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The Potential Effects on Birds of the Greater Gabbard Offshore Wind Farm Report for February 2004 to March 2005

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EXECUTIVE SUMMARY – Baseline

1. Greater Gabbard Offshore Winds Ltd (GGOWL) propose to build an offshore wind farm adjacent to two sandbank areas 23 km off the Suffolk coast, known as the Inner Gabbard and Galloper. The wind farm project is known as Greater Gabbard.

2. GGOWL has contracted the British Trust for Ornithology (BTO) and Environmentally Sustainable Systems (ESS) to undertake surveys and to assess the impacts of the proposed wind farm on bird populations.

3. The North Sea and Suffolk coast are important areas for many waterbirds including divers, seaducks, gulls and auks.

4. Offshore surveys were carried out between February 2004 and March 2005 to ascertain the abundance and distribution of birds in the "footprint" area of the proposed wind farm, plus an extended "reference" survey area. Aerial and boat surveys were used in accordance with COWRIE recommendations. Surveys are ongoing.

5. Onshore breeding birds at Sizewell were surveyed using a six-visit, mapping methodology approach, with visits from late March to late June. Territory analyses were carried out for species of conservation importance and other species likely to be affected by construction work were identified. The results from the survey were supplemented with records from local and national bird surveys and the Suffolk Bird Report.

6. Distance sampling techniques were employed to generate accurate estimates of bird abundance for the two offshore study areas, whilst smoothed surfaces of distribution were obtained using GIS kriging methods.

7. Seventeen principal offshore species were analysed according to conservation designation or national or regional importance, and species accounts are presented in the context of breeding season, wintering season and migration periods.

8. No species were found in numbers estimated to exceed the 1% international population threshold. Three species (Red-throated Diver, Great Skua and Lesser Black-backed Gull) were estimated to occasionally exceed the 1% national population threshold in either the breeding or wintering season, within the entire study area covered (footprint plus reference area), an area approximately five times greater than the proposed wind farm footprint.

9. Six further species (Northern Fulmar, Northern Gannet, Mew Gull, Herring Gull, Great Black-backed Gull and Black-legged Kittiwake), plus the species group containing auks, were estimated to exceed the 1% regional population threshold in either the wintering or breeding season, within the entire study area covered (footprint plus reference area). Regional importance is based on the aerial surveys of the Outer Thames Estuary carried out during the winter of 2004/05.

10. Proportional estimates of offshore bird numbers within the wind farm footprint are low, with no species exceeding the 1% national importance threshold and only three species exceeding the 1% regional threshold.

11. Offshore distribution of most species was broadly evenly spread, except for large feeding flocks of gulls, often found near the southern wind farm footprint area.

12. Boat-based surveys of migrants detected few birds passing through the study area, with Starlings the only species identified in numbers greater than 51.

13. Modelling revealed no conclusive relationships between bird numbers and the available environmental data.

14. Onshore surveys revealed a number of birds of conservation importance in a study area that included the beach at Sizewell and fields around the cable route and proposed substation, including Wood Lark and Cetti's Warbler. However, small numbers of territories were identified for most species.

15. There is little abundance or distributional evidence to suggest that the wind farm area is of more than regional importance for marine bird species.

1. INTRODUCTION

1.1 Objectives

This section provides a baseline description of the avifauna of the offshore and onshore areas where development is proposed, based on field studies. Background information on species' conservation status is also provided.

To assess the importance of the wind farm area and its surrounding marine habitat, a series of aerial and boat-based surveys were undertaken during the period February 2004 – March 2005, using the up-to-date methods recommended by COWRIE (Camphuysen *et al*. 2004). The ornithological data presented feed into the assessment of the significance of the impacts of the wind farm (see section 7).

The objectives of this part of the report are as follows:

- To assess bird abundance and distribution in the *offshore study area* (see definition below), and to place abundances in terms of international, national and regional importance.

- To assess the importance of the *Greater Gabbard wind farm area* (see definition below) for all species during the breeding and non-breeding seasons, and during the migration periods.

- To assess bird abundance and distribution in the *onshore study area* (see definition below)

1.2 Definition of the Study Areas

Offshore study area

The areas studied using aerial and boat surveys varied slightly, but encompassed much of the same regions of the sea, and, critically, both included the area containing the proposed wind farm. Boat survey areas differed slightly between those undertaken in February and March 2004, and those after March 2004. Initially, an area 485 km^2 was surveyed (Figure 1.2-1), with 730 km^2 surveyed after March 2004 (Figure 1.2-2). Both survey areas included the area of the proposed wind farm (the "footprint" area), plus a "reference" zone. On the former surveys, the wind farm area represented 30% of the entire area studied; on the latter, 20%. Aerial surveys covered an area of sea totalling 1,060 km^2. The area containing the proposed wind farm was labelled TH3 (Figure 1.2-3); the wind farm area represented 14% of the total area surveyed.

Greater Gabbard wind farm area

The proposed Greater Gabbard Offshore Wind farm lies approximately 23 km off the Suffolk coast (Longitude 1°57' Latitude 51°43' to Longitude 1°55' Latitude 52°) over an area of 147 km^2. It will comprise up to 140 wind turbines. The area heretofore referred to as the 'Greater Gabbard' will be taken to include two areas adjacent to the shallow sandbanks selected for wind farm location, known as the Inner Gabbard and The Galloper.

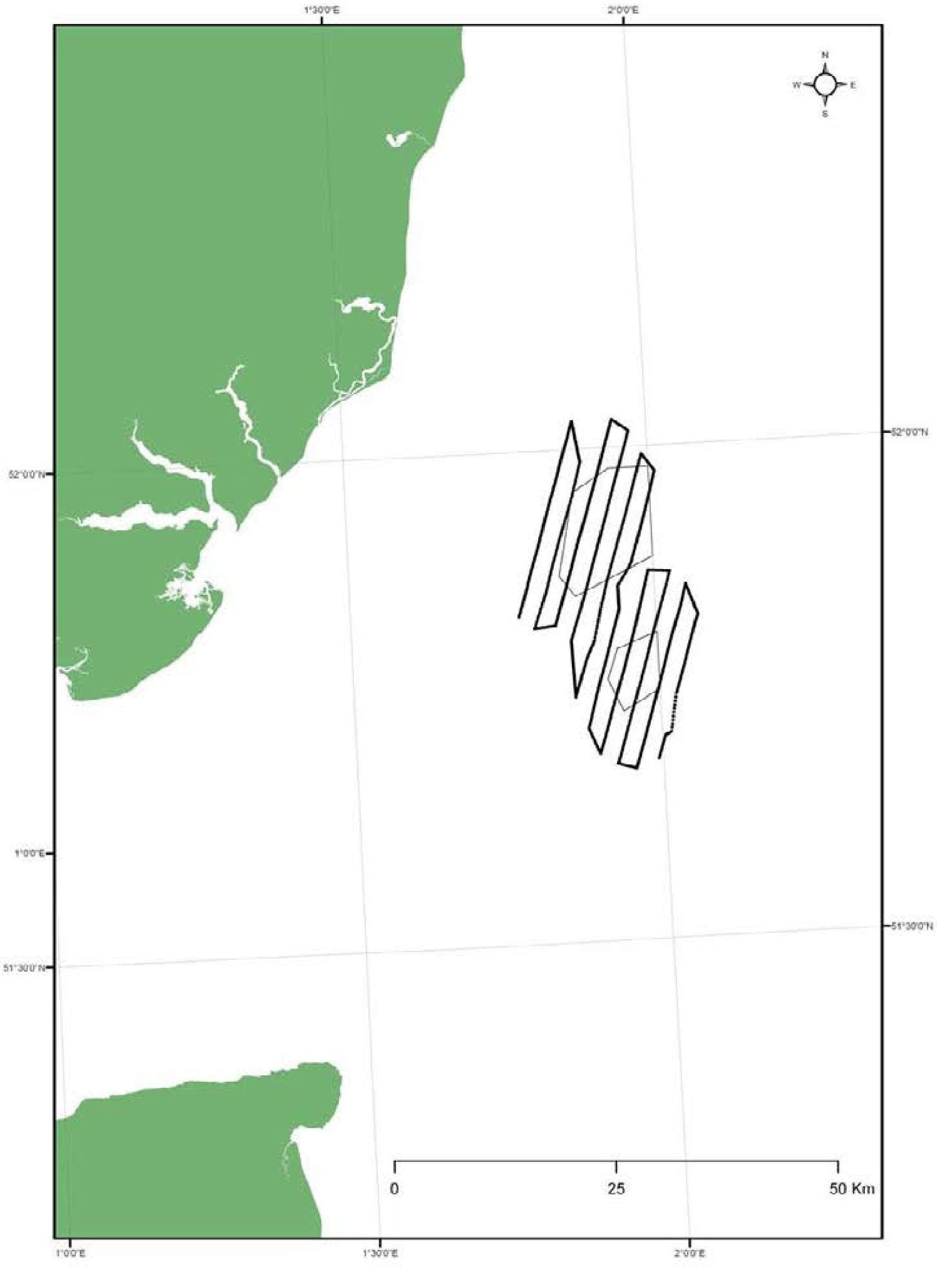

Figure 1.2-1 Boat survey transects February – March 2004. Wind farm area in black, boat track in grey.

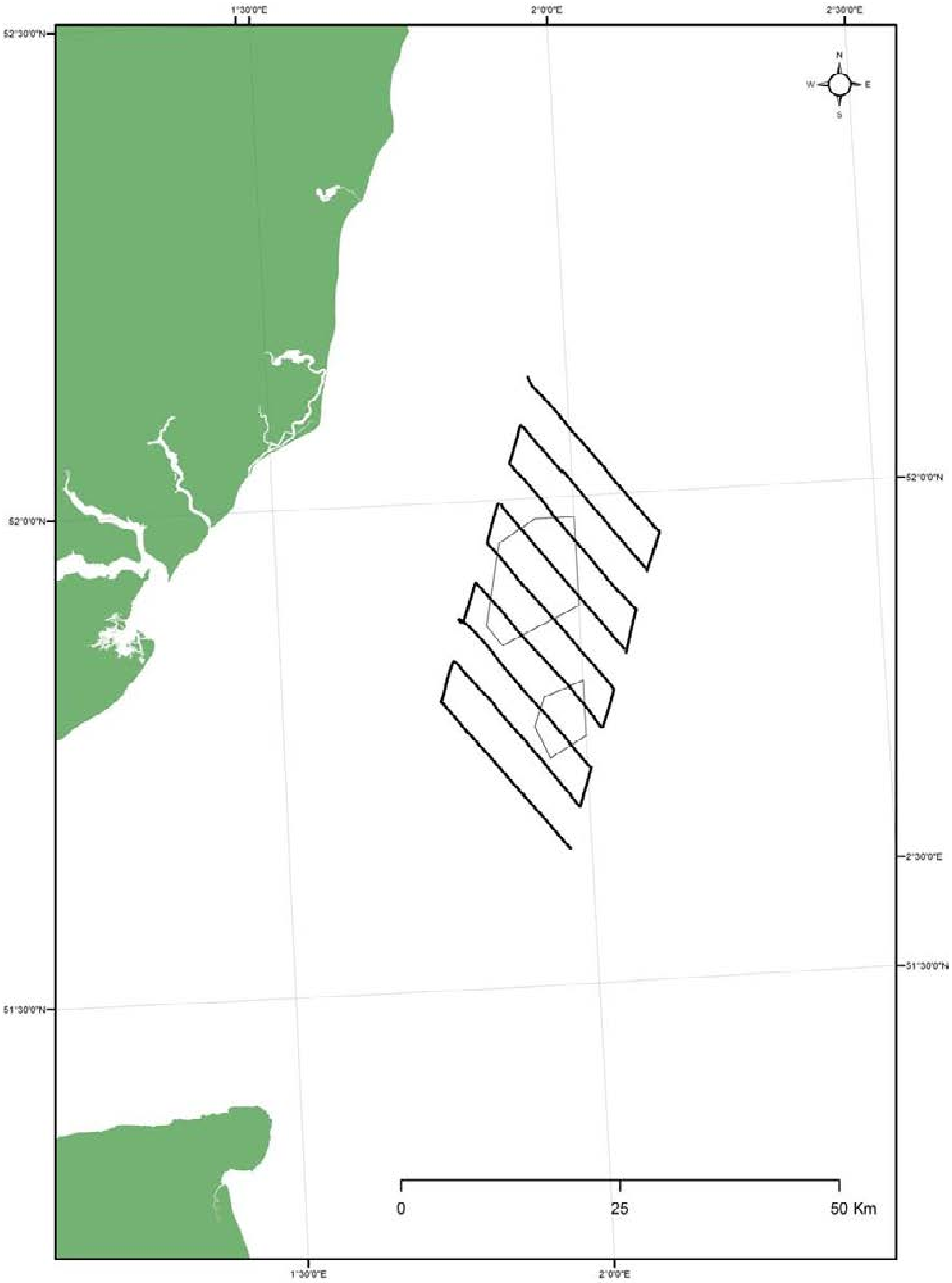

Figure 1.2-2 Boat survey transects April 2004 – March 2005. Wind farm area in black, boat track in grey.

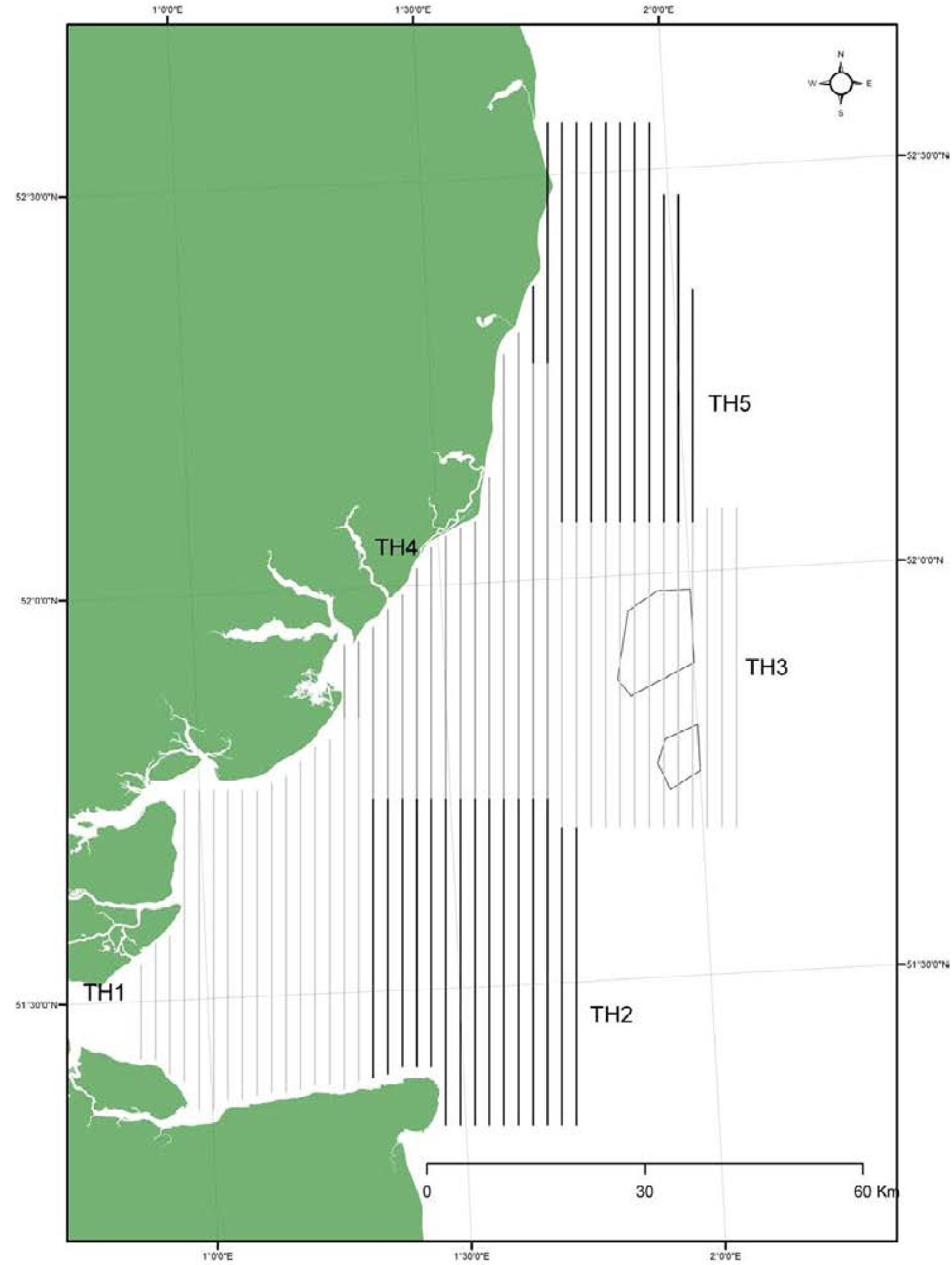

Figure 1.2-3 Transects of Thames Estuary aerial survey areas, DTI 2004/05. Area TH3 (proposed wind farm study area) with other aerial survey areas.

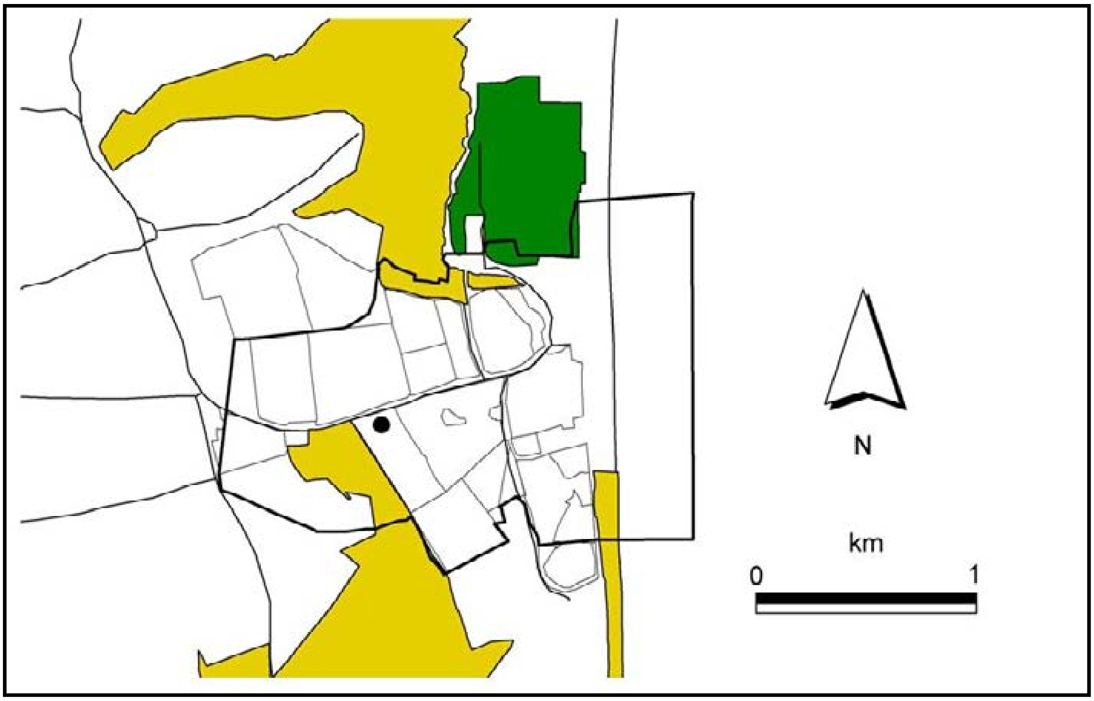

Fig. 1.2-4 The onshore survey area (bold line) at Sizewell showing the location of the proposed substation (black dot), Sizewell power station (dark shading) and protected areas - Leiston-Aldeburgh SSSI, part of the Sandlings SPA to the south and Sizewell Marshes SSSI to the north.

Onshore study area

To investigate the potential effects of the laying of cables and building of the proposed substation to connect with the National Grid at Sizewell, an onshore study area was also surveyed during the 2005 breeding season. The onshore study area covered the beach from Sizewell Hall in the south to the end of the first major building structure within the Sizewell "A" power station complex in the north– a distance of more than 1.5 km (Fig. 1.2-4). The vegetation within this coastal zone included extensive short grass sward, extensive stands of Sea Kale *Crambe maritima* on the shingle, scattered patches of gorse and scrubby woodland in front of the power station complex. A relatively narrow strip of mixed, wet woodland with Alder *Alnus spp.* stands borders the western side of the access road to both the power stations. The south-western edge of the survey area (beyond the proposed location of the substation) included part of the Sandlings Special Protection Area (SPA), a designated area of scrubby heathland. Horse paddocks dominated the south-west edge of the site, adjacent to Halfway Cottages. The remainder of the survey area mostly comprised mixed agriculture crops, including potatoes and peas. A small area of mature mixed woodland, fronted by developing scrubby woodland, lies just west of Sandy Lane, with wetter pasture to the north. Scattered stretches of mature hedgerow are present, notably bordering at least one side of the proposed substation site.

1.3. Species and Conservation Designations

Throughout this report, the term "waterbirds" will comprise divers, grebes, shearwaters, petrels, gannets, cormorants, herons, swans, geese, ducks, waders, skuas, gulls, terns and auks. The term "seabirds" excludes herons, swans, geese, some ducks and waders.

The North Sea as a whole is an important area for waterbirds (Carter *et al*. 1993; Skov *et al*. 1995; Stone *et al*. 1995), especially during winter when birds breeding in the UK may be joined by influxes of migrants from the continent. Therefore any proposed developments in this area must carefully consider not only wintering bird abundance and distribution, but also those species that may forage in the area during the breeding season, and those species likely to pass through the area during post-breeding dispersal and return migration. There is the possibility that the wind farm site and its environs may be designated as a Candidate Special Area of Conservation (cSAC) and areas within the outer Thames Estuary to the south as a Candidate Special Protection Area (cSPA) due to their importance for wintering Red-throated Divers *Gavia stellata*.

There is also the possibility that areas of the Outer Thames may be designated as a cSAC for sub-littoral sandbank features.

A number of SPAs exist along the east coast of England (Figure 1.3-1). Predominantly, the designated species occurring on these SPAs are wintering waders and wildfowl (Appendix 1) which would not be expected to use either the proposed offshore wind farm area or the onshore area where the substation is to be located. The following are notable exceptions:

- Lesser Black-backed Gulls breeding on Orford Ness in the Alde-Ore Estuary SPA, and
- European Nightjars and Wood Larks using the Sandlings SPA.

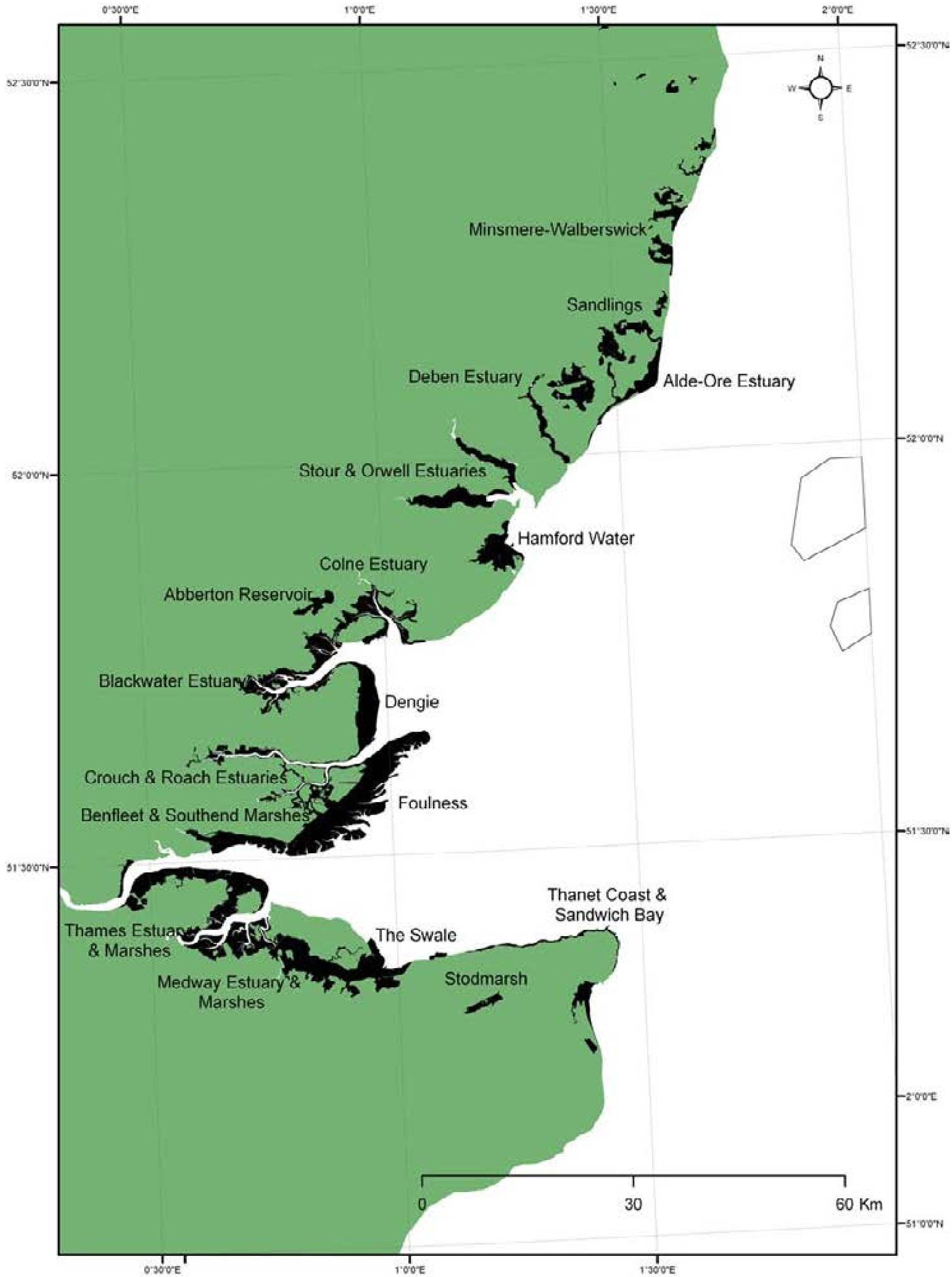

Figure 1.3-1 The Outer Thames Estuary showing the proposed Greater Gabbard wind farm site and neighbouring Special Protection Areas (SPAs: in bold).

1.4 Consultations

Consultations have been undertaken with a range of statutory and non-statutory environmental bodies, including English Nature (EN), the Royal Society for the Protection of Birds (RSPB), the Department of Trade and Industry (DTI), the Department of the Environment, Food and Rural Affairs (Defra), the Joint Nature Conservation Committee (JNCC) and Centre for the Environment, Fisheries & Aquaculture Science (CEFAS). *Ad hoc* meetings with local representatives of English Nature, RSPB and Suffolk Wildlife Trust (SWT) have been held to discuss ornithological issues. Regular meetings of a liaison group comprising representatives of Airtricity, Fluor, PMSS, ABPmer, CMACS, Danbrit, Enviros, ESS, Eversheds, Maritime Archaeology, have been held to oversee the integrated production of the baseline studies and EIA.

2. SURVEY METHODS

2.1 Offshore survey methods

2.1.1 Boat surveys

Boat-based bird surveys aimed to establish the numbers, distributions, flight heights and directions of birds found to be present within the study area (two wind farm sites, a surrounding buffer zone and two control areas) as well as to create a repeatable baseline for future monitoring requirements.

Between February and March 2004, the study area surveyed encompassed 487 km^2 over 10 transects. The entire study area from April 2004 spanned 730 km^2, comprising the wind farm footprint, and the reference area comprising the surrounding buffer zone and two control areas, over nine transects. The area of study was changed in accordance with revisions to the location and alignment of the proposed wind farm. For both areas, surveys were spread over on consecutive days, where weather allowed. The field methods used were adapted from *Counting Birds from Boats* (Webb, in Komdeur *et al.* 1992) and have been developed to maximise accuracy, repeatability, and suitability for two observers. They remain consistent with COWRIE recommendations (Camphuysen *et al*. 2004). Transects were spaced at 1.8 nm intervals, running parallel to the coast for the first three surveys, and perpendicular to the coast thereafter (see Figures 1.2-1 and 1.2-2), and also conform to COWRIE recommendations.

2.1.1.1 Sampling strategy

Two trained observers were present on the observation deck, itself 8 m above sea level, both counting birds simultaneously. One observer scanned through an arc of 90˚ to the port side, the other 90˚ to the starboard side, with birds only being recorded once. Observers periodically swapped sides in order to minimise observer bias. Visual scanning was carried out continuously, using the naked eye to detect all birds on the sea (within the transect) on the surveyor's side of the boat and, with lower priority, birds seen in the air. For birds seen flying in presumed passage or feeding flights, the direction of all flocks or individuals was recorded to the nearest 10˚. Distances of birds seen in the air were measured from the observer, rather than perpendicular to the transect.

Recording forms were used to catalogue bird counts, and these data were later transferred to Excel spreadsheets for eventual input to distance sampling software (Distance 5.0 Beta 4; Research Unit for Wildlife Population Assessment, University of St. Andrews).

The period of each recording sequence was two minutes. Within this period a series of recording activities was undertaken for fixed durations, followed by instantaneous 'snapshot' counts. The majority of each two minute period was devoted to counting water-borne birds that fell within pre-determined 'distance bands', defined as being up to 300 m perpendicular to the boat. This method was effectively a line transect method, that subsequently allowed analysis using distance sampling techniques (Buckland *et al*. 2001). Snapshot counts aimed to quantify those birds in the air in the immediate vicinity of the boat, and also divers that were likely to flush from the water in advance of the boat. In effect this method represented a series of point counts.

Many variables were also recorded during line transect and snapshot counts, with priorities set according to the objectives of the study; these were firstly to produce bird abundance estimates (including quantifications of passage movements), and secondly to produce an assessment of collision risk presented to birds by any offshore wind farm development. Therefore, the hierarchy of recording the relevant variables was as below:

1. Numbers, and species or taxon. 2. Distance from survey vessel. 3. Flight height. 4. Behaviour (including whether feeding). 5. Flight direction. 6. Age. 7. Sex of obviously dimorphic species. 8. Moult status. 9. Plumage.

In addition, extra information was recorded where of biological interest or of likely relevance to bird distribution or detection. This included sightings of marine mammals, registration numbers and names of fishing and commercial vessels operating in the area, positions of vessels at anchor in the vicinity of the project site, visibility and general weather conditions (including wind speed and direction, sea surface features and sun glare), and hydrographic and biological data (*e.g.* water depth and fish recorded on echo sounder).

2.1.1.2 Sampling methods

Line transect method

Birds were recorded within five distance bands, nominally titled A-E, measured perpendicular to the transect line along which the boat progressed at a constant speed (between 6.5 and 10 knots, depending on the vessel). The distance bands were defined thus: A = 0-50 m; B = 50-100 m; C = 100-200 m; D = 200-300 m; E = >300 m. Birds were considered to be 'in transect', and therefore eligible for distance sampling, if they were recorded on the water within one of the five distance bands.

During the earliest surveys (February 2004 – March 2004), transects were designed to run parallel to the coastline, and coverage of the ten transects typically took two days. From April 2004, the design of the survey changed so that transects ran perpendicular to the coast. Nine transects were travelled, usually over two days. The 'short legs' travelled between main transects to preserve the spacing of 2 km were often used to make additional bird counts on these surveys. Table 2.1.1.2-1 illustrates the frequency of surveys.

Year	Month	Dates of survey	Notes
2004	February	14 – 15 February	
	March (1)	2 – 3 March	
	March (2)	17 – 18 March	
	April	23 – 24 April	
	May	25 – 26 May	
	June	9 – 10 June	
	July	19 – 20 July	
	August	5 – 6 August	
	September	29 – 30 September	
	October	N/A	Weather disruption, no survey
	November	9 November – 2 December	Pooled data; weather disruption
	December	7 – 9 December	
2005	January	N/A	Weather disruption, no survey
	February	N/A	Weather disruption, no survey
	March (1)	25 – 28 March	
	March (2)	29 – 31 March	Incomplete survey (fog)

Table 2.1.1.2-1 Boat survey dates

Snapshot counts

Every two minutes, instantaneous 'snapshots' were taken by each observer at the same time. In response to an aural prompt, each observer spent 5 - 10 seconds searching for all birds in the air that were on, or near to, the transect line. At the precise moment of the snapshot the number of those birds actually present within the snapshot zone was confirmed and recorded. The snapshot zone comprised a square block of air extending 300 m to the front and 300 m perpendicularly from the boat.

Migration watch

A 'migration watcher' was deployed during the relevant months, April – May and August – November, in order to record migrants passing through the proposed wind farm area. Both passerines and passage wildfowl (grebes, ducks, swans and geese) and waders were recorded. Birds were quantified and identified to species or family level, and the estimated height above sea level was recorded. The latter variable was of high priority, as it was important to assess the likelihood of collision with any future turbines installed.

Migration counts were often made on the 'short legs' between the major transects. These data were not included in distance analyses and do not contribute to abundance estimates. However, raw counts are presented to provide an idea of species likely to be involved in (diurnal) passage movements.

2.1.2 Aerial surveys

Five survey blocks, labelled TH1 – TH5, were covered four times during the winter of 2004/05 (Figure 1.2-3) by staff at the Wildfowl & Wetlands Trust, the area containing the proposed Greater Gabbard wind farm being TH3. Thirteen line transects were surveyed within TH3, 10 of length 42 km and three of 44 km (Table 2.1.2-1). The total area surveyed was 1,060 km^2. For area TH3, the following dates were used for survey: winter period 1 = 12/11/04; winter period 2 = 24/11/04; winter period 3 = 14/01/05; winter period 4 = 28/02/05.

The survey protocol was designed for distance sampling of data, as proposed by Camphuysen *et al.* (2004). Birds were recorded within four distance bands, nominally titled A-D, measured perpendicular to the transect line along which the aircraft progressed at a constant velocity and altitude (185 kmh^{-1} and 80 m respectively). The distance bands were defined thus: A = 44 m – 163 m; B = 163 m – 282 m; C = 282 m – 426 m; D = 426 m – 1000 m. Note that due to the existence of a 'dead zone' beneath the aeroplane, the first distance band begins at 44 m. Transects were spaced 2 km apart and the direction of flight was always on the north-south axis.

Navigation used a Garmin 12XL GPS following OSGB grid lines. The navigator guided the pilot along the intended transect route, and told observers when to start and stop counting along each transect; due to the angle of tilt of the plane it is not possible to count during turns between transects. To ensure an accurate record of the flight path, the precise location of the plane was downloaded regularly from the GPS onto a laptop computer (*e.g.* every five seconds).

The two observers each counted from one side of the aircraft and counted birds on or flying just above the water's surface to one side of the plane. The species (or species-group where specific identification was not possible), number, behaviour and distance band (recorded when the individuals were perpendicular to the plane) of all birds encountered was recorded using a Dictaphone. To allow the 'distance sampling' approach to be used (Buckland *et al.* 2001), a clinometer was used to allocate birds to the distance bands. Birds more than 1000 m away from the flight path were not recorded. In addition to the information mentioned, other variables were recorded for each observation where possible, including age and gender of birds, and observation conditions. In practice these were rarely used in analyses.

Survey block	Transect number	Length (km)	Area (km^2)
TH1	1	13	1260
	2	16	
	3	19	
	4	40	
	5	44	
	6	44	
	7	42.5	
	8	42.5	
	9	42	
	10	42.5	
	11	43.5	
	12	45	
	13	46.5	
	14	47.5	
	15	51	
	16	50	
TH2	17	38.5	1231
	18	38	
	19	37	
	20	37	
	21	37	
	22	45	
	23	45	
	24	45	
	25	45	
	26	45	
	27	45	
	28	45	
	29	45	
	30	41	
	31	41	
TH3	30	42	1060
	31	42	
	32	42	
	33	42	
	34	42	
	35	42	
	36	42	
	37	42	
	38	42	
	39	42	
	40	44	
	41	44	
	42	44	

Survey block	Transect number	Length (km)	Area (km^2)
TH4	15	10	1126
	16	10.5	
	17	23.5	
	18	26	
	19	28	
	20	31.5	
	21	34.5	
	22	36	
	23	37	
	24	38	
	25	44	
	26	61	
	27	64	
	28	60	
	29	60	
TH5	28	10.5	1076
	29	33	
	30	55	
	31	55	
	32	55	
	33	55	
	34	55	
	35	55	
	36	55	
	37	45	
	38	45	
	39	32	

Table 2.1.2-1 Five aerial survey blocks (TH1 – TH5) with relevant transect labels, transect lengths, and total survey areas.

2.2 Onshore survey methods

Onshore surveys were carried out during the breeding season of 2005, to identify birds likely to be affected by development of the onshore works. The survey covered the site identified for landfall of the cables running from the offshore turbines and the proposed site for location of the substation necessary to connect to the National Grid, all situated to the south of Sizewell "A" Power Station (Figure 1.2-4).

The methodology followed that developed by the BTO for its long-running Common Birds Census (Marchant *et al.* 1990). The basis of this approach is the mapping visit, lasting several hours and involving coverage of all parts of the plot. The location of every bird present on, or flying over, the site was accurately recorded on a large-scale map, using a new map for each visit. Standard two-character codes were used to denote species, and different symbols were used to denote activity such as singing or calling.

A six-visit mapping strategy was used to estimate numbers of breeding and migrant birds and locate breeding territories at Sizewell. A mapping approach has advantages for site-specific work over other approaches, such as line transects and point counts. It attempts to locate all breeding birds, and the accurate mapping of territories can be related to habitat, management practices and impact assessments.

Visits were carried out from late March to late June, to coincide with peak breeding activity. The dates of the visits were: Visit A, 24 March (06.00-11.40); Visit B, 12 April (06.00-11.30); Visit C, 23 May (06.30-10.45); Visit D, 31 May (06.00-10.45); Visit E, 13 June (06.00-10.30); and Visit F, 24 June (06.00-10.00). The first two visits were concentrated on the beach area and the proposed location for the substation, while the final four visits covered an expanded area to provide more detail about birds on adjacent sites designated for nature conservation. Three experienced fieldworkers were used for the surveys, each doing two surveys (Mark Collier the first two surveys; Steve Holloway the middle two surveys; and Mike Raven the final two surveys).

Information on breeding Kittiwakes *Rissa tridactyla*, that nest on two inshore towers at Sizewell, was obtained during the mapping visits. As only a maximum of three sides of the towers could be observed for nests, results from the Suffolk Bird Reports were used to give a more complete picture. Suffolk Bird Reports were also used to report on Black Redstarts *Phoenicurus ochruros* known to breed in locally, and to highlight further important ornithological features of the area.

Data for European Nightjars *Caprimulgus europeaus* breeding in the area were obtained from the 2004 BTO/RSPB/English Nature Nightjar survey. This involved a minimum of two visits to 1 km squares between the last week of May and the middle of July, at dusk or dawn when 'churring' males are most active. Volunteers were asked to walk all rides and paths within their squares, to maximise the likelihood of passing within 200 m of likely European Nightjar areas. The locations of all churring birds and the associated habitat details were recorded on a map.

3. DATA ANALYSIS

3.1 Offshore data analysis

3.1.1 Abundance estimates: distance sampling

For all abundance estimates, figures were calculated at the level of the whole study area as counts were too sparse and clumped to obtain sensible estimates for the wind farm area in isolation. To calculate estimates for the wind farm area itself, it was assumed that abundance was roughly evenly distributed throughout the survey area if backed up by visual observation of the mapped raw count data, and the estimates were divided by the relevant proportional ratio of wind farm area to whole study area.

All birds recorded ‘in transect’ on boat surveys were included for analysis, as were all birds recorded during aerial surveys. However, only those species with at least 40 different observations were eligible for distance sampling, and separate analyses were run for the first three boat surveys (transects and survey area being different from later surveys), the remaining boat surveys, and aerial surveys. For boat surveys, this restriction left nine species for analysis; Fulmar, Northern Gannet, Great Skua, Lesser Black-backed Gull, Herring Gull, Great Black-backed Gull, Black-legged Kittiwake, Common Guillemot and Razorbill. Additionally, all unidentified large gulls were grouped with Great and Lesser Black-backed Gulls, plus Herring Gull, to give an estimate for all large gulls. Distance sampling for aerial surveys was possible for six of the same species (Fulmar, Northern Gannet, Lesser Black-backed Gull, Herring Gull, Great Black-backed Gull, Black-legged Kittiwake) plus Mew Gull and Black-headed Gull. Some species could only be identified to higher taxonomic scales, thus distance estimates were also generated for divers, cormorants and shags, seaducks, and auks. Unidentified gulls were also subject to distance sampling.

The data input to distance software were restricted to those collected on the main transects, as including those data from ‘short legs’ risked double sampling of birds from the areas at the corners where the boat turned to begin the next main transect (Buckland *et al*. 2001). Data collected during ‘snapshots’ on boat surveys were not suitable for distance sampling (Camphuysen *et al*. 2004), and so these counts were not scaled. Instead, the raw counts were added to the distance estimate to provide a minimum total estimate.

A global detection function was applied to counts of each species, as no inherent change in species detectability was discovered between months, with density estimates at the stratum level (in this case, month of survey). As birds of all species were encountered in flocks, where the detection of an individual within the flock cannot be considered independent of the detection of other individuals within that flock, models of detectability were of individual flocks (referred to as clusters). Two types of distance sampling were employed to ensure the best model fit. Conventional Distance Sampling selected between three robust models (half-normal / hermite polynomial; hazard-rate / simple polynomial; uniform / cosine) on the basis of minimum Akaike’s Information Criteria (AIC) and goodness-of-fit. Models were compared with those obtained using Multiple Covariates Distance Sampling, which also used the first two robust models, but allowed modelling of additional variables as covariates. The covariates examined were wind, sea state, sun glare and observer. No other variables were found to improve model fit.

Where distance sampling was not possible (generally for rarely occurring species), correction factors were used according to Stone *et al.* (1995) to generate estimates. These factors are based on a transect of width 300 m.

The lengths of the transects surveyed and the total area covered were calculated for both types of survey, using Arc View GIS. On the first three boat surveys, ten transects were travelled, varying in distance. The area covered was 487 km^2. All nine boat survey transect lengths were 22 km from April 2004, and the total area surveyed amounted to 730 km^2 (Table 2.2 for aerial survey data). It was rarely possible to calculate separate estimates for birds within and without the wind farm, mostly due to a lack of counts for the wind farm area itself. Stretches of transects within the footprint tended to be short, and thus fewer than 40 observations of each species were made. Instead, distance estimates were obtained for the whole study area, as an indication of maxima for the entire area. Distribution maps aided interpretation of the importance of dedicated wind turbine areas.

No attempts were made to compare abundance estimates generated between the two methods of survey (aerial and boat). Aerial surveys during the winter did not coincide with boat survey periods, largely due to weather conditions preventing boat surveys, and thus comparisons of counts were not possible. Similarly, there were some clear differences in the identification of species by aerial and boat surveys, meaning that, for instance, auks were recorded at species level from the boat but not from the aerial surveys.

3.1.2 Distribution: smoothed interpolation

Wherever enough counts permitted, smoothed distribution surfaces were created from both boat and aerial data; this technique is known as kriging. Boat surveys were divided into three categories depending on when the survey was undertaken. The average count of birds in transect at each individual location was then calculated for each of the three categories. ArcMap v. 8 (ESRI, San Diego) was used to then create smoothed (interpolated) surfaces for first winter surveys (February – March 2004), summer surveys (April 2004 – September 2004) and second winter surveys (November 2004 – March 2005). The same procedure was used to produce smoothed maps for aerial surveys over the winter 2004/05.

The method of kriging selected was Inverse Distance Weighting (IDW). This method was preferred as it makes few assumptions about parameters, and is fairly robust at dealing with few data. Due to the nature of the organisms surveyed, datasets were extremely positively skewed, with many counts of individual birds and fewer flocks of varying size, some as large as 300. IDW allows visual approximation of the ‘hotspots’ of bird density, although it tends to overemphasise these as ‘bulls eyes’ when displayed. The limitations of kriging in this context are discussed elsewhere (Section 6.3), and these should be considered when interpreting the smoothed distribution maps.

3.2 Onshore data analysis

Following completion of breeding bird surveys, the number of bird territories were calculated for species of high conservation importance (*i.e.* EU Annex 1 species, Wildlife & Countryside Act Schedule 1 species, SPA designation species, UKBAP species, and red-listed Birds of Conservation Concern). Rules devised for surveys with less than eight visits were used, to ensure consistency of analysis. In addition, other species holding breeding territories near to the locations of the proposed cable landfall site, cable route and substation, were identified as being potentially at risk from construction work.

4. OFFSHORE : SPECIES ACCOUNTS

4.1 Offshore species accounts : selection criteria

A list of all species found during surveys of the offshore study area is given below, together with information on the species' conservation status (EC Annex 1 Species, Wildlife and Countryside Act (WCA) Schedule 1 Species (breeding species only), SPA Feature, UK Biodiversity Action Plan (UKBAP) species, and status under the Birds of Conservation Concern list: Gregory *et al.* 2002).

Species	Scientific name	Annex 1 Species	WCA Species	SPA Feature	UKBAP Species	BOCC Listing
Red-throated Diver	*Gavia stellata*	YES	YES*			AMBER
Black-throated Diver	*Gavia arctica*	YES	YES*			AMBER
Northern Fulmar	*Fulmarus glacialis*					AMBER
European Storm Petrel	*Hydrobates pelagicus*	YES				AMBER
Northern Gannet	*Morus bassunus*					AMBER
Great Cormorant	*Phalacrocorax carbo*					AMBER
Common Scoter	*Melanitta nigra*		YES*		YES*	RED
Grey Plover	*Pluvialis squatarola*					AMBER
Pomarine Skua	*Stercorarius pomarinus*					
Arctic Skua	*Stercorarius parasiticus*					
Great Skua	*Catharacta skua*					AMBER
Little Gull	*Larus minutus*	YES	YES			
Black-headed Gull	*Larus ridibundus*					AMBER
Mew (Common) Gull	*Larus canus*					AMBER
Lesser Black-backed Gull	*Larus fuscus*					AMBER
Herring Gull	*Larus argentatus*					AMBER
Great Black-backed Gull	*Larus marinus*					
Black-legged Kittiwake	*Rissa tridactyla*					AMBER
Sandwich Tern	*Sterna sandvicensis*	YES				AMBER
Little Tern	*Sterna albifrons*	YES	YES			AMBER
Common Guillemot	*Uria aalgae*					AMBER
Razorbill	*Alca torda*					AMBER
Meadow Pipit	*Anthus pratensis*					AMBER
Common Starling	*Sturna vulgaris*					RED
Chaffinch	*Fringilla coelebs*					

Table 4.1-1 Species recorded within the offshore study area and designations regarding their conservation status. * designation refers to the breeding season, but species only recorded within the study area between autumn and spring.

4.1.1 National and Regional importance

The tables below (Tables 4.1.1-1 and 4.1.1-2) illustrate the species found in the study area during offshore surveys by boat and aircraft, and their national or regional importance for the study area (no species were found in internationally important numbers). Table 4.1.1-1 shows the aerial survey counts of the principal species, and estimates of their abundance within the study area compared to estimates for the wider Thames offshore area as a whole (that comprising TH1, TH2, TH3, TH4 and TH5). Table 4.1.1-2 shows the national importance of all of the marine species counted within the study area, in relation to various wintering (and breeding) population estimates for Great Britain. In all cases, estimates below 50 disqualify a species from being important, as a minimum threshold of 50 birds is commonly used in determining importance (*e.g.* Pollitt *et al*. 2003).

The population thresholds used to evaluate the national importance of the breeding and wintering numbers of the species observed offshore were collated from a number of sources. Breeding seabird thresholds were taken from Mitchell *et al*. (2004); wintering gull numbers from Burton *et al*. (2003); other sources included Pollitt *et al*. (2003) and Kershaw & Cranswick (2003). For seabird species for which the winter population is unknown and thus for which no winter threshold exists, the breeding season threshold is used as a surrogate. All thresholds are consistent with BirdLife International (2004). Where breeding populations of particular species are specified in terms of pairs, the 1% threshold was calculated by doubling the figure to estimate the number of individuals, then dividing the new figure by 100.

Species	Peak boat estimate	Peak aerial estimate	Relevant 1% UK threshold	Peak % National threshold	National importance?
Red-throated Diver	77	98	50	1.96%	YES
Black-throated Diver	27	3	50	0.54%	NO
Northern Fulmar	538	376	10,120	0.05%	NO
European Storm Petrel	1	1	422	0.00%	NO
Northern Gannet	257	139	4,520	0.06%	NO
Great Cormorant	3	8	182	0.04%	NO
Common Scoter	24	0	500	0.05%	NO
Grey Plover	1	0	533	0.00%	NO
Pomarine Skua	1	0	N/A	0.00%	NO
Arctic Skua	3	0	50	0.06%	NO
Great Skua	214	1	192	1.11%	YES
Little Gull	3	4	N/A	0.00%	NO
Black-headed Gull	18	10	16,800	0.00%	NO
Mew (Common) Gull	12	56	4,300	0.01%	NO
Lesser Black-backed Gull	1,508	26	610	2.47%	YES
Herring Gull	957	335	3,800	0.25%	NO
Great Black-backed Gull	405	53	430	0.94%	NO
Black-legged Kittiwake	793	1,218	7,600	0.16%	NO
Sandwich Tern	19	0	260	0.07%	NO
Little Tern	1	0	50	0.02%	NO
Common Guillemot	1,607	-	19,040	0.08%	NO
Razorbill	1,411	-	2,520	0.55%	NO
Auks	-	2,851			

Table 4.1.1-1 National importance of species counted on aerial and boat surveys. Relevant 1% UK threshold refers to breeding or non-breeding thresholds for national importance depending on the date of the appropriate survey producing the peak estimate. N/A appears where the species is considered a vagrant and does not routinely breed or winter in the UK. Auks are defined as auk species (Common Guillemot or Razorbill).

It should be noted that in Table 4.1.1-1 above and Table 4.1.1-2 that follows, figures relate to entire study areas comprising the wind farm footprint and reference area. The proposed wind farm area represents between 20 and 30% of the boat survey area, and represents 14% of the area of aerial survey block TH3. Therefore proportional estimates for the wind farm footprint area can be derived by dividing by the appropriate numerator (assuming an even distribution). None of the proportional estimates for the wind farm footprint area is estimated to be nationally important by itself.

Regional importance was gauged by calculating a threshold based on the total number of each species within the wider Thames area (as defined by aerial surveys; Figure 1.2-3). The total number of birds counted, with estimates of the number of birds likely to be missed during surveys, was summed for each of four winter periods on which flights took place. The peak total from these four figures was then used against which to measure the peak winter estimate for the Greater Gabbard study area.

Species	**Peak regional winter total estimate**	**Peak winter count estimate TH3**	**Peak % regional total**	**Regional importance**
Red-throated Diver	4,506	98	2.17%	YES
Black-throated Diver	4,506	3	0.06%	NO
Northern Fulmar	406	376	92.61%	**YES**
European Storm Petrel	1	1	100%	NO
Northern Gannet	1,546	139	8.99%	YES
Great Cormorant	447	8	1.79%	NO
Common Scoter	6,821	0	0.00%	NO
Grey Plover	0	0	0.00%	NO
Pomarine Skua	0	0	0.00%	NO
Arctic Skua	0	0	0.00%	NO
Great Skua	10	1	0.10%	NO
Little Gull	17	4	23.53%	NO
Black-headed Gull	4,155	10	0.24%	NO
Mew (Common) Gull	1,671	56	3.35%	YES
Lesser Black-backed Gull	570	26	4.56%	NO
Herring Gull	4,385	335	7.64%	YES
Great Black-backed Gull	938	53	5.65%	YES
Black-legged Kittiwake	2,678	1,218	45.48%	**YES**
Sandwich Tern	0	0	0.00%	NO
Little Tern	0	0	0.00%	NO
Auks	21,693	2,851	13.14%	**YES**

Table 4.1.1-2 Regional importance of species counted on aerial surveys. Auks are defined as auk species (Common Guillemot or Razorbill). Note: figures relate to entire study areas (footprint + reference); the proposed wind farm area represents 14% of the area of TH3. A bold "YES" appears in the last column if the proportional estimate for the wind farm footprint area is estimated to be regionally important by itself.

The table below (Table 4.1.1-3) summarises the species found on aerial and boat surveys, with their regional and national importance labels.

Species	Scientific name	Regional Importance?	National Importance?
Red-throated Diver	*Gavia stellata*	YES	YES
Black-throated Diver	*Gavia arctica*	NO	NO
Northern Fulmar	*Fulmarus glacialis*	YES	NO
European Storm Petrel	*Hydrobates pelagicus*	NO	NO
Northern Gannet	*Morus bassunus*	YES	NO
Great Cormorant	*Phalacrocorax carbo*	NO	NO
Common Scoter	*Melanitta nigra*	NO	NO
Grey Plover	*Pluvialis squatarola*	NO	NO
Pomarine Skua	*Stercorarius pomarinus*	NO	NO
Arctic Skua	*Stercorarius parasiticus*	NO	NO
Great Skua	*Catharacta skua*	NO	YES
Little Gull	*Larus minutus*	NO	NO
Black-headed Gull	*Larus ridibundus*	NO	NO
Mew (Common) Gull	*Larus canus*	YES	NO
Lesser Black-backed Gull	*Larus fuscus*	NO	YES
Herring Gull	*Larus argentatus*	YES	NO
Great Black-backed Gull	*Larus marinus*	YES	NO
Black-legged Kittiwake	*Rissa tridactyla*	YES	NO
Sandwich Tern	*Sterna sandvicensis*	NO	NO
Little Tern	*Sterna albifrons*	NO	NO
Common Guillemot	*Uria aalgae*		NO
Razorbill	*Alca torda*		NO
Auks		YES	

Table 4.1.1-3 Summary table of national and regional importance of species counted on aerial and boat surveys. Auks are defined as auk species (Common Guillemot or Razorbill).

4.1.2 Species of principal concern

Using Table 4.1-1 to ascertain all species found in the offshore study area designated as either SPA features, EC Annex 1 species, or UKBAP species, and using Table 4.1.1-3 to ascertain additional species found in nationally or regionally important numbers, a list of 'species of principal concern' was made (Table 4.1.2-1). For each of the species on this list, an account has been written presenting counts on the various surveys and smoothed distribution patterns in the survey area. Also, the importance of the Greater Gabbard area to each species at different times of the year is discussed. For quick appraisal of the importance of each species in the Greater Gabbard area, summary header boxes are presented for each species. These include conservation designations, breeding and wintering population thresholds, peak estimates from winter and summer surveys for the whole study area (referred to as 'Gabbard Peak') and proportional estimates for the wind farm area, and calculation of the maximum percentage of national importance achieved. These species accounts are in section 5.

The offshore species of principal concern in this report are:

Common name	Scientific name	Species Sensitivity Index (SSI)
Red-throated Diver	*Gavia stellata*	43.3
Black-throated Diver	*Gavia arctica*	44.0
Northern Fulmar	*Fulmarus glacialis*	5.8
European Storm Petrel	*Hydrobates pelagicus*	
Northern Gannet	*Morus bassunus*	16.5
Common Scoter	*Melanitta nigra*	16.9
Great Skua	*Catharacta skua*	12.4
Little Gull	*Larus minutus*	12.8
Mew (Common) Gull	*Larus canus*	12.0
Lesser Black-backed Gull	*Larus fuscus*	13.8
Herring Gull	*Larus argentatus*	11.0
Great Black-backed Gull	*Larus marinus*	18.3
Black-legged Kittiwake	*Rissa tridactyla*	7.5
Sandwich Tern	*Sterna sandvicensis*	25.0
Little Tern	*Sterna albifrons*	
Common Guillemot	*Uria aalge*	12.0
Razorbill	*Alca torda*	15.8

Table 4.1.2-1 Species of principal consideration. SSI values are measures of species 'vulnerability to marine wind farms', based on nine factors (flight manoeuvrability, flight altitude, % flying, nocturnal flight activity, response to disturbance, habitat use flexibility, population size and status and adult survival rate; from Garthe & Hüppop 2004).

