COUNTRYSIDE SURVEY 2007 QUALITY ASSURANCE EXERCISE : ADDITIONAL ANALYSIS.

INTRODUCTION.

1 The main report raised a number of issues concerning the accuracy of recording of the CS2007 surveyors; in particular it highlighted the under-recording of some taxa (especially the cryptogams) and the depression of species richness compared with both the 2007QA assessors and the previous QA exercises of 1998 and 1990.

2 The 1998 QA report used a number of approaches to assess whether the percentage agreement of the surveyors record introduced bias into the species record and hence its potential to bias future estimates of vegetation change.

3 This appendix uses two data sets to assess whether variation in the species record of the CS2007 surveyors has introduced bias into the data set.

4 The results presented in the main body of the report were drawn from a data set comprising the 266 sample plots from 44 squares surveyed both by CS2007 and QA2007. This will be referred to as the 'Full QA2007' data set.

5 An additional time sequence analysis has been added based on the 108 plots across 25 squares, which are common to the three surveys: Countryside Survey 1990 (Surveyors and QA assessors), Countryside Survey 1998 (Surveyors and QA assessors) and Countryside Survey 2007 (Surveyors and QA assessors), providing six species lists for each plot. This is referred to as the 'Matched Triplicate' data set.

METHODS.

6 Parallel analyses have been carried out on both the full QA2007 data set of 532 samples (representing the 266 plots recorded by both the CS2007 surveyors and the QA2007 assessors) and the Matched triplicate data set, a restricted set of 108 plots recorded in all three QA exercises (1990, 1998 and 2007).

Modifications to the species record.

7 Elimination of the cryptogam records. Early QA exercises assessed species richness of the entire species record; however, in the full analyses of previous Countryside Surveys most analyses have been carried out having eliminated the species on the allowed list of cryptogams. For comparability, the analyses presented in this appendix are based on an amended species record from which all mosses, liverworts and lichens have been eliminated.

8 Use of presence/absence data. The allocation of cover values to species in quadrats is notoriously variable and was one of the main causes of variation in multivariate analyses of the 1998 QA exercise. The main report also highlighted a number of discrepancies in the awarding of cover to the principal species recorded during the 2007CS Survey. Therefore, in common with the full analyses of previous Countryside Surveys the species data has been transformed to presence/absence prior to multivariate analyses.

Species richness.

9 Do significant differences persist in measures of species richness when cryptogams are eliminated from the species record? Mean species/plot values were recalculated for the CS2007 and QA2007 records, segregated into plot type and broad landscape type.

Similar comparisons are also made between the CS and QA records for the 1990 and 1998 QA exercises.

10 For the Matched Triplicate data set additional comparisons are made using species groups for comparison with similar analyses presented in the main report of the 2007 QA exercise.

11 Significant differences in mean species richness were tested using paired t-tests for the 2007 QA exercise and ANOVA with Tukey pairwise comparisons for the matched triplicate data set.

12 In addition, for the Matched Triplicate set a repeat measures ANOVA was used to detect significant effects due to surveyor and time. The ANOVA was run with one grouping variable, surveyor (CS v QA) and one factor (Time) which had three repeat levels (1990, 1998 and 2007). Where significant effects were noted a one way repeat ANOVA was run followed by Wilcox on Matched pair analysis to test the critical pairwise comparisons; e.g. changes in species richness over time for the CS1990 and CS2007 compared to equivalent changes between QA1990 and QA2007. Also, differences between species richness for each QA exercise were tested, i.e. CS90 v QA90, CS98 v QA98 and CS2007 v QA2007.

Multivariate analysis.

13 Two separate DCA analyses were carried out. The first using the Full data from the 2007 QA exercise (532 records), excluding cryptogams and with the data transformed to presence/absence. The second using the Matched triplicate data set of 648 samples, representing 108 plots recorded in each of three QA exercise, with the same data modifications.

14 The DCA was conducted using the default settings allowing for downweighting of rare species and rescaling of axes.

15 Mean axis scores for each recording time were then calculated and significant differences sought; through ANOVA for the full QA2007 data set and repeat measures ANOVA and Wilcox on pairwise comparisons for the triplicate data set.

