Common Standards Monitoring Guidance

for

Rivers

Version September 2016

Updated from (January 2014)

ISSN 1743-8160 (online)

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Foreword

This document has been prepared by the Inter-agency Freshwater Group, comprising representatives of Scottish Natural Heritage, Natural England, Natural Resources Wales and the Northern Ireland Environment Agency.

Note – Safety issues are paramount when surveying rivers. Surveyors should comply with national Health and Safety legislation, and follow any additional guidelines appropriate for working in or near rivers. In particular all necessary biosecurity measures should be taken (e.g. disinfecting footwear and field equipment) to minimize the risk of transferring alien species from one place to another.

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Introduction

This guidance covers condition assessment of river SSSI / ASSI and SAC habitat. It should be used where a site has been notified as an example of a high quality river, or for its special natural characteristics, or as a good representative of one or more river types, as defined in the SSSI selection guidelines. It may also be used to provide an assessment of condition for river SACs designated as examples of the Annex I habitat H3260 ***Water courses of plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation***. Further information on *Ranunculus* communities is given in the LIFE in UK Rivers Project (Hatton-Ellis *et al.,* 2003; Life in UK Rivers, 2003). More detailed environmental requirements of any particular species or habitat features (SSSI / ASSI or SAC) may be superimposed on this guidance, as required. (The guidance for monitoring freshwater fauna is available on the JNCC website.)

The designated river habitat feature includes in-channel, marginal and riparian habitats. The aim of designation is to conserve the habitat for the characteristic communities of the river, in its own right and as an example of its type(s). Sites are selected as the best examples available of the natural variation in river habitats across Great Britain and Northern Ireland.

The guidance treats SSSI/ASSI and SAC designations of river habitat in the same way, and addresses the four main aspects of habitat integrity: hydrological, chemical, physical and biological. In addition to these, there are also some targets that relate more directly to the status of the characteristic biological community.

The attributes and targets selected are those that provide the best measures of ecological integrity and quality within river ecosystems, using the most recent tools available. These attributes reflect the pressures affecting rivers, and their assessment provides a way of determining whether the river is still in favourable condition. Rivers experience a very wide range of pressures and there is therefore a need to monitor more attributes than is usual in terrestrial sites. Although the guidance attempts to provide a comprehensive set of attributes, it is not possible or desirable to measure all aspects of river systems and judgement has been exercised in assessing which parameters to include and exclude from the guidance. Likewise, there are various activities that will need management but may not in themselves need monitoring.

Explanation of terms

The following terms are used in this guidance:

ASSI – Area of Special Scientific Interest (applies in Northern Ireland only)

EQI – Ecological Quality Index

EQR – Ecological Quality Ratio

SSSI – Site of Special Scientific Interest

SAC – Special Area of Conservation

‘Designated site’ – the whole of an SSSI / ASSI / SAC

‘Survey site’ – a length of river within which ecological data are collected.

‘Assessment unit’ – a length of river for which an assessment of condition is made (usually equivalent to an Evaluated Corridor Section (ECS) in SERCON (Boon *et al.*, 1996) or a WFD water body.

1 Dividing the river into assessment units

Boundaries between assessment units are most sensibly focused on significant natural features, the most obvious of which are major confluences. Other considerations, such as geological changes or major changes in slope, may also be used. No set procedure is defined under CSM but the approaches used by SERCON (Box 1.0) or by the environment agencies to identify water bodies for the Water Framework Directive are both suitable.

Box 1.0 Procedure for Dividing Rivers into Evaluated Corridor Sections (ECSs)

ECS characteristics

(a) Each ECS must be a single river (including subsidiary channels) and will often be the main stem of a river. If associated tributaries are to be evaluated this should be done separately.

(b) Each ECS should have essentially uniform gross physical characteristics of geology, slope, size, etc.

(c) The channel length (not the valley length) of each ECS should be between 10 km and 30 km. Reaches longer than 30 km should be divided into shorter ECSs. Where possible, this should be based on an obvious natural division (such as the entry of a large tributary), but if there is no natural break the ECS should simply be halved. ECSs shorter than 10 km are only permitted when any of the following conditions apply:

(i) The ECS is the whole of a short river or tributary;

(ii) The ECS is a short length of river separated from other ECSs by major physical features such as lakes or large waterfalls;

(iii) A short river needs to be divided into ECSs on the basis of major changes in the natural characteristics of the river, but this results in one or more of the ECSs being shorter than 10 km.

The following exceptions to the rule may be used with caution:

(iv) Within an ECS a continuous reach may be deemed to merit separate evaluation. For example, a high quality ECS may contain a severely degraded lower stretch; or a channelized ECS with bank reinforcement may contain a discrete stretch of near-natural river. For part of an ECS (i.e. one originally identified on the basis of natural divisions) to be considered as a separate ECS in its own right, it must represent a **continuous** length of at least 5 km that contrasts in perceived quality with the majority of the ECS. If this stretch is located in the middle of the original ECS, the stretches upstream and downstream should be considered together as one ECS rather than two.

Procedure for identifying ECSs

The following procedure for identifying ECSs should be followed even if the user wishes to evaluate only part of a river:

(a) Identify the source and lower limit with reference to 1:50,000 OS maps. Where several small headwaters combine to form the main river, the point at highest altitude should normally be selected as the source, unless there is a particular reason for including in the uppermost ECS a headwater reach at lower altitude than the source. The lower limit for the main stem of a river should be set at the tidal limit as marked on a 1:50,000 OS map, or its confluence with another river or with a lake.

(b) Assemble information on the physical characteristics of the river, making use of the following:

(i) 1:50,000 (or larger scale) OS maps, providing information on altitude, river length, stream order, sinuosity, and extent of the floodplain. The location of significant features such as lakes and waterfalls will also be indicated. It is recommended that data from maps are used to construct a profile of the river. This will show the change in altitude from source to mouth and give a good visual representation of channel gradient and stretches along the river where the profile changes rapidly;

(ii) Geological maps, providing information on likely downstream changes in substrate and water chemistry;

(iii) Local knowledge and field observations.

(c) Collate and interpret the data to assess the nature of the river in terms of altitude, gradient, size, dominant flow type (from altitude/gradient/sinuosity), substrates, and water chemistry.

(d) Determine the number, lengths and boundaries of ECSs. Using the information in (c), commence at the source and divide the river into ECSs, each one with a river channel length between 10 km and 30 km (apart from exceptions described above). Use the presence of natural features, such as the entry of a major tributary or the location of a large waterfall, to determine where the boundaries should be drawn. Where the boundary between two ECSs is located at the junction with a tributary, that tributary (and its associated catchment) is considered to be part of the lower ECS.

(e) Check that each ECS complies with the guidance on ‘ECS characteristics’ given above.

2 Information needed to assess condition

The approach taken to monitoring rivers involves a combination of collation / interpretation of existing information and field survey. It is strongly recommended that conservation agency staff work closely with the relevant environment agency to ensure that data are collected at appropriate locations and times within the site.

Field survey provides a basic assessment of physical habitat structure and parts of the biological community, and may also contribute to the assessment of river flow and water quality. Some aspects of field survey may be waived if suitable data have already been collected by others, provided that the data relate to the relevant 6-year period of the current reporting cycle. Physical and chemical data and information on other features (e.g. non-native species) must be obtained from the environment agencies and various other sources. Guidance is given on information sources in the appropriate section of the text.

