Guidelines for the Selection of Biological SSSIs

Part 2: Detailed Guidelines for Habitats and Species Groups

Chapter 6 Freshwater Habitats

Authors

Mainstone, C.P., Hall, R.A., Hatton-Ellis, T.W., Boon, P.J., Bean, C.W. and Lee, A.S.L.

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Cover note

This chapter updates and replaces the previous Freshwater Habitats SSSI Selection Guidelines chapter (Nature Conservancy Council 1989). It was prepared by Chris Mainstone and Ruth Hall (Natural England), Tristan Hatton-Ellis (Natural Resources Wales) and Phil Boon, Colin Bean and Alison Lee (Scottish Natural Heritage), and provides detailed guidance for use in selecting freshwater habitat sites throughout Great Britain to recommend for notification as SSSIs. It should be used in conjunction with Part 1 of the SSSI Selection Guidelines, as published in 2013 (Bainbridge *et al* 2013), which detail the overarching rationale, operational approach and criteria for selection of SSSIs.

The main changes from the previous version of the chapter are:

- greater clarity over the importance of selecting the most naturally functioning remaining examples of the natural variation in freshwater habitats;
- reaffirming the exemplary site principle in site selection whilst allowing for a critical standards approach for selecting the best examples of naturally functioning habitat;
- use of a wider set of attributes and typologies for evaluating natural habitat variation in relation to typicalness, including both abiotic and biological elements;
- clearer guidance for evaluating naturalness;
- inclusion of rare habitat types;
- stressing the importance of notifying suitable small water bodies (headwater streams, small lakes and ponds) to capture the full natural habitat variation; and
- greater emphasis on the need to integrate site selection for notified freshwater habitat and species wherever possible, to encourage a parsimonious freshwater SSSI series and promote the conservation of notified species within naturally functioning habitat.

This chapter has been subjected to appropriate levels of evidence quality assurance. It is compliant with the JNCC Evidence Quality Assurance Policy 2014, and has been subjected to external peer review by Dr Ian Strachan.

1 Introduction

1.1 Freshwater systems constitute a diverse range of habitats, from springs, seepages and upland torrents to sluggish slow-flowing rivers, and from cold deep lakes to temporary pools. They support a rich array of biological assemblages, which contain many rare or threatened fish, invertebrates, plants and other species.

1.2 Freshwater habitats are strongly influenced by natural processes, driven by climate and the environmental characteristics of the catchment. Key processes include hydrological regime, geomorphological processes associated with erosion and deposition, and nutrient delivery and cycling. These natural processes create diverse mosaics of aquatic and marginal habitats, with varying water chemistry and natural trophic status, which shape characteristic biological assemblages and the occurrence and abundance of individual species.

1.3 Ecological connectivity is often highly important in freshwater habitats, both within the habitats themselves and within the wider ecological landscape. The river network of an individual catchment is naturally connected, and provides connectivity between associated land areas within the catchment. Networks of standing waters act as ‘stepping stones’ for biota in the landscape. The numerous ecotones that fresh waters form with the terrestrial and marine environments are critical components of connectivity: springs and flushes, marginal wetland vegetation, fens and bogs, floodplain wetlands, carr woodland and saline transition zones at the head of estuaries. Natural barriers to connectivity (watersheds, waterfalls) are also important in fresh waters, by generating distinct species assemblages and food webs (e.g. naturally fishless headwater streams and ponds) and genetically unique populations.

1.4 Small freshwater bodies (such as pools and headwater streams, both ephemeral and perennial) can form part of habitat mosaics at various spatial scales, either entirely within a single terrestrial or wetland habitat type (e.g. wet heath, upland moorland) or in a larger-scale or more heterogeneous mosaic of habitat types. They often have an ecological importance that is disproportionate to their surface area, owing to the extent of ecotone habitat relative to open water area, the specific ecological conditions they provide for specialist species (such as winterbourne streams), as spawning sites for fish (particularly headwaters) or amphibians (particularly ponds and pools), and as a source of water for many non-aquatic species.

1.5 The strong influence of the catchment on freshwater habitats presents a particular challenge for biodiversity conservation, since it connects these habitats to the range of human activities present in their catchments. Many of these activities are focused on the water environment as a vital resource (e.g. abstraction) or as a human hazard (e.g. flood defence). High connectivity makes freshwater systems vulnerable to the accidental or deliberate introduction of non-native species. The conservation of freshwater ecosystems is dependent on the control of the many human stresses that arise from catchment activities, including pollution, hydrological modification and physical modification. Natural ecosystem functioning, based on the operation of natural processes, is therefore a critical consideration in site selection.

1.6 Natural ecosystem functioning comprises natural water quality, hydrological regime, physical habitat and biological communities. For water quality to be considered natural it should have a trophic status that would be expected from the geology of the catchment or from palaeolimnological study, be free from pollutants and unaffected by acidification. A natural hydrological regime is one without impacts from abstraction and impoundment. A natural physical habitat is one that is free from artificial structures within or adjacent to the water body, and includes natural banks with the expression of the full natural riparian zone. Substrates should reflect natural hydraulics: free from artificial siltation and imported materials, and not suffering from extraction. A natural biological community does not include non-native or locally non-native species, and native species should be free from manipulations such as those associated with certain fisheries management practices. Natural ecosystem functioning is relevant to the concept of ‘reference condition’, as envisaged by the EC Water Framework Directive (WFD).

1.7 Natural functioning is important for the resilience of freshwater ecosystems to climate change, allowing characteristic biota to adapt to changing environmental conditions by providing a diverse array of habitat niches and opportunities for species to move through the landscape to reach them. The maintenance and restoration of natural processes should maximise the resilience of freshwater ecosystems in a changing climate (Kernan *et al* 2012) and is the principal adaptation measure for these systems.

1.8 All fresh waters of any size in Great Britain are affected by various types of human impact to some degree. The general approach to SSSI selection for freshwater habitats is therefore necessarily based on selecting the best (most naturally functioning) remaining examples, and conserving them in the most natural state possible.

2 Scope of chapter

2.1 This chapter specifically covers open freshwater and certain brackish habitats and their margins, comprising running waters and standing waters, the latter including lakes and ponds and (where appropriate) water bodies of artificial origin (see Section 5.4 for further explanation of the treatment of artificial habitats). Freshwater habitats as SSSI features include both the abiotic (physical, hydrological and chemical) environment and the characteristic biological assemblages that the abiotic environment supports.

2.2 Owing to the many ecotones with terrestrial and coastal habitats, the boundaries with other habitat chapters are not always distinct and it may be possible to notify certain features using the guidance in more than one chapter. Freshwater habitats naturally form part of broader mosaics consisting of terrestrial, wetland and open water habitats at a range of spatial scales, for example upland peat bog, river–floodplain systems and coastal habitat mosaics.

2.3 Freshwater habitats, and the habitat mosaics to which they contribute, also support a wide range of species and species assemblages that may be notified in their own right under individual chapters on taxonomic groups. Within any given SSSI, a freshwater habitat may:

- be notified as part of a broader habitat mosaic;
- be notified as a specific feature in its own right;
- be supporting habitat for a notified species; and
- have no formal notification status.

2.4 It is therefore important to be explicit and transparent about the status of freshwater habitats within site notifications, recognising that a combination of these circumstances may exist on an individual SSSI.

2.5 Regarding links with other habitat chapters, habitats such as flushes, springs, bog and fen may be considered as part of a freshwater habitat feature if, at a site level, such habitat is inappropriate to notify in its own right (for instance due to the extent or quality of the habitat).

2.6 There are strong links between this chapter and most species chapters and in particular SSSI Guidelines for Freshwater Fish. This chapter should therefore be read in conjunction with species chapters to ensure consistency and complementarity of approach - Section 5.1 in particular.

3 International importance

3.1 Generally, British freshwater habitats fall within the environmental range characteristic of continental Europe. In the north and west of Great Britain there is a predominance of oligotrophic types, and perhaps the most unusual feature is the large extent of dystrophic waters in association with extensive occurrence of blanket bog (in locations where the habitat remains undrained). The extensive chalk stream network and the sporadic occurrence of marl lakes are notable in a European, and possibly a global, context.

3.2 As an example of international importance, Great Britain hosts several habitat types listed below by the EC Habitats Directive that fall within the scope of this chapter.

Table 1. EC Habitats Directive habitat types covered by this chapter.

Code	Description
H3110	Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*)
H3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*
H3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
H3150	Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation
H3160	Natural dystrophic lakes and ponds
H3170	Mediterranean temporary ponds
H3180	Turloughs
H3260	Watercourses of plain to montane levels with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
H7220	Petrifying springs with tufa formation (*Cratoneurion*) (primarily covered by the chapters on fens and upland habitats)

3.3 The characteristic biological assemblages of British freshwater habitats are typically impoverished compared with the equivalent habitats in Europe, owing to glacial extinctions and post-glacial barriers to re-colonisation. Although species richness is often reduced, this impoverishment does confer on British fresh waters distinctive biological assemblages that add to the diversity of assemblages across Europe.

