Countryside Survey 1990

Quality Assurance Exercise

1992

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Ecological Surveys (Bangor)

Report to ITE, Merlewood

1990 COUNTRYSIDE SURVEY: QUALITY ASSURANCE EXERCISE

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Introduction

1. This paper outlines the scope of the quality assurance carried out in connection with the 1990 Countryside Survey, presents the results and includes a series of recommendations in accordance with the aims of the exercise.

Background

2. It is recognised that in a field investigation on the scale of the Countryside Survey the large numbers of recorders and surveyors involved must produce an inherent degree of variation despite the provision of a training course, a field handbook and on-site visits by supervisors (Quality Control). Whilst there is no reason to expect any directional bias in the records made, nor was any subsequently demonstrated, it is important to attempt a measure of the consistency and reliability of the work done within the major components of the field programme (Quality Assurance).

3. In August 1989, during the preparatory phase of the survey, an exercise was conducted whereby a group of field workers were invited both to independently assess the vegetation of a pair of fixed quadrats and to similarly record plots which they were required to find on the basis of crosses marked on a standard map at 1:7500 scale. The results are presented in Hallam and Bunce (1991). The experience gained during this exercise was used during the subsequent training course. Pairs of surveyors were tested on their ability to record both fixed and relocated plots of the types to be used in the main survey. Results for this and for a similar exercise carried out as a trial QA exercise based on the 1988 partial Countryside survey (Wallace and Prosser 1990) are compared with the findings from the most recent field programme and presented and discussed later, (See Table 6 and Para. 26).

4. The difficulties associated with the use of cover estimates derived from a range of recorders has been highlighted by Sykes et. al. (1983) but the broader aspects of plot relocation by teams, bias in species recognition and the effects of such variation on the validity of ecological generalisations has been largely ignored in previous surveys.

Aims

5. (a) To quantify the accuracy of field recording in the Countryside Survey 1990 and to comment on the accuracy of change statistics.

(b) To explain any differences in recording in terms of observer error, time of year, plot location, type of information, geographical region and special factors such as drought.

(c) To relate the conclusions from (a) and (b) to previous comparative work done on ITE survey methods.

(d) To recommend modifications to survey methodology for future surveys which will improve the accuracy and confidence of the resulting statistics.

Methods

6. Two separate series of assessments have been carried out. The first, conducted during October-November 1990, and restricted, by the time available, to 21 of the original survey squares, relied only on the sketch maps of the original surveyors for plot relocation. The work was divided between two independent pairs of assessors. The second phase, during June-September 1991, tested the potential improvement to be gained through the use, in addition, of photographs of individual plots.

7. In 1991 the assessors were provided with a single 1km square from each of the original 32 terrain classes. As an additional exercise in self assessment a group of squares originally surveyed by one or both of the assessors was included in the trial. The 1991 itinerary was so arranged that each 1km square was visited within 14 days of the corresponding original survey date; 28 of the 32 squares were visited by a single pair of assessors. Details of the 1991 QA itinerary form Annex A.

8. One quarter of each square was resurveyed so as to include one of each of the plot types represented in the whole square. The six plot types used in the 1990 Countryside Survey can be sub-divided into;

Quadrats: $200m^2$ (X-plots, after Bunce and Shaw 1973)
$4m^2$ (Y-plots)

Linear plots, all 10x1m which include;

Roadverges, commencing adjacent to and parallel with the carriageway. A second parallel strip was originally surveyed in the case of wide verges (not included in the QA exercise).
Hedges, running parallel with the hedge line and commencing at the mid-point of the hedge.
Streamsides, from normal water level or at the lower limit of vegetation cover in the case of water courses with extensive gravel or pebble beds etc.
Boundaries, in enclosed land only; recorded at the boundary marker (plate) associated with the $200m^2$ X-plot.

An attempt was made in each case to relocate the buried metal plate marking one corner of each quadrat using the original sketch map, the surveyors photograph and a metal detector. The plot was recorded using the standard Countryside Survey 1990 procedure in accordance with the Field Handbook. In addition, the landcover and boundary features were recorded at 9 pre-determined points on a grid within the selected quarter of the square. A synopsis of the methods forms Annex B.

Plate relocation

9. The plot may often be accurately relocated on the basis of the sketch map measurements and a good photograph. However, it was considered important to investigate the effectiveness with which the plates themselves could be physically relocated (Table 1).

Table 1. A record of the plate relocation exercise

Assessment 1: Autumn 1990

	Pair 1	Pair 2	Total
Found	32	34	66
Not found	16	15	27

A 'recovery rate' of 71% using a five minute search time.

Assessment 2: Summer 1991 [Pair 1]

Plot type	Plates expected	(i) Plates found	(ii) Plots found	(iii) Plots not found
Roadverge	31	27	3	1
Hedges	26	19	3	4
Streamside	35	21	9	5
Boundary + 'X' plots	47	32	10	5
'Y' plots	39	17	14	8

A 'recovery rate' of 65% for plates and 87% for plots.

10 Three categories of performance were recognised with respect to the relocation of original plots within a square:
(i) Plate, and hence plot, relocated
(ii) Plate not found, or no plate used, but assessor satisfied that location of resurvey adequately matched original location.
(iii) Plate not found; information insufficient to allow satisfactory relocation of plot.

Species concordance

11. A variety of measures may be used to compare aggregate records made for the same plot at different times. Four indices are used in this report and are defined as follows:

(i) Percentage (%) agreement: common species divided by the aggregate of species at time 1 (T1) plus time 2 (T2). The simplest, crudest, but most objective value.

(ii) T1 agreement: common species divided by the total recorded at T2. This index removes species believed to have been erroneously recorded during the original survey.

(iii) T2 agreement: common species divided by the total recorded at T1. The corollary of T1 agreement whereby the initial recording is regarded as the more correct.

(iv) % accuracy: Common species divided by total species minus T2 errors. This is intended to remove variations due to e.g. season, management change, plot mis-orientation etc. (See para. 20).

The overall concordance given by indices i, ii and iii for individual squares forms Annex C. Percentage accuracy by square is given in Table 5, following Para. 25.

12. An initial exercise carried out by I. Taylor at Merlewood on a selection of the first assessment results indicated that;

(i) the mean number of species recorded at T1 (22.77) and T2 (22.72) was virtually identical,

(ii) the overall % agreement = 45%,

(iii) the variation could be partitioned as follows;

A + D ^	Mis-identification	10%
B + I	Species overlooked on one occasion	33%
C + G	Error in plot location	37%
E	Changes in management of plot	3%
F	Temporal differences	5%
H + J	Mis-alignment of plot	12%

^ The prefix letters will be referred to below.

13. The exercise referred to above was limited to an analysis of the results from 12 squares and compares the species complement of a plot in summer with that in late autumn where fewer species might be present and identifiable.

14. A subsequent analysis of the full data set (21 squares) gives an overall percentage agreement of 47.1.
The results have also been recalculated after subtracting those records for common species present in the original survey which would not have been available for recording during the October QA. Examples: *Ranunculus ficaria, Conopodium majus, Hyacinthoides non-scripta, Arum maculatum, Bromus sterilis* etc.
Out of a total of 2148 species records made in the original survey it is considered that 88 would not have been recorded during the QA due to this seasonal difference (c.3.5%). If these records are deleted from the comparison, the differences in mean number of species per plot recorded becomes;

Original survey 20.2 Autumn QA 20.9

This suggests that the assessors were recording 3.5% more species per plot than were the original surveyors.

15. The results of the 1991 assessment are presented in Table 2 below.

Although the increases in mean species number evident from the results for each plot type were not statistically significant, when the sample size is increased by the pooling of all plots a highly significant increase in species number between the original survey and the 1991 re-assessment is demonstrated.

Table 2 Comparison of species numbers per plot 1990 v 1991.

Plot type	N	Species number 1990	Species number 1991	1990 %	c.v. 1990	c.v. 1991	P*
All plots	207	20.7	23.4	88.5	50.3	45.4	0.009
'X'	43	21.8	24.3	89.7	68.0	59.3	0.43
'Y'	39	16.9	19.0	88.9	43.7	41.8	0.22
Hedges	25	18.8	21.2	88.7	34.2	32.7	0.20
Streams	35	25.1	28.1	89.3	43.1	35.5	0.23
Verges	31	23.8	26.9	88.5	37.5	33.3	0.18
Boundaries	34	17.7	20.8	85.1	41.0	45.1	0.13

* Students t-test probability.
Wilcoxon Matched Pairs; full data set; $z=3.86$, $p < 0.001$

16. Since, in the extended 1991 QA exercise, the same assessors were surveying the plots recorded by the same set of surveyors there is no reason to suppose that the relative efficiency of recording would have changed. Therefore, the indication is that the 13% increase in species per plot found during the 1991 QA (see Table 2) is largely due to real differences in the species complement of the plots. Using the value for efficiency of recording derived above (para. 14) from the 1990 QA exercise, it would seem that c.27% of the species increase can be attributed to a greater efficiency of recording by the assessors and the residual 73% to this real increase in species per plot in the 1991 growing season compared with the same plots in 1990.