The assessment of physical condition relies on River Habitat Survey (RHS). (In Northern Ireland the equivalent is River Hydromorphological Assessment Technique (RHAT) (NIEA, 2009). As this methodology is specific to Northern Ireland, the remainder of this guidance is confined to the use of RHS in undertaking favourable condition assessments.) The preferred option is to carry out RHS or RHAT within each assessment unit using accredited surveyors. The assessment of bank vegetation naturalness requires an additional Phase 1 habitat survey at each spot-check. Observations by the surveyor or gathered by others (e.g. conservation agency staff, environment agency staff) may be interpreted using expert judgement and the results applied to the condition assessment. These observations may also trigger further detailed investigations and/or remedial action.

Where macrophyte and macroinvertebrate assemblages are to form part of the assessment, data on the former should be collected from the field using the standard LEAFPACS method. Data on macroinvertebrates may be obtained from the appropriate environment agency unless a new programme of survey is planned specifically for condition monitoring.

Additional information that could prove useful for subsequent assessment of condition should also be gathered, including evidence of point source pollution, recent management of channel vegetation, and any signs of obvious changes since the previous visit. Points where specific observations are made should be marked on the site map, as well as being noted on the recording form.

3 Skills requirements for monitoring

The field components of assessment require expertise in aquatic macrophyte survey and identification, as well as experience in RHS 2003 (Environment Agency, 2003) and Phase 1 habitat survey. Operational staff in the conservation agencies may be able to carry out some aspects of the field work but external contractors will often be required. All surveyors undertaking field work must have accreditation where such a scheme exists, e.g. RHS accreditation from the Environment Agency.

4 Attributes and targets

Where generic targets are provided in the following sections they should be applied at site-level unless:

- there is specific allowance made for deviating from generic values in the case of an individual attribute;
- compliance with a generic target in an individual assessment unit (or part thereof) can be demonstrated to be technically infeasible, even in the long-term, such that it is not a suitable management objective.

In the case of the latter, a target value should be set to approach the generic target as closely as possible.

Table 1 indicates whether attributes should be considered mandatory or discretionary.

Table 1. List of attributes and when these should be included in condition assessments

Attribute	Mandatory or discretionary
Flow	Mandatory
Water quality	
Organic pollution	Mandatory
Reactive phosphorus	Mandatory
Trophic Diatom Index	Mandatory
Acidification	Mandatory only in low alkalinity assessment units (defined as WFD water bodies with siliceous or peat geologies).
Other pollutants	Mandatory
Habitat structure	
Channel planform	Mandatory
Habitat Modification Score	Mandatory
Bank vegetation naturalness	Mandatory
Riparian zone vegetation naturalness	Mandatory
Large woody debris	Mandatory, except where naturally absent or where removal of woody debris is necessary for public safety.
In-channel structures	Mandatory
Fine sediment	
Siltation	Mandatory
Negative indicators	
Alien/locally absent species	Mandatory
Biological assemblages	
Plant community	Mandatory in relevant units in all sites designated for H3260 Rivers with Ranunculion. Discretionary elsewhere.
Macroinvertebrates:	Mandatory. Use of the AWICS and PSI metrics is discretionary depending on context.
a) General macroinvertebrates assessment	Mandatory
b) AWICS (acidification tool)	Mandatory only in low alkalinity assessment units (defined as WFD water bodies with siliceous or peat geologies).
c) PSI (siltation tool)	Mandatory in lowland areas, and recommended for all assessment units where invertebrate data are available.
Indicators of local distinctiveness	Discretionary
Direct human disturbance	
Fish stocking Exploitation Weed cutting	These activities do not comprise condition targets but are intended to help set the context for condition assessment.

In instances where data are required from the environment agencies (e.g. for flow, water quality) to make an assessment but are not available, yet pressures are evident on the site, conservation agency staff must record the need for further data collation instead of providing a conclusion of favourable condition. These pressures may be sufficient to generate an unfavourable assessment. However, where it is clear that there is no pressure relating to a specific attribute on a site (or part of a site), then it may be appropriate to draw a conclusion of favourable condition in respect of that attribute in the absence of such data.

Note: If standards for GES under the WFD are more stringent than CSM targets then those GES standards should be used as targets for favourable condition. If HES has already been achieved then those standards should be used as favourable condition targets.

4.1 Flow

Assessing compliance with flow targets is mandatory where data are available to make a judgement, unless there are no flow modifications affecting the site that are likely to give rise to non-compliance.

River flow affects a range of habitat factors of critical importance to characteristic flora and fauna, including current velocity, water depth, wetted area, substrate quality, dissolved oxygen levels and water temperature. The maintenance of both flushing flows and seasonal base flows, based on natural hydrological processes, is vital. Detailed investigations of habitat–flow relationships may indicate that a more or less stringent threshold may be appropriate for a specified reach; however, a precautionary approach would need to be taken to the use of less stringent values.

The availability of data on river flows varies considerably around the UK, particularly with respect to human impacts on natural flow regimes. Conservation agency staff may require considerable assistance with handling and interpreting such information. Where available, data on mean daily naturalised flow should be used. Naturalised flow is defined as the flow in the absence of abstractions and discharges. Such an analysis requires that flow naturalisation procedures are applied to the river, with the subsequent application of flow accretion procedures, to assess spatial patterns in naturalised flows and human pressures on those flows (abstraction/impoundment).

The availability and reliability of data is patchy – long-term gauged data can be used until adequate naturalised data become available, although the impact of abstractions on historical flow records should be considered.

Other sources of information, such as specific hydrological studies or strong circumstantial evidence of flow problems on particular river stretches, may also be used to inform the assessment of condition. Indicators of problems may be a very shallow water depth, a reduction in the wetted area, or reduced water movement compared with what might be expected. It can often be very difficult to determine whether low water availability is a consequence of natural processes or human impact, and whether observed impacts result from changes in flow (due to abstractions or upstream impoundment) or from channel engineering (due to over-sizing of the channel or water backing up behind weirs). It is important that any problems that lead to a judgement of ‘unfavourable’ are artificially induced. Headwater sections are particularly vulnerable to abstraction, and downstream migration of perennial heads, other than in times of drought, is a sign of unfavourable condition.

<u>Flow targets</u>

Guidance on generic flow targets is given in Tables 2 and 3. The principle flow targets given in Table 3 should be taken as the minimum expected for an SAC river where appropriate and locally agreed targets are not already in place.

Table 2. River flow targets and method of assessment

Targets for river flow	Method of assessment
The natural flow regime of the river should be protected. Daily flows should be close to what would be expected in the absence of abstractions and discharges (the naturalised flow). Flow targets for WFD high ecological status should be used to avoid deterioration and for restoration where this is technically feasible. These are: <5% deviation at <Qn95 and <10% at >Qn95 - based on 'natural' water (i.e. water that has not been abstracted and returned).	Gauging station data and expert assessment from relevant environment agency
There should be no obvious problems with water availability within the assessment unit	Field observations/spot gauging
Springs in aquifer-fed rivers should be maintained	Field observations

Table 3. Flow targets in relation to river size and discharge

River size	< Qn_{95} (Low flows)	Qn_{50-95} (Low-moderate flows)	Qn_{10-50} (Moderate-high flows)	> Qn_{10} (High flows)
Headwater	5	10	15	15
River	10	15	20	10
Large river	15	20	20	20

Qn: daily naturalised flow. Figures are percentage deviations from daily naturalised flow.
River Habitat Survey (RHS) river flow categories are used to discriminate river size (see below). Figures show annual mean flow.

