Departmental Brief:

Greater Wash potential Special Protection Area

Natural England and JNCC

March 2016

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Glossary of Abbreviations

AEWA	African-Eurasian Waterbird Agreement
AoS	Area of Search
Defra	Department for Environment, Food and Rural Affairs
EC	European Commission
EEC	European Economic Community
JNCC	Joint Nature Conservation Committee
KDE	Kernel Density Estimation
MCA	Maximum Curvature Analysis
MHW	Mean High Water
MoP	Mean of Peak
NBMR	Norfolk Bird and Mammal Report
NNR	National Nature Reserve
OWF	Offshore Wind Farm
pSPA	Potential Special Protection Area
pMCZ	Potential Marine Conservation Zone
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SPA	Special Protection Area
SMP	Seabird Monitoring Programme
SNCB	Statutory Nature Conservation Body
WeBS	Wetland Bird Survey
WWT	Wildfowl and Wetlands Trust

Summary

This departmental brief sets out the scientific case for the classification of the Greater Wash potential Special Protection Area (pSPA). The departmental brief should be read in conjunction with the 'Impact Assessment', which identifies the likely positive and negative impacts on the UK economy, society and the environment of the proposed designation. The Greater Wash pSPA is located in the mid-southern part of the North Sea on the east coast of England, between the counties of Yorkshire (to the north) and Suffolk (to the south). The site extends from Bridlington Bay in the north (at the village of Barmston), to the boundary of the existing Outer Thames Estuary SPA in the south. The Greater Wash pSPA is proposed to protect important areas of sea used by waterbirds during the non-breeding period, and for foraging in the breeding season by the qualifying interest features of a number of already-classified SPAs: Humber Estuary, Gibraltar Point, North Norfolk Coast, Breydon Water and Great Yarmouth North Denes. The boundary is a composite of the areas used by these species. The Greater Wash pSPA qualifies under Article 4 of the Birds Directive (2009/147/EC) for the following reasons (summarised in Table 1):

- The site regularly supports more than 1% of the Great Britain (GB) populations of three breeding and two non-breeding species listed in Annex I of the EC Birds Directive. Therefore the site qualifies for SPA Classification in accordance with the UK SPA selection guidelines (stage 1.1, 1.4).

- The site supports a regularly occurring migratory species not listed in Annex I of the EC Birds Directive, extending the (currently insufficient) range coverage of the current suite of SPAs for this species. Therefore the site qualifies for SPA Classification in accordance with the UK SPA selection guidelines (stage 1.4).

Table 1. Summary of qualifying ornithological interest in the Greater Wash pSPA. Mean of Peak (MoP) for non-breeding populations[1], breeding populations taken from various sources and are summed across the relevant site specific population estimates. GB populations derived from Musgrove *et al*. (2013)[2] unless otherwise stated.

Species	**Count (period)**	**% of subspecies or population**	**Interest type**	**SPA selection guideline**
Red-throated diver *Gavia stellata*	1,511 (MoP 2002/03 - 2005/06)[1]	8.9% GB non-breeding population	Annex I	1.1
Common scoter *Melanitta nigra*	3,463 (MoP 2002/03, - 2007/08)[1]	0.6% Biogeographic population[3]	Regularly occurring migratory species	1.4
Little gull *Hydrocoloeus minutus*	1,303 (MoP 2004/05 – 2005/06)[1]	No current UK population estimate	Annex I	1.4
Sandwich tern *Sterna sandvicensis*	3,852 pairs (5 year MoP 2010-14)[4]	35.0% of GB breeding population	Annex I	1.1
Common tern *Sterna hirundo*	510 breeding pairs (5 year MoP 2010-2014)[4,5]	5.1% of GB breeding population	Annex I	1.1
Little tern *Sternula albifrons*	798 pairs (5 year MoP 2009-2013)[5]	42.0% of GB breeding population	Annex I	1.1

[1] MoP non-breeding populations for red-throated diver, common scoter and little gull were calculated by Natural England using AoS data reported by Lawson *et al* 2015a (Appendix 5).
[2] Musgrove *et al.* (2013) collates population estimates of birds in Great Britain and the UK, by extrapolation of previous estimates using recognised trend measures, new surveys and novel analytical approaches.
[3] Common scoter biogeographic population from Waterbird Population Estimates online database (http://wpe.wetlands.org/) accessed 26/01/2016)
[4] Seabird Monitoring Programme (http://jncc.defra.gov.uk/page-1550)
[5] Direct from site managers

1 Assessment against SPA selection guidelines

The UK SPA Selection Guidelines requires that SPA identification should be determined in two stages (Stroud *et al*., 2001). The first stage is intended to identify areas that are important for a significant proportion of birds on a regular basis (Stage 1.1 – 1.3), or which are of otherwise outstanding ecological importance for the birds (Stage 1.4). The second stage further considers these areas using one or more judgements in Stage 2 to select the most suitable areas in number and size for SPA classification (Stroud *et al*., 2001).

1.1. Stage 1

Under stage 1 of the SPA selection guidelines (Stroud *et al*., 2001), sites eligible for selection as a potential SPA must demonstrate one or more of the following:

1) an area is used regularly by 1% or more of the GB (or in Northern Ireland, the all-Ireland) population of a species listed in Annex I of the Birds Directive (2009/147/EC) in any season;

2) an area is used regularly by 1% or more of the biogeographical population of a regularly occurring migratory species (other than those listed in Annex I) in any season;

3) an area is used regularly by over 20,000 waterbirds (as defined by the Ramsar Convention) or 20,000 seabirds in any season

4) an area which meets the requirements of one or more of the Stage 2 guidelines in any season, where the application of Stage 1 guidelines 1, 2 or 3 for a species does not identify an adequate suite of most suitable sites for the conservation of that species.

The Greater Wash pSPA qualifies under Stage 1.1 because it regularly supports more than 1% of the GB population of four species listed in Annex I of the Birds Directive (*i.e*. red-throated diver, Sandwich tern, common tern, and little tern). It also qualifies under stage 1.4 for little gull and common scoter. See Table 1 for details.

1.2. Stage 2

The Greater Wash pSPA is assessed against Stage 2 of the SPA selection guidelines below (Table 2). In applying the SPA selection guidelines, Stroud *et al.* (2001) note that a site which meets only one of these Stage 2 judgments is not considered any less preferable than a site which meets several of them, as the factors operate independently as indicators of the various different kinds of importance that a site may have. Table 2 demonstrates the comprehensive importance the pSPA has under these different kinds of importance.

Table 2. Assessment of the bird interest against stage 2 of the SPA selection guidelines.

Feature	Qualification	Assessment
1. Population size & density[6]	✓	Red-throated diver – 2nd largest non-breeding population in UK SPA network.
		Common scoter[7] – 5th largest non-breeding population in UK SPA network.
		Little gull – 2nd largest non-breeding population in GB, largest non-breeding marine population in GB.
		Sandwich tern – largest breeding population in UK SPA network.
		Common tern – 6th largest breeding population UK SPA network.
		Little tern - largest breeding population in UK SPA network.
2. Species range	✓	Red-throated diver – Outer Thames Estuary SPA protects only part of the area of the southern North Sea important for this species. The Greater Wash pSPA extends the area protected.
		Common scoter - With the exception of The Wash SPA, the Greater Wash pSPA would be the only site specifically classified for this species within the English southern North Sea (though it is a named component of North Norfolk Coast SPA waterbird assemblage). Likely that the local non-breeding population uses The Wash SPA, North Norfolk Coast SPA and areas identified within the Greater Wash pSPA, and therefore classification of the pSPA provides protection for the whole of this local range.
		Little gull – with the exception of Mersey Narrows & North Wirral Foreshore SPA on the Irish Sea coast, there are currently no SPAs specifically classified for this species in the UK in any season.

[6] Note that these rankings should only be considered indicative of the relative importance of the pSPA, as they are based on comparison of the sum of the most recent 5 year mean populations of each tern species at the source SPAs (as listed in Table 1) with the historical populations of each species at each SPA in the UK as listed in Stroud *et al.* (2001). For non-breeding species relative importance of the pSPA is based on comparison of the population estimates given in Lawson *et al.* (2015a), with historical populations of each species detailed in Table 6.
[7] See section 5.6 for Stage 2 assessment of common scoter.

3. Breeding success	✓	Between 2010 and 2014, Sandwich tern had a mean of 0.41 chicks per pair within the North Norfolk Coast SPA (SMP website (http://jncc.defra.gov.uk/page-1550), higher than the average for England of approximately 0.27 chicks per pair, between 2008 -2013 (http://jncc.defra.gov.uk/page-2890).
		Between 2010 and 2014, common tern had a mean of 0.41 chicks per pair within the North Norfolk Coast SPA, and 0.75 at Breydon Water SPA (SMP http://jncc.defra.gov.uk/page-1550, and RSPB for 2014; Pearson, 2015a &2015b pers. comm) compared with approximately 0.44 chicks per pair in 2009-2013 in England (http://jncc.defra.gov.uk/page-2895).
		For little tern, Winterton Dunes (1.78 chicks per pair in 2012 and 1.64 chicks per pair in 2013) and Scolt Head (0.80 chicks per pair in 2012 and 0.61 chicks per pair in 2013) were the most productive colonies in England, whether most fledged far fewer than 0.50 chicks per pair. Productivity at English colonies fluctuates but generally lies between 0.30-0.50 chicks fledged per pair per year (http://jncc.defra.gov.uk/page-2897).
4. History of occupancy	✓	**All primary source colonies have a long history of occupancy by breeding seabirds:**
		Sandwich tern: Recorded as breeding at Blakeney Point in 1920, Scolt Head colonised in 1923 (Taylor *et al.,* 1999).
		Common tern: First known at Blakeney Point in 1830. Scolt Head colonised in 1922. Breeding on Scroby Sands in most years from 1947 to 1965, and again from 2010 (Taylor *et al.,* 1999).
		Little tern: Breeding at Scolt Head in 1930s. First recorded at Great Yarmouth North Beach during WWII. Colony abandoned after defences were cleared, but returned in 1983. Bred at Scroby Sands between 1955 and 1963 (Taylor *et al.,* 1999). Easington Lagoons wardened since at least 1977.
		Red-throated diver: Recorded in 1967 as occurring on the coast of Norfolk (Seago, 1967).
		Common Scoter: Recorded in 1967 as occurring off the north and east Norfolk coasts (Seago, 1967). Recorded in North Norfolk WeBS counts from 1991/92 (Holt *et al.,* 2015)
		Little Gull: Recorded as a passage migrant, non-breeding summer visitor and winter visitor (Seago, 1967), also records over 60 shot in Norfolk in 1870, but location unknown.
5. Multi-species area	✓	Four qualifying Annex I features, two qualifying regularly occurring migrants.
6. Naturalness		No longer applicable, following ruling from the SPA and Ramsar site Working Group
7. Severe weather refuge		Unclear to what extent the site may provide severe weather refuge to the non-breeding features.

2. Rationale and data underpinning site classification

In 1979 the European Community adopted Council Directive 79/409/EC on the conservation of wild birds, known as the Birds Directive (EEC, 1979). The Birds Directive provides for protection, management and control of naturally occurring wild birds within the European Union through a range of mechanisms. One of the key provisions is the establishment of an ecologically coherent network of protected areas. Member States are required to identify and classify the most suitable territories in size and number for rare or vulnerable species listed in Annex I to the Directive (Article 4.1) and for regularly occurring migratory species (under Article 4.2). These sites are known as Special Protection Areas. Guidelines for selecting SPAs in the UK are derived from knowledge of common international practice and based on scientific criteria (Stroud *et al*., 2001).

The task of identifying all of the UK's terrestrial sites is largely complete, and the rationale is described by Stroud *et al*. (2001). Stroud *et al.* (2001) describe a network of 243 sites in the UK, some of which include areas used by inshore non-breeding waterbirds, for example in estuaries. However, this suite of sites does not address the requirement for the implementation of conservation measures in the wholly marine environment in which many birds access resources that are critical for their survival and reproduction. Johnston *et al*. (2002) describe a process consisting of three strands by which SPAs might be identified for marine birds under the Birds Directive, *i.e*. the identification of:

i. seaward extensions of existing seabird breeding colony SPAs beyond the low water mark ("maintenance extensions");
ii. inshore feeding areas used by concentrations of birds (e.g. seaducks, grebes and divers) in the non-breeding season; and
iii. offshore areas used by marine birds, probably for feeding but also for other purposes.

Under all three of these strands, the Joint Nature Conservation Committee (JNCC) has recommended the classification of new sites in the marine environment and produced generic guidance to implement this measure (Webb and Reid, 2004). To define SPAs at sea, the JNCC has developed specific statistical methods to formulate site boundaries for wintering waterbirds, such as divers (O'Brien *et al.,* 2012).

Since then, a fourth strand was added to the work conducted by the JNCC to address the need for:

iv. other types of SPA (http://jncc.defra.gov.uk/page-4184) that would identify some important areas for marine birds that may not be included within the above three categories and will be considered individually.

It is proposed here that boundary extensions for foraging tern species that could potentially be applied directly to the Humber Estuary SPA, Gibraltar Point SPA, North Norfolk Coast SPA, Breydon Water SPA and Great Yarmouth North Denes SPA are instead incorporated within the Greater Wash pSPA. All five species of tern that breed in the UK (Arctic tern *Sterna paradisaea*, common tern *S. hirundo,* Sandwich tern *S. sandvicensis,* roseate tern *S. dougallii* and little tern *Sternula albifrons*) are listed as rare and vulnerable in Annex I of the EC Birds Directive and thus are subject to special conservation measures, including the classification of SPAs. Within the UK there are currently 57 breeding colony SPAs for which at least one species of tern is protected. However, additional important areas for terns foraging at sea have yet to be classified as marine SPAs to complement the existing terrestrial suite. Since 2007, the JNCC has been working with the four Statutory Nature Conservation Bodies (SNCBs) towards the identification of such areas as, given their likely extent, these cannot be addressed simply by application of the generic "maintenance extensions" approach.

This departmental brief sets out all of the information supporting the identification of the qualifying features of the Greater Wash pSPA and the definition of its proposed boundary. The boundary is based on the areas of sea identified as being most important to the three tern species that make up the qualifying features of this new SPA, as well as those areas supporting qualifying populations of red-throated diver and common scoter.

In the process by which a site becomes fully classified as an SPA, Ministerial approval has to be given to undertake formal consultation on the proposal to classify the site. At this stage in the process, a site becomes known as a potential SPA (pSPA). Within this Departmental Brief, and others being prepared at the same time, sites under consideration include both new sites (such as the Greater Wash) and existing sites (such as Poole Harbour SPA) which are being extended and/or having new features added. For the purpose of clarity in this and other Departmental Briefs, sites are referred to as "SPA" when referring to the existing classified site. Where reference is made to an entirely new site, or to an extended site, or to a site including new features being proposed, it will be referred to as pSPA since the site, or any additional extent or additional feature is not yet fully classified.

SPA site selection guidelines have been applied to the most up-to-date data for the site. Where contemporary data reveal that species are no longer present in qualifying numbers (either through declines or because the relevant threshold has increased) at any relevant source SPA, they are not included within the marine pSPA, although they remain features of the source SPA. Where contemporary data reveal that a source SPA holds qualifying numbers of a species, that species becomes a feature of the marine pSPA and all relevant source SPAs contribute to it.

The Greater Wash pSPA is composed of 95.2% of inshore waters (<12 nm) and 4.8% of offshore water (>12 nm). As statutory advisors for inshore and offshore water, respectively, Natural England and JNCC are providing this advice jointly to Defra.

2.1. Data collection – defining the suite of species and numbers of those supported by the Greater Wash pSPA

The size of each of the bird populations supported by the Greater Wash pSPA have been derived from survey and analysis conducted by and on behalf of JNCC for non-breeding waterbirds (http://jncc.defra.gov.uk/page-4561), and as the sum of the populations of tern species breeding at the existing SPAs, from which individuals recorded foraging at sea within the Greater Wash pSPA must originate. For each of those existing SPAs, the tern numbers have been taken to be the most recently available from the Seabird Monitoring Programme (SMP) website (http://jncc.defra.gov.uk/smp/) i.e. within the last five years, unless otherwise indicated. This dataset has been augmented by information contained within Norfolk Bird and Mammal Reports (NBMRs) published by the Norfolk & Norwich Naturalists Society (for common and little tern) and also directly from colony managers for little tern.

2.2. Data collection – defining the boundary of the Greater Wash pSPA

The overall boundary of the Greater Wash pSPA has been drawn to encompass the sea areas identified under the second and fourth strands of JNCC's work programme as being most important to support red-throated diver, common scoter and terns which are already qualifying features of several source colony SPAs[8]. The work done to identify the areas important to each species differed and was conducted separately. These separate pieces of work are described in the following three sub-sections. The overall site boundary was drawn as a composite of the separate species-specific boundaries and this is described in Section 3.

[8] http://jncc.defra.gov.uk/pdf/SAS_Defining_SPA_boundaries_at_sea

2.3. Identification of important marine areas for non-breeding waterbirds

The Greater Wash Area of Search (AoS) was one of 45 inshore (<12 nm) sites across the UK identified in 2000 as supporting potentially important numbers of inshore waterbirds outside the breeding season (Reid, 2004).

Visual aerial surveys of the Greater Wash were carried out over five winter seasons (2002/03, 2004/05, 2005/06, 2006/07 and 2007/08) using line-transect sampling techniques to which Distance analysis could be applied to provide a corrected estimate of birds in the area. Two to four repeat surveys of the Greater Wash were undertaken within each winter season. The data and survey coverage were carefully assessed prior to analysis to ensure that only representative surveys were included. A survey was representative if it covered the main distribution of the bird population, both spatially and temporally i.e. the survey should have sufficient spatial coverage of the AoS, considering individual species distributions, and surveys should sample across any seasonal variation in the numbers of birds present.

JNCC analysis established whether qualifying numbers of Annex I and migratory species (red-throated diver, little gull and common scoter) for classification as an SPA occurred within the Greater Wash AoS. To estimate the number of individuals within the Greater Wash AoS, a population estimate was determined for each species in each survey[9] using Distance Sampling. A peak count was then identified from these individual survey estimates within a winter season and an average of the peak counts from the five most recent winter seasons was calculated to produce the Mean of Peak population estimate for the AoS. During the most recent five year period, data were available with which to calculate a Mean of Peak in three, four and two seasons for red-throated diver, common scoter and little gull respectively. The Mean of Peak was assessed to determine if the numbers present exceeded the thresholds on a regular basis under the UK SPA Selection Guidelines (Stroud *et al.,* 2001).

The survey data were also spatially modelled to produce a continuous density surface (using Kernel Density Estimation (KDE)). From this density surface, Maximum Curvature Analysis (MCA) determined a density threshold (O'Brien *et al*., 2012), which was used as an objective method to determine those 1 km grid cells which should be included within a pSPA boundary. For further details see Annex I and Lawson *et al.* (2015a).

The maximum curvature threshold for red-throated divers was 0.17 birds per km^2 (Lawson *et al*. 2015). All cells supporting this density of divers or above were included within the maximum curvature boundary defining the pSPA seaward boundary. As the method aims to identify the point of diminishing returns, at which including additional areas of habitat does not result in a proportionate increase in the number of birds included within the boundary (O'Brien *et al*. 2012), some parts of the Area of Search were necessarily excluded from the eventual pSPA boundary.

Comparing population estimates from the Area of Search (Lawson *et al*. 2015) with those from within the pSPA boundary derived using maximum curvature, the pSPA estimate represents 84.6% of the estimated red-throated divers in the Area of Search (i.e. a further 15.4% of divers were estimated in the Area of Search but not the pSPA).

The pSPA boundary is almost entirely based upon red-throated diver density and distribution, but comparative figures for common scoter show that the number of scoters estimated within the pSPA was 98.5% of the estimate for the Area of Search. Little gull

[9] For the pooled data analysis of common scoter, an average population estimate for each season was produced to reduce the confidence intervals around the estimate.

distribution extended beyond the pSPA boundary derived for red-throated divers, meaning the estimate for little gulls within the pSPA boundary represented 60.5% of the Area of Search total.

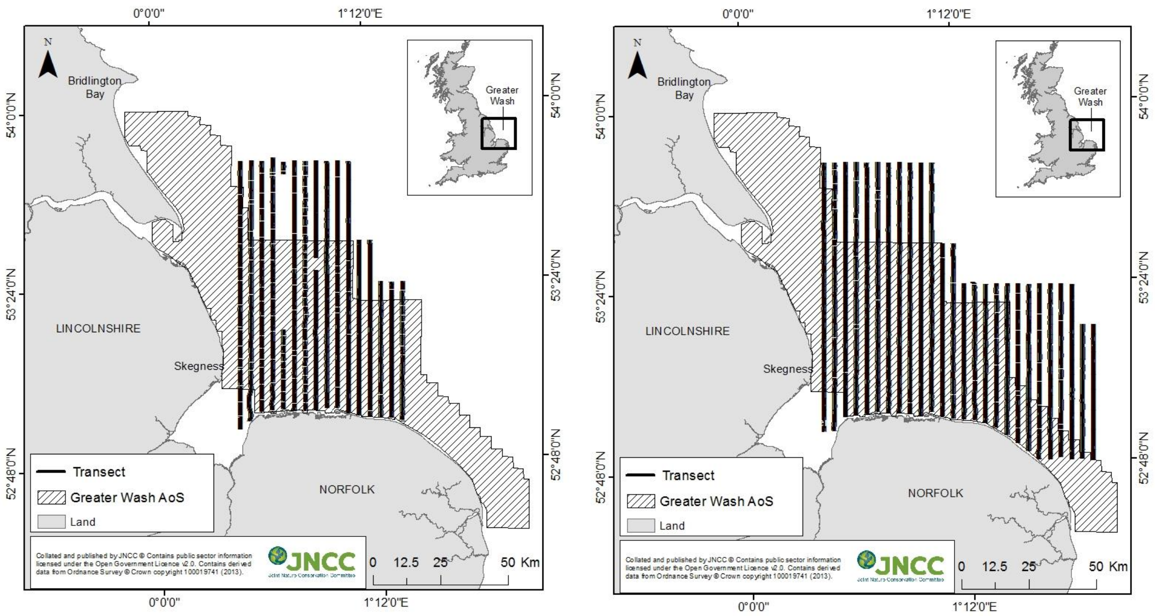
2.3.1. Red-throated diver

A large proportion (81%) of diver observations was recorded as ‘unidentified diver’. It was noted in Cranswick *et. al* (2003) that many unidentified divers were thought to be red-throated diver but only those positively identified were recorded to species level. Of the positively identified divers, 242 were red-throated diver and 12 were great northern diver. Consequently, analyses in the Greater Wash were performed on combined red-throated and unidentified diver records, the latter assumed to be red-throated diver; the small proportion of error (4.7%) relating to other diver species among the unidentified divers is deemed acceptable. This is further discussed in Appendix 2: Table 1 and Lawson *et al.* (2015a).

The spatial coverage varied considerably between surveys and therefore surveys that covered only a small part of the AoS were considered unrepresentative of the true numbers and distribution of red-throated diver within the Greater Wash AoS. Unrepresentative surveys (2006/07 and 2007/08) were excluded from the analysis. Survey coverage in 2003 did not extend to the northern and southern areas of the Greater Wash AoS; these surveys were retained in the analysis but it is likely they may underestimate numbers of red-throated diver within the Greater Wash AoS (Figure 1).

Numbers of red-throated diver in the Greater Wash AoS exceeded 1% of the GB wintering population estimate (170 individuals) in all surveys. Red-throated diver is therefore regularly occurring in numbers exceeding the relevant threshold in the AoS, and can be considered further for classification.

The mean KDE surface and the MCA boundary are shown in Figure 2.



a) Winter season 2002/03 - February b) Winter season 2002/03 - March

Figure 1. Spatial coverage of the aerial surveys in relation to the Greater Wash AoS for surveys in 2002/03. From Lawson *et al.* (2015a).

