Joint Nature Conservation Committee

Guidelines for the selection of biological SSSI's
Part 2: Detailed guidelines for habitats and species groups

7 FENS

To view other chapters of the guidelines visit : http://jncc.defra.gov.uk/page-2303

7 FENS

1 Introduction

1.1 Minerotrophic mires (fens) occur in waterlogged situations where they receive nutrients from the surrounding catchment as well as from rainfall. The catchment, hydrological situation and hydrological characteristics are fundamental influences upon the fen vegetation types. Waterlogging may result from 'ponding-up' of water by topography, or from surface emergence of ground-water as diffuse seepages or springs, or from a combination of these effects. But these circumstances are often complicated by superimposition of management effects. Fens occur in hydroseral sequence at the edges of lakes and rivers, and the largest examples are those that have expanded from such situations to occupy flood plains or main valley floors. Smaller examples occur in more restricted valleys, channels and basins and where ground-water emerges as diffuse seepage areas or more localised springs. The hydrological and morphological classification into **fen types** is shown in Figure 3. Fens can occur at all elevations, but the largest examples are in lowland situations and mountain occurrences are mostly small and scattered.

1.2 The geology and soils of the catchment strongly influence the chemical properties of the water supply and create a range of variation in fen vegetation. Within each fen type there can be plant communities differentiated by the base status (especially calcium) of the drainage water. Fens receiving calcareous, carbonate-rich, neutral to high-pH waters are generally regarded as 'rich fen', and those receiving water poor in calcium and carbonates and with a low pH are regarded as 'poor fen'. Classification according to these terms is often difficult because there is a continuum between the two extremes. Generally, rich fens are concentrated in lowland England and Wales and where calcareous substrates predominate. The predominance of hard, acidic substrates in the north of Britain favours the development of poor fen. Where the water supply is from various sources, more than one category of vegetation can occur within a single fen site, especially in valley mires.

1.3 Fen vegetation consists of a range of plant types varying in their adaptation to water table, from completely aquatic and free-floating to those which tolerate only seasonal root waterlogging. This gradient corresponds to the sequence of hydroseral development whereby open water bodies become colonised at their edges by successive zones of vegetation which migrate towards the centre as each builds up conditions favouring its replacement by a less hydrophilous phase. Monocotyledons figure importantly in fen vegetation, especially in the earlier stages, with grasses (e.g. Phragmites australis and Phalaris arundinacea), rushes and allies (e.g. Scirpus lacustris and Typha spp.) and sedges and allies (e.g. Carex spp. and Cladium mariscus) frequent. Dicotyledonous herbs are also important, especially in the drier phases, and ferns and allies (especially Equisetum spp.) are well represented. Some base-rich but generally oligotrophic fen communities have a carpet of bryalean mosses, mainly pleurocarpous species (often described as 'brown mosses'), but in certain situations the more base-tolerant species of Sphagnum begin to appear and many base-poor oligotrophic fens have a dominance of Sphagnum species. The peat formed from this wide range of plant communities varies considerably. That in eutrophic fens may be characterised by the remains of sedges, whilst that of base-poor, oligotrophic fens may be characterised by the remains of mosses, especially Sphagnum.

1.4 Lowland fens have been particularly subject to modification and destruction through human activity. After deforestation, draining of the great primeval swamps of the plains and valley floors has been the next largest modification of habitat caused by the development of agricultural and urban land. The draining and 'reclamation' of base-rich fen peats can give land of high agricultural productivity. The most celebrated example is the East Anglian Fenland, which covered about 3,380 square km in 1637 AD and is now reduced to remnants totalling some 10 square km, nearly *all* highly modified from their original state (Thomas et al. 1981). The attrition of other remaining fens, often small and isolated fragments or pockets, has continued up to the present day. Even when these remnants are not directly attacked, they may dry out irreversibly through lowering of water tables in the surrounding land. Many valley and basin fens lying within agricultural catchments are also subject to eutrophication effects from the inward drainage of water enriched by nitrogenous and phosphatic fertilisers. Most lowland fens now have highly artificial boundaries with farmland.

1.5 The drying of many lowland fens, through falling water tables, also accelerates the natural succession of the hydrosere, which ends with the formation of woodland. This usually remains as swamp woodland, of alder and willows, but creates a serious management problem in regard to retention of the earlier reed and sedge swamp with their important floristic and faunal communities. Many formerly extensive fen systems have been modified to give areas of seasonally moist 'grazing marsh' with grassland communities of considerable importance in their own right, for example in peripheral areas of the Norfolk Broads (e.g. Halvergate Marshes) and parts of the Somerset Levels. Generally these should be considered for selection as lowland grasslands (see C.3), but in some localities they have to be considered with adjoining fen in the definition of site boundaries. (See also C.6, 5.2.6.) Small areas of fen may develop anew through colonisation of abandoned and flooded sand- and gravel-workings and other artificial excavations, but most of these are so far of only minor interest (see 4.3.1).

1.6 The plant communities of minerotrophic mires are described in detail in the NVC reports on swamps and tall-herb fens (Rodwell 1984), mires (Rodwell 1986-1987), uplands (Rodwell 1989) and woodlands and scrub (Rodwell 1986) and they are summarised in Table 18. Table 19 is based on the NVC and the work of Dr B.D. Wheeler (especially Wheeler 1980a, b, c; Wheeler & Shaw 1987) and provides brief descriptions of the communities and the conditions and areas in which they occur. A glossary of technical terms is provided at the end of this chapter (11).

2 International importance

Lowland fens were once widespread and extensive in continental Europe, and some large examples still remain. There has, however, been the same kind of loss through drainage and reclamation as has occurred in Britain, and this is continuing. Though the British examples are perhaps not as distinctive in their biota as Britain's bogs (see C.8, 2), the best remnants (such as in the Norfolk Broads) nevertheless assume an increasing importance as the loss of continental fens continues. Close allies of the poorer types of northern fen are still widely distributed and extensive in Scandinavia, but even there they are losing ground as draining for commercial afforestation extends through the Boreal region. There has not been a proper assessment of the international value of British fens, and it is better to reserve judgement until such an assessment has been made, while bearing in mind the points made above.

3 Habitat selection requirements

3.1 Within each AOS the complement of fen sites should aim to include examples representing the full range of:

(a) topographical/hydrological fen types;

(b) ground-water chemistry, as reflected in plant communities and species; and

(c) associated animal communities and species (see C.13-19).

3.2 Interrelationships between fen topography, hydrology, water chemistry and vegetation are described in Table 19, as the basis for habitat selection. Although the division between topogenous and soligenous fens broadly corresponds to differences in vegetation types, not all plant communities are strictly confined to one or the other topographical/hydrological category.

3.3 Site selection based on fen habitats should take particular account of the following guidelines.

3.3.1 Within each AOS, at least one (preferably the best) example of every plant community listed in Table 19 that occurs in the AOS should be selected within each topographical/hydrological fen type in which it occurs. In AOSs in which nationally scarce communities and sub-communities are frequent and/or extensive (e.g. S24 in Broadland and M9 in the Borders of Scotland), more numerous examples may be selected.

3.3.2 Within each AOS, the best examples should be selected of clearly developed vegetation mosaics which represent hydroseral zonation or combinations of two or more fen types.

3.3.3 All examples of the rare or highly localised communities and sub-communities marked * in Table 19 should be considered for selection, within the total fen mosaic of which they are a part. If any of these prove to be more common in any part of the country than is currently known, the CSD fen/and specialist should be consulted.

3.3.4 Sites which may characterise either the geographical limits or the core of the national distribution of any fen community should be considered for selection.

3.3.5 Continuous areas of fen, of any category, which are not appreciably degraded and which individually exceed 10 ha in area should be considered for selection. Fens in the cultivated lowlands are now so scarce that even examples of over 5 ha which are not appreciably degraded should be presumed eligible for selection.

3.3.6 Sites of known Quaternary palaeoecological importance and those likely to contain especially long (i.e. inter-glacial or late-glacial) undisturbed sequences of material should be considered for selection.

