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Within-Site Waterbird Trends Relative to Whole-Site and Regional Population Trends: The South Lincs. Shooting Zone on The Wash SPA

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CONTENTS

Page No.

LIST OF TABLES

Page No.

LIST OF FIGURES

Page No.

LIST OF APPENDICES

Page No.

EXECUTIVE SUMMARY

Natural England as the relevant competent authority in England must consider notices for operations on The Wash SPA. One of the major considerations in consenting activities and undertaking/advising on appropriate assessments is the likely impact of the proposed activity or development on SPA birds.

To this end, Wetland Bird Survey (WeBS) data are used to calculate and compare species trends for the South Lincs. Shooting Zone and component units with the aim of gaining a better understanding of fluctuations in bird numbers on this area both temporally and spatially and thus inform the assessment the potential impacts of activities and developments on overall numbers of birds found on The Wash SPA of which this area is a part.

Monthly waterbird counts have been conducted in the UK for Wetland Bird Survey for over 50 years. Since 1993 data have been collated at the level of the count section. These count sectors, while being chosen principally to facilitate count recording, have frequently been aligned to natural ecological boundaries or physical features. Consequently, biologically meaningful interpretations of waterbird trends on these count sectors are possible.

- Thus, this report describes, for each of 15 waterbird species (for which there are sufficient data to support analysis), trends across four WeBS count sectors, together approximating to the South Lincs. Shooting Zone, the individual trends on each of these four sectors and how these compare to the trend across the entire SPA and puts this into the context of the broad-scale regional pattern.

- It is not in the remit of this report to attempt to identify drivers of any observed changes in waterbird numbers, however, common patterns between species trends, how this may relate to their biology and potential pressures are suggested. More importantly, this report contains all the WeBS parameters identified in the Natural England paper "Natural England's approach to assessing and responding to wildfowling notices on SSSIs and European sites" with particular reference to sections 7.7 and Appendices 1 & 4.

- In overview, our analysis suggests that the South Lincs. Shooting Zone is in a favourable state for most of the species for which WeBS provides sufficient data for meaningful analysis when put into the context of trends across the whole of The Wash SPA and at a broader regional scale. There are, however, two groups of waterbird: the dabbling ducks (Teal and Mallard) and the grassland plovers (Golden Plover and Lapwing) that our analysis suggests are fairing relatively poorly within the South Lincs. Shooting Zone.

- Within the South Lincs. Shooting Zone our analysis of trends on the individual WeBS count sections indicate a general pattern of redistribution that can be observed in the majority of species. Thus there has been a consistent shift in usage of the area from the southern end towards the northern end.

- It is not possible solely from the analysis of trends in numbers to determine cause and effect. Both habitat change and changes in levels of disturbance are two prime candidates as the pressures capable of driving the observed trends.

- It is recommended that a more extensive analysis of WeBS count trends on The Wash should be conducted. Whilst it is possible to take some context from the comparisons with the overall SPA, knowledge of trends on sectors adjacent to the South Lincs. Shooting Zone would provide further context that may help determine whether the trends observed within the zone are peculiar to it or part of a more widespread pattern on the Lincolnshire shoreline of the Wash SPA.

1. INTRODUCTION

1.1 Background

The Wash is located on the east coast of England and is the largest estuarine system in the UK. It is fed by the rivers Witham, Welland, Nene and Great Ouse that drain much of the east Midlands of England. The wash comprises of very extensive saltmarshes, major intertidal banks of sand and mud, shallow waters and deep channels. The eastern end of the site includes low chalk cliffs at Hunstanton. In addition, on the eastern side, the gravel pits at Snettisham are an important high-tide roost for waders. The intertidal flats have a rich invertebrate fauna and colonising beds of Glasswort *Salicornia spp*. which are important food sources for the large numbers of waterbirds dependent on this site. The sheltered nature of The Wash creates suitable breeding conditions for shellfish, principally Mussel *Mytilus edulis*, Cockle *Cardium edule* and shrimps. These are important food sources for some species such as Oystercatcher. To the north, the coastal habitats of The Wash are continuous with Gibraltar Point SPA, whilst to the east The Wash adjoins the North Norfolk Coast SPA (Stroud *et al*. 2001).

The Wash is also a site of national and international importance for its wader and wildfowl populations, in addition to a range of other habitats and species. It is the most important site in the UK for its waterbird population, currently supporting c371,000 waterbirds during winter and passage periods. During the winter, this total includes internationally important numbers of 16 species. As a result, it enjoys the highest levels of legal protection currently possible in this country and is designated as a Site of Special Scientific Interest, Special Protection Area, Special Area of Conservation, Ramsar site, European Marine Site, Area of Outstanding Natural Beauty and National Nature Reserve. However, there is concern that numbers of some of the species on importance have declined in numbers across the SPA over recent years.

Under the Wildlife and Countryside Act 1981 (as amended by CRoW 2000) Natural England (NE) must consider notices for operations on The Wash SPA, such as wildfowling, and determine whether to consent or refuse these proposals, or to impose conditions on the way they are carried out. Under the auspices of the Conservation (Natural Habitats) Regulations 1994, Natural England also undertakes and advises on appropriate assessments concerning the effects of plans and projects on the estuary as a European site (SPA, SAC and Ramsar site). One of the major considerations in consenting activities and undertaking/advising on appropriate assessments is the likely impact of the proposed activity or development on species of birds for which the SPA is designated.

To this end, an analysis of information on trends across the entire site and how these relate to regional and country-wide population trends informs as to which waterbird species give particular cause for concern across The Wash as a whole. This information can be obtained from the WeBS-Alerts report (Maclean and Austin 2008). To help Natural England understand how waterbirds may be redistributing within the site and identify areas where there has been a net loss or gain relative to numbers across the whole site, Wetland Bird Survey (WeBS) data are used here to calculate and compare species trends within the SPA for particular component units. This will in turn contribute towards gaining a better understanding of fluctuations in bird numbers on that part of the estuary both temporally and spatially and thus inform the assessment the potential impacts of activities and developments on SPA populations.

1.2 Objectives

Thus the objectives of this report are to gain an understanding of fluctuations in numbers of certain waterbird species to inform the consenting of operations and appropriate assessments of plans and projects on the South Lincs. Shooting Zone by:

- identifying their abundance trends over the last 15 years in each of the WeBS count sectors corresponding to the South Lincs. Shooting Zone and their combined trends and comparing these trends to the estuary as a whole.

- identifying WeBS sectors corresponding to the South Lincs. Shooting Zone with significant numbers of species that are increasing more rapidly or declining more rapidly than across the whole site.

2. METHODS

2.1 Waterbird Data

WeBS is a long-running survey that monitors waterbird numbers on sites throughout the UK by monthly site visits when numbers of all waterbird species are recorded (Holt *et al*. 2009). On large sites, such as The Wash, where it is not feasible, or indeed desirable, to make a single count for the entire site, synchronous counts of smaller count sectors are undertaken. These sector counts are routinely summed to give the overall site total and during this process the completeness of the overall count assessed. This is necessary because all sectors are not necessarily counted on all occasions. This is undertaken in a species-specific manner because the absence of data from a given section would not be expected to affect the overall total equally for all species. Furthermore, completeness is assessed on a month-by-month, year-by-year basis using algorithms that allow for both seasonal and long-term trends in site usage. Thus a consolidated count for a site composed of multiple sectors is considered complete when those sectors counted on the month in question would be expected to hold at least 75% of the site total for the species in question for the season and year in question. Whilst the division of large sites into sectors has evolved principally in response to the practicality of undertaking counts, the divisions between sectors typically follow distinctive features of the environment. Thus an analysis of waterbird trends on the individual sectors can inform in a biologically meaningful manner.

2.2 Species Selection

An initial list of 28 species was considered which included all species for which The Wash SPA has been designated together with any additional quarry species that may be of relevance to the South Lincs. Shooting Zone (Table 2.2.i). Four species (Pink-footed Goose *Anser brachyrhynchus*, European White-fronted Goose *Anser albrifons albifrons*, Cormorant *Phalacrocorax carbo* and Ringed Plover *Charadrius hiaticula*) were excluded from further consideration because the South Lincs. Shooting Zone typically supports less than 1% of the total for The Wash SPA and therefore not considered to be of major conservation concern on this part of The Wash. A further five species (Whooper Swan *Cygnus cygnus*, Pintail *Anas acuta*, Goldeneye *Bucephala clangula*, Little Grebe *Tachybaptus ruficollis*, Avocet *Recurvirostra avosetta*) were excluded from further consideration because the numbers on the South Lincs. Shooting Zone, although exceeding 1% of The Wash SPA total, are nonetheless too small for meaningful interpretation. Finally, three further species (Gadwall *Anas strepera*, Common Scoter *Melanitta nigra*, and Black-tailed Godwit *Limosa limosa islandica*) were excluded from further consideration because their occurrence on the South Lincs. Shooting Zone is intermittent and not suitable for modelling trends.

Thus suitable data for count sector trend analysis were available for 15 species (Dark-bellied Brent Goose *Branta bernicla bernicla*, Shelduck *Tadorna tadorna*, Wigeon *Anas penelope*, Teal *A. crecca,* Mallard *A.platyrhynchos*, Oystercatcher *Haematopus ostralegus*, Golden Plover *Pluvialis apricaria*, Grey Plover *P.squatarola*, Lapwing *Vanellus vanellus*, Knot *Calidris canutus*, Dunlin *C. alpina*, Bar-tailed Godwit *Limosa lapponica*, Curlew *Numenius arquata*, Redshank *Tringa totanus* and Turnstone *Arenaria interpres*).

Species	SPA qualification criterion 4.1	SPA qualification criterion 4.2	SPA qualification criterion - Assemblage	Included as a quarry species	5yr winter mean of peak counts - The Wash SPA	5yr winter mean of peak counts - South Lincs. Shooting Zone	Percentage of SPA on South Lincs. Shooting Zone	Reasons for Exclusions
Whooper Swan	Y	-	-	-	26	3	11.5	low numbers
Pink-footed Goose	-	Y	-	-	32945	96	0.3	<1% SPA of total
European White-fronted Goose	-	-	Y	-	8	0	0.0	<1% SPA of total
Dark-bellied Brent Goose	-	Y	-	-	20485	3689	18.0	
Shelduck	-	Y	-	-	6967	999	12.1	
Wigeon	-	Y	-	-	7787	295	3.8	
Gadwall	-	Y	-	-	112	42	37.5	intermittent
Teal	-	-	-	Y	2736	141	5.2	
Mallard	-	-	Y	-	2461	221	9.0	
Pintail	-	Y	-	-	928	9	1.0	low numbers
Common Scoter	-	Y	-	-	626	151	24.1	Intermittent
Goldeneye	-	Y	-	-	109	8	7.3	low numbers
Little Grebe	-	-	Y	-	80	2	2.5	low numbers
Cormorant	-	-	Y	-	428	3	0.7	<1% SPA of total
Oystercatcher	-	Y	-	-	16744	4172	24.9	
Avocet	Y	-	-	-	213	5	2.3	low numbers
Ringed Plover	-	-	Y	-	297	1	0.3	<1% SPA of total
Golden Plover	Y	-	-	-	31620	4571	14.5	
Grey Plover	-	Y	-	-	6040	2358	39.0	
Lapwing	-	-	Y	-	30575	2154	7.0	
Knot	-	Y	-	-	115748	8033	6.9	
Sanderling	-	Y	-	-	476	9	1.9	low numbers
Dunlin	-	Y	-	-	25873	3241	12.5	
Black-tailed Godwit	-	Y	-	-	4024	742	18.4	intermittent
Bar-tailed Godwit	Y	-	-	-	10469	4096	39.1	
Curlew	-	Y	-	-	3213	865	26.9	
Redshank	-	Y	-	-	2487	473	19.0	
Turnstone	-	Y	-	-	418	110	26.3	

Table 2.2.i: Species considered for this report, indication the reason for which they were considered and were appropriate reasons for their exclusion from analysis.

2.3 Spatial Coverage

There are over 200 constituent and extant sectors of The Wash, though for this report, an analysis of only four sections covering the area of the South Lincs. Shooting Zone (WeBS sections Wrangle, Leverton, Benington and Butterwick) was requested. The precise spatial match between the boundaries of the South Lincs. Shooting Zone and the WeBS count section is, unsurprisingly, not exact (Figure 2.3.i). However, in functional terms, data from four count sections included in this analysis can be expected to give a true indication of waterbird population trends within the South Lincs. Shooting Zone.

