BTO Research Report No. 661

Guidance to Interpretation of Wetland Bird Survey Within-Site Trends

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1. INTRODUCTION

1.1 Background

The Wetland Bird Survey (WeBS) has been monitoring the UK's waterbirds for over 60 years, with coverage maintained at the levels seen today since the early-1970s. WeBS Core Count methodology is based on monthly counts of waterbirds at wetland sites on predetermined dates. Larger sites, including the majority of the UK's estuaries and sizeable inland sites, are subdivided for the purpose of recording numbers of waterbirds into manageable "count sectors". Counts on multi-sector sites are undertaken by teams of counters, coordinated so as to minimize double counting caused by bird movements during the counting period. For estuarine sites, teams of observers typically target the period over high-tide. While the sectors are defined principally to promote the collection of accurate waterbird numbers that when combined will produce a robust estimation of waterbird numbers across entire sites, boundaries between sectors generally follow readily identifiable landmarks, for example fence lines, sea walls, tidal creeks, or habitat boundaries such as those between intertidal flats and saltmarsh. Consequently, sectors tend to relate to a particular habitat type as well as geographic location. Smaller sites may be divided into just a few sectors whilst larger sites like The Wash, Severn or Humber Estuary may be divided into 50 or more sectors. Consideration of trends at this fine scale may reveal responses to environmental pressures acting on species distribution within a site, and suggest how activities or developments might be affecting the overall numbers of a given species which, if qualifying as a feature of a Special Protection Areas (SPA) or Site/Area of Special Scientific Interest (SSSI/ASSI), would be subject to legal directives.

This report gives an overview of analyses that have been developed by the BTO for routine reporting of trends across WeBS count sectors, and guidance to the interpretation of the resulting tables and plots of trends and trend comparisons. The methodology has been developed over a ten year period, evolving to meet the needs of, in particular, country agencies and the Environment Agency (EA) for assessing the state of bird populations. Analyses focus on identifying trends at the finest resolution possible from WeBS count data, identifying areas that are particularly important to birds of a given species and placing results into the context of the trend across the entire site or region. Comparing trends at the finer resolution with trends across the site as a whole, especially when taking into account similar comparisons between the site and the wider region, can usefully identify areas on which numbers of a given species are faring better or worse than would be expected from the broader scale pattern. This in turn can focus attention as to possible causes of any observed change. Originally devised to quantify the effects of development on waterbirds on an estuarine site, this approach has also been adapted to play a major role in informing the process of Appropriate Assessment (AA) for wildfowling consents on protected sites. Thus recommended applications for this approach include investigation of the effects of environmental change at a local level and AA of activities on protected sites.

The analytical techniques described herein were originally devised for reporting site level trends for the routine production of WeBS Alerts, where trends for designated species on protected sites are described and put into a regional and national context. So, for example, the trend in numbers for a species designated for The Wash SPA would be described and compared with those of the East Anglia Region and the whole of Great Britain. In reporting trends on sectors, this methodology has been extended to be used at a finer scale such that trends on individual WeBS count sections are described and compared with those of the whole site. So, for example, the trend for each count sector of The Wash SSSI would be described and compared with the trend across The Wash SSSI as a whole (or some other appropriate boundary such as The Wash National Nature reserve or the contiguous SPAs of The Wash, Gibraltar Point and North Norfolk Marshes).

In principal, such a sector trend analysis could be undertaken for any multi-sector WeBS site.

2. SPECIES CONSIDERED

Typically analyses would be considered for all species of waterbird with sufficient supporting data provided by WeBS. For SPAs the aim would normally be to report on all qualifying waterbird species and all waterbird features of SSSIs or ASSIs. However, analyses may be run for any species for which there is enough WeBS data, and assessment of trends in non-qualifying species is recommended whenever they occur in sufficient numbers. The addition of non-qualifying species can increase our confidence in an observed change for a qualifying species when a similar pattern is repeated across a suite of species. Furthermore, if species with similar habitat preferences or ecological requirements show similar patterns of within-site trends then this may suggest common driving forces underpinning this change. So it may be that declines on a certain part of a site are confined to diving ducks suggesting smothering of the benthos, or restricted to species of wader that prefer muddier sediments, or to species known to be particularly intolerant of disturbance. Had analyses been limited to just one or two qualifying species, such characteristics would not have been apparent.

Whilst it is possible to undertake a sector trend analysis for most wildfowl and wader species, there are certain groups of species, or aspects of site-specific usage by particular species, for which meaningful analyses cannot be undertaken, or useful interpretation cannot be made. Thus it is not possible to undertake these analyses for species that only ever occur in small numbers, such as Bittern or rarer grebes. Nor is it feasible to undertake trend analyses for species that only occur sporadically on a given site. For example, there are a number of SSSIs that are notified for Bewick's Swan, but on which this species may only occur intermittently e.g. in particularly harsh winters. There are two groups of species for which, although trend analyses can be undertaken, the interpretation of the resulting trends is problematic due to the behaviour of the birds in relation to WeBS count methodologies. So, for example, swans and geese are often associated with WeBS count sites by virtue of those sites being roosts, but during the day these species disperse from the roosts to forage in the wider countryside. Consequently, numbers recorded by WeBS observers during the daytime counts may be unrepresentative of numbers using the site, and furthermore be subject to fluctuation due to time of day, weather conditions and disturbance, to a greater extent than species that remain on site throughout the day. Likewise, sea-duck counts recorded by WeBS observers may also be unrepresentative of numbers associated with a site, and subject to fluctuation due to both variations in their visibility under different sea-states, and movements in and out of range for reliable counts from the land depending on weather conditions.

3. LIMITATIONS

Clearly, analyses of WeBS data at the within-site level are only possible for sites that are divided into sectors, the vast majority of which will be estuarine. Where this is the case, these analyses are generally based on WeBS Core Count data which are typically based on counts undertaken around high tide. A small number of sites are, however, routinely counted over the low tide period. Thus the analysis of trends relates principally to high tide distributions. For waders in particular, however, these high tide distributions may differ considerably from low tide distributions and thus reflect not the importance of different areas for feeding birds, but rather the distribution of high tide roosts. Correct interpretation of the sector trends may, therefore, rely on an understanding of the relationship between high-tide and low-tide wader distributions. Many estuarine sites are counted periodically under the WeBS Low Tide Count scheme, and these data, whilst not being suitable for generating trends over time (with a few exceptions, sites are typically surveyed by the WeBS Low Tide Count scheme during one winter in six) can be compared with data from the WeBS Core Count Scheme. In the example below (Fig 3.1), distributions of waders on The Wash at high tide (in red, based on WeBS data) can be compared to distributions at low tide (in blue, based on data reported by Garbutt *et al*. 2010). On larger sites, like The Wash, this can give an insight into how trends determined from high tide counts may reflect usage of mudflats for feeding during low tide. Be aware, however, that on smaller sites birds may move anywhere within the site, or even to neighbouring sites, when displaced by rising tides if local roost options are limited, and in these cases such a comparison may have little meaning without supporting information regarding bird movements.

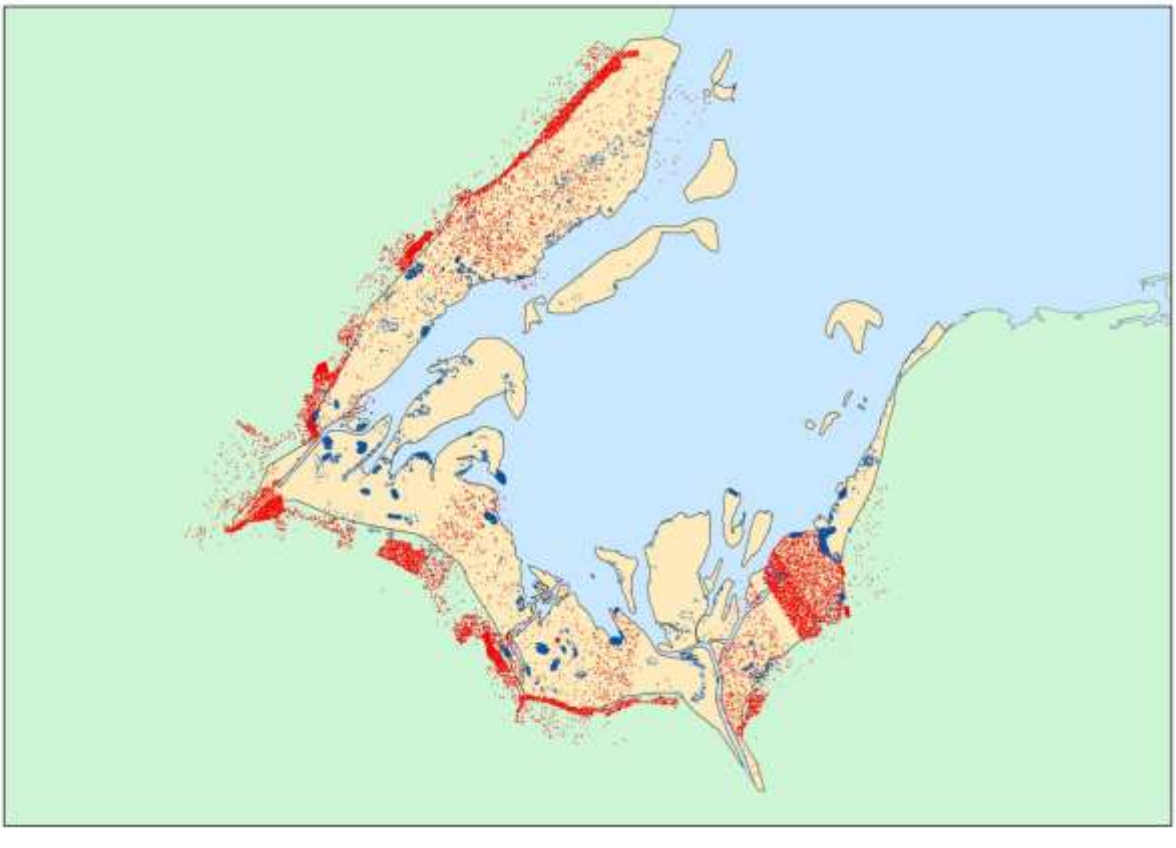


Figure 3.1 The distribution of waders on The Wash at high tide (in red, based on WeBS data) and at low tide (in blue, based on data reported by Garbutt *et al*. 2010). From Ross-Smith *et al*. (2011).