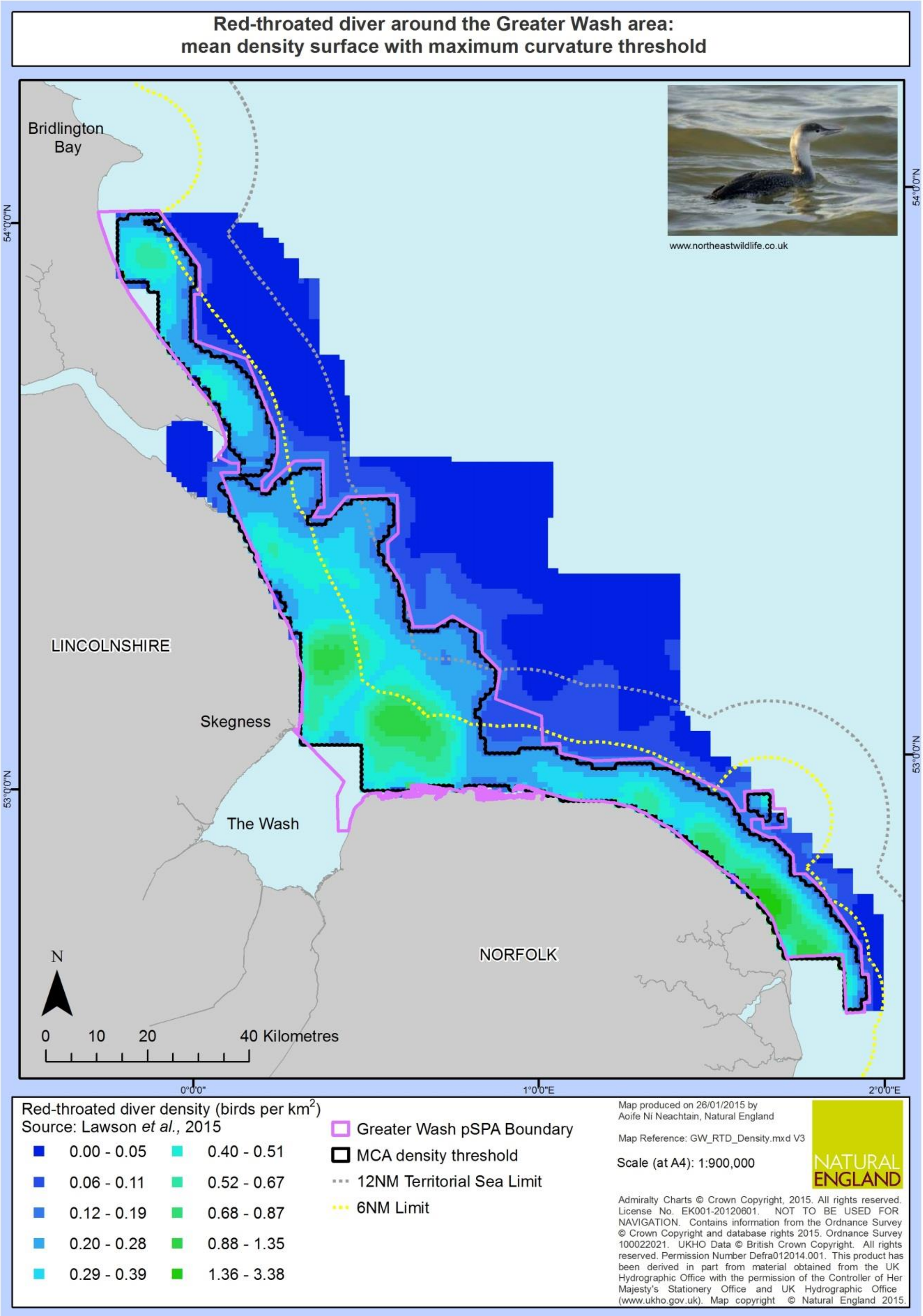


Figure 2. Estimated mean density surface for red-throated diver with the areas delineated by the threshold densities, as identified by MCA and the pSPA boundary proposed by Natural England and JNCC (from Lawson *et al.* 2015a).

2.3.2. Common scoter

There was considerable variation in the numbers of common scoter recorded during the surveys of the Greater Wash AoS (15-3,217). Most of the surveys recorded few flocks consisting of relatively low numbers of common scoter, but three surveys (13 Feb 2003, 26 Feb 2005, and 4 Dec 2007) recorded very large flocks. As a result, the encounter rate variability was very high, leading to problems in producing a reliable population estimate; the initial outputs from conventional Distance analysis techniques showed high variation around the mean (5,533 with confidence intervals of 167 – 44,700) indicating a poor statistical fit. To decrease this variation and improve the population estimate, common scoter data were combined from all surveys within the same winter season and a pooled detection function generated for each i.e. for each winter season, total common scoter detections were divided by total survey effort. There was a strong chance that the same birds were counted in different surveys, but the effect of duplicate counting was counter-acted by the total line transect length (i.e. survey effort) being the sum of all survey line-transect lengths within a winter season. This provided an average abundance estimate for the season with 95% confidence intervals. This approach assumed that the largest flocks would be equally detectable over all distance bands. Pooling data in this way reduced the confidence intervals, producing a more reliable population estimate than the standard procedure. However, as this effectively produces an average population estimate over the surveys of a given season, no survey specific results are available, and the average population estimate is likely to provide a lower/more conservative population estimate compared with the Mean of Peak estimates which were calculated for other species. A similar approach was used previously to produce population estimates for common scoter in Carmarthen Bay when comparing different survey techniques (Buckland *et al.,* 2012, Burt *et al.*, 2010).

The spatial coverage of the surveys in the 2002/03 and 2007/08 winter seasons were not complete and did not cover the northern and southern parts of the AoS. However, these surveys did include the area where the main aggregations of common scoter occurred in the other surveys and were therefore included in the analysis.

Based on the pooled population estimates, numbers of common scoter in the Greater Wash AoS exceeded 1% of the biogeographical wintering population estimate (5,500 individuals) in only one winter season (2004/2005). The Mean of Peak (3,517 individuals within the AoS and 3,463 within the pSPA) does not exceed the 1% threshold based on data from four winter seasons and common scoter is therefore not regularly present in sufficient numbers to be considered under stage 1.2 of the SPA selection guidelines. Common scoter is instead assessed under stage 1.4 of the SPA selection guidelines in Section 5.2.

The mean KDE surface and the Maximum Curvature Analysis boundary are shown in Figure 3.

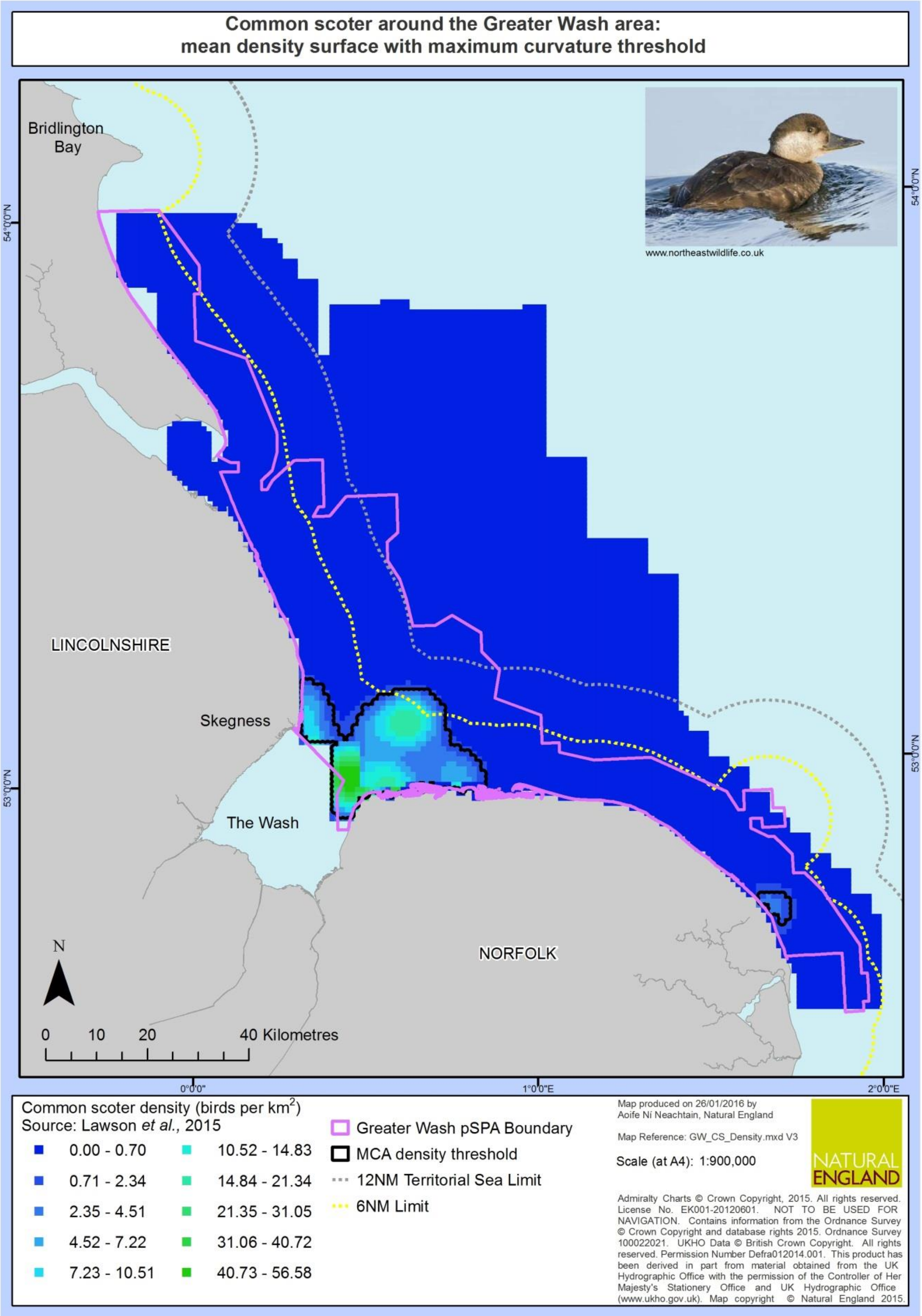


Figure 3. Estimated mean density surface for common scoter (survey specific data) with the areas delineated by the threshold densities, as identified by MCA and the pSPA boundary proposed by Natural England and JNCC (from Lawson *et al.* 2015a).

2.3.3 Little gull

Little gull is considered under stage 1.4 of the SPA selection guidelines as there is no GB population estimate currently available against which to assess it (Musgrove *et al.,* 2013) under stage 1.1. The species is predominantly marine, using inshore and offshore areas, thinly distributed, and is fickle in terms of forming persistent or regularly occurring aggregations, thus making comprehensive assessment of abundance extremely difficult. Despite the lack of a national population estimate and a 1% threshold it remains the responsibility of EU Member States to identify and classify the most suitable territories for this Annex I species. With no threshold value it is necessary to compare with existing data from locations which regularly support little gulls in order to identify the most suitable areas for SPA classification (Table 6).

Survey data for little gull were available for five winter seasons (2002/03 & 2004/05 – 2007/08), but the spatial coverage of the surveys in 2006/07 and 2007/08 were insufficient to provide a representative estimate of the numbers and distribution of little gull within the Greater Wash AoS. The spatial coverage of the 2002/03 surveys covered the main area of little gull observations but there were no surveys in November or December when peak numbers of little gull are most typically recorded. No little gull individuals were recorded during the 2002/03 surveys. These surveys were therefore excluded from the JNCC analysis. Reliable population estimates and distributions were thus available for two full seasons (2004/05 and 2005/06). Observations of little gull are shown in Figure 4.

Of the seven surveys in which little gull was observed in 2004/05 and 2005/06, only one population estimate totalled fewer than 50 birds. The Mean of Peak population estimate for little gull within the Greater Wash AoS based on two seasons of data was 2,153 individuals, and within the pSPA boundary was 1,303 individuals.

We explored defining a seaward boundary for little gull in the same way as other non-breeding species, but it became apparent that that such a boundary would not provide adequate confidence due to the variability in the little gull distribution and the availability of only two years of survey data. Little gull is however proposed as an interest feature (see Appendix 2 for further explanation).

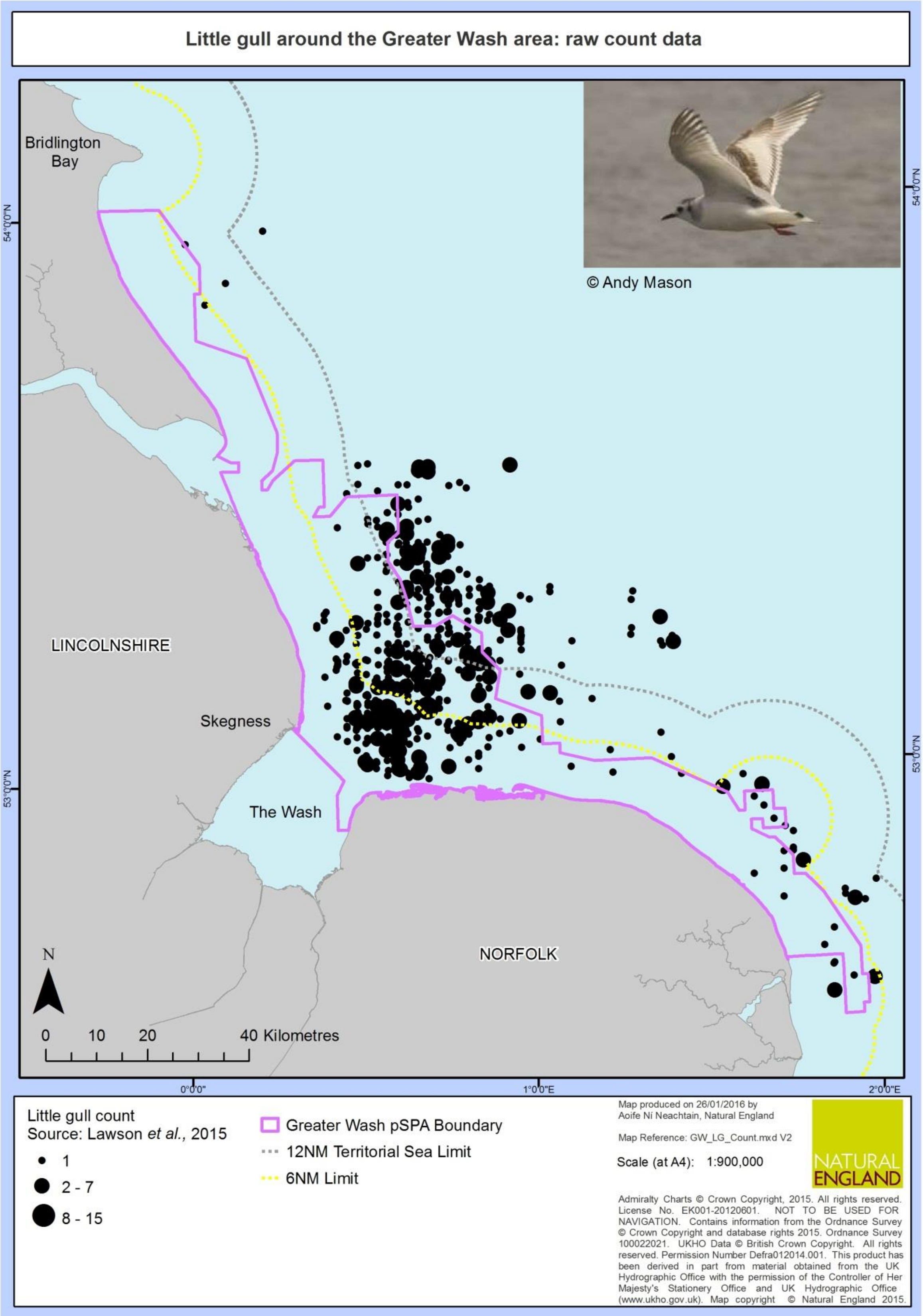


Figure 4. Raw count data of little gull recorded during WWT Consulting aerial surveys within the Greater Wash AoS (2004/05, 2005/06) (from Lawson *et al.* 2015a).

2.3.4 Non-breeding waterbird conclusions

As a result of the above analyses, Natural England and JNCC are recommending one non-breeding species (red-throated diver) as qualifying features of the Greater Wash pSPA, having sufficient abundance to meet UK SPA selection guidelines stage 1.1. In addition, Natural England and JNCC are recommending common scoter and little gull as qualifying features of the Greater Wash pSPA under UK SPA selection guidelines stage 1.4 (see Section 5.2). The distributions and boundaries for red-throated diver and common scoter (Figures 2 and 3) sit wholly within the boundary of the Greater Wash pSPA, guided by the methodology set out in the JNCC document *Defining SPA boundaries at sea*[10]. Little gull are included as a qualifying feature of the Greater Wash pSPA within the boundary defined by other species.

2.4 Identification of important marine areas for larger terns

The four larger species of tern (common, Arctic, Sandwich and roseate) which breed regularly in Great Britain have recorded mean foraging ranges between 4.5 km and 12.2 km and maximum recorded foraging ranges between 15.2 km and 49 km (Thaxter *et al*., 2012). JNCC, in agreement with all of the SNCBs, decided that the most effective method to determine the extent of the areas used most heavily by larger breeding terns would be different to that employed for little terns. In the case of larger terns, the approach was to undertake a programme of boat-based visual tracking of foraging birds. The resultant information on foraging locations chosen by the birds was combined with information on the habitat characteristics of those locations relative to other areas available, to construct habitat association models of tern usage. These models were used to predict species-specific tern usage patterns around breeding colony SPAs. Usage predictions were extended to the maximum recorded foraging range from each colony. This process of producing usage predictions around colonies for which tracking data had been gathered had colony (and species) specific analysis which produced a smoothed map of foraging usage around the colony (Phase 1). In Phase 2, analysis of pooled data across colonies (species-specific) produced generic models which allowed production of maps of smoothed foraging usage around colonies for which no (or insufficient) data were available.

To gather the empirical data necessary for the modelling, JNCC coordinated a programme of visual tracking work between 2009 and 2011 to identify important foraging areas at a number of UK colonies. These surveys were conducted during the chick rearing period in each year and comprised repeated days of observations of individual terns whose tracks were followed by boat as they left the colony to forage.

Visual tracking was carried out or commissioned by JNCC at 10 of 32 UK colony SPAs which were deemed to be recently regularly occupied (Wilson *et al.,* 2014). Survey effort was prioritised at these 10 sites on the basis of several considerations including: maximising geographical coverage across each species’ range, logistical ease of boat-based work, and maximising likely sample sizes (e.g. larger/multi-species colonies with recent successful breeding seasons). As a result no boat-based tracking work was undertaken on the south coast of England.

The total number of tracks obtained was 1,004 including 55 tracks (6%) for roseate tern (2 SPAs), 184 tracks (18%) for arctic tern (6 SPAs, 1 non-SPA), 381 tracks (38%) for common tern (7 SPAs, 1 non-SPA) and 384 tracks (38%) for Sandwich tern (5 SPAs, 1 non-SPA), with multiple years of data collected at five of the ten JNCC study colony SPAs. In addition, visual tracking data were obtained through a data-sharing agreement with ECON Ecological

[10] http://jncc.defra.gov.uk/pdf/SAS_Defining_SPA_boundaries_at_sea

Consultancy Ltd for two SPAs: Ynys Feurig, Cemlyn Bay and The Skerries SPA (136 Sandwich, 2 common and 1 Arctic tern tracks, all collected in 2009) and North Norfolk Coast SPA (108 Sandwich and 24 common tern tracks collected 2006-2008). This gave a total of 1,275 tracks available to the project, although not all data were used in the modelling; incomplete tracks or those which recorded no foraging behaviour were excluded.

In order to draw a boundary around the most important foraging areas for terns from each colony of interest, a cut-off or threshold value of usage has to be found and only those areas in which usage exceeds that cut-off value included within a possible SPA boundary. An objective and repeatable method to identifying a threshold value, based on the law of diminishing returns, is maximum curvature (O'Brien *et al.,* 2012). This method identifies a threshold value below which disproportionately large areas would have to be included within the boundary to accommodate any more increase in, in this case, foraging tern usage[11].

The extent of foraging areas for tern species within the Greater Wash pSPA was determined by a mix of site-specific and generic information. Table 3 gives, from north to south, the type of model used to provide the modelled foraging distributions of: Sandwich tern and common tern at the North Norfolk Coast SPA; common tern at Breydon Water SPA.

Table 3. The type of model (site-specific (phase 1) or generic (phase 2)) which were applied to each of the larger tern species at each source colony.

Species	**Colony**	**Model type**
Sandwich tern	North Norfolk Coast (Scolt Head)	phase 1
Sandwich tern	North Norfolk Coast (Blakeney Point)	phase 1
Common tern	North Norfolk Coast (Scolt Head)	phase 1
Common tern	North Norfolk Coast (Blakeney Point)	phase 1
Common tern	Breydon Water	phase 2

The following two sections outline in summary the survey work and boundaries for common tern and Sandwich tern identified at the three colonies which fall within the Greater Wash pSPA.

2.4.1 North Norfolk Coast SPA

For the North Norfolk Coast SPA, the species of interest for the project were common tern and Sandwich tern. Data were kindly provided to the project by ECON Ecological Consultancy Ltd. A total of 132 tern tracks were available for the two species; Sandwich tern was tracked from both Scolt Head and Blakeney Point over three survey seasons from 2006 to 2008, while common tern was tracked from Blakeney Point during 2008. Tracking work was generally timed to coincide with the chick-rearing season, except in 2007 when data were also collected during the incubation period in May. The distribution of Sandwich tern tracks tended to radiate out to sea in all directions from both Scolt Head and Blakeney Point, while those for common tern tended to be confined to a coastal strip just north and north-east from Blakeney Point (Figure 65).

Common tern was only tracked from Blakeney Point, so the common tern model generated from Blakeney Point data was used to extrapolate usage predictions to Scolt Head. Common tern usage maps for Scolt Head were produced this way rather than from a generic model based on common tern tracks across the UK, because the Scolt Head colony is within the same SPA complex as Blakeney Point and is very close geographically. The model-generated predictions of usage by both tern species are shown in Figure 5 (a-d). In each figure, the full extent of the area over which predictions of usage were made (dark blue

[11] http://jncc.defra.gov.uk/pdf/SAS_Defining_SPA_boundaries_at_sea

circle) was defined by the maximum foraging distance from colony derived from Thaxter *et al.* (2012). The most important areas (black line) were determined by application of the MCA approach to the usage data, constrained to the mean maximum distance to colony derived from tracking data held by JNCC, ECON Ecological Consultancy Ltd (for Scolt Head, Blakeney Point and Cemlyn Bay only) and Thaxter *et al.* (2012)[12].

It can be seen in every case that substantial areas of sea which are distant to the colony and/or distant from the shore are predicted to have very little or no usage by foraging terns.

[12] http://jncc.defra.gov.uk/pdf/SAS_Identification_of_important_marine_areas_for_larger_terns

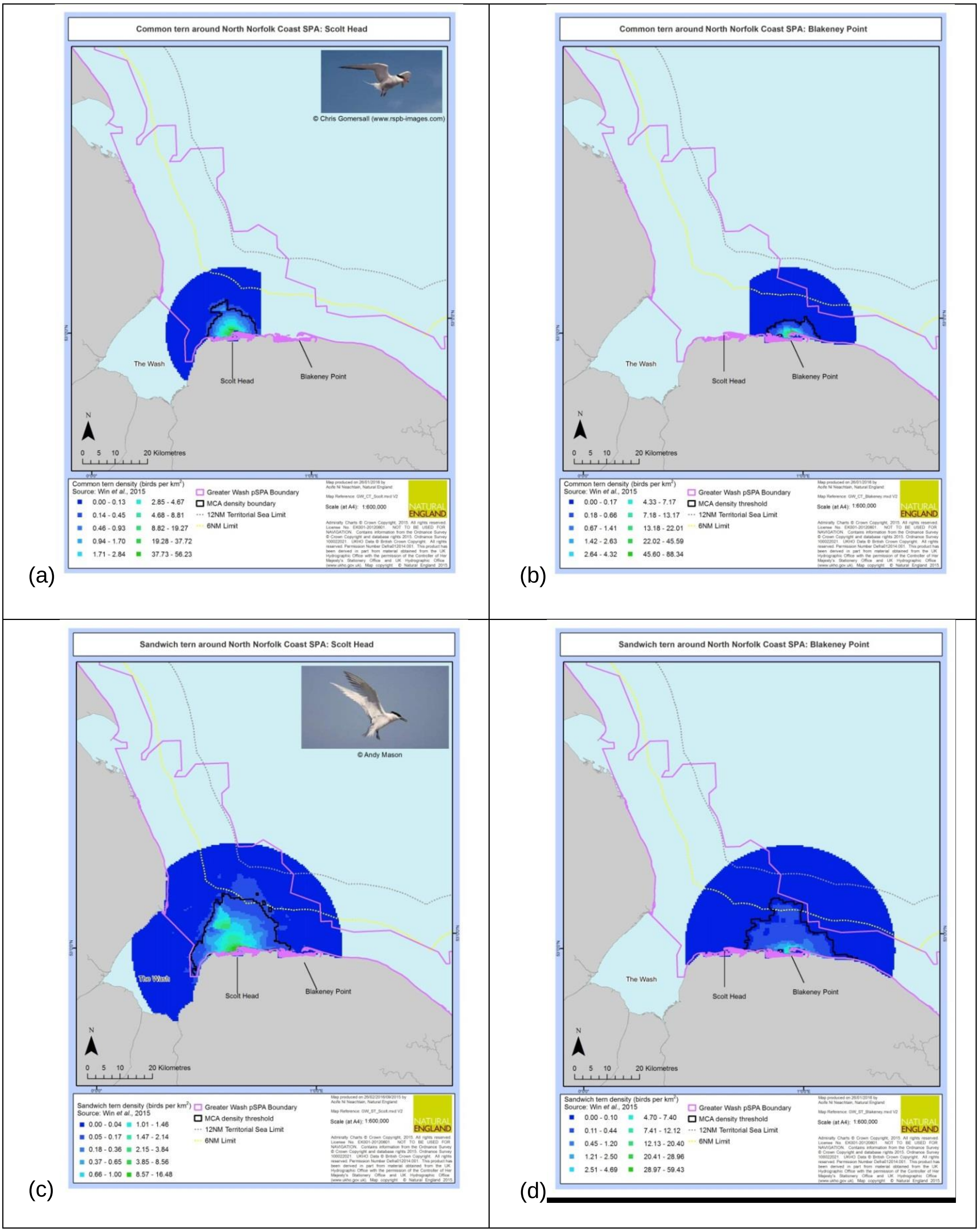


Figure 5. Model predictions of tern usage overlaid with MCA density thresholds derived limits to areas of most importance (black lines) around Scolt Head and Blakeney Point for (a, b) common tern and (c, d) Sandwich tern. A single boundary has been produced for each species, but is shown twice here as the usage predictions for the two colonies differ slightly (due to different distance to colony values for the prediction grid). Derived from Win *et al.*, 2013.

