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The Potential Effects on Birds of the Greater Gabbard Offshore Wind Farm Report for February 2004 to April 2006

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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 Ltd. (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 April 2006 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.

5. 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.

6. Thirty-two principal 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.

7. No species were found in numbers estimated to exceed the 1% international population threshold. Four species (Red-throated Diver, Great Skua, Lesser Black-backed Gull and Great 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.

8. Five further species (Northern Fulmar, Northern Gannet, Mew Gull, Herring 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.

9. Proportional estimates of offshore bird numbers within the wind farm footprint are low, with only Red-throated Diver exceeding the 1% national importance threshold and only four species, Fulmar, Herring Gull, Great Black-backed Gull and Kittiwake (and also Auks) exceeding the 1% regional threshold. However the threshold for Red-throated Diver is probably too low.

10. 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 and additionally in the northeast of the survey after May 2005.

11. The presence of this additional gull flock resulted in most gull species being recorded in greater numbers during the later survey period (May 2005 - April 2006) than in the earlier period of survey (February 2004 - March 2005). Red-throated Diver were also more abundant during the second survey period, but auk species declined in abundance between the two survey periods.

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

13. Modelling on data collected during the first survey period (February 2004 to March 2005) revealed no conclusive relationships between bird numbers and the available environmental data. Consequently such modelling was not attempted on data collected during the second survey period.

14. 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 – April 2006, 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.

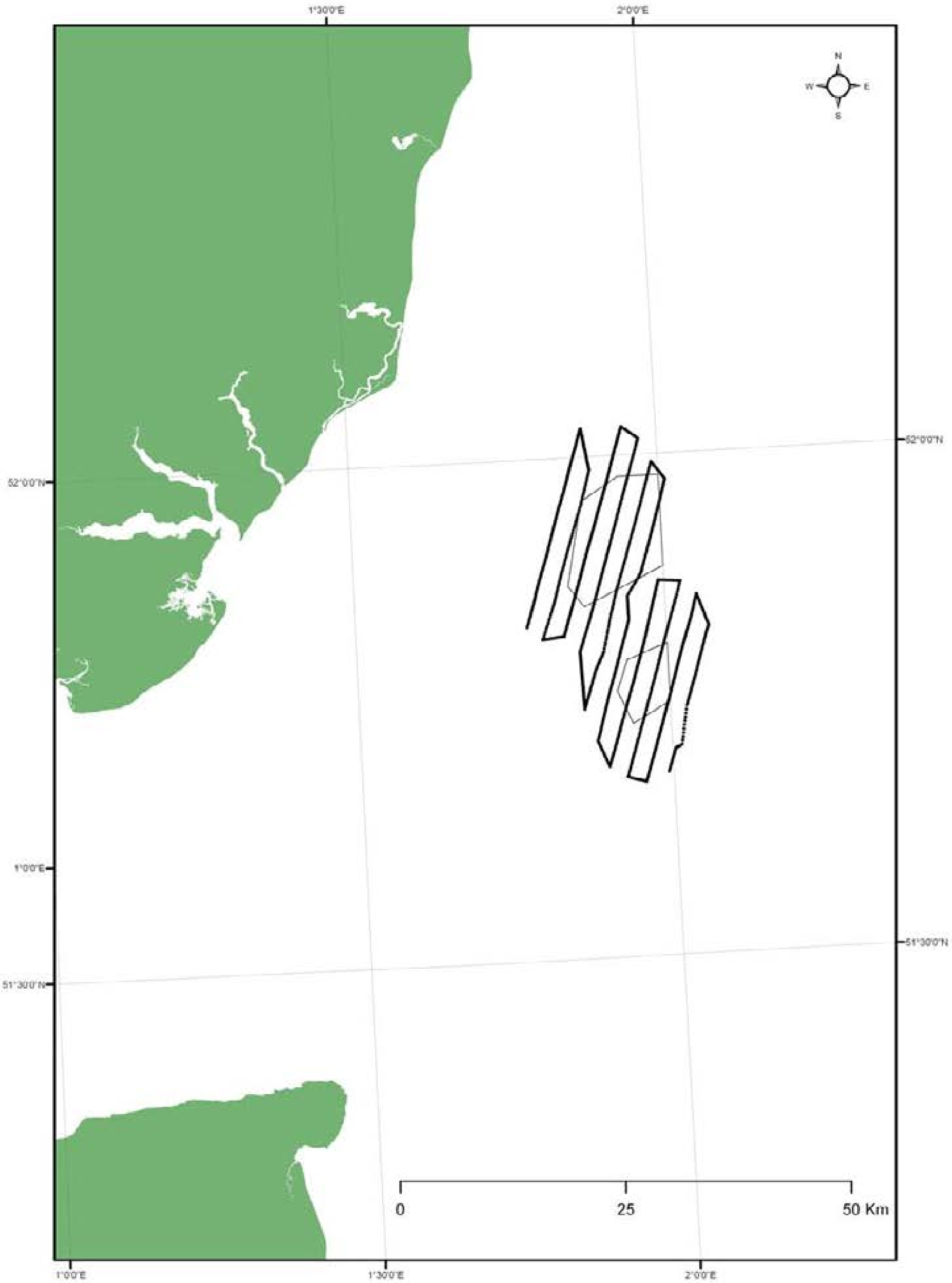

Figure 1.2-1 Boat survey transects February – March 2004. Wind farm area in grey, boat track in black.

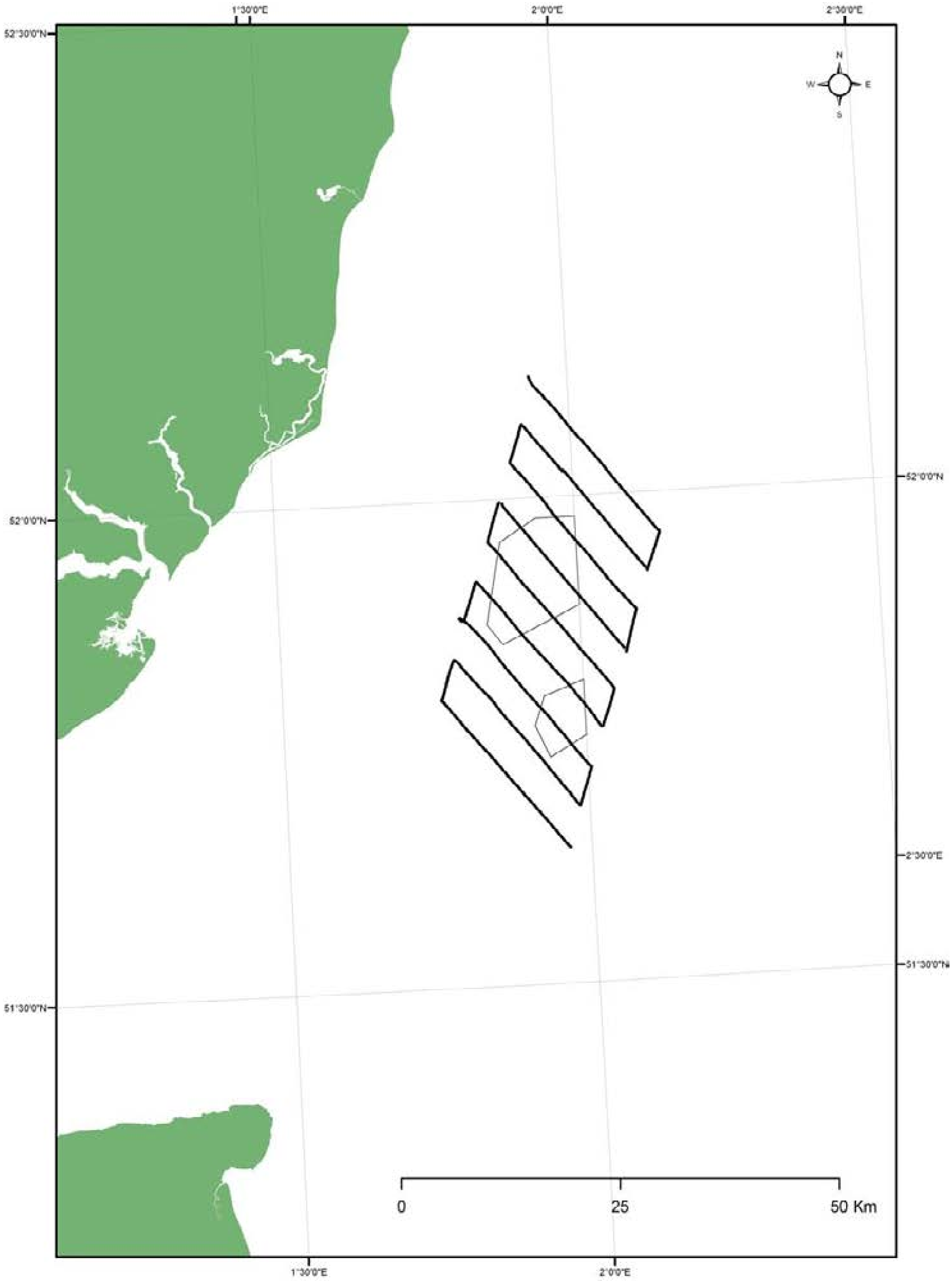

Figure 1.2-2 Boat survey transects April 2004 – April 2006. Wind farm area in grey, boat track in black.

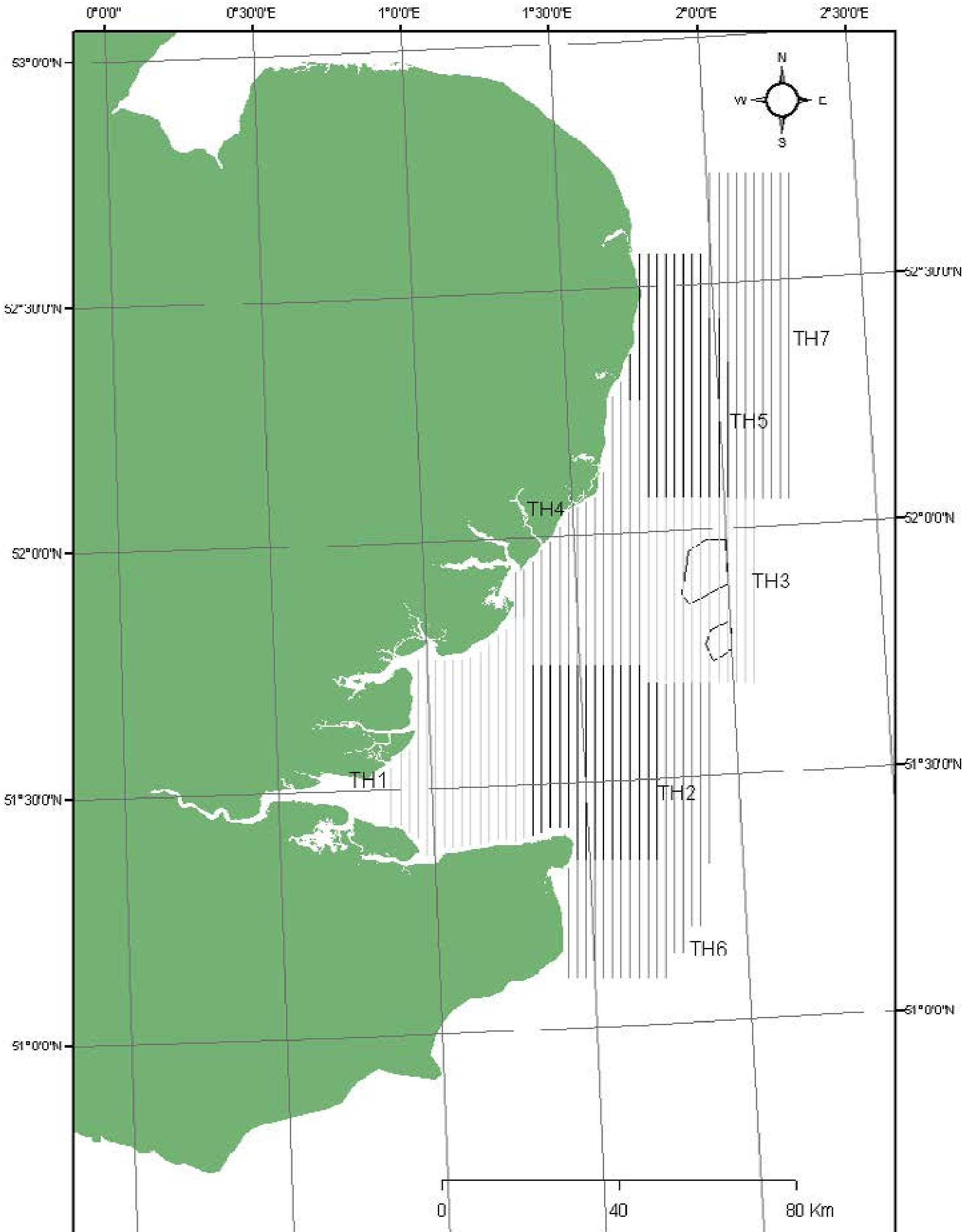

Figure 1.2-3 Transects of Thames Estuary aerial survey areas, DTI 2004 - 2006. Area TH3 (proposed wind farm study area) with other aerial survey areas. Areas TH4 and TH5 were only surveyed during the winter of 2004/05. Areas TH6 and TH7 were only surveyed during the winter of 2005/06.

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, waders and ducks (except Red-breasted Merganser, Eider and scoters).

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 the proposed offshore wind farm area. Lesser Black-backed Gulls breeding on Orford Ness in the Alde-Ore Estuary SPA are a notable exception.

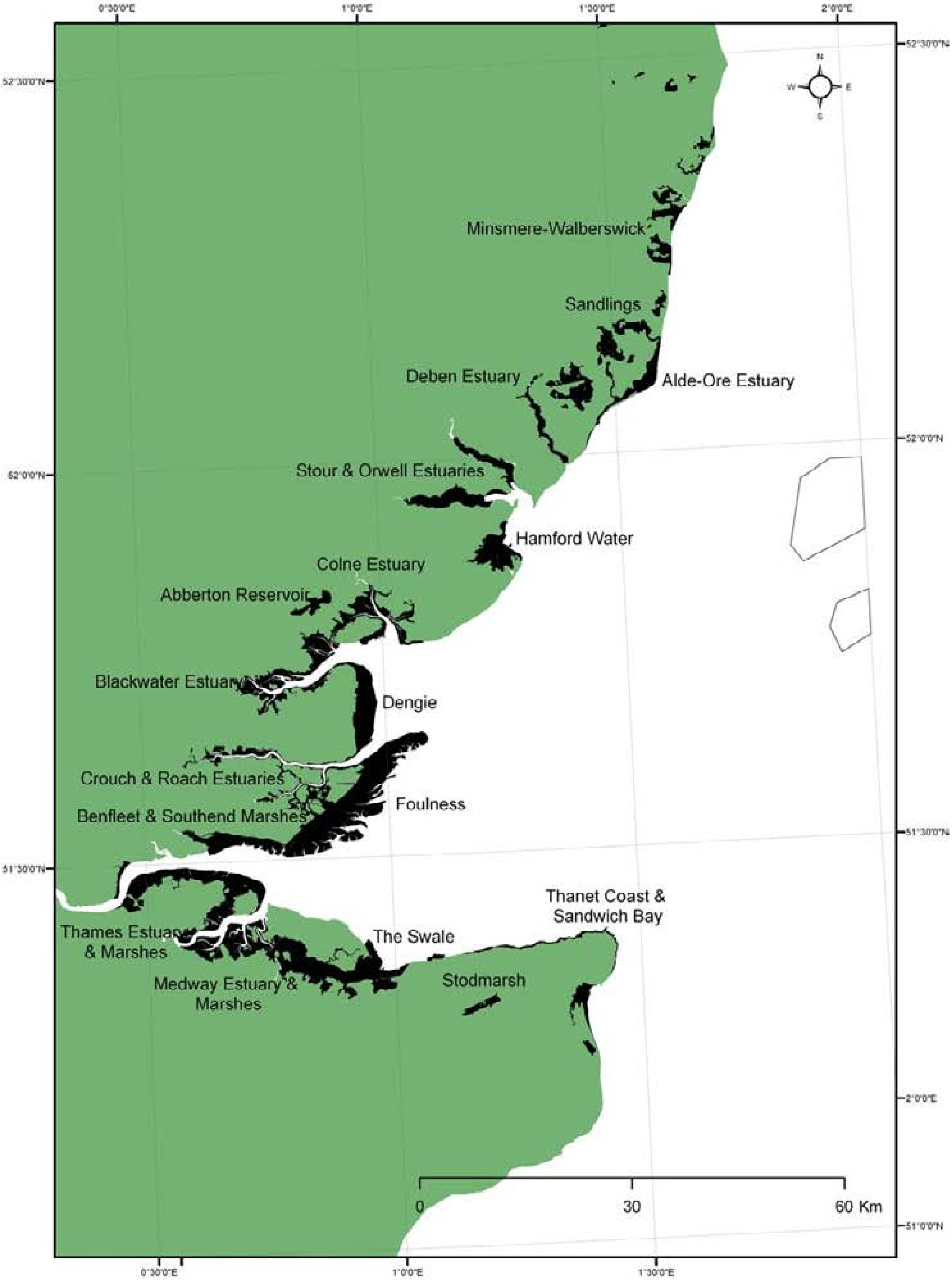

Figure 1.3-1 The Outer Thames Estuary showing the proposed Greater Gabbard wind farm site and neighbouring Special Protection Areas (SPAs: in bold).

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 Ltd., 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 km intervals, running parallel to the coast for the first three surveys, and perpendicular to the coast, spaced 2 km apart 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 5.2 to 6 m above sea level, both observers 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 separately scans were made ahead of the boat using binoculars to sample 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.

Table 2.1.1.2-1 Boat survey dates.

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)
	April	N/A	Weather disruption, no survey
	May	28 - 29 May	
	June	11 - 12 June	
	July	2 - 3 July	
	August	5 - 6 August	
	September	9 - 10 September	
	October	7 - 8 October	
	November	N/A	Weather disruption, no survey
	December	10 - 11 December	
2006	January (1)	7 - 8 January	
	January (2)	21 - 22 January	Incomplete survey (boat problems)
	February	4 - 5 February	
	March	15 - 16 March	Incomplete survey (injury disruption)
	April	15 - 16 April	

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 undertaken or abandoned, noting that many other surveys were cancelled prior to the date of mobilisation.

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

An additional third '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. Furthermore, no attempt to correct counts to account for the proportion of time spent searching for migrants was attempted, as doling so would have lead to unrealistically inflated counts of sporadically encountered flocks.

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 surveyors of the Wildfowl & Wetlands Trust Wetlands Advisory Service, the area containing the proposed Greater Gabbard wind farm being TH3. In the winter of 2005/06, two of the areas counted in 2004/05 (TH4 and TH5) were not counted, but two additional areas (TH6 and TH7) were counted instead. 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 the first set of surveys: winter period 1 = 12/11/04; winter period 2 = 24/11/04; winter period 3 = 14/01/05; winter period 4 = 28/02/05, and the following dates used for the second set of survey: winter period 1 = 16/11/05; winter period 2 = 08/12/05; winter period 3 = 10/02/06; winter period 4 = 03/03/06.

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.

Table 2.1.2-1 Seven aerial survey blocks (TH1 – TH7) with relevant transect labels, transect lengths, and total survey areas.

Survey block	Transect number	Length (km)	Area (km²)
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	
TH4	15	10	1126
	16	10.5	
	17	23.5	
	18	26	
	19	28	
TH4 continued	20	31.5	1126
	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	
TH6	21	25	1286
	22	27	
	23	27	
	24	27	
	25	27	
	26	27	
	27	27	
	28	27	
	29	27	
	30	27	
	31	27	
	32	68	
	33	61	
	34	61	
	35	55	
	36	55	
	37	41	
TH7	37	33	1249
	38	33	
	39	43	
	40	74	
	41	74	
	42	74	
	43	74	
	44	74	
	45	74	
	46	74	

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' and on the water on boat surveys were included for analysis, as were all birds recorded during aerial surveys. 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). In flight bird data and 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 (see 4.2.1).

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 (Common) 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.

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 (boat surveys) and the observation seat (port or starboard) and behaviour of birds (aerial surveys).

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), first summer surveys (April 2004 – September 2004), second winter surveys (November 2004 – March 2005), second summer surveys (April 2005 – September 2005) and third winter surveys (November 2005 – April 2006). The same procedure was used to produce smoothed maps for aerial surveys over the winters 2004/05 and 2005/06.

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.

3.1.3 Between survey period comparisons

To enable useful comparisons to be drawn between data analysed for the first baseline report (Banks *et al.* 2005) and data analysed for this final baseline report, peak counts and percentages of national populations are presented for each of the two survey periods (February 2004 to March 2005 and April 2005 to April 2006). To aid interpretability further, the colour schemes used for kriged maps based on data collected during the first survey period, differs to that used for maps derived from data collected during the second survey period. For the purposes of analysis, the data collected during the boat survey in mid-April 2006 are considered as "winter data", since the count was conducted as a surrogate for March data following the abandonment of the March 2006 survey due to staff injury. Data collected in April 2004 are considered as "summer data" as the survey was conducted towards the end of this month.

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), Species that are features of the SPAs identified in Figure 1.3.1, UK Biodiversity Action Plan (UKBAP) species, and status under the Birds of Conservation Concern list: Gregory *et al.* 2002).

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. § schedule only applies during the close season.

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
Sooty Shearwater	*Puffinus griseus*					
Manx Shearwater	*Puffinus puffinus*					AMBER
European Storm Petrel	*Hydrobates pelagicus*	YES				AMBER
Leach's Storm Petrel	*Oceanodroma leucorhoa*	YES	YES*			AMBER
Northern Gannet	*Morus bassunus*					AMBER
Great Cormorant	*Phalacrocorax carbo*			YES		AMBER
Brent Goose (Dark-bellied)	*Branta bernicla*			YES		AMBER
Eurasian Wigeon	*Anas penelope*			YES		AMBER
Northern Pintail	*Anas acuta*		YES*§	YES		AMBER
Common Eider	*Somateria mollissima*					AMBER
Common Scoter	*Melanitta nigra*		YES		YES	RED
Ringed Plover	*Charadrius hiaticula*			YES		AMBER
Grey Plover	*Pluvialis squatarola*			YES		AMBER
Bar-tailed Godwit	*Limosa lapponica*			YES		
Eurasian Curlew	*Numenius arquata*			YES		AMBER
Ruddy Turnstone	*Arenaria interpres*			YES		AMBER
Pomarine Skua	*Stercorarius pomarinus*					
Arctic Skua	*Stercorarius parasiticus*					
Great Skua	*Catharacta skua*					AMBER
Little Gull	*Larus minutes*	YES	YES			
Black-headed Gull	*Larus ridibundus*			YES		AMBER
Mew (Common) Gull	*Larus canus*					AMBER
Lesser Black-backed Gull	*Larus fuscus*			YES		AMBER
Herring Gull	*Larus argentatus*			YES		AMBER
Great Black-backed Gull	*Larus marinus*					
Black-legged Kittiwake	*Rissa tridactyla*					AMBER
Sandwich Tern	*Sterna sandvicensis*	YES		YES		AMBER
Common Tern	*Sterna hirundo*	YES		YES		

Continued…/

Table 4.1-1. Continued.

Species	Scientific name	Annex 1 Species	WCA Species	SPA Feature	UKBAP Species	BoCC Listing
Little Tern	*Sterna albifrons*	YES	YES	YES		AMBER
Common Guillemot	*Uria aalgae*					AMBER
Razorbill	*Alca torda*					AMBER
Rock (Feral) Pigeon	*Columba livia*					
Common Swift	*Apus apus*					
Sky Lark	*Alauda arvensis*				YES*	RED
Barn Swallow	*Hirundo rustica*					AMBER
Meadow Pipit	*Anthus pratensis*					AMBER
European Robin	*Erithacus rubecula*					
Common Redstart	*Phoenicurus phoenicurus*					AMBER
Northern Wheatear	*Oenanthe oenanthe*					
Common Blackbird	*Turdus merula*					
Song Thrush	*Turdus philomelos*				YES*	RED
Blackcap	*Sylvia atricapilla*					
Common Chiffchaff	*Phylloscopus collybita*					
Willow Warbler	*Phylloscopus trochilus*					AMBER
Goldcrest	*Regulus regulus*					AMBER
Carrion Crow	*Corvus corone*					
Common Starling	*Sturna vulgaris*					RED
Chaffinch	*Fringilla coelebs*					
Eurasian Siskin	*Carduelis spinus*					
Reed Bunting	*Emberiza schoeniclus*				YES*	RED

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). The values given are Distance estimates in instances where such analysis was possible, or scaled raw-counts in instances where such analysis was not possible. Thus methods used vary from species to species, but are described in the species accounts. Table 4.1.1-1 shows the aerial survey counts of the species recorded, 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 in the first survey period or that comprising TH1, TH2, TH3, TH6 and TH7 in the second survey period). 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.* Collier *et al.* 2005). The importance of estimates that exceed the national threshold, but are lower than 50 is discussed in the individual species accounts.

Population thresholds were based on values given in Collier *et al.* (2005). For seabirds recorded during the summer months, for which no national threshold have been specified, national importance was determined using 1% Great Britain population thresholds, using population estimates given in (Baker *et al.* 2005). 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.

Table 4.1.1-1 National importance of species counted on aerial and boat surveys (entire survey area). 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. ? appears where the species is considered a passage migrant and does not routinely breed or winter in the UK. Auks are defined as auk species (Common Guillemot or Razorbill).

*Includes estimates based on unidentified diver species

Species	**Peak boat estimate**	**Peak aerial estimate**	**Relevant 1% GB threshold**	**Proportion of national threshold**	**National importance?**
Red-throated Diver*	135	721	50	14.42	YES
Black-throated Diver	27	3	50	0.54	NO
Northern Fulmar	936	376	9,975	0.09	NO
Sooty Shearwater	2	1	?	?	NO
Manx Shearwater	1	139	5,900	0.02	NO
European Storm Petrel	1	1	513	0.00	NO
Leach's Storm Petrel	1	0	961	0.00	NO
Northern Gannet	268	139	4,371	0.06	NO
Great Cormorant	3	1	230	0.01	NO
Brent Goose (Dark-bellied)	9	0	980	0.01	NO
Eurasian Wigeon	7	0	4,060	0.00	NO
Northern Pintail	1	0	280	0.00	NO
Common Eider	1	0	730	0.00	NO
Common Scoter	46	0	500	0.09	NO
Ringed Plover	1	0	320	0.00	NO
Grey Plover	3	0	530	0.01	NO
Bar-tailed Godwit	6	0	620	0.01	NO
Eurasian Curlew	1	0	1,470	0.00	NO
Ruddy Turnstone	2	0	500	0.00	NO
Pomarine Skua	2	0	?	?	NO
Arctic Skua	12	0	50	0.24	NO
Great Skua	304	1	190	1.58	YES
Little Gull	11	27	?	?	NO
Black-headed Gull	18	10	2,558	0.01	NO
Mew (Common) Gull	79	94	4,300	0.05	NO
Lesser Black-backed Gull	2,419	26	610	3.97	YES
Herring Gull	1,731	335	3,800	0.46	NO
Great Black-backed Gull	582	1,450	430	3.37	YES
Black-legged Kittiwake	1,586	1,218	7,337	0.22	NO
Sandwich Tern	19	0	211	0.09	NO
Common Tern	21	0	203	0.10	NO
Little Tern	1	0	50	0.02	NO
Common Guillemot	1,786	-	26,447	0.07	NO
Razorbill	1,411	-	3,290	0.43	NO
Auks	-	2,851	-		

Continued…/

Table 4.1.1-1. Continued.

Species	Peak boat estimate	Peak aerial estimate	Relevant 1% GB threshold	Proportion of national threshold	National importance?
Rock (Feral) Pigeon	10	0	>2,000	0.00	NO
Common Swift	2	0	1,600	0.00	NO
Sky Lark	1	0	5,400	0.00	NO
Barn Swallow	5	0	13,560	0.00	NO
Meadow Pipit	12	0	32,000	0.00	NO
European Robin	4	0	110,000	0.00	NO
Common Redstart	2	0	2,020	0.00	NO
Northern Wheatear	1	0	1,100	0.00	NO
Common Blackbird	1	0	924,000	0.00	NO
Song Thrush	1	0	20,600	0.00	NO
Blackcap	1	0	18,320	0.00	NO
Common Chiffchaff	1	0	14,980	0.00	NO
Willow Warbler	2	0	39,100	0.00	NO
Goldcrest	1	0	15,460	0.00	NO
Carrion Crow	1	0	15,800	0.00	NO
Common Starling	26	0	14,740	0.00	NO
Chaffinch	1	0	111,240	0.00	NO
Eurasian Siskin	1	0	7,140	0.00	NO
Reed Bunting	1	0	3,520	0.00	NO

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, except Red-throated Diver, although this estimate includes a large number of unidentified divers assumed to be this species.

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.

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 (>1%) by itself. Estimates for TH3 that exceed 1% of the regional population, but do no exceed 50, are not considered regionally important.

*Includes estimates based on unidentified diver species

Species	**Peak regional winter total estimate**	**Peak winter count estimate TH3**	**Peak % regional total**	**Regional importance**
Red-throated Diver*	6,650	721	10.84%	**YES**
Black-throated Diver	31	3	9.68%	NO
Northern Fulmar	729	376	51.58%	**YES**
European Storm Petrel	1	1	100%	NO
Northern Gannet	3,996	139	3.48%	YES
Great Cormorant	447	8	1.79%	NO
Common Scoter	6,821	10	0.15%	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	10.00%	NO
Little Gull	17	4	23.53%	NO
Black-headed Gull	4,155	10	0.24%	NO
Mew (Common) Gull	1,671	94	5.63%	YES
Lesser Black-backed Gull	570	26	4.56%	NO
Herring Gull	4,385	335	7.64%	**YES**
Great Black-backed Gull	10,069	1,450	14.40%	**YES**
Black-legged Kittiwake	16,797	1,218	7.25%	**YES**
Sandwich Tern	0	0	0.00%	NO
Little Tern	0	0	0.00%	NO
Auks	21,693	2,851	13.14%	**YES**

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

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).

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
Sooty Shearwater	*Puffinus griseus*	NO	NO
Manx Shearwater	*Puffinus puffinus*	NO	NO
European Storm Petrel	*Hydrobates pelagicus*	NO	NO
Leach's Storm Petrel	*Oceanodroma leucorhoa*	NO	NO
Northern Gannet	*Morus bassunus*	YES	NO
Great Cormorant	*Phalacrocorax carbo*	NO	NO
Brent Goose (Dark-bellied)	*Branta bernicla*	NO	NO
Eurasian Wigeon	*Anas penelope*	NO	NO
Northern Pintail	*Anas acuta*	NO	NO
Common Eider	*Somateria mollissima*	NO	NO
Common Scoter	*Melanitta nigra*	NO	NO
Ringed Plover	*Charadrius hiaticula*	NO	NO
Grey Plover	*Pluvialis squatarola*	NO	NO
Bar-tailed Godwit	*Limosa lapponica*	NO	NO
Eurasian Curlew	*Numenius arquata*	NO	NO
Ruddy Turnstone	*Arenaria interpres*	NO	NO
Pomarine Skua	*Stercorarius pomarinus*	NO	NO
Arctic Skua	*Stercorarius parasiticus*	NO	NO
Great Skua	*Catharacta skua*	NO	YES
Little Gull	*Larus minutes*	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	YES
Black-legged Kittiwake	*Rissa tridactyla*	YES	NO
Sandwich Tern	*Sterna sandvicensis*	NO	NO
Common Tern	*Sterna hirundo*	NO	NO
Little Tern	*Sterna albifrons*	NO	NO
Common Guillemot	*Uria aalgae*	NO	NO
Razorbill	*Alca torda*	NO	NO
Auks		YES	NO
Rock (Feral) Pigeon	*Columba livia*	NO	NO
Common Swift	*Apus apus*	NO	NO
Sky Lark	*Alauda arvensis*	NO	NO
Barn Swallow	*Hirundo rustica*	NO	NO
Meadow Pipit	*Anthus pratensis*	NO	NO
European Robin	*Erithacus rubecula*	NO	NO

Continued…/

Table 4.1.1-3 Continued.

Species	Scientific name	Regional Importance?	National Importance?
Common Redstart	*Phoenicurus phoenicurus*	NO	NO
Northern Wheatear	*Oenanthe oenanthe*	NO	NO
Common Blackbird	*Turdus merula*	NO	NO
Song Thrush	*Turdus philomelos*	NO	NO
Blackcap	*Sylvia atricapilla*	NO	NO
Common Chiffchaff	*Phylloscopus collybita*	NO	NO
Willow Warbler	*Phylloscopus trochilus*	NO	NO
Goldcrest	*Regulus regulus*	NO	NO
Carrion Crow	*Corvus corone*	NO	NO
Common Starling	*Sturna vulgaris*	NO	NO
Chaffinch	*Fringilla coelebs*	NO	NO
Eurasian Siskin	*Carduelis spinus*	NO	NO
Reed Bunting	*Emberiza schoeniclus*	NO	NO

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 4.1.1-1 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.

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). High values indicate high sensitivity.

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*	
Leach's Storm Petrel	*Oceanodroma leucorhoa*	
Northern Gannet	*Morus bassunus*	16.5
Great Cormorant	*Phalacrocorax carbo*	23.3
Brent Goose (dark-bellied)	*Branta bernicla*	
Eurasian Wigeon	*Anas penelope*	
Northern Pintail	*Anas acuta*	
Common Scoter	*Melanitta nigra*	16.9
Ringed Plover	*Charadrius hiaticula*	
Grey Plover	*Pluvialis squatarola*	
Bar-tailed Godwit	*Limosa lapponica*	
Eurasian Curlew	*Numenius arquata*	
Ruddy Turnstone	*Arenaria interpres*	
Great Skua	*Catharacta skua*	12.4
Little Gull	*Larus minutus*	12.8
Black-headed Gull	*Larus ridibundus*	7.5
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
Common Tern	*Sterna hirundo*	15.0
Little Tern	*Sterna albifrons*	
Common Guillemot	*Uria aalge*	12.0
Razorbill	*Alca torda*	15.8
Sky Lark	*Alauda arvensis*	
Song Thrush	*Turdus philomelos*	
Reed Bunting	*Emberiza schoeniclus*	

4.1.3 Explanation of species accounts

In each of the species headers a summary of baseline data is given. Separate estimates are given for (1) Winter 2004/05 (February 2004 to March 2004 and November 2004 to March 2004), (2) Winter 2005/06 (October 2005 - April 2006), (3) Summer 2004 (April 2004 to September 2004) and (4) Summer 2005 (May 2005 to September 2005). The peak wind farm estimate refers to the estimated peak number occurring in the wind farm footprint area. The peak Gabbard estimate refers to the peak estimate of the number of birds derived in area TH3 for aerial data or to the peak estimate derived from boat data.

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	49*	*GB population*	935-1,500
Wind farm peak est. 04/05	14	Wind farm peak est. 2004	1 bird
Wind farm peak est. 05/06	**101**	Wind farm peak est. 2005	0
Gabbard peak estimate 04/05	98 (*aerial*)	*Gabbard peak estimate 2004*	3 birds (*boat*)
Gabbard peak estimate 05/06	**721** (*aerial*)	*Gabbard peak estimate 2005*	0
Proportion of threshold 04/05	1.96	*Proportion of threshold 2004*	0.16
Proportion of threshold 05/06	**14.42**	*Proportion of threshold 2005*	0.00

*50 is usually used as a minimum threshold for scarcely occurring species. The 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 on data collected in 2004/05. The figures presented in Table 4.2.1-1 are raw counts of birds recorded 'in transect', multiplied by the appropriate correction factor of 1.3 (following Stone *et al.* 1995). For data collected in 2005/06, Distance sampling was possible as sufficient Red-throated Divers were recorded. Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.2.1-2). 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 4.2.1-3). 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.

The Tables (4.2.1-1 and 4.4.1-3) contain 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 two occasions, in March 2004 and in January 2006, the estimated number of Red-throated Divers exceeded the 1% threshold for national importance (Table 4.2.1-1 and 4.2.1-3), with distribution apparently scattered throughout the survey area and few 'hotspots' (Figures 4.2.1-1 to 4.2.2-2). Numbers in the winter of 2004/05 were lower than in January and February 2004, but increased again in the winter of 2005/06. The species was effectively absent from the area through the summer.

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 the proportion of national the national threshold. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

Month	ON SEA	Correction	In flight	Total	Proportion of threshold
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	0.06
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 4.2.1-2 Red-throated Divers 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 20% of the total

MONTH	DS	D	N	LCL	UCL
May 2005	0.0000	0.0000	0	0	0
June 2005	0.0000	0.0000	0	0	0
July 2005	0.0000	0.0000	0	0	0
August 2005	0.0000	0.0000	0	0	0
September 2005	0.0000	0.0000	0	0	0
October 2005	0.0000	0.0000	0	0	0
December 2005	0.0236	0.0236	17	4	69
January 2006	0.0943	0.1388	101	42	244
February 2006	0.0589	0.0821	60	21	169
April 2006	0.0589	7.97	58	21	160

Table 4.2.1-3 'In flight' counts, Distance estimates and total estimates for Red-throated Diver. 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	Proportion of threshold
May 2005	0	0	0	0.00
June 2005	0	0	0	0.00
July 2005	0	0	0	0.00
August 2005	0	0	0	0.00
September 2005	0	0	0	0.00
October 2005	0	0	0	0.00
December 2005	8	17+1	26	0.52
January 2006	22+1	101+11	135	2.70
February 2006	21+2	60+2	85	1.70
April 2006	7+1	58+9	75	1.50

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. During the first set of aerial surveys, 1,949 individuals were identified as divers, two positively identified as Black-throated Diver, eight positively identified as Great Northern Diver and 282 positively identified as 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. On the second set of aerial surveys, 2,198 individuals were identified as divers, five positively identified as Great Northern Diver, 521 as Red-throated Diver and none as Black-throated Diver.

To this end, Table 4.2.2-1 shows Distance estimates for all diver species recorded. Table 4.2.2-2 and 4.2.2-3 show 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 Figures 4.2.2-1 and 4.2.2-2. Aerial surveys suggested that the species was regionally important in the study area.

Table 4.2.2-1 Divers recorded during the first (top) and second (bottom) sets of 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.

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

Continued…/

Table 4.2.2-1 Continued**.**

Survey Block	Survey Period	DS	D	N	LCL	UCL
TH1	WINTER 1	0.0000	0.0000	0	0	0
	WINTER 2	1.782	2.1572	2,718	2,396	3,093
	WINTER 3	1.9425	2.1351	2,690	2,389	3,030
	WINTER 4	1.3171	2.0769	2,617	2,237	3,061
TH2	WINTER 1	0.0387	0.0442	54	22	137
	WINTER 2	0.3539	0.3539	436	340	559
	WINTER 3	1.4599	2.3620	2,908	2,488	3,398
	WINTER 4	1.106	1.9771	2,434	2,029	2,919
TH3	WINTER 1	0.0126	0.0189	20	2	63
	WINTER 2	0.0378	0.0378	40	19	87
	WINTER 3	0.5234	0.5493	582	466	728
	WINTER 4	0.6432	0.6875	729	593	895
TH6	WINTER 1	0.2025	0.2936	378	254	562
	WINTER 2	0.4160	0.4577	589	464	746
	WINTER 3	0.1314	0.1520	195	124	307
	WINTER 4	0.2518	0.2819	362	263	499
TH7	WINTER 1	0.0111	0.0167	21	1	84
	WINTER 2	0.6607	0.7363	920	757	1,118
	WINTER 3	0.2720	0.2798	349	262	467
	WINTER 4	0.0666	0.0749	94	50	175

Table 4.2.2-2 Proportional estimates of Red-throated Diver for area TH3 (first aerial survey) with the proportion of the national threshold. Figures relate to entire TH3 study area; the proposed wind farm area represents 14% of the study area.

Period	Estimated raw count	Proportional Distance estimate	Proportion of threshold
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 4.2.2-3 Proportional estimates of Red-throated Diver for area TH3 (second aerial survey) with % of national importance. Figures relate to entire TH3 study area; the proposed wind farm area represents 14% of the study area.

Period	Estimated raw count	Proportional Distance estimate	Proportion of threshold
Winter 1	3	20	0.40
Winter 2	6	40	0.80
Winter 3	85	576	11.52
Winter 4	113	721	14.42

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 that 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. On boat surveys in March 2004 and January 2006 numbers exceeded the threshold for national importance. Boat surveys in other months during 2004-2006, did not produce counts great enough to reach the same threshold. Aerial survey data were suitable for Distance analysis, and from this method four further counts were estimated to exceed the 1% national threshold, even if the lowest confidence limits represent the 'true' value. 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 721 estimated for the whole survey area. Proportional estimates of the number of Red-throated Divers contained within the wind farm footprint area peak at 101, in excess of the 1% national importance threshold of 49 or minimum threshold of 50. However, 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).

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.

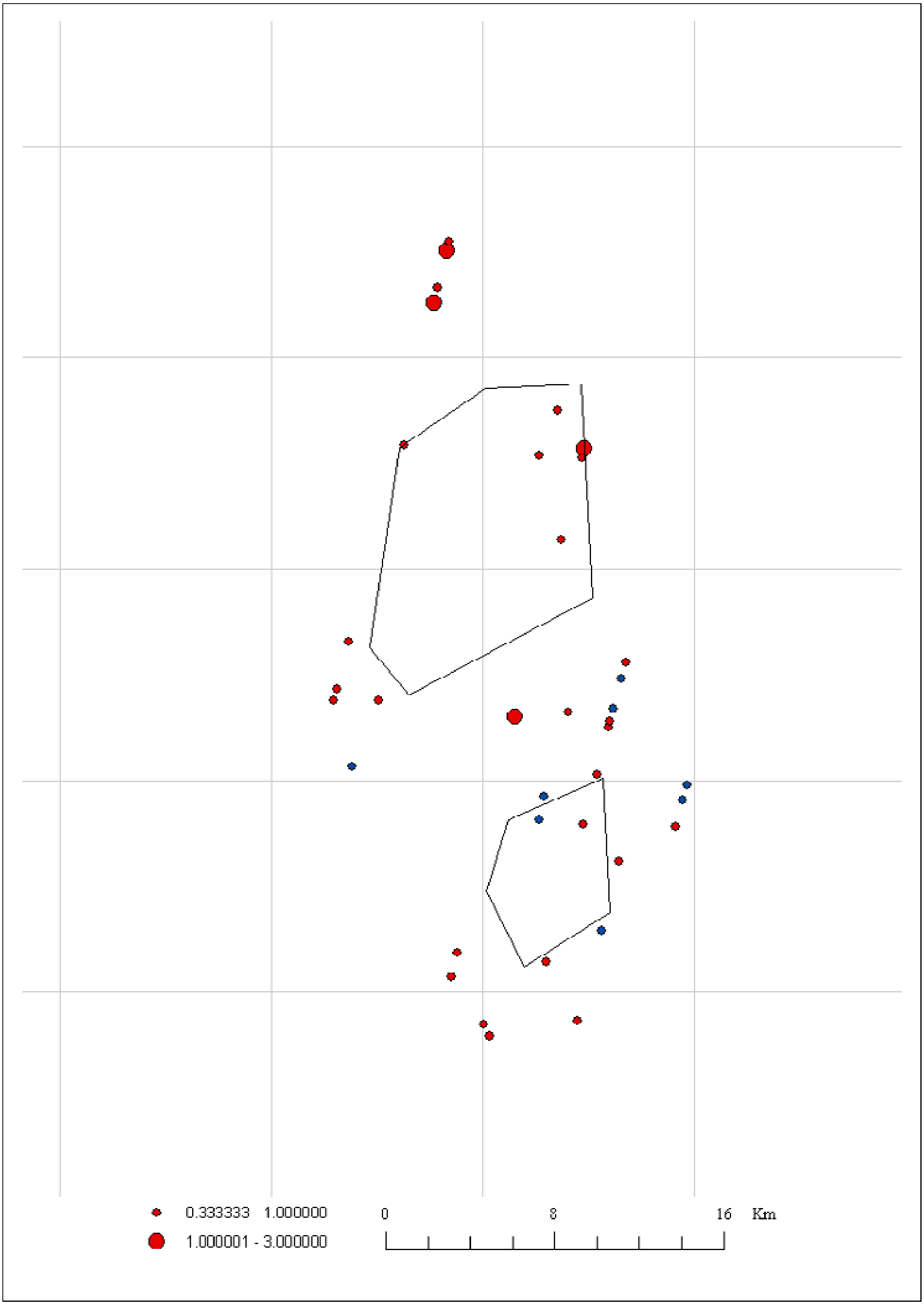

Figure 4.2.1-1 Red-throated (red) and Black-throated (blue) Diver average distributions, first winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

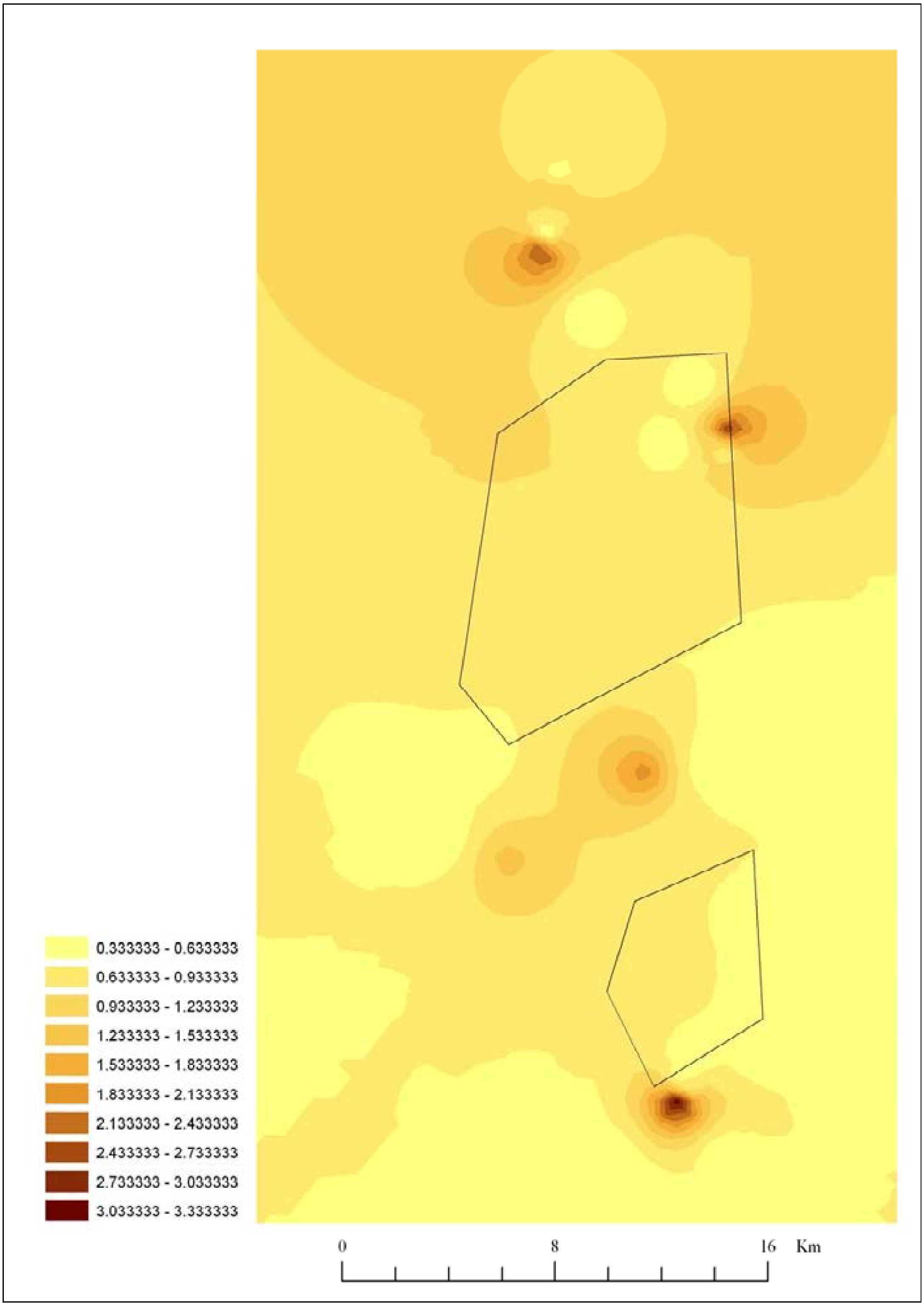

Figure 4.2.1-2 Smoothed average distribution of all diver species, first winter boat surveys. Polygons show boundaries of proposed wind farm.

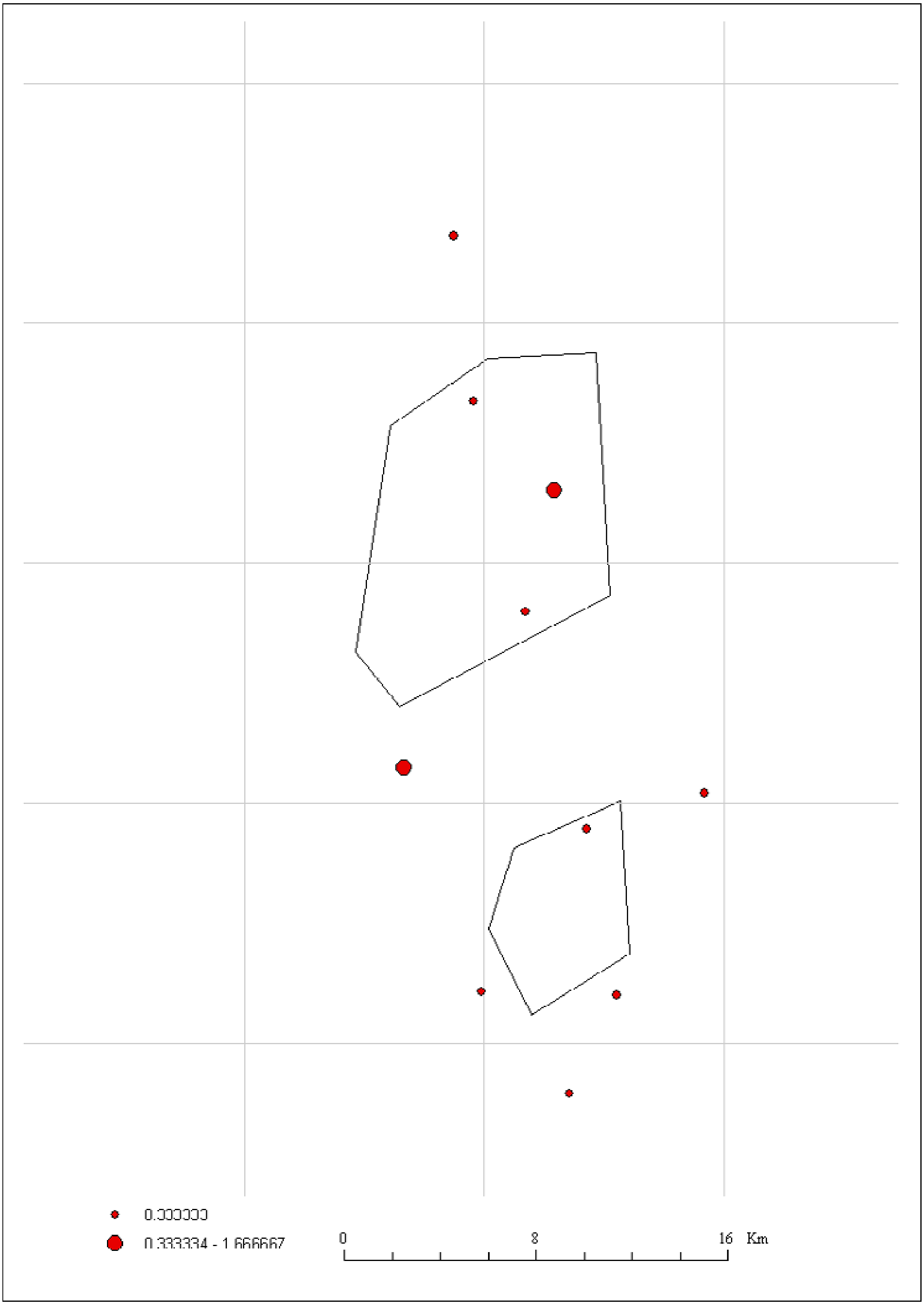

Figure 4.2.1-3 Average Red-throated Diver distribution, second winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

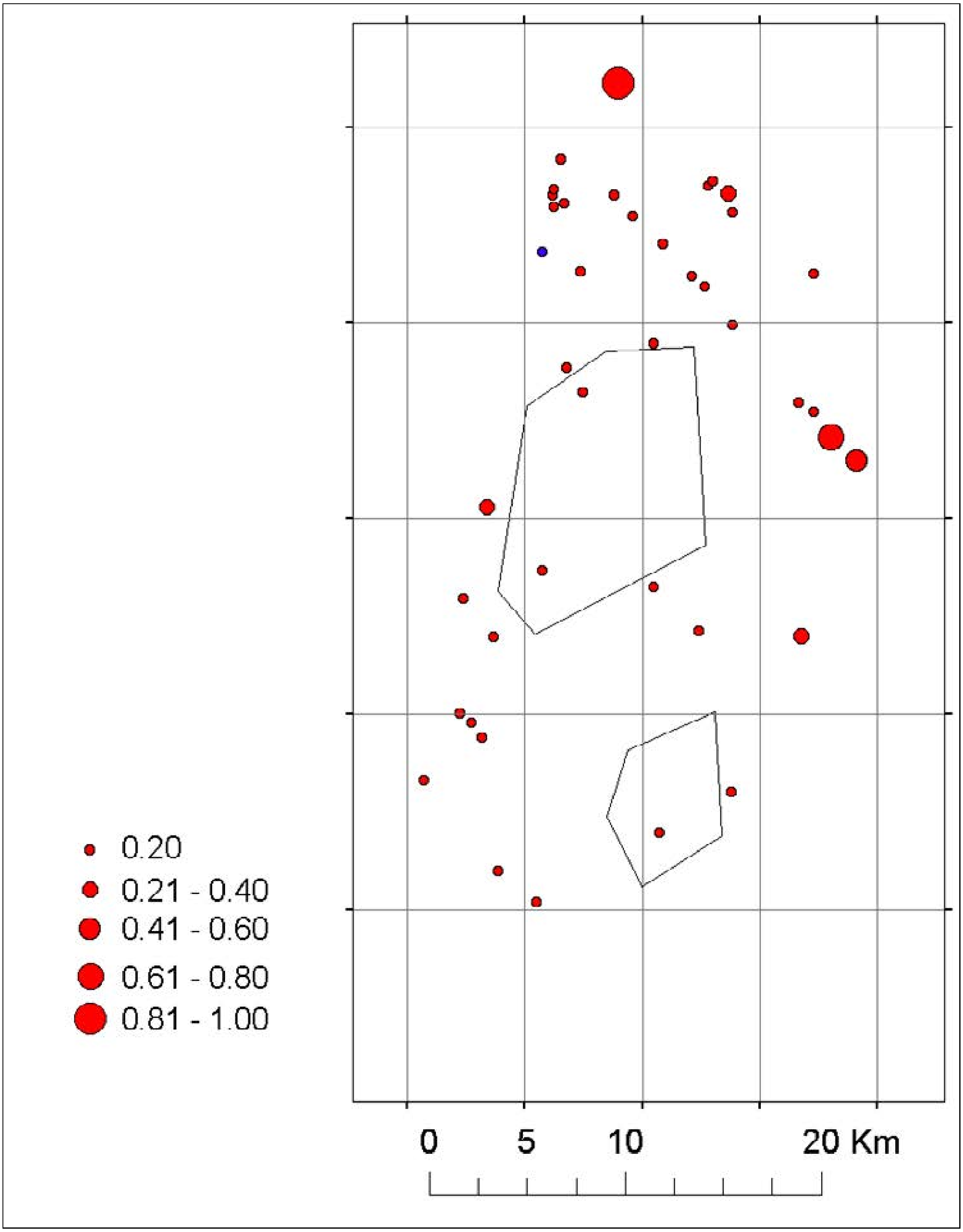

Figure 4.2.1-4 Red-throated (red) and Black-throated (blue) Diver average distributions, third winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

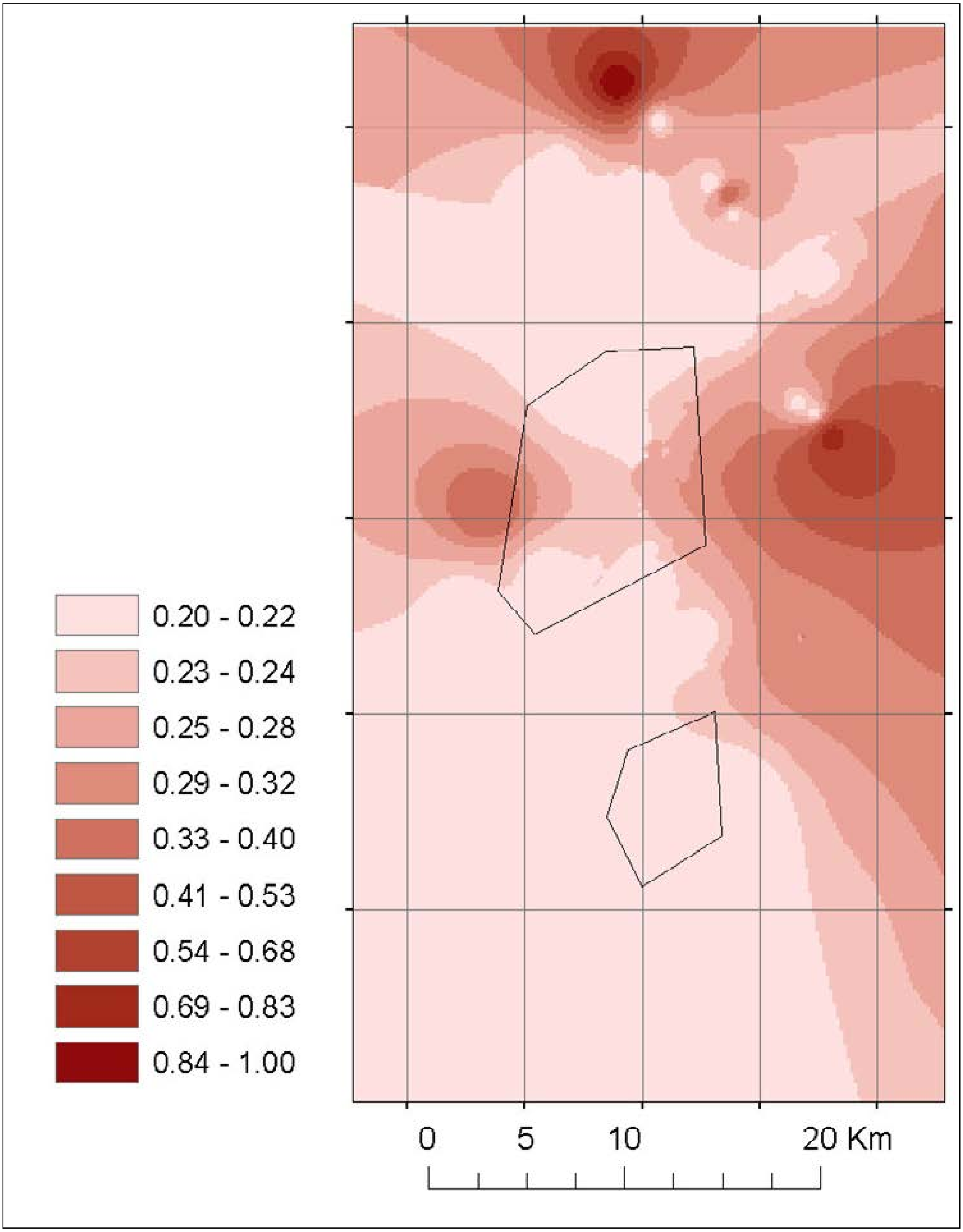

Figure 4.2.1-5 Smoothed average distribution of all diver species, third winter boat surveys. Polygons show boundaries of proposed wind farm.

