GRASSLAND VEGETATION and MANAGEMENT of the GREEN, HILTON, CAMBRIDGESHIRE

Report of 2003 field survey
and subsequent analysis

The Hilton Wildlife Conservation Group

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SUMMARY

The undisturbed permanent grassland Village Green at Hilton, Cambridgeshire, is described. Traditionally grazed up to 1950, it has since been managed for hay, with variations for football and cricket, and elsewhere for amenity. Differences in grassland vegetation from these regimes have become apparent and are likely to be of ecological interest and conservation importance. In 2003 21 compartments were identified for study. A survey based on stratified random sampling was undertaken to describe variation in the vegetation and to provide advice on management. The results have been subjected to statistical analysis. They are discussed in relation to affinities with the *National Vegetation Classification*, to the importance of the Green at county and regional levels, and to differences associated with the main management regimes, categorised broadly as **Hay**, **Parish Council** (extensive amenity), **Cricket** (outfield), and **Intense**. The hayfield compartments are shown to be of the greatest ecological interest. Recommendations are made for the continued current management of the hayfield (and the football pitch as an important variation taking into account recent recreational requirements), and of the cricket ground. Suggestions are made to reduce the turnover of nutrients in the intensively managed and amenity areas to increase biodiversity and for amenity, together with the return of two of the amenity areas to hayfield management.

I Hilton Green: Introduction

History and Location

The Parish of Hilton lies north west of Cambridge and south of Huntingdon within the local authority areas of the Huntingdonshire District Council and the Cambridgeshire County Council. Hilton is a small parish of 536 ha (1325 acres) of mainly open, arable land that surrounds the village of 387 households (2001 census data). The village (map ref. TL 2966) lies astride the B1040 road from Chatteris to Biggleswade. Most of the older parts, including all the Village Green, lie to the east of the road, and the existence of the Green is hidden from the majority of people travelling through the village (Fig. 1).

The Village Green (Dady 2000) is an area of Common Land (registered in 1976 – Commons Registration Act 1963), originally recorded in the Hilton Enclosure Award of 1840 as extending to 29 acres 33 perches, but now reduced to 26.9 acres in the 1976 registration (though this is still large for villages in Cambridgeshire). The freehold passed to the Parish Council by a conveyance of 1970, and the Parish Council (composed of nine elected members) is thus the owner and overall manager of the Green. A joint committee of the council and the commoners safeguard the rights of the Common Rights Holders (see below). The Finance and General Purpose Work Group of the Parish Council instituted a Management Plan for the Green and other areas under its jurisdiction in December 1997, which is updated annually (the last occasion in 2004).

Rights of grazing going back to mediaeval times belong to the Common Rights Owners, with 16 rights recorded amongst 13 owners in the 1976 register. Historically the commoners' rights have priority over any other use of the Green, and the grazing of one cow per Common Right continued as the only effective management of the Green until 1950, except for the cricket square and more occasional cutting of the cricket outfield. Thereafter a regime of haymaking was introduced, replacing the more intensive summer grazing with the Commoner's cows between May and mid-September. The hay is cut and made by local farmers, who also make the decision when to cut – currently in mid June, although later in July for some years prior to 1995. The football pitch was established *ca* 1945 (L King *pers. comm*.) and is cut in winter until March and thereafter for hay in summer. Subsequently, the area of haymaking has been split up further and reduced, with parts of the Green mown for amenity either by the Parish Council or by individual owners of houses fronting onto it ("frontagers"). Those areas (Fig.2) now managed by the Parish Council for amenity are:

- More extensive areas a) south, east and west of the churchyard; and b) in front of *Park Villa*/*The Limes* (see below) – neither convenient for haymaking; and
- Smaller areas around the Village Hall, the Turf Maze, opposite *Manor House* and around the pavilion.

There is a difference between the status of a green and a common. The existence of **Village Greens** seems to go back to the earliest days of village communities. Village greens were held "in common" and developed as open spaces for recreation (*e.g.* for archery in the 14th century), and this remains as the modern definition of their land-use. They may, as at Hilton, or may not be subject to rights of common. **Common land** is private land (in Hilton's case owned by the Parish Council) over which common rights (*e.g.* the grazing of cattle) are restricted to certain individuals, or attached to certain properties. The rights of management or use are confined to these people or properties, and no alterations can be effected without the consent of the whole body of commoners (see Hoskins and Stamp 1963). Thus the Green

at Hilton is both a Green, by immemorial custom, and a registered Common, and is doubly protected.

Physical characteristics

Hilton Green lies at about 15m (50 feet) above sea level, in the valley of the River Great Ouse, on heavy, poorly-drained soil derived from an Oxford Clay substrate, with pH circumneutral or slightly alkaline. The local topography is relatively flat and there is little microtopographic variation on the Green itself, though there are low ridges between the church and the road to the south as well as silted-up ditches either end of the football pitch.

The annual rainfall is amongst the lowest in the UK, averaging 550.4mm (21.6 inches) over the 23-year period from 1981-2003, varying from a minimum of 340mm (13.4 inches) in 1990 to a maximum of 703mm (27.7 inches) in 2001 (G. Sheail *pers. comm*.).

Grasslands and the growth of grass

The herbaceous vegetation of the Green is described botanically as grassland, defined as vegetation where grasses are the dominant plants and the occurrence of other plants depends on their ability to compete with grasses. For example, under fertile conditions the vigorous spring growth of grasses suppresses the growth of other than a few equally vigorous broadleaved herbs (*e.g*. as summarised by Rabotnov 1977). Where nutrient levels (especially of nitrate and phosphate) are lower, the reduced performance of the grasses allows a much greater variety of species to co-exist. As a consequence, the management of grasslands for a range of objectives (*e.g.* agriculture, amenity, sport and biodiversity) focuses on the management of the grasses themselves.

Growth of all higher plants originates in growing points, where cells divide, to subsequently develop and expand. In most plants, the growing points are at the apex of the stem and the leaves, but for vegetative growth in grasses (*Poaceae)*, the growing points are at the stem-base. This gives them the ability to produce lateral vegetative growth (tillers), from the base when the upper leafy parts of the plant are removed by cutting or grazing (defoliation), and allows grasses to tolerate grazing and cutting whereas most broadleaved plants (with notable exceptions) cannot. Hence, the management of swards, and thus the competitiveness and dominance of the grasses, comprises more or less severe defoliation regimes, varying in terms of frequency and height of cutting or grazing (note that grazing is also selective). In contrast, the flowering stems (culms) of grasses have an apical growing point, and hence do not regrow when cut or grazed down.

The value of the Green

Hilton Green in the spring and early summer is a place of beauty, with varied colour and texture in the herbaceous vegetation, framed by large mature oak, beech and other trees (Plate 1). After the hay cut in mid June, the herbaceous vegetation is less colourful, but still attractive and set off by the trees. Besides its amenity value, the Green represents a significant area of relatively undisturbed grassland, never having been ploughed, treated with pesticides, nor received applications of inorganic fertilisers. For hundreds of years, it will have been managed by controlled grazing with consequent recycling of nutrients. As described above, for the last 50 years a varied pattern of mowing (with or without the removal of the cuttings) has developed. Nutrients will have been removed in the hay crop, which is the largest single use of the Green. Ecologists have been aware for some years of

the scientific interest of the resulting grassland mosaic, and in 2003 an opportunity arose following the formation of the *Hilton Wildlife Conservation Group* (*HWCG*) to both record the vegetation, and to characterise it in terms of its plant communities and the management regimes that have shaped their composition.

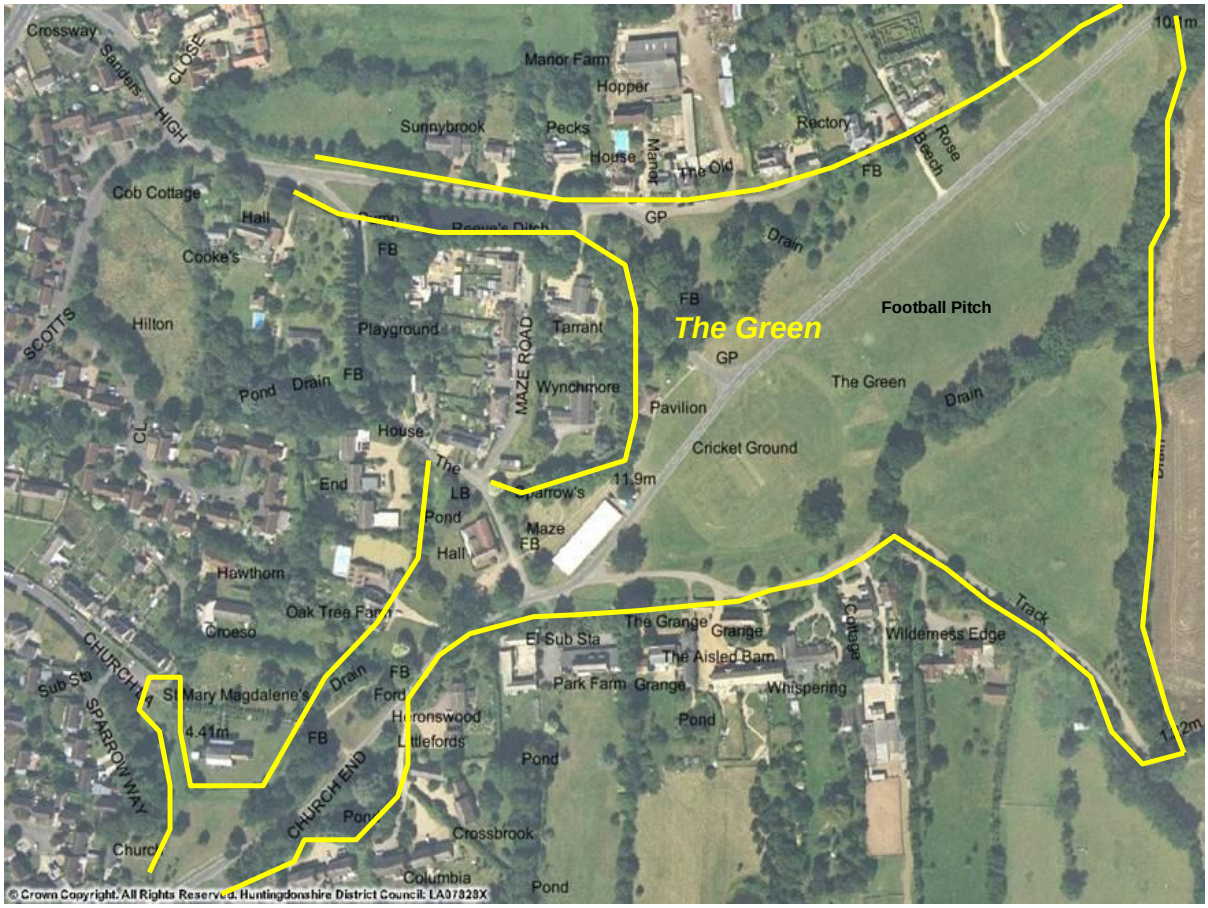

Plate 1: Aerial photo of the eastern part of Hilton Village and generalised boundary of the Green (F.B. = Foot Bridge)

Objectives of the 2003 survey of the Green

The 2003 survey had the following objectives:

- To describe the variation in the composition of the mosaic of grassland vegetation that has developed under a variety of management regimes over the period since 1950.
- To begin compilation of a species list of the herbaceous flora of the Green.
- To provide a scientific basis for advice on the future management and protection of the vegetation of the Green.

II. Compartments and management

The complex management history of the Green means that it is now possible to distinguish many compartments *i.e*. discrete areas differing from those around them in terms of their management or because (although of the same management) they are separated by a road. At first 20 compartments were defined, subsequently Compartment 7 (land managed by the Parish Council (**PC**) north of the cricket pavilion) was divided into 7 "PC north of the Pavilion" and 21 "PC in front of Park Villa", which was seen to be different in character apparently having been cut less intensively (Appendices 1 and 2).

The management regimes of the 21 compartments (Appendix 1) have been divided into three periods:

- since 2002
- from 1996-2001
- before 1996 (to *ca* 1970)

There has been considerable consistency in the regimes applied to particular compartments, notably the haycut areas (**Hay** – see below), cricket ground (**Cricket**) and intensively managed (**Intense**), but some variation in the regimes for compartments inconvenient for hay cutting and/or amenity cut by the Parish Council (**PC**). None of the compartments has been grazed on a regular basis for over 50 years.

The management information (Appendix 1) was classified in two ways in order to facilitate later analysis of the vegetation data in terms of the treatments applied. Firstly, the regimes for most compartments were lumped into four broad types (**A**, **E**, **F** and **G**), which could be treated as *de facto* treatments in an analysis of variance (ANOVA):

A "**Hay**" *i.e.* single hay-cut – compartments 8, 11, 13, 16 and 17.

E "**PC**" *i.e.* managed on by the Parish Council with *ca* 8 cuts per year to 5-10cm – compartments 1 (managed by the District Council), 2, 4, 5, 7 and 21.

F **"Cricket"** (the outfield areas) *i.e.* cut frequently during the cricket season to<5cm (normally 2.5-4cm) – compartments 6 and 14.

G "**Intense**" *i.e.* cut weekly (*ca* 30 times) during the growing season (Feb/Mar onward) to *ca* 2.5 cm, mainly by frontagers, and the cricket square – compartments 3, 9, 10, 15, 18 and 20.

Two other compartments had very distinctive management somewhat intermediate between the annual hay-cut and the parish council areas *i.e*. type **C** the football pitch (12), which differs from the surrounding hayfield in the frequent cuts in the winter, and **D** Crossbrook (19) with 4+ cuts up to the end of May and 1 or 2 cuts in the autumn/early winter. The sequence **A** to **G** represents increasing management intensity. Type **B** (a slight variation of the hay cut, Compartment 8 north-west of the road) was amalgamated with **A**.

Secondly, an attempt was made to characterise and quantify the management in terms of a) the date of the first cut each year; b) the number of cuts per year; c) the cut height; d) the machine used; e) the manager; and f) whether the cuttings were removed or left *in situ* to decompose.