4.2 Red-throated Diver	*Gavia stellata*		
Conservation status:	Annex 1, WCA, BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	750	*European population*	32-92,000
GB threshold	50	*GB population*	935-1,500
Wind farm peak estimate	14	Wind farm peak estimate	1
Gabbard peak estimate	98 (*aerial*)	*Gabbard peak estimate*	3 birds (*boat*)
% National importance	1.96%	*% National importance*	0.16%

*GB threshold is known to be unrealistically low as a result of large numbers of the species discovered in the Outer Thames Estuary (*e.g.*Table 4.1.2-1).

4.2.1 Boat surveys

Firstly, it should be noted that there were insufficient counts of this species to use distance sampling techniques. The figures presented are raw counts of birds recorded 'in transect', multiplied by the appropriate correction factor of 1.3 (according to Stone *et al.* 1995). The table contains additional figures (indicated by a plus sign), which are estimates for unidentified diver species. These are based on the proportion of 'unidentified divers' likely to have been Red-throated Divers, in relation to numbers positively identified as Red- or Black-throated Divers.

On one occasion, in March 2004, raw counts of Red-throated Divers exceeded the 1% threshold for national importance (Table 4.2.1-1), with distribution apparently scattered throughout the survey area and few 'hotspots' (Figures 4.2.1-1, 4.2.1-2). Numbers in the following winter were lower, but it should be noted that distance sampling was not possible and these counts are therefore probably underestimates; there was no clear trend for especially high average counts within the Greater Gabbard area (Figure 4.2.1-3). The species was effectively absent from the area through the summer.

Month	On sea	Correction	In flight	Total	% National importance
February 2004	18	23	23	46	0.92%
March 2004 (1)	8+1	12	14+2	28	0.56%
March 2004 (2)	35+19	70	6+1	77	1.54%
April 2004	2	3	0	3	0.16%
May 2004	0	0	0	0	0.00%
June 2004	0	0	0	0	0.00%
July 2004	0	0	0	0	0.00%
August 2004	0	0	0	0	0.00%
September 2004	0	0	0	0	0.00%
November 2004	3	4	0	7	0.14%
December 2004	0	0	1	1	0.02%
March 2005	15	20	1+2	23	0.46%

Table 4.2.1-1 Red-throated Divers recorded 'in transect' on boat surveys (estimated proportion of unidentified divers thought to be Red-throated indicated with plus sign), with % of national importance. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.2.2 Aerial surveys

Distance sampling was undertaken at the generic level (i.e. *Gavia*), as identification was frequently possible only to this taxonomic scale. Of 1,949 individual survey records, two positively identified Black-throated Diver, eight positively identified Great Northern Diver and 282 positively identified Red-throated Diver. The remaining 1,657 events identified 'diver species' only. On the basis of those birds identified, the majority of unidentified divers (97%) are highly likely to have been Red-throated, assuming that detection and identification was roughly equal for the different species involved.

To this end, Table 4.2.2-1 shows distance estimates for all diver species recorded. Table 4.2.2-2 shows proportional estimates for Red-throated Divers, based on the relative proportions of this species identified in comparison to the other two diver species. It is the latter estimate that is used in the assessment of national importance. Average distributions of all diver species, which appear fairly evenly spread throughout the survey area, are shown in Figure 4.2.2-1. Aerial surveys suggested that the species was regionally important in the study area.

Survey Block	Survey Period	DS	D	N	LCL	UCL
TH1	WINTER 1	0.0456	0.0467	59	32	108
	WINTER 2	0.8096	1.0486	1,321	985	1,773
	WINTER 3	1.3342	1.5595	1,965	1,631	2,367
	WINTER 4	0.3649	1.2444	1,568	789	3,116
TH2	WINTER 1	0.0494	0.0743	91	39	215
	WINTER 2	0.3912	0.5361	660	390	1,118
	WINTER 3	0.5697	0.6391	787	396	1,564
	WINTER 4	0.5431	1.0848	1,335	680	2,622
TH3	WINTER 1	0.0000	0.0000	0	0	0
	WINTER 2	0.0130	0.0130	14	5	41
	WINTER 3	0.0953	0.0953	101	58	175
	WINTER 4	0.0910	0.0910	96	50	188
TH4	WINTER 1	0.0636	0.0646	73	40	132
	WINTER 2	1.3141	1.5573	1,754	1,203	2,557
	WINTER 3	0.7927	1.0933	1,231	800	1,894
	WINTER 4	0.2628	0.4461	502	221	1,141
TH5	WINTER 2	0.6254	0.6589	709	466	1,078
	WINTER 3	0.3127	0.3918	422	310	573
	WINTER 4	0.1086	0.1086	117	79	173

Table 4.2.2-1 Divers recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

Period	Estimated raw count	Proportional distance estimate	% National importance
Winter 1	0	0	0.00%
Winter 2	3	14	0.28%
Winter 3	21	98	1.96%
Winter 4	20	93	1.86%

Table 4.2.2-2 Proportional estimates of Red-throated Diver for area TH3, with % of national importance. Figures relate to entire TH3 study area; the proposed wind farm area represents 14% of the study area.

4.2.3 The importance of the Greater Gabbard for Red-throated Divers through the year

4.2.3.1 Winter and summer

It is clear from boat survey data that the Greater Gabbard area holds few Red-throated Divers during the summer; a result which is not surprising given that this species typically breeds on lochs, lakes and other freshwater inland waterbodies. On only one count during the summer was the species recorded in transect, and this was in April when some birds may not have left for the breeding grounds.

During the winter months November to March, however, the Greater Gabbard area seems of much greater importance for the species, consistent with Stone *et al*. (1995), who found greatest abundances of Red-throated Divers from December to March. One boat survey (March 2004) led to numbers in excess of the threshold for national importance. Boat surveys in other months in 2004, and those in 2005, did not produce counts great enough to reach the same threshold, though it should be noted that without distance sampling these figures should be considered as minima. Aerial survey data were suitable for distance analysis, and from this method two further counts were estimated to exceed the 1% national threshold, even if the lowest confidence limits represent the 'true' value. The peak aerial estimate of 98 birds also exceeded the 1% threshold of regional importance for the winter. One caveat to note is that the survey area TH3, which covers the Greater Gabbard area, is larger than the area covered by boat surveys. Therefore, the area covered by the proposed wind farm is likely to hold fewer birds than the peak of 98 estimated for the whole survey area. Proportional estimates of the number of Red-throated Divers contained within the wind farm footprint area total 14, only 0.28% of the 1% national importance threshold of 50. Also, it is notable that other areas surveyed from the air hold estimates far greater than that for TH3 (Figure 4.2.3.1-1); it is therefore possible that a higher threshold for importance should be used when considering offshore counts, perhaps including greater areas of the North Sea: 20-30,000 Red- and Black-throated Divers are estimated to winter within the 25 m depth contour in the area known as German Bight (Carter *et al*. 1993).

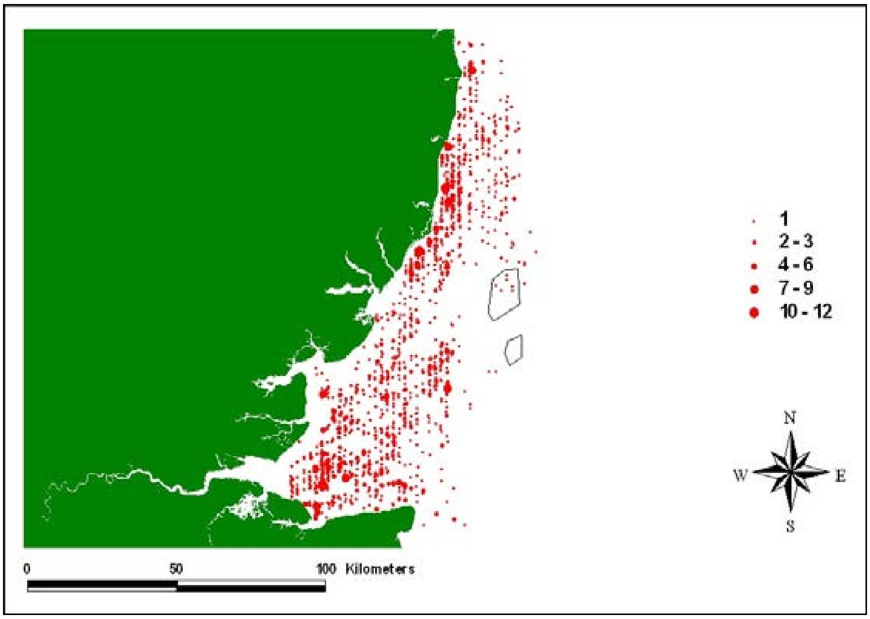

Figure 4.2.3.1-1 Summed aerial survey distribution of Red-throated Divers in winter 2004/05

4.2.3.2 Migration

Red-throated Divers generally move south from their breeding sites during late September and October (Okill 2002). The species tends to widely disperse around the British coast, although concentrations have been noted off the eastern coast of England in the past (Okill 2002). This concentration is likely to include birds from Scandinavian breeding sites (Tasker *et* al. 1987), and there will be some passage across the southern North Sea. Therefore it seems likely that the Greater Gabbard area will be encountered during migration. There may also be movements through the North Sea during April and May, when birds return to their northerly breeding grounds.

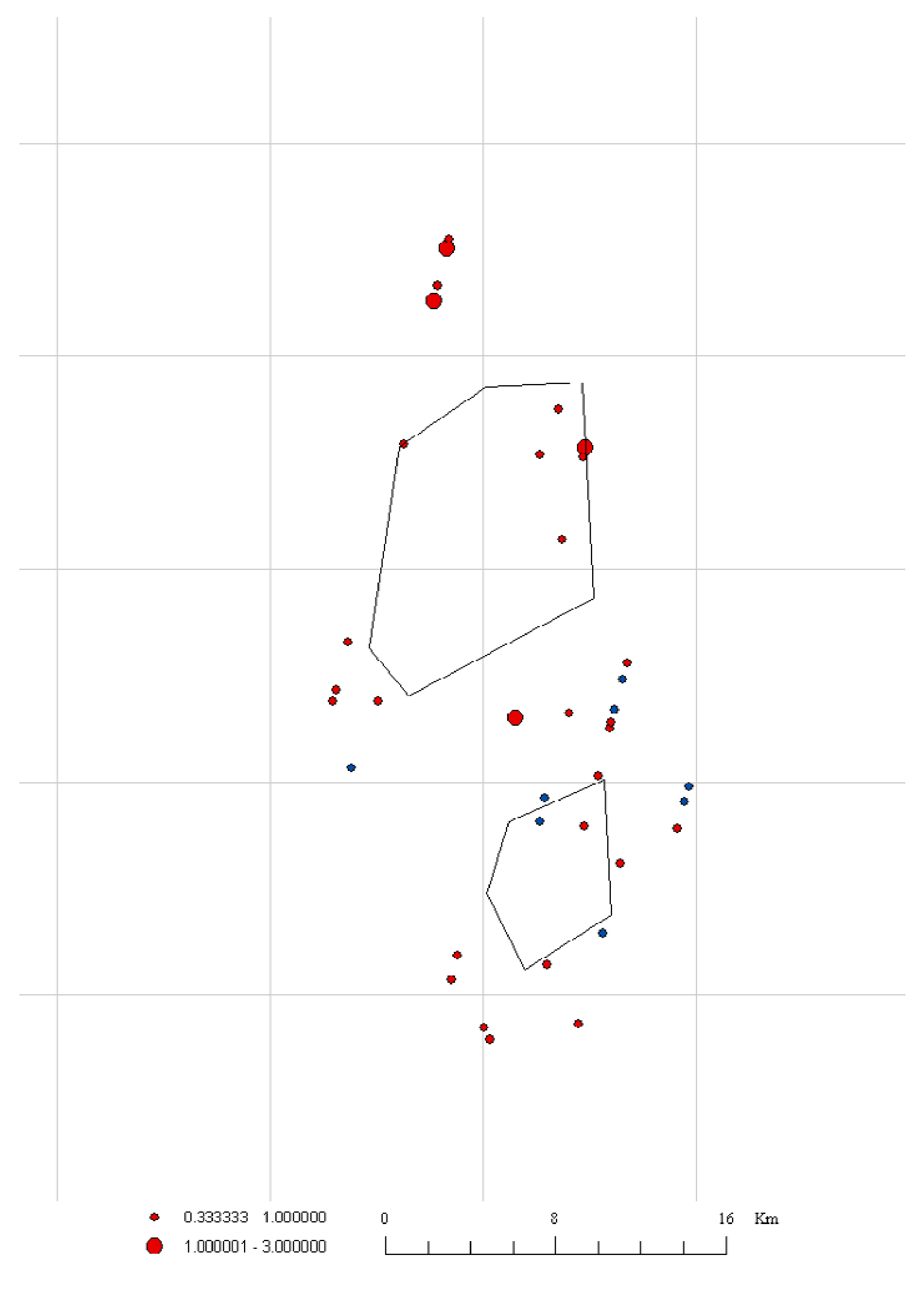

Figure 4.2.1-1 Red-throated (red) and Black-throated (blue) Diver average distributions, first winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

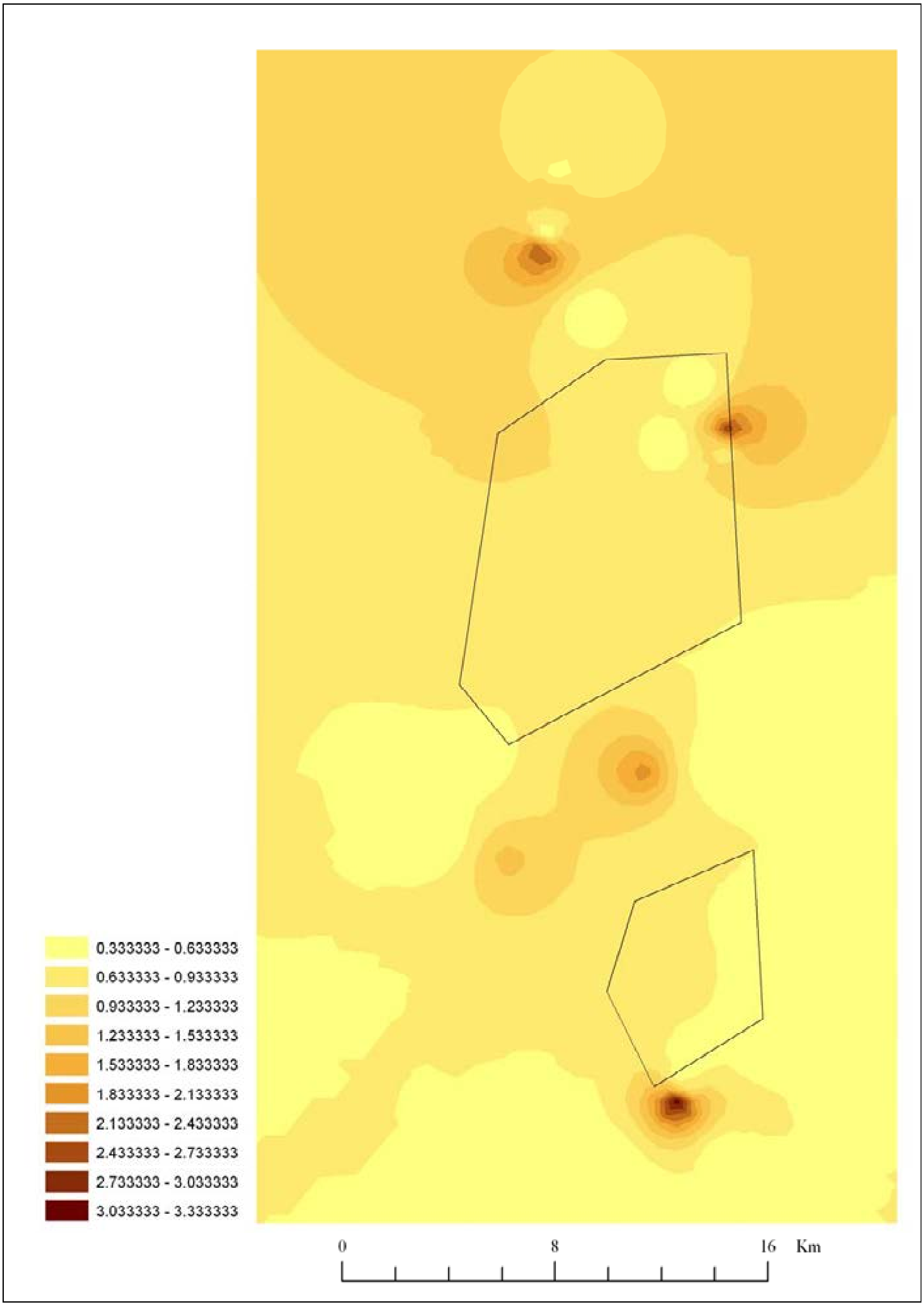

Figure 4.2.1-2 Smoothed average distribution of all diver species, first winter boat surveys. Polygons show boundaries of proposed wind farm.

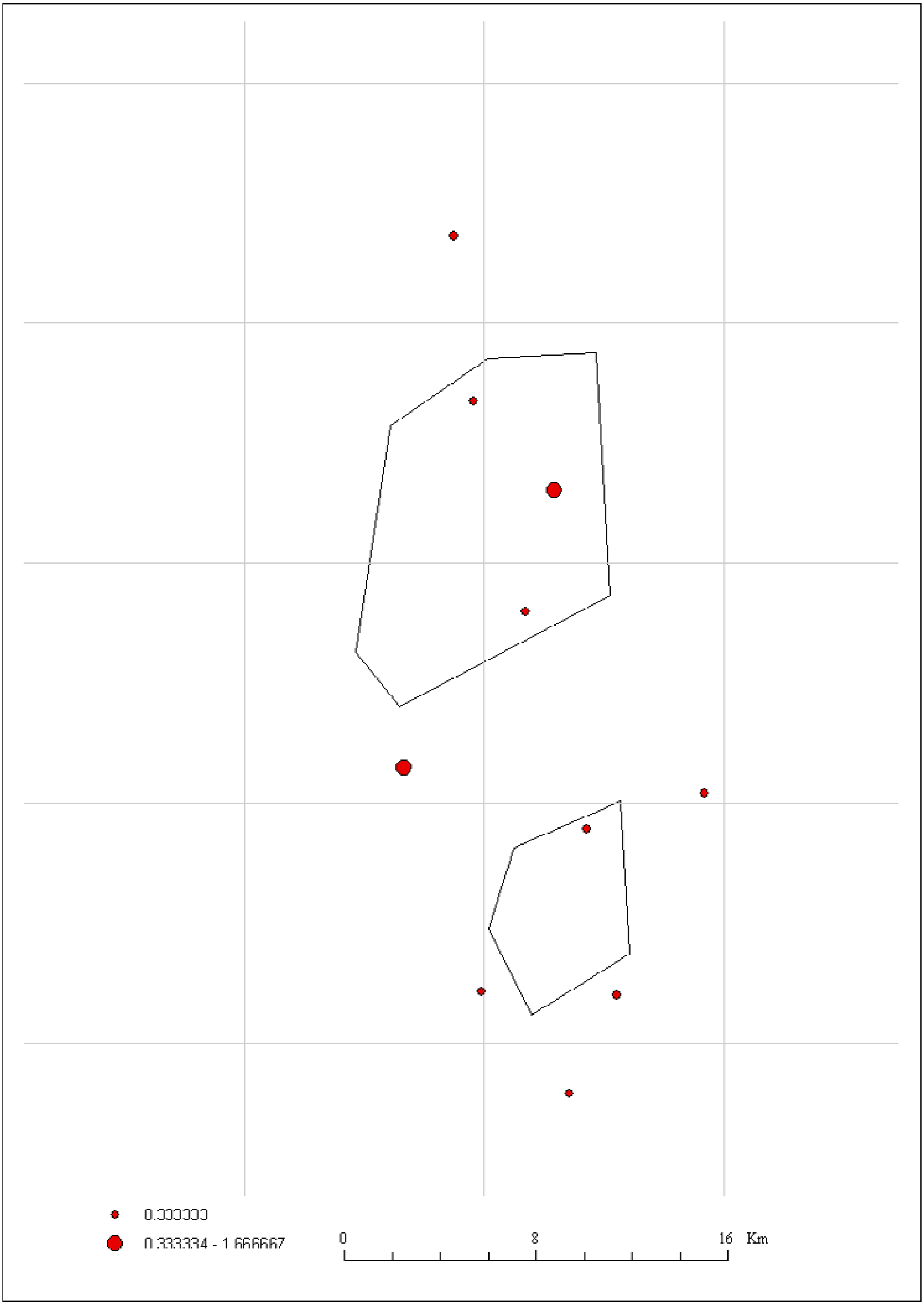

Figure 4.2.1-3 Average Red-throated Diver distribution, second winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

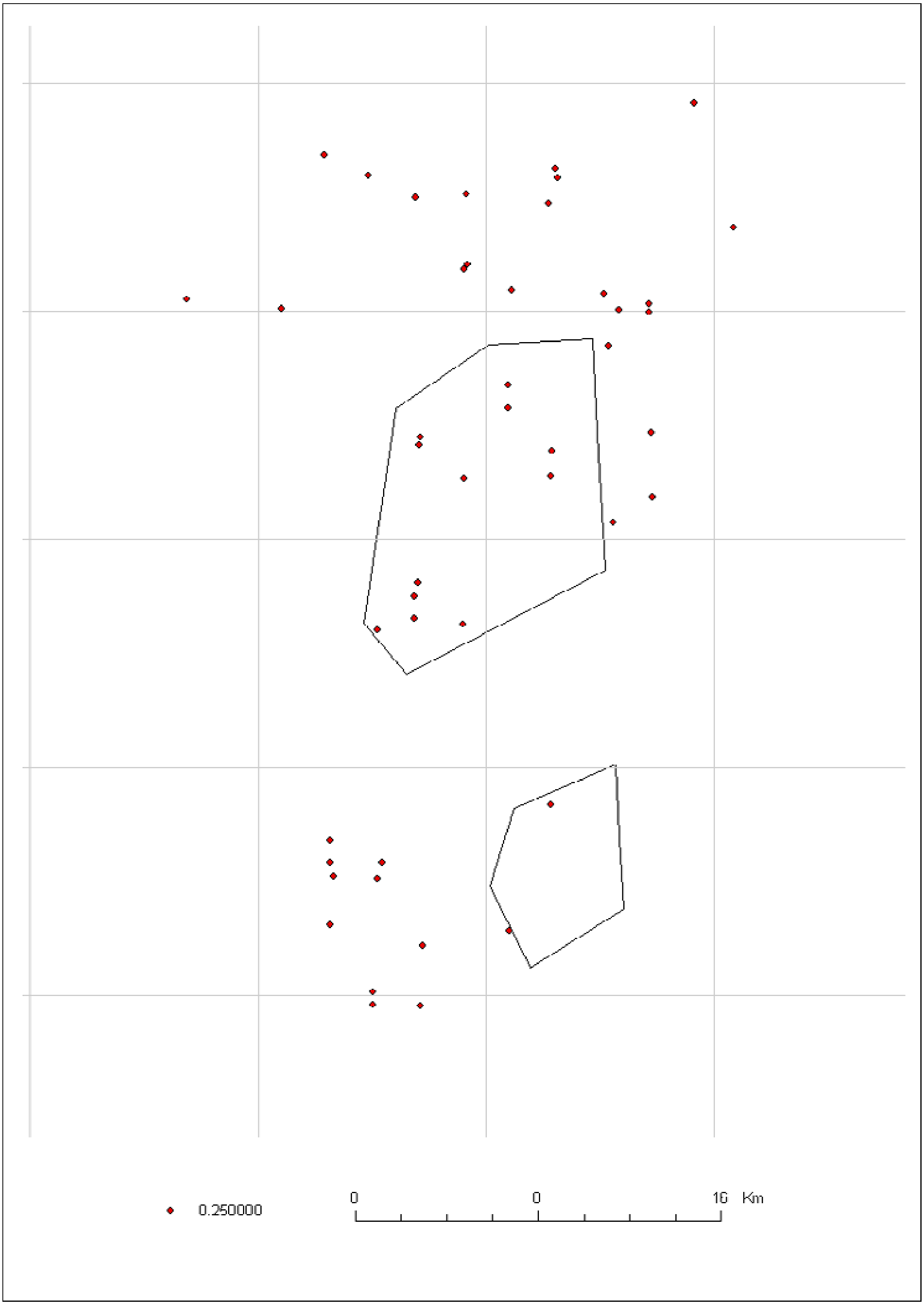

Figure 4.2.2-1 Average distribution of all diver species, aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

4.3 Black-throated Diver	*Gavia arctica*		
Conservation status:	Annex 1, WCA, BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	1,200	*European population*	51-92,000
GB threshold	7*	*GB population*	155-190
Wind farm peak estimate	8	Wind farm peak estimate	0
Gabbard peak estimate	27 (*boat*)	*Gabbard peak estimate*	0
% National importance	0.44%	*% National importance*	0.00%

*50 is usually used as a minimum threshold for scarcely occurring species

4.3.1 Boat surveys

Firstly, it should be noted that there were insufficient counts of this species to use distance sampling techniques. Figures presented are raw counts of birds considered 'in transect', multiplied by the appropriate correction factor of 1.3 (according to Stone *et al.* 1995). The table contains additional figures, which are estimates for unidentified diver species. These are based on the proportion of 'unidentified divers' likely to have been Black-throated Divers in relation to numbers identified as Red- or Black-throated Divers.

The only notable count of Black-throated Divers occurred in March 2004, when 27 were estimated (Table 4.3.1-1). Maps illustrating average distributions for the first winter surveys do not indicate that the proposed wind farm area supports high densities of this species (Figures 4.2.1-1, 4.2.1-2). Only one other count of Black-throated Diver was made, in March 2005.

Month	On sea	Correction	In flight	Total	% National importance
February 2004	0	0	0	0	0.00%
March 2004 (1)	0	0	0	0	0.00%
March 2004 (2)	11+6	22	5	27	0.54%
April 2004	0	0	0	0	0.00%
May 2004	0	0	0	0	0.00%
June 2004	0	0	0	0	0.00%
July 2004	0	0	0	0	0.00%
August 2004	0	0	0	0	0.00%
September 2004	0	0	0	0	0.00%
November 2004	0	0	0	0	0.00%
December 2004	0	0	0	0	0.00%
March 2005	1	1	0	1	0.02%

Table 4.3.1-1 Black-throated Divers recorded 'in transect' on boat surveys (estimated proportion of unidentified divers thought to be Black-throated indicated with plus sign), with % of national importance. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.3.2 Aerial surveys

Distance sampling was undertaken at the generic level (i.e. *Gavia*), as identification was frequently possible only to this taxonomic scale. Of 1,949 individual survey records, two positively identified Black-throated Diver, eight positively identified Great Northern Diver and 282 positively identified Red-throated Diver. The remaining 1,657 events identified 'diver species' only. On the basis of those birds identified, only a few unidentified divers were thought to be Black-throated (<1%), assuming that detection and identification was roughly equal for the different species involved.

To this end, Table 4.2.2-1 shows distance estimates for all diver species recorded. Table 4.3.2-1 shows proportional estimates for Black-throated Divers, based on the relative proportions of this species identified in comparison to the other two diver species. It is the latter estimate that is used in the assessment of national importance. Average distributions of all diver species, which appear fairly evenly spread throughout the survey area, are shown in Figure 4.2.2-1.

Period	**Estimated raw count**	**Proportional distance estimate**	**% National importance**
Winter 1	0	0	0.00%
Winter 2	0	0	0.00%
Winter 3	1	3	0.06%
Winter 4	1	3	0.06%

Table 4.3.2-1 Proportional estimates of Black-throated Diver for area TH3, with % of national importance. Figures relate to entire study area; the proposed wind farm area represents 14% of the study area.

4.3.3 The importance of the Greater Gabbard for Black-throated Divers through the year

4.3.3.1 Winter and summer

Black-throated Divers are relatively uncommon in Britain as both a breeding and wintering species, especially in comparison to the more widely recorded Red-throated Diver. No individuals were reported from summer boat surveys, and like the Red-throated Diver this species would not be expected at such time when breeding is taking place. In the winter months, occasional sightings were made, the most notable being an estimate of 27 birds in March 2004. Although this figure does not reach the notional level of 50 birds necessary to qualify the site as nationally important, it should again be noted that distance sampling was not possible and therefore this figure is a minimum estimate. Furthermore, if the threshold is not increased to the suggested minimum of 50, but set at seven (Pollitt *et al.* 2003), then the count of 27 would represent 3.85% of the national threshold. Counts above 20 are relatively rare according to the Wetland Bird Survey (Pollitt *et al.* 2003), although few of these counts used such extensive methods as used here. Aerial surveys, where distance sampling of all diver species was feasible, recorded very few Black-throated Divers during the winter.

4.3.3.2 Migration

Relatively little is known about the migratory movements of Black-throated Divers, other than that birds wintering around the coasts of Britain are thought to originate from breeding territories in Britain (mainly northern Scotland) and Fennoscandia (Toms 2002). Birds are therefore likely to pass through the North Sea when moving between wintering and breeding grounds.

4.4 Northern Fulmar	*Fulmarus glacialis*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	Unknown	*European population*	2.8-4.4 million
GB threshold	Unknown	*GB population*	506,000
Wind farm peak estimate	75	Wind farm peak estimate	108
Gabbard peak estimate	377 (*boat*)	*Gabbard peak*	538 birds (*boat*)
% National importance	0.04%	*% National importance*	0.05%

4.4.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.4.1-1). Estimates generated relate to the 730 km^2 surveyed by the boat. Those birds recorded in flight during surveys were not suitable for distance analysis, and as such raw counts of these birds are shown (Table 4.4.1-2). Counts of in flight birds were added to the estimates produced from distance sampling to provide an overall estimate of birds in the Greater Gabbard area. This species cannot be accurately quantified in the context of national importance during the non-breeding season, as no valid population estimates exist. As a surrogate, the breeding population threshold was used to assess national importance during the winter. The 1% threshold is therefore set at 10,120 birds. Approximate figures of 1.6 – 1.8 million birds during the non-breeding season are provided by the RSPB (http://www.rspb.org.uk/birds/guide/f/fulmar/index.asp); at this level, 16,000 birds represents the 1% threshold for national importance, far greater than the peak of 337 estimated from boat survey data and supporting the breeding threshold result.

Estimates for the winter abundance were much higher in the second of the two winters of survey, peaking at 377 (95% confidence limits around distance estimate: 151 – 723) in March 2005. Distribution maps for the first winter (Figure 4.4.1-1), summer (Figure 4.4.1-2) and second winter (Figure 4.4.1-3) show that average counts of Northern Fulmar do not seem highly concentrated in consistent areas, although there is some tendency for the east of the survey area to show higher averages. Figure 4.4.1-3 suggests that a high average count was recorded in The Galloper area of the wind farm during the second winter; this may have resulted from one large flock at this location.

MONTH	DS	D	N	LCL	UCL
February	0	0	0	0	0
March (1)	N/A	N/A	N/A	N/A	N/A
March (2)	N/A	N/A	N/A	N/A	N/A
April	0.0522	0.0783	57	9	346
May	0.4180	0.5953	435	189	1,000
June	0.1045	0.1041	76	34	171
July	0.5356	0.7038	514	236	1,119
August	0.0783	0.0783	57	26	126
September	0.1437	0.1687	123	40	381
November	0.2874	0.2937	214	94	490
December	0.2565	0.4667	341	126	920
March 2005	0.3657	0.4529	331	151	723

Table 4.4.1-1 Northern Fulmar recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Where results not available (N/A), insufficient numbers of birds were recorded for analysis; 0 indicates the bird was not present. Figures relate to entire study area, the

proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	21	(0)	21	0.00%
March (1)	69	(14)	83	0.01%
March (2)	9	(17)	26	0.00%
April	15	57	72	0.01%
May	74	435	509	0.05%
June	5	76	81	0.01%
July	24	514	538	0.05%
August	1	57	58	0.01%
September	8	123	131	0.01%
November	35	214	249	0.02%
December	20	341	361	0.04%
March 2005	46	331	377	0.04%

Table 4.4.1-2 'In flight' counts, distance estimates and total estimates for Northern Fulmar. Those figures in brackets are not distance estimates but raw counts multiplied by a correction factor of 1.1 (Stone *et al*. 1995). Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.4.2 Aerial surveys

Table 4.4.2-1 shows distance estimates generated from data collected on aerial surveys. Numbers of Northern Fulmar were estimated to be greater in the Greater Gabbard area (TH3) than in the other survey blocks flown. Distance estimates peaked at 376 (with 95% confidence limits of 245 – 576), a figure similar to the peak estimated from boat surveys.

Average distributions of Northern Fulmar hint at a tendency for larger flocks to the east of the wind farm area, though smoothing suggests that distribution is generally evenly low over the area (Figure 4.4.2-1).

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National importance
TH1	WINTER 1	0	0	0	0	0	
	WINTER 2	0	0	0	0	0	
	WINTER 3	0	0	0	0	0	
	WINTER 4	0	0	0	0	0	
TH2	WINTER 1	0.0201	0.0483	59	11	311	
	WINTER 2	0.0242	0.0242	30	13	70	
	WINTER 3	0.0403	0.0462	57	19	169	
	WINTER 4	0.0040	0.0040	5	1	28	
TH3	WINTER 1	0.0092	0.0092	10	3	37	0.00%
	WINTER 2	0.2847	0.3544	376	245	576	0.04%
	WINTER 3	0.2159	0.2437	258	130	513	0.03%
	WINTER 4	0.0643	0.0643	68	38	122	0.01%
TH4	WINTER 1	0.0045	0.0045	5	1	27	
	WINTER 2	0	0	0	0	0	
	WINTER 3	0	0	0	0	0	
	WINTER 4	0.0135	0.0135	15	3	92	
TH5	WINTER 2	0	0	0	0	0	
	WINTER 3	0.0368	0.0423	46	20	106	
	WINTER 4	0.0138	0.0138	15	5	47	

Table 4.4.2-1 Northern Fulmar recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.4.3 The importance of the Greater Gabbard for Northern Fulmar through the year

4.4.3.1 Winter and summer

The Northern Fulmar is a breeding bird commonly found throughout Great Britain, current estimates standing at between 2.8 and 4.4 million breeding pairs (Mitchell *et al*. 2004). The species generally breeds on coastal cliffs, foraging at sea for fish waste and crustaceans. The peak of 538 birds estimated during July 2004 probably represents a combination of birds travelling from their breeding colonies to feed, early breeders departing the colonies, and part of the non-breeding population; Northern Fulmars can take up to nine years to reach sexual maturity, and are thought to spend the first four years of life after fledging at sea (Anderson & Cosgrove 2002). The numbers found in the Greater Gabbard area suggest that this is not an offshore area supporting high densities of Northern Fulmar during the breeding season.

The winter abundance of Northern Fulmar was estimated to be lower than that estimated for the summer, with peaks of 377 birds recorded in March 2005 and 376 in the second winter period on boat and aerial surveys respectively. During the non-breeding season, this species disperses widely through the offshore marine environment, spending all of its time at sea. It is therefore likely that the wintering distribution is governed by the availability of food resources. This species was found to be regionally important at both levels of analysis: in the study area, estimates represented 93% of the regional total; proportional estimates for the wind farm footprint area represented 13% of the regional total. Although the species was sighted more often than in the other survey blocks examined, perhaps as a consequence of the greater distance from shore, estimates of the numbers present are unlikely to reach any sensible threshold of national importance, and there is little reason to expect this area to be of particular national importance to non-breeding Northern Fulmar.

4.4.3.2 Migration

As the Northern Fulmar is not a migratory bird in the strictest sense, the Greater Gabbard area is not considered to be of particular importance during migratory periods. Any movements this species makes will more likely occur between breeding colonies in Britain and Scandinavia and the North Sea. Unfortunately, relatively little is known about the movements of Northern Fulmars whilst at sea.

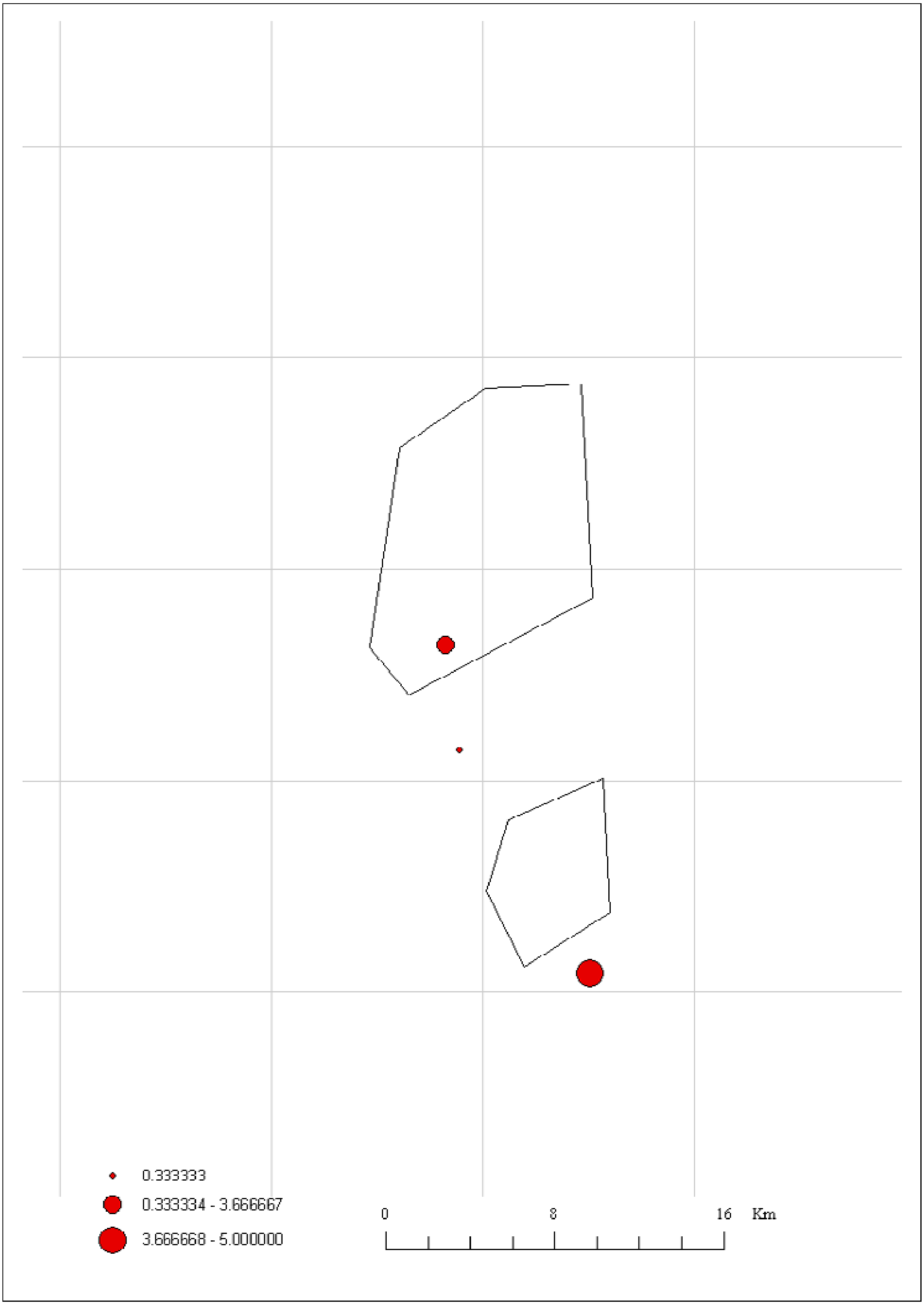

Figure 4.4.1-1 Average Northern Fulmar distribution, first winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

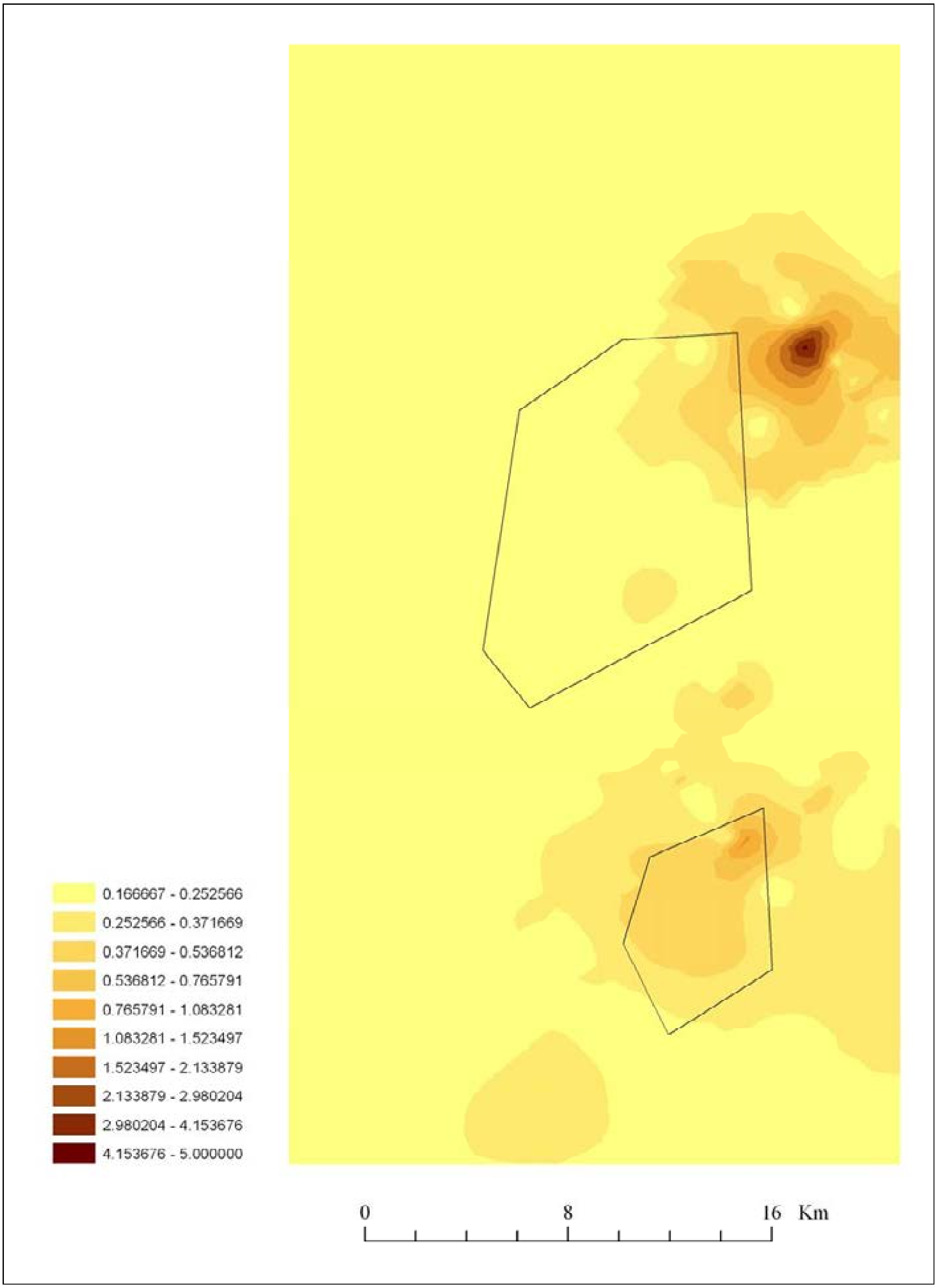

Figure 4.4.1-2 Smoothed average distribution of Northern Fulmar, summer boat surveys. Polygons show boundaries of proposed wind farm.

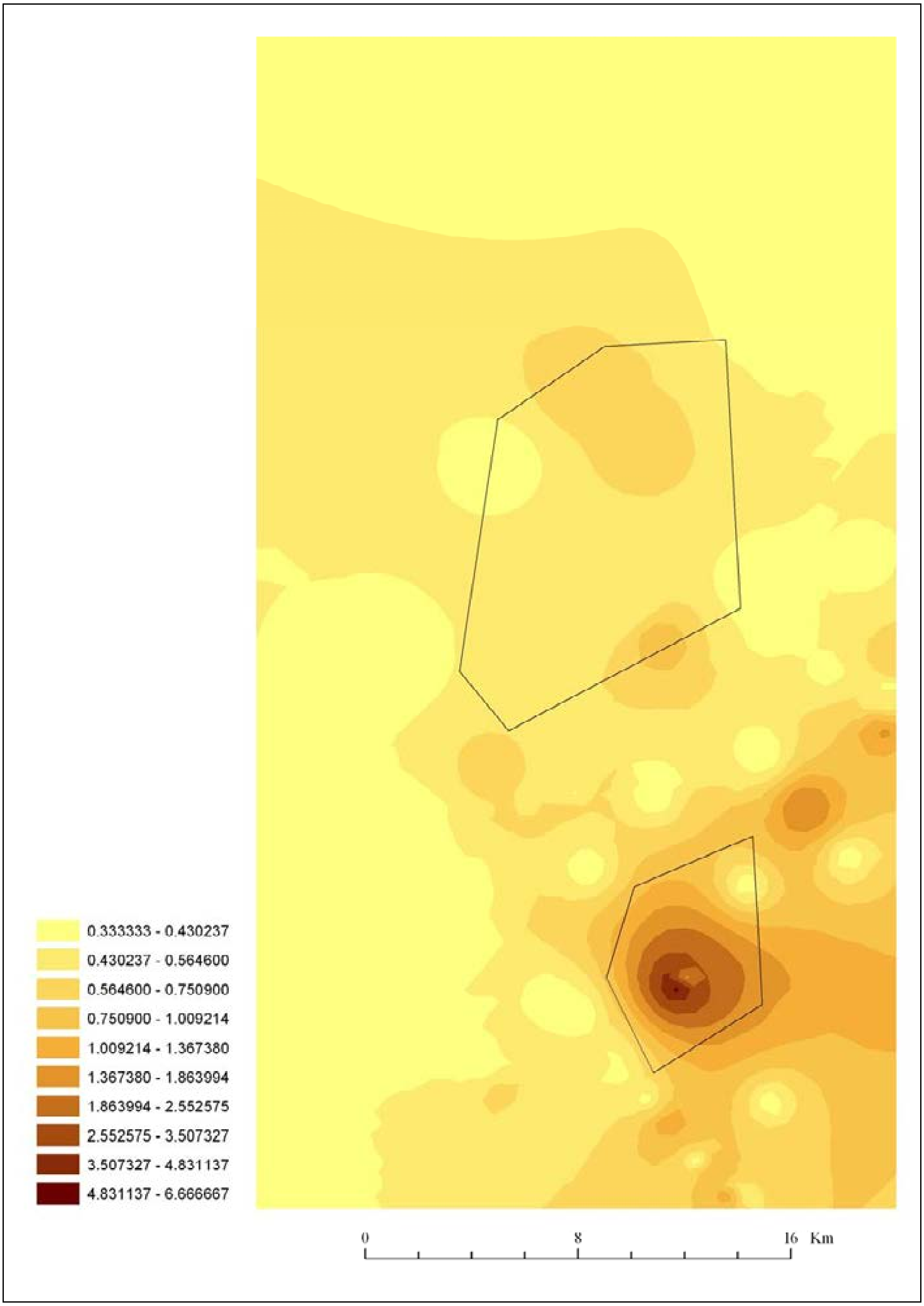

Figure 4.4.1-3 Smoothed average distribution of Northern Fulmar, second winter boat surveys. Polygons show boundaries of proposed wind farm.

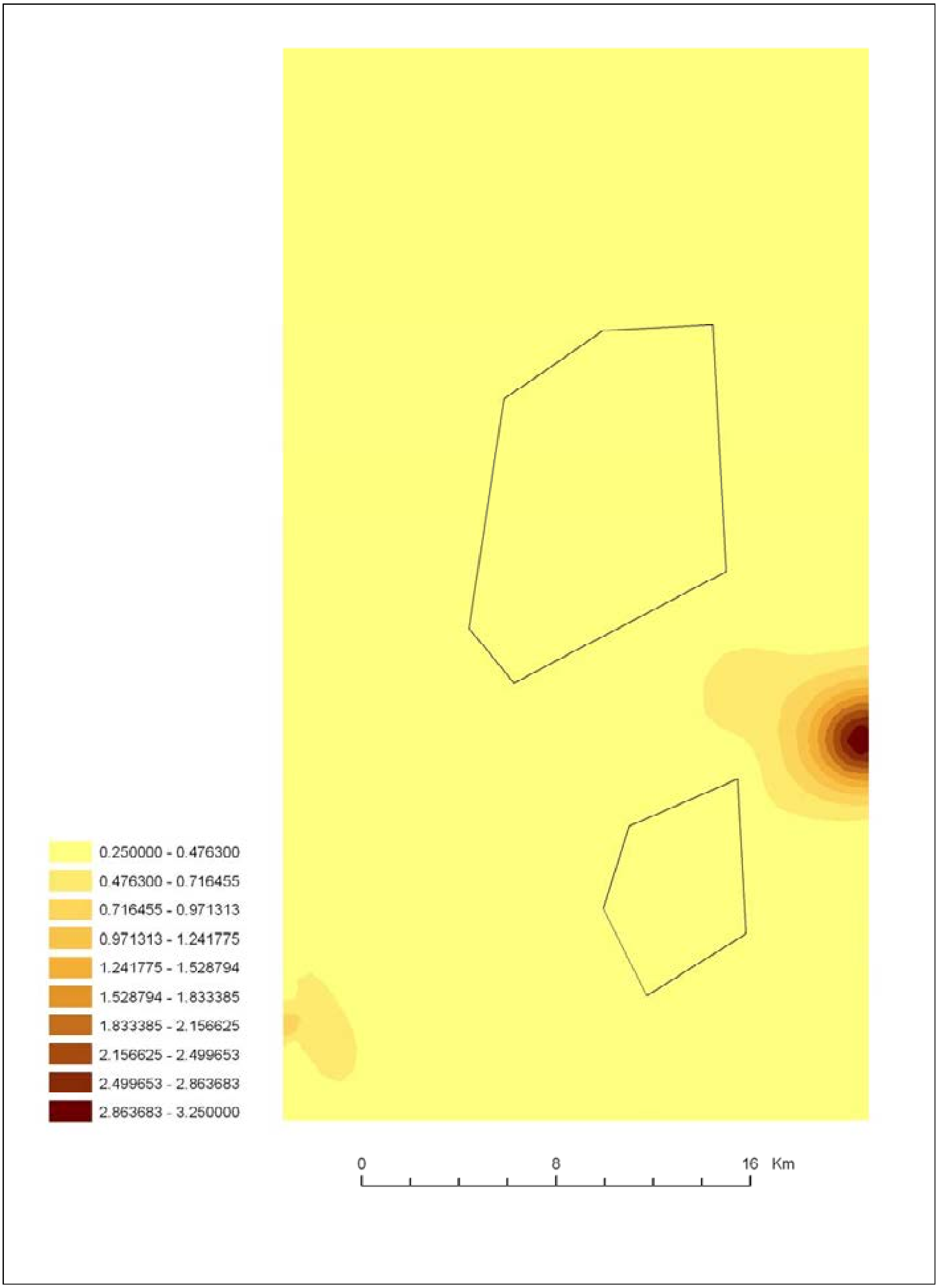

Figure 4.4.2-1 Smoothed average distribution of Northern Fulmar, aerial surveys. Polygons show boundaries of proposed wind farm.

4.5 European Storm Petrel		*Hydrobates pelagicus*	
Conservation status:			
Winter		**Summer (pairs)**	
International threshold	?	European population	430,000-510,000
GB threshold	?	*GB population*	21,100-33,500
Wind farm peak estimate	0	Wind farm peak estimate	0
Gabbard peak	1 (*aerial*)	*Gabbard peak*	1 bird (*boat*)
% National importance	0.00%	*% National importance*	0.00%

4.5.1 Boat surveys

One individual was recorded during the survey in September 2004.

4.5.2 Aerial surveys

One individual was recorded during the survey in the second winter period of aerial surveys.

4.5.3 The importance of the Greater Gabbard for European Storm Petrel through the year

4.5.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for European Storm Petrels, with winter and summer surveys only ever recording single birds.

4.5.3.2 Migration

One bird was recorded during September 2004; it is possible that this individual was on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.6 Northern Gannet	*Morus bassanus*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	European population	300-310,000
GB threshold	?	*GB population*	227,000
Wind farm peak estimate	19	Wind farm peak estimate	51
Gabbard peak	139 (*aerial*)	*Gabbard peak*	257 birds (*boat*)
% National importance	0.03%	*% National importance*	0.06%

4.6.1 Boat surveys

Distance sampling was applied to counts of those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.6.1-1). Estimates generated relate to the 730 km^2 surveyed by the boat. Those birds recorded in flight during surveys were not suitable for distance analysis, and as such raw counts of these birds are shown (Table 4.6.1-2). Stone *et al.* (1995) propose a correction factor of 1.0 for this species and counts are therefore unchanged. Counts of in flight birds were added to the estimates produced from distance sampling to provide an overall estimate of birds in the Greater Gabbard area. This species cannot be accurately quantified in the context of national importance during the non-breeding season, as no valid population estimates exist. Many Northern Gannets breeding in Britain migrate south to Africa, and as the Northern Gannet has a prolonged breeding season (as long as from January to November), it is virtually impossible to quantify a wintering population. As a surrogate, the breeding population threshold has been used; the peak winter count represented only 0.03% of the breeding threshold.

Peak Northern Gannet numbers were recorded in September, with an estimated 257 birds (95% confidence limits for distance estimate: 101 – 596). Approximately half this number represented the winter peak estimate (Table 4.6.1-2). Distribution of Northern Gannet showed some rough patterns, with highest average counts occurring to the southeast of the wind farm area in the first winter (Figure 4.6.1-1), to the northeast and within the area of The Galloper in the summer (Figure 4.6.1-2), and again to the southeast and east in the second winter (Figure 4.6.1-3).

MONTH	DS	D	N	LCL	UCL
February	N/A	N/A	N/A	N/A	N/A
March (1)	0	0	0	0	0
March (2)	N/A	N/A	N/A	N/A	N/A
April	0.0421	0.0421	31	8	112
May	0.0337	0.1179	86	15	487
June	0.0084	0.0084	6	1	42
July	0.2104	0.2357	172	103	287
August	0.1936	0.2104	154	65	364
September	0.1852	0.3367	246	101	596
November	0.0842	0.0842	61	22	169
December	0	0	0	0	0
March 2005	0.0926	0.1179	86	33	222

Table 4.6.1-1 Northern Gannet recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Where results not available (N/A), insufficient numbers of birds were recorded for analysis; 0 indicates the bird was not present. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	97	(8)	105	0.02%
March (1)	49	(0)	49	0.01%
March (2)	20	(12)	32	0.01%
April	14	31	45	0.01%
May	16	86	102	0.02%
June	6	6	12	0.00%
July	39	172	211	0.05%
August	6	154	160	0.04%
September	11	246	257	0.06%
November	16	61	77	0.02%
December	7	0	7	0.00%
March 2005	41	86	127	0.03%

Table 4.6.1-2 'In flight' counts, distance estimates and total estimates for Northern Gannet. Those figures in brackets are not distance estimates but raw counts multiplied by a correction factor (Stone *et al*. 1995). Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.6.2 Aerial surveys

Few Northern Gannets were recorded in the Greater Gabbard area (TH3) during the aerial surveys in the winter of 2004/05 (Table 4.6.2-1). The maximum distance estimate was of 139 (95% confidence limits: 83 – 235), which compared with estimates of 1,130 and 273 for areas TH2 and TH1 respectively. The Greater Gabbard peak was slightly larger than the 127 estimated on boat surveys.

