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The numbers of inshore waterbirds using the Greater Thames during the non-breeding season; an assessment of the area's potential for qualification as a marine SPA

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Contents

1 Summary

Aerial surveys of the Greater Thames were carried out over a total of 58 days over eight winter seasons between 1988/89 – 2006/07. These consisted of three strip transect aerial surveys (1988/89, 1989/90) and 20 line transect aerial surveys (2001/02-2006/07) conducted by Joint Nature Conservation Committee, Wildfowl & Wetlands Trust and the Natural Environmental Research Institute, Denmark.

The species recorded were: common eider *Somateria mollissima*, common scoter *Melanitta nigra,* velvet scoter *Melanitta fusca,* red-breasted merganser *Mergus serrator*, red-throated diver *Gavia stellata*, great northern diver *G. immer*, black-throated diver *G. arctica*, great crested grebe *Podiceps cristatus* and little gull *Larus minutus*.

The first part of this report describes analyses of these data to determine the numbers of birds present for each species. The second part of this report assesses those numbers against the appropriate guideline thresholds, to determine whether the area, or part of it, might meet the site selection requirements under Stage 1 of the UK Site Selection Guidelines as a Special Protection Area (SPA) under the European Union Birds Directive.

The mean of peak estimates of red-throated diver numbers was 6,618 individuals for the inshore areas of the Greater Thames. Peak estimated numbers of red-throated divers exceeded the appropriate Stage 1 threshold (170 individuals) under the UK SPA site selection guidelines in all five out of the five most recent winter seasons.

The mean of peak estimates of little gull numbers was 115 for the inshore areas of the Greater Thames. Peak estimated numbers of little gull exceeded the appropriate Stage 1 threshold (50 individuals) under the UK SPA site selection guidelines in only two out of the five most recent winter seasons. Further surveys are required to determine if this species should be a qualifying feature of any future SPA in the area, as earlier surveys most likely under recorded little gulls.

For common eider, common scoter, velvet scoter, red-breasted merganser, great northern diver, black-throated diver and great crested grebe, peak estimated numbers in the Greater Thames area did not exceed the appropriate Stage 1 threshold under the UK SPA site selection guidelines in any season. Nor did the mean of peak estimates across all surveys exceed qualifying thresholds for these species.

Based on the available data, an estimated 8,355 individual inshore waterbirds regularly use the inshore waters of the Greater Thames during the non-breeding season. This estimate does not exceed the appropriate Stage 1 threshold (20,000 individuals) for an assemblage of non-breeding waterbirds under the UK SPA site selection guidelines.

Based on these analyses:

- The inshore waters of the Greater Thames may be recommended for consideration as a possible marine SPA for red-throated diver at Stage 1.1;

- the inshore waters of the Greater Thames do not currently appear to meet UK SPA Site Selection Guidelines at Stage 1.2 for any other inshore waterbird species during the non-breeding season;

- the inshore waters of the Greater Thames do not currently appear to meet UK SPA Site Selection Guidelines for an inshore waterbird assemblage at Stage 1.3;

- when the complete suite of marine SPAs for inshore areas has been determined then the inshore areas of the Greater Thames (or parts thereof) may possibly be further considered for inclusion at stage 1.4 for little gull based on the mean of peak estimates.

Species distributions using the raw count data are presented in this report. Detailed spatial analyses of bird distributions and boundary location options will be required for any potential SPA, and these will be presented in a separate report if required.

2 Introduction

2.1 Background

In 1979, the European Commission adopted the European Council (EC) Directive on the conservation of wild birds (commonly known as the 'Birds Directive') in response to the 1979 Bern Convention on the conservation of European habitats and species (the 'Bern Convention'). The Birds Directive addresses 'the conservation of all species of naturally occurring birds in the wild state in the European territory of the Member States to which the treaty applies' (79/409/EEC). It requires Member States to identify and classify in particular the most suitable territories in number and size as special protection areas (termed Special Protection Areas or SPAs by Member States) for the conservation of rare and vulnerable species listed on Annex I of the Directive, as well as regularly occurring migratory species.

Although this Birds Directive states that conservation measures should be taken both in 'the geographical sea and land area', most SPAs in the United Kingdom (UK) do not extend further than mean low water mark (or mean low water springs in Scotland). Work to facilitate consideration of SPA below this datum is currently being undertaken by the Joint Nature Conservation Committee (JNCC) in collaboration with the four statutory country conservation agencies: Council for Nature Conservation and the Countryside in Northern Ireland, the Countryside Council for Wales, Natural England and Scottish Natural Heritage.

A number of potential ways of addressing marine SPAs in the UK are currently being considered:

1. Marine extensions to existing seabird colony SPAs into the marine environment (McSorley *et al,* 2003; McSorley *et al,* 2005; McSorley *et al,* 2008; Webb & Reid 2004);
2. inshore areas used by waterbirds (eg seaduck, divers and grebes) outwith the reeding season (eg Dawson *et al,* 2008; Söhle *et al,* 2007; Webb *et al,* 2006a, Webb *et al,* 2006b);
3. offshore areas used by wide-ranging seabirds, for feeding and for other activities; and
4. other types of SPA.

To date, although there are 73 SPA with marine components, only one entirely marine SPA has been designated in UK waters; Bae Caerfyrddin/Carmarthen Bay SPA (Wales) was classified in 2003 for its non-breeding aggregations of common scoter.

The aim of this report is to determine whether the inshore areas of the Greater Thames, or a part thereof, meet UK SPA Site Selection Guidelines (see below, Stroud *et al,* 2001) in respect of the numbers of inshore waterbirds occurring outwith the breeding season.

If the investigated areas of the Greater Thames meet appropriate Stage 1 thresholds under the UK SPA Site Selection Guidelines then it may be considered further for classification, necessitating additional analyses of the data presented herein in order to define site boundaries.

2.2 UK SPA selection guidelines

Selection guidelines for SPAs in the UK (Stroud *et al* 2001) advise that SPA qualification should be determined in two stages.

Stage 1: is intended to identify areas that are likely to qualify for SPA status on the basis of population thresholds, and

Stage 2: is intended to further consider locations identified under Stage 1 to select the most suitable areas.

An area may be considered under any one of four components of Stage 1:

Stage 1.1. Numbers of species listed on Annex I of the EC Birds Directive should exceed 1% of the agreed Great Britain (GB) (or if relevant the all-Ireland) population for the species on a regular basis.

Stage 1.2. For migratory species not listed on Annex I of the EC Birds Directive, numbers at a site should exceed 1% of the agreed biogeographical population for the species on a regular basis.

Stage 1.3. For waterbird species assemblages, more than 20,000 waterbirds (as defined by the Ramsar Committee), of at least two species, should occur regularly at a site.

Stage 1.4. Finally, where the application of stages 1.1-1.3 does not identify an adequate suite of areas, sites may be selected if they satisfy one or more of various ecological criteria listed under Stage 2 (eg by contributing significantly to the species' population viability, such as by virtue of population size and density, by contributing to species range, etc).

For species listed on Annex I of the Birds Directive, the appropriate population for comparison is the GB population (Baker *et al*, 2006); for regularly occurring migratory species, the appropriate population for comparison is the biogeographical population (Wetlands International 2006). Within this report, the size of the waterbird assemblage is assessed only for species the target species of inshore waterbird (see 2.1).

Webb & Reid (2004) considered definitions of regularity for inshore waterbird aggregations and suggested that the most appropriate definition to use is that of the Ramsar site selection criteria stated in *The Convention on Wetlands* (Ramsar, Iran, 1971), where 'the requisite number of birds is known to have occurred in two thirds of the seasons for which adequate data are available' and 'the mean of the maxima of those seasons in which the site is internationally important, taken over at least five years'.

Data from sites identified as possible marine SPAs following the application of both Stages 1 and 2 will be analysed to identify appropriate boundaries for the sites based primarily on species distributions and densities.

2.3 The Greater Thames

The Greater Thames is the largest estuary complex in Britain. It is located on the east coast of England, and, as defined herein, encompasses the inshore areas stretching from Great Yarmouth in the North to Dover in the South (Figure 1). It mainly consists of a maze of winding, shallow creeks, drowned estuaries, mudflats and broad tracts of tidal salt-marsh with sand and shingle beaches along the coast edge. Most of the area is shallow water (<20m) over a sandy, muddy and gravel substrate (Connor *et al*, 2006).

The extensive mudflats and salt marsh present within the survey area provide some of the most important feeding grounds within the Greater Thames Estuary. The distribution of waterbirds is linked to the presence of productive mudflats in these areas which provide key prey items for waterbirds. Figure 1 shows the location of the existing SPAs around the Greater Thames. For further information on SPAs and also Special Areas of Conservation please see http://www.jncc.gov.uk/page-1400 and http://www.jncc.gov.uk/page-1458.

Of these existing terrestrial SPAs, Stroud *et al* (2001) indicates that twelve of the coastal sites within the Greater Thames area of interest protect seabirds or the inshore waterbird species considered in this report. They are the following (Figure 1):

Breydon Water SPA in the north of the Greater Thames survey area covers 1203ha of inland tidal estuary at the mouth of the River Yare. It has extensive areas of mudflats that are exposed at low tide and these are the only tidal flats on the east coast of Norfolk. Under Article 4.1. of the Birds Directive the area regularly supports 1.3% of the GB breeding population (four-year count mean for 1992-94 and 1996) of common terns *Sterna hirundo* during the breeding season. The SPA is internationally important for wintering waterbirds, some of which feed in the Broadland SPA that adjoins the site. Under Article 4.3. the site qualifies also for its waterbird assemblage of 43,225 individuals.

The Benacre to Easton Bavents SPA and Minsmere – Walberswick SPA contain shingle beaches and low cliffs. Under Article 4.1 both sites qualify for their breeding numbers of little terns *Sternula albifrons* which represent 2.2% and 1.2% of the British total, respectively. Currently these birds feed substantially outside the SPA in adjacent marine waters.

The Alde – Ore Estuary SPA covers an area of 2417ha. As well as being an important wintering area for waterbirds, the area also provides important breeding habitat for several species of seabirds. During the breeding season, gulls and terns feed substantially outside the SPA. Under Article 4.1 the site holds 2.0% and 1.2% of the GB breeding population of little tern (five-year count mean 1993-94 and 1996-98) and sandwich tern *Sterna sandvicensis* (five-year mean 1991-95), respectively. Under Article 4.2 the site regularly supports 11.3% of the biogeographical breeding population (five-year mean 1994-98) of lesser black-backed gull *Larus fuscus* and under Article 4.3 it supports a seabird assemblage of international importance of 59,118 breeding individuals. This assemblage includes herring gull *Larus argentatus*, black-headed gull *Larus ridibundus*, lesser black-backed gull, little tern and sandwich tern.

The Stour and Orwell Estuary SPA covers 3324ha of extensive mudflats. Under Article 4.3 it qualifies as an assemblage by regularly supporting 64,768 individual waterbirds, including great crested grebes *Podiceps cristatus*.

Hamford Water SPA covers an area of 2187ha. It is a large, shallow estuarine basin comprising tidal creeks and islands, intertidal mud- and sand-flats, and saltmarsh. The rich invertebrate fauna and sheltered nature of this site result in its importance for internationally important numbers of 44,461 individual waterbirds during the passage and winter periods, as well as for breeding little terns during summer.

The Colne Estuary (Mid-Essex Coast Phase 2) SPA covers an area of 2701ha. It is a short and branching estuary that flows into the main channel of the River Colne. The estuary is of importance for a range of wintering wildfowl and waders, in addition to 1.6% of the GB breeding population of little terns which nest on shell, sand and shingle spits. Also, under Article 4.3 this site qualifies by regularly supporting a waterbird assemblage of 38,548 individuals, including great crested grebe.

At 4395ha, Blackwater Estuary SPA is the largest estuary in Essex and is one of the largest estuarine complexes in East Anglia. During the breeding season it regularly supports 1.5% of the GB breeding population of little terns and under Article 4.3 it regularly holds an assemblage of 109,815 individual waterbirds (five-year peak mean 1991/92-1995/96), which includes great crested grebe, common goldeneye *Bucephala clangula* and red-breasted merganser *Mergus serrator*.

Dengie (Mid-Essex Coast Phase 1) SPA is a 3127ha area of tidal mudflats and saltmarshes. Under Article 4.2 the site regularly supports 31,452 individual waterbirds which include great crested grebe.

Foulness (Mid-Essex Coast Phase 5) SPA is located on the coast of Essex, to the north of the mouth of the Thames estuary. The site is part of an open estuarine system comprising mudflats, cockle-shell banks and sand-flats. It includes one of the three largest continuous sand-silt flats in the UK. Under Article 4.1 the site regularly supports 1.0%, 1.8% and 2.3% of the GB breeding population of little, common and sandwich tern, respectively. Under Article 4.3 the site regularly supports 107,468 individual waterbirds during winter.

Medway Estuary and Marshes SPA feed into and lies on the south side of the outer Thames Estuary in Kent, covering an area of 4684ha. It forms a single tidal system with the Swale and joins the Thames Estuary between the Isle of Grain and Sheerness. The mudflats are rich with invertebrates and shell beaches occur, particularly in the outer part of the estuary. In summer the estuary supports breeding waders and little terns, whilst in winter it holds internationally important numbers of 65,274 individuals (five-year peak mean 1991/92-1995/96), including little grebes *Tachybaptus ruficollis* and great crested grebes.

Finally the Swale SPA is located on the south side of the outer part of the Thames Estuary in south-eastern England. The intertidal flats are extensive and support a dense invertebrate fauna. This, together with large mussel-beds formed on harder areas of substrate, are important food sources for waterbirds. In summer, the site is of national importance for breeding Mediterranean gull *Larus melanocephalus* and black-headed gull (12% and 2.9% of the GB populations, respectively) and also little terns (1% of the GB population). In spring and autumn migration periods, as well as during winter, the Swale supports a waterbird assemblage of 65,390 individuals, including little grebes.

All these SPAs have been designated using land-based counts, which provide good coverage for species breeding on land or concentrated close to the shore, but which often significantly underestimate numbers of species that occur further offshore (Webb & Reid 2004). For wintering inshore waterbirds, most of the SPAs above protect grebes in intertidal areas within the SPA, but seaducks and divers are not protected as they use the adjacent open waters of the large estuary complex, away from the currently designated SPAs.

