Water Framework Directive
Common Implementation Strategy
Working Group 2 A
Ecological Status (ECOSTAT)

Overall Approach to the Classification of Ecological Status and Ecological Potential

This final version was agreed on the meeting of the Water Directors on 24/25 November 2003 in Rome.

27 November 2003

FOREWORD

The Water Directors of the European Union (EU), Acceding Countries, Candidate Countries and EFTA Countries have jointly developed a common strategy for supporting the implementation of the Directive 2000/60/EC, “establishing a framework for Community action in the field of water policy” (the Water Framework Directive). The main aim of this strategy is to allow a coherent and harmonious implementation of the Directive. Focus is on methodological questions related to a common understanding of the technical and scientific implications of the Water Framework Directive.

One of the main short-term objectives of the strategy is the development of non-legally binding and practical guidance documents on various technical issues of the Directive. These guidance documents are targeted to those experts who are directly or indirectly implementing the Water Framework Directive in river basins. The structure, presentation and terminology is therefore adapted to the needs of these experts and formal, legalistic language is avoided wherever possible.

In the context of the above-mentioned strategy, an informal working group dedicated to the ecological status of surface water bodies within implementation of the Water Framework Directive was set up in November 2002 and named ECOSTAT WG 2.A. Within the current work of the ECOSTAT WG, the United Kingdom and Germany have the responsibility of the secretariat and co-ordination of the activity on the development of an ecological classification guidance document which has been developed with a Drafting Group.

The present guidance document contains the output of two drafting group meetings and two meetings of the WG 2.A held in 2003. It summarizes the overall ecological classification rules provided by REFCOND, COAST, HMWB and Monitoring guidance documents. Further this new guidance focuses on certain specific technical issues which had not been resolved in the previous guidance documents, in particular the role of physico-chemical parameters in the ecological status classification.

The development of ecological assessment and classification systems is one of the most important and technically challenging parts of the implementation of the Water Framework Directive. It is the first time such systems have been required under Community legislation and all Member States are in a position of needing to significantly expand their technical knowledge and experience. Consequently, the development and improvement of appropriate systems will involve a learning process. The guidance document provides a starting point for this learning process. It sets out some key principles and ideas on practical approaches. It is hoped these will help Member States build on their existing expertise to develop practical and reliable systems for assessment and classification that satisfy the requirements of the Water Framework Directive.

Much of the guidance document is based on Member States’ existing national experiences of assessing and classifying surface waters or on the interim outcomes of some of the development work currently underway. As implementation progresses and Member States begin to monitor and assess the ecological status of water bodies, the richness of Member States’ practical experiences with ecological classification in relation to all surface water categories will increase. New ways of dealing with some of the technical challenges, such as controlling the risk of misclassification, may be identified. The sharing of this growing body of experience among Member States will benefit all and should be encouraged.

"We, the Water Directors have examined and endorsed this guidance during our informal meeting under the Italian Presidency in Rome (24/25 November 2003). We would like to thank the participants of the Working Group and, in particular, the leaders, Germany and United Kingdom, for preparing this high quality document.

We strongly believe that this and other guidance documents developed under the Common Implementation Strategy will play a key role in the process of implementing the Water Framework Directive. It facilitates the common understanding of ecological classification under the Directive and provides useful tools, in particular as regards the use of physico-chemical parameters in the classification process.

Because of the potentially significant economic consequences of misclassification, this guidance and on-going exchanges of experiences on the assessment and classification of ecological status is important. Therefore, this guidance document is a living document that will need continuous input and improvements as application and experience build up in all countries of the European Union and beyond. We agree, however, that this document will be made publicly available in its current form in order to present it to a wider public as a basis for carrying forward ongoing implementation work."

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1. Introduction

1.1 The purpose of this document is to provide general guidance on the assessment of ecological status and potential leading to the overall ecological classification of water bodies for the purposes of the EC-Water Framework Directive (see Section 2). The document also provides specific guidance on the role of the general physico-chemical quality elements in ecological classification (see Sections 3 and 4). The guidance document draws on the existing guidance documents REFCOND; COAST; MONITORING and HMWB&AWB.

1.2 The Directive requires the establishment of classification schemes to reflect the ecological status or potential of surface water bodies as measured by the condition of specific biological, hydromorphological and chemical and physico-chemical quality elements. The relevant elements, and the specific conditions required for these elements in each of the classes of the classification schemes, depend partly on the surface water category and type to which the water body belongs, and on whether the body is artificial or heavily modified.

1.3 Annex II 1.3 of the WFD requires Member States to achieve adequate confidence and precision in classification, and to give estimates of the level of confidence and precision achieved in the River Basin Management Plans. Guidance on getting better conclusions from monitoring data is provided in Annex I.

2. The Ecological Status and Ecological Potential in the Water Framework Directive

2.1 For surface waters the overall aim of the Water Framework Directive (WFD) is for Member States to achieve "good ecological status" and "good surface water chemical status" in all bodies of surface water by 2015. Some water bodies may not achieve this objective for different reasons. For example, under certain conditions the WFD permits Member States to identify and designate artificial water bodies (AWB) and heavily modified water bodies (HMWB) in accordance with Article 4(3). Instead of "good ecological status", the principal environmental objective for HMWBs and for AWBs is "good ecological potential" (GEP) and "good surface water chemical status", which has to be achieved by 2015.

Article 2(17):

> *"Surface water status" is the general expression of the status of a body of surface water, determined by the poorer of the ecological status and the chemical status.*

Article 2(21):

> *"Ecological status" is an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, classified in accordance with Annex V.*

Article 2(23):

"Good ecological potential" is the status of a heavily modified or an artificial body of water, so classified in accordance with the relevant provisions of Annex V.

2.2 The Directive requires surface water classification through the assessment of ecological status or ecological potential, and surface water chemical status. **Annex V, Table 1.1**, explicitly defines the quality elements that must be used for the assessment of ecological status/potential (see Table 1 below). Separate lists are provided for rivers (section 1.1.1), lakes (section 1.1.2), transitional waters (section 1.1.3) and coastal waters (section 1.1.4). Section 1.1.5 specifies that the quality elements for the classification of heavily modified and artificial water bodies are those relevant to whichever of the four surface water categories the heavily modified or artificial water body most closely resembles. The lists of quality elements for each surface water category are subdivided into 3 groups of 'elements': (1) **biological elements**, (2) **hydromorphological elements** supporting the biological elements; and (3) **chemical and physico-chemical elements** supporting the biological elements. The chemical and physico-chemical quality elements supporting the biological elements include:

- General physico-chemical quality elements (specified in Annex V, table 1.1 of the Directive);
- Specific non-priority pollutants identified by Member States as being discharged in significant quantities; and
- Specific priority pollutants as being discharged (specified in Annex X of the Directive)

Nevertheless it should be noted that once environmental standards have been adopted at Community level for the priority substances listed in Annex X, these substances should only be taken into account in the classification of surface water chemical status and should not be used as supporting elements for the classification of ecological status (see 2.7 and 3.8).

2.3 **Annex V, Table 1.2**, in the Directive provides a general definition of ecological status in each of the five status classes. For each relevant quality element more specific definitions for ecological status at high, good and moderate status in rivers (Table 1.2.1), lakes (Table 1.2.2), transitional waters (Table 1.2.3) and coastal waters (Table 1.2.4) are given. In addition, a similar approach has been used for artificial and heavily modified water bodies with definitions for maximum, good and moderate ecological potential being given (Table 1.2.5). For the purposes of mapping and reporting, the two upper classes for HMWBs and AWBs (i.e. maximum and good ecological potential) are combined as "good and above"[1].

[1] If Member States wish to illustrate all the ecological potential classes, all five classes may be used for mapping and reporting, although this approach is not required by the Directive.

2.4 As a basic step the values of the **biological quality elements** must be taken into account when assigning water bodies to any of the ecological status and ecological potential classes. In order to ensure comparability the results of the biological monitoring systems shall be expressed as ecological quality ratios for the purposes of ecological classification. The ratio shall be expressed as a numerical value between zero (worse class) and one (best class).

2.5 The values of the **hydromorphological quality elements** must be taken into account when assigning water bodies to the high ecological status class and the maximum ecological potential class (i.e. when downgrading from high ecological status or maximum ecological potential to good ecological status/potential). For the other status/potential classes, the hydromorphological elements are required to have "conditions consistent with the achievement of the values specified [in Tables 1.2.1 - 1.2.5] for the biological quality elements." Therefore, the assignment of water bodies to the good, moderate, poor or bad ecological status/ecological potential classes may be made on the basis of the monitoring results for the biological quality elements and also, in the case of the good ecological status/potential the physico-chemical quality elements (see paragraph 2.6 below). This is because if the biological quality element values relevant to good, moderate, poor or bad status/potential are achieved, then by definition the condition of the hydromorphological quality elements must be consistent with that achievement and would not affect the classification of ecological status/potential.

2.6 The values of the **physico-chemical quality elements** must be taken into account when assigning water bodies to the high and good ecological status classes and to the maximum and good ecological potential classes (i.e. when downgrading from high status/maximum ecological potential to good ecological status/potential as well as from good to moderate ecological status/potential). This is discussed in detail in Section 4. For the other status/potential classes the physico-chemical elements are required to have "conditions consistent with the achievement of the values specified [in Tables 1.2.1 - 1.2.5] for the biological quality elements." Therefore, the assignment of water bodies to moderate, poor or bad ecological status/ecological potential may be made on the basis of the monitoring results for the biological quality elements. This is because if the biological quality element values relevant to moderate, poor or bad status/potential are achieved, then by definition the condition of the physico-chemical quality elements must be consistent with that achievement and would not affect the classification of ecological status/potential.

2.7 The "physico-chemical quality elements" of Tables 1.2.1 – 1.2.5 of Annex V mean the "chemical and physico-chemical elements supporting the biological elements" listed in Section 1.1 of Annex V for each surface water category, except those for which an EQS has been set at EU-level.

2.8 The relationships between the biological, hydromorphological and physico-chemical quality elements in status classification are presented in Figure 1 for all natural water categories and types. This is discussed in detail in Section 5.

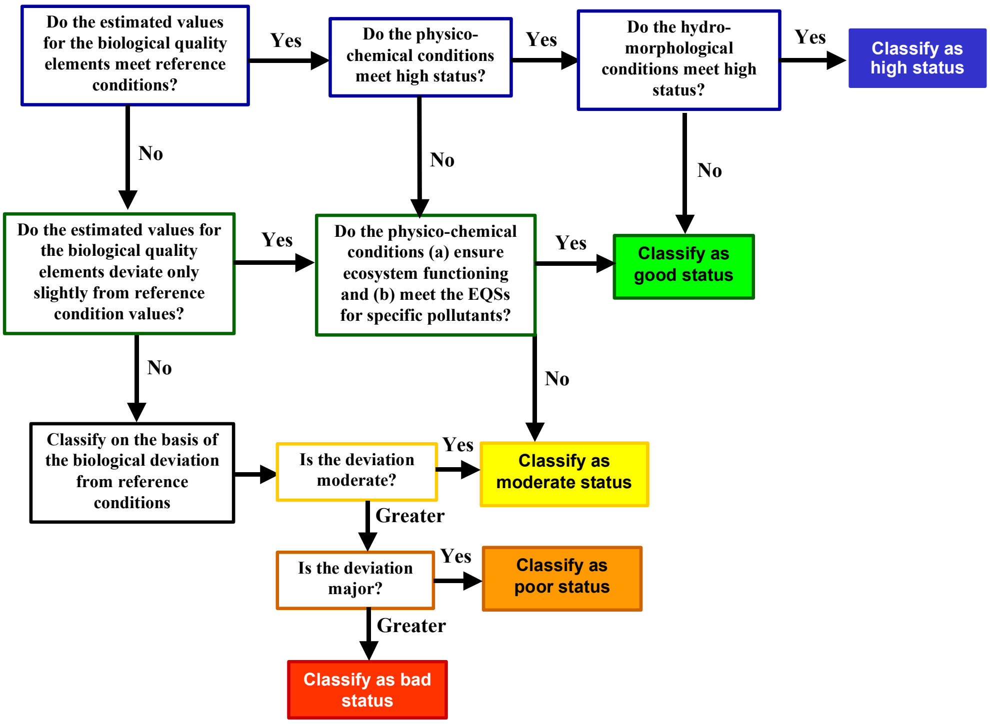

Figure 1. Indication of the relative roles of biological, hydromorphological and physico-chemical quality elements in ecological **status** classification according the normative definitions in Annex V:1.2. [Note: Figure reproduced from REFCOND and COAST guidance documents].

