2	1	5	1	14	>1.00

3.1.2.15 *Lesser black-backed gulls*

Data presented in Table 3.18 refer to lesser black-backed gulls. During the winter 2010 / 11 surveys, lesser black-backed gulls peaked in Zones 1 and 2 during November 2010, when an estimated 54 and 15 individuals were present respectively. During the 2011 / 12 surveys, lesser black-backed gulls peaked in Zone 1 during December 2011 at an estimated 16 individuals. In Zone 2 during the 2011 / 12 surveys, lesser black-backed gulls peaked during November 2011 when nine individuals were estimated to be present.

Table 3.18 Monthly counts, estimates, confidence limits and precision for lesser black-backed gulls in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	7	54	7	147	0.38
		Zone 2	2	15	2	38	0.71
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	1	9	1	27	>1.00
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	2	16	2	49	0.71
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	1	8	1	24	>1.00
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	4	26	7	59	0.50
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	1	5	1	19	>1.00
		Zone 2	0	0	0	0	N/A

3.1.2.16 *Herring gulls*

Data presented in Table 3.19 refer to herring gulls. During the winter 2010 / 11 surveys, herring gulls peaked in Zones 1 and 2 during February 2011 when an estimated 20 and 32 individuals were present, respectively. During the winter 2011 / 12 surveys, herring gulls peaked during December 2011 in both Zones 1 and 2 with an estimated 25 and 196 individuals present, respectively.

Table 3.19 Monthly counts, estimates, confidence limits and precision for herring gulls in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	1	8	1	23	>1.00
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	2	16	2	41	0.71
		Zone 2	5	45	5	125	0.45
December	2010	Zone 1	2	16	2	39	0.71
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	3	25	3	57	0.58
		Zone 2	24	196	24	554	0.20
January	2011	Zone 1	1	6	1	19	>1.00
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	14	114	25	253	0.27
February	2011	Zone 1	3	20	3	52	0.58
		Zone 2	5	32	6	69	0.45
	2012	Zone 1	4	19	5	37	0.50
		Zone 2	16	73	32	123	0.25

3.1.2.17 *Great black-backed gulls*

Data presented in Table 3.20 refer to great black-backed gulls. During the winter 2010 / 11 surveys, great black-backed gulls peaked in Zone 1 during February 2011 when an estimated 26 individuals were present and in Zone 2 during November 2010 when 61 individuals were estimated to be present. During the winter 2011 / 12 surveys, great black-backed gulls peaked at an estimated 179 individuals in Zone 1 during November 2011 whilst in Zone 2 individuals peaked at an estimated 82 individuals during both December 2011 and January 2012.

Table 3.20 Monthly counts, estimates, confidence limits and precision for great black-backed gulls in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	2	15	2	39	0.71
		Zone 2	8	61	15	129	0.35
	2011	Zone 1	22	179	73	302	0.21
		Zone 2	1	9	1	27	>1.00
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	10	82	33	148	0.32
		Zone 2	10	82	10	204	0.32
January	2011	Zone 1	3	19	3	45	0.58
		Zone 2	1	8	1	23	>1.00
	2012	Zone 1	16	130	57	220	0.25
		Zone 2	10	82	16	180	0.32
February	2011	Zone 1	4	26	7	59	0.50
		Zone 2	6	38	6	88	0.41
	2012	Zone 1	1	5	1	14	>1.00
		Zone 2	15	69	32	105	0.26

3.1.2.18 *Total auk species*

Data presented in Table 3.21 refer to all auk species recorded (including individuals identified as either guillemots or razorbills, guillemots, razorbills, little auks, puffins and individuals not identified to species level). During the winter 2010 / 11 surveys, auk species peaked in Zone 1 during January 2011 when an estimated 323 individuals were present. In Zone 2 during the 2010 / 11 surveys, auk species peaked at an estimated 139 individuals during February 2011. During the winter 2011 / 12 surveys, auk species peaked during January 2012 when an estimated 554 individuals were present and in Zone 2 during February 2012 when an estimated 187 individuals were present.

Table 3.21 Monthly counts, estimates, confidence limits and precision for all auk species (identified to group and species levels) in Zones 1 and 2. Estimates within the target precision of 0.16 are in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	17	132	62	232	0.24
		Zone 2	10	76	15	167	0.32
	2011	Zone 1	6	49	16	98	0.41
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	35	272	155	419	0.17
		Zone 2	7	51	7	117	0.38
	2011	Zone 1	18	148	66	246	0.24
		Zone 2	9	73	24	139	0.33
January	2011	Zone 1	<i>50</i>	<i>323</i>	<i>194</i>	<i>484</i>	<i>0.14</i>
		Zone 2	3	23	3	45	0.58
	2012	Zone 1	<i>68</i>	<i>554</i>	<i>399</i>	<i>709</i>	<i>0.12</i>
		Zone 2	20	163	90	245	0.22
February	2011	Zone 1	36	235	117	404	0.17
		Zone 2	22	139	51	253	0.21
	2012	Zone 1	30	139	79	218	0.18
		Zone 2	<i>41</i>	<i>187</i>	<i>91</i>	<i>325</i>	<i>0.16</i>

3.1.2.19 Auk species

Data presented in Table 3.22 refer to all auks that were not identified to species level. Those identified beyond group level appear separately below. During the winter 2010 / 11 surveys, auk species peaked in Zone 1 during January 2011 when an estimated 323 individuals were present. In Zone 2 during the 2010 / 11 surveys, auk species peaked at an estimated 139 individuals during February 2011. During the winter 2011 / 12 surveys, auks peaked at an estimated 19 individuals in Zone 1 during February 2012 and an estimated 16 individuals in Zone 2 during January 2012.

Table 3.22 Monthly counts, estimates, confidence limits and precision for auk species (identified to group level) in Zones 1 and 2. Estimates within the target precision of 0.16 are in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	17	132	62	232	0.24
		Zone 2	10	76	15	167	0.32
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	35	272	155	419	0.17
		Zone 2	7	51	7	117	0.38
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	2	16	2	41	0.71
January	2011	Zone 1	<i>50</i>	<i>323</i>	<i>194</i>	<i>484</i>	<i>0.14</i>
		Zone 2	3	23	3	45	0.58
	2012	Zone 1	2	16	2	41	0.71
		Zone 2	2	16	2	41	0.71
February	2011	Zone 1	36	235	117	404	0.17
		Zone 2	22	139	51	253	0.21
	2012	Zone 1	4	19	4	51	0.50
		Zone 2	0	0	0	0	N/A

3.1.2.20 *Guillemot / razorbills*

Data presented in Table 3.23 refer to individuals identified as either guillemots or razorbills. No guillemots / razorbills were recorded during winter 2010 / 11 surveys. During the winter 2011 / 12 surveys, guillemots / razorbills peaked during January 2012 in Zone 1 with an estimated 489 individuals present. In Zone 2 during the 2011 / 12 surveys, guillemots / razorbills peaked at an estimated 187 individuals during February 2012.

Table 3.23 Monthly counts, estimates, confidence limits and precision for guillemots / razorbills in Zones 1 and 2. Estimates within the target precision of 0.16 in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	6	49	16	90	0.41
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	15	123	49	213	0.26
		Zone 2	7	57	16	106	0.38
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	<i>60</i>	<i>489</i>	<i>342</i>	<i>644</i>	<i>0.13</i>
		Zone 2	16	131	65	212	0.25
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	25	116	60	176	0.20
		Zone 2	<i>41</i>	<i>187</i>	<i>91</i>	<i>315</i>	<i>0.16</i>

3.1.2.21 *Guillemots*

Data in Table 3.24 refer to guillemots. No guillemots were identified during the winter 2010 / 11 surveys. During the winter 2011 / 12 surveys, guillemots peaked in Zone 1 at an estimated eight individuals during both December 2011 and January 2012. In Zone 2 during the 2011 / 12 surveys, guillemots peaked at an estimated eight individuals during January 2012.

Table 3.24 Monthly counts, estimates, confidence limits and precision for guillemots in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	1	8	1	25	>1.00
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	1	8	1	24	>1.00
		Zone 2	1	8	1	25	>1.00
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	1	5	1	14	>1.00
		Zone 2	0	0	0	0	N/A

3.1.2.22 Razorbills

Data presented in Table 3.25 refer to razorbills. No razorbills were identified during the winter 2010 / 11 surveys. During the winter 2011 / 12 surveys, razorbills peaked at an estimated eight individuals in Zone 1 during December 2011. No razorbills were identified in Zone 2 during the winter 2011 / 12 surveys.

Table 3.25 Monthly counts, estimates, confidence limits and precision for razorbills in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	1	8	1	25	>1.00
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A

3.1.2.23 Little auks

Data in Table 3.26 refer to little auks. No little auks were identified during the winter 2010 / 11 surveys. During the winter 2011 / 12 surveys, no little auks were identified in Zone 1 whilst little auks peaked at an estimated eight individuals in Zone 2 during January 2012.

Table 3.26 Monthly counts, estimates, confidence limits and precision for little auks in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	1	8	1	33	>1.00
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A

3.1.2.24 *Puffins*

Data in Table 3.27 refer to puffins. No puffins were identified during the winter 2010 / 11 surveys. During the winter 2011 / 12 surveys, puffins peaked at an estimated 41 individuals in Zone 1 during January 2012 whilst no puffins were identified in Zone 2 in any month during these surveys.

Table 3.27 Monthly counts, estimates, confidence limits and precision for puffins in Zones 1 and 2.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	1	8	1	25	>1.00
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	8	41	8	81	0.45
		Zone 2	0	0	0	0	N/A
February	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A

3.1.3 Marine mammals

Data presented in Table 3.30 refer to marine mammals (all of which were individuals identified as dolphins / porpoises). During the winter 2010 / 11 surveys, marine mammals peaked at an estimated 365 individuals in Zone 1 and 25 individuals in Zone 2 during February 2011. During the winter 2011 / 12 surveys, marine mammals also peaked during February with an estimated 106 individuals present in Zone 1 and 23 individuals present in Zone 2.

Table 3.30 Monthly counts, estimates, confidence limits and precision for marine mammals in Zones 1 & 2. Estimates within the target precision of 0.16 in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
	2011	Zone 1	2	16	2	41	0.71
		Zone 2	0	0	0	0	N/A
December	2010	Zone 1	0	0	0	0	N/A
		Zone 2	1	7	1	22	>1.00
	2011	Zone 1	0	0	0	0	N/A
		Zone 2	0	0	0	0	N/A
January	2011	Zone 1	5	32	6	71	0.45
		Zone 2	0	0	0	0	N/A
	2012	Zone 1	2	16	2	41	0.71
		Zone 2	2	16	2	41	0.71
February	2011	Zone 1	<i>56</i>	<i>365</i>	<i>261</i>	<i>489</i>	<i>0.13</i>
		Zone 2	4	25	6	51	0.50
	2012	Zone 1	23	106	60	157	0.21
		Zone 2	5	23	5	55	0.45

3.2 Distribution

3.2.1 *Distribution of divers*

3.2.1.1 *November 2010*

The relative distribution of divers recorded in Zones 1 and 2 during November 2010 is shown in Figure 3.1: A. The distribution of each individual diver recorded in this survey is shown in Figure 3.3: A & B.

Relatively few divers were recorded in the images taken across Zones 1 and 2 in the November 2010 survey. The birds recorded in Zone 1 were located largely towards the western side of the zone, along the western boundary of the proposed London Array wind farm site and within the western buffer area. The bathymetry data indicate that the birds were located in areas approximately 5 - 20 m in depth and were generally located around the edge of the shallowest areas i.e. sand banks. Data on tide height at the nearest point to the London Array site (Whitaker Beacon) indicate that the tide was outgoing at the time of survey (Appendix III).

Divers were located in two main areas within Zone 2; in the west and south-east of the zone. As with Zone 1, birds were located in areas of approximately 5 - 20 m in depth and were generally around the edge of the shallowest sand bank areas. Data on tide height at Whitaker Beacon indicate that the tide was outgoing at the time of survey (Appendix III).

3.2.1.2 *December 2010*

The relative distribution of divers recorded in Zones 1 and 2 during December 2010 is shown in Figure 3.1: B. The distribution of each individual diver recorded in this survey is shown in Figure 3.4: A & B.

High concentrations of divers were recorded in Zone 1 during this survey. The majority of the divers recorded within this zone were located in the eastern half of the zone, with the highest densities located towards the centre of the zone. Smaller concentrations of individuals were present towards the south-west of the zone. The divers located towards the centre of the zone were in areas of approximately 15 - 20 m in depth and were near to the edge of shallow sand bank areas. Individuals located towards the western and eastern boundaries were present in shallower areas of around 2 - 8 m in depth. Data on tide height at Whitaker Beacon indicate that the tide was approaching high tide towards the beginning of the survey and then outgoing towards the end of the survey (Appendix III).

High concentrations of divers were recorded towards the north of Zone 2 with lower densities recorded towards the east and west. These divers were largely distributed in areas of 10 - 20 m in depth around the edge of the shallowest (sand bank) areas, with a small number of individuals ($n = 2$) located in areas of 2 - 4 m in depth. Data on tide height at Whitaker Beacon indicate that the tide was approaching high tide towards the beginning of the survey and then outgoing towards the end of the survey (Appendix III).

3.2.1.3 *January 2011*

The relative distribution of divers recorded in Zones 1 and 2 during January 2011 is shown in Figure 3.1: C. The distribution of each individual diver recorded in this survey is shown in Figure 3.5: A & B.

High concentrations of divers were again recorded in Zone 1 during the January 2011 survey, with relatively low concentrations recorded in Zone 2. Divers recorded within Zone 1 were distributed along the western side of the zone, largely within the proposed London Array wind farm area. Divers were also located within the buffer area. Further individuals were located towards the eastern side of the zone, with a small concentration located to the north-east of the proposed wind farm area. Divers were largely located in shallow areas (approximately 5 - 10 m in depth) or around the edge of these areas. Data on tide height at Whitaker Beacon indicate that low tide occurred near the start of the survey and for the majority of the survey, the tide was on the way in (Appendix III).

Divers recorded in Zone 2 were all located to the north-east of the zone in shallow areas of less than 5 m in depth. Data on tide height at Whitaker Beacon indicate that it was near high tide at the start of the survey and the tide was on the way at towards the end of the survey (Appendix III).

3.2.1.4 *February 2011*

The relative distribution of divers recorded in Zones 1 and 2 during February 2011 is shown in Figure 3.1: D. The distribution of each individual diver recorded in this survey is shown in Figure 3.6: A & B.

Divers were again concentrated in Zone 1 during this survey, distributed from the north-eastern corner of the zone running down the eastern side of the zone and extending out to the south-west, with small concentrations of divers located within the proposed wind farm site. Divers were also scattered to the south-west of this main concentration and largely located in areas of approximately 10 - 25 m in depth. Relatively low concentrations of divers were recorded in areas of less than 5 m in depth. Data on tide height at Whitaker Beacon indicate that the tide was outgoing at the time of survey (Appendix III).

Divers in Zone 2 were distributed largely around a central line across the zone in shallow areas (i.e. sand banks less than 5 m in depth). Those divers located towards the edge of the zone were in deeper areas of approximately 15 - 20 m in depth. Data on tide height at Whitaker Beacon indicate that high tide occurred approximately a quarter of the way into the survey and following this the tide was on the way out for the remainder of the survey (Appendix III).

3.2.1.5 *November 2011*

The relative distribution of divers recorded in Zones 1 and 2 during November 2010 is shown in Figure 3.2: A. The distribution of each individual diver recorded in this survey is shown in Figure 3.7: A & B.

In Zone 1, two divers were recorded; one towards the north-east of the zone and another towards the north of the London Array wind farm site. The bathymetry data indicates that these individuals were located in areas approximately 5 - 10 m water depth and were generally located around the edges of the shallowest areas (i.e. sand banks). Data on tide height at Whitaker Beacon indicate that the tide was outgoing until approximately half way through the survey and then incoming during the rest of the survey (Appendix III).

A single diver was located within the centre of Zone 2 during the November 2011 survey. As with Zone 1, this individual was located in an area of approximately 10 m water depth, at the edge of the shallowest sand bank areas. Data on tide height indicate that the tide was incoming until approximately half way through the survey and then outgoing for the remainder of the survey (Appendix III).

3.2.1.6. December 2011

The relative distribution of divers recorded in Zones 1 and 2 during the December 2011 survey is shown in Figure 3.2: B. The distribution of each individual diver recorded in this survey is shown in Figure 3.8: A & B.

In Zone 1, two divers were again recorded; one towards the south-east of the London Array wind farm site, the other towards the centre of the northern boundary of the zone. These individuals were recorded near to the edge of shallow sand bank areas, approximately 7 - 20 m water depth. Data on tide height from Whitaker Beacon indicate that the tide was outgoing during most of the survey except for the last two hours when it was incoming (Appendix III). No divers were present in Zone 2 during the December 2011 survey.

3.2.1.7. January 2012

The relative distribution of divers recorded in Zones 1 and 2 in the images from the January 2012 survey is shown in Figure 3.2: C. The distribution of each individual diver recorded in this survey is shown in Figure 3.9: A & B.

Individuals in Zone 1 were largely located along the eastern side of the zone, mostly within the London Array wind farm site (n = 107). The remaining divers were located along the northern border of the zone. Divers were located in shallow areas, approximately 5 - 20 m in depth and around the edge of these areas. Data on tide height at Whitaker Beacon indicate that the tide was outgoing at the time of the survey (Appendix III).

A relatively large number of divers were also located within Zone 2 during the January 2012 survey (n = 87). Divers were distributed throughout Zone 2 but were less concentrated in the eastern and western corners of the zone. All individuals were recorded in shallow areas up to 10 m water depth. Data on tide height at Whitaker Beacon indicate that the tide was on the way out until approximately half way through surveying (Appendix III).

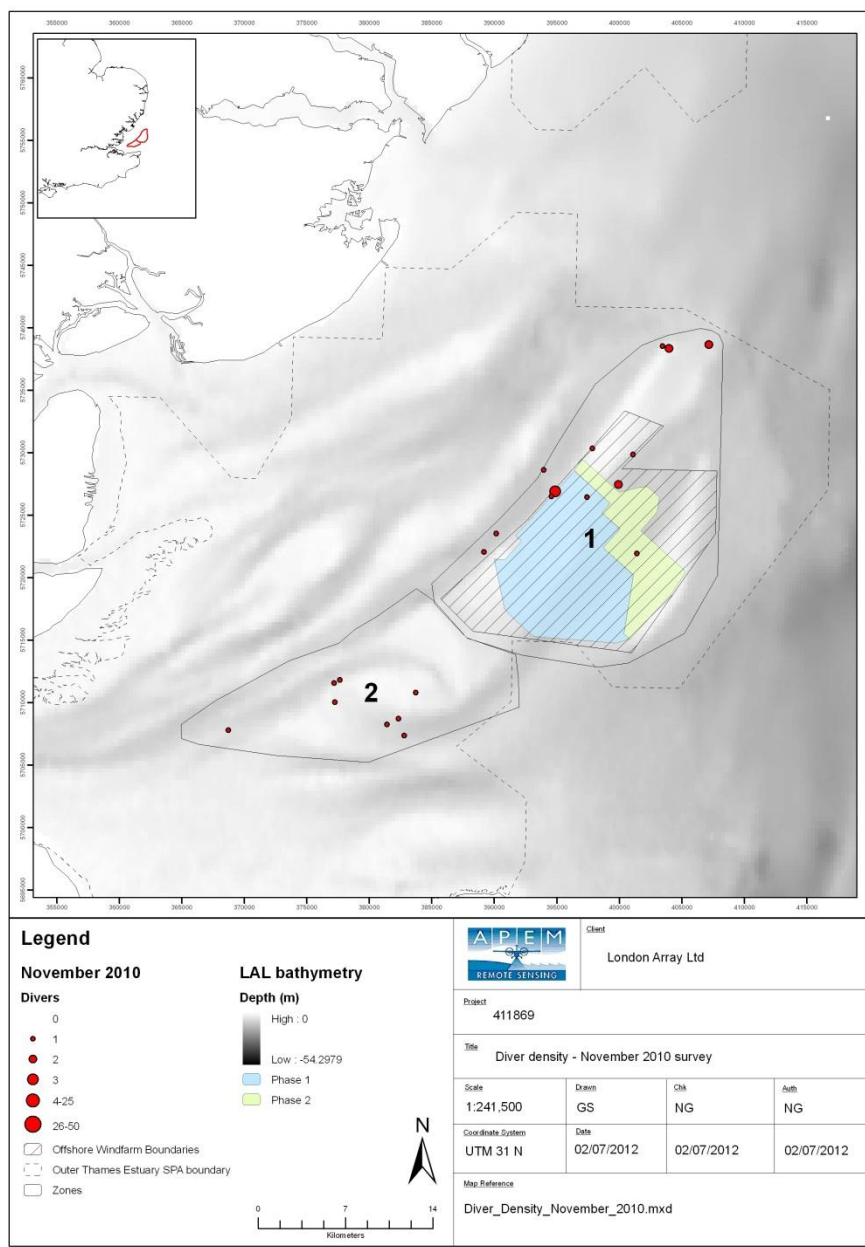
3.2.1.8. February 2012

The relative distribution of divers recorded in Zones 1 and 2 in the images from the February 2012 survey is shown in Figure 3.2: D. The distribution of each individual diver recorded in this survey is shown in Figure 3.10: A & B.