16 Ellenberg scores for Light (L), Fertility (N) and moisture tolerance (F) were also calculated for each quadrat using the amended values of Hill *et.al.* (1999).

17 Correlations between mean plot Ellenberg scores and plot axis scores were sought to help explain the variation in the data.

18 Significant differences in Ellenberg scores between the different species records were also tested.

RESULTS

Full QA 2007 data set

Changes in species number

19 In the draft main report Table 1 presented a comparison of species number per plot recorded by the CS2007 surveyors and the 2007 QA assessors. An amended version is now presented in which all cryptogam records have been removed (Table A.1).

Table A.1.Comparison of species number per plot recorded by the CS 2007 surveyors (CS2007) and the 2007 Quality Assurance assessment (QA 2007) with all records for allowable cryptogams removed.

Values are mean species/plot; *p* values are for paired t-test. The final column expresses the CS 2007 surveyors' records as a percentage of the QA assessors.

Plot type	Number of samples	CS 2007	QA 2007	p	CS 2007 % of QA
All plots	266	16.47	19.13	<0.001	86.10
X	51	18.46	20.86	0.002	88.49
Y	44	11.22	13.55	0.001	82.80
H	26	17.81	18.11	0.756	98.34
R	39	20.03	24.46	<0.001	81.89
B	43	16.00	19.00	<0.001	84.21
U	19	10.42	12.68	0.006	82.18
A	7	19.29	20.00	0.884	96.45
S	37	18.29	21.67	<0.001	84.40

20 The table demonstrates that the number of species recorded by the surveyors remains, in all but the hedge and arable plots, significantly lower than that found by the assessors even when the cryptogams are removed from the data. Expressed as a percentage the shortfall is not great (c.13% overall) but it must be stressed that this is simply a comparison of the number of records and takes no account of the accuracy of the recording.

21 A similar paired t-test has been carried out (Table A.2) on the same data set partitioned into land classes.

Table A.2. Comparison of species number per plot by land class recorded by the CS 2007 surveyors (CS2007) and the 2007 Quality Assurance assessment (QA 2007) with all records for allowable cryptogams removed.

Values are mean species/plot; *p* values are for paired t-test. The final column expresses the CS 2007 surveyors' records as a percentage of the QA assessors.

Landclass ^	N	CS 2007	QA2007	P	CS 2007 as % QA2007
1	68	14.78	16.81	0.008	87.92
2	81	17.41	19.98	<0.001	87.14
3	73	19.08	22.67	<0.001	84.16
4	42	12.83	15.12	<0.001	84.85

^ Landclasses: 1=Lowland arable, 2=Lowland pasture, 3=Marginal upland, 4=Upland

22 It was anticipated that the removal of the cryptogams would have reduced the discrepancies in the marginal upland and upland squares. However, it seems that, in contrast to earlier surveys, that more upland squares have been recorded rather less efficiently than have plots in the lowlands even with the elimination of the cryptogams.

Decorana

23 A Decorana analysis of Hill (McCune and Mefford 1999) was carried out on the full QA2007 data set of 532 samples. To remove the effect of discrepancies in cover estimates the data were transformed to presence/absence prior to all analyses. All cryptogams were also removed from the data.

24 Following an initial run of the 532 samples, three extreme outliers were identified and removed from subsequent runs: one 'X' plot in a rape field and two 'Y' plots, one in a salt marsh and one in a sitka plantation which, after removal of cryptogams, had a single species (Sitka spruce).

Table A.3 Results of DCA on the full CS2007 v QA2007 data set (excluding three plots).

N=526, comprising records from each of the paired CS v QA plots recorded in 2007.

Ellenberg scores are means per quadrat (based on the revised scores of Hill *et.al.*) correlated with quadrat axis score across the entire data set using simple linear regression, *p*=linear regression coefficient, R^2 =explained variance.

