Common Standards Monitoring Guidance

for

Standing Waters

Version March 2005

ISSN 1743-8160 (online)

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1.Introduction

This chapter contains guidance on monitoring standing water habitats (except canals and ditches) where these are notified or qualifying features on SSSI/ASSI, Ramsar sites and cSACs (see section 1.1). Canals and ditches are covered by separate guidance sections. This chapter also provides more specific guidance on monitoring aquatic vascular plant species in standing waters, based on their ecological characteristics and addressing difficulties of carrying out botanical monitoring in sub-aquatic environments. Where these species are notified features in their own right, this guidance should be used in conjunction with the Vascular Plants guidance section.

Standing waters may additionally be notified for a wide range of faunal species, for which the relevant guidance sections should also be used (Birds, Mammals, Reptiles and amphibians, Freshwater fauna, Invertebrates). The Introduction to freshwater habitats and species should also be consulted when using this guidance.

1.1 Standing water features

1.1.1 Habitats

Standing water cSACs in the UK may qualify for one or more of the following Annex I habitat types:

- H3160 Natural dystrophic lakes and ponds
- 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*
- H3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation
- H 3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
- H 3180 Turloughs
- H 3170 Mediterranean temporary ponds

Detailed descriptions of these habitat types are given in McLeod *et al*., 2002 – www.jncc.gov.uk. *Mediterranean temporary ponds* is a very rare type in the UK and is not considered further here. The relation between Annex I habitat types and other habitat classifications can be seen from the Favourable Condition Tablers contained in this guidance.

However, standing water SSSI/ASSI and Ramsar sites in the UK have been notified for a wide variety of standing water feature types. Standing waters can be classified in a variety of ways. *A Nature Conservation Review* (Ratcliffe 1977) identified six broad types, namely dystrophic, oligotrophic, mesotrophic, eutrophic, marl and brackish standing waters. Selection of standing water SSSIs in Great Britain, as set out in the *Guidelines for the Selection of Biological SSSIs* (NCC, 1989) was based primarily on a botanical classification system recognising 10 site types by Palmer (1989). A revision of this classification, using a larger dataset, is in preparation (Duigan *et al.* in press). Chapter 5 of the SSSI guidelines, which gives fuller details of the rationale for site selection, may be helpful. In Northern Ireland, a parallel classification has been produced and used for selection of ASSI in a similar way (Wolfe-Murphy et al., 1992). It is important, though often not straightforward, to determine why a particular site has been notified for its standing water interest and the citation and any notification criteria sheets should be consulted. Appendix 1 gives an approximate relationship between different types of lake classification.

The links between SSSI/ASSI and SAC features may not always be clear. Although most SSSI/ASSI features can be ‘matched’ to Annex I types, there are categories of SSSI/ASSI lakes which are not adequately covered by the SAC habitat definitions. SSSI/ASSI and Ramsar standing water feature descriptions which may not correspond exactly to SAC habitat types include:

oligotrophic lake
mesotrophic lake
oligo-mesotrophic lake
meso-eutrophic lake
base-rich lake
machair lake
brackish lake
trophic range

This list is not necessarily exhaustive.

Difficulties arise in definition of lake types, because of the different methods of classification, based on vegetation, pH/hardness/alkalinity and phosphorus/nitrogen/chlorophyll *a*. A lake with high concentrations of total phosphorus may have been termed eutrophic, but so may a water body with high values for alkalinity or hardness. There is a generic SSSI/ASSI attribute table (see section 2.1) for lake types that may not fit into an Annex I cateogry.

1.1.2 Plant species

Rare vascular plants may be present as part of the standing water interest. Standing waters may also qualify for individual vascular plant species, or assemblages of notable vascular plants and charophytes. The principal species covered by this chapter are listed below. *Najas flexilis* is a Habitats Directive Annex II species; the remaining species are nationally scarce. Other vascular plant species may be notified features of standing water sites, including *Luronium natans* (see Vascular Plants guidance chapter), which is also an Annex II species. Additionally, there are lower plant species which may be notified features of standing water sites, in particular certain stonewort species (Charophytes).

- *Najas flexilis* (**SAC, SSSI/ASSI)**
- *Potamogeton rutilus* (**SSSI/ASSI)**
- *Potamogeton filiformis* (**SSSI/ASSI)**
- *Potamogeton coloratus* (**SSSI/ASSI)**
- *Nuphar pumila* (**SSSI/ASSI)**
- *Isoetes echinospora* (**SSSI/ASSI)**
- *Elatine hydropiper* (**SSSI/ASSI)**
- *Elatine hexandra* **(SSSI/ASSI)**
- *Limosella aquatica* (**SSSI/ASSI)**
- *Pilularia globulifera* (**SSSI/ASSI)**
- *Eriocaulon aquaticum* (**SSSI/ASSI)**

2. Attributes and targets

To assess the condition of features, we need to consider the major characteristics, or attributes, which define them. Targets are set for these in order to assess whether feature attributes are typical for the feature type or are otherwise in favourable condition.

The attributes used in CSM for assessment of **habitat features** are as follows:

- extent
- composition of macrophyte community
- macrophyte community structure
- water quality
- hydrology

- substrate
- sediment load
- indicators of local distinctiveness

It is mandatory to use of all of these attributes in condition assessment.

The attributes used in CSM for assessment of **aquatic vascular plant features**, are as follows:

- presence/absence
- population size/extent
- regeneration
- water quality
- substrate
- hydrology
- sediment load
- indicators of local distinctiveness

2.1 Habitat features

Guidance on the selection of attributes and the setting of appropriate targets for open water habitats is given below and in generic attribute tables 2 to 8. There is a Favourable Condition Table (generic attributes table) for each of the Annex I habitat types, but as indicated in Section 1.1, these are not adequate for all standing water types on SSSI/ASSI and Ramsar sites. To include these lakes, a generic SSSI/ASSI lake attribute table has also been produced (Favourable Condition Table 2). This table should be consulted for Ramsar, SSSI/ASSI and SAC sites prior to examining the specific tables for individual habitats and species.

2.1.1. Biological attributes

Within biological communities, pressures on the habitat result in changes in structure, abundance and biomass before species are lost. A measure of abundance,in terms of the number of points at which a species is recorded, and structure of the macrophyte community, can therefore be examined as indicators of change for condition assessment.

2.1.1.1. Macrophyte community composition

The flora present in standing waters are dependent not only upon water quality but also sediment quality and physical aspects of the system. Macrophytes are therefore appropriate indicators to assess condition. Sites have been designated on the basis of plant species richness, species rarity, absence of alien species and the representativeness of the flora compared with the characteristic lake type, as defined by Palmer (1992) and Palmer *et al*. (1992). It should be borne in mind that a range of lake types is covered in the *Oligotrophic to mesotrophic* SAC habitat feature. For lakes in Northern Ireland, reference should be made to the Northern Ireland Lake Survey 1988-1991 (Wolfe-Murphy *et al*., 1992).

Macrophyte taxa indicate different lake types, reflecting differences in physical and chemical variables. The continuum of environmental gradients in lake ecology means that taxon presence in one lake type does not preclude presence in all other lake types. The 10 lake types (12 including sub-types) defined by Palmer (1992) and Palmer *et al*. (1992) are described using constant and faithful species. Constant species occurred in more than 40% of sites of a type, whilst faithful species were recorded at 20% constancy in three or fewer of the 12 types and sub-types. Constancy categories were

>40-60%, >60-80% and >80%. These descriptions have been updated in Duigan *et al.* (in press). As an example, *Littorella uniflora* is present in 87% of type C2 lakes (an oligotrophic type) and *Myriphyllum alterniflorum* in 75%, so these species would be regarded as characteristic of a C2 type oligotrophic water body.

In addition to constancy tables, the new British lake classification (Duigan *et. al* in press) presents plant lake ecotype indices for macrophyte species (PLEX scores) developed using a modification of the trophic rank scoring method (Palmer *et al.* 1992). A PLEX score for a site is the mean of the species PLEX scores present. Examples are given where PLEX scores are used to pick up environmental changes within lakes, such as acidification or eutrophication. Although this approach is not part of CSM guidance, it may become a useful aid to assessing condition.

The aim for any feature type is that it should support characteristic species. Directional changes in plant species composition from a baseline type may indicate changes in the lake habitat. Changes in frequencies of the most abundant species may indicate more acidic or eutrophic conditions or changes in lake habitat or hydrology. Site accounts and citations should also be used and geographical variation considered when interpreting expected macrophyte assemblages for a particular lake type.

Site specific targets should be set for each standing water, and indicative thresholds interpreted using expert judgement. Guidance is given in section 4 (assessment) and the generic attribute tables.

Invasive non-native species have been set targets (see 4.1.2.). The list of species given is not exhaustive and should be updated as new threats become apparent.

2.1.1.2 Macrophyte community structure

Zonation occurs within the macrophyte community from shallow water to deeper water, depending on the depth preferences of different species. For example, the expected zonation from shallow to deeper water in *Oligotrophic to mesotrophic standing waters* would be *Littorella uniflora*, *Lobelia dortmanna*, then *Isoetes* species. In certain lake types, pondweeds or charophytes may dominate in deeper waters. The precise nature of the zonation will be site specific, depending upon e.g. water colour, substrate type, basin shape. Changes to zonation may indicate stress to the water body. For example, increased phytoplankton or sediment would result in decreased light penetration, thereby adversely affecting plants growing in deeper water. Loss of shallow water species may indicate alteration of the shoreline or changes in substrate.

The different types of plant form present are a further aspect of macrophyte community structure that should be examined. Plant form refers to the shape and size of different types of plants e.g. isoetids are small rosette shaped plants with narrow leaves, whilst water lilies have relatively large, broad, floating leaves. Retaining the vegetation structure, including a well-developed riparian fringe, is important in providing a diversity of habitats within the lake.

2.1.2 Non-biological attributes

Examination of physical and chemical characteristics of lakes is desirable for a comprehensive assessment of habitat condition; as these determine the ecology of lakes. Such attributes include extent, water quality, hydrology, substrate and sediment load.

2.1.2.1. Extent

The extent of standing water may be affected by a range of activities, such as groundwater abstraction, regulationconstruction within the lake, excessive sediment deposition and natural succession. Where a site has been notified for the interest of the open water, it is clearly important to maintain the extent of this but here needs to be a distinction between natural succession and anthropogenic factors when

setting targets and assessing data on this attribute. Evidence of increased sedimentation rates (see section 2.1.2.4) or knowledge of changes in catchment land use, may be important in this respect. In cases where anthropogenic influences have caused a reduction in extent prior to notification of the site, at least the extent at time of notification should be maintained.

2.1.2.2 Water quality

Macrophyte species composition in lakes is partly determined by climatic factors and the physical properties of the catchment area. Geology, soils and land use in the drainage basins of lakes determine the chemistry of the water and sediments in a water body. Water quality parameters of major importance in determining macrophyte species composition are pH, alkalinity and hardness, phosphorus (P) and nitrogen (N).

Many water quality variables may be measured in the investigation of lake habitats e.g. Secchi depth (a surrogate for light attenuation or turbidity), temperature, dissolved oxygen, pH, conductivity, alkalinity, acid neutralising capacity (ANC), total phosphorus (TP), total dissolved phosphorus (TDP) and dissolved reactive phosphorus (DRP), total ammoniacal nitrogen (TAN), nitrate nitrogen (N), nitrite N and chlorophyll *a* (a surrogate for algal biomass). The sum of the concentrations of nitrate N and nitrite N constitutes the level of total oxidised N (TON). Data on all of these variables are useful; but as a minimum, pH, alkalinity and TP should be examined. With little additional effort conductivity can also be measured. Determination of alkalinity allows calculation of ANC which links to the Water Framework Directive (WFD) lake typology, and allows confirmation of water body type. Assigning lakes to the typology is desirable, to facilitate setting of appropriate TP targets. An updated version of the GB lakes inventory currently under development will include lake type for most water bodies over 5ha but as lakes have been assigned from national datasets there may be a requirement for some local validation of type. With pH, conductivity and alkalinity the macrophyte communities present can be compared with those expected, given the background chemistry of the water body. Inclusion of other determinants in CSM will be dependent upon requirements at individual sites and the availability of resources. For SACs and larger SSSIs WFD risk assessments may be helpful in identifying which chemical variables should be measured at a particular site.

pH

pH is an important variable to measure as it influences all chemical and biological processes e.g. P binding in sediments, the source of carbon available for photosynthesis, species present and pollutant toxicity. Changes in pH, either through eutrophication or acidification, can therefore have considerable effects on lake ecology. In setting targets, in addition to ensuring that pH is appropriate for the macrophyte communities characteristic of each habitat type, consideration should also be given to standards for fish health e.g. Council Directive 78/659/EEC, on the quality of waters needing protection or improvement in order to support fish life; see Alabaster and Lloyd (1980). Such references also provide useful information on other water quality variables e.g. dissolved oxygen, suspended solids. The optimum pH range for fish health is pH 5.50 – 9.00, though pH values of between 5.00 and 5.50 are not generally directly toxic to fish. However, certain habitat types such as dystrophic lakes may naturally have pH values lower than those required to ensure fish health. Indeed many dystrophic lakes may not support fish at all due to naturally acidic conditions. It is important when setting targets and carrying out monitoring to take account of natural fluctuations in pH throughout the year e.g. snow melt may lead to pulses of acid water, and increased plant biomass in summer may result in large fluctuations in pH as well as daytime increases in pH values. The models for pH prediction in waters at risk of acidification are outwith the scope of the CSM evaluation. Site specific pH targets should be set, and reference should be made to the alkalinity or ANC of the water body.

Acid neutralising capacity (ANC)

In water bodies at risk of acidification, alterations occur in the ANC of the water column before changes in pH become evident. ANC needs to be assessed to provide an early warning of these changes.

The alkalinity of a lake is the combined concentration of bicarbonate and carbonate, but also includes anions of other weak acids, such as silicate and borate, and the hydroxyl ion. ANC is calculated from alkalinity and dissolved organic carbon (DOC) concentration, to take into account additional buffering capacity provided by humic substances (Cantrell *et al*. 1990, in Fozzard *et al*. 1997). This parameter is used in classification schemes of lake condition, such as the Scottish Environment Protection Agency's (SEPA) lake quality classification scheme (Fozzard *et al*. 1997).

The lowest category of ANC values in SEPA's classification system (0- 0.019 meq l^{-1}), is consistent with the recommendation of a threshold ANC value of 0.020 meq l^{-1}, for protection of natural waters, except in cases where it is estimated that ANC has always been lower than this value, in which case, the recommended standard is 0 meq l^{-1} (DEFRA, 2004). Where site-specific work on ANC standards is possible, this should be undertaken. As many lakes in the UK are naturally acidic, it may be useful to consider ANC in the context of historical values, which may be estimated using models (e.g. Wright and Henriksen, 1983; in Fozzard *et al*. 1997). However, it may not be considered necessary to examine hindcast ANC, where alkalinity and ANC are both > 0.04 meq l^{-1} (Fozzard *et al*. 1997).

Total phosphorus (TP)

Changes in the ecology of a lake from anthropogenic nutrient inputs are often first apparent in the phytoplankton within the water column. The relationship between increased water column TP concentrations and increased phytoplankton biomass is well established (Dillon and Rigler, 1974; Vollenweider, 1976; OECD, 1982). Increasing loads of phosphorus to a water body are therefore likely to lead to enhanced algal growth and increased biomass. This algal growth can have significant impacts upon the standing water ecosystem through for example: competition with vascular plants for nutrients and light; changes in pH; oxygen depletion; secretion of toxins; and high ammonia levels as a result of algal death and decay. TP is therefore a key parameter for assessment.

Data availability
For many larger standing waters there will be TP data from environmental protection agency routine monitoring programmes. Elsewhere, site specific investigations or research projects may have collected some TP data that may be useful, though caution should be exercised in using old data or TP concentrations ascertained from a single sample. Where there are no TP data there are two options: a) to arrange for water sampling and analysis either as part of a CSM monitoring or preferably in liaison with the environmental protection agency; or b) estimate TP concentrations through modelling (e.g. loss coefficient models). The modelling approach is useful in determining the magnitude of likely P loads based on catchment population and land use but due to modelling uncertainties the results should be interpreted with caution and reference to the assumptions of such models. Where these options are not feasible, the nutrient enrichment pressure will have to be assessed through surrogate attributes (e.g. presence of excessive algal growths, changes in flora or water transparency). Where these surrogates point to a problem investigative work should be undertaken and TP concentrations measured along with some estimates of phosphorus loads from different sources.

Certain lake types (e.g. shallow mesotrophic and eutrophic lakes) have some resilience to slight nutrient enrichment as phosphorus can be 'locked up' in macrophyte biomass. However, increases in nutrient loading increase the risk that other factors (e.g. changes in the fish community, damage to submerged plants) will lead to a switch from a macrophyte dominated state to an algal dominated one. Hence, whilst increases in nutrient concentrations alone, do not constitute eutrophication any increase beyond the targets outlined below represents an unacceptable risk to the site integrity. In practice it is useful if an indicator of algal abundance is also examined, such as chlorophyll *a* but it should be noted that a single monitoring visit once every cycle may not reveal these biological problems.

Setting targets

Using SAC lake habitat types to set TP targets is difficult as SSSI/ASSI and SAC habitat types do not completely coincide. Furthermore, SAC habitat types are based on broad macrophyte flora classes, which may occur across a range of water chemistry conditions for example, 'oligo-mesotrophic waters…'. So, using generic figures for SAC habitat types may mean a nutrient poor lake could undergo considerable enrichment before exceeding the SAC target.

Table 1 presents TP targets for the lake types of the UK Water Framework Directive (WFD) typology (http://www.wfduk.org/tag_guidance/Article_05). The typology is defined by the geology of the catchment, validated by alkalinity data where available, and mean lake depth (3m or less: shallow; >3m :deep). The targets are based on proposals for WFD boundaries for high-good ecological status, the OECD report on eutrophication (1982) and expert judgement (including the Ecoframe project Moss *et al.*, 2003). There is considerable work being undertaken at present across Europe linking ecology to nutrient levels to support the implementation of the WFD; the conservation agencies will review this information as it becomes available and consider reviewing the targets in Table 1 in light of any key findings.

Generally, low alkalinity lakes may be described as nutrient and species poor, whilst high alkalinity lakes have naturally higher nutrient levels and as result are rich in flora and fauna.Generally, the higher the alkalinity of a lake, the better its capacity for immobilisation of P, as the concentrations of cations which may bind with P increase. Targets for 'deep' medium and high alkalinity lakes are more stringent recognising that: a) in deep lakes a smaller proportion of the water volume is occupied by macrophytes and hence there is greater potential for algal blooms to develop; b) retention times are generally longer; and c) there is greater potential for P to be lost to the sediment or hypolimnion and thus for a given P load the expression as P concentration in the water column is likely to be lower in a deeper lake.

Shallow lakes may have a higher carrying capacity for nutrient enrichment (see above), but this is not necessarily the case for peaty and low alkalinity lakes. Lakes with low alkalinity and TP levels, and no anthropogenic nutrient input from the catchment area (other than airborne sources) generally have relatively stable TP values, and would be expected to have TP concentrations almost below the limits of detection and certainly less than 10 μg P l^{-1}. Small changes in TP levels of lakes with naturally low TP levels can have significant effects however, particularly on phytoplankton ecology. In addition, although iron, manganese or aluminium may provide binding sites for P there may be few sediment adsorption sites in such lakes which tend to be characterised by relatively coarse substrates.

Marl lakes and peat lakes have particular characteristics which determine their high capacity for P immobilisation due to coprecipitation of P with calcium and magnesium. Thus, P concentrations are typically low in these lakes even under relatively high external P loads. Hence targets for these marl lakes are lower than for equivalent high alkalinity lake types.

In peat dominated catchments, TP may exist in humic-iron-P complexes. Additional P from anthropogenic sources does not bind well with sediments of low pH and high organic content, such as may be found in these water bodies. Although there is reduced light penetration, it is still possible to get increases in algal biomass, as certain algal types (e.g. species of blue-green algae) are suited to harvesting light under such circumstances.

