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SEVENTH FRAMEWORK PROGRAMME

WISER

Water bodies in Europe: Integrative Systems to assess Ecological status and Recovery

DELIVERABLE

Deliverable D6.2-1: Review of approaches for combining BQEs in WFD assessment

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Content

1. Introduction

The EU Water Framework Directive (WFD, 2000/60/EC) represents a modern and holistic water policy for the European Union and defines clear specific tasks. The environmental objectives laid down in Article 4 require Member States (MS) to prevent deterioration of surface waters and to protect, enhance and restore all waters with the aim of achieving good ecological status and good chemical status by 2015.

The first WFD Implementation Report of the Commission (2007) showed that many water bodies across Europe were at risk of failing to reach these objectives. The next step is then to assess and classify the status of the water bodies in line with the requirements established in Annex V of the WFD. The Commission encourages Member States to put in place a comprehensive national ecological assessment and classification system as the basis for implementing the WFD and meeting its 'good ecological status' objective.

New methods for assessing ecological status have been developed or are being developed in most of the Member States. Intercalibration (IC) wants to ensure that the understanding of good ecological status is the same across Europe and comparability in classification results of assessment methods for the biological quality elements. However, the results of the first phase of intercalibration (van de Bund 2009, Poikane 2009, Carletti & Heiskanen 2009) showed a number of gaps. Firstly some water categories (transitional waters) were not intercalibrated at all, secondly results did not cover the full biological quality elements (BQEs) but only a part of them. The second phase of intercalibration aims to close these gaps and to improve comparability of the results in time for the second river management basin plans due in 2015 (ECOSTAT Guidance on intercalibration process, 2009).

The WFD approach for ecological classification

The WFD requires the classification of the ecological status of surface waters in an integrative way, by using several biological quality elements in combination with physico-chemical supporting elements and hydro-morphological elements.

In the context of a common strategy for supporting a coherent and harmonious implementation of the WFD, the ECOSTAT WG 2.A working group was set up in 2002

and dedicated to the ecological status of surface waters. The group produced a guidance in 2003, 'Overall Approach to the Classification of Ecological Status and Ecological Potential', summarizing the overall ecological classification rules. The Classification guidance represents a starting point for the development of ecological assessment and classification systems of surface waters, setting out some key principles and ideas on practical approaches. However, the guidance only partially clarifies how the combination rules for ecological assessment results are to be applied in practice.

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 of water bodies. The relative roles of these elements are illustrated in Figure 1.

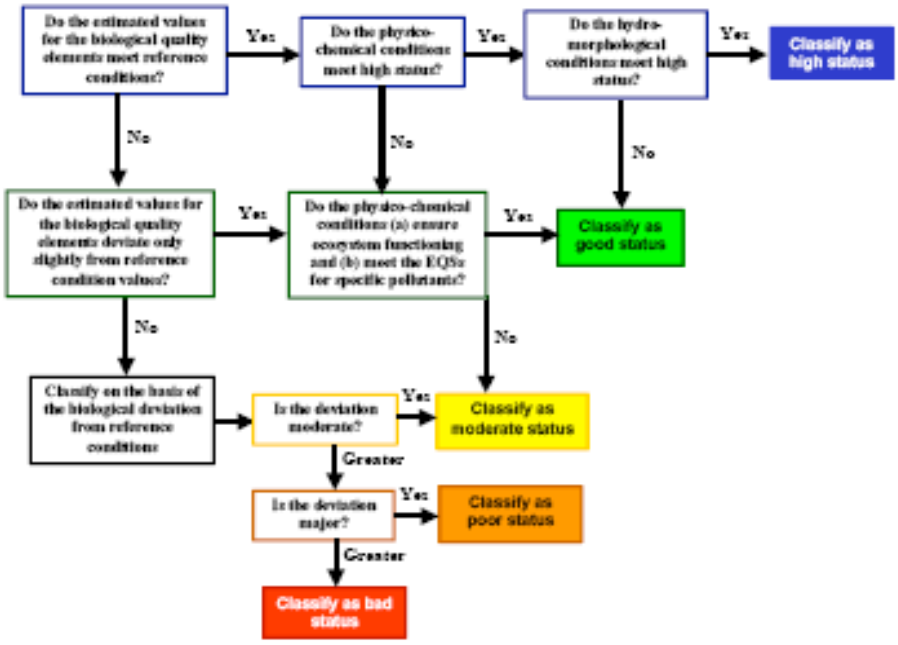

Figure 1. Indication of the relative roles of biological, hydromorphological and physico-chemical quality elements in ecological status classification according the normative definitions in Annex V:1.2. (Classification guidance 2003. Note: Figure reproduced from REFCOND and COAST guidance documents).

The Classification guidance (2003) states that estimates of the condition of the biological quality elements (BQEs) provided by the monitored parameters should be used in classification decisions.

Assigning a particular ecological status or potential class to a water body depends on the condition of the biological element (BQE) worst affected by anthropogenic alterations, unless the monitoring results for the physico-chemical or hydromorphological quality elements indicate a lower class. The WFD classification scheme is thus a 'one-out all-out' scheme on the level of quality elements.

According to the Classification guidance, the condition of a biological quality element (BQE) may be estimated using one or more parameters (or metrics) that are indicative of that quality 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 quality element (Figure 2).

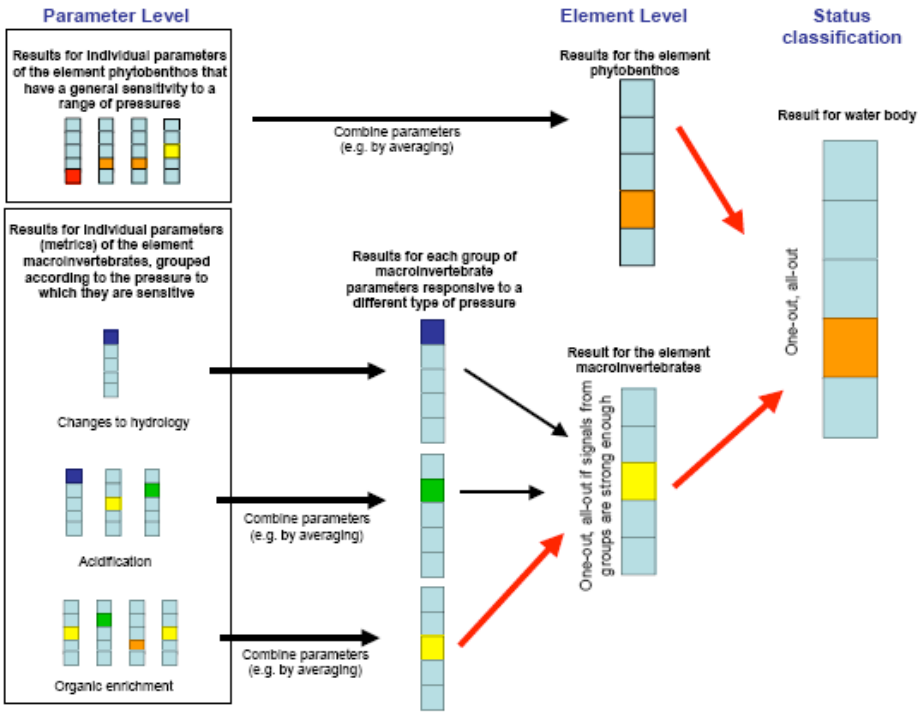

Figure 2. Examples of how indicative parameters may be combined to estimate the condition of the biological quality elements. The 'one-out all-out' principle has to be used

on the quality element level as indicated with the phytobenthos example (Classification guidance 2003).

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.

Although Member States are offered the Classification guidance to facilitate the developing of a classification system that satisfies the requirements of the WFD, each Member State individually builds a national classification system based on existing expertise and knowledge of the ecosystems. As a result, different Member States in Europe have developed, or are developing, different approaches for ecological classification, with diverse ways of combing biological quality elements (BQEs), together with physico-chemical and hydromorphological results in integrative WFD assessment of water bodies.

Partial information on classification methods at BQE level in different Member States are available in the WFD Intercalibration Technical Reports (van de Bund 2009, Poikane 2009, Carletti and Heiskanen 2009) divided for each water categories. In these documents there are broad and exhaustive descriptions of the parameters or metrics utilized for each BQE in individual Member States and how the parameters are, or will be, combined at BQE level. However, there are no equivalent official WFD reports on how the results of the different BQEs are combined into an assessment at water body level, and how supporting elements are used for ecological classification of a water body.

Monitoring and ecological classification

The WFD requires monitoring of ecological status for surface waters in order to classify and finally assign a class to each water body. The results of monitoring will thus determine whether the water bodies are in good status and whether appropriate measures need to be taken in order to reach good status as a rule by 2015 (EC Report on Monitoring 2009).

On the basis of the characterisation of the impact assessment carried out according to Article 5 and Annex II, Member States shall establish surveillance and operational monitoring programmes. For surveillance monitoring all biological quality elements should be monitored, while for operational monitoring only the biological quality elements most sensitive to the pressure to which the water bodies are subject (WFD

2000). According to the second WFD Implementation Report on Monitoring (2009) only three Member States were monitoring all BQEs in their surveillance monitoring network, while for most of the Member States more or less large gaps appeared. The reason could be incorrect reporting, incomplete implementation of monitoring or different interpretation of the WFD requirements. In operational monitoring programmes of some countries only one BQE was monitored, for each water category, while in most of the Member States more than on BQE was monitored.