Based on models of tern usage derived from site-specific survey data of both species, a composite of the modelled foraging ranges of terns from the North Norfolk Coast SPA is shown in Figure 6, indicating a potential SPA boundary for foraging terns from this SPA alone. This partially overlaps The Wash SPA. Therefore, the composite boundary of the Greater Wash pSPA will also partially overlap with The Wash SPA.

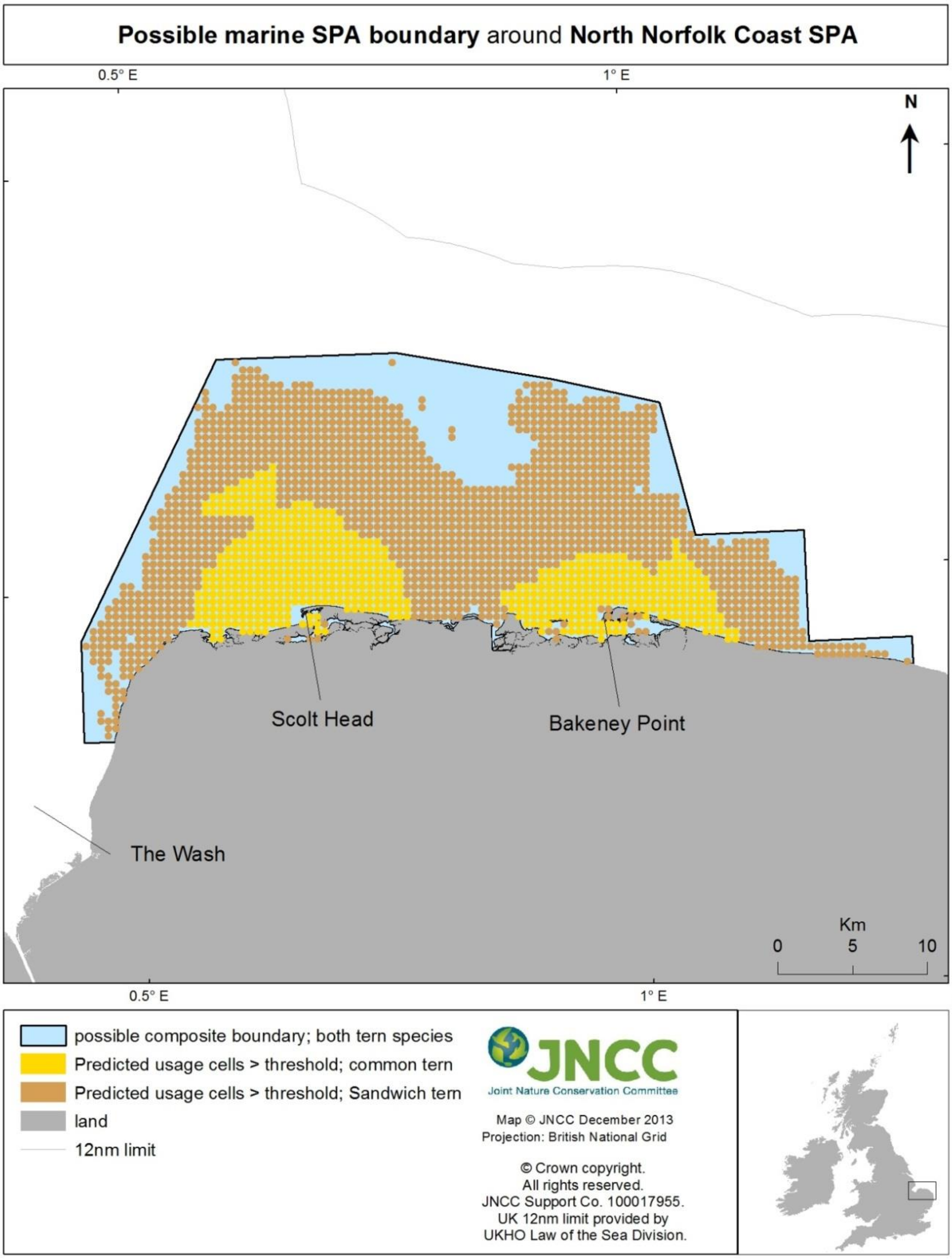


Figure 6. Proposed simple, composite boundary drawn around the species specific complex boundaries derived for each of the two larger tern species at the North Norfolk Coast SPA. Source: Win *et al.* (2013).

2.4.2 Breydon Water SPA

For Breydon Water SPA the species of interest was common tern. No visual tracking data were available from this colony so a generic model of usage distribution was applied using phase 2 of the analysis described above. Details of the modelling process including the phase 2 common tern model used here are given in Wilson *et al.* (2014), and summarised in a document available from the JNCC website[13].

The model-generated prediction of usage by common tern is shown in Figure 8. The full extent of the area over which predictions of usage were made (dark blue circle) was defined by the maximum foraging distance from colony derived from Thaxter *et al.* (2012). The most important areas (black line) were determined by application of the MCA approach to the usage data, constrained to the mean maximum distance to colony derived from tracking data held by JNCC, ECON Ecological Consultancy Ltd (for Scolt Head, Blakeney Point and Cemlyn Bay only) and Thaxter *et al.* (2012).

It can be seen that substantial areas of sea which are distant to the colony and/or distant from the shore are predicted to have very little or no usage by foraging terns.

Common terns also breed on the sandbanks at Scroby Sands, along with little terns. It is likely that the common terns nesting here are functionally linked to the Breydon Water SPA population; as numbers at Breydon Water have declined since Scroby Sands has become exposed, numbers at Scroby Sands have generally increased (Figure 7). The average number of common tern pairs for the two areas combined is 235, with a standard deviation of 54.5 pairs (2009 – 2015). This suggests annual variation is limited, especially with the apparently anomalous large count in 2013, and provides evidence of functional linkage between Breydon Water SPA and Scroby Sands. This provides justification for including data from each of them within the total number of common terns expected to use the Greater Wash pSPA.

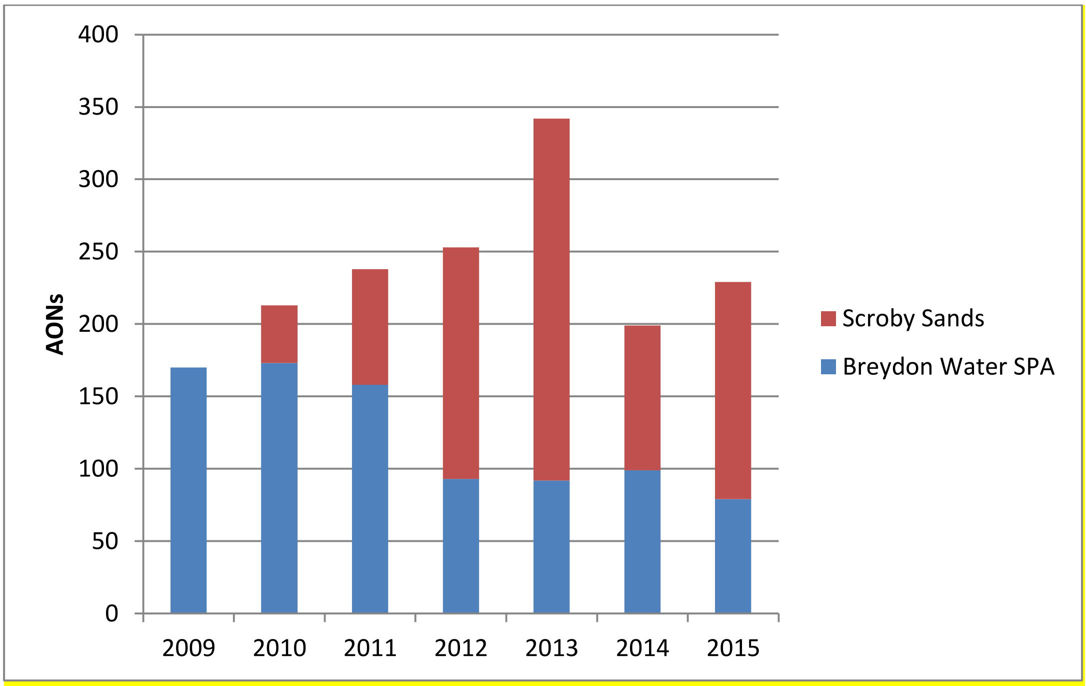


Figure 7 Common tern numbers (Apparently Occupied Nests, AONs) at Scroby Sands and Breydon Water SPA 2009 – 2015.

[13] http://jncc.defra.gov.uk/pdf/SAS_Identification_of_important_marine_areas_for_larger_terns

Boundaries of the Greater Wash pSPA and adjacent Outer Thames Estuary pSPA are largely determined by non-breeding waterbird distribution. However, the marine areas of the two (non-overlapping) pSPAs also encompass different parts of the predicted foraging area for common terns breeding at Breydon Water SPA – that is, these terns may forage either in the Greater Wash pSPA, or the Outer Thames Estuary pSPA, or both.

Consequently, all common terns breeding at Breydon Water pSPA are proposed for inclusion within both Greater Wash and Outer Thames Estuary pSPAs. Although common tern is proposed as a qualifying feature of both pSPAs for additional reasons – predicted foraging areas from the North Norfolk Coast and Foulness SPAs are encompassed by the Greater Wash and Outer Thames Estuary pSPA boundaries respectively – if either pSPA is not classified, the entirety of the Breydon Water SPA tern foraging area will not then be encompassed (Figure 8). This may then require consideration of adapting remaining SPA boundaries to ensure all of this area is protected.

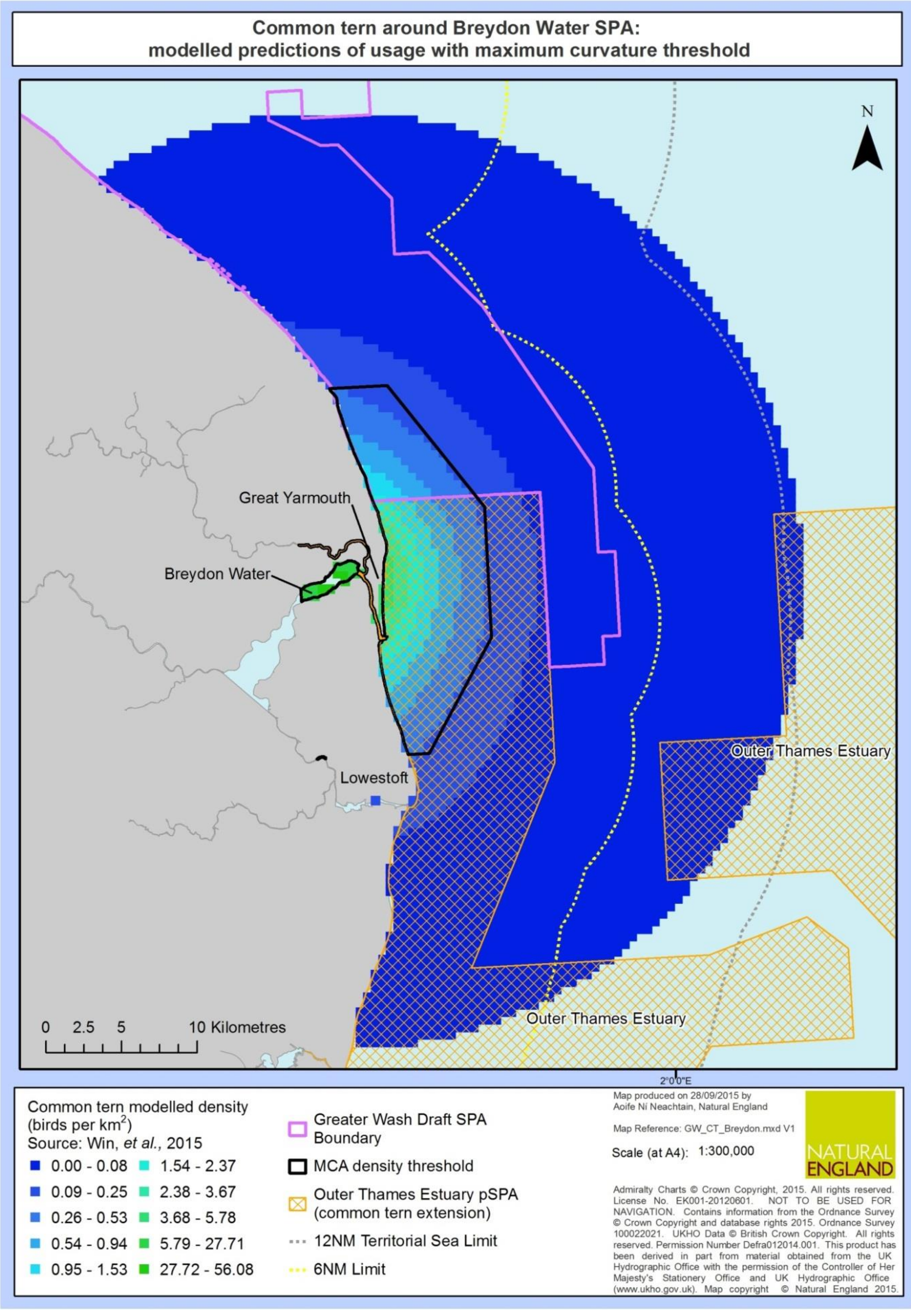


Figure 8. Model predictions of tern usage overlaid with MCA density threshold derived limits to areas of greatest importance (black lines) around Breydon Water SPA for common tern.

2.5 Identification of important marine areas for little tern

Of the five species of tern which regularly breed in Great Britain, little tern is the smallest and has the most limited foraging range: mean range of 2.1 km, mean of recorded maximum of 6.3 km and maximum ever recorded in the literature being 11 km (Thaxter *et al.,* 2012). In the light of this evidence, JNCC, in agreement with all of the Statutory Nature Conservation Bodies (SNCBs), decided that the most effective method to determine the extent of the areas used most heavily for foraging by breeding little terns would be to undertake a programme of shore-based observations and boat-based transects around colonies and to use the resultant distribution data directly in setting the alongshore and seaward boundaries, respectively.

Accordingly, between 2009 and 2013, JNCC coordinated a programme of survey work to identify important foraging areas for little tern at a number of UK colonies. These surveys were conducted during the chick rearing period in each year and comprised repeated shore-based counts of little tern seen at a series of observation stations at increasing distances from the colony locations, and repeated boat-based surveys along transects across the waters around colonies. These surveys sought to establish the distances both alongshore and offshore that little tern was travelling to feed.

In total, 70 shore-based surveys were undertaken at 14 little tern colonies around the UK with a total of 7,006 little tern observations. Twenty three boat-based transect surveys were undertaken across waters near eight colonies around the UK with a total of 781 little tern observations.

Where sufficient colony-specific data were available from the above surveys, these were used to determine the alongshore and seaward extents of important foraging areas. Where colony-specific data were not available, generic distances were applied. Table 4 gives, from north to south, the type of foraging distribution estimate used to provide the modelled foraging distributions of little tern at the Humber Estuary, Gibraltar Point, North Norfolk Coast, and Great Yarmouth North Denes SPAs.

Table 4. The type of model (site specific or generic, along shore and seaward extents) which were applied to little tern populations at each SPA.

SPA	Alongshore	Seaward
Humber Estuary	Site specific	Generic
Gibraltar Point	Generic	Generic
North Norfolk Coast	Site specific	Site specific
Great Yarmouth North Denes	Site specific	Site specific

The following four sections outline in brief the survey work and boundaries identified at the four existing SPAs for which little tern is a feature and which forage within the area of the Greater Wash pSPA. Further information on the little tern survey programme is presented in Parsons *et al*. (2015a) and on the JNCC website[14].

2.5.1 Humber Estuary SPA

Six shore-based surveys were undertaken at the Easington Lagoons colony within and adjacent to the Humber Estuary SPA in 2011 (3 surveys) and 2012 (3 surveys). A total of 455 tern passes were recorded. Predation of the colony occurred during the 2012 survey and consequently the site-specific alongshore extent is determined by using just one season of observations (2011). Based on site-specific survey data, the maximum alongshore extent of little tern observations from the Humber Estuary SPA colony i.e., the colony at Easington

[14] http://jncc.defra.gov.uk/pdf/SAS_Identification_of_important_marine_areas_for_little_terns

Lagoons, was 6,000 m north and 6,000 m south (Parsons *et al.,* 2015b) (Figure 9).

No boat-based surveys were undertaken at the Humber Estuary SPA. Two boat-based surveys were planned in 2012 but cancelled due to predation of the colony. Therefore, the seaward foraging extent that would be relevant to birds from this colony of little tern was set to be the generic seaward extent value derived from all of the surveys at all of the colonies, i.e. 2,176m from Mean High Water (MHW)[13].

The southern part of the area used by foraging little tern breeding at the Easington Lagoons colony extends beyond the MCA density threshold boundary for any of the other species, and therefore defines the pSPA boundary at the mouth of the Humber.

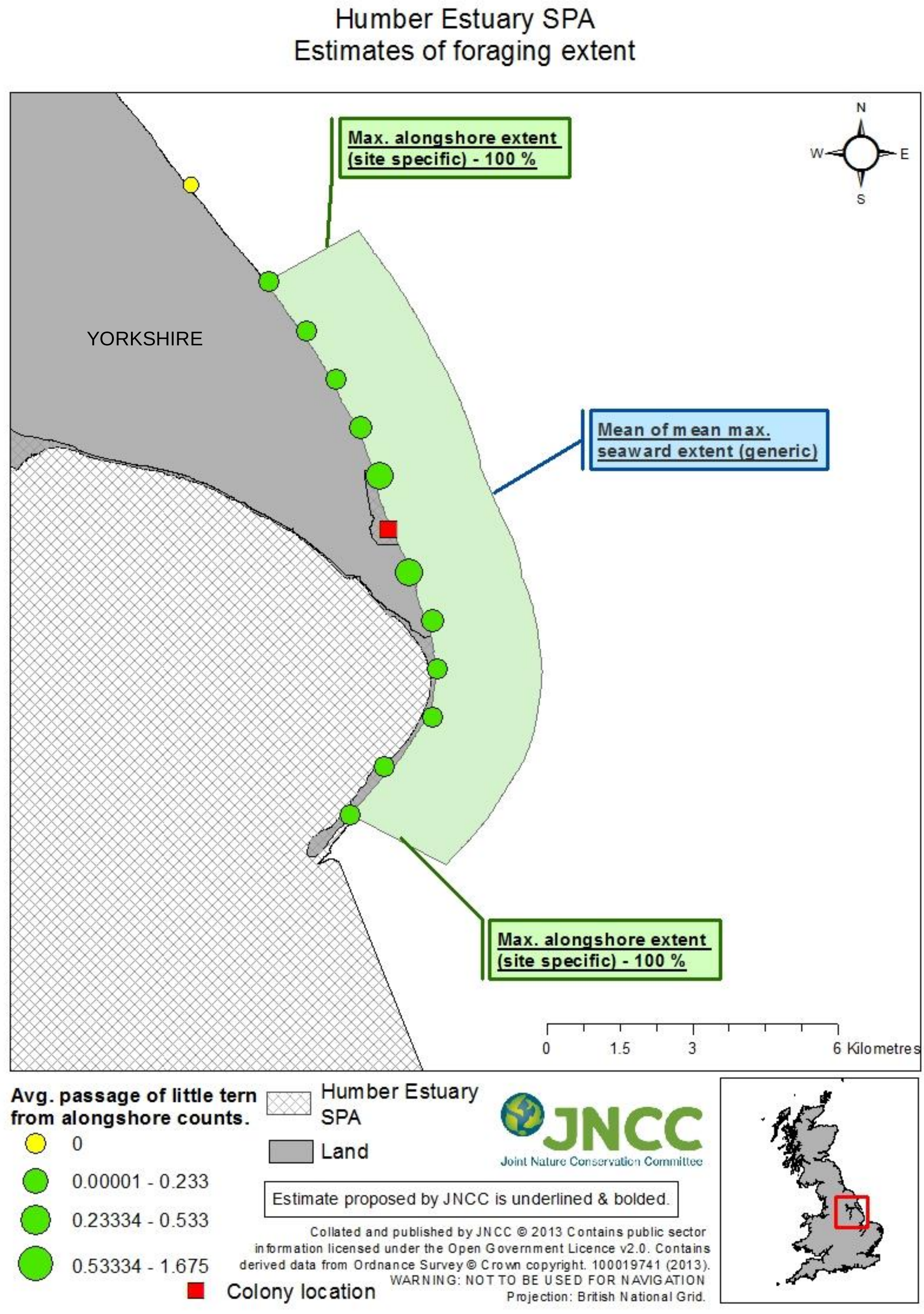


Figure 9. Foraging extent of little tern around the Humber Estuary SPA.

2.5.2 Gibraltar Point SPA

Shore counts of little tern planned for 2012 did not take place at this site as there were no nesting attempts by little tern. A single shore-based survey was undertaken in 2013, and as only two pairs attempted to nest, no repeat surveys were undertaken due to the very low breeding number. The alongshore foraging extent for birds from this colony was therefore set to be the generic alongshore extent derived from all of the surveys at all of the colonies (n=13) i.e. 3,900 m.

As above, boat surveys were planned at the Gibraltar Point site in 2012 and 2013 but due to no and low breeding attempts, these were not undertaken. Therefore, the seaward foraging extent for birds from this colony of little terns was set to be the generic seaward extent derived from all of the surveys at all of the colonies (n=7), i.e. 2,176 m from MHW[15].

In summary, given the absence of site-specific information on seaward extent and of poor data for alongshore extent, the identification of the sea areas most likely to be heavily used by birds from this colony is best based on the generic extents for both these parameters (Figure 10).

The little tern foraging area does not define the boundary of the Greater Wash pSPA. The majority of the foraging area sits within the boundary identified by work on the non-breeding species. Little tern is already a qualifying feature of The Wash SPA, with which a proportion of the foraging area of little tern breeding at Gibraltar Point SPA overlaps; therefore it is not necessary to extend the boundary of the Greater Wash pSPA to overlap with The Wash SPA.