- Flow category 1: < 0.31 $m^3 s^{-1}$ (headwater)
- Flow category 2: 0.31 - 0.62 $m^3 s^{-1}$ (headwater)
- Flow category 3: 0.62 - 1.25 $m^3 s^{-1}$ (river)
- Flow category 4: 1.25 - 2.5 $m^3 s^{-1}$ (river)
- Flow category 5: 2.5 - 5.0 $m^3 s^{-1}$ (river)
- Flow category 6: 5 -10 $m^3 s^{-1}$ (river)
- Flow category 7: 10 - 20 $m^3 s^{-1}$ (river)
- Flow category 8: 20 - 40 $m^3 s^{-1}$ (river)
- Flow category 9: 40 - 80 $m^3 s^{-1}$ (large river)
- Flow category 10: > 80 $m^3 s^{-1}$ (large river)

The results of local hydroecological investigations can be used to refine default generic flow targets where appropriate, or to define additional flow targets. In order to refine default flow targets investigations have to consider all key mechanisms of impact on characteristic biological communities, both in respect of changes in habitat character and habitat space. They also have to recognise that flow targets must be consistent with the needs of the river habitat under favourable physical and chemical conditions, necessitating hydroecological evaluation against suitable reference conditions. In instances where locally derived targets are deemed to be adequate replacements for generic flow targets they should still retain the same form of expression (i.e. % deviations from daily naturalised flows).

Local investigations might not justify refinements to flow targets for the whole assessment unit but might justify a less stringent target over a short length based on a natural lack of flow-sensitive mesohabitats within that length. Any such judgement should be subject to the same evaluation criteria as above. Equally, a local investigation may provide good grounds to modify the generic target for low naturalised flows (<Qn95) but not for higher naturalised flows.

For rivers with a headwater impoundment that cannot be removed, a benchmark flow regime should be derived that is as close to the natural flow regime as possible. The impacts of downstream flow modifications should be based on percentage deviations from this benchmark.

Compliance assessment: flow

Compliance assessment should be undertaken for each assessment unit within the SSSI/SAC in collaboration with the appropriate environment agency, and should consider the 6 years of daily flow data preceding the assessment. Daily observed and naturalised flows should be plotted in a time sequence at any available gauging station within the assessment unit, together with relevant flow targets. Flow accretion diagrams should be generated for a range of flow conditions (Q99, Q95, Q80, Q50, Q30 and Q10) to identify any non-compliant stretches within the assessment unit.

Spatial and temporal tolerance limits can be placed on the compliance test. A total of 10 days of continuous non-compliance in any one year, or 20 days of non-compliance overall in any one year should be considered as the maximum that could be considered acceptable, as long as the increased impact on naturalised flows is not dramatic (perhaps greater than twice the deviations allowed for by the flow targets that apply). It is also suggested that non-compliance over a total river length of no more than 5% of an assessment unit should be considered as the maximum acceptable, again as long as the increased impact on naturalised flows is not dramatic.

Where daily naturalised flows are not available, a crude assessment can be based on weekly or monthly naturalised flows, or historical flow records where these are not significantly affected by flow modifications. However, these should be considered interim measures in lieu of daily naturalised flows, and their application should consider the local likelihood of large flow modifications of short duration that would not be detected by such data.

4.2 Water quality

Assessment of water quality targets is mandatory. Data for each water quality indicator from the past 3 years should be requested from the appropriate environment agency, for all routine water quality survey points within each assessment unit. Compliance with each numerical target should be judged on face value (i.e. is the observed value numerically greater than the target value?). The assessment unit is judged unfavourable for a water quality indicator if any of the routine sampling points within the unit fails to comply with the target.

Sampling sites may be sparsely distributed across the river network and water quality can be very variable within an assessment unit, depending on the location of sources of pollution and dilution. Where modelled data are available, each assessment unit should comply with the relevant target throughout its length. This allows for limited non-compliance with the mixing zones of individual effluents, since water quality models assume full mixing at the point of discharge. Where no modelled data are available, a ‘best-endeavours judgement’ will need to be made about the ability of sparse routine monitoring points to detect spatially significant impacts on organic pollution status within the site and within each assessment unit. This could involve extrapolations of pollutant concentrations from routine monitoring sites to downstream river stretches using crude estimates of dilution from tributaries.

4.2.1 Organic pollution

Organic pollution is assessed using a combination of physico-chemical and biological attributes. Table 4 provides the target values to be applied across all river types. Targets apply throughout the assessment unit, not just at sparsely distributed monitoring sites.

Table 4. Organic pollution targets

Attribute	Target
10%ile DO (% saturation)	85
Mean BOD (mg L^{-1})	1.5
90%ile total ammonia (NH_3-N, mg L^{-1})	0.25
95%ile un-ionised ammonia (NH_3-N, mg L^{-1})	0.025

Compliance assessment: organic pollution

Chemical data from all routine monitoring sites should be obtained from the relevant environment agency for the 3 years preceding the time of condition assessment. The statistics in the table should be calculated using all samples within that 3-year period.

Data should be requested in the form required for CSM targets (relevant summary statistics/metrics). If this is not possible, raw data (i.e. individual measurements) for the 3-year period should be requested and transformed into the relevant summary statistics. Note that data on un-ionised ammonia can be calculated from total ammonia and other physico-chemical data available from routine environment agency monitoring.

4.2.2 Reactive phosphorus

Compliance with these two targets is mandatory as an annual mean and March-September growing season mean. Elevated phosphorus levels interfere with competitive interactions between higher plant species and between higher plants and algae, leading to dominance by attached forms of algae and a loss of characteristic plant species (which may include lower plants such as mosses and liverworts). The respiration of artificially large growths of benthic or floating algae may generate large diurnal sags in dissolved oxygen and poor substrate conditions (increased siltation) for fish and invertebrate species.

Nutrient targets for the river should reflect natural/background concentrations and limit enrichment to levels at which adverse effects on characteristic biodiversity are unlikely. Targets apply throughout the site, not just at sparsely distributed monitoring sites. Tables 5 and 6 provide generic target values for soluble reactive phosphorus (SRP) according to a broad river typology; however, if standards for good ecological status under the Water Framework Directive are **more stringent** than the targets in Tables 5 and 6 then **these apply**. Under these circumstances if high ecological status is already achieved then these targets should continue to be met. **Where current phosphorus concentrations comply with the values laid down in Table 5, these values should form the target**. In rivers/assessment units where it is feasible to reduce phosphorus concentrations to comply with the relevant target in Table 5, this target should also be adopted. **Where a reach is not compliant with the relevant target in Table 6, this target should normally be adopted in conservation objectives**. If better local characterisation of natural/background concentrations is available, (e.g. where observed concentrations in the river are much lower than the generic target implied by the typology), changes to these generic values can be made to give a more accurate description of near-natural nutrient status.

For upland river SSSIs/SACs, organic phosphorus is a major source of P in catchments with significant coverage of peat. Elevated concentrations should be noted as part of condition assessment (national specialists can be consulted).

Table 5. Proposed phosphorus targets (µg L^{-1} SRP) for near-natural examples of SSSI/SAC river habitat.

River type			Headwater	River	Large river
High altitude (>80 metres)	Low alkalinity (<50 mg L^{-1} $CaCO_3$)		5	10	20
	High alkalinity (>50 mg L^{-1} $CaCO_3$)		7	15	25
Low altitude (<80 metres)	Low alkalinity (<50 mg L^{-1} $CaCO_3$)		15	20	30
	High alkalinity (>50 mg L^{-1} $CaCO_3$)	Chalk	20	30	40
		Clay	20	30	40

To be applied as a growing season (March-September) mean and as a whole year mean
River Habitat Survey (RHS) river flow categories are used to discriminate river size. (See notes under Table 3.)

Values for site altitude and alkalinity in the river typology used in Tables 5 and 6 are derived from a WFD typology used by the environment agencies. All river stretches forming part of WFD water bodies will already have been categorised by the environment agencies using these altitude and alkalinity thresholds, and should be available from them.

