4. CONCLUSIONS & DISCUSSION

In this section we give a resumé of the more important floristic and functional changes that have occurred in the three monitoring areas, and consider the factors likely to have been instrumental in 'driving' these changes. We assess the overall impact of transplantation on the transplanted grasslands, and provide an answer to the question posed in 1.4.2.3: "To what extent has transplantation affected the botanical composition and ecological characteristics of the grassland community?"

4.1 The SSSI 'Control' Field

4.1.1 *Floristic changes*

4.1.1.1 It is clear from the results given in 2.1 that the SSSI grassland has changed considerably since the start of the monitoring programme in 1988. It has become more species-rich, and there have been marked increases in the frequency of many species. A considerable number of these species are of 'high value' in nature conservation terms, either because they have restricted distributions locally or nationally, or because they are considered to be declining nationally, or because they help to characterise the grassland community as MG5/MG5c. Species showing a marked overall increase include *Achillea millefolium, Anthoxanthum odoratum, Carex flacca, Danthonia decumbens, Holcus lanatus, Hypochaeris radicata, Leucanthemum vulgare, Luzula campestris, Oenanthe pimpinelloides, Orchis morio, Plantago lanceolata, Prunella vulgaris, Ranunculus acris, Rumex acetosa* and *Trifolium pratense*.

4.1.1.2 In contrast, very few species have shown a marked decrease in frequency: *Pulicaria dysenterica* and *Ranunculus repens* both declined between 1988 and 1990 and have not recovered, while *Poa pratensis/humilis* is showing signs of having declined since 1992. All other species have either been 'stable' overall, or fluctuating but with no consistent trend upwards or downwards; or else are too rare in the dataset for us to be able to detect any marked change.

4.1.2 *Functional changes*

The FIBS analyses given in 2.1.2 reveal considerable functional changes to the grassland since the start of the monitoring programme. The strategy 'profile' has remained similar throughout, the sward being principally composed of CSR-strategists, but with a strong contingent of stress-tolerators (S-strategists). However, there has been an increased representation of species associated with 'pasture' (rather than 'wasteland'), species typically occurring in species-rich (rather than species-poor) communities, that have a 'semi-basal' or 'basal' (rather than 'leafy') canopy structure, and that are low-growing and only capable of limited lateral vegetative spread.

4.1.3 *Likely reasons for the observed changes*

4.1.3.1 **Management.** The overriding factor influencing, or 'driving', these floristic and functional changes has clearly been management. In the early- and mid-1980s the grassland here, like the transplant donor field adjoining it, was left unmanaged (Annex 1). When we first visited the SSSI in 1987-1988 the consequences of this lack of management were all too obvious: the sward was rank, there was a deep 'mattress' of accumulated leaf litter, the hedgerows were 'invading' the margins of the field, and several species known from previous surveys to have been abundant on the site (eg *Orchis morio* and other orchid species) were poorly represented. Since the fields had been acquired by ECC in 1983 the grassland had, in effect, become derelict; only in 1987, following SSSI notification, was active management resumed, initially a late-summer annual hay-cut, then in more recent years a hay-cut followed by occasional sheep grazing between autumn and early spring (Annex 1). Many species increasing in the SSSI are known to benefit from this kind of management (Grime *et al.*, 1988). This is confirmed, not surprisingly, by the FIBS analyses, attributes showing an increased representation often being those that one would expect to be favoured by hay-meadow management and aftermath grazing (Hodgson *et al.*, 1995).

4.1.3.2 **Climate.** Fluctuations in the frequency of several species (eg *Cerastium fontanum* and *Taraxacum* sp.) may have been largely caused by changes in climate, in particular the switch during the study period from 'drought' to 'deluge', and back to 'drought' again. Our field observations suggest that climate is probably having a secondary influence on year-to-year fluctuations in frequency of quite a few other species, through its impact on germination rates and seedling survival/mortality. For the most part, however, climate has been less important than management in determining the general *trends* in frequency which have been noted.

4.2 The Turf Transplant

4.2.1 *Floristic changes*

4.2.1.1 The turf transplant, too, has become more species-rich, though in all years since 1989 it has been slightly less rich than the SSSI 'control'. Many species that have increased in the SSSI have also increased in the turf transplant but, as already noted in 3.2.2, most have generally occurred at lower frequencies in the transplanted sward. Amongst the 'increasing' species in the SSSI, only *Achillea millefolium*, *Rumex acetosa* and, more recently, *Hypochaeris radicata* and *Trifolium pratense*, have performed equally well in the turf transplant; while eight species - *Anthoxanthum odoratum, Danthonia decumbens, Leucanthemum vulgare, Luzula campestris, Orchis morio, Plantago lanceolata, Prunella vulgaris* and *Ranunculus acris* - have all done less well there. Species doing better in the turf transplant than in the SSSI include three post-transplant colonists (*Carex hirta, Equisetum arvense* and *Rhinanthus minor*). *Oenanthe pimpinelloides* has increased markedly in the turf transplant, and is clearly doing better there than in the SSSI.

4.2.1.2 As in the SSSI, there has been a marked decrease in frequency of *Pulicaria dysenterica*, but the other two 'decreasing' species there, *Poa pratensis/humilis* and *Ranunculus repens*, have generally done better in the turf transplant. On the other hand, there are many species that have either decreased, or else failed to do as well as in the SSSI; in addition to the eight species listed in 4.2.1.1 they include *Carex caryophyllea, C.flacca, Centaurea nigra, Dactylis glomerata* and *Lotus corniculatus*. MG5 constants and MG5c preferentials have generally done less well in the turf transplant than in the SSSI, suggesting that the two areas may have diverged somewhat in terms of their NVC categorisation (see 3.2.4.4 - 3.2.4.6).