3.4 Freshwater habitats in Great Britain also host a range of species of European importance, including fish, invertebrates, herptiles and plants. Some of these are widespread and abundant in Great Britain, while others are rare and highly threatened. These species are considered in more detail in the chapters on different taxonomic groups.

4 Nationally rare freshwater habitats

4.1 Some types of freshwater habitat are relatively rare in Britain. Some of these habitats are identifiable in routinely-used freshwater classifications, while others are not. A list of rare habitats in running and standing waters is provided below.

Table 2. Rare freshwater habitats in Britain.

Running waters	**Standing waters**
Gorges	Marl lakes
Tufa depositing rivers and streams	Deep, high alkalinity lakes
Actively braiding river–floodplain complexes	Moderate alkalinity lakes
Very low alkalinity lowland streams	Oligotrophic lakes of sandy plains
Naturally saline inland streams	Turloughs and other aquifer-fed fluctuating water bodies
Subterranean stream and river sections	Mediterranean temporary ponds
	Calcareous fen ponds
	Subterranean pools and lakes

In addition to freshwater habitats that are rare at a Great British-level, some habitats may be common in one part of Great Britain but rare in other parts. This results from the natural spatial distribution of different habitats, and it is important to capture examples that provide adequate coverage of this spatial distribution (Section 5.1).

5 Selection requirements

5.1 Selection rationale and geographical coverage

5.1.1 Owing to the widespread occurrence of freshwater habitats in the landscape, an exemplar approach (i.e. using the exemplary site principle; Bainbridge *et al* 2013) should generally be taken to SSSI selection. Given the operational complexity of managing freshwater habitats (involving their whole catchments which can be very large), and the potential implications of notification for catchment activities, it is vital that notifications are made in a parsimonious way. While not specifying the proportion or area of each type of freshwater habitat that should be notified, it is expected that a greater proportion of internationally important or nationally rare freshwater habitat types will be notified than other types (Section 4).

5.1.2 The national geographical distribution of freshwater SSSIs will not be even, as some areas will contain a greater proportion of a particular freshwater habitat type than others. Consequently, some areas will justifiably have a greater number of freshwater SSSIs. Expert judgement should be used to ensure that sufficient sites are notified to cover the natural variation in the habitat, whilst maintaining the area notified as a limited proportion of the overall freshwater habitat (and catchment) resource.

5.1.3 Sites should be selected using a suitable ‘geographic region of search’ based on the spatial scale of the site and its catchment. The following approach will generate a robust GB-wide network in line with Part 1 of the selection guidelines:

- where sites (or their catchments) are very large, a country-level approach capturing key regional variation is generally more appropriate. Standard Areas of Search (AoS) procedures cannot be used for these sites because the catchments of these sites would often be larger than individual AoS, and the total catchment area of sites selected on that basis would be too large to apply SSSI legislation effectively;

- for smaller water bodies (headwater streams, smaller lakes and ponds) with small catchments, a higher spatial intensity of sites is appropriate, preferably in ecologically linked networks. An approach based on an appropriate hydrometric unit should be used (e.g. standard hydrometric areas or individual catchments), so that the resulting notifications link closely to catchment management planning. Where hydrometric units are unsuitable, the standard AoS can be used.

5.1.4 In addition to the exemplar approach described above, any water body exhibiting very high levels of naturalness should be considered eligible for notification. However, in some parts of Great Britain this could constitute many notifications if there are high levels of naturalness in the area (e.g. parts of Scotland). Consequently, a focus on freshwater sites where the catchment is already notified as an SSSI for terrestrial features is advised in these cases.

5.1.5 Wherever possible and desirable, sites should be selected that contribute to the notification requirements of multiple freshwater habitat and species features. This maximises the conservation value of individual notifications and the efficiency of the freshwater site series, and promotes the conservation of notified species within naturally functioning freshwater habitat. Large-scale notifications based on naturally functioning habitat mosaics provide the greatest scope for multiple feature notifications.

5.1.6 Where sites are notified for a range of freshwater features, it is important to describe the notified features in ways that recognise their ecological relationships. Ideally, notified freshwater habitat features should be components of naturally functioning habitat mosaics. In addition, notified species and assemblage features should be components of freshwater habitat features. This does not affect the legal status of the features, or suggest a hierarchy of importance, but rather clarifies the relationship between features to improve the efficiency and effectiveness of their management based on natural ecosystem functioning.

5.1.7 Characteristic species assemblages of freshwater habitats are intrinsic components of the habitat feature and should not generally be seen as notified features in their own right, unless this is allowed in the relevant species chapter (for instance, invertebrate assemblages of exposed sediments). Instead, they should form part of the description of the habitat feature within the site notification details. Further guidance is provided in Sections 6 and 7.

5.1.8 SSSIs should include ecotones wherever possible, such as marginal wetland transitions, areas of floodplain inundation, wet woodland and springs and flushes. Allowance should be made for dynamic change, particularly in relation to rivers where lateral movement of the channel naturally occurs. Where necessary, land should be included based on potential value, to allow the full expression of ecotones over time. Detail on defining lateral and longitudinal boundaries is provided in Sections 6 and 7.

5.2 Key selection criteria

5.2.1 Part 1 of the guidelines lays out a range of established selection criteria. Those of greatest importance to selecting freshwater habitats are: typicalness, rarity, naturalness and ecological coherence. Diversity is also important in making decisions between candidate sites of otherwise similar merit. A number of these criteria are inter-related.

- **Typicalness, rarity and naturalness -** together these criteria form the foundation of selection for freshwater habitats, providing the basis for selecting the most natural remaining examples of habitat variation occurring across Great Britain. In addition to habitat rarity, consideration of species rarity is also important to try to capture as much biological variation as possible within the series of freshwater habitat SSSIs and thereby maximise the contribution to the notification needs outlined in the chapters on taxonomic groups.

- **Ecological coherence -** important factors for freshwater ecosystems are the integrity and diversity of the habitat and its connection to the surrounding landscape, including terrestrial, other freshwater and marine habitats. For running water this will include factors such as the integrity of the river–floodplain system and ecotone habitats, habitat heterogeneity and the longitudinal connectivity allowing natural movement of water, sediment and organisms. For standing waters, the main considerations include the quality of the land–water gradient and the connectivity or proximity of a water body to other fresh waters. Sites containing many ponds, particularly of varying environmental characteristics, have high ecological coherence by virtue of habitat heterogeneity. These considerations are strongly allied to the naturalness criterion and are critical for providing resilience to climate change.

- **Diversity -** this criterion operates at several ecological scales (habitat types, individual biotopes, species assemblages and taxon richness). Its consideration is intimately linked with consideration of naturalness in freshwater systems, since this drives characteristic diversity. Generally, higher diversity is of higher conservation value provided it is characteristic of natural conditions.

5.2.2 Given the widespread nature of human impacts on fresh waters in Great Britain, even in the uplands (where atmospheric deposition and land management have degraded naturalness and natural processes), the **Potential Value** criterion is also an important consideration in selecting SSSIs for freshwater habitat. It can be used in a variety of ways, many of which relate to setting detailed site boundaries rather than site selection *per se*. Where a choice exists between two sites that are difficult to separate on the criteria above, but where the existing impacts on one site are easier to resolve than the impacts on the other, then potential value can be used to select the former site. Following site selection, the criterion can also be used in support of the inclusion of marginal or interconnecting areas within the site boundary that are currently not of adequate quality but need to be improved to ensure site integrity.

5.3 Applying the criteria

5.3.1 Sites should be selected primarily on the basis of:

- their contribution to representing the full range of natural variation in freshwater habitat conditions in the wider habitat resource (based on consideration of typicalness and rarity); and
- their naturalness, to ensure that the most natural remaining examples are selected.

5.3.2 Comparison of potential sites is necessary to select the best exemplars of habitat variation and naturalness. An outline of the approach to evaluation is provided in Figure 1. Box 1 outlines the technical method, while detailed guidance on data for running and standing waters respectively is provided in Sections 6 and 7. The level of detail and data analysis used increases from the initial screening stage (Stage 1), through more detailed comparison of candidate sites (Stage 2), to the development of the notification package for sites selected for notification (Stage 3). Throughout each stage, an audit trail should be kept of the rationale for selecting candidate sites for subsequent detailed evaluation and comparison.