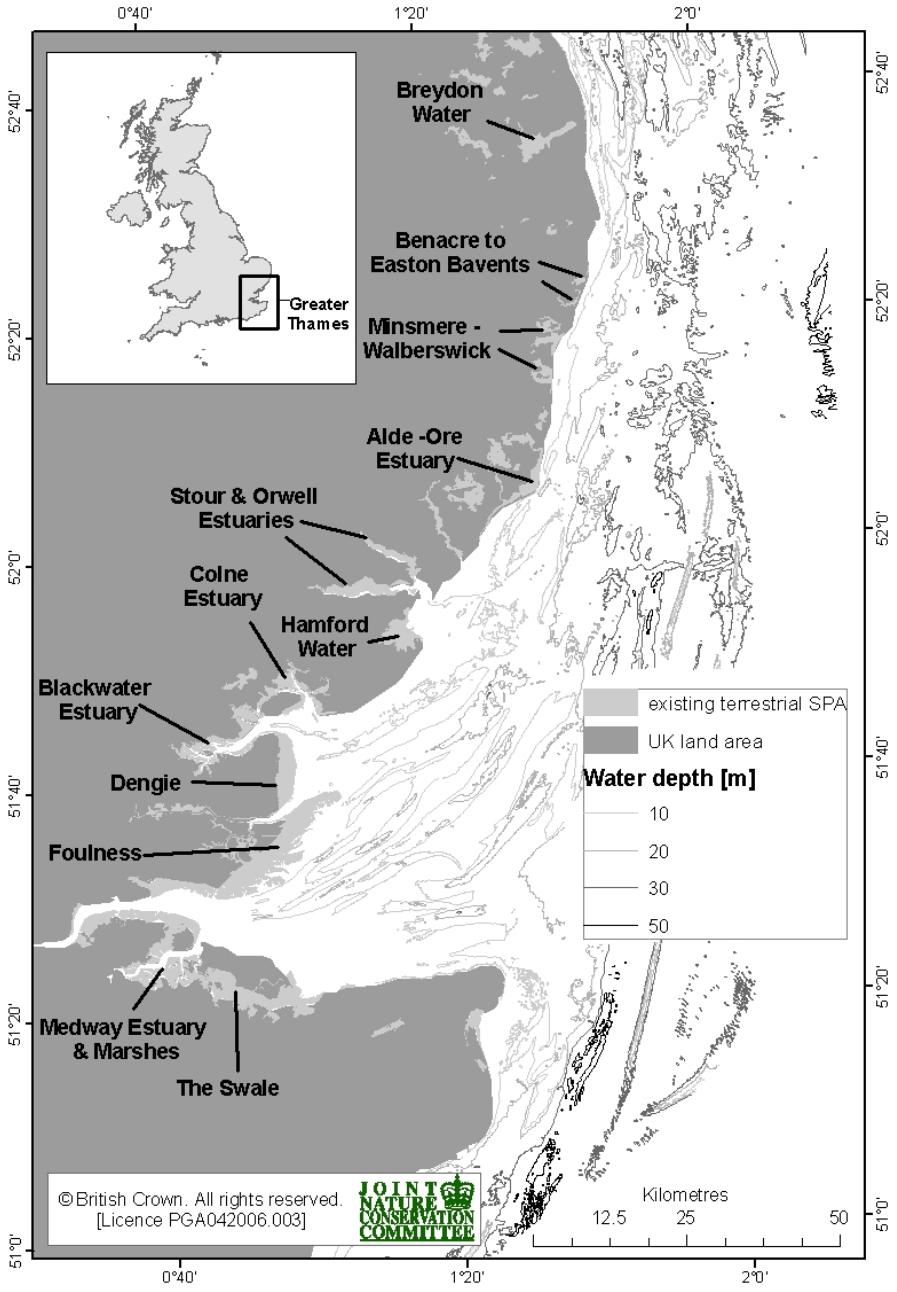

Figure 1. Existing terrestrial Special Protection Areas in the Greater Thames.

3 Methods

3.1 Target species

The target species for aerial surveys were those inshore waterbirds that over-winter within coastal areas of the UK and are listed in Table 1 of the AEWA Action Plan (Convention of Migratory Species 1999): http:// www.cms.int/species/aewa/aew_tabl.htm or in Annex I of the EC Birds Directive, or are migratory species that occur regularly in the UK. These species comprise greater scaup *Aythya marila*, common eider, long-tailed duck *Clangula hyemalis*, common scoter, velvet scoter, common goldeneye, red-breasted merganser, goosander *M. merganser*, red-throated diver, black-throated diver, great northern diver, great crested grebe, red-necked grebe *P. grisegena*, Slavonian grebe *P. auritus*, black-necked grebe *P. nigricollis* and little gull.

In the case of the great northern diver the threshold for such assessment is 50 individuals. The current GB wintering population estimate is 2,500-3,000 individuals (Baker *et al*, 2006). However, Stroud *et al* (2001) recommend that the SPA qualification threshold should be 50 individuals.

Currently there is no GB wintering population estimate for little gulls (Baker *et al*, 2006), therefore the minimum threshold of 50 individuals is applied as recommended by the SPA Ramsar Scientific Working Group.

3.2 Data collection

This report describes analyses of data from aerial surveys conducted in the Greater Thames carried out by the Nature Conservancy Council (NCC) (1988/9 and 1989/90), the Joint Nature Conservation Committee (JNCC) (January 2002), the Wildfowl & Wetlands Trust (WWT) (January 2003 – January/February 2005; February/March 2005, March 2005, November 2006 – March 2007) and the Natural Environmental Research Institute, Denmark (NERI) (January 2005 and March 2005). Surveys carried out by WWT and NERI were commissioned in response to proposals to develop wind farms in the Greater Thames and in other areas around the UK. The surveys were commissioned by a consortium of private companies, as well as DBERR (Department for Business Enterprise and Regulatory Reform, formerly Department of Trade and Industry (DTI)), the Department for the Environment, Food and Rural Affairs (DEFRA) and the Crown Estates.

The data used in these analyses originated from three strip transect aerial surveys (1988/89 and 1989/90) and 20 line transect aerial surveys (2001/02-2006/07) of the Greater Thames, completed over a total of 58 days. Surveys were conducted between November and March to enable estimates of wintering populations to be made.

Survey coverage for 1989-1990 and 2001/02 can be found in Barton *et al* (1993) and Dean *et al* (2003) respectively; see Hall *et al* (2003) and WWT Wetland Advisory Service (2006) for surveys carried out during 2002/03 and 2004/05. Appendix 1 shows coverage for each survey from January 2003 onward, and are summarised for 2004/05-2006/07 in Figure 2. Up to 2004/05, the precise extent of the survey blocks differed between surveys. From winter 2004/05, a much larger area was covered by the survey, and fixed boundaries for six blocks (T1-6) were determined (though an additional area off the east Kent coast, partially

overlapping T6, was also surveyed; see Appendix 1). An additional block T7 was incorporated the following winter. Six survey blocks were covered in 2004/05 (T1-6, plus the east Kent area), five were covered in 2005/06 (T1, 2, 3, 6, 7) and three were covered in 2006/07 (T1, 6, 7). For each 'completed' survey, blocks were not all surveyed on the same day but within a few days of each other in most cases.

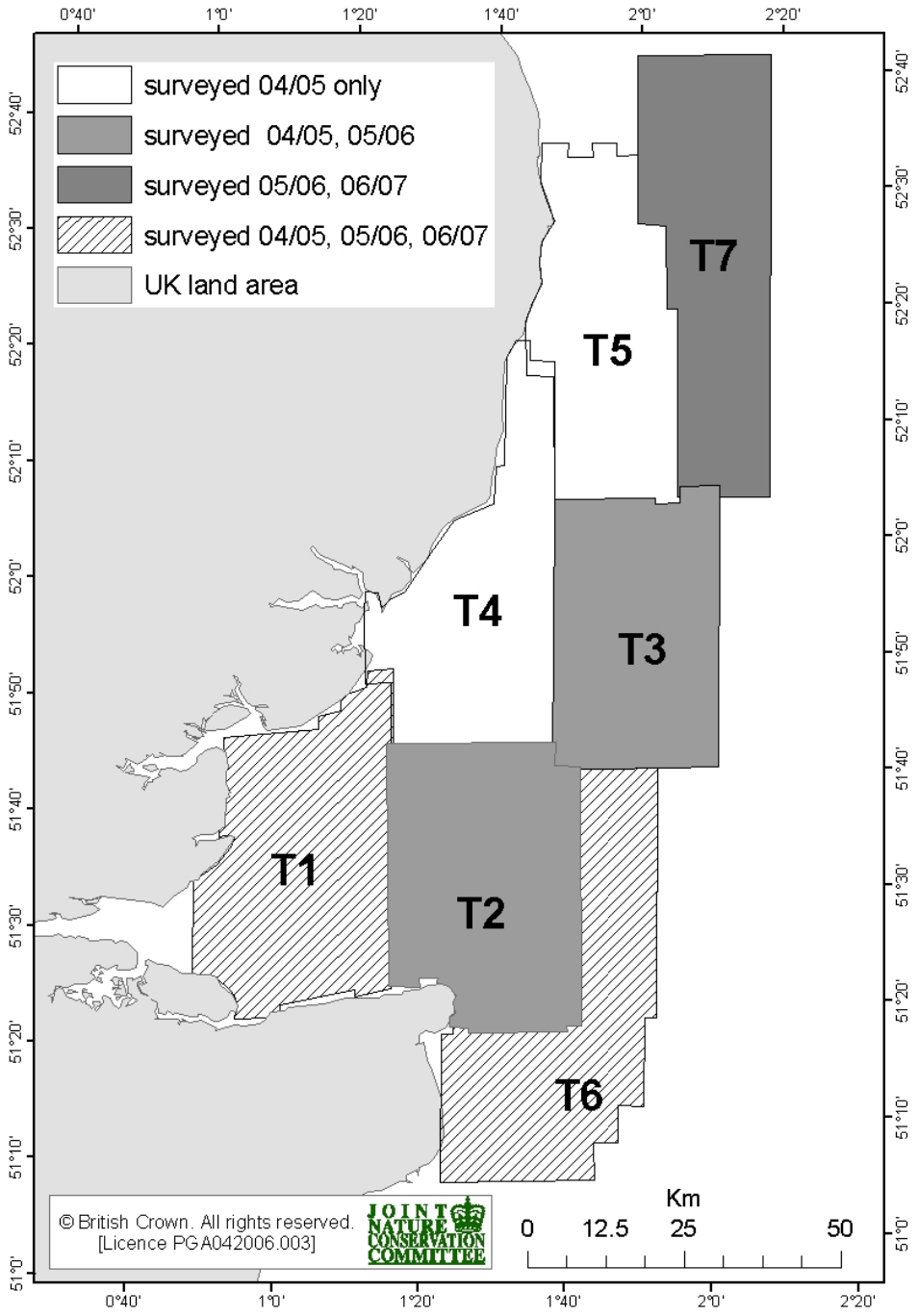

Figure 2. Map of the Greater Thames showing aerial survey block coverage from winter 2004/05 to 2006/07.

3.2.1 Strip transect aerial surveys (1988/89 and 1989/90)

Two strip transect aerial surveys were carried out over four days during 1988/89, and one was carried out over two days in 1989-90. Surveys were conducted from a Britten-Norman Islander aircraft, flown at 60m (183ft) above the sea, at a speed of 185kmh^{-1} (100 knots). At the beginning of each survey one strip-transect was flown along the coastline at a distance of approximately 4km from the shore. Parallel transects, spaced 1km apart, were then flown perpendicular to the Suffolk and Essex coast and one transect was flown along the northern coast of Kent. At the end of each survey one strip-transect was flown along the coastline at a distance of approximately 9km from the shore.

Two observers, one on each side of the aircraft, attempted to detect and count all birds within a 180m strip transect. The width of each transect was defined by using a cardboard protractor, with an angle of 18º downwards from the horizon on the side away from the plane and on the near edge by the aircraft's fuselage (Barton *et al,* 1993). Observations were divided into one minute recording periods. The number of birds recorded was either the exact number counted, or (where large aggregations were encountered) an estimate of flock size. A Global Positioning System (GPS) recorded the location of the aircraft at 1-minute intervals. See Barton *et al* 1993 for a full description of methods.

3.2.2 Line transect aerial surveys (January 2002)

The JNCC conducted one aerial survey over two days (10 and 11 January 2002) using a small aircraft flown in a systematic pattern of line transects designed to repeatedly cross environmental gradients such as sea depth (Dean *et al,* 2003). Surveys were designed following the line transect sampling method developed by NERI (Kahlert *et al,* 2000). Surveys were flown at an altitude of 76m (250ft) and a speed of approximately 185kmh^{-1} (100 knots). East-west transects were spaced 1' latitude apart (approximately 1.85km), while north-south transects were spaced at 2' longitude apart (approximately 2km between 55 º N and 57 º N), running perpendicular to the coast and depth contours, and therefore along the anticipated gradient of bird density. The transects were positioned randomly relative to the bird distributions, one of the assumptions of distance sampling methodology (Buckland *et al,* 2001).

Two observers counted from either side of the aircraft and recorded all observation data onto a dictaphone. Observers determined distances using fixed angles of declination from the visual horizon, which was measured using a clinometer. All observations were allocated to one of three distance bands (A = 44-163m, B = 164-427m and C = ≥ 428m) based on the perpendicular distance of the bird(s) from the aircraft's trackline. This procedure enables the application of distance sampling analyses that models the detectability of a bird as a function of its distance from the observer; thereby, account is taken of the decreased probability of detecting a bird at greater distances from the trackline when estimating total numbers of birds actually present (Buckland *et al,* 2001). Distance sampling also allows estimation of 95% confidence intervals associated with total abundance estimates. Since observers were unable to see birds directly below the aircraft the closest distance band started at 44m from the aircraft.

For each bird, or flock of birds, the time at which it occurred (perpendicular to the aircraft), the distance band, the species, and number of birds were recorded. Where flocks of birds spanned two bands, numbers present in each band were assigned accordingly. It was not

always possible to positively identify a bird species during aerial surveys, and in such cases birds were assigned to the lowest taxonomic level possible. A GPS recorded the location of the plane at one second intervals.

3.2.3 Line transect aerial surveys (2002/03 - 2006/07)

From 2002/03-2006/07, a total of 60 individual (block) surveys (see Appendix 1) were conducted over 50 days between October and March to enable estimates of wintering populations to be made. NERI and WWT conducted these surveys using a light aircraft (Partenavia PN-68) flown in a systematic pattern of line transects. Methods used were identical to the line transects carried out during January 2002, except that four instead of three distance bands were used; all observations were allocated to one of four distance bands (A = 44-162m, B = 163-282m, C = 283-426m and D = 427-1000m). For each bird, or flock of birds, the time at which it occurred (perpendicular to the aircraft), the distance band, the species, and number of birds was recorded.