TP Ranges and Thresholds

In recognition that shallow eutrophic lakes may exist in either a plant-dominated or an algal dominated state across a wide range of nutrient conditions, two sets of values are presented for shallow high alkalinity and shallow marl lakes. For these two lake types a range is presented with the upper figure representing a threshold value above which there is considerable risk of a switch to algal dominance. In practice lakes within these types could remain in favourable condition across the P range presented subject to other factors (e.g. nature and structure of the fish community). However, to assess condition and any proposals for discharges, a management target somewhere within this range

will be required. The appropriate target may vary for individual lakes but will be difficult to determine in the absence of good long term data. As such a default management target of 50µg P l^{-1} is proposed. Where there are good water quality and biological data or evidence from palaeolimnology that another target is more appropriate the management target may be revised to a site specific target. For example, analysis of diatom remains in the sediment may indicate that historically a lake has always had P concentrations (present day relationships between diatom species and chemical variables are used to estimate historical values for chemical variables) in excess of or below 50µg P l^{-1}.

Table 1 Total Phosphorus targets for designated lakes (SAC, SSSI/ASSI, Ramsar)

Lake Type	Approximate corresponding feature type	Depth Category*	TP target/limit (µg P l^{-1})	TP Range** (µg P l^{-1})
Peat	dystrophic	Deep	10	na
		Shallow	10	na
Low Alkalinity	oligotrophic	Deep	10	na
		Shallow	10	na
Medium Alkalinity	mesotrophic	Deep	15	na
		Shallow	20	na
High Alkalinity	eutrophic	Deep	35	na
		Shallow	50	35-100
Marl	hard water	Deep	20	na
		Shallow	35	20-50
Brackish	brackish	Deep	35	na
		Shallow	35	na

na not applicable
* Shallow 3m or less/ Deep: >3m
* See supporting text

Note that the terms oligotrophic, mesotrophic and eutrophic are used in the general sense of biological richness of the water body, rather than referring specifically to levels of P and N. Overlapping categories of different lakes classification systems are also documented in Appendix 1.

Exceptional circumstances
It is anticipated that the targets will be employed in all cases. However, there may be individual lakes where there is a body of robust evidence that indicates that the target given in Table 1 is not valid. Such evidence might be in the form of diatom inferred TP concentrations from palaeolimnology or long term water quality and biological data. In these situations the data should be discussed with the relevant national specialist before setting a site specific target.

Nitrogen

It is generally accepted that in most freshwater situations eutrophication is driven by increases in P loading; this guidance reflects this, providing targets for P but not N. However, there may be standing waters that are sensitive to nitrogen (N) enrichment and where eutrophication may be driven by increases in N. Upland lakes and lowland lakes where the catchment is naturally rich in P, may be N-limited, but site specific information is usually required to determine whether N or P is more important. In enriched lakes, nitrate concentrations may be high in winter, but below the limit of detection in summer. The concept of a limiting nutrient is misleading in situations where either N or P concentrations are already high, for example N may appear to be the 'limiting nutrient' in lakes where there are very high P concentrations but in practice neither will limit algal or plant growth. As such

where N enrichment is thought to be a risk it will be necessary to set a target that also reflects the target P concentration.

Generally, phytoplankton are P-limited. Certain species of algae can grow in waters with extremely low levels of available N, or are capable of fixing N. Whilst P is generally the limiting factor for phytoplankton, the ratio of N:P is important in determining which species of algae will dominate the phytoplankton community. Macrophytes are more likely to be N-limited, as macrophytes rooted in sediment can use sediment P sources. There is some recent evidence that reduced macrophyte species richness may be linked to elevated N concentrations but further work is required to establish a definitive impact. In the interim, where the risk of N enrichment is thought to be significant e.g. because there are signs of ecological change, but P levels have remained within targets, N targets should be set with reference to the normal range for the lake type. When more information becomes available on the N:P ratios which would support stable ecological conditions in different lake types, this will be incorporated in the guidance.

2.1.2.3 Hydrology

Hydrology influences lake ecosystem functioning in two ways: determining residence time (flushing) and water level fluctuations. Flushing of lakes is important for dilution and removal of nutrients and phytoplankton. Both annual and within-year flushing patterns should remain unchanged. The timing of different flushing rates within the year influences the biology of the lake. For example, reduced flushing in summer would encourage bloom conditions. In practice adverse impacts upon flushing should be evident through assessments of water quality and the biology of the system.

Water level fluctuations can have both positive (e.g. providing opportunities for germination or seed dispersal) and negative (e.g. flooding marginal and riparian plants or exposing plants to desiccation) influences on habitat diversity and trophic structure. In particular water level fluctuations play a critical role in the succession and development of littoral and emergent vegetation. Furthermore, water level fluctuations are an important control on lake morphology through wave action and shoreline stability. Reduced water levels, as a result of lake drawdown, have the potential to cause adverse impacts upon littoral floral and faunal communities and may result in the loss of marginal plant populations.

Determining whether there is an appropriate hydrological regime from a single site visit is difficult although there may be evidence of major impacts, for example stranded marginal vegetation, exposed lake sediments or signs of former shorelines. Emergent plants may exhibit morphological differences under different hydrological regimes but this varies between species; for example *Phragmites australis* seedlings may form longer leaves under exposed conditions but in contrast *Scirpus lacustris* seedlings may display the same morphological change when submerged. In practice evidence from site visits will need to be interpreted with reference to information on known changes to the hydrology of the catchment.

The entire catchment area of the lake should be examined when considering hydrological regime. Management of upstream waters e.g. through regulation of reservoirs, may have considerable impacts on downstream water bodies and artificial drainage may alter seasonal dynamics.

2.1.2.4 Lake substrate

Lake sediments consist of mineral material (e.g. clays, silicates), decomposing organic matter, and inorganic components of biological origin (e.g. skeletal material, siliceous shells). Particulate material is transported from the catchment area, but also generated within lakes e.g. plant debris. On reaching a lake, heavier particles are expected to sediment out first, finer material taking longer to settle. Lake sediments are therefore sorted along particle size gradients. Once deposited, sediments are subject to a number of processes such as degradation or slumping. The distribution of sediment particle size and

organic content influences the biology of the lake and will affect the suitability of within-lake habitats for invertebrates and macrophytes, and fish spawning grounds. Increases in sediment loading from activities in the catchment area, including those on the lake shore, may result in the smothering of coarse sediments. Increased inputs of leaf litter, as a result of scrub encroachment, may also be cause for concern, as organic-rich sediments may be a poor rooting medium for macrophytes.

Inclusion of hard engineering solutions to lake management may have detrimental effects on lake ecology, replacing semi-natural substrates with man-made materials. Alteration of the shoreline may also result in changes in water movements within the lake, which would have effects on patterns of sediment deposition.

2.1.2.5 Sediment load

The sediment loading from the catchment area to a lake occurs due to soil disturbance and precipitation. Natural variation occurs in the sediment loading to different lakes, depending on local conditions. The magnitude of loss of soil to water courses is related to catchment size and soil type, but is increased through factors such as lack of vegetation cover, trampling by cattle, inappropriate field drainage and ploughing regimes, type of crop etc. Organic matter may be increased through inadequate storage facilities for biological waste. Increased sediment loadings may result in clogging of the lake bed, increased siltation in the basin and deoxygenation of sediments. Blockage of coarser substrates with finer sediment restricts water flow-through, whilst increases in organic matter increase biochemical oxygen demand.

2.2 Vascular plant features and rare vascular plants

Where rare vascular plants are present in the water body (see FCT Table 1 - *Favourable Condition Table for direct (population) attributes for rare aquatic vascular plants in standing waters*) some assessment of the population status needs to be made. The Vascular plants Guidance (available from the JNCC website) should be also consulted. *Luronium natans* has an individual FCT Table in the Vascular plants guidance.

The habitat attributes water quality, substrate, hydrology and sediment load are mandatory for vascular plant features. Presence/absence of the species is also a mandatory attribute.

The other population attributes described in FCT Table 1 (population size/extent and regeneration) are discretionary. Population size/extent and regeneration data is useful in assessing sustainability, which is an integral part of favourable conservation status (FCS). Monitoring these attributes is therefore recommended, particularly where a site or series of sites support a significant proportion of the UK population of that species. Schedule 8 and Red List species should receive particular survey effort.

2.3. Indicators of local distinctiveness

Indicators of local distinctiveness is intended to cover any site-specific aspects of the habitat feature, forming part of the reason for notification, which are not covered adequately by other attributes, or by separate guidance (e.g. for notified species features). This is a discretionary attribute in that it may not be applicable to every site; but where local distinctiveness has contributed to the selection of a site for standing waters, it should be mandatory. It is not intended that a target is set for detailed species monitoring, rather to provide a rapid indication of presence/absence and or approximate extent, allowing for natural fluctuations in population size. Targets are set as appropriate, on a site by site basis, to maintain distinctive elements at current extent, or levels, and/or in current locations.

2.4. Aspects of environmental disturbance

In addition to examining the above attributes, aspects of environmental disturbance, such as artificial barriers, fish introductions and exploitation should be noted as an accompaniment to assessing condition. These activities do not comprise condition targets but are intended to help set the context for condition assessment.
There is a list of possible impacts that might be observed at the end of each FCT (Favourable Condition Table).

3. Monitoring

3.1 Approach to biological attribute monitoring

Accurate macrophyte distribution maps and plant counts throughout lake basins are not often available or achievable, due to difficulties such as working under water, isolating individual plants or incomplete coverage by plants within areas of colonisation.

CSM requires a semi-quantitative approach. Condition assessments are carried out with respect to targets, but we also need to assess whether feature condition is declining, recovering or unchanging. Essentially a partial survey is recommended, which, in combination with information on other attributes and site management, will identify changes with time. The monitoring methodology recommended for CSM is therefore based on recording presence/absence data in a large number of point samples. This is a more statistically robust approach than assessing counts, or cover, in small numbers of large samples (*Gunn et al*., 2004) and helps minimise the time spent at each water body to be surveyed. Point frequency sampling produces objective, repeatable and quantifiable data.

3.2 Preparation for monitoring of biological attributes

3.2.1 Timing of surveys

Monitoring work should take place once during each reporting cycle. Surveys should be at least 4 years apart. Aquatic macrophytes are most easily located and identified from June to mid-September. Surveys undertaken outwith this growing season are likely to be problematical due to vegetation having lower biomass, individual plants being small and distinguishing characteristics, such as flowering parts absent. The biology of individual species should also be taken into account, as different species develop throughout the summer. For example, *Najas flexilis* is better observed in August and September and surveying in June or early July may be too early for some species. Geographical differences should also be considered when scheduling surveys. The growing season is likely to start later and be of shorter duration in the north of Scotland than in the south of England.

3.2.2 Selection of water bodies to be examined

In sites where the feature is represented by many water bodies, such as occurs in Caithness and Sutherland Peatlands SAC, it will be possible to monitor only a small number of representative lakes. Lakes which should be considered for monitoring are those which:

(a) are named in the citation or site account
(b) have been surveyed previously
(c) are in a near-natural state
(d) support species of particular interest
(e) contain a rich assemblage of characteristic species
(f) are highly representative of their type
(g) are at greater risk of harm.

Where logistical or financial difficulties dictate monitoring be limited to a minimum, the coincidence of qualifying features should also be taken into account, *e.g.* if there are three features in one site and

all are found in one water body, monitoring that water body only would be appropriate and will reduce survey time. Where prioritising selection of standing water other factors such as accessibility, previous survey information, sampling by the environment agency, water body risk assessment under the WFD, will also play a part.

3.2.3 Choice of locations within lakes to be surveyed

Ideally, if adequate baseline information is not available, an initial survey should be carried out to locate species or communities of interest in the lakes to be monitored. In each lake, work will focus in areas which support the macrophyte species or communities characteristic of the feature. Prior to survey, plant records, Ordnance Survey and bathymetrical maps should be examined, along with information on the ecology of different plant species or groups, to identify areas which are likely to support the macrophytes of interest.

Please see **Appendix 2** for greater detail on choice of survey sector location.

3.3 Methods for monitoring

3.3.1 Skill requirements for macrophyte work

Taxonomic expertise is required for monitoring of lake macrophytes. Plants should be recorded to species level using Stace (1997). Voucher specimens should be taken where it is not possible to confirm the identification of a species in the field. For difficult genera such as *Potamogeton*, *Callitriche*, *Utricularia*, *Chara*, and *Nitella*, samples should be collected for independent expert verification .

3.3.2. Methodology

For methodology for biological and non-biological attributes for standing water habitat features and vascular plant species see **Appendix 2.**

3.3.3 Outputs from field work

Field data recording forms (**Appendix 3**) and a reporting form should be submitted for each feature. The reporting form should include site name, feature, summary of results, interpretation of results and recommended condition category. In addition, the activity assessment form will be completed.

3.3.4 Other legal responsibilities relevant to surveyors

Working in or near water carries with it an inherent risk. Legal responsibilities should be observed with regard to the Health and Safety at Work Act (1974), to ensure the health and safety of employees (whether Conservation Agency or contractor staff) and any other person who may be affected by their actions or omissions. Risk assessments should be submitted prior to starting monitoring work. As there may be many sites to visit, sometimes in remote areas, care should also be taken that surveyors are working within the requirements of the Working Time Directive (EU Directive 93/104/EC).

4. Condition assessment

The condition of each feature will be assigned to one of the seven condition categories, unless there are insufficient data available from earlier surveys to make this possible. In the latter case, the feature will be classed as favourable or unfavourable.

Confidence in data collected for non-biological attributes will be high or low, depending upon the method of collection. When confidence is low, the qualifier “at risk,” may be included, where biological attributes indicate that features are in favourable condition, but other habitat factors suggest

that the features may be adversely affected in future. If there is high confidence in the non-biological data, the features should be classed as being in unfavourable condition.

This section includes guidance on the circumstances where a feature is described as being in unfavourable condition. To assess whether a feature in unfavourable condition is improving, declining or remaining the same, it will be necessary to examine the changes in results and management practices, between monitoring cycles. For a site in unfavourable condition to be described as recovering, more direct or indirect targets should be met than in the previous monitoring cycle. To conclude there has been no change at a site, results should be consistent with the previous survey. Where there is conflicting evidence as to whether the condition of a site is declining or improving, the assessment may also be that there has been no change. At sites where less attributes are meeting their targets than in the previous monitoring cycle, the feature can be recorded as declining. Features should be described as destroyed when the species of interest and its habitat have been permanently lost. Features should be termed partially destroyed when this applies to part of the site only. The condition and extent of the remainder of the feature will be reported.

4.1 Habitat features

4.1.1 Vegetation composition: macrophyte community

For each of the Annex I Habitat Types, a list of 'core' characteristic species is provided (see Favourable Condition Tables). These are the species to which greatest attention should be paid. In general, high diversity and frequency of characteristic species is a good indication that the site is in favourable condition. **However, you should not necessarily expect to find every characteristic species at any given site.** Targets have been set so that one or more of these characteristic species must be present for the site to be in favourable condition. (see FCT tables). There is also a target for frequency of ocurrence of core characteristic species (typically - 6 out of 10 sample spots should include at least on of the characteristic species listed).
In addition, there should be no loss of any characteristic species recorded from the site or rare species that is part of the standing water feature. Expert judgement may be required where it appears there has been a loss of a characteristic or component species. Consideration should be given to survey methods, previous abundance ratings and the life strategy of the species of interest.

A list of associates has been provided with the list of characteristic species. Associate species frequently occur in conjunction with the characteristic species but often have broad ecological tolerances and are not good indicators of the habitat type. They are provided for information purposes; the list of associates will not be exhaustive. Reference may be made to the constancy table from work on lake types (Palmer *et al.*, 1992) and the updated lake classification (Duigan *et al.* in press), the data of the Northern Irish Lakes Survey (Wolf-Murphy et al., 1992), and descriptions of the Annex I habitats.

Species presence at a site (in the absence of anthropogenic pressures) is the result of chance colonisation and habitat suitability. Therefore there may be valid reasons why a characteristic species is not present in a particular site. Consequently, in applying targets to an individual site the characteristic species list should be reviewed in light of local knowledge, historical records and known biogeographic ranges. Preston & Croft (1996) is a good starting point.

Vegetation composition: negative indicator species

With regard to non-native species, the feature should be classed as being in unfavourable condition under the circumstances detailed below:

(a) any alien species has recently colonised a water body and is dominant in the plant community

(b) the following invasive species are observed: *Azolla filiculoides*, *Crassula helmsii*, *Hydrocotyle ranunculoides* and *Myriophyllum aquaticum* (***this list is not exhaustive and should be updated as new threats become apparent***)
(c) *Elodea nuttallii* is present at >5% frequency
(d) *Elodea canadensis* has recently colonised a water body and is present at >5% frequency
(e) *Elodea canadensis* is present at >40% frequency in unproductive lakes (e.g. dystrophic and oligotrophic waters) and at >50% frequency in more productive water bodies (e.g. mesotrophic, hard water or eutrophic lakes).

If *Elodea canadensis* or *Elodea nuttallii* have become a naturalised and occur at low frequency, then the feature may be classed as favourable, provided all other attributes meet their targets.

4.1.2 Macrophyte community structure

Habitat features should be classed as being in unfavourable condition when:

(a) there has been a loss of characteristic macrophyte community zonation
(b) there has been a significant decrease (i.e. 0.5 m or more) in the maximum depth of colonisation of deep water species.
(c) there is a significant change in relative abundance of plants of different growth forms. Table 2 lists the growth forms of characteristic species.

4.1.3 Examples of applying biological habitat feature assessments

General examples of how these rules would be applied, based on Gunn et al. (2004), are as follows.

1. In an oligotrophic lake SSSI/ASSI feature, macrophytes recorded in the survey are *Littorella uniflora*, *Lobelia dortmanna*, *Isoetes lacustris*, *Myriophyllum alterniflorum*, *Juncus bulbosus* and *Nitella opaca*. *L. uniflora* was found in shallow water, *L. dortmanna* in slightly deeper water, then *I. lacustris* and *Nitella opaca* in deeper water than *L dortmanna*. No non-native species are recorded. The community is typical for this lake type with a high diversity of characteristic species. The zonation which would be expected from shallow to deep water is present. Macrophyte results indicate that this lake is in favourable condition.

2. In an oligotrophic to mesotrophic lake SAC feature, which is known from previous surveys to be at the richer end of this range, macrophytes recorded in the survey are: *Littorella uniflora*, *Isoetes lacustris*, *Myriophyllum alterniflorum*, *Nitella opaca*, *Potamogeton perfoliatus* and *Nuphar lutea*. These species are all characteristic of the lake type and zonation is present from shallow water *Littorella uniflora* populations to *Isoetes lacustris*, *Potamogeton perfoliatus* and *Nitella opaca* in deeper water. The vegetation structure from small rosette to larger *Potamogeton* forms, with floating-leaved species is also present, as previously recorded. Though not a recent introduction, *Elodea canadensis* is present at 7% frequency. In addition, *Crassula helmsii* is recorded, so the site should be defined as being in unfavourable condition.

3. In a hard water oligo-mesotrophic lake SAC feature, the following taxa are found: *Chara* species, 4 *Potamogeton* species, *Callitriche* species. Also present are *Zannichellia palustris* and *Potamogeton pectinatus*, which are characteristic of more eutrophic conditions. However, the latter two species are present at low frequencies, and *Chara* species dominate the site. The site should therefore be classed as being in favourable condition.

4.1.4 Water quality

Features should be classified as unfavourable when pH, ANC or TP levels are outwith the target ranges for the feature type.

Confidence in the water quality data should be examined. Confidence relates to the representativeness and accuracy of the data. Consideration should be given to the quality assurance of the analytical results, location and timing of sampling. If water quality results are found to be outwith the target range for a water body, and confidence in the data is high, then it should be concluded that the site is not in favourable condition. If confidence in the data is low, the site should be defined as being in favourable condition, but at high risk, and further monitoring should be implemented. The following generalisations on data confidence should be considered when examining water quality, with regard to condition assessment.

Confidence in water quality data decreases from those obtained through multiple, in-lake samples, to single outflow samples, to edge samples. Confidence that results are representative of a water body also decreases depending on time of sampling, from spring to autumn to winter to summer.