Axis	Eigenvalue	Length of gradient	Ellenberg correlation	P	R^2
1	0.764	783	N (negative)	<0.001	93%
2	0.309	578	L (negative)	<0.001	46%
3	0.235	368	F (negative)	<0.001	21%

25 Axis 1 of the ordination appears to relate to fertility, as measured by Ellenberg 'N', with a highly significant negative correlation (Table A.3). Axis 2 appears to be a parameter related to levels of shade versus exposure whereas the ecological gradient represented by axis 3 is less clear but shows a weak negative correlation with Ellenberg 'F' values.

26 The resultant mean axis scores are tabled (Table A.4) together with Ellenberg indicator values according to Hill *et.al* (1999).

27 Differences in the means between the CS surveyors and QA assessors were tested using ANOVA. (A paired t-test gave different results with significant differences between CS and QA for Axis 1 *p=0.002* and for Ellenberg N *p=<0.001).*

28 There are no significant differences between the axis scores or Ellenberg indicator values between the CS2007 surveyors and the QA 2007 assessors.

29 There is thus no evidence of any directional bias in the variations between the original survey and the QA. The 2007 results correspond very closely to those of a similar analysis carried out in 1998 when the difference between the mean Axis 1 score for CS1998 and QA1998 was 1.1%: in this analysis the equivalent value is 1.5%

Table A.4. Mean axis scores and mean Ellenberg Indicator values for the full CS2007 *versus* QA2007 data set. *ANOVA* probabilities

	CS2007	QA2007	*ANOVA P*
Axis 1	433.2	439.9	0.590
Axis 2	263.8	264.3	0.824
Axis 3	154.7	155.4	0.867
Ellenberg			
L	6.66	6.69	0.663
N	5.02	4.96	0.656
F	5.89	5.92	0.692

MATCHED TRIPLICATE DATA SET.

Changes in species number.

30 Values across the data set, initially retaining cryptogams, are compared across the years of survey using ANOVA and Tukey pairwise comparisons.

31 In the following tables mean species number for the countryside surveyors (CS) are compared with those of the QA assessors (QA) for the three years, 1990, 1998 and 2007 (Table A5).

Table A.5 Mean species number including cryptogams. Values are means, probabilities are for Tukey pairwise comparisons following ANOVA .

ANOVA showed a significant effect between the six surveys, *p=<0.001.*

	CS species/plot	QA species/plot		Pairwise comparison	Tukey *p*
1990	20.94	23.29		CS90 v QA 90	0.548
1998	18.03	20.78		CS98 v QA98	0.366
2007	16.54	20.87		CS07 v QA07	0.021
				CS90 v CS07	0.017
				QA90 v QA07	0.513

32 If the allowable cryptogams are excluded the comparable values for the vascular record still show a significant depression in overall species richness in the CS2007 record compared to the CS1990 record but no difference in the QA record between 1990 and 2007 (Table A.6).

Table A.6. Mean species number excluding cryptogams. Mean species number including cryptogams. Values are means, probabilities are for Tukey pairwise comparisons following ANOVA .

ANOVA showed a significant effect between the six surveys, *p=<0.001.*

	CS species/plot	QA species/plot		Paired comparisons	Tukey - p
1990	19.28	21.00		CS90 v QA 90	0.740
1998	16.47	18.49		CS98 v QA98	0.582
2007	15.63	18.42		CS07 v QA07	0.218
				CS90 v CS07	0.038
				QA90 v QA07	0.298

33 These data demonstrate that the biggest difference is the decline between 1990 and 2007 in the surveyors record even when the mosses etc are removed. This suggests that a real decline in species number has occurred but that it has been exaggerated in the 2007 survey.

Species groups.

34 To examine the likelihood of bias in the recording of grasses etc the complete species frequency lists for the matched triplicate samples for each of the three survey years were partitioned into species groups and the number of records for each group were compared.

35 The eight groupings used were: grasses, Cyperaceae, Juncaceae, woody species (excluding subshrubs), subshrubs, fern and fern allies, the residue of forbs and the cryptogams (Table A.7).

Table A.7. Summation of species records by species group for Matched triplicate data set.