4.2.2 *Functional changes*

The FIBS analyses reveal considerable functional changes to the grassland since transplantation. *Changes which appear to be in marked contrast to those noted in the SSSI are shown here in **bold** type.* **The strategy 'profile' has changed, with a decreased representation of stress-tolerators (S-strategists) being particularly noteworthy**. Overall, there has been an increased representation of species associated with 'pasture' (rather than 'wasteland'), while **representation of species typically associated with species-rich communities has failed to increase**. Low-growing species, and those having 'basal' canopy structure (rather than 'leafy') have increased, as have species only capable of limited vegetative spread; although **several species capable of forming extensive patches have also increased**. There has been a **decrease of April- and June-flowering species, and an increase of those typically flowering in May**. Also, **species considered to be decreasing nationally have decreased.**

4.2.3 *Likely reasons for the observed changes*

4.2.3.1 **Management**. As with the SSSI 'control', the turf transplant donor grassland had deteriorated as a result of lack of management in the early- to mid-1980s. Clearly then, many post-transplant changes have occurred as a consequence of the resumption of cutting-and-grazing management in 1987-1988 (Annex 1): for example the increase in species-richness, increased representation of 'pasture' species, 'basal' (rosette) species, low-growing species, and species with limited capacity for lateral vegetative spread.

4.2.3.2 **Climate.** Some changes in species' frequencies may have been due to climate. It is likely that climate-related changes have been exacerbated to some extent by transplantation, with patches of grassland in the turf transplant evidently more prone to drought - and others to waterlogging - than grassland in the SSSI. This may explain, for example, the 1996 upsurge of *Trifolium dubium* and *Leontodon saxatilis* (drought), and the 'enhanced' performance of such species as *Oenanthe pimpinelloides, Juncus acutiflorus, Ranunculus repens* and *Carex hirta* (waterlogging), in comparison with their performance in the SSSI.

4.2.3.3 **Transplantation.** This leaves a substantial number of floristic and functional changes that cannot be satisfactorily explained by 'management regime' or 'climate', for example the 'lagging behind' in species-richness, the change in representation of certain FIBS attributes (eg decline of S-strategists), the failure of certain species to thrive, including 'under-performance' of several that are important in helping to characterise the community as MG5/MG5c. It is hard not to conclude that these changes are a consequence - either directly or indirectly - of transplantation. Some changes could have been due to the direct effects of transplantation (eg 'root-pruning' of deep-rooted species). However, as noted in the 1995 'update' report, we think it likely that many of the emerging differences between the SSSI and turf transplant are due to the new environmental context into which the turves have been placed, rather than to the transplantation operation *per se*. Our view now is that, as the grassland continues to adjust to the post-transplant environment, floristic differences will become more accentuated, with the sward gradually becoming less and less like the SSSI.

4.2.4 *Has transplantation 'worked'?*

4.2.4.1 It is concluded that the transplantation is failing in its original objective to *safeguard the botanical composition and ecological characteristics of the grassland community*, and that this failure is likely to become ever more obvious as the grassland continues to 'adjust' to its new environmental setting. Thus, while the transplanted grassland still contains species and features of interest, it is destined - as a result of having been transplanted - to always be a *different* grassland from the one it would have been had it been conserved *in situ.*

4.2.4.1 The problem here is not just that the two areas have become 'less alike' but that, more importantly, **the turf transplant has consistently - and increasingly - under-performed (in comparison with the SSSI) on a whole range of criteria: species-richness, certain 'desirable' FIBS attributes, and the frequency of occurrence of many species - including some that are important in characterising the grassland community as MG5/MG5c.**

4.3 The Littered Plot

4.3.1 *Floristic changes*

4.3.1.1 As in the other two monitoring areas, there have been a considerable number of floristic changes. Following the 'trauma' of transplantation the species composition changed dramatically, with a large but temporary influx of opportunist species (mainly ruderals) (eg *Anagallis arvensis, Juncus bufonius, Isolepis setacea*), and a somewhat smaller but persistent invasion of 'new' species such as *Holcus mollis, Leontodon saxatilis* and *Ulex europaeus*. Relatively few of the species present in the pre-transplant grassland increased following transplantation, but they did include several (*Danthonia decumbens, Hypochaeris radicata, Leucanthemum vulgare* and *Prunella vulgaris*) that also increased in the SSSI. More recently, there has been a dramatic upsurge in the number of flowering spikes of *Orchis morio*. Also increasing in the littered plot throughout the study period has been *Juncus acutiflorus*, one of several species doing well there that are not normally associated with MG5 grasslands.

4.3.1.2 Several 'pre-transplant' species declined following transplantation, including *Festuca rubra, Luzula campestris, Poa pratensis/humilis, Ranunculus acris* and *R.bulbosus*, and most of these have shown, at best, only a 'partial' recovery. *Trifolium pratense* has shown no sign of increasing, in contrast to its performance in the SSSI and turf transplant.

4.3.2 *Functional changes*

The FIBS analyses point to a considerable number of marked, and sometimes abrupt, *functional* changes since transplantation. *Changes which appear to be in contrast to those noted in the SSSI are shown here* *in bold type*. **The strategy 'profile' has changed, with a decreased representation of CSR-strategists, and an increased representation of stress-tolerators (S-strategists); also, there was a temporary post-transplant increase of ruderals (R-strategists) and competitive-ruderals (CR-strategists). [The strong contingent of stress-tolerant competitors (SC-strategists) was already evident prior to transplantation.]** Overall, there has been **an increased representation of species associated with 'spoil' and 'wasteland' (no increase of 'pasture' species). [The strong contingent of 'wetland' species was already evident prior to transplantation.] Representation of species typically associated with species-poor communities has increased,** as have those associated with the most species-rich communities. There was an abrupt post-transplant **decrease of species having high amounts of nuclear DNA, possibly linked with the decline of May-flowering species and an increase of June- and July-flowering species.** There has been an overall increase in representation of species having 'basal' (rosette) canopy structure, and low-growing species capable of only limited lateral vegetative spread. **There was a temporary post-transplant increase of monocarpic species. There has been a very slight overall increase in representation of species considered to be declining nationally.**

4.3.3 *Likely reasons for the observed changes*

4.3.3.1 **Management.** As with the other areas, management has undoubtedly been important in shaping the present botanical composition. However, the 'littering' process clearly had a much greater initial impact; indeed, hay-meadow management with aftermath grazing was not resumed until 1991, to allow the sward time to become re-established. Since then, management has influenced the grassland in a similar manner to that observed in the SSSI and turf transplant: without it, the littered plot grassland would have rapidly become over-run by *Ulex europaeus*.

