



WETLAND BIRD SURVEY

Survey Methods, Analysis & Interpretation



The Wetland Bird Survey (WeBS) is the monitoring scheme for non-breeding waterbirds in the UK which aims to provide the principal data for the conservation of their populations and wetland habitats. WeBS is a joint scheme of the British Trust for Ornithology, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee, in association with the Wildfowl & Wetlands Trust.

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Introduction

The Wetland Bird Survey (WeBS) is the UK national non-breeding waterbird monitoring scheme. **WeBS Core Counts** are carried out at a wide variety of wetlands throughout the UK; synchronised counts are conducted once per month, particularly from September to March. In addition, **WeBS Low Tide Counts** are undertaken on selected estuaries with the aim of identifying key areas used during the low tide period, principally by feeding birds; areas not otherwise noted for their importance by Core Counts which are normally conducted at high tide.

Survey results are reported in the annual publication *Waterbirds in the UK*, which comprises a summary report that is distributed to all survey participants and updated species and sites data and Low Tide maps via the **WeBS Report Online** interface. *Waterbirds in the UK* is also sometimes referred to as the **WeBS Annual Report**.

This document details the **survey methods** for Core Counts and supplementary counts (Chapter 2). **Analysis, presentation and interpretation** of the main **Core Count outputs** are covered in Chapter 3: count accuracy and completeness; annual indices; monthly indices; site importance; national totals and annual maxima; and treatment of Goose and Eider subspecies / populations. Analysis, presentation and interpretation of the main **Low Tide outputs** are covered in Chapter 4.

1.1 WeBS Aims and Objectives

The Wetland Bird Survey (WeBS) aims to monitor all non-breeding waterbirds in the UK in order to provide the principal data on which the conservation of their populations is based.

To this end, WeBS has three main objectives:

- to assess the **size of non-breeding waterbird populations** in the UK
- to assess **trends** in their numbers and distribution
- to assess the **importance of individual sites** for waterbirds

These results also form the basis for informed decision-making by conservation bodies, planners and developers and contribute to the sustainable and wise use and management of wetlands and their dependent waterbirds. The data and the WeBS Annual Report also fulfil some of the objectives of the Conventions and Directives listed above. UK data contribute to the International Waterbirds Census (IWC) run by Wetlands International to assist their function of coordinating and reporting upon waterbird status at an international flyway scale.

The annual WeBS report presents syntheses of data collected between July and June (the "WeBS Year"), in combination with previous years, in line with the WeBS objectives. Data from other national and local waterbird monitoring schemes, notably the WWT/JNCC/SNH Goose & Swan Monitoring Programme, are included where WeBS data alone are insufficient to fulfil this aim, so that the report provides a single, comprehensive source of information on waterbird status and distribution in the UK.

Species accounts provide yearly maxima for all sites supporting internationally and nationally important numbers. Sites with changed status are highlighted and significant counts are discussed. Wherever possible, counts are placed in an international context and relevant research is summarised. Waterbird totals are provided for all sites meeting criteria for international importance and species occurring in internationally important numbers on each are identified.

1.2 Background and History

The Wetland Bird Survey (WeBS) is a **partnership scheme** of the British Trust for Ornithology (BTO), Royal Society for the Protection of Birds (RSPB) and the Joint Nature Conservation Committee (JNCC) (the last on behalf of the statutory nature conservation bodies: Natural England (NE), Natural Resources Wales (NRW) and Scottish Natural Heritage (SNH) and the Department of Agriculture, Environment and Rural Affairs, Northern Ireland), in association with Wildfowl & Wetlands Trust (WWT).

WeBS continues the traditions of two, long-running count schemes which formed the mainstay of UK waterbird monitoring since **1947** - the National Waterbird Census (NWC) and the Birds of Estuaries Enquiry (BoEE). The success and growth of WeBS accurately reflects the enthusiasm and dedication of the several thousand volunteer ornithologists who participate. It is largely due to their efforts that waterbird monitoring in the UK is held in such high regard internationally.

Further background information can be found on the WeBS website: www.bto.org/webs.

1.3 The WeBS Year

Most waterbird species occur in largest numbers in the UK during winter; some are residents with numbers boosted during winter, while others are solely winter visitors. Some species occur primarily as passage migrants or even just as summer visitors. Although WeBS counts focus primarily on winter months, surveys are carried out year-round. Accordingly, different 12-month periods are used to define a year to report upon different species; in order to define the 'annual' maximum and to identify the peak 'annual' count for assessing site importance.

For most species, the year is defined as **July to June**, inclusive; this is referred to as the WeBS Year or the WeBS recording year. Thus for species present in largest numbers during winter, counts during autumn passage and spring passage the following calendar year are logically associated with the intervening winter. The WeBS Year of 1966/67 refers to the July 1966 to June 1967 period.

For species present as summer visitors - notably terns, Garganey and Little Ringed Plover - the calendar year is used to derive national and site maxima. Within WeBS Report Online the different format used for column headings (e.g. 11/12 or 2011) identify whether a 'winter' or calendar year has been used.

1.4 Waterbirds in the UK - WeBS Report Online

The WeBS Report Online interface provides access to the latest tables of WeBS Core Count data at site and species level via the **'Numbers and Trends'** tab, together with low tide summaries and distribution density maps for certain sites via the **'Low Tide Counts'** tab. The online reporting also includes **periodic results** from the Non-estuarine Waterbird Survey in the **'NEWS'** tab and an **'Alerts'** tab which reports the status of waterbirds on two types of protected sites - SPAs (Special Protection Areas) and SSSIs (Sites of Special Scientific Interest), that are designated for their waterbird features¹.

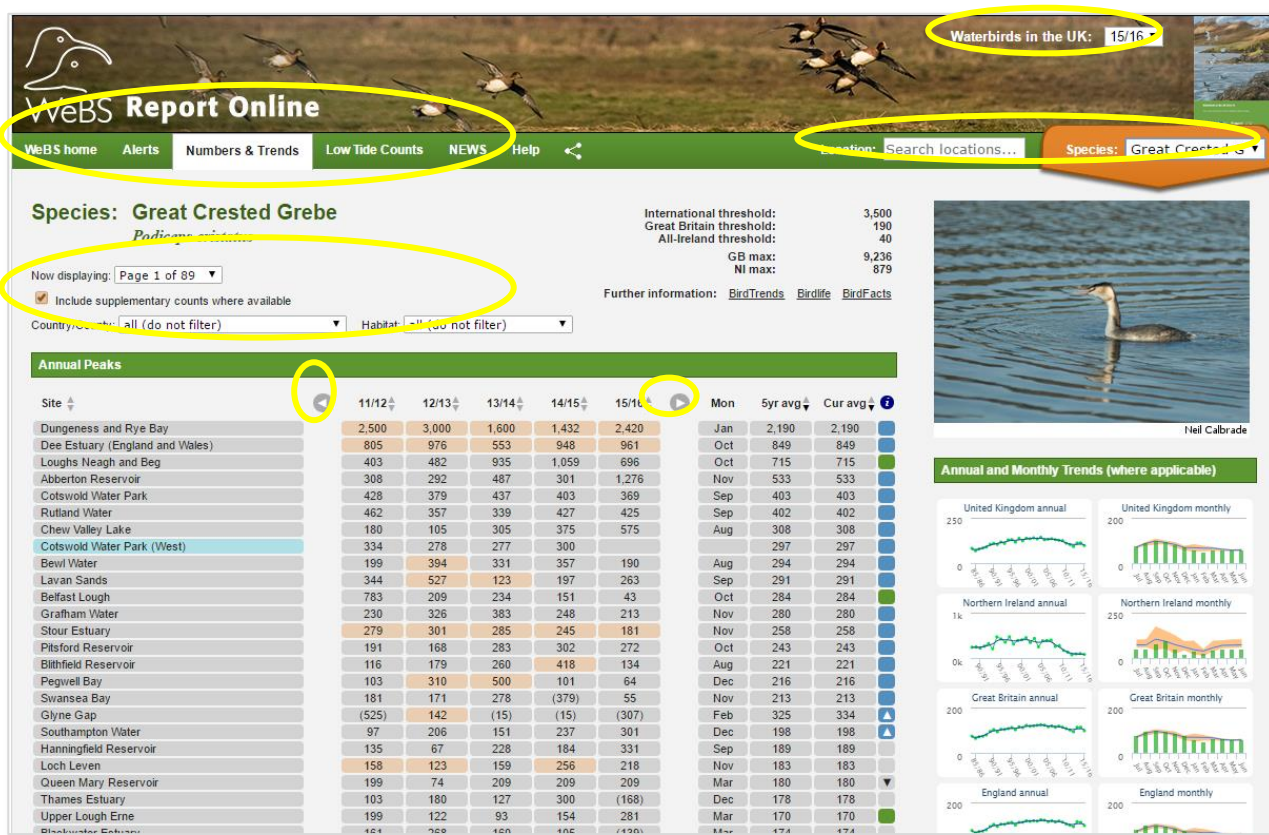


Figure 1 WeBS Report Online interface with main navigation options highlighted.

In the **'Numbers and Trends'** tab, selecting a **Location (site)** from the menu allows users to explore which species have been recorded at the site. Users can see the peak numbers of each species recorded at the site throughout the year, the five-year mean peak count and the month in which the peak count was recorded. The table can be sorted alphabetically or taxonomically by species or by the peak counts. By scrolling back through the years, contemporary counts and associated five-year averages can be compared with historical counts at the site.

To find a site in the WeBS Report Online you can use one of two methods. If you know the site name, start typing it in the **'Search Locations...'** box and select from the list that appears. If you are unsure of the site name, use the **'WeBS Find A Site'** tool² to find the site on a map and bring up the site details. Then click on the "WeBS Report **View Site**" link, which will take you to the right location on the WeBS Report Online (**Figure 2**).

¹ More information on WeBS Alerts methodology can be found at: <https://www.bto.org/webs-alerts>

² <http://app.bto.org/websonline/sites/data/sites-data.jsp>

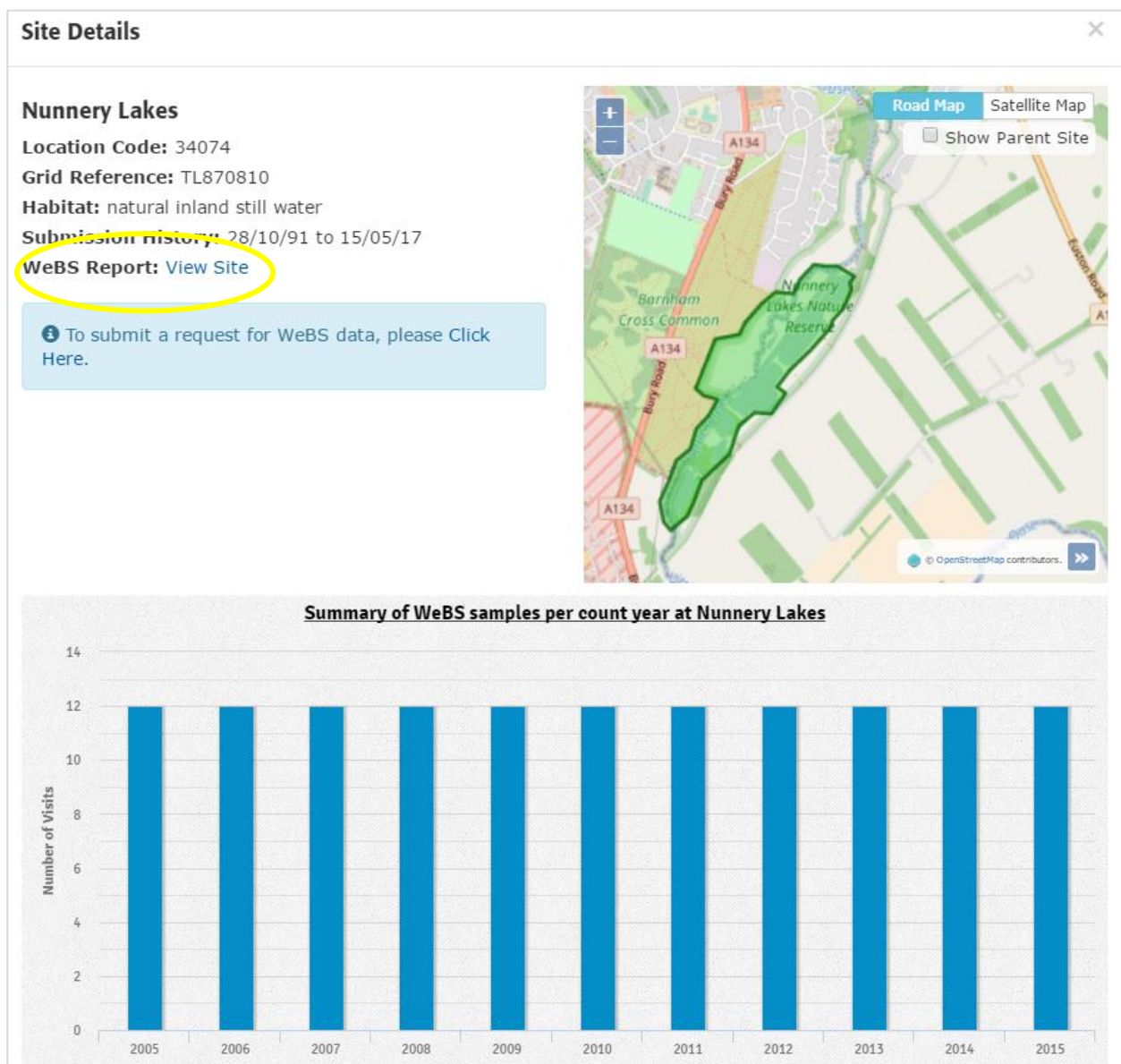


Figure 2 Example site details page on Find a Site Tool, with direct link to the site's page on WeBS Report Online highlighted.