Table 6. Proposed maximum phosphorus concentrations (µg L^{-1} SRP) consistent with favourable condition of SSSI/SAC river habitat.

River type			Headwater	River	Large river
High altitude (>80 metres)	Low alkalinity (<50 mg L^{-1} $CaCO_3$)		10	20	30
	High alkalinity (>50 mg L^{-1} $CaCO_3$)		15	25	40
Low altitude (<80 metres)	Low alkalinity (<50 mg L^{-1} $CaCO_3$)		30	40	50
	High alkalinity (>50 mg L^{-1} $CaCO_3$)	Chalk	40	50	50
		Clay	40	50	60

To be applied as a growing season (March-September) mean and as a whole year mean
River Habitat Survey (RHS) river flow categories are used to discriminate river size. (See notes under Table 3.)

Targets for total inorganic nitrogen (TIN) can be applied where there is site-specific evidence for nitrogen-mediated eutrophication that is not amenable to control by applying phosphorus targets in isolation. As a guide, values of TIN of around 10 times greater than the SRP target applicable to the river stretch are likely to provide equivalent control of nutrient availability to proposed phosphorus targets.

Compliance assessment: phosphorus

In rivers, phosphorus is normally measured using a method with a detection limit of 20 µg L^{-1} (0.02 mg L^{-1}). A more sensitive method with a detection limit of around 1 µg L^{-1} (0.001 mg L^{-1}) is available and for sample points where the measured value is regularly less than the detection limit using the normal method, arrangements should be made to use the sensitive method. There is no additional cost involved but the sensitive method is not suitable for use in rivers with a high P concentration (> about 50 µg L^{-1}) as it gives inaccurate results.

Chemical and biological data from all routine monitoring sites should be obtained from the relevant environment agency for the 3 years preceding the time of condition assessment. Data should be requested in the form required for CSM targets (relevant summary statistics/metrics). Alternatively, raw data (i.e. individual measurements) for the 3-year period should be requested and transformed into the relevant summary statistics.

Note that SRP may be termed 'orthophosphate' in water quality archives, but if this is the case it is important to check that values are expressed as µg P and not µg PO_4. In England and Wales, total reactive phosphorus (TRP) may be monitored – this is the SRP analysis but undertaken on an unfiltered sample. TRP can be significantly higher than SRP from the same sample, but if the sample passes the target using TRP data then it will have passed the SRP target.

For each monitoring site within an assessment unit, all of the data within the 3-year data set that relate to the growing season (taken as March to September inclusive) should be pooled to generate a growing season mean. The mean of all samples within that 3-year period is also taken and that result is used to assess the target for the whole year mean.

4.2.3 Trophic Diatom Index

The target using the Trophic Diatom Index (TDI) Ecological Quality Ratio should be a normalised EQR of≥ 0.8, equivalent to high ecological status (WFD -UKTAG, 2014a). This target should be used as an adjunct to nutrient targets proposed in Tables 5 and 6 respectively.

Environment agencies typically take two or three diatom samples each year at routine monitoring sites. Any sample failing to comply with the relevant biological target within the 3-year period at any sampling site in the assessment unit should be regarded as non-compliant. As with chemical targets, there may be considerable variation in the status of the diatom community within the assessment unit, but it is not possible to characterise this variation with routine monitoring data. If significant problems are suspected that are undetected by routine monitoring, a more detailed investigation should be considered involving spatially intensive sampling within the assessment unit.

4.2.4 Acidification

This target applies only to assessment units whose WFD water body type is classified as siliceous or peat. (See metadata available for WFD water bodies.) Other types have good buffering capacity and therefore will not be affected by acidification.

Acid deposition can cause major changes to flora, fauna and ecosystem functioning and affects organisms as diverse as diatoms, invertebrates and fish. Upland streams are particularly susceptible owing to the higher rainfall in these areas. Acid impacts are typically sporadic and tend to be greatest during the winter months. In humic (peat-stained) waters, pH is naturally lower due to the presence of weak acids, and the pH standard is correspondingly lower for these waters. However, humic compounds also provide buffering capacity that helps to reduce fluctuations in pH. Acidification lowers dissolved organic carbon in these waters, reducing the buffering capacity and altering ecosystem functioning.

It is important when carrying out an assessment to ensure that the monitoring points are appropriately sited within the assessment unit. Upland areas are most sensitive. Sampling points situated in lowland areas may not reflect the extent and severity of acid impacts owing to changes in geology and agricultural activities such as liming.

The targets proposed here are the same as the high/good boundary proposed for the Water Framework Directive (WFD-UKTAG, 2012a). Chemical assessment of acidity may be carried out using either pH or Acid Neutralising Capacity (ANC) data. ANC is calculated as:

$$ANC = (\text{Alkalinity in } \mu \text{ eq } L^{-1} + (4.5 \times \text{Dissolved Organic Carbon in mg } L^{-1}))$$

Water samples usually will include pH, alkalinity and DOC data so it will normally be possible to assess both. An invertebrates tool (AWICS – see 4.6.2b) is available to assess the impact of acidification on the biota and complements this attribute.

Table 7. Acidification targets

Targets for acidification	Method of assessment
ANC: Mean ANC for all waters > 80 pH (Clear waters with DOC<10 mg L^{-1}) : mean > 6.54 pH (Humic waters with DOC>10 mg L^{-1}): mean > 5.1	Analysis of water chemistry data from environment agencies. At least 36 samples (3 years of data) are required, which must include winter samples.

4.2.5 Other pollutants

Data on the chemical status of individual water bodies are available from the environment agencies. Good chemical status is the target for any pollutant listed on Annex VIII of the WFD and not specifically considered above.

4.3 Habitat structure

Watercourses with a high degree of naturalness will be governed by dynamic processes that result in a variety of physical habitat features, including a range of substrate types, variations in flow, channel width and depth, in-channel and side-channel sedimentation features, erosion features and both in-channel and bankside vegetation cover (Boxes 2.0, 2.1 & 2.2).

River sections that fail monitoring targets because of significant physical modification should be subject to a process for planning and implementing physical restoration measures. This should be based on restoring natural geomorphological processes as far as possible to allow restoration of characteristic and sustainable habitats, working within the practical constraints of essential flood protection for people and the built environment. Following such planning, physical habitat targets for favourable condition may need to be adjusted to be compatible with the restoration plan.

Box 2.0 Physical habitat assessment using RHS

Data from RHS and the bank vegetation module are used to provide assessments of the following attributes: Habitat Modification Score; bank and riparian vegetation; large woody debris; in-channel structures; siltation.

The RHS manual (Environment Agency, 2003) must be used for all River Habitat Surveys, recording the results on the standard field survey sheets.

The frequency of RHS sites along a river is likely to be a compromise between a complete coverage of the whole river and the limitations of resources for carrying out survey work. In some cases (e.g. some of the very short stretches of river SSSIs in Scotland that are only a few kilometres in length) it may be feasible to carry out contiguous RHS for the entire designated site. The minimum frequency should be a 10% coverage (i.e. 1 site every 5 km), coincident with macrophyte monitoring sites where this is done. A frequency of 25% (1 site every 2 km), if affordable, is a good compromise as it has been found to provide a reasonably reliable characterisation of the physical features of a river (Wilkinson *et al.*, 1998).

The location of each RHS (and macrophyte monitoring) site should be marked on a map of the site. It is recommended that GPS and site photographs are used to facilitate accurate relocation of sites on future visits; where RHS transects are surveyed each should include a photograph and GPS location record.