Examples of methods of generating results in which confidence would be high are as follows:

- monthly sampling
- quarterly sampling
- annual spring outflow sample, in context of several years' data indicating similar results/trend
- single spring survey, with multiple in-lake sampling locations, and a high quality of analysis

Examples of methods of generating results in which confidence would be low are as follows:

- single spring sample for single year
- single summer sample
- samples taken from water's edge
- observational information of occurrence of algal blooms
- analyses undertaken using kits

4.1.5 Other non-biological attributes

Hydrology, substrate and sedimentation results should be subject to site-specific, expert judgement. Interpretation of the results will be dependent upon the quality and quantity of data available; as with water quality, confidence in the results should be considered, before assigning condition category. To a certain degree, hydrology will have been considered in relation to extent.

4.2 Vascular plant features

4.2.1 Presence/absence (mandatory attribute)

The feature should be described as being in unfavourable condition when there has been a loss of a species which
(a) constitutes the vascular plant feature
(b) contributes to a vascular plant feature

4.2.2 Population size/extent (discretionary attribute)

The feature should be classed as unfavourable when there is a decrease of
(a) the number or size of populations present
(b) occurrence of metapopulations
(c) the class of number of plants present (0-100, 101-300 etc.)
(d) frequency of occurrence of the species of interest of >50%, but also if there has been a total decrease in frequency of occurrence of > 50% over the last two CSM visits.

4.2.3 Successful regeneration (discretionary attribute)

It is recommended that features are classified as being in unfavourable condition when the plants of the species of interest do not exhibit evidence of their reproductive strategy.

4.2.4 Examples of applying vascular plant species feature assessments

General examples of how these rules would be applied, based on Gunn et al. (2004), are as follows.

1. A large population of the species of interest is present (>100m in extent). It contains hundreds of individual plants. Using a bathyscope and grapnel, the species is recorded in 70% of sampling points, whilst cover is generally >75%. Reproductive structures are noted. Results indicate favourable condition.

2. The species of interest cannot be found in any of the areas which would provide suitable habitat, during a search period of four hours. The species is a perennial, so low variability would be expected between years. In addition, survey results from the previous year indicated that the species could not be found. Results therefore indicate unfavourable condition.

3. The species of interest is not recorded. However, water levels are high at the time of survey, and the species requires water levels to be lower, in order for plants to develop. The species is an annual, so between year variability is high. There are no other recent data on the occurrence of the species in the water body. However, the lake is meeting its targets for habitat attributes. The site would therefore be classed as being in favourable condition, but at high risk, and further monitoring should be implemented.

4.2.4 Data confidence

Expert judgement will be necessary when considering apparent loss or extreme decrease in the presence of a species, as different species exhibit a range of natural variability in numbers and distribution within individual water bodies. In general, perennial plants exhibit much less variability than annuals, whilst deep water plants are less variable than shallow water species.

The probability that an observed change in abundance is significant will depend on the intensity and timing of sampling, but also on the variability of the species in question; detection of change will be more easily accomplished for species which remain relatively stable, in terms of numbers and distribution. Further consideration will be required when a highly variable species has seemingly disappeared or become scarce within the water body. The reliability of the viewing method should also be considered (e.g. if boat and bathyscope are used in the examination of deep water species, instead of snorkelling or SCUBA techniques, there is a higher risk of false negatives). A further survey of the same water body may be necessary, to confirm the condition assessment. When signs of reproductive strategy have not been observed, consideration should be given to whether inappropriate timing of the survey could have resulted in a false negative.

When there has been a reduction in the species presence or extent and the species is of low variability the site should be classed as unfavourable. Where a species is highly variable, or difficult to detect the results should be reported as unfavourable but should trigger further monitoring. Consideration of other habitat attributes should be helpful in this respect.

4.3 Overall assessment

Biological and non-biological attributes must be examined for condition assessment of both vascular plant and habitat features. A site should be classed as being in unfavourable condition if any individual attribute fails to meet its targets. However, careful consideration must be given to the confidence in the data collected. If observational information only has been obtained, there would be

low confidence in the data, whereas data from long-term, regular, robust monitoring should have a high level of confidence. The absence of a species when habitat conditions are favourable could be a false negative due to the ecology of the species, or the timing of the survey. Failure of a particular attribute from low confidence data should trigger further investigation and monitoring.

Water Framework Directive Risk Assessments may also prove useful in the final analysis of condition for habitats and species.

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6. Favourable condition tables

Favourable Condition Table (generic attributes) 1
Guidance on assessing direct (population) attributes for aquatic vascular plants in standing waters

SAC features: *Najas flexilis* (slender naiad)
SSSI features: *Elatine hexandra* (six-stamened waterwort), *Elatine hydropiper* (eight-stamened waterwort), *Eriocaulon aquaticum* (pipewort), *Isoetes echinospora* (spring quillwort), *Limosella aquatica* (mudwort), *Najas flexilis* (slender naiad), *Nuphar pumila* (least water lily), *Pilularia globulifera* (pillwort), *Potamogeton coloratus* (fen pondweed), *Potamogeton rutilus* (Shetland pondweed)

For assessment of the habitat attributes of water quality, lake substrate and hydrology, reference should be made to the appropriate habitat feature FCT.

Direct attributes	Targets	Method of assessment	Comments
Presence/absence	Species should be present	Identification of species	If all other targets are met but the species cannot be found then the feature should be referred to the Country Agency specialists.
Additional discretionary attributes:			
Population size/extent	Presence of two or more discrete populations OR single large population of species stretching >100 m	Location of populations using boat and bathyscope and double-headed rake, snorkelling, or SCUBA.	Discrete populations must be greater than 50 m apart. On sites which are too small to contain two distinct clusters sufficiently distant from each other to constitute separate populations (e.g. small peatland or floodplain pools) it is more appropriate to consider whether there are other small populations in the vicinity outside the site. Hydrological connectivity should be maintained between populations.
	Species presence in >20% of point samples from occupied habitat areas.	Habitat areas for shallow water species can be assessed using bathyscope and double-headed rake. Deep water species can be examined with boat, bathyscope and double-headed rake, or by snorkel or SCUBA diving.	Cover may also be used as a guide to condition. Within occupied habitat areas >20 % cover should be provided by species of interest.
	No decline >50 % of presence in point samples within occupied habitat areas	Comparison with previous data	The scale (0-100, 101-300 etc.) is employed to take account of natural fluctuation (vascular plants guidance). However, the life strategy of the species of interest should be considered. Species which exhibit high variability in numbers (e.g. annuals) would preferably be monitored on more than one occasion during each 6-year cycle.
	Maximum decline of 1 category of scale of population size	Comparison with previous data	
Successful regeneration	Plants of differing sizes present OR plants producing flowers or fruits	Visual assessment	Where populations reproduce principally, or exclusively, through vegetative means, evidence of regeneration may be difficult to observe. Perennial populations should exhibit a range of plant sizes as this implies that there are a range of different aged individuals. Annual populations, such as those of shallow pools, should flower and set seed.

Favourable Condition Table (Generic Attributes) 2
Interest feature type(s): Standing waters (non-SAC types)

Equivalent Phase 1 category: G1 Standing water (part)

Broad reporting category: Standing open water and canals

Attribute	Target	Method of Assessment	Comments
Habitat extent	No loss of extent of standing water	Assessment against baseline map. Aerial photographs may be useful.	This attribute is to assess changes caused by active management, such as infilling or channel diversion. Changes due to drying out or successional change are covered under other attributes.
Vegetation composition: macrophyte community composition	i) At least one characteristic species should be present. ii) ii) 6 out of 10 sample spots (boat or wader survey) should include at least one characteristic species. ii) there should be no loss of characteristic species recorded from the site.	Fixed point sector/transect sampling (boat or shore-based methods)	The macrophyte community characteristic of a particular lake will depend on a number of environmental factors such as geology, altitude, basin morphometry and proximity to other water bodies. In general the background nutrient status of the lake (determined by catchment geology) will be the major natural factor affecting both species composition and species richness. **There may be valid reasons why a characteristic species is not present at a site (such as biogeographic range or isolation from source populations) which need to be considered when applying targets to an individual site.**
Vegetation composition: negative indicator species	Non-native species should be absent or present at low frequency. Cover of benthic and epiphytic filamentous algae should be less than 10%.		Introduced species should be identified. A number of non-natives have such invasive potential that they should be assessed separately. Species of particular concern are: *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum* and *Azolla filiculoides*. If any of these species are present, a water body should be considered as being in unfavourable condition. **This list is not exhaustive and should be updated as new threats become apparent**. Colonisation since the previous field visit by *Elodea nuttallii* or *Elodea canadensis* at >5% frequency is indicative of unfavourable condition, as is dominance of naturalised non-native species, such as *E. canadensis*. Occurrence of such species at >40% frequency in unproductive waters, and >50% frequency in more productive waters, is indicative of unfavourable condition. Excessive growths of filamentous algae on lake substrate or macrophytes are indicative of nutrient enrichment. Cover of benthic and epiphytic filamentous algae should be less than 10%.
Vegetation composition: macrophyte	Characteristic zones of vegetation should be present.	Fixed point sector/transect sampling (boat or shore-based methods)	The maximum depth at which submerged vegetation is able to grow is a direct indicator of water clarity and also a general indicator of the status of the macrophyte community. A decrease in the maximum depth of

community structure	Maximum depth distribution should be maintained.		macrophyte colonisation along a fixed point transect of greater than 10% indicates a site moving out of favourable condition. Consideration should be given to e.g. *Isoetes* species, charophytes (particularly *Chara* species) and *Potamogeton* species.
	At least the present structure should be maintained.		Generally, both emergent and floating/submerged vegetation should be present in the littoral zone. However, lakes with exposed shorelines and coarse stony substrates may lack emergent littoral vegetation.
Water quality	Stable nutrient levels appropriate to lake type	Existing data or develop a water-sampling regime. This should be carried out quarterly, ideally monthly. As a minimum samples should be taken in early spring.	Mean annual TP concentrations (based on at least quarterly measurements), or spring TP levels, should meet the targets appropriate for the lake type documented in the guidance, unless site-specific targets are available. If palaeolimnological or hindcast modelling techniques have been employed to reconstruct natural background phosphorus concentrations for a particular lake, these may be used to set targets, although it may be necessary to accept a small deviation from these background conditions. Alternatively, historical water chemistry data may exist for individual lakes. Where existing, site-specific TP concentrations are consistently lower than the standard appropriate for the habitat type, a lower target should be applied to prevent deterioration from current status.
	Stable pH/ANC values appropriate to lake type		Upland lakes in catchments with a hard rock geology have limited buffering capacity and are thus susceptible to acidification. There may be impacts on invertebrate and fish populations at pH levels lower than 5.5. However, dystrophic lakes on peat may have water chemistry more acidic than this.
	Adequate dissolved oxygen levels for health of characteristic fauna	Existing data or temperature/dissolved oxygen profiles	Deep or sheltered lakes exhibit seasonal stratification of temperature and oxygen levels. In eutrophic lakes in which thermal stratification occurs, summer oxygen levels in the hypolimnion may be very low, encouraging phosphorus release from the sediments and impacts upon the biota.
	No excessive growth of cyanobacterial or green algae.	Existing data, shoreline walk, sample of bloom	There should be no evidence of excessive blue-green or green algal blooms. In low nutrient waters, blooms would not be expected to occur.
Hydrology	There should be a natural hydrological regime	Existing data or develop a hydrological model and sampling regime. This should be carried out quarterly, ideally monthly.	The natural flushing rate and seasonal water –level fluctuations of the lake should not be affected by abstractions from inflow streams, groundwater or the lake or by changes to outflows. Online lakes can be assessed by reference to changes in inflow stream flows and changes in lake residence times. Reservoirs will need to be assessed on an individual basis as natural residence times will not necessary be available. Data to assess the following targets should be available from the relevant environmental protection

			agency: Inflow streams: abstractions of no more than 10% of daily naturalised flows Groundwater and abstractions from lake water body: natural residence time not affected by more than 10%. Where groundwater abstractions are suspected of affecting lake hydrology further investigation and/or modelling may be required to inform the flow naturalisation process.
		Shoreline walk	There should be no evidence of impact from lowered or artificially raised water levels. Evidence of lowered water levels include: loss of marginal or littoral vegetation or large areas of exposed lake substrate. Artificially raised water levels may result in the drowning of trees and other terrestrial vegetation above the lake shore.
		Shoreline walk	Recreational or industrial uses of lakes may result in areas of the shoreline and littoral being concreted or modified. Such areas should be limited to a very small proportion of the lake shore as assessed during the walk.
	No loss of marginal vegetation	Shoreline walk	Grazing or erosion from boat wash may reduce marginal vegetation cover.
Lake substrate	Maintain natural shoreline. Maintain natural and characteristic substrate.	Shoreline walk	No more than 5% of lakeshore should heavily modified. Increased sediment loads may result in smothering of coarse substrates with fine sediments. Fine sediments will be readily disturbed by movements in the overlying water column or passage of a plant sampling grapnel. Changes in plant community may result from enriched sediments without an accompanying change in water chemistry.
Sediment load	Maintain natural sediment load.	Establish sedimentation rates from cores or sediment traps. Observe areas of increased erosion and deposition.	Increases in siltation could result from increased lake productivity, changes in catchment land-use (particularly over-grazing), lake level fluctuations, climatic fluctuations, or changes in sewage treatment.

Indicators of local distinctiveness	Maintain distinctive elements (e.g. rare plant or invertebrate species, habitat features) at current extent/levels and/or in current locations.	As appropriate	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not covered adequately by the previous attributes, or by separate guidance (e.g. for notified species features). For species of local distinctiveness, which are documented on citations, and for which records are held for individual lakes, references such as LACON (Palmer, in press) should be consulted for current lists of species rare in the constituent countries of GB and in EA and SEPA areas. For "notable" species (e.g. nationally scarce plants), it is not intended that a target is set for detailed species monitoring. It is intended that a rapid indication of presence/absence and /or approximate extent should be provided. Allowing for natural fluctuations in population size. The same approach applies to "notable" habitats.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Standing waters (non-SAC types)

Disturbance	No introduced species should be present. Minimal impact from recreation and navigation		The impact of introduced plant species may be readily assessed but the impact of introduced fauna may be indirect and difficult to identify. Known problems with introduced species should be addressed through management action. The removal of piscivorous fish or the introduction of benthic-feeding species, such as carp both have the potential to cause switches to phytoplankton-dominated states in lakes with moderate nutrient loads. Fish stocking also has the potential to alter natural fish communities and alter the lake food web. Other introduced species may have effects on ecosystem function through the food web or via direct effects on the plant community e.g. large water fowl populations. Possible negative impacts include: ground-baiting for angling; disturbance through powered boat traffic; pollution from boat marinas; physical destruction of plant communities.

Favourable Condition Table (Generic Attributes) 3
Interest feature type(s): Oligotrophic waters of sandy plains

Includes Annex I type: H3110 **Oligotrophic waters containing very few minerals of sandy plains *(Littorelletalia uniflorae)***
Equivalent Phase 1 category: G1.3 Standing water: oligotrophic (part)
Equivalent British Lakes classification (Duigan *et al.* in press) types A (part), B and C2 (part)

Broad reporting category: Standing open water and canals

Attributes	Target	Method of assessment	Comment
Extent	No loss of extent of standing water	Assessment against baseline map. Aerial photographs may be useful.	This attribute is to assess changes caused by active management, such as infilling or channel diversion. Changes due to drying out or successional change are covered under other attributes.
Vegetation composition: macrophyte community composition	i) Presence of at least one of the characteristic *Littorelletea* species listed in Box 1 ii) Presence of at least three of the characteristic species listed in Box 1 (except where valid reasons (see comments) suggest otherwise, in which case two of the three). ii) No loss of characteristic species (see Box 1) recorded from the site. ii) 6 out of 10 sample spots (boat or wader survey) should include at least one characteristic species from Box 1.	Fixed point sector/transect sampling (boat or shore-based methods)	This is a rare habitat type throughout the Atlantic biogeographic region of Europe and also in the UK, as it is restricted to sandy plains that are acidic and low in nutrients. The only known high quality examples of this habitat type occur in fluvio-glacial deposits in the New Forest and on the Cheshire Plain, and on more recent sand deposits of marine origin in the Outer Hebrides. The submerged vegetation is characterised by *Littorella uniflora*, *Lobelia dortmanna*, *Isoetes lacustris*, *Isoetes echinospora*. Only one species needs to be present to conform to the definition of this Annex 1 type and typically the vegetation consists of zones in which the individual species form submerged, monospecific lawns. *Myriophyllum alterniflorum*, *Apium inundatum* and *Pilularia globulifera* are other characteristic species; while *Nymphaea alba* and *Juncus bulbosus* var. *fluitans*, can occur as associates. Southern sites may only contain *Littorella uniflora* as representatives of the feature. Please see Box 1. **There may be valid reasons why a characteristic species is not present at a site (such as biogeographic range or isolation from source populations) which need to be considered when applying targets to an individual site.** The following indicate that the site may be moving out of favourable condition: presence of high cover of *Sphagnum* species and/or where supporting community contains monospecific stands of *Juncus*

Attributes	Target	Method of assessment	Comment
Vegetation composition: negative indicator species	Non-native species should be absent or present at low frequency Algal dominance: cover of benthic and epiphytic filamentous algae less than 10%		*bulbosus* var. *fluitans* in the vegetated photic zone, and this exceeds 40% cover. The presence of non-characteristic species such as *Zannichellia palustris*, *Potamogeton pectinatus* and *Lemna* spp. would indicate possible eutrophication of the water body Introduced species should be identified. A number of non-natives have such invasive potential that they should be assessed separately. Species of particular concern are: *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum* and *Azolla filiculoides*. If any of these species are present, a water body should be considered as being in unfavourable condition. **This list is not exhaustive and should be updated as new threats become apparent.** Colonisation since the previous field visit by *Elodea nuttallii* or *Elodea canadensis* at >5% frequency is indicative of unfavourable condition, as is dominance of naturalised non-native species, such as *E. canadensis*. Occurrence of such species at >40% frequency in unproductive waters, and >50% frequency in more productive waters, is indicative of unfavourable condition. Excessive growths of filamentous algae on lake substrate or macrophytes are indicative of nutrient enrichment. Cover of benthic and epiphytic filamentous algae should be less than 10%
Macrophyte community structure	Characteristic zones of vegetation should be present. Maximum depth distribution should be maintained. At least the present structure should be maintained.	Fixed point sector/transect sampling (boat or shore-based methods)	Characteristic zonation with increasing depth should be: *Littorella*, then overlapping zones of *Littorella* with *Lobelia*, then *Isoetes* The maximum depth of *Isoetes* colonisation should be examined. Where present, well defined hydroseres should be maintained.
Water quality	Stable nutrient levels appropriate to lake type	Existing data or develop a water-sampling regime. This should be carried out quarterly, ideally monthly. As a minimum, samples should be taken in early spring. ***See Appendix 2 and main text.***	There should be acid conditions and low nutrient levels. Mean annual TP concentrations (based on at least quarterly measurements), or spring TP levels, should meet the targets appropriate for the lake type documented in the guidance, unless site-specific targets are available. If palaeolimnological techniques or hindcast modelling have been employed to reconstruct natural background phosphorus concentrations for a particular lake these can be used to set targets,

Attributes	Target	Method of assessment	Comment
			although it may be necessary to accept a small deviation from these background conditions. Alternatively, historical water chemistry data may exist for individual lakes. Where existing, site-specific TP concentrations are consistently lower than the standard appropriate for the habitat type, a lower target should be applied to prevent deterioration from current status.
	Stable pH/ANC values appropriate for lake type		As a guide, pH always < 7, annual mean usually *ca* 5.5 The acceptable range of chemical conditions (especially total P, other forms of phosphorus, pH/ANC, and where appropriate NO_3-N,) should be set for individual SAC lakes from recent or historical water chemistry data. See section 2.1.2.2.
			Check for changes in catchment land-use causing diffuse pollution and/or siltation and check point sources of pollution. Aerially applied agro-chemicals have a high potential to change plant communities, and move them out of favourable condition.
			Other methodologies involving trophic scoring can contribute to the assessment of favourable condition.
	Adequate dissolved oxygen levels for health of characteristic fauna	Existing data or temperature/dissolved oxygen profile	Dissolved oxygen standards should be appropriate for health of salmonid fish, as low nutrient waters would be expected to support this type of fish.
	No excessive growth of cyanobacteria or green algae.	Existing data, shoreline walk, sample of bloom	Blooms of blue-green or green algae should not occur in low nutrient waters.
Hydrology	There should be a natural hydrological regime	Shoreline walk. Where necessary, develop a hydrological model and sampling regime. This should initially be carried out quarterly as a minimum, ideally monthly.	Natural flushing rate and seasonal pattern of fluctuation need to be considered. Maintain flushing rate of system. Modifications of inflows and outlets or changes in hydrology e.g. from flood control regimes, abstraction and gravel removal can lead to unnatural changes in lake levels. *L. uniflora* has been recorded up to 50 cm above water surface during periods of low water level. *L. uniflora* can tolerate extreme inter-annual fluctuations in water level and long periods of exposure. *L. dortmanna* is tolerant of short periods of exposure

Attributes	Target	Method of assessment	Comment
			but intolerant of desiccation.
Lake substrate character	Maintain the natural shoreline of the lake. Maintain natural and characteristic substrate for lake type	Shoreline walk. ***See Appendix 2 and main text.*** Need to consider the development of a modified freeze coring technique as developed for collecting sediments in rivers.	Substrate is typically sand, gravel and stones with low organic content, <5% loss on ignition. Sediment quality and quantity when enriched can cause excessive growths of *Juncus bulbosus* var. *fluitans* or growths of algae.
Sediment load	Maintain natural sediment load.	Direct observation and /or establish sedimentation rate from sediment cores or sediment traps. ***See Appendix 2 and main text.***	Increases in siltation could result from: e.g. increased lake productivity, changes in catchment land-use (particularly over-grazing), lake level fluctuations, climatic fluctuations or changes in sewage treatment.
Indicators of local distinctiveness	Maintain distinctive elements (e.g. rare plant or invertebrate species, habitat features) at current extent/levels and/or in current locations.	As appropriate	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not covered adequately by the previous attributes, or by separate guidance (e.g. for notified species features). For species of local distinctiveness, which are documented on citations, or for which records are held for individual lakes, references such as LACON (Palmer, in prep.) should be consulted for current lists of species rare in the constituent countries of GB and in EA and SEPA areas. For "notable" species (e.g. nationally scarce plants), it is not intended that a target is set for detailed species monitoring. It is intended that a rapid indication of presence/absence and /or approximate extent should be provided. Allowing for natural fluctuations in population size. The same approach applies to "notable" habitats.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Oligotrophic waters of sandy plains

Objective	Specified assessment method (if appropriate)	Comment
Minimal negative impact from artificial structures		Artificial structures could include boat-mooring facilities, dams, fish reefs.
Minimal negative impact from recreation		Negative impacts from recreational activities can include enrichment caused by ground baiting, introduction of bottom feeding fish and other organisms not characteristic of the habitat, increased disturbance to SACs from water-sports.
Direct application of lime to the water column as an acidification amelioration strategy should not be carried out		Efforts should be directed towards reducing atmospheric emissions and implementing catchment management strategies, especially in relation to coniferous forestry.
No fish farming		Catchment area changes affecting the lake, such as flood defences and infrastructure schemes, should be considered.