3.3 Estimating population size

Three methods were used to assess population size and density estimates: (1) raw counts; (2) extrapolation of mean density derived from distance sampling; and (3) extrapolation of mean density derived from raw counts, where data collected were either too few to apply distance sampling methods or distance sampling methods indicated an unsatisfactory detection function.

1. Raw counts were used to estimate population size for the strip transect aerial surveys (1988/89 and 1989/90), as these surveys assumed that all birds were counted in the surveyed area. As consequence of the shape of the land in the Thames estuary, data were not divided into four and nine kilometres distance from the shore, but were pooled and the results expressed for the whole coastal block (Barton *et al,* 1993).

2. Extrapolation of mean density derived from Distance sampling is one of the most robust methods for estimating total population size (Buckland *et al,* 2001). In carrying out distance sampling, data were analysed using the software *Distance 5.0*. (Thomas *et al,* 2004). For each species and survey a model was chosen that provided the best fit to the data on the basis of minimising the Akaike Information Criterion. Mostly, half-normal and hazard-rate models with zero adjustments and with the size-bias regression method of cluster size estimation were used. Models were stratified by observer or dates of individual survey blocks, and the whole area if these improved the fit of the models. Where possible, non-parametric bootstrapping, re-sampling transects as samples with replacements, was used to produce 95% confidence limits for abundance estimates (Buckland *et al,* 2001). Where models were stratified, the stratified detection functions, estimates of cluster size and encounter rate were used; where stratification was not possible, global estimates of these were used.

3. Extrapolation of density derived from raw counts. On 70% of surveys, either the number of observations or the number of transects were too small to permit density to be estimated using distance sampling. In these cases surveys were treated as strip transect surveys and density was estimated directly from raw sample counts (ie generally less than 14 observations). Detection functions generated by distance sampling analysis showed that detection rate was much lower in bands C and D than

in bands A and B. These more distant bands were excluded from this analysis to avoid underestimating density (apart from three occasions when the single observation was in a more distant band). Transect widths were therefore assumed to be either 764m wide, ie 2 × (118+264) for aerial surveys before October 2002 or 476m wide, ie 2 × (118+120) for surveys after October 2002. This was multiplied by the length of the total survey transects flown to give the area over which observers counted. The number of birds observed in bands A and B (and band C for January 2003, February 2004 and January 2005 surveys) was then divided by the area over which observers counted to give an estimated bird density. This density was then extrapolated across the entire study area to estimate total population size. No confidence limits are given for these estimates.

3.3.1 Waterbird assemblage population estimation

To estimate the size of the waterbird assemblage, only the recorded target inshore waterbird species (see 2.1) were included. For this analysis common scoter and velvet scoter were combined to give estimates for 'all scoter species', similarly great crested grebes and unidentified grebe species were combined to give estimates for 'great crested grebes' (assuming that most unidentified grebes were likely to be great crested grebes). These totals were then added to the numbers of other species present to calculate the total number of inshore waterbirds ('assemblage total') for each survey (Section 3.3, Table 2).

The peak assemblage total for each season (maximum estimate) was then divided by the number of survey seasons to determine the mean peak estimate. Mean peak estimates assist with the assessment of regular occurrence of bird species as defined by the Ramsar site selection criteria, put into context of the UK marine SPA selection process by Webb & Reid (2004).

4 Results

4.1 Number of birds recorded

Three strip transect aerial surveys (1988/89 and 1989/90) and 20 line transect aerial surveys (2001/02 to 2006/07) were conducted in the Greater Thames between 8 January 1989 and 8 March 2007, over a total of 58 days. The raw count data for all surveys are presented in Table 1, while estimated total population sizes are given in Table 2. An assumption of strip transect aerial surveys (1988/89 and 1989/90) is that all birds were counted in the surveyed area, thus the numbers presented in Table 1 are the total number of birds, and so are not listed again in Table 2.

Nine of the target species were recorded on these surveys (Table 1). Additionally, some divers and grebes could not be identified to species level and therefore were recorded as unidentified diver species. Sufficient data to enable distance sampling analysis or extrapolation from raw counts were collected for the following species: common eider, common scoter, red-breasted merganser, red-throated diver, great northern diver, great crested grebes and little gull.

Three different survey methods were used and caution should be applied when comparing raw counts of these surveys. Also the survey area and number of transects surveyed was different for each survey (Appendix 1). For example, T1 was not covered in December 2005 and Blocks T2 and T3 were not covered during 2007. T4 and T5, which lie along the Suffolk coast, were not surveyed at all during 2005/06 and 2006/07 as the distribution of birds in these blocks was thought to be adequately understood and further survey would provide no further information on the westerly extent of the diver distribution.

Furthermore, during strip transect aerial surveys in1988/89 and 1989/90, distance information was not collected and bird densities were calculated over the entire transect width. The assumption that all birds within the survey area were detected is highly unlikely to have been met and these surveys may therefore underestimate bird density considerably.

Table 1. Total numbers (raw counts) of birds and flocks (represented in brackets) counted in inshore waters of the Greater Thames during the 1988/89 to 2006/07 survey seasons. Numbers represent the total sample counts of all birds recorded on the line transect aerial surveys.

Date of survey	Common eider	Common scoter	Velvet scoter	Red-breasted merganser	Red-throated diver	Great northern diver	Black-throated diver	Unidentified diver *Gavia sp.*	Great crested grebes	Unidentified grebe *Podiceps sp.*	Little gull
	Season 1988/89										
8-9 Jan 1989	-	1700 (2)	-	2 (1)	28 (22)	-		8 (8)	-	-	-
11-12 Mar 1989	-	6 (1)	-	4 (1)	9 (4)	-		10 (5)	-	-	-
	Season 1989/90										
5-6 Nov 1989	-	-	-	3 (1)	8 (4)	-		-	-	-	-
	Season 2000/01										
10-11 Jan 2002	-	183 (10)	-	2 (1)	210 (137)	1 (1)		23 (22)	7 (6)	-	-
	Season 2002/03										
18-19 Jan 2003	696 (14)	222 (6)	10 (1)	14 (1)	344 (232)	-		1487 (767)	-	118 (31)	-
15-16 Feb 2003	52 (5)	465 (18)	-	-	104 (74)	-		745 (377)	-	60 (7)	-
	Season 2003/04										
27 Nov 2003	-	22 (7)	-	-	40 (33)	-		79 (70)	-	6 (3)	-
17 Dec 2003	-	-	-	-	215 (177)	-		363 (288)	3 (1)	12 (8)	-
15, 16, 26 Feb 2004	3 (2)	383 (15)	-	1 (1)	828 (144)	-	4 (5)	1644 (674)	11 (5)	-	1 (1)
	Season 2004/05										
30-31 Oct, 18 Nov 2004	-	136 (9)	-	-	34 (27)	-		138 (128)	-	5 (4)	15 (13)
24-25 Nov, 3-5 Dec 04	9 (2)	358 (21)	-	-	250 (200)	-	1 (1)	723 (572)	7 (2)	-	21 (21)
13-14, 26-27 Jan 2005	-	-	-	-	33 (22)	-		133 (121)	-	-	-
14-15 Jan, 3 Feb 2005	-	708 (7)	2 (2)	10 (4)	90 (79)	6 (6)	1 (1)	916 (696)	-	17 (12)	10 (9)

Table 1. (cont) Total numbers (raw counts) of birds and flocks (represented in brackets) counted in inshore waters of the Greater Thames during the 1988/89 to 2006/07 survey seasons. Numbers represent the total sample counts of all birds recorded on the line transect aerial surveys.

Date of survey	Common eider	Common scoter	Velvet scoter	Red-breasted merganser	Red-throated diver	Great northern diver	Black-throated diver	Unidentified diver *Gavia* sp.	Great crested grebes	Unidentified grebe *Podiceps sp.*	Little gull
	Season 2004/05 cont.										
13-14, 26-27 Jan 2005	-	-	-	-	33 (22)	-	1 (1)	133 (121)	-	-	-
28 Feb, 6-8 Mar 2005	6 (1)	142 (4)	-	8 (2)	1 (1)	2 (2)		966 (344)	3 (3)	8 (8)	-
4-5 Mar 2005	-	-	-	-	22 (14)	-		69 (46)	-	-	-
13,15 Mar 2005	5 (1)	-	-	-	6 (4)	-		430 (183)	-	-	-
	Season 2005/06										
13,16-17 Nov 2005	2 (1)	-	-	-	-	-		100 (61)	-	-	59 (27)
6-9 Dec 2005	-	-	-	-	78 (70)	-		217 (195)	-	-	1 (1)
10,13-14,18 Jan 2006	-	278 (11)	5 (1)	-	201 (151)	1 (1)		873 (724)	1 (1)	6 (4)	4 (4)
18 Feb, 2-3,7 Mar 2006	1 (1)	94 (9)	-	-	112 (88)	5 (5)		867 (500)	-	4 (3)	-
	Season 2006/05										
31 Jan, 2-3 Feb 2007	7 (1)	16 (2)	-	-	165 (117)	-	1 (1)	389 (149)	-	-	-
18 Feb, 8 Mar 2007	-	698 (16)	-	-	339 (233)	4 (4)		312 (207)	1 (1)	5 (3)	4 (2)

4.2 Bird distributions (2002/03 – 2006/07)

Bird distributions recorded during 1988-90 surveys can be found in Barton *et al,* (1993), those recorded during the January 2002 survey can be found in Dean *et al* (2003), during 2002/03 are presented in Hall *et al* (2003), and those from 2004/05 are in WWT Wetland Advisory Service (2006). The distributions of the most abundant species are presented in this report for the 19 surveys carried out between January 2003 and February/March 2007 in Appendix 1, Figures A1-A5. These species are common eider, common scoter, red-throated and unidentified diver species combined, great crested grebe and unidentified grebe species combined, and little gull. Numbers of other species were not significant in the SPA context, and were too low to draw any meaningful conclusions about their distribution.

Common eider (Appendix 1, Figure A1)

Common eiders were recorded during nine out of 19 surveys and were observed in high numbers only in January 2003. They were recorded mainly in the inshore areas of the survey area, in water less than 10m very close to the shore.

Common scoter (Appendix 1, Figure A2 (a-i))

Few flocks of common scoter were recorded but more than half the surveys observed moderate numbers up to 650 of individuals (January 2002, February 2003, February 2004, November/December 2004 and January/February 2005). Common scoters were recorded mainly in the inshore areas, in water less than 20m deep. During all surveys in which birds were recorded, T1 was the most favoured area.

All divers (Red-throated diver and unidentified divers) (Appendix 1, Figure A3 (a–s))

Red-throated divers were recorded during all surveys of the Greater Thames, mainly in waters less than 20m deep. High numbers of divers were recorded mainly in December and January/February of each year. Survey areas T1 and T2 held divers more frequently compared with other areas. Birds were regularly recorded in flocks of 5-10 individuals, and frequently up to 20, although the largest aggregation was 150 individuals.

All grebes (Great crested grebe and unidentified grebes) (Appendix 1, Figure A4 (a-c))

Grebes were recorded in low numbers but with up to 20 individuals in one flock (January 2003 and January/February 2005). The survey areas where were most frequently recorded were T1 and T2.

Little gull (Appendix 1, Figure A5 (a–c))

Little gulls were recorded during eight of the 19 surveys and were observed only in low numbers. They were recoded throughout the study area but mainly in the offshore areas,

4.3 Number and density estimates

Data from 52 days' survey of the Greater Thames carried out between January 2002 and March 2007 were analysed to estimate total numbers of each species during each monthly (or near monthly) survey (Table 2). (It should be noted that numbers are not comparable in all months due to differing levels of coverage.)

In many cases, the number of flocks of a given species or group of species was insufficient to permit a robust estimate of density using distance sampling analysis, therefore extrapolation from the raw count data was used instead. Though they are the best estimates possible given the data, many of the extrapolated population estimates should be used with caution as many estimates were based on small sample sizes. 'All scoter species' and 'all grebe species' population estimates were generated only for the purpose of calculating the waterbird assemblage (Section 3.4.9; Table 11).

A large proportion (76%) of diver observations was recorded as 'unidentified diver' rather than to species level. Of the positively identified divers (n = 2,220), all were red-throated divers, apart from eight great northern divers and eight black-throated divers. Consequently, analyses were performed on combined red-throated and unidentified diver records and assumed to pertain to red-throated divers; the small amount of error (0.7%) relating to other diver species among the unidentified divers was deemed acceptable. Great crested grebes were the only grebe species to be positively identified in the surveys; all unidentified grebes were therefore assumed to be this species.

Details of population estimates derived from distance sampling analysis are provided in Appendix 2, red-throated diver and unidentified diver species; all grebe species and little gull.

Table 2. Summary of total estimated numbers of selected species in the Greater Thames during each line transect survey season from 2001/02 to 2006/07. Estimates and 95% confidence intervals (represented in brackets) are derived from distance sampling, apart from those denoted with an asterisk (*), which have been extrapolated from raw counts, or those denoted with a plus ($^{+}$), which have not been extrapolated because birds were seen only in survey band C. Numbers in bold indicate the peak seasonal total estimates of each species in each season. Numbers in shaded cells exceed the appropriate Stage 1 thresholds under the UK SPA Site Selection Guidelines.

Date of survey	Common eider	Common scoter	All scoters	Red-breasted merganser	Red-throated diver	Great northern diver	Great crested grebe	Little gull	Assemblage of all species
SPA qualification threshold	12,850	16,000	n/a	1,700	170	50	3,600	50	20,000
Season 2001/02									
Jan 2002	0	1472*	1472*	32*	2460 (1667-3630)	16*	113*	0	**4093**
Season 2002/03									
Jan 2003	3135*	38*	67*	0^{+}	10884 (8115 –13439)	0	357 (93-668)	0	**14443**
Feb 2003	241*	2088*	2088*	0	3942 (2937-5291)	0	218*	0	6489
Season 2003/04									
Nov 2003	0	98*	98*	0	705 (468-1061)	0	28*	0	831
Dec 2003	0	0	0	0	2888 (2424-3441)	0	53*	0	2941
Feb 2004	4*	255*	255*	0^{+}	7688 (5041-11725)	0	34*	2*	**7984**
Season 2004/05									
Oct/Nov 2004	0	323*	323*	0	1266 (835-1961)	0	21*	78*	1688
Nov/Dec 2004	75*	1082*	1082*	0	5749 (4723-6997)	0	57*	123 (59-255)	7086
Jan 2005	53*	0^{+}	0^{+}	0	912 (621-1339)	0	0	18*	983

Table 2. (cont) Summary of total estimated numbers of selected species in the Greater Thames during each line transect survey season from 2001/02 to 2006/07. Estimates and 95% confidence intervals (represented in brackets) are derived from distance sampling, apart from those denoted with an asterisk (*), which have been extrapolated from raw counts, or those denoted with a plus ($^{+}$), which have not been extrapolated because birds were seen only in survey band C. Numbers in bold indicate the peak seasonal total estimates of each species in each season. Numbers in shaded cells exceed the appropriate Stage 1 thresholds under the UK SPA Site Selection Guidelines.

