

Waterbirds in the UK

SURVEY METHODS

The main source of data for this report is the WeBS scheme, providing regular monthly counts for most waterbird species at the majority of the UK's important wetlands. In order to fulfil the WeBS objectives, however, data from a number of additional schemes are included in this report. In particular, a number of species groups necessitate different counting methodologies in order to monitor numbers adequately, notably most geese and seaducks, and the results of other national and local schemes for these species are routinely included.

The methods for these survey types are outlined below and more detail can be found in Gilbert *et al.* (1998). It should be noted that site definition is likely to vary between these surveys (see *Interpretation of Waterbird Counts*).

WeBS Core Counts

WeBS Core Counts are made using so-called 'look-see' methodology (Bibby *et al.* 2000), whereby the observer, familiar with the species involved, surveys the whole of a predefined area. Counts are made at all wetland habitats, including lakes, lochs/loughs, ponds, reservoirs, gravel pits, rivers, freshwater marshes, canals, sections of open coast and estuaries. Numbers of all waterbird species, as defined by Wetlands International (Rose & Scott 1997), 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.

In line with the recommendations of Vinicombe *et al.* (1993), records of all species recorded by WeBS, including escapes, have been published to contribute to the proper assessment of naturalised populations and escaped birds. Following Holmes & Stroud (1995), 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 native range is given in the species account for naturalised species, escapes and vagrants.

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 and the problems of interpretation are highlighted individually in the Species accounts. 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.

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 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 (see *Coverage*). 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.

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 (see *Analysis*).

Data are input by a professional data input company. Data are keyed twice by different people and discrepancies identified by computer for correction. Any particularly unusual counts are checked by the National Organisers and are confirmed with the counters if necessary.

WeBS Low Tide Counts

This survey aims to assess numbers of waterbirds present during low tide on estuaries, primarily to assess the distribution of feeding birds at that time (Musgrove *et al.* 2003; see the section *Low Tide Counts* for a full explanation of methods).

This survey occasionally provides higher counts for individual sites than Core Counts, for example, where birds feed on one estuary but roost on another. These data are validated before being used for site assessment against 1% thresholds.

Supplementary daytime 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.

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 (see *National totals* below), 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.

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 & Bewick's Swan Census - are included where the data collected are compatible with the presentation formats used in this report.

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, though this technique has been little used in the UK historically. 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.

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. As a result, such aerial surveys are now tabulated separately within the relevant species accounts. These surveys employ a 'distance sampling' methodology (see Buckland *et al.* 2001, 2004), 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 this 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, thus, infer that the tables in the Species accounts include all such suitable data.

Irish Wetland Bird Survey

The Irish Wetland Bird Survey (I-WeBS) monitors non-breeding waterbirds in the Republic of Ireland (Crowe 2005). 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.



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.

ANALYSIS AND PRESENTATION

In fulfilment of the WeBS objectives, results are presented in a number of different sections. An outline of the analyses undertaken for each is given here; further details can be provided upon request. A number of limitations of the data or these analytical techniques necessitate caution when interpreting the results presented in this report (see *Interpretation of Waterbird Counts*).

Count accuracy and 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 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 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 based on the 'OK/Low' information provided by the counter. 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 on 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 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*.

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. Counts flagged as incomplete are treated differently in trend analyses and site importance assessments.

The WeBS Year

Different waterbird species occur in the UK at different times of year. Most occur in largest numbers during winter, some are residents with numbers boosted during winter, while others occur primarily as passage migrants or even just as summer visitors.

Although WeBS counts focus primarily on winter months, surveys can be 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. 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. For species present as summer visitors - notably terns, Garganey and Little Ringed Plover - the calendar year is used to derive national and site maxima. The different format used for column headings (e.g. 07/08 or 2007) in the 'header' and tables in each species account identify whether a 'winter' or calendar year has been used.

Note that national totals (reported in Tables 3 and 4) present data for the period July 2007 to June 2008.

National totals and annual maxima

Total numbers of waterbirds recorded by WeBS and other schemes are presented (Tables 3 and 4, and within individual species accounts). It is very important to appreciate that these 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. Separate totals for England, Scotland, Wales, and the Channel Islands can be obtained from the BTO upon request. 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 this report. A count from any date is used if it is the only one available.