[15] http://jncc.defra.gov.uk/pdf/SAS_Identification_of_important_marine_areas_for_little_terns

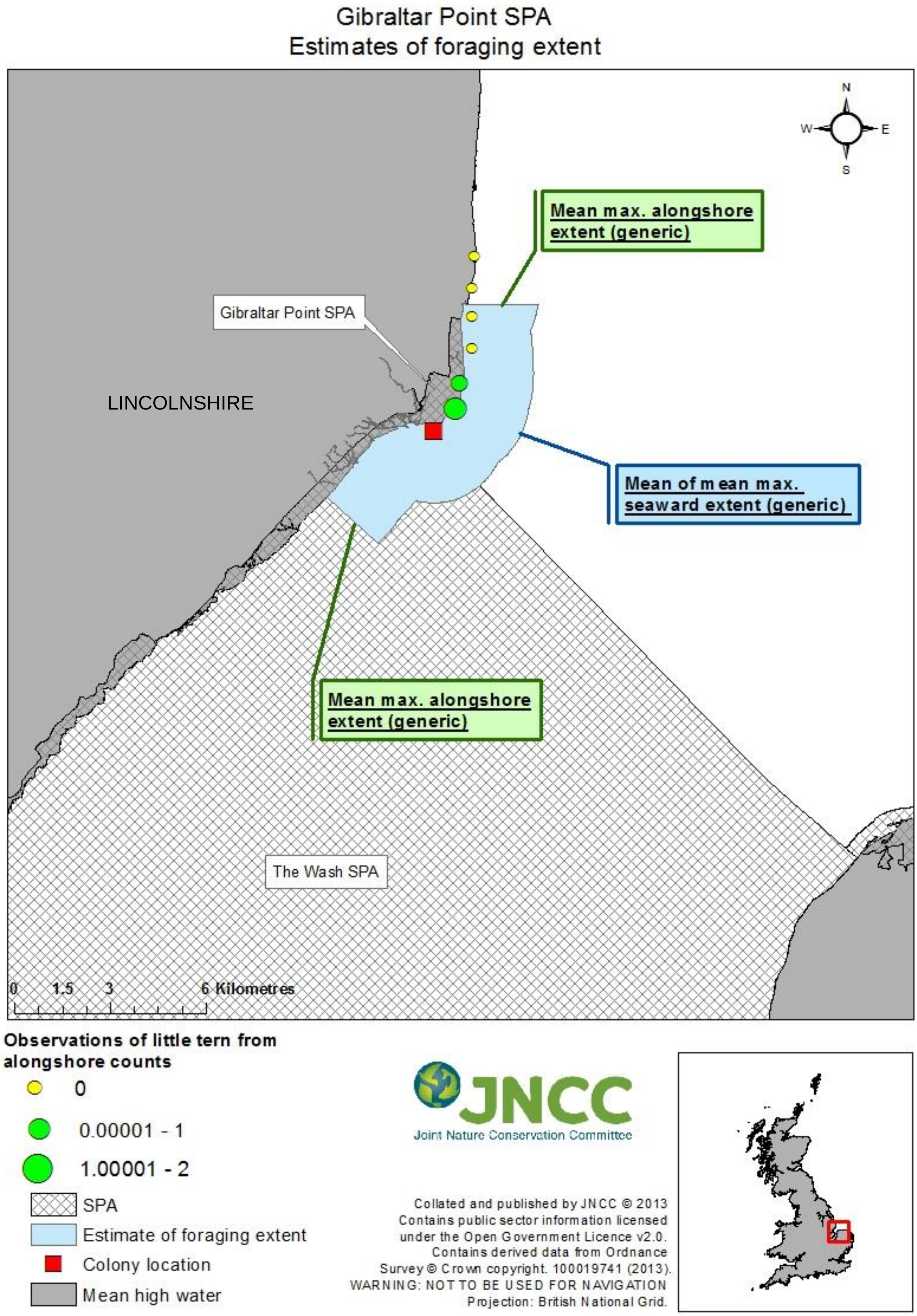


Figure 10. Foraging extent of little tern around Gibraltar Point SPA.

2.5.3 North Norfolk Coast SPA

Three little tern breeding colony locations within the North Norfolk Coast SPA (Scolt Head, Holkham National Nature Reserve (NNR) and Blakeney Point) were surveyed by boat at the North Norfolk Coast SPA in 2012. These were supplemented by 2003 boat transect records from Allcorn *et.al.* (2003). The maximum extent of seaward observations of little tern observations during the boat surveys was 2,129 m, and the mean maximum extent of seaward observations at the North Norfolk Coast was 2,051 m from high water (Parsons *et al.,* 2015b).

Three repeat shore-based surveys were carried out in 2012 at 23 observation points along the North Norfolk Coast SPA. A total of 2,917 little tern were recorded from the shore-based survey (Parsons *et al.,* 2015b). An assessment of the utilisation of the coastal strip with distance from the colony is more difficult at this site due to additional colonies distributed between the three study colonies. However, a decline in the average occurrence rate with distance can still be seen around the study colonies. The distribution (Figure 11) suggests that the observation points to the east captured the foraging range of little tern (birds were observed at 7,000 m, but not at 8,000 m or 9,000 m), while the full extent of the foraging range to the west may not have been captured within the survey area (all surveys to the west recorded birds at the maximum extent of the count points i.e. at 6,000 m and 7,000 m). Therefore, the full range of the birds to the west of the Scolt Head colony may not have been captured by these surveys.

In summary, applying the methods outlined, the maximum alongshore extent of little tern observations at the North Norfolk Coast SPA was (at least) 7,000 m west of the Scolt Head colony and 7,000 m east of the Blakeney colony; and the colony-specific seaward extent was 2,051 m from MHW (Figure 11).

The little tern foraging area does not define the boundary of the Greater Wash pSPA. The majority of the foraging area sits within the boundary identified on the basis of the work on the non-breeding species (and larger terns), although the westward extent of foraging could not be established and likely extends into The Wash SPA. Little tern is already a qualifying feature of The Wash SPA and therefore it is not necessary to extend the boundary of the Greater Wash pSPA to overlap with The Wash SPA.

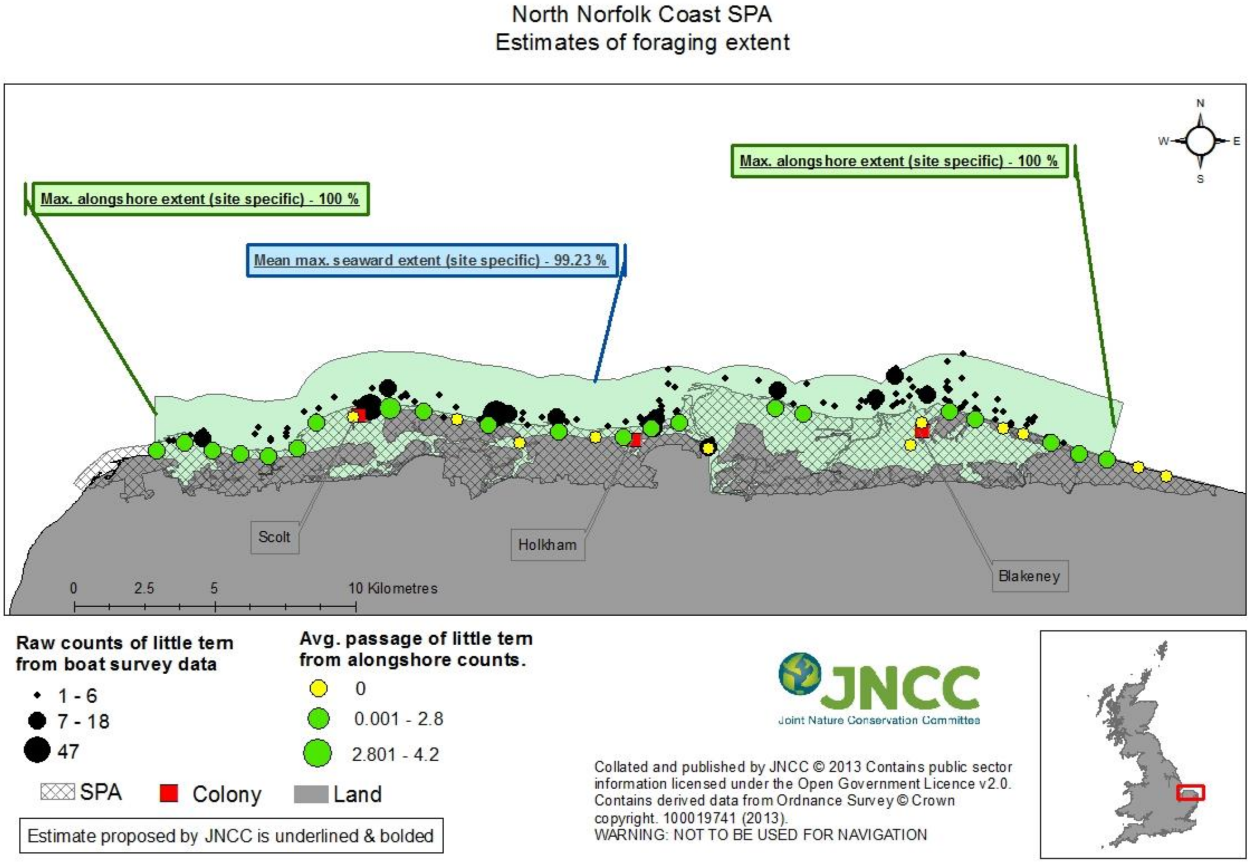


Figure 11. Foraging extent of little tern marine area around the North Norfolk Coast SPA.

2.5.4 Great Yarmouth North Denes SPA

The location of preferred breeding colonies within the Great Yarmouth North Denes SPA has shown marked inter-annual variation, with Winterton in the north holding the majority of little tern in 2010-13 and in 2003-4, while North Denes (in the south) held most in 2005-6. In addition, in recent years a breeding colony has become established on an offshore sandbank at Scroby Sands, which is around 2,000 m from shore and outside the SPA boundary; this site is variably exposed at high water and is prone to tidal inundation, as occurred in 2013.

As well as the boat surveys and shore-based surveys undertaken at this SPA, radio-tracking of foraging little tern was also carried out by Perrow and Skeate (2010) between 2003 and 2006. Two repeat boat transects were undertaken in 2013 (Appendix 1A in Parsons *et al*. 2015b) to corroborate the patterns of spatial use of marine areas by little tern as established by Perrow and Skeate (2010). The boat surveys covered likely foraging extent of little terns from the two breeding colonies within the SPA, plus the Scroby Sands colony (see ECON, 2013). No little tern nested at North Denes in 2013, though prospecting and displaying birds were present and foraging birds were observed at sea in the surrounding area. The site-specific seaward extent from the Winterton and Great Yarmouth colonies (mean of the maximum extent observed (visual and radio-tracking)) was 2,430 m from high water.

Shore-based surveys were conducted in 2013 only (one repeat survey at North Denes colony and three at Winterton colony; Appendix 1B in Parsons *et al*. 2015b). Given the existence of multiple breeding colonies within the SPA, the alongshore northern extent was taken as the northernmost extent of observations of little terns north of the Winterton colony (5,000 m), while the southern extent was informed by both observations furthest south of the

North Denes colony (4,000 m) and the alongshore extent as revealed by earlier radio-tracking undertaken by Perrow and Skeate (2010).

Perrow and Skeate (2010) tagged up to five adult little tern individuals in each year, on up to four separate occasions at the principal colony (Winterton in 2003 and North Denes from 2004-2006) and on one occasion each at the subsidiary colony (Winterton in 2004 and 2005). For the purposes of establishing important foraging areas for breeding birds in each colony, their analysis was restricted to the 27 birds known to maintain an active nest for at least part of the tracking period. All data from all tagged birds at each colony were pooled by Perrow and Skeate (2010) to provide an appropriate expression of the foraging area used by birds at the colony. In accordance with the higher usage of North Denes compared with Winterton during their study years, more data were available from more individuals at the former colony (19 individuals) compared to the latter (8 individuals). Perrow and Skeate (2010) undertook home range analysis including minimum convex polygons (MCP), fixed kernel contour and kernel cluster analysis solely on fixes of tagged birds that were engaged in fishing behaviour.

Information from the various methods over a number of years showed similar spatial usage, particularly for the offshore extent around the Winterton colony. The radio-tracking outputs from Perrow and Skeate (2010) show a more limited seaward extent around Winterton than around North Denes; those authors suggested that this more limited range around Winterton was a consequence of the smaller size (as was then the case, but not in recent years) of the Winterton colony and of the restricted extent of suitable foraging habitat surrounding the colony. We have not provided a foraging extent which takes account of within-SPA variability in foraging range (i.e. more restricted in the north of the SPA and wider to the south) but used the larger seaward extend as a precaution.

Little tern individuals judged likely to be Scroby Sands breeders (i.e. outside the SPA) were removed from the analyses, as the focus is on breeding at existing SPAs (i.e. those where little tern is a feature). Furthermore, the location of the Scroby Sands colony, on an offshore sandbank, makes comparison with onshore colonies difficult. Scroby Sands breeders were taken to be those observed closer to the Scroby Sands colony than to the next nearest extant colony in 2013, at Winterton. Note that Scroby Sands breeders were not tracked by Perrow and Skeate (2010) as they did not breed there during their study.

In summary, the seaward extent is best represented by the site-specific estimates from boat surveys and radio-tracking (2,430 m from MHW). The alongshore extent to the north was set by the furthest observation point of the shore counts (approx. 5,000 m), which slightly exceeds the extent identified by Perrow and Skeate (2010), whereas the southern extent was set by the results of Perrow and Skeate (2010), which exceeded the limit of shore-based observation points (Figure 12).

Little tern is also proposed as a qualifying feature of the Outer Thames Estuary pSPA (currently classified for red-throated diver only). Minsmere-Walberswick and Foulness SPAs regularly support more than 1% of the Great British little tern population and the foraging areas of these birds are encompassed by the Outer Thames Estuary pSPA. Therefore, the Outer Thames Estuary pSPA meets the qualifying threshold for little tern, irrespective of numbers from Great Yarmouth North Denes SPA which may forage within its boundary.

Similarly, qualifying numbers of little tern breeding at Humber Estuary, Gibraltar Point and North Norfolk Coast SPAs forage within the Greater Wash pSPA, irrespective of the population from Great Yarmouth North Denes. Little tern from Great Yarmouth North Denes may forage either in the Greater Wash pSPA, or the Outer Thames Estuary pSPA, or both. Therefore, it is not proposed to overlap either pSPA with the other, and this foraging area does not influence the boundary of either proposed site. However, it should be noted that if either pSPA is not classified, the entirety of the Great Yarmouth North Denes SPA tern foraging area will not then be encompassed. This may then require consideration of adapting remaining SPA boundaries to ensure all of this area is protected.

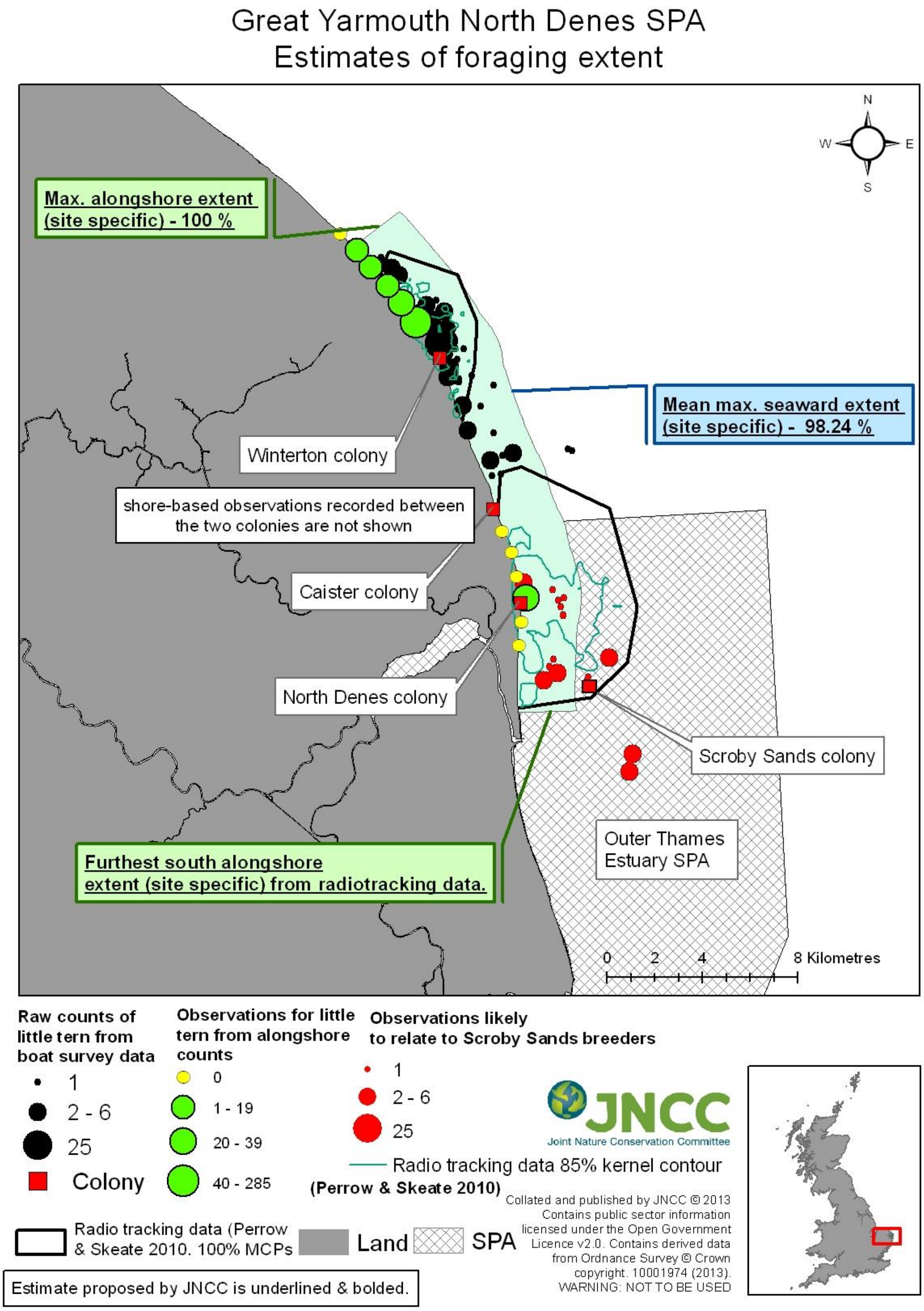


Figure 12. Foraging extent of little tern marine area around the Great Yarmouth North Denes SPA.

2.6 Waterbird assemblage

To assess whether the numbers of birds present in the AoS exceeded the Stage 1.3 threshold (>20,000 individuals) of the UK SPA selection guidelines, the size of the waterbird assemblage was calculated. During the surveys of the Greater Wash AoS, thirteen species of inshore waterbird were recorded. For each species the best available population estimate was used to calculate the assemblage figures. In some cases, due to low numbers of a species recorded during a survey, there were wide confidence intervals around the individual population estimate, indicating low confidence in the estimate. However, these were included in the assemblage calculation as the best estimate available for that species. Wader species recorded during aerial survey were not suited to Distance analysis; for these species, raw counts were added to the assemblage estimate.

The Mean of Peak estimate for the assemblage regularly using the Greater Wash AoS was 13,825 (Lawson *et.al.,* 2015a). This estimate was based on five years of data, during the winter period October to March inclusive. Therefore, during this season the Greater Wash Area of Search does not support a waterfowl or seabird assemblage of over 20,000 individuals, as defined in Stage 1.3 of the SPA Guidelines.

3 Boundary description

3.1 Composite boundary of Greater Wash pSPA

The Greater Wash pSPA boundary is a composite comprising the extent of MCA density thresholds for red-throated diver and the extents of foraging areas of Sandwich, common tern and little tern breeding within the Humber Estuary, Gibraltar Point, North Norfolk Coast and Great Yarmouth North Denes, and Breydon Water SPAs (Figure 13).

The entire distribution of common scoter, and the majority of foraging areas of common and little tern is contained entirely within the composite boundary of the pSPA. Common tern breeding at Breydon Water SPA and little tern breeding at Great Yarmouth North Denes SPA share a proportion of their foraging area with the Outer Thames Estuary pSPA. Given the lack of confidence in the distribution of little gull from two years of survey data described above, this species is included as a qualifying feature of the Greater Wash pSPA within the boundary defined by other species.

The Greater Wash pSPA boundary differs from the more simplified boundary reported in Appendix 1 of Lawson *et al*. (2015a). The boundary was re-drawn to the nearest 1 minute line of latitude and longitude beyond the relevant species MCA density threshold boundary to ensure that qualifying areas were included in the draft boundaries and to remove areas from the boundary that did not support qualifying densities of any species. The resultant total area of the Greater Wash pSPA is approximately 344,267 ha or 3,443 km^2.

3.2 Seaward boundary of the pSPA

The seaward boundary is defined by the area of importance to red-throated diver, and by the foraging area of Sandwich tern off the north Norfolk Coast (Figure 13). Offshore from Lincolnshire and north Norfolk, the pSPA extends to just beyond 12 nautical miles (nm), with the boundary in other areas laying approximately 6 nm from the shore.

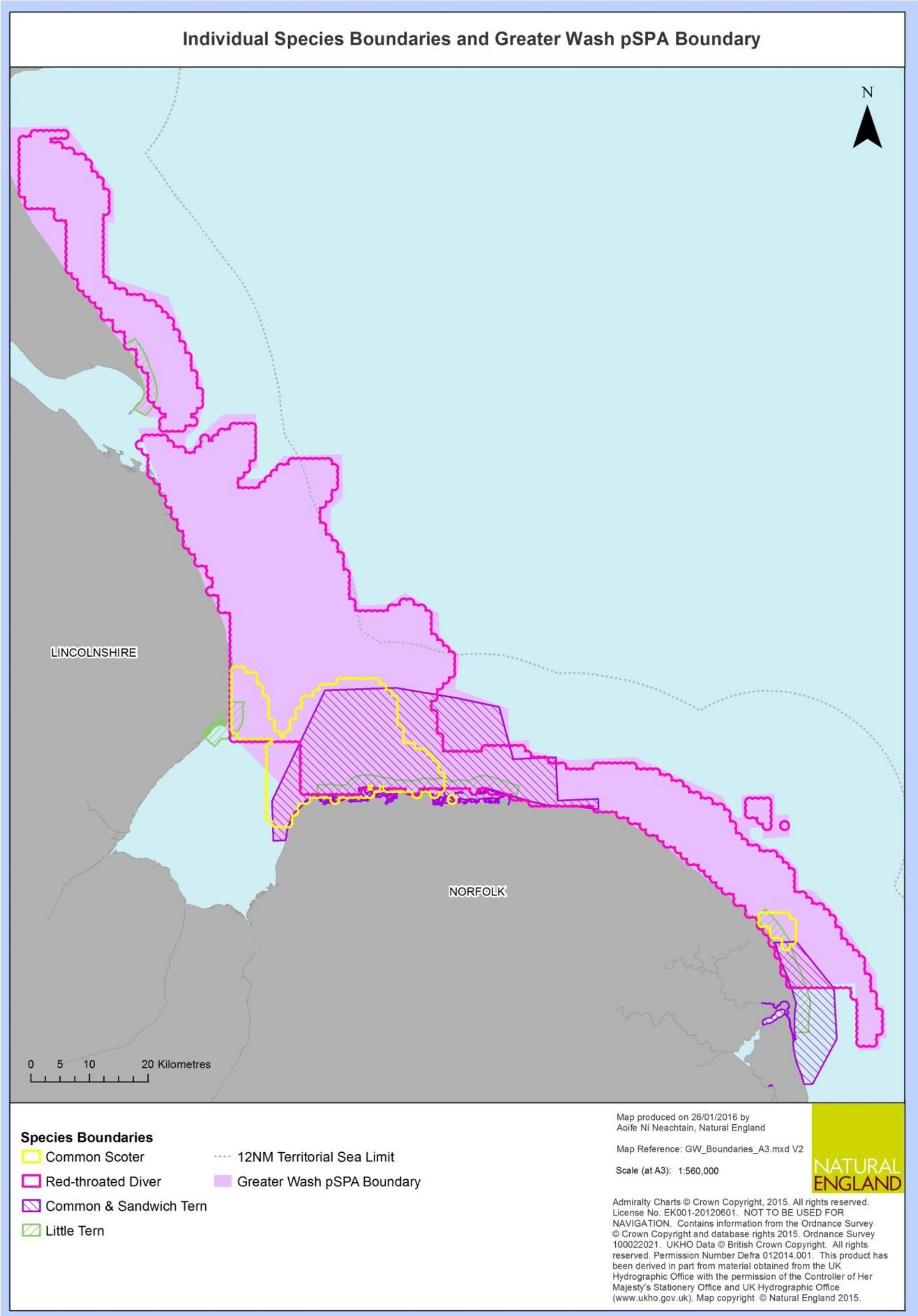


Figure 13. Greater Wash pSPA with MCA boundary for red-throated diver, common scoter, Sandwich tern, and common tern, and little tern foraging areas.

3.3 Landward boundary of the pSPA

The Greater Wash pSPA landward boundary is MHW (Lawson *et al*., 2015a). Webb and Reid, 2004: Annex B states that where the distribution of birds is likely to meet land, landward boundaries should be set at MHW “unless there is evidence that the qualifying species make no use of the intertidal region at high water”. Observations indicated that little tern forage both in the intertidal zone and subtidal zone (Parsons *et al.,* 2015a). Use of such areas by all larger tern species is also likely, as all species of tern considered routinely forage in areas of shallow water (Eglington, 2013). There is therefore no reason to conclude that these species will not forage over intertidal areas. Similarly, there is no evidence that the non-breeding species will not use intertidal areas, although the greatest densities of red-throated diver and little gull are generally found slightly further from the coast (see Figure 2 and 4).

3.4 Overlaps with other existing SPAs

The Greater Wash pSPA overlaps or abuts a number of existing coastal and marine SPAs (Figure 14).