2.9 A comparable approach for heavily modified and artificial water bodies (HMWB&AWB) is shown in Figure 2. The reference conditions of these water bodies mainly depend on the hydromorphological changes necessary to maintain the specified uses listed in Article 4(3)(a). Maximum ecological potential (MEP), as the reference conditions for HMWB&AWB, is intended to describe the best approximation to a natural aquatic ecosystem that could be achieved given the hydromorphological characteristics that cannot be changed without significant adverse effects on the specified use or the wider environment[2]. Accordingly, the MEP biological conditions should reflect, as far as possible, the biological conditions associated with the closest comparable natural water body type at reference conditions, given the MEP hydromorphological and associated physico-chemical conditions (see HMWB Guidance Document Section 6.2.3).

[2] As an illustration, significant adverse effects were calculated by HMWB case studies using local production loss, loss of agricultural land, loss of revenue etc. In general losses of < 1...<10% were considered as insignificant in the case studies, whereas losses> 30% was considered as significant. For the assessment of the significance of adverse effects on the specified use or the wider environment see HMWB / AWB Guidance Document, in particular chapter 5.7.1.

Annex V No. 1.2.5:

[Maximum Ecological Potential (MEP) is defined as the state where] "the values of the relevant biological quality elements reflect, as far as possible, those associated with the closest comparable surface water body type, given the physical conditions which result from the artificial or heavily modified characteristics of the water body."

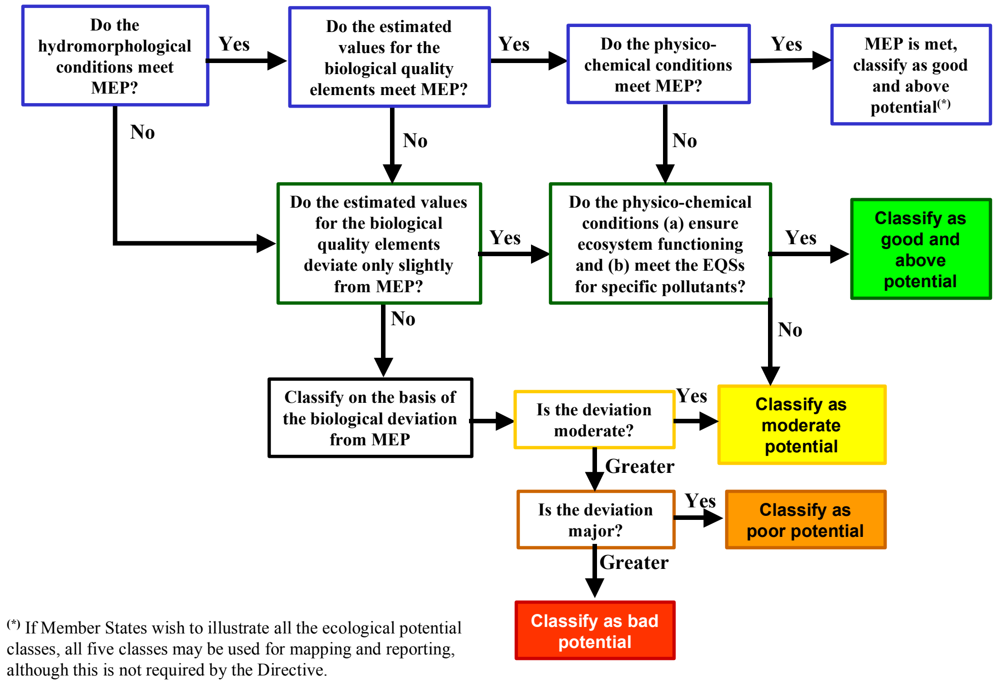

Figure 2. *Indication of the relative roles of biological, hydromorphological and physico-chemical quality elements in ecological **potential** classification according the normative definitions in Annex V:1.2. The two upper classes MEP and GEP are combined for reporting purposes to good and above potential. The color code of the classification shows equal green/yellow/orange/red and light (AWB) or dark grey stripes (HMWB). For further information see HMWB&AWB guidance document.*

2.10 The Directive requires that Member States achieve an adequate level of confidence that water bodies are assigned to their true status classes. The level of confidence achieved must be reported in the river basin management plans. Further guidance is given in the technical Annex I to this guidance document and may also be found in REFCOND Guidance and specifically in the Monitoring Guidance.

3rd paragraph, Section 1.3, Annex V
In selecting parameters for biological quality elements Member States shall identify the appropriate taxonomic level required to achieve adequate confidence and precision in the classification of the quality elements. Estimates of the level of confidence and precision of the results provided by the monitoring programmes shall be given in the Plan.

3rd paragraph, Section 1.3.4, Annex V
[Monitoring] frequencies shall be chosen so as to achieve an acceptable level of confidence and precision. Estimates of the confidence and precision attained by the monitoring system used shall be stated in the River Basin Management Plan.

3. How to Derive the Ecological Status and Potential

3.1 To classify ecological status/potential, the Directive stipulates that the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements should be used (Annex V, 1.4.2. (i)). This implies, de facto, that Member States will need to establish methods/tools for assessing ecological status/potential for both the biological and physico-chemical quality elements. Figures 1 and 2 illustrate that there are separate criteria in WFD Annex V, 1.2, for establishing appropriate ranges for physico-chemcial elements at high and good ecological status and at maximum and good ecological potential.

Annex V, section 1.4.2. Presentation of monitoring results and classification of ecological status and ecological potential

(i) *For surface water categories, the ecological status classification for the body of water shall be represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements classified in accordance with the first column of the table set out below. ....*

(ii) *For heavily modified and artificial water bodies, the ecological potential classification for the body of water shall be represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements classified in accordance with the first column of the table set out below. ....*

3.2 The quality elements for the classification of ecological status/potential are listed in Annex V Section 1.1 of the Directive and reproduced in Table 1 below. Annex V Sections 1.2.1 – 1.2.5 provide definitions of the condition of the quality elements in each status class for each surface water category.

Table 1. Quality elements to be used for the assessment of ecological status/potential based on the list in Annex V, 1.1, of the Directive (for further details see text in 2.2).

Annex V 1.1.1. RIVERS	**Annex V 1.1.2. LAKES**	**Annex V 1.1.3. TRANSITIONAL WATERS**	**Annex V 1.1.4. COASTAL WATERS**
BIOLOGICAL ELEMENTS			
• *Composition and abundance of aquatic flora*[3] • *Composition and abundance of benthic invertebrate fauna* • *Composition, abundance and age structure of fish fauna*	• *Composition, abundance and biomass of phytoplankton* • *Composition and abundance of other aquatic flora*[4] • *Composition and abundance of benthic invertebrate fauna* • *Composition, abundance and age structure of fish fauna*	• *Composition, abundance and biomass of phytoplankton* • *Composition and abundance of other aquatic flora*[5] • *Composition and abundance of benthic invertebrate fauna* • *Composition and abundance of fish fauna*	• *Composition, abundance and biomass of phytoplankton* • *Composition and abundance of other aquatic flora*[5] • *Composition and abundance of benthic invertebrate fauna*
HYDROMORPHOLOGICAL ELEMENTS SUPPORTING THE BIOLOGICAL ELEMENTS			
• *Hydrological regime* ➔ *quantity and dynamics of water flow* ➔ *connection to ground water bodies* • *River continuity* • *Morphological conditions* ➔ *river depth and width variation* ➔ *structure and substrate of the river bed* ➔ *structure of the riparian zone*	• *Hydrological regime* ➔ *quantity and dynamics of water flow* ➔ *residence time* ➔ *connection to the ground water body* • *Morphological conditions* ➔ *lake depth variation* ➔ *quantity, structure and substrate of the lake bed* ➔ *structure of the lake shore*	• *Tidal regime* ➔ *freshwater flow* ➔ *wave exposure* • *Morphological conditions* ➔ *depth variation* ➔ *quantity, structure and substrate of the bed* ➔ *structure of the intertidal zone*	• *Tidal regime* ➔ *direction and dominant currents* ➔ *wave exposure* • *Morphological conditions* ➔ *depth variation* ➔ *structure and substrate of the coastal bed* ➔ *structure of the intertidal zone*
CHEMICAL AND PHYSICOCHEMICAL ELEMENTS SUPPORTING THE BIOLOGICAL ELEMENTS			
• *General* ➔ *Thermal conditions* ➔ *Oxygenation conditions* ➔ *Salinity* ➔ *Acidification status* ➔ *Nutrient conditions* • *Specific pollutants* ➔ *Pollution by priority substances identified as being discharged into the body of water* ➔ *Pollution by other substances identified as being discharged in significant quantities into the body of water*	• *General* ➔ *Transparency* ➔ *Thermal conditions* ➔ *Oxygenation conditions* ➔ *Salinity* ➔ *Acidification status* ➔ *Nutrient conditions* • *Specific pollutants* ➔ *Pollution by priority substances identified as being discharged into the body of water* ➔ *Pollution by other substances identified as being discharged in significant quantities into the body of water*	• *General* ➔ *Transparency* ➔ *Thermal conditions* ➔ *Oxygenation conditions* ➔ *Salinity* ➔ *Nutrient conditions* • *Specific pollutants* ➔ *Pollution by priority substances identified as being discharged into the body of water* ➔ *Pollution by other substances identified as being discharged in significant quantities into the body of water*	• *General* ➔ *Transparency* ➔ *Thermal conditions* ➔ *Oxygenation conditions* ➔ *Salinity* ➔ *Nutrient conditions* • *Specific pollutants* ➔ *Pollution by priority substances identified as being discharged into the body of water* ➔ *Pollution by other substances identified as being discharged in significant quantities into the body of water*

[3] Phytoplankton is not explicitly included in the list of quality elements for rivers in Annex V, 1.1.1, but is included as a biological element in Annex V, 1.2.1. It should therefore be possible to use phytoplankton as a separate element, if needed and appropriate especially in low land large rivers where phytoplankton may be important. The other aquatic flora specifically referred to in the normative definitions for rivers (Annex V 1.2.1) are macrophytes and phytobenthos.

[4] The other aquatic flora specifically referred to in the normative definitions for lakes (Annex V 1.2.2) are macrophytes and phytobenthos.

[5] The other aquatic flora specifically referred to in the normative definitions for transitional waters and coastal waters (Annex V 1.2.3 and Annex V 1.2.4) are macroalgae and angiosperms.

3.3 Member States must monitor parameters indicative of the condition of biological quality elements as part of their monitoring programmes (see Annex V Sections 1.3.1 and Sections 1.3.2). The Directive requires the assessment of the ecological status or /potential class of a water body to be based on the estimate of the condition of the quality element provided by these monitored parameters. In some circumstances, achieving a reliable assessment of the condition of a particular biological quality element may require consideration of the monitoring results for several parameters indicative of that element. A list with all parameters and quality elements is presented in Table 1, but this list could be interpreted in different ways. Therefore in addition Table 1a illustrates, with examples, the understanding of the definitions of parameters, quality elements and groups of quality elements. Further examples of parameters indicative of the condition of the biological quality elements are provided with Table 2.

Table 1a. Examples illustrating the meaning of parameters, quality elements and groups of quality elements, based on the list in Annex V, 1.1; the tables in Annex V, 1.2; and the monitoring requirements in Annex V, 1.3.

Groups of Quality Elements	**Examples of Quality Elements**	**Examples of parameters**
General physico-chemical elements	Oxygenation conditions	COD, BOD, Dissolved oxygen (see point 12 of Annex VIII)
Non-priority, specific pollutants	Copper discharged in significant quantities	Concentrations of copper in water, sediment **or** biota
Hydromorphological elements	Hydrological regime	Quantity of flow, dynamics of flow
Biological elements	Composition and abundance of benthic invertebrate fauna	Composition, abundance (for further examples see Table 2)

3.4 Examples of the sorts of parameters that may be useful in estimating the condition of a biological quality element are given with Table 2. Table 2a provides recommendations on how and under what circumstances monitoring results for parameters indicative of a particular biological quality element may be combined, particularly if pressure related multi metric approaches are used. Further details are given in Annex I.

