BTO Research Report 365

Changes in lowland wet grassland breeding wader number: the influence of site designation

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A report to Defra, RSPB & English Nature

January 2005

British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU
Registered Charity No. 216652

British Trust for Ornithology

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Published in January 2005 by the British Trust for Ornithology
The Nunnery, Thetford, Norfolk, IP24 2PU, UK

ISBN 1-904870-17-1

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SUMMARY

1. Breeding waders on lowland wet grassland have decreased substantially in number during recent decades. Site protection and management through designation has been identified as the main mechanism by which these declines could be stemmed and reversed.

2. The aims of the analysis were to evaluate whether site designation as nature reserves (NR), Sites of Special Scientific Interest (SSSI), or the agri-enviroment schemes (AES) Environmentally Sensitive Areas (ESA) or Countryside Stewardship (CSS) has had significant benefits for breeding wader populations.

3. Changes in breeding wader densities between national surveys in 1982 and 2002 were assessed using a Geographic Information System that allows the locations of pairs of birds to be associated with site designation at the individual field scale.

4. Oystercatcher have increased in all areas, slightly more in areas under AES or site protection.

5. Lapwing densities decreased least, and in some cases actually increased, on nature reserves. There is little evidence that AES have provided much benefit to Lapwings, since outside of protected sites, the rates of decrease were not significantly different to those in the wider countryside. An exception to this is on ESA Reversion where numbers increased by 70% between 1982 and 2002.

6. Snipe have decreased in most areas but decreases have been smallest (and in some cases reversed) where sites are offered a high degree of protection under both nature reserve and SSSI designations. In these areas, AES may confer added benefits but away from this small number of key sites, there is little evidence that either CSS or ESA options have been sufficient to stem the large decline in lowland wet grassland populations of Snipe.

7. The population of Curlew on lowland wet grasslands is small and densities low everywhere. While populations may have fared better in designated areas, there are insufficient data to draw firm conclusions as to whether AES or site protection is the key factor.

8. Redshank densities have increased under many of the designations, in contrast to the large decreases in the wider countryside. While increases were especially marked on protected sites, there were increases in densities of Redshank on all three Tiers of ESAs options, even outside of nature reserves and SSSIs.

9. Wader densities in areas surrounding hotspots do not seem to be heavily influenced by densities within the hotspots, suggesting there is little overspill of populations from core areas into the wider countryside. This suggests that wader populations in key sites are not performing well enough to serve as source populations that can then colonise surrounding poor quality habitats.

10. There is little evidence from these data that the length of time a site has been in an ESA agreement has an impact on the benefits for breeding waders. This suggests that the lack of evidence for major benefits of ESAs in some areas may not be due simply to the fact that they have not been in place long enough.

11. This analysis suggests that conserving wader populations on lowland wet grassland requires a substantial and specific management programme, such as that found on nature reserves or SSSIs, especially where additional funding for the required management is made available through AESs. There is little evidence that “Broad and Shallow” AES options such as CSS and Low Tiers in ESAs are sufficient to reverse declines in Lapwing and Snipe numbers but that Redshank may benefit more widely from these schemes.

12. Low Tier ESA Tiers, while the least expensive, show relatively low returns in terms of wader densities compared to the wider countryside. High Tier options show good returns in the North Kent Marshes and Suffolk River Valleys but poor returns in The Broads and Somerset. ESA Reversion of arable to grassland has a very high return in the North Kent Marshes and a modest return in The Broads.

1. INTRODUCTION

1.1 Background

Wet grassland comprises a range of pasture and hay meadow grassland types that are periodically flooded or which overlie waterlogged soils. This habitat supports a distinctive bird community in the lowlands of Britain and is particularly well known for its importance for breeding waders (Smith 1983, Jefferson & Grice 1998). Seven wader species are associated with lowland wet grassland in England & Wales during the breeding season: Ruff *Philomachus pugnax* and Black-tailed Godwit *Limosa limosa*, which are rare and localised (Ogilvie *et al.* 2003), and Oystercatcher *Haematopus ostralegus*, Lapwing *Vanellus vanellus*, Snipe *Gallinago gallinago*, Curlew *Numenius arquata* and Redshank *Tringa totanus*, which are more widespread. The latter five wader species can be considered wider countryside species (O'Brien & Bainbridge 2002) as they nest in a range of habitats, including uplands and coastal areas. In many parts of lowland England and Wales though, these wader species are characteristic birds of wet grassland, and indeed are virtually restricted to this habitat in some areas.

Lowland grassland systems underwent major changes in management during the second half of the 20th Century (Vickery *et al*. 2001, Shrubb 2003). Drainage of wet grassland was particularly rapid during the 1960s and 1970s, since when much of the drained grassland has been subject to increasingly intensive management through cutting and grazing (Smith 1983, Williams *et al.* 1983). These changes are strongly implicated in the large decreases in breeding wader populations on lowland wet grassland during the same period (Smith 1983, Wilson *et al.* 2005). Wader populations had already declined at the time of the first survey of waders on lowland wet grassland in England and Wales in 1982 (Smith 1983). By 2002 when the survey was repeated, populations had dropped still further with significant declines in the numbers of Lapwing, Snipe, Curlew and Redshank (Wilson *et al.* 2005).

The reversal of recent declines in farmland bird numbers is now a major conservation priority in the UK (Vickery *et al.* 2004). For lowland wader populations, changes in grassland management will be required to return grasslands to a suitable condition for waders to nest and forage (Ausden & Hirons 2002, Wilson *et al.* 2005). These changes in management can be delivered via one or more of three mechanisms in the UK:

1. Designation and management of lowland wet grassland nature reserves
2. Designation and management as Sites of Special Scientific Interest (SSSI)
3. Subsidising sympathetic management techniques through agri-environment schemes (AES): in England, the two main schemes are Environmentally Sensitive Areas (ESAs) and Countryside Stewardship (target habitat listed as: old meadows and pastures)

Wader populations are now concentrated onto a small number of key sites, most of which are managed as nature reserves and/or designated as SSSIs (Wilson *et al.* 2004). Management of these key sites is therefore crucial in maintaining existing wader populations in lowland England and Wales, if the long-term declines are to be reversed. However SSSIs and nature reserves are unlikely to account for large areas of the countryside and there is a real need to encourage sympathetic management of grassland outside these designated areas. Another tool for the delivery of biodiversity benefits in the wider, largely farmed, countryside is via agri-environment schemes such as Countryside Stewardship, ESAs and a successor scheme, which is currently being established. There has been a great deal of interest recently in the extent to which agri-environment schemes and nature reserve designation succeeds in achieving conservation goals (Ausden & Hirons 2002, Kleijn *et al*. 2001, Kleijn & Sutherland 2003). Kleijn and Sutherland highlighted the lack of rigorous monitoring of agri-environment schemes and the same is often true of SSSIs and nature reserves.

1.2 Aims of this Study

Data gathered in the 1982, 1989 and 2002 Breeding Waders of Wet Meadows surveys (funded by RSPB, Defra, English Nature and BTO) were mapped in the field on maps at 1:25000 scale or greater. The locations of waders can therefore be assigned to individual fields, allowing them to be compared with the management of that field where known. This study involved digitising the wader locations from the three national surveys and overlaying these onto information about site designation, using a Geographic Information System (GIS) Environment. These data were then used to investigate the wader population trends in relation to site designation.

Specifically, the four objectives of the study were:

1. To assess whether site designation results in measurable benefits for lowland grassland wader species by slowing down or reversing declines in breeding density when compared with non-designated areas.
2. To identify the most favourable designations or combinations of designations for grassland waders.
3. To assess whether length of time that land has been in an agri-environment scheme has an impact on its effectiveness.
4. To assess the financial costs versus biodiversity benefits of various options within agri-environment schemes.

2. METHODS

2.1 Breeding Wader Survey Methods

The national surveys involved whole area surveys for waders within pre-defined survey sites. The sites varied in size from 2 ha to 1,230 ha, with a mean of 143 ha (standard deviation 169 ha) and in some areas several sites had contiguous boundaries. Three surveys were carried out at each site in each survey year, ensuring coverage during the peak nesting activity of each wader species. For a more complete description of survey methods see Smith (1983) and Wilson *et al.* (2005).

2.2 Inputting Breeding Wader Data

The locations of pairs of breeding waders were input with a high degree of spatial accuracy using a "point theme" in ArcView GIS (ESRI 1996). The wader data were input directly from the maps, pairs of waders were estimated using the approach described for the Moorland Bird Survey, whereby the location of birds or pairs of waders are mapped on two or more visits and the number of pairs estimated using set protocols (see Brown & Shepherd 1993). This ensured that data were analysed in a comparable way for each of the three surveys. Correction factors used for estimating numbers of Snipe (Green 1985), Curlew (Grant *et al*. 2002) and Redshank (Cadbury *et al*. 1987) were not used since these rely on calibrated population estimates, which would not be possible to map. Population density estimates for Snipe and Redshank in particular, therefore should be considered conservative.

2.3 Overlaying Site Designation Data

Digitised Breeding Waders of Wet Meadows Survey (BWWM) site boundaries used in the 1982, 1989 and 2002 surveys were available, along with designation boundaries for the following:

- Major wet grassland nature reserves. Includes National Nature Reserves, RSPB and Wildfowl & Wetlands Trust Reserves.
- Sites of Special Scientific Interest (SSSI) for which lowland wet grassland or breeding waders is specified as an interest feature.
- Countryside Stewardship Scheme (CSS) agreement areas.
- Environmentally Sensitive Area (ESA) agreements. Note that only eight ESAs designated on the basis of the large extent of lowland wet grassland are considered:

    1. Avon Valley (AV)
    2. Essex Coast (EC)
    3. North Kent Marshes (NK)
    4. Somerset Levels and Moors (SL)
    5. Suffolk River Valleys (SRV)
    6. The Broads (NB)
    7. Test Valley (TV)
    8. Upper Thames Tributaries (UTT)

Land is entered under ESA agreements to maintain and enhance the biodiversity value of the landscape. In return for payments, the landowners agree to a range of management prescriptions or Tier options (Ovenden *et al*. 1998). The Tiers that aim to maintain the landscape are usually referred to as "Low Tiers" while those that aim to maintain and enhance the landscape are termed "High Tiers". The High Tiers generally include a range of managements that are more expensive than the Low Tiers, such as raising water levels, and as such generally attract higher payments. Categorisation of Tiers into "Low" and "High" is based on these criteria rather than whether they are officially named Tier 1, Tier 2 or Tier 3, as the latter show a great deal of overlap between ESAs. A full list of Tiers and their description can be found in Appendix 1.

Each BWWM site was divided into separate polygons (units of land) depending on the nature of the coverage of the designation. These polygons were typically individual fields, although some comprised several adjoining fields with the same designation, and some were sections of fields, where designation boundaries didn't correspond with field boundaries. Pairs of each of the five breeding grassland wader species were then counted in each polygon for each of the three surveys. In this way, the distribution and densities of breeding waders could be related directly to units of land in ArcView GIS (Figure 1).

To evaluate the cost effectiveness of Tiers within ESAs, the density change for each ESA Tier was compared to the equivalent figure for the wider countryside in the surrounding region (Government Office Region). The change in density (summed across all five wader species) in the wider countryside was subtracted from the change in density within each Tier to give a figure for a "return" attributable to the ESA. Both wider countryside and ESA figures included areas in site protection as sample sizes would otherwise have been too small. The changes for Suffolk River Valleys and The Broads were therefore compared to the wider countryside regional figures for "Eastern England", the North Kent Marshes with "Southeast England" and the Somerset Levels and Moors with "Southwest England". Sample sizes for the other ESAs were too small to make a valid comparison but figures for all eight ESAs were combined and then compared with wider countryside figures for southern England ("Eastern England", "Southeast England" and "Southwest England").

2.4 Analytical Methods

To ensure comparability, wader numbers from the 1982 and 2002 surveys were compared only for those areas for which wholly comparable accurately mapped bird counts were available. Wader densities were calculated for each polygon in the GIS data set and summed to give a density estimate for each designation type.

Generalised Linear Models (GLMs) using the GENMOD procedure of the SAS statistical package (SAS Institute 1996) with a Negative Binomial error term and log link function were used to compare changes in density between different designation types. Wader densities recorded in 1982 were likely to be highly correlated with certain designation types. Firstly, many wet grassland nature reserves and SSSIs were already designated at that time, or may have been subsequently designated based on findings of high wader numbers in that survey. Secondly, take up of AES prescriptions may have been influenced by the presence of breeding waders or the suitability of the site for AES prescriptions due to landscape or hydrological considerations. A straightforward comparison between density changes therefore would be meaningless. The relative change in density between 1982 and 2002 was therefore modelled by using density of birds in 2002 as the response variable with log(density of pairs in 1982 + density of pairs in 2002) as an offset. The suitability of the distribution of the error term for use in each of the models was assessed by dividing the deviance of the model by the degrees of freedom: values close to 1 suggest that the model is appropriate.

The changes in relative wader populations for each AES and site protection combination were assessed relative to the changes in numbers in the wider countryside. To do this, the independent variables in the model were entered as an interaction term, giving 14 combinations, each of which was compared with the "null" level (sites with no AES or site protection: the wider countryside) using likelihood ratio tests. The parameter estimates produced by this model were then back transformed such that all estimates for each of the 14 designation types were given a value relative to 1 for the wider countryside. A parameter estimate of greater than 1 therefore shows a more preferable change in density than in the wider countryside (either smaller decrease or larger increase) while conversely, a value of less than 1 indicates a less preferable change.