Figure 4.6.2-1 provides some support to the distribution recorded from boat surveys in the winter of 2004/05 (Figure 4.6.1-3), in that a concentration of Northern Gannet was apparent to the northeast of the wind farm area. Some contours of higher average counts extend through the Inner Gabbard wind farm zone, but these contours are of low overall abundance.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National importance
TH1	WINTER 1	0.1259	0.2165	273	158	470	
	WINTER 2	0	0	0	0	0	
	WINTER 3	0	0	0	0	0	
	WINTER 4	0	0	0	0	0	
TH2	WINTER 1	0.5261	0.9178	1,130	505	2,528	
	WINTER 2	0.0057	0.0114	14	2	82	
	WINTER 3	0.0086	0.0086	11	3	43	
	WINTER 4	0	0	0	0	0	
TH3	WINTER 1	0.1109	0.1315	139	83	235	0.03%
	WINTER 2	0.0228	0.0228	24	9	62	0.01%
	WINTER 3	0.0130	0.0447	47	8	291	0.01%
	WINTER 4	0	0	0	0	0	0.00%
TH4	WINTER 1	0.0032	0.0032	4	1	16	
	WINTER 2	0	0	0	0	0	
	WINTER 3	0	0	0	0	0	
	WINTER 4	0	0	0	0	0	
TH5	WINTER 2	0.0033	0.0033	4	1	22	
	WINTER 3	0.0229	0.0277	30	13	68	
	WINTER 4	0	0	0	0	0	

Table 4.6.2-1 Northern Gannet recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; raw count = total number of birds recorded; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.6.3 The importance of the Greater Gabbard for Northern Gannet through the year

4.6.3.1 Winter and summer

Most British breeding colonies of Northern Gannet are found on rocky coastal stacks such as Bass Rock, although birds may travel many kilometres offshore to feed, where profitability is high. Estimates of Northern Gannet in the Greater Gabbard area were generally low throughout the summer, with larger estimates of 211, 160 and 257 appearing in July, August and September respectively. Even at these levels, Northern Gannet occurred in very low densities given that the breeding population numbers some 227,000 pairs (Mitchell *et al.* 2004). The Greater Gabbard area does not seem to hold importance for summering Northern Gannet.

Although wintering estimates of the national population of Northern Gannet are not feasible, it is likely that estimates no greater than 140, as found on both aerial and boat surveys, are not a significant part of the total figure in British waters. This is partially supported by the estimate of 1,130 recorded on the neighbouring survey block TH2 during the aerial survey in winter period 1. However, TH3 was found to be a regionally important area for the species, supporting a maximum of 9% of the regional total. Proportional estimates for the wind farm footprint area are below 50, and thus the species is not estimated to be regionally important at this level.

4.6.3.2 Migration

Northern Gannet migration can occur at any time from August through to November, and juveniles tend to move south towards the Bay of Biscay and North Africa within a few weeks of fledging (Wanless 2002). As many of the breeding colonies in Britain lie in the north east (especially Scotland), and most are likely to return to their natal breeding colonies, it is probable that most migrating birds will travel near to the wind farm area on both outward and return migration (although some travel along the west coast and around north Scotland; Wanless 2002). Most adult Northern Gannet tend to winter closer to their breeding grounds (Wanless 2002) and thus may be less affected by potential risks presented by the wind farm than younger individuals.

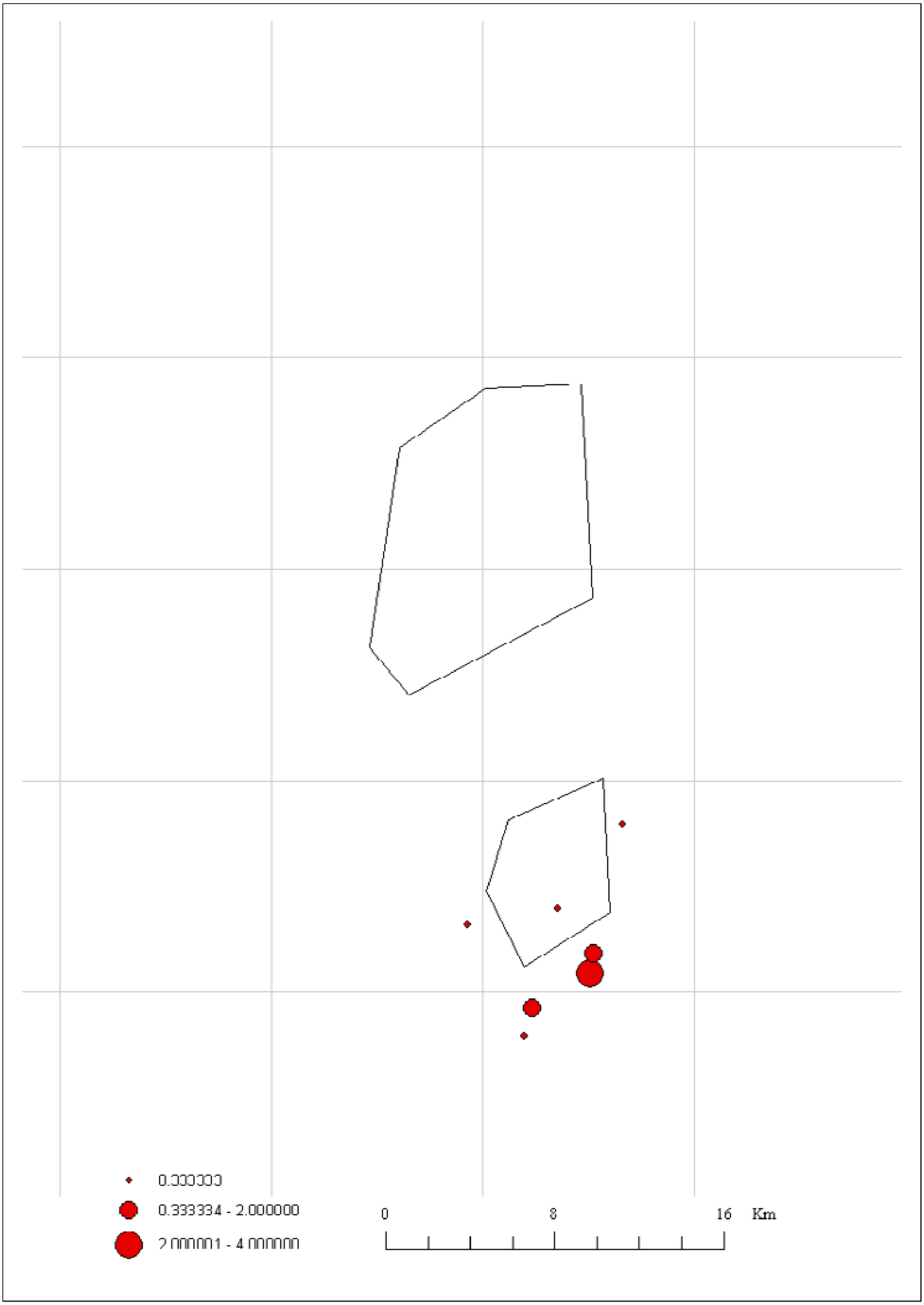

Figure 4.6.1-1 Average distribution of Northern Gannet, first winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

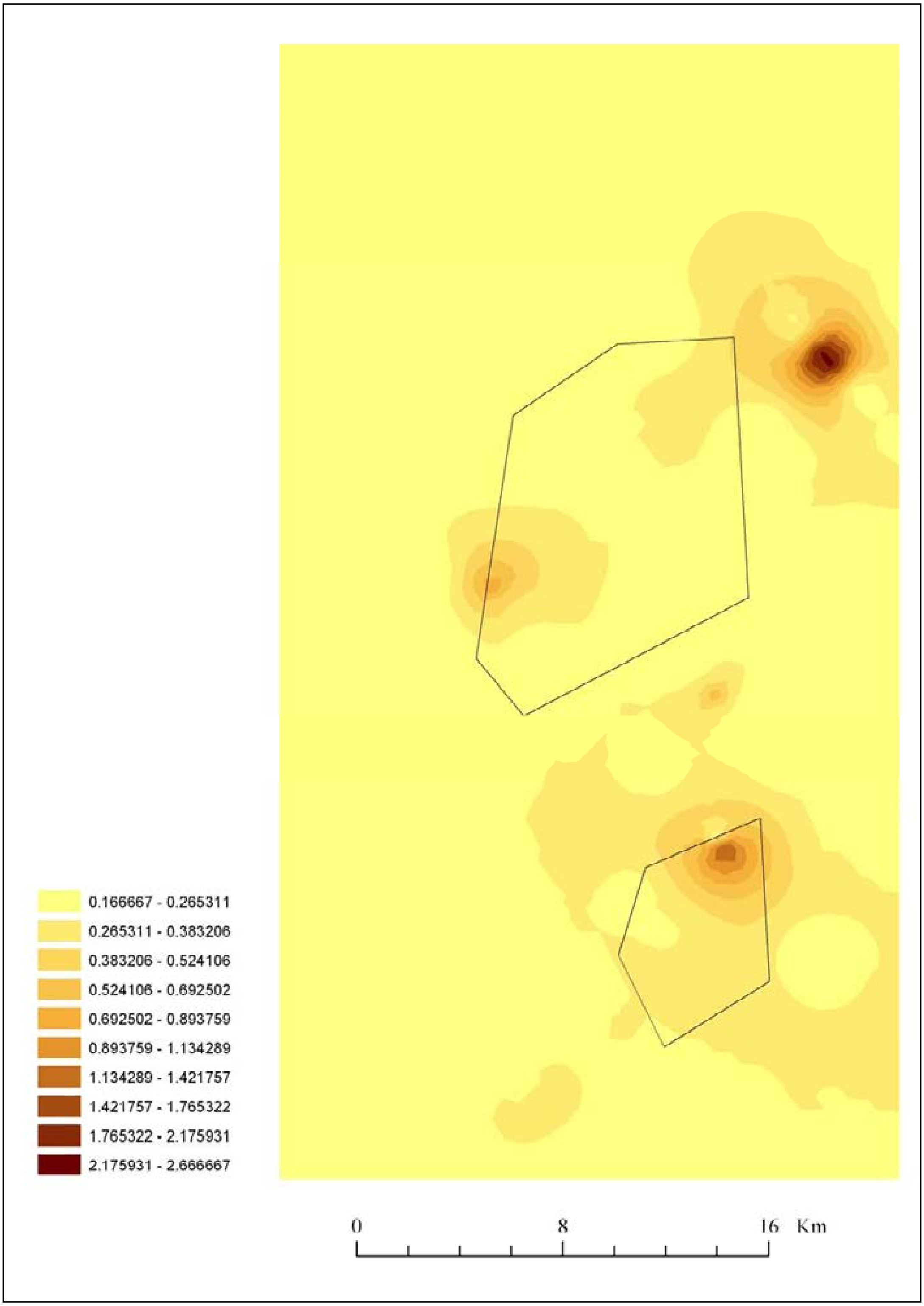

Figure 4.6.1-2 Smoothed average distribution of Northern Gannet, summer boat surveys. Polygons show boundaries of proposed wind farm.

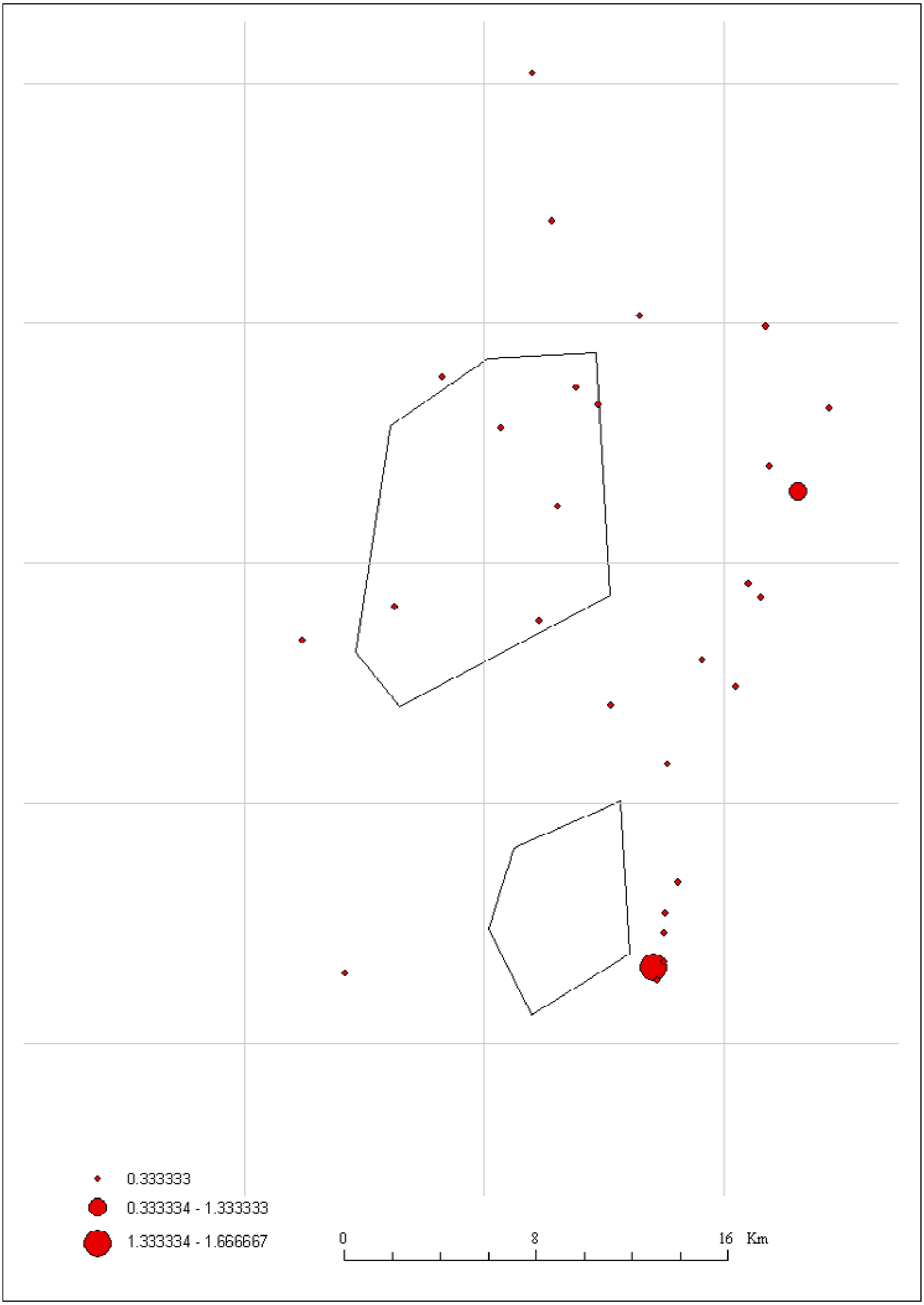

Figure 4.6.1-3 Average distribution of Northern Gannet, second winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

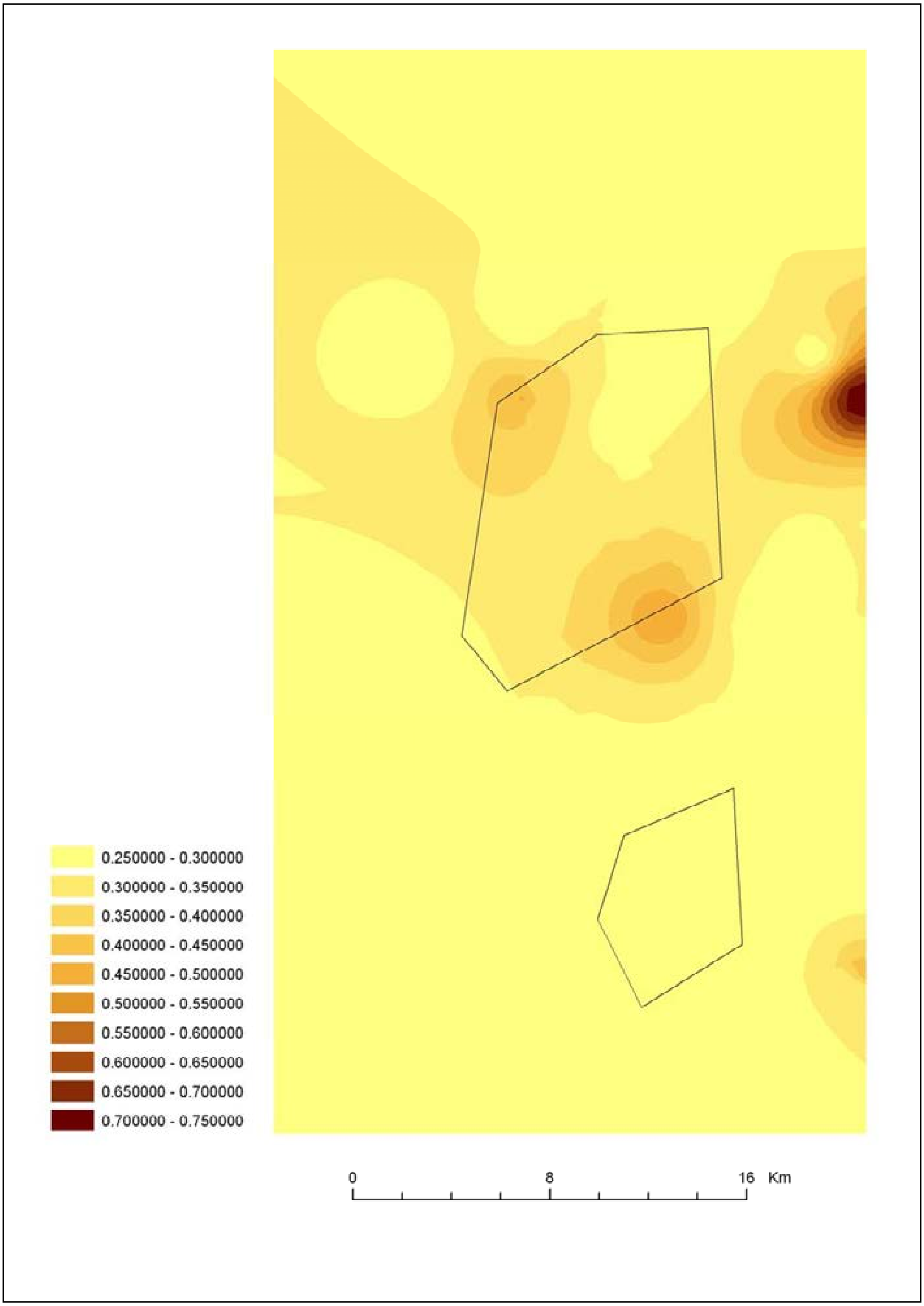

Figure 4.6.2-1 Smoothed average distribution of Northern Gannet, aerial surveys. Polygons show boundaries of proposed wind farm.

4.7 Common Scoter	*Melanitta nigra*		
Conservation status:	WCA, UK BAP, BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	16,000	European population	100-130,000
GB threshold	500	*GB population*	77
Wind farm peak estimate	5	Wind farm peak estimate	0
Gabbard peak	24 (boat)	*Gabbard peak*	1 bird (boat)
% National importance	0.05%	*% National importance*	0.01%

4.7.1 Boat surveys

As no counts were recorded of birds on sea, there were insufficient counts of this species to use distance sampling techniques. Figures presented are raw counts of birds considered 'in transect' (Table 4.7.1-1). Stone *et al.* (1995) propose a correction factor of 1.0 for this species and counts are therefore unchanged. All birds recorded were seen in flight, possibly flushing in response to the approaching boat. One flock of 24, in March 2005, was the only notable count.

Month	On sea	In flight	Total	% National importance
February 2004	0	5	5	0.01%
March 2004 (1)	0	0	0	0.00%
March 2004 (2)	0	0	0	0.00%
April 2004	0	0	0	0.00%
May 2004	0	1	1	0.00%
June 2004	0	0	0	0.00%
July 2004	0	0	0	0.00%
August 2004	0	0	0	0.00%
September 2004	0	0	0	0.00%
November 2004	0	0	0	0.00%
December 2004	0	0	0	0.00%
March 2005	0	24	24	0.04%

Table 4.7.1-1 Common Scoters recorded 'in transect' on boat surveys, with % of national importance. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.7.2 Aerial surveys

Table 4.7.2-1 shows results from aerial surveys, for all seaducks. This category includes unidentified seaducks plus Common Scoter, Velvet Scoter and Eider; the vast majority of positive identifications were of the former species (1,339 counted, versus two Velvet Scoter and 15 Eider). Largest counts were made in survey area TH1, unsurprising in that Common Scoter favour sheltered shallows during the wintering season. No seaducks were recorded in area TH3 despite the fact that shallow sandbanks are present.

Survey Block	Survey Period	DS	D	N	LCL	UCL
TH1	WINTER 1	0.0196	0.1327	167	14	1,979
	WINTER 2	0.1058	1.6268	2,050	473	8,885
	WINTER 3	0.0274	5.3006	6,679	161	277,000
	WINTER 4	0.0196	0.8470	1,067	91	12,562
TH2	WINTER 1	0.0039	0.0313	39	6	252
	WINTER 2	0	0	0	0	0
	WINTER 3	0.0039	0.0118	14	2	94
	WINTER 4	0	0	0	0	0
TH3	WINTER 1	0	0	0	0	0
	WINTER 2	0	0	0	0	0
	WINTER 3	0	0	0	0	0
	WINTER 4	0	0	0	0	0
TH4	WINTER 1	0.0175	0.9397	1,058	285	3,932
	WINTER 2	0.0044	0.0219	25	4	146
	WINTER 3	0.0087	0.1137	128	40	412
	WINTER 4	0	0	0	0	0
TH5	WINTER 2	0	0	0	0	0
	WINTER 3	0	0	0	0	0
	WINTER 4	0.0045	0.3807	410	23	7,445

Table 4.7.2-1 Seaducks recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; raw count = total number of birds recorded; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.7.3 The importance of the Greater Gabbard for Common Scoter through the year

4.7.3.1 Winter and summer

The breeding population of Common Scoter in the United Kingdom is extremely small, most birds migrating to sub-arctic zones of Eurasia to breed. Therefore the Greater Gabbard is of no importance to this species during the summer, and even the one bird recorded in May 2004 was slightly surprising.

The shallow coastal waters of Britain and Ireland are crucial for non-breeding Common Scoter, however, where they typically winter offshore within 2 km of land and within waters 10 m deep (Snow & Perrins 1998), foraging for shellfish and other benthic invertebrates. The most important sites are Carmarthen Bay in Wales and Shell Flats in England, holding estimates of over 20,000 and 10,000 respectively (Pollitt *et al.* 2003; Banks *et al.* 2004); this contrasts sharply with four counts of the Greater Gabbard area yielding no return. These counts were made using the same methodology as for these surveys, so it is likely that the absence of birds means the area is genuinely of no importance for this species, rather than indicating methodological deficiencies.

4.7.3.2 Migration

Although ringing data from Common Scoters are poor, a major moult migration appears to take place from August through to December (Toms 2002), and the return journey to the breeding grounds is generally from late February through to early April. The migratory route taken by Common Scoters leaving the breeding grounds includes both the south western Baltic Sea and the Dutch Wadden Sea as staging grounds, before dispersal into the North Sea and the coasts of western Europe. It is therefore likely that some Common Scoter are likely to pass near to the proposed wind farm area, either on this migration or the return leg. However, given that the major concentrations of wintering Common Scoter occur on the west coast of Britain, it would seem plausible that the majority of movements will be along the English Channel and around the south western peninsula.

4.8 Great Skua	*Catharacta skua*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	European population	16,000
GB threshold	?	*GB population*	9,600
Wind farm peak estimate	0	Wind farm peak estimate	43
Gabbard peak	1 (*boat*)	*Gabbard peak*	214 birds (*boat*)
% National importance	0.00%	*% National importance*	1.11%

4.8.1 Boat surveys

Distance sampling of Great Skua counts was possible for some of the summer months (Table 4.8.1-1), but only individual birds were recorded in the two survey winters, and then only ever in flight. Estimates of 214 (95% confidence limits for distance estimate: 99 – 437) Great Skua recorded in September 2004 are consistent with the peak passage month (Tasker *et al*. 1987) and are likely to have been birds moving between breeding and wintering grounds. The low numbers of birds seen in May and July were possibly foraging adults, maybe associated with fishing activity in the area, or pirating feeding flocks of other seabirds. This species cannot be accurately quantified in the context of national importance during the non-breeding season, as no valid population estimates exist; however, peak counts of single individuals render such assessment irrelevant.

Figure 4.8.1-1 shows that average counts of Great Skua were widely distributed throughout the whole area of survey; therefore there do not appear to be areas of high concentration of this species, and there is no evidence that the areas for the proposed wind farm are especially important.

MONTH	DS	D	N	LCL	UCL
February	0	0	0	0	0
March (1)	0	0	0	0	0
March (2)	0	0	0	0	0
April	0	0	0	0	0
May	0.0250	0.0250	18	4	74
June	0	0	0	0	0
July	0.0250	0.0250	18	4	74
August	0	0	0	0	0
September	0.2622	0.2846	208	99	437
November	0	0	0	0	0
December	0	0	0	0	0
March 2005	0	0	0	0	0

Table 4.8.1-1 Great Skua recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. 0 indicates the bird was not present. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	0	0	0	0.00%
March (1)	0	0	0	0.00%
March (2)	0	0	0	0.00%
April	0	0	0	0.00%
May	1	18	19	0.10%
June	0	0	0	0.00%
July	8	18	26	0.14%
August	1	0	1	0.01%
September	6	208	214	1.11%
November	1	0	1	0.01%
December	1	0	1	0.01%
March 2005	0	0	0	0.00%

Table 4.8.1-2 'In flight' counts, distance estimates and total estimates for Great Skua. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.8.2 Aerial surveys

Individual Great Skua were recorded during second and third winter period aerial surveys.

4.8.3 The importance of the Greater Gabbard for Great Skua through the year

4.8.3.1 Winter and summer

Great Skuas do not breed in any noteworthy numbers on any coastline near to the Greater Gabbard area, being largely confined to Orkney and Shetland, and therefore it is extremely unlikely that this species is reliant on the area for foraging opportunities. Furthermore, during the non-breeding season, both immature and adult birds tend to make a southerly migration. Therefore the Greater Gabbard area holds minimal importance for Great Skua in either breeding or non-breeding seasons.

4.8.3.2 Migration

Great Skua migrations tend to be slow and leisurely, with many birds scattering themselves along the coasts of mainland southern Europe during the winter. Sexually immature birds that have visited breeding colonies in northern Scotland may disperse from June onwards, which could explain why this species was recorded in July. Peak movements of adults are recorded in September (Tasker *et al.* 1987), which coincides with the peak count from boat surveys in this study. This peak estimate for the entire study area exceeded the 1% national threshold; proportional estimates of numbers within the wind farm footprint area, however, did not, numbering below 50 and thus not qualifying as important. Furness (2002) suggests that most movements of Great Skua are north out of the North Sea, birds preferring to travel along the west coasts of Britain. This hypothesis would suggest that most migrating Great Skua would avoid the wind farm area in passage, but does not explain the peak count of 214 recorded; presumably these birds would have been en route from their Scottish breeding colonies to more southerly wintering latitudes.

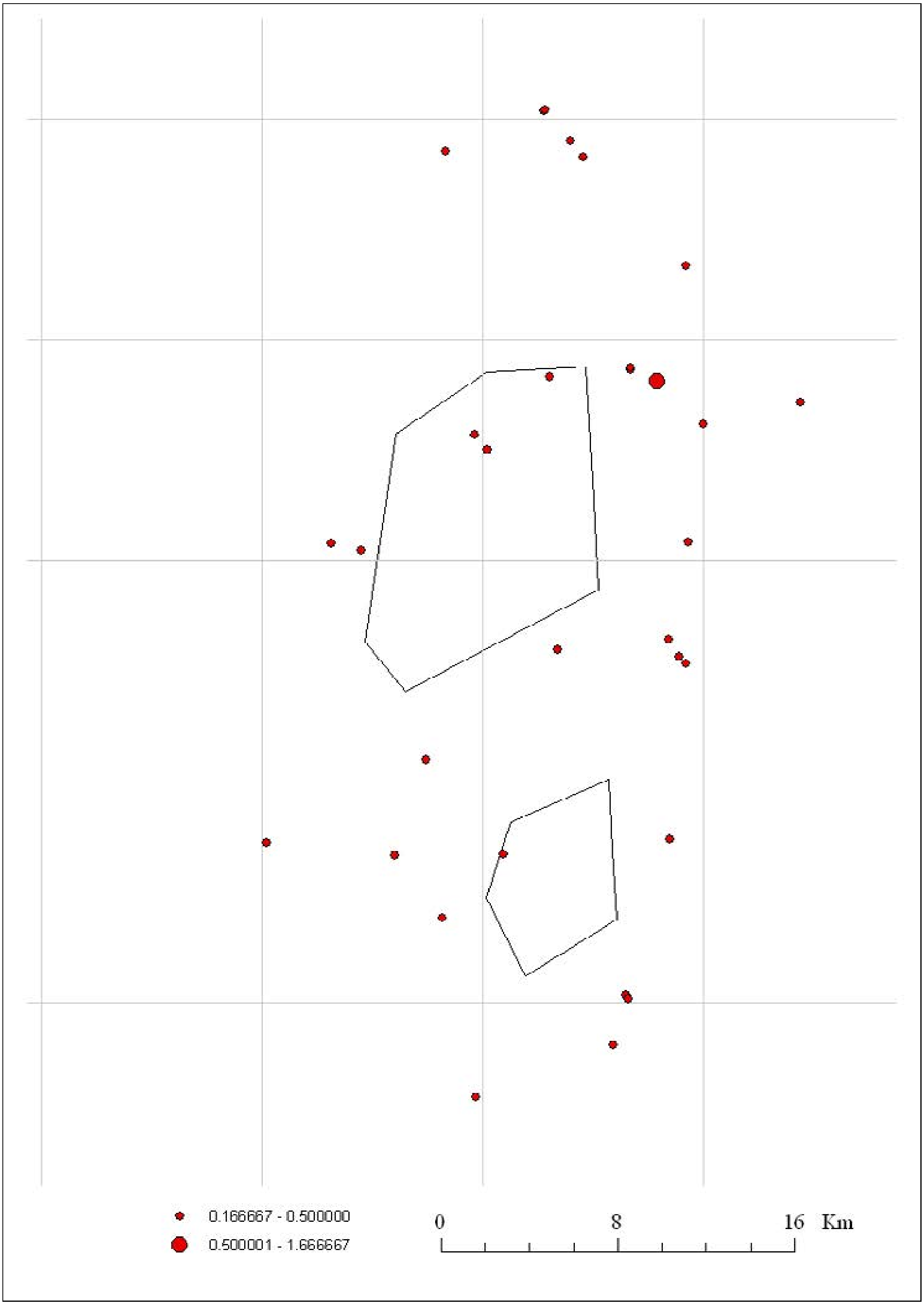

Figure 4.8.1-1 Average distribution of Great Skua, summer boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

4.9 Little Gull	*Larus minutus*		
Conservation status:	Annex 1, WCA		
Winter		**Summer (pairs)**	
International threshold	1,100	*European population*	24,000-58,000
GB threshold	?	*GB population*	0
Wind farm peak estimate	1	Wind farm peak estimate	0
Gabbard peak	4 (*aerial*)	*Gabbard peak*	0
% National importance	negligible	*% National importance*	0.00%

4.9.1 Boat surveys

Three individuals were recorded during the survey in December 2004.

4.9.2 Aerial surveys

Four individuals were recorded during the survey in the second winter period of aerial surveys.

4.9.3 The importance of the Greater Gabbard for Little Gull

4.9.3.1 Winter and summer

The Greater Gabbard area has no importance for Little Gull at any time of the year. On boat surveys, two birds were counted in November 2004, three in December 2004 and one in March 2005. Aerial surveys recorded four birds in the second winter period, and only one in the third winter period.

4.9.3.2 Migration

No Little Gulls were recorded during migratory periods.

4.10 Mew (Common) Gull	*Larus canus*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	16,000	European population	590,000-1.5 million
GB threshold	4,300	*GB population*	49,000
Wind farm peak estimate	8	Wind farm peak estimate	1
Gabbard peak	56 (*aerial*)	*Gabbard peak*	3 birds (*boat*)
% National importance	0.01%	*% National importance*	0.00%

4.10.1 Boat surveys

Note that there were insufficient counts of this species to use distance sampling techniques. Figures presented are raw counts of birds considered 'in transect', multiplied by the appropriate correction factor of 1.4 (according to Stone *et al.* 1995).

Table 4.10.1-1 illustrates the low counts of Mew Gull at all stages of the year. Figure 4.10.1-1 underlines the sparse nature of the counts, with most counts seemingly occurring on one transect.

Month	On sea	Correction	In flight	Total	% National importance
February 2004	1	1	1	2	0.00%
March 2004 (1)	0	0	1	1	0.00%
March 2004 (2)	0	0	12	12	0.00%
April 2004	3	4	0	4	0.00%
May 2004	0	0	0	0	0.00%
June 2004	0	0	0	0	0.00%
July 2004	0	0	0	0	0.00%
August 2004	0	0	0	0	0.00%
September 2004	0	0	0	0	0.00%
November 2004	3	4	4	8	0.00%
December 2004	1	1	6	7	0.00%
March 2005	8	11	1	12	0.00%

Table 4.10.1-1 Mew Gulls recorded 'in transect' on boat surveys, with % of national importance. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.10.2 Aerial surveys

Table 4.10.2-1 shows distance estimates generated from data collected on aerial surveys. Raw counts from aerial surveys were no greater than 10 birds over the winter period, and this agrees with the low counts made from boat surveys. Distance estimates peaked at 56 (95% confidence limits: 0 – 9,533) in winter period 3, though the wide confidence limits prompt cautious interpretation.

Figure 4.10.2-1 shows that no counts of Mew Gull were made inside the proposed wind farm areas, the few birds that were recorded lying closer to shore.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National importance
TH1	WINTER 1	0.0266	0.0508	64	0	10,898	
	WINTER 2	0.4365	0.8751	1,103	6	188,000	
	WINTER 3	0.0479	0.0681	86	1	14,607	
	WINTER 4	0.1650	0.2691	339	2	57,747	
TH2	WINTER 1	0.0053	0.0053	7	0	1,115	
	WINTER 2	0.1277	0.2699	332	2	56,588	
	WINTER 3	0.0213	0.0213	26	0	4,461	
	WINTER 4	0.1224	0.3325	409	2	69,695	
TH3	WINTER 1	0.0182	0.0364	39	0	6,571	0.01%
	WINTER 2	0.0061	0.0061	6	0	1,095	0.00%
	WINTER 3	0.0425	0.0528	56	0	9,533	0.01%
	WINTER 4	0	0	0	0	0	0.00%
TH4	WINTER 1	0.0356	0.0356	40	0	6,831	
	WINTER 2	0.1247	0.1931	217	1	37,023	
	WINTER 3	0.0594	0.0609	69	0	11,680	
	WINTER 4	0	0	0	0	0	
TH5	WINTER 2	0.0122	0.0122	13	0	2,229	
	WINTER 3	0.0182	0.0243	26	0	4,460	
	WINTER 4	0.0061	0.0061	7	0	1,116	

Table 4.10.2-1 Mew Gulls recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.10.3 The importance of the Greater Gabbard for Mew Gulls through the year

4.10.3.1 Winter and summer

On only one occasion during the summer months April – September were Mew Gulls recorded on boat surveys, and this count was of just three individuals. This pattern is unsurprising, as the Greater Gabbard area is not close to any known breeding colonies of the species. Clearly the area is also not important as a foraging area for coastal nesting Mew Gulls.

Winter counts from boats were also notably low, 12 birds estimated in March 2004, with the same estimate in March of the following year. Distance estimates were not possible owing to such infrequent counts, though these were generated from winter aerial surveys. Despite the wide confidence limits, Mew Gulls were calculated to occur at low density and abundance in the Greater Gabbard area, estimates peaking at 56 birds in the third winter period. This peak was large enough to exceed the 1% threshold for regional importance, although with only six birds more than required to fulfil the minimum required for qualification as regionally important. Proportional estimates for the wind farm footprint area are below 50 and thus do not qualify the area as regionally important. These results suggest that the Greater Gabbard area is of limited value for wintering Mew Gulls, with only minimal regional importance. Most gulls wintering in the UK are more likely to forage inland or close to the shore, roosting on inland waterbodies or coastal areas.

4.10.3.2 Migration

August and September marks the onset of migrations of Mew Gulls towards Britain and Ireland, continental breeders moving westerly from Scandinavia and the Baltic region (Douse 2002). It is therefore likely that birds migrating along the coastline of northwest Europe towards Britain will encounter the southern North Sea, and possibly the Greater Gabbard area. Localised movements of juveniles or British breeders are more likely to remain closer to the UK coastline than those continental migrants arriving from Denmark, Sweden and the Low Countries.

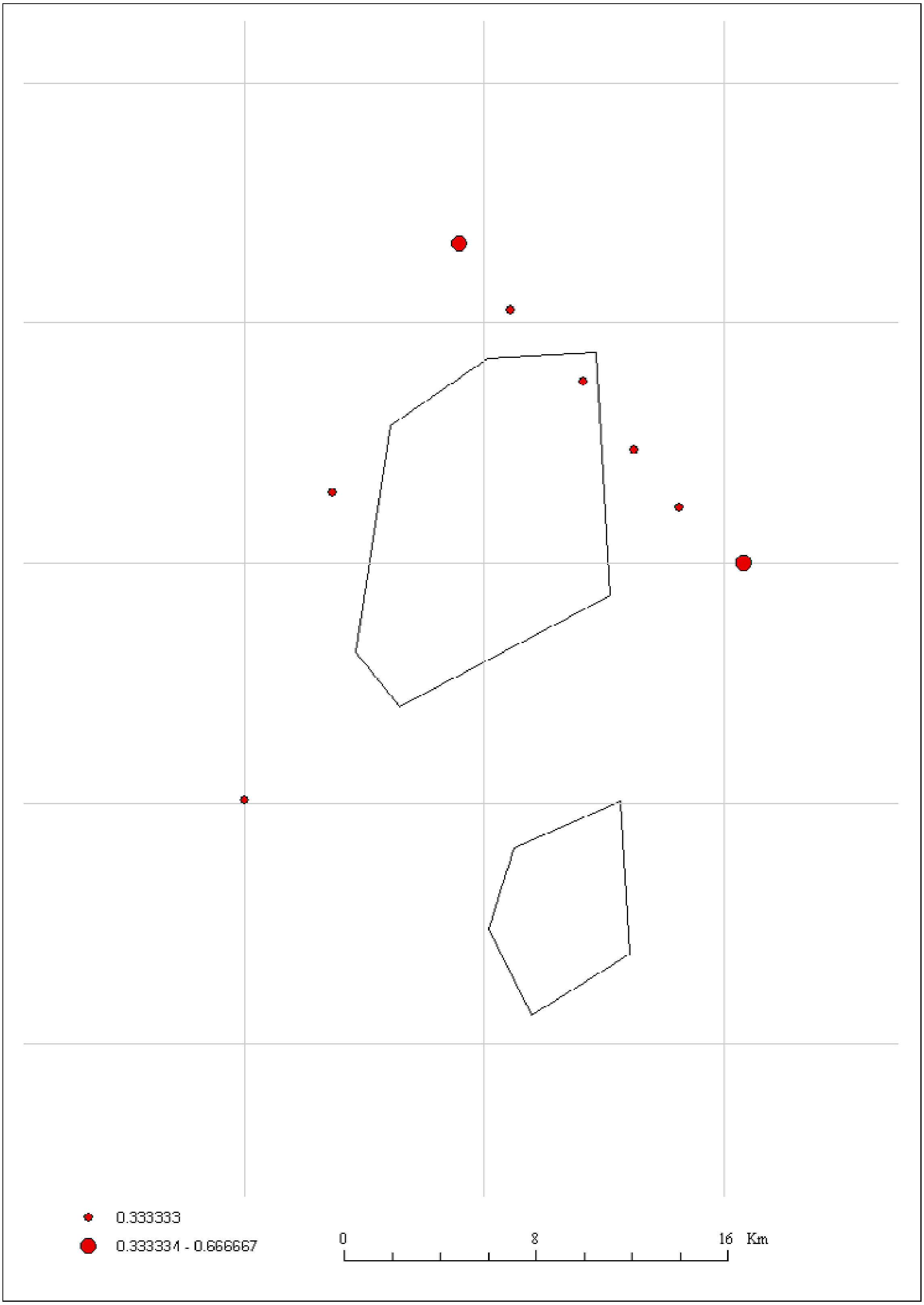

Figure 4.10.1-1 Average distribution of Mew Gull, second winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

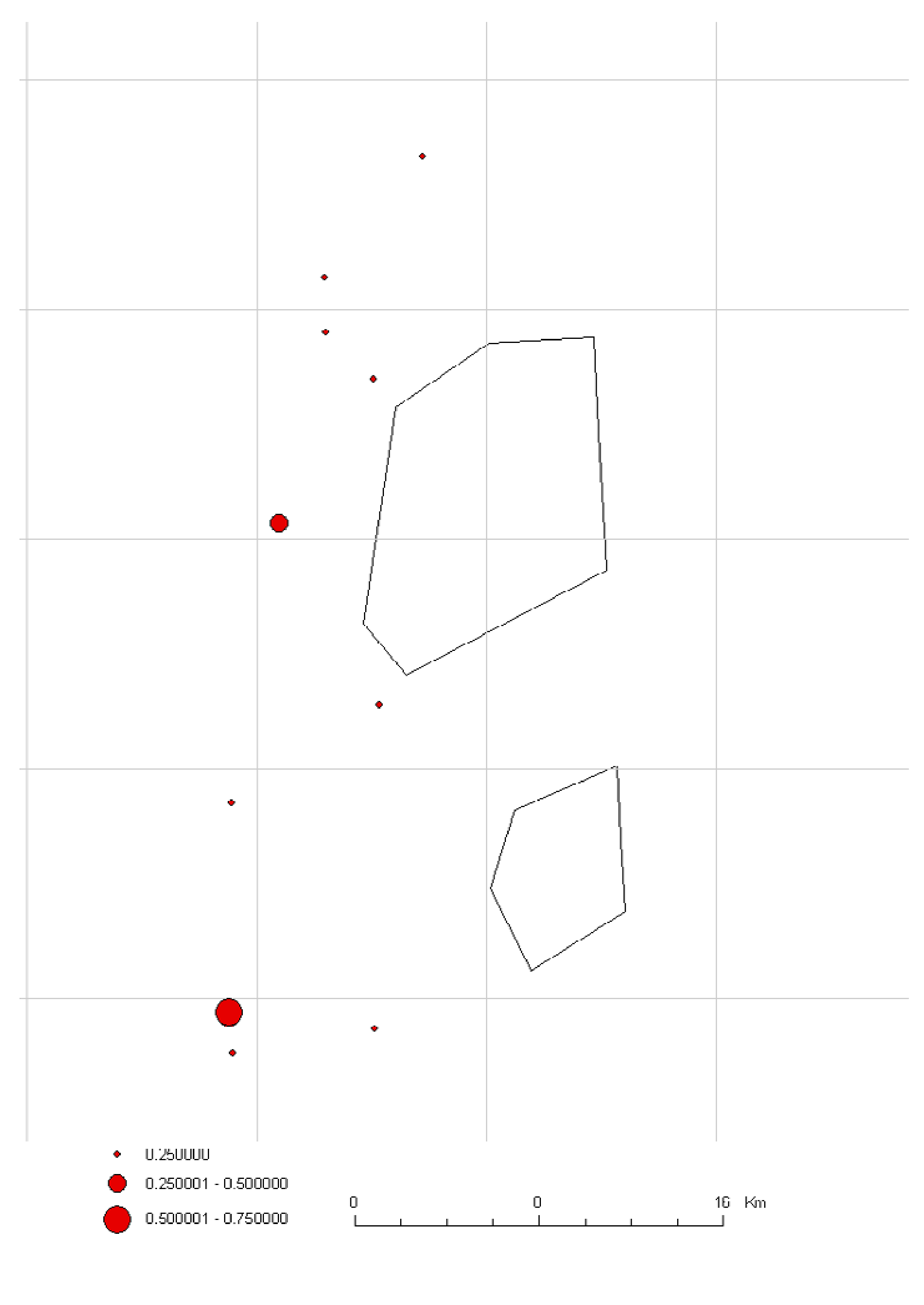

Figure 4.10.2-1 Average distribution of Mew Gull, aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

4.11 Lesser Black-backed Gull	*Larus fuscus*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	4,500	European population	300-350,000
GB threshold	610	*GB population*	114,000
Wind farm peak estimate	302	Wind farm peak estimate	156
Gabbard peak	1,508 (*boat*)	*Gabbard peak*	780 birds (*boat*)
% National importance	2.47%	*% National importance*	0.34%

4.11.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.11.1-1). Estimates generated relate to the 730 km^2 surveyed by the boat. Those birds recorded in flight during surveys were not suitable for distance analysis, and as such raw counts of these birds are shown (Table 4.11.1-2). Counts of in flight birds were added to the estimates produced from distance sampling to provide an overall estimate of birds in the Greater Gabbard area. In calculating national importance, it has been assumed that each individual bird is a member of a nesting pair. Even at this scale, nationally important numbers are not recorded in the breeding season. In one instance, the survey of March 2005, numbers of Lesser Black-backed Gull exceeded the national threshold, representing over 2% of the current minimum wintering estimate (60,830; Burton *et al.* 2003); it is unclear why these estimates should be so much greater than in the first winter of survey, though the area covered was larger in the second winter.

Distributions of Lesser Black-backed Gulls show similar patterns when averaged for the first winter of survey, the summer and the second winter (Figures 4.11.1-1, 4.11.1-2 and 4.11.1-3 respectively). Highest average counts occurred in the south east corner of the survey area, often coinciding with The Galloper area of the wind farm. It is possible that this area is productive for fish that are exploited by feeding flocks of gulls.

MONTH	DS	D	N	LCL	UCL
February	0.0543	0.1320	53	17	172
March (1)	0.0328	0.0700	34	13	87
March (2)	0.0328	0.1939	94	29	312
April	0.0889	0.0889	65	20	216
May	0.1143	0.1109	81	23	287
June	0.6732	0.9280	677	373	1,231
July	0.2159	0.7092	518	233	1,149
August	0.1270	0.2450	179	70	454
September	0.1397	0.1632	119	43	334
November	0.1143	0.1841	134	62	292
December	0.1039	0.6310	461	81	2,634
March 2005	1.0923	1.9054	1,391	648	2,987

Table 4.11.1-1 Lesser Black-backed Gull recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	226	53	279	0.46%
March (1)	160	34	194	0.32%
March (2)	175	94	269	0.44%
April	11	65	76	0.07%
May	86	81	167	0.15%
June	103	677	780	0.68%
July	116	518	634	0.56%
August	18	179	287	0.25%
September	5	119	124	0.11%
November	12	134	146	0.24%
December	24	461	485	0.80%
March 2005	117	1,391	1,508	2.47%

Table 4.11.1-2 'In flight' counts, distance estimates and total estimates for Lesser Black-backed Gull, with % national importance. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.11.2 Aerial surveys

Distance estimates of wintering Lesser Black-backed Gulls were possible, and are presented in Table 4.11.2-1. Counts across all survey areas were very low for this species, with distance estimates for the Greater Gabbard area (TH3) only as high as 26 birds and with tight 95% confidence limits (6 – 105). As counts from boat surveys were considerably higher, it seems likely that aerial surveys are not as effective at recording this species.

Low counts of this species mean that averaged distribution maps are of little relevance, but Figure 4.11.2-1 underlines the infrequency of occurrence of Lesser Black-backed Gulls on aerial surveys.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National importance
TH1	WINTER 1	0.0212	0.0212	27	9	76	
	WINTER 2	0.1128	0.4246	535	251	1,143	
	WINTER 3	0.0071	0.0071	9	2	49	
	WINTER 4	0.0776	0.1026	129	62	268	
TH2	WINTER 1	0.0845	0.0856	105	31	356	
	WINTER 2	0	0	0	0	0	
	WINTER 3	0.0493	0.0634	78	30	203	
	WINTER 4	0.0071	0.0071	9	1	57	
TH3	WINTER 1	0.0161	0.0161	17	4	65	0.03%
	WINTER 2	0.0241	0.0241	26	6	105	0.04%
	WINTER 3	0.0161	0.0161	17	4	65	0.03%
	WINTER 4	0	0	0	0	0	0.00%
TH4	WINTER 1	0.0315	0.0315	35	14	92	
	WINTER 2	0.0079	0.0079	9	1	55	
	WINTER 3	0.1101	0.2901	327	114	937	
	WINTER 4	0	0	0	0	0	
TH5	WINTER 2	0	0	0	0	0	
	WINTER 3	0.0564	0.0564	61	25	146	
	WINTER 4	0.0161	0.0161	17	3	95	

Table 4.11.2-1 Lesser Black-backed Gulls recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; raw count = total number of birds recorded; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.11.3 The importance of the Greater Gabbard for Lesser Black-backed Gulls through the year

4.11.3.1 Winter and summer

The Greater Gabbard area is perhaps more relevant as a site during the breeding season for Lesser Black-backed Gulls than most other species considered in this report, as a large breeding colony (numbering around 6,000 or 7,000 pairs; Wright 2004; Mitchell *et al.* 2004) exists on the Suffolk coast at Orford Ness. As Lesser Black-backed Gulls can fly many kilometres to feed (Rock 2002), the Greater Gabbard area is well within foraging range of the colony. Estimates of Lesser Black-backed Gulls in the study area during June and July 2004 were reasonably high, representing over 0.5% of the estimated British breeding population of 112,000 pairs (Mitchell *et al.* 2004), assuming that each individual bird was one of a different pair. It is probable that estimates in mid-summer reflect birds feeding in the area, although autumn passage may begin as early as July (Rock 2002). In any case, it seems that the Greater Gabbard area in general supports relatively high densities of Lesser Black-backed Gulls in the breeding season.

During the winter, aerial and boat surveys revealed contradictory results, the former producing abundance estimates no greater than 26, the latter a peak of 1,508 birds. This estimate was, however, three times greater than the next highest estimate, suggesting that it could have represented an anomalously large count. Regardless, the estimate exceeded the 1% national importance threshold, representing 2.47% of the national wintering total. For the wind farm footprint area, the estimated proportion of the national total was reduced to 0.5%. As the count was made in late March, it is also highly possible that returning breeders were recorded on passage, as this coincides with their period of return from continental Europe and North Africa. Other estimates during the winter were lower, usually between 150 and 300. These birds were likely to be mature breeding birds, possibly boosted in number by gulls moving in from Iceland and the Faeroes (Rock 2002). Aerial counts of this species were generally low, and as the peak estimate for the Greater Gabbard area did not exceed 50, this species did not surpass the 1% threshold of regional importance.

4.11.3.2 Migration

As mentioned above, Lesser Black-backed Gulls are largely migratory, with the winter distribution generally moving south and east, especially amongst younger individuals. Peak times of passage are between July and October in the autumn, and between mid-February and April in the spring (Rock 2002). During these times, there is likely to be exchange along the continental coast of Europe, and within Britain and Ireland internally. Winter dispersal of juveniles to southerly coasts is unlikely to involve the Greater Gabbard area, as birds will generally fly overland. However, the wind farm may be encountered by influxes of post-breeding gulls from Scandinavia and western European coasts that overwinter in Britain and Ireland, as such movements invariably involve crossing the North Sea.

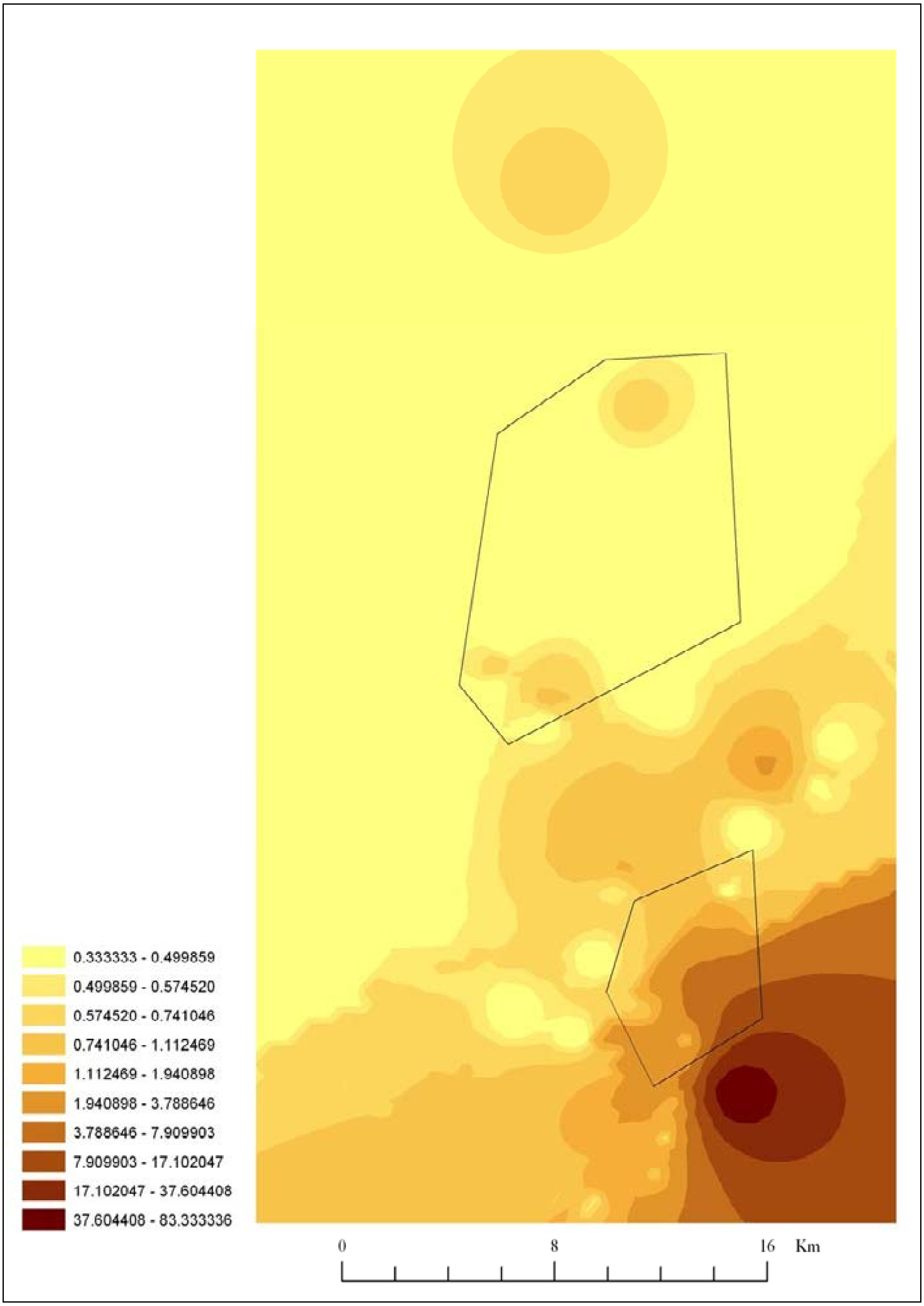

Figure 4.11.1-1 Smoothed average distribution of Lesser Black-backed Gull, first winter boat surveys. Polygons show boundaries of proposed wind farm.

