6 FRESHWATER HABITATS

1 Introduction

1.1 For the purpose of SSSI selection, freshwater habitats are divided into three groups:

1.1.1 standing waters (e.g. lakes, pools, ponds, gravel-pits, reservoirs and canals);

1.1.2 lowland ditch systems (e.g. in grazing marshes);

1.1.3 flowing waters (rivers and streams).

1.2 These groups are not altogether distinct, as, for instance, some canals have an appreciable flow and some rivers are virtually ditches in their uppermost reaches. The groupings do, however, provide convenient subdivisions which have been used in the analysis of data from sites throughout Great Britain.

1.3 There are obvious transitions from fresh waters to other habitats or formations, the most common of which are those to coastal and marine habitats and to marsh, fen and bog. For the purpose of these guidelines oligohaline and mesohaline lakes and brackish ditches (i.e. waters containing 500-18,000 mg/l sodium chloride) are included in 'fresh waters', but small pools in mire systems are omitted because they are dealt with in the peatlands chapters (C.7 and C.8). Emergent fringes of watercourses and standing waters are included as integral parts of the freshwater systems, but other contiguous swamp and fen areas are not considered in this chapter (see C.7).

1.4 Freshwater habitats are in some ways the most difficult kind to conserve. Both standing and flowing water bodies are greatly subject to physical and chemical modification by artificial disturbance within their catchments. Land-use changes can induce profound alterations in water conditions at points far distant, modifying water levels, flow regimes, suspended solids loadings, sedimentation processes, aeration and water chemistry. Land drainage, especially arterial drainage schemes, can affect water tables and flows over large areas. Human effects on water tend to be greatest in the lowland catchments, where development for agriculture and urban/industrial complexes is greatest. Yet they should also be considered in upland catchments, where activities such as broad-scale afforestation have marked effects on all these aspects of hydrology and where exploitation for water supply and hydro-electric power have also caused extensive catchment modification, sometimes with the creation of artificial reservoirs and channels. Acid deposition is greater and has relatively greater effects in upland areas, because these have high rainfall and a prevalence of acidic, unbuffered soils. Recent work (Battarbee et al. 1988) shows that since the Industrial Revolution there has been an increase in acidity of upland waters in poorly buffered catchments. The biological effects of this acidification are still being investigated, but there is strong evidence of damage to invertebrate and fish populations. River regulation, by means of dams, ground-water abstraction and water transfer schemes, may also disrupt natural communities through its influence on flow regimes.

1.5 Artificiality does not necessarily mean that a freshwater habitat lacks special interest. Wildlife value depends greatly on the age and water quality of the system, although some modern reservoirs have quickly become important for wildfowl. The Norfolk Broads were originally created by medieval peat-digging in flat and swampy river valleys, but the process was slow and there was continuity with the natural aquatic ecosystem, so that colonisation of the flooded excavations by a diverse aquatic flora and fauna took place readily. Many old man-made lakes and reservoirs have developed considerable wildlife interest, and some ditch systems and little-used canals have become important habitats in parts of the country otherwise poorly endowed with natural fresh waters of a comparable type. Water bodies with pronounced artificial drawdown zones tend to be low in nature conservation interest, except where communities of specialised rare plants or invertebrates dependent on fluctuating water levels have developed (e.g. Limosella aquatica or Elatine zones in some reservoirs). Botanical interest frequently coincides with invertebrate interest, but it is often divorced from that for birds and otters. Pollution usually has a negative effect on wildlife quality, but if the pollution is recent and not too severe there may be some prospect of removal or amelioration, and so each case has to be considered on its merits when one is assessing potential for recovery of former interest.

2 International importance

We are not yet in a position to assess the international importance of Britain's fresh waters, other than as habitats for particular groups of flora and fauna which are evaluated under their own chapters. In their physical and chemical attributes, British fresh waters fall within the range characteristic of continental Europe. In the north and west of Britain there is a predominance of oligotrophic types, and perhaps the most unusual feature is the wide occurrence of dystrophic waters in association with extensive occurrence of blanket bog. Dystrophic waters are, however, characterised by species-poverty, which thereby limits their biological and conservation significance.

3 Habitat selection requirements

3.1 The selection of freshwater SSSIs may be made on the basis of vegetation, invertebrates, birds, amphibians, fish or otters (see also C.17, 19, 14, 15, 16 and 13, 3.2). The guidelines given here relate largely to vegetation. Invertebrate criteria are also important, but at present detailed ones are available only for dragonflies (see C.19). However, within the next few years it will be possible to develop guidelines for other taxonomic groups, such as water beetles. Moreover, present research on river invertebrates will soon enable SSSI selection in flowing waters to be carried out partly on the basis of invertebrate community composition. It will then be a logical step to consider entire aquatic communities in the SSSI selection process. Meanwhile, the principles set out in the chapter on Invertebrates (C.17) provide some relevant guidance.

3.2 The NVC for aquatic communities is not yet finalised. It will rely heavily on data obtained from NCC surveys of whole standing water sites, 20 m lengths of ditches and 1 km stretches of rivers. The classifications adopted here are based on these units of survey and therefore make use of large assemblages of plants which do not correspond to NVC communities in terrestrial situations, where quadrat data have been used to produce the classifications. The NVC aquatic communities, when available, can be used to describe in detail the vegetation of a site already categorised according to the broad classifications given in these guidelines. Although most freshwater sites are likely to fit within the classification schemes given here, a few may be difficult to categorise. However, this need not preclude their selection as SSSIs if they meet general conservation criteria discussed in Part B.

4 Standing waters

4.1 Classification of sites

Standing waters are classified by treating submerged and floating (open water) vegetation separately from the emergent fringe. This is because the two zones may be subject to different influences (e.g. where acidic water enters a calcareous basin). The existing NVC classification of swamps and tall-herb fens (Rodwell 1984) independently covers most of the emergent vegetation communities.