III. Previous botanical surveys

Surveys since 1980

In 1984, the then *Nature Conservancy Council* (*NCC* now *English Nature*) made a botanical survey of the Green, listing 50 herbaceous plants including the Green-winged Orchid (*Orchis morio*). They reported to the Parish Council that "*the management seems to be ideal, and this is a good example of how an area can be well used and profitable, but retain its wildlife value*" (Everett 1984 – quoted in Dady 2000). Two later surveys, by Emily Randall in 1987 (Randall 1988) and a party from the University of the Third Age in Cambridge (U3AC) Botany Group in 1999, covered only parts of the Green, but provided useful accounts of some of the areas that were also examined by the 2003 survey. The late Derek Wells and JMW produced a general list of species for the Green in 1999 (unpublished), itself based on the previous surveys by the *NCC* and by Randall, and this was used for the basic species list for the proformas used in the 2003 survey (Appendix 4). The occurrence of species in this list was checked against records in *The Flora of Huntingdonshire and the Soke of Peterborough* (Wells 2003) for the area, much of which is included in tetrad 26Y (TL28.66.).

Randall's survey

Randall sought to "*determine how far land-use has affected the changes in vegetation on the Green*" in a stratified random survey of the vegetation using $1m^2$ quadrats and stratifying the land-uses into six areas:

- Disturbed areas – *e.g.* the bonfire site; poached areas by the football and cricket creases; an access track used by farm vehicles; an intensively cut "lawn" outside a frontager's house.
- Cricket pitch.
- Football pitch.
- Main Green including car parking and amenity areas frequently cut by the Parish Council and frontagers.
- Area northeast of the football pitch.
- The Wilderness.

Results were presented as contingency tables of species and numbers of species for each area, and as the result of a quantitative computer analysis using the TWINSPAN (Hill 1979) package, which classifies **all** data and divides them hierarchically into separate groupings of similar data (quadrats). If there are indeed differences between the vegetation in different land-use areas, then it would be expected that the analysis will group the quadrat data from each area and distinguish them from the others.

The contingency tables showed variation in the numbers of species from 23 (cricket outfield) to 51 (Wilderness) and 58 (Main Green) - resulting from diverse impacts on the vegetation when compared to the relative uniformity of management elsewhere. Examination of species recorded in each land-use (area) revealed (with some anomalies) expected variations depending on the nature of the management that each had received. TWINSPAN separated into identifiable groups the data from the disturbed sites, the Main Green, the Cricket outfield (corresponding to compartments 6 and 14 in 2003), the Football pitch (compartment 12 in 2003), and grouped together the data from the area Northeast of the football pitch (compartment 11 in 2003) and the Wilderness (compartment 17) both managed for hay. Thus, importantly, this work showed that there were vegetation differences between the selected land-uses and that these could be quantified. In the conclusions attention was drawn to evidence presented for the loss of species associated with traditional management, and

their replacement by 'weedy' species as a result of modern land uses, and the need for the prevention of further losses to be taken seriously.

U3AC Botany Group survey of 1999

The survey by the U3AC botany group covered just four of the compartments of the 2003 survey, using the "Dafor" scale to record abundance in $1m^2$ quadrats:

- Hay meadow northwest of the Fenstanton Road (compartment 8 in 2003): 4 quadrats.
- Rose Cottage lawn (compartment 9): 3 quadrats.
- Hay meadow northeast of the Football pitch (compartment 11): 3 quadrats.
- Football pitch – winter cut before summer hay cut (compartment12): 3 quadrats.

This was a simple exercise but analysis of the data in terms of species and numbers of species for each area did show identifiable differences between them (Way 1999 *pers. comm.*). Data from the surveys of 1988 and 1999 were punched up in TABLEFIT format at Monks Wood. However, no statistical analysis comparing these earlier surveys with that of 2003 was conducted, due to the partial coverage and much smaller data sets of these surveys.

IV. Survey methods 2003

The survey followed a stratified random sampling approach, with compartments as the strata, and samples (quadrats) randomly located within them. The recording team was led by JOM and JMW mainly drawn from those members of *HWCG* with some experience of biological recording - Hilton is fortunate in having several ecologists and naturalists living in the parish.

Number of samples

The bare minimum of quadrats required to characterise the vegetation of a plot is 3, though 5 is better and more are preferable. Following discussion amongst the authors and taking account of the likely survey effort available, it was decided to allocate the number of quadrats per compartment as follows:

Area of compartment $<2000m^2$.....3-6 quadrats recorded
Area of compartment $2000\text{-}10000m^2$..... 10 quadrats recorded
Area of compartment $>10000m^2$..... 20 quadrats recorded

The allocation of quadrats is shown in Appendix 3. In all 156 quadrats were recorded during the first two weeks of June 2003.

Location of quadrats

Appropriate numbers of paired random co-ordinates (defining the centre of each quadrat) were generated for each compartment and were usually employed to locate each quadrat by pacing south-east from the west[1] corner of the compartment and then north-east, but this convention had to be adjusted in a number of instances where there were irregularly shaped compartments or a usable baseline ran in another direction. Locations were generally excluded that would be unrepresentative of the compartment vegetation as a whole (*e.g.* bonfire sites in the Wilderness), overlap with another quadrat or over-sample one area.

Quadrat size and data recorded

Although $4m^2$ quadrats are frequently advocated for grassland survey especially for the definition of plant communities (Rodwell 1991-2000), a smaller quadrat size (*i.e.* $1m^2$) is preferable where the objective of the survey (as on Hilton Green) is to distinguish the impacts of different management regimes. Such an approach is especially effective where the smaller

[1] *i.e.* the corner of the compartment furthest west

quadrat size allows more quadrats to be recorded, thus increasing the chance that significant differences in management impacts will be detected.

Appendix 4 shows the standard recording quadrat proforma that was employed in the Hilton study. Within each quadrat the following data were recorded:

- Compartment name and number
- Date of record
- Name of recorder(s)
- All vascular plants present – bryophytes (mosses) were not recorded, partly to simplify the work, but also because they are poorly represented both in cover and variety on the Green.
- Domin cover-abundance value for each species (see Appendix 5)
- Management information – entered retrospectively. Additional annotations were made where factors of interest were noted or where there was localised divergence from the main compartment regime.

GPS data were not recorded for practical reasons. It would have been useful for illustrating the distribution of the quadrats, but the data would not have been sufficiently precise for a future surveyor to re-establish exactly the position of the quadrats on the ground.

The proforma lists 38 species of the most common plants recorded in previous surveys (section **III**), and space is provided to record additional species observed in individual quadrats. These species are listed by their vernacular and scientific names, and also by "four-four" couplets (*e.g. Fest rubr* for *Festuca rubra*), which provide the input data structure for TABLEFIT (Hill 1996), one of the analytical techniques employed later. The use of the Domin scale (rather than percentage cover estimates) is justified largely because the data collection at Hilton was undertaken by many different people, and it has been commonly noted that more between-recorder consistency is achieved in such surveys using Domin.

Data entry and format

Preliminary data entry was performed by members of *HWCG* and followed the format required for TABLEFIT *e.g.*

occc q1	DOMIN
poa annu	4
arrh elat	1
dact glom	1
loli pere	10
bell pere	2
plan lanc	1
tara offi	1
trif repe	1

where "occc q1" (*e.g.* quadrat 1 Outside the Churchyard, [compartment 1]) is the individual quadrat identifier, and the species information is entered as four-four couplets with the appropriate Domin value for that quadrat.

For later analyses, the TABLEFIT (Hill 1996) format was converted at *CEH* Monks Wood into a simple matrix of species against quadrats, with Domin values, in the cells of the matrix of the *Excel* spreadsheet. Management information was tabulated on a further worksheet, both in terms of the broad type (*i.e.* **A**-**G** –see Section **II**) and the "components" of these regimes *i.e.* date of first cut, number of cuts *per annum*, cut height, machine used, manager and whether the cuttings were left *in situ* or removed.

V. Analytical approaches

In order to achieve the objectives of the survey outlined in Section **I** it was necessary to:

- Classify the present vegetation in terms of the *National Vegetation Classification* (*NVC*: Rodwell 1991-2000) so that the vegetation of Hilton Green could be assessed in a national context, and its relationships to nationally recognised grassland communities described.
- Relate the current vegetation types and distribution of individual species to the management regimes.
- As a result, make recommendations as to the preferred management regime(s) to maximise biodiversity consonant with other management objectives (haymaking, sports surfaces, amenity).

Two standard multivariate approaches were used:

1) TABLEFIT (Hill 1996) was used to allocate individual quadrats and/or groups of quadrats (*e.g.* all those in one compartment) to their closest fit with the described communities of the *NVC*. Results are presented as overall "goodness-of-fit" values from 0-100, though this figure is itself derived from four measures of correspondence between the observed vegetation and the constancy tables of the *NVC*. The original TABLEFIT analysis was conducted by IPHS, and then further examined by JOM.
2) CANOCO (ter Braak and Šmilauer 1998) ordinated species along axes related to the measured environmental variables (*i.e.* management regimes). For most purposes at Hilton, the Detrended Correspondence Analysis (DCA) option was used – a preliminary method also first developed by Hill (Hill 1979). These analyses were made by THS at Monks Wood, followed by examination by JOM.

Finally the relationship between individual species occurrence/abundance and management was assessed using an analysis of variance (ANOVA) and a Kruskal-Wallis test. To simplify this univariate analysis, only the four regimes **A** (hay), **E** (PC), **F** (Cricket) and **G** (Intense) (section **II**) were assessed *i.e.* those regimes represented in two or more compartments.

TABLEFIT results are presented in Section **VI**, where each compartment is described in terms of those *NVC* communities to which the vegetation best corresponds. TABLEFIT output provides a summary of the five best goodness-of-fit values, and in many instances within mesotrophic (neutral) grasslands, where distinctions between communities depend on subtle differences in the proportions of the same species, it may be that several *NVC* communities have rather similar goodness-of-fit values, for a particular quadrat as shown in this example of the output:

w q13 (*i.e.* quadrat 13, the Wilderness [compartment 17])

NVC code[2]	Overall goodness-of-fit	*NVC* community abbreviated name
MG5b	57	*Cynos cris-Centaur nigr Galium verum*
MG5	56	*Cynos cris-Centaur nigr*
MG1e	55	*Arrhenatheretum Centaurea nigra*
MG8	54	*Cynos cris-Caltha palu*
U4b	54	*Fes ovi-Agr cap-Gal sax Hol lan-Tri rep*

[2] For an explanation of these codes, see Appendix 7

Hence, the TABLEFIT analysis suggest that this sample is best described as *NVC* community **MG5b** (*i.e*. a neutral hay-meadow in its *Galium verum* sub-community)**,** but the results show that other vegetation types have very similar goodness-of-fit values, with (in sequence) the typical neutral hay meadow (**MG5**), a more base-rich variant of coarse *Arrhenatherum* grassland (**MG1e**), and even to a wet meadow (**MG8**) and a rather calcifuge sward (**U4b**). In other words, the sward composition here has some species found in all these communities, but few (if any) species that convincingly distinguish these five options. When summarising the vegetation of a compartment, it is thus best either to pool the quadrats to achieve an overall composition for the plot or to see which *NVC* type(s) have consistently high goodness-of-fit values throughout the samples *i.e.* generally >60. Some compartments on the Green have either marked variation in sward composition between quadrats or a disturbed sward that does not correspond well to any described vegetation type, and summarising results in this way is thus not possible for them, whilst goodness-of-fit values of <50 reflect vegetation that ought not to be ascribed to a particular *NVC* type. Descriptions of vegetation types for which quadrats have higher goodness-of-fit values on the Green are listed in Appendix 7.

A floppy disc of the TABLEFIT analysis is provided with the master copy of this report given to the Parish Council.

The results of both the ordination and individual species analyses (ANOVA *etc*) are outlined in Section **VII,** where patterns across the whole Green are stressed and portrayed through ordination diagrams (Figs 3, 4 and 5), and in the ANOVA table (Table 1). Finally the implications of these results for the future management of Hilton Green are discussed in Section **VIII**. 99 species were recorded in the quadrats of the survey, and these are listed in Appendix 6. Other species (*e.g. Ophioglossum vulgatum* and *Ranunculus auricomus*) were noted in passing, but were absent from the quadrats themselves.

VI. Vegetation types by compartment and evidence of variation within compartment

This section presents a summary of the results of the TABLEFIT analysis by compartment. Two appendices to this report are useful in interpreting the account: Appendix 5 provides a complete inventory of the species recorded in quadrats during the survey; and Appendix 7 lists those vegetation types (communities and sub-communities of the *NVC*) to which quadrats were allotted with a goodness of fit of >50. The great majority of quadrats were allocated to types of "mesotrophic" grassland (**MG**) *i.e*. the vegetation of meadows and pastures on loams and other mineral soils that are neither markedly alkaline nor acid, neither very dry nor wet. The other important group are the "other vegetation" types (**OV**), which comprise disturbed and open vegetation, including several communities created by excessive trampling and nutrient inputs to mesotrophic grasslands. Some parts of the Green have very prominent *Agrostis capillaris* in a short sward resembling more acidic grasslands, and classified by the *NVC* as "upland" (**U**) communities. Where the Green is rather overgrown or the grassland is shaded, there were quadrats that are best allocated to underscrub communities of the "woodland and scrub" (**W**) group. Finally, reference to Appendix 7 (and the compartment descriptions in this section) shows that some quadrats had a composition related to that of coastal grasslands (**MC**, **SD** and **SM**), but in most cases, these samples were simply rather species-poor variants of a mesotrophic grassland.

Compartment 1 - OCCC (Outside the Churchyard):
Although the sward here apparently shows some correspondence to at least three *NVC* communities (**MG7**, **OV22** and **OV23**), these are related types of highly improved, species-poor and often trampled sites, where *Lolium perenne*, *Dactylis glomerata*, *Poa annua*, *Plantago major* and *Trifolium repens* are prominent together with other, often weedy, species of nutrient-rich conditions. The greater part of the plot is best referred to as a *Lolium perenne-Trifolium repens* grassland (**MG7a**), with weedier parts (**OV** communities *etc*) where pressure from people is greatest.