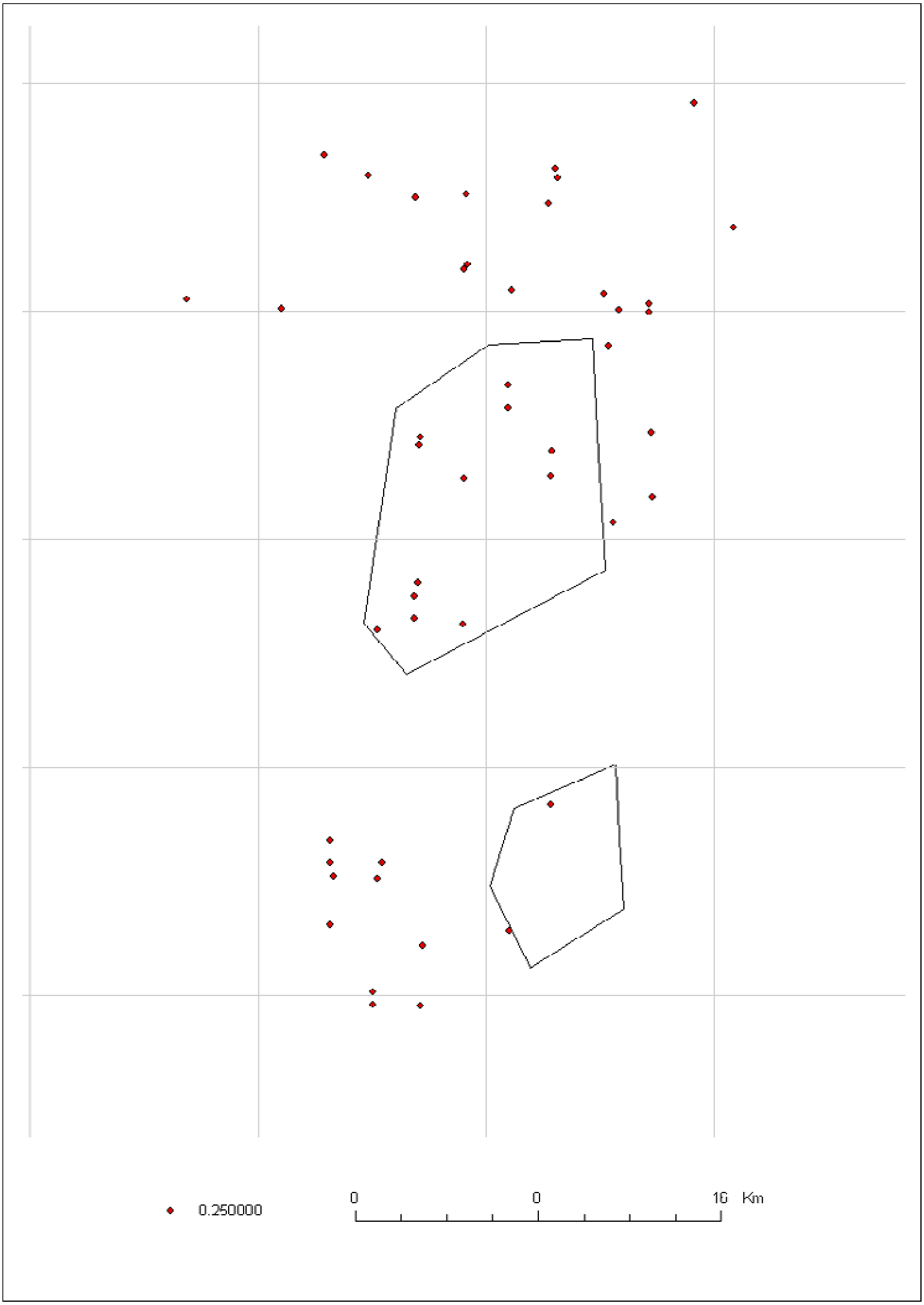

Figure 4.2.2-6 Average distribution of all diver species, first winter aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

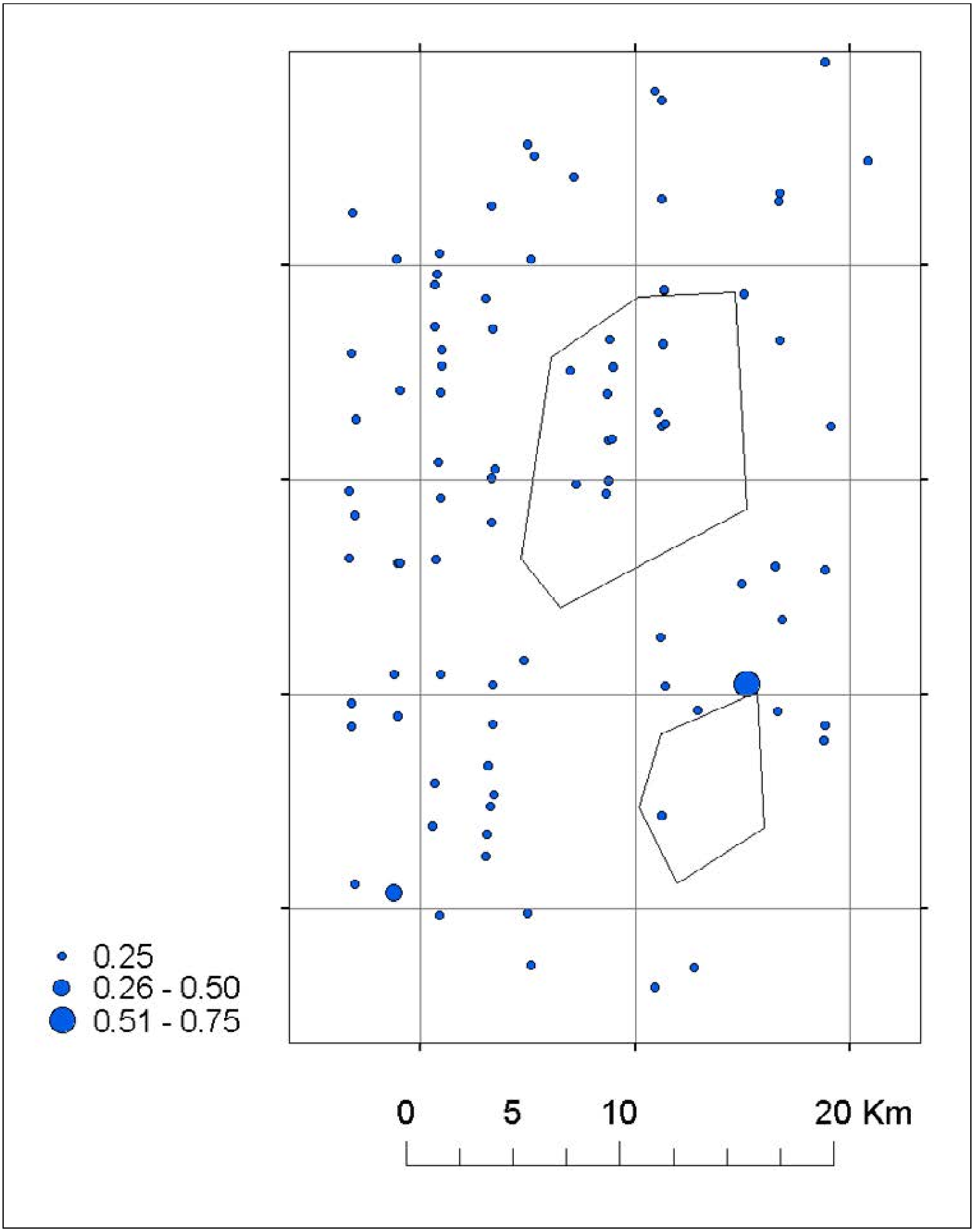

Figure 4.2.2-7 Average distribution of all diver species, second winter aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

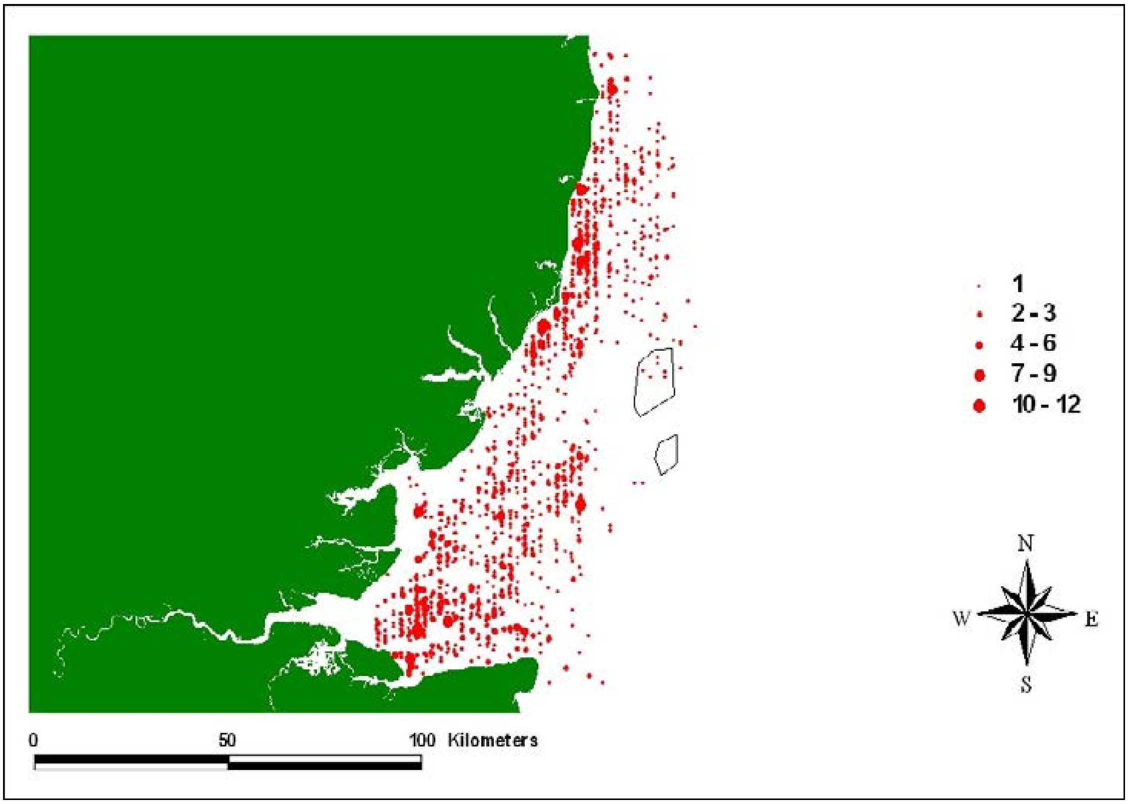

Figure 4.2.3.1-1 Summed aerial survey distribution of Red-throated Divers in winter 2004/05.

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*	155-189
Wind farm peak est. 04/05	**8**	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	1	Wind farm peak est. 2005	0
Gabbard peak estimate 04/05	**27** (*boat*)	***Gabbard peak estimate 2004***	0
Gabbard peak estimate 05/06	4 (*boat*)	*Gabbard peak estimate 2005*	2 birds (*boat*)
Proportion of threshold 04/05	**0.44**	*Proportion of threshold 2004*	0.00
Proportion of threshold 05/06	0.08	*Proportion of threshold 2005*	0.04

*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 (after 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 4.3.1-1, 4.3.1-2, 4.3.1-4).

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 the proportion of the national threshold. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

Month	On sea	Correction	In flight	Total	Proportion of threshold
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
May 2005	0	0	1	1	0.14
June 2005	0	0	0	0	0.00
July 2005	0	0	2	2	0.29
August 2005	0	0	1	1	0.14
September 2005	0	0	0	0	0.00
October 2005	0	0	4	4	0.57
December 2005	0	0	0	0	0.00
January 2006	0	0	2	2	0.29
February 2006	0	0	1	1	0.14
April 2006	0	0	0	0	0.00

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 diver records obtained during the first set of aerial surveys, two were positively identified as Black-throated Diver, eight positively identified as Great Northern Diver and 282 positively identified as 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. During the second set of aerial surveys, no Black-throated Divers were positively identified and consequently such proportion based estimates could not be made.

To this end, Table 4.2.2-1 shows Distance estimates for all diver species recorded in the first aerial survey. 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 Figures 4.3.2-1 and 4.2.2-2.

Table 4.3.2-1 Proportional estimates of Black-throated Diver for area TH3 recording during the first set of aerial surveys, with the proportion of the national threshold. Figures relate to entire study area; the proposed wind farm area represents 14% of the study area. No divers were positively identified as Black-throated Diver during the second set of aerial surveys.

Period	Estimated raw count	Proportional Distance estimate	Proportion of threshold
Winter 1	0	0	0.00
Winter 2	0	0	0.00
Winter 3	1	3	0.06
Winter 4	1	3	0.06

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. Only small numbers were reported from summer boat surveys, 2 in July 2005 and 1 in both May 2005 and August 2005. 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 (Baker *et al.* 2005), 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 (Collier *et al.* 2005), 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*	498,764
Wind farm peak est. 04/05	75	Wind farm peak estimate	108 birds
Wind farm peak est. 05/06	**187**	Wind farm peak estimate	79 birds
Gabbard peak estimate 04/05	377 (*boat*)	*Gabbard peak estimate 2004*	538 birds (*boat*)
Gabbard peak estimate 05/06	**936 (*boat*)**	*Gabbard peak estimate 2005*	395 birds (*boat*)
% National population 04/05	0.04%	*% National population 2004*	0.05%
% National population 05/06	**0.09%**	*% National population 2005*	0.04%

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 9,980 birds.

Estimates for the winter abundance were higher in the third of the three winters of survey, and were much higher in the second than in the first winter, peaking at 936 in October 2005. Distribution maps for the first winter (Figure 4.4.1-1), first summer (Figure 4.4.1-2), second winter (Figure 4.4.1-3), second summer (Figure 4.4.1-4) and third winter (Figure 4.4.1-5) show that average counts of Northern Fulmar do not seem highly concentrated in consistent areas, although there is some tendency for the southeast 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.

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	DS	D	N	LCL	UCL
February 2004	0	0	0	0	0
March 2004 (1)	N/A	N/A	N/A	N/A	N/A
March 2004 (2)	N/A	N/A	N/A	N/A	N/A
April 2004	0.0522	0.0783	57	9	346
May 2004	0.4180	0.5953	435	189	1,000
June 2004	0.1045	0.1041	76	34	171
July 2004	0.5356	0.7038	514	236	1,119
August 2004	0.0783	0.0783	57	26	126
September 2004	0.1437	0.1687	123	40	381

Continued…/

Table 4.4.1-1 Continued.

MONTH	DS	D	N	LCL	UCL
November 2004	0.2874	0.2937	214	94	490
December 2004	0.2565	0.4667	341	126	920
March 2005	0.3657	0.4529	331	151	723
May 2005	0.1208	0.1725	126	47	340
June 2005	0.2415	0.3428	250	82	768
July 2005	0.0537	0.0537	39	12	127
August 2005	0.2013	0.2316	169	53	543
September 2005	0.1610	0.1610	118	59	236
October 2005	0.7514	1.1958	873	408	1866
December 2005	0.1879	0.3649	266	90	786
January 2006	0.1610	0.2415	176	74	418
February 2006	0.3086	0.3594	262	133	518
April 2006	0.3891	0.6375	465	196	1102

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.

MONTH	In flight count	Distance estimate	Total estimate	% National population
February 2004	21	(0)	21	0.00%
March 2004 (1)	69	(14)	83	0.01%
March 2004 (2)	9	(17)	26	0.00%
April 2004	15	57	72	0.01%
May 2004	74	435	509	0.05%
June 2004	5	76	81	0.01%
July 2004	24	514	538	0.05%
August 2004	1	57	58	0.01%
September 2004	8	123	131	0.01%
November 2004	35	214	249	0.02%
December 2004	20	341	361	0.04%
March 2005	46	331	377	0.04%
May 2005	101	126	227	0.02%
June 2005	145	250	395	0.04%
July 2005	6	39	45	0.00%
August 2005	103	169	272	0.03%
September 2005	19	118	137	0.01%
October 2005	63	873	936	0.09%
December 2005	61	266	327	0.03%
January 2006	91	176	267	0.03%
February 2006	128	262	390	0.04%
April 2006	75	465	540	0.05%

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).

Table 4.4.2-1 Northern Fulmar recorded on the first (top) and second (bottom) sets of 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.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National population
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	

Continued…/

Table 4.4.2-1 Continued**.**

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National population
TH1	WINTER 1	0.0000	0.0000	0	0	0	
	WINTER 2	0.0000	0.0000	0	0	0	
	WINTER 3	0.0000	0.0000	0	0	0	
	WINTER 4	0.0000	0.0000	0	0	0	
TH2	WINTER 1	0.0000	0.0000	0	0	0	
	WINTER 2	0.0170	0.0170	21	7	61	
	WINTER 3	0.0000	0.0000	0	0	0	
	WINTER 4	0.0454	0.0297	37	12	112	
TH3	WINTER 1	0.1164	0.1168	124	75	205	0.01%
	WINTER 2	0.2005	0.1855	197	131	295	0.02%
	WINTER 3	0.2199	0.2285	242	165	356	0.02%
	WINTER 4	0.0259	0.0437	46	7	292	0.00%
TH6	WINTER 1	0.1403	0.1751	225	138	369	
	WINTER 2	0.1123	0.1210	156	96	252	
	WINTER 3	0.0337	0.0337	43	20	96	
	WINTER 4	0.0954	0.1003	129	75	222	
TH7	WINTER 1	0.0683	0.0683	85	48	153	
	WINTER 2	0.0399	0.0399	50	24	104	
	WINTER 3	0.0228	0.0228	28	11	73	
	WINTER 4	0.4213	0.4143	517	386	693	

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 (Baker *et al*. 2005). The species generally breeds on coastal cliffs, foraging at sea for fish waste and crustaceans. The peak of 936 birds estimated during October 2005 probably represents a combination of late 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 number of Northern Fulmars varied throughout the year, with high numbers recorded both in winter (peak of 936) and summer (peak of 538) and at various other times of year (e.g. 509 recorded in May 2004). 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 52% of the regional total; proportional estimates for the wind farm footprint area represented 7% 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.

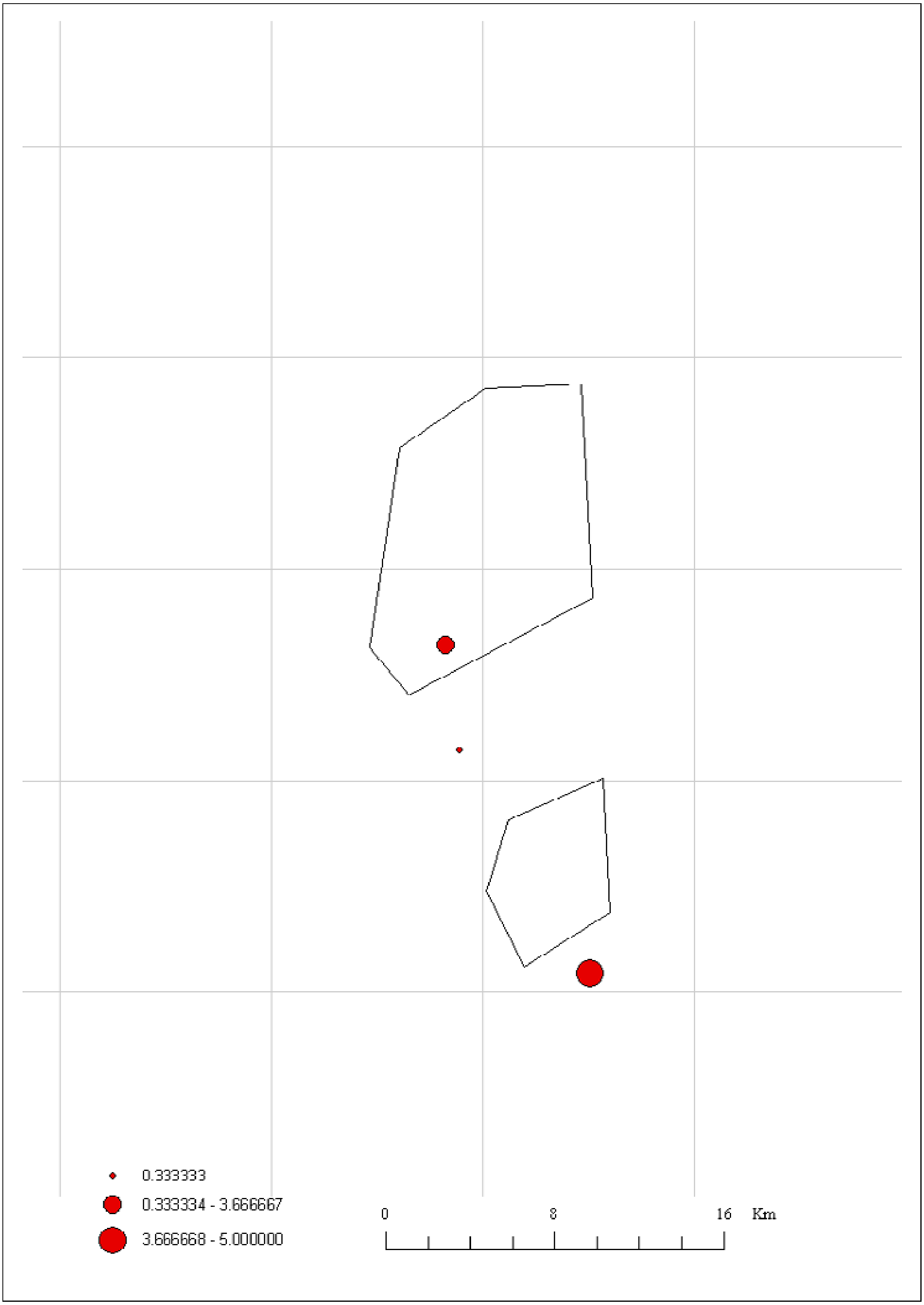

Figure 4.4.1-1 Average Northern Fulmar distribution, first winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

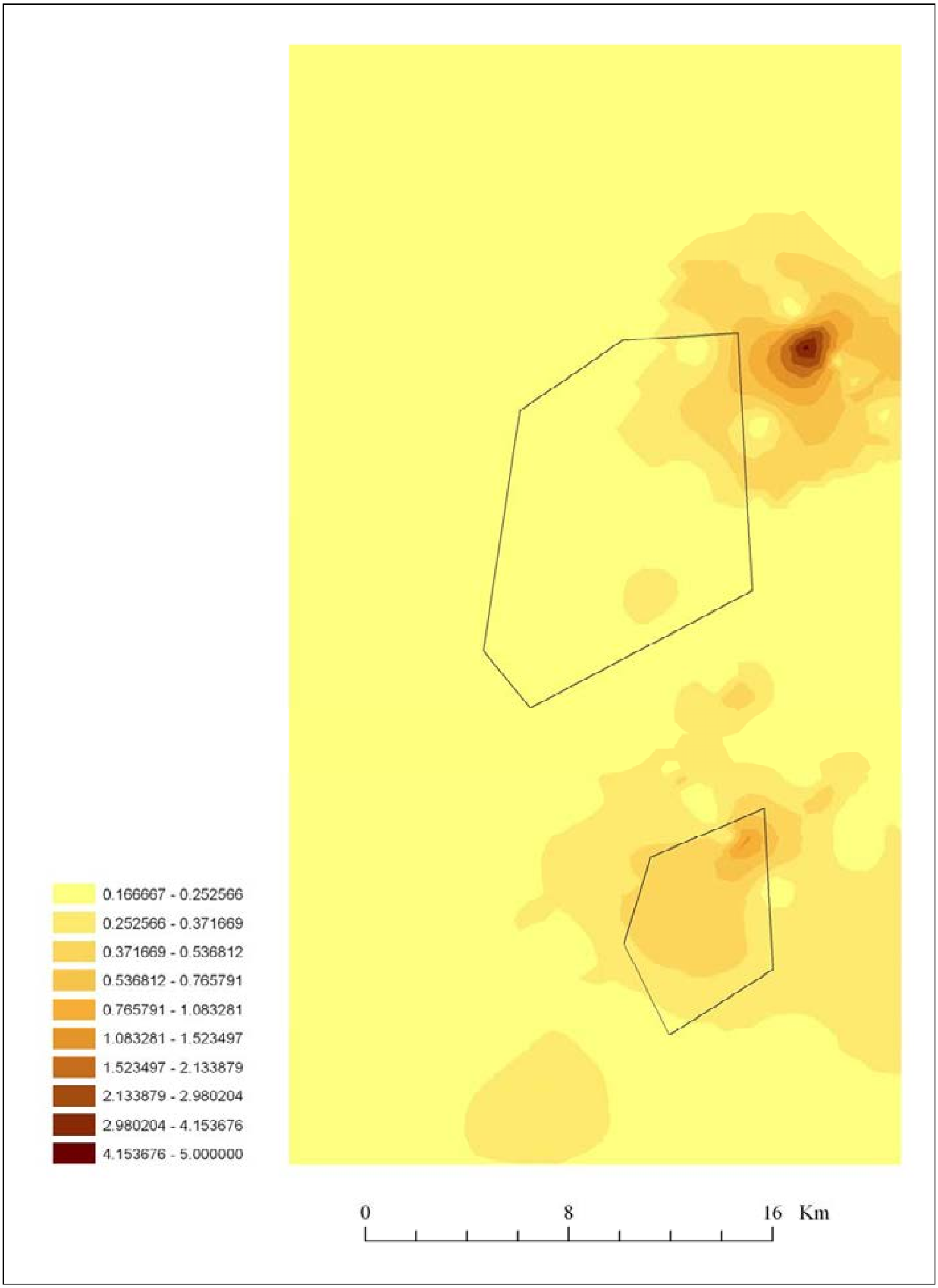

Figure 4.4.1-2 Smoothed average distribution of Northern Fulmar, first summer boat surveys. Polygons show boundaries of proposed wind farm.

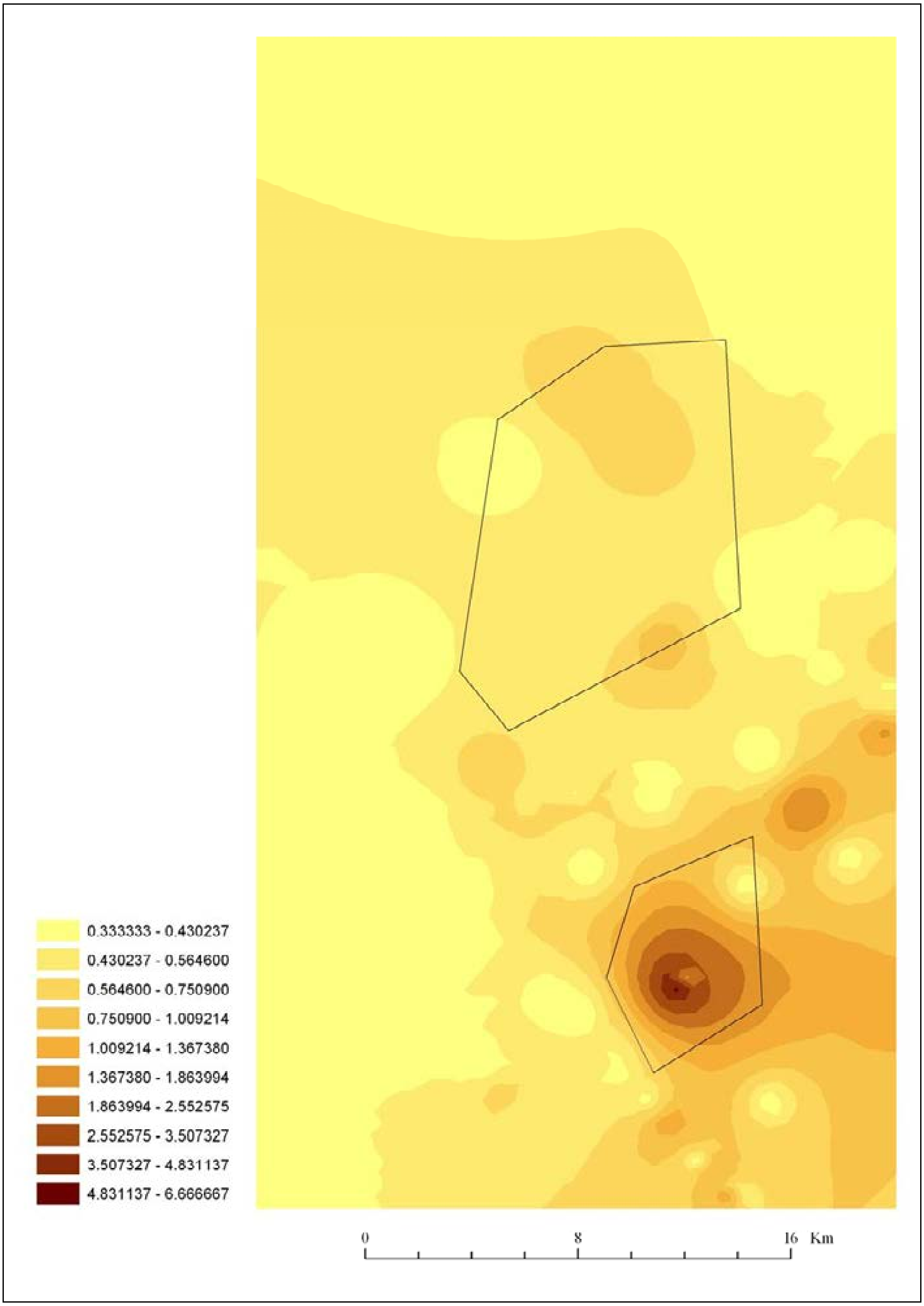

Figure 4.4.1-3 Smoothed average distribution of Northern Fulmar, second winter boat surveys. Polygons show boundaries of proposed wind farm.

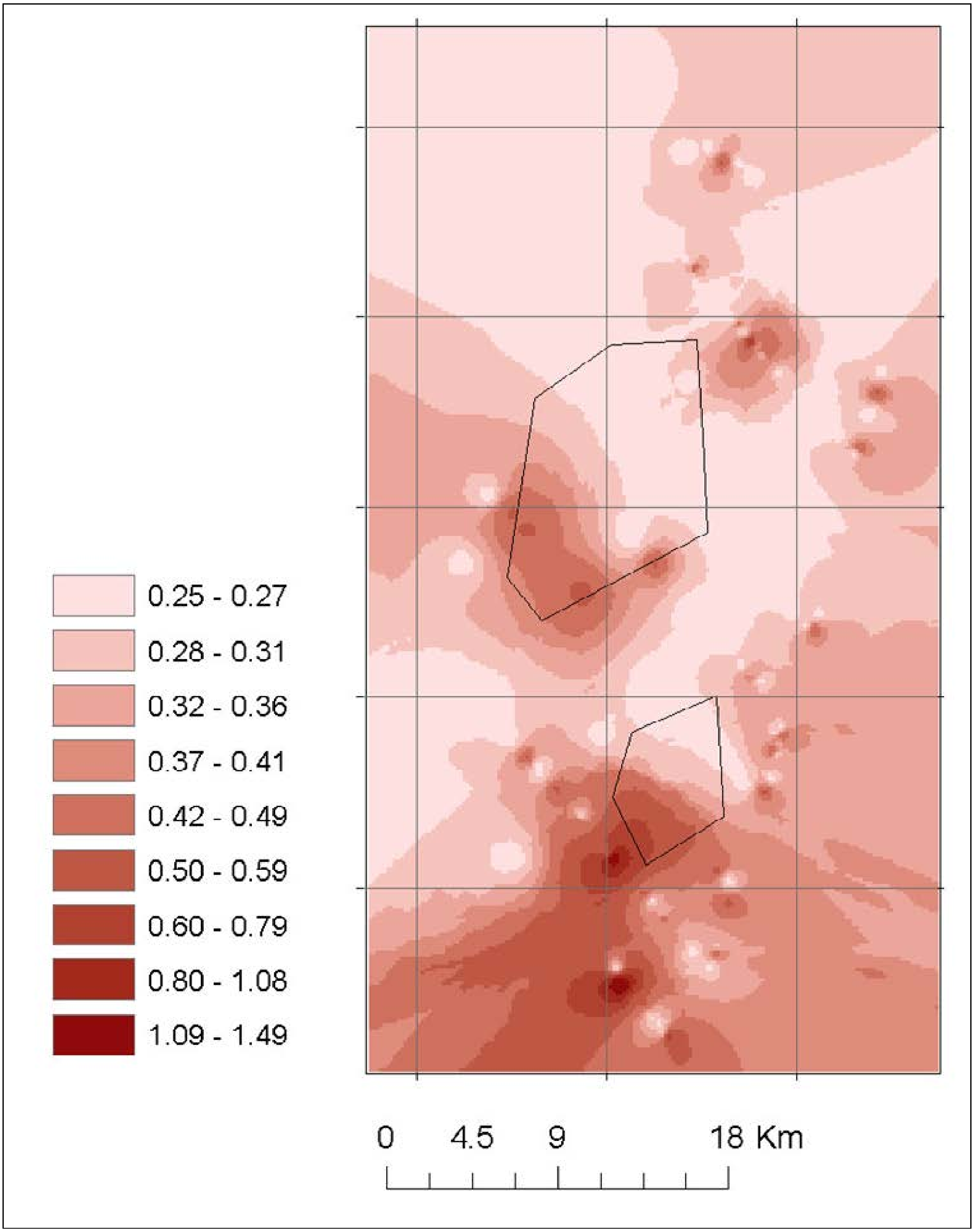

Figure 4.4.1-4 Smoothed average distribution of Northern Fulmar, second summer boat surveys. Polygons show boundaries of proposed wind farm.

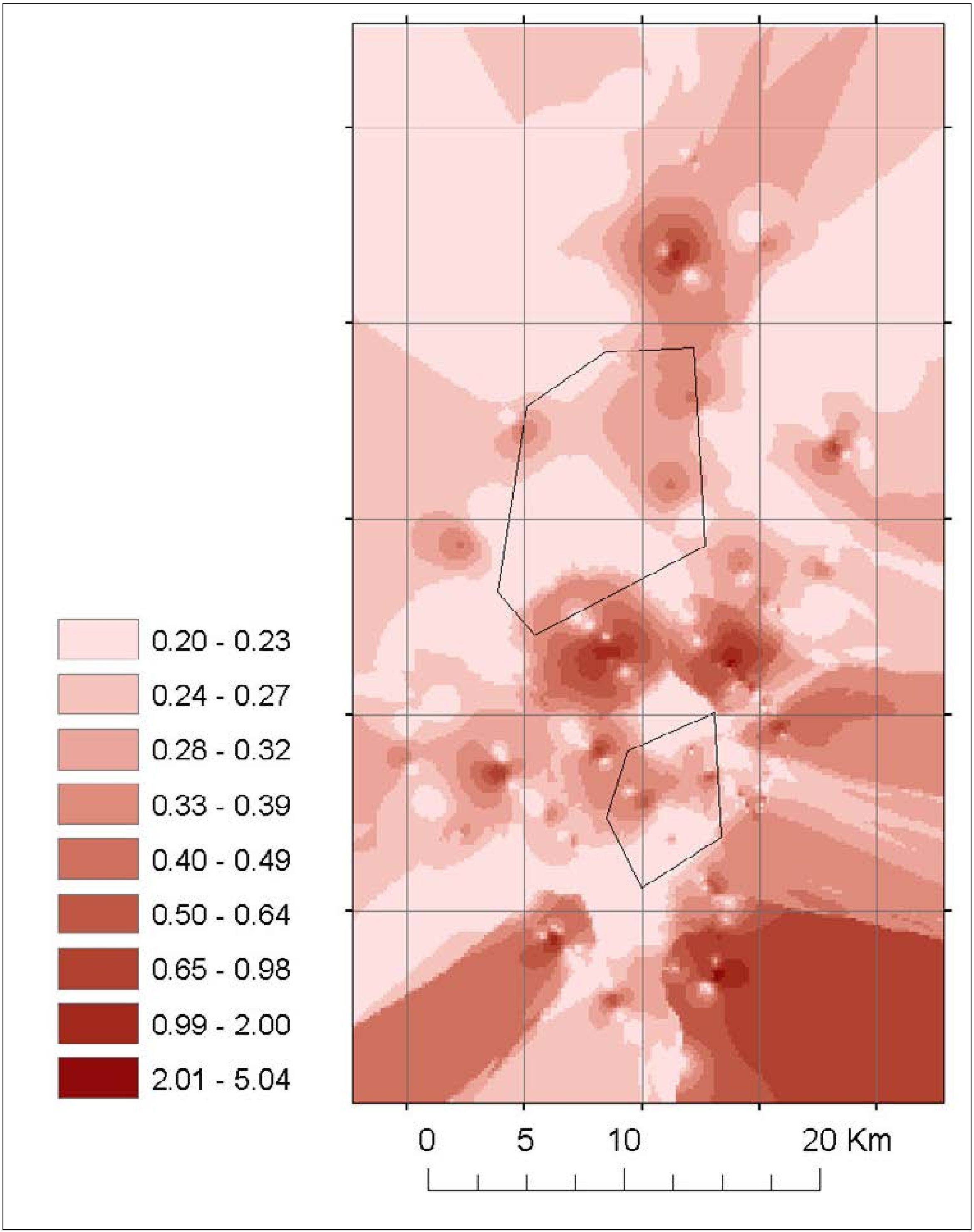

Figure 4.4.1-5 Smoothed average distribution of Northern Fulmar, third winter boat surveys. Polygons show boundaries of proposed wind farm.

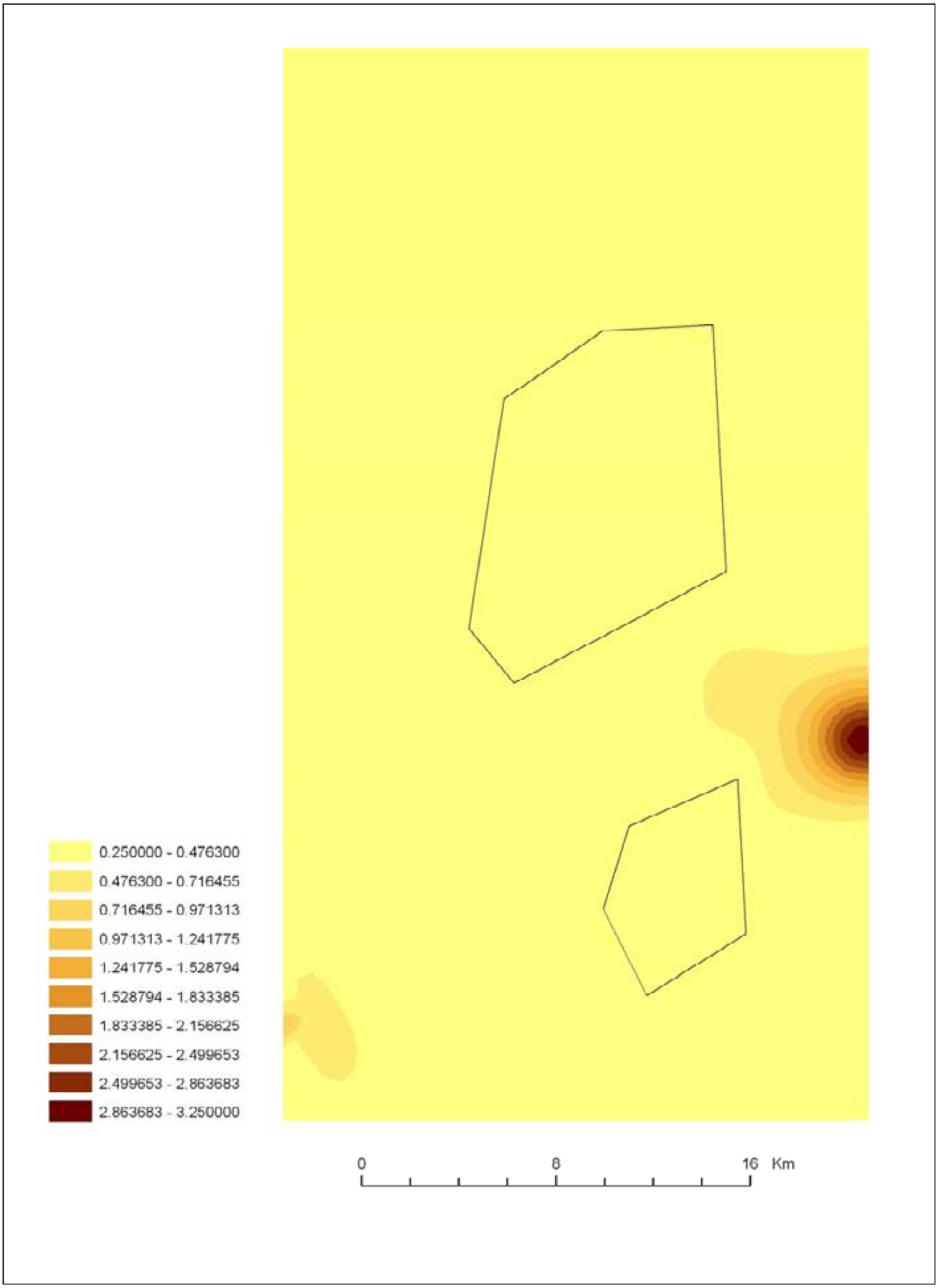

Figure 4.4.2-1 Smoothed average distribution of Northern Fulmar, first aerial surveys. Polygons show boundaries of proposed wind farm.

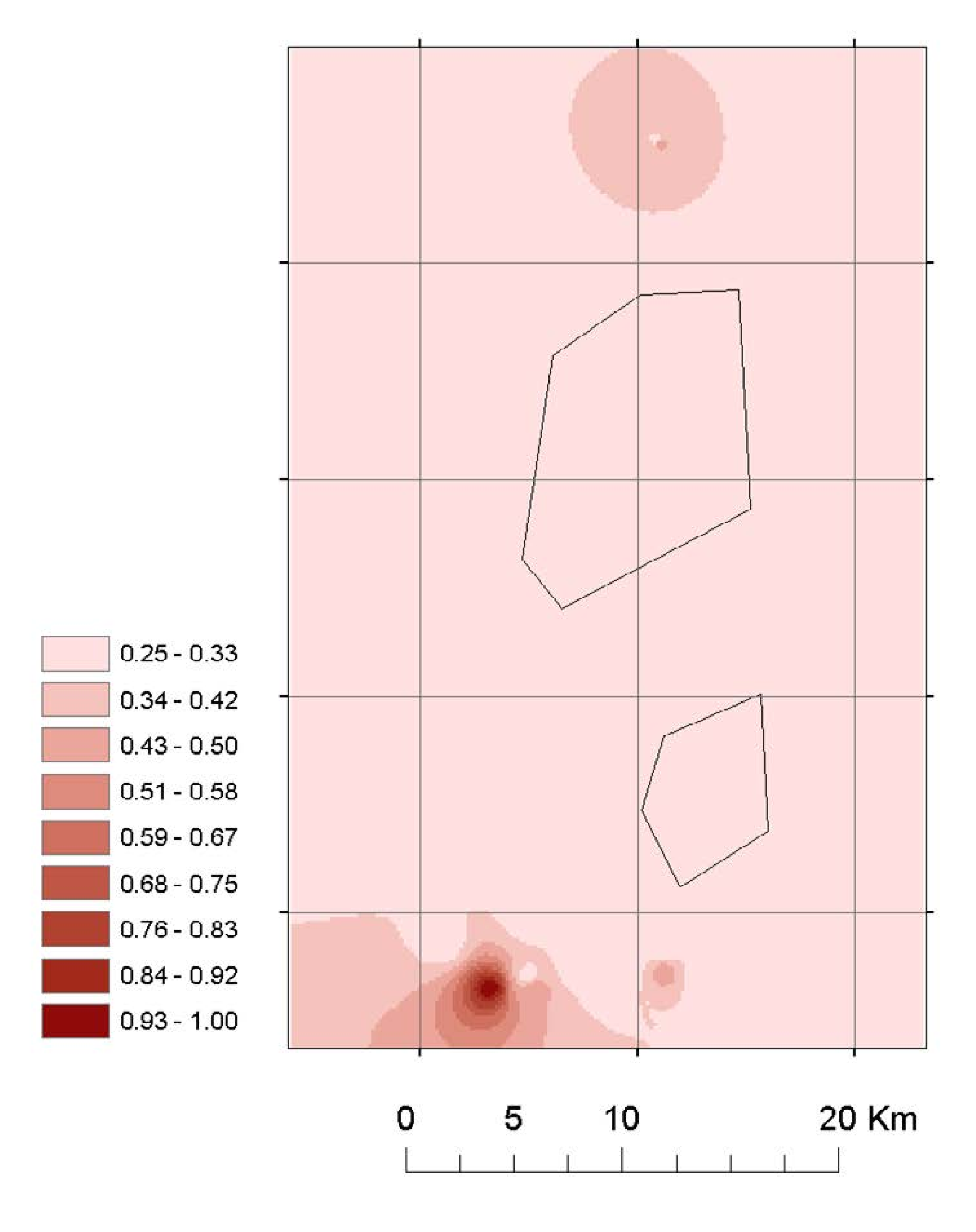

Figure 4.4.2-2 Smoothed average distribution of Northern Fulmar, second aerial surveys. Polygons show boundaries of proposed wind farm.

4.5 European Storm Petrel		*Hydrobates pelagicus*	
Conservation status:		Annex 1, BoCC Amber	
Winter		**Summer (pairs)**	
International threshold	?	**European population**	430,000-510,000
GB threshold	?	*GB population*	25,650
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak estimate 04/05	1 (*aerial*)	*Gabbard peak 2004*	**1 bird (*boat*)**
Gabbard peak estimate 05/06	0	*Gabbard peak 2005*	0
% National population 04/05	0.00%	*% National population 2004*	0.00%
% National population 05/06	0.00%	*% National population 2005*	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 Leach's Storm Petrel		*Oceanodroma leucorhoa*	
Conservation status:		Annex 1, WCA, BoCC Amber	
Winter		**Summer (pairs)**	
International threshold	?	**European population**	120,000-220,000
GB threshold	?	*GB population*	48,047
Wind farm peak est. 04/05	0	Wind farm peak est. 04/05	0
Wind farm peak est. 05/06	0	Wind farm peak est. 05/06	0
Gabbard peak 04/05	0	*Gabbard peak 04/05*	0
Gabbard peak 05/06	**1 (*boat*)**	*Gabbard peak 05/06*	0
% National population 04/05	0.00%	*% National population 2004*	0.00%
% National population 05/06	0.00%	*% National population 2005*	0.00%

4.6.1 Boat surveys

One individual was recorded during the survey in October 2005.

4.6.2 Aerial surveys

No Leach's Storm Petrels were recorded during either of the aerial surveys.

4.6.3 The importance of the Greater Gabbard for Leach's Storm Petrel through the year

4.6.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Leach's Storm Petrels, with winter and summer surveys only ever recording a single bird.

4.6.3.2 Migration

The one bird was recorded during October 2005 is likely to have been on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.7 Northern Gannet	*Morus bassanus*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	**European population**	300-310,000
GB threshold	?	*GB population*	218,546
Wind farm peak est. 04/05	19	Wind farm peak est. 2004	51 birds
Wind farm peak est. 05/06	52	Wind farm peak est. 2005	**54 birds**
Gabbard peak 04/05	139 (*aerial*)	*Gabbard peak 2004*	257 birds (*boat*)
Gabbard peak 05/06	260 (*boat*)	*Gabbard peak 2005*	**268 birds (*boat*)**
% National population 04/05	0.03%	*% National population 2004*	0.06%
% National population 05/06	0.06%	*% National population 2005*	**0.06%**

4.7.1 Boat surveys

Distance sampling was applied to counts of those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.7.1-1). 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 4.7.1-2). 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 0.06% of the breeding threshold.

Table 4.7.1-1 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	DS	D	N	LCL	UCL
February 2004	N/A	N/A	N/A	N/A	N/A
March (1) 2004	0.0000	0.0000	0	0	0
March (2) 2004	N/A	N/A	N/A	N/A	N/A
April 2004	0.0421	0.0421	31	8	112
May 2004	0.0337	0.1179	86	15	487
June 2004	0.0084	0.0084	6	1	42
July 2004	0.2104	0.2357	172	103	287
August 2004	0.1936	0.2104	154	65	364
September 2004	0.1852	0.3367	246	101	596
November 2004	0.0842	0.0842	61	22	169
December 2004	0.0000	0.0000	0	0	0
March 2005	0.0926	0.1179	86	33	222
May 2005	0.0760	0.0760	56	20	156
June 2005	0.0855	0.0855	62	11	356

Continued…/

Table 4.7.1-1 Continued.

MONTH	DS	D	N	LCL	UCL
July 2005	0.0652	0.1226	90	21	388
August 2005	0.1412	0.2363	173	73	409
September 2005	0.0163	0.0163	12	4	35
October 2005	0.2281	0.2281	167	67	416
December 2005	0.0326	0.3258	238	80	710
January 2006	0.0000	0.0000	0	0	0
February 2006	0.0109	0.0109	8	1	64
April 2006	0.1303	0.1303	95	29	309

Peak Northern Gannet numbers were recorded in August 2005, with an estimated 268 birds. However similar numbers were recorded in December 2005, suggesting that high counts are not confined to one season (Table 4.6.1-2). Distributions 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 4.7.1-1), to the northeast and within the area of The Galloper in both summers (Figure 4.7.1-2 and 4.7.1-4), again to the southeast and east in the second winter (Figure 4.7.1-3), but to the northeast in the third winter (Figure 4.7.1-5).

Table 4.7.1-2 '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.

MONTH	In flight count	Distance estimate	Total estimate	% National population
February 2004	97	(8)	105	0.02%
March (1) 2004	49	(0)	49	0.01%
March (2) 2004	20	(12)	32	0.01%
April 2004	14	31	45	0.01%
May 2004	16	86	102	0.02%
June 2004	6	6	12	0.00%
July 2004	39	172	211	0.05%
August 2004	6	154	160	0.04%
September 2004	11	246	257	0.06%
November 2004	16	61	77	0.02%
December 2004	7	0	7	0.00%
March 2005	41	86	127	0.03%
May 2005	18	56	74	0.02%
June 2005	22	62	84	0.02%
July 2005	40	90	130	0.03%
August 2005	95	173	268	0.06%
September 2005	15	12	27	0.01%
October 2005	75	167	242	0.06%
December 2005	22	238	260	0.06%
January 2006	10	0	10	0.00%
February 2006	15	8	23	0.01%
April 2006	26	95	121	0.03%

4.7.2 Aerial surveys

Few Northern Gannets were recorded in the Greater Gabbard area (TH3) during the aerial surveys in the winters of 2004/05 or 2005/06 (Table 4.7.2-1). The maximum Distance estimate was of 139 (95% confidence limits: 83 – 235), which compared with estimates of 3,891 for area TH6, for example. The Greater Gabbard aerial survey peak was lower than the 268 estimated on boat surveys. In both winters, numbers were greater during the early winter period.

Figure 4.7.2-1 provides some support to the distribution recorded from boat surveys in the winter of 2004/05 (Figure 4.7.1-3), 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. Figure 4.7.2-2, shows the presence of a large flock situated between the two proposed wind farm areas.

Table 4.7.2-1 Northern Gannet recorded on the first (top) and second (bottom) sets of 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.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National population
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	

Continued…/

Table 4.7.2-1 Continued.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National population
TH1	WINTER 1	0.0027	0.0027	3	1	17	
	WINTER 2	0.0027	0.0027	3	1	17	
	WINTER 3	0.0000	0.0000	0	0	0	
	WINTER 4	0.0000	0.0000	0	0	0	
TH2	WINTER 1	0.0240	0.0240	30	14	163	
	WINTER 2	0.0613	0.0163	76	50	114	
	WINTER 3	0.0053	0.0080	10	2	47	
	WINTER 4	0.0000	0.0000	0	0	0	
TH3	WINTER 1	0.0973	0.1246	132	89	197	0.03%
	WINTER 2	0.0122	0.0122	13	5	33	0.00%
	WINTER 3	0.0426	0.0542	57	31	108	0.01%
	WINTER 4	0.0189	0.0159	17	6	52	0.00%
TH6	WINTER 1	0.3696	0.5314	683	556	839	
	WINTER 2	0.9477	3.0254	3891	3220	4701	
	WINTER 3	0.4198	0.9311	1200	948	1519	
	WINTER 4	0.0158	0.0264	34	9	129	
TH7	WINTER 1	0.0214	0.0250	31	13	72	
	WINTER 2	0.0107	0.0107	13	5	34	
	WINTER 3	0.0161	0.0161	20	9	43	
	WINTER 4	0.0268	0.0326	41	19	86	

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

4.7.3.1 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 both summers,. Even at these levels, Northern Gannet occurred in very low densities given that the breeding population numbers some 218,546 pairs (Baker *et al.* 2005). 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 268, 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 3,891 recorded on the survey block TH6 during the second set of aerial surveys in winter period 2. However, TH3 was found to be a regionally important area for the species, supporting a maximum of 3.5% of the regional total. Proportional estimates for the wind farm footprint area of 54 qualify this area as regionally important for this species.

4.7.3.2 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.

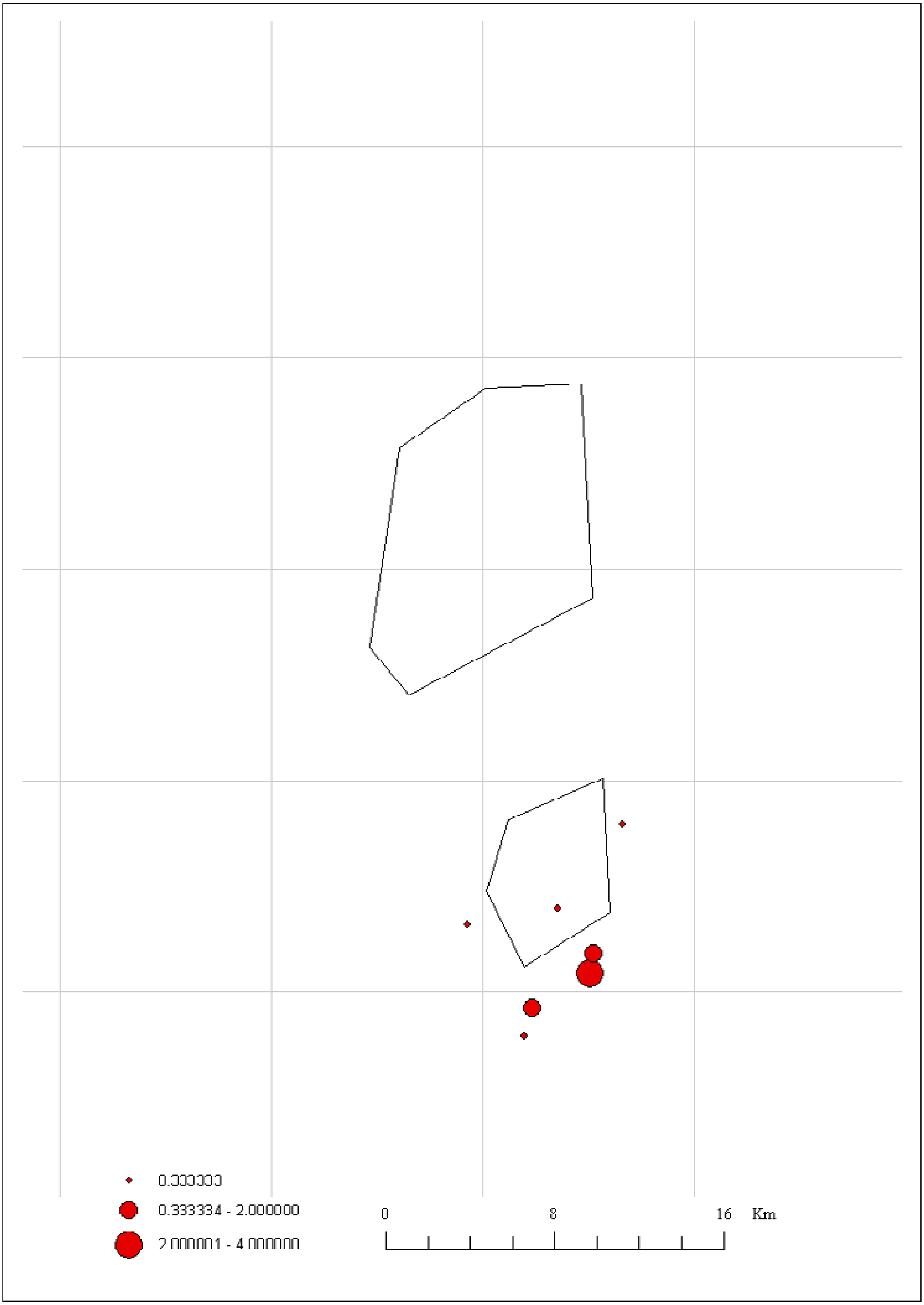

Figure 4.7.1-1 Average distribution of Northern Gannet, first winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

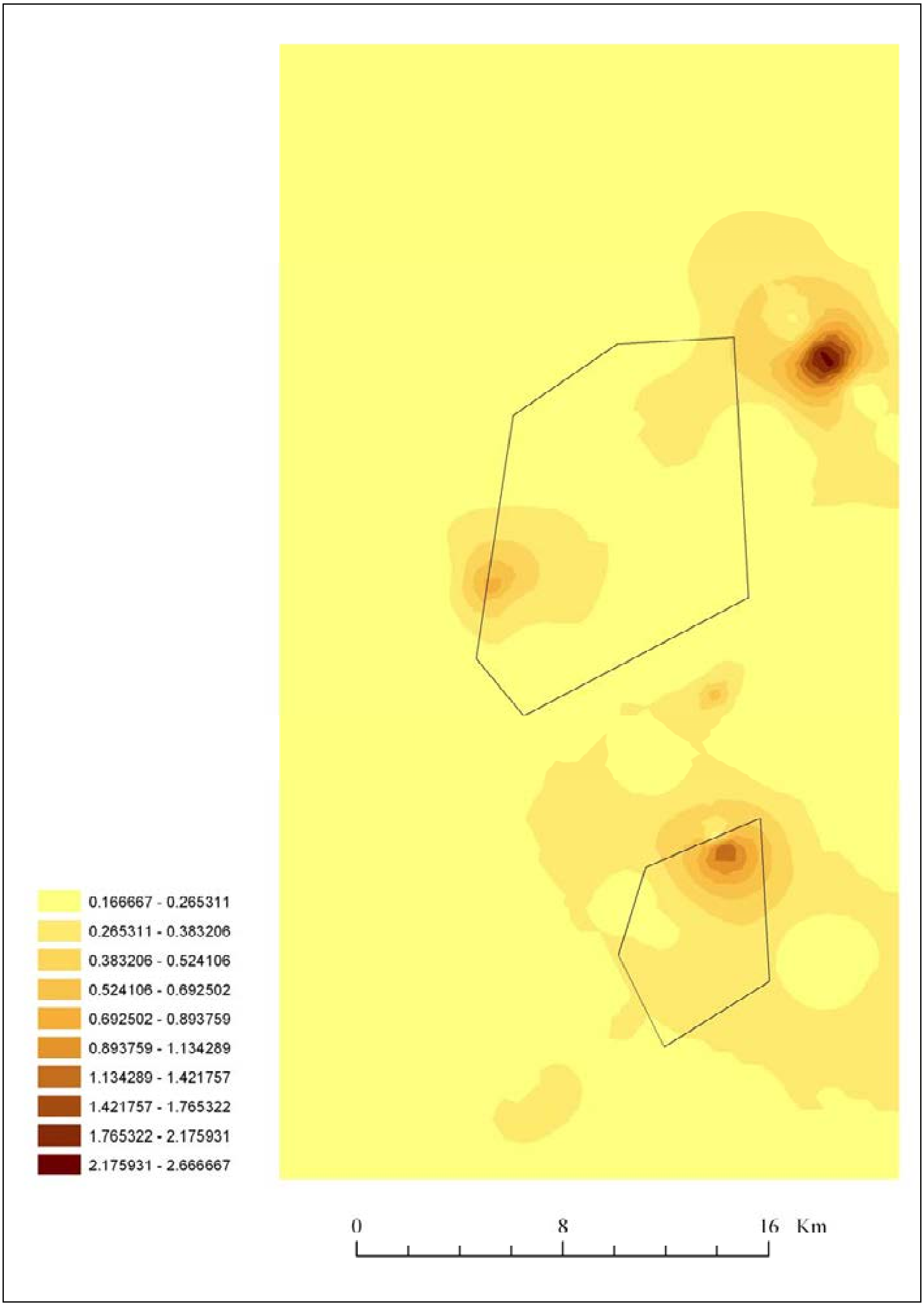

Figure 4.7.1-2 Smoothed average distribution of Northern Gannet, summer boat surveys. Polygons show boundaries of proposed wind farm.