Date of survey	Common eider	Common scoter	All scoters	Red-breasted merganser	Red-throated diver	Great northern diver	Great crested grebe	Little gull	Assemblage of all species
SPA qualification threshold	12,850	16,000	n/a	1,700	170	50	3,600	50	20,000
Season 2004/05 (cont)									
Jan/Feb 2005	0	3060*	3068*	43*	6123 (4996 - 7504)	26*	73*	43*	**9368**
Feb/Mar 2005	53*	253*	253*	72*	4375 (2928-6537)	18*	49*	0	4820
4+5 Mar 2005	0	86*	0	0	435 (254-745)	0	8*	0	529
13+15 Mar 2005	0^{+}	0	0	0	1706 (1196-2433)	0	0	0	1706
Season 2005/06									
Nov 2005	9*	0	0	0	847 (506-1346)	0	0	440 (220-879)	1296
Dec 2005	0	0	0	0	1930 (1362-2366)	0	0	9*	1939
Jan 2006	0	40*	44*	0	5291 (3745-7179)	9*	22*	36*	**5402**
Feb/Mar 2006	10*	216*	216*	0	4481 (3272-5423)	45*	13*	0	4765
Season 2006/07									
Jan/Feb 2007	5*	11*	11*	0	2199 (1321-3388)	0	0	0	2215
Feb/Mar 2007	0	1411*	1411*	0	3106 (2035-4589)	36*	18*	8*	**4579**

4.4 Mean of peak estimates for each species

4.4.1 Common eider

Table 3 shows the peak population estimates for common eider in the Greater Thames for each season, and the mean of these for the five most recent seasons.

Common eiders were observed in nine out of 19 surveys and were relatively uncommon in the Greater Thames during these aerial surveys. There were insufficient observations for common eider to estimate density and abundance for any survey, therefore estimates were extrapolated from raw counts. No confidence limits are associated with these values, so they should be treated with caution. No estimates came close to exceeding the stage 1 threshold in any season.

Table 3. Peak seasonal population estimates for common eider in the Greater Thames for aerial surveys from 2001/02 to 2006/07.

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines Stage 1 threshold = 12,850			
2001/02	extrapolation	0	Jan 2002
2002/03	extrapolation	3135	Jan 2003
2003/04	extrapolation	4	Feb 2004
2004/05	extrapolation	75	Nov/Dec 2004
2005/06	extrapolation	10	Feb/Mar 2006
2006/07	extrapolation	5	Jan/Feb 2007
Mean of peak estimate for the most recent five seasons		646	

4.4.2 Common scoter

Table 4 shows the peak population estimates for common scoter in the Greater Thames for each season, and the mean of these for the five most recent seasons.

There were insufficient observations of common scoters to generate density and population estimates using distance sampling for any survey. There are no confidence limits associated with these estimates as they were derived from extrapolation of raw counts, therefore they should be treated with caution. No estimates came close to exceeding the stage 1 threshold in any season.

Table 4. Peak seasonal population estimates for common scoter in the Greater Thames for aerial surveys from 2001/02 to 2006/07.

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines Stage 1 threshold = 16,000			
2001/02	extrapolation	1472	Jan 2002
2002/03	extrapolation	2088	Feb 2003
2003/04	extrapolation	255	Feb 2004
2004/05	extrapolation	3060	Jan/Feb 2005
2005/06	extrapolation	216	Feb/Mar 2006
2006/07	Distance sampling	1411	Feb/Mar 2007
Mean of peak estimate for the most recent five seasons		1406	

4.4.3 All scoter species

Table 5 shows the peak population estimates for all scoter species in the Greater Thames for each season, and the mean of these for the five most recent seasons.

'All scoter' population estimates, using counts of common scoter, velvet scoter and unidentified scoters combined, were generated using distance sampling to calculate the total number of scoter species for the waterbird assemblage (Section 3.4.9). Only the line transect aerial surveys in January 2003, January/February 2005 and January 2006 resulted in observations of velvet scoter. Therefore, on all other surveys overall density and population estimates for 'all scoters' was equal to the estimated numbers calculated for common scoter. No estimates came close to exceeding the stage 1 threshold in any season.

Table 5. Peak seasonal population estimates for all scoter species in the Greater Thames for aerial surveys from 2001/02 to 2006/07.

Season	Analysis used to derive estimate	Peak estimate	Date
2001/02	extrapolation	1472	Jan 2002
2002/03	Distance sampling	2088	Feb 2003
2003/04	Distance sampling	255	Feb 2004
2004/05	extrapolation	3068	Jan/Feb 2005
2005/06	extrapolation	216	Feb/Mar 2006
2006/07	Distance sampling	1411	Feb/Mar 2007
Mean of peak estimate for the most recent five seasons		1408	

4.4.4 Red-breasted merganser

Table 6 shows the peak population estimates for red-breasted merganser in the Greater Thames for each season, and the mean of these for the five most recent seasons.

Red-breasted merganser occurred only sporadically and in low numbers in the Greater Thames. There were insufficient observations for red-breasted merganser during all aerial

surveys to estimate density and abundance using distance analysis, and therefore estimates were extrapolated from raw counts. No confidence limits are associated with these values, so they should be treated with caution. No estimates came close to exceeding the stage 1 threshold in any season.

Table 6. Peak seasonal population estimates for red-breasted merganser in the Greater Thames for aerial surveys from 2001/02 to 2006/07.

Season	**Analysis used to derive estimate**	**Peak estimate**	**Date**
SPA guidelines Stage 1 threshold = 1,700			
2001/02	extrapolation	32	Jan 2002
2002/03	-	No observations	
2003/04	-	No observations	
2004/05	extrapolation	72	Nov/Dec 2004
2005/06	-	No observations	
2006/07	-	No observations	
Mean of peak estimate for the most recent five seasons		14	

4.4.5 Red-throated diver

Table 7 shows the peak population estimates for red-throated diver and unidentified divers in the Greater Thames for each season, and the mean of these for the five most recent seasons.

Red-throated diver was the dominant diver species, present throughout the survey area. Total numbers showed relatively large variation over the survey period. Numbers of birds ranged from 425 (March 2004) to 10,884 individuals (January 2003). All estimates of density and numbers for red-throated divers were derived by using distance sampling.

Numbers of red-throated divers seemed to be highest during January/February of each season but did not show any other consistent patterns within or between seasons. All estimates greatly exceeded the stage 1 threshold in five of five seasons, as did the mean of peak estimates.

Table 7. Peak seasonal population estimates for red-throated diver and unidentified divers in the Greater Thames for aerial surveys from 2001/02 to 2006/07. Shaded cells indicate estimates which exceed the Stage 1 threshold.

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines Stage 1 threshold = 170			
2001/02	Distance sampling	2460	Jan 2002
2002/03	Distance sampling	10884	Jan 2003
2003/04	Distance sampling	7688	Feb 2004
2004/05	Distance sampling	6123	Jan/Feb 2005
2005/06	Distance sampling	5291	Jan 2006
2006/07	Distance sampling	3106	Feb/Mar 2007
Mean of peak estimate for the most recent five seasons		6618	

4.4.6 Great northern diver

Table 8 shows the peak population estimates for great northern diver in the Greater Thames for each season, and the mean of these for the five most recent seasons.

Great northern divers were recorded during six of 19 aerial surveys. Total numbers were consistently low over the survey period and ranged from nine to 45 individual birds.

There were insufficient observations of great northern diver during all aerial surveys to estimate density and abundance using distance sampling analysis, therefore estimates were extrapolated from raw counts. No confidence limits are associated with these values, so they should be treated with caution. No estimates came close to exceeding the stage 1 threshold in any season.

Table 8. Peak seasonal population estimates for great northern diver in the Greater Thames for aerial surveys from 2001/02 to 2006/07.

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines Stage 1 threshold = 50			
2001/02	extrapolation	16	Jan 2002
2002/03	-	No observations	
2003/04	-	No observations	
2004/05	extrapolation	26	Jan 2005
2005/06	extrapolation	45	Feb/Mar 2006
2006/07	extrapolation	36	Feb/Mar 2007
Mean of peak estimate for the most recent five seasons		21	

4.4.7 Great crested grebe

Table 9 shows the peak population estimates for great crested grebe in the Greater Thames for each season, and the mean of these for the five most recent seasons.

Great crested grebes were observed during all but five aerial surveys. Total population numbers ranged from eight to 357 individual birds. There were insufficient observations for great crested grebes during all but one aerial survey to estimate density and abundance using distance sampling analysis, therefore the majority of estimates were extrapolated from raw counts. No confidence limits are associated with these values, so they should be treated with caution. No estimates came close to exceeding the stage 1 threshold in any season.

Table 9. Peak seasonal population estimates for great crested grebe in the Greater Thames for aerial surveys from 2001/02 to 2006/07.

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines Stage 1 threshold = 3,600			
2001/02	extrapolation	113	Jan 2002
2002/03	Distance sampling	357	Jan 2003
2003/04	extrapolation	53	Dec 2003
2004/05	Distance sampling	73	Jan/Feb 2005
2005/06	extrapolation	22	Jan 2006
2006/07	extrapolation	18	Feb/Mar 2007
Mean of peak estimate for the most recent five seasons		105	

4.4.8 Little gull

Table 10 shows the peak population estimates for little gull in the Greater Thames for each season, and the mean of these for the five most recent seasons.

It should be noted that observers were not sufficiently trained to identify little gulls until 2004/05. Consequently, the mean of peak estimate was calculated for the three (rather than five) most recent seasons. Nevertheless, little gulls were observed during nine out of 19 aerial surveys. Total population numbers ranged from two to 440 individual birds. There were insufficient observations of little gulls during all but two aerial surveys (November/December 2004 and November 2005) to estimate density and abundance using distance sampling analysis, therefore the majority of estimates were extrapolated from raw counts. No confidence limits are associated with these values, so they should be treated with caution. Estimates exceeded the stage 1 threshold in two seasons.

Table 10. Peak seasonal population estimates for little gull in the Greater Thames for aerial surveys from 2001/02 to 2006/07. Shaded cells indicate estimates which exceed the Stage 1 threshold.

Season	Analysis used to derive estimate	Peak estimate	Date
SPA guidelines Stage 1 threshold = 50			
2001/02	-	No observations	
2002/03	-	No observations	
2003/04	extrapolation	2	Feb 2004
2004/05	Distance sampling	123	Nov/Dec 2004
2005/06	Distance sampling	440	Nov 2005
2006/07	extrapolation	8	Feb/Mar 2007
Mean of peak estimate for the most recent three seasons		190	

4.4.9 Waterbird assemblage

Table 10 shows the mean of peak population estimates of common eider, all scoter species, red-breasted merganser, red-throated diver, great northern diver, great crested grebe and little gull. The peak total population estimates of all species for each season can be found in Table 2 and summaries in Table 11. Estimates from aerial surveys did not exceeded 20,000 individuals, the Stage 1.3 threshold, in any season.

Table 11. Summary of mean of peak estimates for selected species in the Greater Thames during each survey season from 2002/03 to 2006/07.

Season	Peak population estimates per season	Date
2002/03	14443	Jan 2003
2003/04	7984	Feb 2004
2004/05	9368	Jan/Feb 2005
2005/06	5402	Jan 2006
2006/07	4579	Feb/Mar 2007
Mean of peak estimate for the five most recent seasons		**8355**

5 Discussion

5.1 Distance sampling analysis

Most species estimates were characterised by insufficient sample sizes and violated one or more of the assumptions of distance sampling. Detection functions could only be generated for all surveys of red-throated divers, one survey of great crested grebes and two surveys of little gulls. The relatively small 95% confidence intervals associated with these estimates of densities and total numbers indicated good confidence in these numbers. Where it was not possible to acquire a detection function, either raw counts or extrapolation of mean density derived from raw counts were used. Though they are the best estimates possible given the data, the majority of these estimates should be used with caution as they were based on small sample sizes.

5.2 Application of Stage 1 UK selection guidelines for the Greater Thames

5.2.1 Common eider

The common eider is a regularly occurring migratory species in the UK. Therefore, stage 1.2 of the UK SPA site selection guidelines should be applied in the initial assessment of whether the site might be suitable for classification as a SPA for the species (Stroud *et al,* 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 12,850 individuals (Wetlands International 2006).

All estimates were obtained from extrapolation of raw counts. Total population numbers varied greatly over the survey period from four (February 2004) to 3,135 individual birds (January 2003), with a mean of peak counts of 646 individuals (Table 3).

Peak estimated numbers of common eider in the Greater Thames did not exceed the qualifying threshold in any of the five seasons surveyed, nor did the mean of peak estimated numbers for the five seasons. Therefore, the area does not meet the requirements of stage 1.2 of the site selection guidelines for this species.

5.2.2 Common scoter

The common scoter is a regularly occurring migratory species in the UK. Therefore, stage 1.2 of the UK SPA site selection guidelines should be applied in the initial assessment of whether the site might be suitable for classification as a SPA for the species (Stroud *et al,* 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 16,000 individuals (Wetlands International 2006).

All estimates were obtained from extrapolation of raw counts. Peak estimates for common scoter ranged from 216 to 3,060 individual birds, with a mean of peak counts of 1,406 individuals (Table 4). Estimates varied greatly across seasons. Common scoter were present in moderate numbers in February 2007.

Peak estimated numbers of common scoter in the Greater Thames did not exceed the qualifying threshold in any of the five seasons surveyed, nor did the mean of peak estimated

numbers for the five seasons. Therefore, the area does not meet the requirements of stage 1.2 of the site selection guidelines for this species.

5.2.3 Red-breasted merganser

The red-breasted merganser is a regularly occurring migratory species in the UK. Therefore, stage 1.2 of the UK SPA site selection guidelines should be applied in the initial assessment of whether the site might be suitable for classification as a SPA for the species (Stroud *et al,* 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 1,700 individuals (Wetlands International 2006).