4. ANALYSES – TECHNICAL DETAILS

4.1 Mean and Maximum Winter Counts

As standard practise, WeBS uses the period September to March to represent winter numbers of waterbirds other than in the case of waders, where November to March is used in order to exclude periods of late passage during September and October. For characterizing the numbers a site typically supports, WeBS routinely reports the "five-year mean peak", a value calculated as the average of the peak counts for each of five winters, although with some complexities associated with treatment of incomplete site coverage. This five-winter mean of peaks is the value presented in the WeBS annual reports (e.g. Austin *et al*. 2014) and for many species this is the value that is fed into the identification of qualifying features during the SPA Review (Stroud *et al*. 2001). The five-winter mean of peaks is also useful for characterizing the relative importance of sectors within a site, as it gives a good indication of how many individuals of a given species a sector can support.

The five-winter mean of peaks is, however, less suitable for characterizing year on year changes. Thus, when comparing numbers between years, it is more appropriate to use individual winter averages. Averages are preferred over peaks because the latter are more susceptible to extreme observations. Furthermore, peak counts in different winters may well come from different parts of the season and could be unduly influenced by single events such as cold weather movements, unusually late autumn passage, early spring passage or even something as mundane as poor visibility on the designated count date. When plotted over time the winter averages are considered to characterise the number of birds supported by the site or sector in question. In fact, if there are no missing counts and values are expressed relative to those in the most recent winter, then the plot obtained is directly comparable to the indices generated by WeBS to characterise national and regional trends. That said, both the mean and maximum counts for each winter are reported as the latter are frequently requested.

The distinction between using winter means and winter peaks is also important when comparing trends between sectors or between a given sector and the site as a whole. While it is straightforward to compare the mean count on one sector with the mean count on another sector or the site, or to compare the trend in mean counts on one sector with the trend in mean counts on another sector or site, it would be conceptually challenging to understand what could be gleaned from comparing the peak count on one sector which might occur in late autumn, for example, with the peak count on another sector or the site which might occur in say late winter. Similarly it is not apparent how one would take meaning from a comparison of a sector trend dominated by counts from early winter, for instance, with a trend on another sector or site dominated by counts from say early spring.

4.2 Smoothed Waterbird Trends and Percentage Change

In describing changes in numbers on sectors or the site as a whole, it is important to concentrate attention on the underlying trend rather than focus on individual observations. It is therefore appropriate to fit a smooth trend through the mean winter values, which is achieved with a Generalized Additive Model (GAM: Hastie & Tibshirani 1990). This smoothing ensures that winter-specific factors, such as poor conditions on the breeding grounds or particularly harsh weather on the wintering grounds, which are not related to changes in the quality of the site itself, do not contribute overly to the trend. The first example (Figure 4.2.i) shows the trend in the number of Knot on The Wash NNR. The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts. In this particular case, the trend through the peak count closely parallels that through the mean, although it still exaggerates the increases and decreases.

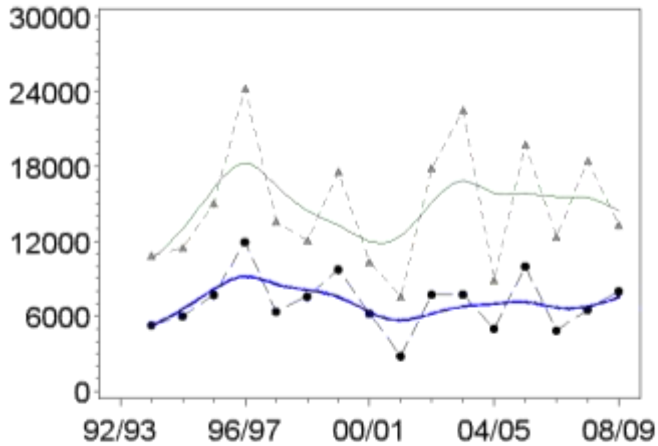


Figure 4.2.i The trend in the number of Knot on The Wash NNR. The upper (green) trend line is fitted through the winter peak counts whilst the lower (blue) line is fitted through the winter mean counts. From Ross-Smith *et al*. (2011).

It is with reference to the smoothed trend through the mean winter values that percentage change is calculated for short- (5yr) medium- (10yr) and long-term (15yr). Generally longer term changes are not calculated, as WeBS does not (at present) have the necessary data collated to the sector level to support analysis extending back beyond the winter of 1993/94. Thus 20yr percentage change will not be available until 2015/16 for most sites. By analogy to the WeBS Alerts system (e.g. Cook *et al*. 2013), declines of at least 25% but below 50% are flagged as moderate declines, and declines of 50% or greater are flagged as substantial declines (we specifically do not use the terms medium- and high-Alerts because, unlike the percentage change reported by WeBS Alerts, moderate and substantial declines reported at the sector level do not constitute a formal WeBS Alert). The corresponding percentage change required to balance the numbers to their former level following a decline or increase are likewise termed moderate (at least 33% but below 100%) and substantial (100% or greater) increases.

We calculate the percentage change in numbers with reference to the penultimate winter, in this case 2007/08. The short-term percentage change is therefore the change between winter 2002/03 and 2007/08 and is calculated as

$$\text{Percentage change} = 100 \times ((W_{07/08} - W_{02/03}) / W_{02/03})$$

Where $W_{07/08}$ is the mean winter count for winter 2007/08 and $W_{02/03}$ is the mean winter count for winter 2002/03. Likewise the medium- and long-term percentage changes are calculated with reference to winter 1997/98 and winter 1992/93 respectively. Where, as in the example below, data are not available across a sufficient time series, the long-term percentage change is calculated with reference to the earliest available winter.

By way of example we will calculate the short-term percentage change for Dunlin numbers on the Terrington West count sector of The Wash SPA (Figure 4.2.ii).

Over winter 2007/08 the mean count on this sector was 460 and the value against the smoothed trend was 437. Five years earlier, over the winter of 2002/03, the mean count on this sector was 1,180 and the value against the smoothed trend was 1799. It is against the smoothed trend that we assess percentage change which is evaluated thus

$$\text{Percentage change} = 100 \times ((437 - 1799) / 1799) = -75.7\%$$

So over the short-term the number of Dunlin on West Terrington has declined by 75.7%. This would be considered a substantial decline.

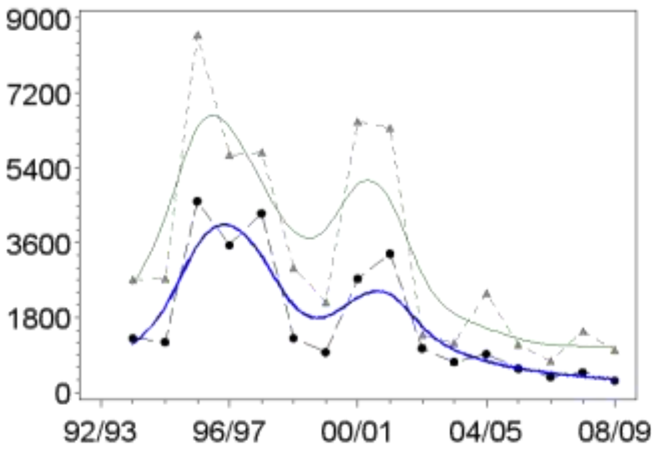


Figure 4.2.ii Dunlin numbers on the Terrington West count sector of The Wash SPA. From Ross-Smith *et al*. (2011).

4.3 Placing the Smoothed Waterbird Indices into Context

Once the smoothed sector indices have been produced, the observed trends are placed in context of the site trends. The current WeBS methodology (Banks & Austin 2004), as used to compare site trends with regional and national trends within the WeBS Alerts reporting, is extended here to compare count sector trends with site trends. Thus the comparisons between sectors and site are derived from a logistic regression model with a binomial error term. The resulting plots depict the percentage contribution of the sector to the site total as a whole and the associated confidence limits represent both variation in this proportion between months in a given year and the underlying sample size (number of months). So for example, we would be more confident of our estimate that a sector contributed 10% of the site total if 100 birds out of 1000 on the site were counted on that sector than we would be if 10 birds out of a site total of 100 were counted on that sector. This comparison is based on the winter period as routinely used for all WeBS reporting (Nov-Mar for waders and Sep-Mar for other species) and only data from months where counts consolidated across the site as a whole have been assessed as complete are used. So for example we would be more confident of a proportion if there were data for say seven months than if there were only data for say three months.