Compartment 2 - SWEC (South, West and East of the Church and toward the village hall):
This compartment does not correspond well with any particular *NVC* community (few goodness-of-fit values >60) and indeed over half the samples have no values greater than 50. Those communities to which some samples appear to correspond are varied, including neutral grasslands (especially **MG7** and **MG1**), but also more rushy swards (**MG10b** and **MG11a**), bramble-rich vegetation (**W24b**), and even to grasslands which apparently indicate high salinity (**SM16d**). This heterogeneity is not surprising since Compartment 2 is varied, with trees providing shade and higher humidity (probably with associated higher soil moisture). It may therefore be considered a mosaic of often disturbed vegetation, where a range of conflicting factors prevents development of any particular semi-natural grassland type. The main area to the west and south of the Church is rather coarse grassland being managed early in the year to suppress Cow Parsley but little used and generally undisturbed, whilst the part to the east is heavily treed.

Compartment 3 - OTF (Oak Tree Farm):
Only three quadrats were recorded in this small patch of intensively mown turf, and they best correspond to improved grassland types with rye-grass (**MG7** and **MG6**). The vegetation differs from that of Compartment 1 in the greater contribution of grasses other than rye-grass *e.g. Festuca rubra* (**MG11a**) and *Agrostis capillaris* (**U4b**). The small sample size does not allow precision in determining the community, but the grassland is probably best considered as a slightly more varied lawn of *Lolium* with other grasses (**MG6a** *etc*).

Compartment 4 - VHS (Village Hall Surrounds):
Although another markedly improved area of grassland, where only two of the samples show reasonable goodness-of-fit values, some general pattern may be discerned. The sward best corresponds to variants of the **MG7** *Lolium* grassland or more disturbed turf where rye-grass remains prominent (**OV23**). The general flora and variation is very similar to that seen in compartment 1.

Compartment 5 - FWM (site of the Feast Week Marquee):
This area of the Green is especially disturbed during the period of the Hilton Feast, but in its grassland strongly resembles other areas managed by the Parish Council(PC). The community is made up of *Lolium perenne*, *Festuca rubra* and *Agrostis capillaris* and best corresponds to one of the variants of *Lolium* grassland (**MG6** and **MG7**). Goodness-of-fit values are fair, but with no strong indication of precise type, being approximately equal for three types of **MG7** and three **MG6** sub-communities.

Compartment 6 – CONP (Cricket Outfield near Pavilion):
Most of the cricket outfield fits very well with *Lolium perenne-Trifolium repens* ley (**MG7a**) though parts show more trampling or vehicle pressure and approach the *Lolio-Plantaginetum* (**MG7e**) or, to some extent, variants of the *Lolium perenne-Dactylis glomerata* community

(**OV23**). Some parts of the outfield have more extensive areas of bare ground than on other compartments of the Green.

Compartment 7 – NCP (North of the Cricket Pavilion):
The four samples within this compartment reflect two rather different situations. Much of the cover is again very typical **MG7a** with high goodness-of-fit values and frequent *Poa trivialis*, although locally showing a trend toward the weedier trampled **OV23**. However, around the trees and margin of the compartment where mowing is locally less intensive, the sward is coarser with prominent *Arrhenatherum* and *Urtica dioica*, as well as *Geum urbanum* and *Glechoma*, and the community fits well with **MG1** *Arrhenatheretum*, though also allied to the nettle-thistle community **OV25c**.

Compartment 8 – HNFR (Hayfield Northwest of the Fenstanton road):
The sward type in this part of the Green is distinctly different from that in those more intensively managed compartments (*e.g.* 1-7). Areas closer to the road have prominent *Anthoxanthum*, *Dactylis*, *Holcus lanatus*, *Festuca rubra*, *Plantago lanceolata* and *Ranunculus bulbosus* and fit most closely with the hay meadow **MG5** (*Cynosurus cristatus-Centaurea nigra* hay-meadow) despite both species being local or absent in the samples. The absence of these two **MG5** constants in many quadrats partly explains why the goodness-of-fit values are mainly 60-65, and not higher. There is some trend toward **MG5** sub-communities, especially **MG5b** where *Galium verum* has high cover, reflecting a drier situation than in some other hay-cut parts of the Green. Where *Agrostis capillaris* is part of the hayfield mixture, a few samples could equally be allocated to **U4b**. Other parts of the compartment are much coarser, with *Arrhenatherum elatius* the main grass, and samples showing a higher goodness-of-fit with various sub-communities of **MG1**.

Compartment 9 – RC (in front of Rose Cottage):
The turf here has been closely cut by a hand rotary mower for >30 years and the mowings left *in situ* to decompose. The resultant sward is intermediate between the *Trisetum flavescens* sub-community of **MG6** (*i.e.* **MG6c**) and the *Poo-Lolietum perennis* (**MG7f**). In addition to *Lolium* and *Poa pratensis*, other prominent grasses are *Agrostis capillaris*, *Festuca rubra* and *Phleum*, with *Leontodon autumnalis, Taraxacum, and Trifolium repens* amongst the forbs.

Compartment 10 – OPG (Outside Punch's Grove):
Although closely adjacent to Rose Cottage, the grassland here differs markedly in appearance with many more forbs in the cover. The frontager also uses a rotary mower, but this is a ride-on machine and, most importantly, the mowings are all removed. This regime serves to remove nutrients from the soil and has produced a vegetation composition that shows some relationship to the **MG5** hay meadow. However, the mixture here does not really "fit" with any typical Cambridgeshire grassland, and indeed the result of the management has been to create a sward that resembles swards normally found on top of sea-cliffs (**MC9** and sub-communities) or on fixed dunes (**SD8** and sub-communities). The two chief grasses are *Agrostis capillaris* and *Festuca rubra*, with *Lotus corniculatus, Medicago lupulina* and *Veronica chamaedrys* among the common forbs. Rosette plants are especially common, including both plantains (*P. lanceolata* and *P. media*) and composites (*Hypochaeris radicata* and *Leontodon autumnalis*).

Compartment 11 – NEH (Northeast End of the Hayfield):
The combination of communities in this hay-cut area is similar to the corresponding part of the Green northwest of the Fenstanton Road (Compartment 8), with areas of **MG5** hay meadow (and sub-communities) as well as parts where *Agrostis* capillaris is common

(approaching **U4b**) or where *Arrhenatherum* is the main dominant (**MG1** and sub-communities). The goodness-of-fit values in this compartment are rather poorer than those in Compartment 8, although even where values are <50, **MG1** and **MG5** are the highest-scoring communities. The sward composition suggests slightly moister conditions than in Compartment 8.

Compartment 12 – FP (Football Pitch):
Samples from the football pitch have a generally similar composition, which might equally be ascribed to either the **MG5** hay meadow (or **MG5a**/**5b**) or to the *Lolium perenne-Cynosurus cristatus* grassland (**MG6b**/**6c**). This intermediate nature probably reflects a situation where the regime for the surrounding hayfield is modified by winter cutting, encouraging *Lolium perenne* and *Trifolium repens* whilst retaining *Anthoxanthum* and a much wider variety of forbs. *Agrostis capillaris* appears to perform especially well under this treatment (Domin values 5-8), with the result that for several samples, marginally the best goodness of fit is for **U4b** grassland. Difficulty in separating the communities on the football pitch is further demonstrated by three samples showing moderate goodness-of-fit values for the *Anthoxanthum-Geranium sylvaticum* grassland (**MG3b**) whose closest actual occurrence is probably in Wensleydale. As with Punch's Grove (Compartment 10), a distinctive management regime has apparently produced a composition with echoes of communities from many miles away!

Compartment 13 – BFCF (hayfield Between the Football and Cricket Outfield):
Although some quadrats from this zone have a composition allied to that of a forb-rich hay-meadow (**MG5**) or a more intensively mown turf with frequent *Lolium* (**MG6**), clearly the closest fit for the Compartment 13 grassland is to **MG1** *Arrhenatherum* grassland. The *Festuca rubra* sub-community (**MG1a**) is the most frequent variant, and indeed these two grasses are very prominent. Locally impeded drainage is reflected in some samples showing a trend to wet meadow types (*e.g.* **MG8** and **MG9b**).

Compartment 14 – CO (Cricket Outfield):
In contrast to the area of outfield near the pavilion (Compartment 6), the grassland in this area fits far more closely with **MG6** (and sub-communities) being dominated by *Lolium* mixed with *Agrostis capillaris*, *Festuca rubra* and *Holcus lanatus*, plus frequent *Bellis* as well as *Trifolium repens* among the prominent forbs. *Agrostis-rich* portions might equally be allotted to **U4b**, and there is some evidence of impeded drainage with quadrats having moderate goodness-of-fit values for **MG8** and **MG11a**.

Compartment 15 – CP (Cricket Pitch):
Agrostis capillaris is much the most extensive turf-forming grass on the square, with samples clearly related to two calcifuge types (**U4b** and the more open **U1f**) as well as to typical intensively mown **MG6** grassland. Bare ground and *Poa annua* also have important cover amongst the *Agrostis* and *Dactylis*, with quadrats consequently approaching **OV10d**.

Compartment 16 – SWCO (hayfield Southwest of the Cricket Outfield):
The wedge of hayfield between the Fenstanton road and the lane to the Wilderness is liable to rather more disturbance than other areas with similar management (Compartments 8, 11, 13 and 17). Old hayfield grasses are uncommon and instead the sward is composed of *Alopecurus pratensis*, *Arrhenatherum*, *Dactylis*, *Elytrigia repens* and *Holcus lanatus*, with some *Lolium*. Like compartments 11 and 13 (but in contrast to compartment 8), the sward composition reflects moister soil conditions. The coarse sward is quite forb-poor, and the

best fit appears to be with either **MG1** (where coarser), varied **MG7** (where *Lolium* more frequent) or to weedy tall herb grassland (**OV23** and **OV25**).

Compartment 17 – W (Wilderness):
Although the Wilderness is much the biggest of the compartments, the vegetation is of a relatively uniform composition (except on and around bonfire-sites), with *Arrhenatherum elatius* common together with *Holcus lanatus*, *Elytrigia* and *Poa trivialis* frequent in an **MG1** sward. However, in contrast to Compartment 16, the grassland is quite forb-rich with much *Centaurea nigra* (hence **MG1e**), as well as *Galium verum* and *Ranunculus acris*. Where *G. verum* is most common and growing with frequent *Anthoxanthum*, the composition is related to **MG5**, though the goodness-of-fit values are never as high as those for **MG1**. Local invasion by *Cirsium arvense* leads to patches of **OV25**, and as elsewhere on the Green, there are wetter (**MG9**) and more *Agrostis*-rich (**U4b**) areas.

Compartment 18 – OPF (Outside Park Farm):
The size of this compartment is at the other extreme from the Wilderness, and only three quadrats were recorded on the closely mown turf here. Consistently the best fit was with the *Lolium perenne* sub-community of the *Festuca rubra-Agrostis stolonifera-Potentilla anserina* grassland (**MG11a**), a community often found on closely grazed/mown sites by ponds and ditches. However, goodness-of-fit values to **MG11a** were only *ca* 48-54, and this compartment was actually typified by the abundance of *A. stolonifera* and the neophyte *Veronica filiformis*, together with occasional *Geranium molle*, *Potentilla reptans* and *Trifolium pratense*.

Compartment 19 – OC (Outside Crossbrook):
As with the football pitch, this compartment receives a management that is distinctly different to any other part of the Green, and whose purpose is to increase biodiversity. As yet, the vegetation is a mixture of *Arrhenatherum, Dactylis, Elytrigia* and *Holcus lanatus*, with tall herbs such as *Anthriscus sylvestris* and *Heracleum* notably more common than elsewhere, especially near the trees that shade part of this compartment. Thus, the best fit for the grassland is to **MG1**/**1a**, with more overgrown parts related to **W24b** or to **OV25**. *Carex hirta* and *Glechoma hederacea* are also particularly extensive here.

Compartment 20 – SHC (the Southern Half of the Churchyard):
Intensively mown, but floriferous, the churchyard supports a grassland where *Agrostis stolonifera, Festuca rubra, Lolium, Poa* species and *Phleum* are common, as well as *Bellis, Plantago species, Veronica chamaedrys, Potentilla reptans, Trifolium repens, Taraxacum* and *Leontodon autumnalis*. The cover is very heterogeneous and several different *NVC* types have relatively similar goodness-of-fit values *e.g.* **MG5** hay-meadow, **MG7e** and **OV23**/**23a** as well as three types where the frequency of *A. stolonifera* appears to indicate moister conditions (**MG8**, **MG9** and **MG11a**). However, even the best goodness-of-fit scores are only 51-58 and, taken as a whole, it is best to think of this compartment as a mosaic of types linked by dominant *Lolium*/*Agrostis stolonifera*/*Festuca rubra*.

Compartment 21 – FPV (in Front of Park Villa):
At first these six quadrats were united with those from Compartment 7, but the physiognomy of the grassland was different and much lusher. None of the samples here fit at all well with the rye-grass dominated turf (**MG7**) that occurs south of the brook. Instead the vegetation resembles that in Compartment 19 with *Arrhenatherum, Dactylis, Elytrigia, Holcus lanatus* and *Poa trivialis* the main grasses, whilst umbellifers were common (*Heracleum* and *Anthriscus sylvestris*) as well as *Glechoma* and more local *Urtica* and *Rumex conglomeratus*.

Table 1 Hilton Green 2003. Species showing significant trends in mean Domin value between the four main management categories (Hay, PC, Cricket and Intense) tested by both ANOVA and the Kruskal-Wallis test (see glossary). Results are also presented for mean species richness per compartment within each category. Significance: ns: not significant; • p≤0.1; * p≤0.05; ** p≤0.01; *** p≤0.001.