17. Some progress on the nature of the change in species number has been made through a simple comparison of the self-assessment plots. These plots, all in the southern half of Britain and surveyed in summer 1990 and summer 1991, give the following results:

N	Species number 1990	Species number 1991	1990%	c.v 1990	c.v 1991	p
42	22.8	24.7	92.4	41.6	39.1	0.37

This again suggests that annual variation is contributing more to the change in species number than is any effect of recorder experience; the figures indicate that under-recording during the initial survey may account for 30% of the difference (or c.3% of the total species record) whilst 70% may be attributable to a difference between the drought year of 1990 and the comparatively normal growing season of 1991.

18. Thus evidence from both QA exercises point to a similar real increase in species numbers between the two years and show that much of the variation within category B (species overlooked) of the original survey was spurious.

19. However, the situation is less straight forward than is demonstrated by this simple approach. If there is a marked difference due to the effect of the 1990 drought, then the values for species per plot for the two years should be very similar in those wet, upland, unenclosed plots not subject to drought. This is not so. When a comparison is made of species per plot in the unenclosed lands of the uplands, the values obtained

are;

	1990	1991
Total species record	825	952
Mean species per plot	27.5	31.7

As the values show these are species-rich plots. It seems that in such diverse vegetation there is liable to be a diminution in the efficiency of recording by the average surveyor. The species record is required to include common and characteristic bryophytes and lichens. It is in these moist, semi-natural habitats that this element becomes pronounced; bryophytes were in general less well recorded than were vascular plants. It is relevant to note here that during the autumn QA a different pair of assessors visited a sample of the species-rich plots of this group in late October with the following outcome;

	Original survey	October 1990
Total species record	586	616
Mean species per plot	32.6	34.2

Even at this late stage of the season experienced assessors were recording more species per plot than the summer values for the original survey. These findings emphasise the difficulty of making generalisations on the accuracy of change statistics across different plot types and in different land classes and demonstrate the need to restrict comparisons of change in species number to areas of similar landuse e.g. arable land, permanent pastures, marginal area, uplands, etc. They also emphasise the need for caution when comparing records made by surveyors with varying levels of field experience.

Recommendation 1. **The list of bryophytes and lichens to be recorded should be retained for general survey, perhaps with minor modifications. During future training courses samples of each species, together with habitat information, should be available for study and familiarisation.**

20. Notwithstanding the results of the 1990 re-assessment, an attempt has been made to apportion sources of error between the original survey and the 1991 QA. This includes a distinction between the lack of agreement due to inadequate recording at the time of initial survey (**T1 variations**) and changes not so attributable (**T2 variations**).
Within each category, sub-divisions have been erected so as to more satisfactorily apportion individual discrepancies within T1 and T2.

21. The categories used are as follows:

T1 variations

A) Apparent mis-identifications or mis-codings
The former are usually apparent. However, there have certainly been instances where the wrong box has been ticked, e.g. in the adjacent pair *Angelica sylvestris* and *Anthriscus sylvestris*, *Primula vulgaris* and *Prunella vulgaris*.

B) Species considered to have been overlooked at T1.
As the season progressed the assessors became increasingly convinced that many species showed an altered profile between the two seasons especially in the more drought-affected lowland squares. Since in many instances individual changes could not be proven, the lack of such species at T1 has been classified as a T1 error. In consequence the apparent error in this category has undoubtedly been over-estimated. Among the more apparent examples of year on year population changes encountered are the annuals *Galium aparine, Geranium robertianum* and *Lapsana communis*, the biennial *Alliaria petiolata* and more surprisingly the perennials of the *Taraxacum* aggregate.

C) Overzealous recording
During the QA particular care was taken to restrict recording to the exact plot size stipulated. It appears that in some cases the initial surveyors had either not adequately measured the plot or had included species adjacent to but not strictly within the defined area.

J) Inadmissible records due to a combination of the positioning of the original plot in a way which did not correspond with the standard protocol and failure to note this on the sketch.

D) Mysteries.
Species records, apparently incorrect, for which no reasonable explanation could be found.

T2 variations

E) Species change due to change in management
Change in crop between years, use of herbicide sprays, vehicle erosion etc.

F) Species change due to seasonal effects.
Partially overlaps with E, i.e. different suites of annual herbs in differing crops; many other changes apparent amongst ephemerals on drier banks and annual herbs such as those in hedgerows.

G) Mis-match of records through failure to exactly relocate plot at T2.

H) Locational mis-matches where plot location was refound but orientation or alignment probably differed markedly from the original.

I) Species present but overlooked at T2.
The protocol adopted at T2 was as follows: the plot was relocated from the map, sketch map and photograph, and recorded 'blind'. After completion of the record the original data sheet was examined and a fresh search made to deal with apparent discrepancies. Species subsequently found but not initially recorded were classed as 'I' errors.

22. It is very probable that many records ascribed to T1 errors are in reality the results of seasonal and/or management changes which could

not be directly demonstrated (see Paras. 3 and 17). In Tables 3 and 4 below Variation B will result in an initial under-recording of species whilst Variation C (directly) and I (indirectly) will inflate the figures for species records. Since it is clear that 'B' errors are greater than the sum of 'C' plus 'I', the overall effect is to produce an under-estimate during the initial survey.

Recommendation 2. Future QA exercises should be carried out as close as is practical to the initial time of survey.

Table 3. <u>Allocation of T1 and T2 variations as a percentage of total mismatches</u>

	Type		I % *	II%**
T1 Variations				
	A	Mis ID	3.04	0.57
	B	Overlooked	14.58	9.94
	C	Over zealous	2.76	1.30
	D	Mysteries	1.28	0.48
	J	Incorrect positioning	1.89	nil
T2 Variations				
	E	Management	0.98	2.53
	F	Season	7.11	11.57
	G	Plot mis-location	1.86	1.79
	H	Plot mis-orientation	5.22	4.65
	I	Overlooked	1.43	3.59

I * assessments of 28 squares originally surveyed by other surveyors

II ** assessments of 7 squares originally surveyed by one or both of the assessors themselves.

23. To further summarise the sources of variation; the total species record for the 28 + 7 squares = 5205: of these, records common to T1 and T2 = 3168, the remaining 2037 records fall into the following categories:

Table 4. <u>Summary of allocations of variation in species records</u>

T1 variation

Type		% of total record	
A	Mis ID	2.46	6.3
B	Overlooked	13.49	34.5
C	Over zealous	2.26	5.8
D	Mysteries	1.09	2.9
J	Incorrect positioning	1.44	3.7
		20.74	

T2 Variation

Type		% of total record	
E	Management	1.34	3.4
F	Season	8.17	20.8
G	Plot mis-location	1.84	4.7
H	Plot mis-orientation	5.09	13.0
I	Overlooked	1.94	5.0
		18.38	

Total percentage mis-match 39.1

24. The percentage agreement is thus 60.9; this compares very favourably with the 45% suggested by the partial analysis of the autumn 1990 QA, (See para. 12). It also accords well with the findings of Kirby et. al. (1986) who give a range of 47-62 for percentage agreement between species lists for woodland 'X' plots relocated from sketch maps by different observers at different seasons of the same year.

25. T2 variations can be removed from the calculation to give an initial efficiency of recording (% accuracy); this original accuracy of recording of the 1990 survey averages 74% (See Table 5). This approaches the value of 79% given as the maximum attainable efficiency between standardised searches by experienced field workers in Nilsson and Nilsson (1985).