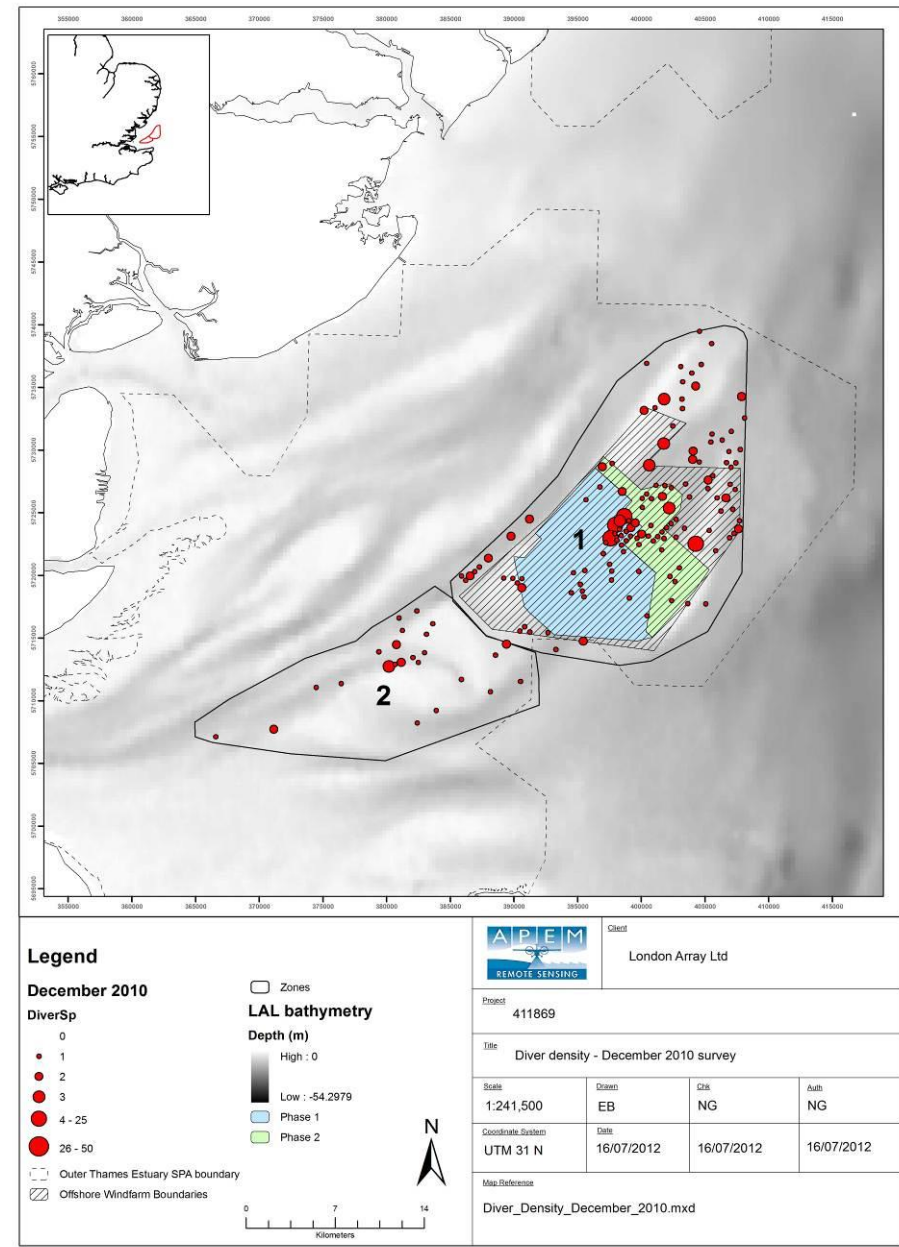
Within Zone 1, a total of 155 divers were present, again concentrated along the eastern side of the zone. Most of these individuals were to the north-east of the London Array wind farm site with 75 individuals located within it. The remaining divers were thinly dispersed across much of the rest of Zone 1. Divers within Zone 1 were largely located in areas of approximately 10 - 25 m water depth, although small numbers of birds were in much shallower areas of less than 5 m water depth. Data on tide height at Whitaker Beacon indicate that high tide was reached approximately half way through the survey (Appendix III).

In contrast to previous surveys, the majority of divers recorded during the February 2012 survey were located in Zone 2 rather than Zone 1 with a total of 433 divers recorded. Large concentrations of divers were located within the eastern half of Zone 2, in the shallowest part 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). Data on tide height at Whitaker Beacon indicate that the tide was incoming at the time of survey (Appendix III).

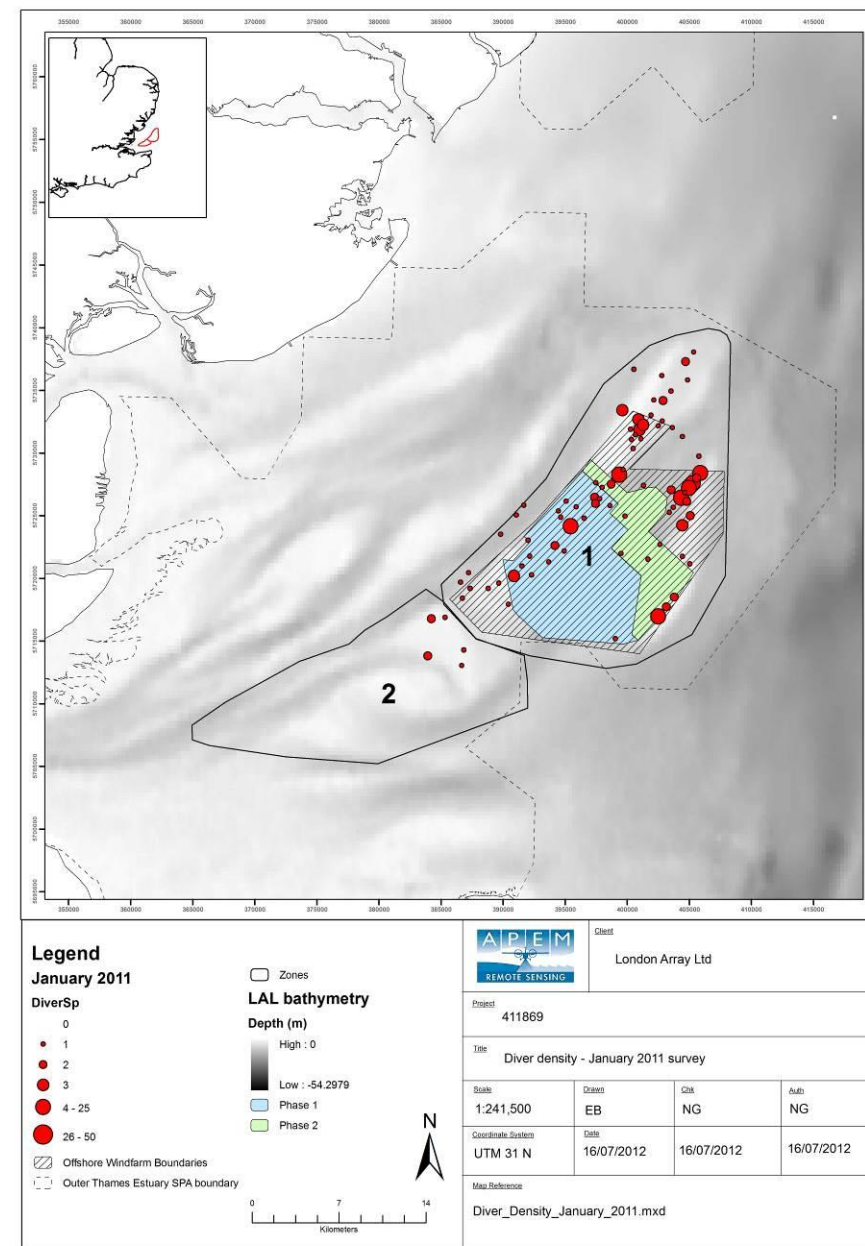
Figure 3.1: Relative distribution of divers recorded in Zones 1 and 2 in each survey month during the winter of 2010 / 2011



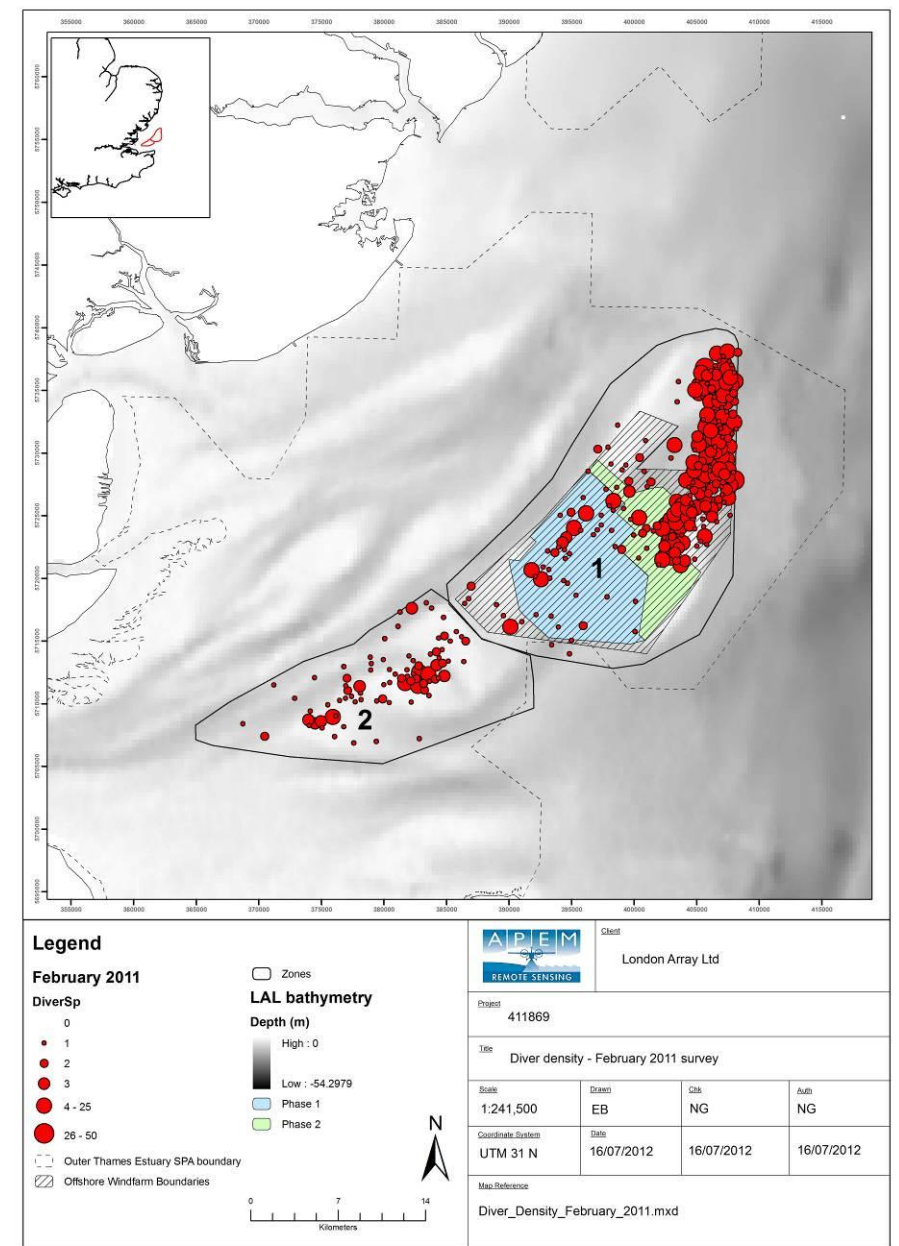
A: November 2010



B: December 2010

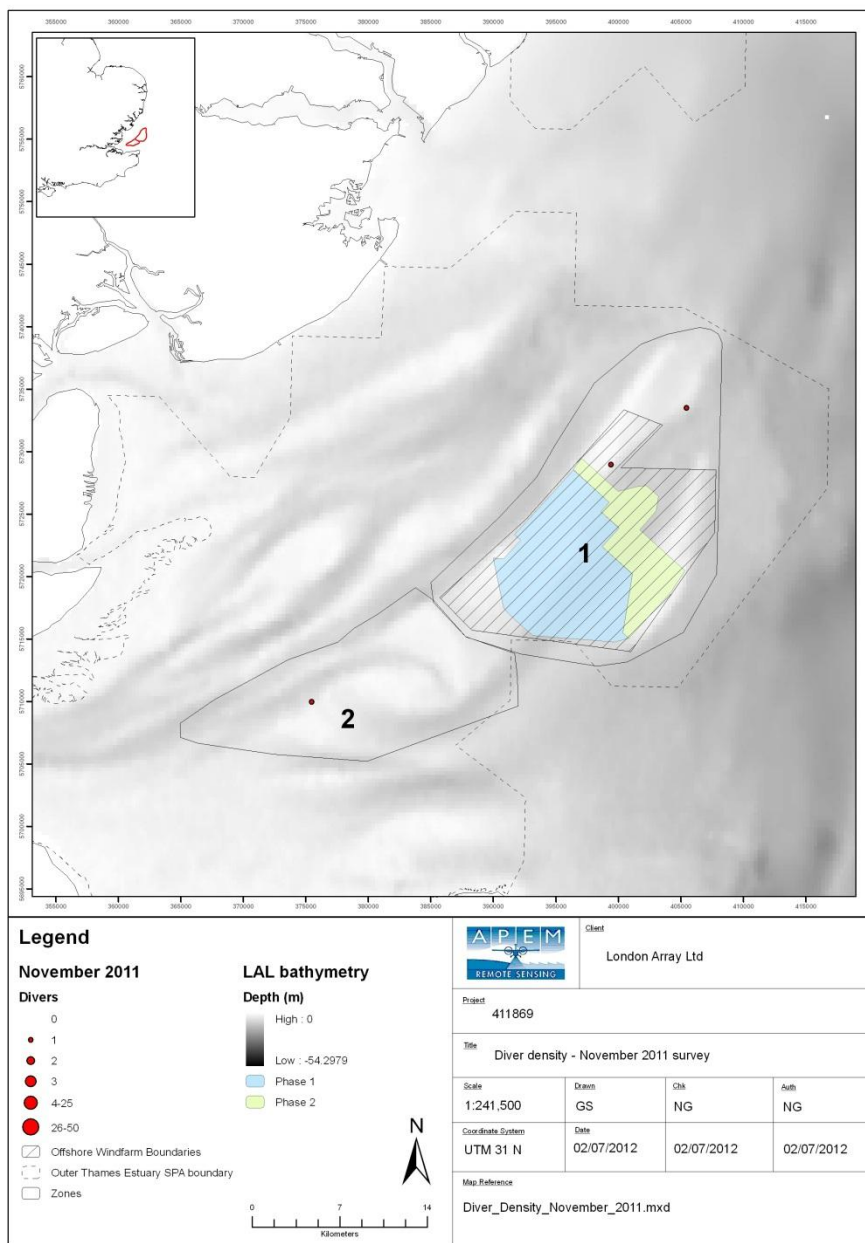


C: January 2011

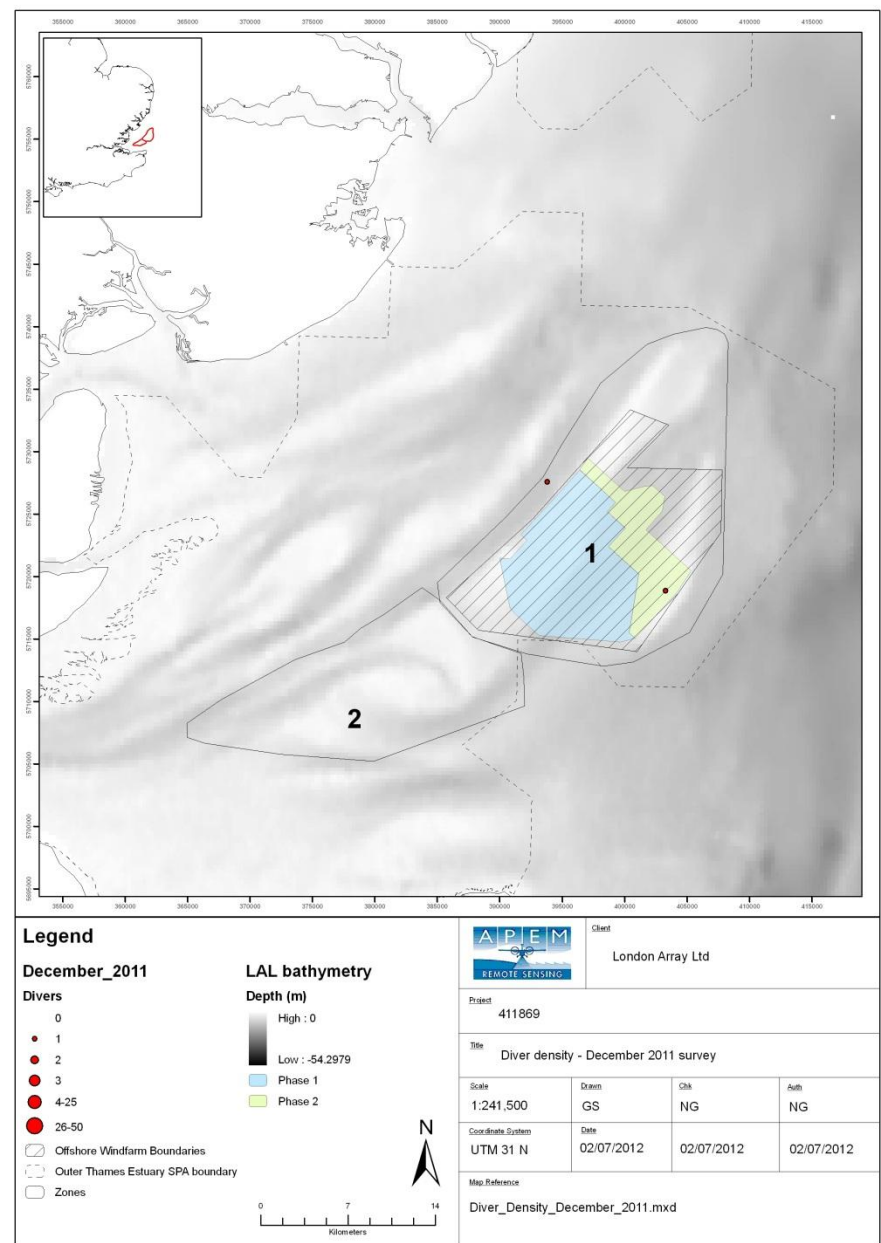


D: February 2011

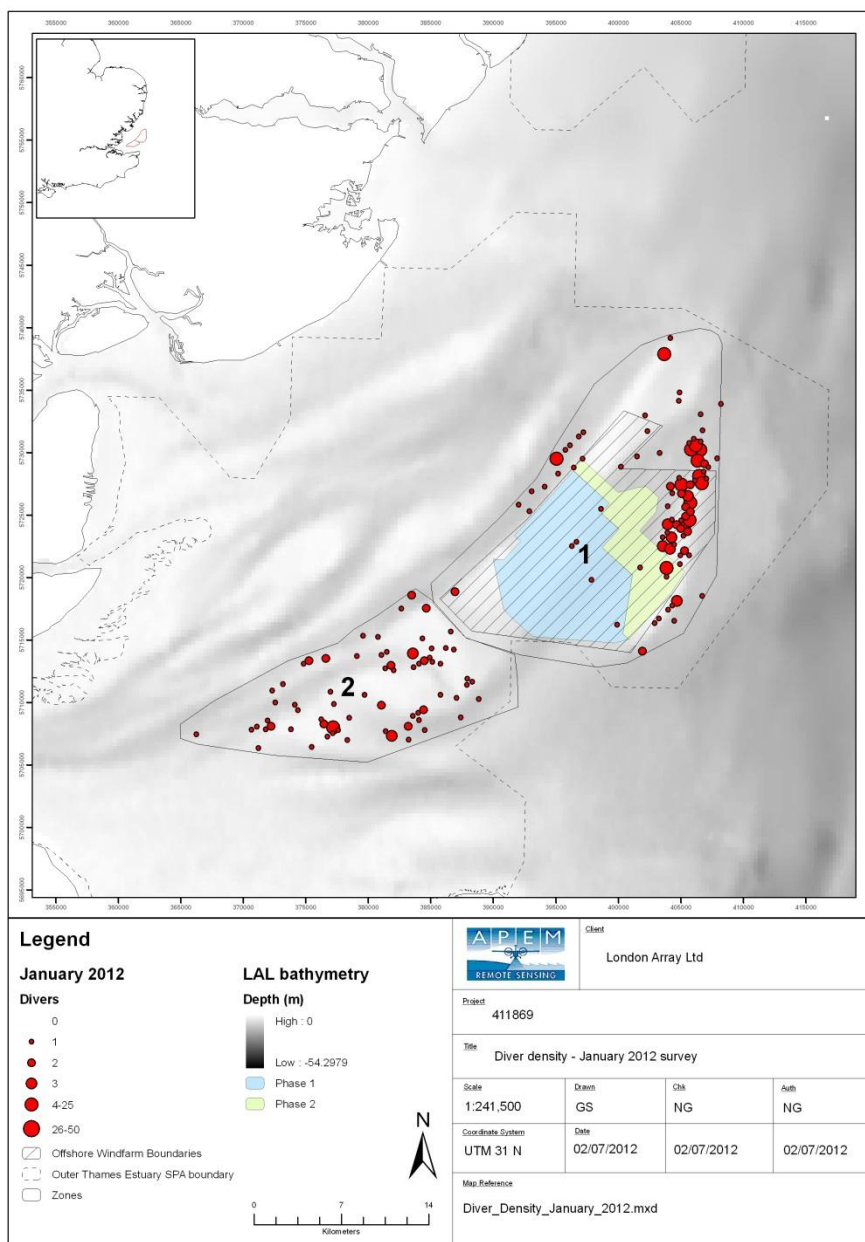
Figure 3.2: Relative distribution of divers recorded Zones 1 and 2 in each survey month during the winter of 2011 / 2012