By way of example, Figure 4.3.i shows the proportion of Mallard on The Wash that have been recorded on the Ouse Mouth count sector between the winters of 1992/93 and 2008/09. The plot represents the proportion of the site total averaged across months for a given winter that occur on that sector (connected by the “horizontal” line) and the vertical bars represent the confidence intervals of each estimate. Thus we can see that back in the 1990s this count section typically supported less than 5% of the total number of Mallard counted on The Wash SSSI, but that since the turn of the century the proportion has more than doubled. Consequently, the relative importance of this count sector has increased over time.

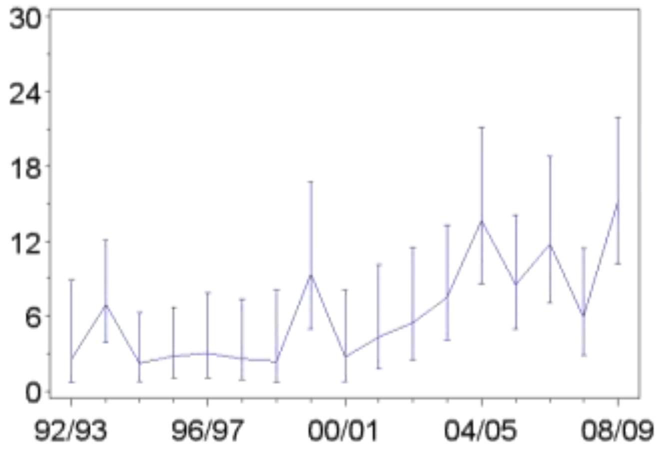
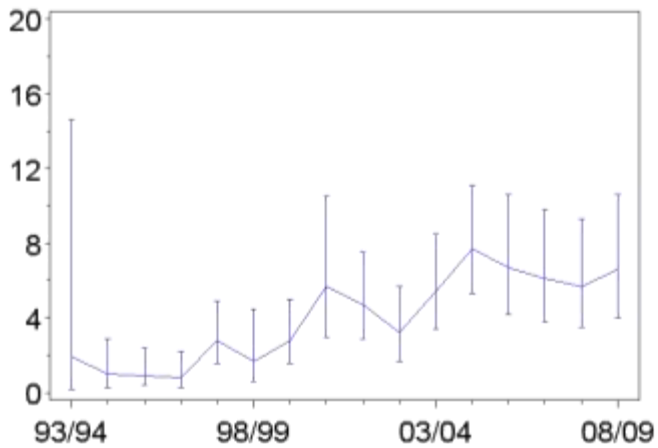


Figure 4.3.i The percent proportion of Mallard on The Wash that have been recorded on the Ouse Mouth count sector between the winters of 1992/93 and 2008/09 From Ross-Smith *et al*. (2011).

In this instance, numbers of Mallard are known to have actually increased across The Wash as a whole, but this plot gives us further insight in that it indicates that numbers on this particular sector have increased disproportionally. Viewed in isolation this plot can not give us the whole story. Numbers on this sector may have increased disproportionally because the environment it offers has become increasingly attractive to this species. Conversely, numbers may have increased disproportionally here because increasing numbers of birds are visiting The Wash and all the more suitable habitat is already at carrying capacity. However, knowing numbers of Mallard across the country and within the region are decreasing suggests it is the former as there is unlikely to be pressure for space.

It is not always the case that an increase in the proportion of a species supported by a sector goes hand in hand with an increase in numbers on that sector. Figure 4.3.ii shows the proportion of Dunlin on The Wash that has been counted on the Leverton count sector. Again we see that this sector has held an increasing proportion of Dunlin on The Wash in recent winters. However, we know that the number of Dunlin across the whole of The Wash has declined over this same period, and in this circumstance the plot indicates that this species is increasingly favouring this sector at the expense of sectors elsewhere.



Fig**ure 4.3.ii** The percent proportion of Dunlin on The Wash that has been counted on the Leverton count sector. From Austin & Calbrade (2010a).

In more general terms, if waterbird numbers of a given species on a given count sector follow those of the species across the site as a whole then the proportion contribution of numbers on the site would remain constant. Any significant deviation from this gradient of zero would indicate that the waterbird populations on the relevant count sector are doing either better or less well than would be expected from the site trend. Consequently:

- where a decline on a sector reflects a decline across the site as a whole it is unlikely that the observed site trends are being driven by factors affecting that sector alone. If this is true of the majority of sectors, then this may indicate that either the observed site decline in the species in question is due to factors external to the site and are thus not due to site management issues *per se* or that birds are responding to pressure affecting the entire site. Comparisons of the site with the regional trend can help us decide which is more likely. So where the site is also following a regional trend we are probably looking at broad-scale cause such as climate change but if the site is bucking the regional trend then trends are probably being driven by factors acting site-wide;

- where a decline on a sector is more substantial than that across the site as a whole, this may suggest that factors affecting that sector could be contributing to the overall decline. Alternatively it may be that the sector in question is relatively unattractive, and so the first to be vacated as numbers on the site decline in response to external factors. Comparison with regional trends may help to deduce which alternative is the most likely. If the site trend is unfavourable in comparison to the broader scale than the former explanation is more likely. If it is favourable in comparison to the broader scale than the latter explanation is more likely;

- where a decline on a sector is less marked than the decline across the site as a whole, this suggests that relatively favourable conditions on that sector are helping to buffer site declines;

- where an increase on a sector is smaller than that across the site as a whole, this suggests that the sector is already at carrying capacity for the species in question or, if historically it supported greater numbers, that the quality of the sector to that species has diminished;

- where an increase on a sector is greater than that across the whole site, this suggests that trends on that sector are driving the increase across the site, or that the sector in question is relatively attractive compared to the site as a whole when increased numbers arrive at the site due to external factors.

We have just seen that when considering the trends on the individual sectors in the context of trends across the site as a whole, it is important to consider the site trends in the context of the region. While it is possible to use alternative regions if required, by default WeBS bases regional comparisons on the EA regions or Scottish Environment Protection Agency areas, as these are considered relevant to water resource management. These “site against region comparisons” can modify our interpretation of the pattern of change across all sectors. This is especially important where there has been an increase or decline regionally. Consequently:

- where there has been an apparent redistribution of a species within the site (i.e. declines on some sectors appear to be balanced by increases on other sectors), but the proportional contribution of the site to increasing regional numbers is declining, then this implies that those sectors on the site with static or declining numbers are actually of concern, because we would expect them to be increasing in parallel with the other sectors. Thus, in such cases, the apparent redistribution within the site is misleading, and the species in question may be facing problems on those sectors not supporting an increase in numbers;

- where a species is in regional decline we would expect declines on at least some of the sectors of the site regardless of whether birds were being affected by adverse factors locally. Thus, we would expect those sectors of least suitable habitat to a given species to be the first to show a decline in numbers.

Given what has been said above, it should be apparent that taking any of the plots for an individual counts sector, whether the plot of mean numbers or the proportional plots, considering them in isolation could easily lead to misinterpretation. Furthermore, it is important to understand what is happening across the site as a whole, or indeed regionally or even nationally, in order to develop a robust interpretation. This leads us to the specific outputs from the analyses.

4.4 Note Regarding Time Frames and Reference Winters

The distinction between the time periods used to characterise numbers and the time-frames over which changes in the underlying trends in numbers are assessed can give cause for confusion.

Typically, we will be reporting on bird numbers and trends over a 15-year period and typically we will have divided this up into reporting periods spanning five winters. For some sites it may be possible to extend the five-year period back further. As described above we report on both absolute numbers of waterbirds and on changes in the underlying trend of numbers. We always make best use of the most topical data available for each task. However, it may have been noted that the five-year periods used to report numbers are not coincident to the five-year time-frames over which changes in the underlying trend are calculated.

Thus, when reporting or characterising absolute numbers we are able to report values from the most recent winter for which data are available. Thus when dividing the data into five-year periods in order to calculate five-winter mean of peaks we subdivide the data into periods that work backwards from the most recent winter. We also report the peak from the most recent winter.

However, when reporting changes in numbers relating to the underlying smoothed trend, while the data from the most recent winter is incorporated in the derivation of the trend, it is not desirable to report change referenced back from the most recent winter in the data series. This is because the end-points of a fitted smooth curve (regardless of technique used) are liable to change with the addition of subsequent data – essentially the endpoint is only informed by preceding years and so only “locked in place” from the one side. Thus the last (and first) winters in the time series are those for which the value on the trend line is least reliable. To lessen the impact of this issue, we therefore reference our five-year periods for reporting percentage change (short-, medium- and long-terms) with reference to the trend value in the penultimate winter, not the final winter.

The schematic below (Figure 4.4) illustrates how winters feed into periods used for characterising numbers (right) and relate to the timeframes for evaluating change (left).

