2 Methods

SITE SELECTION

The scope of the WeBS Low Tide Counts (LTCs) is estuarine sites throughout the United Kingdom. When the LTCs were originally planned, the aim was to 'systematically census each of the 59 main UK estuaries (defined as those supporting more than 5,000 wintering waders) on a five-year rotational basis using standardised methods'. However, this initial plan was modified in subsequent years, for a number of reasons. The waders-only emphasis was removed and monitoring of all waterbirds (notably including ducks and Brent Geese) was considered equally important. Also, as well as the main sites initially chosen, a number of smaller sites were also covered, due to local enthusiasm by counters or local management plans and/or development pressures on those sites leading to a requirement for data. The five-year rotation was extended to a sevenyear cycle, to permit coverage of several sites where there were logistical difficulties in establishing a new counting scheme within the original time allocation and to cover an increased number of sites. Conversely, at a number of sites repeat counts were carried out on the initiative of the local counters, some even instigating LTCs on an annual basis.

It was always recognised that several very large sites (notably the Wash and Morecambe Bay) would be difficult to count. The problem with large estuaries (or rather, wide expanses of intertidal habitat) is that many birds may be present at very great distances, thus reducing an observer's ability to accurately determine the number and identity of birds present on the count section. Safety of counters has to be paramount and so they are discouraged from venturing out on to potentially dangerous intertidal habitats to record more distant birds. Although covering large sites requires the recruitment and co-ordination of large numbers of volunteers, this is not always an insurmountable obstacle. For example, excellent counts of the Moray Firth and Firth of Forth were achieved, both of which are large but relatively linear in shape. The potential of using aerial counts for counting waterbirds on estuaries like the Wash at low tide was examined (Musgrove and Holloway 1997). However, the conclusions were that any attempts to count large estuaries fromthe air were likely to lead to results which were not comparable with shore-based counts, owing to the possibility of missing a very large proportion of the numbers of some species. The WeBS partners are reviewing how to tackle LTCs of large intertidal areas, including reconsideration of aerial survey techniques.

SPECIES COVERAGE

The principal groups of waterbirds of interest for the LTCs are waders and wildfowl, along with additional species characteristic of wetland habitats such as divers, grebes, cormorants, herons, rails, gulls, terns and Kingfisher. The species involved are discussed individually in the Species Accounts. As well as recording at the species level, separation at subspecific level is requested of counters for Brent Goose and Whitefronted Goose. Recording the presence or absence of raptors is also requested, although treated as a category of 'activity/disturbance' (see below) as opposed to a bird count. Although data collection for all waterbird species is encouraged, recording of gulls and terns is optional at the discretion of the individual counter, as they are not priority species for the survey. This is because the counting and identification of gulls can be very time-consuming and consequently may compromise the quality of counts of the priority LTC species. Numbers of gulls on most estuaries vary more with the time of the day than with the state of the tide and many estuaries support important night-time roosts (Burton et al. 2002c). Since the LTCs take place between November and February very few terns are recorded.

COUNTERS AND LOCAL ORGANISERS

Most LTCs are carried out by volunteers with a keen interest in and knowledge of their local estuary. Many of these counters also take part in WeBS Core Counts at the same site. Each counter takes responsibility for a number of count sections, depending on the amount of time they can commit to the survey. To enable efficient administration of the survey, a 'local organiser'

is selected to co-ordinate the counts at the site level and to provide a single point of contact for the national organiser. At the end of a winter, counters are requested to return their forms to their local organiser who can then check for completeness and for any obvious mistakes before returning them to the national organiser. In some cases, the local organiser is a local professional ornithologist, often a reserve warden, although many local organisers work purely in a voluntary capacity. At some sites, local nature reserve staff are among the counters. This has been especially helpful in situations where special equipment (such as boats) has been required or where public access is generally restricted. The co-ordinated network of volunteer fieldworkers forms the backbone of UK bird monitoring and is widely envied in other countries. Counters are experienced and skilled local birdwatchers and include many individuals possessing the most in-depth knowledge of the birds using UK estuaries. The LTCs appear to have been a generally popular survey, partly because the local counters could see the obvious value of the counts and partly because the plan was to count each site at low tide only on a periodic basis, thereby time-limiting the substantial commitment required.

