M22 (*Juncus subnodulosus – Cirsium palustre*) fen-meadow

14.1 Context

M22 is present in a number of SSSI's but is not usually the main designated feature. The community has apparently been used as a basis for SAC habitat designation under the category 'calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*', but this is exceptional and has dubious legitimacy.

14.1.1 Floristic composition

The community is variable but it can be species rich with a total of 403 species recorded in M22 samples (Mean = 26; Range = 3–66 species per sample; total of 31 rare mire species although the mean no. is less than 1 per sample). Rare mire species include *Blysmus compressus, Calamagrostis canescens, Calliergon giganteum, Campylium elodes, Carex acuta, Carex appropinquata, Carex diandra, Carex elata, Carex lasiocarpa, Carex viridula ssp viridula, Cladium mariscus, Dactylorhiza praetermissa, Dactylorhiza traunsteineri, Eleocharis uniglumis, Epipactis palustris, Erica ciliaris, Eriophorum latifolium, Hypericum undulatum, Juncus alpinoarticulatus, Lathyrus palustris, Oenanthe lachenalii, Osmunda regalis, Peucedanum palustre, Philonotis calcarea, Plagiomnium elatum, Potamogeton coloratus, Ranunculus lingua, Sphagnum teres, Stellaria palustris, Thalictrum flavum and Thelypteris palustris*.

M22 is however typically dominated by sedges and rushes of medium height. *Juncus subnodulosus* is the most characteristic rush, though not always present such that *J. acutiflorus* and *J.inflexus* occasionally dominate. *Carex acutiformis* and *C. disticha* are particularly characteristic sedges and can be strongly dominant. M22 is not easy to define because of its floristic variety and lack of good positive characterisation. Particularly distinctive features are essentially (wet) meadow plants such as *Juncus subnodulosus*, *Cirsium palustre*, *Filipendula ulmaria*, *Lotus uliginosus*, *Calliergon cuspidatum*; however these species not only occur in wet meadows, but also in M13 and other communities.

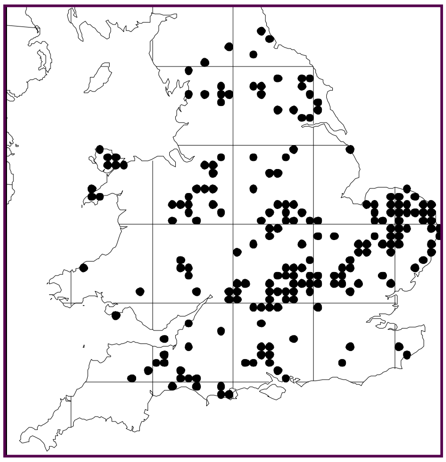
Juncus subnodulosus, a frequent dominant of M22, can also be dominant in M13, but whilst other M22 dominants such as *Carex acutiformis* and *C. disticha* can occur in M13, they are not usually as dominants.

Rodwell (1991) recognised four sub-communities of M22: Typical sub-community (M22a); *Briza media – Trifolium spp.* (M22b); *Carex elata* sub-community (M22c); and *Iris pseudacorus* sub-community (M22d).

14.1.2 Distribution

M22 has been recorded from 331 sites and is the most widespread community of base-rich fens in England and Wales. Its main distribution is central and eastern England, but this is probably due to the presence of suitable substratum conditions (wet, base-rich, mesotrophic soils) rather than a direct influence of climate. The distribution of M22 in England and Wales is shown in Figure 14.1.

Figure 14.1 Distribution of M22 in England and Wales (from FenBASE database)



14.1.3 Landscape situation and topography

M22 is particularly a feature of lowland valleyhead fens, though this has less to do with hydrology than the fact that many are (or were recently) grazed. M22 can also be found in grazed, base-rich floodplain sites (for example, Burgh Common, Norfolk) and some partly drained grazing levels.

The majority of sites occupy flat situations or hollows, with a large number present on seepage slopes and in certain (base-rich mesotrophic–eutrophic) circumstances, they can cover spring mounds.

14.1.4 Substratum

Occurring on shallow peaty soil, sometimes organic gleys, also on deep (>1.5m) peats in floodplains or basins; c.75% were recorded in valleyheads with typically shallow peat (<0.5m). 20% of samples were recorded from floodplains (mean peat depth = 1.47 m), whilst 8% occupied peat deposits deeper than 1.5 m, all in basins or floodplains. Substratum and irrigating water are typically of circumneutral pH, though there are examples of low pH on upland margins or partly drained sites. Lower pH has also been found on sites with less base-rich bedrocks (for example, Nares Gladley Marsh, Bedfordshire). There is considerable variation in fertility, but the majority are mesotrophic.

M22 is associated with a variety of bedrocks; many are strongly calcareous (Chalk, Jurassic and Carboniferous Limestone), although other types such as Old Red Sandstone (Pont y Spig, Monmouth), Upper Greensand (Stowell Meadow, Somerset) and Lower Greensand are less calcareous. Examples on the Lower Greensand tend to be more acidic, often dominated by *Juncus acutiflorus*, representing the base-poor extreme of M22 (perhaps transitional to M23). Many examples are located on superficial deposits having limited interaction with the bedrock (for example, glacial sand and clay such as Clack Fen, Buckinghamshire) and a few are located on non-sedimentary bedrocks.

14.1.5 Zonation and succession

Many M22 stands do not show clear zonations with other mire communities. In some cases they occur as small fragments, in others they occupy entire (valleyhead) sites, bounded by transitions into drier ground or watercourses. In some instances (such as where M22 covers seepage slopes), transition into drier habitats is often abrupt and determined by the topography and controls upon groundwater emergence. In some floodplain locations, M22 can occupy large areas and entire compartments bounded by dykes. Such expanses are not necessarily uniform, but floristic variation within them is expressed in terms of different versions of M22 rather than different communities (often imposed by selective grazing).

In many instances M22 occurs in juxtaposition with other mire communities. M22 is essentially maintained by grazing or regular mowing and where these occur differentially, the community may adjoin dereliction derivatives such as S24 or S25. The boundary between M22 and other communities may be abrupt (for example, along the line of a fence). The community also occurs in more natural zonations. In some seepage systems it forms a zone flanking the main seepage communities (such as M13), in conditions that may or may not be drier but which are often more fertile (when the main seepage is also quite fertile, the whole system tends to be blanketed by forms of M22). Some stands of M22 contain a number of typical *Molinion* species, and these may grade out into examples of M24 in drier conditions. However, other examples of M22 can be as dry as examples of M24, and the consistent difference between these two communities is that M22 is more fertile than M24.

M22 frequently forms a zone in wet hollows, surrounding wetter forms of fen or swamp and grading out into wet or dry grassland, as is seen clearly in some of the West Norfolk pingo fields. In many instances, M22 is not obviously part of the terrestrialisation sequence of the hollows, but occurs on shallow peat or mineral ground around them. Nonetheless, examples of M22 do occur on surfaces which have originated by terrestrialisation, but the community mainly occurs as a grazing-maintained secondary feature (plagioclimax), derived by scrub clearance and encouraged by partial drainage. This seems to be the status of M22 in the topogenous basin at Great Cressingham Fen, where the natural herbaceous vegetation appears to have been a form of M9.

Likewise, examples on floodplains may be a product of scrub clearance or of grazing of tall herb fen (S24, S25), again often – but not always – enhanced by drainage. A corollary is that M22 can disappear as a result of dereliction, though the process can be slow and is not always complete: in a number of locations in Broadland, patches of strong *Juncus subnodulosus*-dominance within S24 are probably the relicts of former M22 litter fens, where mowing seems to have been abandoned well over fifty years ago. Lambert (1948) observed in the Yare valley that replacement of former litter fen by tall herb fen as a consequence of dereliction occurred most rapidly alongside the dykes and least rapidly in the centres of compartments.

