UK Technical Advisory Group on the Water Framework Directive

Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive

December 2007

(alien species list updated – Oct 2008 and Nov 2008)

EXECUTIVE SUMMARY

The UK Technical Advisory Group on the Water Framework Directive (UKTAG) is a partnership of the UK's environment and conservation agencies[1]. It was formed to provide technical advice to the UK's government administrations and to the agencies that make up UKTAG. UKTAG also includes representatives from the Republic of Ireland.

This report on the classification of surface waters is one of a series of reports by UKTAG to the UK administrations setting out UKTAG's recommendations and proposals on how waters should be classified for the purposes of the Water Framework Directive. It also sets out UKTAG's recommendations on how the information provided through classification should be used in the river basin management planning process. Other reports in the series will make recommendations on the classification of surface water bodies designated under the Directive as artificial or heavily modified and on the classification of bodies of groundwater.

The classification process will result in each surface water body[2] being assigned a status class. The class given to a particular water body will represent an estimate of the degree to which the structure and functioning of the aquatic ecosystem supported by the surface water body have been altered by the all the different pressures to which that body is subject. This means that the results of classification will reflect the impacts of a much wider range of pressures on the water environment than previous classification schemes. The latter were focused mainly on chemical pollution whereas the Directive's schemes describe ecological quality and all the pressures that can affect ecological quality. As a consequence, a large proportion of water bodies across the UK are likely to be classed as worse than good status[3].

The first classifications must be published in the 'river basin management plans' at the end of 2009. Classification of all surface water bodies in time to publish maps of their status in these first plans is a considerable challenge. The report makes recommendations on how to ensure that, despite this challenge, the first classification results reflect the best current understanding of the status of the water environment - an understanding which is expected to improve over time as monitoring data, and the scientific techniques used to interpret them, expand and improve. This improvement in understanding will result in the status class of some water bodies being classified as better, or worse, than initially identified.

The principal environmental objectives of the Directive, such as protecting, enhancing and restoring all bodies of surface water with the aim of achieving good surface water status by 2015, are defined in relation to the status class of water bodies. Consequently, classification will be a key part of the implementation of the Directive. The results of classification will be used as part of the

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[1] Countryside Council for Wales (CCW), Natural England (NE), Environment Agency (for England and Wales), Environment & Heritage Service (Northern Ireland) (EHS), Joint Nature Conservation Committee (JNCC), Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH), Republic of Ireland's Department of Environment and Local Government (DELG)

[2] Unless the body is designated as artificial or heavily modified, in which case it will be assigned a chemical status class and an ecological potential class

[3] See also the results of the pressures and impacts analysis conducted as part of the characterisation work in 2004 [http://www.sepa.org.uk/wfd/character/index.htm; http://www.environment-agency.gov.uk/subjects/waterquality/955573/1001324/1654756/?version=1&lang=_e; http://www.ehsni.gov.uk/water/wfd/characterisation.htm]

processes of identifying significant risks to the achievement of the Directive's environmental objectives; directing where action to protect and improve surface waters may be needed; and assessing the success of actions taken to protect and improve these waters.

Assessments of the condition of the environment are never error free. The report makes recommendations on how the risk of misclassifying the status of water bodies can be managed and on how information on confidence in status classifications should be taken into account in deciding where action to protect and improve the status of water bodies is targeted.

The report identifies the wide range of biological, chemical, physicochemical and hydromorphological elements included in the Directive's classification schemes. It recommends how and when these elements are used in making classification decisions and sets out the proposed values for the class boundaries for each of the biological elements. It also recommends how the spatial scale of adverse impacts should be reflected in classification results through the design of monitoring programmes, the interpretation of the results of those programmes and the appropriate delineation of water bodies.

Finally, the report makes recommendations on how the results of classification should be presented. These proposals are designed to enable water managers and other interested parties to drill down to access the level of detailed information they require, including information on the confidence and precision underpinning the classifications.

Guidance on the classification of ecological status[4] has been produced at European (EU) Level through collaboration between Member States and the European Commission. It was produced as part of Europe's Common Implementation Strategy (CIS) for the Water Framework Directive. The recommendations and proposals set out in this report build on, and are consistent with, this EU guidance.

SECTION 1: THE DIRECTIVE'S CLASSIFICATION SCHEMES

1.1 Schemes covered by the report

This report covers the classification of the status of transitional water bodies[5], coastal water bodies, river water bodies and lake water bodies, including proposals for how classification results for these water bodies should be reported in the UK.

The report does not cover the Directive's classification schemes for the following. These are the subjects to separate reports.

(i) surface waters identified under the Directive as 'heavily modified water bodies' or 'artificial water bodies';
(ii) bodies of groundwater[6]; and

[4] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents&vm=detailed&sb=Title
[5] These are estuaries and brackish lagoons

(iii) Protected Areas.

Water bodies may be identified as heavily modified where:

(i) their physical characteristics have been substantially changed in character; and
(ii) the changes to their hydromorphological characteristics necessary to achieve good surface water status would have a significant adverse impact on one or more of the water uses listed in the Directive[7] or on the wider environment.

Protected Areas include the following:

(i) areas designated for the abstraction of water intended for human consumption under the Water Framework Directive;
(ii) areas designated for the protection of economically significant aquatic species. For example, this may include waters previously designated under the Shellfish Waters Directive or the Freshwater Fish Directive;
(iii) bodies of water designated as bathing waters under the Bathing Waters Directive;
(iv) nutrient-sensitive areas, including areas designated as Vulnerable Zones under the Nitrates Directive and areas designated as Sensitive Areas under the Urban Waste Water Treatment Directive; and
(v) areas designated for the protection of habitats or species under the Habitats Directive or the Birds Directive where the maintenance or improvement of the status of water is an important factor in their protection.

The river basin management plans must include maps indicating whether or not the water-related standards and objectives required under the legislation establishing each Protected Area have been achieved. For some of the Protected Areas (e.g. Bathing Waters), such maps are already produced as one of the requirements of the legislation establishing the areas. This is not the case for Drinking Water Protected Areas as these were established under the Water Framework Directive. UKTAG will provide a separate report on how compliance with the standards and objectives for Drinking Water Protected Areas will be assessed and reported.

1.2 Surface water status

Member States are required to classify the 'surface water status' of bodies of surface water. Surface water status is determined by the lower of a water body's 'ecological status' and its 'chemical status'. To achieve the overall aim of good surface water status, the Directive requires that surface waters be of at least good ecological status and good chemical status. Good surface water status is one of the principal objectives for surface water bodies not designated as heavily modified or artificial. The other principal objective is to prevent deterioration of surface water status.

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[6] UKTAG has already provided recommendations on the assessment and classification of the status of bodies of groundwater [http://www.wfduk.org/stakeholder_reviews/stakeholder_review_1-2007/].
The results of groundwater classifications will take account of the impact of groundwater pollution and abstraction on surface waters

[7] See paragraph 3 of Article 4 of the Directive.

1.3 Ecological Status

Ecological status is an expression of the quality of the structure and functioning of surface water ecosystems as indicated by the condition of a number of 'quality elements'. The Directive uses the term "quality elements" to refer to the different indicators of ecological quality comprising its ecological status classification schemes. The quality elements used to assess ecological status are:

(i) biological quality elements [See Section 1.3.1 below];
(ii) chemical and physicochemical quality elements, including general physicochemical quality elements [See Section 1.3.3(a) below], and pollutants being discharged in significant quantities, which are referred to as 'specific pollutants' [See Section 1.3.3(b) below]; and
(iii) hydromorphological quality elements [See Section 1.3.4 below].

There are five classes for ecological status; 'high', 'good', 'moderate', 'poor' and 'bad'. As noted above, the Directive requires that the overall ecological status of a water body be determined by the results for the biological or physicochemical quality element with the worst class (i.e. the quality element worst affected by human activity). This is called the 'one out - all out' principle[8] (See Figure 1a and 1b).

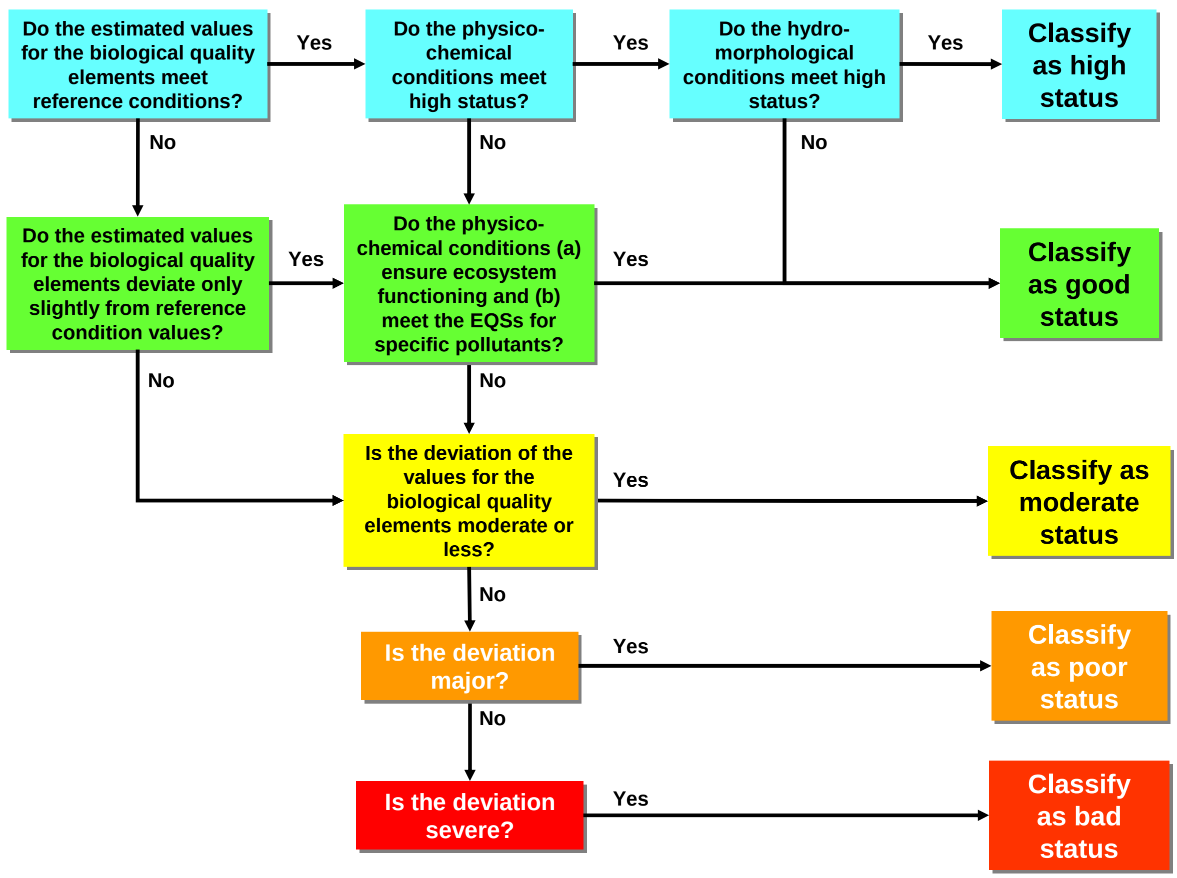

Figure 1a: Decision-tree illustrating the criteria determining the different ecological status classes[9].

[8] Annex V, 1.4.2(i) to the Directive
[9] Note: For all specific pollutants (which are a sub-set of the chemical and physicochemical quality elements) with the exception of ammonia, compliance with the environmental quality standards for good status will be

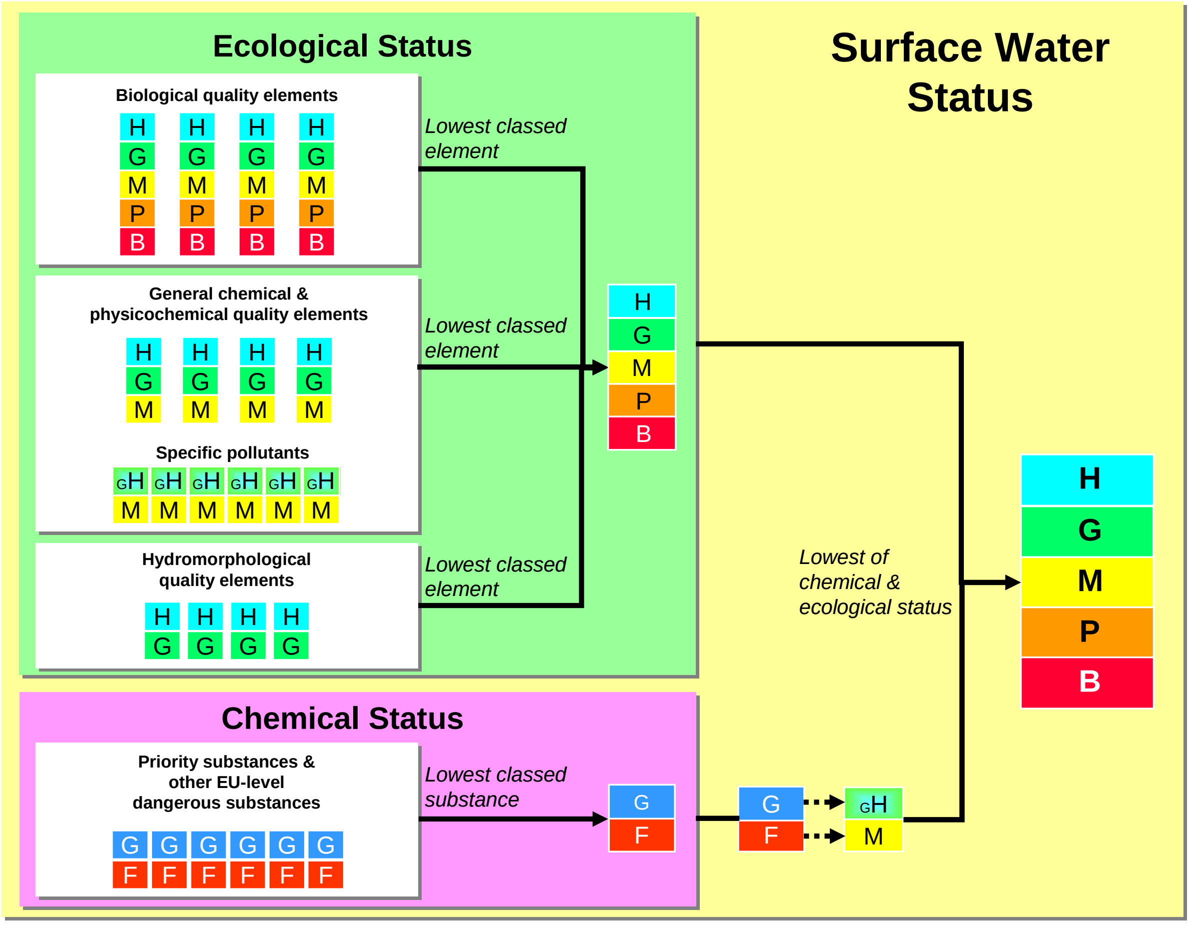

Figure 1b: Schematic representation of how results for different quality elements are combined to classify ecological status, chemical status and surface water status

Key: "H" means high; "G" means good; "GH" means good or better and is normally treated as high for calculating, as relevant, ecological status and surface water status[10]; "M" means moderate; "P" means poor; "B" means bad; and "F" means failing to achieve good surface water chemical status.

1.3.1 Biological quality elements

The Directive provides qualitative descriptions for each biological quality element in each surface water category (i.e. river, lake, transitional water or coastal water) and for each ecological status class. The different classes represent different degrees of disturbance to the quality elements relevant to the category of water concerned. The degree of disturbance to each quality element is assessed against a "reference value or set of values" for that element. A reference value for a biological quality element is a value identified from the range of values the quality element may have when subject to no or only very minor alteration as a result of human disturbance (i.e. when it is in a reference, or high status, condition). UKTAG recommends that reference conditions should reflect "a state in the present or in the past corresponding to very low pressure, without the effects

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consistent with classification as high or good ecological status. Whether high or good is assigned will depend on the condition of the other quality elements (See Figure 1a and Figure 1b)

[10] Except in the case of the specific pollutant, ammonia (See Section 1.3.3)

of major industrialisation, urbanisation and intensification of agriculture, and with only very minor modification of physico-chemistry, hydromorphology and biology"[11].