SUBDIVISION OF SITES

The LTCs are organised around recognisable sites, which are then subdivided into smaller sections, leading to a two-tier count-unit hierarchy. Given their differing methodologies, a site counted for the Core Counts is not considered an identical entity to the same broad geographical site counted for the LTCs (although, clearly, there is a close relationship between the two). The principal distinction between Core Count and LTC site boundaries is their downshore limit. LTC sites are, by their very nature, precisely defined in terms of intertidal habitat, much of which may not be visible during Core Counts if the latter take place at high tide.

WeBS Core Count site boundaries on estuaries are more likely to incorporate adjacent nontidal habitats, especially where these are important roost sites. Such nontidal habitats are also frequently surveyed during LTCs, especially where the area is used by waterbirds during the low tide period. Additionally, at low tide some estuarine species, such as grebes and diving ducks, are present on the water below the tideline. Counters are encouraged to record these species and to assign such counts to the nearest section. In general, the subdivision of a site into sections has been determined by local geography, identifiable features (natural and man-made), accessibility, ease of counting and existing Core Count sections, with a broad stipulation that sections should be relatively similar in size to one another.

Generally, sections have been selected by the local organiser and counters themselves. A map of the subdivisions is then discussed with the national organiser. It is stressed that the same count sections should be used in subsequent count years. However, in a few cases, the experience gained from the first winter's survey led to the splitting of larger sections into several smaller ones, or vice versa, or sometimes to the addition of new count sections. Such details are fully described within the Site Accounts.

COUNT DATES AND TIMES

The LTCs take place during the four months of November to February inclusive and counters are asked to make one visit per month during this period. The mid-winter period was chosen partly because waterbird numbers on estuaries are at their highest then, partly to minimise between month variation in counts and partly because this is the time of year when feeding constraints are likely to be at their greatest. Although three dates were initially considered to be satisfactory, it was decided that using four would allow for a certain amount of redundancy for missing counts due to factors such as poor weather. Although only one visit per month is requested, some counters do carry out more. In such cases, care is taken to select one count only in an unbiased fashion (i.e. without examining the actual numbers of birds counted). In most cases where multiple visits are made to a count section in a particular month, the visit on the date most consistent with the counts on neighbouring sections is taken to be the visit to use for analysis.

Unlike the WeBS Core Counts, no pre-determined count dates are set at a national level but are decided upon by local organisers. Additionally, although simultaneous counts of all sections within a site are preferable, they are not compulsory. The principal reason for this is that the primary purpose of the scheme is to investigate relative distribution, averaged over several dates, and not to determine overall population sizes. Secondly, although weather conditions can affect the ease of carrying out any bird monitoring, conditions of fog, rain or strong winds make the counting of birds on distant mudflats particularly difficult and so the flexibility in count dates makes it possible to make best use of suitable counting conditions. Finally, given that most LTC participants also take part in the WeBS Core Counts which do occur on a predetermined date each month, it was thought useful to allow a degree of flexibility to encourage a high level of participation.

LTC participants are asked to count during the two hours either side of low tide. There were several reasons for low tide being selected as the counting period. A key objective of the scheme is to record feeding distributions and studies have shown that for many of the specialist estuarine species, a high proportion of birds feed during this period (although this proportion varies between species – see Discussion). Also, since the position of the tideline (and thus the availability of food) is relatively stable during this period, changes in the numbers and distribution of waterbirds are consequently relatively small. Although the tideline varies between neap tides and spring tides, the fact that a mean low water (and high water) mark is shown on Ordnance Survey maps means that a standardised, repeatable measurement of area can be achieved. Finally, it is easiest to assign birds in the field to pre-defined count sections when all the features of the intertidal area are visible.