M22 has now virtually disappeared from unmanaged examples of these mires, but at Wheatfen small patches of *Juncus subnodulosus* dominance still persist in locations distant from the dykes.

14.2 Supply mechanism and conceptual model

M22 can be irrigated by surface water (approximately 10% of stands) and groundwater (approximately 70% of stands) depending on the situation. The remaining 20% are either irrigated by mixtures of groundwater and surface water or sites with low summer water tables (where the surface can be exclusively rainwater fed). Examples on river floodplains tend to be surface water fed, whilst examples at valleyheads are mostly groundwater fed. In some topogenous situations, surface water may be derived from proximate groundwater, whilst in some valleyheads with intermittent seepages, rain generated run-off may have a greater importance.

M22 has been recorded from a wide range of WETMECs (5 through to 17). Most are from permanent or intermittent seepages or where groundwater tables are shallowly sub-surface all year, sometimes peripheral to permanent seepages. 30% were from WETMEC 11 (intermittent and part-drained seepages slopes such as Booton Common (Norfolk), Crosby Gill (Cumbria)), with 22% within WETMEC 10 (permanent seepage slopes such as Cors Hirdre, Buxton Heath (Norfolk)). The main water supply mechanisms are illustrated schematically in Figure 14.2.

14.3 Regimes

14.3.1 Water

Water conditions are variable, consequently, mean water table values have limited value, are potentially misleading and should be interpreted with caution. A very low value of 175 cm bgl has been measured at Cornard Mere in a drought period, but this is exceptional. Conditions range from being dry to above the surface, the latter being associated with permanent seepages. Mean values for annual rainfall and potential evaporation for the sites examined are given in Table 14.1, together with mean recorded values for summer water table associated with stands of M22.

Much of the variation in species composition can be attributed to differences in the kind and degree of waterlogging (for example, species such as *Carex acutiformis, C. paniculata* and *C. disticha* tend to be associated with wetter conditions, whilst species such as *C. hirta* and *Deschampsia cespitosa* are more typical of summer-dry conditions).

Specific time-series data for stands of M22 are not available. It is therefore not possible to specify precise water regimes, or tolerance to change, but the following comments can be made:

Optimal water levels

- M22 is usually characterised by summer water tables that are below the surface (-5 to -18 cm).
- M22 stands with the highest summer water tables are usually groundwater fed.
- The most species rich stands are found at water levels between -5 and -20 cm.

Table 14.1 Rainfall, potential evaporation and water table data for M22

	Mean	Min	Max
Rainfall (mm a^{-1})	651	539	1,050
Potential Evaporation (mm a^{-1})	601	435	638
Mean Summer Water Table (cm agl or bgl)	-10.8	-175	+12.2

Figure 14.2 Schematic representation of the major water supply mechanisms to M22 (after Wheeler, Shaw and Tanner, 2009)

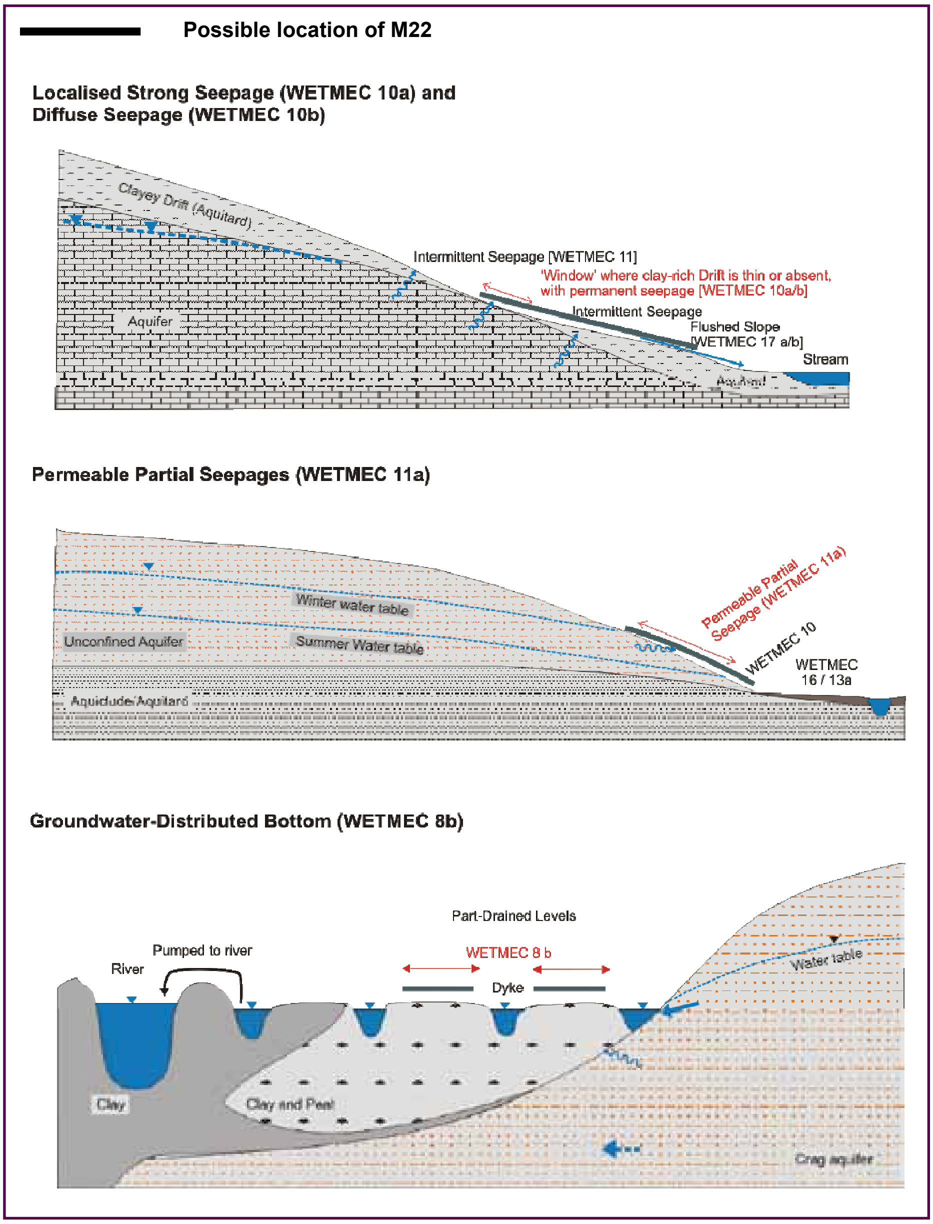
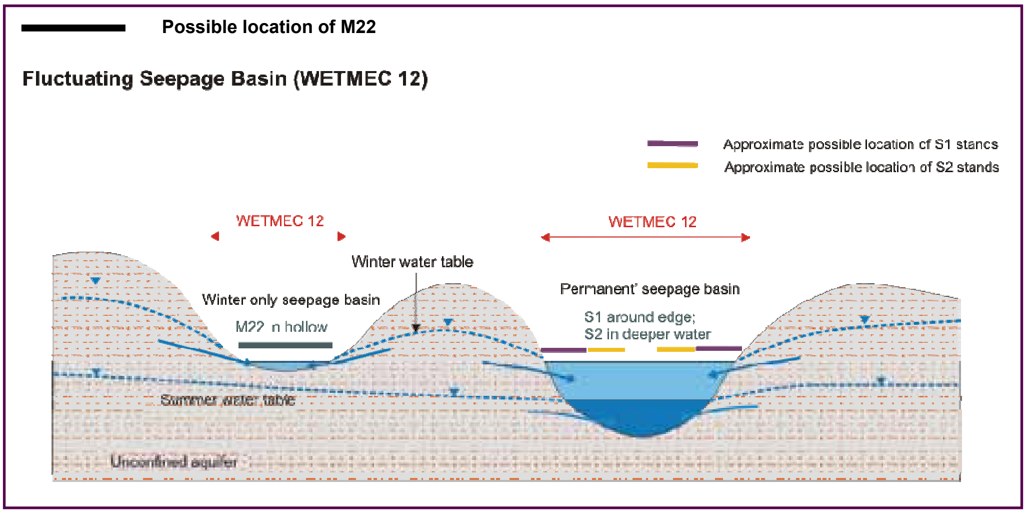


Figure 14.2 (continued)



Sub-optimal or damaging water levels

- Very wet sites (summer water table usually above surface between tussocks) tend to be less species rich. Prolonged deep inundation, particularly in summer, is likely to be damaging.