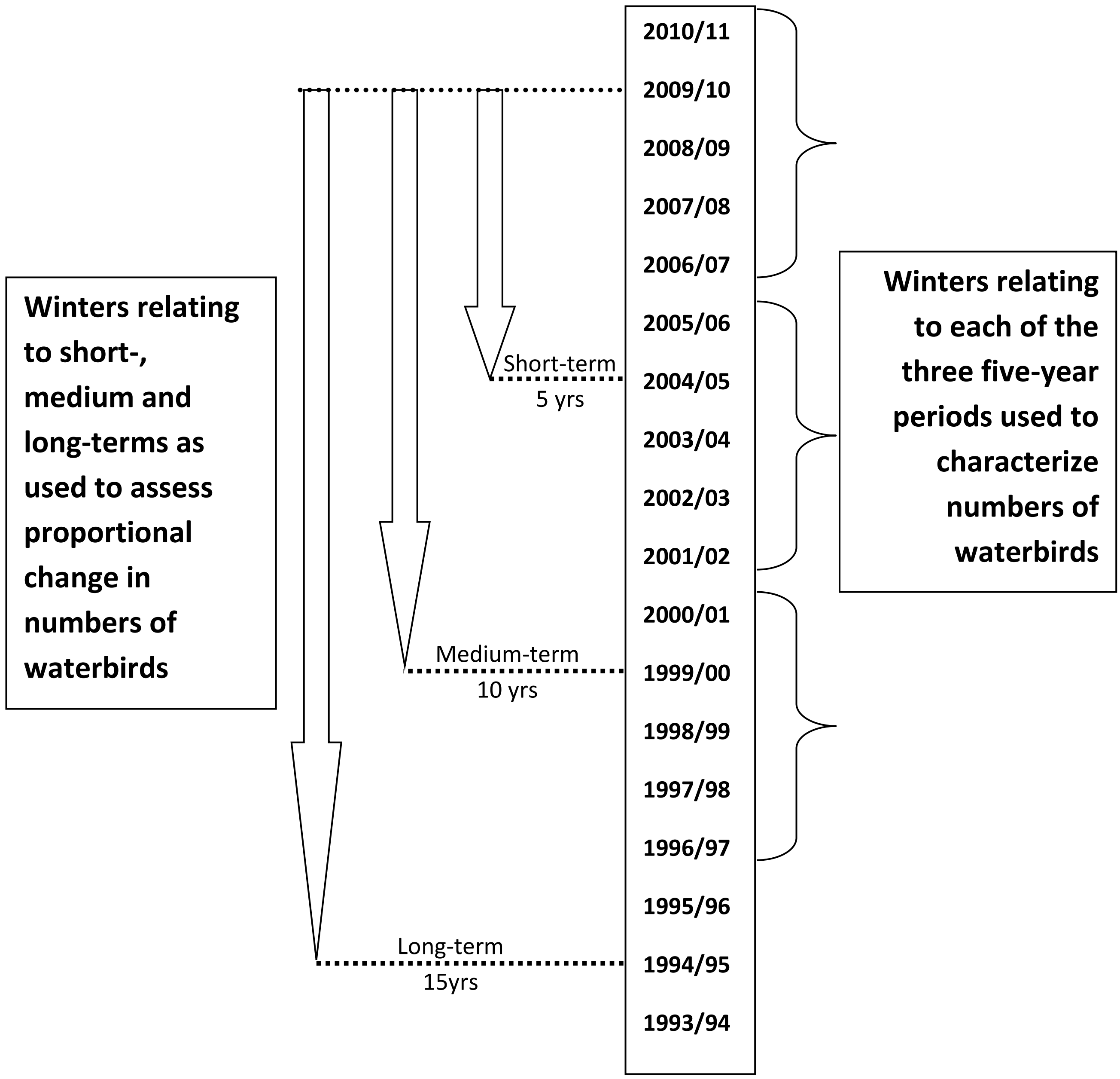


Figure 4.4 Schematic describing the relationship between the time series and both the five-year winter periods used to characterize numbers and the short-, medium- and long-terms used to assess proportional change in numbers.

5. SPECIFIC OUTPUTS FROM THE ANALYSIS

5.1 Plots of Site and Regional Trends

Site trends are normally presented as three plots: a plot of the trend in mean winter numbers on the site; a plot of the trend in mean winter numbers in the region and; a comparison plot of the mean winter numbers on the site as a proportion (shown as a percentage) of the mean winter numbers in the region. If the site in question happens to be a protected site (SPA, SSSI or ASSI) then these three plots will be equivalent to those published tri-annually in the WeBS Alerts report, although here they will always culminate in the most recent winter for which WeBS data are available, whereas the Alerts report is only revised every third year. Also Y-axis values here represent the winter mean number of birds rather than having been adjusted to an index value (referenced relative to the most recent winter which is arbitrarily given a value of 100) as presented in the Alerts report.

Example 1: The first example (Figure 5.1.i) uses Coot on Dungeness, Romney Marsh and Rye Bay SSSI.

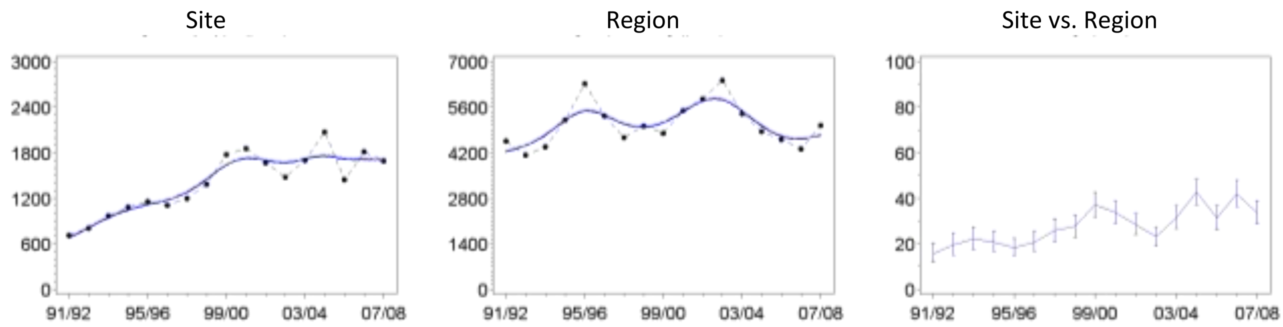


Figure 5.1.i Trends for Coot on Dungeness, Romney Marsh and Rye Bay SSSI. From Austin and Calbrade (2010a).

The first plot shows the year on year winter mean count (dots) and the smoothed trend (line) for the site. This clearly shows that there was a sustained increase during the 1990s, but that since the turn of the century the underlying trend has remained relatively stable. Note how the smoothing has "ironed out" the winter to winter fluctuation that has occurred since the turn of the century. By referring to the smoothed line, we deduce that there is no cause for concern because any comparison we may wish to make between two different winters would either indicate an increase if looking back to the 1990s, or stability if looking back to more recent times. However, if comparisons were to be made with reference to the unsmoothed means we may well have been concerned had we looked back from say winter 2005/06 to winter 2000/01 only to see numbers bounce back the following winter.

The second plot shows the year on year winter mean count across the whole region – in this particular case the EA Southern Region. Numbers across the region have had their ups and downs, and in recent winters have been falling from a historic peak. There is however no sustained increase comparable to that seen on the site during the early-1990s. Although not the case here, in general we might expect a greater degree of fluctuation around the underlying trend for the site than we see around the underlying trend for the region – a straightforward effect of the inclusion of many sites in the latter dampening "noise".

The third plot is the key to putting the trend on the site into context. The underlying line represents the year on year proportional contribution of the site to numbers within the overall region with confidence limits around each winter. In simple terms, if you can fit a line parallel to the X-axis and contained within the confidence limits then there is no evidence of long-term change. In this particular case though, the proportion has certainly increased over time. Thus back in the early-1990s this SSSI supported about 20% of Coot in EA Southern Region (more correctly, 20% of Coot on sites monitored by WeBS in EA Southern

Region). By the mid-2000s, this proportion had risen to over 30%. The SSSI has therefore become increasingly important in a regional context.

Example 2: The next example (Figure 5.1.ii) uses the trend in Oystercatcher numbers on The Wash SSSI.

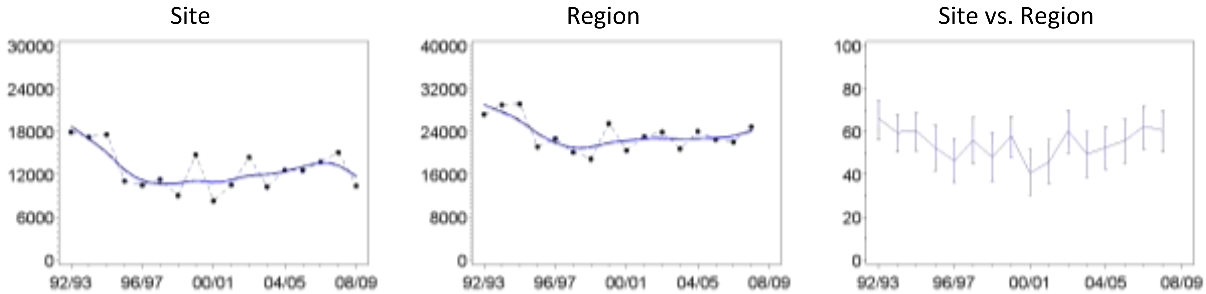


Figure 5.1.ii The trend in Oystercatcher numbers on The Wash SSSI. From Ross-Smith *et al*. (2011).

The site trend shows a distinct downturn in numbers during the early-1990s, a decline that has been associated with decreased survival due to sudden reduction in shellfish availability. A cursory comparison against the regional plot might have suggested that the trend on The Wash was simply following the wider trend across the whole of the EA Anglian Region in which case we would associate the decline with broad-scale change rather than a site-specific problem. We see the same dramatic decline followed by relatively stable or slightly increasing numbers. However, the third plot reveals that the proportional contribution to the number of Oystercatcher in the region decline from about 65% to less than 50% during this period, i.e. numbers on The Wash SSSI were declining faster than across the region. Indeed because of the importance of The Wash SSSI, the site-specific issue was no doubt driving the regional decline as numbers elsewhere in the region on balance remained stable. We can also see that since the turn of the century the balance is being restored.

Example 3: The final example (Figure 5.1.iii) of site plots uses the trend in number of Dark-bellied Brent Goose on The Wash SSSI.