The parameter estimates for the 14 designation types were plotted along with their Wald 95% confidence limits. The data points are relative to the wider countryside, points for which the 95% confidence limits do not overlap a value of 1 (the wider countryside) are those where changes in density in that designation type are significantly different to those in the wider countryside. The five groups of AES (none, CSS, ESA Low Tier, ESA High Tier & ESA Reversion) are grouped together in the graphs to aid comparison. Within AES groups they are then arranged from the sites with least protection (none) to most protection (SSSI & nature reserve).

The various designation were ranked by the relative change figure to indicate which combination of designations performed best for each species in terms of minimising declines or maximising increases. The average rate of decline across all five species was used as a measure of across species change, this gave an even weighting to each species and was not weighted by population size.

As a precursor to this analysis, these data, which include many sites with contiguous boundaries, were assessed for spatial auto correlation, which does not meet assumptions of independence in data and can lead to misleading results. The presence of spatial auto correlation is also important in ecological terms as it may indicate that wader populations in high-density areas serve as sources for surrounding areas, suggesting a vital role for such sites in maintaining populations in a wider area.

The effects of the number of years that a site has been in an agreement was also investigated independently by calculating changes in density for each species by length of time that the land had been entered into an agreement and fitting a linear trend using least-squares regression. Mean density changes were calculated for each tranch (year) of agreements and 95% confidence limits were calculated using bootstrapping with 1000 re-samples (Greenwood 1991).

2.5 Definition of Designations

Densities are compared for a range of designations (see section 2.3). These designations often overlap, therefore to tease out the effects of each designation type; this must be taken into account. In all, there are 20 combinations of AES and site protection categories:

1. No AES or site protection – the wider countryside
2. No AES but is a SSSI (but not a nature reserve)
3. No AES but is a nature Reserve (but not a SSSI)
4. No AES but is a nature reserve and SSSI
5. Countryside Stewardship but no site protection
6. Countryside Stewardship and SSSI (but not a nature reserve)
7. Countryside Stewardship and nature reserve (but not a SSSI)
8. Countryside Stewardship, nature reserve and SSSI
9. ESA Low Tier but no site protection
10. ESA Low Tier and SSSI (but not a nature reserve)
11. ESA Low Tier and nature reserve (but not a SSSI)
12. ESA Low Tier, nature reserve and SSSI
13. ESA High Tier but no site protection
14. ESA High Tier and SSSI (but not a nature reserve)
15. ESA High Tier and nature reserve (but not a SSSI)
16. ESA High Tier, nature reserve and SSSI
17. ESA Reversion but no site protection
18. ESA Reversion and SSSI (but not a nature reserve)
19. ESA Reversion and nature reserve (but not a SSSI)
20. ESA Reversion nature reserve and SSSI

Data for some of these are rather sparse so to aid statistical analysis some categories were combined: 6, 7 and 8 were combined into a “CSS with NR and/or SSSI” and all four ESA Reversion categories were combined. This resulted in a total of 15 categories of AES and site protection combinations being available for comparison. Sample sizes for these 15 designation categories varied from 20 to 1400 polygons and from 153 to 66459 hectares (Table 2).

Densities and density changes were also calculated for each ESA Tier type within the eight grassland ESAs but as some of the sample sizes for these were very small (Table 3) it was not possible to test for differences between them using the GLM approach outlined in section 2.4 as the GLM models did not converge.

3. RESULTS

3.1 Data Coverage

The 1982 survey covered most of the lowland wet grassland sites known to hold breeding wader populations (Smith 1983), the majority of these were resurveyed in 2002 (Wilson *et al.* 2005). The locations of waders were digitised for 1304 sites from the 1982 survey and 950 from 2002, covering 1715 and 1230 km^2 respectively (Table 1). Data from a sample resurvey in 1989 (O'Brien & Smith 1992) were also digitised, providing information on 206 sites (Table 1). This was insufficient to carry out a detailed analysis of changes in wader numbers between 1982, 1989 and 2002 and some key areas were not covered in 1989. In all, the locations of 14307 pairs of waders were plotted from the 1982 survey, 2335 from 1989 and 8045 from 2002 (Table 4). Data for some of these sites were either not mapped or not thought to be mapped accurately enough to use in the GIS data file.

The extent of areas for which comparable data for 1982 and 2002 are available for the eight lowland wet grassland ESAs varies, with good coverage in The Broads, North Kent Marshes and Somerset Levels and Moors but relatively little comparative data for some of the other ESAs (Figure 2). The sites covered are broadly representative of each ESA in terms of the proportion of land in each of the ESA Tiers (Figure 2).

3.2 Densities and Changes in Density of Grassland Waders Between 1982 and 2002

There was very little evidence for spatial-autocorrelation of breeding wader densities or changes in density between adjoining sites for the two most numerous species: Lapwing and Redshank. Changes in numbers of these species were positive on sites identified as wader "hotspots" – those that were in agri-environment schemes and designated as both SSSIs & nature reserves (distance from hotspot=0) but were generally negative or marginally positive in surrounding areas (Figure 4a). Similar patterns held true for densities of both species (Lapwing (Figure 4b) and Redshank (Figure 4c)), in other words densities were much higher in the hotspots but showed no trend with distance from the hotspot. The lack of any evidence for spatial-autocorrelation suggests that this does not need to be taken into account in further analysis. It may also suggest that wader densities and density changes are driven by habitat quality at a very local scale – probably at the individual field scale, providing little evidence of source and sink effects in the breeding wader populations.

3.2.1 Oystercatcher

The highest densities in the 1982 survey were found in areas that subsequently went into High Tier ESA agreements while areas that subsequently went into Low Tier ESA agreements generally had densities lower than in the wider countryside (Table 5a). By 2002 densities had increased in most areas but were highest on land entered into High Tier ESAs or ESA Reversion, remaining lower on Low Tier ESA than in the wider countryside (Table 5a). The fastest rate of increase was on ESA Reversion where numbers rose from three pairs in 1982 to 40 pairs in 2002. Increases on land outside AES but within nature reserves and/or SSSIs were also substantial (Table 5a). However, due to the relatively small number of sites that held Oystercatchers in the surveys, the GLM was not able to detect statistically significant differences in the rates of change encountered on any of the designation when compared with those encountered in the wider countryside (Table 6). The relative density changes (between -1 and 1) on the 15 designation types, ranked from the largest increase down to the largest decreases were (italicised designation are those where samples sizes were small – the number of pairs did not exceed 10 in either 1982 or 2002):

1. *High Tier & NR & SSSI* *1*
2. *High Tier & SSSI* *1*
3. None & NR 0.87
4. Reversion 0.86
5. None & NR & SSSI 0.71

6. None & SSSI 0.56
7. High Tier & NR 0.47
8. *Low Tier & SSSI 0.2*
9. High Tier only 0.19
10. Low Tier only 0.13
11. None (wider countryside) 0.04
12. *CSS only 0*
13. *Low Tier & NR & SSSI 0*
14. *Low Tier & NR 0*
15. *CSS & NR &/or SSSI -0.33*

It can be seen from Figure 3a that the rate of change was more favourable in most designated areas compared with the wider countryside, although there is little otherwise to suggest specific designations in which this species did especially well.

Examining changes within individual ESAs (Table 7a), it can be seen that most of the Oystercatchers noted with ESAs were either in The Broads and the North Kent Marshes, densities in the latter ESA were high in both 1982 and 2002. The most substantial increases were on land reverted to grassland within the North Kent Marshes ESA scheme (up from one to 33 pairs) and in High Tier land within the Suffolk River Valleys (up from zero to 14 pairs).

3.2.2 Lapwing

The highest densities in both 1982 and 2002 were associated with areas under site protection, be it SSSI, nature reserves or both (Table 5b) but do not appear to be associated with the site's subsequent designation in an AES. Declines were noted in most areas between 1982 and 2002 but there were some notable exceptions. There was a substantial increase (from 70 to 181 pairs) on sites that were nature reserves and SSSI and entered into CSS, with smaller increases noted generally on other nature reserves, regardless of whether or not they were in AES. There was also an increase in numbers on land in ESA Reversion schemes, from 56 pairs in 1982 to 95 pairs in 2002 (Table 5a). Rather surprisingly, there was a 55% decrease in numbers in High Tier ESAs that were also SSSIs (not outside of nature reserves) but sample sizes for these areas were small.

Tests for differences in the rates of change between designated areas showed that the changes in density on nature reserves entered into High Tier ESA options were significantly more favourable than in the wider countryside, as were sites that were designated SSSIs and in Low Tier ESA options (Table 6). The relative density changes (between -1 and 1) on the 15 designation types, ranked from the largest increase down to the largest decreases were (italicised designation are those where samples sizes were small – the number of pairs did not exceed 10 in either 1982 or 2002):

1. *Low Tier & NR 1*
2. CSS & NR &/or SSSI 0.44
3. Reversion 0.26
4. Low Tier & SSSI 0.16
5. High Tier & NR 0.11
6. None & NR 0.11
7. None & NR & SSSI 0.01
8. High Tier & NR & SSSI -0.06
9. High Tier only -0.13
10. Low Tier & NR & SSSI -0.14
11. None & SSSI -0.19
12. CSS only -0.26
13. None (wider countryside) -0.31
14. Low Tier only -0.42
15. High Tier & SSSI -0.55

Although rates of change were generally more favourable in designated areas than in the wider countryside (Figure 3b), there is little evidence of an overall difference between CSS, Low Tier ESA and High Tier ESA. The one pattern that emerges from this figure is that changes were most favourable on Nature Reserves in the wider countryside, and when also Low Tier ESAs or High Tier ESAs, in each case the rates of change were more favourable than areas in SSSI and even nature reserve & SSSI combinations.

In both 1982 and 2002 the highest densities of Lapwings were found on the North Kent Marshes, indeed this was the only ESA in which densities averaged more than 10 pairs per square kilometre of land under ESA prescriptions in 2002 (Table 7b). There were notable differences between the ESAs in changes in densities on the three ESA Tiers. Reversion appears to have been successful in increasing Lapwing numbers in the North Kent Marshes (pairs up from 33 to 73) and Norfolk Broads (up from eight to 18) but less so elsewhere. There were substantial increases in numbers on land in High Tier options in the Avon Valley and Upper Thames Tributaries and stability in The Broads but declines in the Somerset Levels and Moors, Suffolk River Valleys and to a lesser extent, the North Kent Marshes (Table 7b). There was a similarly mixed pattern on land in Low Tier options with a substantial increase from 23 to 64 pairs in the North Kent Marshes but declines elsewhere.

3.2.3 Snipe

The highest densities of Snipe in both 1982 and 2002 were found in areas that were designated both SSSI and nature reserves (Table 5c). Large declines in Snipe densities occurred in virtually all areas between 1982 and 2002, typically of more then 75% (Table 5c). In 2002, the only designations supporting Snipe densities of more than one pair per square kilometre were nature reserves. Small increases in Snipe numbers were noted on land in both nature reserves and SSSI, and entered into either Countryside Stewardship or High Tier ESA agreements. Outside land under the protection of both nature reserve and SSSI designation declines were substantial, regardless of whether the land was in an AES.

By far the higher densities of this species in 2002 were found on land in CSS & NR & SSSI. These results are heavily influenced by the large numbers found on a small number of nature reserves such as the Nene Washes RSPB reserve. The latter site entered into a CSS agreement in 2001 – just one year before the 2002 survey, so the increases noted there were almost certainly independent of CSS designation. The relative density changes (between -1 and 1) on the 15 designation types, ranked from the largest increase down to the largest decreases were (italicised designation are those where samples sizes were small – the number of pairs did not exceed 10 in either 1982 or 2002):

1.	High Tier & NR & SSSI	0.19
2.	CSS & NR &/or SSSI	0.04
3.	High Tier & NR	-0.05
4.	*Reversion*	*-0.33*
5.	None & NR & SSSI	-0.4
6.	Low Tier & NR & SSSI	-0.53
7.	None (wider countryside)	-0.63
8.	Low Tier & SSSI	-0.68
9.	None & NR	-0.7
10.	None & SSSI	-0.72
11.	CSS only	-0.74
12.	High Tier only	-0.79
13.	Low Tier only	-0.82
14.	High Tier & SSSI	-1
15.	*Low Tier & NR*	*-1*

As with Oystercatcher, the GLM was not able to detect statistically significant differences in the rate of change on designated areas when compared with the wider countryside. The low statistical power is a result of the extreme aggregation of Snipe into a small number of sites (Wilson *et al*. 2005).

Although the large confidence limits obscure the pattern somewhat, it does appear from Figure 3c that the rates of change in Snipe number are most favourable in areas with increased site protection, generally being least favourable in areas with no protection, followed by SSSI only, Nature Reserve only and most favourable in areas designated both Nature Reserves and SSSIs.

Most of the Snipe found in areas now in ESA are found in The Broads and Somerset Levels and Moors (Table 7c). The small numbers found elsewhere in 1982 were lost by the time of the 2002 survey. In both The Broads and the Somerset Levels decreases were marginally smaller on land in High Tier options than in Low Tiers, but still substantial. One "pair" was noted on ESA reversion land in the North Kent Marshes in 2002, the only "pair" noted on reverted grassland in the sample of sites included in this analysis.