The Greater Wash overlaps with The Wash SPA where the foraging area of Sandwich tern extends into The Wash SPA. Sandwich tern is not a qualifying feature of The Wash SPA, does not breed within The Wash SPA, and it could not be determined that 1% of the GB breeding population would wholly be supported by The Wash SPA. Therefore, Sandwich tern could not be added to The Wash SPA citation, and an overlap of the Greater Wash pSPA is required.

Across the mouth of the Humber Estuary, the boundary abuts the Humber Estuary SPA, except where neither the little tern foraging zone or the red-throated diver MCA density threshold reaches the pSPA.

Seaward boundaries of coastal SPAs are Mean Low Water (Lowest Astronomical Tide in two areas of the Humber Estuary SPA). The landward boundary of the Greater Wash pSPA is Mean High Water, and therefore overlaps the Humber Estuary, Gibraltar Point, North Norfolk Coast and Great Yarmouth North Denes SPAs in the intertidal zone.

The Greater Wash pSPA boundary abuts the northern boundary of the Outer Thames Estuary SPA as the distribution of red-throated diver is continuous between both sites.

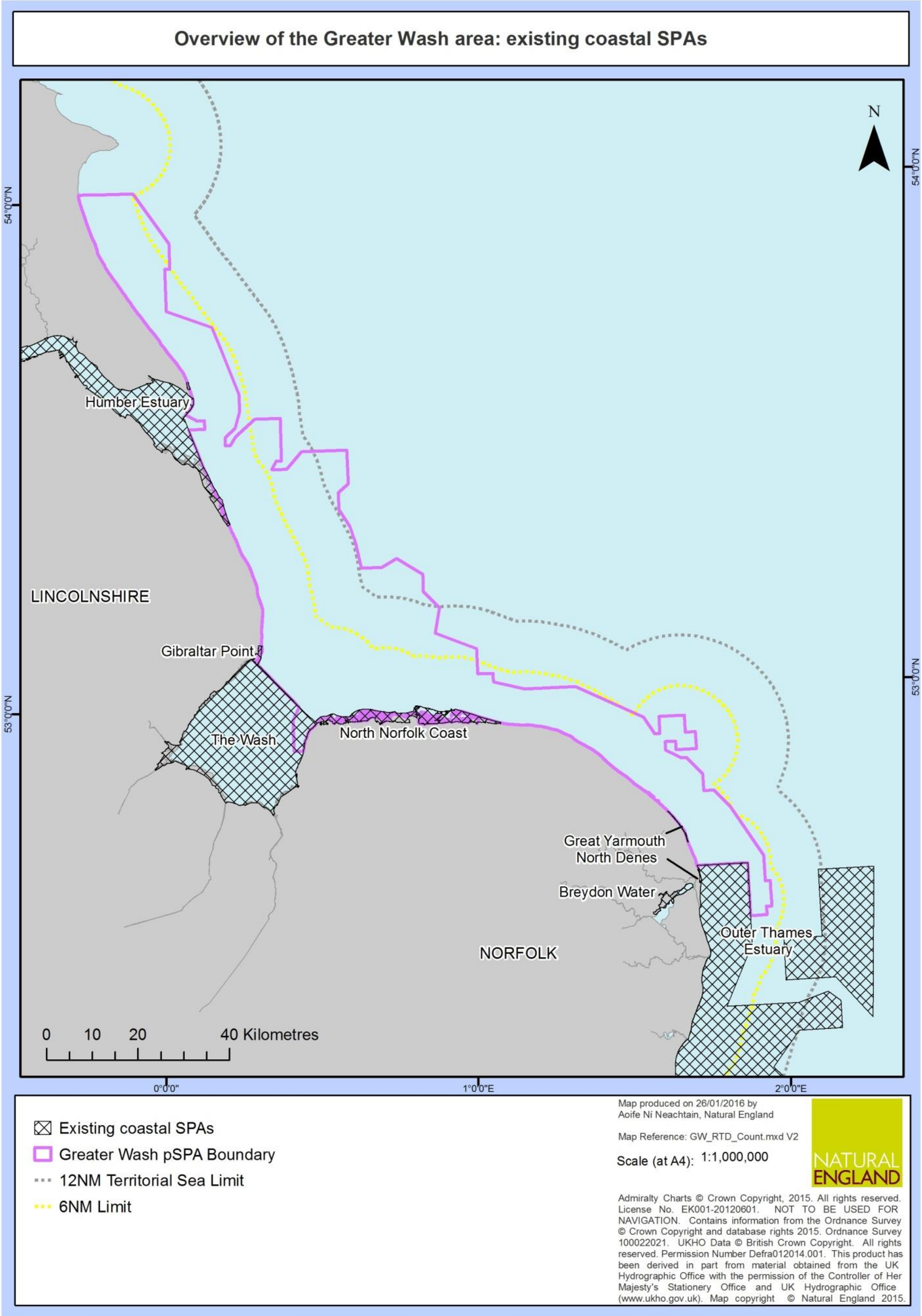


Figure 14. Overview of Greater Wash pSPA boundary and existing coastal SPA boundaries.

4 Location and Habitats

The Greater Wash pSPA is located in the mid-southern part of the North Sea on the east coast of England, between the counties of Yorkshire (to the north) and Suffolk (to the south). The site extends from Bridlington Bay in the north (at the village of Barmston), to the boundary of the existing Outer Thames Estuary SPA in the south. One satellite area (Small SE) lies seaward of the main site off the north Norfolk coast. The seaward boundary extends past the 12nm UK territorial water boundary between the Humber Estuary and north of Sheringham on the North Norfolk coast.

The Yorkshire, Lincolnshire and Norfolk coasts include a range of marine habitats, including intertidal mudflats and sandflats, subtidal sandbanks and biogenic reef, including *Sabellaria* reefs and mussel beds.

In the northernmost section of the Greater Wash pSPA, off the Holderness coast in Yorkshire, seabed habitats primarily comprise coarse sediments, with occasional areas of sand, mud and mixed sediments. The inshore environment is highly dynamic, with large volumes of material being eroded from the shoreline and seabed and transported southwards. Water depth is generally shallow in this part of the pSPA, reaching up to 20 metres towards the offshore boundary.

Subtidal sandbanks occur at the mouth of the Humber Estuary, within the Greater Wash pSPA boundary, primarily comprising sand and coarse sediments. Further down the Lincolnshire coast, seabed habitat information is scarce. In the offshore approaches to The Wash, off the South Lincolnshire and North Norfolk coasts, sediments again form sandbanks, predominantly made of coarse sediments, sand and mixed sediments. Closer inshore at The Wash, sediments comprise a mosaic of sand, muddy sand, mixed sediments and coarse sediments, as well as occasional *Sabellaria* reefs. Depths around The Wash and the Norfolk Coast are generally below 30 metres; however, a deeper channel at The Wash approaches reaches up to 90 metres depth.

Close to shore along the North Norfolk Coast (from The Wash to Blakeney Point), seabed habitats are primarily intertidal mudflats composed of sand and mud, with occasional mussel bed reefs. Nearshore sediments become coarser at Cromer, extending towards the southernmost extend of the Greater Wash pSPA boundary. Habitats further from shore in this region are similar to those seen in the offshore area of The Wash; sandbanks composed of a mosaic of sediment types (coarse sediment, mud, sand and mixed sediment).

The Greater Wash pSPA boundary overlaps and is adjacent to several other sites which have been notified or designated under European conservation legislation. These include Inner Dowsing, Race Bank and North Ridge SAC, The Wash and North Norfolk Coast SAC, and Haisborough, Hammond and Winterton SAC. All three SACs are designated for sandbanks which are slightly covered by sea water all the time and biogenic reefs, while The Wash and North Norfolk Coast SAC is also designated for several intertidal features, such as mudflats and sandflats not covered by seawater at low tide and salt marsh habitats.

The Greater Wash pSPA boundary also encompasses the boundaries of two Marine Conservation Zones (MCZ); the Holderness Inshore MCZ, off the Yorkshire coast and Cromer Shoal Chalk Beds MCZ, off the North Norfolk Coast. Holderness Inshore MCZ has been designated to protect a wide range of features, including subtidal sands, mixed sediments and clay exposures, which support habitats for a diverse range of organisms. Cromer Shoal Chalk Beds MCZ has been designated due to intertidal and subtidal rock features, which again support a wide range of habitats.

5 Assessment of ornithological interest

SPA site selection guidelines have been applied to the most up to date information for the site. However, these contemporary data reveal that at some source SPA colonies some species are no longer present in qualifying numbers (either through declines or because the relevant threshold has increased). It is not clear whether anthropogenic influences have affected the populations at the site. Defra policy indicates that in these circumstances the feature should be retained until such time as the reasons for the reduction in population can be established. Natural England and JNCC therefore consider that these species should be retained on the citation of the source SPAs, and the level of ambition set out in the conservation objectives for the species maintained, until we have evidence to support the conclusion that declines are a result of natural processes and that the SPA is no longer suitable for this species.

Counts of breeding seabirds at the colonies within the existing SPAs (which are also those most likely to be the origin of birds within the marine foraging areas of the pSPA) are from the national Seabird Monitoring Programme (SMP). This dataset has been augmented by information from colony managers and the EU LIFE+ little tern project (Pearson, 2015a and 2015b, pers. comm.).

Details of the work carried out to characterise the foraging areas used by breeding adult terns within the Greater Wash pSPA are provided in Sections 2.4 – 2.5.

Data on populations of non-breeding red-throated diver, common scoter and little gull within the Greater Wash AoS are from Lawson *et al*. (2015a) and the methods used to calculate the pSPA populations are provided in Appendix 4.

5.1 Red-throated diver - *Gavia stellata*

The current estimated non-breeding population of red-throated diver in GB is 17,000 wintering individuals (Musgrove et al., 2013). The UK and pSPA population trends are unknown.

The GB wintering population is aggregated in substantial numbers in several areas, from the Moray Firth in the north, to Kent in the south and almost 50% of this population occurs in the wider Outer Thames Estuary area. It is considered that the wintering population is largely made up of birds which breed in the UK, Greenland, Iceland and Scandinavia.

Very large numbers of red-throated and unidentified diver (which were considered to mainly be red-throated diver) were estimated to occur in the region, and peak seasonal counts within the AoS ranged between 1,407 in March 2003 and 1,971 in February 2006, with a Mean of Peak estimated count of 1,596 individuals. Red-throated diver are distributed throughout the pSPA (Figure 15). Within the boundary of the pSPA, 1,511 individuals or 8.9% of the GB wintering population were estimated to be present.

Given that the Greater Wash AoS contains more than 1% of the GB wintering population of red-throated diver, this Annex I species meets the selection criteria under stage 1.1 of the SPA selection guidelines. Therefore, Natural England and JNCC recommend that red-throated diver should be considered as a qualifying feature of the Greater Wash pSPA.

A comparison of the Greater Wash pSPA with other SPAs and AoSs in the UK selected for wintering red-throated diver is shown in Table 7.

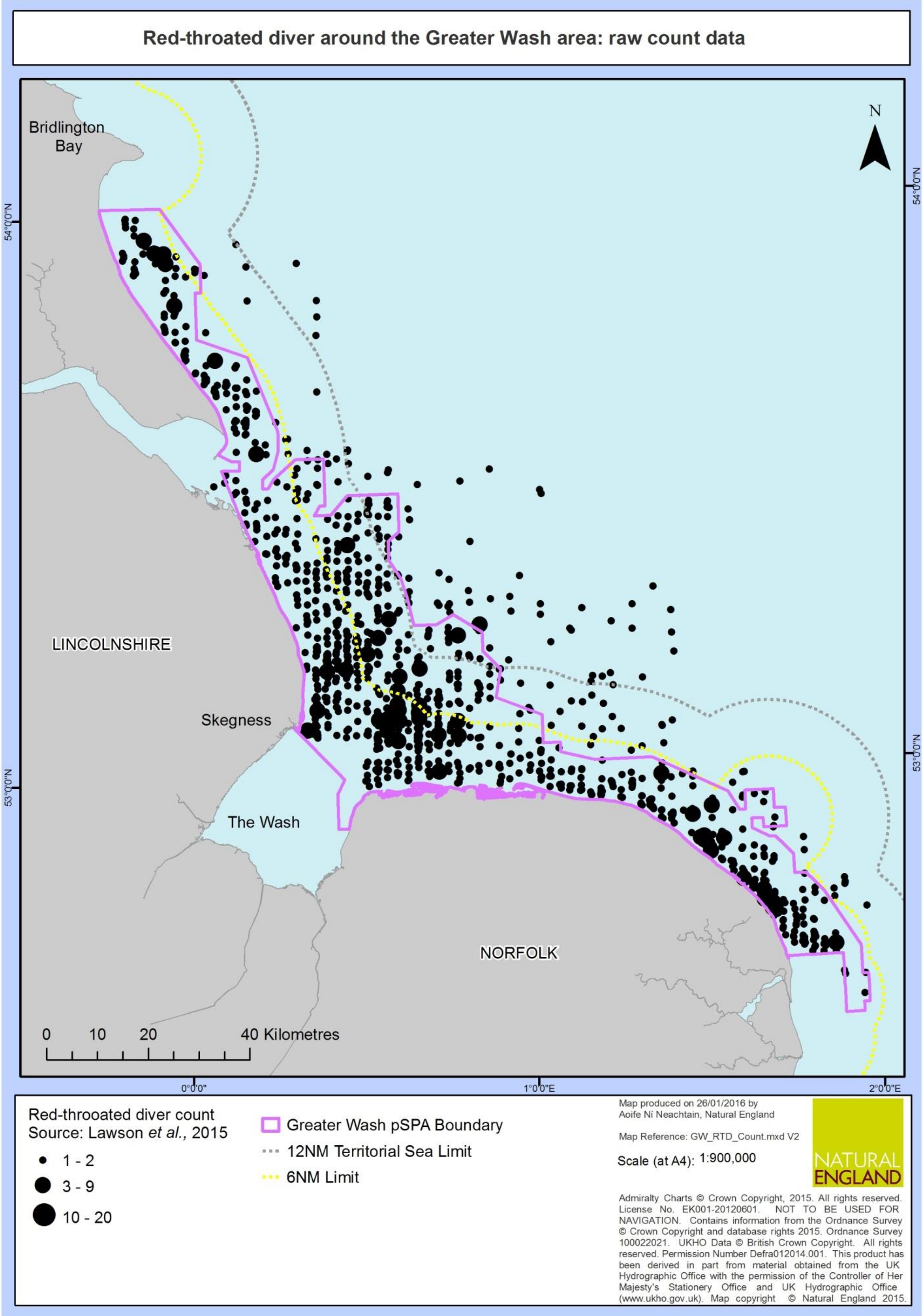


Figure 15. Raw count data of red-throated diver recorded during aerial surveys in the Greater Wash AoS (2002/03, 2004/05, 2005/06).

5.2 Little gull - *Hydrocoloeus minutus*

There is no national population estimate for little gull, and consequently the UK and pSPA population trends are unknown. The species is most numerous during spring and autumn passage to and from breeding areas in Scandinavia and NW Russia. At these times they occur widely in Britain, both on the coast and inland, although generally in small numbers. Only six locations in GB have had average counts of over 50 birds (2004/05 - 2008/09) (section 6; Table 7). Approximately 11,000 individuals are estimated to remain in European waters in winter, with 5000 individuals estimated winter in Dutch waters and 2100 individuals in German waters (DONG Energy 2009).

Between 2004/05 and 2005/06, the Greater Wash pSPA supported a peak mean of 1,303 little gull individuals during the non-breeding period, making the Greater Wash pSPA the second most important site for non-breeding little gull in GB (Section 6; Table 6). Within the Greater Wash pSPA, little gull is widely distributed at low densities across the site, with the main aggregation in The Wash approaches (Figure 4). Given the clear importance of the Greater Wash AoS as a site for over-wintering little gull, this Annex I species meets the selection criteria under stage 1.4 of the SPA selection guidelines. Thus, Natural England and JNCC recommend that little gull should be considered as a qualifying feature of the Greater Wash pSPA.

5.3 Sandwich tern - *Sterna sandvicensis*

The breeding population of Sandwich tern in GB is estimated to be 11,000 pairs (Musgrove *et al*., 2013), representing about 19.3% of the Western Europe/West Africa breeding population (57,000 pairs derived by division by 3 of the upper estimate of 171,000 individuals: AEWA, 2012). In the UK, the species is restricted to relatively few large colonies, most of which are on the east coast of Britain with a few smaller ones on the south and north-west coasts of England and in Northern Ireland. Colonies are mostly confined to coastal shingle beaches, sand dunes and offshore islets (Mitchell *et al*., 2004).

Between 2010 and 2014 the Greater Wash pSPA supported an average of 3,852 breeding pairs of Sandwich tern, which represents 35.0% of the GB breeding population. The population of Sandwich tern within the pSPA has been broadly stable since 1996 (JNCC 2014). The feeding grounds of Sandwich tern that nests at Scolt Head Island NNR and Blakeney Point NNR lie predominantly in marine areas within approximately 21 km of the colony (Win *et.al.,* 2015).

Given that the Greater Wash AoS contains more than 1% of the GB wintering population of sandwich tern, this Annex I species meets the selection criteria under stage 1.1 of the SPA selection guidelines. Therefore, Natural England and JNCC recommend that sandwich tern should be considered as a qualifying feature of the Greater Wash pSPA. The sections below give an account of the contribution of individual colonies to the Greater Wash population.

5.3.1 North Norfolk Coast SPA

Sandwich tern is a qualifying feature of the North Norfolk Coast SPA. The North Norfolk Coast SPA citation (Natural England, 1996) states "up to 4,500 pairs of Sandwich terns *Sterna sandvicensis* (12% of the EC breeding population and one-third of the British breeding population)". The Natura 2000 Standard Data Form (JNCC, 1999a) states 3,700 pairs as a five-year mean (1992-1996), at the time representing 26.4% of the GB breeding population. All breeding Sandwich tern in the SPA nest at two colonies within the North Norfolk Coast SPA; Blakeney Point NNR and Scolt Head Island NNR. At Blakeney Point, the number of pairs of Sandwich terns nesting during a recent 5-year period (2010-2014) were – 2,500 (2010), 3,562 (2011), 3,735 (2012), 4,120 (2013), 2,859 (2014), and at Scolt Head Island the number of breeding pairs were 480, 0, 400, 550 and 1,050 over the same period.

5.4 Little tern - *Sternula albifrons*

The breeding population of little tern in GB is estimated to be 1,900 pairs (Musgrove *et al*., 2013), representing about 10.3% of the Eastern Atlantic breeding population (18,500 pairs derived by division by 3 of the upper estimate of 55,500 individuals: AEWA, 2012). Breeding occurs in scattered colonies along much of the east and west coasts of Britain, from the north of Scotland to (and including) the south coast of England (Mitchell *et al*., 2004). The greater part of the population occurs in south and east England from Dorset to Norfolk (Mitchell *et al*., 2004). All British little terns nest on the coast, utilising sand and shingle beaches and spits, as well as tiny islets of sand or rock close inshore (Mitchell *et al*., 2004).

Between 2009 and 2013 the pSPA, supported an average of 798 breeding pairs of little terns which represents 42.0% of the GB breeding population. The national population of breeding little tern has fallen by approximately 20% since 1996 (JNCC 2014). Within the Greater Wash pSPA, numbers of breeding little tern have fluctuated considerably since 1996, largely driven by the populations breeding within the North Norfolk Coast and Great Yarmouth North Denes SPAs. However, over this period, the overall trend has been one of a stable population within the pSPA (Pearson, 2015a).

Little tern foraging within the Greater Wash SPA breed at Easington Lagoons within the Humber Estuary SPA, in Gibraltar Point SPA, at various colonies and sub colonies within the North Norfolk Coast SPA, and Winterton Dunes and Great Yarmouth North Denes within the Great Yarmouth North Denes SPA.The feeding grounds of little tern lie predominantly in marine areas close to the colony both in seaward and longshore extents. The southerly extent of foraging from Gibraltar Point SPA and westerly extent from the North Norfolk Coast SPA colonies overlap with The Wash SPA in which little tern is already a qualifying feature. It should be noted that the southerly extent of foraging from the Great Yarmouth North Denes SPA colonies means that a significant proportion of the foraging area of little tern from Great Yarmouth North Denes SPA is shared with Outer Thames Estuary pSPA. As it cannot definitively be concluded that little tern from different parts of the Great Yarmouth North Denes SPA colony do not use both Outer Thames Estuary and Greater Wash pSPAs, their numbers contribute to the abundance of both pSPAs.

Given that the Greater Wash AoS contains more than 1% of the GB wintering population of little tern, this Annex I species meets the selection criteria under stage 1.1 of the SPA selection guidelines. Therefore, Natural England and JNCC recommend that little tern should be considered as a qualifying feature of the Greater Wash pSPA. The sections below give an account of the contribution of individual colonies to the Greater Wash population.

5.4.1 Humber Estuary SPA

Little tern is a qualifying feature of this SPA. The citation (Natural England 2007) lists 51 pairs as the 5-year mean (1992-1996). The Natura 2000 Standard Data Form (JNCC, 2007) gives the same information, which at the time represented 2.1% of the GB breeding population. At Easington Lagoons, the number of pairs of little tern nesting during a recent 5-year period (2009-13) were 26 (2009), 11 (2010), 25 (2011), 23 (1012), 36 (2013) giving a 5-year mean of 24, representing 1.3% of the GB breeding population.

5.4.2 Gibraltar Point SPA

Little tern is a qualifying feature of this SPA. The citation (Natural England 1992a) lists 40 as a peak count from 1992. The Natura 2000 Standard Data Form (JNCC, 1999b) states 23 pairs as the 5-year mean (1992-1996) at the time representing 1% of the GB breeding population. At Gibraltar Point, the number of little tern nesting during a recent 5-year period (2009-13) were 15 (2009), 32 (2010), 12 (2011), 0 (2012), 2 (2013), giving a 5-year mean of 12, representing 0.6% of the GB breeding population.

5.4.3 North Norfolk Coast SPA

Little tern is a qualifying feature of this SPA. The citation (Natural England, 1996) states “up to 400 pairs of little tern *Sterna albifrons* (9% of the, EC and 20% of the British breeding populations)”. The Natura 2000 Standard Data Form (JNCC, 1999a) states greater than 330 pairs as the 5-year mean (1992-1996) at the time representing at least 13.8% of the GB breeding population. Within the North Norfolk Coast SPA, little tern nested at main colonies at Scolt Head Island NNR and Blakeney Point NNR, as well as sub-colonies within Holkham NNR, and at Holme Dunes NNR, Titchwell RSPB, and Brancaster. As a whole, the number of nesting pairs that the SPA supported during a recent 5-year period (2009-2013) was: 315 (2009), 366 (2010), 427 (2011), 515 (2012), 517 (2013), giving a 5-year mean of 355, representing 18.7% of the GB breeding population.

5.4.4 Great Yarmouth North Denes SPA

Little tern is a qualifying feature of this SPA. The citation (Natural England, 1992b) lists 277 as a peak count from 1991. The Natura 2000 Standard Data Form (JNCC, 1999c) states 220 pairs as the 5-year mean (1992-1996) at the time representing 9.2% of the GB breeding population. Within Great Yarmouth North Denes SPA, two main colonies are supported at Winterton Dunes NNR and Great Yarmouth North Denes. In any given year, one or other of these locations is favoured for nesting, with North Denes being favoured in more recent years. As a whole, the number of nesting pairs that the SPA supported during a recent 5-year period (2007-11) was: 426 (2009), 45 (2010), 119 (2011), 202 (2012), 200 (2013), giving a 5-year mean of 198, representing 10.4% of the GB breeding population.

It should be noted that when conditions allow, a significant colony breeds on Scroby Sands, approximately 2 km offshore from Great Yarmouth North Denes). For example, Scroby Sands supported: 0 (2009), 200 (2010), 180 (2011), 35 (2012), 120 (2013) pairs. Prior to 2010, Scroby Sands was submerged at high tide and did not provide suitable nesting habitat. Higher breeding numbers within the SPA prior to 2010, and reduced numbers within the SPA when Scroby Sands is available for breeding, suggest that little tern that would otherwise nest at either Winterton Dunes or Great Yarmouth North Denes will nest on Scroby Sands if suitable, possibly because its offshore location reduces the incidence of disturbance and predation, and therefore the local population of little tern is higher than monitoring of the SPA itself would suggest. This is discussed further in the Departmental Brief for the Outer Thames Estuary pSPA.

Combining the counts for Winterton, Great Yarmouth North Denes and Scroby Sands gives a 5-year mean of 305 pairs (2009-2013), representing 16.1% of the GB breeding population. See below for discussion on distribution of foraging area between the Greater Wash and Outer Thames Estuaries pSPAs.