All estimates were obtained from extrapolation of raw counts. Peak estimates for red-breasted merganser ranged from zero to 72 individuals, with a mean of peak counts of 14 (Table 5).

Peak estimated numbers of red-breasted merganser in the Greater Thames did not exceed the qualifying threshold in any of the five seasons surveyed, nor did the mean of peak estimated numbers for the five seasons. Therefore, the area does not meet the requirements of stage 1.2 of the site selection guidelines for this species

5.2.4 Red-throated diver

The red-throated diver is listed on Annex I of the EC Birds Directive. Therefore, stage 1.1 of the UK SPA site selection guidelines should be applied in the initial assessment of whether a site might be suitable for classification as a SPA for the species (Stroud *et al,* 2001). The threshold for such assessment is 1% of the relevant GB (or all-Ireland) wintering population, in this case 170 individuals (O'Brien *et al,* 2008).

Red-throated diver was, by far, the most prevalent species in the Greater Thames. All estimates were obtained from distance sampling analysis. Peak estimates red-throated diver ranged from 2,460 to 10,884 individual birds, with a mean of peak counts of 6,618 individuals (Table 6). Highest numbers tended to occur during January – February, with the highest estimated numbers occurring in January 2003. At 10,884 individuals, this is the single largest aggregation of divers to have been observed in UK waters, and one of the largest in northwest Europe.

Peak estimated numbers of red-throated diver in the Greater Thames exceeded the qualifying threshold in all five seasons, as did the mean of peak estimated numbers for the five seasons. Therefore, the area does meet the requirements of stage 1.1 of the site selection guidelines for this species.

A recent analysis, using extensive aerial survey around much of the British coastline since 2000, has revealed much larger numbers of red-throated divers wintering in Britain that previously thought (O'Brien *et al,* 2008). Almost half (44%) were estimated to occur within the Greater Thames, demonstrating that this is the most important site for wintering red-throated divers in the UK.

5.2.5 Great northern diver

The great northern diver is listed on Annex I of the EC Birds Directive. Therefore, stage 1.1 of the UK SPA site selection guidelines should be applied in the initial assessment of whether a site might be suitable for classification as a SPA for the species (Stroud *et al,* 2001). The threshold for such assessment is 1% of the relevant GB (or all-Ireland) wintering population, in this case 50 individuals (Stroud *et al,* 2001, Baker *et al,* 2006).

All estimates were obtained from extrapolation of raw counts. Peak estimates for each survey ranged from 26 to 45 individual birds, with a mean of peak counts of 21 individuals (Table 8). Estimates were relatively consistent across seasons.

Peak estimated numbers of great northern diver in the Greater Thames did not exceed the qualifying threshold in any of the five seasons surveyed, nor did the mean of peak estimated numbers for the five seasons. Therefore, the area does not meet the requirements of stage 1.1 of the site selection guidelines for this species.

5.2.6 Great crested grebe

The great crested grebe is a regularly occurring migratory species in the UK. Therefore, stage 1.2 of the UK SPA site selection guidelines should be applied in the initial assessment of whether the site might be suitable for classification as a SPA for the species (Stroud *et al,* 2001). The threshold for such assessment is 1% of the relevant biogeographical wintering population, in this case 3,600 individuals (Wetlands International 2006).

Only one estimate was obtained from distance sampling analysis; the others were obtained by extrapolating from the raw counts. Peak estimates of great crested grebe ranged from 22 to 357 individual birds, with a mean of peak counts of 114 individuals (Table 9). Population estimates were relatively consistent across seasons.

Peak estimated numbers of great crested grebe in the Greater Thames did not exceed the threshold in any of five seasons, nor did the mean of peak estimated numbers for the five seasons. Therefore, the area does not meet the requirements of stage 1.2 of the site selection guidelines for this species.

5.2.7 Little gull

The little gull is listed on Annex I of the EC Birds Directive. Therefore, stage 1.1 of the UK SPA site selection guidelines should be applied in the initial assessment of whether a site might be suitable for classification as a SPA for the species (Stroud *et al,* 2001). The threshold for such assessment is 1% of the relevant GB (or all-Ireland) wintering population (Stroud *et al,* 2001). However, there is currently no population estimate for little gulls (Baker *et al,* 2006); therefore the normal minimum qualifying threshold of 50 individuals is applied as recommended by the SPA Ramsar Scientific Working Group.

Two estimates were obtained from distance sampling analysis. Peak estimates of little gull ranged from two to 440 individual birds, with a mean of peak counts of 115 individuals (Table 10).

If the minimum threshold of 50 individuals is applied, peak estimated numbers of little gull in the Greater Thames exceeded the qualifying threshold in two of the five seasons of survey, as did the mean of peak estimated numbers for the five seasons. Based on the available data, the area does not meet the requirements of stage 1.1 of the site selection guidelines for this species. However, given that observers were not sufficiently trained to identify little gulls until 2004/05, further surveys are required to determine if this species should be a qualifying feature of any future SPA in the area.

5.2.8 Other waterbird species

No other species of inshore waterbird observed in the Greater Thames (such as other seaduck, diver or grebe species) were recorded in sufficient numbers to produce reliable estimates of total numbers (Table 1). It is highly unlikely that any of these species regularly occur in numbers that would meet SPA stage 1 site selection thresholds.

5.2.9 Waterbird assemblage

The threshold for an assemblage of waterbirds is that numbers regularly exceed 20,000 individuals, comprising two or more species, each present in numbers equal to at least 1% of the national population, and 2,000 individuals (Stroud *et al*, 2001). Regularity is assessed as for single species guidelines (stages 1.1 and 1.2) and as described in Webb and Reid (2004).

Summing the mean peak estimates of inshore waterbirds in the Greater Thames resulted in a total of 8,355 individual birds (Table 11). Therefore, the assemblage of inshore waterbirds in the Greater Thames does not meet the requirements for stage 1.3 of the UK SPA site selection guidelines.

6 Conclusion

On the basis of the UK SPA site selection guidelines (Stroud *et al,* 2001) the inshore waters within the Greater Thames meet the criteria for further consideration as a possible marine SPA for red-throated divers at stage 1.1.

The Greater Thames does not meet the criteria of the UK SPA Site Selection Guidelines (Stroud *et al,* 2001) as marine SPA at stage 1.2 or 1.3 for the target species considered in this report. However, when the complete suite of marine SPAs has been determined, then the inshore areas of the Greater Thames (or parts thereof) could possibly be considered for inclusion at stage 1.4 for little gull, though further surveys would be needed to support this.

Further consideration may be given to inclusion of other species using stage 1.4 of the SPA selection guidelines, once the relative importance of other potential areas for these species has been clarified and representation of range been considered.

If the inshore areas of the Greater Thames are further considered for SPA classification then additional analysis will be required of the data presented here in order to determine a boundary for that SPA.

7 Acknowledgements

Aerial surveys by the WWT were coordinated by Peter Cranswick and Rebecca Woodward and carried out by Gareth Bradbury, Peter Cranswick, Colette Hall, Anne Harrison, Martin McGill, David Paynter, Phil Shepherd, Lucy Smith and Jenny Worden. Aircraft were provided by Ravenair.

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Surveys conducted by the NCC were carried out by Andy Webb, Genevieve Leaper, Dave Steele and Simon Aspinall. Surveys conducted by JNCC were carried out by Andy Webb, Ben Dean and Richard Schofield. The aircraft was provided by Ravenair and flown by Howard Fenby.

Data collected between October 2002 and March 2005 were jointly commissioned by a consortium of companies. These were London Array Limited (E.ON UK Renewables Developments Limited), Elsam A/S, Vestas Wind Systems A/S, GE Gunfleet Limited, Greater Gabbard Offshore Winds Limited (Airtricity and Fluor Corporation), Thanet Offshore Wind Limited (Warwick Energy Limited) and Npower Renewables. In addition, the DTI and DEFRA provided funding for surveys carried out in the winter of 2004/05. These surveys were co-ordinated initially by Peter Cranswick of the WWT, then latterly by Phil Bloor of the former DTI.

Data collected between November 2005 and February/March 2007 were coordinated by a Steering Group, comprising WWT Consulting expertise; Philip Bloor (DTI project manager) and Angela Wratten (DTI). Members of the expert working group comprising of representatives from JNCC, Natural England (NE), Countryside Council for Wales (CCW), Scottish Natural Heritage (SNH) and Department for Environment and DEFRA, provided encouragement, support and invaluable expertise.

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9 Appendix 1. Distribution of birds recorded during aerial surveys

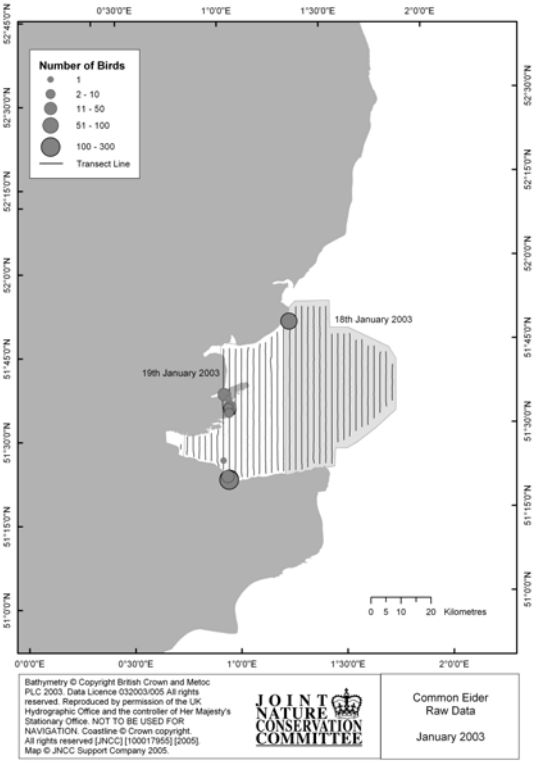


Figure 9.1. Size and location of flocks of common eider counted during aerial surveys of the Greater Thames during January 2003. Shaded areas depict boundaries of survey blocks used for estimating population size using *Distance 5.0*.

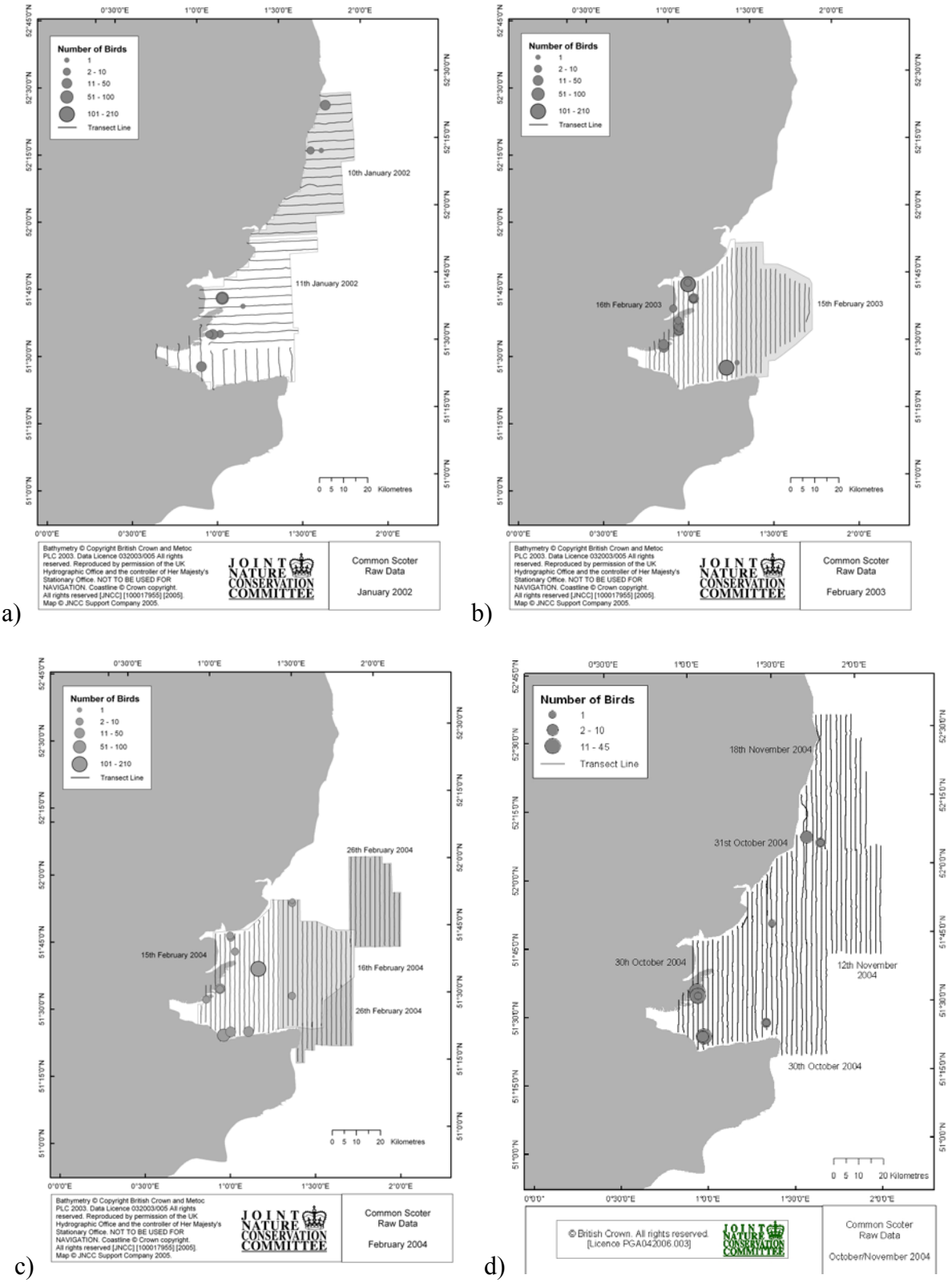


Figure 9.2 (a–d). Size and location of flocks of common scoters counted during aerial surveys of the Greater Thames during a) January 2002, b) February 2003, c) February 2004, and d) October/November 2004. Shaded areas depict survey blocks used for estimating population size using *Distance 5.0*.

