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Progress Reports on Monitoring of Grassland Transplant Sites

Brampton Meadow, Cambridgeshire 1987-1991

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ABSTRACT

This report summarises five years of pre-transplant monitoring at Brampton Meadow, Cambridgeshire, one of eight grassland transplantation sites being studied by English Nature. Field methods and analytical methods are described and floristic data tabulated. Changes in species composition and frequency are assessed with particular reference to plant strategy theory (CSR) and management practices.

CONTENTS

1. INTRODUCTION

1.1 Background to the NCC monitoring study of grassland transplantation sites

In recent years it has been increasingly suggested by developers that habitats of value to nature conservation (especially grasslands) should be moved if they are threatened by proposed developments. Various transplantation techniques have been attempted, with grasslands usually being moved either as turves or as mixtures of stripped topsoil and turf fragments (Byrne, 1990).

The claim being made is that a grassland can be successfully 'dismantled', the pieces (soils, plant and animal populations) moved to a new location and 'reassembled'. Such proposals are certainly technologically appealing, although they appear to ignore the fact that the way in which a grassland is constituted is very largely determined by the environmental context within which it has developed.

There have been many attempts at grassland transplantation (Prigmore, 1987; Buckley, 1989; Byrne, 1990), yet the monitoring data available are rarely sufficient to indicate whether or not they have been 'successful' according to nature conservation criteria. To address this problem, in 1987 NCC's England Field Unit (EFU) commenced long-term monitoring of eight grassland sites in England where transplantation was imminent (Leach *et al*, 1990). The sites chosen were generally of high (SSSI standard) nature conservation interest, and covered a range of plant communities, soil types and management regimes. They also varied in the transplantation techniques to be employed: transplantation by turf cutting was to be used on all but one of the eight sites, while at three of these some of the grassland was also to be moved by topsoil stripping ('blading'), therereby allowing investigation of the relative merits of the two techniques. In addition, on three sites some grassland was to be left *in situ*, thus providing 'controls' against which to assess the transplanted swards.

1.2 The Brampton Meadow site

The present report summarizes monitoring work carried out by the EFU and staff from the NCC's successor organisation, English Nature, at Brampton Meadow in Cambridgeshire (Grid Ref: TL173719). In the limited time available, statistical analyses of the data were not possible. However, changes in species composition and frequency are summarized and tabulated and the results examined for any obvious trends. It is hoped that statistical analysis will be carried out when post-transplant data are available.

Brampton Meadow is a small (1.9 ha) species-rich meadow with a pronounced ridge and furrow topography. The plant communities are of the calcareous clay pasture type which is generally found in the south of the country and is declining due to changes in farming practices. Locally rare plant species, including *Orchis morio* and *Ophioglossum vulgatum*, are found on the site which was designated a SSSI in 1986.

In the base line report about the site, Buckingham (1987) recorded that the field had been cut for hay in 1984 and last grazed in the late 1970s by horses and bullocks. She suggested that the lack of regular management might explain the predominance of plant communities characteristic of this type of situation elsewhere (MG1, *Arrheratherum elatius* coarse grassland). She also reported that as far as the owner

was aware no artificial fertiliser has ever been applied to the sward and that the northern half of the field flooded at least twice a year until the late 1960s.

There seems to have been a greater degree of management of the site since notification. It has followed a pattern of sheep grazing in March/April, a hay cut in late July/August and an autumn grazing in September/October, again by sheep. It is not certain, however, that all these activities were carried out in every year.

Plans to build the A1-M1 link road through Brampton Meadow were proposed in 1987 and translocation expected to take place in 1988; a series of delays has meant that the meadow was finally moved in October 1991. In the intervening time, five years of field survey of vascular plants were carried out at the site providing extensive base line data for later comparison. The base line plant survey of 1987 is described in Buckingham (1987). Between 1987 and 1990, the monitoring was done by the EFU. In 1991, after the re-organisation of the NCC, regional and headquarters staff of the NCC's successor organisation, English Nature, carried out the monitoring.

The road corridor, which occupies 0.46 ha, passes through the centre of the meadow (Fig 1). The translocated turves were placed at the extreme northern end of the site, which had previously been an area of *Crataegus monogyna* dominated scrub. Planning approval is now being sought for the southern end of the meadow and this area may also be translocated, possibly to an adjoining field.

2. METHODS

2.1 Field methods

In 1987 and 1988 the EFU considered that the meadow could be divided into distinct NVC communities, as described by Rodwell (1992): MG5, *Centaurea nigra-Cynosurus cristatus* grassland; MG1 species rich, *Arrhenatherum elatius* grassland, *Centaurea nigra* sub-community, MG1 species poor *Arrhenatherum elatius* grassland, *Urtica dioica* sub-community (Buckingham 1987 and unpublished EFU data). The monitoring programme was aimed initially at being able to compare differences and similarities between the communities in relation to transplantation. By 1989, however, the distinctions between communities had blurred and the emphasis changed to surveying the whole field as one entity and comparing data between years. Table 1 summarizes the data collection techniques employed over the five years 1987-1991. Recording took place at periods between mid-May and mid-June.

2.1.1 Species lists with DAFORs

In each year a vascular plant species list was made for the whole site (in 1987 and 1988 the lists were made at a community level and then combined) and a DAFOR abundance rating (Dominant, Abundant etc) allocated to each species.

2.1.2 Frequency of species in randomly located 10 x 10 cm quadrats

In 1987 transect lines were drawn, east to west, across the field and the quadrats were located randomly along the lines. In 1988 10 transect strips were measured out across the field and 10 quadrats were randomly located

within each strip. The method followed that described by Byrne (1991), Appendix 6. Plant species present in each quadrat were recorded. In 1989, 1990 and 1991 three recorders each recorded 10 randomly located quadrats within each of the transect strips running across the field so that a total of 30 were recorded in each strip. In 1990 and 1991 quadrats were additionally recorded as falling within or outside road corridor.

In some years 'extra' quadrats were recorded within certain community types or areas to increase the representation of that area for the purpose of analysis, although these have not been included in this report.

2.1.3 Permanent quadrats

In 1987, nine permanent $1m^2$ quadrats were established. They were not randomly located but chosen to represent various sward types.

