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An assessment of the numbers and distributions of wintering waterbirds and seabirds in Liverpool Bay/Bae Lerpwl area of search

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Population estimates, with the exception of little gull and great cormorant were produced by Wildfowl and Wetlands Trust, under contract to JNCC.

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Summary

Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds, commonly known as the Birds Directive, requires EU member states to identify as Special Protection Areas (SPAs) the most suitable territories on land and at sea for species listed on Annex I of the Directive and regularly occurring migratory species. To identify inshore areas that might be suitable for SPA classification, 45 areas of search were selected where potentially important numbers of waterbirds congregate outside the breeding season; Liverpool Bay/Bae Lerpwl was one of these areas.

In 2010 Liverpool Bay/Bae Lerpwl SPA was classified for the protection of wintering red-throated diver (*Gavia stellata*), common scoter (*Melanitta nigra)* and an assemblage of greater than 20,000 waterfowl. Additional intertidal SPAs fringing Liverpool Bay/Bae Lerpwl area provide protection for a variety of bird features above mean low water mark.
The analysis in this report re-assesses the number of waterbirds and seabirds within Liverpool Bay/Bae Lerpwl area of search because additional survey data from the winter seasons of 2007/08 and 2010/11 became available. The aim was to determine whether any species could be considered under the SPA guidelines for protection within the site as interest features in their own right, in addition to the red-throated diver and common scoter populations which were identified for classification in the Liverpool Bay/Bae Lerpwl SPA in 2010. The results were also assessed to see whether any named component species should be added to the existing assemblage within Liverpool Bay/Bae Lerpwl SPA.

Eight winter seasons of aerial survey data (2001/02, 2002/03, 2003/04, 2004/05, 2005/06, 2006/07, 2007/08, 2010/11) were analysed using distance sampling methods. A population estimate was produced for each species by calculating the mean of the highest counts from each year (mean of peak), over the most recent five years if data were available, as is standard practice defined by the Ramsar convention (Ramsar Convention Secretariat 2013). The estimated population of each species was then assessed against the UK SPA selection guideline thresholds (Stroud *et al* 2001) to determine whether any species occurred in numbers exceeding these thresholds.

In addition to red-throated diver and common scoter, the estimated populations within the area of search indicated this was an important site for little gull (*Hydrocoloeus minutus*), and two additional species were present in sufficient numbers to be added as named component species of the assemblage feature. No other species exceeded their respective population thresholds under the UK SPA selection guidelines.

Little gull had a mean of peak population estimate of 333 individuals within Liverpool Bay/Bae Lerpwl area of search. The highest densities of little gull were consistently located offshore of Blackpool and the Ribble Estuary, close to the 12 nautical mile line. The numbers of little gull recorded in Liverpool Bay/Bae Lerpwl were the second highest of all inshore areas of search around the UK. There is no GB population estimate for little gull currently available due to difficulties with adequately surveying this species. Accordingly the importance of the aggregation of little gull in the Liverpool Bay/Bae Lerpwl was considered alongside other little gull aggregations around the UK under Stage 1.4 of the UK SPA selection guidelines.

The Liverpool Bay/Bae Lerpwl SPA was classified for the protection of an assemblage feature (under Stage 1.3 of the UK SPA selection guidelines) based on the numbers of red-throated diver and common scoter supported by the site. This report provides an estimate of the total number of birds of all marine species occurring within the potential revised boundary, 69,687 individuals. Marine species were defined as those with an ecological dependency on the marine environment. In addition to red-throated diver and common

scoter, the following species were present in sufficient numbers to be added as named component species of the existing assemblage feature: great cormorant (*Phalacrocorax carbo)* and red-breasted merganser (*Mergus serrator*).

Contents

1 Introduction

In 1979, the European Commission adopted the European Council (EC) Directive on the conservation of wild birds, commonly known as the Birds Directive (EC 2009; codified version). It requires Member States to classify the “most suitable territories” in number and size as Special Protection Areas (SPAs) for species listed on Annex I of the Directive and regularly occurring migratory species.

The UK SPA selection guidelines for the identification of SPAs advise that sites should be identified in two stages (Stroud *et al* 2001). While Stage 1 identifies areas that are likely to qualify for SPA status, Stage 2 further considers these areas to select the most suitable areas in number and size for SPA classification.

Stage 1 of the Guidelines identifies areas as follows:

1. Stage 1.1: an area is used regularly by 1% or more of the Great Britain (GB) population of a species listed in Annex I of the EC Birds Directive;
2. Stage 1.2: an area is used regularly by 1% or more of the biogeographic population of a regularly occurring migratory species, other than those listed in Annex I of the EC Birds Directive;
3. Stage 1.3: an area is used regularly by an assemblage of more than 20,000 waterbirds comprising at least two species;
4. Stage 1.4: where the application of stages 1.1-1.3 does not identify an adequate suite of areas, additional sites may be selected if they meet one or more of the Stage 2 guidelines.

Stage 1's fourth guideline gives consideration, using the Stage 2 judgements, to cases where a species' population status, ecology or movement patterns may mean that an adequate number of areas cannot be identified from Stage 1's first three guidelines alone.

Stage 2 of the Guidelines considers the following:

1. Population size and density: Areas holding or supporting more birds than others and/or holding or supporting birds at higher concentrations are favoured for selection.
2. Species range: Areas selected for a given species provide as wide a geographic coverage across the species' range as possible.
3. Breeding success: Areas of higher breeding success than others are favoured for selection.
4. History of occupancy: Areas known to have a longer history of occupation or use by the relevant species are favoured for selection.
5. Multi-species areas: Areas holding or supporting the larger number of qualifying species under Article 4 of the Directive are favoured for selection.
6. Naturalness: Areas comprising natural or semi-natural habitats are favoured for selection over those which do not.
7. Severe weather refuges: Areas used at least once a decade by significant proportions of the biogeographical population of a species in periods of severe weather in any season, and which are vital to the survival of a viable population, are favoured for selection.

Previous analyses of data on the number of waterbird and seabirds within Liverpool Bay/Bae Lerpwl identified red-throated diver (*Gavia stellata*), common scoter (*Melanitta nigra*) and an assemblage of >20,000 waterbirds to be regularly occurring in numbers that exceeded the thresholds under the UK SPA Selection Guidelines. These features are protected within the Liverpool Bay/Bae Lerpwl SPA classified in 2010 (Webb *et al* 2006a, 2006b).

These previous analyses also indicated additional species may occur in numbers that exceed the SPA thresholds, but the data available at the time were insufficient to determine this. Further data collection was therefore required for some seabird species (e.g. little gull *Hydrocoloeus minutus*) to determine whether these birds use the area in important numbers on a regular basis. For other waterbird species it could not be determined whether the birds were using the SPA or the coastal areas immediately adjacent to it.

As an Annex 1 species, little gull would be assessed against 1% of the GB population estimate under Stage 1.1. However, there is no GB population estimate currently available for little gull (Musgrove *et al* 2013). The Birds Directive requires that the most suitable territories for Annex 1 species are classified as Special Protection Areas. If no GB population estimate is available, the application of Stage 1.4 of the SPA Guidelines is a possibility to identify the most suitable sites with help of Stage 2 judgements.

Consequently this report presents an analysis of waterbird and seabird numbers based on additional survey data.

The aim of this report is to provide Natural England and Natural Resources Wales with the evidence needed to form its advice to Government on possible additional features or updates for the SPA classified in Liverpool Bay/Bae Lerpwl. The report presents the numbers of wintering aggregations of inshore waterbirds and indicates if species exceed their respective population thresholds under the UK SPA Selection Guidelines within the area of search. Where species exceeded their population thresholds, Appendix 1 analyses the data further and delineates where the important aggregations occur in Liverpool Bay/Bae Lerpwl. Appendix 2 presents more detailed information about the survey effort. Appendix 3 presents another analysis of the same data for comparison (Bradbury *et al* 2014).

2 Methods

2.1 Liverpool Bay/Bae Lerpwl area of search

Liverpool Bay/Bae Lerpwl area of search, extends from north of the Duddon channel in Cumbria to the north west of Anglesey, in Wales (Figure 1). The survey coverage showed some gaps along the inshore boundary of the area of search as data were collected in a series of survey blocks and were not originally designed for the purpose of SPA identification (Figure 3).

Most of the marine area is shallow water (<20m) with a predominantly sand to muddy sand substrate with patches of coarse and mixed sediment and rock or reef (McBreen *et al* 2011).

Several Special Areas of Conservation (SACs) and SPAs have been designated within Liverpool Bay/Bae Lerpwl area (Stroud *et al* 2001). There are six SACs in this area to protect Annex I habitat types under the Habitats Directive (EC 2007; consolidated version 1.1), such as estuaries, large shallow inlets and bays, mudflats and sandflats which are slightly covered by sea water all the time, reefs, and coastal lagoons (Figure 2).

There are ten SPAs in or adjacent to Liverpool Bay/Bae Lerpwl area of search (Figure 1). These, provide protection for some waterbird and seabird species extending to mean low water. The species protected within these existing SPAs include: little tern (*Sterna albifrons),* common tern *(Sterna hirundo),* sandwich tern (*Sterna sandvicensis),* roseate tern (*Sterna dougallii*) and Arctic tern (*Sterna paradisaea*) under Article 4.1; and lesser black-backed gull (*Larus fuscus),* greater scaup *(Anthya marila*), black-headed gull (*Chroicocephalus ridibundus),* common scoter, great cormorant (*Phalacrocorax carbo),* great crested grebe (*Podiceps cristatus*) under Article 4.2 of the Birds Directive. Liverpool Bay/Bae Lerpwl SPA is the only fully marine SPA in the area.

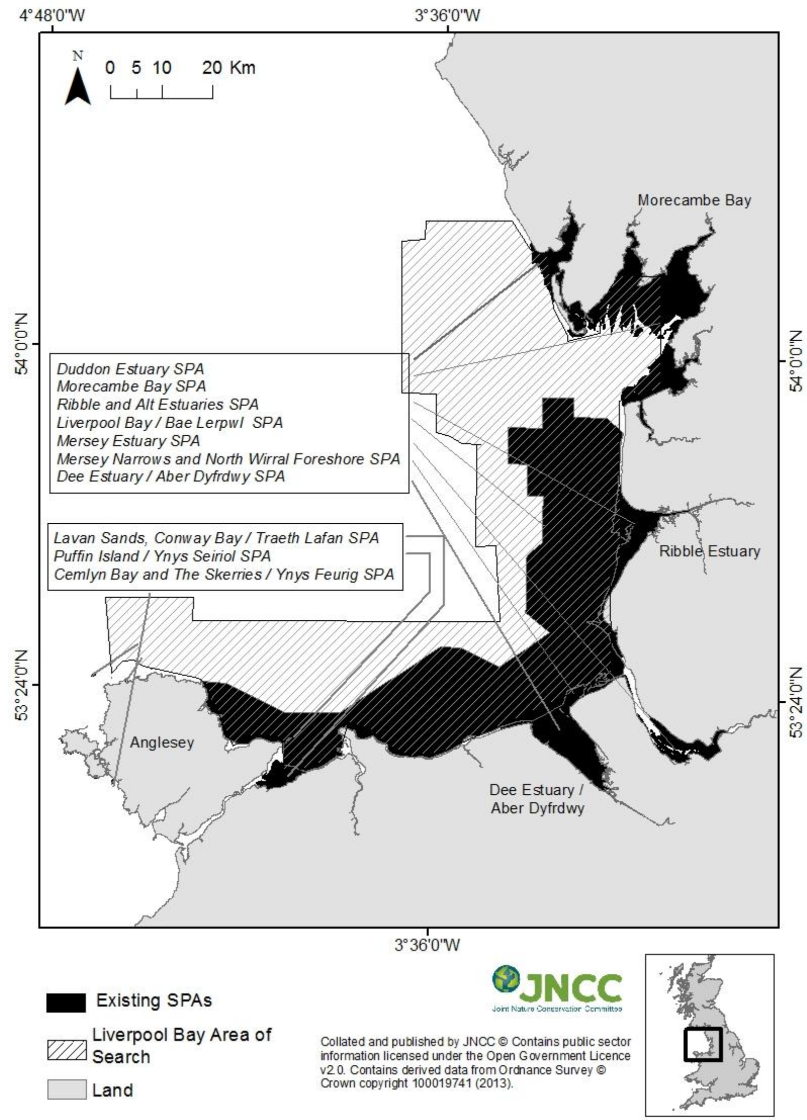

Figure 1. Map indicating the location of existing SPAs in relation to Liverpool Bay/Bae Lerpwl area of search.

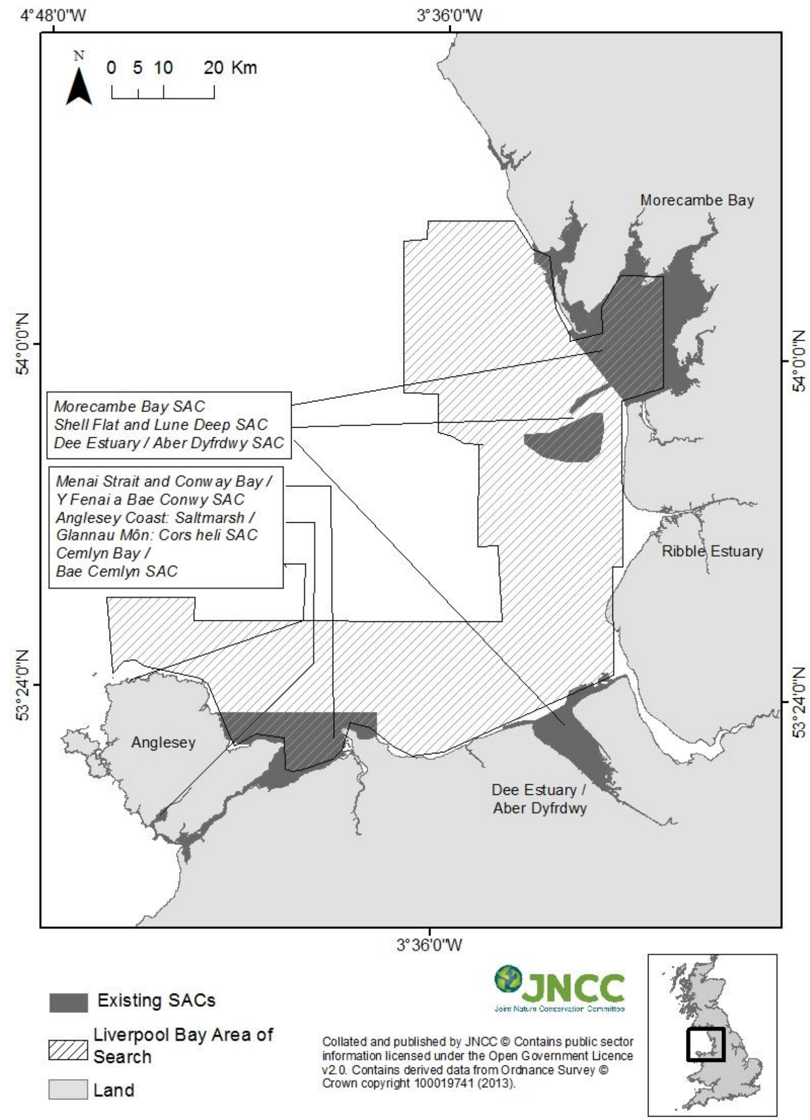

Figure 2. Map indicating the location of existing SACs in relation to Liverpool Bay/Bae Lerpwl area of search.

2.2 Survey design

Liverpool Bay/Bae Lerpwl area of search was one of 45 inshore sites across the UK that were identified in 2000 as supporting potentially important numbers of inshore waterbirds (seaducks, divers, grebes and Phalacrocoracidae) outside the breeding season. These areas of search were initially identified by reviewing existing data and literature. The seaward limits to the areas of search were defined by water depth, based on expert knowledge of the ecology of the target species. Where feasible, the areas of search extended to cover inshore waters up to 30-50m depth.

Aerial survey is the preferred method for data collection to inform marine SPA classification for aggregations of inshore wintering waterbirds (Webb & Reid 2004; Camphuysen *et al* 2004). Aerial surveys allow large areas of water to be surveyed in a relatively short time period, thereby enabling repeat surveys to be undertaken. They generally provide more robust estimates of the numbers of wintering divers and seaduck than boat-based surveys, particularly for species prone to disturbance by boats (Schwemmer *et al* 2011). However, species that aggregate very close to the coast are often missed by visual aerial surveys as the aircraft has to climb or turn as it approaches land.

Aerial surveys of Liverpool Bay/Bae Lerpwl, conducted by the Wildfowl & Wetlands Trust (WWT) were carried out over eight winter seasons (2001/02, 2002/03, 2003/04, 2004/05, 2005/06, 2006/07, 2007/08 and 2010/11). The surveys deployed line-transect sampling techniques, with which distance analysis can be used to provide an estimate of the total numbers of birds in the area corrected for the individuals likely to have been missed by the observer. Distance analysis was conducted using the software Distance 6.0 (Thomas *et al* 2010). The most recent five years of suitable data were used in these analyses, as is standard practice defined by the Ramsar convention (Austin *et al* 2014; Musgrove *et al* 2013; Ramsar Convention Secretariat 2013).

A number of surveys (between one and four) of the Liverpool Bay/Bae Lerpwl area of search were undertaken during each winter season. 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. This is not ideal as there is the potential for double-counting birds that have moved and changed their distribution within a single survey. However, birds could have moved such that they were missed on either survey, so there was no systematic bias towards under- or overestimating numbers.

The spatial coverage of surveys within the area of search was not consistent. Figure 3 shows the varying survey effort across the area of search and Figure A2 1, in Appendix 2, shows the survey transect lines for each of the surveys within the area of search. This may underestimate the numbers of birds in certain years for example where surveys within a season did not cover the main distribution of a species or the time period when peak numbers were present. To avoid underestimating the number of birds that the area supports, data and survey coverage were carefully assessed prior to analysis to ensure that only representative surveys were included. A survey was considered representative if it covered the main distribution of the bird population both spatially and temporally, i.e. the survey should have sufficient spatial coverage, considering individual species distributions, and sufficient temporal coverage including periods of individual species peak abundances. The distribution of observations of little gull is shown in Figure 8 and these can be compared with Figure A2 1 a-r (showing survey transects) to assess how representative each survey was in relation to the distribution of species.