Once completed, RHS survey forms must be collated and sent (along with site photos) to the Environment Agency for quality assurance and entry of data into the RHS Database. Data are then extracted from the RHS Database in processed spreadsheets and sent back to the conservation agency. (Note that this process can take time so this must be taken into account when planning monitoring for condition assessments.) Data can then be used to assess the condition targets below which require RHS data. For 'riparian zone vegetation naturalness' data can be extracted directly from the RHS processed spreadsheets and copied into the data processing template which is used to assess this attribute.

4.3.1 Channel planform

An assessment of river planform (i.e. the shape of the river when viewed from above) is important in determining whether the natural course of the river has been artificially straightened or moved. In many circumstances, a natural channel may move in response to extreme floods - this is a positive conservation attribute, as opposed to re-alignments for flood defence which aim to keep the river in its modified channel permanently.

Table 8. Channel planform targets

Targets for channel planform	Method of assessment
Channel form should be generally characteristic of river type, with predominantly unmodified planform. ≤ 5% of the assessment unit should be artificial, re-aligned or constrained.	Assess planform using map data, aerial survey data, historical records and local knowledge.

4.3.2 Habitat Modification Score (HMS)

HMS is a metric derived from RHS data. It is based on the nature of modifications to a river and their estimated persistence, and is used to indicate the overall extent of habitat modification.

Table 9. Targets for Habitat Modification Score

Target for HMS	Method of assessment
≥65% or more of condition monitoring sites should fall within the *semi-natural* HMS class 1, with the remainder *predominantly unmodified* (class 2). No (or minimal) deterioration from the last monitoring cycle.	HMS scores obtained from the Environment Agency.

4.3.3 Bank vegetation naturalness

Table 10. Targets for bank vegetation naturalness

Target for bank vegetation naturalness	Method of assessment
Mean SERCON score for the assessment unit of 4 or 5	Simplified Phase I habitat survey, carried out at the 10 RHS transect locations (Box 2.1).

Box 2.1 Assessing Bank Vegetation Naturalness

Note: these data are not recorded in the standard RHS survey. The simplified Phase 1 Habitat Survey should be undertaken while carrying out the RHS survey work, using a separate sheet to note down bank vegetation categories.

The following text is modified from the SERCON 2 technical manual (SERCON attribute NA 5 – Naturalness: Plant Assemblages on the Banks)

Each RHS site is surveyed with respect to the broad habitat categories listed in Table 1 (below) and in the descriptive notes beneath the table. When recording a vegetation type as present (✓), it must occur as more than a single out-crop (i.e. it should be ≥5 m^2 or occupy at least 1% of the bank face on a 500 m length). For land-use categories to be recorded as extensive these should "occur" (= presence) along > 33% of the total bank length (but not necessarily cover > 33%).

When recording vegetation types on river banks as an added module to standard RHS, spot-check records relate to the bankface and banktop in the 10 m wide transect. Surveys result in 20 separate records for each RHS site – the left and right bankfaces and banktops of the 10 spot-check transects. **Use the Bank Vegetation Naturalness Excel file to collate and analyse field data.** This includes step-by-step instructions and automated routines for the following calculations.

Using points assigned to vegetation types in Table 1:

(i) Calculate the total points for each RHS site within the assessment unit (maximum score 100 if all 10 transects score (2x) 5 points for the presence of one of the semi-natural vegetation types in Table 1);

(ii) Assign the initial SERCON score for each RHS site as follows:

SERCON score	Points
0	0-15
1	>15-30
2	>30-45
3	>45-60
4	>60-75
5	>75-100

(iii) Calculate the overall score for the assessment unit as the mean of scores from all RHS sites.

Table 1. Phase 1 vegetation categories together with points assigned for use in assessments of the naturalness of bank plant assemblages

Broad description	Code	Detailed description	Points
A. Woodland and scrub	A1	Semi-natural deciduous/coniferous	5
	A2	Scrub	3
	A1p	Plantation (& planted trees)	0
B. Grassland and marsh	B1-3	Unimproved & good semi-improved	4
	B4	Improved & amenity grassland	0
	B5	Marshy grassland	4
	B6	Poor semi-improved	1
C. Tall herb and fern	C1	Bracken	1
	C2	Upland species-rich	4
	C3.1	Tall ruderal	1
	C3.2	Fern/non-ruderal	4
D. Heathland	D(1-6)	Heath & heathy acid grass	5
E. Mire	E(1-3)	Bog, flush & fen/mire	5
F. Marginal, etc.	F(1-2)	Inundation/swamp/marginal	5
	Fa	Planted reeds/marginals, etc.	2
I. Rock & artificial exposure	I1	Natural shingle/boulders/rocks	5
	I2	Artificial (e.g. revetment bryophytes)	0
J. Miscellaneous	J4a	Bare (natural)	2
	J4b	Bare (artificial)	0
	J5a	Bryophytes	5
	J5b	Other	0

Box 2.1 cont. Notes to Table 1:

A. Woodland and scrub

A1. Semi-natural deciduous/coniferous - natural and semi-natural woodland, excluding plantation.
A1p. Plantation and planted trees (sub-category of A1).
A2. Scrub - standard Phase 1, with standard exclusions such as *Myrica* (E)*, Ulex* (D).

B. Grassland and marsh

B1-3. Unimproved and Good Semi-improved Grasslands - record Unimproved Acid (B1), Neutral (B2), Calcareous (B3) according to standard Phase 1 descriptions, and also all good semi-improved grassland.
B4. Standard Phase 1 Improved grassland - also include Amenity grassland (J1.2)
B5. Marshy grassland - standard Phase 1 description - this is the category for bankside communities with a mixed herb/grass flora with abundant rushes, sedges and/or wetland herbs such as meadow-sweet, purple loose-strife, etc. Also include banks with reeds/sedges that do not have permanently high water table (*cf*. 'F').
B6. Poor semi-improved - record where flora of meadow character, but with poor diversity; exclude 'improved/amenity/tall grass/ruderal' (B4).

C. Tall herb and fern

C1. Bracken - standard Phase 1 description.
C2. Upland species-rich - standard Phase 1 description, primarily devoted to small patches of natural/semi-natural flora with species such as *Angelica*, *Filipendula*, *Solidago*, *Athyrium*, *Trollius* and *Crepis*.
C3.1 Tall ruderal - standard Phase 1 description, primarily for nettle, knotweed, etc.
C3.2 Fern/non-ruderal - standard Phase 1 description, primarily for shaded banks with ferns or *Luzula*.

D. Heathland

Phase 1 has 6 categories (D1-6) for Heath & heathy acid grass - use standard Phase 1 descriptions to code just as 'D' and provide D1-6 information as target notes if desired. Includes heather, gorse, lichen/bryophyte.

E. Mire

Phase 1 has 3 categories - Bog (E1), Flush (E2) and Fen/Mire (E3) - use standard Phase 1 descriptions to record as 'E' - target notes referring to E1-3 will be determined by the adjacent riparian habitat type.

F. Marginal, etc.

F. Swamp/Marginal/Inundation **-** use standard Phase 1 descriptions to record as 'F' where river margin merges with natural or semi-natural tall reed/sedge/mixed communities with permanently high water-table.
Fa. Planted reeds/marginals, etc. (not standard Phase 1 category - reserved for vegetation restoration areas).

I. Rock & artificial exposure

I1. Natural shingle/boulder/rock - extend standard Phase 1 descriptions to include banks with shingle flora (transient) and banks dominated by natural boulders or other rocks with bryophytes and semi-natural herb communities between and in fissures.
I2. Artificial - extend standard Phase 1 description to include all revetments and artificial structures with bryophytes or higher plants between cracks, etc.

J. Miscellaneous

J4a. Miscellaneous - Naturally bare - include standard Phase 1 descriptions and bare peat category (E4).
J4b. Miscellaneous - Artificially bare - include all bare man-made banks.
J5a. Bryophytes – banks dominated by mosses and liverworts (common for upland river banks).
J5b. Other - use for any other communities not covered above (should be avoided unless essential, and target notes provided).