At good ecological status, none of the biological quality elements can be more than slightly altered from their reference conditions. At moderate status, one or more of the biological elements may be moderately altered. At poor status, the alterations to one or more biological quality elements are major and, at bad status, there are severe alterations such that a large proportion of the reference biological community is absent.

Table 1: Biological quality elements relevant to the different categories of surface water

Rivers	Lakes	Transitional waters	Coastal waters
(i) Benthic invertebrates (ii) Fish (iii) Phytoplankton (iv) Macrophytes and phytobenthos	(i) Benthic invertebrates (ii) Fish (iii) Phytoplankton (iv) Macrophytes and phytobenthos	(i) Benthic invertebrates (ii) Fish (iii) Phytoplankton (iv) Macroalgae; and (v) Angiosperms	(i) Benthic invertebrates (ii) Phytoplankton (iii) Macroalgae and angiosperms

Reference values may be determined using (1) networks of reference sites, (2) modelling approaches; or (3), where 1 and 2 are not possible (even in combination), expert judgement. The reference values recommended by UKTAG have generally been based on information obtained from sites at which the quality element concerned is in reference condition (i.e. at high status). This does not mean that at these sites the quality element is entirely unaffected by human activities. However, it does mean that alterations to it are expected to be minor. There are relatively few sites across the UK at which all quality elements are in reference conditions and from which data suitable for establishing reference values are available. Consequently, reference values have been derived from sites at which the quality element concerned is estimated to be in its reference condition but other elements at the sites may not be so. These sites may also be in water bodies within which there are other sites at which the quality element may not be in its reference condition.

It is not always possible to establish reliable reference values for a particular biological quality element due to high degrees of natural variability in that element. Where this is the case, the Directive allows that the element can be excluded from the assessment of ecological status. UKTAG recommends that phytoplankton in rivers be excluded from assessments of ecological status in rivers for this reason. Rivers in the UK are relatively short and fast flowing compared with the larger continental rivers. Consequently, true phytoplankton communities tend not to develop.

A number of different parameters (e.g. the balance of different groups of species; the number of different species; the overall abundance of species; etc) may be used to estimate the status of a quality element. These parameters are sometimes called metrics of the quality element. Different metrics may be used to indicate the impact of different types of pressure (e.g. the effects of pollution or the effects of morphological alterations) on the element. In other cases, monitoring results for different metrics may be combined to give a representative picture of the impact of a

[11] Description taken from the current version on the Commission's draft technical guidelines on the implementation of Annex II and V to the Directive which the Commission intends to make under Article 20 of the Directive.

particular type of pressure (or range of pressures) on the quality element. For example, using multiple metrics may be appropriate where none of the metrics on their own give a sufficiently reliable indication that the quality element has been adversely impacted as a result of human activities.

The use of multiple metrics can improve confidence in the final classification. For example, when assessing phytoplankton, biomass is an important metric because it determines the overall amount of phytoplankton which in turn influences light penetration and oxygen concentration in a water body. Taxonomic composition is also an important metric of phytoplankton because it shows when highly undesirable species, such as cyanobacteria and other opportunistic taxa, are starting to dominant the phytoplankton community.

A list of the biological classification tools which UKTAG recommends for use in classification is given in Sections 1 to 3 of the Appendix to this report. Details of these methods, including the proposed class boundaries for each method will be added to the report by Spring, 2008.

The class boundaries for the biological classification tools will be expressed as ecological quality ratios (EQRs). EQRs are a means of expressing class boundaries on a common scale from zero to one. The boundary EQR values represent particular degrees of deviation from the corresponding reference values. High status is represented by values relatively close to one (i.e. little or no deviation) and bad status by values relatively close to zero (i.e. substantial deviation).

UKTAG recommends that the tools developed for classification should continue to be refined. This development work should take account of new data collected through the monitoring programmes and improvements in scientific understanding on causes and effects. New or modified tools should also be developed where the existing tools are unable to properly reflect the impact of particular pressures on the water environment.

1.3.2 Intercalibration

To promote consistent and comparable classification across Europe, Member States and the European Commission are participating in an 'intercalibration' exercise. The aim of this exercise is to agree comparable good status class boundaries for the different classification tools each Member State uses to estimate the condition of each of the biological quality elements.

This is the first time that such an “intercalibration” across the EU has been attempted. The first phase of intercalibration is expected to be completed by the end of 2007. The results from this first phase do not cover all the biological classification tools required and provide only partial results for others. A second round of intercalibration is expected to be completed in time to incorporate its results in planning for the first updates of the river basin management plans. Information on the results of expected from the intercalibration exercise are provided in Section 4 of the Appendix to this report.

1.3.3 Chemical and physicochemical quality elements

<u>1.3.3(a) General chemical and physicochemical quality elements</u>

The general chemical and physicochemical quality elements describe water quality. They include chemical substances, such as nutrients, and physical properties, such as the thermal regime. At high ecological status, the condition of each element must be within the range of conditions normally associated with undisturbed conditions. At good ecological status, the Directive requires that the general physicochemical quality elements comply with standards established by the Member State to protect the functioning of the ecosystem.

Table 2: General chemical and physicochemical quality elements relevant to the different categories of surface water

Water category	Quality elements	Indicators for which standards have been proposed by UKTAG
Rivers	1. **Thermal conditions** 2. **Oxygenation conditions** 3. Salinity 4. **Acidification status** 5. **Nutrient conditions**	1. Temperature 2. Dissolved oxygen concentration 3. - 4. pH 5. Soluble reactive phosphorus concentration
Lakes	1. Transparency 2. Thermal conditions 3. **Oxygenation conditions** 4. **Salinity** 5. **Acidification status** 6. **Nutrient conditions**	1. - 2. - 3. Dissolved oxygen concentration 4. Conductivity 5. Acid neutralising capacity 6. Total phosphorus concentration
Transitional waters (e.g. estuaries)	1. Transparency 2. Thermal conditions 3. **Oxygenation conditions** 4. **Nutrient conditions**	1. - 2. - 3. Dissolved oxygen concentration 4. Dissolved inorganic nitrogen
Coastal waters	1. Transparency 2. Thermal conditions 3. **Oxygenation conditions** 4. **Nutrient conditions**	1. - 2. - 3. Dissolved oxygen concentration 4. Dissolved inorganic nitrogen

UKTAG has already provided recommendations on standards for indicators for most of the general chemical and physicochemical quality elements. These elements are indicated in bold font in Table 2. The recommendations on the standards for these elements can be found at: http://www.wfduk.org/stakeholder_reviews/. For the remaining elements, UKTAG considers that the data currently available or the natural variability do not allow the derivation of a reliable standard for use in classifying aquatic ecosystems.

UKTAG recommends that the standards are reviewed, and where necessary revised early in each planning cycle where mismatches become apparent between the monitoring results for biological quality elements and those for the general chemical and physicochemical quality elements. UKTAG also recommends that the standards are revised where necessary to take account of

changes to the class boundaries for biological quality elements which may be agreed in future phases of the European intercalibration exercise (see Section 1.3.2).

1.3.3(b) Specific pollutants

Member States are required to identify 'specific pollutants' (i.e. those pollutants being discharged in significant quantities) from the Directive's general list of the main types of pollutants[12]. The list is reproduced in Table 3.

Table 3: Specific pollutants - any pollutant from the list below which is being discharged in significant quantities into the body of water	
(i)	Organohalogen compounds and substances which may form such compounds in the aquatic environment.
(ii)	Organophosphorus compounds.
(iii)	Organotin compounds.
(iv)	Substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties which may affect steroidogenic, thyroid, reproduction or other endocrine-related functions in or via the aquatic environment.
(v)	Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances.
(vi)	Cyanides.
(vii)	Metals and their compounds.
(viii)	Arsenic and its compounds.
(ix)	Biocides and plant protection products

UKTAG has made recommendations on an initial list of specific pollutants comprising substances known to be being discharged in significant quantities into waters within the UK and on environmental quality standards for these substances[13]. The list of specific pollutants is reproduced in Table 4. Further substances may be identified in future cycles. Substances may also be removed from the list if they cease to be discharged in significant quantities.

The environmental quality standards for pollutants listed under points 1 to 11 in Table 4 have been derived or updated in line with the procedure specified by the Directive[14], including peer review and public consultation. For the pollutants listed in points 12 to 19, UKTAG recommends that the quality standards previously established under the Dangerous Substances Directive should apply[15]. This is because there are insufficient data available at present to recommend revision of these standards.

For good ecological status, the environmental quality standards established for specific pollutants must not be exceeded. With the exception of ammonia in freshwaters, environmental quality standards for the specific pollutants have been set in such a way that, where the standards are met, no adverse effects on aquatic plants and animals should occur. Consequently, UKTAG recommends that in a water body complying with the standards for these specific pollutants, the

[12] See Annex VIII to the Directive.
[13] http://www.wfduk.org/stakeholder_reviews/stakeholder_review_1-2007/LibraryPublicDocs/UKTAG_2007_%20Final_Specific_Pollutants_Master
[14] See Section 1.2.6 of Annex V to the Directive.
[15] These are environmental quality standards for List II substances established under the Dangerous Substances Directive. The standards will also continue to apply under that Directive until the end of 2013 when the Directive is repealed.

water quality - as far as these specific pollutants are concerned - is capable of supporting the achievement of high or good ecological status[16].

For ammonia in freshwaters, UKTAG has proposed type-specific standards for high status and good status[17]. These standards have been derived using field data collected from thousands of sites over several decades. This has enabled the identification of standards consistent with slight ecological disturbance (i.e. good status) and those consistent with high status. Subject to consideration of other impacts on the water body, UKTAG recommends that a river or lake water body failing the high status ammonia standard will be classed as good status rather than high status. Those failing the good status ammonia standard will be classed as moderate status.

Table 4: Initial list of specific pollutants	
1. 2,4-D	11. Chlorine
2. Chromium (vi)	12. Copper
3. Chromium (iii)	13. Cyanide
4. Cypermethrin	14. Permethrin
5. Diazinon	15. Iron
6. Dimethoate	16. Zinc
7. Linuron	17. 2,4-dichlorophenol
8. Phenol	18. Arsenic
9. Toluene	
10. Ammonia[18]	

With the exception of the standard for total ammonium in freshwaters, the environmental quality standards for specific pollutants are expressed as a long term (annual mean) and as a short-term (maximum admissible concentration). UKTAG recommends that the long-term standards is used for classification[19] and that failure of the maximum admissible concentration is used to trigger additional investigation[20] which, in turn, may lead to further monitoring and, where appropriate, action aimed at preventing deterioration of status.

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[16] In their consultation on the implementation of Annexes II and V to the Directive in 2002 [http://www.sepa.org.uk/pdf/publications/wfd/future_for_scotlands_waters.pdf], the agencies noted that if concentrations of a pollutant where significantly less than the EQS, the pollutant could not be being discharged in significant quantities and would therefore not qualify as a specific pollutant.

[17] http://www.wfduk.org/stakeholder_reviews/Standards_Jan_2006/LibraryPublicDocs/UKTAG%20ReportAug%202006UKEnvironmentalStandardsandConditionsFinalReport

[18] For freshwaters, the environmental quality standards proposed for use in classification are the type-specific standards for total ammonium in the UKTAG Report on environmental standards and conditions (phase 1) [http://www.wfduk.org/stakeholder_reviews/Standards_Jan_2006/LibraryPublicDocs/UKTAG%20ReportAug%202006UKEnvironmentalStandardsandConditionsFinalReport]. These standards are proposed for application to rivers and to lakes. For the purpose of applying the standards to lakes, UKTAG recommends that the lakes are classified into types based on the same alkalinity and altitude criteria recommended in the report referred to above to discriminate river types. For transitional waters and coastal waters, the proposed environmental quality standard for use in classification is that for un-ionised ammonia in salt water set out in UKTAG report on environmental quality standards for Annex VIII pollutants [http://www.wfduk.org/stakeholder_reviews/stakeholder_review_1-2007/LibraryPublicDocs/UKTAG_2007_%20Final_Specific_Pollutants_Master]

[19] This is because the long-term standards embrace a level of protection against extremes and are compatible with the design of controls for example on discharges, land use, and the use of chemicals. The Maximum Admissible Concentration is more relevant to managing unexpected accidents.

[20] e.g. auditing compliance with discharge authorisation conditions, etc

UKTAG recommends that priority substances (See Section 1.4) are not included as specific pollutants for the purpose of ecological status classification. Any failures of standards for priority substances will be reflected instead in surface water chemical status classification. This approach reflects the understanding of the Common Implementation Strategy which has been endorsed by Member States and the European Commission.

1.3.4 Hydromorphological quality elements

For high status to be achieved, the Directive requires that there are no more than very minor human alterations to the hydromorphological quality elements (See Table 5). UKTAG has already provided recommendations on standards and condition limits for use in assessing whether these conditions are met[21]. UKTAG recommends that these standards and condition limits are taken into account in classifying high status where the necessary data to do so are available. Where they are not, UKTAG recommends that classification is based on the best available alternative information and the use of comparable assessment criteria.

At good, moderate, poor and bad status, the required values for the hydromorphological quality elements must be such as to support the required biological quality element values for the relevant class. The standards and condition limits recommended by UKTAG are intended to help assess the risk of failing to achieve the necessary values.

Table 5: Hydromorphological quality elements

Rivers	**Lakes**	**Transitional Waters**	**Coastal Waters**
(i) quantity and dynamics of water flow (ii) connection to ground water bodies (iii) river continuity (iv) river depth and width variation (v) structure and substrate of the river bed (vi) structure of the riparian zone	(i) quantity and dynamics of water flow (ii) residence time (iii) connection to the ground water body (iv) lake depth variation (v) quantity, structure and substrate of the lake bed (vi) structure of the lake shore	(i) depth variation, (ii) quantity, structure and substrate of the bed (iii) structure of the inter-tidal zone (iv) freshwater flow (v) wave exposure	(i) depth variation (ii) structure and substrate of the coastal bed (iii) structure of the inter-tidal zone (iv) direction of dominant currents (v) wave exposure

1.3.5 Classification and alien species

The impacts of invasive alien species on aquatic ecosystems can be many and varied, including disruption to ecological function and process, displacement of indigenous species through competition or predation and structural damage to aquatic habitats. Classification based on the

[21] http://www.wfduk.org/stakeholder_reviews/Standards_Jan_2006/LibraryPublicDocs/UKTAG%20ReportAug%202006UKEnvironmentalStandardsandConditionsFinalReport & http://www.wfduk.org/stakeholder_reviews/stakeholder_review_1-2007/LibraryPublicDocs/UKTAG_Report_Surface_Water_Standards_and_Conditions

results obtained from using the biological classification tools listed in the Appendix to this report will not always adequately reflect these impacts. This is because most of the biological classification tools are not yet designed to assess the impact of alien species on the quality element concerned.

To ensure the classifications presented in the first river basin management plans reflect the best understanding of alien species impacts on the water environment, UKTAG recommends taking account of the presence of known high impact alien species when classifying the status of water bodies. A provisional list of high impact alien species occurring in the UK species is provided in Table B1 and Table B2 of Annex B to this report. The list is currently being reviewed by UKTAG experts and will be revised early in 2008 to reflect the outcome of the review.

The procedure proposed for taking account of alien species in classification decisions is illustrated in Figure 2 and described below.

Under the proposed procedure, a water body will be classed as worse than high status if there is evidence that one or more species on the high impact list has become established over a significant spatial extent of the water body (e.g. the alien species is present and reproducing successfully in the water body and the length or area of the water body infested by the species is inconsistent with the spatial criteria for high status set out in Table A1a of Annex A[22]). The confidence in the classification will depend on the confidence that the species is established.

Because of their invasiveness, once alien species on the high impact list are present in a high status water body, there is a high risk that they will become established[23] and the status of the water body will deteriorate. Consequently, water bodies in which alien species are present but not yet established will be at risk of deterioration of status unless effective action is taken to prevent the establishment of the species concerned. The administrations may wish to consult on UKTAG's proposed distinction between 'established' and 'present' in relation to the proposed procedure.

[22] See also Section 5.
[23] In the context of this report, the word 'established' is taken to mean 'reproductively self-sustaining and/or persistent.