4.3.3.2 **Climate.** In the littered plot our observations lead us to believe that climate-related effects have been exacerbated by post-transplant soil conditions. In dry weather the thin topsoil layer bakes hard, and the sward quickly becomes parched; in wet weather, on the other hand, the compacted surface inhibits water penetration, leading to surface runoff and 'puddling' in ruts and depressions. Drought-stress and (locally) waterlogging-stress both appear to be more pronounced there than in the other monitoring areas. This may be one reason for the high frequency of *Leontodon saxatilis*, a species known to be drought-tolerant, and might also help to explain the performance of certain FIBS species-groupings, such as the relatively high representation of stress-tolerant competitors

(SC-strategists) and the marked increase of stress-tolerators (S-strategists).

4.3.3.3 **Transplantation.** Many of the floristic changes taking place in recent years in the littered plot have differed markedly from those in the SSSI and turf transplant. The FIBS analyses, too, indicate a number of functional differences between the littered plot and the other monitoring areas. Throughout the post-transplant period it has consistently shown fewer floristic and functional similarities to the SSSI than has the turf transplant. It should be remembered that the 'integrity' of the grassland transplanted by littering was badly disrupted, and that vegetative fragments (rather than turves) and the soil seed-bank were the 'raw materials' from which it reconstructed itself. That being the case, it is hardly surprising that its development has taken a different course from the turf transplant. The severe disturbance of transplantation was probably responsible for many of the initial changes, but as the vegetation has re-established the differences produced by these changes have become less marked. However, many floristic differences have persisted.

4.3.4 *Has transplantation 'worked'?*

4.3.4.1 In the 1994 'update' report it was concluded that littering had "clearly failed" to achieve the original aim of transplantation, to *safeguard the botanical composition and ecological characteristics of the grassland community.* In the 1995 'update', on the other hand, we allowed for the possibility that at least *some* of the littered sward might in the long term develop into something floristically close to the SSSI. While we are still of the opinion that there are parts of the littered plot that "superficially resemble" the SSSI, nevertheless the differences still clearly outweigh the similarities.

4.3.4.2 Further monitoring will be required before this issue can finally be resolved, but our current view is that while the littered transplantation is an interesting example of habitat *creation*, as an example of habitat *protection* it has clearly failed.

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7. GLOSSARY

CANOPY HEIGHT. One of the morphological attributes within the FIBS [qv] database. Each species is allocated to one of the following height classes: foliage <100mm in height, 101-299mm, 300-599mm, 600-999mm, 1-3m and >3m. "Canopy height is often regulated by the effects of land management. Heavy grazing is likely to favour plants with a low-growing canopy while, for example, the conversion of pasture to hay-meadow will favour certain taller grassland species" (Hodgson *et al.*, 1995).

CANOPY STRUCTURE. Another morphological attribute within the FIBS [qv] database. For dryland species three structural categories are recognised: **basal** (leaves confined to a basal rosette or a prostrate stem), **semi-basal** (stems leafy but with the largest leaves towards their base; also monocarpic species which when young form a rosette but which produce a leafy flowering stem), and **leafy** (no basal rosette, leaves of approximately equal size all the way up the stem). "Canopy structure... affects vulnerability to various forms of management practice. Thus, species with erect leafy stems tend to be more prevalent in unmanaged habitats and many with only basal leaves are commonest in grazed habitats. Species with a [semi-basal] canopy structure are perhaps best suited to habitats such as hay-meadows subject to aftermath grazing" (Hodgson *et al.*, 1995).

FIBS (Functional Interpretation of Botanical Surveys). A computer package developed by the Unit of Comparative Plant Ecology at Sheffield University. For a full discussion of the rationale behind FIBS, and for details of the criteria used in defining and describing the morphological, physiological and ecological attributes of species, see Grime *et al.* (1988) and Hodgson *et al.* (1995). Species sharing a particular attribute form a *functional* grouping of species, with changes in their frequencies of occurrence causing the representation of that *attribute* to change. Obviously, attributes are interlinked (for example, many species having low *canopy height* [qv] also have a basal or semi-basal, rather than leafy, *canopy structure* [qv]); taken together, however, they allow a picture to be built up of which kinds of species are decreasing or increasing. In this way, floristic changes can be assessed in terms of their *functional* significance, and likely factors 'driving' these changes can be identified.

It should be noted that two species occurring at Brocks Farm are not included in the FIBS database, namely *Bromus racemosus* and *Oenanthe pimpinelloides*. Also, for purposes of FIBS, we have treated the *Poa pratensis/humilis* species-pair as *P.pratensis*, and the *Mentha aquatica/arvensis* species-pair as *M.aquatica*.

HABITAT. This term can be used loosely to describe the physical and biological 'setting' of an organism. In the present report, however, it is frequently mentioned as one of the ecological attributes included in the FIBS [qv] database. Within this database each species is ascribed to the habitat type in which it most frequently occurs (Grime *et al.*, 1988). This ascription is based largely on fieldwork done in central England, supplemented to some extent by searches of the phytosociological literature. Changing representation of species most commonly associated with particular habitats may be instructive in understanding the effects of management: for example, **'pasture'** species would be expected to benefit from grazing management, while certain **'wasteland'** species would be favoured by *lack* of management (dereliction).

LITTERING, LITTERED PLOT, LITTERED AREA. 'Littering' is the term used in the present report to describe the transplantation of rotovated topsoil and turf fragments, as opposed to 'turf transplantation' which involved the careful removal and translocation of large turves with a good depth of topsoil attached. 'Littering' is analogous to 'blading', a term frequently used in other reports. The 'littered plot' is the term used to describe the area (c. 60x25m) within which NCC/EN carried out post-transplant monitoring, which forms part of the receptor site for littered material which, in its entirety, we call the 'littered area'.

NATIONAL VEGETATION CLASSIFICATION (NVC). This is the standard classification of British plant-communities. It provides a systematic and comprehensive account of the vegetation types occurring in all natural, semi-natural and major artificial habitats in Britain. The main grassland communities are dealt with in *British Plant Communities, Volume 3 (Grasslands and montane communities)* (Rodwell 1992). Communities and sub-communities are code-numbered according to their position within the NVC scheme: thus, 'MG5' is the fifth community described within the Mesotrophic Grasslands section, and MG5c is the third sub-community described within MG5.