- Moderate reductions in water levels may increase species richness, but a long term reduction of the summer water table beneath high quality stands of M22 can be expected to result in the loss of some botanical interest.

14.3.2 Nutrients/hydrochemistry

Table 14.2 presents figures for pH, conductivity and substratum fertility measured in stands of M22. The community is typically found in base-rich conditions over a wide range, but usually moderate level of fertility, usually occupying more fertile situations than M24 or M13. Some of the least fertile sites were the most species rich, although studies have not demonstrated a significant relationship between substratum fertility and species richness, indicating that other variables may also be important. Low fertility may help to retard invasion by tall-herb fen and scrub into unmanaged stands.

Shaw and Wheeler (1991) reported a decrease in species diversity of M22 associated with an increase in base status.

Table 14.2 **pH, conductivity and substratum fertility measured in stands of M22**

Variable	Mean	±SE	Min	Max
Water pH	6.6	0.02	4.5	8.1
Soil pH	6.9	0.03	4.9	7.6
Water conductivity (Kcorr µS cm^{-1})	612	1.2	113	1,780
Substratum fertility[22] (mg phytometer)	13.9	0.25	2	49

[22] Experience has shown that N and P data derived from soil analysis has only limited use in assessing fertility of wetlands. Consequently the technique of phytometry (measuring the biomass of test species (phytometers) grown on soil samples) was developed. Typical phytometer yields (dry wt.); low fertility ‹ 8 mg, high fertility › 18 mg.

14.3.3 Management

M22 owes its origin to mowing or grazing, and depends on this for persistence. It once formed extensive areas in the mowing and grazing marshes of Broadland and other floodplain systems. There are no known examples of naturally generated equivalents of M22; rather it is a product of clearance of wet woodland followed by management. Variations in management regime (including timing, frequency and intensity) and their histories are reflected in variations in species composition. Conservation management involves ensuring conditions are relatively wet, mesotrophic and base-rich.

14.4 Implications for decision making

14.4.1 Vulnerability

The main threats are from dereliction and drainage (or interception of supply). As M22 does not normally define an SAC habitat and because it is widespread, it is often not normally assigned a high priority for protection. However in some districts it represents the only form of base-rich mire vegetation and repository of mire species, and can therefore have considerable local or regional significance.

The largest threat is dereliction, which is likely to lead first to the development of tall-herb vegetation (with associated species loss) and then to the development of wet woodland (for example, W2). The wet woodland may continue to support the majority of M22 species in reduced numbers and probably without *Juncus subnodulosus*. A change in the timing or frequency of the management regime is likely to result in a change in species composition. Management regime can also affect the flowering performance of some less common species (for example, *Dactylorhiza* spp.). Overgrazing may also result in species loss, as well as poaching of the ground.

The wide range of water table conditions makes it difficult to advance simple comments on how vulnerable M22 is to drainage. Drying of M22 could result in species alteration, although the impact will depend on the pre-drying start point as well as the magnitude of change. In other cases, drying can lead to a change from one sub-community of M22 to another. Absence of a clear relationship between water levels and species richness coupled with the fact that many of the distinguishing M22 species are essentially wet meadow species, means that drying may have little impact on species richness *per se*, and in some cases could lead to a net increase in species richness.

M22 can accommodate eutrophication without change to the basic composition provided active management continues, although eutrophication of low fertility stands could cause floristic change and possible loss of distinctive features.

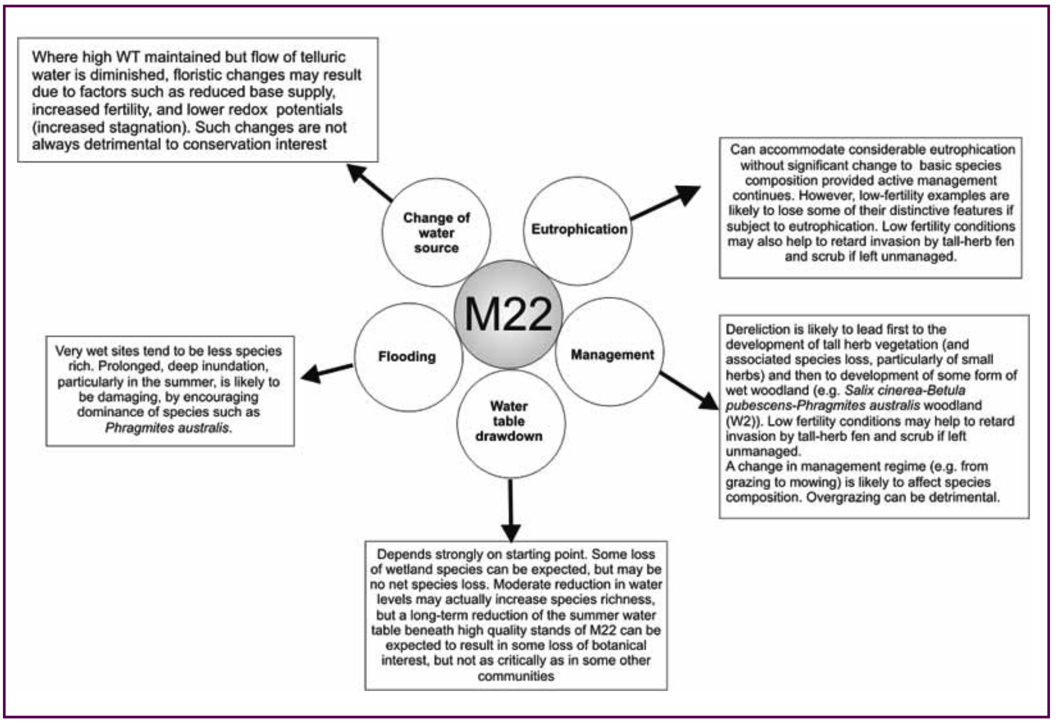
Figure 14.3 shows some of the possible floristic impacts of changes to the stand environment. The concept of 'vulnerability' is complex; depending on the starting conditions (including floristic composition), sensitivity of the stand and sensitivity of the site to change. Some stands may be regarded as *sensitive* to change but not necessarily *vulnerable*. For this reason, accurate assessment of vulnerability should require careful site-specific investigations.

14.4.2 Restorability

As with all restoration measures, their likely success depends on the cause of the 'damage', and how far the starting conditions are from the objective, both in time and conditions (for example, numbers of species lost, damage to substratum, degree of enrichment etc). Limited information is available on the restoration of M22 stands, but the following observations can be made:

- Where the community has been recently damaged, but this has not been intensive, corrective management may be sufficient to rehabilitate M22 in the short to medium term.
- Scrub removal and re-instatement of vegetation management may help to restore M22 that has been left unmanaged, provided other conditions have not changed irreversibly.
- Attempts to increase the wetness of M22 sites by blocking outflows could be detrimental to the vegetation if they result in stagnant, strongly reducing conditions.

Figure 14.3 **The possible effects of environmental change on stands of M22**



14.4.3 Limitations of these guidelines and gaps in knowledge

The limitations of the information presented here related to M22 include the following:

- There are currently no data to better describe the temporal water table characteristics of M22 stands. Time series of dipwell measurements are required to fill this gap.
- In order to make predictions on the vulnerability of M22 stands to water levels, models are required that can connect hydrogeological processes with hydrological conditions at the fen surface. This may require detailed ecohydrological investigations at representative sites.
- Data on the spatial extent of M22 are lacking.
- Possible differences in environmental conditions influencing the four sub-communities have not been explored here.
- More information is needed on tolerance to nutrient enrichment and nutrient budgets.
- More information is needed on appropriate restoration techniques.