A species list for each of the nine quadrats was compiled and DOMIN abundance values assigned. In 1987, 1988 and 1990, but not in 1989, frequency of species was assessed by recording presence/absence of species in 25 10 x 10 cm quadrats randomly located within each m^2 quadrat. The permanent quadrats were not recorded in 1991.

2.1.4 Vegetation structure

A standard 30 cm diameter drop disc and metre rule were used to measure vegetation height as described by Byrne (1991), at randomly located points within each of the transect strips. Recording was carried out in 1989, 1990 and 1991 with additional recording in the two latter years of whether the point was within or outside the road corridor.

2.2 Analytical methods

2.2.1 Species list with DAFORs

Recent work by NCC (Leach, 1988; Leach and Doarks, 1991) has questioned the usefulness of species lists and DAFOR ratings as a monitoring technique unless used for a small number of highly visible species. The inherent subjectivity of the technique makes it unsuitable for statistical analysis. Nevertheless such lists provide a useful overview of possible trends, extinctions and arrivals and as confirmatory evidence in comparison with the frequency of species data from random quadrat sampling.

The lists can also be used in conjunction with Plant Strategy Theory (see para 2.2.4). From Grime *et al.* (1988), the strategy of each species in its 'established' life-history phase was ascertained and the species assigned to four partially overlapping strategy sectors (see para 2.2.4 and Appendix 1).

2.2.2 Frequency of species within randomly located 10 x 10 cm quadrats

Data for individual species in any particular year were pooled to give a frequency value, ie the percentage of the total number of quadrats in which

the species was found that year. Initial analysis of the frequency values looked at the maximum change in frequencies. Considerable change was defined as occuring when the species frequency over the five years changed by 10% or more, a criterion used by Leach *et al* (1991). Plant strategy theory (see para 2.2.4) and data in Grime *et al* (1988) were used to classify species according to their strategy in their 'established' phases in order to examine the possible interpretation of significant changes in frequency. For 1990 and 1991, the species frequencies within and outside the road corridor were calculated.

2.2.3 Permanent quadrats and vegetation structure

Analysis of these data are not included in this report.

2.2.4 Analysis of species changes using Plant Strategy Theory (CSR)

This section draws heavily on the use of Plant Strategy Theory as described by Leach *et al* (1991).

The CSR model provides a way of describing the ecological strategies of plant species (Grime *et al*, 1988). It originates from the suggestion by Grime (1974) that it is useful to classify the external factors which affect vegetation into two broad categories, namely stress and disturbance. Stress consists of phenomena which restrict photosynthetic production, such as unfavourable temperatures, shortages of light, water or nutrients. Disturbance consists of partial or total destruction of the plant biomass, caused either by the activities of herbivores, pathogens and humans, or by phenomena such as drought, frost, soil-erosion, wind and fire.

There are four permutations of high and low stress with high and low disturbance, of which only three are viable as plant habitats. (The combination of high stress and high disturbance effectively prevents the establishment of vegetation). Grime (1974) suggested that there are three primary strategies which plants use to survive in these conditions, and the plants which survive them are classified as competitors (exploiting conditions of low stress and low disturbance), stress-tolerators (high stress and low disturbance), and ruderals (low stress and high disturbance).

Competitors are often robust perennials of high potential growth rate which form a tall and dense canopy of leaves, and have well-defined peaks of leaf production coinciding with periods of maximum potential productivity. Examples are *Urtica dioica* and *Arrhenatherum elatius.*

Stress-tolerators are often small, leathery or needle-leaved evergreens with a relatively low potential growth rate, and which have a long 'established phase' in their life histories. They are also often unpalatable to herbivores. Examples are *Primula veris, Carex flacca* and *Briza media.*

Ruderals are usually small and fast growing species which reproduce early in the short "established phase" of their life histories, and they devote a large

proportion of their annual production towards the formation of seeds. Examples are *Bromus hordeaceus* and *Stellaria media.*

There are other plants which exploit the various intermediate conditions between stress, disturbance and competition.

Plant Strategy Theory is potentially of great value in identifying and interpreting vegetation changes, and in understanding their likely causes. Species having particular strategies - or having particular physiological, autecological or morphological traits - may increase or decrease in abundance as a result of particular environmental changes, enabling distinction between, for example, disturbance effects and the effects of changes in management.

For purposes of the present report the 'Sheffield Triangle' was subdivided into four, partially overlapping, sectors according to a scheme described by Simon Leach (pers. comm.): an S-sector (comprising species having S, SR and SC strategies); an R-sector (R, SR and CR strategies); a C-sector (C, SC and CR strategies); and a CSR-sector (CSR strategy). Appendix 1 gives an example of the allocation of species to sectors. For particular groups of species, the proportions falling within each of these sectors are examined. An increase in C-sector species, for example, would suggest dereliction, while an increase in R-sector species would suggest disturbance. This 'bulking up' from seven strategies to four strategic 'sectors' is particularly useful when, as is often the case, the numbers of species in the groups being examined are small.

3. RESULTS AND DISCUSSION

3.1 Species lists with DAFORs

The species lists for the whole site for the years 1987 to 1991 are given in Table 2. The total number of species present appears to have increased from a low of 77 species in 1987 to a high of 99 species in 1990 (Table 3). After removing all those species listed as 'e' (ie found on the edge only) the results are more consistent, with a low of 71 species in 1991 and a high of 78 species in 1988 (Table 3).

While numbers of species are fairly stable, species composition differed quite considerably from year to year. Only 50% of the total number of species recorded during the period 1987-91 (118), were recorded as present every year and 53% were present in four or five of the years. However, the differences between years were largely made up of species that were not abundant in the years that they were present, or those that were only recorded from the edge of the field, so in both cases may have been missed by the recorders. Species that were recorded as rare or very rare comprised 50% of these species not present in all five years, 35% were only found on the field edge and 15% were recorded as either no more than locally frequent or occasional, or in two cases, *Bromus erectus* and *Ranunculus repens*, as occasional in one year (Table 2).

The changes in proportions of the four strategy sectors is shown graphically in Figure 2. As can be seen from this graph, the variation in proportions of the four sectors between 1987 and 1991 was less than 10%.