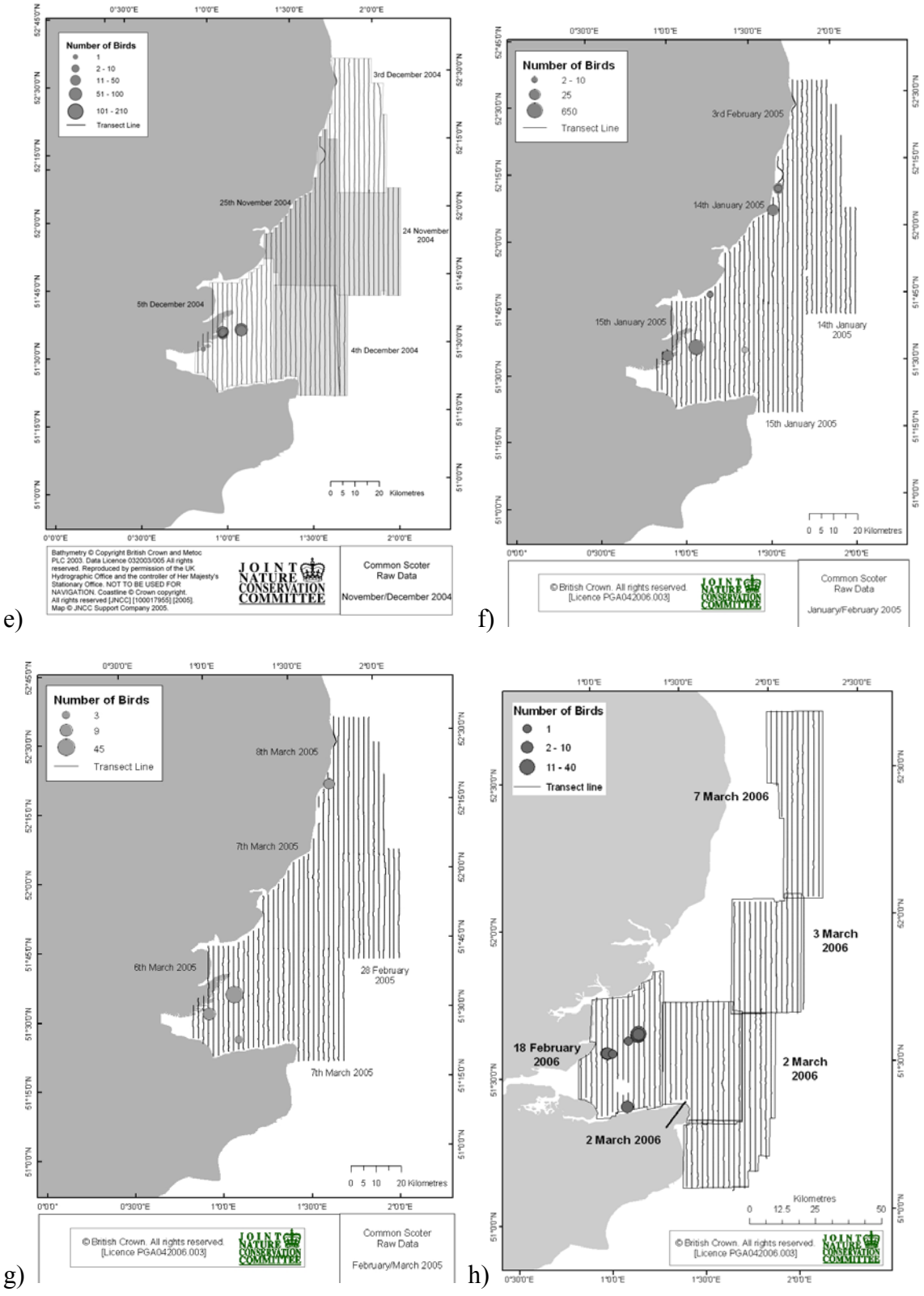
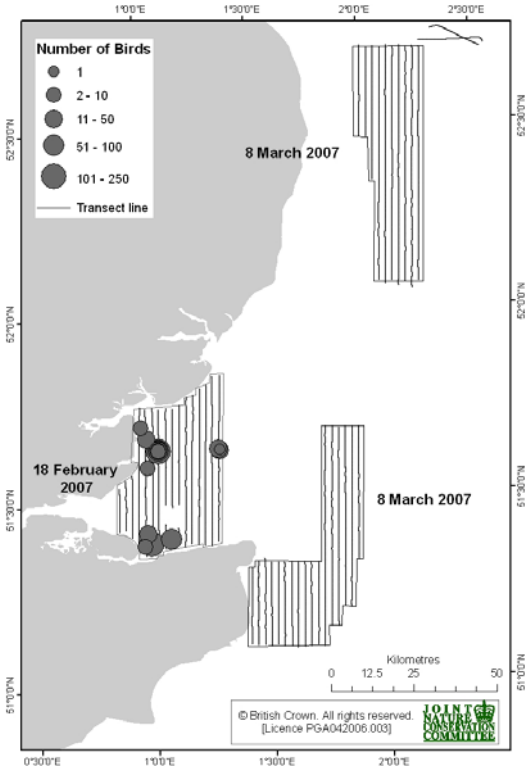


Figure 9.2 (e–h) (cont). Size and location of flocks of common scoters counted during aerial surveys of the Greater Thames during e) November/December 2004, and f) January/February 2005, g) February/March 2005 and h) February/March 2006.



i)

Figure 9.2. (i) (cont). Size and location of flocks of common scoters counted during aerial surveys of the Greater Thames during February/March 2007.

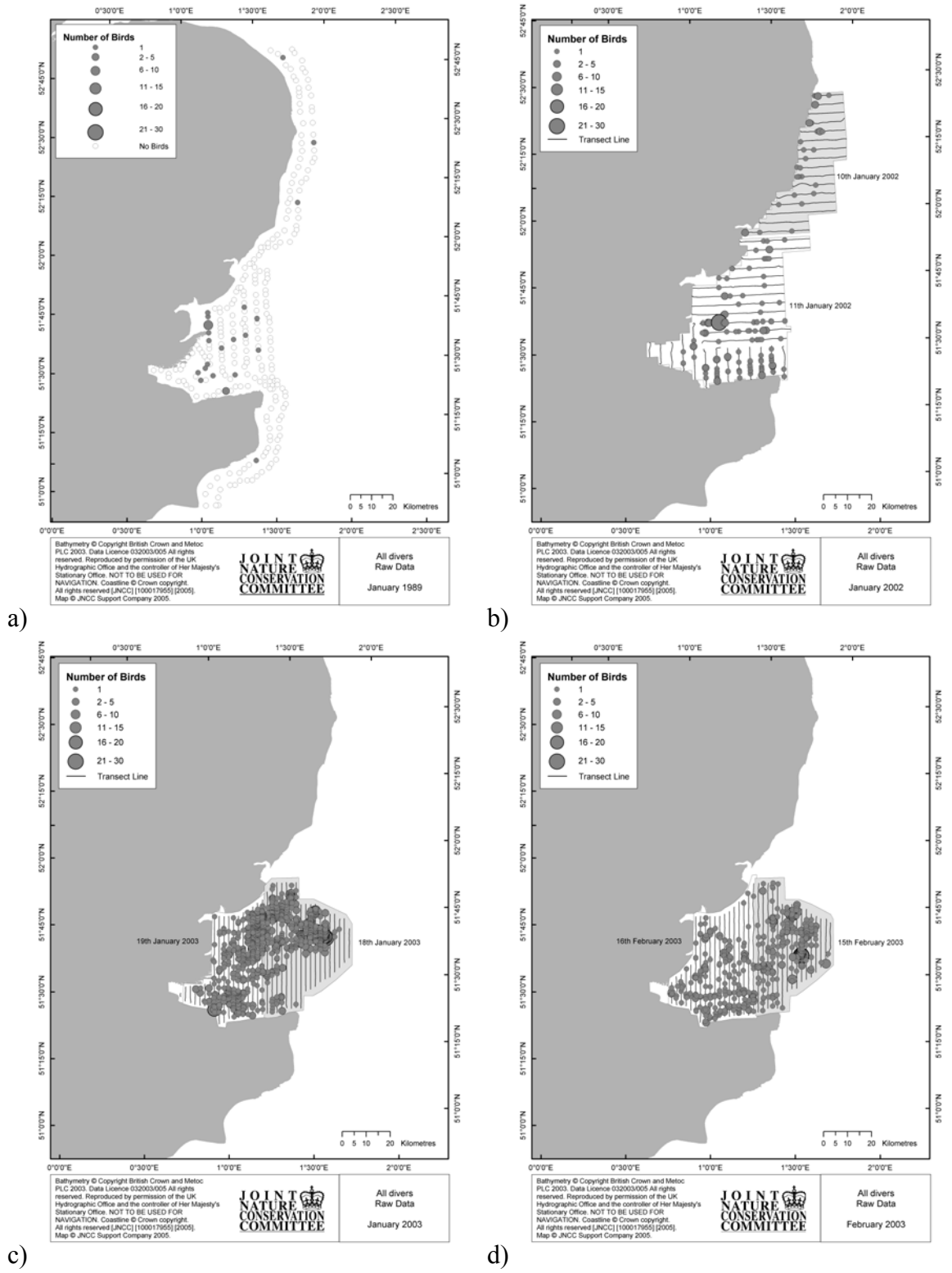


Figure 9.3 (a–d). Size and location of flocks of all diver species counted during aerial surveys of the Greater Thames during a) January 1989, b) January 2002, c) January 2003 and d) February 2003. Shaded areas depict survey blocks used for estimating population size using *Distance 5.0*.

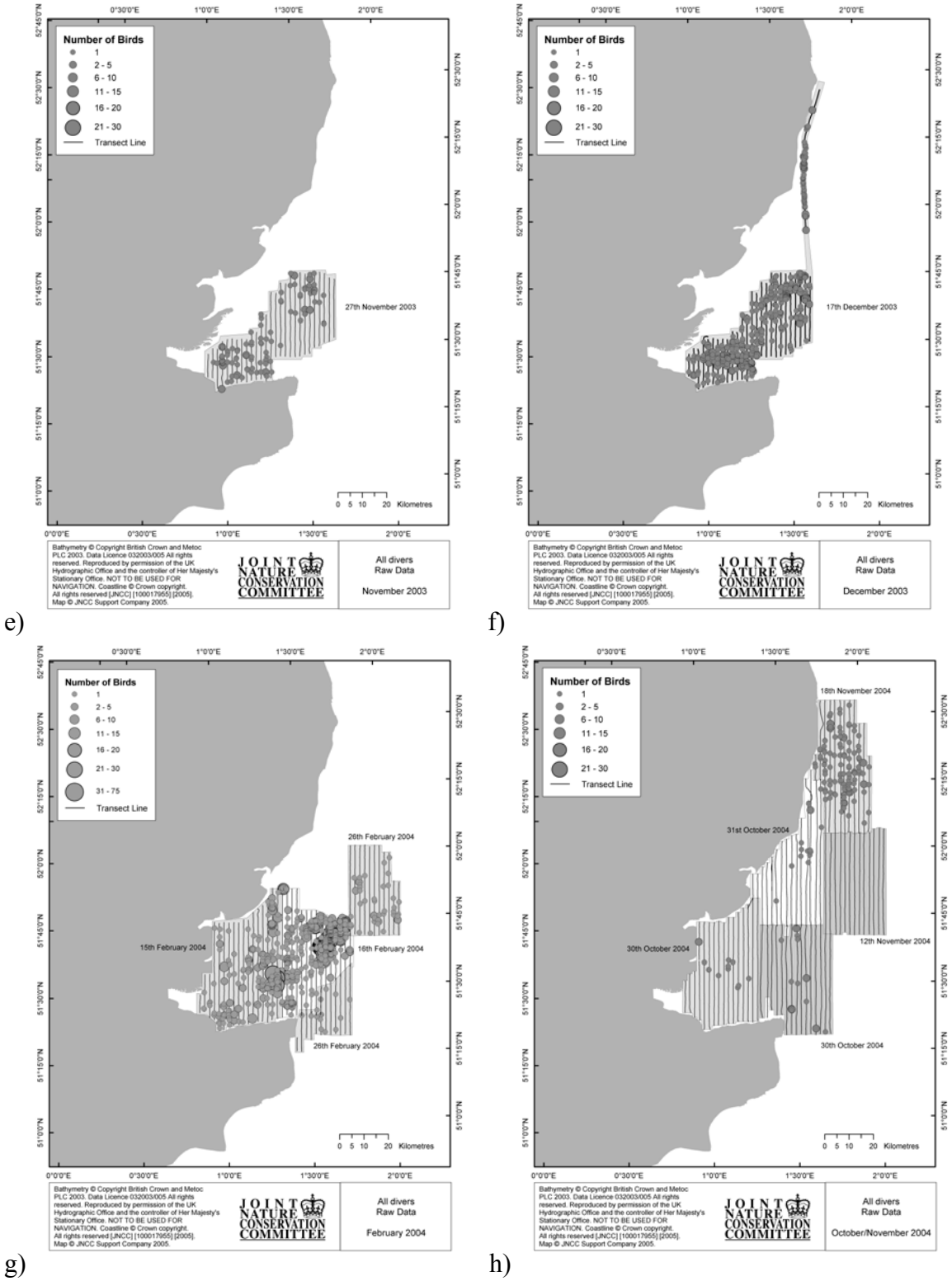
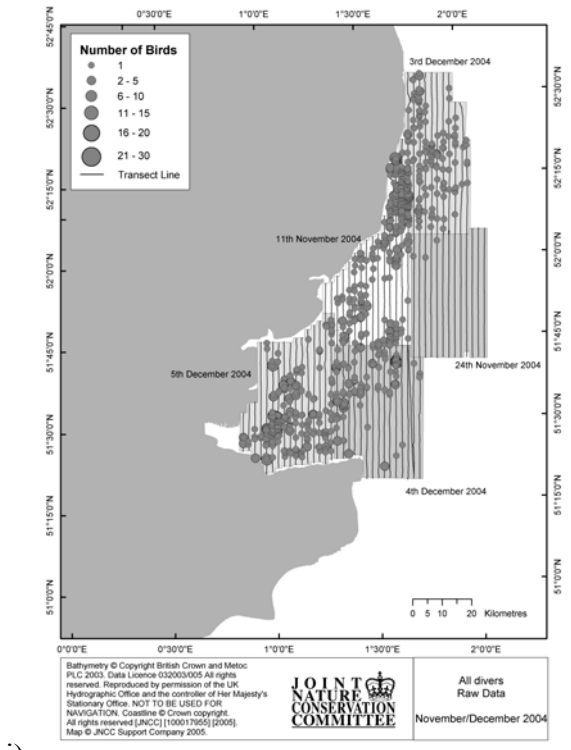
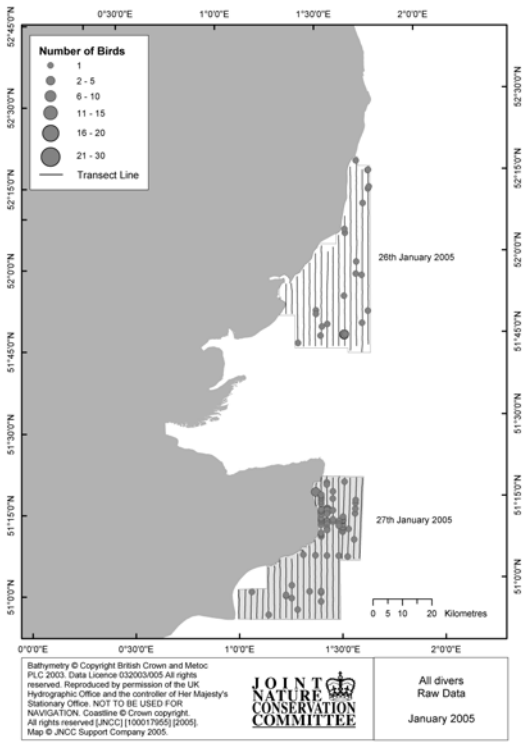