Table 2: Examples of the sorts of parameters that may be useful in estimating the condition of a biological quality element

(a) Example Biological Quality Element	**(b) Example (type-specific) conditions specified for the element at good status**	**(c) Examples of indicative parameters (metrics) based on measurements of composition and abundance**	
Benthic Invertebrate Fauna (rivers)	There must be no more than slight changes in composition and abundance There must be no more than slight changes in the ratio of disturbance sensitive taxa to insensitive taxa There must be no more than slight signs of alteration to the level of diversity	Presence or absence of particular species or groups of species Overall richness or richness of particular taxonomic groups Relative number of taxa in particular taxanomic groups Abundance of particular species or groups of species Relative abundance of particular species or groups of species Overall diversity, or diversity within particular taxonomic groups	Taxa could be selected and/or grouped by known sensitivity/tolerance, feeding type, habitat preferences, etc

Table 2a. Guidance on combining parameters to estimate the condition of the biological quality element through operational monitoring, if pressure related multi metric approaches are used (i.e. use of multi-metric indices to assess whether the element has been affected by the pressures to which the water body is subject)
(i) Any number of parameters (see column c in Table 2) that are indicative of the biological quality element and relevant to assessing the effects of particular pressures may be combined, for example, by averaging their results. Combining parameters can help reduce the risk of misclassification by improving confidence in the assessment. (ii) Parameters that are sensitive to different pressures should not be combined unless they are also considered independently, since averaging results for non-sensitive and sensitive parameters may conceal failures to meet the relevant type-specific conditions (see column b in Table 2 and point v below). (iii) **The results for parameters likely to respond to a range of pressures may also be combined to estimate the condition of a biological quality element** (iv) The combination of parameters **indicative of the biological quality element** is optional, and the results for individual indicative parameters may be used directly to estimate whether the condition of the biological quality element meets the relevant type-specific conditions. (v) The results for several parameters or groups of parameters, each sensitive to a different pressure, or set of pressures, may be used in estimating the condition of the biological quality element. A one-out, all-out rule, rather than averaging, should be applied in this case such that the condition of the biological quality element is determined by whichever of the grouped or ungrouped parameters sensitive to the different pressures shows the greatest anthropogenic disturbance.

3.5 Figure 3 illustrates the relationship between biological quality elements and indicator parameters and their use in classification decisions. The example in the upper part of the figure illustrates the results for individual parameters of a biological quality element like phytobenthos with general sensitivity to a broad range of pressures (e.g. pressures resulting in morphological and hydrological changes as well as in changes to nutrient conditions). Parameters may be combined by, for example, averaging or weighting (see Section 6 of Annex I to this guidance) to estimate the status of the quality element.

3.6 The second example in Figure 3 illustrates the procedure of combining parameters, if pressure-related, multi-metric approaches are used. Under this approach, individual parameters indicative of the effects of a particular type of pressure on a biological quality element are identified. Where several parameters responsive to the same pressure are identified, these may be grouped and the results for individual parameters in the group combined in order to increase confidence in the assessment of the impact of that pressure on the quality element. If several groups of parameters are identified, each indicating the effects of a different pressure on the quality element, the status of the quality element will be indicated by the results for the group that indicates the greatest impact on the element. However, if the parameters in a group are actually responding to the effects of a range of pressures on the quality element (see paragraph 3.5 above) or there is low confidence in the results for a group of parameters, such pressure-related, multi-metric approaches may not be possible. In such cases, where the groups of parameters are not clearly signalling how the quality element has been affected by different pressures, the approach outlined in paragraph 3.5 and the upper part of Figure 3 may be more appropriate.

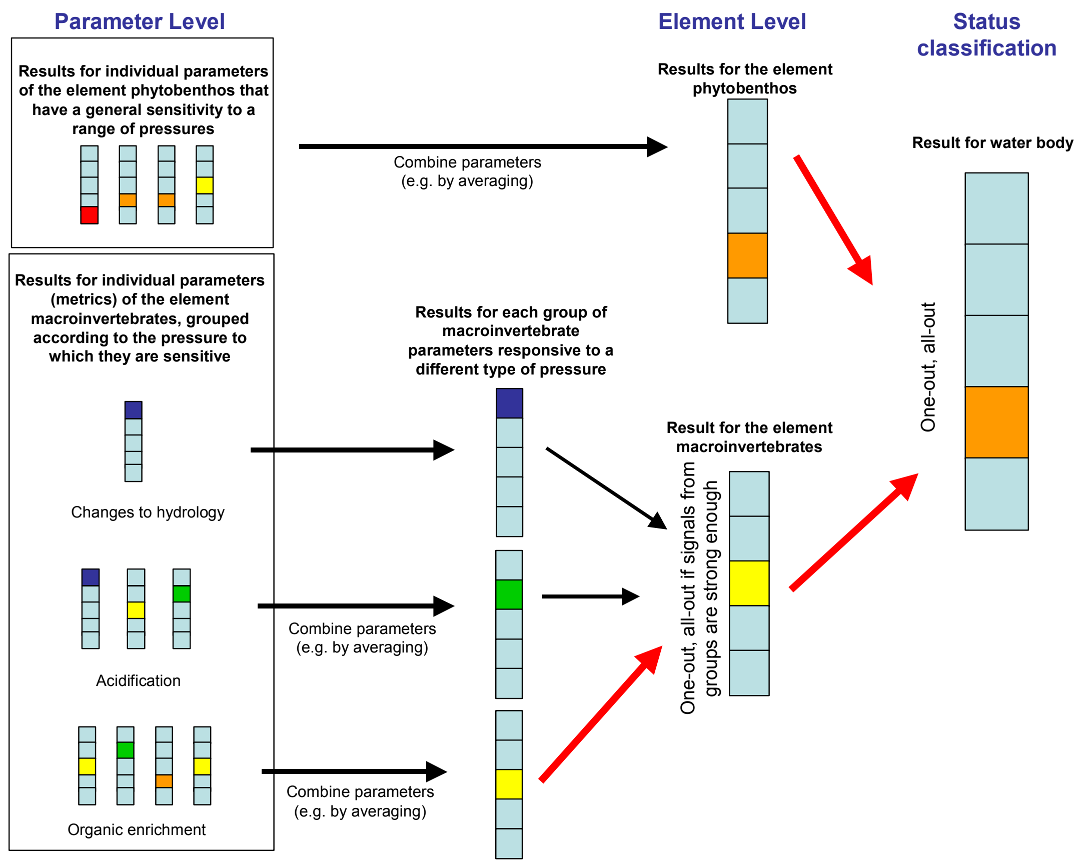

Figure 3. Examples of how indicative parameters may be combined to estimate the condition of the biological quality elements. The one-out all-out principle has to be used on the quality element level as indicated with the phytobenthos example.

3.7 The Directive's normative definitions for ecological status and potential also describe the conditions required for the general physico-chemical quality elements and the specific pollutants at good status/potential. The general physico-chemical quality elements should not reach levels outside the range established to ensure ecosystem functioning and the achievement of the values specified for the biological quality elements [See point (a) in the middle box in Figures 1 and 2]. The concentrations of specific pollutants should not exceed environmental quality standards (EQSs) set in accordance with Annex V, Section 1.2.6 of the Directive [See Figure 4].

3.8 It has been agreed under the Common Implementation Strategy that once environmental quality standards have been adopted at Community-level for the priority substances (Art. 16, Annex X), the concentrations of these substances in water bodies should only be taken into account in the classification of **surface water chemical status** and not in the classification of ecological status/potential. This does not affect the overall classification of a water body because for good surface water status, both ecological and chemical status must be good. However, if any of the biological quality elements are found, from biological monitoring, to be showing adverse effects from exposure to priority substances (e.g. direct ecotoxicological effects), these effects must be taken into account when classifying ecological status/potential.

3.9 Similarly, compliance with EQSs for other substances for which EQSs have been set at Community level (e.g. substances relevant to the Directives listed in Annex IX of the Water Framework Directive, see Annex V, 1.4.3) should also be taken into account in the classification of surface water chemical status and not in the classification of ecological status/potential.

3.10 For the purpose of assessing ecological status/potential, the specific pollutants listed in Annex V, 1.1 and 1.2 ("specific synthetic pollutants" and "specific non-synthetic pollutants") must be considered and for good status/potential the environmental quality standards established for them at Member State-level using the procedure set out in Annex V 1.2.6 must be met (like list II substances under 76/464-Directive). In addition to the general approach presented in the IMPRESS guidance, specific guidance on the selection of those substances may be prepared by EAF Priority Substances.

4. The Role of the General Physico-chemical Quality Elements in the Ecological Classification of Good and Moderate Status/Potential

4.1 For the general physico-chemical elements, the Tables 1.2.1 – 1.2.5 in Annex V specify that for good ecological status/potential to be achieved **the values for the general elements must not reach levels outside the range[6] or exceed the levels[7]** established so as to ensure:

(a) The functioning of the (type specific) ecosystem; and

(b) The achievement of the values specified for the biological quality elements.

> **Annex V, Section 1.2**
> General definitions for rivers, lakes, transitional waters and coastal waters for **Good status/potential** for "General Conditions":
> *Temperature (R, L, T, C)[8], oxygen balance (R, L, T, C)[8] , pH (R, L)[8], acid neutralising capacity (R, L)[10] transparency (L, T, C)[8] and salinity (R, L)[8] do not reach levels outside the range established so as to ensure the functioning of the type specific ecosystem and the achievement of the values specified above for the biological quality elements.*
> *Nutrient concentrations (R, L, T, C)[8], do not exceed the levels established so as to ensure the functioning of the ecosystem and the achievement of the values specified above for the biological quality elements.*

4.2 The ranges and levels established for the general physico-chemical quality elements must support the achievement of the values required for the biological quality elements at good status or good potential, as relevant. Since the values for the biological quality elements at good status will be type-specific, it is reasonable to assume that the ranges and levels established for the general physico-chemical quality elements should also be type-specific. Several types may share the same ranges or levels for some or all of the general physico-chemical quality elements.

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[6] Applies for transparency, thermal conditions, oxygenation conditions, salinity and acidification status

[7] Applies for nutrient conditions

[8] R = applies for rivers; L = applies for lakes; T = applies for transitional waters; C = applies for coastal waters

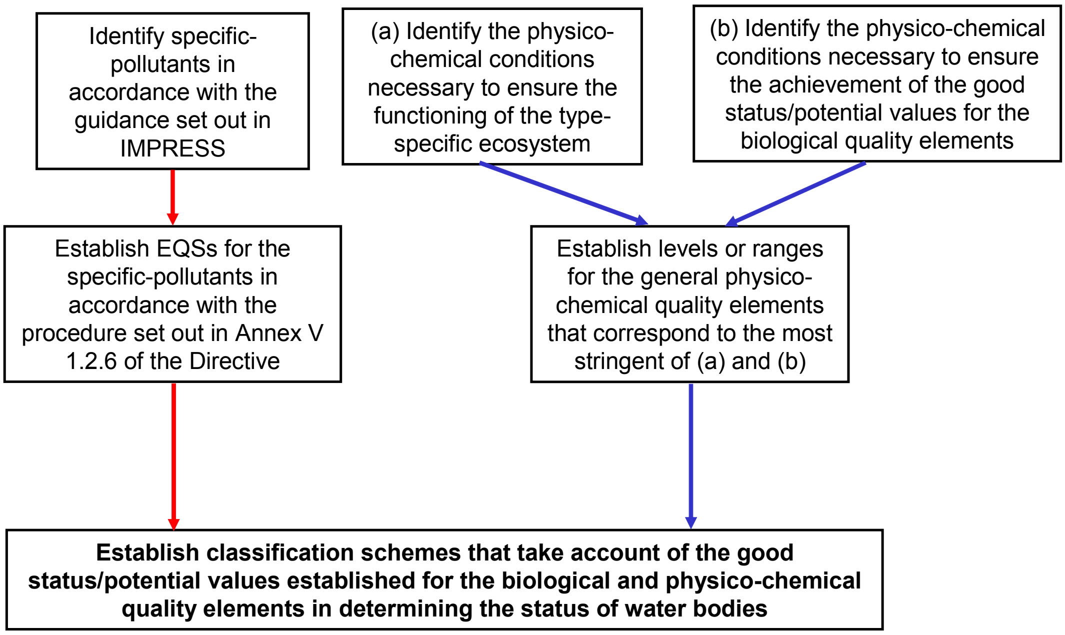

Figure 4. The establishment of ranges and levels for the physico-chemical quality elements at good ecological status/potential.

4.3 If the monitoring results for both the biological quality elements and the general and specific physico-chemical quality elements in a water body meet the conditions required for good ecological status/potential, the overall ecological status/potential of the water body will be good. However, if one or more of the general physico-chemical quality elements or specific pollutants do not meet the conditions required for good ecological status/potential but the biological quality elements do, the overall ecological status/potential will be moderate.

4.4 The following sections outline a checking procedure designed to ensure that the type-specific values established for the general physico-chemical quality elements are no more or no less stringent than required by the Directive, and hence do not cause water bodies to be wrongly downgraded to moderate ecological status or potential. The checking procedures apply only in relation to values for the good-moderate status/potential boundaries. They apply where Member States are confident that there is a real mismatch between the monitoring results for the biological and general physico-chemical quality elements, and not just a mismatch resulting from uncertainties from monitoring. For example, this will usually require evidence that there is a consistent mismatch from a significant number of water bodies in the type. In checking whether the physico-chemical ranges are valid, there is a balance between the scale of the discrepancy that can be demonstrated and the number of sites where the physico-chemical data and the biological data are not compatible. For example, where there are only a few sites monitored, it will be possible only to confirm large discrepancies.