Box 1. Characteristic species of oligotrophic waters containing few minerals of sandy plains (*Littorelletalia uniflorae*)

Characteristic species	Associates
***Littorelletea* flora:**	*Potamogeton polygonifolius*
Littorella uniflora	*Nitella translucens*
Isoetes lacustris	*Nymphaea alba*
Isoetes echinospora	*Juncus bulbosus*
Lobelia dortmanna	*Luronium natans*
Other characteristic species:	
Eleogiton fluitans	
Elatine hexandra	
Pilularia globulifera	
Myriophyllum alterniflorum	
Apium inundatum	

Favourable Condition Table (Generic Attributes) 4
Interest feature type(s): Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*

Includes Annex I type: H3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*
Equivalent Phase 1 categories: G1.2 Standing water : mesotrophic (part) and G1.3 standing water: oligotrophic (part)
Equivalent British Lakes classification (Duigan *et al.* in press) types C1, C2 (part), D (part) and E (part)

Broad reporting category: Standing open water and canals

Attributes	Target	Method of assessment	Comment
Extent	No loss of extent of standing water	Assessment against baseline map. Aerial photographs may be useful.	This attribute is to assess changes caused by active management, such as infilling or channel diversion. Changes due to drying out or successional change are covered under other attributes.
Vegetation composition: macrophyte community composition	**Oligotrophic standing waters:** i) Presence of at least three of the characteristic *Littorelletea* species listed in Box 2 (except where valid reasons (see comments) suggest otherwise, in which case two of the three). ii) No loss of characteristic species (see Box 2) recorded from the site. ii) 6 out of 10 vegetated sample spots (boat or wader survey) should include at least one characteristic species from Box 2. **Mesotrophic standing waters:** i) Presence of at least 3 of the characteristic *Potamogeton* species listed in Box 2 for mesotrophic waters.	Fixed point sector/transect sampling (boat or shore-based methods)	This type of water body occurs in the majority of Member States and is abundant in the more mountainous areas of Europe. In the UK this freshwater habitat type is largely confined to the mountainous regions of the north and west and is characterised by two intergrading types: oligotrophic and mesotrophic waters. The vegetation community is characterised by amphibious short perennial vegetation, with shoreweed *Littorella uniflora* being considered a defining component. There are two disjunct community types, one extremely oligotrophic with *Subularia aquatica, Littorella uniflora, Isoetes lacustris, Myriophyllum alterniflorum, Lobelia dortmanna* and *Sparganium angustifolium*. **See Box 2.** **There may be valid reasons why a characteristic species is not present at a site (such as biogeographic range or isolation from source populations) which need to be considered when applying targets to an individual site.** The other community has a clinal range of species as the trophic state increases. These richer trophic states cannot support *Subularia aquatica* but are indicated by the presence of broad-leaved *Potamogeton* spp. *Potamogeton perfoliatus, P. gramineus, Nitella* spp. *Sparganium natans* is indicative of an increased trophic state. (N.B. *Subularia* may be naturally absent from some regional areas.) *Persicaria amphibia* can be present as an associate. Two nationally scarce plants *Luronium natans* and *Pilularia globulifera* occur at the

Attributes	Target	Method of assessment	Comment
	ii) Presence of at least 8 of the characteristic species listed in Box 2 (except where valid reasons (see comments) suggest otherwise). iii) No loss of characteristic species (see Box 2) recorded from the site. iv) 6 out of 10 sample spots (boat or wader survey) should include at least one characteristic species from Box 2 .		interface between oligotrophic and mesotrophic water types. *Najas flexilis*, an Annex II species, is restricted to mesotrophic lochs in Scotland, and has its own FCT in the Vascular plants CSM guidance to be found on the JNCC website. As this interest feature covers a wide range of trophic states it is essential to establish which community type represents the feature for the site in question. The presence of *Sphagnum* species and/or *Juncus bulbosus* var. *fluitans* at >40% frequency of occurrence for oligotrophic waters, and the presence of *Myriophyllum alterniflorum* at >40% frequency in mesotrophic waters, are indicative that a lake is not in favourable condition. The presence of non-characteristic species such as *Zannichellia palustris*, *Potamogeton pectinatus*, *Lemna* spp. And fine-leaved *Potamogeton* spp. (except *P. berchtoldii*) would indicate possible eutrophication of the water body.
Vegetation composition: **negative indicator species**	Non-native species should be absent or present at low frequency Algal dominance: cover of benthic and epiphytic filamentous algae less than 10%		Introduced species should be identified. A number of non-natives have such invasive potential that they should be assessed separately. Species of particular concern are: *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum* and *Azolla filiculoides*. If any of these species are present, a water body should be considered as being in unfavourable condition. **This list is not exhaustive and should be updated as new threats become apparent.** Colonisation since the previous field visit by *Elodea nuttallii* or *Elodea canadensis* at >5% frequency is indicative of unfavourable condition, as is dominance of naturalised non-native species, such as *E. canadensis*. Occurrence of such species at >40% frequency in unproductive waters, and >50% frequency in more productive waters, is indicative of unfavourable condition. Excessive growths of filamentous algae on lake substrate or macrophytes are indicative of nutrient enrichment.
Macrophyte community structure	Characteristic zones of vegetation should be present. Maximum depth distribution	Fixed point sector/transect sampling (boat or shore-based methods)	Characteristic zonation with increasing depth should be: *Littorella*, then overlapping zones of *Littorella* with *Lobelia*, then *Isoetes* *L. uniflora* and *L. dortmanna* dominant in depths <1.5 m; *Isoetes* dominant > 1.5 m. *Isoetes* has been recorded in Wast Water at depths of 7 m. It is very sensitive to wave action, setting a shallow depth limit particularly in exposed sites. The maximum depth of *Isoetes* colonisation should be examined, but also the depth of

Attributes	Target	Method of assessment	Comment
	should be maintained. At least the present structure should be maintained.		colonisation of other taxa in richer waters within this range e.g. *Potamogeton* spp.. Where present, well defined hydroseres should be maintained.
Water quality	Stable nutrient levels appropriate to lake type	Existing data or develop a water-sampling regime. This should be carried out quarterly, ideally monthly. As a minimum samples should be taken in early spring. ***See Appendix 2 and main text.***	Mean annual TP concentrations (based on at least quarterly measurements), or spring TP levels, should meet the targets appropriate for the lake type documented in the guidance, unless site-specific targets are available. If palaeolimnological techniques or hindcast modelling have been employed to reconstruct natural background TP concentrations for a particular lake these can be used to set targets, although it may be necessary to accept a small deviation from these background conditions. Alternatively, historical water chemistry data may exist for individual lakes. Where existing, site-specific TP concentrations are consistently lower than the standard appropriate for the habitat type, a lower target should be applied to prevent deterioration from current status.
	Stable pH/ANC values appropriate to lake type		As a guide, for oligotrophic waters, pH 5.50 to circumneutral and for mesotrophic waters, pH circumneutral to < 8.00 There is a wide clinal range of community types embraced in this feature. Water quality targets should be set for individual SAC lakes and an acceptable range established. The acceptable range of chemical conditions (especially total P, other forms of phosphorus, pH/ANC, and where appropriate NO_3-N,) should be set for individual SACs from recent or historical water chemistry data. See secion 2.1.2.2. Check for changes in land-use in the catchment causing diffuse pollution and/or siltation and check point sources of pollution. Aerially applied agro-chemicals have a high potential to change plant communities, and to move them out of favourable condition. Other methodologies involving trophic scoring can contribute to the assessment of favourable condition.
	Adequate dissolved oxygen levels for health of characteristic fauna	Existing data or temperature/dissolved oxygen profile	Levels of dissolved oxygen should support the invertebrate and vertebrate taxa associated with this lake type.

Attributes	Target	Method of assessment	Comment
	No excessive growth of cyanobacteria or green algae	Existing data, shoreline walk, sample of bloom	There should be no evidence of blue-green or green algal blooms.
Hydrology	There should be a natural hydrological regime	Shoreline walk. Where necessary, develop a hydrological model and sampling regime. This should initially be carried out quarterly as a minimum, ideally monthly. ***See Appendix 2 and main text.***	Natural flushing rate and seasonal pattern of fluctuation need to be considered. Maintain flushing rate of system. Modifications of inflows and outlets or changes in hydrology (e.g. from flood control regimes, abstraction and gravel removal) can lead to unnatural changes in lake levels. *L. uniflora* can tolerate extreme inter-annual fluctuations in water level and long periods of exposure. *L. dortmanna* is tolerant of short periods of exposure but intolerant of desiccation.
Lake substrate	Maintain the natural shoreline of the lake. Maintain natural and characteristic substrate for lake type.	Shoreline walk. ***See Appendix 2 and main text.*** Need to consider the development of a modified freeze coring technique as developed for collecting substratum sediments in rivers.	Substrate is typically sand, gravel, stones and boulders with low organic content but sometimes locally high peat content. Sediment quality and quantity when enriched can cause excessive growths of *Juncus bulbosus* var. *fluitans* or growths of algae.
Sediment load	Maintain natural sediment load.	Direct observation and/or establish sedimentation rate from sediment cores. ***See Appendix 2 and main text.***	Increases in siltation could result from increased lake productivity, changes in catchment land-use (particularly over-grazing), lake level fluctuations, climatic fluctuations or changes in sewage treatment.
Indicators of local distinctiveness	Maintain distinctive elements (e.g. rare plant or invertebrate species, habitat features) at current extent/levels and/or in current locations.	As appropriate	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not covered adequately by the previous attributes, or by separate guidance (e.g. for notified species features). For species of local distinctiveness, which are documented on citations, or for which records are held for individual lakes, references such as LACON (Palmer, in prep.) should be consulted for current lists of species rare in the constituent countries of GB and in EA and SEPA areas. For “notable” species (e.g. nationally scarce plants), it is not intended that a target is set for detailed species monitoring. It is intended that a rapid indication of presence/absence and /or approximate extent should be provided. Allowing for natural fluctuations in population size. The same approach applies to “notable” habitats.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Oligotrophic to mesotrophic standing waters H3130

Objective	Specified assessment method (if appropriate)	Comment
Minimal negative impact from artificial structures		Artificial structures could include boat-mooring facilities, dams, fish reefs.
Minimal negative impact from recreation		Negative impacts from recreational activities can include enrichment caused by ground baiting, introduction of bottom feeding fish and other organisms not characteristic of the habitat, increased disturbance to SACs from water-sports.
Direct application of lime to the water column as an acidification amelioration strategy should not be carried out		Efforts should be directed towards reducing atmospheric emissions and implementing catchment management strategies, especially in relation to coniferous forestry.
No fish farming		Catchment area changes affecting the lake, such as flood defences and infrastructure schemes, should be considered.

Box 2. Characteristic species of oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Iseoto-Nanojuncetea*. **mesotrophic standing waters only.

Characteristic species:	**Associates:**
***Littorelletea* flora:**	*Callitriche hamulata*
Littorella uniflora	*Callitriche brutia*
Isoetes lacustris	*Myriophyllum alterniflorum*
Isoetes echinospora	*Potamogeton polygonifolius*
Lobelia dortmanna	*Potamogeton berchtoldii*
Subularia aquatica	*Potamogeton natans*
Sparganium angustifolium	*Nymphaea alba*
Luronium natans	*Juncus bulbosus*
Potamogeton rutilis	*Eleogiton fluitans*
Other characteristic species:	*Equisetum fluviatile*
Pilularia globulifera	*Nuphar lutea*
Elatine hexandra	*Menyanthes trifoliata*
Baldellia ranunculoides	*Eleocharis acicularis*
Carex rostrata	
Utricularia spp.	***Persicaria amphibia*
** *Nitella* spp.	
***Sparganium natans*	
**Broadleaved *Potamogeton* species:	
P. alpinus	
P. praelongus	
P. perfoliatus	
P. gramineus	
P x nitens (and any other established hybrid of these species)	
***Najas flexilis*	

Favourable Condition Table (Generic Attributes) 5
Interest feature type(s): Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.

Includes Annex I type: H3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
Equivalent Phase 1 category: G1.5 Standing water: marl (part)
Equivalent British Lakes classification (Duigan *et al.* in press) types C2 (part), E (part), F and I (part)

Broad reporting category: Standing open water and canals

Attributes	Target	Method of assessment	Comment
Extent	No loss of extent of standing water	Assessment against baseline map. Aerial photographs may be useful.	This attribute is to assess changes caused by active management, such as infilling or channel diversion. Changes due to drying out or successional change are covered under other attributes.
Vegetation composition: macrophyte community composition.	i) Characteristic species (see Box 3) should be present. ii) 7 out of 10 sample spots (boat or wader survey) should include at least one characteristic species from Box 3.	Fixed point sector/transect sampling (boat or shore-based methods)	These waters are scarce in the UK, and the best examples are restricted to the north and west. This habitat type is characterised by water with a high base content, most often calcium but very rarely magnesium, and is usually confined to areas of limestone and other base-rich substrates, from which the dissolved minerals are derived. The following are likely to form *Chara* associations: nationally scarce species - *Chara aspera*, *Chara canescens*, *Chara pedunculata*; endangered/vulnerable species - *Chara baltica* and *Chara fragifera*; and nationally threatened species - *Chara curta* and *Chara rudis*. Associated species are *Potamogeton praelongus*, *P. coloratus*, *P. filiformis*, and the common water moss *Fontinalis antipyretica*. Hard water lakes are often fringed by *Phragmites communis* and *Schoenoplectus* species. **There may be valid reasons why a characteristic species is not present at a site (such as biogeographic range or isolation from source populations) which need to be considered when applying targets to an individual site.**

Attributes	Target	Method of assessment	Comment
Vegetation composition: negative indicator species	Non-native species should be absent or present at low frequency Non-*Chara* algal dominance: cover of benthic and epiphytic filamentous algae less than 10%		In many sites there is permanent *Chara* dominance. In smaller sites management may be necessary to prevent the loss of *Chara* by natural succession. Introduced species should be identified. A number of non-natives have such invasive potential that they should be assessed separately. Species of particular concern are: *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum* and *Azolla filiculoides*. If any of these species are present, a water body should be considered as being in unfavourable condition. **This list is not exhaustive and should be updated as new threats become apparent.** Colonisation since the previous field visit by *Elodea nuttallii* or *Elodea canadensis* at >5% frequency is indicative of unfavourable condition, as is dominance of naturalised non-native species, such as *E. canadensis*. Occurrence of such species at >40% frequency in unproductive waters, and >50% frequency in more productive waters, is indicative of unfavourable condition. Excessive growths of filamentous algae on lake substrate or macrophytes are indicative of nutrient enrichment.
Macrophyte community structure	Characteristic zones of vegetation should be present. Maximum depth distribution should be maintained At least the current structure should be maintained.	Fixed point sector/transect sampling (boat or shore-based methods)	*Chara* beds should normally cover a minimum of 50% of the photic zone, although extent will be variable according to site and seasonal changes. In many cases *Chara* will be the dominant feature. The maximum depth of *Chara* colonisation should be examined. "Holes" in *Chara* beds should be monitored, as significant increases are likely to indicate that the site is moving out of favourable condition. Where present, well defined hydroseres should be maintained.
Water quality	Stable nutrient levels appropriate for lake type	Existing data or develop a water-sampling regime. This should be carried out quarterly, ideally monthly. As a minimum, samples should be taken in early spring. Water transparency measurements should also be taken. ***See Appendix 2 and main text.***	There should be clear, base-rich water with moderate levels of nutrients. The acceptable range of chemical conditions (especially total P, other P fractions, pH/ANC, and where appropriate NO_3-N,) should be set for individual SAC lakes from recent or historical water chemistry data. From a management perspective it would be useful to establish whether the individual systems are N or P limited. See section 2.1.2.2. Mean annual TP concentrations (based on at least quarterly measurements), or spring TP levels, should meet the targets appropriate for the lake type documented in the guidance, unless site-specific targets are available.

Attributes	Target	Method of assessment	Comment
			If palaeolimnological techniques or hindcast modelling have been employed to reconstruct natural background TP concentrations for a particular lake, these can be used to set targets, although it may be necessary to accept a small deviation from these background conditions. Alternatively, historical water chemistry data may exist for individual lakes. Where existing, site-specific TP concentrations are consistently lower than the standard appropriate for the habitat type, a lower target should be applied to prevent deterioration from current status. However, it should be considered that there are often problems using diatoms in palaeolimnogical studies of hard-water lakes because of silica dissolution. Therefore, the development of water quality targets based on palaeolimnology is sometimes problematic. Other microfossils (e.g. chironomids, Cladocera, ostracods) could be examined to establish trends in water quality. Hindcasting and the use of other historical data are still viable options for developing quantitative targets. The range of hard-water lakes exhibit a continuum of trophic conditions from oligotrophic to mesotrophic, so the appropriate trophic condition for each hard-water lake should be maintained. If filamentous algae are dominant, check for diffuse or point sources of pollution and/or check TP levels in aquifer if aquifer-fed. If non-*Chara* algal growth is excessive check for inputs of point or diffuse sources of pollution.
	Stable pH/ANC values appropriate for lake type		As a guide, pH 7.00 to 8.50
	Adequate dissolved oxygen levels for health of characteristic fauna	Existing data, or dissolved oxygen /temperature profiles	Levels of dissolved oxygen should support the invertebrate and vertebrate taxa associated with this lake type.
	No excessive growth of cyanobacteria or green algae	Existing data, shoreline walk, sample of bloom	There should be no evidence of excessive blue-green or green algal blooms.
Hydrology	There should be a natural hydrological regime	Shoreline walk. Where necessary, develop a hydrological model and sampling regime, which should include the aquifer. This should initially be carried out quarterly as a minimum, ideally monthly. ***See Appendix 2 and main text.***	Natural flushing rate and seasonal pattern of fluctuation need to be considered. Many of these sites will be aquifer-fed. Maintain flushing rate of system. Modifications of inflows and outlets or changes in hydrology (e.g. from flood control regimes and abstraction) can lead to unnatural changes in lake levels.
Lake substrate	Maintain natural shoreline of the lake Maintain natural and characteristic substrate for lake type.	Shoreline walk. ***See Appendix 2 and main text.*** Check for marl production on macrophytes and in sediment cores.	Marl production is desirable, although this may be low or absent in oligotrophic hard waters.