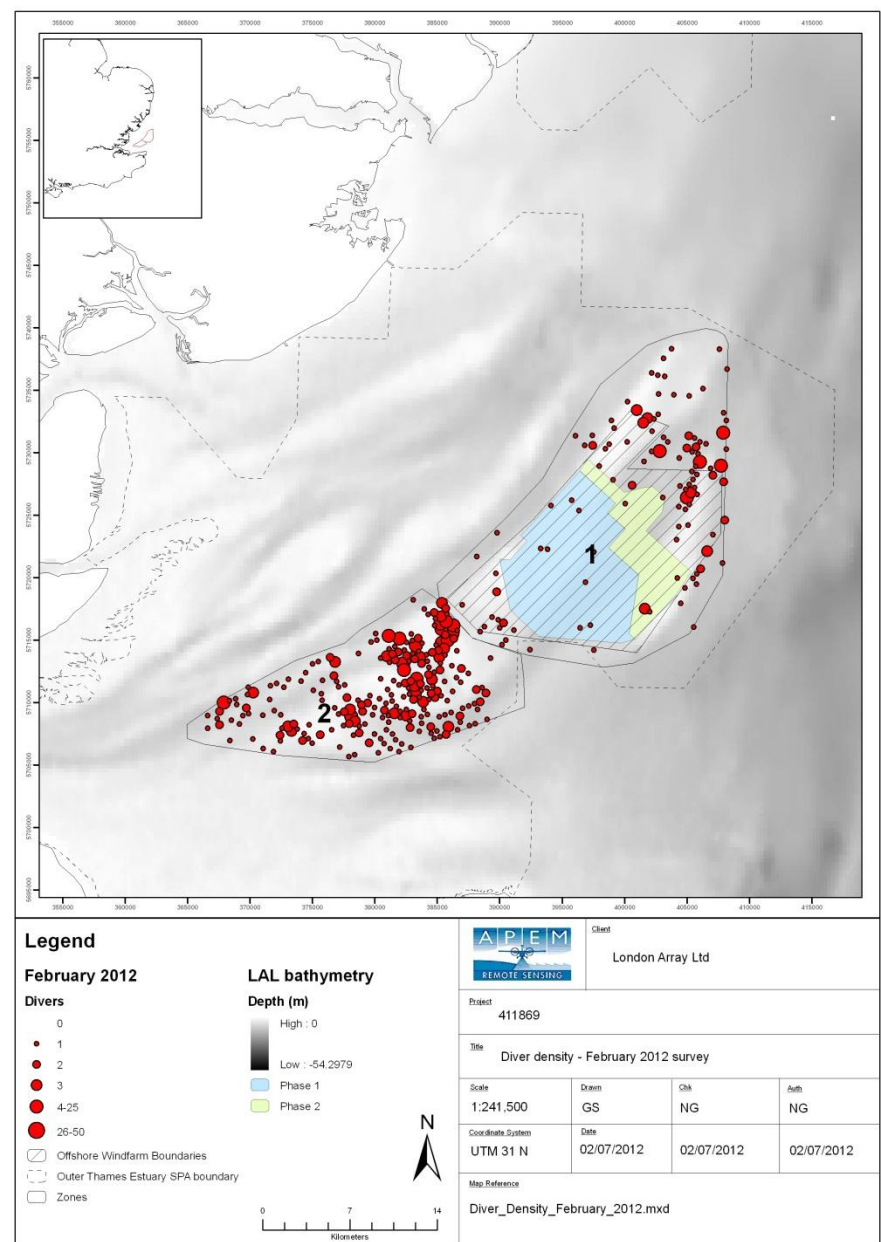
A: November 2011



B: December 2011



C: January 2012



D: February 2012

3.2.2 *Distribution of other bird species*

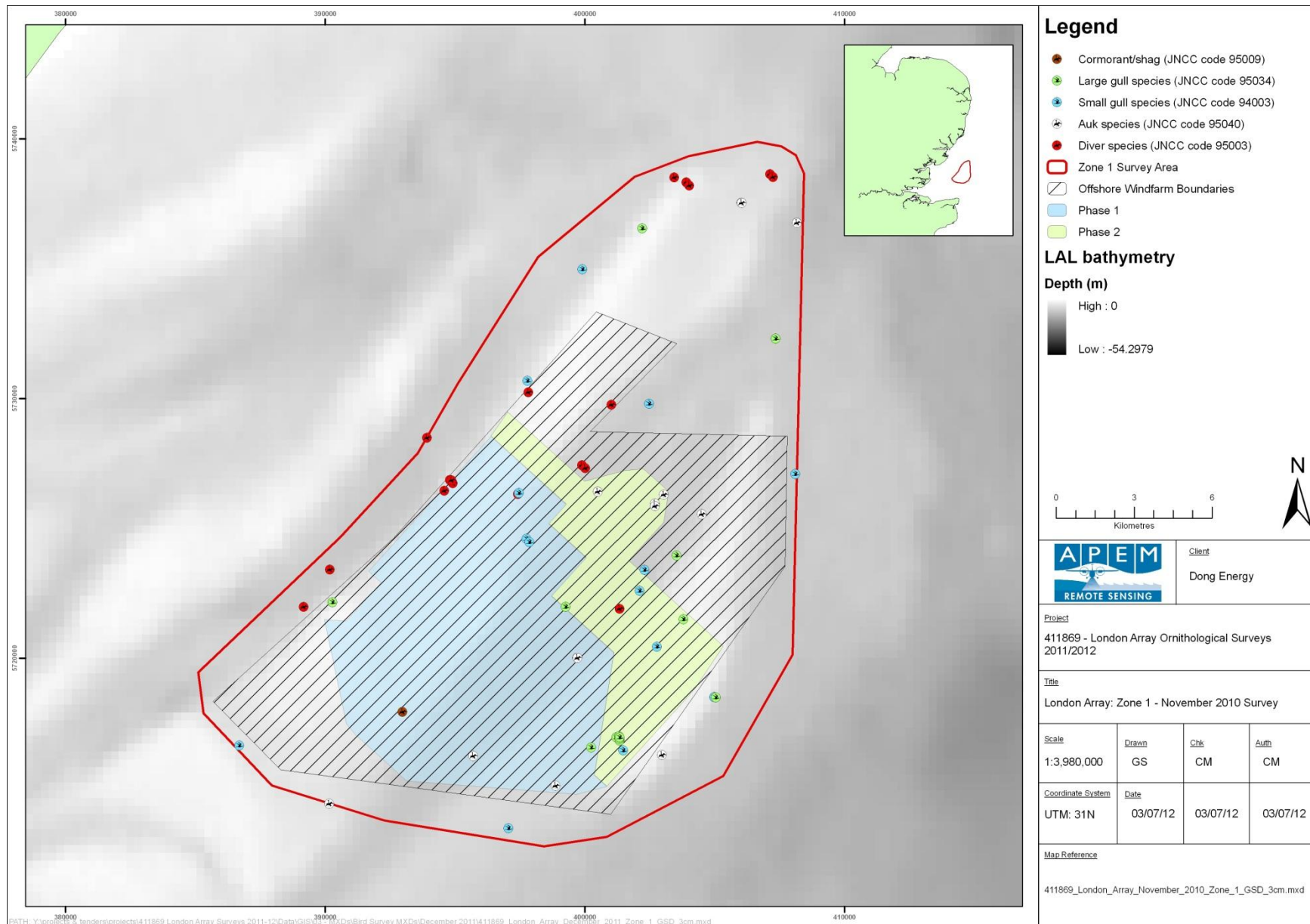
This section describes the distribution of all bird species / groups, excluding divers, that were recorded in each month during the winter surveys 2010 / 11 & 2011 / 12 in Zones 1 & 2. Diver distribution is described in Section 3.2.1 above. For each month, two maps have been produced to illustrate all bird locations in Zone 1 and Zone 2; the maps for each zone are labelled 'A' & 'B' respectively.

3.2.2.1 *November 2010*

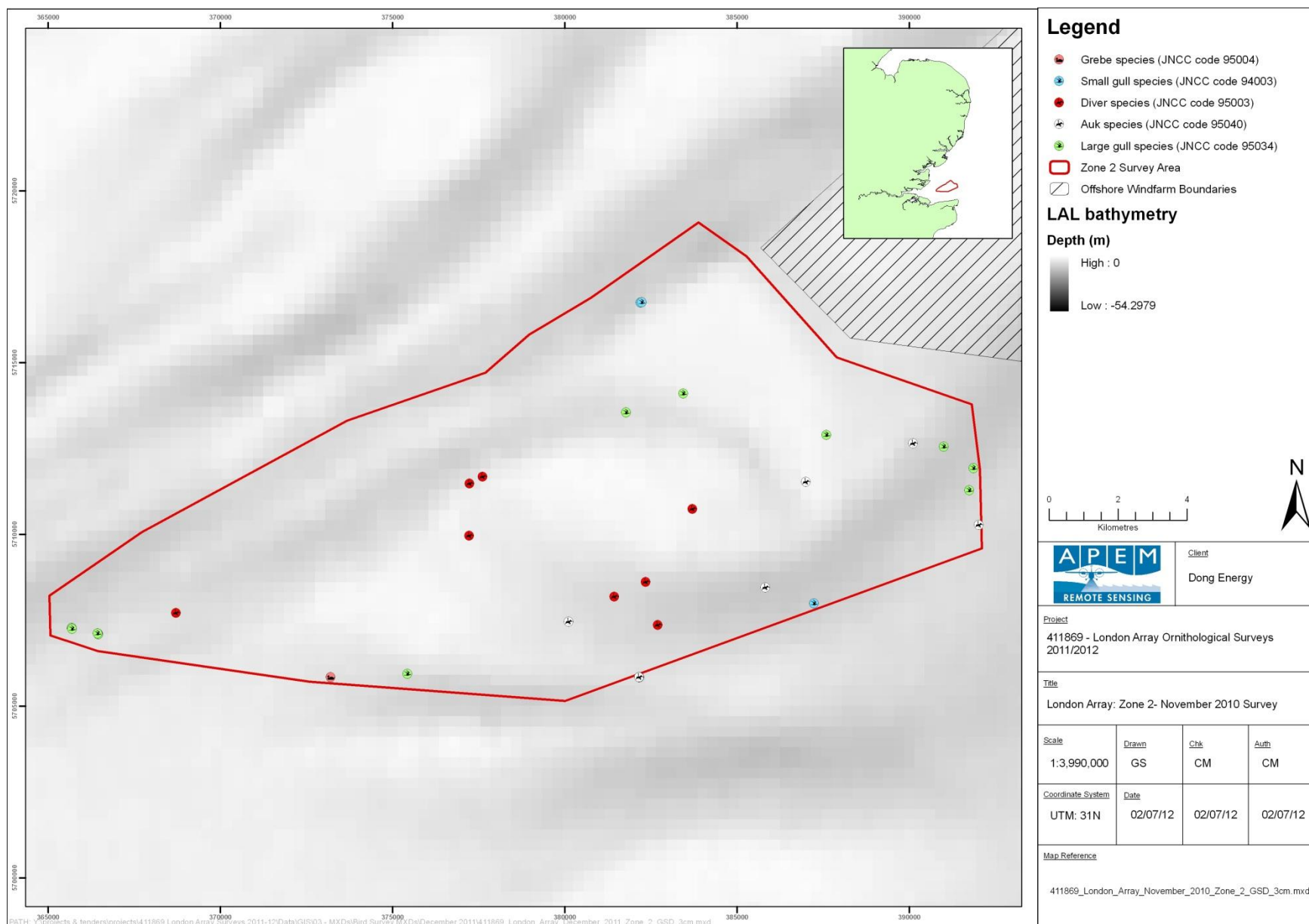
In November 2010 (Figure 3.3), the majority of the other bird species / groups (auks, large gulls and small gulls) recorded in Zone 1 were located in the eastern half of the proposed London Array wind farm area and in the buffer area to the north-east, east and south. A single cormorant / shag was located in the south-west of the zone.

Birds recorded within Zone 2 were generally located towards the edges of the zone. Auks were located towards the south and east of the zone. Small gulls were located towards the northern point of the zone and near the boundary in the south-east of the zone. Large gulls were largely located towards the west of the zone near the southern boundary or towards the eastern corner of the zone, with two birds located nearer to the centre.

Figure 3.3: Distribution of bird species / groups and marine mammals recorded in Zones 1 and 2 during the November 2010 survey.



A: Zone 1



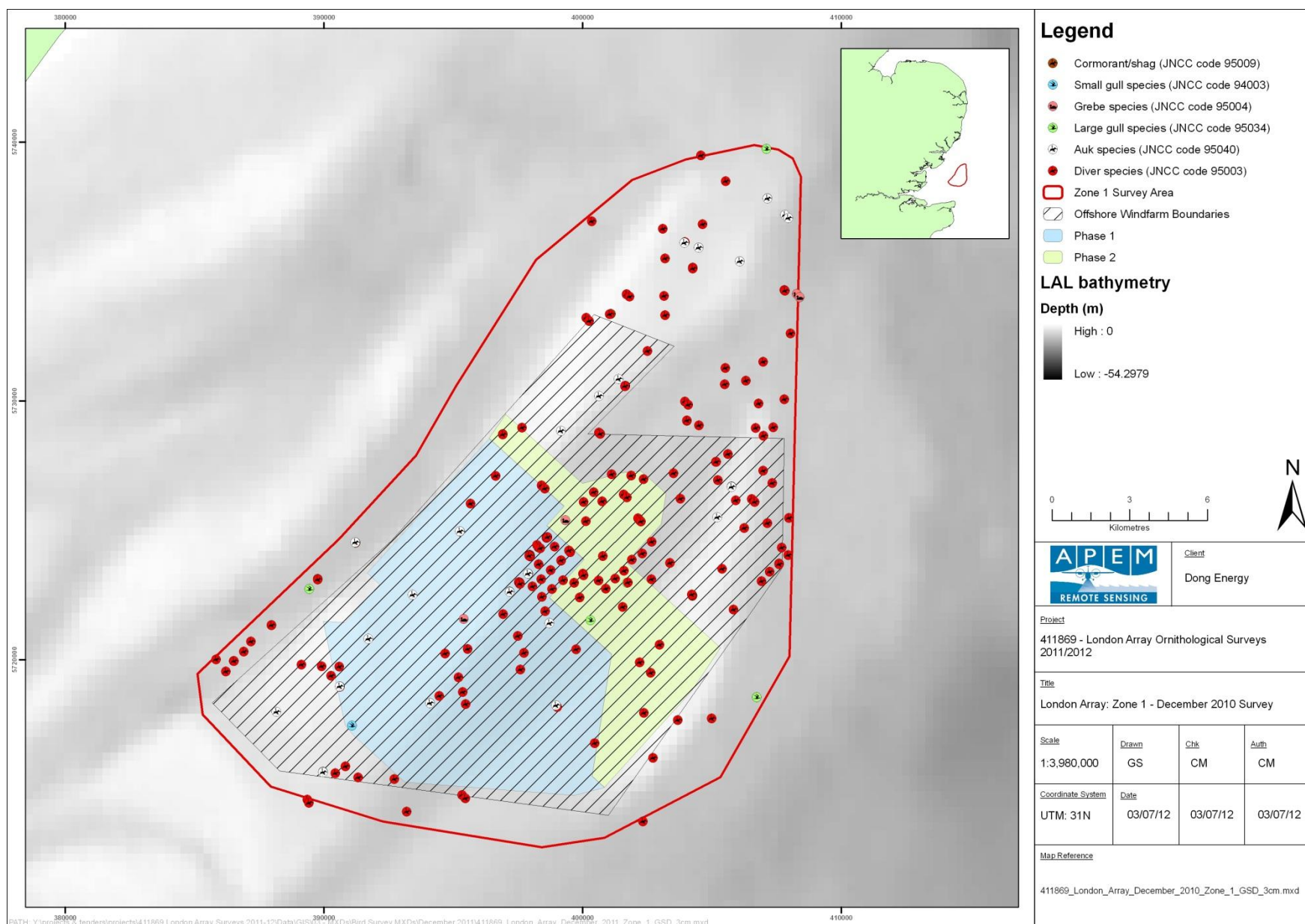
B: Zone 2

3.2.2.2 *December 2010*

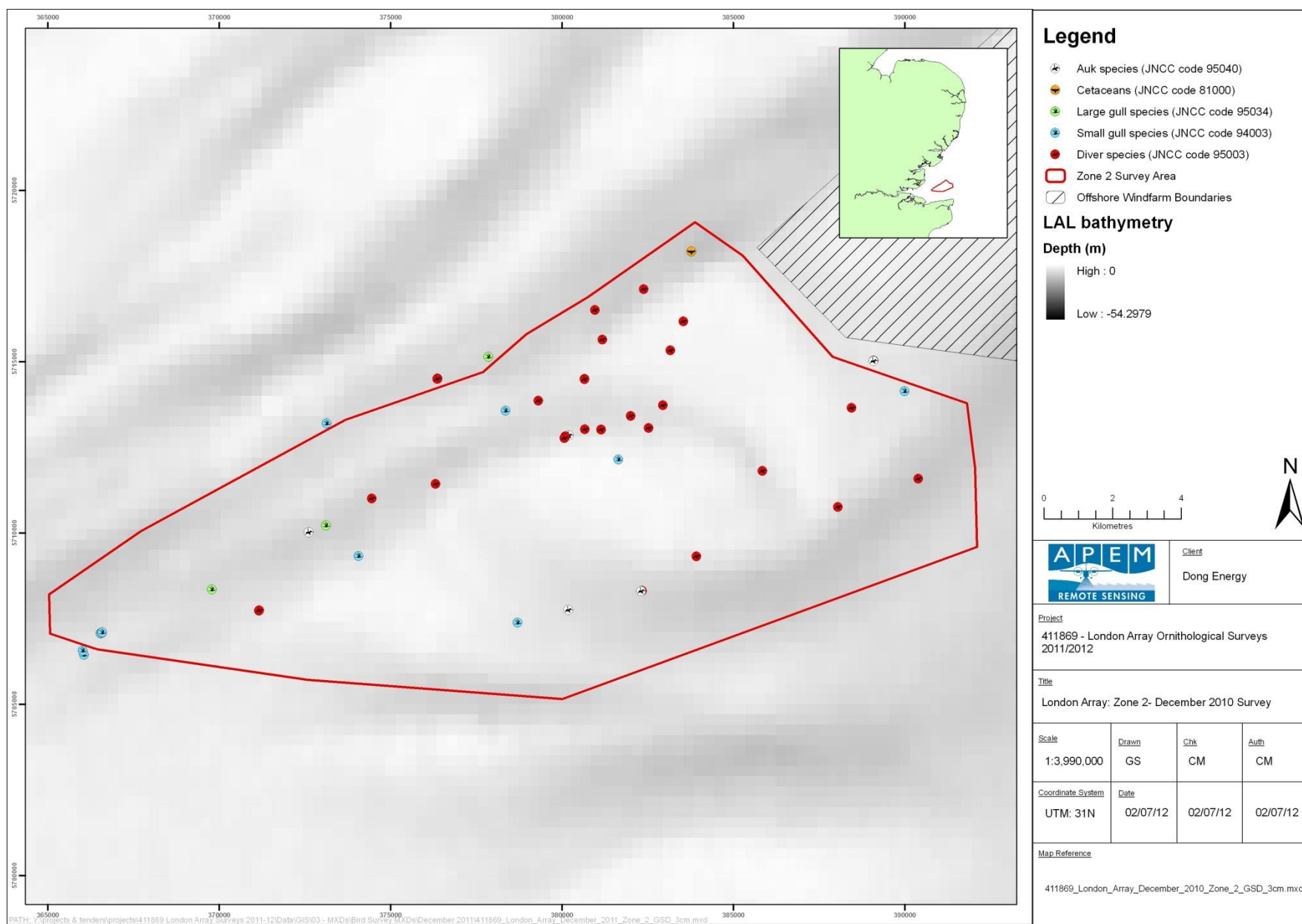
In December 2010 (Figure 3.4), auks were distributed around a central band running south-east to south-west through Zone 1. A total of five large gulls were recorded in the zone: four were located along a band from west to east towards the south of the zone, whilst a single bird was located near to the boundary in the north-eastern corner. Three grebes were recorded in the zone: one was located near the centre of the zone; another was located to the south-west of the centre; whilst the remaining bird was located near to the eastern boundary. The only other species / groups recorded were a single cormorant / shag just outside the northern point of the proposed wind farm area and a single small gull that was located towards the south-western corner of the zone.

