



Research Report No. 655

**WeBS LOW TIDE COUNTS
ON ENGLISH SPAs**

Author

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on behalf of Natural England

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1. INTRODUCTION

1.1 Background

The Wetland Bird Survey (WeBS), a partnership between the British Trust for Ornithology, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee (the last on behalf of the statutory nature conservation bodies: Natural England, Natural Resources Wales and Scottish Natural Heritage and the Department of the Environment Northern Ireland), in association with the Wildfowl and Wetlands Trust, monitors non-breeding waterbirds in the UK.

WeBS Core Counts are carried out once a month, principally from September to March, but on some key sites including the Humber, they continue all year round. These counts are generally undertaken on a high tide at coastal and estuarine sites, partly because high tides bring birds closer to the shore and into high tide roosts, thus concentrating them into relatively small and easily accessible areas for the purposes of counting. Whilst these data enable the production of population estimates and trends, they provide little information about bird distribution on an individual site basis.

The WeBS Low Tide Count scheme, which began in the winter of 1992/93, provides information on the numbers of waterbirds feeding on subdivisions of the intertidal habitat within estuaries. These counts complement the Core Counts by helping to identify important feeding areas.

The Low Tide Count programme involves monthly co-ordinated counts by volunteers, made across the intertidal areas of the estuaries. On a few occasions (e.g Humber Estuary 2011/12 and Severn Estuary 2008/09) where specific funding was received, further gap-filling of count sections where volunteers were not able to cover was carried out by professional fieldworkers.

The aims of this project are:

- to produce GIS data layers which and are able to present the data in a way that is readily interpretable by the Inshore Fisheries Conservation Authorities (IFCAs), for the purposes of their site-based comparisons of the LTC data to spatial/temporal fishing activity data in English Special Protection Areas (SPAs).
- to provide a written report that provides a clear explanation/representation of the data limitations e.g. where there are gaps in the data due to no survey having been carried out as opposed to a survey having taken place, but no observations having been made. Also, this guidance document should aim to help ensure the IFCAs understand how the data are collected and their limitations more generally

2. METHODS

2.1 WeBS Core Counts

WeBS Core Counts are made using so-called 'look-see' methodology (Bibby *et al.* 2000), whereby the observer, familiar with the species involved, surveys the whole of a predefined area. Counts are made at all wetland habitats, including lakes, lochs/loughs, ponds, reservoirs, gravel pits, rivers, freshwater marshes, canals, sections of open coast and estuaries. At many estuarine sites where birds at high tide move out of the estuary onto adjacent agricultural land, these areas will also be counted to ensure these birds are not missed. Numbers of all waterbird species, as defined by Wetlands International (Rose & Scott 1997), are recorded. In the UK, this includes divers, grebes, cormorants, herons, Spoonbill, swans, geese, ducks, rails, cranes, waders and Kingfisher. Counts of gulls and terns are optional. In line with the recommendations of Vinicombe *et al.* (1993), records of all species recorded by WeBS, including escapes, are collected to contribute to the proper assessment of naturalised populations and escaped birds. Counts are made once per month, ideally on predetermined 'priority dates'. This enables counts across the whole country to be synchronised, thus reducing the likelihood of birds being double counted or missed. Such synchronisation is imperative at large sites, which are divided into sectors, each of which can be practicably counted by a single person in a reasonable amount of time. Local Organisers ensure coordination in these cases due to the high possibility of local movements affecting count totals.

2.2 WeBS Low Tide Counts

The Low Tide Count scheme provides information on the numbers of waterbirds feeding on subdivisions of the intertidal habitat within estuaries. The count methods for Low Tide Counts are much the same as for Core Counts, although unlike for the standard monthly WeBS Core Counts, the Low Tide scheme doesn't demand that counts are made on specific dates. The principal reason for this is **that the primary purpose of the scheme is to investigate relative distribution, averaged over several dates, and not to determine overall population sizes**. Also, on some estuaries, counters take more than one day to cover all sectors. This is justified in that the scheme aims to measure relative bird density on sites: that is, if a sector is important for birds at low water, it does not matter if a flock of Dunlin recorded there was also recorded elsewhere - the outcome is that we know both areas to be important. The full detailed methodology can be found in '*Estuarine waterbirds at Low Tide*' (Musgrove *et al.* 2003).

The Low Tide Counts are carried out over a period of two hours either side of low tide on all sectors **between November and February**. Standard WeBS Low Tide Counts take place between November and February, partly because waterbird numbers on estuaries are at their highest then, partly to minimise between month variations in counts and partly because this is the time of year when feeding constraints are likely to be at their greatest. A key objective of the scheme is to record feeding distributions and studies have shown that, for many of the specialist estuarine species, a high proportion of birds feed during this four hour period across the low tide. Also since the position of the tideline (and thus the availability of food) is relatively stable during this period, changes in the numbers and distribution of waterbirds are consequently relatively small.

The Low Tide sections used usually differ from those used for Core Counts, with the former being smaller to allow finer detail of distribution of birds within the estuary. The area covered at low tide is defined as the habitat between the high water mark and the low water mark. This includes intertidal marshes and dune systems in addition to the extensive intertidal mud and sand flats.

For the purposes of mapping distributions of birds, each section is split into different habitat types where present: intertidal refers to areas that lie between mean high water and mean low water;

sub-tidal refers to areas that lie below mean low water. In more 'open-coast'-type situations, a sub-tidal zone reaching 500 m out from the inter-tidal sections has been created arbitrarily, to indicate the approximate extent of visibility offshore from land-based counts; and non-tidal zone referring to areas that lie above mean high water (usually saltmarsh although some grazing marshes and areas such as pits or fields may also be covered if they are readily used by birds (e.g geese and Curlew) which are otherwise associated with the estuary).

2.2.1 Site coverage

Given the extra work that Low Tide Counts entail, often to the same counters that carry out the Core Counts, WeBS aims to cover most individual estuaries about once every six years, although on some sites more frequent counts are made. A total of 51 estuaries in England have been included in the Low Tide Count programme to date which are shown in Figure 1 and the coverage of the individual sections can be found in the 'WeBS_LTC_sites_Monthly_coverage' tab of the accompanying excel document. A table showing the estuary coverage throughout the course of the Low Tide Count programme is presented in Appendix A and can also be found in the 'Site_Feature_LTC_list' tab of the accompanying excel document.

2.2.2 SPA coverage

Of the 51 coastal SPAs in England, 37 have estuaries within them which have been counted under the WeBS Low Tide Count Scheme. Appendix B shows the SPA under which the estuary is included where appropriate. The extent of area covered by Low Tide Counts within these SPAs can be found in Appendix C. Eight additional estuaries – Adur, Camel, Fal, Fowey, Hayle, Kingsbridge, Taw/Torridge and Wear Estuaries have also been included within the WeBS Low Tide Count Scheme but do not fall within any SPAs.

2.2.3 Species coverage

The list of species of interest for the Low Tide Count Programme was that adopted for the WeBS Core Counts, and included all waders and wildfowl, along with divers, grebes, cormorants, herons, rails, gulls, terns and kingfisher. Although data collection for all waterbirds was encouraged, recording of gulls and terns is optional and is left at the discretion of the individual counter. As Low Tide Counts are carried out only between November and February, **tern species rarely feature and any numbers present would not be representative on an SPA scale.**

2.3. Survey Analysis and Interpretation

2.3.1 Data storage, validation and calculation

The inputting of WeBS Counts has changed over the years. Up until the WeBS year 2006/07, counters entered their counts on paper forms which were then sent to an external inputting company, the resulting files were then validated and stored in the WeBS database. Since the advent of WeBS Online in May 2007, counters could enter their counts direct into WeBS Online, which has a built in system whereby the counts are validated using pre-existing threshold levels for each species and flagging up any records which break these. This allows the counter to re-check their records and if they have made an error whilst inputting their data, they can edit the record before it gets submitted to the WeBS Online database. Once the counts had been submitted, any records which had been flagged by the online system were verified by WeBS staff at the BTO and if any irregularities were found, these were discussed with the relevant counter.

2.3.2 Presentation of Low Tide Count data

Low Tide Count data can be assigned to well-defined geographical areas. The presentation of results in map form has many advantages over a simple tabulation of statistics since it enables an appreciation of the relationship between different count sections. We chose to present the results in the form of 'dot density' maps. Using GIS technology, the production of maps depicting bird distribution has been a major theme from the beginning of the Low Tide Counts data collection (Musgrove *et al.* 2003).

Since the mean numbers of waterbirds are used for plotting the results, there is a continuous depiction of relative densities (as opposed to a discrete set of abundance bands, for example). For some species (e.g. Knot), there may be such large numbers of birds on some count sections that it is not possible to differentiate between densities in different sections. In such a case, the GIS can be instructed to display, for example, one dot for every five Knot. Species-specific habitat associations have been applied in production of the distribution maps and so, for example, Bar-tailed Godwits are plotted only on intertidal parts of a count section whilst Common Scoters are plotted in the sub-tidal zone. Other species, less specialised in habitat use, have been assigned to more than one zone for mapping purposes (e.g. Curlew on both saltmarsh and mudflats) (Musgrove *et al.* 2003).

The dot density distribution maps display the average number of birds in each count section as dots spread randomly across habitat components of count sections, thus providing an indication of both numbers and density. **It is important to note that individual dots do not represent the precise position of individual birds; dots have been assigned to habitat components proportionally and are then randomly placed within those areas. No information about the distribution of birds at a finer scale than the count sector level should be inferred from the dot density maps.** A list of the species habitat preferences can be found in Appendix D.

2.3.3 Areas and densities

The presentation and analysis of Low Tide Count results are based on bird density, primarily because the individual count sectors are not of equal size, and therefore a density value provides the best method for inter-sector comparison (Mander & Cutts 2005). To calculate the density, it is necessary to have an area measurement for the estuary as a whole and for sectors, with area values derived from a Geographic Information System (GIS), for the purposes of this report, using ArcMap 10. One of the many advantages of the use of a GIS for storing and manipulating maps is that the area of each section can be calculated automatically, which is faster than using traditional methods, but is also less prone to error and, more importantly, importantly, completely repeatable. In the shapefiles, areas are measured in hectares (1 ha = 100m x 100m) and consequently **densities are given as birds per hectare (b/ha).**

Throughout all WeBS Low Tide Count analyses, mean low tide and mean high tide are taken from the most recent Ordnance Survey 1:25000. It is recognised, unfortunately, that these maps represent the current real shape of the mudflats, water channels and saltmarshes to varying degrees of accuracy. Whilst intertidal flats, saltmarshes and channels are often of relatively stable shape between years, at some sites major changes occur. However, in the interests of uniformity across the UK, the Ordnance Survey outlines are adhered to throughout these analyses.

2.3.4 Limitations of using dot density maps

As Low Tide Counts on a sector are carried out on a single day (though counts on the site may be carried out over several) each month, it should be remembered that the WeBS counts are a

snapshot of what is there on the day of the count and so factors such as disturbance or weather on the day may affect numbers present on a section. This is especially important when looking at the distributions of birds for the individual months, and particular caution needs to be exercised. Over the course of a winter, if counted every month, these issues become less of a problem as the dots presented are based on the mean of the four months and so a disturbance event in a single month is less likely to give a false impression of distribution. Making comparisons of birds between years can highlight true shifts in distributions though care must be taken to ensure the count effort in both years is comparable (see the coverage of the individual sections can be found in the 'WeBS_LTC_sites_Monthly_coverage' tab of the accompanying excel document) and a full estuary count of all four months isn't compared with a count from just a single month.

On some distribution maps, there may be artificially sharp boundaries between the dots representing one count section and those representing a neighbouring one. These sharp demarcations are a product of the count sections selected and, in many cases, the change from high density to a low density would be less well marked in reality.

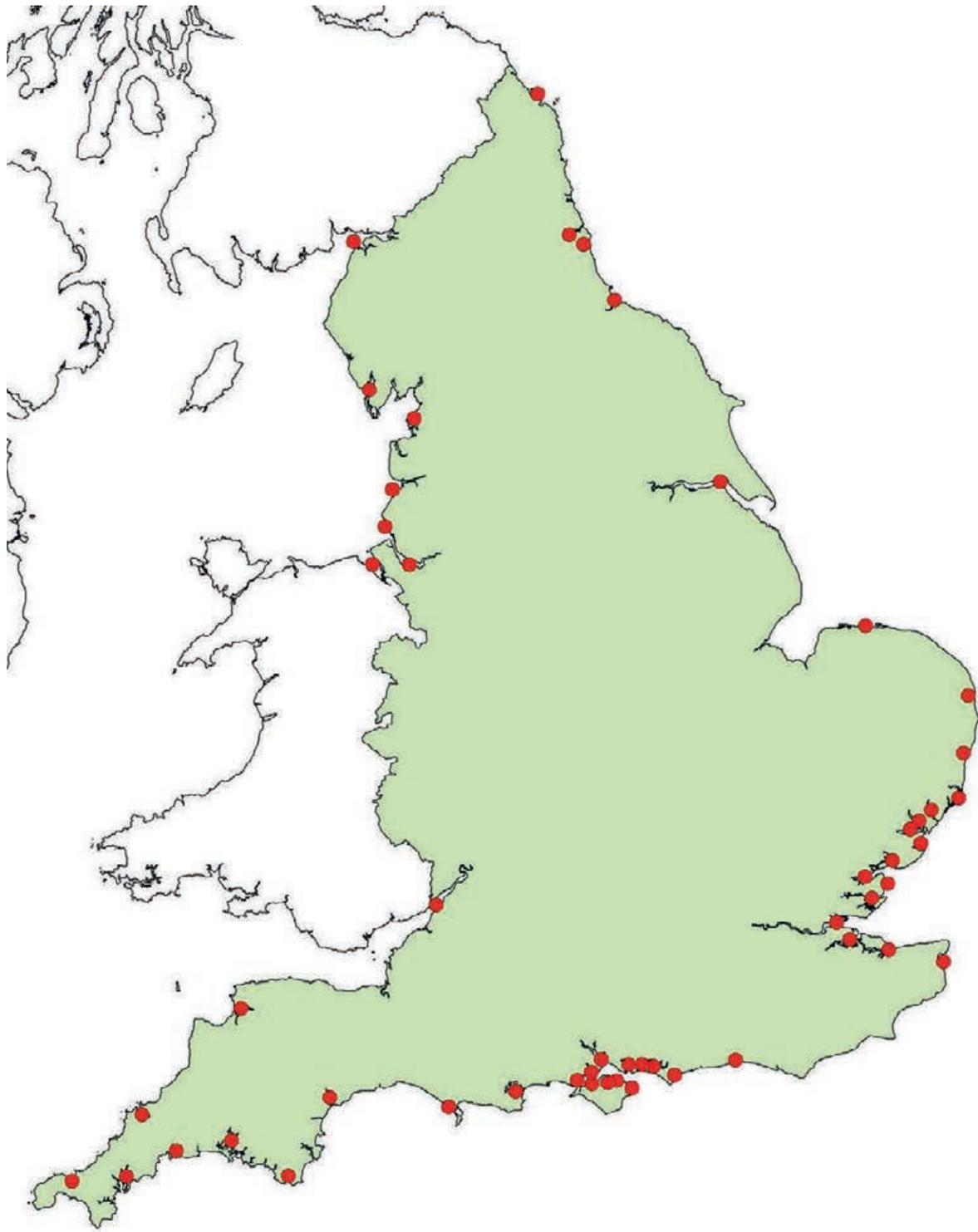


Figure 1 Map of estuaries counted under the WeBS Low Tide Count Scheme in England