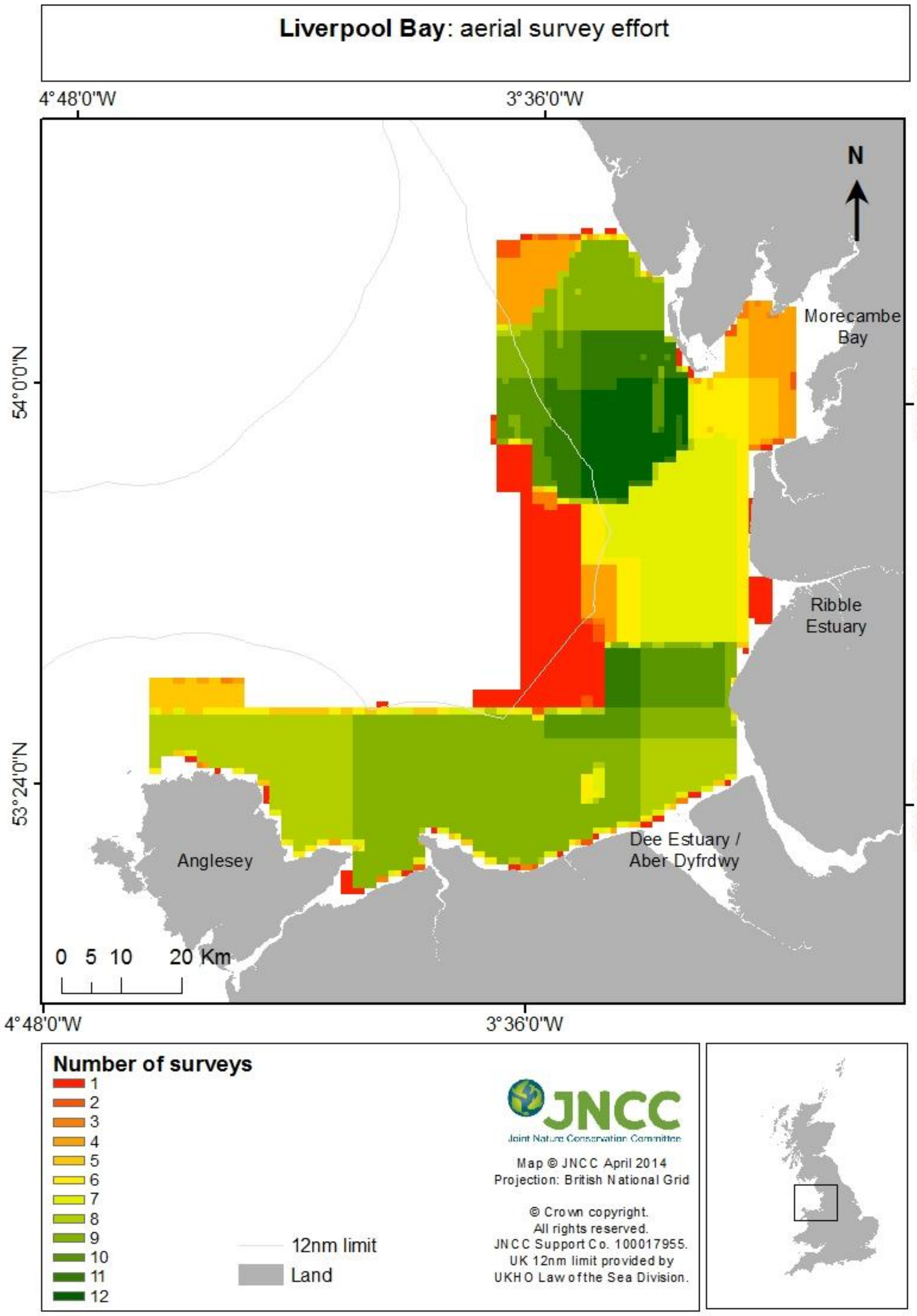

Figure 3. Aerial survey effort within Liverpool Bay/Bae Lerpwl area of search 2004-2011.

2.3 Data Collection

A summary of data collection methods is presented here, but see Kahlert *et al* (2000) and Camphuysen *et al* (2004) for more detail on general survey methods.

Surveys were carried out from a Partenavia PN68 aircraft flying at an altitude of 76m (250ft) and a speed of approximately 185kmh-1 (100 knots). The aircraft flew in a systematic pattern of line-transects, designed to repeatedly cross environmental gradients such as sea depth. In 2011, line transects were spaced 4km apart, but in all previous surveys transects were spaced 2km apart to ensure better coverage. Following Kahlert *et al* (2000), this distance was chosen to maximise the detection of birds, or flocks of birds, located between transects, while minimising the risk of double counting birds on neighbouring transects.

Two observers recorded numbers of birds (identified to species level where possible) and time of observation from either side of the aircraft. A Global Positioning System (GPS) recorded the location of the aircraft. All bird observations were allocated to one of four distance bands (A = 44-162m, B = 163-282m, C = 283-426m and D = 427-1000m), based on the perpendicular distance of the bird(s) from the aircraft track line. Data were collected to the nearest second, though an error margin of up to 5 seconds (which equates to a distance of approximately 250m) is possible between the exact location of the bird and the time at which it was recorded. Observers were unable to see birds directly below the aircraft, so the closest distance band started 44m from the aircraft. Observers determined these distances using fixed angles of declination from the visual horizon, measured using a clinometer. For each bird, or flock of birds, the time at which it was perpendicular to the flight path of the aircraft was recorded. When it was not always possible to identify birds to species level during aerial surveys, birds were assigned to the lowest taxonomic level possible. The survey data were collected over eight seasons, the five most recent winter seasons were analysed in this report, from 2004/05 to 2010/11 between the months of October to March, inclusive.

2.4 Number of birds in Liverpool Bay/Bae Lerpwl area of search

The UK SPA selection guideline thresholds are provided as a percentage (1%) of the national or biogeographic populations of a given species (Stroud *et al* 2001). The biogeographic population estimates used to assess regularly occurring migratory species, under Stage 1.2 of the UK SPA selection guidelines, are published in *Waterbird Population Estimates* WPE5 (Wetlands International 2015). The Great Britain population estimates used to assess Annex 1 species, under Stage 1.1 of the UK SPA selection guidelines, are published in Musgrove *et al* (2013).

To estimate the number of individuals within Liverpool Bay/Bae Lerpwl area of search, a population estimate was determined for each species and survey with the help of Distance Sampling (WWT Consulting 2014). 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 area of search. 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). Only reliable population estimates were included in calculating the mean of peak e.g. surveys that had poor coverage of the area of search or a high % coefficient of variation around the estimate were excluded.

Little gull is considered under stage 1.4 of the Guidelines as there is no GB population estimate currently available against which to assess it. It is nonetheless relevant to establish the numbers of little gull that regularly occur to determine the relative importance of this area in a UK context and thereby identify the most important site/s for this Annex 1 species as required under the Birds Directive.

2.4.1 Distance sampling

Distance sampling uses a detection function to model the decline in the probability of detecting an individual with increasing distance from the transect line. By assuming that the observer has seen all birds on the transect line closest to the aircraft, the numbers of undetected individuals can be estimated with the help of the detection function, and the total number of individuals in the survey area - including missed individuals - can be estimated for each survey.

Distance sampling is widely used in ecology to estimate the numbers of animals in an area when it is not feasible to make a complete count (Buckland *et al* 2001). It has also been used in other parts of JNCC's marine SPA work (e.g. O'Brien *et al* 2012; O'Brien 2014). Distance analysis undertaken by WWT Consulting was applied using the R package 'Distance' (Miller 2013). The software Distance 6.0 was used by JNCC to undertake the analysis of little gull and great cormorant numbers. See Thomas *et al* (2010) for more information on distance sampling methods.

Little gull were not recorded in sufficient numbers on most surveys of Liverpool Bay/Bae Lerpwl area of search to generate a reliable detection function using conventional distance sampling methods. To overcome this problem, data on little gulls from all surveys of Liverpool Bay/Bae Lerpwl and the Outer Thames Estuary were pooled after first confirming that the shape of the detection function was similar across the surveys at both sites. Pooling the data and creating a single global detection function improves the model for the detection function and does not bias the estimates for individual surveys (pers. comm. Eric Rexstad, CREEM, St Andrews). The detection functions for Liverpool Bay/Bae Lerpwl and the Outer Thames Estuary are presented in (Figure 4). The detection function (red line) was fitted to little gull observations (blue histogram) from distance Bands A, B and C. No little gulls were recorded in Band D, so this was excluded from the analysis. The histograms for Liverpool Bay/Bae Lerpwl (Figure 4a) and the Outer Thames (Figure 4b) present the data from Bands B and C together.

Distance sampling produced a population estimate for each survey, even if the number of observations on which the population estimate was based was very low. The number of little gulls recorded on each survey was plotted against the respective coefficient of variation (CV) of the distance-corrected population estimates to identify the point when CV became very high and population estimates were likely to be unreliable (Figure 5). When the number of raw observations of little gull recorded on a survey was low, the coefficient of variation became very high (Figure 5), implying there was considerable uncertainty associated with the population estimate. The percentage CV did not change as the number of raw observations increased above this, suggesting that surveys on which more individuals were recorded were reliable (Figure 5). Surveys with a high CV (>70%) were not used to find a mean of peaks population estimate.

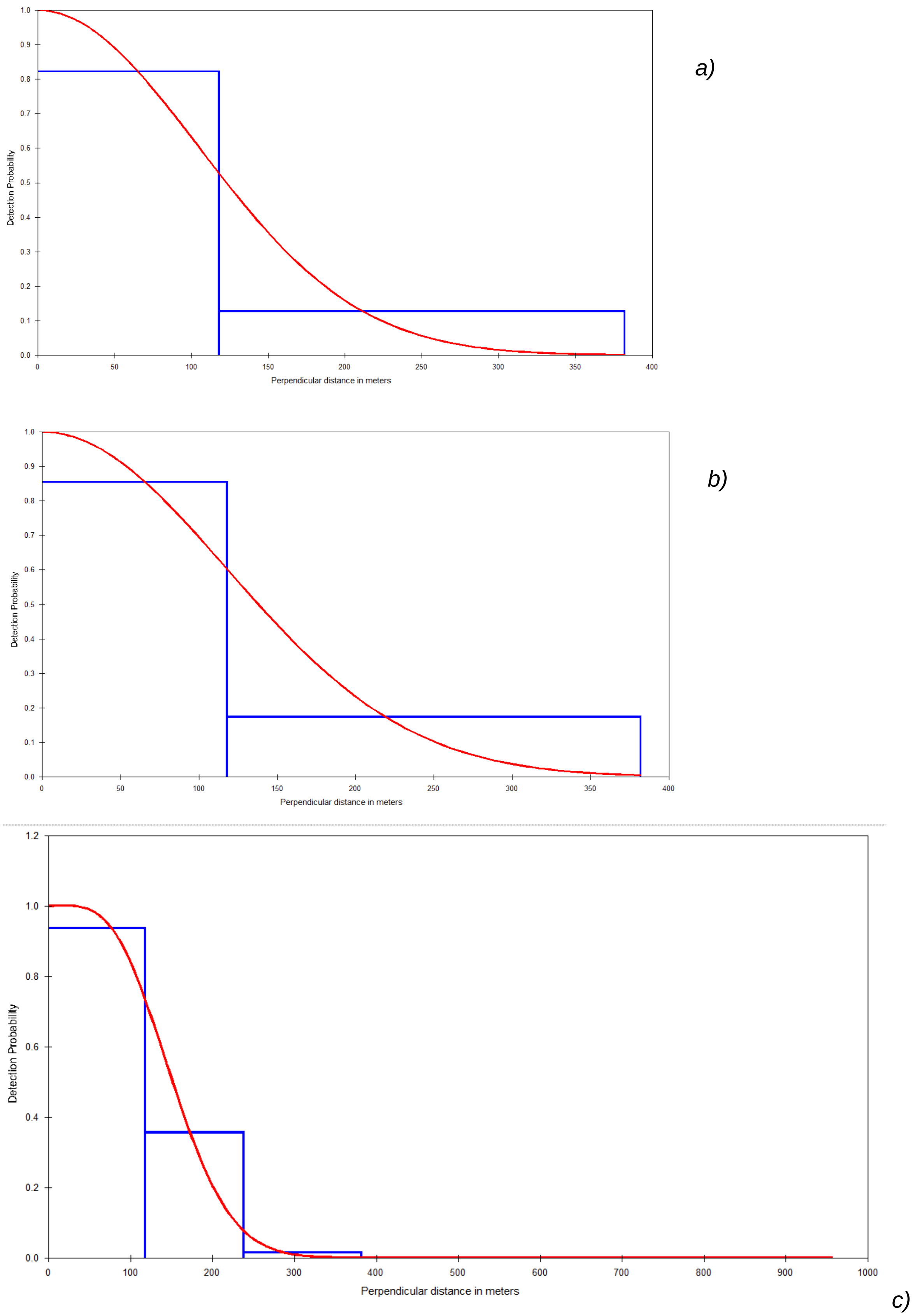

Figure 4. Detection functions of (a) Liverpool Bay/Bae Lerpwl, (b) Outer Thames in which bands b and c are displayed together and (c) the global detection function using data from both of these areas of search. Perpendicular distance in metres = x axis, detection probability = y axis.

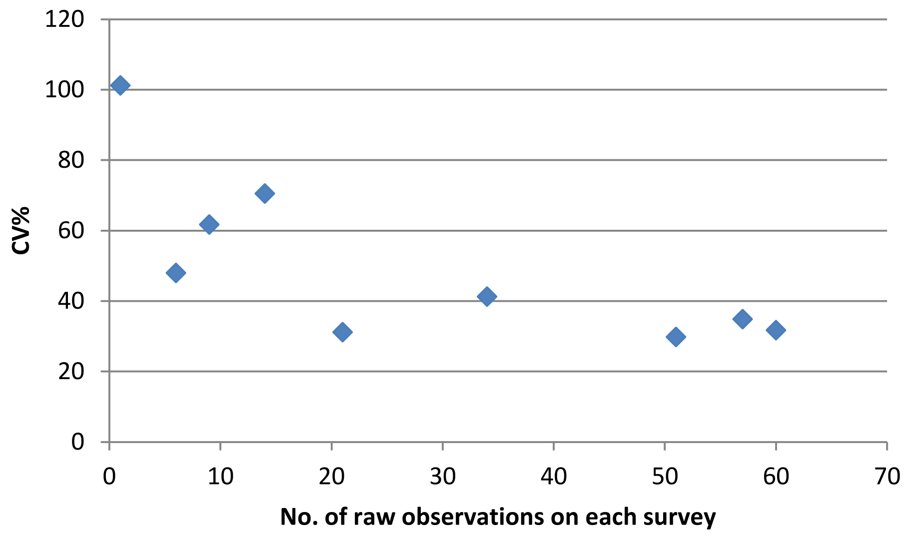

Figure 5. Relationship between percentage coefficient of variation (%CV) and number of raw observations of little gulls. Each data point represents a survey.

2.4.2 Calculating an assemblage, Stage 1.3

Under Stage 1.3 of the SPA guidelines a site may be considered for classification as an SPA if it is used regularly by an assemblage of more than 20,000 waterbirds or seabirds comprising at least two species.

For the purpose of this report only marine species were included in calculating numbers for the assemblage. Marine species were defined as those with an ecological dependency on the marine environment. Intertidal or wader species were not included as the landward boundary of the existing Liverpool Bay/Bae Lerpwl SPA extends to mean low water and does not include the intertidal area.

Stroud *et al* (2001) provides further guidance on applying Stage 1.3 of the guidelines: All migratory and Annex I waterbirds within an assemblage are qualifying species however the main component species that characterise an assemblage are identified as those species that occur in numbers that are at least 1% of their national populations or 2,000 individuals. To calculate the total numbers of birds regularly using the area the mean of peak population estimates produced for each species were summed. It is standard practice deriving from the Ramsar convention to use five seasons of data to calculate the mean of peak, but a minimum of three is required (Ramsar Convention Secretariat 2013).

For each species the best available population estimate was used to calculate the assemblage total. For some species, particularly where the numbers of birds recorded was very low, the confidence intervals around the estimate were wide, nevertheless these estimates were added to the total number of individuals for that survey as these were the best available estimate for that species.

2.4.3 Regularity

An assessment was made of the regularity with which numbers of birds in excess of their 1% population thresholds occurred within Liverpool Bay/Bae Lerpwl area of search. The UK SPA Selection Guidelines define regular occurrence as:

- 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; or
- the mean of the maxima of those seasons in which the site is internationally important, taken over at least five years, amounts to the required level.

Webb and Reid (2004) considered these definitions of regularity for inshore waterbird aggregations and suggested the most appropriate definition to use is that "two thirds of the seasons for which adequate data are available, the total number of seasons being not less than three". Using the mean of peak method for assessing regularity "...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."

However, there are circumstances in which the mean of peaks method would be more appropriate. For example where there is evidence that a site provides a severe weather refuge resulting in unusually high counts in one year.

2.5 Identifying important aggregations within the area of search

It was assumed that the areas supporting the highest densities of birds represented the most suitable areas to protect those species. Where population estimates of species exceeded the relevant UK SPA Selection Guidelines thresholds, a modelled density surface was produced which was used to identify the location with the most important aggregations.

2.5.1 Modelling bird densities

For each species and survey, density surfaces were generated using Kernel Density Estimation (KDE) applied to the raw bird observations. Raw count data were converted to densities at five second intervals along each transect line. The chosen bandwidth ensures the density estimate was produced from data collected on at least one and usually two transects, in this case 3km. This retains sufficient detail in the bird distribution patterns to allow identification of areas of higher density without excessively smoothing and flattening out high density areas (O'Brien *et al* 2012). KDE smoothed the point density estimates into a surface of relative densities (Silverman 1998), displayed on a grid of 1km by 1km cells.

The density surface was restricted to the area where data were collected, defined as the area within 1km of any line transects, to ensure it was not estimating densities over areas without survey data. In order to obtain density estimates from the KDE surfaces that accorded with the robust estimates derived from distance analysis, the relative density values were rescaled such that the sum of all densities on the modelled density surface was equal to the population estimate for that survey, as obtained from Distance sampling.

Finally, a single mean modelled density surface for the area of search was created for each species and area of search by overlaying the KDE surfaces from all surveys and calculating the mean density in each 1km x 1km cell. All surveys were given equal weight, irrespective of survey month and year. The resulting mean density surface might be described as representing an average or typical indication of where birds regularly occur in higher numbers.

3 Results

3.1 Numbers of birds in Liverpool Bay/Bae Lerpwl area of search

Population estimates were produced for 20 individual seabird and waterbird species, as well as for the groups auk species, red-throated diver and diver species, grebe species, shag/cormorant and the assemblage total (the sum of the populations estimates for all marine species (Table 1).