Relatively few other bird species / groups were recorded within Zone 2. Small gulls were recorded largely within the upper half of the zone from the south-western corner to approximately two thirds of the way up in a north-easterly direction. Two auks were located to the north of the central area of the zone and two auks were located to the south of this area, whilst three auks were located just outside the zone boundary to the north-east. Two large gulls were located towards the south-west of the zone and a single bird was located just outside the upper boundary approximately two thirds of the way along.

Figure 3.4: Distribution of bird species / groups and marine mammals recorded in Zones 1 and 2 in the December 2010 survey.



A: Zone 1



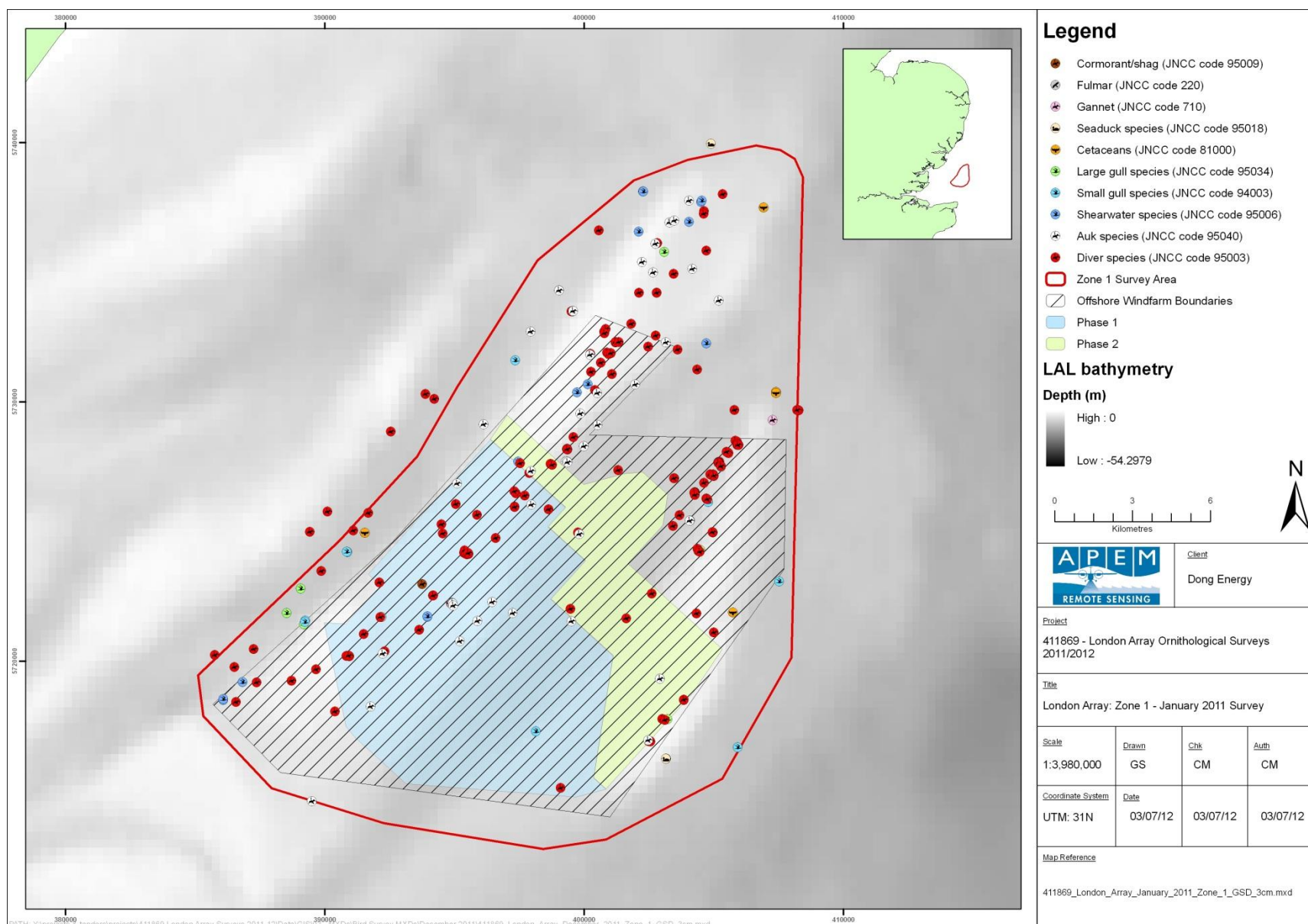
B: Zone 1

3.2.2.3 *January 2011*

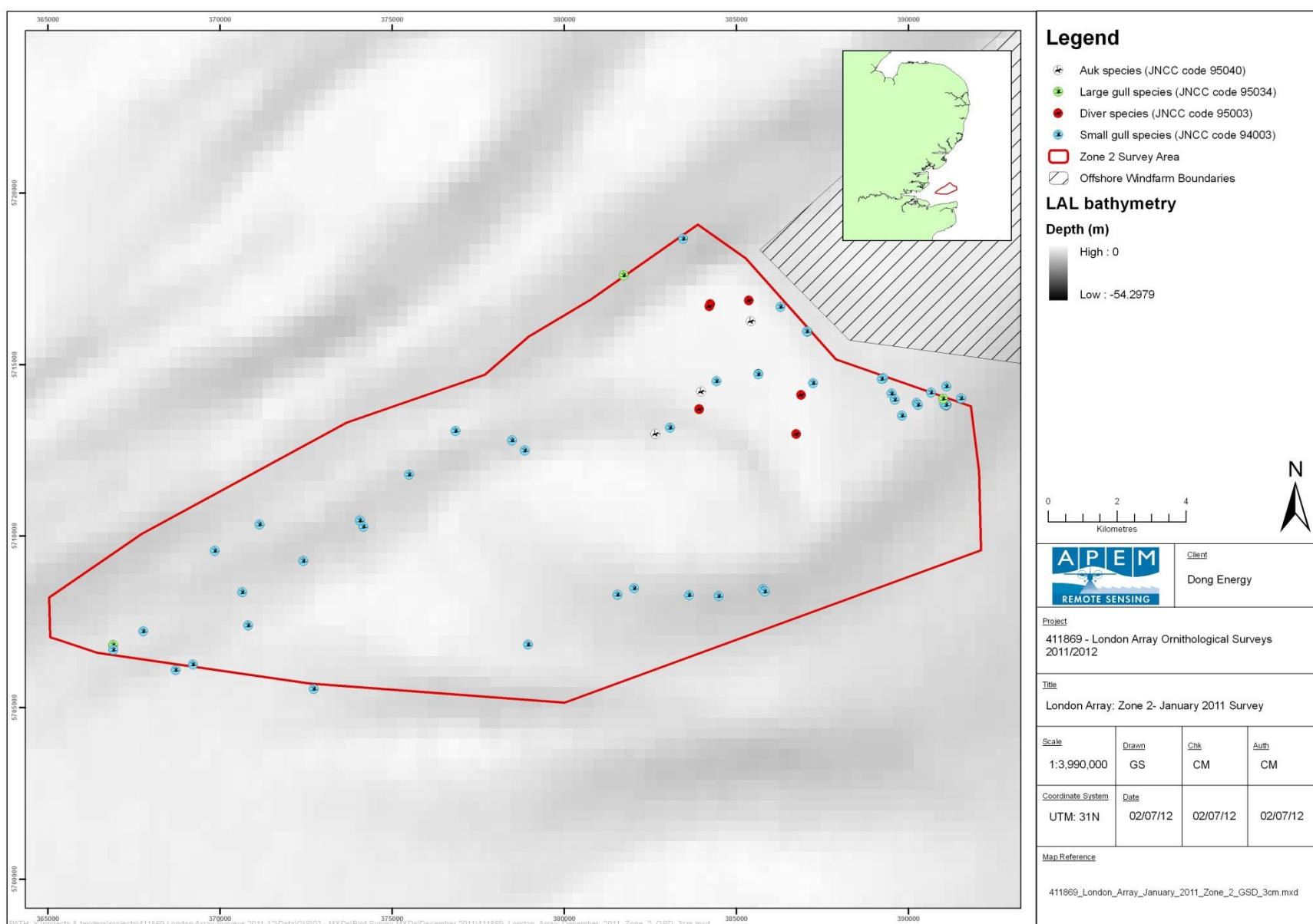
In January 2011 (Figure 3.5), many of the other bird species / groups recorded within Zone 1 were located towards the western side of the zone. Both small and large gull species were located towards the west of the zone within the buffer area, but birds were also located towards the east and south-east, mainly in the buffer area. The shearwaters recorded in this zone were distributed in a band running along the western side of the zone from the south-western corner to the north-eastern corner. Most of the shearwaters were within the proposed wind farm area, but those in the north-eastern corner of the zone were within the buffer area. Auks were spread across the western half of the zone, with a few birds near the centre and to the east. A single cormorant / shag and a single fulmar were located towards the south-west of the zone and a single gannet was located near the eastern boundary. Three seaducks were located in the south-east of the zone, whilst a single seaduck was present just outside the northern boundary of the zone.

In Zone 2 the other bird species / groups were largely located towards the edges of the zone, with no birds recorded within the central zone. Small gulls were located around the edge of almost the entire zone with the exception of the south-eastern corner. Only two large gulls were recorded within the zone: one was located just west of the most northerly part of the zone and the other was near the boundary near to the eastern corner of the zone. The only other species / group recorded in the zone were auks. The three auks recorded were located in a line running south-west from just east of the most northerly point of the zone.

Figure 3.5: Distribution of bird species / groups and marine mammals recorded in Zones 1 and 2 in the January 2011 survey.



A: Zone 1



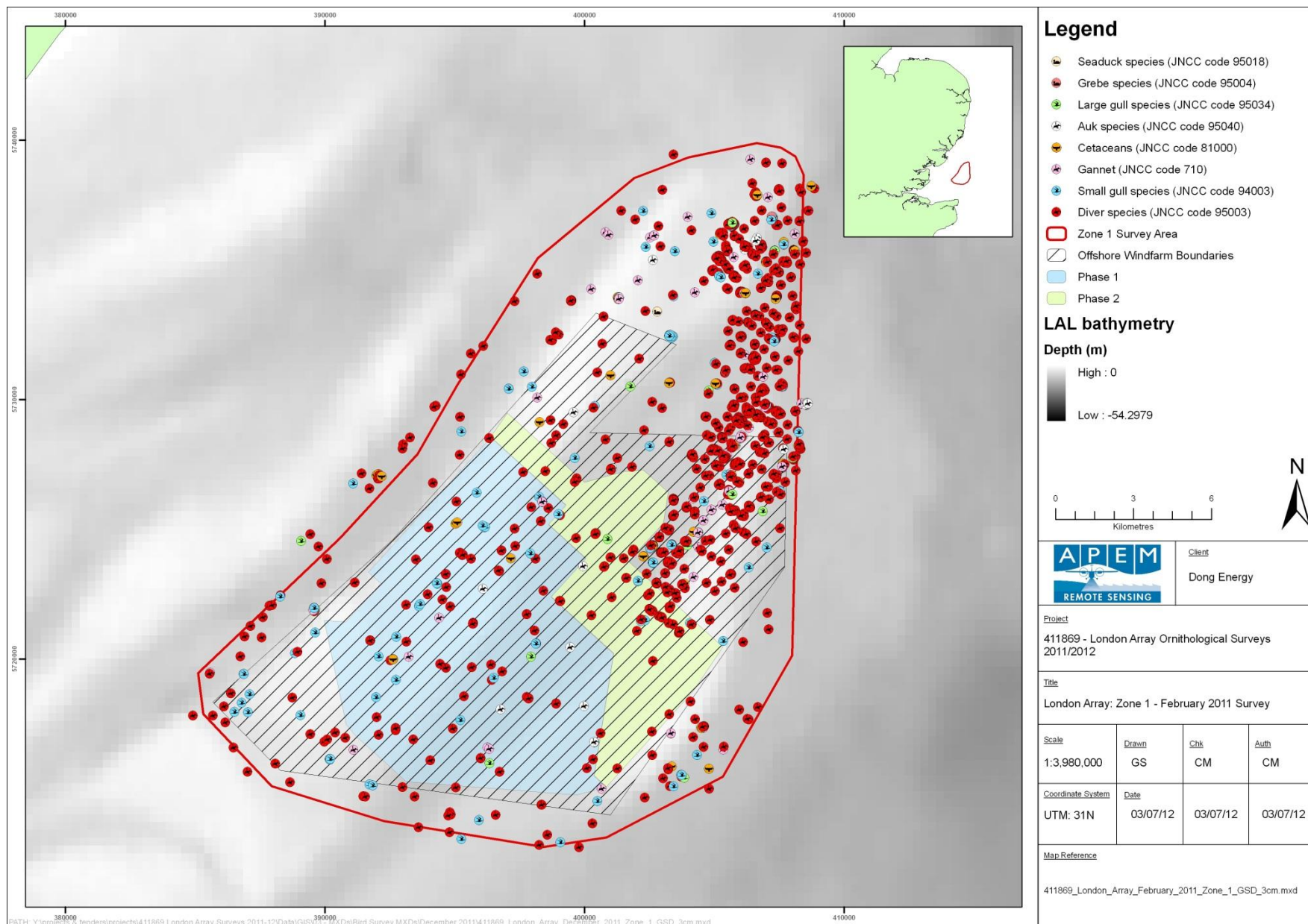
B: Zone 2

3.2.2.4 *February 2011*

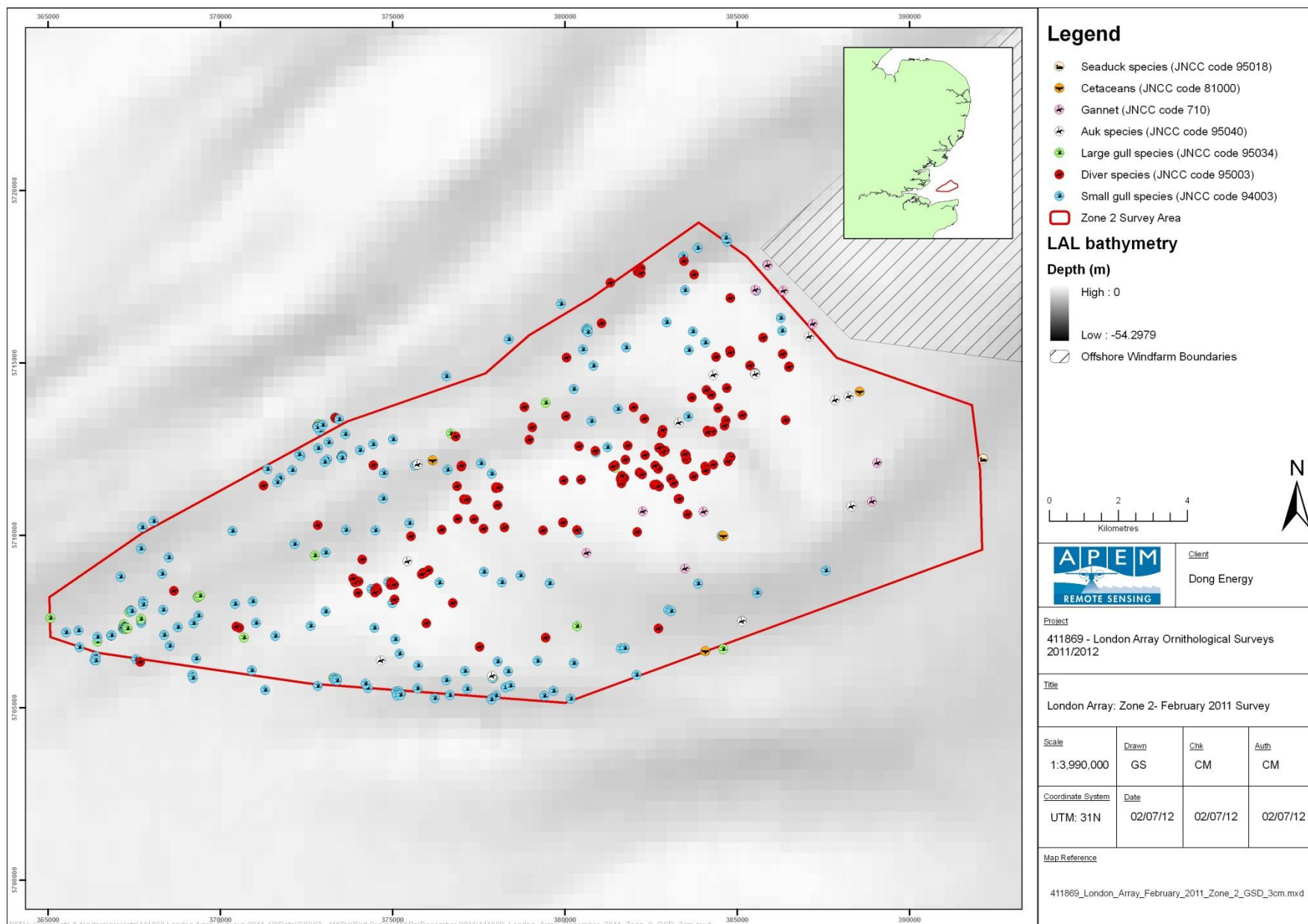
In February 2011 (Figure 3.6), auks were generally located towards the edges of Zone 1 mainly in the north-west, east and south-east, although two individuals were located in the south-west. Gannets were largely distributed in the eastern half of the zone with concentrations in the north, east and south-east of this area. Smaller numbers were also scattered towards the south-west. Large gulls were located largely across the central horizontal third of the zone, with two birds located further to the north, whilst small gulls were distributed across the zone. Additionally, two grebes were present: one in the north-west of the zone and the other in the south-west, and a single seaduck was present in the south-east of the zone.