3. USING THE GIS SHAPEFILES

3.1 Creating dot density maps

For ease of use, both the species and habitat shapefiles have been created with one shapefile of each for each winter (e.g. 2011-12_birds.shp and 2011-12_sites.shp). These can be displayed together so that the habitat files can be overlaid with the species which can be shown as dot density maps. In addition to the aggregated winter totals, shapefiles containing the data for each month (November to February) of every winter are also available to be presented (e.g. December_1992-93_birds.shp).

3.2 Birds shapefiles

The attributes table of the shapefile containing the bird information (e.g. 2011-12_birds.shp and December_1992-93_birds) contains the following columns:

NWC	Estuary	Two letter species code			
		AV	BA	BB	BE
CB001a	Blackwater	0	5	0	0
CB001b	Blackwater	0	0	0	0
CB001c	Blackwater	0	0	1	0

NWC – This column indicates the section number. Each section has a different line for each distinct habitat which is signified by the letter at the end of the five digit section code where a = intertidal, b = sub-tidal and c = non-tidal.

Estuary – The name of the WeBS site (see Appendix B)

Two-letter species codes – the remaining columns contain the mean count over the winter period of each species; the column header is the two letter species code used. A full list of the two letter BTO codes of the most common species can be found in Appendix E.

3.3 Habitat Shapefiles

The attributes table of the shapefile containing the habitat and coverage information (e.g. 2011-12_sites.shp) contains the following columns:

NWC	HABITAT	AREA	X_COORD	Y_COORD	SPA	Estuary
CB001a	1	50	597963	211352	Blackwater Estuary	Blackwater
CB001b	2	31	600032	211300	Blackwater Estuary	Blackwater
CB001c	3	11	598657	211028	Blackwater Estuary	Blackwater
CB002a	0	36	597337	211909	Blackwater Estuary	Blackwater
CB002b	0	10	597278	211758	Blackwater Estuary	Blackwater

NWC – This column indicates the five digit section number and habitat code. Each section has a different line for each distinct habitat which is signified by the letter at the end of the five digit section code where a = intertidal, b = sub-tidal and c = non-tidal.

Habitat – Used for displaying the coverage where 1 = intertidal, 2 = sub-tidal, 3 = non-tidal and 0 = area not counted that year.

Area – The area of the habitat in hectares

X_COORD – The X coordinate of the centre of the count section

Y_COORD – The Y coordinate of the centre of the count section

SPA – The SPA under which the estuary falls

Estuary – The name of the WeBS site (see Appendix B)

3.4 Creating dot density maps

Creating dot density maps for either the whole winter or individual months is very straightforward using the following steps:

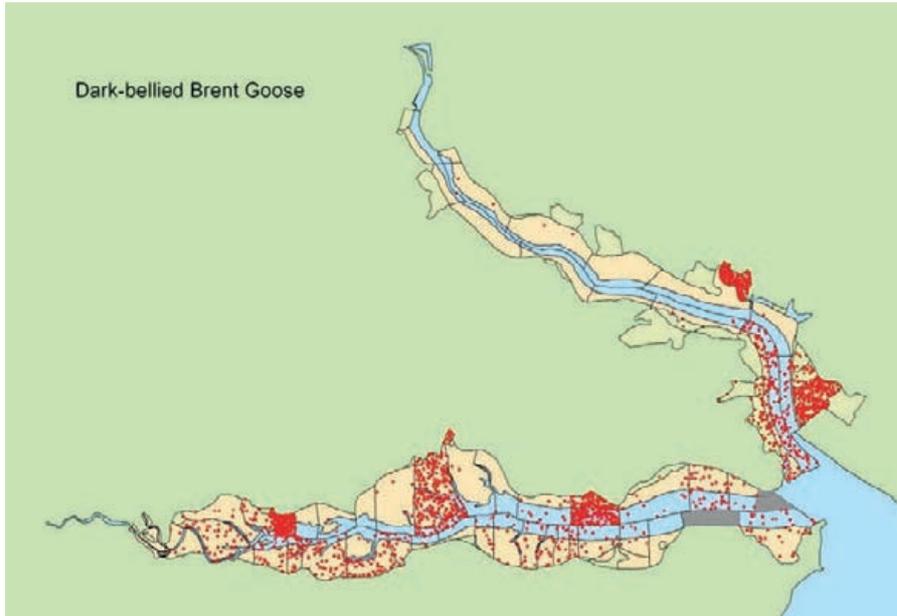
To create habitat backdrops:

1. Open the symbology of the sites shapefile by right clicking on the required layer name (e.g 2011_sites) and select 'properties'.
2. Of the options given under the symbology tab, select to show 'categories'
3. In the 'Value Field', select 'Habitat' and then add all values.
4. The four possible habitats as listed in 3.3 will then be available which can be coloured up as necessary.

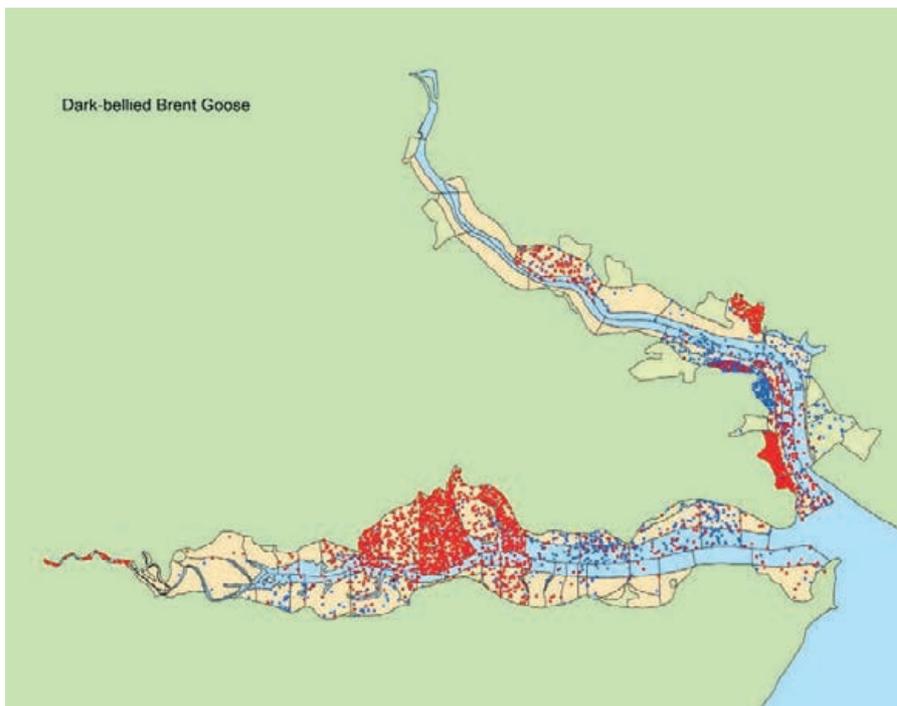
To show densities of birds:

5. Open the symbology of the birds shapefile by right clicking on the required layer name (e.g 2011_birds or December_1992-93_birds.shp) and select 'properties'.
6. Of the options given under the symbology tab, select to show 'quantities'
7. You should be able to decide how to show these, one of the options will be 'dot density'
8. From here you can select which species you want to display (several species can be shown at once if necessary) and also can specify how many birds are represented by a single dot (dot value). The ability to change the dot value is very useful for areas where there are high concentrations of a particular species.

The final map should now show the species overlaying the habitats. In the example below of Dark-bellied Brent Goose on the Stour and Orwell Estuaries, each dot represents one bird. The habitats have been coloured 1 – beige, 2 - light blue, 3 – olive and 0 – grey (see section 3.3). The ability to highlight areas using the habitat field that weren't counted in that winter allows the user to be able to differentiate between areas where there was a count made but no birds and no count made.



More than one year or month can be displayed on the same map and coloured differently to show changes in distribution. In the example below, the 2011/12 data are shown as red dots and the 2004/05 birds as blue dots.



References

Bibby, C.J., Burgess, N.D., Hill, D.A. & Mustoe, S. (2000). *Bird Census Techniques*. Second Edition. Academic Press, London.

Mander, L & Cutts, N.D, 2005. Humber Estuary Low Tide Programme 2003-2004. *English Nature Research Reports*, No. 656.

Musgrove, A.J., Langston, R.H.W, Baker, H, and Ward, R.M. 2003. *Estuarine Waterbirds at Low Tide: the WeBS Low Tide Counts 1992-93 to 1998-99*. Thetford: WSG/BTO/WWT/RSPB/JNCC.

Vinicombe, K., Marchant, J. & Knox, A. (1993). Review of status and categorization of feral birds on the British List. *British Birds*, **75**, 1-11.

Appendix A Estuary coverage under the WeBS Low Tide Count scheme which fall within SPAs. Red box denotes at least one count made that winter.

Estuary	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12
Alde																				
Alt																				
Beaulieu																				
Bembridge Harbour																				
Blackwater																				
Blyth (Suffolk)																				
Breydon Water																				
Chichester Harbour																				
Colne																				
Crouch/Roach																				
Deben																				
Dee																				
Dengie Flats																				
Duddon																				
Exe																				
Hamford Water																				
Humber																				
Langstone Harbour																				
Lindisfarne																				
Medina																				
Medway																				
Mersey																				
Morecambe Bay																				
Newtown Harbour																				
North Norfolk Coast																				
North-west Solent																				
Orwell																				
Pagham Harbour																				
Pegwell Bay																				
Poole Harbour																				
Portland Harbour																				
Portsmouth Harbour																				
Ribble																				

Estuary	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12
Severn																				
Solway Firth																				
Southampton Water																				
Stour																				
Swale																				
Tamar																				
Tees																				
Thames																				
Tyne																				
Wootton Estuary																				

Appendix B SPA and related WeBS site (estuary).

SPA	WeBS site
Alde-Ore SPA UK9009112	Alde Estuary
Benfleet and Southend Marshes SPA UK9009171	Thames Estuary
Blackwater Estuary SPA UK9009245	Blackwater Estuary
Breydon Water SPA UK9009181	Breydon Water
Chesil Beach and The Fleet SPA UK9010091	Portland Harbour
Chichester and Langstone Harbours SPA UK9011011	Chichester Harbour
Chichester and Langstone Harbours SPA UK9011011	Langstone Harbour
Colne Estuary SPA UK9009243	Colne Estuary
Crouch and Roach Estuaries SPA UK9009244	Crouch/Roach
Deben Estuary SPA UK9009261	Deben Estuary
Dengie SPA UK9009242	Dengie Flats
Duddon Estuary SPA UK9005031	Duddon Estuary
Exe Estuary SPA UK9010081	Exe Estuary
Foulness SPA UK9009246	Crouch/Roach
Hamford Water SPA UK9009131	Hamford Water
Humber Flats, Marshes and Coast (Phases 1 and 2) UK9006111	Humber Estuary
Lindisfarne SPA UK9006011	Lindisfarne
Medway Estuary and Marshes SPA UK9012031	Medway Estuary
Mersey Estuary SPA UK9005131	Mersey Estuary
Minsmere-Walberswick SPA UK9009101	Blyth Estuary (Suffolk)
Morecambe Bay SPA UK9005081	Morecambe Bay
North Norfolk Coast SPA UK9009031	North Norfolk Coast
Northumbria Coast SPA UK9006131	Tyne Estuary
Pagham Harbour SPA UK9012041	Pagham Harbour
Poole Harbour SPA UK9010111	Poole Harbour
Portsmouth Harbour SPA UK9011051	Portsmouth Harbour
Ribble and Alt Estuaries Phase 2 SPA UK9005103	Alt Estuary
Ribble and Alt Estuaries Phase 2 SPA UK9005103	Ribble Estuary
Severn Estuary SPA UK9015022	Severn Estuary
Solent and Southampton Water SPA UK9011061	Beaulieu Estuary
Solent and Southampton Water SPA UK9011061	Medina Estuary
Solent and Southampton Water SPA UK9011061	Newtown Harbour
Solent and Southampton Water SPA UK9011061	North-west Solent
Solent and Southampton Water SPA UK9011061	Southampton Water
Solent and Southampton Water SPA UK9011061	Wootton Estuary
Solent and Southampton Water SPA UK9011062	Bembridge Harbour
Stour and Orwell Estuaries SPA UK9009121	Orwell Estuary
Stour and Orwell Estuaries SPA UK9009121	Stour Estuary
Tamar Estuaries Complex SPA UK9010141	Tamar Complex
Teesmouth and Cleveland Coast SPA UK9006061	Tees Estuary
Thames Estuary and Marshes SPA UK9012021	Thames Estuary
Thanet Coast and Sandwich Bay SPA UK9012071	Pegwell Bay