3.2 Frequency of species

One-third of the species recorded from the 10 x 10 m quadrats showed variation in frequency levels of more than 10% (Tables 4 and 5). The greatest variation was found among the grasses (Table 5). For example, five out of eight grasses in the 'variable change' category had variation in frequency of greater than 30% while only one out of eight forbs had variation greater than 30% (Table 5). The explanation may lie in the greater difficulty of identification of vegetative grass stems as compared to forbs, or possibly seasonal differences in growth and abundance of grasses.

Very few species showed consistent increases or decreases in frequency levels, making a CSR analysis difficult (Table 5). Two species, *Anthriscus sylvestris* and *Primula veris* decreased over the five years but had different strategies, CR and S respectively. Five species showed increases; three grasses, *Agrostis capillaris, Festuca rubra* and *Trisetum flavenscens* (CSR strategists) and two forbs, *Geranium dissectum* (R/SR) and *Potentilla reptans* (CR/CSR). Interestingly the DAFOR ratings for these seven species show similar patterns of change to a greater or lesser extent: eg there was a close match for *Anthrisus sylvestris* it was recorded as 'frequent' to 'locally dominant' in 1987 and by 1991 was classed as 'rare'. The match for *Primula veris* was less clear, it was recorded as 'abundant' in 1987 and 'frequent' in 1991 with a fair amount of variation in intervening years (Table 2). It would be helpful to investigate the strength of these trends in frequency levels using statistics when the data from pre- and post-transplantation periods are analysed.

The 16 species that changed in frequency by more than 10% represent a wide range of strategies (Table 5). Species with the same established strategy did not necessarily show a change in frequency in the same direction in particular years, eg *Centaurea nigra* and *Veronica chamaedrys* (both CSR strategists, Table 4).

A comparison of the species list and DAFORS of the whole field and the list of species recorded from the 10 x 10 cm quadrats shows that, as expected, fewer species were recorded from the quadrats (68 species as compared to 118 species). However, of the 50 species not on the frequency list, 20 were recorded from the edge of the field and 26 were noted as rare or very rare in the field. Of the remaining four species, two had a very localised distribution in the field (*Ophioglossum vulgatum* and *Ranunculus auricomus*). The remaining two species were *Rubus ideaus* and *Bromus commutatus*. The former was recorded twice, and as an edge species in one of these years, the latter was only recorded in one year.

3.3 Frequency of species within and outside road corridor

Comparison of frequency levels of species occurring within and outside the road corridor suggests that there are no marked differences in species composition and abundance in these two areas (Table 6). Only three species, all grasses (*Alopecurus pratensis, Festuca rubra* and *Trisetum flavescens*), varied by more than 10% between the two areas in 1990. In 1991, four forbs (*Centaurea nigra, Galium verum, Geranium dissectum* and *Pontentilla reptans*) varied by more than 10% when frequencies within and outside the road corridor were compared (Table 6).

3.4 Management and species and community changes

Examination of the species composition and abundance data for the five years did not discover any strong trends over time. However, the EFU reported in 1990 that the NVC community types did change over the monitoring period, with the MG1, *Arrheratherum elatius* grassland present in 1987 becoming more similar to MG5 *Centaurea nigra - Cynosurus cristatus* grassland (EFU unpublished notes). This observation is borne out by the admittedly subjective DAFOR records and to some extent by the frequency records. Buckingham (1987) referred to the prominence of *Arrhenatherum elatius, Heracleum sphondylium, Anthriscus sylvestris* and *Urtica dioica* in the MG1 community. The DAFOR values for *H. sphondylium* and *A. sylvestris* do decline over time, particularly those for *A. sylvestris*. The trend in values for *U. dioica* and *A elatius* is less clear (Table 2). The changes in frequency in 10 x 10 cm quadrats match the decline in DAFOR values for *A. sylvestris* (which had disappeared from the frequency records by 1991) and *A. elatius* which increased again in 1991 after a four year decline (Table 4). *Glechoma hederacea*, a species found in MG1 grassland (Rodwell 1992) was notable in the early years at Brampton (Leach pers. comm.) but has subsequently declined. *Agrostis capillaris* and *Festuca rubra*, both constant species of MG5 grassland (Rodwell 1992), increased over the five years. However the decline of *Primula veris* and to a lesser extent *Leontoden hispidus*, which are found quite frequently in MG5 grassland, is difficult to explain. *Geranium dissectum*, which has ruderal characteristics, has increased and may have responded to increased disturbance and extent of bare ground resulting from grazing (Leach pers. comm.). The frequency of *H. sphondylium* was rather variable year to year and *U. dioica* declined, although from an initially low level (Table 4). The management of the site does seem to have been more intensive from 1987 onwards compared to the early 1980s (EFU unpublished notes). The change to more regular cutting and grazing since 1987 may have underlain the changes in abundance of prominent species and thus the perception of the NVC community types that were present.

4. CONCLUSIONS

1. Species numbers in the field remained relatively constant over the five years. Differences in species composition were largely due to species that, when recorded as present, were only rare or very rare or only occurred at the field edge.

2. Few species showed consistent increases or decreases in frequency and there were no clear trends in the frequency data or the species list data that could be related to plant strategy theory.

3. Comparison of data for frequency of species within and outside the road corridor showed no obvious differences between species frequencies in these two areas.

4. Observed change in NVC community types from MG1 to MG5 was matched to some extent by declines in prominent species of the MG1 type over the monitoring period and may be linked to more regular grazing and cutting of the field since 1987.

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TABLE 1

Summary of data collection techniques at Brampton Meadow

1987
1. Species list for whole field and DAFOR ratings.
2. Frequency of species assessed using a total of 153 10 x 10 cm quadrats randomly located along 15 transect lines.
3. Nine 1 m^2 permanent quadrats positioned and recorded.
   - species list and DOMIN values
   - frequency of species in 25 (10 x 10 cm) random quadrats within permanent quadrat
   - average height and maximum height of vegetation within quadrat.
4. Rare and/or interesting species mapped.
5. Photographic record made of site.