	CS1990	QA1990	CS1998	QA1998	CS2007	QA2007
Cryptogams	179	248	168	242	89	265
Grasses	574	586	518	552	452	529
Cyperaceae	98	103	86	104	68	95
Juncaceae	63	58	43	53	43	53
Woody species	136	165	142	173	178	200
Subshrubs	60	60	54	67	58	61
Ferns	32	41	32	35	39	40
Forbs	1120	1255	904	1018	850	1011

36 Grasses. The QA results indicate that the decline apparent between 1990 and 1998 has continued but at a slower rate. The CS record shows a similar rate of decline as that seen from 1990 to 1998 with no slowing. It would seem that the 2007 surveyors have recorded c.10% fewer grasses than would have been the case were the efficiency of the 1998 surveyors to have been maintained.

37 Cyperaceae. The QA results for this smaller data set shows no difference between 1990 and 1998 followed by a modest decline in 2007. The CS records show an accelerating

decline in sedges and their allies. The comparative shortfall in the recording of this group suggests that c.15% less of this group were found than would have been expected if the level of CS1998 had been maintained.

38 Juncaceae. Another small data set but one with a somewhat different pattern. Both CS and QA follow a similar pattern of a decline between 1990 and 1998 after which the values have not changed. There is thus no reason to expect the level of recording of rushes for the whole survey to have differed in efficiency compared to that of 1998.

39 Woody species (excluding subshrubs). In contrast to all other species groups the frequency of recording of trees, bushes and woody perennials within the matched data set has increased both between 1990 and 1998 and from 1998 to 2007. The increases found in CS and QA since 1998 are parallel and hence the level of surveyor efficiency may be considered equal to that of previous surveys.

40 Subshrubs. A small subset featuring principally *Calluna* and *Vaccinium spp.*: the values have changed little and the CS2007 recording seems very adequate.

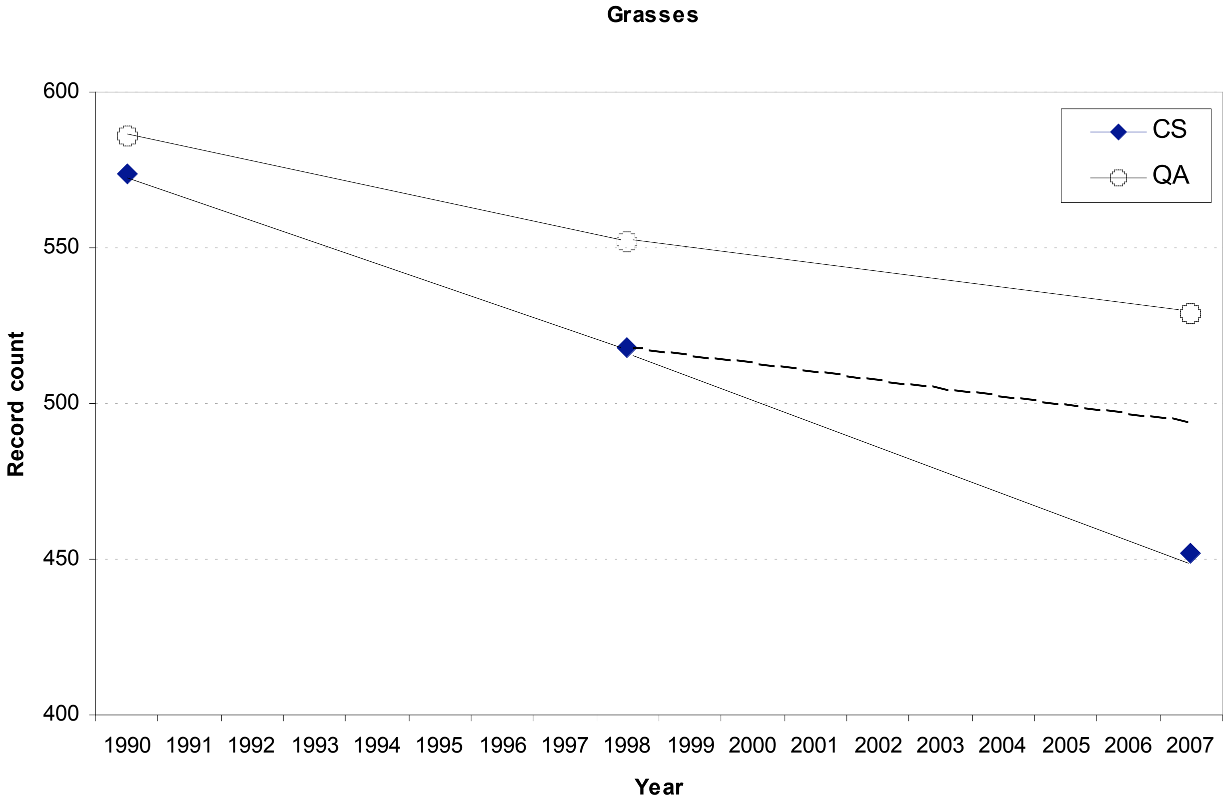
41 Ferns and fern allies. The number of records is too small to allow for firm conclusions but there is a suggestion of an increase in these species as also seen for the woody hedgerow taxa. There seems to have been no decline in the efficiency of recording since earlier surveys.