4.1.1 Open water zone

Table 12 indicates constancies of over 20% for the floating and submerged water plants occurring in 10 open water site types, obtained by TWINSPAN analysis (Hill 1979) of vegetation from more than 1,100 sites throughout Great Britain. A site can be classified by comparing its species list with those in the columns of the table and finding the closest match or by using the key given in Table 13. Further information on physical characteristics of the site types is given in Table 14. If the species list for a site is unusually short, it may be difficult to place the site within the scheme by using information from Table 12, and the site may be misclassified by the key, so Table 14 can be used to put the site into context. Where small sites, such as ponds or dubh lochain within blanket mire, are clustered and physically similar, it is usually advisable to treat the group as a single site, in order to obtain a comprehensive species list. There is a general trend from left to right in Tables 12 and 14, corresponding roughly to a gradation from dystrophic to eutrophic sites. Broadly, type 1 sites are dystrophic; types 2 and 3 are oligotrophic; type 5 represents mesotrophy; and types 7, 8, 9 and 10 comprise eutrophic sites. Concentrations of calcium, nitrogen and phosphorus are obviously highly influential factors in determining the composition of plant assemblages. Data on nitrogen and phosphorus concentrations are available for only a small proportion of sites in the NCC database. However, alkalinity data exist for about half the sites, and the alkalinity ranges indicated for the vegetation types (Table 14) confirm the general trend from dystrophy to eutrophy. Type 6 is a very distinct brackish-water group. Type 4 sites show characteristics of both oligotrophy and eutrophy. Type 5 is subdivided into A and B categories, the B category being a species-poor variant.

4.1.2 Emergent zone

Generally, emergent vegetation can be classified according to the NVC swamp/tall-herb fen communities, most of which are based on single tall dominant plant species (see C.7, Table 19). Other emergent vegetation, for instance communities characterised by *Eriophorum angustifolium*, *Juncus effusus* or *Iris pseudacorus*, is best classified according to the NVC mire system (Rodwell 1986-1987). Table 15 shows which emergent communites are found most often in association with each open water type. Some emergents have a broad spectrum of association, while others are more restricted.

4.2 Site description

A standing water body should be described in terms both of its open water type and of its emergent communities, e.g. open water type 9 (Nuphar lutea/Nymphaea alba) with emergent fringe of S4 (Phragmites australis) and S12 (Typha latifolia). There are, consequently, a number of variants for each open water type, depending on associations with emergent vegetation types. Further variants can be described within each open water type once the NVC aquatic communities are finalised.

4.3 Site selection

Once standing water sites in a particular AOS have been classified, selection for SSSI notification should be made on the following basis.

4.3.1 In a particular AOS there will be a number of open water site types present. At least one site of each type should be chosen, bearing in mind that there may be some water bodies already represented in other habitat formations (especially type 1 waters in mire or upland sites). Where a number of variants of a particular open water type exist (as defined by different emergent or open water communities or combinations of communities), one of each may be chosen, provided that all these sites fulfil criteria of diversity and naturalness (see 4.3.2-9).

4.3.2 Sites with high numbers of species and/or NVC communities for a particular type should be chosen in preference to sites with low diversity, except in the case of very nutrient-poor waters or sites where exceptional species-richness is an indication of artificiality (see 4.3.7). For this reason, sites in the B category of type 5 would not normally be considered unless they are unusually species-rich, and sites of type 8, which are generally poor in open water species, should be chosen mainly on the basis of emergent aquatic plants. In areas where a site type is common, only sites with at least the mean number of species for that type (either of all aquatics or of floating and submerged species: see Table 12) qualify for selection if the choice is made on botanical grounds alone. This advice does not apply to sites at high altitudes or to other naturally species-poor sites. A checklist of the higher plant species regarded as fully aquatic is provided by Palmer & Newbold (1983).

4.3.3 A rich assemblage of Potamogeton species is a good indication of high botanical quality. Any site with eight or more species of Potamogeton will generally qualify for consideration as an SSSI, as long as at least one of these species is nationally uncommon or rare within the relevant water authority area (see Palmer & Newbold 1983). Extensive reedswamp fringes are a desirable feature of an open water site, even if their intrinsic value as fen habitat is not great.

4.3.4 Diversity of physical features is an important factor to be taken into account when selecting open water sites. Varied shorelines, a range of pH, substrates and depths, and transitions from fresh to brackish or from nutrient-poor to naturally nutrient-rich conditions are the kinds of features which should be considered. In upland areas altitude should also be taken into account. If there are representatives of particular site types at widely different altitudes, a series of sites should be chosen covering, if possible, examples below 200 m, between 200 and 500 m, and above 500 m.

4.3.5 Unusual site types and community associations should be given special consideration. The following open water types are relatively uncommon in Great Britain.

Type 4: Sites with a rare combination of communities - Potamogeton pectinatus/Myriophyllum spicatum, typical of eutrophic conditions, in association with Potamogeton gramineus/Myriophyllum alterniflorum, characteristic of less nutrient-rich situations. These sites usually occur where nutrient-poor water flows into basins on calcareous substrates.

Type 5: Mesotrophic sites, especially uncommon in lowland Britain. (These sites are at present over-represented in the NCC database.)

Type 6 and other brackish sites: Type 6 sites showing a transition from freshwater to saline conditions and those with a halocline are of special value.

Type 7: Eutrophic sites, usually showing maritime influence, typically found in the Northern and Western Isles of Scotland.

Marl water bodies (alkalinity in excess of 100 mg/l $CaCo_3$) of any site type.

High-altitude arctic-alpine lakes with very few or no higher plants and extremely nutrient-poor water.

Water bodies which have a natural pattern of intermittently drying out (e.g. meres of the Norfolk Breckland).

Several examples of the open water types listed above may be selected within an AOS in order to cover the full range of variants.