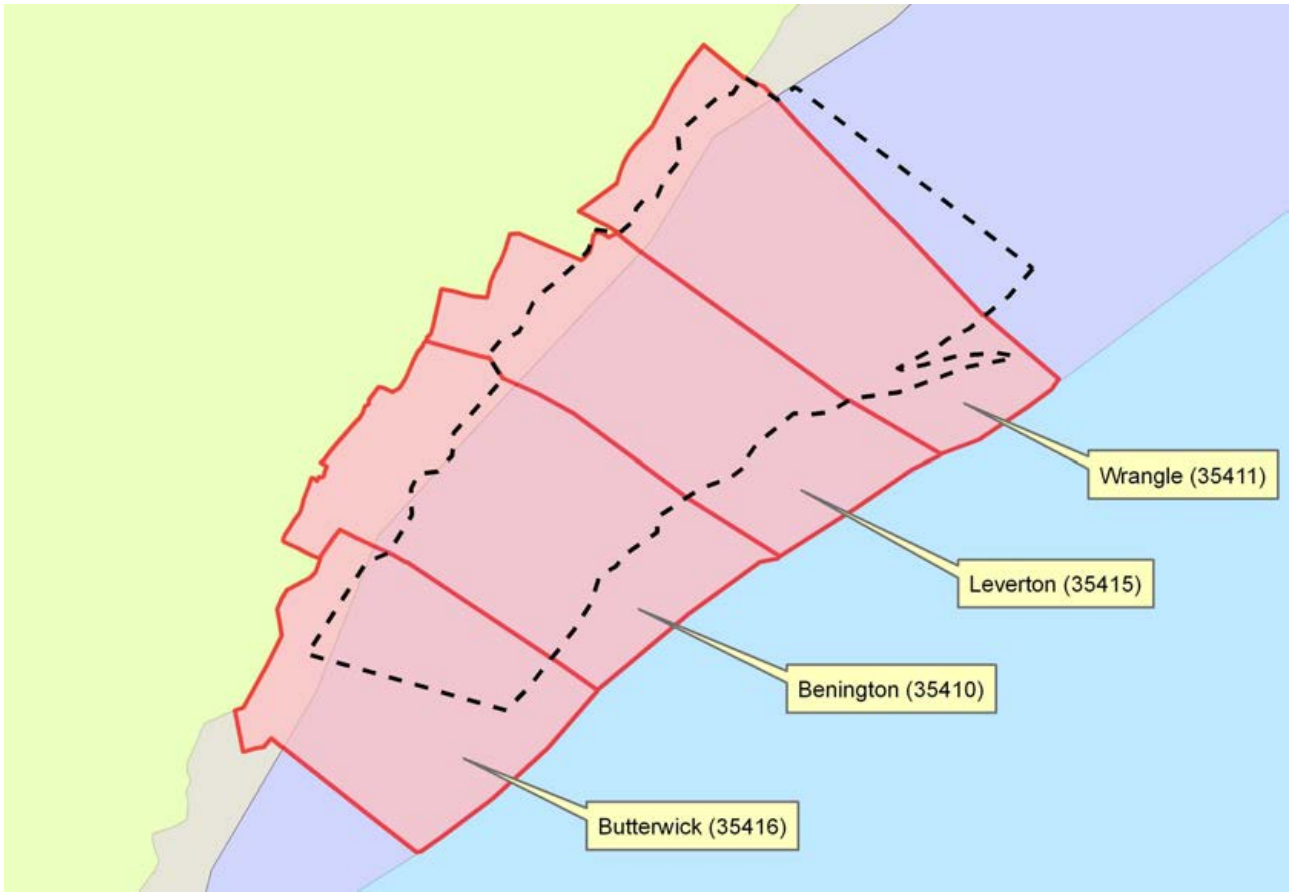


Figure 2.3.i: Spatial extent of WeBS count sectors in relation to the South Lincs. Shooting Zone. WeBS codes associated with these count sectors are given in parentheses and are used throughout this report for figure numbering. The South Lincs. Shooting Zone is indicated by the dashed line (digitised freehand with reference to the NE project specification).

2.4 Smoothed Waterbird Trends and Percentage Change

The methodology used to produce smoothed site, regional and national trends as reported by WeBS Alerts (Maclean and Austin 2008) can be usefully extended to generate trends on smaller areas of interest such as WeBS count sectors or appropriately grouped count sectors. It is, however, 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. Consequently, individual trends should not be 'over-interpreted'. For example, a 50% decline from 30 birds to 15 birds would give much less cause for

concern than a 50% decline from 1000 to 500 birds the latter being much more likely to reflect a real and substantial loss of birds from an area than the former. 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 and 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).

Thus, using the latest available validated WeBS data (to winter 2008/09 inclusive), following Atkinson *et al*. (2000, 2006), smoothed indices (trends) were calculated using Generalized Additive Models (GAMs) for the relevant species. The smoothing is to ensure that year-specific factors, such as poor conditions on the breeding grounds or particularly harsh weather on the wintering grounds, that are not related to changes in the quality of the site itself, do not contribute overly to the trend. Percentage change has been calculated for short- (5yr) medium- (10yr) and long-term (15yr). WeBS does not hold the necessary data collated at the sector level to support analysis of longer time-series. By way of analogy with the WeBS Alerts system, declines of at least 25% but below 50% are flagged as medium-declines, and declines of 50% or greater are flagged as high-declines (we specifically do not use the terms medium- and high-Alerts because unlike the percentage change reported by WeBS Alerts, medium and high 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 medium- (at least 33% but below 100%) and high- (100% or greater) increases.

2.5 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 (Maclean and Austin 2008) is extended here to compare count sector trends with site trends. 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 is being driven by factors affecting that sector. If this is true of the majority of sectors, then this may indicate that 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*;

- 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 favourable in comparison to the broader scale than the latter explanation is more likely;

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

- where an increase on a sector is less 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.

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 (e.g. 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 there than we would be if this was 10 out of 100). This is based on the winter period as routinely used for all WeBS reporting (Nov-Mar for waders and Sep-Mar for other species). Only data from months where counts consolidated across the site as a whole had been assessed as complete are available were used - following standard WeBS protocol described above.

Having considered the trends on the sectors, each in the context of trends across the site as a whole, it is worth considering the site trends in the context of the region – here the Environment Agency Anglia Region, as this 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 re-distribution 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 are 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.

3. RESULTS

Throughout this section and the next the term 'trend' is used to reference the smoothed line through the indices and 'numbers' is used to refer to the mean annual counts (points on plots).

3.1 SPA Trends

Plots of trends across the The Wash SPA as a whole, regional trends and The Wash relative to the region are presented in Figure 3.1.i. The region referred to in this report is the EA East Anglia Region.

3.2 Sector Trends

Plots of the trends of each species on each sector together with those comparing annual (winter) mean counts on each sector with those for The Wash SPA as a whole are presented in Figures 3.2.i.-SLZL, -35416, -35410, -35415 & -35411. Plots are grouped by sector and the species presented in taxonomic order. Figure numbering corresponds to the WeBS count sector codes for individual count sectors with the code SLSZ (**S**outh **L**incs. **S**hooting **Z**one) being used for figures related to counts for the four sectors combined. The information derived from these plots is given in Appendices A, B and C. i.e.

A: percentage change over the short- (5 yr), medium- (10 yr) and long- (15 yr) terms),

B: trend in site proportion on each sector and

C: five-year mean of peak counts for each of the periods 199495 to 1998/99, 1999/2000 2003/04 and 2004/05 to 2008/09 together with the peak count during winter 2008/09.

These data are also available in the MS Excel workbook accompanying this report.

This information is summarised below (Tables 3.2.i, 3.2.ii & 3.2.iii respectively). Species are listed in taxonomic order. Colour coding is used to represent declines or increases and it should be noted that because the aim of this report is to identify areas where there may be cause for concern the colour coding is weighted towards the least positive change. For example, a sector for which a medium- and long-term increase but a short term decrease in numbers of a given species has been recorded will be coloured to emphasise the short-term decrease. Caution is advisable when interpreting individual cells in Table 3.2.i as, for example, a 50% decline (shown in red) could represent a decline from 10,000 to 5,000 birds or a decline from 20 to 10. It is therefore important to consider these percentage declines with regard for the number of birds involved (see Table 3.2.iii) and the variability around the trend (apparent from Figures 3.2.1). However, consistency between adjacent cells would suggest that either a group of species or a group of adjacent sectors have similar trends. Where this is the case, this may suggest that the trends represent real ecological changes.

This information is also presented in map format, which further emphasises any spatial patterns that may be present in the trends (Figures 3.2.ii).

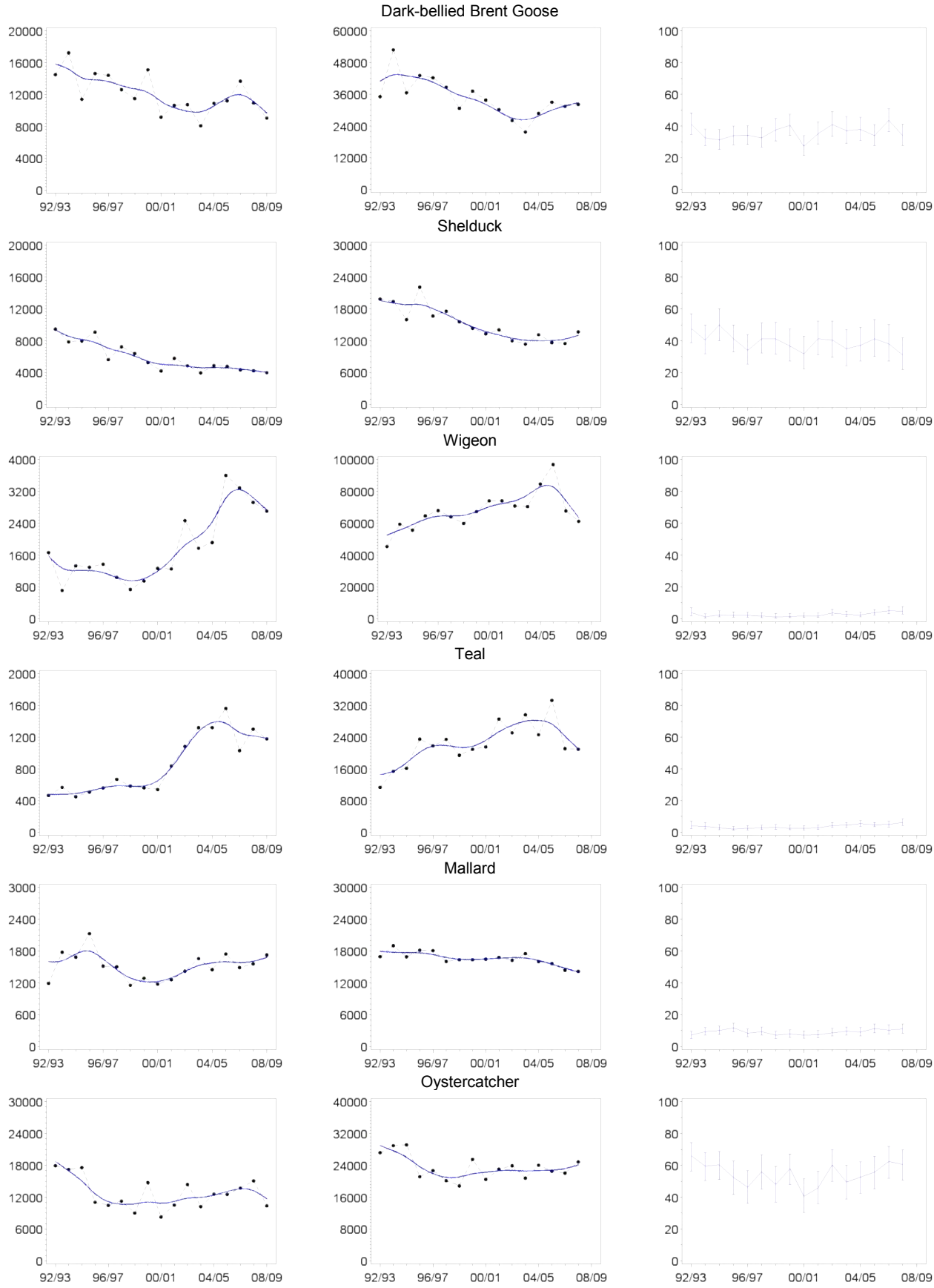


Figure 3.1.i: Species numbers and trends on The Wash SPA (left), the EA Anglia Region (centre) and the proportional contribution (as a percentage) of The Wash SPA to the regional trend. Smoothed species trends are plotted through the average winter counts. Proportional trends are based on individual monthly values. Note that these plots contain more recent data than those available during similar analyses undertaken for the forthcoming release of the WeBS Alerts report (Austin *et al*. 2010).

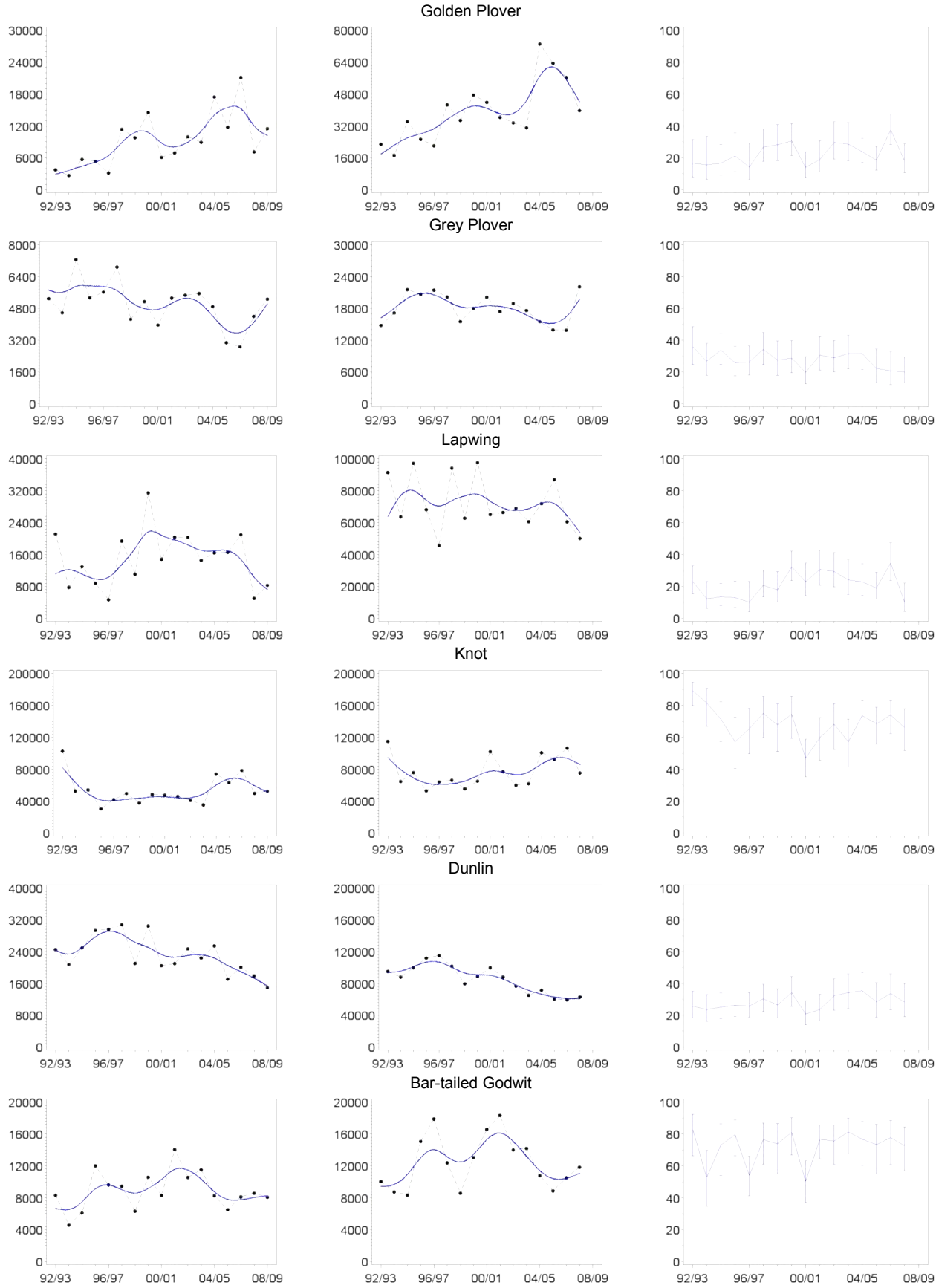


Figure 3.1.i: (continued).