4.3.4 Riparian zone vegetation naturalness

Table 11. Target for riparian zone vegetation

Target for riparian zone vegetation	Method of assessment
Mean score for the assessment unit of 4 or 5	RHS transect data using the method described in Box 2.2.

Box 2.2 Assessing riparian zone vegetation naturalness

The following text is modified from the SERCON 2 technical manual (SERCON attribute NA 6 – Naturalness: Riparian Zones)

Naturalness of the vegetation of the riparian zone is scored using data recorded in section 'F' of the RHS form (land-use within 5 m of bank-top). Twenty land-use values are recorded for each RHS site, 10 on each bank. Eighteen categories can be coded, each one of which has been assigned points of 0-4 according to the 'naturalness' of the vegetation (see Table 1 below). Ignore entries of 'NV' (not visible). For land use categories to be recorded as extensive these should "occur" (= presence) along > 33% of the total bank length (but not necessarily cover > 33%).

Use the Riparian Zone Naturalness Excel file to collate and analyse field data. This includes step-by-step instructions and automated routines for the following calculations. The score is derived in four steps (a-d):

(a) Using points assigned to vegetation categories in Table 1:

(i) Calculate the total points for each RHS site within the assessment unit (maximum score 80 if all 10 transects score (2x) 4 points for the presence of one of the semi-natural land-use types in Table 1).

(ii) Determine the mean score by dividing the total points by the number of entries (normally 20, but will be fewer if 'NV' has been entered).

(iii) Calculate the score for each RHS site as follows:

Score	Points
0	0 – 0.5
1	> 0.5 – 1.25
2	> 1.25 – 2.00
3	> 2.00 – 2.50
4	> 2.50 – 3.00
5	> 3.00

Table 1: RHS land-use categories together with points assigned for use in assessments of riparian zone naturalness

RHS land-use categories	RHS code	Points
Broadleaf/mixed woodland	BL	4
Broadleaf/mixed plantation	BP	1
Coniferous woodland	CW	4
Coniferous plantation	CP	0
Scrub and shrubs	SH	3
Orchard	OR	1
Wetland (e.g. bog, marsh, fen)	WL	4
Moorland/heath	MH	4
Artificial open water	AW	1
Natural open water	OW	3
Rough/unimproved grassland/pasture	RP	3
Improved/semi-improved grassland	IG	1
Tall herb/rank vegetation	TH	2
Rock, scree or sand dunes	RD	4
Suburban/urban development	SU	0
Tilled land	TL	0
Irrigated land	IL	0
Parkland or gardens	PG	0

(b) Using Section H of the RHS form, modify the initial SERCON score for each RHS site as follows:

Add 1 to the SERCON score when one or more of the following is recorded as extensive ('E') on one bank: RP, SH, OW
Add 2 to the SERCON score when one or more of the following is recorded as extensive ('E') on both banks: RP, SH, OW

Add 2 to the SERCON score when one or more of the following is recorded as extensive ('E') on one bank: BL, CW, WL, MH, RD
Add 3 to the SERCON score when one or more of the following is recorded as extensive ('E') on both banks: BL, CW, WL, MH, RD

Subtract 1 from the SERCON score when one or more of the following is recorded as extensive ('E') on one bank: CP, TL, IL, PG
Subtract 2 from the SERCON score when one or more of the following is recorded as extensive ('E') on both banks: CP, TL, IL, PG

Subtract 2 from the SERCON score when SU is recorded as extensive ('E') on one bank.
Subtract 3 from the SERCON score when SU is recorded as extensive ('E') on both banks.

(c) Following additions/subtractions, round the score down to 5 (if the score is greater than 5 following additions) and up to 0 (if the score is less than 0 following subtractions).

(d) Calculate the overall score in the assessment unit as the mean of scores from all RHS sites.

4.3.5 Large woody debris

Dead woody material that falls into streams ('woody debris') plays an important role in increasing habitat diversity, providing shelter for fish, supplying a food source for aquatic invertebrates, and for slowing the passage of nutrients downstream. Large woody debris, as defined in RHS as, 'whole trees or large trunks and branches swept downstream and lodged in the channel or on the banks', is a key feature of healthy rivers. However, it may be removed by flood defence engineers, angling organisations and farmers to reduce flood risk and avoid entangling fishing lines. Large woody debris is also sometimes perceived as an obstacle to fish migration, although such obstacles are usually temporary.

Data on large woody debris are available from the 'sweep-up' section of the River Habitat Survey form (Section J – 'Extent of trees and associated features'), recorded as 'absent', 'present' (>0-33% of bank length) or 'extensive' (>33% of bank length).

Two targets are available, reflecting the tendency of woody debris to be moved during floods and occasionally to form debris dams. These targets should be viewed as interchangeable for all assessment units.

Trends in status cannot be determined for an individual assessment unit. Recovering or declining trends can only be assessed by comparing the number of units passing the target within the entire designated site.

Table 12. Targets for large woody debris

Targets for large woody debris	Method of assessment
Within each assessment unit: EITHER 75% or more RHS sites have large woody debris 'Present' OR 10% or more of RHS sites have large woody debris 'Extensive'	River Habitat Survey Data. At least 5 RHS sites should be examined for this target – if fewer than 5 sites are available, assessment units should be amalgamated.

Where targets are not met, the reasons should be identified. An assessment unit should not fail if there are no (or very few) naturally occurring trees to provide a source of woody debris (e.g. upland or fenland rivers), or where this is removed for overriding reasons of public safety (for example to prevent flooding or bridge collapse).

4.3.6 In-channel structures

Artificial in-channel structures such as weirs, dams, sluices, fords, groynes and culverts may constitute barriers to the free movement of water, sediment and aquatic organisms, and may affect river-bed structure and hydrology downstream. Although attention is often focused on whether artificial structures allow the passage of migratory fish, the wider environmental impacts also need to be considered in the assessment of site condition.

The extent of the changes brought about by artificial structures depends on the size and location of the barrier, and (in some cases) on the mode of operation. For example, flow regimes downstream of hydroelectric dams often show rapid increases and declines, with high, stable peak flows during periods of power generation. This is likely to cause significant alterations to substrate character, and exert direct impacts on plant and animal populations. The effect on habitats and species of a small weir or groyne may be relatively insignificant, although a number of such weirs may have a significant cumulative impact.

Table 13. Targets for in-channel structures

Targets for in-channel structures	Method of assessment
Throughout the assessment unit: if present, structures should have no effect (or minor effect) on migration, on sediment transport, and habitat structure. Assessments should include the upstream 'ponding' effects that artificial structures have on flow patterns and habitat structure.	Use expert judgement to assess the assessment unit. Data sources may include: * Local/management personnel/expert assessment * Hydromorphological and walk-over surveys * River Habitat Survey (RHS) * Air photos * Fisheries personnel * Special surveys assessing structures * River Obstructions (EA dataset) * Rapid assessment methodology to assess obstacles to fish migration (SNIFFER project WFD 111)

4.4 Fine sediment

4.4.1 Siltation

Siltation is the unnatural accumulation of silt on other substrates (including aquatic plants), and is caused by high particulate loads or reduced scour within the channel. There is general agreement that siltation is one of the most widespread pressures on rivers in farmed landscapes. Siltation within and on top of coarse beds is a major threat to interest features (including species such as salmon and freshwater pearl mussel) and is poorly measured by existing WFD tools. For river types characterised by extensive *Ranunculus* beds, there should be a predominance of 'clean' gravels, pebbles and cobbles with relatively low cover by silt-dominated substrates. Localised accumulations of silt on the inside of bends or in back channels do not necessarily indicate a problem.