Attributes	Target	Method of assessment	Comment
Sediment load	Maintain natural sediment load.	Existing data, sediment cores or sediment traps.	Increases in non-calcium carbonate siltation could result from increased lake productivity, changes in catchment land-use, lake level fluctuations, climatic fluctuations or changes in sewage treatment. Check immediate catchment area for drainage or land-use change, which might induce high sediment loads to enter system. Some peat slumping is acceptable, provided this is not induced due to land drainage.
Indicators of local distinctiveness	Maintain distinctive elements (e.g. rare plant or invertebrate species, habitat features) at current extent/levels and/or in current locations.	As appropriate	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not covered adequately by the previous attributes, or by separate guidance (e.g. for notified species features). For species of local distinctiveness, which are documented on citations, or for which records are held for individual lakes, references such as LACON (Palmer, in prep.) should be consulted for current lists of species rare in the constituent countries of GB and in EA and SEPA areas. For "notable" species (e.g. nationally scarce plants), it is not intended that a target is set for detailed species monitoring. It is intended that a rapid indication of presence/absence and /or approximate extent should be provided. Allowing for natural fluctuations in population size. The same approach applies to "notable" habitats.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Hard oligo-mesotrophic waters

Objective	Specified assessment method (if appropriate)	Comment
Impact of factors that can act as "forward switches" to phytoplankton-dominant turbid-water conditions should be minimised. Minimal negative impact from artificial structures Minimal negative impact from recreation No introduction, or stocking, of fish or other organisms not indigenous to the water body. No fish farming, excessive stocking or selective removal of piscivores. No herbicide or pesticide use in water or catchment areas vulnerable to runoff.		Forward switches include nutrient addition, mechanical or boat damage to plants, herbicides, exotic vertebrate grazers (e.g. carp), pesticides, increased salinity and differential kills of piscivores. Artificial structures could include boat-mooring facilities, dams, fish reefs, fishing platforms. Negative impacts from recreational activities can include enrichment caused by ground baiting, introduction of herbivorous, planktivorous or bottom feeding fish and other organisms not characteristic of the habitat, increased disturbance to SACs from water-sports. Zebra mussels have the potential to change the fundamental character of the ecosystem. Catchment area changes affecting the lake, such as flood defences and infrastructure schemes should be considered.

Box 3. Characteristic species of hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.

Characteristic species	Associates
*Chara spp. (*excluding *Chara vulgaris) e.g :*	*Potamogeton praelongus*
C. rudis	*Potamogeton lucens*
C. pendunculata	*Potamogeton coloratus*
C. aspera	*Fontanalis antipyretica*
C. curta	*Chara vulgaris*
C. fragifera	*Nitella sp.*
C. intermedia	*Schoenoplectus lacustris*
C. hispida	*Hippuris vulgaris*
	Potamogeton filiformis
	Utricularia vulgaris
	Utricularia australis

Favourable Condition Table (Generic Attributes) 6
Interest feature type(s): Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation

Includes Annex I type: H3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation.
Equivalent Phase 1 category: G1.1 Standing water: eutrophic (part)
Equivalent British Lakes classification (Duigan *et al.* in press) types D (part), E (part), G and I (part)

Broad reporting category: Standing open water and canals

Attributes	Target	Method of assessment	Comment
Extent	No loss of extent of standing water	Assessment against baseline map. Aerial photographs may be useful.	This attribute is to assess changes caused by active management, such as infilling or channel diversion. Changes due to drying out or successional change are covered under other attributes.
Vegetation composition: macrophyte community composition	i) Presence of at least 6 of the characteristic species listed in Box 4 and one broadleaf Potamogeton species (except where valid reasons (see comments) suggest otherwise. At least two species should be from the appropriate water type (i.e. mesotrophic or eutrophic). ii) No loss of characteristic species recorded from the site (see Box 4) iii) 6 out of 10 sample spots (boat or wader survey) should include at least one characteristic species from Box 4.	Fixed point sector/transect sampling (boat or shore-based methods)	It is likely that natural eutrophic lakes are now uncommon in the EU owing to pollution, but the exact status of the habitat type is unknown. In the UK, lakes of this type are comparatively rare, although they have a wide and scattered distribution. These water bodies have nutrient levels that are higher than those of oligotrophic, dystrophic or mesotrophic lakes, resulting in higher natural productivity, and are typically species-rich. *Magnopotamion* vegetation are pondweed-dominated formations of submerged rooted perrennials with species such as *Potamogeton perfoliatus, P. lucens, P. praelongus, P. coloratus* and various submerged associates such as *Myriophyllum spicatum* and *Ceratophyllum demersum. Magnopotamion* vegetation is generally quite sensitive to adverse impacts such as eutrophication or fish disturbance. *Hydrocharition*-type vegetation are largely free-floating surface communities with species such as *Lemna* spp., *Hydrocharis morsus-ranae* and *Stratiodes aloides*. *Hydrocharition*-type vegetation in the UK is rare in lakes and seems to be confined to Northern Ireland. In the rest of the UK the most complete expression of this community type is found in the ditch systems of the Norfolk Broads. *Hydrocharition* vegetation is sensitive to wave action. **There may be valid reasons why a characteristic species is not present at a site (such as biogeographic range or isolation from source populations) which need to be considered when applying targets to an individual site.** Except in the most northerly areas, *Scirpo-Phragmitetum* associations fringe many eutrophic lakes. More northern shorelines may have *Phalaris-Littorella-Eleocharis* associations. Most eutrophic lakes are formed on soft rocks but wave-washed rocky shores can form an important part of the habitat on larger lakes.

Attributes	Target	Method of assessment	Comment
Vegetation composition: negative indicator species	Non-native species should be absent or present at low frequency Non-*Chara* algal dominance: cover of benthic and epiphytic filamentous algae less than 10%		The UK selection of sites was based largely on the presence of remnants of the *Hydrocharition* (mainly duckweed *Lemna* spp.) and a good representation of the *Magnopotamion*. Check for increased frequency of occurrence of pollution tolerant species, such as *Potamogeton pectinatus*, *Zannichellia palustris* and/or *Ceratophyllum demersum*. Dominance of these species may indicate a site is in unfavourable condition. Introduced species should be identified. A number of non-natives have such invasive potential that they should be assessed separately. Species of particular concern are: *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum* and *Azolla filiculoides*. If any of these species are present, a water body should be considered as being in unfavourable condition. **This list is not exhaustive and should be updated as new threats become apparent.** Colonisation since the previous field visit by *Elodea nuttallii* or *Elodea canadensis* at >5% frequency is indicative of unfavourable condition, as is dominance of naturalised non-native species, such as *E. canadensis*. Occurrence of such species at >50% frequency in productive waters, is indicative of unfavourable condition. Presence of extensive cover of filamentous algae and especially *Cladophora glomerata* is indicative of a site moving out of favourable condition. There should be no persistent blanket growth of filamentous algae on macrophytes or substrate
Macrophyte community structure	Characteristic zones of vegetation should be present Maximum depth distribution should be maintained Maintain at least the present structure	Fixed point sector/transect sampling (boat or shore-based methods)	Extensive beds of submerged macrophytes should be present. Emergent vegetation may include beds of *Phragmites australis*, *Schoenoplectus lacustris* and *S. tabernaemontani* or *Typha latifolia* and *T. angustifolia* and, in the north and west of the UK, lawns of *Littorella uniflora*. Depth penetration of *Potamogeton* spp. should not be compromised by changes in water quality Where present, well defined hydroseres should be maintained.
Water quality	Stable nutrient levels appropriate for the lake type	Existing data or develop a water-sampling regime. This should be carried out quarterly, ideally monthly. As a minimum, samples should be taken in early spring. Water transparency measurements should also be taken. ***See Appendix 2 and main text***	These are oxygen- and nutrient-rich waters, clear except for periods of increased algal biomass in seasonal succession of algal blooms. As there is a wide clinal range of community types embraced by this feature, the acceptable range of chemical conditions (especially total P, other elements of phosphorus, pH/ANC, and where appropriate NO_3-N,) should be set for individual SAC lakes from recent or historical water chemistry data. Acceptable ranges of values for each variable

Attributes	Target	Method of assessment	Comment
			should be established. Mean annual TP concentrations (based on at least quarterly measurements), or spring TP levels, should meet the targets appropriate for the lake type documented in the guidance, unless site-specific targets are available. If palaeolimnological techniques or hindcast modelling have been employed to reconstruct natural background TP concentrations for a particular lake these can be used to set targets, although it may be necessary to accept a small deviation from these background conditions. Alternatively, historical water chemistry data may exist for individual lakes. Where existing, site-specific TP concentrations are consistently lower than the standard appropriate for the habitat type, a lower target should be applied to prevent deterioration from current status. As a guide, generally pH > 7.00 and < 9.00
	Stable pH/ANC values appropriate for the lake type.		The acceptable range of chemical conditions (especially total P, other P fractions, pH/ANC, and where appropriate NO_3-N) should be set for individual SAC lakes from recent or historical water chemistry data. From a management perspective it would be useful to establish whether the individual systems are N or P limited. Check for changes in land-use in the catchment causing diffuse pollution and/or siltation and check point sources of pollution. Aerially applied agro-chemicals have a high potential to change plant communities, and move them out of favourable condition. Other methodologies involving trophic scoring can contribute to the assessment of favourable condition.
	Adequate dissolved oxygen levels for health of characteristic fauna	Existing data, or dissolved oxygen/temperature profile	Levels of dissolved oxygen should support the invertebrate and vertebrate taxa associated with this lake type.
	No excessive growth of cyanobacteria or green algae.	Existing data, shoreline walk, sampling of bloom	There should be no evidence that algal blooms are excessive and/or persistent.
Hydrology	There should be a natural hydrological regime	Shoreline walk. Where necessary, develop a hydrological model and sampling regime. This should initially be carried out quarterly as a minimum, ideally monthly. ***See Appendix 2 and main text***	Natural flushing rate and seasonal pattern of fluctuation need to be considered. Maintain flushing rate of system. Modifications of inflows and outlets or changes in hydrology (e.g. from flood control regimes and abstraction) can lead to unnatural changes in lake levels.

Attributes	Target	Method of assessment	Comment
Lake substrate character	Maintain the natural shoreline of the lake. Maintain natural and characteristic substrate for lake type.	Shoreline walk. ***See Appendix 2 and main text.*** Need to consider the development of a modified freeze coring technique as developed for collecting sediments in rivers.	Sediment quality and quantity when enriched can cause excessive growths of *Juncus bulbosus* var. *fluitans* or growths of algae.
Sediment load	Maintain natural sediment load.	Direct observation and /or establish sedimentation rate from sediment cores or sediment traps. ***See Appendix 2 and main text.***	Increases in siltation could result from e.g. increased lake productivity, changes in catchment land-use (particularly over-grazing), lake level fluctuations, climatic fluctuations or changes in sewage treatment. If broad-leaved *Potamogeton* species decline and the fine-leaved *Potamogeton pectinatus* increases above 40% level or *Myriophyllum spicatum*/*Ceratophyllum demersum/Zannichellia palustris* become dominant, yet water quality is at target levels, then enrichment of sediments may be an issue.
Indicators of local distinctiveness	Maintain distinctive elements (e.g. rare plant or invertebrate species, habitat features) at current extent/levels and/or in current locations.	As appropriate	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not covered adequately by the previous attributes, or by separate guidance (e.g. for notified species features). For species of local distinctiveness, which are documented on citations, or for which records are held for individual lakes, references such as LACON (Palmer, in prep.) should be consulted for current lists of species rare in the constituent countries of GB and in EA and SEPA areas. For "notable" species (e.g. nationally scarce plants), it is not intended that a target is set for detailed species monitoring. It is intended that a rapid indication of presence/absence and /or approximate extent should be provided. Allowing for natural fluctuations in population size. The same approach applies to "notable" habitats.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Natural eutrophic lake

Objective	Specified assessment method (if appropriate)	Comment
Impact of factors that can act as "forward switches" to phytoplankton-dominant turbid- water conditions should be minimised.		Forward switches include nutrient addition, mechanical or boat damage to plants, herbicides, exotic vertebrate grazers (e.g. grass carp), pesticides, increased salinity and differential kills of piscivores.
Minimal negative impact from artificial structures		Artificial structures could include boat-mooring facilities, dams, fish reefs, fishing platforms.
Minimal negative impact from recreation or navigation		Negative impacts from recreational activities can include enrichment caused by ground baiting, introduction of herbivorous, planktivorous or bottom feeding fish and other organisms not characteristic of the habitat, increased disturbance to SACs from water-sports. Negative impacts from navigation can include sediment disturbance and physical destruction of plant communities.
No introduction, or stocking, of fish or other organisms not indigenous to the water body.		
No fish farming, excessive stocking or selective removal of piscivores.		Zebra mussels have the potential to change the fundamental character of the ecosystem.
No herbicide or pesticide use in water or catchment areas vulnerable to runoff.		Catchment area changes affecting the lake, such as flood defences and infrastructure schemes should be considered.

Box 4. Characteristic species of natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation

Characteristic species	Associates
Magnopotamion species:	Various submerged species including:
Potamogeton spp:	*Ceratophyllum demersum*
Potamogeton.lucens	
Potamogeton perfoliatus	*Potamogeton pectinatus*
Potamogeton coloratus	*Myriophyllum spicatum*
Potamogeton praelongus	*Zannichellia palustris*
P. x zizii (or any other hybrid with one of the above three species as a parent)	
Potamogeton pusillus	
Potamogeton friesii	
Potamogeton obtusifolius	
Potamogeton berchtoldii	
Potamogeton trichoides	
Potamogeton filiformis	
Potamogeton crispus	
Ranunculus circinatus	
Chara spp.	
Callitriche spp.	

***Hydrocharition* species:**	**Associates**
Stratiotes aloides	*Nuphar lutea*
Lemna sp.	*Nymphaea alba*
Hydrocharis morsus-ranae	*Potamogeton natans*
Riccia fluitans	*Butomus umbellatus*
Utricularia australis/vulgaris	*Callitriche* spp.
Spirodela polyrhiza	

Associated marginal *Scirpo-Phragmitetum* species include: *Phragmites australis*, *Schoenoplectus lacustris*, *Sparganium erectum*, *Typha* spp., *Alisma plantago-aquatica*.

Favourable Condition Table (Generic Attributes) 7
Interest feature type(s): Natural dystrophic lakes and ponds

Includes Annex I type: H3160 Natural dystrophic lakes and ponds
Equivalent Phase 1 category: G1.4 Standing water: dystrophic

Broad reporting category: Standing open water and canals

Attributes	Target	Method of assessment	Comment
Extent	No loss of extent of standing water	Assessment against baseline map. Aerial photographs may be useful.	This attribute is to assess changes caused by active management, such as infilling or channel diversion. Changes due to drying out or successional change are covered under other attributes.
Vegetation composition: species composition	i). No loss of characteristic species present at the site (see Box 5)	Fixed point sector/transect sampling (boat or shore-based methods)	In the UK dystrophic lakes are widespread in the north west and scarce in the south. These systems most often occur on blanket bog and may include isolated seasonal pools, random collections of irregularly shaped waters and ordered linear or concentric arrays of pools and small lochs. Dystrophic pools may also be found on raised bogs situated mainly on plains and valley bottoms. The water usually has a high humic acid content and is usually stained brown through exposure to peat. Some dystrophic lakes are completely devoid of all macrophytes, while others may be completely dominated by bryophytes. This does not necessarily indicate unfavourable condition. With increasing diversity the characteristic species are usually *Drepanocladus fluitans* and/or *Juncus bulbosus* as submerged macrophytes, with *Sphagnum* communities present around the edge or in the littoral zone. *Menyanthes trifoliata*, *Potamogeton polygonifolius* and *Nymphaea alba* may also be present and at richer sites, *Utricularia minor* and *Nuphar lutea.* **There may be valid reasons why a characteristic species is not present at a site (such as biogeographic range or isolation from source populations) which need to be considered when applying targets to an individual site.** As this interest feature covers a floristic range it is essential to establish which community type represents the feature for the site in question. If algal growth is excessive, check for inputs of point or diffuse sources of pollution. If mire communities surround the site, the mire vegetation will turn green in the presence of fertilisers.

Attributes	Target	Method of assessment	Comment
			Increased growth of *Sphagnum* may indicate the occurrence of artificial acidification. Turbid water conditions can also give blue-green algae a competitive advantage in the phytoplankton, where artificial nutrient enrichment is taking place. *Juncus bulbosus* var. *fluitans* can naturally grow as the dominant plant i.e. > 40% cover in depths up to 1.75 m, and is not necessarily an indicator of a site in unfavourable condition.
Vegetation composition: negative indicator species	Non-native species should be absent or present at low frequency		Introduced species should be identified. A number of non-natives have such invasive potential that they should be assessed separately. Species of particular concern are: *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum* and *Azolla filiculoides*. If any of these species are present, a water body should be considered as being in unfavourable condition. **This list is not exhaustive and should be updated as new threats become apparent.** Colonisation since the previous field visit by *Elodea nuttallii* or *Elodea canadensis* at >5% frequency is indicative of unfavourable condition, as is dominance of naturalised non-native species, such as *E. canadensis*. Occurrence of such species, at >40% frequency in unproductive waters, is indicative of unfavourable condition. Excessive growths of filamentous algae on lake substrate or macrophytes are indicative of nutrient enrichment. Increased filamentous green algae may also indicate the occurrence of artificial acidification.
Macrophyte community structure	Characteristic zones of vegetation should be present. Maximum depth distribution should be maintained. Maintain at least the present structure.	Fixed point sector/transect sampling (boat or shore-based methods)	Zonation , depth distribution and structure will be site specific. Colonisation at depth may be limited by poor light penetration or unsuitable sediment type. Where present, well defined hydroseres should be maintained.
Water quality	Stable nutrient levels appropriate to the lake type	Existing data or develop a water-sampling regime. This should be carried out quarterly, ideally monthly. As a minimum, samples should be taken in early spring. Water transparency measurements should also be taken. ***See Appendix 2 and main text.***	Water should be acid and poor in available nutrients. It should be stained by dissolved humic material, and will usually be visibly brown. As there is a wide clinal range of community types embraced by this feature, the acceptable range of chemical conditions (especially total P, other P fractions, pH/ANC, and where appropriate NO_3-N,) should be set for individual SAC lakes, from recent or historical water chemistry data. Acceptable ranges of values for each variable should be established. See main text. Mean annual TP concentrations (based on at least quarterly measurements), or spring TP levels, should meet the targets appropriate for the lake type documented in the guidance,

Attributes	Target	Method of assessment	Comment
			unless site-specific targets are available. If palaeolimnological techniques or hindcast modelling have been employed to reconstruct natural background TP concentrations for a particular lake these can be used to set targets, although it may be necessary to accept a small deviation from these background conditions. Alternatively, historical water chemistry data may exist for individual lakes. Where existing, site-specific TP concentrations are consistently lower than the standard appropriate for the habitat type, a lower target should be applied to prevent deterioration from current status. Phosphorus and nitrogen values can be very variable, P is often in excess and plant development is limited by unavailability of N in the peat. Check for changes in catchment land-use in catchment causing diffuse pollution and/or siltation and check point sources of pollution. Aerially applied agro-chemicals have a high potential to change plant communities, and move them out of favourable condition. Other methodologies involving trophic scoring can contribute to the assessment of favourable condition.
	Stable pH/ANC values appropriate for the lake type		As a guide, pH < 5.00. Note that where water column pH is 4.5 or less, alkalinity will be 0.
	Adequate dissolved oxygen levels for health of characteristic fauna.	Existing data, or dissolved oxygen/temperature profile.	Levels of dissolved oxygen should support the invertebrate and vertebrate taxa associated with this lake type.
	No excessive growth of cyanobacteria or green algae.	Existing data, shoreline walk, sample bloom.	There should be no evidence of excessive blue-green or green algal blooms.
Hydrology	There should be a natural hydrological regime	Shoreline walk. Where necessary, develop a hydrological model and sampling regime. This should initially be carried out quarterly as a minimum, ideally monthly. ***See Appendix 2 and main text.***	Natural flushing rate and seasonal pattern of fluctuation need to be considered. Maintain flushing rate of system. Modifications of inflows and outlets (where present), the creation of outlets, or changes in hydrology from flood control regimes, abstraction, peat harvesting and gravel removal, can lead to unnatural changes in lake levels.
Lake substrate character	Maintain the natural shoreline of the lake. Maintain natural and characteristic substrate for lake	Shoreline walk. ***See Appendix 2 and main text.*** Need to consider the development of a modified freeze coring technique as developed for collecting sediments in rivers.	Sediment quality and quantity when enriched can cause excessive growths of *Juncus bulbosus* var. *fluitans* or growths of algae.