4.3.6 Some open water site types which are widespread in Great Britain as a whole are rare in certain areas. Types 8, 9 and 10 - eutrophic, calcium-rich sites typical of lowland England - are uncommon in upland Wales and northern and western Scotland. Acid waters - types 1, 2 and 3 - although common in upland Britain, are rare in southern and eastern England and the Midlands. All these regionally rare site types should receive special consideration. Where possible, a range of variants (as defined by the emergent plant communities) of these types should be included in the SSSI series in relevant AOSs.

4.3.7 Artificial features should weigh against a site where there is a choice of examples for a single site type. Artificial features include dams, unnatural fluctuations in water level, pollution (including eutrophication) and the presence of introduced species. These factors can influence species numbers, and this should be remembered in the assessment of diversity. Man-made eutrophication can lead to the appearance or the dominance of plants such as Potamogeton pectinatus, Zannichellia palustris and Elodea species in unusual situations. Elodea canadensis and Elodea nuttallii are the commonest aquatic aliens. Their dominance detracts from the value of a site, but, because their populations fluctuate, an otherwise promising site rejected because of these species should be monitored for at least five years with a view to possible reassessment. The fact that water-lilies (especially Nymphaea alba) and certain rarer species (e.g. Stratiotes aloides) are often introduced as ornamentals should also be borne in mind in the assessment of sites.

4.3.8 Where there is a choice between a natural site and a canal with similar floristic attributes, the natural system should usually be selected. However, little-used canals are often extremely species-rich and contain a relict wetland flora which may be present only in an impoverished form in the remaining natural situations in an AOS. Also, canals may display transitions from one vegetation type to another, thereby adding to their value.

4.3.9 Palaeolimnological and geological features of lakes should be taken into account in site selection. For instance, good examples of undisturbed sediments (which are of value as records of lake development), corrie lakes, kettleholes, pingo systems or shingle-bar lagoons should be selected rather than poor examples with similar floras.

4.3.10 Emphasis should be given to sites which are constituents of ecological series. Examples are adjacent water bodies which show the transition from fresh to brackish conditions or which demonstrate a range of nutrient states or stages in seral succession. Where an ecological series exists, it is important to include the full range, even if one element duplicates a site type better represented elsewhere in the AOS.

4.3.11 Large sites may or may not be preferable to small ones. Extensive sites often have large catchments, posing problems for the conservation of the water body itself. Situations in which large size is advantageous can occur where diversity (of species or physical features) depends on extent or where there is a large population of a rare species in an extensive site. Large size is often important for the conservation of mobile species such as birds. Where a site type is well represented within a geographical area, examples may be chosen in each of these categories - smaller than 10 ha, 10 to 100 ha, 100 ha to 1,000 ha and larger than 1,000 ha.

4.3.12 Naturalness of the catchment should be considered in the choice of standing water SSSIs. Natural and semi-natural surroundings are preferable to arable, afforested or urban catchments. Generally, the lower the flushing rate the more vulnerable a lake will be to agricultural improvement of its catchment. However, major afforestation often has its greatest impact on freshwater systems where the rate of run-off from the catchment is high. If possible, where a catchment is still natural or semi-natural and especially where it is small and discrete, the whole of it should be included within the SSSI. Normally, however, only a much narrower 'buffer zone' can be incorporated. Depending on the circumstances and the current land-use, the 'buffer zone' will vary from a grass field's width or the area delineated by the first break of slope to a minimum of 5 m from the water's edge. The former alternative is obviously preferable. If there is a clear feature on the ground, such as a hedge or a change to more intensive land-use, this can be used as a convenient boundary line. Successional vegetation, such as swamp, fen or alder carr, should always be included, to complete the ecological unit. Other tall vegetation on the margin of a water body should also be included, even if it is of no intrinsic value, because it may help to protect the water from nutrient enrichment and may be important for associated fauna such as otters, birds or invertebrates. In areas where there is a threat from afforestation, SSSI boundaries should be set at least 50 m from the water's edge. Where there is a clear functional connection in hydrological terms between the water body and an area of adjacent land, for instance a spring line, it is important to include the adjacent land within the SSSI boundary. For lakes, the boundary should be drawn to include a length of the outflow stream, in order to gain some control over modifications to channel profile which may effect lake water levels.

5 Lowland ditch systems

5.1 Classification of sites

Large networks of ditches in grazing marshes of England and Wales have recently been surveyed by NCC staff and contractors, including the Institute of Terrestrial Ecology. The principal areas examined have been the levels of Somerset, Gwent and Pevensey, Romney Marsh, the North Kent Marshes, the Suffolk/Essex marshes, the Norfolk Broadland, the Idle/Misson levels of north Nottinghamshire, Humberside and South Yorkshire, the Derwent Ings and Malltraeth Marsh on Anglesey. For each area a detailed classification of ditch vegetation types has been produced, but as yet the data have not been analysed nationally. Because of the geographical spread of the sites and their various management histories, a wide diversity of ditch types has been recognised. When new areas are surveyed, it is important that the standard method set out by Alcock & Palmer (1985) is employed. This is based on detailed records for 20 m ditch lengths as well as extensive survey of the ditch network.

5.1.1 Ditch vegetation usually represents several stages in the hydrosere, with submerged, floating and emergent vegetation zones condensed into a small area. The elements are therefore inseparable, and analyses of ditch vegetation have included all types of aquatic plants together, which means that direct parallels with the standing waters classification (4.1 above) cannot be made. Also, because of their artificial nature, ditch systems are categorised separately from rivers. In the absence of a detailed national classification, the broad scheme given in Table 16 can be used to classify ditches. With this broad classification as a framework, a more detailed description of the vegetation can be made by superimposing NVC swamp, fen and aquatic communities. Freshwater drains and ditches have their nearest equivalent in lowland rivers of types I, II and IV (see 6.1) or in standing water types 8, 9 and 10 (Table 12).