PRESENT STATUS (GB). Another attribute used within the FIBS database [qv], with each species allocated to a 'status' category according to whether it is considered, from field surveys and literature search, to be **decreasing, increasing** or 'neither decreasing nor increasing' ('uncertain') in Britain (see Grime *et al.* (1988) for details). 'Decreasing' species tend to be valued more highly than 'increasing' species, because they are likely to have a more restricted or localised distribution, to be more strictly confined to natural or semi-natural vegetation types, and to be more vulnerable to land-use changes and intensification of management.

RANDOM MINI-QUADRAT (RM-Q). At Brocks Farm the monitoring programme has involved recording species present within large numbers of randomly located 10x10cm quadrats (random mini-quadrats). Sampling strategy has been the same in all areas in all years, each area being subdivided into strips and randomly located RM-Qs being recorded within each strip. RM-Q locations are derived from computer-generated random number coordinates (new sets of random numbers on each visit), the position of each RM-Q 'on the ground' being determined by pacing, not by precise measurement.

Throughout the study we have recorded *shooted* rather than *rooted* frequency in the RM-Qs; in other words, for a species to be recorded as present it does not have to be rooted within the RM-Q. In the RM-Qs we have also recorded whether species are present as 'adult' plants or as 'seedlings' (or both), and we note which species contribute most to total vegetation cover. However, these additional data have not been analysed, and so are not referred to in the present report.

SPECIES RICHNESS. In the Brocks Farm study RM-Q [qv] data were used to derive indices of species-richness, with species-richness being calculated as the mean number of vascular plant species per RM-Q. 'Species richness' is also an attribute within the FIBS [qv] database, each species being categorised according to the species-richness of the vegetation with which it is normally associated. As noted by Hodgson *et al.* (1995), "a sward with many species m^{-2} is often regarded as a desirable feature in vegetation managed for conservation, and inappropriate management may lead to a reduction in the percentage of species characteristic of species rich vegetation. Data are available from the phytosociological literature and from vegetation surveys, but species [may] differ in their association with species rich vegetation according to geographical area and geological strata".

STRATEGY. Another attribute within the FIBS [qv] database. Plant Strategy Theory originates from the suggestion by Grime (1974) that external factors affecting vegetation can be divided into two broad categories, namely *stress* and *disturbance*. 'Stress' consists of phenomena which restrict photosynthetic production, such as unfavourable temperatures, shortages of light, water and nutrients, while 'disturbance' consists of partial or total destruction of the plant biomass, caused either by the activities of herbivores, pathogens or humans, or by phenomena such as 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 natural vegetation.) Grime (1974) suggested that there are three *primary strategies* which plants use to survive in these conditions, and the plants which use them he 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 (C-strategists) 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* (Common Nettle) and *Cirsium arvense* (Creeping Thistle).

Stress-tolerators (S-strategists) are often small, leathery or needle-leaved evergreens with a relatively low potential growth rate, and with a long established phase in their life histories. Examples are *Carex flacca* and *Danthonia decumbens*.

Ruderals (R-strategists) 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 to the formation of seeds. Examples are *Juncus bufonius* and *Poa annua* (Annual Meadow-grass).

Many species exploit the various intermediate conditions between stress, disturbance and competition, and Grime (1974) identified four intermediate strategies, namely **stress-tolerant ruderals (SR-strategists)**, **stress-tolerant**

competitors (SC-strategists), **competitive ruderals (CR-strategists)** and **CSR-strategists**. This array of strategies is conventionally displayed in the form of a triangular diagram (Figure 26, taken from Hodgson *et al.* (1995)).

Plant Strategy Theory is of value in identifying and interpreting vegetation changes. Species adopting particular strategies may increase or decrease in abundance as a result of particular environmental changes (Figure 26), enabling us to distinguish between, for example, disturbance effects and the effects of changes in management.

VEGETATIVE SPREAD. A morphological attribute within the FIBS [qv] database. As in Grime *et al.* (1988) the following classes are recognised:-

1. Monocarpic species (lateral spread extremely limited in extent and duration); perennials with compact unbranched rhizomes or forming small tussocks (<100mm in diameter);

2. Perennials with rhizome systems or tussocks attaining 100-250mm;

3. Perennials attaining a diameter of 251-1000mm;

4. Perennials attaining a diameter of >1000mm.

"Ramets [vegetative off-shoots] are generally subject to lower mortalities than seeds and seedlings. Thus, vegetative spread, usually by means of rhizomes or stolons... is a particularly reliable method of increasing biomass and area of ground occupied. On theoretical grounds, we may expect species with lateral vegetative spread to increase at a faster rate and under a wider range of habitat change scenarios than polycarpic perennials reproducing entirely by seed" (Hodgson *et al.*, 1995).