Table 5. Initial efficiency of recording

Square	% accuracy	Square	% accuracy	Square	% accuracy
1/ 110	58	14/ 561	56	28/ 751	71
2/ 111	65	15/ 676	71	29/1118	71
3/ 311	74	16/ 657	68	30/ 966	77
4/ 366	71	17/ 539	71	31/1152	76
5/ 230	86	18/ 431	70	32/1163	85
6/ 40	83	20/1212	51	1/ 353	77
9/ 331	72	21/1090	87	1/ 325	86
10/ 545	73	22/ 773	67	5/ 383	79
11/ 336	71	24/ 921	68	15/ 352	93
12/ 364	74	25/ 898	71	15/ 518	81
13/ 569	76	26/ 912	65	17/ 540	87
		27/ 672	77	17/ 351	75

26. To draw together the information available on the percentage agreement between the initial recording and the resurvey of the same plots, the results of a series of trials are summarised in Table 6. The comparisons include a mixture of 'X' plots and linear plots and represent both 'lowland' and 'upland' situations. In this and in subsequent analyses plot data were partitioned into four Land Class aggregates following the practice adopted during the ECOLOC project whereby:

- LC: land classes dominated by the arable-growing areas of the lowlands
- LG: land classes dominated by lowland grasslands
- MA: land classes in marginal areas
- UP: land classes in the uplands

LC plus LG and MA plus UP were also considered as representative of 'lowland' and 'upland' situations respectively.

Table 6. Comparison of QA trials 1989-1991

Trial	Type	N	Interval between surveys	Sketch map	Plate	Photo	% agreement
1	Relocate	25	12 months	-	-	-	36.0
2	Relocate	32	2 days	-	-	-	45.6
3	Relocate	103	3 months	+	+	-	47.1
4	Relocate	29	2 days	+	-	-	49.1
5	Relocate	207	12 months	+	+	+	60.9
6	Fixed	50	2 days	NA	NA	NA	69.6

Notes:
1. QA conducted in August 1989 on three squares recorded during the 1988 survey: two from landclass LG and one from landclass MA.
2. 1989 trial (see Para. 3)
3. Initial QA exercise, using two pairs of assessors, conducted in October 1990 (see Para. 6)
4. 1990 Countryside survey; training course exercise.
5. Full 1991 QA of 1990 survey (see Table 4 and Para. 21)
6. 1990 Countryside survey; training course exercise.

27. Trial 6, in which both seasonal and locational errors are eliminated, indicates the level of recording immediately prior to the start of the survey. It may be compared with the 74% accuracy measured for the full QA exercise (see Para. 25). The improvement may reflect a combination of the surveyors increasing familiarity with the methods and the opportunity to make subsequent identifications of material collected from plots during actual fieldwork; an opportunity not available during the observer bias experiment itself. Comparisons of the other results show the dramatic improvement associated with the use of photographs to re-establish the exact position of plots and, to a lesser but still marked extent, the effect of seasonal and annual changes in depressing the level of agreement between records for individual plots.

28. Further analysis of the sources of error within individual plot types and a comparison of enclosed versus unenclosed situations is useful for the planning of further training courses, surveys, etc.

29. A breakdown of the main sources of error by plot type, with a further sub-division into lowland (LC + LG) and upland (MA + UP) landclasses is given below [Table 7].

Table 7. Sources of variation by plot type
(values in brackets are percentages of the total record)

Plot type		N	Total species record	Mean species/ plot	Number of discrepancies due to individual types of variation A	B	F	G+H
X plots	{Lowland	22	473	21.5	10 (2.1)	43 (9.1)	57(12.0)	46 (9.7)
	{Upland	16	636	37.4	11 (1.8)	69(10.8)	17 (2.7)	67(10.5)
Y plots	{Lowland	21	418	19.9	9 (2.2)	62(14.8)	30 (7.2)	47(11.3)
	{Upland	14	371	26.5	12 (3.2)	50(13.5)	8 (2.2)	58(15.6)
Road verge	{Lowland	22	651	22.6	20 (3.1)	96(14.7)	82(12.6)	17(2.6)
	{Upland	8	302	37.8	16 (5.3)	46(15.2)	33(10.9)	2 (0.7)
Hedges *		24	601	25.0	9 (1.5)	76(12.7)	44 (7.3)	36 (6.0)
Stream sides	{Lowland	20	591	31.1	11 (1.9)	87(14.7)	64(10.8)	25 (4.2)
	{Upland	13	452	34.8	15 (3.4)	64(14.2)	23 (5.1)	31 (6.8)
Boundary plots	{Lowland	23	516	22.3	14 (2.7)	75(14.5)	46 (8.9)	23 (4.5)
	{Upland	7	225	32.1	4 (1.8)	40(17.8)	23(10.1)	13 (5.8)

* All samples grouped irrespective of the landclass since insufficient in 'upland' to allow of separate listing. Underlining is used to emphasise major discrepancies

Type of variation (see Para. 21)

A Mis-identification
B Species apparently overlooked in original survey
F Species change apparently due to seasonal or annual effects
G+H Failures to locate or align plots at T2.

30. The results indicate:

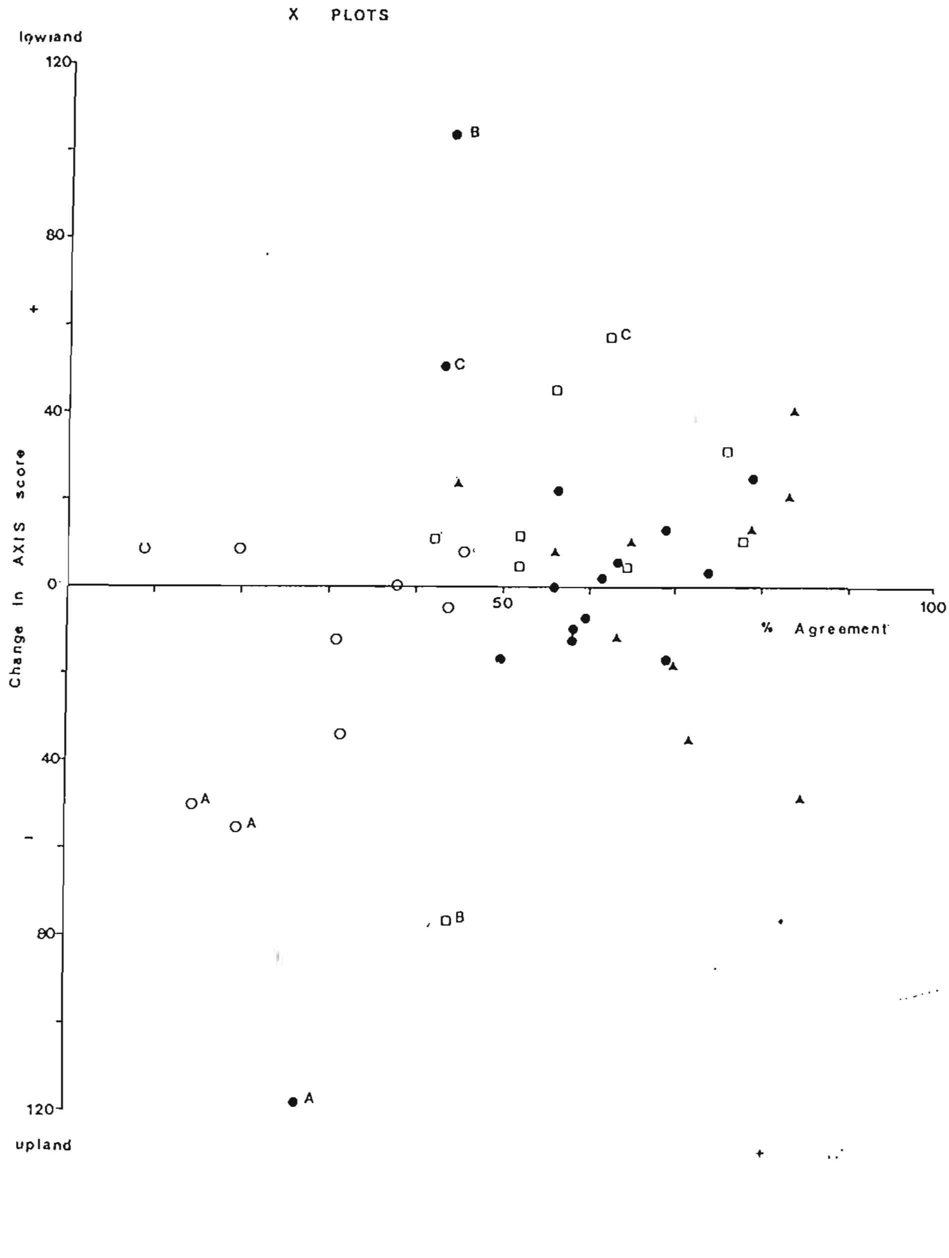
(i) a better search image in X plots
(ii) less seasonal effect in upland squares
(iii) the ease with which roadside plots could be relocated
(iv) the relative difficulty of accurately relocating S and X plots; X plots would have been more efficiently compared were they to have been marked with a plate in all cases.
(v) the extreme difficulty in accurately relocating the small Y plots

Recommendation 3. Surveyors should be responsible for annotating their photographs and relating the photograph to the relevant sketch map which should include distance of plot to nearby features

Recommendation 4. Metal marker plates should be used where ever possible to mark X plots in enclosed land.