Species	Mean Domin value for each management regime				ANOVA	Kruskal-Wallis
	Hay	**PC**	**Cricket**	**Intense**		
Alopecurus pratensis	1.81	0.07	0.0	0.0	***	**
Anthoxanthum odoratum	2.2	0.0	0.0	0.0	***	***
Anthriscus sylvestris	0.27	0.67	0.0	0.0	Ns	**
Arrhenatherum elatius	4.15	1.63	0.01	0.47	**	*
Briza media	0.17	0.0	0.0	0.0	Ns	•
Bromus hordeaceus	0.43	0.0	0.0	0.0	**	***
Cardamine pratensis	0.03	0.0	0.42	0.11	•	**Ns**
Centaurea nigra	1.01	0.0	0.0	0.03	*	**Ns**
Cirsium arvense	0.53	0.03	0.0	0.0	***	**
Crepis capillaris	0.0	0.0	0.0	0.01	*	**Ns**
Cynosurus cristatus	0.01	0.0	0.45	0.04	**	**Ns**
Dactylis glomerata	2.89	2.5	0.7	0.7	**	*
Deschampsia cespitosa	0.59	0.0	0.0	0.0	Ns	**
Elytrigia repens	1.83	1.05	0.0	0.0	*	*
Galium verum	2.04	0.0	0.0	0.2	*	*
Glechoma hederacea	0.59	1.44	0.0	0.27	*	•
Helictotrichon pubescens	0.68	0.0	0.0	0.0	*	•
Holcus lanatus	3.78	1.44	2.55	1.24	*	•
Lamium album	0.0	0.2	0.0	0.0	•	•
Lathyrus pratensis	1.32	0.0	0.0	0.0	*	**
Leontodon autumnalis	0.31	0.39	1.26	1.88	•	**Ns**
Lolium perenne	1.38	5.29	7.5	3.41	*	•
Plantago media	0.03	0.0	0.41	0.9	*	•
Poa trivialis	0.88	3.5	0.25	0.67	*	*
Potentilla reptans	0.26	0.0	0.0	1.31	*	•
Primula veris	0.3	0.0	0.0	0.0	•	•
Prunella vulgaris	0.0	0.0	0.16	0.53	Ns	*
Ranunculus acris	2.18	0.26	0.8	0.0	***	*
Rumex acetosa	0.6	0.26	0.0	0.07	Ns	•
Sanguisorba minor	0.02	0.0	0.0	0.0	Ns	•
Tragopogon pratensis	0.24	0.0	0.0	0.0	Ns	**
Trifolium pratense	0.99	0.07	0.0	0.77	Ns	*
Trifolium repens	0.74	0.65	5.45	3.04	**	*
Urtica dioica	0.0	0.42	0.0	0.0	Ns	•
Veronica chamaedrys	1.07	0.25	0.0	1.85	*	*
Veronica serpyllifolia	0.0	0.0	0.7	0.0	*	*
Species richness	**16.35**	**9.63**	**9.55**	**12.8**	*	**n/a**

Notes **Hay-cut** compartments were cut with tractor mounted reciprocating cutter bar until 1995, then with a rotary hay-cutter; **Parish Council** compartments cut with a tractor mounted flail till 2000, then with a ride-on rotary mower; **Cricket** outfield cut with a cylinder mower; **Intense** management compartments cut with either ride-on or hand held cylinder or rotary mowers, with or without removal of cuttings.

Hence, most of the compartment fits moderately well with *Arrhenatheretum* (**MG1** and sub-communities), with the marginal, overgrown or disturbed parts being closest to a **W24**/**24b** *Rubus fruticosus-Holcus lanatus* underscrub.

VII. Overall vegetation and species trends

Appendix 6 provides a list of all those species found within the quadrats of the 2003 survey. The flora of the Green is largely composed of lowland grassland species, especially those of moderately base-rich loams that are neither prone to waterlogging nor drought. Most of the flora also comprises species typical of situations with intermediate fertility *i.e.* soils that are neither very rich nor very poor in nitrogen, phosphorus and potassium. However, conditions on the Green are by no means absolutely uniform, and the flora reflects such heterogeneity:

- Drier more distinctly calcareous soils: *Briza media, Helictotrichon pratense, Pimpinella saxifraga, Plantago media* and *Sanguisorba minor*.
- Shaded margins: *Anthriscus sylvestris, Elymus caninus, Geum urbanum* and *Hedera helix*.
- Areas of impeded drainage: *Cardamine pratensis, Carex otrubae, Deschampsia cespitosa* and *Potentilla anserina*.
- More nutrient-enriched soils: *Galium aparine, Plantago major, Rumex obtusifolius* and *Urtica dioica*.

Table 1 (on page 14) lists the 36 species that showed significant trends in mean Domin value between the four main management categories (*i.e.* **Hay, PC, Cricket** and **Intense**), tested by both analysis of variance and the Kruskal-Wallis test (see glossary for explanation). To aid in interpretation of the results, the table also lists (for each species) the mean Domin value within each management category. The discussion below focuses firstly on the ANOVA results in Table 1, which omits compartments with unique management regimes such as the football pitch. The discussion then goes on to examine trends revealed through the ordination, which includes all the compartments covered by the survey.

To some extent, one might interpret these results in terms of a single axis of variation *i.e.* greater intensity of cutting regime from hay, through PC and Cricket to Intense. However, the regimes differ in more than simply the number of cuts per year, but also in the type of machine used, the timing of the first cut and the height at which the cutting blade is set. The management regimes are multivariate, affecting the competitive balance between species. Thus, for example, one regime might favour both species A and B, whilst another regime favours B, but reduces the abundance of species A. With these caveats, one may distinguish clear patterns in the composition of the vegetation and the abundance of individual species.

Hay: Of the 36 species that showed significant trends in relation to management, 19 were clearly commonest under a regime of hay-cutting, and a further three species (*Glechoma hederacea*, *Trifolium pratense* and *Veronica chamaedrys*) were strongly associated with this regime and one of the other management categories. Patterns in individual species are associated with trends in overall species-richness *i.e.* hay-cut compartments have markedly more species than those under other treatments (Table 1). Many of the 19 species commonest under hay cutting were tall, often coarse, grasses, and most of the remaining species are tall leafy herbs (true hemicryptophytes), though a few low-growing species (*) were also commonest here:

Alopecurus pratensis	*Dactylis glomerata*	*Lathyrus pratensis*
Anthoxanthum odoratum	*Deschampsia cespitosa*	**Primula veris*
Arrhenatherum elatius	*Elytrigia repens*	*Ranunculus acris*
**Briza media*	*Galium verum*	*Rumex acetosa*
Bromus hordeaceus	*Helictotrichon pubescens*	**Sanguisorba minor*
Centaurea nigra	*Holcus lanatus*	*Tragopogon pratensis*
Cirsium arvense		

As would be expected from the results reported in section **VI**, these 19 species are overwhelmingly associated with *NVC* vegetation types **MG1** *Arrhenatherum elatius* grassland and, to a somewhat lesser extent, **MG5** *Cynosurus cristatus-Centaurea nigra* hay meadow. Many of these species are suppressed by frequent defoliation *i.e.* grazing or many cuts per year.

Parish Council (PC): Those compartments maintained by the Parish Council are markedly more species-poor than hay-cut areas (species richness <60% that of the hayfields). Although *Arrhenatherum*, *Dactylis* and *Elytrigia* are again important in these plots, *Lolium* is also common and *Poa trivialis* is especially associated with these more frequently mown swards. Nine species are especially common in the PC compartments:

Anthriscus sylvestris	*Elytrigia repens*	*Lolium perenne*
Arrhenatherum elatius	*Glechoma hederacea*	*Poa trivialis*
Dactylis glomerata	*Lamium album*	*Urtica dioica*

In terms of plant community, these species and compartments are often intermediate between **MG1** and **MG7** *Lolium perenne* grasslands, though disturbed areas are related to the **OV23** *Lolium perenne-Dactylis glomerata* community. Several of these compartments show some zonation with more intensively mown edges by paths and roads and coarser swards under the numerous trees. Several of the species are quite shade-tolerant and occur commonly along woodland edges and hedgerows *e.g. Anthriscus*, *Glechoma*, *Lamium album*, *Poa trivialis* and *Urtica*. Hence, these compartments do not correspond especially well to named grassland types but are probably best considered as marginal, transitional types.

Cricket: The two compartments of the cricket outfield are mown frequently during the season. The species-richness is comparable to the PC compartments, and markedly poorer than both Hay and Intense areas. Although *Holcus lanatus* is also quite extensive in these grasslands, the most characteristic plants are:

Cardamine pratensis	*Leontodon autumnalis*	*Trifolium repens*
Cynosurus cristatus	*Lolium perenne*	*Veronica serpyllifolia*

Such a flora corresponds very well to the short species-poor swards of the **MG7** *Lolium perenne* and **MG6** *Lolium perenne-Cynosurus cristatus* grasslands. The very high Domin values for *Lolium* and *Trifolium repens* indicate mean covers of >40% and *ca* 20% respectively. All the species are low-growing, often mat-forming or creeping, and include rosette and semi-rosette hemicryptophytes.

Intense: The most intensively mown compartments are more species-rich than the PC and Cricket areas, but markedly poorer than the hayfields. Like the cricket outfield, *Lolium perenne* and *Trifolium repens* are common, though mean Domin values reflect much lower cover (both *ca* 10% or less). *Trifolium pratense* is frequent here and in the hayfields, but five species are especially associated with those compartments that are repeatedly mown short:

Leontodon autumnalis	*Potentilla reptans*	*Veronica chamaedrys*
Plantago media	*Prunella vulgaris*	

As noted in section **VI**, some of the sward under intense mowing fits with **MG6** or **MG7**, but the quadrats here are quite diverse reflecting the variation in detailed management. The relative species-richness of these compartments is not due to a group of "faithful" species (*i.e.* largely confined to these areas), but rather due to low frequencies of a very wide range of species that are more common individually under the other treatments.

Similar patterns can also be perceived by examination of the DCA ordination diagrams for individual quadrats (Figure 3), individual species (Fig. 4) and compartments (Fig. 5).

Distribution of the quadrats in Fig. 3 shows a relatively clear trend in relation to intensification of management from the hay fields in the bottom right of the figure through to those receiving frequent mowing on the left side of the diagram. The ordination confirms that the hayfields form a compact and consistent group, whereas the distinctions between the other treatments (PC, Cricket and Intense) are less clear.

Fig. 3 also indicates the affinities of compartments 12 and 19, whose management regimes did not fit simply into the four broad types. Despite the differences in the timing and frequency of cuts, the Crossbrook (19) quadrats appear as yet indistinguishable from compartment 2 over the road under the PC regime. Shade from surrounding trees may be a major influence on the composition, and partially explain the similarity to the PC areas (especially compartment 21) where shade is also important. The management regime on the football pitch (12) is essentially a modified form of the hayfield type, and the ordination position of the quadrats is close to those from hay-cut compartments, but shows some trend toward more intensive regimes. The football pitch is in many respects (especially visually) one of the most attractive areas of the Green. The combination of mowing and disturbance (through playing football) in winter may well provide more regeneration opportunities for grassland species, contributing to the species richness of the sward.

The species ordination (Fig. 4) serves largely to confirm the associations between management and species revealed by the ANOVA (see Table 1 and discussion above). However, the diagram does show the affinities of several species with too few data to allow significant associations to be demonstrated by ANOVA. Hence amongst the other hayfield species would appear to be *Allium vineale*, *Carex* spp (*C. flacca* and *C. caryophyllea*) and *Luzula campestris*. Indicators of overgrown and shady conditions appear at the top of the diagram where most of the Parish Council quadrats are placed *e.g. Galium aparine*, *Geum urbanum* and a few tree species. A further group of species show a strong association with the shortly mown samples on the left-hand side of the ordination *e.g. Bellis*, *Plantago major*, *Poa annua* and *Veronica arvensis*.

Finally, Fig. 5 sums up these species and quadrat patterns in terms of the compartments, and shows that the four broad management types are relatively distinct one from the other. The hay-cut compartments form a group at the bottom right of the ordination, with the related football pitch immediately to the left of this group. The parish council (**PC**) compartments are mainly in the upper right part of the ordination, again with the linked Crossbrook samples in the same area. Both **Cricket** outfield and **Intense** compartments are well to the left of the diagram, and cannot be separated.

This figure also indicates that certain compartments are rather different from those others with the same regime. Thus the **PC** area south and west of the church (compartment 1) appears to be much closer to the **Intense** compartments in overall composition, a conclusion that was suggested by the TABLEFIT analysis. Compartment 1 differs somewhat from the other parish council compartments in receiving more frequent mowing and trampling, producing vegetation more like the other repeatedly short-mown areas. The marquee site (5) also differs from other **PC** compartments, and this may be a consequence of heavier trampling throughout the year and other disturbances especially in mid-summer. Park Farm (18) appears distinct from most intensively-mown compartments, although this may be on one hand an artefact of the very small sample size (only 3 quadrats) and on the other a consequence of close cutting with a cylinder mower.

The patterns of species, quadrats and compartments on the ordination diagrams (Figs 3-5) may also be interpreted in terms of the cutting machines employed. Thus the bottom right of the ordinations includes swards cut *inter alia* with a tractor mounted reciprocating cutter-bar/rotary hay cutter, whereas the left-hand side of the diagrams is occupied by samples cut using garden rotary mowers. The intermediate zone of the ordinations includes compartments cut until 2000 with a tractor mounted flail mower, and subsequently by a ride-on rotary mower. The impact of these different machines on the sward is discussed below, but it is possible to distinguish groups of species associated with each machine type:

- Tractor mounted reciprocating cutter-bar/rotary hay cutter *e.g. Anthoxanthum odoratum, Centaurea nigra, Galium verum, Lathyrus pratensis* and *Silaum silaus.*
- Tractor mounted flail to 2000, thereafter ride-on rotary mower *e.g. Crepis capillaris, Dactylis glomerata, Holcus lanatus, Lotus corniculatus* and *Potentilla reptans*.
- Garden rotary mower *e.g. Bellis perennis, Lolium perenne, Plantago major, Poa annua, Ranunculus repens, Trifolium repens* and *Veronica serpyllifolia*.

Effects of different kinds of machine

a) Hand held and ride-on machines: height of cut can be quite precisely regulated. In a domestic "lawn" situation, the ground is usually level and a close cut (*ca* 3cm) sward achieved. Where ride-on machines are used extensively (as in Compartments 1,2,4,5,7,and 21, cut by the Parish Council, and also 19), the ground may be uneven, so that a varied height of cut may result (*i.e*. up to 10cm.).

Cylinder mowers usually cut more closely and evenly than rotary cutters, except where "bents" (e.g. stalks of *Agrostis* and *Lolium*) are present, which are dealt with more effectively by rotary mowers. Cylinder mowers require the ground to be level, and for the grass to be quite short at the first cut. They are most effective when used frequently and when the first cut is early in the year. Rotary mowers are more versatile and able to cut grass that has been allowed to grow long prior to the first cut. A cylinder mower is used for the Cricket square (Compartment 15) and either a tractor pulled cylinder gang-mower or hand operated cylinder mower for the outfield (Compartments 6 and 14), and both rotary and cylinder mowers are used by frontagers for the intensive management of the grass in front of their properties (Compartments 3,9,10 and 18, and also 21).