M24 (*Molinia caerulea – Cirsium dissectum*) fen-meadow

15.1 Context

Examples of the M24 community have been included within the SAC 'calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*' category and (probably) '*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils'. The community can be found in fens and wet grasslands. However, whilst stands of M24 may be semi-natural features of the margins of mires, their occurrence within mires is often indicative of drying or drainage and may therefore be degenerative rather than desirable.

15.1.1 Floristic composition

The M24 community typically comprises much *Molinia caerulea* and *Cirsium dissectum* with a range of other forbs. Rushes such as *Juncus subnodulosus* often occur, but are generally less abundant than in many mire communities. *Cirsium dissectum* is not always present, and is notably absent from all examples in North-West Wales, which are outwith the range of this species. The vegetation can be fairly species-rich and supports a few rare mire species including *Calamagrostis canescens, Calliergon giganteum, Carex appropinquata, Carex elata, Carex lasiocarpa, Cladium mariscus, Dactylorhiza praetermissa, Dactylorhiza traunsteineri, Epipactis palustris, Erica ciliaris, Eriophorum latifolium, Hypericum undulatum, Lathyrus palustris, Oenanthe lachenalii, Osmunda regalis, Peucedanum palustre, Plagiomnium elatum, Primula farinosa, Pyrola rotundifolia, Selinum carvifolia, Stellaria palustris, Thalictrum flavum* and *Thelypteris palustris*.

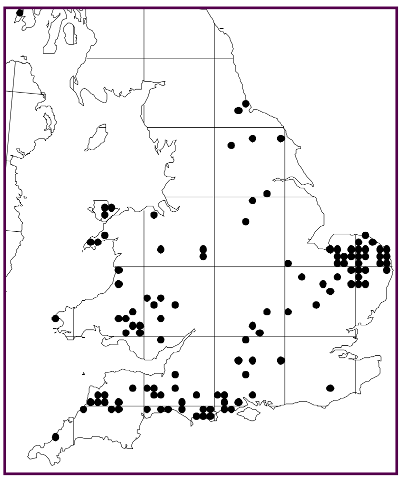
However, the species complement varies considerably (mean of 23, range of 5–56 spp per sample (Rodwell, 1995)), and the community is not particularly distinctive in terms of species composition. With the exception of the rare *Selinum carvifolia*, which is primarily associated with this community, all of the typical M24 species also occur in allied communities such as M13, though often at reduced frequency and constancy compared to M13. A number of M13 characteristic species (see Table 10.1) also occur in M24. Wetter stands of M24 contain the most mire species and M13 characteristic species, though there is no comparable increase in the number of rare species with increased wetness.

Rodwell (1991) recognises three sub-communities of M24: *Eupatorium cannabinum* sub community (M24a); Typical sub-community (M24b), and *Juncus acutiflorus–Erica tetralix* sub community (M24c).

15.1.2 Distribution

The community primarily occurs in the warmer parts of Britain and has been recorded from 181 sites in England and Wales (Figure 15.1). It is widespread in Eastern England, where it occurs in scattered and infrequent locations. M24 is also widespread in parts of South-West England and Wales, but here it occurs widely in habitats that would often have been regarded as wet grassland rather than mire. Non-mire examples of M24 in Western Britain tend to have a different species composition to examples from the East, and none has been included in these analyses.

Figure 15.1 Distribution of M24 in England and Wales (from FenBASE database)



15.1.3 Landscape situation and topography

M24 occurs in a variety of wetland contexts, usually peripheral to the main areas of wetter mire. The majority of stands are associated with valleyhead wetlands (usually occupying a zone between wetter fen communities and drier grassland and heath). It also occurs in some floodplains and occasionally, in basins. Examples in undrained floodplain wetlands often occupy narrow, marginal zones alongside the main stands of fen vegetation, but in part-drained floodplains or those that naturally experience low summer water tables, M24 can occur over large areas of the floodplain proper. M24 can be extensive in some summer-dry, rather flat, valleyhead fens. In part-drained situations the community has usually replaced a wetter fen vegetation type, sometimes M13. In parts of South-Western England and Wales, stands of M24 are widespread in valleyheads and hillslopes that are perhaps better considered as wet grassland than fen meadow, though every intergradation between these two habitat categories seems to occur.

15.1.4 Substratum

M24 is most often found over organic or strongly humic soils (Rodwell, 1991). Where M24 is located at the margins of fens the community is usually underlain by a relatively shallow (less than 50 cm) depth of organic soil and peat. The community can be found on deeper peat in locations with impeded drainage, for example, in groundwater-fed basins (for example, Banham Great Fen, Norfolk) or on floodplains (for example, Woodwalton Fen, Cambridgeshire).

15.2 Water supply mechanisms

A number of water supply mechanisms can support the M24 community. The main source of water to the substratum supporting this vegetation is usually groundwater in valleyhead sites (notably through intermittent seepages) and surface water in the floodplains, though some floodplain examples may also receive groundwater seepage inputs, either directly or distributed through the surface water system. In some cases, M24 *surfaces* may be largely rain-fed, with base-rich conditions a product of a base-rich substratum or a legacy of former groundwater seepages.

Forty-two per cent of M24 samples recorded occurred within WETMEC 11 (intermittent and part drained seepages such as Roydon Fen (Norfolk), Bryn Mwcog (Anglesey)), with 19% within WETMEC 9 (groundwater-fed bottoms such as Hopton Fen (Suffolk)), 10% within WETMEC 7 (groundwater floodplains such as Bransbury Common (Hants), Chippenham Fen (Cambridgeshire)) and 9% in WETMEC 8 (such as Cors Erddreiniog, Anglesey). A few examples were found within WETMECs 4, 5, 10, 16 and 17. The main water supply mechanisms are illustrated schematically in Figure 15.2.