Recommendation 5. $4m^2$ (Y) plots should be defined using a survey tape and should be orientated such that the side rather than the diagonal is oriented N-S. The plate should then be placed at the SE corner.

Figure 1.
Plot of changes in first axis scores of DECORANA ordination against percentage agreement between species recorded in the 1990 Countryside Survey and the 1991 QA exercise.
Landclass aggregates are distinguished and the principal causes of individual major shifts are indicated.

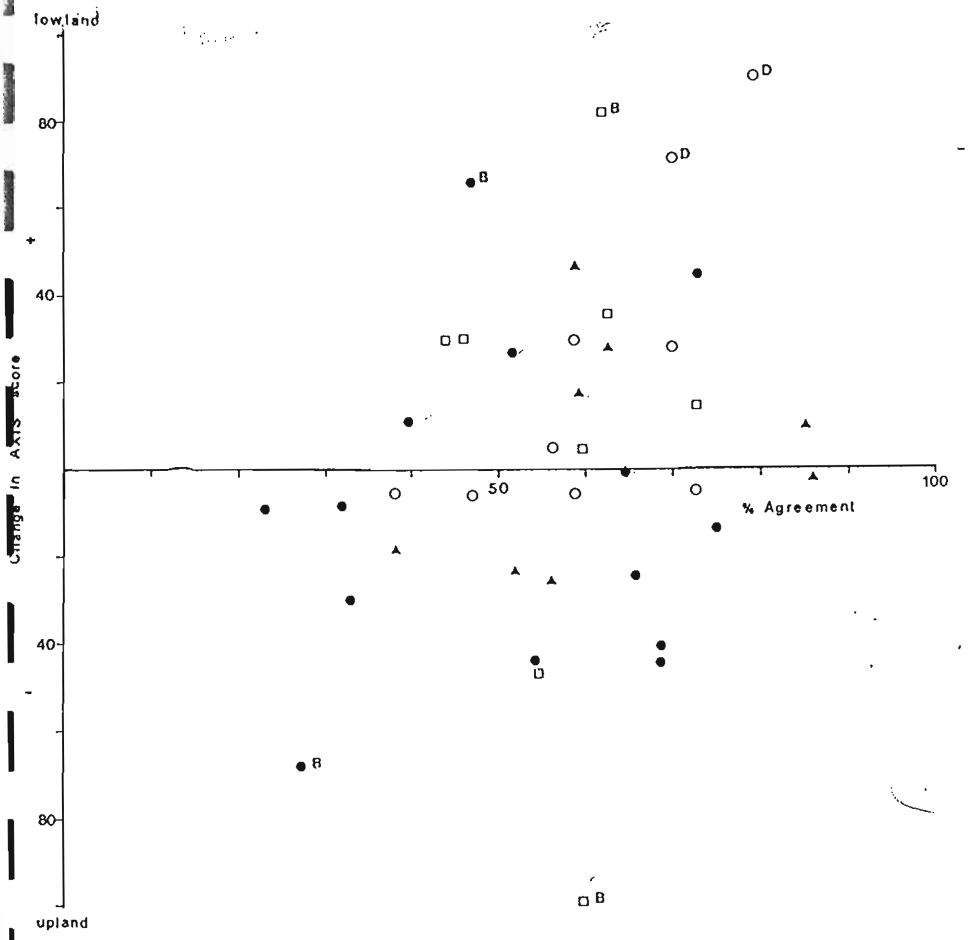


A. Crop change
B. Problems in relocation
C. Inefficient species recording during the original survey (likely to include an element of seasonal change)
D. Disparities in the awarding of cover values.

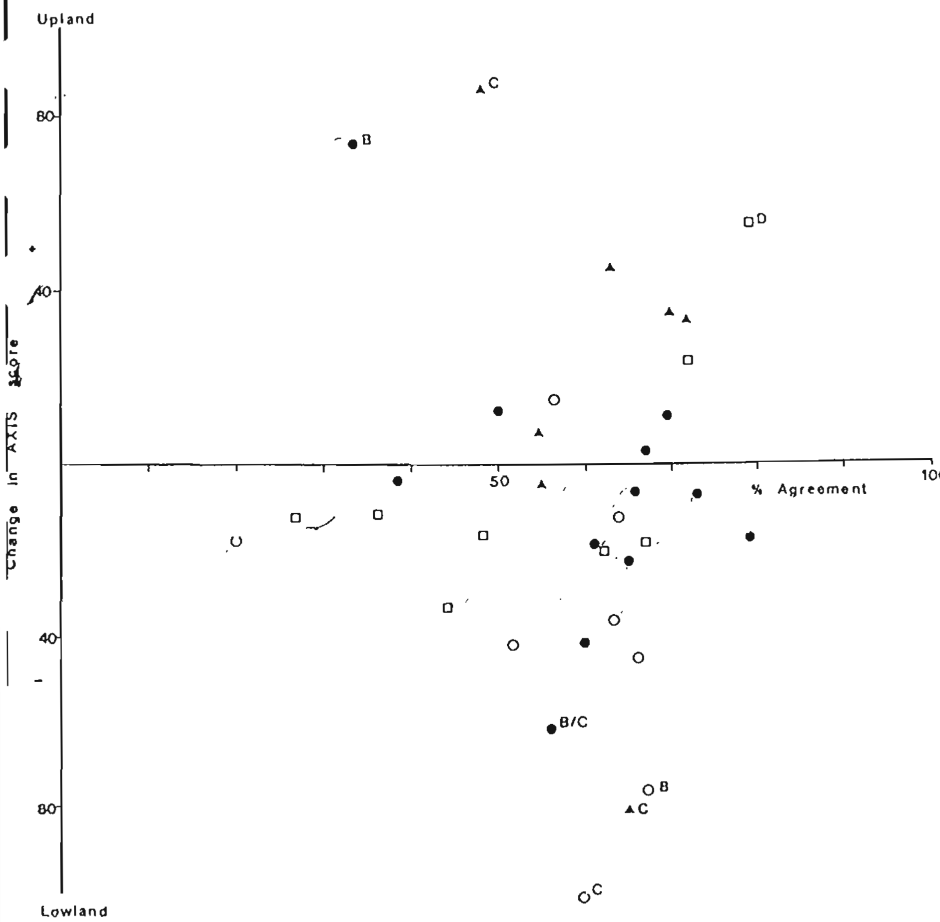
Landclass Aggregates:

○ LC
● LG
□ MA
▲ UP

'Y' PLOTS



STREAM PLOTS



31. An analysis of variance of the 1991 QA exercise by plot type and landclass shows no significant difference in the **% accuracy** achieved in the individual survey between plot types but a highly significant difference between landclass aggregates:

	F	P	
Plot	1.003	0.418	NS
Landclass aggregate	10.56	0.001	***
Interaction	0.87	0.565	NS

Notes: percentage accuracy is arrived at by eliminating T2 variations which are due largely to errors in plot location (see Para. 11). X plots which have undergone a change of crop have been excluded from the analysis.

32. The effect demonstrated is due to a significantly lower degree of accuracy in the recording of those plots falling in the lowland arable landclasses (LC); the other classes have all been recorded at approximately the same level of efficiency. The reasons for the comparatively poor performance in the most lowland squares are unclear but may include a lower overall level of experience amongst the surveyors involved, a generally greater level of species diversity in lowland squares and a greater short-term species flux especially in arable areas.

The recording of vegetation cover

33. As an integral part of the original recording schedule, surveyors were required to give visual estimates for cover for any species perceived to exceed 5% cover in a plot. These estimates were repeated during the QA. The comparison of cover values presented in Table 8 matches estimates made in all plots where the species was recorded as present at both times of survey.

34. Although the table below shows only two species, *Holcus lanatus* and *Poa trivialis*, to have been recorded at significantly different covers in the original survey and the assessment, several other significant differences are apparent when the data are sub divided into lowland, marginal and upland groups of squares.
Cover estimates by landclass aggregate, for a selection of relevant species, are presented as Annex D.