3.3.7 In the uplands, where soligenous fens of various kinds are usually well developed, their representation will largely be taken into account in the selection of upland sites (see C.9); in a few cases, however, upland sites will be chosen largely for the interest of their soligenous and/or topogenous fens, particularly on the basis of the extent of the different communities and their diversity within a single area.

3.3.8 Transitions to other types of non-peat/and habitat are also features of some significance in the selection process (see 8 below).

3.4 More specific guidance is given below. The main topographical/hydrological fen types are illustrated in Figure 3.

4 Topogenous fens

Three main types of topogenous fen are distinguished - flood-plain fens, basin fens and open water transition fens. Basin and open water transition fens are very similar in essential characteristics but differ in the proportion of fen area to that of open water. Topogenous fens are in general peat-forming systems, though flood-plain fen peats may show considerable mineral content close to the river. This mineral input provides a source of nutrients to flood-plain fens, and some sites in nutrient-rich catchments may be naturally eutrophic. The size of topogenous fens is variable: in general, basin fens are not large, but flood-plain fens can be extensive.

4.1 Flood-plain fens

4.1.1 This fen type is still widely distributed throughout Britain, but the once vast tracts of ill-drained, flooded valley floors alongside mature rivers have been drained and reclaimed largely for agricultural use. There are only a few large expanses of flood-plain fen remaining, such as the East Anglian Broadland, Cors Erdreinniog on Anglesey and Irish Marshes in Scotland. In general this site type is represented by isolated patches surrounded by drained fields, as at Cors Geirch. Thus large sites of over 10 ha are at a premium and any that are not appreciably degraded should be selected.

4.1.2 In situations where individual fen sites within a flood-plain are separated by reclaimed land, consideration should be given to including the reclaimed land within the SSSI, thus uniting the sites. Further drainage activities within the intervening land can detrimentally affect the remaining fens. Furthermore, in many cases the conversion of the reclaimed fields back to a fen hydrology, even if only a limited fen vegetation, may be feasible and indeed a desirable aim in order to re-establish a more natural hydrological regime for the surviving fragments.

4.1.3 Flood-plain fens may exhibit vegetation zonation reflecting decreasing soligenous influence away from the valley sides towards an increasing influence of a vertically fluctuating water table of the flood-plain expanse. As the river is approached, the influence of more frequent flooding and silt deposition may be reflected in the vegetation. In most sites this zonation is blurred by management activities, but, if apparent, it is a valuable site attribute.

4.1.4 South and south-east Britain is the locus for eutrophic flood-plain fens, with the main concentrations in the Broadland of East Anglia. Examples of this fen type are particularly rare in north and west Britain and therefore all sites of acceptable quality there should be selected.

4.1.5 Oligotrophic flood-plain poor fen is the most frequent fen type of flood-plains in north and west Britain, but only in relatively few sites such as Insh Marshes are extensive stands present. Therefore all examples of over 10 ha should be selected if they are not appreciably degraded.

4.1.6 Management of flood-plain fens for grazing has given rise to various fen meadow communities, and these are discussed in 6 below. Management is also undertaken for reed and sedge and less often for 'litter' (hay). Such forms of management are traditional and can be acceptable and indeed are often desirable for conservation purposes, particularly in controlling scrub encroachment. In the assessment of sites for SSSI selection, management which is sympathetic to nature conservation is valuable, and this factor should be given extra weight.

4.2 Basin fens

4.2.1 These fens are usually of limited size (often less than 10 ha). Therefore even sites as small as 1 ha should be considered for selection if of acceptable vegetational quality.

4.2.2 Two separate forms of basin fen, based upon mode of development, have been recognised (Figure 3) - those having a continuous sequence of peat from the surface to the fen base and those in which layers of peat are separated by lenses of water (the Schwingmoor type). The latter is scarce, though quite frequently small areas of Schwingmoor can be found within other fen types, such as open water transition fens. Where basin fens have developed within pingos and kettleholes and a long stratigraphical record is present, they are often of particular palynological (pollen-study) importance.

4.2.3 Some basin fens show unusual features. Those fed by peripheral springs may take on a soligenous character. Others feature vegetation zonation in relation to water movement, where enhanced peripheral flows may produce a more soligenous fen community type; this surrounds a 'fen plane' community type where vertical water table fluctuations are more significant than lateral movements.

4.2.4 Base-rich, calcareous basin fens are particularly uncommon. Community M9 is often characteristic of such sites, but drier sites, particularly in northern Britain, may display examples of community M26 (Molinia caerulea - Crepis paludosa mire).

4.2.5 Base-poor basin fens are more widespread than base-rich sites, though stands larger than 10 ha are infrequent.

4.2.6 The site boundary of a basin fen should ideally encompass all influencing slopes and feeding springs and flushes. It should also extend part of the way along the outflow stream as a protection against lowering of the channel, which can effectively drain the fen. However, it is not possible to generalise how far the boundary should extend along the stream; this will have to be judged on site.

Figure 3 to be inserted after consultation

Flood-plain fen
This type of fen develops on a waterlogged, often periodically inundated flood-plain adjacent to a river or stream.

Basin fen
This type develops in a waterlogged basin with limited through-flow of water. Within the basin the water table is level, but small flushes may occur along the basin's sides. The proportion of open water, if present, is small.

Basin fen - Schwingmoor type
A raft of vegetation colonising an open water surface eventually sinks to form a layer of peat. This process is repeated, giving rise to a semi-floating structure formed by layers of peat alternating with semi-liquid lenses.

Open water transition fen
This type of fen develops around a body of open water. The proportion of open water is large.

Figure 3 The main topographical/hydrological types of fens (after Wheeler 1984) - topogenous and soligenous

Valley fen
This type of fen develops along the lower slopes and floor of a small valley where there is some water movement. Springs and seepage from the valley sides provide the main source of water. The topography of the valley often also helps to maintain a high water table.

Spring fen
This type arises on a slope beneath a spring or line of water seepage. The fen is discrete and not part of an elongated mire along a valley.

Spring fen
Water reaching the surface under artesian pressure gives rise to a small dome of mire, usually on flat ground.

Soakway within an oligotrophic mire
This type of fen occupies channels and areas of lateral movement within oligotrophic peatlands.

'Ladder fen'
This recently identified type of fen is exclusively associated with sloping, elongated depressions within blanket mire which have a degree of enhanced lateral water movement. A series of pools separated by narrow ridges lies across the main direction of water flow. There is no evident central water-track.

4.3 Open water transition fens

4.3.1 Extensive areas of swamp and fen may occur around lakes and pools in sheltered positions. Open water transition fens tend to be widespread, except in lowland England where standing open water is comparatively scarce. Though fen development may occur quite readily in, for example, sand- and gravel-pits, such sites rarely exhibit the full diversity of natural sites.

4.3.2 Open water transition fens are essentially similar to basin fens, though the proportion of open water is greater than that of fen. Because of this alteration of emphasis, site selection should pay particular attention to the aquatic communities (see C.6, 4) as well as to the fen. Where full hydroseral succession occurs, this should favour site selection. Often successional sequences are blurred or even truncated by management, disturbance and fluctuations in the level of the water body.

4.3.3 Communities which may be found in drier areas of these sites have been discussed in the sections dealing with flood-plain and basin fens. Attention needs to be given to swamp communities (see Table 19), swamp being defined as species-poor vegetation types generally dominated by bulky emergent monocotyledons in open water transitions with permanently or seasonally submerged substrates (Tansley 1939; Spence 1964).

4.3.4 Where open water transition fen communities are not of special interest in their own right, for example owing to their small size, they may nevertheless be a desirable feature of an open water site and should be considered in the selection of such sites (see C.6, 4.3.1-3).

5 Soligenous fens

5.1 This group of fens includes mires associated with springs, rills and flushes in the uplands, 'ladder fens', valley mires, springs and flushes in the lowlands, soligenous trackways in blanket bogs and laggs of raised bogs.