3.1.1 Red-throated diver

Red-throated diver is a feature of the existing Liverpool Bay/Bae Lerpwl SPA under Stage 1.1 of the UK SPA selection guidelines. The numbers within the area of search are well above the 1% GB population threshold in all five seasons 2004/05 – 2010/11 (Table 1). An updated population estimate within the potential revised SPA boundary is provided for red-throated diver in Table A1 of Appendix 1.

3.1.2 Common scoter

Common scoter is a feature of the existing Liverpool Bay/Bae Lerpwl SPA under Stage 1.2 of the UK SPA selection guidelines. The numbers within the area of search are well above the 1% biogeographic population threshold in all five seasons 2004/05 – 2010/11 (Table 1). An updated population estimate within the potential revised SPA boundary is provided for common scoter in Table A1 1 of Appendix 1.

3.1.3 Little gull

The estimated population of little gull in Liverpool Bay/Bae Lerpwl area of search was 333 individuals, based on a mean of peak taken over three winter seasons (2004/05, 2005/06 and 2010/11). Population estimates from the surveys in the 2006/07 season were not included due to insufficient survey coverage in the January 2007 survey, and low confidence in the February-March 2007 survey, indicated by the high percentage coefficient of variation (>70%CV). Similarly, the population estimates from the two surveys in the 2007/08 season were not included as the survey coverage was insufficient to provide representative estimates. These two seasons were not used in calculating the mean of peak estimate.

Little gulls are difficult to distinguish from other small gull species on aerial surveys, many may have been recorded as small gull species. Only birds indentified as little gulls were included in the analyses, and population estimates presented are therefore likely to be underestimates of the true numbers of birds.

The most important area for this species was offshore of Blackpool close to the 12 nautical mile line (Figure 8). Only surveys that covered this area were used to calculate the mean of peak population estimate for little gulls.

A seasonal pattern was not evident in the numbers of little gull recorded in Liverpool Bay/Bae Lerpwl, unlike other inshore sites (Greater Wash and Outer Thames Estuary) where higher numbers of little gull were recorded at the start of the winter period (Oct/Nov/Dec).

Table 1. Population estimates were produced for each species and survey. From these individual survey estimates a mean of the peak (MoP) population estimate was calculated and assessed under Stage 1 of the SPA Guidelines. Species with a MoP that exceeded the 1% GB threshold are highlighted in **bold text.** Where the %CV>70 the estimate is in brackets and the raw count data is provided. Estimates that were not used in calculating the mean of peak are in grey text.

	2004/05				2005/06				2006/07		2007/08		2010/11	**MoP**	**1% GB**	**1% SPA guideline threshold**
species	Oct/ Nov	Nov/ Dec	Jan	Feb/ Mar	Oct/ Nov	Nov/ Dec	Jan/ Feb	Feb/ Mar	Jan	Feb/ Mar	Oct	Feb	Feb/ Mar			
auk sp.	21,973	14,449	5,687	4,767	14,009	13,334	10,166	10,743	2,937	6,809	10,103	4,696	20,676	14,714	-	-
black-headed gull	558	46	80	1,109	67	792	42	262	34	30	0	0	1,069	601	22,000	22,000
cormorant	529	365	717	361	584	1,530	1,004	719	75	314	0	135	1,433	826	350	1,200
common gull	1,339	346	511	1,388	55(800)	272	250	397	64	55	4	383	5,581	1,494	7,000	17,250
common scoter	46,168	59,190	48,270	65,305	19,314	15,416	74,131	20,282	9,939	82,955	0	23324	44,261	**57,995**	1,000	5,500
common eider	5,518	4,390	908	3,914	0	119	5,049	319	8	89	0	29	876	2,312	600	10,300
fulmar	21	68	583	68	25	93	235	251	8	25	4	15	51	185	-	20,000
great black-backed gull	523	347	142	201	89	81	187	157	30	51	51	0	660	294	760	4,350
great crested grebe	0	0	0	0	0	4	0	13	0	0	0	0	13(110)	5	190	3,500
guillemot	0	0	0	0	0	0	6(25)	8	1(4)	0	0	0	7,341	1,470	-	20,000
gannet	68	0	8	21	297	8	0	312	0	0	1(4)	0	68	90	-	9,700
herring gull	1,293	562	703	827	282	2,139	2,176	538	170	1,918	51	327	1,171	1,377	7,300	22,000
kittiwake	2,048	1,100	680	162	1,339	2,603	1,430	1,528	216	605	459	436	2,007	1,545	-	66,000
lesser black-backed gull	183	8	59	68	46	200	4	21	25	34	2(8)	0	710	226	1,200	5,500
little gull	271	374	172	37	7	0	325	572	4	14(95)	59	0	52	**333**	-	-
great northern diver	2(9)	4	4	4	0	0	0	17	4	17	0	0	0	7	25	25
puffin	0	0	0	0	0	0	0	0	0	0	0	0	6(51)	1	-	135,000
razorbill	0	0	0	0	0	0	4(17)	4	0	0	0	0	279	57	-	13,800
red-throated diver sp.	639	627	468	1,317	310	1,383	1,023	1,235	303	838	13	258	3,250	**1,409**	170	170
red-breasted merganser	157	59	59	403	51	89	97	147	51	131	0	25	93	160	84	1,700
shag	87	319	232	151	17	64	188	236	55	42	0	0	85	139	1,100	2,000
grebe sp.	0	13(55)	4	6(25)	21	85	4	46	0	0	0	0	8(68)	21	-	-
velvet scoter	3(13)	0	0	3(13)	0	5(21)	8(34)	0	3	13	0	0	0	5	25	4,500
shag / cormorant	151	55	38	42	21	25	55	34	4	25(106)	0	0	142	75	-	-
ASSEMBLAGE														**85,340**		

Great Britain wintering population estimates were taken from Musgrove *et al* (2013), biogeographic population estimates are from *Waterbird Population Estimates* WPE5 (Wetlands International 2015).

Higher numbers of little gull were recorded in 2004/05 and 2005/06 compared to later years (Table 2), however, the survey effort and survey coverage was also greater in these two seasons (Figure A2 1, Appendix 2).

Aggregations of little gull were regularly occurring within Liverpool Bay/Bae Lerpwl and the numbers of birds observed indicated this is an important location for wintering little gull supporting the second largest wintering aggregation in the UK. Little gull could therefore be considered for SPA classification at this site under stage 1.4 of the SPA selection guidelines.

Table 2. Population estimates for little gull in the Liverpool Bay/Bae Lerpwl area of search. A number of surveys were excluded due to low confidence in the population estimate (Feb-Mar 2007), or insufficient survey coverage (Jan 2007, and the season 2007/08), indicated by grey text in the table. **Bold** text indicates the estimates were used to calculate the mean of peak. CI = confidence intervals.

Season	Date	Estimate	Lower CI	Upper CI	CV%	raw number of individuals	all clusters
2004/05	Oct-Nov 2004	271	124	595	41.27	34	28
	Nov-Dec 2004	**374**	191	731	34.87	57	51
	Jan 2005	172	94	315	31.17	21	19
	Feb-Mar 2005	37	15	92	47.99	6	6
2005/06	Oct-Nov 2005	7	1	35	101.22	1	1
	Nov-Dec 2005	0	0	0	0	0	0
	Jan-Feb 2006	325	182	578	29.81	51	42
	Feb-Mar 2006	**572**	309	1059	31.74	60	41
2006/07	Jan 2007	4	1	22	-	1	1
	Feb-Mar 2007	95	27	342	70.52	14	7
2007/08	Oct 2007	59	18	195	61.73	9	9
	Feb 2008	0	0	0	-	0	0
2010/11	**Feb-Mar 2011**	**52**	24	110	39.6	6	6
MoP		**333**					

3.1.4 Assemblage

The existing Liverpool Bay/Bae Lerpwl SPA classified in 2010 supports an assemblage of >20,000 waterfowl based on the numbers of red-throated diver and common scoter that were regularly occurring within the site.

This report provides an updated assessment of the numbers of all seabird and waterbird species (excluding waders) within the Liverpool Bay/Bae Lerpwl area of search during the period 2004/05 – 2010/11 (Table 1). The sum of the peak species estimates exceeded 20,000 individuals in all five seasons. The assemblage estimate within the potential revised SPA boundary is provided in Table A1 1 of Appendix 1.

This analysis identified a number of additional species that occurred in nationally important numbers (1% GB), or at least 2,000 individuals within Liverpool Bay/Bae Lerpwl area of search (Table 3). In addition to red-throated diver and common scoter; these species were: great cormorant and red-breasted merganser. Common eider also exceeded these thresholds within the area of search; however the distribution of common eider was such that these numbers did not occur within the potential revised SPA boundary (Appendix 1).

Since these latter species are not listed on Annex 1 of the Birds Directive, they are assessed against 1% of their biogeographic populations, at Stage 1.2 of the UK SPA Selection Guidelines, and so do not meet thresholds for classification as individual species interest features. They are, however, present in sufficient numbers to be considered as named components of the assemblage feature. Numbers of these species were therefore calculated within the potential revised boundary and presented in Tables A1 6 to A1 9 of Appendix 1.

Table 3. Species occurring in nationally important numbers (1% GB), or at least 2,000 individuals present within the Liverpool Bay/Bae Lerpwl area of search. * Although common eider exceeded the relevant thresholds within the area of search these numbers did not occur within the potential revised boundary (Appendix 1).

Species	5 year mean of peak **2004/05 – 2010/11**	**Criteria**
red-throated diver sp.	1,409 ind.	>1% of GB population (170 ind.)
common scoter	57,995 ind.	>1% of GB population (1,000 ind.)
*common eider	2,312 ind.	>1% of GB population (600 ind.)
great cormorant	826 ind.	>1% of GB population (350 ind.)
red-breasted merganser	160 ind.	>1% of GB population (84 ind.)

3.2 Distribution and densities of birds in Liverpool Bay/Bae Lerpwl area of search

3.2.1 Red-throated diver

The higher density areas of red-throated diver are located along the coastline close inshore. The main aggregation of red-throated diver is captured within the existing Liverpool Bay/Bae Lerpwl SPA, although a satellite aggregation is evident to the north of this, adjacent to the Duddon Estuary SPA and extending around towards Morecambe Bay.

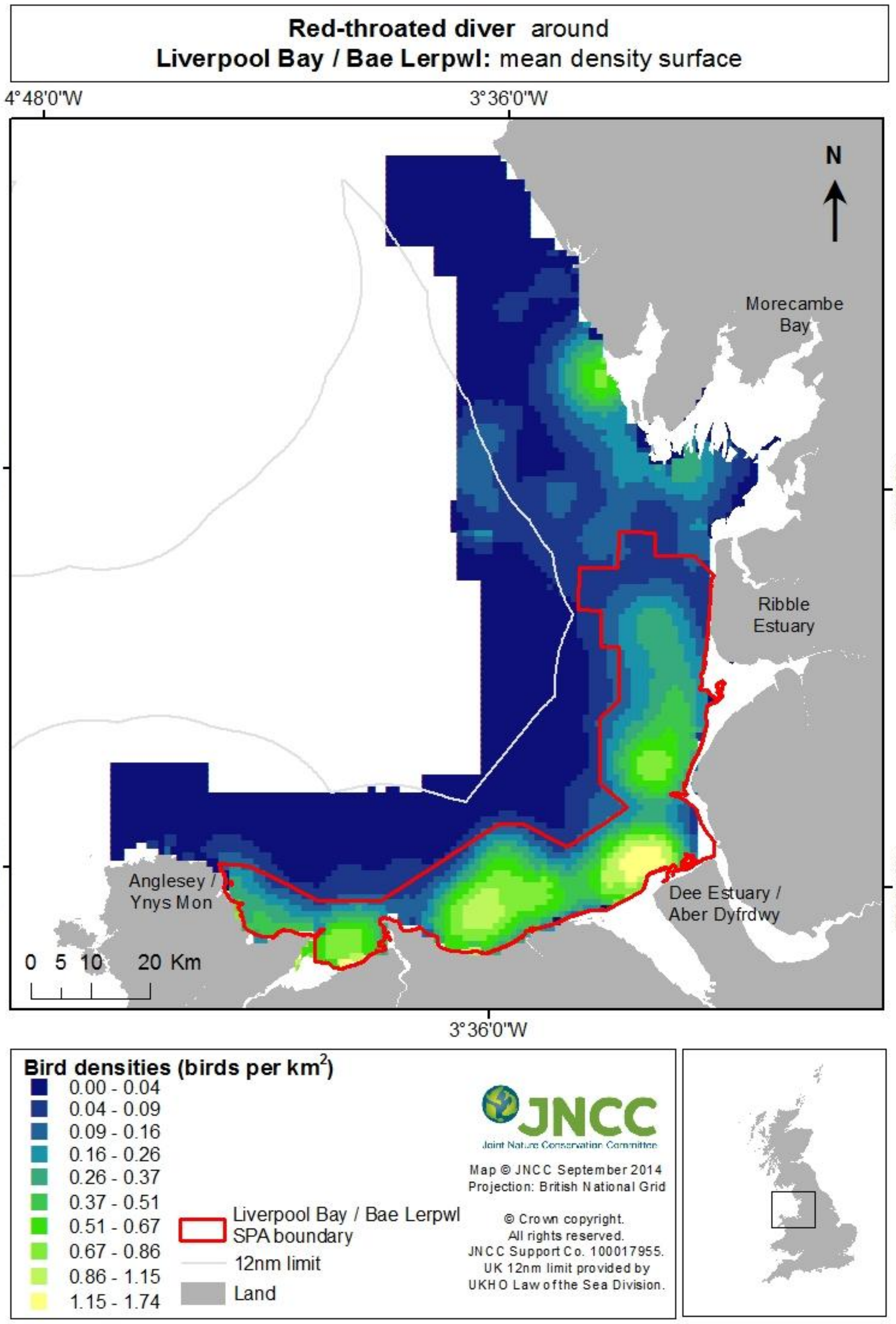

Figure 6. Estimated mean density surface of red-throated diver recorded from aerial surveys within Liverpool Bay/Bae Lerpwl area of search (2004/05, 2005/06, 2006/07, 2007/08, 2010/11).

3.2.2 Common scoter

Two main aggregations of common scoter are evident from the mean density surface and these are contained within the existing Liverpool Bay/Bae Lerpwl SPA.

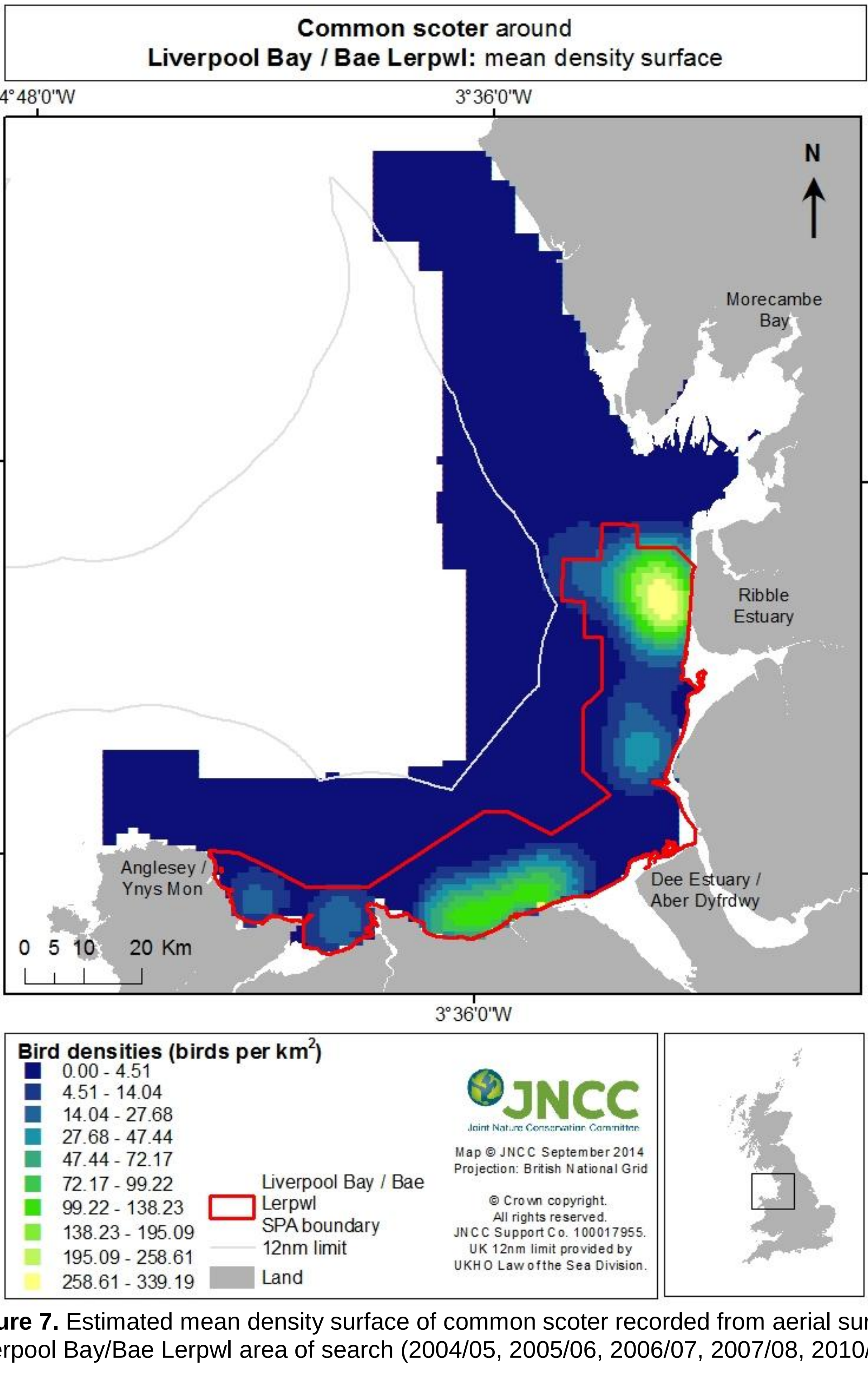

Figure 7. Estimated mean density surface of common scoter recorded from aerial surveys within Liverpool Bay/Bae Lerpwl area of search (2004/05, 2005/06, 2006/07, 2007/08, 2010/11).