Table 8. Comparison of cover values for the principal species: 1990 v 1991

Plots having the species recorded at both T1 and T2.
Results of Wilcoxon Matched Pair analysis.

	N	t1	t2	z	p
Holcus lanatus	93	8.3	5.5	- 2.87	**0.004**
Urtica diocia	82	6.8	8.1	+ 1.40	0.16
Lolium perenne	81	21.7	22.7	+ 0.8	0.43
Dactylis glomerata	73	7.0	5.4	- 1.56	0.12
Trifolium repens	65	7.6	7.8	+ 1.01	0.31
Ranunculus repens	63	2.9	3.4	+ 0.99	0.32
Arrhenatherum elatius	56	12.5	10.7	- 0.99	0.32
Rubus fruticosus	56	8.4	7.8	+ 0.32	0.75
Festuca rubra	54	10.1	8.2	- 1.48	0.14
Poa trivialis	54	4.0	6.3	+ 2.16	**0.03**
Agrostis stolonifera	48	12.8	8.9	- 1.52	0.13
Anthoxanthum odoratum	38	5.3	5.9	+ 0.55	0.58
Agrostis capillaris	37	20.8	16.4	- 1.70	0.09
Calluna vulgaris	28	22.4	18.6	- 1.24	0.22
Trichophorum cespitosum	16	11.6	14.1	+ 0.98	0.32
Eriophorum angustif.	14	2.6	2.6	0.00	1.00
Eriophorum vaginatum	9	17.3	14.7	+ 0.06	0.95

Effects of variations in recording

35. Although there are almost 40% of species mis-matches when direct comparisons are made between individual pairs of plots it might be expected that these differences would, for many of the commoner individual species, average out over a large number of plots. To test this assumption the frequencies of all species recorded have been compared for the 1990 survey and the subsequent full re-assessment.

36. A comparison of the frequencies of the most prevalent species across all terrain classes is presented in Table 9.

Table 9. Changes in frequency of the most prevalent species

Figures in brackets give the ranked order of prevalence

	1990	1991		1990	1991
Holcus lanatus	107 (1)	116 (1)	Galium aparine	68 (8)	80 (9)
Lolium perenne	88 (3)	102 (2)	Arrhenatherum elatius	59 (=13)	73 (=11)
Urtica dioica	94 (2)	89 (3)	Rubus fruticosus	61 (=11)	66 (13)
Dactylis glomerata	84 (4)	83 (=7)	Rumex obtusifolius	59 (=13)	54 (18)
Ranunculus repens	80 (5)	85 (6)	Cerastium fontanum	51 (=17)	60 (14)
Poa trivialis	71 (7)	87 (4)	Rumex acetosa	51 (=17)	59 (15)
Taraxacum agg.	64 (=9)	86 (5)	Agrostis capillaris	55 (15)	52 (=20)
Trifolium repens	72 (6)	73 (=7)	Poa annua	52 (16)	53 (19)
Agrostis stolonifera	64 (=9)	79 (10)	Cirsium arvense	49 (19)	56 (16)
			Anthoxanthum odoratum	48 (=20)	52 (=20)

37. It is not possible to apportion the reasons for individual discrepancies with any confidence but the following points may be made.

(i) The apparent increases in *Taraxacum spp.*, *Galium aparine* and *Cirsium arvense* along with similar increases in frequency for the less prevalent species *Lapsana communis* and *Alliaria petiolata* do appear to reflect a genuine change in the populations of these species between the two years of survey.

(ii) In contrast, the apparent changes in *Lolium perenne* and *Poa trivialis* seem to result from under-recording during the initial survey; *Poa trivialis* across all plot types and *Lolium* in more marginal and upland situations.

(iii) Of the less prevalent species only *Holcus mollis* appears to have been consistently over-recorded in the original survey. Kirby also refers to an inconsistency of distinction between *Holcus mollis* and *H.lanatus* in his observer bias trials.

Recommendation 6. **One aspect of future training courses should involve a concentration on the field characteristics which serve to distinguish the members of similar taxa with emphasis on vegetative identification of common grasses.**

Overall effects of species change

38. Marked changes in apparent species composition have been demonstrated for individual plots of all types. In order to assess the effects of this variation on the plots as a whole the quadrats have been arranged on a continuum using the first axis of a DECORANA analysis (Hill 1979) as the gradient. All pairs of quadrats of a single plot type from the original survey and from the 1991 re-assessment have been pooled. For each pair the change in axis score has been plotted against the percentage agreement in species complement at the two times of survey. The assumption to be tested is that, though the axis scores for individual pairs may shift markedly due to e.g. a change in management between years or a failure to accurately relocate a particular plot, the results for the two total records should form a single population with little or no overall shift in mean axis score.

39. The resulting graphs for individual plot types form Figure 1. Three plot types are represented in the Figure; those omitted, hedge, boundary and roadverge plots show a very similar distribution of points. A 50 unit change in First AXIS score has been taken as a purely arbitrary level above which reasons are sought for the discrepancy between Time 1 and Time 2 records. No single cause for large discrepancies is evident; four causes of variation contribute to the scatter of points; crop change, problems of plot relocation, failures in species recording during the original survey and disparity in the awarding of cover values for species recorded. (Variations due to the latter are notable in woodland plots. The field handbook states 'cover of tree species should be put in parentheses'; surveyors were not consistent in their attitude to cover resulting from species not obviously rooted in the plot.)

Recommendation 7. Recording of tree and shrub cover should be dealt with more explicitly in handbooks and training courses. Rules should also be adopted for the use of such data in subsequent analyses.

40 Percentage agreement has been selected as the X-axis since it demonstrates the full extent of variation between pairs of quadrats. Thus, the cluster of open circles to the LHS of the 'X' plot graph results largely from changes between cereal and other arable crops over the two years. Different crops are accompanied by different suites of arable weeds and in consequence there may be a high level of mis-match which only infrequently results in an appreciable shift along the axis.

41. With the exception of the hedge data, the Eigenvalue for the first axis was uniformly high and the gradient between the acid soils of the uplands and the possibly more nutrient-rich lowlands was strong.
Hedges are not prevalent in the uplands and, perhaps in consequence of the inevitable 'clumping' of the data, even the first axis Eigenvalue was low (0.54) and correlation between axes was marked. The first axis appeared to reflect a gradient between shade intolerant and shade tolerant species.

When the shift in **median** position of axis 1 is calculated it is seen to range for the different plot types as shown in Table 10.

Table 10.

Plot type	Median shift in axis score	Direction of change
'X'	0.3 units	towards 'lowland'
Verges	4.1 units	towards 'lowland'
Streams	4.3 units	towards 'lowland'
'Y'	4.4 units	towards 'lowland'
Boundaries	5.1 units	towards 'lowland'
Hedges	5.3 units	towards 'shade'

42. The preliminary results for changes in **mean axis score** as distinct from changes in median position, together with a comparison the coefficients of variance, are presented in Table 11.
Although the shift in the ecological gradient is always in the same direction the polarity of the axis is arbitrary. Hence, the uplands may attract either the highest or lowest scores in an individual analysis.
Since the range of first axis scores varies markedly between analyses for individual plot types no direct comparison may be made between them.

Table 11. Changes in mean axis score and variance, 1990-1991, for the six plot types

Means tests using Bartlett test of homogeneity, CV=coefficient of variance.

Plot type	Year	Mean score axis 1	p	CV (%)
'X' plots	1990	515.3}	0.84	{60.6
	1991	516.0}		{58.7
Boundaries	1990	525.3}	0.62	{31.2
	1991	536.7}		{28.1
'Y' plots	1990	573.5}	0.95	{49.6
	1991	577.8}		{49.8
Hedges	1990	176.8}	0.67	{54.2
	1991	188.2}		{49.7
Verges	1990	349.2}	0.45	{32.9
	1991	341.2}		{29.3
Streams	1990	442.0}	0.87	{47.3
	1991	433.7}		{49.5

43. An analysis of variance, using pooled data from all plot types, by year, landclass aggregate and level of interaction between these two variables with respect to mean first axis score demonstrates no significant difference either between 1990 and 1991 or any interaction between year and landclass aggregate. However, the mean axis score for the aggregate UP differs significantly from those of all other landclass aggregates. This reflects the very distinctive and stable vegetation of the moors, heaths and bogs which have been little influence by changes in recent agricultural practices.