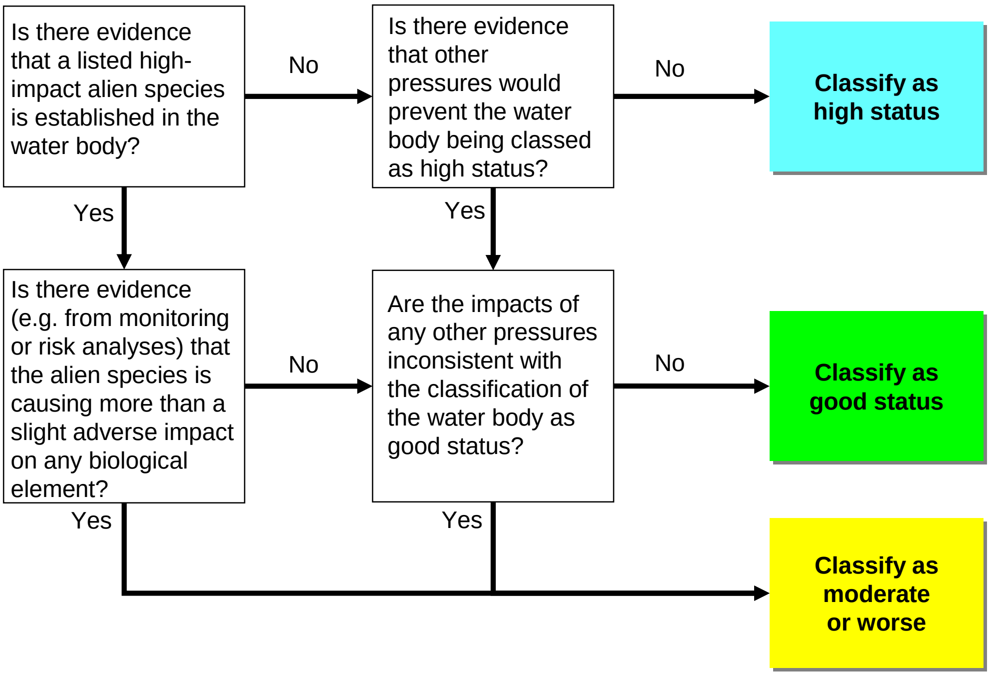


Figure 2: Outline of recommended procedure for taking into account the impact of alien species in classification decisions. Note: Reference in the Figure to 'slight adverse impact' is a reference to the good/moderate ecological status boundary, as defined in terms of modifications to the values of the biological quality elements (See Section 1.3.1)

A water body will be classed as worse than good status if there is evidence that an alien species on the high impact list is causing the biological quality elements (See Section 1.3.1) to deviate more than slightly from their reference conditions. The evidence used to assess whether the impacts of listed alien species are incompatible with good status will be obtained from biological quality element monitoring results where suitable data are available. Where those data are unavailable (e.g. because of the limitations of the biological classification tools), the evidence may be derived from risk analyses. In the latter case, if the risk analyses indicate that status is worse than good, the status assigned on the basis of the alien species assessment will be moderate.

UKTAG recommends that confidence in the results of classifications based on risk assessments should be reported in accordance with Section 4.4. Risk analyses will normally be based on evidence of the severity and probability of adverse impacts derived from studies of other comparable sites in which the species concerned has become established. For example, such studies indicate that, where established populations of signal crayfish are present, the probability of greater than slight adverse impacts on biological quality elements is high and therefore incompatible with good ecological status[24].

UKTAG recommends that the lists of high-impact alien species are reviewed and, where appropriate, revised in time to inform the updates of the pressures and impacts analyses (See Section 2) which underpin each river basin planning cycle. Among other things, reviews of the lists should take account of species whose range may be extended by climate change.

[24] e.g. Crawford, L., Yeomans, W.E. & Adams, C.E. 2006. The impact of introduced signal crayfish *Pacifastacus leniusculus* on stream invertebrate communities. *Aquatic Conservation: Marine Freshwater Ecosystems* **16** (6) 611-621; Nyström, P. & Strand, J.A. 1996. Grazing by native and an exotic crayfish on aquatic macrophytes, *Freshwater Biology* **36** 673-682.

Species native to the UK can also have significant adverse impacts when translocated to waters in which they would not naturally have been present. In some cases, the impacts of these species may be detected incidentally in the results provided by the classification tools developed to assess the biological quality elements. However, UKTAG considers that further work is necessary before the presence of native but translocated species can be fully taken into account in classification. UKTAG recommends that such work be undertaken in time to provide methods for application in the next river basin planning cycle.

1.4 Surface water chemical status

There are two classes for chemical status; 'good' and 'failing to achieve good'. The quality elements for assessing surface water chemical status are:

(i) priority substances[25] for which environmental quality standards are established at European level; and
(ii) other dangerous substances for which environmental quality standards have been established at European level

At the time of writing, negotiations on a daughter directive, which will set out the environmental quality standards for priority substances, are yet to be concluded. However, a common view was reached in June 2007 by the Environment Council of the 27 Member States on environmental quality standards for the priority substances. This common position may be subject to change depending on the outcomes of the European Parliament's 2nd reading of the proposed directive during 2008. In the meantime, UKTAG recommends that surface water chemical status classification is based on the standards for the annual average concentration of the substances as set out in the Member States' agreed position. For three priority substances, hexachlorobenzene, hexachlorobutadiene, and mercury, the standards apply to the concentration of the substances in biota. For the others, the standards refer to the concentration of the substances in water.

Environmental quality standards have already been established at EU level for a number of substances identified as List 1 substances under the Dangerous Substances Directive. Where these substances have not also been identified as priority substances, failures of the environmental quality standards established for them under the Dangerous Substances Directive must be reflected in the classification of chemical status.

The list of priority substances and other dangerous substances is set out in Table 6 below:

Table 6: Priority substances (1 - 36) and other dangerous substances (37 - 45)		
1. Alachlor 2. Anthracene 3. Atrazine 4. Benzene 5. Brominated diphenylether 6. Cadmium and its compounds	20. Mercury and its compounds 21. Naphthalene 22. Nickel and its compounds 23. Nonylphenol (4-Nonylphenol)	37. Aldrin 38. Carbon tetrachloride 39. Dieldrin 40. Endrin 41. Isodrin 42. DDT Total 43. Para-para-DDT

[25] Decision 2455/2001/EC established the list of priority substances

7. C10-13 Chloroalkanes	24. Octylphenol ((4-(1,1',3,3'-tetramethylbutyl)-phenol))	44. Tetrachloroethylene
8. Chlorfenvinphos	25. Pentachloro-benzene	45. Trichloroethylene
9. Chlorpyrifos (Chlorpyrifos-ethyl)	26. Pentachloro-phenol	
10. 1,2-Dichloroethane	27. Benzo(a)pyrene	
11. Dichloromethane	28. Benzo(b)fluor-anthene	
12. Di(2-ethylhexyl)-phthalate (DEHP)	29. Benzo(k)fluor-anthene	
13. Diuron	30. Benzo(g,h,i)-perylene	
14. Endosulfan	31. Indeno(1,2,3-cd)-pyrene	
15. Fluoranthene	32. Simazine	
16. Hexachloro-benzene	33. Tributyltin compounds (Tributyltin-cation)	
17. Hexachloro-butadiene	34. Trichloro-benzenes	
18. Hexachloro-cyclohexane Isoproturon	35. Trichloro-methane	
19. Lead and its compounds	36. Trifluralin	

The status of a water body must be classed as failing to achieve good surface water chemical status if an environmental quality standard for one or more of the priority substances or other dangerous substances listed in Table 6 is failed.

SECTION 2: CLASSIFICATION AND RIVER BASIN MANAGEMENT PLANNING

The objectives of the Directive include preventing deterioration of the status of surface water bodies and protecting, enhancing or restoring all surface water bodies with the aim of achieving good surface water status by 2015[26].

The Directive allows Member States to set alternative objectives to that of achieving good status where, for example, achieving good status by 2015 would be disproportionately expensive or technically infeasible[27]. In certain circumstances, it also allows exemptions from its objective of preventing deterioration of status[28].

The process of river basin management planning will determine where alternative objectives are appropriate and establish programmes of measures through which action will be taken to achieve the agreed objectives. The role of classification in this process is summarised in Figure 3 and outlined below.

[26] The environmental objectives are defined in Article 4 of the Directive.
[27] See paragraphs 4 and 5 of Article 4 of the Directive.
[28] See paragraphs 6 & 7 of Article 4 of the Directive.

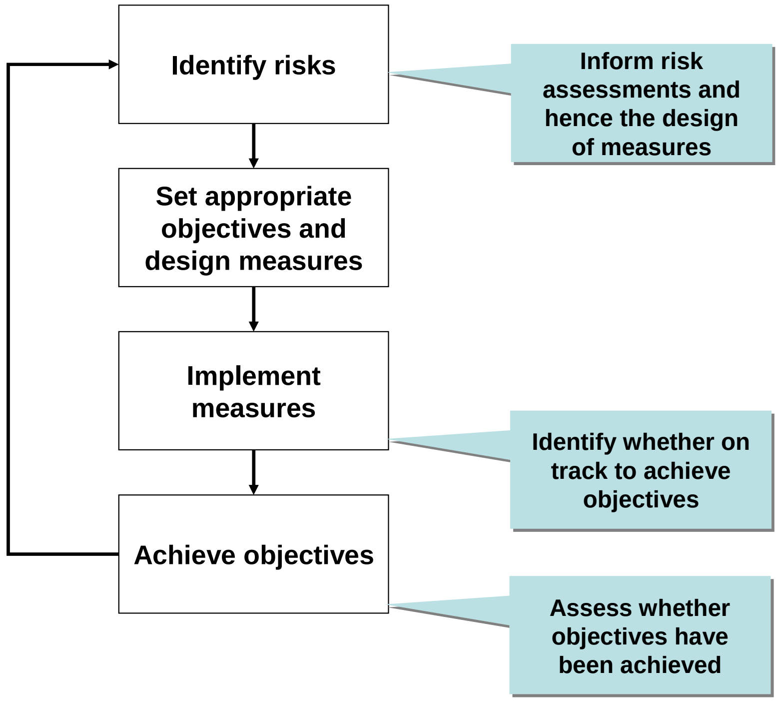


Figure 3: Key roles of classification information in river basin management planning

As there are only two full years of monitoring between the start of the monitoring programmes and the production of the first river basin management plans, a complete classification for all water bodies will not be available in time for use in identifying the first programmes of measures. Consequently, UKTAG recommends that the most up to date risk analysis results[29], supplemented by the most up-to-date results coming through from work on classification, should be used to design the programmes of measures.

Subsequently, UKTAG recommends that the agencies use the results of classification to:

- assess whether the measures implemented are on course to achieve the objectives of agreed in the river basin management plans and hence identify where further measures may be needed;
- inform the reviews of the pressures and impact analyses in 2013 (and subsequent reviews every six years thereafter); and
- assess whether the objectives established in the river basin management plans have been achieved.

UKTAG also recommends that the data collected for classification is used to help identify deterioration of status and long-term changes likely to lead to deterioration of status.

[29] The UK completed a first analysis of the risks to the achievement of the Directive's objectives in 2004. The results are being updated to take account of further information. Information on the outcome of recent revisions is available in the Significant Water Management Issues Reports. The risk analyses take account of data from current programmes of monitoring, previous programmes of monitoring, investigations and modelling work.

The timetable for the river basin planning process dictates key times at which classification results must be available for publication, reporting or enabling specific tasks (see Table 7). However, UKTAG recommends that after the first river basin management plans are published in 2009, that estimates of the status of water bodies are updated in the periods between each update of the plans in order to help:

1. identify risks of deterioration of status; and
2. provide information with which to assess how the status of water bodies is changing as a result of the implementation of the programmes of measures.

<table>
<tr><th colspan="3">Table 7: Timetable for classification in river basin planning cycles</th></tr>
<tr><td>2008</td><td>December: The drafts of the river basin management plans, including initial views on water body classifications, are published for consultation.</td><td></td></tr>
<tr><td>2009</td><td>December: Maps of the status of water bodies are included in the first river basin management plans.</td><td rowspan="4">Up-to-date results of classification are used to assess the effectiveness of the programmes of measures.</td></tr>
<tr><td>2010</td><td>March: The results of classification, as set out in the river basin management plans in 2009, are reported to the European Commission on the data base - Water Information System for Europe.</td></tr>
<tr><td>2013</td><td>Up-to-date results of classification are used in reviewing the analysis of pressures and impacts to inform the development of the first updates of the river basin management plans.</td></tr>
<tr><td>2015</td><td>December: Up-to-date results of classification are included in the first updates of the river basin management plans, enabling an assessment of whether the objectives of the original plans have been achieved.</td></tr>
<tr><td>2016</td><td colspan="2">March: The results of classification as set out in the first updates of the river basin management plans in 2015 are reported to the European Commission on the data base – Water Information System for Europe.</td></tr>
<tr><td>2019</td><td colspan="2">Up-to-date results of classification are used in reviewing the analysis of pressures and impacts to inform the development of the second updates of the river basin management plans.</td></tr>
<tr><td>2021</td><td colspan="2">December: Up-to-date results of classification are set out in the second updates of the river basin management plans.</td></tr>
<tr><td colspan="3">The timetable for 2015 – 2021 is then repeated for 2021 – 2027 and so on</td></tr>
</table>

SECTION 3: CLASSIFICATION AND MONITORING DATA

3.1 Risk-based monitoring

The process of classification involves making estimates of status mainly from the results of risk-based programmes of monitoring and assessment that are targeted according to the identified risks to water bodies. Sometimes monitoring data are used directly, as, for example, in comparing measurements of the average concentrations of chemical with an environmental quality standard. In other cases monitoring data are used with other information to estimate status using modelling techniques.

Estimates of the status of the water environment will improve over time. More data will accumulate, more advanced scientific techniques for collecting and interpreting data will be developed and the environmental standards used in assessing status may need to be updated to reflect the latest research. As a result, the status of some water bodies will be re-classed as better, or worse, than previously estimated. This may include some water bodies previously estimated to be high status or good status.

UKTAG recommends that, where there is no evidence from monitoring or risk assessments to the contrary; the status of a water body should be classed as being at high ecological status and good chemical status. The confidence in such classifications (See Section 4) will depend on the quality of the information on pressures and the reliability of the methods of risk analysis. For example, there are places where water bodies are so free of significant pressures that a simple risk analysis will provide high confidence that the water bodies are at high status.

Occasionally, it may not be possible to estimate the status of a water body. For example, this may be the case where access to monitor the water bodies has not been possible in time to enable the necessary data for classification to be obtained (e.g. because of access restrictions during a foot and mouth outbreak).

3.2 Monitoring networks and classification

The environment agencies have designed their monitoring networks in accordance with EU[30] and UK[31] guidance to ensure comparability across the EU.

To avoid duplication and ensure best value for money, where practicable monitoring effort has been coordinated between different agencies and non-governmental organisations. Further opportunities for coordination may be identified in the future. To this end, efforts are being made to ensure that methods of monitoring and assessment, and systems of quality assurance and reporting are standardised in order to be able to make effective use in classification of the data generated by different organisations.

The Water Framework Directive splits its monitoring for surface waters into three groups: surveillance; operational; and investigative. In surveillance monitoring, all quality elements (See Sections 1.3 and 1.4) relevant to the water body category are monitored. One of the aims is to provide sets of data that can be used to detect long-term trends. For the latter purpose, surveillance monitoring has been designed to build on past monitoring.

[30] http://circa.europa.eu
[31] http://www.wfduk.org/tag_guidance/Article_08/12aGuidanceDoc and http://www.wfduk.org/tag_guidance/Article_08/12A%28II%29_TRAC

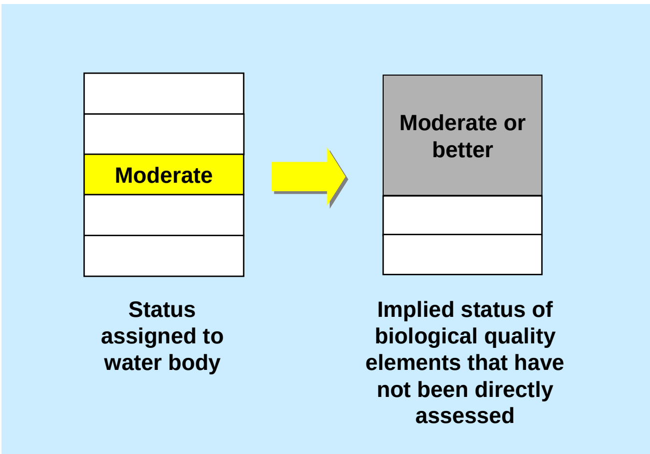
Operational monitoring is carried out to classify water bodies at risk of failing to meet the objectives of the Water Framework Directive: those quality elements most sensitive to the pressures on the water body are monitored. Water bodies can be grouped together (according to the pressures to which they are subject, their characteristics and their proximity) and monitoring data from a representative water body or sub-group of water bodies used in estimating the status of each of the water bodies in the group.

