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REVIEW OF THE INITIAL DEVELOPMENT OF THE ECOLOGICAL STATUS CLASSIFICATION OF WATER FRAMEWORK DIRECTIVE RIVER WATERBODY TYPOLOGIES

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1. INTRODUCTION

This document sets out the review of the classification methodology for classifying surface water bodies (rivers) under the EU Water Framework Directive (WFD). During 2016 more data have been included into the databases and consequently a new version of the ESCS document has been developed. This new version is intended to provide a reviewed version of the overview of the process and does not go into details on how specific tools or classification databases work. Additionally, this document tries to add general guidance on the assessment of ecological status using historical data leading to the overall ecological classification of water bodies (rivers) for the purposes of the WFD. The document also provides specific guidance on the role of the general physico-chemical and hydromorphological quality elements in ecological classification.

The WFD 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 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.

In the cases where it was not possible to determine the ecological status classification using available data, expert judgement was used to classify the ecological status of water bodies.

2. SUMMARY

The development of ecological assessment and classification systems is one of the most important and technically challenging parts of WFD implementation, and consequently for the EPIRB project. The first version prepared in 2015 was a first step on this complex process that has been completed with additional field works and historical physico-chemical analysis. In that version early results for some of the pilot basins were included.

The WFD specifies the quality elements that are used to assess the ecological and chemical status of a water body. Quality elements are generally biological (e.g. fish, invertebrates, macrophytes) or chemical (e.g. heavy metals, pesticides, nutrients).

Classifications indicate where the quality of the environment is good, where it may need improvement, and what may need to be improved. They can also be used, over the years, to plan improvements, show trends and to monitor success.

<u>Ecological status classifications can be composed of up to four different types of assessments:</u>

- **An assessment of status indicated by a biological quality element such as fish, invertebrates or phytoplankton. Herein, macroinvertebrates have been selected as the indicator. This new proposal includes updated values calculated from historical datasets from the last 4 years of the project. During 2015 and 2016 field works, a new biological element, macrophytes, was analysed in the field but due to lack of specimens in all the sites and both the early season in spring for this flora, it is not possible to use yet this element in the ESCS. It is needed to have in the future additional biological elements to complement the classification exercice.**

- **An assessment of compliance with environmental standards for supporting physico-chemical conditions, such as dissolved oxygen, phosphate and ammonia. This new proposal includes updated values calculated from historical datasets from the last 15 years for some places (Dnieper, Caucasus, Upper Prut,...).**
- **An assessment of compliance with environmental standards for concentrations of other specific pollutants (such as the heavy metals As, Cu and Zn). This new proposal includes updated values calculated from historical datasets from the last 15 years for some places (Dnieper, Caucasus, Upper Prut,...).**

And in determining high status only

- **A series of tests to make sure that hydromorphology is largely undisturbed. These premises were used as the base for the reference site definition unless it has to be reviewed in the future to confirm that these sites are undisturbed.**

This document is the second step of a long process related to the development and improvement of appropriate systems that will involve a learning process.

The guidance document provides a starting point for this learning process in the 6 countries and 5 pilot basins involved in the project. It sets out some key principles and ideas based on practical approaches and on experience gained in EU Member States. It is hoped these will help the authorities build on their existing expertise to develop practical and reliable systems for the assessment and classification of waterbodies that satisfy the requirements of the EU Water Framework Directive.

Since 2013, surveys and datasets have been recorded under the EU guidelines in the EPIRB pilot river basins. The project used macroinvertebrates as the biological element in this first approach of development of a classification scheme, complimented by physico-chemical and hydromorphological elements.

The hydromorphological classification is divided into 5 different classes instead of 3 as EU recommended in order to undertake risk assessments, where such schemes are used. It would be useful for countries to distinguish different conditions with regard the hydromorphological alterations (e. g. establishment the heavily modified water bodies).

3. THE ECOLOGICAL STATUS AND ECOLOGICAL POTENTIAL IN THE WATER FRAMEWORK DIRECTIVE

For surface waters the overall aim of the WFD is for Member States to achieve “good ecological status” (“good ecological potential” in artificial or heavily modified waterbodies) and “good chemical status” in all bodies of surface water by 2015 or to adapted deadlines according to each country’s process.