5.1.2 Management obviously has a profound effect on the type of vegetation present. After dredging or the application of herbicide, a ditch may progress, in the absent of further disturbance, from type IAc (with algae dominant) to IAb (open water with a mixed community) and finally to IB (with emergents dominant) within a few years. As ditch vegetation is so dynamic, it is often impossible to categorise a particular ditch permanently. With a stable management regime it is, however, possible to classify a whole ditch system in terms of the ditch types represented during the management cycle. Pollution or intensive management may hold ditches permanently in a phase dominated by algae (type IAc).

5.2 Site selection

5.2.1 Most lowland freshwater ditch systems are eutrophic, but a few, usually on peaty soil, contain mesotrophic elements (see Table 16). If both types of system occur within a single AOS, both should normally be represented. Similarly, if brackish ditch systems are present as well as freshwater systems, the whole range should usually be represented. However, ditch systems are often isolated remnants of wetlands which once occupied extensive areas, and their selection will be influenced by the extent and quality of what remains of these natural habitats. Care should be taken that the ditch system is not merely duplicating the vegetation types found within the AOS in more natural habitats. This can be checked by comparing the species composition and diversity of the whole ditch system with those of local standing waters and rivers. A ditch system would need to be either more extensive than the natural equivalent or different in vegetation types or of higher botanical quality to qualify for SSSI status (but see 6.3.2).

5.2.2 Ditch systems are often very species-rich. Some grazing marsh SSSIs support over 100 species of aquatic higher plants and have very diverse invertebrate faunas, often including relict fen species. To qualify for selection as an SSSI, a ditch system should normally contain a high diversity of invertebrates (e.g. after a thorough survey a list of over 50 species of water beetles or an outstanding dragonfly assemblage: see C.19) and of plants, including nationally rare or scarce species (see C.11). However, some types of system, notably brackish ditches, are intrinsically species-poor, but these are still worthy of representation. Within individual 20 m ditch lengths the following standards apply for plants.

Diversity	No. of submerged/floating/emergent/ wet bank species per 20 m
Freshwater	
Exceptional	15 or more
Good	10 - 14
Fair	6 - 9
Poor	5 or fewer
Brackish	
Exceptional	10 or more
Good	6 - 9
Fair/poor	1 - 5

For the most saline ditches, these totals do not include semi-terrestrial saltmarsh species, which add to the diversity.

5.2.3 Ditches dominated by emergents are usually poorer in species than those with open water and an emergent fringe. Generally, for an area to qualify for selection as an SSSI on botanical grounds alone, at least 50% of wet ditches in a complex should rate as "good" or "exceptional" or, in a freshwater system, the mean number of species per 20 m ditch length should be 10 or more.

5.2.4 The presence of a wide range of ditch types (i.e. the vegetation types listed in Table 16) is likely to produce a high total of species for a wetland complex. Certain kinds of vegetation are, however, of no value in SSSI selection, and a predominance of these is often indicative of hypertrophy. These are assemblages dominated by filamentous algae, Elodea nuttallii or floating rafts of grasses such as Glyceria fluitans. Aquatic invertebrate faunas are richest in ditches with open water. Paradoxically, semi-aquatic faunas are often more interesting in ditches dominated by emergents and seldom disturbed by management. This type of ditch is also important for birds such as the reed warbler. Wide, relatively undisturbed fringes of emergents lining open water ditches can compensate for a lack of emergent-dominated ditches.

5.2.5 If possible, a range of differently-sized watercourses (wide drains, intermediate ditches and field ditches) and a variety of substrates (peat, clay, alluvium, etc.) should be included within a selected ditch network, provided that botanical and/or entomological quality is satisfactory throughout the range. Where mesotrophic elements are present, it is important to incorporate them. The existence of a transition from fresh to brackish water lends great importance to a site. Extensive brackish systems are rare in Britain and should receive special consideration. The more extensive the ditch system, the greater the chances of maintaining populations of rare and localised species of plants and animals and of enhancing the wildlife interest through management. A short total length (i.e. 1-5 km) of ditches would need to be extremely species-rich or to score highly for rare species to qualify for selection as an SSSI.

5.2.6 Ditch systems with permanently high water levels and rich floras and faunas are seldom found outside predominantly pastoral areas. Where a ditch system is of SSSI quality but the grassland matrix has little intrinsic interest for its vegetation or birds, the fields should nevertheless be included as a 'buffer zone' for the ditches (see B, 5.4). It is inadvisable to include extensive arable areas within an SSSI unless the flora and fauna can be shown to have special interest on a ditch-by-ditch basis or the land is an integral part of the hydrological system or the area is subject to a rotation of arable and grazing management. In arable land the water table is usually very low or subject to wide fluctuations, and nutrient levels in the ditches are often extremely high. Even grassland intensively managed for silage production is more acceptable than arable land, and the associated ditch flora and fauna are more frequently of SSSI quality. This is probably because the water table is usually kept higher and flushing rates are greater than in arable land, resulting in a dilution of nutrients. Problems of polluted run-off in urban areas should also be considered, as this can quickly degrade aquatic communities.

6 Flowing waters (rivers and streams)

6.1 Classification of sites

A classification of river types using aquatic and marginal wetland species recorded from 1 km lengths is described by Holmes (1983). This classification should be used as a basis for SSSI selection, but 10 major types, rather than the 54 subdivisions given by Holmes, should be employed. These types are:

Type I	- Group A1	- lowland rivers with minimal gradients, in England
Type II	- Group A2	- clay rivers
Type III	- Group A3	- chalk and oolite rivers
Type IV	- Group A4	- rivers with impoverished ditch floras, in lowland England
Type V	- Groups B1 and B2	- rivers on rich geological strata in Scotland and northern England
Type VI	- Groups B3 and B4	- rivers on sandstone, mudstone and hard limestone in England and Wales
Type VII	- Groups C1 and C2	- mesotrophic rivers downstream from oligotrophic catchments
Type VIII	- Groups C3 and C4	- oligo-mesotrophic rivers, predominantly upland
Type IX	- Groups D1, D3 and D4	- oligotrophic rivers of mountains and moorlands
Type X	- Group D2	- ultra-oligotrophic rivers in mountains

A river can be placed within one of these 10 types by using the key given in Table 17. The Freshwater Biological Association is at present refining a system for classifying rivers on the basis of their invertebrate communities which will provide a zoological component for the process of site selection.