FIELD METHODS AND THE RECORDING FORM

Counters are provided with pre-prepared count forms on which to record counts of feeding and roosting birds, along with the date, section code and the start and finish times of the count. Additional details on count accuracy, weather, human activities, raptors and disturbance are also requested. The count forms include the basic instructions on how to carry out the survey. Some counters use their forms in the field whereas others record counts in their notebooks and transfer details to the form later.

DATA STORAGE AND VALIDATION

Once the count forms for a site over a winter have been received, they are checked for completeness and any apparent irregularities are discussed with the local organiser. The data from all forms are then input independently by two different people, using a customised inputting form. The two resulting sets of digital data are then checked against one another by computer and any discrepancies are flagged, investigated and resolved. This ensures the virtual elimination of errors in the dataset due to inputting mistakes, since the chances of both people making the same inputting error are very small. Once both sets of data are the same, one set is loaded into the purpose-built LTC database.

Double-inputting, whilst effectively eliminating keyboard errors, cannot pick out other types of error. The most common of these are when a counter records a count against the wrong species (usually that adjacent on the count form to the intended target). Such errors can be easy to spot if, for example, an abnormally high count of an unlikely species occurs (e.g. a count of 50 Ringed Plovers mistakenly recorded as 50 Little Ringed Plovers). However, other mistakes in recording can be much less obvious and in some cases are probably undetectable (e.g. a count of 20 Mallards mistakenly recorded as 20 Teal). The only chance of discovering such errors is to create tables of summary data and distribution maps of each species on the site (as discussed below) and to return these to the local organiser and counters for checking, which generally identifies any gross errors outstanding. At the end of the process of checking, inputting, validation and loading, the end result is a rigorously-derived definitive dataset.

AREAS AND DENSITIES

Whilst the collection of LTC data is concerned with making counts of birds, further presentation and analysis of results is based mostly around bird densities, for the simple reason that count sections are not of equal size. To calculate a density, it is clearly necessary to have an area measurement to divide a count by. Throughout the LTCs, areas are measured in hectares (1 ha = 100 m x 100 m) and consequently densities are given as birds per hectare (b/ha).

To derive the areas of count sections, a map of the site is drawn carefully onto a photocopy of a 1:25,000 map of the area, although for Northern Ireland only maps at the 1:50,000 scale are available. A digitising tablet is then used to transfer the relevant features of each paper map into digital form for incorporation into a Geographical Information System (GIS). One of the many advantages of the use of a GIS for storing and manipulating maps is that the area of each section can be calculated automatically. This is not only far faster than using traditional methods, but is also less prone to error and, importantly, completely repeatable.

For the purposes of determining useful area measurements, each count section is subdivided into up to three zones. The intertidal zone is that situated between mean low water and mean high water, the subtidal zone is below mean low water (both in creeks and 'offshore') and the nontidal zone is found above mean high water – often saltmarsh (so strictly not entirely lacking a tidal influence) but sometimes grazing marshes, higher areas of sandflats, adjacent freshwater reserves, etc. It is important to note that these definitions apply only within the context of the LTCs and these terms may (and do) have different meanings elsewhere. Although it is usually straightforward to define the intertidal and nontidal extent of a count section on a map, the subtidal zone being surveyed is less readily delineated. It is taken throughout that the subtidal zone of a count section extends half way across a channel or, where the channel is wide or the section has a more 'open-coast' aspect, the subtidal zone is taken to extend an arbitrary 500m offshore.