Investigative monitoring is intended to respond to unplanned events and emerging risks, and where the cause of an impact is not well understood. At some sites, investigative monitoring may be of low frequency and irregular; its data may not be compatible for use with the tools established for the formal process of classification. In other cases the results of investigative monitoring may be in a form that can be used to increase confidence in classification results.

3.3 Classification process

Where a water body is identified as at risk of failing to achieve good status, the pressure or combination of pressures that may cause this is identified, and the quality element or elements most sensitive to this pressure or combination of pressures are then assessed through operational monitoring[32] (See Section 3.2).

By classifying the status of the water body on the basis of the quality element or elements expected to be worst affected by the pressures to which the body is subject, the condition of other quality elements in the water body can be assumed to be of the "same status as, or better than" the assigned status of the water body. However, it will not normally be possible to know in which particular status class these elements fall. For example, suppose a water body is classed as moderate ecological status and that no monitoring and assessment has been considered necessary for fish or macrophytes to produce this estimate. It can only be stated that the condition of fish and macrophytes is expected to be "at least moderate status but may be better" (See Figure 4).



[32] Where there is uncertainty as to the most sensitive element, UKTAG recommends that the likely most sensitive elements are monitored.

Figure 4: Implied status of biological quality elements which are not monitored and assessed to estimate the status of a water body (i.e. they are not considered more sensitive to the pressures than those elements that have been monitored)

Classification is normally built up from the monitoring data through a number of stages. The raw monitoring data on a quality element are brought together in agreed and established methods of calculation to give summary statistics that can be compared with status class boundaries and the results of this comparison used to estimate the status class.

The raw data are often collected using rolling programmes in which, for example, a site is monitored one or more times every year. The data collected in these programmes must be representative of the period of time covered by the standards defining the class boundaries. For example, the class boundaries may be defined as annual percentiles. It would be wrong to assess compliance with a chemical standard expressed as an annual 95-percentile with data collected only in December unless it was demonstrated that this would cause no bias. However, provided data are representative, data from any year may be combined with data from any other to produce the required summary statistics.

UKTAG recommends that classification is based on as many years data as possible, subject to it being a reasonable assumption that impacts have not changed in that time. For rivers at risk from point source discharges or diffuse pollution, the use of representative data from the three most recent years will normally be appropriate. This provides a compromise between achieving precision in classification and keeping pace with changes resulting from, for example, improvements in discharge quality.

3.4 Delivering classification in time for publication in the river basin management plans

As also noted in Section 2, producing classifications for all water bodies solely using the results of the new monitoring programmes outlined in Section 3.2 will not be possible by 2009 when the first river basin management plans must be published. The new monitoring programmes only became operational at the end of 2006. Consequently, UKTAG recommends that use is also to be made of data collected under previous monitoring programmes and the results of appropriate risk assessments.

In particular, biological monitoring systems for assessing the impact of hydromorphological alterations are still in the early stages of development and existing biological classification tools were not designed to assess the impacts of such alterations on biological quality elements. For example, when using the UK river invertebrate classification tool, sampling is concentrated in the riffle habitat areas in most river types. This works well for detecting the impact of pollution since invertebrates in all parts of the channel will be exposed to any pollution. However, typically hydromorphological impacts will affect the balance of habitat types in a river, including habitat types such as pools and backwaters which are normally omitted from water quality targeted invertebrate monitoring.

To ensure that the classification results in the first river basin management plans reflect the best estimate of the status of water bodies, UKTAG recommends that all reasonably available and suitable information is used to estimate the status of water bodies. This should include the results of risk assessments and any relevant biological data that may be available. UKTAG recommends that risk assessments are informed by assessments of compliance with the hydromorphological environmental standards and conditions recommended by UKTAG[33] where such information is available (See also Section 4.4).

3.5 Monitoring, Classification and Climate Change

It is difficult to separate the effects of climate change from natural changes in the water environment; changes in the use of the water environment; and effects of other long-term changes, such as changes in the atmospheric deposition of pollutants.

Surveillance monitoring may pick up changes that result from climate change, particularly if the results can be aggregated across the UK or even Europe, or if data are collected over a long period of time. Part of the surveillance network is designed to do just this. Where changes from climate change have reached a level sufficient to affect status classification, the agencies will need to decide whether:

(a) the reference conditions used in defining the class boundaries for the different biological quality elements (See Section 1.3.1) are revised so that they, and consequently high and good status, reflect the prevailing climatic conditions; or
(b) impacts on status resulting from the direct effects of climate change are reflected in classification results.

UKTAG recommends that any decision to revise reference conditions is coordinated across the UK.

Changes in the use of the water environment in response to climate change may also enhance the risk of deterioration of status. For example, a drier climate may lead to increased pressure on scarcer water resources.

SECTION 4 – PRESENTING AND USING INFORMATION ON CONFIDENCE IN CLASS

4.1 Risk of misclassification

In an ideal world of comprehensive monitoring data containing no errors, water bodies would always be assigned to their true class with 100 per cent confidence. But estimates of the truth

[33] http://www.wfduk.org/stakeholder_reviews/

based on monitoring are subject to error because monitoring is not done everywhere and all the time, and because monitoring systems, equipment and people are less than perfect.

Understanding and managing the risk of misclassification as a result of uncertainties in the results of monitoring is important because of the potential to fail to act because a water body has been wrongly reported as better than it is, or wasting resources on water bodies that have been wrongly classed as worse than they are.

Despite uncertainties in monitoring results, statements like "30 per cent of the water bodies in a particular country or river basin district are worse than good status" can be very accurate. This is because the random uncertainties average out. On the other hand a list of named water bodies that are classed as worse than good status will include some water bodies which are, in truth, good status or better.

The effect of any errors in monitoring results is more dramatic when allied to the one-out all-out principle. This is because monitoring results for only one quality element or chemical need to wrongly suggest an adverse impact in order for the water body to be assigned a lower class than its true class. The probability of placing water bodies wrongly in a lower class than their true class increases as more quality elements are brought into the classification process. It is important that this risk is managed in order to reduce the risk of wasting resources on unneeded improvements in status. One way of helping with this, for example, is to keep the number of quality elements to a minimum, consistent with assessing all the important pressures. UKTAG recommends that only data on the condition of the quality elements most sensitive to the pressures placing a water body at risk[34] are used in classifying that water body.

The level of confidence and precision achieved in classifications must be reported in the river basin management plans. EU guidance on classification proposes that this is done by indicating the degree of certainty that the water is in a class, or is worse than a particular class. Accordingly, when water bodies are classified, UKTAG advises that information is also presented on the confidence, or probability, that the true class of a water body, for each quality element or chemical, is:

a. as reported;
b. worse than reported; or
c. better than reported.

To facilitate this, UKTAG has recommended to the agencies that all monitoring and modelling methods provide estimates of the confidence in their results. Such estimates allow the confidence that class boundaries are exceeded to be assessed. For example, statistical calculations can produce the sort of information on confidence of class illustrated in Table 8.

In the example of Table 8, suppose that the upper and lower class limits for the moderate class are 0.7 and 0.5 respectively. Suppose further that the measured ecological quality is 0.58. Taking this result at face value would place the water body in moderate status. However, the information on confidence in column 2 of the table shows that, because of uncertainties, there is a 30 per cent

[34] Or combination of pressures

chance that the water body is actually better than moderate and a 10 % chance that it is worse[35]. On the basis of this information, a sensible option may be to try to improve the confidence of class by getting more data.

Table 8: Example of confidence in classification	
Column 1	**Column 2**
Face value class	**Confidence of class (%)**
High	5.0
Good	25.0
Moderate	60.0
Poor	9.9
Bad	0.1

4.2 Presenting information on confidence in classifications

There will be many cases where a table like Table 8 shows 100 per cent confidence in the assignment of class - particularly where quality is truly very good or very bad. But UKTAG suggests that it is important to know this fact and to present the full range of information about the assessment of the status of water bodies. Accordingly, UKTAG recommends that the agencies produce and make available:

(1) maps for each river basin district showing the overall status of water bodies based on the face value results of monitoring and modelling for all the elements;
(2) maps for each river basin district of the face value results for each quality element used to determine the face value class of water bodies;
(3) Information for each water body on the confidence of class for each quality element or combination of quality elements used to classify the body's ecological or chemical status

The face value maps will illustrate accurately the total number of water bodies in each class in a particular river basin district. As noted above, the accuracy results because misclassifications of individual water bodies tend to average out when looking at the results for large numbers of water bodies.

Face value results will thus provide a good, general indicator of overall improvement or deterioration[36]. They will allow answers to questions like: 'how many water bodies have improved? And 'how many water bodies are affected by a particular pressure?' This sort of information can help identify whether new national measures are needed to address a problem affecting large

[35] These calculations are done using standard statistical methods used in water quality planning.
[36] - recognising that uncertainties in measurement, in conjunction with the one-out all-out rule, will distort trends if the number of quality elements or chemicals expands or contracts over the years.

numbers of water bodies. For example, it could help Ministers decide if new national measures are needed to control a particular diffuse source of pollution.

Face value maps do not provide a good basis for identifying which particular water bodies are truly worse than good. Consequently, they should not be used to indicate if local action[37] to improve a particular water body is really needed. To decide this, information is needed on the confidence of class such as that in Table 8. This is because face value classifications will include many individual water bodies that are put in the wrong class because of the uncertainties[38] that are involved in monitoring and modelling.

To make information on confidence of class easier to understand and to enable estimates of confidence of class derived from modelling and from assessments of the weight of evidence to be represented in a common format, UKTAG recommends the use of categories of 'high', 'medium' and 'low' in terms of a statement that a water body is in the assigned class or worse than or better than this. For example, applying this to the information in Table 8 would produce the information set out in column 3 of Table 9. There is “medium confidence that status is moderate or worse”. In this case this is 70 per cent confidence. If this were than 95 per cent or more, the confidence would be high. An example where the face value class is poor is in Table 10.

Table 9: Example of confidence in classification - moderate status

Column 1	**Column 2**	**Column 3**
Face value class	**Confidence of class (%)**	**Confidence of class**
High	5.0	Low confidence that status is good or better
Good	25.0	
Moderate	60.0	Medium confidence that status is moderate or worse
Poor	9.9	Low confidence that status is worse than moderate
Bad	0.1	

Table 10: Example of confidence in classification - poor status

Column 1	**Column 2**	**Column 3**
Face value class	**Confidence of class (%)**	**Confidence of class**
High	0	Low confidence that status is good or better
Good	5	
Moderate	25	High confidence that

[37] Particularly if the action is expensive and controversial
[38] This is not because a lot of mistakes are made with sampling and analysis. It is mainly the consequence of variability in the environment and the laws of chance that apply over taking samples.

		status is moderate or worse
Poor	60	Medium confidence that status is poor or worse
Bad	10	

4.3 Using information on confidence to prioritise action

UKTAG proposes that action to improve a particular water body should normally only be sought if there is 'high' confidence that such action is truly needed (e.g. because there is high confidence that a water body is truly worse than good). UKTAG recommends that, in general, confidence is considered 'high' when one or more of the following conditions are met:

(a) monitoring data provide at least 95 per cent confidence that the condition of one or more quality elements is truly worse than good[39]; or

(b) the results of modelling and a proper sensitivity analyses provide a high level of confidence that the condition of one or more quality elements is truly worse than good[31]; or

(c) a number of types and sources of information, including monitoring results for different quality elements known to respond to a pressure to which the water body is subject, all reinforce the understanding of how the water body is behaving in response to pressures and this understanding provides a high level of confidence that the status of the water body is truly worse than good (i.e. the weight of evidence overall provides high confidence).

However, for hydromorphological quality elements and certain chemical and physicochemical quality elements, achieving a high confidence of failure of environmental standards or condition limits (See points (a) or (b) above) will not necessarily be sufficient on its own to provide high confidence that the status of a water body is truly worse than good status. Confidence of classification in relation to these elements is discussed in Sections 4.4 and 4.5 respectively.

With reference to point (a) above it may be that to secure 95 per cent confidence is a tall order for a particular method of classification because of the limited monitoring data available. In such cases, there may be corroborating information such that the weight of evidence overall provides high confidence [See point (c) above]. For example, where an agency is monitoring more than one indicator of a quality element (e.g. diatoms and macrophytes), it may take into account the weight of evidence provided by the monitoring results for the different indicators concerned when assessing, as relevant, confidence of class or the confidence that the particular pressure is responsible for the impact on the quality element.

UKTAG recommends that confidence is classed as "medium" if there is more than a 50 per cent confidence or equivalent that a water body is better or worse than a particular class (i.e. being better or worse than a particular class is more likely than not).

UKTAG recommends that where there is medium confidence that the class of a water body is worse than its target class, the water body should be prioritised for further investigation to improve

[39] or other target objective where good status is not the target objective

confidence and appropriate action should be instigated to avoid deterioration of status. There may also be cases where all parties are willing to take measures even though there is less than high confidence that status is truly worse than good. For example, the measures may deliver other benefits which the parties consider worthwhile in their own right or, because of the low cost of the measures; the parties consider that action is appropriate, taking into account the risk that the action may actually be unnecessary.

4.4 Use of risk assessment information in classification

Confidence in classification will be affected by the type, quality and quantity of information on which it is based. This is particularly an issue for the first river basin management plans because of the short period of time available for collecting new monitoring data and the newness of many of the biological classification tools. In particular, the ability of the biological classification tools to directly measure the biological impact of hydromorphological alterations or alien species is limited at present.

To ensure the first classifications reflect the agencies' best understanding of status, UKTAG recommended in Section 3.4 and Section 1.3.5 that risk assessment results should to be used alongside any available and relevant biological data to estimate status. The extent of reliance on such risk assessments will vary between different parts of the UK depending on the availability of suitable biological data from previous monitoring programmes or targeted studies.

The confidence in the results of risk-based assessments of the impact of hydromorphological alterations on status will depend on the degree to which the environmental standards and conditions for hydromorphological quality elements are failed and whether or not there are corroborating biological data indicating damage. For example, in the absence of relevant information from biological monitoring and assessment results, the greater the degree by which a hydromorphological standard or condition limit for good status is failed, the greater will be the confidence that the ecological status of the water body is truly worse than good. In contrast, where there is corroborating evidence of impact from biological monitoring and assessment, there may be high confidence that the status is truly worse than good even if the margin of failure of a hydromorphological standard or condition limit is relatively small. UKTAG recommends that, when using risk assessments to underpin estimates of status, confidence in the resulting classifications is reported according to the approach illustrated in Table 11.

Table 11: Confidence of class in classifications based on risk assessments where suitable biological monitoring and assessment data are unavailable

Example 1		Example 2		Example 3	
Class based on risk assessment	Confidence of class	Class based on risk assessment	Confidence of class	Class based on risk assessment	Confidence of class
High		High		High	
Good		Good		Good	

Moderate	Medium confidence Moderate or worse
Poor	
Bad	

Moderate	High confidence moderate or worse
Poor	Medium confidence Poor or worse
Bad	

Moderate	
Poor	High confidence Poor or worse
Bad	

4.5 Confidence of classification and environmental standards for certain chemical and physicochemical quality elements

For the general physicochemical quality elements listed in Table 12 below, current scientific understanding means that there is some uncertainty in the precise standards for the quality element, which, if failed in any water body, would always correspond with an adverse impact on the status of that water body's aquatic ecosystem. This may be because other factors, such as the depth to which sunlight penetrates into the water body, can affect the ecological response to the chemical or physicochemical quality element.

Consequently, UKTAG recommends that confidence in the classification of a water body in which one or more of these standards is failed should depend on whether or not there is other corroborating evidence of adverse biological impact and the nature of that evidence.

However, UKTAG also recommends that failure of the good status standard for one or more of the quality elements listed in Table 12 should result in the water body concerned being identified as at risk of failing to achieve good status and hence subject to operational monitoring aimed at improving confidence of class.

Table12: Indicators of general chemical and physicochemical quality elements for which a failure of a good status environmental standard requires additional weight of evidence before there can be high confidence in the resulting classification

Water category	Indicator
Rivers	Temperature Soluble reactive phosphorus
Lakes	Total phosphorus Dissolved oxygen
Transitional waters	Dissolved inorganic nitrogen
Coastal waters	Dissolved inorganic nitrogen

Table 13 sets out a series of scenarios illustrating how, when the good status standards for a quality element indicator listed in Table 12 are failed, UKTAG recommends confidence of class should be affected by the weight of other available information.