For those looking for information on a particular **species** (or biogeographic population) of waterbird, every species ever recorded by WeBS features on its own page, with every site where the species has been recorded listed. As well as offering the functionality to sort sites in tables either alphabetically, by annual peak, or by five-year average, the interface also allows the user to filter sites by country, county and/ or habitat. **Annual and monthly trend plots** for the UK and constituent countries are shown (where applicable) and there are also links to other sources of web-based information.

Species which occur at a site in nationally or internationally important numbers are flagged in both the species and site tables. Supplementary counts can be included or excluded in the tables. More detail on the methods and presentation used in the Numbers and Trends tab is given in Chapter 3. Detail on the Low Tide Counts tab is given in Chapter 4. The methods for **WeBS Alerts** and **NEWS** are not covered in this document.

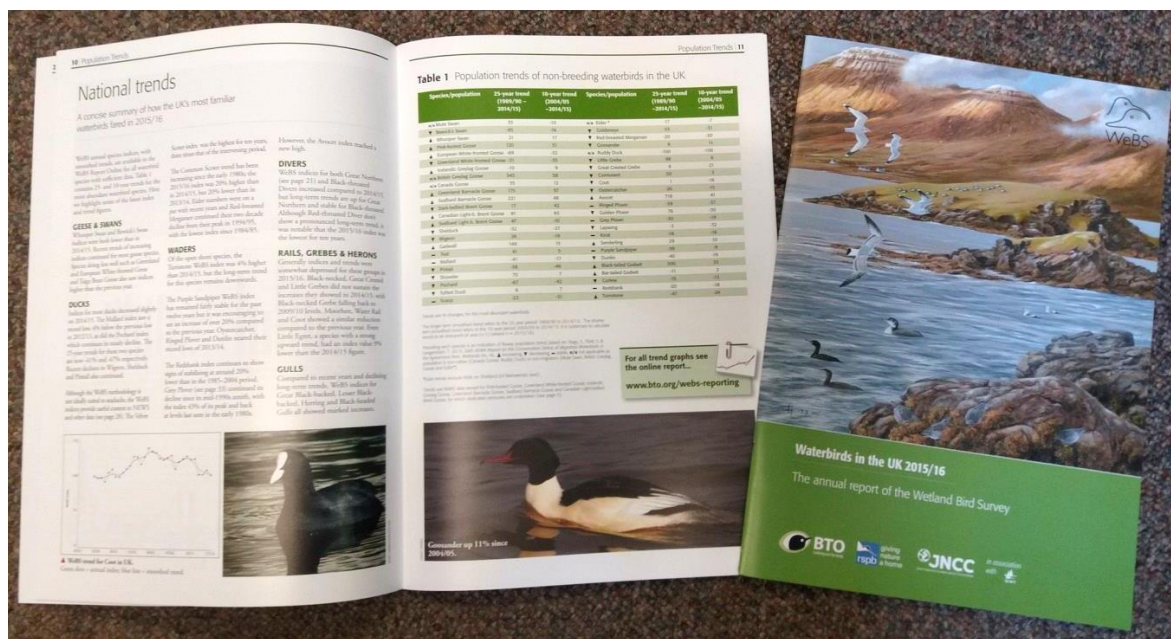
WeBS Report Online is updated once a year at the same time as the summary report is published. The online and summary outputs in conjunction constitute the report *Waterbirds in the UK* for the published year.

For reference purposes, numbers and trends from **annual reports for previous years** can be accessed by choosing the appropriate WeBS year from the ‘Waterbirds in the UK’ drop-down menu.

1.5 Waterbirds in the UK – Summary Report

The summary report includes:

- a summary of the latest waterbird indices and trends;
- the latest 10- and 25-year trend statistics;
- coverage statistics;
- table of principal sites containing with species maxima of 20,000 birds or greater;
- features on recent research using WeBS data or explaining waterbird trends;
- species features including trends and background information and research for selected species;
- site focus on Low Tide results;
- and other articles of interest to WeBS counters and data users.



More information, including site tables and trends for all regular WeBS species, is available online at: www.bto.org/webs-reporting

An interactive map of WeBS sites can be explored in the Find A Site tool at: <http://app.bto.org/websonline/sites/data/sites-data.jsp>

The summary report can be downloaded from the WeBS website at: www.bto.org/webs-publications



Survey Methods

2.1 Site Definition

To compare count data from year to year requires that the individual sites - in terms of the area surveyed - remain the same. The **boundary** of many wetlands are readily defined by the extent of habitat (e.g. for reservoirs and gravel pits), but are less obvious for other sites (e.g. some large estuaries). Here **count boundaries** have often been defined over time by a number of factors to a greater or lesser degree, including the distribution of birds at the time of the count, known movements of birds from roost to feeding areas, the extent of habitat, and even ease of access.

Sites are defined for a variety of purposes, and the precise boundary of sites describing ostensibly the same wetland may differ accordingly. For example, the boundaries used to define a large lake may differ for its definition as a wetland (based on habitat), as a waterbird count area (some birds may use adjacent non-wetland habitat), and as a statutorily designated site for nature conservation (which may be constrained by the need to follow boundaries easily demarcated in planning and legal terms). It should be recognised that the boundary of a site for counting may even **differ between different waterbird surveys**, particularly where different methodologies are employed, e.g. the 'Forth Estuary' comprises one large site for WeBS Core Counts, a slightly different area for Low Tide Counts, and two roost sites for Pink-footed Geese.

Data from different waterbird surveys are used for assessment of site importance in the WeBS annual report if collected for ostensibly the same site, but can be turned off optionally (see Section 3.5).

Particular caution is urged, however, in noting that, owing to possible boundary differences, totals given for WeBS or other sites in the annual report are **not necessarily the same** as totals for designated statutory sites (ASSIs/SSSIs, SPAs or Ramsar Sites) with the same or similar names.

It should also be borne in mind that whilst discrete wetlands may represent obvious sites for waterbirds, there is no strict definition of a site as an ecological unit for birds. Thus, some wetlands may satisfy all requirements - feeding, loafing and roosting areas - for some species, but a 'site' for other species may comprise a variety of disparate areas, not all of which are counted for WeBS. Similarly, for some habitats, particularly linear areas such as rivers and rocky coasts, and marine areas, the definition of a site as used by waterbirds is not readily discerned without extensive survey or research that is usually beyond the scope of WeBS or other similar surveys. **The definitions of such sites may thus evolve, and therefore change between annual reports.** Further, the number of birds recorded by WeBS at particular sites should not be taken to indicate the total number of birds in that local area.

In some cases, for example where feeding geese are recorded by daytime WeBS Core Counts over large sites and again at discrete roosts within or adjacent to that same site, data are presented for both sites on the WeBS Report Online because of the very different nature or extent of the sites and often number of birds - even though the same birds will have been counted at both.

What if I want data for a different site boundary to that used in *Waterbirds in the UK*?



Data is stored at the count sector level, and can be obtained as the best match for your site boundary of interest through bespoke WeBS data requests.

For more information please visit:

www.bto.org/webs-data

2.2 WeBS Core Count Survey Methods

WeBS Core Counts are made using the ‘**look-see**’ methodology³, whereby the observer, familiar with the species involved, surveys the whole of a predefined area. Counts are made at all wetland habitats used by waterbirds, including lakes, lochs/loughs, ponds, reservoirs, gravel pits, rivers, freshwater marshes, canals, sections of open coast and estuaries.

Numbers of all waterbird species, as defined by Wetlands International, are recorded. In the UK, this includes **swans, geese, ducks, divers, grebes, cormorants, herons, Spoonbill, rails, cranes, waders and Kingfisher. Counts of gulls and terns are optional.**



³ Bibby CJ, Burgess ND, Hill DA & Mustoe S. 2000. *Bird Census Techniques*. Second Edition. Academic Press, London.

2.2.1 Non-native Species

In line with the recommendations of Vinicombe et al. (1993)⁴, **records of all waterbird species recorded by WeBS, including escapes, are published** to contribute to the proper assessment of naturalised populations and escaped birds. Non-native species, which have become established are termed ‘naturalised’. These species are categorised according to the process by which they became established: naturalised feral (domesticated species gone wild); naturalised introduction (introduced by man); naturalised re-establishment (species re-established in an area of former occurrence); or naturalised establishment (a species which occurs, but does not breed naturally, e.g. potentially Barnacle Goose in southern England). With the exception of vagrants, all other non-native species have been classed as ‘escapes’. The **species status** is given on the species page on WeBS Report Online for naturalised species, escapes and vagrants.

2.2.2 Waterbird Detectability

Most waterbirds are readily visible. Secretive species, such as snipes, are generally under-recorded. No allowance is made for these habits by the observer and only birds seen or heard are recorded. The species affected by such biases are well known. Most species and many subspecies are readily identifiable during the counts. Categories may be used, e.g. unidentified scoter species, where it is not possible to be confident of identification, e.g. under poor light conditions.

2.2.3 Estimating numbers

Species present in relatively small numbers or dispersed widely may be counted singly. The number of birds in large flocks is generally estimated by mentally dividing the birds into groups, which may vary from five to 1,000 depending on the size of the flock, and counting the number of groups. Notebooks and tally counters may be used to aid counts.

Counts suspected to be gross under-estimates of the true number of non-secretive species present are specifically noted, e.g. a large flock of roosting waders only partially counted before being flushed by a predator, or a distant flock of seaduck in heavy swell. These counts may then be treated differently when calculating site totals.

2.2.4 Count synchronisation

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. **The priority dates are pre-selected with a view to optimising tidal conditions for counters covering coastal sites at high tide on a Sunday.** The dates used for individual sites may vary due to differences in the tidal regime around the country. **Coordination within a site takes priority over national synchronisation.**

⁴ Vinicombe K, Marchant J & Knox A. 2013. Review of status and categorization of feral birds on the British List. *British Birds* 75: 1-11.

2.2.5 Data validation and verification

Data is input by the counters themselves, or in some cases the Local Organiser, a volunteer or the National Organisers, into the WeBS Online database, which includes data validation and verification procedures. Any particularly unusual counts are checked by the Local Organisers or National Organisers and are confirmed with the counters if necessary.

2.3 Supplementary Counts

Additional supplementary waterbird counts outside Core Count visits are used to provide the most representative picture of **waterbird status and site importance**. Apart from for some geese and swans (see below), only **Core Count data are used in the derivation of species population trends**.

Supplementary counts appear on the WeBS Report Online with orange shading (Figure 3). They can be turned on and off in the tables by ticking/unticking the “include supplementary counts where available”.



Figure 3 WeBS Online Report species page with supplementary count option and details highlighted.

2.3.1 Supplementary core counts and roost counts

Supplementary counts are made at some sites where WeBS counts are known to under-represent the true value of the site. In particular, some species occur in much larger sites when using the site as a night-time roost, e.g. geese, Goosander and gulls, that are not present during WeBS daytime counts. Some sites are also counted more frequently than once per month by some observers.

Supplementary counts are collected by counters familiar with the site for WeBS surveys, thus employing the same site definition and, for daytime counts, the same counting methods. These counts are submitted on standardised recording forms adapted from those used for WeBS Core Counts.

2.3.2 Goose roost censuses

Many geese (*Anser* and *Branta* spp) spend daylight hours in agricultural landscapes, and are therefore missed during counts at wetlands by WeBS. These species are usually best counted as they fly to or

from their **roost sites at dawn or dusk**, since these are generally discrete wetlands and birds often follow traditional flight lines approaching or leaving the site. Even in half-light, birds can generally be counted with relative ease against the sky, although they may not be specifically identifiable at mixed species roosts.

In order to produce population estimates, counts are synchronised nationally for particular species, although normally only one or two such counts are made each year. The priority count dates are determined according to the state of the moon, since large numbers of geese may remain on fields during moonlit nights. Additional counts are made by some observers, particularly during times of high turnover when large numbers may occur for just a few days.

In some areas, where roost sites are poorly known or difficult to access, counts of birds in fields are made during the daytime. As with WeBS Core Counts, the accuracy of the count is noted.

2.3.3 Productivity monitoring

Changes in numbers of waterbirds counted in the UK between years are likely to result from a number of factors, including coverage and weather, particularly for European and Russian breeding species which may winter further east or west within Europe according to the severity of the winter. Genuine changes in population size will, however, result from differences in recruitment and mortality between years.

For several species of swans and geese, young of the year can be readily identified in the field and a measure of productivity can be obtained by recording the number of young birds in sampled flocks, expressed as a percentage of the total number of birds aged. Experienced fieldworkers by observing the behaviour of and relationship between individuals in a flock, can record brood sizes as the number of young birds associating with, usually, two adults. Monitoring is part of the Goose and Swan Monitoring Programme⁵.

2.3.4 Additional counts

Additional, ad hoc, data are also sought for important sites not otherwise regularly monitored; particularly open coast sections in Scotland. The results of **periodic, coordinated surveys** - such as the non-estuarine coastal waterbird survey (NEWS), International Greenland Barnacle Goose Census and International Whooper and Bewick's Swan Census - are included where the data collected are compatible with WeBS reporting.

The accuracy of counts of **waterbirds on the sea** is particularly dependent on prevailing weather conditions at the time of or directly preceding the count. Birds are often distant from land, and wind or rain can cause considerable difficulty with identifying and counting birds. Wind not only causes telescope instability, but even a moderate swell at sites without high vantage points can hamper counts considerably. The need to count other waterbirds in 'terrestrial' habitats at the site often precludes the time required for an accurate assessment of seaducks. Many sites may be best covered using aerial surveys. Consequently, the best counts of most divers, grebes and seaduck at open coast and many estuarine sites are made simply when conditions allow; only rarely will such conditions occur by chance during WeBS counts. Synchronisation between different sites may be difficult or impossible to achieve, and thus coordination of most counts to date has occurred at a regional or site level, e.g. within the Moray Firth and within North Cardigan Bay.