42 Forbs. Recording of this group, which accounts for approximately 50% of all records, follows a similar, though less marked pattern, to that shown for the grasses. Although most of the commonest species were adequately recorded there was, overall, a decline in the efficiency of recording of forbs since the 1998 survey. It is estimated from the matched data set that c.5% less forbs were recorded than would have appeared in the data set from the CS1998 level of search.

43 Allowable cryptogams. The poor level of identification of mosses *etc* was noted in the main report: values from the matched triplicate analysis suggest that the 2007 surveyors recorded slightly less than 50% of the allowable cryptogams than would have been distinguished in the current survey by their 1998 counterparts.

44 Recording of *Sphagna*. Within the cryptogams the recording of *Sphagna* is a special case since the surveyors were not required to distinguish species but to allocate a species to a species group. Although the outcome for the matched set was rather better than for the rest of the cryptogams it remained disappointing: only 48% of the assessors records for the presence of *Sphagnum* types were recorded by the surveyors – this compares with 86% in 1990 and 77% in 1998. However, when a *Sphagnum* **was** recorded it was usually allocated to the correct species group (93% accuracy).

Figure A.1 The total species record for grasses across the QA exercises of 1990, 1998 and 2007. The dashed line for CS illustrates the predicted species record, had the 2007 surveyors recorded to the same level of accuracy as the 1998 surveyors.



Species richness by Plot types.

45 The results, with cryptogams removed, were broken down by plot type and subjected to a repeated measures ANOVA. The initial model used year of survey as the repeated measure and class of survey (CS or QA) as a fixed factor; the results showed significant changes over time but no surveyor effect i.e. there was no difference in the level of change noted by the surveyors and the QA assessors (Table A.8).

46 Wilcoxon matched pair nonparametric test of significance was used to test for pair wise differences between years. In general, this yielded many more significant differences than does the Anova.

Table A.8. Results of repeat measure ANOVA for each plot type for the triplicate data set. Values are probability levels. The means for the individual plot types together with the oneway repeat measure results are presented in paragraphs 48-53.

	All plots	X	Y	H	S	R	B
Between surveyors	0.058	0.458	0.712	0.856	0.305	0.182	0.241
Within subjects							
Time	<0.001	0.044	<0.001	<0.001	<0.001	<0.001	0.771
Time*Surveyor	0.438	0.496	0.389	0.172	0.803	0.857	0.417
Repeat measures							
Time	<0.001	0.009	0.003	<0.001	<0.001	<0.001	0.673
Time*Surveyor	0.531	0.405	0.340	0.303	0.810	0.937	0.405

47 A oneway repeat measures ANOVA however, using each time x surveyor combination as independent repeats, produced a number of between class of survey differences (i.e. differences between CS and QA). In this latter analysis all plot types gave a significant value of *p* for either surveyor or time effect, or both: time and surveyor elements were then further tested for significance *via* the Wilcoxon Matched Pair test.