1988
1. Species list for whole site and DAFOR ratings.
2. Frequency of species assessed using 100 (10 x 10 cm) quadrats randomly located within 10 transect strips.
3. Nine 1 m^2 permanent quadrats recorded
   - species list and DOMIN values
   - frequency of species in 25 (10 x 10 cm) random quadrats.
4. Rare and/or interesting species mapped.
5. Photographic record made of site.

1989
1. Species list for whole field and DAFOR ratings.
2. Frequency of species assesed using 292 (10 x 10 cm) quadrats randomly located in 10 transect strips.
3. Nine 1 m^2 permanent quadrats recorded
   - species list and DOMIN values
   - No frequency assessments
4. Rare and/or interesting species mapped.

5. Photographic record made of site.

6. Vegetation structure using standard disc technique of 7-10 random locations within 10 transect strips.

1990 1. Species list for whole field and DAFOR rating.

2. Frequency of species assessed using 294 (10 x 10 cm) quadrats, randomly located in 10 transect strips, quadrats recorded as falling within or outside road corridor.

3. Nine 1 m^2 permanent quadrats recorded

- species list and DOMIN values

- frequency of species in 25 (10 x 10 cm) quadrats

4. Rare and/or interesting species mapped.

5. Photographic record made of site.

6. Vegetation structure using standard disc technique, 10 random locations in 10 transect strips, positions recorded as falling within or outside road corridor.

1991 1. Species list for whole field and DAFOR rating.

2. Frequency of species assessed using 300 (10 x 10 cm) quadrats randomly located in 10 transect strips, quadrats recorded as falling within or outside road corridor.

3. No permanent quadrats recorded.

4. Rare and/or interesting species mapped.

5. Photographic record made of site.

6. Vegetation structure using standard disc technique, 10 random locations in 10 transect strips, positions recorded as falling within or outside road corridor.

TABLE 2

SPECIES LISTS AND DAFOR RATINGS FOR 1987-1991

TREES AND SHRUBS

Species	1987	1988	1989	1990	1991	Number of years present
Crataegus monogyna	R	-	e	e	R	4
Fraxinus excelsior	-	-	e	e	-	2
Prunus spinosa	-	-	-	R-LOF	e	2
Quercus sp.	-	-	-	e	-	1
Rhamnus catharticus	-	-	-	e	-	1
Rosa sp.	-	R	R	R	R	4
Rubus fruticosus	R	R	R-LF	e	e	5
Rubus idaeus	-	-	-	R-LO	e	2
Salix alba	-	-	-	e	e	2
Sambucus nigra	-	-	-	e	-	1
Ulmus procera	-	-	-	e	-	1

SEDGES

Species	1987	1988	1989	1990	1991	Number of years present
Carex flacca	O	VR	VR	R	R	5
Carex hirta	R	VR	-	VR	-	3

Table 2 cont

Spcies lists and DAFOR ratings

GRASSES

Species	1987	1988	1989	1990	1991	Number of years present
Agrostis capillaris	O	P	P	F	F-LA	5
Agrostis stolonifera	R	R	R	R	R-LF	5
Alopecurus pratensis	A	F-LA	F-LA	FA-LAD	A	5
Anthoxanthum odoratum	A	FA	A	O	F	5
Arrhenatherum elatius	A-LD	FA	F	O	F	5
Avenula pubescens	F	O-LF	OF	O	O	5
Briza media	O	P	R	VR	R	5
Bromus commutatus	-	-	R-LF	-	-	1
Bromus erectus	-	-	O	RO	R	3
Bromus hordeaceus	R	VR	R	RO-LA	R-LO	5
Bromus sterilis	-	VR	e	R	R-LF	4
Cynosurus cristatus	OF	P	F	O	O-LF	5
Dactylis glomerata	F	O	O	A	F-LA	5
Deschampsia caespitosa	-	-	-	VR	-	1
Festuca pratensis	O	P	O	O-LF	O	5
Festuca rubra	F	F	FA	A	A	5
Holcus lanatus	O	O	F-LA	F	A	5
Hordeum secalinum	-	R	R	R	R-LO	4
Lolium perenne	R	VR	RO	RO	R	5
Poa annua	R	-	-	-	-	1
Poa pratensis	F	O	R	R	O	5
Poa trivialis	O	O-LF	A	O-LFA	F	5
Trisetum flavescens	F	F	A	A	A	5

Table 2 cont

Spcies lists and DAFOR ratings

FORBS

Species	1987	1988	1989	1990	1991	Number of years present
Achillea millefolium	R	VR	R	R	R	5
Agrimonia eupatoria	R	P	R-LO	R	R	5
Alliaria petiolata	e	-	-	e	e	3
Anthriscus sylvestris	F-LD	O-LA	O-LA	RO-LF	R	5
Arctium minus	-	VR	VR	e	e	4
Arum maculatum	e	VR	e	-	-	3
Bellis perennis	F	R	O	RO	R	5
Bryonia dioica	-	-	-	e	-	1
Cardamine pratensis	O	O-LF	O-LF	RO	R	5
Centaurea nigra	A	A	FA	A	A	5
Cerastium fontanum	F	O	F	O	O	5
Chenopodium polyspermum	-	-	-	e	-	1
Cirsium arvense	O	R	RO	R-LF	O	5
Cirsium vulgare	O	RO	R	R	R	5
Conium maculatum	-	-	-	e	-	1
Conopodium majus	F-LA	F	A	O-LF	F	5
Crepis capillaris	-	-	R	-	-	1
Epilobium hirsutum	-	-	-	e	e	2
Filipendula ulmaria	F-LD	O-LA	O-LAD	O-LF	O-LA	5
Filipendula vulgaris	R	R	RO-LOF	R	R	5
Galium aparine	O	O-LF	R-LD	R-LA	RO	5
Galium verum	F-LA	F	F	A	A	5
Geranium dissectum	R	RO	O	RO	OF-LA	5
Geranium pratense	-	VR	R	VR	e	4
Glechoma hederacea	F	OF	RO-LF	R-LO	R	5
Hedera helix	-	-	e	-	-	1

Table 2 cont

Spcies lists and DAFOR ratings

Forbs cont....