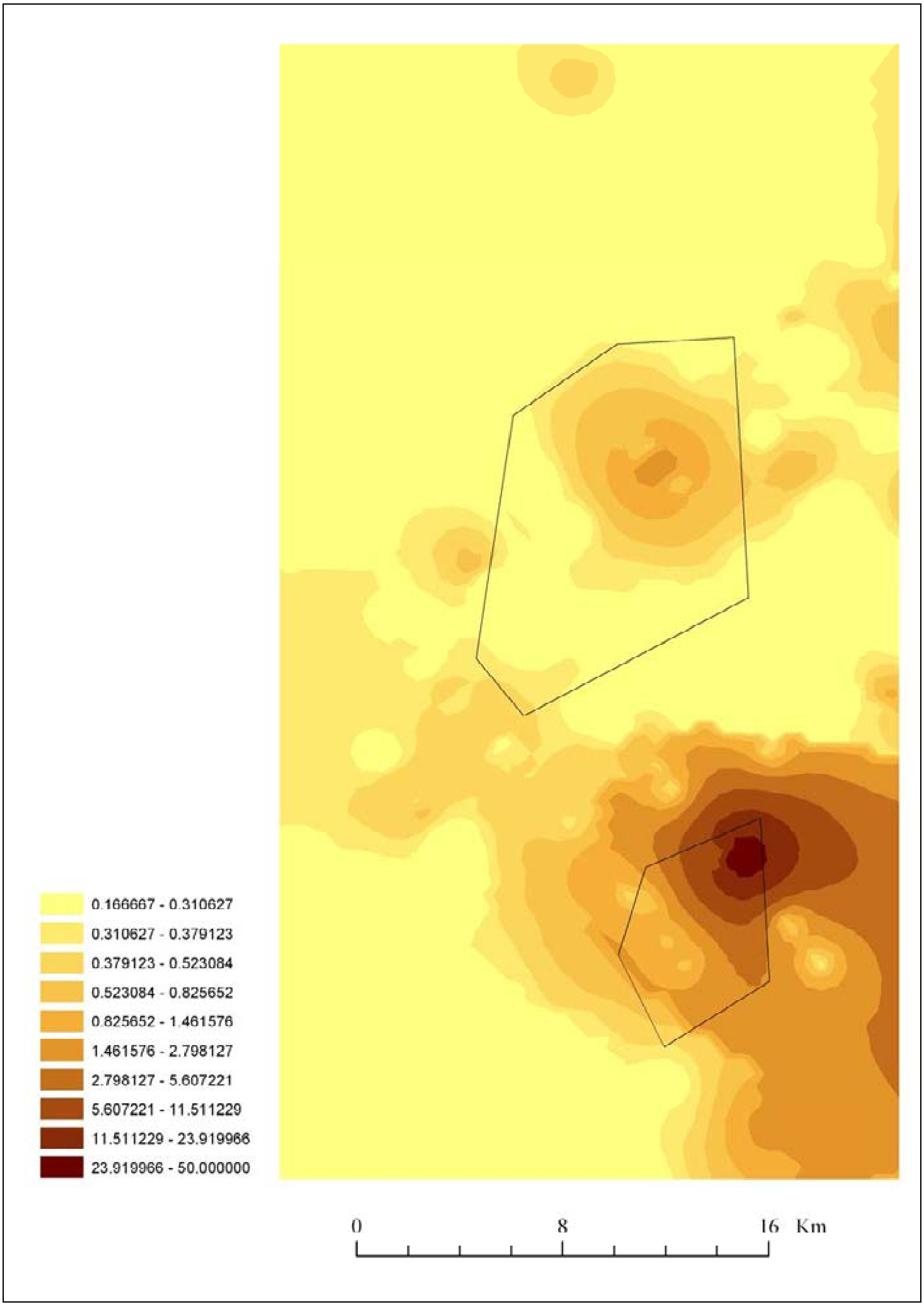

Figure 4.11.1-2 Smoothed average distribution of Lesser Black-backed Gull, summer boat surveys. Polygons show boundaries of proposed wind farm.

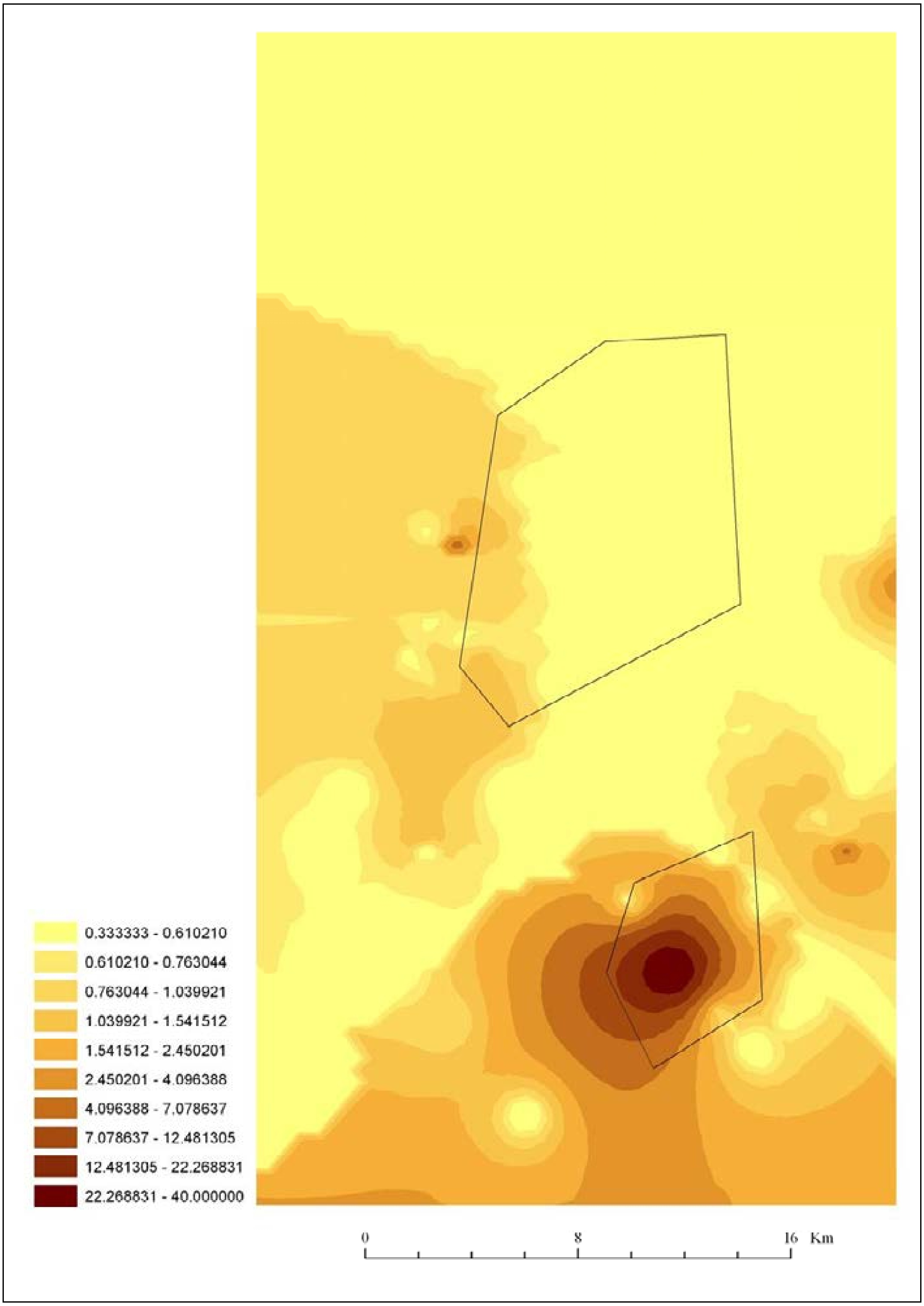

Figure 4.11.1-3 Smoothed average distribution of Lesser Black-backed Gull, second winter boat surveys. Polygons show boundaries of proposed wind farm.

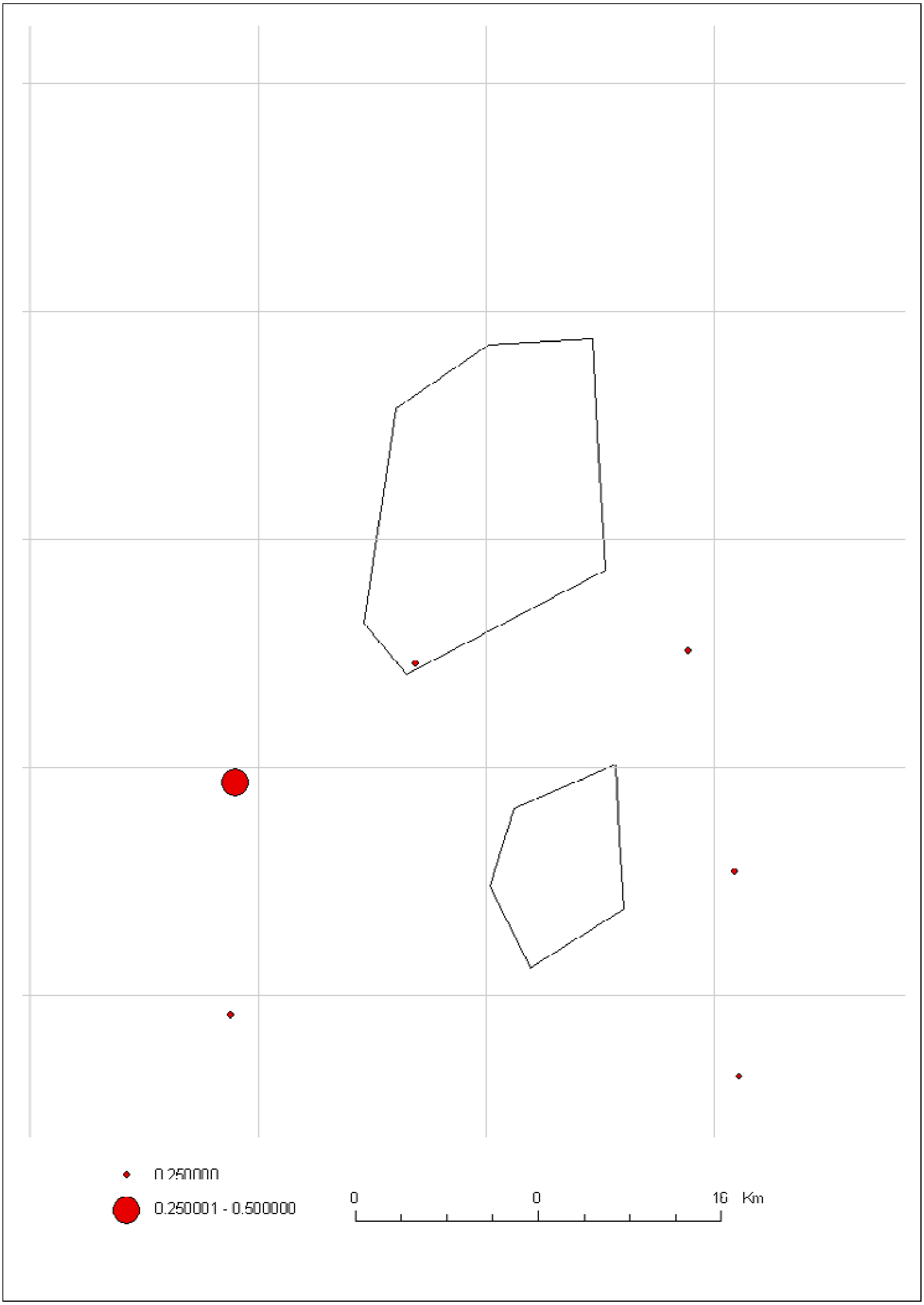

Figure 4.11.2-1 Average distribution of Lesser Black-backed Gull aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

4.12 Herring Gull	*Larus argentatus*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	13,000	European population	760,000-1.4 million
GB threshold	3,800	*GB population*	144,000
Wind farm peak estimate	191	Wind farm peak estimate	0
Gabbard peak	957 (*boat*)	*Gabbard peak*	0
% National importance	0.25%	*% National importance*	0.00%

4.12.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.12.1-1). Estimates generated relate to the 730 km^2 surveyed by the boat. Those birds recorded in flight during surveys were not suitable for distance analysis, and as such raw counts of these birds are shown (Table 4.12.1-2). Counts of in flight birds were added to the estimates produced from distance sampling to provide an overall estimate of birds in the Greater Gabbard area. Negligible numbers of Herring Gull were seen in the summer months, but in both winters of survey the species was more abundant. Distance estimates were greater in the second winter of survey, possibly owing to increases in the transect area. The peak estimate of 957 (95% confidence limits on distance estimate: 252 – 3,532) Herring Gull in December 2004 translates as only 0.25% of the 1% national importance threshold of 3,800 birds (Burton *et al*. 2003).

Figures 4.12.1-1.1 and 4.12.1-2 show the averaged distribution of Herring Gulls in the two winters surveyed by boat. In both winters, the largest flocks were recorded in the south east part of the survey area, with average counts of up to 50. The Galloper may therefore represent a productive area for Herring Gulls. Secondary concentrations were seen to the east of the Inner Gabbard, and this area was predicted to support intermediate average counts of the species.

MONTH	DS	D	N	LCL	UCL
February	0.0363	0.0627	25	8	77
March (1)	0.0456	0.0811	39	11	136
March (2)	0.0279	0.2626	128	25	644
April	0	0	0	0	0
May	0	0	0	0	0
June	0	0	0	0	0
July	0	0	0	0	0
August	0	0	0	0	0
September	0	0	0	0	0
November	0.2220	0.5613	410	161	1,045
December	0.2375	1.2919	943	252	3,532
March 2005	0.3415	0.7547	551	195	1,558

Table 4.12.1-1 Herring Gull recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	164	25	189	0.05%
March (1)	133	39	172	0.05%
March (2)	48	128	176	0.05%
April	7	0	7	0.00%
May	2	0	2	0.00%
June	0	0	0	0.00%
July	0	0	0	0.00%
August	0	0	0	0.00%
September	0	0	0	0.00%
November	16	410	426	0.11%
December	14	943	957	0.25%
March 2005	15	551	566	0.15%

Table 4.12.1-2 'In flight' counts, distance estimates and total estimates for Herring Gull, with % national importance. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.12.2 Aerial surveys

Distance estimates of wintering Herring Gulls were possible (Table 4.12.2-1). Distance estimates for the Greater Gabbard area (TH3) peaked at 335 (95% confidence limits: 71 – 1571), which is lower than that for boat surveys in the same winter. An estimate of 3,251 in survey area TH4 was notable.

Infrequent counts in the Greater Gabbard area meant that only two areas were judged to hold the majority of Herring Gulls; these can be seen on the distribution map (Figure 4.12.2-1).

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National importance
TH1	WINTER 1	0.1851	0.2302	290	179	469	
	WINTER 2	0.3965	0.7160	902	518	1,572	
	WINTER 3	0.1388	0.1742	219	112	429	
	WINTER 4	0.1388	0.2293	289	121	690	
TH2	WINTER 1	0.0330	0.0330	41	18	93	
	WINTER 2	0.1453	0.2742	338	161	710	
	WINTER 3	0.2047	0.5069	624	217	1,792	
	WINTER 4	0.0396	0.0396	49	18	130	
TH3	WINTER 1	0.0753	0.3157	335	71	1,571	0.09%
	WINTER 2	0.0452	0.0639	68	18	259	0.02%
	WINTER 3	0.1506	0.1984	210	110	403	0.06%
	WINTER 4	0	0	0	0	0	0.00%
TH4	WINTER 1	0.1253	0.1681	189	121	296	
	WINTER 2	0.1106	0.2911	328	172	625	
	WINTER 3	0.2137	2.8874	3,251	984	10,738	
	WINTER 4	0	0	0	0	0	
TH5	WINTER 2	0.1359	0.1493	161	99	260	
	WINTER 3	0.0755	0.0755	81	37	178	
	WINTER 4	0.0453	0.0578	62	15	258	

Table 4.12.2-1 Herring Gull recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; raw count = total number of birds recorded; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.12.3 The importance of the Greater Gabbard for Herring Gulls through the year

4.12.3.1 Winter and summer

Unlike the closely related Lesser Black-backed Gull, Herring Gulls were largely absent from the Greater Gabbard area during the breeding season, with only seven birds recorded in April and a further two in May. Herring Gulls generally breed on or near to the coast, increasingly in urban areas where foraging opportunities are plentiful. Clearly the Greater Gabbard area is of little significance for Herring Gulls during the breeding season; most birds are likely to forage closer to their breeding grounds.

Distance estimates from aerial and boat surveys were often in the order of hundreds during winter, reaching just under 1,000 from the boat survey in December 2004. Although this is a substantial number of birds, and is likely to include breeding birds from continental Europe as well as Britain, the estimate is only representative of 0.25% of the 1% national importance threshold, and the species is widely distributed through the North Sea (Skov *et al.* 1995). However, in relation to the other survey blocks studied in the Thames on aerial surveys, this species does qualify as being of regional importance in the study area, but not when considering the wind farm footprint alone.

4.12.3.2 Migration

Breeding Herring Gulls may remain close to their colonies for most of the year, though the British population of the species as a whole exhibits a general southerly movement during winter. September to February sees the population of Herring Gulls maximise (Calladine 2002), with birds wintering in Britain that breed in continental Europe and Scandinavia. As Herring Gulls tend to migrate within 25 km of coasts (Calladine 2002), it is likely that some movements through the Greater Gabbard area would occur in autumn and spring.

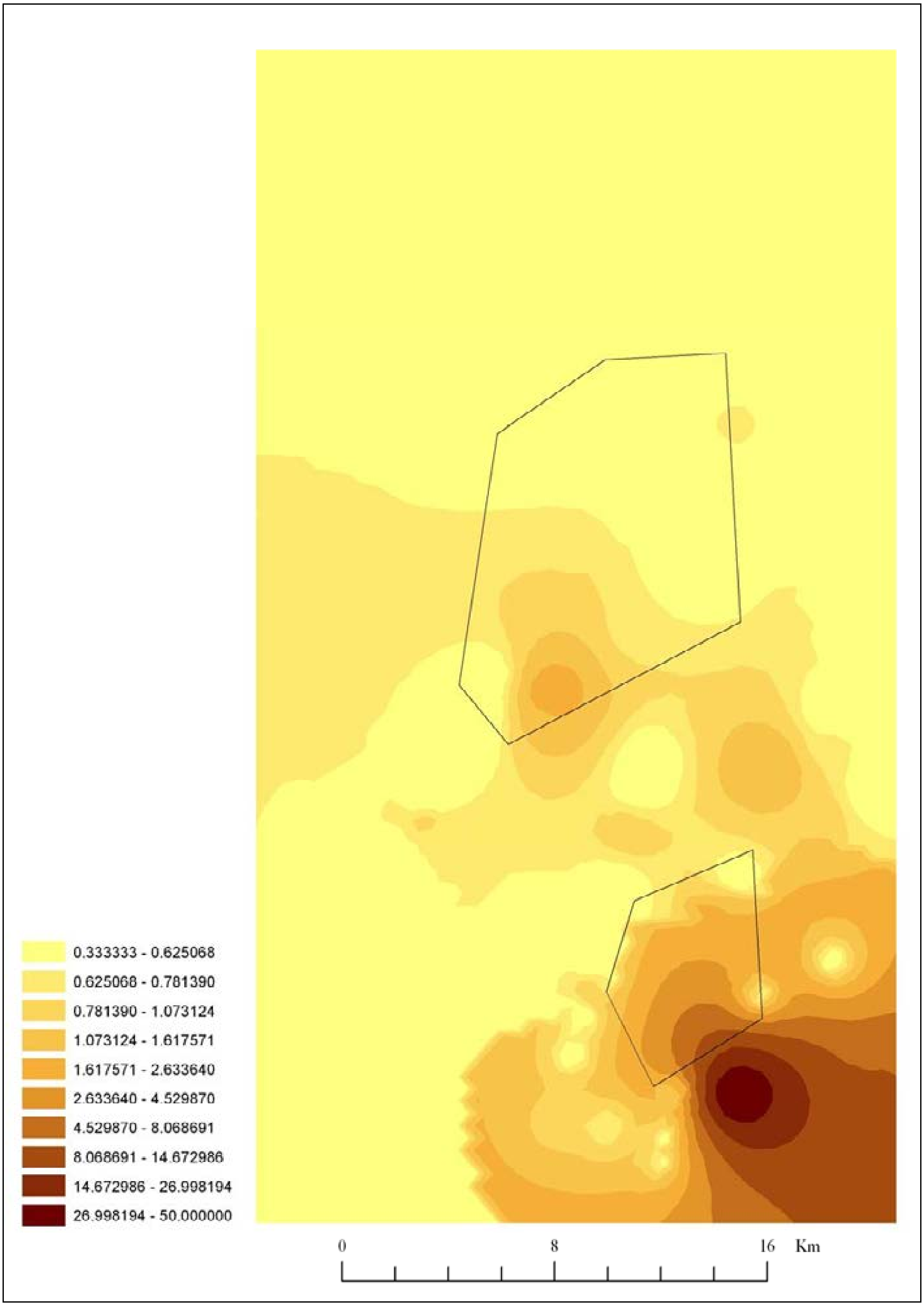

Figure 4.12.1-1 Smoothed average distribution of Herring Gull, first winter boat surveys. Polygons show boundaries of proposed wind farm.

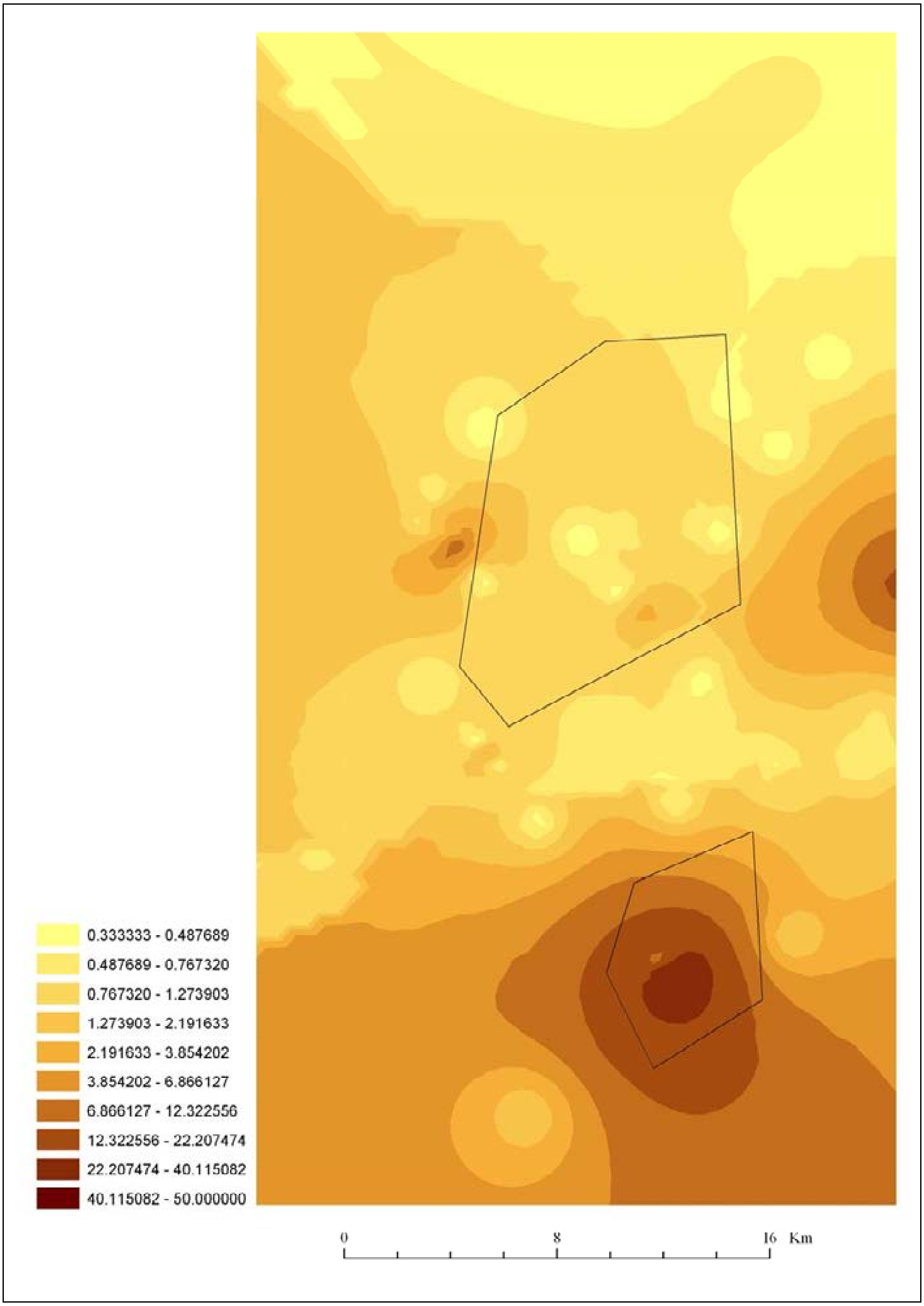

Figure 4.12.1-2 Smoothed average distribution of Herring Gull, second winter boat surveys. Polygons show boundaries of proposed wind farm.

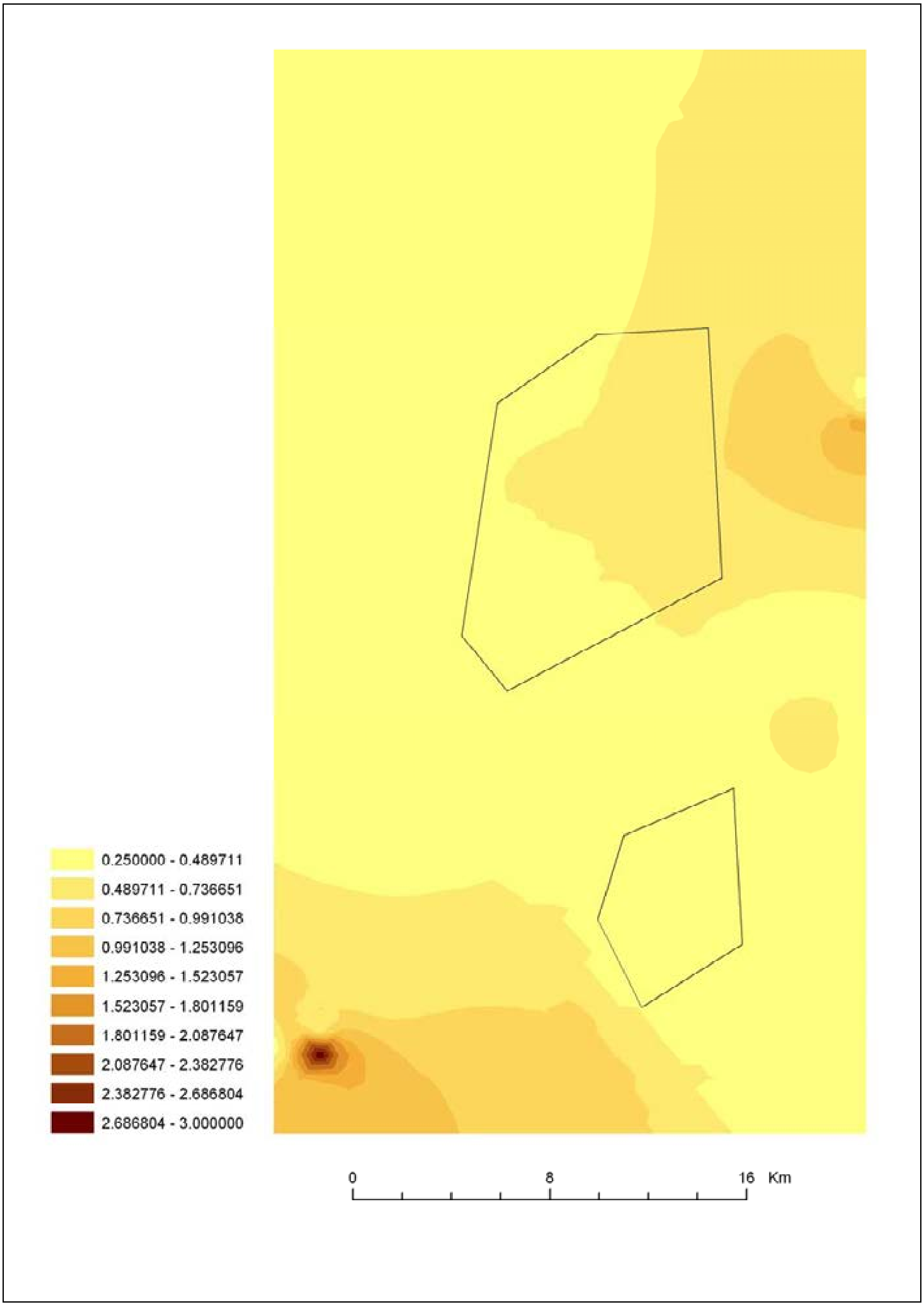

Figure 4.12.2-1 Smoothed average distribution of Herring Gull, aerial surveys. Polygons show boundaries of proposed wind farm.

4.13 Great Black-backed Gull *Larus marinus*			
Conservation status:	Not designated		
Winter (individuals)		**Summer (pairs)**	
International threshold	4,800	European population	110-180,000
GB threshold	430	*GB population*	18,000
Wind farm peak estimate	81	Wind farm peak estimate	7
Gabbard peak	405 (*boat*)	*Gabbard peak*	34 birds (*boat*)
% National importance	0.94%	*% National importance*	0.09%

4.13.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.13.1-1). Estimates generated relate to the 730 km^2 surveyed by the boat. Those birds recorded in flight during surveys were not suitable for distance analysis, and as such raw counts of these birds are shown (Table 4.13.1-2). Counts of in flight birds were added to the estimates produced from distance sampling, or the scaled raw counts for the first winter (using the correction factor of 1.4 after Stone *et al*. 1995) to provide an overall estimate of birds in the Greater Gabbard area. Few birds were recorded during the summer months April to September, and as such distance estimates are low (Table 4.13.1-2). The pattern in winter is inconsistent; no birds were recorded during the first winter of survey, but in December 2004 estimates of 405 Great Black-backed Gulls were almost large enough to exceed the 1% national importance threshold of 430 (Burton *et al*. 2003). Note that confidence limits ranging from 89 – 1,823 were calculated for the estimate of 402 birds on the sea.

Figure 4.13.1-1 highlights the lack of this species recorded in the first winter. During the summer, the few birds present were concentrated in two main areas (Figure 4.13.1-2), neither within the proposed wind farm area. Figure 4.13.1-3 suggests that during the second winter, the largest flocks were seen in the area of The Galloper, with very few birds in the north part of the Greater Gabbard area.

MONTH	DS	D	N	LCL	UCL
February	N/A	N/A	N/A	N/A	N/A
March (1)	0	0	0	0	0
March (2)	N/A	N/A	N/A	N/A	N/A
April	0.0253	0.0253	18	3	126
May	0	0	0	0	0
June	0	0	0	0	0
July	0.0084	0.0084	6	1	42
August	0	0	0	0	0
September	0.0253	0.0253	18	3	126
November	0.0926	0.1094	80	42	153
December	0.0826	0.5510	402	89	1,823
March 2005	0.0926	0.1010	74	33	164

Table 4.13.1-1 Great Black-backed Gull recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Where results not available (N/A), insufficient numbers of birds were recorded for analysis; 0 indicates the bird was not present. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	23	(10)	33	0.08%
March (1)	7	0	7	0.02%
March (2)	3	(1)	4	0.00%
April	6	18	24	0.13%
May	0	0	0	0.00%
June	0	0	0	0.00%
July	1	6	7	0.04%
August	0	0	0	0.00%
September	2	18	20	0.11%
November	7	80	87	0.20%
December	3	402	405	0.94%
March 2005	5	74	79	0.18%

Table 4.13.1-2 'In flight' counts, distance estimates and total estimates for Great Black-backed Gull, with % national importance. Those figures in brackets are not distance estimates but raw counts multiplied by a correction factor (Stone *et al*. 1995). Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.13.2 Aerial surveys

Distance estimates of wintering Great Black-backed Gulls were possible (Table 4.13.2-1). Distance estimates for the Greater Gabbard area (TH3) peaked at just 53 (95% confidence limits: 32 – 88), which is far lower than that for boat surveys in the same winter. Of the five aerial survey blocks studied, TH2 contained the greatest estimated abundance of Great Black-backed Gulls, the peak estimate of 636 (with 95% confidence limits of 463 – 873) in excess of the threshold of 400 necessary to qualify a site as nationally important.

Figure 4.13.2-1 presents average count distributions for the survey area TH3. Only two areas were shown to have concentrations of Great Black-backed Gulls, and these are of very low abundance.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National importance
TH1	WINTER 1	0.1144	0.1396	176	110	281	
	WINTER 2	0.0868	0.1045	132	87	200	
	WINTER 3	0.0710	0.0827	104	50	219	
	WINTER 4	0.0237	0.0271	34	13	92	
TH2	WINTER 1	0.3745	0.5163	636	463	873	
	WINTER 2	0.0670	0.0924	114	65	199	
	WINTER 3	0.1104	0.2493	307	158	598	
	WINTER 4	0.0079	0.0079	10	3	37	
TH3	WINTER 1	0.0180	0.0180	19	4	85	0.04%
	WINTER 2	0.0315	0.0315	33	13	86	0.08%
	WINTER 3	0.0495	0.0498	53	32	88	0.12%
	WINTER 4	0.0045	0.0045	5	1	29	0.01%
TH4	WINTER 1	0.0616	0.0953	107	43	267	
	WINTER 2	0.0616	0.0734	83	37	183	
	WINTER 3	0.0308	0.0308	35	10	119	
	WINTER 4	0	0	0	0	0	
TH5	WINTER 2	0.0316	0.0451	49	21	114	
	WINTER 3	0.0090	0.0090	10	3	36	
	WINTER 4	0	0	0	0	0	

Table 4.13.2-1 Great Black-backed Gull recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; raw count = total number of birds recorded; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.13.3 The importance of the Greater Gabbard for Great Black-backed Gulls through the year

4.13.3.1 Winter and summer

The Greater Gabbard area is of no importance to Great Black-backed Gulls during the breeding season, as reflected by the negligible distance estimates generated from boat survey data. Wintering numbers of Great Black-backed Gulls are generally acknowledged to be very high in the North Sea as a whole (Reid 2002), where birds may scavenge discarded waste from fishing trawlers. Stone *et al.* (1995) report that greatest numbers of offshore Great Black-backed Gulls are present between November and February, which is consistent with results from the second winter of boat surveys. As many as 300,000 gulls of this species may be found in the North Sea during winter (Skov *et al*. 1995), and it is perhaps therefore questionable whether the threshold for national importance should be applied to the peak estimate of 405 calculated from these surveys. The Greater Gabbard area supports but a fraction of the hundreds of thousands of widely dispersed Great Black-backed Gulls found offshore during winter, and it is debatable to what extent the area itself is important to the species, particularly as the absence of birds in the first winter of survey suggests that the population may shift between sites between years. Regardless, aerial surveys suggested that the Greater Gabbard study area is of regional importance for Great Black-backed Gull, though the peak estimate of 53 nearly fell under the minimum level for inclusion of 50 birds. The proportional estimate for the wind farm footprint itself numbered only seven, and the area is thus not of regional importance.

4.13.3.2 Migration

Most Great Black-backed Gulls show only limited post-breeding dispersal, generally no further than 60 km from breeding sites (Reid 2002). The presence of large numbers of these gulls in the North Sea during winter is accounted for by mass movements of breeders from Norway and Russia (Reid 2002). These birds move throughout July, reaching a peak in September which is sustained throughout the winter. Return migrations occur from February onwards. Therefore during spring and autumn there are likely to be large scale movements of Great Black-backed Gulls between Britain, her offshore waters, and the mainland continent. The Greater Gabbard area is likely to be passed by migrants, although its importance during migration will be governed by food supplies, and perhaps more importantly, fishing activity.

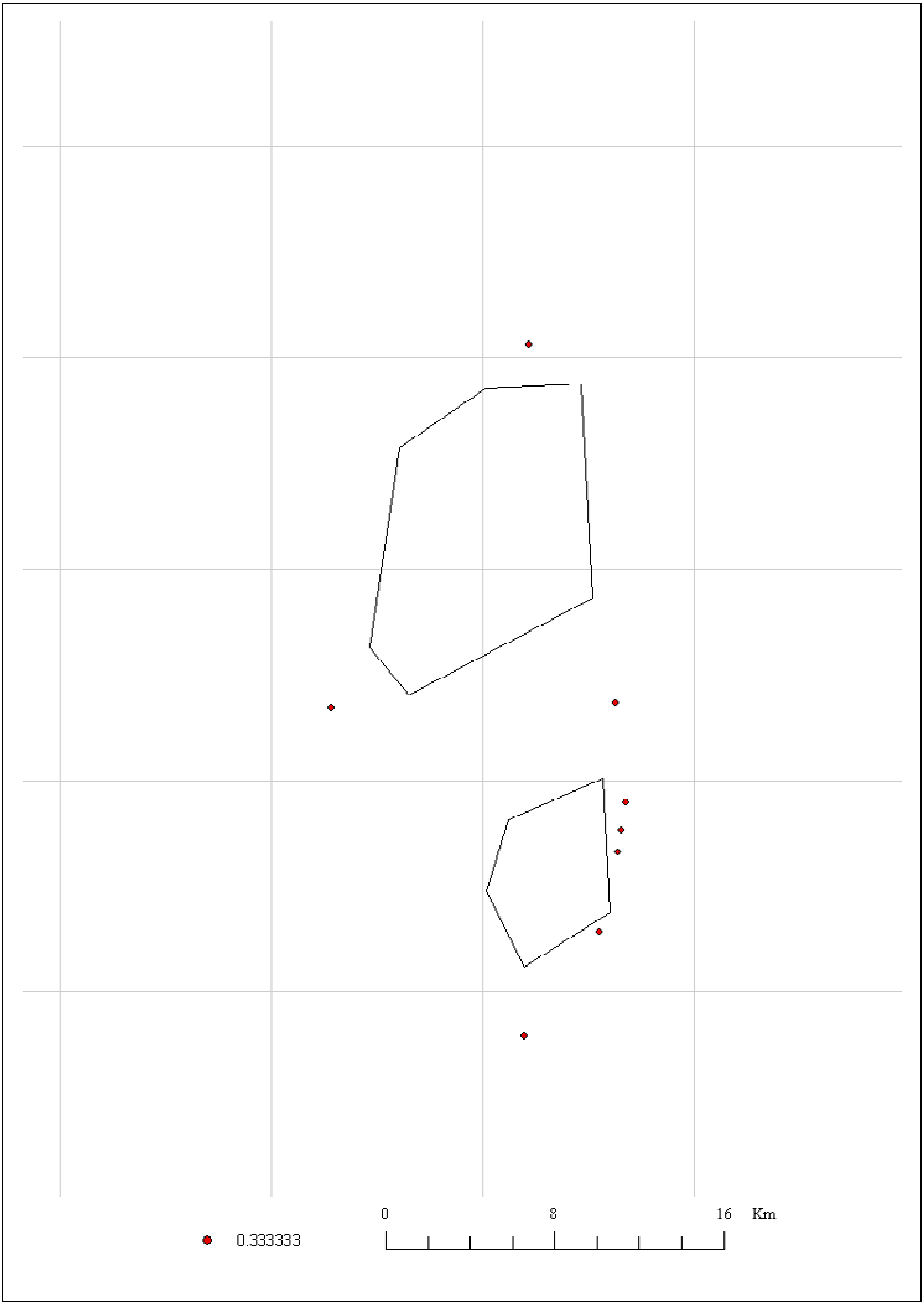

Figure 4.13.1-1 Average distribution of Great Black-backed Gull, first winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

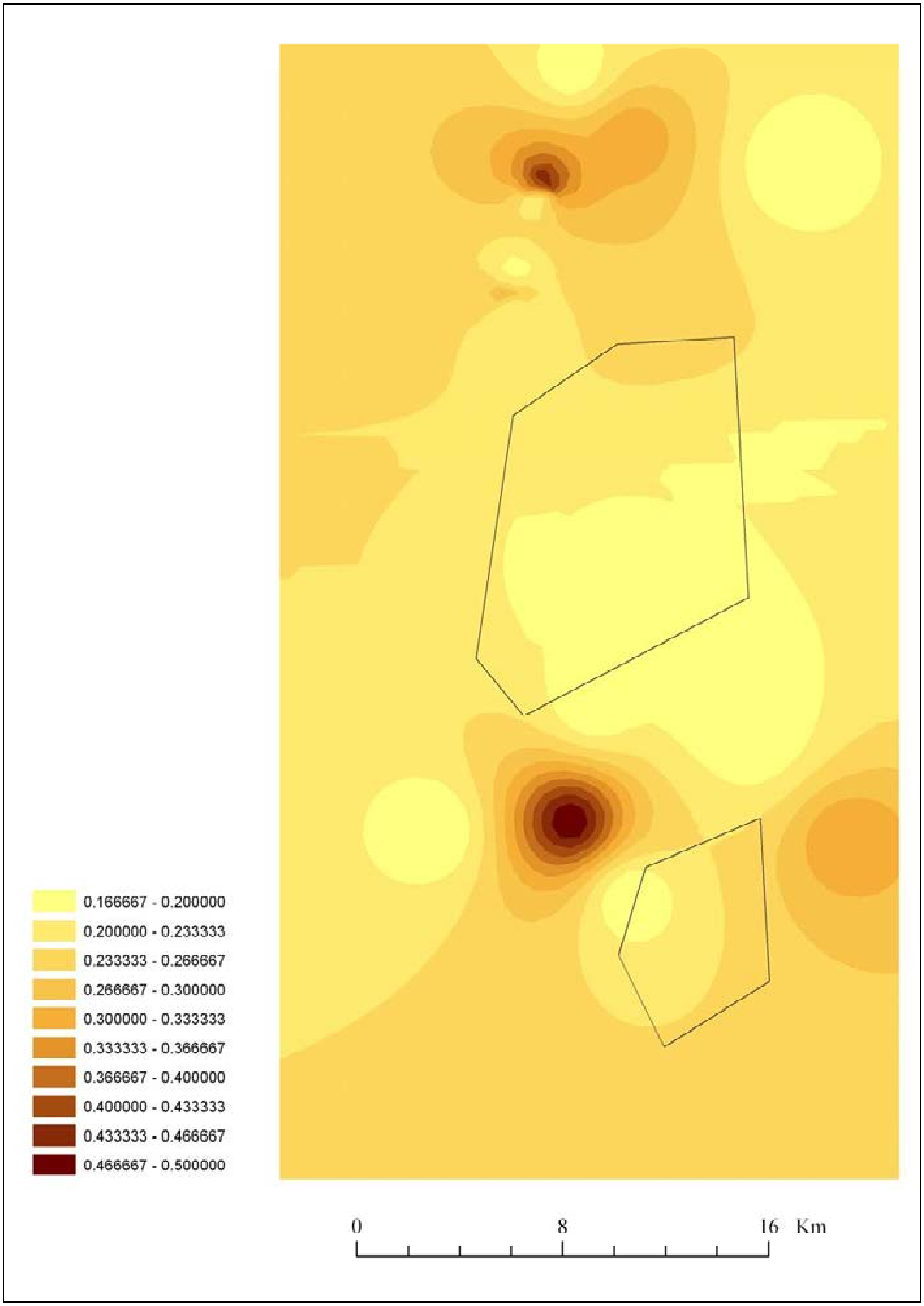

Figure 4.13.1-2 Smoothed average distribution of Great Black-backed Gull, summer boat surveys. Polygons show boundaries of proposed wind farm.

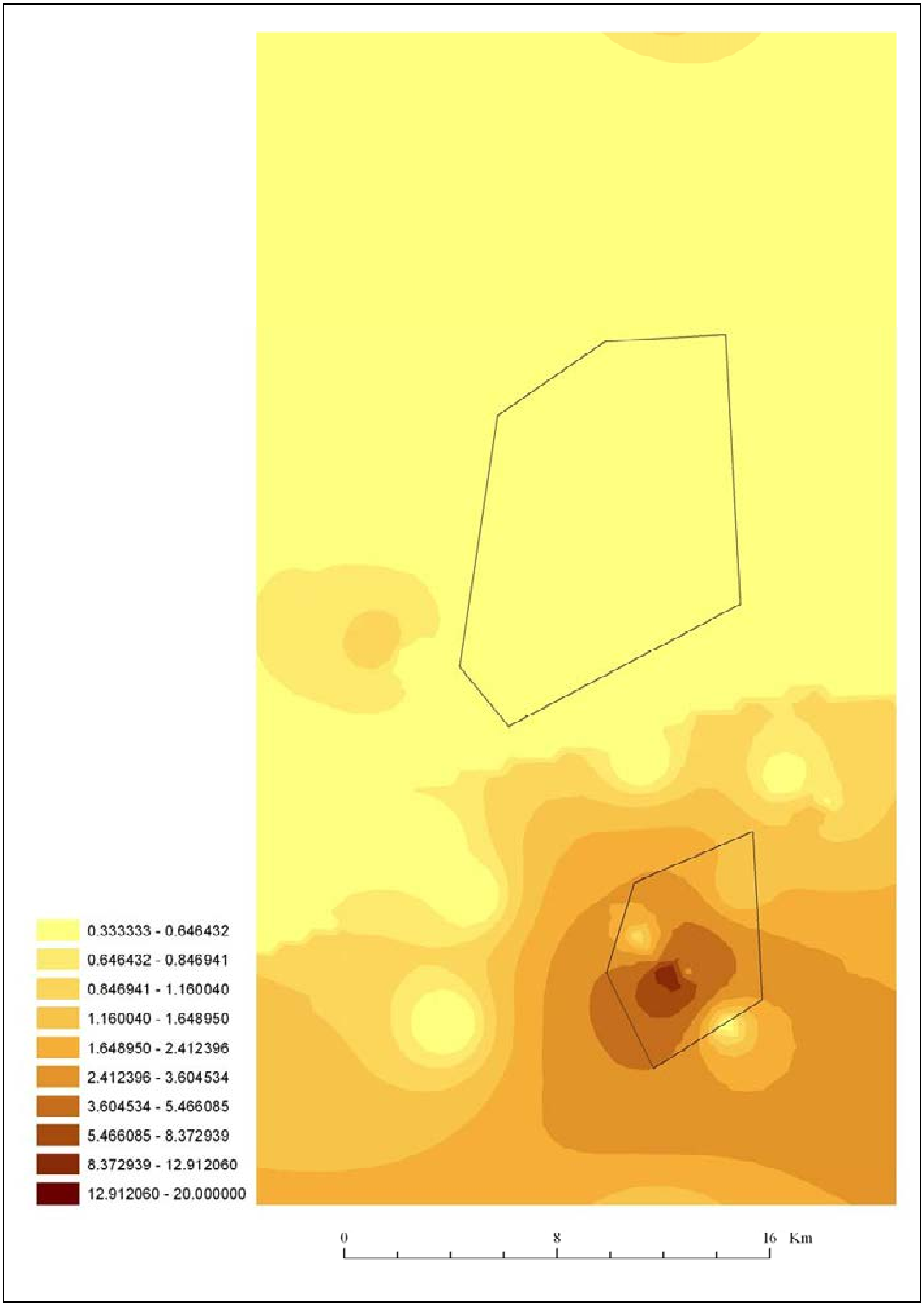

Figure 4.13.1-3 Smoothed average distribution of Great Black-backed Gull, second winter boat surveys. Polygons show boundaries of proposed wind farm.

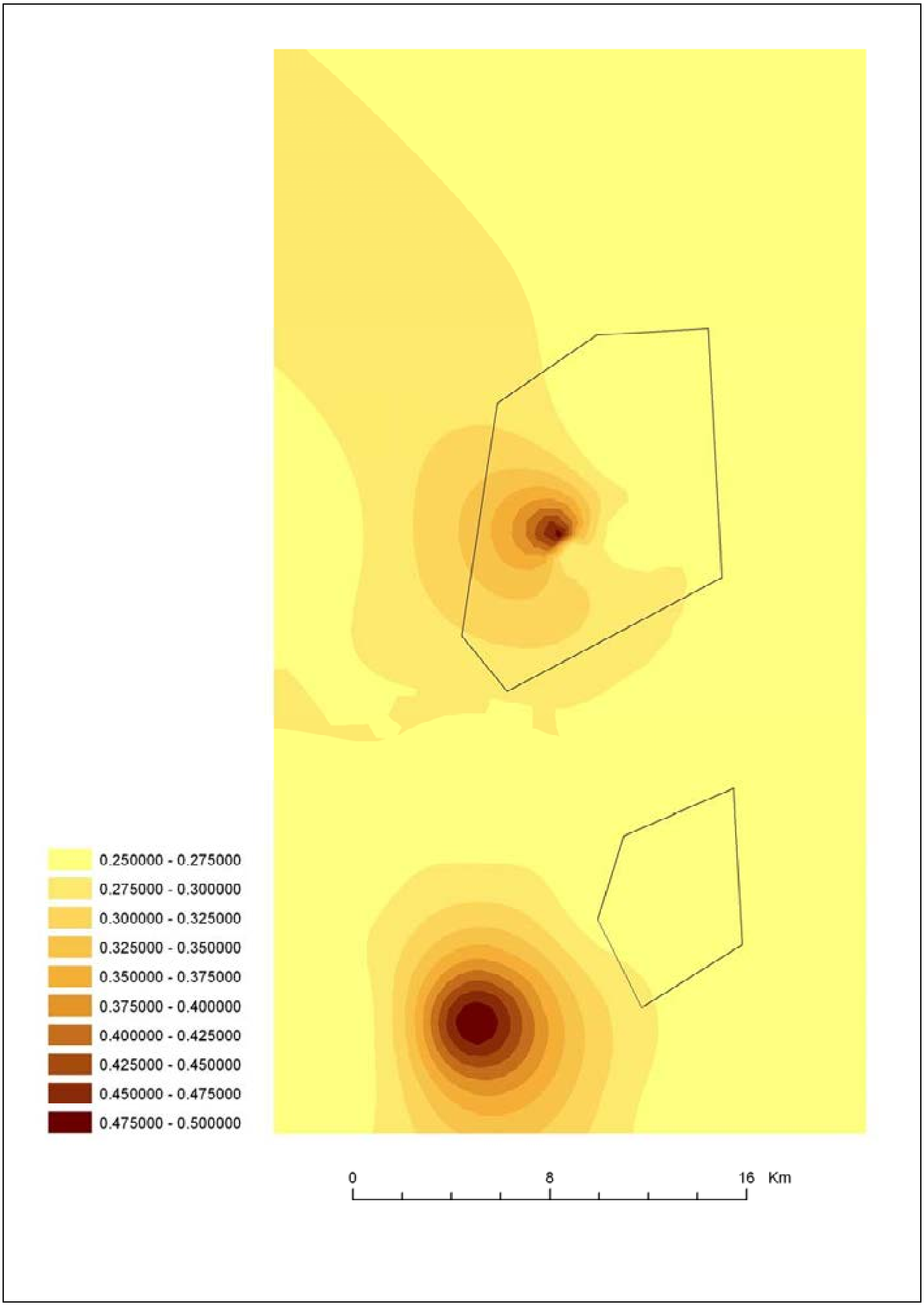

Figure 4.13.2-1 Smoothed average distribution of Great Black-backed Gull, aerial surveys. Polygons show boundaries of proposed wind farm.

4.14 Black-legged Kittiwake	*Rissa tridactyla*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	European population	2.1-3 million
GB threshold	?	*GB population*	380,000
Wind farm peak estimate	171	Wind farm peak estimate	39
Gabbard peak	1,218 (*aerial*)	*Gabbard peak*	205 birds (*boat*)
% National importance	0.16%	*% National importance*	0.03%

4.14.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.14.1-1). Estimates generated relate to the 730 km^2 surveyed by the boat. Those birds recorded in flight during surveys were not suitable for distance analysis, and as such raw counts of these birds are shown (Table 4.14.1-2). Counts of in flight birds were added to the estimates produced from distance sampling to provide an overall estimate of birds in the Greater Gabbard area. This species cannot be quantified in the context of national importance during the non-breeding season, as its distribution is almost exclusively oceanic, and no valid population estimates exist. The peak estimate recorded was in December 2004, and totalled 793 birds (95% confidence limits on distance estimate: 412 – 1,421). Few birds were recorded during the summer, when birds would have been breeding, and as such estimates are low.

Distributions of Black-legged Kittiwakes, averaged over the winter or summer, are shown in Figures 4.14.1-1 – 4.14.1-3. In all cases, the largest averages are low, but there appears some tendency for these 'hotspots' to occur in the south east corner of the survey area, sometimes overlapping or nearing the area of The Galloper.

MONTH	DS	D	N	LCL	UCL
February	0.0902	0.1105	45	18	111
March (1)	0.0124	0.0122	6	2	23
March (2)	0.0124	0.0980	48	6	369
April	0.1702	0.2697	197	65	599
May	0.0262	0.0262	19	5	77
June	0	0	0	0	0
July	0.0393	0.0393	29	7	125
August	0.0524	0.0524	38	16	93
September	0.0786	0.0786	57	22	150
November	0.1702	0.1702	124	65	239
December	0.3964	1.0487	766	412	1,421
March 2005	0.3273	0.4399	321	152	679

Table 4.14.1-1 Black-legged Kittiwake recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	110	45	155	0.02%
March (1)	31	6	37	0.00%
March (2)	26	48	74	0.01%
April	8	197	205	0.03%
May	9	19	28	0.00%
June	3	0	3	0.00%
July	14	29	43	0.01%
August	4	38	42	0.01%
September	4	57	61	0.01%
November	29	124	153	0.02%
December	27	766	793	0.10%
March 2005	7	321	328	0.04%

Table 4.14.1-2 In flight' counts, distance estimates and total estimates for Black-legged Kittiwake. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.14.2 Aerial surveys

Distance sampling was undertaken, as Black-legged Kittiwake was frequently recorded on aerial surveys. 95% confidence limits around distance estimates tended to be rather wide, and caution should perhaps be taken in interpreting these estimates. The Greater Gabbard area (TH3) contained the highest abundance estimate for the five survey areas covered at 1,218 birds (95% confidence limits: 3 – 470,700) in winter period 3.

Figure 4.14.2-1 shows that the Inner Gabbard wind farm area supported very low average abundances of Black-legged Kittiwake, though The Galloper did show one distribution ‘hotspot’, albeit still at very low density.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National importance
TH1	WINTER 1	0.0755	0.0899	113	0	43,747	
	WINTER 2	0.0425	0.0559	70	0	27,209	
	WINTER 3	0.1274	0.1347	170	0	65,575	
	WINTER 4	0.0236	0.0236	30	0	11,485	
TH2	WINTER 1	0.2121	0.3243	399	1	154,000	
	WINTER 2	0.3960	0.4668	575	1	222,000	
	WINTER 3	0.6317	0.6790	836	2	323,000	
	WINTER 4	0.0896	0.2499	308	1	119,000	
TH3	WINTER 1	0.0968	0.1115	118	0	45,649	0.02%
	WINTER 2	0.3710	0.4672	495	1	191,000	0.07%
	WINTER 3	0.9032	1.1492	1218	3	470,700	0.16%
	WINTER 4	0.0161	0.0161	17	0	6,606	0.00%
TH4	WINTER 1	0.0421	0.0494	56	0	21,475	
	WINTER 2	0.6998	1.0353	1166	3	450,000	
	WINTER 3	0.2789	0.2913	328	1	127,000	
	WINTER 4	0.0316	0.0368	41	0	16,025	
TH5	WINTER 2	0.1348	0.1620	174	0	67,333	
	WINTER 3	0.0593	0.1168	126	0	48,543	
	WINTER 4	0.0216	0.0216	23	0	8,965	

Table 4.14.2-1 Black-legged Kittiwake recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; raw count = total number of birds recorded; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.14.3 The importance of the Greater Gabbard for Black-legged Kittiwakes through the year

4.14.3.1 Winter and summer

Black-legged Kittiwakes favour coastal cliffs for breeding, and as such are scarce breeders in south eastern England. However, small populations do exist, such as that on the coastal towers at Sizewell Power Station (237 nests in 2003; Wright 2004) and the 96 nests known at Lowestoft Harbour (Wright 2004). This may partially explain the sparse estimates calculated for May to September; alternatively these may have been non-breeding Black-legged Kittiwakes. The estimate of 205 in April 2004 may have reflected late movements to the breeding grounds of birds wintering in the remoter marine environment; regardless, numbers are not considered great enough to infer that the Greater Gabbard area is especially important for Black-legged Kittiwakes in the summer.