15.3 Regimes

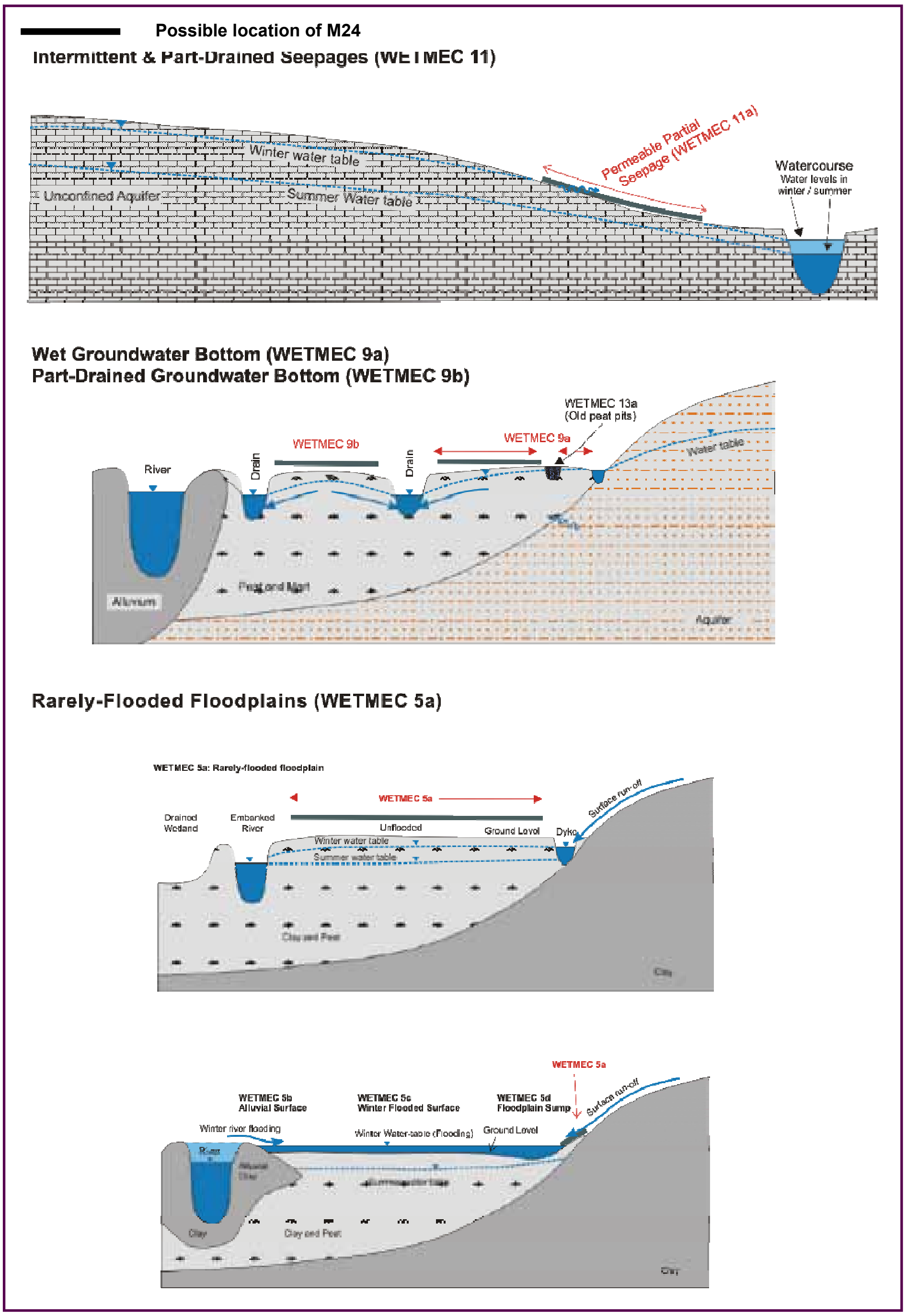
15.3.1 Water

Mean values for annual rainfall and potential evaporation for the sites examined are given in Table 15.1.

Table 15.1 Rainfall and potential evaporation data for M24

	Mean	Min	Max
Rainfall (mm a^{-1})	674	546	1,202
Potential Evaporation (mm a^{-1})	612	590	646

Figure 15.2 Schematic representation of the major water supply mechanisms to M24 (after Wheeler, Shaw and Tanner, 2009)



Mean recorded values for summer water-table associated with stands of M24 in mire systems and segregated into data from Eastern England and for the rest of England and Wales are presented in Table 15.2 below.

M24 characteristically occurs on sites with subsurface water tables, at least during summer. Some stands occupy areas with intermittent seepage, with winter water levels at or near the surface, but in others the water table is permanently subsurface. Sites with relatively high summer water tables tend to show the greatest affinity towards M13. Examples from mires in Eastern England have significantly lower summer water tables than stands in mires elsewhere in England and Wales, but are not obviously less good examples of M24.

Specific time-series data for stands of M24 are not available for the majority of sites. It is therefore not possible to specify precise water regimes, or tolerance to change, but the following comments can be made:

Optimal water levels

- M24 may occupy a broad band of subsurface summer water tables. Sites with a relatively high summer water tables tend to show the greatest affinity towards M13. Winter water tables may be more or less at the surface in some sites.
- A relatively deep subsurface water table may be a perfectly natural feature of some sites. It is often difficult to know to what extent relatively dry stands are natural or represent remnants of formerly wetter M24 or another mire community.
- M24 is not normally associated with inundation, except to a very minor degree in the winter at particularly wet sites.

Suboptimal or damaging water levels

- A summer water table at or near the surface is likely to generate vegetation closer to other fen types than M24 (M24 is one of the few mire communities in which persistently high summer water tables may be damaging).
- Prolonged inundation in winter or summer is likely to lead to species losses.
- Strongly subsurface winter and summer water tables are probably outside of the normal range of this community. Precise tolerances are not known but it can be speculated that this will lead to a loss of wetland interest and increased representation by ‘dryland’ species.
- The potential for restoring M24 through rewetting of strongly dehydrated sites is largely untested.

15.3.2 Nutrients/hydrochemistry

Values for pH of soils supporting M24 are variable, ranging from mildly acidic to base-rich (Table 15.3). More acidic examples of the community are associated with less base-rich bedrocks and these are often transitional to M25.

Soil fertility is also variable: most examples are nutrient-poor or mesotrophic, but some eutrophic examples occur on deep peats of partly drained floodplain sites (for example, Barnby Broad, Suffolk) and tend to be transitional to M22.

15.3.3 Management

Mostly a secondary vegetation type with no natural analogues. Maintenance depends upon mowing or grazing management. The community can establish following woodland clearance and/or fen drainage on sites with a tradition of annual grazing and/or mowing for litter.

Table 15.2 Mean summer water table data for M24 stands in England and Wales

Mean Summer Water Table (cm bgl)	Mean	Min	Max
Eastern England (EE)	-21.4	-48.4	-10.0
England and Wales except EE	-9.2	-31.6	-2.0
All England and Wales	-15.1	-48.4	-2.0

Table 15.3 pH, conductivity and substratum fertility measured in stands of M24

Variable	Mean	±SE	Min	Max
Water pH	6.6	0.03	5.3	7.6
Water Conductivity (Kcorr µS cm^{-1})	581	2.0	60	1,034
Soil pH	6.7	0.02	5.4	7.7
Soil Fertility[23] (mg phytometer)	8.9	0.31	3	26

15.4 Implications for decision making

15.4.1 Vulnerability

M24 is particularly vulnerable to a reduction in water table, flooding and dereliction. The probable impacts of changes to the stand environment related to these three factors are identified in Figure 15.3. However, M24 can often be a product of drying of a former wetter fen community (such as M13).

For wet examples of M24, a reduction in water table will result in loss of mire and M13 species.

M24 is associated with relatively low summer water tables; attempts to make them wetter may have unexpected/undesired effects (for example, high dyke water levels at Chippenham Fen increased abundance of *Agrostis stolonifera* and probably reduced *Selinum carvifolia*).

Derelict stands are likely to become tall, rank and botanically impoverished and will be prone to scrub invasion and woodland succession. Typical M24 species (for example, *Cirsium dissectum*), are not woodland species and are likely to be intolerant of closed canopy shading.

15.4.2 Restorability

Reinstating regular vegetation management can improve stand quality. A degree of rewetting may be required in severely drained situations (though such measures are generally untested with respect to M24 restoration).