Ecological status is recorded as high, good, moderate, poor or bad. ‘High’ represents ‘largely undisturbed conditions’. Other classes show increasing deviation from undisturbed or reference conditions. This deviation is expressed as an ecological quality ratio (EQR) which ranges from zero at the extreme bad end of the scale to one at the extreme high end of the scale. However, for the purpose of this document, for ecological *potential* is recorded into four classes only (good and above, moderate, poor and bad).

The ecological status of a water body is determined by the worst scoring element (one-out-all-out principle).

In this document, this first approach of ecological status classification in rivers in the EPIRB project, macroinvertebrate community status has been selected as a biological quality element monitoring, but full implementation of the WFD requires assessment of phytoplankton, fish, macroinvertebrate, macrophyte and phytobenthos communities.

The WFD asks us to look at the water environment as a whole, integrating water quality, quantity and physical habitat with ecological indicators.

3.1 What is classification?

The WFD asks us to classify waters in a different way, using new and revised environmental standards to assess whether environmental conditions are good enough to support biology (aquatic fauna and flora). This briefing note outlines the process of classification and the development of environmental standards within the EPIRB Project.

We use classification systems to assess the state of the environment at any point in time. They show us where the environment is of good quality and where it may require improvement. Classification systems therefore help us in planning what measures might be required for improvements, and will eventually show how our actions have benefited the environment.

The purpose of this classification is: (i) to be a useful tool for measuring the quality of the rivers; and (ii) to provide a snapshot of levels of pollution.

3.2 Surface waters classification

The status of each surface water body is judged using separate 'Ecological classification' and 'Physico-chemical classification' systems. The overall status of the water body will be determined by whichever of these is the poorer. To achieve 'good status' overall, a water body must achieve at least both good ecological and good chemical status.

3.3 Ecological classification

The Ecological classification system has five classes, from high to bad, and uses biological, physico-chemical, hydromorphological and chemical assessments of status. Biological assessment uses numeric measures of communities of plants and animals (e.g. fish and macrophytes). Physico-chemical assessment looks at elements such as temperature, pH, oxygen content and the levels of nutrients, which support the biology. The hydromorphological assessment looks at water flow and physical habitat. The WFD only gives definitions for three classes for these quality elements (high, good and moderate status), but for the purposes of planning improvements and assessing deterioration, we need numeric values equivalent to all five biological classes.

The chemical assessment within Ecological classification refers to other specific pollutants - in our case, heavy metals and other polluting substances that could adversely affect river ecology.

The overall ecological status of a water body is determined by whichever of these assessments is the poorer. So, a water body might pass 'good status' for physico-chemical and hydromorphological assessments, but be classified as 'moderate status' for the biological assessment. In this case it would be classified finally as "moderate ecological status".

3.4 Type(s) of data

Ideally, this dataset should:

- Sufficiently cover the geographical area in which the types occur within the States,
- Encompass sampling sites covering the entire gradients of pressures encountered, and hence the complete ecological quality gradient ranging from high to poor ecological status, and
- Contain non-biological (environmental) and biological data to conduct pressure-impact analyses. The non-biological data must be contemporaneous with the accompanying biological and physico-chemical data to be used for pressure impact analyses.

Process of preparing the classification proposal: In documents included in the Annex of this report further details are provided on the process of classifying rivers, but for biology (macroinvertebrates) this encompassed:

1. Common metrics were calculated from the river basin dataset (6 different biological indexes were calculated using ASTERICS software).
2. Monitoring results and associated pressure data were used to identify reference (non-impacted) condition locations.
3. The classes for the monitoring locations were calculated and boundaries created for the different indexes with matching EQR values.
   The H/G boundary was set to the 25th percentile of the type-specific reference value distribution and to illustrate the effect of the H/G-boundary value.

3.5 Selection of the locations with type specific reference conditions in the pilot river basins

The process of classification involves estimates of status from monitoring programmes that are targeted according to the identified pressures on water bodies. Sometimes monitoring data are used directly, as, for example, in comparing measurements of the average concentrations of chemical with an environmental quality standard. In other cases monitoring data are used with other information to estimate status using modelling techniques, comparing the observed values with the expected ones.