Species	1987	1988	1989	1990	1991	Number of years present
Heracleum sphondylium	F-LD	O-LD	AD	O-LA	OF	5
Juncus articulatus	-	-	-	-	R	1
Lamium album	-	VR	e	e	e	4
Lamium purpureum	-	-	-	e	e	2
Lathyrus pratensis	O	R	O	O	O	5
Leontodon autumnalis	-	-	R	-	R	2
Leontodon hispidus	O-LF	O	O	R-LF	R	5
Leontodon taraxacoides ?	-	-	-	R	-	1
Leucanthemum vulgare	O	O	R	R	R	5
Linum catharticum	R	-	-	VR	-	2
Lotus corniculatus	A	F-LA	FA	OF-LA	OF-LA	5
Lotus uligonosus	?-LF	R	-	R	-	3
Luzula campestris/multiflora	F	O-LF	OF	RO	O	5
Matricaria matricariodes	-	-	-	e	-	1
Mercurialis perennis	-	-	-	e	-	1
Odontites verna	R	-	-	-	-	1
Ophioglossum vulgatum	O-LF	R	R-LF	R	R	5
Orchis morio	-	VR	-	-	R	2
Plantago lanceolata	O	O	F	OF	O-LF	5
Plantago major	-	-	-	-	e	1
Plantago media	R	-	-	-	P	2
Potentilla anserina	R	VR	R	R	e	5
Potentilla reptans	O	O	OF	RO-LF	OF	5
Primula veris	A	O-LA	A	O-LF	F	5
Prunella vulgaris	O	O	OF	O	OF	5
Ranunculus acris	O-LF	OF	FA	F	F	5

Table 2 cont

Spcies lists and DAFOR ratings

Forbs cont....

Species	1987	1988	1989	1990	1991	Number of years present
Ranunculus auricomus	R	VR	-	e	R-LF	4
Ranunculus bulbosus	F-LA	F-LA	F	F	F	5
Ranunculus ficaria	R	R	R	R	R	5
Ranunculus flammula	-	-	-	-	e	1
Ranunculus repens	O	R	RO-LF	-	e	4
Rhinanthus minor	R	VR	R	VR	-	4
Rumex acetosa	A	F	A	F	A	5
Rumex crispus	-	-	-	R	-	1
Rumex obtusifolius	R	R-LF	R	R	e	5
Rumex sanguineus	-	-	-	e	-	1
Sanguisorba minor	LA	R-LF	O-LFA	O-LA	O-LA	5
Sanguisorba officinalis	R	R	O-LF	R-LA	R-LA	5
Senecio jacobaea	R	VR	VR	-	-	3
Silaum silaus	R	VR	R	R	R	5
Sonchus asper	-	VR	VR	-	-	2
Sonchus oleraceus	-	-	-	e	e	2
Stachys sylvatica	-	-	-	e	-	1
Stellaria graminea	-	-	R	R	-	2
Stellaria media	R	VR	-	-	e	3
Taraxacum officinale	R	R	-	R	R	4
Tragopogon pratensis	R	-	VR	R	R	4
Trifolium dubium	-	-	VR	R	R	3
Trifolium pratense	O-LF	RO	O	O	R	5
Trifolium repens	R	R	R	R	R	5
Urtica dioica	O	O-LD	R-LA	RO-LF	R-LF	5
Veronica chamaedrys	F	O	F	OF	F	5

Table 2 cont

Spcies lists and DAFOR ratings

Forbs cont....

Species	1987	1988	1989	1990	1991	Number of years present
Vicia cracca	-	VR	R	VR	R	4
Vicia sativa	-	-	-	-	R	1
Vicia sepium	R	-	-	-	-	1
Viola hirta	R	VR	R	-	-	3
Total no. of species	77	78	82	99	88	
Total trees/shrubs	2	2	4	11	6	
Total grasses/sedges	20	21	22	23	21	
Total forbs	55	55	56	65	61	

e recorded at edge of site only
- not recorded in that year
P recorded in 10 x 10 cm quadrats but not in site species list

DAFOR SCALE

D	-	Dominant
AD	-	Abundant to Dominant
A	-	Abundant
FA	-	Frequent to Abundant
F	-	Frequent
OF	-	Occasional to Frequent
O	-	Occasional
RO	-	Rare to Occasional
R	-	Rare
VR	-	Very Rare (one or two plants only)
L	-	Locally (eg LF = Locally Frequent)

TABLE 3

SUMMARY OF SPECIES CHANGE

Overall change					
	1987	**1988**	**1989**	**1990**	**1991**
Total no of species	77	78	82	99	88
Removing e-rated species	75	78	76	77	71
Changes within lifeforms (including e-rated species)					
Trees & shrubs		+1, -1	+2, -	+7, -	- , -5
Sedges		- , -	- , -1	+1, -	- , -1
Grasses		+2, -1	+2, -	+1, -1	- , -1
Forbs		+6, -6	+5, -5	+18, -8	+7, -12

Total species list for site is 118 of which 50% are present in every year and 53% for four years or more.

TABLE 4

FREQUENCY OF SPECIES FROM THE 10 X 10 CM QUADRATS RECORDED EACH YEAR

	FREQUENCIES (%)					
YEAR	**1987**	**1988**	**1989**	**1990**	**1991**	**RANGE IN FREQUENCY**
NO OF QUADRATS	**153**	**100**	**292**	**294**	**300**	
SPECIES						
Trees + shrubs						
Prunus spinosa	-	-	-	1	-	1
Rosa sp.	-	-	1	1	-	1
Rubus fruticosus	-	-	1	-	1	1
Grasses						
Agrostis capillaris	-	6	24	31	51	51
Agrostis stolonifera	1	6	1	2	3	5
Alopecurus pratensis	16	17	17	53	33	37
Anthoxanthum odoratum	10	9	15	4	7	11
Arrhenatherum elatius	86	56	37	11	63	75
Avenula pubescens	4	8	4	5	9	5
Briza media	3	1	-	-	1	3
Bromus erectus	-	-	1	1	1	1
Bromus hordeaceus	-	-	1	1	2	2
Bromus sterilis	-	-	1	1	3	3
Cynosurus cristatus	3	4	16	2	12	14
Dactylis glomerata	37	50	40	53	57	20
Festuca pratensis	1	3	5	7	9	8
Festuca rubra	23	41	41	50	70	47
Holcus lanatus	20	50	72	58	62	52
Hordeum secalinum	-	-	1	2	1	2
Lolium perenne	3	-	2	1	2	3
Poa pratensis	6	36	9	3	11	33
Poa trivialis	28	67	69	20	16	53