3.2.4 Curlew

Curlews were not found in high densities on wet grassland anywhere in either 1982 or 2002 (Table 5d). Due to these small numbers it is difficult to draw firm conclusions about changes in numbers between 1982 and 2002, although an increase on nature reserves outside AES (from 14 to 35 pairs) is substantial when compared with general declines in numbers elsewhere. As a result of the low densities, the GLM was not able to detect significant differences in rates of density change between designation types (Table 6). The relative density changes (between -1 and 1) on the 15 designation types, ranked from the largest increase down to the largest decreases were (italicised designation are those where samples sizes were small – the number of pairs did not exceed 10 in either 1982 or 2002):

1. *High Tier only* *0.43*
2. None & NR 0.43
3. CSS only 0.1
4. Low Tier & SSSI 0.05
5. *Low Tier & NR & SSSI* *0.5*
6. *Reversion* *0*
7. *High Tier & NR & SSSI* *0*
8. *High Tier & NR* *0*
9. *Low Tier & NR* *0*
10. *CSS & NR &/or SSSI* *0*
11. Low Tier only -0.11
12. *None & SSSI* *-0.13*
13. *None & NR & SSSI* *-0.14*
14. None (wider countryside) -0.27
15. *High Tier & SSSI* *-0.29*

Reference to Table 7d shows that most of the Curlews found within ESAs were in either the Somerset Levels and Moors or Upper Thames Tributaries. There was a noticeable difference in the change in numbers between these areas with decrease in the former (from 28 to 19 pairs) and an increase in the latter (from nine to 16 pairs). There is little evidence from Figure 3d that site protection adds significantly to the rates of change shown by this species between 1982 and 2002.

3.2.5 Redshank

The highest densities in 1982 were on nature reserve land that was subsequently entered into High Tier ESA options (Table 5e). Densities remained high in these areas in 2002 but were surpassed on land in CSS that was also under the protection of nature reserve and/or SSSI designations. There was a 63% decline in densities on land in the wider countryside between 1982 and 2002; areas with no site protection but in SSSI experienced a similar decline, along with land that has now been entered into CSS but without SSSI or nature reserve status. In contrast to these declines, some areas under both AES and site protection experienced substantial increases in Redshank numbers between 1982 and 2002 (Table 5e). Changes in numbers in several areas were statistically more favourable than in the wider countryside (Table 6). In the 1103 hectares of ESA Reversion, numbers increased from 18 pairs in 1982 to 64 pairs in 2002 (Table 5e).

The relative density changes (between -1 and 1) on the 15 designation types, ranked from the largest increase down to the largest decreases were (italicised designation are those where samples sizes were small – the number of pairs did not exceed 10 in either 1982 or 2002):

1.	*Low Tier & NR*	*1*
2.	CSS & NR &/or SSSI	0.83
3.	Reversion	0.56
4.	None & NR	0.46
5.	Low Tier only	0.39
6.	Low Tier & NR & SSSI	0.33
7.	None & NR & SSSI	0.31
8.	High Tier & NR & SSSI	0.22
9.	High Tier & SSSI	0.15
10.	High Tier only	0.01
11.	Low Tier & SSSI	-0.1
12.	High Tier & NR	-0.22
13.	None & SSSI	-0.37
14.	None (wider countryside)	-0.46
15.	CSS only	-0.68

Most areas with one or more designations showed more favourable rates of change than the wider countryside (Figure 3e). As with Snipe there is a general pattern whereby sites with the greatest site protection have shown the most favourable rates of change.

Within individual ESA, the highest numbers were in the North Kent Marshes and The Broads, where overall numbers were little changed between 1982 and 2002 (Table 7e). The only ESA in which numbers increased on land in High Tier options between the two surveys was the Suffolk River Valleys, while numbers in Low Tier areas increased there and also in The Broads. There was an appreciable increase in numbers on Reversion land in the North Kent Marshes (up from 10 to 46 pairs) and a smaller increase on Reversion in the Essex Coast ESA, elsewhere, very few were located on reverted land (Table 7e).

3.2.6 All grassland waders

A GLM was performed to compare changes in population within designated areas with the wider countryside for all five grassland waders combined (Table 6). The results for this are heavily influenced by those for Lapwing as it accounts for more than half of the overall wader population. The only designations that performed statistically significantly better than the wider countryside were ESA Reversion, High Tier (with no protection) and Low Tier ESA with SSSI designation.

Most areas of the site designations performed better than the wider countryside for grassland waders in terms of overall rate of change in density (Figure 3e). The general pattern is for areas with the most site protection to fare better than those with no site protection, the exceptional case of the poor overall performance of High Tier ESAs that are also SSSI is largely due to the decrease in Lapwing densities in that combination of designations.

A more equitable way of comparing the designations for all waders combined is to look at the average rate of change across the five species. In this way the relative density changes (between -1 and 1) on the 15 designation types, ranked from the largest increase down to the largest decreases were:

1.	Reversion	0.27
2.	High Tier & NR & SSSI	0.27

3. None & NR 0.234
4. Low Tier & NR 0.2
5. CSS & NR &/or SSSI 0.196
6. None & NR & SSSI 0.098
7. High Tier & NR 0.062
8. High Tier only -0.058
9. Low Tier & NR & SSSI -0.068
10. Low Tier & SSSI -0.074
11. High Tier & SSSI -0.138
12. Low Tier only -0.166
13. None & SSSI -0.17
14. CSS only -0.316
15. None (wider countryside) -0.326

This demonstrates that across all five species, ESA Reversion was the most beneficial and that most of the designations where the mean relative change is positive (i.e. on average densities increased between 1982 and 2002) were on nature reserves. It is interesting to note that the wider countryside is at the bottom of the list but that CSS, where there are no other designations, is close to it. This could reflect the different levels of management compared with CSS & NR &/or SSSI where management is generally not carried out by farmers.

3.3 Effects of Length of Time in Designation on Effectiveness of ESA Prescriptions

There is little evidence that wader populations fare better on land that has been in an ESA option for a longer period of time. Figure 5 shows that there are positive relationships between more favourable changes in density and length of time in ESA for Oystercatcher, Snipe and Redshank, but that slope of the linear regression trend line is not statistically significant (Table 8). For Lapwing and Curlew, the trend is negative (Figure 5) but again, these relationships are not statistically significant (Table 8). Sample sizes for individual ESAs and Tiers are generally too small to calculate trends relating to the year of agreement (Appendix 1). The ESA and Tier with the most data for this analysis is the Low Tier in the Somerset Levels. Even here though, there is little evidence that increasing time in an agreement results in greater benefits for Lapwings (Figure 6).

3.4 Relationship Between Cost of ESA Options and Their Benefits in Terms of Changes in Wader Densities

The effectiveness of ESA Tiers in slowing down or reversing population declines appears to be related to the overall cost of the scheme within ESAs but there are large differences between ESAs. For the four ESAs with reasonable sample sizes, Low Tier options provide a very modest return in terms of the net increase in wader densities compared to the wider countryside, although such options were designed primarily to protect or enhance landscape character and below-ground archaeology. High Tier options have a much higher return in the North Kent Marshes and Suffolk River Valleys but in The Broads they have provided only a marginally higher return than Low Tier options, and the Somerset Levels and Moors have provided a very similar return to Low Tier options. ESA grassland Reversion has provided a very good return in the North Kent Marshes and a substantially better return than Low and High Tiers in the Norfolk Broads (note that sample sizes for Reversion in Suffolk River Valleys was very small and there were no such sites in the sample from the Somerset Levels and Moors). Overall, across all eight ESAs, the net return from Low Tier options was a negligible 0.12 pairs of waders per square kilometre, from High Tier options it was 2.3 pairs per square kilometre and from ESA Reversion was 13.1 pairs per square kilometre.

4. DISCUSSION

The five grassland waders included in this analysis have shown differing population trends in the period 1982 to 2002 with a substantial increase in Oystercatcher numbers, overall declines in Lapwing, Curlew and Redshank numbers and a steep decline in Snipe numbers (Wilson *et al.* 2005). These divergent population trends are suggested to reflect the species' sensitivity to changes in wet grassland management, ecology and hydrology. The Oystercatcher, which has expanded its range into inland areas of England in recent decades is something of a generalist: unlike other grassland waders the parents bring food to chicks and due to this, it is able to nest in a wide range of open habitats, while the Snipe is very much tied to wet habitats, principally wet grasslands in the lowlands (Wilson *et al*. 2004). This undoubtedly has implications on the likely effect of grassland management on these five species and as such, one would not expect them to respond to the management options utilised in AES in the same way. What is clear from this analysis though is that population changes of these species between 1982 and 2002 were not consistent across designation types, implying that site designation, either as part of an AES or due to site protection as SSSIs or nature reserves does have an impact on grassland wader population dynamics.

For two species – Oystercatcher and Curlew, there was evidence that populations generally fared better on land that was designated but there was little evidence to suggest that AES led to significant benefits for these species. In the case of the former species, the largest increases were on protected land while in the case of the latter, numbers were small and no overall pattern emerged to suggest that it was specific designations that were beneficial. Lowland wet grassland populations of these two species represent a very small proportion of their respective populations in England and Wales.

For Lapwing, Snipe and Redshank, lowland wet grassland is of greater conservation significance, especially in the south and east of England where there are no upland breeding populations. While there was evidence that populations of each of these species fared better in some designated areas than in the wider countryside, the pattern was by no means consistent, suggesting that certain aspects of AES and/or site protection may be not be universally beneficial.

Lapwings fared best of all on nature reserves, regardless of whether or not these were in AES. There was less conclusive evidence that numbers decreased more slowly on SSSIs than land with no site designation; the large decreases noted on SSSIs in High Tier ESAs was a somewhat surprising result that did not follow the pattern shown elsewhere. There was little evidence that Lapwing numbers fared differently in ESA Low Tier options when compared with the more expensive High Tier options. However, the 70% increase in numbers on ESA Reversion was encouraging when compared with a 48% decrease in the wider countryside, and indeed densities on new grasslands in 2002 were high at 8.62 pairs per square kilometre. Note that at the site level, not all reversion resulted in increases in wader numbers. Loss of arable to low quality grassland may in fact be detrimental as arable farmland can be an important nesting habitat for Lapwing.

Snipe showed steep declines on virtually all combinations of designations between 1982 and 2002 and in only a few cases was there any evidence that either AES or site protection slowed down the rate of decline when compared with the wider countryside. There is a general pattern for the smallest declines to be in sites that are protected, and indeed, that populations increased slightly on some sites that were both SSSIs and nature reserves. Densities found on land now in Low Tier ESA options were very low by 2002 and declines just as rapid as in the wider countryside, while in CSS and High Tier ESA areas, Snipe did fare better but only on nature reserves. The result of these changes is that Snipe are now highly aggregated into just a few key areas, most of which are nature reserves and many are also SSSIs – over 70% of Snipe located in 2002 (in the sample of sites used in this analysis) were on nature reserves and virtually all of these were on nature reserves also in AES. In these areas, careful habitat management, perhaps aided by AES funds, has provided areas of grassland that still hold significant populations of this species but without this management, numbers on grassland elsewhere have declined close to extinction.

The most clear-cut evidence for benefits of AES and site protection is shown by Redshank. This is a species that declined by 63% in areas with no AES or site protection between 1982 and 2002 but in contrast, in many designated areas, populations increased over that same period. Again, there is a general pattern whereby sites that are protected fared best, stressing the importance of nature reserves and to a lesser extent SSSI designation. However, that populations in all three ESA Tiers showed an increase, even outside protected areas, against the backdrop of large decreases in the wider countryside, indicates that ESA options are beneficial for this species.

Given that this analysis is based on data from just two survey years, one must consider the validity of such comparisons, especially when the surveys were 20 years apart. In particular, the fact that the AESs were designated between the survey periods, and in many cases, only a few years before the second survey, is likely to have an impact on what conclusions may be drawn. It might be supposed that benefits of AESs options increase over time, although Ausden & Hirons (2002) showed that on nature reserves maximum densities were achieved six to seven years after the onset of management and then declined slightly thereafter. The analysis carried out here shows little evidence of an increased benefit from a greater length of time in the ESA scheme, however, there are a number of caveats in relation to the pattern. Firstly, for some of these species (Snipe and Redshank) there is evidence of an increased benefit of greater time in the agreement over the first four years but that the pattern is not maintained thereafter. The cause of this might be that the timing of the management agreements varies between ESAs (see Appendix 1) and so a tranch of management agreements in a certain area might have heavily influenced these data. It is also true that the relative stability in numbers within ESAs shown by four species regardless of which year the agreement went in (the exception being Snipe) is likely to be against a background of continuing declines outside designated areas. Alternatively though, there may be an ecological explanation, whereby short-term habitat conditions are suitable but these are not attainable over a longer time period, as invertebrate (food) communities and vegetation composition and structure stabilise as a less suitable level. Sample sizes for individual ESAs and Tiers are generally too small to calculate trends relating to the year of agreement (Appendix 1).

Unfortunately, there are insufficient data from years between the 1982 and 2002 surveys to give an indication of what happened to wader populations in the interim period. It could be that in some areas, wader populations declined to a trough somewhere between the two surveys and that by 2002 populations had recovered slightly. This is likely to be the case for some designated areas at least, as evidenced by the numbers of waders found in ESA Reversion in 1982. No less than 56 pairs of Lapwings and 18 pairs of Redshank were found on land that between 1982 and 2002, was reverted from arable to grassland. Although Lapwings do nest on arable land, it is unusual for Redshanks to do so. This suggests that some of the ESA Reversion grassland may have been grassland in 1982 and was subsequently ploughed up and then reverted under the ESA scheme. This being the case, it is likely that the increases noted on ESA Reversion are in fact underestimated. The areas of arable that could be converted back to grassland in most ESAs is however finite, and indeed there may be conservation value in retaining arable pockets in these landscapes (Robinson *et al.* 2002). While reversion has met with some success, the effective long-term management of this new grassland and existing areas of grassland within ESAs may be the key to their success henceforth.