3.2.3 Little gull

Observations of little gull within the Liverpool Bay/Bae Lerpwl area of search were concentrated off Blackpool close to the 12 nautical mile limit, the mean density surface reflects this pattern (Figure 8 and Figure 9), the higher density aggregation of little gull extends beyond the existing Liverpool/Bae Lerpwl SPA boundary to just beyond the 12 nautical mile line.

To assess the consistency of these aggregations or hotspots, the density threshold (0.0648 birds per km^2) - determined by maximum curvature analysis - was applied to each survey-specific density surface. As a result each cell on the surface with a density equal to or greater than the density threshold was given a score of 1 (hotspot present) and cells with a density less than the threshold were given a score of 0 (hotspot absent). The survey-specific density surfaces were then overlaid and summed to create a hotspot assessment surface, such that each cell on this surface had a count of the number of times a hotspot was present in that cell.

The results of this hotspot analysis are presented in Figure 10 and shows that little gull were consistently present in a well defined location within the Liverpool Bay/Bae Lerpwl area of search. Twelve surveys were assessed in the hotspot analysis from the seasons (2004/05–2010/11), though the area covered varied between surveys.

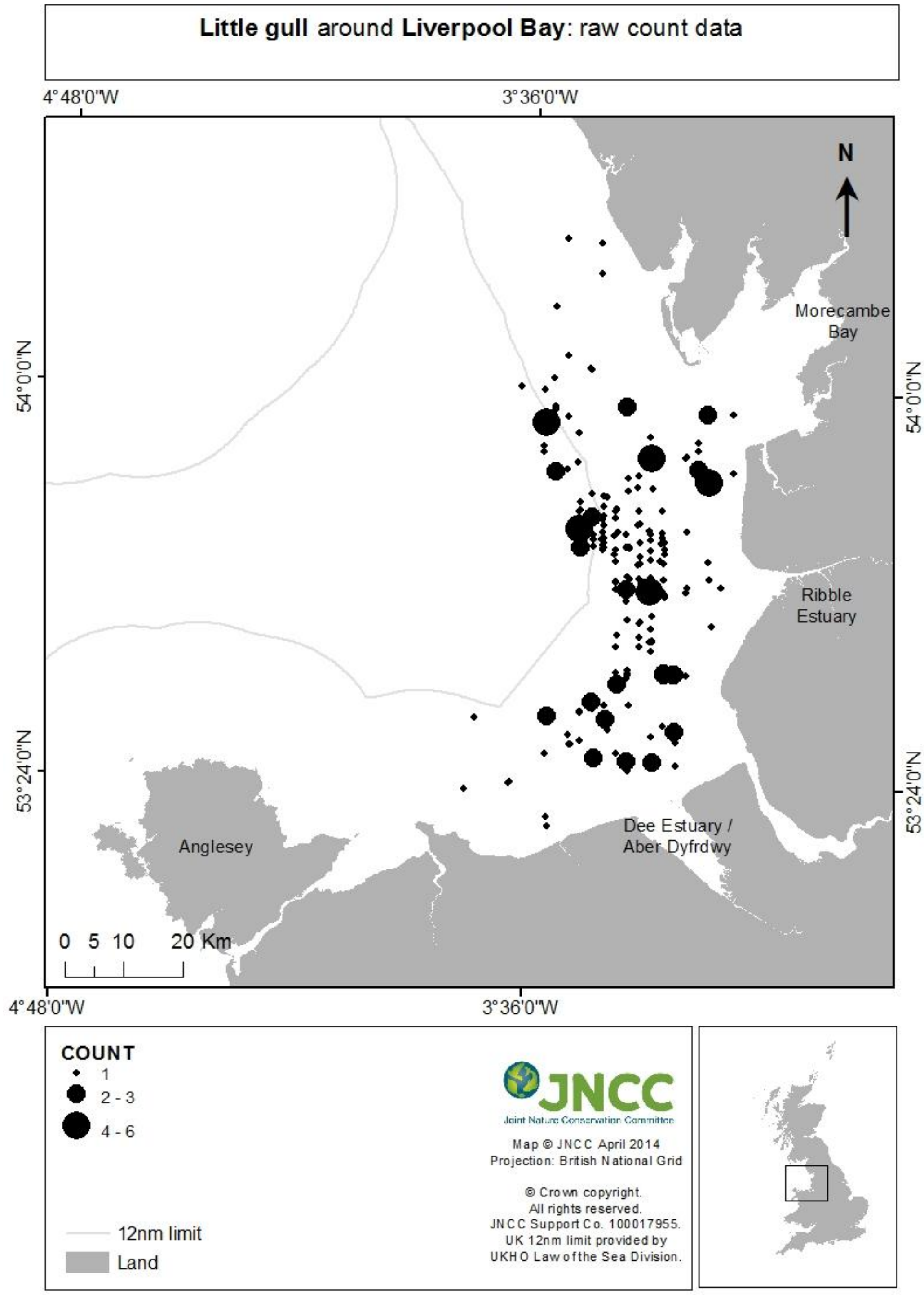

Figure 8. Raw count data of little gull recorded during WWT Consulting aerial surveys within Liverpool Bay/Bae Lerpwl area of search (2004/05, 2005/06, 2006/07, 2007/08, 2010/11).

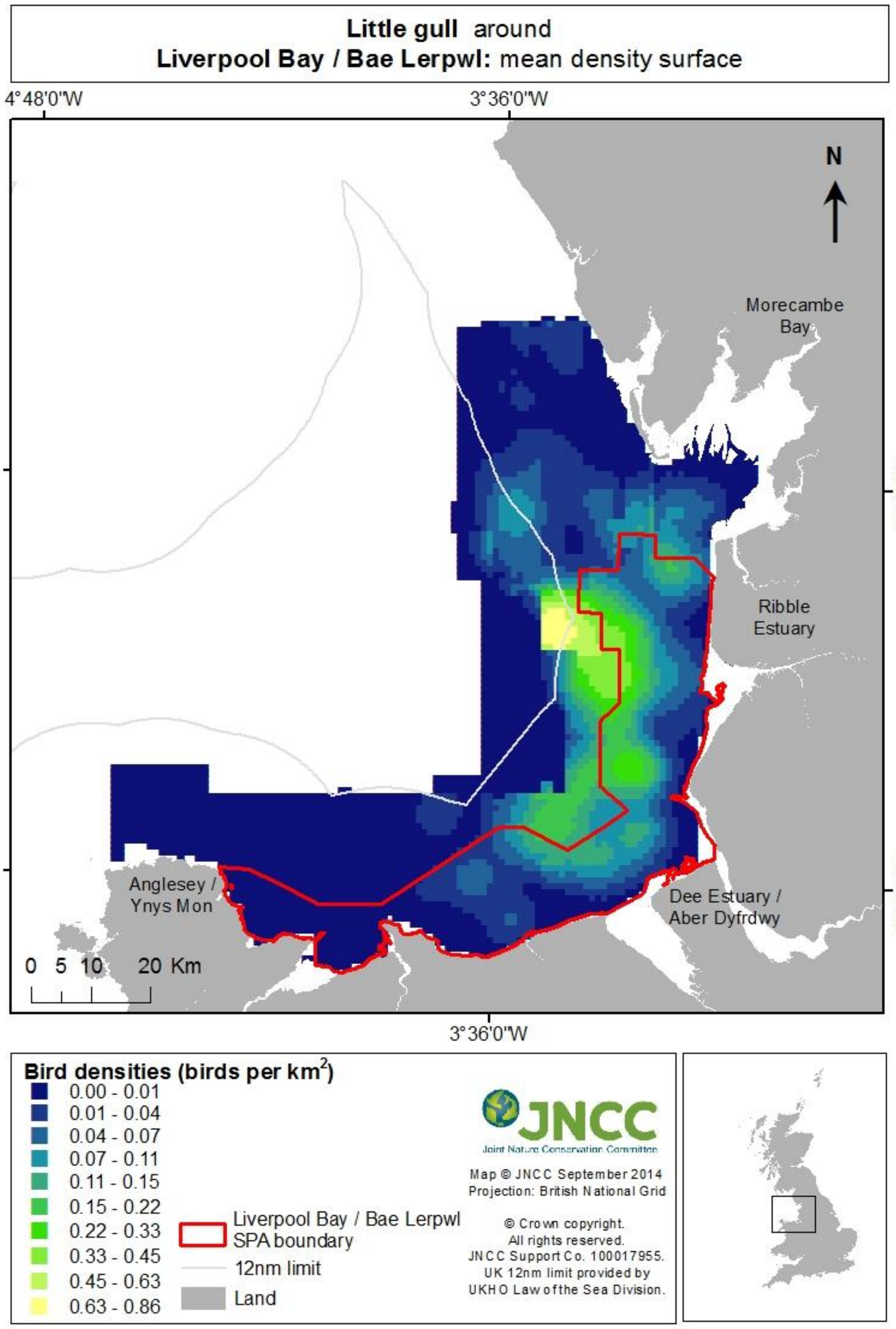

Figure 9. Estimated mean density surface of little gull recorded from aerial surveys within Liverpool Bay/Bae Lerpwl area of search (2004/05, 2005/06, 2006/07, 2007/08, 2010/11).

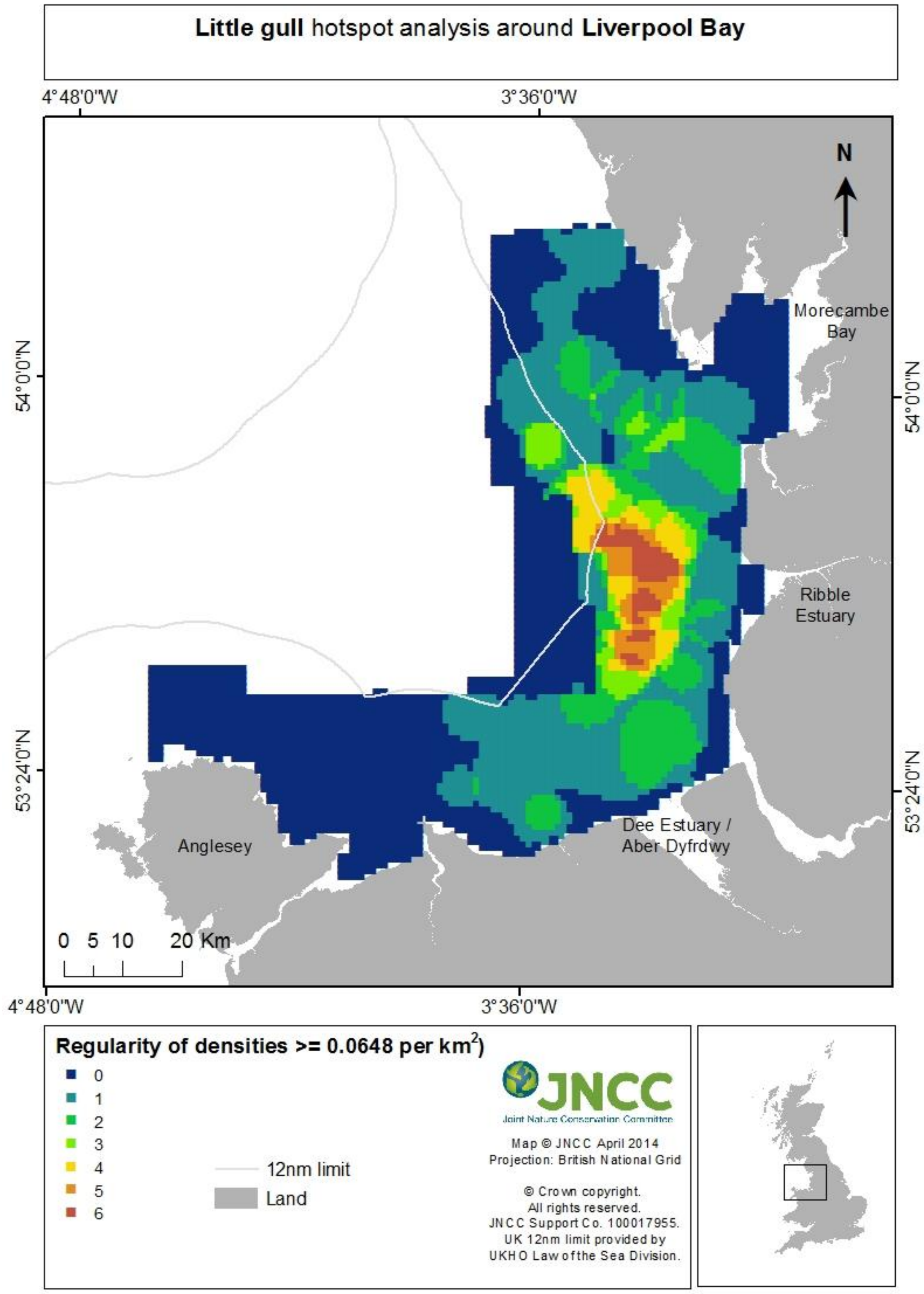

Figure 10. The number of surveys on which little gull densities met or exceeded the maximum curvature density threshold (0.0648 birds per km^2) in the Liverpool Bay/Bae Lerpwl area of search.

4 Discussion

With an estimated population of 333 little gulls at the Liverpool Bay/Bae Lerpwl area of search, this is an important site for this species in the UK. It is the second largest wintering population estimate for little gull of the inshore areas of search around the UK, only the Greater Wash held higher numbers of wintering little gull. The data also show that observations of little gull were consistently recorded at a well defined location within the area of search. Little gull could therefore be considered for SPA classification at this site under stage 1.4 of the SPA selection guidelines.

In 2013, WWT Consulting analysed the same aerial survey data around English EEZ (Exclusive Economic Zone) waters for the purpose of seabird sensitivity mapping (Bradbury *et al* 2014). They used an alternative technique, Density Surface Modelling (DSM), for spatially modelling seabird densities. Their analyses of wintering birds (October – March) were at a different temporal and spatial scale (3km x 3km) but provides a useful comparison with the results presented here. The analysis by WWT Consulting also identified higher density areas of little gull in the Greater Wash and Liverpool Bay/Bae Lerpwl, areas which correspond well with the higher densities area from this report (Figure A3 1, in Appendix 3).

In addition to the data presented in this report, JNCC commissioned two digital aerial surveys of Liverpool Bay in February and March 2011. The purpose of these surveys was to assess the power of different survey regimes to detect a change in numbers of inshore waterbirds. Different survey methods and different analyses were used compared to the methods presented in this report (Webb *et al* 2014). Both surveys were undertaken in February/March and therefore will not have sampled during the period of peak abundance for some species. Nonetheless it is worth noting the hotspots identified by these density surfaces for common scoter and red-throated diver match closely with those areas identified in this report. Maps of raw observations of little gull, red-breasted merganser and cormorant also generally agreed with the higher density areas identified in this report.

An assemblage total of 85,340 birds that regularly use the Liverpool Bay/Bae Lerpwl area of search has been calculated, now based on data from 2004/2005 – 2010/2011. Red-throated diver, common scoter; common eider, great cormorant and red-breasted merganser occurred in numbers that exceeded 1% of their GB population estimates and numbers of these species were calculated within the potential revised boundary (Appendix 1) for consideration as component species of the assemblage. The previous assemblage estimate (55,597 individuals) from the Liverpool Bay/Bae Lerpwl SPA classified in 2010 was based on the sum of the population estimates for red-throated diver and common scoter.

5 Conclusion

In 2010 Liverpool Bay/Bae Lerpwl SPA was classified for the protection of wintering red-throated diver (*Gavia stellata*), common scoter (*Melanitta nigra)* and an assemblage of greater than 20,000 waterfowl. This previous analysis had indicated the area might be important for little gull but insufficient data were available to determine this at that time. This report re-assessed the number of waterbirds and seabirds within Liverpool Bay/Bae Lerpwl area of search with additional survey data from the winter seasons of 2007/08 and 2010/11. The results identified a regularly occurring aggregation of little gull, the second largest wintering population estimate for little gull of the inshore areas of search around the UK.

A potential revised boundary for Liverpool Bay/Bae Lerpwl SPA was therefore suggested which combined the existing (2010) boundary with the area identified as important for little gull; the numbers of birds within this potential revised boundary were then updated (Appendix 1). Little gull is the only new species suggested as an additional feature for the site, all other species are protected under the qualifying features of the existing Liverpool Bay/Bae Lerpwl SPA classified in 2010. The updated population estimates for these species within the suggested revised SPA boundary are as follows: the assemblage total (number of birds of all marine species) occurring within this potential revised boundary is 69,687 individuals. Marine species were defined as those with an ecological dependency on the marine environment. In addition to red-throated diver (1,171) common scoter (56,679), and little gull (319), two species were present in sufficient numbers to be added as named component species of the assemblage feature, great cormorant (*Phalacrocorax carbo)* and red-breasted merganser (*Mergus serrator*).

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Appendix 1 - Delineating important aggregations of little gull within Liverpool Bay/Bae Lerpwl survey area

Delineating important areas at sea for SPA classification presents particular challenges as physical features or habitat boundaries are rarely visible and are not readily detectable without time-consuming and costly data collection and analysis. Identifying important areas at sea therefore is usually a process driven by the dispersion of the birds themselves.

Maximum curvature was used to delineate areas of high bird density on the mean modelled density surface. This method identifies the point of greatest change in a curve in the relationship between two values (Mel'nikov 1995). It is a relatively objective and repeatable method to identify a threshold density for determining the important parts of aggregated species' distributions. Grid cells hosting densities above the threshold density may be deemed as important and used to define a boundary to the important parts of the distribution (O'Brien *et al* 2012).

Application of maximum curvature follows a stepwise procedure. Large areas of a density surface might have no observations of a particular species, i.e. zero density. These areas were excluded from the analysis because the threshold density identified by maximum curvature analysis is sensitive to the size of the area considered (Webb *et al* 2009). These areas were excluded using the software *Geospatial Modelling Environment* (Beyer 2012) to draw one or more minimum convex polygons (MCPs) around the raw observations. These MCPs were then over-laid on the mean modelled density surface and any cells with a zero density within the MCPs were excluded from the maximum curvature analysis. The remaining grid cells were then ranked from high to low based on bird density. The relationship between the cumulative number of birds and cumulative area is not linear but curved, increasing rapidly at first as high density areas are selected and then increasing more slowly as larger areas are required to capture the same number of birds in low density areas. Maximum curvature identifies the point of greatest change in the relationship between the cumulative modelled number of birds and the cumulative area that supports that number of birds (see Cannone (2004) and Holt and Mantua (2009) for examples of the application of maximum curvature elsewhere in ecology). The point of maximum curvature is used as the threshold density to inform boundary placement as this represents the point of optimal trade-off between the gain (increased numbers of birds) and the cost (increased area within a boundary), see O'Brien *et al* (2012) for more details. It was determined by fitting a statistical model, either exponential, or double exponential (depending on which best fitted the observed data) to best fit the relationship between cumulative usage against cumulative area supporting that usage. Maximum curvature analysis has been used extensively in JNCC's marine SPA work (e.g. O'Brien *et al* 2012; O'Brien 2014). It should be noted that this procedure is applied to determine a seaward boundary only; definition of the landward boundary to any SPAs identified is a matter of judgement and other considerations (see below).