5.2 Soligenous fens may or may not form peats, but they typically overlie peaty gley soils where the humus is no more than 30-40 cm deep. In the uplands, springs, rills and flushes are normally associated with immature soils where continual erosion by moving water prevents the accumulation of any organic material. In upland valleys and in the lowlands, soligenous fens are more likely to be peat-accumulating systems (though there are exceptions). Peat deposits associated with calcareous springs are often mixed with tufa (deposits of calcium carbonate formed by precipitation from water on plant remains).

5.3 The size of soligenous fens is very variable: spring fens in both the uplands and the lowlands are usually very small, but valley fens may be extensive in both situations. Valley fens tend to lose the distinctiveness of their hydromorphological form in areas of northern Britain dominated by blanket bog.

5.4 'Ladder fens' are a very recently identified mire type in Britain. They have so far been recorded from the blanket mires of Caithness and Sutherland, Wester Ross and the Outer Hebrides. Though always small, they resemble Fennoscandian aapa mires in structure and hydrology, in that they lie in a broad zone of water seepage but have ridges which lie across the direction of seepage (Figure 3; Lindsay et al. 1988, pp. 72-74). Their name has been borrowed from Canadian literature, after those 'ribbed' (= aapa) fens of Canada that lie in oceanic regions. These are distinct from the larger, more continental ribbed fens and are termed 'ladder fens' in Canada. Dr Stephen Zoltai, of the National Wetland Inventory of Canada, has confirmed the similarity between British and Canadian ladder fens. However, vegetation types associated with these fens in Britain have yet to be defined.

5.5 The problem of catchments and boundaries is particularly acute when one is considering soligenous fens. Their dependence upon subsurface sources of water for their essential characteristics and existence means that activities which can influence water table level, flow and pressure, such as water abstraction and damage to aquifers by quarrying, should be viewed with concern. Boundaries should encompass all springs and flushes upon which the fen is dependent. Ideally, all slopes potentially influencing the fen should be included within the site. However, as this may not always prove practicable, boundaries should extend at least as far as the first major break of slope (see 9.2).

5.6 The vegetation communities of soligenous fens can be broadly subdivided according to the altitude at which they are found (though there is a degree of overlap). High-altitude communities (M7, 10, 11, 12, 31, 31, 33, 34, 35, 37 and 38) are usually selected in conjunction with upland sites (see C.9).

6 Fen-meadows

6.1 These communities do not show a close association with a particular fen hydromorphological type and are therefore considered separately. Fen-meadows may occupy two sorts of location:

(a) peripheral to other fen vegetation, usually on drier land, though in some cases the adjacent fen vegetation may have been lost, thereby isolating the fen-meadow;

(b) intermixed with other fen communities.

In both situations the fen-meadow has been produced by management (grazing, mowing and/or burning) and is dependent upon the maintenance of management for its continued existence. Neglect results in dominance by tall herbaceous species and/or invasion by woody plants. Sizes of fen-meadow sites are variable and defy generalisation.

6.2 Fen-meadows are usually part of the farming landscape and therefore site boundaries may coincide with field boundaries for the sake of practicality. Where these sites are located at the foot of or on a slope, the boundary should ideally encompass the area upslope of the site (see 9.2). Seven fen-meadow communities (M22-28) are identified (see Table 18) and descriptions are presented in Table 19.

7 Fen woodlands

7.1 Fen woodland communities (Rodwell 1986) may occur as isolated stands - regarded as woodland habitat - or in association with open fen - regarded as fen habitat. Table 19 characterises the main fen woodland communities (W1-6) and it can be seen that they tend to be associated with (though they are not restricted to) topogenous sites. Within flood-plain fens, basin fens and open water transition fens, woodland communities may occupy distinct zones and readily invade open fen areas. The previous fen community often remains in the field layer. Invasion often follows a cessation of management or some disturbance, though it can be a natural development (as in the invasion of Carex paniculata tussock tops by Salix cinerea).

7.2 Selection of isolated fen woodlands should follow recommendations made in C.2. Fen woodland communities associated with open fen should be considered for inclusion in open fen sites. Communities W2 and. W3 (particularly W3b) are particularly scarce and contain rare species; they may therefore constitute the main reason for selecting a site.

8 Transitions between fen and other semi natural habitats

8.1 In site selection it is important to consider the relationship between the fen habitat and adjacent semi-natural habitats. Natural transitions are now infrequently encountered and zonations are often truncated and degraded. The main transitions found are to open water, heathland, ombrotrophic mire, grassland, woodland (see 7 above) and to a lesser extent saltmarsh and sand-dunes.

8.2 Open water

The transition from fen (with the summer water table generally at or below the surface) to open water through a range of swamp (with the summer water table at or above the surface) and aquatic communities is usually best developed where lakes display:

(a) a shallow periphery gradually deepening towards the centre;

(b) a relatively stable water level; and

(c) limited erosion along the shore.

The fen/open water sequence is predominantly hydroseral, with colonisation by fen occurring from the shore into the lake. Colonisation may be in the form of rooted emergents and/or floating rafts of vegetation which are still attached to the main fen body. Particular fen and swamp communities tend to be associated with certain aquatic communities according to the trophic status of the water body (see C.6, Table 14).

Recommendation: The boundary of an open water transition community should ideally include the water body and the outlet stream for the following reasons.

8.2.1 The water level of the lake generally represents the controlling level of the fen water table. Therefore, if the lake water level drops, the water table of the fen can be expected to do so also.

8.2.2 Although floating fen rafts are able to compensate for fluctuations in lake level within limits, the structure of the raft and underlying substrate is not necessarily known. Though the raft is apparently floating, beneath it there may in fact be part-liquid peat or even submerged older rafts which will form a semi-solid mass if the lake level drops.

8.2.3 Extreme draw-down will lead to the exposure of substrate. Though this may be colonised by fen plants, it is just as likely to be colonised by such species as Juncus effusus and Bidens spp. However, very occasionally this draw-down zone becomes colonised by an unusual combination of species, and such sites should be considered on their merits.

8.3 Heathland

The transition from fen (mainly valley mires) to heathland occurs mainly on the large heathland complexes of southern England and Wales. In general, the sequence is from poor fen through wet heath and humid heath communities to dry heath. In some notable cases rich fen may occur within the poor fen/heath sequence, as at Buxton Heath and Roydon Common in Norfolk, and this is particularly unusual. Flushes may interrupt this neat sequence. The full expression of the sequence is most often encountered in gentle-sided, shallow valleys. In poor fens of southern England Narthecium ossifragum - Sphagnum papillosum valley mire (M21) communities are gradually replaced by wet heath communities, e.g. Erica tetralix - Sphagnum compactum (M16), with dry heath communities (Rodwell 1988) on the upper slopes and hilltops.

Recommendation: The boundary of valley mires should ideally incorporate all adjacent heathland. Even where the heathland is particularly degraded but still contributes to the whole catchment area, it should be included within the site boundary.

8.4 Ombrotrophic mire

The transition from fen to ombrotrophic mire occurs in three situations:

(a) seepages within or adjoining blanket mire;

(b) the lagg of raised mires;

(c) within peat-cuttings which have penetrated to a mineral substrate.

8.4.1 Within blanket mire, enhanced seepages, run-off from mineral outcrops (as on Rannoch Moor) and springs allow the development of poor fen. Similarly, poor fen may develop where blanket mires adjoin mineral slopes. The most frequent communities are Carex rostrata - Sphagnum recurvum (M4), Carex echinata - Sphagnum recurvum/ auriculatum (M6), Carex rostrata - Potentilla palustris (S27) and Carex rostrata - Sphagnum squarrosum (M5). These communities may grade into Scirpus cespitosus - Eriophorum vaginatum (M17), Calluna vulgaris

Eriophorum vaginatum (M19) or Erica tetralix - Sphagnum papillosum mire (M18) (Rodwell 1986-1987).

8.4.2 Fen communities are usually developed peripherally to a raised mire and occupy the lagg zone, which may or may not carry a stream. Here minerotrophic water may give rise to a number of plant communities which are usually poor fen in character (similar to the above) but may occasionally approach rich fen, as at Borth Bog near Aberystwyth, where Phragmites australis is an important component.