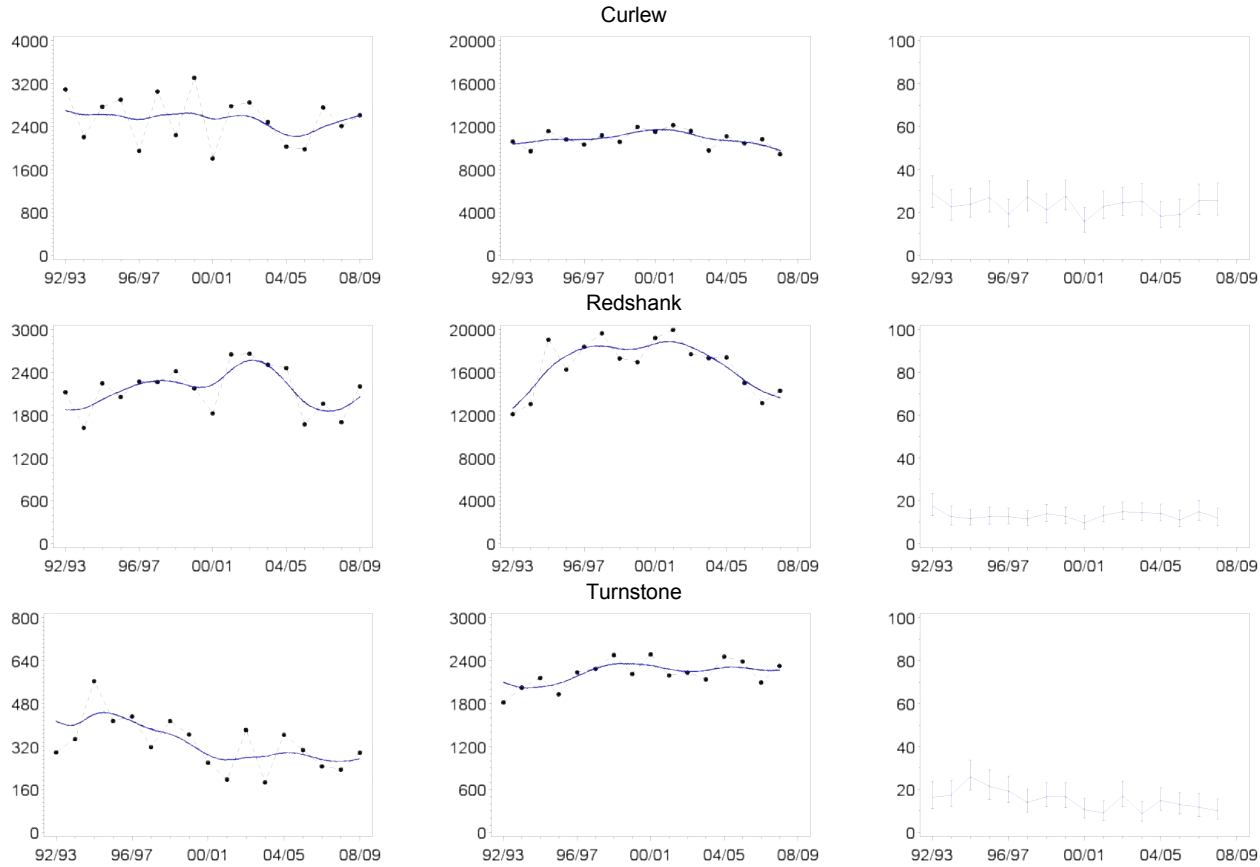


Figure 3.1.i: (continued).

Sector		GooseDark-bellied Brent	Shelduck	Wigeon	Teal	Mallard	Oystercatcher	Golden Plover	Grey Plover	Lapwing	Knot	Dunlin	GodwitBar-tailed	Curlew	Redshank	Turnstone
SLSZ	Wrangle to Butterwick	xol	oml	oyZ	XmZ	xmo	xyo	omZ	ooo	SML	oyl	oml	syZ	xoz	smo	oml
35410	Benington	oML	oyo	SMo		XYo	xMl	sML	SML	SML	SML	SML	oML	sml	smo	Smo
35411	Wrangle	ool	SML		SML	XYZ	XYl	omo	sYz	SML	soL	xoo	XyZ	XYZ	Syo	xYZ
35415	Leverton	ooz	oml	SYZ		oYZ	oYo	oYZ	oyo	SMl	oYz	oYZ	syZ	oyz	omo	xYZ
35416	Butterwick	xyo	omL	XYZ	xmZ	SML	ool	omZ	xol	SML	SML	SML	SML	oMl	oMo	SML
35901	The Wash SPA	ool	omL	xYz	oYZ	ooo	ool	xyZ	oml	soo	xyl	oml	soo	ooo	soo	oml

Table 3.2.i Overview of trends of each species on the South Lincs. Shooting Zone, by WeBS count sector assessed over three timescales: short- (5-year), medium- (10-year) and long-term (15-year). For complete details of underlying values refer to Appendix A. Cells are coloured to indicate trend status for each sector. Declines are given precedence over increases as the former are of primary concern. Colour coding is as follows: Red - a maximum decline in numbers of at least 50% over at least one timescale; Orange - a maximum decline in numbers of at least 25% but less than 50% over at least one timescale; Light green – a maximum increased of at least 33% but less than 100% over at least one timescale; Dark green - a maximum increase of at least 100% on at least one timescale; White - a maximum decline less than 25% or maximum increase less than 33% on all three timescales. Grey - insufficient data for or too few individuals (arbitrarily taken as an average of ten or less) of, a given species to allow meaningful smoothed trends to be generated. Decreases over short-, medium- and long-terms are indicated by S/s, M/m and L/l respectively while increases are indicated by X/x (short), Y/y (medium) and Z/z (long). 'No' change (-25% to 33%) is indicated by 'o'. Upper case indicates high declines / increases and lower case , lower case medium declines / increases.

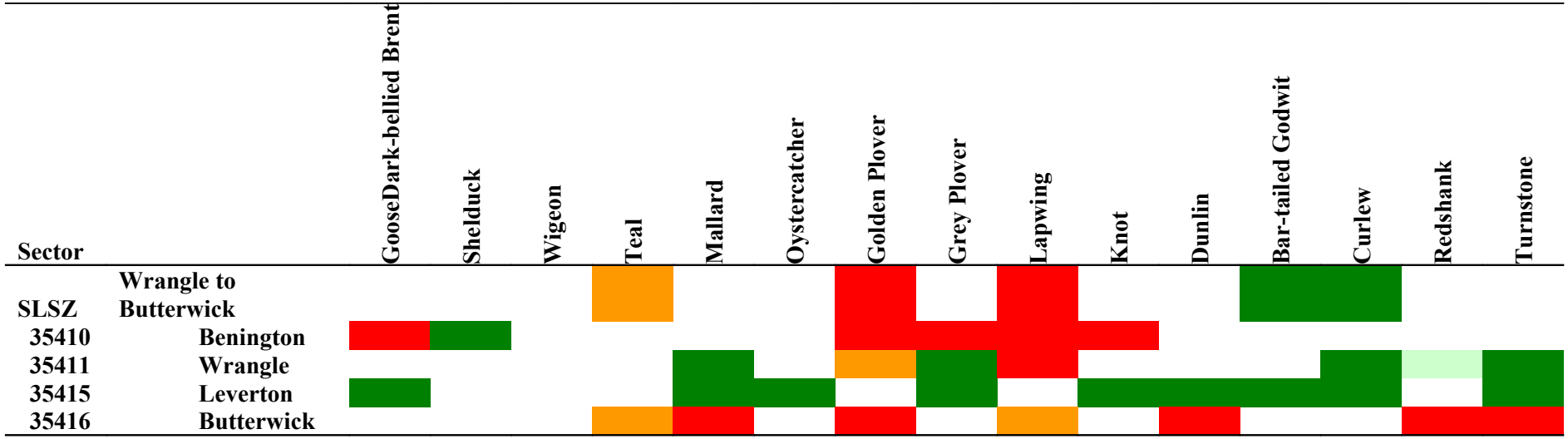


Table 3.2.ii: Changes in the proportion of the total site population of each species supported by each WeBS count sector, assessed over the most recent 15-year period. Cells are coloured to indicate a sector's proportional contribution to numbers on The Wash SPA as a whole, as follows: Red - a highly significant decline ($P < 0.01$); Orange - a significant decline ($P < 0.05$); Light green – a significant increase ($P < 0.05$); Dark green - a highly significant increase ($P < 0.01$); White – no significant trend over the period. Grey - insufficient data for or too few individuals (arbitrarily taken as an average of ten or less) of, a given species to allow a meaningful Logit model to be fitted. Underlying values are available from Appendix B.

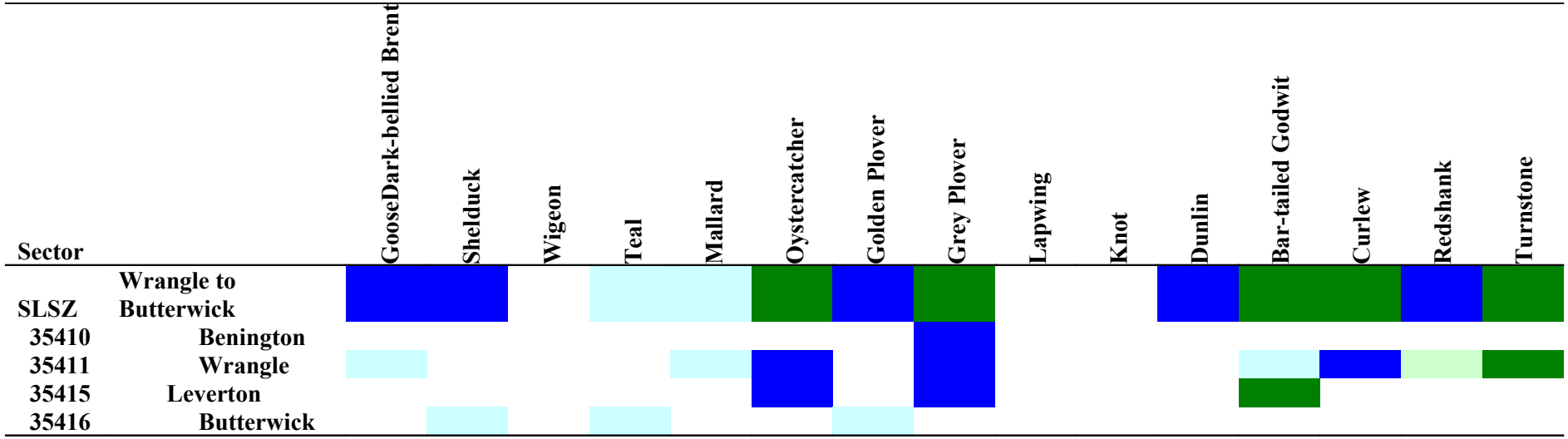


Table 3.2.iii: Importance of WeBS count sectors on the South Lincs. Shooting Zone by species. Cells are colour coded to indicate sectors that hold a substantial proportion of the overall Wash SPA total for the species arbitrarily defined and in order of priority as follows: Dark Green – sectors with a mean of peak counts over the last five winters that is at least 20% of the total mean of peak counts for the estuary over the same period; Dark Blue – Sites with a mean of peak count over the last five winters that is between 10% and 20% of the total mean of peak count for the estuary over the same period; Light Green – Sites with a peak count in the latest year that is at least 20% of the total peak count for the estuary in the latest year; Light Blue – Sites with a peak count in the latest year that is between 10% and 20% of the total peak count for the estuary in the latest year. Underlying values are available from Appendix C together with five year mean of peaks for each of the previous five winter periods.