In this way species specific maximum curvature boundaries were identified. The high bird density areas defined by the maximum curvature threshold density for little gull (0.0648 birds per km^2) are presented in Figure A1 1.

The boundary presented below is a simplified boundary, drawn around the grid cells equal to or above the maximum curvature threshold.

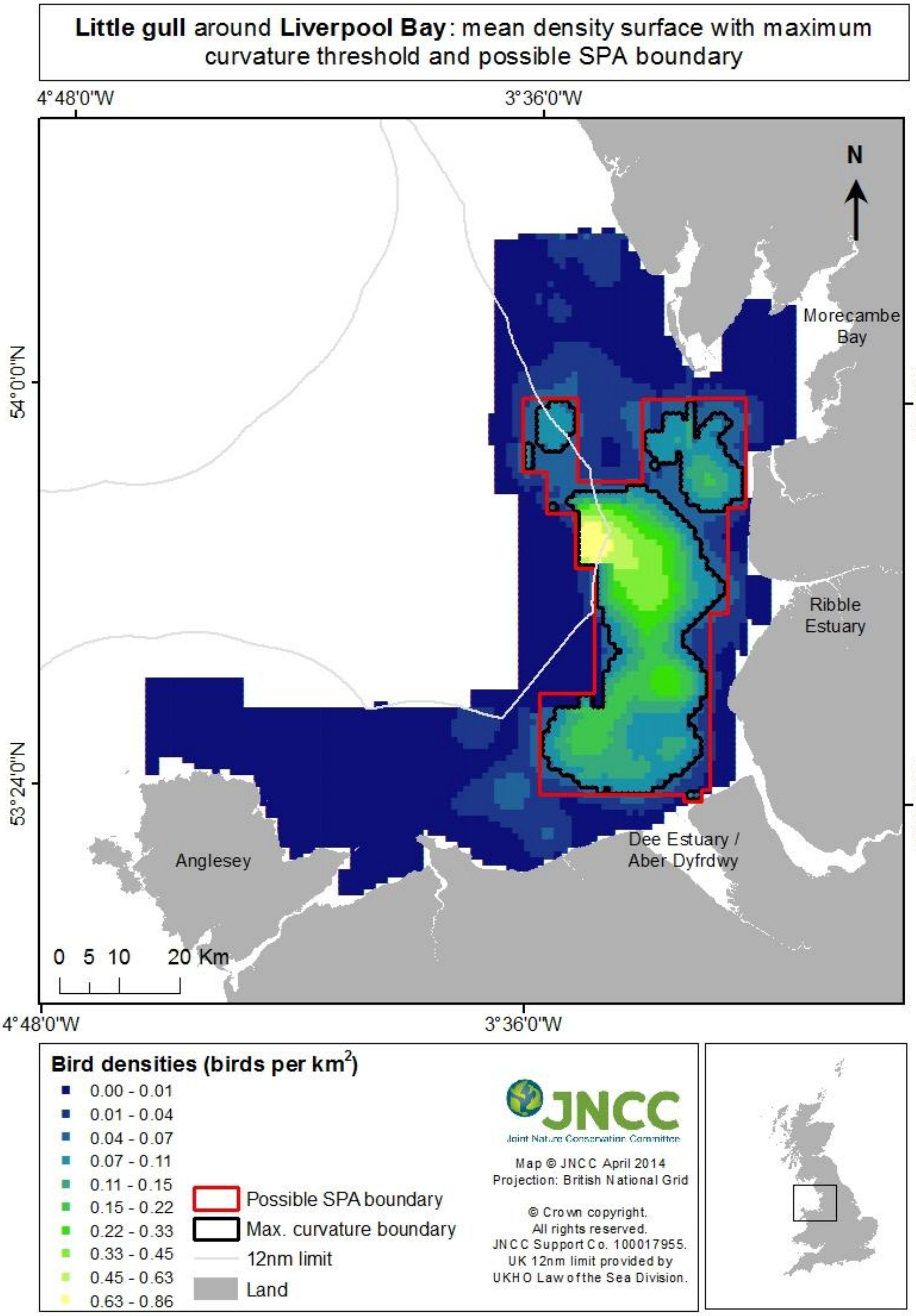


Figure A1 1. Estimated mean density surface for little gull with the threshold densities (0.0648 birds per km^2) delineated, as identified by maximum curvature and the possible SPA boundary.

Estimating numbers of birds within a possible SPA boundary

The existing Liverpool Bay/Bae Lerpwl SPA boundary (2010) was combined with the boundary identifying important aggregations of little gull to produce a possible new SPA boundary for the Liverpool Bay/Bae Lerpwl area of search (Figure A1 2 and Figure A1 3).

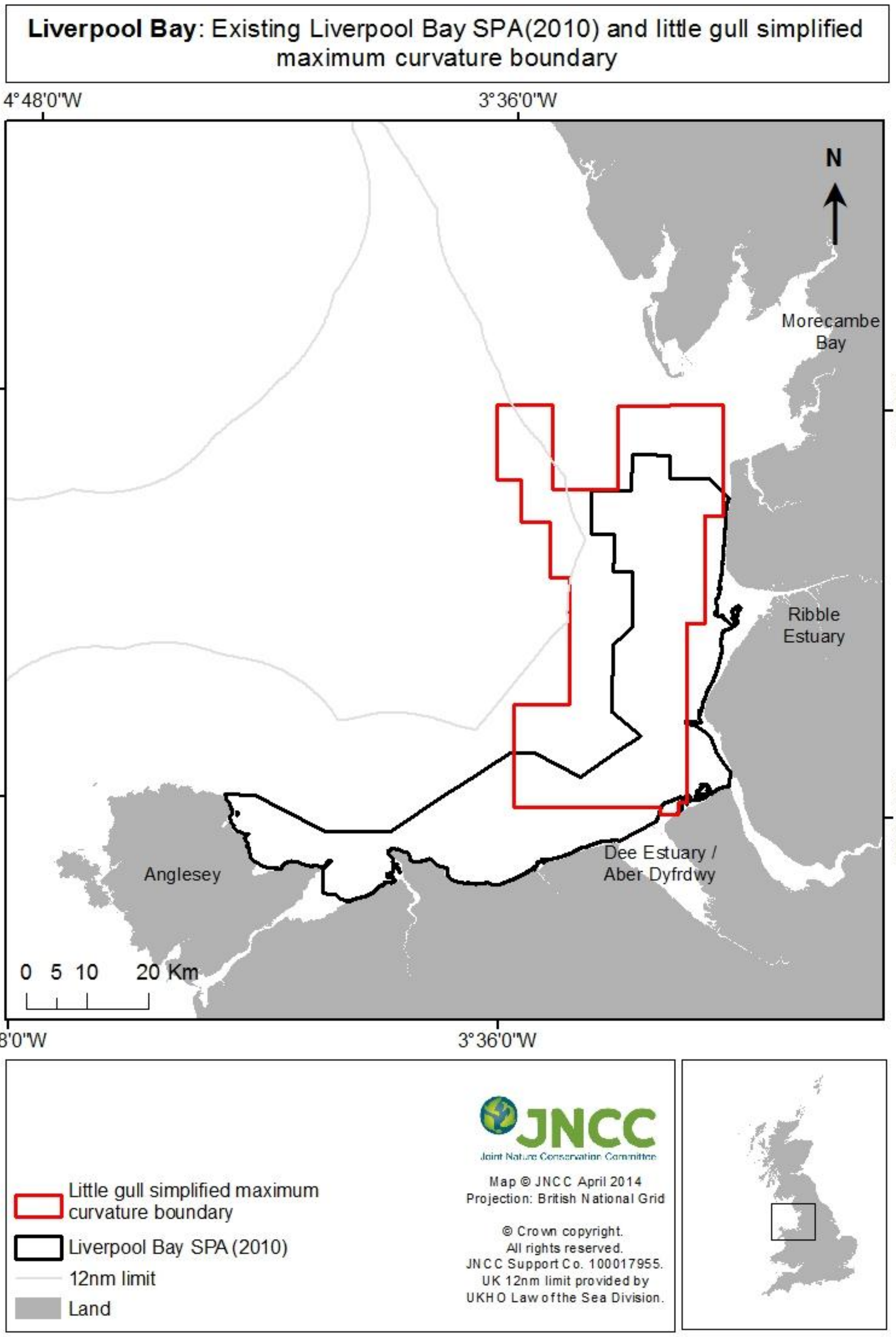


Figure A1 2. The existing Liverpool Bay/Bae Lerpwl SPA (2010) and the boundary around important aggregations of little gull in Liverpool Bay/Bae Lerpwl.

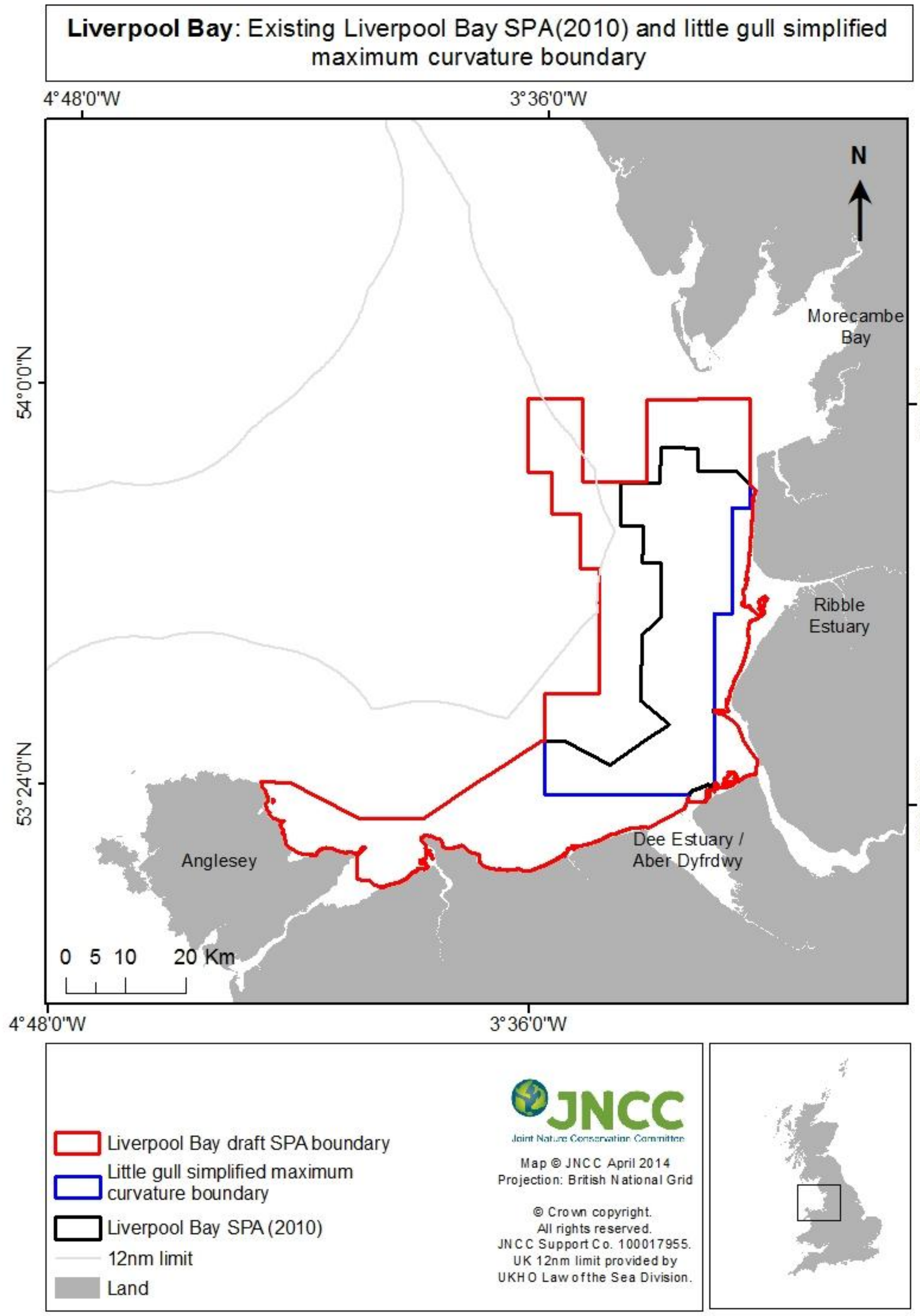


Figure A1 3. The existing Liverpool Bay/Bae Lerpwl SPA (2010) and the boundary around important aggregations of little gull were combined to produce a possible new SPA boundary for Liverpool Bay/Bae Lerpwl.

The numbers of little gull, red-throated diver and common scoter within this possible new SPA boundary were then calculated. The total numbers of birds, forming the assemblage feature under Stage 1.3 of the SPA guidelines were also calculated within this possible new boundary in addition to the numbers of the species identified as possible named components of that assemblage within the Liverpool Bay/Bae Lerpwl area of search (red-throated diver, common scoter, common eider, red-breasted merganser and cormorant).

Distance sampling methods provide the most reliable assessment of the numbers of birds within an area, but this method can generate biased estimates if the same data are used to estimate a population estimate for an area of search, and then used again to reassess the numbers of birds in a part of the area of search (S. Buckland and E. Rexstad, pers. comm.). Therefore, in order to estimate population sizes within a boundary, the density surfaces generated for each individual survey and rescaled to Distance corrected population estimate were used.

For each density surface i.e. each survey, the densities of all cells that had their centre point within the boundary were summed. This provided a population estimate within the boundary for that survey. The mean of peak population estimates within the boundary were calculated from these surveys and are presented in Table A1 1 below.

Table A1 1: Population estimates within the potential revised SPA boundary.

Survey date	Season	little gull		red-throated diver		common scoter		assemblage	
		Sum within pSPA boundary	Peak	Sum within pSPA boundary	Peak	Sum within pSPA boundary	Peak	Sum within pSPA boundary	Peak
Oct-Nov 04	2004/05	270		479		45,201		**78,286**	
Nov-Dec 04	2004/05	**354**	**354**	558		56,467		70,258	
Jan-05	2004/05	165		413		47,444		54,598	
Feb-Mar 05	2004/05	37		**939**	**939**	**64,020**	**64,020**	67,901	**78,286**
Oct-Nov 05	2005/06	5		288		19,064		30,833	
Nov-Dec 05	2005/06	0		**1,133**	**1,133**	14,951		29,498	
Jan-Feb 06	2005/06	259		879		**72,200**	**72,200**	**90,486**	
Feb-Mar 06	2005/06	**555**	**555**	1,072		19,066		28,179	**90,486**
Jan-07	2006/07	0		101		9,801		12,510	
Feb-Mar 07	2006/07	75		**608**	**608**	**81,578**	**81,578**	**87,227**	**87,227**
Oct-07	2007/08	47						926	
Feb-08	2007/08	0		**196**	**196**	**23,247**	**23,247**	**26,849**	**26,849**
Feb-Mar 11	2010/11	**48**	**48**	**2,980**	**2,980**	**42,349**	**42,349**	**65,587**	**65,587**
MoP			**319**		**1,171**		**56,679**		**69,687**

Table A1 2 below shows the population estimates for red-throated diver, common scoter and the waterfowl assemblage within the existing Liverpool Bay/Bae Lerpwl SPA compared with the numbers in the possible new SPA boundary. The population within the possible new SPA boundary include two additional winter seasons of data from 2007/08 and 2010/11.

Table A1 2. Comparison of population estimates for red-throated diver, common scoter, and the assemblage in the existing Liverpool Bay/Bae Lerpwl and the possible new SPA boundary.

	Liverpool Bay/Bae Lerpwl SPA (2001/02 – 2006/07**)**	**Possible new SPA boundary** (2004/05 – 2010/11)
Species		
red-throated diver	922 ind.	1,171 ind.
common scoter	54,675 ind.	56,679 ind.
assemblage	*55,597 ind.	69,687 ind.

* The assemblage estimate for the existing Liverpool Bay/Bae Lerpwl SPA was the sum of the red-throated diver and common scoter population estimates.

The distributions of red-throated diver, common scoter and the assemblage feature within the possible new Liverpool Bay/Bae Lerpwl SPA boundary are provided as mean density surfaces in figures to A1 4 to A1 6 below.