Although the Countryside Stewardship Scheme started in 1991, many sites have actually been entered into the scheme more recently than that, therefore, it may be too early to evaluate the merits of this scheme for grassland waders. While regular monitoring of grassland wader populations now takes place in most wet grassland ESAs (typically every five years), there is currently no large-scale system for monitoring the effectiveness of CSS and we suggest that a programme of regular surveys be instigated. While it is encouraging that monitoring of wader population on ESAs is taking place, the results of these surveys need to be synthesised to enable a broader picture of the effectiveness of these schemes in maintaining wader populations to be established.

In terms of cost-benefits of ESA options, Low Tier options, which cost an average of £146 per hectare in 2002 had a very low return in terms of additional pairs of waders compared to the wider countryside, with a net return rate of 0.12 pairs per square kilometre. High Tier options, which cost an average of £213 per hectare had a net return of 2.03 pairs of wader per square kilometre while ESA Reversion, costing on average £278 per hectare, had a net return rate of 13.1 pairs per square kilometre. However, this picture masks massive differences between individual ESAs, the North Kent Marshes ESA appears to have been very successful in contrast to other areas where returns are very small, even for High Tier options. The reasons for the differing levels of success achieved by the eight grassland ESAs are open to conjecture, prescriptions do differ between ESAs. The causes of the differences in success but must be understood if the successes are to be replicated elsewhere.

This study indicates that managing grassland nature reserves is the single most effective mechanism for maintaining breeding grassland wader numbers. However, as this is an expensive option, the additional funds available to grassland nature reserve managers through the ESA and CSS payments may have an important role to play in making the management of these sites viable. Wet grassland nature reserves now hold key populations of these species, especially in the case of Snipe, which is now virtually confined to nature reserves in parts of its range in England and Wales. However, due to the high costs of buying and running nature reserves (Ausden & Hirons 2002), it is unlikely that the proportion of grassland protected and managed in this way will ever be sufficient to return breeding waders to the population levels of a few decades ago. This can only be achieved by mimicking the success of nature reserve management at a larger scale through AES.

The evidence presented in this report shows that the current AESs designed to benefit breeding grassland waders are not sufficiently effective to reverse the declines in numbers witnessed in the wider countryside. While the results for Redshank are promising in that a reversal of the long-term declines has been noted in some areas, there is little to suggest that Lapwing or Snipe numbers have benefited greatly on wet grasslands from either ESA or CSS outside of nature reserves. While local successes have been achieved, these are not universal enough to suggest that expansion of these schemes in their current forms will have significant positive impacts on wet grassland wader numbers.

There is still a great deal to learn about why similar ESA prescriptions are more successful in some areas than others. The practicalities of returning wader populations to areas where they are greatly diminished or even extinct are still unknown and it could be that the lack of success shown by some ESAs could be simply due to the low recolonisation potential of these species. The evidence of successes in areas that have been reverted to grassland under ESA options does, however, show that recolonisation at a local scale is possible. In order that the processes involved in re-establishing diminished wader populations in lowland wet grassland be fully understood, continued monitoring and evaluation of agri-environment schemes is essential. In particular, the successes of some AESs (such as the North Kent Marshes) and the general success of nature reserves in stabilizing and reversing wader declines should be seen as the standards to which other AESs should be measured. Only then can the schemes be fine-tuned to ensure that they provide good quality wader habitat and good value for money.

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Table 1 Areas covered (square kilometres) for which useable spatial data are available from the Breeding Waders of Wet Meadows surveys in 1982, 1989 and 2002.

		1982 survey	1989 survey	2002 survey
Sites used	area	1715	300	1230
	number	1304	206	950
Sites for which data input but unusable	area	272	31	88
	number	205	18	67

Table 2 Areas used for comparisons on wader numbers between 1982 and 2002 by site designation.

AES	Protection	Numbers of sites (polygons)	Total area (hectares)
none	None	1323	66459.1
none	SSSI	255	5416.2
none	NR	112	2502.4
none	NR & SSSI	70	3057.7
CSS	None	164	2373
CSS	NR &/or SSSI	20	337
Low Tier	None	1400	5831.5
Low Tier	SSSI	691	2988.1
Low Tier	NR	21	152.8
Low Tier	NR & SSSI	154	836.2
High Tier	none	374	5046.6
High Tier	SSSI	1216	1527.2
High Tier	NR	93	757.8
High Tier	NR & SSSI	84	468.1
Reversion		197	1102.5

Table 3 Areas used for comparisons on wader numbers between 1982 and 2002 by site designations within ESAs.

AES	Protection	Numbers of sites (polygons)	Total area (hectares)
Avon Valley	High	141	348.5
Avon Valley	Low	6	13.6
Essex Coast	Reversion	11	75.4
Essex Coast	Low	5	5.9
North Kent Marshes	Reversion	55	390.2
North Kent Marshes	High	100	526.9
North Kent Marshes	Low	403	1637.5
Somerset Levels and Moors	High	459	2014.8
Somerset Levels and Moors	Low	794	4030.9
Suffolk River Valleys	Reversion	16	55.9
Suffolk River Valleys	High	86	451.2
Suffolk River Valleys	Low	119	683.8
Test Valley	Reversion	3	3.2
Test Valley	High	81	164.3
Test Valley	Low	10	24.5
The Broads	Reversion	80	479.5
The Broads	High	768	3844.6
The Broads	Low	848	2925.7
Upper Thames Tributaries	Reversion	31	110.5
Upper Thames Tributaries	High	132	449.4
Upper Thames Tributaries	Low	81	486.7

Table 4 Number of pairs of waders digitised from the data from the Breeding Waders of Wet Meadows surveys.

	1982 survey	1989 survey	2002 survey
Oystercatcher	686	103	875
Lapwing	7905	974	4189
Snipe	2119	508	609
Curlew	585	110	337
Redshank	3012	640	2035
Total	14307	2335	8045

Table 5 Wader numbers, densities and density changes between the 1982 and 2002 surveys, by site designations.

Table 5a Oystercatcher

AES	Protection	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
None	None	340	369	0.51	0.56	9
None	SSSI	6	21	0.11	0.39	250
None	NR	3	43	0.12	1.72	1333
None	NR & SSSI	7	41	0.23	1.34	486
CSS	none	3	3	0.13	0.13	0
CSS	NR &/or SSSI	2	1	0.59	0.30	-50
Low Tier	none	14	18	0.24	0.31	29
Low Tier	SSSI	4	6	0.13	0.20	50
Low Tier	NR	0	0	0.00	0.00	0
Low Tier	NR & SSSI	0	0	0.00	0.00	0
High Tier	none	43	63	0.85	1.25	47
High Tier	SSSI	0	7	0.00	0.46	+∞
High Tier	NR	23	64	3.04	8.45	178
High Tier	NR & SSSI	0	2	0.00	0.43	+∞
Reversion		3	40	0.27	3.63	1233

Table 5b Lapwing

AES	Protection	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
None	none	1976	1033	2.97	1.55	-48
None	SSSI	231	156	4.26	2.88	-32
None	NR	125	156	5.00	6.23	25
None	NR & SSSI	365	371	11.94	12.13	2
CSS	none	71	42	2.99	1.77	-41
CSS	NR &/or SSSI	70	181	20.77	53.71	159
Low Tier	none	241	99	4.13	1.70	-59
Low Tier	SSSI	69	96	2.31	3.21	39
Low Tier	NR	0	2	0.00	1.31	+∞
Low Tier	NR & SSSI	25	19	2.99	2.27	-24
High Tier	none	314	243	6.22	4.82	-23
High Tier	SSSI	117	34	7.66	2.23	-71
High Tier	NR	180	226	23.75	29.82	26
High Tier	NR & SSSI	25	22	5.34	4.70	-12
Reversion		56	95	5.08	8.62	70

Table 5c Snipe

AES	Protection	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
None	None	343	78	0.52	0.12	-77
None	SSSI	227	37	4.19	0.68	-84
None	NR	57	10	2.28	0.40	-82
None	NR & SSSI	475	203	15.53	6.64	-57
CSS	None	27	4	1.14	0.17	-85
CSS	NR &/or SSSI	76	83	22.55	24.63	9
Low Tier	None	41	4	0.70	0.07	-90
Low Tier	SSSI	37	7	1.24	0.23	-81
Low Tier	NR	4	0	2.62	0.00	-100
Low Tier	NR & SSSI	29	9	3.47	1.08	-69
High Tier	none	85	10	1.68	0.20	-88
High Tier	SSSI	37	0	2.42	0.00	-100
High Tier	NR	11	10	1.45	1.32	-9
High Tier	NR & SSSI	11	16	2.35	3.42	45
Reversion		2	1	0.18	0.09	-50

Table 5d Curlew

AES	Protection	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
None	none	290	165	0.44	0.25	-43
None	SSSI	9	7	0.17	0.13	-22
None	NR	14	35	0.56	1.40	150
None	NR & SSSI	4	3	0.13	0.10	-25
CSS	none	9	11	0.38	0.46	22
CSS	NR &/or SSSI	0	0	0.00	0.00	0
Low Tier	none	10	8	0.17	0.14	-20
Low Tier	SSSI	9	10	0.30	0.33	11
Low Tier	NR	0	0	0.00	0.00	0
Low Tier	NR & SSSI	4	4	0.48	0.48	0
High Tier	none	2	5	0.04	0.10	150
High Tier	SSSI	9	5	0.59	0.33	-44
High Tier	NR	2	2	0.26	0.26	0
High Tier	NR & SSSI	2	2	0.43	0.43	0
Reversion		0	0	0.00	0.00	0

Table 5e Redshank

AES	Protection	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
None	none	733	268	1.10	0.40	-63
None	SSSI	149	69	2.75	1.27	-54
None	NR	48	131	1.92	5.23	173
None	NR & SSSI	196	372	6.41	12.17	90
CSS	none	21	4	0.88	0.17	-81
CSS	NR &/or SSSI	12	131	3.56	38.87	992
Low Tier	none	23	52	0.39	0.89	126
Low Tier	SSSI	93	76	3.11	2.54	-18
Low Tier	NR	0	2	0.00	1.31	+∞
Low Tier	NR & SSSI	17	34	2.03	4.07	100
High Tier	none	127	130	2.52	2.58	2
High Tier	SSSI	31	42	2.03	2.75	35
High Tier	NR	203	129	26.79	17.02	-36
High Tier	NR & SSSI	9	14	1.92	2.99	56
Reversion		18	64	1.63	5.80	256

Table 6 Agri-environment scheme (AES) and site protection (Protection) parameter estimates and significance of changes in wader densities between 1982 and 2002 derived from a Generalised Linear Model. The dependent variable is the wader density in 2002. Est = back-transformed parameter estimates, which are set relative to a value of 1 for areas that are outside AES and have no site protection (null level). P = significance of difference from the null level. N=6174 polygons. Δ = the relative density change between -1 (extinction) and 1 (colonisation).

		Oystercatcher			Lapwing			Snipe		
Deviance/d.f.		1.17			0.96			0.54		
AES	Protection	Δ	Est	P	Δ	Est	P	Δ	Est	P
Reversion		0.86	1.32	0.4570	0.26	1.89	0.1270	-0.33	6.54	0.5234
High Tier	NR & SSSI	1.00	-		-0.06	0.76	0.5960	0.19	5.52	0.1602
High Tier	NR	0.47	1.42	0.4180	0.11	1.71	0.0220	-0.05	2.98	0.2619
High Tier	SSSI	1.00	1.74	0.6135	-0.55	0.54	0.0527	-1.00	0.00	0.9775
High Tier	none	0.19	1.06	0.7769	-0.13	1.49	0.1088	-0.79	0.46	0.1214
Low Tier	NR & SSSI		-		-0.14	1.70	0.2339	-0.53	1.91	0.4222
Low Tier	NR		-		1.00	3.24	0.4011	-1.00	0.00	0.9999
Low Tier	SSSI	0.20	1.29	0.5436	0.16	1.99	0.0042	-0.68	0.92	0.8846
Low Tier	none	0.13	1.03	0.9134	-0.42	0.96	0.0847	-0.82	0.81	0.7274
CSS	NR &/or SSSI	-0.33	0.69	0.7702	0.44	1.97	0.2939	0.04	5.15	0.2173
CSS	none	0.00	0.81	0.7142	-0.26	1.06	0.8638	-0.74	0.88	0.8855
None	NR & SSSI	0.71	1.40	0.5453	0.01	1.30	0.5554	-0.40	2.05	0.4065
None	NR	0.87	1.49	0.4319	0.11	1.68	0.2638	-0.70	1.37	0.7397
None	SSSI	0.56	1.50	0.2548	-0.19	1.33	0.3458	-0.72	0.79	0.6805
None	none	0.04	1.00		-0.31	1.00		-0.63	1.00	
Intercept			0.58			0.31			0.15	

Table 6 continued

		Curlew			Redshank			All waders		
Deviance/d.f.		1.03			0.91			0.97		
AES	Protection	Δ	Est	P	Δ	Est	P	Δ	Est	P
Reversion			-		0.56	2.81	0.0227	0.43	2.19	0.0169
High Tier	NR & SSSI	0.00	1.52	0.5561	0.22	3.36	0.0747	0.09	1.71	0.2211
High Tier	NR	0.00	1.07	0.9452	-0.22	2.10	0.1273	0.01	1.48	0.3142
High Tier	SSSI	-0.29	0.92	0.8769	0.15	0.92	0.8820	-0.38	0.50	0.0051
High Tier	none	0.43	2.20	0.1308	0.01	1.94	0.0042	-0.12	1.44	0.0099
Low Tier	NR & SSSI	0.00	1.10	0.8796	0.33	2.70	0.0208	-0.06	1.66	0.1144
Low Tier	NR		-		1.00	4.70	0.2626	0.00	2.12	0.3952
Low Tier	SSSI	0.05	1.55	0.2217	-0.10	1.84	0.0149	-0.04	1.43	0.0423
Low Tier	none	-0.11	1.45	0.3524	0.39	2.65	0.0054	-0.29	1.20	0.2795
CSS	NR &/or SSSI		-		0.83	4.50	0.0762	0.42	2.13	0.2376
CSS	none	0.10	1.84	0.1093	-0.68	0.79	0.6989	-0.34	1.40	0.2563
None	NR & SSSI	-0.14	0.64	0.6907	0.31	3.25	0.0135	-0.03	1.54	0.2757
None	NR	0.43	2.16	0.1145	0.46	2.63	0.0891	0.21	1.66	0.1983
None	SSSI	-0.13	1.74	0.3872	-0.37	1.90	0.0421	-0.36	1.28	0.3027
None	none	-0.27	1.00		-0.46	1.00		-0.32	1.00	
Intercept			0.33			0.21			0.28	

Table 7 Wader numbers, densities and density changes between the 1982 and 2002 Surveys in ESAs by Tiers.