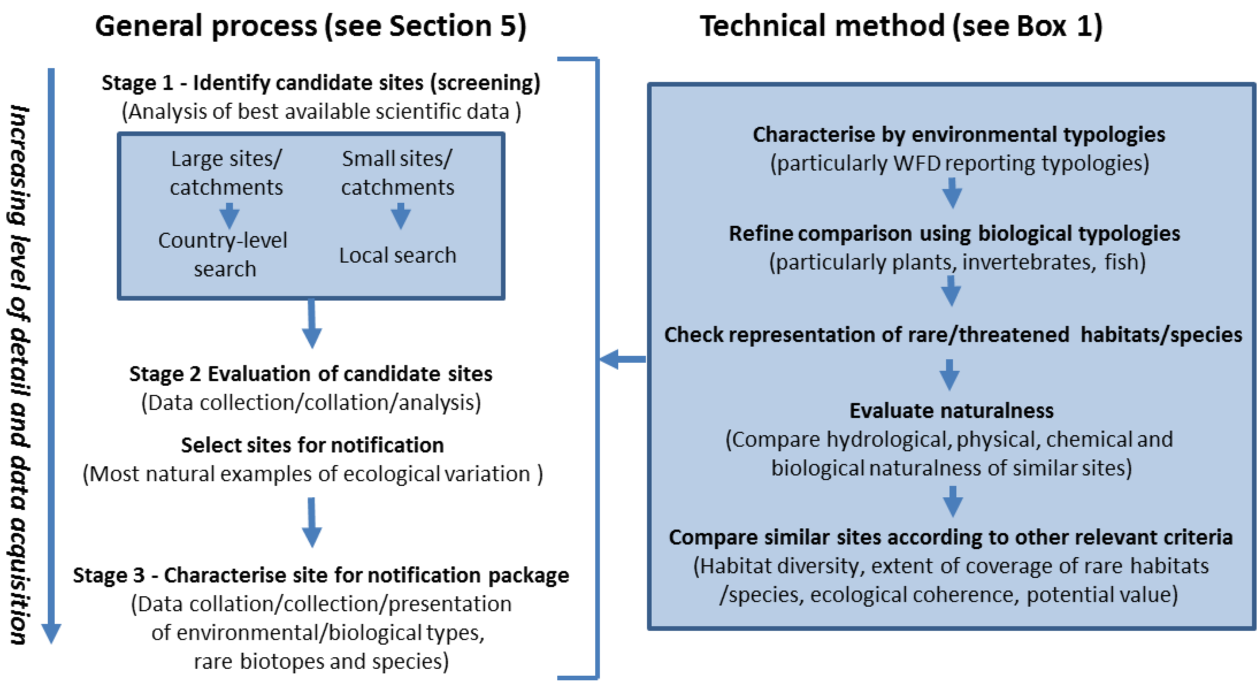

Figure 1. Approach to evaluation.

Stage 1 - Identifying candidate sites

Stage 1 aims to identify candidate sites using a structured assessment of the best available scientific evidence. An assessment is undertaken to gain an understanding of how the site fits into the context of the wider habitat resource. The best available data should be used to provide this wider context and select sites for more detailed evaluation and comparison in Stage 2. Although at this stage, data are likely to be coarse or based on modelling and enhanced by expert knowledge of the site, the evaluation should still follow the general principles outlined in Box 1. These principles apply to all three stages, although an increasing level of detail, data acquisition and analysis is used in the later stages of the process (Figure 1).

Box 1. Outline of the technical evaluation

Assessment of natural variation (typicalness and rarity) should focus on environmental variation, supported by information on natural biological variation (in relation to characteristic assemblages of key biological groups, including plants, invertebrates and fish). Care should be taken when using real data to characterise natural variation, as many types of data are affected by artificial impacts on sites. Sections 6 and 7 provide more detail on the typologies available for running waters and standing waters respectively. Attention should also be given to the representation of rare and threatened habitats (see section 4), which may or may not be identifiable with available typologies.

Ideally, an understanding of the representation of different environmental and biological types in the wider habitat resource would be available to judge the need for representation within the SSSI series, and the extent to which the need is filled by candidate sites. Where available, models that predict reference biological communities from environmental variables unaffected by artificial influence are valuable in providing this context.

Analysis of the presence of rare and threatened species associated with freshwater habitats should also be undertaken. Up-to-date listings of species with rare or threatened status are provided by JNCC here, collating available information from IUCN red lists, national assessments of rarity and designations at UK and country-level (including lists of priority species). This spreadsheet is updated regularly based on GB-level reviews of individual taxonomic groups, which are available from JNCC here as and when they are published. Available data on the distribution of species, from the National Biodiversity Network (NBN) and other relevant sources, can be used to make an initial assessment of the importance of different sites in supporting rare and threatened species in the wider habitat resource. Care should be taken in the interpretation of such data, since species may be present on a site due to impacts on natural habitat function, and species recording is highly patchy.

Assessment of naturalness should consider artificial modifications to hydrology, physical habitat condition and water quality, and direct biological pressures such as non-native species, locally non-native species and fisheries management. Various pressure-related datasets are available at country level, including (at least for monitored water bodies) data from WFD-related environmental monitoring. Data on WFD biological metrics (macroinvertebrates, macrophytes, diatoms and fish) also provide valuable information on the integrated effect of some of these pressures. More detailed information on relevant datasets for naturalness is provided on running and standing waters in Sections 6 and 7 respectively. Reference lists for non-native species and locally non-native fish species are updated periodically and these are available on the WFD UKTAG website. Other species not relevant to the WFD should also be considered.

An assessment of the extent of near-natural vegetation cover, urban development and other cover types in the catchment can assist in a wider evaluation of naturalness. Features such as broadleaved woodland, coniferous woodland, improved grassland and urban development can be estimated using GIS layers such as the Land Cover Map (LCM) 2007 developed by the Centre for Ecology and Hydrology (CEH). For small water bodies, the naturalness of catchment land cover may be the only easily accessible information at the level of the whole habitat resource.

The naturalness assessment needs to be made by habitat type (e.g. different river types, different standing water types) to ensure that sites of similar character are compared, since different habitat types tend to be degraded in different ways and to different degrees.

Other considerations. Following the assessment of natural variation and naturalness, sites showing most potential for selection should be compared across the broader range of selection criteria, as far as available data allow at each stage of the evaluation. It is here where sites showing greater levels of natural habitat and assemblage and species diversity (including rare and threatened habitats and species), greater site coherence, or showing higher levels of potential value, should be favoured for selection.

Stage 2 – Evaluation of candidate sites

Sufficient data should be collated (where already available) and collected (where necessary) on candidate sites to make final judgements and select sites for notification. Candidate sites should be adequately typed according to the classifications identified in Sections 6 and 7, and there should be sufficient data to enable an assessment of each of the main elements of naturalness. The extent to which detailed biological survey should be conducted will depend on the number of candidate sites being compared and the historical recording effort. New survey of rare species would not normally be expected at this stage.

Stage 3 – Site characterisation for the notification package
Sufficient data should be collected on each selected site to make an adequate assessment of conservation value and justify selection as the best (most natural) example of type within the appropriate geographic region of search. The habitat types and biological community types present should be confirmed. Where information from Stage 2 is insufficient, species-level biological surveys should be undertaken as necessary and may include survey of aquatic macrophytes and marginal vegetation, aquatic and semi-aquatic macroinvertebrates, fish, herptiles and birds. The data should be analysed for the presence of rare or otherwise threatened species on a country, Great Britain, European and international basis. The Stage 3 evaluation should also confirm the level of environmental naturalness and biological naturalness of the site. A Common Standards Monitoring condition assessment (IAFG 2014; 2015) should be undertaken to establish current condition, and general issues requiring restoration action should be identified.

5.4 General treatment of artificial sites

5.4.1 For standing waters, the concepts of natural origin and natural functioning (as described in Section 1) can be considered separately. This is because some standing waters of artificial origin can function naturally and support characteristic assemblages and, in such situations, it can be difficult to be sure of the origin of the water body. This is different from the situation with running waters where artificial origin relates to the construction of drains, which are usually obvious and generally bear no resemblance to naturally functioning running water habitat (headwater drains with significant gradient can be an exception)

5.4.2 In a naturally functioning landscape, small standing waters would gradually infill and new standing waters would be created, but the natural loss of standing waters has been exacerbated by infilling and drainage, and the natural processes that would create new water bodies often no longer operate. In addition, many larger standing waters have been degraded. Consequently, it may be necessary to designate standing waters of artificial origin, e.g. man-made ponds, gravel pits and peat excavations, but these should still be the most naturally functioning standing water bodies in a geographic region of search. In these situations, care should always be taken to ensure that a water body of artificial origin is sustainable and is not restricting natural processes in the landscape.

5.4.3 Examples that are unlikely to meet these requirements include:

- lakes generated by impounding rivers, which prevent natural river habitat function and are often subject to rapid in-filling and enrichment;

- canals, which cut across watersheds and can interfere with the hydrological and chemical function of natural freshwater habitats and rely on regular maintenance;

- ditches, which constrain the restoration of natural wetland mosaics and rely on regular maintenance; and

- reservoirs with highly artificial hydrological regimes or lake margins preventing them being of value as surrogate examples of natural lake habitat.

5.4.4 Species characteristic of natural habitats often seek refuge in artificial habitats if their natural habitats have been destroyed or degraded. Whilst these artificial sites are not suitable for notification for freshwater habitat (e.g. canals and ditches), they may be considered suitable for notification as refuge sites for their biological assemblages (see Section 8), or for specific rare species under chapters on taxonomic groups.