Grass clippings can be collected by these machines (other than ride-on cylinder gang mowers), but on those parts of the Green surveyed in 2003, mowings were collected only in compartments 3 (to 1997) and 10 (since *ca* 1970).

With any of these machines, where the ground is uneven, "scalping" (*i.e.* cutting down to bare ground) can occur, opening up the sward and thus often allowing broadleaved species and mosses to colonise.

b) Tractor mounted mowers: The effectiveness of rear-mounted cutters is influenced by the compression of vegetation by the tractor wheels, creating lines of uncut material. This does not occur with side-mounted cutters, whether at the side of the tractor or side-mounted behind.

Reciprocating cutter-bar (RCB). The traditional hay-mower, but now largely superseded for hay and amenity mowing (though still used on combine harvesters). Previously, up to about 1995, used for the hay cut (Compartments 8,11,13,16 and 17). RCB mowers cut the vegetation cleanly, but work best on upstanding uniform vegetation and level ground without obstructions. Such mowers are difficult to use in matted vegetation, and need to be sharp and well-maintained. Under suitable conditions, they can cut down to about 10cm, but in amenity and hayfield situations, the cut may be ragged and some patches of grass be missed. Long cuttings are left in swathes, which should be collected – otherwise the bulky material may suppress or kill the underlying vegetation.

Rotary hay-mowers. Cutters of various kinds on horizontal arms or discs rotate at a height of about 10cm. Once again long cuttings are left in swathes and, where floristic diversity is a consideration, should be collected. The cut is generally clean, but may be ragged on uneven ground or with matted vegetation. Now used for the hay cut compartments (see above).

Flails. Vertical blades or plates flexibly mounted on a horizontal axle rotate at high speed and macerate (rather than cut) the vegetation, leaving a mulch that breaks down quite quickly. Skilfully used on even ground, these machines can produce an even result, but the cut is often uneven, or the ground may be scalped. Flails are more versatile than either RCB or Rotary mowers and are often the only option in areas, such as sloping ground, where other mowers cannot be easily used. A flail was used for the PC cut compartments (see above) up to 2001, but this type is not now used on the Green.

VIII. Conclusions and Recommendations

Hilton Green is managed for several objectives, including sport (both cricket and football, with different requirements), amenity (tidiness and recreation), production (the hay crop) and biodiversity. This report focuses principally on biodiversity including floristic richness, presence of rare or local species and correspondence of the vegetation to grassland types of regional or national importance. In this section these parameters are discussed with reference to the other objectives.

The measurement of biodiversity

A simple inventory of species can be misleading as a measure of the effects of management on biodiversity, particularly if the data are presented simply in terms of overall species richness without regard to the particular species involved, what communities they represent and what their occurrence indicates. A site with 50 species is not *de facto* a "better" site than one with 30 species. For example, disturbance, such as the three bonfire-sites, spoil dumping and poached areas (goalmouths, paths *etc*), all add species to the Green's flora that might otherwise be absent, but are specific to disturbed sites, and most (if not all) are commonplace weeds of habitats throughout the region. Certain species, by their presence or loss, are useful indicators of the effects of management, and especially which regimes are most beneficial for the conservation of vulnerable and declining communities. Thus the loss from the Green of nationally or regionally scarce species such as Green-winged Orchid (*Orchis morio*) last recorded by Everett in 1984 and Sulphur Clover (*Trifolium ochroleucon*) last recorded by Randall (1988), may indicate subtle changes in the management of the hay cut areas (*e.g.* variation in cutting date or machine) where they used to occur. Sulphur Clover may have been a victim of a bonfire site, or possibly disturbance from travellers. The regimes applied on the Green might benefit from comparison with sites where such species do flourish in a comparably rich grassland, although such assessment should be done with care *e.g.* the Upwood Meadows NNR shares many key species with the Green at Hilton, but depends on grazing, which is not a practical option for Hilton.

Generally though, the continued presence of such species as Cuckoo-flower (*Cardamine pratensis*), Cowslip (*Primula veris*) and Adder's-tongue Fern (*Ophioglossum vulgatum*) *inter alia*, provide evidence for the sympathetic management of those areas of the Green where they occur.

Comparison of the flora of the Green with trends reported elsewhere locally (Wells 2003) or nationally (Preston *et al.* 2002) may also help inform management priorities and decisions. Probably the strongest trend in wild plants over the past 50 years has been a decline of species typical of low fertility situations (Preston *et al.* 2002*),* at least partly as a result of increased atmospheric nitrogen deposition (Stevens *et al.* 2004). There is clearly little that can be done by local managers to reverse a decline in the species of the Green as a result of atmospheric inputs. Nonetheless, acknowledging the sensitivity of such grasslands to nutrient inputs should provide the local managers with a sound reason for resisting any new disturbance or management that increases the trophic level of the soil.

Where local managers have an influence is with the cutting regimes, and one purpose of this report is to determine the best regimes for conservation of wild plants on the Green, and where desirable suggest remedial action. The three analytical approaches used (*i.e.* univariate (ANOVA) and Kruskal-Wallis, the multivariate (DCA ordinations), and the *NVC* classification (TABLEFIT) together provide a picture of management impacts on sward composition and biodiversity. The statistical glossary provides a brief outline of what these methods test and what they show. From such a body of rigorously-derived results, one may reliably make the following conclusions and recommendations.

Recommendations for future management and monitoring

The Green at Hilton is an important area of semi-natural grassland, especially in the context of a county and a region where intensive arable agriculture and urbanisation have expanded greatly over the last 100 years, largely at the expense of grasslands. Many of the species for which the Green has been renowned survive, particularly where the management has been of

low intensity hay cutting. The Green merits protected area status certainly at county level and, considering how little species-rich grassland survives in East Anglia, very probably at national level also. Protection of biodiversity should be a central objective of the management plan for the Green. Management regimes should take account of the physiology of grasses (see section **1**) in terms of frequency and time of mowing, and the impact of the effects of the various machines (see above).

- **HAY:** The **hay-cut** (compartments 8,11,13,16 and 17) regime is associated with: a) the most species-rich vegetation, b) the best representation of old grassland species (notably those typical of less fertile situations and/or more localised distributions); and c) the closest fit to those vegetation types that are nationally/internationally recognised as of biodiversity importance. The football pitch (compartment 12) represents an important variation of the hay-cut regime. It has produced a very attractive sward with *inter alia* drifts of Cowslips (*Primula veris*), and holds and complements the typical hay-meadow species of other areas of the hayfield. The removal of hay, and consequently of nutrients, is crucial to the management of these areas.
    - Retain the present area of the hayfield that is subject to the single hay cut without allowing further encroachment. If practical, extend the regime to compartments 2 and 21 currently managed by the Parish Council (see below).
    - Continue the current management of the football pitch (Compartment 12) taking into account current recreational requirements. The pitch receives a similar management regime to the other hay-cut compartments, but has also been closely-mown during the winter up to the end of March. It is important on bio-diversity criteria that this management regime should be continued.

    If circumstances were to change, variations on the current management (but with continued removal of cuttings) could include:

    - Timing of the cut. This can be altered depending on the season, but should normally not be before the beginning of July. In very occasional years, small parts of the hay-cut area should be left uncut for a whole season to encourage seeding of late-flowering species – the locations of any such areas should be varied.
    - Limited and controlled aftermath grazing of the hayfield on some parts of the Green, specifically those areas with coarser *Arrhenatherum-Elytrigia* grassland and poorer representation of meadow forbs *e.g.* the Wilderness (17). Guidance on stock type, timing and intensity might be derived from the system applied at Upwood Meadows NNR. It is recognised that grazing on the Green is not practical under current conditions, but it should be a consideration if they were to change.

- **PC:** The compartments managed by the **Parish Council** have a species-poor sward with very few features of nature conservation interest. The shade influence in some compartments of the trees is not conducive to species-rich grassland. For amenity and to encourage biodiversity, given that it is not practical to remove cuttings, it is recommended that the grass is kept short by frequent cutting, especially early in the season, and not allowed to grow more than 5 cm. By frequent cutting the overall biomass of the cuttings, and therefore the return of nutrients, may be reduced, mowing

on any occasion made easier with a more even result, and unsightly windrows of dense cuttings avoided. The additional cost would be compensated for by savings in returning two of the compartments (2 and 21) to the hayfield (see below).

- It is suggested that the more extensive open compartments 2 (south and west but not east) of the churchyard and 21 (in front of Manor Farm/The Limes) should be returned to the hayfield. Although no immediate increase in biodiversity is likely to occur, consistent management over many years will encourage the development of a more diverse flora, without necessarily affecting amenity.
- Shaded areas may be best managed for biodiversity either by introduction of shade-tolerant plants to create a woodland flora, or even allowed to revert to scrub naturally, but otherwise to be kept mown for amenity. Some old woodland plants are already present *e.g.* Goldilocks (*Ranunculus auricomus)* on other parts of the Green although not in the managed Compartments.

- **CRICKET:** The **cricket outfield** (compartments 6 and 14) is similarly species-poor, closely resembling many thousands of hectares of intensive pasture throughout the UK.
  - No change in the regime is likely because of the needs of cricket.

- **INTENSE:** The **intensively mown** areas are varied in management and in terms of their vegetation. Some of these compartments are of negligible nature conservation interest, whereas Punch's Grove (10) and the churchyard (20) have a distinctive and attractive flora.
  - Approach other private owners to adopt the Compartment 10 regime *i.e.* remove mowings (and hence strip nutrients). Try to ensure that any method that increases fertility or suppresses herbs be discouraged, especially any pesticide/herbicide treatment or application of organic or inorganic fertiliser.

Monitoring

A Programme of Monitoring should be introduced if possible, following as closely as possible the methods that were used in 2003, and at the same intensity (which was already minimal for some compartments). Any programme adopted should be robust enough to compensate for reduced recording effort, and for missing values (*i.e.* no data for particular compartments or years). Single compartments may be selected from each of the main management regimes to provide an occasional quality check on the Green. Ideally, however, a fully representative re-survey should occur with the monitoring data analysed both by ordination and by ANOVA, and any new management regime incorporated as an environmental variable. Such monitoring could be implemented as follows:

- If there is no change in the management regime of any compartment, then repeat the 2003 approach every 5-6 years ("Main Survey").
- If management alters in any compartment, monitor the sward in that area every year if possible and at least every two years between main surveys.

Introductions

In a public area such as Hilton Green, there are pressures to ***introduce cultivated or non-native plants*** such as snowdrops or daffodil cultivars. In order to conserve the natural integrity of the Green, and from a nature conservation point of view, any introductions are undesirable; but in a practical world some flexibility is needed. Recent reviews of ecological restoration (Walker *et al*. 2001) describe methods for re-creating and rehabilitating grasslands using local provenance native seed and plants, useful where the site (like Hilton Green) is some distance from a likely source of seed for natural colonisation. A policy should be established to confine introductions to such local native wild species, properly sourced and planted or sown, with the advice of a local ecology adviser and permission of the Parish Council. Any such activity should be confined to the more species-poor parts of the Green and thoroughly documented so that introductions can be distinguished from naturally occurring species.

Advice

Hilton is fortunate in having a number of people with expertise in ecology and habitat management in the village available to give advice on the management of the Green. However, this cannot be guaranteed in perpetuity and it is suggested that formal arrangements should be put in place to assure relevant management advice in the future. To that end it is recommended that the Parish Council and the Hilton Wildlife Conservation Group should make contact, where it has not been made before, with the local County and District Council ecologists, with Natural England (until recently English Nature) and with the Cambridgeshire Naturalist Trust for advice; and to research institutions at the Anglia Polytechnic and Cambridge Universities, and the Centre for Ecology and Hydrology (Monks Wood). It is important that the Parish Council should have access to the best advice and be aware of any new developments in grassland management for biodiversity, as well as any opportunities that might exist for external funding.

Acknowledgements

The survey was carried out under the auspices of the *Hilton Wildlife Conservation Group* (*HWCG*) and would not have been possible without the enthusiasm of the Chairman, Mr Bob Amos, succeeded by Mrs Julie Briggs, the committee and members. The Group provided field recorders and assistants, in spite of the majority having had little or no previous experience of the identification of grasses or of this kind of survey. The authors of the report are very grateful to members of the field team who voluntarily gave up their weekends and evenings to record the vegetation, in particular Jack and Gill Dempster, Frances Dipper and Alix Way. We also acknowledge the financial support from *HWCG* for the purchase of the Tablefit software and subsequent data input as well as the Hilton Town Trust for its contribution towards the cost of printing. Individual thanks also go to Gillian Sheail for the provision of rainfall data, to Lou King for information about the history of the Green, to Ian Bates for obtaining the Huntingdonshire District Council's aerial photograph of Hilton and to Ken Harris and Nigel Pratt for help with the text and maps respectively.

Glossary of Statistical approaches

ANOVA *i.e.* Analysis of Variance:

A method to assess, by examining variation in the data, whether observed effects are likely to be real or random.

Correspondence (in the statistical sense):

The level of agreement, determined mathematically, between individuals.

Detrended Correspondence Analysis (DCA):

A particular form of ordination suitable when very different plant communities are being examined.

Kruskal-Wallis test:

Similar in rational to ANOVA, except that rather fewer assumptions are made about the mathematical distribution of the data.

Ordination (in the statistical sense):

A graphical representation of a plant community such that species behaving similarly are plotted close together.