⁵ <http://monitoring.wwt.org.uk/our-work/goose-swan-monitoring-programme/>

The extensive use of **aerial survey** methods in nearshore marine waters in recent years means that data are available for a number of sites. However, the boundaries of such sites frequently do not correspond to those counted for WeBS Core Counts, and indeed the area surveyed from the air can vary between years. These surveys employ a ‘distance sampling’ methodology (see Buckland et al. 2004)⁶, whereby only a proportion of birds are counted, and the missed proportion estimated by statistical means. Some published reports from these surveys provide only the counted number, whilst others also include the calculated estimates (which often have relatively wide confidence intervals).

Some data are provided directly by individuals (for example, reserve wardens), often undertaking counts for site survey purposes but whose data are not formally published in a report.

A significant point is that these additional data are taken from published sources, from surveys with the specific aim of monitoring waterbirds and where methods have been published, or where data have been collected by known individuals usually undertaking site-based surveys, and are provided directly for use in *Waterbirds in the UK*. Casual records and data from, e.g. county bird reports, where the methods and/or site boundaries used have not been documented are not included. Reports and data for important sites from surveys that the authors know to have taken place in recent years are actively sought for inclusion in the annual report, but it is likely that other sources of suitable data are overlooked. **The inclusion of such data for some species and sites does not infer that the tables in WeBS Report Online include all such suitable data.**

The type of supplementary data source (supplementary core counts, casual counts, roost counts and other additional counts) can be identified by hovering over the count value in the WeBS Online Report.

2.3.5 Irish Wetland Bird Survey

The Irish Wetland Bird Survey (I-WeBS) monitors non-breeding waterbirds in the Republic of Ireland (Boland & Crowe 2005)⁷. I-WeBS was launched in 1994 as a joint partnership between BirdWatch Ireland, National Parks and Wildlife Service of Dúchas, The Heritage Service of the Department of Environment and Local Government (Ireland), and WWT, with additional funding and support from the Heritage Council and WWF UK (World Wide Fund for Nature). I-WeBS is complementary to and compatible with the UK scheme. The main methodological difference from UK-WeBS is that counts are made only between September and March, inclusive.

2.4 WeBS Low Tide Counts Survey Methods

The Low Tide Counts scheme provides information on the numbers of waterbirds feeding on subdivisions of the inter-tidal habitat within estuaries. Given the extra work that Low Tide Counts entail, often by 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. Co-ordinated counts of waterbirds are made by volunteers each month between November and February on pre-established subdivisions of the inter-tidal habitat in the period two hours either side of low tide.

⁶ Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers DL & Thomas L (editors). 2004. *Advanced Distance Sampling*. Oxford University Press, London.

⁷ Boland H & Crowe O. 2005. *Irish wetland bird survey: waterbird status and distribution 2001/02 - 2008/09*. Birdwatch Ireland, Kilcolle, Co. Wicklow.



Data Analysis, Presentation and Interpretation (Core Counts)

An outline of the analyses undertaken for each distinct element of WeBS is given here; further details can be provided upon request.

Caution is always necessary in the interpretation and application of waterbird counts given the limitations of these data. This is especially true of the summary form, which by necessity, is used in the annual report. A primary aim of the annual report remains the rapid feedback of key results to the many participants in the WeBS scheme. More detailed information on how to make use of the data for research or site assessment purposes can be obtained from the British Trust for Ornithology (see Contacts).

While the manner of presentation is consistent within the WeBS annual reports, it should be noted that the information collated by WeBS and other surveys can be held or used in a variety of ways. Data may also be summarised and analysed differently depending on the requirements of the user. Consequently, calculations used to interpret data and their presentation may vary between this and other publications, and indeed between organisations or individual users. The terminology used by different organisations may not always highlight these differences. This particularly applies to summary data. Such variations do not detract from the value of each different method, but offer greater choice to users according to the different questions being addressed. This should always be borne in mind when using data presented in the report.

For ease of reference, the methodologies and interpretation notes provided below are broadly categorised according to the presentation of results for each of the key objectives of WeBS: Section **3.2** covers **annual indices**; Section **3.3**, **monthly indices**; **3.4** covers **national totals**; and **3.5 site importance and annual maxima**. Several points, however, are general in nature and apply to a broad range of uses of the data. In particular, Sections **3.1** on **count completeness** and **3.6** on treatment of **rares and populations** of geese and Eider are widely applicable to WeBS data analysis and results.

3.1 Count completeness

Counts at individual sites may be hampered by poor conditions, or parts of the site may not be covered. This may result in counts missing a significant proportion of one or more species. It is important to flag such counts as **incomplete counts**, since using them at face-value would under-represent the importance of the site and generate misleading results, e.g. when used for trend calculations and assessment of site importance. **Counts flagged as incomplete are treated differently in trend analyses and site importance assessments.**

Incomplete counts are flagged with brackets around them in the WeBS Report Online (Figure 4).

Annual Peaks									
Site	10/11	11/12	12/13	13/14	14/15	Mon	5yr avg	Cur avg	
The Wash	10,223	7,588	6,693	11,919	9,190	May	9,123	9,123	
Dengie Flats	9,058	7,300	6,500	(14,530)	2,936	Nov	8,065	8,065	
Thames Estuary	4,288	3,709	3,283	(5,219)	3,055	Dec	4,316	4,316	
Ribble Estuary	1,272	(5,319)	7,647	(5,219)	1,094	May	4,110	4,110	
Humber Estuary	2,218	3,190	3,171	3,832	2,128	Apr	2,908	2,908	

Figure 4 Complete and incomplete (highlighted) counts of Grey Plover on WeBS Report Online.

3.1.1 Assigning count completeness

Counts at sites - and at individual sectors of large sites that are counted using a series of sub-divisions (known as ‘complex sites’) - **are flagged as ‘OK’ or ‘Low’ by the counter**. ‘Low’ indicates that the counter feels a significant proportion of the birds present at the time of the count may have been missed, e.g. because all of the site or sector was not visited, or because a large flock of birds flew before counts were complete. Such assessments may be provided for individual species, or for all species present.

Similarly, **at complex sites, one or more sectors may be missed** in a particular month, again rendering the total count for the site incomplete to a greater or lesser degree for one or more species.

For **single sector sites**, counts are assessed as incomplete if the counter has reported the count as ‘Low’.

For **complex sites**, an algorithm is used to assess whether **missed sectors and/or ‘Low’ counts in some sectors constitute an incomplete count at the site level**. The mean count of each sector is calculated based on ‘OK’ counts from a window extending a month either side of the month of the count in question, and using earlier or subsequent years, such that within this window the 15 nearest counts are used to make the assessment. The total count for the site in any one month is considered incomplete if the sectors for which the count is missing or ‘Low’ in that month tend to hold, based of their mean values, more than 25% of the sum of all sector means. The assessment is made on a species-by-species basis, recognising the fact that species distribution is not uniform across a site that and a missed sector may be particularly important for some species but not for others.

Completeness assessments are made for all WeBS Core Counts, and for most goose roost counts (which, as single-sector sites, are made on the basis of the ‘OK/Low’ assessment provided by the counter).

Because the completeness calculation for complex sites is based on a moving window of counts, and the use of different parts of the site by species may change, the addition of new data each year may result in counts flagged as complete in previous *Waterbirds in the UK* (prior to 2004/05 published as *Wildfowl and Wader Counts*) now being considered incomplete, and vice versa.

3.1.2 Systematic undercounts

Species counts are not flagged as ‘Low’ if a large number of the birds present is routinely missed, e.g. because they are cryptic, secretive, or hide in reeds - such as Snipe, Teal and Water Rail. ‘Low’ indicates that a significant proportion of the birds that could reasonably be expected to be counted under normal conditions were considered to have been missed. Similarly, many counts of waterbirds on the sea may be undercounts. Indeed, if the distribution of a flock stretches beyond the limits of visibility, the counter - as with birds hidden in reeds - can never know with confidence whether the count included all birds present.

3.2 Annual Indices

Because the same sites are not necessarily covered by WeBS on every month in every year, relative changes in waterbird numbers cannot be determined simply by comparing the total number of birds counted each year. This issue is addressed by using **indexing techniques that have been developed to track relative changes in numbers from incomplete data.**

In summary, for occasions when a particular site has not been visited, an expected count for each species is calculated (imputed) based on the pattern of counts across months, years and other sites. This effectively means that a complete set of counts are available for all years and all months for a sample of sites. **Only sites that have a good overall level of coverage are used (at least 50% of possible visits undertaken) and the underlying assumption is that the pattern of change in numbers across these sites (the index) is representative of the pattern of change in numbers at the country level.**

Annual index values are expressed relative to the most recent year, which takes an arbitrary value of **100.**

3.2.1 Underhill index method for annual indices

The **‘Underhill index’** was specifically developed for waterbird populations (see Underhill 1989⁸, Underhill & Prys-Jones 1994⁹ and Kirby et al. 1995¹⁰ for a full explanation of this indexing process and its application for WeBS data). The annual report uses Generalized Additive Models (GAMs) to fit both index values and a smoothed trend to the WeBS count data (see Maclean et al. 2005¹¹ for a full explanation of this process and its application for WeBS data) whilst retaining elements from the Underhill method that allows the assessment of whether or not counts flagged as incomplete should

⁸ Underhill, L.G. 1989. *Indices for Waterbird Populations*. BTO Research Report 52.

⁹ Underhill L.G. & Prys-Jones, R. 1994. Index numbers for waterbird populations. I. Review and methodology. *Journal of Applied Ecology* 31: 463-480.

¹⁰ Kirby, J.S., Salmon, D.G., Atkinson-Willes, G.L. & Cranswick, P. A. 1995. Index numbers for waterbird populations.III. Long-term trends in the abundance of wintering wildfowl in Great Britain, 1966/67- 1991/92. *Journal of Applied Ecology* 32: 536–551.

¹¹ Maclean, I.M.D., Austin ,G.E. & Mellan, H.J. 2005. *Wetland Bird Survey Alerts 2003/04 Changes in numbers of wintering waterbirds in the constituent countries of the UK, Special Protection Areas (SPA's) and Sites of Special Scientific Interest (SSSI's)*. BTO Research Report 416.

be treated as missing data. From 2009 a **moving window approach for imputing** has been implemented (please contact the WeBS office for further details if required).

The generated **smoothed trends** are less influenced by years of abnormally high or low numbers and sampling 'noise' than are the raw index values. This makes them especially useful when assessing changes through time (e.g. WeBS Alerts; Maclean et al. 2008).

The **months** included in calculating annual indices varies by species as follows:

- **waders** are based on data from the months of November to March, inclusive;
- summer and passage waders (**Little Ringed Plover, Common Sandpiper, Garganey, terns** and **British/Irish Greylag Goose** (see Section 3.6.3) are based on data from the summer months of April to September, inclusive;
- annual census data are used to generate indices for **Icelandic Greylag Goose, Pink-footed Goose, Taiga Bean Goose, Greenland White-fronted Goose, Greenland Barnacle Goose** and **Svalbard Barnacle Goose** (see Section 3.6);
- **all other species** are based on data from the months of September to March, inclusive.

Previously, the months used for indexing were assigned in a species-specific manner following established recommendations (Underhill & Prys-Jones 1994 and Kirby *et al.* 1995). The current approach, in addition to improving the robustness of the indices to changes in the timing of arrivals and departures with climate change and increasing comparability between species, brings WeBS indexing into line with other WeBS methodologies, specifically reporting of Alerts and computation of five-year mean of peaks.

The **years** included also varies by species group.

- Data for **wildfowl** are presented for the period 1966/67 to present.
- Data from 1974/75 onwards have been used for **waders** as a high proportion of counts before this winter were imputed.
- For species added later to the scheme, (i.e. **Great Crested Grebe** and **Coot** in 1982/83, **Little Grebe** in 1985/86, **Cormorant** in 1986/87 and **gulls, terns, divers, rare grebes and other species** from 1993/94), data from the first two years following their inclusion have been omitted from indices, as initial take-up by counters appears not to have been complete, resulting in apparent sharp increases in numbers during this time.
- For similar reasons, the first two years of data have been excluded from indices for **Northern Ireland**.

Indices for species that occur substantially on **habitats poorly monitored by WeBS** (e.g. Moorhen and Snipe) and **species that occur at sites sporadically and/or in small numbers** (e.g. Bean Goose and Smew), although included within the online report, should be **treated with an element of caution**. This is also true for **gulls** and **terns**, which are counted optionally. Indices are not computed for **scarce species**.

3.2.2 Annual trends

Index values, where calculated, are graphed for each species/population. The underlying trend from the GAM is shown using a blue line in these plots (Figure 5).