TABLE 1

BROCKS FARM

SPECIES' FREQUENCIES FOR THE SSSI FIELD 1988-1996

Surveyors	SJL SAB	SJL CPB SAB	SJL CPB JC	SJL RDP MB	SJL	SJL JC MB PE	SJL MB	SJL PE LW	SJL PE CD
Date of survey (all May)	18	17	15	14	18	18	23	15	13
Number of quadrats	100	120	120	120	100	100	100	100	100
SPECIES	FREQUENCIES (%)								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
Trees and shrubs									
Crataegus monogyna	-	-	-	-	-	1	-	-	-
Prunus spinosa	-	-	-	-	-	1	-	-	-
Quercus robur	1	-	-	-	-	-	-	-	-
Rosa canina/arvensis	-	-	-	-	-	1	-	-	-
Rubus fruticosus *agg*	1	-	-	-	-	1	-	-	-
Salix cf. cinerea	-	-	1	1	1	-	1	-	1
Grasses									
Agrostis canina	-	2	-	-	-	-	-	-	-
Agrostis capillaris	76	69	66	86	73	71	76	82	77
Agrostis stolonifera	-	1	2	-	-	2	-	-	-
Alopecurus pratensis	-	-	1	-	-	-	-	-	-
Anthoxanthum odoratum	45	50	39	13	38	52	76	79	75
Arrhenatherum elatius	1	-	-	-	-	-	-	-	-
Briza media	-	-	1	-	1	1	-	-	-
Cynosurus cristatus	1	3	2	-	-	5	-	2	6
Dactylis glomerata	6	6	5	8	11	9	11	4	19
Danthonia decumbens	1	2	2	17	23	35	37	34	37
Festuca pratensis	-	-	-	-	-	-	-	1	-
Festuca rubra	90	92	91	96	96	91	99	98	98
Holcus lanatus	31	29	30	19	26	43	36	47	57
Holcus mollis	1	-	2	-	2	-	-	-	1
Lolium perenne	2	1	-	-	-	-	-	1	1
Phleum pratense	2	1	-	2	-	-	-	-	-
Poa pratensis/humilis	18	16	18	14	16	8	11	9	7
Sedges and Rushes									
Carex caryophyllea	20	7	8	14	10	7	9	15	23
Carex flacca	19	13	16	23	17	14	25	33	33
Carex hirta	1	1	4	1	-	1	2	2	2
Carex panicea	3	7	2	3	-	-	5	2	5
Carex pulicaris	-	1	-	1	-	-	-	4	-
Juncus acutiflorus	11	21	19	13	14	19	14	23	24
Juncus articulatus	2	-	-	-	-	-	-	-	-
Juncus bufonius	-	-	1	-	-	-	-	-	-
Juncus conglomeratus	-	-	1	-	-	-	-	-	-
Juncus effusus	-	-	-	-	-	-	-	-	2
Luzula campestris	23	43	34	49	57	76	73	63	46

TABLE 1 (continued)

SPECIES	FREQUENCIES (%)								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
Forbs									
Achillea millefolium	3	3	2	9	7	9	11	11	8
Agrimonia eupatoria	2	2	2	1	1	1	-	-	1
Ajuga reptans	2	1	2	3	2	3	1	5	1
Anagallis arvensis	-	-	1	-	-	-	-	-	-
Cardamine pratensis	-	2	3	-	2	4	-	-	1
Centaurea nigra	51	36	48	28	51	65	51	59	53
Cerastium fontanum	5	4	2	1	6	17	12	2	1
Cirsium arvense	-	-	-	1	-	-	-	-	-
Cirsium palustre	1	-	1	-	2	1	-	-	1
Dactylorhiza fuchsii	-	-	-	-	-	-	-	2	1
Dactylorhiza praetermissa	2	2	2	2	1	1	7	9	2
Galium mollugo	-	-	-	-	1	-	-	-	-
Galium palustre	-	-	1	-	-	-	-	-	-
Glechoma hederacea	-	-	-	-	-	-	-	1	-
Hypericum humifusum	-	-	-	-	-	-	-	1	-
Hypochaeris radicata	-	3	-	6	13	36	35	39	44
Lathyrus pratensis	2	2	7	5	2	2	6	6	3
Leontodon saxatilis	-	1	-	-	1	-	1	1	3
Leucanthemum vulgare	-	-	2	1	10	17	21	17	26
Linum catharticum	-	-	-	1	-	-	4	-	-
Lotus corniculatus	72	78	69	63	68	73	83	78	72
Lotus pedunculatus	11	3	-	1	2	6	10	2	3
Mentha aquatica	1	-	-	1	-	-	-	-	-
Oenanthe pimpinelloides	3	3	2	3	5	7	8	16	13
Orchis morio	-	1	1	2	4	3	1	3	9
Plantago lanceolata	44	43	49	53	84	89	85	87	87
Polygala vulgaris	-	-	-	-	-	-	-	1	-
Potentilla anserina	-	-	-	-	-	-	-	-	1
Potentilla erecta	8	3	6	-	-	2	2	5	8
Potentilla reptans	28	27	20	30	40	39	34	21	17
Prunella vulgaris	2	3	3	3	9	16	22	23	18
Pulicaria dysenterica	9	6	2	2	3	3	-	3	-
Ranunculus acris	22	16	18	18	23	47	62	58	68
Ranunculus bulbosus	13	1	2	8	20	18	28	29	25
Ranunculus repens	9	13	2	2	-	3	5	5	1
Rumex acetosa	8	9	7	12	19	33	25	27	22
Senecio erucifolius	-	2	-	-	1	-	-	-	-
Senecio jacobaea	-	-	1	-	1	-	-	-	-
Stellaria graminea	1	-	2	1	-	2	1	1	-
Succisa pratensis	-	2	1	1	2	4	14	1	-
Taraxacum *sp*	14	9	12	17	16	15	20	9	7
Trifolium dubium	-	-	-	-	-	-	-	-	2
Trifolium pratense	6	7	8	8	18	19	23	31	33
Trifolium repens	5	-	-	2	-	6	5	6	10
Veronica chamaedrys	-	2	-	1	-	1	-	-	1
Vicia cracca	-	-	-	1	-	-	-	-	-
Bare ground	6	20	4	3	13	30	24	26	35
Mean no. of spp/sample	7.5	5.8	6.8	6.5	8.0	9.9	10.5	10.7	10.6

TABLE 2

BROCKS FARM

NUMBERS OF FLOWERING SPIKES OF *ORCHIS MORIO* IN THE THREE MONITORING AREAS, 1988-1996

	(1988)	1989	1990	1991	1992	1993	1994	1995	1996
SSSI 'Control' Field	(50-100)	29	566	643	3658	2550	4400	4560	8160
Turf Transplant	(>100)	32	64	98	370	325	376	380	952
Littered Plot	?	19	41	27	85	140	346	1450	2797

O.morio was not censused in 1988; the only data available are estimates of numbers of flowering spikes given in field notes attached to the record cards. The figure for the turf transplant is for the donor field in its entirety, although most flowering spikes were in the half of the field subsequently moved as turves. No 1988 estimate is possible for the littered plot as it is not known which part(s) of the donor area ended up being located within the littered plot area