SPA	WeBS site
The Dee Estuary SPA UK9013011	Dee Estuary
The Swale SPA UK9012011	Swale Estuary
Upper Solway Flats and Marshes SPA UK9005012	Solway Firth

Appendix C Coverage of each SPA by WeBS Low Tide Count sectors

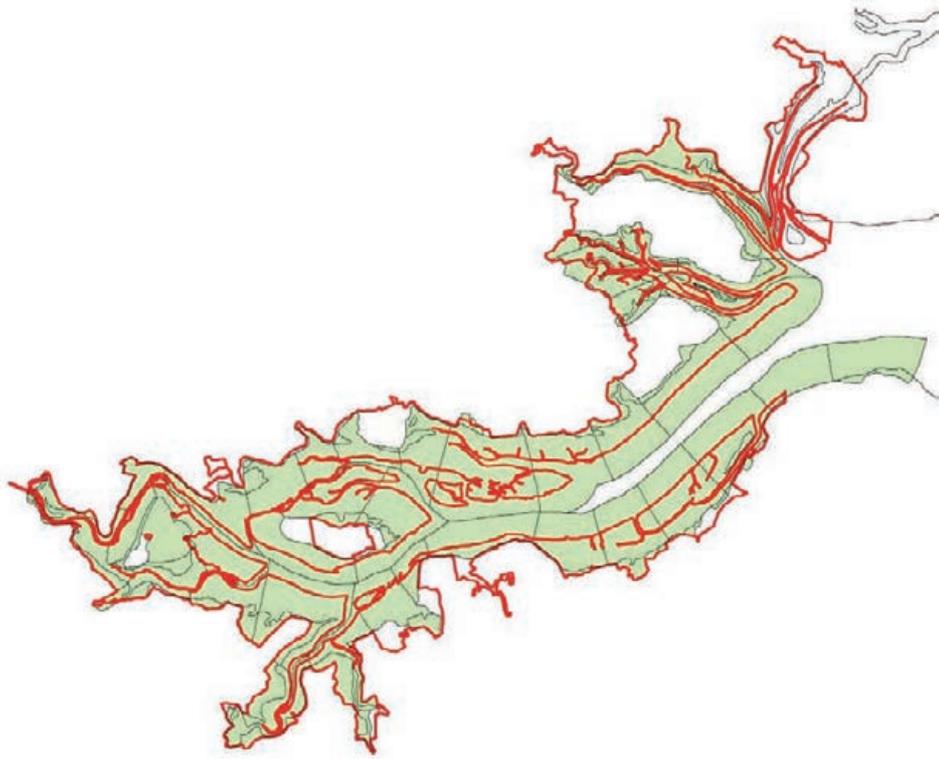
Red outline shows the SPA boundary, green areas the WeBS Low Tide Count sections.