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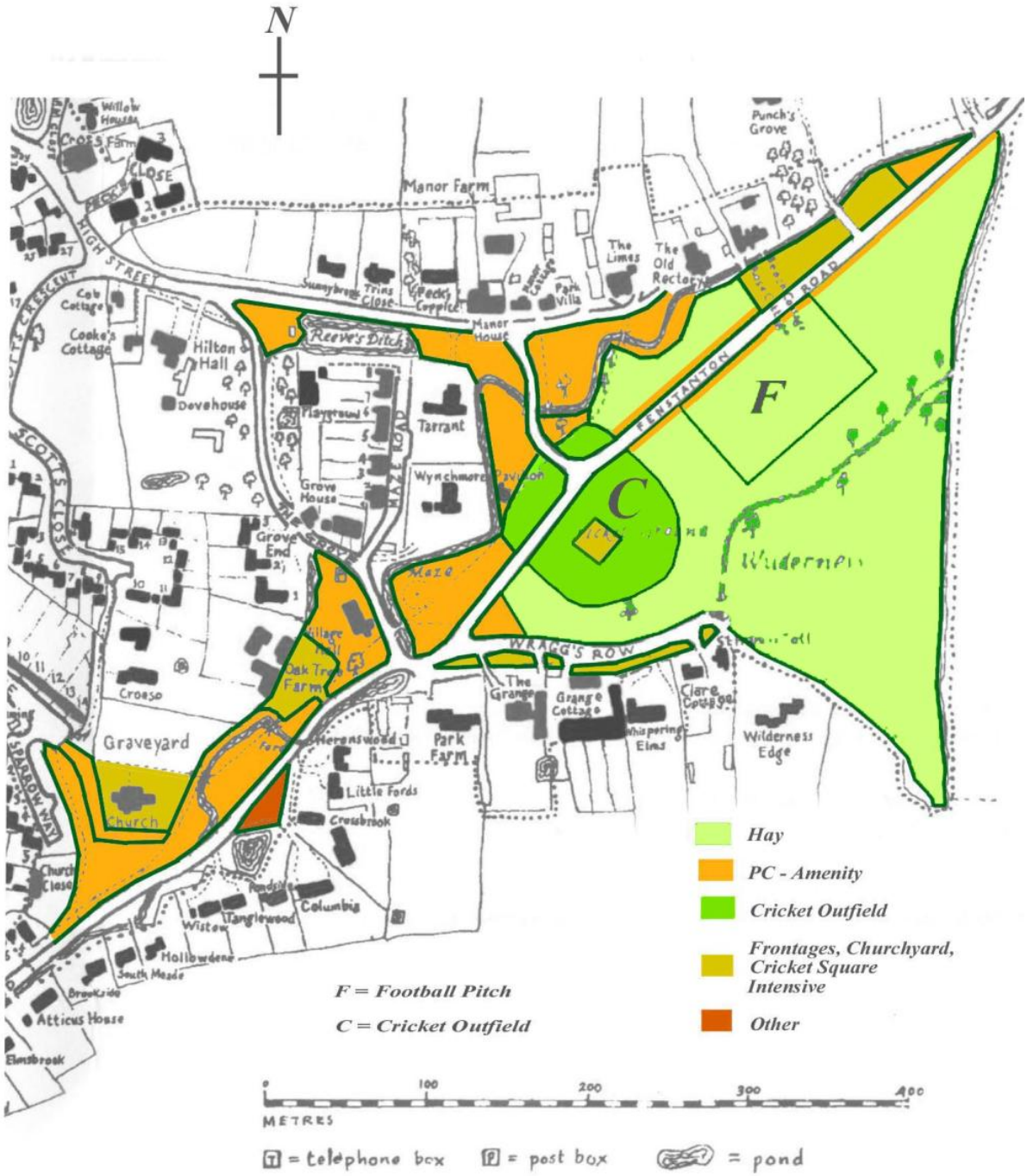
Figure 1: Hilton village map with principle roads, watercourses and location map of the Green.



Adapted from an original drawn by Richard Garnett.
Based on the Ordanace Survey.

Figure 2: Indicative map of Hilton Green showing principle land uses.

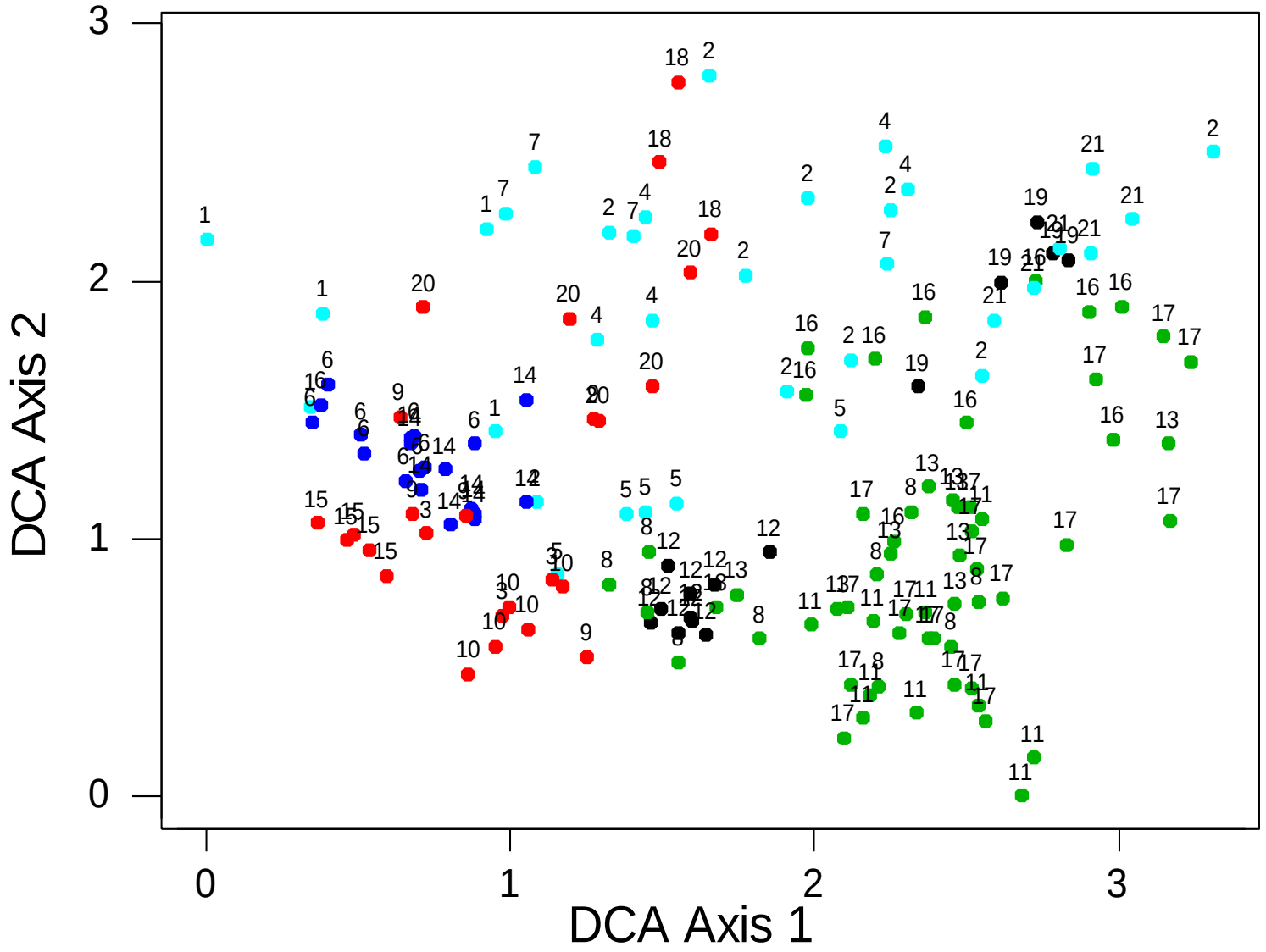


Figure 3: Hilton Green 2003. DCA Ordination of individual quadrats. Each quadrat is labelled with its compartment number and the broad management regime applied *i.e*. green = hayfield; cyan = parish council (*ca* 8 cuts); blue = cricket outfield; red = intensive mowing; and black = other regimes (Crossbrook and Football)

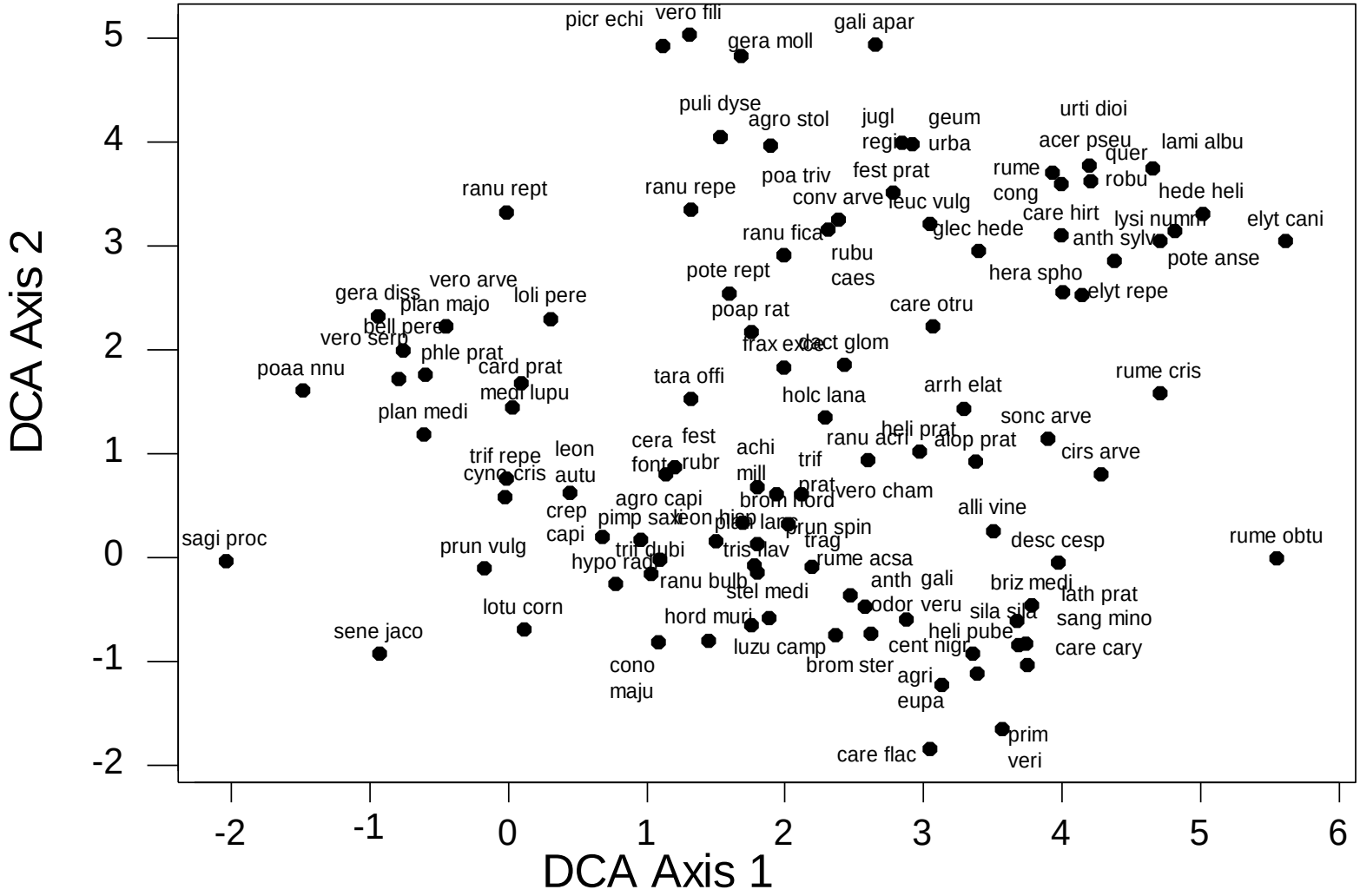


Figure 4: Hilton Green 2003. DCA Ordination of individual species. Each species is indicated by ● and an abbreviated scientific name.

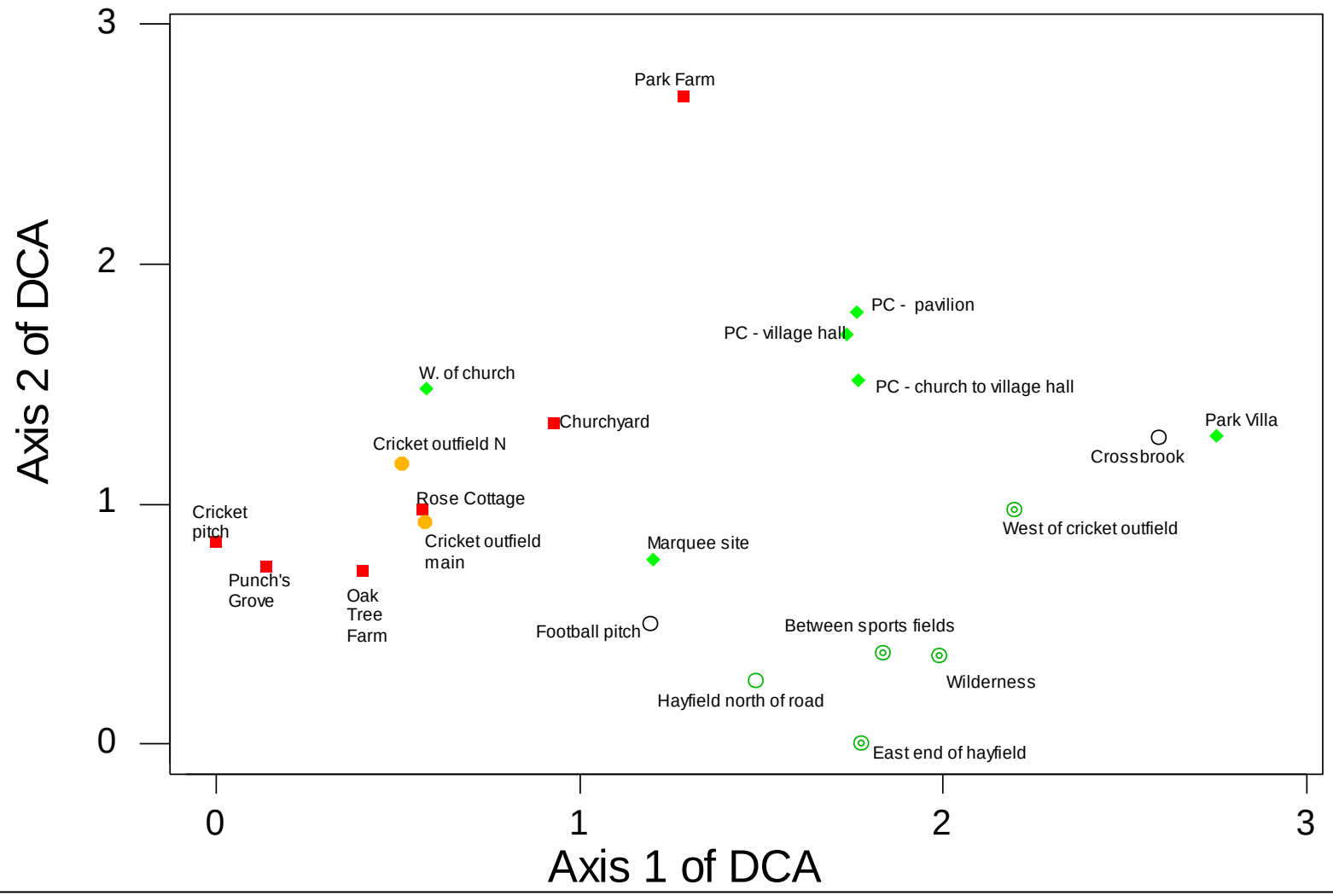


Figure 5: Hilton Green 2003. DCA Ordination based on mean Domin value of each species for each compartment (indicated by name). The broad management regime is indicated by: green circles = hayfield (mostly double empty circles, but compartment 8 a single circle – NW of Fenstanton Road); light green diamonds = parish council; ochre filled circles = cricket outfield; red squares = intensive mowing; and black empty circles = other regimes (Crossbrook and Football). Note that the "East" end of the hayfield is strictly northeast and the area "West" of the cricket outfield is strictly southwest.