Even where the checking procedure applies, it may not be appropriate to revise the level or ranges using the checking procedures if the established levels or ranges are being exceeded because of temporary alterations to the values for the general physico-chemical conditions due to unusual natural conditions, such as prolonged droughts or flooding.

4.5 In individual water bodies, there will be cases where the monitoring results for the biology are good but the results for the general physico-chemical quality elements appear, at face value, to be less than good (i.e. the ranges or levels established for the type appear to have been exceeded). Because of the statistical errors in sampling and analysis described 3.3 in Annex I, this situation could be common even though the physico-chemical ranges are thought to be valid. In these cases, Member States may decide to classify the body as less than good only when they have checked that the statistical confidence that the general physico-chemical elements are really less than good is adequate. Where it is not, Member States may take steps to improve confidence, for example, by doing more monitoring.

4.6 The ranges or levels that Member States establish for the general physico-chemical quality elements should be as ecologically relevant as current expert knowledge permits. Specifically, Member States should establish levels or ranges that they consider would, if not exceeded, ensure the functioning of the type-specific ecosystem and the achievement of good status/potential values specified in Annex V Tables 1.2.1 – 1.2.5 for the biological quality elements.

4.7 In addition to enabling classification, the establishment of ranges or levels for the general physico-chemical quality elements will be needed by Member States to set appropriate controls on discharges liable to adversely affect the general physico-chemical conditions and hence the achievement of the values specified for the biological quality elements at good status/potential or the functioning of the ecosystem.

4.8 The initial levels or ranges established by Member States are likely to be based on an incomplete knowledge of the general physico-chemical conditions needed to ensure the functioning of the type-specific ecosystem and the achievement of the good status/potential values for the biological quality elements. Member States may therefore wish to revise the levels and ranges established for the types as their knowledge improves through the river basin planning cycles.

4.9 There may be cases where the levels or ranges proposed for a general physico-chemical quality element in a type are being exceeded as a result of anthropogenic alterations to the conditions of the general physico-chemical quality elements but no biological impacts are being detected. In such cases, it is recommended that a checking procedure should be undertaken. This procedure should be used to assess whether the established type-specfic levels or ranges for the elements are more stringent than is necessary to ensure the functioning of the ecosystem and the achievement of the values specified for the biological quality elements at good status/potential. An outline checking procedure is presented in Figure 5.

4.10 The mismatch between the biological monitoring results and the general physico-chemical monitoring results may be because the biological methods being used in monitoring are not sensitive to the effects of anthropogenic changes in the condition of the physico-chemical quality element. In such cases, improvements to the biological methods should be made on an on-going basis with the aim of developing methods that are sufficiently sensitive. This improvement work should not stop after the first classification decisions are made.

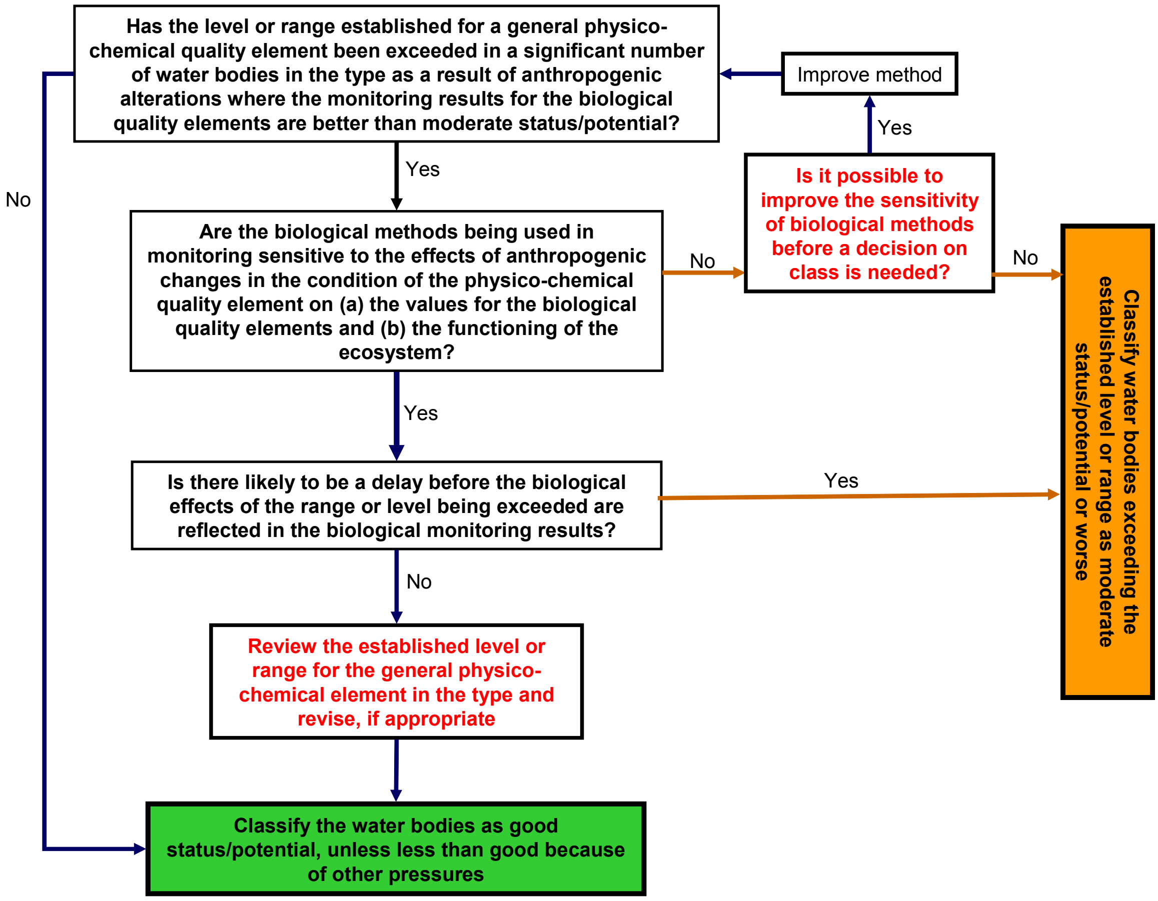

Figure 5. Checking procedure for assessing whether a level or range established for a general physico-chemical quality element is more stringent than required by the Directive, according to the normative definitions of ecological status/potential. See text for further information.

4.11 Water bodies in which an established level or range for a general physico-chemical quality element is exceeded should be classified as moderate status/potential or worse unless the established level or range for the type is revised as a result of the checking procedures outlined in Figure 5.

4.12 In establishing and revising the ranges or levels for the general physico-chemical quality elements, Member States should ensure that the same level of protection as provided for under existing Community legislation is guaranteed.

4.13 A checking procedure, such as that illustrated in Figure 6, could be used where the levels or ranges proposed for a general physico-chemical quality element in a type are not exceeded but, because of anthropogenic alterations to the general physico-chemical conditions:

(a) The good status/potential values for the biological quality elements in water bodies in the type are not being met; or
(b) There is evidence of impairment to ecosystem functioning in water bodies in the type.

In this case, the checking procedure would assess whether the established levels or ranges for the general physico-chemical quality elements:

(a) Met the Directive's requirements; or
(b) Were insufficiently stringent to ensure the functioning of the ecosystem and the achievement of the good status/potential values for the biological quality elements.

The procedure would not be applicable where temporary alterations to the physico-chemical conditions had occurred because of unusual natural conditions, such as prolonged droughts or flooding.

4.14 The purpose of the procedure is to check whether there is a need to review the ranges or levels established for the type. If a review is initiated, this may not always indicate that a revision of the established levels or ranges is appropriate. For example, it may not be appropriate to revise the ranges or levels where:

(a) The biological monitoring results are detecting the effects on the biology of intermittent anthropogenic alterations to the physico-chemical conditions but the actual alterations to the physico-chemical conditions are not being detected by monitoring of the general physico-chemical quality elements. Instead, it may be appropriate to change the sampling design; or

(b) The biological elements are responding to the combined effects of alterations to a number of different general physico-chemical quality elements (e.g. the combined effects on the biological elements are greater or lower than would be the effects of alterations to only one of the physico-chemical quality elements). In such cases, however, it may be possible to devise a level or range for the general physico-chemical quality element that takes account of combination effects.

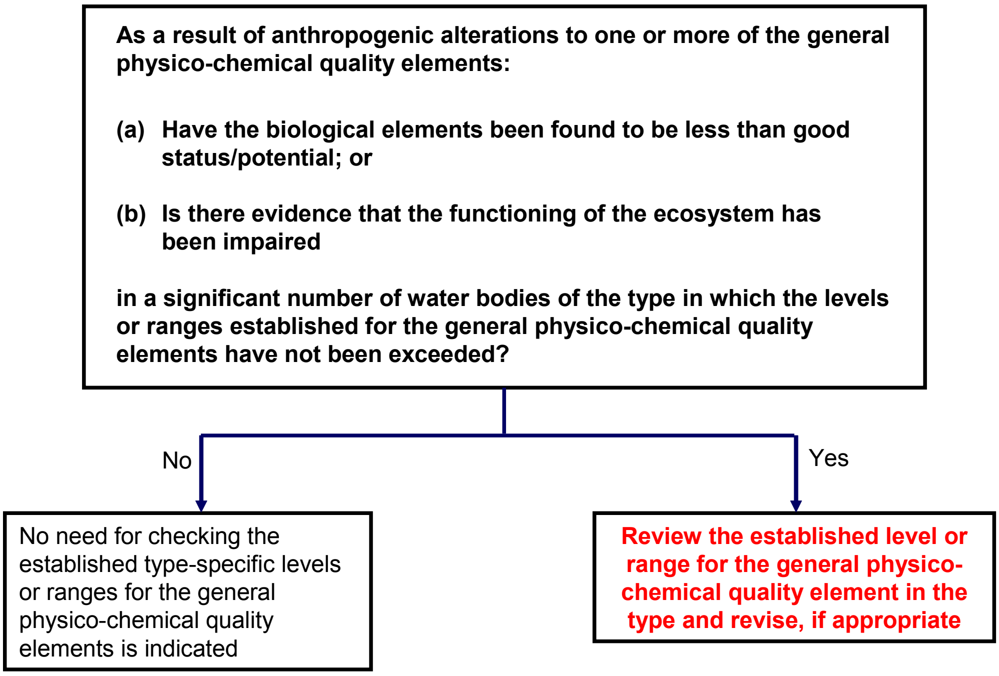

Figure 6. Checking procedure to assess whether a level or range established for a general physico-chemical quality element is insufficiently stringent to meet the Directive's requirements, according to the normative definitions of ecological status/potential.

4.15 Member States are recommended to keep in mind when applying the checking procedures that physico-chemical methods have been developed over a long period of time and may, at first stage, give a better, more reliable indication of ecological impact than some less well tried and tested biological methods. This does not mean that physico-chemical methods can ever replace biological methods. Both are required by the Directive.

4.16 For each planning cycle, it is recommended that Member States should complete the checking procedures in sufficient time to enable the classification of water bodies and the design of suitable programmes of measures.