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

According to the REFCOND guidance (2005)[1], the establishment of reference conditions and classification of ecological status (and thus border securities class status) can be performed using the following options:

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[1] Guidance document n.o 10 River and lakes – Typology, reference conditions and classification systems WFD http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

- Monitoring of physically-similar, but quasi-pristine sites (when compared to impacted sites)
- Predictive models
- Historical or paleolimnological time series data
- Expert judgment.

In the project the reference conditions locations were selected using the pressure analysis, expert judgement and local knowledge/experience in the area in the last years.

4. SCHEMES COVERED BY THE REPORT

This report covers the updated classification of the ecological status of river water bodies. The classification results for these water bodies should be reviewed and updated in the future as further monitoring is undertaken. Comparing to the previous version of this document, the actual one includes double amount of data that were showing more reliable results for this classification.

In the Annexes, specific recommendations are made for monitoring in Georgia, Armenia, Azerbaijan and Ukraine, based on data collected from the EU Kura Project and the EU EPIRB Project Joint Field Surveys .

Additionally, a renovated proposal is included and presented in order to cover the classification for Caucasic areas and lowland rivers present in the Dnieper River Basin in Ukraine and Belarus, and Prut and small tributaries with seasonal influence in Moldova and the Upper Prut River Basin in Ukraine.

5. OPTIONS FOR THE BASINS

Despite the large number of results/amount of monitoring undertaken in field surveys during 2013, 2014, 2015 and 2016, still more data are needed to develop sound classification systems. River quality classification is a data-hungry process, and to reduce effort and time, it may be necessary to use classification schemes and reference condition data for similar waterbodies in other countries. Reference sites have to be stablished in order to compare the monitoring programs results with the pristine conditions for each waterbody and also all gradient sites have to be checked to cover all the possible situations in the waterbody quality.

6. GENERAL INFORMATION INCLUDED IN EACH OF THE ANNEXES

There are 6 different Annexes with information of the classification scheme related to all the pilot basins of the EPIRB project with updated class definition:

6 Status documents have been prepared for the river basins that are included in EU Kura project, as well as the seven Pilot Basins in the 6 countries of the EU EPIRB project:

- Kura pilots:
  - Khrami River in Georgia
  - Debed River in Armenia
  - Alazani River in Azerbaijan
- EPIRB surveys:
  - Upper Prut River in Ukraine
  - Lowland rivers in Dnieper River Basin (Belarus and Ukraine),
  - Lowland Prut River and small and seasonal tributaries in Moldova

The following sections are included in each document:

Methods and data

Sampling methods

A modified multi-habitat sampling method was used, in accordance with the AQEM/STAR methodology.

Macroinvertebrates community

A summary of available macroinvertebrate data including the overall number of families per order identified in the River basin.

Environmental data

The physico-chemical parameters used in the assessment of the ecological status in the River basin are presented in a table.

Standardised methods were used for the subsequent analysis of the physico-chemical quality parameters. These are explained below.

Hydro-morphological status is based on the hydromorphological field protocol and hydromorphology assessment protocol. Status is quantified using the hydromorphology quality score (HMQS). In general, the characteristics of the river bed, riparian zones and flood plain are assessed using the method.

Selection of biological metrics

Using as a base the definitions of ecological status classes given in Annex V of the WFD, a wide range of different metrics were calculated using AQEM (Asterics) software. From this list, the following six metrics were selected for use on the macroinvertebrate data collected:

Biological Monitoring Working Party Score, Belgium Biotic Indez, Index Biotic E, Ephemeroptera Plecoptera Trichoptera Taxa and Margalef´s Diversity Index***.***

Establishment of the type-specific reference conditions values

In this case a regional approach using the general classification of altitude, geomorphology and geology, has been used for the classification system development.

Analyses of data for each river basin:

Effect of sampling season

Generally, macroinvertebrate data varies between seasons. For this analysis, a Student´s t-test was used for the spring and autumn data sets of the selected metrics to determine whether the results were significantly different from each other.

Variation of selected metrics

Within – type variation

Selected metrics should have low within type variation (less than 30%). It is necessary to study the coefficient of variation among reference sites equal to or less than 30 %. On the other hand, variations of the metrics values in the monitoring locations (impacted sites) should be higher to leave scope for values from highly impacted sites to differ substantially from those in weakly impacted and reference sites within a given water body type.