48 X-plots. N=25. ANOVA: within subjects *p=<0.001,* repeated measures *p=0.001.*

	CS	**QA**			**Wilcoxon *p***
1990	18.40	20.40		CS90 v QA 90	0.014
1998	17.04	18.36		CS98 v QA98	0.051
2007	16.04	19.48		CS07 v QA07	0.001
				CS90 v CS07	0.195
				QA90 v QA07	0.474

There is a strong effect due to surveyor especially through the low species number recorded by the CS2007 surveyors. There appears to be no substantial change over time for these plots.

49 Y-Plots. N=18. ANOVA: within subjects *p<0.001,* repeated measures *P=0.057*

	CS	**QA**			**Wilcoxon *p***
1990	14.61	15.94		CS90 v QA 90	0.129
1998	12.56	13.28		CS98 v QA98	0.251
2007	10.72	13.39		CS07 v QA07	0.007
				CS90 v CS07	0.013
				QA90 v QA07	0.048

There appears to have been a genuine decline in the species richness of these small 2m x 2m plots but again the decline appears to be exaggerated in the results of the 2007 surveyors.

50 Hedge Plots. N=12. ANOVA: within subjects *p<0.001,* repeated measures *P=0.001*

	CS	**QA**			**Wilcoxon *p***
1990	18.33	20.00		CS90 v QA 90	0.270
1998	12.92	14.58		CS98 v QA98	0.076
2007	16.58	14.75		CS07 v QA07	0.199
				CS90 v CS07	0.238
				QA90 v QA07	0.010

The results indicate a decrease in species richness over time but this decline indicated by the QA values and is not mirrored to the same extent in the CS results: this may be partially explained through the tendency in CS2007 to extend the recording plot further from the mid-point of the hedge, especially when the plot features a wide hedge.

51 Stream plots. N=16. ANOVA: within subjects *p=<0.001,* repeated measures *P=0.001*

	CS	**QA**			**Wilcoxon *p***	**Paired t-test**
1990	24.38	26.63		CS90 v QA 90	0.035	0.029
1998	19.69	22.94		CS98 v QA98	0.009	0.006
2007	17.19	21.19		CS07 v QA07	0.002	0.001
				CS90 v CS07	0.003	0.002
				QA90 v QA07	0.012	0.014

The results for stream plots demonstrate both a genuine decline in species per plot and a consistent discrepancy between the records of the surveyors and the assessors. However, the reduction in species per plot shown by the assessors over time is exaggerated when the CS2007 record is compared with those of previous surveys.

52 Verge plots. N=18. ANOVA: within subjects *p=<0.001,* repeated measures *P=0.003*

	CS	**QA**			**Wilcoxon *p***
1990	23.78	26.33		CS90 v QA 90	0.092
1998	20.17	22.78		CS98 v QA98	0.012
2007	18.78	22.17		CS07 v QA07	0.011
				CS90 v CS07	0.011
				QA90 v QA07	0.020

Effects both of time and surveyor are demonstrated with a broadly similar pattern seen to that found for both the Y and S plots with the declines indicated by the CS2007 results greater than those found by the QA 2007 results.

53 Boundaries. N=19. ANOVA: within subjects *p=0.012,* repeated measures *P=0.085*

	CS	**QA**			**Wilcoxon *P***
1990	16.95	17.42		CS90 v QA 90	0.459
1998	15.47	18.26		CS98 v QA98	0.028
2007	14.84	18.21		CS07 v QA07	0.027
				CS90 v CS07	0.360
				QA90 v QA07	0.493

A less clear-cut pattern than for other plot types with no significant effect demonstrated for change over time. It would appear however that the CS2007 surveyors have produced lower than expected values for these plots.

Species richness by landscape class.

When the same matched triplicate data set is partitioned into lowland and upland categories the ANOVA demonstrates highly significant differences within both the lowland and upland categories. There is now a time*surveyor significance.