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;
- 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. Where a census total replaces a standard Core Count these data are indicated by '**'.

Some of the goose populations are identified according to location (from research into movements of marked birds) as they cannot be separated in the field by appearance alone. In such cases, a standard region of the UK is used each year to assign individual birds to particular populations and thus to derive national totals. For full details please contact BTO, but broadly the breakdown is as follows:

- Icelandic Greylag Goose - all other areas of Scotland plus Northumberland and North Cumbria.
- British/Irish Greylag Goose - other areas.
- Greenland Barnacle Goose - Scottish west coast plus Shetland and Orkney.
- Svalbard Barnacle Goose - other Scottish regions plus Northumberland and North Cumbria.
- Naturalised Barnacle Goose - other areas.
- Canadian Light-bellied Brent Goose - Northern Ireland, Wales, western and northern Scotland, Cornwall, Devon, west coastal England, Irish Sea and Channel Islands.
- Svalbard Light-bellied Brent Goose - other areas.

(Note that the separate populations overlap to varying extents, and some birds are likely to be mis-assigned using these areas. This is particularly so for Greylag Goose and the formerly listed populations of 'NW Scotland Greylag Goose' and 're-established Greylag Goose' are now pooled and listed as British/Irish Greylag Goose (Holt et al. 2011)).

Data from counts at all sites are used, irrespective of whether they are considered complete or not. Numbers presented in this 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'.

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 (Tables 3 and 4). 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 (see *Interpretation of Waterbird Counts* below). Annual index values are expressed relative to the most recent year, which takes an arbitrary value of 100.

The 'Underhill index' was specifically developed for waterbird populations (see Underhill 1989, Prys-Jones et al. 1994, Underhill & Prys-Jones 1994 and Kirby et al. 1995 for a full explanation of this indexing process and its application for WeBS data). This report uses Generalized Additive Models (GAMs; Hastie & Tibshirani 1990) to fit both index values and a smoothed trend to the WeBS count data (see Maclean et al. 2005 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 be treated as missing data. 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; Thaxter *et al.* 2010). Following recent development work undertaken by WeBS, winter indices for waders are for the first time based on data from the months of November to March, inclusive, while those for other species additionally include September and October. Exceptions are made for the indices for Icelandic Greylag Goose, Pink-footed Goose, Greenland White-fronted Goose and Svalbard Barnacle Goose, for which annual census data are preferentially used to generate indices. 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 new 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.

Not all species are included in the indexing process. Terns are excluded because counting of them is optional. Species that occur substantially on habitats poorly monitored by WeBS (e.g. Snipe) are excluded as are species that occur at sites sporadically and/or in small numbers (e.g. Bean Goose and Smew). Indices and associated national trends were published for Moorhen and for the six regularly occurring species of gull (Black-headed, Mediterranean, Common, Herring, Lesser Black-backed and Great Black-backed) for the first time in the annual WeBS report in Holt *et al.* (2011).

The periods of years for which indices are calculated have been revised slightly in the light of recent analyses. Data for wildfowl continue to be 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.

Index values, where calculated, are graphed within each account. The underlying trend is shown using a broken line and the range of the previous five years as a shaded area. The actual index values used to produce the graphs in this report can be obtained on request from the British Trust for Ornithology (see *Contacts*).

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.

The imputing process used to derive missing data for generating annual trends 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 accounts, showing the value for the most recent winter, and the average value and range over the five preceding winters. Monthly graphs are not presented for the goose species for which annual indices are based on censuses as data for these are available for a limited number of months only.

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.

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>. There are currently 256 SPAs and 146 Ramsar sites in the UK.

Population estimates are revised once every three years, in keeping with internationally agreed timetables (Rose & Stroud 1994). International estimates used in this report follow recent revisions of international populations (Wetlands International 2006) and of estimates for Great Britain (Musgrove *et al.* 2011, Crowe *et al.* 2008). The relevant 1% thresholds are given in Appendix 1 and are also listed at the start of each individual species account. (It should be noted that the estimates and thresholds for some species or populations which should be the same at an international and national level because all birds are found in Britain, e.g. for Pink-footed Goose, differ slightly because of the rounding conventions applied. In most species accounts, these differences have been rationalised and only one or other of the estimates used).