Table 13: Scenarios illustrating the assignment of confidence of class in relation to failures of environmental standards for the indicators of general chemical and physicochemical quality elements listed in Table 12

Scenarios	Class assigned	Confidence that

		status is as assigned or worse
Scenario 1 (a) Monitoring data indicate at face value that the good status standard for phosphorus is failed (b) The confidence that the phosphorus standard is failed is (i) medium or (ii) high (c) There is no suitable biological monitoring and assessment information available for the water body[40]	**Moderate**	**Medium** [under b(i) & b(ii)]
Scenario 2 (a) Monitoring data indicate at face value that the good status standard for phosphorus is failed (b) The confidence that the phosphorus standard is failed is (i) medium or (ii) high (c) Biological monitoring data for quality elements sensitive to nutrient enrichment indicate that the biological elements are at good status. There is a low probability that the true class of the biological quality elements is worse than good	**Moderate**	**Low** [under b(i) & b(ii)]
Scenario 3 (a) Monitoring data indicate at face value that the good status standard for phosphorus is failed. (b) The confidence of failure is (i) medium or (ii) high (c) At face value, biological monitoring data for quality elements sensitive to nutrient enrichment indicate those biological elements are at moderate status. The confidence that the elements are moderate or worse is high	**Moderate**	**High** **[under b(i) & b(ii)]**
Scenario 4 (a) Monitoring data indicate at face value that the good status standard for phosphorus is failed. (b) The confidence of failure is (i) medium or (ii) high (c) Biological monitoring data for quality elements sensitive to nutrient enrichment indicate the biological elements are worse than good status. (d) The confidence that the elements are moderate or worse is medium	**Moderate**	**Medium or High depending on the weight of the evidence**

Scenario 2 in Table 13 illustrates a situation in which there may be a mismatch between the standard set for the chemical quality element and the conditions needed to protect the biological quality elements. This may be an artefact of the play of errors in monitoring results for the water body concerned or it may be, for example, that the particular characteristics of the water body are such that the standard is more stringent than it need be to protect the body's biological community.

[40] For example, it may be the case that, for practical reasons, sampling has not been possible in a particular water body during the limited period of time before the first classification results must be reported in 2009.

Such results will be considered as part of the reviews of environmental standards referred to in Section 1.3.3.

In Scenario 4, the confidence of class will depend on the weight of evidence [See point (c) in Section 4.3 above]. An assessment of the weight of evidence may include consideration of the magnitude by which the environmental standard for the chemical or physicochemical quality element has been failed (See related principles in Section 4.4); the number of biological quality elements for which there are indications of impact; the actual level of confidence in the biological results; evidence of impact on other quality elements which may be affected, such as oxygen conditions in the case of nutrient enrichment; information on the recent trends in the water body; and evidence from studies of other comparable water bodies subject to similar pressures.

SECTION 5: SPATIAL AND TEMPORAL ISSUES AND CLASSIFICATION

5.1 General approach to assessing the extent of spatial impact

The spatial extent of an impact is one of the factors relevant to the significance of an impact on the water environment. Consequently, it is important that classification results represent spatially significant impacts.

To do this, it is not possible or necessary to monitor every cubic centimetre of the water environment. Instead, monitoring stations and monitoring strategies are set up that provide information that is representative of a volume or section of the water environment.

Classification results are assigned to sub-divisions of the water environment called water bodies. This leads to simple maps showing the status of the water in a region or country. The maps can show where there are differences in environmental quality. The intent is that each water body is defined so that the environmental quality within it does not vary significantly from place to place[41]. However, for practical reasons discussed later in this section, this will not always have been achieved in practice and, even where it was, spatial variation may develop overtime as pressures change.

Suppose failure of a standard is detected at a monitoring point that has been nominated as representative of the environmental quality in a particular water body. This indicates that there is an impact affecting a significant proportion of the water body[42]. The impact is therefore of a sufficient spatial extent to affect the status reported for the water body.

This conclusion holds so long as:

(a) water bodies are delineated, as far as possible, as zones in which there is only modest

[41] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents&vm=detailed&sb=Title

[42] If it did not, the monitoring point would not be representative of the quality of the water body.

variation in impact from place to place[43]; and
(b) the selected monitoring stations are representative of the ecological quality in respect of variations from place to place.

In practice there will be cases where conditions (a) or (b) above do not apply. This will include situations where the quality within a water body has changed since it was delineated. There may also have been uncertainty about spatial variation, and hence about how to sub-divide the water environment into water bodies in the first place, and about how to identify representative monitoring stations. In some cases, this risk will have been met by having more than one monitoring station for the water body.

The criteria proposed by UKTAG for dealing with this issue are set out in Annex A. UKTAG recommends that they are used to ensure that impacts of a sufficient spatial scale to affect status are represented in classifications of the status of the water environment. The criteria do not mean that adverse impacts that are too small to affect the reported status of a water body are unimportant. On the contrary, such impacts may be very important, for example for local interests of nature conservation or recreation. The agencies will continue to use their powers to manage and correct such impacts.

5.2 Reflecting changes in impacts in classification results

Suppose that a new adverse impact on the water environment occurs. Under the Directive, deterioration of status can be permitted in certain circumstances so that developments can proceed that are important for human health, human safety or sustainable development[44]. To assess the risk of deterioration of status, the criteria set out in Annex A will be compared with modelled estimates of the expected extent of alteration to the hydromorphological, chemical or physicochemical quality elements. This will enable the agencies to decide whether:

(a) the adverse impact of the development would be of sufficient spatial scale to cause a deterioration of status of the water body; and
(b) there is a need to revise the delineation of water bodies (e.g. by sub-dividing them), move monitoring stations or change the strategy of monitoring, so as to represent the effect of the new impact in subsequent classification results.

With reference to point (b) above, Figure 5 illustrates how revisions to the delineation of river water bodies or the locations of monitoring stations, as informed by impact modelling, can be used to ensure that new impacts are reflected in the results of classification. The same principles apply in relation to other water body categories. UKTAG suggests that, in the example illustrated, splitting the original water body is the preferred course of action[45].

[43] Noting that quality may vary strongly and randomly through the time within a reporting period and this may come through as apparent spatial differences.
[44] See paragraph 7 of Article 4 of the Directive
[45] In practice, instead of creating an additional 'water body' through such sub-division, divisions of the original water body may instead be combined with adjacent water bodies of equivalent status

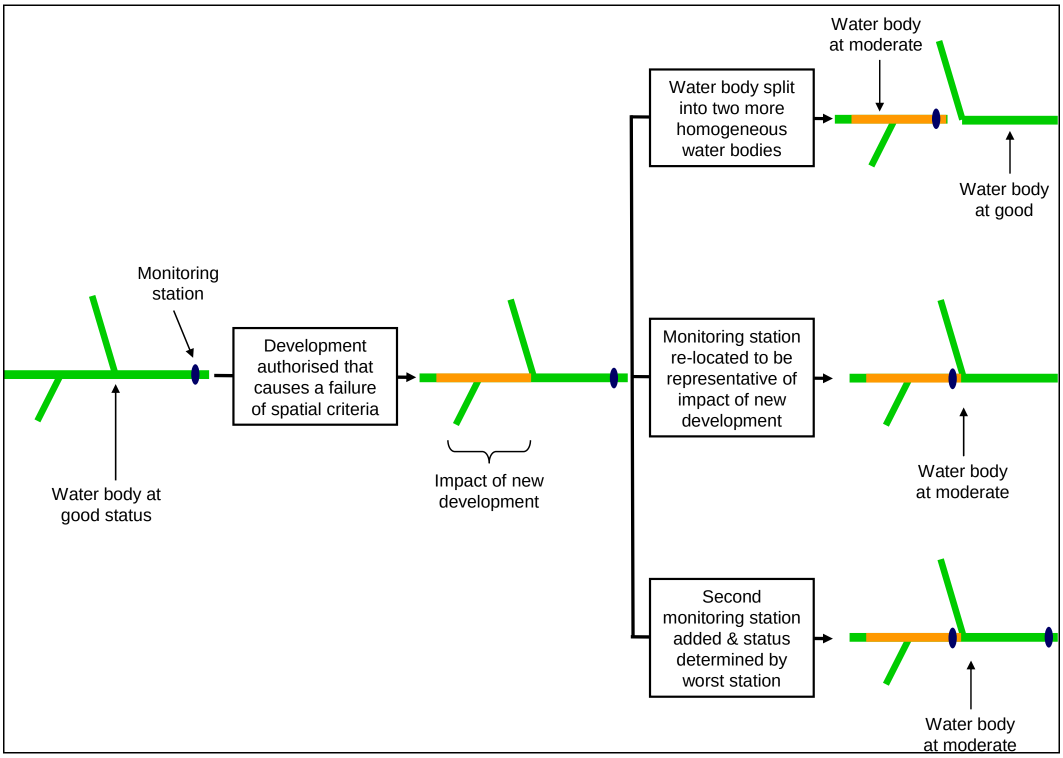


Figure 5: Reflecting the impacts of new developments in status classification. Note: in the top right option, no operational monitoring station is shown in the water body on the right. This would be because this water body is considered not at risk.

5.3. Spatial issues and the use of multiple monitoring stations

On occasions, it may be useful to have more than one monitoring station in a water body for assessing the impact of a pressure. This might be to:

(i) improve the confidence of classification by increasing the amount of data used to make a classification decision;
(ii) detect early, signs of deterioration where there is a significant risk that deterioration might start to occur independently at different places in the water body; or
(iii) understand how quality varies from place to place within a water body.

The following options are available for classifying a water body with multiple monitoring points[46]:

(a) identify a single representative monitoring station for the water body for the purposes of reporting the classification;
(b) take account of the results from all the monitoring stations in an appropriate way; or
(c) classify using the results for the monitoring station indicating the greatest adverse impact.

The choice of option will depend on a number of factors and the reasons why multiple monitoring stations have been established.

[46] Whenever multiple monitoring stations are used to assess status, it is important that the set of monitoring stations must have been chosen to be representative of the water body (and not targeted at places where poor quality is expected).

For example, option (a) may be appropriate when the purpose of the other stations is to validate that a single monitoring station is representative of the quality of the body (e.g. by assessing the extent to which quality varies from place to place and provide early warning of possible changes in that variation because of deterioration).

Option (b) may be appropriate where the aim is to improve confidence in classification by increasing the amount of data used to make classification decisions. For example, this could be achieved by averaging the results from the different monitoring stations. However, it is important not to average results or to pool data from different monitoring stations if the results from the stations indicate significant spatial variation in environmental quality within the water body.

Where there is significant spatial variation, UKTAG recommends the following options are considered:

(i) If there are only a handful of sites and each monitoring station is representative of a significant proportion[47] of the water body, it will normally be the case that the entire water body can be classified on the basis of the results for the monitoring station indicating the worst impact [i.e. option (c) may be more appropriate than option (b)]; or

(ii) If it is not clear that each monitoring station is representative of a significant proportion of the water body, each monitoring 'point' should be 'classified' and the set of results used - sometimes with the aid of modelling[48] - to estimate the proportion of the water body to have failed. This proportion can then be compared with the defined proportion of the water body that can fail without affecting the status of the entire water body (See Annex A).

With respect to point (ii) above, where the number of monitoring stations is small (<10), UKTAG recommends that the percentage of water body which is impacted is estimated from the length or area represented by each monitoring station showing an impact and this estimate is then compared with the criteria given in Table A1a in Annex A. Where the number of monitoring points is sufficiently large, appropriate statistical techniques can be used to help estimate the proportion of the water body that has been impacted.

5.4 Classification and temporal impacts resulting from short-term and rare events

In accordance with EU guidance[49], UKTAG recommends that monitoring results which are influenced by one-off[50] and transient pollution incidents or floods can be discounted from use in classification schemes provided, that the condition of each affected water body is adversely affected for "only a short period of time, and recovers within a short period of time without the need

[47] i.e. a proportion clearly larger than those set out in Annex A.
[48] i.e. of the extent of failure of environmental standards or condition limits for chemical, physicochemical or hydromorphological quality elements.
[49] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/thematic_documents/environmental_objectives/article_circapdf/_EN_1.0_&a=d
[50] The effects of events which are representative, such as pollution events recurring roughly annually, will be reflected in classification results

for any restoration measures" (i.e. there is a transient blip in the condition of the water body). This is because such fluctuations will not constitute deterioration of status.

Typically, waters affected by such one-off incidents will recover to the same, or close to the same, status within one sample period (e.g. the chemistry sample taken the following month would show little sign of the incident; the biological sample taken in the summer shows no sign of the impact which occurred in spring). However, summer blooms of phytoplankton sampled from a highly-dynamic system such as a lake would not be excluded from use in classification, despite the return to low levels in the autumn sample. This is because such blooms are an expression of the status of the phytoplankton in the lake rather than a short-term response to a one-off incident – they are likely to recur in the following summer.

Sometimes, impacts arising from a pollution event or from other short-term activities persist such that the condition of a water body is significantly impaired and would not recover within a short period of time without restoration measures being taken. In these circumstances, deterioration of status will have occurred and will be reflected in the classification results. The provisions of the Directive for allowing exemption from its objective of deterioration of status may also be applicable[51]. Where such exemptions are applied, this will also be reported in the relevant River Basin Management Plan.

SECTION 6: MAPPING AND REPORTING THE RESULTS OF CLASSIFICATION

6.1 Maps and colour coding

UKTAG recommends that two sets of maps are produced. The first set will consist of three maps showing:

(i) the overall surface water status class of water bodies;
(ii) the ecological status class of water bodies; and
(iii) the chemical status class.

These maps will be based on the face-value results of monitoring and, where relevant and appropriate, risk analyses (See Sections 3.1 and 4.4). The maps will be colour coded in accordance with Tables 14 and 15 below.

Table 14: Colour coding used to map the results of surface water status; ecological status classification; and the results for quality elements used to produce the ecological status classifications

Status	Colour Code
High	Blue

[51] See paragraphs 6 and 7 of Article 4 of the Directive.

Good	Green
Moderate	Yellow
Poor	Orange
Bad	Red

Any non-compliance with a good status environmental quality standard for a specific pollutant will also be indicated by a black dot on the ecological status maps.

Table 15: Colour coding used to map the results of chemical status classification and the results for individual priority substances used to produce those classifications	
Chemical Status Classification	**Colour Code**
Good	Blue
Failing to Achieve Good	Red

For rivers, the relevant colour code will be marked on the main stem of the river water body. Any tributary streams in a water body will not normally be mapped. This is because maps including all such streams would be extremely difficult to read due to the density of lines on them.

Where it has not been possible to obtain information in time to estimate the status of a water body (See Section 3.1), the water body will be colour coded as grey.

The second set of maps will present the classification results for the individual quality elements used to produce the maps referred to in points (i), (ii) and (iii) above. These maps will be colour coded in the same way (See also points 4 to 10 of Table 16).

The UK will report the status of water bodies to the European Commission electronically via the Water Information System for Europe (WISE). The details of reporting formats have yet to be finalised.

6.2 Presentation of information on classification results

Figure 6 shows the different tiers of status assessment carried out in rivers.

Tier 1 components	Tier 2 components	Tier 3 components	Tier 4 components
Cadmium		**Overall surface water chemical status**	**Overall surface water status**
Lead			
Mercury			
etc.			
Dissolved Oxygen	**General chemical and physicochemical conditions**	**Overall ecological status**	
pH			
Soluble Reactive Phosphorus			
Hydrology	**Hydromorphological**		

Morphology	**conditions**		
Phytobenthos	**Biological conditions**		
Macrophytes			
Macroinvertebrates			
Fish			
Chlorine	**Specific pollutants**		
Cypermethrin			
etc.			

Figure 6: Illustrative example of classification tiers for rivers. The respective roles of the Tier 2 components in calculating overall status (Tier 4) are illustrated in Figure 1b.

In Figure 6, the results for the components of a tier are combined, on a one-out all-out basis and in accordance with the rules described in Section 1.2 and Figures 1a and 1b, to produce a classification for the corresponding component of the tier above. Take for example the physicochemical classification. Three parameters in tier 1 (dissolved oxygen, pH and total phosphorus) are combined to produce the tier 2 general physicochemical classification. This is combined with the other tier 2 classifications to produce a classification for overall ecological status (tier 3) before being combined with the overall assessment of chemical status to make up the final surface water status classification (tier 4).