Member States had also different proportions of monitoring site numbers for surveillance and operational monitoring; some countries had much more sites for surveillance in comparison to operational monitoring sites (e.g. Estonia), while others had the opposite proportion (Germany). In other cases (e.g. Denmark and Italy) monitoring programmes were not differentiated in surveillance and operational. These considerations indicate that monitoring according to the WFD might be interpreted in different ways across Europe. As a consequence, the number and the selection of BQEs to be monitored and finally utilised for ecological classification of water bodies could be very different in different Member States, and this represents a further complication in the comparability of classification systems in European surface waters.

Annex I of the Classification guidance (2003) offers a technical approach for classification methods and for managing the risk of misclassification of water bodies. A key recommendation of the guidance is that Member States estimate and report the risk that a water body is assigned to the wrong class because of the errors in monitoring data. Information on confidence and precision in monitoring results help quantify the uncertainty from errors and gaps in data, allowing an estimate of the confidence, or probability, of the reported class of a water body. Managing the risk of misclassification is important because of the potential to waste resources on water bodies that have been wrongly downgraded of to fail to act because a water body has been wrongly reported as better than it is.

Scope of this report

The scope of the present work is to review how different BQEs are combined in WFD monitoring and assessment programmes in the different Member States. According to the WFD the ecological state is determined by the quality element with the worst class value, or the so-called ‘one-out all-out’ principle. A further intention of the work is the identification and the description of overall national classification systems adopted in Member States for assessing ecological status of water bodies.

Information on this topic is quite sparse and not officially disseminated to the public and scarcely circulated within the scientific community. Although there are ongoing debates on the classification systems to be used for ecological classification, there is not yet a complete overview of the national classification systems adopted in individual Member States. In particular, it is not clear how Member States deal with the 'one-out all-out' principle required by the WFD, or whether some are opting for alternative approaches for combining quality elements into ecological classification of water bodies.

Two main workshops were held on this topic respectively in France in 2007 and in Belgium in 2008. During these workshops important issues have been discussed, such as the ecological significance and combination of the biological quality elements, the role and place of the physico-chemical elements and the effects of aggregation, uncertainty, confidence and precision. The main conclusions of the workshops were that different Member States utilize different approaches and methods within national classification systems including aggregation of data, combination of quality elements, use of 'one out, all out' principle, use of expert judgment. Moreover, Member States are classifying using different numbers of elements to assess the impact of the same pressure or combination of pressures. This is producing different overall results. It was thus recognized that there was a need for setting common rules for classification as a complement to the classification guidance (within ECOSTAT activity 4) and for managing the risks of misclassification. It was also outlined that different approaches combining results in the process of waterbody classifications contribute to a reduced comparability of the overall classification results among Member States.

2. Preliminary overview of national classification systems in MS

Sources of information

In order to review the classification systems adopted in individual Member States, different sources have been investigated:

a. Scientific papers published
b. EU Technical reports
c. Official WFD implementation web sites of the EU Member States
d. Reports and presentation of Classification workshops at European level

Details of the sources that were used for the current report are found in the Appendix.

Most of relevant scientific papers published since the implementation of the WFD dealt with the development of individual indicators at Biological Quality Element (BQE) level.

Some papers described the classification system taking into account only one or a few BQEs, while very few scientific papers describing the national classification systems adopted in MS and the way of combining results from different BQEs have been published.

The available EU technical reports published, such as the Water Framework Directive Intercalibration Reports (2009) and the Implementation Report on Monitoring (2009) mostly focus on the parameters or metrics and the relative indices utilized for those BQEs that have been calibrated among Member States and for methods utilized and developed in different Member States for each BQE. They are, however, lacking of information on the combination of results and the overall systems utilized for ecological assessment of a water body.

A number of official WFD implementation web sites of the EU Member States have been explored and represented a starting point to investigate whether detailed information on national classification systems were present and accessible. However, very little information could be found or was available to public access.

Two workshops were held at European level about classification systems for ecological assessment of surface waters, respectively in France (Paris) in 2007 and in Belgium (Brussels) in 2008. As mentioned already, throughout these workshops important topics on classification systems and combination rules for quality elements have been discussed.

The workshops revealed that different approaches are utilized in different Member States and thus that there is a need for setting common rules in classification methods. The presentations given at these workshops represent a useful source of information on the classification systems adopted in the different Member States.

General overview

From the documents and the information gathered and been collected, an overview of the national methods for ecological classification utilized in the Member States is presented in Table 1 in the Appendix of this report

For each document the following categories are recorded: the related Member State, the source of information (whether is a scientific paper, a document published on the web or an oral presentation), the title of the document, the name of the person or the Institute responsible of the method, the surface water category (river, lake, coastal, transitional water), the biological quality elements (BQEs) considered and the method of combination of the different BQEs to express a whole biological state/class, the method to combine biological and physico-chemical results and the integrative system to combine all the elements in a overall ecological assessment of a water body.

Additional information includes comments on the 'one-out all-out' principle and whether the uncertainty of the classification has been considered in the method.

From Table 1 it can be concluded that different Member States have generally diverse approaches for classification systems. Starting from the choice of the biological elements to be monitored, some Member States strictly follow the recommendations of the WFD (Annex V) for each water category while others include also optional biological elements (such as zooplankton in Danish lakes) considered important in the assessment of the ecosystem functioning and structure. Other countries make a choice of monitoring the quality elements most sensitive to different pressures, for example UK for operational monitoring (WFD UK TAG, 2007) and Germany for rivers (Hering *et al*., 2004; Meier & Hering, 2007). This variety may be complicated further by the relative importance that individual Member States give to surveillance versus operational monitoring programmes. Because within surveillance monitoring all the BQEs need to be monitored, while for operational monitoring only the most sensitive to defined pressures, the choice of the combination rules to apply for multiple BQEs have different implications.

When considering the way of combining different biological elements or BQEs to express a whole biological state/class, the approaches across countries are quite assorted.

Some Member State apply the 'one-out all-out' principle as suggested by the WFD and classify the biological status of the water body on the basis of the BQE with the worst class score (for example Portugal for rivers, Ireland and Slovakia), while other countries utilized alternative procedures. Some MS proposed multimetric methods combining results from different BQEs (Czech Republic), others (Sandin and Wasson, 2007) proposed to average the EQRs of each biological element or to use classification grids. The Finnish classification system for lakes (Alahuhta *et al*., 2009) calculates the final lake status as a median score value across all quality elements. Other methodologies proposed to weight different biological quality elements (for example the Italian classification proposal for rivers by Nardini *et al*. 2008), with sometimes having particular consideration for a BQE regarded as particularly sensitive to a pressure or determinant in the functioning of the ecosystem/water category monitored (see for example the approach of the Basque Countries-Spain- in coastal and transitional waters with macrobenthos).

When focusing on the overall classification systems, including biological, physico-chemical and hydromorphological results, into a final ecological status, the information accessible are quite scarce and limited to a few countries. From the available documents is it understandable, however, that different Member States have different combination approaches and rules. Decision trees and classification schemes are peculiar to each country and they often reflect the pre-WFD country classification approach, even with adaptations to the new rules recommended by the Water Framework Directive.

For example, the classification system utilized in Spain (Basque Country) for coastal and transitional water and described by A. Borja *et al*. (2009) includes all the results indicated by the WFD (biological, physico-chemical, hydro-morphological) in a modified version of the WFD scheme. The proposed decision tree considered first the biological quality/status from each biological quality element, but different weighting of some quality elements is applied, such as for the macrobenthos community. Another approach was adopted by Søndergaard *et al*. (2005) for the ecological classification of Danish lakes, focusing on eutrophication as the main pressures on 709 selected lakes. A preliminary TP-based classification defined boundaries for biological indicators; the final ecological assessment was the result of a compliance level or the 'mean value' of all the 22 indicators selected (including biological and physico-chemical).

Examples of national classification systems for ecological status

For some Member States comprehensive information were found for national classification systems adopted and are here described. For each of these Member States a general description of the classification system is given, together with some practical examples of their application when possible. Table 2 shows these Member States and summarises the available parameters for drawing a more or less exhaustive description of their national classification systems.

Table 2. Member States chosen for their comprehensive description of national classification system of ecological status

country	water category	list of BQEs considered for classification	list of metrics for each BQE	parameters of physico-chemical status	parameters of hydromorphological status	specific pollutants	combination of BQEs	integration of physico-chemical elements	integration of hydromorphological elements	overall system for ecological assessment
Spain, Basque Country	coastal and transitional waters	included	included	described	described	included	explained; particular weight to macroinvertebrates to assess the biological status	explained	explained	explained
UK	all water categories	included	included	described	described	included	explained; only the most sensitive QEs considered for classification; with more than one BQE, 'ooao' principle adopted	explained	explained	explained
Finland	lakes and rivers	included	included	described	described	included	explained; median score across the BQEs	explained	explained	explained
Portugal	rivers	included	included	described	described	included	explained; with more than one BQE, 'ooao' principle adopted	explained	explained	explained

Ecological classification in SPAIN (Basque Country)

Clear concepts for a national system of ecological classification adopted in the Basque Country are found in diverse scientific papers by A. Borja (example in Borja *et al*. 2004 and Borja *et al.* 2009) and in oral presentations by the same author at the already mentioned classification workshops in Paris (2007) and Brussels (2008).

The methodology adopted in the Basque Country for assessing coastal and transitional waters utilizes multiple ecosystem components. The system integrates information from several biological elements (phytoplankton, macrobenthos, algae, phanerogams, fish) and physico-chemical elements into a unique quality assessment. For each monitoring station, a decision tree is used to integrate: i) water, sediment and biomonitor chemical data to achieve an integrated physico-chemical assessment and ii) multiple biological ecosystem elements into an integrated biological assessment.