However, where possible, freshwater species and species assemblages are best conserved in naturally functioning habitat (see Section 5.1) and notification of artificial freshwater habitat for species features and assemblages should try to be avoided.

6 Running water habitats

6.1 Types of river habitat SSSI

6.1.1 Two types of notification are valid for river habitat:

- ‘whole-river’ notification, in which a river system is notified as a longitudinal continuum of change; and
- ‘sectional’ and headwater notifications, in which a river section is notified, which may be the most upstream section within the catchment.

6.1.2 In the entire SSSI series, whole-river notifications aim to capture the most natural remaining examples of key longitudinal continua in river habitat at country-level, encompassing key aspects of regional variation. This framework is supported by additional sectional and headwater SSSIs in other catchments that can add more local coverage of the most natural remaining examples of environmental and biological variation in river habitat.

6.2 Selecting whole-river SSSIs

6.2.1 Whole-river SSSIs are important in capturing the full ecological continuum characteristic of river ecosystems (Vannote *et al* 1980), through the full range of associated nested spatial scales of variation (Frissell *et al* 1986). Such sites have high internal ecological coherence by virtue of their size and diversity.

6.2.2 Comparison of candidate sites should be based on whole river systems, from headwater zones with their associated ephemeral sections, seepages and flushes, through to the saline transition zone at the estuary head (taken as the mean low water mark), and encompassing the tributary network. It should include the riparian corridor and hyporheic zone, as integral parts of the river habitat, as well as interactions with the natural floodplain. There should be sufficient resolution in the assessment to evaluate the character and naturalness of different river reaches within the river continuum.

6.2.3 Environmental parameters for evaluating natural environmental variation in river systems include site altitude, catchment altitude, stream gradient, baseflow index, alkalinity (strongly allied to natural trophic status), distance from source, stream order (e.g. Strahler 1952) and rainfall. These parameters are built into various established typologies, either as numerical type delimiters (in environmental typologies) or general type descriptors (in biological typologies).

6.2.4 There are various typologies available for rivers that can help in describing environmental and biological variation. It should be stressed that typologies are simply tools to help make the assessment and are subsequently useful in describing the range of variation covered by the river habitat notification at a given site. River networks are dynamic ecological continua with few fixed boundary conditions, so all typologies produce an artificial segmentation, and each typology segments in different ways and at different points in the river network. Environmental variation in river systems can be evaluated without reference to a typology, for instance by generating scatter plots of key variables and highlighting existing and potential river SSSIs within these.

6.2.5 Of the wide range of river typologies that exist, those in Table 3 are considered most suitable for site selection, reflecting key aspects of natural habitat variation including hydrological regime, water chemistry, trophic status, physical form and characteristic assemblages. The river habitat SSSI series should include representation of all WFD types occurring at country level. For the recommended biological typologies, the river habitat SSSI series should include representation of the main types occurring at country level. Since these typologies simply segment the full habitat variation in different ways, each typology can be considered in isolation and there is no need to consider the detailed interaction between typologies. Note that there is no suitable Great British typology for fish assemblages, but natural variation in assemblages is broadly captured by the other typologies recommended for site selection.

6.2.6 Evaluation of rivers is complicated by the presence of multiple river types within each river system, such that simple comparison of two candidate rivers is rarely possible. Each river system must be considered for its overall contribution to representing habitat variation at the country level of search. Such comparisons should extend into the extent of coverage of biological sub-types within the typologies in Table 3, to include as much variation as possible in the sites selected.

Table 3. Typologies for river SSSI selection.

Typological basis	**Typology name**	**Comments**	**Reference**
Environmental	Water Framework Directive reporting typology	Uses three variables: dominant catchment geology (calcareous, siliceous, organic i.e. peat), catchment size (>1000km^2, 100-1000km^2, 10-100km^2) and catchment altitude (>800m, 200-800m and <200m). Generates 27 potential types, some of which do not exist, or do not occur in Great Britain, or are restricted to certain parts of Britain. For the purposes of SSSI selection, additional types for headwater streams, with catchment areas of <10km^2, should be included.	WFD-UK TAG 2003
	UK BAP priority habitats	The UK definition of priority river habitat includes chalk rivers, active shingle rivers, headwater streams and Habitats Directive Annex I river habitat H3260 (watercourses of plain to montane levels, with submerged or floating vegetation of the *Ranunculion fluitantis* and *Callitricho-Batrachion* or aquatic mosses).	BRIG 2007
Plants	JNCC River Community Type classification	Comprises 10 main types (I-X) and 38 sub-types. Covers channel and marginal species.	Holmes *et al* 1999
Macro-invertebrates	RIVPACS	Comprises 43 end-groups clustered into seven main types ('super-groups'). Only covers aquatic, largely benthic, species. Does not cover ephemeral species such as those associated with exposed riverine sediments.	Davy-Bowker *et al* 2008

6.2.7 General environmental typologies for rivers are not sufficiently detailed to allow consideration of particular habitats and individual biotopes, such as gorges, exposed riverine sediments and ephemeral streams, and these limitations are not necessarily addressed by the biological typologies used in Table 3. Although different river types might reasonably be expected to support the full range of characteristic biotopes under natural conditions (naturalness being a key selection criterion), explicit attention should be paid to those biotopes that may be missed by the typological assessment, to ensure that adequate coverage is achieved within the site series. This should consider the rare and threatened running water habitats listed in Section 4.

6.2.8 NVC classifications for swamps and mire are useful in helping to characterise a site fully and to compare the diversity of candidate sites. However, the NVC classification of running waters does not add value to the JNCC classification in respect of site selection and so is not recommended for use.

6.2.9 Assessment of the presence of rare and threatened plant, invertebrate and fish species associated with riverine habitats should be undertaken using the guidance on species conservation status in Box 1. This should include consideration of ephemeral habitats such as exposed riverine sediments and ephemeral headwater stream sections where they occur.

6.2.10 Table 4 provides a suggested list of indicators to use in the evaluation of naturalness. These attributes are essentially the same as those used in Common Standards Monitoring guidance for assessing the condition of river habitat, and that guidance can be used for more detailed explanation of individual attributes (IAFG 2014). However, depending on the number of candidate sites it may not be possible to consider all these attributes at Stage 2, and readily available data together with expert judgement will probably need to be used. As a minimum, some assessment of each of the main elements of naturalness should be made, at least using an assessment of the scale of human pressure on each element. Information on these attributes should be classified and aggregated to provide an overall comparison of candidate sites. Sites should be grouped by broad type (for instance using the WFD reporting typology) before making a comparison, to ensure that only sites of similar natural character are compared. The evaluation system SERCON (Boon *et al* 2002) provides a structured evaluation of naturalness that can be used if sufficient data are available in an appropriate form.

Table 4. Naturalness elements for rivers (based on Common Standards Monitoring guidance for assessing SSSI/SAC river habitat).

Main Element	Sub-elements	Description of assessment	Suggested data sources
Hydrological integrity	Flow modification	Deviations from daily naturalised flows (including spatial assessment)	Environment agencies
Physical integrity	Planform modification	Artificial changes in planform	Maps
	In-channel structures	Effect on hydraulics (impoundment), sediment transport, species movement	Various
	Aggregated physical modifications	Habitat Modification Score – includes channel and bank resectioning, flood banks, etc)	River Habitat Survey*
	Large woody debris	Extent	River Habitat Survey*
	Bank vegetation	Extent of near-natural vegetation	River Habitat Survey*
	Riparian vegetation	Extent of near-natural vegetation	River Habitat Survey*
Physico-chemical integrity (water and sediment quality)	Organic pollution	Dissolved oxygen, total/un-ionised ammonia, Biochemical Oxygen Demand	Environment agencies
		ASPT/NTAXA (Average Score Per Taxon and Number of Taxa)	Environment agencies
	Nutrient enrichment	Soluble Reactive Phosphorus	Environment agencies
		Trophic Diatom Index and River Macrophyte Nutrient Index	Environment agencies, plant community survey
	Acidification (acid sensitive types only)	Acid Neutralising Capacity/pH	Environment agencies
		AWICS - Acid Waters Invertebrate Classification System	Environment agencies
	Other pollutants	EQS compliance	Environment agencies
		Various WFD biological metrics	Environment agencies
	Siltation	Silt levels	River Habitat Survey*
		PSI – Physical Siltation Index	Environment agencies

Main Element	Sub-elements	Description of assessment	Suggested data sources
Biological stressors	Non-native and locally non-native species	Presence of species, using WFD UK TAG impact categories (see Box 1)	Various
	Fish introductions	Stocking records	Licensing authorities
	Exploitation	Rate of exploitation	Fishery authorities
	Weed-cutting	Extent/pattern of cutting	Environment agencies
Biological community	In-channel community (macroinvertebrates, macrophytes)	Changes in community composition from reference conditions - WFD metrics and HES class boundaries used as surrogates	Environment agencies, or independent macrophyte survey

*River Habitat Survey (RHS) - Raven *et al* (1997) and Environment Agency (2003).
See http://www.riverhabitatsurvey.org/ for more information on RHS.