TABLE 3
BROCKS FARM - FIBS ANALYSIS, SSSI FIELD 1988-1996

All figures are percentages

ATTRIBUTE	YEAR 1988	1989	1990	1991	1992	1993	1994	1995	1996	**1988-96 change**
STRATEGY										
C	2	1	1	1	1	1	1	0	1	**-1**
CSR	70	69	73	71	71	72	69	70	70	**0**
SC	3	6	3	2	2	3	1	2	2	**-1**
CR	4	5	3	4	4	4	4	3	3	**-1**
R	1	1	2	1	2	2	2	1	1	**0**
SR	5	4	4	3	5	5	7	7	7	**2**
S	14	15	14	18	15	14	17	16	16	**2**
HABITAT										
Wetland	6	8	6	4	3	4	4	5	4	**-2**
Skeletal	0	0	0	0	0	0	0	0	0	**0**
Arable	4	4	2	2	2	3	3	4	5	**1**
Pasture	63	64	63	65	65	68	70	71	70	**7**
Spoil	16	18	17	15	16	18	18	19	20	**4**
Wasteland	52	52	53	56	51	48	48	46	44	**-8**
Woodland	1	0	0	1	0	1	0	1	0	**-1**
SOIL pH<5	13	11	12	14	10	8	8	9	8	**-5**
SPECIES RICHNESS										
<10 spp m-2	0	0	0	0	0	0	0	0	0	**0**
10.1-14	12	11	11	14	9	8	7	8	8	**-4**
14.1-18	46	52	47	44	44	45	43	42	42	**-4**
18.1-22	34	31	36	33	38	41	40	39	39	**5**
>22	8	5	5	8	8	6	10	10	11	**3**
NUCLEAR DNA >10pg	30	30	29	26	27	26	31	30	30	**0**
CANOPY STRUCTURE										
Leafy	44	44	41	37	37	36	37	37	36	**-8**
Semi-basal	47	48	49	51	49	49	49	50	49	**2**
Basal	9	9	10	12	14	15	14	14	15	**6**
Floating	0	0	0	0	0	0	0	0	0	**0**
Other	0	0	0	0	0	0	0	0	0	**0**
HEIGHT										
<100mm	10	11	9	13	15	19	19	17	17	**7**
100-299	68	70	69	70	67	62	64	65	64	**-4**
300-599	20	15	17	13	15	17	15	15	17	**-3**
600-999	2	5	5	3	2	2	2	3	3	**1**
1000-3000	0	0	0	0	0	0	0	0	0	**0**
>3000	0	0	0	0	0	0	0	0	0	**0**

TABLE 3 (continued)
BROCKS FARM - FIBS ANALYSIS, SSSI FIELD 1988-1996

ATTRIBUTE	YEAR 1988	1989	1990	1991	1992	1993	1994	1995	1996	1988-96 change
VEGETATIVE SPREAD										
Monocarpic	0	0	1	0	0	0	0	0	0	**0**
Patch <100mm	41	40	42	38	48	53	53	52	52	**11**
100-250	18	19	20	19	19	19	18	20	20	**2**
251-1000	32	30	29	34	24	20	21	22	22	**-10**
>1000	8	12	8	9	8	8	6	6	5	**-3**
REGENERATIVE STRATEGY										
Persistent seed bank	77	77	77	74	76	77	78	80	78	**1**
Numerous widely dispersed seeds	4	4	3	5	5	6	6	6	7	**3**
Vegetative fragments important	8	8	7	8	8	7	6	4	3	**-5**
SEED WEIGHT										
Minute	0	0	0	1	1	0	1	1	1	**1**
<0.2mg	16	18	16	18	13	13	11	12	11	**-5**
0.2-0.5	23	22	21	16	19	19	21	20	22	**-1**
0.51-1.0	23	27	27	33	31	34	32	30	30	**7**
1.01-2.0	25	25	25	26	26	25	27	27	28	**3**
2.01-10.0	12	8	9	6	9	9	8	9	8	**-4**
>10.0	0	0	1	1	0	0	1	1	0	**0**
POLYCARPIC PERENNIALS	99	99	99	100	99	98	98	100	99	**0**
FLOWERING TIME										
Jan-Feb	0	0	0	0	0	0	0	0	0	**0**
March	5	8	8	10	9	9	9	7	5	**0**
April	17	17	16	13	18	17	17	18	18	**1**
May	30	29	30	32	29	26	29	31	32	**2**
June	44	41	42	40	39	40	38	39	39	**-5**
July	2	6	4	5	5	6	6	6	6	**4**
August	1	1	0	0	0	0	0	0	0	**-1**
September	0	0	0	0	0	0	0	0	0	**0**
Oct-Dec	0	0	0	0	0	0	0	0	0	**0**
GEOGRAPHICAL RESTRICTION										
(A) LATITUDINAL										
Northern	0	0	0	0	0	0	0	0	0	**0**
Slight northern	0	0	0	0	0	0	0	0	0	**0**
No latitudinal restriction	59	60	60	57	52	51	55	53	54	**-5**
Slight southern	33	33	35	37	41	43	40	43	43	**10**
Southern	8	7	5	6	7	6	5	4	4	**-4**

TABLE 3 (continued)
BROCKS FARM - FIBS ANALYSIS, SSSI FIELD 1988-1996

ATTRIBUTE	YEAR 1988	1989	1990	1991	1992	1993	1994	1995	1996	**1988-96 change**
GEOGRAPHICAL RESTRICTION (continued)										
(B) LONGITUDINAL										
Western	8	6	8	5	7	7	6	7	5	**-3**
Slight western	2	4	3	2	2	2	1	2	2	**0**
No longitudinal restriction	91	90	89	93	92	91	93	91	92	**1**
Slight eastern	0	0	0	0	0	0	0	0	0	**0**
Eastern	0	0	0	0	0	0	0	0	0	**0**
PRESENT STATUS (GB)										
Decreasing	62	62	62	61	55	54	59	60	62	**0**
Uncertain	17	18	18	19	22	22	20	21	18	**1**
Increasing	21	20	20	20	23	24	21	19	20	**-1**

TABLE 4

BROCKS FARM

SPECIES' FREQUENCIES FOR THE TURF TRANSPLANT 1988-1996

Surveyors	SJL SAB	SJL CPB SAB	SJL CPB JC	SJL RDP	SJL	SJL JC MB PE	SJL MB AM	SJL PE LW	SJL CP CD
Date of survey (all May)	17	17	16	15	19	18 19	24	16	13 14
Number of quadrats	50	115	115	97	104	101	102	98	108