The results are summarised below:

	Mean Axis score		ANOVA	
Landclass aggregate	1990	1991 QA	Variable	p
			Year	0.923
LC	492	492	Landclass	0.001
LG	466	466	Year*Landclass	1.000
MA	455	460		
UP	292	299		

44. The overall axis shift between 1990 and 1991, though insufficient to be significant at this relatively small sample size, parallells that previously demonstrated during the ECOLUC project. To what extent the 1990-1991 results reinforce the changes previously demonstrated or are evidence of a singular climatic shift between the two individual seasons cannot at present be established with certainty.

45. That both factors are operating is suggested by the results of a further DECORANA analysis. A comparison has been made of the 50 plots, comprising 'X' plots, roadverges, hedges and streamsides, for which data were available for three time periods; the 1978 survey, the 1990 survey and the 1991 QA exercise. When the quadrat data are pooled in a single analysis and the first axis scores are compared for each plot at each time the following axis shifts (Table 12) are produced.

Table 12. Changes in DECORANA first axis scores with time

	N	1978-1990	1990-1991	1978-1991
All Data	50	+ 21.20	+ 3.12	+ 24.32
LC + LG Landclasses	31	+ 41.55	+ 2.81	+ 44.35
MA + UP Landclasses	19	- 12.00	+ 3.63	- 8.37

Note: Plus scores (+) indicate an increase in axis score which relates to a shift towards the more eutrophic end of the gradient.

For the lowland squares and in the overall analysis both the direction and rate of change shown in the 1991 re-assessment are as predicted and thus lend support to the contention that the results of the 1990 Countryside survey are in line with the changes previously indicated for the period 1978-1988. In contrast, the temporary reversal of the trend in the less intensively farmed areas may illustrate the effect of annual variation (possibly an enhanced effect of drought on the more susceptible vegetation of marginal areas) which is likely to cause year to year perturbations within the general trend.

Performance of species groups

46. In addition to the performance of individual species and to changes in the total complement of a given plot, changes in the cumulative frequency of species groups is of interest in the context of landuse change. In a preliminary exercise a group of 10 species has been selected from each plot type (15 in the case of 'Y' plots), their frequencies summed for each of the two years under examination and a simple 't' test performed to establish whether the overall frequency of the members of a group has differed significantly. The species chosen in each case are selected as being representative of the central portion of the relevant species ordination. Any change in frequency in these 'conservative' species would provide strong evidence for a significant landuse change.

47. The results are presented below. Numbers in brackets refer to the frequency of occurrence of each species in 1990 and 1991. Differences between years are testing using Students 't'.

(i) 'X' plots:
Ranunculus acris (7,8) Taraxacum agg. (18,23) Campanula rotundifolia (1,2) Festuca rubra (9,11) Leontodon autumnalis (3,3) Trisetum flavescens (1,1) Cynosurus cristatus (8,8) Potentilla reptans (3,3) Rumex acetosa (11,14) and Holcus lanatus (22,19).

Mean frequency 1990=8.3, 1991=9.2 't'=0.275 p =0.787

(ii) Verges
Potentilla anserina (2,2) Festuca rubra (17,19) Trifolium repens (7,7) Bellis perennis (3,2) Ranunculus repens (12,13) Dryopteris felix-mas (1,1) Stellaria holostea (5,5) Holcus lanatus (20,21) Crepis capillaris (2,3) and Conopodium majus (3,3).

Mean frequency 1990=7.2, 1991=7.6 't'=0.126 p=0.908

(iii) Hedges
Sambucus nigra (5,7) Geranium robertianum (5,7) Crataegus monogyna (21,22) Mercurialis perennis (1,2) Hedera helix (15,13) Lapsana communis (0,6) Brachypodium sylvaticum (5,2) Tamus communis (5,8) Anthriscus sylvestris (7,6) and Lamiastrum galeobdolon (2,1).

Mean frequency 1990=6.6, 1991=7.4 't'=0.28 p=0.78

(iv) Boundaries
Equisetum arvensis (2,3) Agrostis stolonifera (9,10) Cirsium vulgare (4,5) Artemesia vulgaris (2,1) Arrhenatherum elatius (14,13) Heracleum sphondylium (6,7) Elymus repens (11,10) Stachys sylvatica (2,3) Senecio jacobea (3,4) and Rubus fruticosus (13,14).

Mean frequency 1990=6.6, 1991=7.0 't'=0.193 p=0.849

(v) Streamsides
Stellaria graminea (2,3) Holcus lanatus (21,20) Cardamine hir/flex. (6,11) Angelica sylvestris (7,6) Potentilla sterilis (3,3) Stellaria alsine (5,6) Ranunculus repens (17,17) Glyceria fluitans (4,5) Veronica beccabunga (5,4) and Filipendula ulmeria (7,9).

Mean frequency 1990-7.7, 1991=8.4 't'=0.257 p=0.8

(vi) 'Y' plots
Festuca rubra (10,14) Leucanthemum vulgare (1,0) Centaurea nigra (2,3) Hypericum perforatum (1,1) Achillea millifolium (4,5) Veronica chamaedrys (4,4) Hydrocotyle vulgaris (1,1) Chrysosplenium oppositifolium (2,3) Cynosurus cristatus (6,6) Lychnis flos-cuculi (1,1) Anthoxanthum odoratum (10,12) Cerastium fontanum (7,8) Cirsium arvense (7,9) Dactylis glomerata (9,7) and Ranunculus repens (13,13).

Mean frequency 1990=5.2, 1991=5.8 't'=0.386 p=0.71

Although changes are seen in some individual species; *Lapsana communis* and *Taraxacum agg.* are examples of species which appear to have been affected by the differing climatic conditions of the two years, no species group shows any significant difference in cumulative frequency between the original survey and the reassessment.

The mapping of agricultural landuse and the distribution of natural vegetation

48. This involves the use of a series of codes which may, for the purpose of analysis, be sub-divided into three groups;

(i) Primary codes: major habitat and crop types,
(ii) Secondary descriptive codes: relate to stock and variations in land management,
(iii) Cover codes: a further characterisation of a given parcel of land using a combination of the mapping of the most prevalent species together with a code denoting the cover of each.

49. The efficiency of mapping can be tested in two ways. The frequency of primary codes can provide a population estimate which will indicate any overall discrepancy in the units mapped. The accuracy of mapping at a

particular point can be gauged by matching the primary code awarded by the assessors at a point location with the code given in the original survey for the parcel of land in which the point is located.

50. A comparison of the frequency of use of primary landuse codes is presented in Table 13.

Table 13. The Number of times individual primary codes are assigned

	Lowland square		Upland square		Total	
Primary code	1990	1991	1990	1991	1990	1991
101	77	76	30	30	107	106
Arable codes	43	42	0	0	43	42
111	0	0	26	24	26	24
104	0	0	23	21	23	21
102	1	0	14	10	15	10
105	4	4	0	0	4	4
114	0	3	1	4	1	7
109	1	1	0	0	1	1
103	0	0	2	6	2	6
112	0	0	2	3	2	3
115	0	0	5	5	5	5
Total	126	126	103	103	229	229

51. It is clear that the allocation of primary codes to the principal types of landuse and of natural vegetation cover is very reliable. The minor categories occur with such limited frequency that the sampling is insufficient to adequately test the effectiveness of the original recording.

52. When point by point comparisons are made over the grid of sample points for each square assessed the general results show a very high level of agreement for the lowland areas and a greater variability in the interpretation of upland vegetation (See Table 14). Some of the latter may be due to problems of location in unenclosed land.

Table 14. Pair-wise comparisons of primary codes

	Lowland	Upland	Overall
Primary codes concurring	120	73	193
Primary codes not-concurring	6	30	36
Percentage agreement	95.2%	70.9%	84.3%

53. An extended comparison of the use of codes, both for landuse and for boundary features, has been made using the data from all squares where a three-way comparison is possible i.e. those squares which were either re-surveyed both in autumn 1990 and in summer 1991 by the same pair of

assessors, or were re-visited on the two occasions by different pairs of assessors. The results are summarised in Table 15.

Points arising:
(i) The overall concordance between landuse primary codes (88.7%) is similar to that shown for the initial exercise presented in Table 14 (84.3%).

(ii) The equivalent concordance for the primary codes used to describe boundary features is slightly lower (80.3%) and yet is noticeably inflated by the high level of agreement resulting from the same assessors re-visiting the same squares in both autumn 1990 and summer 1991. (The 1990 data were not referred to in the subsequent survey so both the location of the point on the grid and its assessment were independent on the two occasions).