Table 4 cont

Frequency of species from the 10 x 10 m quadrats

	FREQUENCIES (%)					
YEAR	**1987**	**1988**	**1989**	**1990**	**1991**	**RANGE IN FREQUENCY**
NO OF QUADRATS	**153**	**100**	**292**	**294**	**300**	
SPECIES						
Trisetum flavescens	35	49	63	57	74	39
Sedges						
Carex flacca	-	-	-	-	1	1
Forbs						
Achillea millefolium	-	-	1	-	1	1
Agrimonia eupatoria	2	1	1	1	1	1
Anthriscus sylvestris	14	7	6	2	-	14
Bellis perennis	-	1	1	1	1	1
Cardamine pratensis	3	4	3	5	1	4
Centaurea nigra	39	46	30	36	45	16
Cerastium fontanum	14	6	7	3	8	11
Cirsium arvense	1	1	1	1	2	1
Cirsium vulgare	-	-	-	-	1	1
Conopodium majus	38	12	19	6	11	32
Filipendula ulmaria	3	5	4	3	2	3
Filipendula vulgaris	-	1	-	-	-	1
Galium aparine	9	11	12	1	3	11
Galium verum	17	21	12	21	27	15
Geranium dissectum	1	3	5	2	17	16
Glechoma hederacea	25	8	3	1	2	24
Heracleum sphondylium	20	30	31	26	15	16
Lathyrus pratensis	2	3	6	5	7	5
Leontodon autumnalis	-	-	-	-	1	1
Leontodon hispidus	7	4	1	-	1	7
Leontodon taraxacoides	-	-	-	1	-	1

Table 4 cont

Frequency of species from the 10 x 10 m quadrats

	FREQUENCIES (%)					RANGE IN FREQUENCY
YEAR	**1987**	**1988**	**1989**	**1990**	**1991**	
NO OF QUADRATS	**153**	**100**	**292**	**294**	**300**	
SPECIES						
Leucanthemum vulgare	1	-	-	-	1	1
Linum catharticum	-	-	-	1	-	1
Lotus corniculatus	12	4	10	13	11	9
Lotus uliginosus	-	3	-	-	-	3
Luzula campestris/multiflora	16	10	9	6	10	10
Plantago lanceolata	8	4	5	6	9	5
Plantago media	-	-	-	-	1	1
Potentilla reptans	7	5	8	11	15	10
Primula veris	29	21	16	15	12	17
Prunella vulgaris	3	3	3	3	1	2
Ranunculus acris	7	22	17	22	24	17
Ranunculus bulbosus	22	9	18	10	19	13
Ranunculus repens	-	3	-	-	1	3
Rumex acetosa	38	50	61	48	55	23
Rumex obtusifolius	1	-	1	-	-	1
Sanguisorba minor	2	-	2	2	2	2
Sanguisorba officinalis	-	-	1	1	1	1
Trifolium dubium	-	-	1	1	-	1
Trifolium pratense	1	1	1	1	1	1
Trifolium repens	2	3	1	1	1	2
Urtica dioica	5	3	1	1	1	4
Veronica chamaedrys	33	20	25	22	29	13
Vicia sativa	-	-	-	-	1	1

TABLE 5

CONSIDERABLE CHANGE (≥ 10%) IN FREQUENCY VALUES OF SPECIES 1987-1991 AND THEIR ESTABLISHED CSR STRATEGIES

	Established Strategy (Grime *et al* 1988)	% change 1987-1991
Consistent increases		
Agrostis capillaris	CSR	51
Festuca rubra	CSR	47
Trisetum flavescens	CSR	39
Geranium dissectum	R/SR	16
Potentilla reptans	CR/CSR	10
Consistent decreases		
Anthriscus sylvestris	CR	14
Primula veris	S	17
Variable change		
Alopecurus pratensis	CSR/C	37
Anthoxanthum odoratum	SR/CSR	11
Arrhenatherum elatius	C	75
Cynosurus cristatus	CSR	14
Dactylis glomerata	CSR/C	20
Holcus lanatus	CSR	52
Poa pratensis	CSR	33
Poa trivialis	CR/CSR	53
Centaurea nigra	CSR/S	16
Cerastium fontanum	R/CSR	11
Conopodium majus	SR	32
Galium aparine	CR	11
Galium verum	SC/CSR	15
Luzula campestris/multiflora	S/CSR	10
Rumex acetosa	CSR	23
Veronica chamaedrys	S/CSR	13

TABLE 6

FREQUENCY OF SPECIES FROM THE 10 X 10 CM QUADRATS IN 1990 & 1991, WITHIN AND OUTSIDE THE ROAD CORRIDOR

	FREQUENCIES (%)					
YEAR	**1990**	**1990**		**1991**	**1991**	
NO OF QUADRATS	**OUTSIDE 175**	**WITHIN 119**	**DIFFERENCE**	**OUTSIDE 187**	**WITHIN 113**	**DIFFERENCE**
SPECIES						
Trees/shrubs						
Prunus spinosa	1	-	**1**	-	-	-
Rosa sp.	1	-	**1**	-	-	-
Rubus fruticosus	-	-	-	2	-	**2**
Grasses						
Agrostis capillaris	29	34	**5**	52	49	**3**
Agrostis stolonifera	3	1	**2**	4	1	**3**
Alopecurus pratensis	54	65	**11**	34	32	**2**
Anthoxanthum odoratum	5	2	**3**	9	4	**5**
Arrhenatherum elatius	11	10	**1**	61	66	**5**
Avenula pubescans	6	4	**2**	11	4	**7**
Briza media	-	-	-	1	-	**1**
Bromus erectus	2	1	**1**	1	-	**1**
Bromus hordeceus	1	1	-	3	1	**2**
Bromus sterilis	1	1	-	4	2	**2**
Cynosurus cristatus	3	1	**2**	14	8	**6**
Dactylis glomerata	53	54	**1**	58	57	**1**
Festuca pratensis	10	3	**7**	10	7	**3**
Festuca rubra	45	58	**13**	74	65	**9**
Holcus lanatus	61	54	**7**	64	58	**8**
Hordeum secalinum	2	2	-	1	2	**1**
Lolium perenne	1	1	-	3	1	**2**
Poa pratensis	3	3	-	11	11	-
Poa trivialis	22	18	**4**	18	13	**5**
Trisetum flavescens	51	66	**15**	77	80	**9**

Table 6 cont...