The biological quality element monitored for coastal and transitional waters are phytoplankton, macroalgae, fish and macrobenthos. The latter element is considered the most studied, with more data available and with the most accurate methodologies existing; furthermore, macrobenthos responds relatively rapidly to anthropic and natural pressures (Borja et al. 2000, Dauer 1993). The metrics used are integrated into the multivariate tool called M-AMBI (Borja et. al, 2000). Macrobenthos has thus a particular and more significant weight for the determination of the biological status (see the practical procedures and combination in the 'decision tree' of Figure 3) in this classification approach. The method emphasized the BQE (macrobenthos) with a higher confidence than the others BQEs.

The first step of the classification system consists of the assessment of the biological quality status made from macrobenthos and other three BQEs (phytoplankton, macroalgae, fish and macrobenthos). When the biological quality is moderate, poor or bad, the corresponding ecological status is moderate, poor or bad, respectively. When the biological quality is high or good, a series of steps, involving physico-chemical and hydromorphological conditions, must then follow (Borja et. al, 2009). Figure 3 illustrates the process of the overall ecological classification adopted in the Basque Country.

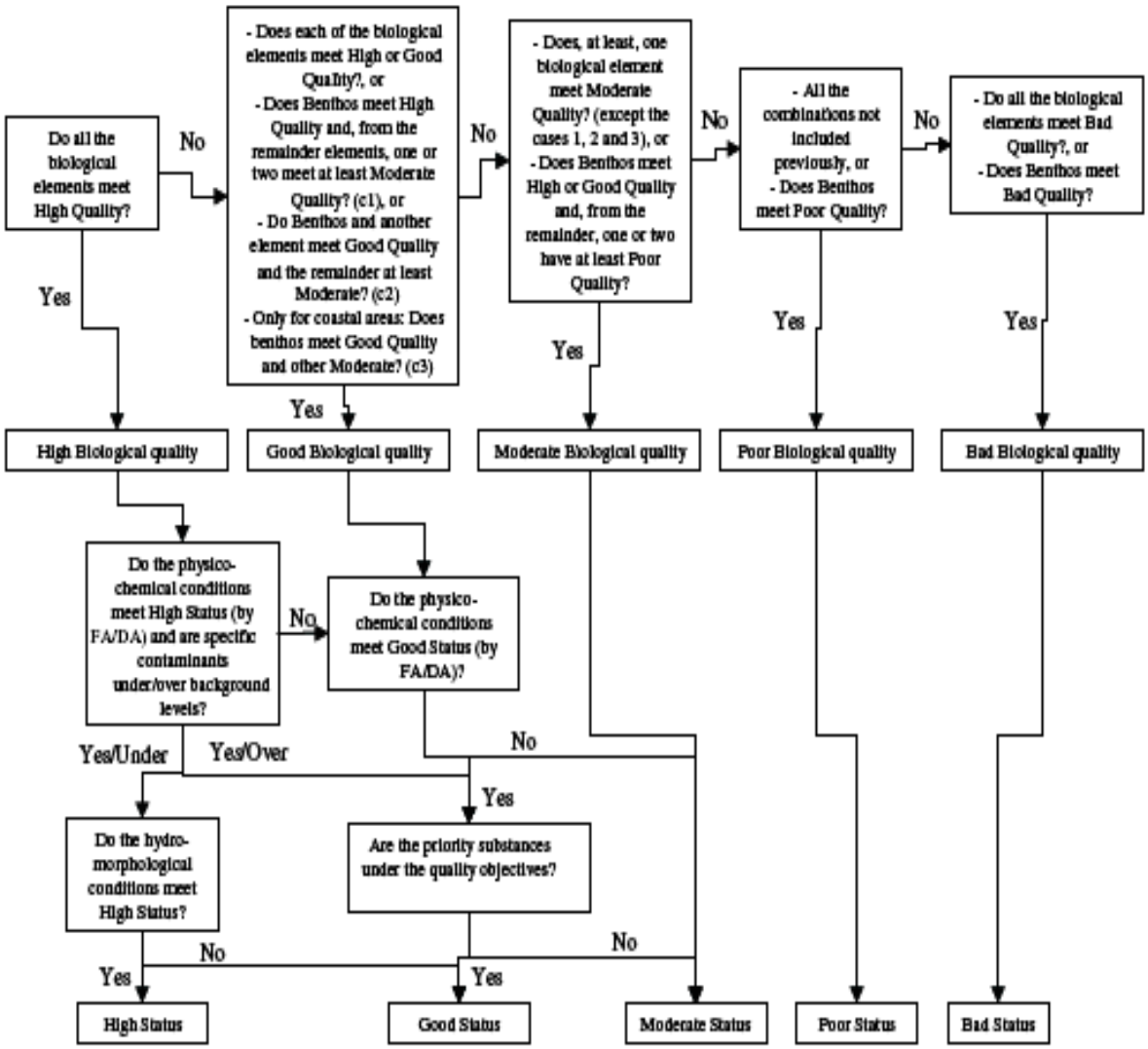

Figure 3. 'Decision-tree' used in assessing the integrative ecological status (Borja *et al*., 2009; modified from Borja *et al*, 2004) of coastal and transitional waters in the Basque Country (Spain).

It is considered by the authors that the WFD 'one-out all-out' principle in determining the ecological status, should be considered for further discussions. Due to different sampling frequencies, the high spatial and temporal variability of some biological quality elements

and the role of some biological elements as good indicators, i.e. benthos, any form of weighting in the data should be investigated (Borja *et al.*, 2004; Borja *et al.*, 2009).

Ecological classification in the UK

Concepts for a national classification system were found in different sources such as internal/national reports (UKTAG classification guidance 2007, Environment Agency 2008 classification guidance, SEPA 2002 technical guidance, etc.) and inside WISE, under Reports for monitoring. The classification system is adopted in England, Wales and Scotland.

The classification system in the UK is closely related to the priorities of the monitoring programmes and the results of the water body risk assessment.

At water bodies chosen for surveillance monitoring, all biological quality elements, with only few exceptions (fish not monitored in lakes) are monitored. One of the aims of surveillance monitoring is to look for signs of impact from any pressure in order to validate the risk assessment. Operational monitoring is carried out to classify water bodies at risk of failing to meet the objectives of the Water Framework Directive. The operational monitoring focus on biological elements that are most sensitive to a particular pressure, or a combination of pressures, acting on a water body (Table 3). This is also called 'risk-based monitoring' and the UKTAG indicates a list of primary pressures and sensitive elements to guide the selection of quality elements to monitor in relation to risk assessment (UKTAG classification guidance, 2007).

The process of classification involves making estimates of status mainly from the results of risk-based programmes of monitoring and assessment that are targeted according to the identified risks to water bodies (UKTAG classification guidance, 2007).

Under UKTAG's research programmes, the intent was to cover all biological parameters in the first phase of development of the classification tools, and then select those that can be best taken forward. It also focused on those tools that measure the most important pressures that need to be addressed under the first River Basin Management Plan (RBMP).

Table 3. Pressures indicated by quality elements (Environmental Agency, Method statement for the classification of surface water bodies, 2008):

Quality element	**Pressures indicated**
Rivers	
Macrophytes and phytobenthos - diatoms	Primarily nutrient enrichment
Macrophytes and phytobenthos - macrophytes	Sensitive to nutrient enrichment and morphological alterations
Macro-invertebrates	Sensitive to organic enrichment, pollution by toxic chemicals, acidification, abstraction of water
Fish	Sensitive to all pressures, but primarily sensitive to abstraction of water and morphological alterations
Lakes	
Phytoplankton	Nutrient enrichment
Macrophytes and phytobenthos - diatoms	Nutrient enrichment
Macrophytes and phytobenthos - macrophytes	Nutrient enrichment
Macro-invertebrates	The Chironomid Pupal Exuviae Technique (CPET) tool is sensitive to nutrient enrichment, Clear Lake Acidification Macroinvertebrate Metric (CLAMM) and Humic Lake Acidification Macroinvertebrate Metric (HLAMM) are sensitive to acidification
Transitional and coastal waters	
Phytoplankton	Nutrient enrichment
Macroalgae	Nutrient enrichment
Abgiosperms (sea grasses)	Nutrient enrichment
Benthic invertebrates	Respond equally to organic pollution and toxic chemicals
Fish (transitional only)	Organic enrichment, habitat destruction

By classifying the status of the water body on the basis of the quality element or elements expected to be worst affected by the pressures to which the body is subject, the condition of other quality elements in the water body can be assumed to be of the "same status as, or better than" the assigned status of the water body. However, it will not normally be possible to know in which particular status class these elements fall. For example, suppose a water body is classed as moderate ecological status and that no monitoring and assessment has been considered necessary for fish or macrophytes to produce this estimate. It can only be stated that the condition of fish and macrophytes is expected to be "at least moderate status but may be better" (UKTAG classification guidance, 2007).

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

UKTAG recommends that classification is based on as many years data as possible, subject to it being a reasonable assumption that impacts have not changed in that time.

The UK system operates the ‘one out-all out’ approach in case of combining multiple quality elements for classification. However, some caution is taken if there is low confidence in the result of the BQE giving worst than good ecological status; in this case, they might use evidence from the other BQEs to increase confidence. The ‘follow-up’ measures are not taken until there is a significant level of confidence in the results (personal communication Owen 2010; Environmental Agency, 2008).

As prescribed by the WFD, the quality element with the lowest (worst) status for a water body determines the overall ecological status. Biology plays a role in determining poor and bad status and hydromorphology a central role in deciding high status (Figure 4).

In combination with biological classifications, supporting physico-chemical elements including specific pollutants (Annex VIII substances) can results in high, good or moderate but do not determine poor or bad status.