Targets for siltation are derived from RHS. The Proportion of Sediment-sensitive Invertebrates (PSI) metric may also be used (see section 4.6.2c). Direct measurement of suspended solids

or turbidity is not recommended, because values vary naturally in response to changes in flows with no clear understanding of a suitable reference value.

Table 14. Targets for siltation

Targets for siltation	Method of assessment
No unnaturally high levels of siltation as indicated by: (a) 'silting' highlighted in section P of the RHS form ('Overall characteristics – major impacts') OR (b) one-third or more of the total number of RHS spot-checks in the assessment unit have silt (SI) as the predominant channel substrate	Field observations and site specific information derived from RHS.

4.5 Negative indicators

4.5.1 Alien/locally absent species

Non-native species constitute a major threat to many river systems. For example, species such as signal crayfish have been responsible for much of the decline of native crayfish through competition, habitat damage and the introduction of crayfish plague.

Some species native to Britain can be as damaging as alien species when they are introduced to parts of the country from which they were previously absent. These species are referred to as 'locally absent'. As evidence becomes available on the impacts of particular locally absent species this will enable more accurate assessments to be made of the effect these species are having on favourable condition.

Once a site is recorded as unfavourable due to alien species a control or eradication plan should be put in place as quickly as possible. If possible, eradication is the first priority, followed by control to 'ecologically acceptable' levels of infestation. The subsequent round of monitoring should assess the success of management action and consider whether the site has improved to favourable condition.

Assessment of alien species is based on the principles used in assessing high ecological status under the WFD, and applies to species on the banks and in the riparian zone as well as species of the channel and the margins.

Table 15. Targets for alien / locally absent species

Targets for alien/locally absent species	Method of assessment
No high-impact alien species established (i.e. self-sustaining populations). Standard checklists of species are based on those used for WFD assessments[1]. A site will be assessed as unfavourable when there is good evidence that any non-native species or locally absent species is causing an impact on site integrity	Where a macrophyte survey has been carried out, the presence of alien species in the UKTAG lists[1] should be noted. Where there are no macrophyte survey data, and for other organisms (e.g. invertebrates, mink), contact external organisations (e.g. EA, SEPA, NIEA, fisheries trusts and boards) for local reports on alien or locally absent species.

[1] http://www.wfduk.org/tagged/alien-species#. Note: This document includes a separate list of alien species for Ecoregion 17 (in which Northern Ireland lies); this list contains only high-impact species.

4.6 Biological assemblages

4.6.1 Plant community

Plant communities have formed the basis for identification of river types and subsequent SSSI selection (see Holmes *et al*., 1999). They are also the basis for SAC selection through the 'Rivers with *Ranunculion* vegetation' Annex 1 Habitat (H3260). Aquatic plants form an important structural and functional element in rivers, and some rivers may also support rare plant taxa that contribute to local distinctiveness, such as river jelly-lichen.

However, some river sections naturally contain few or no plants. Sections dominated by bedrock or with unstable gravels, or lowland silty sections are examples of this. The plant community may also not always be the most sensitive part of the community – for example in situations where pesticides are likely to be a threat, monitoring the invertebrate community may be preferable. For these reasons, monitoring the plant community is mandatory only in sites designated for H3260.

The assessment of plant community condition is based on the assessment of ecological status under the WFD, using the LEAFPACS methodology (Box 3.0). It is assumed that high ecological status constrains changes in the macrophyte community to an acceptable level and is therefore the target for favourable condition. Note that the assessment of algal cover is included within the LEAFPACS analysis for plant community, so it is not considered as a separate attribute within this guidance.

Box 3.0 Environment agency assessment of ecological status using LEAFPACS

The environment agencies collect data using LEAFPACS (WFD-UKTAG, 2014b), a standardised method where aquatic plant data are sampled from 100m river sections. To provide adequate confidence in the assessment, 3-5 survey sections per assessment unit must be surveyed. Data are assessed against four metrics:

- River Macrophyte Nutrient Index (RMNI), which provides an index of eutrophication;
- Number of Macrophyte Taxa (NTAXA);
- Number of Functional Groups (NFG), which assesses the structural diversity of the plant community;
- Filamentous algal cover (ALG). (Excessive cover of filamentous and epiphytic algae may be caused by prolonged low flow and/or high summer water temperatures, and may have an adverse effect on other biota and river habitats.)

These metrics are combined to give an overall EQR for the monitoring point. EQRs from several monitoring points are then combined to give an assessment of ecological status for the water body. The water body will be reported as high status for macrophytes if the LEAFPACS tool calculates that there is a 50% or more chance of reaching high status.

Where plant data have already been collected in the past 6 years by the relevant environment agency, the calculated status class should be used. Where no plant data are available new LEAFPACS survey should be undertaken. All new data must be recorded in the standard LEAFPACS river macrophyte recording Excel sheet to enable automated calculation of the biological metrics used for site classification. In addition to the plant data, other details such as site and surveyor information must be recorded. The following environmental variables are also recorded at each site: width, depth, substrate, habitat, shading, clarity and bed stability.

In addition to the information recorded during field survey, the following data must be derived for each 100m LEAFPACS site. This will enable the ecological status assessment to be made for each assessment unit.

- Slope (m km^{-1}): the drop in altitude in metres per kilometre between the altitude of the upstream and downstream ends of the assessment unit.
- Distance to source (km): distance from the upstream end of the assessment unit to the furthest upstream point of any tributary shown on a 1:50,000 scale map.
- Altitude of source (m): metres above mean sea level of the furthest upstream point of any tributary of the river shown on a 1:50,000 scale map.
- Alkalinity.

All survey data and additional information must be sent to the relevant environment agency for processing using the LEAFPACS software. (Arrangements will vary by country.) LEAFPACS metrics will then be generated and the overall classification result can be used to assess the target.

Where the assessment unit coincides with a WFD water body, the most recent LEAFPACS classification result can be used. Where the assessment unit contains parts of two or more WFD water bodies, the lowest status class applicable to the assessment unit should be used.

Table 16. Target for plant community

Targets for plant community	Method of assessment
LEAFPACS tool should give a result of high ecological status for the assessment unit.	LEAFPACS method, with 3-5 sections per assessment unit surveyed depending on its size. More variable assessment units may require more surveys.

4.6.2 Macroinvertebrates

Macroinvertebrates form a major part of the biological community of rivers and are sensitive to a range of environmental pressures. They have been routinely monitored by the UK environment agencies, and long runs of data should be available from multiple monitoring points. Most data are available at family level, although in some areas species-level data[2] may be available (Box 3.1). It is recommended that species-level data are used wherever possible as this gives increased precision to some tools, can be used retrospectively for other investigative purposes, and has the added benefit that rare species can be monitored.

[2] Strictly speaking this should be referred to as 'Taxon Level 5 (TL5)'. Not all aquatic taxa can be identified to species level, but TL5 requires that all taxa are identified to as high a resolution as possible.

Box 3.1 Environment agency assessment of ecological status using macroinvertebrates

River invertebrate data are stored by the UK environment agencies on their databases and assessed using the River Invertebrate Classification Tool (RICT). RICT is a development of the earlier RIVPACS system (Wright *et al*. 2000).