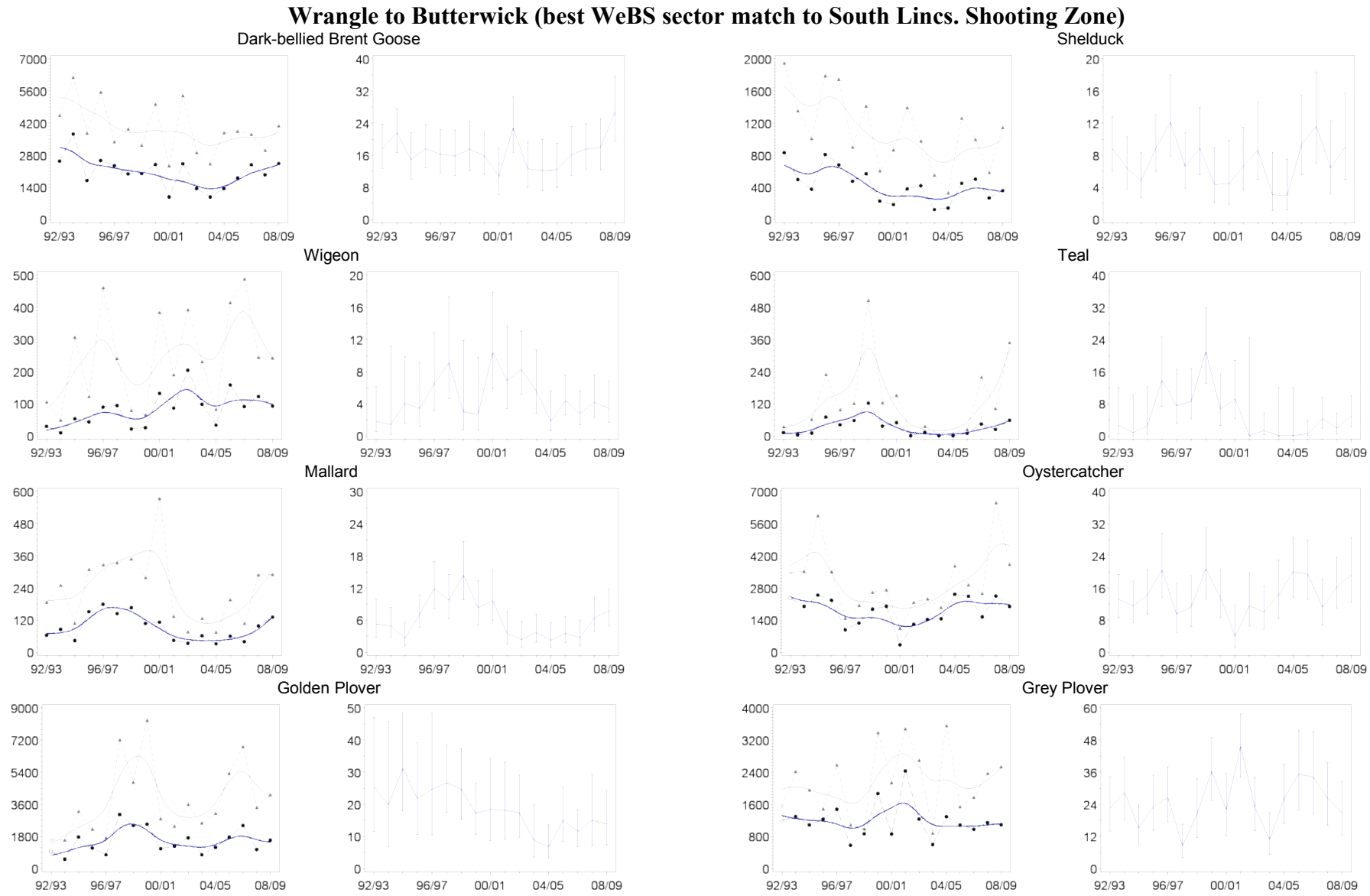
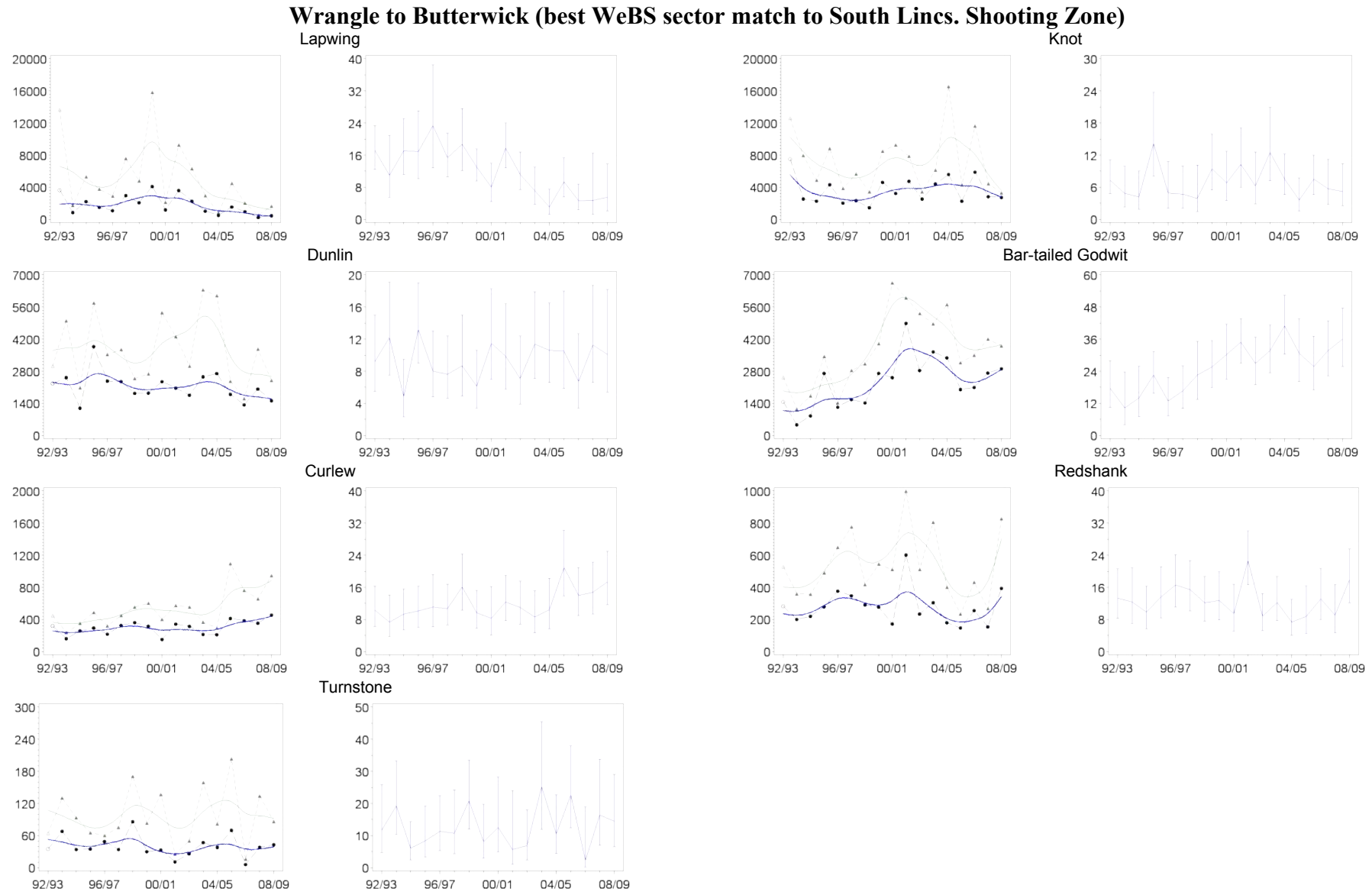


Figure 3.2.i.SLSZ. Numbers of each species in sector consolidation SLSZ (Wrangle to Butterwick) (left-hand graphs), and the proportion (as a percentage) of The Wash SPA population found in this sector per year (right-hand graphs). Smoothed species trends are fitted through the average winter count (lower curve - blue) and annual peak count (upper curve – green). Proportional trends are based on individual monthly values.



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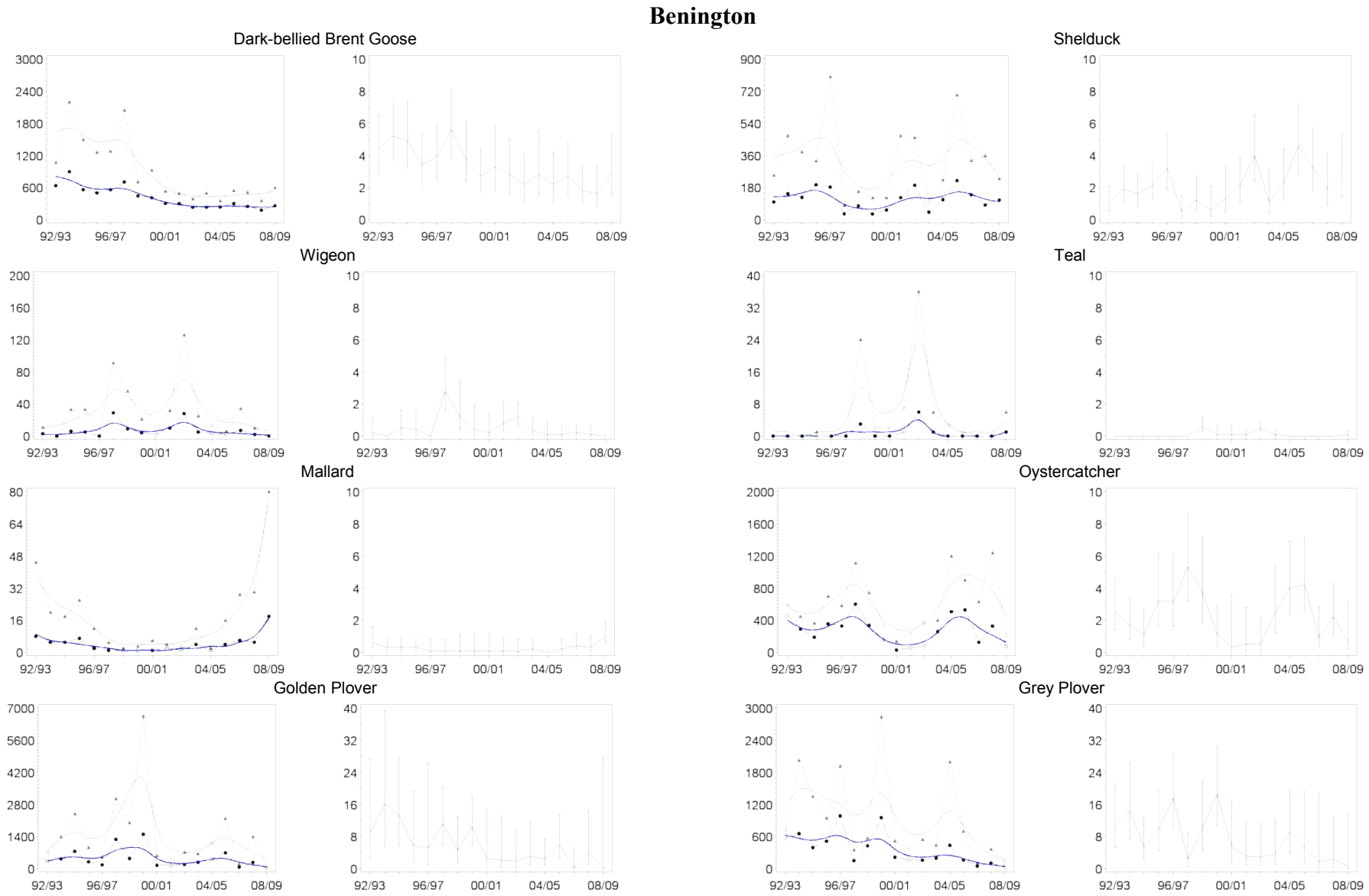
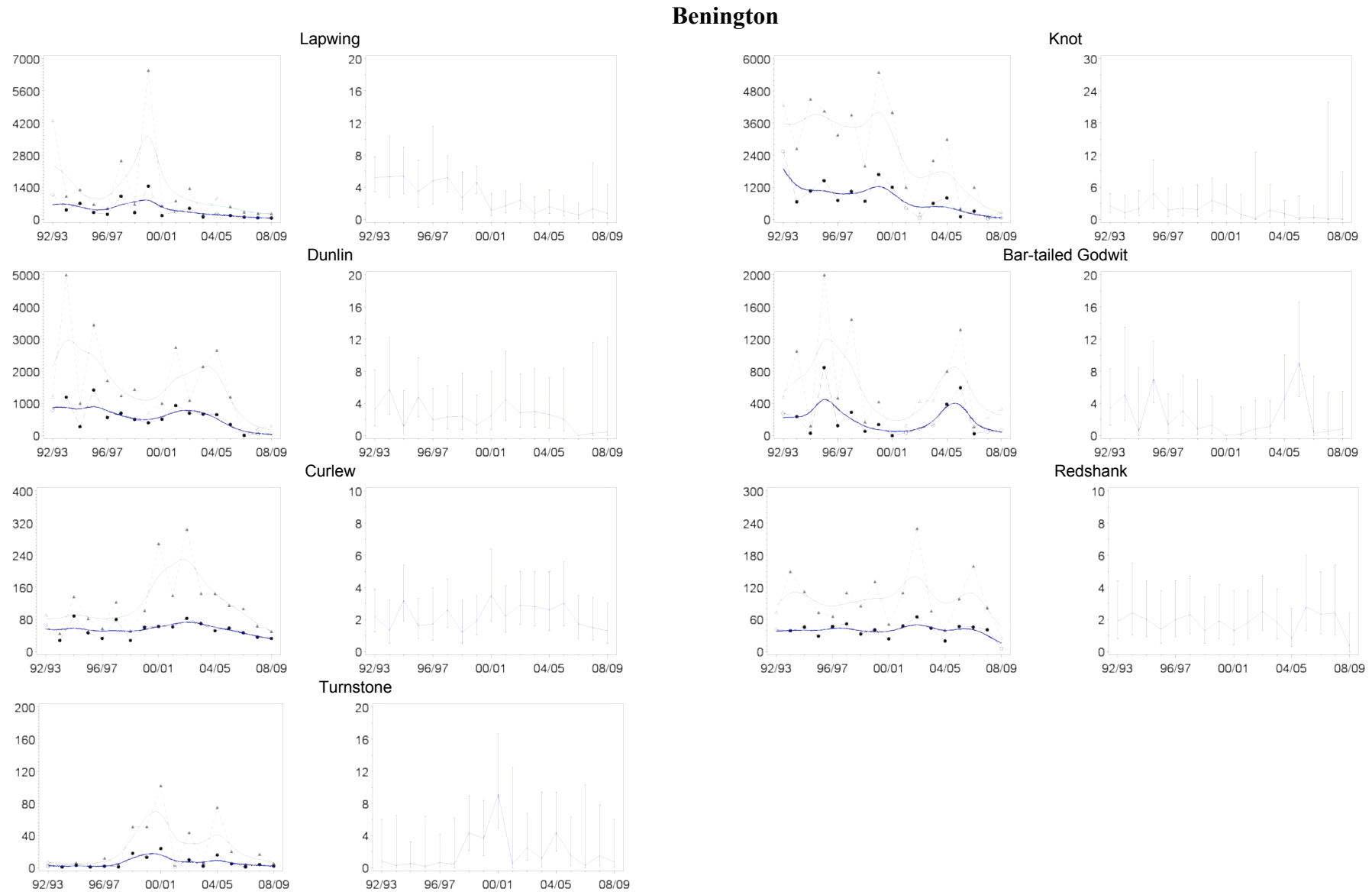


Figure 3.2.i.35410. Numbers of each species in sector 35410 (Benington) (left-hand graphs), and the proportion of The Wash SPA population found in this sector per year (right-hand graphs). Smoothed species trends are fitted through the average winter count (lower curve - blue) and annual peak count (upper curve – green). Proportional trends are based on individual monthly values.