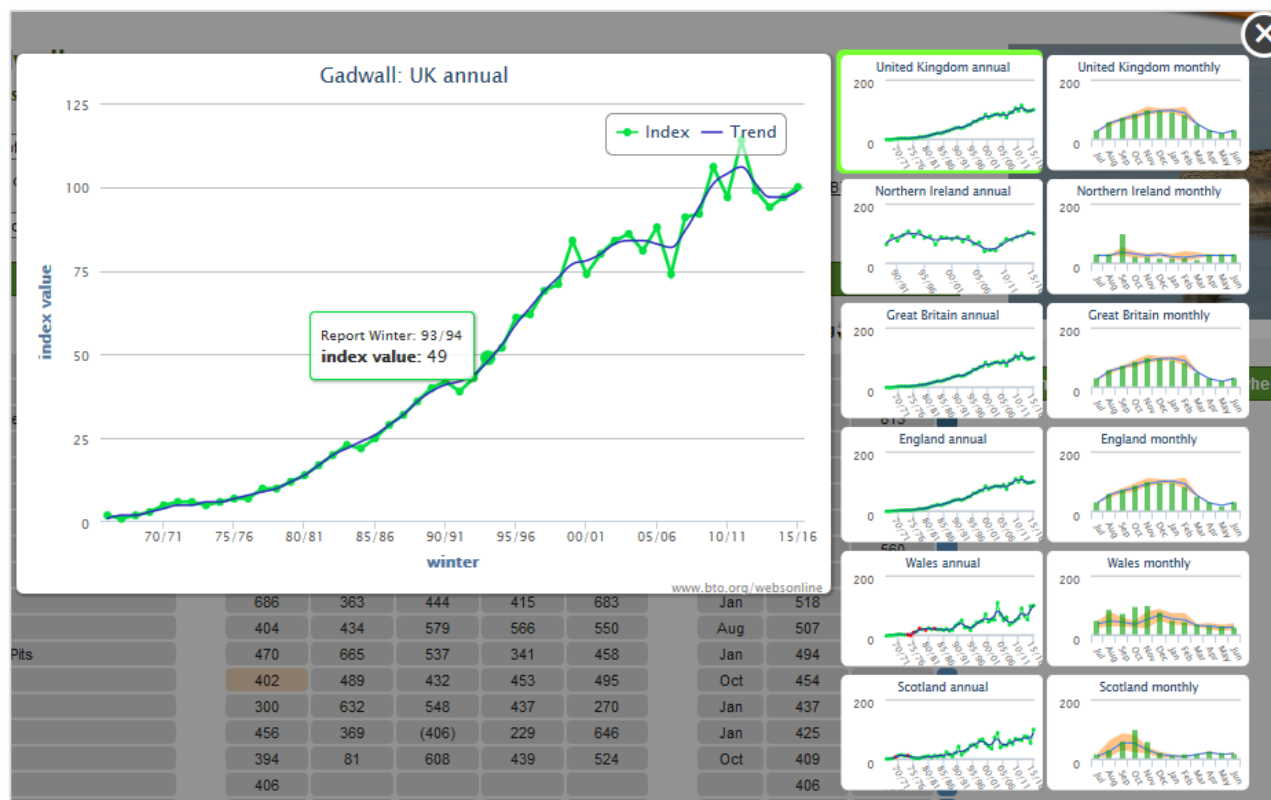


Figure 5 Annual and Monthly index and trend plots on WeBS Report Online. Select a plot to enlarge. Hover over a point to see the index value.

For the most abundant waterbirds **25-year and 10-year population trends** are published in the summary report of *Waterbirds in the UK*. These are calculated by comparing using the smoothed trend value for the previous year and 25 and 10 years previous to that year. For example, *Waterbirds in the UK 2015/16* contains trends for the periods 2004/05 – 2014/15 and 1989/90-2014/15, but uses data up to 2015/16 to compute these. This is customary due to the higher sensitivity of the trend to individual index values in the first and last years.

The actual index values and trend values used to produce the graphs in the annual report are published as downloadable tables on the annual report pages at www.bto.org/webs-annual-report.

3.2.3 Interpretation of annual indices and trends

For most species, the long-term trends in index values can be used to assess changes in overall wintering numbers with confidence. However, the above comments concerning the differential coverage of different habitats remain important. For some species, a substantial proportion of wintering birds occur away from those sites monitored by the WeBS Core Count scheme, or use these sites at certain times of day that make them unlikely to be encountered by WeBS counters. Consequently, this **incomplete coverage needs to be borne in mind when interpreting the indices**

for some species. The proportion of some of these species being monitored by the WeBS Core Count scheme can be quantified and biases understood by comparison to other surveys.

- Results from the Non-estuarine Coastal Waterbird Survey (NEWS) indicate that WeBS Core Counts monitor between one quarter and one half of wintering **Ringed Plover, Purple Sandpiper, Sanderling** and **Turnstone**, and that the indices and trends reported from WeBS data will be **biased towards changes occurring on estuaries**.
- Similarly, trends reported for **seaduck** and **grassland plovers** will be biased towards changes occurring within estuaries, although for these species the proportion of overall numbers monitored by WeBS Core Counts is less well understood. For species such as **Eider, Common Scoter, Velvet Scoter** and **Long-tailed Duck**, although there are a number of representative Core Counts from many WeBS sites, a substantial proportion of wintering birds occur away from those sites monitored by the WeBS scheme.
- In the case of **Whooper and Bewick's Swans**, although the sites on which they occur are generally well monitored by WeBS Core Counts, they are mainly used by the birds as roost sites. Therefore **variation in the birds' daily routine** with changes in weather or local feeding opportunities may have considerable influence on whether they are present during the WeBS count and thus affect the reported indices and trends.
- Indices and trends for **Pink-footed Goose, Greenland White-fronted Goose, Icelandic Greylag Goose** and **Svalbard Barnacle Goose** can be considered to be especially representative of national patterns. The numbers of these species are not well monitored by monthly WeBS Core Counts but rather are preferentially **monitored by the annual coordinated censuses** that cover the majority of the British wintering populations.
- Indices for strictly or principally **estuarine species** (e.g. **Wigeon** and **Knot**) can also be considered especially **representative** as over 90% of British estuaries, including all major sites, are counted each month between September and March.
- Similarly, species that occur **principally on larger inland waterbodies** (e.g. **Pochard**) are well monitored by WeBS Core Counts, although the proportion of the numbers not being monitored is largely unquantified. For these species the indices and trends reported can be considered representative of the national pattern.
- For more **widespread species** (e.g. **Mallard, Tufted Duck** and **Curlew**) a large proportion of birds occur at small inland sites and habitats not well monitored by WeBS Core Counts. The selection of such sites follows no formal sampling pattern and therefore **it is unclear as to whether these wetlands are a representative sample of the country** as a whole.
- Caution should be used in interpreting figures for species that only **occur in small numbers** or are relatively poorly monitored by WeBS. Thus, numbers tend to fluctuate more widely for many species in **Northern Ireland**, largely as a result of the smaller numbers of birds involved, but also, being at the western most limit of their range, due to variable use made of Ireland by wintering waterbirds.

Because short-term fluctuations provide a less rigorous indication of population changes, care should be taken in their interpretation. The underlying trend, denoted by the blue smoothed line in the annual index graphs, will give a better overall impression of trends for species with marked inter-annual variation, although it should be noted that unusually high or low index values in the most recent year will have a disproportionate effect on the trend at that point.

It should be borne in mind that **the imputed values, used in place of missing and incomplete counts, are calculated anew each year**. Within the completeness calculation for 'complex sites', this may cause the same count to change from complete to incomplete or vice versa with the addition

of a new year's data. Because **the index formula uses data from all years, the inclusion of a new year's counts will slightly alter the site, month and year factors.** Additionally, data submitted too late for inclusion are added to the dataset subsequently. In turn, the assessment of missing counts may differ slightly and, as a result, **the index values produced each year are likely to differ from those published in the previous Waterbirds in the UK** (prior to 2004/05 published as Wildfowl and Wader Counts). Hence indices published each year represent an improvement on previous figures as any additional years' data allow calculation of the site, month and year factors with greater confidence.

3.3 Monthly Indices

The abundance of different waterbird species varies during the winter due to a number of factors, most notably the timing of their movements along the flyway, whilst severe weather, particularly on the continent, may also affect numbers in the UK. However, due to differences in site coverage between months, such patterns cannot be reliably detected using count totals. Consequently, an index is calculated for each **month** to reflect **changes in relative abundance** during the season.

3.3.1 Underhill index method for monthly indices

The imputing process used to derive missing data for generating annual trends (Section 3.2.1) also allows monthly indices to be calculated across the same suite of sites. This reveals patterns of seasonality for the species considered. These are presented as graphs in the species pages on the annual report, showing the value for the most recent winter, and the average value and range over the five preceding winters (Figure 6). WeBS Core Counts are also used to present monthly indices for the goose species for which annual indices are based on censuses (as census data are available for a limited number of months only).

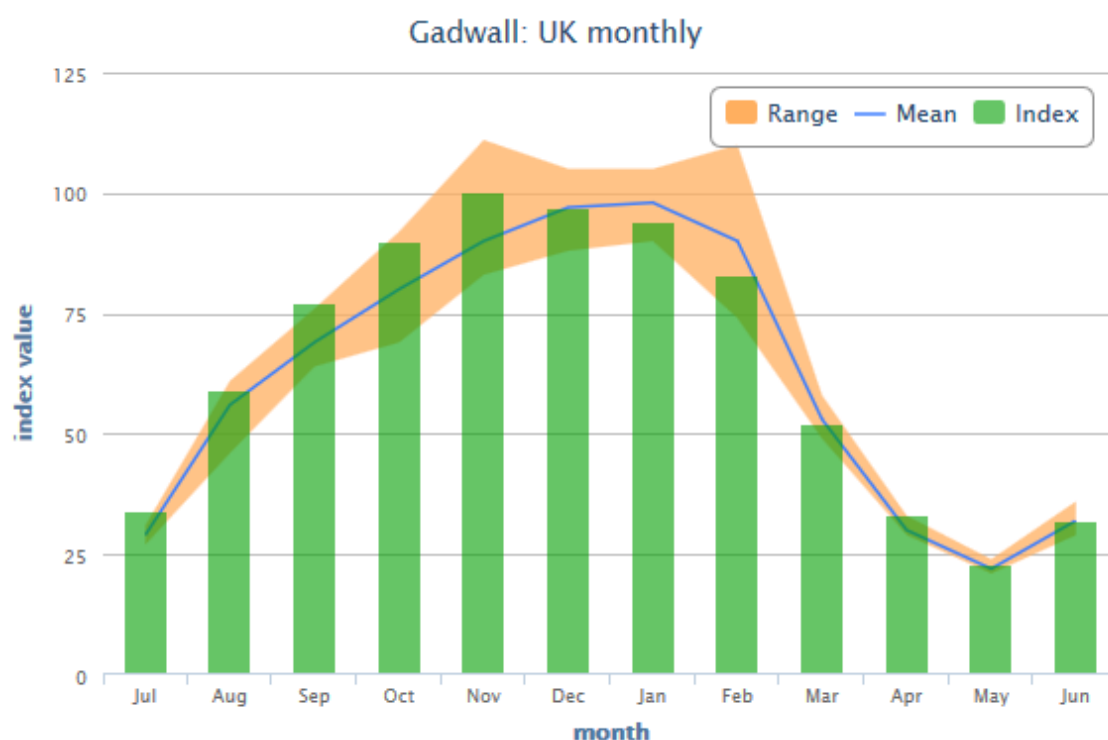


Figure 6 Monthly index plot showing index and the average value and range over preceding five winters.

Broad differences in the monthly values between species reflect their status in the UK. **Resident** species, or those with large UK breeding populations, e.g. some grebes and Mallard, are present in large numbers early in the winter. Declines through the winter result in part from mortality of first-year birds, but also birds returning to remote or small breeding sites that are not covered by WeBS. The majority of UK waterbirds either occur solely as winter visitors, or have small breeding populations that are swelled by winter immigrants, with peak abundance generally occurring in mid winter.

The vast majority of the wintering populations of many wader species are found on **estuaries**, and, since coverage of this habitat is relatively complete and more or less constant throughout the winter, meaningful comparisons of total monthly counts can be made for many species.

3.3.2 Interpretation of monthly indices

Many of the caveats in Section 3.2.3 should be borne in mind when interpreting monthly indices. As for annual indices, it should be particularly noted that the reduced numbers of both sites and birds in **Northern Ireland** result in a greater degree of fluctuation in numbers used in the analyses of data from there.



3.4 National Totals

WeBS national totals are not population estimates, as WeBS does not cover 100% of the population of any species. The totals are presented separately for Great Britain (including Isle of Man but excluding the Channel Islands) and Northern Ireland in recognition of the different legislation that applies to each and are given on the species pages on the WeBS Online Report (Figure 7). Separate totals for England, Scotland, Wales, and the Channel Islands and monthly totals can be obtained from the BTO upon request.

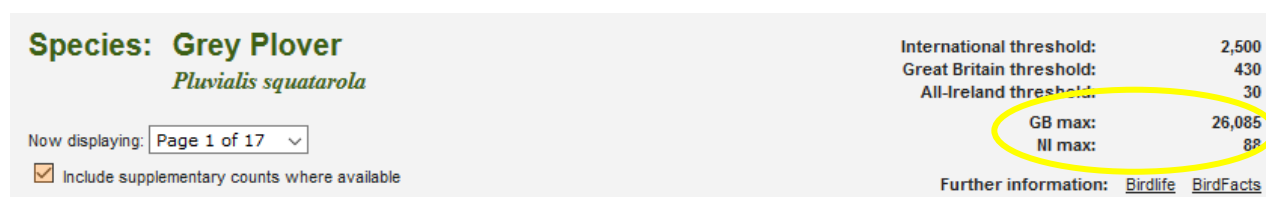


Figure 7 National total (maxima over twelve months) for Grey Plover for Great Britain and Northern Ireland highlighted on WeBS Report Online.

3.4.1 Method for calculating national totals

If several accurate counts are available for the same month, the count nearest the monthly priority date or, alternatively, the count coordinated with nearby sites if there is considered to be significant interchange, is chosen for use in the annual report. A count from any date is used if it is the only one available.

In calculating national totals, data from counts at all sites are used, **irrespective of whether they are considered complete** or not. Numbers presented in the annual report are not rounded. National and site totals calculated as the sum of counts from several sectors or sites may imply a false sense of accuracy if different methods for recording numbers have been used, e.g. 1,000 birds estimated on one sector and a count of seven individuals on another is presented as 1,007. It is safe to **assume that any large count includes a proportion of estimated birds**. Reproducing the submitted counts in this way is, however, deemed the most appropriate means of presentation and avoids the summation of ‘rounding error’.

Totals from different count methods are mostly not combined to produce national totals because the lack of synchronisation may result in errors, e.g. birds counted at roost by one method may be effectively double-counted during the WeBS count at a different site in that month. Total counts from **several national goose surveys** are, however, used instead of WeBS Core Counts where the census total provides a better estimate of the total numbers, as follows:

- **Pink-footed** and **Icelandic Greylag Geese** in October, November and December;
- **Greenland White-fronted Goose** in December and March;
- **Greenland Barnacle Geese** in November and March;
- NW Scotland **Greylag Geese** in August and February;
- **Canadian Light-bellied Brent Geese** in October.