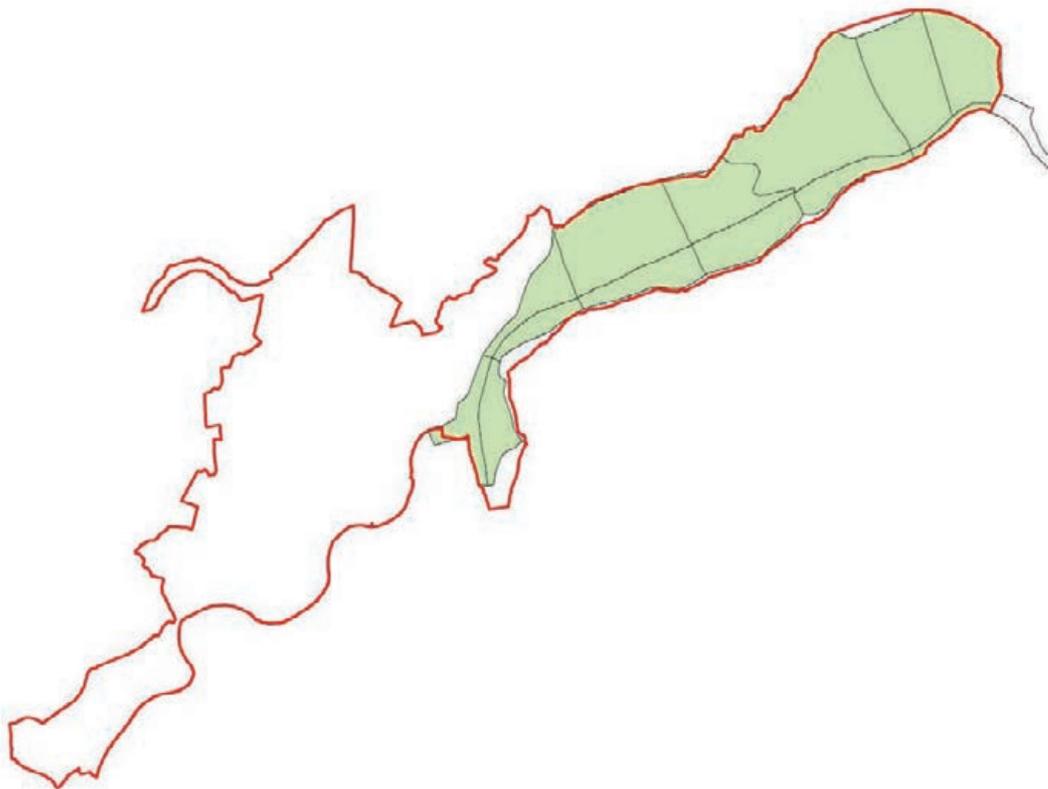
Alde-Ore Estuary SPA



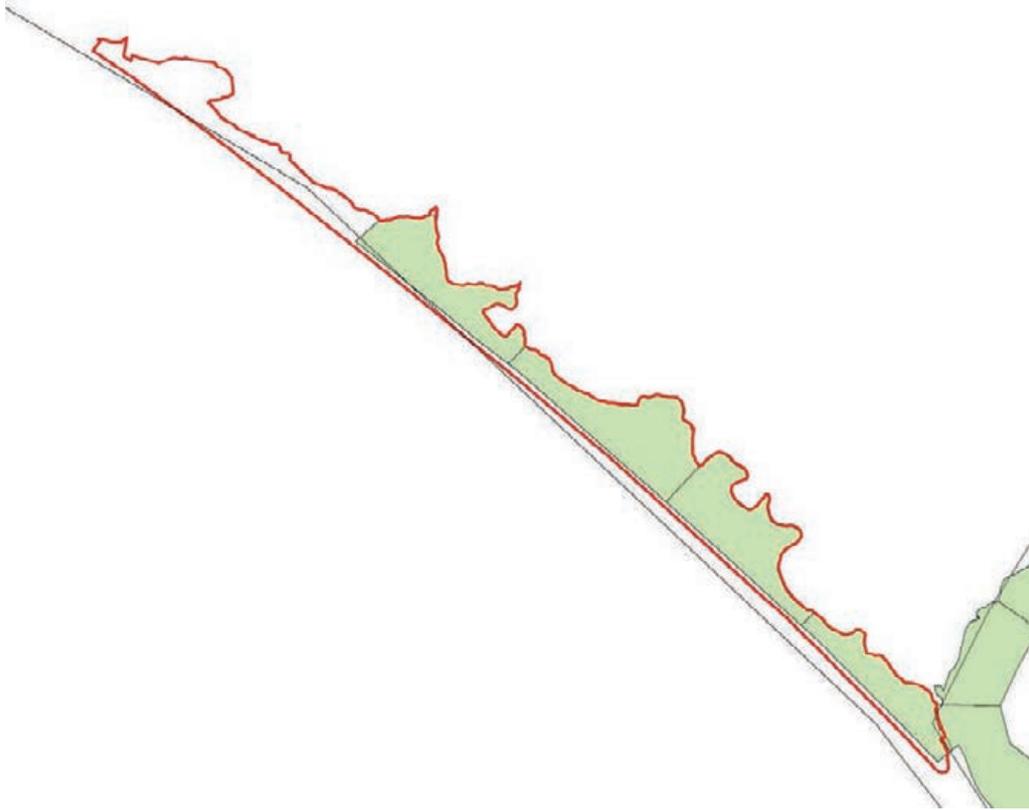
Benfleet and Southend Marshes SPA



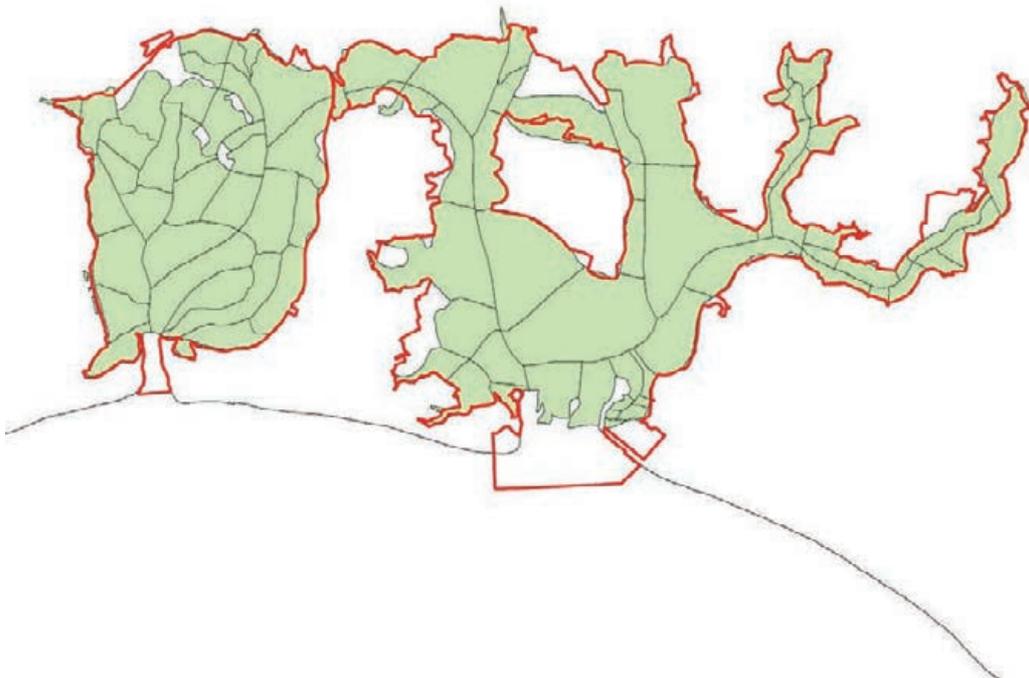
Blackwater Estuary SPA



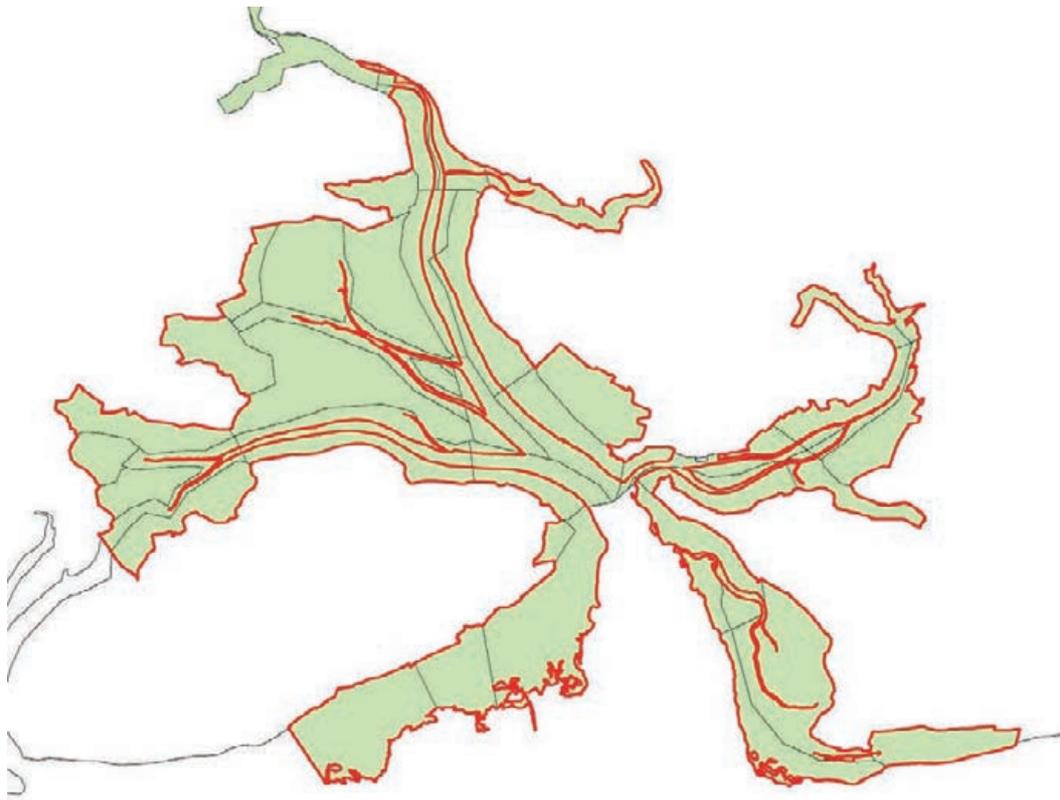
Breydon Water SPA



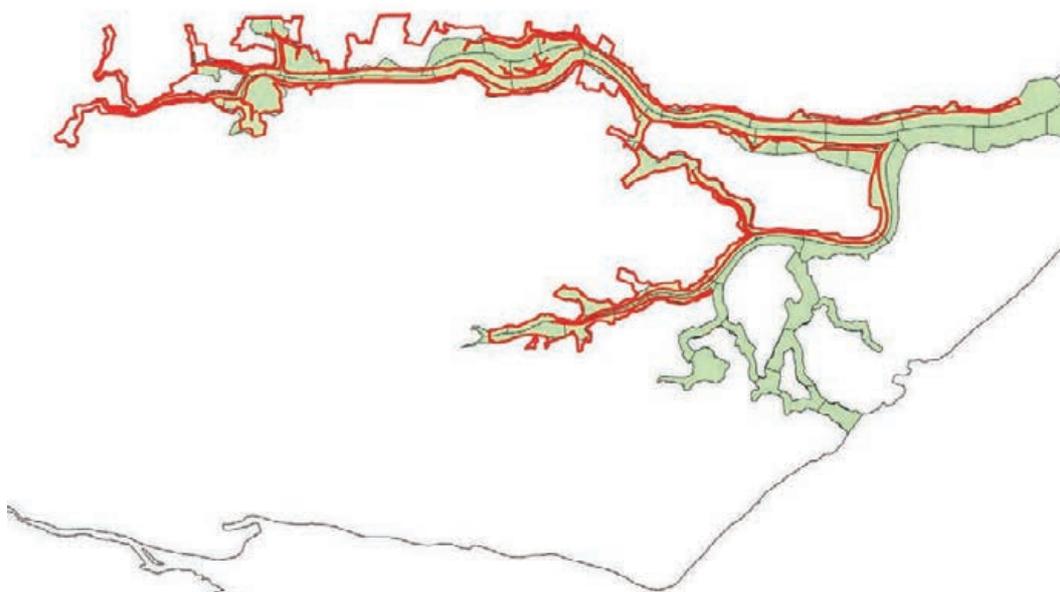
Chesil Beach and The Fleet SPA



Chichester and Langstone Harbours SPA



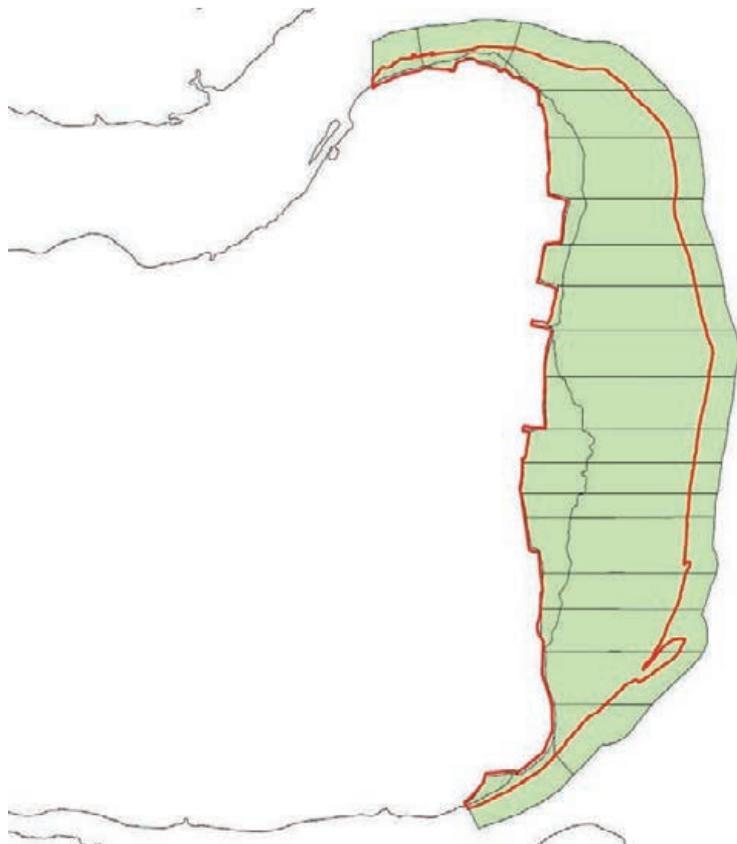
Colne Estuary SPA



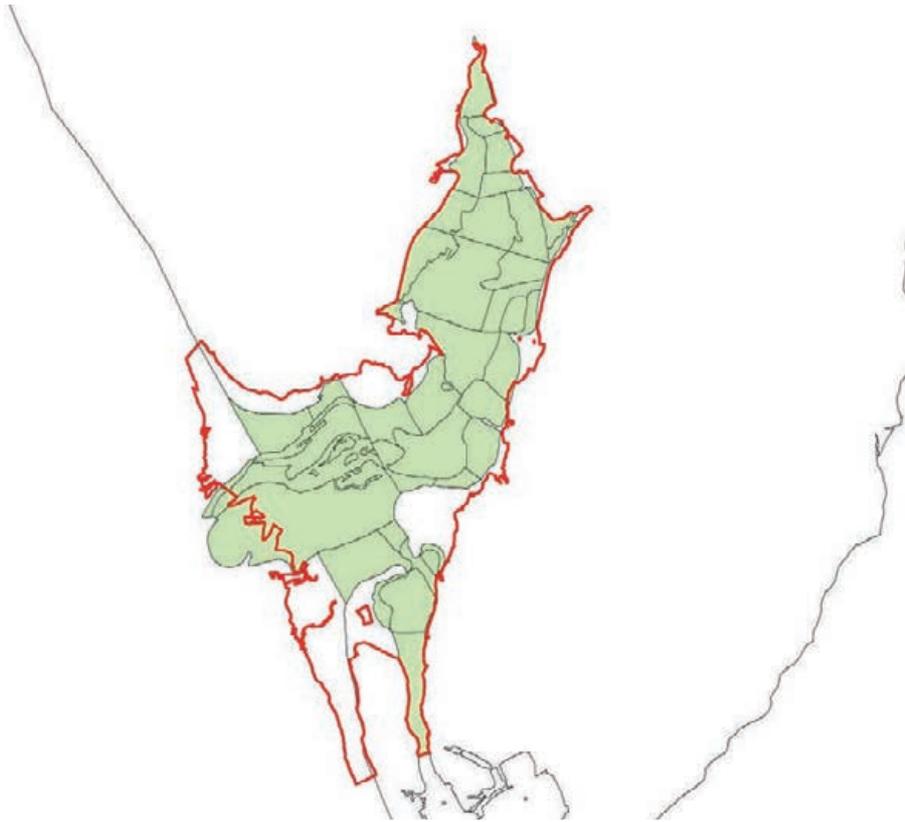
Crouch and Roach Estuaries SPA



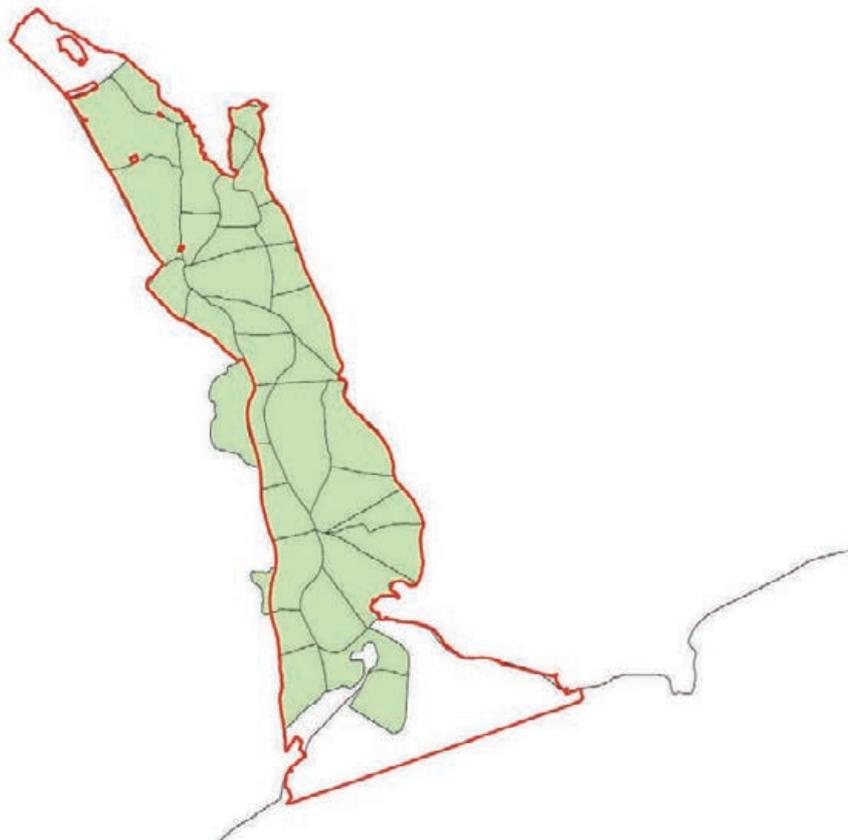