6.2.11 Assessment should also be made of the extent to which a river SSSI notification would link with other valuable habitats (which may or may not be SSSIs) that form natural continuities with river habitat, such as bog, fen, swamp, wet woodland, wet heath and estuary.

6.2.12 Further comparisons between candidate rivers can be made based on the ease with which any existing impacts on naturalness and natural processes can be addressed (i.e. potential value). This would include consideration of floodplain activities and their compatibility with future restoration of river–floodplain interactions.

6.2.13 Selected sites within the geographical region of search should aim to display no obvious gaps in the coverage of environmental conditions manifest in the wider river network, or major omissions of typical or rare habitats and biotopes and biological assemblages. Key longitudinal transitions in conditions and biological communities should be captured.

6.3 Defining longitudinal site boundaries for whole-river SSSIs

6.3.1 Headwater streams constitute most of the river network by length, have their own characteristic assemblages and are very important in river ecosystem functioning. There should be a presumption in favour of including tributaries within whole-river notifications up to and including the headwater zone (including perennial and ephemeral sections and any associated mire). However, tributaries that are heavily degraded should not normally form part of the designation, except where they can be considered to be a necessary part of characterising the full longitudinal transition within the river system.

6.3.2 The notification should include the natural location of the saline transition zone; if this zone is truncated because of physical barriers, the natural transition zone should be included based on its potential value. If the estuary is notified, the boundary of the river notification should be contiguous with the estuary notification.

6.3.3 Where the site boundary would extend upstream into an extensive terrestrial SSSI, it is recommended that the terrestrial SSSI is used to extend the notification, including river habitat as an explicit part of the habitat mosaic.

6.3.4 Where part of the principal longitudinal river continuum, degraded sections of selected rivers should be notified to ensure ecological coherence of the site and based on their potential value. The level of restoration of these sections may, however, be constrained by the nature of the impacts and the technical feasibility of remedial action. In general, such sections would be expected to be infrequent, and short in length.

6.4 Selecting sectional and headwater SSSIs

6.4.1 The selection of such SSSIs should focus on headwater areas where the most natural remaining examples of river habitat are generally found. Caution should be exercised when considering examples from the middle and lower reaches of river systems, since conserving the naturalness of such sites by protecting them against impacts from hydrological, physical, chemical and biological stressors is affected by management of the whole catchment upstream of the site. This issue is most problematic in lowland England where catchment pressures are generally most varied and intense.

6.4.2 Candidate sites should be identified through similar procedures to those outlined above for whole-river SSSIs, but based on a standard hydrometric unit approach as outlined in Section 5.1.3. All types of headwater stream should be considered, drawing on the typologies in Table 3 and including types that are not well-covered, such as coastal and ephemeral streams. In addition, any headwater stream exhibiting very high levels of naturalness (nearly totally undisturbed across all naturalness elements in Table 4) should be considered eligible for notification. Given that in some parts of Great Britain this could constitute many headwater streams, it is advised that notification based on very high levels of naturalness could be focused on areas where the catchment is already notified as an SSSI for terrestrial features. As with whole-river SSSIs, the site boundary should generally extend upstream into and including the stream/mire transition, and connect with SSSI notifications for other habitats where present.

6.5 Defining lateral boundaries of river SSSIs

6.5.1 The notifiable feature ‘river habitat’ should generally be taken to comprise the river corridor, including the river channel, its banks and riparian zone, operating under natural processes and within its functional floodplain. The width of these three elements will vary along the course of a river, but the SSSI boundary should always encompass all of them.

6.5.2 As a minimum, the lateral extent of the SSSI boundary should be broad enough to act as a functional habitat and river corridor for riverine and riparian species, and include wetland transitions. The minimum width considered necessary for adequate site coherence is 10 metres from the banktop, but the boundary would preferably encompass a wide zone out to the limits of the natural floodplain where this is under near-natural vegetation. Where the channel runs through gorge habitat, the boundary should be set to encompass the full height of the gorge.

6.5.3 Any adjacent near-natural, wet habitat which is intimately linked with the river and which may be dependent on the river for its continued existence should be included within the SSSI boundary. Such areas may be unimproved alluvial floodplain 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.

6.5.4 Many species, including invertebrates with aquatic life stages, a range of bird species, and mammals such as otter and water vole, require both the river and adjacent standing water, wetland and terrestrial habitats to thrive, even if those habitats are not directly dependent on the river. These habitats adjacent to the river can be included within the SSSI boundary if they contribute significantly to sustaining fauna associated with the river.

6.5.5 The site boundary should allow for lateral channel movement. The site boundary should include an ‘erodible corridor’ that takes account of likely lateral movement of the river channel over a timescale of 20-50 years, and should be reviewed regularly for any necessary adjustments. As a minimum, the site boundary should be defined to reflect lateral movement of the channel and its riparian zone, rather than being fixed to a historical mapped location.

6.5.6 The site boundary should incorporate regularly inundated riparian and floodplain land, defined as all land frequently inundated by fluvial flooding (1 in 5-year floodplain).

6.5.7 Where the inclusion of riparian and floodplain land within the site boundary involves land at present of low conservation value, this land should generally be included based on potential value and can over time develop the conservation interest expected of a natural river system. However, where the channel runs through occasional urban areas, a pragmatic approach needs to be taken to the boundary; in these instances, it may need to be located close to the bank top.

6.5.8 Opportunities should be taken to connect the site boundary to other notified sites such as natural valley mire, heath, moorland and floodplain habitats, to encourage their integrated management. The concept of compound SSSIs (see Part 1 Section 4 of the guidelines) is particularly relevant to more developed river/floodplain systems, allowing dispersed but ecologically linked SSSI interest in the catchment and the floodplain to be formally linked to river notification. This provides a better basis for promoting large-scale habitat mosaics and natural river processes within the SSSI network, offering a more flexible approach to management and adaptation to climate change.

6.5.9 In areas where there is intensive landuse, an additional buffer may be required to protect against adverse effects on the riparian and open water habitat. For example, the Forests and Water Guidelines (Forestry Commission 2011) recommend a 20m buffer as a minimum.

6.6 Defining the river habitat feature when notifying sites

6.6.1 The notified feature should be expressed as ‘river habitat’ at a general level, including running waters of all sizes. This feature comprises the abiotic (physical, hydrological and chemical) environment and the characteristic assemblages that the abiotic environment supports. At a more detailed level, the environmental and biological character of the site should be expressed through relevant typologies, starting with the WFD reporting types and including plant and invertebrate types and sub-types. Since there is no suitable GB typology to describe the natural fish assemblage, this should be done on a site-specific basis using local knowledge of the natural fish fauna (including information on known introductions to the site and locally absent native GB fish species (see Box 1). Species that do not occur naturally at the site should not be included in the feature description. NVC vegetation types should be noted for marginal and other hydrologically connected land.

6.6.2 The scope of the river habitat feature should be made clear, to include the river channel, its banks, riparian and hyporheic zones, and where appropriate connected spring and flush habitat and saline transition zone, all operating under natural processes and within the functional floodplain. It should also be clear that the notification is based on naturalness criteria, recognising the site as one of the best (most natural) examples of relevant aspects of variation in river habitat in the wider habitat resource.

7 Standing water habitats

7.1 Types of standing water habitats

7.1.1 Water bodies of all sizes can be considered for SSSI selection of standing water habitat. Although the same principles should be applied to the selection of sites that are large (lakes) and small (ponds), fewer data and tools are available for small water bodies, so how the principles are applied varies depending on the tools and data available. Some tools were designed for lakes rather than ponds and consequently judgement needs to be applied as to whether they are suitable for smaller water bodies. Annex 1 gives further information on whether a water body may be functioning as a pond or lake.

7.1.2 Saline lagoons are defined in Chapter 1 (Coastal and Marine Habitats); brackish standing waters which are not included in that definition can be selected using the guidelines in this chapter.

7.2 Selecting standing water habitat SSSIs

7.2.1 Lakes and ponds should be selected based on contributing to the natural environmental and biological range of standing waters within the appropriate geographic region of search. The SSSI standing water habitat series should represent the full natural environmental range of standing waters, including both common and rare habitats. Key environmental parameters which need to be considered are alkalinity, colour, hydrological regime, mean water depth, surface area, site altitude and connectedness. Due to human influences upon nutrient status, natural trophic state is best reflected by alkalinity (Vighi & Chiaudani 1985). To assess the coverage of standing waters of varying alkalinity and colour the WFD lake typology (WFD-UKTAG 2004) should be used (Table 5). Although the WFD typology was developed for lakes, the range of alkalinity and colour is equally applicable to ponds and should also be used for their selection where data allow.