SPECIES	FREQUENCIES (%)								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
Trees & shrubs									
Salix *sp*	-	-	-	-	-	-	1	-	-
Grasses									
Agrostis canina	4	-	-	-	-	-	-	-	-
Agrostis capillaris	80	77	89	93	92	90	93	69	87
Agrostis stolonifera	-	-	1	-	-	2	-	-	1
Anthoxanthum odoratum	44	57	12	8	23	25	45	58	54
Arrhenatherum elatius	2	1	-	4	-	-	-	-	-
Briza media	-	-	-	1	-	1	-	-	-
Bromus hordeaceus	-	-	-	-	-	-	-	-	1
Bromus racemosus	-	-	-	-	2	1	3	-	3
Cynosurus cristatus	8	1	3	-	-	2	2	9	6
Dactylis glomerata	6	3	4	3	6	4	7	6	7
Danthonia decumbens	6	2	2	4	1	5	-	1	2
Deschampsia cespitosa	-	-	-	-	-	1	-	-	-
Elytrigia repens	-	-	-	-	-	1	-	-	1
Festuca arundinacea	2	-	-	-	-	-	-	-	-
Festuca pratensis	4	-	-	-	-	-	-	-	-
Festuca rubra	86	77	88	94	93	90	91	91	88
Glycera fluitans	-	-	-	-	-	-	-	-	1
Holcus lanatus	38	47	50	30	35	53	55	73	60
Lolium perenne	-	-	2	-	-	1	-	-	-
Poa pratensis/humilis	28	19	10	9	16	28	37	13	28
Poa trivialis	-	3	-	-	-	1	1	-	2
Sedges and Rushes									
Carex caryophyllea	12	6	2	4	2	1	7	2	5
Carex flacca	16	11	7	2	10	11	6	6	7
Carex hirta	-	2	3	3	5	10	10	11	11
Carex ovalis	-	-	-	-	-	1	-	-	-
Carex panicea	-	4	-	1	-	-	-	-	2
Juncus acutiflorus	20	17	13	11	18	18	21	23	33
Juncus conglomeratus	2	-	3	4	2	1	-	3	-
Juncus effusus	-	-	3	-	-	-	1	1	1
Juncus inflexus	-	-	1	-	-	-	-	-	-
Luzula campestris	28	40	17	22	31	51	57	49	60

TABLE 4 (continued)

SPECIES	FREQUENCIES (%)								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
Forbs									
Achillea millefolium	2	3	2	4	12	9	10	18	13
Agrimonia eupatoria	-	-	-	-	-	1	1	1	-
Ajuga reptans	6	1	-	1	1	1	-	1	1
Bellis perennis	-	-	-	-	-	-	1	-	-
Cardamine pratensis	4	2	1	-	2	1	5	9	3
Centaurea nigra	56	26	23	42	26	46	35	36	44
Cerastium fontanum	10	16	2	1	1	10	14	7	13
Cirsium arvense	2	-	-	-	-	1	1	-	-
Cirsium palustre	2	2	-	-	1	1	-	1	-
Crepis capillaris	-	-	-	-	-	-	1	-	1
Dactylorhiza praetermissa	2	-	-	1	1	1	1	1	-
Equisetum arvense	-	-	1	1	-	2	1	7	3
Galium aparine	-	-	-	1	-	1	-	-	-
Galium palustre	2	-	-	-	-	-	-	1	-
Glechoma hederacea	-	-	-	-	1	-	-	-	-
Heracleum sphondylium	-	-	-	-	-	2	-	-	-
Hypochaeris radicata	2	-	2	3	4	10	12	12	49
Lathyrus pratensis	14	22	23	16	12	20	21	28	27
Leontodon autumnalis	-	-	-	1	-	-	2	2	1
Leontodon saxatilis	-	-	-	-	-	-	-	-	10
Leucanthemum vulgare	-	1	-	-	-	2	-	2	3
Lotus corniculatus	54	62	23	13	28	28	31	47	39
Lotus pedunculatus	8	-	2	-	1	3	5	5	1
Mentha aquatica/arvensis	2	-	-	-	-	-	-	2	-
Oenanthe pimpinelloides	2	2	3	7	4	16	21	31	31
Orchis morio	2	1	1	-	-	3	-	1	2
Plantago lanceolata	50	50	56	40	45	44	47	50	46
Potentilla reptans	4	5	1	1	7	6	6	11	6
Prunella vulgaris	2	1	1	1	-	5	-	2	7
Pulicaria dysenterica	12	8	1	1	1	4	2	3	2
Ranunculus acris	32	27	17	8	8	18	48	53	44
Ranunculus bulbosus	24	3	6	8	8	19	18	19	41
Ranunculus ficaria	-	-	-	-	-	-	-	-	1
Ranunculus repens	6	12	4	1	1	11	6	29	12
Rhinanthus minor	-	-	1	-	-	1	3	8	15
Rumex acetosa	8	12	10	8	11	33	37	31	28
Senecio erucifolius	-	3	1	-	-	1	-	2	-
Senecio jacobaea	-	2	1	-	-	-	1	-	-
Stellaria graminea	-	3	1	3	1	6	6	4	-
Stellaria uliginosa	-	-	-	-	-	-	-	-	1
Succisa pratensis	2	-	1	-	-	-	-	2	-
Taraxacum *sp*	14	18	8	11	17	11	18	18	19
Trifolium dubium	-	-	-	-	-	-	-	-	10
Trifolium pratense	2	3	-	4	-	2	8	22	29
Trifolium repens	2	5	-	2	1	1	1	8	10
Veronica chamaedrys	-	2	1	-	-	1	1	1	-
Veronica serpyllifolia	-	1	-	-	-	-	-	2	-
Vicia cracca	-	-	1	2	-	1	2	1	4
Vicia sativa	2	-	-	-	-	-	-	-	-
Bare ground	4	44	3	13	6	30	22	28	20
Mean no. of spp/sample	7.3	6.5	4.8	4.9	5.2	7.2	7.9	8.8	9.7

Sampling density was less in 1988 than in following years, as in that year the whole of the donor field was sampled, and only half the quadrats (50) occurred within the area which was subsequently moved to become the turf transplant plot.