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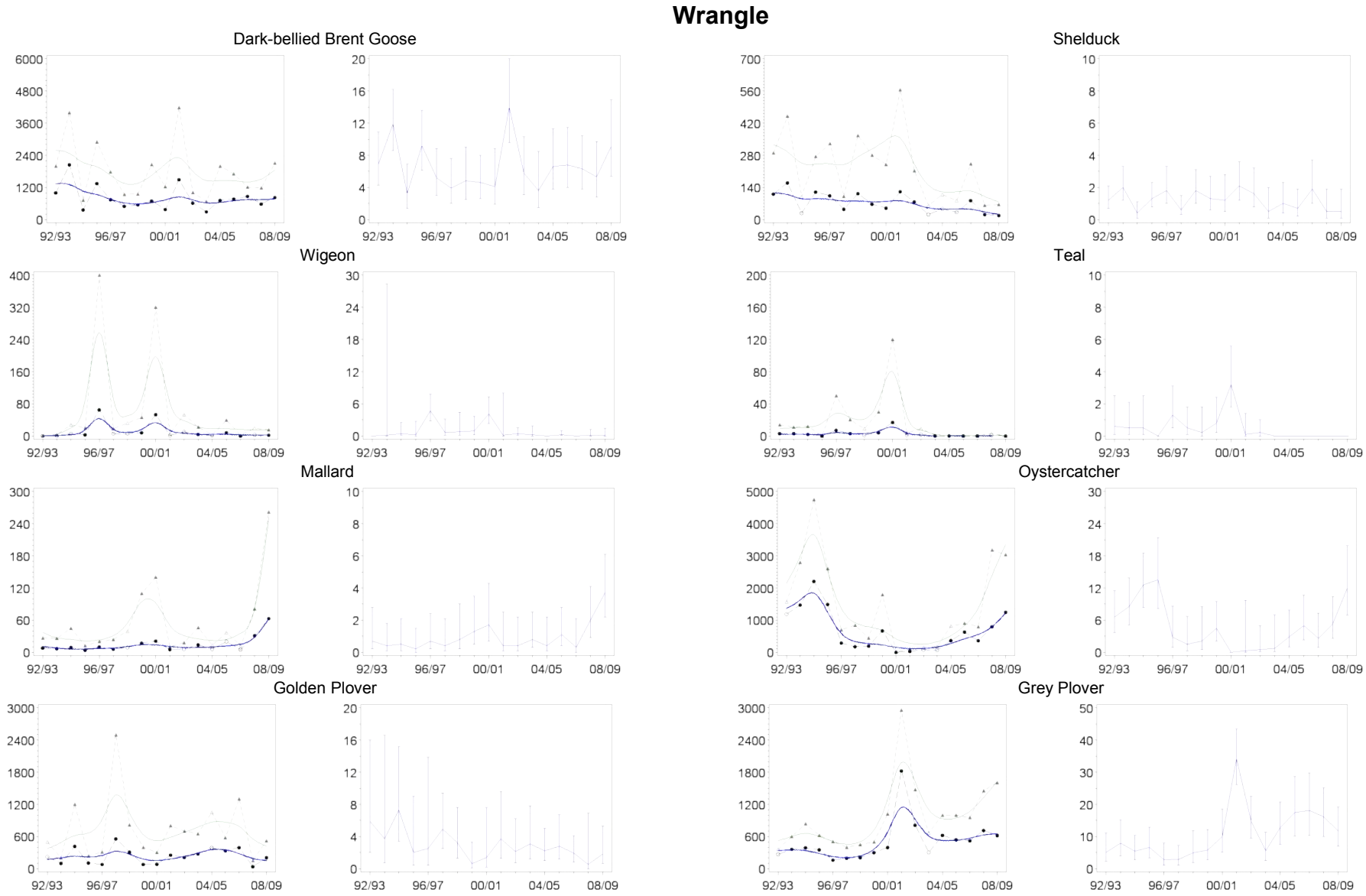
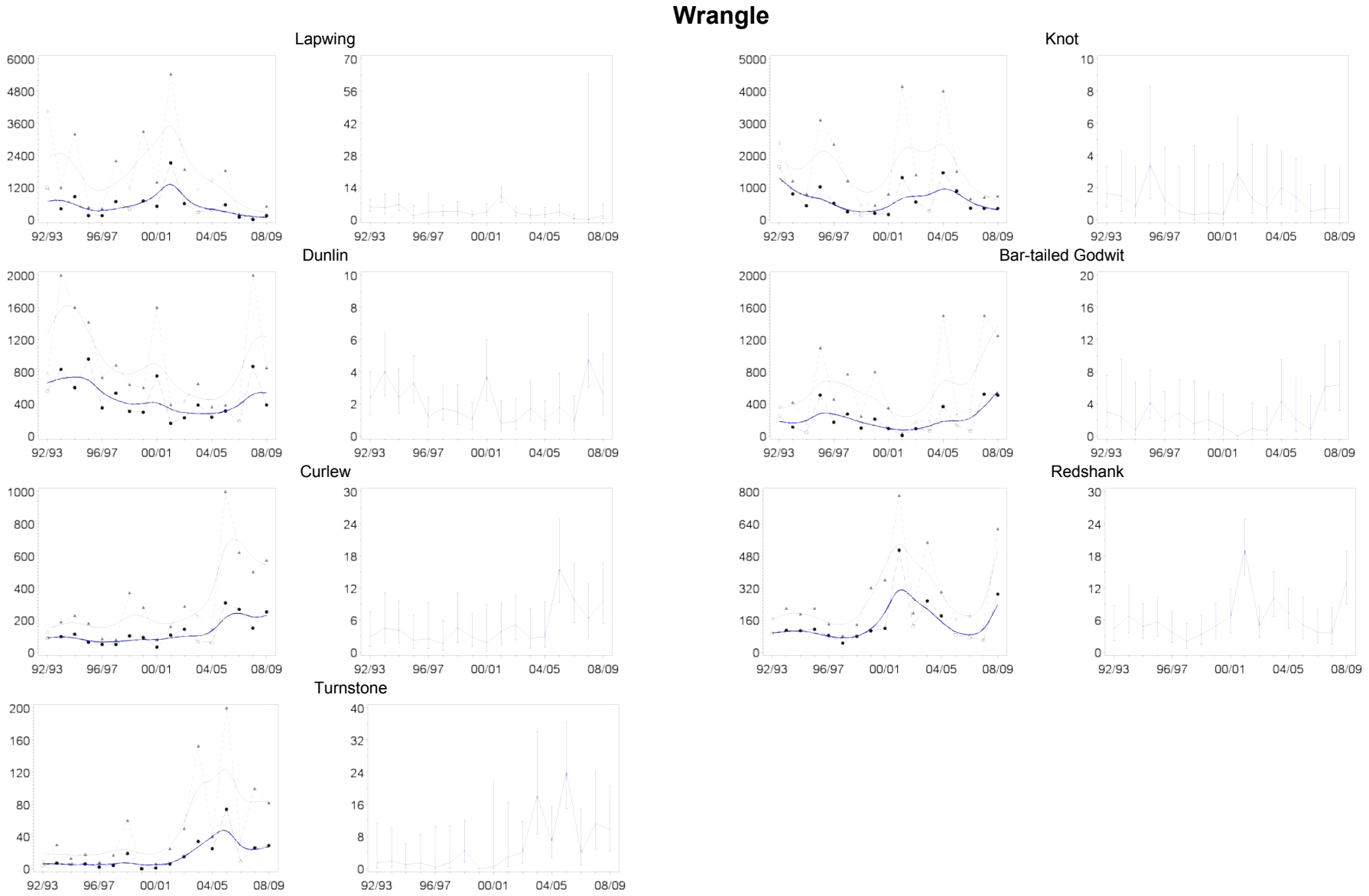


Figure 3.2.i.35411. Numbers of each species in sector 35411 (Wrangle) (left-hand graphs), and the proportion of The Wash SPA population found in this sector per year (right-hand graphs). Smoothed species trends are fitted through the average winter count (lower curve - blue) and annual peak count (upper curve – green). Proportional trends are based on individual monthly values.



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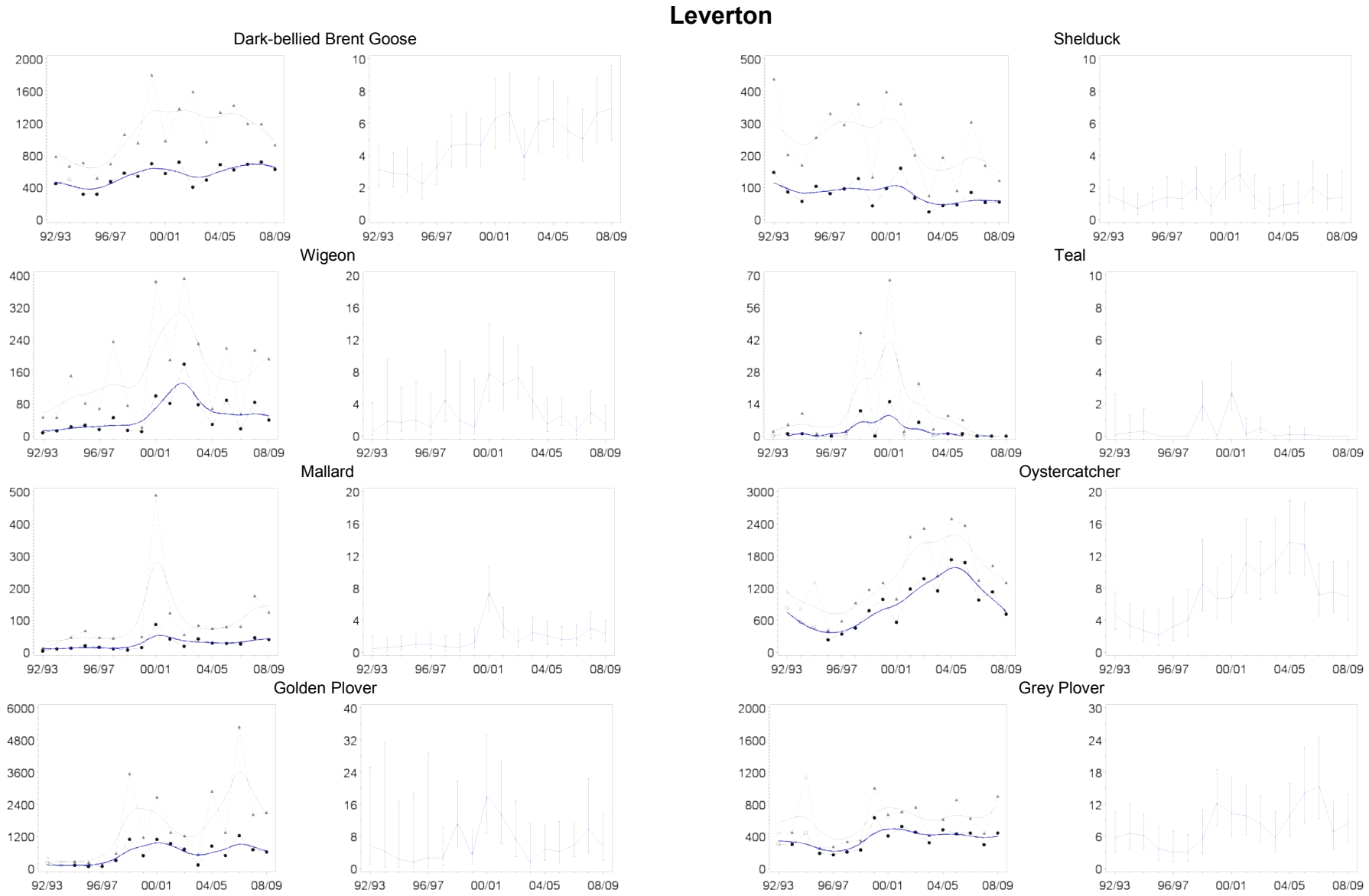

Figure 3.2.i.35415. Population trends of each species in sector 35415 (Leverton) (left-hand graphs), and the proportion of The Wash SPA population found in this sector per year (right-hand graphs). Smoothed species trends are fitted through the average winter count (lower curve - blue) and annual peak count (upper curve – green). Proportional trends are based on individual monthly values.