5.4.5 Little tern breeding outside of existing SPAs

Little tern breed at two locations on the Norfolk coast that are outside of existing SPAs, but where their foraging areas would be within the Greater Wash pSPA: Eccles and Caister North Beach. As a whole, the number of nesting pairs that these two sites supported during a recent 5-year period (2007-11) was: 0 (2009), 10 (2010), 59 (2011), 66 (2012), 22 (2013) giving a 5-year mean of 31, representing 1.6% of the GB breeding population.

5.5 Common tern - *Sterna hirundo*

The breeding population of common tern in GB is estimated to be 10,000 pairs (Musgrove *et al*., 2013), representing at least 15% of the South and Western European breeding population (67,000 pairs derived by division by 3 of the upper estimate of 200,000 individuals and rounded to the nearest 1,000: AEWA, 2012). A significant proportion of the British population breeds in Scotland. Coastal colonies in England are concentrated in the north-east, East Anglia, at a few localities along the south coast, and in the north-west (Mitchell *et al*., 2004). Common tern not only breeds around coasts but, unlike the other tern species which breed in the UK, also frequently beside inland freshwater bodies.

Between 2010 and 2014, the SPA supported an average of 510 breeding pairs of common tern, which represents 5.18% of the GB breeding population. The population of common tern within the SPA has declined since 1996. The breeding population at the North Norfolk Coast SPA has declined by approximately one third during this period, and while the population at Breydon Water SPA was stable for most of this time there has been a 50% decrease since 2008 (JNCC 2014). The feeding grounds of common tern lie predominantly in marine areas within approximately 10 km of the colonies at Blakeney Point and Scolt Head Island, and approximately 13 km of the colony at Breydon Water (Win *et al.,* 2013).

Given that the Greater Wash AoS contains more than 1% of the GB wintering population of common tern, this Annex I species meets the selection criteria under stage 1.1 of the SPA selection guidelines. Therefore, Natural England and JNCC recommend that common tern should be considered as a qualifying feature of the Greater Wash pSPA. The sections below give an account of the contribution of individual colonies to the Greater Wash population.

5.5.1 Breydon Water SPA

Common tern is a qualifying feature of this SPA and breeds on raised platforms within the estuary. The SPA citation (Natural England, 2000) states 155 pairs, at that time representing 1.3% of the GB breeding population (5-year peak mean, 1992-94 & 1996).The Natura 2000 Standard Data Form (JNCC, 2000) gives the same information. The number of pairs of common tern nesting during the most recent 5-year period (2010-2014) were 173 (2010), 158 (2011), 93 (2012), 92 (2013) 99 (2014). This provides a recent 5-year mean of 123 pairs (or 246 breeding adults), representing 1.2% of the GB breeding population.

5.5.2 Scroby Sands

Common tern breed on the sandbanks at Scroby Sands, and as has been established above there is functional linkage between Scroby Sands and Breydon Water SPA. The number of pairs of common tern nesting during the most recent 5-year period (2010-2014) were 40 (2010), 80 (2011), 160 (2012), 250 (2013) 100 (2014). This provides a recent 5-year mean of 126 pairs (or 252 breeding adults), representing 1.3% of the GB breeding population.

5.5.3 North Norfolk Coast SPA

Common tern is a qualifying feature of this SPA, the citation (Natural England, 1996) stating up to 1,000 pairs. The Natura 2000 Standard Data Form (JNCC, 1999a) states “up to 1,000 pairs of common tern *Sterna hirundo* (3% of the EC and 9% of the British breeding populations)”. Common tern nests in three main colonies at Blakeney Point NNR, Holkham NNR and Scolt Head Island NNR, as well as smaller sub-colonies throughout the SPA (Titchwell, Cley, Salthouse, Wells Outer Harbour). Information on the most recent breeding numbers (from JNCC Seabird Monitoring Programme and the Norfolk County Bird Recorder reported in Norfolk Bird and Mammal reports) is presented in Table 5. This provides a recent 5-year mean of 261 pairs (or 522 breeding adults), representing 2.6% of the GB breeding population.

Table 5. Common tern breeding data (pairs) within the North Norfolk Coast SPA

	2010	**2011**	**2012**	**2013**	**2014**
Blakeney Point	75	92	67	48	87
Holkham NNR	95	87	55	37	40
Scolt Head NNR	177	91	75	133	145
Titchwell	0	1	1	1	0

5.6 Common scoter – *Melanitta nigra*

Common scoter is not listed in Annex I of the Birds Directive and is assessed against stage 1.2 of the SPA selection guidelines (Stroud et al., 2001) using the relevant biogeographical population estimate. Common scoter is a regularly occurring migratory species and the subspecies *M.n. nigra* winters in the Baltic and West Atlantic south of Mauritania (Wetlands International, 2002).

The wintering biogeographic population (West Siberia & northern Europe/western Europe & north western Africa) of common scoter is considered to be approximately 550,000 individuals (Wetlands International, 2012), accessed 15/07/2015). Non-breeding common scoter is thinly distributed around most of the coast of the UK (Balmer et al., 2013), with notably larger concentrations (>15,000 birds) in Liverpool Bay and Carmarthen Bay, both already classified as marine SPAs for the species. The GB wintering population is estimated to be 100,000 individuals (Musgrove et al., 2013). The GB population trend is unknown. There are no previous surveys of the AoS upon which to determine the population trend for the pSPA. However, numbers of individuals recorded in

Wetland Bird Surveys of the North Norfolk Coast (Holt *et. at.* 2015) indicate an increase in observations to the winter of 2000/01. While numbers recorded fluctuate after this, the local population appears stable.

During aerial surveys of the Greater Wash AoS a clear cluster of common scoter observations were recorded just east of The Wash SPA, and in lower numbers near Skegness and the east Norfolk coast (Figure 16). Highest densities of common scoter were observed in the area outside The Wash SPA and along the North Norfolk Coast SPA.

Common scoter use the pSPA in winter in numbers that do not meet the 1% threshold (peak mean 2002/03 – 2007/08 3,463 individuals, 0.6% biogeographic population). However, the species may also be assessed against stage 1.4 of the SPA selection guidelines:

> *An area which meets the requirements of one or more of the Stage 2 guidelines in any season, where the application of Stage 1 guidelines 1, 2 or 3 for a species does not identify an adequate suite of most suitable sites for the conservation of that species.*

Stroud *et al*. (2001) identified the North Norfolk Coast SPA as supporting numbers of common scoter worthy of inclusion in its waterbird assemblage, one of only two sites in eastern England identified (the other being Lindisfarne) and supporting the greatest total of all UK sites discussed. These birds are very likely part of the same population now considered within the Greater Wash pSPA.

Since Stroud *et al*. (2001), knowledge of marine scoter distribution has expanded sufficiently to identify Liverpool Bay and Carmarthen Bay SPAs as the most important sites in the UK; however, the Greater Wash pSPA remains relatively important amongst other candidate SPA sites, and would be the only such SPA between Lindisfarne and Carmarthen Bay.

Therefore, Natural England and JNCC recommend that common scoter is a qualifying feature of the Greater Wash pSPA on the basis of:

5.6.1 Population size and density

Lawson *et al.* (2015a) demonstrates that the distribution of common scoter is limited and concentrated to specific areas (Figures 3 & 15) and shows consistent use over the survey period. This is supported by both Wetland Bird Survey (WeBS) data and data collated in the Norfolk Bird and Mammal Reports (NBMRs), published by the Norfolk and Norwich Naturalist's Society. WeBS data from the North Norfolk Coast SPA (Appendix 3, Table 1) has a five year peak mean of 4,488 (2002/03 – 2007/08), and abundances quoted in the NBMR are at similar levels (Appendix 3, Table 2).

It should be noted that the usefulness of WeBS and NBMR data is limited in justifying the inclusion of common scoter as a feature without reference to other data. Count accuracy is constrained to the visible limit from shore, they cannot be analysed spatially in the same way as boat and aerial survey data to provide a site boundary. Additionally for NBMR data, it is not clear if these were coordinated to avoid double counting or taken from individual observations submitted to the recorders. However, they are helpful in corroborating the general population levels of common scoter in the near-shore area.

It is clear that the population seen within the Greater Wash AoS from all the available data (aerial survey used in the JNCC analysis, and shore-based WeBS and NBMR observation), would render the Greater Wash the fifth most important UK site for non-breeding common scoter if classified (Section 6; Table 7).

5.6.2 Species range

Common scoter is a component of the waterfowl assemblage of the North Norfolk Coast SPA. With the exception of The Wash SPA, the Greater Wash pSPA would be the only site specifically classified for this species within the English southern North Sea. It is highly likely that individuals occurring within the Greater Wash pSPA are part of the same population also using the above existing SPAs, and therefore classification of the Greater Wash pSPA would complete the protection of this wider local population and its supporting habitats.

5.6.3 History of occupancy

Both Lawson *et al.* (2015a) and WeBS data demonstrate consistency of use throughout the survey period, and WeBS data further suggests a history of occupancy in similar numbers from at least 1991/92.

In conclusion, on the basis that the Greater Wash has a history of supporting large numbers of individuals during the non-breeding season, that the geographic range of this population is not currently completely protected within the UK SPA suite, and that there is currently uncertainty about the sufficiency of protection within the SPA network for this species, Natural England and JNCC recommend common scoter is a qualifying feature of the pSPA.

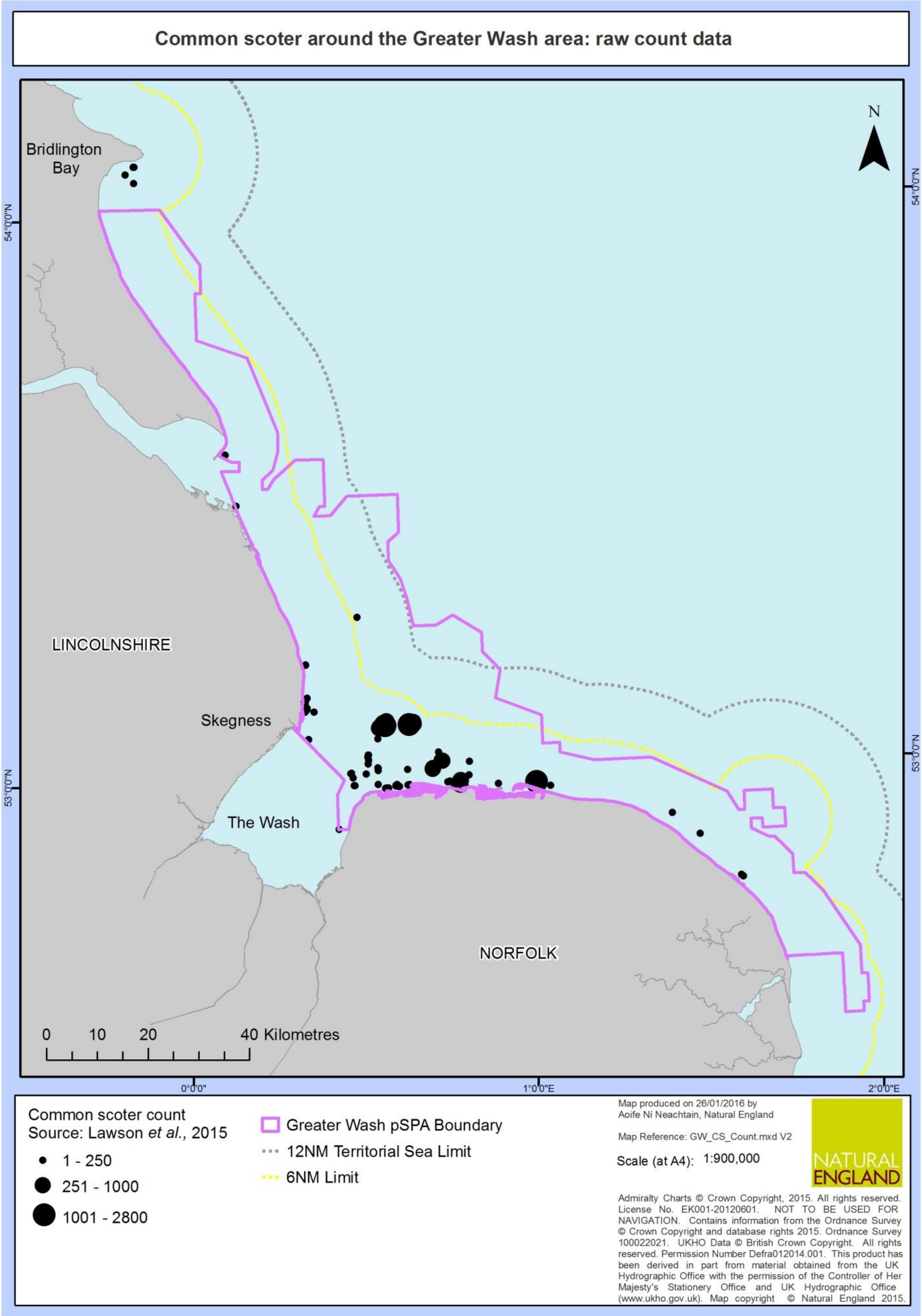


Figure 16. Raw count data of common scoter recorded during WWT Consulting aerial surveys within the Greater Wash AoS (2002/03, 2004/05, 2005/06).

6 Comparison with other sites in the UK

Tables 6 and 7 compare the proposed qualifying features (non-breeding and breeding respectively) of the Greater Wash pSPA against all UK SPAs (and for little gull, against SPAs where they occur but are not necessarily features).

Table 6. Comparison of the numbers of individuals of each of the named non-breeding features of the Greater Wash pSPA with those at other sites supporting those species. As only one SPA is currently classified for little gull, other sites recorded as regularly supporting more than 50 individuals are included for comparison. For brevity, only the top five ranked sites are tabulated for each species.

Species	Site	Count (individuals)	Rank	Comments
Red-throated diver[16]	Outer Thames Estuary SPA	6,466 (MoP 1989–2006/07)	1st of 3	
	Greater Wash pSPA	1,511 (MoP 2002/03-2005/06)-	2nd of 3	
	Liverpool Bay/Bae Lerpwl SPA	922 (MoP 2001/2-2006/07)	3rd of 3	
Common scoter[17]	Liverpool Bay/Bae Lerpwl SPA	54,675 (MoP 2001/02-2006/07)	1st of 25	
	Carmarthen Bay/Bae Cearfyrddin SPA	16,946 (MoP 1997/98-2001/02)	2nd of 25	
	Moray Firth dSPA	5,479 (Mean of Max. Ests. 2001/02 - 2006/07.5)	3rd of 25	
	Outer Firth of Forth and St Andrews Bay complex dSPA	4,700 (Mean of Max. Ests. 2001/02 and 2003/04-2004/05)	4th of 25	
	Greater Wash pSPA	3,463 (MoP 2002/03-2007/08)	5th of 25	
Little gull[18]	Hornsea Mere SPA	7,645 (MoP 2004/05-2008/09)	1st of 7	
	Greater Wash pSPA	1,303 (MoP 2004/04-2005/06)	2nd of 7	
	Mersey Narrows and North Wirral Foreshore SPA	213 (MoP 2004/05-2008/09)	3rd of 7	Includes Alt Estuary discussed in Calbrade *et al. (*2010)
	Tophill Low Reservoirs	173 (MoP 2004/05-2008/09)	4th of 7	
	Forth Estuary	90 (MoP 2004/05-2008/09	5th of 7	

[16] Red-throated diver populations from: Liverpool Bay/Bae Lerpwl SPA Natura 2000 Standard Data Form (http://publications.naturalengland.org.uk/publication/3236717), Outer Thames Estuary SPA Natura 2000 Standard Data Form (http://publications.naturalengland.org.uk/publication/3233957?map=true), Greater Wash pSPA – calculated from data presented in Lawson *et al.* 2015a (see Appendix 5)

[17] Common scoter populations from: Liverpool Bay/Bae Lerpwl SPA Natura 2000 Standard Data Form (http://publications.naturalengland.org.uk/publication/3236717); Carmarthen Bay/Bae Cearfyrddin SPA Natura 2000 Standard Data Form (http://jncc.defra.gov.uk/pdf/SPA/UK9014091.pdf); Greater Wash pSPA - calculated from data presented in Lawson *et al.* 2015a (see Appendix 5); Moray Firth dSPA and Firth of Forth and Tay Bay Complex dSPA – Lawson *et al.* (2015b).

[18] Little gull populations calculated from data presented in Lawson *et.al.* (2015a) for Greater Wash pSPA (see Appendix 5) and SPA Citation for Mersey Narrows and North Wirral Foreshore SPA (http://publications.naturalengland.org.uk/publication/6521906232557568?category=4582026845880320). . All other little gull populations taken from Calbrade *et al.* (2010).

Table 7. Comparison of the numbers of individuals (and pairs) of each of the named features of the Greater Wash pSPA with those at other SPAs identified by the JNCC SPA review as supporting those features. Figures for the Greater Wash pSPA are, with the exception of little tern (2007-2011), based on count data between 2010 and 2014 inclusive. Figures for all other sites are taken from Stroud *et al*. (2001).

Species	Site	Individuals (pairs)[19]	Rank[20,21]	Comments
Sandwich tern	Greater Wash	7,704 (3,852)	1st of 17	
	North Norfolk Coast	6,914 (3,457)	2nd of 17	
	Farne Islands	4,140 (2,070)	3rd of 17	
	Coquet Island	3,180 (1,590)	4th of 17	
	Ythan Estuary, Sands of Forvie and Meikle Loch	1,200 (600)	5th of 17	
Common tern	Firth of Forth Islands	1,600 (800)	1st of 23	
	Coquet Island	1,480 (740)	2nd of 23	
	Strangford Lough	1,206 (603)	3rd of 23	
	Glas Eileanan	1,060 (530)	4th of 23	
	Greater Wash	1036 (518)	5th of 23	
	North Norfolk Coast	920 (46)	6th of 23	North Norfolk Coast SPA population contributes to Greater Wash. Declines in NNC population since Seabird 2000 account for discrepancy in population totals
Little tern	Greater Wash	1,560 (780)	1st of 28	
	North Norfolk Coast	754 (377)	2nd of 28	
	Great Yarmouth North Denes	440 (220)	3rd of 28	
	Chichester and Langstone Harbours	200 (100)	4th of 28	
	Humber Flats, Marshes and Coast	126 (63)	5th of 28	

[19] Stroud *et al. (2001)* notes: Data from the JNCC/RSPB/ Seabird Group's Seabird Colony Register have been used. These comprised the best available, whole colony counts for the period 1993-1997 or earlier. These data have been supplemented with additional census data for some sites provided by country agencies (especially in Scotland) and/or as a result of more recent surveys of particular species.

[20] Note that these rankings should only be considered indicative of the relative importance of the pSPA as they are based on comparison of the sum of the most recent 5 year mean populations of each species at the source SPAs (as listed in Table 1) with the historical populations of each species at each SPA in the UK as listed in Stroud *et al.* (2001). The number of sites ranked is based on the number of sites listed for each species in Stroud *et al*. (2001) and included from that list are SPAs contributing to the total presented for the Greater Wash pSPA, and adding one site to account for the pSPA itself. For brevity, only the top 5 ranked sites are tabulated for each species, except where the Greater Wash pSPA position in the rank order is lower than this – in which case all sites down to that rank position are tabulated.

[21] These rank orders to not take account of numbers currently being considered in the context of other pSPAs in the United Kingdom.

7 Conclusion

The Greater Wash pSPA is proposed for classification to protect the important areas used by non-breeding red-throated diver, common scoter and little gull. It is also proposed to protect the foraging areas used by Sandwich, common and little tern breeding at existing coastal SPAs.

An assessment has been made of the evidence used against Natural England's Evidence Standards (Appendix 2), and Natural England and JNCC are therefore confident that the evidence is sufficient to support the pSPA being taken forward to formal consultation.

7.1 Qualification

The numbers of all six qualifying features found within the Greater Wash pSPA rank within the top six sites proposed for these species across the UK SPA suite.

Red-throated diver, Sandwich tern, common tern and little tern all occur in numbers (1,538 individuals, 3,852 pairs, 384 pairs and 798 pairs respectively) greater than 1% of UK population. These species therefore qualify for protection under Stage 1.1 of the UK SPA Selection Guidelines (Stroud *et al*., 2001). There is no population estimate for little gull, however the pSPA has been identified as the most important marine site for little gull in the UK, with more than 50 individuals (2,071). It therefore qualifies under Stage 1.4 of the JNCC selection criteria.

Common scoter does not meet the 1% abundance criteria (3,463 individuals, 0.6% of the biogeographic population). However this species does qualify under Stage 1.4 criteria for density (forms a discrete identifiable population), species range (most southerly location in North Sea, and would fully protect the area used by the local population), and history of use (consistency of use during JNCC surveys, WeBS data shows presence at least to 1991/92, and recorded as present in 1967 (Birds of Norfolk)).

7.2 Population estimation and identification of areas

Populations of the non-breeding species (red-throated diver, common scoter, little gull) have been calculated to the pSPA boundary using the density surfaces published in Lawson *et. al.* (2015a). Populations of the tern species are taken from breeding colony data provided by site managers and obtained from the JNCC Seabird Monitoring Programme database (Sandwich and common terns, 2014 data for Breydon Water from RSPB) and the RSPB (little tern, collected as part of the EU LIFE+ Project).

Three years of survey data were used in the population estimate of red throated diver. 81% of divers were 'unidentified' during surveys, but the small proportion of identified divers being other species (4.7% were great northern diver) gives confidence that unidentified divers can be assumed to be red throated diver.

Common scoter is not evenly distributed, with small numbers of very large congregations of this species observed. Distance Analysis using data from individual surveys produces population estimates with very large confidence intervals. To improve confidence in the population estimate, data were pooled across winter seasons and density surfaces calculated from this. This potentially underestimates population size. However, shore-based WeBS data provides population estimates of similar magnitude.

A population estimate for little gull was only possible from two years of survey (2004/05 and 05/06), with spatial coverage during other years not being representative of the distribution of this species. Site specific (tracking) data was used to model foraging areas of Sandwich and common tern from North Norfolk Coast SPA. A generic model was applied to common tern from Breydon Water SPA, derived from data from colonies where survey had been undertaken.

For little tern, site specific data was applied to the longshore and seaward extent of foraging from the colonies in the North Norfolk Coast and Great Yarmouth North Denes SPAs. Site specific information determined the alongshore boundary of the foraging area for the Humber Estuary SPA colony, with seaward boundary using a generic extent. Gibraltar Point SPA had no site specific data, and generic extents were applied to the alongshore and seaward boundaries. Generic extents are the maximum distance of observations from all surveyed colonies.

7.3 Boundary

The proposed boundary of the pSPA is a composite of all of the areas identified as important to each species through Maximum Curvature Analysis (or alongshore and seaward observation for little tern).

The pSPA boundary encompasses the important areas identified for Sandwich tern, common tern, little tern, red-throated diver and common scoter. For little gull, the available data were insufficient to define all important areas for this species in the Greater Wash area with certainty, but the existing data suggests that a large part of their wintering population is likely to be incorporated into the boundary. The landward boundary is Mean High Water and the seaward boundary is determined by the distribution of red throated diver and Sandwich tern. Sandwich tern foraging area also determines the overlap of the Greater Wash pSPA, and a small area extends down Spurn Head for foraging little terns. The foraging areas of common tern breeding at Breydon Water SPA and little tern breeding at Great Yarmouth North Denes SPA are shared with the Outer Thames Estuary SPA. The distribution of common scoter is contained within the composite boundary.

Care has been taken to establish a boundary around these areas to provide sufficient protection for each qualifying feature, whilst ensuring that where practical areas that do not meet the Maximum Curvature density threshold for any qualifying feature were excluded. As such, the draft boundary is drawn to one minute lines around the MCA for red-throated diver and tern foraging areas.

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Appendix 1 Site Citation

EC Directive 79/409 on the Conservation of Wild Birds

potential Special Protection Area (pSPA)

Name: Greater Wash pSPA

Counties/Unitary Authorities: East Riding of Yorkshire, Lincolnshire, Norfolk, Suffolk

Boundary of the SPA:

The landward boundary of the pSPA covers the coastline from Bridlington Bay in the north (at the village of Barmston), to the existing boundary of the Outer Thames Estuary SPA in the south. Along this stretch of coast, the boundary will come to Mean High Water (MHW). Across the mouth of the Humber Estuary, the boundary abuts the boundary of the Humber Estuary SPA, except where neither the little tern foraging zone or the red-throated diver MCA density threshold reaches the SPA. The landward boundary abuts the seaward boundary of The Wash SPA except where the former overlaps the latter to encompass the foraging area of Sandwich tern.

The seaward boundary lies approximately 14 nautical miles (nm) from the shore at its furthest extent and is driven by the distribution of red-throated diver along the length of the SPA, with a small length off the north Norfolk Coast driven by the area used by foraging Sandwich tern.

Size of SPA: The pSPA covers an area of 344, 267 ha, or 3,443 km^2.