Frequency of species from the 10 x 10 cm quadrats in 1990 & 1991, within and outside the road corridor

	FREQUENCIES (%)					
YEAR	**1990**	**1990**		**1991**	**1991**	
NO OF QUADRATS	**OUTSIDE 175**	**WITHIN 119**	**DIFFERENCE**	**OUTSIDE 187**	**WITHIN 113**	**DIFFERENCE**
SPECIES						
Sedge						
Carex flacca	-	1	**1**	2	-	**2**
Forbs						
Achillea millefolium	-	-	-	1	-	**1**
Agrimonia eupatoria	1	-	**1**	1	1	-
Anthriscus sylvestris	2	2	-	-	-	-
Bellis perennis	1	-	**1**	-	1	**1**
Cardamine pratensis	5	4	**1**	1	1	-
Centaurea nigra	39	31	**8**	52	34	**18**
Cerastium fontanum	3	3	-	9	5	**4**
Cirsium arvense	1	1	-	1	4	**3**
Cirsium vulgare	-	-	-	1	1	-
Conopodium majus	7	5	**2**	12	9	**3**
Filipendula ulmaria	5	1	**4**	3	2	**1**
Galium aparine	2	1	**1**	5	1	**4**
Galium verum	22	17	**5**	32	19	**13**
Geranium dissectum	2	2	-	21	11	**10**
Glechoma hederacea	2	-	-	2	1	**1**
Heracleum sphondylium	27	24	**3**	17	12	**5**
Lathyrus pratensis	6	4	**2**	8	8	-
Leontodon autumnalis	-	-	-	1	-	-
Leontodon hispidus	-	-	-	1	1	-
Leontodon taraxacoides	1	-	**1**	-	-	-
Leucanthemum vulgare	-	-	-	1	-	**1**
Linum catharticum	1	-	**1**	-	-	-
Lotus corniculatus	15	9	**6**	14	5	**9**

Table 6 cont...

Frequency of species from the 10 x 10 cm quadrats in 1990 & 1991, within and outside the road corridor

	FREQUENCIES (%)					
YEAR	**1990**	**1990**		**1991**	**1991**	
NO OF QUADRATS	**OUTSIDE 175**	**WITHIN 119**	**DIFFERENCE**	**OUTSIDE 187**	**WITHIN 113**	**DIFFERENCE**
SPECIES						
Luzula campestris/multiflora	9	3	**6**	13	6	**7**
Plantago lanceolata	10	1	**9**	10	7	**3**
Plantago media	-	-	**-**	-	1	**1**
Potentilla reptans	13	7	**6**	21	6	**15**
Primula veris	13	18	**5**	12	13	**1**
Prunella vulgaris	4	1	**3**	2	-	**2**
Ranunculus acris	25	18	**7**	27	20	**7**
Ranunculus bulbosus	11	8	**3**	20	16	**4**
Ranunculus repens	-	-	**-**	2	-	**2**
Rumex acetosa	47	50	**3**	56	54	**2**
Sanguisorba minor	1	3	**2**	2	2	**-**
Sanguisorba officinalis	1	1	**-**	-	2	**2**
Trifolium dubium	1	-	**1**	-	-	**-**
Trifolium pratense	1	1	**-**	1	-	**1**
Trifolium repens	1	1	**-**	1	1	**-**
Urtica dioica	2	1	**1**	1	-	**1**
Veronica chamaedrys	25	18	**7**	28	30	**2**
Vicia sativa	-	-	**-**	-	1	**1**