For some species (e.g. Lapwing) no national thresholds are available and arbitrary levels have been used to compile the table of sites, the chosen level being given in the sub-heading of the table. Passage thresholds, applied to counts of some wader species in Great Britain, are also listed.

'National threshold' is used as a generic term to imply the 1% British threshold for sites in Great Britain, and the all-Ireland threshold for sites in Northern Ireland. Similarly, the term 'national importance' implies sites in Great Britain and in Northern Ireland that meet the respective thresholds.

Tables in the Species accounts rank the principal sites for each species according to the mean of annual maxima for the last five years (the five-year peak mean), in line with recommendations of the Ramsar Convention, and identify those meeting national and international qualifying levels (see also *Interpretation of Waterbird Counts*). For each site, the maximum count in each of the five most recent years, the month of occurrence of the peak in the most recent year, and the five-year peak mean are given. Incomplete counts are bracketed.

For all species, annual maxima are derived from any month in the appropriate 12-month period (see *The WeBS Year*). 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 using a superscripted number after the count (a list of sources is given at the beginning of the accounts).

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. Averages enclosed by brackets are based solely on incomplete counts.

Sites are selected for presentation using a strict interpretation of the 1% threshold (for convenience, sites in the Channel Islands and Isle of Man are identified using 1% thresholds for Great Britain and included under the Great Britain section of the tables). For some species with very small national populations, and consequently very low 1% thresholds, an arbitrary, higher level has been chosen for the inclusion of sites. Where no thresholds are given, e.g. for introduced species, and where no or very few sites in the UK reach the relevant national qualifying levels, an arbitrary threshold has been chosen to select a list of sites for this report. These adopted thresholds are given in the sub-headings of the table. A blank line has been inserted in the table to separate sites that qualify as nationally important from those with five-year peak mean counts of less than 50 birds.

All sites that held numbers exceeding the relevant national threshold (or adopted qualifying level) in the most recent year, but with five-year peak means below this value, are listed separately. This serves to highlight important sites worthy of continued close attention.

For a number of wader species, where different thresholds exist for passage periods, the peak count during this period and month of occurrence are also listed. This list includes all those sites

with counts above the relevant threshold, even if already listed in the main part of the table by virtue of the five-year winter peak mean attaining the national threshold.

Where the importance of a site has changed since the previous *Waterbirds in the UK* (prior to 2004/05 published as *Wildfowl and Wader Counts*) 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 in the table to the right of the five-year peak mean. Sites with elevated status have a black triangle pointing up (▲) to the right of the average, whilst those with lowered status are indicated using a triangle pointing down (▼). Sites for which the average fell below the threshold for national importance following 2003/04 are listed at the end of the table.

It should be noted that a site may appear to have been flagged erroneously as having elevated status if the most recent count was below the relevant threshold. However, a particularly low count six years previously will have depressed the mean in the previous report. The converse may be true for sites with lowered status and thus, in exceptional circumstances, a site may be listed in the relevant sections of the table as both no longer being of national importance yet also with a peak count in the most recent year exceeding the national threshold.

WeBS Alerts

WeBS Alerts have been developed to provide a standardised method of measuring and reporting on changes in wintering waterbird numbers at different temporal and spatial scales using WeBS data. Generalized Additive Models (GAMs) are used to fit smoothed trends to annual population indices (changes in population size calculated using these smoothed values are less susceptible to the effects of short-term fluctuations in population size or to errors when sampling than are results produced using raw data plots). Alerts are triggered for populations that have undergone major declines, and are intended to help identify where research into causes of decline may be needed and inform conservation management.

Proportional changes in the smoothed index value of a population over short- (5-year), medium- (10-year) and long- (25-year) term time frames are categorised according to their magnitude and direction. Population declines of between 25% and 50% trigger Medium Alerts and declines of greater than 50% trigger High Alerts. Increases of 33% and 100% (values chosen to be those necessary to return a population to its former size following declines of 25% and 50% respectively) are also identified, albeit that these are rarely of conservation concern.

National Alerts are generated for species (or specific populations of a species) using data from across the WeBS site network, for Great Britain and the constituent countries of the UK (Maclean *et al.* 2008). These Alerts provide some context for understanding finer scale changes in numbers. Alerts are calculated only for native species for which WeBS annual indices are calculated. Alerts are not available for some species over long time periods because there were only relatively recently included in WeBS Core Counts. Full results from the latest Alerts report are available to download from www.bto.org/webs/alerts/.