When combined with biological quality elements, hydrology and morphology assessments determine high status only (according to the CIS ECOSTAT guidance on classification, 2003).

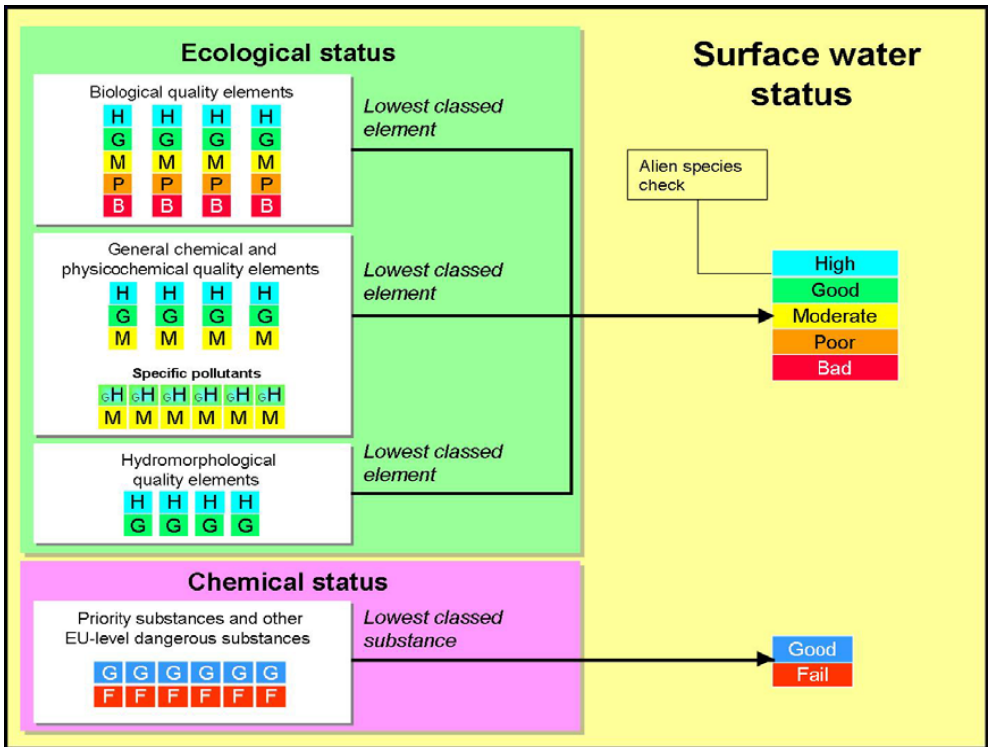

Figure 4. Overall classification system adopted in the UK for surface waters (Environmental Agency, Method statement for the classification of surface water bodies, 2008)

To ensure that classification include understanding of alien species impact on the water environment, UKTAG recommends taking account of the presence of known high impact alien species when classifying the status of water body (Figure 4).

Ecological classification in FINLAND

Concepts for a national classification system in Finland (called Finnish classification system FinEQ) were found in the scientific paper by Alahuhta J. *et al*. (2009), Rask *et al.* (2010) and various presentations by Vuori Kari-Matti (example 27-29 October 2009, Second Nordic workshop on Harmonization and realisation of the WFD in the Nordic countries). The described classification system has been adopted and guidance accepted by the Finnish Ministry of Environment (personal communication, Vuori 2010).

The Finnish classification system FinEQ represents a holistic view of the ecosystem status and a tool for integrating multiple results and different assessments and evidences in the overall assessment of a water body. The classification system is a part of the Ecological Risk Analysis (ERA) of water bodies and helps to integrate multiple lines of evidence such as different classification metrics, present & past anthropogenic pressures and characteristics of the ecosystem. Introducing the weight-of-evidence principle, the classification system opens the status assessment to critical discussions, to credibility of results and to the relative importance of different factors. According to their authors it represents a systematic framework for bringing more science into status assessment and river basin management planning (Vuori, 2009).

The FinEQ is based on the integration of multiple metrics and biological elements. The system harmonizes the metrics and quality elements by scoring them and expressing the overall calculated status class as a median score value across all quality elements.

The calculated status class is further evaluated by weigh-of-evidence approach commonly used in risk assessment, in which quality elements and monitoring results are weighted according to their relevance and reliability and the strength of their associations with environmental pressures. According to this approach results based on low sampling frequency/replication and/or representing only a small proportion of the water body, as well as results having no credible associations with anthropogenic pressures, may be given lower weights in the final classification. By the same token, representative, comprehensive data with credible associations to pressures may be given a higher weight (Rask *et al*. 2010).

A clear example of the new overall classification system compliant with the WFD is found in the paper by Alahuhta *et al*. (2009) to assess lake ecological status. The classification is based on metrics involving four biological quality elements

(phytoplankton, macrophytes, benthic macroinvertebrates and fish). The national classification system scores the individual measures and utilized a median score across the biological quality elements.

In the scoring system high status class (H) values are given a score of 0.9, good status (G) values 0.7, moderate (M) values 0.5, poor (P) values 0.3 and bad (B) values 0.1. Medians of the scores across all metrics are then classified according to the following class boundaries: high> 0.8, good ≤ 0.8, moderate ≤ 0.6, poor ≤ 0.4 and bad ≤ 0.2

The resulting status class was further evaluated by the weigh-of-evidence approach. In addition, because reference data on the selected lakes were limited, paleolimnological analyses were utilized to determine lake changes in the past decades.

Other explanations and practical examples of the new Finnish classification system compliant with the WFD were given in the presentation of Vuori (2009). The final overall decision of the status class of a water body is based on the integration of multiple lines of evidence. The system takes into consideration first the biological results and their described integration rules. The calculated biological status class is further evaluated by weigh-of-evidence approach commonly used in risk assessment.

Physico-chemical quality elements, hydromorphological quality elements, ecotoxicity results (example are morphological biomarkers in caddisfly larvae, such as gills and/or mentum deformities, etc.) and concentrations of specific harmful substances are analyzed to support or not the calculated biological status. Sometimes also results from paleolimnology are used to support the results and give an overall assessment of the water body.

A practical application of the classification system (Vuori 2009) was offered for clarification, regarding the ecological assessment of river Kymijoki (Finland) and it is presented below.

The BQEs considered and their results in the river assessment were the following:

- Diatom (IPS index) status class: (average of the monitored stations) Moderate.

- Fish (Multimetric fish index) status class: (average of the monitored stations) Good.

- Benthic macroinvertebrates (Benthic index) status class: (average of the monitored stations) Good.

So the overall status (average across median scores) would result Good.

However, considering the Weight-of-evidence and Integrating lines of evidence:

- Hydromorphological status: Moderate. Moderate level of hydromorphological alterations

- Pollutant loading/nutrient status: moderate to poor. The considered levels of nutrients do not fully support classification results. Point and non-point sources have caused eutrophication of the river ecosystem. Mesotrophic conditions prevail, increasing the risks of failing the good ecological status

- Exposure to toxic substances: substantial to severe. Ecotoxicological evidence don't support classification results. Exposure was substantial, but patchy and has at least moderate impacts on the benthic populations.

Results of morphological biomarker of caddisfly larvae indicating toxic conditions (tracheal gill damages in *Cheumatopsyche lepida*: 40-45%; *Chironomus* mentum-deformities 54%)

For the final overall assessment, while considering risks from all the lines of evidence, the assignment of Moderate status appeared most credible.

The paper by Alahuhta *et al*. (2009) represents a comparative study on the performance of the 'one-out all-out' principle and the Finnish integrative system (FinEQ). A striking difference was found when the two systems were applied to six small forest lakes (see table below), differently affected by catchment forestry. The ecological status of the lakes was good (G) or high (H) in terms of median score status scores and FinQE method, whereas would have been assigned to a lower status when applying the 'one-out all-out' principle. The Finnish integrated classification principle was considered more realistic while the 'one-out all-out' principle not adequate for the classification of this lake type.

Lake/ method	Ooao principle	FinEQ
Saari-Kiekki	P	G
Itäjärvi	M	H
Iso Akonjärvi	M	H
Pirttijärvi	B	G
Roukajärvi	B	G
Matalanjärvi	B	G

Ecological classification in PORTUGAL

Clear concepts for a national classification system were found mainly in a national report by Inag I.P., Critérios para a classificação do estado das massas de água superficiais. Rios e albufeiras (2009) Istituto da água, I.P., Ministério do Ambiente (in Portuguese).

Portugal seems to follow strictly the indications of the ECOSTAT Classification Guidance (2003) for classifying rivers in the country, at least in a preliminary phase. The reason is likely to be found in the very recent history of monitoring biological elements in Portugal and of a previous lack of monitoring addressed to an evaluation of ecological status of water bodies.

The Portuguese system operates the 'one-out all-out' approach in case of combining multiple quality elements for classification. In case of rivers, phytobenthos and macroinvertebrates are the BQEs considered, at least for the first phase of intercalibration.

For the overall assessment of water body ecological status, Portugal applies the same indication given by the WFD and accordingly to a scheme similar to the one adopted by the UK (Figure 5).

Figure 5 – Conceptual scheme for classification system in Portugal according to the WFD (adapted from UK TAG, 2007)

3. Discussion and conclusions

The WFD requires the classification of the ecological status of surface waters in an integrative way, by using several biological quality elements in combination with physico-chemical supporting elements and hydro-morphological elements. It is well-known that the development of ecological assessment and classification systems is one of most important and technically challenging part of the implementation of the Water Framework Directive (WFD). It is the first time such classification systems have been required under Community legislation and all Member States need to expand their knowledge and experience to fulfil this aim (Classification Guidance, 2003).