Deben Estuary SPA



Dengie SPA



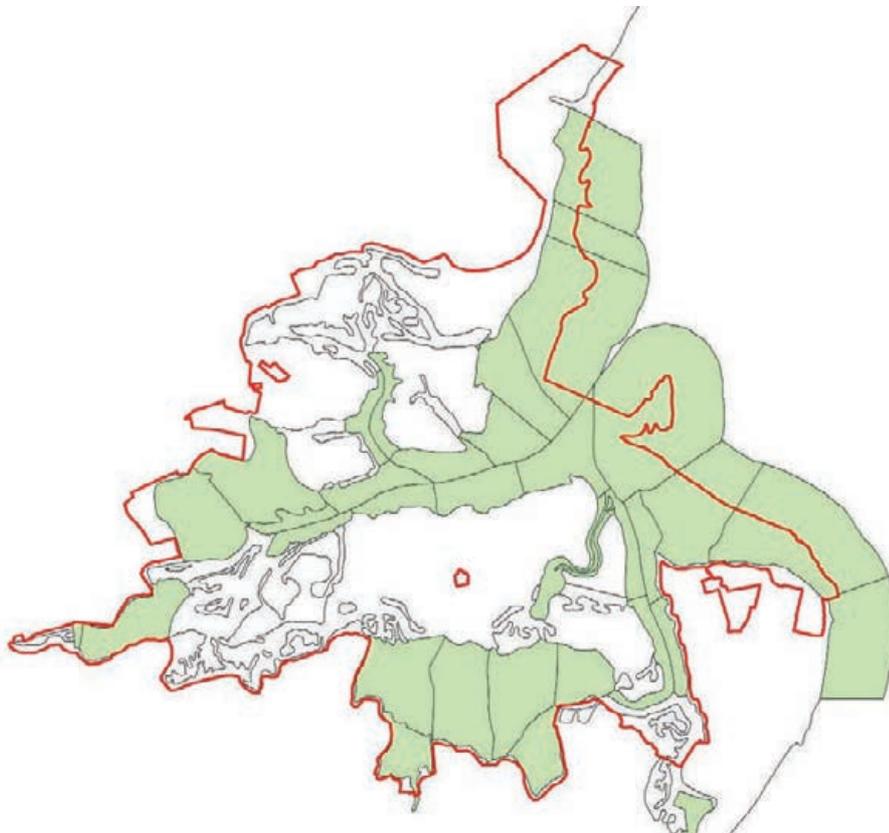
Duddon Estuary SPA



Exe Estuary SPA



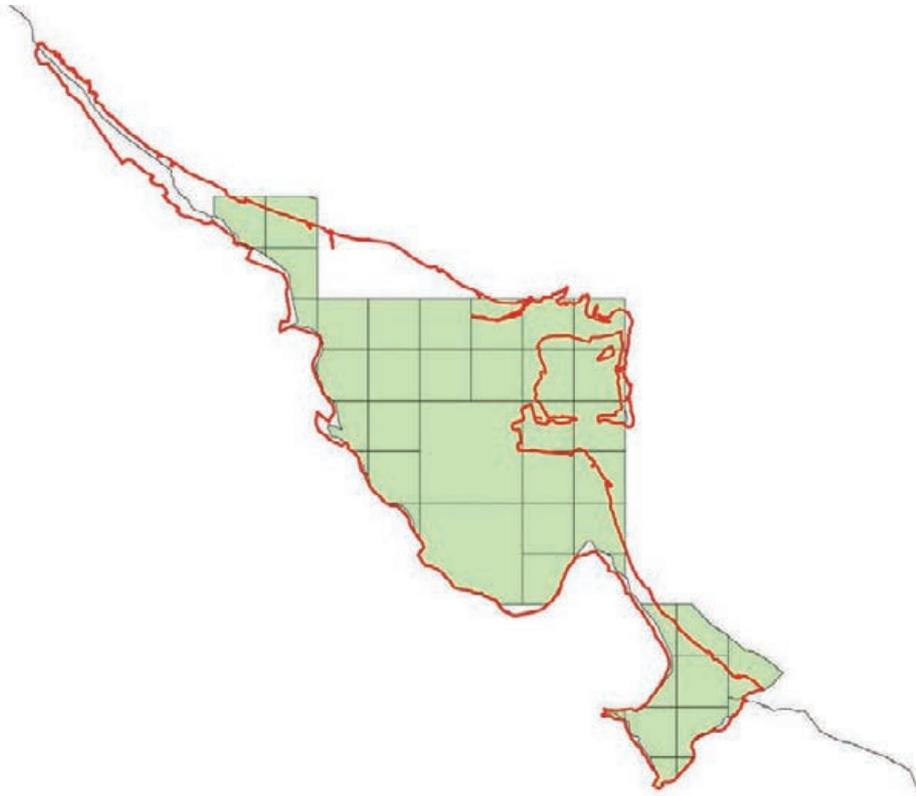
Foulness SPA



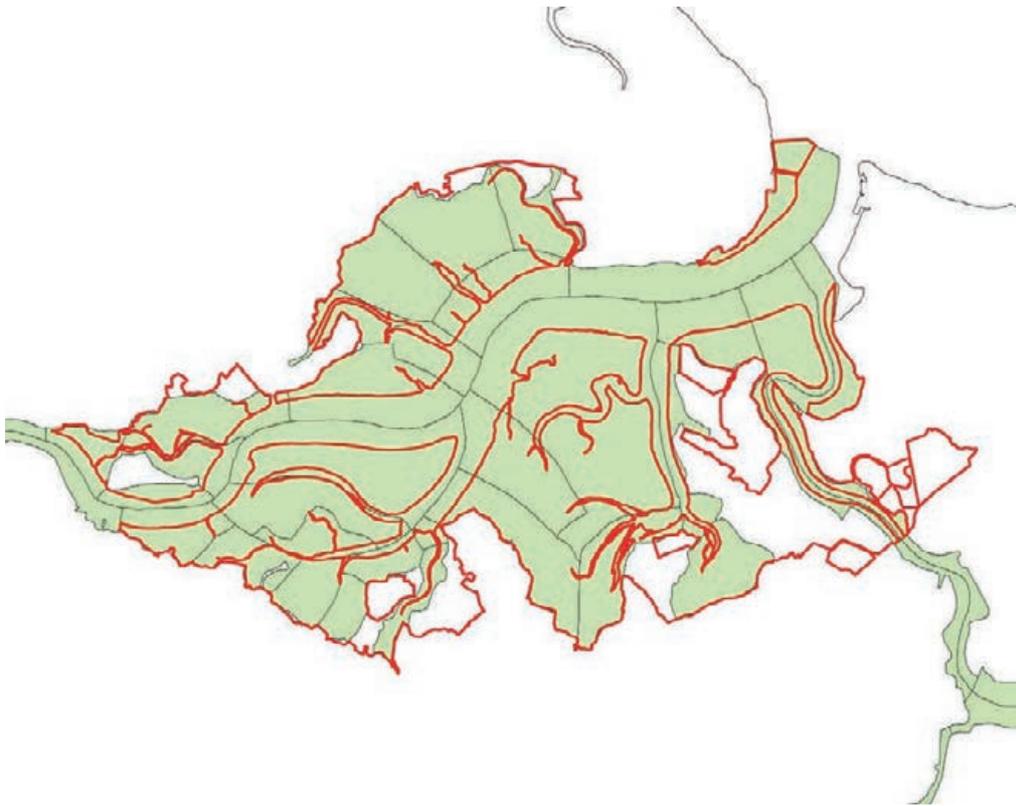
Hamford Water SPA



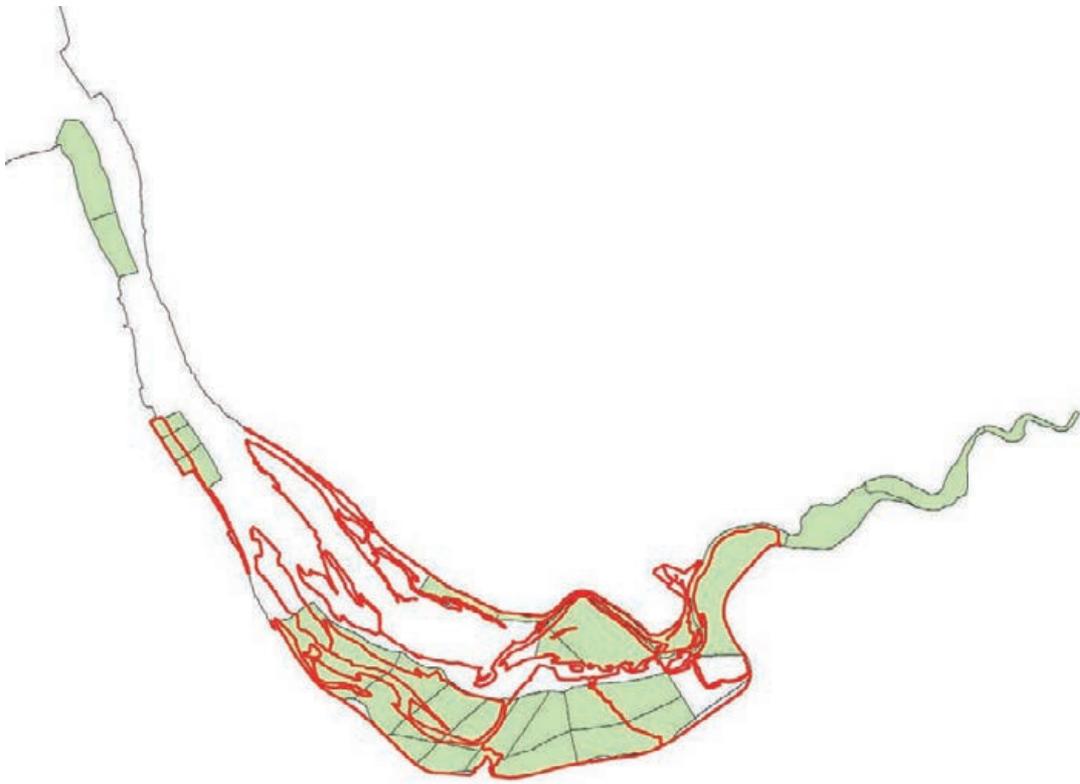
Humber Flats, Marshes and Coast (Phases 1 and 2)



Lindisfarne SPA



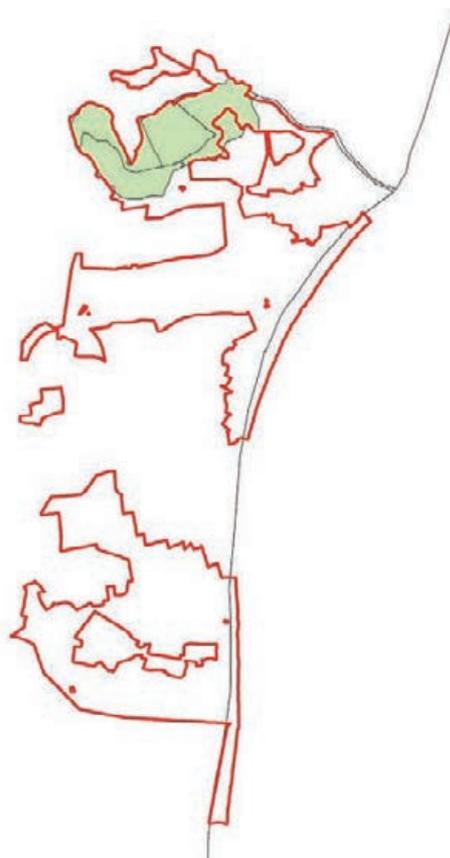
Medway Estuary and Marshes SPA



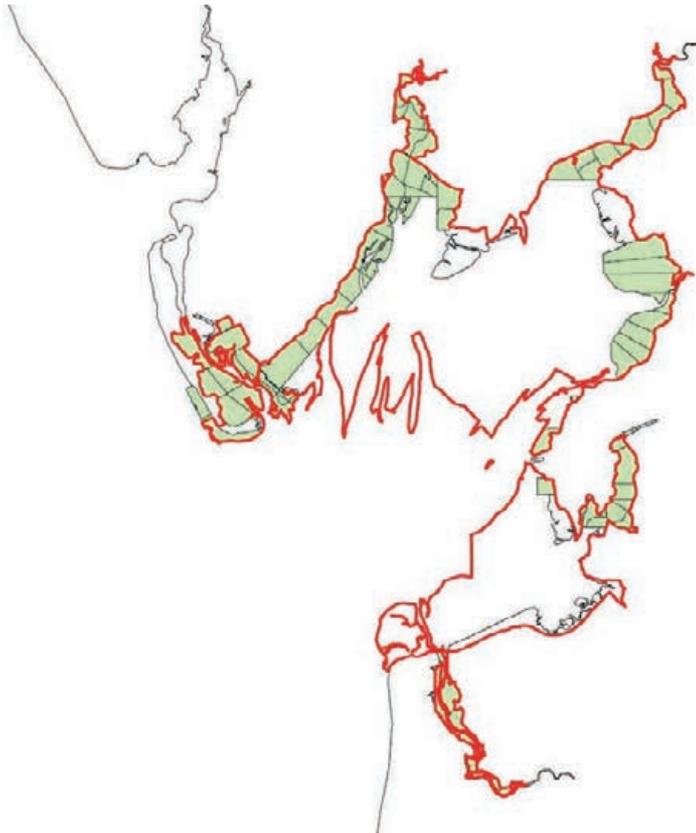
Mersey Estuary SPA



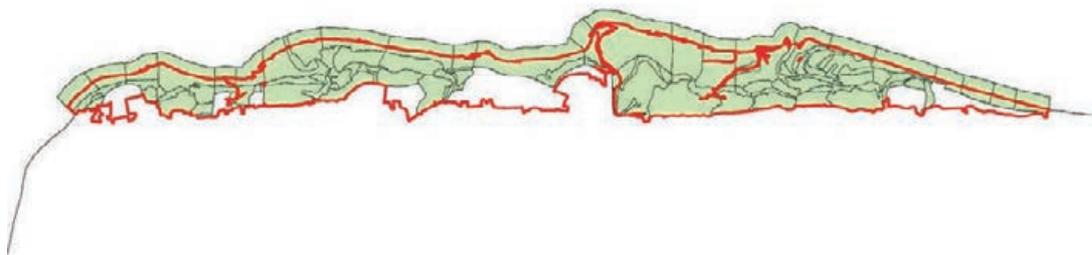
Mersey Narrows and North Wirral Foreshore SPA