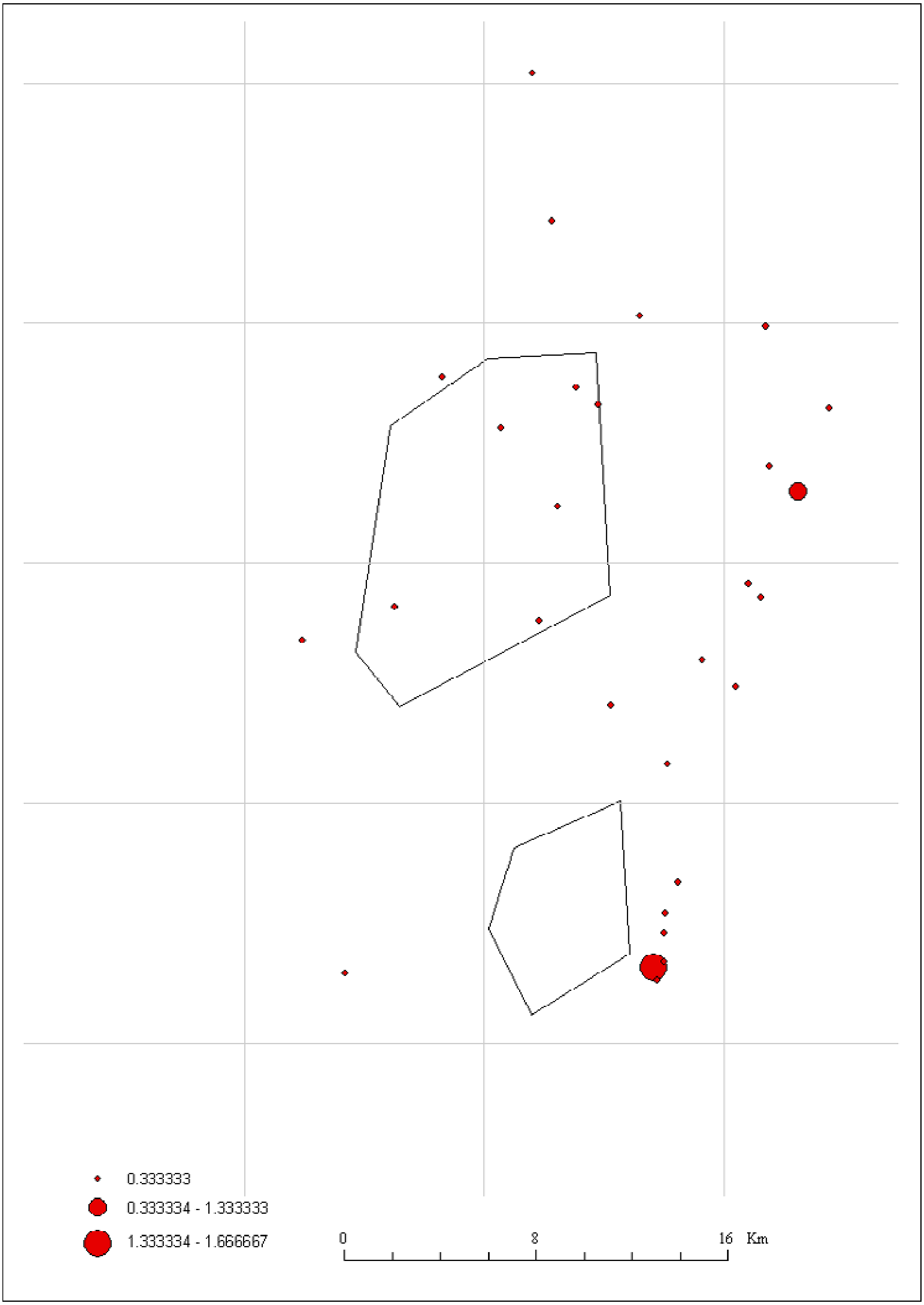

Figure 4.7.1-3 Average distribution of Northern Gannet, second winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

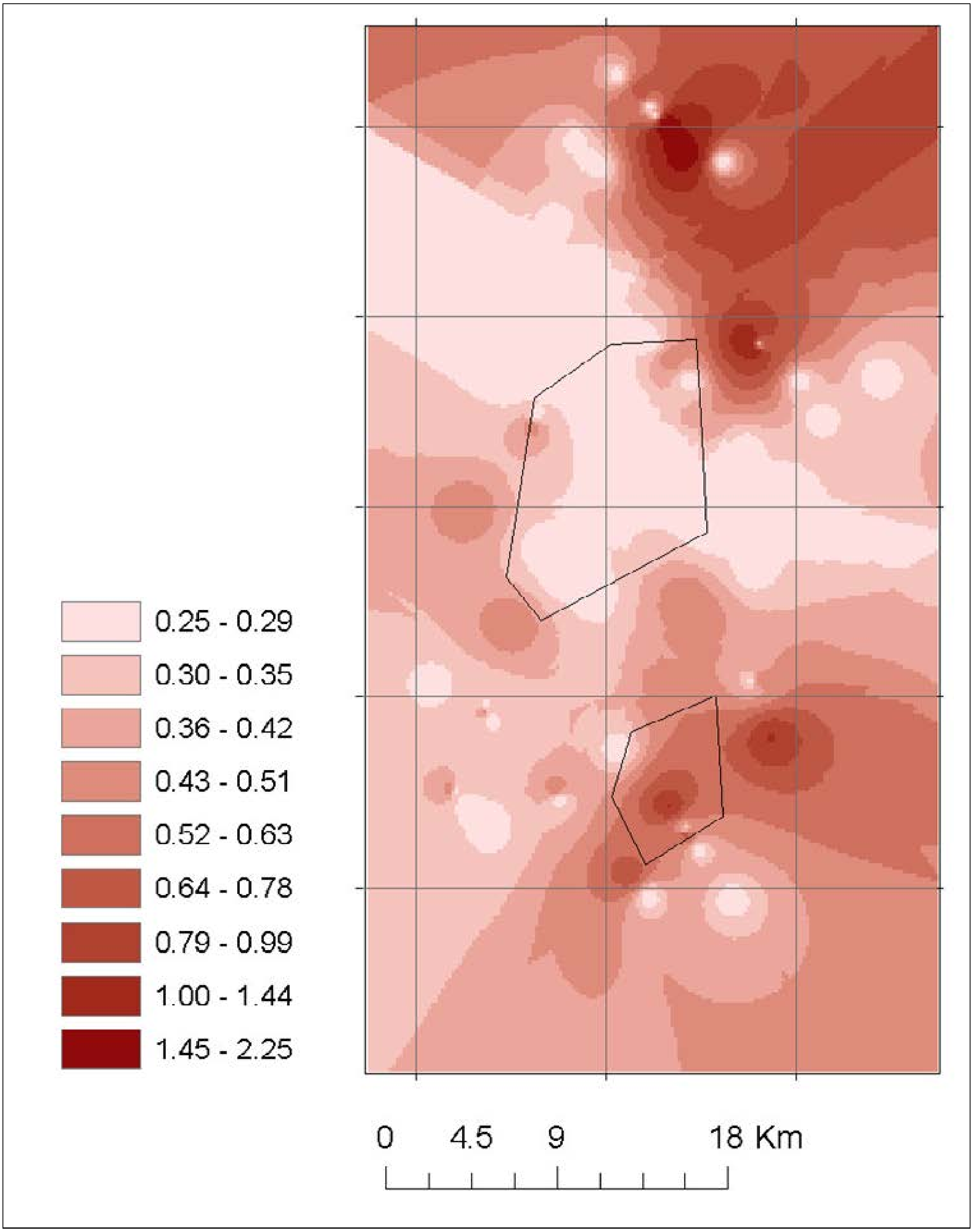

Figure 4.7.1-4 Average distribution of Northern Gannet, second summer boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

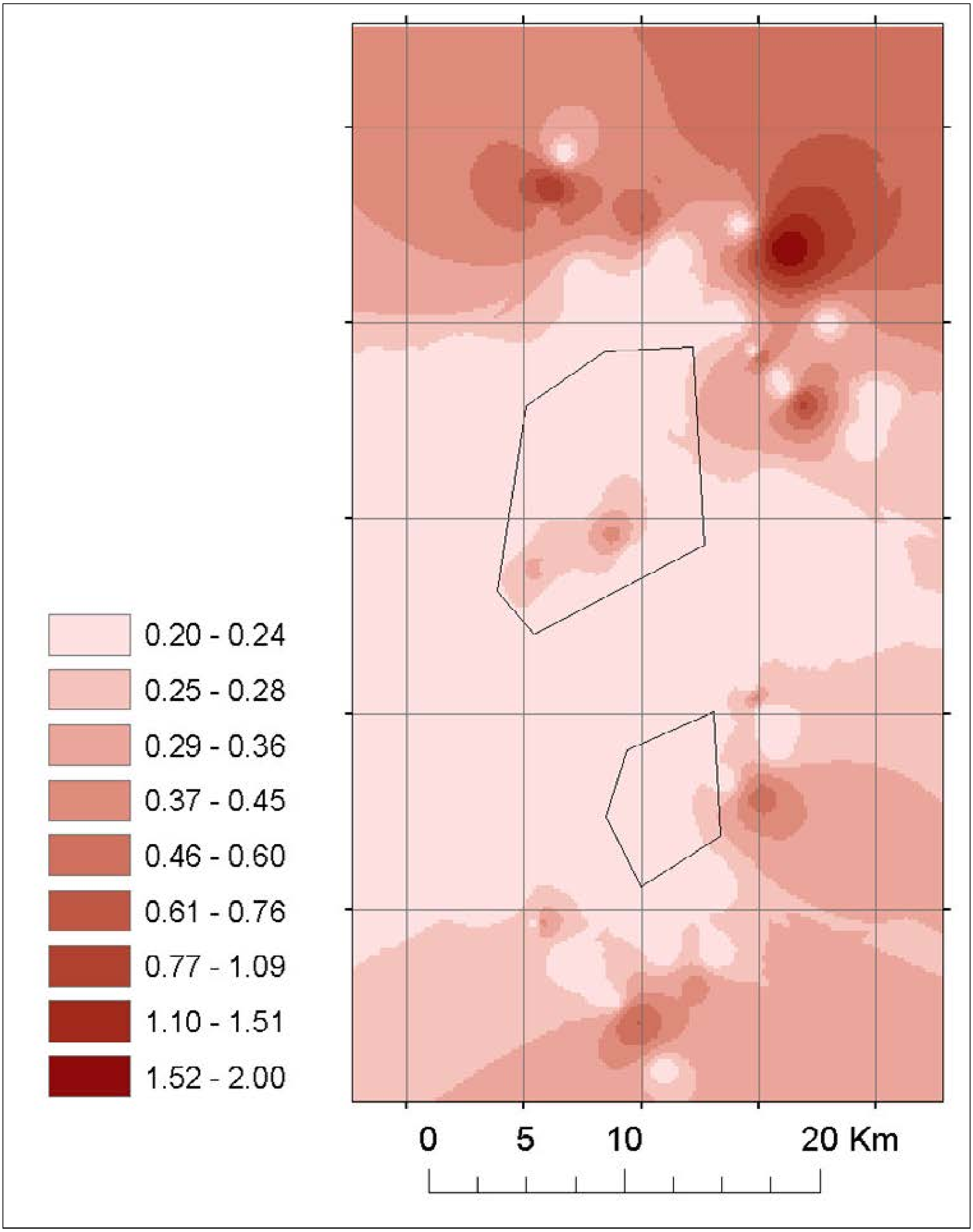

Figure 4.7.1-5 Average distribution of Northern Gannet, third winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

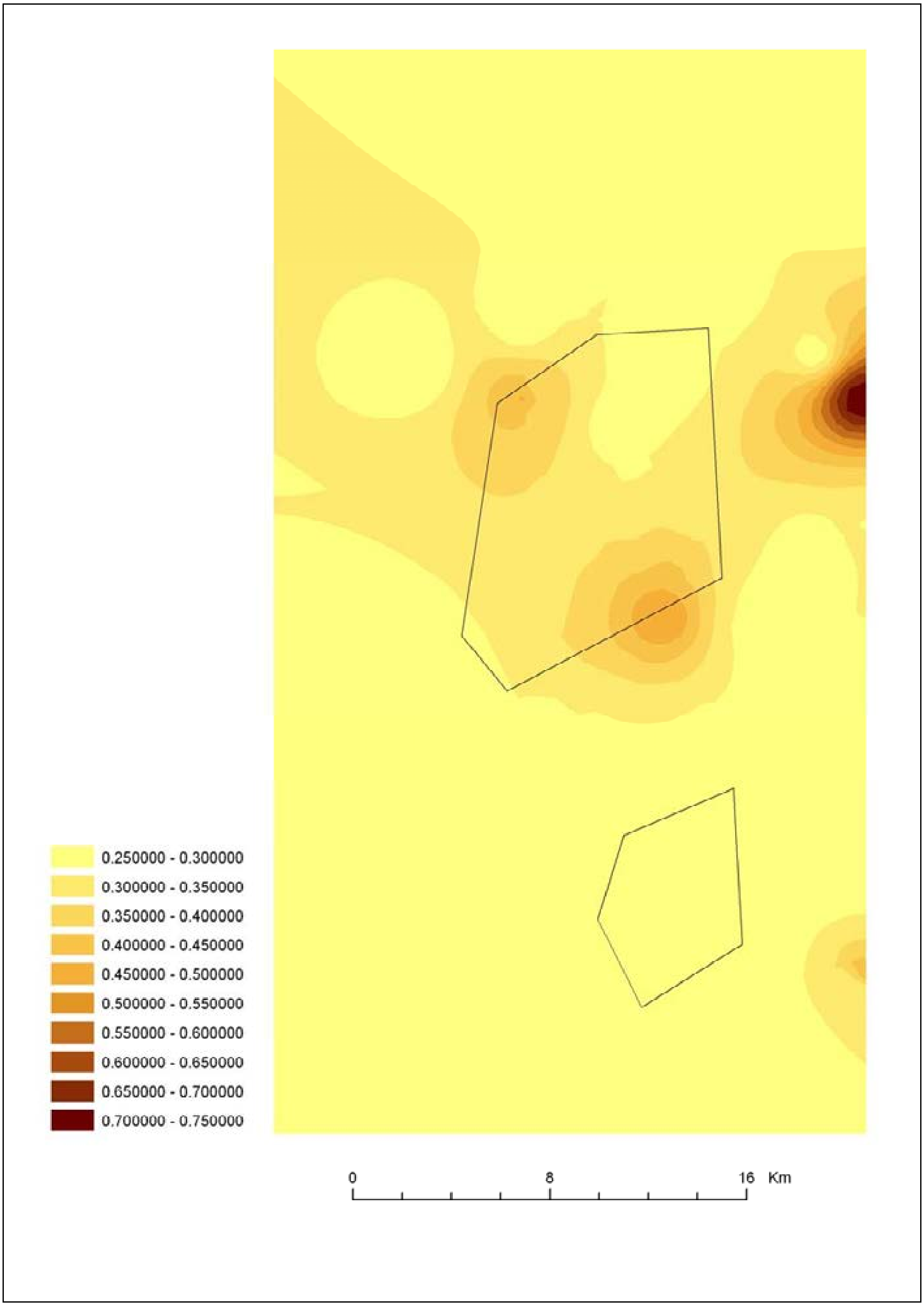

Figure 4.7.2-1 Smoothed average distribution of Northern Gannet, first aerial surveys. Polygons show boundaries of proposed wind farm.

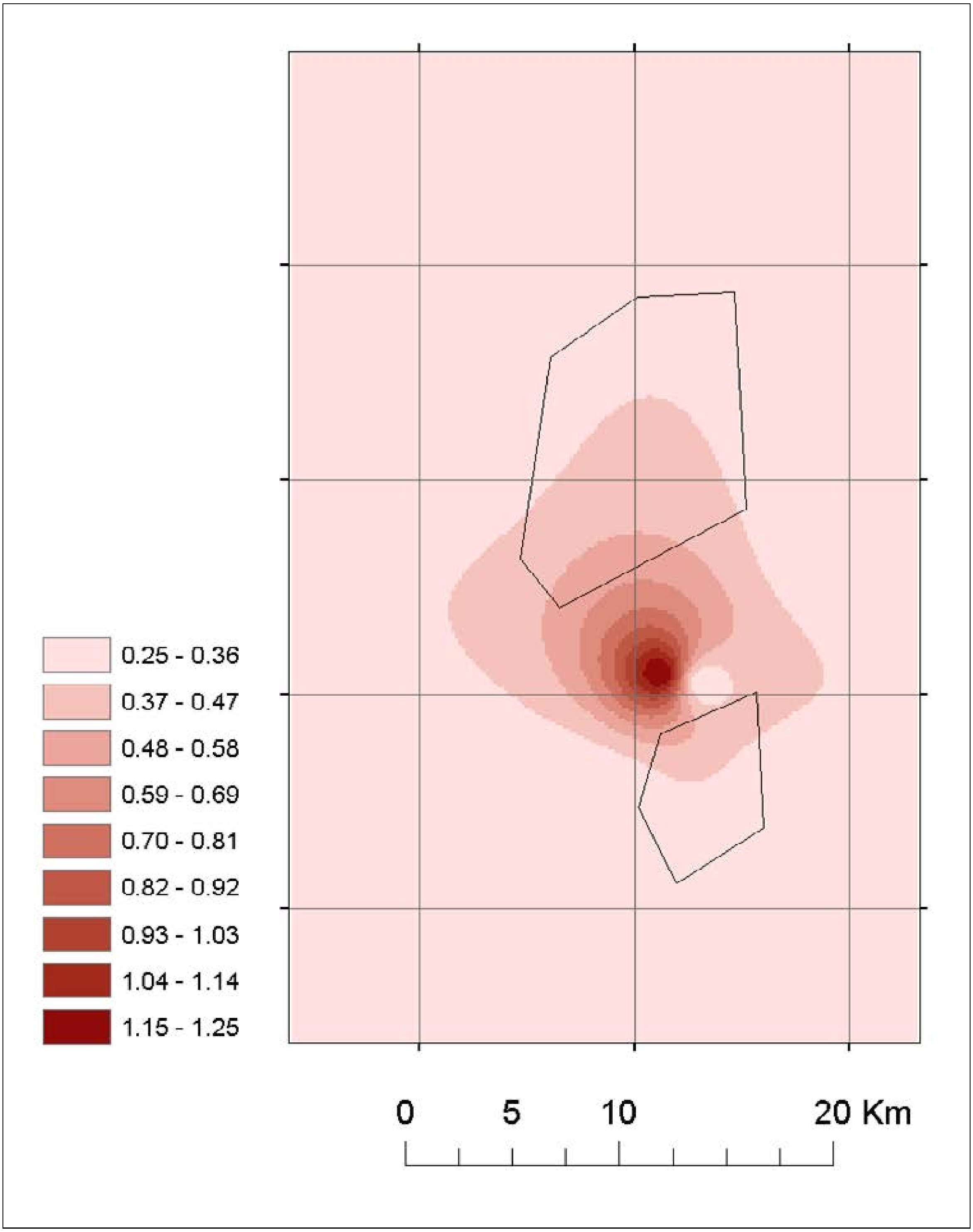

Figure 4.7.2-2 Smoothed average distribution of Northern Gannet, second aerial surveys. Polygons show boundaries of proposed wind farm.

4.8 Great Cormorant	*Phalacrocorax carbo*		
Conservation status:	SPA feature, BoCC Amber		
Winter		**Summer (pairs)**	
International threshold	1,200	**European population**	310,000-370,000
GB threshold	230	*GB population*	8,355
Wind farm peak est. 04/05	**1**	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak 04/05	**3 (*boat*)**	*Gabbard peak 2004*	0
Gabbard peak 05/06	1 (*boat*)	*Gabbard peak 2005*	0
Proportion of threshold 04/05	**0.01**	*Proportion of threshold 2004*	0
Proportion of threshold 05/06	0.00	*Proportion of threshold 2005*	0

4.8.1 Boat surveys

Three individuals were recorded during boat surveys in March 2004 and March 2005 and one individual in April 2006.

4.8.2 Aerial surveys

One individual was recorded during the first set of aerial surveys during winter period 3, but no individuals were recorded during the second set of aerial surveys.

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

4.8.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Cormorants, with winter and summer surveys only ever recording a maximum of three birds.

4.8.3.2 Migration

Three bird were recorded during March of both 2004 and 2005; it is likely that these individuals were on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.9 Brent Goose (dark-bellied)		*Branta bernicla bernicla*	
Conservation status:		SPA feature, BoCC Amber	
Winter		**Summer (pairs)**	
International threshold	2,200	**European population**	?
GB threshold	980	*GB population*	?
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	**4 birds**
Wind farm peak est. 05/06	2	Wind farm peak est. 2005	0
Gabbard peak 04/05	0	*Gabbard peak 2004*	**21 birds**
Gabbard peak 05/06	9	*Gabbard peak 2005*	0
Proportion of threshold 04/05	0.00	*Proportion of threshold*	**0.02**
Proportion of threshold 05/06	0.01	*Proportion of threshold*	0.00

4.9.1 Boat surveys

A flock of twenty-one birds were recorded in September 2004, one individual was recorded in October 2005 and a flock of 9 was recorded in December 2005.

4.9.2 Aerial surveys

No individuals were recorded during aerial surveys.

4.9.3 The importance of the Greater Gabbard for Brent Geese through the year

4.9.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Brent Geese, with a maximum of one flock of twenty-one birds recorded.

4.9.3.2 Migration

The flock of twenty-one birds recorded during September 2005 are likely to represent individuals on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.10 European Wigeon	*Anas penelope*		
Conservation status:	SPA feature, BoCC Amber		
Winter		**Summer (pairs)**	
International threshold	15,000	**European population**	300,000-360,000
GB threshold	4,060	*GB population*	300-500
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	**1**	Wind farm peak est. 2005	1 bird
Gabbard peak 04/05	0	*Gabbard peak 2004*	0
Gabbard peak 05/06	**7**	*Gabbard peak 2005*	5 birds
Proportion of threshold 04/05	0.00	*Proportion of threshold 2004*	0.00
Proportion of threshold 05/06	0.00	*Proportion of threshold 2005*	0.00

4.10.1 Boat surveys

A flock of five individuals was recorded in September 2005 and a flock of seven in October 2005.

4.10.2 Aerial surveys

No individuals were recorded during either of the sets of aerial surveys.

4.10.3 The importance of the Greater Gabbard for European Wigeon through the year

4.10.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for European Wigeon, with winter and summer surveys only ever recording a maximum of seven birds.

4.10.3.2 Migration

A flock of seven birds was recorded during October 2005; it is likely that these individual were on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.11 Northern Pintail	*Anus acuta*		
Conservation status:	WCA, SPA feature, BoCC Amber		
Winter		**Summer (pairs)**	
International threshold	600	**European population**	320,000-360,000
GB threshold	280	*GB population*	10-34
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak 04/05	0	*Gabbard peak 2004*	0
Gabbard peak 05/06	0	*Gabbard peak 2005*	**1 (*boat*)**
Proportion of threshold 04/05	0.00	*Proportion of threshold 2004*	0.00
Proportion of threshold 05/06	0.00	*Proportion of threshold 2005*	0.00

4.11.1 Boat surveys

One individual was recorded in September 2005.

4.11.2 Aerial surveys

No individuals were recorded during wither of the sets of aerial surveys

4.11.3 The importance of the Greater Gabbard for Northern Pintail through the year

4.11.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Northern Pintail, with winter and summer surveys only ever recording one bird.

4.11.3.2 Migration

The individual recorded during September 2005 is likely to have been on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.12 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*	95
Wind farm peak est. 04/05	5	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	1	Wind farm peak est. 2005	**9 birds**
Gabbard peak 04/05	24 (*boat*)	*Gabbard peak 2004*	1 bird (*boat*)
Gabbard peak 05/06	7 (*boat*)	*Gabbard peak 2005*	**46 birds (*boat*)**
Proportion of threshold 04/05	0.05	*Proportion of threshold 2004*	0.00
Proportion of threshold 05/06	0.01	*Proportion of threshold 2005*	**0.09**

4.12.1 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 4.12.1-1). 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, another of 27 in July 2005 and another of 46 in September 2005, were the only notable counts.

Table 4.12.1-1 Common Scoters recorded 'in transect' on boat surveys, with the proportion of the national threshold. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

Month	On sea	In flight	Total	Proportion of threshold
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
May 2004	0	0	0	0.00
June 2005	0	0	0	0.00
July 2005	0	27	27	0.05
August 2005	0	0	0	0.00
September 2005	0	46	46	0.09
October 2005	0	7	7	0.01
December 2005	0	0	0	0.00
January 2006	0	0	0	0.00
February 2006	0	1	1	0.00
April 2006	0	0	0	0.00

4.12.2 Aerial surveys

Table 4.12.2-1 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 in the first set of aerial surveys for example). Largest counts were made in survey area TH1, unsurprising in that Common Scoter favour sheltered shallows during the wintering season. Only small numbers of seaducks were recorded in area TH3 despite the fact that shallow sandbanks are present.

Table 4.12.2-1 Seaducks recorded during the first (top) and second (bottom) set of 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.

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

Continued…/

Table 4.12.2-1 Continued.

Survey Block	Survey Period	DS	D	N	LCL	UCL
TH1	WINTER 1	0.0000	0.0000	0	0	0
	WINTER 2	0.0802	0.4259	536	254	1133
	WINTER 3	0.0380	0.2662	335	83	1,348
	WINTER 4	0.0464	0.1956	256	71	856
TH2	WINTER 1	0.0000	0.0000	0	0	0
	WINTER 2	0.0000	0.0000	0	0	0
	WINTER 3	0.00844	0.1012	125	10	387
	WINTER 4	0.0000	0.0000	0	0	0
TH3	WINTER 1	0.0048	0.0096	10	2	55
	WINTER 2	0.0000	0.0000	0	0	0
	WINTER 3	0.0000	0.0000	0	0	0
	WINTER 4	0.0000	0.0000	0	0	0
TH6	WINTER 1	0.0000	0.0000	0	0	0
	WINTER 2	0.0000	0.0000	0	0	0
	WINTER 3	0.0000	0.0000	0	0	0
	WINTER 4	0.0000	0.0000	0	0	0
TH7	WINTER 1	0.0000	0.0000	0	0	0
	WINTER 2	0.0000	0.0000	0	0	0
	WINTER 3	0.00426	0.0212	26	5	143
	WINTER 4	0.0000	0.0000	0	0	0

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

4.12.3.1 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. The 27 individuals recorded in July 2005 was surprising, representing 14% of the breeding population of 95 birds (Baker *et al.* 2005). However, it is likely that these individuals were non-breeding birds or early breeders returning from breeding grounds outside Great Britain. It is thus more appropriate to compare this figure to the estimate of 50,000 over-wintering birds, in which case a count of 46 represents only 0.05% of the over-wintering population.

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 the Liverpool Bay area in England, both holding estimates of over 20,000 (Banks *et al.* 2004; Collier *et al.* 2005); this contrasts sharply with counts peaking at 46 in Greater Gabbard area. Aerial surveys, the same methodology used to estimate numbers in Bay and Shell Flats yielded a peak of only sea ducks, 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.

4.12.3.2 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.

4.13 Ringed Plover	***Charadrius hiaticula***		
Conservation status:	SPA feature, BoCC Amber		
Winter		**Summer (pairs)**	
International threshold	730	**European population**	120,000-220,000
GB threshold	320	*GB population*	8,400
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak 04/05	0	*Gabbard peak 2004*	0
Gabbard peak 05/06	0	*Gabbard peak 2005*	**1 bird**
Proportion of threshold 04/05	0.00	*Proportion of threshold 2004*	0.00
Proportion of threshold 05/06	0.00	*Proportion of threshold 2005*	**0.01**

4.13.1 Boat surveys

One individual was recorded during the survey in September 2005.

4.13.2 Aerial surveys

No individuals were recorded during either set of aerial surveys

4.13.3 The importance of the Greater Gabbard for Ringed Plover through the year

4.13.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Ringed Plover, with winter and summer surveys only ever recording one bird.

4.13.3.2 Migration

One bird was recorded during September 2005; it is likely that this individual was on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.14 Grey Plover	*Pluvialis squatarola*		
Conservation status:	SPA feature, BoCC Amber		
Winter		**Summer (pairs)**	
International threshold	2,500	**European population**	2,100-11,000
GB threshold	520	*GB population*	?
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	**1**
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak 04/05	0	*Gabbard peak 2004*	**3 birds (*boat*)**
Gabbard peak 05/06	2 (*boat*)	*Gabbard peak 2005*	0
Proportion of threshold 04/05	0.00	*Proportion of threshold 2004*	**0.01**
Proportion of threshold 05/06	0.00	*Proportion of threshold 2005*	0.00

4.14.1 Boat surveys

Three individuals were recorded during surveys in May 2004, and 2 during April 2006.

4.14.2 Aerial surveys

No individuals were recorded during either of the sets of aerial surveys

4.14.3 The importance of the Greater Gabbard for Grey Plover through the year

4.14.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Grey Plover, with winter and summer surveys only ever recording a peak of three birds.

4.14.3.2 Migration

The three birds recorded during May 2004 are likely to have been on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.15 Bar-tailed Godwit	*Limosa lapponica*		
Conservation status:	SPA feature		
Winter		**Summer (pairs)**	
International threshold	1,200	**European population**	1,400-7,400
GB threshold	620	*GB population*	?
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	**1**	Wind farm peak est. 2005	0
Gabbard peak 04/05	0	*Gabbard peak 2004*	0
Gabbard peak 05/06	**6 (*boat*)**	*Gabbard peak 2005*	0
Proportion of threshold 04/05	0.00	*Proportion of threshold 2004*	0.00
Proportion of threshold 05/06	**0.01**	*Proportion of threshold 2005*	0.00

4.15.1 Boat surveys

A flock of six individuals was recorded during the boat surveys in April 2006.

4.15.2 Aerial surveys

No individuals were recorded during either of the sets of aerial surveys.

4.15.3 The importance of the Greater Gabbard for bar-tailed Godwits through the year

4.15.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Bar-tailed Godwits, with winter and summer surveys only ever recording one flock of six birds.

4.15.3.2 Migration

The flock of six birds recorded during April 2006 are likely to have been on passage. However there is no reason to suspect that large numbers pass through the Greater Gabbard area during migration.

4.16 Eurasian Curlew	*Numenius arquata*		
Conservation status:	SPA feature, BoCC Amber		
Winter		**Summer (pairs)**	
International threshold	4,200	**European population**	220,000-360,000
GB threshold	1,470	*GB population*	105,000
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	**1 bird**
Gabbard peak 04/05	1 (*boat*)	*Gabbard peak 2004*	**3 birds (*boat*)**
Gabbard peak 05/06	0	*Gabbard peak 2005*	1 birds (*boat*)
Proportion of threshold 04/05	0.00	*Proportion of threshold 2004*	0.00
Proportion of threshold 05/06	0.00	*Proportion of threshold 2005*	0.00

4.16.1 Boat surveys

One individual was recorded during the February 2004 survey, three during the July 2004 survey and one during the July 2005 survey.

4.16.2 Aerial surveys

No individuals were recorded during either set of aerial surveys.

4.16.3 The importance of the Greater Gabbard for Eurasian Curlew through the year

4.16.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Eurasian Curlew, with winter and summer surveys only ever recording one bird.

4.16.3.2 Migration

The one individual recorded, could potentially have represented an early breeder on migration, but there is no reason to suspect that large numbers pass through the Greater Gabbard area.

4.17 Ruddy Turnstone	*Arenaria intepres*		
Conservation status:	SPA feature, BoCC Amber		
Winter		**Summer (pairs)**	
International threshold	1,000	**European population**	34,000-81,000
GB threshold	500	*GB population*	?
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak est. 04/05	0	*Gabbard peak 2004*	0
Gabbard peak est. 05/06	0	*Gabbard peak 2005*	**2 birds**
Proportion of threshold 04/05	0.00	*Proportion of threshold 2004*	0.00
Proportion of threshold 05/06	0.00	*Proportion of threshold 2005*	0.00

4.17.1 Boat surveys

Two individuals were recorded in September 2005.

4.17.2 Aerial surveys

No individuals were recorded during either of the sets of aerial surveys.

4.17.3 The importance of the Greater Gabbard for Ruddy Turnstone through the year

4.17.3.1 Winter and summer

The Greater Gabbard area holds virtually no importance for Ruddy Turnstone, with winter and summer surveys only ever recording one bird.

4.17.3.2 Migration

Two birds were recorded during September 2005; it is likely that these individuals were on passage, but there is no reason to suspect that large numbers pass through the Greater Gabbard area whilst on migration.

4.18 Great Skua	*Catharacta skua*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	**European population**	16,000
GB threshold	?	*GB population*	9,634
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	43 birds
Wind farm peak est. 05/06	**61**	Wind farm peak est. 2005	7 birds
Gabbard peak 04/05	1 (*boat*)	*Gabbard peak 2004*	214 birds (*boat*)
Gabbard peak 05/06	**304 (*boat*)**	*Gabbard peak 2005*	37 birds (*boat*)
% National population 04/05	0.00%	*% National population 2004*	1.11%
% National population 05/06	**1.58%**	*% National population 2005*	0.19%

4.18.1 Boat surveys

Distance sampling was applied to counts of those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.18.1-1). 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 4.18.1-2). Estimates of 214 recorded in September 2004 and 304 recorded in October 2005 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 2004 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. However as the peak of 304, recorded in October, is likely to represent breeding birds from Great Britain, it is reasonable to use the breeding population as a surrogate threshold. The peak counts of 214 and 304 thus both represent nationally important numbers as these figures represent 1.58% and 1.11% of the national population respectively.

Figures 4.18.1-1 and 4.18.1.2 show 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. However Figure 3.18.1-3, derived mostly from counts in October 2005, show that high concentrations do sometimes occur within the vicinity of the proposed wind farm.

Table 4.18.1-1 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	DS	D	N	LCL	UCL
February 2004	0.0000	0.0000	0	0	0
March (1) 2004	0.0000	0.0000	0	0	0
March (2) 2004	0.0000	0.0000	0	0	0
April 2004	0.0000	0.0000	0	0	0
May 2004	0.0250	0.0250	18	4	74
June 2004	0.0000	0.0000	0	0	0
July 2004	0.0250	0.0250	18	4	74
August 2004	0.0000	0.0000	0	0	0
September 2004	0.2622	0.2846	208	99	437

Continued…/

Table 4.18.1-1 Continued.

MONTH	DS	D	N	LCL	UCL
November 2004	0.0000	0.0000	0	0	0
December 2004	0.0000	0.0000	0	0	0
March 2005	0.0000	0.0000	0	0	0
May 2005	0.0000	0.0000	0	0	0
June 2005	0.0000	0.0000	0	0	0
July 2005	0.0000	0.0000	0	0	0
August 2005	0.0000	0.0000	0	0	0
September 2005	0.0337	0.0337	25	8	75
October 2005	0.2697	0.3462	253	115	554
December 2005	0.0096	0.0096	7	1	48
January 2006	0.0000	0.0000	0	0	0
February 2006	0.0000	0.0000	0	0	0
April 2006	0.0000	0.0000	0	0	0

Table 4.18.1-2 '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.

MONTH	In flight count	Distance estimate	Total estimate	% National population
February 2004	0	0	0	0.00%
March (1) 2004	0	0	0	0.00%
March (2) 2004	0	0	0	0.00%
April 2004	0	0	0	0.00%
May 2004	1	18	19	0.10%
June 2004	0	0	0	0.00%
July 2004	8	18	26	0.14%
August 2004	1	0	1	0.01%
September 2004	6	208	214	1.11%
November 2004	1	0	1	0.01%
December 2004	1	0	1	0.01%
March 2005	0	0	0	0.00%
May 2005	1	0	1	0.01%
June 2005	0	0	0	0.00%
July 2005	0	0	0	0.00%
August 2005	5	0	5	0.03%
September 2005	12	25	37	0.19%
October 2005	51	253	304	1.58%
December 2005	2	7	9	0.05%
January 2006	1	0	1	0.01%
February 2006	0	0	0	0.00%
April 2006	0	0	0	0.00%

4.18.2 Aerial surveys

Individual Great Skua were recorded during second and third winter period of the first set of aerial surveys and the first winter period of the second set of aerial surveys.

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

4.18.3.1 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.

4.18.3.2 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 coinciding approximately with the peak counts from boat surveys in this study. The peak estimates for the entire study area exceeded the 1% national threshold on two occasions; proportional estimates of numbers within the wind farm footprint area, however, did not, peaking at 61 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 304 recorded; presumably these birds would have been en route from their Scottish breeding colonies to more southerly wintering latitudes.

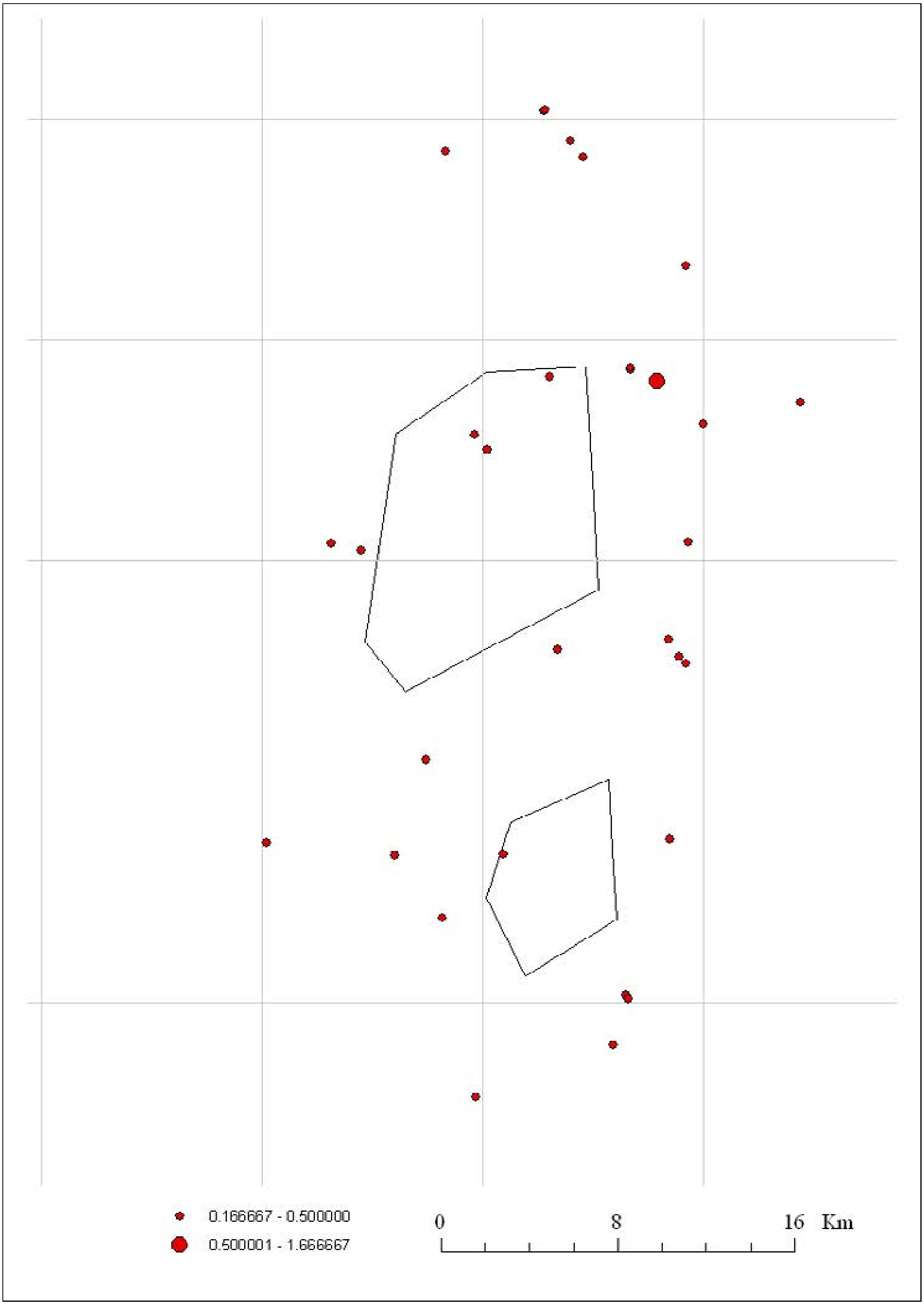

Figure 4.18.1-1 Average distribution of Great Skua, first summer boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

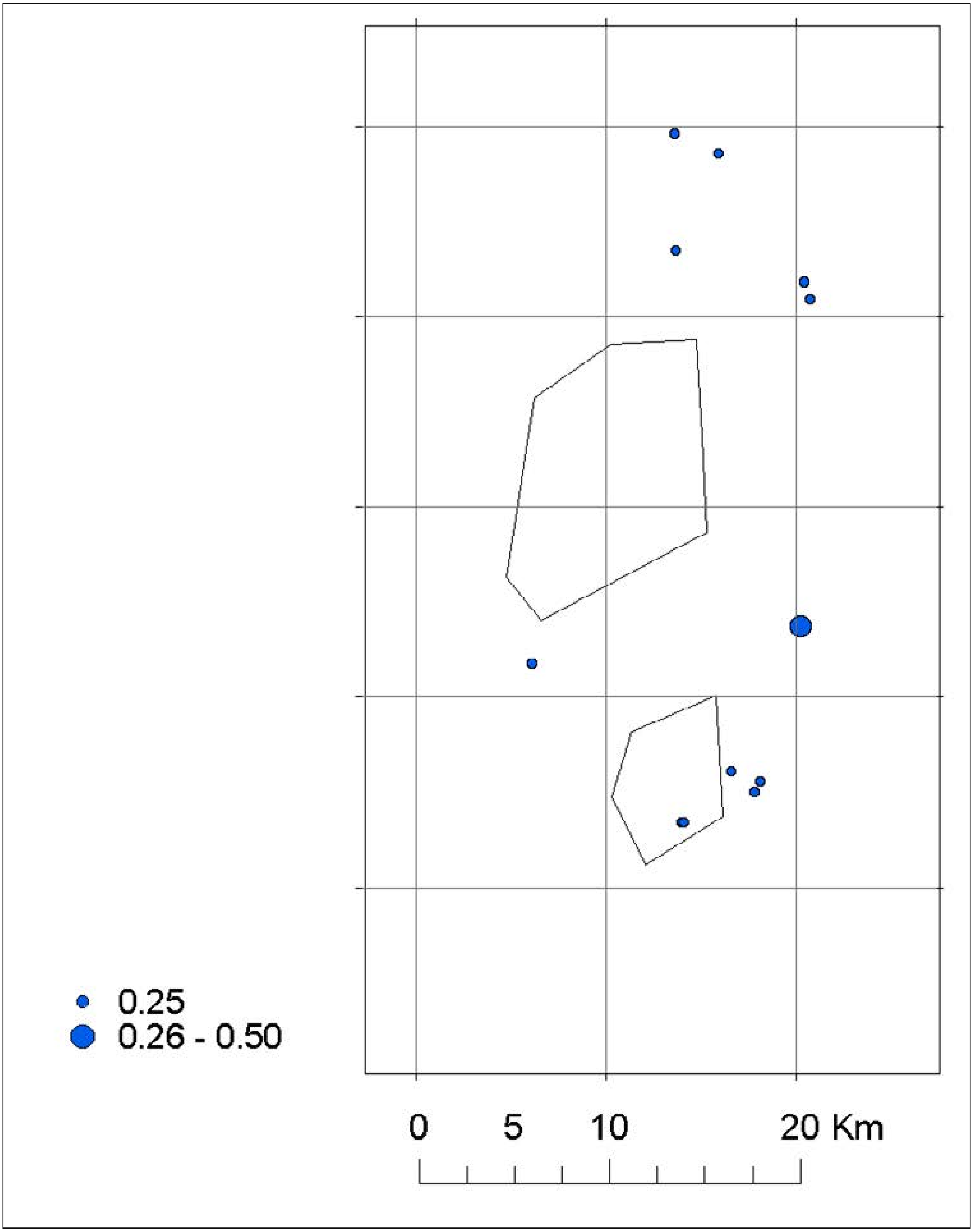

Figure 4.18.1-2 Average distribution of Great Skua, second summer boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

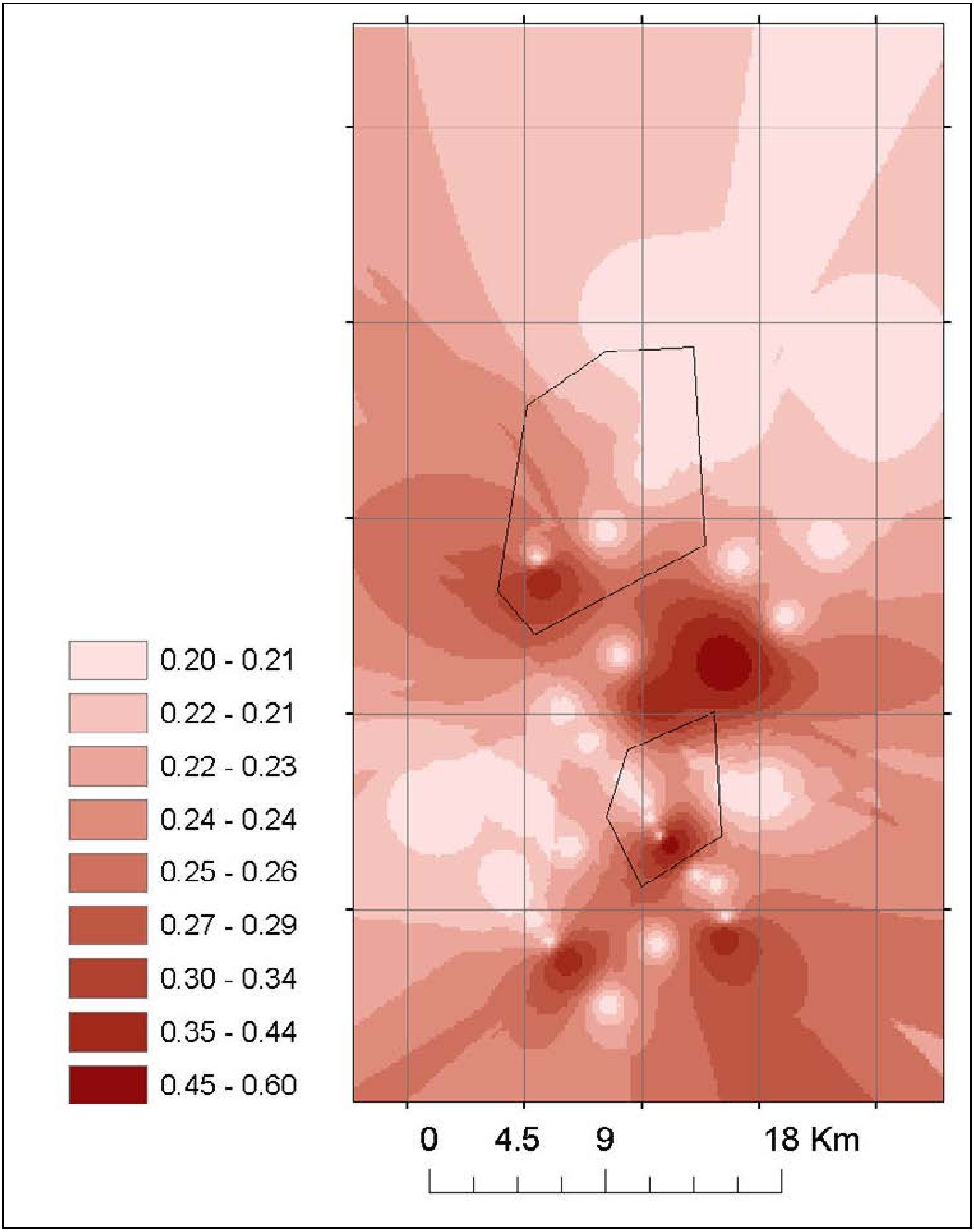

Figure 4.18.1-1 Average distribution of Great Skua, third winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

4.19 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 est. 04/05	1	Wind farm peak est. 2004	1 bird
Wind farm peak est. 05/06	**4**	Wind farm peak est. 2005	2 birds
Gabbard peak 04/05	4 (*boat*)	*Gabbard peak 2004*	5 birds (*boat*)
Gabbard peak 05/06	**27 (*aerial*)**	*Gabbard peak 2005*	11 birds (*boat*)
Proportion of threshold 04/05	?	*Proportion of threshold 2004*	?
Proportion of threshold 05/06	?	*Proportion of threshold 2005*	?

4.19.1 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 4.19.1-1 illustrates that small numbers of Little Gull can occur at almost any time of year, but tend to be present in slightly greater numbers from late summer to early winter.

Table 4.19.1-1 The number of Little Gulls recorded 'in transect' on boat surveys, together with corrected values and numbers recorded in flight. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

Month	On sea	Correction	In flight	Total
February 2004	0	0	0	0
March 2004 (1)	0	0	0	0
March 2004 (2)	0	0	0	0
April 2004	0	0	0	0
May 2004	0	0	0	0
June 2004	0	0	0	0
July 2004	0	0	1	1
August 2004	0	0	0	0
September 2004	0	0	5	5
November 2004	0	0	2	2
December 2004	0	0	3	3
March 2005	0	0	2	2
May 2005	0	0	0	0
June 2005	0	0	0	0
July 2005	8	11	0	11
August 2005	0	0	0	0
September 2005	0	0	0	0
October 2005	0	0	0	0
December 2005	0	0	0	0
January 2006	0	0	0	0
February 2006	0	0	0	0
April 2006	0	0	1	1

4.19.2 Aerial surveys

During the first set of aerial surveys, four individuals were recorded during the second winter period and one during the third winter period. During the second set of aerial surveys, 27 individuals were recorded during the first winter period.

4.19.3 The importance of the Greater Gabbard for Little Gull

4.19.3.1 Winter and summer

On boat surveys, two birds were counted in November 2004, three in December 2004 and one in March 2005. Aerial surveys recorded 27 birds in the first winter period of the second set of surveys. Without accurate national population estimates it is hard to assess the importance of the Greater Gabbard area. There is evidence to suggest that the area is regionally important however, with peak numbers in excess of 50% of the regional peak. However, the estimated peak count of only four birds within the proposed wind farm footprint, suggests that this latter area is of only minimal importance for this species.

4.19.3.2 Migration

No Little Gulls were recorded during migratory periods.

4.20 Black-headed Gull	***Larus ridibundus***		
Conservation status:	SPA feature, BoCC Amber		
Winter		**Summer (pairs)**	
International threshold	20,000	***European population***	1,500,000-2,200,000
GB threshold	16,820	*GB population*	127,907
Wind farm peak est. 04/05	2	Wind farm peak est. 2004	**5 birds**
Wind farm peak est. 05/06	2	Wind farm peak est. 2005	1 birds
Gabbard peak 04/05	9 (*boat*)	*Gabbard peak 2004*	**23 birds (*boat*)**
Gabbard peak 05/06	10 (*boat*)	*Gabbard peak 2005*	5 birds (*boat*)
Proportion of threshold 04/05	0.00	*% National population 2004*	**0.01**
Proportion of threshold 05/06	0.00	*% National population 2005*	0.00

4.20.1 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 4.20.1-1 illustrates the low counts of Black-headed Gull at all stages of the year.

Table 4.20.1-1 The number of Black-headed Gulls recorded 'in transect' on boat surveys, together with corrected values, numbers recorded in flight and the percentage of the national population (summer) or proportion of the national threshold (winter). Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

Month	On sea	Correction	In flight	Total	% National population (summer) / Proportion of threshold (winter)
February 2004	0	0	5	5	0.00
March 2004 (1)	0	0	0	0	0.00
March 2004 (2)	0	0	4	4	0.00
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	23	23	0.01%
August 2004	0	0	0	0	0.00%
September 2004	0	0	7	7	0.00
November 2004	0	0	1	1	0.00
December 2004	0	0	9	9	0.00
March 2005	1	1	4	5	0.00
May 2005	0	0	1	1	0.00%
June 2005	0	0	0	0	0.00%
July 2005	0	0	5	5	0.00%
August 2005	0	0	1	1	0.00%
September 2005	0	0	0	0	0.00
October 2005	0	0	10	10	0.00
December 2005	0	0	0	0	0.00
January 2006	0	0	2	2	0.00
February 2006	0	0	0	0	0.00
April 2006	0	0	0	0	0.00

4.20.2 Aerial surveys

During the first set of aerial surveys, two individuals were recorded during the third winter period and one during the second winter period. During the second set of aerial surveys, only one individual was recorded (during the third winter period).

4.20.3 The importance of the Greater Gabbard for Black-headed Gull

4.20.3.1 Winter and summer

The Greater Gabbard area has very little importance for Black-headed Gull at any time of the year. A peak of 23 individuals was recorded in July 2004, representing only 0.01% of the national population.

4.20.3.2 Migration

Only low numbers of Black-headed Gull were recorded during the passage period. Consequently there is no reason to suggest that large numbers of this species migrate through the Greater Gabbard area.

4.21 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*	48,163
Wind farm peak est. 04/05	8	Wind farm peak est. 2004	1 bird
Wind farm peak est. 05/06	**31**	Wind farm peak est. 2005	0
Gabbard peak 04/05	56 (*aerial*)	*Gabbard peak 2004*	3 birds (*boat*)
Gabbard peak 05/06	**94 (*aerial*)**	*Gabbard peak 2005*	0
Proportion of threshold 04/05	0.01	*% National population 2004*	0.00
Proportion of threshold 05/06	**0.02**	*% National population 2005*	0.00

4.21.1 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 4.21.1-1 illustrates the low counts of Mew Gull at all stages of the year. Figure 4.21.1-1 underlines the sparse nature of the counts, with most counts seemingly occurring on one transect in the second winter. In the third winter the species was slightly more widespread (Figure 4.21.1-2), with highest densities close to the Galloper proposed wind farm area.

Table 4.21.1-1 Mew Gulls recorded 'in transect' on boat surveys, with the proportion of the national threshold. Figures relate to entire study area, the proposed wind farm area representing between 20 and 30% of the total depending on survey month.

Month	**On sea**	**Correction**	**In flight**	**Total**	**% National population (summer) / proportion of threshold (winter)**
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
May 2005	0	0	0	0	0.00
June 2005	0	0	0	0	0.00
July 2005	0	0	0	0	0.00
August 2005	0	0	0	0	0.00
September 2005	0	0	0	0	0.00
October 2005	0	0	9	9	0.00
December 2005	0	0	9	9	0.00
January 2006	3	4	75	79	0.02
February 2006	2	3	25	28	0.01
April 2006	0	0	1	1	0.00

4.21.2 Aerial surveys

Table 4.21.2-1 shows Distance estimates generated from data collected on aerial surveys. Raw counts from aerial surveys were no greater than 20 birds over the winter period, and this agrees with the low counts made from boat surveys. Distance estimates peaked at 94 (95% confidence limits: 40 – 220) in winter period 4 of the second set of aerial surveys.

Figures 4.21.2-1 and 4.21.2-2 show that few counts of Mew Gull were made inside the proposed wind farm areas, the few birds that were recorded lying closer to shore.

Table 4.21.2-1 Mew Gulls recorded on the first (top) and second (bottom) set of 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.

Survey Block	Survey Period	DS	D	N	LCL	UCL	Proportion of threshold
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	

Continued…/

Table 4.21.2-1 Continued.

Survey Block	Survey Period	DS	D	N	LCL	UCL	Proportion of threshold
TH1	WINTER 1	0.0258	0.0411	52	6	479	
	WINTER 2	0.1227	0.1566	197	119	326	
	WINTER 3	0.0000	0.0000	0	0	0	
	WINTER 4	0.4004	0.6564	827	561	1220	
TH2	WINTER 1	0.0000	0.0000	0	0	0	
	WINTER 2	0.0194	0.0194	24	8	69	
	WINTER 3	0.0710	0.1004	124	62	245	
	WINTER 4	0.1743	0.1863	229	150	350	
TH3	WINTER 1	0.0074	0.0074	8	2	40	0.00
	WINTER 2	0.000	0.000	0	0	0	0.00
	WINTER 3	0.0294	0.0294	31	12	80	0.01
	WINTER 4	0.0589	0.0883	94	40	220	0.02
TH6	WINTER 1	0.0000	0.0000	0	0	0	
	WINTER 2	0.0000	0.0000	0	0	0	
	WINTER 3	0.0767	0.0715	92	50	168	
	WINTER 4	0.1725	0.3047	392	227	676	
TH7	WINTER 1	0.0518	0.0972	121	41	360	
	WINTER 2	0.0130	0.0454	57	3	93	
	WINTER 3	0.0259	0.0259	32	13	83	
	WINTER 4	0.0130	0.0130	16	5	57	

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

4.21.3.1 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 four 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 relatively low, 79 birds estimated in January 2006. Distance estimates were not possible owing to such infrequent counts, though these were generated from winter aerial surveys. Aerial surveys also reveal that Mew Gulls occur at low density and abundance in the Greater Gabbard area, estimates peaking at 94 birds in the fourth winter period of the second set of surveys. This peak was large enough to exceed the 1% threshold for regional importance, with a peak of 5.6% of the regional peak occurring within the Greater Gabbard area. 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.

4.21.3.2 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.

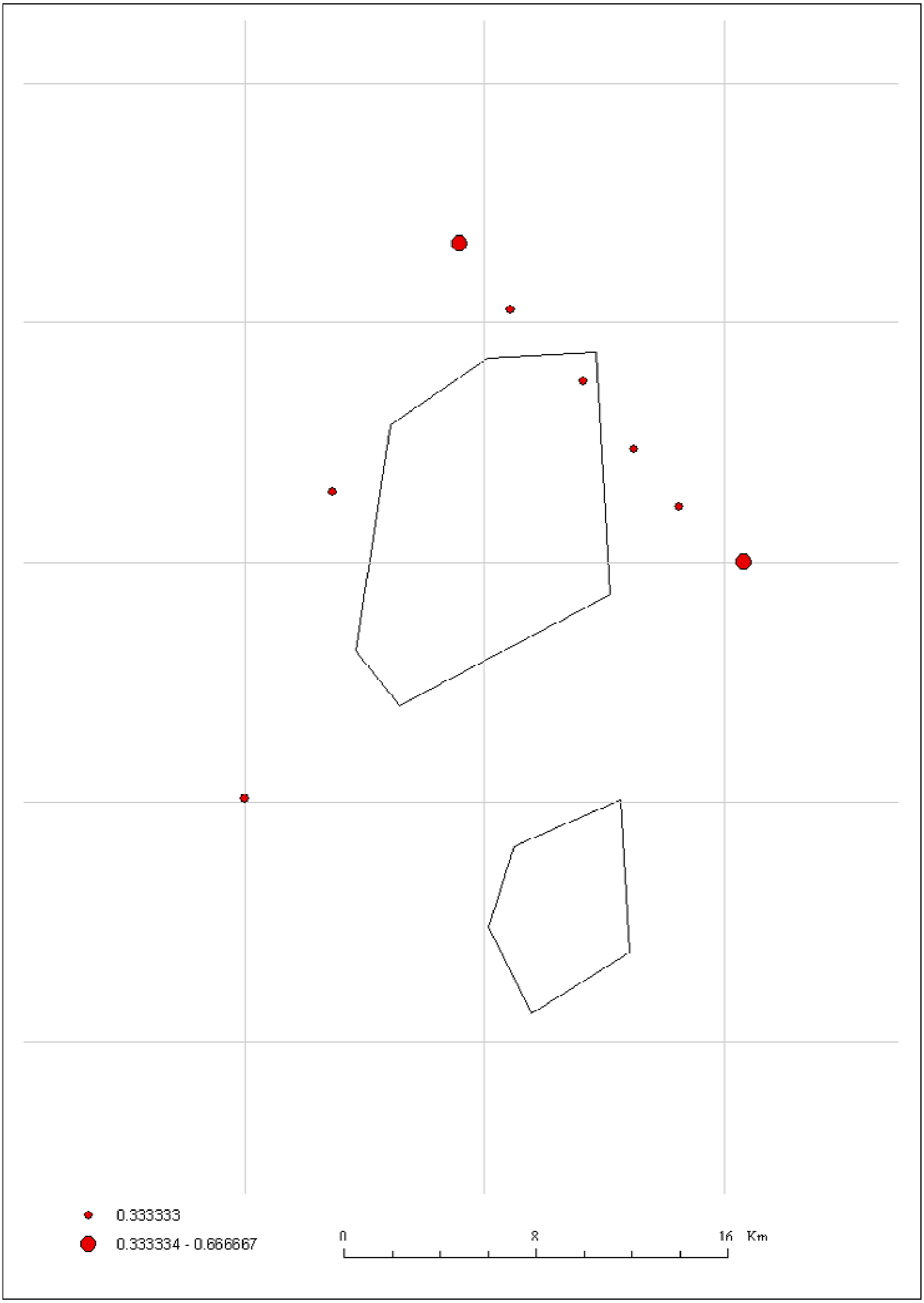

Figure 4.21.1-1 Average distribution of Mew Gull, second winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

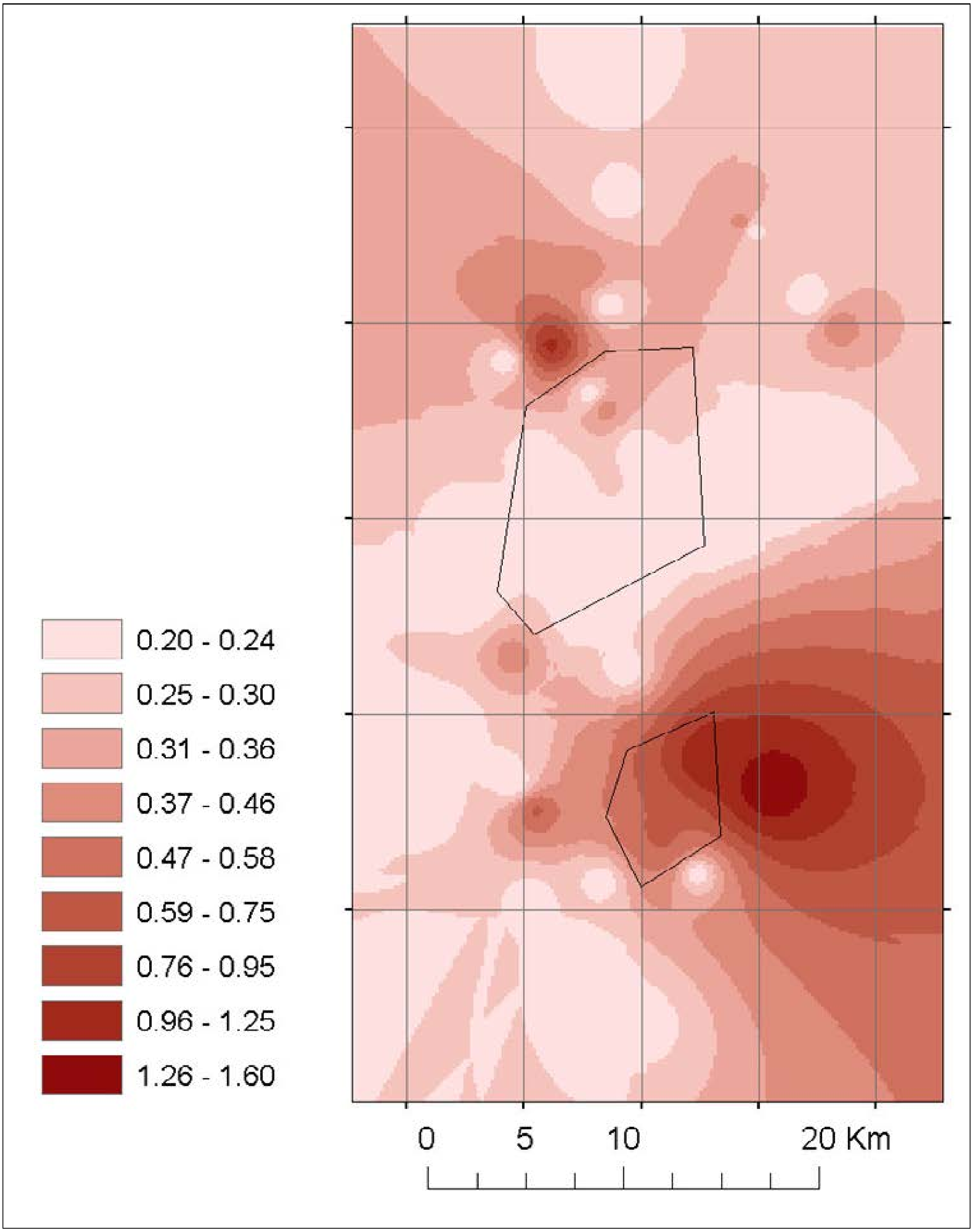

Figure 4.21.1-2 Average distribution of Mew Gull, third winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

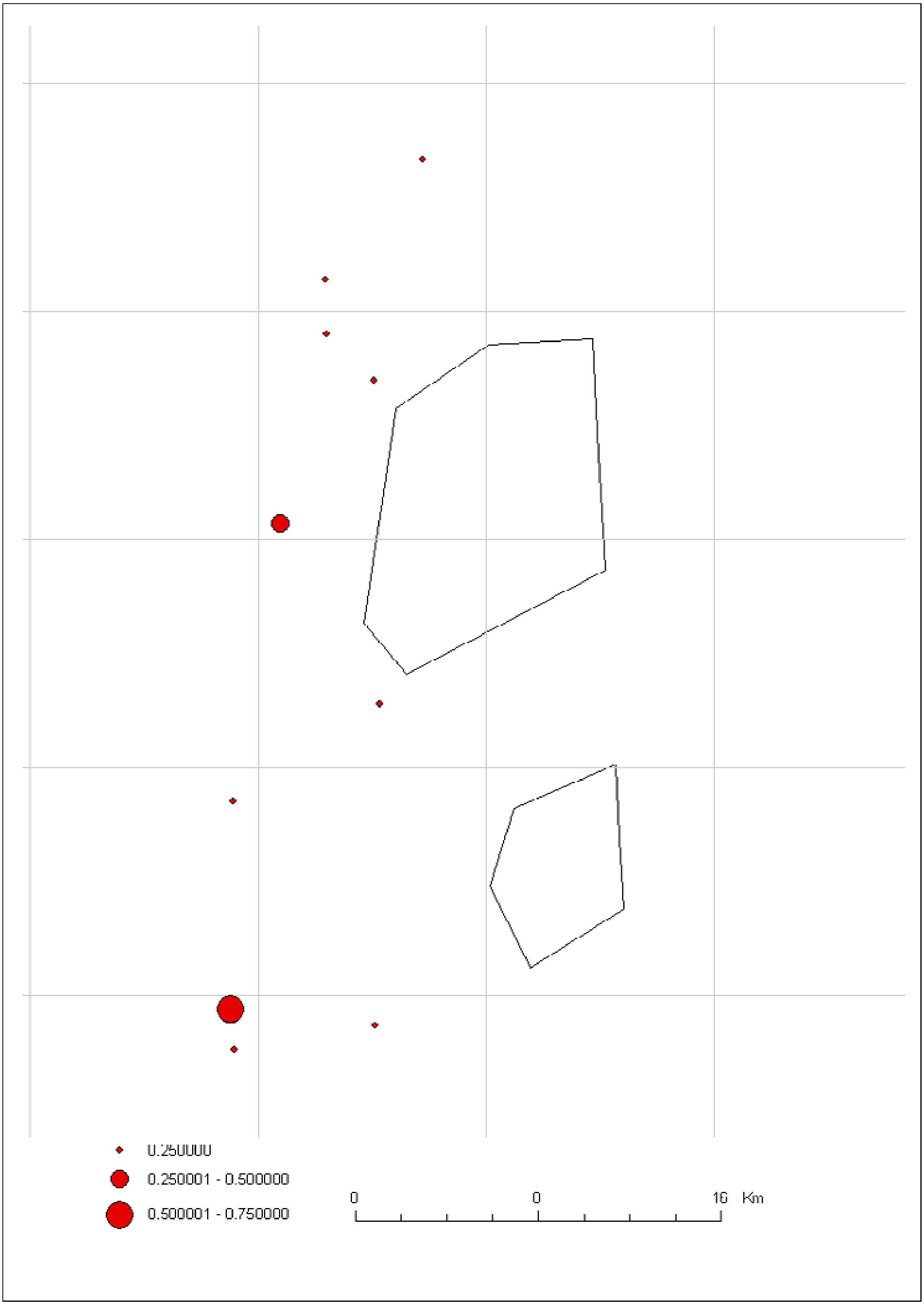

Figure 4.21.2-1 Average distribution of Mew Gull, first aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

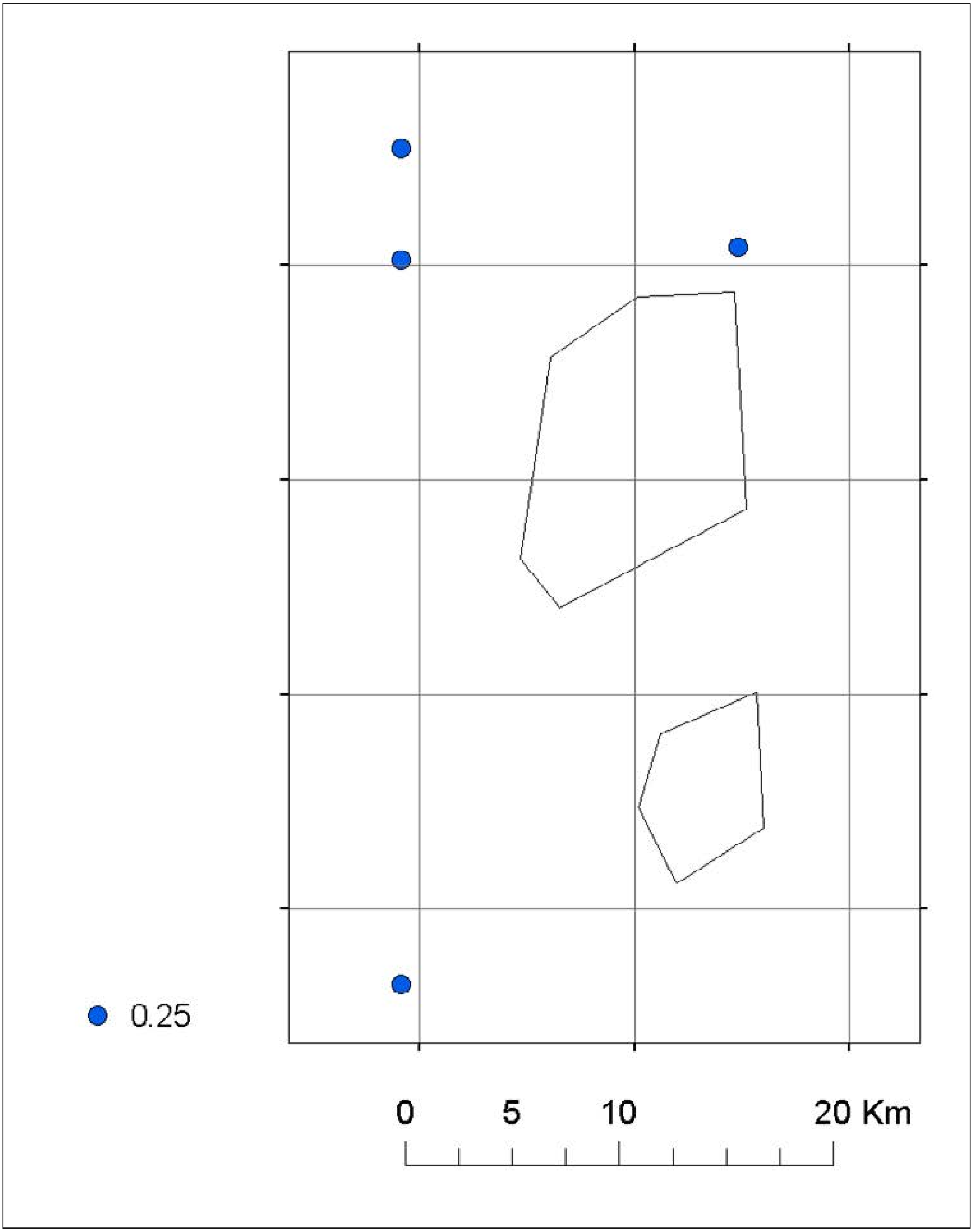

Figure 4.21.2-2 Average distribution of Mew Gull, second aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

4.22 Lesser Black-backed Gull	*Larus fuscus*		
Conservation status:	SPA feature, BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	4,500	**European population**	300,000-350,000
GB threshold	610	*GB population*	110,101
Wind farm peak est. 04/05	302	Wind farm peak est. 2004	156
Wind farm peak est. 05/06	**484**	Wind farm peak est. 2005	382
Gabbard peak 04/05	1,508 (*boat*)	*Gabbard peak 2004*	780 birds (*boat*)
Gabbard peak 05/06	**2,419 (boat)**	*Gabbard peak 2005*	1,909 birds (*boat*)
Proportion of threshold 04/05	2.47	*% National population 2004*	0.35%
Proportion of threshold 05/06	**3.97**	*% National population 2005*	0.87%

4.22.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.22.1-1). 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 4.22.1-2). 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 two instances, the survey of March 2005 and that of December 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 and third 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 4.22.1-1, 4.22.1-2 and 4.22.1-3 respectively). Highest average counts occurred in the south east corner of the survey area, often coinciding with The Galloper area of the wind farm. During the second summer and third winter (Figures 4.22.1-4 and 4.22.1-5), the pattern of distribution appeared to have changed somewhat, with high densities recorded in the north-east of the survey area. It is possible that these areas are productive for fish that are exploited by feeding flocks of gulls.