It appears, however, that this process has not been applied in a consistent way by many Member States and that overall and final assignment of classification status for water bodies has been left as a secondary decision issue. In comparison, most of the attention, both in the scientific and in the policy world, has been concentrated on the developing of classification methodologies focused on just one or a few quality elements, with an extensive production and development of metrics and indices at element level.

The review presented in this report intended to gather information of ecological classification systems adopted at national level in Member States, and in particular of the combination rules utilized for multiple BQEs.

A review of published scientific papers revealed that the focus of research supporting the implementation of the WFD, since its publication in 2000, has been on the development of individual indicators at Biological Quality Element (BQE) level or single parameters within a BQE (see also Nõges *et al*. 2009).

Official reports for the implementation of the WFD such as the Intercalibration Technical Reports, deal with the description and the analysis of biological parameters or metrics and indices developed at national level and the comparison of indices among the Member States at European level; however the information focuses again on the combination of results at singular BQE level.

In contrast, the integration of multiple BQEs or indices at water body level have been undertaken in very few published studies (e.g. Borja *et al.* 2009, Alahuhta *et al.* 2009, Nõges and Nõges 2006, Søndergaard *et al*. 2005, Moss *et al.* 2003) and it is clear that more research in this topic is needed. The methodologies for combining results and for assessing the final ecological status of a water body utilized in each Member State have been largely neglected in the scientific literature.

A review of information sources other than published scientific literature, such as technical reports and official WFD implementation web sites of individual EU Member States, revealed that information on methodologies adopted for results integration into the overall evaluation of ecological status were limited or difficult to find. There is, therefore, a need to have more transparent information in order to draw a clear overall view of the different classification methods in individual Member States. The best way to fill this information gap would be to produce a questionnaire to be filled in by each Member State in each water category.

From the information gathered so far, we provided a preliminary overview of national classification systems utilized in Member States, in particular for those Member States where information on classification systems was found and accessible. The main results were that different Member States have generally diverse approaches for classification systems. This includes the choice of biological quality elements (BQEs) monitored and then evaluated for classification, the combination of BQEs to express a whole biological state, and the overall classification system integrating biological, physico-chemical and hydromorphological results.

When considering, in particular, the way of combining multiple BQEs into ecological assessments, it appeared that two general approaches were adopted. Some Member States seem to follow strictly the 'one-out all-out' principle as required by the WFD and the ECOSTAT Classification guidance (2003), classifying the biological status of the water body on the basis of the BQE with the worst class score. Other Member States are instead already applying, or are considering applying, alternative systems.

In the latter case, the 'one-out all-out' principle has been criticised mainly because it could very likely downgrade a water body to a worse class than its real state, if the criteria of classifying the biological status according to the BQE with the worst class score is strictly applied. In some of the Member States it is generally considered that the 'one-out all-out' principle in determining the ecological status needs be further discussed and its application shouldn't be carried out unconsciously.

In some cases, like for the UK, the choice of monitoring only the BQEs most sensitive to a particular pressure and to classify the water body accordingly to these results seems a considerate way for optimizing monitoring (according to the water body risk assessment) and avoiding a strict application of the 'one-out all-out' principle. In the report for classification by the Environmental Agency (2008) it is recognized that the use of many quality elements, and the assigning of class by the worst of these, will bias the overall assessment towards bad quality unless all those elements are measured with 100 per cent

precision. This issue needs to be taken into consideration also when looking at trends and including more quality elements might lead to more reported failure. This risk could be countered by looking at the individual elements, one at a time (Environment Agency, Method statement for the classification of surface water bodies, 2008). Furthermore, the 'one-out all-out' principle in the UK classification system is applied only when the confidence in the result is high. This overall approach could, however, minimise the general principles of the WFD of considering and thus assessing the aquatic ecosystem as a whole, including the consequent use of multiple BQEs for ecological classification. The greatest objection is that ecology is reduced to a few elements, while the WFD proposed a more complex system to replace previous simple systems (Moss 2008).

The Basque Country (Spain) classification system considers different weighting for different BQEs, giving particular importance to the macroinvertebrate community of coastal and transitional waters because considered as particularly sensitive to most of the anthropic and natural pressures (Borja *et al.*, 2000). Furthermore, due to different sampling frequencies, to the high spatial and temporal variability of some biological quality elements and to the role of some biological elements as good indicators, any form of weighting in the data should be investigated according to Borja *et al*. (2004; 2009). Thus the WFD principle 'one-out all-out' in determining ecological status should be considered for discussion according to the Basque authorities.

Also the classification approach of Finland wants to take into account different aspects of a water body in ecological assessment. In the presentation given by Vuori (2008), it was stated that a straightforward application of the 'one-out all-out' principle in ecological classification may ignore the multiple lines of evidence and some very basic principles of ecological risk assessment. The paper by Alahuhta *et al.* (2009) described a comparative study between the application of the 'one-out all-out' principle and the Finnish integrative system (FinEQ). A remarkable difference was found when the two systems were applied to some small forest lakes, with the 'one-out all-out' principle giving worse/poorer results. The authors stated that the 'one-out all-out' principle is unrealistic for use in the assessment of such small humic boreal forest lakes and that the Finnish integrated classification principle seems to provide more stable and reliable results for this lake type.

In the approach adopted by Søndergaard *et al*. (2005) for their study of ecological classification of Danish lakes, a main environmental stressor (total phosphorous) was selected as a key variable for water quality and as the main determining factor for numerous biological variables in lakes. Different ecological indicators were chosen according to their response to eutrophication and their median value was utilised for the calculation of the final EQR value. The authors raised the problem that gradual rather than stepwise changes occurred for the indicators and that large variability of indicators

within lake classes was observed. They thus recognised a risk of classifying a lake into the 'wrong' class using the 'one-out all-out' principle for ecological classification.

Moss *et al*. (2003), in the pan European project ECOFRAME, proposed a classification system for shallow lakes that included different biological variables and some variables that were considered as ecologically inseparable (pH, TP, TN, Secchi depth, shoreline structure). The chosen variables might be best used to measure features that contribute to the concept of ecological quality in lakes, according to the authors. They assessed the ecological status of 66 lakes across Europe comparing different criteria: 100%, 75% and 50% compliance of the chosen variables. According to the interpretation of the WFD, to attain a given status, all variables must meet the required standard (Environment Agency, 2002) or the 100% criterion. This was considered unrealistic because of the high natural variability in most of the characteristics, while a level of 75-80% compliance was considered as more appropriate (Moss *et al*., 2003).

The debate on the importance of considering the integration of biological parameters into overall ecological assessments of water bodies is certainly present among both the Working Groups for the implementation of the WFD and scientists in the Member States. It is also recognised that applying the 'one-out all-out' principle inconsiderately could be unsafe because of the danger of ending up with average environmental situations, where ecological problems may be levelled out (Borja and Heirich, 2005).

It seems, however, that a pragmatic proposal for combining BQEs hasn't been put forward yet, a unifying proposal agreed by different (if not possible all) Member States that analyzes the implications of the 'one-out all-out' principle and the possibility of applying alternative combining rules in classification systems.

The environmental objective of the Water Framework Directive is that, by year 2015, all surface waters in Europe should achieve good ecological status. Where there is a risk of failure to meet such environmental objectives, a 'programme of measures' has to be implemented. For water basin management, the most critical boundary of the five ecological categories (high, good, moderate, poor, bad) is between good and moderate, as water bodies that fail to meet good status need to be restored and brought up to higher standards by a programme of measures. This is a very important point with high economical consequences on the national budget of Member States. For instance, it has been estimated in England and Wales that more than 90% of water bodies will fail to meet 'good quality' (Moss 2007; UK Environmental Agency web site). It is fundamental to understand whether sufficient resources will be available in each Member State to support adequate monitoring and restoration measures.

A weak classification system can easily lead to misclassification of water bodies, and this will have great ecological and economic implications. If a water body is classified as good, when in reality its water status is less than good, no measures will be taken to improve it and this will be unsuccessful for the general purposes of the WFD of preventing deterioration, protecting and enhancing the status of aquatic ecosystems in Europe (art. 1 of the WFD). On the other hand, classifying a water body as moderate when it is actually in good status, it will allow starting a useless/futile programme of measures to improve its ecological state, with a consequent waste of time and resources. Risk of misclassifications needs to be incorporated in the reports of monitoring under the WFD; the fact that this may cause administrative problems should be overcome by the concept that natural systems don't fit easily into anthropogenic boxes (Irvine, 2004).

It is clear that the classification system adopted, together with its associated uncertainty, is of fundamental importance and has very determinant consequences on the programme of measures that each Member State needs to implement. As a lot of work and thinking has been done so far at quality element level, there should be at least the same consideration and amount of effort to develop a suitable classification system which combines multiple BQEs into an overall assessment of water bodies. The focus of research and management should thus move from individual biological components or BQE to the overall ecological assessment, considering the ecosystem as a whole.

As suggested in other works (for examples van de Bund and Solimini in the Rebecca Deliverables 10, 2006; Borja 2009; Nõges and Nõges 2006), in practice it may be good to reconsider the 'one-out all-out' principle and investigate further alternative classification systems. Moreover, because of the substantial variability in classification results of different BQEs, classification based on the worst BQE and thus ultimately on a single quality element, representing only a single habitat, may not adequately represent the overall quality status of the ecosystem (Rask et at. 2010, Nõges and Nõges 2006, Søndergaard *et al*. 2005).