The most predominant of the other bird species / groups recorded in Zone 2 were small gulls, which were located across the zone, with the exception of the most eastern corner. Large gulls were largely distributed along the western side of the southern boundary of the zone, although a few birds were found further to the north. Auks and gannets were mainly found towards the eastern half of the zone. The only other birds recorded were two seaducks that were located just outside of the eastern boundary.

Figure 3.6: Distribution of bird species / groups and marine mammals recorded in Zones 1 and 2 in the February 2011 survey.



A: Zone 1



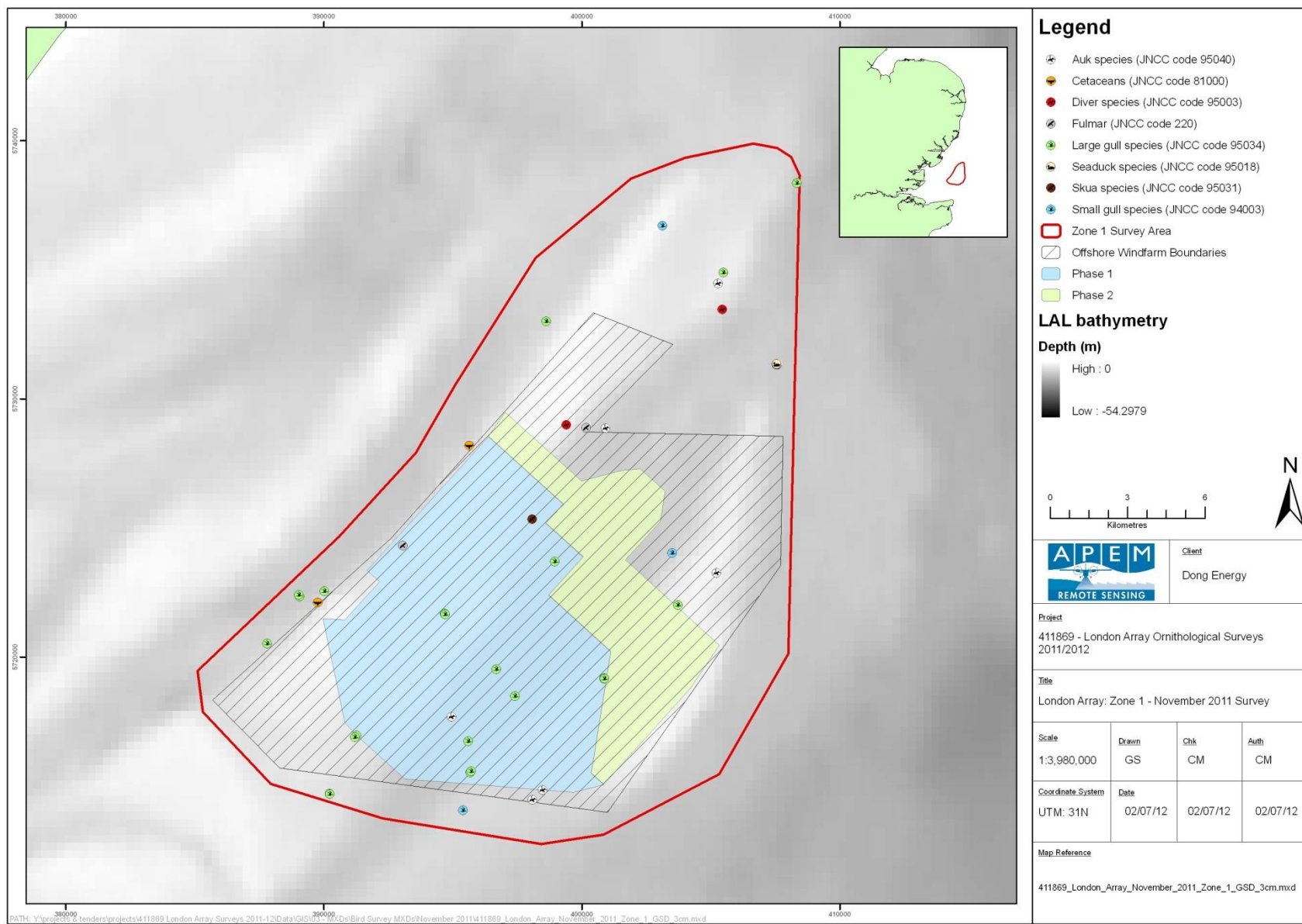
B: Zone 2

3.2.2.5 *November 2011*

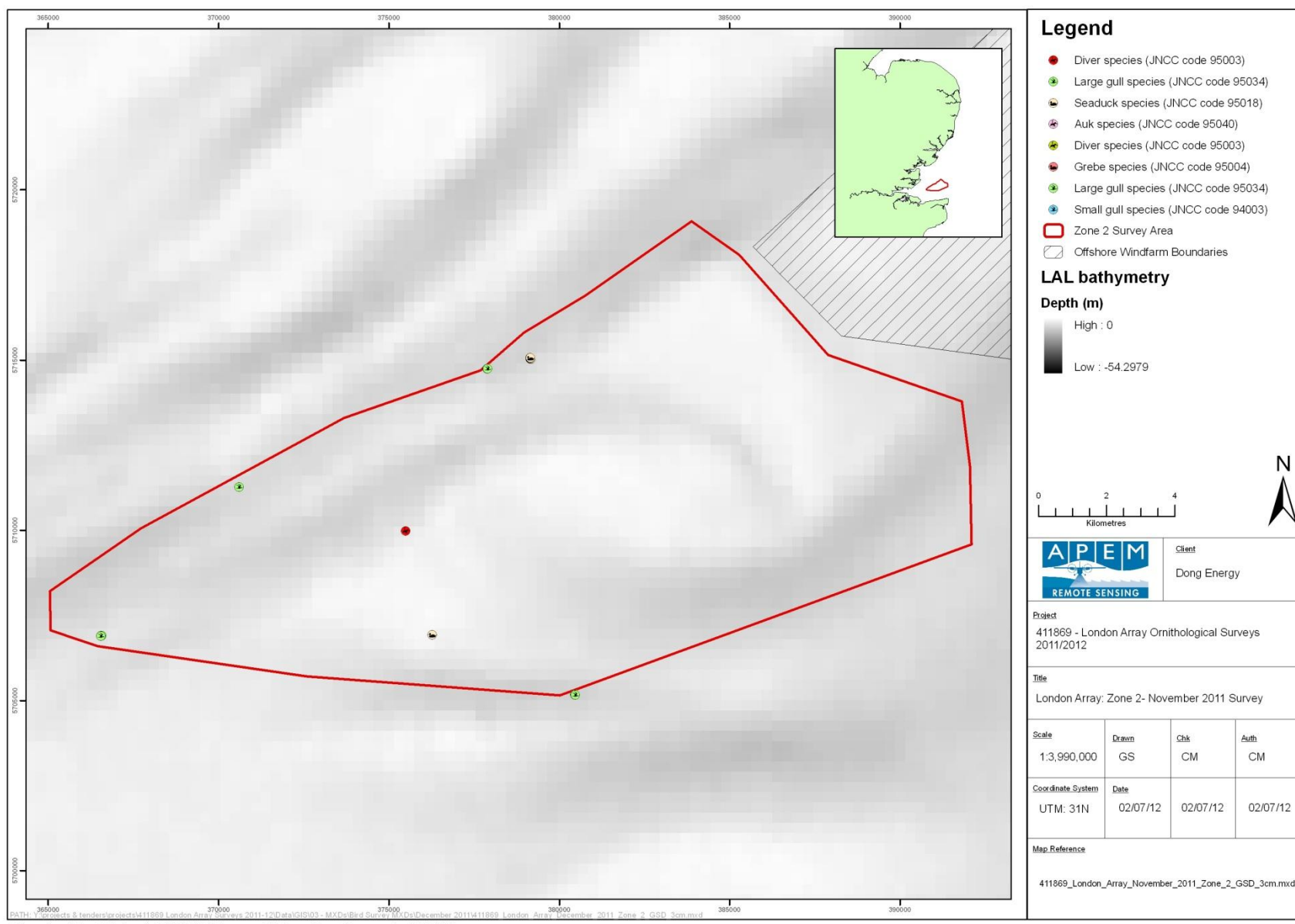
In November 2011 (Figure 3.7), the other bird species / groups recorded in Zone 1 were thinly distributed throughout, with slightly fewer individuals towards the northern boundary of the zone. Seaducks were concentrated along the eastern boundary of Zone 1, north of the London Array wind farm site. Both fulmars recorded during the survey were within the London Array development site, one along the north-eastern boundary and the other along the north-west edge of the site. Small gulls were generally located throughout the southern half of Zone 1, whilst large gulls were located in the centre of the London Array wind farm site and towards the northern boundary of the buffer area. Auks were located towards the north of Zone 1, with a concentration just inside the London Array wind farm site and a further concentration towards the northern tip of the zone.

The other birds recorded within Zone 2 were generally located towards the north-western edges and also closer to the centre towards the west of the zone. Seaducks were concentrated in the centre of the zone, along the north-western border and towards the south-western border of the area. Large gulls were largely located along the north-western border although individuals were also recorded along the south-western border of the zone.

Figure 3.7: Distribution of bird species / groups and marine mammals recorded in Zones 1 and 2 in the November 2011 survey.



A: Zone 1



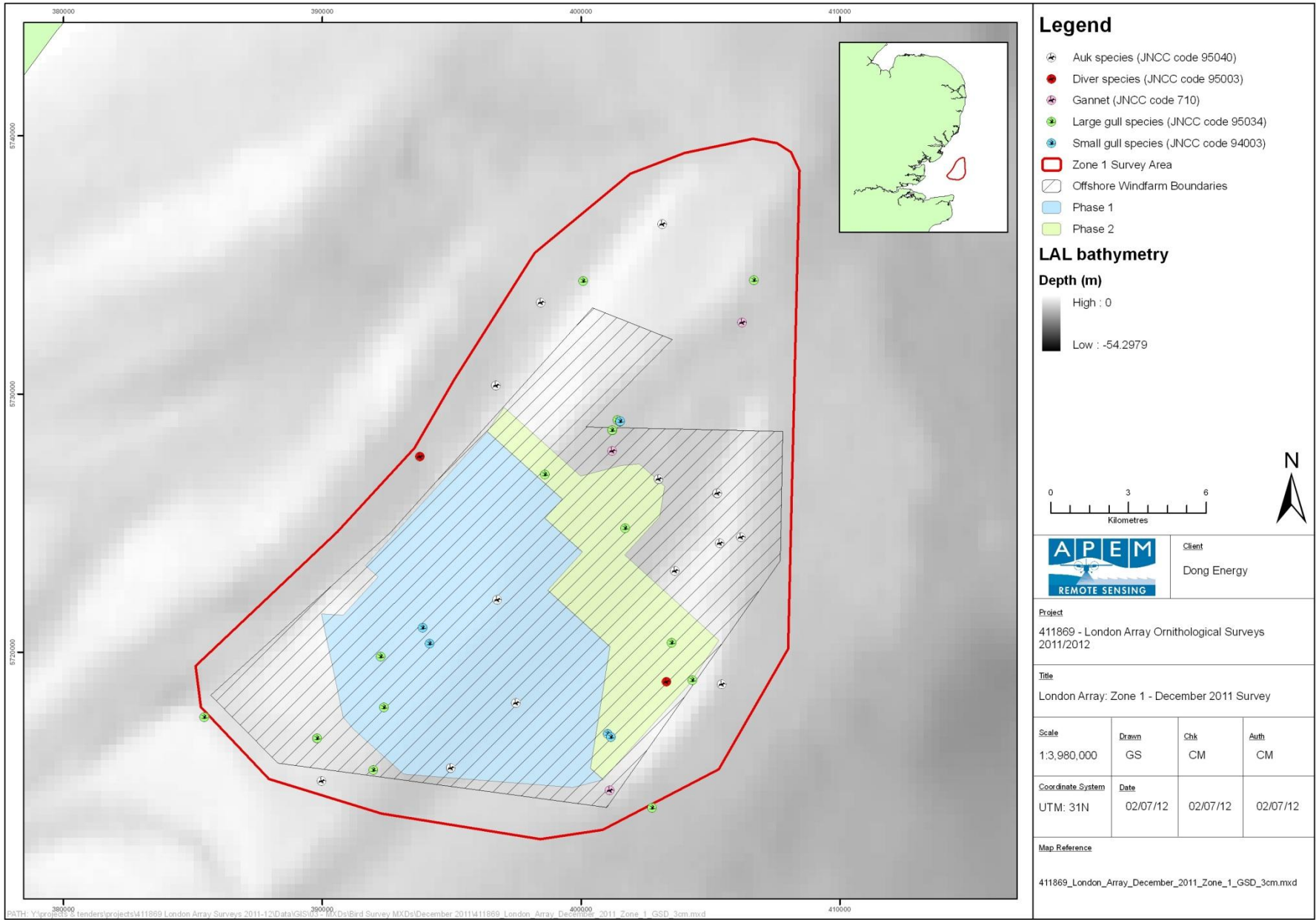
B: Zone 2

3.2.2.6 *December 2011*

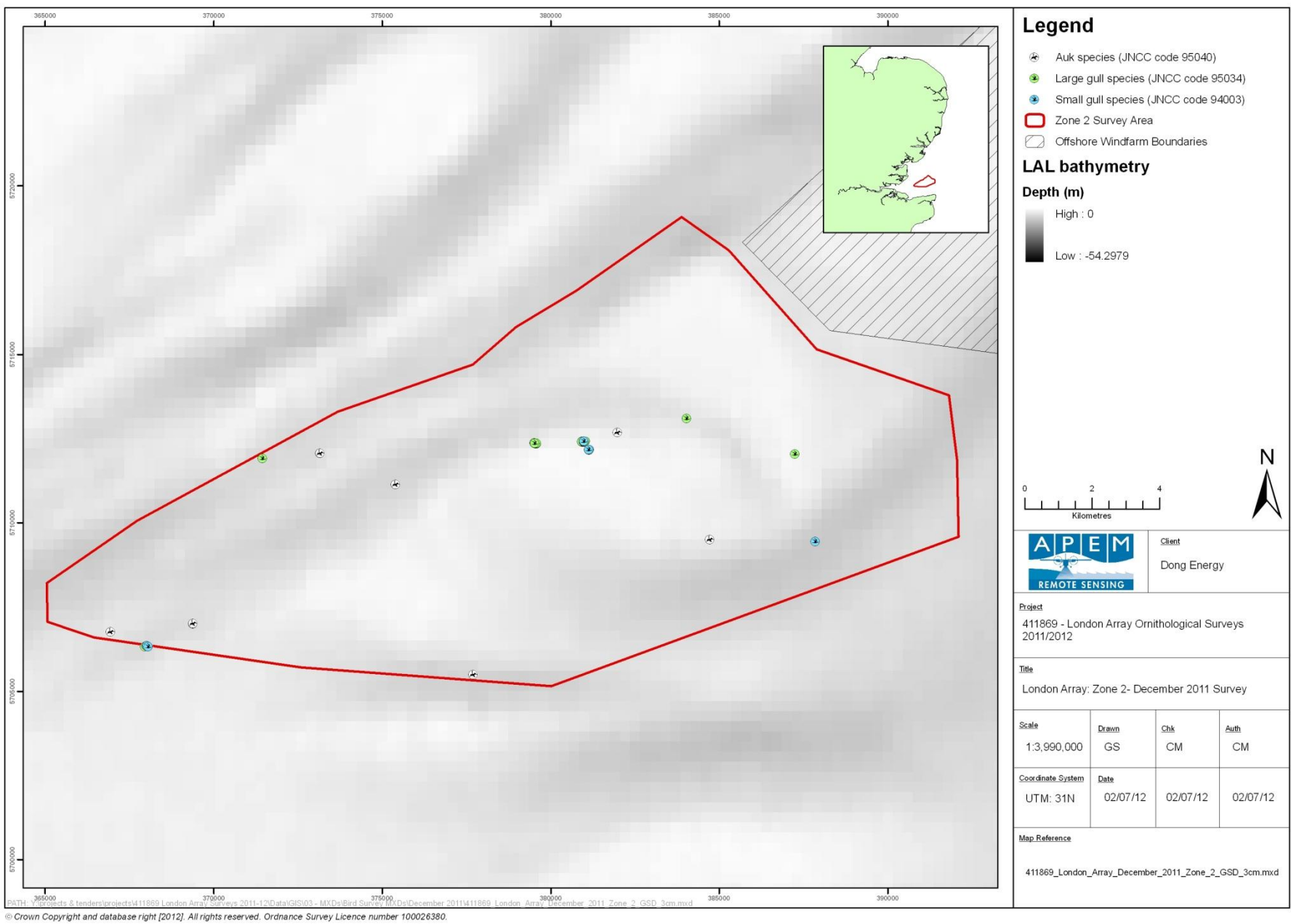
In December 2011 (Figure 3.8), two gannets were observed within the London Array wind farm site in Zone 1; one in the southern corner and the other towards the north. Another gannet was recorded towards the northern corner of the buffer area. Four small gulls were also recorded within the London Array wind farm site, with two individuals observed towards the southern corner and two individuals located in the west of the site. The majority of large gulls recorded during the survey were located throughout the London Array wind farm site, with further individuals in the buffer north of the site. Auks were distributed throughout much of the Zone, with fewer individuals recorded in the north.

Within Zone 2, small gulls were recorded largely within the upper half of the zone in a band running from east to west. Large gulls were mainly concentrated in the centre of the zone over a shallow sand bank area. Further large gulls were recorded on the western border and towards the eastern corner of the zone. Auks were thinly dispersed across much of the zone, with no individuals recorded in the far north and east of the zone.

Figure 3.8: Distribution of bird species / groups and marine mammals recorded in Zones 1 and 2 in the December 2011 survey.