Table 7a Oystercatcher

ESA	Tier	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
Avon Valley	High	0	0	0.00	0.00	0
Avon Valley	Low	0	0	0.00	0.00	0
Essex Coast	Reversion	2	2	2.65	2.65	0
Essex Coast	Low	0	0	0.00	0.00	0
North Kent Marshes	Reversion	1	33	0.26	8.46	3200
North Kent Marshes	High	24	60	4.55	11.39	150
North Kent Marshes	Low	6	9	0.37	0.55	50
Somerset Levels and Moors	High	0	0	0.00	0.00	0
Somerset Levels and Moors	Low	0	0	0.00	0.00	0
Suffolk River Valleys	Reversion	0	0	0.00	0.00	0
Suffolk River Valleys	High	0	14	0.00	3.10	+∞
Suffolk River Valleys	Low	2	2	0.29	0.29	0
Test Valley	Reversion	0	0	0.00	0.00	0
Test Valley	High	0	1	0.00	0.61	+∞
Test Valley	Low	0	0	0.00	0.00	0
The Broads	Reversion	0	5	0.00	1.04	+∞
The Broads	High	42	61	1.09	1.59	45
The Broads	Low	10	13	0.34	0.44	30
Upper Thames Tributaries	Reversion	0	0	0.00	0.00	0
Upper Thames Tributaries	High	0	0	0.00	0.00	0
Upper Thames Tributaries	Low	0	0	0.00	0.00	0

Table 7b Lapwing

ESA	Tier	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
Avon Valley	High	11	32	3.16	9.18	191
Avon Valley	Low	0	0	0.00	0.00	0
Essex Coast	Reversion	11	0	14.59	0.00	-100
Essex Coast	Low	0	0	0.00	0.00	0
North Kent Marshes	Reversion	33	73	8.46	18.71	121
North Kent Marshes	High	157	126	29.80	23.91	-20
North Kent Marshes	Low	23	64	1.40	3.91	178
Somerset Levels and Moors	High	92	24	4.57	1.19	-74
Somerset Levels and Moors	Low	115	66	2.85	1.64	-43
Suffolk River Valleys	Reversion	3	4	5.37	7.16	33
Suffolk River Valleys	High	77	43	17.07	9.53	-44
Suffolk River Valleys	Low	50	3	7.31	0.44	-94
Test Valley	Reversion	0	0	0.00	0.00	0
Test Valley	High	1	1	0.61	0.61	0
Test Valley	Low	0	0	0.00	0.00	0
The Broads	Reversion	8	18	1.67	3.75	125
The Broads	High	298	291	7.75	7.57	-2
The Broads	Low	147	64	5.02	2.19	-56
Upper Thames Tributaries	Reversion	1	0	0.90	0.00	-100
Upper Thames Tributaries	High	0	8	0.00	1.78	+∞
Upper Thames Tributaries	Low	0	19	0.00	3.90	+∞

Table 7c Snipe

ESA	Tier	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
Avon Valley	High	27	1	7.75	0.29	-96
Avon Valley	Low	0	0	0.00	0.00	0
Essex Coast	Reversion	0	0	0.00	0.00	0
Essex Coast	Low	0	0	0.00	0.00	0
North Kent Marshes	Reversion	0	1	0.00	0.26	+∞
North Kent Marshes	High	0	0	0.00	0.00	0
North Kent Marshes	Low	11	0	0.67	0.00	-100
Somerset Levels and Moors	High	42	16	2.08	0.79	-62
Somerset Levels and Moors	Low	65	17	1.61	0.42	-74
Suffolk River Valleys	Reversion	2	0	3.58	0.00	-100
Suffolk River Valleys	High	13	0	2.88	0.00	-100
Suffolk River Valleys	Low	1	0	0.15	0.00	-100
Test Valley	Reversion	0	0	0.00	0.00	0
Test Valley	High	4	0	2.43	0.00	-100
Test Valley	Low	0	0	0.00	0.00	0
The Broads	Reversion	0	0	0.00	0.00	0
The Broads	High	56	19	1.46	0.49	-66
The Broads	Low	25	3	0.85	0.10	-88
Upper Thames Tributaries	Reversion	0	0	0.00	0.00	0
Upper Thames Tributaries	High	2	0	0.45	0.00	-100
Upper Thames Tributaries	Low	9	0	1.85	0.00	-100

Table 7d Curlew

ESA	Tier	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
Avon Valley	High	1	1	0.29	0.29	0
Avon Valley	Low	0	0	0.00	0.00	0
Essex Coast	Reversion	0	0	0.00	0.00	0
Essex Coast	Low	0	0	0.00	0.00	0
North Kent Marshes	Reversion	0	0	0.00	0.00	0
North Kent Marshes	High	0	0	0.00	0.00	0
North Kent Marshes	Low	0	0	0.00	0.00	0
Somerset Levels and Moors	High	11	8	0.55	0.40	-27
Somerset Levels and Moors	Low	17	11	0.42	0.27	-35
Suffolk River Valleys	Reversion	0	0	0.00	0.00	0
Suffolk River Valleys	High	0	0	0.00	0.00	0
Suffolk River Valleys	Low	0	0	0.00	0.00	0
Test Valley	Reversion	0	0	0.00	0.00	0
Test Valley	High	0	0	0.00	0.00	0
Test Valley	Low	0	0	0.00	0.00	0
The Broads	Reversion	0	0	0.00	0.00	0
The Broads	High	0	0	0.00	0.00	0
The Broads	Low	0	0	0.00	0.00	0
Upper Thames Tributaries	Reversion	0	0	0.00	0.00	0
Upper Thames Tributaries	High	3	5	0.67	1.11	67
Upper Thames Tributaries	Low	6	11	1.23	2.26	83

Table 7e Redshank

ESA	Tier	Pairs in 1982	Pairs in 2002	Pairs/km^2 in 1982	Pairs/km^2 in 2002	% change 1982-2002
Avon Valley	High	56	14	16.07	4.02	-75
Avon Valley	Low	0	0	0.00	0.00	0
Essex Coast	Reversion	7	16	9.28	21.22	129
Essex Coast	Low	1	0	16.95	0.00	-100
North Kent Marshes	Reversion	10	46	2.56	11.79	360
North Kent Marshes	High	141	138	26.76	26.19	-2
North Kent Marshes	Low	95	72	5.80	4.40	-24
Somerset Levels and Moors	High	17	16	0.84	0.79	-6
Somerset Levels and Moors	Low	26	27	0.65	0.67	4
Suffolk River Valleys	Reversion	0	0	0.00	0.00	0
Suffolk River Valleys	High	21	53	4.65	11.75	152
Suffolk River Valleys	Low	4	24	0.58	3.51	500
Test Valley	Reversion	0	0	0.00	0.00	0
Test Valley	High	11	0	6.70	0.00	-100
Test Valley	Low	0	0	0.00	0.00	0
The Broads	Reversion	1	2	0.21	0.42	100
The Broads	High	122	94	3.17	2.44	-23
The Broads	Low	4	35	0.14	1.20	775
Upper Thames Tributaries	Reversion	0	0	0.00	0.00	0
Upper Thames Tributaries	High	2	0	0.45	0.00	-100
Upper Thames Tributaries	Low	3	6	0.62	1.23	100

Table 8 Results of linear regression analysis of changes in wader densities with regards number of years in ESA agreement.

	Oystercatcher	**Lapwing**	**Snipe**	**Curlew**	**Redshank**	**Lapwing Low Tier in Somerset Levels & Moors**
Intercept	0.72	-5.65	-0.73	-0.067	0.918	-1.684
year coefficient	-0.056	0.42	-0.09	0.0079	-0.14	0.059
R^2	0.18	0.14	0.19	0.026	0.08	0.027
F	1.07	1.49	1.49	1.62	0.78	0.25
significance	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

Figure 1 Example of GIS data analysis.

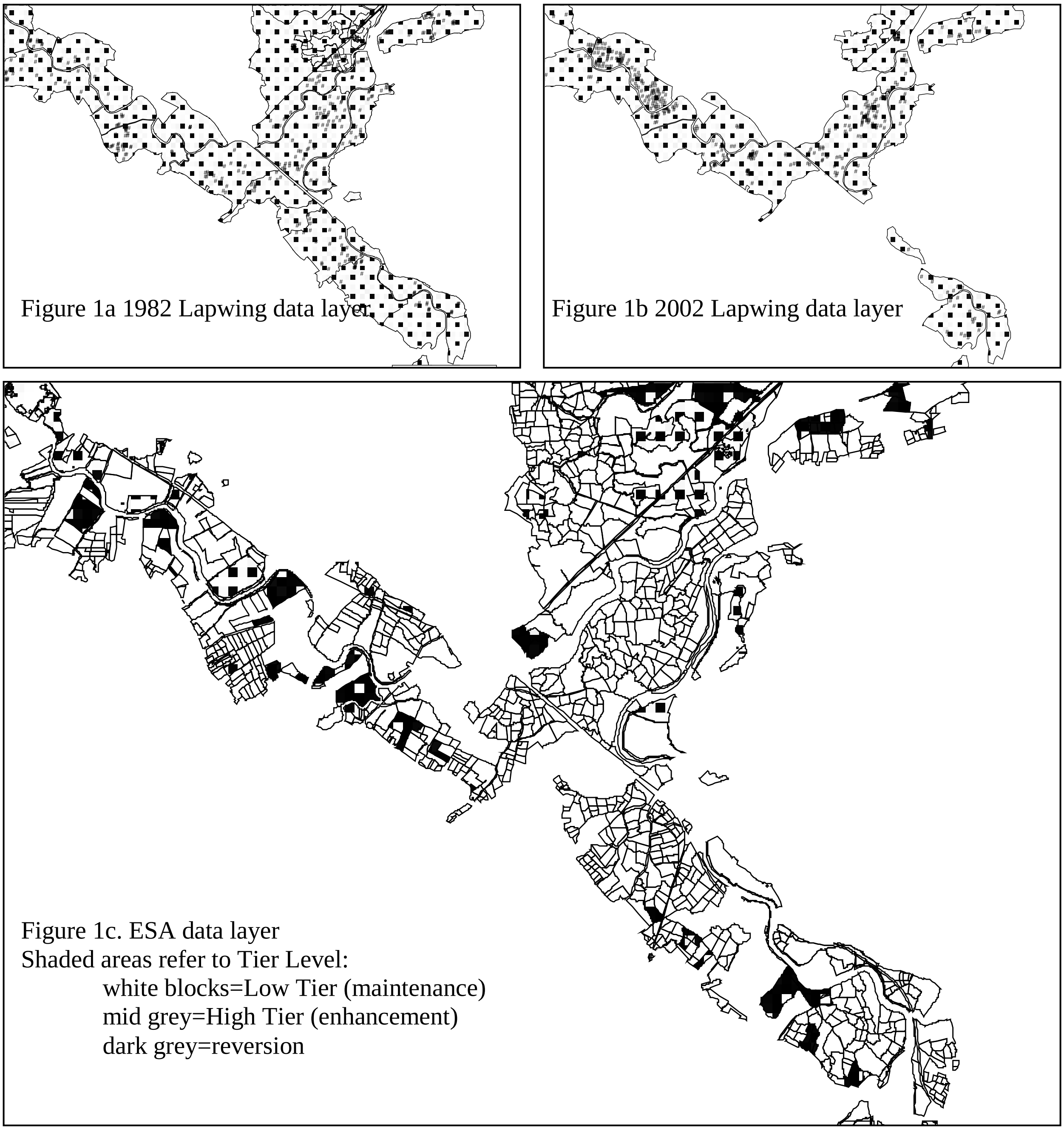


Figure 2 Areas of lowland wet grassland entered into ESA Tiers in England by 2002 (actual) and areas for which comparable data are available from the 1982 and 2002 surveys (covered). For abbreviated names of ESA see section 2.2.