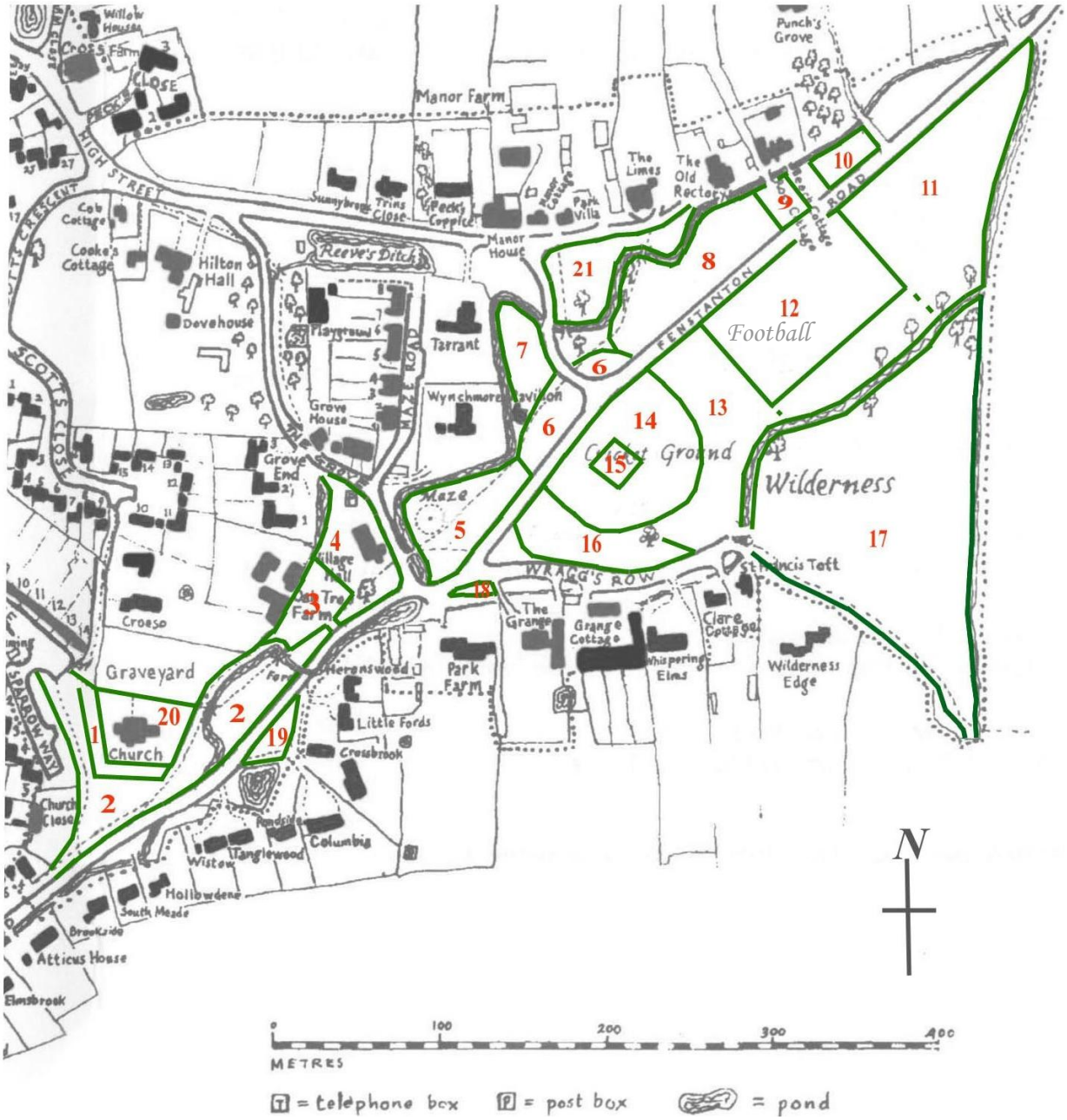
Appendix 1 Hilton Green: Management by compartment

COMPARTMENT MANAGER. LOCATION & AIM.		MACHINE. APPROX HEIGHT OF CUT & FREQUENCY.			NOTES
		2002-onwards	1996-2001	PRE 1996	
1	-H.D.C. – frequent. -S & W of church wall. -Bridle path/amenity.	-Ride-on rotary. -4.0 cm -12/year	-Ride-on rotary. -4.0 cm -12/year	-Ride-on rotary. -4.0 cm ` -12/year	Width of area has varied from 5 metres to 6 metres.
2	-P.C. – occasional. -S. E. & W. of church. -Amenity & biodiversity.	-Ride-on rotary. -7.5 – 10.0 cm -8/year	-Flail. -Uneven to 10.0 cm. -5/year	-Flail. -Uneven to 10.0 cm. -Frequency according to growth.	Area east of churchyard heavily shaded by large trees. Pre 1996 cut by local farm staff.
3	-Private – intense. -Oak Tree Farm. -Amenity	-Hand rotary -2.5 cm -1/week in season.	-Hand rotary -2.5 cm -1/week in season.	-Cylinder mower. -2.5 -1/week in season.	Close cut for at least 30 years. Cuttings removed pre- 1998.
4	-P.C. – occasional. -Village hall surrounds. -Amenity.	-Ride-on rotary. -7.5 – 10.0 cm -8/year.	-Flail. -Uneven to 10.0 cm. -5/year.	-Flail. -Uneven to 10.0 cm. -5/year.	Part of area immediately to west of village hall subject to extra cuts for fetes etc. As 5,7,21. Pre 1996 cut by local farm staff.
5	-P.C. –occasional. -From maze and brow to Holm Oak. -Amenity.	-Ride-on rotary. -7.5 – 10.0 cm -8/year	-Flail. -Uneven to 10.0 cm. -5/year.	-Flail. -Uneven to 10.0 cm. -Frequency according to growth.	Feast week marquee site trampled in late July. 1-2 additional slightly shorter cuts in mid July. As 4,7,21 Pre 1996 cut by local farm staff.
6	-Cricket club – frequent. -Outfield in front of pavilion. -Cricket.	-Tractor cylinder gang mower. -2.5 – 4.0 cm -As required for cricket matches about every 10 days in season.	-Rotary or cylinder mower. -2.5 - 4.0 cm. -As required for cricket matches about every 10 days in season.	-Rotary or cylinder mower. -2.5 - 4.0 cm. -As required for cricket matches about every 10 days in season.	Generally close sward with additional cuts if needed before cricket matches. Continuous management since 1947. As 14
7	-P.C. – occasional. -North of cricket pavilion. -Amenity.	-Ride-on rotary. -7.5 – 10.0cm -8/year.	-Flail. -Uneven to 10.0 cm. -5/year.	-Flail. -Uneven to 10.0 cm. -5/year.	About half of area heavily shaded by trees. As 4,5,21 Pre 1996 cut by local farm staff.

8	-Farmer. -Hay meadow NW of road. -Hay crop.	-Rotary hay mower. -7.5-10.0 cm. -1 x mid June for hay.	-Rotary hay mower. -7.5-10.0 cm. -1 x mid June for hay.	- Prior to 1995 reciprocating cutter bar. 1995 and onwards, rotary hay mower. -7.5-10.0 cm. -1 x July for hay.	Hay crop removed since 1952. Parts affected by pathways and car parking. Mostly dry. As 11,13,16,17
9	-Private – intense. -Rose Cottage. -Amenity.	-Hand rotary. -2.5 cm -1/week in season. c. 30/year.	-Hand rotary. -2.5 cm -1/week in season. c. 30/year.	-Hand rotary. -2.5 cm -1/week in season. c. 30/year.	Continuous for at least 30 years. Cuttings left.
10	-Private - intense -Punch's Grove. -Amenity.	-Ride-on rotary. -2.5 cm. -1/week in season. c. 30/year.	-Ride-on rotary. -2.5 cm. -1/week in season. c. 30/year.	-Ride-on rotary. -2.5 cm. -1/week in season. c. 30/year.	Continuous for at least 30 years. Cuttings removed.
11	-Farmer. -Hay meadow at NE end of Green. -Hay crop.	As 8,13,16,17	As 8,13,16,17	As 8,13,16,17	Hay crop removed since 1950. Some parts wetter than others. Largely undisturbed.
12	-P.C./Farmer/Football club. -Football pitch. -Hay crop/winter football/biodiversity.	A. Football -Tractor cylinder gang mower Sept-March. -5.0 cm. -3 x + additional cuts for football matches. B. -Hay as 8,11,13,16,17.	A. Football -Overwinter to March for football matches. -5.0 cm. -3 x + additional cuts for football matches. B. -Hay as 8,11,13,16,17.	A. Football -Overwinter to March for football matches. -5.0 cm. -3 x + additional cuts for football matches. B. -Hay as 8,11,13,16,17.	Programme varied widely over the years. No football in 2000 and only infrequently since. Management plan now requires a slightly reduced overwinter cutting regime to maintain biodiversity, whether football is played or not.
13	-Farmer. -Hay meadow between football and cricket pitches. -Hay crop.	As 8,11,16,17.	As 8,11,16,17.	As 8,11,16,17.	Hay crop removed since 1950. Largely undisturbed. Some wetter parts.
14	-Cricket club – frequent. -Cricket outfield. -Cricket.	As 6	As 6	As 6	

15	-Cricket club - intense. -Cricket square. -Playing surface.	-Cylinder mower. -1.5-2.0 cm. -1 x or 2 x per week in season depending on matches.	-Cylinder mower. -1.5-2.0 cm. -1 x or 2 x per week in season depending on matches.	-Cylinder mower. -1.5-2.0 cm. -1 x or 2 x per week in season depending on matches.	Sward killed off, ground cultivated and re-sown in 1994. Subsequent fertiliser applications and other management. Cuttings removed.
16	-Farmer. -Hay meadow between area 14 and Wragg's Row. -Hay crop.	As 8,11,13,17.	As 8,11,13,17.	As 8,11,13,17.	Recently reduced by expansion of cricket outfield (14) and amenity cutting. Some wetter parts. Footpath crosses.
17	-Farmer. -The Wilderness. -Hay crop	As 8,11,13,16.	As 8,11,13,16.	As 8,11,13,16.	NW side shaded by trees. Local disturbance by traveller's vehicles. 3 bonfire sites.
18	-Private – intense. -Park Farm. -Amenity.	-Ride-on cylinder gang mower. -2.5 cm -1/week in season.	-Ride-on cylinder gang mower. -2.5 cm -1/week in season.	-Ride-on cylinder gang mower. -2.5 cm -1/week in season.	Continuous for about 30 years. Cuttings left.
19	-Private - experimental. -Crossbrook. -Amenity and biodiversity.	-Ride-on rotary mower. -6.0cm. -March-May x 4 Sept-Oct x 2	-Ride-on rotary mower. -6.0cm. -March-May x 4 Sept-Oct x 2	-(Ride-on) rotary mower. -6.0cm. -March-May x 4 Sept-Oct x 2	Early spring and late autumn cutting to encourage summer flowering species. Continuous for about 30 years. Cuttings left.
20	-P.C.C. – frequent. -Southern half of Churchyard. -Amenity.	-Ride-on rotary mower. -2.5cm. -Frequent cutting about 15/year.	-Ride-on rotary mower. -2.5cm. -Frequent cutting about 15/year.	-Ride-on rotary mower. -2.5cm. -Frequent cutting about 15/year.	Continuous over many years. Few gravestones. Cuttings left.
21	-P.C. – occasional. -In front of Park Villa/The Limes to the ditch. -Amenity/biodiversity.	-Ride-on rotary. -7.5 – 10.0cm -8/year.	-Flail. -Uneven to 10.0 cm. -5/year.	-Flail. -Uneven to 10.0 cm. -5/year.	Mainly open but some shading to south east. Some reseeding opposite The Limes. As 4,5,7 Pre 1996 cut by local farm staff. Cuttings left.

H.D.C. = Huntingdon District Council. P.C. = Hilton Parish Council. P.C.C. = Parochial Church Council.
All cutting heights approximate; frequency (except hay) varies from year to year according to growth



Adapted from an original drawn by Richard Garnett.
Based on the Ordanace Survey.