Principal sites

In addition to the assessment of sites against 1% thresholds in Species accounts, sites are identified for their importance in terms of overall waterbird numbers in the section *Principal Sites*. The peak count at each site is calculated by summing the individual species maxima during the season, irrespective of the month in which they occurred, or whether counts were complete or not. Data from all sources used for site assessment within the species accounts are used here, including wader numbers during passage periods. Non-native introduced or escaped species (*i.e.* those not listed in BOURC category A) are not included in these totals.

Counts made using methodologies that employ different site definitions to those used by WeBS (*e.g.* seaducks on the Moray Firth) are not incorporated into the calculations. Such sites are, however, listed at the end of the table.

INTERPRETATION OF WATERBIRD COUNTS

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 this report. A primary aim here 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 this report, 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 this report.

For ease of reference, the caveats provided below are broadly categorised according to the presentation of results for each of the key objectives of WeBS. Several points, however, are general in nature and apply to a broad range of uses of the data.

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. Data are collected during other months and have been presented where relevant. Caution is urged, however, regarding their interpretation 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 (see *The WeBS Year*), matching the period for which data are provided *en masse* by counters.

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. Only for a handful of species, primarily geese, can count totals be considered as a census.

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 this report does not imply acceptance by the British Birds Rarities Committee (e.g. Hudson *et al.* 2010). All such records should be submitted by the observers to BBRC via the relevant county recorders.

Annual indices

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. For example, 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. In the case of winter 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.

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 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.

Caution should be used in interpreting figures for species that only occur in small numbers. 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.

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. 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*). Additionally, data submitted too late for inclusion are added to the dataset subsequently. Hence indices published here represent an improvement on previous figures as any additional years' data allow calculation of the site, month and year factors with greater confidence.

Monthly indices

As for annual indices, 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 the province.

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 have been used for assessment of site importance in this report if collected for ostensibly the same site, and are unlikely to cause significant discrepancies in the vast majority of cases (though see *Site importance*).

Particular caution is urged, however, in noting that, owing to possible boundary differences, totals given for WeBS or other sites in this 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 *Waterbirds in the UK* (prior to 2004/05 published as *Wildfowl and Wader Counts*) 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.

Since last year, individual sites on Dungeness peninsula (including, for example, Dungeness RSPB Reserve, Scotney Pits and Rye Harbour) have been combined. Data from this recording area are now presented as 'Dungeness and Rye Bay'.

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 in the table of key sites 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.

Site importance

Sites are selected for presentation in this report using a strict interpretation of the 1% threshold. 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 should also be noted that the 'qualifying levels' used for introduced species are used purely as a guide for presentation of sites in this report and do not infer any conservation importance for the species or the sites concerned, since protected sites would not be identified for these non-native birds.

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 (calculated as the mean winter maxima from the last five seasons for most species in this 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 included 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 *Principal Sites*) 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 this 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. This problem is overcome to some extent by the selection of counts from a limited winter window for wader species, although this will also tend to an underestimation of the mean if it excludes large counts at other times of year. 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 seaducks 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, this 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. The national thresholds have been chosen in order to provide a reasonable amount of information in the context of this report only. Thus, for example, many sites of regional importance or those of importance because of their species assemblage are not included here. 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.

For the reasons of poor coverage, whether geographical or temporal, outlined above, it should be recognised that lists of sites supporting internationally and nationally important numbers of birds 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.

Some counts in this report differ from those presented previously; this results from the submission of late data and corrections, and in some cases, the use of different count seasons or changes to site structures. Additionally, some sites may have been previously omitted from tables due to oversight. It is likely that small changes will continue as definitions of sites are revised in the light of new information from counters. Most changes are minor, but comment is made in the text where they are of a significant nature.

Note that sites listed under 'Sites no longer meeting table qualifying levels' represent those that would have been noted of national importance based on data from the preceding five years (*i.e.* 2002/03 to 2006/07) but which, following the 2007/08 counts, no longer met the relevant threshold. It should not be considered an exhaustive list of additional sites which in the past have been of national or all-Ireland importance.

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