Additionally, counts of **Svalbard Barnacle Geese** from North Cumbria and Dumfries & Galloway are replaced by Solway-wide dedicated counts between October and May. Finally, the maximum British totals for both **Bewick's and Whooper Swan** do include roost counts from the Ouse and Nene Washes and Martin Mere in place of Core Counts at these locations, given the particular concentration of these species feeding around and roosting at these sites. Counts from other site or regional-based surveys, for example of seaducks, are not included in national totals.

In calculating national totals, as with other WeBS outputs, treatment of geese and eider populations is as detailed in **Section 3.6**.

3.4.2 Interpretation of National Totals

The majority of count data are collected between September and March, when most species of waterbird are present in the UK in highest numbers. Caution is urged, however, regarding interpretation of counts outside this period both due to the relative sparsity of counts from this period and the different count effort for different sites. Data are presented for the months July to June inclusive or by calendar year as appropriate (see Section **1.3**).

A number of **systematic biases** of WeBS or other count methodology must be borne in mind when considering the data. Coverage by WeBS of estuarine habitats and large, standing waters is good or excellent. Consequently, **counted totals of those species which occur wholly or primarily on these habitats during winter will approach a census**.

Those **species dispersed** widely over rivers, non-estuarine coast or small inland waters are, however, likely to be considerably under-represented, as will **secretive or cryptic species**, such as snipes, or those which **occur on non-wetlands**, e.g. grassland plovers.

Species which occur in large numbers during **passage** are also likely to be under-represented, not only because of poorer coverage at this time, but due to the high turnover of birds in a short period. Furthermore, since counts of **gulls and terns are optional**, national totals are likely to be considerable underestimates of the number using the network of WeBS sites.

One instance of possible over-estimation may occur if using summed site maxima as a guide to the total number of **scarcer species**. For species with mobile flocks in an area well covered by WeBS, e.g. Snow Goose in southeast England, it is likely that a degree of double-counting will occur, particularly if birds move between sites at different times of the year.

The **publication of records of vagrants in the annual report does not imply acceptance by the British Birds Rarities Committee**. All such records should be submitted by the observers to BBRC via the relevant county recorders.

3.5 Annual Maxima and Site Importance

Criteria for assessing the international importance of wetlands have been agreed by the Contracting Parties to the **Ramsar Convention on Wetlands of International Importance** (Ramsar Convention Bureau 1988). Under criterion 6, a wetland is considered **internationally important** if it regularly supports **1% of the individuals in a population** of one species or subspecies of waterbird, whilst any **site regularly supporting 20,000 or more waterbirds** qualifies under criterion 5.

Similar criteria have been adopted for identification of SPAs under the EC Birds Directive in the UK legislation. A wetland in Britain is considered **nationally important** if it regularly holds **1% or more of the estimated British numbers** of one species or subspecies of waterbird, and in **Northern Ireland**, important in an all-Ireland context if it **holds 1% or more of the all-Ireland estimate**. More detailed information about SPAs and Ramsar sites in the UK can be accessed via the JNCC website at <http://www.jncc.gov.uk/page-4>.

3.5.1 Method for calculating annual maxima and site importance

Species and sites tables in the online report give the maximum monthly count of each species at each site and the month of occurrence of the peak (Figure 8). For all species, **annual maxima are derived from any month in the appropriate 12-month period** (see Section 1.3). The month in which the annual maximum occurred is shown in the “Mon” column for the last year shown. By scrolling back in the table to show earlier years, the month in which the peak occurred in each year may be seen.

Data from other sources, often involving different methods, e.g. goose roost censuses, are used where these provide more representative, i.e. larger, counts for individual sites. The source of all counts, if not derived from WeBS Core Counts, is indicated and non-Core Counts can be turned off by un-ticking the supplementary counts box (see Section 2.3). **Incomplete counts** are bracketed (see Section 3.1).

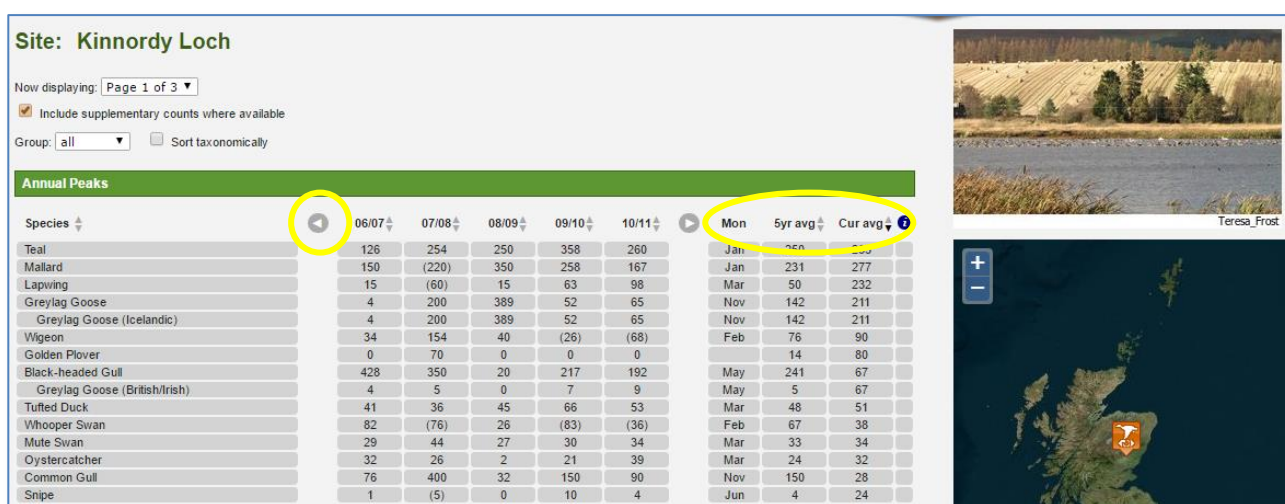


Figure 8 Example site table showing annual maxima. The table has been ordered by the current five-year peak mean and scrolled back using the arrow indicated to show annual maxima for 2006/07 to 2010/11. Here the mon column indicates the month in which the annual maxima occurred for each species in 2010/11; 5yr avg is the five-year peak mean for 2006/07 to 2010/11; and Cur avg is the five-year peak mean for 2011/12 to 2015/16.

For each site/species, the **five-year peak mean** of annual maxima is given, i.e. the mean of annual maxima for the last five years. In the first instance, five-year peak means are calculated using only complete counts; incomplete counts are not used if they depress the mean count. **Incomplete counts are, however, included in the calculation of the mean if they raise the value of the mean.** Where all annual maxima are incomplete, the five-year peak mean is the highest of these individual counts.

By default, species tables are ranked in order of the **five-year peak mean**, in line with recommendations of the Ramsar Convention. Site tables are listed in taxonomic order by default, but can also be listed in order of the five-year peak mean by selecting the “Cur avg” header (Figure 8).

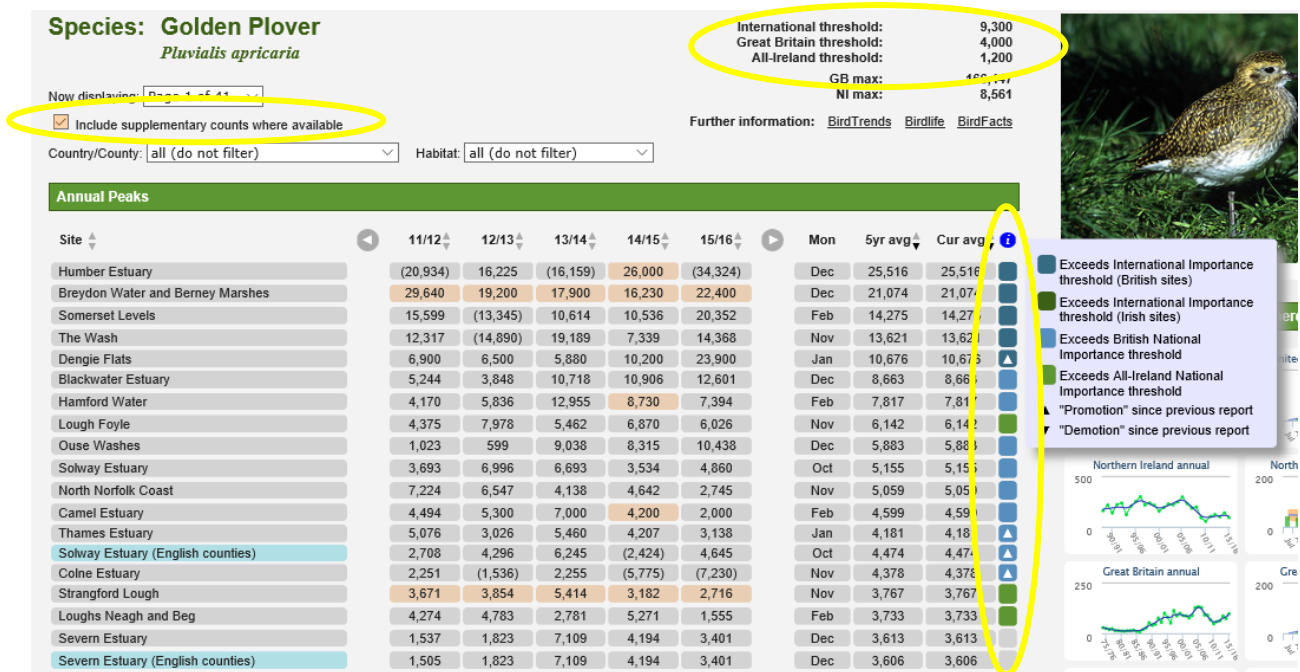


Figure 9 Flagging of internationally and nationally important sites in the WeBS Online Report with supplementary count option and national and international thresholds highlighted. Hovering over the *i* shows the legend for the flags.

Sites **meeting national and international qualifying levels** are **identified by coloured flags**; the relevant 1% qualification thresholds are also given (Figure 9). Flags relating to sites in Great Britain are coloured blue and those for sites in Northern Ireland are coloured green (for both, the darker shade equates to international importance, the pale shade to national importance).

The 1% **thresholds** are based on **population estimates** which are generally revised once every three years, in keeping with internationally agreed timetables (Rose & Stroud 1994¹²). International estimates used in the annual report follow recent revisions of international populations (Wetlands International 2012¹³) and of estimates for Great Britain and Ireland (Musgrove et al. 2011¹⁴, Crowe et al. 2008¹⁵).

¹² Rose, P.M. & Stroud, D.A. 1994. Estimating international waterfowl populations: current activity and future directions. *Wader Study Group Bulletin* 73:19-26.
¹³ Wetlands International, 2012. *Waterbird Population Estimates, Fifth Edition. Summary Report*. Wetlands International, Wageningen, The Netherlands.
¹⁴ Musgrove, A.J., Austin, G.E., Hearn, R.D., Holt, C.A., Stroud, D.A. & Wotton, S.R., 2011. Overwinter population estimates of British waterbirds. *British Birds* 104(7): 364–397.
¹⁵ Crowe, O., Austin, G.E., Colhoun, K., Cranswick, P.A., Kershaw, M. & Musgrove, A.J. 2008. Estimates and trends of waterbird numbers wintering in Ireland, 1994/95 to 2003/04. *Bird Study* 55:66-77.

Sites are flagged using a strict interpretation of the 1% thresholds. For convenience, sites in the Channel Islands and Isle of Man are identified using 1% thresholds for Great Britain. For some species with very small national populations, and consequently very low 1% thresholds, no sites are flagged; this is indicated by the threshold.

Where the **importance of a site has changed since the previous year** as a result of the data collected since - i.e. it has become nationally or internationally important having not been following the previous year, or it has changed from international to national importance or vice versa - this is indicated. Sites with **elevated status** have a triangle pointing up in the coloured flag, whilst those with **lowered status** are indicated using a triangle pointing down.

3.5.2 Method for calculating principal sites

A table of **principal sites** for non-breeding waterbirds in the UK as monitored by WeBS is included in the summary report of *Waterbirds in the UK*, with an extended version online (Figure 10). The table gives the **number of birds supported by the site** in each year, and the **five-year peak mean** of these.

The number of birds supported is calculated by **adding together the annual species maxima at the site**. Species maxima do not all have to occur in the same month and the source can be supplementary data as well as Core Counts, where these available. **Naturalised and non-native species**, including **Canada Geese** are not included in the table. **Gulls and terns are also not included** since counting them is optional (see Section 2.2). **Native species**, including all **Greylag Geese populations**, are included. No attempt is made to account for missing visits or reduced coverage at a site. The summary report includes sites supporting 20,000 birds or more, and the online version 10,000 birds or more.