Figure 9.3 (e–h) (cont). Size and location of flocks of all diver species counted during aerial surveys of the Greater Thames during e) November 2003, f) December 2003, g) February 2004 and h) October/November 2004. Shaded areas depict survey blocks used for estimating population size using *Distance 5.0*.



i)



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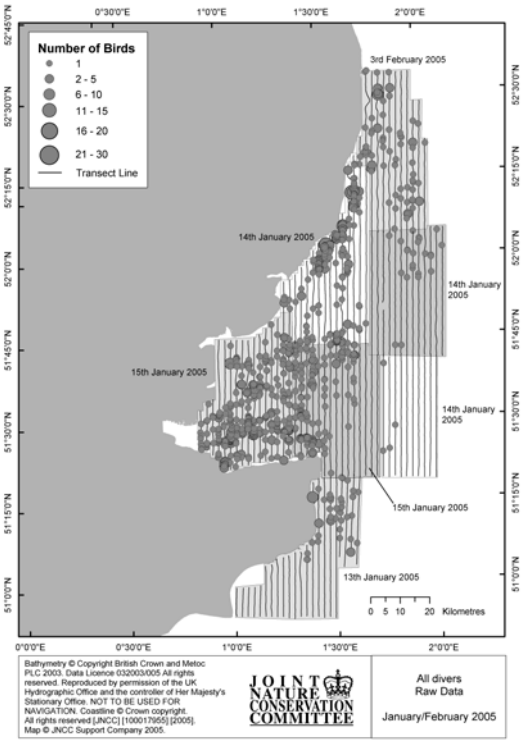
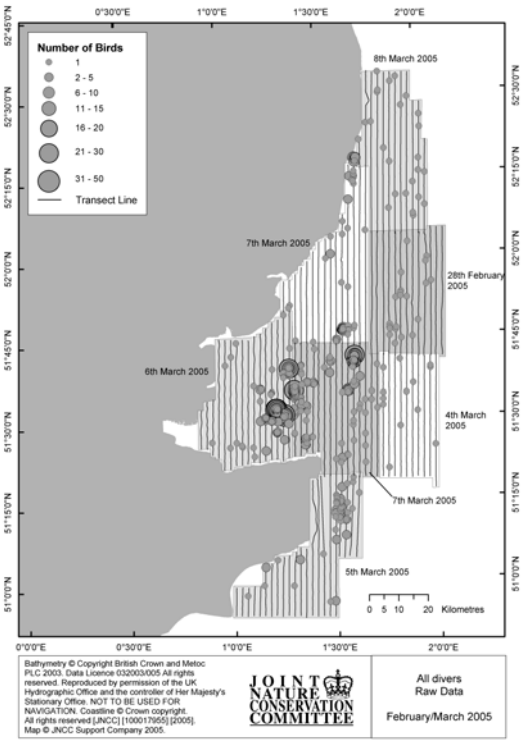
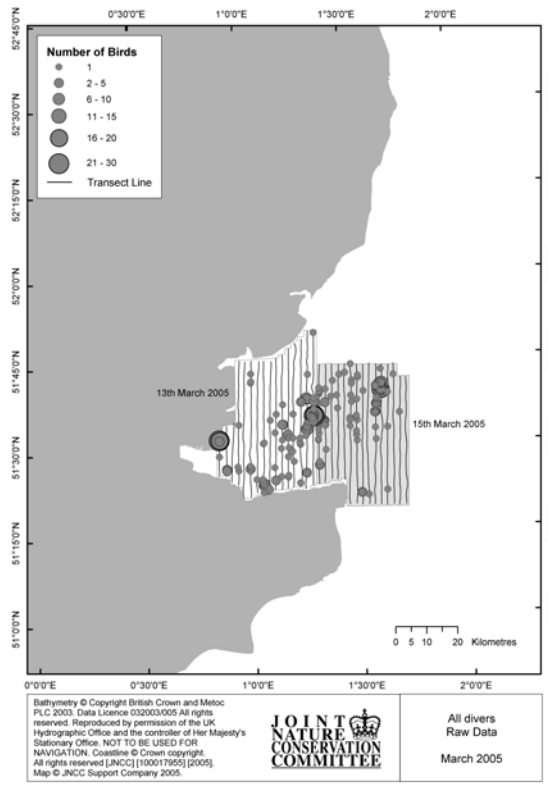


k)

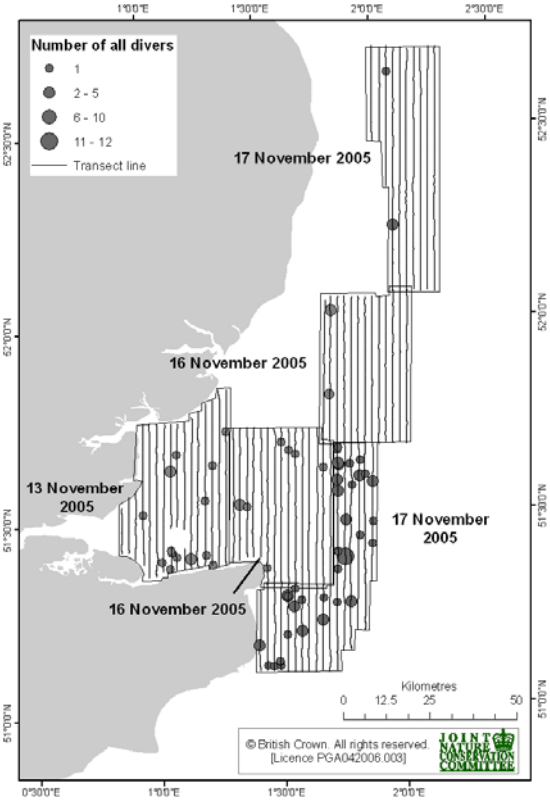


l)

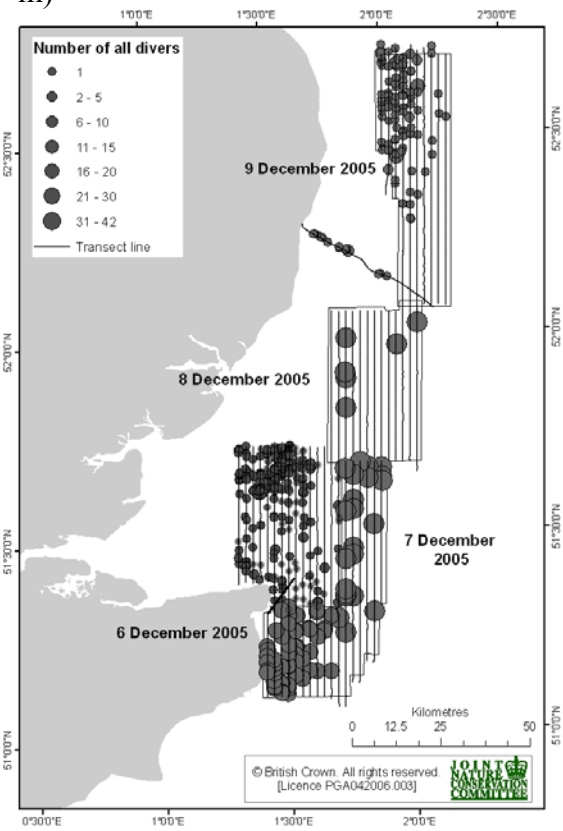
Figure 9.3 (i–l) (cont). Size and location of flocks of all diver species counted during aerial surveys of the Greater Thames during i) November/December 2004, j) January 2005, k) January/February 2005 and l) February/March 2005. Shaded areas depict survey blocks used for estimating population size using *Distance 5.0*.



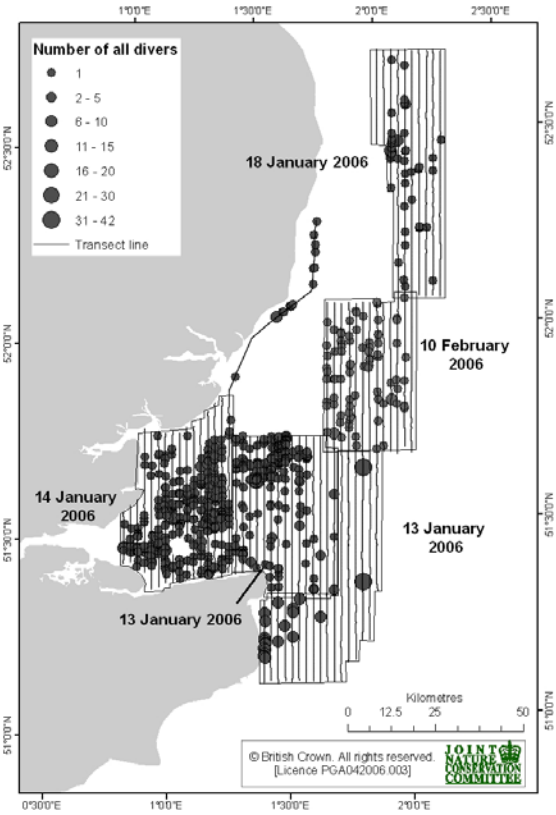
m)



n)

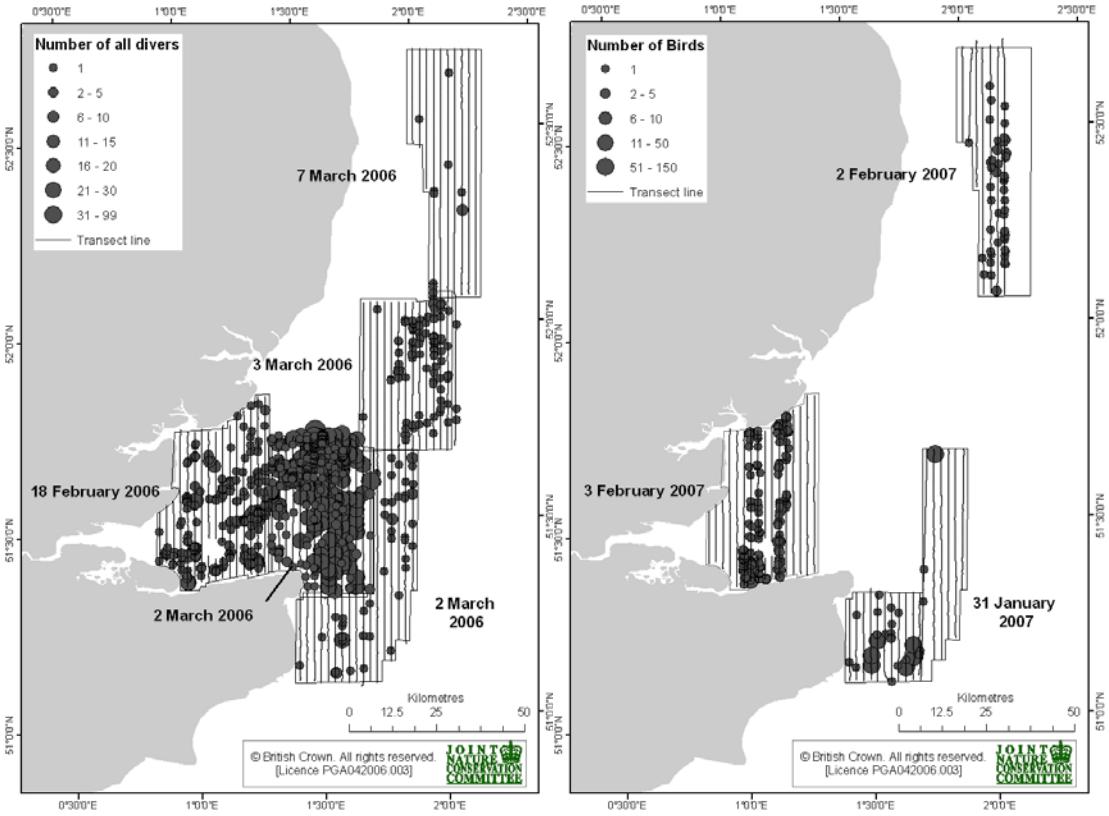


o)

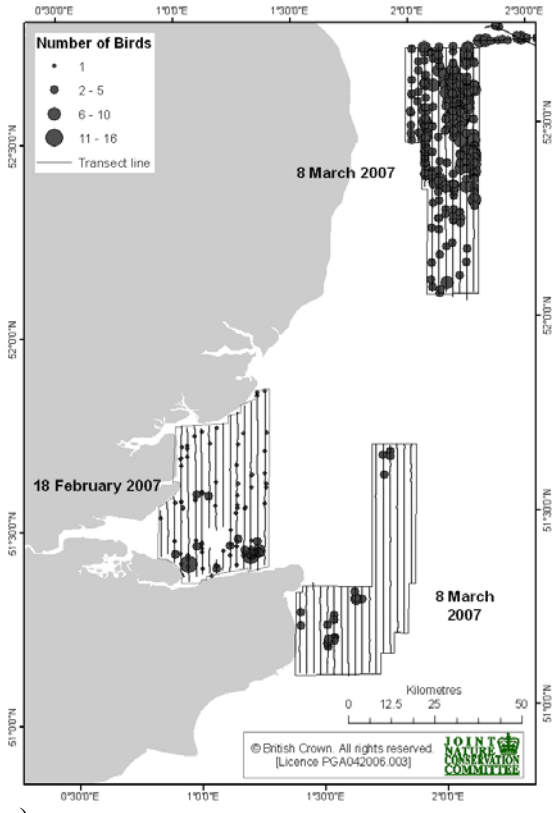


p)

Figure 9.3 (m-p) (cont). Size and location of flocks of all diver species counted during aerial surveys of the Greater Thames during m) March 2005, n) November 2005, o) December 2005 and p) January/February 2006.



q) r)



s)

Figure 9.3 (q-s) (cont). Size and location of flocks of all diver species counted during aerial surveys of the Greater Thames during q) February/March 2006, r) January/February 2007 and s) February/March 2007.