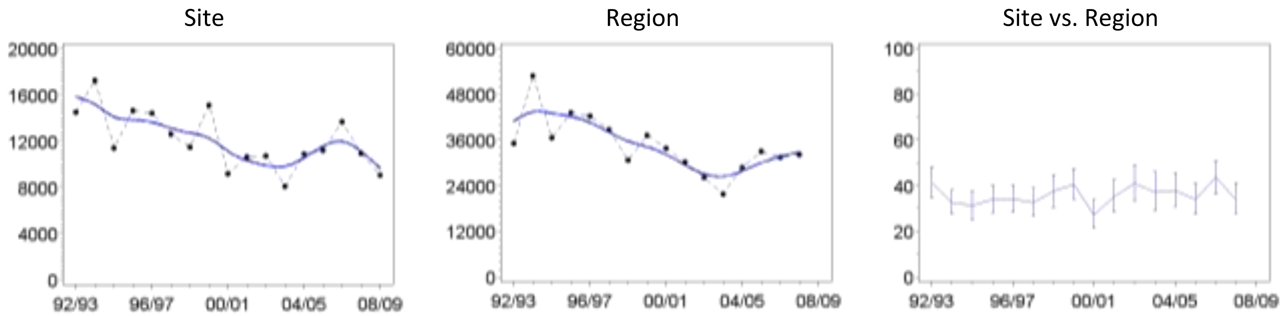


Figure 5.1.iii The trend in number of Dark-bellied Brent Goose on The Wash SSSI. From Ross-Smith *et al*. (2011).

In this case, if we were to examine the trend on the site in isolation, we might well be concerned about long-term decline and look for site-specific drivers of decline. However, the proportional contribution to Dark-bellied Goose numbers in the region has remained steady at about 35% (it is possible to visualize a flat line running parallel to the X-axis of the third plot remaining more or less within the confidence limits). Consequently, we would conclude that the trend on the site is tracking broad-scale change and site-specific issues are unlikely to be adversely affecting numbers. That is not to say that we would not wish to take action to improve numbers – just that the driving force for decline is occurring on a larger scale. The trends could therefore be due to climate change, or other broad-scale environmental changes, or a decline in numbers visiting the UK during the winter for whatever reason.

5.2 Sector Trends – Plots

These plots essentially do for sectors what the site plots do for the site. Here, trends on sectors are compared with trends across the site as a whole. It is normally not sensible to do a comparison of sector level data with the regional trend as the proportions would be so small. Site trend plots are therefore presented as two plots. The first plot shows both the trend in mean winter numbers on the site and the trend in peak winter counts on the site. The trend in means is most suitable for determining changes over time. The trend in peaks is useful for showing how many individuals the sector can support, at least for a short period, but is more susceptible to extreme values and so is not so suitable for assessing changes over time. The second plot gives the comparison of the mean winter numbers on the sector as a proportion (shown as a percentage) of the mean winter numbers on the site.

Our first example uses the trend in Dunlin numbers on Leverton, a count sector to the north-west of The Wash SSSI (Figure 5.2.i).

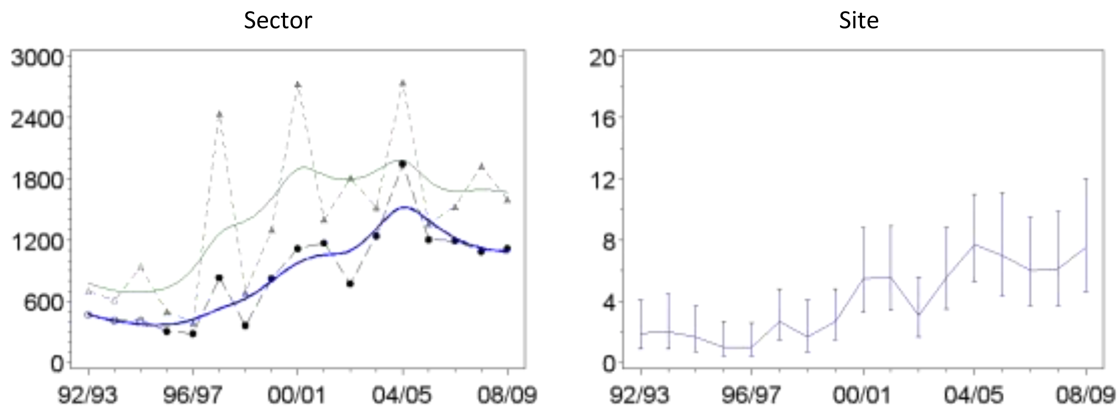


Figure 5.2.i The trend in Dunlin numbers on the Leverton count sector of The Wash SSSI. From Ross-Smith *et al*. (2011).

The first plot shows the smoothed trends for both the annual means (lower blue line) and annual peaks (upper green line). The second plot shows the comparison between the annual means of the sector with the annual mean across The Wash SSSI as a whole. Clearly numbers on this sector have been increasing since the late-1990s. Furthermore, the second plot demonstrates that this sector has become increasingly important in a site context; having supported less than 2% of Dunlin on the site back in the 1990s, this proportion has now increased four-fold. This increase is partially due to increased numbers on the sector and partially due to an overall decline in numbers on the site.

Our second example uses the trend in Dark-bellied Brent Goose on Bennington, another count sector of The Wash SSSI (Figure 5.2.ii).

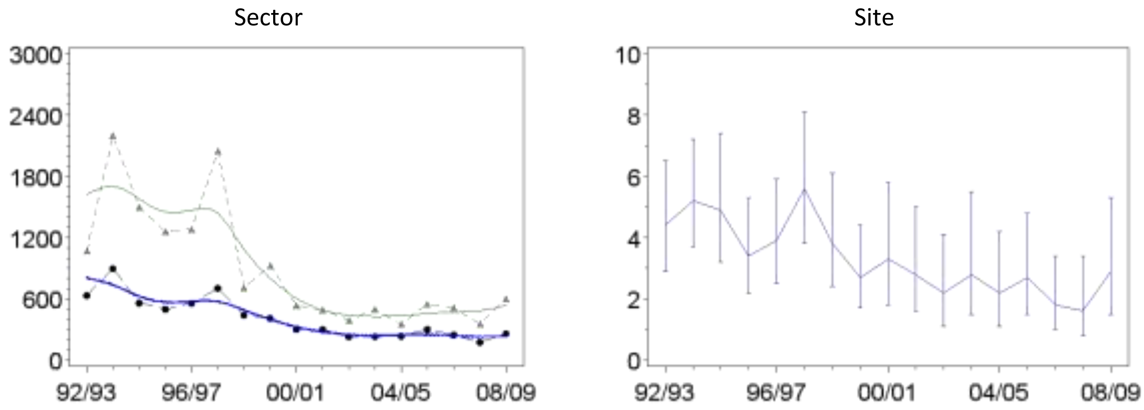


Figure 5.2.ii The trend in Dark-bellied Brent Goose on the Bennington count sector of The Wash SSSI. From Ross-Smith *et al*. (2011).

We have seen above that numbers of Dark-bellied Brent Goose on The Wash SSSI have been declining, but that that downward trend is apparently tracking broad-scale change. We therefore might expect numbers on any given sector to also be declining, and indeed it is clear from the first plot that this is happening on Bennington. However, the second plot clearly shows that numbers on Bennington have been declining disproportionally compared to the site as a whole i.e. more rapidly than it would do if it were simply tracking the site trend. There are two possibilities that could explain this disproportionate decline. Firstly, it could be that there are local factors driving the decline on this sector. Secondly, it could be that the habitat in this sector is naturally less attractive to this species, and so it has been the first to be abandoned as numbers visiting the site have diminished in line with broad-scale change. It is difficult to determine which might the primary explanation when viewing this sector in isolation. However, comparison with what is happening on neighbouring sectors and/or what is happening to numbers of other species on this sector would help form opinion.

The next example of sector plots also comes from the Bennington count sector on The Wash SSSI, this time for Lapwing (Figure 5.2.iii).

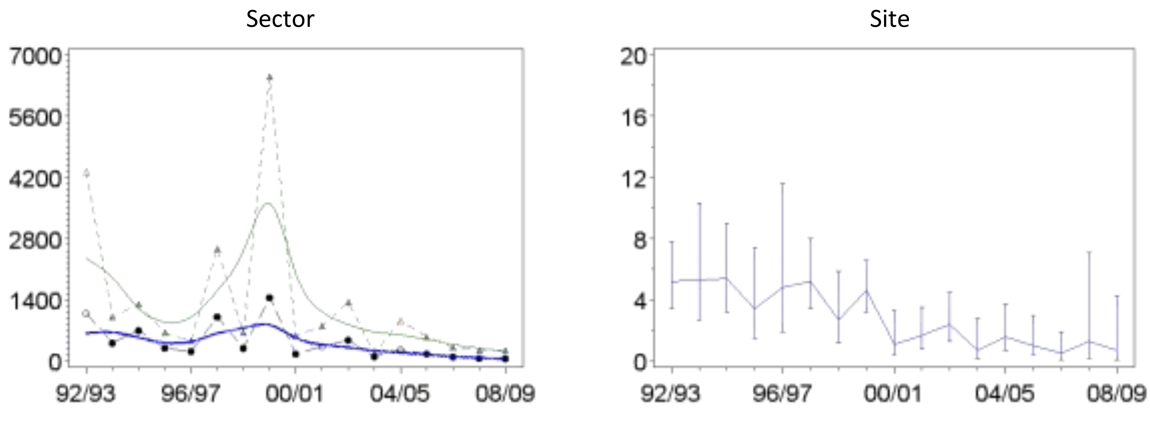


Figure 5.2.iii The trend in lapwing on the Bennington count sector on The Wash SSSI. From Ross-Smith *et al*. (2011).