6.2 River SSSI framework

River SSSIs may be selected according to a dual system, with the object of developing a national series. (Newbold, Purseglove & Holmes (1983) discuss the relevance of general nature conservation criteria in the selection of river SSSIs.)

6.2.1 'Whole river SSSIs'

These will represent the main types of river (as shown in 6.1) or rivers which show classic and representative transitions down their lengths from oligotrophy to natural eutrophy. It is envisaged that they will ultimately comprise a national series of about 20-30 rivers. Selection will be centrally co-ordinated by the CSD in liaison with regional staff. Examples will be chosen from rivers running from their source to the sea or from tributaries with a branching order of at least three. Where the main river channel forms the SSSI, the downstream boundary will normally be the saline limit. Tributaries may also be included if they are of contrasting interest to, and cause transitions in, the main channel. Where a major tributary forms the 'whole river SSSI', the same principle of including other smaller tributaries will apply.

6.2.2 'Sectional SSSIs'

Although a complete series of 'whole river SSSIs' will ensure a basic national coverage of most principal river types, the very best examples of some types will only occur as short stretches within rivers. For this reason shorter stretches of river should still be selected where they are of high nature conservation interest. 'Sectional SSSIs' thus fulfil three roles: (i) they assist in conserving parts of rivers in areas of the country (such as the eastern lowlands) where few, if any, examples of natural or semi-natural watercourses remain; (ii) they expand the overall coverage of river SSSIs and provide adequate regional representation; and (iii) they ensure that the best examples of each river type are included in the SSSI series. The upstream and downstream limits of 'sectional SSSIs' should accord with the start and finish of the interest and should not include impoverished sections above or below. Sites in this category will be selected by regional staff in collaboration with the CSD.

6.3 Site selection

6.3.1 A survey of macrophytes in 1 km lengths of the river, with 7 km intervals between them, followed by a classification of these lengths, is usually a preliminary requirement for site selection. Once such a survey indicates potential interest, further work is needed, principally a broad habitat survey as described in the NCC's (1985) draft methodology for surveys of wildlife in river corridors. This will indicate the extent of interest in the channel, on the banks and in adjacent areas. Normally, further studies to determine the value of the river corridor for birds, fish, otters and invertebrates should be undertaken, but in the absence of these surveys a site may be selected on grounds of botanical interest combined with habitat characteristics. As information from the NCC's invertebrate survey programme becomes available, it will be necessary to ensure that representatives of each of the Freshwater Biological Association's main river types are included in the SSSI series.

6.3.2 Each NCC region should select 'sectional SSSIs', using the best examples of the river types which occur within the regional boundaries, provided that they are not degraded examples of types represented elsewhere in Great Britain. (N.B. Type IV rivers may be better represented by a ditch system: see 5 above.) If a particular river type is well represented, a number of examples should be selected showing differences in size, peripheral environments and so on, so that the variation within this river type is adequately covered.

6.3.3 As a result of land drainage schemes, natural and semi-natural rivers are scarce in lowland England. The major criterion for selection in these parts of Britain should be relative naturalness. A candidate river must have the expected (or better than expected) flora and/or fauna and show a minimum of modification to bed and water level.

6.3.4 For river types with a restricted distribution (e.g. Type VIII rivers in England - lowland, acid heath streams), several examples within the main area of occurrence should be selected even if they all lie within a single AOS or NCC region.

6.4 Defining lateral boundaries of riverine SSSIs

The core of the selected area should be the channel of the river and its banks. The upper limit of the banks is defined as the first (or major) break of slope. Where the channel alone is of interest, the boundary should follow the break of slope unless there is a demarcating feature on the ground such as a hedge, fence, wall, tree-line or flood-bank. Where extensive riparian vegetation occurs along the river banks, this should be included within the boundary if possible. The main core of interest may vary from less than 1 m high or wide in narrow, shallow rivers to as much as 100 m high or wide in rivers which pass through gorges or meander unconstrained through wide, flat flood-plains. Any adjacent semi-natural, wet habitat which is intimately linked with the river and which is probably dependent on the river for its continued existence should be included within the SSSI boundary. Such areas may be unimproved alluvial flood-plain meadows, marshland, wet heathland (both dwarf scrub and heathy grassland types), fens, bogs, flushes, swamps and wet woodland such as willow and alder carr. Ponds and other standing water habitats with water tables linked with the river should also be included. In most cases good quality habitats which are adjacent to the river but not dependent on it for their continued existence should not be included even if they are of SSSI status: they should be selected in their own right as separate sites. Otters and many birds require both the river and adjacent land habitats to thrive; the same is true for many invertebrates. Thus, non-wetland habitats adjacent to the river can be included within an SSSI boundary provided that they contribute significantly to sustaining fauna associated with the river. Marginal vegetation should also be included if it is thought to be important as a nutrient interceptor. Islands within rivers are normally included within the boundary unless specifically excluded because of their degree of modification.