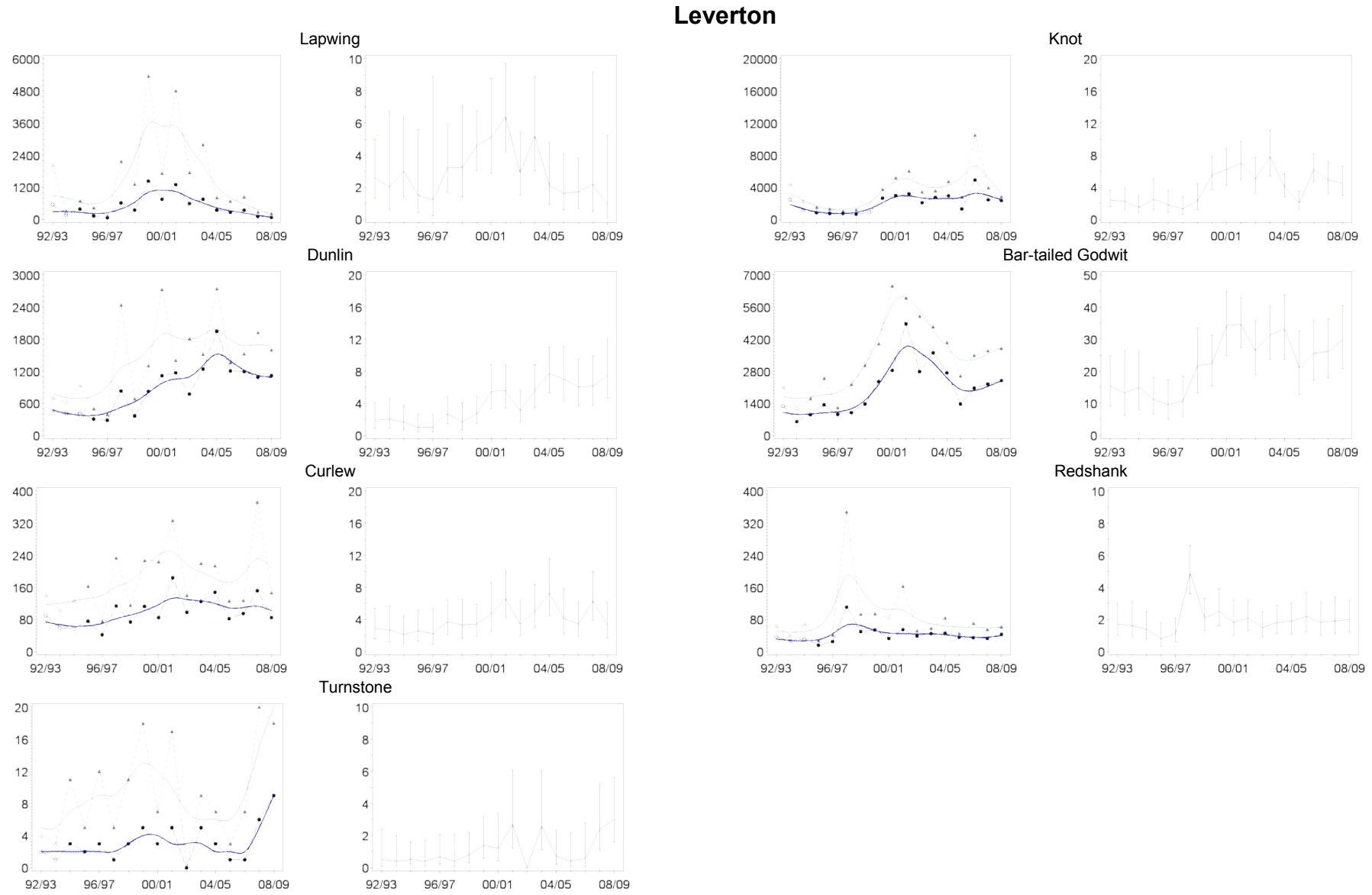

Figure 3.2.i.35415. Continued

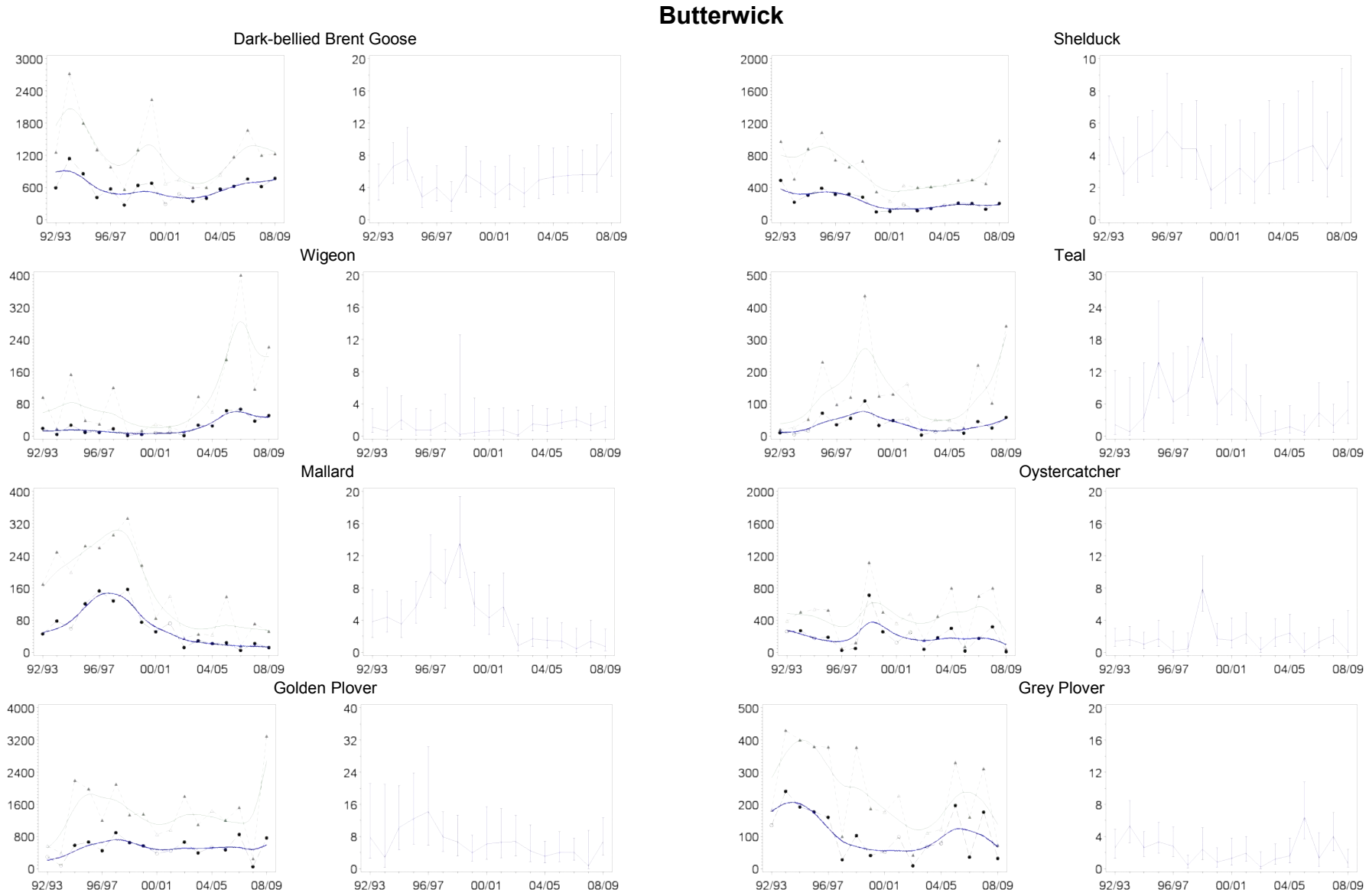

Figure 3.2.i.35416. Numbers of each species in sector 35416 (Butterwick) (left-hand graphs), and the proportion of The Wash SPA population found in this sector per year (right-hand graphs). Smoothed species trends are fitted through the average winter count (lower curve - blue) and annual peak count (upper curve – green). Proportional trends are based on individual monthly values.

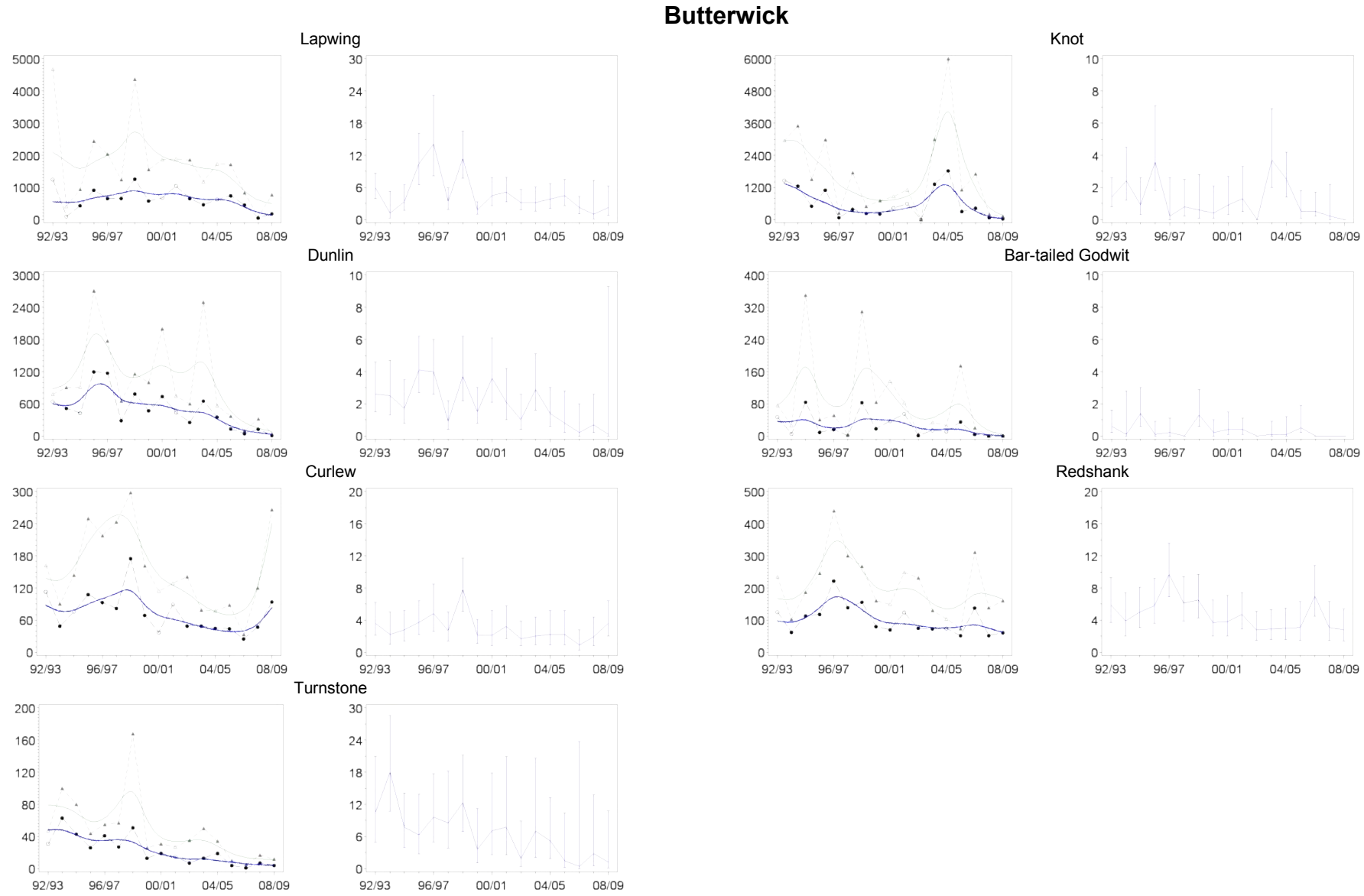

Figure 3.2.i.35416. Continued

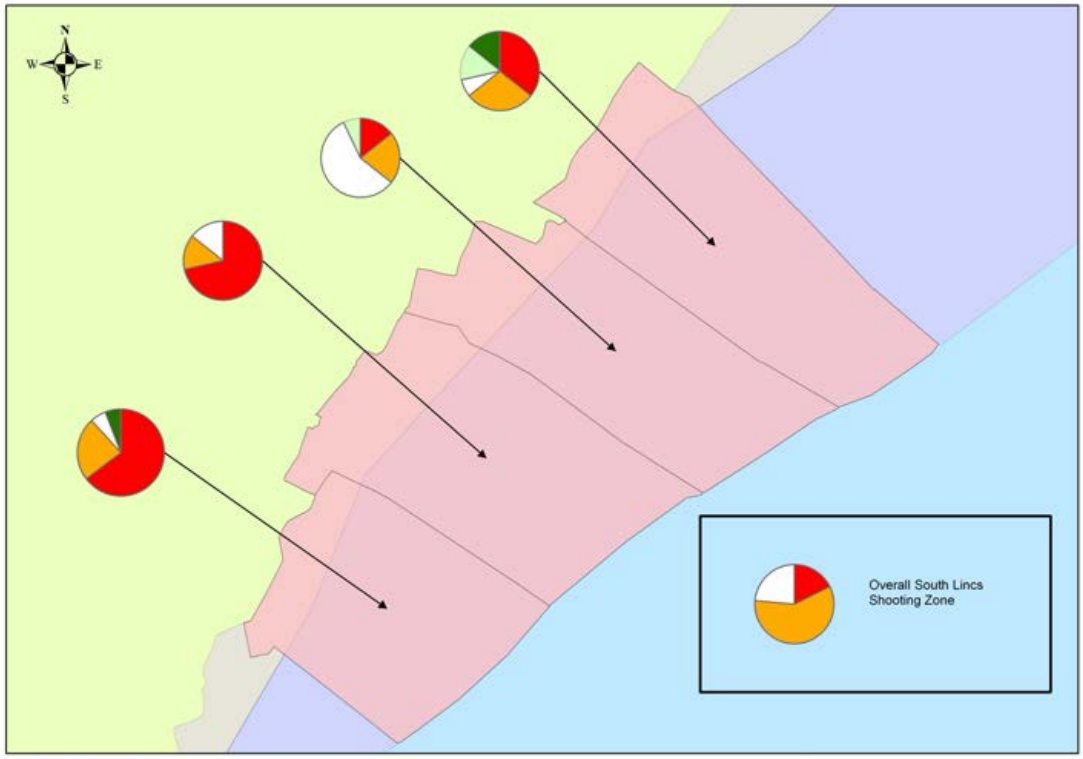

Figure 3.2.ii: Spatial overview of changes on WeBS count sectors on the South Lincs. Shooting Zone. The size of each pie chart relates to the number of species for which there are sufficient data to generate trends, and within each pie chart the proportion of species whose populations have shown high declines (>50%, red), medium declines (25% to 50%, orange), no medium or high change (-25% to +33%, white), medium increase (33% to 100%, light green) or high increase (>100%, dark green).

4. DISCUSSION AND CONCLUSIONS

4.1 Species Trends

Throughout these accounts, comments regarding short-, medium- and long-terms are made with reference to Table 3.2.i which provide 'snap-shots' of change over particular time-frames. Most interpretation is, however, based on the smoothed trends fitted through the annual mean counts together with the plots of the proportion (as a percentage) of the overall SPA numbers each sector has supported through time (Figures 3.2.i.SLSZ, 3.2.i.35410, 3.2.1.34511, 3.2.i.34515 & 3.2.i.34516). While peak counts have been plotted and trends fitted through them all comments regarding trends relate to those based on annual means. The plots of peak counts has been provided in accordance with Natural England's specification, however, it is not clear how one would draw comparisons between trends that may be representing numbers at different times of the season for each count sector, the overall South Lincs. Shooting Zone, the overall SPA and the region. Also trends based on a single peak observation will be more prone to influence from random variation and anomalous observations.

4.1.1 Dark-bellied Brent Goose *Branta bernicla bernicla*

The Wash is the most important site in the country for this species. Across the SPA, l numbers have declined over the long-term in line with the regional trend. More recently, over the short- to medium-term numbers have tended to stabilise. This same pattern is also reflected within the South Lincs. Shooting Zone. Within this zone there is some evidence of a redistribution of this species with a shift from the Benington section where numbers recorded continue to decline towards Leverton where numbers recorded have increased steadily throughout the period considered. This may be because Leverton has become more attractive to this species over time such the geese are choosing the area in preference to Benington or alternatively it may be that adverse pressures acting on the Benington section have made it less suitable and geese have responded accordingly. While this within-zone redistribution may be worthy of further investigation to identify any potential localised pressure on the Benington section, despite the recorded declines there is little indication that there are any adverse pressures overall on this species within the South Lincs. Shooting Zone.