Site description:

Greater Wash pSPA is located in the mid-southern North Sea between Bridlington Bay in the north and the Outer Thames Estuary SPA in the south. To the north, off the Holderness coast in Yorkshire, seabed habitats primarily comprise coarse sediments, with occasional areas of sand, mud and mixed sediments. Subtidal sandbanks occur at the mouth of the Humber Estuary, primarily comprising sand and coarse sediments. Offshore, soft sediments dominate, with extensive areas of subtidal sandbanks off The Wash and north and east Norfolk coasts. Closer inshore at The Wash, sediments comprise a mosaic of sand, muddy sand, mixed sediments and coarse sediments, as well as occasional *Sabellaria* reefs. Close to shore along the north Norfolk Coast seabed habitats are primarily intertidal mudflats composed of sand and mud, with occasional mussel bed reefs.

Qualifying species:

The site qualifies under **Article 4** of the Birds Directive (2009/147/EC) for the following reasons (summarised in Table 1):

- The site regularly supports more than 1% of the GB breeding populations of three species, and the non-breeding populations of two species listed in Annex I of the EC Birds Directive. Therefore, the site qualifies for SPA Classification in accordance with the UK SPA selection guidelines (stage 1.1, 1.4).

- The site supports a regularly occurring migratory species not listed in Annex I of the EC Birds Directive extending the (currently insufficient) range coverage of the current suite of SPAs for this species. Therefore, the site qualifies for SPA Classification in accordance with the UK SPA selection guidelines (stage 1.4).

Table 1. Summary of qualifying ornithological interest in Greater Wash pSPA. Mean of Peak (MoP) for non-breeding populations[22], breeding populations taken from various sources and are summed across the relevant site specific population estimates. GB populations derived from Musgrove *et al*. (2013)[23] unless otherwise stated.

Species	Count (period)	% of subspecies or population	Interest type	SPA selection guideline
Red-throated diver *Gavia stellata*	1,511 (MoP 2002/03 - 2005/06)[22]	8.9% GB non-breeding population	Annex I	1.1
Common scoter *Melanitta nigra*	3,463 (MoP 2002/03, - 2007/08)[21]	0.6% Biogeographic population[24]	Regularly occurring migratory species	1.4
Little gull *Hydrocoloeus minutus*	1,303 (MoP 2004/05 – 2005/06)[21]	No current UK population estimate	Annex I	1.4
Sandwich tern *Sterna sandvicensis*	3,852 pairs (5 year MoP 2010-14)[25]	35.0% of GB breeding population	Annex I	1.1
Common tern *Sterna hirundo*	510 breeding pairs (5 year MoP 2010-2014)[25,26]	5.1% of GB breeding population	Annex I	1.1
Little tern *Sternula albifrons*	798 pairs (5 year MoP 2009-2013)[26]	42.0% of GB breeding population	Annex I	1.1

Principal bird data sources:

Populations on non-breeding waterbirds from:

MoP non-breeding populations for red-throated diver, common scoter and little gull were calculated by Natural England using AoS data reported by Lawson *et al* 2015a (Appendix 4).

Colony counts for Sandwich and common tern from:

JNCC Seabird Monitoring Programme contributed by colony managers: National Trust and Natural England (North Norfolk Coast SPA) and RSPB (Breydon Water SPA).

Colony counts for little tern from:

RSPB for EU LIFE+ Little Tern Recovery Project contributed by site managers: Easington Little Tern Protection Scheme (Humber Estuary SPA); Lincolnshire Wildlife Trust (Gibraltar Point SPA); RSPB, National Trust, Norfolk Wildlife Trust, Natural England (North Norfolk Coast SPA); and RSPB (Great Yarmouth North Denes SPA).

[22] MoP non-breeding populations for red-throated diver, common scoter and little gull were calculated by Natural England using AoS data reported by Lawson *et al* 2015a (Appendix 4).
[23] Musgrove *et al.* (2013) collates population estimates of birds in Great Britain and the UK, by extrapolation of previous estimates using recognised trend measures, new surveys and novel analytical approaches.
[24] Common scoter biogeographic population from Waterbird Population Estimates online database (http://wpe.wetlands.org/) accessed 26/01/2016)
[25] Seabird Monitoring Programme (http://jncc.defra.gov.uk/page-1550)
[26] Direct from site managers

Appendix 2 Implementation of Evidence standards within Boundary Making decision process

Decision-making processes within NE are evidence driven and the Natural England strategic evidence standard, and supporting guidance were followed. In particular, the four principles for the analysis of evidence set out in the Natural England Standard *Analysis of Evidence* have been adhered to. These two standards documents can be downloaded from the following web-links:

Strategic Evidence Standard:

http://publications.naturalengland.org.uk/publication/7699291?category=3769710

Analysis of Evidence Standard:

http://publications.naturalengland.org.uk/publication/7850003?category=3769710

An explanation follows as to how the principles within the *Analysis of Evidence* standard have been applied in defining the set of qualifying features and boundary of the Greater Wash pSPA.

1.) The evidence used is of a quality and relevance appropriate to the research question or issue requiring advice or decision

Quantification of Greater Wash pSPA interest feature population sizes.

In order to determine the suite of species present within the Greater Wash pSPA which meet the SPA selection guidelines, and to determine the nature and size of the breeding seabird assemblage supported by this site, bird count data at each of the existing coastal SPAs from which birds within the marine pSPA may originate were used as the evidence base. These data were as follows:

1. Lawson *et al.* 2015a provided population estimates for red-throated diver, common scoter and little gull within the Greater Wash AoS and the draft boundary defined by JNCC. These population estimates were recalculated following revision of the boundary to remove little gull satellite aggregations that could not be demonstrated to have regularity of use, and removal of areas of the JNCC draft boundary that did not meet the Maximum Curvature density threshold of any species (or landward/seaward boundary of foraging for little tern). As these populations are derived from modelling of survey data rather than counts of all individual birds, they are assessed as estimates.
2. Data from JNCC's Seabird Monitoring Programme (SMP) (http://jncc.defra.gov.uk/smp/)

   a) North Norfolk Coast SPA data 2010-2014 for Sandwich and common tern species. All of these counts are assessed as "accurate" except for Sandwich tern counts at Blakeney Point in 2010 which is assessed as "estimate" and common tern counts at Blakeney Point in 2013 are assessed as "estimate".

   b) Breydon Water SPA/Scroby Sands: Common tern count data 2010-2013. All are assessed as "accurate".
3. Data from colony managers supplemented the SMP data where this was not available, in the following instances:

   3.1 Humber Estuary SPA. Little tern counts were obtained from the Easington Little Tern Protection Scheme 2014 annual report for 2010-2014. All of these counts are assessed as "accurate"

   3.2 Data for other little tern colonies (Gibraltar Point SPA, North Norfolk Coast SPA, Great Yarmouth North Denes SPA, colonies outside SPAs) were supplied by RSPB from data provided direct from site managers.

The count data taken from the SMP database is the best available information. In addition, the 2014 SMP data has been checked by JNCC. The count data which were obtained directly from the colony managers is source information that will in due course become part of the SMP database. As such, it too is the best available information.

Alternative sources of data were available for little terns (Parsons *et al.* 2015, Norfolk Bird and Mammal Reports) which to some degree were at variance with each other and with EU LIFE+ Little Tern Project data. Natural England contacted Philip Pearson at RSPB for clarity on methods of collating data for the EU LIFE+ project. Data supplied is based on based on the peak AON and numbers fledged as recorded by the site managers, confirmed through post-season meetings of Norfolk and Suffolk little tern groups.

Establishment of extent of marine pSPAs using non-breeding water bird survey and tern tracking data

Webb & Reid (2004) note that the guidelines for selecting SPAs in the United Kingdom are described in Stroud *et al*. (2001), and are adequate and competent for application to site selection in the inshore environment for inshore non-breeding waterbird aggregations. The Greater Wash pSPA is a composite of the areas of importance for non-breeding waterbirds and the three breeding tern species, and the guidelines provided by Webb & Reid (2004) for the selection of marine SPAs for aggregations of inshore non-breeding waterbirds which can be applied directly to the data regarding the non-breeding waterbird features of the Greater Wash pSPA. The analysis of whether numbers recorded met the appropriate SPA qualifying criteria for the species of interest was conducted on the basis of mean peak estimates of bird abundance over three, four and two years of survey (red-throated diver, common scoter and little gull respectively). This is entirely appropriate, and consistent with the ‘mean maxima’ approach employed by Ramsar and used by JNCC to recommend SPAs for classification (JNCC 1999). The approach is followed by reporting mechanisms of WeBS, which feeds in to monitoring of SPAs.

The other major analysis relates to landward and seaward boundary definition. In both cases this relies on an established method (maximum curvature analysis) used at other inshore marine SPAs (O’Brien *et al.* 2012), and thus is also entirely relevant to defining the boundary for this proposed pSPA.

This guidance does not directly consider the evidence requirements for the selection of marine SPAs focusing on the principal foraging areas used by breeding seabirds. However, a number of the issues and principles covered in Webb & Reid (2004) nonetheless have some relevance in this context. Accordingly, the following section describes in broad terms a comparison of the quality and relevance of the tern evidence base with the guidelines produced by Webb & Reid (2004).

Given that the type and quality of data which underpins the justification of qualification of Greater Wash pSPA for breeding terns differs from those used in identifying sites for terrestrial birds and aggregations of non-breeding waterbirds, it is necessary to consider their adequacy and relevance. Webb & Reid (2004) set out seven criteria to assess the adequacy of count data. Although not all of direct relevance in the current case these criteria are set out in Table 1 with accompanying comments regarding the surveys of the non-breeding features of the site and the tern tracking and modelling work.

Table 1. Criteria for inshore SPA data adequacy.

Criterion	Adequacy of non-breeding bird surveys (WWF)	Adequacy of JNCC led larger tern surveys	Adequacy of JNCC led little tern surveys
Experience of observers	All visual aerial survey was undertaken by WWT Consulting using experience observers with experience of aerial surveys of OWF sites and surveys to identify sites for classification as SPAs	All tracking of terns was undertaken either by JNCC staff or experienced contractors commissioned by JNCC to do the work.	All observations of terns was undertaken either by JNCC staff or experienced contractors commissioned by JNCC or volunteer counters who received training in the shore-based observation techniques.
Systematic	Survey was undertaken in a systematic way, using a	Tern tracking was conducted in as systematic	Boat-based survey work followed systematic

surveys	methodology developed in Denmark by the National Environment Research Institute (NERI).	a way as possible. Tracking at each colony was carried out during well-defined periods of the breeding season (chick-rearing) in one or more years. Tracking was undertaken in accordance with a field protocol established by JNCC. In the context of tern tracking, the movements of birds is an essential component of the technique and not a source of systematic bias in the survey results as it may be in conventional transect surveys.	transect survey designs that were appropriate to each colony and were followed on repeated surveys. Shore based survey work used systematic series of observation stations and a standard recording protocol which was used repeatedly at each colony.
Completeness	The spatial coverage of surveys within the Area of Search was not consistent; The data and survey coverage were carefully assessed prior to analysis to ensure that only representative surveys were included. A survey was representative if it covered the main distribution of the bird population both spatially and temporally i.e. the survey should have sufficient spatial coverage of the Area of Search, considering individual species distributions and surveys within a season should sample across any seasonal variation in the numbers of birds present.	The aim of the tracking survey method was not to cover all of the areas sea to consider for inclusion in the pSPA, but to ensure that the tracking effort was sufficient to capture tern usage across a representative proportion of that area on the basis of which reliable habitat association models could be constructed and used to predict tern usage patterns across the wider area – including those areas in which no direct observations of terns were made.	Boat-based transects extended up to 6km offshore and alongshore survey stations were positioned at 1km intervals up to at least 6km in either direction from the colony (and where necessary, further). With the mean maximum foraging range reported to be 6.3km, the survey areas gave virtual complete coverage of the likely areas of greatest importance.
Counting method	Counts were undertaken along a series of north-south transects spaced at 2km intervals, involving a ‘distance sampling’ approach.	The larger tern tracking work did not involve counting of birds or use of such information to derive population estimates for the pSPA. However, the modelling is based on samples of tracks of relatively few individual terns from each colony rather than surveys of the distribution of terns (of unknown origin) around the colony. Cross-validation tests of the models’ predictions and analysis of sample adequacy both suggest that the results of the models, although based on the samples of tracks,	At sea observations included instantaneous counts at predetermined distances along transects at which all terns in flight within 300 m in an 180º arc of the boat were recorded. Between these points, continuous records of all little terns seen were also made to provide an index of relative abundance. During shore-based observations, terns recorded within 300 m of the observation point were recorded during timed observation periods. Counts at each station

		are robust.	were standardised to birds/minute and expressed as proportions of the value recorded at the 1 km observation station to standardise across sites.
Quality of sampling	A large proportion (81%) of diver observations was recorded as 'unidentified diver'. It was noted in Cranswick *et.al* (2003) that many of these unidentified divers were thought to be red-throated diver but only those positively identified were recorded to species level. Of the positively identified divers (n=254), all were red-throated divers, apart from 12 great northern divers. Consequently, analyses were performed on combined red-throated and unidentified diver records, the latter being assumed to be of red-throated divers. Little gulls are difficult to distinguish from other small gull species on aerial surveys so many little gulls may have been recorded as 'small gull species' or the birds missed altogether by less experienced observers. Little gulls were certainly under recorded on some aerial surveys but it is impossible to estimate the proportion of birds recorded as 'small gull species' that were actually little gulls. Only birds identified as little gulls were included in the analyses.	Cross-validation tests of the models' predictions and analysis of sample size adequacy both suggest that the results of the models based on the samples of tracks are robust.	This was affected by the low numbers of birds at many colonies and the frequent breeding failures. At colonies with 5 or more shore-based surveys yielding records of 200 or more terns, this was deemed sufficient to derive site-specific along shore boundaries. At colonies with at least 2 boat-based surveys yielding at least 20 tern sightings this was deemed sufficient to derive site-specific seaward boundaries. At colonies where these criteria were not met, a generic approach was used by pooling sample data across sites to yield better-evidence based estimates of limits.
Robustness of population estimate	It is assumed that all unidientified divers are in fact red-throated diver, based on the small (4.7%) incidence of great northern diver in the cadre of divers identified to species. If 4.7% of unidentified diver were great northern diver, or if all 'unidentified' divers were great northern diver, the population within the Greater Wash pSPA would be 4.7% and 81% smaller than estimated	Not applicable as the tern tracking work was not used to generate a population estimate	Not applicable as the tern observation work was not used to generate a population estimate

	respectively. The pSPA would still exceed the threshold for qualification for this red-throated diver (1466 and 292 individuals respectively, greater than the 170 population threshold). Most of the flocks of common scoter recorded in the Greater Wash comprised low numbers of birds, but a few very large flocks were recorded. This resulted in a very high variance for cluster size in the distance analysis, and the encounter rate variance was also very high due to the very low number of flocks seen per transect. Pooling data (by season rather than using individual surveys) improves this variance somewhat (also large variance remains). The population estimates based on pooled data to provide an average population estimate over the winter season, rather than the standard approach that uses the peak survey estimate from each season in calculating the Mean of Peak of the Area of Search. This is a more conservative approach given the uncertainty around the estimate, as the Mean of Peak is based on the average rather than the peak population for each season. Little gulls were certainly under recorded on some aerial surveys but it is impossible to estimate the proportion of birds recorded as 'small gull species' that were actually little gulls. The true numbers of little gull within the survey area may have been at least double that recorded. Surveys (conducted November-March) may have missed peak autumn aggregations of this species. Survey work for Westernmost Rough		

	Offshore Wind Farm (DONG Energy 2009) found little gull present in August and September, and suggested that this population was a transient rather than sedentary one. This suggests that peak occurence of little gull within the Greater Wash pSPA may occur in autumn.		
External factors affecting the survey	Surveys were undertaken in good weather conditions, generally with wind speeds of 15 knots or less. In some cases, one survey took a number of days to complete and although the dates were not always consecutive they were as close as possible given weather conditions and logistical constraints. Observers were unable to see birds directly below the aircraft so the closest distance band started 44m from the aircraft.	Tracking was constrained by weather, e.g. tracking could not take place with sea state ≥3 and during rain. Thus, tracking data were gathered only under favourable weather conditions.	Although the aim was to collect data from most currently occupied SPAs, in many cases data on seaward or alongshore extent could not be collected due to colony failure (caused by tidal inundation, predation or disturbance) or simply too few breeding pairs for sufficient observations to be detected by surveys. Accessibility to count points in all parts of the possible extent of a foraging area limited the ability to provide site-specific alongshore extents in some cases.

Webb & Reid (2004) also discuss the issue of establishing sufficient evidence in the case of marine SPAs to establish regularity of use, which is a key element of the SPA selection guidelines. An assessment was made of the regularity with which numbers of birds in excess of their 1% population thresholds occurred within the Greater Wash area of search, with a population considered regularly occurring if “the requisite number of birds is known to have occurred in two thirds of the seasons for which adequate data are available, the total number of seasons being not less than three”. Surveys in 2004/05 and 2005/06 provided representative population estimates, and surveys in 2002/03 covered the main area of little gull observations, fulfilling this criteria

The tern tracking work was never intended to establish regularity of use of certain sea areas by particular species around particular colonies. The aim of that work was simply to capture sufficient representative information on tern foraging behaviour to allow reliable habitat association models to be constructed and used to generate maps of areas of principal usage. The results of the cross validation of those models’ predictions, in which data from different years were used as test datasets, suggests a relatively high degree of consistency in usage patterns between years i.e. regularity of use of those most important areas (Wilson *et al.* 2014). However, no formal tests of the regularity of use of the sea areas within the pSPA boundary for tern species have been made. Regularity of use of the pSPA has been reasonably inferred from the continued existence of the site’s named features in qualifying numbers in each of the existing coastal SPAs from which birds within the marine SPA are most likely to originate.

Webb & Reid (2004) discuss the issue of boundary placement. They note that the principles for defining boundaries for terrestrial SPAs in the UK are described in Stroud *et al.* (2001) thus (emphasis added):

"The first stage of boundary determination involves ***defining the extent of area required by the qualifying species concerned****. These scientific judgements are made in the light of the ecological requirements of the relevant species that may be delivered by that particular site, and the extent to which the site can fulfil these requirements. This follows a* ***rigorous assessment of the best-available local information regarding distribution, abundance and movements of the qualifying species****. It may also involve the* ***commissioning of special surveys*** *where the information base is weak. Following this stage, every attempt is made to define a boundary that is identifiable on the ground and can be recognised by those responsible for the management of the site. This* ***boundary will include the most suitable areas for the qualifying species*** *identified in the first stage……"*

The Visual Aerial Surveys for non-breeding species were primarily commissioned to inform further rounds of OWF development, through the Strategic Environmental Assessment (SEA) process, plus surveys conducted for the purpose of continued monitoring of SPAs. The larger tern tracking and little tern observations were conducted to define the extent of the area required by these species on the basis of specially commissioned surveys that generated the best available local information regarding distribution, abundance and movements of these qualifying species.

Webb & Reid (2004) discuss the principles of setting both landward and seaward boundaries of marine SPAs.

In regard of setting landward boundaries they note that "*Where the distribution of birds at a site is likely to meet land, a boundary should usually be set at the mean high water mark (MHW)……. unless there is evidence that the qualifying species make no use of the intertidal region at high water*."

The landward boundary of the pSPA has been drawn at MHW along the mainland coast in the light of: i) model predictions of the usage of such areas by foraging larger terns, ii) existing evidence which indicates that all three species of tern considered here routinely forage in areas of shallow water (Eglington 2013), iii) observations that little terns forage in the intertidal zone (Parsons et al. 2015), iv) the general habits of the three non-breeding waterbird species include the use of intertidal habitats (Birdlife International 2015a, 2015b, 2015c) and there is no site specific information to suggest that this is not the case within the Greater Wash pSPA and v) to ensure protection of these areas as supporting habitat for all species within the pSPA in locations where these species are not already features of the existing SPA with which the overlap will occur (eg Sandwich tern at The Wash SPA; red-throated diver, common scoter and little gull at the Humber Estuary, Gibraltar Point, North Norfolk Coast and Great Yarmouth North Denes SPAs).

Webb & Reid (2004) set out a recommended method for defining the seaward boundary of SPAs for inshore non-breeding waterbirds on the basis of analysing bird data from aerial or boat-based sample surveys using spatial interpolation combined with spatial analysis. This has been applied to the seaward boundary of this pSPA where it is defined by red-throated diver. We explored defining a seaward boundary for little gull in the same way, which produced a boundary beyond that of the boundary presented for the pSPA. However, this was based on two years of survey data only and analysis of the distribution of this species between surveys demonstrates that aggregations occur within different parts of the pSPA in different surveys (albeit with relatively consistent usage of a core area). Webb and Reid (2004) state *"...[regularity can be determined] if suitable data are only available for three years, or even if there are two years with good data and one with poor data. ...*"; but caution that *"...[fewer counts than obtained in 3 years] may be inappropriate in the marine environment, where transient aggregations of prey might lead to irregular occurrences of very large numbers of some inshore birds at a site*. ...". Where species exhibit different and e.g. very variable distribution patterns, such as that observed for little gull, JNCC suggest applying the guidelines with appropriate caution. It became apparent that while the available data provides sufficient confidence in the population size within the Area of Search and the pSPA boundary as a whole, it does not provide sufficient confidence in hotspots within this and hence a seaward boundary based on this species was not carried forward in the proposals.

Webb & Reid (2004) note exceptions to this method which include the case in which "*habitat data are also used in combination with bird distribution data to determine boundaries*". This is the approach which has been used in the both the larger tern and little tern work.

Webb & Reid (2004) describe spatial interpolation methods by which survey sample data can be used to generate maps of species probability of occurrence or abundance. This involves use of a "….*suite of modelling techniques in which the probability of bird occurrence or the total number of birds present is estimated at unsampled locations (usually in grid cells) using information on the presence or absence, or the number of birds recorded at sampled locations*". This is the principle underlying the modelling of the non-breeding water bird and tern tracking data, albeit that the nature of the statistical models used in determining the extent of breeding tern foraging is somewhat different to those considered by Webb & Reid (2004). As such, the principle of the method which has been used to define the seaward boundary of the pSPA is entirely in line with the recommendation of Webb & Reid (2004).

Webb & Reid (2004) conclude by discussing the method by which a boundary should be drawn around the parts of a site identified as being most important. They refer to Webb *et al.* (2003) which sets out a method for classifying grid cells so that the most important ones for a species on any given survey are highlighted. In that method, the grid cells are ranked from lowest predicted bird abundance to highest, and the cumulative population calculated from lowest ranked grid cell to highest. The highest ranking grid cells were selected such that they comprised 95% of the total population. The analytical approach which has been applied to the grid-based, modelled predictions of non-breeding waterbirds and large tern usage to define the most important areas to include within the pSPA boundary (Win *et al.* 2013) follows the basic ranking principle outlined by Webb *et al.* (2003). However, the application of the maximum curvature technique to such cumulative usage curves in the current case (non-breeding birds, Lawson *et al.* 2015a; larger terns, Win *et al*. 2013) reflects the advances in the details of this analytical method by JNCC since then (O'Brien *et al.,* 2012). For little tern a different approach has been adopted using observations of the maximum alongshore and seaward extent of foraging around tern colonies (Parsons *et al.* 2015).

Thus, in summary, although Webb & Reid (2004) does not directly address the issue of data requirements in regard of establishing marine SPAs for breeding seabirds, many aspects of the collection and analysis of the tern tracking work which has been used to define the location and extent of the Northumberland Marine pSPA can be seen to be in accord with the guidelines set out in that document.

Establishment of the extent of the Greater Wash pSPA

The extent of and boundary to the Greater Wash pSPA is determined by the extent of the model generated predictions of which areas of sea are most heavily used by two non-breeding water bird species (red-throated diver, common scoter) and by foraging terns originating from a number of source colonies within five existing SPAs. For the tern species, some of these species and colony-specific areas of use have been derived from models based on at sea records of the foraging locations of the particular species at the particular colonies i.e. site-specific models (e.g. Sandwich tern at the Scolt Head and Blakeney Point). Other species and colony-specific areas of use have been derived from models based on at sea records of the foraging locations of the particular species but at other colonies around the UK i.e. generic models (e.g. common terns at Breydon Water). Table 2 presents the models used to determine foraging areas for Sandwich and common tern, Table 3 presents the source of the data used to determine the alongshore and seaward extents for foraging by little tern. The quality and relevance of the evidence provided in both of these ways is discussed in the following section.

Table 2. Species and source colonies within the Greater Wash pSPA, and the nature of the model on which those areas of usage were based. Source: Wilson *et al.* 2014 Table 4.