Attributes	Target	Method of assessment	Comment
	type.		
Sediment Load	Maintain natural sediment load.	Direct observation and /or establish sedimentation rate from sediment cores or sediment traps. ***See Appendix 2 and main text.***	Increases in siltation could result from increased lake productivity, changes in catchment land-use (particularly over-grazing, peat harvesting), lake level fluctuations, climatic fluctuations or changes in sewage treatment.
Indicators of local distinctiveness	Maintain distinctive elements (e.g. rare plant or invertebrate species, habitat features) at current extent/levels and/or in current locations.	As appropriate	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not covered adequately by the previous attributes, or by separate guidance (e.g. for notified species features). For species of local distinctiveness, which are documented on citations, or for which records are held for individual lakes, references such as LACON (Palmer, in prep.) should be consulted for current lists of species rare in the constituent countries of GB, and in EA and SEPA areas. For "notable" species (e.g. nationally scarce plants), it is not intended that a target is set for detailed species monitoring. It is intended that a rapid indication of presence/absence and /or approximate extent should be provided. Allowing for natural fluctuations in population size. The same approach applies to "notable" habitats.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Natural dystrophic lakes and ponds

Objective	Specified assessment method (if appropriate)	Comment
No introduction of non-native plants		
Minimal negative impact from artificial structures		Artificial structures could include dams. Catchment area changes affecting the lake, such as land drainage and infrastructure schemes, should be considered.
No peat cutting within the vicinity of the water body		
Direct application of lime to the water column as an acidification amelioration strategy should not be carried out		Efforts should be directed towards reducing atmospheric emissions and implementing catchment management strategies, especially in relation to coniferous forestry

Box 5. Characteristic species of natural dystrophic lakes and ponds

Characteristic species	Associates
Utricularia spp.	*Sparganium angustifolium*
Sphagnum spp.	*Eleogiton fluitans*
Juncus bulbosus	*Drepanocladus spp.*
Nymphaea alba	
Menyanthes trifoliata	
Potamogeton polygonifolius	

Favourable Condition Table (Generic Attributes) 8
Interest feature type(s): Turloughs and Breckland Meres

Includes Annex I type: H3160 Turloughs
Equivalent Phase 1 categories: G1 Standing water (part), B5 Marshy grassland (part), F2.2 Inundation (part) and others

Broad reporting category: Standing open water and canals

Attributes	Target	Method of assessment	Comments
Extent	No loss of extent of standing water	Assessment against baseline map. Aerial photographs may be useful.	This attribute is to assess changes caused by active management, such as infilling or channel diversion. Changes due to drying out or successional change are covered under other attributes.
Vegetation composition: macrophyte community composition	There should be no loss of characteristic species at the site (see comments).	Fixed point sector/transect sampling (boat or shore-based methods)	Turloughs are temporary lakes principally filled by subterranean waters and considered particular to karstic limestone areas in Ireland. Most flood in autumn and then dry up between April and July. However, some may flood at any time of the year after heavy rainfall and dry out again in a few days. These lakes fill and empty at particular places ("swallow holes"). The soils are quite variable, including limestone bedrock, marls, peat, clay and humus, while aquatic conditions range from ultra-oligotrophic to eutrophic. The aquatic vegetation can be diverse, including several species of *Potamogeton* and the bryophytes *Cinclidotus fontinaloides* and *Fontinalis antipyretica*. The terrestrial vegetation associated with the dry phase belongs mainly to the alliance *Lolio-Potentillion anserinae*, but also *Caricion davallianae*. In the UK, this habitat is represented by turloughs in Northern Ireland, Pant-y-llyn (the seasonal water body partly on limestone in south Wales) and the Breckland Meres on chalk in eastern England. Together these sites exhibit a diversity of plant communities in the wet and dry phases, so it is necessary to define the plant community composition at a site-specific level.
	Non-native species should be absent or present at low frequency. This needs to be defined on a site-specific basis.		Introduced species should be identified. A number of non-natives have such invasive potential that they should be assessed separately. Species of particular concern are: *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Myriophyllum aquaticum* and *Azolla filiculoides*. If any of these species are present, a water body should be considered as being in unfavourable condition. Colonisation since the previous field visit by *Elodea nuttallii* or *Elodea canadensis* at >5% frequency is indicative of unfavourable condition, as is dominance of naturalised non-native species, such as *E. canadensis*. Occurrence of such species, at >40% frequency in unproductive waters, or 50% frequency in productive waters is indicative of unfavourable condition.

Attributes	Target	Method of assessment	Comments
			Blanketing growths of filamentous algae can be considered characteristic of this habitat type and should not be considered a symptom of unfavourable condition.
Macrophyte community structure	Characteristic zones of vegetation should be present. Maximum depth distribution should be maintained. Maintain at least the present structure.	Fixed point sector/transect sampling (boat or shore-based methods)	Characteristic zones of vegetation should be present in both the wet and the dry phases. The classic plant zonation of Irish turloughs has been described in the scientific literature but it is variable between sites depending on physical factors such as basin hydrology and morphometry, and degree of inundation. A similar series of distinct vegetation zones can be recognised in the Breckland Meres. Pant-y-llyn displays a sequence of bryophyte, herbaceous swamp and woody plant communities, which occupy different depth zones in the basin.
Water quality	Stable nutrient levels appropriate to the lake type Stable pH/ANC values appropriate for the lake type Adequate dissolved oxygen levels for health of characteristic fauna. No excessive growth of cyanobacteria or green algae.	Existing data or develop a water-sampling regime suitable for the different hydrological cycles exhibited by these systems and their supporting aquifer. ***See Appendix 2 and main text.***	Water should be clear and base-rich. Nutrient levels may extend throughout oligotrophic, mesotrophic and eutrophic conditions. Water quality targets for phosphorus and nitrogen need to be defined on a site-by-site basis. As sites are aquifer-fed any pollution will be difficult to address. Check obvious source of potential pollution from land use to sewage sources. As a guide, pH >6.
Hydrology	There should be a natural hydrological regime.	Shoreline walk. Where necessary, develop a hydrological model and sampling regime. ***See Appendix 2 and main text.***	Links with aquifers should be maintained. Natural fluctuating water pattern needs to be considered. Turloughs have an annual refill cycle linked with the water table and rainfall levels. The response of the Breckland Meres to water table changes is highly lagged and they do not flood and drain in a regular seasonal cycle. Modification of inflows and outlets, groundwater abstraction, drainage schemes and quarrying can lead to unnatural changes in water level.
Indicators of local distinctiveness	Maintain distinctive elements (e.g. rare plant or invertebrate species, habitat features) at current extent/levels and/or in current locations.	As appropriate	This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) which are not covered adequately by the previous attributes, or by separate guidance (e.g. for notified species features). For species of local distinctiveness, which are documented on citations, or for

Attributes	Target	Method of assessment	Comments
			which records are held for individual lakes, references such as LACON (Palmer, in prep.) should be consulted for current lists of species rare in the constituent countries of GB and in EA and SEPA areas. For "notable" species (e.g. nationally scarce plants), it is not intended that a target is set for detailed species monitoring. It is intended that a rapid indication of presence/absence and /or approximate extent should be provided. Allowing for natural fluctuations in population size. The same approach applies to "notable" habitats.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Turloughs and Breckland Meres

Objective	Specified assessment method (if appropriate)	Comment
No introduction of non-native species.		Other sources of possible disturbance include: inappropriate grazing regimes (impact on vegetation, enrichment, sediment disturbance and erosion), quarrying, drainage, vehicles on Breckland Meres, abstraction from aquifers, enrichment of water column by wildfowl and climate change are all possible sources of concern. Check habitat action plan.

Appendix 1. Broad correspondence between UK standing water classifications

This includes associated NVC communities, Habitats Directive Annex I types and BAP Priority habitats. NB In most cases there are no exact equivalents under each heading for the standing water categories. The NVC types are indicative only, with much overlap. Standing waters include both natural and artificial water bodies (e.g. lakes, meres, pools, ponds, gravel pits).
You may refer to the Favourable Condition tables for correspondence between Annex I and other classification types.

WATER CATEGORY	PHASE 1	JNCC TYPES (1989)[1]	NI LOUGH GROUPS[2]	2005 JNCC TYPES[3]	NVC COMMUNITIES (Aquatic, Swamp, Mire)	HABITATS DIRECTIVE ANNEX I TYPE	BAP PRIORITY HABITAT AND/OR FEATURE TYPE*
High alkalinity	Standing water: eutrophic G1.1	7, 8, 9, 10a, 10b	V, VI, VII, X, XI, XII, XIII, (XVI)	F, G, H, I	**A** 1, 2, 3, 5, 6, 8, 9a & b, 10, 11, 12, 15, 16, 19, 20 **S** 1-8, 10, 12-19, 22-24	Natural eutrophic lakes H3150	Eutrophic standing waters, Machair (part) Base-rich lake*
Moderate alkalinity	Standing water: mesotrophic G1.2	4, 5	(V), (VII), VIII, IX, XIV, XVI	D, E	**A** 2, 3, 4, 7, 8, 9a, 9c, 10, 13, 15, 16, 19, 20 **S** 1-4, 6-12, 14, 17, 19, 22, 23	Oligotrophic to mesotrophic standing waters H3130 (part)	Mesotrophic lakes, Machair (part)
Low alkalinity	Standing water: oligotrophic G1.3	2, 3	II, III, IV, VIII, IX	B, C1, C2, D, E	**A** 7, 9c, 14, 22, 23, 24 **S** 4, 9, 10, 19	Oligotrophic to mesotrophic standing waters H3130 (part); Oligotrophic waters of sandy plains H3110	Oligotrophic lakes*
Highly acidic (peat)	Standing water: dystrophic G1.4	1	I, (IX)	A	**A** 24 **M** 1-3	Natural dystrophic lakes and ponds H3160	Blanket bog Dystrophic lakes*
Very high alkalinity (marl)	Standing water: marl G1.5	4, 5, 7, 10b	(VI), VIII, (XII), XV, XVI	I	Various, but especially **A** 8, 11 **S** 2, 3, 4	Hard oligo-mesotrophic with *Chara* spp. H3140	Machair (part) Base-rich lake* Mesotrophic lake
Brackish (oligohaline)	Standing water: brackish G1.6	6	V	J	Various, but especially **A** 6, 12, 21 **S** 4, 13, 20, 21	Coastal lagoons H1150 (part)	Saline lagoons (part) Brackish lake*
Naturally fluctuating (turloughs, Breckland Meres, Lizard & New Forest pools)	Standing water G1, Marshy grassland B5, Inundation F2.2	2, 7, 10	Turloughs	B, I	Various, but especially **A** 10, 16	Turloughs H3180; Mediterranean temporary pools H3170	Aquifer-fed naturally fluctuating water bodies

* Non-BAP feature type
[1]Palmer M. (1989).
[2]Wolfe-Murphy et al. (1992).
[3]Duigan *et al*. (in prep).

Table 2. Growth Forms of commoner aquatic plant species in Britain and Ireland, for use when assessing structural targets. Only those species likely to form significant stands / beds are listed. Non-native species are excluded.

Growth Form	Species
Isoetids	*Isoetes echinospora* *Isoetes lacustris* *Littorella uniflora* *Lobelia dortmanna*
Charophytes and Mosses	*Chara* spp. *Nitella* spp. *Sphagnum* spp. *Fontinalis antipyretica*
Submerged Fine / Strap-leaved	*Apium inundatum* *Groenlandia densa* *Juncus bulbosus var. fluitans* *Myriophyllum alterniflorum* *Myriophyllum spicatum* *Potamogeton berchtoldii* *Potamogeton filiformis* *Potamogeton friesii* *Potamogeton gramineus* *Potamogeton obtusifolius* *Potamogeton pectinatus* *Potamogeton pusillus* *Ranunculus aquatilis* *Ranunculus baudotii* *Ranunculus circinatus* *Ranunculus peltatus* *Ranunculus trichophyllus* *Zannichellia palustris*
Submerged Broad-leaved	*Potamogeton alpinus* *Potamogeton coloratus* *Potamogeton crispus* *Potamogeton lucens* *Potamogeton perfoliatus* *Potamogeton praelongus*
Free-floating	*Hydrocharis morsus-ranae* *Lemna* spp. *Riccia fluitans* *Spirodela polyrhiza* *Stratiotes aloides*
Floating-leaved	*Nuphar lutea* *Nymphaea alba* *Nymphoides peltata* *Potamogeton natans* *Potamogeton polygonifolius* *Sparganium angustifolium* *Sparganium natans*
Emergent	*Carex* spp. (any larger Carex in shallow water, most often *Carex rostrata)* *Cladium mariscus* *Equisetum fluviatile* *Menyanthes trifoliata* *Phalaris arundinacea* *Phragmites australis* *Schoenoplectus* spp. *Typha* spp.

Appendix 2. Methodology for assessing standing water habitat features and vascular plant species features of interest.

1. Biological monitoring of standing water habitats

The following standardised approach to biological monitoring of standing water habitats is recommended, based on literature review and the results of field trials in 2003/04(Gunn *et al*., 2004).

2. Sampling strategy

2.1. Sampling sectors

Each sampling sector is 100m. At small, simple lakes, supporting relatively few macrophyte species, a minimum of four 100m sectors should be examined. At large, complex water bodies, where many aquatic plant species are present, consideration should be given to increasing the number of sectors to e.g. six or eight, whereas at extremely small water body, e.g. peatland pools, two sectors may be sufficient to monitor the macrophytes in the water body.

2.2. Location of the Sampling Survey sectors

i. To locate the survey sectors (target four 100m sectors) it is useful to focus on areas where characteristic macrophyte communities or species feature are likely to occur (i.e. not random).

ii. Where possible, the selection should be based on previous surveys. If macrophyte data are not available locations should be chosen to represent the potential range of habitats or species at site.

iii. One habitat sector should normally be in the sheltered part of the shore, where plant fragments are likely to accumulate

iv. However, where there is no previous information, easy access may be a deciding factor. And for sampling efficiency, the habitat sector is often located where you would be likely to find shallow species.

3. Survey method

A **strandline survey** and a **wader or boat survey** should be carried out in each water body to be examined. Work should be undertaken in deeper water if use of a boat is possible.

3.1. Strandline (perimeter) survey

Along each 100m sector plants are recorded as “S” if washed up and “G” if growing at the water’s edge. Plants present in both categories should be labelled “SG”. At 10 points in each 100m species presence is noted and frequencies calculated over all the 100m sectors surveyed.

3.2. In-water surveys

3.2.1. Choice of in-water habitat survey

The habitat survey method chosen will be influenced by:

i. the type of feature being assessed; i.e. the habitat type and whether species are found typically in shallow or deep water (see later).

ii. accessibility to the site, i.e. is there safe access and could a boat be used.

iii. weather conditions. Bad weather may prevent the use of a boat.

iv. findings from initial sectors will guide the choice of survey method used at later sectors

v. it may be necessary to use a boat where there are access difficulties or where the substrate is unsuitable for wading

vi. Boats are useful for the survey of certain habitat features (e.g. hard oligo-mesotrophic) & for assessing macrophyte structure (e.g. drawdown impacts). Boat transects are, however, less practical and not as repeatable as shore-based (wader) methods (it is practically more difficult to get accurate GPS locations) so caution is urged in using them as a baseline for future monitoring.

The survey method will vary from lake to lake. It is very important that the chosen method is recorded so future surveys are repeatable.

3.2.2. Wader survey

The wader survey ***for each 100m sector*** should include 20 sampling points. Five transects from the shore to deeper water should be spaced at 20m intervals along the 100m sector. On each transect, a $1m^2$ sampling point should be surveyd at 0.25m, 0.5m, 0.75m and >0.75m depth, using a bathyscope and a grapnel, if necessary. In addition, a grapnel haul of 4m length should be undertaken parallel to the shore, at 0.25m, 0.5m and 0.75 m depth. At >0.75m depth, a 4m grapnel haul should be taken at a direction perpendicular to the sector. The positions of sampling points for each 100m sector are illustrated in Figure 1.

The following data should be recorded from the $1m^2$ sampling point and from the grapnel:

(a) all species present
(b) an estimate of total vegetation biomass (scoring 0 - 3)

The scoring for vegetation biomass should be assigned as follows:

0 absent (bare substrate)
1 <25% cover
2 25 – 75% cover
3 >75% cover

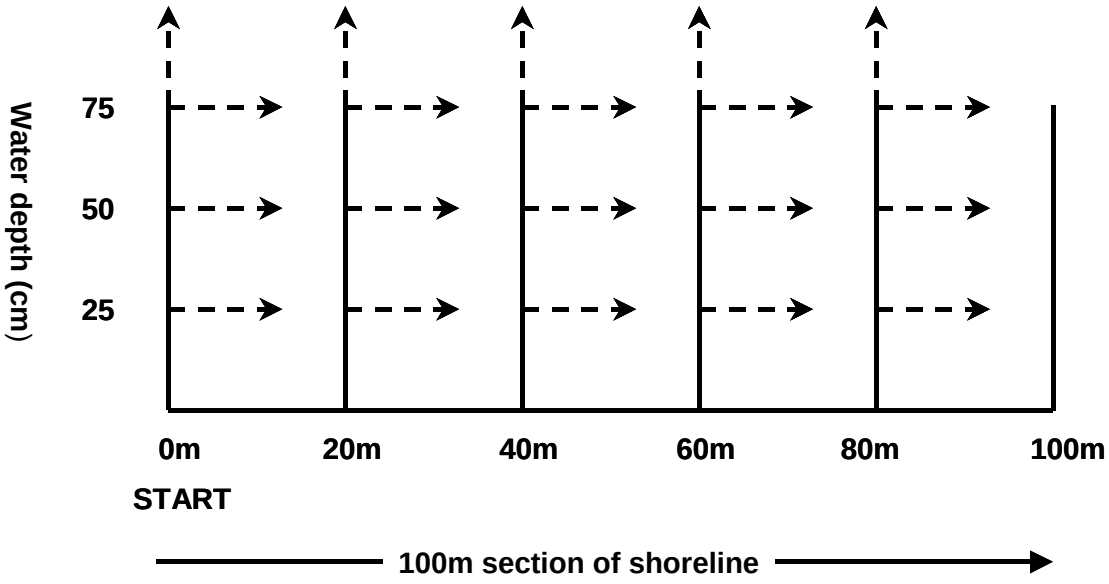


Figure 1 The location of sampling points on each 100m sector (Gunn et al., 2004)

3.2.3. Boat Survey

Where lakes macrophyte communities have a significant deep water element comprising *e.g. Potamogeton* species, or a characteristic macrophyte zonation, or where access to shallow water is difficult, a boat survey can be considered. In such cases, when available, a boat may be used to undertake 100m transects, from deep water to shallow water. Each 100m transect should be located at the 50m point on the 100m sector. The transect should begin at the maximum depth of macrophyte colonisation. At each of 20 regularly spaced sampling points, an area of water body bed of $1m^2$ should be examined, or if visibility is poor, a 4m grapnel haul should be carried out. At each sampling point, records should be made of the following:

(a) water depth
(b) all species present
(c) an estimate of total vegetation biomass (scoring 0 - 3).