4.17 To support the proposed practical approach, the relevant box in the general Figures 1 and 2 on ecological classification should be expanded for clarification as illustrated in Figure 7 below:

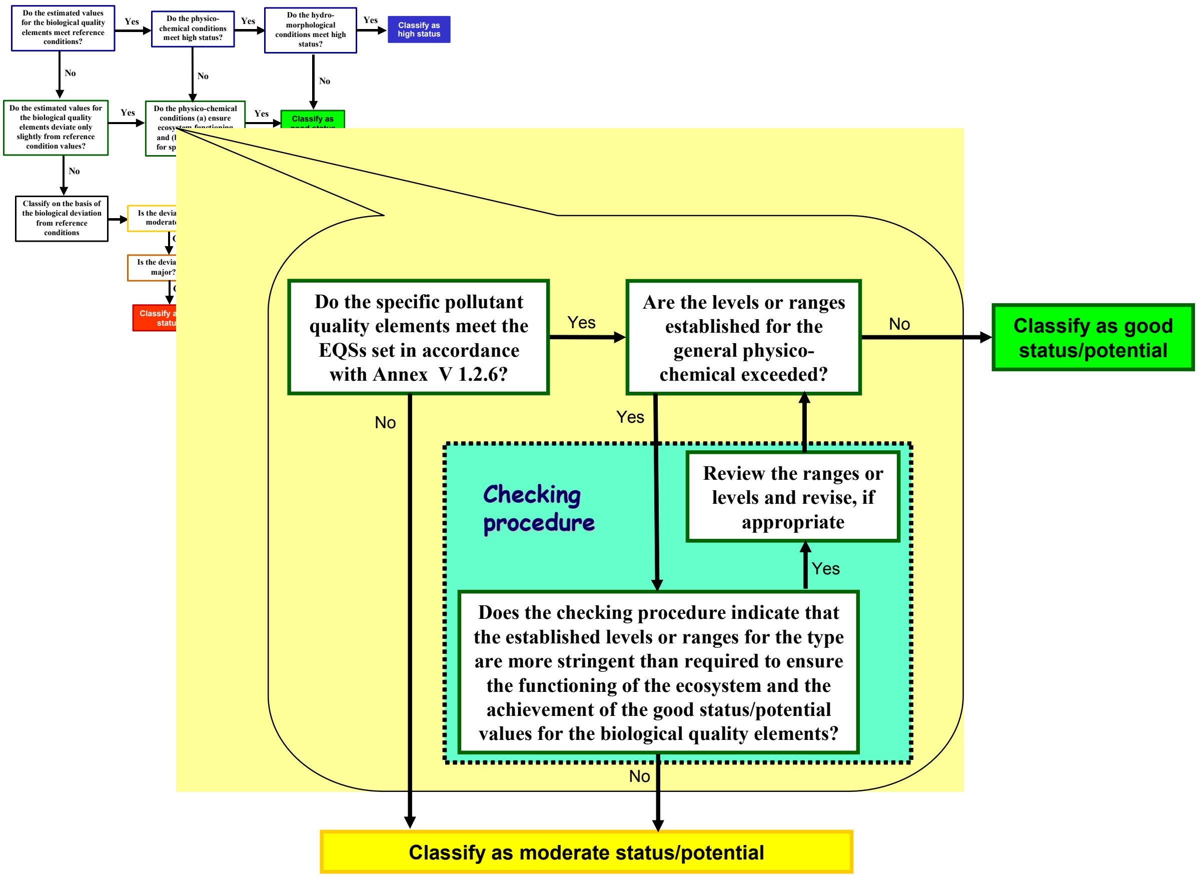

Figure 7. Elaboration of second box in the good status/potential line of the ecological classification diagrams (see Figures 1 and 2). Details of the checking procedure are given in Figure 5 and paragraphs 4.3 – 4.9.

4.18 It is important to note that the use of non-biological indicators for estimating the condition of a biological quality element may complement the use of biological indicators in groups of bodies, as for example in the way described below, <u>but it cannot replace it</u>. Representative biological monitoring is required by the Directive (see CIS Monitoring Guidance). Where a reliable dose response relationship has already been established between the condition of a biological element and that of a general physico-chemical quality element, monitoring results for the physico-chemical quality element could, in certain circumstances, provide for a reliable estimate of the condition of the biological element. For example, imagine groups of similar water bodies subject to pressures that may affect their pH, such as lakes in Norway, Scotland, Finland and Sweden. If the dose response relationship between pH and the condition of a biological element is well established and there are no confounding effects of other pressures, it may be possible to estimate the condition of the biological elements in the water bodies in the group by monitoring (a) biological parameters in a few of the water bodies to check the dose response relationship is correct for that group, and (b) by monitoring pH in a sufficient proportion of the bodies in the group to obtain sufficient data to enable the bodies to be classified as resource-efficiently as possible but still with an adequate level of confidence and precision.

5. Stepwise Approach for the Ecological Classification

5.1 Step 1: High Ecological Status (HES) and Maximum Ecological Potential (MEP)

5.1.1 Annex II 1.3 requires Member States to establish type-specific biological, hydromorphological and physico-chemical conditions representing the values defined in Tables 1.2.1 – 1.2.5 of Annex V for HES or MEP.

5.1.2 A slightly different approach has to be used for natural and heavily modified or artificial water bodies according to Figures 1 and 2. Generally, the assessment of whether a HMWB or an AWB is at MEP should start with an assessment of whether the condition of the hydromorphological quality elements is consistent with the condition expected for them if all mitigation measures were taken to ensure the best approximation to ecological continuum.

5.1.3 The mitigation measures must be compatible with the use for which the water body is designated (see Section 4.1.3), making them and the resulting values for MEP hydromorphology potentially very specific to particular water bodies or groups of water bodies. Since the MEP hydromorphology dictates the MEP biological and physico-chemical conditions, it is appropriate in the case of those AWBs and HMWBs that may be at MEP to check if their hydromorphology is at MEP before considering the condition of the other quality elements.

5.1.4 Only if the values for all the biological, hydromorphological and physico-chemical quality elements reflect their type-specific conditions can the resulting class be high ecological status or MEP.

Biological Quality Elements

5.1.5 For natural water bodies, the values of the relevant biological quality elements at high status reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion; i.e. the biological quality elements correspond totally, or nearly totally, to undisturbed conditions (HES).

5.1.6 For HMWBs & AWBs, the values of the relevant biological quality elements at MEP, reflect, as far as possible given the MEP hydromorphological and associated physico-chemical conditions, those of the closest comparable surface water body type.

Physico-chemical Quality Elements

5.1.7 For natural water bodies, the values for the **general physico-chemical quality elements** at high ecological status correspond totally or nearly totally to undisturbed conditions. A further qualification specifies that the values for the physico-chemical quality elements must remain within the ranges normally associated with undisturbed conditions.

5.1.8 For HMWBs and AWBs, the MEP values for the general physico-chemical quality elements are derived from the ”undisturbed conditions” for the surface water body type most closely comparable to the artificial or heavily modified water body concerned, given the MEP hydromorphological conditions. The CIS guidance on HMWBs and AWBs recognises that in the case of some MEP hydromorphological conditions, the values for some of the general physico-chemical quality elements will be very different to those of the closest comparable type. The guidance therefore suggests that, provided the differences are an inevitable and direct result of the MEP hydromorphological conditions, they may be taken into account when establishing the MEP values for the general physico-chemical quality elements. The following example illustrates how to define MEP physico-chemical reference conditions: The hydromorphological characteristics of impoundment created for hydropower and water supply can dictate the oxygen and temperature conditions in the impounded water and the downstream river. These may be different from those in a natural water body. These differences can be taken into account when defining MEP.

5.1.9 The specific pollutant quality elements have been subdivided into **specific synthetic pollutants** and **specific non-synthetic pollutants**. For HES/MEP to be achieved the concentrations of the specific synthetic pollutants must be close to zero and at least below the limits of detection of the most advanced analytical techniques in general use. The concentrations of the specific non-synthetic pollutants must be within the range normally associated with undisturbed conditions. CIS IMPRESS provides guidance on the identification of specific pollutants.

Hydromorphological Quality Elements

5.1.10 For **HES,** the values for the hydromorphological quality elements correspond totally or nearly totally to undisturbed conditions.

5.1.11 For **MEP,** the hydromorphological conditions are consistent with the only impacts on the surface water body being those resulting from the artificial or heavily modified characteristics of the water body once all mitigation measures have been taken to ensure the best approximation to ecological continuum, in particular with respect to migration of fauna and appropriate spawning and breeding grounds. The mitigation measures should not include those that would have a significant adverse effect on the specified uses of the water body or the wider environment.

5.2 Step 2: Good Ecological Status (GES) and Good Ecological Potential (GEP)

5.2.1 For natural and heavily modified or artificial water bodies the same approach has to be used according to Figures 1 and 2.

5.2.2 Only if the values for the biological and physico-chemical quality elements reflect, as relevant, the values defined for GES or GEP should a water body be classified as GES or GEP.

Biological Quality Elements

5.2.3 For natural water bodies, the values of the relevant biological quality elements for the surface water body show low levels of distortion resulting from human activity, but deviate only slightly[9] from those normally associated with the surface water body type under undisturbed conditions (HES).

5.2.4 For an HMWB or AWB to be classified as being at GEP there must be no more than slight changes in the values of the relevant biological quality elements as compared to their values at MEP.

Physico-chemical Quality Elements

5.2.5 For a water body to be classified as being at good ecological status/potential, the values for the **general physico-chemical quality elements** must comply with the ranges or levels established so as to ensure:
(a) the functioning of the type specific ecosystem; and
(b) the achievement of the values specified for the relevant biological quality elements.

5.2.6 Where the levels or ranges proposed for a general physico-chemical quality element in a type are being exceeded, a checking procedure should be used to assess whether the established levels or ranges for the elements are more stringent than is necessary to ensure the functioning of the ecosystem and the achievement of the values specified for the biological quality elements at good status/potential. An outline checking procedure is presented in Figure 5. Similarly, where the levels or ranges proposed for a general physico-chemical quality element in a type are not exceeded but, because of anthropogenic alterations to the general physico-chemical conditions:

(a) The good status/potential values for the biological quality elements are not being met; or
(b) There is evidence of impairment to ecosystem functioning

[9] The meaning of slight deviation is being considered as part of the intercalibration exercise.

a second checking procedure could be used as a means of assessing whether the established levels or ranges meet the Directive's requirements or are insufficiently stringent to ensure the functioning of the ecosystem and the achievement of the good status/potential values for the biological quality elements. An outline checking procedure is presented in Figure 6.

5.2.7 Good ecological status/potential also requires that the concentrations of the **specific pollutant quality elements** are not in excess of the environmental quality standards (EQS) set at Member State level in accordance with the procedure laid down in Annex V, Section 1.2.6.

Hydromorphological Quality Elements

5.2.8 The conditions of the hydromorphological quality elements at GES and GEP must be consistent with the achievement of the values specified for the relevant biological quality elements at GES/GEP level.

5.3 Step 3: Moderate Ecological Status and Moderate Ecological Potential

5.3.1 For natural, heavily modified and artificial water bodies the same approach has to be used according to Figures 1 and 2. A water body should be classified as moderate status/potential where:

(a) The values for the biological quality elements differ moderately[10] from the type specific communities;

(b) The values for the biological quality elements differ moderately and the physico-chemical quality element values are less than good or;

(c) The values for the biological quality elements are better than moderate but the physico-chemical quality element values are less than good.

5.3.2 If the biological quality elements are at moderate status or potential, the condition of the physico-chemical and hydromorphological quality elements must, by definition, be consistent with the achievement of those biological values.

5.3.3 If the biological quality elements reflect good status/potential, but the values of the general physico-chemical quality elements do not ensure the functioning of the type specific ecosystem or the concentrations of one or more of the specific pollutant quality elements are not in compliance with relevant EQSs, the resulting ecological status/potential is "moderate" (see chapter paragraph 5.2.6).

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[10] The meaning of moderate deviation is being considered as part of the intercalibration exercise.

5.4 Step 4: Poor Ecological Status and Poor Ecological Potential

5.4.1 For natural, heavily modified and artificial water bodies the same approach has to be used according to Figures 1 and 2.

5.4.2 In accordance with Annex V, Section 1.2, if the values for the relevant biological quality elements show evidence of major alteration from their type specific values [i.e. the relevant biological communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions], the water body must be classified as ”poor”. The decision on whether a water body is at poor status/potential or not is dictated by the condition of the biological quality elements. The condition of the physico-chemical and hydromorphological quality elements only affects that decision indirectly through their influence on the condition of the biological elements.

5.5 Step 5: Bad Ecological Status and Bad Ecological Potential

5.5.1 For natural, heavily modified and artificial water bodies the same approach has to be used according to Figures 1 and 2.

5.5.2 In accordance with Annex V, Section 1.2, if the values for the relevant biological quality elements show evidence of severe alteration from their type specific values [i.e. large portions of the relevant biological communities normally associated with the type are absent], the water body must be classified as bad”. The decision on whether a water body is at bad status/potential or not is dictated by the condition of the biological quality elements. The condition of the physico-chemical and hydromorphological quality elements only affects that decision indirectly through their influence on the condition of the biological elements.

6. Presentation of Monitoring Results and Mapping of the Ecological Status and Ecological Potential

6.1 Section 1.4.2 (i, ii) of Annex V to the Directive requires that the ecological status/potential classification for a body of surface water be represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements as indicated in Figures 1 and 2. The monitoring results for the physico-chemical quality elements must therefore be taken into account when classifying surface water bodies.

6.2 Section 1.4.2 (iii) of Annex V to the Directive requires Member States to also indicate, by a black dot on the map, those bodies of water where failure to achieve good status or good ecological potential is due to non-compliance with one or more environmental quality standards (EQS) which have been established for that body of water in respect of specific synthetic and non-synthetic pollutants (in accordance with the compliance regime established by the Member State). So for example, if a water body is classified as moderate ecological status/potential because of a failure to achieve an EQS for a specific pollutant, this must be reported by (a) colouring the water body yellow in the maps included in the river basin management plan and (b) indicating, using a black dot, that the reason for classifying the body as moderate status/potential is non-compliance with the requirements for specific pollutants.