(iii) The reasonably good agreement in the use of Level 1 qualifiers, 79% for landuse and 83% in the case of boundaries, together with the concordance for primary codes reflects the product of two opposing trends in the survey: the conscientiousness of the surveyors (there was virtually no evidence of guess work) and the level of interpretation residing in the codes provided despite the great efforts made to furnish unique definitions for each code.

(iv) The remarkable similarity in overall performance shown in Comparison 2 emphasises this element of interpretation: there was no real difference in the use of codes between pairs of assessors and between assessors and surveyors. Unlike the situation in species recording within quadrats, the assessors proved themselves to be very average surveyors with respect to the use of mapping codes.

54. Level 1 versus Level 2 agreement.
The large number of available codes, especially in connection with boundary features, make adequate comparisons of T1 and T2 mapping difficult. The approach adopted is best illustrated with a simple example.

A typical pair of code combinations for a survey point might be:

Original survey Code				QA
321		Hedge, 50% hawthorn		321
342		<2m high		342
351	Stockproof		Not stockproof	352
353	Filled gaps <10%			-
-			Trimmed	357
			Laying	361

This would translate in Table 15 as;

Primary code agreement	√		
Qualifying codes			
Agreement at Level 1	√	X	(50%)
Agreement at Level 2			(20%)

since, of a total of six qualifying codes used, one was common to both records, one pair represented a mismatch, one was noted at T1 but not T2 and two appeared at T2 but were absent at the T1 record.

Table 15. Comparison of efficiency of use of mapping codes

Comparison 1 - where 1 = original 1990 survey
2 = autumn 1990 QA
3 = 1991 QA

Codes	1v2	1v3	2v3
		percentage	
Landuse primaries	95	94	95
Landuse qualifiers			
Agreement at level 1	66	75	80
Agreement at level 2	35	37	51
Boundary primaries			
Agreement at level 1	85	86	92
Agreement at level 2	67	68	77
Boundary qualifiers			
Agreement at level 1	78	81	91
Agreement at level 2	49	53	74
	(68)	(71)	(80)

Comparison 2 - where 1 = original 1990 survey
2 = assessors B + B
3 = assessors W + P

Codes	1v2	1v3	2v3
Landuse primaries	85	82	81
Landuse qualifiers			
Agreement at level 1	81	84	89
Agreement at level 2	42	52	50
Boundary primaries			
Agreement at level 1	71	76	72
Agreement at level 2	49	52	54
Boundary qualifiers			
Agreement at level 1	82	78	88
Agreement at level 2	47	52	47
	(65)	(68)	(69)

Note.
Agreement 1. Percentage concordance between 'yes - no' couplets: examples stockproof v. non-stockproof, mixed hedge v. hawthorn hedge, >2m v. <2m, hay v. silage.

Agreement 2. Total percentage concordance including all descriptive qualifying codes.

55. Despite the thoroughness with which the Field Handbook of the 1990 Countryside Survey was compiled it is clear that confusion remained in the allocating of some codes. Two sources of variation were apparent;
(i) inversions of particular pairs of codes and
(ii) difficulties of interpretation of some qualifying codes.

56. With respect to the first source of variation, the commonest primary landuse codes, the collection of arable codes and 101 lowland agricultural grassland were clear, unambiguous and were, in consequence, mapped with a very high level of accuracy. However;

(i) some clearly improved pastures of marginal or moderately high altitude land presented difficulties. Were they '101' because they were improved or were they '102' because they retained notable amounts of *Agrostis capillaris* or bracken ?

(ii) the code '114', marsh, was used inconsistently. The handbook definition required the unit to be a nutrient-rich mire/wetland dominated by rushes or sedges. Some surveyors followed this definition and used the code only very sparingly. Others used the code to map parcels of land dominated by rushes in otherwise improved lowland agricultural grassland.

(iii) the partitioning of areas between '104', moorland-shrub heath and '111', blanket bog was in some cases rather arbitrary. Some surveyors, encouraged by the handbook, mapped extensive tracts of high rainfall wetland as '111', irrespective of the presence or absence of significant amounts of *Eriophorum* spp.; others mapped a mosaic of blanket bog and moorland. Vegetation dominated by a combination of *Calluna* and *Trichophorum* seemed to have an equal chance of attracting either code.

Recommendation 8. That the present code '102', upland grassland be sub-divided into:
Upland improved meadow/pasture; usually a mixture of *Lolium perenne* and *Agrostis capillaris* with *Anthoxanthum odoratum*, if present, sparse. Enclosed or unenclosed.
Upland grassland; less or unimproved grassland on mineral soil, lacking significant amounts of *Lolium perenne*. Typically with prominent *Anthoxanthum odoratum*; often supporting bracken.

Recommendation 9. There should be a code for lowland rush pasture.

Recommendation 10. That 'wet heath' be recognised as a widespread and distinctive vegetation type and be awarded a primary code.

57. Even the awarding of primary boundary codes could result in mis-matches. The most consistent source of variation was the failure to distinguish between codes 321-323; hedges with >50% hawthorn, >50% dominance by another species and mixed species hedges respectively.

Recommendation 11. That the primary boundary code be restricted to 'hedge' and its species composition covered by qualifying codes.

58. Of other codes which produced a marked lack of concordance the most common mis-matches were those concerning forb cover and hedge condition. The codes for forb cover (138-140) were not defined in the handbook and were, in consequence, frequently misused. The restriction of code '357', 'trimmed', to hedges managed within the current year seems to have led to an over-use of code '358', 'uncut'; many hedges nowadays are only managed in alternate years.

Mapping of species cover

59. In an attempt to measure the level of concordance between species mapped in a vegetation unit and those subsequently recorded around an assessment point the following values have been calculated for the degree of agreement between species codes at each of the nine points of the grid across all squares revisited.

Species 1	81%
Species 2	34%
Species 3	5%

Thus, if a given species is recorded at a cover of >25% at one time, there is an 81% likelihood that it will appear as a dominant or sub-dominant at the other time of survey. However, if two species are given as co-dominants the likelihood that both will be so recorded at both times drops to 34%. A level of concordance such that a vegetation unit having three co-dominants will be exactly matched at both survey times is only rarely achieved (5% concordance).

60. Considering the values given in paragraph 59 together with the values for concordance given in Table 16 below, two generalisations could be made;

(i) even the unenclosed upland areas were very conscientiously mapped; the vegetation at the assessment point almost always bore some resemblance to that mapped but
(ii) only the more evident and widespread species gave a reasonable level of concordance and then only if comparisons are restricted to the most apparent species at a point.

Recommendation 12. Only the two most prevalent species should be recorded during the mapping of landuse parcels

Table 16. Frequency of species records with over 25% cover.

Species	1990	1991	Species	1990	1991
Lolium perenne	77	69	Bromus hordeaceus	3	2
Calluna vulgaris	46	43	Alopecurus pratensis	4	1
Trifolium repens	34	31	Festuca pratensis	3	1
Molinia caerulea	22	18	Erica cinerea	0	3
Cynosurus cristatus	20	12	Nardus stricta	4	1
Trichophorum cesp.	20	24	Rhacomitricum spp.	1	3
Eriophorum vaginatum	14	9	Juncus acutiflorus	1	2
Agrostis capillaris	8	14	Phleum pratense	1	2
Festuca ovina	15	2	Galium saxatile	3	0
Sphagnum spp.	6	9	Elymus repens	1	1
Myrica gale	9	5	Agrostis can/vin.	1	2
Juncus effusus	5	8	Erica tetralix	0	1
Eriophorum ang.	4	7	Rhynchospora alba	1	1
Poa trivialis	2	7	Stellaria media	0	2
Holcus lanatus	4	5	Dactylis glomerata	0	2
Vaccinium mytrillus	5	3	Taraxacum agg.	0	1
Anthoxanthum odoratum	3	5	Cirsium vulgare	2	0
Deschampsia flexuosa	2	5	Phalaris arundinacea	0	1
Rubus chamaemorus	4	3	Filipendula ulmeria	1	0
Schoenus nigricans	6*	1	Polygonum bistorta	1	0
Poa pratensis	10^	0	Brachypodium pinnatum	1	0
Agrostis stolonifera	3	4	Arctous alpinus	1	0
			Juncus squarrosus	1	1

* All points from a single square
^ Includes 9 records from a single square.

Conclusions with respect to future surveys .

60. Sensible photographs are a very important aid in the relocation of plots, especially in unenclosed land. In general the sketches and photographs for the 1990 survey were very reasonable but some points are worth noting for future surveys.

(i) Distance of plot to <u>nearby</u> features often not given. Many such features, whilst not sufficiently fixed to be used as prime locators, would have been very useful in practice.