7 References

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Table 12 TWINSPAN classification of standing water sites – submerged and floating vegetation

Site type	1	2	3	4	5 A	5 B	6	7	8	9	10
Potamogeton polygonifolius	II	IV	III								
Utricularia intermedia		II									
Lobelia dortmanna		IV	III		II						
Sparganium angustifolium		II	III								
Isoetes lacustris			III								
Subularia aquatica			II								
Myriophyllum alterniflorum		III	IV	IV	V*						
Sparganium minimum					II						
Juncus bulbosus	V*	IV	V*	II	III						
Scirpus fluitans		II									
Sphagnum spp.	IV										
Nymphaea alba		III			III	V*				IV	
Potamogeton alpinus					II						
Nitella spp.			II		IV*						
Callitriche hamulata			II		II						
Littorella uniflora		IV	V*	V*	V*		II	III			
Apium inundatum				II							
Potamogeton natans		IV	III	III	III	IV*		II		II	II
Glyceria fluitans			III	II				II	II		
Potamogeton gramineus				III	III			II			
Fontinalis antipyretica			III	II	II			II		II	
Potamogeton perfoliatus			II	IV	III			II			
Potamogeton obtusifolius					III						
Potamogeton berchtoldii				II	IV			II			II
Callitriche stagnalis			II	II				II	IV	II	
Elodea canadensis					IV*				II	II	III
Nuphar lutea					II				III	V*	
Lemna minor									IV	III	II
Lemna trisulca										III	
Elodea nuttallii											II
Sparganium emersum											II
Polygonum amphibium					II			II	IV	II	III
Zannichellia palustris								II	III		
Enteromorpha spp.							II				
Myriophyllum spicatum				II				III			III
Potamogeton crispus					II			II			II
Potamogeton pectinatus				II			IV*	III			III
Potamogeton pusillus				II	II			II			III
Callitriche hermaphroditica				II	II			II			
Chara spp.				III	III*			III		II	III
Fucoids							III				
Ranunculus baudotii				II				III			
Ruppia spp.							IV*				
Hippuris vulgaris				II				IV		II	
Potamogeton filiformis				III				III			
No. of sites in group	48	192	322	72	52	34	15	127	70	28	158
no. of spp. per site (submerged & floating)	3	7	9	10	13	4	3	8	7	7	8
Av. no. of spp. per site (submerged, floating & emergent)	7	14	17	19	24	11	6	16	24	19	19

Constancy classes

V = 80+ to 100%
IV = 60+ to 80%
III = 40+ to 60%
II = 20+ to 40%

* = cover value high (frequent to abundant)

'Species' numbers include bryophytes and algae determined to genus only.

Note

Ultra-oligotrophic, high-altitude lakes, containing only bryophytes, are not included.

Table 13 Key to standing water site types (submerged and floating species)

Indications of minimum abundance levels are given according to the DAFOR scale:

Dominant (never a requirement)
Abundant (never a requirement)
Frequent
Occasional
Rare (minimum abundance level required unless stipulated otherwise)

	-1	+1	Score	
1	Juncus bulbosus Myriophyllum alterniflorum Littorella uniflora Lobelia dortmanna Potamogeton polygonifolius	Potamogeton pectinatus Polygonum amphibium	-1 or less ..... 0 or more	go to 2 go to 3
2	Sphagnum spp. (at least occasional)	Littorella uniflora Myriophyllum alterniflorum (at least occasional) Potamogeton natans	-1 or less ..... 0 or more	Type 1 go to 4
3	Potamogeton filiformis Hippuris vulgaris Ranunculus baudotii Littorella uniflora (at least occasional)	Elodea canadensis Lemna minor Nuphar lutea	-1 or less ..... 0 or more	go to 5 go to 6
4	Juncus bulbosus (at least occasional) Lobelia dortmanna (at least occasional) Potamogeton polygonifolius Isoetes lacustris Sparganium angustifolium	Potamogeton gramineus Potamogeton perfoliatus (at least occasional)	-1 or less ..... 0 or more	go to 7 go to 8
5	Ruppia spp. Fucoids (at least occasional)	Chara spp. Hippuris vulgaris Myriophyllum spicatum Potamogeton filiformis Ranunculus baudotii Polygonum amphibium	0 or less ..... 1 or more	Type 6 Type 7
6	Nuphar lutea Callitriche stagnalis	Myriophyllum spicatum Chara spp. Potamogeton pectinatus Potamogeton pusillus Elodea nuttallii	0 or less ..... 1 or more	go to 9 Type 10
7	Nymphaea alba (at least occasional)	Fontinalis antipyretica Isoetes lacustris Glyceria fluitans (at least occasional) Callitriche hamulata	0 or less ..... 1 or more	Type 2 Type 3

	-1	+1	Score	
8	Littorella uniflora Myriophyllum alterniflorum Potamogeton perfoliatus Potamogeton gramineus Chara spp. Potamogeton berchtoldii	Nymphaea alba (at least occasional)	-1 or less ..... 0 or more	go to 10 Type 5B
9	Callitriche stagnalis Zannichellia palustris Polygonum amphibium	Nymphaea alba (at least occasional) Nuphar lutea (at least frequent) Lemna trisulca (at least frequent) Hippuris vulgaris	0 or less ..... 1 or more	Type 8 Type 9
10	Potamogeton filiformis (at least occasional)	Elodea canadensis Nitella spp.	0 or less ..... 1 or more	Type 4 Type 5A