UKTAG recommends that the agencies produce maps on 'geographic information systems' (GIS) and make these available to the public as interactive maps via their websites. UKTAG suggests that these maps should be designed to allow people to “zoom in” to water bodies in different areas of a river basin district and then drill down to see classification results for the different tiers referred to above.

Table 16: Summary of recommended mapping and reporting information	
Report	**Description of requirements**
River Basin Plan	1. Map of the river basin district showing the overall surface water status of each water body. 2. Map of the river basin district showing the overall ecological status of each water body. 3. Map of the river basin district showing the overall surface water chemical status of each water body. 4. Map of water bodies classed as worse than good ecological status with high confidence. 5. Map of water bodies classed as failing to achieve good surface water chemical status with high confidence. 6. Tabular information and, as and when systems are developed, geographic information system map layers setting out the assessment results for each quality element or group of quality elements affecting the body's status[52], including information on the

[52] The status of quality elements whose condition has not been monitored or assessed for the purposes of determining the status of a water body would be indicated as grey for that water body, as outlined in Section 3.3.

	confidence of class of those elements[53]. 7. Maps of water bodies showing where the status of particular quality elements or groups of quality elements relevant to ecological status has improved or deteriorated during the period covered by the river basin management plan or last update thereof. 8. For water bodies classed as failing to achieve good chemical status, maps of the results for each substance or group of substances accounting for that classification. 9. Tabular information - linked where systems permit to the maps referred to in point 8 above - providing information on the confidence of class for each relevant substance or group of substances. 10. Map of water bodies showing where the status class of particular substances or groups of substances relevant to chemical status classification has improved during the period covered by the river basin management plan or last update thereof.
EU WISE Report[54]	Map 1: Ecological status of non-heavily modified water bodies. Map 2: Ecological potential class for Heavily Modified Water Bodies[55]. Map 3: Status for Protected Areas. Map 4: Compliance for heavy metals[56] in the list of Priority Substances. Map 5: Compliance for pesticides[57] in the list of Priority Substances. Map 6: Compliance for industrial pollutants[58] in the list of Priority Substances. Map 7: Compliance for other pollutants[59] in list of Priority Substances. Map 8: Compliance for specific pollutants.
Web-based information	Defined by each agency and designed to supplement the above reports.
Domestic Report	Defined by each agency (e.g. information on litter)

[53] These maps will include the same information for heavily modified and artificial water bodies.
[54] Data will be provided in the format necessary to generate the maps listed.
[55] This will be the subject of a separate UKTAG report.
[56] cadmium, lead, mercury, nickel.
[57] Alachlor, atrazine, chlorpyriphos, chlorvenfinphos, diuron, endosulfan, isoproturon, HCH, pentachlorobenzene, simazine, trifluralin.
[58] Anthracene, Benzene, C_{10-13}-chloroalkanes, Naphthalene, Nonylphenol, octylphenol, chlorinated organics (incl. SCCP, TRI, PER, DCM, Chloroform, 1,2-Dichloroethane...), PentaBDE, DEHP.
[59] DDT, HCB, HCBd, TBT, PAHs (including Fluoranthene), PCP, TCB, drins.

GLOSSARY

Alien species	A species, sub-species or lower taxon introduced as a result of human activity to a geographic area beyond the geographic distribution of the species, sub-species or lower taxon expected in the absence of human impacts on its distribution *(synonyms: non-native, non-indigenous, foreign, exotic):*
Angiosperms	The flowering plants. The group is specified in the Directive as a relevant biological element in transitional and coastal waters. In these waters, angiosperms include sea grasses and the flowering plants found in salt marshes
Artificial Water Body (AWB)	A discrete and significant man-made water body or part of a man-made water body (as opposed to a modified natural water body) with the potential to support, or supporting, a functioning aquatic ecosystem. Includes canals, some docks and some man-made reservoirs.
Confidence	In this report, confidence is used to refer to both statistically derived numerical estimates of confidence given as percentages and other means of estimating the certainty that a particular outcome will occur or that an estimated state of the environment is the true state, including qualitative means.
Ecological potential	The status of a heavily modified or artificial water body measured against the maximum ecological quality it could achieve given the constraints imposed on it by those heavily modified or artificial characteristics necessary for its use or for the protection of the wider environment. There are five ecological potential classes (maximum, good, moderate, poor and bad).
EU	European Union.
Heavily Modified Water Body (HMWB)	A surface water body that does not achieve good ecological status because of substantial changes to its physical character resulting from physical alterations caused by human activity, and which has been designated, in accordance with criteria specified in the Directive, as “heavily modified”.
Indicators	A parameter that can be monitored to estimate the value of a quality element. Indicators may include, among other things, the presence or absence of a particularly sensitive species or groups of species; the abundance of species or groups of species; or the relative balance of different groups of species.
Macroalgae	Multicellular algae such as seaweeds and filamentous algae.
Macrophyte	Larger plants, typically including flowering plants, mosses and larger algae, but not including single-celled phytoplankton or diatoms.
Metric	Alternative term for "indicator"
Phytobenthos	Bottom-dwelling multi-cellular and unicellular aquatic plants such as some species of diatom.
Phytoplankton	Solitary and colonial unicellular algae and cyanobacteria that live in the water column, at least for part of their lifecycle.

Pollution	The direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which: (i) may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems; (ii) result in damage to material property; or (iii) impair or interfere with amenities and other legitimate uses of the environment.
Pressures	Human activities such as abstraction, effluent discharges or engineering works that have the potential to have adverse effects on the water environment.
Priority Hazardous Substances	A pollutant, or group of pollutants identified at Community level under Article 16 of the Directive that presents a significant risk to or via the aquatic environment because of its toxicity, persistence and liability to bioaccumulate, or because of other characteristics which give rise to an equivalent level of concern.
Priority Substances	A pollutant, or group of pollutants, presenting a significant risk to or via the aquatic environment that has been identified at Community level under Article 16 of the Directive. They include "priority hazardous substances".
Protected Areas	Areas that have been designated as requiring special protection under Community legislation for the protection of their surface waters and groundwater or for the protection of habitats and species directly depending on water.
Quality element	A feature of an aquatic ecosystem listed in the WFD and which is measured and used as part of the process of assessing the quality of the ecosystem.
Reference conditions	The benchmark against which the effects on surface water ecosystems of human activities can be measured and reported in the relevant classification scheme. For waters not designated as heavily modified or artificial, the reference conditions are synonymous with the high ecological status class. This is defined in Annex V of the Directive and elaborated in a number of Common Implementation Strategy Guidance documents including Guidance Number 10 (REFCOND)[60] and Guidance Number 5 (COAST)[61]
River basin	Sometimes known as a river catchment, a "river basin" is the area of land from which all surface run-off flows through a sequence of streams, rivers and sometimes lakes into the sea at a single river mouth, estuary or delta.
River basin district	A river basin or several small river basins combined with larger river basins or joined with neighbouring small basins together with stretches of coastal waters.
River Basin Management Plan (RBMP)	For each River Basin District, the Directive requires a River Basin Management Plan to be published. The Plan must set out the environmental objectives for water bodies and provide a summary of the measures that are being used to achieve them. The Plans must be reviewed every six years.

[60] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidancesnos10sreference/_EN_1.0_&a=d
[61] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidancesnos5scharacteri/_EN_1.0_&a=d

Transitional water	Surface waters in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows. They include estuaries and brackish lagoons.
Water body	A “body of surface water” is a discrete and significant element of surface water such as part of a stream, river or canal, or a lake or a reservoir, or a transitional water such as an estuary or brackish lagoon, or a stretch of coastal water.
WFD	Water Framework Directive.

A.1 General Criteria

This Annex sets out the criteria proposed by UKTAG to ensure that spatial impacts sufficient to affect the status of a water body are reflected in classification results. The Annex should be read in conjunction with Section 5 of the report.

Table A1a below sets out the general criteria. These criteria do not apply to any minor tributaries of rivers which are part of a larger river water body (i.e. tributaries with catchment areas less than 10 km^2). Impacts on such tributaries are considered further in Section A.2. Table A1b sets out specific criteria relating to impacts on fish migration.

The spatial criteria in Tables A1a and A2a do not apply in relation to morphological condition limits. This is because spatial criteria are already incorporated into UKTAG's recommendations on such condition limits. The recommendations can be found in the UKTAG phase 1 report on environmental standards and condition limits[62] and in the phase 2 report on such standards and condition limits[63].

Table A1a: Spatial criteria for the geographic extents of failures of one or more of standards or condition limits (other than the morphological condition limits) that are expected to have a significant effect on the ecological status of a water body

Category of water body	Failures inconsistent with classification as high ecological status	Failures inconsistent with, as applicable, classification as good, moderate or poor ecological status
River	Failure of a standard or condition limit for 'high' in more than 0.5 km of contiguous length of river length; or failure of a standard or condition limit for 'high' in more than 5 % of river length unless 5 % of river length is 0.5 km or less. Where the latter applies, failure of the applicable standard or condition limit in a total of more than 0.5 km, or in100 %, of river length, whichever is the smaller	Failure of a standard or condition limit for 'good', 'moderate' or 'poor' in more than 1.5 km of contiguous river length; or failure of a standard or condition limit for 'good', 'moderate' or 'poor' in more than 15 % of river length unless 15 % of river length is 1.5 km or less. Where the latter applies, failure of the applicable standard or condition limit in a total of more than 1.5 km, or in 100 %, of river length, whichever is the smaller

[62] http://www.wfduk.org/UK_Environmental_Standards/LibraryPublicDocs/UKTAG%20ReportAug%202006UKEnvironmentalStandardsandConditionsFinalReport
[63] http://www.wfduk.org/UK_Environmental_Standards/LibraryPublicDocs/UKTAG_Report_Surface_Water_Standards_and_Conditions

	For the purposes of the above criteria, 'river length' means the length of river (in kilometres) in the water body excluding the length of any tributary streams in the water body that have a catchment area of less than 10 km^2	
Inland loch	Failure of a standard or condition limit for 'high' over more than 5 % of the total surface area of the water body	Failure of a standard or condition limit for 'good', 'moderate' or 'poor' in more than 15 % of the total surface area of the water body
Transitional water	Failure of a standard or condition limit for 'high' over more than 0.5 km^2 of contiguous surface area of the water body; or failure of a standard or condition limit for 'high' over more than 5 % of the surface area of the water body unless 5 % of the surface area of the water body is 0.5 km^2 or less. Where the latter applies, failure of the standard or condition limit over a total surface area of more than 0.5 km^2 or over 100 % of the surface area of the water body, whichever is the smaller	Failure of a standard or condition limit for 'good', 'moderate' or 'poor' over more than 1.5 km^2 of contiguous surface area of the water body; or failure of a standard or condition limit for 'good', 'moderate' or 'poor' over more than 15 % of the surface area of the water body unless 15 % of the surface area of the water body is 1.5 km^2 or less. Where the latter applies, failure of the standard or condition limit over a total surface area of more than 1.5 km^2 or over 100 % of the surface area of the water body, whichever is the smaller
Coastal water	Failure of a standard or condition limit for 'high' over more than 0.5 km^2 of contiguous surface area of the water body; or failure of a standard or condition limit for 'high' over more than 5 % of the surface area of the water body, unless 5 % of the surface area of the water body is 0.5 km^2 or less. Where the latter applies, failure of the standard or condition limit over a total surface area of more than 0.5 km^2 or over 100 % of the surface area of the water body, whichever is the smaller[64]	Failure of a standard or condition limit for 'good', 'moderate' or 'poor' over more than 1.5 km^2 of contiguous surface area of the water body; or failure of a standard or condition limit for 'good', 'moderate' or 'poor' over more than 15 % of the surface area of the water body unless 15 % of the surface area of the water body is 1.5 km^2 or less. Where the latter applies, failure of the standard or condition limit over a total surface area of more than 1.5 km^2 or over 100 % of the surface area of the water body, whichever is the smaller

Man-made impediments to fish migration, such as dams and weirs, can reduce the accessibility to fish of different lengths of rivers and streams. Where it is unclear whether a dam or weir is impassable, fish monitoring data may be used to determine whether fish migration has been significantly impaired. If only a small part of a river system becomes inaccessible to a fish population, this may not have a significant adverse impact on that fish population in the river

[64] For example, if 5% of the water body surface area is only 0.3 km^2, this rule means that the standard must be failed over either (a) an area of more than 0.5 km^2 or (b), if the total surface area of water body is less than 0.5 km^2, over the whole water body.

system as a whole. However, loss of access for fish to a large area of habitat important for that fish population is likely to have a significant adverse impact.

Table A1b: Standards for the hydromorphological quality element, 'river continuity' to be used in assessing impacts on the movement of fish species in river systems		
Column 1	**Column 2**	**Column 3**
High	**Good**	**Moderate**
Severe loss of fish access to rivers draining less than 1 % of catchment area of the water body	Severe loss of fish access to rivers draining less than 5 % of catchment area of the water body	Severe loss of fish access to rivers draining less than 20 % of the catchment area of the water body

Notes on Table A1b

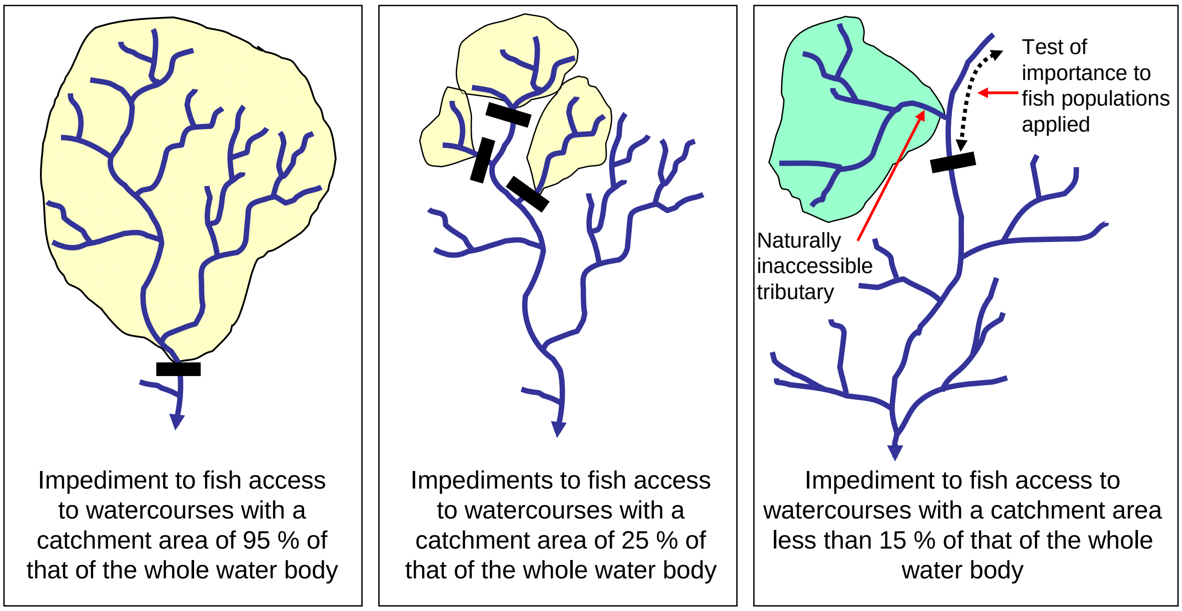
(a) The condition limits refer to lost access by fish to the catchment areas during that part of the year in which fish movement to those areas would normally be expected to occur in the absence of man-made barriers to fish movements.

(b) Catchment areas known to be naturally inaccessible to the fish species should be disregarded when applying the condition limits.

(c) Where a loss of access to waters draining smaller catchment areas than those referred to in Column 1, 2 or 3 is assessed as having, respectively, more than a very minor, slight or moderate adverse impact on fish, the criteria in Column 1, 2 or 3, as the case may be, shall not apply and the water body will be classed according to the estimated impact on fish populations. This may be the case where the waters are particularly important in the lifecycle of the fish species concerned.

(d) A severe loss of access means that more than 80 % of fish that would otherwise access the catchment areas concerned are judged unable to do so because of man-made barriers to their movements.

Figure A1 illustrates impediments affecting different spatial scales in water bodies. Series of dams may also have a significant cumulative impact on fish migration even if each individual dam causes only a small reduction in the number of fish that would otherwise have found passage. In due course, as such risks become better understood and methods to assess them develop, they will be reflected in classification results.