One important conclusion that can be drawn is that currently there is insufficient information available to review national classification systems and combination rules adopted for multiple BQEs for all Member States across Europe. It is clear from the literature available that there already exists a diversity of approaches in this area. Given the importance of this final step in classification, it is necessary for greater emphasis to assign to this task. While intercalibration has focused in detail on singular BQE, this will not result in harmonisation of water body classification in the EU if the final classification is arrived at using different systems/methodologies.

A more detailed and exhaustive review could be presented after the return of the proposed classification questionnaire by each Member State, where information can be collected in a standardized way. The importance of comparability of classification systems across Europe was also advised by EC authorities; J.R. Romero of the European Commission (DG Environment, Water and Marine, WFD Team) in his presentation in Paris (classification workshop, 2007), pointed out that combination rules for different quality elements in the ecological classification should ensure comparability (need to have common principles) and be transparent in the final presentation of classification results. While filling a questionnaire could be seen as a nuisance for some, it requires a relatively little time and it represents a useful and optimizing tool to gather the required information. We are confident that these results, available for both the scientific and the policy makers' community, will be of great importance and value for the ongoing debate on ecological classification in Europe. A wider view of the national classification system adopted in Europe could give a positive input for finding reasonable solutions which can be significant both ecologically and economically.

5. Proposal for a questionnaire for Member States on national classification systems

The European Water Framework Directive requires classifying the ecological quality of surface waters. The final ecological status is evaluated by the integration of different biological elements (BQEs) and physico-chemical and hydromorphological elements. Although the determination of the final ecological status is a very important and composite issue, it appears to be left to a secondary consideration by Member State (MS), while the main focus of the work has been so far on classification methods through metrics and individual quality elements.

From the overview of this report it is clear so far that information on overall classification systems are:

- in general quite scarce or scarcely accessible
- information on combination rules are limited
- restricted to a few countries
- scattered among diverse sources (scientific paper, official documents, national reports, web pages, workshop presentations, etc.)

There is thus a pressing need to draw a clearer overview of the classification systems adopted in each MS and to harmonize the parameters necessary for such overview. As stated in the conclusions of this report, we thought that a good and direct solution would be collecting information by means of a questionnaire on classification systems for each MS, with key questions helping to develop an overall understanding of the procedures utilized. In particular we would like to explore the combination rules implemented by each MS at different levels such as:

- the biological status through the integration of different biological quality elements (BQEs) results;
- the final ecological status through the integration of biological, physico-chemical and hydromorphological results

We choose to include also just a few questions at element level regarding the method for assessing a BQE (metrics and parameters utilized in the calculation of singular BQE/EQR). Although general information are already available from diverse source (scientific papers, intercalibration technical reports, etc) and have been collected through a previous Wiser questionnaire (on biological assessment methodologies, Birk *et al*. 2010), we are particularly interested in the combination rules utilized.

The first draft of the proposed questionnaire for Member States on national classification systems is available in the Appendix of this report.

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APPENDIX

1. Details of information sources

a. Scientific papers

Most of relevant scientific papers published since the implementation of the WFD dealt with the development of individual indicators at Biological Quality Element (BQE) level.

Many papers describe the classification system taking into account only one or a few BQEs. Among a large number of scientific papers, recent examples include most of the papers published in *Hydrobiologia* Vol. 633 'Assessment of the ecological status of European surface waters'(October 2009), papers published in *Ecological Indicators* Vol. 6 (2006) and Vol. 8 (2008), a review of assessment criteria for lakes in *Inland Waters* (2009). A considerable number of scientific papers have been published proposing individual BQE as ecological status indicators. A few examples include papers on assessment of lakes using submerged macrophytes (Søndergaard *et al*. 2010; Penning *et al.* 2008; Coops *et al*. 2007), on the assessment of lakes using phytoplankton (Salmaso *et al.* 2006; Padisák *et al.* 2006), on rivers assessment through macroinvertebrates (Hering *et al*. 2003, Hering *et al*. 2004), on estuarine and coastal water assessment through macroinvertebrates (Borja and Dauer 2008), on assessment of coastal waters through phytoplankton and phytobenthos (Sagert *et al*. 2005), on lake assessment through macrophytes and phytobenthos (Schaumburg *et al.* 2004), on marine waters assessment through benthic fauna (Rosenberg *et al*. 2004), on macroinvertebrates for ecological assessment of lakes (White & Irvine 2003) and many others.

In contrast, very few scientific papers have been published describing the national classification systems adopted and the way of combining results from different BQEs, or the overall assessment systems integrating biological with physico-chemical and hydromorphological results. Some examples are found in papers published by A. Borja *et al*. (2009 on Spanish –Basque Country coastal waters classification), J. Alahuhta (2009 on ecological status of Finnish lakes), Søndergaard *et al*. (2005 on Danish lakes classification), and partially in J. Bowman (2009 for Irish surface waters classification). Moss *et al*. published in 2003 the overall results of the ECOFRAME project on the determination of ecological status in European shallow lakes, with description of the

methodology adopted and some criticism to the WFD indications for surface waters classification.

Furthermore, some authors have published opinion papers analyzing and criticizing the classification system proposed by the Water Framework Directive. Examples can be found in P. Nõges *et al.* (2009), B. Moss (2007) and K. Irvine (2004).

b. EU Technical reports

- Water Framework Directive Intercalibration reports (2009)

In the WFD intercalibration technical reports, for each water category (example lakes, rivers, coastal waters) and each GIGs (Alpine, Mediterranean, etc) there are information on the parameters or metrics and the relative indices utilized for those biological quality elements that have been calibrated among Member States. Furthermore there is a brief description of how the parameters/metrics are or will be combined at biological quality element level, in particular if the 'one-out all-out' principle is utilized for such combination. Much information is still missing in the Intercalibration reports recently published (2009); the ongoing second round of intercalibration exercise will collect information in a more systematic way, completing the intercalibration for some biological quality elements not yet done/considered and for water categories that to date have been more neglected than others.

- Second Implementation Report on monitoring (2009)

The second implementation report was published on 1st April 2009. It addresses the establishment of monitoring programmes for surface waters and groundwater (see Article 8 and Annex V of the WFD).

Possibly useful information, in relation to our review on classification systems, found in this Implementation Report are on the biological quality elements monitored for surveillance and operational monitoring programmes in each Member State. There are no, however, information related to the classification systems utilized in Member States.

The Implementation Report states that for surveillance monitoring only three MS (Bulgaria, Czech Republic and Luxemburg) are monitoring all biological quality elements, while other Member States are monitoring less elements (Figure 7 of the Implementation Report: 'Percentage of water bodies in surveillance monitoring in which the relevant biological quality elements are monitored'). For operational monitoring some Member States monitor only one biological quality element in each category, while in

most of the Member States more than one biological quality element is monitored (Figure 13: 'Number of sites monitored for each of the four biological quality elements). Detailed information on monitoring programmes, including the selection of quality elements, for each Member State are reported in Annex 2 of the Implementation Report.

The Implementation Report, in paragraph 4.3.4 called 'Status of the development of assessment methods' discusses the development of methods for the assessment of ecological status; this, however, refers only to assessment methods utilized and developed in different Member States at element level for each biological quality element and not to the overall systems utilized for ecological assessment of a water body.

- Eionet, Central Data Repository

Eionet is a partnership network of the European Environment Agency (EEA); the network supports the collection and organization of data and the development and dissemination of information concerning Europe's environment. The Central Data Repository is a collection of reports on the environment as submitted by Member States.

The link to this web page is:

http://cdr.eionet.europa.eu/

Under the folders 'EU obligations', a number of technical reports on the environment can be found for each country. There are in particular folders regarding the implementation of the WFD, such as WFD monitoring programmes, WFD river basin management plans.

The research into this database is very laborious and time consuming, and often the information in the reports are different in different MS. For the purpose of this review, useful information has been found on the monitoring programmes, the BQE utilized and their methodology. However, very little help was found when looking for information about national classification systems for ecological assessment of water bodies.

c. Official WFD implementation web sites of the EU Member States

A number of links concerning the Water Framework Directive have been found in the EU official web page:

http://ec.europa.eu/environment/water/water-framework/links/index_en.htm

Country	web address
Austria	http://www.lebensministerium.at/wasser/
Belgium	http://eau.wallonie.be http://www.ciwvlaanderen.be http://www.ibgebim.be/francais/contenu/content.asp?ref=2102
Bulgaria	http://www.moew.government.bg/
Cyprus	http://www.wfd.wdd.moa.gov.cy
Czech Republic	http://www.env.cz http://www.mze.cz
Denmark	http://www.mst.dk/vand/06000000.htm
Estonia	http://www.envir.ee
Finland	http://www.ymparisto.fi/
France	http://www.eaufrance.fr/
Germany	http://www.bmu.de/gewaesserschutz http://wasserblick.net/
Greece	http://www.minenv.gr/welcome_gr.html
Hungary	http://euvki.hu
Ireland	http://www.wfdireland.ie/
Italy	See annex 4 of the Commission's Staff working document SEC(2007) 362 final

Latvia	http://www.lvgma.gov.lv
Lithuania	http://aaa.am.lt/
Luxembourg	http://www.waasser.lu/gestion_de_leau/gestion.html
Malta	http://www.mra.org.mt/wfd_introduction.shtml
Netherlands	http://www.kaderrichtlijnwater.nl http://www.waterland.net
Poland	http://www.rdw.org.pl/index.php
Portugal	http://dqa.inag.pt/
Romania	http://www.rowater.ro/
Slovakia	http://www.enviro.gov.sk
Slovenia	http://www.mop.gov.si
Spain	http://www.mma.es/portal/secciones/acm/politica_agua/directiva_marco_aguas/
Sweden	http://www.vattenportalen.se/
United Kingdom	http://www.defra.gov.uk/environment/water/wfd/index.htm http://www.scotland.gov.uk/Topics/Environment/Water/WFD

These links (see table above) represent the official WFD implementation web sites of the EU Member States. The web page states also that on these sites you can often access more detailed information on water management in specific countries than the Commission has the possibility to provide.