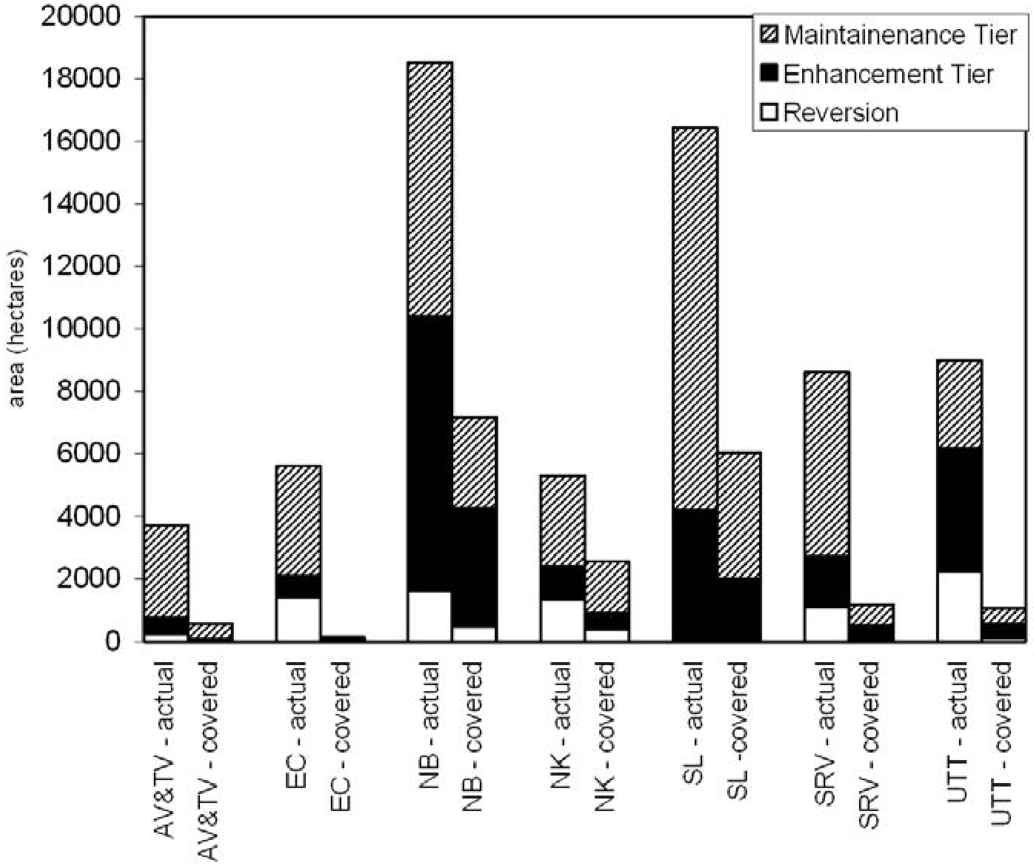
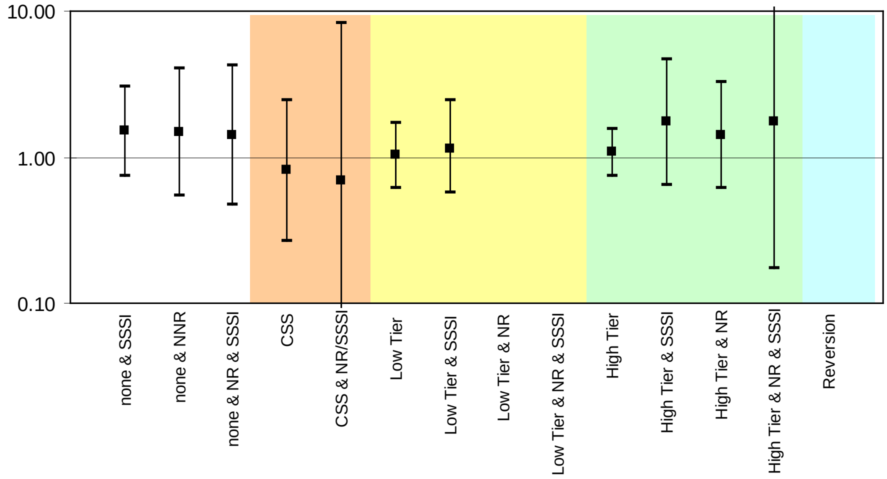
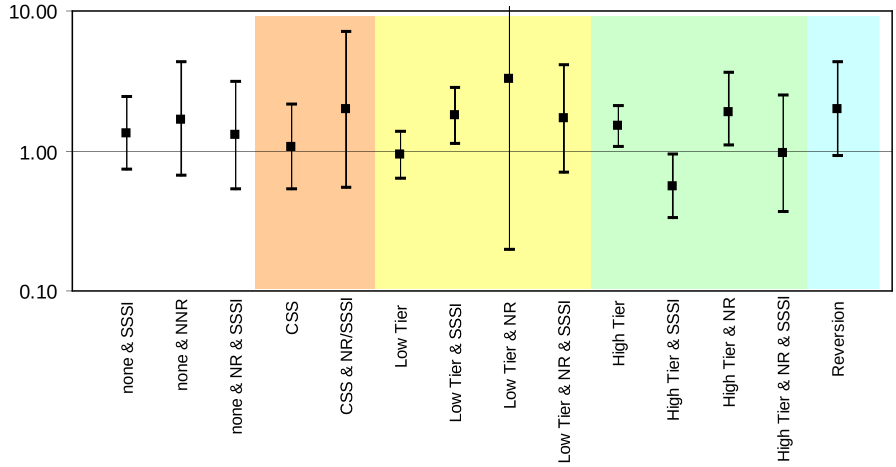


Figure 3 Wader population density changes between 1982 and 2002 on sites with either (or both) an Agri-environment scheme or site protection, relative to changes in the wider countryside. Values of greater than 1 represent a more favourable rate of change, and values of less than 1 represent a less favourable rate of change than in the wider countryside (CSS=Countryside Stewardship Scheme,

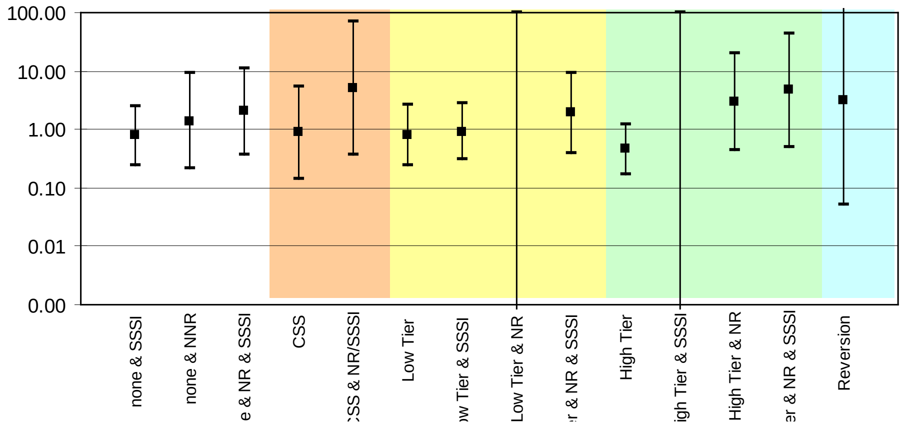
3a. Oystercatcher



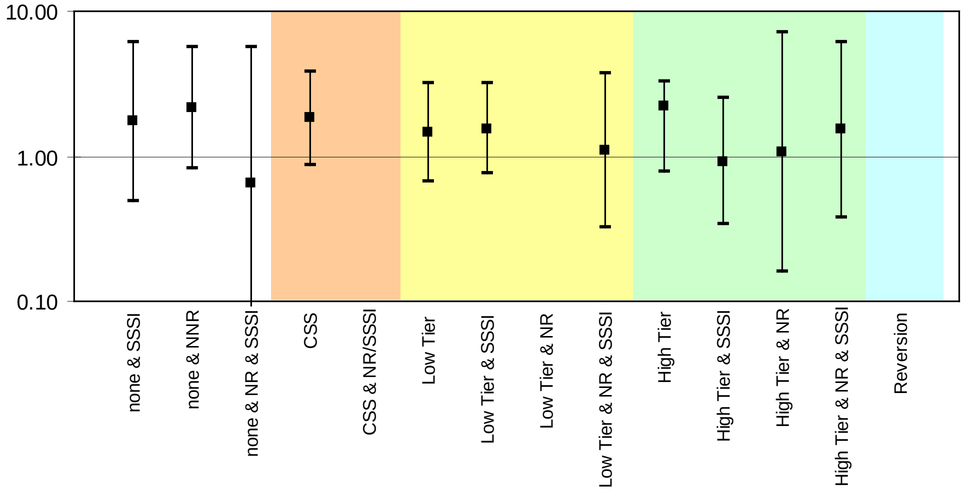
3b. Lapwing



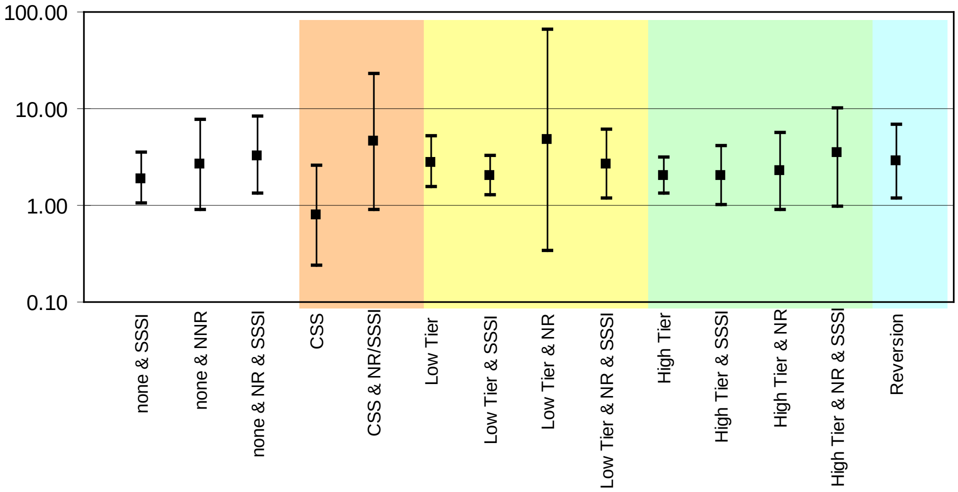
3c. Snipe



3d. Curlew



3e. Redshank



3f. All grassland waders

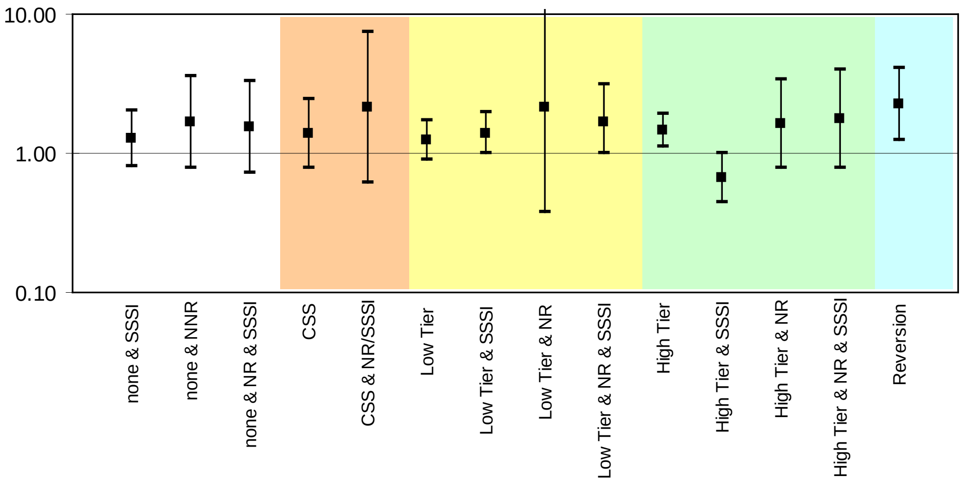


Figure 4 Graphs to detect evidence of Autocorrelation in the Breeding Wader Survey data. 4a shows the changes in density of Lapwing and Redshank with increasing distance from wader "hotspots", 4b shows Lapwing densities in 1982 and 2002 and 4c shows Redshank densities in 1982 and 2002.