7.2.2 The WFD size and depth classes should not be used for SSSI site selection as they do not place sufficient emphasis on small water bodies. Small water bodies have particular value as SSSIs as they contain a disproportionate diversity of species in relation to their size, and their small surface area leads to different environmental conditions from those in larger lakes. Appropriate depth, size and altitude types which incorporate the environmental variation in standing waters in Great Britain are shown in Tables 4-6.

7.2.3 Data on alkalinity, colour, surface area, altitude and depth are available via the UK Lakes Portal and may be useful at the screening stage. However, many small ponds are not covered and much of the data are modelled rather than measured.

Table 5. WFD lake typology alkalinity and colour**.**

Geology	Abbr	Catchment	Alkalinity		Conductivity	Colour
			ueq L^{-1}	mg $CaCO_3$ L^{-1}	uS cm^{-1}	mg Pt L^{-1}
Organic	P	>75% Peat				>30
Siliceous	LA	>90% siliceous solid geology	<200	<10	<70	<=30
	MA	>50% siliceous solid geology	200 – 1000	10 – 50	71 – 250	
Calcareous	HA	>50% calcareous geology	>1000	>50	251 – 1000	
	Marl	>65% limestone				
Brackish	B				>1000	

Notes on Table 5:
Geology: solid geology overridden by base status of drift and soil type.
Conductivity: is used only as a guide to lake type.

Table 6. Depth types for SSSI selection.

Depth	Abbr	Mean depth (m)
Extremely shallow	VVSh	<= 1.0m
Very Shallow	VSh	<= 3.0m
Shallow	Sh	3-15m
Deep	D	>15m

Table 7. Surface area types for SSSI selection.

Area (ha)
<2
>2-10
>10-50
>50

Table 6. Altitude types for SSSI selection.

Altitude (m)
<200
200-500
>500

7.2.4 The natural range of hydrological regimes should be included in the standing water SSSI series. This includes groundwater- and surface-water-fed water bodies with a range of connectedness, i.e. both those naturally present on river systems and those that are not. Information on connectedness is readily available from maps, but the extent to which a water body is groundwater- or surface-water-fed is not always apparent. This characteristic can only be used when relevant information is available, although catchment geology is a useful guide. Small water bodies are less likely to be directly connected to watercourses, so examples of this may be absent from the SSSI series. Water bodies with varying natural water-level regimes should also be included, such as temporary and permanent ponds and turloughs and aquifer-fed naturally fluctuating water bodies as well as permanent lakes.

7.2.5 The natural biological range should be represented in the SSSI series by including the range of environmental types outlined above cross-checked with the botanical classification of lakes (Duigan *et al* 2006). Biological typologies for other taxonomic groups are not available for standing waters. The botanical classification of lakes is based on the most comprehensive GB dataset available and can be used to describe the botanical variation present in the habitat resource. There is great environmental variability within groups, in part due to the wide ecological tolerance of some macrophytes, and since this classification lacks a reference model, groups may include highly degraded lakes. Group F contains few submerged plants because of impacts on them; it is not necessary, therefore, to include lakes supporting this vegetation group in the SSSI series if more naturally functioning lakes are available.

7.2.6 This typology does not include emergent vegetation, which can poorly reflect lake type; instead emergent vegetation is considered under naturalness as ‘characteristic zones of vegetation’. When ponds are sufficiently shallow or seasonal and are dominated by emergent rather than submerged and floating species use of this typology is not appropriate. NVC classifications for swamps and mire are useful in helping to characterise a site fully and to compare the diversity of candidate sites and may be useful in describing some pond vegetation. However, the NVC classification of standing waters does not add value to the Duigan typology in respect of site selection and so is not recommended for use.

7.2.7 There is no widely accepted classification of macroinvertebrate or fish assemblages in standing waters that would allow them to be used to select a representative range of sites. Consequently, incorporating the natural environmental range of standing waters has to act as a surrogate for capturing the range of fish and invertebrate assemblages where they are not qualifying features in their own right.

7.2.8 Not all standing water types are present in Great Britain, and those that are will not be represented in all areas, as some characteristics have a certain interdependency and limited geographic distribution. For example, large lakes in northern Great Britain tend to be oligotrophic and deep, while eutrophic standing waters in southern Great Britain tend to be shallow. Where examples would exist naturally, sites should be selected, and several examples of a type may be needed to cover the full range of variants. Examples that are on the boundary between two types can also be as valuable as those representing the centre of a type, and nationally rare types justify notification of a greater number of examples in a single locality.

7.2.9 Part 1 of the SSSI guidelines (Section 2.3) emphasises the need to consider the coverage of priority habitats, and sections 3 and 4 of this chapter refer to the internationally important habitats and rare habitats within Great Britain. Table 9 indicates general correspondence between these additional habitat descriptions which should be considered when selecting sites.

7.2.10 Sites selected should include naturally diverse and naturally impoverished communities, including standing waters with high levels of genetic variability in resident species, as well as fishless standing waters with their own characteristic food webs. Assessment of the presence of rare and threatened plant, invertebrate and fish species in lakes and ponds should be made using the guidance on species conservation status in Box 1.

7.2.11 Natural functioning in standing waters is more important than natural origin, and water bodies of artificial origin may be selected for notification, when they are the most naturally functioning sites in an area.

7.2.12 Naturalness should be evaluated through a structured analysis of key components of habitat integrity: Table 30 provides a suggested list of indicators to use in the evaluation of naturalness for lakes and ponds. This process is essentially the same as that used in Common Standards Monitoring for assessing the condition of lake habitat (IAFG 2015). If there is uncertainty regarding the biological assemblages a site would naturally support, palaeolimnological analysis may be useful (Box 2).

Table 9. Comparability of habitat descriptions and typologies to be used when selecting standing water SSSIs.

<table>
<tr><th>WFD alkalinity/ colour types</th><th>BAP priority habitat types</th><th>Habitats Directive Annex 1 types</th><th>JNCC vegetation types</th><th>Rare SSSI types</th></tr>
<tr><td>High alkalinity</td><td>Naturally eutrophic standing waters >2ha</td><td>Natural eutrophic lakes H3150</td><td>E, G, I, H</td><td>*High alkalinity deep lakes</td></tr>
<tr><td>Marl</td><td rowspan="2">Mesotrophic lakes >2ha</td><td>Hard oligo-mesotrophic with Chara spp. H3140</td><td>B, C2, E, F, G, I</td><td>Marl lakes</td></tr>
<tr><td>Moderate alkalinity</td><td rowspan="2">Oligotrophic to mesotrophic standing waters H3130</td><td>D, E,</td><td>*Moderate alkalinity deep lakes</td></tr>
<tr><td rowspan="2">Low alkalinity</td><td rowspan="3">Oligotrophic and dystrophic lakes >2ha</td><td rowspan="2">B, C1, C2,</td><td rowspan="2">*Oligotrophic standing waters of sandy plains</td></tr>
<tr><td>Oligotrophic standing waters of sandy plains H3110</td></tr>
<tr><td>Peat</td><td>Natural dystrophic lakes and ponds H3160</td><td>A, B, C1,C2</td><td></td></tr>
<tr><td>WFD typology does not include hydrological regime</td><td>Aquifer fed naturally fluctuating water bodies</td><td>*Turloughs H3180</td><td>B, I</td><td>Aquifer fed naturally fluctuating water bodies</td></tr>
</table>

WFD typology does not refer specifically to ponds	Ponds <2ha	*Mediterranean temporary ponds H3170 Ponds and pools can represent any of the above habitat types	Any but especially A, B, C1, G, H (small, richer ponds not well covered)	*Mediterranean temporary ponds *Calcareous fen ponds
Brackish lakes	Saline lagoons	Saline lagoons	**J**	Brackish lakes

Habitat types denoted * are a subset of the priority habitat and/or WFD type in the same row of the table. The closest correspondence between JNCC vegetation types and WFD alkalinity/colour types is shown in **bold** in the 'JNCC vegetation types' column. Equally important representatives or regional variants may occur in the other groups listed.
Note that BAP priority habitat types of surface area 1-2ha may be ponds or lakes (see Annex I).

Table 30. Naturalness elements for standing waters (based on Common Standards Monitoring guidance (IAFG 2015) for assessing SSSI/SAC lake habitat).