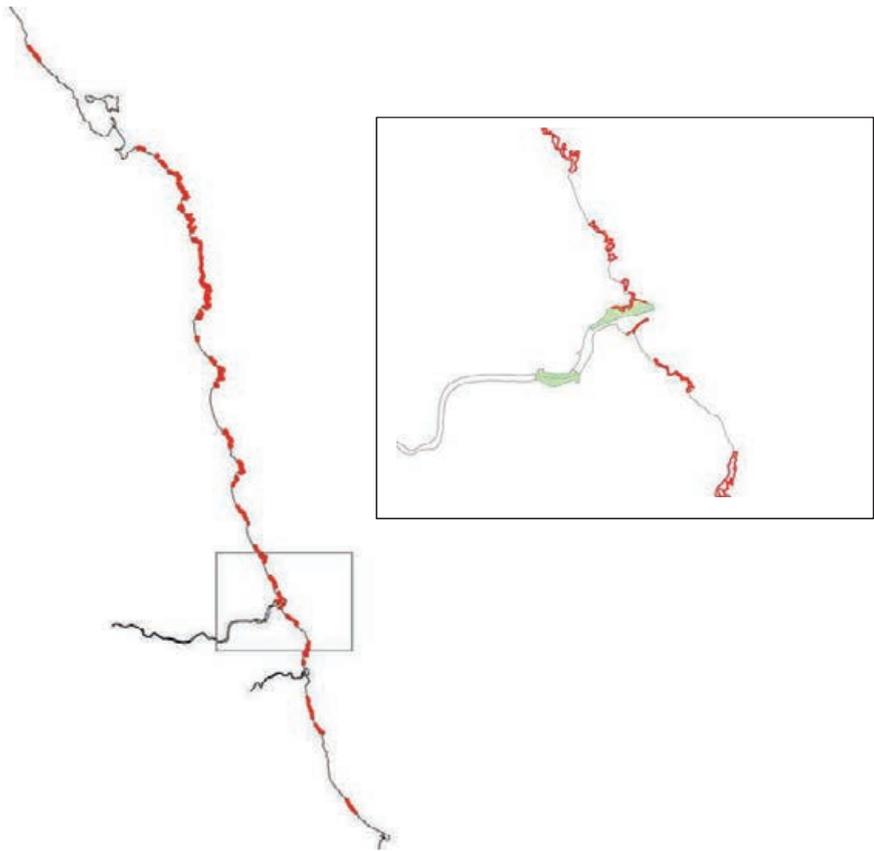
Minsmere to Walberswick SPA



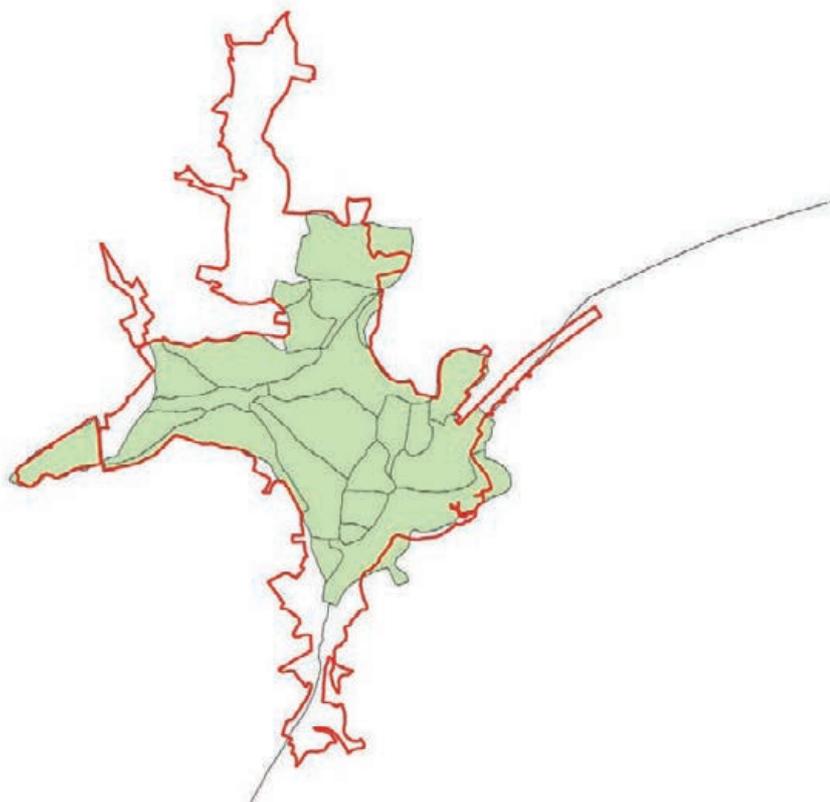
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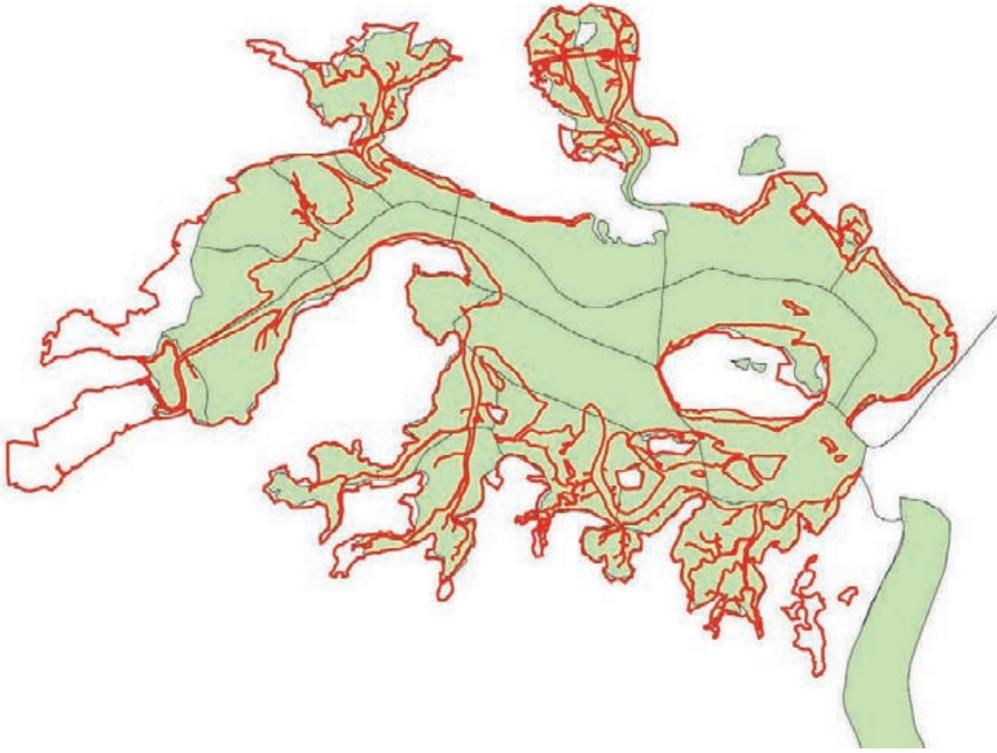
North Norfolk Coast SPA



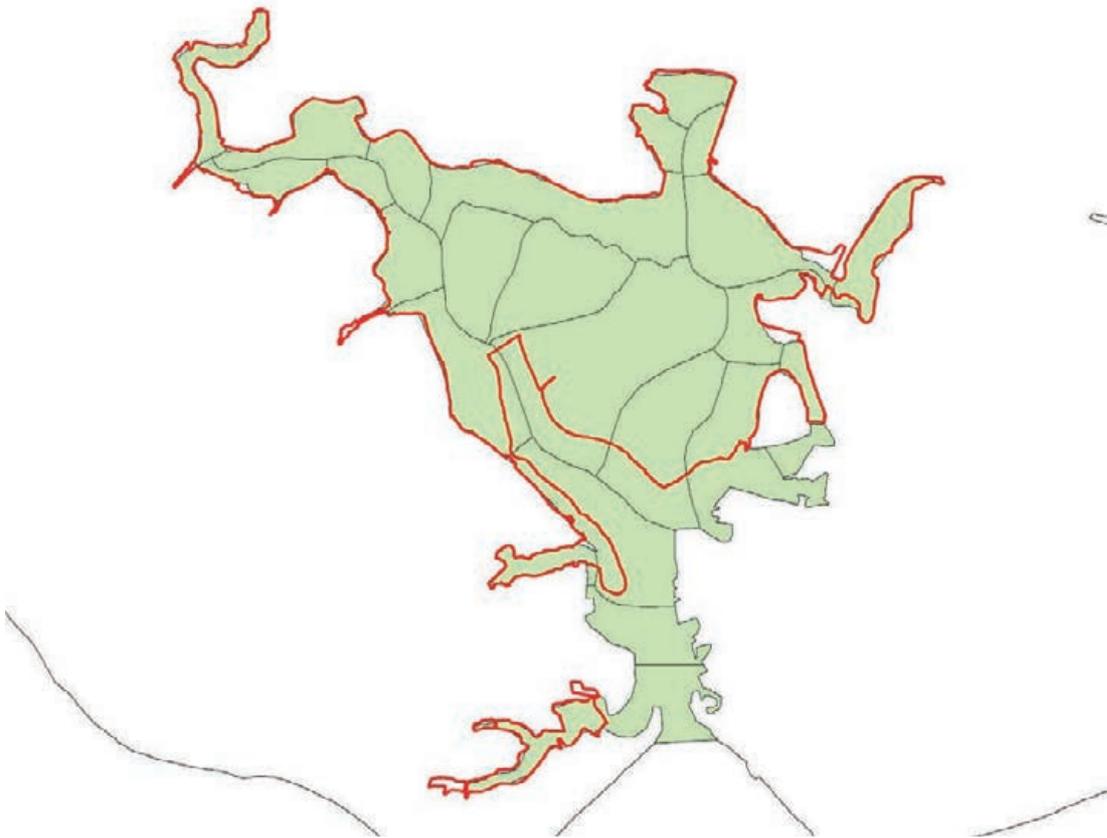
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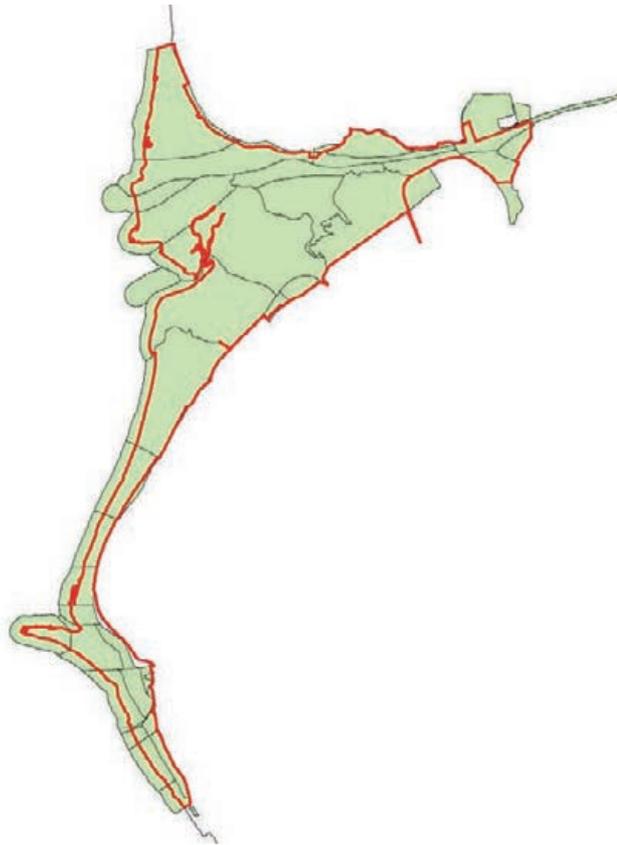
Pagham Harbour SPA