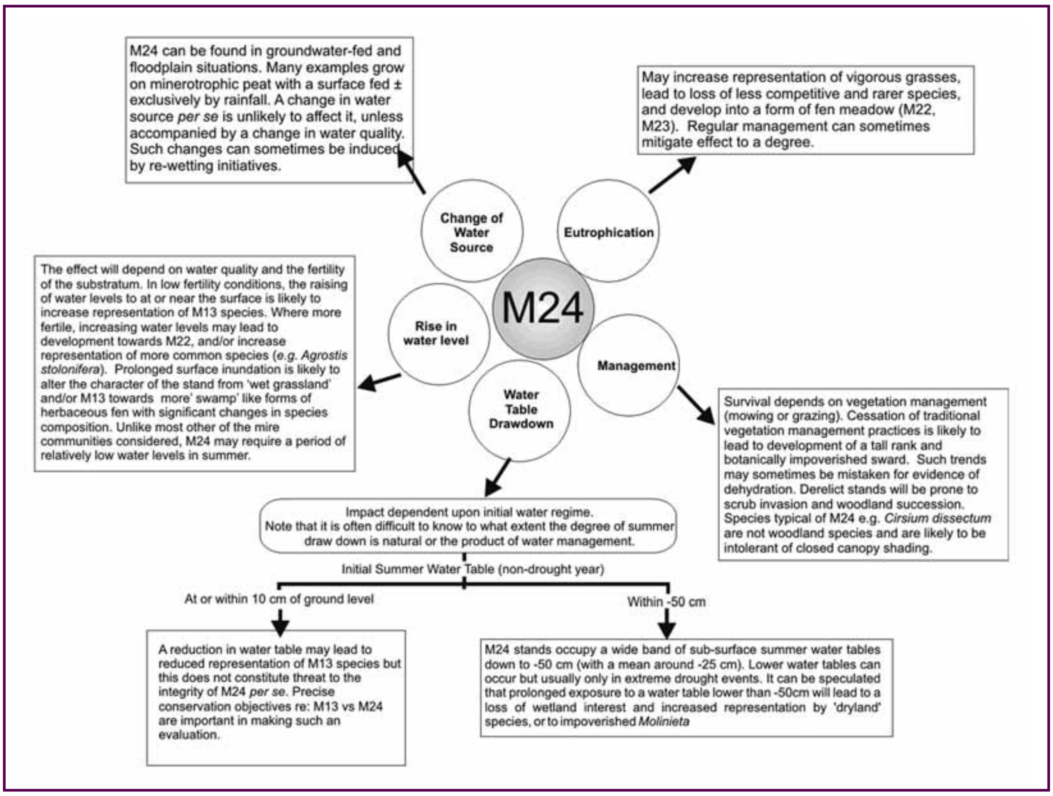
15.4.3 Limitations of these guidelines and gaps in knowledge

The limitations of the information presented here related to M24 include the following:

- The information presented here is primarily based on information from fen sites supporting M24, in which this community is frequently peripheral. No attempt has been made to collate/examine environmental information relating to this vegetation type from drained sites that are more wet grassland than fen, or from western examples (such as culm grasslands in the South-West and Rhôs pastures in Wales).
- There are currently no data to better inform the temporal water table characteristics of M24 stands. Time series of dipwell measurements are required to fill this gap.

[23] Experience has shown that N and P data derived from soil analysis has only limited use in assessing fertility of wetlands. Consequently the technique of phytometry (measuring the biomass of test species (phytometers) grown on soil samples) was developed. Typical phytometer yields (dry wt.); low fertility ‹ 8 mg, high fertility › 18 mg.

Figure 15.3 The possible effects of environmental change on stands of M24



- In order to make predictions on the vulnerability of M24 stands to water levels, models are required that can connect hydrogeological processes with hydrological conditions at the fen surface. This may require detailed ecohydrological studies at representative sites.
- A better understanding is needed of the water regime tolerances of M24. As it is often associated with sub-surface water tables, soil properties and precipitation inputs may be more critical than the position of the groundwater table.
- Data on the spatial extent of M24 are lacking.
- Possible differences in environmental conditions influencing the three sub-communities have not been explored.

M29 (*Hypericum elodes – Potamogeton polygonifolius*) soakway

16.1 Context

Examples of the M29 community have been included in the 'transition mire and quaking bog' SAC interest feature.

16.1.1 Floristic composition

M29 can be variable in species composition, but often moderately species-rich (Mean = 19.3; Range = 7–32). The community typically consists of mats of *Hypericum elodes* and *Potamogeton polygonifolius*, often within a submerged carpet of *Sphagnum auriculatum*, but with a limited range of vascular associates (for example, *Ranunculus flammula, Juncus bulbosus*). Although characteristically low-growing, M29 may be associated with *Phragmites*, with the core community persisting even in quite dense reedbeds (for example, Wilverley Bog, New Forest). On some flushed slopes the community can occupy a series of runnels, or in some cases form a mosaic with tussocks of *Molinia caerulea*.

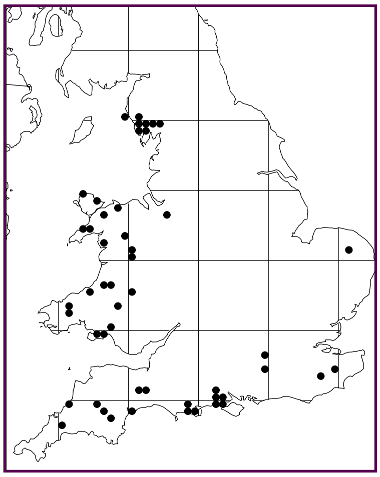
Fourteen rare mire species have been recorded from samples allocated to M29, of which perhaps the most distinguished is *Eriophorum gracile*. This occurs in water tracks that are clearly M29 at Fort Bog (New Forest) and in soakways which are less clearly this community at Crymlyn Bog (West Glamorgan). The Crymlyn examples also account for all of the known localities for *Carex elata* in this community.

16.1.2 Distribution

Characteristic of warm, oceanic parts of the country where February minima are usually above freezing; M29 has an exclusively western distribution in Britain, mainly occurring in the South-West, New Forest, Surrey, and throughout Wales, extending north into Southern Cumbria (recorded from 75 sites). FENBASE also has a number of M29 samples from the west coast of Scotland (Argyll and the Hebrides). The distribution maps do not do justice to the prevalence of this community in the New Forest, where it occurs widely and frequently to a degree not normally encountered in other locations.

The strongly oceanic distribution of this community, which reflects the oceanic distribution of *Hypericum elodes*, is suggestive of a climatic control on its distribution, but does not provide a reason for its distinctiveness from other soakway communities (such as M14, M9-1), which sometimes occur in close proximity to M29. The distribution of M29 in England and Wales is shown in Figure 16.1.

Figure 16.1 Distribution of M29 in England and Wales (from FENBASE database)



16.1.3 Landscape situation and topography

Particularly characteristic of shallow soakways, pools and water tracks within valleyhead wetlands but can also occur in hillslope, basin and floodplain wetlands. In some topogenous basins it can form a narrow trail through the main topogenous vegetation, probably representing a zone of greater lateral water flow. Sometimes found in isolated, shallow seasonal pools on heathlands.

16.1.4 Substratum

M29 soakways and water tracks occur both embedded within the (mostly shallow) peat of mires and as channels crossing sticky, clay-rich soils. The shallow soakways and pools usually have a substratum consisting of a mix of very loose peat, water and liquid muds over a more solid peat, although sometimes with a more consolidated surface, but some examples are quite strongly mineral (silt or clay) based. Basal material ranges from sands and gravels to silts and clays.

16.1.5 Zonation and succession

Some stands of M29 occupy channels within wet grassland or wet heath rather than mire, and can form the only representative of mire, often with a fairly sharp transition to adjoining drier ground. Most examples are however embedded within mire, typically as axial soakways and water channels flanked by mire slopes in valleyhead systems, but sometimes as soakways and runnels running transversely down the slopes of a valleyhead. The community also occurs in channels (in some cases occluded drains) flowing along the top of the mire slope and collecting water from springs and seepages. M29 is most often confined to discrete soakways and water tracks, but on occasion large areas of flushed slopes may support the community as a series of runnels and soakways in mosaic with tussocks of *Molinia* and shallow tumps of elevated peat. The most frequent flanking community is M21, but in drier circumstances it may be M25 and unusually, but where there is greater base enrichment, M10.

M29 can form discrete trails within topogenous hollows, apparently marking zones of lateral water flow. For example, in the north-western arm of Cors Gyfelog (Caernarvonshire) trails of M29 occur within a community of uncertain affinities, but which is probably mainly a form of M9-1. At Llyn y Fawnog (Denbighshire), M29 occupies a broad inflow track into the basin, flanked partly by carr and by M5 and extending into the central swamp of *Carex rostrata* and *Equisetum fluviatile*.