(ii) Directions, and especially compass bearings, were often given from the plot <u>to</u> nearby features rather than *vice versa.* This made relocation especially difficult.

(iii) Whilst in unenclosed situations, the photographs and sketches often enabled one to get very close to the actual location and were efficient in preventing the re-survey of adjacent but totally dissimilar habitat types, relocation would often have been greatly assisted if distances and compass bearings had been included on the sketch for features identifiable in the photograph. Ideally time should be made available for the surveyors to annotate photos taken during the survey.

61. The relocation rate for the metal plates was sufficiently high to consider their use a success. However, the relocation of plates in unenclosed uplands was very time-consuming; 30 minutes per plot was not unusual. If the system is to be retained for such areas extra man power would by required for relocation in future surveys.

62. Difficulties in location and orientation were particularly pronounced for the 'Y' plots. An improved technique for quadrat positioning on the ground has been recommended (Recommendation 5). Photographs of the location of the plot should clearly show the 2x2m area delineated on the ground. Nearby distinguishing features should be shown both on the photograph and on the accompanying sketch map (Recommendation 3). It is felt that such modifications would enhance the efficiency of recording of these small quadrats.

63. Although species identification was in general very adequate, errors associated with the recording of species, especially grasses having broadly similar vegetative characteristics and the failure to consistently record the allowable bryophytes, suggest that these groups should be targeted both during future training course and in the early stages of a QA exercise. Additional allowable bryophytes may be considered necessary where survey is restricted to individual habitats, especially in the context of the National Vegetation Classification, which relies heavily on bryophyte species in wetland/mire communities. Additional species which might need to be added to the list for other habitat-specific surveys might include;
Homalothecium lutescens and *Ctenidium molluscum* in calcareous grassland
Tortula ruraliformis and *Brachythecium albicans* on sand dunes
Fontinalis antipyretica and *Rhynchostegium riparioides* in running waters
and *Schistidium maritimum* on coastal rocks.

64. The high level of species mis-matches apparently due to variations in climatic conditions between year serves to emphasise the need for future QA to be made in the same year as the actual survey. Discrepancies due to summer *versus* autumn recording within a single year though less pronounced remain significant and should be avoided. QA should thus be restricted to the season and year of original survey (see also Recommendation 2).

65. With respect to landuse mapping and especially in view of the possibility of relating natural vegetation to the National Vegetation Classification the number of primary codes should be increased and the field surveyors provided with simple dichotomous keys to allow for unambiguous recording. Less emphasis during the mapping exercise should be given to the cover of individual species present. Only cover for the most prevalent species should be recorded. This would almost certainly result in more reproducible mapping (Recommendation 12).

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Annex A.

1. SUMMARY OF SQUARES ASSESSED

Square	Assessors	Date surveyed 1990 ^	1991	
1/110	HW/MP	11/06	04/06	
2/111	''	18/06	05/06	
3/311	''	16/08	13/08	
4/366	''	26/06	20/06	
5/230	''	22/08	14/08	
6/ 40	''	02/06	06/06	
7/ 68	RB/MG	14/07	19/07	
8/ 63	RB/MG	20/07	19/07	
9/331	HW/MP	22/08	13/08	
10/545	''	04/07	25/06	
11/336	''	23/06	20/06	
12/364	''	08/06	02/06	
13/569	''	03/07	21/06	
14/561	''	03/06	24/05	
15/676	''	01/06	22/05	
16/657	''	26/06	24/06	
17/539	''	01/06	23/05	
18/431	''	21/07	09/08	
19/847	DS	10/06	26/06	
20/1212	HW/MP	07/07	28/06	
21/1090	''	23/06	02/07	*
22/773	''	25/07	03/08	
23/804	DS	03/07	04/07	
24/921	HW/MP	03/09	08/09	*
25/898	''	26/06	30/06	
26/912	''	23/06	29/06	
27/672	''	04/07	24/06	
28/751	''		02/08	
29/1118	''	25/06	03/07	
30/966	''	05/09	09/09	*
31/1152	''	26/06	04/07	*
32/1163	''	23/06	05/07	*

ADDITIONAL SELF-ASSESSMENT SQUARES OF HW/MP

Square	Original surveyors	Date surveyed 1990	1991
1/325	HW/MP	20/09	06/09
1/353	''	10/09	04/09
5/383	''	13/09	05/09
15/352	''	07/09	04/09
15/518	HW/GW	06/06	29/05
17/351	HW/MP	03/09	19/08
17/540	HW/GW	01/06	29/05

^ Mid-point of original survey

* Unenclosed area sampled

Annex B.

Method

1. Choose one quarter of the square which ideally:

   a) includes 6 different plot types (X,Y,B,H,S or W,R or V)
   b) has few landowners
   c) is easily accessible

2. Seek permission to access land, using the approach that we are looking at seasonal variation in vegetation and have taken a small sub-sample for study. If you fail to negotiate access, try a different part of the square.

Mapping land cover and boundary features

3. Place grid of nine points to cover the quarter of a square that you have chosen. A specimen is attached. Label Q1 to Q9 as follows:

Q1	Q2	Q3
Q4	Q5	Q6
Q7	Q8	Q9

4. Locate each position and code the mappable area in which the point occurs (might be a whole field), using the Countryside Survey 1990 code list. If the point falls on a boundary, move to one side (furthest from other points). If the point falls on a road, or on houses etc, record accordingly.

5. For each position, locate the nearest boundary, if within 100m, and code as a mappable length. (If the position is more than 100m from the nearest boundary, record "No boundary".) Record the approximate direction of the boundary from the Q position (eg SW of Q2). Use convention of QB1 to QB9 to identify boundaries.

Vegetation

6. For one only of each plot type (X,Y,B,H,S or W, R or V) locate the metal plate using the sketch map and then the metal detector.

7. Record the plot using the standard Countryside Survey 1990 procedure, on a new form.

8. If you are unable to locate the plate, record this and survey where you believe the plot to be.

9. If any one of the 6 types does not occur in the quarter, use a plot from elsewhere within the square. If a plot type does not occur anywhere within the square, then ignore (eg do not compensate by replicating other types).

Annex D. Variations in estimates of cover for most prevalent species by landclass aggregate.

Differences in mean cover in 1990 (t1) and 1991 (t2) tested using Wilcoxon Matched pairs analysis. Probability values given (p).

Note: analysis restricted to cells having eight or more couplets.

		Landclass aggregate					
		LC		LG		MA+UP	
		Cover	p	Cover	p	Cover	p
Lolium perenne	t1	22.9	0.12	26.1	0.92	12.4	**0.01**
	t2	19.3		24.9		21.6	
Agrostis stolonifera	t1	22.9	0.14	26.1	0.77	16.7	0.13
	t2	19.3		24.9		8.3	
Holcus lanatus	t1	14.2	0.14	7.6	0.30	8.5	**0.01**
	t2	9.5		5.8		4.3	
Festuca rubra	t1	12.7	0.26	8.6	0.97	10.2	0.12
	t2	8.3		8.8		7.4	
Trifolium repens	t1	12.4	0.42	6.6	0.18	7.3	0.35
	t2	7.4		7.4		7.9	
Poa trivialis	t1	4.3	0.59	3.8	**0.03**	4.0	0.58
	t2	5.1		7.1		6.0	
Ranunculus repens	t1	1.4	0.32	3.0	0.16	3.7	0.16
	t2	2.2		2.8		4.9	
Urtica dioica	t1	3.5	**0.04**	9.6	0.54	2.3	0.71
	t2	5.9		10.7		1.8	
Dactylis glomerata	t1	7.3	0.54	7.3	0.30	6.1	0.37
	t2	5.6		5.6		4.6	
Arrhenatherum elatius	t1	18.5	0.07	7.8	0.28		
	t2	12.4		9.5			
Rubus fruticosus	t1	8.9	0.32	8.8	0.69		
	t2	7.8		8.2			
Elymus repens	t1	15.9	0.19				
	t2	11.0					
Cynosurus cristatus	t1			6.7	0.87		
	t2			7.0			
Agrostis capillaris	t1					17.8	0.35
	t2					15.3	
Calluna vulgaris	t1					22.4	0.21
	t2					18.6	
Anthoxanthum odoratum	t1					6.1	1.0
	t2					6.6	
Molinia caerulea	t1					16.8	0.89
	t2					17.7	
Nardus stricta	t1					2.2	**0.02**
	t2					5.8	
Trichophorum cespitosus	t1					11.6	0.32
	t2					14.1	