6.3 The analysis set out in the Sections above concludes that the Directive requires the establishment of, and compliance with, specific values for the physico-chemical quality elements for the high and good ecological status classes as well as for the maximum and good ecological potential. For the lower ecological status/potential classes (i.e. moderate, poor and bad status/potential) it only appears to require the establishment of, and compliance with, values for the biological quality elements. Where monitoring results indicate that the condition of the physico-chemical quality elements is worse than good, the status/potential class assigned to the water body must also be less than good, and should be determined with reference to the type specific condition of the biological quality elements as outlined in Figures 5 and 6.

Annex V, Section 1.4.2: Presentation of monitoring results and classification of ecological status and ecological potential

(i) *For surface water categories, the ecological status classification for the body of water shall be represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements classified in accordance with the first column of the table set out below:*

Ecological Status Classification	***Colour Code***
High	*Blue*
Good	*Green*
Moderate	*Yellow*
Poor	*Orange*
Bad	*Red*

(ii) *For heavily modified and artificial water bodies, the ecological potential classification for the body of water shall be represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements classified in accordance with the first column of the table set out below:*

Ecological Potential Classification	***Colour Code***		
		AWBs	***HMWBs***
Good and above	*Equal green and…*	*light grey stripes*	*dark grey stripes*
Moderate	*Equal yellow and…*	*light grey stripes*	*dark grey stripes*
Poor	*Equal orange and..*	*light grey stripes*	*dark grey stripes*
Bad	*Equal red and…*	*light grey stripes*	*dark grey stripes*

(iii) *Member States shall also indicate, by a black dot on the map, those bodies of water where failure to achieve good status … is due to non-compliance with one or more environmental quality standards which have been established for that body of water in respect of specific synthetic and non-synthetic pollutants (in accordance with the compliance regime established by the Member State).*

7. Conclusions

1. The normative definitions of the Directive (Annex V, Table 1.2) provide the basis for classifying the ecological status or potential of surface water bodies, and each Member State must develop classification systems that conform to these definitions.

   Biological as well as supporting hydromorphological and physico-chemical quality elements are to be used by Member States in the assessment of ecological status/potential. The relative roles of these elements are illustrated in Figures 1 and 2. The estimates of the condition of the biological quality elements provided by the monitored parameters should be used in classification decisions. The monitoring results for several parameters may be combined, where appropriate, to provide these estimates.

2. The use of non-biological indicators for estimating the condition of a biological quality element may complement the use of biological indicators but it cannot replace it.

3. Deciding if a particular ecological status or potential class can be assigned to a water body depends on whether the quality element worst affected by anthropogenic alterations matches its normative definition for that class. In short-hand, the classification scheme is a one-out, all-out scheme on the level of the quality elements.

4. The condition of a biological element, such as benthic invertebrates, may be estimated using one or more parameters that are indicative of that element, bearing in mind the normative definitions for the element. Where more than one parameter is monitored, the results for each may be combined to estimate the condition of the element. This may be achieved by averaging, unless the parameters are sensitive to different pressures. In the latter case, the condition of the element should be estimated by the results for the worst affected parameter, or group of parameters, indicative of the effects of different pressures on the element.

5. The condition of the biological element estimated to be worst affected by anthropogenic alterations will dictate the class that can be assigned to the water body, unless the monitoring results for the physico-chemical or hydromorphological quality elements indicate a lower class (see Figures 1 and 2).

6. A decision to assign a water body to the good status/potential class rather than the moderate status/potential class should be made on the basis of the relevant biological and physico-

chemical results. The ecological status/potential class is represented by the lower of the values for the biological and physico-chemical monitoring results for the relevant quality elements.

7. Where the levels or ranges proposed for a general physico-chemical quality element are being exceeded as a result of anthropogenic alterations to the conditions of the general physico-chemical quality elements but no biological impacts are being detected in a significant number of water bodies in a type, it is recommended that a checking procedure should be undertaken. This procedure should be used to assess whether the established type-specific levels or ranges for the elements are more stringent than is necessary to ensure the functioning of the ecosystem and the achievement of the values specified for the biological quality elements at good status/potential. In some cases it may be that the biological method is insufficiently sensitive. An improvement in the biological methods may be appropriate rather than a revision of the range or level established for the general physico-chemical quality element (Figure 5). Similarly, where the levels or ranges are not exceeded but, for example, the good status/potential values for the biological quality elements are not being met as a result of anthropogenic alterations to the general physico-chemical conditions, a second checking procedure could be used as a means of assessing whether the established levels or ranges are insufficiently stringent and consequently need to be revised to meet the Directive's requirements (Figure 6).

8. The specific synthetic and non-synthetic pollutants relevant to the classification of bodies at high ecological status/maximum ecological potential or good ecological status/potential (see Figures 1 and 2) do not include those pollutants for which relevant environmental quality standards have been established at Community-level. Guidance on identifying specific pollutants is provided in IMPRESS Guidance**.**

Annex I: Technical Approach on Achieving and Reporting Adequate Confidence and Precision in Classification

1. Introduction

1.1 This annex provides guidance on getting better conclusions from monitoring data by using general statistical principles to manage errors. The approach deals mainly with the use of numeric data from operational monitoring in classification decisions. Appendix 1 looks at the surveillance monitoring programmes.

1.2 Information on the confidence and precision that can be achieved using particular methods and monitoring designs is not provided in this guidance. Other international initiatives focused on specific issues or monitoring methods may include such information [e.g. OSPAR (www.ospar.org); FAME (www.fame.boku.ac.at); AQEM (www.aqem.de); STAR (www.eu-star.at); ECOFRAME (Contact Brian Moss, Liverpool University UK); CEN (http://www.cenom.be/cenom/index.htm)]

1.3 In an ideal world with comprehensive monitoring data containing no errors, water bodies would always be assigned correctly to their true class with 100 per cent confidence. But estimates of the truth based on monitoring data are subject to error if monitoring is not done everywhere and all the time, and because monitoring systems, equipment and people are less than perfect. A key recommendation of this guidance is that Member States estimate and report (see Section 9) the risk that a water body is assigned to the wrong class because of the errors in monitoring data.

1.4 Managing the risk of misclassification is important because of the potential to waste resources on water bodies that have been wrongly downgraded or to fail to act because a water body has been wrongly reported as better than it is.

2. Background

2.1 In general, the risk of misclassification is likely to be lower if the quality element is in truth, nearer the middle of the class than the class boundaries. The consequence of this is that enhanced monitoring is likely to be needed for water bodies close to the good-moderate class boundary.

2.2 The results of the pressures and impacts analysis will be used to help design, and subsequently refine, the monitoring programmes and, in turn, information from the monitoring programmes will be used to improve the analysis of which bodies are at risk of failing to achieve their objectives (see Section 2.1.2 IMPRESS Guidance & Section 2.2 Monitoring Guidance).

2.3 One of the reasons a water body may be identified as being at risk is if the pressures and impacts analysis suggests that it is currently less than good status. Once identified as being at risk, the water body must be considered within the operational monitoring programme for the river basin district, although it may be grouped with other bodies at risk for this purpose under certain conditions. The results of operational monitoring programme must be used to establish the status of the body.

2.4 If the results of monitoring subsequently provide adequate confidence that the status of the body is good or better and there is no significant risk of deterioration in the body's status, the body would no longer need to be considered as being at risk of failing to achieve its status objectives. The results of the pressures and impacts analysis could be updated accordingly. If, on the other hand, the results of operational monitoring confirmed, with adequate confidence, that the water body is less than good status the water body would remain at risk, and be subject to on-going consideration within the operational monitoring programme. It would also be subject to the application of suitable measures aimed at restoring its status to good.

2.5 The confidence in the results of operational monitoring may not always be adequate, and a Member State could find itself uncertain as to whether the body is at good status or not. An adequate level of confidence should be achieved in time to enable the achievement of the Directive's objectives.

3. Sources of error and their management

3.1 An estimate of the confidence and precision provided by the methods used in monitoring is necessary for assessing the confidence in the results of monitoring and the confidence that the class assigned to a water body is the true class. The need for such estimates should be an important consideration in the development and the application of methods.

3.2 There are several ways in which errors in a method can be estimated, one of which is to test the method using replicate sampling and simulations to produce quantitative estimates. In other cases, it may be appropriate to ask independent experts to provide a suitable estimate.

3.3 A water body can be subject to some or all of the following variations (or ways of describing variation), for whatever mixes of natural or other causes:

(a) Apparent random variations from second to second, minute to minute, or hour by hour;
(b) Diurnal patterns;
(c) Seasonal patterns;
(d) Longer term trends, cycles and random influences, including year to year variation;
(e) Step changes (random, regular or permanent);
(f) Variation with depth of water;
(g) Variation with location (spatial variation);
(h) Correlations with physical and other biological properties (though these can be thought of as causing the above);
(i) Serial correlation, for example, clusters of bad months or bad years;

(j) Bias and random errors from equipment; and
(k) Human error.

3.4 Subsequently in this Annex, where we refer to “error and uncertainty”, we mean the outcome of all the factors listed in paragraph 3.3 that is produced when a monitoring programme is applied to a water body. This may take the form of a total error in the numerical results from monitoring and in the Ecological Quality Ratios that are calculated from those results. The errors might be quantified as the standard deviation, standard error, error bands or confidence limits, or other in other ways by which scientists normally assign a range to the numerical values produced by monitoring. As discussed later (in paragraph 4.3 and Table 1), the probability that a water body is in a particular class is estimated as the proportion of the range in error that is cut by the boundaries of the class.

3.5 If measured everywhere and continuously, with an error-free monitor operated by infallible people, we get the full picture of the property and perfectly true and exact estimates of temporal and spatial distributions, or summary statistics like the mean and variance.

3.6 For any particular water body property one or more of variations may be large and others may be known to be absent. There is no need to determine all errors, only the dominant ones. For all monitoring systems, it is recommended that sources of error are analysed and quantified, for example, by replicate sampling programme, by the examination of long or extensive series of historic data, or by simulations.

3.7 For some biological parameters, we will be able to exploit the natural averaging that means we need not worry much about short term fluctuations and cycles [variations a, b and c above] that do not damage the biology. For chemical parameters it will be more important to demonstrate lack of bias due to unrepresentative sampling against diurnal and seasonal cycles [variations (b) and (c) above], and to manage random temporal variation [variation a above] through statistical estimation of confidence limits on summary statistics like means and percentiles. Where the source of potential error is, for example, seasonal variation, [variation c above] this may be managed by selecting appropriate monitoring frequencies.

3.8 The spatial errors [variations f and g above] should also be quantified and managed, as far as possible, by an informed selection of monitoring sites. Failure of a sampling method and operator to capture or detect species actually present may produce errors that dominate. This source of error can be reduced by precisely defining sampling seasons, sampling methods, sorting procedures and identification levels supported by training and analytical quality control. Errors may also result if the biological method used is based on a taxonomic level that is, for example, insufficiently sensitive to the pressures.

4. The use of estimates of confidence in class

4.1 Information on confidence and precision in monitoring results will help quantify the uncertainty from errors and gaps in data, allowing an estimate to be made of the confidence, or probability, that the true class of a water body is:

(a) As reported;
(b) Worse than reported; or,
(c) Better than reported.

4.2 The main recommendation of this paper is that the estimates for (a), (b) and (c) should always be made. Such an outcome for data with errors is shown in Table 1. In this hypothetical example the error leads to a range of uncertainty that spans the classes from High to Bad.

Table 1

Class	Probability of Class (per cent)
High	10
Good	60
Moderate	25
Poor	4.9
Bad	0.1

4.3 In Table 1, there is confidence of 70% for the result of good or better status. The confidence that the class is less than good is 30 per cent. These percentages are calculated in the following way. Suppose that the upper and lower class limits for the good class are ecological quality ratios of 0.9 and 0.7 respectively. Suppose further that the measured ecological quality ratio is 0.78. At face value this would place the water body in the good class. Because of errors in monitoring, the value of 0.78 may actually be associated with a range, say, 0.62 to 0.92. This range crosses the class limits of 0.9 and 0.7, leading to a probability that the true class is worse than good, or better than good.

4.4 Technically it is best if the error band, 0.62 to 0.92, is a pair of confidence limits; say the pair of 95 per cent confidence limits. The facility to estimate these confidence limits relies on the fact that the error band is two points from a probability distribution, sometimes called the error distribution. The confidence that the water body is in any class is calculated by looking at where the class limits cross this distribution. In Table 1, 60 per cent of the distribution falls between the good class boundaries, 25 per cent falls between the moderate class boundaries, and so on.