Principal Sites | 13

Table 2 Principal Sites for non-breeding waterbirds in the UK

Site	2011/12	2012/13	2013/14	2014/15	2015/16	5-year mean
The Wash	294,609	350,031	393,260	343,932	345,366	345,440
Ribble Estuary	259,990	178,318	174,200	171,680	160,906	189,019
Morecambe Bay	201,581	191,056	181,689	171,968	183,770	186,013
Thames Estuary	152,161	179,961	194,525	173,331	141,064	168,208
Dee Estuary (England and Wales)	120,763	151,290	124,605	136,507	146,277	135,888
North Norfolk Coast	158,303	121,563	153,507	121,202	106,257	132,166
Solway Estuary	106,767	112,658	139,738	153,676	126,320	127,832
Humber Estuary	104,213	128,117	129,926	113,202	130,628	121,217
Somerset Levels	76,790	93,386	88,701	102,726	122,057	96,732
Breydon Water and Berney Marshes	91,014	96,523	88,857	91,413	114,626	96,487
Mersey Estuary	94,564	63,412	89,102	85,422	107,271	87,954
Montrose Basin	76,611	77,551	61,718	98,098	101,538	83,103
Severn Estuary	83,605	75,151	74,834	71,476	92,107	79,435
Ouse Washes	63,938	63,088	101,941	75,902	87,704	78,515
Blackwater Estuary	68,017	66,111	83,696	91,090	82,988	78,380
Alt Estuary	64,034	87,950	78,759	73,792	87,308	78,369
Forth Estuary	70,412	76,301	59,353	77,236	79,427	72,546
Strangford Lough	78,759	60,881	65,256	46,204	60,683	62,357
Hamford Water	41,404	63,372	62,228	52,570	46,142	53,143
Dengie Flats	49,715	45,021	55,842	46,460	62,344	51,876
Stour Estuary	50,276	44,520	48,566	52,699	54,283	50,069
Isle of Man and Channel Islands	15,574	18,758	16,518	17,382	18,112	17,117

Figure 10 Example table of Principal Sites for non-breeding waterbirds in the UK

3.5.3 Interpretation of site importance

Sites are selected for **flagging** in the annual report using a strict interpretation of the 1% threshold. However, it should be noted that where 1% of the national population is less than 50 birds, 50 is normally used as a minimum qualifying threshold for the **designation** of sites of national importance.

It is necessary to bear in mind the distinction between sites that **regularly hold wintering waterbird populations of national or international importance and those which may happen to exceed the appropriate qualifying levels only in occasional winters**. This follows the Ramsar Convention, which states that key sites must be identified on the basis of demonstrated regular use (taken as the five-year peak mean in the annual report); otherwise a large number of sites might qualify as a consequence of irregular visitation by one-off large numbers of waterbirds. However, the Convention also indicates that provisional assessments may be made on the basis of a minimum of three years' data. These rules of thumb are applied to SPAs and national assessments also. **Sites with just one or two years' data are also flagged in the tables if the mean exceeds the relevant threshold for completeness but this does not, as such, imply qualification**. This caveat applies also to sites that are counted in more than two years but, because one or more of the peak counts are incomplete, whose means surpass the 1% threshold based on counts from only one or two years.

Nevertheless, **sites which irregularly support nationally or internationally important numbers may be extremely important** at certain times, e.g. when the UK population is high, during the main migratory periods, or during cold weather, when they may act as refuges for birds away from traditionally used sites. For this reason also, the ranking of sites according to the total numbers of birds they support (particularly in the Principal Sites table) should **not be taken as a rank order of the conservation importance of these sites**. Certain sites, perhaps low down in terms of their total 'average' numbers, may nevertheless be of critical importance to certain species or populations at particular times.

Peak counts derived from a number of visits to a particular site in a given season will reflect more accurately the relative importance of the site for the species than do single visits. It is important to bear this in mind since, despite considerable improvements with respect to coverage, data for a few sites presented in the annual report derive from single counts in some years. Similarly, in assessing the importance of a site, peak counts from several winters should ideally be used, as the peak count made in any one year may be unreliable due to gaps in coverage and disturbance- or weather-induced effects. The short-term movement of birds between closely adjacent sites may lead to altered assessments of a site's apparent importance for a particular species. More frequent counts than the once-monthly WeBS visits are necessary to assess more accurately the rapid turnover of waterbird populations that occurs during migration or cold weather movements.

It should also be borne in mind that because a count is considered complete for WeBS, **it does not imply that it fully represents the importance of the site**. A site of importance for a wintering species may have been counted only in autumn or spring, and thus while a valid complete count is available for that year, it under-represents the importance of the site for that species. A similar issue arises for counts derived from different survey methods. For example, many sites important as gull roosts are identified on the basis of evening roost counts. Valid and complete counts may have been made by WeBS Core Counts during daytime over the course of a particular winter but, if no roost counts were made, the mean will be depressed by the much lower Core Count in that year. Thus, when counts appear to **fluctuate greatly between years at individual sites** on the basis of data from different sources - particularly for geese and gulls in the absence of roost counts, and for seabirds in the absence of dedicated survey - **the five-year means and apparent trends over time should be viewed with caution**.

Caution is also urged regarding the use of Low Tide Count data in site assessment. Whilst this survey serves to highlight the importance of some estuaries for feeding birds that, because they roost on other sites, are missed by Core Counts, the objectives of Low Tide Counts do not require strict synchronisation across the site. This may result in **double counting** of birds on some occasions. It should also be noted that count completeness assessments are not made for Low Tide Count totals at complex sites, and any undercounts from this scheme are not flagged in the tables, leading to under-estimation of the site's importance.

This list of potential sources of error in counting wetland birds, though not exhaustive, suggests that the net effect tends towards under- rather than over-estimation of numbers, and provides justification for the use of maximum counts for the assessment of site importance or the size of a population.

Factors causing under-estimation are normally constant at a given site in a given month, so that while under-estimates may occur, comparisons between sites and years remain valid.

It should be recognised that, in presenting sites supporting nationally or internationally important numbers of birds, the **annual report provides just one means of identifying important sites and does not provide a definitive statement on the conservation value of individual sites for waterbirds**, let alone other conservation interests. European Directives and conservation Conventions stress the need for a holistic approach to effect successful conservation, and lay great importance on maintaining the distribution and range of species, in addition to the conservation of networks of individual key sites.

Poor coverage, whether geographical or temporal, can occur, and it should be recognised that **lists of sites supporting internationally and nationally important numbers of birds in the WeBS Report Online are limited by the availability of WeBS and other survey data**. Whilst the counter network is likely to cover the vast majority of important sites, others may be missed and therefore will not be listed in the tables due to lack of appropriate data.

It should also be remembered that the **WeBS site boundaries do not necessarily match existing designated site boundaries** (Section 2.1). In general, any comprehensive assessment of individual site importance is likely to analyse detailed WeBS data obtained via the **WeBS data request service**, along with other evidence.

Detailed site data and sites trends are available via the WeBS data request service:

www.bto.org/webs-data

Statutory government agency staff may obtain ongoing access to detailed data via WeBS Online.

Please arrange this by contacting us via **websdata@bto.org**

3.6 Treatment of Goose and Eider subspecies / populations

There are a number of species of waterbird, particularly geese, for which subspecies or distinct populations are known to winter in geographically distinct ranges, or for which it is possible to differentiate between subspecies or populations in the field.

In some cases, for example the White-fronted Goose *Anser albifrons* where two subspecies *albifrons* and *flavirostris* winter in the UK, records received from WeBS counters will normally record the subspecies in question, with very few unspecified birds reported.

In other cases, for example the Barnacle Goose *Branta leucopsis*, although we know that three populations are recorded in the UK, these cannot be distinguished in the field and virtually all records received from WeBS counters will simply record the species. However, there have been studies that have related birds frequenting particular sites to particular populations.

WeBS makes use of this knowledge when reporting these species. In order to do so, certain assumptions need to be made about the likely origin of individuals from records of species for which subspecies or population is unspecified, and these are detailed below.

3.6.1 WeBS treatment of Bean Goose populations

Reports to 2010/11 - Taiga Bean Goose, Tundra Bean Goose.

Reports from 2011/12 - As above with the addition of 'unspecified' Bean Goose.

Two distinct populations of Bean Goose *Anser fabalis* winter in the UK, and although not unanimously accepted, most authorities would consider these to each belong to a separate subspecies, the Taiga Bean Goose *A.f.fabalis* and the Tundra Bean goose *A.f.rossicus*.

In Britain, **Taiga Bean Geese** are concentrated predominately in two areas: the Slamannan Plateau, in Falkirk, Scotland, and the Yare Marshes in Norfolk, England where they number in the lower hundreds. Traditionally, records of unspecified Bean Goose other than from these two areas have been assumed to be **Tundra Bean Goose**. Records away from the two principal sites for Taiga Bean Geese only occasionally reach double figures regardless of subspecies. However, since WeBS counters have been submitting records through the online system, many of the Bean Goose reports include determination to subspecies. This indicates that Taiga Bean Goose occasionally occurs in small numbers away from the two principal sites and that Tundra Bean Goose are occasionally found associating with flocks of Taiga Bean Goose.

WeBS allocation of Bean Goose records for reporting purposes

Taiga Bean Goose: all records of unspecified Bean Goose from either the Slamannan Plateau or the Middle Yare Marshes. All records reported specifically as Taiga Bean Goose.

Tundra Bean Goose: All records reported specifically as Tundra Bean Goose.

Bean Goose (from winter 2011/12): All records of Taiga Bean Goose, Tundra Bean Goose or unspecified Bean Goose.

WeBS reporting of Bean Goose annual trends:

Taiga Bean Goose: WeBS does not calculate annual trends for this subspecies but rather reports trends derived from the annual winter census of birds at the two principal locations. Monthly trends are derived from WeBS data.

3.6.2 WeBS treatment of White-fronted Goose populations

Reports to 2010/11 - Greenland-White-fronted Goose & European White-fronted Goose.

Reports from 2011/12 - As above with the addition of 'unspecified' White-fronted Goose.

Two subspecies of White-fronted Goose *Anser albifrons* winter in the UK, these being the European White-fronted Goose *A.a.albifrons* and the Greenland White-fronted Goose *A.a.flavirostris*.

In Britain, **European White-fronted Goose** winter mainly in the South and East of England although in recent winters records of this subspecies have been received from as far North as Orkney. Balmer et al. (2013)¹⁶ indicates them to be frequent in other parts of England with isolated records as far afield as Western Scotland. The main wintering areas of the **Greenland White-fronted Goose** in the UK are in Northern Ireland and Western Scotland, particularly on Islay. Balmer et al. (2013) indicates them to be frequent in other parts of Scotland and Northwest England. A small flock of several hundred geese belonging to this subspecies have a long association with the Dyfi in Wales.

These two subspecies are readily distinguished in the field. Hence, all but a few records received by WeBS include determination to subspecies.

WeBS allocation of White-fronted Goose records for reporting purposes

2011/12 onwards:

European White-fronted Goose: All records reported specifically as European White-fronted Goose. All unspecified records of White-fronted Geese from the Severn Estuary and coastal counties of South and East England.

Greenland White-fronted Goose: All records reported specifically as Greenland White-fronted Goose. All unspecified records of White-fronted Geese from Northern Ireland, North and West Scotland and the Dyfi in Wales not recorded to subspecies.

'Generic' White-fronted Goose: All records of European White-fronted Goose, Greenland White-fronted Goose or birds for which the subspecies was not determined (of which there are very few).

Prior to 2011/12:

European White-fronted Goose: All records reported specifically as European White-fronted Goose. All records of unspecified White-fronted Goose from England and South Wales.

Greenland White-fronted Goose: All records reported specifically as Greenland White-fronted Goose. All unspecified records of White-fronted Goose from Scotland, West and North Wales, Northwest England and Northern Ireland.

¹⁶ Balmer, D.E., Gillings, S., Caffrey, B.J, Swanne, R.L., Downie, I.S. & Fuller, R.L. 2013 *Bird Atlas 2007-11: the breeding and wintering birds of Britain and Ireland*. BTO Books, Thetford.

WeBS reporting of White-fronted Goose annual trends:

European White-fronted Goose: Both annual and monthly trends are derived from WeBS data.

Greenland White-fronted Goose: WeBS does not calculate annual trends for the Greenland population but rather reports trends derived from the annual winter census organised by the Greenland White-fronted Goose Study Group. Monthly trends are derived from WeBS data.

3.6.3 WeBS treatment of Greylag Goose populations

Reports to 2008/09 - Icelandic Greylag goose, Northwest Scotland Greylag Goose & re-established Greylag Goose.

Reports from 2009/10 - Icelandic Greylag Goose & British/Irish Greylag Goose

Reports from 2011/12 - As above with the addition of 'unspecified' Greylag Goose.

Two populations of Greylag Goose *Anser anser* occur in the UK, these being the **migratory Icelandic population** and the **resident British/Irish population**. Although the latter may migrate within the UK, there is no evidence of international movements for this population. Formerly, the **British/Irish Greylag** could be itself separated into two distinct populations based on geographic range, these being the relict native population restricted to Northwest Scotland, and the population of re-established birds largely restricted to England. However, with both the resident populations expanding their ranges, by winter 2009/10 rising levels of range overlap had made separate reporting of these two populations (indistinguishable in the field) untenable and from that winter onwards the two populations have been considered as merged. See Mitchell et al. (2012)¹⁷ for further background on merging of Greylag Geese in Britain.

The **Icelandic and British/Irish birds are indistinguishable in the field** and range overlap between them is extensive. This makes it impossible to assign individuals to one or the other population over much of the UK with complete confidence. During the 'summer' months (May to September) it is reasonable to treat all Greylags in Britain and Ireland as belonging to the British/Irish population. It is also reasonable to treat all Greylags recorded during the winter in Wales and the South and East of England as belonging to the British/Irish population. Currently, winter numbers of occurring on sites in Scotland other than the core range of the Northwest Scottish breeding birds and the North of Cumbria (Solway Estuary) are reported as Icelandic Greylag. However, Balmer et al. (2013) found the resident breeding population to be widespread and numerous in Scotland and so this treatment is becoming less tenable as the resident breeding population continues to spread and increase in number. We therefore draw attention to WeBS reporting of the 'generic' Greylag Goose from the 2011/12 winter, with the recommendation to further research of the year-round use of any given site as a means of deducing what population(s) may be involved.

WeBS allocation of Greylag Goose records for reporting purposes

2009/10 onwards:

Icelandic Greylag Goose: All records reported specifically as Icelandic Greylag. All unspecified records reported from between September and April of Greylag from Scotland excluding the core breeding range of the Northwest Scotland population (Hebrides), and North Cumbria. Records for

¹⁷ Mitchell, C., Hearn, R. & Stroud, D. 2012. The merging of populations of Greylag Geese breeding in Britain. *British Birds* 105: 498-505

most of the more important sites come to WeBS as supplementary counts, primarily roost counts made under the WWT annual winter census.