Table 4.22.1-1 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	DS	D	N	LCL	UCL
February 2004	0.0543	0.1320	53	17	172
March (1) 2004	0.0328	0.0700	34	13	87
March (2) 2004	0.0328	0.1939	94	29	312
April 2004	0.0889	0.0889	65	20	216
May 2004	0.1143	0.1109	81	23	287
June 2004	0.6732	0.9280	677	373	1,231
July 2004	0.2159	0.7092	518	233	1,149
August 2004	0.1270	0.2450	179	70	454
September 2004	0.1397	0.1632	119	43	334
November 2004	0.1143	0.1841	134	62	292

Continued…/

Table 4.22.1-1 Continued.

MONTH	DS	D	N	LCL	UCL
December 2004	0.1039	0.6310	461	81	2,634
March 2005	1.0923	1.9054	1,391	648	2,987
May 2005	0.4969	2.1084	1,539	485	4,883
June 2005	0.5137	0.6799	496	285	864
July 2005	0.24173	1.2758	931	254	3,414
August 2005	0.0806	1.6787	1,225	165	9,099
September 2005	0.1880	0.9266	676	277	1,652
October 2005	0.4177	1.0609	774	202	2,963
December 2005	0.0806	3.1693	2,314	370	14,471
January 2006	0.0134	0.1074	78	11	535
February 2006	0.2552	0.8326	608	242	1,529
April 2006	0.1746	0.9938	725	194	2,719

Table 4.22.1-2 'In flight' counts, Distance estimates and total estimates for Lesser Black-backed Gull, with % national population (summer) and the proportion of the national threshold (winter). 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 (summer) / Proportion of threshold (winter)
February 2004	226	53	279	0.46
March (1) 2004	160	34	194	0.32
March (2) 2004	175	94	269	0.44
April 2004	11	65	76	0.03%
May 2004	86	81	167	0.08%
June 2004	103	677	780	0.35%
July 2004	116	518	634	0.29%
August 2004	18	179	287	0.13%
September 2004	5	119	124	0.20
November 2004	12	134	146	0.24
December 2004	24	461	485	0.80
March 2005	117	1,391	1,508	2.47
May 2005	319	1,539	1,858	0.84%
June 2005	1,413	496	1,909	0.87%
July 2005	237	931	1,168	0.53%
August 2005	23	1,225	1,248	0.57%
September 2005	279	676	955	1.57
October 2005	178	774	952	1.56
December 2005	105	2,314	2,419	3.97
January 2006	83	78	161	0.26
February 2006	185	608	793	1.30
April 2006	151	725	876	1.44

4.22.2 Aerial surveys

Distance estimates of wintering Lesser Black-backed Gulls were possible, and are presented in Table 4.22.2-1. 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 Figures 4.22.2-1 and 4.22.2-2 underline the infrequency of occurrence of Lesser Black-backed Gulls on aerial surveys.

Table 4.22.2-1 Lesser Black-backed Gulls recorded on the first (top) second (bottom) set of 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.

Survey Block	Survey Period	DS	D	N	LCL	UCL	Proportion of threshold
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	

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Table 4.22.2-1 Continued.

Survey Block	Survey Period	DS	D	N	LCL	UCL	Proportion of threshold
TH1	WINTER 1	0.0123	0.0706	89	23	193	
	WINTER 2	0.0572	0.0563	71	40	125	
	WINTER 3	0.0286	0.0286	36	17	76	
	WINTER 4	0.0327	0.0396	50	23	110	
TH2	WINTER 1	0.0000	0.0000	0	0	0	
	WINTER 2	0.0163	0.0163	20	8	52	
	WINTER 3	0.0041	0.0041	5	1	27	
	WINTER 4	0.0041	0.0041	5	1	27	
TH3	WINTER 1	0.0047	0.0047	5	1	26	0.01
	WINTER 2	0.0000	0.0000	0	0	0	0.00
	WINTER 3	0.0093	0.0140	15	3	42	0.02
	WINTER 4	0.0047	0.0047	5	1	26	0.01
TH6	WINTER 1	0.0000	0.0000	0	0	0	
	WINTER 2	0.0081	0.0081	10	3	37	
	WINTER 3	0.0364	0.0364	47	24	91	
	WINTER 4	0.0246	0.0296	37	12	112	
TH7	WINTER 1	0.0246	0.0296	37	12	112	
	WINTER 2	0.0000	0.0000	0	0	0	
	WINTER 3	0.0123	0.0439	55	24	121	
	WINTER 4	0.0123	0.0123	15	5	45	

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

4.22.3.1 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 May and June 2005 were reasonably high, representing over 0.8% of the estimated British breeding population of 110,101 pairs (Baker *et al.* 2005), 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, and it thus 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 2,314 birds. The later estimate exceeds the 1% national importance threshold, representing almost 4% of the national wintering total. For the wind farm footprint area, the estimated proportion of the national total was reduced to 0.8%. However, other estimates during the winter were lower, usually between 150 and 700. 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.

4.22.3.2 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 over-winter in Britain and Ireland, as such movements invariably involve crossing the North Sea.

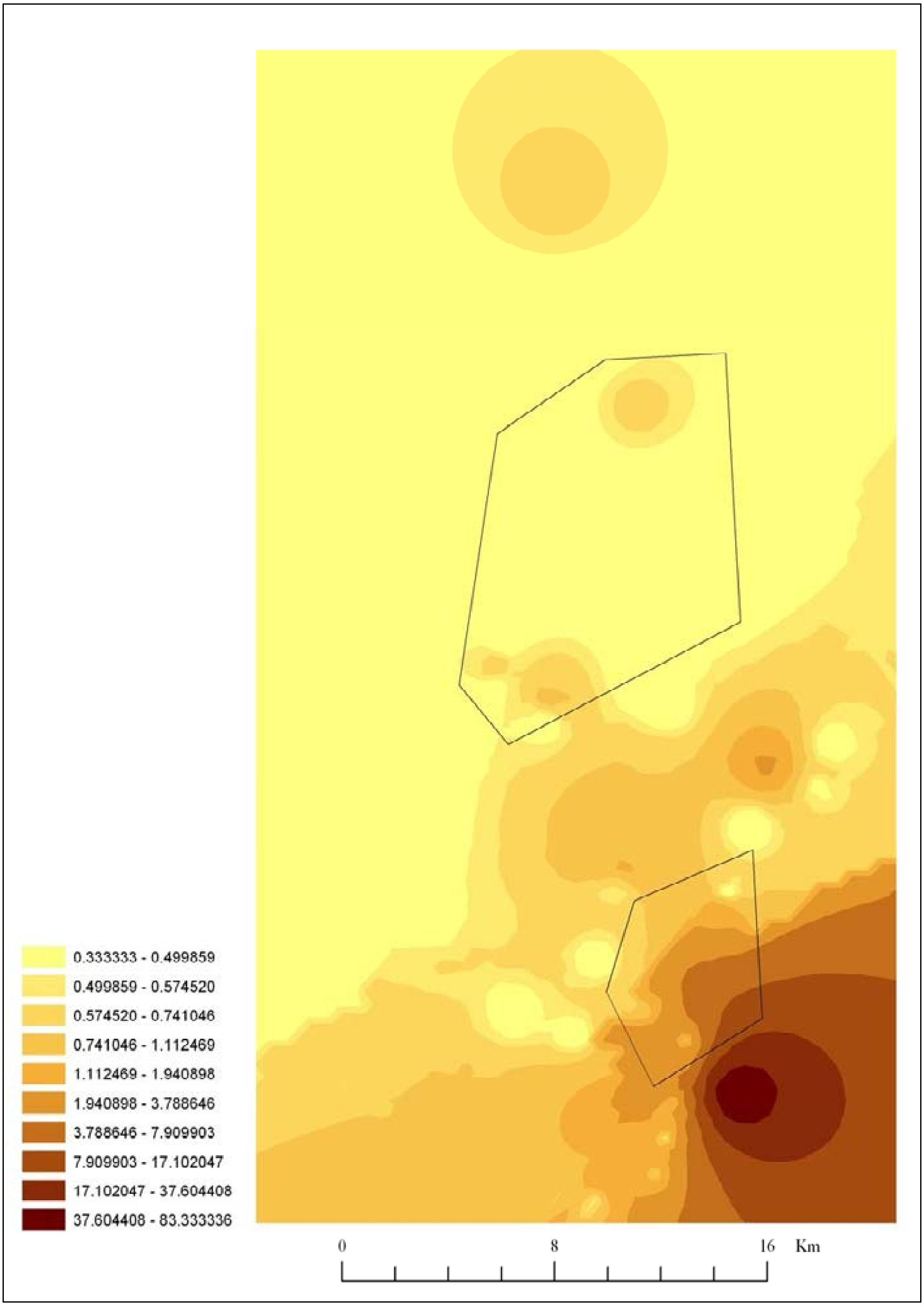

Figure 4.22.1-1 Smoothed average distribution of Lesser Black-backed Gull, first winter boat surveys. Polygons show boundaries of proposed wind farm.

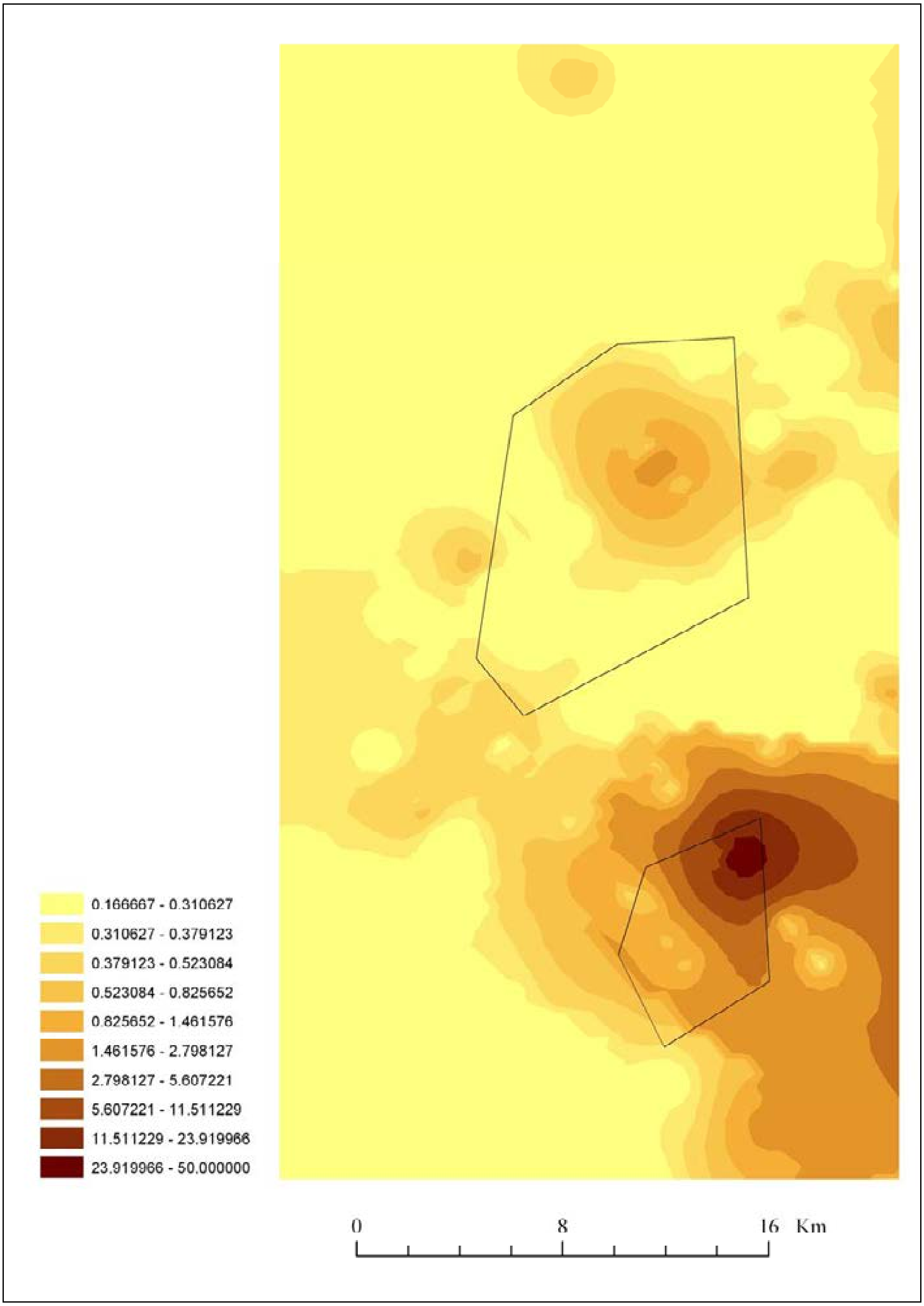

Figure 4.22.1-2 Smoothed average distribution of Lesser Black-backed Gull, first summer boat surveys. Polygons show boundaries of proposed wind farm.

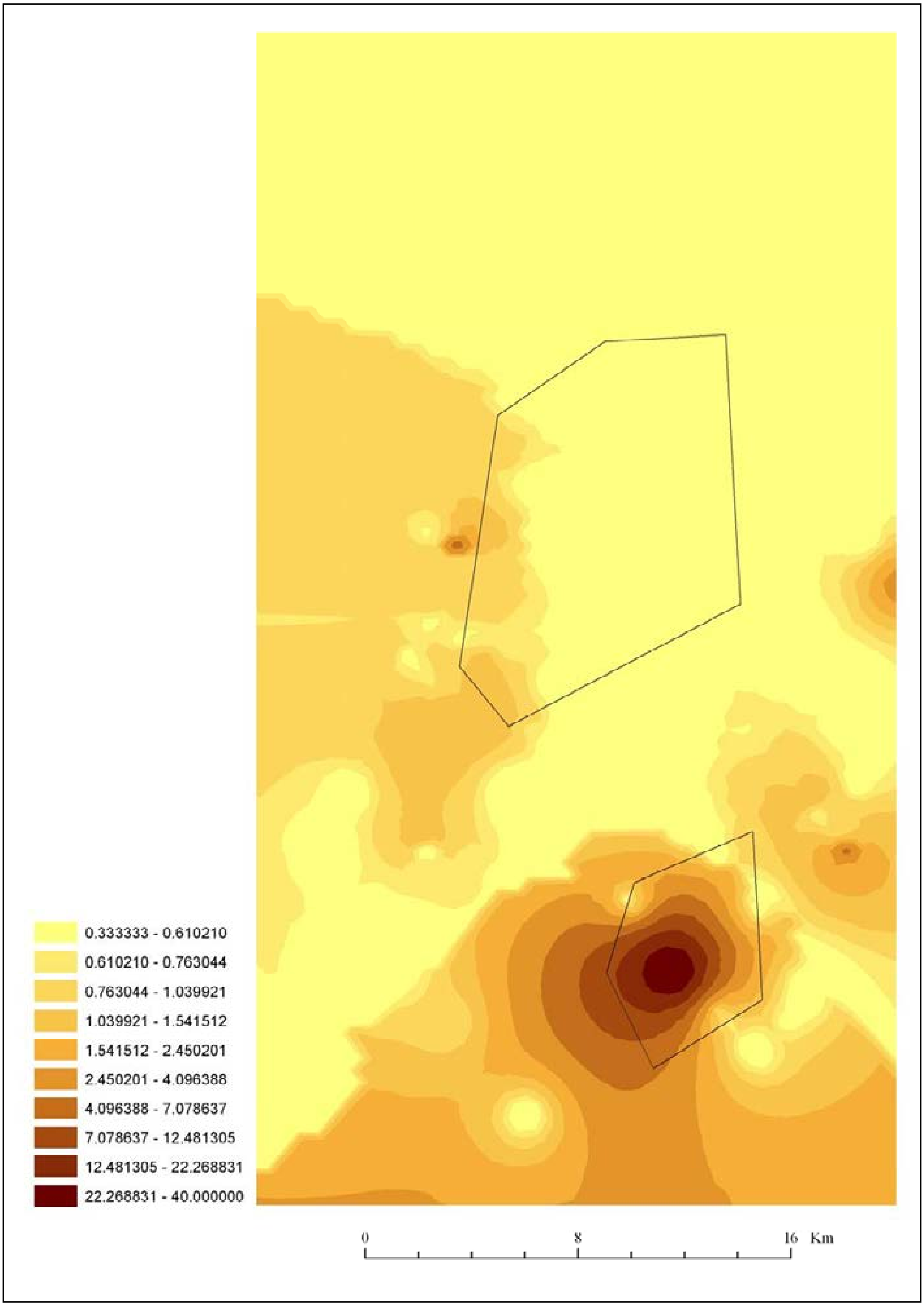

Figure 4.22.1-3 Smoothed average distribution of Lesser Black-backed Gull, second winter boat surveys. Polygons show boundaries of proposed wind farm.

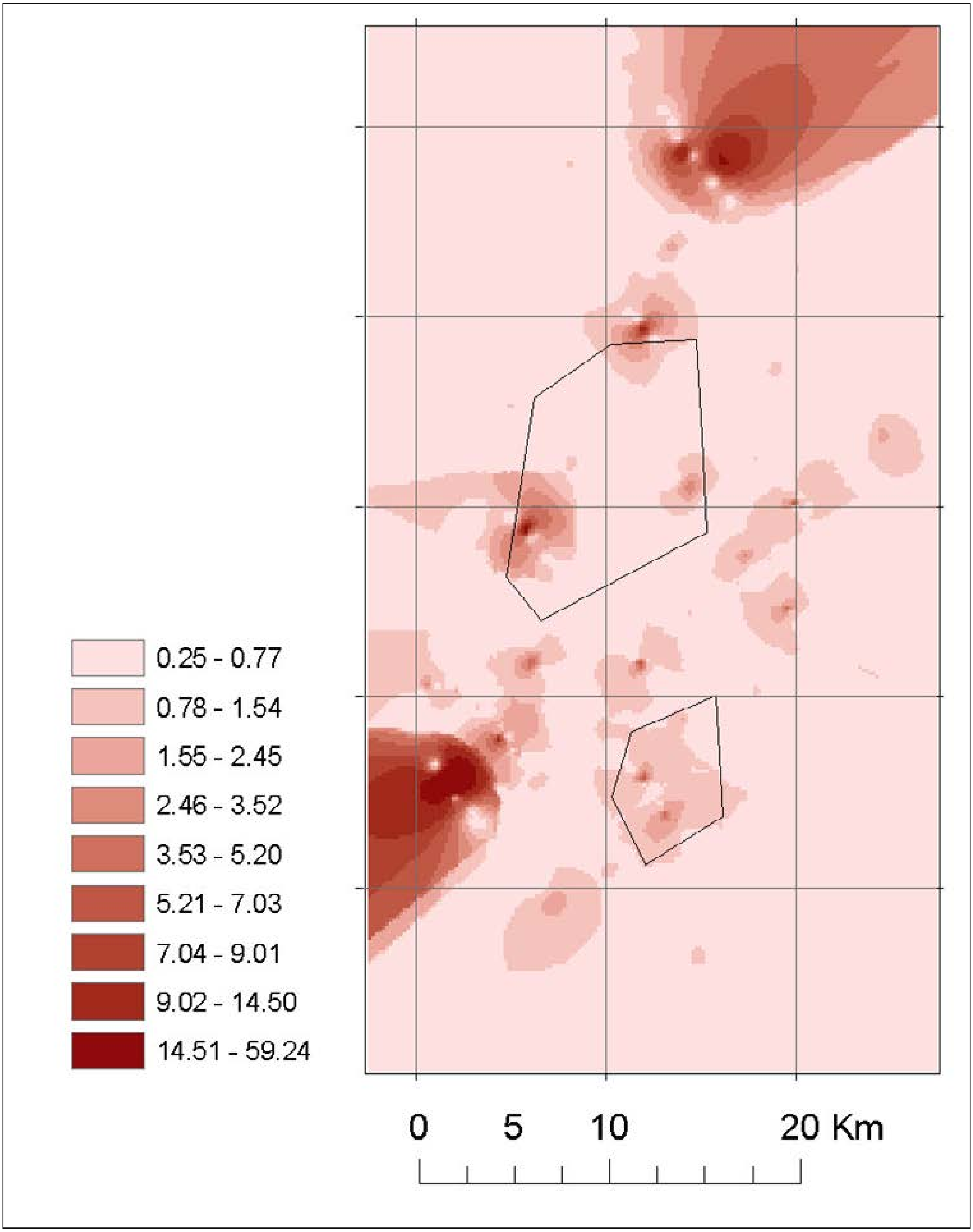

Figure 4.22.1-4 Smoothed average distribution of Lesser Black-backed Gull, second summer boat surveys. Polygons show boundaries of proposed wind farm.

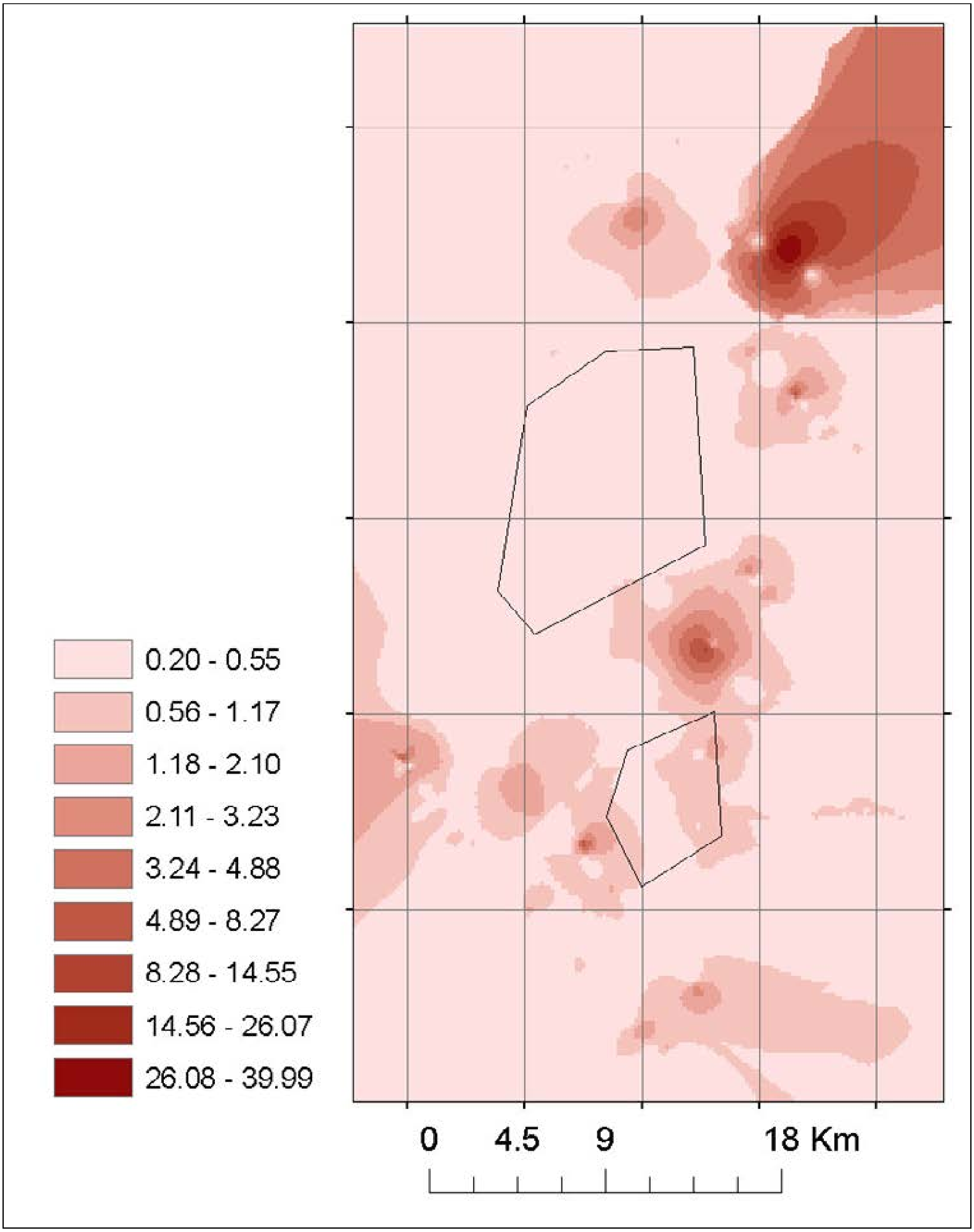

Figure 4.22.1-5 Smoothed average distribution of Lesser Black-backed Gull, third winter boat surveys. Polygons show boundaries of proposed wind farm.

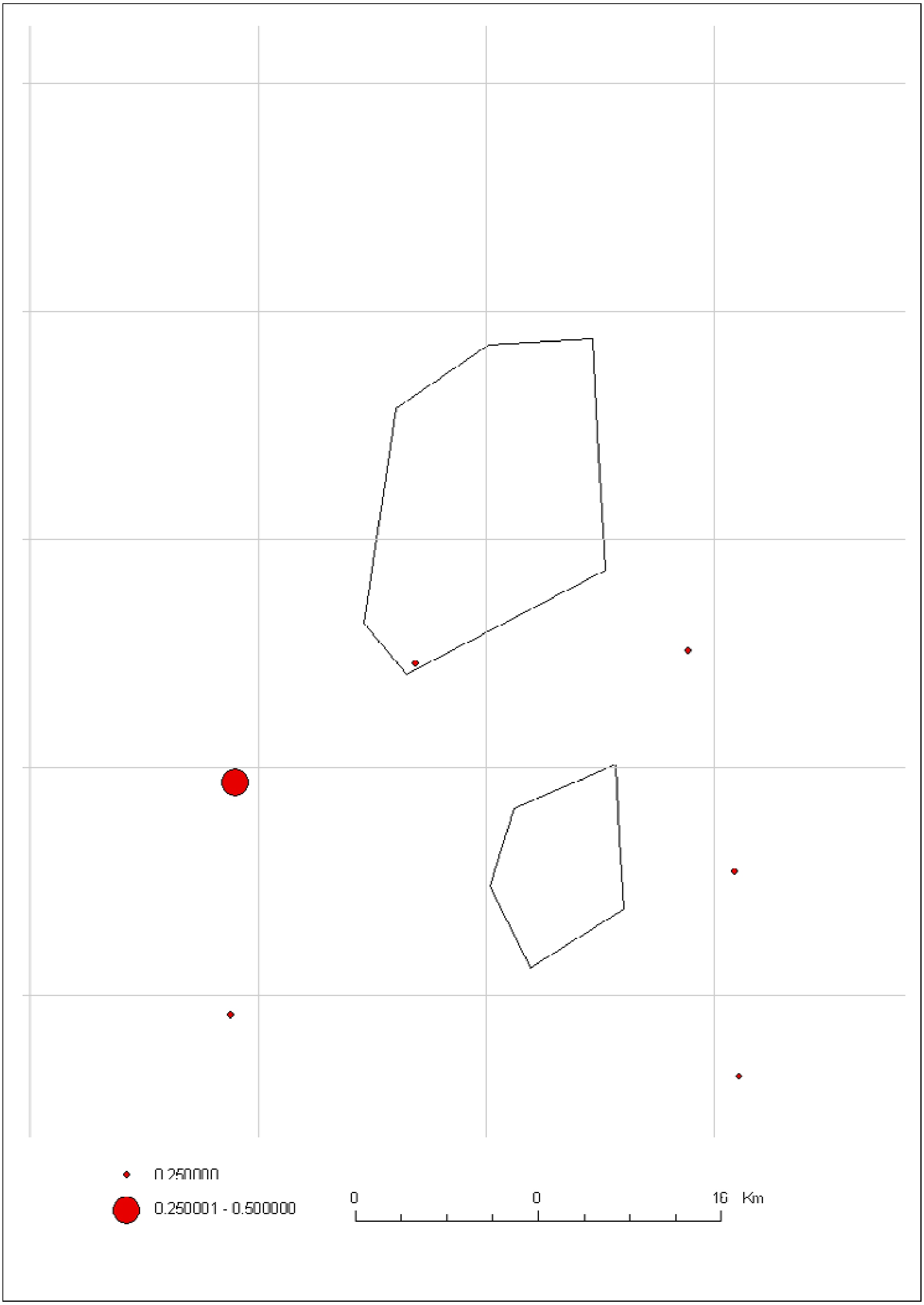

Figure 4.22.2-1 Average distribution of Lesser Black-backed Gull first aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

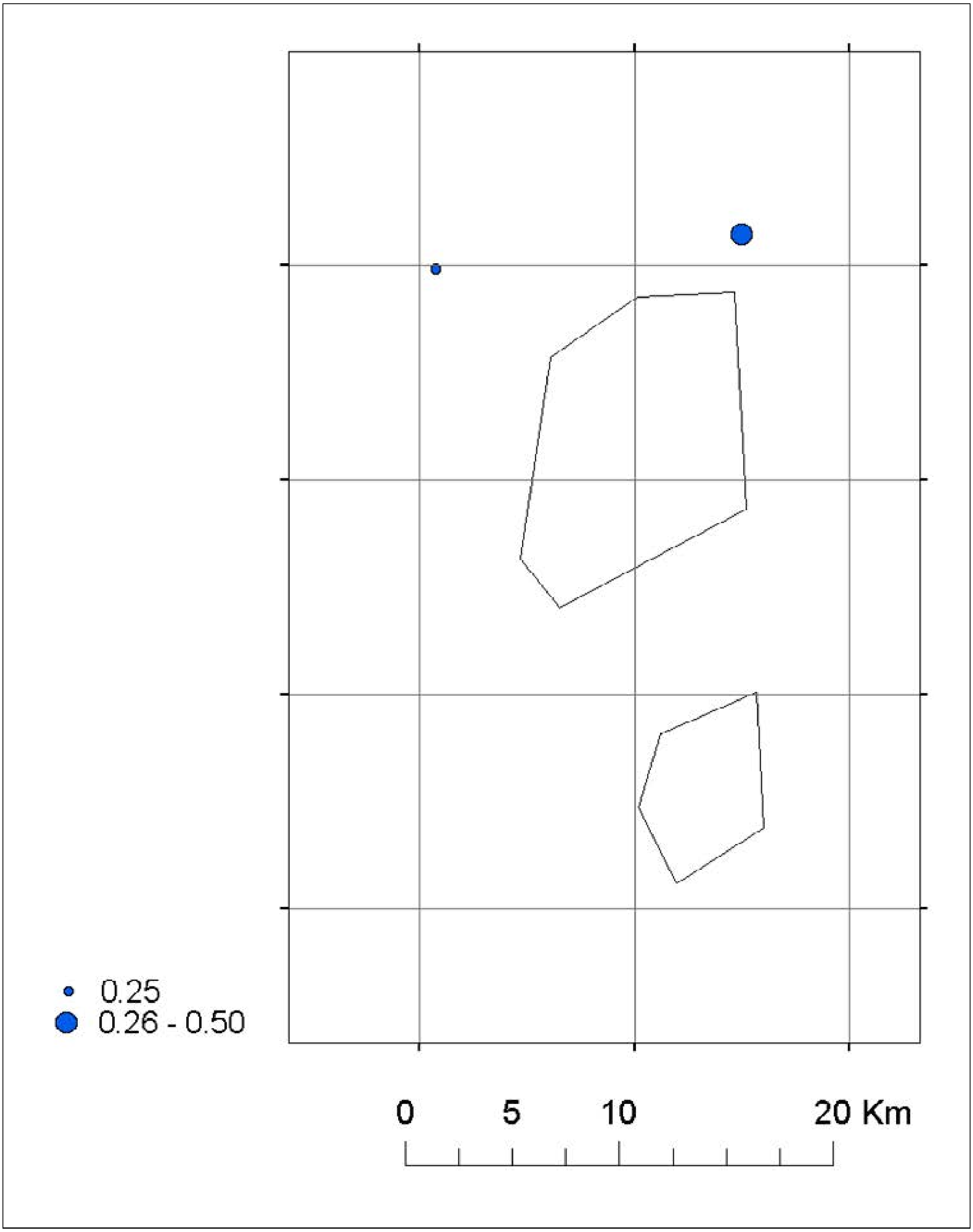

Figure 4.22.2-2 Average distribution of Lesser Black-backed Gull second aerial surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

4.23 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*	131,469
Wind farm peak est. 04/05	191	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	**346**	Wind farm peak est. 2005	23 birds
Gabbard peak 04/05	957 (*boat*)	*Gabbard peak 2004*	0
Gabbard peak 05/06	**1,731 (*boat*)**	*Gabbard peak 2005*	115 birds (*boat*)
Proportion of threshold 04/05	0.25	*% National population 2004*	0.00%
Proportion of threshold 05/06	**0.46**	*% National population 2005*	0.04%

4.23.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.23.1-1). 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 4.23.1-2). 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 and third winters of survey, possibly owing to increases in the transect area. The peak estimate of 1,731 Herring Gull in December 2005 translates as 0.46% of the national population of 376,775 birds (Baker *et al*. 2005).

Figures 4.23.1-1, 4.23.1-2 and 4.23.1-3 show the averaged distribution of Herring Gulls in the three winters surveyed by boat. In the first two winters, the largest flocks were recorded in the south east part of the survey area, with average counts of up to 50. In the third winter, most birds occurred in the northeast of the survey area, with average counts of up to 12, but high densities also occurred within the Galloper. 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.

Table 4.23.1-1 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	DS	D	N	LCL	UCL
February 2004	0.0363	0.0627	25	8	77
March (1) 2004	0.0456	0.0811	39	11	136
March (2) 2004	0.0279	0.2626	128	25	644
April 2004	0.0000	0.0000	0	0	0
May 2004	0.0000	0.0000	0	0	0
June 2004	0.0000	0.0000	0	0	0
July 2004	0.0000	0.0000	0	0	0
August 2004	0.0000	0.0000	0	0	0
September 2004	0.0000	0.0000	0	0	0
November 2004	0.2220	0.5613	410	161	1,045

Continued…/

Table 4.23.1-1 Continued.

MONTH	DS	D	N	LCL	UCL
December 2004	0.2375	1.2919	943	252	3,532
March 2005	0.3415	0.7547	551	195	1,558
May 2005	0.0138	0.1377	101	15	686
June 2005	0.0000	0.0000	0	0	0
July 2005	0.0138	0.0138	10	1	69
August 2005	0.0000	0.0000	0	0	0
September 2005	0.0000	0.0000	0	0	0
October 2005	0.0000	0.0000	0	0	0
December 2005	0.0689	2.303	1,681	182	15,546
January 2006	0.0413	0.2479	181	34	963
February 2006	0.2341	0.9436	689	255	1,587
April 2006	0.0000	0.0000	0	0	0

Table 4.23.1-2 'In flight' counts, Distance estimates and total estimates for Herring Gull, with % national population (summer) and proportion of threshold (winter). 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 population (summer) / proportion of threshold (winter)
February 2004	164	25	189	0.05
March (1) 2004	133	39	172	0.05
March (2) 2004	48	128	176	0.05
April 2004	7	0	7	0.00
May 2004	2	0	2	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	16	410	426	0.11
December 2004	14	943	957	0.25
March 2005	15	551	566	0.15
May 2005	14	101	115	0.04%
June 2005	4	0	4	0.00%
July 2005	1	10	11	0.00%
August 2005	0	0	0	0.00%
September 2005	1	0	1	0.00%
October 2005	3	0	3	0.00
December 2005	50	1,681	1,731	0.46
January 2006	79	181	260	0.07
February 2006	87	689	776	0.20
April 2006	2	0	2	0.00

4.23.2 Aerial surveys

Distance estimates of wintering Herring Gulls were possible (Table 4.23.2-1). 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 during the first set of aerial surveys; these can be seen on the distribution map (Figure 4.23.2-1). During the second set of aerial surveys the species was spread more sporadically (Figure 4.23.2-2).

Table 4.23.2-1 Herring Gull recorded on the first (top) and second (bottom) set of 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.

Survey Block	Survey Period	DS	D	N	LCL	UCL	Proportion of threshold
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	0.0000	0.0000	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	0.0000	0.0000	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	

Survey Block	Survey Period	DS	D	N	LCL	UCL	Proportion of threshold
TH1	WINTER 1	0.4140	2.0625	2,599	1,696	3,989	
	WINTER 2	1.2771	2.8233	3,557	2,665	4,748	
	WINTER 3	0.1866	0.2328	293	185	465	
	WINTER 4	0.3616	0.4106	517	365	733	
TH2	WINTER 1	0.0000	0.0000	0	0	0	
	WINTER 2	0.0233	0.0359	44	7	263	
	WINTER 3	0.0758	0.0984	121	65	225	
	WINTER 4	0.0058	0.0058	7	1	37	
TH3	WINTER 1	0.0133	0.0133	14	4	50	0.00
	WINTER 2	0.0266	0.0266	28	11	73	0.01
	WINTER 3	0.0332	0.0332	35	15	84	0.01
	WINTER 4	0.0199	0.0199	21	7	62	0.01
TH6	WINTER 1	0.0000	0.0000	0	0	0	
	WINTER 2	0.2538	0.4627	595	377	939	
	WINTER 3	0.1788	0.1796	231	151	354	
	WINTER 4	0.0404	0.0404	52	25	110	
TH7	WINTER 1	0.0059	0.0059	7	1	38	
	WINTER 2	0.0410	0.0410	51	24	108	
	WINTER 3	0.0000	0.0000	0	0	0	
	WINTER 4	0.1112	0.1193	149	90	247	

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

4.23.3.1 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 a peak of 11 birds recorded in July 2005. 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 a peak of 1,731 from the boat survey in December 2005. Although this is a substantial number of birds, representing 0.46% of the national population, the species is widely distributed through the North Sea (Skov *et al.* 1995). In relation to the other survey blocks studied in the Thames on aerial surveys, this species qualifies as being of regional importance in the study area, but not when considering the wind farm footprint alone.

4.23.3.2 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.

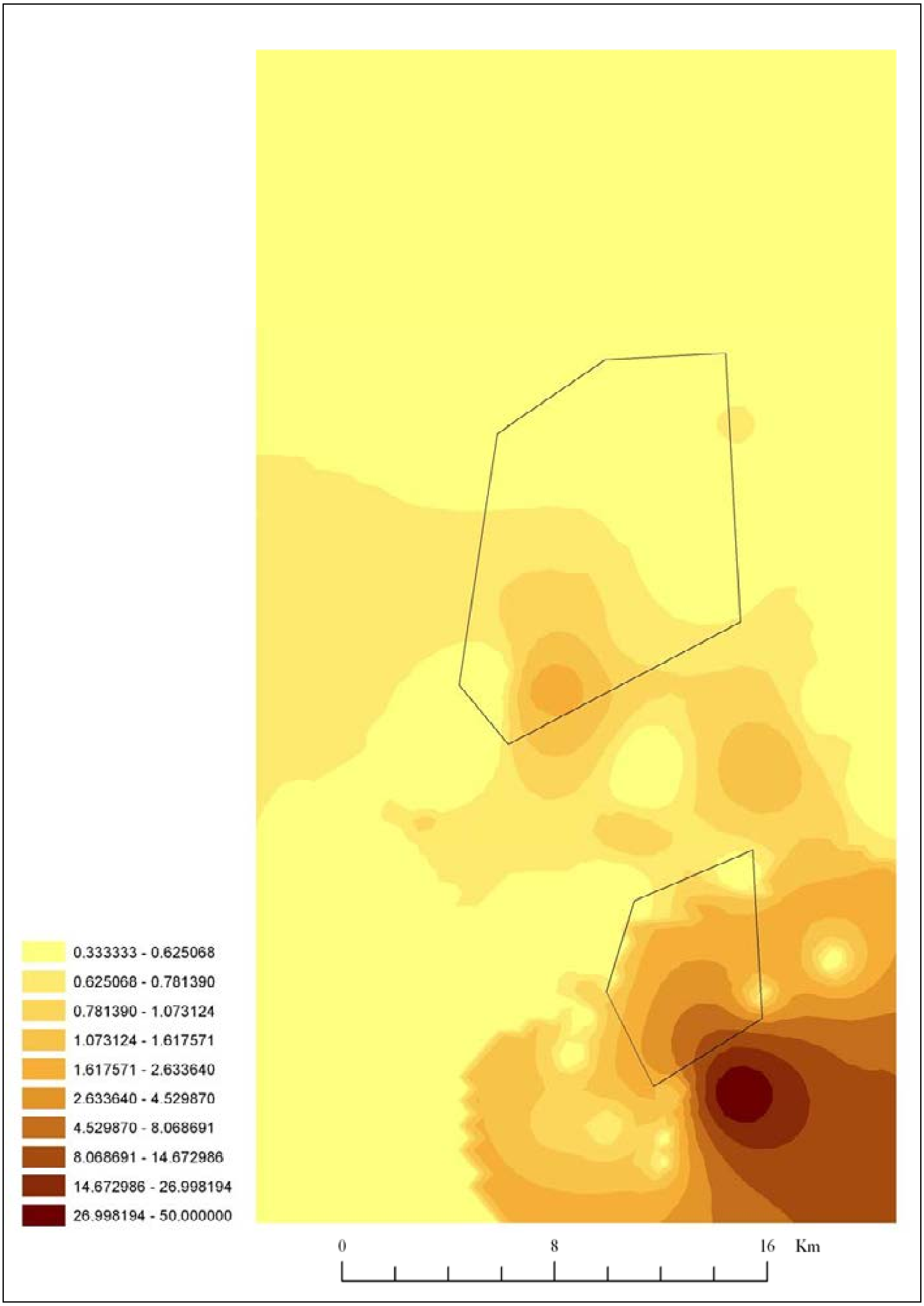

Figure 4.23.1-1 Smoothed average distribution of Herring Gull, first winter boat surveys. Polygons show boundaries of proposed wind farm.

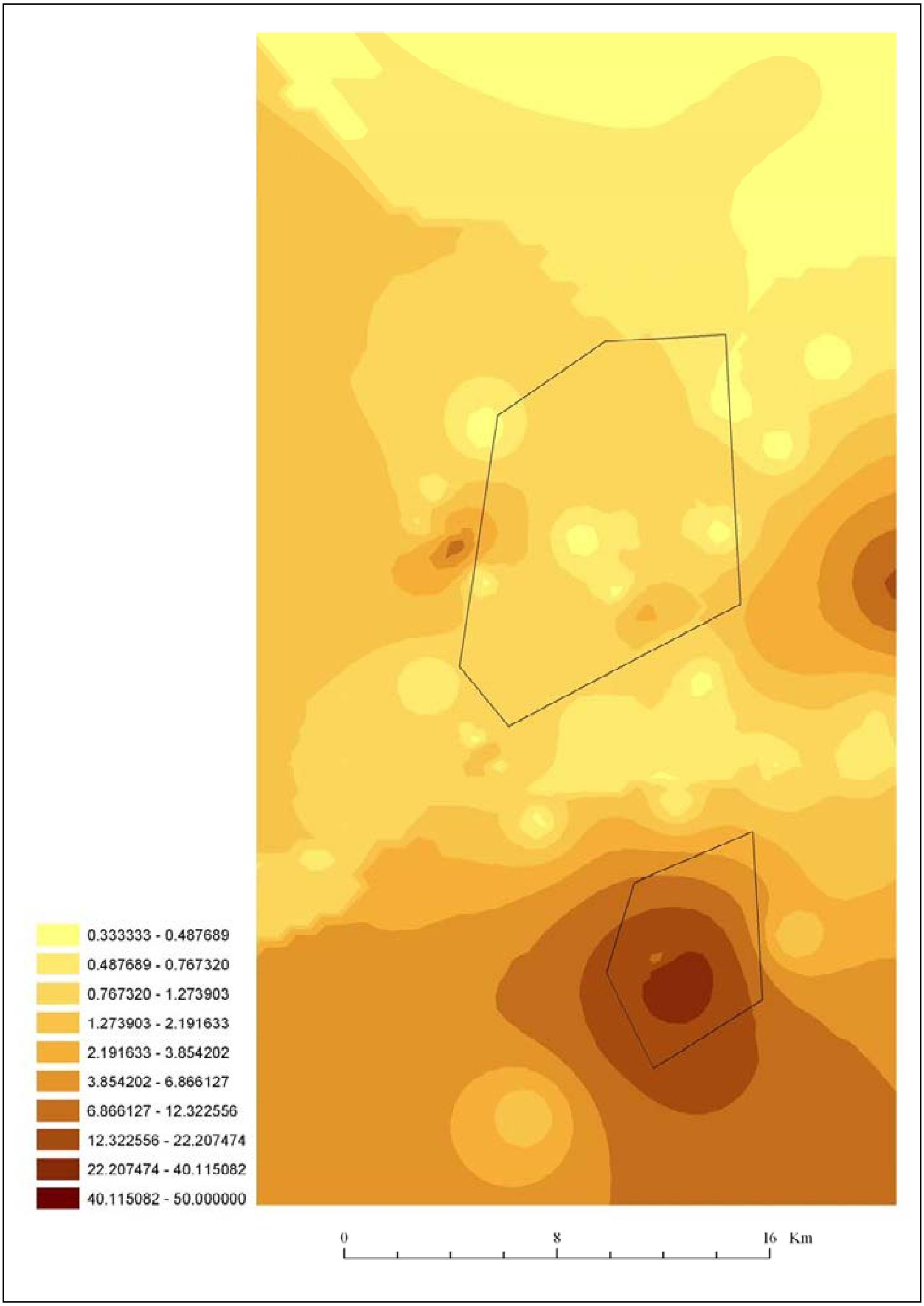

Figure 4.23.1-2 Smoothed average distribution of Herring Gull, second winter boat surveys. Polygons show boundaries of proposed wind farm.

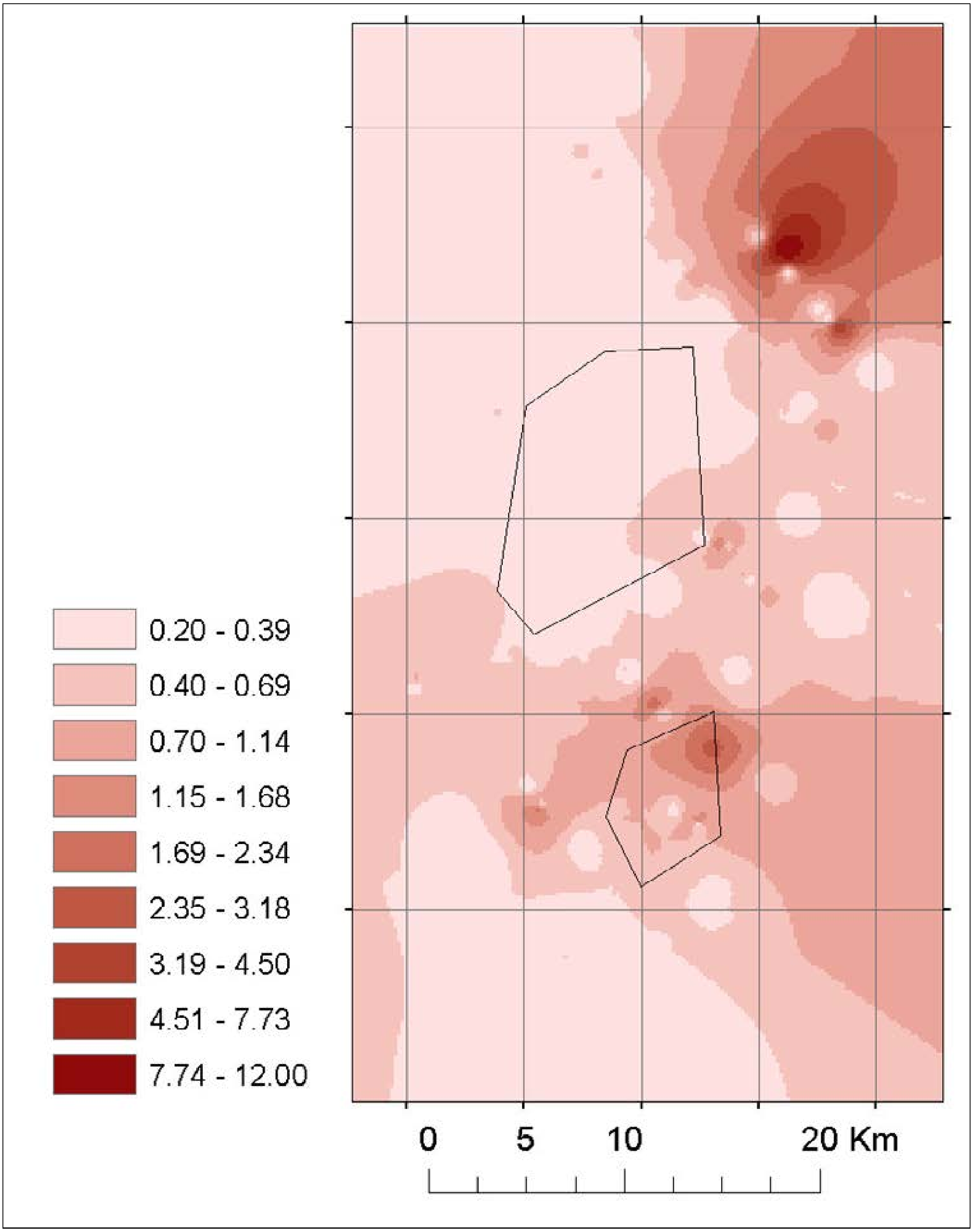

Figure 4.23.1-3 Smoothed average distribution of Herring Gull, third winter boat surveys. Polygons show boundaries of proposed wind farm.

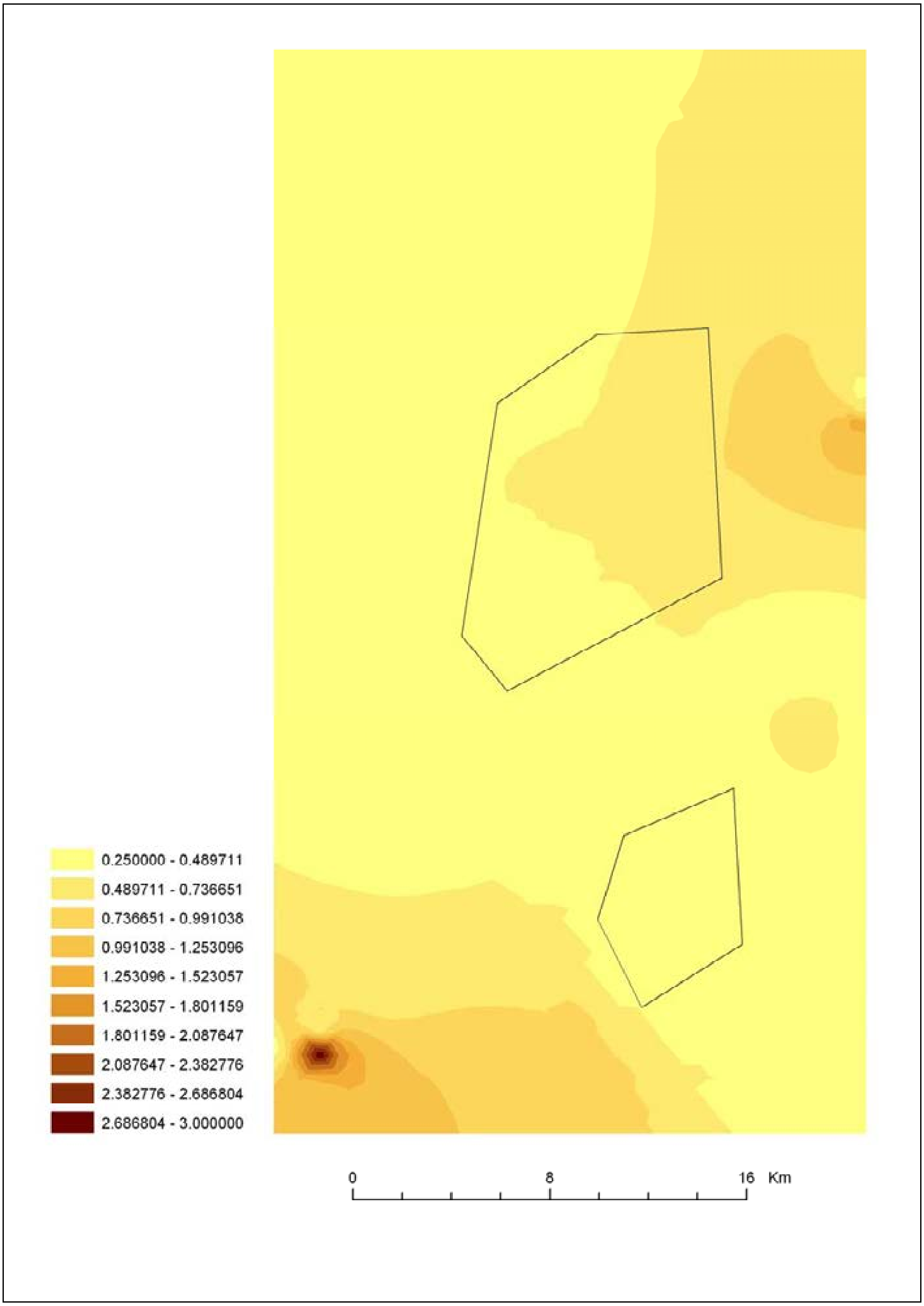

Figure 4.23.2-1 Smoothed average distribution of Herring Gull, first aerial surveys. Polygons show boundaries of proposed wind farm.

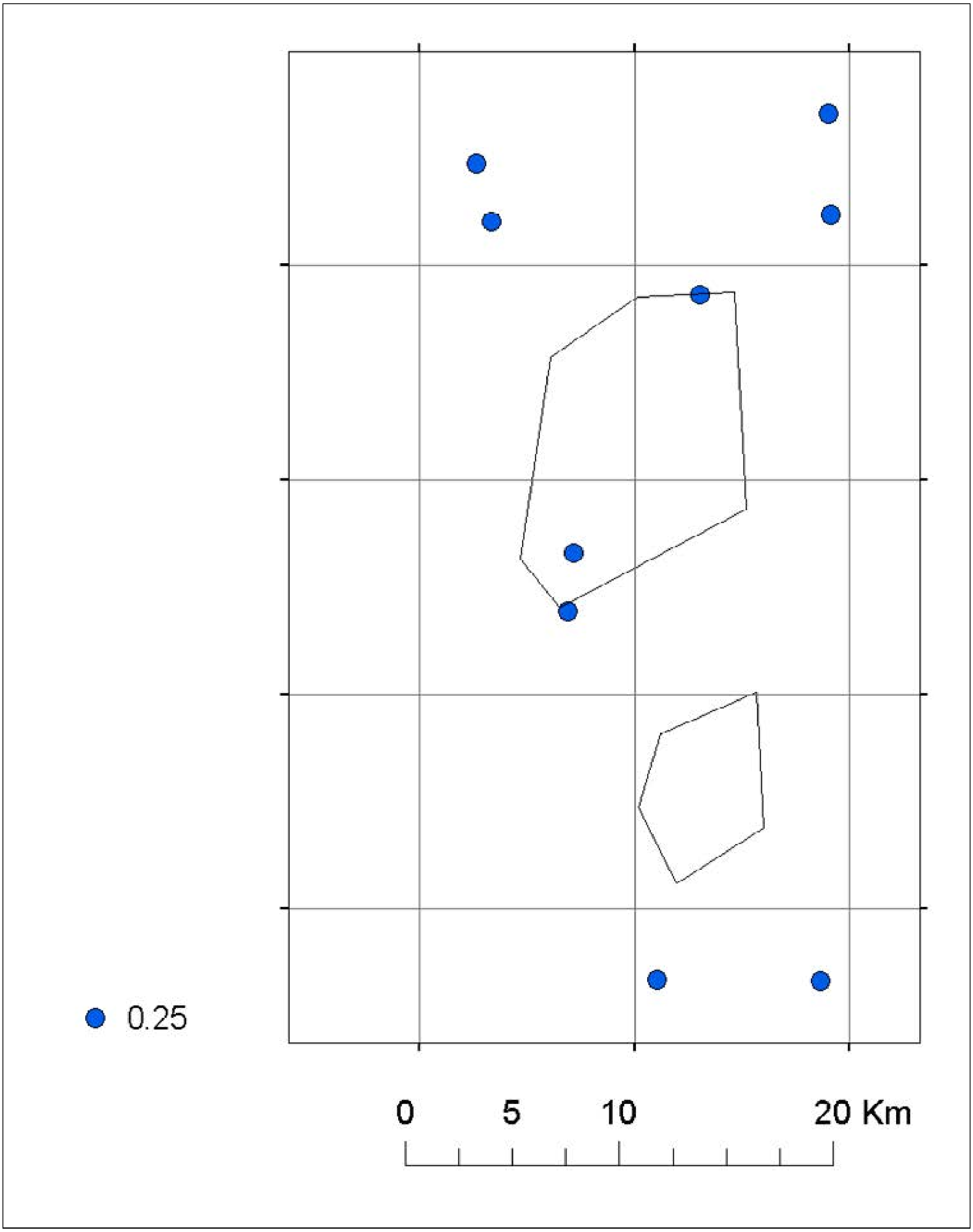

Figure 4.23.2-2 Average distribution of Herring Gull, second aerial surveys. Polygons show boundaries of proposed wind farm.

4.24 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*	17,084
Wind farm peak est. 04/05	81	Wind farm peak est. 2004	7 birds
Wind farm peak est. 05/06	**203**	Wind farm peak est. 2005	1 bird
Gabbard peak 04/05	405 (*boat*)	*Gabbard peak 2004*	34 birds (*boat*)
Gabbard peak 05/06	**1,450 (*aerial*)**	*Gabbard peak 2005*	7 birds (*boat*)
Proportion of threshold 04/05	0.94%	*Proportion of threshold 2004*	0.1%
Proportion of threshold 05/06	**3.37%**	*Proportion of threshold 2005*	0.02%

*GB threshold may be unrealistically low as a result of large numbers of the species that over-winter in the North Sea

4.24.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.24.1-1). 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 4.24.1-2). 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 4.24.1-2). The pattern in winter is inconsistent; few birds were recorded during the first winter of survey, with a peak of 405 marginally below the 1% national importance threshold in the second winter. In the third winter, (December 2005) estimates of 582 Great Black-backed Gulls were large enough to exceed the 1% national importance threshold of 430 (Baker *et al*. 2005). Note that confidence limits ranging from 178 – 1,824 were calculated for the estimate of 569 birds on the sea.