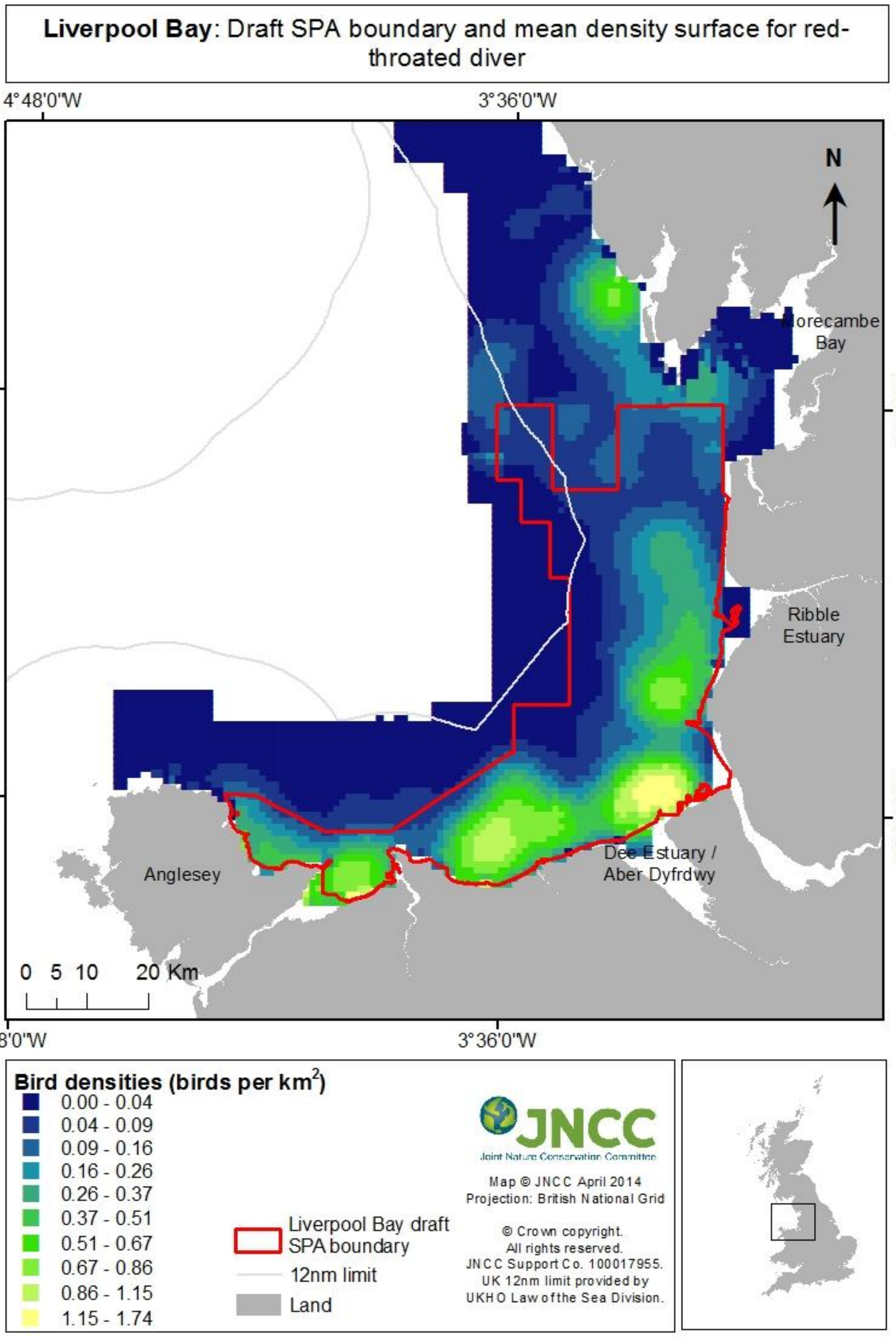


Figure A1 4. Mean density surface for red-throated diver within the possible new Liverpool Bay/Bae Lerpwl SPA boundary, this density surface includes two additional winter seasons of data from 2007/08 and 2010/11.

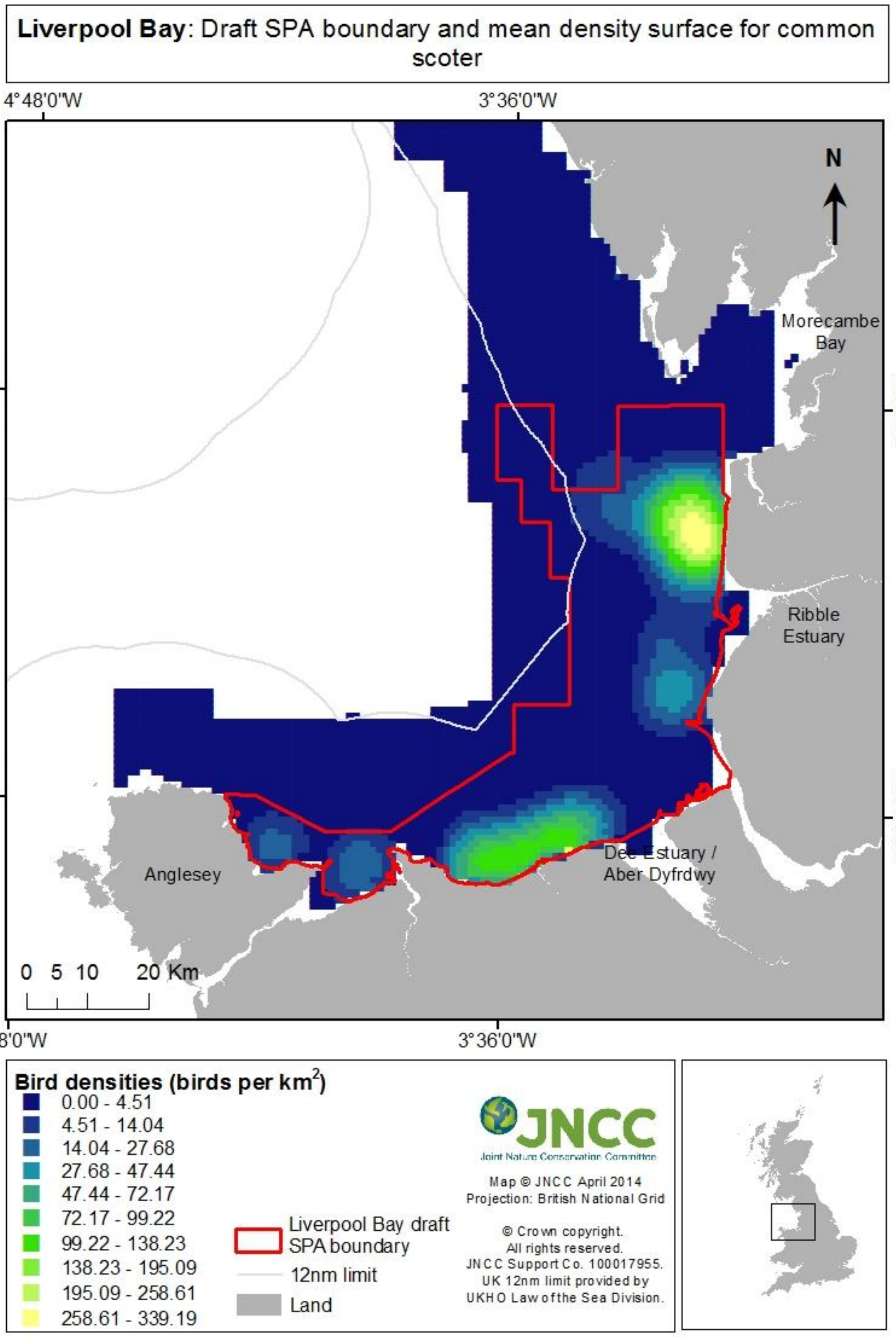


Figure A1 5. Mean density surface for common scoter within the possible new Liverpool Bay/Bae Lerpwl SPA boundary, this density surface includes two additional winter seasons of data from 2007/08 and 2010/11.

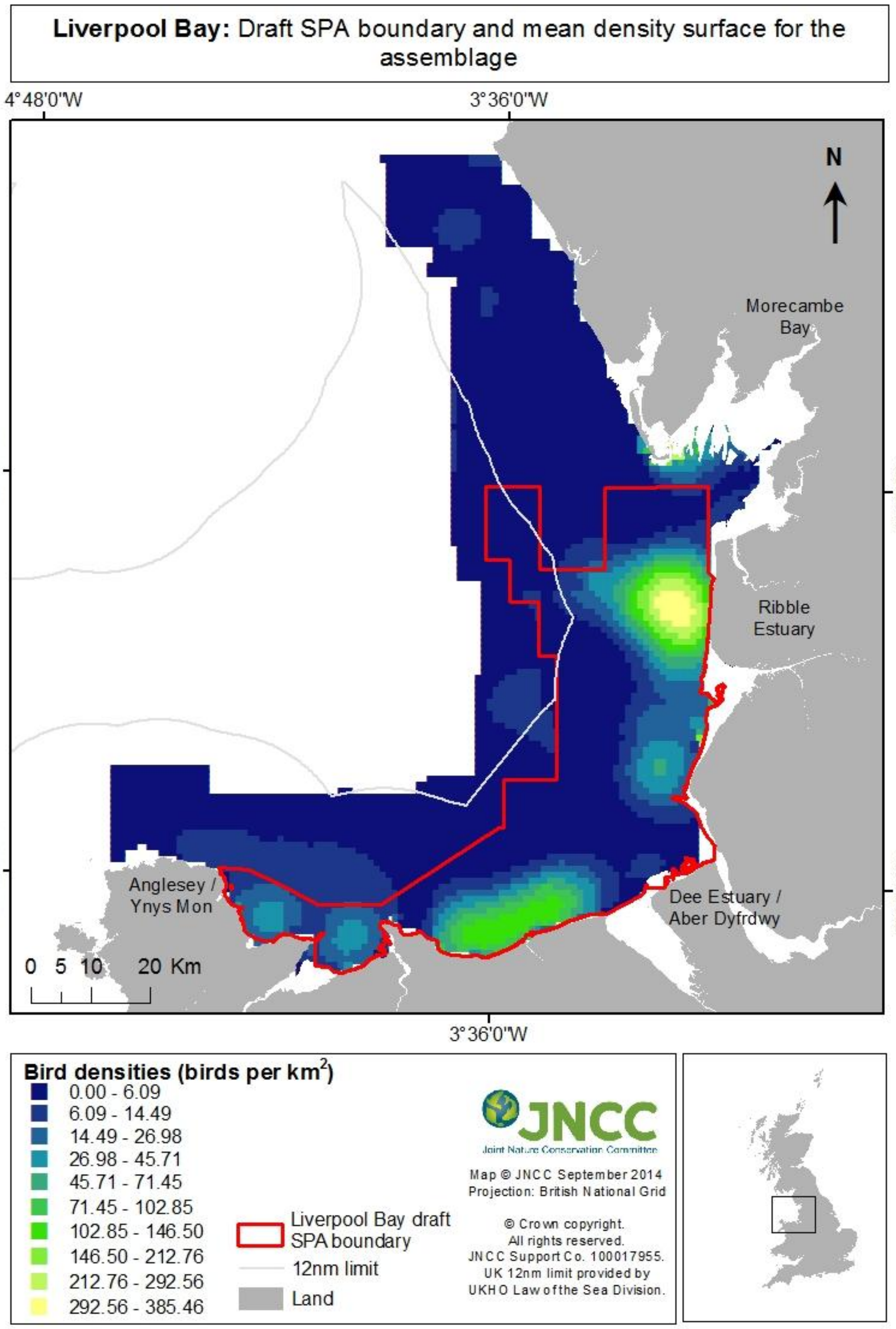


Figure A1 6. Mean density surface for the assemblage within the possible new Liverpool Bay/Bae Lerpwl SPA boundary.

Table A1 6. Population estimates for great cormorant within the potential revised SPA boundary.

Survey date	Season	Species	Sum within pSPA boundary	Peak	MoP within pSPA boundary
Oct Nov 04	2004/05	Corm	505		
Nov Dec 04	2004/05	Corm	341		
Jan-05	2004/05	Corm	**680**	**680**	
Feb Mar 05	2004/05	Corm	320		
Oct Nov 05	2005/06	Corm	551		
Nov Dec 05	2005/06	Corm	**1,425**	**1,425**	
Jan Feb 06	2005/06	Corm	943		
Feb Mar 06	2005/06	Corm	674		
Jan-07	2006/07	Corm	75		
Feb Mar 07	2006/07	Corm	**290**	**290**	
Oct-07	2007/08	Corm			
Feb-08	2007/08	Corm	**112**	**112**	
Feb Mar 11	2007/08	Corm	**1,151**	**1,151**	
					732

Table A1 7. Population estimates for red-breasted merganser within the potential revised SPA boundary.

Survey date	Season	Species	Sum within pSPA boundary	Peak	MoP within pSPA boundary
Oct Nov 04	2004/05	RBM	123		
Nov-Dec 04	2004/05	RBM	54		
Jan-05	2004/05	RBM	56		
Feb-Mar 05	2004/05	RBM	**360**	**360**	
Oct Nov 05	2005/06	RBM	50		
Nov-Dec 05	2005/06	RBM	85		
Jan-Feb 06	2005/06	RBM	86		
Feb-Mar 06	2005/06	RBM	**128**	**128**	
Jan-07	2006/07	RBM	32		
Feb-Mar 07	2006/07	RBM	**125**	**125**	
Oct-07	2007/08	RBM			
Feb-08	2007/08	RBM	**25**	**25**	
Feb-Mar 11	2010/11	RBM	**16**	**16**	
					131

Table A1 8. Population estimates for common eider within the potential revised SPA boundary.

Survey date	Season	Species	Sum within pSPA boundary	Peak	MoP within pSPA boundary
Oct Nov 04	2004/05	Eider	317		
Nov-Dec 04	2004/05	Eider	63		
Jan-05	2004/05	Eider	63		
Feb-Mar 05	2004/05	Eider	**678**	**678**	
Oct Nov 05	2005/06	Eider	0		
Nov-Dec 05	2005/06	Eider	59		
Jan-Feb 06	2005/06	Eider	**945**	**945**	
Feb-Mar 06	2005/06	Eider	13		
Jan-07	2006/07	Eider	0		
Feb-Mar 07	2006/07	Eider	**1**	**1**	
Oct-07	2007/08	Eider			
Feb-08	2007/08	Eider	**22**	**22**	
Feb-Mar 11	2007/08	Eider	**391**	**391**	
					407

Table A1 9. Main component species considered to be part of the assemblage within the potential revised SPA boundary.

Species	Liverpool Bay/Bae Lerpwl area of search	Possible new SPA boundary	Criteria	Meets criteria of named components of assemblage?
	5 year mean of peak 2004/05 – 2010/11			
red-throated diver	1,409 ind.	1,171 ind.	>1% of GB population (170 ind.)	Yes
common scoter	57,995 ind.	56,679 ind.	>1% of GB population (1,000 ind.)	Yes
great cormorant	826 ind.	732 ind.	>1% of GB population (350 ind.)	Yes
red-breasted merganser	160 ind.	131 ind.	>1% of GB population (84 ind.)	Yes
common eider	2,312 ind.	407 ind.	>1% of GB population (600 ind.)	No

Numbers of common eider within the possible new SPA boundary are below 1% of the GB population therefore common eider is not one of the main component species of this assemblage feature. The Liverpool Bay/Bae Lerpwl area of search overlapped with part of the Morecambe Bay SPA which held high density areas of great cormorant and common eider. However, this area of overlap was excluded from the boundary analysis and the possible extended Liverpool Bay/Bae Lerpwl SPA based on the distributions of little gull, red-throated diver and common scoter does not include this area. The species exceeding the relevant thresholds for named components in an assemblage within the possible extended Liverpool Bay/Bae Lerpwl SPA boundary are red-throated diver, common scoter, great cormorant, and red-breasted merganser.

Summary of the key conclusions

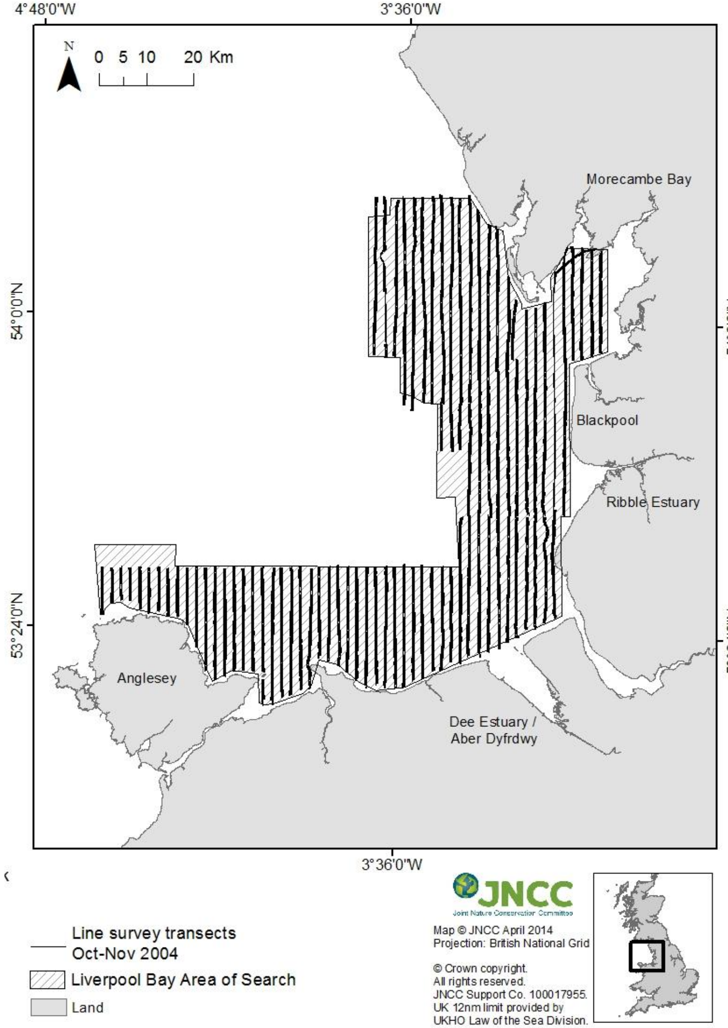
A revised boundary is suggested to include an important area for little gull, this area was defined by maximum curvature analysis of the mean density surface for little gull. This extends the northern and seawards limit of the 2010 SPA boundary. A small area in the north-west of this revised boundary extends beyond 12 nautical miles.

The report presents updated population estimates within a potential revised SPA boundary for the existing qualifying features of red-throated diver and common scoter. The numbers of little gull observed from inshore aerial survey indicated this is an important location for wintering little gull supporting the second largest wintering aggregation in the UK. Aggregations of little gull occur regularly and should be considered as a feature in their own right. Two additional species (red-breasted merganser and cormorant) are identified which occur in numbers that exceed 1% of their respective GB populations within the potential revised boundary and which can be considered as named components species within the assemblage feature. Little gull is the only new species suggested as an additional feature for the site, all other species are protected under the qualifying features of the existing SPA. The updated population estimates for these species within the suggested revised SPA boundary are as follows:

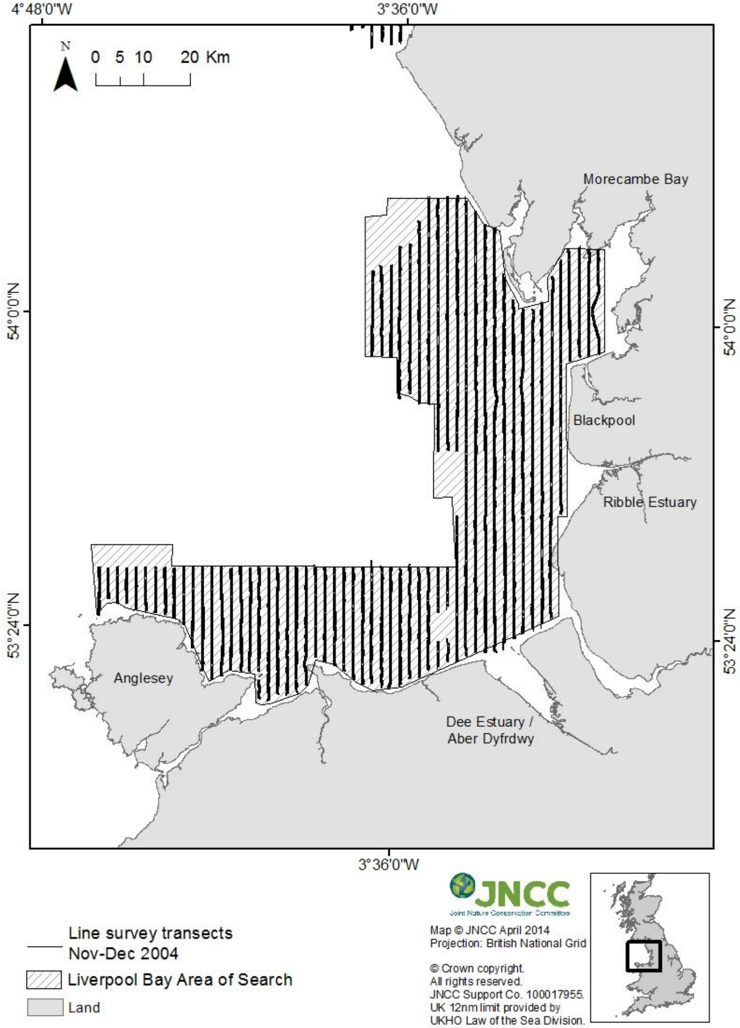
Table A1 10.