Element	Sub-elements	Description of assessment	Suggested data sources	Relevant for lake or pond
Hydrological integrity	Hydrological regime	Deviations from the natural hydrological regime.	Environment agencies and site observations	Lake & pond
Physical integrity	Shoreline	Artificial changes in shoreline	Maps, aerial photographs, Lake Habitat Survey (LHS)	Lake & pond
	Lake substrate	Changes to the natural water body substrate	Site observations, LHS.	Lake & pond
	Sediment load	Changes to the natural sediment load	Site observations, LHS, palaeo study for sedimentation rate	Lake & pond
	Connectedness	Barriers	Site observations, LHS	Lake & pond
Physico-chemical integrity (water quality)	Nutrient enrichment	Total phosphorus	Environment agencies	Lake & pond
		Total nitrogen	Environment agencies,	Lake & pond
		Chlorophyll a	Environment agencies	Lake & pond
		Dissolved oxygen	Environment agencies	Lake & pond
		Lake Trophic Diatom Index (LTDI) in Diatom Assessment of River and Lake Ecological Quality (DARLEQ)	Environment agencies	Lake
		Chironomid Pupal Exuvial Technique (CPET)	Environment agencies	Lake
		Water clarity	Site based observations	Lake & pond
	Acidification (acid sensitive types only)	Acid Neutralising Capacity/ pH	Environment agencies	Lake & pond
		Lake Acidification Macroinvertebrate Metric (LAMM)	Environment agencies	Lake
		Diatom Acidification Metric (DAM) in DARLEQ		
	Other pollutants	EQS compliance	Environment agencies	Lake

Other stressors	Non-native and locally non-native species	Presence of species, using WFD UK TAG impact categories (see Box 1)	Various	Lake & pond
	Filamentous algae	Abundance of filamentous algae	Macrophyte survey	
	Fish introductions	Stocking records, fish survey, eDNA.	Licensing authorities	
	Exploitation	Rate of exploitation	Fishery authorities	
	Vegetation management	Extent/pattern of cutting	Site observations	
	Boating	Extent of disturbance via boating	Site observations	
	Catchment land-use	Extent of natural and near-natural habitats in the catchment	Maps, aerial photography, land cover map, observations	
Biological community	Macrophyte community composition for lakes	Characteristic species for lake type as listed in Lake Common Standards Monitoring	Data may be available from the environment agencies, otherwise independent macrophyte survey will be required	Lake
		Characteristic zones of vegetation across the entire hydrosere including marginal vegetation	Aerial photography, LHS, macrophyte survey	Lake
		Maximum depth of colonisation	Macrophyte survey	Lake
	Pond assemblage	Characteristic pond assemblages. (Characteristic species for lake type as listed in Lake CSM or PSYM (Ponds Conservation Trust (2002) may be useful.)	Survey and Freshwater Habitat Trust	Pond

Notes on Table 30:
Lake Habitat Survey: the LHS methodology can be found in Rowan *et al* (2006) and Rowan (2008).
Nutrient enrichment: palaeolimnology may be used to determine the natural condition of the lake (see Box 2).

Box 2. Use of palaeolimnology to inform site selection

Palaeolimnology is the reconstruction of past lake ecosystems by studying the sediments deposited at the bottom of lakes. Over time, sediment slowly accumulates on the lake bed. Sediment at different times will reflect different environmental conditions, including the physico-chemical conditions at the time of deposition. In addition, the remains of many different types of organisms become preserved in the sediment, including diatoms, charophyte oospores, plant leaf fragments and seeds, zooplankton, chironomid head capsules, mollusc shells and fish scales.

By carefully taking one or more sediment cores from the lake and comparing the chemistry and subfossil remains from different depths, it is possible to reconstruct and describe changes in lake ecology over time. Several different dating techniques are available to estimate the timing of any changes, generally involving radioisotopes. Statistical models have been developed that can ‘hind-cast’ the pH and phosphorus concentrations based on these organisms; in other cases, descriptions of changes may be more qualitative. In general, palaeolimnology is a particularly powerful tool for detecting change over time.

Palaeolimnology is particularly useful for addressing the following types of question (Sayer *et al* 2012):

- Naturalness: Is there evidence of long-term environmental damage and/or recovery (e.g. nutrient enrichment, fish stocking)?
- Representativity: Has the water body always been its current type? If not, when did it change and why?
- Management: How has the recorded history of catchment management affected the lake?
- Physical: What are the sedimentation rates in the lake and have these changed over time?

7.2.13 Depending on data availability it may not be possible to consider all these attributes, and readily available data together with expert judgement will probably need to be used. As a minimum, some assessment of each of the main elements of naturalness should be made, at least using an assessment of the extent of human pressure on each element. It is strongly recommended that water quality data are collected for lakes before notification, but where data are lacking and eutrophication is considered to be affecting a site the Lakes LEAFPACS2 tool (WFD-UKTAG 2014) may be used to test for deviation from naturalness. For ponds, water quality data are informative but not essential if all other attributes are favourable. As fewer data and tools are available for ponds, site-based observations and biological surveys will often form the basis of assessments for these sites.

7.2.14 Information on these attributes should be classified and aggregated to allow their impact on the site to be assessed collectively, so that the sites with the fewest pressures of the smallest magnitude are selected. Sites should be grouped by type before making a comparison, to ensure that only sites of similar natural character are compared.

7.2.15 Naturalness of the catchment should also be considered in the choice of standing water SSSIs of all sizes. Natural and near-natural surroundings are preferable to arable, afforested or urban catchments. The connectivity and natural continuities of lake and pond sites with other valuable habitats also add value.

7.2.16 Further comparisons between candidate lakes and ponds can be made based on the ease with which any existing impacts on naturalness and natural processes can be addressed (i.e. potential value). In addition, any standing water exhibiting very high levels of naturalness (nearly totally undisturbed across all naturalness elements in Table 30) should be considered eligible for notification. Given that in some parts of GB this could constitute many standing waters, it is advised that notification based on very high levels of naturalness could be focused on areas where the catchment is already notified as an SSSI for terrestrial features.

7.3 Defining lateral boundaries of standing water SSSIs

7.3.1 If possible, where the surface water or groundwater catchment of the site is still natural or near- natural, and especially where it is small (< 100ha) and discrete, the whole of it should be included within the SSSI. Such sites may act as a habitat mosaic with separate parcels of land being notified for different habitats within the catchment. Even if the catchment cannot be notified in its entirety, connecting the site boundary to existing habitat notifications occupying a smaller proportion of the catchment through a compound SSSI notification would be beneficial. This provides a better basis for promoting large-scale habitat mosaics and natural standing water processes, allowing a more flexible approach to management and climate change adaptation.

7.3.2 Where the whole catchment is not notified, site boundaries must as a minimum provide adequate space for a fully functioning hydrosere. This is an integral part of the feature and important for habitat functioning and to allow species to complete their life cycles. The width of this will depend on the natural hydrology of the site, including water-level fluctuations and the natural bank slope. Where no hydrosere is evident the site boundary must be a minimum of 10m from the high-water line. Where there is a clear functional connection hydrologically 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. It may be necessary to include marginal land that currently has low intrinsic conservation value as part of the site, to restore a functional hydrosere, support fauna associated with margins (such as otters, birds and invertebrates) or to help protect from adjacent intensive land-use.

7.3.3 The boundary should be drawn to include at least 100m of all outflows and inflows where present. This is to protect the habitat connectivity required for site integrity and migratory species. This distance may need to be increased to ensure that characteristic lake species such as Arctic charr and ferox trout can reach spawning habitat. Including inflows within the site boundary gives some control over inputs to the water body, while inclusion of the outflow helps prevent activities that may affect water levels within the water body. The inflow and outflow streams within the site boundary should have a lateral buffer broad enough to act as functional habitat and include wetland transitions. The minimum width considered necessary for adequate site coherence is 10m from the banktop, but the boundary should preferably encompass a wide zone out to the limits of the natural floodplain where this supports near-natural vegetation.

7.3.4 Some lakes are partly or heavily influenced by groundwater inputs. Owing to the highly variable nature of groundwater catchments it is not possible to give general advice on defining boundaries for these lakes. However, site boundaries should take into consideration groundwater catchments and inputs as far as possible.

7.3.5 In areas where there is intensive landuse, an additional buffer may be required to protect against adverse effects on the riparian and open water habitat. For example, the Forests and Water Guidelines (Forestry Commission 2011) recommend a 20m buffer as a minimum.

7.4 Defining the standing water habitat feature when notifying sites

7.4.1 The notified feature should be expressed as 'standing water habitat' immediately followed by the relevant environmental type as explained in Tables 3 and 4, e.g. Standing Water, High Alkalinity, Shallow. Rare habitat types should be specified simply as 'Standing Water, [Habitat Type]'. The biological assemblages should be described, including macrophytes, marginal vegetation (NVC types), fish and invertebrates. It should also be clear that the notification is based on naturalness criteria, recognising the site as one of the best (most natural) examples of the variation in standing water habitat in the geographic region of search. The ecological extent of the standing water habitat feature should also be described, including the open water, its shoreline and riparian zone operating under natural processes.

8 Notifying artificial freshwater habitats as refugia for species

8.1. This section provides selection guidelines for characteristic freshwater assemblages that may occur in canals and ditches, as well as advice on boundary setting in such habitats.

8.2. There is no requirement for a representative series of ditch or canal habitat SSSIs, but they can be notified for the species or species assemblages they support. In most instances, this is best covered by the relevant species chapter. However, owing to the widespread degradation of the freshwater habitat resource, there may be an additional requirement to designate some canals and ditches to protect the typical characteristic freshwater assemblages naturally found in a geographic region, which would normally be protected by a natural freshwater habitat rather than a species designation. The relevant geographic region of search will depend upon the scale of the feature (see Section 5.1.3).