British/Irish Greylag: All records reported specifically as British/Irish Greylag. All unspecified records of Greylag from Northern Ireland, Wales and England (excluding North Cumbria). All unspecified records of Greylag in Scotland between May and September.

'Generic' Greylag (2011/12 onwards): All records of Greylag whether unspecified or reported as belonging to a specific population.

Prior to 2009/10:

Icelandic Greylag Goose: All records reported specifically as Icelandic Greylag. All unspecified records of Greylag from Scotland excluding the core breeding range of the Northwest Scotland population (Hebrides), and North Cumbria. Records for most of the more important sites come to WeBS as supplementary counts, primarily roost counts made under the annual WWT/JNCC winter census.

Northwest Scotland Greylag Goose: All records reported specifically as Northwest Scotland Greylag. Records for most of the more important sites come to WeBS as supplementary counts, primarily as roost counts made under the annual WWT autumn census.

Re-established Greylag Goose: All records reported specifically as re-established Greylag. All records of unspecified Greylag from Wales, England (excluding North Cumbria) and Northern Ireland.

WeBS reporting of Greylag Goose annual trends:

Icelandic Greylag: WeBS does not calculate annual trends for the Icelandic population but rather reports trends derived from the annual WWT/JNCC winter census. Monthly trends are derived from WeBS data.

British/Irish Greylag Goose: Both annual and monthly trends are derived from WeBS data. Since the 2011/12 report, the **summer months of April to September have been used instead of the standard September to March used by WeBS for calculating waterbird trends**. This change has been implemented in order to rule out the inclusion of other than trivial numbers of Greylag from the Icelandic population.

Re-established Greylag Goose: prior to the 2009/10 report, trends for this population were based on WeBS 'winter' counts (September to March) of Greylag from England (excluding North Cumbria) and Wales.

3.6.4 WeBS treatment of Barnacle Goose populations:

Reports to 2010/11 - Greenland Barnacle Goose; Svalbard Barnacle Goose & Naturalised Barnacle Goose.

Reports from 2011/12 - Greenland Barnacle Goose; Svalbard Barnacle Goose; Naturalised barnacle Goose & 'generic' Barnacle Goose.

Two distinct populations of Barnacle Goose *Branta leucopsis* are known to winter in the UK. **Barnacle Goose from the Svalbard population** are known to winter at three principal sites in the UK: Solway Firth, Lindisfarne and Loch of Strathbeg. Those from the **Greenland** population winter chiefly in the

Western Isles. In addition to these two migratory populations, the UK has an increasing population of **naturalised Barnacle Goose**.

Individuals of these three populations are **indistinguishable** in the field. Consequently, all but a few records received by WeBS refer simply to 'Barnacle Goose'. When reporting this species, WeBS assumes that records from any of the three sites associated with the Svalbard population belong to that population, records from elsewhere in Scotland belong to the Greenland population, and remaining records belong to the naturalised population. However, the Svalbard population continues to increase and birds from this population may begin to expand their winter range within the UK.

WeBS allocation of Barnacle Goose records for reporting purposes

Greenland Barnacle Goose: All records of Barnacle Goose from Scotland other than the Solway Estuary and Loch of Strathbeg. Any record specifically reported as Greenland Barnacle Goose.

Svalbard Barnacle Goose: All records of Barnacle Goose from coastal counties bordering the Solway Estuary, Loch of Strathbeg or Lindisfarne. Any record specifically reported as Svalbard Barnacle Goose.

Naturalised Barnacle Goose: All records of Barnacle Goose from England and Wales but excluding those from north Cumbria. Any records reported specifically as naturalised Barnacle Goose.

Barnacle Goose (from winter 2011/12): All records of Barnacle Goose.

WeBS reporting of Barnacle Goose annual trends:

Greenland Barnacle Goose: WeBS does not calculate annual trends for the Greenland population but rather reports trends derived from the annual WWT/JNCC/SNH winter census. Monthly trends are derived from WeBS data.

Svalbard Barnacle Goose: WeBS does not calculate annual trends for the Svalbard population but rather reports trends derived from the annual WWT/JNCC/SNH winter census. Monthly trends are derived from WeBS data.

Naturalised Barnacle Goose: both annual and monthly trends are derived from WeBS data.

3.6.5 WeBS treatment of Brent Goose populations:

Reports to 2010/11 - Dark-bellied Brent Goose, Canadian light-bellied Brent Goose and Svalbard Light-bellied Brent Goose.

Reports from 2011/12 - As above with the addition of 'generic' Light-bellied Brent Goose and 'generic' Brent Goose.

Two subspecies of Brent Goose *Branta bernicla* winter in the UK, these being the Dark-bellied Brent Goose *B.b.bernicla* and the Light-bellied Brent Goose *B.b.brota*. Furthermore, two distinct populations of the Light-bellied Brent Goose are involved, the Svalbard population and the Canadian population.

Dark-bellied Brent Geese winter primarily in England, occurring in substantial numbers on sites from the Humber Estuary southwards on the East coast, along the South coast; and with smaller numbers being recorded intermittently at sites in Wales and Northwest England. Birds from the **Svalbard population of Light-bellied Brent** winter principally at Lindisfarne where they number in the thousands, but are also recorded annually at other sites in Northeast England and Southeast Scotland in smaller numbers. Records of Light-bellied Brent further afield in the East of Britain are

generally taken to be from this population. The majority of **Light-bellied Brent from the Canadian population** visiting the UK during the winter are to be found in Northern Ireland, especially on Strangford Lough which alone hosts about 80% of the UK total. Smaller numbers of Canadian birds are also to be found on the North and West coasts of Scotland with occasional records from Western and Southern generally being taken to be from this population.

Although **Dark and Light-bellied Brent are readily distinguished** in the field, the **two populations of Light-bellied Brent cannot be separated**. Accordingly, most records of the latter refer simply to Light-bellied Brent. When reporting Light-bellied Brent, WeBS allocates all records from counties along the East coast of mainland Britain to the Svalbard population and all other records for coastal counties to the Canadian population. From the WeBS report for winter 2011/12 onwards, the few records received of Light-bellied Brent from land-locked counties have not been assigned to population. Very occasionally reports are received simply recorded as Brent Goose. Of these, those from Northern Ireland are assumed to be from the Canadian population of Light-bellied Brent, but otherwise they are not assigned to subspecies or population. The inclusion in the WeBS report from winter 2011/12 onwards of 'generic' Brent Goose and 'generic' Light-bellied Brent Goose ensures all such records are reported.

WeBS allocation of Brent Goose records for reporting purposes

Dark-bellied Brent Goose: all records reported as Dark-bellied Brent.

Canadian Light bellied Brent Goose: all records reported as Light-bellied Brent from Northern Ireland, and coastal counties of the North coast of Scotland (including Orkney and Shetland), West and South coast Britain and the Channel Islands, Any records of unspecified Brent Goose from Northern Ireland. Any records specifically reported as Canadian Light-bellied Brent.

Svalbard Light-bellied Brent Goose: all records of Light-bellied Brent from coastal counties of East coast Britain. Any records specifically reported as Svalbard Light-bellied Brent.

Light-bellied Brent Goose (from 2011/12 onwards): All records reporting Light-bellied Brent and unspecified records of Brent in Northern Ireland.

Brent Goose (from 2011/12 onwards): All records of Brent.

WeBS reporting of Brent Goose annual trends:

Dark-bellied Brent Goose: Both annual and monthly trends are derived from WeBS data.

Canadian Light-bellied Brent Goose: Both annual and monthly trends are derived from WeBS data.

Svalbard Light-bellied Brent Goose: Both annual and monthly trends are derived from WeBS data.

3.6.6 WeBS treatment of Eider populations:

Reports to winter 2007/08 - Eider - with no differentiation of populations.

Reports for winters 2008/09 to 2010/11 - Eider (Shetland population) & Eider (UK excluding Shetland).

Reports from winter 2011/12 onwards - Eider (Shetland), Eider (UK excluding Shetland) & 'generic' Eider.

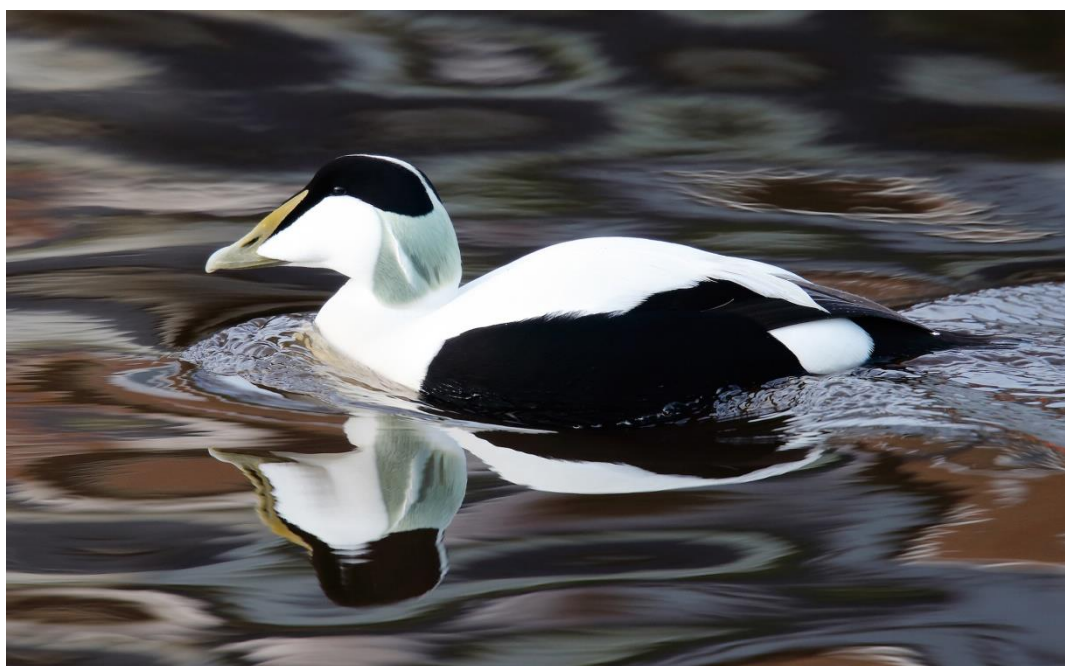
Following the recommendations of Scott & Rose (1996)¹⁸ and Furness et al. (2010)¹⁹, since the WeBS report for winter 2008/09²⁰ (Calbrade et al. 2009), Common Eiders *Somateria mollissima* on Shetland have been treated as a separate population from those elsewhere in the UK. However, the taxonomic recommendation of Furness et al. (2010) has not been followed since the BOU has yet to recognise this population as belonging to the subspecies *faeroensis*.

WeBS allocation of Eider records for reporting purposes

Eider (Shetland) (from winter 2008/09): All records of Eider from Shetland.

Eider (except Shetland) (from winter 2008/09 onwards): All records other than from Shetland.

Eider (from 2010/11): All records of Eider.



¹⁸ Scott, D.A. & Rose, P.M. 1996. *Atlas of Anatidae populations in Africa and western Eurasia*. Wetlands international Publication No. 41, Wageningen

¹⁹ Furness, R.W., Mable, B., Savouy, F., Griffiths, K., Baillie, S.R. & Heubeck, M. 2010. Subspecies status of common eiders *Somateria mollissima* in Shetland based on morphology and DNA. *Bird Study* 57: 330-335.

²⁰ Calbrade, N.A., Holt, C.A., Austin, G.E., Mellan, H.J., Hearn, R.D. Stroud, D.A. Wotton, S.R. & Musgrove, A.J. 2010. *Waterbirds in the UK 2008/09: The Wetland Bird Survey*. BTO/RSPB/JNCC in association with WWT, Thetford.



Data Analysis, Presentation and Interpretation (Low Tide Counts)

Estuarine sites in the UK provide the most important habitat for non-breeding waterbirds, acting as wintering grounds for many migrants but also as stopover feeding locations for other waterbirds passing along the East Atlantic Flyway. **Core Counts** on estuaries tend to quantify birds present at high tide roosts (although at a small number of estuaries core counts are carried out at low tide as local conditions means assessing the number of birds present is more easily achieved at this stage of the tidal cycle). Although important, knowledge of roost sites provides only part of the picture, and does not elucidate the use that waterbirds make of a site for feeding.

The **WeBS Low Tide Counts** scheme was launched in the winter of 1992/93, with most of the major estuaries covered at least once since then. **The scheme aims principally to monitor, assess and regularly update information on the relative importance of inter-tidal feeding areas of UK estuaries for wintering waterbirds and thus to complement the information gathered by WeBS Core Counts.**

The data gathered contribute greatly to the conservation of waterbirds by providing **supporting information** for the establishment and management of UK Ramsar sites and Special Protection Areas (SPAs), other site designations and whole estuary conservation plans. In addition, WeBS Low Tide Counts enhance our knowledge of the **low water distribution of waterbirds** and provide data that highlight **regional and temporal variations in habitat use**, whilst also informing protection of the important foraging areas identified. WeBS Low Tide Counts provide valuable information needed to gauge the potential effects on waterbirds of a variety of human activities which affect the extent or value of inter-tidal habitats, such as proposals for dock developments, recreational activities, tidal power barrages, marinas and housing schemes. Designing mitigation or compensation for such activities can be assisted using data collected under the scheme. Furthermore, the effects on bird distributions of climate change and sea level rise can be assessed.

The survey methods for Low Tide Counts were covered in Section **2.4**. The main outputs of Low Tide Counts are outlined below.

4.1 Low Tide Estuary Accounts

As with Core Counts, results are published annually as part of the WeBS annual report *Waterbirds in the UK*. The Low Tide Counts tab on the WeBS Report Online includes tabulated statistics (see Section 4.2) and dot density maps (Section 4.3) for each site covered by the scheme for each year for which that site has been surveyed (Figure 11). The site page includes a brief description of the site.