Winter surveys suggest that this area of the North Sea supports a comparatively high abundance of Black-legged Kittiwake, with peaks of 793 (95% confidence limits: 412 – 1,421) estimated from boat surveys, and 1,218 (3 – 470,700) from aerial surveys. Black-legged Kittiwakes spend most of the winter at sea, and movements are governed largely by weather patterns (Coulson 2002). Little is known about winter Black-legged Kittiwake distributions, other than that the species is somewhat nomadic, and that winter aggregations of the species in the Atlantic and North Sea are likely to contain breeding birds of mixed origin (Coulson 2002). In comparison to the other areas surveyed from the air, mean winter estimates for the Greater Gabbard area (TH3) were higher than everywhere but area TH2, perhaps reflecting its offshore location. Peak winter estimates for the Greater Gabbard study area reached 45% of the regional total, easily making the area regionally important for the species.

Furthermore, considering the wind farm footprint area alone, proportional estimates still represented 6% of the regional total estimated. Black-legged Kittiwake clearly do occur in the Greater Gabbard in winter, but to what extent this area is crucial on a national basis is unclear.

4.14.3.2 Migration

Those Black-legged Kittiwakes wintering in the North Sea are likely to have originated from breeding sites across many parts of western Europe (Coulson 2002), and thus it is difficult to assess how important the Greater Gabbard area may be post-breeding or before return migration. As the Black-legged Kittiwake is a nomadic species spending its time at sea during winter, mass movements during passage are perhaps not as relevant as those that might occur at any time throughout the winter.

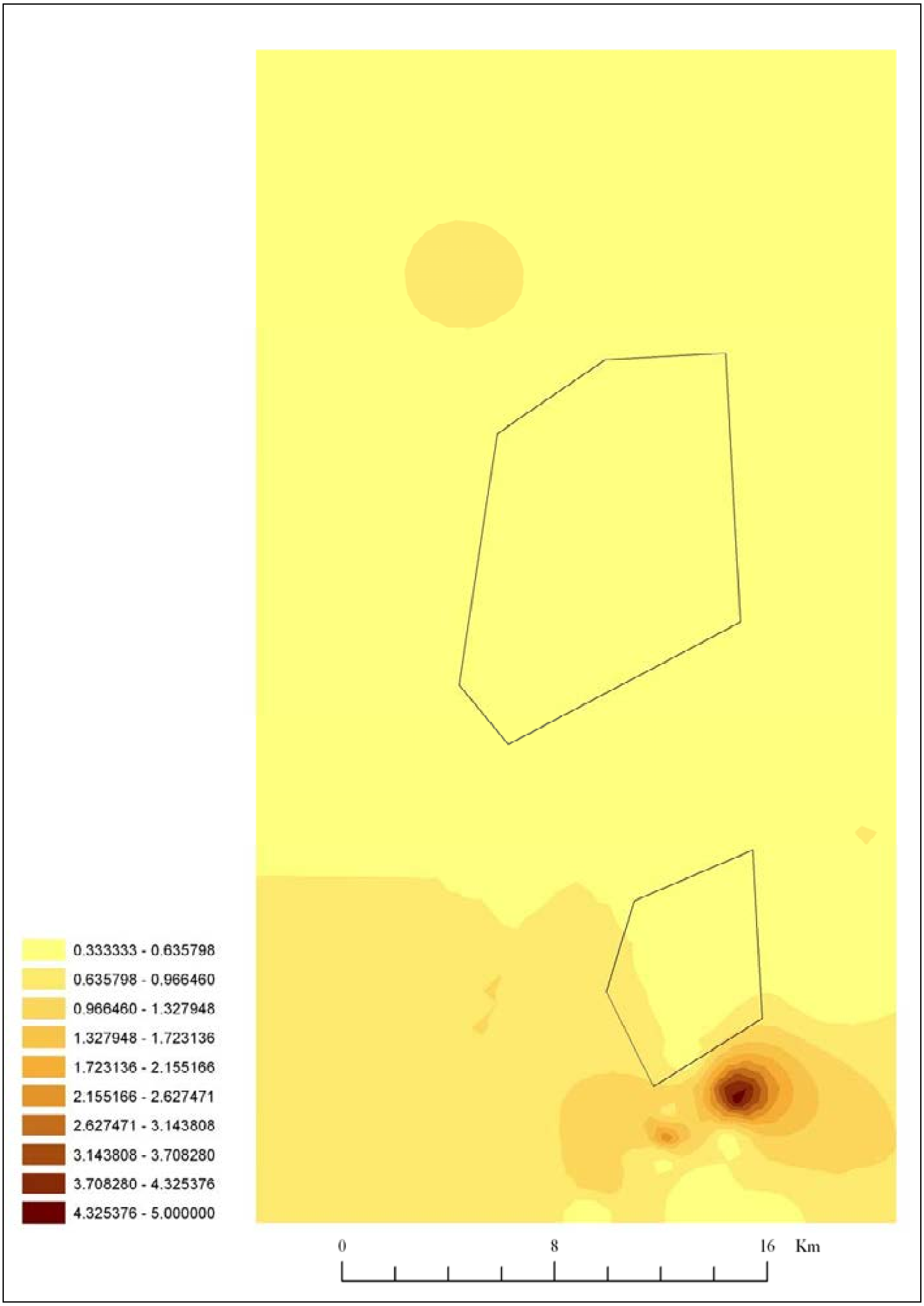

Figure 4.14.1.1 Smoothed average distribution of Black-legged Kittiwake, first winter boat surveys. Polygons show boundaries of proposed wind farm.

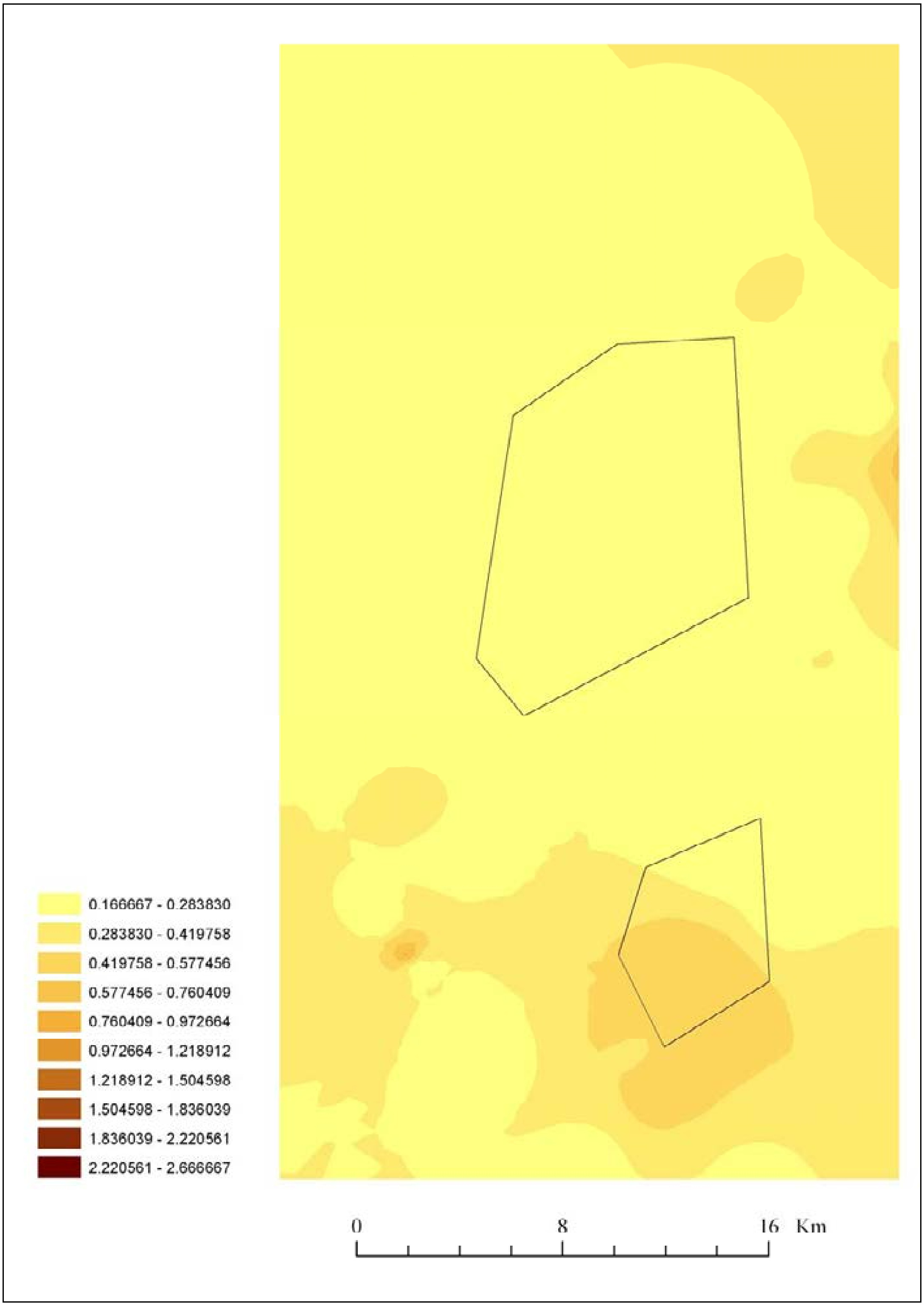

Figure 4.14.1-2 Smoothed average distribution of Black-legged Kittiwake, summer boat surveys. Polygons show boundaries of proposed wind farm.

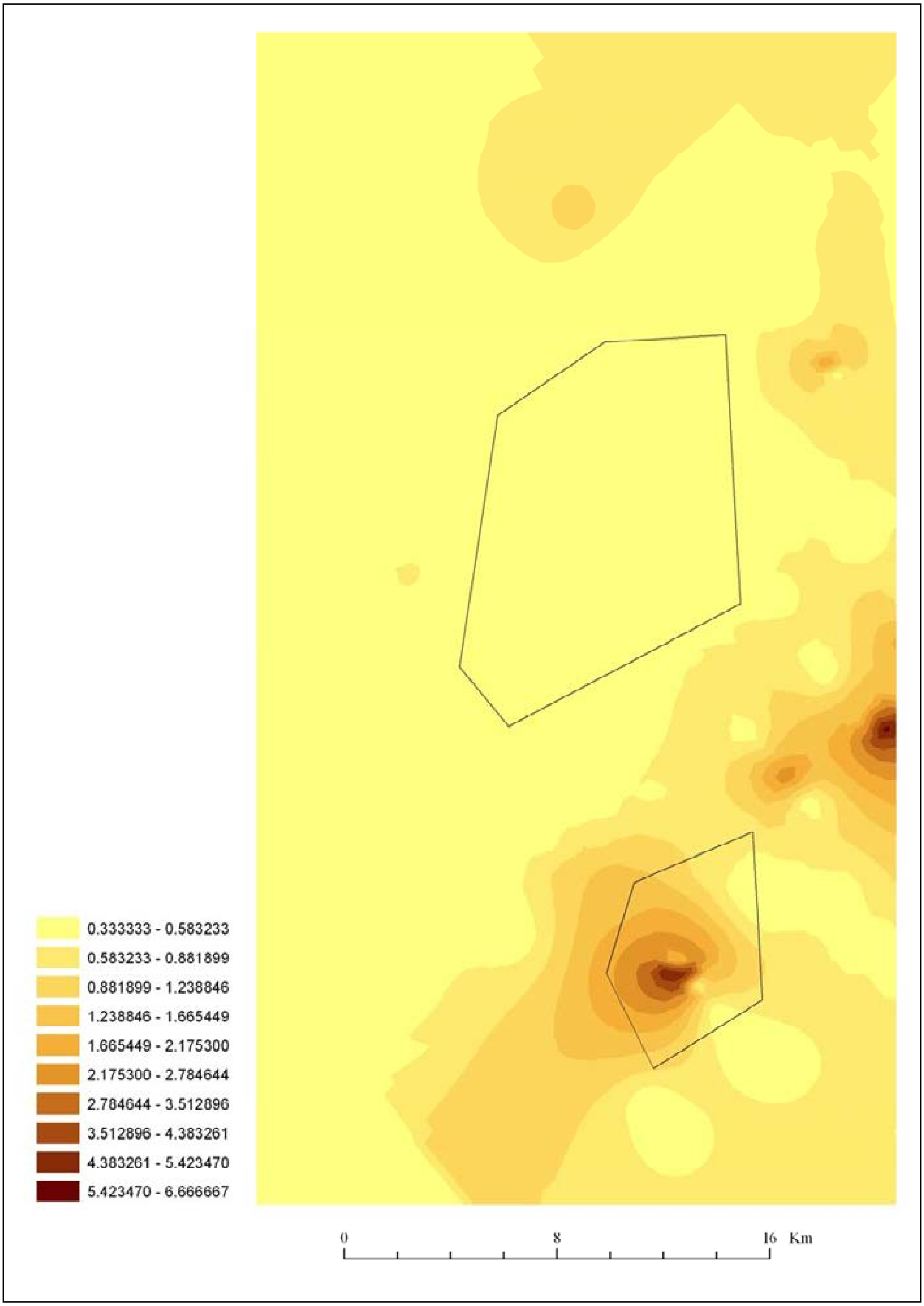

Figure 4.14.1-3 Smoothed average distribution of Black-legged Kittiwake, second winter boat surveys. Polygons show boundaries of proposed wind farm.

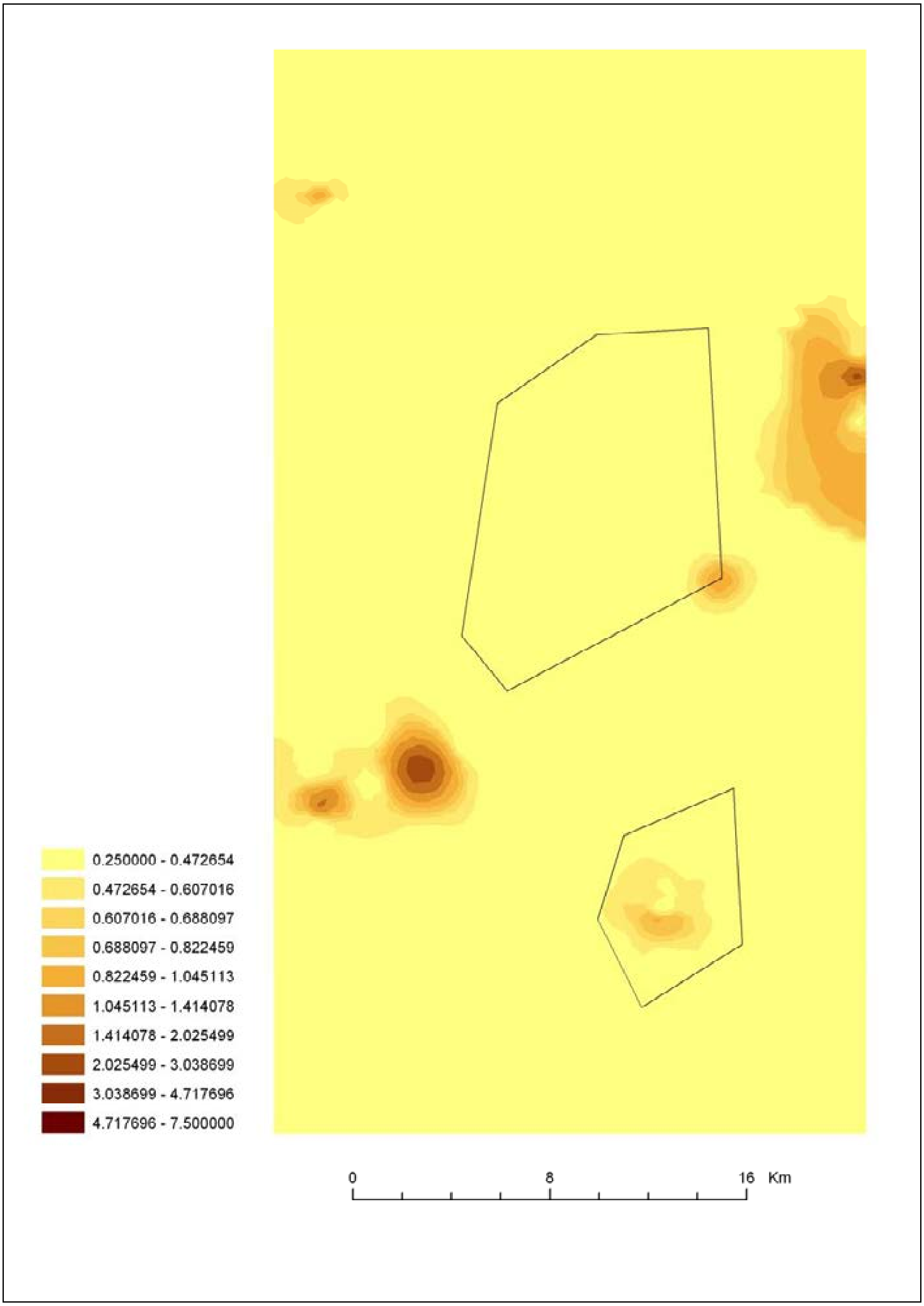

Figure 4.14.2.1 Smoothed average distribution of Black-legged Kittiwake, aerial surveys. Polygons show boundaries of proposed wind farm.

4.15 Sandwich Tern	*Sterna sandvicensis*		
Conservation status:	Annex 1, BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	n/a	European population	82-130,000
GB threshold	n/a	*GB population*	12,500
Wind farm peak estimate	2	Wind farm peak estimate	4
Gabbard peak	9 (*boat*)	*Gabbard peak*	19 birds (*boat*)
% National importance	0.04%	*% National importance*	0.08%

4.15.1 Boat surveys

Sandwich Terns were seen very infrequently on boat surveys, and thus there were insufficient data to run distance analyses. Table 4.15.1-1 shows those Black-headed Gulls recorded either on the sea or during aerial snapshots, and thus considered to be 'in transect'. Extremely few birds of this species were recorded in either breeding or non-breeding seasons, the peak estimate being 19 birds in April 2004. A correction factor of 1.7 (after Stone *et al*. 1995) was applied to the on sea count.

Month	On sea	In flight	Total	% National importance
February 2004	0	0	**0**	0.00%
March 2004 (1)	0	0	**0**	0.00%
March 2004 (2)	0	0	**0**	0.00%
April 2004	12	7	**19**	0.08%
May 2004	0	0	**0**	0.00%
June 2004	0	0	**0**	0.00%
July 2004	0	3	**3**	0.01%
August 2004	0	0	**0**	0.00%
September 2004	0	0	**0**	0.00%
November 2004	0	0	**0**	0.00%
December 2004	0	0	**0**	0.00%
March 2005	3	6	**9**	0.04%

Table 4.15.1-1 Sandwich Terns recorded 'in transect' on boat surveys. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.15.2 Aerial surveys

This species was not surveyed by winter aerial surveys, as it is not generally found in Britain during the non-breeding season.

4.15.3 The importance of the Greater Gabbard for Sandwich Terns through the year

4.15.3.1 Winter and summer

Sandwich Terns breed on the Norfolk and Suffolk coasts, and therefore are relevant to the proposed Greater Gabbard wind farm. However, very few birds of this species were ever recorded on boat surveys, implying that the area is not important as a foraging site for breeding birds. The peak estimate of 19 in April 2004 may have included birds returning from southerly migration sites, and the Greater Gabbard area holds no apparent importance for this species in the summer.

Sandwich Terns commonly migrate to southern Europe and Africa, some even wintering as far south as the South African Cape. Therefore the Greater Gabbard area is of no relevance to this species in winter.

4.15.3.2 Migration

Late June sees post-fledging dispersal of Sandwich Terns, with increasing redistribution during July and August, these birds moving between the coasts of Britain, the Netherlands and Denmark (Noble-Rollin & Redfern 2002). Thus, these birds may begin their migration to southern Europe and Africa by crossing the North Sea, and thus the Greater Gabbard area may be encountered. Breeding adults return to sites close to their natal colonies during March, and at this time movements are generally northward; the Greater Gabbard area is therefore perhaps of concern only for dispersing Sandwich Terns in the post-breeding season.

4.16 Little Tern	*Sterna albifrons*		
Conservation status:	Annex 1, WCA, BCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	n/a	European population	35,000-55,000
GB threshold	n/a	*GB population*	1,900
Wind farm peak estimate	0	Wind farm peak estimate	0
Gabbard peak	0	*Gabbard peak*	1 bird (*boat*)
% National importance	0.00%	*% National importance*	0.03%

4.16.1 Boat surveys

One individual was recorded during the survey in May 2004.

4.16.2 Aerial surveys

No individuals were recorded during any aerial surveys.

4.16.3 The importance of the Greater Gabbard for Little Terns through the year

4.16.3.1 Winter and summer

Only one Little Tern was recorded on any of the boat or aerial surveys. Therefore the Greater Gabbard area is not at all important for Little Terns, presumably out of foraging range for those birds breeding on the east coast of south England.

4.16.3.2 Migration

No birds were recorded in the Greater Gabbard area during migratory periods.

4.17 Common Guillemot	*Uria aalgae*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	European population	2-2.7 million
GB threshold	?	*GB population*	952,000
Wind farm peak estimate	321	Wind farm peak estimate	107
Gabbard peak	1,607* (*boat*)	*Gabbard peak*	533 birds (*boat*)
% National importance	0.08%	*% National importance*	0.03%

*2,851 estimated on aerial surveys for all auk species

4.17.1 Boat surveys

Common Guillemots were recorded frequently on all boat surveys. However, during the first three surveys, some auks were only identified to the family level, and as such total estimates of Common Guillemots for these surveys are based on distance estimates for identified birds, plus estimates for the likely proportion of unidentified auks thought to be Common Guillemots. This additional figure was calculated from the ratio of Common Guillemots to Razorbills amongst those auks that were identified positively. Table 4.17.1-1 shows distance estimates for identified Common Guillemots; Table 4.17.1-2 shows distance estimates for unidentified auks on surveys in February and March 2004; and Table 4.17.1-3 presents total estimates based on distance estimates, in flight counts and calculated proportions of unidentified auks likely to have been Common Guillemots.

Numbers of Common Guillemots were lowest in May and June, when most breeding adults would have been on land and nesting. Generally, estimates were in the hundreds for other months of the year, with a peak of 1,607 (95% confidence limits on distance estimate: 980 – 2,585) estimated in November. At this time of year, the North Sea is likely to contain dispersed breeders from colonies across northern Europe, plus some late moulting adults. The main moult occurs throughout late summer and early autumn, as reflected by the absence of birds in flight during August and September (Table 4.17.1-3). It was not possible to assess numbers of wintering Common Guillemots in context of national importance, as no estimates exist for the British wintering population, and much of the population occurs on open sea.

During the first winter of survey, Common Guillemots were frequently recorded throughout the survey area, and additional counts were made of ‘auks’ in general. Figure 4.17.1-1 shows that Common Guillemot distribution was reasonably even, with some peaks around The Galloper area of the wind farm. ‘Auks’ in general were concentrated in the same areas, with additional high average counts in the Inner Gabbard zone (Figure 4.17.1-2), though still only at a maximum average of five birds. Distribution was different during the summer, the only peaks occurring to the north of the wind farm area (Figure 4.17.1-3), whilst in the second winter Common Guillemots were again thinly and evenly distributed with occasional small peak concentrations (Figure 4.17.1-4).

MONTH	DS	D	N	LCL	UCL
February	0.0959	0.1311	53	0.0959	0.1311
March (1)	0.0745	0.1699	83	0.0745	0.1699
March (2)	0.1540	0.2301	112	0.1540	0.2301
April	0.3116	0.3901	285	120	676
May	0.0708	0.0708	52	20	135
June	0.0425	0.0425	31	10	92
July	0.3116	0.7303	533	151	1,877
August	0.2550	0.3067	224	105	478
September	0.0708	0.0708	52	25	106
November	1.8272	2.1800	1,591	980	2,585
December	0.7070	0.7661	559	315	994
March 2005	0.5241	0.9435	689	316	1,499

Table 4.17.1-1 Common Guillemot recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	DS	D	N	LCL	UCL
February	0.2305	0.4216	171	108	269
March (1)	0.0952	0.2260	110	56	218
March (2)	0.1950	0.3360	164	74	362

Table 4.17.1-2 Auks recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study area, the proposed wind farm area representing 30% of the total.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	15+5	53+55	128	0.01%
March (1)	87+124	83+101	395	0.02%
March (2)	3+24	112+131	270	0.01%
April	3	285	287	0.02%
May	1	52	53	0.00%
June	0	31	31	0.00%
July	0	533	533	0.03%
August	0	224	224	0.01%
September	0	52	52	0.00%
November	16	1,591	1,607	0.08%
December	14	559	573	0.03%
March 2005	5	689	694	0.04%

Table 4.17.1-3 ‘In flight’ counts, distance estimates and total estimates for Common Guillemot. Additional figures are estimates of unidentified auks likely to be Common Guillemots. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.17.2 Aerial surveys

On aerial surveys, Common Guillemots and Razorbills were not distinguished between, and these birds were recorded to the family level (*i.e.* auks). Therefore it is not possible to discern the relative proportions of the two species recorded. Table 4.17.2-1 shows distance estimates for all auks surveyed. The peak estimate for TH3 (Greater Gabbard area) occurred in the second winter period (2,851; 95% confidence limits 1,848 – 4,397). During the same winter period, much larger estimates were made for other survey areas (6,935 in TH2; 8,962 in TH4) but the southern North Sea clearly holds many auks throughout the whole winter.

Figure 4.17.2-1 suggests that the abundance of auks wintering in the Greater Gabbard area is evenly distributed and not confined to specific localities. Many contours of relatively high average counts exist throughout the entire survey area.

Survey block	Survey period	DS	D	N	LCL	UCL
TH1	WINTER 1	0.0176	0.0176	22	8	63
	WINTER 2	0.1720	0.2324	293	178	481
	WINTER 3	0.0794	0.1124	142	78	259
	WINTER 4	0	0	0	0	0
TH2	WINTER 1	2.6311	3.0552	3,761	2,921	4,843
	WINTER 2	2.8823	5.6335	6,935	5,040	9,542
	WINTER 3	0.7845	0.9143	1,125	810	1,563
	WINTER 4	0.1190	0.1370	169	65	441
TH3	WINTER 1	0.3719	0.5540	587	408	845
	WINTER 2	1.2113	2.6892	2,851	1,848	4,397
	WINTER 3	0.6534	0.8169	866	561	1,336
	WINTER 4	0.6433	1.3215	1,401	911	2,154
TH4	WINTER 1	0.2460	0.2578	290	137	616
	WINTER 2	2.3759	7.9594	8,962	6,405	12,540
	WINTER 3	0.2361	0.3464	390	285	533
	WINTER 4	0.0246	0.0246	28	12	65
TH5	WINTER 2	1.7135	2.4645	2,652	1,739	4,043
	WINTER 3	1.2246	3.2269	3,472	2,670	4,515
	WINTER 4	0.1260	0.1773	191	86	425

Table 4.17.2-1 Auks recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; raw count = total number of birds recorded; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

4.17.3 The importance of the Greater Gabbard for Common Guillemots through the year

4.17.3.1 Winter and summer

Very low numbers of Common Guillemots were estimated to occur in the Greater Gabbard area through the summer months of May and June, an unsurprising event as breeding adults would have been at their breeding colonies on remote islands and cliffs. The peak estimate of 533 birds from boat surveys, recorded in July, is paltry in comparison to the number of Common Guillemots thought to be in Britain during the summer (1.3 million birds; Mitchell *et al.* 2004). The Greater Gabbard area, and

North Sea in general, is likely to assume some significance for post-fledgling juveniles and post-breeding adults, with the latter spending the flightless moult period in the open sea.

However, numbers did not often exceed 500 until the winter months from November onward. 1,607 Common Guillemots were estimated to be present in the Greater Gabbard area from boat surveys, whilst the peak of 2,851 auks estimated from aerial surveys may have contained a similar abundance of Common Guillemots. To what extent the Greater Gabbard area is important for Common Guillemots in relation to other areas of the North Sea is unclear, although aerial surveys of neighbouring offshore areas suggested that the Greater Gabbard area did not support obviously greater abundances. However, for all auk species counted, TH3 was calculated to be of regional importance, at its peak representing 13% of the regional total. The 1% regional threshold importance was also exceeded by proportional estimates of numbers within the wind farm footprint area alone (1.82%).

4.17.3.2 Migration

The North Sea is an important wintering area for Common Guillemots dispersing from breeding colonies such as those in Helgoland and the Baltic (Harris & Swann 2002). Harris *et al*. (1997) note that the southern North Sea has become increasingly utilised by wintering Common Guillemots, and so there is likely to be movement in and out of the area during autumn and spring, though the autumn migration is likely to be fast and without significant concentrations of Common Guillemots forming (Skov *et al*. 1995). Additional through movements may be made by breeders returning to the British east coast from the coasts of France and Spain.

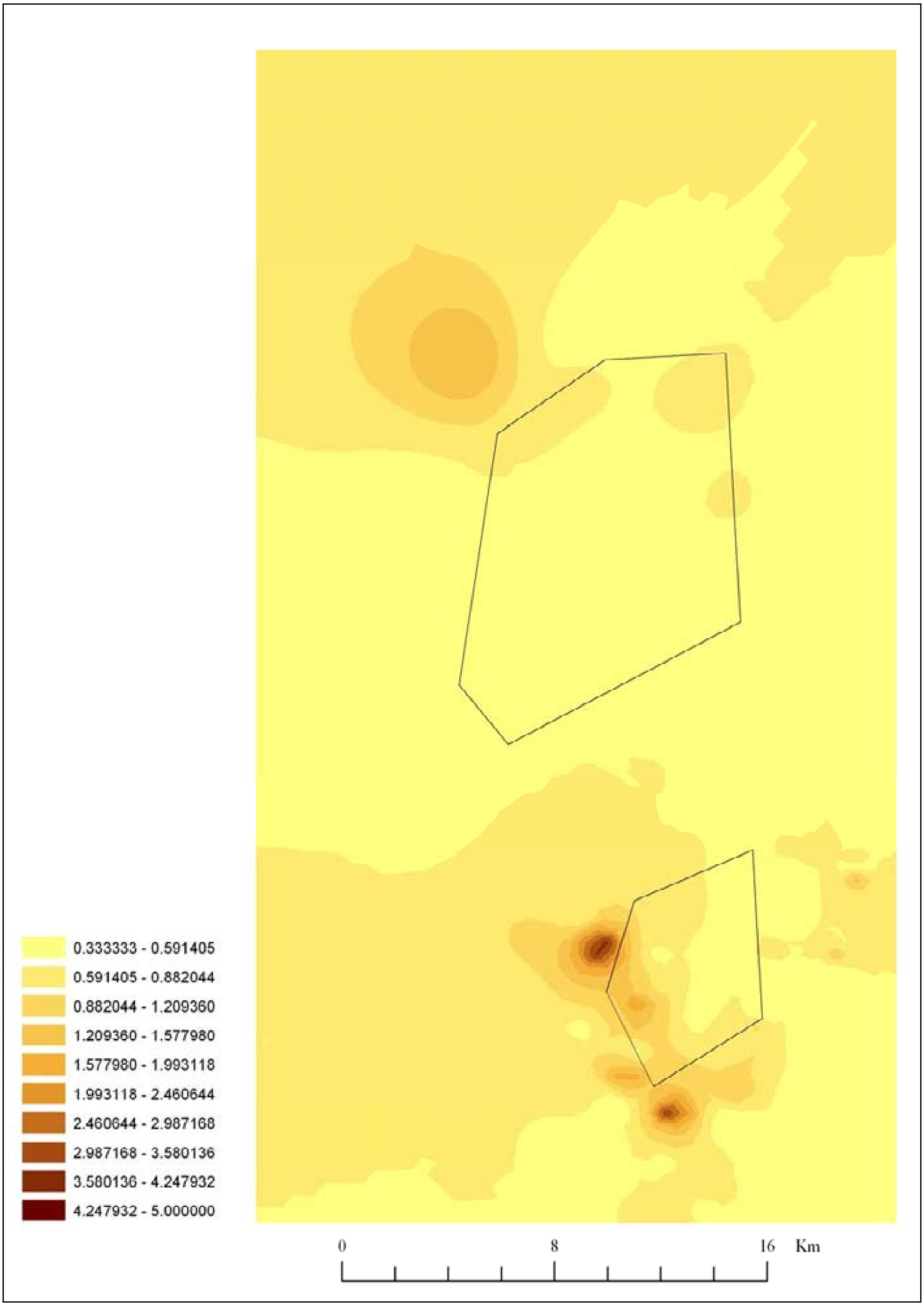

Figure 4.17.1-1 Smoothed average distribution of Common Guillemot, first winter boat surveys. Polygons show boundaries of proposed wind farm.

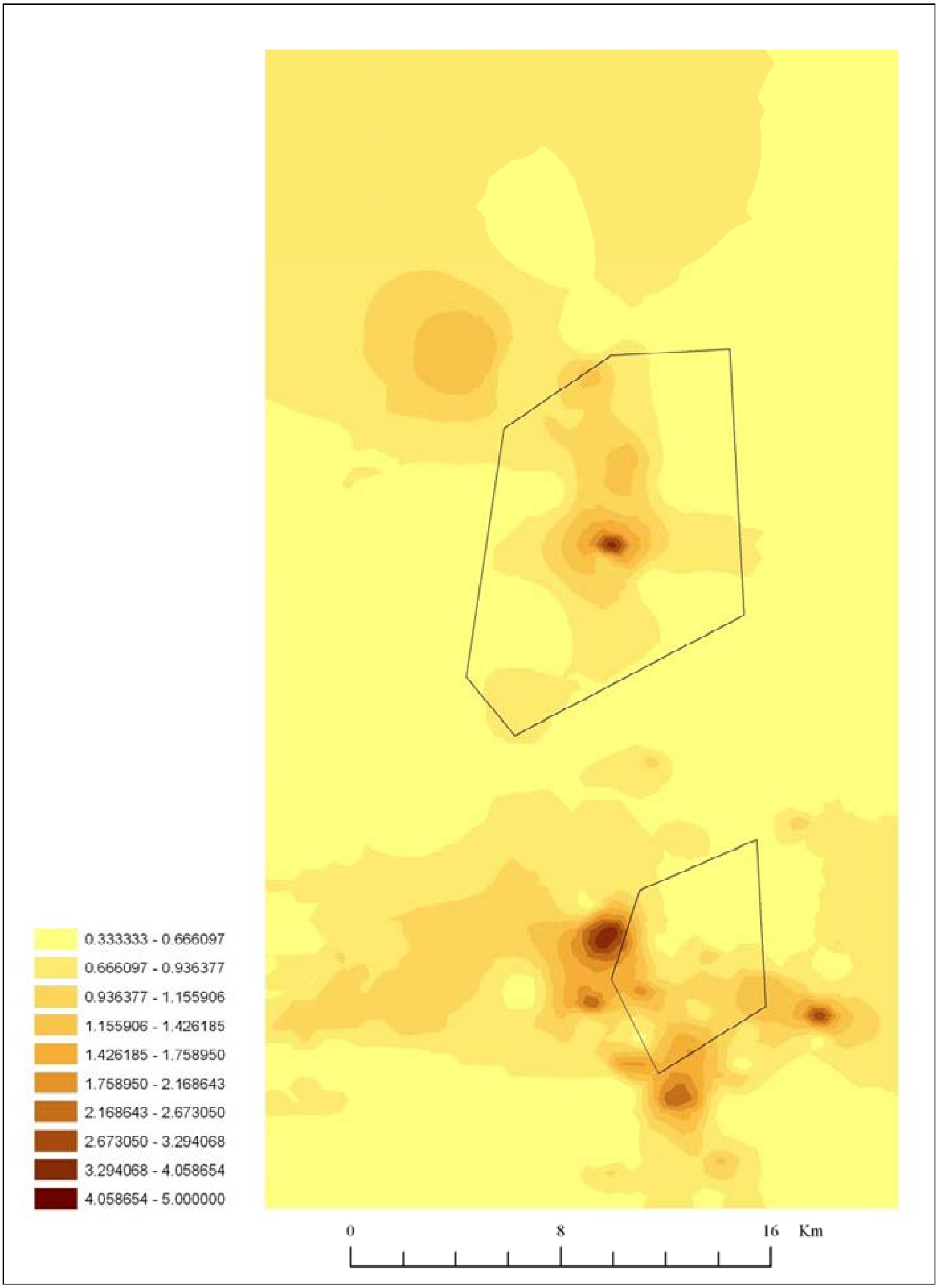

Figure 4.17.1-2 Smoothed average distribution of all auk species, first winter boat surveys. Polygons show boundaries of proposed wind farm.

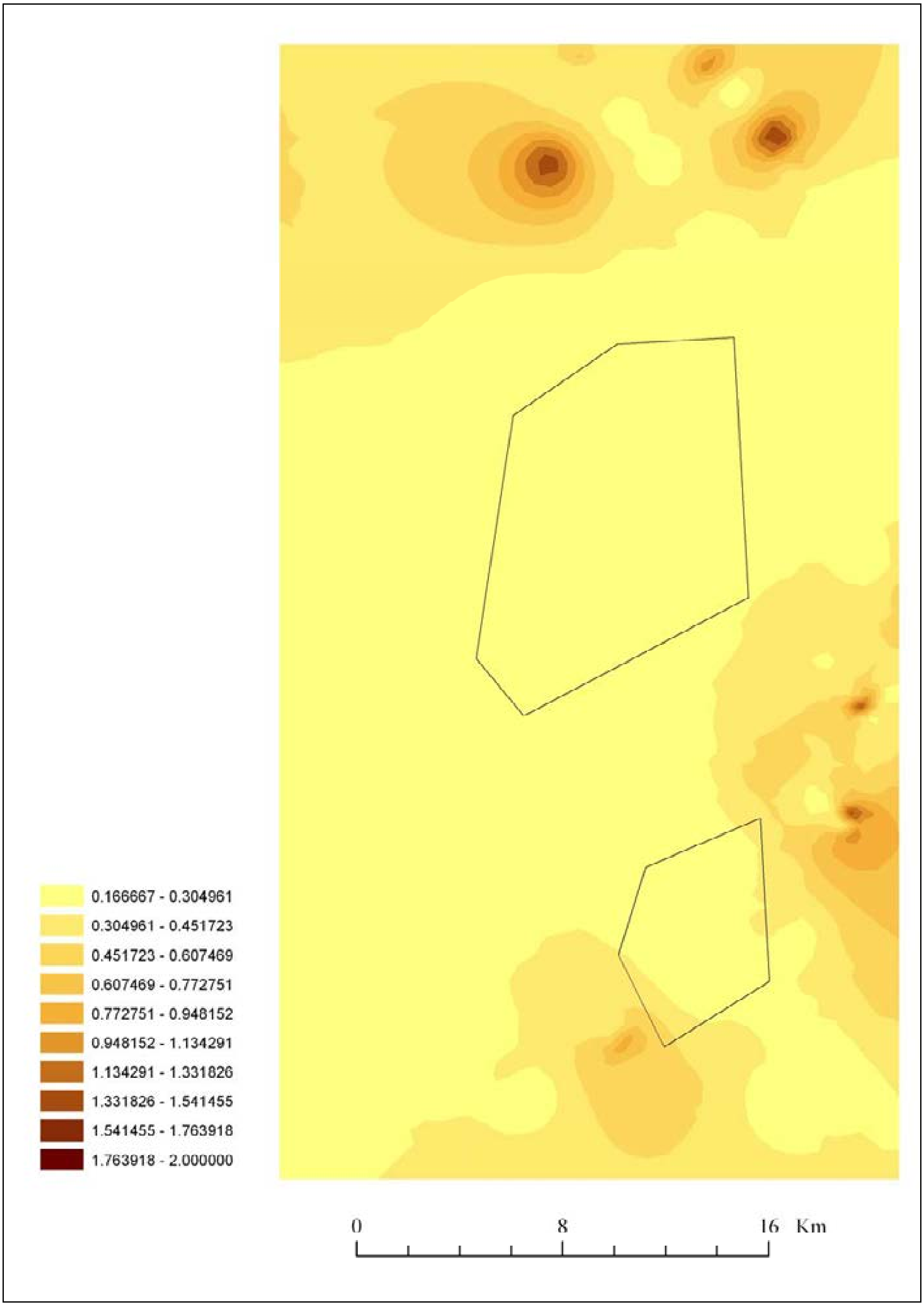

Figure 4.17.1-3 Smoothed average distribution of Common Guillemot, summer boat surveys. Polygons show boundaries of proposed wind farm.

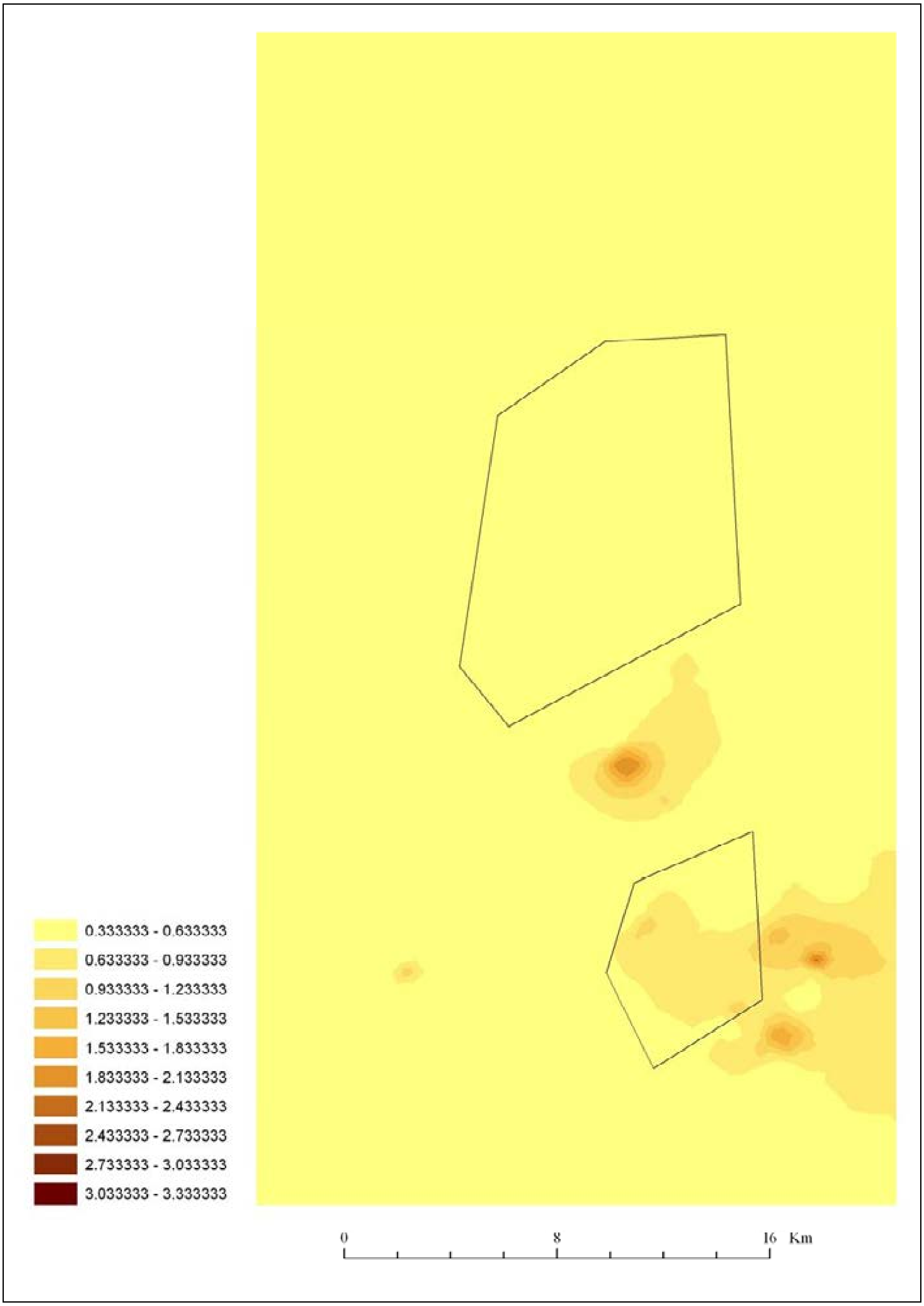

Figure 4.17.1-4 Smoothed average distribution of Common Guillemot, second winter boat surveys. Polygons show boundaries of proposed wind farm.

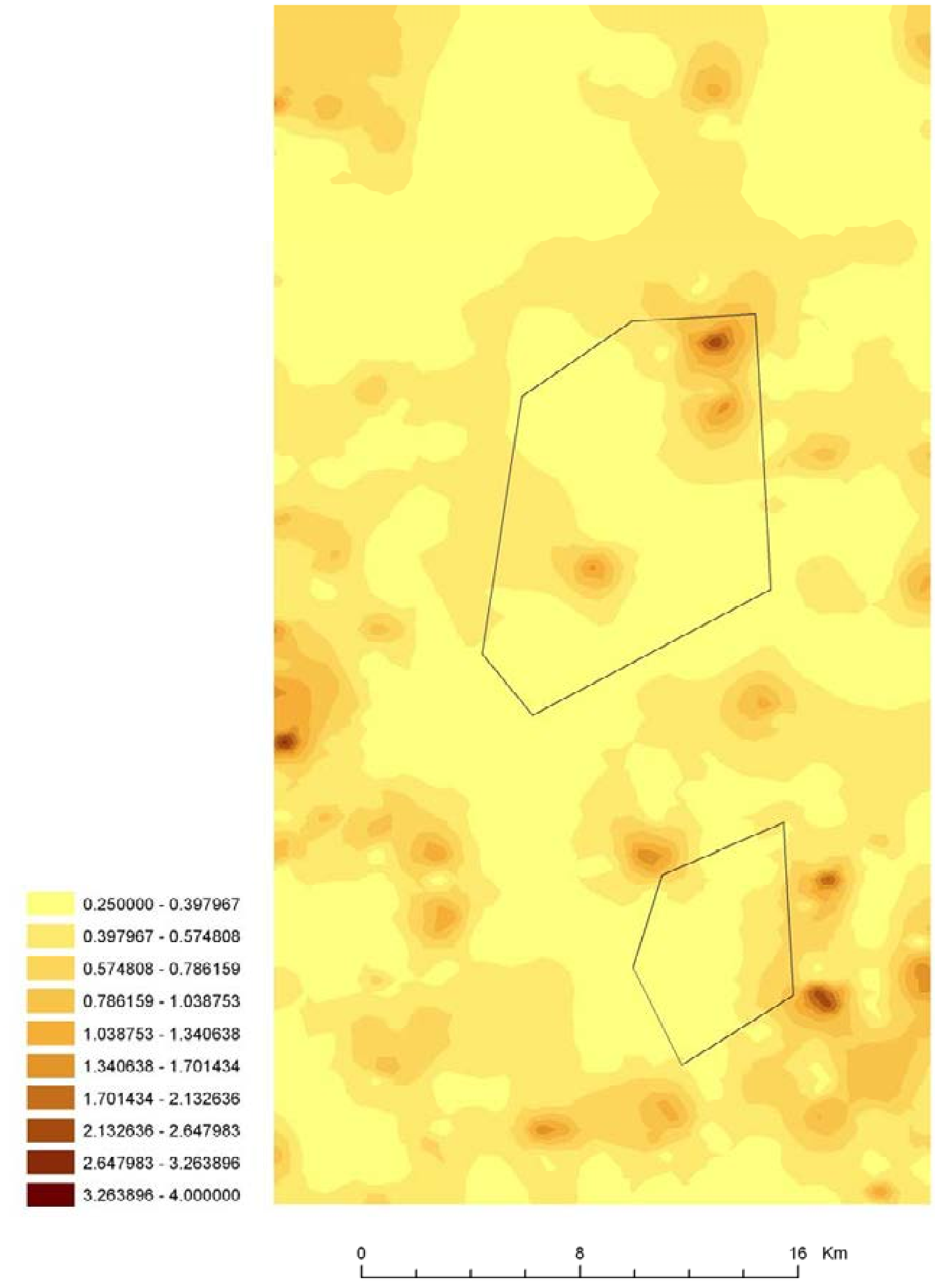

Figure 4.17.2-1 Smoothed average distribution of auk species, aerial surveys. Polygons show boundaries of proposed wind farm.

4.18 Razorbill	*Alca torda*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	European population	430-770,000
GB threshold	?	*GB population*	126,000
Wind farm peak estimate	282	Wind farm peak estimate	0
Gabbard peak	1,411* (*boat*)	*Gabbard peak*	0
% National importance	0.56%	*% National importance*	0.00%

*2,851 estimated on aerial surveys for all auk species

4.18.1 Boat surveys

Razorbills were recorded frequently on all boat surveys. However, during the first three surveys, some auks were only identified to the family level, and as such total estimates of Razorbills for these surveys are based on distance estimates for identified birds, plus estimates for the likely proportion of unidentified auks thought to be Razorbills. This additional figure was calculated from the ratio of Common Guillemots to Razorbills amongst those auks that were identified positively. Table 4.18.1-1 shows distance estimates for identified Razorbills; Table 4.17.1-2 shows distance estimates for unidentified auks on surveys in February and March 2004; and Table 4.18.1-2 presents total estimates based on distance estimates, in flight counts and calculated proportions of unidentified auks likely to have been Razorbills.

Razorbills were completely absent during the months April – September, as during this time birds will have been attending breeding colonies, with little post-breeding dispersal of either juveniles or adults until October (Merne 2002). The peak estimate from boat surveys was made from the November count, and reached 1,411 (95% confidence limits: 754 – 2,631). The estimate for the following month was comparable (1,269; 95% confidence limits: 713 – 2,259), before numbers dropped in March 2005. Estimates for March 2004 were, however, considerably lower than those in March 2005 (Table 4.18.1-2). It was not possible to assess numbers of wintering Razorbills in context of national importance, as no estimates exist for the British wintering population, and much of the population occurs on open sea.

The winter distribution of Razorbills was reasonably similar in both periods of survey (Figures 4.18.1-1 and 4.18.1-2). Concentrations of Razorbill were recorded in or near to the Inner Gabbard area, with secondary peaks to the south. On average, the species was thinly and fairly evenly distributed. Figure 4.18.1-2 displays the distribution of unidentified auks in the first winter.

MONTH	DS	D	N	LCL	UCL
February	0.1409	0.2996	121	56	265
March (1)	0.0064	0.0192	9	2	57
March (2)	0.0383	0.0872	42	15	123
April	0	0	0	0	0
May	0	0	0	0	0
June	0	0	0	0	0
July	0	0	0	0	0
August	0	0	0	0	0
September	0	0	0	0	0
November	0.7838	1.9290	1,408	754	2,631
December	0.7922	1.7387	1,269	713	2,259
March 2005	0.2613	0.4937	360	169	768

Table 4.18.1-1 Razorbill recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February	17+10	121+116	264	0.10%
March (1)	0+11	9+9	29	0.01%
March (2)	0+6	42+33	81	0.03%
April	0	0	0	0.00%
May	0	0	0	0.00%
June	0	0	0	0.00%
July	0	0	0	0.00%
August	0	0	0	0.00%
September	0	0	0	0.00%
November	3	1,408	1,411	0.56%
December	0	1,269	1,269	0.50%
March 2005	0	360	360	0.14%

Table 4.18.1-2 'In flight' counts, distance estimates and total estimates for Razorbill. Additional figures are estimates of unidentified auks likely to be Razorbills. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.18.2 Aerial surveys

On aerial surveys, Common Guillemots and Razorbills were not distinguished between, and these birds were recorded to the family level (*i.e.* auks). Therefore it is not possible to discern the relative proportions of the two species recorded. Table 4.17.2-1 shows distance estimates for all auks surveyed, and Figure 4.17.2-1 illustrates the smoothed average distribution of auks recorded on aerial surveys.

4.18.3 The importance of the Greater Gabbard for Razorbills through the year

4.18.3.1 Winter and summer

The Greater Gabbard area holds no importance for Razorbills during the breeding season.

Estimates of 1,411 and 1,269 from boat surveys in November and December suggest that the Greater Gabbard area has some importance for Razorbills during the winter, whilst the peak of 2,851 auks estimated from aerial surveys may have contained a similar abundance of Razorbills. The southern North Sea becomes important for Razorbills in December, as younger birds disperse further from their colonies (Carter *et al*. 1993). Aerial surveys of neighbouring offshore areas suggest that birds are widely distributed, and it seems unlikely that the Greater Gabbard area holds elevated importance for this species, although see section 4.17.3.1 for assessment of importance of all auk species.

4.18.3.2 Migration

Migratory routes of Razorbill are poorly defined, although there is a general distributional shift south in autumn, and north in spring (Merne 2002). Although some birds will disperse to the coasts of northern Europe, it is unlikely that major movements of Razorbill will pass through the Greater Gabbard area.

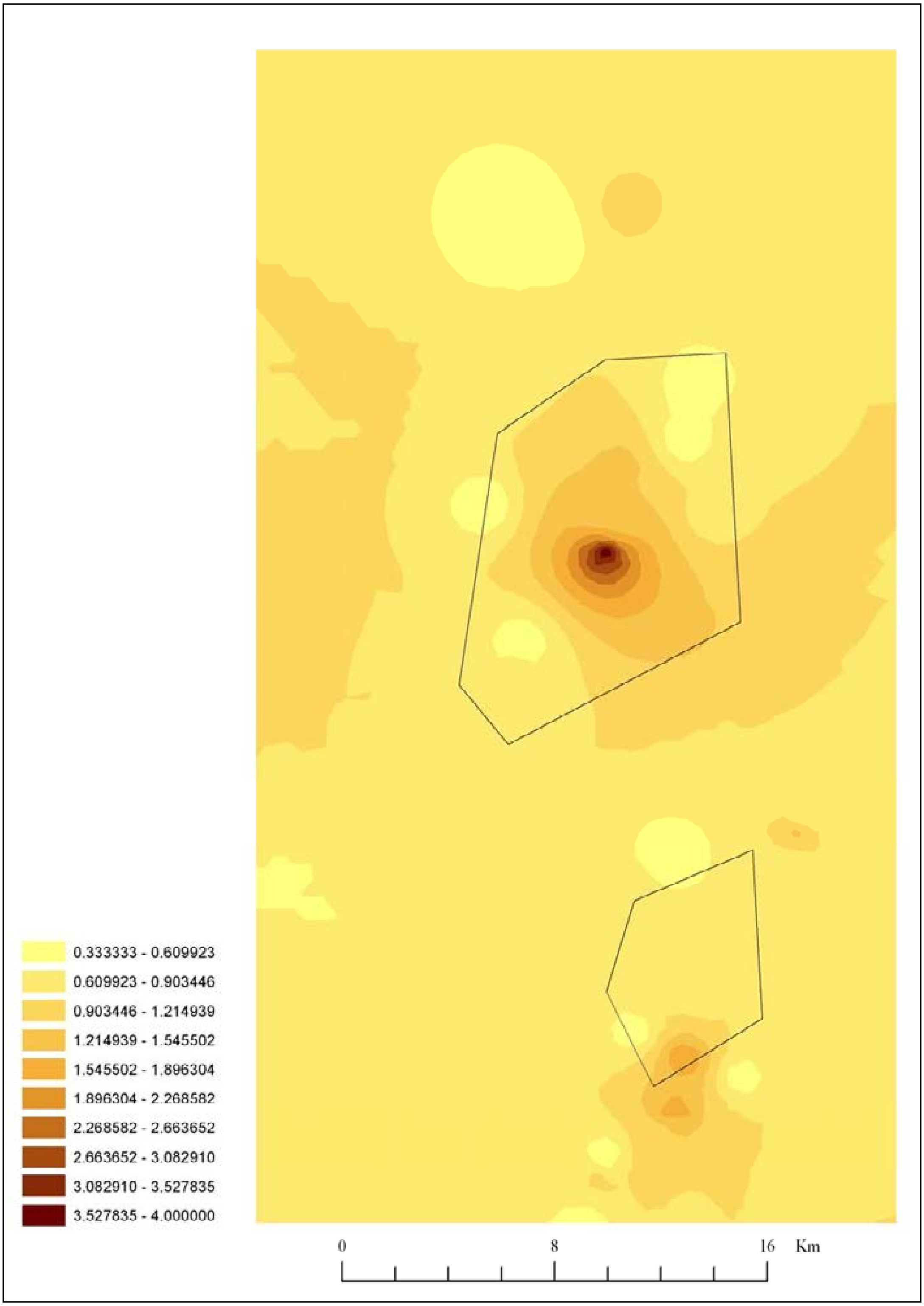

Figure 4.18.1-1 Smoothed average distribution of Razorbill, first winter boat surveys. Polygons show boundaries of proposed wind farm.