8.4.3 The minerotrophic influence present at the base of some peat-cuttings may lead to the localised development of fen communities. Once again poor fen is more usually present, but in some lowland localities rich fen communities occur, as at Thorne, Crowle and Goole Moors in Humberside, where Cladium mariscus is found in ditches.

Recommendations: The poor fen communities associated with blanket mires add habitat diversity to this vegetation type and form intimate hydrological links with the main peat body; they should therefore be included within the site boundary. The lagg-fen of raised mires is often missing through peat-cutting, but when present it should be regarded as an integral part of the raised mire site. Fen communities occupying peat-cuttings may be of intrinsic interest in themselves and may also show a distinct tendency towards the development of more typical ombrotrophic mire communities.

8.5 Grassland

In many situations the transition between fen/mire and grassland has been truncated by agricultural activities. Improved pasture often abuts directly on to fen-meadow or rush-pasture (M22-24) and Molinia-dominated mire communities (M25 and M26). However, it is possible to differentiate both mesotrophic and calcareous grassland communities which are associated with fens.

8.5.1 Mesotrophic grassland communities (Rodwell 1981) typical of ill-drained permanent pastures and occurring both as a mosaic with the wetter fen communities and occupying a peripheral position are:

(a) Holcus lanatus - Juncus effusus rush-pasture (MG10), which in some cases may be derived by grazing from Iris pseudacorus - Filipendula ulmaria mire (M28); this is found in the lowlands up to the upland fringes;

(b) Holcus lanatus - Deschampsia cespitosa coarse grassland

(MG9), within the lowlands;

(c) Cynosurus cristatus - Caltha palustris flood-pasture (MG8), associated with springs, flushes and seepages particularly in water meadows.

8.5.2 Calcicolous grassland communities (Rodwell 1985a) which are often associated with small sedge mires and calcareous flushes mainly in northern Britain are:

(a) Festuca ovina - Agrostis capillaris - Thymus praecox grassland (CG10);

(b) Festuca ovina - Agrostis capillaris - Alchemilla alpina grass-heath (CG11);

(c) Festuca ovina - Alchernilla alpina - Silene acaulis dwarf-herb community (CG12).

Recommendations: In the selection of SSSIs, due regard should be given to the need to include related grassland types. Where such communities are not of SSSI standard in their own right they may be included within the fen SSSI boundary if:

(a) they occur as part of an intricate wet/dry mosaic with the fen;

(b) they form the principal communities of surrounding slopes which may have an important influence on the fen; or

(c) they form the principal communities of adjacent land regarded as required buffer land.

8.6 Coastal communities

The transition zone from fen communities to coastal communities (saltmarsh and sand-dunes: Rodwell 1983, 1985b) has usually been disturbed or truncated. In this situation fen communities develop where there is wholly or predominantly a freshwater influence (brackish Phragmites beds possibly being an exception) and where slopes are gentle.

8.6.1 The upper saltmarsh communities, e.g. Festuca rubra (SM16), may grade into Phragmites australis (S4), Eleocharis palustris (S 19), Scirpus lacustris ssp. tabernaemontani (S20) and Scirpus maritimus (S21) swamp communities (see C.1, Table 2a, 5). The extent of such swamps is often limited, though estuaries in particular may contain extensive stands (e.g. the Deben Estuary in Suffolk and the Tamar Estuary near Plymouth). Characteristically, the Puccinellia maritime (SM13) community of Scottish loch-heads can be seen grading into small stands of Iris pseudacorus - Filipendula ulmaria mire (M28) (see C.1, Table 2a, 6).

8.6.2 Sand-dunes may also exhibit a landward transition to the above-mentioned swamp communities and also to Equisetum fluviatile swamp (S10) and to Juncus effusus/acutiflorus - Galium palustre rush-pasture (M23). In addition, fen/swamp communities may also be associated with dune slacks. This intermixture of fen communities within a dune complex is particularly notable.

Recommendation: The fens associated with the landward transition of saltmarsh and sand-dune habitats, unless particularly degraded, should be included within the boundary of a site selected for the related coastal habitat (see C.1).

9 SSSI boundaries, catchments and buffer zones

9.1 Most fens have *a* surface catchment contributing water to the fen and a subsurface catchment which influences the ground water table and hydrological inputs from springs and seepage. The subsurface catchment may be particularly extensive when formed by the regional aquifer. The surface catchment or contributing slopes will vary in their extent, and so the degree of sensitivity of fens to activities taking place within the catchment will also vary.

9.2 Many fens require a buffer zone (see B, 5.4; C.8, 6) of land adjacent to or surrounding the fen proper. This additional area has to be regarded as integral to the special interest of the site, because adverse land-use (e.g. drainage or fertiliser application) within it can profoundly modify and degrade the fen. It may or may not be semi-natural habitat and is included to protect the fen core against potentially damaging operations. The size of the buffer zone should be determined in the field and from soil evidence. Ideally, the site boundary of a fen should encompass the surface catchment and follow an identifiable feature in the field, even if this boundary encompasses 'improved' land. But such an approach is not always practicable, and in such situations the following guidelines apply.

9.2.1 The boundary should include the steepest slopes adjacent to the fen, at least as far as the first break of slope (i.e. where a change in angle of slope occurs).

9.2.2 The boundary should include all peripheral ditches, following the outer edge of such ditches (i.e. the side furthest from the fen).

9.2.3 The boundary should encompass all feeding springs and zones of seepage (see 4.2.6).

9.2.4 The boundary should extend part of the way along the outflow stream of the site (see 4.2.6).

9.3 Fens may be detrimentally affected by influences derived even from outside the surface catchment; for example sewage pipes may be directed towards the fen from adjacent catchments. Investigations into possible sources of fen eutrophication should include an assessment of influences from outside the fen catchment.

10 References

FULLER, R.M. 1986. Taking stock of changing Broadland. IL Status of semi-natural and man-made habitats. Journal of Biogeography, 13, 327-331.

LINDSAY, R.A., CHARMAN, D.J., EVERINGHAM, F., O'REILLY, R.M., PALMER, M.A., ROWELL, T.A., & STROUD, D.A. 1988. The Flow Country. The peatlands of Caithness and Sutherland, ed. by D.A. Ratcliffe and P.H. Oswald. Peterborough, Nature Conservancy Council.

RODWELL, J. 1982. National Vegetation Classification. Mestotrophic grasslands. University of Lancaster, unpublished report to the Nature Conservancy Council.

RODWELL, J. 1983. Natural Vegetation Classification. Salt-marsh communities. University of Lancaster, unpublished report to the Nature Conservancy Council.

RODWELL, J. 1984. National Vegetation Classification. Swamps and tall-herb fens. University of Lancaster, unpublished report to the Nature Conservancy Council.

RODWELL, 3. 1985a. National Vegetation Classification. Calcicolous grasslands and related vegetation types. University of Lancaster, unpublished report to the Nature Conservancy Council.

RODWELL, J. 1985b. National Vegetation Classification. Shingle, strandline and sand-dune vegetation (preliminary conspectus). University of Lancaster, unpublished report to the Nature Conservancy Council.

RODWELL, J. 1986. National Vegetation Classification. Woodlands and scrub. University of Lancaster, unpublished report to the Nature Conservancy Council.

RODWELL, J. 1986-1987. National Vegetation Classification. Mires. University of Lancaster, unpublished report to the Nature Conservancy Council.

RODWELL, J. 1988. National Vegetation Classification. Heaths. University of Lancaster, unpublished report to the Nature Conservancy Council.

RODWELL, J. 1989. National Vegetation Classification. Calcifugous grasslands and miscellaneous upland communities. University of Lancaster, unpublished report to the Nature Conservancy Council.

SPENCE, D.H.N. 1964. The macrophytic vegetation of freshwater lochs, swamps and associated fens. In: The vegetation of Scotland, ed. by J.H. Burnett, 306-425. Edinburgh, Oliver and Boyd.

TANSLEY, A.G. 1939. The British Islands and their vegetation. Cambridge, Cambridge University Press.

THOMAS, G.J., ALLEN, D.A., & GROSE, P.B. 1981. The demography and flora of the Ouse Washes, England. Biological Conservation, 21, 197-229.