In addition, one or two Low Tide estuaries are featured in the **summary report** part of *Waterbirds in the UK*. These feature articles typically include example dot density maps which compare data between surveys where repeat surveys have been made; an extended overview or description of the site and its management or history; and general statistics for the site. The summary report also includes a list of all the estuaries surveyed for Low Tide Counts in that WeBS year.

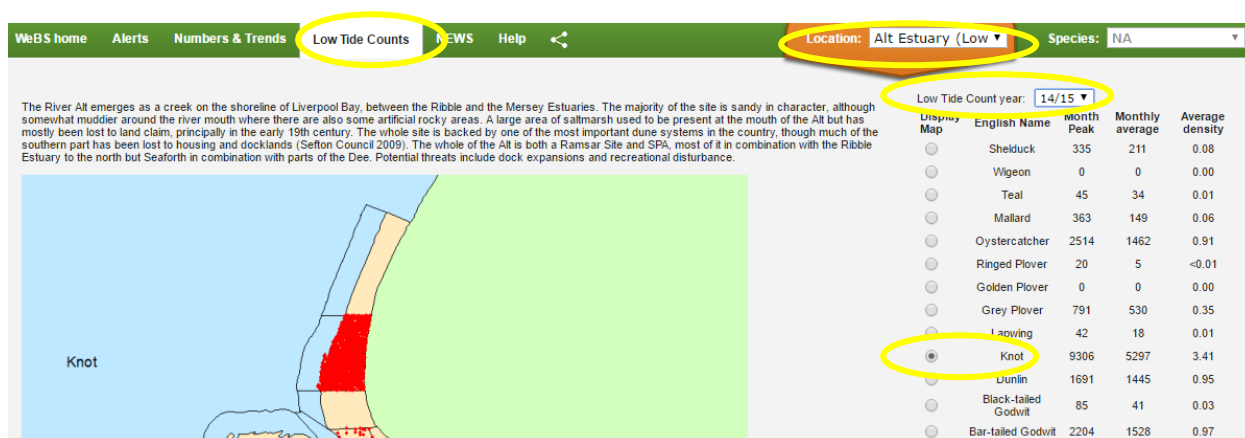


Figure 11 Low Tide Counts tab on WeBS Report Online with navigation options highlighted.

4.2 Tabulated Statistics

On each estuary page the table on the right-hand side presents three statistics for all waterbird species recorded during the survey (Figure 11). These are:

- the **peak** number of a species over the whole site counted in any one month (with checks for count synchronicity made from assessing proximity of count dates and consultation with Local Organisers);
- an **estimate of the average (mean)** number present over the winter for the whole site (obtained by summing the mean counts of each species for each count section); and
- the **average (mean) density over the site (in birds per hectare)**, which is the mean number divided by the total area surveyed (in hectares).

The surveyed area value used for these calculations is **the sum of the inter-tidal and non-tidal components of each count section but omits the sub-tidal areas** (i.e. those parts of the count section which are under water on a mean low tide).

4.3 Dot Density Maps

For the most abundant wildfowl and waders, WeBS Low Tide Count data are presented as **dot density maps**, visible on the Online Report by selecting the species of interest.

4.3.1 Method for producing Dot Density Maps

In the maps count sections are shown with subdivision into basic habitat elements (**Figure 12**). The reason for such a subdivision is to ensure species are plotted on appropriate habitat areas and to improve the accuracy of density estimates. Each section for which a count has been made is divided into a maximum of three different habitat components:

- **Inter-tidal:** Areas that lie between mean high water and mean low water.
- **Sub-tidal:** 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, indicating the approximate extent of visibility offshore from land-based counts.
- **Non-tidal:** Areas that lie above mean high water (usually saltmarsh although some grazing marshes are also covered).

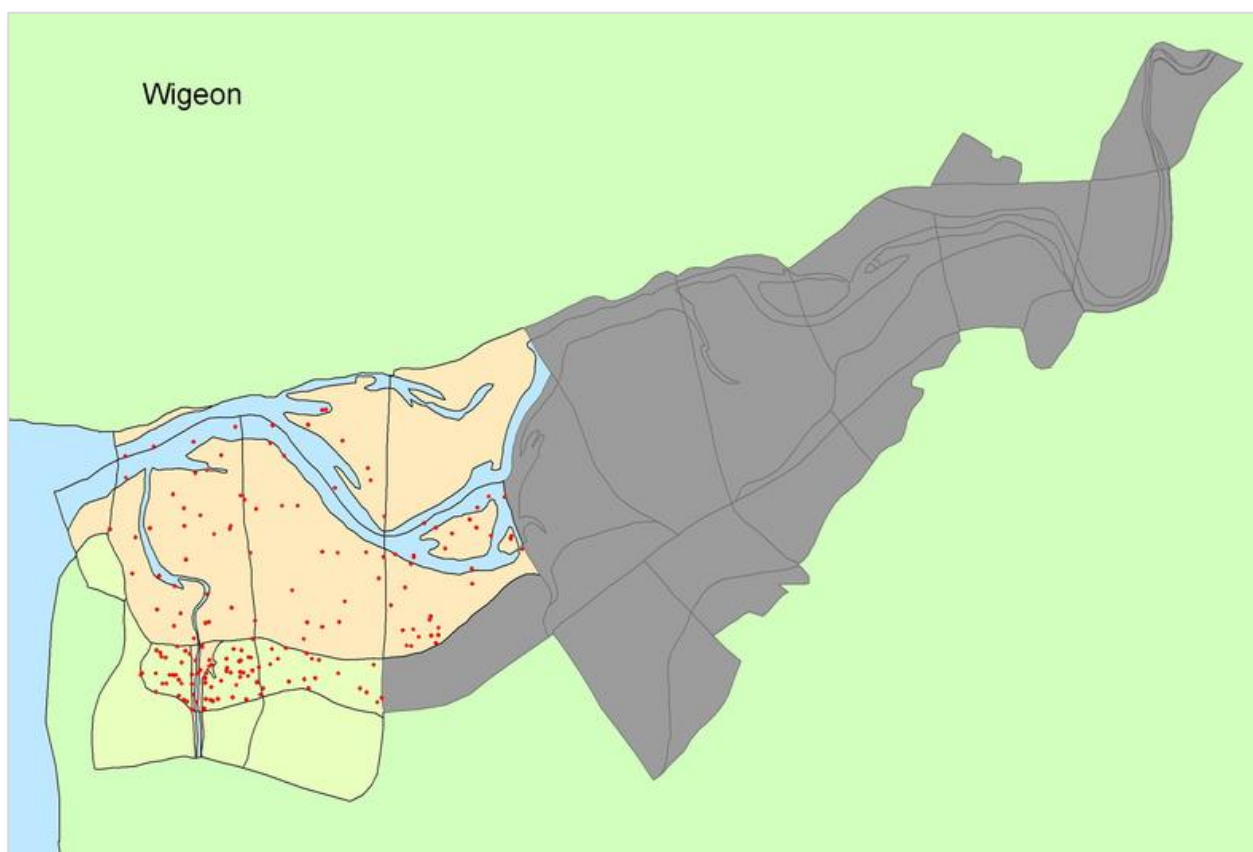


Figure 12 Dot Density Map with inter-tidal (beige), sub-tidal (blue) and non-tidal (pale green) habitats and areas not surveyed (grey).

The **mean count for the sector is then divided amongst a varying number of the different components, dependent on the usual habitat preferences of the species involved.** For example, **Dunlin** dots are plotted exclusively on inter-tidal sections whereas **Wigeon** dots are spread across inter-tidal, sub-tidal and non-tidal areas (in proportion to the relative areas of these three components).

Currently, throughout all WeBS Low Tide Count analyses, mean low tide and mean high tide are taken from the most recent Ordnance Survey 1:25000 maps (in Scotland, the mean low water springs and mean high water springs lines on the OS maps are used instead).

The 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.** The following colour conventions apply to density maps: red dots = birds; pale blue = water; beige = inter-tidal habitat (e.g. mudflat, sandflat); pale green = non-tidal habitat (e.g. saltmarsh, reedbed); grey = not covered in one survey winter (**Figure 12**).

4.3.1 Interpretation of Dot Density Maps

It is hoped that dot density distributions enable fuller appreciation of low tide estuarine waterbird distribution, and changes therein by selecting earlier surveys from the drop-down.

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.

It is recognised, unfortunately, that **maps represent the current real shape of the mudflats, water channels and saltmarshes to varying degrees of accuracy.** However, in the interests of uniformity across the UK, the Ordnance Survey outlines of mean low and high tide are adhered to throughout the analyses.

For all maps in the annual report, **one dot is equivalent to one bird, except where stated.** The size of individual dots has no relevance other than for clarity.

It should be noted that the aim of Low Tide Counts is to highlight the importance of some estuaries for feeding birds and this does not require strict synchronisation across the site. This may result in **double counting** of birds on some occasions.

More detailed information concerning analysis and presentation of WeBS Low Tide Counts can be obtained from the Low Tide Counts Organiser (see **Contacts**) or from the book *Estuarine Waterbirds at Low Tide*.²¹

²¹ Musgrove, A.J., Langston, R.H.W., Baker, H. & Ward, R.M. 2003. *Estuarine Waterbirds at Low Tide: the WeBS Low Tide Counts 1992/93 to 1998/99*. WSG/BTO/WWT/RSPB/JNCC, Thetford.



Appendices

Appendix 1 – Site Hierarchies

WeBS sites vary in size from a small village pond to large estuaries. Large sites would be difficult to cover without splitting the site down into smaller, more manageable areas that can be counted by one or two people. Over the last 70 years these large sites have become **complex sites** having been split and re-split several times.

In order for us to make current data comparable to the historic data there are rules about how sites are split or merged. The **site hierarchy or 'Site Tree'** documents how a site has been split and how the data can be traced from the smallest sub-sector up to the top-level site.

Below is an example of a site that has been split several times.

Level 1	Level 2	Level 3	Level 4	
Original Site	Sector 1	Sector 1A		
		Sector 1B		
	Sector 2	Sector 2A	Sector 2AA	
			Sector 2AB	
		Sector 2B		
	Sector 3	Sector 3A		
		Sector 3B		
		Sector 3C		

The orange site at level 1 is the **original, 'top-level' or 'Ancestor' site**. The grey sectors at level 2 and 3 are **'mid-level' sectors** and the sub-sectors that are coloured blue as referred to as **'lowest-level' or 'bottom-level' sectors**.

It is the top-level sites that appear in the WeBS Annual Report.

Preferably, counts are carried out and recorded at the lowest levels, but at some sites it is necessary to count at mid-levels for some parts of the site.

The WeBS reporting algorithms compute on a **species by species basis**. Sometimes a particular count is entered for a species at a higher level on the site tree due to double counting at lower levels. For example, if when you look at the counts for 3A, 3B and 3C a flock of Spoonbills has moved from 3A to 3B and been counted twice (and wasn't seen on 3C), the true total for Spoonbill may be stored at Sector 3. The analysis programs will still calculate the totals and completeness for the other species recorded separately on the three lower sectors.

Same-level sectors can be split or merged when this is required for counting purposes. For example, Sectors 3B and 3C are on the same level, they could be merged and counted as a new, single mid-level sector (see red box in the figure below).

Level 1	Level 2	Level 3	Level 4
Original Site	Sector 1	Sector 1A	
		Sector 1B	
	Sector 2	Sector 2A	Sector 2AA
		Sector 2B	Sector 2AB
		Sector 2C	
	Sector 3	Sector 3A	
		New Sector	Sector 3B
		New Sector	Sector 3C

Site trees to aid interpretation of WeBS data are available from the WeBS Office (webs@bto.org) as required.

Glossary

Casual Count	An incomplete count, normally consisting on just one or two species, used to record rarities or large flocks of birds seen outside of the Primary Core Count.
Complex Site	A large site that has been split into several count units/sectors and possibly sub-sectors. Sometimes called a Multi-level Site.
Core Count	The principal scheme of the Wetland Bird Survey. WeBS Core Counts are made once a month using so-called 'look-see' methodology, whereby the observer surveys the whole of a predefined area. Core Counts at coastal sites/sectors are usually completed at high tide.
Counter	A volunteer who has agreed to visit a site or sector in order to collect and submit WeBS data (including Core Counts, Low Tide counts, Roost counts and Casual records).
Low Tide Count	The Low Tide Count scheme aims to provide information on the numbers of waterbirds feeding on subdivisions of the inter-tidal habitat within estuaries. Low Tide counts are completed between November and February at individual estuaries about once every six years, although, more frequent counts can be made.
Primary Count	The main Core Count for any given month. This is the count that is used for trends analysis and in the main tables on the WeBS Report Online.
Recording Year	The WeBS recording year runs from July to June
Roost Count	A supplementary count of birds using the site as a roost. Normally completed at dusk and consisting of one or two species only.
Sector	A count area created by splitting an existing site or sector into two or more.
Site	A waterbody that is counted as a single, stand-alone site; or the top-level of a complex site that has been split into smaller sectors.
Site Tree	A hierarchy system of organising sectors to show how a site has been counted. Site Trees can change over time.
Supplementary Count	An additional complete Core Count.
Supplementary Data	Can include supplementary counts using the Core Count methodology, casual counts, roost counts and Low Tide counts. Where the maximum is larger than that of the Primary count, the supplementary data will also be displayed in the Report.
Waterbirds in the UK	The Wetland Bird Survey annual report containing the latest results and interpretation. Consists of a summary report together with tables, plots and maps on WeBS Report Online.
WeBS Report Online	The online reporting interface for key results from WeBS Core Counts ("numbers and trends"), Low Tide Counts, WeBS Alerts and the Non-estuarine Waterbird Survey.

Contacts

Should you have a query regarding any WeBS matter, please contact the WeBS Office at the address below.

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