Relevant WFD metrics are:

- Whalley-Hawkes-Paisley-Trigg (WHPT) index (WFD-UKTAG, 2012b). (WHPT is an updated version of the BMWP scoring system.)
- Number of taxa (NTAXA) and Average Score Per Taxon (ASPT)
- Acid Waters Invertebrate Classification System (AWICS)
- Proportion of Sediment-sensitive Invertebrates (PSI)

The AWICS tool (Murphy *et al*., 2013) uses species-specific acid sensitivity of different invertebrate taxa to calculate the amount of acidification for each sample site against a type-specific reference value. Rivers are classified as either humic or clear depending on their dissolved organic carbon (DOC) concentration. WFD-UKTAG (2012c) provides a method statement.

PSI uses an index based on taxonomic composition and abundance to calculate siltation impacts. Reference values are site-specific based on RIVPACS predictor variables (Extence *et al*., 2013). PSI is best calculated using species-level data, but can also be applied to family-level data with some loss of resolution.

RICT allows the metric score predicted under reference conditions to be compared with observed score as a measure of impact. The water body will be reported as 'invertebrates high status' if the WHPT tool calculates that there is a 50% or more chance of reaching high status.

AWICS and PSI are used by the environment agencies but data may not be as widely available as for WHPT.

Where the assessment unit coincides with a WFD water body, the result for that water body can be used. Where the assessment unit contains parts of two or more WFD water bodies, the lowest status class applicable to the assessment unit should be used.

4.6.2a General macroinvertebrates assessment

The assessment of macroinvertebrate community condition is based on the assessment of ecological status under the WFD. It is assumed that high ecological status constrains changes in the macroinvertebrate community to an acceptable level and is therefore the target for favourable condition. The most recent WHPT classification result should be used to assess the target.

Table 17. Targets for general macroinvertebrates assessment

Targets for macroinvertebrate community	Method of assessment
WHPT tool should give a result of high ecological status for the assessment unit.	RICT macroinvertebrate data, collected by environment agencies.

4.6.2b AWICS (acidification tool)

Acidification may be measured using water chemistry (see section 4.2.4) but the extent of impacts is more reliably measured using species-level invertebrate community data. Ideally, both methods should be used.

No formal WFD targets are proposed for acidity in England and Northern Ireland, or for humic waters outside Scotland. The most appropriate targets have been applied but users should be aware that there is greater uncertainty regarding appropriate targets in these areas.

Table 18. Targets for AWICS (acidification tool)

Targets for AWICS	Method of assessment
Assessment should meet the targets for high ecological status: Clear waters (England, Wales and NI): EQR ≥ 1 Clear waters (Scotland): EQR ≥ 0.91 Humic waters: EQR ≥ 0.93	Analysis of macroinvertebrate data from environment agencies. (The target applies to low alkalinity assessment units only. It is not applicable to water bodies with mean pH > 7.)

As with chemical measurements of acidity, it is important to ensure that monitoring points are sited at locations that are likely to experience acid pressure. Routine WFD monitoring sites may not be suitable as they tend not to be located in headwaters. Discussions with the relevant environment agency may be required to influence the location of monitoring points.

4.6.2c PSI (siltation tool)

PSI (Proportion of Sediment-sensitive Invertebrates) is an index specifically developed to measure the impact of fine sediment on river-bed invertebrates (Extence *et al*., 2013). It complements the methods suggested in the siltation section, although it is recommended as a more cost-effective, accurate and easily measurable target.

PSI is at present being developed by the environment agencies as a WFD tool, and it is likely to be incorporated into standard WFD assessments by 2016.

Table 19. Targets for PSI (siltation tool)

Targets for macroinvertebrate community	Method of assessment
When PSI is formally adopted under the WFD, the target for the assessment unit should be high ecological status. Until formally adopted, the mean EQI for the assessment unit should be 0.9 or more.	Macroinvertebrate data collected and analysed by environment agencies.

4.7 Indicators of local distinctiveness

This attribute is intended to cover any site-specific aspects of this habitat feature (forming part of the reason for notification) that are not covered adequately by the previous attributes, or by separate guidance (e.g. for notified species features).

For ‘notable’ species (e.g. Red List and Nationally scarce plants or species rare in rivers) it is not intended to set a target for detailed species monitoring, rather to provide a rapid indication of presence/absence and/or approximate extent, allowing for natural fluctuations in population size. For ‘notable’ features (e.g. shingle bars) the same approach applies.

Table 20. Targets for local distinctiveness (discretionary)

Targets for local distinctiveness	Method of assessment
Maintain distinctive elements (e.g. rare species, habitat features) at current extent/levels and/or in current locations	As appropriate. See JNCC website for lists of riverine Red List, Nationally Scarce plant and invertebrate species, and others: http://jncc.defra.gov.uk/default.aspx?page=3408

4.8 Direct human disturbance

Aspects of direct human disturbance 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.

4.8.1 Fish stocking

Many priority species can be affected by fish introductions, through increased predation, competition or genetic introgression, or through disease transfer. Stocking is undesirable within SSSIs/ASSIs unless undertaken as an agreed emergency interim measure for priority species while underlying adverse environmental factors are resolved. (See also 'Negative indicators: Alien/local absent species'.)

Table 21. Target for fish stocking

Objective	Method of assessment
Fish introductions should not interfere with the ability of the river to support self-sustaining populations of characteristic species	Use stocking consents

4.8.2 Exploitation

Exploitation of particular species may pose a threat in some rivers. Species under threat include Atlantic salmon, brown trout, and sea and river lampreys. Exploitation should be licensed at sustainable levels.

Table 22. Targets for exploitation

Objective	Method of assessment
Exploitation (e.g. netting or angling) should not interfere with the ability of the river to support self-sustaining populations of characteristic species	Assessed through recorded exploitation and status of target species

4.8.3 Weed cutting

Weed cutting occurs most commonly in rivers with *Ranunculus* but can also be used in other vegetation types. It is important that patches of plants are left to flower and set seed, and a minimum of 20% of the total habitat should be left uncut for the full duration of the growing season. However, as it is not feasible to monitor this no quantitative target is given.

Table 23. Target for weed cutting

Objective	Method of assessment
A sufficient proportion of all aquatic macrophytes should be allowed to reproduce in suitable habitat, unaffected by river management practices	Field observations during macrophyte survey

5 Derivation of overall condition categories

Appendix 1 contains a summary sheet to record the results of the condition assessment.

If condition assessment is required for the whole site then all assessment units must be in favourable condition to report the whole site as favourable. However, expert judgement can be used to decide whether the failure of individual assessment units in a larger SSSI is sufficient to warrant the whole site being classed as unfavourable.

Note that agencies should communicate with each other when monitoring and reporting on cross-border rivers to ensure that a common approach is taken on either side of the border. This includes liaison with the environment agencies.

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7 Further reading

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Appendix 1. Overall condition assessment form

(One form required per designated site unless >10 assessment units)

Record - F: favourable, U: unfavourable and ND: no data
**For overall attribute: record condition category based upon assessment of all units.*

Attribute	**Assessment Unit**										***Attribute overall**
	1	2	3	4	5	6	7	8	9	10	
Flow											
Flow											
Water quality											
Organic pollution											
Reactive phosphorus											
Trophic Diatom Index											
Acidification											
Other pollutants											
Habitat structure											
Channel planform											
Habitat Modification Score											
Bank vegetation naturalness											
Riparian zone naturalness											
Large woody debris											
In-channel structures											
Fine sediment											
Siltation											
Negative indicators											
Alien/locally absent species											
Biological assemblages											
Plant community											
General macroinvertebrates assessment											

Attribute	**Assessment Unit**										***Attribute overall**
	1	2	3	4	5	6	7	8	9	10	
AWICS (acidification tool)											
PSI (siltation tool)											
Indicators of local distinctiveness											
Indicators of local distinctiveness											
Direct human disturbance											
Fish stocking											
Exploitation											
Weed cutting											
Overall condition of unit (Favourable / Unfavourable)											