Species	MoP population estimate within potential revised SPA boundary	Qualifying threshold	UK SPA selection guideline	Number of years in which qualifying numbers reached
red-throated diver	1,171	170	Stage 1.1	5 of 5
common scoter	56,679	5,500	Stage 1.2	5 of 5
little gull	319	-	Stage 1.4	3 of 3
assemblage	69,687	20,000	Stage 1.3	5 of 5
red-breasted merganser	131	84	Named component species of the assemblage feature	
great cormorant	732	350	Named component species of the assemblage feature	

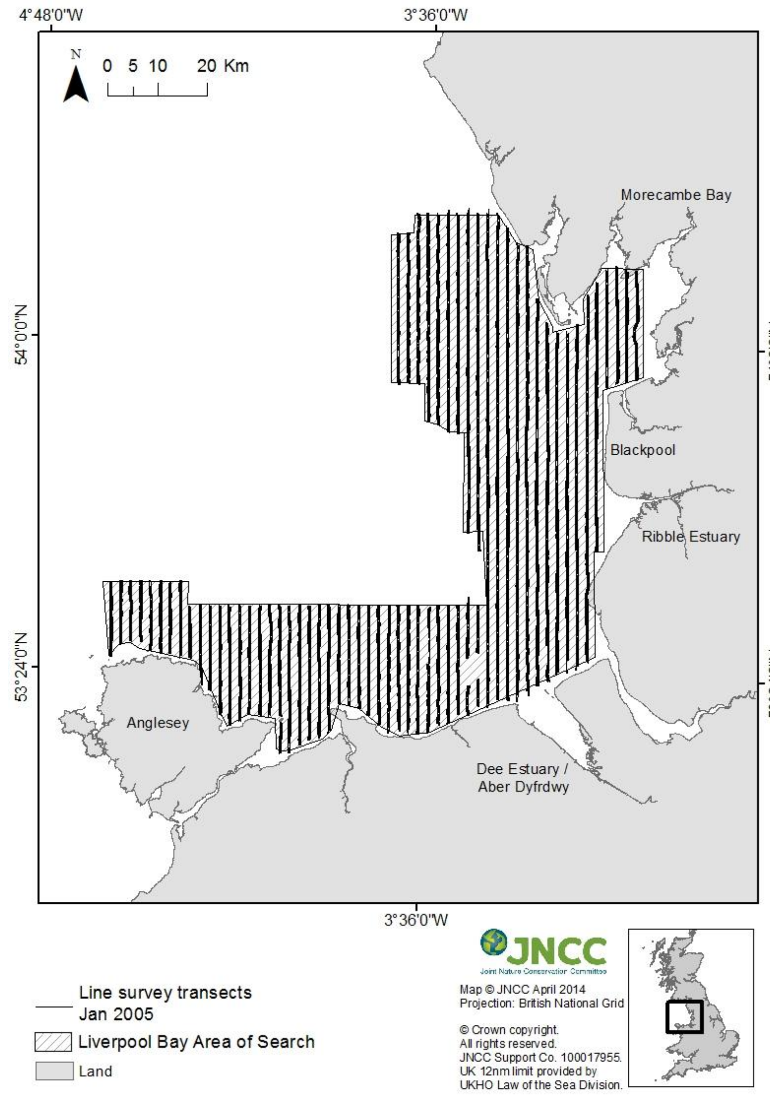
Appendix 2 – survey effort within Liverpool Bay/Bae Lerpwl area of search



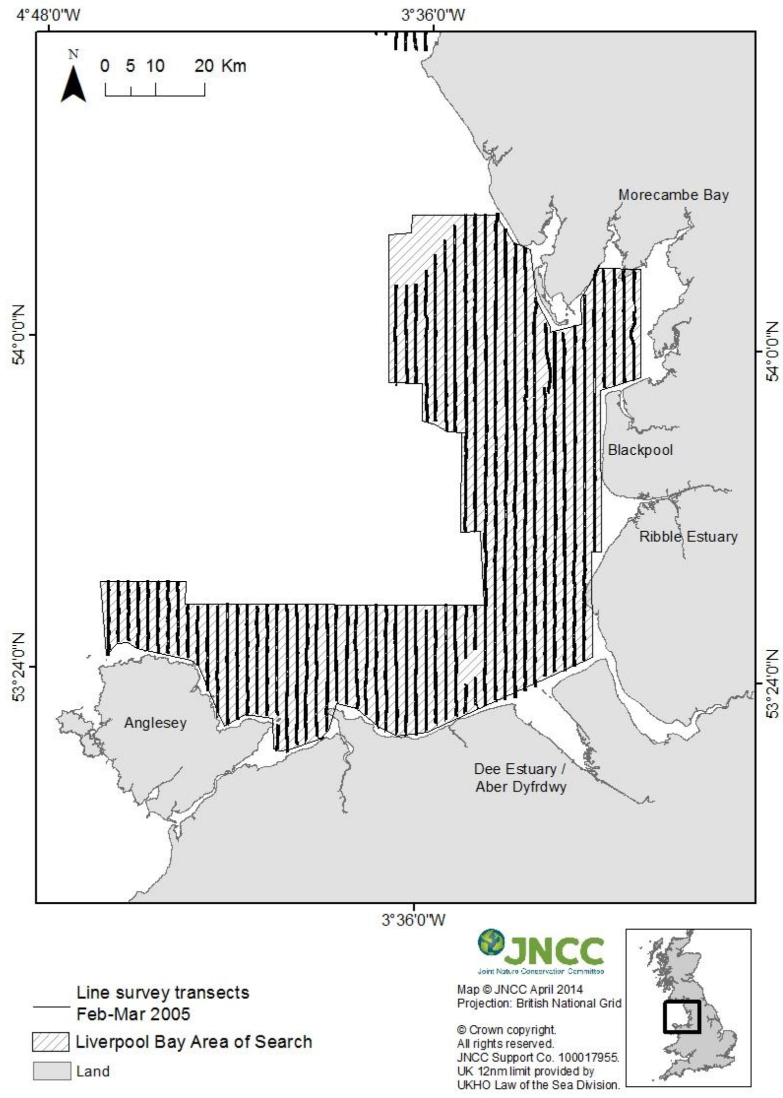
a) Winter season 2004/05 October-November



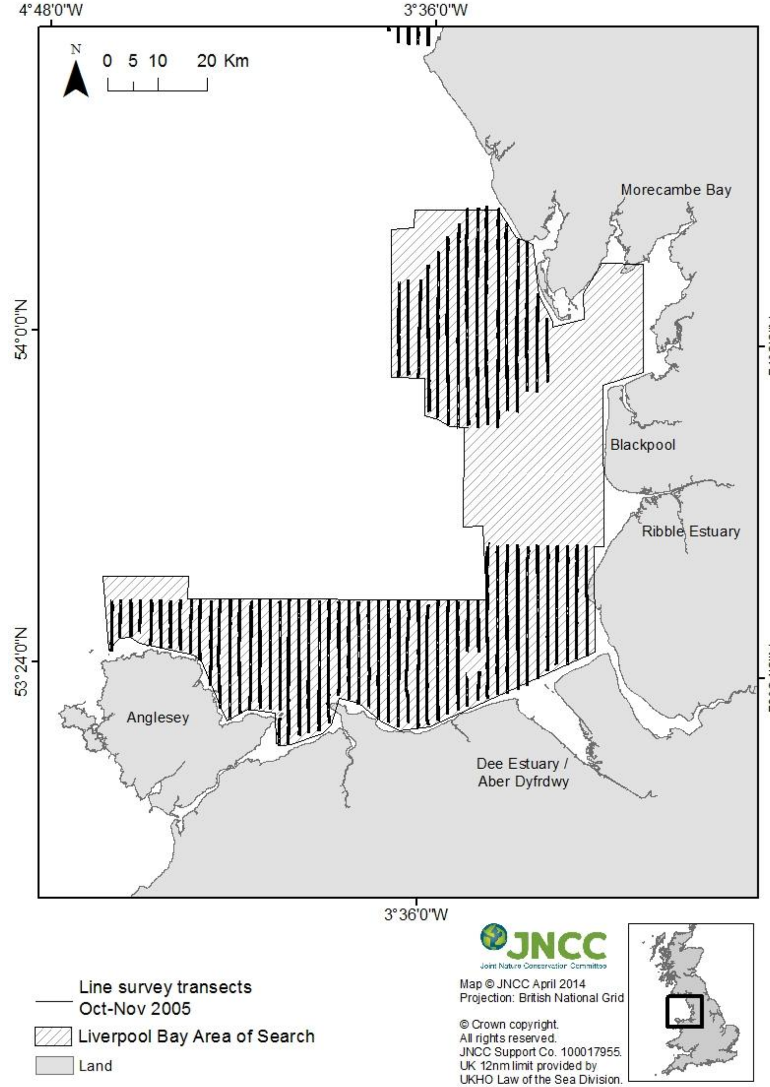
b) Winter season 2004/05 November-December



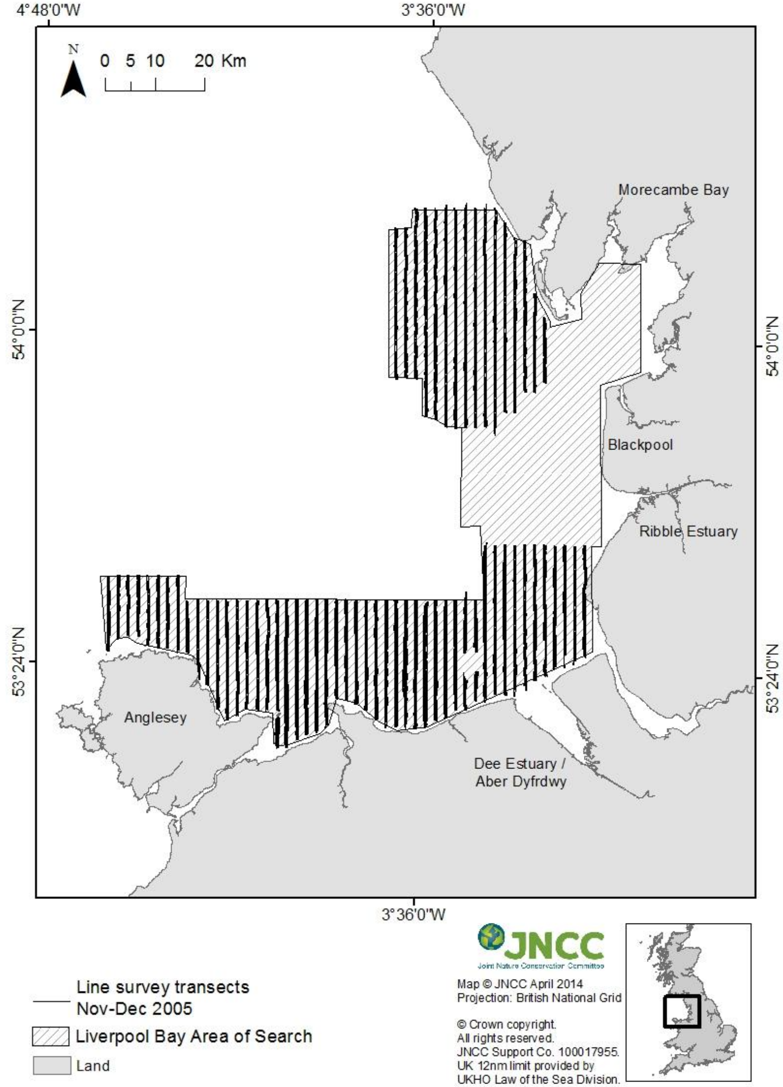
c) Winter season 2004/05 January



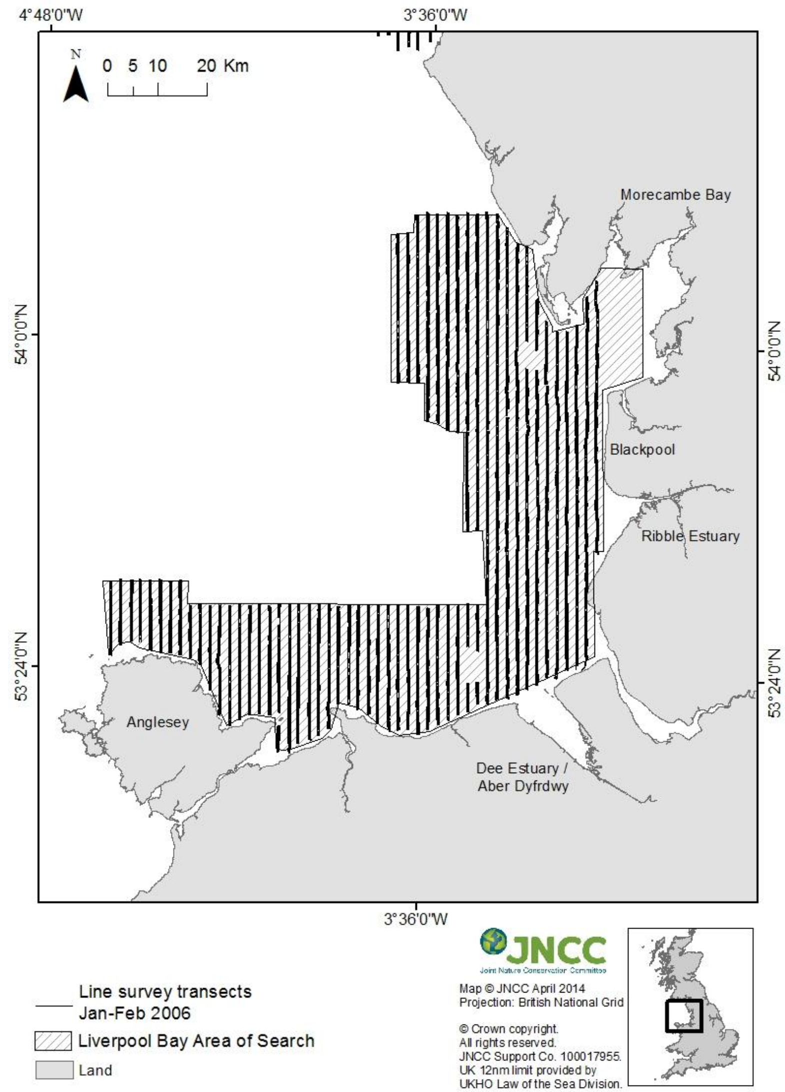
d) Winter season 2004/05 February-March



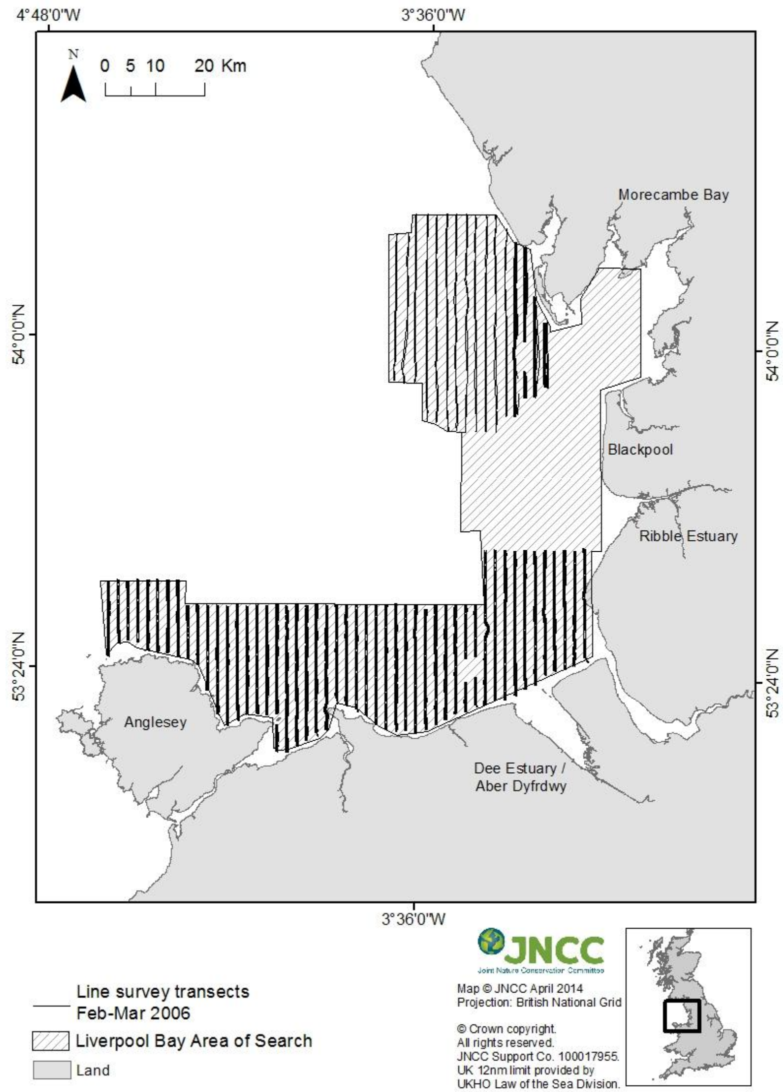
e) Winter season 2005/06 October-November