WHEELER, B.D. 1980a. Plant communities of rich-fen systems in England and Wales. I. Introduction. Tall sedge and reed communities. Journal of Ecology, 68, 365-395.

WHEELER, B.D. 1980b. Plant communities of rich-fen systems in England and Wales. IL Communities of calcareous mires. Journal of Ecology, 68, 405-420.

WHEELER, B.D. 1980c. Plant communities of rich-fen systems in England and Wales. M. Fen meadow, *fen* grassland and fen woodland communities and contact communities. Journal of Ecology, 68, 761-788.

WHEELER, B.D. 1984. British fens: . a review. In: European mires, ed. by P.D. Moore, 237-281. London, Academic Press.

WHEELER, B.D., & SHAW, S.C. 1987. Comparative survey of habitat conditions and management characteristics of herbaceous rich-fen vegetation types. Peterborough, Nature Conservancy Council (Contract surveys No. 6).

11 Glossary of technical terms

Kettlehole	This term applies to a depression originally formed when stagnant ice which had been buried beneath fluvioglacial deposits subsequently melted.
Laza	This term applies to the natural peripheral zone of a raised mire, which receives water from adjacent mineral ground as well as from the mire itself and from rainfall.
Minerotrophic	The supply of nutrients in the water feeding the fen is principally derived from the mineral catchment.
Pingo	During periglacial conditions extending permafrost caused previously unfrozen ground-water lenses to expand under pressure, leading to the doming of the overlying deposits. When the frozen ground-water melted, the overlying deposits collapsed and a basin was produced.
Soligenous	High water tables are maintained principally by lateral water movement.
Topogenous	High water tables are maintained principally by the topography of the site.

Table 18 National Vegetation Classification - communities of minerotrophic mires

The NVC communities are here divided into:

(a) hydrological types, i.e. topogenous and soligenous;

(b) fen-meadows and fen woodlands.

Topogenous situations

S24	Phragmites australis - Peucedanum palustre tall-herb fen
S25	Phragmites australis - Eupatorium cannabinum tall-herb fen
S26	Phragmites australis - Urtica dioica tall-herb fen
S27	Carex rostrata - Potentilla palustris tall-herb fen
S28	Phalaris arundinacea tall-herb fen
M4	Carex rostrata - Sphagnum recurvum mire (also soligenous)
M5	Carex rostrata - Sphagnum squarrosum mire
M8	Carex rostrata - Sphagnum warnstorfii mire
M9	Carex rostrata - Calliergon cuspidatum mire

Swamp communities (mainly topogenous)

S1	Carex elata swamp
S2	Cladium mariscus swamp and sedge-beds
S3	Carex paniculata swamp
S4	Phragmites australis swamp and reed-beds
S5	Glyceria maxima swamp
S6	Carex riparia swamp
S7	Carex acutiformis swamp
S8	Scirpus lacustris ssp. lacustris swamp
S9	Carex rostrata swamp
S10	Equisetum fluviatile swamp
S11	Carex vesicaria swamp
S12	Typha latifolia swamp
S13	Typha angustifolla swamp
S14	Sparganium erectum swamp
S15	Acorus calamus swamp
S16	Sagittaria sagittifolia swamp
S17	Carex pseudocyperus swamp
S18	Carex otrubae swamp
S19	Eleocharis palustris swamp
520	Scirpus lacustris ssp. tabernaemontani swamp
522	Glyceria fluitans swamp

Soligenous situations

M4	Carex rostrata - Sphagnum recurvum mire (also topogenous)
M6	Carex echinata - Sphagnum recurvum/auriculatum mire
M7	Carex curta - Sphagnum russowii mire
M10	Carex dioica - Pinguicula vulgaris mire
M11	Carex demissa - Saxifraga aizoides mire
M12	Carex saxatilis mire

M13 Schoenus nigricans - Juncus subnodulosus mire
M14 Schoenus nigricans - Narthecium ossifragrum mire
M17 Scirpus cespitosus - Eriophorum vaginatum blanket mire
(can occupy valley situations in northern Britain)
M21 Narthecium ossifragum - Sphagnum papillosum valley mire
M29 Hypericum elodes - Potamogeton polygonifolius soakway

Communities particularly associated with springs and flushes

M31 Anthelia julacea - Sphagnum auriculatum spring
M32 Philonotis fontana - Saxifraga stellaris spring
M33 Pohila wahlenbergii var. glaciaiis spring
M34 Carex demissa - Koenigia islandica flush
M35 Ranunculus omiophyllus - Montia fontana
M36 Communities of shaded springs and streambank
M37 Cratoneuron cornmutaturn/filicinum - Festuca rubra spring
M38 Cratoneuron commutatum - Carex nigra spring

Fen-meadows

M22 Juncus subnodulosus - Cirsium palustre fen-meadow
M23 Juncus effusus/acutiflorus - Galium palustre rush-pasture
M24 Molinia caerulea - Cirsium dissectum fen-meadow
M25 Molinia caerulea - Potentilla erecta mire
M26 Molinia caerulea - Crepis paludosa mire
M27 Filipendula ulmaria - Angelica sylvestris mire
M28 Iris pseudacorus - Filipendula ulmaria mire

Fen woodlands

W1 Salix cinerea - Galium palustre
W2 Salix cinerea - Betula pubescens - Phragmites australis
W3 Salix pentandra - Carex rostrata
W4 Betula pubescens - Molinia caerulea
W5 Alnus glutinosa - Carex paniculata
W6 Alnus glutinosa - Urtica dioica

Table 19 Description, habitat conditions and range of fen communities

Notes

Community names in brackets in column 1 are those of Dr B.D. Wheeler.
The figures in brackets in column 2 represent mean species per 2 x 2 m quadrat.
* Rare or highly localised communities or sub-communities, of which all examples should be considered for selection (see 3.3.3).
** Information presented here is taken from Wheeler & Shaw (1987).

Approximate ranges of environmental variables in five descriptive categories

	Very low	Low	Moderate	High	Very high
pH (water)	<5	5 - 6	6 - 6.6	6.7 - 7.1	>7.1
Bicarbonate (mg/l) (water)	<105	106 - 250	251 - 369	370 - 460	>460
Calcium (mg/l) (peat)	<620	621-1200	1200 - 2000	2000 - 3000	>3000
Water depth (cm)	<-25	-25 - -10	-9 - -1	+1 - +9	>+9

Topogenous fens

	Community		Description	Habitat conditions and range
*	S24	Phragmites australis - Peucedanum palustre fen (Peucedano-Phragmiteturn australis p. p. and Caricetum paniculatae peucedarietosum)	Composed of tall monocotyledons (e.g. Phragmites and Cladium) and herbaceous dicotyledons with a lower layer of sedges and rushes and a patchy bryophyte layer. Generally species-rich (24).	Associated with flood-plain fens in England, especially in Broadland, where it occupies an intermediate zone between swamp and carr. pH, bicarbonate and calcium all moderate (pH 5.5-6.9). Mean water levels are low, though winter flooding occurs. Fertility is moderate; S24f is particularly low, whilst S24b is higher.
	S25	Phragmites australis - Eupatorium cannabinum fen (Angelico-Phragmitetum australis)	Characterised by tall monocotyledons and dicotyledons with variable amounts of small herbs and sedges. Less species-rich than S24 (11).	Found in flood-plain fens, open water transitions and 'sump' areas of valley mires in England and Wales. Generally associated with calcareous, base-rich water and moderately eutrophic (either natural or caused by disturbance). Mean water table levels generally low, though higher than in S24.
	S26	Phragmites australis - Urtica dioica fen	Generally dominated by P. australis and U. dioica but associates are variable. Generally species-poor (9).	Associated with eutrophic, neutral to slightly basic water margins throughout the lowlands where winter flooding and summer drying occur. Also found in coastal reed-beds and flood-plains which have been disturbed.
	S27	Carex rostrata - Potentilla palustris fen (Potentillo-Caricetum rostratae)	C. rostrata may or may not be dominant, but P. palustris and Menyanthes trifoliate are constant. Species-poor (5).	Almost exclusively a topogenous community in basin and flood-plain mires and may occur as a floating mat. Generally water levels are continuously high. pH, bicarbonate and calcium levels are low for rich fen communities. Fertility levels are high.** Absent from England south of East Anglia.
	S28	Phalaris arundinacea fen	P. arundinacea is usually dominant, though associates are variable. Species-poor (8).	Typical of circumneutral, mesotrophic to eutrophic waters. Marking the upper limit of water fluctuations in open water transition, flood-plain and basin fens and on stream-sides, especially where enrichment has occurred. Widespread and common throughout the lowlands and upland margins.
	M4	Carex rostrata - Sphagnum recurvum mire	See **Soligenous fens** (below).	
	M5	Carex rostrata - Sphagnum squarrosum mire	Sedges and scattered poor fen herbs over a carpet of base-tolerant Sphagna. Of medium species-richness (17).	May occur as a floating raft in topogenous and even soligenous fens which are mildly acid or moderately calcareous but oligotrophic. The two main habitats where it is found are in open water transition and flood-plain fens and where a soligenous influx ameliorates an acid environment. Water levels are usually high. Fairly local, mainly in the north-west of Britain.