4.1.2 Shelduck *Tadorna tadorna*

The Wash was once the most important site in Britain for Shelduck hosting over one fifth of the national population (almost 20,000 individuals) during the mid-1980s (Maclean and Austin 2008). However, Shelduck numbers across The Wash have declined markedly within the past 15 years and this decline is reflected at the regional level, whereas nationally numbers have steadily increased (Holt *et al*. 2009) during this period. The observed decline across the South Lincs. Shooting Zone mirrors that across the whole site. Within the zone the most marked declines have been on the Wrangle and Butterwick sections while numbers on the Benington section have remained reasonably stable. Consequently, there is no indication from the trends that Shelduck are subjected to any adverse pressures within the South Lincs. Shooting Zone.

4.1.3 Wigeon *Anas penelope*

Following a sharp increase in the late 1990s, Wigeon numbers on The Wash have remained stable although there is an indication that numbers may have declines over the last few winters. The Wash is not especially important for this species in a regional context holding in the region of 5% of the total recorded by WeBS in this region. Within the South Lincs. Shooting Zone, numbers have fluctuated but a slow increase has been apparent. Within the zone the small numbers involved preclude meaningful interpretation on trends on individual count sections. Whilst it is clear that the zone has become less attractive for this species relative to SPA as a whole over the most recent five winters this is probably due to the existence of more suitable areas for this species being occupied preferentially as numbers across the SPA increase. Thus although the zone held a higher proportion of the SPA total

from the mid 1990s to winter 2003/04, numbers have increased and, consequently, there is no indication that Wigeon are under any adverse pressure within the South Lincs. Shooting Zone.

4.1.4 Teal *Anas crecca*

The number of Teal on The Wash as a whole has increased in both the long- and short-term although in the medium-term they have shown a slight decline from their peak in winter 1998/99. Within the South Lincs. Shooting Zone numbers remain low and since winter 2001/02 the relative importance of this area in comparison to the SPA has remained low following a substantial decline returning it to levels similar to what it had been in the early 1990s. Given the small numbers of individuals recorded within the South Lincs. Shooting Zone, unless the habitat there is considered unsuitable for this species, it is unlikely to be at carrying capacity for Teal. Consequently, increases in line with those across The Wash as a whole would have been expected. This suggests that Teal within the South Lincs. Shooting Zone may be reacting to adverse pressures.

4.1.5 Mallard *Anas platyrhynchos*

Across the whole Wash there has been no notable change in numbers of Mallard and this contrasts the regional trend, and indeed national trend (Holt *et al.* 2009), for this species which has shown a steady decline over the past 15 years. Consequently, numbers on the South Lincs. Shooting Zone would be expected to be relatively stable. In the long-term this is indeed the case, however they remain below their mid-1990s peak. Numbers on the individual sections are generally too low for meaningful interpretation although the trend on the Butterwick section, where most occur, shows the decline from the mid-1990s peak particularly strongly. In a similar manner to that observed for Teal, the South Lincs. Shooting Zone has decreased disproportionally in importance to The Wash since winter 2001/02. This suggests that Mallard within the South Lincs. Shooting Zone may be reacting to adverse pressures.

4.1.6 Oystercatcher *Haematopus ostralegus*

Although within the time-frame being considered, Oystercatcher numbers on The Wash are now showing a steady increase, they are in a recovery phase following a serious crash in numbers in 1991/92 with survival being linked to the availability of shellfish (Atkinson *et al*. 2003). This somewhat complicates interpretation of trends within the site as one would expect numbers on the most favourable areas to be the first to recover and numbers have yet to attain their former levels. Numbers on the South Lincs. Shooting Zone have remained reasonably stable over the long-term and have increased slightly in both the short- and medium-terms, especially on the Wrangle section. Thus, the trends within the zone have tended to follow those across the SPA as a whole and, consequently, there are no indications that Oystercatcher in the South Lincs. Shooting Zone are under any adverse pressure.

4.1.7 Golden Plover *Pluvialis apricaria*

Golden Plover numbers have increased over The Wash as a whole and regionally, but numbers have fluctuated substantially between winters making interpretation difficult. Numbers on the South Lincs. Shooting Zone peaked during the mid- to late-1990s and following a decline have remained relatively stable. However, given the general increase across The Wash as a whole, there has been a steady decline in the relative importance of the zone. This may be because the habitat in the area is relatively unattractive to this species or Golden Plover may be reacting to adverse pressures within the zone preventing the expected increase in line with the trend across the whole SPA.

4.1.8 Grey Plover *Pluvialis squatarola*

Numbers of Grey Plovers on The Wash have declined in both the long- and medium-term following a slightly less pronounced regional decline. There has been no marked trend in the numbers of this

species across the South Lincs. Shooting Zone as a whole although there is evidence of redistribution within the zone. To the south, numbers on the Benington section and to a lesser extent the Butterwick section have declined steadily over the time frame being considered whilst numbers on the northern sections have increased to near the same extent. This shift could be due to either the habitat towards the northern end of the zone having become more attractive to this species, displacement due to adverse pressures towards the southern end or both. Given the general decline across the SPA and the relatively stable trend on the South Lincs. Shooting Zone as a whole, this area remains in a favourable condition for this species.

4.1.9 **Lapwing** *Vanellus vanellus*

The number of Lapwing on The Wash, and indeed the EA Anglia Region, have fluctuated markedly over the most recent 15 winters making interpretation of trends difficult. There was, however, been a substantial drop in numbers between winters 2006/07 and 2007/08 from one of the highest winter averages to one of the lowest. Lapwing numbers have been declining across all four sections of the South Lincs. Shooting Zone steadily since they peaked around the turn of the century. Furthermore, the relative importance of the zone has been decreasing throughout the time frame being considered. This may have been driven by habitat change, for example if the saltmarsh has been accreting and vegetation becoming more rank, then this would be less suitable for roosting birds, or it may be due to increasing disturbance, something to which this species is quite sensitive.

4.1.10 **Knot** *Calidris canutus*

The Wash remains by far the most important site in the UK for this species, with an average winter peak of over 124,000 birds (Holt *et al.* 2009). Long-term numbers of Knot on The Wash have declined although numbers have increased in both the short- and medium-terms. Across the South Lincs. Shooting Zone numbers of Knot recorded have remained relatively stable and has tracked closely the trend across the whole SPA. There is, however, evidence of redistribution within the zone with numbers recorded on both the Benington and Butterwick having declined over the long-, medium- and short-terms. Thus, in Knot, we have another species that has redistributed northwards within the zone.

4.1.11 **Dunlin** *Calidris alpina*

Dunlin numbers have been in decline on The Wash, throughout the time frame being considered, a trend reflecting the regional, and indeed country-wide pattern. The observed decline in numbers recorded on the South Lincs. Shooting Zone is, therefore, to be expected, and there is no indication that this decline has been disproportional within the zone. However, within the zone there has been a disproportional decline towards the southern end on the Benington and Butterwick sections.

4.1.12 **Bar-tailed Godwit** *Limosa lapponica*

Both regionally and on The Wash, numbers of Bar-tailed Godwit have fluctuated over the time-frame being considered with no marked long-term trend. This is in contrast to the South Lincs. Shooting Zone where numbers have more than doubled over the long-term and, regardless of whether numbers over a given winter have been high or low there was a steady increase in the relative importance of the zone with respect to the overall SPA numbers. This increase has been driven by increased numbers being recorded on the Wrangle and Leverton section to the north whilst, if anything, numbers have declined to the southern end of the zone.

4.1.13 **Curlew** *Numenius arquata*

Throughout the time-frame being considered there has been no marked trend in numbers of Curlew recorded on The Wash and this is a pattern observed at the regional and indeed national (Holt *et al*. 2009) levels. Consequently, numbers of Curlew recorded on the South Lincs. Shooting Zone would be expected to be relatively stable. In actuality, there is evidence that numbers have increased within the zone and, consequently, the importance of the zone in the context of the whole SPA has increased steadily. Within the zone this trend has been driven by increased use of the Wrangle and Leverton sections. Once again to the southern end of the zone numbers recorded have been decreasing. Thus, while the zone as a whole clearly provides favourable conditions for Curlew, there is again an indication that this species is under adverse pressure towards the southern end.

4.1.14 Redshank *Tringa totanus*

The Redshank numbers on The Wash have remained relatively stable over the long-term although there was a gradual increase towards a peak at the beginning of the century with numbers then returning to their previous level. Numbers recorded on the South Lincs. Shooting Zone have fluctuated through time and although there have been declines over both the short- and medium-terms there is no distinctive pattern. The variation precludes any meaningful interpretation of trend within the individual count sections. Consequently, there is no evidence that Redshank are under any adverse pressure within the South Lincs. Shooting Zone as a whole.

4.1.15 Turnstone *Arenaria interpres*

Turnstone numbers on The Wash have declined steadily over the time-frame being considered. This is in contrast with the regional trend thus suggesting that The Wash is becoming less favourable for this species. No marked long-term trend is apparent for the South Lincs. Shooting Zone and, consequently there is no evidence that this species is under any adverse pressure across the zone as a whole. Numbers involved are, however, rather low and so this should not be interpreted as the zone becoming more favourable for this species. Within the zone, numbers on the individual sections are perhaps too low for meaningful interpretation when taken in isolation although given the consistent pattern observed across many of the other species considered, the decline in numbers recorded on the Wrangle section and decrease on the Butterwick section may be part of the general shift.

4.2 Within Site Patterns

Looking at the broad patterns across the site can reveal patterns that may be overlooked when considering each species in isolation. For example, when considering numeric change on a species by species basis and dealing with relatively small numbers of individuals it can be difficult to distinguish between changes due to chance and changes that are being driven by real pressures. However, when similar patterns can be identified across several species this increases ones confidence that real changes are being observed. This is especially so when species share common ecological traits or requirements and, considering these aspects can help to narrow down the list of potential causes.

4.2.1 Wildfowl

Across the South Lincs. Shooting Zone, with the exception of Wigeon, wildfowl numbers have declined. Whilst numbers of three of the four species considered (note Shelduck is discussed below with the waders) have declined on the South Lincs. Shooting Zone, across The Wash as a whole, only two of these species have shown similar declines. Thus, for the South Lincs. Shooting Zone as a whole, declines in numbers of Dark-bellied Brent Goose across are in accord with the trend across the SPA, the trend in the number of Wigeon is favourable, whilst the declines in the numbers of both Teal and Mallard suggest these two species are under pressure within this area.

4.2.2 Waders

Shelduck and waders are discussed together because Shelduck feed on mudflat invertebrates, as do the waders, and therefore they are likely to respond in a similar manner to particular environmental pressures.

The two 'grassland plovers', Golden Plover and Lapwing have both faired badly across the South Lincs. Shooting Zone compared to what would be expected from their overall trends across the SPA. Trends in the numbers of Shelduck, Oystercatcher, Knot, Dunlin and, Redshank are as would be expected, while the trends within the zone for Grey Plover, Bar-tailed Godwit, Curlew and, maybe, Turnstone are favourable given their equivalent trends across the whole of The Wash SPA, this regardless of whether their numbers are increasing, stable or declining within the South Lincs. Shooting Zone itself.
Despite, this overall favourable situation for waders within the South Lincs. Shooting Zone, a consistent pattern of redistribution is apparent. This involves a general shift of waders from the southern part towards the northern part of the zone, a pattern that had become established for most species by the early 2000s. This may be related to changes in habitat making the northern end more attractive or the southern end less attractive, or be due to these species reacting to other adverse pressures towards the southern end or the moderation of adverse pressures at the northern end.

4.3 Site Overview

At first glance, the overall state of the South Lincs. Shooting Zone for waterbirds appears very poor, with long-, medium- and short term declines being recorded across the majority of species. However, a more detailed consideration of these trends indicates that, for most species for which declines can be observed, these are in line with or less severe that those observed across The Wash as a whole.

This should not distract from the fact that while there is no immediate cause for concern across the South Lincs. Shooting Zone as a whole, within the area there has been some pressure acting to displace waterbirds from the southern end, a displacement that is currently being absorbed by the northern end.

Two groups of waterbird do give cause for concern though, these being the dabbling ducks: Teal and Mallard, and the grassland plovers: Golden Plover and Lapwing. Unfortunately, analysis of trends and numbers alone can not determine what pressures may be causing this.

Two plausible causes for the distribution shifts observed within the South Lincs. Shooting Zone would be changes in habitat or changes in disturbance levels. In both cases the shift from the southern towards the northern ends of the zone could be related to either the northern becoming more favourable or the southern end becoming less

Habitat change may well be responsible as saltmarsh in this part of The Wash may well be accreting leading to less frequent inundation by the high tide, increasingly rank vegetation and less standing water. If this is indeed the case, then this would fit well with the relative fortunes of the grassland plovers and dabbling ducks (fairing poorly), smaller waders (paralleling the site) and larger waders - perhaps less susceptible to rank vegetation (favourable).

4.4 Recommendations

It is recommended that a more extensive analysis of WeBS count trends on The Wash should be conducted. Whilst it is possible to take some context from the comparisons with the overall SPA, knowledge of trends on sectors adjacent to the South Lincs. Shooting Zone would provide further context that may help determine whether the trends observed within the zone are peculiar to it or part of a more widespread pattern on the Lincolnshire shoreline of the Wash SPA.

Collation of any historical data on, and future monitoring of changes in, levels of disturbance and habitat change may prove enlightening with regard to the distribution shifts within the South Lincs. Shooting Zone.

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Appendix A

Percentage change in the numbers of each species over the short- (5 yr), medium- (10 yr) and long- (15 yr) terms), for the South Lincs. Shooting Zone and its constituent WeBS count sections.

These values underlie Table 3.2.i.

Cells are coloured to indicate trend status as follows: For each sector, declines are given precedence over increases as the former are of primary concern. Red - a maximum decline in numbers of at least 50% over at least one timescale; Orange - a maximum decline in numbers of at least 25% but less than 50% over at least one timescale; Light green – a maximum increased of at least 33% but less than 100% over at least one timescale; Dark green - a maximum increase of at least 100% on at least one timescale; White - a maximum decline less than 25% or maximum increase less than 33% on all three timescales. Grey - insufficient data for or too few individuals (arbitrarily taken as an average of ten or less) of, a given species to allow meaningful smoothed trends to be generated.