A: Zone 1



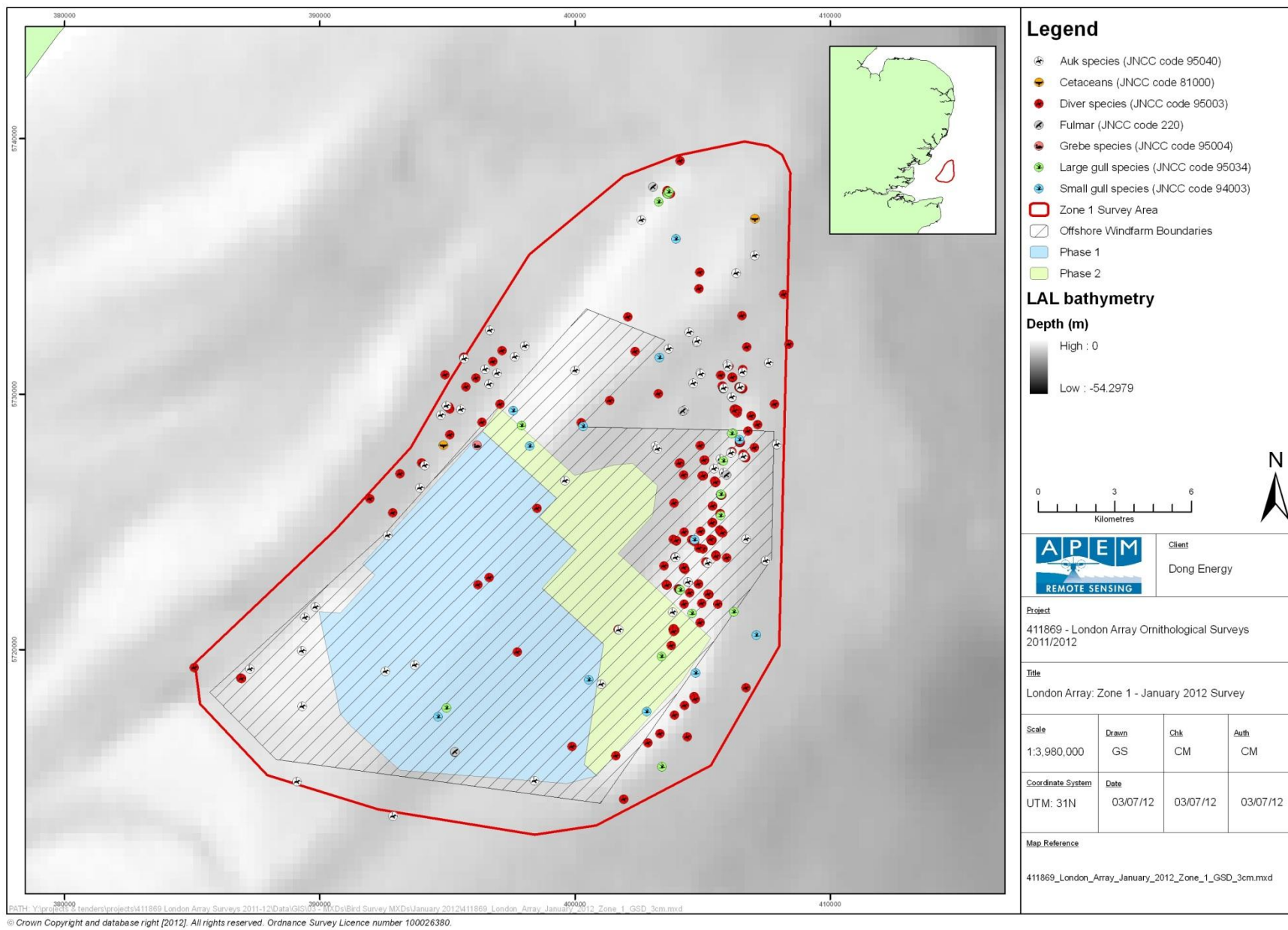
B: Zone 2

3.2.2.7 *January 2012*

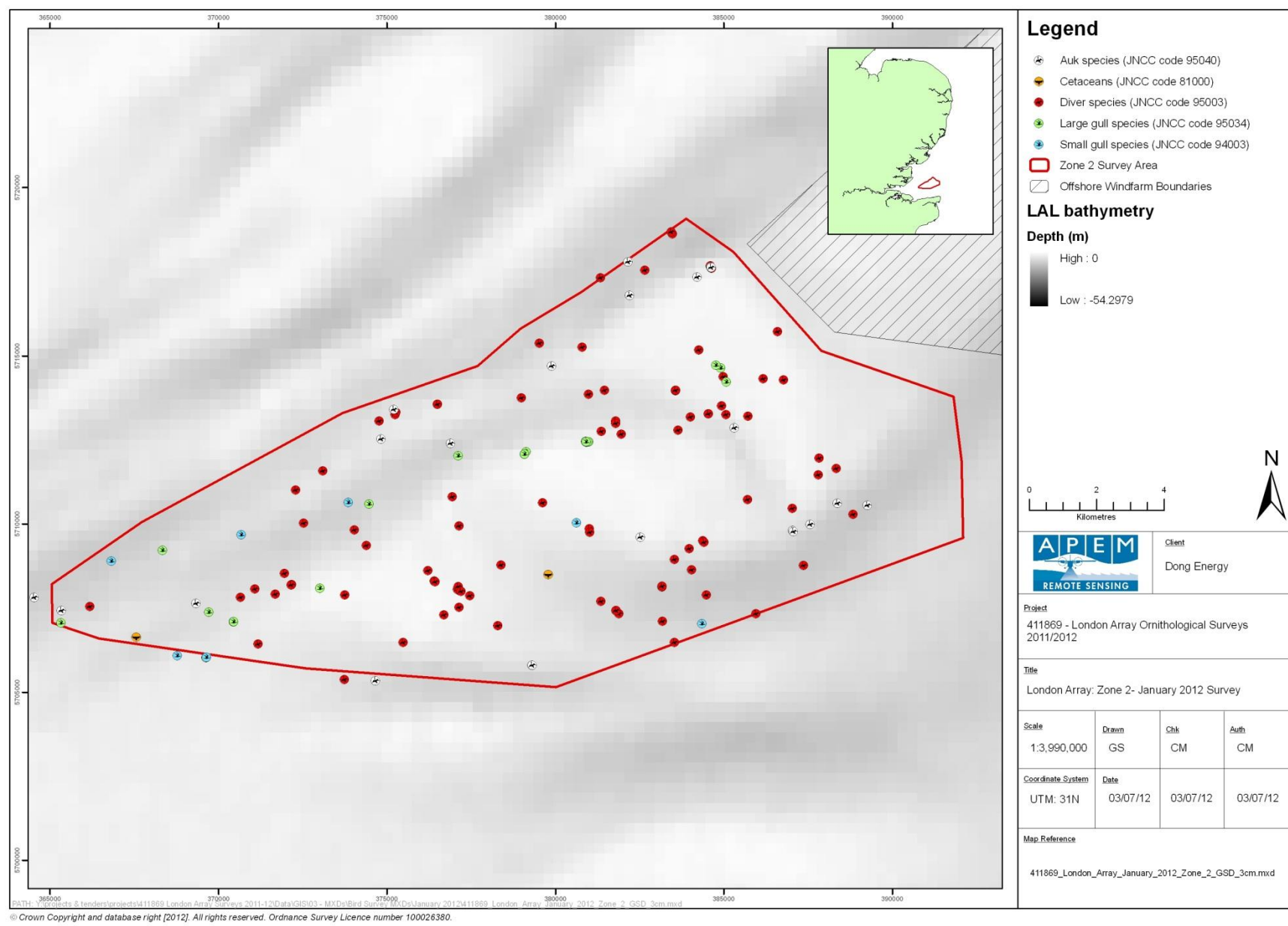
In January 2012 (Figure 3.9), many of the other bird species / groups recorded within Zone 1 were located along the eastern edge of the zone, with birds also located along the north-western edge of the zone, north of the London Array wind farm site. Fulmars were located both within and outside the London Array wind farm site; those within the site were generally distributed around the edges of the site, and those outside were recorded in the northern part of the buffer. A single grebe was recorded inside the London Array wind farm site along the north-western border. Small gulls were distributed throughout much of Zone 1; those inside the London Array wind farm site were distributed around the edges of the site. There were no small gulls in the south-western corner of Zone 1. Large gulls were largely concentrated in the same areas as divers along the eastern edge of the zone; smaller numbers of large gulls were also recorded towards the south and far north of the buffer and in the south-west of London Array wind farm site. Auks were observed across Zone 1 with concentrations along the eastern edge of the London Array wind farm site and in the north-east and north-west of the buffer.

In Zone 2, small gulls were thinly distributed across the western half of the zone, with several individuals located just outside of the south-western zone boundary. Large gulls were recorded in a band running from the north-east to the south-west of the zone, towards the upper half of the area. Auks were also recorded within Zone 2, and were dispersed across much of the area with fewer individuals in the centre of the zone.

Figure 3.9: Distribution of bird species / groups and marine mammals recorded in Zones 1 and 2 in the January 2012 survey.



A: Zone 1



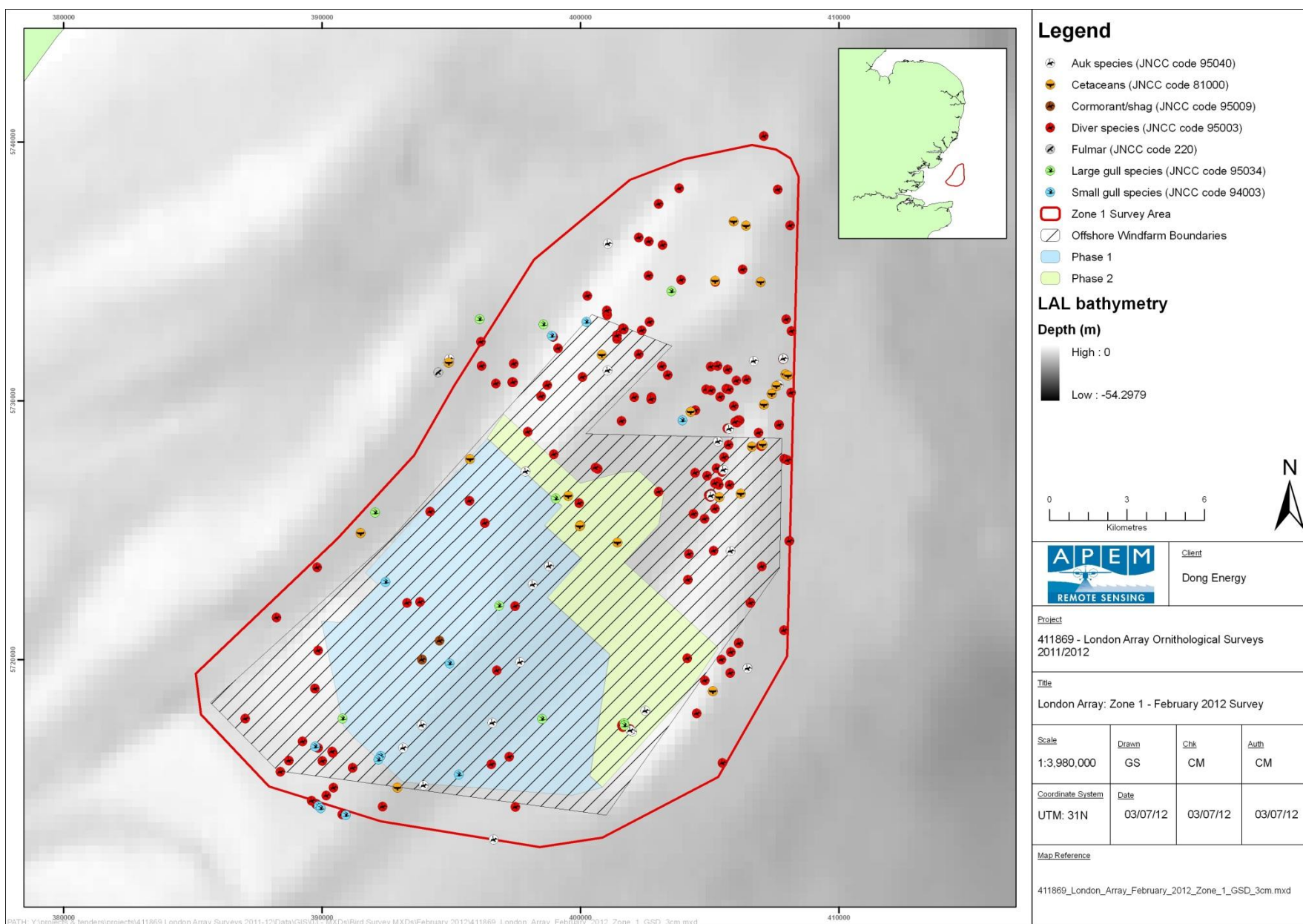
B: Zone 2

3.2.2.8 *February 2012*

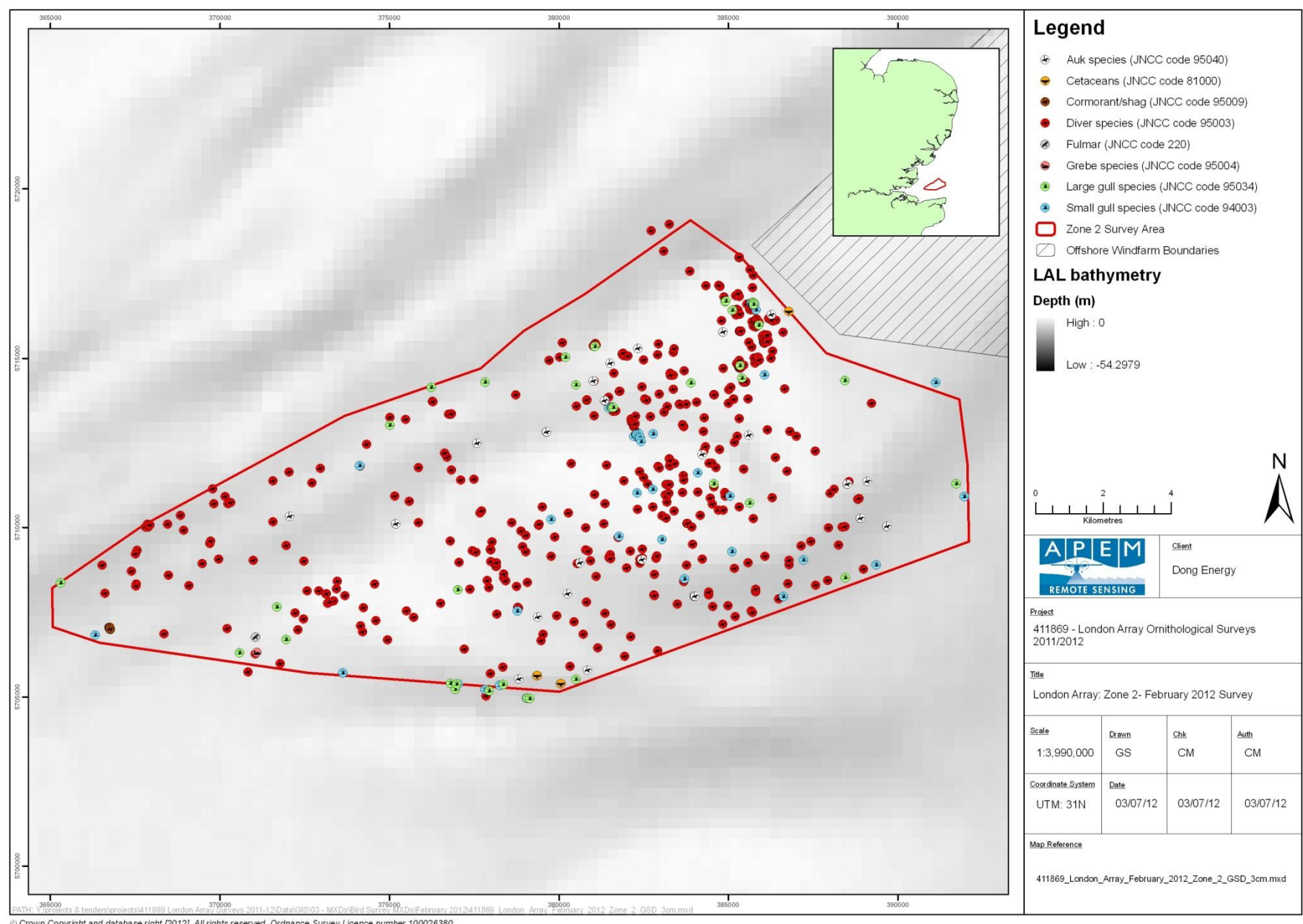
In February 2012 (Figure 3.10), birds were generally scattered throughout much of Zone 1, including the London Array wind farm site. A group of four cormorants / shags were located within the centre of the wind farm site, slightly towards the south-west. A single fulmar was identified outside the northern border of Zone 1. The majority of small gulls recorded were observed within the south-western half of the zone, with a group of four individuals located just inside the wind farm area and three small gulls just outside the zonal border. Two small gulls were observed towards the centre of the wind farm zone and a further three individuals were located further north on the edge of the wind farm site. Large gulls were scattered thinly across the zone, whilst auks were concentrated in two bands running from the north to the south of the zone; one towards the centre and the other towards the east of the zone.

The most predominant of the other bird species / groups recorded in Zone 2 were small gulls, which were concentrated mainly in the eastern side of the area. Large gulls were observed throughout the zone, although few individuals were observed in the very centre of the zone and along the north-eastern border. A single fulmar was recorded close to the south-western border, as was a single grebe. A relatively large group (n = 23) of cormorants / shags were also recorded in this area but further to the west. Auks were concentrated mainly in the east of the zone with bands of scattered individuals running into the west of the zone.

Figure 3.10: Distribution of bird species / groups and marine mammals recorded in Zones 1 and 2 in the February 2011 survey.



A: Zone 1



B: Zone 2

Figure 3.11: Estimated number of divers in Zones 1 and 2 during winters of 2010 / 11 and 2011 / 12

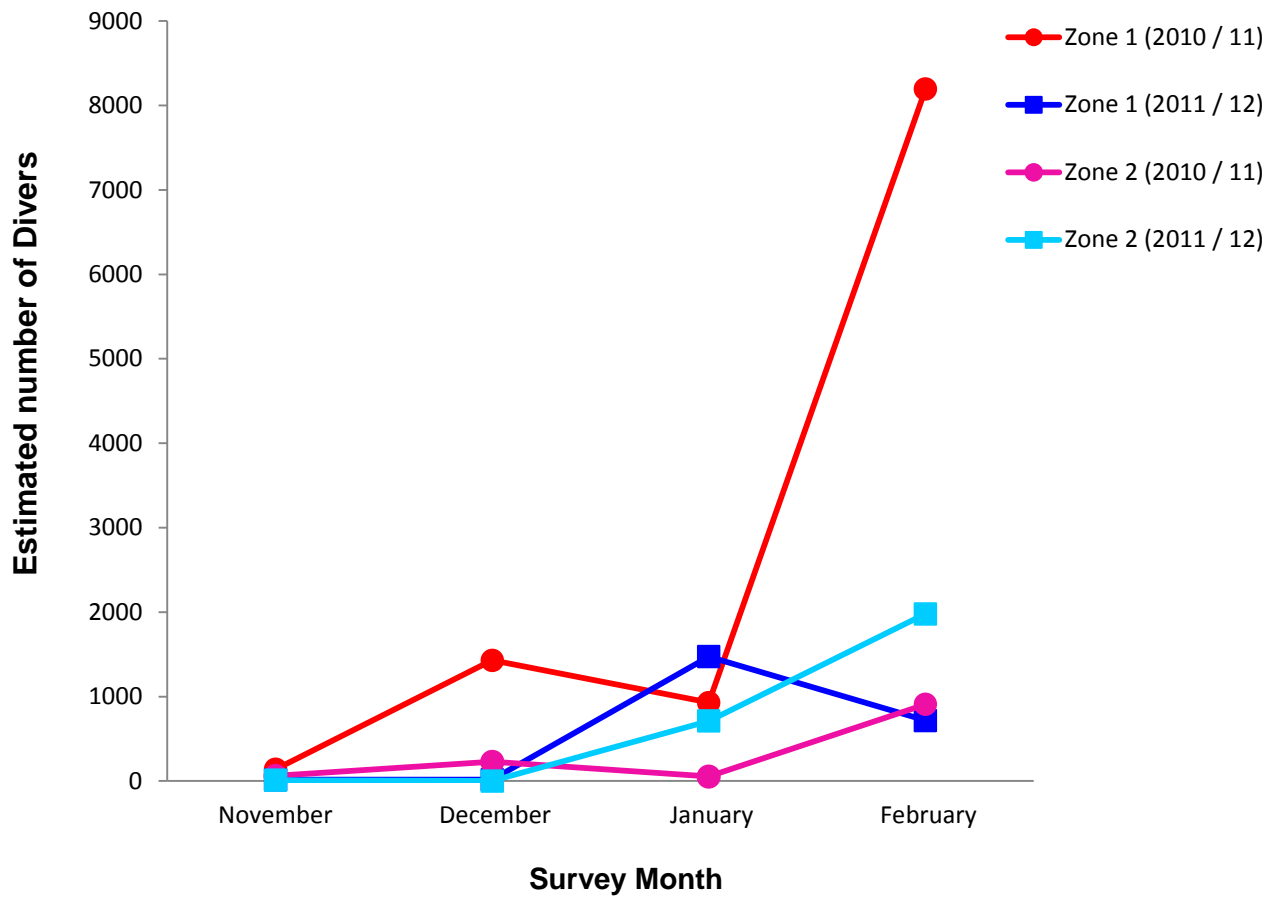
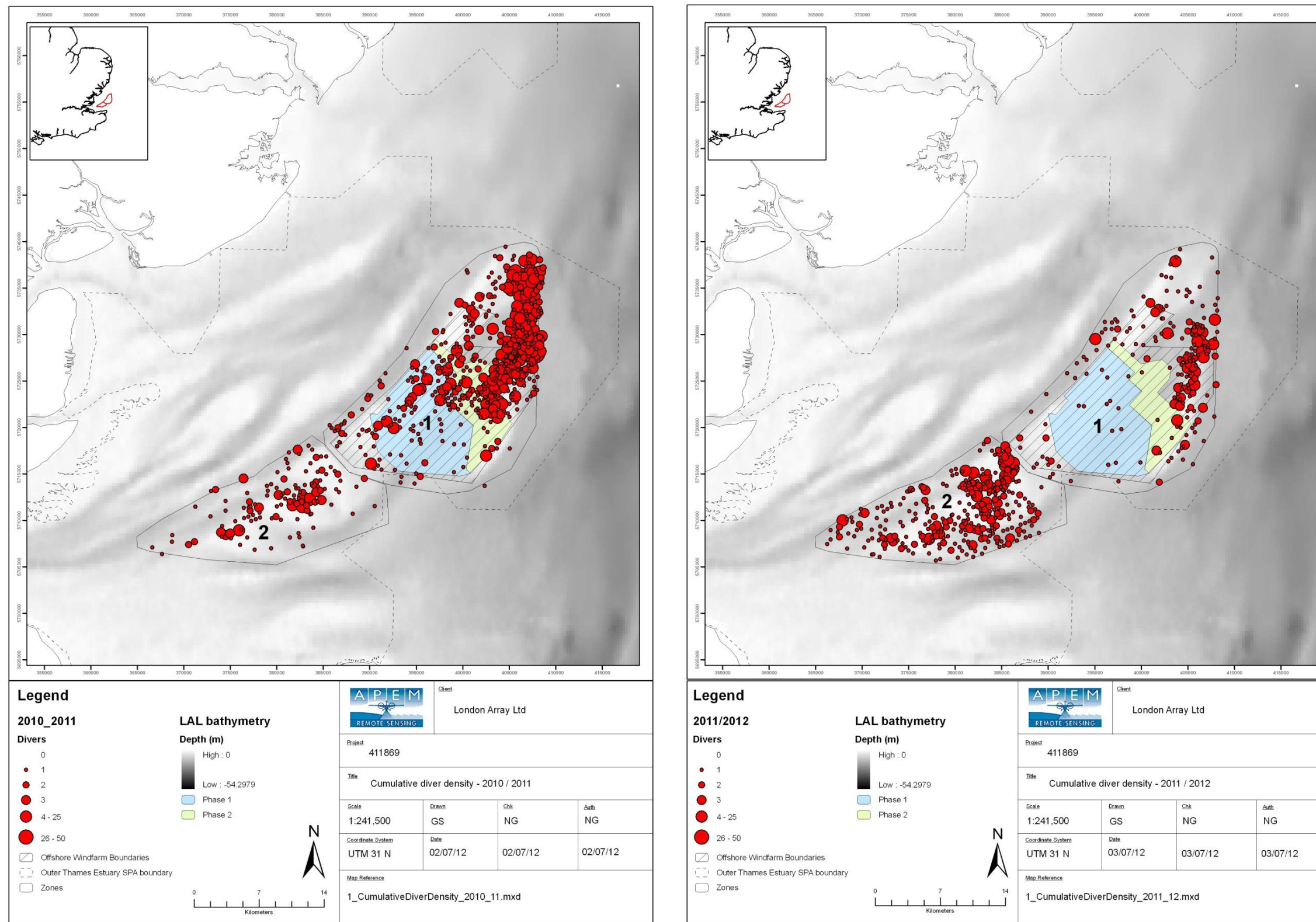


Figure 3.12: Cumulative distribution of divers in all zones during the winter of A: 2010 / 11 and B: 2011 / 12.