Impediment to fish access to watercourses with a catchment area of 95 % of that of the whole water body

Impediments to fish access to watercourses with a catchment area of 25 % of that of the whole water body

Impediment to fish access to watercourses with a catchment area less than 15 % of that of the whole water body

Figure A1: Impediments to migration affecting access to streams

A.2 Impacts on small tributaries in water bodies

Many river water bodies include minor tributaries with catchment areas of less than 10 square kilometres. Although impacts on such small watercourses can be locally severe, on their own they may not be significant enough to threaten the status of the water body as a whole. The minor tributary may be a small, narrow stream providing limited aquatic habitat per unit length. However, cumulatively impacts on the minor tributaries can threaten a water body's status by, for example, damaging spawning and nursery habitat for fish and through loss of the often diverse aquatic habitats and associated assemblages of aquatic plants and animals they contain.

Table A2a sets out the criteria proposed by UKTAG to judge whether impacts on minor tributaries are likely to threaten the status of a water body. The criteria are intended to reflect the relatively smaller area of habitat per unit length which minor tributaries contain compared with larger watercourses.

The criteria in Table A2a are recommended for use where there is evidence from risk assessments of a risk to the ecological quality of a water body as a result of cumulative impacts on its minor tributaries. When applying the criteria for water resource or water quality impacts, UKTAG recommends that an assessment of conditions at the downstream end of the minor tributaries supported by modelling work where appropriate should be used to help judge whether there are extensive impacts on those tributaries.

Table A2a: Taking account of impacts on the minor tributaries within a river water body when classifying the water body		
Water body category	**Spatial extent of failure of one or more standards defined for high status which would affect the status of a water body**	**Spatial extent of failure of one or more standards defined for good, moderate or poor status which would affect the status of a water body**
River	Failure is extensive in tributaries collectively draining **more than 10 per cent** of the catchment area of the water body	Failure is extensive in tributaries collectively draining **more than 25 per cent** of the catchment area of the water body

ANNEX B: LIST OF ALIEN SPECIES RELEVANT TO CLASSIFICATION

Subject to any revisions resulting from ongoing review undertaken[65] by UKTAG experts on alien species, UKTAG recommends that the list of alien species in Table B1 below be taken into account as indicated in Section 1.3.5 of this report when classifying water bodies in England, Scotland and Wales and the list in Table B2 be taken into account when classifying the status of water bodies in Northern Ireland.

Table B1: Provisional list of high impact alien species for use in classifying ecological status in England, Scotland and Wales

Species common name	Species scientific name	Plant/ Animal	Habitat
1. Australian swamp stonecrop	*Crassula helmsii*	Plant	Lakes
2. Floating pennywort	*Hydrocotyle ranunculoides*	Plant	Rivers
3. Water fern	*Azolla filiculoides*	Plant	Rivers and lakes
4. Parrot's feather	*Myriophyllum aquaticum*	Plant	Lakes
5. Curly water-thyme	*Lagarosiphon major*	Plant	Lakes
6. Water primrose	*Ludwigia grandiflora*	Plant	Lakes
7. Canadian pondweed	*Elodea canadensis*	Plant	Rivers and lakes
8. Nuttall's pondweed	*Elodea nuttallii*	Plant	Rivers and lakes
9. Japanese knotweed*	*Fallopia japonica*	Plant	Rivers
10. Himalayan balsam*	*Impatiens glandulifera*	Plant	Rivers
11. Giant hogweed*	*Heracleum mantegazzianum*	Plant	Rivers
12. Rhododendron*	*Rhododendron ponticum*	Plant	Rivers
13. Common cord-grass, Townsend's grass or ricegrass	*Spartina anglica*	Plant	Transitional and coastal waters
14. Japanese weed	*Sargassum muticum*	Plant	Transitional and coastal waters
15. North American signal crayfish	*Pacifastacus leniusculus*	Animal	Rivers and lakes
16. Red swamp crayfish	*Procambarus clarkii*	Animal	Rivers and lakes
17. Freshwater amphipod	*Dikerogammarus villosus*	Animal	Rivers and lakes
18. Freshwater amphipod	*Crangonyx pseudogracilis*	Animal	Rivers and lakes
19. Mysid crustacean	*Hemimysis anomala*	Animal	Rivers and lakes
20. Chinese mitten crab	*Eriocheir sinensis*	Animal	Rivers, transitional and coastal waters
21. Slipper limpet	*Crepidula fornicata*	Animal	Transitional and coastal waters
22. Zebra mussel	*Dreissena polymorpha*	Animal	Rivers and lakes

[65] The review is expected to be completed in 2008. Tables B1 and B2 will be updated on its completion.

23. Quagga mussel	*Dreissena bugensis*	Animal	Rivers and lakes
24. Leathery sea squirt	*Styela clava*	Animal	Transitional and coastal waters
25. American oyster drill	*Urosalpinx cinerea*	Animal	Transitional and coastal waters
26. Pacific oyster	*Crassotrea gigas*	Animal	Transitional and coastal waters
27. Colonial tunicate	Non native *Didemnum spp.*	Animal	Transitional and coastal waters
28. Marine tubeworm	*Ficopomatus enigmaticus*	Animal	Transitional and coastal waters
29. Common carp[66]	*Cyprinus carpio*	Animal	Rivers and lakes
30. Topmouth gudgeon	*Pseudorasbora parva*	Animal	Lakes
31. Goldfish	*Carassius auratus*	Animal	Rivers and lakes

Table B2: Provisional Invasive Alien List for Ecoregion 17 for use in classifying ecological status in Northern Ireland

*Note that the list does not include invasives that have not been recorded in the Ecoregion and the list will need to be updated if additional species arrive***

**Last updated November 2008.

	Species	Common Name
Aquatic Plants	*Lagarosiphon major*	Curly Waterweed
	Elodea nuttallii	Nuttall's waterweed
	Myriophyllum aquaticum	Parrots Feather
	Crassuala helmsii	New zealand pigmyweed
	Azolla filiculoides	Water fern
	Lemna minuta	Least duckweed
	Nymphoides peltata	Fringed waterlily
	Hydrocotyle ranunculoides	Floating pennywort
Riparian species	*Heracleum mantegazzianum*	Giant hogweed
	Impatiens glandulifera	Indian balsam
	Fallopia japonica	Japanese knotweed
Invertebrate	*Dreissena polymorpha*	Zebra mussel
	Crangonyx pseudogracilis	Crustacean
Fish	*Leuciscus cephalus*	Chub
	Leuciscus leuciscus	Dace
Fish parasite	*Anguillicola crassus*	Swim Bladder Nematode
Marine species	*Didemnum spp*	Ascidian species
	Spartina anglica	smooth cord-grass
	Sargassum muticum	Wire weed
	Eriocheir sinensis	Chinese mitten crab
	Crassostrea gigas	*Pacific Oyster*

[66] More investigation is required on the status of this species and the report will be updated in the near future

	Styela clava	*Leathery Sea Squirt*

Species indicated in Table B1 and Table B2 by an asterix (*) are terrestrial species that have adverse impacts on the structure and condition of the riparian and shore zones of water bodies, including impacts on the roles those zones play in supporting biological quality elements (See Section 1.3.1). The structure and condition of these zones is also one of the hydromorphological quality elements (See Section 1.3.4).

For the purpose of determining if a water body is at high status, UKTAG recommends that, where the impacts of terrestrial alien species are taken into account as part of a hydromorphological assessment, the procedure described in Section 1.3.5 is not applied. This is because to do so would double count the impact of alien species.

UKTAG also recommends that, where listed alien species are identified as present in a high status or good status water body, the likelihood that those species will cause deterioration of status of the water body is taken into account in updates of the pressures and impacts analyses.

APPENDIX: BIOLOGICAL METHODS RECOMMENDED FOR USE IN CLASSIFICATION

1. LIST OF METHODS RECOMMENDED FOR USE IN CLASSIFYING RIVERS

Table AP1: List of biological methods recommended for use in classifying rivers subject to the pressures listed in column 1.

Column 1	Column 2	Column 3
Pressure	**Biological quality elements**	**Name of classification methods**
Organic enrichment	Macro-invertebrates	River Invertebrate Classification Tool (RCIT)
Nutrient enrichment	Phytobenthos	Diatoms for Assessing River Ecological Status (DARES)
	Macrophytes	Macrophyte Prediction & Classification System (LEAFPACS) Canonical Correlation Analysis Based Assessment System (CBAS)
Pollution by toxic chemicals	Macro-invertebrates	River Invertebrate Classification Tool (RCIT)
Acidification	Macro-invertebrates Phytobenthos	River Invertebrate Classification Tool (RCIT) Diatoms for Assessing River Ecological Status (DARES)
Abstraction of water	Macro-invertebrates	Lotic-invertebrate Index for Flow Evaluation (LIFE index). Not yet developed and tested for general use across the UK. Limited applicability geographically at present.
	Fish	Fisheries Classification Scheme (FCS). Not yet fully tested and capability in diagnosing impact of abstraction pressures still to be assessed. Will need further development to apply to all parts of the UK.
Morphological alterations	Fish	Fisheries Classification Scheme (FCS). Not yet fully tested and capability of diagnosing impact of morphological pressures still be assessed. Would need further development to apply to all parts of the UK.
	Macrophytes	Macrophyte Prediction & Classification System (LEAFPACS). Not yet fully developed and tested for use across the UK. May in due course provide some capability to indicate hydromorphological impacts

2. LIST OF METHODS RECOMMENDED FOR USE IN CLASSIFYING LAKES

Table AP2: List of biological methods recommended for use in classifying lakes subject to the pressures listed in column 1

Column 1	Column 2	Column 3
Pressure	**Biological Quality Elements**	**Name of tool(s)**
Organic enrichment	no specific tool but other tools expected to show response	
Nutrient enrichment	Phytoplankton Phytobenthos Macrophytes Invertebrates	Phytoplankton (chlorophyll a & taxonomic composition) Diatoms for Assessing Lake Ecological Status (DALES) Macrophyte Prediction & Classification System (LEAFPACS) Chironomid Pupal Exuvial Tool (CPET)
Pollution by toxic chemicals	No specific tool developed	
Acidification	Macro-invertebrate	Macro-invertebrate acidification tool (expected to be available from summer 2008) Chironomid Pupal Exuvial Tool (CPET)
Abstraction of water	Macrophytes	Macrophyte Prediction & Classification System (LEAFPACS) (expected to be available from spring 2008)
Morphological alterations	Macrophytes	Macrophyte Prediction & Classification System (LEAFPACS) (expected to be available from spring 2008)

3. LIST OF METHODS RECOMMENDED FOR USE IN CLASSIFYING TRANSITIONAL AND COASTAL WATERS

Table AP3: Overview of biological methods recommended for use in classifying transitional and coastal waters subject to the pressures listed in column 1

Column 1	Column 2	Column 3
Pressure	**Biological Quality Elements**	**Name of tool(s)**
Organic enrichment	Benthic Invertebrates Fish (transitional only)	Infaunal Quality Index (IQI)* Fish UK multi-metric
Nutrient enrichment	Phytoplankton	Phytoplankton toolbox – a) Chlorophyll biomass index*, b) Seasonal succession index (possibly not available for Year 1 reporting) c) Elevated taxa count index

	Macroalgae Angiosperms	Reduced species list (RSL) Opportuntistic algae Seagrass (intertidal only for Year 1) Saltmarsh (classification tool not yet developed)
Pollution by toxic chemicals	Benthic Invertebrates Macroalgae Fish (transitional only)	Infaunal Quality Index (IQI)* The Vas Deferens Sequence Index (VDSI) – imposex in dogwhelks (TBT specific) Fuccoid extent tool Fish UK multi-metric
Commercial Fishing	Angiosperms Benthic invertebrates Fish (trans)	Seagrass (intertidal) Infaunal Quality Index (IQI)* Fish UK multi-metric
Change in freshwater flow	Benthic Invertebrates Fish (transitional only)	Infaunal Quality Index (IQI)* Fish UK multi-metric
Aquaculture	Phytoplankton Benthic invertebrates Fish (transitional only)	Phytoplankton toolbox – a) Chlorophyll biomass index*, b) Seasonal succession index (possibly not available for Year 1 reporting), c) Elevated taxa count index Infaunal Quality Index (IQI)* Fish UK multi-metric

4. OVERVIEW OF THE INTERCALIBRATION STATUS OF THE BIOLOGICAL METHODS RECOMMENDED FOR USE IN CLASSIFICATION

A first round of intercalibration (phase 1) is expected to be completed in early 2008 (See Section 1.3.2). Table AP4 identifies those quality elements for which intercalibration results are expected in phase 1. The remaining quality elements are expected to be considered in a subsequent round (phase 2).

Table AP4: Intercalibration status of the different biological quality elements

Biological Quality Element	Transitional waters	Coastal waters	Rivers	Lakes
Angiosperms	Phase 1*	Phase 1 *	n/a	n/a
Macroinvertebrates	Phase 2	Phase 1*	Phase 1	Phase 2
Macroalgae	Phase 1*	Phase 1*	n/a	n/a
Phytoplankton	Phase 2	Phase 1* (At metric level in Phase 1. At classification tool level in Phase 2)	n/a	Phase 1* (At metric level in Phase 1. At classification tool level in Phase 2)
Saltmarsh	Phase 2	Phase 2	n/a	n/a
Fish	Phase 2	n/a	Phase 2	Phase 2?
Phytobenthos	n/a	n/a	Phase 1 (for metrics sensitive to nutrient enrichment)	Phase 2
Macrophytes	n/a	n/a	Phase 2	Phase 1*

Key to Table D:
"**n/a**" means that the quality element is not applicable in the water category concerned.
"**Phase 1**" means intercalibration results for the element will be included in the first intercalibration decision.
"**Phase 1***" means partial intercalibration results for the element will be included in the first intercalibration decision but further work is expected in phase 2. For example, this may include work on: other habitat types; different salinity ranges in transitional waters; the effects of different pressures on the quality element; additional metrics of the quality element; or the national classification systems rather than common metrics.
"**Phase 2**" means intercalibration work on the element is expected in the proposed second round of intercalibration.
"**Phase 2?**" means that it is not clear at this stage whether intercalibration of the element concerned will be possible even in the second round of intercalibration.

5. PROFORMAS OF BIOLOGICAL CLASSIFICATION TOOLS

In order to classify surface water bodies throughout the UK, a number of classification tools have been developed. The summaries of these tools have been detailed below, if you would like further information please click on the links to see the more detailed proformas.

Rivers

Summary for River Invertebrate Tool (RICT)

The Regulatory Agencies in the UK currently use RIVPACS software to classify ecological quality in rivers using data from invertebrate samples. RIVPACS predicts the river invertebrate community that would be found at a site by reference to a database of river sites considered to be the best available of their type.
A new River Invertebrate Classification Tool (RICT) has been developed to meet the needs of the WFD. It includes the ability to predict new biological indices, produce biological status assessments based on these new indices (including those that have been intercalibrated) and it is able to estimate the errors involved in sampling and analysis. This system also ensures that the predictions of biological indices are genuinely compatible with the WFD concept of reference condition.

The UK river invertebrate classification will be based on biological surveys conducted once, twice or three times over a three-year period. Each survey will comprise a spring and autumn visit, and in certain cases a summer sample will also be taken. Specifically the EQR for each year will be derived from a spring and autumn combined sample or for spring, summer and autumn combined where these are routinely taken. These annual classifications will be combined to give a three-year rolling classification, which will increase the confidence in the final result.

Link to proforma:

Summary for Diatom Tool (Diatom Assessment of River and Lake Environmental Quality)

DARLEQ is a benthic diatom-based tool developed to fulfil the obligation to include phytobenthos in the assessment of ecological status of freshwaters. Separate tools have been developed for lakes and rivers, although they share a common approach. The tools are based on changes in the species composition and abundance of the benthic diatom flora (the bio-film) in response to nutrient pressure. The dynamic nature of bio-films means they mat change over relatively short time scales.

The tool is based on the Trophic Diatom Index (TDI), which is already used by the UK Statutory Agencies for the assessment of eutrophication in rivers. A new index (TDLI) has been developed for use in lakes.

Reference TDI values (or TDLI for lakes) are calculated using site-specific predictions, and compared with the observed values to produce an EQR. The high/good status boundary was defined as the 25th percentile of the EQRs of all sites considered to be at reference condition; the good/moderate boundary is the point at which the relative proportions of diatoms present belonging to nutrient-sensitive and nutrient-tolerant taxa were approximately equal. As a consequence of the dynamic nature of bio-films there may be a considerable amount of within-site variability, although

less so in lakes compared to flowing waters. Both tools include an estimation of uncertainty along with their Ecological Quality Ratio (EQR) outputs.