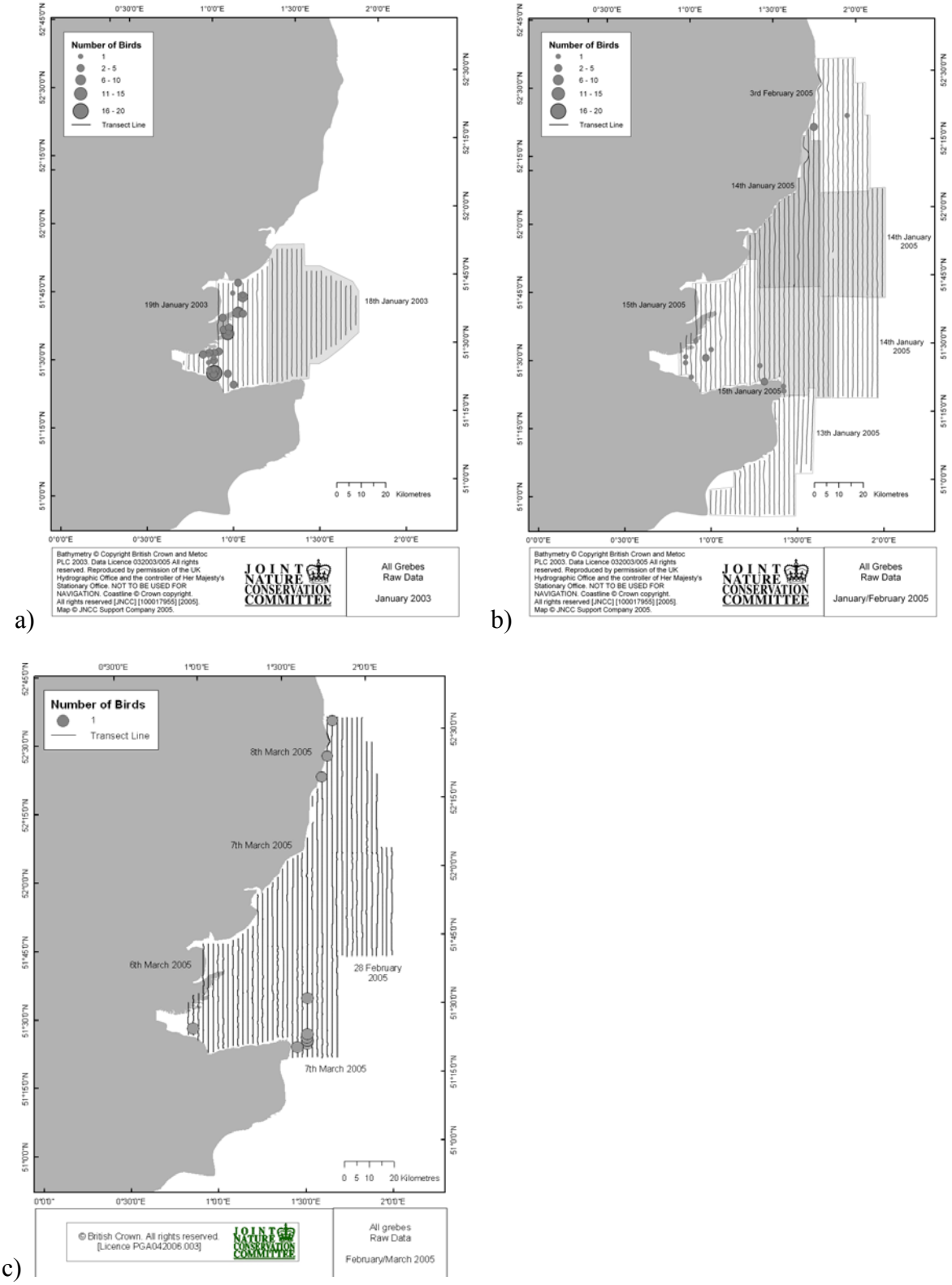
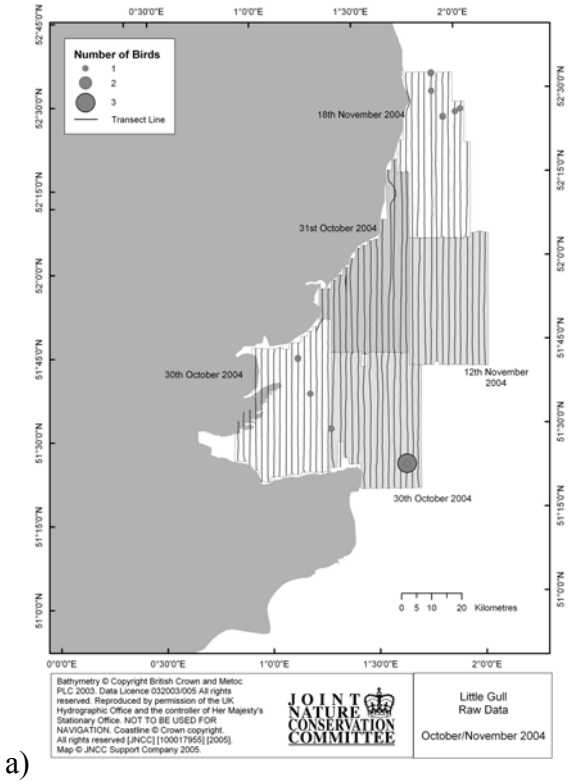
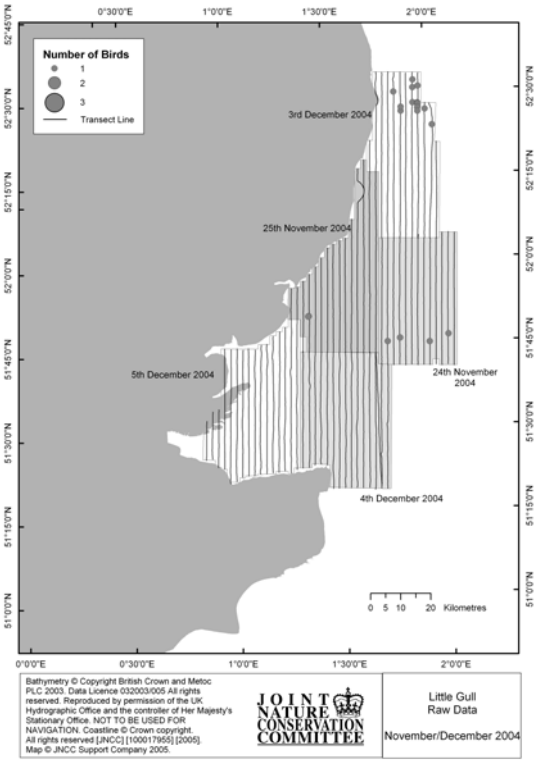


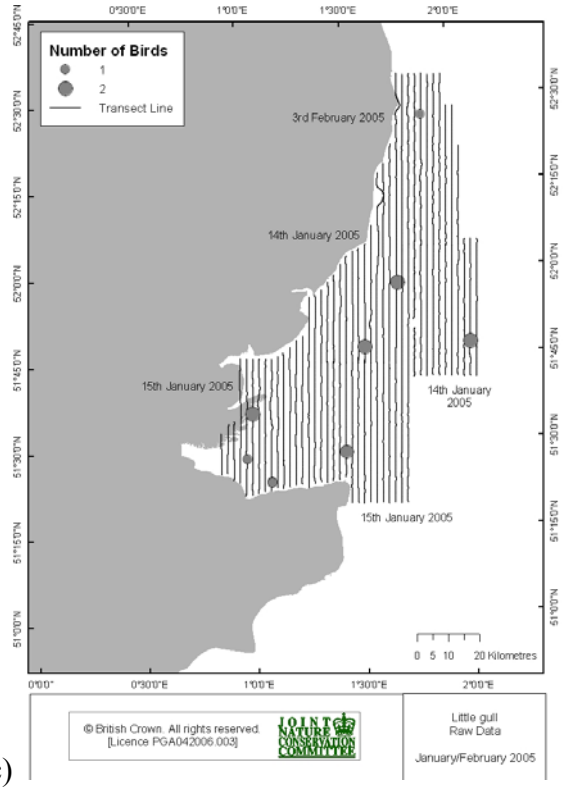
Figure 9.4 (a–c). Size and location of flocks of all grebes counted during aerial surveys of the Greater Thames during a) January 2003, b) January/February 2005 and c) February/March 2005. Shaded areas depict boundaries of sectors used for estimating population size using *Distance 5.0*.



a)



b)



c)

Figure 9.5 (a–c). Size and location of flocks of little gulls counted during aerial surveys of the Greater Thames during a) October/November 2004, and b) November/December 2004

10 Appendix 2. Detailed population estimates derived from *Distance 5.0*

Table 10.1. Density and population estimates for **red-throated diver and diver species** from strip transect (2001/02) and line transect aerial surveys (2002/03-2006/07) carried out in the Greater Thames. Estimates were derived from distance sampling. The 95% confidence intervals (CI) of distance sampling estimates given are empirical ([e]) or bootstrap ([b]) estimates. Here, PStrat = Post-stratified or Strat = stratified.

Survey date	Survey area (s)	Survey undertaken by	No. transects	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)	Model
Season 2001/02								
10-11 Jan 2002	T(N), T(S)	NCC	41	159	3329	0.739 (0.501 – 1.091)	2460 (1667 – 3630)	PStrat; Strat by Observer
Season 2002/03								
18+19 Jan 2003	T(E), T(W)	WWT	36	999	2705	4.099 (3.000 – 5.602)	10884 (8115 –13439)e	Strat by Site
15+16 Feb 2003	T(E), T(W)	WWT	34	375	2826	1.546 (1.152 - 2.076)	4368 (3253 – 5864)e	PStrat; PStrat by Observer
Season 2003/04								
27 Nov 2003	T(SE)	WWT	27	103	1463	0.482 (0.320 - 0.725)	705 (468 - 1061)	Half-normal
17 Dec 2003	T(SE) + 1 transect to North	WWT	27	465	1588	1.818 (1.526 - 2.166)	2888 (2424 - 3441)	PStrat by Observer
15+16+26 Feb 2004	T(W), T(E), $T(E^n)$ + $T(E^n)$	WWT	54	818	3788	2.030 (1.331 - 3.095)	7688 (5041 - 11725)	PStrat by Observer
Season 2004/05								
30+31 Oct, 18 Nov 2004	T1, T2, T4, T5	WWT	58	155	5839	0.250 (0.195 – 0.319)	1191 (932 – 1523)[b]	Strat by Site
24+25 Nov, 3+4+5 Dec 2004	T1-T5	WWT	71	772	5878	0.978 (0.804 – 1.190)	5749 (4723 – 6997)[b]	Strat by Site
13+14, 26+27 Jan 2005	T6, East of T2, T4, T6	NERI	22	143	1154	0.216 (0.147 - 0.317)	912 (621-1339)[e]	Half-normal
14+15 Jan, 3 Feb 2005	T1-T5	WWT	71	775	6023	0.017 (0.830 – 1.246)	6123 (4996 - 7504)[b]	Strat by Site

Survey date	Survey area (s)	Survey undertaken by	No. transects	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)	Model
28 Feb, 6+7+8 Mar 2005	T1, T2, T4, T5, T5	WWT	71	345	6013	0.728 (0.487 - 1.087)	4375 (2928 - 6537)[2]	Strat by Site
4+5 Mar 2005	East of T2, T6	NERI	32	60	2051	0.212 (0.124 - 0.363)	435 (254 – 745) [2]	PStrat by Observer
13+15 Mar 2005	T1, T2	WWT	31	4	1283	0.661 (0.436 – 1.002)	1706 (1196-2433)[e]	Half-normal,
Season 2005/06								
13+16+17 Nov 2005	T1, T2, T6, T7	WWT	71	61	6119	0.099 (0.064-0.155)	847 (506-1346)[b]	Half-normal
6+7+8+9 Dec 2005	T2, T3, T6, T7	WWT	54	265	4894	0.394 (0.553-0.171)	1930 (1362-2366)[b]	Half-normal
13+14+18 Jan, 10 Feb 2006	T1, T2, T3, T6, T7	WWT	62	770	5428	0.837 (0.628-1.115)	5291 (3745-7179)[b]	Hazard-rate
18 Feb., 2+3+7 Mar 2006	T1, T2, T3, T6, T7	WWT	74	588	6209	0.361 (0.293-0.445)	4481 (3272-5423)[b]	Half-normal
Season 2006/07								
31 Jan, 2+3 Feb 2007,	T1, T6, T7	WWT	40	266	3273	0.672 (0.435-1.038)	2199 (1321-3388)[b]	Half-normal
18 Feb, 8 Mar 2007	T1, T6, T7	WWT	45	440	3841	0.809 (0.041-15.979)	3106 (2035-4589)[b]	Half-normal

Table 10.2. Density and population estimates for **all grebe species** from line transect aerial survey of January 2003, carried out in the Greater Thames. Estimates were derived from distance sampling. The 95% confidence interval (CI) of distance sampling estimates given is a bootstrap ([b]) estimate.

Survey date	Survey area (s)	Survey undertaken by	No. transects	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)	Model
Season 2002/03								
18+19 Jan 2003	T(E), T(W)	WWT	36	31	2705	0.311 (0.099-0.975)	357 (93-668)[b]	Half-normal

Table 10.3. Density and population estimates for **little gull** from line transect aerial surveys (November/December 2004 and November 2005) carried out in the Greater Thames. Estimates were derived from distance sampling. The 95% confidence intervals (CI) of distance sampling estimates given are empirical ([e]) estimates.

Survey date	Survey area (s)	Survey undertaken by	No. transects	No. flocks	Survey area (km^2)	Density [birds/area] (CI)	Total number (CI)	Model
Season 2004/05								
24+25 Nov, 3+4+5 Dec 2004	T1 + T2, T4, T5	WWT	58	13	4771	0.021 (0.010 - 0.043)	122 (58 - 255)[e]	Half-normal
13+16+17 Nov 2005	T1-T5	WWT	71	21	5878	0.190 (0.095 - 0.380)	440 (220-879)[e]	Half-normal