Topogenous fens (contd)

		Community	Description	Habitat conditions and range
	M8	Carex rostrata - Sphagnum warnstorfii mire	Dominant cover of sedges over an extensive carpet of base-tolerant Sphagna and herbs. Species-rich (36). May be found within montane grasslands and below M19 mire.	Strictly confined to waterlogged montane hollows where moderate base-enrichment by drainage from calcareous rocks occurs, mainly in the central Highlands. Water tables are high and stagnant.
*	M9	Carex rostrata - Calliergon cuspidatum mire (Acrocladio-Caricetum diandrae p. p. and Peucedano-Phragmitetum caricetosum p. p.)	Medium to tall fen vegetation, often species-rich, typically dominated by such species as C. rostrata, C. diandra, C. lasiocarpa and Eriophorum angustifolium. Sometimes there is patchy Cladium and/or Phragmites. Bryophytes, particularly Calliergon species, are conspicuous. Species-richness very variable (25).	In northern and western Britain mainly associated with basin fens, whilst in the south often hydroseral within flood-plain or even valley fens (but usually associated with topogenous hollows). Calcium and bicarbonate values are usually low and pH moderate. Mean water level is high. Low fertilities are associated with optimal community development.**

Swamp communities

		Community	Description	Habitat conditions and range
*	S1	Carex elata swamp	Vegetation dominated by C. elata tussocks with some taller herbaceous dicotyledons. Generally species-poor (12). Found with S2 and S27.	Associated with open water transitions, mesotrophic to eutrophic, shallow pools and turf-cuttings, only in west Norfolk, Cumbria and Anglesey. pH range 5.5-7.2 (Norfolk). Water levels up to +40 cm.
*	S2	Cladium mariscus swamp and sedge-beds (Cladietum marisci)	Cladium-dominated vegetation. Pure stands common and no other species frequent. Species-poor (7). Associated with S1 and S4 in East Anglia and S27 in NW England.	Found in open water transition, floodplain and especially basin fens. Usual calcareous and base-rich. Shallow standing water tables. Tolerant of the range -15 to +40 cm. Local, including Anglesey, Norfolk, Cheshire and Cumbria.
	S3	Carex paniculata swamp (Caricetum paniculatae typicum)	Dominated by C. paniculata tussocks. Species-poor (8). Associated with S4 and S13.	Found in open water transition, flood-plain and basin fens and in peat-cuttings. Generally base-rich and calcareous (71-74 mg/l). pH range 7-1-8.1, mesotrophic to eutrophic. Able to tolerate a degree of seasonal water table movement. Widespread but local.
	S4	Phragmites australis swamp and reed-beds	P. australis is the dominant. Generally species-poor (3), though variable; e.g. Galium palustre sub-community is richer.	Widespread in open water transition and flood-plain fens, usually in hydroseral situations. Management extends the community into drier situations but water regimes can be variable. Does not have strict substrate preferences.
	S5?	Glyceria maxima swamp (Glyceria maxima sociation p. p.)	Species-poor vegetation (4) dominated by G. maxima with a variable range of associates, e.g. Epilobium hirsutum, Filipendula ulmaria, Solarium dulcarnara. In open water transitions it may occur between S14 and S28 and landward of S4.	Mainly found in flood-plain fens (though not confined to fens), often on substrates containing a substantial mineral component, e.g. mineral alluvium- May develop as a floating raft. Mean values of pH, bicarbonate and calcium are high, though variable. Water table levels have a low mean value. Associated with eutrophic, fertile conditions (particularly with high phosphate levels).** Widespread in the lowlands, but of very restricted occurrence in Wales.
	S6	Carex riparia swamp	Large tufts of C. riparia are dominant; hence stands are usually species-poor.	Characteristic of margins of standing or slow-moving water in mesotrophic to eutrophic conditions in the agricultural lowlands of England and Wales.
	S7	Carex acutiformis swamp	Dominated by C. acutiformis. No other species constant. May grade into S24 in flood-plain fens.	Eutrophic margins of slow-moving water.
	S8	Scirpus lacustris ssp. lacustrus swamp	Typically with a somewhat open cover of S. lacustris ssp. lacustris.	Often occupies the deep-water limit of swamp vegetation in mesotrophic to eutrophic waters. Sub-communities are related to water depth and trophic status. Notably uncommon in Broadland.
	S9	Carex rostrata swamp	C. rostrata dominant, with no other species in abundance. Generally species-poor (6). May grade into S27. May occur in mires, grading into M3 pools.	Found in mesotrophic to oligotrophic waters of moderate depth, mainly in the north and west. Pure stands often found in deepest waters.

Swamp communities (contd)

	Community	Description	Habitat conditions and range
S10	Equisetum fluviatile swamp	Most abundant species is E. fluviatile. Stands generally species-poor (6). May grade into S9.	May form a floating raft or occur on mineral substrates. Generally associated with open water transitions in the north and west, mesotrophic to oligotrophic in character, shallow to moderately deep.
S11	Carex vesicaria swamp	*Slla C. vesicaria sub-community can be almost pure, but a variety of associates occur in the other sub-communities. Associated with slow-moving water landward of S9.	Pure stands are found in deeper water, but mixed stands in slightly drier situations as well as wetter areas. Mainly in Scotland, south of the Great Glen.
S12	Typha latifolia swamp	T. latifolia is dominant and stands are often species-poor (4). May be associated with S9 and grade landward into S25b.	Widespread through the agricultural lowlands of England but less common in Wales and Scotland. The sub-communities S12b and S12c are found in shallower water with little annual fluctuation, S12a in deeper water with some fluctuation and S12d in deeper water with more stable levels. Waters tend to be mesotrophic to eutrophic.
S13	Typha angustifolia swamp (Typha angustifolia society)	Dominated by T. angustifolia. Species-poor (4). May give way to S14 in shallower water.	Found in standing or slow-moving water on silt, neutral to basic. Scattered distribution in England, becoming rare in Wales and to the north.
S14	Sparganium erectum swamp	S. erectum is generally dominant, but associates can be important.	Very common in shallow mesotrophic to eutrophic water on a mineral substrate and found both in pools and alongside streams and rivers throughout the agricultural lowlands.
S15	Acorns calamus swamp	A. calamus may form an open or closed cover. Species-poor (6).	Occurring in standing or slow-moving water 20-80 cm deep. Substrate usually silt or clay. pH range 5.7 - 7.2. Scattered through the English lowlands.
S16	Sagittaria sagittifolia swamp	S. sagittifolia is dominant and other species are usually only occasional.	Most characteristic of moderately deep eutrophic waters and soft silty substrates. Water standing or slow-flowing. Scattered through the southern and central English lowlands.
S17	Carex pseudocyperus swamp	Can form almost pure stands or be intermixed with other emergents. May be adjacent to S4 or associated with S24.	Most typical of shallow, mesotrophic to eutrophic, standing or sluggish water. Patchily distributed in the English lowland and most characteristic of the Midlands.
S18	Carex obtrubae swamp	C. otrubae forms a generally patchy cover and there can be a great variety of associates, e.g. Juncus effusus and tall herbs, but most are not frequent.	Characteristic of clayey margins of standing or slow-moving, moderately eutrophic waters in the English and Welsh lowlands.
S19	Eleocharis palustris swamp	Dominated by E. palustris, with few other species frequent. Generally species-poor (7).	Found in a wide variety of sites, often over silt, in mesotrophic to eutrophic, standing or running water throughout Britain.
S20	Scirpus lacustris ssp. tabernaemontani swamp	S. lacustris ssp. tabernaemontani dominates, with a variety of saltmarsh species and species of disturbed and/or moist soils.	Found most frequently in moist, brackish sites with soft gleys of silt or clay.
S22	Glyceria fluitans swamp	G. fluitans occurs as a low mat or floating carpet. Generally species-poor (5).	Characteristic of shallow, standing or slow-moving water on a mineral substrate in the agricultural lowlands.