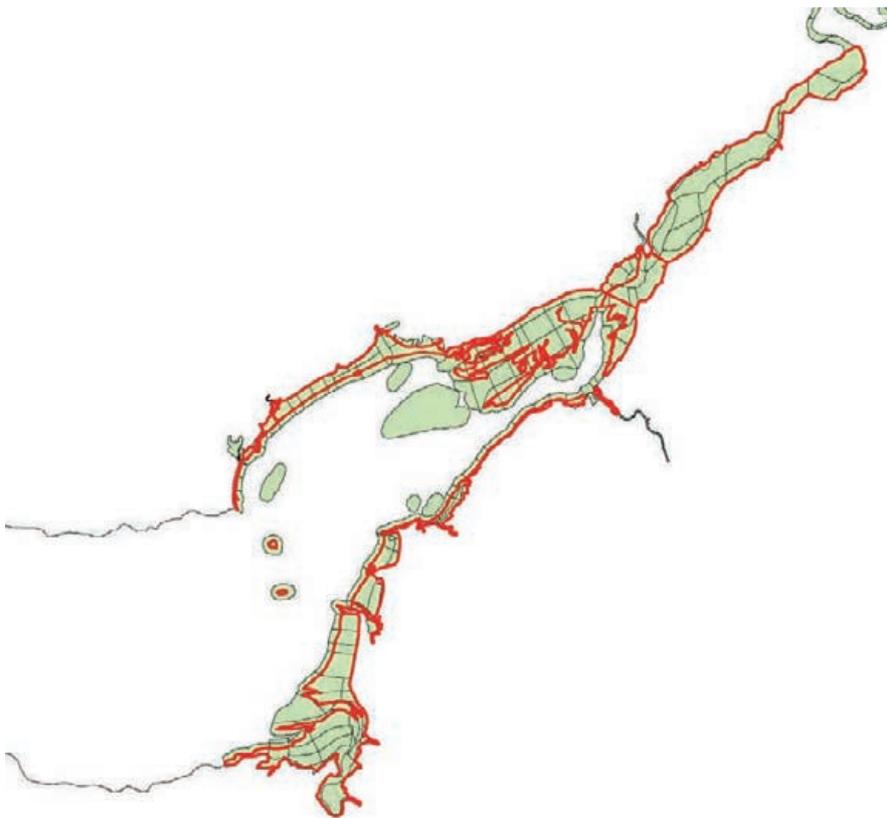
Poole Harbour SPA



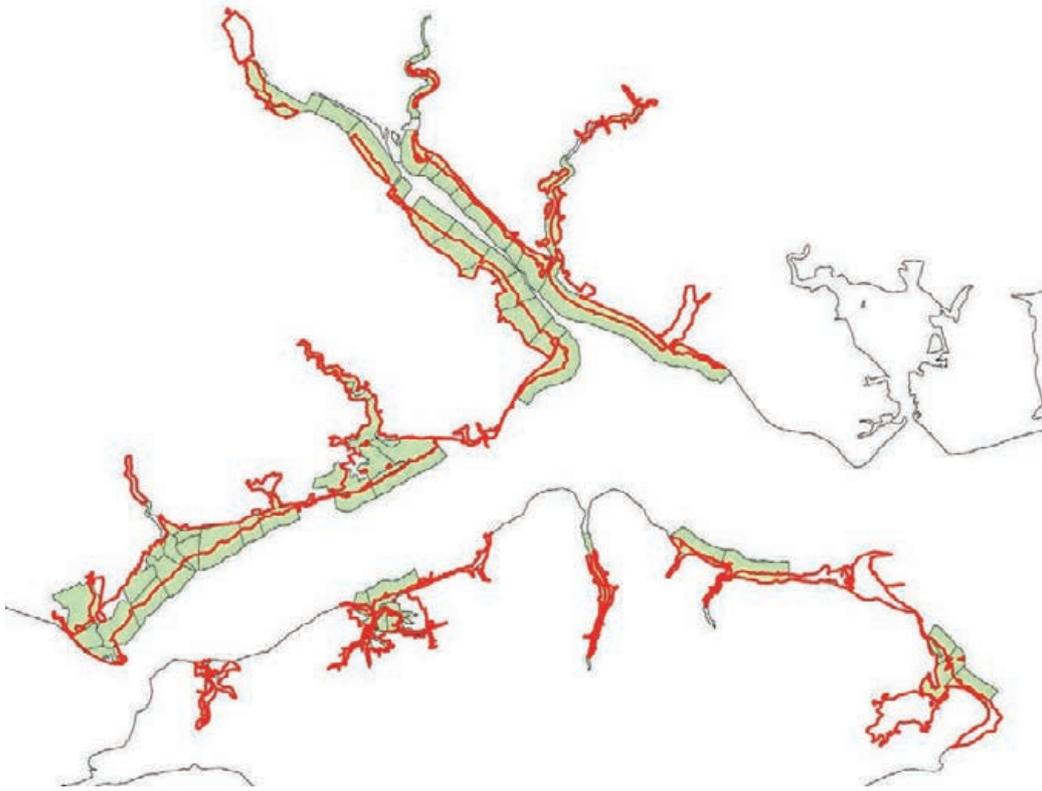
Portsmouth Harbour SPA



Ribble and Alt Estuaries Phase 2 SPA



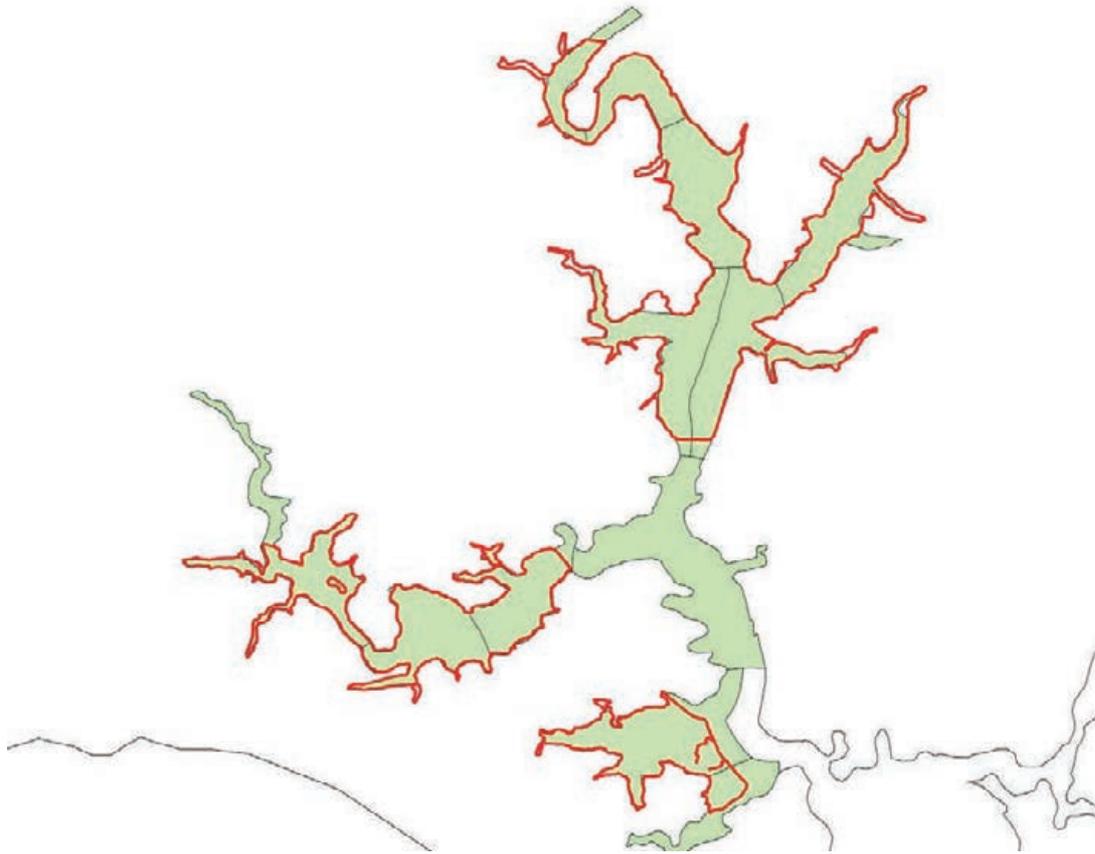
Severn Estuary SPA



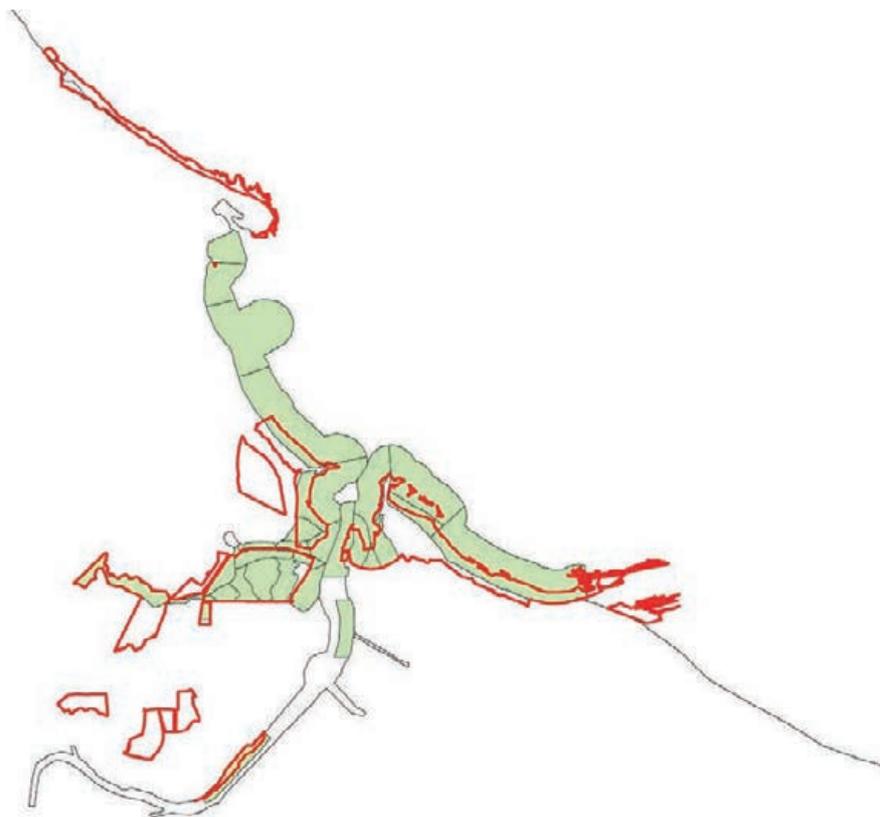
Solent and Southampton Water SPA



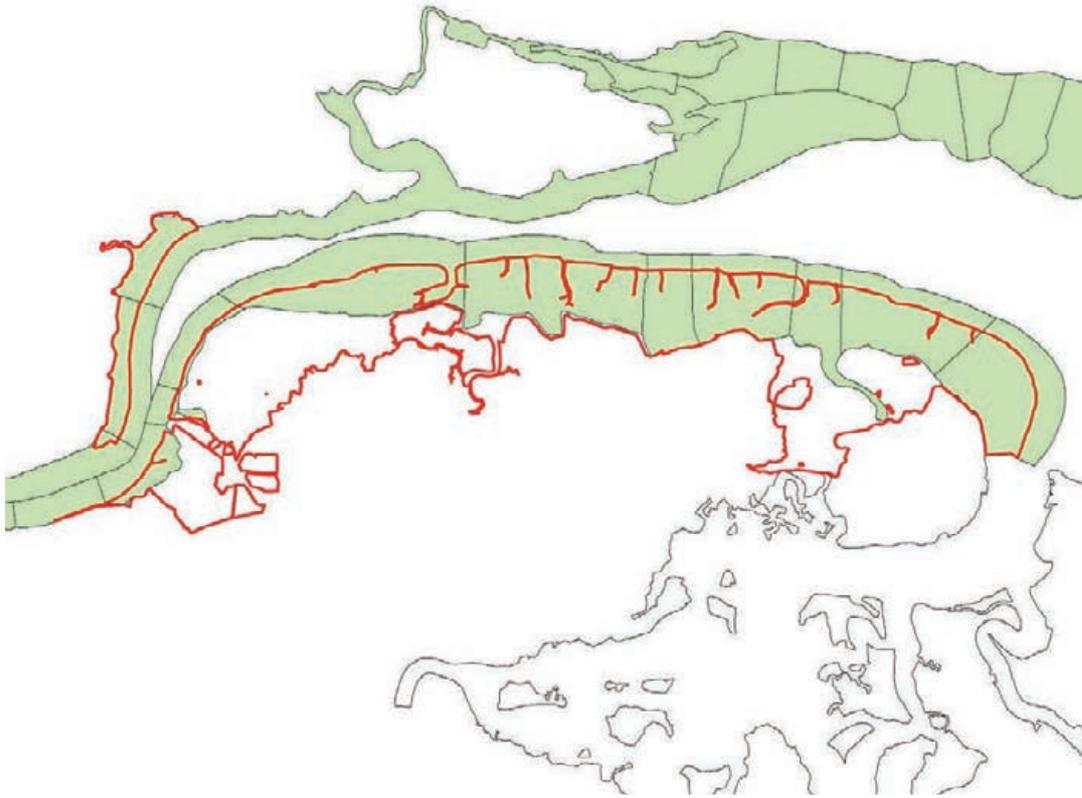
Stour and Orwell Estuaries SPA



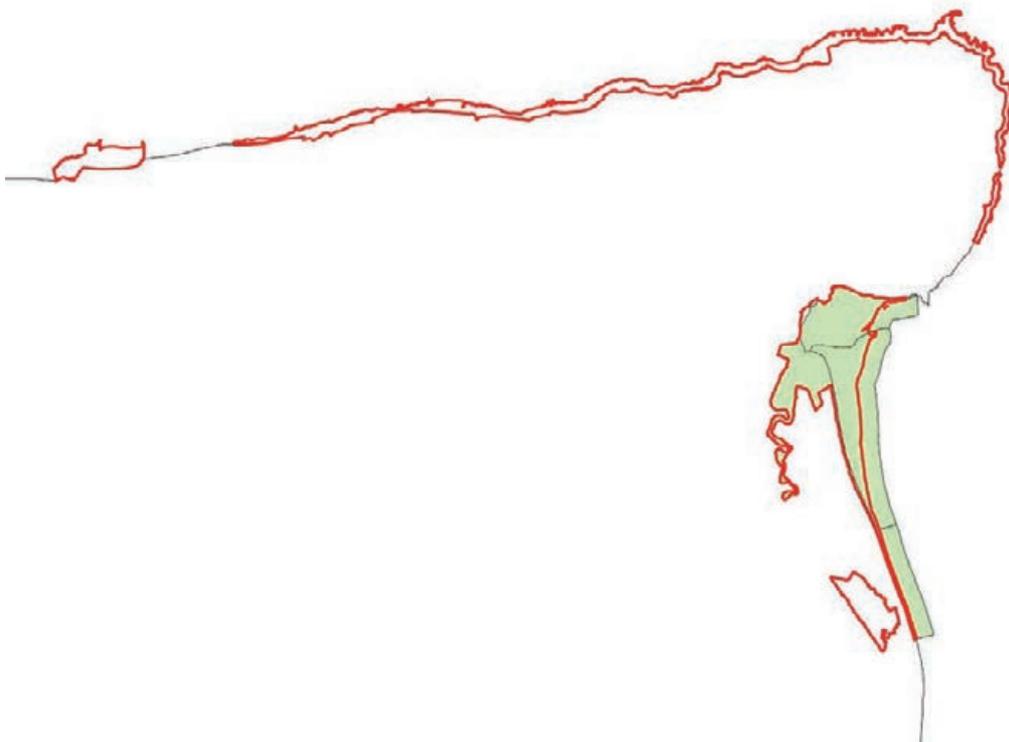
Tamar Estuaries Complex SPA



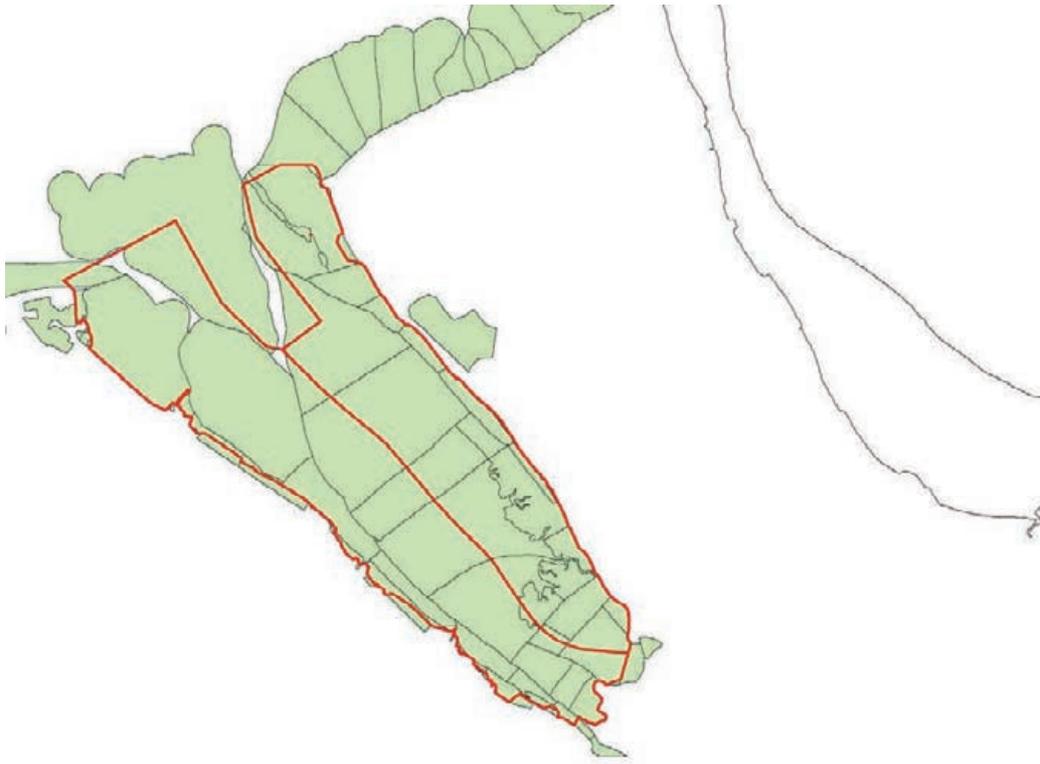
Teesmouth and Cleveland Coast SPA



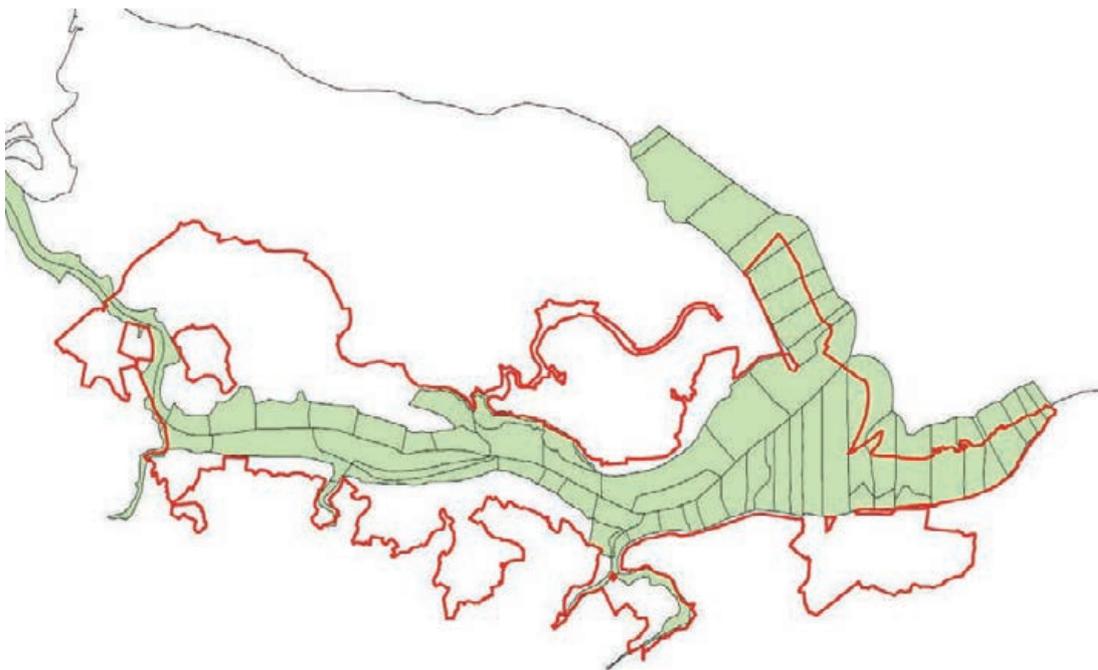
Thames Estuary and Marshes SPA



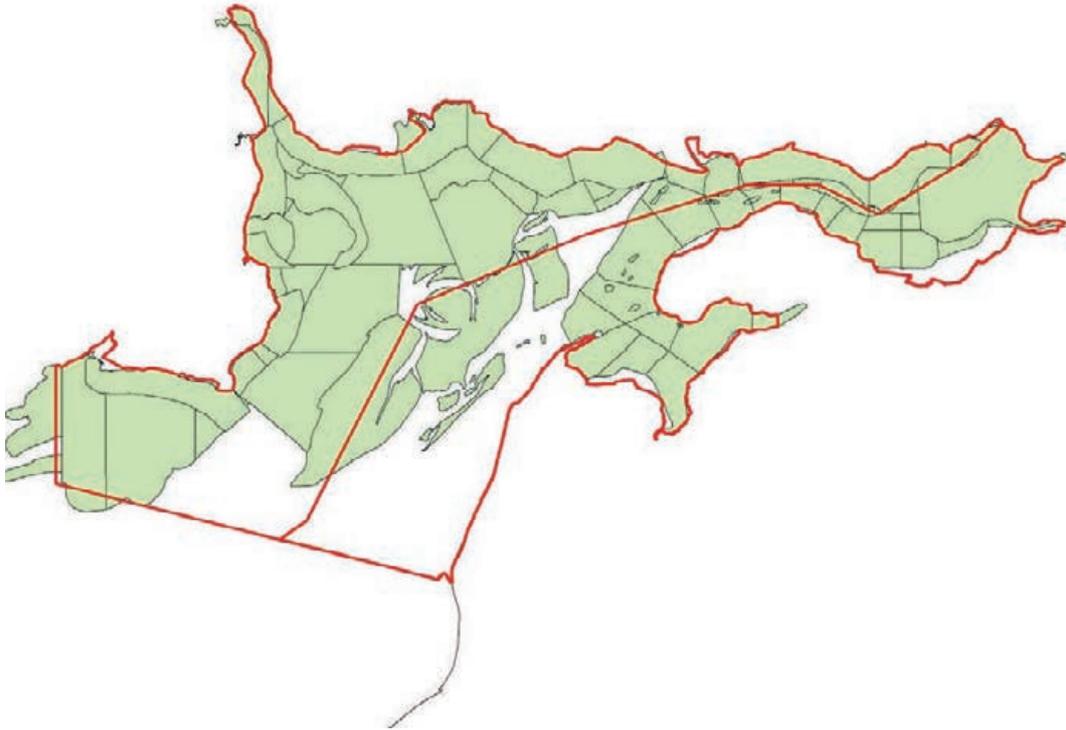
Thanet Coast and Sandwich Bay SPA



The Dee Estuary SPA



The Swale SPA



Upper Solway Flats and Marshes SPA

Appendix D Habitat preferences of species counted by the WeBS Low Tide Count Scheme

Species	Habitat preference
Avocet	Intertidal only
Barnacle Goose	All habitats
Bar-tailed Godwit	Intertidal only
Bean Goose	All habitats
Bewick's Swan	All habitats
Bittern	Intertidal and nontidal
Black-headed Gull	All habitats
Black-necked Grebe	Subtidal only
Black-tailed Godwit	Intertidal and nontidal
Black-throated Diver	Subtidal only
Black-winged Stilt	Intertidal and nontidal
Brent Goose	All habitats
Brent Goose (dark-bellied)	All habitats
Brent Goose (light-bellied)	All habitats
Brent Goose (Nearctic Light-bellied)	All habitats
Brent Goose (Svalbard Light-bellied)	All habitats
Canada Goose	All habitats
Caspian Gull	All habitats
Common Gull	All habitats
Common Sandpiper	Intertidal and nontidal
Common Scoter	Subtidal only
Coot	Subtidal only
Cormorant	All habitats
Curlew	Intertidal and nontidal
Curlew Sandpiper	Intertidal and nontidal
Dunlin	Intertidal only
Egyptian Goose	All habitats
Eider	Subtidal only
European White-fronted Goose	All habitats
Gadwall	All habitats
Garganey	All habitats
Glaucous Gull	All habitats
Golden Plover	Intertidal and nontidal
Goldeneye	Subtidal only
Goosander	Subtidal only
Great Black-backed Gull	All habitats
Great Crested Grebe	Subtidal only
Great Northern Diver	Subtidal only
Green Sandpiper	Intertidal and nontidal
Greenland White-fronted Goose	All habitats

Species	Habitat preference
Greenshank	Intertidal and nontidal
Grey Heron	Intertidal and nontidal
Grey Plover	Intertidal only
Greylag Goose	All habitats
Greylag Goose	All habitats
Herring Gull	All habitats
Iceland Gull	All habitats
Jack Snipe	Intertidal and nontidal
Kingfisher	All habitats
Kittiwake	All habitats
Knot	Intertidal only
Lapwing	Intertidal and nontidal
Lesser Black-backed Gull	All habitats
Little Egret	Intertidal and nontidal
Little Grebe	Subtidal only
Little Gull	All habitats
Little Ringed Plover	Intertidal and nontidal
Little Stint	Intertidal and nontidal
Long-tailed Duck	Subtidal only
Mallard	All habitats
Mediterranean Gull	All habitats
Moorhen	All habitats
Mute Swan	Subtidal only
Oystercatcher	Intertidal only
Pink-footed Goose	All habitats
Pintail	All habitats
Pochard	Subtidal only
Purple Sandpiper	Intertidal only
Red-breasted Merganser	Subtidal only
Red-necked Grebe	Subtidal only
Redshank	Intertidal and nontidal
Red-throated Diver	Subtidal only
Ringed Plover	Intertidal only
Ruddy Shelduck	All habitats
Ruff	Intertidal and nontidal
Sanderling	Intertidal only
Sandwich Tern	All habitats
Scaup	Subtidal only
Shag	Subtidal only
Shelduck	All habitats
Shoveler	All habitats

Species	Habitat preference
Slavonian Grebe	Subtidal only
Smew	Subtidal only
Snipe	Nontidal only
Spoonbill	Intertidal and nontidal
Spotted Redshank	Intertidal and nontidal
Teal	All habitats
Tufted Duck	Subtidal only
Turnstone	Intertidal only
Velvet Scoter	Subtidal only
Water Rail	Intertidal and nontidal
Whimbrel	Intertidal and nontidal
White-fronted Goose	All habitats
Whooper Swan	All habitats
Wigeon	All habitats
Woodcock	Intertidal and nontidal
Yellow-legged Gull	All habitats

Appendix E Two-letter species codes of the most common species used within the GIS shapefiles

BTO code	Common Name	Scientific Name
MS	Mute Swan	<i>Cygnus olor</i>
BS	Bewick's Swan	<i>Cygnus columbianus</i>
WS	Whooper Swan	<i>Cygnus cygnus</i>
BE	Bean Goose (unassigned)	<i>Anser fabilis</i>
XF	Taiga Bean Goose	<i>Anser fabilis fabilis</i>
XR	Tundra Bean Goose	<i>Anser fabilis rossicus</i>
PG	Pink-footed Goose	<i>Anser brachyrhynchus</i>