The links represented a starting point to explore whether detailed information on classification systems utilized in each of the Member States were publically accessible.

Out of a total of 27 countries, 78% contained general information on the WFD, about 50% had more detailed information about the implementation of the WFD in the specific Member State, but only in less than 10% were found detailed descriptions of the

classification system adopted at national level and that were in line with the WFD principles.

In general, English and/or French version of the web pages were available and only three MS had just the national language version. However, more detailed information about the application of the WFD, national reports on water relevant issues and information on the classification systems adopted were often presented only in the national language of the specific MS. This inconvenience complicated further the access to detailed and relevant information through the web pages.

d. Reports and presentation of Classification workshops at European level

Two main workshops held at European level about classification systems for ecological assessment of surface waters were held respectively in France, Paris on the 11-12 of June 2007 and in Belgium, Brussels on the 6-7 of March 2008. Reports, conclusions, list of Member State participants and oral presentations are available on the Circa web site http://circa.europa.eu/.

The main sessions of the workshops discussed the following topics:

- ecological significance and combination of the biological quality elements
- combination of results for different quality elements
- role and place of the physico-chemical elements
- effect of aggregation, uncertainty, confidence and precision
- presenting classification results

The presentations given at these workshops represent a useful source of information on the classification systems adopted in the different Member States.

2. *DRAFT OF A QUESTIONNAIRE for Member States on national classification systems for surface waters ecological status in WFD programmes*

Introduction

The European Water Framework Directive (WFD, 2000/60/EC) requires the classification of the ecological status of surface waters in an integrative way, by using several biological quality elements in combination with physico-chemical supporting elements and hydro morphological elements. However, the methodologies or procedures adopted by the Member States for such integration into a final and overall evaluation/assignment of ecological status are scarcely accessible or sufficiently transparent.

Purpose

To provide information on how the different Member States define the ecological classification of a water body;

To describe the methodologies or procedures to define the final classification of ecological status integrating information about the biological quality elements, physico-chemical status and hydromorphological elements into the final EQR and the corresponding ecological quality class.

To describe the procedures adopted, from the combination of the metrics and indices for each biological quality element (BQE), to the combination of different BQEs in a biological state/class, to the final integration of biological results with physico-chemical and hydromorphological results into an overall final assignment of ecological status.

Content

The questionnaire is divided into two main sections. Section I includes information at element level, investigating how parameters/metrics are combine and integrated into each biological quality element (BQEs); Part II includes information about the combination rules utilized for the overall final assignment of ecological status.

Both sections are introduced by General Information regarding the person filling the specific section of the questionnaire.

Example**: Water category: LAKES**

Section I

1) **General information**
2) **Combination rules at Quality Element level**

A) phytoplankton

Integration of parameters/metrics into BQE

B) macrophytes

Integration of parameters/metrics into BQE

C) phytobenthos

Integration of parameters/metrics into BQE

D) macroinvertebrates

Integration of parameters/metrics into BQE

E) fish

Integration of parameters/metrics into BQE

G) physico-chemical parameters

Integration of indicators into physico-chemical status

H) hydromorphology

Integration of indicators into hydro-morphological status

Part II

1) **General information**
2) **Combination rules of BQE results**
3) **Overall ecological classification system**

Section I

To be filled in for each Biological Quality Element (BQE) and physico-chemical or hydromorphological element

1) **General information**
   Please fill in this section to identify the person responsible for specific biological quality or physico-chemical or hydromorphological element classification at national level

- Name of the person responsible
- E-mail of the person responsible
- Institute of the person responsible
- Water category
  - lakes
  - rivers
  - coastal waters
  - transitional waters

2) **Combination rules at Quality Element level**

- What Biological Quality Element will be described
  - phytoplankton
  - macrophytes
  - phytobenthos
  - macroinvertebrates
  - fish

- If the parameters/metrics for the specific BQE have been grouped according to different pressures, which type of separate pressures have been considered?
  - acidification
  - aquatic habitat degradation
  - eutrophication
  - flow modification
  - connectivity
  - general water quality degradation
  - hydromorphological degradation
  - pollution by organic matter
  - pollution by organic compounds
  - pressure by alien species
  - others (please specify)

- If the metrics respond to a combination of pressures, how the results have been combined to produce the biological element status/value (quality element level)?
    - average of the metrics
    - average of the standardized score of the metrics
    - median of the metrics
    - weighted average of the metrics
    - sum of the single metrics
    - worst metric value
    - multimetric index
    - others

- If the metrics have been grouped according to different pressures, how the results have been combined to produce a value for each pressure (at parameter level)?
    - average of the metrics
    - average of the standardized score of the metrics
    - median of the metrics
    - weighted average of the metrics
    - sum of the single metrics
    - worst metric value
    - multimetric index
    - others

- If the metrics have been grouped according to different pressures, how the values for each pressure have been combined to produce the biological element status/value (at quality element level)?
    - according to the 'one out-all out' principle
    - other criteria

- For the calculation of the biological element status/value, please specify what metrics or indices have been considered and write the formula if possible

- How the uncertainty in assigning the EQR for the specific element has been measured and reported?

- What parameters have been considered for the determination of physico-chemical status?

- Is one or some of these parameters considered particularly significant in your method for the procedure of ecological classification?

- How is the physico-chemical status been evaluated?

- Name of the methods applied to evaluate the physico-chemical status

- What parameters have been considered for the determination of the hydromorphological status?

- How is the hydromorphological status been evaluated?

- Name of the methods applied to evaluate the hydromorphological status

Section II

1) General information

General data about the person and/or the institute responsible for the overall integration of results into an assessment of ecological status of water bodies

- Name of the person completing the questionnaire
- E-mail of the person completing the questionnaire
- Institute of the person completing the questionnaire
- EU member state
- Water category
    - rivers
    - lakes
    - coastal waters
    - transitional waters

- Name of the methodology or procedure utilized for the whole ecological status assessment
- Web page describing the application of the procedure of ecological status assessment
- Pertinent literature of mandatory character (official notes, national standard)
- Scientific literature
- Comments

2) Combination rules of BQE results

- What Biological Quality Elements (BQEs) have been considered in the classification system?
    - phytoplankton

- phytobenthos
- macrophytes
- macrobenthos
- macroalgae
- fish
- others

- Before the BQEs combination in an overall biological quality class, how are the results of the individual BQE expressed?
    - EQR (0-1)
    - Others

- How the results or EQRs of the different biological elements (BQEs) are combined to give an overall biological quality class?

  - 'one-out all-out' principle, i.e the biological quality element showing the worst classification determines the biological status
  - mean of the EQRs of all the different biological elements
  - compensation criteria with a weighed average of the EQRs, all biological elements have equal importance
  - compensation criteria with a weighed average of the EQRs, biological elements have different importance
  - classification grid: at least two biological quality element EQRs in a given class to classify the site in this class
  - other types of classification grid: please specify
  - expert judgment
  -combination of 'one-out all-out' principle and expert judgment
  - others

- Please write briefly the formula or the methodology utilized to combine results of different biological elements (BQEs) in the overall biological quality class

- Has the uncertainty of assigning the biological quality class been taken into consideration?

- How the uncertainty of assigning the biological quality class has been measured and reported?

3) Overall ecological classification system

- To which water categories the overall classification system does apply to?
    - lakes
    - rivers
    - coastal waters
    - transitional waters
    - all water categories
    - to a combination of the following: (please specify)

- How the physico-chemical results/EQRs are incorporated into the final ecological status assessment?

- In the final ecological status assessment, is the whole physico-chemical status (EQR) considered or only specific components (for example only nutrients levels) of the physico-chemical status considered?

- In the overall ecological status classification, does the integration of biological and physico-chemical results follows
    - the 'one-out all-out' principle
    - other compensation criteria
    - multimetric evaluation
    - a series of steps of decisions

- If compensation criteria are adopted, the biological and physico-chemical results are
    - averaged
    - weighed
    - judge by expert opinion
    - others

- If a series of steps criteria are adopted, does the integration of biological and physico-chemical results differentiate according to the biological quality status? (i.e. different if the biological quality status is high or good, and if it is moderate, poor or bad)

- Are the concentrations for specific pollutants (EQSs, Annex VIII) considered into the final ecological status assessment?

- How the concentrations for specific pollutants (EQSs) are incorporated into the final ecological status assessment?

- Are the hydromorphological results considered into the final ecological status assessment?

- How the hydromorphological results are incorporated into the final ecological status assessment?

- Are the hydromorphological results considered only when biological and physico-chemical results are in high class/status?

- In the overall ecological status classification, does the integration of biological, physico-chemical and hydromorphological results follows
    - the 'one-out all-out' principle?
    - other compensation criteria?
    - multimetric evaluation
    - a series of steps of decisions

- If compensation criteria are adopted, the biological, physico-chemical and hydromorphological results (or EQRs) are
    - averaged
    - weighed
    - judge by expert opinion
    - others

- If a series of steps criteria are adopted, do they differentiate according to the biological quality status? (i.e. different if the biological quality status is high or good, and if it is moderate, poor or bad)

- How is the uncertainty of assigning the final ecological class been measured and reported?

- How do you proceed if the uncertainty plays a significant role in the classification results?