Soligenous fens

	Community	Description	Habitat conditions and range
M4	Carex rostrata - Sphagnum recurvum mire	There is usually a cover of sedges (mainly C. rostrata) over a carpet of semi-aquatic Sphagna with few other associates. Rather species-poor (10). Regarded as poor fen.	Often found along water-tracks within or around raised and blanket mires in the north and west. pH usually around 4. Water levels are high and it may form a semi-floating carpet.

Soligenous fens (contd)

		Community	Description	Habitat conditions and range
	M6	Carex echinata - Sphagnum recurvum/auriculatum mire	Small sedges or rushes dominate over a carpet of more oligotrophic Sphagna with a variable contribution from higher plants. Of medium species-richness (17). Regarded as poor fen.	Associated with slopes within M17 and M19 mire systems and over mineral ground, virtually ubiquitously in the upland fringes. Mainly on peats and peaty gleys irrigated by rather base-poor but not excessively oligotrophic water. Water tables are high. pH 4.5 - 5.5. Calcium and bicarbonate levels low.
	M7	Carex curta - Sphagnum russowii mire	Cyperaceaus plants dominate over a Sphagnum carpet. Associated herb and grass species are limited. Of medium species-richness (17). Regarded as poor fen.	Found in hollows and drainage channels in M19 blanket mire and flushes in montane moss heaths at high altitudes (higher than 650 m) in the Scottish Highlands. On moist peats irrigated by nutrient-poor water.
	M10	Carex dioica - Pinguicula vulgaris mire (Pinguiculo-Caricetum dioicae and Schoenus ferrugineus stands)	In general this is a low-growing small-sedge community. Schoenus and Molinia may be present. Moderate to high species-richness (15). May be associated with a wide variety of peripheral communities.	Mainly occurs in small, often isolated, spring fens, though larger stands occur if springs amalgamate to form a flushed slope. Occurs on a wide range of soils, usually not peaty. Bedrock is often limestone. pH and calcium levels are high (similar to M13), but bicarbonate values are moderate (less than for M13). Water levels moderate, redox high. Fertility values are low.** Widespread but local throughout northern England and Scotland, with fragmentary, often rather impoverished, stands in Wales and the Midlands.
	M11	Carex demissa - Saxifrage aizoides mire (Schoenus ferrugineus stands)	This open community containing a rich mixture of small sedges and herbs with many bryophytes occurs among water-scoured runnels. Usually no single vascular plant is dominant. Generally species-rich (16). Grades into M37 at spring-heads and may also pass into M10.	Largely confined to high altitudes in Scotland (though at sea level in far NW Scotland), irrigated with moderately base-rich water on generally steep slopes. Also locally in northern England and North Wales.
	M12	Carex saxatilis mire	Short, open sedge sward with sparse herbs and usually low cover of individual bryophytes apart from Drepanocladus revolvens. Species-rich (26).	Confined to margins of high-altitude base-rich and calcareous flushes in the Scottish Highlands, with pH 4.6 - 6.3. It is probably influenced by long snow-lie.
*	M13	Schoenus nigricans - Juncus subnodulosus mire (Schoeno-Juncetum subnodulosi p. p.)	This vegetation is usually distinguished by both S. nigricans and J. subnoulosus and a wide range of low-growing associates. Phragmites, Molinia and sometimes Cladium may be important. The community has a high mean species-richness (37). When occurring as a hydroseral stage in turf-cuttings it grades into S24 and S25.	Predominately found in soligenous mires (valley and spring fens) on a wide range of soil types and geological strata in lowland England and Wales. It is usually associated with high base-richness, water pH (6.5 - 8.0) and calcium concentration, though high base-richness does not seem to be a prerequisite. Summer water levels range from low to high, though moderate to high levels without stagnation appear to be optimal. Sites have a low productivity.**
*	M14	Schoenus nigricans - Narthecium ossifragum mire (Schoeno-Juncetum subnodulosi ericetorum p. p.)	S. nigricans is usually dominant, with Molinia generally abundant and bryophytes variable in cover. Regarded as poor fen.	Characteristic of soligenous zones in valleys on peats or mineral soils irrigated by only moderately base-rich and slightly calcareous water. pH 5-6. Calcium levels 5-35 mg/l. So far recorded from SW England and west Norfolk.
	M17	Scirpus cespitosus - Eriophorum vaginatum blanket mire	Dominated by mixtures of monocotyledons, ericoid sub-shrubs and Sphagna.	Occupies valley mires as well as forming extensive blanket mire in north-west Britain. Water table levels are high. pH usually not much above 4 and often less.
*	M21	Narthecium ossifragum -Sphagnum papillosum valley mire	Carpets of Sphagna are characteristic, with scattered herbs and sub-shrubs. Of medium species-richness (14). Associated with M29 water-tracks and M14 flushed zones and often grades into M16 wet heath. Regarded as poor fen.	A local community of permanently waterlogged, acid, oligotrophic peats in the lowlands of England and Wales, mainly in the south. Waters base-poor and nutrient-poor, with pH 3.5-4.5. Peat depths often quite shallow (20-150 cm).
	M29	Hypericum elodes - Potamogeton polygonifolius soakaway	H. elodes and P. polygonifolius (singly or jointly) may form floating mats on water in runnels and pools. Other higher plants and bryophytes have variable presence. Regarded as poor fen.	Found within M21 valley mires and wet heath/mire transitions. Waters moderately acid to neutral (4.0-5.5). Calcium concentrations are probably low. Water levels are said to be fluctuating, though situations are always wet. So far known from west Surrey to Cornwall and through Wales to Galloway.

Soligenous fens (contd)

	Community	Description	Habitat conditions and range
M31	Anthelia julacea - Sphagnum auriculatum spring	A. julacea forms mounds, with tufts of Deschampsia cespitosa frequent. May grade into snow-bed communities at higher altitudes, but also grades into montane grasslands and grass-heaths. May form a mosaic with M31.	An upland community associated with oligotrophic spring-heads on skeletal soils on sloping ground in Scotland, the Lake District and Snowdonia.
M32	Philonotis fontana - Saxifraga stellaris spring	P. fontana forms swelling mounds around flushes and seepages, with scattered rosettes of S. stellaris.	An upland community found on flattish, gently sloping areas around spring-heads and flushes in Scotland, the Lake District, Snowdonia and non-calcareous parts of the Pennines.
M33	Pohlia wahlenbergii var. glacialis spring	Pohlia forms spongy carpets dotted with S. stellaris and scattered Deschampsia cespitosa ssp. alpina. May grade into M32.	Strictly confined to spring-heads associated with late snow-beds in the higher reaches of the Highlands.
M34	Carex demissa - Keonigia islandica flush	Open community consisting of a bryophyte carpet with sparse vascular plants.	On flushed skeletal silty and stony soils on the basalt of the Trotternish ridge, Skye.
M35	Ranunculus omiophllus - Montia fontana rill	Usually dominated by M. fontana and R. omiophyllus with Sphagnum auriculatum. May grade into M29.	Found around spring-heads and rills in upland moors mainly in south-western England and Wales.
M36	Communities of shaded lowland springs and streambanks	Chrysosplenium oppositifolium and Pellia epiphylla are prominent.	Found around lowland springs and streambanks in shady positions.
M37	Cratoneuron commutatum - Festuca rubra spring	C. commutatum and/or C. filicinum dominant, but with variable vascular species.	Marks base-rich and calcareous springs and seepage lines, mainly in montane sites, thought similar stands at lower altitudes are known.
M38	Cratoneuron commuatitum - Carex nigra spring	C. commutatum and/or C. filicinum dominant, but there is a rich associated flora of bryophytes and vascular plants.	Confined to base-rich, calcareous and oligotrophic montane springs and flushes around Upper Teesdale and in the central Scottish Highlands, where there is sheep- and/or deer-grazing.