TABLE 5
BROCKS FARM - FIBS ANALYSIS, TURF TRANSPLANT 1988-1996

All figures are percentages

ATTRIBUTE	YEAR 1988	1989	1990	1991	1992	1993	1994	1995	1996	**1988-96 change**
STRATEGY										
C	2	0	2	2	1	2	2	2	1	**-1**
CSR	76	73	83	84	79	76	77	73	71	**-5**
SC	3	4	4	3	4	3	3	3	4	**1**
CR	1	4	2	1	2	4	2	7	4	**3**
R	1	3	1	1	2	2	3	3	3	**2**
SR	4	5	3	3	4	5	5	6	4	**0**
S	13	11	6	6	8	9	7	7	6	**-7**
HABITAT										
Wetland	8	5	5	4	6	6	6	7	6	**-2**
Skeletal	0	0	0	1	0	0	0	0	1	**1**
Arable	0	3	1	2	0	3	2	7	7	**7**
Pasture	63	72	67	60	63	66	68	72	67	**4**
Spoil	17	18	16	10	13	14	13	17	18	**1**
Wasteland	52	43	41	47	47	46	42	38	40	**-12**
Woodland	1	0	0	0	0	0	0	0	0	**-1**
SOIL pH<5	14	12	18	20	18	13	12	8	9	**-5**
SPECIES RICHNESS										
<10 spp m-2	0	0	0	0	0	0	0	0	0	**0**
10.1-14	15	12	19	22	18	14	13	9	12	**-3**
14.1-18	43	49	45	44	51	50	52	51	49	**6**
18.1-22	37	34	32	31	28	30	31	35	30	**-7**
>22	5	4	4	4	4	6	4	5	9	**4**
NUCLEAR DNA >10pg	29	34	33	33	33	32	36	37	34	**5**
CANOPY STRUCTURE										
Leafy	43	47	42	38	39	37	38	40	38	**-5**
Semi-basal	48	42	44	49	48	53	51	48	48	**0**
Basal	9	11	13	12	13	9	10	10	14	**5**
Floating	0	0	0	0	0	0	0	0	0	**0**
Other	0	0	0	0	0	0	0	0	0	**0**
HEIGHT										
<100mm	11	12	7	9	9	15	15	13	21	**10**
100-299	63	65	65	63	67	59	61	60	55	**-8**
300-599	19	16	18	19	18	20	18	19	17	**-2**
600-999	7	7	8	7	6	6	6	7	7	**0**
1000-3000	1	0	1	1	0	0	0	0	1	**0**
>3000	0	0	0	0	0	0	0	0	0	**0**

TABLE 5 (continued)
BROCKS FARM - FIBS ANALYSIS, TURF TRANSPLANT 1988-1996

ATTRIBUTE	YEAR 1988	1989	1990	1991	1992	1993	1994	1995	1996	**1988-96 change**
VEGETATIVE SPREAD										
Monocarpic	0	1	0	0	0	0	1	1	3	**3**
Patch <100mm	40	43	33	32	33	37	41	42	43	**3**
100-250	21	22	23	20	20	24	25	23	24	**3**
251-1000	33	29	39	43	38	30	27	22	22	**-11**
>1000	5	6	5	4	8	9	7	12	8	**3**
REGENERATIVE STRATEGY										
Persistent seed bank	79	81	74	69	72	74	75	76	73	**-6**
Numerous widely dispersed seeds	2	5	3	4	5	5	5	5	9	**7**
Vegetative fragments important	5	6	5	4	8	9	7	12	8	**3**
SEED WEIGHT										
Minute	1	0	0	0	0	1	0	1	1	**0**
<0.2mg	20	20	23	24	24	19	19	15	16	**-4**
0.2-0.5	22	22	17	12	18	20	21	20	19	**-3**
0.51-1.0	24	25	27	32	32	30	30	28	30	**6**
1.01-2.0	22	24	20	15	16	14	18	21	18	**-4**
2.01-10.0	10	7	7	13	8	13	9	12	13	**3**
>10.0	2	3	5	4	2	3	3	3	3	**1**
POLYCARPIC PERENNIALS	98	97	99	100	99	98	98	98	95	**-3**
FLOWERING TIME										
Jan-Feb	0	0	0	0	0	0	0	0	0	**0**
March	5	9	5	7	9	9	10	8	8	**3**
April	20	20	15	12	14	12	15	16	13	**-7**
May	26	30	36	35	33	37	38	38	38	**12**
June	44	36	40	43	40	38	33	35	37	**-7**
July	5	4	4	3	4	4	3	4	4	**-1**
August	0	1	0	0	0	1	0	0	0	**0**
September	0	0	0	0	0	0	0	0	0	**0**
Oct-Dec	0	0	0	0	0	0	0	0	0	**0**
GEOGRAPHICAL RESTRICTION										
(A) LATITUDINAL										
Northern	0	0	0	0	0	0	0	0	0	**0**
Slight northern	0	0	0	0	0	0	0	0	0	**0**
No latitudinal restriction	56	66	60	62	62	58	63	63	57	**1**
Slight southern	41	31	38	37	35	38	34	33	39	**-2**
Southern	2	3	2	1	3	4	3	4	3	**1**

TABLE 5 (continued)
BROCKS FARM - FIBS ANALYSIS, TURF TRANSPLANT 1988-1996

ATTRIBUTE	YEAR 1988	1989	1990	1991	1992	1993	1994	1995	1996	**1988-96 change**
GEOGRAPHICAL RESTRICTION (continued)										
(B) LONGITUDINAL										
Western	10	4	5	9	5	7	5	4	5	**-5**
Slight western	3	3	3	2	3	3	3	3	3	**0**
No longitudinal restriction	87	93	93	88	91	91	93	93	92	**5**
Slight eastern	0	0	0	0	0	0	0	0	0	**0**
Eastern	0	0	0	0	0	0	0	0	0	**0**
PRESENT STATUS (GB)										
Decreasing	67	61	62	61	62	56	60	56	59	**-8**
Uncertain	17	15	12	19	18	22	20	20	21	**4**
Increasing	17	25	26	20	20	22	20	25	21	**4**