The maximum depth of macrophyte colonisation should also be noted.

But note: boat transect methods will have to be adapted to suit the characteristics of each water body. The chosen method should be recorded so future surveys are repeatable.

4. General points

The combination of 100m shore sectors with short transects, and 100m boat transects, should not total less than four, unless the water body is small and species-poor. Where necessary (*e.g.* large, rich sites), the number of transects per shore sector may be reduced in order to increase the number of sectors examined. However, there should not be less than three transects per sector.

Where a transition from freshwater to wetland interests has been documented on the citation, this should be checked as being present at the time of survey.

5. Example of field application

The methodology developed above needs to be cost effective, practical and flexible in response to different macrophyte communities, substrate types and accessibility. For example, a field survey of Scottish standing waters (Gunn *et al*., 2004) reported the following to be the most practical strategy for producing reliable information:

- 3 habitat survey methods were used, i.e. perimeter, boat transect and wader to assess macrophyte attributes
- Non-biological attributes were also assessed. e.g. LHS, TP levels
- A combination of 2-3 perimeter and wader surveys commonly carried out
- Dystrophic waters were usually limited to 1 or 2 perimeter surveys

In practice each site took an average of 2.5 days (surveying 3 sectors -1 day; data entry and sample sorting - 0.5 days; reporting 1 day).

6. Vascular plant features and rare species as part of the standing water interest

The following standardised approach to monitoring of rare aquatic plants is recommended, based on literature review and results from field trials (Gunn *et al*., 2004).

Areas of lake bed, which have been colonised by the species of interest, should be located from earlier records, knowledge of each species' habitat requirements and use of appropriate viewing techniques, *i.e.* by wading, using a boat and bathyscope, snorkelling or SCUBA techniques. Depending on the size of the water body and the distances between areas of plant colonisation, clusters of plants may be regarded either as discrete populations, or as metapopulations of the complete population. In large sites, discrete populations may be defined as areas of plant colonisation which are at least 50m apart. In lakes supporting more than one population of the species of interest, at least two populations should be examined.

Minimum and maximum depth of each population should be recorded. If a population extends to water deeper than the depth which can be sampled when using the wader method, this should be noted and, if possible, a boat should be used to cover the remainder of the population. Where a population extends beyond 100m in any direction, this should be recorded. In small water bodies, where there may be one large population, adjacent water bodies should be investigated for the presence of the species.

6.1. Survey method

6.1.1. Choice of survey method

The choice of survey method will depend on factors discussed already above for habitat but also on the rare species to be monitored. Species such as *Limosella aquatica*, *Pilularia globulifera*, *Potamogeton coloratus, Potamogeton filiformis*, *Elatine hydropiper* can typically be surveyed using the wader method. Examples of species usually growing in deeper waters and typically requiring a boat/snorkelling survey are: *Nuphar pumila, Potamogeton rutilus, Najas flexilis, Isoetes echinospora, Elatine hexandra*. This list is a guide only as some species, e.g. *Elatine hexandra* have been found in deep or shallow water.

6.1.2.Wader survey

For shallow water species, surveys can be undertaken using waders and bathyscopes.

6.1.3. Boat/snorkelling survey

Where species distribution is too deep for wader survey, the minimum requirement should be that macrophytes are examined using a boat and bathyscope. Where resources allow, snorkelling should

be considered as the favoured method of viewing submerged plants. In particular, snorkelling should be considered for SAC sites, at which slender naiad (*Najas flexilis*) is the feature. In highly turbid waters or sites where the plant of interest is in deeper water than can be adequately surveyed by snorkelling, SCUBA techniques should be considered.

Within each population, 20 x 1m^2 quadrats should be placed at random. Within each quadrat, the following should be recorded:

all species present
abundance of each species recorded (scoring 1 - 3)
proportion of quadrat with bare substrate (scoring 1 - 3)
depth of sampling point
evidence of reproductive strategy *(e.g.* rhizomes, flowers).

The number of individual plants in each population should be estimated as 0-100, 101-300, 301-1000, 1001-3000, 3001-10000, >10000.

Issues to be aware of when assessing species features:

- grid references for species records are sometimes unreliable or wrong
- the source of species records for sites sometimes unclear
- the target population may be very small and easily missed when there are time constraints
- it is sometimes difficult to determine extent of target population
- the timing of the survey is important in assessing species feature
- the habitat conditions at time of survey need to be taken into account
- sometimes additional sampling may be necessary when conditions are suitable for the species

6.2. Notes

Use of a grapnel should be avoided in areas of colonisation of rare or protected species, unless the water is turbid and the population of rare species is large. A licence must be obtained from the relevant conservation agency for work with slender naiad (*Najas flexilis*) and floating water plantain (*Luronium natans*).

GPS and NGR coordinates should be used to map sampling positions. These data should be supplemented with photos if necessary. Notes on recording point survey data are presented in Appendix 3.

7. Collection of information on non-biological attributes

7.1 Lake Habitat Survey (LHS)

Collection of data for non-biological attributes should be undertaken with reference to Lake Habitat Survey (LHS) methods (Rowan et al., 2004). The purpose of the LHS technique is to describe the hydromorphology of and pressures on lakes, in a consistent, systematic way. All records are made on the standard LHS form, then data may be used to calculate either a lake habitat modification score, or a lake habitat quality assessment.

There are three elements to a full LHS survey:

a) the Habplot
b) the shoreline survey
c) the reference site

The Habplot is 15m wide, with length defined by the littoral, shore and riparian zones. For the purposes of LHS, the littoral zone section is the area between maximum wader depth (up to 10 m from the waterline) and the start of the shore zone. The shore zone is situated between the littoral and riparian zones. The riparian zone occupies the area from the top of the bank of the shore zone to 15m inland.

The shoreline survey is conducted between Habplots, from a boat, or from an opposite shoreline. Observations are made on e.g. bank construction, land cover, landforms and pressures. In this way, information on habitats and pressures is recorded for the entire lake.

The reference site is situated at the deepest part of a lake. At this location, the following determinations are made: temperature and dissolved oxygen profiles, Secchi depth, pH and alkalinity. Observational information is also recorded on water quality e.g. the presence of an algal bloom is noted.

While developing LHS, it was found that 8 to 10 Habplots are required to characterise a lake (Rowan *et al*., 2004). Given the time requirements of the botanical survey methods, this survey effort is beyond the scope of SCM. For SCM, surveyors should undertake Habplots at the locations of the sectors for the botanical surveys only. Whole lake shoreline observations should also be undertaken whilst carrying out the botanical surveys. Typically, it would not be expected that the reference site is visited during SCM, unless surveyors have access to a boat and equipment for measurement of physico-chemical variables.

Although this approach will not normally result in collection of sufficient data to characterise an entire water body, it ensures consistency in recording and provides detailed information on the physical environment associated with each sector. In addition to allowing records to be taken with reference to the attributes in SCM, the LHS form also facilitates collection of useful background information on pressures. Examples of sections of the LHS form which are applicable to each CSM attribute are given in the relevant secions below. The present version of the LHS form is presented in Appendix 5.

7.2. Extent

The simplest method of measuring extent is to examine surface area, since if the same area remains covered, the depth and volume must remain the same. However, this is not necessarily so if there has been extraction of sediment or increased sedimentation occurring in the water body. The surface area of a water body may be compared to a baseline map; aerial photographs may also be useful in this regard. However, allowances should be made for natural succession. It is intended that examination of this attribute will indicate changes in available freshwater habitat, so evidence of activities such as sediment extraction and in-lake construction should be sought.

Use of the LHS form (Appendix 5) will facilitate recording of data relevant to this attribute (e.g. section 4 hydrology)

7.3. Water quality

General advice on taking and treating samples is documented in Standing Committee of Analysts (1980). As with botanical surveys, specialists are required for reliable water sampling and analyses. Sampling vessels should be of appropriate materials and should have undergone an adequate treatment, cleaning and rinsing regime, with reference to the determinants to be measured. For example, containers for samples for TP analysis should be of glass, or polyethylene treated with iodine. The importance of these factors should not be underestimate. In low level nutrient analysis, the accuracy, precision and limit of detection are easily compromised by inadequate cleaning or containment.

The timing and location of sampling points are extremely important in collecting representative samples. In order to obtain useful water quality results, monthly, or at least quarterly, water sampling is recommended. If only one sampling visit is possible, this should take place early in spring. Nutrient concentrations determined at this time of year represent the total available for algal growth, prior to increased biological activity, and after the previous year's inputs have been assimilated, at a time when the water column is fully mixed. The results from spring samples may be compared from year to year. In low nutrient waters, there may be little change in nutrient levels throughout the year. However, in richer systems, in summer, TP and N levels may be influenced by sediment processes and uptake by algal cells. Consequently, it may be difficult to compare the results of summer sampling between years, unless several samples have been taken throughout the summer. At the time of a single summer sampling visit, algal biomass may be at its peak, but conversely, the sampling may coincide with the clear water period. Timing of water sampling should be considered further, e.g. the sample may not be representative of the water body during high winds, as there may be considerable resuspension of sediment in shallow basins.

With regard to sampling location, sampling from the water's edge is likely to generate spurious results. Sampling from the outflow may also generate spurious results due to e.g. incomplete mixing of the water body, localised increased sedimentation, or resuspension, proximity of the sampling location to lake sediment and localised build-up of algal biomass. Water samples should be taken from several locations and depths, from surface to deep water; sampling points should include the deepest part of the lake. During full surveys of lakes, temperature and dissolved oxygen profiles should be recorded, from surface to deep water, at each sampling site. However, despite the advantages sampling within lakes, restriction of resources or access may necessitate outflow sampling.

Samples should be kept cold ($4^{o}C$) and dark until processing is possible. Processing should be undertaken as soon as possible after sampling, on the same day as collection. Water samples should not be stored with other samples of high nutrient content e.g. sediments. With regard to analytical quality assurance, the laboratory should use techniques which are consistent with HMSO Blue Book methods (The Standing Committee of Analysts) and should have high standards of accuracy and precision, good sensitivity, and in the case of TP, preferably a limit of detection of 1.0 $\mu g\ P\ l^{-1}$. Measurement of pH should be undertaken in the laboratory, with a calibrated, robust and accurate bench-top meter and probe. Alkalinity should be measured by titration of the sample with hydrochloric acid, to a pH 4.5 end point, using an indicator solution.

Collection and analysis of water samples to obtain meaningful results may be beyond the scope of CSM. However, it is mandatory to consider water quality in condition assessment. It may be possible to obtain data on a number of sites from the statutory environmental protection agency (EPA). Where no sampling regime exists, it is recommended that the possibility of future sampling is discussed with the appropriate EPA. When data are not available, observations should be noted on whether there is an algal bloom in the lake. If possible, the dominant species in the bloom should be identified. Blooms of blue-green algae may suggest that TP levels have increased, whilst blooms of green algae may indicate a higher TP concentration than those of blue-green algae. Where access to open water is possible, temperature and dissolved oxygen profiles, and Secchi depth should be measured in the deepest part of the lake. However, interpretation of Secchi data, in terms of water quality, should be undertaken with caution, as water transparency is influenced by factors other than increased algal biomass e.g. water colour.

Information on water quality may be recorded using the LHS form (Appendix 5) (e.g. LHS form sections 2.4 littoral zone and 5 reference site).

7.4. Hydrology

Owing to natural variability in lake water levels and inflow/outflow rates, ideally long-term monitoring data should be used when considering this attribute. However, such data are often

unavailable. It therefore likely that it will be necessary to base the assessment of this attribute on observational data. Information should be collected in accordance with LHS methods (e.g. LHS form section 4 hydrology). When visiting the site, it should be borne in mind that the following hydrological variables all constitute elements of the extent and quality of habitat: surface area, mean and maximum depth, volume, residence time/flushing rate. Evidence to suggest that there has been a change in hydrology includes lack of marginal vegetation, "stranded" littoral vegetation, exposed littoral sediments, a clear distinction between the physical lip of the basin and the extent of the water in the lake. In interpreting this evidence, it will be important to consider both the timing of the site visit and natural fluctuations in water levels. If possible, observations should be noted several times within the year.

7.5. Substrate and sedimentation

Sedimentation rates may be examined through collection of cores, or use of sediment traps. Sampling of sediment would allow work on the particle size distribution (through e.g. use of sieving techniques, coulter counter analysis), organic content (e.g. through loss on ignition) and nutrient concentrations (e.g. through use of acid digestion, followed by colorimetric techniques, or use of C/H/N analyser). Collection of data on suspended solids concentrations and flow rates of lake inflows allows calculation of sediment loadings.

Detailed examination of substrate and sedimentation is unlikely to be possible within the constraints of CSM. Projects running at other institutions may involve collection of such data, at individual drainage basins, or sub-catchment areas. It is recommended that the relevant institutions are requested for information.

If is not possible to follow a detailed monitoring programme for these aspects of the lake environment, observations should be made on these attributes, ideally several times within the year. Information should be collected in a manner consistent with LHS methods (e.g. LHS form sections 2.2 shore zone, 2.4 littoral zone, 3.2 whole lake pressures and 3.3 landform features).". Obvious erosional features proximate to inflow waters and the lake itself should be recorded. Notes should be taken on evident contraventions of the code on Prevention of Environmental Pollution From Agricultural Activity (PEPFAA) (SOAEFD, 1997), the 4 Point Plan, or the Forest and Water Guidelines (Forestry Commission, 2003), which may be causing increased soil losses within the watershed. Evidence should be gathered from visual assessment of the lake's substrate e.g. smothering of course substrate with fine material, build-up of leaf litter on mineral sediments.

8. Equipment

Equipment required for shore-based monitoring includes the following:

lifejackets
waders
latex gloves
bathyscope
double-headed rake and 5m rope
quadrat
1m rule
sample containers
polaroid sunglasses
GPS
site map
recording forms (Appendix 3)
camera

If survey in deeper water is intended, the following will also be required:

boat
marker buoys
weight
anchor
rope
survey pole
SCUBA or snorkelling equipment

Surveyors should ensure that all equipment required under health and safety regulations is included.

Appendix 3. Recording forms

SCM: ASSESSMENT OF HABITAT FEATURES				
General site details				
Site Name:	SNH Area/contact:			
Designation: SSSI / SAC / SPA / RAMSAR				
Grid reference (mid-point):				
Lake area (ha):				
Altitude (m):				
Catchment (ha):				
Geology:	Access contact:			
Water clarity (clear, turbid, peaty) and secchi depth:				
Water colour: (peaty brown, green-brown, green)				
Survey date:				
Surveyors:				
Proportion of shoreline surveyed:				
Number of 100m shore surveys:				
Number of boat transects:				
Names of features to be assessed				
Noted pressures/Environmental data				
(e.g. abstraction, regulation of water level, morphological alterations, species introductions, physical disturbances, recreational activities, point-source pressures, diffuse pressures, algal booms, angling)				
Notes				
				F/U
	Macrophyte composition			
	Macrophyte abundance			
	Macrophyte zonation			
	Water quality			
	Hydrology			
	Lake substrates			
	Shoreline modification			
	Invasive species			
	Other			

SCM: ASSESSMENT OF HABITAT FEATURES									
Method: Perimeter strandline survey									
Site Name:									
Survey date:									
Surveyors:									
Section Number (approx 100m)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Section start-point (GPS)									
Time spent getting to section									
Time to complete section									
Submerged and floating species									
List species (presence/absence)									**Site DAFOR**
Stranded, emergent and edge species									
List species or vegetation type (presence/absence)									

SCM: ASSESSMENT OF HABITAT FEATURES																							
Method: Shore based survey (approx. 100m)																							
Site Name:					**Survey Section No.:**												**Time spent getting to section:**						
Survey date:					**Section start-point (GPS):**												**Time to complete section:**						
Surveyors:					**Section end-point (GPS):**																		
Sample sub-section	**1**				**2**				**3**				**4**				**5**						
Sample point	**1a**	**1b**	**1c**	**1d**	**2a**	**2b**	**2c**	**2d**	**3a**	**3b**	**3c**	**3d**	**4a**	**4b**	**4c**	**4d**	**5a**	**5b**	**5c**	**5d**			
Water Depth (cm)	**25**	**50**	**75**	**>75**	**25**	**50**	**75**	**>75**	**25**	**50**	**75**	**>75**	**25**	**50**	**75**	**>75**	**25**	**50**	**75**	**>75**			
Substrate type																							
Aquatic plant biomass rating (0-3)																							
Filamentous algae (0-3)																							
Time to complete sub-section																							
SPECIES (presence/absence)																					**sub-tot.**		

SCM: ASSESSMENT OF HABITAT FEATURES																								
Method: Boat-based survey																								
Site Name:	**Depth of max. colonisation:**																			**Time spent getting to section:**				
Survey date:	**Position of shore-end of transect line (GPS):**																			**Time spent finding max. depth:**				
Surveyors:	**Position of o/w end of transect line (GPS):**																			**Time to complete "transect"**				
Section No.:	**Compass bearing of transect line:**																							
SAMPLE POINT:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**				
Water depth (cm)																								
Substrate type																								
Aquatic plant biomass rating (0-3)																								
Filamentous algae (0-3)																								
SPECIES (presence/absence)																					**Total**			

SCM: ASSESSMENT OF SHALLOW WATER SPECIES FEATURES																								
Method: Shoreline/shallow water survey																								
Site Name:						**Time to locate target species population:**																		
Shallow water target species:						**Time to complete survey:**																		
Survey date:						**Position of target species population (GPS):**																		
Surveyors:						**Max. depth of target species (cm):**																		
Survey No.:						**Min. depth of target species (cm):**																		
						Does target species extend beyond max. wader depth?:																		
Species abundance: 0 = 0 % of quadrat covered by species						*Area of bare substrate: 1 = < 25 % of quadrat covered by bare substrate*																		
Species abundance: 1 = < 25% of quadrat covered by species						*Area of bare substrate: 2 = < 75 % of quadrat covered by bare substrate*																		
Species abundance: 2 = < 75% of quadrat covered by species						*Area of bare substrate: 3 = > 75 % of quadrat covered by bare substrate*																		
Species abundance: 3 = > 75% of quadrat covered by species																								
SAMPLE QUADRAT	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**				
Water Depth (cm)																								
Area of bare substrate in quadrat (1-3)																								
																					TOTAL		
Flowers or flowering stems of target species?																								
Vegetative spread of target species?																								
Species abundance (0-3)																								
List species																								

SCM: ASSESSMENT OF DEEP WATER SPECIES FEATURES																									
Method: Bathyscope/grapnel survey																									
Site name:						**Time to set up survey:**																			
Deep water target species:						**Time to complete survey:**																			
Survey date:						**Position of target species population (GPS):**																			
Surveyors:						**Max. depth of target species (cm):**																			
Survey number:						**Min depth of target species (cm):**																			
Species abundance: 1 = < 25% of quadrat covered by species						*Area of bare substrate: 1 = < 25% of quadrat covered by bare substrate*																			
Species abundance: 2 = < 75% of quadrat covered by species						*Area of bare substrate: 2 = < 75% of quadrat covered by bare substrate*																			
Species abundance: 3 = > 75% of quadrat covered by species						*Area of bare substrate: 3 = > 75% of quadrat covered by bare substrate*																			
SAMPLE QUADRAT	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**					
Water depth (cm)																									
Area of bare substrate in quadrat (0-3)																									
																								TOTAL	
Flowers or flowering stems of target species?																									
Vegetative spread of target species?																									
Species abundance (1-3)																									
List species																									

SCM: ASSESSMENT OF DEEP WATER SPECIES FEATURES																															
Method: snorkel diver survey																															
Site Name:														**Time to set up survey:**															
Deep water target species:														**Time to complete survey:**															
Survey date:														**Position of target species population (GPS):**															
Surveyors:														**Max. depth of target species(cm):**															
Survey Number:														**Min. depth of target species (cm):**															
Species abundance: 1 = < 25% of quadrat covered by species														*Area of bare substrate: 1 = <25% of quadrat covered by bare substrate*															
Species abundance: 2 = < 75% of quadrat covered by species														*Area of bare substrate: 2 = <75% of quadrat covered by bare substrate*															
Species abundance: 3 = > 75% of quadrat covered by species														*Area of bare substrate: 3 = >75% of quadrat covered by bare substrate*															
SAMPLE QUADRAT						**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**						
Water depth (cm)																															
Area of bare substrate in quadrat (1-3)																															
																														TOTAL	
Flowers or flowering stems of target species?																															
Vegetative spread of target species?																															
Species abundance (13)																															
List species																															

Appendix 4 Guidelines for recording point survey data

1. Record the data in a .xls spreadsheet – not a .txt file.
2. Each point must have a unique identifier (UID)
3. Grid references must be given as full **number** resolution **eastings** and **northings** (NOT using the letter system). Eastings and northings must be listed in separate columns.
Eastings will have 6 numbers e.g. 438200
Northings will have 7 numbers for sites in Shetland e.g. 1172150 (Fraw Houll)
4. Each column should not be more than 150 characters wide. Try to limit what you include in the spreadsheet to attributes you might actually want to re-classify and map. Keep to a standard format for each attribute.
5. For attributes like height, use a consistent unit of measurement and only quote the number in the column.
6. Notes/ descriptions should be held in separate text files and referred to by file name in a column. The file name for each species (or group of species) should be unique. Links to these text files can then be made in ArcView to access this data.
7. Avoid the use of commas in the columns as this can upset conversion to ArcView format.