4.5 Ideally, we would like to get closer to the position illustrated in Table 2. In this case there is 100 per cent confidence that the water body is in the good class. This outcome occurs if the error bands on the estimated Ecological Quality Ratio are small. To continue with the example in the last paragraph, the confidence limits about the estimate of 0.78 might have been 0.75 to 0.85, lying entirely within the good class boundaries of 0.9 and 0.7

Table 2	
Class	Probability of Class (per cent)
High	0
Good	100
Moderate	0
Poor	0
Bad	0

4.6 We might expect to move from Table 1, towards an outcome like that in Table 2, by getting more, better or more appropriate data. It should be noted that in doing this we might find that a water body which starts out having a probability of only 4.9 per cent of being in the poor status class ends up being classed as poor status with near 100 per cent confidence when better data is taken into account.

4.7 We have to decide how to use information on the error in monitoring results, and in particular whether and how to be influenced by the error in assigning and reporting the status class of a water body. Where the errors are small, and consequently the confidence that the water body is in a particular class is high and therefore clearly adequate, classification decisions will be straightforward (see Section 8).

4.8 In the example given in Table 1, the most likely class is good status (60 per cent confidence). Generally most old classification systems, including those that ignored errors, would report this as the outcome if required to answer the question: “What is the class?” The data in Table 1 could then be used to decide if the water body should still be identified as being at risk of failing good status because of the 30 per cent chance that its class is worse than good compared to the 70 per cent chance that it is at least good.

4.9 The subsequent sections of this annex describe the ways in which errors can be reduced so that more water bodies can be assigned a class with high confidence. But even if these techniques are used, Member States are likely to end up with lots of water bodies like the one in Table 1, and will need to reach a view on how to answer to the question “What is the class?” in such cases.

5. Summary of possible approaches to managing the risk of misclassification

5.1 Figure 1 represents a generalised view of the Directive’s classification scheme. The number of quality elements (QEs) relevant in principle in classification will vary, depending on, for example, the number of specific pollutants being discharged in significant quantities. Under the scheme, the class of a water body is determined by the condition of the quality element most affected by the pressures to which the water body is subject. In shorthand, classification is based on a one-out all-out system.

5.2 Based on experience with existing classification schemes, the error and uncertainty in monitoring results (see paragraph 3.4), coupled with the fact that a proportion of waters will, in truth, be close to a class boundary, tends to lead to a risk that about 20 per cent of assignments of class will be wrong. Where water bodies are, in truth, extremely HIGH or extremely BAD, this risk will be very much lower. The risk of wrongly deciding that the class of a water body has changed (i.e. that a deterioration in status has occurred) tends to be closer to 30 per cent[11].

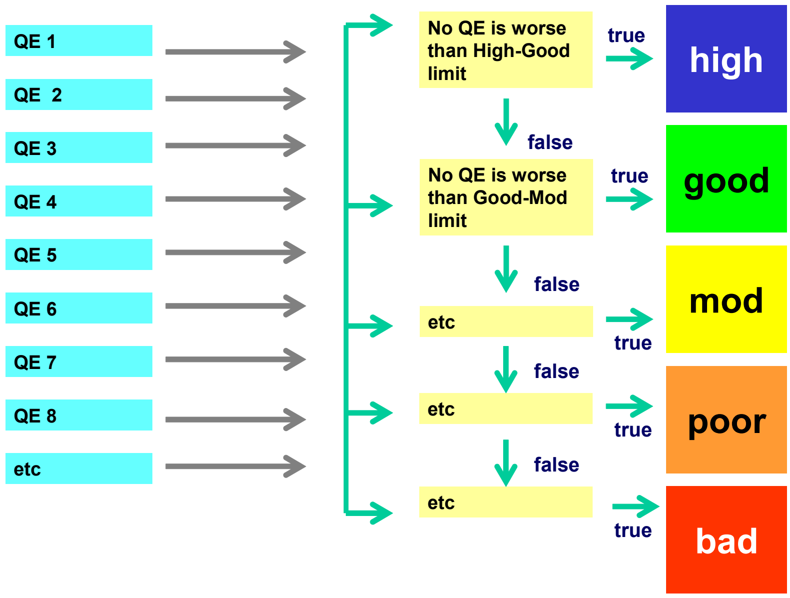

Figure 1: Representation of the Directive's classification scheme for ecological status. The ecological potential classification scheme for heavily modified and artificial water bodies operates according to the same principles. Note that the number of relevant elements (e.g. benthic invertebrates, specific pollutants, etc) depends on (a) the status class (see Section 2 of the main guidance document); and (b) factors such as the number of specific pollutants being discharged in significant quantities.

5.3 Low confidence and precision leads to a risk of misclassification. The main components of a strategy for reducing the risk of misclassification by managing errors are outlined in following section and summarised below.

(i) Estimate the errors in the monitoring results for each quality element (e.g. quote the value of the classification variable as, say, plus or minus X % - see paragraph 3.4). This will enable the probability that a water body is in a particular class to be estimated.

[11] Given an estimate of the errors and uncertainty in monitoring results, the risk of misclassification can be calculated by, for example, Monte Carlo simulation for any classification system and are recommended to be calculated for the classification procedures set up for the purposes of the Directive.

(ii) Decide what level of confidence is adequate for assigning a water body to a particular class. There will be many cases where there is less that 100 per cent probability that a water body is in any of the classes. In Table 1, for example, there is only 60 per cent probability that the class is good. It is necessary to decide the level of confidence that is considered adequate in order to declare that a water body is in a particular class;

(iii) If the errors in the results of monitoring are too large to achieve adequate confidence about the class that should be assigned, reduce them through, for example, more monitoring[12], the use of more reliable monitoring systems, better monitoring design[13], improved assessment and modelling, and/or by combining the monitoring results for different indicative parameters to estimate the condition of the quality element;

(iv) Minimise the number of different quality elements used in making classification decisions by only taking into account the monitoring results for those elements most sensitive to the pressures to which the water body is subject (i.e. by excluding the monitoring results for elements that are NOT among the most sensitive to the pressure)

5.4 There will be clear cut situations where the class is clear even though the confidence in biological monitoring results, if considered on their own, would be low. For example, it may be clear that the entire river length upstream of a weir that is not equipped with a fish ladder will be worse than good ecological status until improvements to river continuity are made, even though the monitoring results for the fish fauna themselves are equivocal because of errors in the method used.

6. Managing errors in monitoring data for individual elements

6.1 The risk of error in classification cannot be assumed to be zero just because a method of calculating it has not been developed. Monitoring results that do not include an estimate of their errors should not be used in classification. If they were, it would not be possible to estimate the level of confidence achieved in classification, as required by the Directive.

6.2 The measurements for any quality element will involve error. For example, the mean from 12 samples can have an uncertainty of plus or minus 50 per cent[14]. A monitoring result that detects 12 species might need to be qualified by an error ranging from 11 to 15[15]. Such errors can be reduced in a predictable way if they are preventing the achievement of an adequate level of confidence in classification by, for example, extra monitoring and assessment, improved monitoring design[16], the use of better monitoring systems or by combining the

12 At its simplest increasing the number of samples by n reduces errors by the square root of n.

13 Controlling the variability contributed by the natural environment allows anthropogenic contributions to changes in quality elements to be detected with increased confidence.

14 50% is a typical figure where the standard deviation equals the mean.

15 The quoted figures are derived from an assessment of errors in monitoring for the UK river invertebrate monitoring system, RIVPACS. There were random errors and biologists missed, on average, two species of invertebrates in sampling.

16 Natural sources of environmental variation and measurement error can contribute significantly to uncertainty in estimates of a quality element. These can be controlled by sampling design, allowing anthropogenic influences to be more readily detected.

results for different parameters that are indicative of the condition of an element into an index for that element.

6.3 The sensitivity of biological elements and of the parameters monitored to estimate their condition may be considered in terms of (a) their actual sensitivity to the pressure; and (b) the degree of confidence that can be achieved in monitoring results. For example, a fish species might be sensitive to a particular toxin but it might not be possible to obtain low error monitoring data for that species using existing sampling methods.

6.4 Figure 2 illustrates how metrics A, B and C are combined, perhaps by averaging, to assess the condition of element 1 (see also Section 3 of the main guidance document). Combining the metrics can produce a smaller error in the estimate of the quality element than that provided by the original metrics. For this reason, combining metrics may allow a number of individually weak indicators of impact to come through as a statistically significant conclusion.

6.5 The term "averaging" may involve taking the arithmetic average, or a weighted average, median or percentile of the monitoring results for a number of parameters and using this statistic to classify rather than the individual ecological quality ratios calculated for each parameter. There need be no restriction in how the data are combined provided the outcome is ecologically sensible and provided the error in the resulting summary statistic can be estimated.

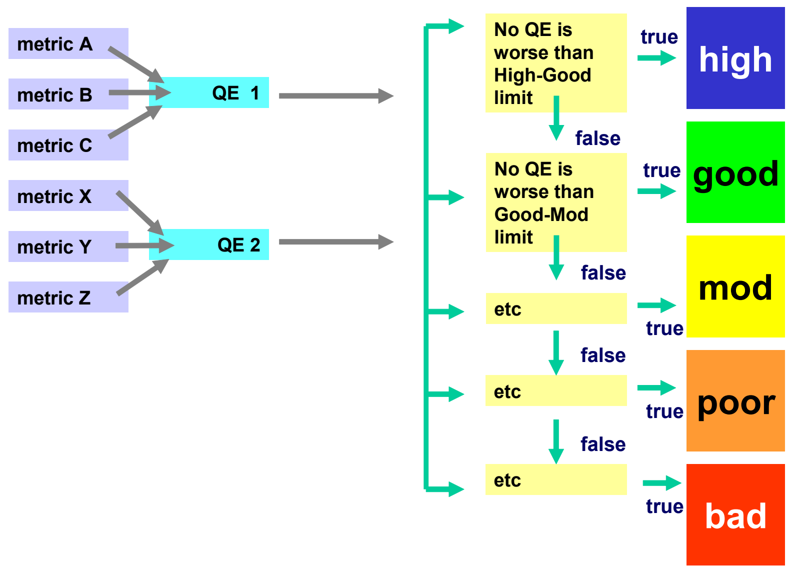

Figure 2: Representation of the Directive's ecological classification scheme, using multiple indicative parameters, or metrics, to estimate the condition of individual elements

6.6 The average for five independent metrics, each with 30 per cent error, will come through as an error of around 13 per cent. The reduction from 30 per cent to 13 per cent is the result of the Central Limits Theorem and applies to all sets of data that are independent. This would be a good reduction but the error should still to be taken into account in estimating the risk that the assigned class is not the true class (i.e. in assessing confidence in class). Care is needed where the metrics are correlated as, for example, in the use of the same set of data to calculate several metrics. In the case of 100 percent correlation, the reduction in error vanishes.

6.7 Averaging the results for a parameter with low error with those for parameters with much bigger errors could increase the risk of misclassification rather than reduce it, and would therefore defeat the purpose of combining results for different parameters. Similarly, averaging the results for parameters that are sensitive to a pressure with those that are relatively insensitive to that pressure could conceal failures to meet the conditions specified in the Directive's normative definitions of ecological status (Annex V, Section 1.2.1 – 1.2.5).

6.8 It should be noted that different types of metrics are differently affected by errors. The most stable results are usually delivered by metrics whose derivation includes a step involving averaging taxa, such as Saprobic Indices or Average Score Per Taxon. Metrics reflecting the proportion of taxa with particular preferences, such as feeding or microhabitat preferences, will also tend to have lower errors than metrics such as taxonomic richness (e.g. number of Ephemeroptera taxa).

7. Managing the effect of combining results for individual elements

7.1 The potential for misclassification is amplified by the number of quality elements that are taken into account in the one-out all-out system. If a water body is truly in the HIGH status class and the monitoring results for any quality element included in the classification scheme can place the water body wrongly in a lower class, the probability of misclassification multiplies up with increasing numbers of quality elements. This is illustrated in Figure 3 below. The outcome is dominated by the quality elements with the biggest errors – the biggest probability of putting the water body in the wrong class.

7.2 The orange dotted line in Figure 3 occurs as follows. Suppose, for simplicity, that there are 10 quality elements and each is associated with a risk of 10 per cent that it will assign a class that is worse than the true class. In reality the risk may differ for each quality element. It may be zero for some and very large for others. If all the risks are zero there is no problem and the orange dotted line would run along the full green line.

7.3 For 10 quality elements each with 10 per cent risk, the risk of declaring a wrong class increases as each quality element is introduced. It is 10 per cent for the first quality element, 19 per cent for two, 27 per cent for three, rising to 65 per cent for all 10.