Species	Source colony	Model type	Tern tracks contributing to model	Number of sites contributing to model	Number of tern site/years of data underlying model
Sandwich tern	North Norfolk Coast	Site specific	88	1	3
Common tern	North Norfolk Coast	Site specific	20	1	1
Common tern	Breydon Water	Generic	297	6	11

The adequacy and relevance of these various models and of the modelling approach in general, was addressed by JNCC in 3 ways (Wilson *et al.* 2014):

i) Cross-validation of site specific models
ii) Cross-validation of generic models
iii) Adequacy of sample size data

A summary of the results of the cross-validation of both site specific and generic models of larger tern usage can be found at http://jncc.defra.gov.uk/pdf/SAS_Identification_of_important_marine_areas_for_larger_terns, as is a summary of the analysis addressing the adequacy of the sample sizes.

Table 3. Summary of basis for draft foraging extent at each site within Greater Wash pSPA, model used for defining Seaward and alongshore foraging extent, and of the supporting evidence base in each. *=includes 4 radio-tracking surveys from Perrow and Skeate (2010); **=includes 3 radio-tracking surveys from Perrow and Skeate (2010).

Source colony	Data source for seaward extent	Number of terns registered on boat surveys	Data source for Alongshore extent	Number of terns registered on shore-based surveys
Humber Estuary	Generic	-	Site-specific	455
Gibraltar Point	Generic	-	Generic	-
North Norfolk Coast	Site-specific	344	Site-specific	2917
Great Yarmouth North Denes	Site-specific	202*	Site-specific	937**

2.) The Analysis carried out is appropriate to the evidence available and the question or issue under consideration

Natural England and JNCC have defined the boundary of the Greater Wash pSPA around the Maximum Curvature density threshold (MCDT) for all species considered (seaward and alongshore foraging extents for little tern). Use of MCDT to define the areas of importance for non-breeding waterbirds following the generic guidance recommended by JNCC has already been implemented at 2 English sites (Liverpool Bay/Bae Lerpwl SPA and Outer Thames Estuary SPA). Therefore, the use of MCDT to define the boundary of the pSPA cannot be considered a novel approach, but an application of a well-established approach. The site-specific evidence – qualifying populations of non-breeding waterbirds, qualifying breeding populations of Sandwich tern (North Norfolk Coast SPA), common tern (Norfolk Norfolk Coast and Breydon Water SPAs), and little tern (Humber Estuary, Gibraltar Point, North Norfolk Coast and Great Yarmouth North Denes SPAs) – required to justify inclusion of these species in is provided by Lawson *et al.* 2015a, the Seabird Monitoring Programme database (http://jncc.defra.gov.uk/smp/), Wetland Bird Survey database (http://www.bto.org/volunteer-surveys/webs) and Easington Little Tern Protection Scheme/RSPB survey data. These data were compared to established site selection criteria (JNCC 1999), meaning the analysis is entirely appropriate.

The other major analyses which underpin the pSPA are: i) the boat-based and shore-based observations of little terns, ii) the habitat-association based modelling of larger tern usage patterns and ii) identification of threshold levels of predicted larger tern usage which were used to define elements of the site boundary.

The very restricted foraging range of little terns precluded the use of the predictive habitat association modelling approach that was used for the larger terns. Accordingly, it was appropriate to gather empirical evidence on little tern distributions from which to determine directly the boundaries to the areas of greatest usage by foraging birds at each colony. At colonies where evidence was lacking or insufficient it was considered appropriate to make use of data gathered at other colonies to determine "generic" boundaries which, comparison with all available data indicated, would capture a very significant proportion of total usage (see http://jncc.defra.gov.uk/pdf/SAS_Identification_of_important_marine_areas_for_little_terns).

The habitat association modelling approach for large terns is a novel one which has not been used in defining the extent or boundaries of any marine SPA to date. However, the decision to adopt a habitat association modelling approach was the subject of discussion between JNCC and all other statutory nature conservation bodies over many years and agreement to follow this approach informed the design of the survey programme coordinated by JNCC since 2009. For the modelling analysis part of the project JNCC worked collaboratively with their statistical advisors Biomathematics and Statistics Scotland (BioSS).

Although the method by which the grid-cell based maps of predicted bird distribution were drawn up in this case differed in detail from more conventional spatial interpolation and spatial analysis considered by Webb & Reid (2004), the way in which the resultant maps of predicted bird distribution were analysed to determine threshold levels of predicted tern usage, and hence to define the site boundary, (i.e. maximum curvature analysis) represents application of an established method used at other marine SPAs (O'Brien *et al.* 2012) and is thus entirely appropriate to the evidence available.

Following completion of the work on non-breeding birds, larger terns and little terns, JNCC commissioned external peer review of all three pieces of work. Peer review of the tern work did not highlight any significant issues with the appropriateness of the analyses which were not resolved by subsequent discussion between the reviewers and JNCC. Peer review of the non-breeding waterbird work did raise issues which were not resolved. However, Natural England and JNCC are confident that data collection and analysis were appropriate. Further details of the external peer review are provided in section 5 of this Appendix.

3.) ***Conclusions are drawn which clearly relate to the evidence and analysis***

The conclusions regarding the list of features and their reference population sizes within the pSPA are based on application of the SPA selection guidelines issued by JNCC (JNCC 1999) to the best and most recent count data. In the case of breeding terns this is from the principal source breeding colonies from which birds within the pSPA are most likely to originate and for non-breeding waterbirds this is from the population estimates provided by Lawson *et. al.* 2015a that were later recalculated by Natural England (Appendix 5). As such the conclusions in this respect clearly relate to the best available evidence.

The conclusions regarding the drawing of the landward boundary of the pSPA along the mainland coast at MHW are based upon the evidence provided in the form of models of predicted usage by foraging larger tern species. In several instances these models included distance from shore as a significant covariate with a negative coefficient indicative of highest use being closest to shore and therefore in many instances inclusive of intertidal areas. The use of intertidal areas between MLW and MHW by foraging little terns is recorded in Parsons *et al.* (2015). That the use of such areas by all larger tern species is also likely is supported by information in the scientific literature. A review of tern foraging ecology (Eglington 2013) notes that all five species of tern considered here routinely forage in areas of shallow water. There is no reason on the basis of that review to consider it likely that that these birds will not forage over intertidal areas. Of the non-breeding waterbird species, particularly red-throated diver and little gull will use intertidal (and terrestrial) habitats (Birdlife International 2015a and 2015b) and there is no site specific evidence to suggest that either species completely avoids intertidal habitats within the Greater Wash pSPA. Common scoter occur generally between 500 m and approximately 2 km from the shore, over wintering on shallow inshore waters less than 20 m deep (Birdlife International 2015c). It should be noted that common scoter are regularly recorded in WeBS counts along the north Norfolk coast with no indication as to whether some usage of intertidal habitats is made. In addition, commons scoter distribution is confined within that of little gull and red-throated diver. Accordingly, in this respect too, the conclusions clearly relate to the best available evidence.

The conclusions regarding the drawing of the seaward boundary of the pSPA are based upon the evidence provided in the form of models of predicted density of non-breeding waterbird species and usage by breeding tern species, and the application of a standard analytical method, already well-established for use in marine SPA boundary setting i.e. maximum curvature (O'Brien *et al*. 2012), to the models' outputs. Thus, the conclusions in this respect clearly relate to the best available analysis of the best available evidence.

Since the larger tern modelling work was completed by JNCC, the Department of the Environment, Northern Ireland (DoENI) commissioned in 2014 a programme of land-based and at-sea surveys to verify the extents of tern foraging activity at three sites in Northern Ireland i.e. Larne Lough, Strangford Lough and Carlingford Lough. At each of these sites, the same generic predictive models, as already described in this Departmental Brief, had also been used to generate relative usage maps for at least one species of larger tern (and in some cases for all species) and hence to determine proposed site boundaries. In summary, this work (Allen & Mellon Environmental Ltd 2015) confirmed the presence of terns (mainly Sandwich) to the furthermost alongshore limits of the areas searched and in one case beyond the limit of the modelled alongshore boundaries. The work provided some evidence that the larger terns do feed further out to sea than the limits of the modelled boundaries. However, the use of the threshold setting approach to the predicted relative usage maps does not deny that terns may forage beyond that limit. The work also provided some evidence that the very intense use of localised hotspots of activity recorded in or close to the entrances to the loughs were not as clearly identified as such by the models. However, the proposed boundaries in each of the three sites did contain the hotspots within the lough entrances. Thus, these verification surveys provide: confirmation that hotspots of usage near colonies are contained within modelled boundaries, some evidence that proposed boundaries, based on model predictions, may be somewhat conservative in regard of their seaward limits, and no evidence that their alongshore or seaward extents are in any way excessive.

4.) ***Uncertainty arising due to the nature of the evidence and analysis is clearly identified, explained and recorded.***

Count data

Survey for non-breeding waterbirds was undertaken according to an established methodology used for survey of waterbirds at sea for a number of purposes. Analysis of this data (Distance) to provide population estimates is also well established.

The UK SMP is an internationally recognised monitoring scheme coordinated by JNCC in partnership with others (e.g. statutory nature conservation bodies, the RSPB and other colony managers as data providers, etc.). It collects data according to standardised field methods (Walsh *et al.* 1995). SMP data are verified by the JNCC seabird team. Therefore, there is high confidence in SMP data. The majority of the data which has been used in determining the size of the populations of each of the species considered for inclusion as features of the pSPA is based on counts which are on the SMP database and so justify high confidence.

RSPB survey data are verified and quality assured by the RSPB count coordinator and site manager and Easington Lagoons little tern data was taken from the annual report produced to contribute to the EU LIFE+ Little Tern Recovery Project, and the Easington Little Tern Protection Scheme is a partnership led by Spurn Bird Observatory. Both are professional organisations with long-standing experience of seabird monitoring, and surveys are conducted by trained surveyors. There is therefore high confidence in this survey data. Accordingly, even the most recent count data referred to in this Departmental Brief can be considered to justify high confidence.

Landward boundary

The issue regarding the confidence in the evidence base upon which the decision to draw the landward boundary of the pSPA to MHW along the coast has been made, is discussed in the previous section.

Seaward boundary

The position of the seaward boundary of the pSPA has been determined on the basis of outputs of statistical models which in some cases are based on tern behaviour at colonies in other parts of the United Kingdom. However, where this occurs (for example common tern foraging area from Breydon Water SPA), this does not define the seaward boundary of the SPA, which is driven by the extents of use determined by site-based survey data (red-throated diver and little gull distributions, foraging extends of Sandwich tern - into The Wash SPA, and little tern - Humber Estuary SPA). As discussed, analysis of little gull distribution data produced a boundary for this species beyond that of the boundary presented for the pSPA. As this was based on two years of data only, and analysis of the distribution of this species between surveys demonstrates that aggregations occur within different parts of the pSPA in different surveys (albeit with relatively consistent usage of a core area), confidence in this boundary was low and was not carried forward in the proposals.

5.) Independent expert review and internal quality assurance processes

Independent expert review

Natural England's standard in quality assurance of use of evidence, including peer review, (http://www.naturalengland.org.uk/images/operationalstandardsforevidence_tcm6-28588.pdf) has been followed in determining the level of independent expert review and internal quality assurance required in relation to Natural England's analysis of the evidence for this site and the way that the boundary has been drawn up. Independent expert review is to be adopted where there is a high novelty or technical difficulty to the analysis.

The analysis of the colony count data from which the populations of the breeding terns within the pSPA have been derived are considered not to be novel or technically difficult because the colony count data have been analysed and assessed in the same way as carried out for other terrestrial SPAs in England and conforms to the SPA selection guidelines (JNCC 1999).

Thus, Natural England believes these elements of the recommendation are not contentious. Therefore independent expert review of how Natural England has applied the evidence standards in drawing up the population sizes of the qualifying features of the pSPA is not being sought.

While not being a novel approach, in recognition of size and complexity of the Greater Wash pSPA produced by the MCDT boundaries for the three non-breeding waterbird species, Natural England commissioned independent expert review of the non-breeding waterbird work (Lawson *et al.* 2014). Henrik Skov (Danish Hydrological Institute) was appointed as independent expert reviewer. In summary, the review raised three primary issues with; i) data collection via aerial survey, ii) bias in density estimation by Kernal Density Estimation through variable survey coverage, and iii) recommendation to further evaluate distribution patterns of non-breeding waterbirds using density surfaces produced on the basis of spatial prediction models. Natural England notes the point on use of aerial survey. However, visual aerial survey is a widely accepted method for surveying inshore waterbirds. Particularly for covering large areas, and enabled better coverage in areas of very shallow water Aerial survey also allowed repeated surveys to be undertaken over a number of years, something which would have been difficult to achieve with the much slower boat based surveys. Regardless of the method of data collection, repeated surveys using appropriate survey design should allow determination of relative spatial distributions which is the key requirement for boundary delineation. Along with distance analysis, an estimate of numbers should also be possible which may need to be treated as a minimum if concerns about detection ability remain. On the second point, each density surface was rescaled using correction factors, and then a mean density surface was calculated. Particularly patchy surveys were excluded from estimation of populations as they might bias the overall population estimate. All surveys were included for distribution analysis. The fewer surveys the mean is based on, the more susceptible they are to random (or otherwise) fluctuations in numbers. We accept that some areas may be more susceptible to this than others given available survey coverage. On the final point, Natural England notes this recommendation. JNCC have applied spatial prediction models which incorporate habitat characteristics where insufficient site-specific data is available for example in the larger tern work). However in the situation described in Lawson et al. (2015a), there was felt to be sufficient good quality site-specific data covering several years, ie locations where birds aggregate consistently can be determined rather than predicting where there would aggregate based on habitat. Habitat modelling would allow an understanding of habitat preferences/associations of the species at these sites, which would aid in ecological understanding of why the birds are there as the reviewer points out, which the analysis presented in these reports is unable to do.

The derivation of the alongshore extent and seaward boundary to the pSPA in regard to breeding terns is based on an entirely novel approach, never used before in SPA designation, and has entailed considerable technical difficulty in the analyses. In recognition of this, JNCC commissioned independent expert review of both the larger tern and little tern programmes of work. A representative of Natural England, along with those of all other country statutory nature conservation bodies, was involved by JNCC in setting the terms of reference for the review work, in nominating potential reviewers for JNCC to consider approaching, and in the selection of those who carried out the reviews.

The larger tern modelling work was reviewed by two independent scientists (Dr Mark Bolton of the British Trust for Ornithology and Dr Norman Ratcliffe of the British Antarctic Survey). In summary, both reviewers raised two primary issues with the data collection and its analyses. These related to: i) the focus of the tern tracking work during the chick-rearing phase of the breeding season and ii) to the details of the way in which control points denoting tern absence were generated to match track locations where terns were recorded and the use of that information to determine terns' preference for each location and the conversion of that preference pattern into a pattern of tern usage. In regard to the first issue, JNCC acknowledged that the focus of the tracking work was only on the chick-rearing period, partly in order to ensure that sufficient data were gathered during that one period, but also in recognition of the need to focus attention on the identification and protection of those sea areas which are of most importance to the birds when their ability to buffer themselves against adverse environmental conditions by foraging further from the colony is most limited by time and energy constraints and their need to provision their chicks. The report (Wilson *et al*. 2014) was amended to acknowledge the fact that the modelled boundaries are unlikely to fully capture areas of importance during the incubation phase of the breeding cycle. The second point of concern raised by the reviewers led to extended discussion between the reviewers, JNCC and BiOSS. As part of this process, independent advice was sought from Dr Geert Aarts (AEW Wageningen University). In summary, the conclusion of those discussions, agreed by all, was that the methods used by JNCC and BioSS were sound and appropriate, but that further clarification was needed in the text of the report. As a result of these discussions, the relevant section of the report (Box 1 in Wilson *et al.* 2014) was amended.

The reports on the little tern field work methodology and results and subsequent boundary setting work were also put out to independent peer review by JNCC. One main point made by the peer reviewer(s) was that the boat and shore-based observations should have been corroborated more extensively with data from radio tracking or even habitat modelling. JNCC did in fact use radio tracking, at one site, where it confirmed the results of their techniques. JNCC did not consider it to be necessary or even practicable to apply this approach more widely. JNCC considered that habitat modelling was not possible, given the small range of the species and the limited availability of environmental data over that range. JNCC noted that it would have been prohibitively expensive to collect their own environmental data, even at a few sites, and with unknown chance of "success". The other main point made by the peer reviewers (in accord with the same suggestion made by the peer reviewers of the larger tern work) was for data to have also been collected during the incubation period. However, as noted above in regard of work on larger terns, it was decided at the outset of the work that the priority should be on the chick-rearing period, because it is probably at this time when little terns face the greatest energetic demands. The focus was on chick-rearing for biological reasons but also logistical ones; JNCC noted that there would have been a risk of obtaining too few data during both incubation and chick-rearing if both periods were studied. One reviewer asked for greater reference to the findings of other studies but JNCC considered this aspect to be sufficient. A number of improvements were made to text, tables and figures by JNCC, on the recommendation of the reviewer, and some additional text was included in the Discussion to serve as a Conclusion to the report.

In the light of Natural England's involvement with the review process conducted by JNCC and in the light of its outcomes, Natural England did not consider it necessary to initiate its own independent expert review of the reports prepared by JNCC.

Internal peer review and quality assurance

A representative of Natural England has been involved in the entire history of the larger and little tern monitoring and modelling work programme since its inception. Since late 2009, this role was fulfilled by Dr Richard Caldow (Senior Environmental Specialist: Marine Ornithology). Accordingly, Natural England has, in conjunction with Scottish Natural Heritage (SNH), Natural Resources Wales (NRW) and Department of the Environment Northern Ireland (DoENI), been in a position to review and provide quality assurance of the programme of JNCCs work and its findings from start to finish as detailed below.

JNCC evidence reports relating to marine SPA identification go through an extensive internal and external QA process. This has applied to all of the main strands of analysis (ESAS analyses to identify offshore hotspots of usage, inshore wintering waterbird work, larger tern work, and little tern work).

The general approach and survey methods are subject to internal and external discussion, often in workshop format. External discussion can involve organisations such as SNCBs who will use the outputs, academics and other researchers in the field. Once an approach and survey method has been agreed and data collection has started, interim reports are prepared which are subject to internal and SNCB review. Analysis of data is subject to discussions (and workshops if appropriate) internally and with academics and statistical contractors if appropriate. For particularly challenging analyses (such as larger tern modelling work) statistical contractors may undertake significant portions of exploration and development work, and/or of final analysis. Finally, once all the data has been collected and analysed, JNCC prepare an extensive report which has contributions from several JNCC staff, undergoes several rounds of JNCC and SNCB comment, and is finally signed off at JNCC Grade 7 level. At this stage it goes to SNCBs for use in their own work in parallel with going to external peer review, where a minimum of 2 reviewers are sought. Reviewers are usually sought with knowledge of the species ecologies and/or statistical and technical understanding, with reviewers sought to complement each other (for example with differing expertise, from differing types of organisation). JNCC then respond to peer reviews, making changes to ‘final’ reports if appropriate. Only if peer review comments are significant and fundamental is further grade 7 sign off sought before publishing as part of the JNCC report series.

The first version of this Departmental Brief was drawn up by Stephen Treby (Lead Adviser) of Natural England. This was edited by Ivan Lakin (Marine Ornithologist) and Dr Richard Caldow (with further input from the original author) to produce this version of the Departmental Brief.

Departmental Briefs are drafted by an ornithologist with support from the site lead who provides the local site specific detail. This document is then quality assured by the marine N2K National Project Management team as well as selected members of the Project Board. The brief is then circulated for external comments from Defra Marine Policy Officer, JNCC senior seabird ecologists, Marine Protected Area Technical Group (MPATG) and UK Marine Biodiversity Policy Steering Group (UKMBPSG). The briefs are also sent to Natural England Board members for early sight of SPA proposals. The amended briefs are then reviewed and approved by the Marine N2K Project Board, Marine Director and relevant Area Managers and subsequently by the Natural England Chief Scientist in accordance with our Quality Management Standard. The brief is then signed off as required by our Non-Financial Scheme of Delegation by a representative of the Senior Leadership Team with delegated authority before being submitted to Defra.

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Appendix 3 Corroborative common scoter data

Table 1 Peak counts of common scoter for North Norfolk Coast SPA for winter periods 2002/03 to 2007/08. From BTO 2015 http://blx1.bto.org/webs-reporting/

Year	2002/03	2003/04	2005/06	2006/07	2007/08
Peak Count	2252	4866	6830	4960	3530
				5yr peak mean	4488

Table 2 Location and North Norfolk Coast SPA peak counts for common scoter for winter periods 2002/03 to 2007/08. Taken from Norfolk Bird and Mammal Reports.

Year	Location	Month							
		Sept	Oct	Nov	Dec	Jan	Feb	Mar	
2002/03	Holme	300	200	7	5000	5000	1500	35	2002/03 Peak count = 6726
	Titchwell	4	-	1500	226	-	-	-	
	Scolt Head Island	126	375	1300	-	-	-	-	
	Holkham Bay	-	-	750	1500	250	1100	500	
	Cley/Salthouse	-	-	-	-	-	-	-	
2003/04	Holme	320	155	20	150	-	-	-	2003/04 Peak count = 5120
	Titchwell	-	-	-	-	2000	2000	1500	
	Scolt Head Island	-	-	-	-	3000	900	900	
	Holkham Bay	-	200	500	300	120	600	2000	
	Cley/Salthouse	-	-	-	-	-	-	-	
2004/05	Holme	-	-	-	-	-	-	-	2004/05 Peak count = 9560
	Titchwell	50	500	4960	5000	650	145	2000	
	Scolt Head Island	1125	-	600	1500	-	1500	4000	
	Holkham Bay	-	1000	4000	3000	42	8	6	
	Cley/Salthouse	-	-	-	-	-	-	-	
2005/06	Holme	-	-	-	-	522	450	2000	2002/03 Peak count = 9872
	Titchwell	300	700	800	2000	5340	2700	4750	
	Scolt Head Island	400	1150	-	1250	2000	500	2000	
	Holkham Bay	64	600	2000	2500	3810	1000	1100	
	Cley/Salthouse	-	-	-	-	-	-	-	
2006/07	Holme	200	182	1000	577	1000	1000	139	2006/07 Peak count = 7078
	Titchwell	720	2000	2236	2000	217	78	165	
	Scolt Head Island	450	25	200	100	-	-	-	
	Holkham Bay	-	-	2000	690	52	3000	700	
	Cley/Salthouse	-	-	-	-	3500	3000	240	
2007/08	Holme	1990	600	676	1230	2585	1000	210	2007/08 Peak count = 9000
	Titchwell	419	60	540	304	2000	4	200	
	Scolt Head Island	653	400	400	-	3000	-	3000	
	Holkham Bay	21	-	-	-	4000	-	-	
	Cley/Salthouse	90	134	788	6	-	-	-	
									5 yr peak mean (2003 /04 – 2007/08) = 6710

Appendix 4 Red-throated Diver, Little Gull and Common Scoter populations within the boundary of the Greater Wash pSPA

This note records the recalculation of Red-throated Diver, Little Gull and Common Scoter populations within the amended boundary of the possible new marine SPA in the Greater Wash. The work was carried out by Natural England in order to adjust the population size for each species to account for a change to the SPA boundary[27].

These populations were recalculated using the following steps:

1. 1km x 1km density estimates[28] for each species for each representative[29] survey were provided by JNCC. ArcMap was used to select all 1km x 1km cells within the new boundary.

2. 1km x 1km cells within the boundary were summed to establish the 'within-boundary' population of each species for each survey.

3. From these, the peak population was identified for each season.

4. The mean of the peak (MoP) population was calculated for each species

Table 1 shows the revised MoP population estimates for all three species.

[27] The change to the Greater Wash boundary reflects the JNCC's MPA subgroup's decision to remove little gull as a boundary-setting species (but retaining little gull as a potential interest feature).
[28] Method used to produce the density estimates is outlined in Lawson *et al*. 2015. The density estimates used for this recalculation were those which had been rescaled to match the distance estimates produced by Lawson et al 2014.
[29] Surveys identified by Lawson *et al.* 2015 as unrepresentative were not used for this recalculation.

Table 1. Revised population estimates for red-throated diver, little gull and common scoter surveyed during Greater Wash aerial surveys between 2002 and 2008. Numbers in **bold** text indicate the peak estimates that were used in the Mean of Peak (MoP) calculation.

season	2002/03		2004/05				2005/06				2007/08			**MoP**
species			Oct/ Nov	Dec	Jan/ Feb	Feb/ Mar	Nov	Nov/ Dec	Jan/ Feb	Feb/ Mar	Nov	Dec	Feb/ Mar	
common scoter	**2947**		**7685**				**878**				**2341**			**3463**
little gull			**1128**	698	25	0	**1478**	131						**1303**
red-throated diver	524	**1365**	675	**1332**	879	1246	584	581	1647	**1837**				**1511**

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