Figure 4.24.1-1 highlights the lack of this species recorded in the first winter. During the first summer, the few birds present were concentrated in two main areas (Figure 4.24.1-2), neither within the proposed wind farm area. Figures 4.24.1-3 and 4.24.1- suggests that during the second winter and second summer, the largest flocks were seen in the area of The Galloper, with very few birds in the north part of the Greater Gabbard area. In the t4hird winter, large concentrations occurred in both the Galloper area and in the northeast of the area surveyed (Figure 4.24.1-5).

Table 4.24.1-1 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	DS	D	N	LCL	UCL
February 2004	N/A	N/A	N/A	N/A	N/A
March (1) 2004	0	0	0	0	0
March (2) 2004	N/A	N/A	N/A	N/A	N/A
April 2004	0.0253	0.0253	18	3	126
May 2004	0	0	0	0	0
June 2004	0	0	0	0	0

Continued…/

Table 4.24.1-1 Continued**.**

MONTH	DS	D	N	LCL	UCL
July 2004	0.0084	0.0084	6	1	42
August 2004	0	0	0	0	0
September 2004	0.0253	0.0253	18	3	126
November 2004	0.0926	0.1094	80	42	153
December 2004	0.0826	0.5510	402	89	1,823
March 2005	0.0926	0.1010	74	33	164
May 2005	0.0000	0.0000	0	0	0
June 2005	0.0000	0.0000	0	0	0
July 2005	0.0000	0.0000	0	0	0
August 2005	0.0000	0.0000	0	0	0
September 2005	0.0057	0.0057	4	1	24
October 2005	0.0455	0.0455	33	10	108
December 2005	0.1478	0.7800	569	178	1,824
January 2006	0.0796	0.0910	66	23	189
February 2006	0.1592	0.2306	168	71	401
April 2006	0.0114	0.0114	8	1	57

Table 4.24.1-2 'In flight' counts, Distance estimates and total estimates for Great Black-backed Gull, with % national population (summer) or proportion of national threshold (winter). 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.

MONTH	In flight count	Distance estimate	Total estimate	% National population summer) / proportion of threshold (winter)
February 2004	23	(10)	33	0.08
March (1) 2004	7	0	7	0.02
March (2) 2004	3	(1)	4	0.01
April 2004	6	18	24	0.07%
May 2004	0	0	0	0.00%
June 2004	0	0	0	0.00%
July 2004	1	6	7	0.02%
August 2004	0	0	0	0.00%
September 2004	2	18	20	0.05%
November 2004	7	80	87	0.20
December 2004	3	402	405	0.94
March 2005	5	74	79	0.18
May 2005	1	0	1	0.00%
June 2005	2	0	2	0.01%
July 2005	3	0	3	0.01%
August 2005	1	0	1	0.00%
September 2005	3	4	7	0.02%
October 2005	3	33	36	0.08
December 2005	13	569	582	1.35
January 2006	10	66	76	0.18
February 2006	25	168	193	0.45
April 2006	5	8	13	0.03

4.24.2 Aerial surveys

Distance estimates of wintering Great Black-backed Gulls were possible (Table 4.24.2-1). Distance estimates for the Greater Gabbard area (TH3) peaked at 1,450, but note the wide 95% confidence limits of 180 – 11,647. This count, representing 3.36% of the estimated national population (Baker *et al.* 2005), far exceeds that recorded during any of the other survey periods, but is broadly consistent with peaks estimated from boat surveys. Of the seven aerial survey blocks studied, TH6 contained the greatest estimated abundance of Great Black-backed Gulls, the peak estimate of 8,002 (with 95% confidence limits of 1,279 – 50,055) representing almost 19% of the estimated national population. It is thus possible that higher thresholds should be used when considering offshore counts of this species.

Figures 4.24.2-1 and 4.24.2-2 present average count distributions for the survey area TH3. High densities within or close to the proposed wind farm footprint are evident from both figures.

Table 4.24.2-1 Great Black-backed Gull recorded on the first (top) and second (bottom) set of 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.

Survey Block	Survey Period	DS	D	N	LCL	UCL	Proportion of threshold
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	

Continued…/

Table 4.24.2-1 Continued.

Survey Block	Survey Period	DS	D	N	LCL	UCL	Proportion of threshold
TH1	WINTER 1	0.1172	0.1172	148	24	900	
	WINTER 2	0.2564	0.4539	572	95	3,461	
	WINTER 3	0.1538	0.1705	215	35	1,301	
	WINTER 4	0.0879	0.0879	111	18	681	
TH2	WINTER 1	0.0220	0.0220	27	4	185	
	WINTER 2	0.0220	0.0220	27	4	185	
	WINTER 3	0.0952	0.0952	117	19	718	
	WINTER 4	0.0439	0.0355	44	5	412	
TH3	WINTER 1	0.0000	0.0000	0	0	0	0.00
	WINTER 2	0.0668	1.3675	1,450	180	11,647	3.37
	WINTER 3	0.2588	0.3473	368	61	2,215	0.86
	WINTER 4	0.1586	0.0797	84	14	524	0.20
TH6	WINTER 1	0.0725	0.1014	130	20	838	
	WINTER 2	0.4057	6.2224	8,002	1,279	50,055	
	WINTER 3	0.2536	0.1873	241	40	1,450	
	WINTER 4	0.0507	0.0507	65	10	412	
TH7	WINTER 1	0.0147	0.0147	18	3	133	
	WINTER 2	0.0147	0.0147	18	3	133	
	WINTER 3	0.0367	0.0367	46	7	297	
	WINTER 4	0.2131	0.2298	287	48	1,726	

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

4.24.3.1 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 and third 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 1,450 calculated from these surveys. The Greater Gabbard area supports 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 birds 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, with peak estimates representing 14.5% of regional the regional population. The proportional estimate for the wind farm footprint itself numbered 203, suggesting that the area is of regional, but not national, importance.

4.24.3.2 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.

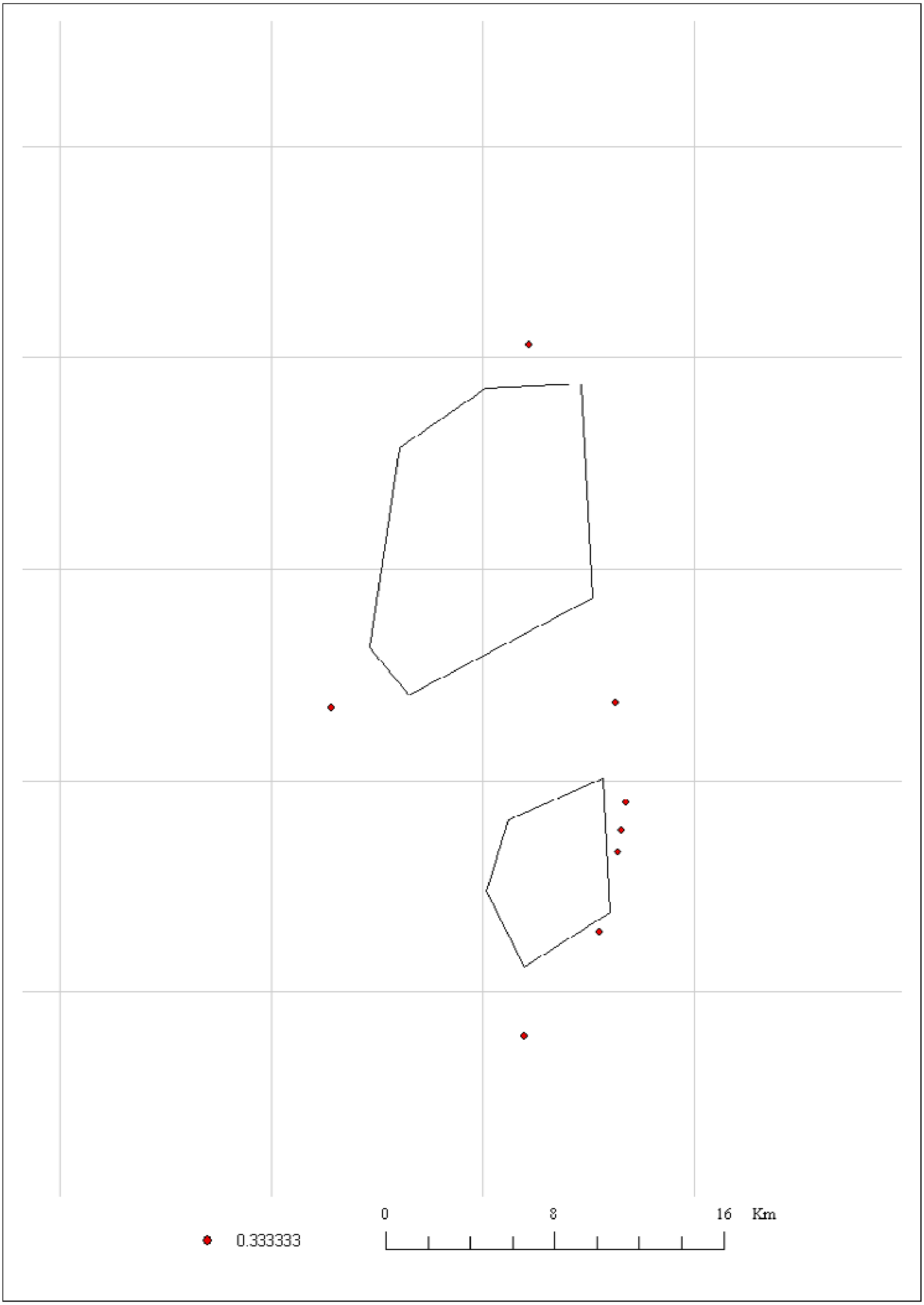

Figure 4.24.1-1 Average distribution of Great Black-backed Gull, first winter boat surveys. Grid is of 10 km squares. Polygons show boundaries of proposed wind farm.

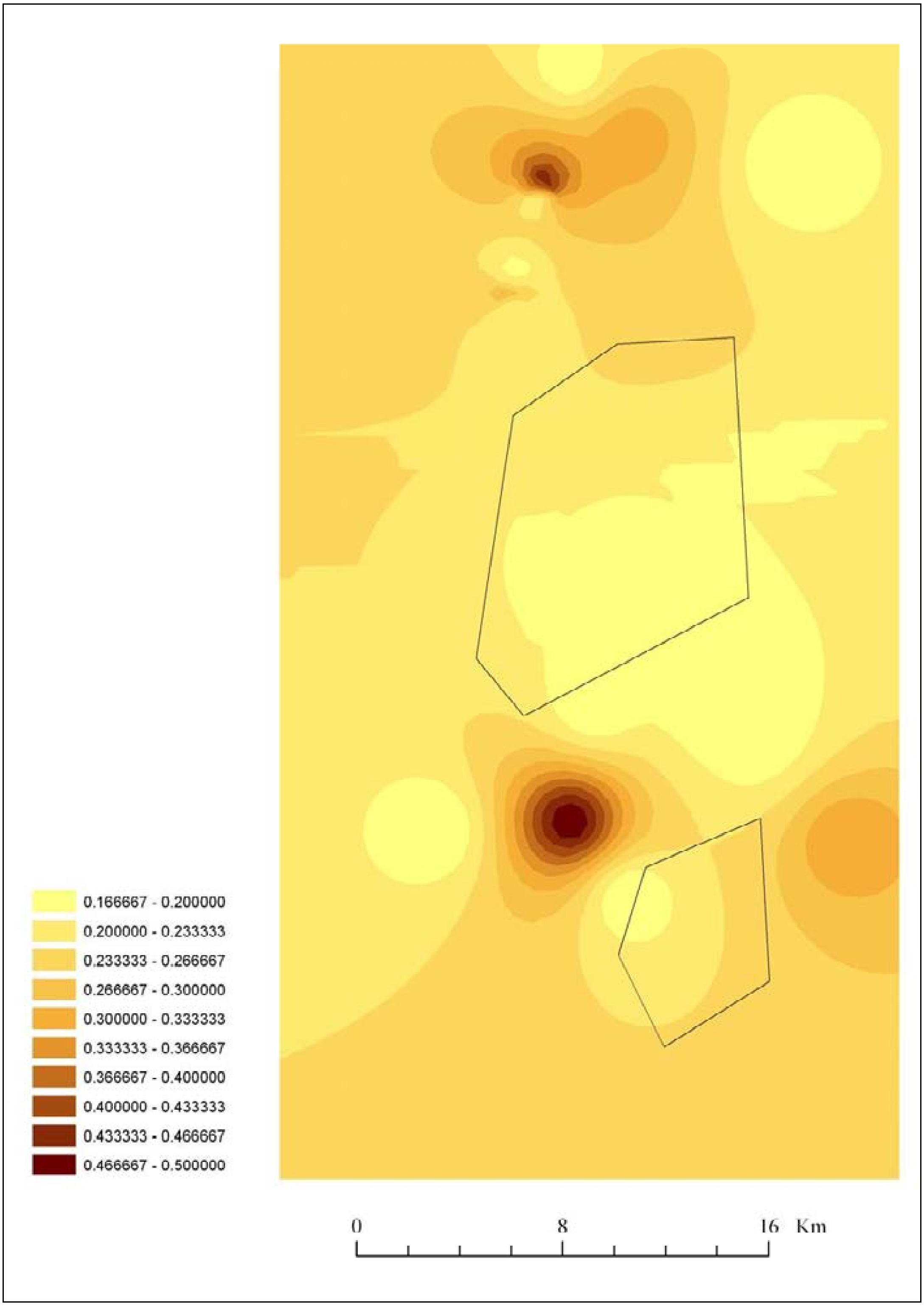

Figure 4.24.1-2 Smoothed average distribution of Great Black-backed Gull, first summer boat surveys. Polygons show boundaries of proposed wind farm.

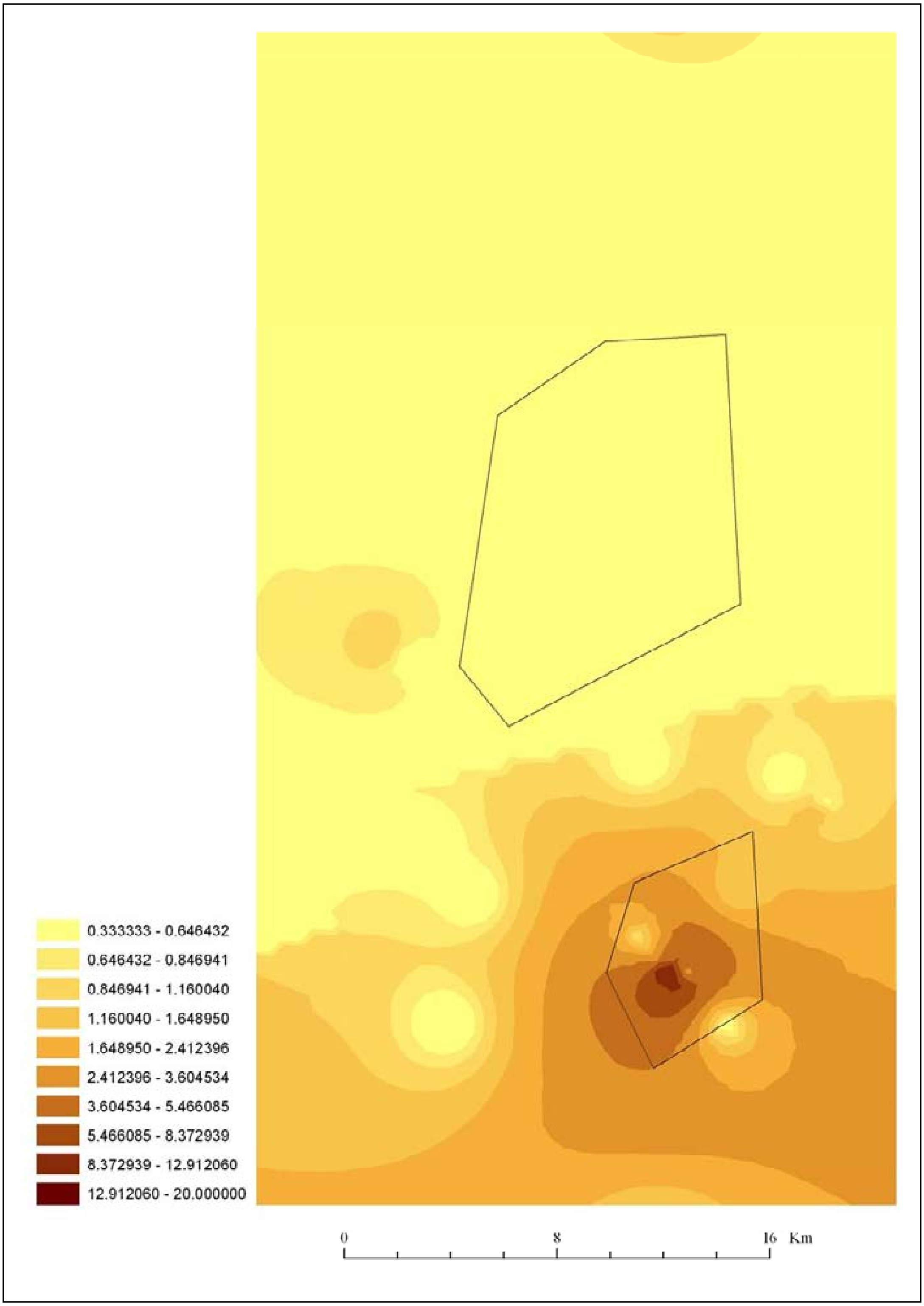

Figure 4.24.1-3 Smoothed average distribution of Great Black-backed Gull, second winter boat surveys. Polygons show boundaries of proposed wind farm.

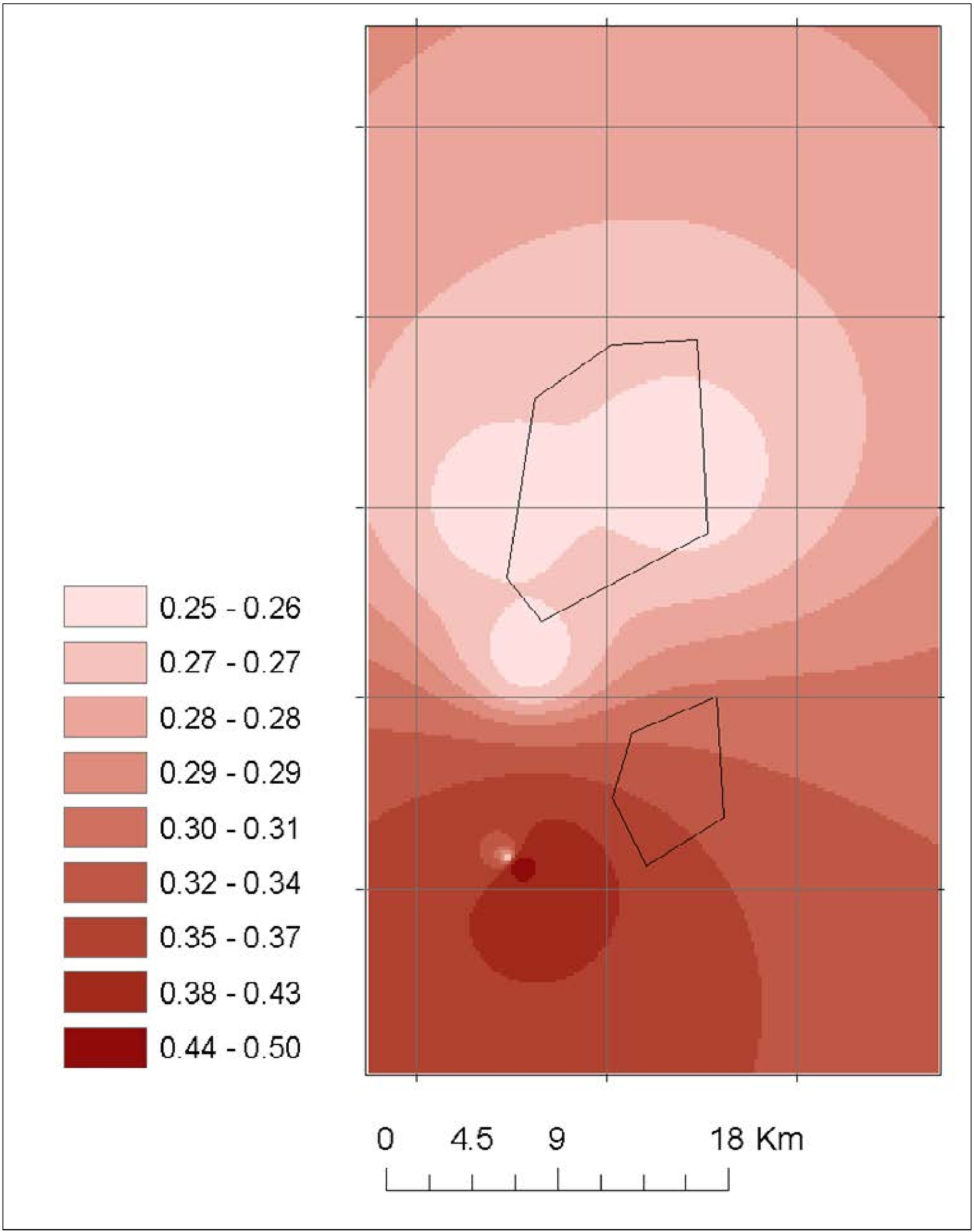

Figure 4.24.1-4 Smoothed average distribution of Great Black-backed Gull, second summer boat surveys. Polygons show boundaries of proposed wind farm.

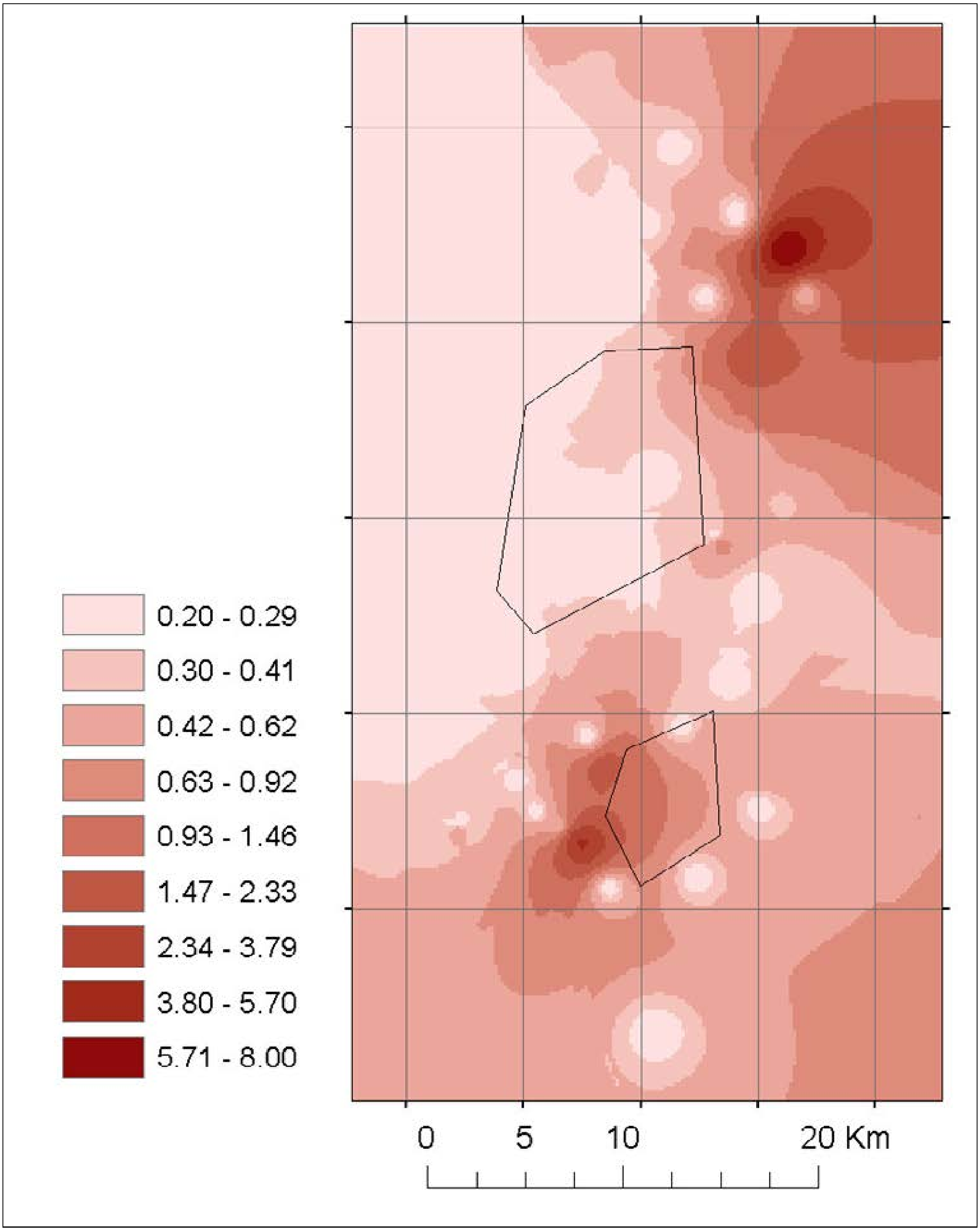

Figure 4.24.1-5 Smoothed average distribution of Great Black-backed Gull, third winter boat surveys. Polygons show boundaries of proposed wind farm.

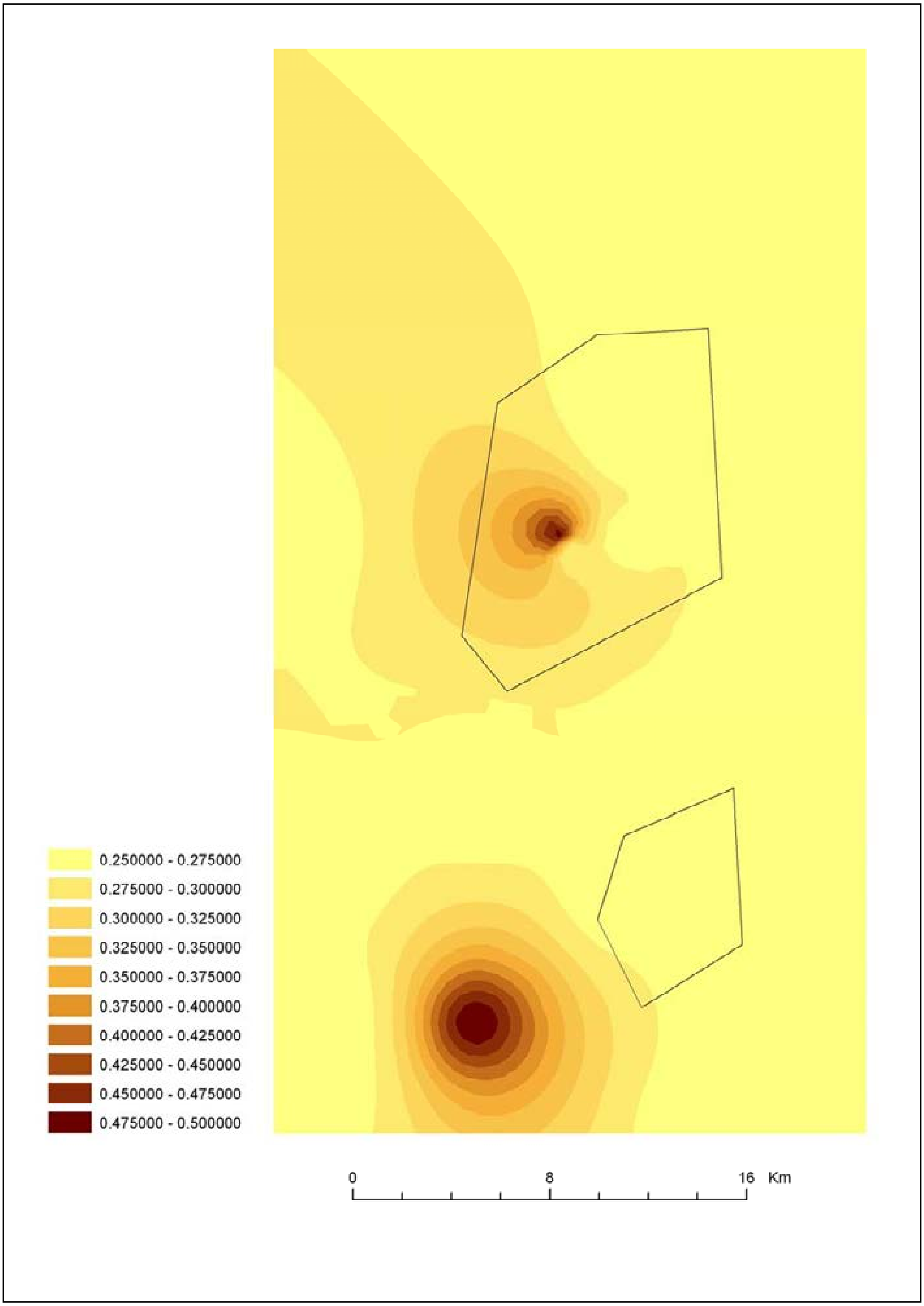

Figure 4.24.2-1 Smoothed average distribution of Great Black-backed Gull, first aerial surveys. Polygons show boundaries of proposed wind farm.

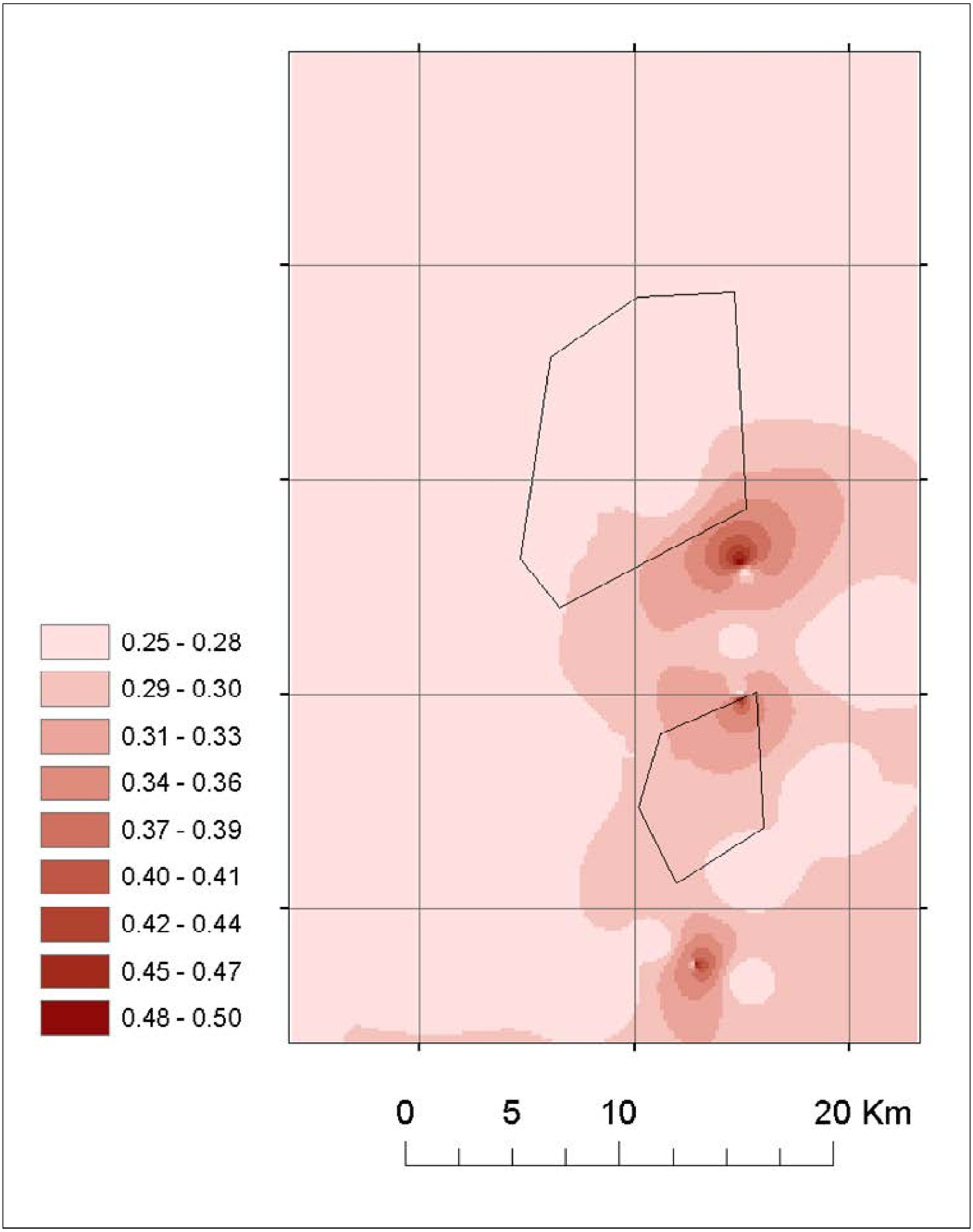

Figure 4.24.2-2 Smoothed average distribution of Great Black-backed Gull, second aerial surveys. Polygons show boundaries of proposed wind farm.

4.25 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*	366,832
Wind farm peak est. 04/05	171	Wind farm peak est. 2004	39 birds
Wind farm peak est. 05/06	**317**	Wind farm peak est. 2005	225 birds
Gabbard peak 04/05	1,218 (*aerial*)	*Gabbard peak 2004*	205 birds (*boat*)
Gabbard peak 05/06	**1,586 (*boat*)**	*Gabbard peak 2005*	1,126 (*boat*)
% National population 04/05	0.17%	*% National population 2004*	0.03%
% National population 05/06	**0.22%**	*% National population 2005*	0.15%

4.25.1 Boat surveys

Distance sampling was applied to those birds recorded as 'in transect' and on the sea at time of sighting (Table 4.25.1-1). 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 4.25.1-2). 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 January 2006, and totalled 1,587 birds. Although few birds were generally recorded during the summer, when birds would have been breeding, the estimate of 1,126 in June 2005 is uncharacteristically high when compared to other counts in summer months.

Distributions of Black-legged Kittiwakes, averaged over each winter and summer, are shown in Figures 4.25.1-1 to 4.25.1-5. 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 during the first two years and for the species to be more widely distributed in the latter summer and winter, with high densities sometimes overlapping or nearing the area of The Galloper.

Table 4.25.1-1 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	DS	D	N	LCL	UCL
February 2004	0.0902	0.1105	45	18	111
March (1) 2004	0.0124	0.0122	6	2	23
March (2) 2004	0.0124	0.0980	48	6	369
April 2004	0.1702	0.2697	197	65	599
May 2004	0.0262	0.0262	19	5	77
June 2004	0.0000	0.0000	0	0	0
July 2004	0.0393	0.0393	29	7	125
August 2004	0.0524	0.0524	38	16	93
September 2004	0.0786	0.0786	57	22	150
November 2004	0.1702	0.1702	124	65	239
December 2004	0.3964	1.0487	766	412	1,421

Continued…/

Table 4.25.1-1 Continued.

March 2005	0.3273	0.4399	321	152	679
May 2005	0.0154	0.0154	11	2	77
June 2005	0.2251	1.4778	1,079	258	4,515
July 2005	0.0000	0.0000	0	0	0
August 2005	0.0462	0.1174	86	15	481
September 2005	0.0231	0.0231	17	6	49
October 2005	0.0154	0.0154	11	2	77
December 2005	0.2616	0.2636	192	90	411
January 2006	0.1231	1.8985	1,386	221	8,698
February 2006	0.2616	0.2636	192	90	411
April 2006	0.1077	0.1077	79	28	220

Table 4.25.1-2 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.

MONTH	In flight count	Distance estimate	Total estimate	% National population
February 2004	110	45	155	0.02%
March (1) 2004	31	6	37	0.01%
March (2) 2004	26	48	74	0.01%
April 2004	8	197	205	0.03%
May 2004	9	19	28	0.00%
June 2004	3	0	3	0.00%
July 2004	14	29	43	0.01%
August 2004	4	38	42	0.01%
September 2004	4	57	61	0.01%
November 2004	29	124	153	0.02%
December 2004	27	766	793	0.11%
March 2005	7	321	328	0.04%
May 2005	22	11	33	0.00%
June 2005	47	1,079	1,126	0.15%
July 2005	5	0	5	0.00%
August 2005	29	86	115	0.02%
September 2005	15	17	32	0.00%
October 2005	4	11	15	0.00%
December 2005	144	192	336	0.05%
January 2006	200	1,386	1,586	0.22%
February 2006	138	192	330	0.04%
April 2006	15	79	94	0.01%

4.25.2 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.

Figures 4.25.2-1 and 4.25.2-2 show 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 during the first period of aerial surveys (Figure 4.24.2-1).

Table 4.25.2-1 Black-legged Kittiwake recorded on the first (top) and second (bottom) set of 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.

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National population
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	1,218	3	470,700	0.17%
	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	1,166	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	

Survey Block	Survey Period	DS	D	N	LCL	UCL	% National importance
TH1	WINTER 1	0.0569	0.15522	196	12	3,229	
	WINTER 2	0.0081	0.0081	10	2	52	
	WINTER 3	0.5364	3.8642	4,869	1,485	15,961	
	WINTER 4	0.11378	11.162	14,064	2,364	83,684	
TH2	WINTER 1	0.0975	0.0975	120	69	210	
	WINTER 2	0.4710	3.1285	3,851	2,371	6,255	
	WINTER 3	0.8364	0.7688	946	705	1,271	
	WINTER 4	0.1949	0.1082	133	46	387	
TH3	WINTER 1	0.4445	0.6303	668	451	989	0.09%
	WINTER 2	0.3149	0.3149	334	237	470	0.05%
	WINTER 3	0.9354	1.088	1,153	933	1,426	0.16%
	WINTER 4	0.1760	0.3380	358	205	625	0.05%
TH6	WINTER 1	0.4984	0.8027	1,032	745	1,431	
	WINTER 2	1.6960	2.5559	3,287	2,694	4,010	
	WINTER 3	2.8534	3.6350	4,675	4,031	5,421	
	WINTER 4	0.4099	1.5694	2,018	883	4,615	
TH7	WINTER 1	0.1141	0.1201	150	7	3,301	
	WINTER 2	0.4077	0.7856	981	707	1,361	
	WINTER 3	0.3180	0.1237	154	100	238	
	WINTER 4	0.1794	0.1794	224	147	341	

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

4.25.3.1 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). The estimate of 1,126 in June 2005 is thus surprising but may have reflected early movements of breeding birds. Despite high numbers, the Greater Gabbard area does not appear to be especially important for Black-legged Kittiwakes in the summer, as the national threshold of this species stands at 7,340 individuals.

Winter surveys suggest that this area of the North Sea also supports a comparatively high abundance of Black-legged Kittiwake, with peaks of 1,586 birds estimated from boat surveys, and 1,218 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 and TH6, perhaps reflecting its offshore location. Peak winter estimates for the Greater Gabbard study area reached 7.25% of the regional total, making the area regionally important for the species. Considering the wind farm footprint area alone, proportional estimates still represented 1.9% of the regional total estimated. Black-legged Kittiwakes clearly do occur in the Greater Gabbard in winter, but to what extent this area is crucial on a national basis is unclear.

4.25.3.2 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.

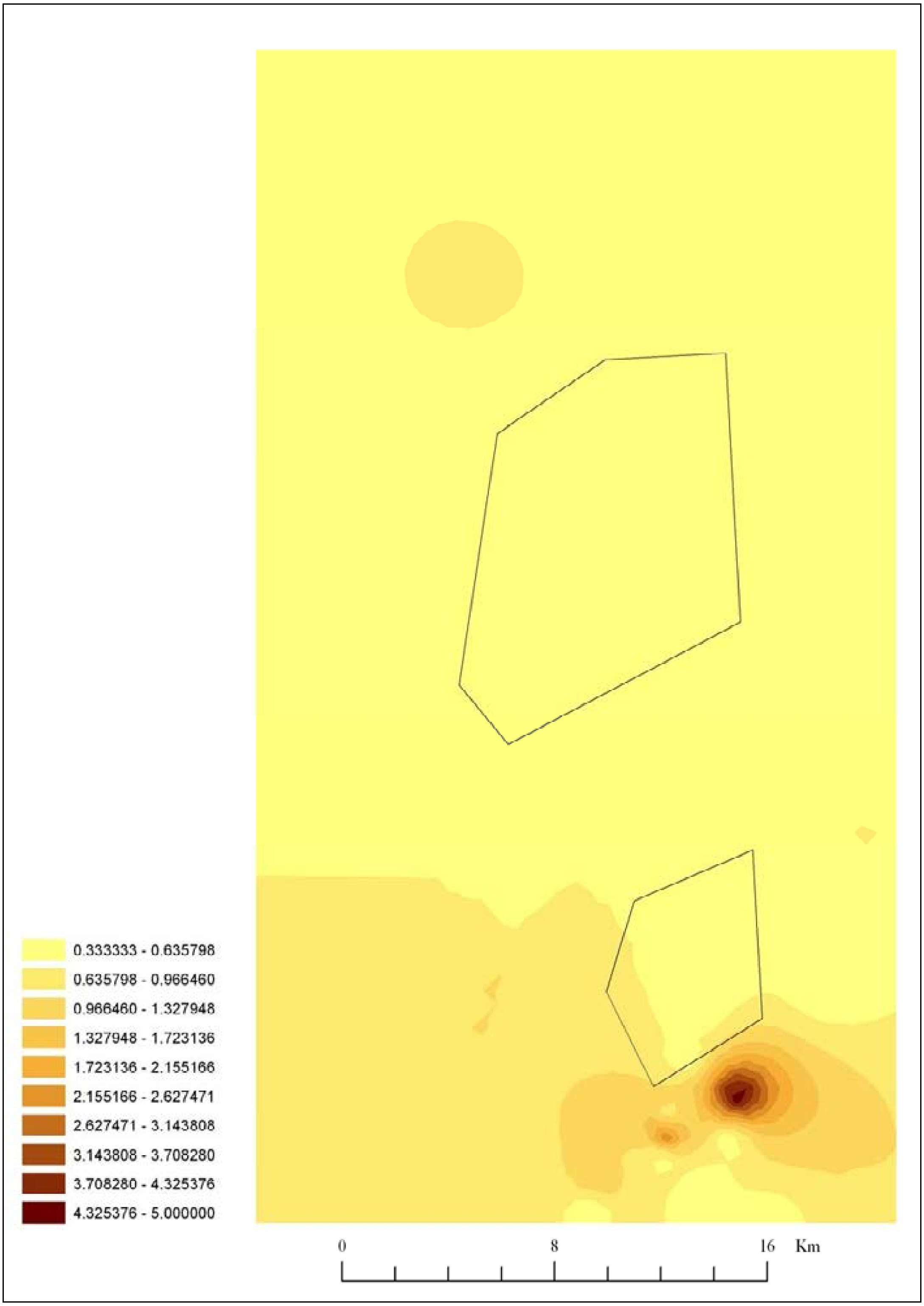

Figure 4.25.1.1 Smoothed average distribution of Black-legged Kittiwake, first winter boat surveys. Polygons show boundaries of proposed wind farm.

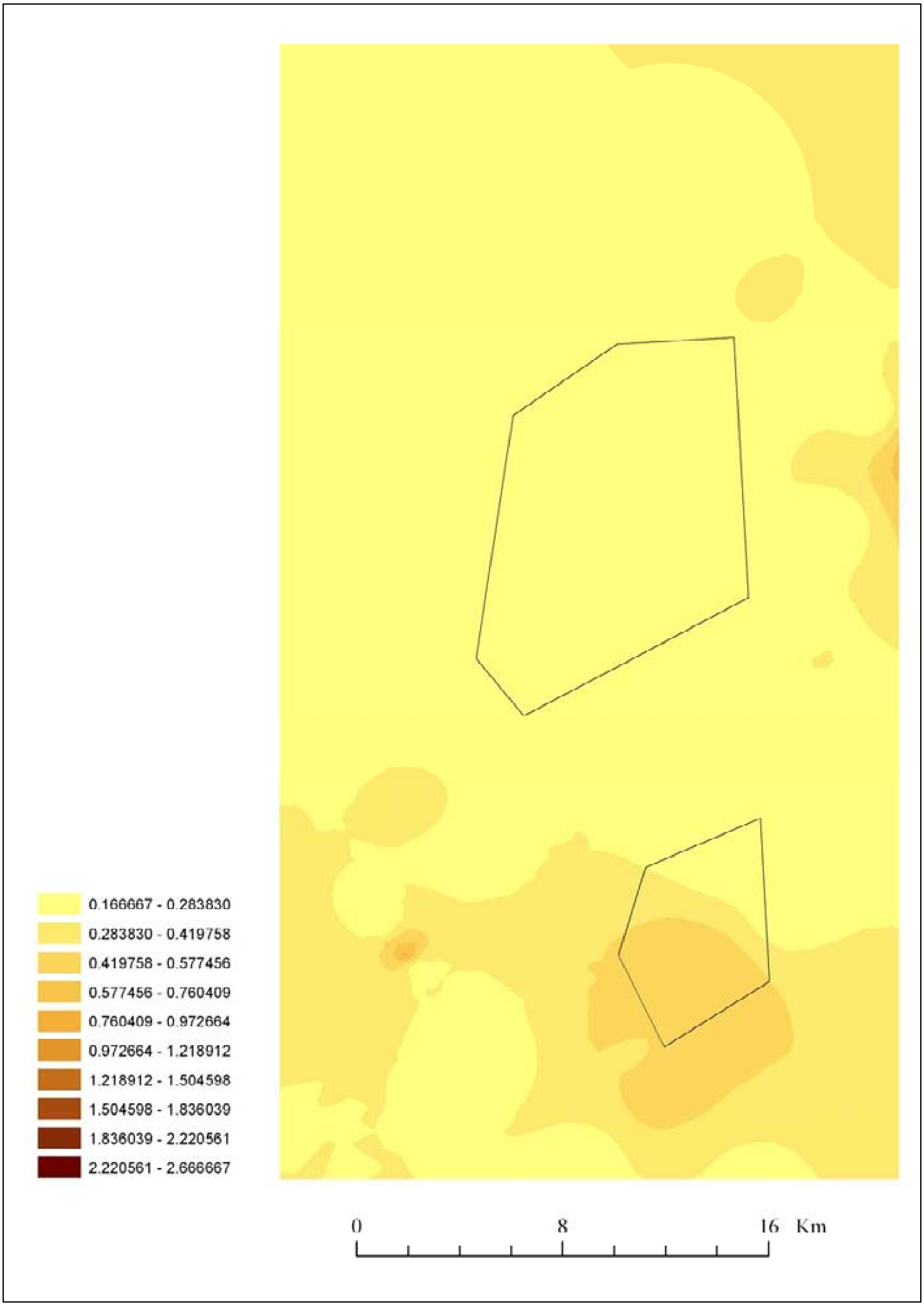

Figure 4.25.1-2 Smoothed average distribution of Black-legged Kittiwake, summer boat surveys. Polygons show boundaries of proposed wind farm.

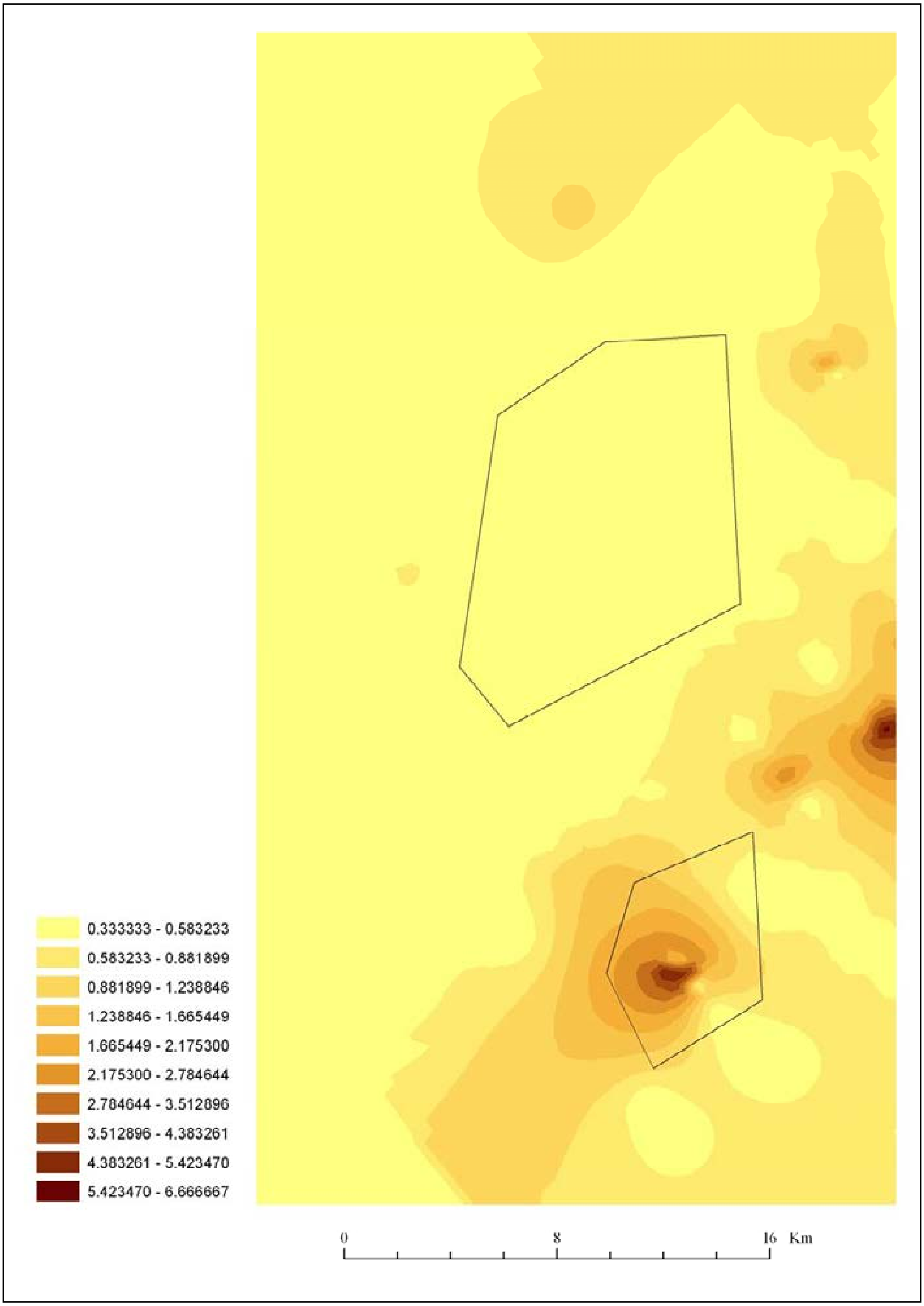

Figure 4.25.1-3 Smoothed average distribution of Black-legged Kittiwake, second winter boat surveys. Polygons show boundaries of proposed wind farm.

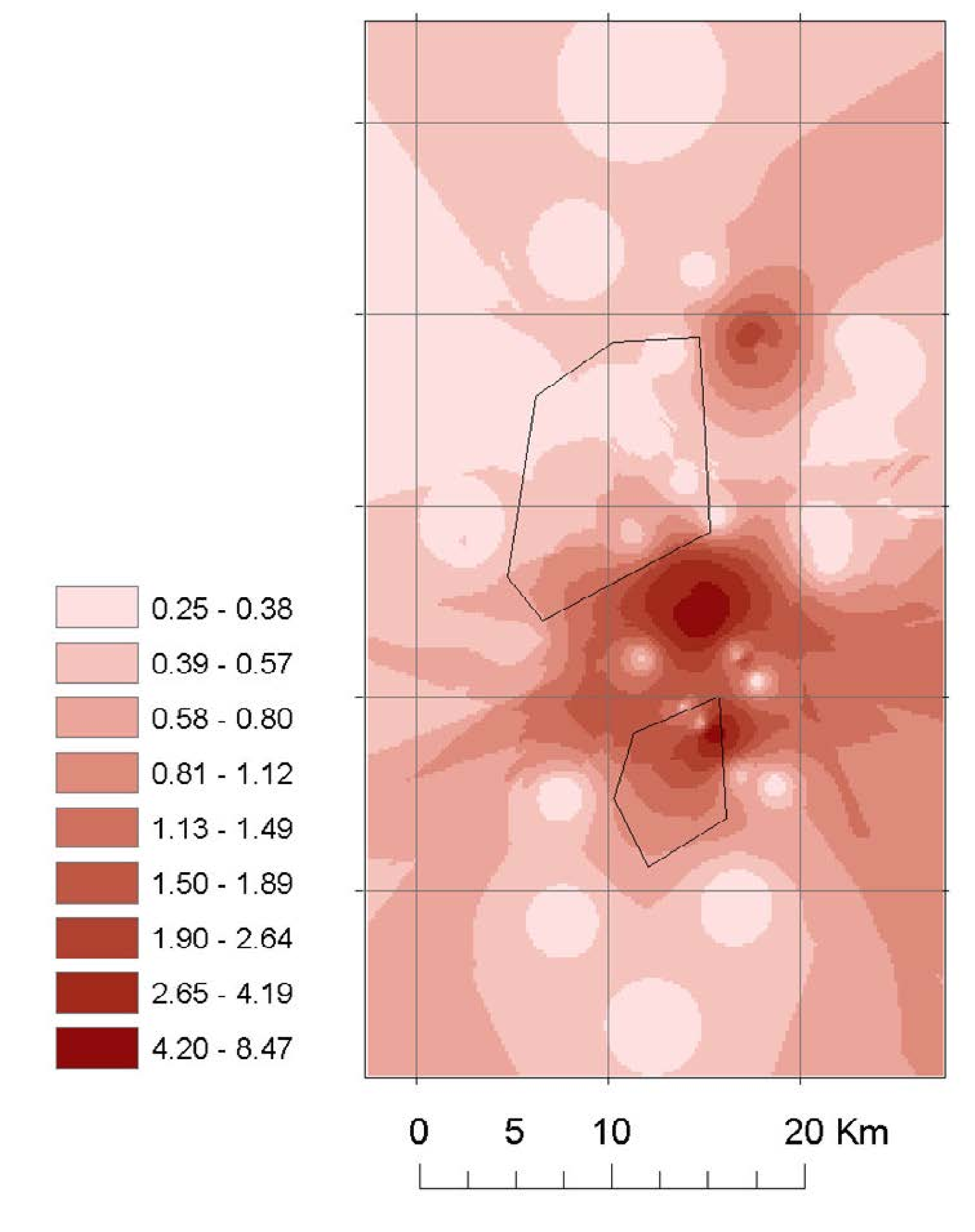

Figure 4.25.1-4 Smoothed average distribution of Black-legged Kittiwake, second summer boat surveys. Polygons show boundaries of proposed wind farm.

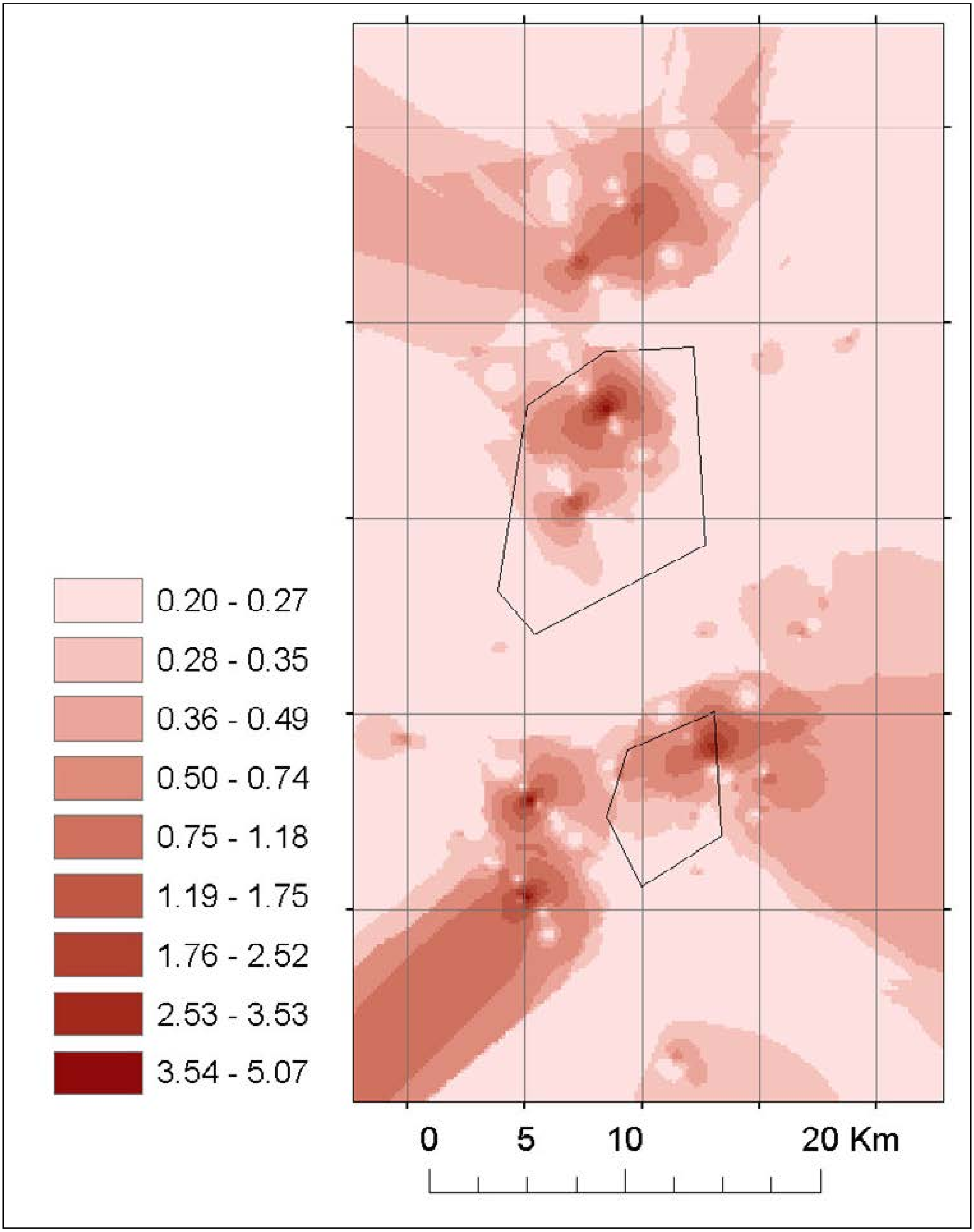

Figure 4.25.1-5 Smoothed average distribution of Black-legged Kittiwake, third winter boat surveys. Polygons show boundaries of proposed wind farm.

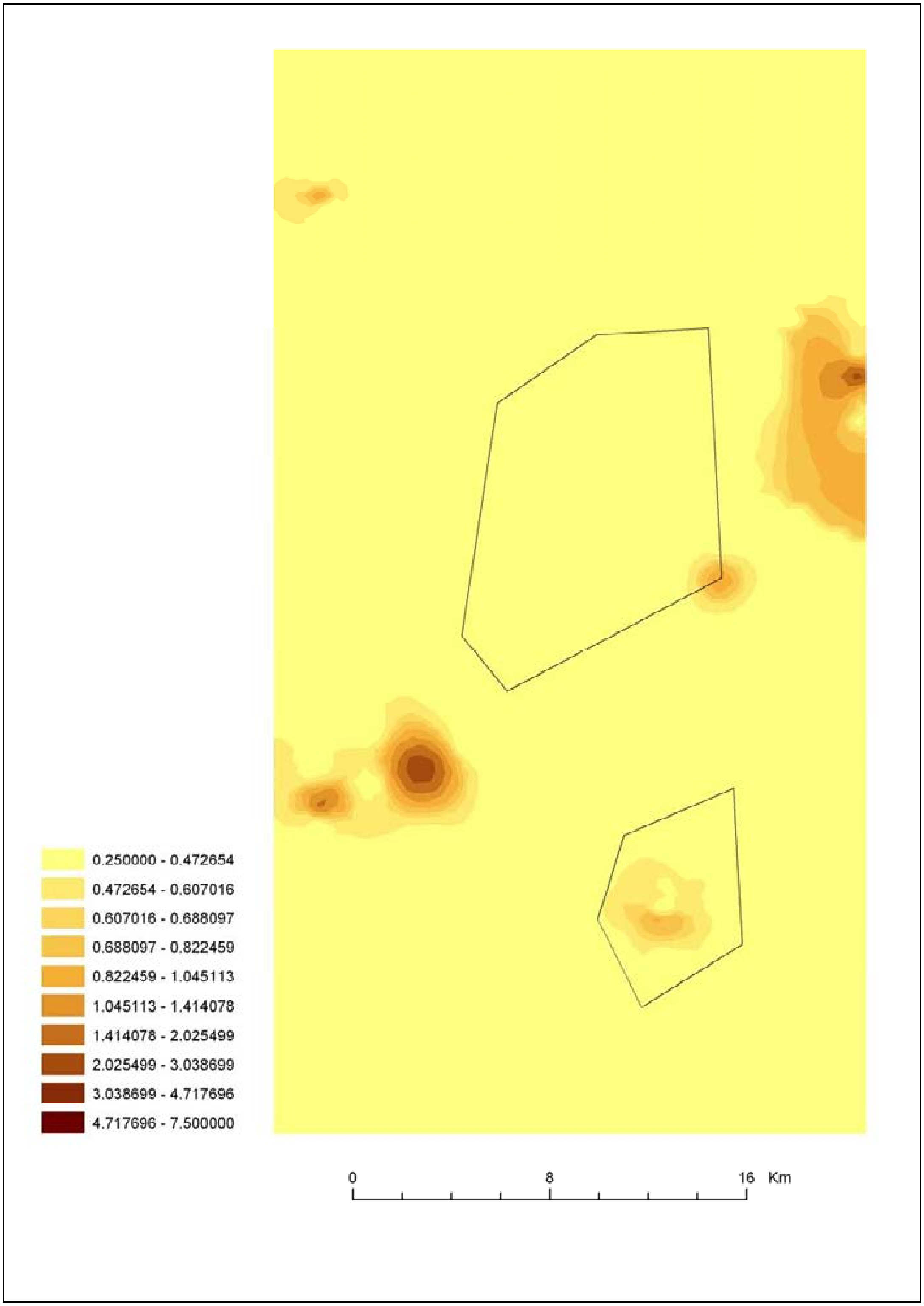

Figure 4.25.2-1 Smoothed average distribution of Black-legged Kittiwake, first set of aerial surveys. Polygons show boundaries of proposed wind farm.