At sites such as Llyn y Fawnog and Cors Gyfelog, M29 appears to form part of the hydroseral process, albeit one that is sometimes disruptive of the broader hydroseral pattern. Both sites seem likely to be reflooded turbaries and the M29 trails may perhaps be best seen as units that are emerging within the hydroseral succession, in locations where gradual consolidation of the flanking peat infill constrains water flow into increasingly discrete water tracks. At Llyn y Fawnog, *Hypericum elodes* and *Potamogeton polygonifolius* patches are locally prominent components of the central swamp, particularly in some of the most tremulous locations of the floating mat, and may represent the precursors of future hydroseral spread of M29 across the basin. Both *H. elodes* and *P. polygonifolius* are known from hydroseral situations elsewhere, such as Louisa Lake (Kent) (Rose, 1953; Bellamy, 1967), where they form a vegetation which may be considered a species-poor, hydroseral variant of M29. However, the syntaxonomic status of some such topogenous stands is not clear: MATCH analyses reveal that their highest affinities are with M29, but the coefficients are small and their allocation to M29 may just reflect the absence of a better alternative.

Figure 16.2 Schematic representation of the major water supply mechanisms to M29 (after Wheeler, Shaw and Tanner, 2009)

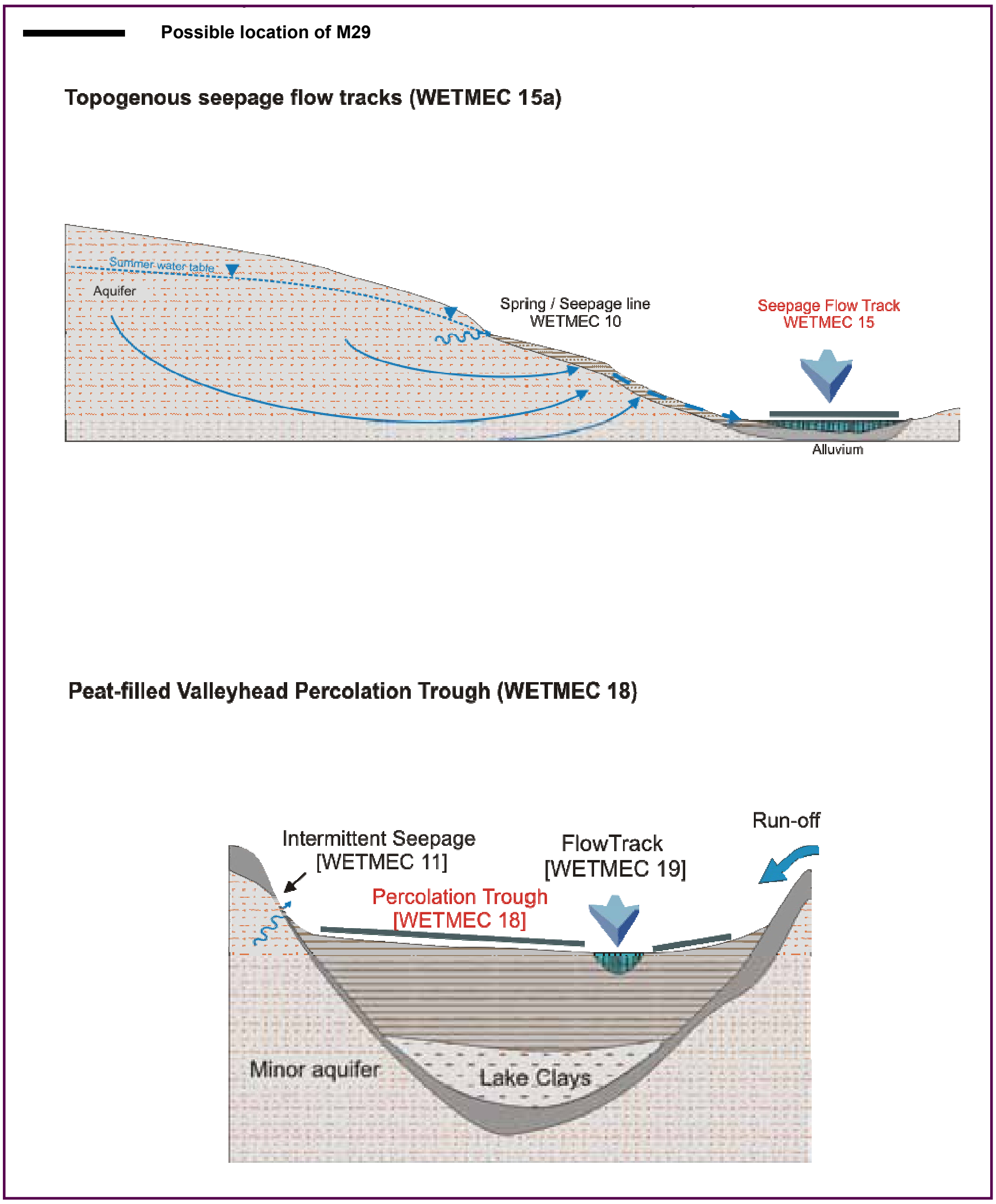
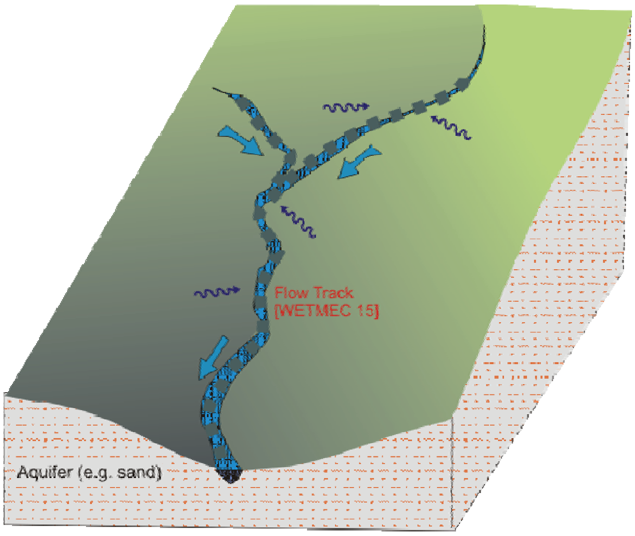


Figure 16.2 (continued)

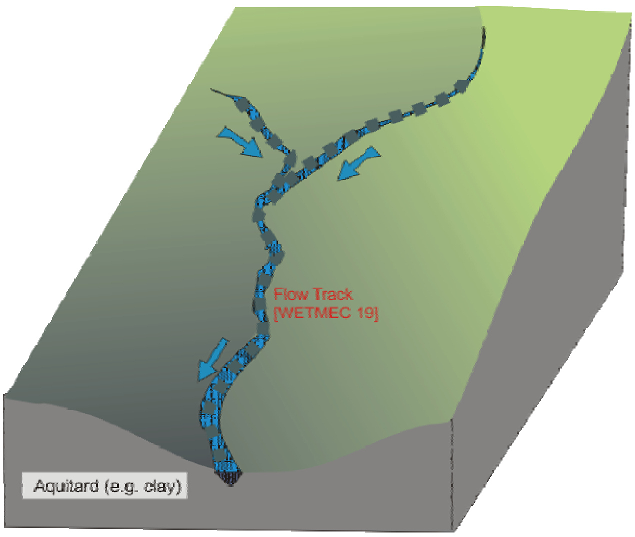
Possible location of M29

Seepage flow tracks (WETMEC 15)

Sloping seepage flow tracks (WETMEC 15b)



Flow tracks (WETMEC 19)



16.2 Supply mechanism and conceptual model

M29 stands are confined to situations with at least gently flowing water conditions: the majority are in soakways and water tracks, and examples in more topogenous locations (including peat cuttings) almost certainly received throughflow of water. 56% of M29 samples were identified as occurring within WETMEC 15 (seepage flow tracks such as Cors Graianog (Caernarfonlog (Caernarfon), Fort Bog (New Forest)), and 25% within WETMEC 19 (flow tracks such as Cors Gyfelog (Caernarfon)). A few examples occurred within WETMECs 10, 17 and 20. The main water supply mechanisms are illustrated schematically in Figure 16.2.