Detection of impact

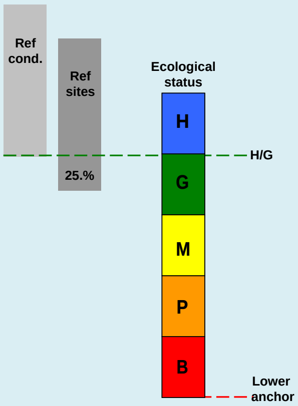
Another important aspect of the selected metrics is that their values should be significantly different between reference condition locations and impacted locations. To evaluate/quantify such a difference, a Student´s t-test was applied to the data sets comparing the reference sites and the monitoring sites.

Metric redundancy

When metrics are selected it is also necessary to test on the redundancy among them, to ensure that they measure sufficiently different responses to environmental variables, such as nutrient enrichment, organic enrichment, heavy metal pollution, etc. This was tested using Pearson correlations between selected metrics.

Class boundaries and classification

In most cases the reference conditions locations have, unavoidably, some degree of human influence, and thus do not fully represent true reference conditions. This is often taken into account by setting the High/Good –boundary (see Figure below) to some percentile (e.g. 25th %tile, 50th %tile) of the distribution of parameter values among the reference sites within a type.



Class boundaries for physico-chemical parameters

Based on the pressure -impact analysis, organic pollution from untreated waste waters, nutrients from agricultural activities and heavy metals from mining industry are recognized as stress factors in all river basins.

Background concentrations

It is important to know the background (natural) concentrations of heavy metals in the river in order to assess the contribution of human activities to the total heavy metals concentrations detected. Background concentrations were calculated using the statistical method based on theoretical log-normal distribution defined by two parameters (mean value μ and standard deviation σ).

Relationship with stressors

Relationships between the 6 selected biological metrics and physico-chemical parameters were tested using Pearson correlation analysis.

Class boundaries for hydromorphological quality elements

Presently used HMQE assessment system (HM Quality Score) is used for the classification in the pilot river basins.

7. CLASSIFICATION SCHEME FOR THE COUNTRIES OF THE EPIRB PROJECT

In the following paragraphs the Classification Schemes with the tables of the boundaries for each country are presented. Additionally, there are 6 complete documents with the procedures and the details of all the calculations done for each River Basin.

7.1 Ecological Status Classification Schemes for the Alazani/Ganikh River basin

The scheme used classifies river water bodies based on: (i) macroinvertebrate status as a biological element, (ii) physico-chemical status and (iii) hydromorphological elements. To establish reference conditions, values and class boundary data from previous surveys in the Alazani/Ganikh River basin (2012 – 2016) were used. Where possible, the estimated reference values and class boundaries are compared with those reported from other EU Member countries.

Because no typology was originally undertaken for the Alazani/Ganikh River basin, the river network was subdivided into three water body groups:

- The Small ´gravel´ mountainous rivers represented by the following sampling locations - *the Batsara - upstream, the Bitdilichay - Yuxari Chardagli and the Qumchay – Qumkendi.*
- The Middle ´gravel´ mountainous rivers represented by the following sampling locations – *the Stori – Lechuri upstream, the Stori – Lechuri downstream, the Gurmukhchay – Ilisu*.
- The Middle ´gravel´ mountainous braided rivers represented by the following sampling locations – *the Kabal – Kabalhesi, the Balakanchay – upstream, the Talachay – upstream, the Meshlek – mouth, the Acchay – Acchay, the Kishchay – Darmaq*.

In the case of the Alazani/Ganikh River basin boundary setting, H/G boundary was set to 25th percentile of type-specific reference value distribution and to illustrate the effect of the H/G-boundary value. LA was set to the approximate theoretical minimum value (i.e. the lowest attainable value („0“)) of the metric and quality classes were evenly spaced within the range LA – G/M class boundary

Based on the previous analysis of the macroinvertebrates data from the JFS in the Alazani/Ganikh River basin (2012 – 2016) the classifications schemes were developed for the Alpine meadows, and small gravel mountainous and middle gravel mountainous river types. Combined data sets (spring and autumn) were used in this process and classification schemes are presented in Table 1-6.