3. Table 1 Preliminary overview of national classification systems

country	source of information	journal/workshop/web page	title of presentation/paper	name of responsible/author for classification system	water category	selected BQEs	combination of BQEs	combination of biological and physico-chemical	pollutants	hydromorphological	integration all elements in overall assessment	ooao principle	uncertainty of classification
Spain (Basque Country)	scientific paper	Marine Pollution Bulletin (2009) 59: 54-64	Using multiple ecosystem components in assessing ecological status in Spanish (Basque Country) Atlantic marine waters	A. Borja et al.	coastal and transitional	phytoplankton, macroalgae, benthos, fish	weighting of some elements, with particular attention to benthos	decision tree'	included	included	decision tree'	not applied directly, needs to be discussed	included at element level
Spain (Basque Country)	presentation	Classification workshop Brussels 2008	Integrating physicochemical and biological elements in assessing the ecological quality status within estuaries and coastal area in the Basque Country (Spain)	A. Borja	coastal and transitional	phytoplankton, macroalgae, benthos, fish	weighting of some elements, with particular attention to benthos	decision tree'	included	included	decision tree'	not applied directly, needs to be discussed	included at element level
UK	presentation	Classification workshop Brussels 2008	Physicochemical results and combining results across quality elements	WFD UK TAG	not specified, general	choice of quality element most sensitive to different pressure(s)	ooao principle, applied taking into consideration the level of confidence. The 'follow-up' measures depend on the level of confidence obtained	according to the CIS Guidance and depending on the level of confidence plus weight of evidence approach	included	included	ooao principle, depending on the level of confidence plus weight of evidence approach	applied, taking into consideration uncertainty	broadly discussed and included
UK	document on the web	www.environment-agency.gov.uk	Method statement for the classification of surface water bodies (2008)	WFD UK TAG	not specified, general	choice of quality element most sensitive to different pressure(s)	ooao principle, applied taking into consideration the level of confidence. The 'follow-up' measures depend on the level of confidence obtained	according to the CIS Guidance and depending on the level of confidence plus weight of evidence approach	included	included	ecological status determined by the worst scoring	applied, taking into consideration uncertainty	broadly discussed and included
UK (UKTAG)	document on the web	http://www.wfduk.org/UKCLASSPUB/	Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive (2008)	WFD UK TAG	not specified, general	choice of quality element most sensitive to different pressure(s)	ooao principle, applied taking into consideration the level of confidence. The 'follow-up' measures depend on the level of confidence obtained	according to the CIS Guidance and depending on the level of confidence plus weight of evidence approach	included	included	ecological status determined by the worst scoring	applied, taking into consideration uncertainty	broadly discussed and included
UK/Europe	scientific paper	Aquatic Conservation: Marine and Freshwater Ecosystems (2003) 13: 507-549	The determination of ecological status in shallow lakes: a tested system (ECOFRAME) of the European Water Framework Directive	Moss et el.	lakes	phytoplankton, phytobenthos, zooplankton, macrophytes, macroinvertebrates, fish	use of percentage compliance (80%) for all the variables	use of percentage compliance (80%) for all the variables	included	included	use of percentage compliance (80%) for all the variables	not adopted and criticised	discussed
Portugal	document on the web / internal report	http://dqa.inag.pt	Criterio para a classificacao do estado das massas de agua superficiaias (2009)	Istituto da agua I.P.	rivers and lagoon	macrobenthos, phytobenthos, phytoplankton,	ooao principle	according to the CIS guidance	included	included	ooao principle	adopted	mentioned
Finland	scientific paper	Fundamental and Applied Limnology, Archiv für Hydrobiology (2009) 175/3: 203-216.	Defining the ecological status of small forest lakes using multiple biological quality elements and paleolimnological analysis	Alahuhta J., Vuori K-M., et al.	lakes	phytoplankton, macrophytes, macroinvertebtaes, fish	median score value across all quality elements	biological status and weight-of-evidence approach	included	included	biological status and weight-of-evidence approach used in risk assessment	not adopted and criticised	mentioned
Finland	presentation	Second Nordic workshop on Harmonisation and realisation of the WFD in the Nordic countries , 2009	The weight-of-evidence approach in classification of the ecological status of water bodies in Finland Highlights/examples of rivers& humic lakes.	Vuori Kari-Matti	lakes and rivers	phytoplankton, macrophytes, macroinvertebrates, fish	median score value across all quality elements	biological status and weight-of-evidence approach	included	included	biological status and weight-of-evidence approach used in risk assessment	not adopted and criticised	mentioned
Netherlands	presentation	Classification workshop Brussels 2008	Role of supporting elements in classification	M. van den Berg, Centre for Water management	not specified, general	not specified	not explained	four different combinations with different measures to take	not specified	not specified	different number of combinations with relevant measures to take	criticised	mentioned
Sweden	presentation	Classification workshop Paris 2007	Classification of ecological status in Sweden	M. Gunnarsson, Swedish EPA			not clear	not clear			not clear		broadly discussed and included
Slovakia	presentation	Classification workshop Brussels 2008	ES classification in Slovakia	Water Research Institute	not clear (rivers?)	benthos, phytobenthos, fish, phytoplankton, macrophytes	ooao principle	not clear	not clear	not clear	not clear	adopted at element level	not discussed
Czech Republic	presentation	Classification workshop Paris 2007	ARROW: system for the evaluation of the status of waters in the Czech Republic	Jiří Jarkovský	not specified (examples given for rivers)	macroinvertebrates, fish, macrophytes, phytobenthos	multimetric method	multimetric evaluation and expert opinion	included	included	multimetric evaluation/ complex statistical methodology and expert opinion	applied between ecological and chemical status	mentioned
France	presentation	Classification workshop Paris 2007	How to derive a WFD compliant and ecologically relevant classification system for rivers?	J.B. Wasson & L. Sandin	rivers	macrobenthos, phytobenthos, fish	average of EQRs or classification grids	need of harmonization of biological and physico-chemical classification	included	included	not specified	needs to be discussed; only negative variation are taken into account.	broadly discussed and included
Germany	presentation	Classification workshop Paris 2007	Ecological classification in Germany using the example of the german river assessment system with benthic invertebrates (PERLODES)	C. Meier & D. Hering	rivers	macrobenthos	ooao principle	according to the CIS guidance	included	included	according to the CIS guidance	adopted at element level	
Germany	scientific paper	Hydrobiologia (2006) 566:109-113	Linking organism groups- major results and conclusions from the STAR project	Hering D., Johnson R.K. & Buffagni A.	rivers	different organism groups depending on the different pressures (and different river types)	not specified	not specified	included	included	not specified	not specified	not discussed
Estonia	presentation	Classification workshop Paris 2007	Classification of rivers and lakes in Estonia	P. Marksoo	rivers and lakes	macrobenthos, phytobenthos and fish for rivers; macrobenthos, phytoplankton, macrophytes for lakes	integration of biological indicators	integration of (2/3 of) indicators	included	included	integration on 2/3 of biological, physico-chemical and hydromorphological indicators	not mentioned	not discussed
Ireland	scientific paper	Biology & Environment (2009) 109: 247-260	New Water framework Directive quality standards and biological and hydromorphological classification systems for surface waters in Ireland	J. Bowman, EPA	all categories	depending on water category	ooao principle	according to the CIS guidance	included	included	ooao principle (and weigh-of-evidence approach)	adopted	developed method to be
Ireland	internal report	www.epa.ie; EPA report 2009	Interim Classification of Rivers for the purposes of the EU Water framework Directive (2009)	EPA	rivers	macroinvertebrates, diatoms, fish	ooao principle	according to the CIS guidance	included	included	ooao principle (and weigh-of-evidence approach)	adopted	developed method to be
Italy	discussion paper	www.cirf.org	The Water Framework Directive: a soap bubble? An integrative proposal: FLEA -Fluvial Ecosystem Assessment (2008)	A. Nardini et al.	rivers	macroinvertebrates, aquatic flora, fish, riparian vegetation	weighed sum of different BQEs	weighed of biological and physico-chemical results	included	included	weighed sum of biological, physico-chemical and hydrobiological results	criticised	developed not discussed
Italy	internal document	www.apat.gov.it	Classificazione dello stato ecologico dei corpi idrici delle acque marino costiere e di transizione (2009)	A.M. Cicero, F. Giovanardi, R. Boscolo et al.	coastal and transitional waters	phytoplankton, macroalgae, macrobenthos, macrophytes for coastal; macroalgae, macrophytes and macrobenthos for transitional.	ooao principle	according to the CIS Guidance 2003 and to Eutrophycation Guidance 2009	included	included	according to the CIS Guidance 2003 and to Eutrophycation Guidance 2009	adopted	not discussed
Denmark	scientific paper	Journal of Applied Ecology (2005) 42: 616-629	Water Framework Directive: ecological classification of Danish lakes	M. Søndergaard et al.	lakes	phytoplankton, zooplankton, macrophytes, fish	mean value of the EQRs of all biological indicators	mean value of EQRs indicators (biological+physico-chemical)	not specified	not specified	mean value of EQRs indicators	not adopted and criticised	discussed
Austria	presentation	Classification workshop Paris 2007	General chemical and physico-chemical elements – Type-specific assessment of rivers in Austria	K. Deutsch, Lebensministerium.at	rivers	macrobenthos, phytobenthos, fish	not specified	not specified			not described (probably ooao principle)	not specified	not discussed
Austria	scientific paper	Hydrobiologia (2000) 422/423: 445–452	The Austrian way of assessing the ecological integrity of running waters: a contribution to the WFD	A. Chovanec et al.	rivers	macrobenthos, fish	not specified	not specified	included	included	not described	not specified	not discussed