	Lowland	**Upland**
Between surveyors	0.085	0.350
Within subjects		
Time	<0.001	<0.001
Time*Surveyor	0.871	0.048
Repeat measures		
Time	0.001	<0.001
Time*Surveyor	0.839	0.076

54 Lowland. N=72. ANOVA: within subjects *p=<0.001,* repeated measures *P=<0.001*

	CS	**QA**			**Wilcoxon *p***
1990	17.47	19.92		CS90 v QA 90	<0.001
1998	15.28	17.14		CS98 v QA98	<0.001
2007	15.17	17.50		CS07 v QA07	<0.001
				CS90 v CS07	0.019
				QA90 v QA07	0.014

55 Upland. N=36. ANOVA: within subjects *p=<0.001,* repeated measures *P=<0.001*

	CS	**QA**			**Wilcoxon *p***
1990	22.92	23.17		CS90 v QA 90	0.753
1998	18.86	21.19		CS98 v QA98	0.001
2007	16.55	20.25		CS07 v QA07	<0.001
				CS90 v CS07	<0.001
				QA90 v QA07	0.004

The upland squares were surveyed to a high standard in 1990 but subsequent survey teams have been less effective with a result that the decline in species appears exaggerated in both the 1998 and 2007 surveys, despite having removed all cryptogam records. A similar, though less extreme, situation pertains to the overall recording of the lowland plots; here however the level of recording in 2007 is broadly comparable with that of CS1998.

Ordination.

56 A second set of ordinations have been performed on the smaller matched triplicate data set of plots common to all six surveys (CS90, QA90, CS98, QA98, CS07, QA07). Two of the outliers noted in the full data ordination were also found to be grossly distorting the axes of the initial run (the third original outlier was not part of the matched data set) and thus all six records from each of the these plots were excluded from subsequent analyses. As before cryptogams were excluded and cover effects eliminated by running on presence/absence data.

57 During this analysis a further outlier was identified, an X-plot in a wheat field in square 331 with only wheat recorded, this resulted in an extended Axis 1 and instability in the third axis of the ordination; the six records for this plot were also eliminated from the data and the results of the final analysis based on 105 matched triplicate plot records are presented in Table A.9.

Table A.9 Summary of the Matched triplicate DCA.

N=630, comprising 105 records from each of the paired CS v QA exercises in 1990, 1998 and 2007. Ellenberg scores are means per quadrat (based on the revised scores of Hill *et.al.)* correlated with quadrat axis score across the entire data set using simple linear regression.

Axis	Eigenvalue	Length of gradient	Ellenberg correlation	P	R^2
1	0.810	998	N (negative)	<0.001	94%
2	0.266	506	L (positive)	<0.001	39%
3	0.216	320	F (negative)	<0.001	20%

58 It is heartening to compare Table A.8 with Table A.4: the results of the smaller data set are closely paralleled to those of the larger CS2007 analysis except for the reversal of Axis2.

59 To determine whether bias has been introduced into the data through the variation in recording efficiency shifts in axis score and in mean ellenberg indicator values are considered using repeat measure ANOVA and Wilcoxon matched pair analyses using the software package SYSTAT.

60 The ANOVA was a Repeat measure Anova using year of survey as the reaped measure and class of survey (CS and QA) as the fixed factor. There was therefore one grouping factor (surveyor: CS v QA) and one within factor with three repeats (time: 1990, 1998 and 2007). Table A.10 gives a summary of the results of the ANOVA for Axis scores and Ellenberg indicator values

61 Pairwise comparisons between years and between CS and QA assessors were carried out to detect the magnitude of the changes over time. These comparisons used One-way repeated measures ANOVA and Wilcoxon matched pair comparisons. However, a number of discrepancies appear between the results in Table A.10 and Table A.11.

Table 10. Results of repeat measure ANOVA. Probability values.

Means and Wilcoxon matched pair analysis form Table 10.