Example

UID	**Easting**	**Northing**	**Common_Name**	**Latin_name**	**Height (mm)**	**Notes_File**
1	438200	1172150	Italian Rye-Grass	*Lolium Multiflorum*	500	Veg1.txt
2						
3						
4						
5						
6						
7						
8						
9						

Appendix 5. LHS field survey form (revised version 2)

LAKE HABITAT SURVEY (LHS)

Name of Lake:	GBLakes code: WBID _____	Date:	Visit #

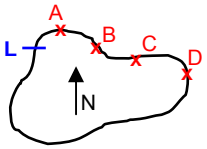
1. LAKE INFORMATION AND SURVEY DETAILS

1.1 BACKGROUND INFORMATION (use GBLakes database and recent OS 1:50,000 topographic map)

Maximum depth (m) *[if known]*	*Circle method by which depth was determined*		Modelled / Measured
Lake perimeter (m)		Lake altitude (m)	
Lake surface area [L] (km^2)		Catchment area [C] (km^2)	

Catchment geology [circle]:	Siliceous/Calcareous/Organic/Mixed
Dominant catchment land-cover [circle]:	NV, BL, BP, CW, CP, SH, WL, MH, RP, IG, TH, TL, IL, PG, SU
Mode of lake formation *[if known]* [circle]:	RV, RC, KL, KH, GD, DP, FV, WW, BS, CW, IW, EH, ED, BP, OT
Designation status [circle]:	SAC, SPA, NNR, SSSI/ASSI, LNR , Ramsar Site, or OTHER (specify section 6)

MARK ON MAP
Arrow indicating North and scale bar
L = Launch site (if using boat)
A,B,C,D…etc = location each Hab-Plot



Trace lake outline into space provided below (from map).
Or attach a photocopy of an appropriately scaled topographic base-map for annotation.

Trace from topographic base map (circle scale) [1:10,000, 1:25,000, 1:50,000, other specify]:
Indicate source of map (e.g. Mastermap, OS Map, Other):
Indicate age of map:

1.2 SURVEY DETAILS (fill in when commencing field survey)

Surveyor name(s):		Time at start of survey:	
Organisation:		Time at end of survey:	
Survey method (circle):	Boat/ Foot	Estimated time to complete LHS components:	

Adverse conditions affecting survey? (☐ ✓ tick if none, otherwise specify):

LAKE IDENTITY VERIFIED BY (✓ all that apply) GPS ☐ Local contact ☐ Signs ☐ Topo. Map ☐

1.3 PHOTOGRAPHS (Take two to illustrate the lake's characteristics and one of each Hab-Plot)

LAKE HABITAT SURVEY (LHS)

Name of Lake:	GBLakes code: WBID _____	Date:	Visit #

Using GPS record 12 figure Ordnance Survey Grid Reference for launch site (if using boat) and Hab-Plots (Two letters, and 10 digit eastings & northings e.g. NO 14729 34834)

Launch (L)		E		
Hab-Plots		F		
A		G		
B		H		
C		I		
D		J		

2. PHYSICAL ATTRIBUTES *(to be assessed across TEN 15 m wide observation plots)*

	New Hab-Plot ID (if needed):									
	Hab-Plot ID:	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
2.1 RIPARIAN ZONE (15 m x 15 m plot landwards from bank top)											
Estimate aerial cover over plot *(0 (<1%), 1 (1-<10%), 2 (10-40%), 3 (>40-75%), 4 (>75%))*											
CANOPY LAYER (> 5 m)	Trees ≥ 0.3 m diameter										
	Trees < 0.3 m diameter										
	Evidence of canopy damage/disease										
UNDERSTOREY (0.5 – 5 m)	Woody shrubs & saplings										
	Tall herbs & grasses										
GROUND COVER (< 0.5 m)	Woody shrubs & seedlings										
	Herbs, grasses, bryophytes										
OTHER	Standing water or inundated vegetation										
	Pine needles or leaf litter										
	Bare ground										
	Artificial										
Dominant land-cover within riparian zone (NV, BL, BP, CW, CP, SH, OR, WL, MH, AW, OW, RP, IG, TH, RD, TL, IL, PG, SU)											
Notable nuisance plant species (NO=No, GH=Giant hogweed, RH= Rhododendron, HB=Himalayan balsam, JK=Japanese knotweed, OT=Other)											
Dominant bank top (1 m wide) vegetation type (NO=No, CL=Canopy layer (>5 m), US=Understorey (0.5-5 m), GC=Ground cover (<0.5 m). MI=Mixed)											
Bank top features (BE=Bedrock, BO=Boulders, BC=Beach ridges, DU=Dunes, QB=Quaking bank, OT=Other)											
2.2 SHORE ZONE (15 m wide plot of variable length between bank top and waterline)											
BANK FACE (if present- includes boulder aprons)	Bank face present (NO=No, YE=Yes)										
	Bank face height (m) (estimate to nearest metre)										
	Angle (GE=Gentle (5 -30°), SL=Sloped (>30-75°), VE=near Vertical (>75 °), UN=Undercut)										
	Bank material (NV, BE, BO, CO, GP, GS, SA, SI, EA, PE, CL, CC, SP, WP, GA, BR, RR, TD, FA, BI, OT)										
	Bank face modification(s) (NO, NV, RS, RI, PC, EM, DM, OT)										
	Bank face vegetation cover (*0 (<1%), 1 (1-<10%), 2 (10-40%), 3 (>40-75%), 4 (>75%)*)										
	Bank face vegetation structure (NO=No, CL=Canopy layer (>5 m), US=Understorey (0.5-5 m), GC=Ground cover (<0.5 m). MI=Mixed)										
	Evidence of bank face erosion (NO=No, ER=Eroding)										
SHORE/BEACH (if present)	Beach present (NO=No, YE=Yes)										
	Shore width (m) (estimate to nearest metre)										
	Slope (HO=near Horizontal, GE=Gentle (5 -30°), SL=Sloped (>30-75°), VE=near Vertical (>75°)										
	Shore material (NV, BE, BO, CO, GP, GS, SA, SI, EA, PE, CL, CC, SP, WP, GA, BR, RR, TD, FA, BI, OT)										
	Shore modification(s) (NO, NV, RS, RI, PC, EM, DM, OT)										
	Shore vegetation cover (*0 (<1%), 1 (1-<10%), 2 (10-40%), 3 (>40-75%), 4 (>75%)*)										
	Shore vegetation structure (NO=No, CL=Canopy layer (>5 m), US=Understorey (0.5-5 m), GC=Ground cover (<0.5 m). MI=Mixed)										
	Evidence of shore geomorphological activity: (NO=No, ER=Eroding, DS=Depositional)										
	Presence of shore organic debris/trash-lines (NO=No, YE=Yes)										

LAKE HABITAT SURVEY (LHS)

Name of Lake:	GBLakes code: WBID _____	Date:	Visit #

New Hab-Plot ID (if needed):										
Hab-Plot ID:	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
2.3 HUMAN PRESSURES (to be assessed over entire plot) ✓*(tick) if present, B = behind or adjacent to plot (within 50m radius)*										
Commercial activities										
Residential developments										
Roads or railways										
Parks and gardens										
Docks, marinas, jetties or boats										
Walls, dykes or revetments										
Recreational beaches										
Educational recreation										
Litter, dump or landfill										
Quarrying or mining										
Pasture (ring if observed grazing)										
Coniferous plantation (ring if evidence logging)										
Tilled land										
Orchard										
Pipes, outfalls										
Dredging										
Riparian vegetation control										
Macrophyte cutting										
2.4 LITTORAL ZONE (15 m x 10 m plot extending from waterline to offshore station)										
Depth (m) at offshore station (10 m offshore or maximum wading point)										
Distance (m) of offshore station from waterline (10 m or maximum wading point)										
Substrate (NV, BE, BO, CO, GP, GS, SA, SI, EA, PE, CL, CC, SP, WP, GA, BR, RR, TD, FA, BI, OT)										
Any sedimentation over natural substrate? (NV, NO, BE, BO, CO, GP, SA, SI, EA, PE, CL)										
Odour *(NO = No, HS = H_2S, SW = Sewage, OI = Oil, CH = Chemical, OT= Other)*										
Surface film *(NO = No, SC= Scum, AM = Algal Mat, OI = Oily, OT=Other)*										
MACROPHYTES ***Estimate aerial cover (****0 (<1%), 1 (1-<10%), 2 (10-40%), 3 (>40-75%), 4 (>75%))*										
Liverworts/mosses/lichens										
Emergent broad leaved herbs										
Emergent reeds/sedges/rushes										
Floating-leaved (rooted)										
Free-floating										
Amphibious										
Submerged broad-leaved										
Submerged linear-leaved										
Submerged fine-leaved										
Filamentous algae										
Cover of inundated terrestrial vegetation in littoral zone										
Total macrophyte percent volume inhabited (PVI) ***Estimate volume of macrophytes within littoral plot*** *(0 (<1%), 1 (1-<10%), 2 (10-40%), 3 (>40-75%), 4 (>75%))*										
Do macrophytes extend lakewards? (NV=Not Visible, NO=No, YE=Yes)										
Notable nuisance plant species (NO=No, NP=Nuttall's pondweed, AS=Australian swamp stonecrop, PF=Parrots feather, FP=Floating pennywort, OT=Other)										
LITTORAL HABITAT FEATURES *Estimate aerial cover (0 (<1%), 1 (1-<10%), 2 (10-40%), 3 (>40-75%), 4 (>75%))*										
Underwater tree roots										
Woody debris (ring if predominantly > 0.3 m diameter)										
Inundated live trees (ring if predominantly > 0.3 m diameter)										
Overhanging vegetation close to water surface (< 1 m above)										
Rock ledges or sharp drop offs										
Boulders										

Any other pressures or comments for this section (indicate which Hab-Plots affected):

LAKE HABITAT SURVEY (LHS)

Name of Lake:	GBLakes code: WBID _____	Date:	Visit #

3. WHOLE LAKE ASSESSMENT (carry out in consultation with recent OS 1:50,000 topographic map)

3.1 SHORELINE CHARACTERISTICS

Complete table from either a boat-based survey (cruising and observing between Hab-Plots) ***OR*** *by viewing visible shoreline sections from each Hab-Plot (these must be shown on sketch map). Observe progressively from Hab-Plots A, B, C, etc (or add more appropriate viewing locations) until at least 75% of shoreline is observed (observe 100% if possible).* ***If shoreline can be viewed from one location, do so; this will minimise uncertainty in estimations of overall % for the entire shoreline.***

EXTENT OF SHORELINE SECTION AFFECTED BY (OR COMPRISED OF) EACH PRESSURE OR LAND-COVER TYPE

Estimate extent (0 (<1%), 1 (1-<10%), 2 (10-40%), 3 (>40-75%), 4 (>75%)). Ring entry if known to affect 'critical' area.

Shoreline section number		1		2		3		4		5		6		7		8		9		10	
Circle option used	Boat: viewed between Hab-Plots	A-B		B-C		C-D		D-E		E-F		F-G		G-H		H-I		I-J		J-A	
	Shore: viewed from Hab-Plots	A		B		C		D		E		F		G		H		I		J	
New viewing locations (if req.)																					
Section as % of total shore																					
% shoreline at 15 and 50 m		15	50	15	50	15	50	15	50	15	50	15	50	15	50	15	50	15	50	15	50
Bank construction	Impoundments																				
	Hard engineering																				
	Soft engineering																				
	Docks and marinas																				
Pressures and non-natural land-use	Commercial activities																				
	Residential																				
	Roads or railways																				
	Parks and gardens																				
	Recreational beaches																				
	Educational recreation																				
	Litter, dump, landfill																				
	Quarrying or mining																				
	Coniferous plantation																				
	Evidence recent logging																				
	Pasture																				
	Observed grazing																				
	Tilled land																				
	Orchard																				
Erosion																					
Wetland habitats	Fringing reed banks																				
	Wet woodlands																				
	Alders (ring if diseased)																				
	Bogs																				
	Quaking banks																				
	Other (e.g. fen, marsh)																				
Other natural habitats	Broadleaf/mixed woodland																				
	Broadleaf/mixed plantation																				
	Scrub and shrubs																				
	Moorland/heath																				
	Open water																				
	Rough grassland																				
	Tall herb/rank vegetation																				
	Rock, scree or dunes																				

LAKE HABITAT SURVEY (LHS)

Name of Lake:	GBLakes code: WBID _____	Date:	Visit #

3.2 LAKE SITE ACTIVITIES/PRESSURES

*✓(tick) box (**P**) if known to be present, and ring entry if actually observed*
If possible to estimate, ✓(tick) boxes (E) and/or (I) if the pressure appears to be Extensive or Intensive, respectively

	P	E	I		P	E	I		P	E	I
Motorboat sporting activities				Navigation				Surface films			
Non-motor boat activities				Military activities				Dredging			
Non-boat recreation/swimming				Powerlines				Liming			
Angling from shore				Macrophyte control				Litter			
Angling from boat				Nuisance sp (specify section 6)				Odour			
Fish cages											

Others (add in spaces above and/or specify in Section 6)

3.3 LANDFORM FEATURES

Estimate extent as % lake surface area (0 (<1%), 1 (1-<10%), 2 (10-40%), 3 (>40-75%), 4 (>75%))

Vegetated islands (non deltaic)		Stable vegetated islands (deltaic)		Deltaic gravel deposit	
Unvegetated islands (non deltaic)		Aggrading vegetated deltaic deposit		Deltaic sand/silt/clay deposit	
Others (add here or specify in Section 6)					

3.4 ANIMALS *(tick if observed, and specify in right had column)*

Piscivores		*e.g. Cormorant, Kingfisher*
Macrophyte dependent species		*e.g. Swan, Grebe*
Non-native invasive species		*e.g. Mink*
Species of conservation interest		*e.g. Dragonflies, Osprey*

4. HYDROLOGY (to be assessed over entire lake)

Principal use(s) *(circle)*	None / Hydro-power / Water supply / Flood control / Navigation / Amenity / Other (specify)
Water body type *(circle)*	Natural(unmodified) / Natural(raised) /Natural(lowered) / Impoundment / Flooded pit

If raised or lowered, state height difference of water level relative to natural condition (m) *[if known]*	(m)
If raised or lowered, state when this occurred *[if known]*	
Estimate maximum height from lake bed of principal retaining structure (m)	(m)

Number of significant influent streams (stream catchment >10% total catchment)	
Are there any upstream impoundments? (circle)	No / Yes / Unsure
Evidence of significant flow diversion (i.e. may affect residence time) into/out of catchment? (circle)	No / Into / Out of / Unsure
Does water level experience tidal influence? (circle)	No / Yes / Unsure

Vertical range of water level fluctuation (m) *(✓tick appropriate box)*

Daily$_{max}$	< 0.5 ☐ > 0.5 – 2 ☐ >2 – 5 ☐ > 5 – 20 ☐ > 20 ☐ Unsure ☐	**This question answered by:**
Annual$_{max}$	< 0.5 ☐ > 0.5 – 2 ☐ >2 – 5 ☐ > 5 – 20 ☐ > 20 ☐ Unsure ☐	On-site estimation ☐ Data ☐

Water management structures observed (total each type in boxes provided). Where possible, indicate if critical areas are affected. Mark the location of any structures on the sketch map or photocopy of OS map.

Inflow	Dam without fish pass		Barrage		Weir		
	Dam with fish pass		Sluice		Outfall		
	Channelised channel		Lock		Intake		
Outflow	Dam without fish pass		Barrage		Weir		
	Dam with fish pass		Sluice		Outfall		
	Channelised channel		Lock		Intake		

Other (specify here or section 6):

LAKE HABITAT SURVEY (LHS)

Name of Lake:	GBLakes code: WBID _____	Date:	Visit #

5. LAKE PROFILE INFORMATION AT INDEX SITE (to be measured at deepest point of lake)

Using GPS record 12 figure Ordnance Survey Grid Reference at the Index site (Two letters, and 10 digit eastings & northings)

5.1 INDEX SITE AND WATER CONDITIONS

Surface conditions (circle):	Flat / Ripple / Choppy / Breaking waves
Surface films (circle):	None / Scum / Algal mat / Oil / Other (specify)
Odour (circle):	None / H_2S / Sewage / Oil / Chemical / Other (specify)

MEASUREMENTS AT INDEX SITE		SECCHI DISK TRANSPARENCY	
Index Site water depth (m)		Clear to bottom (circle):	Yes / No
Alkalinity (meq L^{-1})		Depth disk disappears (m)	
pH		Depth disk reappears (m)	

5.2 DISSOLVED OXYGEN AND TEMPERATURE PROFILE

Measure at depths of (m) surface, 0.5, 1, 1.5, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 25, 30, 35, 40 and 50 m. Include readings at 1 m above lake bottom). If depth ≤ 3 m, take readings at the surface, every 0.5 m, and 0.5 m above the bottom.

Calibration check confirmed (circle) Yes / No

Comments	Depth (m)	O_2 (mg L^{-1})	Temp (^oC)	Metalimnion (T,B)
	Surface			
	Surface (duplicate)			

Confirm that duplicate O_2 reading is within ± 0.5 mg L^{-1} of initial surface reading (Yes / No)

Metalimnion (T, B): locate the position of the metalimnion, i.e. region of the water temperature profile where the temperature changes at a rate of 1°C or greater per metre of depth. Indicate the depth of the top of the metalimnion with a "T", and the bottom of the metalimnion (when the rate of change becomes less than 1°C per metre) with a "B". After the metalimnion is encountered, take readings every 1 m until bottom of the metalimnion is reached.

Name of Lake:	GBLakes code: WBID _____	Date:	Visit #

FIELD SURVEY QUALITY CONTROL (✓tick boxes to confirm checks, explain in section 6 if necessary)

- ★ Have you taken two or more photographs of the site and one of each Hab-Plot? ☐
- ★ Have you filled in the lake's name, GBLakes WBID, date and visit number on each page? ☐
- ★ Have you sketched the lake on page 1 (or provided photocopy of OS map), and annotated it? ☐
- ★ Have you completed the background data (from GBLakes) on page 1? ☐
- ★ Have you filled in 'time at end of survey' and 'estimated LHS time' (Section 1.2) on page 1? ☐
- ★ Have you completed 10 Hab-Plots, including GPS locations (Section 2) on pages 2 and 3? ☐
- ★ Have you surveyed at least 75% of the lake shoreline (Section 3) on page 4? ☐
- ★ Have you completed the whole lake survey (Section 3), activities, special habitats, and animals on page 5? ☐
- ★ Have you completed the hydrology section (Section 4) on page 5 answering all questions possible? ☐
- ★ If a boat is available, have you completed the Index Site (Section 5)? ☐

6. FURTHER COMMENTS

Use this section to describe any incidences of 'OT= Other' used in the survey, where insufficient room was provided within the section. Also include general comments and problems encountered during the survey.