The area of each zone of each section is calculated separately by the GIS. To achieve this, the mean low water and mean high water marks around each site are also digitised. It should be noted, however, that on Ordnance Survey maps, whereas mean low water and mean high water are mapped for England and Wales, for Scotland the equivalent lines on the maps represent mean low water springs and mean high water springs. Thus, for the same actual area of intertidal habitat, a larger area will be depicted on a Scottish map than on an English or Welsh one. Unfortunately, there is no straightforward conversion factor, the difference between the two depending upon the gradient of the substrate between the two lines.

Estuaries are mobile systems and although intertidal flats, saltmarshes and channels are often of relatively stable shape between years, at some sites major changes occur. This means that commercially available maps may diverge increasingly from reality over the years. Although a counter can inform the national organiser that, for example, a particular saltmarsh has decreased in extent by 50% compared to that mapped, it is not straightforward to incorporate such information in a systematic fashion. Therefore, the commercial maps have to be taken as a standard, even where divergences are known to occur. This issue is discussed within the Site

Accounts for those individual sites most affected. Aerial photographs have been suggested as a way to counteract this problem but in reality these are seldom taken frequently enough to allow a systematic determination of a mean low water mark.

Although the density of birds on a count section is expressed as a count divided by an area, with a basic knowledge of the ecological differences between species it is clear that it is not sensible to use the same area measurement for all species. For example, consider a count section of 100 ha in size, composed half of open mudflat and half of saltmarsh, on which a flock of 100 Knot was present. One might make the assumption that the Knot were evenly distributed over that count section, leading to a density of 1 b/ha. However, a basic knowledge of the feeding habits of Knot would tell us that they are seldom found feeding in saltmarsh and all or the majority would have been present on the mudflat, suggesting that the real density should be 2 b/ ha. Throughout this book, densities have been calculated in such a way so as to take into account such species-specific habitat associations.

DISTRIBUTION MAPS

When data can be assigned to well-defined geographical areas, as is the case with the LTCs, the presentation of results in map form has many advantages over a simple tabulation of statistics since it enables an appreciation of the relationship between different count sections. The production of maps depicting bird distribution has been a major theme from the beginning of the LTCs, with GIS technology providing great versatility in the range of presentational options available. After examining the possibilities, ‘dotdensity’ maps were chosen as the preferred means of presentation.

To create a dot-density map, the GIS is instructed to take a number of dots equal to the mean number of individuals of a species present in a count section and to place them randomly within the polygon representing the count section. Although the information presented is actually a number of dots, the fact that the number is spread across an area makes it equivalent to a density. It is thus immediately apparent to anyone examining the map how the species is distributed across the site at low tide. Since the actual mean numbers are used for the display there is a continuous, not discrete, depiction of densities. The main potential misunderstanding arising from dot-density maps is that there is a tendency to equate the precise position of each dot with the precise position of a bird, whereas no conclusions should actually be drawn at a resolution greater than that of the count section. The higher the number of birds present, the less this is an issue. Ideally, one would distribute dots evenly within a count section, rather than randomly, but this has not been possible to date with the available software.

On some distribution maps, there appear to be artificially sharp boundaries between the dots representing one count section and those representing a neighbouring one. Clearly, these sharp demarcations are a product of the count sections selected and, in many cases, the change from a high density to a low density would be far less marked in reality. However, such marked changes in density may be realistic where there is a distinct change in habitat (such as with an isolated mussel scar, for example). It is thus important to assess maps on a case-by-case basis, with reference to any other available sources of information. In some cases, slight modifications have to be made. For example, there may be such large numbers of a species (e.g. Dunlin) on many count sections that it is not possible to differentiate between densities. In such a case, either the size of the individual dots can be reduced or else the GIS can be instructed to display, for example, one dot for every ten Dunlin. As with the calculation of densities discussed above, species-specific habitat associations have been applied in production of distribution maps and so, for example, Knot are plotted only on intertidal parts of a count section. Similarly, Great Crested Grebes would be plotted in the subtidal zone. Other species, less specialised in habitat use, have been assigned to more than one zone for mapping purposes (e.g. Curlew on both saltmarsh and mudflats).