Figure 4a

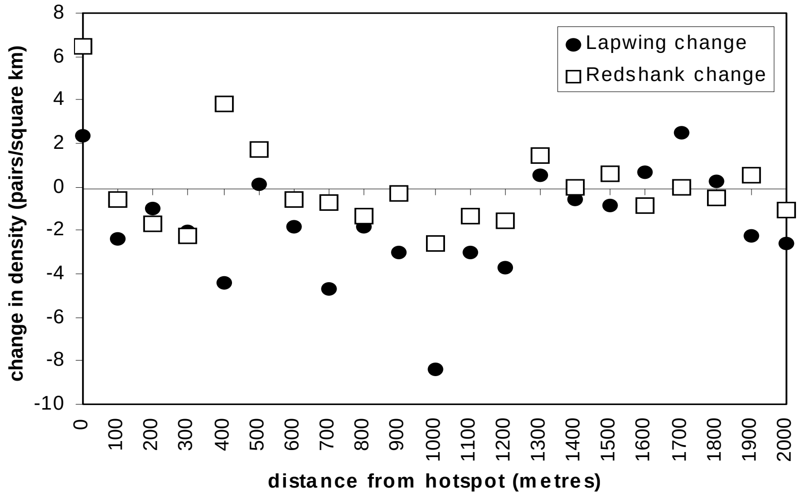


Figure 4b

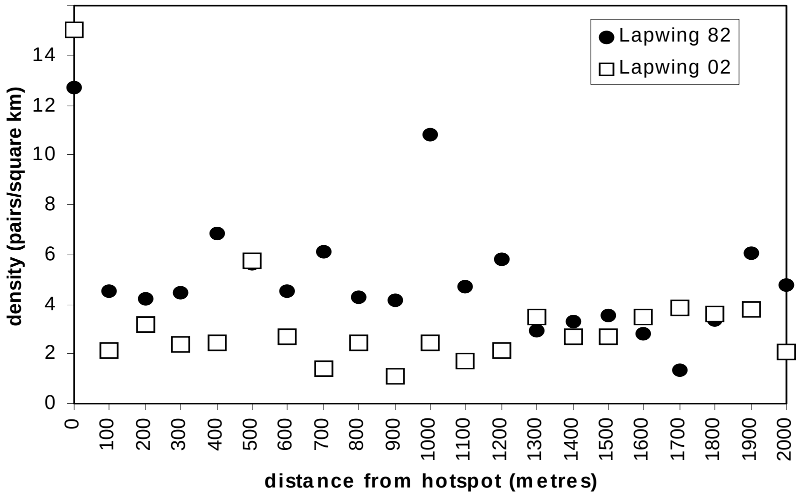


Figure 4c

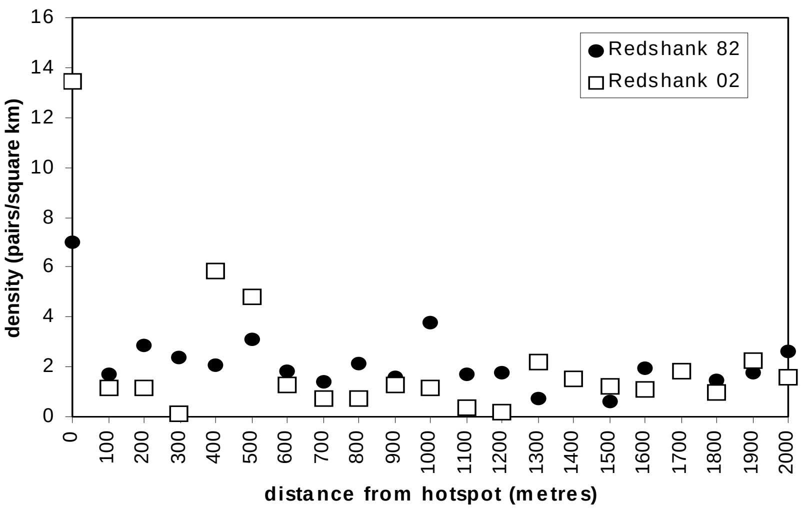
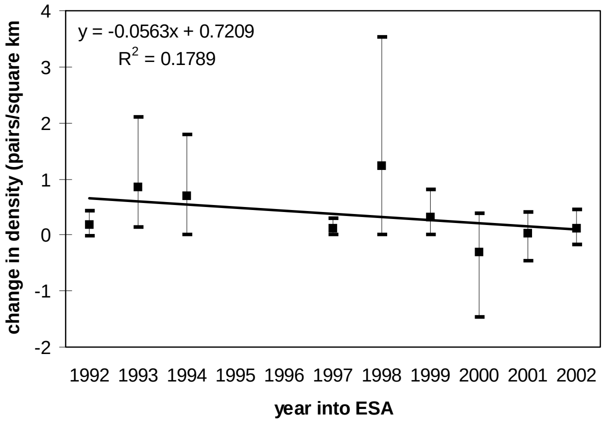
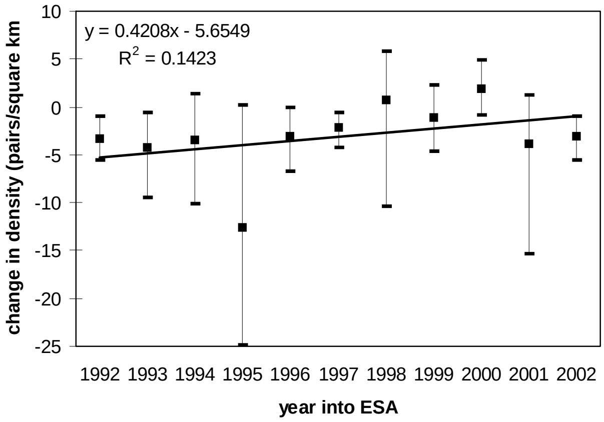


Figure 5 Changes in wader densities between 1982 and 2002 in areas under ESA agreements by year of entry into agreement.

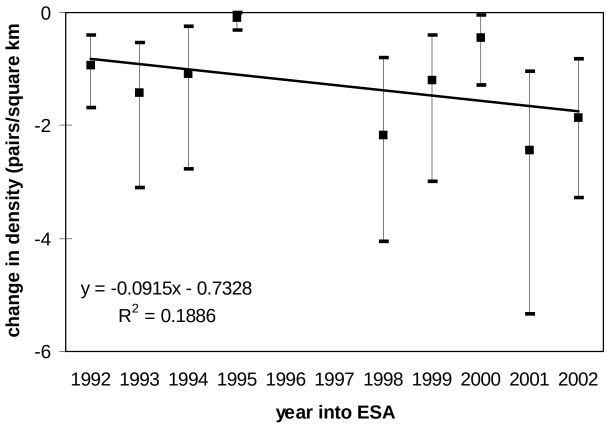
5a Oystercatcher



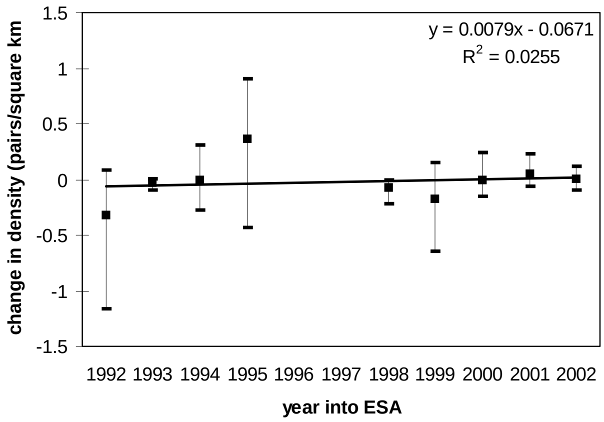
5b Lapwing



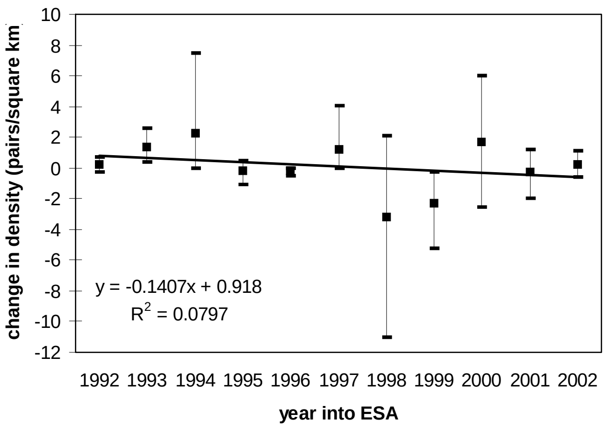
5c Snipe



5d Curlew



5e Redshank



Notes:

1. Trend line given are from Linear Regression, equation and fit (R^2) given in each graph.

2. Error bars represent 95% confidence limits from 1000 bootstrapped re-samples.

Figure 6 Changes in wader densities between 1982 and 2002 in areas under Low Tier (maintenance) agreements in the Somerset Levels and Moors ESA by year of entry into agreement.

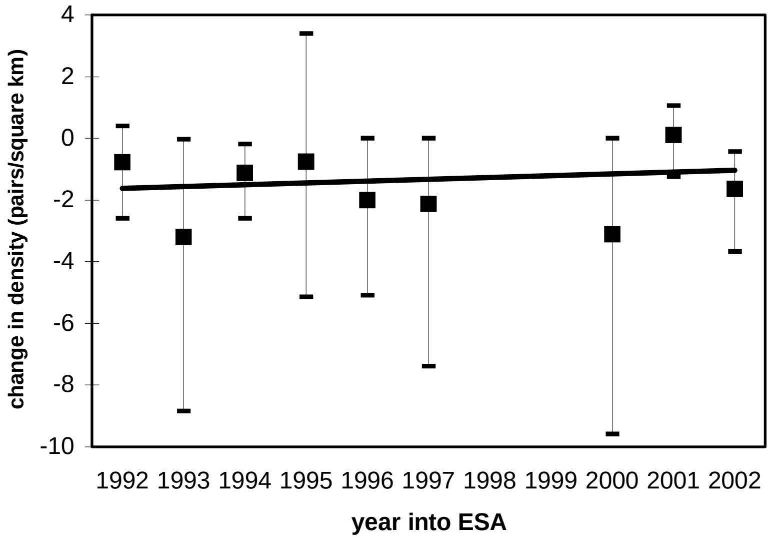
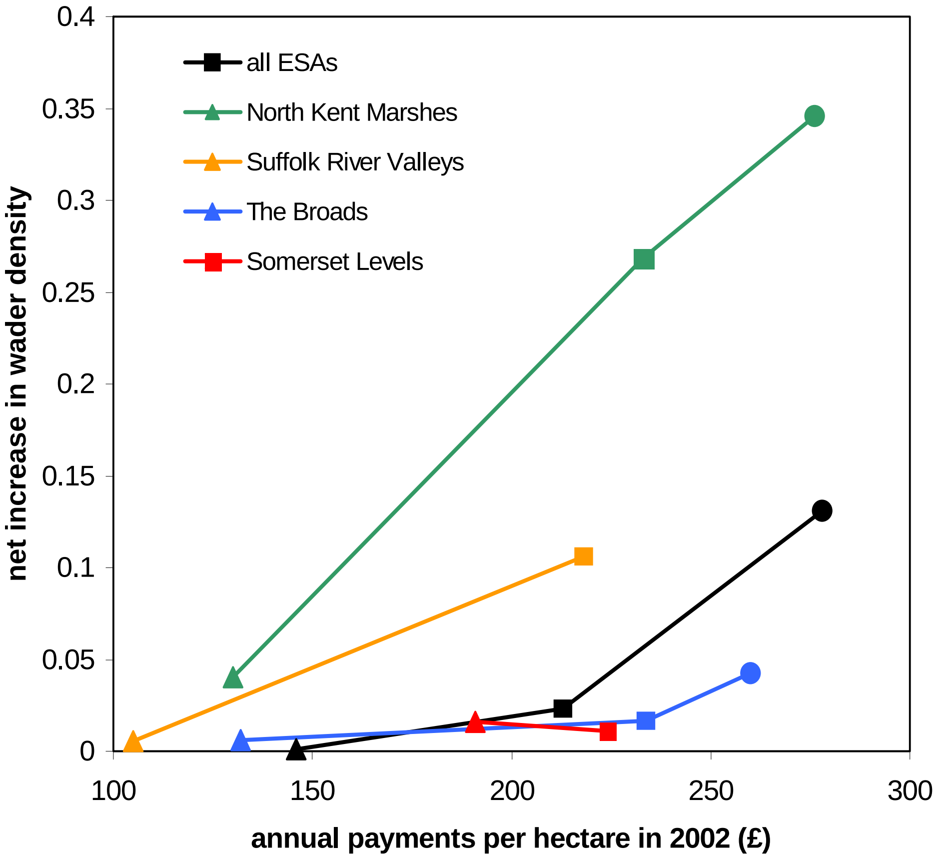


Figure 7 Net change in wader density (pairs per hectare) over the surrounding wider countryside between 1982 and 2002 for ESA Tiers against annual cost of management prescriptions (£ per hectare). ▲= Low Tier ■= High Tier ●= Reversion.