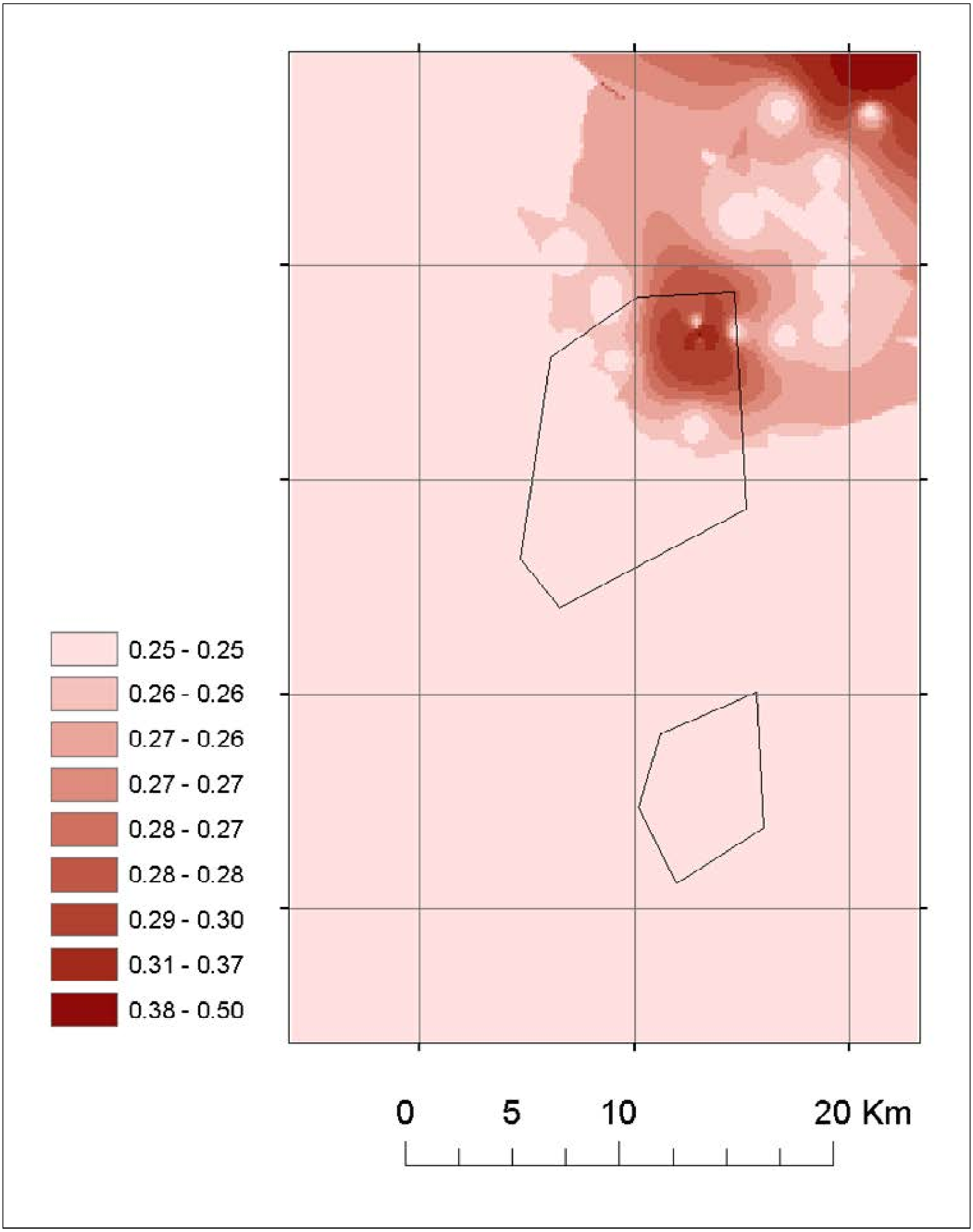

Figure 4.25.2-2 Smoothed average distribution of Black-legged Kittiwake, second set of aerial surveys. Polygons show boundaries of proposed wind farm.

4.26 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*	10,536
Wind farm peak est. 04/05	2	Wind farm peak est. 2004	**4**
Wind farm peak est. 05/06	2	Wind farm peak est. 2005	2
Gabbard peak 04/05	9 (*boat*)	*Gabbard peak 2004*	**19 birds (*boat*)**
Gabbard peak 05/06	9 (*boat*)	*Gabbard peak 2005*	9 birds (*boat*)
% National population 04/05	0.04%	*% National population 2004*	**0.09%**
% National population 05/06	0.04%	*% National population 2005*	0.04%

4.26.1 Boat surveys

Sandwich Terns were seen very infrequently on boat surveys, and thus there were insufficient data to run Distance analyses. Table 4.26.1-1 shows those Sandwich Terns 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.

Table 4.26.1-1 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.

Month	On sea	In flight	Total	% National population
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**	0.09%
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%
May 2005	0	3	**3**	0.01%
June 2005	0	9	**9**	0.04%
July 2005	0	1	**1**	0.00%
August 2005	0	0	**0**	0.00%
September 2005	0	4	**4**	0.02%
October 2005	0	0	**0**	0.00%
December 2005	0	0	**0**	0.00%
January 2006	0	0	**0**	0.00%
February 2006	0	0	**0**	0.00%
April 2006	9	0	**9**	0.04%

4.26.2 Aerial surveys

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

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

4.26.3.1 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.

4.26.3.2 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.

4.27 Common Tern	*Sterna hirundo*		
Conservation status:	Annex 1, WCA		
Winter		**Summer (pairs)**	
International threshold	1,900	***European population***	270,000-570,000
GB threshold	?	*GB population*	10,134
Wind farm peak est. 04/05	1	Wind farm peak est. 2004	1 bird
Wind farm peak est. 05/06	**4**	Wind farm peak est. 2005	2 birds
Gabbard peak 04/05	7 (*boat*)	*Gabbard peak 2004*	5 birds (*boat*)
Gabbard peak 05/06	**21 (*boat*)**	*Gabbard peak 2005*	9 birds (*boat*)
% National population 04/05	0.03%	*% National population 2004*	0.02%
% National population 05/06	**0.10%**	*% National population 2005*	0.04%

4.27.1 Boat surveys

Common Terns were seen very infrequently on boat surveys, and thus there were insufficient data to run Distance analyses. Table 4.27.1-1 shows those Common Terns 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 21 birds in September 2005. A correction factor of 1.4 (after Stone *et al*. 1995) was applied to the on sea count.

Table 4.27.1-1 Common 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.

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	0	0	**0**	0.00%
May 2004	0	0	**0**	0.00%
June 2004	0	0	**0**	0.00%
July 2004	0	0	**0**	0.00%
August 2004	0	7	**7**	0.03%
September 2004	0	5	**5**	0.02%
November 2004	0	0	**0**	0.00%
December 2004	0	0	**0**	0.00%
March 2005	0	0	**0**	0.00%
May 2005	0	0	**0**	0.00%
June 2005	0	0	**0**	0.00%
July 2005	0	0	**0**	0.00%
August 2005	0	9	**9**	0.04%
September 2005	0	21	**21**	0.10%
October 2005	0	3	**3**	0.01%
December 2005	0	0	**0**	0.00%
January 2006	0	0	**0**	0.00%
February 2006	0	0	**0**	0.00%
April 2006	0	0	**0**	0.00%

4.27.2 Aerial surveys

No individuals were recorded during either of the sets of aerial surveys

4.27.3 The importance of the Greater Gabbard for Common Terns

4.27.3.1 Winter and summer

Common Terns do not generally spend the winter in Great Britain, but do so in sub-Saharan Africa. This is reflected in the complete absence of any counts during winter months. The Greater Gabbard area has little importance for Common Terns in summer, with a peak of only 21 birds recorded in September 2005.

4.27.3.2 Migration

The peak count of 21 birds in September 2005 is likely to have represented birds passing through the area during passage. However there is no evidence to suggest that the Greater Gabbard area is important for this species during the passage period.

4.28 Little Tern	***Sterna albifrons***		
Conservation status:	Annex 1, WCA, SPA feature, BCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	n/a	**European population**	35,000-55,000
GB threshold	n/a	*GB population*	1,947
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak 04/05	0	*Gabbard peak 2004*	**2 bird (*boat*)**
Gabbard peak 05/06	0	*Gabbard peak 2005*	0
% National population 04/05	0.00%	*% National population 2004*	**0.04%**
% National population 05/06	0.00%	*% National population 2005*	0.00%

4.28.1 Boat surveys

Two individuals were recorded during the survey in April 2004

4.28.2 Aerial surveys

No individuals were recorded during any aerial surveys.

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

4.28.3.1 Winter and summer

Only two Little Terns were 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.

4.28.3.2 Migration

The two individuals recorded in April 2004 may have been migrating individuals. However there is no evidence to suggest that the Greater Gabbard area is important for this species during migration.

4.29 Common Guillemot	*Uria aalgae*		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	**European population**	2-2.7 million
GB threshold	?	*GB population*	1,322,354
Wind farm peak est. 04/05	321	Wind farm peak est. 2004	107
Wind farm peak est. 05/06	**357**	Wind farm peak est. 2005	84
Gabbard peak 04/05	1,607* (*boat*)	*Gabbard peak 2004*	533 birds (*boat*)
Gabbard peak 05/06	**1,786 (*boat*)**	*Gabbard peak 2005*	422 birds (*boat*)
% National population 04/05	0.06%	*% National population 2004*	0.02%
% National population 05/06	**0.07%**	*% National population 2005*	0.02%

*2,851 estimated on the first set of aerial surveys for all auk species

4.29.1 Boat surveys

Common Guillemots were recorded frequently on all boat surveys. However, some auks on surveys in February and March 2004 and from May 2005 onwards 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 4.29.1-1 shows Distance estimates for identified Common Guillemots; Table 4.29.1-2 shows Distance estimates for unidentified auks on surveys in February and March 2004 and from May 2005 onwards and Table 4.29.1-3 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 1,786 estimated in December 2005. 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 absence of birds in flight during August and September (Table 4.29.1-3). 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. As a surrogate, the estimated number of breeding birds was used to determine the national importance of the Greater Gabbard area during the winter months.

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 4.29.2-1 shows that Common Guillemot distributions were 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 (Figures 4.29.1-2), 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 (Figures 4.29.1-3 and 4.29.1-5), whilst in the second and third winters Common Guillemots were again thinly and evenly distributed with occasional small peak concentrations (Figure 4.29.1-4 and 4.29.1-6).

Table 4.29.1-1 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 2004	0.0959	0.1311	53	0.0959	0.1311
March (1) 2004	0.0745	0.1699	83	0.0745	0.1699
March (2) 2004	0.1540	0.2301	112	0.1540	0.2301
April 2004	0.3116	0.3901	285	120	676
May 2004	0.0708	0.0708	52	20	135
June 2004	0.0425	0.0425	31	10	92
July 2004	0.3116	0.7303	533	151	1,877
August 2004	0.2550	0.3067	224	105	478
September 2004	0.0708	0.0708	52	25	106
November 2004	1.8272	2.1800	1,591	980	2,585
December 2004	0.7070	0.7661	559	315	994
March 2005	0.5241	0.9435	689	316	1,499
May 2005	0.0308	0.0462	34	7	153
June 2005	0.0173	0.0173	13	2	90
July 2005	0.0000	0.0000	0	0	0
August 2005	0.3847	0.5786	422	117	1,529
September 2005	0.0000	0.0000	0	0	0
October 2005	0.1539	0.1539	112	48	263
December 2005	1.9235	2.3383	1,740	1,189	2,546
January 2006	1.0925	1.7797	1,299	821	2,055
February 2006	0.8002	0.8580	626	474	828
April 2006	0.5078	0.5940	434	284	662

Table 4.29.1-2 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	DS	D	N	LCL	UCL
February 2004	0.2305	0.4216	171	108	269
March (1) 2004	0.0952	0.2260	110	56	218
March (2) 2004	0.1950	0.3360	164	74	362
May 2005	0.0311	0.0467	34	7	155
June 2005	0.0175	0.0175	13	2	91
July 2005	0.000	0.0000	0	0	0
August 2005	0.3890	0.5854	427	118	1,547
September 2005	0.0000	0.0000	0	0	0
October 2005	0.1556	0.1556	114	49	266
December 2005	2.2713	3.2266	2,355	1,745	3,180
January 2006	1.3068	2.0941	1,529	913	2,558
February 2006	1.0423	1.1525	841	710	998
April 2006	0.6067	0.7081	517	308	867

Table 4.29.1-3 '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.

MONTH	IN FLIGHT COUNT	Distance estimate	Total estimate	% National population
February 2004	15+5	53+55	128	0.00%
March (1) 2004	87+124	83+101	395	0.01%
March (2) 2004	3+24	112+131	270	0.01%
April 2004	3	285	287	0.01%
May 2004	1	52	53	0.00%
June 2004	0	31	31	0.00%
July 2004	0	533	533	0.02%
August 2004	0	224	224	0.01%
September 2004	0	52	52	0.00%
November 2004	16	1,591	1,607	0.06%
December 2004	14	559	573	0.02%
March 2005	5	689	694	0.03%
May 2005	0	34	34	0.00%
June 2005	0	13	13	0.00%
July 2005	0	0	0	0.00%
August 2005	0	422	422	0.02%
September 2005	0	0	0	0.00%
October 2005	1+1	112	114	0.00%
December 2005	24+5	1,740+17	1,786	0.07%
January 2006	42+6	1,299+48	1,395	0.05%
February 2006	0+1	626+43	670	0.03%
April 2006	1+1	434+19	455	0.02%

4.29.2 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 4.29.2-1 shows Distance estimates for all auks surveyed. The peak estimate for TH3 (Greater Gabbard area) occurred in the second winter period of the first set of surveys (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.

Figures 4.29.2-1 and 4.29.2-2 suggest 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.

Table 4.29.2-1 Auks recorded on the first (top) and second (bottom) sets of 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.

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

Survey block	Survey period	DS	D	N	LCL	UCL
TH1	WINTER 1	0.0000	0.0000	0	0	0
	WINTER 2	0.2497	0.2948	371	277	499
	WINTER 3	0.2728	0.4027	507	379	680
	WINTER 4	0.0185	0.0185	23	9	59
TH2	WINTER 1	0.1941	0.2829	348	241	504
	WINTER 2	0.2818	0.3336	411	314	537
	WINTER 3	0.3280	0.7273	895	663	1,209
	WINTER 4	0.0832	0.0899	111	68	180
TH3	WINTER 1	0.2740	0.3406	361	264	493
	WINTER 2	0.8641	1.1855	1,257	1,059	1,491
	WINTER 3	0.5111	0.6788	720	579	894
	WINTER 4	0.3425	0.4287	454	349	591
TH6	WINTER 1	0.1692	0.2559	329	222	489
	WINTER 2	2.7712	3.7174	4,781	4,351	5,252
	WINTER 3	1.8978	3.9094	5,027	4,447	5,684
	WINTER 4	0.3933	0.6233	802	622	1033
TH7	WINTER 1	0.2830	0.3396	424	324	555
	WINTER 2	1.2014	1.6276	2,033	1,769	2,337
	WINTER 3	1.2339	2.2052	2,563	2,216	2,964
	WINTER 4	0.36665	0.4856	607	472	779

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

4.29.3.1 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 2004, is paltry in comparison to the number of Common Guillemots thought to be in Britain during the summer (more than 1.3 million birds; Baker *et al.* 2005). 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. 1,786 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%).

4.29.3.2 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.

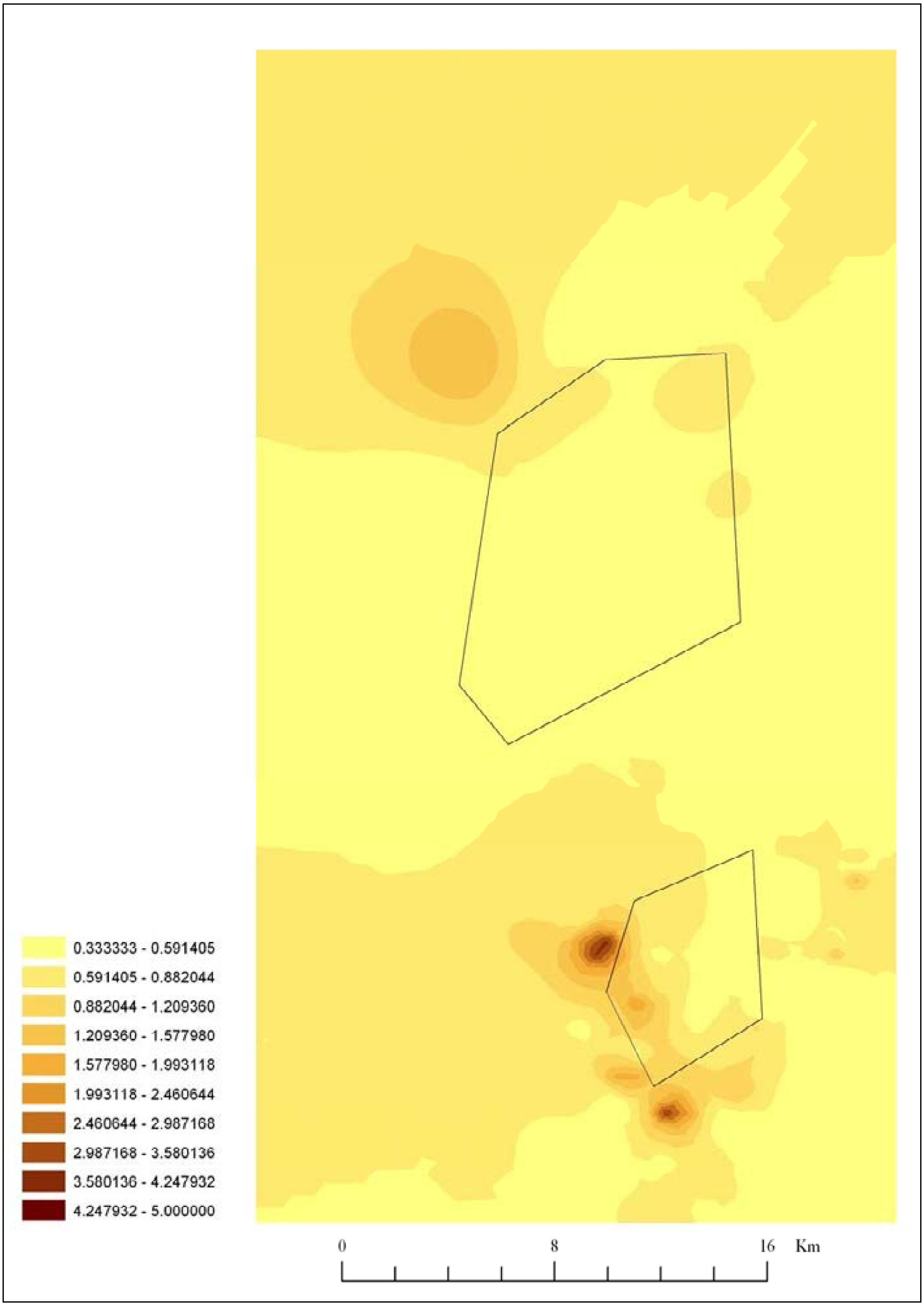

Figure 4.29.1-1 Smoothed average distribution of Common Guillemot, first winter boat surveys. Polygons show boundaries of proposed wind farm.

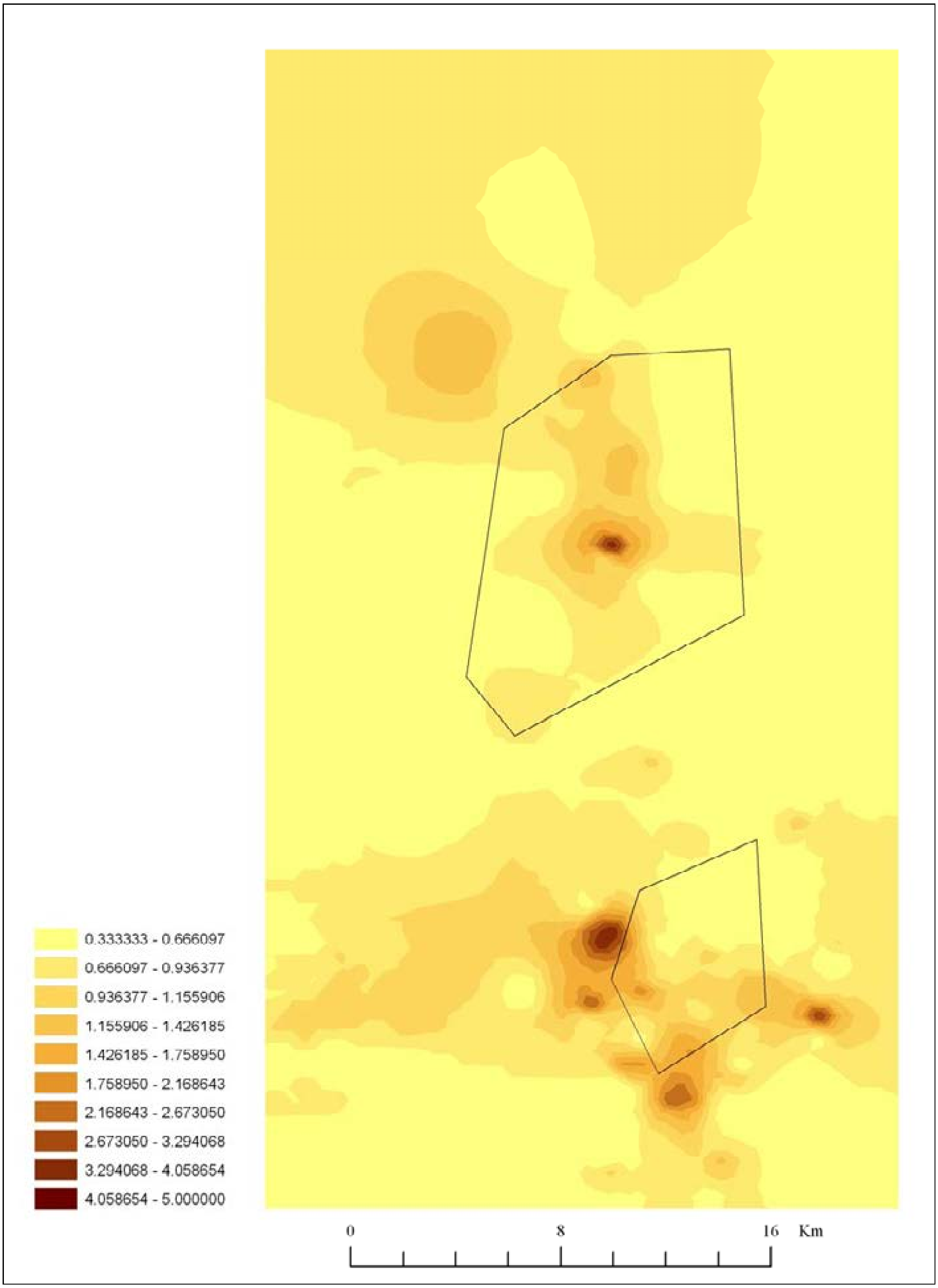

Figure 4.29.1-2 Smoothed average distribution of all auk species, first winter boat surveys. Polygons show boundaries of proposed wind farm.

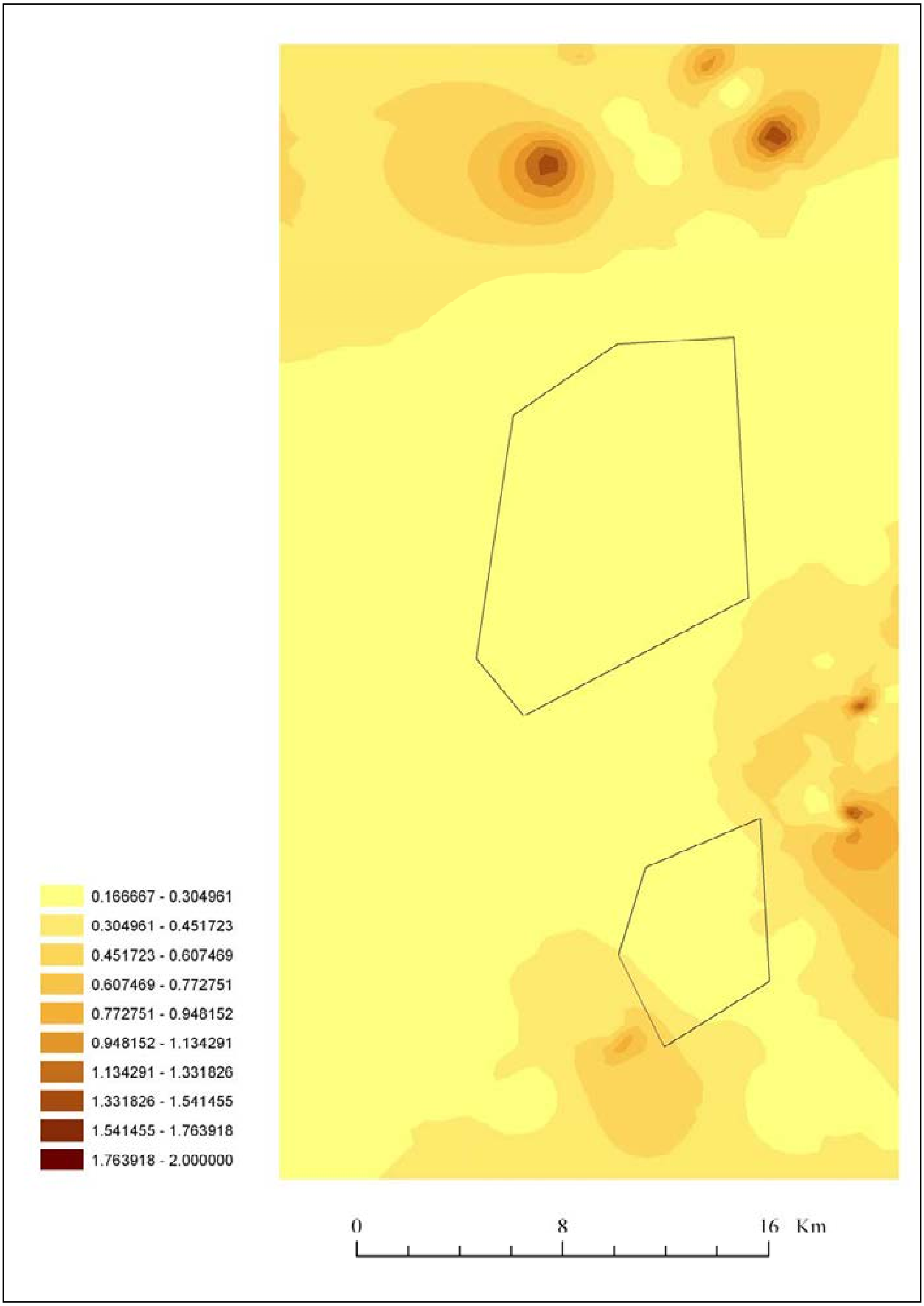

Figure 4.29.1-3 Smoothed average distribution of Common Guillemot, first summer boat surveys. Polygons show boundaries of proposed wind farm.

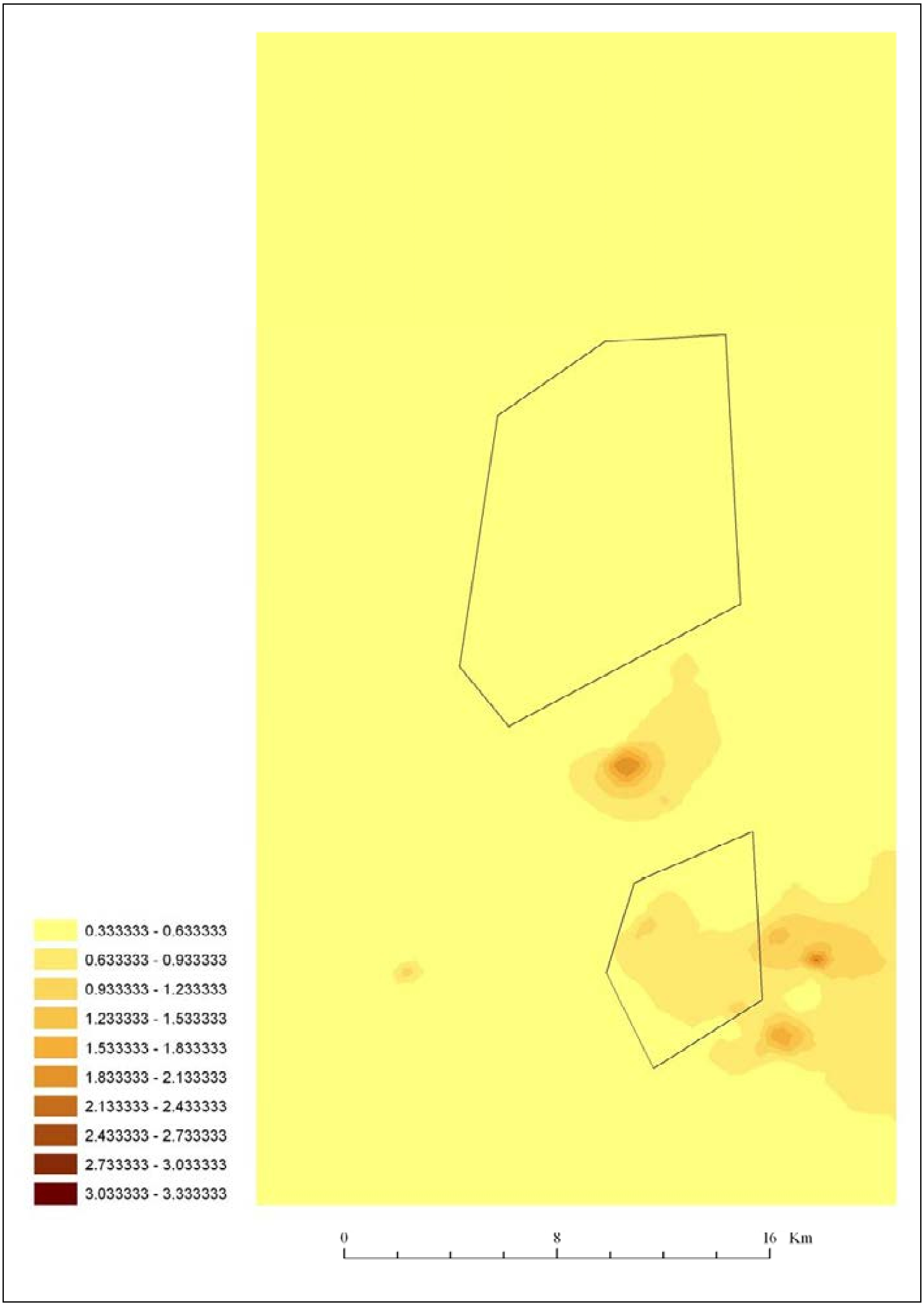

Figure 4.29.1-4 Smoothed average distribution of Common Guillemot, second winter boat surveys. Polygons show boundaries of proposed wind farm.

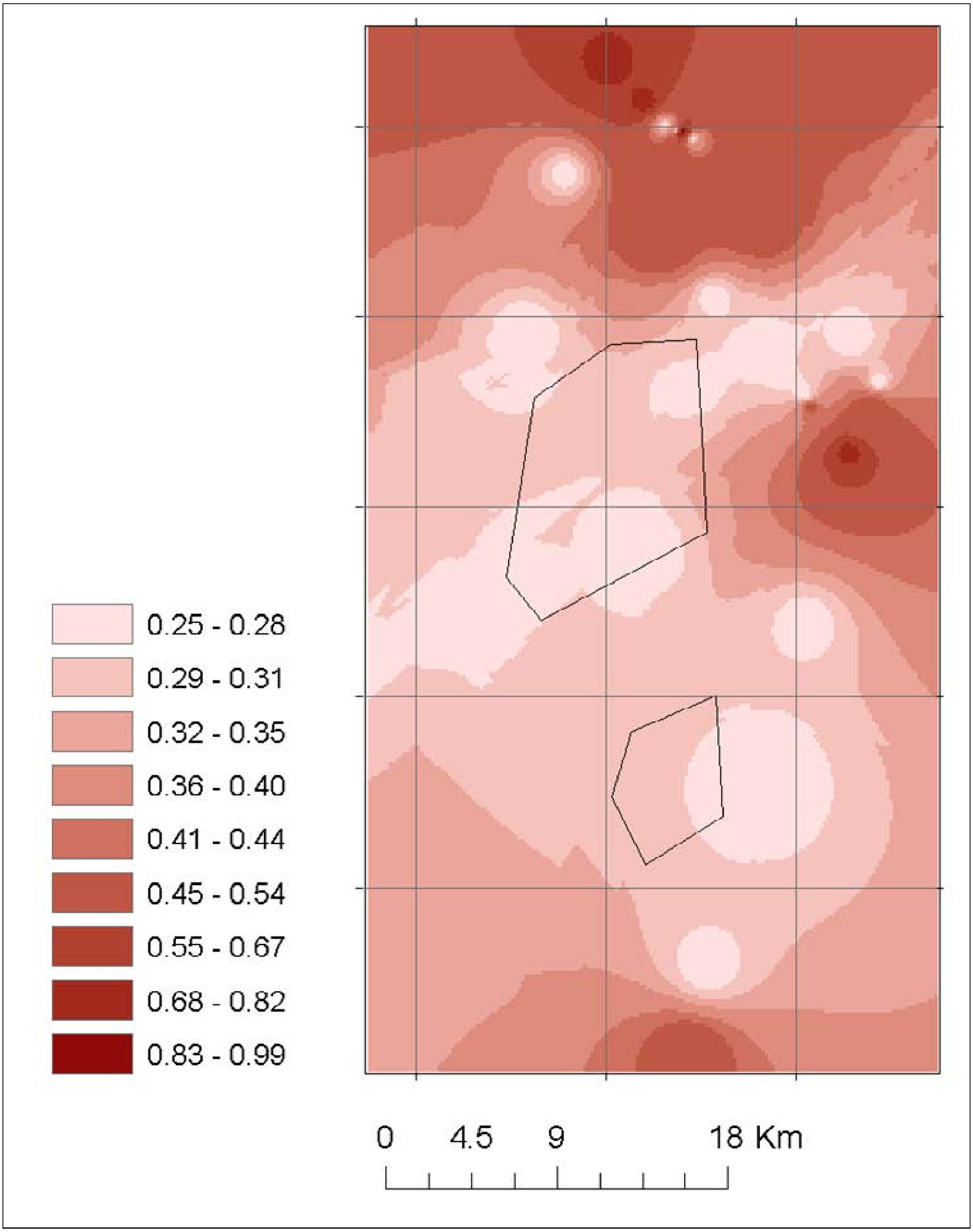

Figure 4.29.1-5 Smoothed average distribution of Common Guillemot, second summer boat surveys. Polygons show boundaries of proposed wind farm.

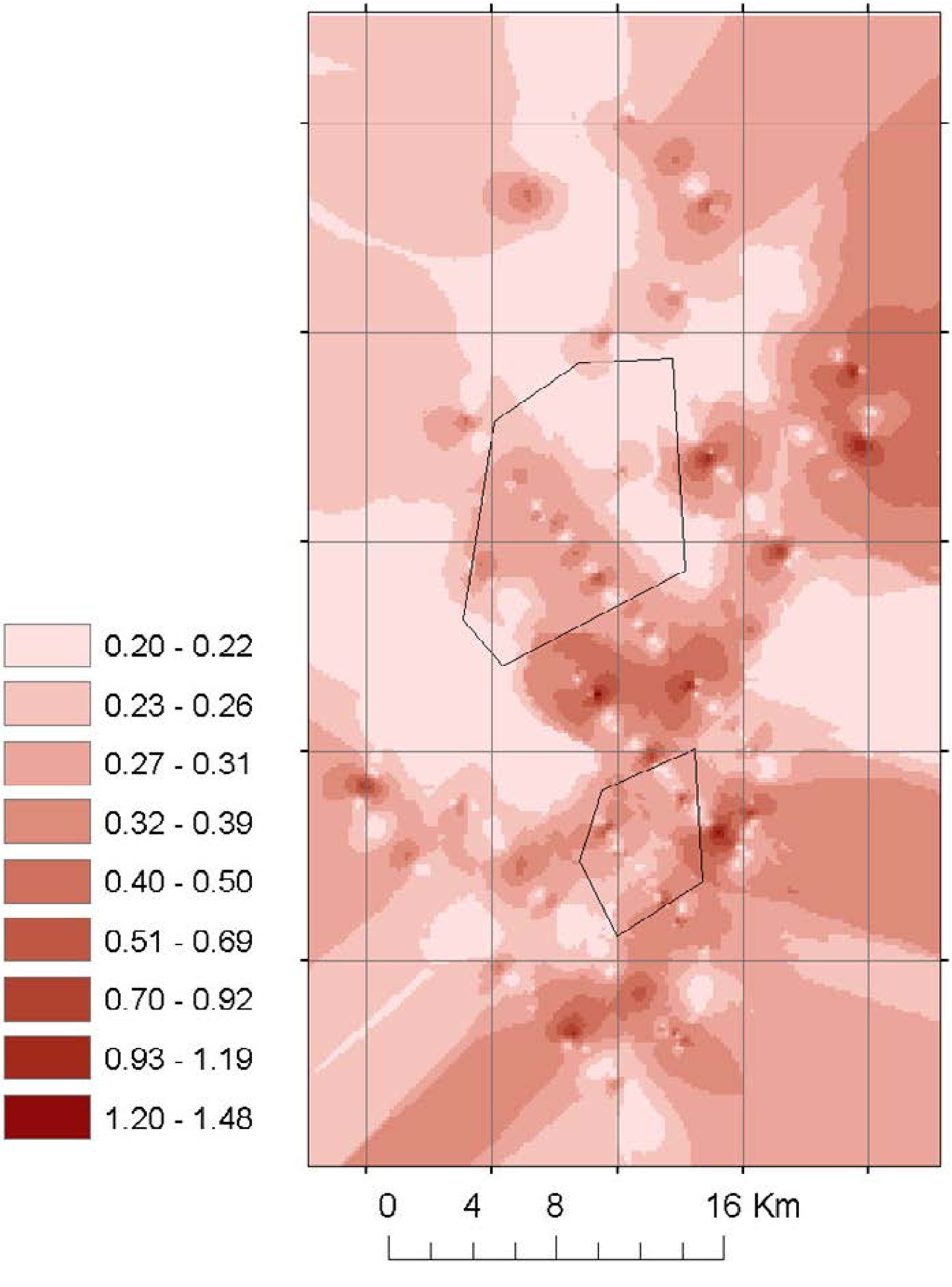

Figure 4.29.1-6 Smoothed average distribution of Common Guillemot, third winter boat surveys. Polygons show boundaries of proposed wind farm.

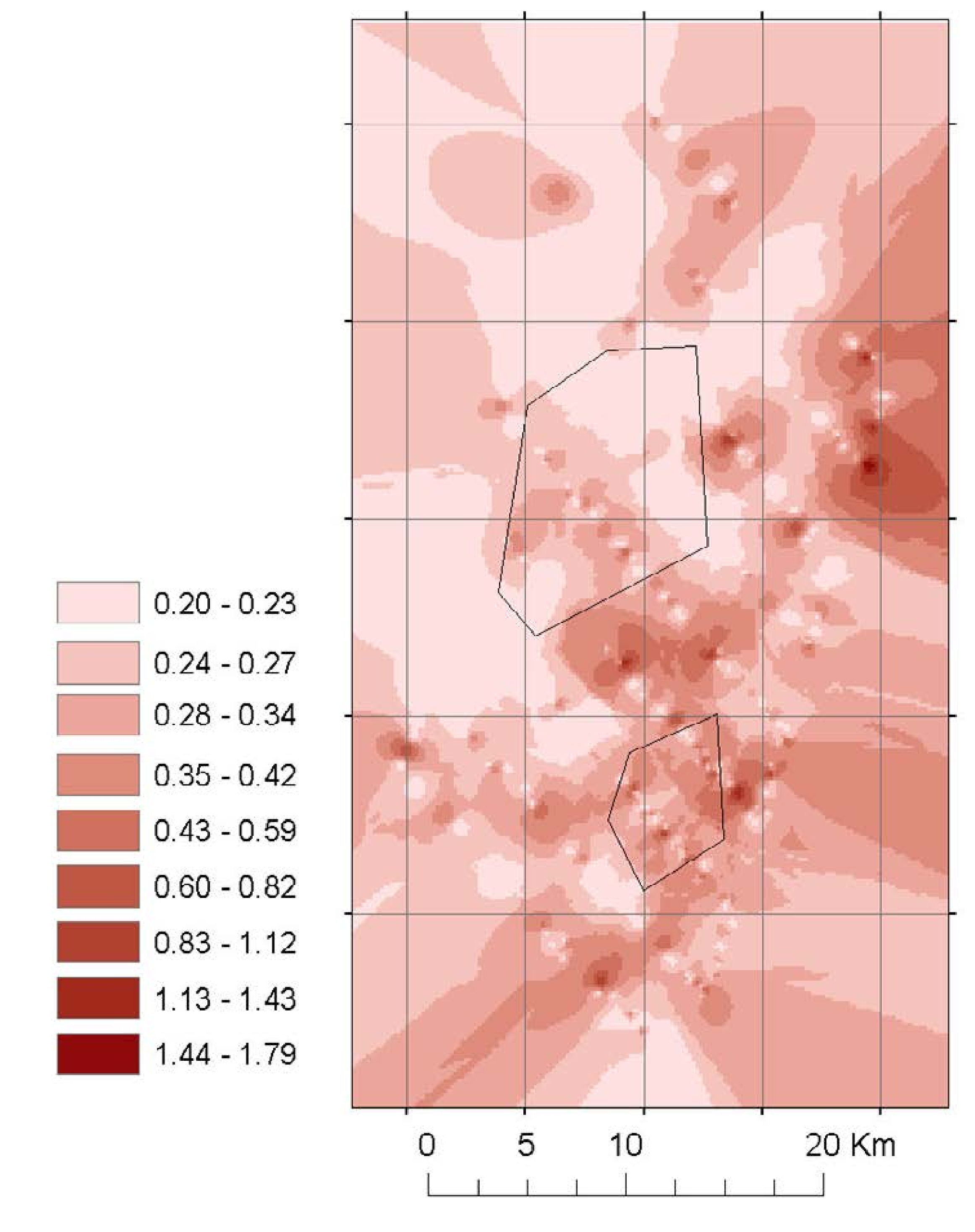

Figure 4.29.1-7 Smoothed average distribution of all auk species, third winter boat surveys. Polygons show boundaries of proposed wind farm.

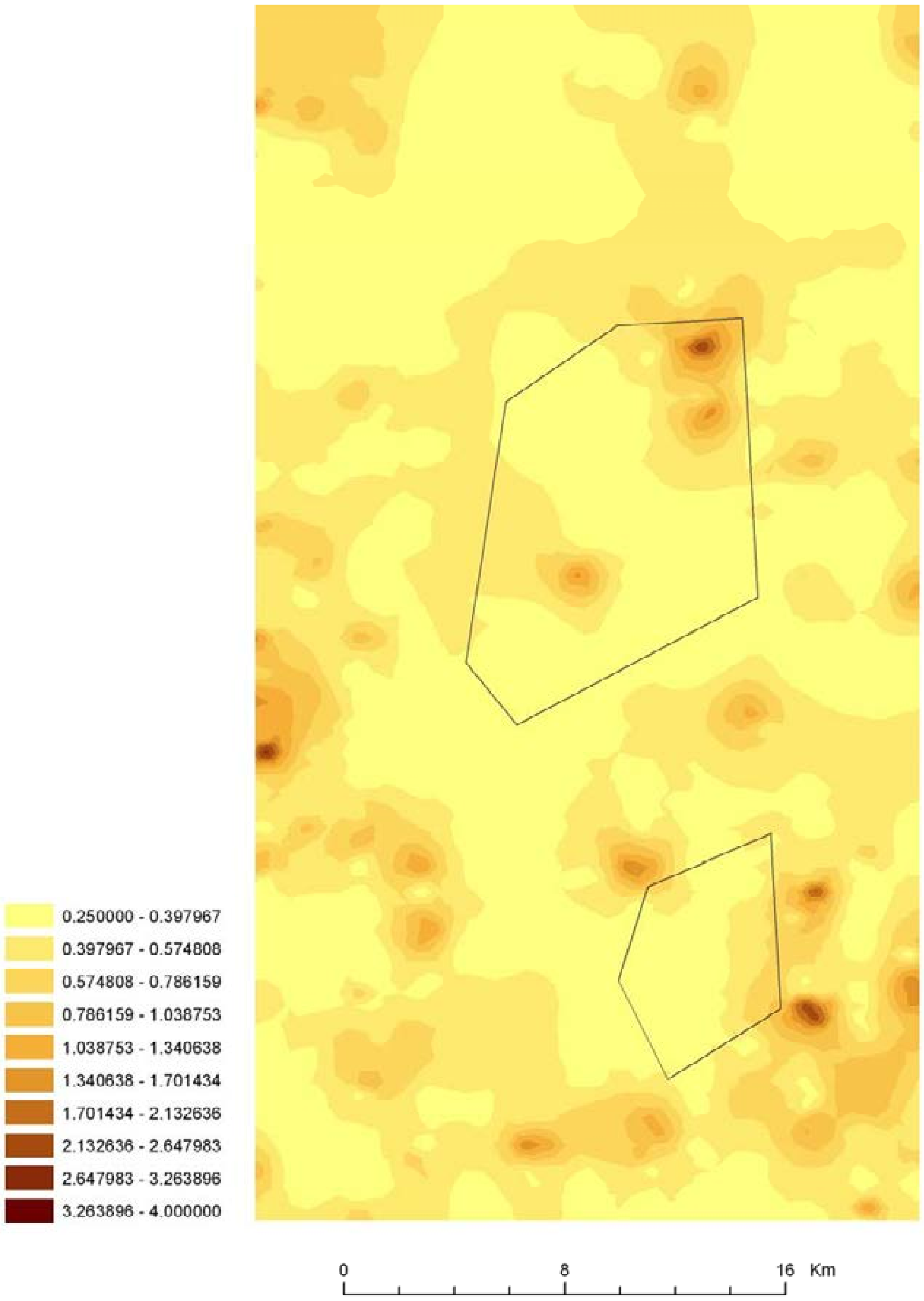

Figure 4.29.2-1 Smoothed average distribution of auk species, first set of aerial surveys. Polygons show boundaries of proposed wind farm.

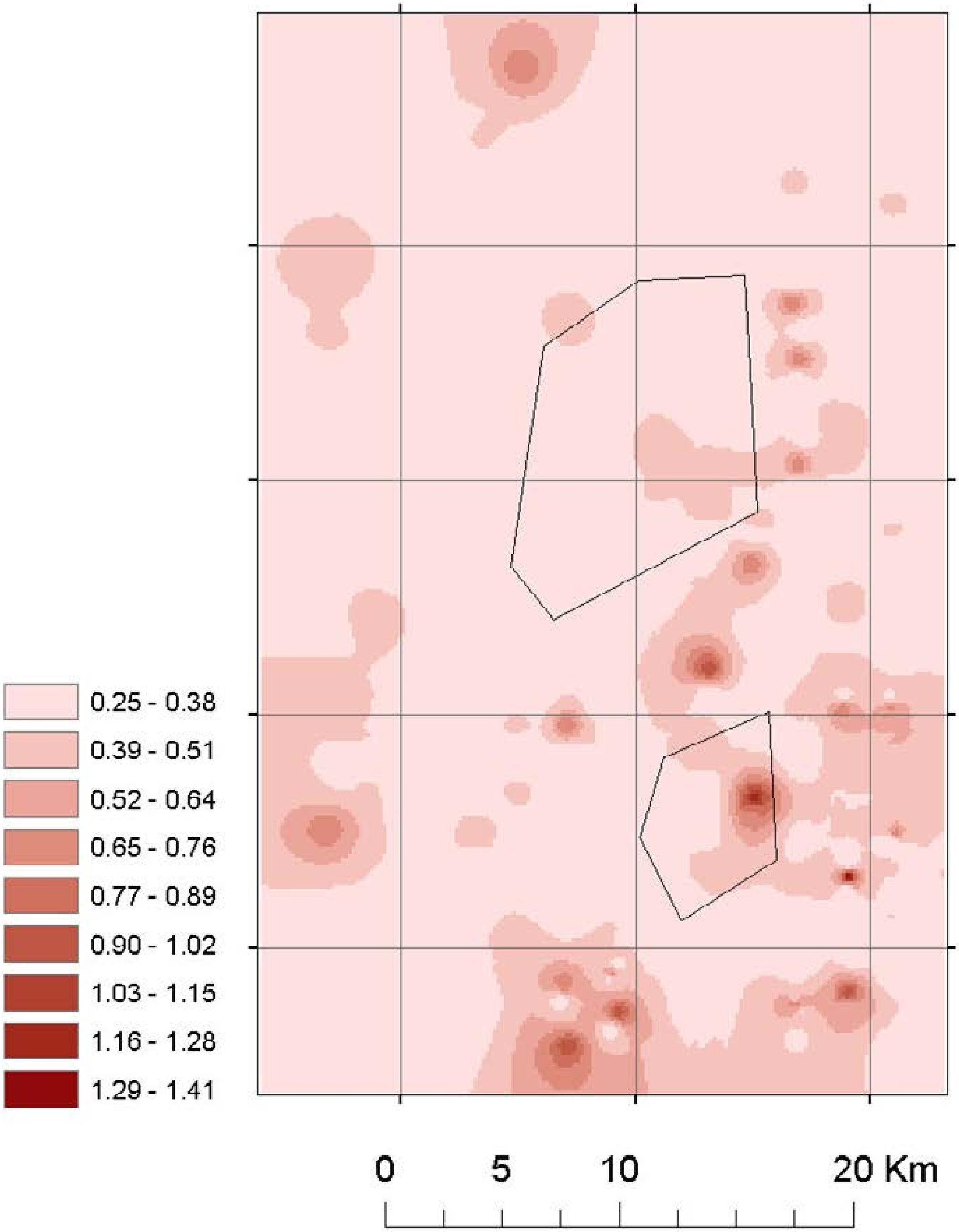

Figure 4.29.2-2 Smoothed average distribution of auk species, second set of aerial surveys. Polygons show boundaries of proposed wind farm.

4.30 Razorbill	***Alca torda***		
Conservation status:	BoCC Amber		
Winter (individuals)		**Summer (pairs)**	
International threshold	?	**European population**	430-770,000
GB threshold	?	*GB population*	164,492
Wind farm peak est. 04/05	**282**	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	113	Wind farm peak est. 2005	0
Gabbard peak 04/05	**1,411* (*boat*)**	*Gabbard peak 2004*	0
Gabbard peak 05/06	565* (*boat*)	*Gabbard peak 2005*	1 bird (*boat*)
% National population 04/05	**0.43%**	*% National population 2004*	0.00%
% National population 05/06	0.17%	*% National population 2005*	0.00%

*2,851 estimated on the first set of aerial surveys for all auk species
*1,257 estimated on the second set of aerial surveys for all auk species

4.30.1 Boat surveys

Razorbills were recorded frequently on all boat surveys. However, during the course of the surveys (February - March 2004 and May 2005 onwards), 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 4.30.1-1 shows Distance estimates for identified Razorbills; Table 4.30.1-2 shows Distance estimates for unidentified auks on surveys in February and March 2004; and Table 4.30.1-2 presents total estimates based on Distance estimates, in flight counts and calculated proportions of unidentified auks likely to have been Razorbills.

Razorbills were almost entirely 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 2004 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. However, estimates for March 2004 were considerably lower than those in March 2005 (Table 4.30.1-2). Similarly counts in December 2005 were lower than those for the previous year. 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. As a surrogate, the estimated number of breeding birds was used to determine the national importance of the Greater Gabbard area during the winter months.

The winter distribution of Razorbills was reasonably similar in during all three winters (Figures 4.30.1-1 to 4.30.1-3). 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.

Table 4.30.1-1 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	DS	D	N	LCL	UCL
February 2004	0.1409	0.2996	121	56	265
March (1) 2004	0.0064	0.0192	9	2	57
March (2) 2004	0.0383	0.0872	42	15	123

Continued…/

Table 4.30.1-1 Continued.

MONTH	DS	D	N	LCL	UCL
April 2004	0.0000	0.0000	0	0	0
May 2004	0.0000	0.0000	0	0	0
June 2004	0.0000	0.0000	0	0	0
July 2004	0.0000	0.0000	0	0	0
August 2004	0.0000	0.0000	0	0	0
September 2004	0.0000	0.0000	0	0	0
November 2004	0.7838	1.9290	1,408	754	2,631
December 2004	0.7922	1.7387	1,269	713	2,259
March 2005	0.2613	0.4937	360	169	768
May 2005	0.0000	0.0000	0	0	0
June 2005	0.0000	0.0000	0	0	0
July 2005	0.0000	0.0000	0	0	0
August 2005	0.0000	0.0000	0	0	0
September 2005	0.0000	0.0000	0	0	0
October 2005	0.0000	0.0000	0	0	0
December 2005	0.3353	0.7689	561	265	1,187
January 2006	0.2012	0.2265	165	63	434
February 2006	0.1844	0.2530	185	97	353
April 2006	0.0671	0.0838	61	9	420

Table 4.30.1-2 '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.

MONTH	In flight count	Distance estimate	Total estimate	% National importance
February 2004	17+10	121+116	264	0.08%
March (1) 2004	0+11	9+9	29	0.01%
March (2) 2004	0+6	42+33	81	0.02%
April 2004	0	0	0	0.00%
May 2004	0	0	0	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	3	1,408	1,411	0.43%
December 2004	0	1,269	1,269	0.39%
March 2005	0	360	360	0.11%
May 2005	1	0	1	0.00%
June 2005	0	0	0	0.00%
July 2005	0	0	0	0.00%
August 2005	0	0	0	0.00%
September 2005	0	0	0	0.00%
October 2005	0	0	0	0.00%
December 2005	0	561+4	565	0.17%
January 2006	2	165+9	174	0.05%
February 2006	2	185+10	195	0.06%
April 2006	2	61+4	65	0.02%

4.30.2 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 4.29.2-1 shows Distance estimates for all auks surveyed, and Figures 4.29.2-1 and 4.29.2-2 illustrates the smoothed average distribution of auks recorded on aerial surveys.

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

4.30.3.1 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 2004 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.

4.30.3.2 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.

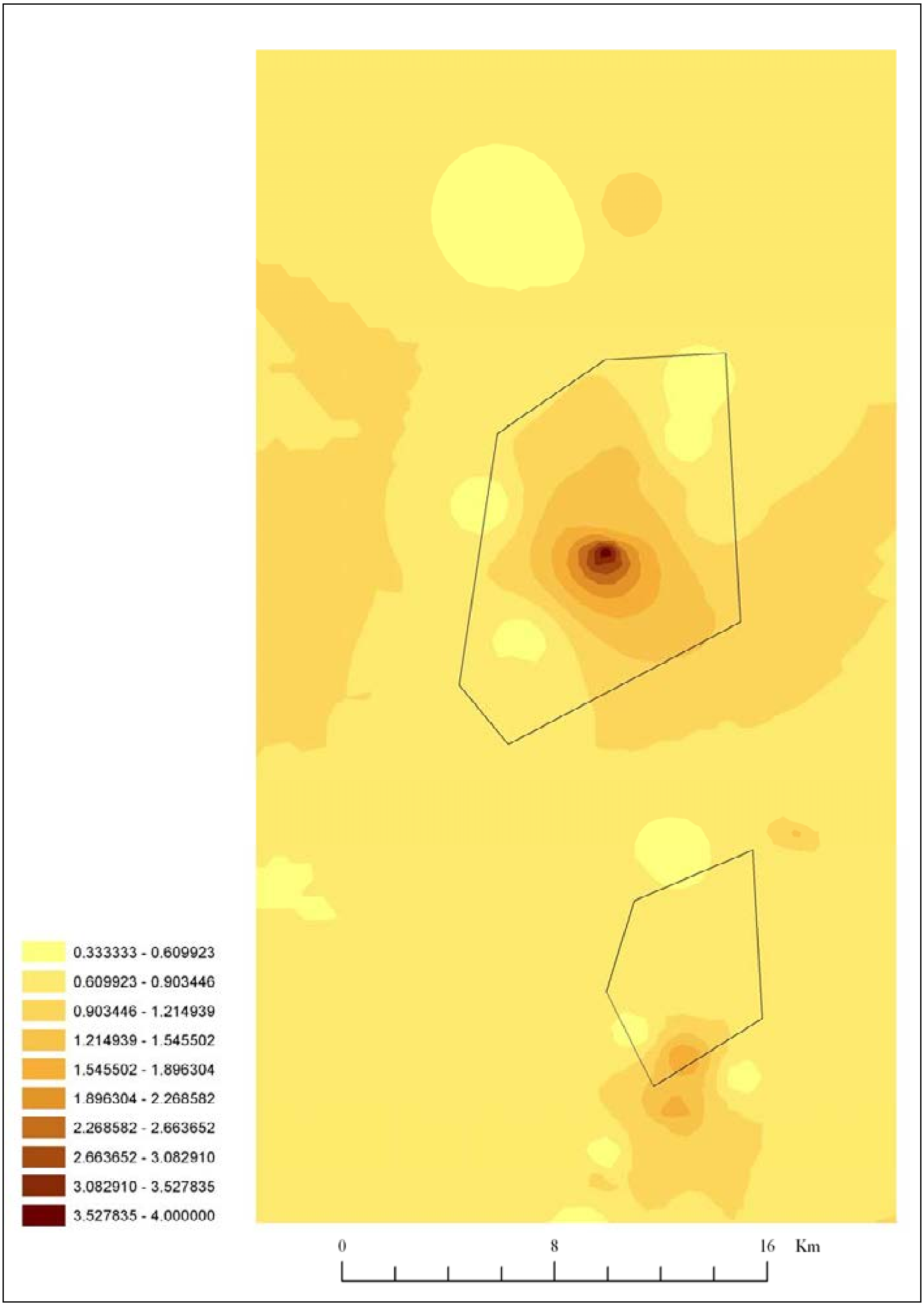

Figure 4.30.1-1 Smoothed average distribution of Razorbill, first winter boat surveys. Polygons show boundaries of proposed wind farm.

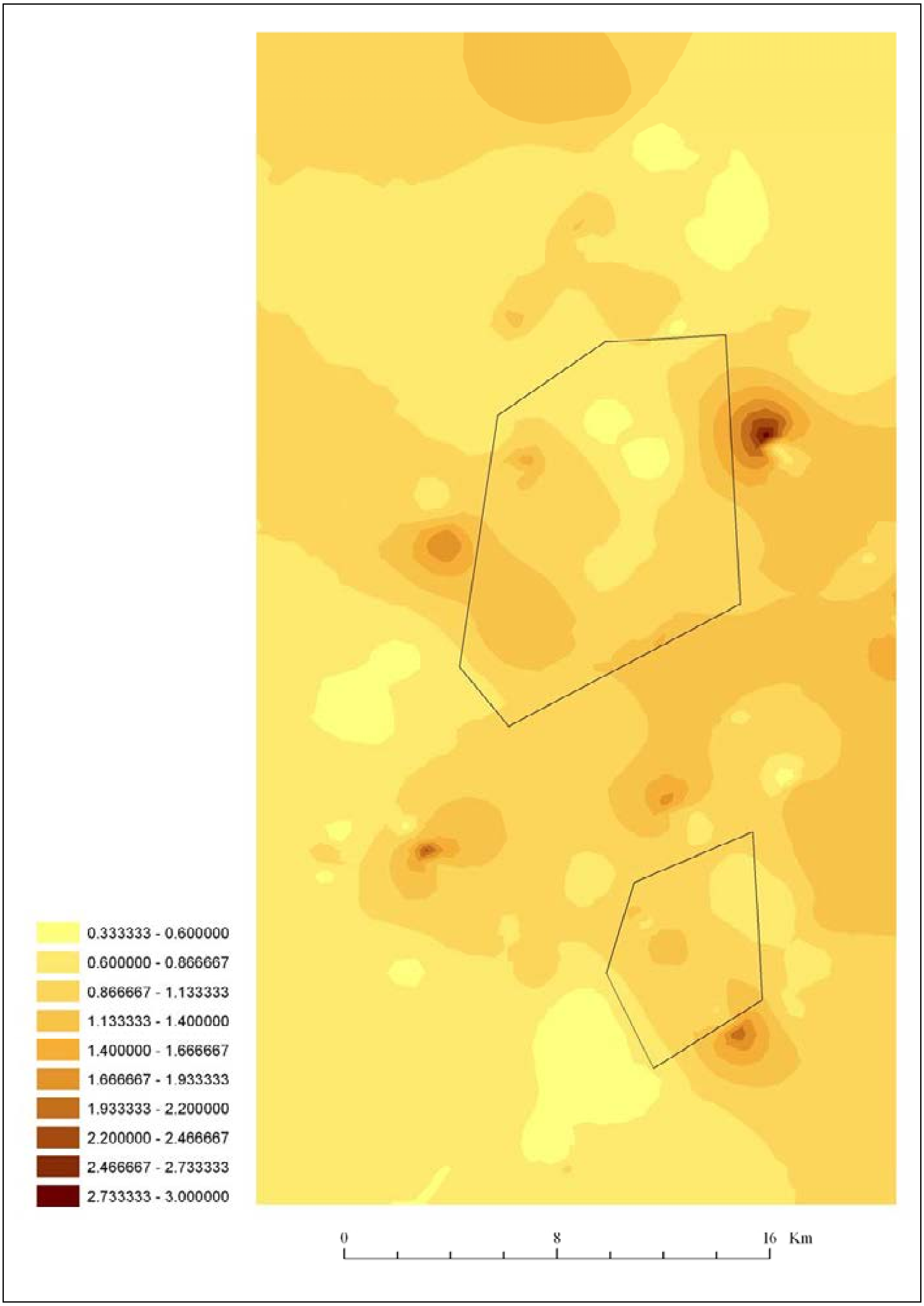

Figure 4.30.1-2 Smoothed average distribution of Razorbill, second winter boat surveys. Polygons show boundaries of proposed wind farm.

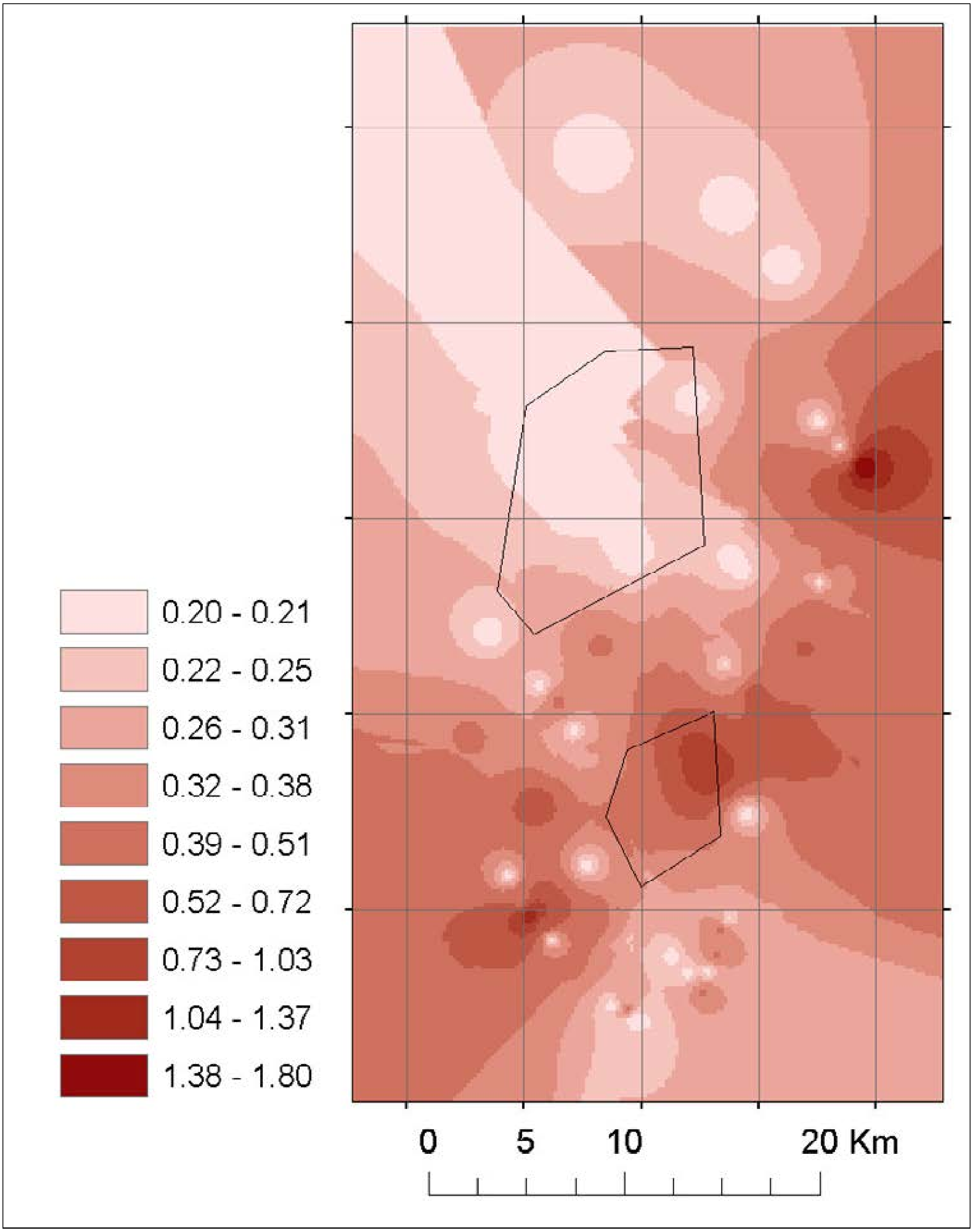

Figure 4.30.1-3 Smoothed average distribution of Razorbill, third winter boat surveys. Polygons show boundaries of proposed wind farm.

4.31 Sky Lark	***Alauda arvensis***		
Conservation status:	UKBAP, BoCC Red		
Winter		**Summer (pairs)**	
International threshold	?	***European population***	40-80 million
GB threshold	?	*GB population*	1,700,000
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak 04/05	**1 (*boat*)**	*Gabbard peak 2004*	0
Gabbard peak 05/06	**1 (*boat*)**	*Gabbard peak 2005*	0
Proportion of threshold 04/05	0.00%	*Proportion of threshold 2004*	0.00%
Proportion of threshold 05/06	0.00%	*Proportion of threshold 2005*	0.00%

4.31.1 Boat surveys

Individuals were recorded in September 2004 and February 2006.

4.31.2 Aerial surveys

No individuals were recorded during either of the sets of aerial surveys.

4.31.3 The importance of the Greater Gabbard for Sky Lark

4.31.3.1 Winter and summer

The Greater Gabbard area has no importance for Sky Lark at any time of the year, with only one individual recorded on only two occasions.

4.31.3.2 Migration

The Sky Lark recorded in September 2004 may have been a migrating individual, as this species is known to undergo local migrations. However there is no reason to suppose that this species occurs in significant numbers within the Greater Gabbard area during the passage period.

4.32 Song Thrush	***Turdus philomelos***		
Conservation status:	UKBAP, BoCC Red		
Winter		**Summer (pairs)**	
International threshold	?	***European population***	20-36 million
GB threshold	?	*GB population*	1,030,000
Wind farm peak est. 04/05	**4**	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	1	Wind farm peak est. 2005	0
Gabbard peak 04/05	**20**	*Gabbard peak 2004*	0
Gabbard peak 05/06	1	*Gabbard peak 2005*	0
Proportion of threshold 04/05	0.00%	*% National importance 2004*	0.00%
Proportion of threshold 05/06	0.00%	*% National importance 2005*	0.00%

4.32.1 Boat surveys

20 individuals were recorded in September 2004, 15 in March 2005 and 1 in October 2005.

4.32.2 Aerial surveys

No individuals were recorded during wither of the sets of aerial surveys.

4.32.3 The importance of the Greater Gabbard for Song Thrush

4.32.3.1 Winter and summer

The Greater Gabbard area is of little importance to Song Thrushes at any time of the year. Occasional small flocks appear to pass through the area, with a peak of 20 recorded in September 2004.

4.32.3.2 Migration

All the Song Thrushes recorded are likely to represent birds passing through the area on passage. However there is no reason to suppose that large numbers pass through the area during the migration period.

4.33 Reed Bunting	***Emberiza schoeniclus***		
Conservation status:	UKBAP, BoCC Red		
Winter		**Summer (pairs)**	
International threshold	?	***European population***	4.8-8.8 million
GB threshold	?	*GB population*	176,000-193,000
Wind farm peak est. 04/05	0	Wind farm peak est. 2004	0
Wind farm peak est. 05/06	0	Wind farm peak est. 2005	0
Gabbard peak 04/05	0	*Gabbard peak 2004*	0
Gabbard peak 05/06	**1**	*Gabbard peak 2005*	0
Proportion of threshold 04/05	0.00%	*Proportion of threshold 2004*	0.00%
Proportion of threshold 05/06	0.00%	*Proportion of threshold 2005*	0.00%

4.33.1 Boat surveys

One individual was recorded in October 2005.

4.33.2 Aerial surveys

No individuals were recorded during wither of the sets of aerial surveys.

4.33.3 The importance of the Greater Gabbard for Reed Bunting

4.33.3.1 Winter and summer

The Greater Gabbard area has no importance for Reed Bunting at any time of the year. Only one individual was recorded on one occasion,

4.33.3.2 Migration

The individual recorded in October 2005 is likely to represent a bird passing through the area on passage as this species is known to undergo local migration. However there is no evidence to suggest that large numbers of migrating Reed Buntings pass through the Greater Gabbard area.

4.34 Unidentified Gulls

4.34.1 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 4.34.1-1), 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 2004, 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 1,539 in May 2005 (95% confidence limits: 484 – 4,483).

Figures 4.34.1-1 and 4.34.1-2 show the average distributions of large gulls for the first 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. Figures 4.34.1-3 and 4.34.1-4. show the average distributions of large gulls for the second summer and third winter respectively. Again peak concentrations appear to be in the south or southeast corner of the study area, but there is an additional peak towards the north. It is likely that these high concentrations were influenced by sizable feeding flocks of gulls in these locations.

Table 4.34.1-1 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.

MONTH	DS	D	N	LCL	UCL
February 2004	N/A	N/A	N/A	N/A	N/A
March (1) 2004	N/A	N/A	N/A	N/A	N/A
March (2) 2004	N/A	N/A	N/A	N/A	N/A
April 2004	0.1613	0.7290	532	88	3,201
May 2004	0.1116	0.3349	244	32	1,895
June 2004	0.6574	0.7238	528	291	960
July 2004	0.2357	0.6964	508	235	1,099
August 2004	0.1240	0.1613	118	48	291
September 2004	0.1737	0.1914	140	45	438
November 2004	0.4217	1.0413	760	382	1,511
December 2004	0.4364	5.9277	4,327	1,516	12,350
March 2005	1.4761	2.4880	1,816	883	3,735
May 2005	0.4969	2.1084	1,539	484	4,883
June 2005	0.5137	0.6799	496	285	864
July 2005	0.2417	1.2758	931	254	3,414
August 2005	0.0806	1.6788	1,225	165	9,099
September 2005	0.1880	0.9266	676	277	1,652
October 2005	0.1477	1.0609	774	202	2,963
December 2005	0.0806	3.1693	2,314	370	14,471

January 2006	0.0134	0.1074	78	11	535
February 2006	0.2552	0.8326	608	242	1,529
April 2006	0.1746	0.9938	725	194	2,719

4.34.2 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 4.34.2-1). 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. The peak count within the region was one of 23,022 (95% confidence limits: 19,426 – 27,785) in TH1 during the second winter period of the second set of aerial surveys, suggesting that other parts of the region host considerably higher numbers of unidentified gulls.

Figures 4.34.2-1 and 4.34.2-2 show the distribution of unidentified gulls from both sets of 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.

Table 4.34.2-1 Unidentified Gulls recorded on the first (top) and second (bottom) set of 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.

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

Continued…/

Table 4.34.2-1 Continued.

Survey Block	Survey Period	DS	D	N	LCL	UCL
TH1	WINTER 1	0.8602	4.9327	6,215	4,935	7,827
	WINTER 2	1.9197	18.2720	23,022	19,426	27,285
	WINTER 3	0.3131	1.8891	2,380	1,575	3,596
	WINTER 4	1.4801	3.9295	4,951	4,300	5,701
TH2	WINTER 1	0.2048	0.45712	563	293	1138
	WINTER 2	0.1169	1.7753	2,185	863	5,531
	WINTER 3	0.2370	0.2911	358	275	466
	WINTER 4	0.3919	0.7956	979	758	1,265
TH3	WINTER 1	0.0901	0.1562	166	83	370
	WINTER 2	0.0252	0.0252	27	13	55
	WINTER 3	0.4253	0.5418	574	463	712
	WINTER 4	0.0108	0.0107	11	3	40
TH6	WINTER 1	0.4598	1.8769	2,414	1,717	3,393
	WINTER 2	0.8789	8.2052	10,552	7,732	14,400
	WINTER 3	0.17829	0.7234	930	567	1,525
	WINTER 4	0.4504	0.7303	939	755	1,168
TH7	WINTER 1	0.0888	0.4020	502	221	1,141
	WINTER 2	0.1650	1.1647	1,455	705	3,001
	WINTER 3	0.19988	0.4795	599	419	855
	WINTER 4	0.1206	1.3614	1,700	756	3,826

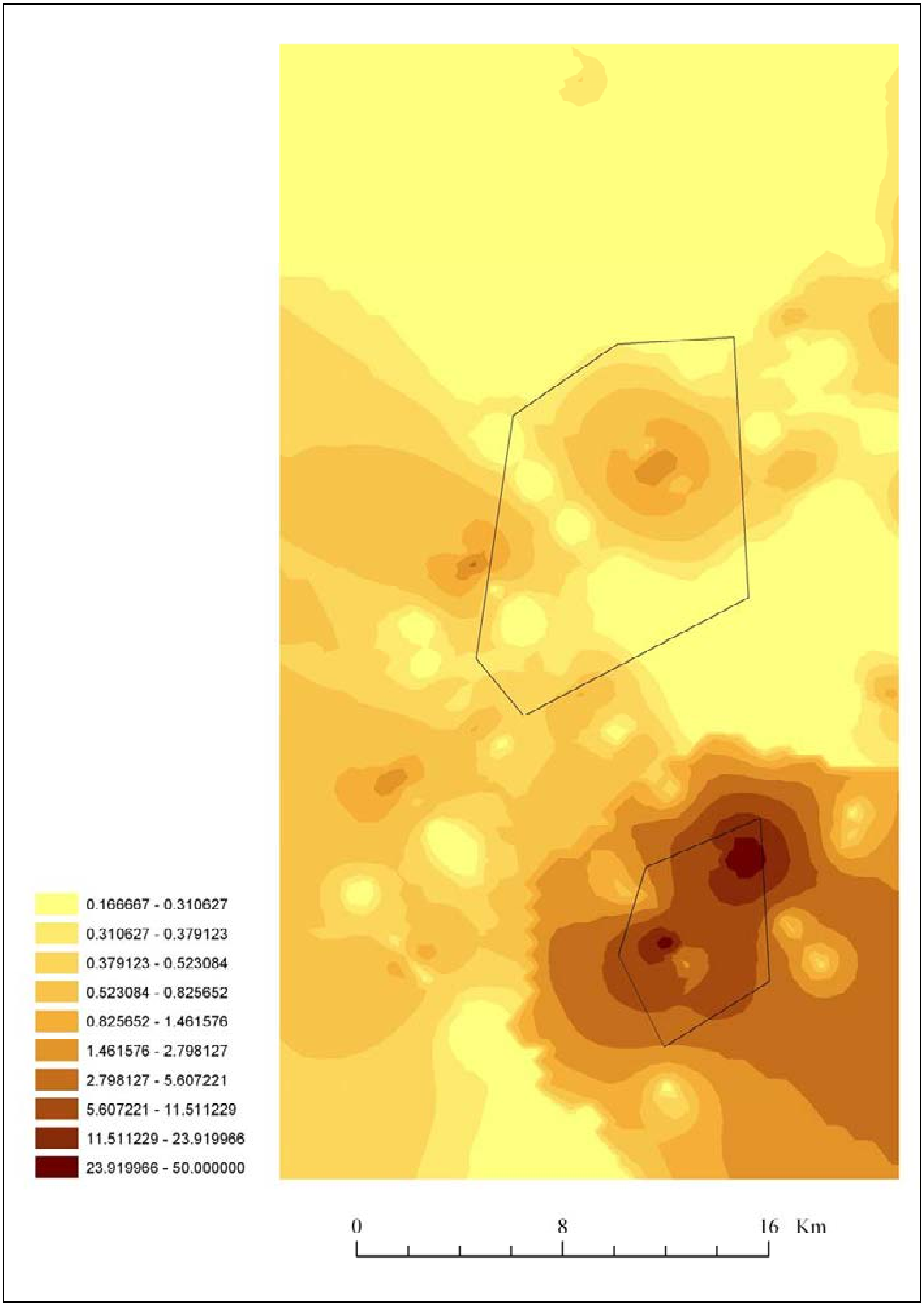

Figure 4.34.1-1 Smoothed average distribution of large gulls, first summer boat surveys. Polygons show boundaries of proposed wind farm.

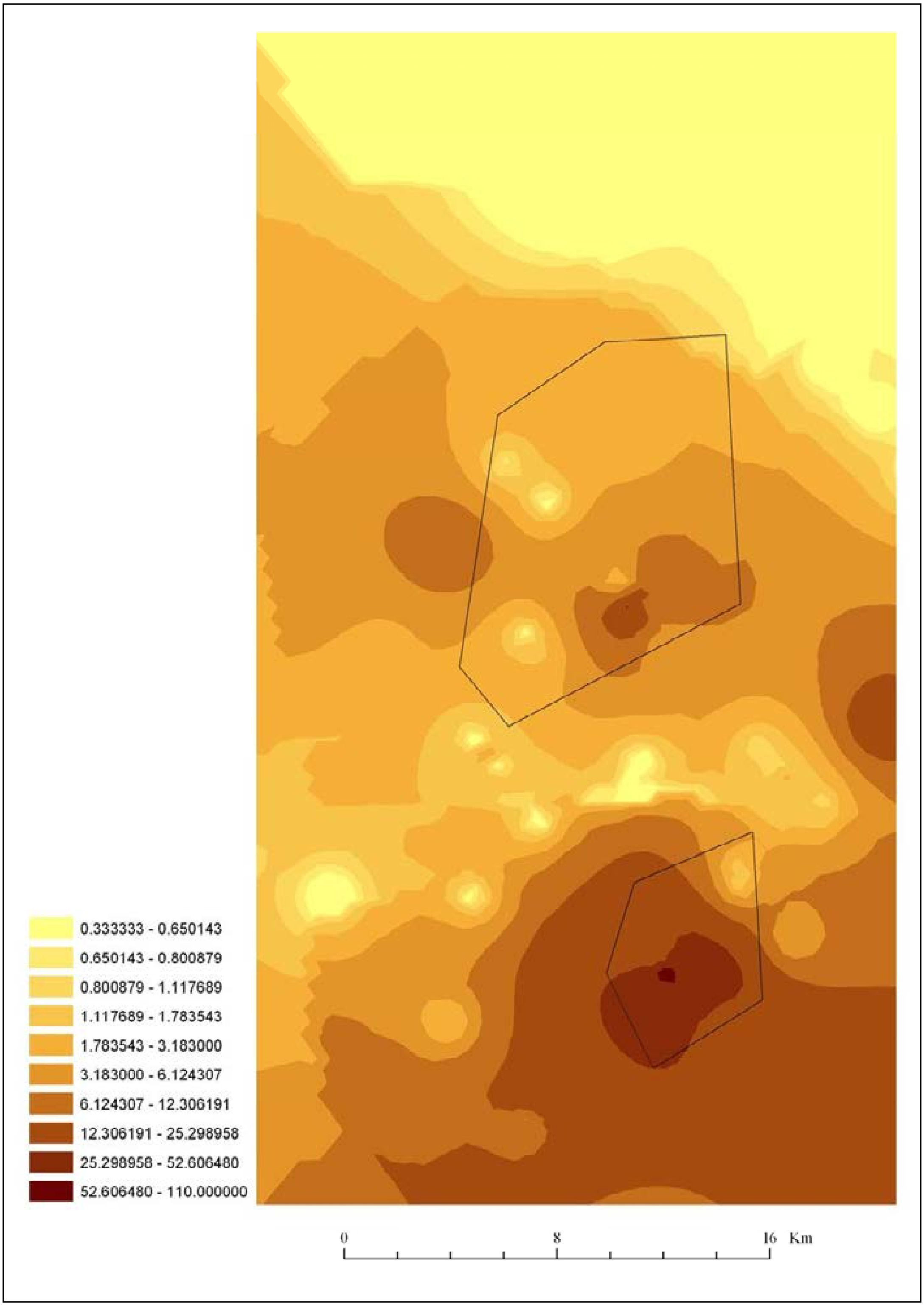

Figure 4.34.1-2 Smoothed average distribution of large gulls, second winter boat surveys. Polygons show boundaries of proposed wind farm.

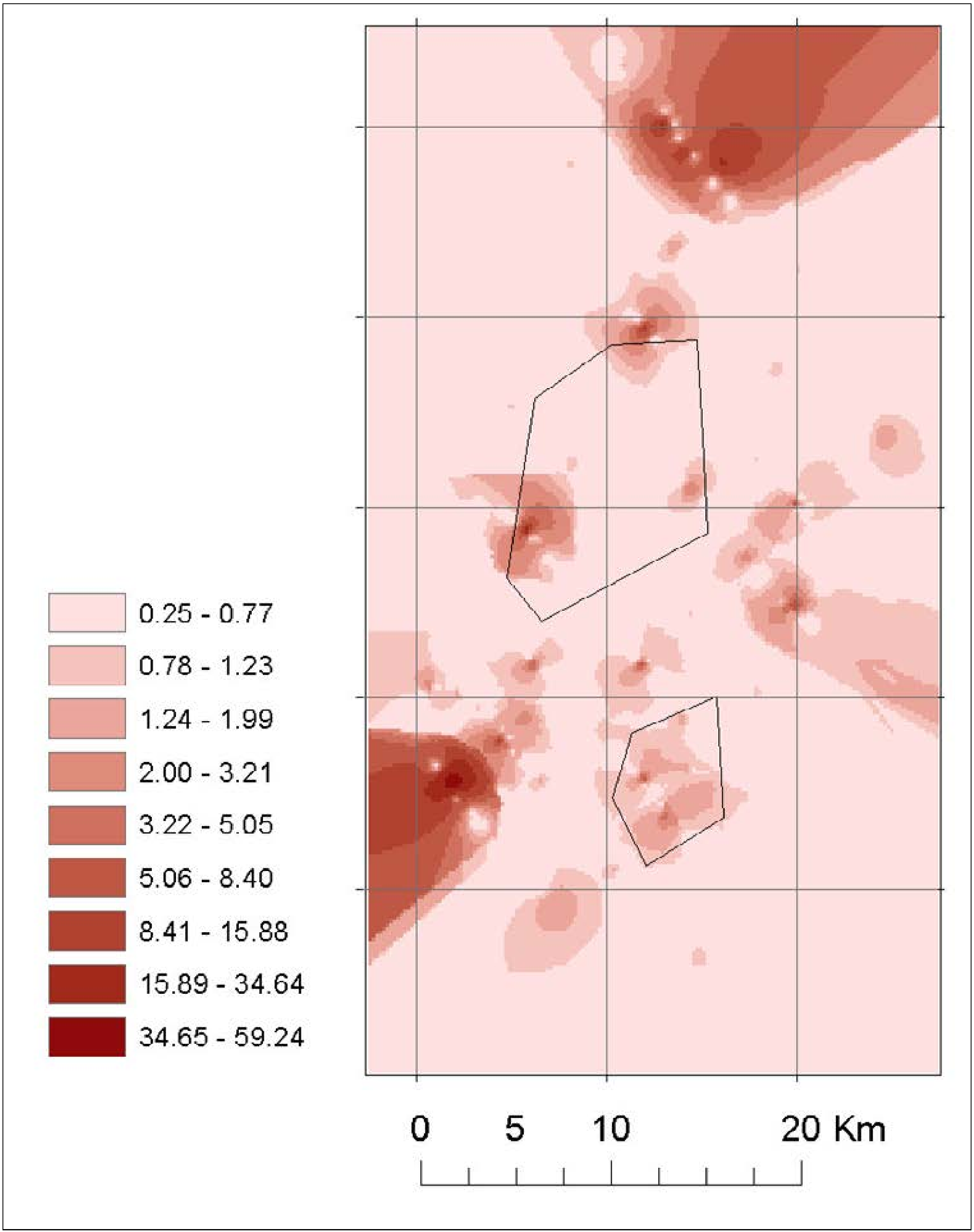

Figure 4.34.1-3 Smoothed average distribution of large gulls, second summer boat surveys. Polygons show boundaries of proposed wind farm.

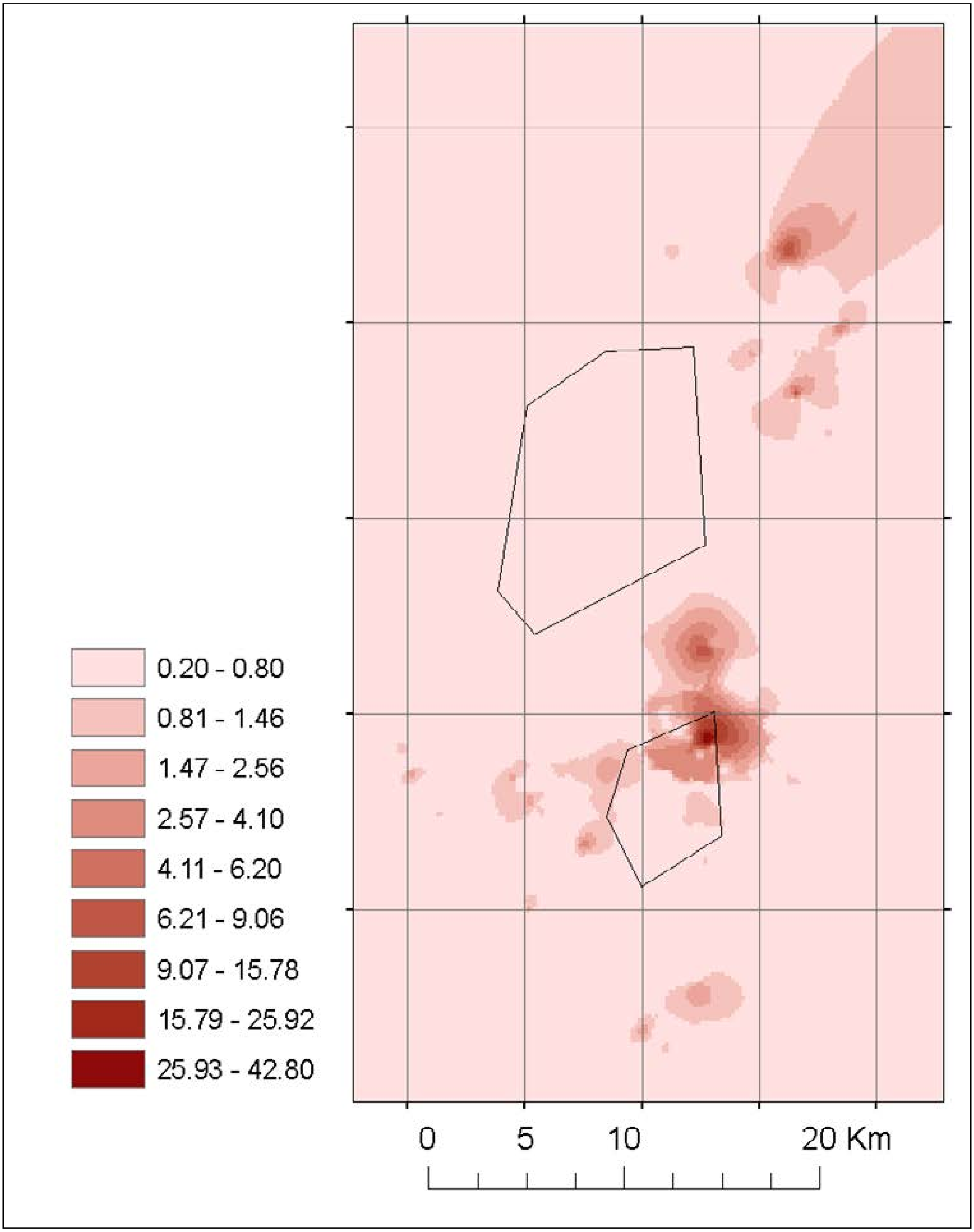

Figure 4.34.1-4 Smoothed average distribution of large gulls, third winter boat surveys. Polygons show boundaries of proposed wind farm.

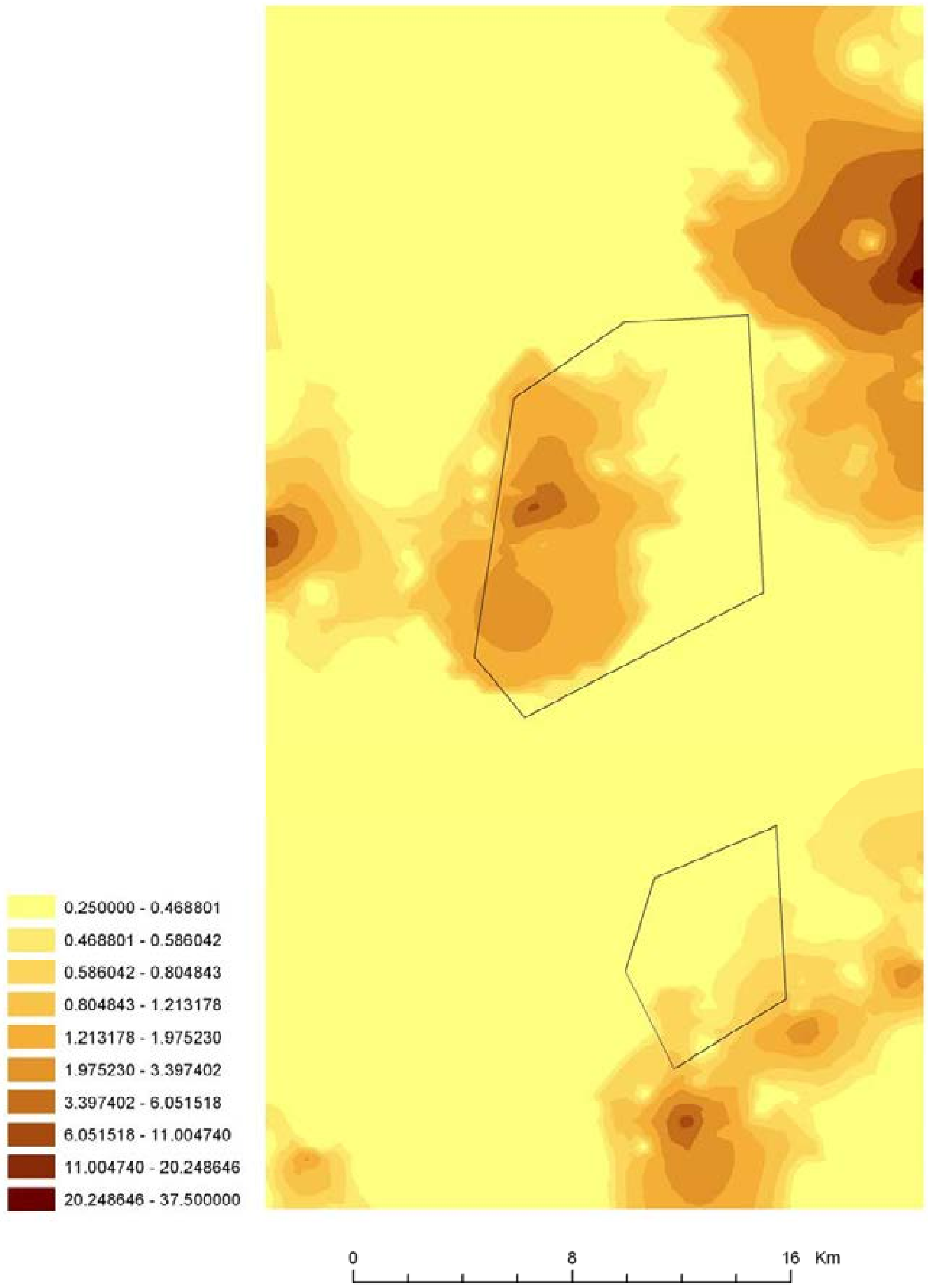

Figure 4.34.2-1 Smoothed average distribution of unidentified gulls, first set of aerial surveys. Polygons show boundaries of proposed wind farm.

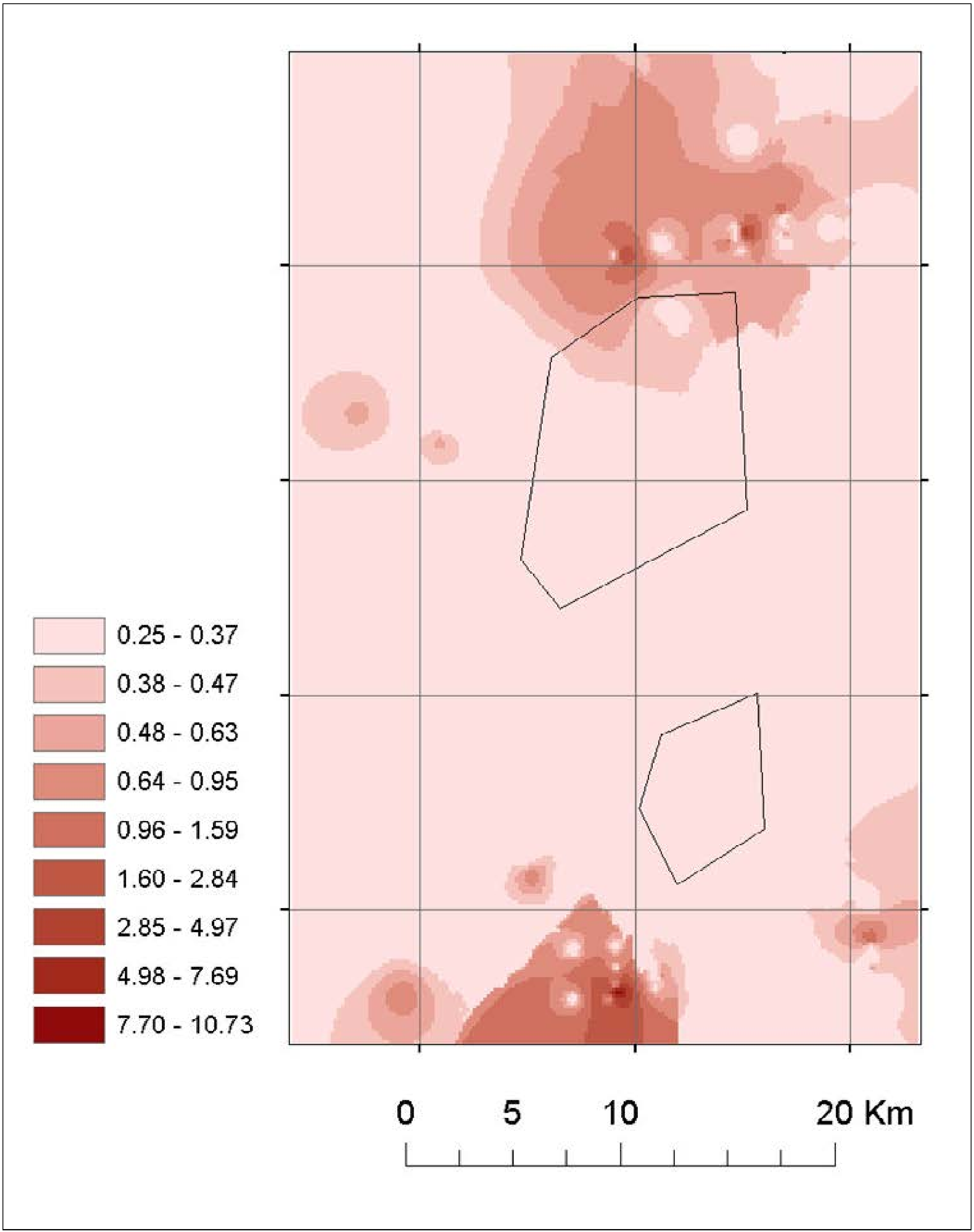

Figure 4.34.2-2 Smoothed average distribution of unidentified gulls, second set of aerial surveys. Polygons show boundaries of proposed wind farm.

4.35 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 4.35-1), a further 333 passerines were counted, of which 120 were Meadow Pipits and 158 were Starlings during boat surveys up to March 2005. Although there was no October 2004 survey, migrants were still recorded in early November (Table 4.35-1). An additional 229 passerines (of which 210 were Starlings) were seen on 9 November 2004. As this survey took place over a long period of time, and as few birds were recorded late in the month, Table 4.35-1 shows those birds recorded only on 9 November. The following spring, migration was recorded during the March 2005 survey and the following autumn in September and October 2005. In addition to the species recorded in Table 4.35-1, 21 Sandwich Terns and 79 passerines were noted during the main survey. During surveys conducted from May 2005 onwards, a total of 99 passerines were recorded. Of these, 18 were Meadow Pipits and 38 were Starlings. No attempt was made to correct numbers for viewing effort because the very occasional nature of sightings could lead to totally unrealistic numerical estimates.

Table 4.35-1 Species recorded during 'migration watch' on boat surveys.

Common Name	Sep 2004	Nov 2004	Mar 2005	Sep 2005	Oct 2005
Red-throated Diver	0	0	2	0	0
Great Cormorant	0	0	1	0	0
Grey Heron	4	0	0	0	0
Brent Goose	21	6	0	0	0
Great Skua	0	1	0	0	0
Common Scoter	48	0	0	0	0
Grey Plover	7	0	0	0	0
Lapwing	1	0	0	0	0
Knot	17	0	0	0	0
Dunlin	0	0	1	0	0
Turnstone	0	0	0	8	0
Little Gull	4	0	0	0	0
Sandwich Tern	6	0	0	0	0
Common Tern	2	0	0	0	0
Arctic Tern	1	0	0	0	0
Guillemot	0	0	0	0	0
Meadow Pipit	51	10	10	9	3
Rock Pipit	0	0	2	0	0
Unidentified pipit	2	0	0	0	0
Robin	3	0	0	0	4
Redstart	0	0	0	1	0
Wheatear	0	0	0	1	0
Fieldfare	0	0	1	0	0
Blackbird	0	0	0	0	1
Song Thrush	18	0	2	0	1
Unidentified thrush	2	8	0	0	1
Blackcap	0	0	0	0	1
Willow Warbler	0	0	0	12	0
Goldcrest	0	0	0	0	1
Starling	37	620	116	0	5
Chaffinch	1	0	28	0	0
Reed Bunting	0	0	0	0	1
Unidentified passerine	18	171	0	0	12

Table 4.35-1 Continued.

Common Name	Sep 2004	Nov 2004	Mar 2005	Sep 2005	Oct 2005
Unidentified bird	0	0	0	0	1
Total for all birds	243	816	163	20	31

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 4.35-2). Most migrants were recorded under a height of 10 m above sea level, which would see them pass under the sweep of the turbines.

Table 4.35-2 Average flight heights of principal migrating species (metres)

Common Name	Sep 2004	Nov 2004	Mar 2005	Sep 2005	Oct 2005
Brent Goose	2.5	-	-	-	15.0
Common Scoter	4.0	-	-	6.8	2.0
Meadow Pipit	4.0	-	-	7.5	25.0
Starling	5.0	9.0	6.5	-	5.2
Chaffinch	-	-	7.5	-	-

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.

4.36. Differences observed between the two survey reporting periods

The principle noteworthy difference observed between the two survey reporting periods (February 2004 to March 2005 and May 2005 to April 2006), was the presence of a large mixed gull flock, in the north-eastern part of the boat survey area in December 2005. This flock, comprising mostly larger gull species, was responsible for the higher estimates of Lesser Black-backed, Herring and Great Black-backed Gulls reported during the second survey period. Large gull flocks out to sea are often somewhat ephemeral in nature, and usually signify the presence of schools of fish or trawlers. Whilst it is likely that gulls tend to congregate at favourable feeding locations, they may not do so permanently, especially as mobile food resources are spatially unpredictable. Thus, encountering such flocks may sometimes be a chance event. It is possible therefore, that the December 2005 boat survey happened, coincidentally, to coincide with the presence of such a flock within the survey area. Consequently, the long-term and overall significance of high numbers of gull species within the survey area, such that national thresholds were exceeded, is hard to assess.

Another noteworthy difference was that a much larger number of Red-throated Divers were recorded during the second set of aerial surveys than during the first. Numbers in the later set of surveys were such that even the proposed wind farm area is predicted to host peak counts in excess of the national 1% threshold, if the number of unidentified divers assumed to be this species are included in the total. The only other differences of note were that a small flock of Common Scoter were present in the survey area during the second summer, but not during the first, and that numbers of auks were generally lower.

4.37 Modelling offshore bird distributions

Bird count data from boat surveys conducted in the first survey period (February 2004 to March 2005) 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. Consequently no attempt to model species abundances in relation to environmental variables was attempted on data collected during the second survey period (May 2005 to April 2006).

4.38 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 (Crick & 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. BASELINE CONCLUSIONS

5.1 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 and the steaming distance from local ports. Thus, boat surveys for October 2004, January 2005 and February 2005 were not feasible during the first survey period and November 2005 and March 2006 during the second survey period, 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.

5.2 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 during several surveys: during March 2004 and January 2006 of boat surveys and during the last two winter aerial surveys. Lesser Black-backed Gulls were estimated to occur in nationally important numbers on five occasions: March 2005, December 2005, February 2006 and April 2006, whilst Great Black-backed Gull estimates exceeded national importance on one occasions: in December 2005. Great Skua exceeded national importance on two on occasions: in September 2205 and in October 2005, but these estimates are likely to 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 Great Black-backed Gull represented 52% and 15% 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.

5.3 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, Great Black-backed Gull and Great Skua reaching the 1% national importance threshold. It should be noted, however, that on only a handful of 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 of these species, except for one aerial count of Red-throated Diver.

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 occurring in particularly noteworthy proportions (52%). Proportional estimates of those birds in the wind farm area itself led to at least four of these species remaining in numbers above 50 and in excess of the 1% regional threshold (Red-throated Diver 1.5%, Northern Fulmar 7.2%, Great Black-backed Gull 2.0%, Kittiwake 1.0%. The summed peaks for Common Guillemot and Razorbill are also in excess of 1% of the regional peak estimate for auks at 1.8%. For a further three species, the peak estimate within the wind farm area derived from boat surveys is in excess of 1% of the regional total: Herring Gull, Great Skua and Lesser Black-backed Gull. For the latter two species, figures derived from boat data are hard to compare to aerial data, as there are large discrepancies between estimated numbers dependent on the method used. Migrant numbers were fairly low, only Starlings occurring in large flocks during November 2004.

6. ENVIRONMENTAL IMPACT ASSESSMENT – OFFSHORE

6.1 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 offshore wind farm and their potential effects (Sections 6.3 and 6.4).

- To assess the Significance of these impacts on species of importance in the offshore area (Section 6.5).

The assessment is based on the wind farm boundaries presented earlier (in Section 1.2), comprising two arrays of up to 140 wind turbines in total.

6.2 Assessment Methodology

The definition of areas used in this assessment follows that outlined in the ornithological baseline. In summary, the "*study area*" is the area covered by surveys (though, note, this varied slightly between aerial and boat surveys) including both the area containing the proposed wind farm and a reference area. The "*wind farm area*" (or "*Greater Gabbard wind farm area*") comprises the two areas – the Inner Gabbard and The Galloper – selected for wind farm location, totally 147 km^2, c. 14% of the aerial survey study area. The effects of indirect habitat loss through disturbance or the disruption of flight-lines are also considered for not just of the wind farm area but also "*buffer zones*" around it – in this case 800 m and 4 km (see section 6.3.3 below).

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:

Table 6.2-1 Definitions of terms relating to the "Sensitivity" of the ornithological features of the site (Percival *et al.* 1999).

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)

The sensitivities of different species are assessed on the basis of existing designations and the results of surveys of the study area. For example, the proposed offshore development could affect birds, such as Lesser Black-backed Gulls breeding on the nearby Alde-Ore SPA.

The Magnitudes of effects are assessed as follows:

Table 6.2-2 Definitions of terms relating to the "Magnitude" of ornithological effects (Percival *et al.* 1999).

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

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:

Table 6.2-3 Impact matrix of "Significance" (Percival *et al.* 1999).

		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

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.

For the purposes of this assessment, we consider the Significance of effects for all those species found in the wider study area, whose numbers were of national or regional importance and/or are listed as EC Annex 1, Wildlife and Countryside Act Schedule 1 or UK Biodiversity Action Plan species or as features of the SPAs identified in Figure 1.3-1 for the Outer Thames Estuary region (see Section 4.1).

6.3 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 offshore development which might affect birds are:

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 (noise/vibration) and maintenance visits
4. The attraction of birds to lit structures
5. Increased prey availability and the provision of roost structures

6.3.1 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 in the area. 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 8) may help reduce the effects of disturbance during this phase (see for example Noer *et al.* 2000) and subsequent decommissioning.

6.3.2 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).

For Lesser Black-backed Gull, the one species classified in this assessment as a Very High Sensitivity species (see Section 6.5.3 below), the effects should be considered as of Low Significance. However, for all other species, these effects will be only of Very Low Significance and thus as they are not considered of concern they are not discussed in any further detail.

6.3.3 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 & Kahlert (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 & Kahlert 2005), not just of the wind farm area but in a buffer zone area around it. Here we consider two buffers, one of 800 m following the maximum avoidance distance reported in the review by Percival (2005) and a second of 4 km following the results of Petersen *et al.* (2004) and Petersen (2005) (see also Drewitt & Langston 2006). The latter studies of the Horns Rev wind farm found that divers, Common Scoter and Guillemots / Razorbills showed an increased avoidance of areas within 2 to 4 km of the wind farm, whereas Herring Gulls, Little Gulls and Arctic/Common Terns showed decreased avoidance. Note, the extent of the buffer considered may considerably affect the level of Significance determined. 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 the two buffer zones of 800 m and 4 km) 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' regional 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 in the region, 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 (e.g. Burton *et al.* 2006) and a decline in the size of the regional 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 9 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 7 on cumulative impacts.

6.3.4 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). Additional mortality resulting from collisions following attraction to the lights of a wind farm will only appreciably add to the high background annual mortality rates typical amongst such species if 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 (Section 6.4).

Mitigation against the effects of lighting in the wind farm is considered in Section 8.

6.3.5 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 wind farm 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 Magnitude. For Lesser Black-backed Gull, the one species classified in this assessment as a Very High Sensitivity species (see Section 6.5.3 below), the effects should thus be considered as of Low Significance. However, for all other species, these effects will be only of Very Low Significance and, therefore, are not considered further.

6.4 Collision Risk

6.4.1 Background

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.* 2006). Here we assume three different rates, a high rate, a medium rate – considered realistic – and for illustrative purposes, an extremely 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.* 2005). 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 & Kahlert 2005).

The CRM was used to estimate diurnal collision probabilities and mortality rates of four species at the Greater Gabbard wind farm: Red-throated Diver, Great Skua, Lesser Black-backed Gull and Great Black-backed Gull. These 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. Collision risk estimates were calculated separately for the two survey years (hereafter referred to as 2004/05: February 2004 to March 2005 and 2005/06: April 2005 to April 2006) to illustrate the inherent variation in risk that results from differences in bird numbers and their behaviour over time (note, Great Black-backed Gulls were only found in nationally important numbers in the study area in the second year and thus for this species, estimates were only calculated for that year). The issue of collision risk, is also 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.

The Magnitudes (and thus the Significance) of the effects of collisions are assessed by determining the percentage of the regional population of each species that would be lost each year. It should be noted, though, that seabirds are long-lived birds with relatively low reproduction rates and thus even small changes in mortality could lead to population change / decline. For the four key species, therefore, we also discuss how the mortality from collisions might increase normal background mortality rates (taken from Garthe & Hüppop 2004).

6.4.2 Modelling

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 6.4.2-1). (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.

Table 6.4.2-1 Input parameters used to determine strike probability of a bird flying through a wind turbine from the Collision Risk Model (Band *et al*. 2005), assuming no avoiding action.

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)

Predicted collision risk from the CRM varies according to whether a bird is flying upwind or downwind. Table 6.4.2-2 presents collision risks for the four 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* 2006). 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*. 2006). Application of a 10% slower speed in each species made relatively little difference (<1%) to the estimated collision risk (Table 6.4.2-2).

Table 6.4.2-2 Strike probability of four 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.

SPECIES	**Collision risk**	**Collision risk (-10% speed)**
Red-throated Diver	0.048	0.052
Great Skua	0.052	0.057
Lesser Black-backed Gull	0.076	0.084
Great Black-backed Gull	0.067	0.073

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 6.4.2-2 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*. 2006). 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 (1992a) (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). (Note, a similar mean avoidance rate of 0.9993 has recently reported for geese from an assessment of collisions at four wind farms in the U.S.A.: Fernley *et al.* 2006). 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 *unpublished*.).

Even with the scenario of relatively low avoidance rates, estimated strike rates using data from 2004/05 were very low in all species (for example in comparison to Gill *et al.* 2002) (Table 6.4.2-3). 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 6.4.2-3).

Table 6.4.2-3 Strike probability of four 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.

(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}	0.006
Great Skua	5.2×10^{-6}	9.36×10^{-5}	0.007
Lesser Black-backed Gull	7.6×10^{-6}	1.37×10^{-4}	0.010
Great Black-backed Gull	6.7×10^{-6}	1.21×10^{-4}	0.009

(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}	0.007
Great Skua	5.7×10^{-6}	1.03×10^{-4}	0.007
Lesser Black-backed Gull	8.4×10^{-6}	1.51×10^{-4}	0.011
Great Black-backed Gull	7.3×10^{-6}	1.31×10^{-4}	0.009

6.4.3 First year results

The final stage in estimating mortality rates is to combine the probabilities from Table 6.4.2-3 (for a single bird flying through the turbine area) with the numbers of birds estimated to be at risk.

To estimate the numbers of birds at risk, the mean distance estimates for the two wind farm areas from boat survey data for each species were first multiplied by the percentage of birds recorded in flight on all aerial surveys in the Outer Thames region to give maximum estimates of birds likely to be in flight (Table 6.4.3-1). 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. These figures were 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 numbers flying through at the height of 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 6.4.3-1).

Table 6.4.3-1 The % of birds of different species recorded in flight (by aerial surveys) and the % of these recorded within rotor height (by boat surveys) in 2004/05. 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.

Species	**% of birds in flight (all TH region)**	**% birds within rotor height**
Divers	10	0
Northern Fulmar	67	0
Northern Gannet	30	0.6
Common Scoter	31	0
Skuas	92	11.1

Little Gull	98	0
Mew (Common) Gull	86	4.2
Lesser Black-backed Gull	70	6.6
Herring Gull	91	10.1
Great Black-backed Gull	30	13.8
Black-legged Kittiwake	83	1.5
Auks	4	0

Finally, these figures were 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.* 2005). 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 for 2004/05 in Table 6.4.3-2.

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.

Table 6.4.3-2 Numbers of birds at risk (N) per unit time (T – minutes), calculated using data from 2004/05 for both slow (T_{SLOW}) and fast (T_{FAST}) flight speeds, 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 the 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.

Site	**Species**	**N summer**	**N winter**	**T_{FAST} (min)**	**T_{SLOW} (min)**
All	Red-Throated Diver	0.01	0.67	10.06	11.18
	Great Skua	93.61	0.00	11.47	12.75
	Lesser Black-backed Gull	127.49	175.58	17.28	19.20
Galloper	Red-Throated Diver	0.00	0.00	3.51	3.90
	Great Skua	1.06	0.00	4.00	4.45
	Lesser Black-backed Gull	0.86	1.19	6.03	6.70
Inner Gabbard	Red-Throated Diver	0.00	0.00	6.55	7.28
	Great Skua	5.81	0.00	7.47	8.30
	Lesser Black-backed Gull	4.71	6.48	11.25	12.50

The estimated numbers of birds struck per unit time in summer and winter and for the two separate parts of the site (Galloper and Inner Gabbard) are given in Table 6.4.3-3 for 2004/05 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, though this species was only recorded in summer. The highest hourly mortality rate predicted (with lowest avoidance rates) was 0.34 for Lesser Black-backed Gull at the Inner Gabbard in winter. 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.

Hourly and monthly mortality rates for the Galloper and Inner Gabbard areas combined, using data from 2004/05 and assuming a medium avoidance rate of 0.9982, are summarised in Table 6.4.3-4. These rates are used in the final assessment to assess the Magnitude of the collision risk effects and thus their Significance for the four species.

Details of monthly mortality estimates and all other parameters estimated from the CRM are given for 2004/05 in Appendix 3.

Table 6.4.3-3 Estimated numbers of birds struck per hour using data from 2004/05, derived from estimated strike rates for slow flight speed (Table 6.4.2-3b) and numbers at risk (Table 6.4.3-2). 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) Galloper- Winter

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

(b) Galloper- Summer

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

(c) Inner Gabbard- Winter

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

(d) Inner Gabbard- Summer

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

Table 6.4.3-4 Mortality rates using data from 2004/05, assuming a medium avoidance rate and as used in the final assessment.

Species	**Season**	**Max. count**	**Collision risk**	**Mortality/hour**	**Mortality/month**
Red-Throated Diver	Winter	0.67	0.052	0	0
Great Skua	Summer	93.61	0.057	0.0058	2.4
Lesser Black-backed Gull	Winter	175.58	0.084	0.0063	1.9
Lesser Black-backed Gull	Summer	127.49	0.084	0.0043	1.8

A worst-case scenario is considered by using the maximum collision risk for each species in Table 6.4.2-3, and the highest count of each species in the wind farm area (*i.e.* not just at risk height). Table 6.4.3-5 shows that hourly mortality rates of Red-Throated Diver are likely to be negligible even if all birds estimated to be in the wind farm area 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 1,798 and 1,371 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 1992a; Painter *et al*. 1999).

Table 6.4.3-5 Mortality rates using data from 2004/05, assuming a worst-case scenario of highest collision risk, lowest avoidance rates (0.87) and maximum count over the season 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 2,520 hours in summer (14 hour day, 30 day month, 6 month season).

Species	**Season**	**Max. count**	**Collision risk**	**Mortality/hour**	**Mortality/month**
Red-Throated Diver	Winter	0.67	0.052	0.024	7.3
Great Skua	Summer	93.61	0.057	3.264	1,371
Lesser Black-backed Gull	Winter	175.58	0.084	5.992	1,798
Lesser Black-backed Gull	Summer	127.49	0.084	1.392	1,827

6.4.4 Second year results

The percentages of birds recorded in flight (by aerial surveys) in 2005/06 and the percentage of these within rotor height are shown in Table 6.4.4-1.

Table 6.4.4-1 The % of birds of different species recorded in flight (by aerial surveys) and the % of these recorded within rotor height (by boat surveys) in 2005/06. Figures for Red-throated Diver, Great Skua, Guillemot and Razorbill are based on all divers, skuas and auks observed respectively.

Species	**% of birds in flight (all TH region)**	**% birds within rotor height**
Divers	9	0
Northern Fulmar	91	0
Northern Gannet	56	3.0
Skuas	91	0
Little Gull	98	0
Mew (Common) Gull	95	5.8
Lesser Black-backed Gull	76	17.7
Herring Gull	86	16.8
Great Black-backed Gull	74	25.0
Black-legged Kittiwake	86	16.1
Auks	10	0

The numbers of birds of the four species estimated to be at risk using data from 2005/06 are given in Table 6.4.4-2. The estimated time that birds are at risk is also calculated, based on the width of the turbine area and the flight speed of each species. As before, two estimates are given based on slow and fast flight speeds (respectively T_{SLOW} and T_{FAST}). Red-throated Diver was recorded only in low numbers in winter 2005/06, but was never recorded at risk height in the vicinity of the two windfarms. Similarly, Great Skua was not recorded at risk height but was recorded in the whole study area and was more common in winter. Lesser Black-backed Gull was easily the most numerous species, both in the whole study area and in the wind farm areas. Great Black-backed Gull was scarce in the summer but was relatively numerous over the study area and in the wind farm areas in winter.

Table 6.4.4-2 Numbers of birds at risk (N) per unit time (T – minutes), calculated using data from 2005/06 for both slow (T_{SLOW}) and fast (T_{FAST}) flight speeds, 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 the 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.

Site	Species	N summer	N winter	T_{FAST} (min)	T_{SLOW} (min)
All	Red-Throated Diver	0.00	0.97	10.06	11.18
	Great Skua	10.50	109.20	11.47	12.75
	Lesser Black-backed Gull	625.03	577.77	17.28	19.20
	Great Black-backed Gull	0.46	96.09	13.16	14.62
Galloper	Red-Throated Diver	0.00	0.00	3.51	3.90
	Great Skua	0.00	0.00	4.00	4.45
	Lesser Black-backed Gull	11.34	10.48	6.03	6.70
	Great Black-backed Gull	0.01	2.46	4.59	5.10
Inner Gabbard	Red-Throated Diver	0.00	0.00	6.55	7.28
	Great Skua	0.00	0.00	7.47	8.30
	Lesser Black-backed Gull	61.88	57.20	11.25	12.50
	Great Black-backed Gull	0.060	13.44	8.57	9.52

The numbers of birds predicted to be killed using data from 2005/06 were calculated by multiplying strike rates in Table 6.4.2-3 by the number of birds estimated to be at risk (Table 6.4.4-2) for slow flight speeds at Inner Gabbard and Galloper. The predictions were converted to hourly rates by multiplying by $60/T_{SLOW}$. Predicted mortality rates using data from 2005/06 are shown in Table 6.4.4-3. Red-throated Diver and Great Skua were not recorded flying at risk height in the survey as a whole, so the estimated mortality was 0 for these species. Predicted Lesser Black-backed Gull mortality was less than 0.05 birds per hour for high and medium avoidance in each case. For low avoidance rates, predicted mortality was c. 1 bird per hour at Galloper and c. 3 birds per hour at Inner Gabbard. This species showed similar predictions in both seasons. Great Black-backed Gull, due to its much lower abundance, had lower predicted mortality, the highest being 0.80 birds struck per hour at Inner Gabbard in the winter.

Hourly and monthly mortality rates for the Galloper and Inner Gabbard areas combined, using data from 2005/06 and assuming a medium avoidance rate of 0.9982, are summarised in Table 6.4.4-4. These rates are used in the final assessment to assess the Magnitude of the collision risk effects and thus their Significance for the four species.

Table 6.4.4-3 Predicted numbers of birds struck per hour using data from 2005/06, derived from estimated strike rates for slow flight speed (Table 6.4.2-3b) and numbers at risk (Table 6.4.4-2). To calculate seasonal totals, assume 1,8000 minutes per month in winter (10 hour day, 30 day month) and 25,200 minutes in summer (14 hour day, 30 day month).

(a) Galloper- Winter

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	0	0	0
Great Skua	0	0	0
Lesser Black-backed Gull	0.0008	0.0142	1.0249
Great Black-backed Gull	0.0001	0.0038	0.2747

(b) Galloper- Summer

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	0	0	0
Great Skua	0	0	0
Lesser Black-backed Gull	0.0009	0.0154	1.1090
Great Black-backed Gull	8.59×10^{-7}	1.54×10^{-5}	0.0011

(c) Inner Gabbard- Winter

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	0	0	0
Great Skua	0	0	0
Lesser Black-backed Gull	0.0023	0.0415	2.9982
Great Black-backed Gull	0.0006	0.0111	0.8039

(d) Inner Gabbard- Summer

Species	**High avoidance (0.9999)**	**Med. avoidance (0.9982)**	**Low avoidance (0.87)**
Red-Throated Diver	0	0	0
Great Skua	0	0	0
Lesser Black-backed Gull	0.0025	0.0449	3.2435
Great Black-backed Gull	2.76×10^{-6}	4.95×10^{-5}	0.0036

Table 6.4.4-4 Mortality rates using data from 2004/05, assuming a medium avoidance rate and as used in the final assessment.

Species	**Season**	**Max. count**	**Collision risk**	**Mortality/hour**	**Mortality/month**
Red-Throated Diver	Winter	0.970	0.052	0	0
Great Skua	Winter	109.2	0.057	0	0
Great Skua	Summer	10.50	0.057	0	0
Lesser Black-backed Gull	Winter	577.8	0.084	0.0557	16.7
Lesser Black-backed Gull	Summer	625.0	0.084	0.0603	25.3
Great Black-backed Gull	Winter	96.09	0.073	0.0149	4.5
Great Black-backed Gull	Summer	0.46	0.073	6.49×10^{-5}	0.03

A worst-case scenario is again considered by using the maximum collision risk for each species in Table 6.4.2-3, and the highest count of each species in the wind farm area (*i.e.* not just at risk height). Table 6.4.4-5 shows that, using 2005/06 data, mortality rates of Red-Throated Diver are still likely to be low at c. 11 birds per month, even if all birds estimated to be in the study are could be considered at risk, but considerably higher for Great Black-backed Gull, Great Skua and particularly Lesser Black-backed Gull. Again it should be noted that this an extreme example, though, that there may be certain conditions (especially in very poor visibility) when such low avoidance rates are possible.

Table 6.4.4-5 Mortality rates using data from 2005/06, assuming a worst-case scenario of highest collision risk, lowest avoidance rates (0.87) and maximum count over the season over the whole wind farm area (*i.e.* not just birds at risk height).

Species	**Season**	**Max. count**	**Collision risk**	**Mortality/hour**	**Mortality/month**
Red-Throated Diver	Winter	0.970	0.052	0.035	10.6
Great Skua	Winter	109.2	0.057	3.808	1,142
Great Skua	Summer	10.50	0.057	0.078	153.8
Lesser Black-backed Gull	Winter	577.8	0.084	6.309	5,915
Lesser Black-backed Gull	Summer	625.0	0.084	21.329	8,958
Great Black-backed Gull	Winter	96.09	0.073	3.742	1,123
Great Black-backed Gull	Summer	0.46	0.073	0.004	7.5

6.4.5 Previous studies of offshore collision risks

Most previous studies of casualties at wind farm sites have recorded low levels of mortality (Erickson *et al.* 2001), though the majority of these relate 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). Winkelman (1989, 1992a, 1992b, 1992c, 1995) (in Drewitt & Langston 2006) reported collision rates ranging from 0.01 to 1.2 birds per turbine per year at a site off the Dutch coast. At Blyth Harbour wind farm in Northumberland, most casualties were Common Eiders and gulls, but strike rates were considered low – six birds per turbine per year (Painter *et al.* 1999). Everaert *et al.* (2002) also found gulls principal amongst casualties at an estuarine wind farm, in Belgium. Estimates of mortality varied between four and 23 dead birds per turbine per year; most mortality was thought to be of migrants and not locally breeding birds. As noted by Drewitt & Langston (2006), none of these examples have been associated with significant population declines.

6.5 Significance of Impacts

Species of Very High / High Sensitivity

6.5.1 Red-throated Diver

Annex 1, WCA, BCC Amber, Regionally & Nationally Important (winter)

The numbers of Red-throated Divers present in the wider study area in both winters, and also in the area of the proposed wind farm in winter 2005/06, were judged as nationally important using the current 1% threshold of 50. (The study area and the wind farm area were estimated to support respective peaks of 721 and 101 birds, 14.42 and 2.02 times the threshold.) Thus, this species is considered to be of High Sensitivity to the effects of the wind farm. However, the actual importance of this area is likely to be relatively less given the numbers of the species revealed by the recent aerial surveys in the southern North Sea region (WWT Wetlands Advisory Service 2005). A potential SPA is being investigated in the Outer Thames due to the numbers of Red-throated Divers found by these surveys; it is assumed that the Greater Gabbard wind farm area will be adjacent to this.

Indirect Habitat Loss / Disruption of Flight-lines

Movements of Red-throated Divers are likely to occur both on a local scale within the region 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 boat traffic.

The concentration of Red-throated Divers found in the whole study area was of national and regional importance and the peak winter numbers estimated to be within the area of the wind farm and the wind farm plus 800 m and 4 km buffer zones were, respectively, 1.50%, 2.07% and 5.19% of those found in the wider Thames offshore region. The main concentrations of Red-throated Divers in the region are 20-30 kilometres south and west (Fig. 4.2.3.1-1). In the worst case scenario, it would be assumed that birds would be displaced from an area equivalent to the wind farm and 4 km buffer and that none would be able to successfully settle in these areas.

In this case, the effects on the regional population through increased mortality following displacement of the birds local to the wind farm area (plus 4 km buffer) should be considered to be of Medium Magnitude and consequently of High Significance. Note, though, that if a buffer of 800 m was to be used, the effect would be of Low Magnitude and thus 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 appreciably.

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.

6.5.2 Great Skua — BCC Amber, Nationally Important (autumn)

The numbers of Great Skuas passing through the wider study area in early autumn in both years were judged as nationally important using the species' summer population threshold. (The study area and the wind farm area were estimated to support respective peaks of 1.58% and 0.22% of the species' national population.) 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 and the small numbers recorded in winter it is not possible to reliably assess what proportion of the regional population uses the Greater Gabbard wind farm 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 to remain 2-5 km from coasts when migrating (Furness 2002), easily avoiding the Greater Gabbard wind farm area 23 km offshore.

As the peak numbers recorded only occur during relatively short passage periods, the effects on the regional population through increased mortality following displacement of the birds local to the wind farm area are considered to be of Negligible Magnitude and consequently of Very Low Significance.

Collision Risk

Birds recorded in flight in September 2004 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, using data from 2004/05 and assuming a medium avoidance rate of 0.9982, an estimated 2.44 birds per month were predicted to hit the wind farm turbines in the two areas – a mean of 0.104 birds per turbine per summer season. In contrast, the following autumn, none were recorded at turbine height. In reality, the number of Great Skuas hitting turbines is likely to be considerably lower than suggested by the first year's data, as the peak count seen in September almost certainly reflected birds on passage and numbers were not sustained at this level in other months. 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.

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

Lesser Black-backed Gulls were recorded in the Greater Gabbard study 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.

In summer, the majority of birds using the Greater Gabbard are likely to originate from the Alde-Ore SPA (given the lack of other sizeable colonies in the immediate vicinity). A total of 21,700 pairs of Lesser Black-backed Gulls are estimated to breed here on Orford Ness, this total representing at least 17.5% of the breeding Western Europe/Mediterranean/Western Africa population and 26.1% of the national population (Stroud *et al.* 2001). 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. Peaks of 780 and 1,909 Lesser Black-backed Gulls were estimated for the study area in the summers of 2004 and 2005, both figures less than the threshold for national importance.

Despite the presence of the large breeding colony at Orford Ness, numbers of Lesser Black-backed Gulls using the study area were actually found to be greater in winter than summer. Peaks of 1,508 and 2,419 birds were estimated in the winters of 2004/05 and 2005/06, these figures suggesting that the wider study area was of national importance for the species at this time. (The study area and the wind farm area were estimated to support peaks that were respectively 3.97 and 0.55 times the national importance threshold.) Lesser Black-backed Gulls breeding in Britain typically move south in winter, with many (including birds from Orford Ness) moving to coastal France and Iberia (Rock 2002). The majority of birds present in the study area in winter are thus likely to originate from breeding sites further north or east rather than from Alde-Ore SPA. The species was under-recorded in the area by winter 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 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 and 4 km buffer zones were, respectively, only 0.63%, 0.87% and 2.18% of those found in the wider Thames offshore region. Assuming that birds would be lost from an area equivalent to the wind farm and 4 km buffer, the effects on the regional population should thus be considered to be of Low Magnitude and consequently of Medium Significance. Note, though, that if a buffer of 800 m was to be used, the effect would be of Negligible Magnitude and thus Low Significance.

Collision Risk

Collision risk analyses suggested that the wind farm does not offer a serious potential risk to Lesser Black-backed Gulls. Averages of 70 and 76% of all Lesser Black-backed Gulls were estimated to be in flight at any one time in 2004/05 and 2005/06 respectively and an estimated 6.6 and 17.7% 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, using data from the first year of study and assuming a medium avoidance rate of 0.9982, an estimated 1.8 and 1.9 birds per month would be predicted to hit the wind farm turbines in summer and winter respectively. In contrast, values of 25.3 and 16.7 birds per month were estimated using data from the second year (due to greater numbers of birds and the larger proportion at rotor height). These figures suggest that between 0.08 and 1.08 birds would hit each turbine each season. The regional population present in winter was probably considerably underestimated by aerial surveys. However, the loss of up to 152 birds per summer season to the wind farm would represent only 0.3% of the number of birds breeding at Orford Ness in the Alde-Ore SPA. Assuming a similar rate for the winter, a total annual loss of 0.6% of the region's birds would represent a c. 9% increase on a background (adult) annual mortality rate of 7% (taken from Garthe & Hüppop 2004), and thus 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.

6.5.4 Great Black-backed Gull — Nationally and Regionally Important (winter)

Great Black-backed Gulls are most numerous in the study area in winter, with peaks estimate of 405 and 1,450 birds in the wider study area in 2004/05 and 2005/06 respectively, the latter figure of national importance. (The study area and the wind farm area were estimated to support peaks that were respectively 3.37 and 0.47 times the national importance threshold.) Due to this, the species is considered to be of High 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 study area was of regional importance and the peak winter numbers estimated to be within the area of the wind farm and the wind farm plus 800 m and 4 km buffer zones were, respectively, 2.00%, 2.76% and 6.90% of those found in the wider Thames offshore region.

The importance of the study 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 wind farm area (plus 4 km buffer) mean that the effect of indirect habitat loss should be considered to be of Medium Magnitude and thus of High Significance. Note, though, that if a buffer of 800 m was to be used, the effect would be of Low Magnitude and thus Low Significance.

Collision Risk

Collision risk analyses suggested that the wind farm does not offer a serious potential risk to Great Black-backed Gulls. Averages of 30 and 74% of all Great Black-backed Gulls were estimated to be in flight at any one time in 2004/05 and 2005/06 respectively and an estimated 13.8 and 25.0% within the height of the sweep of the turbine rotors. Garthe & Hüppop (2004) suggest that Great Black-backed Gulls predominantly fly at heights of between 10 and 20 m. On average, using data from the second year of study and assuming a medium avoidance rate of 0.9982, an estimated <0.1 and 4.5 birds per month would be predicted to hit the wind farm turbines in summer and winter respectively. These figures suggest that between <0.01 and 0.19 birds would hit each turbine each season. The loss of c. 27 birds per winter season would represent only 0.3% of the regional population present in winter (10,069) and a c. 4% increase on a background (adult) annual mortality rate of 7% (taken from Garthe & Hüppop 2004), and thus is unlikely to contribute greatly to changes in the Great 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 Very Low Significance.

Species of Medium / Low Sensitivity

6.5.5 Black-throated Diver — Annex 1, WCA, BCC Amber

Numbers of Black-throated Divers in the wider study area were low with a recorded peak of 27 birds in winter – though this is less than the minimum threshold for national importance of 50, this peak count would actually represent 3.9% of the current estimate for the national wintering population (Baker *et al.* 2005). Due to its conservation status, 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 the 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 southerly wintering sites and northerly breeding grounds.

The numbers of Black-throated Divers estimated to occur in the study area (by boat surveys) and region as a whole (by aerial surveys), although greater than 1% of the national population, cannot be considered nationally important as they were less than the minimum threshold for national importance of 50. For the same reason, the species' numbers in the study area can also not be considered regionally important.

The effects on the regional population through increased mortality following displacement of the birds local to the wind farm area (plus 4 km buffer) 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% in 2004/05 and 9% in 2005/06, 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.

6.5.6 Northern Fulmar — BCC Amber, Regionally Important (winter)

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 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 study area was of regional importance and the peak winter numbers estimated to be within the area of the wind farm and the wind farm plus 800 m and 4 km buffer zones were, respectively, 7.15%, 9.87% and 24.71% 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 wind farm area (plus 4 km buffer) mean that the effect of indirect habitat loss should be considered of High Magnitude and thus of Medium Significance. Note, though, that if a buffer of 800 m was to be used, the effect would be of Medium Magnitude and thus Low Significance.

Collision Risk

Northern Fulmars spend much of their time on the wing – 67% of birds being recorded in flight in 2004/05 and 91% in 2005/06 – and thus there is the possibility 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 in both years of surveys.

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.

6.5.7 European Storm Petrel — Annex 1, BCC Amber

Only one European Storm Petrel was recorded during the surveys, 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.

6.5.8 Leach's Storm Petrel — Annex 1, WCA, BCC Amber

Only one Leach's Storm Petrel was recorded during the surveys, in October 2005. 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

As with European Storm Petrels, Leach's 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.

6.5.9 Northern Gannet — BCC Amber, Regionally Important (winter)

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 study area. Peak numbers of 139 and 260 birds were estimated in winters 2004/05 and 2005/06 respectively and peaks of 257 and 268 in the summers of 2004 and 20065. The species' winter numbers in the wider study area were of regional importance and, as such, it 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 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 and 4 km buffer zones were, respectively, 0.48%, 0.67% and 1.67% of those found in the wider Thames offshore region. Northern Gannets are among the most maritime of the species found in the study area; 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 wind farm area (plus 4 km buffer) mean that the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance. Note, though, that if a buffer of 800 m was to be used, the effect would be of Negligible Magnitude and thus Very 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% (2004/05) to 56% (2005/06) of Gannets are in flight at any one time and that only 0.6% (2004/05) to 3.0% (2005/06) 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 study area, therefore, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.10 Great Cormorant — (SPA), BCC Amber

A maximum of just three Great Cormorants was recorded in the study area during winter and none in summer. This species is not a designated feature of the Alde-Ore SPA, though is a feature at a number of more distant SPAs in the wider Outer Thames Estuary region – Abberton Reservoir (in the breeding and wintering seasons), the Blackwater Estuary, the Colne Estuary, Dengie, the Medway Estuary and Marshes and The Swale (winter). Given the small number of birds recorded and the distance of these

SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Low Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Great Cormorants are predominantly associated with sheltered coastal or inland locations in winter (Stroud *et al.* 2001) and are largely absent from offshore locations at any significant distance from the coast (Stone *et al.* 1995). Due to this and their low numbers in the study area, 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 Great Cormorants typically fly close to the sea below the height of turbine rotors (Garthe & Hüppop 2004), the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.11 Dark-bellied Brent Goose (SPA), BCC Amber

A maximum of just 21 Dark-bellied Brent Geese was recorded in the study area in September 2004, with only two further occurrences in the rest of the study period. This species is not a designated feature of the Alde-Ore SPA, though is a winter feature at a number of more distant SPAs in the wider Outer Thames Estuary region – Benfleet & Southend Marshes, the Blackwater Estuary, the Colne Estuary, the Crouch and Roach Estuaries, Dengie, Foulness, Hamford Water, the Medway Estuary and Marshes, the Stour and Orwell Estuaries and The Swale. Given the small number of birds recorded and the distance of these SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Low Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Dark-bellied Brent Geese are predominantly found in winter on shallow coasts and estuaries with extensive mudflats where they feed on intertidal plants (Stroud *et al.* 2001) and are thus not usually found at any significant distance from the coast. The birds reported in the offshore study area are thus likely to have been on passage between their breeding and wintering grounds. Due to this and their low numbers in the study area, 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 in the study area and habitat preferences, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.12 Eurasian Wigeon (SPA), BCC Amber

Two flocks of just seven and five Eurasian Wigeon were recorded in the study area in autumn 2005. This species is a feature of the Alde-Ore SPA and also a number of more distant SPAs in the wider Outer Thames Estuary region – Abberton Reservoir, the Blackwater Estuary, Foulness, Hamford Water, the Medway Estuary and Marshes, the Stour and Orwell Estuaries and The Swale. Given the small number of birds recorded and the distance of most of these SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Low Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Wigeon are found in winter on mudflats and saltmarsh, as well as flooded grassland on the coast and inland (Stroud *et al.* 2001) and are thus not usually found at any significant distance from the coast. The birds reported in the offshore study area are thus likely to have been on passage between their breeding and wintering grounds. Due to this and their low numbers in the study area, 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 in the study area and habitat preferences, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.13 Pintail — WCA, (SPA), BCC Amber

Just a single Pintail was recorded in the study area in September 2005. This species is not a designated feature of the Alde-Ore SPA, though is a winter feature at a number of more distant SPAs in the wider Outer Thames Estuary region – Abberton Reservoir, the Blackwater Estuary, the Medway Estuary and Marshes, the Stour and Orwell Estuaries, the Thames Estuary and Marshes and The Swale. Given that only one bird was recorded and the distance of these SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Medium Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Pintail are found in winter both on estuarine and inland freshwater sites (Stroud *et al.* 2001) and are thus not usually found at any significant distance from the coast. Any birds in the study area are thus likely to be on passage between their breeding and wintering grounds. Due to this and the low numbers likely to pass through the study area, 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 in the study area and habitat preferences, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.14 Common Scoter — WCA, UK BAP, BCC Amber

Maxima of just 24 and seven Common Scoters were recorded in the study area in the winters of 2004/05 and 2005/06 respectively and just one and 46 in the summers of 2004 and 2005. 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.

6.5.15 Ringed Plover (SPA), BCC Amber

Just a single Ringed Plover was recorded in the study area in September 2005. This species is not a designated feature of the Alde-Ore SPA, though is a winter feature at a number of more distant SPAs in the wider Outer Thames Estuary region – Benfleet & Southend Marshes, the Blackwater Estuary, the Colne Estuary, Hamford Water, the Medway Estuary and Marshes, the Stour and Orwell Estuaries, the Thames Estuary and Marshes and The Swale. Given that only one bird was recorded and the distance of these SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Low Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Ringed Plover are found on estuaries and open coasts in winter and any birds found in the study area are thus likely to be on passage between their breeding and wintering grounds. Due to this and the low numbers likely to pass through the study area, 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 in the study area and habitat preferences, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.16 Grey Plover (SPA), BCC Amber

Grey Plover were recorded just twice on surveys – three individuals in May 2004 and two during April 2006. This species is not a designated feature of the Alde-Ore SPA, though is a winter feature at a number of more distant SPAs in the wider Outer Thames Estuary region – Benfleet & Southend Marshes, the Blackwater Estuary, the Colne Estuary, Dengie, Foulness, Hamford Water, the Medway Estuary and Marshes, the Stour and Orwell Estuaries, the Thames Estuary and Marshes and The Swale. Given the small number of birds recorded and the distance of these SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Low Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Grey Plover are predominantly found on estuaries in winter and any birds found in the study area are thus likely to be on passage between their breeding and wintering grounds. Due to this and the low numbers likely to pass through the study area, 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 in the study area and habitat preferences, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.17 Bar-tailed Godwit (SPA), BCC Amber

Just a single flock of six Bar-tailed Godwit was recorded during surveys. This species is not a designated feature of the Alde-Ore SPA, though is a winter feature at four more distant SPAs in the wider Outer Thames Estuary region – Dengie, Foulness, Hamford Water and The Swale. Given the small number of birds recorded and the distance of these SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Low Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Bar-tailed Godwit are predominantly found on estuaries in winter and any birds found in the study area are thus likely to be on passage between their breeding and wintering grounds. Due to this and the low numbers likely to pass through the study area, 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 in the study area and habitat preferences, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.18 Eurasian Curlew (SPA), BCC Amber

Just a single Eurasian Curlew was recorded in the study area in September 2005. This species is not a designated feature of the Alde-Ore SPA, though is a winter feature at a number of more distant SPAs in the wider Outer Thames Estuary region – the Blackwater Estuary, Foulness, the Medway Estuary and Marshes, the Stour and Orwell Estuaries and The Swale. Given that only one bird was recorded and the distance of these SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Low Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Eurasian Curlew are found on estuaries and open coasts in winter and any birds found in the study area are thus likely to be on passage between their breeding and wintering grounds. Due to this and the low numbers likely to pass through the study area, 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 in the study area and habitat preferences, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.19 Ruddy Turnstone (SPA), BCC Amber

Just a single flock of two Ruddy Turnstones was recorded during surveys. This species is not a designated feature of the Alde-Ore SPA, though is a winter feature at two more distant SPAs in the wider Outer Thames Estuary region – the Stour and Orwell Estuaries and Thanet Coast and Sandwich Bay. Given the small number of birds recorded and the distance of these SPAs to the Greater Gabbard wind farm area, this species is assessed on the basis of its other conservation designations to be of Low Sensitivity to the effects of the wind farm.

Indirect Habitat Loss / Disruption of Flight-lines

Ruddy Turnstone are found on estuaries and open coasts in winter and any birds found in the Greater study area are thus likely to be on passage between their breeding and wintering grounds. Due to this and the low numbers likely to pass through the study area, 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 in the study area and habitat preferences, the effects of collision risk would appear to be of Negligible Magnitude and thus of Very Low Significance.

6.5.20 Little Gull — Annex 1, WCA

Maxima of just four and 27 Little Gulls were recorded in the study area during the survey in the winters of 2004/05 and 2005/06 respectively and just five and 11 in the summers of 2004 and 2005. 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, given the species' low numbers and the fact that no Little Gulls were recorded at turbine height in either year of study, the effects of collision risk are also likely to be of Negligible Magnitude and thus of Very Low Significance.

6.5.21 Black-headed Gull — (SPA), BCC Amber

The Black-headed Gull is a designated feature of the Alde-Ore SPA, with a total of 1,582 pairs estimated to breed there – 1.0% of the national population (Stroud *et al.* 2001). Despite the presence of this breeding site, maxima of just 23 and five Black-headed Gulls were recorded in the study area in the summers of 2004 and 2005 respectively, probably due to its distance offshore. Similarly, peaks of just nine and 10 were recorded in the winters of 2004/05 and 2005/06.

Due to the apparent limited use of the study area by birds from the SPA, this species is assessed, on the basis of its other conservation designations, to be of Low Sensitivity to the effects of the wind farm species.

Indirect Habitat Loss / Disruption of Flight-lines

As a consequence of the low number of birds recorded in the study area in both summer and winter, 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.

6.5.22 Mew (Common) Gull — BCC Amber, Regionally Important

Maxima of 56 and 220 Mew Gulls were estimated for the study area during the winters of 2004/05 and 2005/06 respectively, with a maximum of just three in summer 2004. The winter peak was 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.

The concentration of Mew Gulls found in the whole 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 and 4 km buffer zones were, respectively, 0.78%, 1.08% and 2.69% of those found in the wider Thames offshore region. Given the apparent regional importance of the species' numbers in the wind farm area (plus 4 km buffer), the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance. Note, a similar result would be attained assuming an 800 m buffer.

Collision Risk

The proposed wind farm could present a collision risk to foraging birds as well as birds passing through the area on migration in the spring and autumn. Results indicated that 86% (2004/05) to 95% (2005/06) of Mew Gulls are in flight at any one time, though that only 4.2% (2004/05) to 5.8% (2005/06) of these fly at the height of the turbine rotors. Garthe & Hüppop (2004) suggest that Mew Gulls predominantly fly between 10 and 20 m.

Given these figures, collision risk would not be expected to exceed that predicted for Lesser Black-backed Gull, and thus in spite of the regional importance of the study area for Mew Gulls, the effects of collision risk for this species are assessed to be of Negligible Magnitude and thus of Very Low Significance.

6.5.23 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, with an estimated 6,050 pairs (3.8% of the national population) breeding on Orford Ness (Stroud *et al.* 2001). Despite this, no Herring Gulls were recorded in the study area in summer 2004 and a peak of only 110 in summer 2005 (<0.1% of the national population), probably due to its distance offshore.

As with Lesser Black-backed Gull, considerably more Herring Gulls used the study area in winter, with peaks of 957 and 1,731 birds in 2004/05 and 2005/06 respectively. During winter the southern North Sea may contain many Herring Gulls (Carter *et al.* 1993; Stone *et al.* 1995) due to large influxes of northern breeders joining wintering British birds (Calladine 2002). The British breeding population is dispersive with some birds remaining in the same regions through the year and thus a proportion of the birds using the study area in winter may originate from the Alde-Ore SPA.

Due to the apparent limited use of the study area by birds from the SPA in summer, this species is assessed to be of Medium Sensitivity to the effects of the wind farm based on the regional importance of the study area for the species in winter.

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 study area in winter 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 and 4 km buffer zones were, respectively, 1.06%, 1.46% and 3.66% of those found in the wider Thames offshore region. The importance of the study and wind farm areas for Herring Gulls in winter 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). The apparent regional importance of the species' numbers in the wind farm area (plus 4 km buffer) means that the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance. Note, a similar result would be attained assuming an 800 m buffer.

Collision Risk

The proposed wind farm is likely to mainly pose 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 86% (2005/06) to 91% (2004/05) of Herring Gulls are in flight at any one time, and that 10.1% (2004/05) to 16.8% (2005/06) of these fly at the height of the turbine rotors. Garthe & Hüppop (2004) suggest that Herring Gulls predominantly fly between 20 and 50 m.

Given these figures, collision risk would not be expected to exceed that predicted for Lesser Black-backed Gull, and thus in spite of the regional importance of the study and wind farm areas for the species, the effects of collision risk for this species are assessed to be of Negligible Magnitude and thus of Very Low Significance.

6.5.24 Black-legged Kittiwake — BCC Amber, Regionally Important

Black-legged Kittiwakes were recorded in the study area throughout the year. In summer, some of the birds present may have originated from the small colonies at Sizewell and Lowestoft. However, 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 away (Carter *et al*. 1993).

Peaks of 205 and 1,126 Black-legged Kittiwakes were estimated in the study area in the summers of 2004 and 2005 respectively. In comparison, peaks of 1,218 and 1,586 were estimated in the following winters – numbers that were of regional importance. As such, the species is considered to be of Medium Sensitivity to the effects of the wind farm.

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 and 4 km buffer zones were, respectively, 1.01%, 1.39% and 3.47% 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 wind farm area (plus 4 km buffer) mean that the effect of indirect habitat loss should be considered of Low Magnitude and thus of Low Significance. Note, a similar result would be attained assuming an 800 m buffer.

Collision Risk

The proposed wind farm could present a collision risk to foraging birds both in summer and winter. Aerial surveys indicated that 83% (2004/05) to 86% (2005/06) of Black-legged Kittiwakes are in flight at any one time, although only 1.5% (2004/05) to 16.1% (2005/06) 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 would not be expected to exceed that predicted for Lesser Black-backed

Gulls, and thus the effects of collision risk for this species are assessed to be of Negligible Magnitude and thus of Very Low Significance.

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

The Sandwich Tern is a designated feature of the Alde-Ore SPA, with a total of 169 pairs estimated to breed there – 1.2% of the national population. A further 320 pairs are also estimated to breed on the Foulness SPA, further south in the Outer Thames Estuary region (Stroud *et al.* 2001). Although most Sandwich Terns using the study area in summer are likely to originate from the Alde-Ore SPA, the species predominantly forages in shallow inshore waters and few were found in the deeper waters of the proposed wind farm area, 23 km offshore. Indeed, maxima of just 19 and nine Sandwich Terns were recorded in the study area in the summers of 2004 and 2005 respectively. Peaks of nine Sandwich Terns were also recorded at the end of each winter as birds returned from Africa for the breeding season.

Due to the apparent limited use of the study area by birds from the SPA, this species is assessed, on the basis of its other conservation designations, to be of Medium Sensitivity to the effects of the wind farm species.

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.

6.5.26 Common Tern (SPA), Annex 1

This species is not a designated feature of the Alde-Ore SPA, though is a breeding feature at the Foulness SPA, further south in the Outer Thames Estuary region where an estimated 220 pairs breed – 1.8% of the national population (Stroud *et al.* 2001). As with other terns, on the coast the species predominantly forages in shallow inshore waters and few were found in the deeper waters of the proposed wind farm area, 23 km offshore. Indeed, maxima of just five and nine Common Terns were recorded in the study area in the summers of 2004 and 2005 respectively. Peaks of seven and 21 Common Terns were also recorded at the end of the two winters of study as birds returned for the breeding season.

Due to the apparent limited use of the study area by birds from SPAs, this species is assessed, on the basis of its other conservation designations, to be of Medium Sensitivity to the effects of the wind farm species.

Indirect Habitat Loss / Disruption of Flight-lines

The majority of migration and foraging activity of Common Terns is likely to occur along the coast, 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 on the coast 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.

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

The Little Tern is a designated feature of the Alde-Ore SPA, with a total of 48 pairs estimated to breed there – 2.0% of the national population. This species is also a feature of a number of more distant SPAs in the wider Outer Thames Estuary region – the Blackwater Estuary, the Colne Estuary, Hamford Water, the Medway Estuary and Marshes and Minsmere-Walberswick (Stroud *et al.* 2001). Although most Little Terns using the study area in summer are likely to originate from the Alde-Ore SPA, the species predominantly forages in shallow inshore waters and indeed, only two Little Terns were recorded during surveys of the study area, in April 2004.

Due to the apparent limited use of the study area by birds from the SPA, this species is assessed, on the basis of its other conservation designations, to be of Medium Sensitivity to the effects of the wind farm species.

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.

6.5.28 Common Guillemot BCC Amber, Regionally Important

Common Guillemots were recorded in the study area throughout the year, though do not breed in the local region and were thus most numerous in winter. Peak numbers of 1,607 and 1,786 Common Guillemots were estimated in the winters of 2004/05 and 2005/06 respectively and peaks of 533 and 422 in the summers of 2004 and 2005. Numbers of auks as a combined species group were of regional importance in the wider study area in winter 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 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 and 4 km buffer zones were, respectively, 1.82%, 2.52% and 6.30% of those found in the wider Thames offshore region.

The apparent regional importance of the numbers of auks in the wind farm area (plus 4 km buffer) means that the effect of indirect habitat loss should be considered of Medium Magnitude and thus of Low Significance. Note, that if a buffer of 800 m was to be used, the effect would be of Low Magnitude, but also Low Significance.

Collision Risk

Common Guillemots spend much of their time rafting on the surface of the sea; indeed only 4% (2004/05) to 10% (2005/06) 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 in either year of study. 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.

6.5.29 Razorbill — BCC Amber, Regionally Important

Peaks of 1,411 and 565 Razorbills were estimated for the study area in the winters of 2004/05 and 2005/06 respectively. Numbers of auks as a combined species group were 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 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 and 4 km buffer zones were, respectively, 1.82%, 2.52% and 6.30% of those found in the wider Thames offshore region.

The apparent regional importance of the numbers of auks in the wind farm area (plus 4 km buffer) means that the effect of indirect habitat loss should be considered of Medium Magnitude and thus of Low Significance. Note, that if a buffer of 800 m was to be used, the effect would be of Low Magnitude, but also Low Significance.

Collision Risk

Razorbills spend much of their time rafting on the surface of the sea; indeed only 4% (2004/05) to 10% (2005/06) 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 in either year of study. 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

6.5.30 Sky Lark — UK BAP, BCC Red

Single Sky Larks were recorded in the study area in September 2004 and February 2006. 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 & Collision Risk

Any Sky Larks found in the study area are likely to be on passage between their breeding and wintering grounds and it should be noted that passerine species often migrate nocturnally. However, given that only two birds were recorded during the whole period of study there is no reason to suppose that this species passes through the study area in significant numbers.

Thus both the effects of displacement and collision risk are considered to be of Negligible Magnitude and Very Low Significance.

6.5.31 Song Thrush — UK BAP, BCC Red

Song Thrushes were recorded in the study area on just three occasions, with a peak of 20 birds 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 & Collision Risk

Any Song Thrushes found in the study area are likely to be on passage between their breeding and wintering grounds and it should be noted that passerine species often migrate nocturnally. However, given the limited occurrence of the species in the area during the period of the study there is no reason to suppose that this species passes through the study area in significant numbers.

Thus both the effects of displacement and collision risk are considered to be of Negligible Magnitude and Very Low Significance.

6.5.32 Reed Bunting — UK BAP, BCC Red

Just a single Reed Bunting was recorded in the study area in October 2005. 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 & Collision Risk

Any Reed Buntings found in the study area are likely to be on passage between their breeding and wintering grounds and it should be noted that passerine species often migrate nocturnally. However, given that only one bird was recorded during the whole period of study there is no reason to suppose that this species passes through the study area in significant numbers.

Thus both the effects of displacement and collision risk are considered to be of Negligible Magnitude and Very Low Significance.

6.6 Conclusions

Table 6.6-1 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.

Table 6.6-1 Significance of the effects of the major impacts of the wind farm for bird species of conservation importance. Note, two alternate scenarios are presented for the effects of indirect habitat loss / disruption of flight-lines, one where it was assumed that birds would be displaced from an area equivalent to the wind farm plus a 800 m buffer, the second assuming a 4 km buffer – differences in the resulting evaluations between the two scenarios are highlighted.

	Indirect habitat loss / disruption of flight-lines		**Collision risk**
	Using 800 m buffer	**Using 4 km buffer**	
SPECIES OF VERY HIGH / HIGH SENSITIVITY			
Red-throated Diver	Low	High	Very Low
Great Skua	Very Low	Very Low	Very Low
Lesser Black-backed Gull	Low	Medium	Low
Great Black-backed Gull	Low	High	Very Low
SPECIES OF MEDIUM / LOW SENSITIVITY			
Black-throated Diver	Very Low	Very Low	Very Low
Northern Fulmar	Low	Medium	Very Low
European Storm Petrel	Very Low	Very Low	Very Low
Leach's Storm Petrel	Very Low	Very Low	Very Low
Northern Gannet	Very Low	Low	Very Low
Great Cormorant	Very Low	Very Low	Very Low
Dark-bellied Brent Goose	Very Low	Very Low	Very Low
Eurasian Wigeon	Very Low	Very Low	Very Low
Pintail	Very Low	Very Low	Very Low
Common Scoter	Very Low	Very Low	Very Low
Ringed Plover	Very Low	Very Low	Very Low
Grey Plover	Very Low	Very Low	Very Low
Bar-tailed Godwit	Very Low	Very Low	Very Low
Eurasian Curlew	Very Low	Very Low	Very Low
Ruddy Turnstone	Very Low	Very Low	Very Low
Little Gull	Very Low	Very Low	Very Low
Black-headed Gull	Very Low	Very Low	Very Low
Mew (Common) Gull	Low	Low	Very Low
Herring Gull	Low	Low	Very Low
Black-legged Kittiwake	Low	Low	Very Low
Sandwich Tern	Very Low	Very Low	Very Low
Common Tern	Very Low	Very Low	Very Low
Little Tern	Very Low	Very Low	Very Low
Common Guillemot	Low	Low	Very Low
Razorbill	Low	Low	Very Low
Sky Lark	Very Low	Very Low	Very Low
Song Thrush	Very Low	Very Low	Very Low
Reed Bunting	Very Low	Very Low	Very Low

The assessment has shown that the main effects of the wind farm will only be of Very Low or Low Significance for the majority of the bird species of conservation importance presently found offshore at Greater Gabbard. The highest levels of Significance have been estimated for the effects of indirect habitat loss / disruption of flight-lines on Red-throated Diver, Lesser Black-backed Gull, Great Black-backed Gull and Northern Fulmar. These results are for worst-case scenarios, based on the assumption that all birds would be displaced from an area equivalent to the wind farm plus a 4 km buffer and unable to settle elsewhere. Effects would have been of Low Significance in each case if it had been assumed that the effects were limited to a buffer distance of 800 m around the wind farm. It should also be noted that the actual effects on bird mortality and thus populations of displacement following disturbance / habitat loss are difficult to predict or monitor.

6.7 SPA species

Five species – Black-headed Gull, Lesser Black-backed Gull, Herring Gull, Sandwich Tern and Little Tern – designated as breeding features of the Alde-Ore SPA were recorded in the study area during the breeding season. Although it is likely that many of these birds will have originated from the SPA, only Lesser Black-backed Gull was recorded in significant numbers in the study area and thus considered of Very High Sensitivity to the effects of the wind farm. For this species, the effects of indirect habitat loss / disruption of flight-lines were considered of Medium Significance and collision risk of Low Significance, primarily, though, due to the numbers of the species recorded in the study area in winter. For other species, due to their limited use of the wind farm, effects on the species and thus on the integrity of the SPA were mostly considered to be of Very Low Significance; effects of indirect habitat loss / disruption of flight-lines for Herring Gull were considered to be of Low Significance again due to numbers found in the study area in winter.

One species – Eurasian Wigeon – designated as a winter feature of the SPA was also recorded in the study area in winter, though only two small flocks were recorded probably on passage between their breeding and wintering grounds. Likewise, therefore, effects on this species and thus the SPA are considered to be of Very Low Significance.

7. CUMULATIVE ASSESSMENT

7.1 Background

The effects of the Greater Gabbard wind farm need to be considered in conjunction with those from other local developments to determine possible cumulative impacts on i. the nationally important bird populations occurring in the region, ii. species that are designated features of local SPAs – notably Lesser Black-backed Gulls from the Alde-Ore SPA – and which occur in significant numbers in the study area, and iii. species such as Red-throated Diver that may be features of a hypothetical Outer Thames SPA.

There are no known developments that will directly impact the Alde-Ore SPA and which may act in combination to the effects from the Greater Gabbard wind farm. The SPA is vulnerable to sea-level rise and coastal squeeze; human disturbance from recreation and shooting is thought to be minimal. Much of the site is also managed by the Suffolk Wildlife Trust, the National Trust, the Royal Society for the Protection of Birds and English Nature and thus further protected from development.

However, in addition to the Greater Gabbard 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 using this area. Thirty turbines have already been constructed at Kentish Flats 8 km off Whitstable (GREP UK Ltd 2002). Consent has also been given to another Round 1 wind farm project within the Thames offshore region, for 30 turbines at Gunfleet Sands 8 km off Clacton-on-Sea (Hydrosearch 2002). In addition, there have been applications for Round 2 projects of a further 16 turbines at Gunfleet Sands, up to 100 turbines 10 km off the Thanet coast and up to 300 turbines in the proposed London Array wind farm towards the inner Thames Estuary (RPS 2005) – the largest of the proposed sites in the region. The Greater Gabbard site is the furthest north of these and is also the most exposed, the furthest offshore and surrounded by the deepest water.

Additionally it should be noted that future port expansions at Bathside Bay, Harwich, Felixstowe and London Gateway and associated capital dredging and disposal of sediments offshore, as well as marine aggregate extraction (11 projects are licensed or proposed in the Outer Thames area) may also potentially add to these effects.

As detailed above, the main effects for birds of the construction, operation and decommissioning of the proposed Greater Gabbard 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:

7.2 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 be the most sensitive species in each area. There is thus likely to be little additional impact from these sites during the construction period as birds would not be displaced.

The proposed Greater Gabbard 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 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 High Significance for Red-throated Diver and Great Black-backed Gull, of Medium Significance for Lesser Black-backed Gull and Northern Fulmar, though of Very Low to Low Significance for all other species.

In comparing the effects of habitat loss predicted to occur at the Greater Gabbard wind farm with those predicted for other sites, however, it should be noted that the present assessment considered a buffer distance of 4 km around the wind farm, whereas, for example, the London Array study only considered a 1 km buffer. Up to 6,775 Red-throated Divers were recorded in the proposed London Array wind farm plus 1 km buffer area, in comparison to peak estimates of 138 and 345 for the Greater Gabbard wind farm plus 800 m and 4 km buffers. Using an 800 m buffer that is more comparable to the other studies, the effects of indirect habitat loss at Greater Gabbard would be considered of Low Significance for all four of the above species.

Due to its relative proximity to the site, the Greater Gabbard wind farm is likely to have more effect on features at the Alde-Ore SPA than any of the other proposed wind farms, though as noted in the species accounts (Section 6.5), the effects of indirect habitat loss are only likely to be of Significance for Lesser Black-backed Gull.

Effects of indirect habitat loss at Greater Gabbard on the status of birds occurring in nationally important numbers in the region as a whole (or those utilising a hypothetical Outer Thames SPA), such as divers, are clearly likely to be smaller than those at the London Array site should consents be granted for that project. It should also be noted that should divers be displaced from the London Array site, these birds are perhaps more likely to attempt to settle in areas immediately adjacent to this site where further concentrations of divers already occur (see Figure 4.2.3.1-1 in the baseline report) than the Greater Gabbard area which lies c. 20 km distant. The effects of the proposed Greater Gabbard Offshore Wind farm, though of Significance for four species, will thus make a relatively small addition to the much larger cumulative impact that may occur for birds in the region as a result of indirect loss of habitat should all of the proposed wind farms be developed.

7.3 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 calculations used in the different studies. Nevertheless it is possible to make a broad assessment of the cumulative impacts posed by the Greater Gabbard 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 Low Significance for Lesser Black-backed Gull but Very Low Significance for all other 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.

8. MITIGATION MEASURES

Bird studies undertaken to date have found that Red-throated Diver, Great Skua, Lesser Black-Backed Gull and Great Black-backed Gull reach levels of national significance within the offshore study area, though only the former species within the area of the proposed wind farm itself. A further five species and the species group containing auks were found in regionally important numbers.

Among species found to be of national importance in the study area during the baseline surveys, numbers of Red-throated Diver peaked during the winter (November to March), those of Great Skua in September, those of Lesser Black-backed Gull in midwinter (December) and also on spring and autumn passage and those of Great Black-backed Gull in midwinter (see tables in Sections 4.2, 4.18, 4.22 and 4.24).

Some recommendations for mitigation can be made:

- *Offshore construction*. Given the predicted levels of Significance of indirect habitat loss / disruption of flight-lines for Red-throated Diver, Lesser Black-Backed Gull and Great Black-backed Gull as well as Northern Fulmar, consideration needs to be made of the effects of construction, particularly at key periods for these species (as detailed above and in the species accounts).

  Due to day-length and the weather, construction work is likely to be reduced during the winter and this will help lessen the possibility of disturbance to divers and gulls in the short-term. However, limiting work at any one time to sections of the wind farm area may also be considered to minimise the temporary "loss" of habitat to the birds.

  If turbines are to be supported by monopiles, on-site monitoring of seabird activity should be undertaken in order to record the numbers of birds using the area and all disturbance events, quantifying for example numbers of birds involved and distances flown.

- *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 and in poor weather.

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 & Kahlert 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.

9. CURRENT AND FUTURE MONITORING

9.1 Monitoring during Construction and Operation

- It is recommended that offshore monitoring continues for the interim period prior to construction, for continuity and critically in order to maximise the quantity of data against which any subsequent effects of the wind farm on birds can be assessed.

- It is also recommended that offshore monitoring is undertaken during the construction period so as to be able to assess the possible effects of disturbance on birds, in particular if turbines are to be supported by monopiles, and to aid mitigation.

- Following good practice, monitoring during the first three years of operation is recommended, so as to better understand the direct (collisions) and indirect (attraction, habituation and displacement) 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.

- 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.

9.2 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 has funded 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. Work to develop approaches to model cumulative effects and to prepare advice relevant to avian conservation is also planned at Glasgow University, funded by Scottish Natural Heritage. To be able to carry out a Cumulative Assessment of the effect of the Thames region wind farms on the birds that the area 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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References

Aebischer, N.J., Coulson, J.C. & Colebrook, J.M. (1990) Parallel long-term trends across four marine trophic levels and weather. *Nature*, **347**, 753-755.

Anderson, A. & Cosgrove, P. (2002) Northern Fulmar. Pp. 117-199 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Arnott, S.A. & Ruxton, G.D. (2002) Sandeel recruitment in the North Sea: demographic, climatic and trophic effects. *Marine Ecology Progress Series*, **238**, 199-210.

Austin, G., Peachel, I. & Rehfisch, M.M. (2000) Regional trends in coastal wintering waders in Britain. *Bird Study*, **47**, 352-371.

Austin, G., Jackson, S.F. & Mellan, H.J. (2004) *WeBS Alerts 2000/2001: changes in numbers of wintering waterbirds in the United Kingdom, its constituent countries, Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs)*. BTO Research Report No. 349 to the WeBS Partnership. BTO, Thetford.

Austin, G. & Rehfisch, M.M. (2005) Shifting nonbreeding distributions of migratory fauna in relation to climatic change. *Global Change Biology*, **11**, 31–38.

Austin, G.E, & Rehfisch. M.M. (2003) The likely impact of sea level rise on waders (Charadrii) wintering on estuaries. *Journal for Nature Conservation*, **11**: 1-16.

Baker, H., Stroud, D.A., Aebischer, N.J., Cranswick, P.A., Gregory, R.D., McSorley, C.A., Noble, D.G. & Rehfisch, M.M. (2005) Population estimates of birds in Great Britain and the United Kingdom. *British Birds* **99**: 25-44.

Band, W. (2000) *Windfarms and birds: calculating a theoretical collision risk assuming no avoidance action*. Scottish Natural Heritage Report.

Band, W., Madders, M. & Whitfield, D.P. (2005) *Developing field and analytical methods to assess avian collision risk at windfarms*. In: de Lucas, M., Janss, G. & Ferrer, M. (eds.) Birds and Wind Power. Lynx Editions, Barcelona. http://www.quercus.pt

Banks, A., Bolt, D., Bullock, I., Haycock, B., Musgrove, A., Newson, S., Fairney, N., Sanderson, W., Schofield, R., Smith, L., Taylor, R. & Whitehead, S. (2004) *Ground and aerial monitoring protocols for in shore Special Protection Areas*. Countryside Council for Wales Marine Monitoring Report No: 11, 89 pp.

Banks, A.N., Burton, N.H.K., Austin, G.E., Carter, N., Chamberlain, D.N., Holt, C., Rehfisch, M.M., Wakefield, E. & Gill, P. (2005) *The potential effects on birds of the Greater Gabbard Offshore Wind Farm: Report for February 2004 to March 2005*. BTO Research Report No. 419, Thetford.

Barbraud, C. & Weimerskirch, H. (2001) Emperor penguins and climate change. *Nature*, **411**, 183–186.

Barrios, L. & Rodriguez, A. (2004) Behavioural and environmental correlates of soaring bird mortality at on-shore wind turbines. *Journal of Applied Ecology*, **41**, 72-81.

BirdLife International (2004) *Birds in Europe: population estimates, trends and conservation status*. BirdLife International, Cambridge.

Buckland, S.T., Anderson, D., Burnham, K., Laake, J., Borchers, D. & Thomas, L. (2001) *Introduction to distance sampling: estimating abundance of biological populations.* Oxford University Press, Oxford.

Burton, N.H.K., Musgrove, A.J., Rehfisch, M.M., Sutcliffe, A. & Waters, R. (2003) Numbers of wintering gulls in the United Kingdom, Channel Islands and Isle of Man: a review of the 1993 and previous Winter Gull Roost Surveys. *British Birds*, **96**, 376-401.

Burton, N.H.K., Rehfisch, M.M., Clark, N.A. & Dodd, S.G. (2006) Impacts of sudden winter habitat loss on the body condition and survival of Redshank *Tringa totanus*. *Journal of Applied Ecology*, **43**, 464-473.

Buse, A., Dury, S.J., Woodburn, R.J.W., Perrins, C.M. & Good, J.E.G. (1999) Effects of elevated temperature on multispecies interactions: the case of Pedunculate Oak, Winter Moth and Tits. *Functional Ecology* **13** (Suppl. 1): 74–82.

Calladine, J. (2002) Herring Gull. Pp. 369-372 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Campbell, B. & Lack, E. (1985) *A Dictionary of Birds*. Poyser, Calton.

Camphuysen, C.J., Fox, A.D., Leopold, M.F. & Petersen, I.K. (2004) *Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K.* Report to COWRIE in conjunction with NIOZ.
http://www.thecrownestate.co.uk/1352_bird_survey_phase1_final_04_05_06.pdf

Carter, I.C., Williams, J.M., Webb, A. & Tasker, M.L. (1993) *Seabird concentrations in the North Sea: an atlas of vulnerability to surface pollutants*. Joint Nature Conservation Committee, Peterborough.

Chamberlain, D.E., Rehfisch, M.R., Fox. T., Desholm, M. & Anthony, S.J. (2006) The effect of avoidance rates on bird mortality predictions made by wind turbine collision risk models. *Ibis*, **148**, 198-202.

Christensen, T.K., Hounisen, J.P., Clausager, I. & Petersen, I.K. (2004) *Visual and radar observations of birds in relation to collision risk at the Horns Rev offshore wind farm - annual status report 2003*. NERI Report, 53pp.

Collier, M, Banks, A., Austin, G., Girling, T., Hearn, R. & Musgrove, A. (2005) *The Wetland Bird Survey 2003-04: Wildfowl and Wader Counts*. BTO/WWT/RSPB/JNCC.

Coulson, J.C. (2002) Black-legged Kittiwake. Pp. 377-380 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Crick, H.Q.P. (2004) The impact of climate change on birds. *Ibis*, **146** (Suppl.1), S48–S56.

Crick, H.Q.P. & Sparks, T.H. (1999) Climate change related to egg-laying trends. *Nature*, **399**, 423–424.

Crooks, S. (2004) The effect of sea-level rise on coastal geomorphology. *Ibis*, **146** (Suppl.1), S18-S20.

Desholm, M. & Kahlert, J. (2005) Avian collision risk at an offshore wind farm. *Biology Letters*, **1**, 296-298.

Douse, A. (2002) Common Gull. Pp. 361-364 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Drewitt, A.L. & Langston, R.H.W. (2006) Assessing the impacts of wind farms on birds. *Ibis*, **148** (Suppl. 1), 29-42.

Erickson, W. P., Johnson, G. D., Strickland, M. D., Young, Jr, D. P., Sernka, K. J., & Good, R. E. (2001) *Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the United States*. National Wind Coordinating Committee (NWCC) Resource Document.

Everaert, J., Devos, K., & Kuijken, E. (2002) Windturbines en vogels in Vlaanderen: voorlopige onderzoeksresultaten en buitenlandse bevindingen. [Wind turbines and birds in Flanders (Belgium): preliminary results in a European context]. *Rapport Instituut voor Natuurbehoud*, 2002.3. Instituut voor Natuurbehoud, Brussels, Belgium.

Fernley, J., Lowther, S. & Whitfield, P. (2006) *A review of goose collisions at operating wind farms and estimation of the goose avoidance rate*. Natural Research Ltd / West Coast Energy / Hyder Consulting.

Furness, B. (2002) Great Skua. Pp. 353-355 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Garthe, S. & Hüppop, O. (2004) Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *Journal of Applied Ecology*, **41**, 724-734.

Gauthreaux, S.A., Jr. & C.G. Belser (1999) The behavioral responses of migrating birds to different lighting systems on tall towers. In: *Proceedings of Conference on Avian Mortality at Communication Towers*, August 11, 1999, Cornell University, Ithaca, NY.

Gill, J.P., Sales, D., Pullinger, M. & Durward, J. (2002) *The potential ornithological impact of the proposed Kentish Flats offshore windfarm. Ornithological technical addendum*. Report to GREP UK Marine Ltd. Environmentally Sustainable Systems, Edinburgh.

Goss-Custard, J.D. (1985) Foraging behaviour of wading birds and the carrying capacity of estuaries. Pp. 169-188 in Sibly, R.M. & Smith, R.H. (eds.) *Behavioural Ecology: Ecological Consequences of Adaptive Behaviour*. Blackwell Scientific Publications, Oxford.

Goss-Custard, J.D., Stillman, R.A., West, A.D., Caldow, R.W.G. & McGrorty, S. (2002) Carrying capacity in overwintering migratory birds. *Biological Conservation*, **105**, 27-41.

Gregory R.D., Wilkinson N.I., Noble D.G., Robinson J.A., Brown A.F., Hughes J., Procter D.A., Gibbons D.W. & Galbraith C.A. (2002) The population status of birds in the United Kingdom, Channel Islands and Isle of Man: an analysis of conservation concern 2002-2007. *British Birds*, **95**, 410–450.

GREP UK Ltd (2002) Kentish Flats Environmental Statement.

Harris, M.P. & Swann, B. (2002) Guillemot. Pp. 397-400 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Harris, M.P., Baillie, S.R. & Dudley, C. (1997) Ringing recoveries and colony attendance of Isle of May Guillemots. *Seabird*, **19**, 31-39.

Henderson, N. & Sutherland, W.J. (1996) Two truths about discounting and their environmental consequences. *Trends in Ecology & Evolution*, **11**, 527-528.

Heubeck, M. & Shaw, D. (2005). Shetland's seabird meltdown. *British Birds*, **97**, 425.

Hope-Jones, P. (1980) The effect on birds of a North Sea gas flare. *British Birds*, **73**, 547-555.

Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. & Johnson, C.A. (2001) Climate Change 2001: The scientific basis. Cambridge University Press, Cambridge, UK and New York, USA.

Hughes, L. (2000) Biological consequences of global warming: is the signal already apparent? *Trends in Ecology & Evolution*, **15**, 56-61.

Hughes, R.G. (2004) Climate change and loss of saltmarshes: consequences for birds. *Ibis*, **146** (Suppl.1), S21-S28.

Hulme, M., Jenkins, G. Lu, X., Turnpenny, J. R., Mitchell, T. D., Jones, R. G., Lowe, J., Murphy, J. M., Hassell, D., Boorman, P., McDonald, R. & Hill, S. (2002a) Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report. Tyndall Centre for Climate Change Research, 120pp.

Hulme, M., Turnpenny, J. & Jenkins, G. (2002b) Climate Change scenarios for the United Kingdom: the UKCIP02 briefing report. Tyndall Centre for Climate Change Research, Norwich, UK.

Hydrosearch (2002) Gunfleet Sands Offshore Windfarm Environmental Statement. Prepared for GE Gunfleet Ltd.

IEA (Institute of Environment Assessment) (1995) Guidelines for Baseline Ecological Assessment. E. & F.N. Spon.

IWSG (International Wader Study Group) (2003) Waders are declining worldwide: conclusions from the 2003 International Wader Study Group Conference, Cádiz, Spain. http://web.uct.ac.za/depts/stats/adu/wsg

Järvinen, A. (1989) Patterns and causes of long-term variation in reproductive traits of the Pied Flycatcher *Ficedula hypoleuca* in Finnish Lapland. *Ornis Fennica*, **66**, 24-31.

Järvinen, A. (1994) Global warming and egg size of birds. *Ecography*, **17**, 108-110.

Järvinen, A. (1996) Correlation between egg size and clutch size in the Pied Flycatcher *Ficedula hypoleuca* in cold and warm summers. *Ibis*, **138**, 620-623.

Jenkins, D. & Watson, A. (2000) Dates of first arrival and song of birds during 1974-99 in mid-Deeside, Scotland. *Bird Study*, **47**, 249-251.

Jones, J. & Francis, C.M. (2003) The effects of light characteristics on avian mortality at lighthouses. *Journal of Avian Biology*, **34**, 328–333.

Kendall, M.A., Burrows, M.T., Southward, A.J. & Hawkins, S.J. (2004) Predicting the effects of marine climate change on the invertebrate prey of the birds of rocky shores. *Ibis*, **146** (Suppl.1), S40-S47.

Kershaw, M & Cranswick, P.A. (2003) Numbers of wintering waterbirds in Great Britain, 1994/95-1998/99: I. Wildfowl and selected waterbirds. *Biological Conservation*, **111**, 91-104.

King, D. (2004) Climate change science: adapt, mitigate, or ignore? *Science*, **303**, 176–177.

Kingsley, A., & Whittam, B. (2003) *Wind turbines and birds: a guidance document for environmental Assessment. Draft report to the Canadian Wildlife Service*. Bird Studies Canada.

Kitaysky, A.S. & Golubova, E.G. (2000) Climate change causes contrasting trends in reproductive performance of planktivorous and piscivorous alcids. *Journal of Animal Ecology,* **69**, 248-262.

Komdeur, J., Bertelsen, J. & Cracknell, G. (1992) *Manual for aeroplane and ship surveys of waterfowl and seabirds*. IWRB Special Publ., no. 19 NERI, Kalø.

Langston, R.H.W. & Pullan, J.D. (2003) *Windfarms and birds. An analysis of the effects of windfarms on birds, guidance on environmental assessment criteria and site selection issues*. BirdLife International Report to the Council of Europe on behalf of the Bern Convention.

Lawrence, A.J. & Soame, J.M. (2004) Effects of climate change on the reproduction of coastal invertebrates. *Ibis*, **146** (Suppl.1), S29-S39.

Merne, O.J. (2002) Razorbill. Pp. 401-404 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Mitchell, I.P., Newton, S.F., Ratcliffe, N. & Dunn, T.E. (2004) *Seabird populations of Britain and Ireland*. T. & A.D. Poyser, London.

Musters, C.J.M., Noordervliet, M.A.W. & Ter Keus, W.J. (1996) Bird casualties caused by a wind energy project in an estuary. *Bird Study*, **43**, 124-126.

Noble-Rollin, D. & Redfern, C. (2002) Sandwich Tern. Pp. 381-384 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Noer, H., T. K. Christensen, I. Clausager & I. Krag Petersen (2000): *Effects on birds of an offshore wind park at Horns Rev: Environmental Impact Assessment*. National Environmental Research Institute, Ministry of Environment and Energy, Kalo, Denmark.

Okill, D. (2002) Red-throated Diver. Pp. 109-111 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Painter, S., Little, B. & Lawrence, S. (1999) *Continuation of bird Studies at Blyth Harbour wind farm and the implications for offshore wind farms. ETSU W/13/00485/00/00*. Report to Border Wind Limited.

Parmesan, C. & Yohe, G. (2003) A globally coherent fingerprint of climate change impacts across natural systems. *Nature*, **421**, 37-42.

Piersma, T. & Lindström, Å (2004) Migrating shorebirds as integrators of global environmental information. *Ibis*, **146** (Suppl.1), S61-S69.

Pennycuick, C.J. (1997) Actual and "optimum" flight speeds: field data reassessed. *Journal of Experimental Biology*, **200**, 2355-2361.

Penuelas, J., Filella, I. & Comas, P. (2002) Changed plant and animal life cycles from 1952 to 2000 in the Mediterranean region. *Global Change Biology*, **8**, 531-544.

Percival, S.M. (2005) Birds and windfarms: what are the real issues? *British Birds*, **98**, 194-204.

Percival, S.M., Band, B. & Leeming, T. (1999) *Assessing the ornithological effects of wind farms: developing a standard methodology*. Proceedings of the 21st British Wind Energy Association Conference 1999.

Perrins, C.M. (1991) Tits and their caterpillar food supply. *Ibis*, **133**, S49-S54.

Petersen, I.K. (2005) *Bird numbers and distribution in the Horns Rev offshore wind farm area. Annual status report 2004*. Report commissioned by Elsam Engineering A/S 2005. National Environmental. Research Institute, Rønde, Denmark.

Petersen, I.K., Clausager, I. & Christensen, T.J. (2004) *Bird numbers and distribution in the Horns Rev offshore wind farm area. Annual status report 2003*. Report commissioned by Elsam Engineering A/S 2003. National Environmental. Research Institute, Rønde, Denmark.

Pettersson, J. (2005) *The impact of offshore wind farms on bird life in Southern Kalmar Sound, Sweden. A final report based on studies 1999-2003*. Lund University Report to the Swedish Energy Association.

Pettersson, J. & Stalin, T. (2003) *Influence of offshore windmills on migration of birds on southeast coast of Sweden*. Report to GE Wind Energy.

Pitches, A. (2005a) Seabird meltdown not confined to Shetland. *British Birds*, **97**, 484.

Pitches, A. (2005b) Seabirds starve out in Yorkshire. *British Birds*, **97**, 484-485.

Pollitt, M.S., Hall, C., Holloway, S.J., Hearn, R.D., Marshall, P.E., Musgrove, A.J., Robinson, J.A. & Cranswick, P.A. (2003) *The Wetland Bird Survey 2000-01: Wildfowl and Wader Counts*. BTO/WWT/RSPB/JNCC, Slimbridge.

Rehfisch, M.M., Austin, G.E., Armitage, M.J.S, Atkinson, P.W., Holloway, S.J., Musgrove, A.J. & Pollitt, M.S. (2003a) Numbers of wintering waterbirds in Great Britain and the Isle of Man (1994/95-1998/99): II. Coastal waders (Charadrii). *Biological Conservation*, **112**, 329-341.

Rehfisch, M.M., Austin, G.E., Freeman, S.N., Armitage, M.J.S. & Burton, N.H.K. (2004) The possible impact of climate change on the future distributions and numbers of waders on Britain's non-estuarine coast. *Ibis*, **146** (Suppl. 1), 70-81.

Rehfisch, M.M. & Crick, H.Q.P. (2003) Predicting the impact of climate change on Arctic-breeding waders. *Wader Study Group Bulletin*, **100**, 86-95.

Rehfisch, M.M., Holloway, S.J. & Austin, G.E. (2003b) Population estimates of waders on the non-estuarine coasts of the United Kingdom and the Isle of Man during the winter of 1997-98. *Bird Study*, **50**, 22-32.

Reid, J. (2002) Great Black-backed Gull. Pp. 373-376 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Retallack, S. (2005) *Setting a long-term climate objective. A paper for the International Climate Change Taskforce*. Institute for public policy research, London, UK.

RPSS (2005) London Array Offshore Wind Farm Environmental Statement.

Robinson, R.A. (2005) *Bird Facts: species profiles of birds occurring in Britain and Ireland. BTO Research Report 407*, BTO, Thetford. http://www.bto.org/birdfacts

Rock, P. (2002) Lesser Black-backed Gull. Pp. 365-368 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Root, T.L., Price, J.T., Hall, K.R., Schneider, S.H., Rosenzweig, C. & Pounds, J.A. (2003) Fingerprints of global warming on wild animals and plants. *Nature*, **421**, 57–60.

Sage, B. (1979) Flare up over North Sea birds. *New Scientist*, **81**, 464-466.

Skov, H., Durinck, J., Leopold, M.F. & Tasker, M.L. (1995) *Important bird areas for seabirds in the North Sea*. Birdlife International, Cambridge.

Snow, D.W. & Perrins, C.M. (1998) *Birds of the Western Palearctic Concise Edition*. Oxford University Press, Oxford.

Sparks, T.H. & Mason C.F. (2001) Dates of arrivals and departures of spring migrants taken from the Essex Bird Reports 1950-1998. *Essex Bird Report* 1999, 154-164.

Sparks, T.H. & Mason, C.F. (2004) Changes in phenology of winter migrant birds in Essex. *Ibis*, **146** (Suppl.1), S57-S60.

Stewart, G.B., Pullin, A.S. & Coles, C.F. (2005) *Effects of wind turbines on bird abundance. Review Report. Centre for Evidence-Based Conservation Systematic Review No. 4*. Centre for Evidence-Based Conservation, University of Birmingham.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Reed, T.C., Tasker, M.L., Camphuysen, C.J. & Pienkowski, M.W. (1995) *An atlas of seabird distribution in north-west European waters*. Joint Nature Conservation Committee and Nederlands Instituut voor Onderzoek der Zee, Peterborough.

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

Sutherland, W.J. (2004) Climate change and coastal birds: research questions and policy responses. *Ibis*, **146** (Suppl.1), S120-S124.

Tasker, M.L., Hope-Jones, P., Blake, B.F., Dixon, T.J. & Wallis, A.W. (1986) Seabirds associated with oil production platforms in the North Sea. *Ringing & Migration*, **7**, 7-14.

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

Thelander, C.G., Smallwood, K.S. & Rugge, L. (2003) *Bird risk behaviours and fatalities at the Altamont Pass Wind Resource Area*. Report to the National Renewable Energy Laboratory.

Thomas, C.D., Cameron, A. Green, R.E., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., De Siqueira, M.F., Grainger, A., Hannah, L., Hughes, L., Huntley, B., Van Jaarsveld, A.S., Midgley, G.F., Miles, L., Ortega-Huerta, M.A., Peterson, A.T., Phillips, O.L. & Williams, S.E. (2004) Extinction risk from climate change. *Nature*, **427**, 145-148.

Thomas, C.D. & Lennon, J.L. (1999) Birds extend their ranges northwards. *Nature*, **399**, 213.

Thompson, P.M. & Ollason, J.C. (2001) Lagged effects of ocean climate change on fulmar population dynamics. *Nature*, **413**, 417-420.

Toms, M. (2002) Black-throated Diver. Pp 680. In: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) (2002) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Tulp, I., Schekkerman, H., Larsen, J.K., van der Winden, J., van de Haterd, R.J.W., van Horssen, P., Dirksen, S. & Spaans, A.L. (1999) *Nocturnal flight activity of sea ducks near the windfarm Tunø Knob in the Kattegat.* IBN-DLO Report No. 99.30.

Verheijen, F.J. (1981) Bird kills at tall lighted structures in the USA in the period 1935-1973 and kills at a Dutch lighthouse in the period 1924-1928 show similar lunar periodicity. *Ardea*, **69**, 199-203.

Wadhams, P. (1997) *Ice in the Ocean*. Gordon & Breach, London.

Wanless, S. (2002) Gannet. Pp. 130-132 in: Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. & Baillie, S. (eds.) *The migration atlas: movements of the birds of Britain and Ireland*. T. & A.D. Poyser, London. 884 pp.

Wiese F.K., Montevecchi W.A. & Davoren G.K. (2001) Seabirds at risk around offshore oil platforms in the North-west Atlantic. *Marine Pollution Bulletin*, **42**, 1285-90.

Winkel, W. & Hudde, H. (1997) Long-term trends in reproductive traits of tits (*Parus major, P. caeruleus*) and Pied Flycatchers *Ficedula hypoleuca*. *Journal of Avian Biology*, **28**, 187-190.

Winkelman, J.E. (1989) *Birds and the wind park near Urk: bird collision victims and disturbance of wintering ducks, geese and swans*. RIN rapport 89/15. Arnhem: Rijksintituut voor Natuurbeheer.

Winkelman, J.E. (1992a) *The impact of the Sep wind park near Oosterbierum, The Netherlands on birds 1: collision victims*. RIN rapport 92/2 Arnhem: Rijksintituut voor Natuurbeheer.

Winkelman, J.E. (1992b) *The impact of the Sep wind park near Oosterbierum, The Netherlands on birds 2: nocturnal collision risks*. RIN rapport 92/3 Arnhem: Rijksintituut voor Natuurbeheer.

Winkelman, J.E. (1992c) *The impact of the Sep wind park near Oosterbierum, The Netherlands on birds 3: flight behaviour during daylight*. RIN rapport 92/4 Arnhem: Rijksintituut voor Natuurbeheer.

Winkelman, J.E. (1995) Bird/wind turbine investigations in Europe. In *Proceedings of the National Avian-Wind Power Planning Meeting 1994*.

Wright, M. (2004) *Suffolk birds 2003*. Suffolk Naturalists' Society, Ipswich.

WWT Wetlands Advisory Service (2005) *Aerial surveys of waterbirds in strategic windfarm areas: winter 2004/05 – interim report*. Report to DTI, WWT, Slimbridge.

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			×		×	×	×		×	×		×	×	×	×	×	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RU						×			×								
BW			×		×	×	×	×	×	×		×		×	×	×	
BA										×		×				×	
CU					×				×			×			×	×	
RK			×		×	×	×		×			×		×	×	×	
TT					×												×
MU																×	
BH			×														
LB			×														
HG			×														
TE			×									×					
CN												×					
AF	×		×			×	×		×			×			×		
NJ	×	×															
WL	×	×															

Appendix 1 Continued.

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 H_0: 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 H_0: 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 H_0: 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 H_0: 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 H_0: 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 H_0: 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 H_0: 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
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):

Logistic regression for Kittiwake

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

Estimated monthly mortality rates using data from 2004/05 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. 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	0.104
		0.048		0.87	0.67	0.004	10.06	7.481
		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	7.292

(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	1.390
		0.076		0.9982	175.6	0.0240	17.28	25.02
		0.076		0.87	175.6	1.735	17.28	1,807
		0.084	S	0.9999	175.6	0.0015	19.20	1.383
		0.084		0.9982	175.6	0.0266	19.20	24.89
		0.084		0.87	175.6	1.918	19.20	1,798
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	0.486
		0.076		0.87	1.19	0.0018	6.03	35.10
		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	0.483
		0.084		0.87	1.19	0.0130	6.70	34.91
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	1.411
		0.084		0.87	6.48	0.0708	12.50	101.9
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	25.43
		0.076		0.87	127.5	1.2597	17.28	1,837
		0.084	S	0.9999	127.5	0.0011	19.20	1.406
		0.084		0.9982	127.5	0.0197	19.20	25.30
		0.084		0.87	127.5	1.3923	19.20	1,827
Galloper		0.076	F	0.9999	0.68	5.16×10^{-6}	6.03	0.027
		0.076		0.9982	0.68	9.30×10^{-5}	6.03	0.492
		0.076		0.87	0.68	0.0067	6.03	35.51
		0.084	S	0.9999	0.68	5.71×10^{-6}	6.70	0.027
		0.084		0.9982	0.68	1.03×10^{-4}	6.70	0.489
		0.084		0.87	0.68	0.0074	6.70	35.32
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	1.436
		0.084		0.87	4.71	0.0514	12.50	103.7

(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	1.069
		0.052		0.9982	93.61	0.0088	11.47	19.25
		0.052		0.87	93.61	0.6328	11.47	1,390
		0.057	S	0.9999	93.61	5.33×10^{-4}	12.75	1.055
		0.057		0.9982	93.61	0.0096	12.75	18.98
		0.057		0.87	93.61	0.6937	12.75	1,370
Galloper		0.052	F	0.9999	1.06	5.20×10^{-6}	4.00	0.035
		0.052		0.9982	1.06	9.92×10^{-5}	4.00	0.625
		0.052		0.87	1.06	0.0072	4.00	45.14
		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	0.616
		0.057		0.87	1.06	0.0078	4.45	44.48
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	132.5
		0.057	S	0.9999	5.81	3.31×10^{-5}	8.30	0.101
		0.057		0.9982	5.81	5.96×10^{-4}	8.30	1.810
		0.057		0.87	5.81	0.0431	8.30	130.7