	Axis 1	Axis 2	Axis 3	N	L	F	Spno
Between surveyors	0.759	0.770	0.867	0.087	0.009	0.008	0.058
Within subjects							
Time	0.002	0.010	0.138	0.025	<0.001	0.713	<0.001
Time*Surveyor	0.258	0.578	0.355	0.243	0.216	0.465	0.438
Repeat measures							
Time	0.005	0.006	0.091	0.039	<0.001	0.647	<0.001
Time*Surveyor	0.200	0.547	0.419	0.201	0.225	0.455	0.531

Table A.11 Variation in DCA axis score and Ellenberg indicator values between surveys.

(a) Axis 1. One way Repeat measures ANOVA:within subjects *p*= 0.002, repeat measures *p*=<0.001

	CS Axis1	QA Axis1			Wilcoxon *p*	Paired t-test
1990	531	533		CS90 v QA 90	0.394	0.360
1998	521	532		CS98 v QA98	0.002	0.001
2007	516	527		CS07 v QA07	0.029	0.017
				CS90 v CS07	0.001	0.005
				QA90 v QA07	0.105	0.114

(b) Axis 2. One way Repeat measures ANOVA:within subjects *p*= 0.077, repeat measures *p*=<0.034

	CS Axis2	QA Axis2			Wilcoxon *P*
1990	191	191		CS90 v QA 90	0.627
1998	190	184		CS98 v QA98	0.077
2007	183	182		CS07 v QA07	0.556
				CS90 v CS07	0.020
1				QA90 v QA07	0.004

(c) Ellenberg N scores.

One way Repeat measures ANOVA: within subject *p=0.012,* repeat measures *p=<0.001*

	CS Axis1	QA Axis1			Wilcoxon *p*
1990	5.17	5.16		CS90 v QA 90	0.530
1998	5.26	5.16		CS98 v QA98	<0.001
2007	5.28	5.19		CS07 v QA07	0.008
				CS90 v CS07	0.012
				QA90 v QA07	0.698

(d) Ellenberg L scores.

One way Repeat measures ANOVA: within subjects *p=<0.001,* repeat measures *p=<0.001.*

	CS Axis1	**QA Axis1**			**Wilcoxon *p***
1990	6.822	6.815		CS90 v QA 90	0.147
1998	6.825	6.795		CS98 v QA98	0.203
2007	6.693	6.723		CS07 v QA07	0.326
				CS90 v CS07	<0.001
				QA90 v QA07	0.001

62 The first axis of the DCA (related to fertility and showing a negative correlation with Ellenberg N) shows a decline in score over time for both the CS surveyors and the QA assessors. However, the change is exaggerated in the CS record and a significant change in Axis 1 score is noted between the CS1990 record and the CS2007 record resulting in a significant difference between the CS2007 and QA2007 records. There is no significant effect noted in the QA1990 to QA2007 comparison. Since the correlation between Axis 1 and Ellenberg N is negative a decline in Axis 1 score indicates an increase in the presence of species benefiting from higher fertility levels. This trend appears to have been exaggerated by both the CS1998 and CS2007 surveyors. The Ellenberg N scores substantiate this effect (Table A9 c).

63 The weaker gradient of Axis 2, which may relate to levels of increased shade tolerance, show a smaller magnitude of change with significant differences being achieved by both the CS and QA assessors. There appears to have been a significant decline in Axis 2 scores since 1990, indicating an increased shadiness: this is substantiated by the decline in Ellenberg L values between 1990 and 2007.

EPILOGUE.

To alleviate the difference in species number recorded a series of ‘par’ scores are tentatively suggested based on the results of the matched triplicate analysis. The number of species /plot that would need to be added to the CS2007 results to achieve the equivalent of the CS1998 level of recording, if cryptogams are excluded would be:

Hedge plots	No change
Boundary plots	0.3
Stream and Verge plots	0.8
Y plot	1.9
X and U plots	2.1

These are very crude estimates based on graphical extrapolation of the CS1998 values parallel to the line of the QA1998 – QA2007 records and determining the difference in angle between this line and the actual CS1998 and CS2007 line (See Figure A1 for an example). These values are based on the matched triplicate plots, with the exception of the U plots which are based on a simple comparison of the 1998 and 2007 records.