APPENDIX 1. Tables of Extent of Land Under Agreements in 2002 for Each Major Lowland Wet Grassland ESA

Appendix 1.1 Avon Valley

Tier Description	**Tier**	**Payment (£/ha) 2002**	**Area**	**Year into agreement**						**Total**
				unknown	**1998**	**1999**	**2000**	**2001**	**2002**	
Arable reversion to permanent grassland	2A "R"	300	Total		21.9	36.3	9.7	24.0		91.9
			Mean block size		11.0	5.2	1.9	3.0		
Extensive permanent grassland	1B "L"	135	Total	28.1	640.2	112.6	340.7	59.2	281.4	1462.2
			Mean block size	2.8	2.1	2.7	3.0	3.7	3.2	
Extensive permanent grassland with breeding wader supplement	1B "L"	175	Total		143.2	2.9	41.1	5.4	22.1	214.7
			Mean block size		4.1	2.9	3.2	5.4	2.2	
Grassland (former scheme)	1 "L"	135	Total			148.4	3.8			152.2
			Mean block size			4.6	1.9			
Improved permanent grassland	1A "L"	35	Total		33.1		21.4	27.1		81.6
			Mean block size		1.8		3.1	3.9		
Improved permanent grassland with low fertiliser supplement	1A "L"	85	Total		57.8	9.3	11.4			78.5
			Mean block size		2.8	2.3	2.3			
Wet grassland	1C "H"	330	Total		70.9		47.6	12.8	32.5	163.8
			Mean block size		2.2		4.3	3.2	2.2	
Wet grassland with breeding wader supplement	1C "H"	370	Total		7.5					7.5
			Mean block size		7.5					

Appendix 1.2 Essex Coast

Tier Description	Tier	Payment (£/ha) 2002	Area	Year into agreement										Total
				unknown	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Arable reversion to permanent grassland	3 “R”	275	Total	37.5	120.5	1	211.8		47.5	43.5	35.2	210.6	117.1	833.9
			Mean block size	3.4	6.0	2.5	5.7		5.3	4.0	5.0	5.3	9.8	
Arable reversion to permanent grassland with grazing marsh supplement	3 “R”	355	Total		9.9	80.7	23.4			76.8	76.5	5.1	118.3	390.8
			Mean block size		5.0	4.5	11.7			11.0	19.1	5.1	29.6	
Arable reversion to permanent grassland with wildfowl pasture supplement	3 “R”	325	Total								18.2			18.2
			Mean block size								9.1			
Arable reversion with grazing marsh and wildfowl pasture supplements	3 “R”	405	Total			109.6				48.1	42.5			200.2
			Mean block size			11.0				24.0	21.3			
Marshland	2B “L”	250	Total		14.2	15.3	38.2			48.3	6.7			122.7
			Mean block size		2.8	3.1	19.1			4.4	6.7			
Permanent grassland	1A “L”	70	Total	124.5	308.1	136.6	202.0	240.6	227.3	517.3	105.5	241.6	152.6	2256.0
			Mean block size	8.9	5.6	5.5	4.5	14.2	10.8	7.1	3.8	4.2	5.5	
Permanent grassland with grazing marsh and wildfowl pasture supplements	1A “L”	200	Total			13.5				5.9	17.8	9.8		47.0
			Mean block size			13.5				5.9	3.6	4.9		
Permanent grassland with grazing marsh supplement	1A “L”	150	Total		5.1	24.7	10.9	145.0	92.2	575.7	26.4	38.1	13.4	931.4
			Mean block size		2.5	1.6	2.7	18.1	23.1	6.3	2.2	3.5	6.7	
Permanent grassland with wildfowl pasture supplement	1A “L”	120	Total					57.3		71.1				128.5
			Mean block size					14.3		8.9				
Wet grassland	2A “H”	190	Total		82.9	16.6	13.4	2.4	16.3	476.5		59.9	2.0	669.9
			Mean block size		7.5	2.4	4.5	2.4	8.1	17.0		3.3	2.0	

Appendix 1.3 North Kent Marshes

Tier Description	Tier	Payment (£/ha) 2002	Area	Year into agreement							Total
				unknown	1993	1998	1999	2000	2001	2002	
Arable reversion to permanent grassland	2 “R”	275	Total			266.8	643.1	1.6	244.4	189.6	1345.5
			Mean block size			17.8	6.9	1.6	17.4	12.6	
Permanent grassland	1 “L”	130	Total	76.5	26.9	72.5	2212.6	16.7	281.7	213.4	2900.4
			Mean block size	3.8	2.7	2.4	4.4	3.3	3.4	5.0	
Water management	1B “H”	290	Total			213.6	143.8	8.3	81.9	109.6	557.2
			Mean block size			7.1	3.6	2.8	6.8	5.5	
Wet grassland	1A “H”	180	Total		12.3		501.0				513.3
			Mean block size		2.1		5.4				

Appendix 1.4 Somerset Levels

Tier Description	Tier	Payment (£/ha) 2002	Area	Year into agreement											Total
				1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	
Extensive permanent grassland	1A "L"	200	Total	340.2	84.3	9.9	16.3		64.0	18.8	44.6	19.4	130.9	231.6	960.0
			Mean block size	5.2	3.7	2.5	3.3		4.0	3.1	3.0	3.9	4.2	4.5	
Permanent grassland	1 "L"	125	Total	3284.5	689.9	202.3	215.2	238.3	597.1	584.0	574.1	466.3	576.9	3847.5	11276.1
			Mean block size	5.7	5.1	4.3	4.5	7.0	5.5	7.2	5.2	6.1	5.2	6.3	
Permanent grassland raised water level area	3 "H"	430	Total	239.0	327.9	77.8	58.3	1.2		8.0		14.7	182.6	311.4	1221.0
			Mean block size	6.3	14.3	38.9	7.3	1.2		8.0		7.4	5.9	8.4	
Permanent grassland with raised water level area supplement	1 "L"	205	Total	1.5	11.6									3.5	16.6
			Mean block size	0.8	5.8									1.7	
Wet permanent grassland	2 "H"	225	Total	912.4	327.3	41.9	34.6	4.3	84.5	53.2	118.4	101.0	298.7	850.2	2826.4
			Mean block size	4.3	6.2	4.2	2.9	4.3	7.7	4.1	4.1	4.2	4.2	4.5	
Wet permanent grassland with raised water level area supplement	2 "H"	305	Total	24.2	103.4							1.2	5.3	1.4	135.5
			Mean block size	4.0	12.9							1.2	2.6	1.4	

Appendix 1.5 Suffolk River Valleys

Tier Description	Tier	Payment (£/ha) 2002	Area	Year into agreement											Total
				1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Arable reversion to grassland	3	290	Total	19.1	199.2	94.1	136.2	97.1	31.4	76.7	83.6	89.7	84.3	171.8	1083.3
			Mean block size	2.1	3.6	3.9	5.4	5.7	3.9	4.8	4.0	4.1	3.2	4.2	6.4
Fen tier	Fen	170	Total	18.6	24.0					0.3	193.7	22.4		22.8	281.9
			Mean block size	9.3	12.0					0.3	12.1	1.5		5.7	
Fen tier with water level supplement	Fen	230	Total								9.8				9.8
			Mean block size								3.3				
Low input grassland	2	190	Total	69.2	554.8	269.1	11.6	6.3	50.0	59.3	54.8	4.7	57.8	62.0	1199.8
			Mean block size	3.8	5.8	7.7	2.3	2.1	12.5	7.4	3.0	1.6	2.1	4.1	
Low input grassland previous reversion + marshland + water level supplements	3 to 2	430	Total		77.3										77.3
			Mean block size		25.8										
Low input grassland previous reversion + marshland supplement	3 to 2	370	Total		5.3										5.3
			Mean block size		5.3										
Low input grassland reverted under previous agreement	3 to 2	190	Total		54.9					8.2			3.8		66.9
			Mean block size		2.2					2.0			3.8		
Low input grassland with marshland and water level supplements	2	330	Total		80.9			9.9			53.1		5.7	1.3	150.9
			Mean block size		20.2			4.9			17.7		1.9	1.3	
Low input grassland with marshland supplement	2	270	Total	13.7	82.6	73.6	14.4				5.8		11.1		201.2
			Mean block size	3.4	9.2	5.3	4.8				5.8		2.2		
Low input grassland with water level supplement	2	250	Total	4.2	25.6						42.0				71.7
			Mean block size	4.2	25.6						5.2				
Permanent grassland	1	75	Total	384.9	1965.1	632.3	279.6	79.3	67.9	171.0	74.8	75.9	137.6	288.5	4156.8
			Mean block size	5.6	5.2	5.3	4.1	2.3	2.8	2.8	2.2	1.4	2.4	5.8	
Permanent grassland reverted under previous agreement	3 to 1	75	Total	48.6	1040.6	375.3	55.7	7.6	1.6	36.3	15.7	2.0	27.9	136.6	1747.8
			Mean block size	3.2	7.8	8.2	18.6	1.9	1.6	5.2	2.2	2.0	2.3	10.5	

Appendix 1.6 The Broads

Tier Description	Tier	Payment (£/ha) 2002	Area	Year into agreement												Total
				Un-known	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Arable reversion to permanent grassland	4A	260	Total	27.4	204.2	176.8	17.0	29.2	29.2	91.6	68.1	107.3	96.2	243.7	536.1	1626.9
			Mean block size	4.5	3.7	6.8	3.4	5.8	3.2	3.4	6.2	11.9	2.8	6.5	5.3	
Extensive grassland	2	225	Total	104.0	2389.8	1093.6	65.9	70.0	32.0	358.5	64.0	56.8	65.9	291.3	2970.2	7562.0
			Mean block size	4.3	3.9	6.1	8.2	5.0	2.9	6.2	3.6	3.5	2.5	7.5	4.1	
Extensive grassland with water level supplement	2	295	Total				3.5					1.7			171.9	177.1
			Mean block size				1.8					1.7			10.7	
Fen	Fen	150	Total	8.1	20.9	26.0			13.9	138.9	9.6	148.8	50.5	44.4	487.8	949.0
			Mean block size	2.0	2.1	1.7			6.9	4.3	1.6	7.1	6.3	4.0	4.8	
Permanent grassland	1	130	Total	176.6	2436.4	826.9	63.6	61.3	48.5	855.9	152.6	79.9	320.4	321.2	2772.9	8116.4
			Mean block size	2.8	3.5	3.8	2.7	3.3	2.0	4.8	3.2	2.9	1.9	2.6	3.6	
Wet grassland	3	310	Total	4.3	197.8	277.3	6.8	1.9	2.2	47.8	1.5	13.3		2.9	239.1	794.8
			Mean block size	2.1	4.5	10.7	6.8	0.9	2.2	2.8	1.5	2.7		2.9	5.3	
Wet grassland with water level supplement	3	380	Total		6.3	17.3	8.0	50.9		55.8					100.9	239.3
			Mean block size		2.1	8.7	8.0	12.7		3.7					7.2	

Appendix 1.7 Test Valley

Tier Description	Tier	Payment (£/ha) 2002	Area (ha)	Year into agreement									Total
				Un-known	1995	1996	1997	1998	1999	2000	2001	2002	
Arable reversion to permanent grassland	2A	300	Total					57.7	18.1	9.7	16.4	46.0	148.0
			Mean block size					4.1	1.8	2.4	4.1	4.2	
Extensive permanent grassland	1B	135	Total	55.6	4.4	5.5		457.8	193.3	19.7	172.6	62.7	971.6
			Mean block size	2.1	1.5	2.7		2.4	2.3	2.8	2.2	2.4	
Extensive permanent grassland with breeding wader supplement	1B	175	Total					46.7	0.3	4.7	60.3	13.5	125.5
			Mean block size					6.7	0.3	2.4	1.8	3.4	
Improved permanent grassland	1A	35	Total					186.3					186.3
			Mean block size					2.3					
Improved permanent grassland with low fertiliser supplement	1A	85	Total					22.6	56.1	11.3		12.0	102.1
			Mean block size					1.7	3.0	2.8		1.5	
Unimproved grassland (former scheme)	1	135?	Total				28.5						28.5
			Mean block size				1.9						

Appendix 1.8 Upper Thames Tributaries

Tier Description	Tier	Payment (£/ha) 2002	Area (ha)	Year into agreement										Total
				Un-known	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Extensive permanent grassland	1B	105	Total	79.7	589.3	290.7	62.1	29.4	54.6	1360.1	143.2	337.8	67.7	3014.5
			Mean block size	3.3	4.2	2.9	1.8	3.3	3.0	3.5	3.6	3.3	3.4	
Extensive permanent grassland with hay making supplement	1B	160	Total	24.1	15.2		11.2		3.7	178.0	8.4	7.8	18.7	267.2
			Mean block size	3.0	3.8		3.7		3.7	4.0	2.8	2.0	6.2	
Extensive permanent grassland with stock exclusion supplement	1B	155	Total	20.4	15.9				5.9	106.5	1.7	66.6	26.7	243.6
			Mean block size	6.8	15.9				5.9	4.8	1.7	6.7	4.5	
Permanent grassland	1A	35	Total	14.7	167.7	209.6	110.3	35.4	118.6	387.5	54.1	299.7	20.1	1417.7
			Mean block size	2.9	3.0	4.2	3.7	7.1	4.0	2.4	3.4	4.7	2.0	
Permanent grassland with headland supplement	1A	55	Total	2.5	3.1	32.3	39.8		201.6	639.8	124.9	124.0	229.1	1397.1
			Mean block size	1.2	1.6	10.8	2.8		4.9	4.1	4.2	3.9	3.5	
Reversion of arable land to extensive perm grass + stock exclusion supp	3A	360	Total							36.8			12.6	49.4
			Mean block size							7.4			6.3	
Reversion of arable land to extensive perm grass with haymaking supp	3A	365	Total		4.0		2.2			25.7	32.2		3.0	67.2
			Mean block size		4.0		2.2			5.1	6.4		3.0	
Reversion of arable land to extensive permanent grassland	3A	310	Total		205.8	40.0	54.6		125.3	526.0	93.7	301.9	404.3	1751.6
			Mean block size		6.6	4.4	3.6		5.0	6.8	4.9	6.3	8.1	
Reversion of arable land to wet grassland	3B	435	Total		11.8	4.0					21.2			37.0
			Mean block size		2.4	4.0					4.2			
Reversion of arable land to wet grassland (former scheme)	3A?	435?	Total							296.6	38.4			335.1
			Mean block size							24.7	12.8			
Wet grassland	2	270	Total	2.6	70.5	9.5				112.3				194.9
			Mean block size	1.3	3.5	4.8				5.1				
Wet grassland (former scheme)	2?	270?	Total	3.1	7.9	6.3				193.8	6.0		0.3	217.4
			Mean block size	1.6	2.6	3.1				8.1	6.0		0.3	