The rivers tool has been successfully intercalibrated. Intercalibration of the lakes tool is under consideration.

Link to proforma:

Summary for Fish Tool (FCS)

The Fisheries Classification Scheme (FCS) was originally developed to classify the abundance of coarse fish, trout and juvenile salmon in relation to what would be expected for a given river type (defined by width and gradient). The habitat models used by the FCS have been updated as part of the River Fish Habitat Inventory (RFHI) project. FCS 2 now uses a Bayesian statistical model that describes the expected prevalence and abundance of 23 individual fish species in relation to river type (defined by altitude, width, and geographic location). The classification can be applied to individual species, or to any group of species, such as all 23 species combined. The classification has also been recalibrated on data from the National Fish Populations Database (NFPD) collected between 2000 and 2005

In a final development, the outputs from FCS 2 have been made WFD compliant and now use ecological status classes. It includes data on environmental pressures to help define reference conditions, and estimates the degree to which different species groups respond to these pressures. Class boundaries for EQRs are derived from critical values for pressure variables. FCS also describes the uncertainty associated with its classification of a waterbody, using "probability of class"(PofC). This is based on the number and variability of sites within the waterbody.

Link to proforma

Summary of River Macrophyte tool

The LEAFPACS classification method uses 3 key aspects of the aquatic plant community to assess the ecological status of rivers – species composition, diversity and abundance. The assessment is based on the response of these characteristics to nutrient and hydromorphological pressures, quantified with the following metrics:

- Species composition and diversity: River Macrophyte Nutrient Index (RMNI), River Macrophyte Hydrological Index (RMHI), number of functional groups, number of taxa,
- Abundance indicators: % cover of macrophytes

The method is designed to distinguish the anthropogenic effects of nutrient enrichment from a natural nutrient gradient, and to take into account the impact of changes in river hydromorphology on the macrophyte community. Each of the observed characteristics is compared with a reference value, and expressed as a calculated ecological quality ratio (EQR). Reference values specific to each river water body are determined from a set of environmental predictors, including geographical location, altitude, slope, distance from source and alkalinity. EQRs for each of the metrics are adjusted to a common scale and combined using weighted averaging to give an overall status class. Confidence of class can then be calculated. The river tool is currently the subject of intercalibration.

Link to proforma

Lakes

Summary for Diatom Tool (Diatom Assessment of River and Lake Environmental Quality)

DARLEQ is a benthic diatom-based tool developed to fulfil the obligation to include phytobenthos in the assessment of ecological status of freshwaters. Separate tools have been developed for lakes and rivers, although they share a common approach. The tools are based on changes in the species composition and abundance of the benthic diatom flora (the bio-film) in response to nutrient pressure. The dynamic nature of bio-films means they mat change over relatively short time scales.

The tool is based on the Trophic Diatom Index (TDI), which is already used by the UK Statutory Agencies for the assessment of eutrophication in rivers. A new index (TDLI) has been developed for use in lakes.

Reference TDI values (or TDLI for lakes) are calculated using site-specific predictions, and compared with the observed values to produce an EQR. The high/good status boundary was defined as the 25th percentile of the EQRs of all sites considered to be at reference condition; the good/moderate boundary is the point at which the relative proportions of diatoms present belonging to nutrient-sensitive and nutrient-tolerant taxa were approximately equal. As a consequence of the dynamic nature of bio-films there may be a considerable amount of within-site variability, although less so in lakes compared to flowing waters. Both tools include an estimation of uncertainty along with their Ecological Quality Ratio (EQR) outputs.

The rivers tool has been successfully intercalibrated. Intercalibration of the lakes tool is under consideration.

Link to proforma:

Summary of Lake Macrophyte tool

The LEAFPACS classification method uses 3 key aspects of the aquatic plant community to assess the ecological status of lakes – species composition, diversity and abundance. The assessment is based on the response of these characteristics to nutrients, quantified with the following metrics:

- Species composition and diversity: Lake Macrophyte Nutrient Index (LMNI), number of functional groups, number of taxa, relative cover of invasive alien species
- Abundance indicators: % cover of macrophytes, relative cover macroalgae.

The method is designed to distinguish the anthropogenic effects of nutrient enrichment from a natural nutrient gradient. Each of the observed characteristics is compared with a reference value, and expressed as a calculated ecological quality ratio (EQR). Reference values specific to each lake are determined from a set of environmental predictors, which have been derived from a model based on a population of lakes considered to represent reference conditions. EQRs for each of the metrics are adjusted to a common scale and combined using weighted averaging to give an overall status class. Confidence of class can then be calculated. The lake tool has been successfully intercalibrated for nutrient pressures.

Link to proforma:

Summary for the Lake Phytoplankton tool

Classification of lake phytoplankton is based on two metrics that have been developed and intercalibrated separately.

- *Phytoplankton biomass* is represented by chlorophyll.
- *Phytoplankton taxonomic composition and abundance* is represented by the percentage of nuisance cyanobacteria (blue-green algae) as measured by biovolume.

Chlorophyll is measured monthly and an annual average is used for classification whereas the percentage of nuisance cyanobacteria is determined from late summer samples.

Environmental quality ratios (EQRs) for both chlorophyll and % cyanobacteria are calculated as a ratio of the observed values to the expected values at Reference condition. Reference conditions for chlorophyll are predicted on a site-specific basis using a relationship between total phosphorus and chlorophyll. Reference total phosphorus is predicted from the alkalinity and mean depth of the lake. For % cyanobacteria, reference conditions are based on lake type only and determined using data from lakes considered to be in reference condition across Europe.

EQRs and reference conditions for both chlorophyll and % nuisance cyanobacteria have been successfully intercalibrated.

Chlorophyll and % nuisance cyanobacteria classifications will be combined using a one-out, all-out approach. An overall confidence of class is calculated using the combined confidence of class from the two individual classifications.

Link to proforma:

Summary for the CPET tool

Chironomid pupal exuviae technique (CPET) is a simple and effective sampling method for assessing the impact of acidification and eutrophication pressures on aquatic invertebrates. Reference conditions were derived from a combination of pressure threshold limits and ratio of pressure-sensitive to tolerant species presence. Class boundaries are defined by relative frequencies of sensitive to tolerant species according to normative definitions.

Over the wide range of lake types surveyed, generic-level CPET performed ecological classifications close to that achieved with species-level data, with low sampling error and high confidence.

The European Committee for Standardisation has approved the final draft of ‘Water quality – Guidance on sampling and processing of the pupal exuviae of chironomidae for ecological assessment’ CEN standard 15196.

Link to proforma:

Please note the CPET tool has only been approved for use when assessing nutrient enrichment pressures; it has not yet been approved for use when assessing acidification pressures.

Summary for the Lake Acidification Macroinvertebrate Metric (LAMM)

The Lake Acidification Macroinvertebrate Metric (LAMM) has two constituent metrics, one developed for clear lakes; Clear Lake Acidification Macroinvertebrate Metric (CLAMM), the other for humic lakes; Humic Lake Acidification Macroinvertebrate Metric (HLAMM). This determination is based on Dissolved Organic Carbon (threshold 5 mg/l), to account for the presence of naturally occurring humic acids (i.e. natural acidity).

Data are collected from combined 2 x 3 minute kick samples plus 2 x 1 minute search from the stony littoral zone. Identifications are based on mixed-taxon level and the metric values are derived by taxon sensitivity, niche breadth and abundance, measured as a percentage contribution to the scoring taxa present.

Ecological Quality Ratios (EQR)are calculated as a ratio between the observed and expected values based on a type-specific reference condition. Reference conditions were determined by Acid NeutralisingCapacity (ANC) linked to calcium levels, coupled with hindcasting ANC. The EQR is further supported by checks with the presence of sensitive groups and, in the case of CLAMM, functional change. An overall Confidence of Class (CoC) is calculated based on the EQR and number of samples used in the EQR calculation.

Link to prof orma

Transitional and Coastal

Summary for the Benthic Invert Tool (IQI)

The Infaunal Quality Index (IQI) assesses ecological status based on the soft sediment infaunal communities of Transitional and Coastal waters, and forms part of the Benthic Invertebrate Biological Quality Element.

The IQI is a multi-metric tool composed of: AZTI Marine Biotic Index, Simpson's Evenness, and number of taxa. Individual metrics have been weighted and combined to show changes in the benthic invertebrate community due to anthropogenic pressures. The tool operates over a range from zero (bad status) to one (high status).

Each metric is compared to a reference value specified for that habitat type. Maximum values for habitat and sample type have been established using historic data and expert judgement. Class boundaries were defined using the behaviour of the benthic invertebrate communities over a quantifiable organic enrichment gradient from a sewage sludge disposal site.

Intercalibrated boundaries for the IQI for coastal waters of specified habitat type, (subtidal muddy sands/sandy muds) and sample type (0.1m^2, 1mm mesh) have been agreed.

Link to proforma:

Summary for the Benthic Invert Imposex Tool

The Vas Deferens Sequence Index (VDSI) is a component of the Benthic Invertebrate Biological Quality Element and is used to assess the impact of TBT on the common dogwhelk *Nucella lapillus*, populations in coastal water bodies. It indicates the occurrence and degree of imposex on the population. The index ranges from zero (unaffected community) to six, (majority of females are sterile due to imposex).

Five categories of VDSI were proposed by an OSPAR workshop to describe the effects of TBT on *Nucella lapillus*. These categories are associated with WFD categories using the definition of Good Ecological Status The normative definitions indicate that at moderate status dogwhelks would be absent or present in reduced numbers

Reference conditions and class boundaries were set with respect to OSPAR guidance -JAMP Guidelines for contaminant-specific biological effects monitoring (OSPAR, 2002).

The VDSI has not been included in Phase I Intercalibration.

Link to proforma:

Summary for Transitional Fish Tool

The Transitional Fish Classification Index (TFCI) has been developed to assess the ecological status of fish within transitional waters.

TFCI is a multi metric index which combines both structural and functional attributes of estuarine fish communities and integrates these to provide a robust and sensitive method for assessing the ecological condition of estuarine systems. It uses 10 ecological metrics to analyse fish populations (Table 1). The overall assessment is based on a comparison to a 'reference community' calculated from historic reference data and from survey data from transitional waters of the same type.

Further tool testing & intercalibration assessment is proposed throughout 2007/8.

Table 1

Metric Type	No.	Metric
Species diversity and composition	1	'Species composition'
	2	Presence of 'Indicator Species'
Species abundance	3	Species relative 'abundance'
	4	Number of taxa that make up 90% of the 'abundance'

Nursery function	5	Number of estuarine resident taxa
	6	Number of estuarine-dependent marine taxa
Trophic integrity	7	Functional Guild Composition
	8	Number of benthic invertebrate feeding taxa
	9	Number of piscivorous taxa
	10	Feeding Guild Composition

Link to proforma:

Summary of Macro-algae – Fucoid Extent

The Water Framework Directive requires that ecological quality be assessed in transitional waters using the abundance and species composition of macroalgae. In estuaries, which form the majority of transitional waters, species composition is not a suitable measure because:

(i) there is a continuous, natural change in species composition along the gradient of estuarine conditions which makes it difficult to know where within an estuary the species composition should be assessed;

(ii) the inner estuarine macroalgal community of mat-forming species is very tolerant to both natural and anthropogenic stress and species poor which makes it insensitive to environmental variations in terms of species composition.

Two indices have been developed for fucoid extent:

- Presence of zone B fucoids
- Salinity regime at the upstream point of fucoid extent

This proposal is founded on a series of case studies of the changes in fucoid limits, within a number of estuaries in the British Isles, as a result of changes in pollution status over the last three decades. This also takes into account variations of fucoid penetration owing to natural factors such as range of salinity variation and turbidity

Link to proforma:

Summary of Opportunistic Macro-algae

A suite of measures have been developed to fulfil the normative definitions of the WFD TraC opportunistic macroalgae as part of the Macroalgal Biological Element.

The basic indices are:

- Total extent of macroalgae bed
- % cover of available intertidal habitat at site (derived measure) and at quadrat level,
- biomass of opportunistic macroalgal mats (g m^{-2}),
- biomass over available intertidal habitat
- presence of entrained algae,

These are field measurements together with additional observations on the state of the habitat (e.g. worm casts, anoxic sediment and disturbance due to bait digging). It was considered that the effects of weed cover would be greatest on those sites, which are consistently covered by blooms; sites that are impacted only intermittently have greater opportunity to recover, with recycling of

sediment-bound nutrients. Evidence from well-studied UK sites demonstrated considerable inter-annual variation in the extent and location of spatial cover (Withers (EA), 2003).

These metrics have been developed using published and unpublished literature, and expert opinion. They have been tested at individual beds and water bodies and the results published in scientific journals

Link to proforma:

Summary Rocky shore Macro-algae

A suit of measures have been developed to fulfil the normative definitions of the WFD TraC rocky shore macroalgae as part of the Macroalgal Biological Element.

The basic indices are:

- Shore description
- Species richness
- Proportion of chlorophyta (green seaweed's)
- Proportion of rhodophyta (red seaweed's)
- Ecological Status Group Ratio – ESG ratio indicates shift from a pristine state (EGS1 – late successionals or perennials) to a degraded state (ESG2 – opportunistic or annuals)
- Proportion of opportunists

All of these are field descriptions and / or identifications from collected samples

A database of species found on over 300 shores in the British Isles, has given ranges of values of species richness to be expected and has allowed for variations in these values due to sub-habitat variability, wave exposure and turbidity to be factored in. A reduced species list has been extracted from the database using species commonly present and identifiable with reasonable certainty.

A numerical index of ecological quality was developed based on scores for various aspects of the physical nature of the habitat, combined with a score for species richness which may be based on the reduced species list. Three regional lists are used:

- Scotland and Northern England
- England/Wales and RoI
- Northern Ireland

The scoring system also uses further aspects of community structure, such as ecological status groups and the proportions of rhodophyta, chlorophyta and opportunist species.

Members of the North East Atlantic Geographical Intercalibration Group (NEAGIG) Marine Plants Expert group have agreed intercalibration for Northern and Southern Europe where the basic principles behind this tool are being used

Link to proforma:

Summary for Marine Angiosperms – Intertidal Seagrasses

The basic indices are:

- Taxonomic composition – seagrass species present

- Shoot density – measured as the estimated percentage cover of seagrass using $\leq 1m^2$ quadrates in a sampling grid
- Bed extent – measured as area cover in m^2 of the continuous bed (deemed to be at >5% shoot density) and, where possible, the whole bed (<5% shoot density).

All of these are field measurements together with observations on the state of the bed (e.g. disturbance due to anchors or bait digging).

These seagrass metrics have been developed and tested at individual beds and water bodies and the results published in scientific journals.

Members of the North East Atlantic Geographical Intercalibration Group (NEAGIG) Marine Plants Expert group have agreed a common matrix for allocating status to intertidal seagrass assessments. This matrix combines both losses of species and degradation in the % cover (measured as % cover of seagrass within a quadrat, as shoot counting is not practical in intertidal environment). The intercalibration matrix covers both situations where naturally either two or three species of seagrass are found within either a type or where there are differences within types in specified geographic areas. Seagrass bed extent is assessed separately for intercalibration.

Link to proforma:

Summary of Marine Phytoplankton

A suit of measures has been developed to fulfil the normative definitions of the WFD TraC phytoplankton biological element.

The basic indices are:
1. Phytoplankton biomass (measured as 90% chlorophyll over the growing season)
2. The frequency of elevated chlorophyll and taxa cell counts (4 sub-metrics, over the whole year)
3. Seasonal succession of phytoplankton functional groups (over the whole year)

Other complementary metrics are proposed to be added to the tool kit for 2008/9

A comprehensive UK phytoplankton database has been compiled covering data from five regions (England, Wales, Scotland, Northern Ireland and Republic of Ireland), with data spanning a temporal range of 23 years. The database presently holds over 225,000 phytoplankton taxon records.

Over 20 years worth of chlorophyll data has been combined with physico-chemical and nutrient data into a nutrient/chlorophyll database which can be matched with the phytoplankton records. These data sets have been used to develop and test the above tools.

The North East Atlantic Geographical Intercalibration Group (NEAGIG) Marine Plants Expert group have agreed Intercalibration for index 1 (Chlorophyll) for 2 Regional thresholds; and some of the sub-components of metric 2.

Link to proforma: