Community	Description	Habitat conditions
M6 *Carex echinata-Sphagnum recurvum/auriculatum* mire	Characterised by the dominance of small sedges or rushes over a carpet of *Sphagna*, but very heterogenous in nature and reflected by range of species density (3-49 spp 4 m^{-2})	Wide range water levels and base status reflecting wide distribution of the community. Mean Fe and Al concentrations were high. There was a negative relationship between Fe concentration and species richness for the community as a whole. Fertilities variable, but no higher than moderate.
M6a *Carex echinata* sub-community	Typically dominated by a mixture of sedges (commonly *C. echinata*), over a carpet of *Sphagna*. Mean species density PFS score was high, though RFS scores were low.	Typically found under conditions of low base status, although mean concentrations of bicarbonate and Ca were relatively high in relation to other poor fens. Water levels were at or near the surface. Fertilities were moderate to low.
M6b *Carex nigra-Nardus stricta* sub-community (NB. only a few samples examined)	Mean species density values were high. PFS scores moderate and RFS scores were low.	Recorded from conditions similar to those of M6a, but within generally smaller ranges and extending into slightly drier and more fertile substrata.
M6c *Juncus effusus* sub-community	Dominated by *J. effusus* set in a carpet of *Sphagnum*, most typically *S. recurvum*, with only a few associated poor fen species. Generally species poor with species density lower than the other 3 sub-communities.	Generally found in the most base-poor and Fe-rich situations of the 4 sub-communities and water levels are often above the surface. Generally found in moderately fertile situations.
M6d *Juncus acutiflorus* sub-community	Dominated by *J. acutiflorus* over a carpet of *Sphagnum* and often accompanied by *Molinia*. Mean species density was moderate but variable.	Mean water levels were moderate. The range of base-status was the widest of the four sub-communities and base enrichment was significantly positively related to species density, PFS and RFS scores associated with generally lower fertility substrata than the other three sub-communities.
M10 *Carex dioica-Pinguicula vulgaris* mire	Mostly low-growing vegetation, typically dominated by short sedges, including *Schoenus nigricans* at some sites. *Molinia* may be important and there may be an extensive bryophyte component. Mean species richness was very high, similar to M13 and the same applies to RFS and PFS scores.	Found in base rich sites, though less base-rich than M13. An increase in base status is associated with an increase in rare fen species. Water level was moderate and the variance lower than that found for M13. Fertilities were low, similar to M13. Analysis showed that base richness, substrate fertility and P concentration have a significant effect of the community floristics.
M10a *Carex demissa-Juncus bulbosus/kochii* sub-community	Comprises the less calcicolous kind of M10 as shown by the decrease in the more calcicolous herbs and increase of *Carex demissa, C. echinata, E. tetralix*. PFS, RFS scores were the highest of all the sub-communities examined, though not significantly different to the scores of M10b.	Water levels were moderate, slightly less than M10b. Found under lower base status conditions than M10b, and an increase in base status was related to an increase in species richness, particularly RFS score. Fertility values were variable and the mean value was slightly less than M10b.
M10b *Briza media-Primula farinosa* sub-community	Has a greater calcicolous component than M10a. Species richness ranged from moderate to extremely high and individual RFS scores can be very high.	Mean water level was moderate. pH, HCO_3 and Ca values are high and there was a significant, negative relationship between species richness and base status. Mean fertilities slightly higher than M10b and similar to M13 values.
M13 *Schoenus nigricans-Juncus subnodulosus* mire	Often characterised by a dominance of *Schoenus nigricans, J. subnodulosus* with a wide range of characteristic low-growing associates. *Phragmites, Molinia* and *Cladium* may be important. The community has high species richness, PFS and RFS scores.	Mean water levels were moderate, similar to M10 and M22. Low water table levels were not necessarily associated with low species richness, but there was a tendency for sites with lowest water table to have fewer RFS. Mean pH, HCO_3 Ca values were high, but there was variability suggesting that extreme base-richness *per se* may not be a pre-requisite for the development of the community. Mean values of fertility were low, similar to M10, but far less than those of M22. There was a significant increase in fertility with an increase in P concentration. There was a significant positive correlation between species density and soil fertility. This is because a modest increase in fertility permits the greater occurrence of fen meadow and other species, whilst not eliminating most typical *Schoeno-Juncetum* species. Fertility is very important in determining floristic variation.
M13a *Festuca rubra-Juncus acutiflorus* sub-community	Comprises the more impoverished stands of the M13 and whilst species densities may be very high, mean PFS and RPFS scores were less than those for M13b and M13c.	Water levels were moderate and there was no obvious relationship between water levels of individual sites and species richness or PFS scores. Fertilities were low, similar to M13c, but slightly higher than M13b.
M13b *Briza media-Pinguicula vulgaris* sub-community	Usually dominated by *Schoenus, J. subnodulosus* and/or *Molinia*, with a distinctive small herb component. There are strong floristic links with M10. Very species-rich with a high RFS score.	Water levels were variable but the mean value was the lowest of all M13 sub-communities. Mean fertility was lowest of all the M13 sub-communities. Fertility levels were related to P concentration and there was a negative relationship between the number of rare fen species and P concentration.

M13c *Caltha palustris* and *Galium uliginosum* sub-community	The usually dominants are still important but they may be augmented by *Cladium, C. rostrata, C. diandra* or *Phragmites*. Species richness, PFS and RFS values are high, the latter significantly higher than M13a.	pH, NCO_3 and Ca values are very high or extremely high and mean water level was the highest for all the sub-communities. Mean fertilities were similar to M13a, but less than M13b.
M14 *Schoenus nigricans-Narthecium ossifragum* mire	The vegetation is dominated by *Schoenus* but is less species rich than M13 and *Sphagna* are more prominent, though the brown masses may also be frequent. Mean species density and PFS scores were moderate, but RFS scores were high.	Water levels were typically supra-surface and redox values were high. Mean pH, HCO_3 and Ca values were high or very high and higher than other poor fen communities. Found in low fertility situations and though N values could be high, P values were always low. There was a trend for an increase in species density and RFS score with increasing substrate fertility. The substrate also had high Fe, Mn and Al concentrations. The community clearly occupies an intermediate position with respect to M21 and M13 floristically and in terms of base status. Measured environmental variables are sufficient to explain the major variation amongst stands with ionic strength, base status and fertility being particularly influential.
M14a Typical sub-community	Mean species richness was moderate (21.7 spp 4 m^{-2}) compared to a mean of 32.5 spp 4 m^{-2} for M13 and 17.9 spp 4 m^{-2} for M21.	pH, bicarbonate and Ca concentrations were respectively moderate, moderate and low. There was a significant positive relationship between species density and Ca concentration. Mean water levels were invariable supra-surface (+ 2.5 cm). Generally found in situations of low to moderate fertility. There was a trend for an increase in species diversity and substrata fertility.
M14b Provisional sub-community	This sub-community is found where base enrichment has ameliorated the extreme conditions of blanket mire. *Schoenus* is prominent and often accompanied by *C. lasiocarpa*. In places, it comes close to M15a but ordination showed that floristic affinities with M14. Species density was high (mean of 27 spp 4 m^{-2}).	Water levels had a narrow range (-0.2 - +4.4 cm) and with high redox potentials. Base richness was less than M14a. Found on low fertility substrates with low concentrations of P and K moderating the influence of high N (found in N Scotland).

M15 *Scirpus cespitosus-Erica tetralix* wet heath (M15a *Carex panicea* sub-community)	M15a is commonly found in soakways or water tracks, and could be described as poor fen. Mean species density was high (24 spp 4 m^{-2}) and the PFS and RFS scores were moderate.	Frequently occupy a narrow range of water level (-10 - + 2 cm), but an increase in water levels is associated with a decrease in species density. Redox values were low, significantly lower than M6, M21 and M14. Mean pH, HCO_3 and Ca concentrations were low or very low, but pH substratum was moderate. All were higher than might be expected for blanket bog or typical wet heath. Found on substrata of low fertility, low or moderate concentrations of P and K, though N could be high. Substrate fertility was positively related to concentration of K and P.
M21 *Narthecium ossifragum-Sphagnum papillosum* valley mire	Mire vegetation dominated by carpets of *Sphagna* (typically *S. papillosum*) with scattered herbs and sub-shrubs, but infrequent small sedges and rushes. There can be a wide range of species density with a moderate mean of 17.9 spp 4 m^{-2}.	Mean water level was sub-surface (-1.8 cm) but was biased by low values recorded during a period of drought (1989). There was a significant negative relationship between water table height and substratum fertility, and a positive relationship with P. Fertility was overall low and was significantly, positively related to base-richness, N and Mn concentrations. Higher fertility (and associated Ca) was associated with the occurrence of more calcicoles eg *Campylium stellatum, Scorpidium scorpiodes* and *Schoenus*. There is a good separation of sub-communities on the basis of measured variables and there is a trend for M21a stands to be associated with conditions of higher water levels, lower Ca and fertility than M21b.
M21a *Rhyncospora alba-Sphagnum auriculatum* sub-community	*R. alba* and *Myrica gale* are preferential here. Mean species density, and PFS score were slightly lower than M21b, but RFS score higher, though the differences were not significant.	Water levels were supra-surface and significantly higher than M21b. Though base richness was largely typical of the community, ranges are generally smaller. Base enrichment was significantly related to an increase in species density, PFS and RFS scores. Fertility levels are typical of the community, though N values are generally lower than M21b.

M21b	*Vaccinium oxycoccus-Sphagnum recurvum* sub-community	*S. recurvum* is preferential here with other species eg *C. echinata, C. panicea* and *Succisa pratensis*. There was no significant difference in species density between the two sub-communities but the mean value was slightly higher than for M21a.	Mean water level was significantly lower than for M21a and redox potentials reached lower levels, indicating less dependence on soligenous input of water. Base richness was generally typical and an increase was related to an increase in species richness. Generally associated with infertile situations N values could be high. The higher fertility sites tended to be those of higher base status and lower water tables than average.
M29	*Hypericum elodes-Potamogeton polygonifolius* soakway	Typically consisting of mats of *Hypericum elodes* and *Potamogeton polygonifolius* with a carpet of *S. auriculatum*. Mean species richness was 20 spp 4 m^{-2}, significantly higher than M1, M2, M4. PFS and RFS scores were respectively moderate and low.	Summer water tables are usually above the surface and redox values spanned a wide range. Mean Ca and HCO_3 values were very low, pH was low-moderate, but significantly higher than M21 with which it is often associated. An increase in Ca and bicarbonate concentrations were significantly related to an increase in species density, PFS and RFS scores. Generally associated with low fertilities. Measured environmental variables had a significant effect on floristics of the community.
M30	Related vegetation of seasonally-inundated habitats (*Eleocharis multicaulis* water tracks)	*Eleocharis multicaulis* is preferential in stands with *S. auriculatum* and associated poor-fen herbs. Species densities were lower than for M29, PFS and RFS scores were low.	Found to have a narrow range in water table level (- 0.5 - + 7 cm) and moderate redox potentials occupies situations of similar base status to M29 (and M1b). Significant positive relationship between RFS score and Ca concentration. Fertility values are generally low but can have high N concentration and low K and P concentrations.

Community	Description	Habitat conditions
M22 *Juncus subnodulosus-Cirsium palustre* fen meadow	Vegetation containing a range of grasses and 'wet meadow species' but usually dominated rushes especially *J. subnodulosus* and/medium height sedges eg *Carex acutiformis, C. disticha*. Species density was variable, with a moderate mean value. Mean species density, PFS and RFS values are less than M13.	Water levels ranged from low to high with a moderate mean value. Species density and PFS score showed a significant negative relationship with water level. Mean values of pH, HCO_3 and Ca were high, very high and extremely high respectively. Species density showed significant negative relationship with substrate pH. A notable feature of some samples was the occurrence of relatively high extractable levels of Fe and Mn. Species density, PFS and RFS scores all show a significant negative relationship with Fe concentration. Mean fertility was moderate, but the range was large. Measured environmental variables especially water pH, conductivity, Mg and fertility explained floristic variation as did substrate pH, and water table. Though management was found to affect floristics it was found that differences in floristics due to management could be examined by underlying variation in the environmental factors. Tends to be in more fertile situations than M24 and M13.
M22a Typical sub-community	The most common and widespread kind of *Juncus-Cirsium* fen meadow, but often rather rank and impoverished compared with the other sub-communities. Mean species richness and PFS values were low; RFS values were moderate; all three were significantly lower than M13b and M13c.	Mean water value was moderate and significantly higher than M22b and M22c and comparable with that of many examples of M13. Mean values of pH, HCO_3 and Ca were all very or extremely high with stands generally being found in higher base status situations than M22b, M22d. Mean fertility was moderate, similar to M22b and M22d. There was a significant positive relationship between subtrate fertility and P concentration.
M22b *Briza media-Trifolium* spp. sub-community	Usually a more diverse flora compared to M22a. Mean species richness was moderate/high.	Mean water table depth was low, with a maximum of only -9 cm. Generally found under conditions of lower base status than M22a. Mean substrate fertility was moderate.
M22d *Iris pseudacorus* sub-community	*J. subnodulosus* is joined here by tall dicots such as *I. pseudacorus, Lythrum salicaria, Valeriana officinalis*. Species density, PFS and RFS scores were all moderate; the scores for the last two being higher than M22a and M22b.	Mean water levels was very low, lower than M22a, but similar to M22b. There was no relationship between water level and PFS score. Mean values of pH, HCO_3 and Ca are high or very high, but lower than M22a and M22b. There were a wide range of substrate fertilities, but mean fertility was moderate.
M23 *Juncus effusus/acutiflorus-Galium palustre* rush pasture (*J. acutiflorus* sub-community)	This community encompasses a wide range of floristic variation. Species density was moderate, but with a wide range (12-34 spp 4 m^{-2}). PFS numbers were moderate and with only few rare fen species.	Water levels were at or below the surface and redox values were moderate to high reflecting soligenous situations of the samples. Generally found under conditions of moderate base status. Substrate fertility values spanned a wide range but with a moderate mean. Mean values of P and K were respectively low and moderate, but N concentrations were generally high. Fertility was significantly positively related to base-richness and Mn concentrations. Analysis indicates that the main environmental factors separating M23 from M25 appears to be related to a combination of higher fertility and base status, but lower water levels in the former. Similarly compared to M24, M23 is in less well aerated situation.
M24 *Molinia caerulea-Cirsium dissectum* fen meadow	Fen grassland dominated by *M. caerulea*, typically with *Cirsium dissectum, Carex hostiana, C. pulicaris, Gymnadenia conopsea, Succisa pratensis*. Mean species density was high/very high and not significantly different from that of M10, M13 or M22. But mean PFS and RFS scores were lower than M10 or M13.	Mean water level was low and mean redox was high. However, although the community is undoubtedly generally associated with dry conditions of fen margins, in some sites it occupies flushed slopes with a moderate water level, where good aeration is maintained. Mean values of pH, HCO_3 and Ca were high or very high rejecting the occurrence of the community in some very calcareous sites, though it can be found in less base-rich sites. Most base-poor examples tend to have the lowest RFS scores. Mean fertility was low/moderate, but significantly below that of M23 and tall herb-*Phragmites* communities (S24, S23, S26 and S27). Analysis showed a strong relationship between species composition and measured environmental variables, with fertility, conductivity and water pH being important influences.
M24a Typical sub-community	Strongly dominated by *Molinia*. Mean species density moderate/high, similar to M24b. Mean PFS and RFS scores were moderate, but slightly below those of M24b.	Reflects the habitat conditions of the whole community, though M24a generally has a higher water table than M24b or M24c.

M24b *Eupatorium* sub-community	Distinguished by the occurrence of tall herbs such as *E. cannabinum, Lythrum salicaria, Lysimachia vulgaris* and there may be abundant *Phragmites* or *Cladium*. Species richness is similar to M24a.	Habitat conditions are similar to the range occupied by the whole community with the exception of water levels which was very low.
M24c *Juncus acutiflorus-Erica tetralix* sub-community	This community has the high mean species density (37 spp 4 m^{-2}), though these samples may not be representative as the NVC gives a sub-community mean of 19 spp 4 m^{-2}. PFS and RFS scores were high.	Water table levels were low. Found in conditions of lower base status than M24a, but higher fertility.
Cladio-Molinietum	Usually defined by the dominance of *C. mariscus* and *Molinia caerulea* with various tall herbs (*Eupatorium cannabinum*), rushes (*Juncus subnodulosus*) and dwarf herbs (*Potentilla erecta*) being fairly constant. These examples are not readily accommodated into various NVC communities such as M24. It is not generally a species-rich vegetation type.	Water levels are variable, very low to very high; generally the wetter sites are the more species-rich. The ranges of pH, bicarbonate and calcium levels is very large and not very informative. Fertilities were low-moderate.
Cladio-Molinietum typicum	Characterised negatively by the absence of species differential for the *ericetosum* sub-association. Mean species densities are low, significantly below that of *C-M ericetosum*, though PFS and RFS scores are comparable.	This sub-association is found in more base-rich situations than the *ericetosum* often drier, more fertile.
Cladio-Molinietum ericetosum	Characterised by *Calluna vulgaris, Erica tetralix, Myrica gale, Osmunda regalis* significantly more species-rich than the *typicum*.	Base-richness is significantly lower than values for *typicum*, but individual sites had high values indicating that base-richness may not be a requirement for the development of the vegetation. Fertilities of most sites low-very low.

M25 *Molinia caerulea-Potentilla erecta* mire	Comprises vegetation of widely differing composition. Species density was typically low to moderate (mean = 17.8 spp 4 m^{-2}). Mean PFS and RFS scores were both low.	Mean water level was slightly sub-surface, but the variability was high. Redox values were generally high. Base richness values were variable, though the mean values were low/moderate. Substrate fertility was typically low, but variability was high. Fertility was positively related to species density, PFS and RFS scores. Concentrations of P and K were generally low to moderate, but N concentrations were relatively high. Analysis shows that M25 is typically found in water and better aerated conditions - lower base status and fertility than M23. M25 is also found in conditions which are wetter and of a lower base status than M24 and in better aerated conditions than M6.
M27 *Filipendula ulmaria-Angelica sylvestris* mire	Robust vegetation dominated strongly by *Filipendula ulmaria* with generally only few associates. Mean species density was moderate, but PFS and RFS scores were low to very low repsectively.	All stands had sub-surface water levels, and mean water level was low (-22 cm). Found on substrata of moderate to high base status, though significantly lower than those of S25 and S26. Substrate fertility and concentrations of all the major nutrients were high. An increase in fertility and P concentration was associated with a decrease in species density, PFS and RFS scores.

TABLE 5 FEN VEGETATION COMMUNITIES, MANAGEMENT AND ENVIRONMENTAL INFLUENCES, THREATS AND THEIR IMPACTS

TOPOGENOUS FENS

M1 *Sphagnum auriculatum* bog pool

Threats and their impacts

The soft substrate may protect the community against burning and grazing. Drainage is likely to be detrimental as is much base or fertiliser enrichment.

M2 *Sphagnum cuspidatum/auriculatum* bog pool community

Threats and their impacts

Any increase in ionic strength, base status and fertility is likely to be detrimental to the community, particularly in combination, through a change in species composition. The community may form a floating raft giving some buffering capacity against temporary falls in water level and inundation, though a permanent drop in water level would be of detriment to the community.

M4 *Carex rostrata-Sphagnum recurvum* mire

Management influences

It was shown that management did not have a major impact upon floristics of the community, though heavy grazing may be important.

Environmental influences

Measured environmental variables were shown to have a significant effect on the floristics of the community. Base richness, ionic strength, Fe, Mn, P and fertility were influential. Species whose distributions were unrelated to the measured environmental variables include the community constants; *C. rostrata, S. recurvum* and *P. commune*. Species associated with conditions of higher base status and fertility and lower water table than average include atypical species for the community; *S. subnitens, Cirsium palustre, Angelica sylvestris, Juncus conglomeratus,* and interestingly *Dactylorhiza incarnata* and *D. fuchsii.*

Threats and their impacts

Heavy grazing may be detrimental in breaking up the *Sphagnum* carpet and could produce conditions suitable for the establishment of *Juncus* species, particularly where the water table is sub-surface. All investigated examples were found where the water table was above -10 cm, so that drainage is also likely to have an adverse effect, possibly leading to transition to M6, or M5 where there is also some base or nutrient enrichment.

M5 *Carex rostrata-Sphagnum squarrosum* mire

Environmental influences

Floristic variability in the community was not great but there are a number of general trends. Species such as *Pedicularis palustris, Caltha palustris, Ranunculus flammula, Myosotis laxa* are associated with conditions of higher than average levels of fertility, Fe concentration and water table suggesting a trend towards S27. Species associated with conditions which were more base rich than typical, with a lower water table and fertility include; *Sphagnum warnstorfii, S. teres, S. contortum, Utricularia minor, Aneura multifida, Bryum pseudotriquetrum,* also *S. papillosum* and *Drosera rotundifolia.* Species which were particularly associated with an increase in N were *Cicuta virosa, Juncus bulbosus, Filipendula ulmaria, Mentha aquatica, Myrica gale* and *Carex panicea.* The community constants are unrelated to the environmental variables measured.

Threats and their impacts

The floating raft which this community may form may provide a buffer against dessication and inundation. Nutrient enrichment (particularly P) seems to be associated with a loss of species diversity. Drainage is seen as a threat, probably leading to a loss of *Sphagna* and succession to a coarser vegetation type as the substrata are relatively fertile. Management may ameliorate the effects of enrichment, but this is not always practicable, as the substrate is unstable, and over grazing could lead to disintegration of the *Sphagnum* carpet.

M9 *Carex rostrata-Calliergon cuspidatum* mire

Environmental influences

The measured environmental variables cannot fully explain the variation but there are some general trends. The major influence on floristic variation was fertility (P in particular) acting together with base status. Species that have distributions that are unrelated to the measured environmental variables include all the community constants *C. rostrata, Eriophorum angustifolium, Galium palustre, Menyanthes trifoliata, Potentilla palustris, Calliergon cuspidatum* together with *Ranunculus flammula, S. subnitens, P. australis, C. diandra, C. lasiocarpa,* and *Calliergon giganteum.* Those associated with low base status and low-moderate fertility include; *Campylium stramineum, Scorpidium scorpioides, C. limosa, C. echinata* and *N. ossifragum* and *Sphagna* including *S. contortum* and *S auriculatum.*

Threats and their impacts

Partial drainage of the community is an obvious threat, though the vertical mobility of the raft may be able to accommodate modest changes in water level. Some examples of the community seem to be able to persist in low water conditions, but this is not the general rule. The richest and "best" examples of the community are of very low fertility and this is almost certainly essential to the maintenance of their character. Eutrophication may lead to a general shift in species composition and possibly loss of rare species; high eutrophication leads to an increase in species such as *Agrostis stolonifera* and *P. australis.* Though the community may persist for some time, it is likely that it will eventually be replaced by a more eutrophic type eg S27 or even S4. Many examples are unmanaged and this community can undoubtedly retain its essential identity for a considerable period without management. But some of the most species-rich examples are lightly grazed. An eventual threat to some examples is ongoing terrestrialisation by which poor fen (*Sphagnum*) or a form of fen woodland may ultimately develop. The hydrosere can be rejuvinated by turf digging.

S4 ***Phragmites australis*** swamp and reed-beds

Management influences

This vegetation is not often subject to summer management, but it may be cut in winter. Community composition rapidly changes in response to much grazing.

Environmental influences

Multivariate analysis on floristic/environmental relationships within the community was not undertaken because too few stands were sampled. Generally, this vegetation can be found under a very wide range of conditions and little consistent environmental characterisation can be made. Not usually associated with low water conditions, though it can persist in dry sites.

Threats and their impacts

Established reed beds may accommodate partial drainage for a while, but eventually tall herbs will invade. This will also be the case with eutrophication and here *Phalaris arundinacea* and *Glyceria maxima* may invade. If the reed is sufficiently tall and dense, it may be quite resistant to scrub invasion.

S5 ***Glyceria maxima*** swamp

Management influences

Strong *Glyceria* dominance in suitably fertile sites can be maintained under some grazing or mowing regimes as well as by lack of management. Management cannot be used to supress *Glyceria.*

Environmental influences

Multivariate analysis was not undertaken on floristic/environmental relationships within the community because too few stands were sampled.

S24 ***Phragmites australis-Peucedanum palustre*** fen

Management influences

Largely summer mowing either for litter (done annually) or for sedge (on a 3-4 yr rotation)was and is the main type of management. Though litter mowing is now only done for conservation purposes. Grazing of S24 was probably never extensive in Broadland, except in some marginal situations where S24 has been replaced by M22. Generally S24 is too mixed for reed production and therefore this management was not frequent.

Environmental influences

The measured environmental variables can account for much of the floristic variation within the community. The first axis of variation was strongly related to Ca and water table height, the second mainly to fertility and conductivity. Species that have distributions unrelated to the environmental variables measured include *Peucedanum, Galium palustre* and *Iris pseudacorus*. Species associated with higher fertility and water table than average and lower Ca and conductivity are typical of the S24e *Cicuta virosa* sub-community; *C. virosa, Typha latifolia, Sium latifolium*, and also *Oenanthe fistulosa, Myosotis scorpioides*, and *Eleocharis multicaulis*. There was a significant correlation between Ca and water table. It is difficult to separate the 2 variables. Species which could be associated with higher levels Ca, fertility and lower water tables than average include; *Urtica dioica, Glyceria maxima, Juncus effusus, Phalaris arundinacea, Holcus lanatus, Epilobium hirsutum.* Species associated with low fertility (and higher conductivity) than average included *S. nigricans, C. giganteum, C mariscus, Aneura multifida, Oenanthe lachenelii, Campylium stellatum, Succisa pratensis* and *Epipactis palustris*.

Threats and their impacts

Despite its floristic distinctiveness and localisation in Britain, S24 occupies a wide range of environmental conditions which makes it difficult to succinctly characterise the conditions typical of the community. Water level is variable, but a low summer (but not necessarily winter) water level is found in many sites. It is possible that the basic character of the community may survive drainage. Though dry conditions may lead to an increase prominence of fen grassland species and the community may develop into M24. Furthermore, certain sub-communities eg S24e are consistently associated with higher water levels and may not be expected to survive summer dry conditions. Fertility is moderate and some stands are associated with unproductive substrata, though these examples are not associated with species-rich vegetation. However, there is little doubt that whilst the community does not depend upon low fertility conditions (unlike *P. P. caricetosum*) ongoing eutrophication does lead to loss of the characteristic species (especially if coupled with lack of management) and degeneration into some form of tall herb fen. When unmanaged the florstic richness of the vegetation rapidly declines and scrub invasion can occur quickly (though it can be delayed by dense *Cladium*). Management is therefore essential to maintain a relatively rich sward. Certain characteristic species tolerate shading and will survive in fen carr eg *Carex elata, Peucedanum, Thelypteris thelypteroides*. Note that some mowing regimes may be detrimental to some species eg *Peucedanum*. Other plant species are unable to tolerate continued, deep shade.

Peucedanum-Phragmitetum caricetosum

Threats and their impacts

This community is characterised broadly by a moderate, though fairly constant, water table level, low fertility and freshwater conditions. Management is necessary for the long-term conservation of the community, but it can withstand several years of dereliction without serious floristic consequences (probably an account of its low fertility). The major threat is ongoing terrestrialisation because the community is essentially hydroseral. Partial drainage is also likely to be detrimental, especially to the *Ranunculus lingua* variant. The community is unlikely to tolerate much enrichment. Conservation management should therefore ensure low fertility, periodic summer mowing, and ultimately maintenance of hydroseral conditions (peat excavation).

S25 *Phragmites australis-Eupatorium cannabinum* fen

Environmental influences

Analysis showed that although measured environmental variables cannot account for all the main variation in species composition they do relate to underlying trends. The most important influences are found to be pH, ionic strength and HCO_3, followed by redox potential. Substrate fertility was clearly of less influence on species distribution than those other factors. Species which were found to be unrelated to environment were *P. australis* and *H. lanatus*. Those species which tend to be associated with conditions which are more base-rich than average include: *Valeriana dioica, Epipactis palustris, Juncus subnodulosus, Dactylorhiza incarnata, D fuchsii.* However, *V. dioica, Epipactis palustris* with *Galium aparine* and *Rubus fruticosus* were also associated with drier/better aerated conditions than average.

Threats and their impacts

The main characteristics of S25 are a high (but not excessively high) fertility; a variable, but typically low water table, and little (if any) vegetation management (the community has often developed in response to cessation of active management). The community is very susceptible to scrub encroachment. Excessive eutrophication may lead to impoverishment of the vegetation, especially if richer stands are involved and this would be exacerbated by a lack of management.

S26 *Phragmites australis-Urtica dioica* fen

Threats and their impacts

This community is unmanaged and occupies very fertile substrata. Some examples occupy naturally fertile substrata, others are maintained by nutrient run-off from agricultural land. It is generally not more fertile than fen meadow, but whilst management may help diversify the vegetation, this cannot be guaranteed, at least in the short term.

S27 *Carex rostrata-Potentilla palustris* fen

Environmental influences

Analysis showed that although the measured variables do not account for the main variation in species composition they do relate to an underlying trend. Influential factors were found to be firstly Fe, fertility, N; secondly base status and thirdly Ca, Mg and water table. Species distributions unrelated to the environmental variables include the community constants; *Carex rostrata, G palustre, Menyanthes trifoliata, Potentilla palustris* and *Calliergon cuspidatum*, together with *Angelica sylvestris, Caltha palustris, Epilobium palustre, Equisetum fluviatile, Equistum palustre, Eriophorum angustifolium, Juncus effusus, Lythrum salicaria, Ranunculus flammula* and *Sphagnum fimbriatum.* Species associated with higher base-richness and fertility than average, include *Solanum dulcamara, Calliergon giganteum, C. lepidocarpa, Peucedanum palustre, Lysimachia vulgaris, Utricularia vulgaris* and *Calamagrostis canescens.* Species associated with a lower base status and fertility than average include; *Eleocharis multicaulis, Utricularia intermedia, Carex limosa, Myrica gale, Polytrichum commune, Juncus bufonius, Sphagnum palustre, S. auriculatum, Potamogeton polygonifolius, Hypericum elodes.* Species associated with an increase in water table, or lower Ca and Mg levels than average include *Peucedanum palustre, Calamagrostis canescens, Eleocharis multicaulis* and *S. auriculatum.*

Threats and their impacts

S27 is broadly characterised by high water-tables and moderate fertility. It can persist over a long period without vegetation management and is not very responsive, in the short-term at least, to moderate eutrophication. But high eutrophication leads to impoverishment of the community, with an increased prominance of such species as *Agrostis stolonifera, Juncus effusus* and *Phragmites australis*. Drainage will lead to substantial change in the nature of the vegetation, though if it is only partial and accompanied by vegetation management, an increase in species-richness may be predicted, as a form of fen meadow becomes established.

W2 ***Betulo-Dryopteridetum cristatae***

Threats and their impacts

This vegetation appears to represent the first stages of the hydroseral development of poor fen from rich fen. It is apparently confined to areas of former peat cuttings or dykes, where the vertical mobility of the raft prevents dessication of the *Sphagnum* while helping to isolate the *Sphagnum* from the influence of eutrophic river water. Drainage and scrub dominance are the main threat to the community.

SOLIGENOUS FENS

M6 ***Carex echinata-Sphagnum recurvum/auriculatum*** mire

Management influences

Many stands are grazed and there is no evidence that lack of management would be detrimental.

Environmental influences

Analysis showed that the measured environmental variables could not fully explain the floristic variation, although underlying trends could be highlighted. Influential variables were; base status, ionic strength, fertility and redox. The community constants; *Carex echinata, M. caerulea, Potentilla erecta* had distributions unrelated to environmental variables, as did; *Carex nigra, Cirsium palustre, Eriophorum angustifolium* and *S. palustre*. Species associated with higher base status and ionic strength than average include; *Anagallis tenella, Sphagnum warnstorfii* and *Lotus uliginosus*. Species associated with conditions of higher fertility than average were; *Juncus effusus, Lychnis flos-cuculi, Sphagnum fimbriatum* and *Holcus mollis*.

Threats and their impacts

Heavy grazing could lead to *Juncus* dominance. There is no evidence that lack of management was detrimental. Though the community may tolerate temporary falls in water level, drainage is still a major threat and may lead to the development of *Junco-Molinion* or *Nardetalia* wet grassland.

M10 ***Carex dioica-Pinguicula vulgaris*** mire

Management influences

Stands were mostly grazed or had a history of grazing. Heavy grazing does not seem to affect the number of species per unit area, but can decrease the number of individuals.

Environmental influences

Environmental variables were shown to have a significant effect on the floristics of the community, with base richness, ionic strength, substrate fertility and P being important. Water table levels are also important. Species that have distributions that are unrelated to the environmental variables measured include; *Epipactis palustris, Dactylorhiza majalis, Carex panicea, Pinguicula vulgaris, Fissidens adianthoides* and *Aneura pinguis*. Species associated with conditions of higher base status and higher fertility than average include; *Filipendula ulmaria, Galium palustre, Caltha palustris, Cardamine pratensis, Epilobium palustre*. Species associated with higher water tables than average include; *Eleocharis multicaulis, Utricularia minor, Pinguicula lusitanica* and *Schoenus nigricans*. Species associated with lower water table levels than average include; *Salix cinerea, Juncus inflexus* and *Trifolium pratense*.

Threats and their impacts

Light grazing is probably essential to maintain the community. Low substrate fertility may help maintain the system in the absence of management. Heavy grazing may damage the substrate and vegetation and lead to a marked loss in the number of species per unit area. Scouring by running water may lead to erosion in some circumstances.

M13 *Schoenus nigricans-Juncus subnodulosus* mire

Management influences

Management helps maintain the species richness of the community.

Environmental influences

Analysis showed that environmental variables did have a significant effect on the floristics of the community. Important variables are; fertility, ionic strength, base richness and Mg. Fertility is especially important. Species whose distributions are unrelated to environmental variables include; *Cirsium palustre, Schoenus nigricans, Juncus subnodulosus, Menyanthes trifoliata, Molinia caerulea, Calliergon cuspidatum.* There was no evidence from the anlaysis that the occurrence of *Phragmites* was related to substrate fertility, nor was it associated with higher water tables than average.

Threats and their impacts

The main feature of this community is that it is associated with low productivity, very base-rich spring-fed sites. Whilst the 'best' sites had water levels close to the surface, some examples had a surprisingly low water table. But it is not known for how long they can maintain their status in such dry conditions. The capacity of examples to tolerate dry conditions is almost certainly a result of the inherently low substratum fertility which helps check potentially more aggressive dominant species. Active management also restricts such species. Examples of the community can apparently tolerate small increases in site fertility and it is likely that calcite precipitation can lock-up P making it unavailable to the plants. If so, the habitat conditions typical of this community are essentially a feature of the springs and seepages themselves and not their water. Therefore irrigation or ponding of water by sluices may not encourage the development or maintenance of M13. Ponding may in fact modify the essential character of the system by reducing flow and redox potentials. Though the community may have some tolerance to enrichment on account of the low fertility, enrichment by P especially, is not to be encouraged. In general, the richest M13 mire sites are associated with a low-growing vegetation. Sites with taller vegetation are least rich. There is evidence of impoverishment of some examples associated with increased productivity. The vegetation of the runnels is especially susceptible. Management (occasional summer mowing (not annual); light grazing (heavy grazing is detrimental) and even occasional burning (this has occurred at some sites without damage) can maintain species richness.

M14 *Schoenus nigricans-Narthecium ossifragum* mire

Management influences

Management does have an impact upon the floristics of the community. Species such as *Phragmites australis, Angelica sylvestris, Eupatorium cannabinum* and *Juncus subnodulosus* were more common in unmanaged stands.

Environmental influences

The measured environmental variables are sufficient to explain the floristic variation. Variables which are important are ionic strength, base status, and fertility and water table levels. Species whose distributions are unrelated to environmental variables are; *Carex demissa, C. panicea, Drosera rotundifolia, Erica tetralix, Molinia, Myrica gale, Narthecium ossifragum* and *Schoenus nigricans.* Species which are associated with conditions of higher base status and fertility than average include; *Angelica sylvestris, Eupatorium cannabinum, J. subnodulosus, Pedicularis palustris.* Species associated with conditions typical of low fertility and base poor conditions include *Rhyncospora alba, Sphagnum subnitens, Viola palustris, Hammarbya paludosa.*

Threats and their impacts

This community is confined to low fertility substrata, indicating that nutrient enrichment is likely to be detrimental. It does occupy some soils with elevated N concentrations; presumably P is the major limiting factor to plant growth. The majority of stands were grazed, and there was some evidence that both heavy grazing and lack of management were associated with a decrease in species density. Water levels were typically at or above the surface, the community being dependent on a constant flow of relatively base-enriched water, and drainage is likely to be highly detrimental.

M15 ***Scirpus cespitosus-Erica tetralix*** wet heath (***C. panicea*** sub-community)

Environmental influences

Substrata were typically of low fertility and of moderate base status and water levels were all below - 10 cm. The community appears to be dependent on a constant supply of relatively base-enriched water.

M21 ***Narthecium ossifragum-Sphagnum papillosum*** valley mire

Management influences

Management was shown not to have a major impact on the floristics of the community.

Environmental influences

The measured environmental variables have a significant effect upon the floristics of the community. Water level and fertility are important with base status, redox potential and Mg. Species that have distributions that are unrelated to the environmental variables measured included all the community constants; *Narthecium ossifragum, Sphagnum papillosum, Calluna vulgaris, Drosera rotundifolia, Erica tetralix, Eriophorum angustifolium* and *Molinia caerulea.* Species associated with conditions of higher fertility and base status than average include; *Campylium stellatum, Carex dioica, Caltha palustris, Scorpidium scorpiodes, Potentilla palustris, Equisetum fluviatile, Angelica sylvestris, C. lasiocarpa. Juncus effusus* can be associated with the atypical conditions of higher fertility, low base status and low water tables. The rare *Hammarbya paludosa* can be seen to have been recorded from stands with higher redox potentials, water levels and ionic strength for the community.

Threats and their impacts

Management may help to maintain higher species diversity, though there is a danger that heavy grazing may tend to fragment the *Sphagnum* carpets. Low water table levels were only recorded in exceptional conditions, and drainage must pose an obvious threat to the community, particularly through the loss of *Sphagnum*, though the generally low fertility of the substrata may help to prevent the rapid establishment of "coarse" species, especially where grazed. The generally high water tables may also help protect the community against the detrimental effects of burning and grazing. In some situations nutrient enrichment may cause a loss in species diversity, in others it may encourage the establishment of some atypical species.

M29 ***Hypericum elodes-Potamogeton polygonifolius***
Soakway

Environmental influences

Measured environmental variables can account for much of the variation in species composition between stands. Fertility, P, Ca, redox potential, water table levels, K and Mg were important influences. Species that have distributions that are unrelated to the environmental variables include the community constants; *Hypericum elodes, Potamogeton polygonifolius* and *Ranunculus flammula* with *Carex echinata.* Species associated with a higher fertility than average included *Cardamine pratensis, Lotus uliginosus, Epilobium palustre, Caltha palustris* and those particularly related to an increase in P included; *Agrostis stolonifera, Holcus lanatus, Juncus effusus, Anthoxanthum odoratum.* The latter three are also associated with lower than average water table levels. *Cardamine pratensis* and *Lotus uliginosus* were particularly associated with conditions of increased fertility and water table. A shift in conditions towards an increase in base-richness and water table/redox (with generally lower fertility than average) could be related to species such as *Rhyncospora alba, Drosera intermedia, Cirsium dissectum, Equisetum palustre, Utricularia minor, Eriophorum gracile, P. australis, C. lepidocarpa* and *S. scorpiodes.*

Threats and their impacts

The community may be able to tolerate short periods of drought, but drainage can be expected to have an adverse effect on the community, not only through direct effects on the flora, but also through improving accessibility to stock. Heavy grazing can be detrimental in breaking up the surface and there was some evidence for a reduction in species density caused by heavy grazing. It is likely that enrichment would have an adverse impact on the community.

M30 **Related vegetation of seasonally-inundated habitats**
(Eleocharis multicaulis water tracks)

Threats and their impacts

Because of only a few stands sampled it is difficult to generalise about any ecological preferences, but clearly the community would be very vulnerable to drainage or eutrophication.

FEN MEADOW

M22 *Juncus subnodulosus-Cirsium palustre* Fen meadow

Management influences

Management does have a significant impact upon the floristics of the community, but the impact is subsidiary to that of the environmental variables. Some general trends were identified: species associated with heavily grazed situations included; *Carex flacca, Succisa pratensis, J. articulatus, Poa annua, Urtica dioica.* Those associated with lack of management included; *Filipendula ulmaria, Epilobium hirsutum, Galium uliginosum, Caltha palustris, Molinia caerulea* and *Angelica sylvestris.*

Environmental influences

The measured environmental variables had a significant effect on the floristics of the community. The most important factors were; water pH, conductivity, Mg, fertility, substrate pH and water table. Species whose distributions are unrelated to the measured variables included the community constants; *Cirsium palustre, Holcus lanatus* and *Calliergon cuspidatum* with *Hydrocotyle, Mentha aquatica, Valeriana dioica* and *Vicia cracca.* Species associated with conditions of higher base status, water level and fertility than average includes *Myosotis laxa, M. scorpioides, Drepanocladus revolvens, S nigricans, Eupatorium cannabinum* and *Phalaris arundinacea.* A shift towards conditions of a lower base status and water levels than average was associated with species such as *Caltha palustris, Iris pseudacorus, Peucedanum palustre, Carex elata, Lythrum salicaria* and *Juncus effusus.*

Threats and their impacts

Management (grazing/mowing) is an essential feature of fen meadows. Following abandonment of active management they revert to taller herbaceous fen vegetation or become invaded by scrub. Active management may be able to reduce some impact of enrichment, but floristic change will cause some floristic change especially of low fertility stands. Fen meadow vegetation associated with the very lowest water table levels usually had low PFS and RFS scores and therefore indicate vulnerability. But the correlation between PFS and species density (but not RFS) with water levels showed a significant negative relationship suggesting less vulnerability. But the reason for this needs to be explored further.

M23 *Juncus effusus/acutiflorus-Galium palustre* rush pasture (*J. acutiflorus* sub-community)

Threats and their impacts

Management is important in maintaining species diversity, especially as substratum fertility is moderate, and drainage is likely to lead to an increase in grasses and conversion to wet grassland.

M24 *Molinia caerulea-Cirsium dissectum* fen meadow

Environmental influences

Analysis showed that although the measured environmental variables cannot account for all the major variation in species composition a strong relationship still exists between species composition and measured environmental variables. Fertility, conductivity, water pH and water levels were found to be important.

Threats and their impacts

This community is essentially a wet grassland vegetation of some unproductive fen sites. The water level is usually low, though the community is found on wetter slopes. The driest examples may not contain some of the more characteristic species (eg *Carex hostiana*). Though such a low fertility vegetation would be expected to be susceptible to enrichment, none of the sites examined showed evidence of this. But lack of management is associated with a reduction in species richness.

Cladio-Molinietum

Threats and their impacts

Most typically a community of rather unproductive fen sites which are often, but not always, rather dry and subject to little, if any, management. The community retains its essential characteristics if subject to low intensity management. More intense management may lead to the development of fen meadow or *Molinia* grassland. Though the community may be able to tolerate some drying, this does not mean to say that significant drying will not have an impact. Low-intensity management may ameliorate any influence of modest enrichment, substantial enrichment will probably lead to its replacement by a more coarse type.

M25 ***Molinia caerulea-Potentilla erecta*** mire

Threats and their impacts

Species richness of this community can generally be related to the degree of dominance of *Molinia* (and/or *Myrica* where it occurs), which in turn can be related to aeration of the substrate, substrate fertility and management. *Molinia* abundance increases greatly with a decrease in water table or increase in aeration. Grazing can suppress *Molinia* dominance and lead to an increase in species density. Burning may encourage tussock-structure and lead to a decrease in species density. But if carried out when water table levels are high this problem may not occur.

M27 ***Filipendula ulmaria-Angelica sylvestris*** mire

Threats and their impacts

This community is characterised by high fertility (though higher fertility than average had lower species richness), moderate base status and low water tables, together with absence of management.

TABLE 6 MEAN VALUES OF ENVIRONMENTAL VARIABLES ASSOCIATED WITH RICH AND POOR FENS AND ALL SAMPLED FENS

	Mean value rich fens	Mean value poor fens	All fens
pH Water	6.2	5.0	5.6
pH substratum	6.3	5.1	5.7
Bicarbonate (mgl^{-1})	228.8	27.5	135.5
Calcium (mgl $peat^{-1}$)	1420	323	931
Water depth (cm)	-4.5	0.2	-2.5
Redox potential	283	256	274
Ionic strength	494	142	336
Sodium (mgl $peat^{-1}$)	43.2	27.7	36.7
Magnesium (mgl $peat^{-1}$)	88.4	71.8	82.6
Iron (mgl $peat^{-1}$)	36.8	166.8	106.3
Manganese (mgl $peat^{-1}$)	19.4	25.4	24.1
Aluminium (mgl $peat^{-1}$)	8.9	47.3	26.3
Nitrogen (mgl $peat^{-1}$)	5.41	8.4	6.86
Phosphate (mgl $peat^{-1}$)	0.59	0.41	0.50
Potassium (mgl $peat^{-1}$)	22.6	24.8	24.0