As in the previous example, here we have a species that is declining in numbers on this sector. Once again the comparison plot indicates that numbers on this sector have been declining more rapidly than expected from the trend on the site as a whole. It also demonstrates why we choose not to assess trends over time based on peak counts. Aside from the fact that the month of the peak counts on this sector may vary from winter to winter, or may typically occur at a different time of year to the peak across the site, in this plot we can see the effect of a single extreme count in the late-1990s on the underlying trend. Were we to assess percentage decline from the late-1990s based on the trend in peaks, we would get an extremely inflated value for that decline.

Our final example of sector plots again comes from The Wash SSSI, this time for Shelduck. Here we are looking not at a single sector, but rather a combination of four sectors (Bennington, Wrangle, Leverton and Butterwick) that together approximate to the South Lincs. Shooting Zone and which we wish to compare to the overall trend on The Wash SSSI (Figure 5.2.iv).

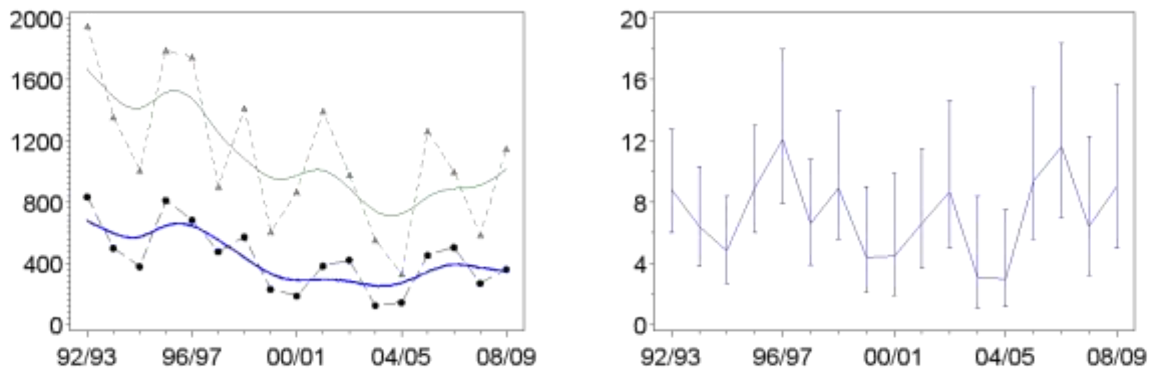


Figure 5.2.iv The Trend in Shelduck on the South Lincs. Shooting Zone (approximated by four WeBS count sectors (Bennington, Wrangle, Leverton and Butterwick) on The Wash SSSI. From Austin & Calbrade (2010b).

The first plot shows that numbers of Shelduck declined consistently through the 1990s and have remained more or less stable since the turn of the century. Taking this in isolation we may well begin to look to activities taking place within this area to explain this decline. However, the second plot shows there to has been no sustained decline in the numbers on this area relative to the numbers across The Wash SSSI as a whole, suggesting that whatever is driving this decline is acting at a larger scale and the numbers on this area are simply tracking the fortunes of the species across the whole site.

5.3 Overview of Sector Trends Across the Site

Whilst interpretation of the individual sector trends is important, it is easy to over-interpret what is happening for any given species-sector combination and it is difficult to remain consistent in how much weight you give to a particular aspect of the underlying trend as you move from sector to sector and species to species. It is therefore useful to have a standard approach to assessing change that allows one to step back and view the broader picture.

5.3.1. Table of change

Using a similar approach to that used for WeBS Alerts, the percentage change in numbers is calculated from the relevant base winter to the reference winter, the latter being the penultimate winter in the time series available. The three time periods used represent short- (5yr), medium- (10yr) and long-term (15yr) change.

By analogy to the WeBS Alerts system, declines of at least 25% but below 50% are flagged as moderate declines, and declines of 50% or greater are flagged as substantial declines. The corresponding percentage change required to balance the numbers to their former level following a decline or increase are likewise termed moderate (at least 33% but below 100%) and substantial (100% or greater) increases. While the actual values from these computations will normally be made available as supplementary information provided in a spreadsheet, the real intention here is to enable one to step back from the detail and look for broad patterns that may aid interpretation. Consequently, the results of this analysis are presented in 'The Table of Change' without values, but are rather colour coded as follows:

- Red = substantial decline (decline of 50% or greater)
- Amber = moderate decline (decline of at least 25% but less than 50%)
- Grey =”no” change (decline less than 25% or increase less than 33%)
- Light green = moderate increase (increase of at least 33% but less than 100%)
- Dark green = substantial increase (increase of at least 100%)

Columns for species are arranged taxonomically, and rows for sectors are arranged, as we are best able, by geographic location. Normally, change for the overall site is given in the top row for reference. For each species/location short-, medium- and long-term trends are presented separately (note that in reports prior to 2011 cells were coloured for the worst case scenario of the three timeframes rather than individually for each).

These tables therefore summarise and standardise the myriad of information encompassed in the individual plots of sector trends. By way of example we consider the example from an analysis of sector trends for The Wash SSSI (Figure 5.3.i).

The primary purpose of this table is not really to allow one to read off the individual category of change for any particular combination of sector, species and time-frame, although clearly it can be used for that purpose. Its primary aim is to allow one to form an overview of the situation across the whole site and look for patterns associated with both geographic location and ecological similarities of species. It is important to recognise that the numbers of birds underlying the observed trend on sectors are generally much lower than those underlying site trends reported by WeBS Alerts which are, by definition, at least equal to the national qualifying threshold. As already pointed out, a 50% decline from 30 birds to 15 birds, for example, would give much less cause for concern than a 50% decline from 1000 to 500 birds. While bearing this in mind, a consistent pattern of decline across multiple species, even when the numbers involved for some of them are comparatively low, is strongly indicative of adverse factors affecting the sector in question, while the particular suite of species showing a decline in numbers can guide us in where to look for problems (e.g. does the suite of species represent those known to be particularly sensitive to disturbance or those with similar ecological requirements?).

So in the example it is clear that numbers of Shelduck, a species declining on The Wash SSSI as a whole (top row), have been falling consistently across all parts of this site. Numbers of Wigeon on the other hand, a species increasing on The Wash SSSI as a whole, has been declining on the northern part of The Wash's Lincolnshire coastline (Wainfleet to Leverton) but increasing to the south (between Butterwick and Witham) suggesting a local shift, perhaps in response to local pressures to the north or improvement in habitat to the south. We would also note that for the area from Frampton to Dawsmere, there is a block of predominantly red and amber against the two geese and Shelduck, but of predominantly green against the dabbling ducks. Thus, if there is some local pressure driving down numbers of geese and Shelduck in this area, it is something that is having little effect on dabbling ducks. For example it could be due to something like increasing height of saltmarsh vegetation making the area less attractive to the geese species and Shelduck, but providing shelter for the dabbling ducks at high tide, or perhaps increased inundation of the salt marsh by higher tides making it more likely to be visited by dabbling ducks. Where we have species like Mallard, numbers of which are relatively stable on The Wash SSSI, there is often a mix of sectors on which they are increasing, declining and stable, but with no real geographic pattern within the column. While this might not tell us much about Mallard numbers, if these declines or increases line up with similar for other species, this may tell us something about particular sectors. So, for example, we could say that conditions on Snettisham are generally favourable, whereas Friskney gives us cause for concern.