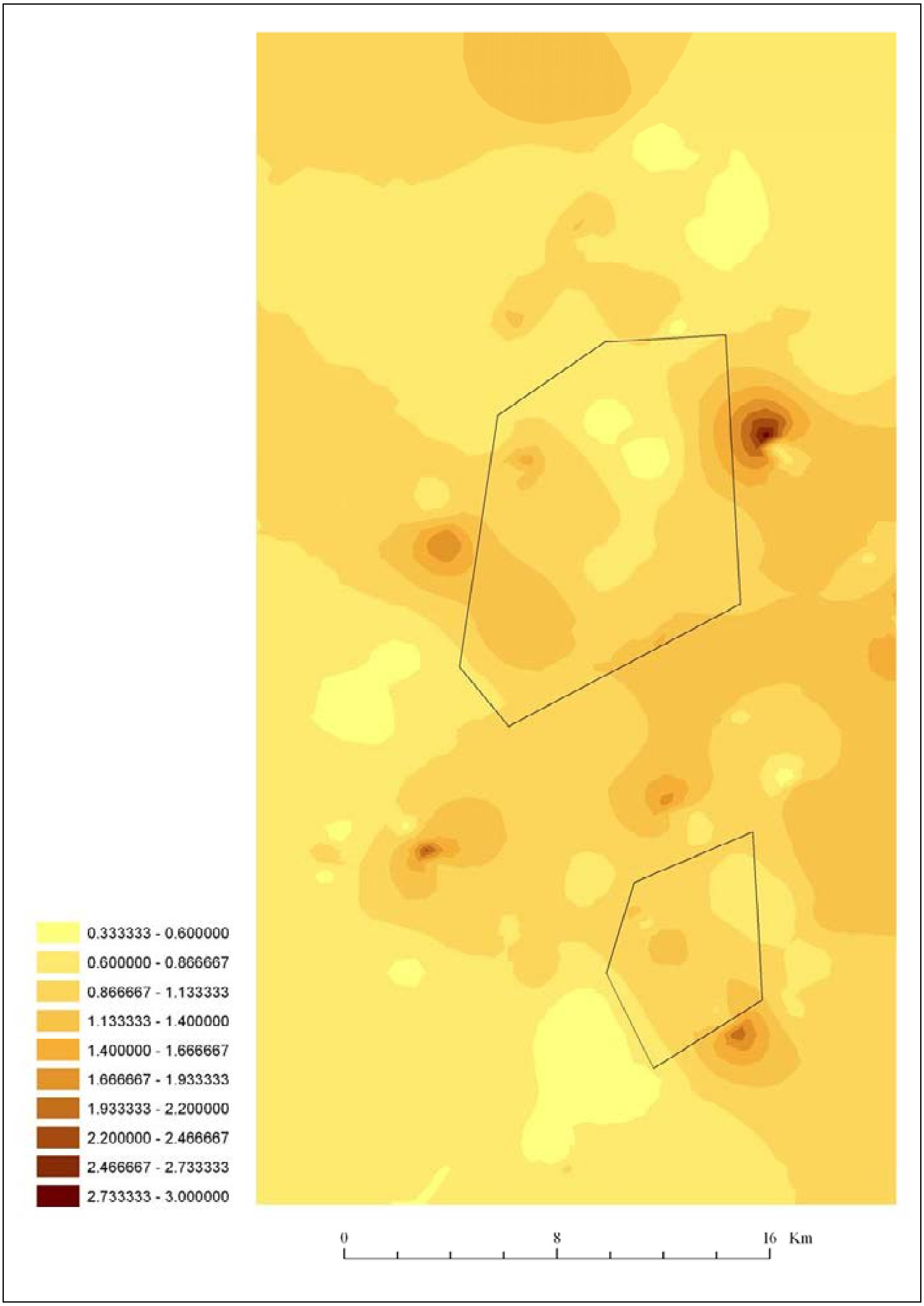

Figure 4.18.1-2 Smoothed average distribution of Razorbill, second winter boat surveys. Polygons show boundaries of proposed wind farm.

4.19 Unidentified Gulls

4.19.1 Boat surveys

Boat surveys after March 2004 recorded many instances of unidentified 'Large Gulls', a category that includes gulls likely to be either Herring Gulls, Great or Lesser Black-backed Gulls. As it is not clear why identification was not possible (for instance, confusion between Herring and Lesser Black-backed Gulls may have been greater than with Great Black-backed Gulls), distance analysis was run to include all identified gulls of the three species mentioned with all unidentified large gulls. This provides estimates for all large gulls found in the Greater Gabbard area (Table 4.19.1-1), and should be considered supplementary to individual species accounts.

The greatest abundances of large gulls were estimated to have occurred in the winter period, with a peak estimate of 4,327 in December, likely to be a consequence of an influx of continental Herring and Great Black-backed Gulls. Note, however, that 95% confidence limits are very wide (1,516 – 12,350). Between April and September, the peak estimate for large gulls was only 532 (95% confidence limits: 88 – 3,201).

Figures 4.19.1-1 and 4.19.1-2 show the average distributions of large gulls for the summer and second winter of survey respectively. Peak concentrations appear to be in the south east corner of the survey area, overlapping with The Galloper area of the wind farm. It is likely that these high concentrations were influenced by sizable feeding flocks of gulls in these locations.

MONTH	DS	D	N	LCL	UCL
February	N/A	N/A	N/A	N/A	N/A
March (1)	N/A	N/A	N/A	N/A	N/A
March (2)	N/A	N/A	N/A	N/A	N/A
April	0.1613	0.7290	532	88	3,201
May	0.1116	0.3349	244	32	1,895
June	0.6574	0.7238	528	291	960
July	0.2357	0.6964	508	235	1,099
August	0.1240	0.1613	118	48	291
September	0.1737	0.1914	140	45	438
November	0.4217	1.0413	760	382	1,511
December	0.4364	5.9277	4,327	1,516	12,350
March 2005	1.4761	2.4880	1,816	883	3,735

Table 4.19.1-1 Large Gulls recorded on sea during boat surveys, with distance estimates. DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Where results not available (N/A), insufficient numbers of birds were recorded for analysis. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

4.19.2 Aerial surveys

Identification of gulls during aerial surveys is often problematic, as rapid determination of species is frequently impossible. Therefore many gull species were recorded to a categorical level (*e.g.* small gulls). To provide some idea of the number of gulls present in the Greater Gabbard area in comparison to other survey areas during winter, counts of all unidentified gulls (including unidentified small gulls, large gulls, gulls, black-backed gulls and grey gulls) were pooled for distance analysis (Table 4.19.2-1). This method was considered preferable to partitioning estimates according to those (relatively rare) cases where identification was possible.

The peak estimate for the Greater Gabbard was of 1,316 (95% confidence limits: 696 – 2,486) on the third winter survey. This figure is within a few hundred of the estimates for survey areas TH1, TH2 and TH5 for the same period, though the estimate of 8,693 (95% confidence limits: 4,754 – 15,897) is considerably higher for area TH4. In other periods of the winter, the Greater Gabbard area generally held fewer gulls than the other survey areas.

Figure 4.19.2-1 shows the distribution of unidentified gulls from aerial surveys. Unlike boat surveys, the largest concentrations of unidentified gulls occurred in the northern half of the survey area, especially to the north east of the Inner Gabbard. It is unclear which of the two methods records the more accurate distribution of gulls.

Survey Block	Survey Period	DS	D	N	LCL	UCL
TH1	WINTER 1	0.5751	0.8831	1,113	779	1,589
	WINTER 2	1.4539	4.7184	5,945	3,397	10,406
	WINTER 3	0.8271	1.5171	1,912	1,399	2,611
	WINTER 4	1.1954	2.6288	3,312	1,863	5,889
TH2	WINTER 1	0.6457	2.1344	2,627	1,829	3,773
	WINTER 2	0.5262	1.9089	2,350	1,627	3,394
	WINTER 3	0.4487	0.8811	1,085	632	1,862
	WINTER 4	0.0839	0.1323	163	93	284
TH3	WINTER 1	0.1510	0.1923	204	103	405
	WINTER 2	0.3129	0.4387	465	271	798
	WINTER 3	0.3645	1.2411	1,316	696	2,486
	WINTER 4	0.0589	0.1277	135	62	295
TH4	WINTER 1	0.2847	0.4946	557	387	801
	WINTER 2	1.0774	2.6468	2,980	2,141	4,149
	WINTER 3	1.6323	7.7205	8,693	4,754	15,897
	WINTER 4	0.5765	0.9685	1,091	574	2,071
TH5	WINTER 2	0.4504	1.3025	1,402	797	2,464
	WINTER 3	0.4910	1.2931	1,391	748	2,589
	WINTER 4	0.0517	0.1034	111	47	264

Table 4.19.2-1 Unidentified Gulls recorded on aerial surveys, with distance estimates. Survey block = code for survey area; survey period = stage of winter; raw count = total number of birds recorded; DS = estimated cluster density; D = density of individuals estimate; N = numerical estimate; LCL = lower confidence limit; UCL = upper confidence limit. Figures relate to entire study areas; the proposed wind farm area represents 14% of the area of TH3.

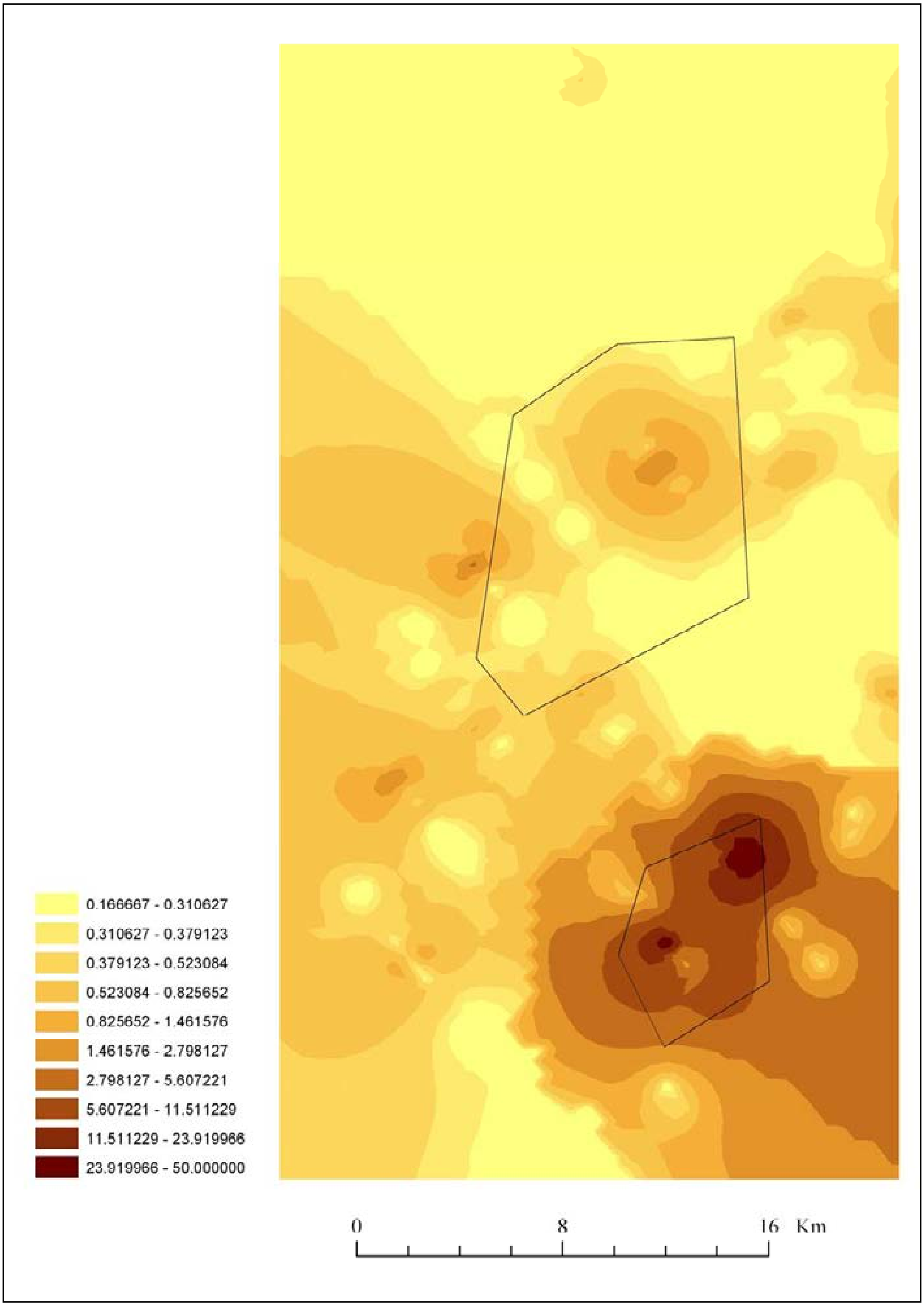

Figure 4.19.1-1 Smoothed average distribution of large gulls, summer boat surveys. Polygons show boundaries of proposed wind farm.

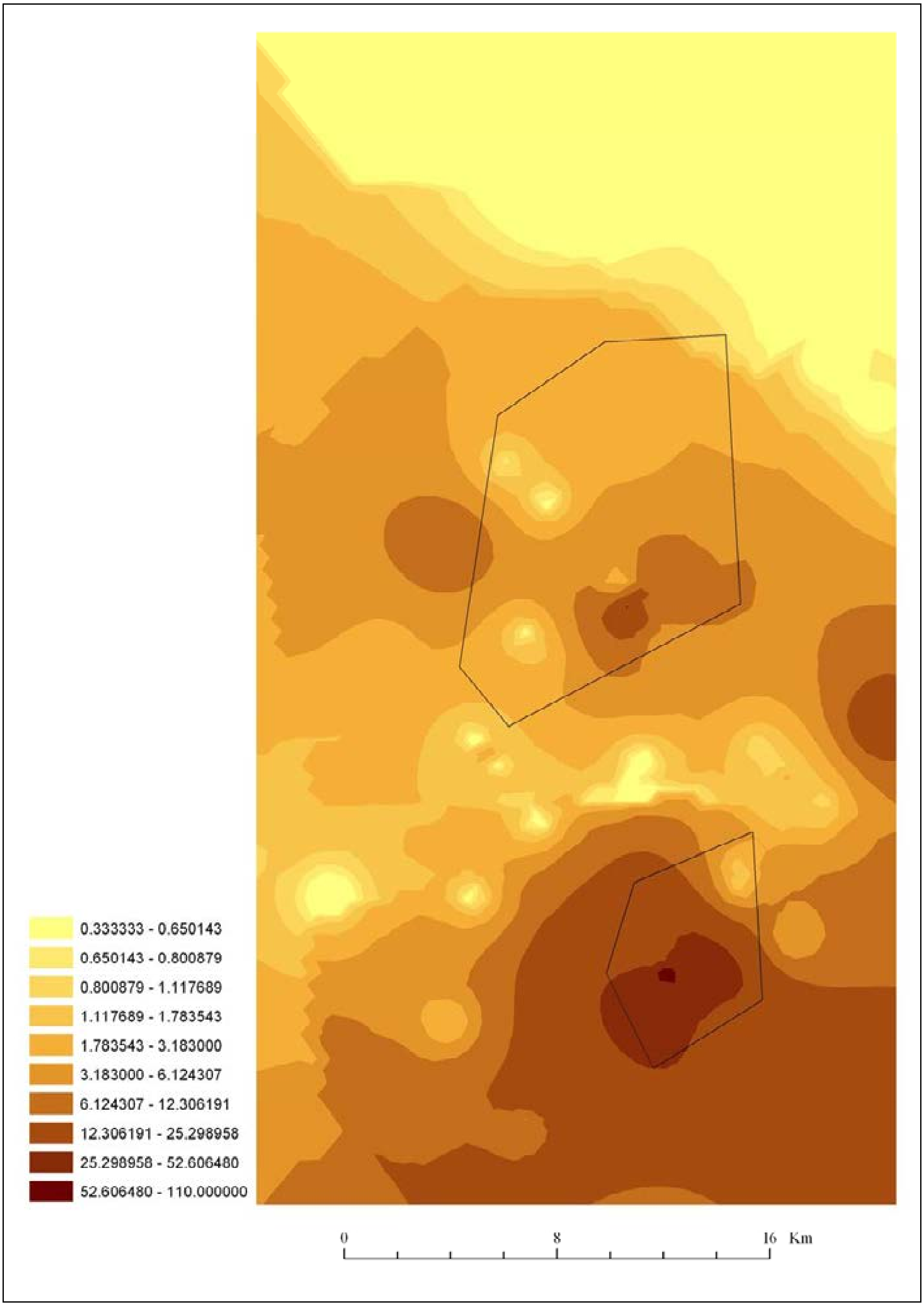

Figure 4.19.1-2 Smoothed average distribution of large gulls, second winter boat surveys. Polygons show boundaries of proposed wind farm.

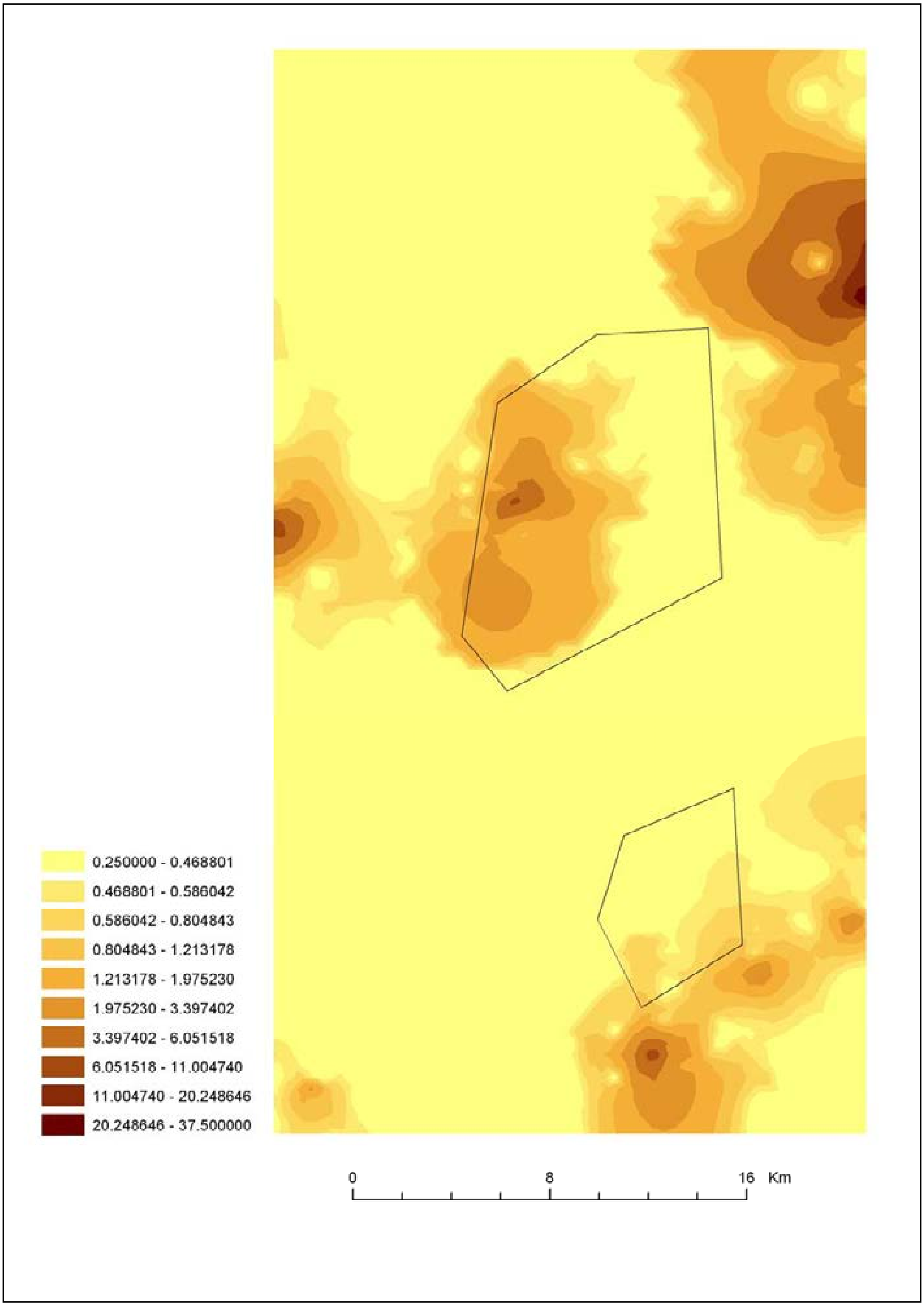

Figure 4.19.2-1 Smoothed average distribution of unidentified gulls, aerial surveys. Polygons show boundaries of proposed wind farm.

4.20 Migration periods

Despite the presence of a dedicated ‘migration watcher’, relatively few birds were recorded on passage through the Greater Gabbard area from boat surveys. Few migrants were recorded between April and August, but in September 2004, a number of passerines and other species were recorded in the area. In addition to the species recorded by the migration watcher (Table 4.20-1), a further 333 passerines were counted, of which 120 were Meadow Pipits and 158 were Starlings. Although there was no October survey, migrants were still recorded in early November (Table 4.20-1). An additional 229 passerines (of which 210 were Starlings) were seen on 9 November. As this survey took place over a long period of time, and as few birds were recorded late in the month, Table 4.20-1 shows those birds recorded only on 9 November.

The following spring, migration was recorded during the March 2005 survey. In addition to the species recorded in Table 4.20-1, 21 Sandwich Terns and 79 passerines were noted during the main survey.

Common Name	Species	September 2004	November 2004	March 2005
Red-throated Diver	*Gavia stellata*	0	0	2
Great Cormorant	*Phalacrocorax carbo*	0	0	1
Grey Heron	*Ardea cinerea*	4	0	0
Brent Goose	*Branta bernicla*	21	6	0
Great Skua	*Catharacta skua*	0	1	0
Common Scoter	*Melanitta nigra*	48	0	0
Grey Plover	*Pluvialis squatarola*	7	0	0
Lapwing	*Vanellus vanellus*	1	0	0
Knot	*Calidris canutus*	17	0	0
Dunlin	*Calidris alpina*	0	0	1
Little Gull	*Larus minutus*	4	0	0
Sandwich Tern	*Sterna sandvicensis*	6	0	0
Common Tern	*Sterna hirundo*	2	0	0
Arctic Tern	*Sterna paradisaea*	1	0	0
Meadow Pipit	*Anthus pratensis*	51	10	10
Rock Pipit	*Anthus petrosus*	0	0	2
Unidentified pipit		2	0	0
Robin	*Erithacus rubecula*	3	0	0
Fieldfare	*Turdus pilaris*	0	0	1
Song Thrush	*Turdus philomelos*	18	0	2
Unidentified thrush		2	8	0
Starling	*Sturnus vulgaris*	37	620	116
Chaffinch	*Fringilla coelebs*	1	0	28
Unidentified passerine		18	171	0
Total for all birds		243	816	163

Table 4.20-1 Species recorded during ‘migration watch’ on boat surveys

In general, there do not appear to be mass migrations through the Greater Gabbard area on either the autumn or spring surveys, although data are limited and nocturnal surveillance would provide different results. September provided the greatest species diversity, whilst there seemed to be some movement of small groups of Starlings during November and March. Where more than 20 birds were recorded, the measured height at time of survey was averaged for each month (Table 4.20-2). All migrants were recorded under a height of 10 m above sea level, which would see them pass under the sweep of the turbines.

Common Name	September	November	March
Brent Goose	2.5	-	-
Common Scoter	4	-	-
Meadow Pipit	4	-	-
Starling	5	9	6.5
Chaffinch	-	-	7.5

Table 4.20-2 Average flight heights of principal migrating species (metres)

As identified in the species accounts, several of the major species found in the Greater Gabbard area may also pass through the wind farm during autumn or spring migration. Species such as Northern Gannet, Great Skua, and the gulls moving in to winter in or around the UK (Lesser Black-backed Gulls, Herring Gulls and Black-headed Gulls) may be presented with a collision risk. The skuas and gulls are perhaps most vulnerable, as these species often fly up to 40 or 50 m above sea level, and thus could encounter the blades of the wind turbines.

4.21 Modelling offshore bird distributions

Bird count data from boat surveys were modelled against three types of predictor variables, to ascertain to what extent species distribution could be explained by these factors. Data were obtained on bathymetry (water depth readings from SeaRoc), fish and benthic fauna (biomass data from CMACS), and shipping (traffic density from MARICO). All data were incorporated within a GIS to enable matching and generation of dependent and predictor variables.

It was decided to use actual bird count data rather than smoothed (kriged) data, as fewer assumptions were made about areas between transects using this approach. This avoids instances where, for instance, a flock of birds feeding over a shallow sand bank would be incorrectly 'smoothed' over deeper areas of water, and thus allows relationships to be examined more accurately. A quadrat sampling approach was therefore used based on 500 m x 600 m sampling quadrats. These adjoining quadrats were centred on the line transect along the prescribed route of the vessel on boat surveys in the Greater Gabbard study area. The quadrat width was selected so that the strip extended 300 m either side of the transect line, *i.e.* the upper limit of the distance bands used for survey. The 500 m length was selected as an arbitrary unit to divide the total transect line.

Bird numbers for each cell for each season for each species were characterised by taking the average number of birds recorded within each of the 455 quadrats across all boat surveys. Water depth for each cell was characterised by averaging all water depth readings from within each of 82 quadrats for which bathymetry data were available. While this meant that no estimate of water depth was made for many quadrats, available alternative data sets were not of a suitable geographic resolution. Potential prey within each cell was characterised by calculating average weight from biomass data of all samples within an area defined by a 200 m buffer of each quadrat. Fish biomass data were grouped by family and also overall fish biomass was calculated. Benthic organisms were treated in a similar manner to fish data and grouped into mollusc, non-mollusc and overall biomass variables. Biomass data were available for 61 quadrats for winter analyses and 82 quadrats for summer analyses. Intensity of shipping within each of the 455 quadrats was characterised by taking the total length of all traces within each quadrat. These were summarised by season and whether or not they were fishing vessels (potentially attracting birds) or otherwise (potentially disturbing birds).

Initially, a number of exploratory analyses were carried out in order to determine whether the available data would support predictive models of bird numbers.

Firstly, Spearman's rank correlations were carried out between the potential predictor variables. High degrees of correlation between the by family fish biomass and overall fish biomass suggested that only the latter need be considered in any final models. Similarly, for benthic biomass only the overall biomass need be considered in any final models. With regard to shipping, the correlation matrix suggested that fishing and non-fishing vessels should be considered separately.

Secondly, Spearman's rank correlations were used to explore possible associations between bird numbers and the potential predictor variables. With regard to fish data correlations, each of eight and two bird species in winter and summer respectively, were correlated respectively against five and seven fish biomass variables – overall seasonal average biomass and by family seasonal average biomass, the discrepancy in the number of fish variables between seasons being due to seasonal differences in families represented in the sample. Out of 54 comparisons, 12 significant correlations were found. Note that with this many comparisons and when using probability value of $P < 0.05$ to indicate significance then about three apparently significant correlations would be expected to occur by chance. Although the number obtained exceeds this suggesting that perhaps 75% of the apparently significant associations may be valid, because of the high degree of correlation between the fish biomass variables the proportion of significant correlations detected is somewhat inflated. With this in mind the correlations suggest that winter numbers of Guillemot are weakly associated with overall fish biomass and that summer numbers of Gannet are weakly associated with sandeel biomass. There was also a weak negative correlation of winter Herring Gull numbers with fish biomass. Out of 30 correlations undertaken between bird numbers and benthic variables only one significant result was obtained *i.e.* no more than would have been expected by chance. Similarly the number of significant correlations obtained between bird numbers and shipping data were no more than would have been expected by chance.

The third exploratory approach used was to assess contingency tables of bird numbers against the individual potential predictive variables using Chi-squared analysis. In order to facilitate this analysis both bird data and predictor variables were converted to categorical data. Initially bird numbers were classified as low, medium or high and each of the predictor variables treated likewise. Again the number of significant results obtained were no more than would have been expected by chance.

Despite there being little to suggest that the available data would support modelling bird numbers in relation to the available environmental data, further analysis was attempted. The most appropriate approach was to model the bird data as a presence / absence dependent variable using Logistic Regression. The software used was SAS (SAS Inc 2005) which allows both continuous and class variables as predictor variables. For each species, models were constructed with multiple predictor variables offered in a stepwise model. Because these multiple predictor models are limited to the sample size dictated by the variable with fewest observations single predictor models were also considered. No multiple variable models were obtained. Thus the only model obtained was one relating winter Kittiwake numbers to depth. Again, given the number of models considered, a single significant model might have been expected by chance, especially as depth did not emerge as a variable associated with Kittiwake numbers in any of the exploratory analyses.

In conclusion the attempt to model bird numbers in relation to the available environmental data has not resulted in useful predictive models for any of the species considered (see Appendix 2 for detailed results tables). This may well be a consequence of the various data sets having been collected independently of each other and for different purposes rather than in a single coordinated effort directed specifically with this type of modelling as its principal aim.

4.22 Response of waterbird populations to future climate change

Climate change is occurring worldwide and its effects are already visible on habitats and fauna, including the internationally important populations of waterbirds in the UK. In assessing the impact of the wind farm on the environment, and more especially the waterbirds and migratory birds presently using its proposed site, it is important to consider what may happen to these species if no attempt is made to lessen the effects of climatic change (e.g. by utilising non-fossil fuels or renewable energy). This helps place the possible negative impacts of the wind farm on local wildlife into the wider context of the effects that lessening climate change will have on the phenology, distribution, demographic parameters and ultimately survival of birds and other fauna. The following text often uses examples taken from the Sub-order Charadrii or waders, a sub-set of waterbirds that have been better studied in the context of climate change, and occasionally from non-waterbirds. However, many of the issues identified are likely to apply to the species of waterbird found in the area of the Greater Gabbard Offshore Wind farm.

Changing weather

Globally, the 10 hottest years on record had occurred between 1991 and 2004; during the last century temperatures have risen by 0.6ºC and global sea level has risen by 20 cm (Houghton *et al.* 2001). Ice caps are disappearing from mountain peaks and Arctic sea ice has thinned by 40% (Wadhams 1997). Thus, climate change is occurring and the causal link to increased greenhouse emissions is established (Houghton *et al.* 2001). The Chief Scientific Adviser to the British Government has suggested that climate change is the most severe problem being faced today (King 2004). In 2003, in France and the UK, 20,000 people were estimated to have died as a consequence of an unprecedented heat wave that the French Ministry of the Environment expects to occur henceforth every 3-4 years. By 2080, in UK, extreme tidal events previously expected every 100 years could be occurring every 3 years and 3.5 million people could be at "high" risk of flooding with hundreds of millions at risk worldwide (King 2004).

Waterbird phenology

Meta-analyses confirm the changing phenology of bird populations with changing weather over recent decades worldwide (Parmesan & Yohe 2003, Root *et al.* 2003). In the UK, the timing of arrival and breeding of migrant waterbirds can be responsive to ambient temperatures. In NE Scotland, between 1974-1999, Eurasian Curlew *Numenius arquata* arrived to breed 25 days earlier (Jenkins & Watson 2000), and between 1950 and 1998, first arrival dates of Little Ringed Plovers *Charadrius dubius* and Whimbrels *Numenius phaeopus* in SE England have advanced by 6 and 22 days per decade, and 3 and 6 days per °C in relation to mean January to March temperatures, respectively (Sparks & Mason 2001). Between 1966-67 and 2000-01, the first arrival date of wintering Tundra Swan *Cygnus columbianus* advanced by 7 days whereas that of Jack Snipe *Lymnocryptes minimus* regressed by 6 days per decade (Sparks & Mason 2004). In the UK, between 1944-1995, Ringed Plover *Charadrius hiaticula* laying date has become earlier at a rate of 1.1 days per mean monthly °C and, between 1962-1995 Eurasian Oystercatcher laying date has become earlier at the rate of 0.06 day per mm increase in May precipitation (Crick & Sparks 1999).

Waterbird distributional shifts

Meta-analyses confirm that the distributions of bird populations are changing worldwide with changing weather over recent decades (Parmesan & Yohe 2003, Root *et al.* 2003). The breeding distributions of some British birds have extended northwards with climate change (Thomas & Lennon 1999). In Britain, wintering wader distributions have changed since the 1970s (Austin *et al.* 2000). Since the mid-1980s, with an increase of 1.5°C in mean winter temperature in the UK, the distributions of seven out of nine of the common wader species found on estuaries have moved in an eastwards direction across the winter isotherms, with the smaller species showing the greatest shifts as is expected if mediated by temperature (Austin & Rehfisch 2005). On Britain's non-estuarine coasts, between 1984-85 and 1997-98, the distributions of eight wader species moved in an eastwards and/or northwards direction with increasingly mild winter temperatures and changes in mean rainfall, wind speed and wind-chill (Rehfisch *et al.* 2004), probably to winter closer to their breeding grounds. The recent decline in eight of the 14 species of common coastal wader in Britain (Rehfisch *et al.* 2003a, 2003b) could be due to the waders now wintering even further north and east, on the European mainland (Rehfisch & Crick 2003). Worldwide, 103 out of 207 wader populations with known trends are probably in decline or extinct for reasons that are unclear, but may include the direct or indirect effects of climate change (IWSG 2003).

Impacts on waterbird demographic factors

The impacts of climate change on demographics factors, breeding performance and survival, that affect the population dynamics of species have been less well explored than phenology. There is often a range of interacting factors that may influence any one demographic parameter, such that the influence of weather or climate may be difficult to elucidate clearly. For example, clutch size may vary with laying date, age and experience, population density, and a range of environmental factors such as latitude, altitude and habitat. However, several studies have shown trends in various aspects of breeding performance that correlate with trends in climate.

The migratory Pied Flycatchers *Ficedula hypoleuca* have been studied in both Germany and Finland, showing increases in egg size with warmer springs (Järvinen 1994) and clutch sizes have tended to increase with earlier laying dates and warmer springs (Järvinen 1996, Winkel & Hudde 1997). However, nest success in Finland has not increased because it is related most to June temperatures, which had not shown any trend in that region (Järvinen 1989), whereas it had improved in Germany, at a lower latitude (Winkel & Hudde 1997).

Long-term studies of seabirds have demonstrated a climatic influence on breeding performance. Aebischer *et al*. (1990) showed that the laying date, clutch size, and brood size of Kittiwakes *Rissa tridactyla* at a colony by the North Sea were related to a measure of "westerly weather", that is analogous to the impact of the North Atlantic Oscillation (NAO), a meteorological feature that determines the weather affecting NW Europe. They were also able to demonstrate parallel impacts at lower levels in the food chain, through phyto- and zooplankton and herring stocks, that suggests the mechanism for such changes. At a colony in northern Scotland, between 1950-2000, the hatching and fledging success of Fulmars *Fulmarus glacialis* was related to the NAO, due potentially to the climate effects on the abundance of their crustacean and fish food supplies or due to the impact of severe winter weather on parental body condition (Thompson & Ollason 2001). Furthermore, the cohort recruitment rate of Fulmars was related to growing season temperatures in the year of their birth, despite recruitment occurring some five years later due to delayed maturity. The response of marine seabirds to climate change may depend on the response of their main prey to changes in warmth. In Siberia, the planktivorous Crested *Aethia cristatella* and Parakeet Auklets *Cyclorhynchus psittacula* increase their reproductive success when sea-surface temperatures (SSTs) are colder, because they feed on macro-zooplankton that are favoured under such conditions; whereas the piscivorous Horned *Fratercula corniculata* and Tufted Puffins *Lunda cirrhata* have better reproductive success when SSTs are warmer, because this favours the mesoplankton that are eaten by the fish that are eaten by the puffins (Kitayski & Golubova 2000). In this case, long-term changes in SSTs are likely to affect the viability of the populations of each group of species in different ways and may alter the seabird community in the area.

The only demographic study that also investigated the impact of climate change on survival rates is of a large colony of Emperor Penguins *Aptenodytes forsteri* in Terre Adelie, Antarctica, since the 1960s (Barbraud & Weimerskirch 2001). This colony declined in the mid-1970s due to decreased adult survival during a relatively warm period. Warm SSTs are associated with poorer Antarctic Krill *Euphausia superba* production and reduce populations of the fish and squid that feed upon them, all prey of the penguins. Although warmer SSTs reduce the distance that parent penguins must travel to reach the sea (because of reduced pack ice), the benefit of this, in terms of improved hatching success, was relatively insignificant for maintaining colony size. Thus climate change can affect different aspects of a species' demography in both positive and negative ways at the same time.

Recent failures in the breeding success of seabirds in the North Sea (Heubeck & Shaw 2005, Pitches 2005a, 2005b) may also be linked to climate change. A study of North Sea sandeels found evidence that their numbers are inversely proportional to sea temperature during egg and larval stages and that this is, in turn, linked to plankton abundance at the time of sandeel egg hatching (Arnott & Ruxton 2002). The adverse effects of rising sea temperatures are most marked in the southern North Sea where the lesser sandeel is near the southern limit of its range. Ant resultant northward shift in sandeel distribution as conditions get warmer is likely to continue to impact seabird numbers.

Conservation implications for waterbirds

Waterbirds can be designated features of Special Protection Areas (SPAs). As wader distributions in Britain change with climate change, numbers of some species on some British SPAs are dropping below the thresholds upon which the designations are based. For example, the over-winter average number of Dunlin *Calidris alpina* on the Severn Estuary has dropped from an average count of over 40,000 in the mid-1970s to below its 14,000 international threshold during the recent winters up to and including the 2000-01 winter (Austin & Rehfisch 2005). This is not an isolated example. Many species of wader are declining more rapidly in the West of Britain than in the East (Austin *et al*. 2004).

Scenarios of future change

Hughes (2000) suggests that the challenge for ecologists, physiologists and land managers is to predict the effects of human-induced climate and atmospheric change on species and on communities. However, modelling the future status of waterbirds or any other biota under climatic conditions that are out of the range of human knowledge is a major challenge. To develop realistic models of the likely effect of climate change on waterbirds that can migrate annually over huge distances, the factors and interactions that influence their demographics must be much better understood than at present (Rehfisch & Crick 2003, Piersma & Lindström 2004). For example, the single issue of time lag leading to phenological disjunction is of considerable conservation importance (Sutherland 2004) for climate change is expected to occur very rapidly (Houghton *et al*. 2001) and yet there is much uncertainty as to whether biota have the capacity to respond sufficiently fast and whether habitat responses will take years or centuries. Examples of biota finding it difficult to remain in step with their environment already exist. Although Great Tits *Parus major* can lay earlier in response to early warm spring weather, often in parallel to the emergence of the winter moth caterpillars that they feed to their young (Perrins 1991), they cannot significantly decrease their incubation period. However, the winter moth caterpillars can halve their development time in sufficiently warm weather leading to an early shortage of food for Great Tit young (Buse *et al*. 1999). There is also some evidence that long-distance migrants have not responded as rapidly to climate change as short-distance migrants (Jenkins & Watson 2000, Penuelas *et al*. 2002).

Scenarios of how biota may change with climate change already exist but these have to be treated with caution. Austin and Rehfisch (2003) use habitat association models to suggest that in 2020 and 2050 sufficient estuarine habitat will be available to sustain the present numbers of waterbirds wintering in the UK under four UKCIP scenarios of sea-level rise. Rehfisch *et al*. (2004) tentatively suggest that the numbers of some wader species presently wintering on the UK's non-estuarine coasts in internationally important numbers may decline considerably under the 2080 UKCIP scenarios. Thomas *et al*. (2004) predict the first human-induced massive extinction of biota as a result of climate change, a decline of 20% or more in the numbers of species in the world by the end of the century.

Planning for the future

Climate is changing now (Houghton *et al*. 2001, Hulme *et al*. 2002a, 2002b), and its effect on biota is apparent worldwide (Parmesan & Yohe 2003, Root *et al*. 2003). Waterbirds are, and will continue to be, increasingly affected by rising temperatures and sea-levels that change their habitat (Crooks 2004) and the communities of plants and animals that they depend on (Hughes 2004, Kendall *et al*. 2004, Lawrence & Soame 2004). These changes are reflected in existing changes in waterbird phenology (Cricks & Sparks 1999, Rehfisch & Crick 2003, Crick 2004, Sparks & Mason 2004), distributional shifts (Austin *et al*. 2000, Rehfisch *et al*. 2004, Austin & Rehfisch 2005), and declines in survival.

Assuming that the IPCC future weather scenarios are broadly correct, the Earth is about to change radically with potentially largely disastrous consequences for humans (Retallack 2005) and the first human-induced massive extinction of biota (Thomas *et al*. 2004). Even with a complete and immediate switch to renewable energy the Earth would continue to warm and sea level to rise for decades due to the time lags built into the system (Houghton *et al*. 2001). Solutions to the effects of climate change on waterbirds and other fauna require changes in human behaviour. A useful first step would be to radically change the discounting philosophy that gives a very low value to long term benefits and makes politicians reluctant to affect present economic growth for even major long term benefits (Henderson & Sutherland 1996).

In the immediate, increasing the production of renewable energy should be seen as an important contribution towards lessening the effects of climate change on habitats and fauna at a broad spatial scale. This should be borne in mind when evaluating the impacts of wind farms on the habitats and fauna found in their footprint areas and vicinity.

5. ONSHORE : SPECIES ACCOUNTS

5.1 Onshore Species

The planned location of the substation connecting to overhead wires from Sizewell Nuclear Power Station is in a field lying immediately adjacent to part of the Leiston-Aldeburgh Site of Special Scientific Interest (SSSI), part of the Sandlings Special Protection Area (SPA). This SPA is designated for its national importance for breeding European Nightjars and Wood Larks *Lullula arborea* (Stroud *et al.* 2001).

A list of all species found during surveys of the onshore study area (including some seabirds seen from shore) is given below together with information on the species' conservation status (Sandlings SPA, EC Annex 1, WCA Schedule 1 and UK Biodiversity Action Plan (UKBAP) species, status under the Birds of Conservation Concern list: Gregory *et al.* 2002).

Species	Scientific name	Annex 1	WCA	SPA	UKBAP	BOCC
Northern Gannet	*Morus bassanus*					AMBER
Great Cormorant	*Phalacrocorax carbo*					AMBER
Shelduck	*Tadorna tadorna*					AMBER
Sparrowhawk	*Accipiter nisus*					
Red-legged Partridge	*Alectoris rufa*					
Pheasant	*Phasianus colchicus*					
Lapwing	*Vanellus vanellus*					AMBER
Mediterranean Gull	*Larus melanocephalus*	YES	YES			AMBER
Black-headed Gull	*Larus ridibundus*					AMBER
Mew (Common) Gull	*Larus canus*					AMBER
Lesser Black-backed Gull	*Larus fuscus*					AMBER
Herring Gull	*Larus argentatus*					AMBER
Black-legged Kittiwake	*Rissa tridactyla*					AMBER
Sandwich Tern	*Sterna sandvicensis*	YES				AMBER
Common Tern	*Sterna hirundo*	YES				
Little Tern	*Sterna albifrons*	YES	YES			AMBER
Feral Pigeon	*Columba livia*					
Stock Dove	*Columba oenas*					AMBER
Common Woodpigeon	*Columba palumbus*					
Eurasian Collared Dove	*Streptopelia decaocto*					
European Turtle Dove	*Streptopelia turtur*				YES	RED
Common Cuckoo	*Cuculus canorus*					AMBER
Barn Owl	*Tyto alba*		YES			AMBER
European Nightjar	*Caprimulgus europaeus*	YES		YES	YES	RED
Common Swift	*Apus apus*					
Green Woodpecker	*Picus viridis*					AMBER
Great Spotted Woodpecker	*Dendrocopos major*					
Wood Lark	*Lullula arborea*	YES	YES	YES	YES	RED
Sky Lark	*Alauda arvensis*				YES	RED
Barn Swallow	*Hirundo rustica*					AMBER
House Martin	*Delichon urbicum*					AMBER
Meadow Pipit	*Anthus pratensis*					AMBER
Pied Wagtail	*Motacilla alba*					
Winter Wren	*Troglodytes troglodytes*					
Hedge Accentor (Dunnock)	*Prunella modularis*					AMBER

European Robin	*Erithacus rubecula*					
Stonechat	*Saxicola torquatus*					AMBER
Common Blackbird	*Turdus merula*					
Song Thrush	*Turdus philomelos*				YES	RED
Mistle Thrush	*Turdus viscivorus*					AMBER
Cetti's Warbler	*Cettia cettia*		YES			
Lesser Whitethroat	*Sylvia curruca*					
Whitethroat	*Sylvia communis*					
Garden Warbler	*Sylvia borin*					
Blackcap	*Sylvia atricapilla*					
Common Chiffchaff	*Phylloscopus collybita*					
Willow Warbler	*Phylloscopus trochilus*					AMBER
Goldcrest	*Regulus regulus*					AMBER
Long-tailed Tit	*Aegithalos caudatus*					
Coal Tit	*Parus ater*					
Blue Tit	*Parus caeruleus*					
Great Tit	*Parus major*					
Eurasian Treecreeper	*Certhia familiaris*					
Black-billed Magpie	*Pica pica*					
Eurasian Jackdaw	*Corvus monedula*					
Rook	*Corvus frugilegus*					
Carrion Crow	*Corvus corone*					
Common Starling	*Sturnus vulgaris*					RED
House Sparrow	*Passer domesticus*					RED
Chaffinch	*Fringilla coelebs*					
European Greenfinch	*Carduelis chloris*					
European Goldfinch	*Carduelis carduelis*					
Common Linnet	*Carduelis cannabina*				YES	RED
Common Bullfinch	*Pyrrhula pyrrhula*				YES	RED
Yellowhammer	*Emberiza citrinella*					RED

Table 5.1-1 Species recorded within the onshore study area and designations regarding their conservation status.

Individual species accounts and impact assessments are provided for all Sandlings SPA, EC Annex 1, WCA Schedule 1, UK BAP and BoCC red list species for which breeding evidence was found during surveys, as well as European Nightjar, a designated feature of the Sandlings SPA and an EC Annex 1, UK BAP and BoCC red list species. Where species were seen but not considered to be breeding, no species account is present.

5.2 Onshore species accounts

5.2.1 European Turtle Dove

During the current surveys, two territories were found; one to the west of the proposed site for the substation (to the south of Halfway Cottages on the Sandlings SPA) and the other in a field to the south of the nuclear power station complex. This second territory, however, only consisted of one singing male and another bird, both observed on visit E (13 June).

5.2.2 Barn Owl

Although largely a nocturnal and crepuscular species, Barn Owls can be active during the day in the breeding season. Only one Barn Owl was observed during the six visits, during visit E (13 June) from the fields between the power station and Broom Covert, approximately 700 m north west of the proposed substation site.

5.2.3 European Nightjar

European Nightjar is one of the birds for which the Sandlings SPA is designated. According to the 2004 Breeding Nightjar Survey, none of the 1 km squares (including the substation site) directly affected by the onshore developments have habitat deemed to be suitable for breeding European Nightjars.

5.2.4 Wood Lark

During the survey on visit C (23 May), one singing bird circled over the proposed substation site. No further records of Wood Lark were obtained during the subsequent three visits.

5.2.5 Sky Lark

In the current survey Sky Lark held 15 to 16 territories in the area. Two were centred on the proposed substation site and with a third territory encompassing part of this site. The other territories stretched over much of the area surveyed, from the beach in the east through to the field north of Halfway Cottages in the west. The majority of the territories (at least 10) were south of the beach access road.

5.2.6 Song Thrush

In the current survey, Song Thrushes were considered to be holding three territories, though none were located at the site proposed for the substation.

5.2.7 Cetti's Warbler

During the current survey there were three registrations in the area. Two (visits D and F, 31 May and 24 June respectively) were from the wet carr woodland near to the nuclear power station complex, and are thought to constitute one territory. The local Suffolk Wildlife Trust warden verified previous records of singing birds in this locality (Alan Miller, *pers. comm.*). The third registration (visit C, 23 May) came from near Home Farm, along the minor road that runs south from the Sizewell Beach access road. This would seem to be unsuitable habitat, being a dry location, and may relate to a wandering bird, perhaps even the same territorial bird as found on earlier visits.

5.2.8 Common Starling

Small flocks, perhaps family parties, were encountered regularly on the beach and car park area on onshore surveys. Breeding was concentrated on the houses near to the beach (*i.e.* Sizewell village itself) and the nuclear power station complex. Approximately five pairs were associated with the village and a similar number with the power station complex. In addition, a further pair was associated with Halfway Cottages and small flocks were also encountered in the SPA adjacent to the site proposed for the substation.

5.2.9 House Sparrow

During the current surveys, as with Starling, House Sparrow colonies were centred on Sizewell Village and Halfway Cottages. Approximately 10-12 pairs were centred on the village, with a further two or three pairs to the south. There were a further five pairs or so at the cottages. The birds were also frequently encountered on the beach in small flocks.

5.2.10 Common Linnet

In the current survey, Common Linnet were concentrated along the beach and hinterland, although one bird was singing on the SPA close to the site proposed for the substation (and a few other birds were also seen in that area). Common Linnets range widely during the breeding season and it is difficult to estimate breeding densities accurately. There could be up to 20 pairs along the coastal fringe from the nuclear power station to the caravan park to the south.

5.2.11 Common Bullfinch

During the current surveys a pair was located on one visit only, visit D (31 May), just south of Home Farm. With the rules for a reduced visit survey this would constitute a territory.

5.2.12 Yellowhammer

Yellowhammers were deemed to be holding eight territories on these surveys. Four of these were located on the SPA land to the south and west of the proposed substation site. Of the other four, three were in fields south-west of the power station and the fourth was along the Sizewell road.

5.2.13 Other species breeding in the vicinity of operations

A number of other species use the land that may be affected by the cable route and substation, including for nesting.

Black-legged Kittiwake have resorted to nesting on man-made structures on the Suffolk coast, due to a lack of coastal cliff habitat, including two inshore towers on the coast off Sizewell Power Station. Counts from the shore during the current survey, indicated approximately 100 nests on the three landward sides of the more southerly tower and about 50 nests on the more northerly. However, it was not possible to view the seaward side of these towers from the land.

On the beach and hinterland, to the south of the Sizewell road, Winter Wren, Stonechat, Hedge Accentor (Dunnock), Pied Wagtail, Chaffinch, Common Blackbird, Meadow Pipit, European Goldfinch, Whitethroat and European Robin were all encountered at least once during the six visits, and could all be nesting on the beach or vegetated bank behind the beach. In particular, Whitethroat, Meadow Pipit, Winter Wren, Stonechat (as well as Sky Lark and Linnet) all nest at or near ground level (Harrison & Castell 2002) and would be particularly susceptible to the cabling operation.

One or more pairs of Black Redstart are thought to nest in the power station complex (Wright 2003, 2004) although it is difficult to confirm successful breeding. No birds were seen during the six visits, despite searching from outside the power station complex.

Fewer birds were associated with the fields along the south side of the road where the cable would be laid. Chaffinch, Common Blackbird, Whitethroat, Hedge Accentor (Dunnock), Common Wood Pigeon, Pied Wagtail and Blue Tit were observed in this area and some of these could be breeding in or at the base of the hedgerow. Only Sky Lark would be breeding in the fields themselves. Some of these species were also encountered in the field where the substation could be built, but again only Sky Lark would actually be breeding in the field.

5.2.14 Summary of territories of species of conservation concern

Table 5.2-1 shows the number of territories recorded in the onshore study area for species of conservation concern. It is suggested that two bird registrations are necessary to reveal a territory, and figures based on this rule appear under 'method 2' in the table. 'Method 1' shows territory numbers assuming one bird registration is sufficient to reveal one territory.

It should be noted that for species such as Common Starling, House Sparrow and Common Linnet, allocation of territories to pairs is difficult, as these species are frequently seen in flocking parties. See Appendix 3 for explanation of territory enumeration for these species.

Species	Territories (method 1)	Territories (method 2)
European Turtle Dove	2	1
Barn Owl	1	Present
European Nightjar	0	0
Wood Lark	1	Present
Sky Lark	16	15
Song Thrush	3	3
Cetti's Warbler	2	1
Common Starling	32	14
House Sparrow	23	17
Common Linnet	27	14
Common Bullfinch	1	1
Yellowhammer	8	8

Table 5.2-1 Territories found within onshore survey area for species of conservation concern. Method 1 assumes one bird registration represents a territory. Method 2 is preferred and assumes two bird registrations are necessary to be recorded as a breeding territory. 'Present' under this method reflects a singular bird registration (see Appendix 3).

6. BASELINE CONCLUSIONS

6.1 Limitations of methods

There were noteworthy limitations in the methods employed to calculate both offshore abundance estimates and bird distribution, which should be considered when interpreting the results.

Perhaps the most significant disadvantage is that in a number of months, surveys were incomplete or not carried out, generally owing to adverse weather conditions. Thus, boat surveys for October, January and February were not feasible, and such months are likely to show amongst the highest densities of waterbirds such as Red-throated Divers, Herring Gulls and Great Black-backed Gulls (Carter *et al*. 1993).

Distance sampling was effective in many cases, with estimates generated for many species. However, it was often not possible to generate separate estimates for counts within and without the specific area dedicated to the wind farm for comparison to the reference area, due to insufficient and skewed data. Estimates were generated for the entire reference area as a 'worst case scenario'; as most species showed little importance even at this expanded scale, it is safe to assume that in most cases distance estimates for the specific wind farm area would be even lower. Also, where distance estimates were not possible, correction factors were used after Stone *et al*. (1995). These multipliers go some way to estimate the proportion of birds missed by counters, but do not allow confidence limits to be generated.

Finally, the kriging methods used to examine distributions were perhaps not entirely suited to these types of surveys, though they do allow intuitive visual assessment of 'hotspots'. Sampling within the reference area was not random but on predetermined transects, and furthermore for much of the time on these transects no birds were recorded. However, one effect of smoothing interpolated surfaces is that a value will be assigned to every location – clearly not accurate at the transect line where no birds were encountered.

6.2 Bird abundance and distribution in the Greater Gabbard area

Very few species were estimated to occur in numbers approaching national importance in the Greater Gabbard area, even when considering the entire survey areas of 730 km^2 and 1,060 km^2 employed by the later boat surveys and the aerial surveys. Red-throated Divers were estimated to be present in nationally important numbers on one survey only (March 2004), whilst Black-throated Divers were recorded in similarly important numbers (depending on choice of threshold) on the same survey. These results were not repeated in the second winter of survey, however. Lesser Black-backed Gulls were estimated to occur in nationally important numbers on one occasion (March 2005), whilst Great Black-backed Gull estimates approached national importance (0.94%) in December 2004. Great Skua peak estimates on one occasion exceeded the national importance threshold; as this count was in September, it may have included birds on passage.

For many species (Northern Fulmar, Northern Gannet, Great Skua, Black-legged Kittiwake, Common Guillemot, Razorbill) it was not possible to accurately assess winter numbers in the context of national importance given that wintering estimates have never been made, owing largely to their wide marine dispersal in the non-breeding season. By the same token, such species might be expected to be mobile and scattered in their locational preferences and thus assessment in such context may not be meaningful. Instead, breeding population thresholds were used as a surrogate. Using this threshold, none of these species were estimated to occur in nationally important numbers in the study area.

As mentioned, Lesser and Great Black-backed Gulls were estimated to occur in numbers substantial enough to approach or exceed national importance. Of the other gull species, Black-headed and Mew Gull were both rarely recorded, with only a few individuals estimated in the winter. Herring Gulls were absent in the summer, but were estimated in the order of hundreds during winter. This is likely to be an effect of breeding birds from across Europe wintering in the North Sea.

An assessment of regional importance was made, based on numbers estimated to be present in the Greater Gabbard study area and the neighbouring study areas in the wider Thames offshore region, using winter aerial surveys. This technique suggested that many of the marine species for which wintering estimates are not known did occur in at least regionally important numbers. For example, within the Greater Gabbard study area, peak winter numbers of the nomadic seafaring Northern Fulmar and Black-legged Kittiwake represented 93% and 45% of the regional total peak numbers respectively. Other species deemed to be at least regionally important included Northern Gannet, Mew Gull, Herring Gull, Great Black-backed Gull and the auks.

Some sensitive and threatened marine species, such as Common Scoter and Sandwich Tern, were rarely seen in the Greater Gabbard area by either survey method. It does not appear that this area holds any value for wintering seaducks or breeding terns. Furthermore Great Cormorants (and European Shags) were scarcely seen, as these species must remain near to the coast in order to find perches to dry their plumage.

Distribution of birds, plotted as average count per individual count location for two winters and one summer, seemed to be fairly even for most species. Of those species estimated to be present in the study area in nationally important numbers, diver species in particular seemed thinly distributed and showed little evidence of intensive aggregation. Lesser Black-backed Gulls, and to an extent Great Black-backed Gulls, did however show evidence of some 'hotspots' of distribution, and often these were situated in or near the area known as The Galloper. In reality these hotspots were likely to reflect the presence of large feeding flocks of gulls, which sometimes totalled 300 birds. Whether these flocks are particularly reliant on the area in and around The Galloper, or whether such flocks move in response to fish movements is unclear. Fish surveys and modelling the relationship between gulls, water depth, sediments and fishing boats may help to clarify the issue.

It is perhaps worth noting that species with similar foraging ecologies (surface feeders and plunge-diving piscivores) showed some similar patterns of distribution at different times of year, with The Galloper area showing highest average count densities for species including Fulmar, Northern Gannet, Herring Gull and Black-legged Kittiwake. Whether flocks and individuals of these species are particularly reliant on the area in and around The Galloper, or whether such birds move in response to fish movements is unclear. Fish surveys may help to clarify the issue.

Auks, whether analysed as a species group or as Common Guillemots and Razorbills separately, showed a widely dispersed and thinly distributed pattern, perhaps unsurprising for a taxon which is widespread throughout marine areas, and somewhat nomadic in its behavioural habits.

6.3 Onshore bird abundance and distribution

A number of breeding birds of conservation importance were found during the onshore surveys in a wide study area that included the beach at Sizewell and fields close to the proposed cable route and substation. These were European Turtle Dove, Barn Owl, Wood Lark, Sky Lark, Song Thrush, Cetti's Warbler, Common Starling, House Sparrow, Common Linnet, Common Bullfinch and Yellowhammer.

Three Sky Lark territories were found in the field comprising the second proposed substation site and Common Starling and Yellowhammer territories were in adjacent land.

Several other species probably nest in the area to be used for cabling and construction of the substation. In addition, Black-legged Kittiwake nests in locally important numbers on the towers to the north of the cable landfall, and Black Redstarts nest in the power station complex, although none were seen during the survey despite targeted searching.

6.4 General conclusions

No species were found to be of international importance within the offshore study area, and very few species were considered to be of national importance within the wind farm study area, only winter estimates of Red-throated Diver and Lesser Black-backed Gull, plus a September estimate of Great Skua reaching the 1% national importance threshold. It should be noted, however, that on only singular occasions did these estimates exceed the threshold, and so passage movements cannot be ruled out as a factor contributing to these high figures. Furthermore, these estimates are for the entire study area. Dividing the relative area of the wind farm by the entire study area leads to proportional estimates for the wind farm area that are below the 1% national importance threshold for all three species.

Eight species were judged to be of wintering regional importance within the aerial survey study area TH3, when compared with the neighbouring study areas covering the entire offshore area from the Thames to the Norfolk coast. Red-throated Diver, Northern Fulmar, Northern Gannet, Mew Gull, Herring Gull, Great Black-backed Gull, Black-Legged Kittiwake and the auks (Common Guillemot and Razorbill) were estimated to be of regional importance, with Northern Fulmar and Black-legged Kittiwake occurring in particularly noteworthy proportions (93% and 45% respectively). Proportional estimates of those birds in the wind farm area itself led to three of these species remaining in numbers above 50 and in excess of the 1% regional threshold (Northern Fulmar 13%, Kittiwake 6.4%, auks 1.8%). Migrant numbers were fairly low, only Starlings occurring in large flocks during November 2004.

Although many different species were seen on onshore surveys, few species had established territories in the field where construction of the substation is proposed. Three Sky Lark territories were found in the area of the proposed substation, with further species on adjacent habitat in the Sandlings SPA.

7. ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Introduction

Baseline data on the bird species using the study area and wind farm area and their conservation status have been used to assess the potential effects on these species of the proposed development. Direct and indirect, temporary and long-term effects are considered, and these are put in context using information from other studies, either predictive or of existing operational wind farms.

This section has the following aims:

- To describe the factors that might affect the bird populations using the areas of the proposed wind farm and onshore substation and describe their potential effects (subsections 7.3 and 7.4).

- To assess the Significance of these impacts on species of importance in the offshore and onshore areas (subsection 7.5).

The assessment is based on the wind farm boundaries presented earlier, comprising two arrays of up to 140 wind turbines in total.

7.2 Assessment Methodology

The determination of the Significance of the ornithological effects described below is based on the Environmental Assessment Regulations 1999 and Institute of Environmental Assessment guidelines (IEA 1995) and follows the methodology developed by Scottish Natural Heritage (SNH) and the British Wind Energy Association (BWEA) (Percival *et al.* 1999).

The effect is firstly dependent upon the Sensitivity of each species, as defined below:

Sensitivity	Definition
Very High	Bird species for which an SPA or SAC is designated or a SSSI notified
High	Other bird species that contribute to the integrity of an SPA or SSSI Species of international or national importance, i.e. those whose numbers surpass 1% of international or national populations (see baseline methods) Ecologically sensitive species, e.g. large birds of prey or nationally rare species (< 300 breeding pairs in the UK)
Medium	Species of regional importance (see baseline methods) EU Birds Directive Annex 1 species, EU Habitats Directive priority habitat/species and WCA Schedule 1 species (if not covered above) UK BAP species (if not covered above)
Low	Any other species of conservation interest, such as those on the Birds of Conservation Concern lists (if not covered above)

Table 7.2-1 Definitions of terms relating to the "Sensitivity" of the ornithological features of the site (Percival *et al.* 1999).

The sensitivities of different species are assessed on the basis of existing designations and the results of surveys. For example, the proposed onshore works lie adjacent the Leiston-Aldeburgh SSSI / Sandlings SPA, though the offshore development could also affect birds, such as Lesser Black-backed Gulls, from the nearby Alde-Ore SPA.

The Magnitudes of effects are assessed as follows:

Magnitude	Definition
Very High	Total loss or very major alteration of key elements/features of the baseline (pre-development) conditions such that post-development character/composition/attributes of baseline condition will be fundamentally changed and may be lost from the site altogether Guide: >80% of population/habitat lost
High	Major alteration of key elements/features of the baseline conditions such that post-development character/composition/attributes of baseline condition will be fundamentally changed Guide: 20-80% of population/habitat lost
Medium	Loss or alteration to one or more key elements/features of the baseline conditions such that post-development character/composition/attributes will be partially changed Guide: 5-20% of population/habitat lost
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernable but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns Guide: 1-5% of population/habitat lost
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the "no change" situation Guide: <1% of population/habitat lost

Table 7.2-2 Definitions of terms relating to the "Magnitude" of ornithological effects (Percival *et al.* 1999).

In this study, Magnitudes of effects are assessed in relation to the populations of birds using the wider Thames offshore region, thus, for example, a Very High Magnitude effect would be one which resulted in the loss of 80% of the regional population of a species.

The combined assessment of Sensitivity and Magnitude to provide the level of Significance of an Impact is assessed by the matrix below:

		SENSITIVITY			
MAGNITUDE		Very High	High	Medium	Low
	Very High	Very High	Very High	High	Medium
	High	Very High	Very High	Medium	Low
	Medium	Very High	High	Low	Very Low
	Low	Medium	Low	Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low

Table 7.2-3 Impact matrix of "Significance" (Percival *et al.* 1999).

Effects of Very Low or Low Significance are not normally of concern. In contrast, effects considered Very High or High should be regarded as of importance for the purposes of environmental impact assessment. Effects of Medium Significance may still be of importance, though in comparison to effects of Very High or High Significance may be mitigated against more readily.

7.3 Description of Effects – Disturbance / Habitat Loss

In addition to the possible risk of collision with turbines (as well as towers and other ancillary structures) – which is considered separately below – the principal impacts from the development which might affect birds are:

In relation to the offshore works:

1. The effects of noise and vibration during wind farm construction and decommissioning

2. Direct habitat loss due to the placement of turbines

3. Indirect habitat loss through disturbance from the turbines

4. The attraction of birds to lit structures

5. Increased prey availability and the provision of roost structures

In relation to the onshore works:

6. The effects of intertidal works on wading birds

7. The effects of the construction of the onshore electrical infrastructure – disturbance and habitat loss

The effects of noise and vibration during wind farm construction and decommissioning

Effects of construction noise are likely to be greatest if turbines are to be supported by monopiles, due to the impact energy required to install them. The noise of this may lead to a displacement of birds (and the fish that they forage on) away from the wind farm area and thus at least during the period of work an effective loss of habitat. In one previous study of construction work disturbance effects on birds at an offshore wind farm, no significant effects were recorded (Christensen *et al.* 2004), though bird numbers were inherently low. Disturbance resulting from construction activities will be temporary – though the rates at which birds return to the area after the cessation of activities are unknown.

Construction work disturbance effects will vary between species and are considered in more detail in species accounts below. For example, disturbance may be especially important for divers and auks during moulting periods when these species are flightless. Mitigation measures (Section 9) may help reduce the effects of disturbance during this phase (see for example Noer *et al.* 2000) and subsequent decommissioning.

Direct habitat loss due to the placement of foundations

The placement of turbines, whether using monopile, multipile or gravity based foundations will lead to habitat loss on the seabed. The maximum loss of seabed relates to the gravity base, equivalent to 2,290 m^2 per base, 320,600 m^2 for the 140 bases. Likewise, the analyses of coastal processes have shown that there will be some changes in sediment and current movements around the foundations, although these effects are restricted to individual distinct structures. These changes may affect both the benthic fauna and fish populations and are considered elsewhere within the Environmental Statement. Any loss of food resources resulting from these changes is considered to be of Negligible Magnitude for the bird populations using the area (as the habitat loss equates to less than 1% of the total area of the proposed wind farm).

As none of the species found in the offshore study area is a Very High Sensitivity species, these effects will be only of Very Low Significance and thus they are not considered of concern or therefore discussed in any further detail.

Indirect habitat loss through disturbance / disruption of flight-lines

In comparison to disturbance during the construction phase, disturbance during the operational period may have more potential for effects on birds. Birds may be disturbed both by the turbines themselves and by boat traffic during maintenance visits. The effects of this disturbance can be twofold:

- *Barrier Effect:* disruptions to the flight-lines of birds due to the barrier presented by wind farms may lead to an increase in the energetic costs of the daily movements of birds or of migrants (Tulp *et al.* 1999, Pettersson & Stalin 2003). Tulp *et al.* (1999), for example, found that Common Eiders didn't fly between turbines that were placed 200 m apart at the Tunø Knob in the Kattegat; Desholm & Kalhert (2005) similarly reported that migrant wildfowl diverted around the Nysted wind farm. In contrast, gulls have been found to regularly fly between turbines (e.g. Painter *et al.* 1999). In the present proposal there will be a minimum distance of 650 m between turbines.

- *Indirect Habitat Loss:* avoidance of the turbines will lead to an effective loss of habitat (Desholm & Kalhert 2005), not just of the wind farm area but a buffer zone area around it – up to a maximum of 800 m (Percival 2005). It is possible that birds resident in the area during either the summer or winter may become habituated to the wind farm area, though this has not yet been proven for offshore wind farms. Stewart *et al.* (2005) reviewed existing wind farm studies and found some evidence that wildfowl experience greater declines in abundance in response to wind farms than other bird groups.

Here, a hypothetical worst case approach is taken in which disturbance from the wind farm is assumed to lead to complete avoidance of the wind farm area (and a buffer zone of 800 m) and that there is no habituation. The Magnitude of the effect of this avoidance will depend on the availability of habitat / resources (i.e. food) elsewhere and the birds' behaviour and will thus vary between species. Effects will be at their worst should the species' local population be completely dependent on the habitat in the proposed wind farm area and therefore likely to experience 100% mortality following displacement. Should other areas of suitable habitat exist locally, then effects on birds' probability of survival will be lessened. However, if these areas were limited in quality or extent and already occupied, then increased densities may lead to intense competition for available resources (Goss-Custard 1985; Goss-Custard *et al.* 2002) and thus increased mortality and a decline in the size of the local population.

The Magnitudes of disturbance effects are thus assessed in light of the availability of alternative habitat in the region, determined by looking at the size and distribution of the regional populations of each species. Clearly, this is a simplistic approach and ideally an assessment should be made with information on food availability throughout the region and a working knowledge of how birds are distributed in relation to this (see section on current and future work), while also assessing the impacts of other developments.

Effects of an indirect loss of habitat through disturbance should be considered in light of other wind farm developments in the southern North Sea – see section on cumulative impacts.

The attraction of birds to lit structures

Lighting around offshore structures, such as oil platforms, may benefit seabirds in that it may help with nocturnal prey location and may even attract fish to the area. The resulting aggregations, however, may lead to mortality due to collisions with the structures and oil flares (Sage 1979, Hope-Jones 1980, Tasker *et al.* 1986, Wiese *et al.* 2001). The lighting on turbines may not lead to such aggregations as the yellow flashing lights will have a restricted range and will be located at least 12 m above the high water level.

In certain weather and lunar conditions, though, birds may be attracted to lights and evidence from studies of lighthouses show that this can cause high levels of mortality (Verheijen 1981, Jones & Francis 2003). Clearly any attraction to lighting in the wind farm is likely to increase the risks of collision with the turbine blades and structures, particularly for nocturnal migrant passerines. As well as attracting birds to the rotor blades, attraction to lights can lead to energy loss and exhaustion (*e.g.* Gauthreaux & Belser 1999; references in Kingsley & Whittam 2003). However, it is unlikely that additional mortality resulting from collisions following attraction to the lights of a wind farm will appreciably add to the high background annual mortality rates typical amongst such species unless very many birds were regularly passing through the wind farm area.

Assessment of any additional effects on birds of their attraction to lit structures is considered within the appraisal of collision risk.

Mitigation against the effects of lighting in the wind farm is considered in Section 9.

Increased prey availability and the provision of roost structures

The turbines' foundations and any scour protection may provide a novel sublittoral habitat, which may act as an artificial reef attracting the settlement of marine invertebrates. This may thus benefit fish and birds. If, for example, shellfish beds develop, more seaducks such as Common Scoter could begin to exploit the resource. Furthermore, as human fishing activity may be affected within the Greater Gabbard area, it is possible that elevated levels of prey from reduced competition could make the wind farm area potentially attractive to foraging waterbirds (Kingsley & Whittam 2003).

Nevertheless, as the foundations will only cover a limited area (dependent on design) and the extent of the resultant food resource is thus likely to be too small to attract appreciably larger concentrations of birds.

The turbines may provide platforms for perching and roosting birds, thus attracting birds to the area that would not have exploited it previously, e.g. gulls and cormorants (as has been seen in studies of the Danish wind farms at Nysted and Horns Rev). Irrespective of changes in food supply there may thus appear to be a small apparent benefit for these species.

In addition, for some migrant species, the turbines may also provide roosting sites and be of particular benefit for tired individuals during periods of poor visibility. However, the risks that the turbines pose, particularly for nocturnal migrants (see above) are likely to outweigh these benefits.

The overall benefits of increased prey availability and the provision of roost structures are considered to be of Negligible effect and, as none of the species found in the area is a Very High Sensitivity species, thus of Very Low Significance for all the species found in the offshore study area and, therefore, are not considered further.

The effects of intertidal works on waterbirds

The transmission of power generated by the Greater Gabbard Offshore Wind farm will require four cables to be lain within the seabed. These cables are planned to come ashore between Sizewell village and Sizewell Hall. The intertidal area here is narrow and composed of shingle and thus provides few food resources for wintering waders or other waterbird species (the majority of which prefer the muddy sediments of estuaries). The shingle beaches along the Suffolk coast provide breeding habitat for Ringed Plovers *Charadrius hiaticula* and terns, though present disturbance levels close to Sizewell (general beach activity, dog walking etc) preclude this – indeed, though three species of terns were recorded during onshore surveys none was found to be nesting in the survey area.

The effects of intertidal works are thus considered to be of Negligible Magnitude and of Very Low Significance for the bird species using the area.

Nevertheless, it is important that the intertidal area is surveyed for any nesting activity prior to the commencement of and during construction work (and appropriate measures taken if necessary) to ensure that disturbance to breeding birds is kept to a minimum.

The effects of the construction of the onshore electrical infrastructure – disturbance and habitat loss

From the intertidal area, the four cables will follow a route to the south of the Sizewell Gap road inside the hedgerow of the adjacent fields to a substation built on arable land by Halfway Cottages. Topsoil strip and earthmoving activities will take place during the summer (March to September) to avoid unnecessary mud on roads, soil washout from prolonged rain, slumping of banks, bunds and stockpiles and the increased potential for pollution incidents.

The effects on birds of the construction of the onshore electrical infrastructure and of the resultant habitat loss are considered separately in the individual species accounts.

Construction work disturbance

The cable route will cross the road to Sizewell Hall and then proceed along the south of the Sizewell Gap road. The corridor containing the trenches for the four cables will be approximately 12 m wide.

The substation itself will be lowered in the field by Halfway Cottages and then screened by an engineered earthen bund and plantings of small native trees and shrubs. Within the site there will be three 400/132 kV transformers, 132 kV switchgear and buildings. A new access road will also connect the site with the existing Sizewell Gap road.

The laying of cables from the intertidal area to the substation and the construction of the substation itself are likely to have some disturbance effect on the birds in the area and this is likely to be greatest during the breeding season. The proposed site for the substation lies just outside the Leiston-Aldeburgh SSSI / Sandlings SPA. Due to its proximity, the possible effect of construction work on the designated features of this SPA – European Nightjars and Wood Larks – are considered as well as on other species of conservation importance breeding in the area. Both European Nightjars and Wood Larks have recently been shown to be at risk of decreased densities and breeding failure in areas of high disturbance (Liley & Clarke 2002, 2003, Taylor 2002).

The potential effects of the construction work are twofold. Firstly, there will be direct disturbance due to the noise, vibration, lighting and visual intrusion of the work (see reviews of effects of disturbance on birds by Hockin *et al.* 1992 and Hill *et al.* 1997). Secondly, there will be a temporary loss of habitat, both along the route of the cable laying due to excavation work and also around the substation itself.

In general, birds are less disturbed by vehicles than people and by continual noise than sudden / intermittent noise. Given the short time-scale of the works, though, it is unlikely that birds will habituate to the disturbance and in this assessment, it is assumed that disturbance from the construction work will lead to complete avoidance and thus an effective loss of habitat for its duration. The lighting of the site also needs to be considered, as this may affect the behaviour of nocturnally feeding European Nightjars and it is important that lighting is directed away from the adjacent SPA.

The effects of both disturbance and the direct loss of habitat are short-term and considered to be of Negligible Magnitude for all species of conservation importance in the area. However, as topsoil strip and earthmoving activities will take place during the summer (March to September) to avoid unnecessary mud on roads, soil washout from prolonged rain, slumping of banks, bunds and stockpiles and the increased potential for pollution incidents, mitigation options for the potential disturbance to breeding birds are considered later.

Habitat loss

The construction of the substation will lead to the loss of 1.5 ha of the arable field by Halfway Cottages. However, the remainder of this field (6.5 ha) will be restored to heathland or acid grassland habitat to compensate for the impact of the development within the Suffolk Coast and Heaths Area of Outstanding Natural Beauty (see project description and Section 9 "Mitigation Measures" for more details). The substation will also be screened by an earthen bund planted with small trees and shrubs and the substation boundary planted with native species such as hawthorn and blackthorn.

As with the possible effects of construction work, the effects of habitat loss are considered for European Nightjars and Wood Larks, i.e. the designated features of the neighbouring Leiston-Aldeburgh SSSI / Sandlings SPA, as well as other species of conservation importance breeding in the area.

7.4 Collision Risk

This section provides an assessment of the risk to birds of collision with turbine rotors. Estimation of these risks is highly dependent on the avoidance rate assumed for birds approaching turbines (Chamberlain *et al.* 2005). Here we assume three different rates, a high rate, a medium rate – considered realistic – and for illustrative purposes, an extreme low avoidance rate. The latter is in our judgement considered highly unrealistic (and beyond the range considered by comparable offshore assessments: Hydrosearch 2002, GREP UK Ltd 2002, RPS 2005) but is shown to highlight the important influence of these rates on the calculation of collision risk. The scenario used in the final assessment takes the numbers of birds at risk from boat survey data – which unlike aerial surveys did not appear to underestimate bird numbers – but uses a credible medium avoidance rate.

Estimation of the risk of collision with turbines within the wind farm uses the Collision Risk Model (CRM) developed by Band (2000; also Band *et al.* in press). This model is based on mechanical rather than biological grounds in that it assumes that no avoidance action is taken by the birds flying towards turbines. However, recent studies and reviews have suggested that, for most wind farms, avian collisions with turbines are actually uncommon (Langston & Pullan 2003, Percival 2005, Pettersson 2005, though see Thelander *et al.* 2003, Barrios & Rodriguez 2004). In many cases birds do take avoiding action – either of the wind farms in their entirety or of individual turbines as they are approached (Desholm & Kalhert 2005).

The CRM was used to estimate diurnal collision probabilities and mortality rates of three species recorded on boat surveys within the Greater Gabbard: Red-throated Diver, Lesser Black-backed Gull and Great Skua. These three species were selected for detailed analysis as they were recorded in nationally important numbers in the study area and thus assessed to be of High or Very High Sensitivity; the issue of collision risk, is, however, further discussed for other species recorded, in light of the numbers of birds recorded in flight, their flight altitude, and other factors relating to predicted sensitivity to offshore wind farms.

It should be noted, in determining the Significance of the effects of collisions, that seabirds are long-lived birds with relatively low reproduction rates and thus even small changes in mortality could lead to population change / decline. It is important, therefore, to assess the mortality from collisions in relation to normal background mortality rates.

The first stage of the modelling process is to determine the risk of a bird being struck by a turbine blade (mortality is assumed after such a strike) if it flies in a straight line through the plane of the rotors and takes no avoiding action. Model input parameters used for this calculation include bird dimensions and speed, and operational measures of the wind turbines (Table 7.4-1). (A worst case scenario of turbines with a maximum rotor diameter of 150 m is assumed, though the predicted rotor diameter is 130 m). Bird dimensions were derived from Robinson (2005). Bird speeds were taken from Campbell and Lack (1985) and Pennycuick (1997). Lesser Black-backed Gull speed is not given in either source, but was assumed to be the same as Herring Gull.

Input variable	**Units**
Maximum chord width of rotor	2 m
Pitch angle of rotor	24 degrees
Rotor diameter	150 m
Rotation period	14 rpm
Bird length	Varies by species (m)
Wingspan	Varies by species (m)
Bird Speed	Varies by species (m/s)

Table 7.4-1 Input parameters used to determine strike probability of a bird flying through a wind turbine from the Collision Risk Model (Band *et al.* in press), assuming no avoiding action.

Predicted collision risk from the CRM varies according to whether a bird is flying upwind or downwind. Table 7.4-2 presents collision risks for the three target species that are an average of upwind and downwind models (but note that in each case, variation was within 2%, so this makes little difference to predictions). Collision risk was low in all species, in comparison with calculations from other studies (*e.g.* an average collision risk of 6% for divers, 8% for Gannets and 7% for Black-headed Gulls from Gill *et al.* 2002; see also Chamberlain *et al* 2005). Both Red-throated Diver and Great Skua had estimated collision risks of approximately 5%, whilst Lesser Black-backed Gull was slightly higher at 7.6%. Bird speeds are likely to vary and the published speeds are typically derived from long-distance flights, therefore it seems feasible that birds may fly slower than this in the vicinity of wind farms (Chamberlain *et al*. 2005). Application of a 10% slower speed in each species made relatively little difference (<1%) to the estimated collision risk (Table 7.4-2).

Species	**Collision risk**	**Collision risk (-10% speed)**
Red-throated Diver	0.048	0.052
Lesser Black-backed Gull	0.076	0.084
Great Skua	0.052	0.057

Table 7.4-2 Strike probability of three selected species at Greater Gabbard per flight in a straight line through the plane of the rotors, estimated from the CRM, assuming no avoiding action. Probabilities have been calculated for different bird speeds.

It seems likely that birds will take avoiding action when encountering a wind turbine. To determine collision risk where birds take avoiding action, the collision risk as derived in Table 7.4-2 was simply multiplied by an avoidance rate. Avoidance rates have been calculated by comparing the number of birds flying at risk height through extant wind farms to the number estimated to have died due to collision with turbine blades, the latter often derived from tide line searches for corpses. Avoidance rates calculated in this way have typically been found to be very high (>90% and often nearer 100%). However, there are flaws in the way these avoidance rates are calculated and used, as the rates are likely to vary according to weather conditions, time of day and to the topographical specific conditions of a given site (Chamberlain *et al*. 2005). Here, a range of values are used to represent a range of conditions over which avoidance behaviour may vary. High (0.9999) and medium (0.9982) avoidance rates were based on mortality rates estimated for gulls for (respectively) all records and nocturnal records only from Winkelman (1992) (but note that we are not making any conclusions about nocturnal collision risk at Greater Gabbard – we are merely using the published figure for illustrative purposes). Low avoidance rates (0.87) – considered unrealistic, but used for illustrative purposes – were based on the lowest avoidance rates found for any species in the literature, in this case American Kestrels *Falco sparvarius* in California (Whitfield & Band *in prep*.). Even with the latter scenario of relatively low avoidance rates, estimated mortality rates were very low in all species (for example in comparison to Gill *et al.* 2002) (Table 7.4-3). The highest rate was estimated for Lesser Black-backed Gull with slow flight speed and the lowest avoidance rate, but this was only just over 1% (Table 7.4-3).

(a) Low collision risk (fast flight)

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	4.8×10^{-6}	8.64×10^{-5}	0.0062
Lesser Black-backed Gull	7.6×10^{-6}	13.68×10^{-5}	0.0099
Great Skua	5.2×10^{-6}	9.36×10^{-5}	0.0068

(b) High collision risk (slow flight)

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	5.2×10^{-6}	9.36×10^{-5}	0.0068
Lesser Black-backed Gull	8.4×10^{-6}	1.51×10^{-4}	0.0109
Great Skua	5.7×10^{-6}	1.03×10^{-4}	0.0074

Table 7.4-3 Strike probability of three selected species at Greater Gabbard per flight in a straight line through the plane of the rotors estimated from the CRM, incorporating high, medium and low avoidance rates. Estimates are presented for both fast (a) and slow (b) flight speeds.

The final stage in estimating mortality rates is to combine the probabilities from Table 7.4-3 (for a single bird flying through the turbine area) with the number of birds estimated to be at risk.

To estimate the number of birds at risk, the distance estimate from boat survey data for each species was first multiplied by the percentage of birds recorded in flight on all aerial surveys in the wider Thames area to give a maximum estimate of birds likely to be in flight (Table 7.4-4). Boat survey data were used so as to ensure that bird numbers were not underestimated in this critical assessment as aerial survey counts of some species (especially gulls) were much lower than boat survey counts. This figure was then multiplied by the percentage of flying birds that were estimated (from boat surveys) to be within the height range presented by the turbine rotor blades to give the number flying through the "risk window"– *i.e.* between 30 m and 180 m above sea level (assuming a hub height of 105 m and a maximum 150 m rotor diameter) (Table 7.4-4).

Species	% of birds in flight (all TH area)	% birds within rotor height
Divers	10	0
Skuas	92	11.1
Common Scoter	31	0
Lesser Black-backed Gull	70	6.6
Northern Fulmar	67	0
Northern Gannet	30	0.6
Little Gull	98	0
Common Gull	86	4.2
Herring Gull	91	10.1
Great Black-backed Gull	30	13.8
Black-legged Kittiwake	83	1.5
Auks	4	0

Table 7.4-4 The % of birds of different species recorded in flight (by aerial surveys) and the % of these recorded within rotor height (by boat surveys). Figures for Red-throated Diver, Great Skua, Guillemot and Razorbill are based on all divers, skuas and auks observed respectively. Only one Storm Petrel was recorded during surveys and so this species is not included in this table.

Finally, this figure was multiplied by the proportion of the "risk window" (*i.e.* the wind farm's frontal area) encompassed by the rotors. The size of the "risk window" was calculated as the length of the longest diagonal across the wind farm multiplied by the diameter of the turbine blades and the area presented by the wind farm rotors calculated following Band (2000; also Band *et al.* in press). The final figures calculated thus estimated the numbers of each species considered to be "at risk" of flying through the wind farm's rotors. These figures are shown in Table 7.4-5.

The unit of time used to derive hourly and monthly mortality was considered to be the length of time taken for one bird to cross the width of the wind farm, flying at a representative speed. This unit was considered the most appropriate, as it assumes a conservative approach with a continuous stream of birds through the area (*i.e.* each bird that flies through the wind farm area is replaced by another). Other studies have tended to divide the total number of birds seen by the numbers of hours of observation, to calculate the number of birds passing through each hour. Our approach is stricter as it is assumed that birds passing through the wind farm area do so at the rate at which each species flies.

Site	Species	N summer	N winter	T (*mins*)
All	Red-Throated Diver	0.01	0.67	10.06
	Lesser Black-backed Gull	127.49	175.58	17.28
	Great Skua	93.61	0.00	11.47
Galloper	Red-Throated Diver	0.00	0.00	3.51
	Lesser Black-backed Gull	0.86	1.19	6.03
	Great Skua	1.06	0.00	4.00
Inner Gabbard	Red-Throated Diver	0.00	0.00	6.55
	Lesser Black-backed Gull	4.71	6.48	11.25
	Great Skua	5.81	0.00	7.47

Table 7.4-5 Numbers of birds at risk (N) per unit time (T – minutes), calculated by dividing the distance across the width of the wind farm area (Inner Gabbard = 6.68 km ; Galloper = 3.58 km) by bird flight speed, effectively allowing for bird turnover through area. Note that T is increased when models use lower bird speed. "All" represents the worst case scenario whereby all birds in flight over the whole wind farm area pass through the rotors.

The estimated number of birds struck per unit time in summer and winter and for the two separate parts of the site (Galloper and Inner Gabbard) is given in Table 7.4-6 for the three target species. Red-throated Diver was not recorded flying at risk height in the survey as a whole, so the estimated mortality was 0 for this species. For Great Skua, predicted mortality rates were generally highest of the three species considered. The highest hourly mortality rate predicted (with lowest avoidance rates) was 0.46 at Inner Gabbard in summer. Great Skua was not recorded on the site in the winter. In summer, the highest predicted mortality rates were at Inner Gabbard. Monthly mortality rates were calculated by assuming that there are 10 hours of daylight per day in winter and 14 in the summer and taking a 30 day month. In most cases, estimated mortality was less than one bird per month and usually much less. Mortality was predicted to be high (>100 deaths per month) for Lesser Black-backed Gull and Great Skua when using the very low avoidance rate of 0.87. However, at Inner Gabbard, mortality was predicted to be 1.4 deaths per month for Lesser Black-backed Gull (winter and summer) and 1.8 deaths per month for Great Skua (summer only) with a medium avoidance risk of 0.9982. Details of monthly mortality estimates and all other parameters estimated from the CRM are given in Appendix 4.

(a) Galloper- Winter

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	0	0	0
Lesser Black-backed Gull	8.9×10^{-5}	0.0016	0.1164
Great Skua	0	0	0

(b) Galloper- Summer

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	0	0	0
Lesser Black-backed Gull	5.22×10^{-5}	9.21×10^{-4}	0.0660
Great Skua	8.14×10^{-5}	0.0015	0.1052

(c) Inner Gabbard- Winter

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	0	0	0
Lesser Black-backed Gull	2.61×10^{-4}	0.0047	0.3389
Great Skua	0	0	0

(d) Inner Gabbard- Summer

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	0	0	0
Lesser Black-backed Gull	1.90×10^{-4}	0.0034	0.2462
Great Skua	2.39×10^{-4}	0.0043	0.3120

Table 7.4-6 Estimated numbers of birds struck per hour, derived from estimated strike rates for slow flight speed (Table 7.4-3b) and numbers at risk (Table 7.4-5). To calculate seasonal totals, assume 1,800 hours per season in winter (10 hour day, 30 day month, 6 month season) and 2,520 hours in summer (14 hour day, 30 day month, 6 month season).

A worst-case scenario is considered by using the maximum collision risk for each species in Table 7.4-3, and the highest count of each species in the survey area (*i.e.* not just at risk height). Table 7.4-7 shows that mortality rates of Red-Throated Diver are likely to be negligible even if all birds estimated to be in the study could be considered at risk. Mortality estimates were higher for Great Skua (3.26 birds killed per hour) and especially Lesser Black-backed Gull (5.99 birds killed per hour). Monthly mortality rates would be 7.25 Red-throated Divers on average, but very high numbers of 1798 and 1371 for Lesser Black-backed Gull and Great Skua respectively. Although this is an admittedly extreme example, there may be certain conditions when such low avoidance rates are possible. Poor weather conditions may have various effects on birds. Firstly, the lower cloud base may force the birds to fly at lower altitudes than is usual. Secondly, visibility is likely to be reduced in heavy rain or cloud. Thirdly, wind may make manoeuvrability and adjustment of flight path more difficult. Some studies have inferred that such conditions have been associated with increased evidence of bird mortality at wind farms (Winkelman 1992; Painter *et al*. 1999).

Species	**Season**	**Max. count**	**Collision risk**	**Mortality/hour**
Red-Throated Diver	Winter	0.67	0.052	0.024
Lesser Black-backed Gull	Winter	175.58	0.084	5.992
Great Skua	Summer	93.61	0.057	3.264

Table 7.4-7 Mortality rates per hour assuming a worst-case scenario of highest collision risk, lowest avoidance rates (0.87) and maximum count over both seasons over the whole wind farm area (*i.e.* not just birds at risk height). Assume 1,800 hours per season in winter (10 hour day, 30 day month, 6 month season) and 25,20 hours in summer (14 hour day, 30 day month, 6 month season).

Most other studies of casualties at wind farm sites have also recorded low levels of mortality (Erickson *et al.* 2001), though the majority of these related to onshore sites, and offshore wind farms may present different problems (Kingsley & Whittam 2003). Of the offshore studies that do exist, at an estuarine wind farm in Holland, an estimated 0.01 birds (all species combined) per turbine per day were predicted to be killed (Musters *et al.* 1996). Similarly, in an offshore wind farm study in the UK, Gill *et al.* (2002) calculated negligible rates of collision for seabirds including divers, Northern Gannets and gulls (though see critique of methods used to determine bird avoidance rates; Chamberlain *et al.* 2005). At Blyth Harbour wind farm, most casualties were gulls (mainly resident birds), but strike rates were considered low (Painter *et al.* 1999). Everaert *et al.* (2002) also found gulls principal amongst casualties at an estuarine wind farm, in Belgium. Estimates of mortality were comparatively high, and varied between 4 and 23 dead birds, per turbine, per year; most mortality was thought to be of migrants and not locally breeding birds.

7.5 Significance of Impacts

Species of Very High / High Sensitivity

Red-throated Diver **Annex 1, WCA, BCC Amber, Regionally & Nationally Important**

The numbers of Red-throated Divers present in the wider Greater Gabbard study area were judged as nationally important using the current 1% threshold of 50, after distance sampling, and this species is thus considered to be of High Sensitivity to the effects of the wind farm. However, the actual importance of this area is likely to be less given the numbers of the species revealed by the recent aerial surveys in the southern North Sea region.

Indirect Habitat Loss / Disruption of Flight-lines

Movements of Red-throated Divers are likely to occur both on a local scale throughout the winter, in response to fish prey movements, and on a larger scale during migration. The alignment of the wind farm would not appear to present a barrier to birds moving between northerly breeding grounds and southerly wintering sites; those birds travelling between the coasts of Scandinavia and Britain would face more of an obstacle. As birds are likely to disperse widely through the North Sea there would not seem to be a barrier effect during migration periods.

Garthe & Hüppop (2004) determined that Red-throated Divers had an especially high Species Sensitivity Index (SSI) to wind farms in part due to the species' proneness to disturbance (as well as its inability to rapidly avoid turbines – see below). Disturbance would likely be greatest during construction and maintenance, especially between mid-September and December when the birds are in moult and flightless, and thus unable to quickly escape fast-moving traffic.

Although the concentration of Red-throated Divers found in the whole Greater Gabbard study area was estimated to be of national and regional importance, the peak winter numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, only 0.3% and 0.41% of those found in the wider Thames offshore region. The displacement of birds from the proposed wind farm area is thus unlikely to appreciably add to densities of birds in adjacent habitat. Additionally, the main concentrations of Red-throated Divers in the region are only a few kilometres south and west (Fig. 4.2.3.1). Thus, unless these other areas are at carrying capacity for the species, it is likely that the relatively small numbers that might be displaced from the proposed wind farm site will be able to settle elsewhere.

The effects on the local population through increased mortality following displacement are thus considered to be likely to be of Negligible Magnitude and consequently of Very Low Significance.

Collision Risk

The risk of collision with the turbines for divers in the study area was estimated to be zero as none were found to fly at the height of rotor blades during the boat surveys. Previous assessments have reported that some divers may fly at rotor height and be at risk due to the species low manoeuvrability and inability to rapidly avoid turbines (see Garthe & Hüppop 2004). The species annual (adult) mortality rate is estimated to be 16% (Garthe & Hüppop 2004). However, even assuming that some birds would fly at turbine height, it is unlikely that the number of collisions would increase this rate significantly.

Collision risk for this species in the area of the proposed Greater Gabbard wind farm is thus assessed to be of Negligible Magnitude and thus of Very Low Significance.

Great Skua **BCC Amber, Nationally Important**

The numbers of Great Skuas passing through the wider Greater Gabbard study area in early autumn were judged as nationally important using the species' summer population threshold. This species is thus considered to be of High Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

The only foreseeable effect the Greater Gabbard wind farm would have on Great Skua populations is during periods of migration, from August to September and on return to breeding colonies in northern Scotland in early spring (predominantly March and April).

Given the absence of aerial surveys during summer months it is not possible to assess what proportion of the regional population uses the Greater Gabbard area. However, it is unlikely that the wind farm will form a barrier to the movements of the species or displace a considerable proportion of the regional population as most Great Skua are considered by some sources to remain 2-5 km from coasts when migrating (Furness 2002), easily avoiding the Greater Gabbard area 23 km offshore.

The effects on the local population through increased mortality following displacement are thus considered to be of Negligible Magnitude and consequently of Very Low Significance.

Collision Risk

Birds recorded in flight in September were at an average height of 15 m above the sea, though some were recorded above 40 m above sea level and an estimated 11% were within the height of the sweep of the turbine rotors. On average, an estimated 2.43 birds per month would be predicted to hit the wind farm turbines in the two areas, assuming a medium avoidance rate of 0.9982 – a mean of 0.102 birds per turbine per summer season. In reality, the figure is likely to be even lower, as the peak count seen in September almost certainly reflected birds on passage; numbers were not sustained at this level in other summer months, and therefore there are likely to be fewer birds at risk of collision. Given this very low predicted mortality rate, and a background (adult) annual mortality rate of 10% (Garthe & Hüppop 2004), it is unlikely that the wind farm will noticeably alter the size of the Great Skua population.

Collision risk for this species in the area of the proposed Greater Gabbard wind farm is thus assessed to be of Negligible Magnitude and thus of Very Low Significance.

Lesser Black-backed Gull (SPA), BCC Amber, Nationally Important

The Lesser Black-backed Gull is a designated feature of the Alde-Ore SPA, the estimated 21,700 pairs of birds breeding at Orford Ness representing at least 17.5% of the breeding Western Europe/Mediterranean/Western Africa population (Stroud *et al.* 2001). Although the proposed wind farm area will lie 23 km offshore, Lesser Black-backed Gulls do use the area in summer and many of these are likely to originate from the SPA. Any negative effects of the wind farm to these birds may therefore have knock-on consequences for the productivity and breeding success of the colony as a whole.

Lesser Black-backed Gulls were recorded in the Greater Gabbard area throughout the year and thus the effects of the wind farm need to be considered for the birds present in breeding and wintering seasons, as well as during times of passage. Although in summer many Lesser Black-backed Gulls are likely to have originated from the large breeding colony at Orford Ness, numbers using the wider Greater Gabbard study area were actually found to be greater in winter than summer, boat surveys suggesting that the area was of national importance for the species. The species was under-recorded in the area by aerial surveys – many gulls being unidentifiable to species – and thus contradictorily was not found to be regionally important.

Due to the combination of the national importance of the numbers using the study area (in winter) and the likely use of the wind farm area (in summer) by birds from the Alde-Ore SPA, this species is considered to be of Very High Sensitivity to the wind farm's effects.

Indirect Habitat Loss / Disruption of Flight-lines

The alignment of the wind farm would not appear to present a barrier to Lesser Black-backed Gulls moving between breeding grounds in northern Britain and southerly wintering sites. Those birds travelling between the coasts of Scandinavia and Britain and foraging from the breeding colony on Orford Ness would face more of an obstacle. However, given that Lesser Black-backed Gulls may move considerable distances whilst foraging – up to 100 km a day – and during migration (Rock 2002) it is unlikely that the wind farm would form a barrier to their movements.

The Lesser Black-backed Gulls that use the wind farm area are likely to be foraging for mobile prey such as fish and therefore may shift their distribution in response to fish movements induced by disturbance and habitat change during wind farm construction. The species also regularly follows fishing boats for discards and changes in the species movements may also reflect those of the local fisheries.

Although boat surveys indicated that the winter numbers of Lesser Black-backed Gulls found in the whole Greater Gabbard study area were of national importance, aerial surveys suggested that the peak numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, only 0.64% and 0.88% of those found in the wider Thames offshore region. The displacement of birds from the proposed wind farm area is thus unlikely to appreciably add to densities of birds in adjacent habitat.

The effects on the local population through increased mortality following displacement are thus considered to be of Negligible Magnitude and consequently of Low Significance.

Collision Risk

Collision risk analyses suggested that the wind farm does not offer a serious potential risk to Lesser Black-backed Gulls. An average of 70% of all Lesser Black-backed Gulls were estimated to be in flight at any one time and an estimated 6.6% within the height of the sweep of the turbine rotors (c.f. Garthe & Hüppop (2004) who suggest that Lesser Black-backed Gulls predominantly fly between 20 and 50 m). On average, an estimated 1.8 birds per month would be predicted to hit the wind farms turbines in both seasons, assuming a medium avoidance rate of 0.9982 – a mean of 0.08 birds per turbine, per season. Against a background (adult) annual mortality rate of 7% (Garthe & Hüppop 2004), this extremely low mortality prediction is unlikely to contribute greatly to changes in the Lesser Black-backed Gull population.

Collision risk for this species in the area of the proposed Greater Gabbard wind farm is thus assessed to be of Negligible Magnitude and thus of Low Significance.

European Nightjar **Annex 1, SPA, UK BAP, BCC Red**

The European Nightjar is a designated feature of the Sandlings SPA which lies adjacent to the planned location of the substation at Sizewell. Although no European Nightjars were recorded on the part of the SPA immediately adjacent to the proposed substation, this species is known to be susceptible to disturbance (Liley & Clarke 2002, 2003) and thus is considered to be of Very High Sensitivity.

Construction work disturbance and habitat loss

Construction work on the substation will occur outside of the SPA on arable land, a habitat not used by European Nightjars. Furthermore, the habitat in the part of the SPA lying immediately adjacent to the planned location of the substation appears to be of limited suitability for the species at present, in part consisting of horse paddocks. Given this and the recorded lack of birds in the immediate area, the negative effect of this work is assessed to be of Negligible Magnitude for this species and thus of Low Significance. The loss of habitat resulting from the building of the substation is likewise also considered to be of Negligible Magnitude and for this species of Low Significance.

It should also be noted that the recreation of heathland or acid grassland in the remainder of the field in which the substation is to be located (see Section 9 "Mitigation Measures") is likely to be of benefit for this species.

Wood Lark **Annex 1, WCA (Schedule 1), SPA, UK BAP, BCC Red**

As with the European Nightjar, the Wood Lark is a designated feature of the Sandlings SPA which lies adjacent to the planned location of the substation at Sizewell. Only one Wood Lark was recorded on the part of the SPA immediately adjacent, though this species is known to be susceptible to disturbance (Taylor 2002) and thus is considered to be of Very High Sensitivity.

Construction work disturbance and habitat loss

Construction work on the substation will occur outside of the SPA on arable land, a habitat only occasionally used by foraging Wood Larks. Furthermore, the habitat in the part of the SPA lying immediately adjacent to the planned location of the substation appears to be of limited suitability for the species at present, in part consisting of horse paddocks. Given this and the recorded lack of birds in the immediate area, the negative effect of this work is assessed to be of Negligible Magnitude for this species and thus of Low Significance. The loss of habitat resulting from the building of the substation is likewise also considered to be of Negligible Magnitude and for this species of Low Significance.

It should also be noted that the recreation of heathland or acid grassland in the remainder of the field in which the substation is to be located (see Section 9 "Mitigation Measures") is likely to be of benefit for this species.

Species of Medium / Low Sensitivity

Black-throated Diver **Annex 1, WCA, BCC Amber**

Numbers of Black-throated Divers in the study area were low with a recorded peak of just 27 birds in winter (the species was present on just three of 13 boat surveys). Due to its conservation status though, this species is considered to be of Medium Sensitivity.

Indirect Habitat Loss / Disruption of Flight-lines

Garthe & Hüppop (2004) considered this species to be the seabird most sensitive to potential effects of wind farms, due to the species' proneness to disturbance (as well as its inability to rapidly avoid turbines – see below).

Perhaps the greatest possible effect of the wind farm would be in late winter / early spring, when the species is moulting, often offshore, and then moving north through the North Sea to the breeding grounds. However, the alignment of the wind farm would not appear to present a major barrier to birds moving between northerly breeding grounds and southerly wintering sites.

The low concentrations of Black-throated Divers found in the study area – peak winter numbers found within the area of the wind farm (or even the wind farm plus 800 m buffer zone) were < 0.01% of those found in the wider Thames offshore region – suggest that any displacement of birds from the proposed Gabbard wind farm area is likely to be negligible.

The effects on the local population through increased mortality following displacement are thus considered to be of Negligible Magnitude and consequently of Very Low Significance.

Collision Risk

The proportion of all divers recorded in flight from aerial surveys was 10%, though Garthe & Hüppop (2004) suggested that the species spent more time in flight than Red-throated Divers. As with that species, however, no Black-throated Divers were recorded flying at the height of the rotors of the proposed turbines in the present study.

Collision risk for this species in the area of the proposed Greater Gabbard wind farm is assessed to be of Negligible Magnitude and thus of Very Low Significance.

Northern Fulmar **BCC Amber, Regionally Important**

The greatest densities of Northern Fulmar in the North Sea are found much to the north of the Greater Gabbard at all times of year (Carter *et al*. 1993; Skov *et al*. 1995). Data from aerial surveys indicated that the Greater Gabbard study area and the wind farm area itself were of regional importance for the species and as such it is considered to be of Medium Sensitivity.

Indirect Habitat Loss / Disruption of Flight-lines

Garthe & Hüppop (2004) considered Northern Fulmars to be the least sensitive to the effects of wind farms of the seabird species they investigated. The species is highly mobile and it is unlikely that the wind farm would form a barrier to the species movements.

The concentration of Northern Fulmars found in the whole Greater Gabbard study area was estimated to be of regional importance and the peak winter numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, 12.97% and 17.89% of those found in the wider Thames offshore region. Northern Fulmars are among the most maritime of the species found in the study area and it is probable that the importance of the area in comparison to the rest of the Thames offshore region reflects its greater distance offshore. Although further concentrations of birds do lie further offshore (Skov *et al.* 1995, Stone *et al.* 1995) and the species' mobility would suggest that displaced birds should be capable of relocation, the apparent regional importance of the species' numbers in the Greater Gabbard study area mean that the effect of indirect habitat loss should be considered of Medium Magnitude and thus of Low Significance.

Collision Risk

Northern Fulmars spend much of their time on the wing – 67% of birds being recorded in flight in the current survey – and thus there is the possibility of that locally moving individuals or birds migrating between Scandinavia and Britain in spring and autumn may collide with the turbines. In addition, the species shows a high level of nocturnal flight activity (Garthe & Hüppop 2004) and thus the lighting and visibility of turbines may be of an issue. However, the present study found that all birds flew under the height of the proposed turbine rotors.

Collision risk for this species in the area of the proposed Greater Gabbard wind farm is thus assessed to be of Negligible Magnitude and thus of Very Low Significance.

European Storm Petrel **Annex 1, BCC Amber**

Only one European Storm Petrel was recorded during the survey in September 2004. However, due to its conservation status, this species is considered to be of Medium Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

As a consequence of the low number of birds recorded in the study area, the likely effects of indirect habitat loss are of Negligible Magnitude and thus Very Low Significance.

Collision Risk

European Storm Petrels also forage nocturnally and are amongst those species that may be attracted to lights on oil platforms and other offshore structures (Sage 1979, Hope-Jones 1980, Tasker *et al.* 1986). Although the numbers using the area nocturnally are unknown, the low number of birds recorded in the study area in the day and the surface feeding behaviour of this species suggest that the effects of collisions will be of Negligible Magnitude and thus Very Low Significance.

Northern Gannet **BCC Amber, Regionally Important**

Northern Gannets typically associate with areas close to their breeding grounds for much of the year, and thus are not found in large numbers in the Greater Gabbard study area. Peak numbers of 139 and

257 birds were estimated in winter and summer respectively, the winter numbers being regionally important. As such, the species is considered to be of Medium Sensitivity.

Indirect Habitat Loss / Disruption of Flight-lines

Northern Gannets have a large foraging range, plunge-diving for fish and sometimes scavenging by trawlers and spend much time on the wing when maturing to non-breeding adult stages. Dispersal occurs in autumn, and Stone *et al*. (1995) reported October to reveal the highest densities of Northern Gannet in the southern North Sea, broadly consistent with peak estimates from September boat surveys. The alignment of the wind farm would not appear to present a barrier to birds moving between northerly breeding grounds and southerly wintering sites, although it might impede local movements slightly.

The concentration of Northern Gannets found in the whole Greater Gabbard study area was estimated to be of regional importance and the peak winter numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, 1.26% and 1.74% of those found in the wider Thames offshore region. Northern Gannets are among the most maritime of the species found in the study area and it is probable that the importance of the area in relation to the rest of the Thames offshore region reflects its greater distance offshore. Further concentrations of birds lie further offshore (Skov *et al.* 1995, Stone *et al.* 1995) and the species' mobility would suggest that displaced birds should be capable of relocation (Garthe & Hüppop 2004). Nevertheless, the apparent regional importance of the species' numbers in the Greater Gabbard study area mean that the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance.

Collision Risk

The proposed wind farm could present a collision risk to foraging birds, with (especially younger) migrants potentially also at risk during passage movements through the area. However, results indicated that only 30% of Gannets are in flight at any one time and that only 0.6% of these fly at the height of the turbine rotors. Garthe & Hüppop (2004) suggest that Northern Gannets predominantly fly between 10 and 20 m. In spite of their regional importance in the Greater Gabbard area, therefore, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

Common Scoter **WCA, UK BAP, BCC Amber**

A maximum of just 24 Common Scoter was recorded in the Greater Gabbard study area during winter, with just a single bird in summer. However, due to its conservation status, this species is considered to be of Medium Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Common Scoter feed on molluscs on the seabed and as such are predominantly found in shallow inshore waters (though, in this study, partly because of the low numbers recorded in the study area, it was not possible to establish any relationships with either food resources or water depth). Due to their low numbers and preference for inshore waters, the wind farm is unlikely to form either a barrier to the regular movements of the species or cause disturbance. The effects of indirect habitat loss are thus considered to be of Negligible Magnitude and thus Very Low Significance.

Collision Risk

Given the species' low numbers and the fact that all birds recorded in flight were below the height of the turbine rotors, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

Little Gull **Annex 1, WCA**

A maximum of just four Little Gulls was recorded in the study area during the survey in winter. However, due to its conservation status, this species is considered to be of Medium Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

As a consequence of the low number of birds recorded in the study area, the likely effects of indirect habitat loss are of Negligible Magnitude and thus Very Low Significance.

Collision Risk

Likewise, the low number of birds also mean that the effects of collisions will be of Negligible Magnitude and thus Very Low Significance.

Mew (Common) Gull **BCC Amber, Regionally Important**

A maximum of just 56 Mew Gulls was recorded in the Greater Gabbard study area during winter, with a maximum of just three in summer. The winter peak was nevertheless of regional importance and, as such, this species is considered to be of Medium Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

The alignment of the wind farm would not appear to present a barrier to Mew Gulls moving between breeding grounds in northern Britain and southerly wintering sites. Those birds travelling between the coasts of Scandinavia and Britain or foraging locally might face more of an obstacle.

Although the concentration of Mew Gulls found in the whole Greater Gabbard study area was estimated to be of regional importance, the peak winter numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, only 0.47% and 0.65% of those found in the wider Thames offshore region. The displacement of birds from the proposed wind farm area is thus unlikely to appreciably add to densities of birds in adjacent habitat.

The effects on the local population through increased mortality following displacement are thus considered to be of Negligible Magnitude and consequently of Very Low Significance.

Collision Risk

The proposed wind farm could present a collision risk to foraging birds and birds passing through the area on migration in the spring and autumn. Aerial surveys indicated that 86% of Mew Gulls are in flight at any one time, though that only 4.2% of these fly at the height of the turbine rotors. Garthe & Hüppop (2004) suggest that Mew Gulls predominantly fly between 10 and 20 m. Collision risk is not expected to exceed that predicted for Lesser Black-backed Gulls, however, and in spite of their regional importance in the Greater Gabbard area, the effects of collision risk for this species are assessed to be of Negligible Magnitude and thus of Very Low Significance.

Herring Gull **(SPA), BCC Amber, Regionally Important**

The Herring Gull forms part of the breeding seabird assemblage which is a designated feature of the Alde-Ore SPA, though does not occur there in nationally important numbers itself. Despite this, no Herring Gulls were recorded in the Greater Gabbard study area in summer, probably due to its distance offshore. The species Sensitivity to the effects of the wind farm is thus assessed on the basis of its passage and winter numbers and other conservation designations.

December produced the largest distance estimate from ship surveys, and the southern North Sea is known to contain many Herring Gulls at this time (Stone *et al*. 1995) due to influxes of northern breeders joining wintering British breeders (Carter *et al*. 1993). The study area and wind farm area itself were found to be of regional importance for the species and as such it is considered to be of Medium Sensitivity.

Indirect Habitat Loss / Disruption of Flight-lines

The alignment of the wind farm would not appear to present a barrier to Herring Gulls moving between breeding grounds in northern Britain and southerly wintering sites. Those birds travelling between the coasts of Scandinavia and Britain or foraging locally might face more of an obstacle.

The concentration of Herring Gulls found in the whole Greater Gabbard study area was estimated to be of regional importance and the peak winter numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, 1.07% and 1.48% of those found in the wider Thames offshore region.

The importance of the Greater Gabbard area for Herring Gulls in relation to the rest of the Thames offshore region reflects the area's distance from shore as other concentrations of birds lie further out into the North Sea (Skov *et al.* 1995, Stone *et al.* 1995). Nevertheless, the apparent regional importance of the species' numbers in the Greater Gabbard study area means that the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance.

Collision Risk

The proposed wind farm is likely to present a collision risk to foraging birds in winter and birds passing through the area on migration in the spring and autumn. Aerial surveys indicated that 91% of Herring Gulls are in flight at any one time, and that 10.1% of these fly at the height of the turbine rotors. Garthe & Hüppop (2004) suggest that Herring Gulls predominantly fly between 20 and 50 m.

Collision risk for this species is thus likely to be at least as great as that for Lesser Black-backed Gulls, *i.e.* of Negligible Magnitude, and thus of Very Low Significance.

Great Black-backed Gull **Regionally Important**

Great Black-backed Gulls are most numerous in the Greater Gabbard area in winter, with a peak estimate of 405 birds in the study area, a figure of almost national importance. Due to the regional importance of the numbers found in the study area, the species is considered to be of Medium Sensitivity.

Indirect Habitat Loss / Disruption of Flight-lines

The alignment of the wind farm would not appear to present a barrier to Great Black-backed Gulls moving between breeding grounds in northern Britain and southerly wintering sites. Those birds travelling between the coasts of Scandinavia and Britain or foraging locally might face more of an obstacle.

The concentration of Great Black-backed Gulls found in the whole Greater Gabbard study area was estimated to be of regional importance and the peak winter numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, 0.79% and 1.09% of those found in the wider Thames offshore region.

The importance of the Greater Gabbard area for Great Black-backed Gulls in relation to the rest of the Thames offshore region reflects the area's distance from shore as other concentrations of birds lie further out into the North Sea (Skov *et al.* 1995, Stone *et al.* 1995). Nevertheless, the apparent regional importance of the species' numbers in the Greater Gabbard study area mean that the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance.

Collision Risk

The proposed wind farm may pose a collision risk to Great Black-backed Gulls. Results indicated that although only 30% of Great Black-backed Gulls are in flight at any one time, 13.8% of these fly at the height of the turbine rotors. Garthe & Hüppop (2004) suggest that Great Black-backed Gulls predominantly fly between 10 and 20 m. Collision risk is not expected to exceed that predicted for Lesser Black-backed Gulls, however, and the effects of collision risk for this species are assessed to be of Negligible Magnitude and thus of Very Low Significance.

Black-legged Kittiwake **BCC Amber, Regionally Important**

Although most British breeding Black-legged Kittiwakes remain fairly close to their breeding colonies year round, some concentrations of Black-legged Kittiwakes can occur up to 120 km from such locations (Carter *et al*. 1993). As the species breeds in small numbers at Sizewell as well as at Lowestoft, the Greater Gabbard area may thus be within summer foraging range as well as part of the species' wintering range. Estimate numbers were greatest in winter, when the study area was found to be of regional importance for the species; as such it is considered to be of Medium Sensitivity.

Indirect Habitat Loss / Disruption of Flight-lines

Peak winter numbers of Black-legged Kittiwakes found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, 6.37% and 8.8% of those found in the wider Thames offshore region. Black-legged Kittiwakes are among the most maritime of the species found in the study area and it is probable that the importance of the area in comparison to the rest of the Thames offshore region reflects its greater distance offshore. Although further concentrations of birds do lie further offshore (Skov *et al.* 1995, Stone *et al.* 1995) and the species' mobility would suggest that displaced birds should be capable of relocation, the apparent regional importance of the species' numbers in the Greater Gabbard study area mean that the effect of indirect habitat loss should be considered of Medium Magnitude and thus of Low Significance.

Collision Risk

The proposed wind farm could present a collision risk to foraging birds both in summer and winter. Aerial surveys indicated that 83% of Black-legged Kittiwakes are in flight at any one time, although only 1.5% of these fly at the height of the turbine rotors. Garthe & Hüppop (2004) suggest that Black-legged Kittiwakes predominantly fly between 5 and 10 m and that, as surface feeders, were among the least sensitive species to the effects of wind farms. Collision risk is not expected to exceed that predicted for Lesser Black-backed Gulls, and thus in spite of their regional importance in the Greater Gabbard area, the effects of collision risk for this species are assessed to be of Negligible Magnitude and thus of Very Low Significance.

Sandwich Tern **(SPA), Annex 1, BCC Amber**

The Sandwich Tern is a designated feature of the Alde-Ore SPA due to the size of the breeding population found there. However, Sandwich Terns predominantly forage in shallow inshore waters and few birds from the SPA are likely to be found in the deeper waters of the proposed wind farm area, 23 km offshore. Indeed, a maximum of just 19 Sandwich Terns was recorded in the Greater Gabbard study area during summer and nine in winter. The species Sensitivity to the effects of the wind farm is thus assessed to be Medium on the basis of its other conservation designations.

Indirect Habitat Loss / Disruption of Flight-lines

The majority of migration and foraging activity of Sandwich Terns is likely to occur along coastlines, and so there is unlikely to be any barrier presented by the wind farm or significant indirect loss of habitat, except perhaps during post-breeding dispersal, when there may be movements within the North Sea area.

The effects of indirect habitat loss are thus assessed to be of Negligible Magnitude and thus Very Low Significance.

Collision Risk

As the species predominantly feeds close to the water surface in shallow inshore waters , the effects of collisions for this species are also assessed to be of Negligible Magnitude and Very Low Significance.

Little Tern **(SPA), Annex 1, WCA, BCC Amber**

The Little Tern is a designated feature of the Alde-Ore SPA due to the size of the breeding population found there. However, as with Sandwich Tern, this species predominantly forages in shallow inshore waters and thus few birds from the SPA are likely to be found in the area of the proposed wind farm area. Indeed, only one Little Tern was recorded during surveys of the study area, in May 2004. The species Sensitivity to the effects of the wind farm is thus assessed to be Medium on the basis of its other conservation designations.

Indirect Habitat Loss / Disruption of Flight-lines

Little Terns predominantly feed close to the water surface in shallow inshore waters and, as the surveys indicate, are rarely likely to be found as far offshore as the proposed wind farm. The effects of indirect habitat loss are thus assessed to be of Negligible Magnitude and thus Very Low Significance.

Collision Risk

The effects of collisions for this species are similarly assessed to be of Negligible Magnitude and Very Low Significance.

Common Guillemot **BCC Amber, Regionally Important**

Peak estimated numbers of Common Guillemots in the study area were 1,607 in winter and 533 in summer. Numbers of auks as a combined species group are of regional importance and thus Common Guillemot is considered to be of Medium Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

The alignment of the wind farm would not appear to present a barrier to Common Guillemots moving between breeding grounds in northern Britain and southerly wintering sites, although it could pose more of an obstacle to birds foraging locally.

Guillemots and other auks may also be disturbed by construction work and maintenance traffic to and from the wind farm. During the autumn moult period (July to September) auks are flightless and so cannot quickly escape boats or other causes of disturbance.

Concentration of auks (primarily Common Guillemots and Razorbills) found in the whole Greater Gabbard study area were estimated to be of regional importance and the peak winter numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, 1.84% and 2.54% of those found in the wider Thames offshore region. The apparent regional importance of the species' numbers in the Greater Gabbard study area means that the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance.

Collision Risk

Common Guillemots spend much of their time rafting on the surface of the sea; indeed only 4% of auks were recorded to be in flight at one time in this study and none were recorded flying at the height of the proposed turbine rotors. Garthe & Hüppop (2004) similarly found that Common Guillemots predominantly fly close to the sea at an average altitude of 0 to 5 m. As such, the effects of collisions for this species are also assessed to be of Negligible Magnitude and Very Low Significance

Razorbill **BCC Amber, Regionally Important**

A peak of 1,411 Razorbills was estimated for the study area in winter. Numbers of auks as a combined species group are of regional importance and thus this species is considered to be of Medium Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

The alignment of the wind farm would not appear to present a barrier to Razorbills moving between breeding grounds in northern Britain and southerly wintering sites, although it could pose more of an obstacle to birds foraging locally.

As with Guillemots, Razorbills may also be disturbed by construction work and maintenance traffic to and from the wind farm. During the autumn moult period they are flightless and so cannot quickly escape boats or other causes of disturbance; however, no Razorbills were recorded in the Greater Gabbard at this time.

Concentration of auks found in the whole Greater Gabbard study area were estimated to be of regional importance and the peak winter numbers found within the area of the wind farm and the wind farm plus 800 m buffer zone were, respectively, 1.84% and 2.54% of those found in the wider Thames offshore region. The apparent regional importance of the species' numbers in the Greater Gabbard study area means that the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance.

Collision Risk

Razorbills spend much of their time rafting on the surface of the sea; indeed only 4% of auks were recorded to be in flight at one time in this study and none were recorded flying at the height of the proposed turbine rotors. Garthe & Hüppop (2004) similarly found that Razorbills predominantly fly close to the sea at an average altitude of 0 to 5 m. As such, the effects of collisions for this species are also assessed to be of Negligible Magnitude and Very Low Significance

European Turtle Dove **UK BAP, BCC Red**

Two territories were recorded in the onshore study area. The species is considered to be of Medium Sensitivity, as it is a UK BAP species.

Construction work disturbance and habitat loss

European Turtle Doves are summer migrants, normally arriving in late April and May and departing from early September onwards. The species is widely distributed throughout Suffolk with concentrations on the coast and in Breckland, although numbers are declining (Piotrowski 2003). Neither territory in the study area was in the area where construction of the substation is proposed and thus the effects of construction and habitat loss are considered to be of Negligible Magnitude and of Very Low Significance for this species.

It should also be noted that any loss of hedgerow habitat that potentially could be used for nesting by European Turtle Doves is likely to be compensated for by mitigation planting (see Section 9).

Sky Lark **UK BAP, BCC Red**

Sky Lark is a common resident, winter visitor and passage migrant, favouring open arable fields and coastal areas (Piotrowski 2003). A total of 15 territories were discovered in the study area, and as the species is a UK BAP species, it is considered to be of Medium Sensitivity.

Construction work disturbance and habitat loss

Three Sky Lark territories were found in the site of proposed substation construction. It is possible that construction work would temporarily displace these birds from their current nesting sites, but as little habitat is likely to be permanently lost, and as much less than 1% of the regional population will be lost, the effects of this are considered to be of Negligible Magnitude and thus Very Low Significance.

It should also be noted that the recreation of heathland or acid grassland in the remainder of the field in which the substation is to be located (see Section 9) is likely to be of benefit for this species.

Song Thrush **UK BAP, BCC Red**

The Song Thrush is a common resident, passage migrant and winter visitor, widespread across Suffolk in parks, gardens, heathland, woodland, farms and hedgerows (Piotrowski 2003). However, as a UK BAP species it is considered to be of Medium Sensitivity. Three territories were found during onshore surveys, though these did not overlap with the site of proposed substation construction.

Construction work disturbance and habitat loss

Song Thrush is probably declining in Suffolk in line with the regional trend for eastern England (Raven, Noble & Baillie 2005). As no territories were found in the area of the proposed substation, the effects of the substation's construction and subsequent loss of habitat are considered to be of Negligible Magnitude and thus of Very Low Significance.

It should also be noted that any loss of hedgerow habitat that potentially could be used for nesting by Song Thrushes is likely to be compensated for by mitigation planting (see Section 9).

Cetti's Warbler **WCA**

A single Cetti's Warbler territory was thought to be held in the study area, though observations were away from the proposed route of the cables and substation area. This species is considered to be of Medium Sensitivity due to its listing as a WCA Schedule 1 species.

Construction work disturbance and habitat loss

This species is a scarce resident in Suffolk with the first county record in 1971, at nearby Minsmere (Piotrowski 2003). In 2003 singing birds were found in the breeding season at 22 sites (Wright 2004). As no Cetti's Warblers were found in the area of the proposed substation, the effects of the construction work and resultant loss of habitat are considered to be of Negligible Magnitude for this species and thus of Very Low Significance.

Common Starling **BCC Red**

The Common Starling is an abundant resident, winter visitor and passage migrant in Suffolk, although numbers are probably declining (Piotrowski 2003). They are encountered in a variety of habitats, including urban and rural dwellings and woodland. It is difficult to census the breeding population as they nest semi-colonially, but at least 14 territories were thought to exist in the study area. These were predominantly near buildings, and as the species is not designated apart from being red-listed as a Bird of Conservation Concern, it is rated as being of Low Sensitivity.

Construction work disturbance and habitat loss

The effects of construction work and the loss of habitat resulting from the building of the substation are assessed to be of Negligible Magnitude, and the effects of construction are thus of Very Low Significance.

House Sparrow **BCC Red**

This abundant, but declining, resident is typically concentrated around buildings and other artificial features, and this was the case at Sizewell, with 17 territories estimated. The species is not designated apart from being red-listed as a Bird of Conservation Concern, and is rated as being of Low Sensitivity.

Construction work disturbance and habitat loss

The effects of construction work and the loss of habitat resulting from the building of the substation are assessed to be of Negligible Magnitude, and the effects of construction are thus of Very Low Significance.

Common Linnet **UK BAP, BCC Red**

This common resident was thought to be holding 14 territories from onshore surveys. It is a UK BAP species and thus is rated as being of Medium Sensitivity.

Construction work disturbance and habitat loss

This is a common resident, although it is thought fewer birds overwinter. It breeds widely throughout the county where it favours open farmland, young plantations, heathland and other scrub areas, such as found in the coastal fringe (Piotrowski 2003). On farmland it particularly favours oilseed rape. Considerably less than 1% of the regional population will be affected by the construction work and the loss of habitat resulting from the building of the substation and thus the effects are assessed to be of Negligible Magnitude and thus of Very Low Significance for this species.

It should also be noted that any loss of hedgerow habitat that potentially could be used for nesting by Linnets is likely to be compensated for by mitigation planting (see Section 9). Furthermore, the recreation of heathland or acid grassland in the remainder of the field in which the substation is to be located is likely to be of benefit for this species.

Common Bullfinch **UK BAP, BCC Red**

This is a common, widespread, but shy and declining bird in Suffolk. It is absent from tetrad TM4662 although it is recorded as breeding in TM4660 (Sanford 1993; Piotrowski 2003). The species held one territory on onshore surveys, and is of Medium Sensitivity owing to its UKBAP status.

Construction work disturbance and habitat loss

As only one territory was found during surveys, it is extremely unlikely that the construction work and the loss of habitat resulting from the building of the substation will affect this species' regional population. The effects are thus assessed to be of Negligible Magnitude and of Very Low Significance.

It should also be noted that any loss of hedgerow habitat that potentially could be used for nesting by Bullfinches is likely to be compensated for by mitigation planting (see Section 9).

Yellowhammer **BCC Red**

Yellowhammer is a common, but declining, resident and passage migrant, breeding in most coastal tetrads in Suffolk (Sanford 1993; Piotrowski 2003). The species is not designated apart from being red-listed as a Bird of Conservation Concern, and is rated as being of Low Sensitivity.

Construction work disturbance and habitat loss

Considerably less than 1% of the species' regional population will be affected by the construction work and the loss of habitat resulting from the building of the substation and thus the effects are assessed to be of Negligible Magnitude and thus of Very Low Significance.

It should also be noted that any loss of hedgerow habitat that potentially could be used for nesting by Yellowhammers is likely to be compensated for by mitigation planting (see Section 9). Furthermore, the recreation of heathland or acid grassland in the remainder of the field in which the substation is to be located is likely to be of benefit for this species.

7.6 Conclusions

Table 7.6-1 summarises the predicted Significance of the main effects of the wind farm on the bird species considered, i.e. for offshore species, indirect habitat loss / disruption of flight-lines and collision risk, and for onshore species, construction work disturbance and habitat loss.

	Indirect habitat loss / disruption of flight-lines	Collision risk	Construction work disturbance and habitat loss
Species of Very High / High Sensitivity			
Red-throated Diver	Very Low	Very Low	
Great Skua	Very Low	Very Low	
Lesser Black-backed Gull	Low	Low	
European Nightjar			Low
Wood Lark			Low
Species of Medium / Low Sensitivity			
Black-throated Diver	Very Low	Very Low	
Northern Fulmar	Low	Very Low	
European Storm Petrel	Very Low	Very Low	
Northern Gannet	Low	Very Low	
Common Scoter	Very Low	Very Low	
Little Gull	Very Low	Very Low	
Mew (Common) Gull	Very Low	Very Low	
Herring Gull	Low	Very Low	
Great Black-backed Gull	Low	Very Low	
Black-legged Kittiwake	Low	Very Low	
Sandwich Tern	Very Low	Very Low	
Little Tern	Very Low	Very Low	
Common Guillemot	Low	Very Low	
Razorbill	Low	Very Low	
European Turtle Dove			Very Low
Sky Lark			Very Low
Song Thrush			Very Low
Cetti's Warbler			Very Low
Starling			Very Low
House Sparrow			Very Low
Linnet			Very Low
Bullfinch			Very Low
Yellowhammer			Very Low

Table 7.6-1 Significance of the effects of the major impacts of the wind farm for bird species of conservation importance.

The assessment has shown that the main effects of the wind farm will only be of Very Low or Low Significance to the bird species of conservation importance presently found offshore at Greater Gabbard and onshore at Sizewell. The risk of collisions for migrating skuas perhaps poses the greatest threat to bird life offshore. It should be noted, though, that the actual effects on bird mortality and thus populations of displacement following disturbance / habitat loss are difficult to predict or monitor. Given present knowledge, however, none of the effects appear significant in terms of EIA Regulations.

8. CUMULATIVE ASSESSMENT

In addition to the Greater Gabbard Offshore Wind farm there are a number of other wind farm projects in the wider Thames offshore region which together may contribute to more significant effects for birds in this area. Additionally it should also be noted that future changes or developments in shipping (e.g. port expansions at Harwich Haven and London Gateway) and marine aggregate extraction and capital dredging may also add to these effects.

Consents have been given to two Round 1 wind farm projects within the Thames offshore region, at Gunfleet Sands (Hydrosearch 2002) and Kentish Flats (presently under construction) (GREP UK Ltd 2002). In addition, an application has recently been submitted for the London Array wind farm towards the inner Thames Estuary (RPS 2005) – the largest of the proposed sites in the region – and another application expected for a site off the Thanet coast. The Greater Gabbard site is the furthest north of these and is also the most exposed, the furthest offshore and in the deepest water.

As detailed above, the main effects for birds of the construction, operation and decommissioning of the Greater Gabbard Offshore Wind farm lie in the indirect loss of habitat through disturbance / disruption of flight-lines and the risk of collision. (Cumulative loss of habitat due to placement of foundations is likely to be small in relation to the availability of habitat in the region and thus of Negligible Significance for all species.) The development of other wind farms in the region may act cumulatively in both these aspects:

Indirect Habitat Loss / Disruption of Flight-lines

Construction activities at Gunfleet Sands, Kentish Flats and at the proposed London Array wind farm are to be restricted during the winter period (Hydrosearch 2002, GREP UK Ltd 2002, RPS 2005). This will be of benefit to Red-throated Divers, which was found to the most sensitive species in each area. There is thus likely to be little additional impact from these sites during the construction period.

The proposed Greater Gabbard Offshore Wind farm will occupy an area of c.145 km^2. In comparison, the Gunfleet Sands and Kentish Flats sites are to be less than 10 km^2 while the Thames Array site is proposed to occupy an area up to 245 km^2. The effects of indirect loss of habitat through disturbance / disruption of flight-lines during operation were assessed as Negligible / Minor to Minor / Moderate (for Red-throated Diver) at Gunfleet Sands and Low for all species at Kentish Flats. In comparison, due to its larger area and important habitats, effects at the proposed London Array were estimated to be of Very High Significance for divers – up to 6,775 Red-throated Divers were recorded in the defined wind farm and buffer area – though Very Low to Low for all other species.

At the Greater Gabbard site, effects of indirect loss of habitat through disturbance / disruption of flight-lines were considered of Very Low to Low Significance for all species and any displacement – certainly of divers – is likely to be small in comparison to that at the London Array site should consents be granted for that project. Should this happen, it is possible that the Greater Gabbard area may support more birds than at present, though – in the long-term – only if local food resources allow. The proposed Greater Gabbard Offshore Wind farm is thus unlikely to add appreciably to the cumulative impact of indirect loss of habitat of all of the proposed wind farms.

Collision Risk

Direct comparison of the collision risks posed by the wind farms being built or proposed in the Thames offshore region is problematic due to the differing assumptions made in the calculation used in the different studies. Nevertheless it is possible to make a broad assessment of the cumulative impacts posed by the Greater Gabbard Offshore Wind farm in conjunction with the other sites. The Gunfleet Sands and Kentish Flats sites will comprise 30 turbines each, though the Significance of the collision risks at each site were assessed to be Low for all species. At the proposed London Array site, there will be up to 271 turbines. The Significance of collision risks here was assessed to range from Very Low to Medium / Very High (for divers).

At the Greater Gabbard site, collision risks were assessed to be of Very Low Significance for all species and appear slight in comparison to those at London Array. The proposed wind farm is thus unlikely to add appreciably to the cumulative impact in the mortality rate from collisions at all of the proposed wind farms.

9. MITIGATION MEASURES

Bird studies undertaken to date have found that only Red-throated Diver, Great Skua and Lesser Black-backed Gull reach levels of national significance within the offshore study area (though not within the area of the proposed wind farm itself), with a further six species and the species group containing auks found in regionally important numbers. The levels of Significance of the effects of the wind farm for these species are considered to be Very Low or Low.

Among species found to be of national importance in the study area during the baseline surveys, numbers of Red-throated Diver peaked between November and March, those of Great Skua in September and those of Lesser Black-backed Gull in June and July (when breeding) and also on spring and autumn passage. Due to weather considerations, construction work may be at a minimum during the winter and this will help reduce the possibility of disturbance to divers in the short-term.

Onshore, the area affected by the substation lies outside the Sandlings SPA (though work will be required on a pylon within the SPA) and the Significance of the effects of this construction are also considered to be Very Low or Low for all species.

Despite the likely low effects of the wind farm and substation, some recommendations for mitigation can be made:

- **Offshore construction**. If turbines are to be supported by monopiles, on-site monitoring of seabird activity should be considered so that piling can be stopped if an agreed threshold of birds is recorded within a specified distance of the work. The observer(s) should also record all disturbance events, quantifying, for example, numbers of birds involved and distances flown. (The methodology for this will need to be agreed with relevant agencies).

- **Wind farm lighting.** There are legal requirements for lighting from both Trinity House (navigational lights) and from the Civil Aviation Authority (aircraft), which are bound by the conditions of the Section 36 consent from DTI and through the Coast Protection Act licence issued by DEFRA. However, extreme level of lighting will be avoided so as to minimise the numbers of birds attracted to the wind farm at night. Lighting will be yellow and flashing and ideally should be directed below the horizontal to minimise the numbers of birds attracted.

- **Onshore construction.** Topsoil strip and earthmoving activities will take place during the summer (March to September) to avoid unnecessary mud on roads, soil washout from prolonged rain, slumping of banks, bunds and stockpiles and the increased potential for pollution incidents. Additionally, work on bringing the cables ashore will also take place in this period. As this work coincides with the breeding season for birds, surveys will be needed to ensure that disturbance to nesting birds is minimised.

  During construction it is recommended that lighting is directed away from the adjacent SPA so as to avoid affecting the behaviour of nocturnally feeding European Nightjars. Once operational the substation would not normally be lit.

- **Substation.** The immediate bounds of the substation will include an engineered earthen bund and plantings of small native trees and shrubs (see project description) and this will help to reduce disturbance to birds breeding in the area immediately surrounding the site.

  Beyond the perimeter planting and in the remainder of the field in which the substation is to be located, GGOWL will undertake to establish heathland or acid grassland recreation, depending on soil chemistry and sand content. Both would be of benefit to breeding birds and, in particular, would complement and add to the habitat contained within the adjacent Leiston-Aldeburgh SSSI / Sandlings SPA, designated for its breeding European Nightjars and

Wood Larks. Advice will be taken from both Suffolk Wildlife Trust and the RSPB (who have undertaken similar work on their nearby Minsmere reserve) and other relevant bodies.

It should also be noted that some inherent features of the project design might also minimise effects for birds. In addition to the wind farm's location relatively far offshore in comparison to other proposed wind farm sites in the region, the regular layout of the turbine array might also be of benefit. Recent work in Denmark has highlighted the fact that birds which do fly within offshore wind farms prefer to travel along corridors between turbines (Desholm & Kalhert 2005). Thus the regular layout proposed here should help reduce the risk of collisions. Likewise, the gap between the two wind farm areas proposed should also allow birds to fly through without much disruption to their journeys.

10. CURRENT AND FUTURE MONITORING

Current Monitoring

- The proposed Greater Gabbard wind farm site and larger offshore study area are being surveyed this year (April 2005 to March 2006), following the same methodologies described above, in order to provide a second year of baseline data. These data will be analysed, again following the methods present here, and presented in a second year monitoring report in summer 2006.

  The further surveying will be of particular importance in assessing: firstly, the importance of the offshore area for Red-throated Divers, Great Skuas and Lesser Black-backed Gulls, the only species found to be of national importance within the study area thus far and, secondly, annual variation in bird numbers and bird distributions within the study area.

  The results of these assessments will feed into the Cumulative Effects Assessment.

Monitoring during Construction and Operation

- It is recommended that offshore monitoring continues during the construction period in order to be able to assess the possible effects of disturbance on birds, in particular if turbines are to be supported by monopiles – see above.

- Onshore, monitoring will also be required to help minimise the disturbance of construction work to birds nesting in the study area.

- Following good practice, monitoring during the first three years of operation is also recommended, so as to better understand the direct (collisions) and indirect (avoidance) effects of the wind farm on the area's bird populations, and to assess how the presence of the wind farm has affected the local carrying capacity (number of birds) of the area for birds.

- Monitoring of the settlement of birds into the proposed heathland or grassland recreation area is also recommended to determine the success of this approach to mitigation.

- Methodologies should take into account any future guidelines and technologies and be consistent with procedures at other wind farm sites, e.g. in regard to measuring collision rates, and determining what is happening at night and in poor weather.

Cumulative Assessment

- To be able to assess the Cumulative Effects on birds of building several wind farms in a region it is necessary to be to determine what makes the region suitable for birds. This can be summarised as the suitability of a habitat, and the amount and availability of food. Whereas, the theoretical framework exists, detailed methodologies need to be developed for different groups of birds, and this is a governmental responsibility (Langston & Pullan 2003).

- COWRIE is funding the development of an approach to assess the carrying capacity of offshore areas for Common Scoters, a species that feeds by diving for bivalves in the sediments of offshore waters. To be able to carry out a Cumulative Assessment of the effect of the Thames region wind farms on the birds that it holds in nationally important numbers, detailed generic methodologies will have to be developed to determine the carrying capacity of offshore areas for two categories of birds that have two different feeding strategies. First, the gulls and terns that feed primarily on prey that are in the upper reaches of the water column, and second, the auks and divers that feed on prey that are deeper in the water column.

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Appendix 1

Special Protection Areas (SPAs) in the outer Thames Estuary area and the species for which they are important. 1 – Minsmere-Walberswick; 2 – Sandlings; 3 – Alde-Ore Estuary; 4 – Deben Estuary; 5 – Stour & Orwell Estuaries; 6 – Hamford Water; 7 – Colne Estuary; 8 – Abberton Reservoir; 9 – Blackwater Estuary; 10 – Dengie; 11 – Crouch & Roach Estuaries; 12 – Foulness; 13 – Benfleet & Southend Marshes; 14 – Thames Estuary & Marshes; 15 – Medway Estuary & Marshes; 16 – The Swale; 17 – Thanet Coast & Sandwich Bay. LG = Little Grebe *Tachybaptus ruficollis*, GG = Great Crested Grebe *Podiceps cristatus*, CA = Great Cormorant *Phalacrocorax carbo*, BI = Great Bittern *Botaurus stellaris*, EW = European White-fronted Goose *Anser erythropus*, DB = Dark-bellied Brent Goose *Branta bernicla bernicla*, SU = Shelduck *Tadorna tadorna*, WN = Wigeon *Anas penelope*, GA = Gadwall *A. strepera*, T. = Common Teal *A. crecca*, PT = Northern Pintail *A. acuta*, SV = Northern Shoveler *A. clypeata*, PO = Common Pochard *Aythya ferina*, TU = Tufted Duck *A. fuligula*, GN = Common Goldeneye *Bucephala clangula*, RM = Red-breasted Merganser *Mergus serrator*, MR = Eurasian Marsh Harrier *Circus aeruginosus*, HH = Hen Harrier *C. cyaneus*, CO = Coot *Fulica atra*, OC = Eurasian Oystercatcher *Haematopus ostralegus*, AV = Pied Avocet *Recurvirostra avosetta*, RP = Ringed Plover *Charadrius hiaticula*, GP = European Golden Plover *Pluvialis apricaria*, GV = Grey Plover *P. squatarola*, L. = Northern Lapwing *Vanellus vanellus*, KN = Red Knot *Calidris canutus*, DN = Dunlin *C. alpina*, RU = Ruff *Philomachus pugnax*, BW = Black-tailed Godwit *Limosa limosa*, BA = Bar-tailed Godwit *L. lapponica*, CU = Curlew *Numenius arquata*, RK = Common Redshank *Tringa totanus*, TT = Ruddy Turnstones *Arenaria interpres*, MU = Mediterranean Gull *Larus melanocephalus*, BH = Black-headed Gull *L. ridibundus*, LB = Lesser Black-backed Gull *L. fuscus*, HG = Herring Gull *L. argentatus*, TE = Sandwich Tern *Sterna sandvicensis*, CN = Common Tern *S. hirundo*, AF = Little Tern *S. albifrons*, NJ = European Nightjar *Caprimulgus europeaus*, WL = Wood Lark *Lullula arborea*.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
LG												×		×	×	×	
GG					×		×	×	×	×					×		
CA					×		×	×	×	×					×	×	
BI	×																
EW			×											×		×	
DB					×	×	×		×	×	×	×	×		×	×	
SU			×		×	×	×		×			×		×	×	×	
WN			×		×	×		×	×			×			×	×	
GA								×						×		×	
T.			×			×		×	×						×	×	
PT					×			×	×						×	×	
SV			×					×	×					×		×	
PO								×									
TU								×									
GN					×			×	×								
RM									×								
MR	×		×													×	
HH	×				×		×		×	×		×		×		×	
CO								×									
OC					×					×		×	×		×	×	
AV	×		×	×		×	×		×			×		×	×	×	
RP					×	×	×		×				×	×	×	×	
GP						×	×	×	×			×				×	
GV					×	×	×		×	×		×	×	×	×	×	
L.			×		×	×	×	×	×			×		×	×	×	
KN					×					×		×	×			×	
DN			×		×	×	×		×	×		×	×	×	×	×	

RU						×			×								
BW			×		×	×	×	×	×	×		×		×	×	×	
BA										×		×				×	
CU					×				×			×			×	×	
RK			×		×	×	×		×			×		×	×	×	
TT					×												×
MU																×	
BH			×														
LB			×														
HG			×														
TE			×									×					
CN												×					
AF	×		×			×	×		×			×			×		
NJ	×	×															
WL	×	×															

Appendix 2. Modelling results.

Appendix 2-1: Winter Fish covariate correlations. Fish biomass derived from CMACS trawl data using species / family length to weight correction factor. Biomass summed by family and summed across all families. Fish biomass within each quadrat was characterised by calculating average weight from CMACS data of all samples within an area defined by a 200 m buffer of that quadrat during the winter. Table gives Spearman Correlation Coefficient, r_s, and $P > |r_s|$ under H0: Rho=0. N=61

	All Fish	Clupeids	Gadoids	Pleuronectids	Triglids
All Fish	1.00000	-0.03139	0.90076	0.67555	0.80308
		0.8102	<.0001	<.0001	<.0001
Clupeids	-0.03139	1.00000	0.03478	-0.01299	0.07447
	0.8102		0.7902	0.9208	0.5684
Gadoids	0.90076	0.03478	1.00000	0.49089	0.8276
	<.0001	0.7902		<.0001	<.0001
Pleuronectids	0.67555	-0.01299	0.49089	1.00000	0.80247
	<.0001	0.9208	<.0001		<.0001
Triglids	0.80308	0.07447	0.8276	0.80247	1.00000
	<.0001	0.5684	<.0001		<.0001

Appendix 2-2: Summer Fish covariate correlations. Fish biomass derived from CMACS trawl data using species / family length to weight correction factor. Biomass summed by family and summed across all families. Fish biomass within each quadrat was characterised by calculating average weight from CMACS data of all samples within an area defined by a 200 m buffer of that quadrat during the summer. Table gives Spearman Correlation Coefficient, r_s, and $P > |r_s|$ under H0: Rho=0. N=82

	All Fish	Ammodytids	Clupeids	Gadoids	Gobiids	Pleuronectids	Triglids
All Fish	1.00000	-0.41597	0.6214	0.7474	0.36674	0.82868	0.29468
		0.0002	<.0001	<.0001	0.001	<.0001	0.0088
Ammodytids	-0.41597	1.00000	-0.64488	-0.56671	-0.204	-0.21745	-0.29822
	0.0002		<.0001	<.0001	0.0732	0.0558	0.008
Clupeids	0.6214	-0.64488	1.00000	0.57905	0.31361	0.6286	-0.06266
	<.0001	<.0001		<.0001	0.0052	<.0001	0.5858
Gadoids	0.7474	-0.56671	0.57905	1.00000	0.46549	0.51191	0.41278
	<.0001	<.0001	<.0001		<.0001	<.0001	0.0002
Gobiids	0.36674	-0.204	0.31361	0.46549	1.00000	0.32197	-0.10013
	0.001	0.0732	0.0052	<.0001		0.004	0.3831
Pleuronectids	0.82868	-0.21745	0.6286	0.51191	0.32197	1.00000	0.16207
	<.0001	0.0558	<.0001	<.0001	0.004		0.1563
Triglids	0.29468	-0.29822	-0.06266	0.41278	-0.10013	0.16207	1.00000
	0.0088	0.008	0.5858	0.0002	0.3831		0.1563

Appendix 2-3: Shipping and Depth covariate correlations. Water depth for each cell was characterised by averaging all water depth readings from within each of 82 quadrats for which bathymetry data were available. Intensity of shipping within each of the 455 quadrats was characterised by taking the total length of all traces within each quadrat. These were summarised by season and whether or not they were fishing vessels (potentially attracting birds) or otherwise (potentially disturbing birds). Table gives Spearman Correlation Coefficient, r_s, P > $|r_s|$ under H0: Rho=0 and sample size.

	Depth	**Fishing Vessels (winter)**	**Fishing Vessels (summer)**	**Non-Fishing Vessels (winter)**	**Non-Fishing Vessels (summer)**
Depth	1.00000	0.49332	0.08248	0.24006	0.15982
		<.0001	0.4613	0.0298	0.1515
	82	82	82	82	82
Fishing Vessels (winter)	0.49332	1.00000	0.08472	0.22111	0.15218
	<.0001		0.071	<.0001	0.0011
	82	455	455	455	455
Fishing Vessels (summer)	0.08248	0.08472	1.00000	0.25637	0.22198
	0.4613	0.071		<.0001	<.0001
	82	455	455	455	455
Non-Fishing Vessels (winter)	0.24006	0.22111	0.25637	1.00000	0.76137
	0.0298	<.0001	<.0001		<.0001
	82	455	455	455	455
Non-Fishing Vessels (summer)	0.15982	0.15218	0.22198	0.76137	1.00000
	0.1515	0.0011	<.0001	<.0001	
	82	455	455	455	455

Appendix 2-4a: Bird to Winter Fish correlations. Bird numbers for each cell for each season for each species were characterised by taking the average number of birds recorded within each of the 455 quadrats across all boat surveys. Fish variables as above. Table gives Spearman Correlation Coefficient, r_s and P > $|r_s|$ under H0: Rho=0. N=61

	All Fish	**Clupeids**	**Gadoids**	**Pleuronectids**	**Triglids**
Fulmar	-0.02947	0.28098	-0.04363	0.03723	0.00563
	0.8216	**0.0283**	0.7385	0.7757	0.9656
Great Black-backed Gull	-0.05935	0.15058	-0.01815	0.01618	-0.02369
	0.6496	0.2467	0.8896	0.9015	0.8562
Guillemot	0.32632	-0.01262	0.33758	0.42012	0.44679
	0.0103	0.9231	**0.0078**	**0.0007**	**0.0003**
Herring Gull	-0.27298	0.34071	-0.2661	-0.15659	-0.19778
	0.0333	**0.0072**	**0.0382**	0.2281	0.1265
Kittiwake	0.06175	-0.34709	0.07241	0.20554	0.12596
	0.6364	**0.0061**	0.5792	0.112	0.3334
Lesser Black-backed Gull	-0.15064	0.14058	-0.13475	0.07352	0.05584
	0.2465	0.2799	0.3005	0.5734	0.669

Razorbill	-0.01811	0.03813	0.16986	-0.08408	0.12175
	0.8898	0.7705	0.1906	0.5194	0.3499
Red-throated Diver	0.01877	0.19431	-0.04498	0.12292	0.03857
	0.8858	0.1335	0.7307	0.3453	0.7679

Appendix 2-4b: Bird to Summer Fish correlations. Bird numbers for each cell for each season for each species were characterised by taking the average number of birds recorded within each of the 455 quadrats across all boat surveys. Fish variables as above. Table gives Spearman Correlation Coefficient, r_s, and P > $|r_s|$ under H0: Rho=0. N=78.

	All Fish	Ammodytids	Clupeids	Gadoids	Gobiids	Pleuronectids	Triglids
Gannet	-0.05749	0.2245	-0.23409	-0.039	-0.14689	-0.04636	0.11258
	0.6171	**0.0482**	0.0391	0.7346	0.1994	0.6869	0.3264
Great Skua	-0.06495	0.30185	-0.19439	-0.13834	-0.04246	0.00753	-0.06206
	0.5721	**0.0072**	**0.0881**	0.2271	0.7121	0.9478	0.5893

Appendix 2-4c: Bird to Benthic data correlations. Bird numbers as above. Benthic organisms were treated in a similar manner to fish data and grouped into mollusc, non-mollusc and overall biomass variables. Table gives Spearman Correlation Coefficient, r_s, and P > $|r_s|$ under H0: Rho=0. N_{winter}=61, N_{summer}=81

	Total Benthic	Molluscs	Non Molluscs
Common Gull (winter)	-0.0272	0.02954	-0.02992
	0.7288	0.7065	0.7029
Fulmar (winter)	0.02073	-0.00728	0.04184
	0.7915	0.9261	0.5937
Great Black-backed Gull (winter)	0.07157	-0.03696	0.10172
	0.361	0.6374	0.1936
Guillemot (winter)	0.0562	0.11227	0.06869
	0.4734	0.1511	0.3807
Herring Gull (winter)	-0.01293	-0.07405	-0.00374
	0.869	0.3445	0.962
Kittiwake (winter)	-0.01457	-0.06417	0.00711
	0.8527	0.4129	0.9278
Lesser Black-backed Gull (winter)	0.3062	0.14859	0.32799
	<.0001	0.0568	<.0001
Razorbill (winter)	0.06726	-0.00198	0.09722
	0.3907	0.9799	0.2142
Red-throated Diver (winter)	-0.06548	-0.12777	-0.06409
	0.4034	0.102	0.4135
Gannet (summer)	-0.12942	-0.05281	-0.1229
	0.0976	0.5005	0.1158

Appendix 2-4d: Bird to Shipping and Depth data correlations. Bird variables as above. Shipping intensity as above. Table gives Spearman Correlation Coefficient, r_s, $P > |r_s|$ under H0: Rho=0 and sample size.

	Depth	Fishing Vessels (winter)	Non-Fishing Vessels (winter)
Common Gull	.	-0.01416	-0.06187
	.	0.7632	0.1877
	82	455	455
Fulmar	0.08049	0.01614	0.0483
	0.4722	0.7313	0.304
	82	455	455
Great Black-backed Gull	-0.02709	-0.01407	-0.10848
	0.8091	0.7647	**0.0206**
	82	455	455
Guillemot	-0.07947	-0.02344	0.1
	0.4779	0.618	**0.0330**
	82	455	455
Herring Gull	-0.20062	-0.04051	-0.07961
	0.0707	0.3887	0.0899
	82	455	455
Kittiwake	0.03648	0.01582	0.02835
	0.7449	0.7365	0.5463
	82	455	455
Lesser Black-backed Gull	0.09673	0.06462	-0.03161
	0.3873	0.1688	0.5012
	82	455	455
Razorbill	0.04864	0.04152	-0.06632
	0.6643	0.3769	0.1578
	82	455	455
Red-throated Diver	-0.21433	-0.15142	-0.0404
	0.0532	**0.0012**	0.3899
	82	455	455

	Depth	Fishing Vessels (summer)	Non-Fishing Vessels (summer)
Gannet	-0.06775	0.06349	-0.02861
	0.5453	0.1764	0.5427
	82	455	455
Great Skua	.	-0.06035	-0.08208
	.	0.1988	0.0803
	82	455	455

Appendix 2-5a: Summary of results from Chi-sq analysis used for exploratory purposes. Birds vs. categorical environmental variables.

Categorical variable definition		
Birds (dependent variable)	O=none recorded; M = average < 1: H = average >=1	
All Fish (winter):	O=zero; L=(>0,<100; M=(>=100,<1000); H=(>=1000)	(grams)
All Fish (summer):	O=zero; L=(>0,<100; M=(>=100,<1000); H=(>=1000)	(grams)
Depth;	O=<20; L=(>=20,<30); M=(>=30,<40); H= (>=40)	(metres)
Fishing Vessels (winter)	O=zero; L=(>0,<1000); M=(>=1000,<2500); H=(>=2500)	(metres)
Fishing Vessels (summer)	O=zero; L=(>0,<500); M=(>=5000,<1000); H=(>=1000)	(metres)
Non-Fishing Vessels (winter)	O=zero; L=(>0,<1000); M=(>=1000,<10000); H=(>=10000)	(metres)
Non-Fishing Vessels (summer)	O=zero; L=(>0,<1000); M=(>=1000,<10000); H=(>=10000)	(metres)
Molluscs	O=zero; L=(>0,<10); M=(>=10,<100); H=(>=100)	(grams)
Non-Molluscs	O=zero; L=(>0,<100); M=(>=100,<1000); H=(>=1000)	(grams)
Benthic	O=zero; L=(>0,<100); M=(>=100,<1000); H=(>=1000)	(grams)

	All Fish (winter)	**All Fish (summer)**	**Depth**	**Fishing Vessels (winter)**	**Fishing Vessels (summer)**	**Non-Fishing Vessels (winter)**	**Non-Fishing Vessels (summer)**	**Molluscs**	**Non-Molluscs**	**Benthic**
Common Gull	X	-	X	X	-	Q	-	Q	Q	Q
Fulmar	Q	-	Q	NS	-	NS	-	Q	Q	Q
Greater Black-backed Gull	Q	-	Q	Q	-	Q	-	Q	Q	Q
Guillemot	Q	-	Q	NS	-	NS	-	**NS**	**NS**	**NS**
Herring Gull	Q	-	Q	Q	-	Q	-	Q	Q	Q
Kittiwake	Q	-	Q	Q	-	Q	-	Q	Q	Q
Lesser Black-backed Gull	Q	-	Q	Q	-	NS	-	**NS**	**NS**	**NS**
Razorbill	Q	-	Q	Q	-	Q	-	**NS**	**P=0.0161**	**P=0.0381**
Red-throated Diver	Q	-	Q	Q	-	Q	-	Q	Q	Q
Gannet	-	Q	Q	-	Q	-	Q	Q	Q	Q
Great Skua	-	Q	X	-	Q	-	Q	Q	Q	Q

- = not applicable; Q = questionable matrix for Chi-sqr; X = not feasible

Appendix 2-5b: Summary of results from Chi-sq analysis used for exploratory purposes. Birds presence / absence vs. categorical environmental variables (lumped to get valid Chi-sq).

Categorical variable definition		
Birds (dependent variable)	present / absent	
All Fish (winter):	L = <100g; H = (>=100)	(grams)
All Fish (summer):	L = <100g; H = (>=100)	(grams)
Depth;	L = (<30); H = (>=30)	(metres)
Fishing Vessels (winter)	L = (<1000); H = (>=1000)	(metres)
Fishing Vessels (summer)	L = (<500); H = (>=5000)	(metres)
Non-Fishing Vessels (winter)	L = (<1000); H = (>=1000)	(metres)
Non-Fishing Vessels (summer)	L = (<1000); H = (>=1000)	(metres)
Molluscs	L = (<10); H = (>=10)	(grams)
Non-Molluscs	L = (<100); H = (>=100)	(grams)
Benthic	L = (<100); H = (>=100)	(grams)

	All Fish (winter)	**All Fish (summer)**	**Depth**	**Fishing Vessels (winter)**	**Fishing Vessels (summer)**	**Non-Fishing Vessels (winter)**	**Non-Fishing Vessels (summer)**	**Molluscs**	**Non-Molluscs**	**Benthic**
Common Gull	X	-	X	NS	-	NS	-	NS	NS	NS
Fulmar	NS	-	NS	NS	-	NS	-	NS	NS	P=0.0066
Greater Black-backed Gull	NS	-	NS	NS	-	NS	-	NS	NS	NS
Guillemot	NS	-	NS	NS	-	NS	-	NS	NS	NS
Herring Gull	NS	-	NS	NS	-	NS	-	NS	NS	NS
Kittiwake	NS	-	NS	NS	-	NS	-	NS	NS	NS
Lesser Black-backed Gull	NS	-	NS	NS	-	NS	-	NS	NS	NS
Razorbill	NS	-	NS	P=0.0092	-	NS	-	NS	NS	NS
Red-throated Diver	NS	-	NS	NS	-	NS	-	NS	NS	NS
Gannet	-	NS		-	NS	-	NS	P=0.0429	NS	NS
Great Skua	-	NS	X	-	NS	-	NS	NS	**P=0.0093**	**P=0.0061**

NA = not applicable; Q = questionable matrix for Chi-sqr; X = not feasible

Appendix 2-6: Summary of Logistic Regressions of Birds presence / absence vs. environmental variables

Variables considered		
Birds (dependent variable)	present / absent	
All Fish (winter):	average weight	(grams)
Depth;	Depth	(metres)
Fishing Vessels (winter)	marico traces	(metres)
Non-Fishing Vessels (winter)	marico traces	(metres)
Benthic	O=zero; L=(>0,<100); M=(>=100,<1000); H=(>=1000)	(grams)
AllFish (winter)	O=zero; L=(>0,<100g; M=(>=100,<1000); H=(>=1000)	(grams)
Benthic	O=zero; L=(>0,<100); M=(>=100,<1000); H=(>=1000)	(grams)

Summary of model statistics for Kittiwake (this was the only significant model obtained):

<u>Logistic regression for Kittiwake</u>

Number of Observations Read	455
Number of Observations Used	29

Response Profile

Ordered Value	Kittiwake (presence / absence)	Total Frequency
1	Absent	15
2	Present	14

Probability modelled is winter Kittiwake = 1

Analysis of Maximum Likelihood Estimates

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > Chi Square
Intercept	1	8.4194	4.1083	4.2	0.0404
Depth	1	-0.3305	0.1543	4.5848	0.0323

Appendix 3 Methodology for analysis of 6-visit Territory Mapping census of onshore site

The survey method used for the woodland project is a modified version of the Common Birds Census (Marchant 1983), and will use the following principles to define territory circles on the species maps:

1. Broadly, the minimum number of visit registrations (from different visits) used to form a territory was TWO, although as many registrations as possible were placed into a single territory.
2. Where the species is a songbird, that is alone and in song, in correct habitat, such a registration can stand alone as a territory.
3. A lone bird alarm calling or giving other vocalisations thought to have strong territorial significance is acceptable as a territory.
4. The presence of an occupied nest on just one visit, with no other registrations is acceptable as a territory.
5. A lone songbird not in song CANNOT count as a territory, regardless of whether it is located toward the middle of the plot or near the edges.
6. A territory was not counted where there was just a single registration of a bird in mid-flight.
7. The presence of a family on a single visit (juvenile birds with attendant parents) is not permitted as a territory, since they may have moved into the area from outside the CBC plot.
8. A lone pair of the same registration, e.g. 2A or Bx2, was permitted as a territory, provided that the birds were not in mid-flight. In instances involving pairs of birds in flight, territories were only permitted when the pair was recorded taking off from a fixed point, e.g. a tree or the ground (but excluded when they have been seen in mid-flight) – Wood Pigeon. Such registrations are acceptable even if the sex of the individuals is not known, because this will follow the rationale already widely used and accepted in CBC territory analysis (it can be assumed that they might be a pair; this is regularly assumed when placing surplus registrations into an established territory cluster).
9. For species that are semi-colonial, or occur in large groups where it may be hard to define separate individual territories (referred to as "group count" species, e.g. Wood Pigeon, Feral Pigeon, Linnet), the numbers of birds per visit were counted up. Then the maximum count of the visits was divided by 2 to give the number of territories. Note that the second highest count was not used, as this is only appropriate for a census involving 8-10 visits, not four visits, such as this. Additionally, for "group count" species, birds only seen flying over the plot, and large groups were excluded from potential territory circles. Wood Pigeons – Leave out large groups from the analysis as they are unlikely to be nesting in a large groups (they may just be resting).
10. Counting methods for further selected species can be summarised as follows:
11. Swift, hirundines: since these species do not nest in woodland, ignore these registrations.
12. Rook, a colonial nesting species: impossible to draw territories for, so recorded as "present" or "not recorded". Nest counts in rookery trees is the only acceptable method for recording territories for this species.

Low density species seen just once, and not in song are NOT permitted as a territory, regardless of whether the bird is in flight or perched. There needs to be a minimum of two visit registrations for these species to count.

Appendix 4

Estimated monthly mortality rates under different scenarios of flight speed, avoidance rate and birds at risk. Assume bird surveys take a rate of no. birds/time taken to cross width of wind farm. There are 18,000 minutes per month in winter (10 hour day, 30 day month) and 25,200 minutes in summer (14 hour day, 30 day month). CR = collision risk with no avoidance, S = speed (F = fast, S = slow), Av = avoidance, N = number at risk, M_{rate} = predicted number of birds killed (CR x Av x N) per observation period T in minutes, M_{month} = predicted monthly mortality (M is given to 4 significant figures). Note that site = "All" is not the combined mortality from Inner Gabbard and Galloper, but all birds recorded in flight within the wind farm study area (see Table 9.3.5). T varies due to flight speed – a decrease in flight speed increases M_{rate} but also increases T.

(a) Red-throated Diver

Site	Season	CR	S	Av	N	M_{rate}	T	M_{month}
All	Winter	0.048	F	0.9999	0.67	3.22×10^{-6}	10.06	0.006
		0.048		0.9982	0.67	5.79×10^{-5}	10.06	0.100
		0.048		0.87	0.67	0.004	10.06	7.157
		0.052	S	0.9999	0.67	3.48×10^{-6}	11.18	0.006
		0.052		0.9982	0.67	6.27×10^{-5}	11.18	0.101
		0.052		0.87	0.67	0.0045	11.18	7.247

(b) Lesser Black-backed Gull

Site	Season	CR	S	Av	N	M_{rate}	T	M_{month}
All	Winter	0.076	F	0.9999	175.6	0.0013	17.28	1.354
		0.076		0.9982	175.6	0.0240	17.28	25
		0.076		0.87	175.6	1.735	17.28	1807
		0.084	S	0.9999	175.6	0.0015	19.20	1.406
		0.084		0.9982	175.6	0.0266	19.20	24.94
		0.084		0.87	175.6	1.918	19.20	1798
Galloper		0.076	F	0.9999	1.19	9.04×10^{-6}	6.03	0.027
		0.076		0.9982	1.19	1.63×10^{-4}	6.03	0.487
		0.076		0.87	1.19	0.0018	6.03	5.373
		0.084	S	0.9999	1.19	9.99×10^{-6}	6.70	0.027
		0.084		0.9982	1.19	1.79×10^{-4}	6.70	0.481
		0.084		0.87	1.19	0.0130	6.70	34.93
Inner Gabbard		0.076	F	0.9999	6.48	4.92×10^{-5}	11.25	0.079
		0.076		0.9982	6.48	8.86×10^{-4}	11.25	1.418
		0.076		0.87	6.48	0.0640	11.25	102.4
		0.084	S	0.9999	6.48	5.44×10^{-5}	12.50	0.078
		0.084		0.9982	6.48	9.79×10^{-4}	12.50	1.410
		0.084		0.87	6.48	0.0708	12.50	102.0
All	Summer	0.076	F	0.9999	127.5	9.69×10^{-4}	17.28	1.413
		0.076		0.9982	127.5	0.0174	17.28	25.38
		0.076		0.87	127.5	1.2597	17.28	1837
		0.084	S	0.9999	127.5	0.0011	19.20	1.444
		0.084		0.9982	127.5	0.0197	19.20	25.86
		0.084		0.87	127.5	1.3923	19.20	1827
Galloper		0.076	F	0.9999	0.68	5.16×10^{-6}	6.03	0.022
		0.076		0.9982	0.68	9.30×10^{-5}	6.03	0.389
		0.076		0.87	0.68	0.0067	6.03	28
		0.084	S	0.9999	0.68	5.71×10^{-6}	6.70	0.022
		0.084		0.9982	0.68	1.03×10^{-4}	6.70	0.387
		0.084		0.87	0.68	0.0074	6.70	27.83
Inner Gabbard		0.076	F	0.9999	4.71	3.58×10^{-5}	11.25	0.080
		0.076		0.9982	4.71	6.44×10^{-4}	11.25	1.443
		0.076		0.87	4.71	0.0465	11.25	104.2
		0.084	S	0.9999	4.71	3.96×10^{-5}	12.50	0.080
		0.084		0.9982	4.71	7.12×10^{-4}	12.50	1.435
		0.084		0.87	4.71	0.0514	12.50	103.6

(c) Great Skua

Site	Season	CR	S	Av	N	M_{rate}	T	M_{month}
All	Summer	0.052	F	0.9999	93.61	4.86×10^{-4}	11.47	1.068
		0.052		0.9982	93.61	0.0088	11.47	19.33
		0.052		0.87	93.61	0.6328	11.47	1390
		0.057	S	0.9999	93.61	5.33×10^{-4}	12.75	1.053
		0.057		0.9982	93.61	0.0096	12.75	18.97
		0.057		0.87	93.61	0.6937	12.75	1371
Galloper		0.052	F	0.9999	1.06	5.20×10^{-6}	4.00	0.033
		0.052		0.9982	1.06	9.92×10^{-5}	4.00	0.625
		0.052		0.87	1.06	0.0072	4.00	45.36
		0.057	S	0.9999	1.06	6.04×10^{-6}	4.45	0.034
		0.057		0.9982	1.06	1.09×10^{-4}	4.45	0.617
		0.057		0.87	1.06	0.0078	4.45	44.17
Inner Gabbard		0.052	F	0.9999	5.81	3.02×10^{-5}	7.47	0.102
		0.052		0.9982	5.81	5.44×10^{-4}	7.47	1.835
		0.052		0.87	5.81	0.0393	7.47	132.6
		0.057	S	0.9999	5.81	3.31×10^{-5}	8.30	0.100
		0.057		0.9982	5.81	5.96×10^{-4}	8.30	1.810
		0.057		0.87	5.81	0.0431	8.30	130.9