WG	White-fronted Goose (unassigned)	<i>Anser albifrons</i>
EW	European White-fronted Goose	<i>Anser albifrons albifrons</i>
NW	Greenland White-fronted Goose	<i>Anser albifrons flavirostris</i>
GJ	Greylag Goose (unassigned)	<i>Anser anser</i>
JI	Icelandic Greylag Goose	<i>Anser anser</i>
JH	NW Scotland Greylag Goose	<i>Anser anser</i>
BY	Barnacle Goose (unassigned)	<i>Branta leucopsis</i>
YN	Greenland Barnacle Goose	<i>Branta leucopsis</i>
YS	Svalbard Barnacle Goose	<i>Branta leucopsis</i>
BG	Brent Goose (unassigned)	<i>Branta leucopsis/bernicla</i>
DB	Dark-bellied Brent Goose	<i>Branta bernicla bernicla</i>
PB	Light-bellied Brent Goose (unassigned)	<i>Branta bernicla hrota</i>
QN	Nearctic Light-bellied Brent Goose	<i>Branta bernicla hrota</i>
QS	Svalbard Light-bellied Brent Goose	<i>Branta bernicla hrota</i>
SU	Shelduck	<i>Tadorna tadorna</i>
WN	Wigeon	<i>Anas penelope</i>
GA	Gadwall	<i>Anas strepera</i>
T_	Teal	<i>Anas crecca</i>
MA	Mallard	<i>Anas platyrhynchos</i>
PT	Pintail	<i>Anas acuta</i>
SV	Shoveler	<i>Anas clypeata</i>
RQ	Red-crested Pochard	<i>Netta rufina</i>
PO	Pochard	<i>Aythya ferina</i>
TU	Tufted Duck	<i>Aythya fuligula</i>
SP	Scaup	<i>Aythya marila</i>
E_	Eider	<i>Somateria mollissima</i>
LN	Long-tailed Duck	<i>Clangula hyemalis</i>
CX	Common Scoter	<i>Melanitta nigra</i>
VS	Velvet Scoter	<i>Melanitta fusca</i>
GN	Goldeneye	<i>Bucephala clangula</i>
SY	Smew	<i>Mergellus albellus</i>
RM	Red-breasted Merganser	<i>Mergus serrator</i>
GD	Goosander	<i>Mergus merganser</i>

BTO code	Common Name	Scientific Name
RH	Red-throated Diver	<i>Gavia stellata</i>
BV	Black-throated Diver	<i>Gavia arctica</i>
ND	Great Northern Diver	<i>Gavia immer</i>
LG	Little Grebe	<i>Tachybaptus ruficollis</i>
GG	Great Crested Grebe	<i>Podiceps cristatus</i>
RX	Red-necked Grebe	<i>Podiceps grisegena</i>
SZ	Slavonian Grebe	<i>Podiceps auritus</i>
BN	Black-necked Grebe	<i>Podiceps nigricollis</i>
CA	Cormorant	<i>Phalacrocorax carbo</i>
SA	Shag	<i>Phalacrocorax aristotelis</i>
BI	Bittern	<i>Botaurus stellaris</i>
ET	Little Egret	<i>Egretta garzetta</i>
H_	Grey Heron	<i>Ardea cinerea</i>
NB	Spoonbill	<i>Platalea leucorodia</i>
WA	Water Rail	<i>Rallus aquaticus</i>
MH	Moorhen	<i>Gallinula chloropus</i>
CO	Coot	<i>Fulica atra</i>
OC	Oystercatcher	<i>Haematopus ostralegus</i>
AV	Avocet	<i>Recurvirostra avosetta</i>
LP	Little Ringed Plover	<i>Charadrius dubius</i>
RP	Ringed Plover	<i>Charadrius hiaticula</i>
GP	Golden Plover	<i>Pluvialis apricaria</i>
GV	Grey Plover	<i>Pluvialis squatarola</i>
L_	Lapwing	<i>Vanellus vanellus</i>
KN	Knot	<i>Calidris canutus</i>
SS	Sanderling	<i>Calidris alba</i>
LX	Little Stint	<i>Calidris minuta</i>
CV	Curlew Sandpiper	<i>Calidris ferruginea</i>
PS	Purple Sandpiper	<i>Calidris maritima</i>
DN	Dunlin	<i>Calidris alpina</i>
RU	Ruff	<i>Philomachus pugnax</i>
JS	Jack Snipe	<i>Lymnocyptes minimus</i>
SN	Snipe	<i>Gallinago gallinago</i>
WK	Woodcock	<i>Scolopax rusticola</i>
BW	Black-tailed Godwit	<i>Limosa limosa</i>
BA	Bar-tailed Godwit	<i>Limosa lapponica</i>
WM	Whimbrel	<i>Numenius phaeopus</i>
CU	Curlew	<i>Numenius arquata</i>
CS	Common Sandpiper	<i>Tringa hypoleucos</i>
GE	Green Sandpiper	<i>Tringa ochropus</i>
DR	Spotted Redshank	<i>Tringa erythropus</i>
GK	Greenshank	<i>Tringa nebularia</i>
OD	Wood Sandpiper	<i>Tringa glareola</i>

BTO code	Common Name	Scientific Name
RK	Redshank	<i>Tringa totanus</i>
TT	Turnstone	<i>Arenaria interpres</i>
KI	Kittiwake	<i>Rissa tridactyla</i>
BH	Black-headed Gull	<i>Chroicocephalus ridibundus</i>
LU	Little Gull	<i>Hydrocoloeus minutus</i>
MU	Mediterranean Gull	<i>Larus melanocephalus</i>
CM	Common Gull	<i>Larus canus</i>
YM	Yellow-legged Gull	<i>Larus michahellis/cachinnans</i>
YG	Yellow-legged Gull (unassigned)	<i>Larus michahellis</i>
YC	Caspian Gull	<i>Larus cachinnans</i>
LB	Lesser Black-backed Gull	<i>Larus fuscus</i>
HG	Herring Gull	<i>Larus argentatus</i>
IG	Iceland Gull	<i>Larus glaucoides</i>
GZ	Glaucous Gull	<i>Larus hyperboreus</i>
GB	Great Black-backed Gull	<i>Larus marinus</i>
TE	Sandwich Tern	<i>Sterna sandvicensis</i>
AE	Arctic Tern	<i>Sterna paradisaea</i>
CN	Common Tern	<i>Sterna hirundo</i>
AF	Little Tern	<i>Sterna albrifrons</i>
BJ	Black Tern	<i>Chlidonias niger</i>
KF	Kingfisher	<i>Alcedo atthis</i>