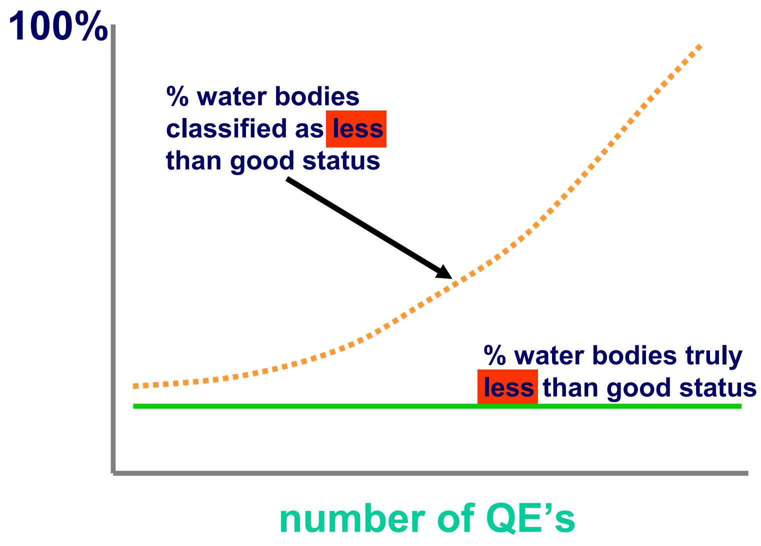

Figure 3: Effect of increasing the number of different elements in a one-out, all-out classification scheme

7.4 The Directive specifies that, for operational monitoring, Member States should monitor among other things parameters indicative of the biological quality element, or elements, most sensitive to the pressures to which the water bodies are subject[17] and pollutants discharged in significant quantities. The Directive specifies that the results of operational monitoring are to be used in establishing the status of bodies at risk of failing to achieve environmental objectives[18].

7.5 The Directive also says that where it is not possible to establish reliable reference conditions due to high natural variability, a quality element may be excluded from the assessment of ecological status[19]. The number of quality elements that need to be considered in classifying bodies at risk can be reduced according to these provisions.

7.6 When making difficult classification decisions for bodies at risk (i.e. deciding the status of bodies which may be less than good status but which are not obviously very bad), Member States should focus on obtaining, and basing their decisions on, reliable operational monitoring programme results for those elements most sensitive to the pressures to which the water body is subject. The AQEM[20] system for example, aims to use only metrics that show a dose-response across a gradient of human influence that is "reliable, interpretable and not obscured by natural variation". Figure 4 represents how the principle of minimising the number of quality elements considered in any one classification decision can be applied using the results of operational monitoring.

17 Annex V 1.3.2 Design of Operational Monitoring.
18 Note: Member States must monitor parameters indicative of the status of each of the quality elements for the purposes of surveillance monitoring.
19 Annex II, Section 1.3 Paragraph (vi).
20 http://www.aqem.de

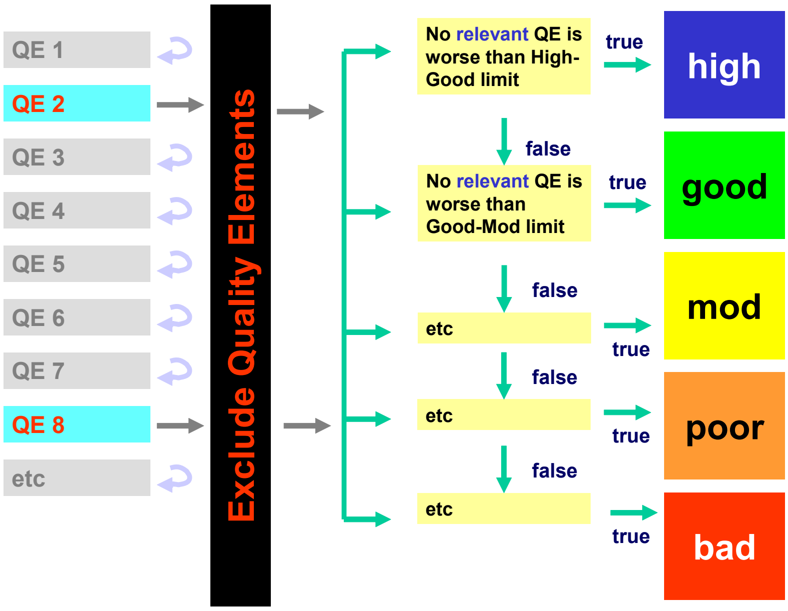

Figure 4: Representation of the Directive's ecological classification scheme, taking account only of operational monitoring results for those elements (a) most sensitive to the pressures to which the water body is subject; and (b) for which reliable type-specific reference conditions can be established.

7.7 As illustrated in Figure 5, when deciding the class of a water body (a) minimising the number of quality elements considered in the decision [See Section 7]; (b) the use of averaging of multiple indicative parameters in estimating the condition of the individual elements that are considered [See Section 6]; (c) obtaining results for the indicative parameters from well designed and operated monitoring [See Monitoring Guidance]; and (d) ensuring appropriate consideration is given to the statistical confidence in the final assessment will help ensure that the class assigned (the short blue line) can be made to stay close to the green line (the truth).

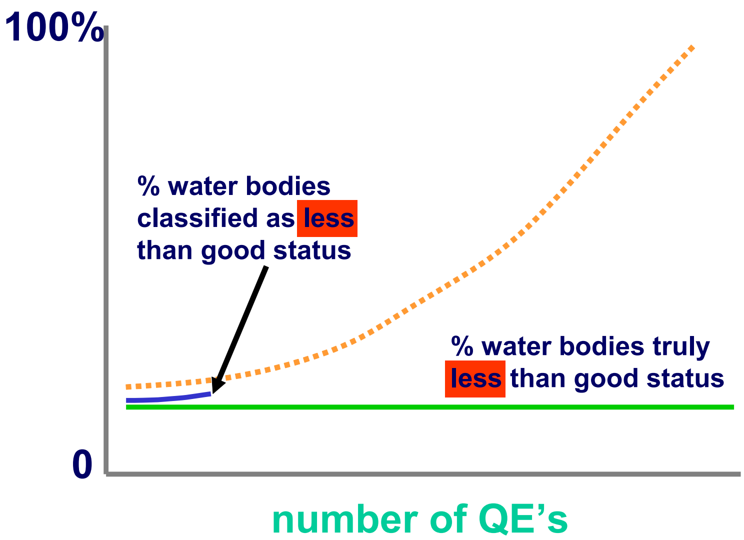

Figure 5: Illustration of the objective of managing the risk of misclassification

8. Deciding on the level of confidence that can be considered adequate

8.1 The following guidance on confidence and precision is reproduced from Section 2.5 (see paragraphs 8.2 – 8.4 below) and Section 2.8.1 (see paragraphs 8.5 – 8.7 below) of the CIS Monitoring Guidance. The status of water bodies must be classified in time to enable a presentation in map form in the River Basin Management Plans of the results of the monitoring programmes for the status of surface water. The first Plans must be published by the end of 2009. This means that by this date, Member States will have to have achieved an acceptable level of confidence and precision for assigning water bodies to an appropriate class. Estimates of the level of confidence and precision of the results provided by the monitoring programmes must also be given in the Plan.

8.2 Choosing levels of precision and confidence will set limits on how much uncertainty can be tolerated in the results of monitoring programmes. The level of acceptable risk of misclassification will affect the amount of monitoring required to estimate a water body's status. In general terms, the lower the risk of misclassification desired, the more monitoring (and hence costs) required to assess the status of a water body. It is likely that there will have to be a balance between the costs of monitoring against the risk of a water body being misclassified. Misclassification may mean that measures to improve status could be inefficiently and inappropriately targeted. It should also be borne in mind that in general the cost of measures for improvement in water status would be orders of magnitude greater than the costs of monitoring. The extra costs of monitoring to reduce the risk of misclassification might therefore be justified in terms of ensuring that decisions to spend larger sums of money required for improvements are based on reliable information on status. Further, from an economic point of view, stronger criteria should be applied to avoid a situation where water bodies fulfilling the objective are misjudged and new measures applied.

8.3 The Directive does not specify the levels of precision and confidence required from monitoring programmes and status assessments. This perhaps recognises that demanding a too rigorous level of precision and confidence may entail a much-increased level of monitoring for some, if not all, Member States. On the other hand the actual precision and confidence levels achieved should enable meaningful assessments of status in time and space to be made. Member States will have to quote these levels in RBMPs and will thus be open to scrutiny and comment by others. This should serve to highlight any obvious deficiencies or inadequacies in the future.

8.4 The starting point for many Member States will probably be an assessment of existing monitoring programmes to see what level of precision and confidence they are achieving. It is likely that this will have to be an iterative process with modification and revision of monitoring programmes to achieve levels of precision and confidence that allow meaningful assessments and classification.

Key Question For operational monitoring, what is the acceptable level of risk of a body being wrongly classified?

8.5 The answer partly depends on what action is likely to be required if the objective is failed. Expensive measures would require higher certainty of failure to obtain environmental quality objectives to justify them than would low cost measures. Because the implications of misclassification could be serious for water users, there should be a high level of confidence in the estimates produced from operational monitoring data. In some cases failing objectives can be serious for water users, but in many cases implementation of unnecessary measures have more serious consequences for the community and therefore it is important to judge whether or not a water body is fulfilling its objectives.

8.6 Thus the required confidence in establishing the status of a water body will be highest where the implications of a misclassification to below good status are high with costs potentially being wrongly imposed on a water user. Similarly there needs to be high confidence in ensuring that water bodies of less than good status are not misclassified as good. In short a high level of confidence will be required close to the boundary of good/moderate status.

8.7 The more water bodies identified as being at risk of failing to achieve an environmental objective, the more operational monitoring will be required. Put more accurately: the more significant pressures there are upon the water environment, the more monitoring will be required to provide the information for managing those pressures. Generally it should be easier to achieve high levels of confidence in status classification where the pressure is very high and well identified, than at sites that lie close to the good/moderate status boundary.

9. Options for reporting confidence and precision in monitoring results

9.1 The Directive does not specify how the level of confidence and precision achieved in the results of monitoring should be reported in the river basin management plans. It is recommended that the confidence and precision in the status class assigned to water bodies or groups of water bodies be reported, and appropriate information on the reasons for classification as less than good be given.

9.2 It is recommended that the main sources of uncertainty in the class assigned should be identified, with particular reference to monitoring frequencies and taxonomic resolution and how these have been used to achieve adequate confidence. As discussed above (paragraph 3.4) this is done using the normal methods by which scientists estimate the errors and confidence limits in the numerical results produced by their monitoring.

10. Conclusion

10.1 To control misclassification, Member States are recommended to apply the following principles to help achieve an adequate level of confidence in classification, as required by the Water Framework Directive:

- Only use procedures (e.g. monitoring and analysis) for classification that quantify their errors and use the information on errors to calculate the risk of misclassification;

- Aim to reduce errors in the status assigned to a water body by minimising the number of different quality elements used in making the classification decision. This can be done by using only the operational monitoring results for those elements most sensitive to the pressures to which the water body, or group of bodies, is subject; and

- Aim to reduce errors, where necessary, in the results for individual quality elements by using more and better monitoring and assessment, and by estimating the condition of the biological elements using more than one indicative parameter, and then combining the results for these parameters by, for example, averaging.

11. Appendix 1: Confidence and precision in the surveillance monitoring

11.1 The objectives of surveillance monitoring are to provide information for:

a. Supplementing and validating the impact assessment procedure detailed in Annex II;
b. The efficient and effective design of future monitoring programmes;
c. The assessment of long term changes in natural conditions; and
d. The assessment of long term changes resulting from widespread anthropogenic activity.

11.2 For surveillance monitoring, Member States must monitor parameters indicative of each of the biological, physico-chemical and hydromorphological quality elements [Annex V Section 1.3.1]. This means that a larger number of different quality elements may need to be monitored in surveillance monitoring compared with operational monitoring. Suppose we monitor all the quality elements in a water body that has been declared not at risk on the basis of the pressures and impacts analysis. An initial view of the data, ignoring errors, and looking at the worst quality element might indicate the possibility that the water body is less than good status/potential and therefore at risk.

11.3 If this happens the water body should be reviewed in the pressures and impacts analysis, and if appropriate identified as being at risk. For this review, we could:

- Look at which of the results of surveillance monitoring for the different quality elements appear to dominate the result;
- Check the confidence in these particular results;
- Review the identification of pressures to see if there are any pressures that could affect these elements [Where an impact indicated by the surveillance monitoring results does not appear to be related to any known pressures, investigative monitoring may be appropriate]; and,
- Decide if the water body should be identified as being at risk and therefore subject to operational monitoring to determine its status.

11.4 The basic principles recommended in this paper for operational monitoring apply to other forms of monitoring. Monitoring results that do not include an estimate of their errors should not be used.

Annex II

Status: 20.10.2003

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