Table 14 Physical characteristics of standing water site types

Site type	Water: Usual pH	Usual conductivity (μmhos)	Usual alkalinity (mg/l $CaCO_3$)	Category	Substrate	Geology/ soil	Altitude (m) Percentages are of sites in NCC database.	Distribution in GB	Comments
1	3.5-5.5	50-200 (mostly <100)	Negative to 2	Dystrophic	Peat; rarely sand	Bogs on acid rock or soil	Mostly below 200	Mainly northern	Typical of blanket bog, but can occur on lowland heath.
2	5-7.5 (mostly <7)	10-200	0-25	Oligotrophic	Fine to coarse; often peat	Base-poor rocks (e.g. gneiss, granite)	c. 40% above 200	North and west	Oligotrophic sites heavily influenced by peat. Often small.
3	5-7.5 (mostly <7)	10-200	0-25	Oligotrophic	Predominantly coarse (stones, boulders)	Base-poor rocks (e.g. gneiss, granite)	c. 40% above 200	Mainly north and west	Oligotrophic sites less heavily influenced by peat than type 2.
4	7-9	100-700	25-200	Oligotrophic with eutrophic influence	Fine to coarse	Usually sedimentary rock; substrate often base-rich (e.g. Old Red Sandstone, machair sand)	c. 25% above 200	Mainly coastal Scotland, especially Northern & Western Isles	Often coastal water bodies in calcareous basins, with acid inflows.
5	6-8 (mostly around 7)	50-300	10-50	Mesotrophic	Fine to coarse	Wide variety; often slightly base-rich	c. 30% above 200	Mainly north and west	An uncommon type, over-represented in the NCC database.
6	8-9	5,000-35,000	-	Brackish (oligohaline to mesohaline)	Fine to coarse	Wide variety	Sea level	Northern & Western Isles of Scotland	This type probably also occurs on the mainland of Scotland.
7	7.5-9.5	300-750 (occasionally up to 15,000)	50-200	Eutrophic; often marl; sometimes oligohaline	Fine to coarse	Usually sedimentary rock; substrate base-rich (e.g. Old Red Sandstone, limestone, machair sand)	Mostly below 200	Mainly coastal Scotland, especially Northern & Western Isles	Similar to type 4 (but with less influence from acid inflows) and to southern brackish ditches.
8	7-8.5	200-750	50-250	Eutrophic; often marl	Predominantly fine	Mainly base-rich rocks or glacial drift	Below 200	Lowlands throughout Britain	Open water, often species-poor, but emergent fringe typically rich.
9	6.5-8.5	100-750	10-200	Mainly eutrophic; sometimes marl	Predominantly fine	Mainly sedimentary rocks	Mostly below 200	Mainly England and Wales	Floating-leaved communities dominant. Water-lilies may be introduced.
10	6.5-8.5	100-750	25-200	Eutrophic; sometimes marl	Predominantly fine	Sedimentary rocks, often limestone	Mostly below 200	Lowlands throughout Britain	Submerged communities well developed. Includes a number of canals and gravel-pits.

Table 15 National Vegetation Classification communities most common in emergent fringes of standing water site types

Site type	1	2	3	4	5 A	5 B	6	7	8	9	10	Codes of likely NVC communities
Emergent species												
Eriophorum angustifolium	III	III	II									Many mire communities
Juncus effusus	IV	III	IV	III	IV	III		II	IV	II	III	M5/M6c
Carex rostrata	III	IV	IV	II	V	IV			II	II		M4/M5/M8/M9/S9/S27
Menyanthes trifoliata	II	IV	III	III	III	III		II		II		) M1/M5/M9/S27
Potentilla palustris	II	II	II	III	III	III			II	II		)
Equisetum fluviatile		III	III	III	IV	III		III	II	II	II	S10
Eleocharis palustris		II	III	IV	IV	II	II	V	II		III	S19
Phragmites australis		II		II	III	III			IV	IV	II	S4/S25/S26
Iris pseudacorus				III	II			II	IV	III	III	M28
Phalaris arundinacea					III				IV	II	II	S28
Scirpus lacustris					II	III				III	II	S20
Carex paniculata									III	II		S3
Carex acutiformis									III	II		S7
Typha latifolia									III	III	IV	S12
Carex elata									II			S1
Typha angustifolia									II	II		S13
Carex riparia									II	II		S6
Sparganium erectum										III	II	S14
Site category	Dys-trophic	Oligotrophic		Oligo/eutrophic	Mesotrophic		Brackish	Eutrophic		Eutrophic		

Constancy classes

V = 80+ to 100%
IV = 60+ to 80%
III = 40+ to 60%
II = 20+ to 40%

Table 16 Classification of ditch vegetation types

I FRESHWATER DITCHES
(conductivity usually below 2,000 μmhos; salinity below 500mg/l NaCl)

IA Open water present, with emergent plants absent or forming fringes occupying up to 70% of the width of the watercourse.

IAa Watercourses with a low cover (less than about 30%) of Lemnaceae and/or *Azolla filiculoides*.
Often large ditches and drains with water over 1 m deep.
Typically one or more of the following open water species:

Potamogeton berchtoldii
P. crispus
P. pectinatus
P. pusillus
P. coloratus
Elodea spp.
Chara spp.
Zannichellia palustris
Ceratophyllum demersum
Myriophyllum spicatum
M. verticillatum
Ranunculus spp. (especially *R. circinatus*)
Polygonum amphibium
Callitriche spp.
Nuphar lutea)
Sagittaria sagittifolia) species most
Potamogeton natans) characteristic
P. lucens) of Type IAa
P. perfoliatus)

IAb Watercourses with a moderate or high cover (over about 30%) of Lemnaceae and/or *Azolla filiculoides*.
Often small ditches with water less than 1 m deep.
Typically one or more of the following open water species:

Potamogeton berchtoldii
P. crispus
P. pectinatus
P. pusillus
Elodea spp.
Chara spp.
Zannichellia palustris
Ceratophyllum demersum
Myriophyllum spicatum
M. verticillatum
Ranunculus spp. (especially *R. circinatus*)
Callitriche spp.
Hydrocharis morsus-ranae) species most
Hottonia palustris) characteristic
Stratiotes aloides) of Type IAb

IAc Watercourses with few or no higher plants in open water.
Filamentous algae and/or *Enteromorpha* spp. present and often abundant.