8.3. Such sites should only be notified where more naturally functioning freshwater habitats, which support the same characteristic biota, do not exist in an area. There is no need to notify sites to represent a freshwater assemblage that would not naturally occur in an area, e.g. assemblages of species characteristic of hard waters in a naturally soft-water catchment, present due to water transfer across catchments. Consequently, sites are likely to be designated through this route when either:

- a gap has been identified in the freshwater habitat series and there are no natural remaining examples to fill the gap; or
- all naturally occurring freshwater habitat types are covered in the SSSI habitat series, but in a geographic region there are no examples of characteristic assemblages that are in favourable condition due to habitat degradation, yet the artificial habitat in that region does support the characteristic assemblages.

8.4. These sites are effectively ark sites for the freshwater species assemblages that would be found in natural freshwater habitats. Consequently, such sites should be selected where they support an assemblage of species most closely matching that which is missing from the habitat series. The characteristic species lists in CSM for standing waters can be used to assess this. The presence of diverse vegetation structure, including emergent and riparian vegetation, should also be considered of additional value. Sites with good water quality are most likely to provide a sustainable basis for conserving these assemblages.

8.5. Where notifying such sites, it is important that the designated feature is clearly the species assemblage rather than the artificial habitat. This is to avoid protecting the artificiality of the site in a way that might inhibit the future restoration of more natural freshwater habitat mosaics within the landscape, which ultimately is the best and most sustainable way to protect these freshwater species assemblages.

Defining boundaries

8.6. Despite the interest feature being the species assemblage and not the habitat, it is important that notification enables the habitat to be managed in such a way that the species assemblage can be protected. Consequently, size is important in the notification of ditch systems, and entire ditch systems should be included within the site boundary. This allows for rotational management and the persistence of biodiversity at a site level, since ditches require regular management that drastically alters the vegetation.

8.7. The quality of the ditch system is critically dependent on the management of the adjacent land. Where a ditch site is notified, the grassland matrix within which the ditches occur should always be included regardless of its intrinsic value. It is inadvisable to include extensive arable areas within a ditch system SSSI unless the aquatic flora and fauna can be shown to have special interest ditch-by-ditch, or the land is an integral part of the hydrological system, or the area is subject to a rotation of arable and grazing management.

8.8. Canals are often relatively isolated hydrologically from the surrounding land, although surface water run-off can still jeopardise the integrity of a site. Consequently, the minimum site boundary should include the limit of the canal corridor, which should include the open water, its banks, riparian zone, and any near-natural vegetation associated with the corridor. The site boundary should include the towpath where the natural vegetation (including hedges) extends beyond it.

8.9. Many species, including invertebrates with aquatic life stages, a range of bird species, mammals such as otter and water vole, require both the open water and adjacent wetland and terrestrial habitats to thrive. These habitats adjacent to the canal can be included within the SSSI boundary if they contribute significantly to sustaining fauna associated with the canal.

8.10. Opportunities should be taken to connect the site boundary of both canal and ditch sites to other notified sites such as natural valley mire, heath, moorland and floodplain habitats, to encourage their integrated management. This provides a better basis for promoting large-scale, naturally functioning habitat mosaics within the SSSI network, offering a more flexible approach to management and adaptation to climate change.

9 Glossary

Baseflow Index - a measure of the hydrological ‘flashiness’ of a river or stream. It ranges from 0 to 1, with lower numbers having low baseflows and high spate flows, and higher numbers having high baseflows and low spate flows.

Brackish water - water that has elevated salt levels but not as elevated as seawater.

Country-level - activities undertaken separately within England, Scotland and Wales.

CSM - Common Standards Monitoring. Freshwater CSM guidance is available on the JNCC website at: http://jncc.defra.gov.uk/page-2232

Ecotone - the transition zone between two habitats or biological communities.

Headwater streams - small streams that occur in the most upstream parts of a river network. Often defined as streams at no more than 2.5km from the source, as defined on a 1:50,000 scale map. However, it also includes ephemeral sections that occur upstream of the perennial head of streams. Pragmatically, it is useful to think of headwater streams as those with a catchment area of less than $10km^2$, since this is not dependent on determining the source of the stream, transparently accommodates ephemeral sections, and is compatible with the WFD reporting typology for rivers.

HES - high ecological status under the Water Framework Directive.

High water line - the limit beyond which a lake or pond does not reach. LHS suggests that this line separates any beach from the bank. A trash-line of deposited submerged plant material may help indicate the position of the high-water line when no obvious beach or bank is visible.

Hydrometric area - either a single large river catchment having one or more outlets to the sea (or tidal estuary), or a group of smaller contiguous river catchments having topographical similarity with separate tidal outlets. In mainland Great Britain they are numbered from 1 to 97 in clockwise order around the coast starting from north-east Scotland. The larger islands and groups of islands are numbered 100-108. Hydrometric areas are used to organise river flow measurement and hydrometric data collection in the UK.

See CEH website: https://catalogue.ceh.ac.uk/documents/1957166d-7523-44f4-b279-aa5314163237.

Hydrosere - the succession of vegetation over time from fully aquatic, through wetland to terrestrial communities. In this context, the term is used to describe the spatial zonation of vegetation around the margins of a standing water body according to the degree of wetness.

Hyporheic zone - spatio-temporally dynamic ecotone between the surficial benthic substrate and the underlying aquifer.

Lake Habitat Survey (LHS) - a method designed to characterise and assess the hydromorphology of lakes.

Locally non-native species - species that are native to Great Britain but absent from certain regions, and if artificially introduced to these regions would cause changes in characteristic assemblages.

River Habitat Survey (RHS) - a method designed to characterise and assess the physical structure of rivers and streams. The survey is carried out along a standard 500m length of river channel.

Riparian - vegetation, habitats or ecosystems that are associated with bodies of water (running or standing water).

Saline transition zone - the natural brackish water zone at the downstream end of a river, immediately upstream of the estuary (taken as the mean low water mark). This zone is very important to many fish species for migration to and from fresh water and (for some species) spawning, feeding and shelter.

Stream order - a term that describes the position of a river or stream within a drainage network. It relates most closely to river size and distance from source.

Water body - a river, stream, lake or pond. Note: within these guidelines the term 'water body' is used in this general sense and not as defined by the Water Framework Directive.

Wetland - ecosystems at the interface between aquatic and terrestrial environments, permanently or periodically inundated by shallow water or consisting of waterlogged soils.

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Annex 1. General characteristics distinguishing lakes and ponds

Characteristic	Pond	Lake	Comment
Area	Usually <1ha, and often much less. Rarely up to 5ha.	Usually >1ha; smaller examples are rare.	Indicative only; ecological factors are more important.
Mean depth	Usually <1m depth.	>1m depth; often much more.	Depth is very important as it affects various aspects of ecology, especially fish and plankton.
Vegetation structure	Often dominated by emergent and floating species influenced by shading of riparian vegetation. Open water habitats may be limited.	Full hydrosere present, including open water.	Weak indicator.
Top predator	Apart from species such as waterbirds and otter, large invertebrates e.g. beetle and dragonfly larvae or amphibians (e.g. newts) are often the top predators; fish, if present, are usually rare unless deliberately stocked.	Most lake ecosystems are strongly influenced by the fish population, which has important top-down effects on ecosystem structure.	Generally a good indicator, although there are exceptions.
Fish	Often fishless. If fish are present there are few species and often few individuals.	More diverse community often including trout, eel, perch or roach. However, some upland lakes are naturally fishless.	Although it is not possible to state that ponds are fishless and lakes contain fish, the relative ecological importance of fish is an important means of discriminating ecosystems.
Amphibians	Usually present; may be relatively species-rich.	Usually absent (at least in Britain), with the possible exception of common toad.	Amphibians and fish are often mutually exclusive.
Waterfowl	Generally restricted to small numbers of commoner species such as moorhen, grey heron and mallard.	Wider range of species present, often in large numbers.	Many waterfowl depend on deeper water and the security from predators offered by lakes.
Wind exposure	Low (even upland ponds are relatively sheltered by vegetation and weak fetch).	High – drift lines are usually visible on lakes and wave action is often important in structuring communities.	
Seasonality	May be ephemeral or permanent; if permanent may lose a high proportion of their surface area during dry periods. Ponds can be subject to high variability in water level.	Permanent. Water levels fluctuate but lakes rarely dry out.	This aspect can be an important driver in maintaining pond ecology.
Characteristic	**Pond**	**Lake**	**Comment**
Water chemistry	Very variable, including periods of significant stress.	More or less stable; stresses are rarer and often reflect pressures.	The small size and shallow nature of ponds means that major diel and seasonal changes in chemistry, such as

			dissolved oxygen, alkalinity, conductivity and nutrients, are very likely.
Inflows and outflows	Often /usually absent.	Usually present (groundwater-fed lakes are the most likely exception).	
Age	Generally recent although may persist for several centuries (either formed by natural processes or by human activity).	Usually ancient (postglacial) although artificial examples are reasonably common.	