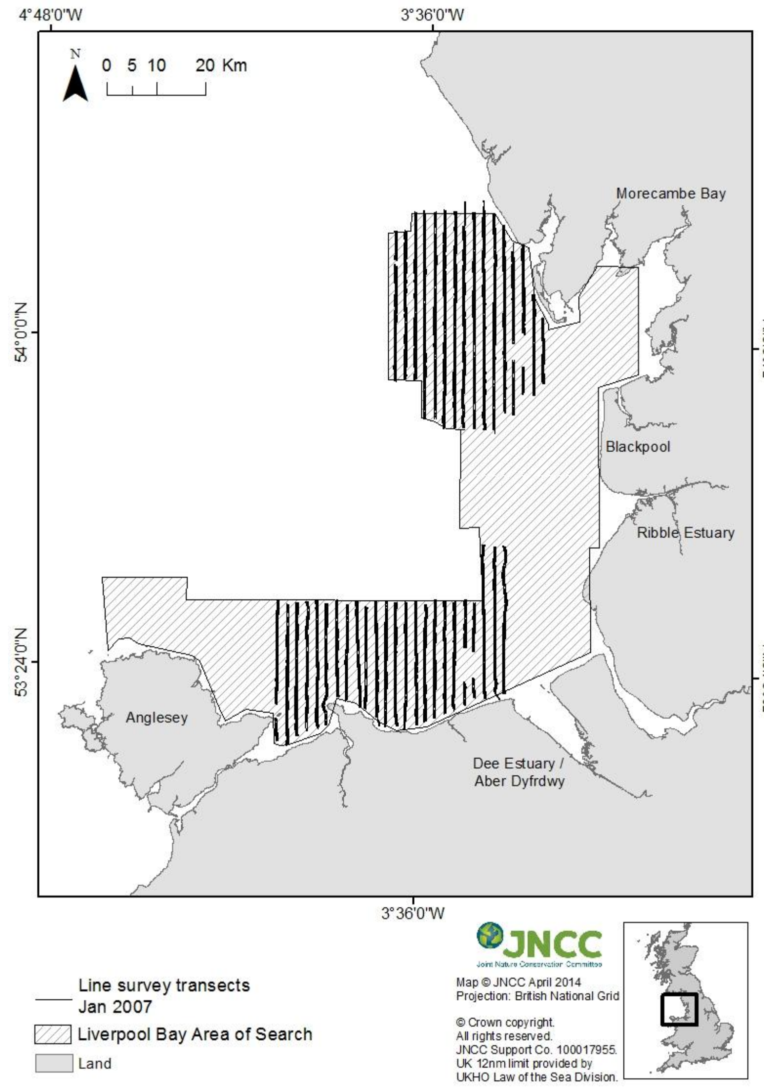
f) Winter season 2005/06 November-December



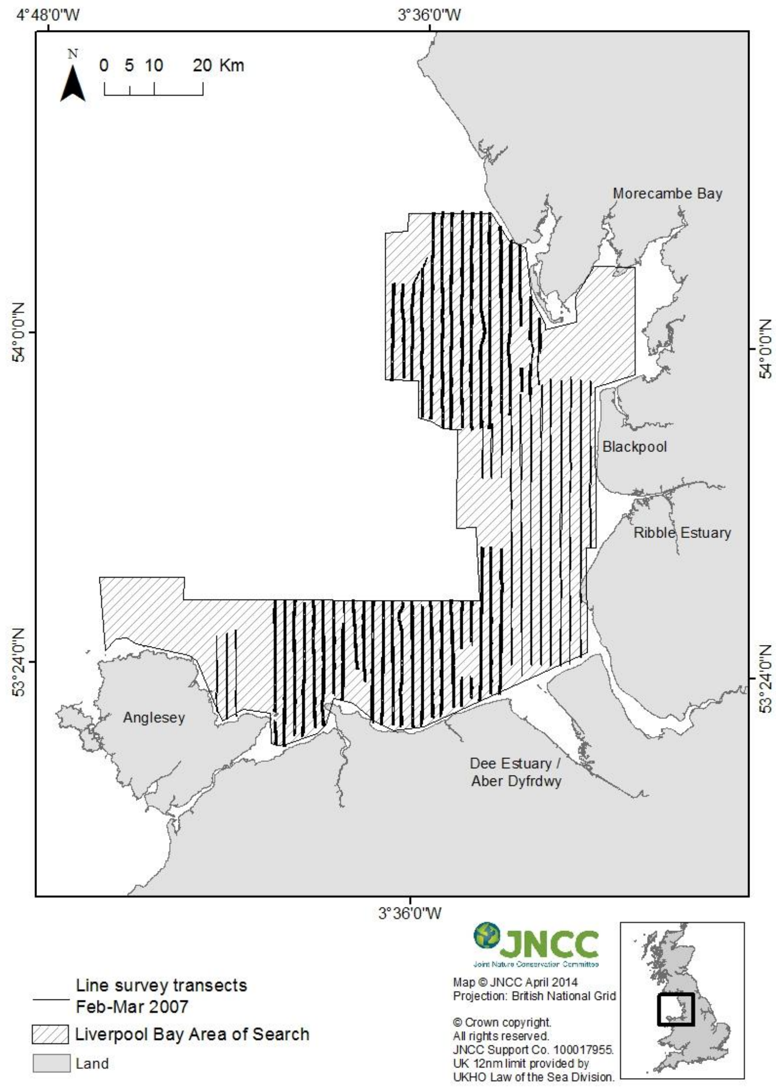
g) Winter season 2005/06 January-February



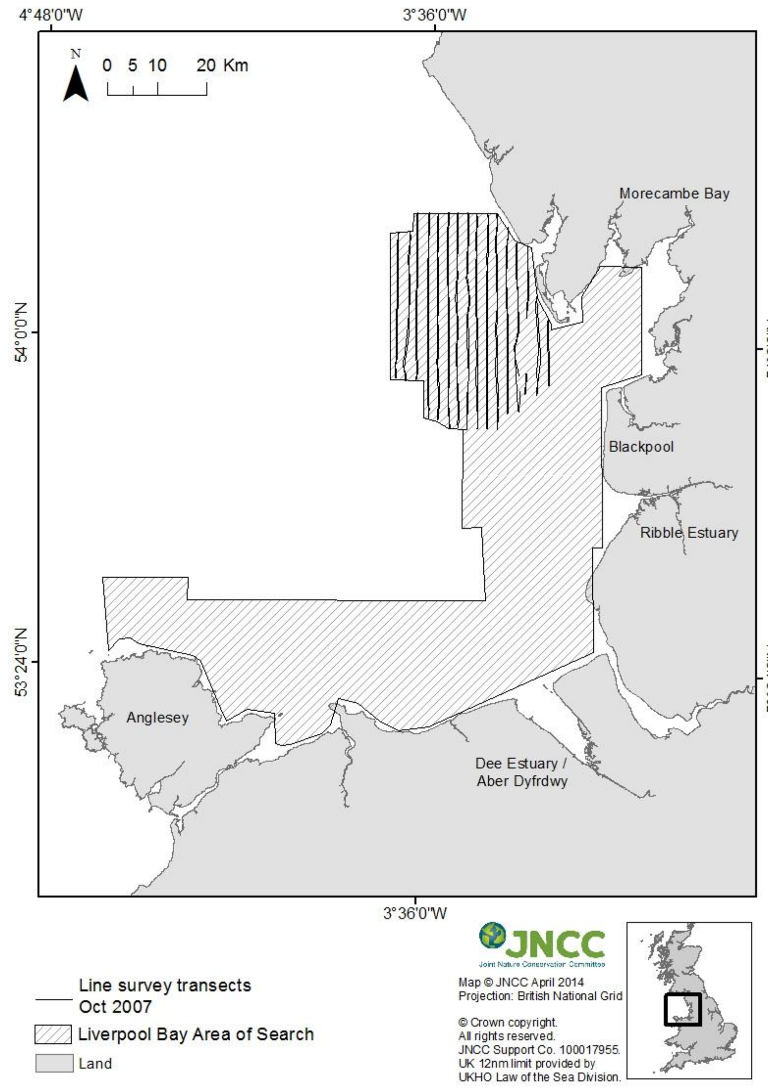
h) Winter season 2005/06 February-March



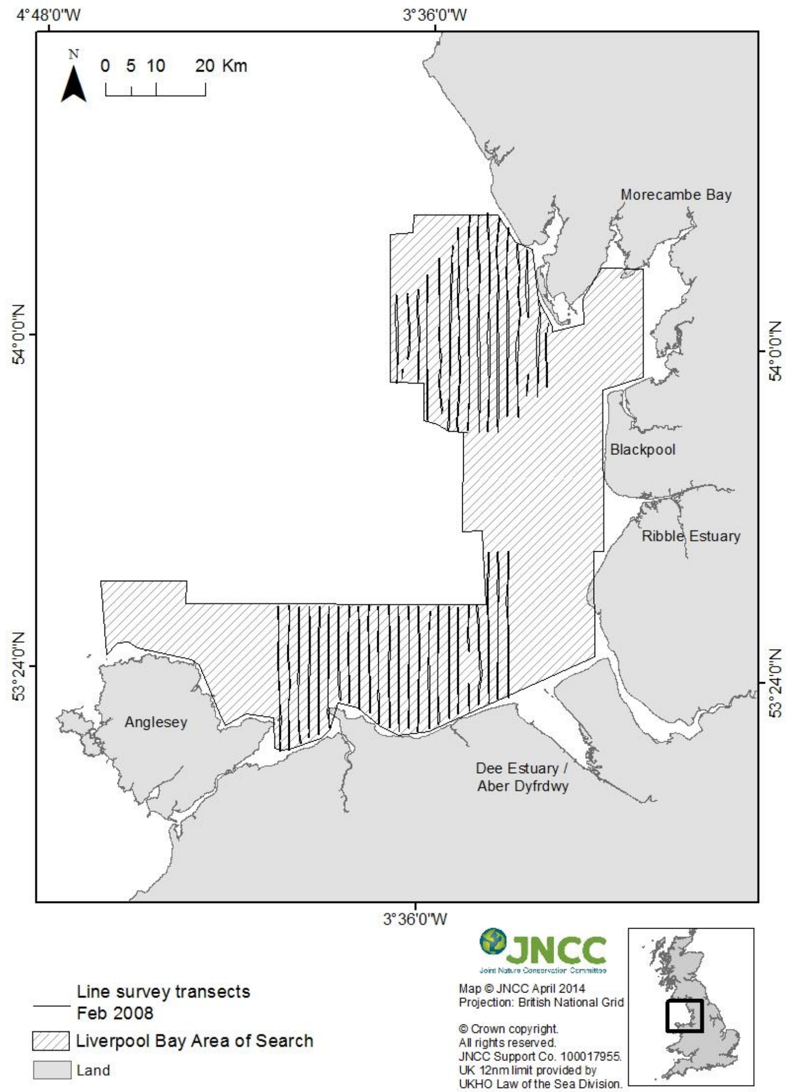
i) Winter season 2006/07 January



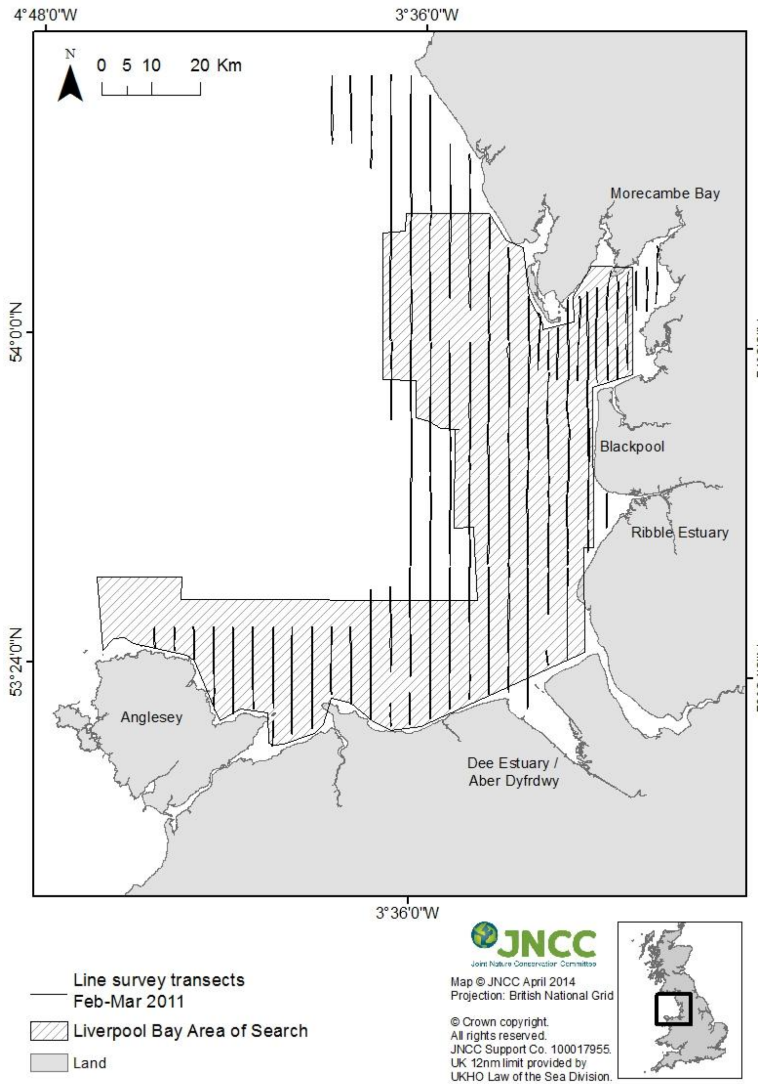
j) Winter season 2006/07 February-March



k) Winter season 2007/08 October



l) Winter season 2007/08 February



m) Winter season 2010/11 February-March

Figure A2 1. Spatial coverage of the aerial surveys in relation to Liverpool Bay/Bae Lerpwl area of search for each of the winter seasons.

Table A2 1. Dates for surveys undertaken in Liverpool Bay/Bae Lerpwl area of search. In many cases one survey of the area was split over a number of dates, the dates that together make a single survey are shown in the table below.

Winter season	Survey	Date
2004/05	Oct-Nov 2004	26 Oct 2004 01 Nov 2004 02 Nov 2004 10 Nov 2004 19 Nov 2004
	Nov-Dec 2004	27 Nov 2004 29 Nov 2004 30 Nov 2004 02 Dec 2004
	Jan 2005	13 Jan 2005 16 Jan 2005 23 Jan 2005
	Feb-Mar 2005	15 Feb 2005 16 Feb 2005 02 Mar 2005
2005/06	Oct-Nov 2005	19 Oct 2005 20 Oct 2005 10 Nov 2005
	Nov-Dec 2005	22 Nov 2005 02 Dec 2005 08 Dec 2005
	Jan-Feb 2006	11 Jan 2006 17 Jan 2006 01 Feb 2006 03 Feb 2006
	Feb-Mar 2006	14 Feb 2006 06 Mar 2006
2006/07	Jan 2007	16 Jan 2007 23 Jan 2007
	Feb-Mar 2007	21 Feb 2007 24 Feb 2007 03 Mar 2007
2007/08	Oct 2007	30 Oct 2007
	Feb 2008	15 Feb 2008 28 Feb 2008
2010/11	Feb-Mar 2011	17 Feb 2011 01 Mar 2011 05 Mar 2011

Appendix 3 – Density Surface Model little gull (Bradbury *et al* 2014)

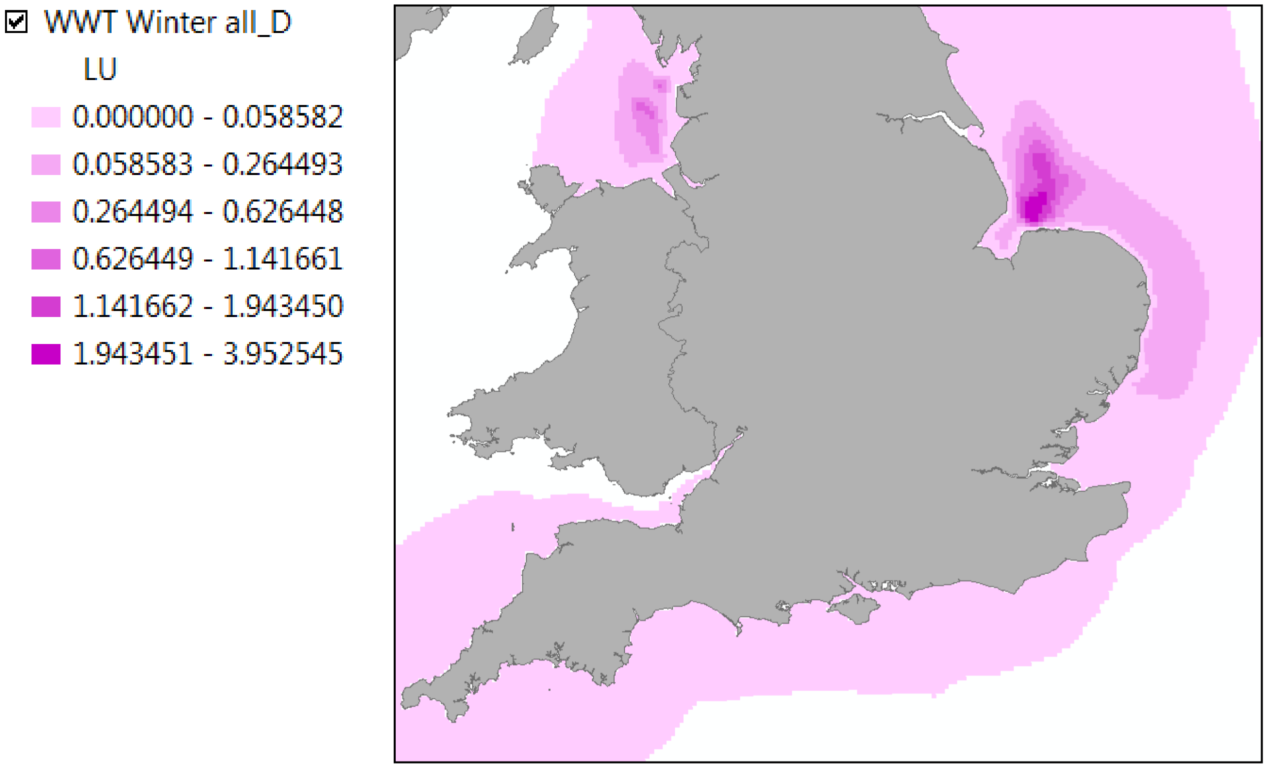


Figure A3 1. Density Surface Model for little gull, reproduced from Bradbury *et al* 2014.