A: Winter survey 2010 / 2011

B: Winter survey 2011 / 2012

3.2.3 Marine mammals

3.2.3.1 November 2010

No marine mammals were recorded during November 2010 survey in Zone 1 or Zone 2.

3.2.3.2 December 2010

In December 2010, no marine mammals were recorded in Zone 1 and one individual identified as either a dolphin or a porpoise was located within the northern tip of Zone 2 (Figure 3.4: B).

3.2.3.3 January 2011

Five marine mammals were recorded within Zone 1 in January 2011; four of these individuals were recorded near to the eastern boundary of the zone. The remaining marine mammal was located near to the western boundary (Figure 3.5: A). No marine mammals were recorded within Zone 2 during the January 2011 survey.

3.2.3.4 February 2011

Marine mammals were recorded within Zones 1 and 2, during the February 2011 survey. All of the marine mammals recorded were identified as dolphins and / or porpoises. During February 2011 a total of 56 dolphins / porpoises were distributed across Zone 1, largely along the eastern and southern sides of the zone (Figure 3.6: A). Four dolphins / porpoises were recorded within Zone 2; two were located towards the south-east, one was located towards the east and one was located north-west of the centre of the zone (Figure 3.6: B).

3.2.3.5 November 2011

Two marine mammals, both identified as dolphins and / or porpoises, were recorded during the November 2011 survey in Zone 1, along the north-western border of the London Array wind farm site (Figure 3.7: A). No marine mammals were recorded in Zone 2 during November 2011.

3.2.3.6 December 2011

No marine mammals were recorded in Zone 1 or Zone 2 during December 2011.

3.2.3.7 January 2012

Two marine mammals (dolphins / porpoises) were recorded within Zone 1 during the January 2012 survey; one was recorded just outside of London Array wind farm site on the north-western border and the other was recorded in the buffer to the north of the wind farm area (Figure 3.9: A). A further two marine mammals (dolphins / porpoises) were observed within the southern half of Zone 2; one towards the centre of the zone and the other towards the western zonal border (Figure 3.9: B).

3.2.3.8 February 2012

Marine mammals were recorded within Zones 1 and 2 during the February 2012 survey. All of the marine mammals recorded were identified as dolphins and / or porpoises. A total of 23 dolphins / porpoises were distributed across Zone 1 in February 2012, largely along the eastern and northern parts of the zone, with a total of ten individuals recorded within the London Array wind farm site (Figure 3.10: A). Five cetaceans were recorded within Zone 2, located at the southern-most tip of the zone, close to the north-eastern border of the zone (Figure 3.10: B).

4 DISCUSSION

4.1 Diver abundance and distribution during the winter of 2010 / 11

Diver abundance generally increased across both Zone 1 and Zone 2 throughout the winter of 2010 / 11 (Figure 3.1: A to D). Numbers of divers were lowest in November 2010 (estimated 200 birds) and greatest in February 2011 (estimated 9,103 birds) across both zones, although the rate of increase through the winter in Zone 1 was greater than Zone 2. Reasons for this pattern of increase through the winter may be linked to weather; November and December 2010 in the UK were unusually cold, becoming milder into 2011. This general pattern extended into much of northern Europe. It is also possible that the large numbers seen in February represent pre-migration aggregations of birds; pairs return to territories in the UK typically in March and April, although birds can return as early as February in some years (Wernham *et al.* 2002). January or February has previously been identified as the peak months for divers in the Greater Thames (Webb *et al.* 2009).

The peak diver population estimate from this survey of 8,194 birds (-CL: 6,727; +CL: 9,830; precision: 0.03) in February 2011 in Zone 1 (including the London Array OWF site) exceeds both the Outer Thames Estuary SPA designated total of 6,466, and the 8,130 estimated across the wider greater Thames area (O'Brien *et al.*, 2008). Whilst it has been shown in previous surveys (e.g. APEM, 2010) that visual surveys underestimate the numbers that digital surveys estimate, the figure is nonetheless of interest. The peak diver population from this survey in Zone 2 (control zone) was estimated at 909 birds (-CL: 682; +CL: 1,174; precision: 0.08) in February 2011. By summing the population estimates for both Zone 1 and Zone 2 in February 2011, a total of 9,103 birds is reached (though note this will include some temporal variation as surveys spanned two days). This suggests that numbers within the part of the SPA surveyed (approximately 16%), as estimated by digital still methods, are higher than those upon which the SPA was designated.

Precision (target level $CV' < 0.16$) was high for diver estimates for the majority of surveys; Zone 1 CV' ranged between 0.03 – 0.24 and in Zone 2 CV' ranged between 0.08 – 0.35. Average coverage of each zone was 15%. The peak diver population estimate during February in Zone 1 was associated with an above Class 1 level of precision ($CV' = 0.05$: Bohlin *et al.* 1990), and allows approximately a 12.5% change in diver numbers to be detected. The survey design is thus justified, especially as the precision target of < 0.16 was met for Zone 1 at 500 m grid resolution for three of the four months (December, January and February). Lower numbers of birds were recorded in Zone 2 and the target precision of < 0.16 was met in February but not in the other three months (although the precision of 0.18 was very close to the target in December). Low numbers of individuals recorded in a survey mean that lower precision estimates will be calculated; sometimes it is just not statistically possible to obtain a CV' of < 0.16 irrespective of the level of survey sampling effort.

Distribution of divers in the London Array area should be generally indicative of habitat preferences, with the birds occurring mainly in water less than 20 m in depth as identified by Skov & Prins (2001). Although no associated hydrodynamic variables known to predict diver density have been formally examined in this report, there is an apparent association between the distribution of the divers and bank regions, with divers in most months scattered around areas of lowest depth.

Tide data from the nearest available point to the London Array site (Whitaker Beacon: Appendix III) 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). Use of these sand banks could be to exploit fish (including herring and sprat which use sand banks as nursery and feeding habitat: Natural England 2009) or in response to hydrographic variables (eddies and current speed are significant response variables explaining diver density at London Array; Skov *et al.* 2010). Previous modelling of visual aerial survey data suggests that there are areas of very high / high habitat suitability for divers off the north of the OWF footprint area under certain tidal flow phases, possibly reflecting the pattern in February 2011 (Skov *et al.* 2010); at the time when images were collected in February that contained the majority of divers in the north east of Zone 1, the tide was falling to low. Under ebb tide conditions, water velocity is predicted to be lower than under other flow phases, perhaps explaining why density should be higher in this area than in previous months (high tide in December, low tide in January). It is also worth adding that all of the divers with the exception of 55 individuals (< 4%) recorded in February 2011 within Zones 1 and 2 were associated with water < 23 m in depth. All divers in Zone 1 & 2 were recorded in water < 26 m in depth.

4.2 Diver abundance and distribution during the winter of 2011 / 12

Diver abundance generally increased across both Zones 1 and 2 throughout the winter of 2011 / 2012 (Figure 3.2: A to D). The estimated diver population across both zones was relatively low in November (estimated 25 birds) and December 2011 (estimated 16 birds) whilst the highest estimated numbers of divers across both zones were recorded during February 2012 (estimated 2,697 birds). 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).

Although diver abundance was greatest across both zones in February 2012, peak estimates within each zone varied between months. In Zone 1, divers were estimated to peak at 1,474 (-CL: 1,108; +CL: 1,906; precision: 0.07) birds in January 2012, but by February 2012 this population had reduced to an estimated 717 (-CL: 551; +CL: 921; precision: 0.08) birds. Conversely, in Zone 2 the diver population increased from an estimated 711 (-CL: 523; +CL: 899; precision: 0.11) birds recorded in January 2012 to an estimated 1,980 (-CL: 1,536; +CL: 2,469; precision: 0.05) birds in February 2012 (this was the peak population estimate from the winter 2011 / 12 surveys). This perhaps suggests a movement of divers out of Zone 1 and into Zone 2 between January and February 2012.

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). By summing the diver population estimates for both Zone 1 and Zone 2 in

February 2012, a total of 2,697 divers is reached (though note this may include some temporal variation as surveys spanned two days) which is equal to 42% of the SPA designated population. As Zones 1 & 2 cover approximately 16% of the Outer Thames Estuary SPA, if this peak diver number was extrapolated to the size of the SPA, it possible that diver numbers could be higher than those upon which the SPA was designated. Although, as this extrapolation would assume a uniform distribution of divers across the SPA and does not account for patchy distribution of suitable habitat, this basic extrapolation may overestimate the SPA population.

Diver abundance and distribution are influenced on a diurnal basis according to the state of the tide. Similarly to the previous year, tide data from the nearest available point to the London Array site (Whitaker Beacon: Appendix III) 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). Modelling of visual aerial survey data suggests that there are areas of high habitat suitability for divers off the north east of the OWF footprint area in Zone 1 under certain tidal flow phases. In a similar way to February 2011, the flow phase may have influenced the distribution of divers in January 2012 (Skov *et al.* 2010); at the time when the images were collected in January the tide was falling to low and the majority of divers were recorded in the north east of Zone 1. At the time of the survey in February 2012 the tide was incoming into Zone 2 which may have influenced the peak number of divers that were recorded in this zone in February 2012. All birds recorded in Zones 1 & 2 were located in shallow waters < 26 m in depth.

4.3 Comparison of winter 2010 / 11 with winter 2011 / 12

4.3.1 Diver abundance

Overall, fewer divers were estimated to be present in Zones 1 and 2 during the winter 2011 / 12 (estimated 4,923 birds; Figure 3.12: B) compared to winter 2010 / 11 (estimated 11,942 birds; Figure 3.12: A). This largely reflects a reduction in the total abundance of divers estimated over the winter in Zone 1 for 2011 / 12 (estimate $n=2,223$, 45% of total divers) compared with 2010 / 2011 (estimated $n = 10,692$; 89% of total divers). Comparing peak counts (Table 4.1), there were 6,720 fewer divers recorded during the peak estimate in Zone 1 in the winter of 2011 / 12 compared with 2010 / 11. On the other hand, the peak diver population estimated for Zone 2 increased by 1,071 birds in 2011 / 12 compared with the previous year (Table 4.1). As a proportion of the total abundance of divers estimated over the winter, diver abundance in Zone 2 increased in 2011 / 12 ($n = 2,700$; 55% of total divers) compared with 2010 / 11 ($n = 1,250$; 10% of total divers) which shows there has been a change in the distribution of divers between years.

Fewer divers were recorded across both Zones 1 and 2 during November and December 2011 / 12 in comparison to the previous year (November estimate: $n = 25$ in 2011 / 12 versus $n = 200$ in 2010 / 11; December estimate: $n = 16$ in 2011 / 12 versus $n = 1,656$ in 2010 / 11). Diver numbers increased during the last two months of winter in 2011 / 12 (January estimate:

n = 2,185; February estimate: n = 2,697) whereas in 2010 / 11 diver numbers decreased in January (estimate n = 983) and rose to peak in February (estimate n = 9,103). These values indicate that divers arrived later in the survey area during winter 2011 / 12 in comparison to the previous year.

Since it has been shown in previous surveys (e.g. APEM 2010) that digital surveys do not underestimate species abundance, it may be that the relatively low peak number of divers recorded during the winter 2011 / 12 in comparison to the previous year reflects inter-annual variation of environmental conditions which in turn affects diver abundance. There are a range of factors that may explain inter-annual variation of diver abundance and distribution in the Outer Thames Estuary. 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. 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 winter of 2011 / 12 was much milder and may have given rise to a wider dispersion of divers outside of the study zones. As previously mentioned, diurnal variation in diver movements between surveys in different years may have influenced the number of divers recorded, as well as any possible effects of construction of Phase 1 of the London Array OWF that could have resulted in displacement, or a combination of these effects.

Table 4.1 Peak population estimates and precision for divers across all Zones during winter 2010 / 11 and 2011 / 12. Estimates within target precision of 0.16 are in red italic text.

Zone	Year	Month	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
1	2011	February	<i>1,257</i>	<i>8,194</i>	<i>6,727</i>	<i>9,830</i>	<i>0.03</i>
	2012	January	<i>181</i>	<i>1,474</i>	<i>1,108</i>	<i>1,906</i>	<i>0.07</i>
2	2011	February	<i>144</i>	<i>909</i>	<i>682</i>	<i>1,174</i>	<i>0.08</i>
	2012	February	<i>433</i>	<i>1,980</i>	<i>1,536</i>	<i>2,469</i>	<i>0.05</i>

4.3.2 Diver distribution

Generally few divers were located in either Zones 1 or 2 during the 2011 / 12 surveys in November and December. Few divers were also similarly recorded in these zones during the November 2010 / 11 survey, although in December 2010 / 11, relatively high concentrations of divers were observed within the London Array OWF site in Zone 1, with divers also located in smaller concentrations in the control Zone 2.

A large concentration of divers was recorded along the north-eastern boundary of Zone 1, outside of the Phase 1 development site during February 2011. Although there were fewer divers recorded overall in February 2012, the distribution along the north-eastern edge of Zone 1 was similar to the previous year. During January 2012 (when a greater number of divers were recorded in comparison to February 2012), a concentration of divers was again

located along the north-eastern edge of Zone 1. The majority of divers in February 2012 were located in Zone 2, not in Zone 1. This concentration of divers in the north-eastern corner of Zone 1 is similar to previous historical aerial surveys in 2003 / 2004 and 2004 / 2005. The higher numbers recorded within Zone 2 during February 2012 indicate that divers within the survey area may have shifted their distribution out of Zone 1 and into the control Zone 2.

Across both Zones 1 and 2, the distribution of divers was generally indicative of habitat preferences, generally preferring water depths of less than 20 m which were associated with sand bank regions (Skov & Prins 2001). However, no associated hydrodynamic variables known to predict diver density have been examined in this report and there has been no use of GAM modelling to look at diver area preferences in relation to environmental variables.

4.4 Other bird abundance and distribution during winter 2010 / 11 & 2011 / 12

A range of other bird species were recorded in addition to divers during the winters of 2010 / 11 and 2011 / 12 in both Zones 1 and 2.

During the winter surveys 2010 / 11, the population estimate of all birds across Zones 1 & 2 was relatively low in November 2010 (estimate: 762 birds), increased in December 2010 (estimate: 2,166 birds), decreased in January 2011 (estimate: 1,983 birds) and increased in February 2011 (estimate: 12,717 birds). During the winter surveys 2011 / 12, the population estimate of all birds across Zones 1 & 2 was low in November (estimate: 729 birds) and December (estimate: 744 birds) in 2011 and increased in January (estimate: 3,441 birds) and February 2012 (estimate: 3,798 birds). These results show that overall there were more birds recorded in Zones 1 & 2 during the winter surveys 2010 / 11 (cumulative estimate over four months = 17,628) than there were recorded during the winter surveys 2011 / 12 (cumulative estimate over four months = 8,712).

During winter 2010 / 11 surveys, seabirds (not identified to species level) were recorded in small numbers in November 2010 when 26 birds were estimated for Zone 1. Small numbers were also recorded in December 2010 when 7 birds were estimated for Zone 1 and 13 birds were estimated for Zone 2. During winter 2011 / 12, common scoters were recorded in November 2011 when estimates peaked at 250 common scoter in Zone 2. A further 90 common scoters were estimated to be present within Zone 1 in November 2011. Seabirds recorded in 2010 may also have been common scoters which are known to winter around much of the UK shoreline during the winter months preferring shallow offshore areas with sandy sea beds (Lack 1986).

During winter 2010 / 11, very few fulmars were recorded; the only records were 6 birds estimated for January 2011 in Zone 1. During winter 2011 / 12, relatively low numbers of fulmars were recorded, with numbers peaking at an estimated 49 individuals during January 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 is to be expected. Indeed, low numbers of fulmars were also recorded during winter 2010 / 11.

During winter 2010 / 11, gannets were recorded in Zone 1 during February 2011, with an estimated population of 593 birds ($CV' = 0.10$); in the same month 69 birds were estimated for Zone 2. During winter 2011 / 12, gannets were absent apart from in December, with 25 birds estimated in Zone 1. Timing may reflect the gradual passage of gannets through the North Sea from wintering quarters to more northerly breeding grounds (Wernham *et al.* 2002).

During winter 2010 / 11, small numbers of cormorants / shags were recorded in Zone 1 between November 2010 to January 2011, peaking in November and December at an estimated 8 birds each month. During winter 2011 / 12, cormorants / shags were present in Zones 1 & 2 during February, with numbers peaking at an estimated 105 birds in Zone 2. Zone 2 is closer to land compared with Zone 1. Since cormorants and shags show a coastal distribution year-round (Cramp & Simmons 1977), it is unsurprising that the largest number of these individuals were located in the Zone closest to shore.

During winter 2010 / 11, small numbers of grebes were estimated in all months except January 2011, the peak population was estimated at 31 birds in Zone 1 during December 2010. During winter 2011 / 12, an estimated peak of eight great crested grebes were present within Zone 1 during January 2012. 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).

There were no skuas recorded during the winter 2010 / 11. During winter 2011 / 12, an estimated eight great skuas were located within Zone 1 during November 2011. These individuals are likely to reflect autumn passage to wintering grounds (Tasker *et al.* 1987).

During winter 2010 / 11, small gulls (including black-headed gulls, common gulls and kittiwakes) were widespread across the survey area; higher estimates were recorded in January / February compared with November / December. Across both Zones 1 & 2 in January and February 2011, approximately 438 – 2,258 small gulls were estimated. In contrast, a total of 219 small gulls were estimated in November and December 2010, suggesting an influx of small gulls in the later part of the winter. In comparison to winter 2010 / 11, a higher number of small gulls were identified to species level during winter 2011 / 12 due to improvements made in identification techniques as well as calmer weather conditions in 2011 / 12. Furthermore, unlike winter 2010 / 11, small gulls were less numerous than large gulls in 2011 / 12, with numbers peaking at an estimated 261 birds within Zone 2 during February 2012. Small gulls such as 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). Black-headed gulls immigrate to the UK through the winter from the east and north. Although the largest increases occur from September, recovery of birds ringed in continental Europe is greatest in the UK in January and February (Wernham *et al.* 2002), reflecting patterns found here. Kittiwakes are known to move in response to atmospheric depressions at sea (Wernham *et al.* 2002), though we have no evidence to assert this as an explanation for increased small gull numbers.