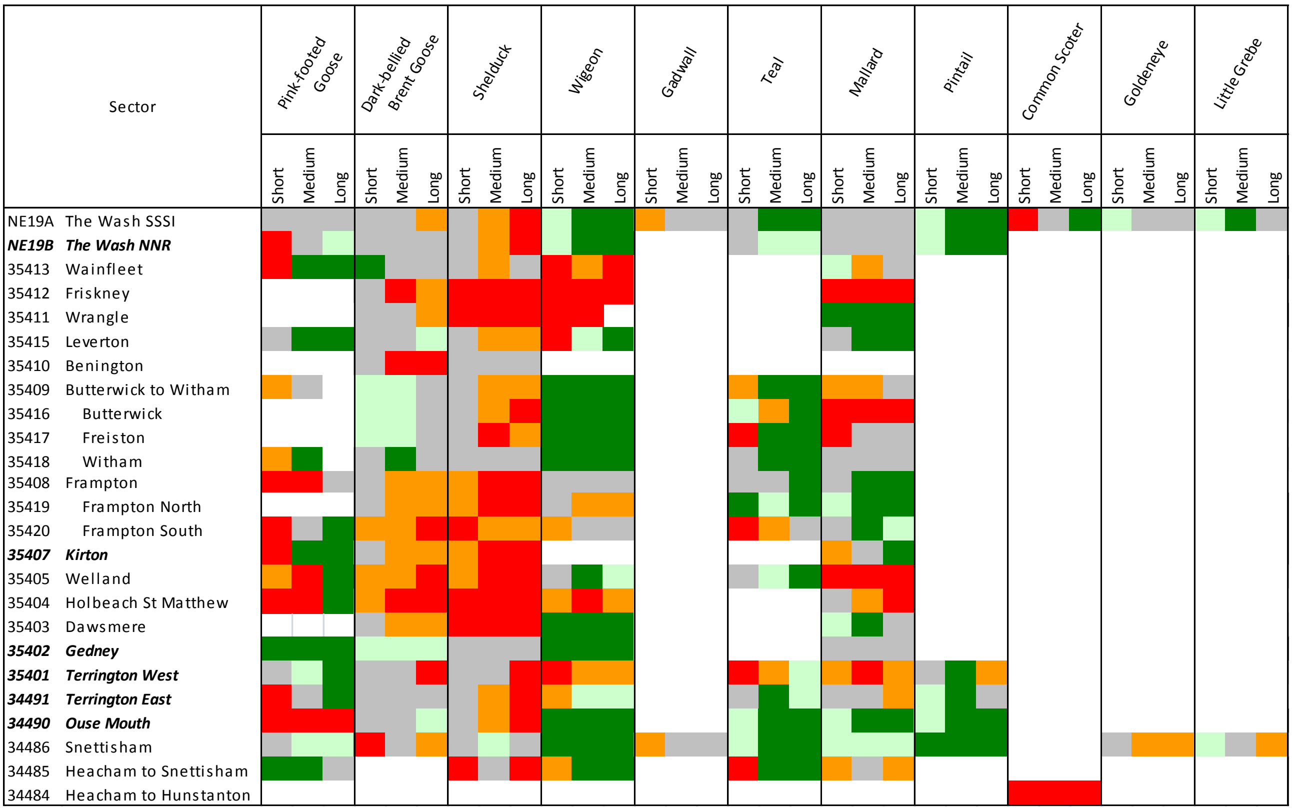


Figure 5.3.i The 'Table of Change' for The Wash SSSI. An overview of sector trends across species and sectors. Note that uncoloured cells correspond to species/sector combinations where numbers are too low to allow meaningful trend analysis. Red = substantial decline (decline of 50% or greater); Amber = moderate decline (decline of at least 25% but less than 50%); Grey ="no" change (decline less than 25% or increase less than 33%); Light green = moderate increase (increase of at least 33% but less than 100%); Dark green = substantial increase (increase of at least 100%). From Ross-Smith *et al*. (2011).

5.3.2 Pie charts summarising change

The information in the table of change can be further summarised and mapped. While this provides very little detail it can be useful for focusing attention to problem areas on larger sites.

By way of example, we consider the north shore of the Humber Estuary (Figure 5.3.ii). Each pie chart summarises across all species for which analysis of trends were possible for a particular count section. The area of each pie chart is scaled proportional to the number of species for which analyses were obtained, and the slices within each pie chart represent the proportion of those species in each of the five change categories using the same colour coding as used for the Table of Change (See Figure 5.3.i). The situation is rarely clear cut, but here, for example, you can see there to be a predominance of red and amber to the left which would indicate that there may be more (or more serious) problems to be investigated towards the inner north shore as compared to the outer reaches of the north shore (with the exception of the outermost sector).

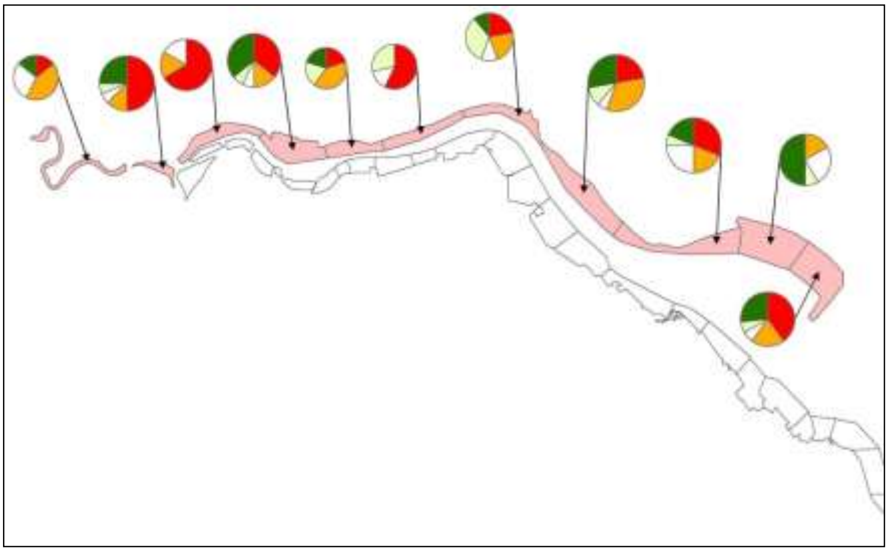


Figure 5.3.ii Summary map of sector trends for north shore of the Humber Estuary SPA. The area of each pie chart is scaled proportional to the number of species for which analyses were obtained. Slices within each pie chart represent the proportion of those species in each of the five change categories. From Ross-Smith *et al*. 2013.

5.3.3 Table of long-term changes in proportional contribution of sectors

The plots of the proportional contribution of each sector to the total numbers of a species on a site are modelled winter on winter. During interpretation of those plots we would concentrate on increases or declines in those proportions for runs of consecutive winters. Sometimes though, we may be interested in whether there has been a significant long-term increase or decrease. This is achieved by fitting a linear model through the time series, the results of which are summarised in a table. Again the underlying values will generally be supplied as supplementary data in spreadsheet format but, like the Table of Change, the Table of Proportional Change is intended to give an overview of the situation. Consequently, the results of this analysis are presented as tables and without values, but rather colour coded as follows:

- Red = negative linear trend, highly significant (P<0.01)
- Amber = negative linear trend, significant (P<0.05)
- Grey = no significant linear trend
- Light green = positive linear trend, significant (P<0.05)
- Dark green = positive linear trend, highly significant (P<0.01)

We take as an example the table of change from the Humber Estuary (Figure 5.3.iii). Columns correspond to species and are arranged in taxonomic order. Rows correspond to sectors arranged, as we are best able, by geographic location.

The Table of Proportional Change tends not to be over-played during interpretation, as the analysis represents the all-time linear change in the proportion of birds that a given sector contributes to the site total, and as such loses the important detail i.e. when the trend is clearly not linear this over-simplifies the situation. Indeed, taken in isolation it could be misleading. For example, when numbers are in decline following a peak, the overall linear trend will generally remain positive for a considerable length of time. It can, however, reinforce confidence in our interpretation. For example, in the case of the middle stretch of the south bank of the Humber Estuary seen above, significant linear declines have been evident for all but one species of wader, and so any statements regarding declines in this area being disproportionally greater than expected, or increases being less than expected relative to the trend across the whole site, can be made with high confidence.

Figure 5.3.iii Table of Proportional Change for the Humber Estuary SPA. Columns relate to species (taxonomically ordered), rows relate to count sections (geographically ordered). Red = negative linear trend, highly significant (P<0.01); Amber = negative linear trend, significant (P<0.05); Grey = no significant linear trend; Light green = positive linear trend, significant (P<0.05); Dark green = positive linear trend, highly significant (P<0.01). From Austin *et al.* (2008).

5.3.4 Peak counts by species and count sector

When we come to compare trends between different sectors, or when a downward trend gives us cause for concern, it is essential to consider the relative importance of these different sectors. The parameter used by WeBS to characterise the number of birds of a given species that a site or sector can support, is the average of the peak counts over a five-winter period. Accordingly, we calculate the five-winter mean of peaks for each of the five-winter blocks within the most recent 15 winters, and the peak count in the most recent winter. While the actual values from these computations will generally be made available as supplementary data in the form of a spreadsheet, these values are usefully summarised for quick reference in table form without values, and colour coded to indicate its importance in terms of its five-winter mean of peaks as a proportion of the most recent five-winter mean of peaks for the whole site as follows:

- Dark Blue = five-winter mean of peaks at least 20% of the value for the whole site
- Light Blue = five winter mean peaks between 10% and 20% of the value for the whole site

- Dark Green = peak count in the latest winter at least 20% of the peak count for the whole site
- Light Green = peak count in the latest winter between 10% and 20% of the peak count for the whole site

By way of example we consider the Table of Peak Counts for The Wash SSSI (Figure 5.3.iv). Cells coloured in the table flag up sectors that are particularly important for each of the species. So in the this particular example we can see that the Snettisham sector is particularly important for most species of wildfowl, whereas the Friskney sector is not especially important for any species of wildfowl. We can also see that while a relatively small number of sectors are really important for Pintail, Wigeon occur in large numbers across many sections. The reference values of 10% and 20% of the equivalent value for the whole site are generally used, as for most sites, this does an acceptable job of highlighting important sectors. However, lower percentages may be used where species tend to be more evenly spread across the sectors of a particular site, or higher percentages used where species tend to be especially concentrated on particular sectors of a site.