Fen-meadow

	Community	Description	Habitat conditions and range
M22	Juncus subnodulosus - Cirsium palustre fen-meadow (Rich-fen meadows p. p.)	Variable but usually dominated by a range of grasses, rushes (especially Juncus subnodulosus) and sedges (e.g. Carex acutiformis and C. disticha). Species-richness variable. Regarded as rich fen-meadow.	Found in a wide variety of situations both topogenous and soligenous, on various soil types and geology (though usually on chalk or limestone) in England and Wales. Generally pH, bicarbonate and calcium levels are high. Water level is variable. Fertility values moderate.** *M22c Carex elata sub-community occurs mostly in East Anglia as local small stands in topogenous mires. *M22d Iris pseudacorus sub-community is somewhat more widespread but still local in England; stands may be larger.
M23	Juncus effusus/acutiflorus - Galium palustre rush-pasture	Characterised by both or just one of the rushes with a range of herbs.	Found in both topogenous and soligenous sites on moist, moderately acid to neutral, peaty and mineral soils, mainly in the west of Britain. Characteristic of relatively unimproved or reverted pasture. Small fluctuations in water table can occur, often giving rise to stagnogley soils with pH 4-6. Usually calcium-poor.
M24	Molinia caerulea - Cirsium dissectum fen-meadow (Cirsio-Molinieturn p. p.)	Almost always dominated by Molinia, typically with Potentilla erecta, Succisa pratensis, C. dissectum and smaller Carex species and sometimes with Gymnadenia conoysea. Species-richness fairly high. Regarded as rich fen-meadow.	Often associated with marginal areas of both topogenous and soligenous fens, though not restricted to these systems. Often quite calcareous and base-rich, with pH levels moderate to high. Mean water levels are low. Fertility levels are very low to low.** Widespread but increasingly local in the southern lowlands.

Fen-meadow (contd)

		Community	Description	Habitat conditions and range
	M25	Molinia <u>caerulea</u> - <u>Potentilla</u> <u>erecta</u> mire (<u>Molinia</u> <u>caerulea</u> - <u>Myrica</u> <u>gale</u> community)	Though the community is variable <u>Molinia</u> is usually abundant. Generally poor in species, though rushes and a range of herbs are frequent. <u>Myrica</u> <u>gale</u> can form a patchy or dense over-canopy.	Tends to be associated with aerated substrates, e.g. seepage zones in topogenous and soligenous mires, but generally moist to very wet. Substrates are peat or peaty soils and even brown earths. pH, bicarbonate and calcium levels are variable, but fertilities are usually very low.** Mainly in the west.
*	M26	<u>Molinia</u> <u>caerulea</u> - <u>Crepis</u> <u>paludosa</u> mire (<u>Carex</u> <u>nigra</u> - <u>Sanguisorba</u> <u>officinalis</u> community)	<u>Molinia</u> and often <u>Carex</u> <u>nigra</u> form tussocks. Herbs are quite frequent, both tall and short-growing species.	A very local community of moist, moderately base-rich and calcareous peats and peaty mineral soils in both topogenous and soligenous mires in the northern Pennines and Lake District. Prefers a degree of substrate aeration even though it may be flooded in the winter.
	M27	<u>Filipendula</u> <u>ulmaria</u> - <u>Angelica</u> <u>sylvestris</u> mire (<u>Epilobium</u> <u>hirsutum</u> - <u>Filipendula</u> <u>ulmaria</u> community <u>p. p.</u>)	<u>F.</u> <u>ulmaria</u> is usually dominant and the associated flora is variable and frequently poor in species.	Not confined to fens, but here can occur in both topogenous and soligenous situations. Generally found in moist relatively nutrient-rich, circumneutral situations protected from grazing, on mineral and organic soils with seasonal water table fluctuations. Occurs throughout lowland Britain.
	M28	<u>Iris</u> <u>pseudacoris</u> - <u>Filipendula</u> <u>ulmaria</u> mire	<u>I.</u> <u>pseudacorus</u> and often <u>Oenanthe</u> <u>crocata</u> are frequent to dominant, with scattered <u>F.</u> <u>ulmaria</u>. Other tall herbs are found, and rushes and grasses are important in the lower tiers.	Confined to moist, nutrient-rich soils along the oceanic seaboard, especially at the upper edges of saltmarshes of sea-lochs of western Scotland.

Fen woodland

		Community	Description	Habitat conditions and range
	W1	<u>Salix</u> <u>cinerea</u> - <u>Calium</u> <u>palustre</u> woodland	<u>S.</u> <u>cinerea</u> dominates the canopy. Ground flora consists of small herbs. May grade into S25 or S26.	Mainly on topogenous sites - flood-plain fens, open water transitions and basin mires - scattered through the lowlands.
*	W2	<u>Salix</u> <u>cinerea</u> - <u>Betula</u> <u>pubescens</u> - <u>Phragmites</u> <u>australis</u> woodland	Canopy of <u>S.</u> <u>cinerea</u>, <u>B.</u> <u>pubescens</u> and <u>Alnus</u> <u>glutinosa</u>. Ground flora related to previous community, from which this has developed.	Found on topogenous sites, particularly flood-plain mires. Most extensive examples in East Anglia and around the Cheshire ad Shropshire meres.
	W3	<u>Salix</u> <u>pentandra</u> - <u>Carex</u> <u>rostrata</u> woodland (Crepido-Salicetum pentandrae)	<u>S.</u> <u>pentandra</u> and/or <u>S.</u> <u>cinerea</u> dominant in the canopy. The field layer is quite species-rich, dominated by <u>Carex</u> <u>rostrata</u>. May be in a zonation with S27 and M9.	Found on topogenous base-rich, calcareous sites, locally throughout the sub-montane zone of northern Britain but not yet recorded from Wales.
	W4	<u>Betula</u> <u>pubescens</u> - <u>Molinia</u> <u>caerulea</u> woodland (Betulo-Myricetum molinietosum and Osmundo-Alnetum sphagnetosum)	<u>B.</u> <u>pubescens</u> forms an open canopy. <u>Molinia</u> dominates the ground later and <u>Sphagnum</u> is patchily developed.	Associated with moderately acid peats on a variety of mire types, e.g. drying ombrogenous peats and soligenous fens, locally throughout the lowland and upland fringes.
	W5	<u>Alnus</u> <u>glutinosa</u> - <u>Carex</u> <u>paniculata</u> woodland (Osmundo-Alnetum glutinosae <u>p. p.</u>)	<u>A.</u> <u>glutinosa</u> is abundant, with <u>Salix</u> <u>cinerea</u>, both often initially rooted in <u>C.</u> <u>paniculata</u> tussocks.	Found on topogenous, usually base-rich, mesotrophic to eutrophic sites. W5c is typical of valley-side springs and seepage lines. Local but quite widespread in the English lowlands, with very few localities in Scotland and Wales.
	W6	<u>Alnus</u> <u>glutinosa</u> - <u>Utica</u> <u>dioica</u> woodland	Canopy may be composed of <u>A.</u> <u>glutinosa</u>, <u>Betula</u> <u>pubescens</u> and/or <u>Salix</u> species. <u>U.</u> <u>dioica</u> is constant in the field layer.	Found on topogenous sites - usually flood-plain mires, enriched by silt - widespread but locally in the lowlands.