Appendix 2. Indicative map of Hilton Green with compartment outlines and numbering for the 2003 survey

Appendix 3: Hilton Green compartments: numbers, names, sampling intensity, area and broad management regime

Compartment number	Compartment Name	Number of quadrats	Approx. area (m^2)	Regime type
1	Outside churchyard (OCCC)	5	544	E
2	S, W & E of church (SWEC)	10	2481	E
3	Oak Tree Farm (OTF)	3	309	G
4	Village Hall surrounds (VHS)	5	1383	E
5	Feast Week marquee (FWM)	5	1227	E
6	Cricket outfield near pavilion (CONP)	10	1986	F
7	North of cricket pavilion (NCP) - ex **7a**	4	992	E
8	Hayfield NW of Fenstanton Road (HNFR)	10	4567	A
9	Rose Cottage (RC)	5	347	G
10	Outside Punch's Grove (OPG)	5	1739	G
11	NE of hayfield (NEH)	10	8362	A
12	Football Pitch (FP)	10	7700	C
13	Between football and cricket fields (BFCF)	10	1749	A
14	Cricket outfield (CO)	10	4275	F
15	Cricket pitch (CP)	5	525	G
16	SW of cricket outfield (SWCO)	10	3263	A
17	Wilderness (W)	20	12377	A
18	Outside Park Farm (OPF)	3	73	G
19	Outside Crossbrook (OC)	5	503	D
20	Southern half of churchyard (SHC)	5	742	G
21	In front of Park Villa (FPV) – ex **7b**	6	1993	E

Appendix 4: Recording proforma

HILTON GREEN QUADRAT RECORD

Compartment Name			
Recorder(s)		**Date of record**	
Management regime (general description)			
Mown?	**Yes/No**	**Machine type**	
Frequency of mowing (cuts per year)		**Date of first mowing**	
For how many years has present management applied?			
What was previous management?			

General GPS Location (relevant to all quadrats on this sheet)……...

	Quadrat numbers									
Detailed GPS Location										

OTHER SPECIES OBSERVED

Species	**Tablefit Code**	**Quadrat numbers**									

Appendix 4 – continued. MAJOR HILTON GREEN GRASSLAND SPECIES

Species	Tablefit Code	Quadrat numbers									
Agrostis capillaris (Fine Bent-grass)	Agro capi										
Alopecurus pratensis (Meadow Foxtail)	Alop prat										
Anthoxanthum odoratum (Sweet V-g)	Anth odor										
Bromus hordeaceus s.l. (Soft Brome)	Brom hord										
Cynosurus cristatus (Dog's-tail)	Cyno cris										
Dactylis glomerata (Cock's-foot)	Dact glom										
Deschampsia cespitosa (Tufted Hair-g.)	Desc cesp										
Elytrigia repens (Couch)	Elyt repe										
Festuca rubra (Red Fescue)	Fest rubr										
Holcus lanatus (Yorkshire-fog)	Holc lana										
Lolium perenne (Rye-grass)	Loli pere										
Poa pratensis s.l. (Smooth Meadow-g.)	Poa prat										
Luzula campestris (Field Woodrush)	Luzu camp										
Achillea millefolium (Yarrow)	Achi mill										
Allium vineale (Crow Garlic)	Alli vine										
Anthriscus sylvestris (Cow Parsley)	Anth sylv										
Bellis perennis (Daisy)	Bell pere										
Centaurea nigra (Lesser Knapweed)	Cent nigr										
Cerastium fontanum (Mouse-ear)	Cera font										
Cirsium arvense (Creeping Thistle)	Cirs arve										
Galium verum (Lady's Bedstraw)	Gali veru										
Glechoma hederacea (Ground-ivy)	Glec hede										
Heracleum sphondylium (Hogweed)	Hera spho										
Hypochoeris radicata (Cat's-ear)	Hypo radi										
Lathyrus pratensis (Meadow Pea)	Lath prat										
Lotus corniculatus (Birdsfoot-trefoil)	Lotu corn										
Plantago lanceolata (Ribwort Plantain)	Plan lanc										
Plantago media (Hoary Plantain)	Plan medi										
Primula veris (Cowslip)	Prim veri										
Ranunculus acris (Meadow Buttercup)	Ranu acri										
Ranunculus bulbosus (Bulbous B.)	Ranu bulb										
Ranunculus ficaria (Lesser Celandine)	Ranu fica										
Rumex acetosa (Common Sorrel)	Rume acsa										
Taraxacum spp. (Dandelion)	Tara offi										
Tragopogon pratensis (Goat's-beard)	Trag prat										
Trifolium pratense (Red Clover)	Trif prat										
Trifolium repens (White Clover)	Trif repe										
Veronica chamaedrys (Birdseye S.)	Vero cham										

Appendix 5: Explanation of Domin scale

Value	Domin
+	1 individual, with no measurable cover
1	No more than 1% cover with few individuals
2	<4% cover with several individuals
3	<4% cover with many individuals
4	4-10% cover4
5	11-25% cover
6	26-33% cover
7	34-50% cover
8	51-75% cover
9	76-90% cover
10	91-100% cover

Appendix 6. Species List of All Plants Recorded within Quadrats of the Survey

Acer pseudoplatanus	Sycamore
Achillea millefolium	Yarrow or Milfoil
Agrimonia eupatoria	Agrimony
Agrostis capillaris	Common Bent
Agrostis stolonifera	Creeping Bent
Allium vineale	Wild Onion or Crow garlic
Alopecurus pratensis	Meadow Foxtail
Anisantha sterilis	Barren Brome
Anthoxanthum odoratum	Sweet Vernal-grass
Anthriscus sylvestris	Cow Parsley, Keck or Queen Anne's Lace
Arrhenatherum elatius	False Oat-grass
Bellis perennis	Daisy
Briza media	Quaking Grass
Bromus hordeaceus	Soft Brome or Lop-grass
Cardamine pratensis	Cuckoo-flower, Lady's-smock or Milkmaids
Carex caryophyllea	Spring Sedge
Carex flacca	Glaucous Sedge
Carex hirta	Hairy Sedge
Carex otrubae	False Fox-sedge
Centaurea nigra	Hardheads or Common/Lesser Knapweed
Cerastium fontanum	Common Mouse-ear
Cirsium arvense	Creeping Thistle
Conopodium majus	Pignut or Earthnut
Convolvulus arvensis	Field Bindweed
Crepis capillaris	Smooth Hawk's-beard
Cynosurus cristatus	Crested Dog's-tail
Dactylis glomerata	Cock's-foot
Deschampsia cespitosa	Tufted Hair-grass or Hassocks
Elymus caninus	Bearded Couch
Elytrigia repens	Common Couch
Festuca pratensis	Meadow Fescue
Festuca rubra	Red Fescue
Fraxinus excelsior	Ash
Galium aparine	Cleavers or Goosegrass
Galium verum	Lady's Bedstraw
Geranium dissectum	Cut-leaved Crane's-bill
Geranium molle	Dove's-foot Crane's-bill
Geum urbanum	Herb Benet or Wood Avens
Glechoma hederacea	Ground-ivy
Hedera helix	Ivy
Helictotrichon pratense	Meadow Oat-grass
Helictotrichon pubescens	Downy Oat-grass
Heracleum sphondylium	Hogweed or Cow Parsnip
Holcus lanatus	Yorkshire Fog
Hordeum murinum	Wall Barley
Hypochaeris radicata	Common Cat's-ear
Juglans regia	Walnut
Lamium album	White Dead-nettle
Lathyrus pratensis	Meadow Pea/Vetchling
Leontodon autumnalis	Autumnal Hawkbit
Leontodon hispidus	Hairy/Rough Hawkbit
Leucanthemum vulgare	Oxeye Daisy, Moon Daisy, Dog Daisy or Marguerite

Appendix 6. Species List (continued)

Lolium perenne	Perennial Rye-grass
Lotus corniculatus	Common Bird's-foot-trefoil or Lady's-fingers
Luzula campestris	Field Woodrush or Good Friday Grass
Lysimachia nummularia	Creeping Jenny or Herb-Twopence
Medicago lupulina	Black Medick
Phleum pratense	Timothy or Cat's-tail
Picris echioides	Bristly Oxtongue
Pimpinella saxifraga	Common Burnet-saxifrage
Plantago lanceolata	Ribwort Plantain
Plantago major	Hoary Plantain
Plantago media	Greater or Rat's-tail Plantain
Poa annua	Annual Meadow-grass
Poa pratensis	Smooth Meadow-grass
Poa trivialis	Rough Meadow-grass
Potentilla anserina	Silverweed
Potentilla reptans	Creeping Cinquefoil
Primula veris	Cowslip
Prunella vulgaris	Self-heal
Prunus spinosa	Blackthorn
Pulicaris dysenterica	Common Fleabane
Quercus robur	Pedunculate (or English) Oak
Ranunculus acris	Meadow Buttercup
Ranunculus bulbosus	Bulbous Buttercup
Ranunculus ficaria	Lesser Celandine
Ranunculus repens	Creeping Buttercup
Rubus caesius	Dewberry
Rumex acetosa	Common Sorrel
Rumex conglomeratus	Clustered Dock
Rumex crispus	Curled Dock
Rumex obtusifolius	Broad-leaved Dock
Sagina procumbens	Mossy/Procumbent Pearlwort
Sanguisorba minor	Salad Burnet
Senecio jacobaea	Common Ragwort
Silaum silaus	Pepper-saxifrage
Sonchus arvensis	Corn/Field/Perennial Sow-thistle
Stellaria media	Common Chickweed
Taraxacum officinale s.l.	Dandelion
Tragopogon pratensis	Goat's-beard or Jack-go-to-bed-at-noon
Trifolium dubium	Lesser Trefoil
Trifolium pratense	Red Clover
Trifolium repens	White Clover
Trisetum flavescens	Yellow Oat-grass
Urtica dioica	Stinging Nettle
Veronica arvensis	Wall Speedwell
Veronica chamaedrys	Bird's-eye Speedwell or Germander Speedwell
Veronica filiformis	Slender Speedwell
Veronica serpyllifolia	Thyme-leaved Speedwell

Appendix 7: Vegetation types (communities and sub-communities) of the *National Vegetation Classification* (Rodwell 1991-2000) identified on Hilton Green with TABLEFIT goodness-of-fit values of >50.

Notes: The presence of certain communities in the TABLEFIT output (indicated * below) must be considered an artefact of the analytical approach, and does not suggest that sea-cliffs, sand-dunes, saltmarshes and limestone dales are a feature of Hilton Green! In most cases, such results reflect a situation where a likely community (*e.g.* **MG** type) and a highly unlikely community (*e.g.* **MC** or **SD** type) cannot be adequately distinguished based upon the species present. Also at a site like the Green with its wide variety of management regimes and disturbance, combinations of species occur that do not correspond well with any typical community of the region, but come closest to grassland types that occur by the sea or in the hills.

MC: "maritime cliff" *i.e.* plant mixtures normally occurring in turf on sea-cliffs (see caveat above)
MG: "mesotrophic grasslands" *i.e.* neutral grasslands etc.
OV: "other vegetation" *i.e.* open, often weedy, disturbed habitats
SD: "sand dune" *i.e.* plant mixtures typically found on dunes and the slacks between them (see caveat above)
SM: "saltmarsh" *i.e.* plant mixtures typical of brackish or saline sites (see caveat above)
U: "upland" communities *i.e.* grasslands typical of acid soils or sub-montane sites.
W: "woodland and scrub" *i.e.* habitats dominated by woody plants, including brambles and other underscrub.

***MC9** *Festuca rubra-Holcus lanatus* maritime grassland
- ***MC9c** *Achillea millefolium* sub-community
- ***MC9e** *Anthoxanthum odoratum* sub-community

MG1 *Arrhenatherum elatius* grassland
- **MG1a** *Festuca rubra* sub-community
- **MG1b** *Urtica dioica* sub-community
- **MG1c** *Filipendula ulmaria* sub-community
- **MG1d** *Pastinaca sativa* sub-community
- **MG1e** *Centaurea nigra* sub-community

***MG3** *Anthoxanthum odoratum-Geranium sylvaticum* grassland
- ***MG3b** *Briza media* sub-community

MG5 *Cynosurus cristatus-Centaurea nigra* grassland
- **MG5a** *Lathyrus pratensis* sub-community
- **MG5b** *Galium verum* sub-community

MG6 *Lolium perenne-Cynosurus cristatus* grassland
- **MG6a** Typical sub-community
- **MG6b** *Anthoxanthum odoratum* sub-community
- **MG6c** *Trisetum flavescens* sub-community

MG7 *Lolium perenne* leys and related grasslands
- **MG7a** *Lolium perenne-Trifolium repens* leys
- **MG7b** *Lolium perenne-Poa trivialis* leys
- **MG7c** *Lolium perenne-Alopecurus pratensis-Festuca pratensis* grassland
- **MG7d** *Lolium perenne-Alopecurus pratensis* grassland
- **MG7e** *Lolio-Plantaginetum*
- **MG7f** *Poo-Lolietum perennis*

MG8 *Cynosurus cristatus-Caltha palustris* grassland

MG9 *Holcus lanatus-Deschampsia cespitosa* grassland
- **MG9a** *Poa trivialis* sub-community
- **MG9b** *Arrhenatherum elatius* sub-community

MG10 *Holcus lanatus-Juncus effusus* rush-pasture
- **MG10b** *Juncus inflexus* sub-community

MG11 *Festuca rubra-Agrostis stolonifera-Potentilla anserina* grassland
- **MG11a** *Lolium perenne* sub-community

Appendix 7: (continued)

OV10		*Poa annua-Senecio vulgaris* community
	OV10d	*Dactylis glomerata-Agrostis capillaris* sub-community
OV22		*Poa annua-Taraxacum officinale* community
	OV22b	*Cirsium vulgare-Cirsium arvense* sub-community
OV23		*Lolium perenne-Dactylis glomerata* community
	OV23a	Typical sub-community
	OV23b	*Crepis vesicaria-Rumex obtusifolius* sub-community
	OV23c	*Plantago major-Trifolium repens* sub-community
	OV23d	*Arrhenatherum elatius-Medicago lupulina* sub-community
OV25		*Urtica dioica-Cirsium arvense* community
	OV25b	*Rumex obtusifolius-Artemisia vulgaris* sub-community
	OV25c	*Lolium perenne-Papaver rhoeas* sub-community
***SD8**		*Festuca rubra-Galium verum* fixed dune grassland
	***SD8a**	Typical sub-community
	***SD8b**	*Luzula campestris* sub-community
***SM16**		*Festuca rubra* saltmarsh community
	SM16d	Sub-community with tall *Festuca rubra* dominant
U1		*Festuca ovina-Agrostis capillaris-Rumex acetosella* grassland
	U1f	*Hypochaeris radicata* sub-community
U4		*Festuca ovina-Agrostis capillaris-Galium saxatile* grassland
	U4b	*Holcus lanatus-Trifolium repens* sub-community
W24		*Rubus fruticosus-Holcus lanatus* underscrub
	W24b	*Arrhenatherum elatius-Heracleum sphondylium* sub-community