IB Emergent plants dominant, filling over 70% of the watercourse, so that submerged plants are scarce or absent.
Main vegetation types:

IBa *Phragmites australis*

IBb *Glyceria maxima*

IBc *Glyceria fluitans*, *Alopecurus geniculatus* or *Agrostis stolonifera* forming floating mats

IBd Other species in various combinations, often of the following:

- *Sparganium erectum*
- *Carex riparia*
- *Typha* spp.
- *Alisma plantago-aquatica*
- *Apium nodiflorum*
- *Berula erecta*
- *Oenanthe* spp.
- *Scirpus lacustris* ssp. *lacustris*
- *Mentha aquatica*
- *Iris pseudacorus*
- *Veronica* spp.
- *Myosotis* spp.

Note: Mesotrophic ditches

Most lowland ditch systems are eutrophic, but some, usually associated with peaty soils, may contain mesotrophic elements. 'Indicator species' for mesotrophic variants of ditch types IAa and IAb are:

- *Potamogeton polygonifolius*
- *P. gramineus*
- *P. obtusifolius*
- *P. alpinus*
- *Myriophyllum alterniflorum*
- *Callitriche hamulata*
- *Apium inundatum*
- *Scirpus fluitans*
- *Juncus bulbosus* var. *fluitans*
- *Baldellia ranunculoides*

II BRACKISH DITCHES
(conductivity usually 2,000 - 35,000 µmhos; salinity 500-18,000mg/l NaCl)

IIA Open water present, with emergent plants absent or forming fringes occupying up to 70% of the width of the watercourse.

IIAa Higher plants dominant.
Typically one or more of the following open water species:

- *Potamogeton pectinatus*
- *P. pusillus*
- *Zannichellia palustris*
- *Ruppia* spp.
- *Ceratophyllum submersum*
- *Myriophyllum spicatum*
- *Ranunculus baudotii*

IIAb Very few or no higher plants present.
Enteromorpha spp. or filamentous algae present and often abundant.
Ulva lactuca and *Fucus ceranoides* may be present in the most saline situations.

IIB Emergent plants dominant, filling at least 70% of the ditch.
Main vegetation types:

IIBa *Phragmites australis*
IIBb *Scirpus maritimus*
IIBc Other species, in various combinations, usually of the following:
Scirpus lacustris ssp. *tabernaemontani*
Ranunculus sceleratus
Typha angustifolia
Aster tripolium

N.B. Dry ditches are not included in this scheme, unless emergent species are abundant, in which case they should be categorised as IB or IIB.

Transitions between IA and IB and between IIA and IIB occur during the ditch management cycle.

Table 17 Key to river types (adapted from Holmes 1983)

Numbers in parentheses refer to a DAFOR scale: 1 (not specified in this table) = rare, 2 = occasional or frequent, and 3 = abundant or dominant. Species with such numbers should be scored only if they reach the abundance level indicated.

	-1	+1	Score	Go to
1	Epilobium hirsutum Solanum dulcamara Cladophora glomerata	Hygrohypnum ochraceum Pellia epiphylla Ranunculus flammula Scapania undulata	-1 or less 0 or more	2 3
2	Glyceria maxima	Verrucaria spp. Hildenbrandia rivularis Amblystegium fluviatile Rhynchostegium riparioides Lemanea fluviatilis Conocephalum conicum	2 or less 3 or more	4 5
3	Phalaris arundinacea	Anthoxanthum odoratum Polytrichum commune Hyocomium armoricum Juncus bulbosus Marsupella emarginata Racomitrium aciculare (2)	2 or less 3 or more	6 7
4	Potamogeton pectinatus Enteromorpha spp. Nuphar lutea		-1 or less 0 or more	8 9
5	Mimulus guttatus Potamogeton crispus Polygonum amphibium Elodea canadensis (2) Alopercurus geniculatus Myriophyllum alterniflorum	Pellia endiviifolia	-3 or less -2 or more	10 11
6	Thamnobryum alopecurum Conocephalum conicum Rhynchostegium riparioides (3)	Glyceria fluitans (2) Myriophyllum alterniflorum (2) Equisetum fluviatile Juncus acutiflorus (2)	0 or less 1 or more	12 13
7	Brachythecium rivulare Sagina procumbens Dichodontium pellucidum Hygrohypnum luridum Schistidium alpicola (2)	Sphagnum spp.	-2 or less -1 or more	14 15

	-1	+1	Score	River type
8	Zannichellia palustris Enteromorpha spp. (2)	Sparganium erectum (3) Rorippa palustris Juncus effusus Rorippa amphibia (2) Trees (2)	0 or less 1 or more	A1 Type I A2 Type II
9	Carex acutiformis (2) Berula erecta Ranunculus calcareus		-2 or less -1 or more	A3 Type III A4 Type IV
10	Juncus effusus Myriophyllum alterniflorum (2)	Ranunculus fluitans Myriophyllum spicatum Impatiens glandulifera Rorippa sylvestris Enteromorpha spp.	1 or less 2 or more	B1) B2) Type V
11	Epilobium hirsutum (2) Ranunculus fluitans Nasturtium officinale Myosotis scorpioides	Lemanea fluviatilis (2) Oenanthe crocata (2)	-2 or less -1 or more	B3) B4) Type VI
12	Dichodontium pellucidum Tussilago farfara Sagina procumbens	Oenanthe crocata Fontinalis squamosa (3)	-1 or less 0 or more	C1) C2) Type VII
13	Oenanthe crocata	Tussilago farfara Carex nigra Calliergon cuspidatum Schistidium alpicola Myosotis scorpioides (2)	1 or less 2 or more	C3) C4) Type VIII
14	Glyceria fluitans Agrostis stolonifera (2) Myriophyllum alterniflorum Ranunculus flammula		-2 or less -1 or more	D1 Type IX D2 Type X
15	Scapania undulata (3)	Carex rostrata Equisetum fluviatile Eleocharis palustris Myriophyllum alterniflorum Achillea ptarmica Juncus acutiflorus (3)	3 or less 4 or more	D3) D4) Type IX

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.