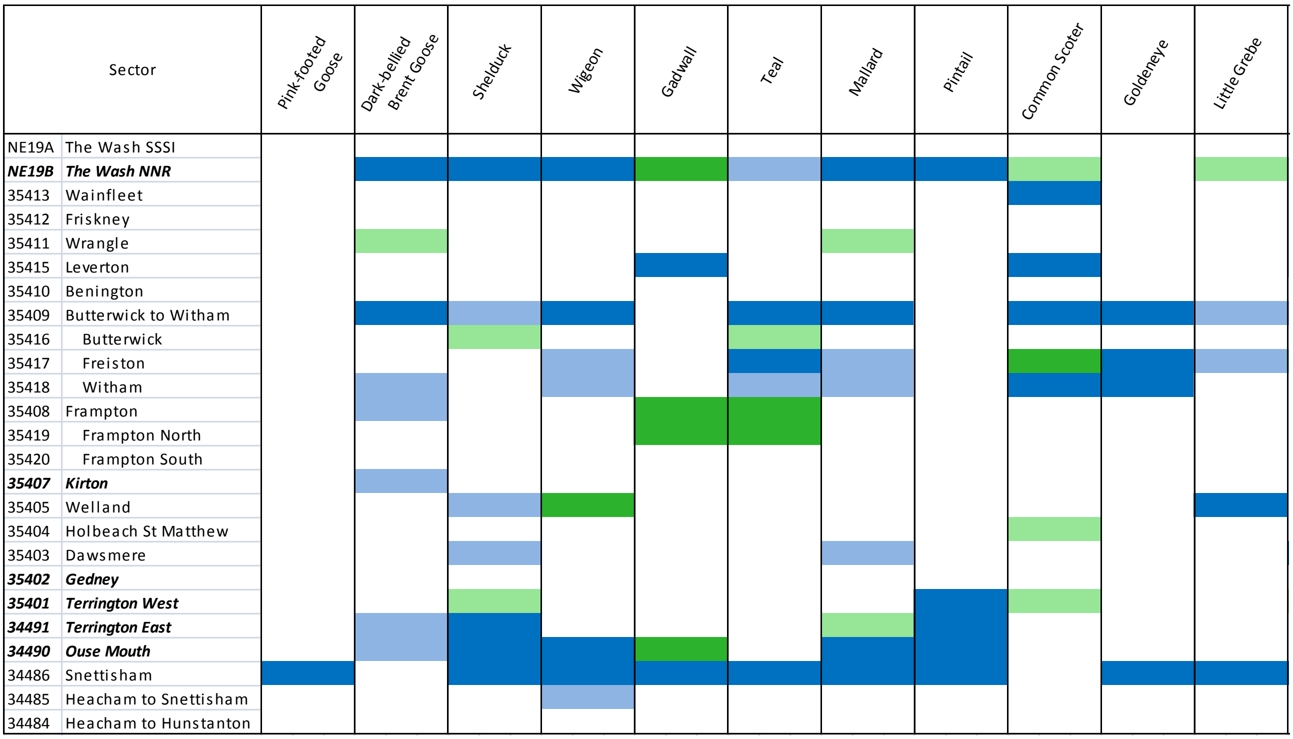


Figure 5.3.iv Table of Peak Counts for The Wash SSSI. Columns relate to species (ordered taxonomically) and rows relate to count sector (arranged geographically). Dark Blue = five-winter mean of peaks at least 20% of the value for the whole site; Light Blue = five winter mean peaks between 10% and 20% of the value for the whole site; Dark Green = peak count in the latest winter at least 20% of the peak count for the whole site; Light Green = peak count in the latest winter between 10% and 20% of the peak count for the whole site. From Ross-Smith *et al*. (2011).

5.3.5 Density plots

Mapped density plots may also be provided. These provide a quick and easy method of identifying those sectors most important to each species. They may be presented as either dot-density plots or shaded on a colour gradient, the symbology chosen largely being dictated by what works best for a particular site.

By way of example we use Dark-bellied Brent Geese on the Humber Estuary (Figure 5.3.v). The depth of red (or alternatively the density of dots) represents the most recent five-year mean of peak counts for each sector and that value is also given on the map. In this particular example, it illustrates the importance of the outer reaches of the Humber Estuary, especially at the estuary mouth itself, to this particular species.

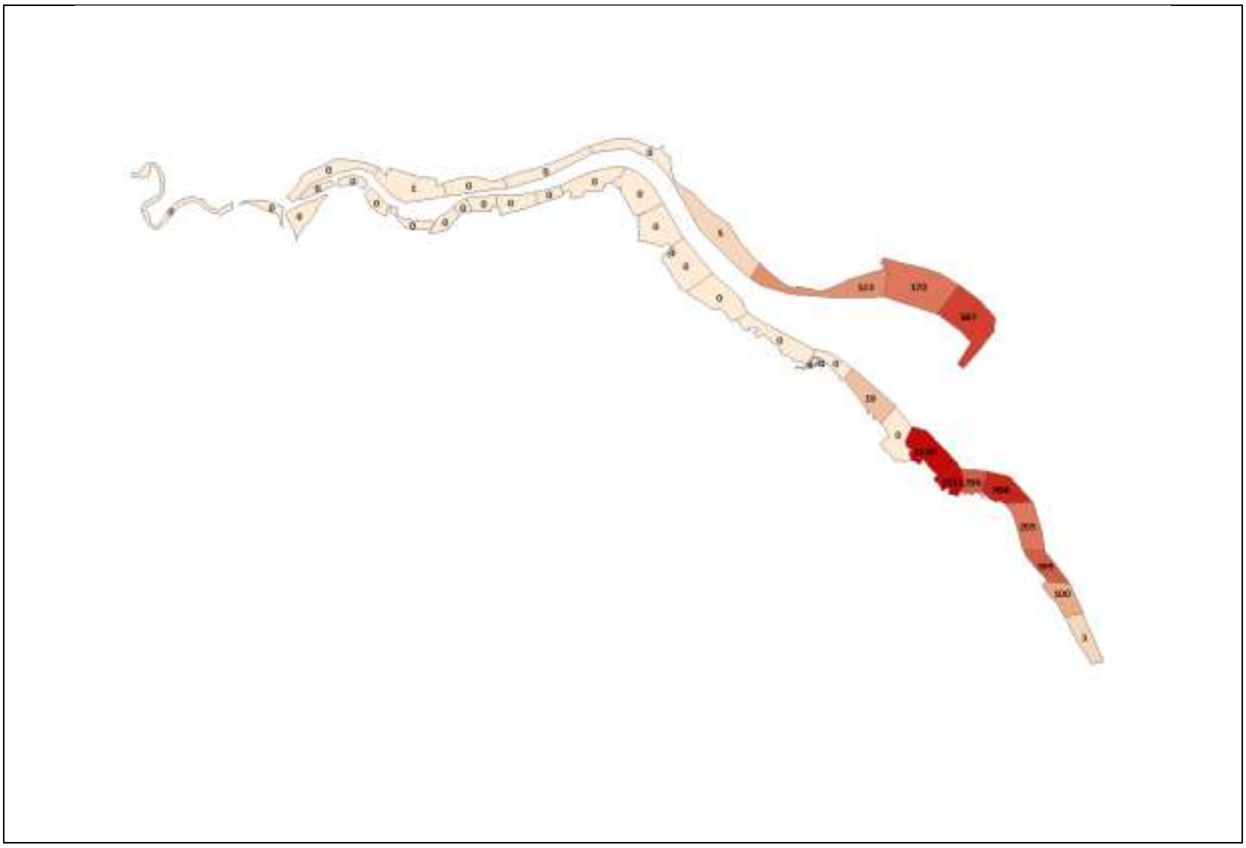


Figure 5.3.v Density of Dark-bellied Brent Goose by WeBS count section. The depth of red (or alternatively the density of dots) and value represents the most recent five-year mean of peak counts for each sector. From Ross-Smith *et al*. (2013).

References

Austin, G.E., Calbrade, N.A., Mellan, H.J., Musgrove, A.J., Hearn, R.D., Stroud, D.A., Wotton, S.R. And Holt, C.A. 2014. Waterbirds in the UK 2012/13: The Wetland Bird Survey. BTO/RSPB/JNCC, Thetford.http://www.bto.org/volunteer-surveys/webs/publications/webs-annual-report

Austin, G.E., Calbrade, M.R., Rehfisch, M.R. & Wright, L.J. 2008. *Humber Estuary SPA waterbird populations: trend analyses by count sector*. BTO Research Report No. 497, BTO, Thetford.

Austin, G.E & Calbrade, N.A. 2010a. *Within-Site Waterbird Trends Relative to Whole-Site and Regional Population Trends: Dungeness, Romney Marsh and Rye Bay SSSI*. BTO Research Report No. 546, BTO, Thetford.

Austin, G.E & Calbrade, N.A. 2010b. *Within-Site Waterbird Trends Relative to Whole-Site and Regional Population Trends: The South Lincs. Shooting Zone on The Wash SPA*. BTO Research Report No. 548, BTO, Thetford.

Banks, A.N. & Austin G.E. 2004. *Statistical comparisons of waterbird site trends with regional and national trends for incorporation within the WeBS Alerts system*. BTO Research Report No. 359, BTO, Thetford.

Cook, A.S.C.P., Barimore, C., Holt, C.A., Read, W.J. And Austin, G.E. (2013). Wetland Bird Survey Alerts 2009/2010: Changes in numbers of wintering waterbirds in the Constituent Countries of the United Kingdom, Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs). BTO Research Report 641. BTO, Thetford.http://www.bto.org/volunteer-surveys/webs/publications/webs-annual-report

Ross-Smith, V.H., Calbrade, N.A. & Austin, G.E. 2011. *Analysis of Wetland Bird Survey (WeBS) data for The Wash SSSI/NNR*. BTO Research Report No. 587, BTO, Thetford.

Ross-Smith, V.H., Calbrade, N.A. & Austin, G.E. 2013. *Updated analysis of Wetland Bird Survey (WeBS) Data for The Humber Estuary SSSI, SAC, SPA and Ramsar site*. BTO Research Report No. 636, BTO, Thetford.

Stroud, D.A., Chambers, D., Cook, S., Buxton, N., Fraser, B., Clement, P., Lewis, P., Mclean, I., Baker, H. & Whitehead, S. 2001. *The UK SPA network: its scope and content.* JNCC, Peterborough, UK.