Sector		Dark-bellied Brent Goose	Shelduck	Wigeon	Teal	Mallard
SLSZ	Wrangle to Butterwick	51 %; 3.3 %; -29.7%	31.3 %; -32.5%; -45.3%	-23.6%; 64.2 %; 511.1%	375 %; -48.6%; 322.2%	81.3 %; -47.6%; 24.3 %
35410	Benington	-7.6 %; -59.7%; -71.3%	-6.5 %; 33.7 %; -10.2%	-88.2%; -87.5%; 0 %	N/A	300 %; 300 %; -11.1%
35411	Wrangle	1.1 %; 19.3 %; -44.3%	-50 %; -58 %; -70.9%	N/A	-100 %; -100 %; -100 %	211.1%; 250 %; 154.5%
35415	Leverton	28.7 %; 30.2 %; 46.9 %	-20 %; -37.5%; -47.8%	-58 %; 111.5%; 323.1%	N/A	5.6 %; 192.3%; 216.7%
35416	Butterwick	75 %; 48.8 %; -20.5%	30.9 %; -39.9%; -53.2%	400 %; 455.6%; 316.7%	85 %; -43.9%; 208.3%	-53.1%; -89.7%; -69.4%
35901	The Wash SPA	12.3 %; -15.3%; -29.7%	-11.4%; -35.9%; -54.6%	64.5 %; 193 %; 92.7 %	15.6 %; 106.5%; 152.3%	13.4 %; 10.8 %; 0.4 %

Table A.i: Percentage change in the numbers of each species over the short- (5 yr), medium- (10 yr) and long- (15 yr) terms), for the South Lincs. Shooting Zone and its constituent WeBS count sections: Wildfowl.

Sector		Oystercatcher	Golden Plover	Grey Plover	Lapwing	Knot
SLSZ	Wrangle to Butterwick	55.7 %; 42.9 %; -12 %	28.9 %; -28 %; 118.4%	-19.7%; 8 %; -17.4%	-73.4%; -75.4%; -70.9%	-10.5%; 45.6 %; -37.3%
35410	Benington	57.5 %; -51.9%; -47.8%	-29 %; -79.4%; -50.3%	-66.5%; -85.7%; -88.5%	-74.9%; -87.6%; -87.6%	-76.7%; -88.8%; -94.2%
35411	Wrangle	566.4%; 134.6%; -41.6%	-16.6%; -40.9%; 13 %	-32.2%; 204.4%; 86.6 %	-86.6%; -71.6%; -83 %	-45.9%; 28 %; -69.8%
35415	Leverton	-21.2%; 102 %; 32 %	27.5 %; 114.4%; 512.7%	-13.6%; 62.6 %; 11.5 %	-81.7%; -62.5%; -47.5%	11.1 %; 237.5%; 61.8 %
35416	Butterwick	9.5 %; -24.4%; -41.7%	-5.5 %; -33.4%; 125.8%	80.4 %; 17.4 %; -43.3%	-68 %; -72.5%; -59.4%	-80 %; -59.6%; -91.1%
35901	The Wash SPA	11.8 %; 23.6 %; -29.3%	33.9 %; 35.5 %; 309.3%	-22.9%; -28.2%; -28.5%	-44 %; -23.5%; -7.6 %	34.4 %; 40 %; -27.8%

Table A.ii: Percentage change in the numbers of each species over the short- (5 yr), medium- (10 yr) and long- (15 yr) terms), for the South Lincs. Shooting Zone and its constituent WeBS count sections: Waders (Oystercatcher to Knot.

Sector		Dunlin	Bar-tailed Godwit	Curlew	Redshank	Turnstone
SLSZ	Wrangle to Butterwick	-22.4%; -27.3%; -27.8%	-31 %; 55.4 %; 132.9%	46.9 %; 30.1 %; 54.9 %	-27.7%; -27.9%; 1.3 %	20.7 %; -30 %; -34 %
35410	Benington	-91.5%; -89.4%; -92.4%	-12.2%; -61.5%; -65 %	-46.6%; -25 %; -30.4%	-40 %; -30.2%; -21.1%	-57.1%; -40 %; 0 %
35411	Wrangle	77.9 %; 14.7 %; -22.1%	323 %; 62.8 %; 104.4%	122.2%; 233.3%; 144.4%	-56.5%; 62.5 %; 21.9 %	60 %; 300 %; 300 %
35415	Leverton	2.5 %; 114.3%; 137.3%	-41.2%; 82.8 %; 113.3%	-13.1%; 37.8 %; 52.7 %	-18.2%; -45.5%; 16.1 %	66.7 %; 150 %; 150 %
35416	Butterwick	-86.8%; -91.3%; -90 %	-85 %; -88 %; -91.7%	-3.6 %; -51.8%; -39.8%	-9.6 %; -53.7%; -23.5%	-58.3%; -86.1%; -89.6%
35901	The Wash SPA	-24.8%; -38.9%; -28.9%	-29.8%; -10.9%; 20.6 %	-3.1 %; -3.5 %; -7 %	-26.4%; -17.2%; 0.7 %	-5 %; -31.2%; -36 %

Table A.iii: Percentage change in the numbers of each species over the short- (5 yr), medium- (10 yr) and long- (15 yr) terms), for the South Lincs. Shooting Zone and its constituent WeBS count sections: Waders (Dunlin to Turnstone).

Appendix B

Significance of long term change in the proportional contribution of numbers of each species for the South Lincs. Shooting Zone and its constituent WeBS count sections to the numbers on The Wash SPA.

Cells are coloured to indicate a sector's proportional contribution to numbers on the South Lincs. Shooting Zone and its constituent WeBS count sectors to overall numbers on The Wash SPA, as follows: Red - a highly significant decline ($P < 0.01$); Orange - a significant decline ($P < 0.05$); Light green – a significant increase ($P < 0.05$); Dark green - a highly significant increase ($P < 0.01$); White – no significant trend over the period. Grey - insufficient data for or too few individuals (arbitrarily taken as an average of ten or less) of, a given species to allow a meaningful Logit model to be fitted

Sector		Dark-bellied Brent Goose	Shelduck	Wigeon	Teal	Mallard
NE020	Wrangle to Butterwick	0; P 0.999	-0.0026; P 0.867	-0.0067; P 0.7642	-0.0937; P 0.0158	-0.0279; P 0.1124
35410	Benington	-0.0621; P <0.0001	0.0508; P 0.0085	-0.0795; P 0.0817	-0.0217; P 0.7707	0.0491; P 0.2022
35411	Wrangle	-0.0093; P 0.5825	-0.0206; P 0.3431	-0.1182; P 0.0689	-0.1642; P 0.0651	0.1181; P 0.0025
35415	Leverton	0.0572; P <0.0001	0.009; P 0.6134	0.0019; P 0.9506	-0.0956; P 0.1986	0.0758; P 0.0039
35416	Butterwick	0.0162; P 0.2691	-0.0091; P 0.5786	0.0482; P 0.1176	-0.0786; P 0.0213	-0.1073; P <0.0001
35901	The Wash	-0.0301; P 1	0.0513; P 1	0.0132; P 1	0.0175; P 1	-0.0058; P 1

Table B.i: Significance of long term change in the proportional contribution of numbers of each species for the South Lincs. Shooting Zone and its constituent WeBS count sections to the numbers on The Wash SPA: Wildfowl.

Sector		Oystercatcher	Golden Plover	Grey Plover	Lapwing	Knot
NE020	Wrangle to Butterwick	0.0167; P 0.2282	-0.0814; P <0.0001	0.0213; P 0.2279	-0.0839; P <0.0001	-0.0006; P 0.9736
35410	Benington	-0.0124; P 0.5803	-0.1546; P 0.0001	-0.0981; P 0.0025	-0.1288; P 0.0001	-0.1106; P 0.0015
35411	Wrangle	-0.0594; P 0.0521	-0.0742; P 0.0132	0.09; P <0.0001	-0.0672; P 0.0099	-0.0289; P 0.3725
35415	Leverton	0.0759; P 0	0.0169; P 0.5993	0.0538; P 0.0024	-0.0114; P 0.6084	0.0597; P 0
35416	Butterwick	-0.0138; P 0.6659	-0.0693; P 0.0023	-0.037; P 0.1449	-0.0527; P 0.016	-0.0508; P 0.1233

Table B.ii: Significance of long term change in the proportional contribution of numbers of each species for the South Lincs. Shooting Zone and its constituent WeBS count sections to the numbers on The Wash SPA: Waders (Oystercatcher to Knot).

Sector		Dunlin	Bar-tailed Godwit	Curlew	Redshank	Turnstone
NE020	Wrangle to Butterwick	0.0058; P 0.7123	0.0736; P 0	0.0393; P 0.0053	-0.0062; P 0.6876	0.0162; P 0.5369
35410	Benington	-0.0696; P 0.0599	-0.0616; P 0.1589	-0.0037; P 0.836	-0.0164; P 0.4766	0.052; P 0.2949
35411	Wrangle	-0.0203; P 0.3769	0.0351; P 0.3147	0.0954; P 0.0003	0.0468; P 0.0384	0.1913; P <0.0001
35415	Leverton	0.1199; P 0.0001	0.0759; P 0.0001	0.0445; P 0.0088	0.0046; P 0.8010	0.0957; P 0.0041
35416	Butterwick	-0.0832; P 0.0007	-0.1078; P 0.114	-0.0376; P 0.0808	-0.0456; P 0.0041	-0.1232; P 0.0001

Table B.iii: Significance of long term change in the proportional contribution of numbers of each species for the South Lincs. Shooting Zone and its constituent WeBS count sections to the numbers on The Wash SPA: Waders (Dunlin to Turnstone).

Appendix C

Five-year mean of peaks for the periods 1994/95 to 1998/99, 1999/2000 to 2003/04 and 2004/05 to 2008/09 and Peak count over winter 2007/08 for the South Lincs. Shooting Zone and its constituent WeBS count sections.

Cells are colour coded to indicate sectors that hold a substantial proportion of the total numbers of each species on The Wash SPA arbitrarily defined and in order of priority as follows: Dark Green – sectors with a mean of peak counts over the last five winters that is at least 20% of the total mean of peak counts for the estuary over the same period; Dark Blue – Sites with a mean of peak count over the last five winters that is between 10% and 20% of the total mean of peak count for the estuary over the same period; Light Green – Sites with a peak count in the latest year that is at least 20% of the total peak count for the estuary in the latest year; Light Blue – Sites with a peak count in the latest year that is between 10% and 20% of the total peak count for the estuary in the latest year.

Sector		Dark-bellied Brent Goose	Shelduck	Wigeon	Teal	Mallard
NE020	Wrangle to Butterwick	**3988;3621;3689; (4089)**	**1463;881;999; (1149)**	243;269;295;(242)	**204;104;141; (348)**	**330;310;221; (291)**
35410	Benington	1418;563;474;(600)	350;249;359;(230)	45;42;11;(0)	6;8;1;(6)	13;5;31;(80)
35411	Wrangle	**1590;1829;1632; (2105)**	222;265;84;(66)	111;78;11;(15)	18;31;0;(0)	**22;64;75;(262)**
35415	Leverton	788;1340;1215;(929)	329;233;176;(122)	132;244;150;(192)	14;19;3;(0)	44;160;107;(125)
35416	Butterwick	1347;877;1146;(1230)	**818;325;506;(986)**	70;30;191;(222)	**187;69;138;(342)**	248;93;59;(52)
35901	The Wash	21511;21060;20485; (13993)	12252;8929;6967; ((6046))	2941;3285;7787; ((5124))	1215;2196;2736; (2308)	2862;2500;2461; ((2586))

Table C.i: Five-year mean of peaks for the periods 1993/94 to 1997/98, 1998/99 to 2002/03 and 2003/04 to 2007/08 and Peak count over winter 2007/08 for the South Lincs. Shooting Zone and its constituent WeBS count sections: Wildfowl

Sector		Oystercatcher	Golden Plover	Grey Plover	Lapwing	Knot
NE020	Wrangle to Butterwick	**3653;2047;4172;(3829)**	**6033;4828;4571;(4151)**	**1753;2520;2358;(2535)**	4854;7285;2154;(1608)	5318;7031;8033;(3263)
35410	Benington	813;164;822;(140)	2094;1763;881;(4)	**1029;915;633;(0)**	1293;1850;328;(250)	3521;2590;932;(0)
35411	Wrangle	**2123;399;1683;(3034)**	1208;570;609;(521)	**603;1277;1203;(1608)**	1377;2411;526;(502)	1613;1374;1516;(738)
35415	Leverton	**759;1643;1827;(1300)**	1126;1394;2737;(2100)	**348;711;688;(900)**	946;3283;561;(220)	1140;4374;4959;(2847)
35416	Butterwick	393;287;481;(37)	**1765;1124;1505;(3300)**	327;80;177;(73)	2206;1080;914;(764)	1394;953;1827;(130)
35901	The Wash	17165;14795;16744; (15319)	17936;23103;31620; (40588)	10478;8309;6040; (9590)	25451;46775;30575; (24543)	73507;62823;115748; (93957)

Table C.ii: Five-year mean of peaks for the periods 1993/94 to 1997/98, 1998/99 to 2002/03 and 2003/04 to 2007/08 and Peak count over winter 2007/08 for the South Lincs. Shooting Zone and its constituent WeBS count sections: Waders (Oystercatcher to Knot).

Sector		Dunlin	Bar-tailed Godwit	Curlew	Redshank	Turnstone
NE020	Wrangle to Butterwick	3782;4342;3241;(2390)	2507;5370;4096;(3900)	453;533;865;(946)	538;715;473;(827)	93;91;110;(86)
35410	Benington	1960;1490;784;(0)	1020;116;446;(0)	90;187;95;(45)	102;120;95;((2))	27;41;24;(5)
35411	Wrangle	1054;708;745;(850)	644;260;850;(1250)	189;172;548;(575)	154;435;231;(615)	26;47;87;(82)
35415	Leverton	883;1752;1831;(1600)	2119;5292;3530;(3800)	131;228;197;(147)	108;82;63;(62)	10;10;11;(18)
35416	Butterwick	1358;1525;243;(40)	151;23;40;(0)	230;97;109;(266)	287;150;141;(160)	81;35;14;(12)
35901	The Wash	37415;36414;25873; (20284)	13443;17738;10469; (10712)	3844;4453;3213; (3016)	3380;3508;2487; (2702)	808;522;418; (450)

Table C.iii: Five-year mean of peaks for the periods 1993/94 to 1997/98, 1998/99 to 2002/03 and 2003/04 to 2007/08 and Peak count over winter 2007/08 for the South Lincs. Shooting Zone and its constituent WeBS count sections: Waders (Dunlin to Turnstone).