FIGURE 1

Map of Brampton Meadow showing the proposed road corridor

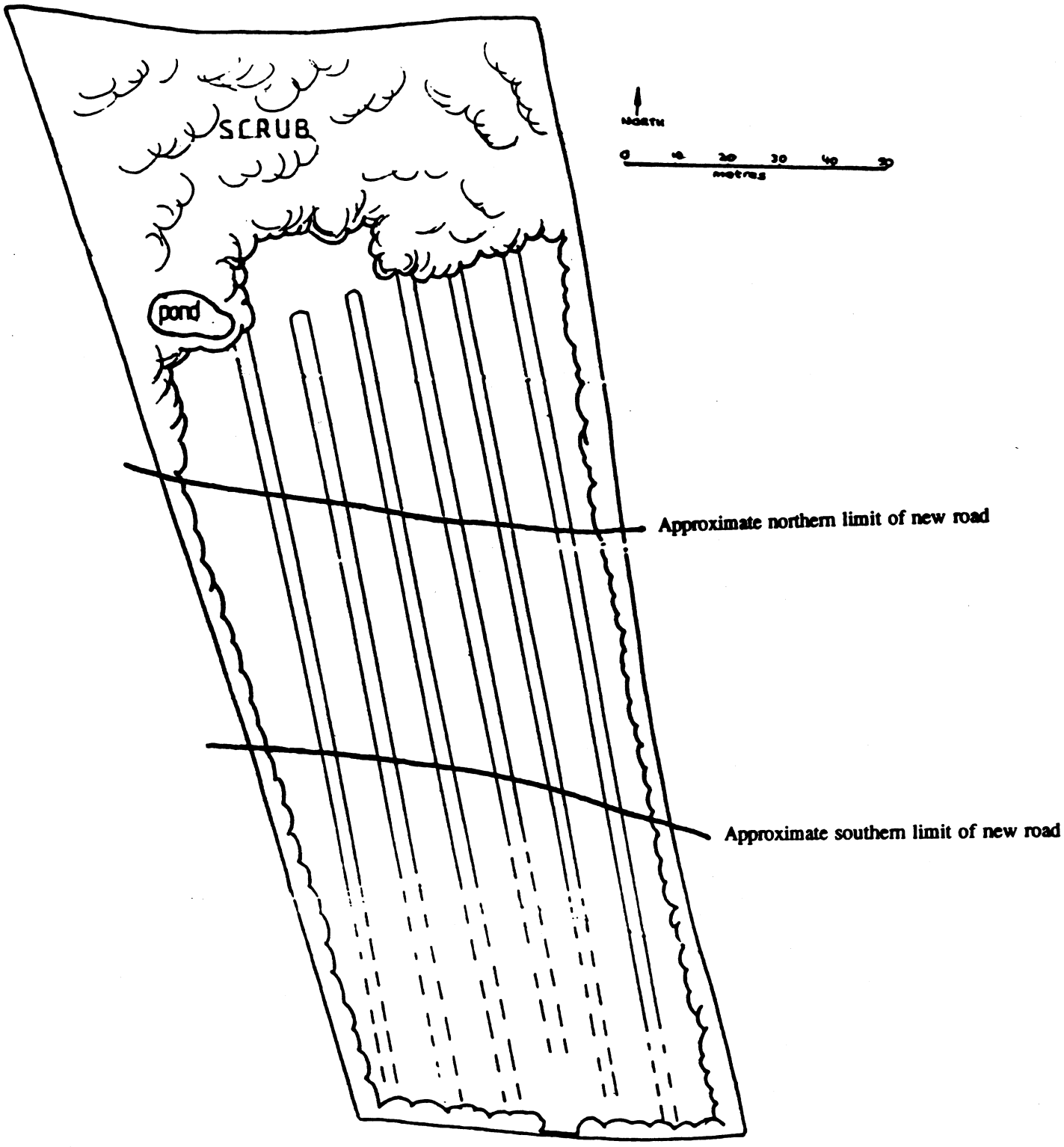
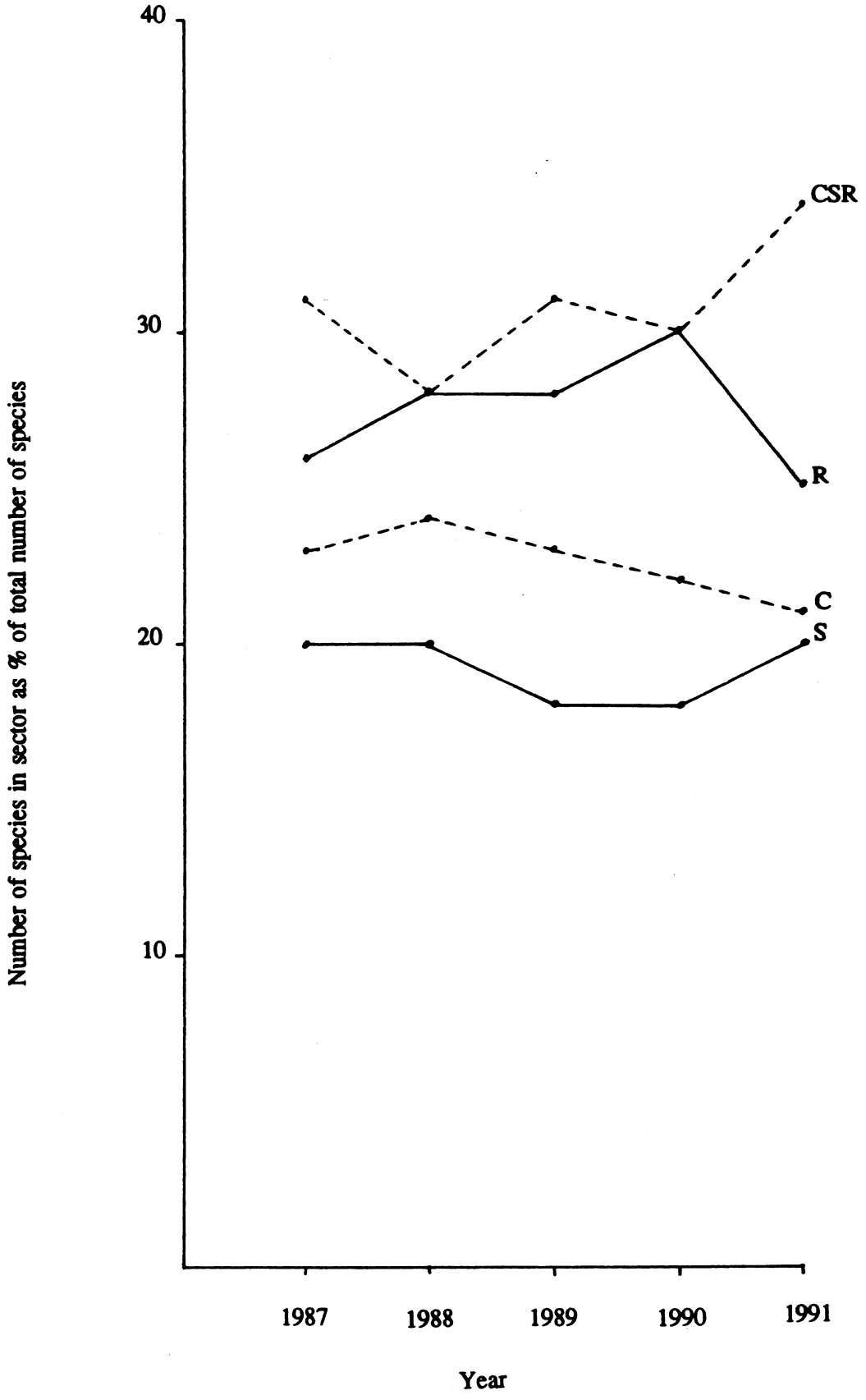


FIGURE 2

Changes in percentages of species in different stragety sectors from 1987 to 1991, excluding records from the edges ('e' in Table 2) of the field



APPENDIX 1

An example of the scoring system used to allocate species to 4 strategic sectors

The following scoring system was adopted (Leach pers. comm.). Stress-tolerators and ruderals were treated in the same way as this example of competitors.

C	-	Score 1 in C-sector
CR	-	Score 1 in C-sector and 1 in R-sector
C/CSR	-	Score ½ in C-sector and ½ in CSR-sector
R/CR	-	Score 1 in R-sector and ½ in C-sector
CR/CSR	-	Score ½ in C-sector, ½ in R-sector and ½ in CSR-sector