During winter 2010 / 11, large gulls (i.e. herring gulls, lesser black-backed gulls and great

black-backed gulls), whether identified to species or group level, were recorded low numbers compared with small gulls, and were fairly evenly spread across survey areas. The population of large gulls peaked in February 2011 when 137 birds were estimated for Zone 1 and 152 birds were estimated for Zone 2. During winter 2011 / 12, large gulls were recorded in relatively high numbers in comparison to small gulls. Herring gulls were the most numerous species, peaking at an estimated 196 birds in Zone 2 during December 2012. Relatively low numbers of both herring gulls and lesser black-backed gulls were recorded within Zone 1 and the London Array OWF site, although 179 great black-backed gulls were estimated to be present within Zone 1 during November 2011 with some of these birds located within the centre of the London Array OWF site. 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 these individuals were passing through Zone 1 to move further offshore.

During winter 2010 / 11, estimates of auks peaked at 323 birds in Zone 1 in January ($CV' = 0.14$), and this zone was estimated to hold at least 100 auks in each month of survey; Zone 2 (February) returned the next greatest estimates. During winter 2011 / 12, auk numbers peaked in January 2012 with 489 guillemots and / or razorbills estimated to be present in Zone 1, and this Zone was estimated to hold at least 100 auks in each month of survey, with the exception of November 2011. Auk numbers also peaked in Zone 1 during January 2011, although this peak was smaller (estimate $n = 323$). Auks are generally widespread in marine areas in winter, and numbers can fluctuate at a given site and numbers have been low on previous historical visual surveys (e.g. DTI 2006).

4.5 Marine mammal abundance and distribution during winter 2010 / 11 & 2011 / 12

Marine mammal abundance peaked during February in Zone 1 during both winter 2010 / 11 and winter 2011 / 12, although the number of individuals estimated to be present was lower during 2011 / 12 (estimated $n=365$ versus estimate $n = 106$, respectively). The same pattern occurred in Zone 2 with numbers peaking in February during both survey years (estimated $n = 25$ (2010 / 2011) versus estimated $n = 23$ (2011 / 12)). These individuals were thinly distributed in groups no bigger than two or three. Marine mammal abundance was relatively low across all other survey months during 2010 / 2011 and 2011 / 12 in both zones. Across both years, marine mammals were thinly distributed in groups no bigger than two or three.

All marine mammals recorded during both winter 2010 / 11 and 2011 / 12 surveys in Zones 1 and 2 were identified as dolphins and / or porpoises. It is likely that most of these animals were harbour porpoises, which are most often seen between January and April in the south-eastern North Sea (Reid *et al.* 2003). Previous marine mammal surveys have shown that the highest harbour porpoise sighting rates in the south-eastern North Sea (where there are relatively few sightings during the whole for this species) occur during the first four months of the year, whereas the highest rates around the Outer Hebrides appear to be during the summer (June to September). It is not yet known whether these observations show a real seasonal movement, or are simply the differences in sighting efficiency between surveys (Reid *et al.* 2003).

5 CONCLUSIONS

- Comparison of results between years showed that overall there were more birds in total recorded in Zones 1 & 2 during the winter surveys 2010 / 11 (cumulative estimate over four months = 17,628) than there were recorded during the winter surveys 2011 / 12 (cumulative estimate over four months = 8,712).
- During the winter surveys 2010 / 11, numbers of red-throated divers in Zones 1 & 2 were generally lowest in November 2010 (estimate: 200 birds), increased in December 2010 (estimate: 1,656 birds) and decreased in January 2011 (estimate: 983 birds) and increased again in February 2011 when numbers peaked at an estimated 9,103 divers in both zones (Figure 3.11).
- During the winter surveys 2011 / 12, numbers of red-throated divers in Zones 1 & 2 were very low through November (estimate: 25 birds) and December 2011 (estimate: 16 birds), increased in January 2012 (estimate: 2,185 birds) and peaked in February 2012 with an estimated 2,697 divers in both zones (although peak estimates within the Zone 1 London Array OWF site occurred in January).
- The peak diver estimates were recorded in February for both survey years, although during winter 2010 / 11 the peak diver estimate was recorded in Zone 1 and in 2011 / 12 the peak diver estimate was recorded in Zone 2.
- The peak diver estimate within the London Array OWF site (Zone 1) in 2011 / 12 was lower than 2010 / 11. During 2010 / 11 the peak estimate in Zone 1 was recorded in February, but during 2011 / 12 the peak estimate in Zone 1 was recorded in January.
- More divers were recorded in the control Zone 2 during winter 2011 / 12 compared with the previous year, indicating a shift in distribution which may be due to inter-annual variation related to changes in environmental patterns, diurnal movements, Phase 1 construction of the London Array OWF or a combination of these effects.
- Comparison of results between years showed that divers arrived later into Zones 1 & 2 in 2011 / 12 and also that fewer divers were recorded in these zones in 2011 / 12 compared with 2010 / 11.
- Precision was high for diver estimates on most surveys, ranging from 0.03 – 0.71 in Zone 1 over the two years of winter surveys. In February when diver numbers were at their highest over both years, precision ranged between 0.03 – 0.08.
- Distribution of divers appeared to reflect shallow water areas. All divers in Zones 1 & 2 were recorded in water < 26 m in depth.
- February 2011 was notable for high diver density in the north-east of the wind farm survey zone and this pattern was also repeated in January 2012, although there were generally fewer divers recorded in the second year. The majority of divers along the

north-eastern border of Zone were mostly outside of the Phase 1 development area. This distribution of divers in Zone 1 was similar to historical layout.

- Several other bird species / groups were recorded on the surveys, the most abundant of which were gulls (kittiwakes, herring gulls and great black-backed gulls). These birds generally appeared to influx in the latter part of the winter.
- Peak abundance estimates increased for four bird groups (seaducks, fulmars, cormorants / shags and great black-backed gulls) during 2011 / 12 surveys in comparison to 2010 / 11. For all other species, peak abundance estimates were lower during 2011 / 12 in comparison to 2010 / 11.
- Marine mammals, likely harbour porpoises, were most abundant during February in Zone 1 during both winter 2010 / 11 and winter 2011 / 12, although the number of individuals estimated to be present was lower during 2011 / 12. In Zone 2 numbers also peaked in February during both survey years. Marine mammal abundance was relatively low across all other survey months during 2010 / 11 and 2011 / 12 in both zones. Across both years, marine mammals were thinly distributed in groups no bigger than two or three.

6 REFERENCES

APEM (2010). *London Array offshore wind farm: Aerial survey methods, data collection and statistical analysis*. APEM Scientific Report 410955. London Array Ltd., August 2010 v3 Final, 40 pp.

APEM (2011). *Red-throated divers & offshore wind farms in the Outer Thames: historic data review*. APEM Scientific Report 411134. London Array Ltd., June 2011 v2 Final, 154 pp.

Banks, A.N., Maclean, I.M.D., Burton, N.H.K., Austin, G.E., Carter, N., Chamberlain, D.E., Holt, C. & Rehfisch, M.M. (2006) *The Potential Effects on Birds of the GGOWF: Report February 2004 – April 2006*. BTO Research Report 440. BTO, Thetford.

Blomdahl, A., Breife, B. & Holmstrom, N. (2003) *Flight Identification of European Seabirds*. Helm, London.

Bohlin, T. (1990) *Estimation of population parameters using electric fishing: aspects of the sampling design with emphasis on salmonids in streams*. In, Cowx, I.G. & Lamarque, P. (eds.) *Fishing with Electricity*. Fishing News Books, Oxford, pp. 156-173.

Cramp, S. & Simmons, K.E.L. (1977) *The Birds of the Western Palearctic*. Vol I. Oxford University Press, Oxford.

DTI (2006). *Aerial Surveys of Waterbirds in Strategic Windfarm Areas: 2004/05 Final Report*. DTI, London.

Efron, B. & Tibshirani, R.J. (1993) *An Introduction to the Bootstrap*. Chapman & Hall, London.

Lack, P (1986) *The Atlas of Wintering Birds in Britain and Ireland*. T & AD Poyser, London.

Natural England & JNCC (2010) *Departmental Brief: Outer Thames Estuary Special Protection Area*. JNCC/NE, Peterborough. http://www.naturalengland.org.uk/Images/Thames-brief_tcm6-21728.pdf

O'Brien, S.H., Wilson, L.J., Webb, A. & Cranswick, P.A. (2008) Revised estimate of wintering Red-throated Divers *Gavia stellata* in Great Britain. *Bird Study*, **55**, 152-160.

Reid, J.B., Evans, P.G.H. & Northridge, S.P. (2003) *Atlas of cetacean distribution in north-west waters*. JNCC, Peterborough.

Skov, H. & Prins, E. (2001) Impact of estuarine fronts on the dispersal of piscivorous birds in the German Bight. *Marine Ecology Progress Series*, **214**, 279 – 287.

Skov, H., Heinänen, S., Lohier, S., Thaxter, C., Zydalis, R. & Stock, A. (2010) Modelling the abundance and area use of wintering red-throated divers in the Outer Thames Estuary. DHI draft report to London Array Ltd.

Stone, C. J., Webb, A., Barton, C., Ratcliffe, N., Reed, T.C., Tasker, M. L., Camphuysen, C. J. & Pienkowski, M. W. (1995) *An atlas of seabird distribution in north-west European waters*. JNCC, Peterborough.

Stroud, D.A., Chambers, D., Cook, S., Buxton, N., Fraser, B., Clement, P., Lewis, I., McLean, I., Baker, H. & Whitehead, S. (2001). *The UK SPA Network: its scope and content Vols 1 – 3*. JNCC, Peterborough.

Tasker, M.L., Webb, A., Hall, A.J., Pienkowski, M.W. & Langslow, D.R. (1987) *Seabirds in the North Sea*. Nature Conservancy Council, Peterborough.

Webb, A., Dean, B. J., O'Brien, S. H., Söhle, I., McSorley, C. A., Reid, J. B., Cranswick, P. A., Smith, L. E. & Hall, C. (2009) *The numbers of inshore waterbirds using the Greater Thames during the non-breeding season: an assessment of the area's potential for qualification as a marine SPA*. JNCC Report 374, JNCC, Peterborough.

Wernham, C. V., Toms, M. P., Marchant, J. H., Clark, J. A., Siriwardena, G. M. & Baillie, S. R. (eds) (2002) *The migration atlas: Movements of the birds of Britain and Ireland*. T. & A. D. Poyser, London.

7 APPENDIX I: SURVEY CONDITIONS

Year	Date surveys undertaken	Zone(s) surveyed	State of seas*	Wind speed / direction	Visibility	Other significant information
2010	November 23rd	1	3-4	25-30 knots/NW	Cloud cover scattered at 1500 feet, with > 10 km visibility.	
	November 24th	2	2-3	15-20 knots/W	Cloud cover scattered at 1200 feet, with > 10 km visibility.	
2011	November 2 nd	2	3-4	30-40 knots / N	Cloud cover broken at 2000 feet with > 10 km visibility	
	November 3 rd	2	3-4	30-40 knots / N	Overcast with rain. Cloud cover broken at 800 feet, with > 10 km visibility	
	November 4 th	1	3-4	13 knots / SW	Broken cloud at 1000 feet with visibility > 10 km	Between the 5 th and 10 th of November, the local weather was not suitable for survey. The remaining zones were therefore surveyed on the 10 th and 17 th of November.
2010	December 9th	1,2	3-4	30 knots /NW	Clear skies with > 10 km visibility.	
2011	December 2 nd	1	2	0-20 knots / W	Clear skies with visibility > 10 km. Clouds began to form at high altitude by late afternoon	
	December 3 rd	2	3-4	0-35 knots / W	Clear with a few scattered clouds at 1500 feet and visibility > 10 km	
2011	January 10 th	1	2-3	30 knots/ SW	Cloud cover was partial above 5000 feet in the morning and broken cloud above 5000 feet in the afternoon. Visibility was > 10 km throughout the day.	
	January 11 th	1	2-3	30 knots / SW	Cloud cover was scattered at 2000 feet in the morning and broken at 700 feet in the afternoon, with visibility > 10 km throughout the day.	Between the 11 th and 17 th of January, and local weather was not suitable for survey. The remaining zones were therefore surveyed on the 17 th and 18 th of January.
	January 18 th	2	2	10 knots / SW	Mist was observed at 800 to 1000 feet in the morning but visibility quickly rose to >10 km.	

2012	January 16th	2	2-3	0 – 20 knots / SE	Clear with visibility > 10 km	
	January 17th	1	1-2	0-10 knots / SW	Bright with scattered clouds at 1000 feet and visibility > 10 km	
2011	February 14th	1	1-2	30 knots / NW (morning) 12 knots/ SW (afternoon)	Cloud cover was sparse at 2,000 to 3,000 feet in the morning lifting to 3,000 feet in the afternoon. Visibility throughout the day was reported to be > 10 km.	
	February 15th	2	15 -25 knots/S	15-25 knots/S	Cloud cover was scattered at 3,000 feet in the morning and overcast at 4,800 feet in the afternoon, with visibility > 10 km throughout the day.	
2012	February 7th	2	2, 3	2	15-20 knots / SE	Scattered clouds at 1500 feet and visibility > 10 km
	February 8th	1	1	2-3	15-20 knots / NE	Overcast with cloud cover at 1500 feet at visibility > 10 km

8 APPENDIX II: COUNTS AND ABUNDANCE ESTIMATES FOR ALL BIRDS

Table 8.1 Monthly counts, estimates, confidence limits and precision for all birds in Zone 1 and 2. Estimates within target precision of 0.16 are in red italic text.

Month	Year	Zone	Count	Population Estimate	Lower Confidence Limit	Upper Confidence Limit	Precision
November	2010	Zone 1	<i>64</i>	<i>496</i>	<i>349</i>	<i>658</i>	<i>0.13</i>
		Zone 2	35	266	152	402	0.17
	2011	Zone 1	<i>50</i>	<i>408</i>	<i>220</i>	<i>668</i>	<i>0.14</i>
		Zone 2	36	321	36	902	0.17
December	2010	Zone 1	<i>230</i>	<i>1,786</i>	<i>1,491</i>	<i>2,097</i>	<i>0.07</i>
		Zone 2	<i>52</i>	<i>380</i>	<i>256</i>	<i>556</i>	<i>0.14</i>
	2011	Zone 1	<i>43</i>	<i>353</i>	<i>221</i>	<i>492</i>	<i>0.15</i>
		Zone 2	<i>48</i>	<i>391</i>	<i>90</i>	<i>880</i>	<i>0.14</i>
January	2011	Zone 1	<i>237</i>	<i>1,531</i>	<i>1,208</i>	<i>1,886</i>	<i>0.07</i>
		Zone 2	<i>60</i>	<i>452</i>	<i>309</i>	<i>618</i>	<i>0.13</i>
	2012	Zone 1	<i>286</i>	<i>2330</i>	<i>1865</i>	<i>2859</i>	<i>0.06</i>
		Zone 2	<i>136</i>	<i>1111</i>	<i>866</i>	<i>1389</i>	<i>0.09</i>
February	2011	Zone 1	<i>1,580</i>	<i>10,299</i>	<i>8,637</i>	<i>11,896</i>	<i>0.03</i>
		Zone 2	<i>383</i>	<i>2,418</i>	<i>2,021</i>	<i>2,822</i>	<i>0.05</i>
	2012	Zone 1	<i>211</i>	<i>977</i>	<i>778</i>	<i>1199</i>	<i>0.07</i>
		Zone 2	<i>617</i>	<i>2821</i>	<i>2240</i>	<i>3457</i>	<i>0.04</i>

9 APPENDIX III: TIDE INFORMATION FROM WHITAKER BEACON



Figure 9.1 Location of Whitaker Beacon tide monitoring site

Table 9.1 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 2010	23/11/2010	1	09:47 – 14:24	08:57 : 4.79m 15:01: 0.5m	Outgoing
	24/11/2010	2	09:15 - 12:06	09:58: 4.82m 15:41: 0.55m	Outgoing
December 2010	09/12/2010	1	08:54 – 13:49	10:22: 4.59m 16:24: 0.82m	Approaching high tide, then outgoing
	09/12/2010	1	08:54 – 13:49	10:22: 4.59m 16:24: 0.82m	Approaching high tide, then outgoing
January 2011	10/01/2011	1	09:12 – 13:46	10:34: 0.63m 16:51: 4.24m	Low to start then incoming
	18/01/2011	2	12:30 – 16:19	11:51: 4.27m 17:58:0.88m	Near high tide at start of survey, then outgoing
February 2011	14/02/2011	1	09:33 – 16:10	09:04: 3.62m 15:21: 1.46m	Outgoing neap tide
	15/02/2011	2	09:28 – 13:43	10:25: 3.87m 16:36: 1.26m	Reaching high tide approx. ¼ way into survey, then outgoing neap tide
November 2011	04/11/2011	1	12:20 – 16:17	07:23: 3.59m 13:44: 1.27m	Outgoing until about half way through and then incoming
	02/11/2011	2	13:00 – 15:56	11:34: 0.87m 17:58: 4.00m	Incoming
	03/11/2011	2	09:50 – 10:26	06:16: 3.81m 12:35: 1.12m	Outgoing
December 2011	02/12/2011	1	08:30 – 14:09	11:59: 0.95m 18:24: 3.88 m	Outgoing and then incoming for last 2 hours
	03/12/2011	2	08:58 – 11:31	10:22: 4.59m 16:24: 0.82m	Incoming at start and then outgoing
January 2012	17/01/2012	1	08:50 – 14:35	06:37: 4.29m 12:53: 0.80m	Outgoing
	16/01/2012	2	10:32 – 13:02	11:55: 0.53m 18:16: 4.36m	Outgoing until half way through and then incoming
February 2012	08/02/2012	1	10:03 – 15:50	07:19: 0.20m 13:35: 4.95m	Incoming until half way through and then outgoing
	07/02/2012	2	10:08 – 12:42	06:36: 0.53m 12:54: 4.62m	Incoming

10 APPENDIX IV: JNCC BIRD & MARINE MAMMAL GROUPS

JNCC Code	Grouping	Species Code	Species
95018	Seaduck species	2130	Common scoter
		2150	Velvet scoter
95003	Diver species	20	Red-throated diver
		30	Black-throated diver
		40	Great northern diver
95004	Grebe species	90	Great crested grebe
	Grebe species	100	Red-necked grebe
	Grebe species	110	Slavonian grebe
	Grebe species	120	Black-necked grebe
220	Fulmar	220	Fulmar
95006	Shearwater species	360 - 480	Shearwater species
95008	Petrel species	500 - 550	Storm petrel species
710	Gannet	710	Gannet
95009	Cormorant / shag	720	Cormorant
		800	Shag
95031	Skua species	5690	Great skua
94003	Small gull species	6020	Kittiwake
		5900	Common gull
95034	Large gull species	5910	Lesser black-backed gull
		5920	Herring gull
		6000	Great black-backed gull
95037	Tern species	6110 - 6270	Tern species
95040	Auk species	6470	Little auk
		6380	Black guillemot
		6340	Guillemot
		6540	Puffin
		6360	Razorbill
71000	All Phocids (e.g. seals)	n/a	
80000	All Cetaceans (whales, dolphins)	n/a	

11 APPENDIX VII: LATIN NAMES OF BIRD SPECIES

Common name	Latin name
Common scoter	<i>Melanitta nigra</i>
Velvet Scoter	<i>Melanitta fusca</i>
Black-throated Diver	<i>Gavia arctica</i>
Red-throated diver	<i>Gavia stellata</i>
Great northern diver	<i>Gavia immer</i>
Fulmar	<i>Fulmarus glacialis</i>
European Storm Petrel	<i>Hydrobates pelagicus</i>
Gannet	<i>Morus bassanus</i>
Cormorant	<i>Phalacrocorax carbo</i>
Shag	<i>Phalacrocorax aristotelis</i>
Slavonian Grebe	<i>Podiceps auritus</i>
Little Grebe	<i>Tachybaptus ruficollis</i>
Black-necked Grebe	<i>Podiceps nigricollis</i>
Red-necked Grebe	<i>Podiceps grisegena</i>
Great crested grebe	<i>Podiceps cristatus</i>
Great skua	<i>Stercorarius skua</i>
Kittiwake	<i>Rissa tridactyla</i>
Common gull	<i>Larus canus</i>
Black-headed Gull	<i>Chroicocephalus ridibundus</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>