16.3 Regimes

16.3.1 Water

Mean values for annual rainfall and potential evaporation for the sites examined are given in Table 16.1, together with mean recorded values for summer water table associated with stands of M29.

Specific time-series data for stands of M29 are not available, and in general few detailed data are available for this distinctive, but little-investigated, community. It is therefore not possible to specify precise water regimes or tolerance to change, but the following comments can be made:

Optimal water levels

- Vegetation is usually shallowly flooded. Summer water levels are variable: in some sites they are generally at or just below the surface during the summer, but some soakways and hollows may have a summer water table well below the surface, though generally the mud bottom remains moist.
- Often forms a narrow, distinct zone within other vegetation types, picking out areas of increased lateral water movement or vertical fluctuation in water level.
- Above-ground water with at least some water movement through the stand during part of the year is a characteristic of this community, and may well be essential.

Sub-optimal or damaging water levels

- Strongly sub-surface water levels, particularly in winter, are outside of the normal range of this community, although some examples appear to tolerate drawdown in summer. Prolonged summer drawdown is likely to lead to a loss of wetland species and an increase of dryland species; it is also likely to improve accessibility to stock.
- Prolonged deep flooding may lead to loss of species diversity, though some examples of M29 frequently experience above-surface water levels.

Table 16.1 Rainfall, potential evaporation and water table data for M29

	Mean	Min	Max
Rainfall (mm a^{-1})	1,253	627	2,101
Potential Evaporation (mm a^{-1})	572	524	614
Mean Summer Water Table (cm agl or bgl)	2.5	-10	15

[24] Experience has shown that N and P data derived from soil analysis has only limited use in assessing fertility of wetlands. Consequently the technique of phytometry (measuring the biomass of test species (phytometers) grown on soil samples) was developed. Typical phytometer yields (dry wt.); low fertility ‹ 8 mg, high fertility › 18 mg.

16.3.2 Nutrients/hydrochemistry

Table 16.2 presents figures for pH, conductivity and substratum fertility measured in stands of M29. M29 is typically found in base-poor conditions with low fertility. Species richness has been found to increase with increases in calcium and bicarbonate concentrations, and more rare species were found in sites with higher conductivity and magnesium than average for the community (Shaw and Wheeler, 1991). Rodwell (1991) comments that "*the situations occupied by this vegetation are very distinctive but little understood*".

16.3.3 Management

Stands usually occur within grazed sites, although lack of management is not necessarily detrimental to species richness, although this may depend on the wetness of the substratum – in sites that dry out in summer, grazing may help to prevent scrub invasion. Heavy grazing may lead to poaching, in particular causing damage to the *Sphagnum* carpet. Heavily grazed sites tend to have lower species densities, and fewer fen and rare fen species than lightly grazed sites (Shaw and Wheeler, 1991). However, the nominative, and often dominant, species of the community (*Hypericum elodes* and *Potamogeton polygonifolius*) appear to be resistant to close grazing, and in some circumstances it is possible that such grazing may help account for the abundance and prominence of this community.

16.4 Implications for decision making

16.4.1 Vulnerability

Conservation management involves ensuring low fertility and relatively base-poor conditions, possibly coupled with some grazing. A substantial increase in fertility, which may occur as a result of substratum mineralisation following prolonged lowering of the water table, as well as direct nutrient inputs, may be detrimental to this community, and promote the establishment of more rank vegetation. Figure 16.3 shows some of the possible floristic impacts of changes to the stand environment.

16.4.2 Restorability

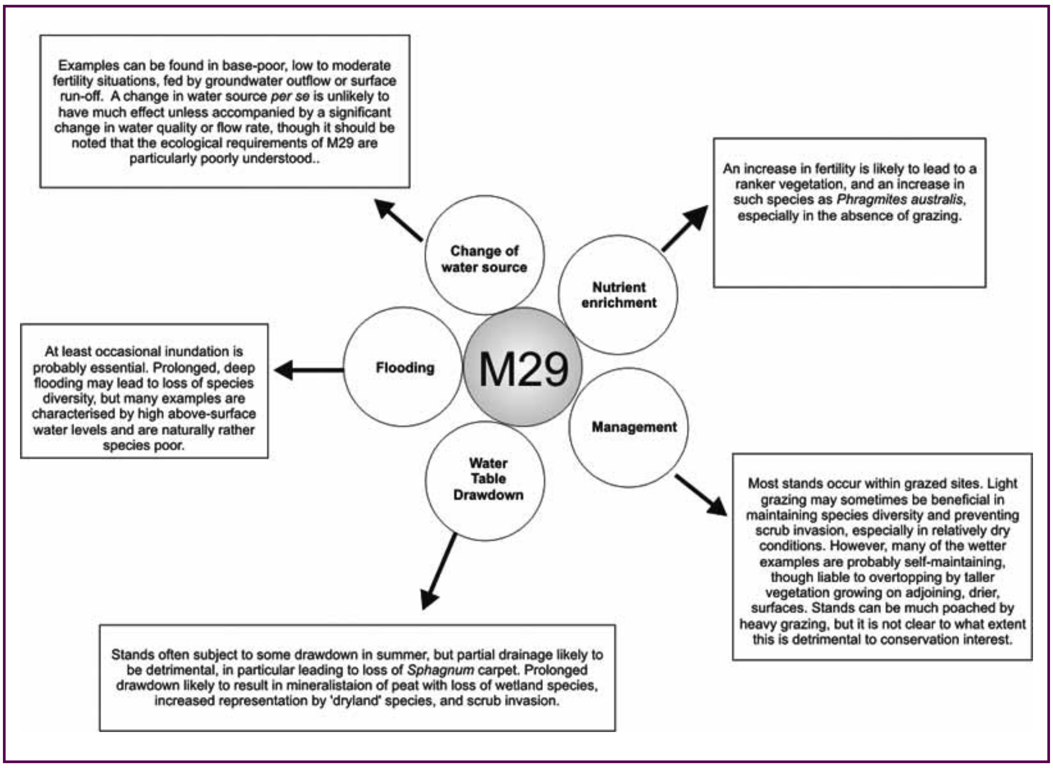
As with all restoration measures, their likely success depends on the cause of the 'damage', and how far the starting conditions are from the objective, both in time and conditions (for example, numbers of species lost, damage to substratum, degree of enrichment etc). Limited information is available on the restoration of M29 stands, but the following observations can be made:

- Where the community has been recently damaged, but this has not been intensive, corrective management may be sufficient to rehabilitate M29 in the short to medium term.

Table 16.2 pH, conductivity and substratum fertility measured in stands of M29

Variable	Mean	±SE	Min	Max
Water pH	5.2	0.03	4.5	6.4
Soil pH	5.3	0.04	4.5	6.4
Water conductivity (Kcorr $\mu S\ cm^{-1}$)	131	1.5	40	691
Substratum fertility[24] (mg phytometer)	6.9	0.2	2	13

Figure 16.3 The possible effects of environmental change on stands of M29



- In some circumstances, attempts to increase the wetness of examples of M29 by blocking outflows could be detrimental to the vegetation, but in general the response of this community to impeded drainage is to colonise the shallow pools thus created. In some circumstances, M29 may expand at the expense of flanking communities (such as M21).

16.4.3 Limitations of these guidelines and gaps in knowledge

The limitations of the information presented here related to M29 include the following:

- There are currently no data to better describe the temporal water table characteristics of M29 stands. Time series of dipwell measurements are required to fill this gap.
- In order to make predictions on the vulnerability of M29 stands to water levels, models are required that can connect hydrogeological processes with hydrological conditions at the fen surface. This may require detailed ecohydrological investigations at representative sites.
- Data on the spatial extent of M29 are lacking.
- More information is needed on tolerance to nutrient enrichment and nutrient budgets.
- More information is needed on appropriate restoration techniques.