Table 1 Classification scheme for the Middle gravel mountainous river type in the Alazani/Ganikh River basin

	Middle gravel mountainous type				
Class	I	II	III	IV	V
EQR	>0,86	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>95**	**>66**	**>44**	**>22**	**≤22**
EQR	>0,89	>0,6	>0,4	>0,2	≤0,2
BBI	**>8,0**	**>5,2**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,94	>0,6	>0,4	>0,2	≤0,2
IBE	**>8,5**	**>5,4**	**>3,6**	**>1,8**	**≤1,2**
EQR	>0,83	>0,6	>0,4	>0,2	≤0,2
EPT	**>10**	**>8**	**>5**	**>3**	**≤3**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>3,4**	**>2,25**	**>1,4**	**>0,7**	**≤0,7**
Multimetrics Index EQR	**>0,88**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Table 2 Classification scheme for the Middle gravel braided mountainous river type in the Alazani/Ganikh River basin

	Middle gravel braided mountainous type				
Class	I	II	III	IV	V
EQR	>0,8	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>32**	**>24**	**>16**	**>8**	**≤8**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BBI	**>8**	**>5,4**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,94	>0,6	>0,4	>0,2	≤0,2
IBE	**>7,8**	**>4,9**	**>3,3**	**>1,7**	**≤1,7**
EQR	>0,7	>0,6	>0,4	>0,2	≤0,2
EPT	**>6**	**>5**	**>4**	**>2**	**≤2**
EQR	>0,82	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>2,0**	**>1,68**	**>1,12**	**>0,56**	**≤0,56**
Multimetrics Index EQR	**>0,83**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Table 3 Classification scheme for the Small gravel mountainous river type in the Alazani/Ganikh River basin

	Small gravel mountainous type				
Class	I	II	III	IV	V
EQR	>0,82	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>80**	**>59**	**>40**	**>20**	**≤20**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BBI	**>8**	**>5,4**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,93	>0,6	>0,4	>0,2	≤0,2
IBE	**>8,2**	**>5,2**	**>3,4**	**>1,7**	**≤1,7**
EQR	>0,83	>0,6	>0,4	>0,2	≤0,2
EPT	**>9**	**>7**	**>4**	**>2**	**≤2**
EQR	>0,82	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>2,7**	**>1,98**	**>1,32**	**>0,66**	**≤0,66**
Multimetrics Index EQR	**>0,86**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Note: Multimetrics Index EQR values were calculated as averages EQRs values for the selected metrics.

Table 4 Classification scheme for general physico-chemical parameters for Small gravel mountainous river types in the Alazani/Ganikh River basin

Parameter		unit	I	II	III
Temperature	90%-tile	°C	<18	<21	≥21
Conductivity		µS/cm			
pH		-	(7,0; 8,5)	(6,0; 7,0> or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	Min	mg/l	>8,0	>6,0	≤6,0
BOD5	Mean	mg/l	<2,0	<4,0	≥4,0
COD-Cr	Mean	mg/l	<6,0	<15,0	≥15,0
N-NH4	Mean	mg/l	<0,15	<0,5	≥0,5
N-NO3	Mean	mg/l	<1,5	<3,0	≥3,0
P-PO4	Mean	mg/l	<0,03	<0,08	≥0,08

Table 5 Classification scheme for general physico-chemical parameters for Middle gravel mountainous and braided river types in the Alazani/Ganikh River basin

Parameter		unit	I	II	III
Temperature	Mean	°C	<20	<23	≥23
Conductivity		µS/cm			
pH		-	(7,0; 8,5)	(6,0; 7,0> or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	Min	mg/l	>7,0	>6,0	≤6,0
BOD5	Mean	mg/l	<3,0	<5,0	≥5,0
COD-Cr	Mean	mg/l	<7,0	<15,0	≥15,0
N-NH4	Mean	mg/l	<0,15	<0,5	≥0,5
N-NO3	Mean	mg/l	<1,5	<3,0	≥3,0
P-PO4	Mean	mg/l	<0,04	<0,08	≥0,08

Table 6 Classification scheme for other specific pollutants relevant for the Alazani/Ganikh River basin

Parameter		unit	I	II	III
Cu	Mean	µg/l	<5,3	<10,0	≥10,0
Zn	Mean	µg/l	<16,9	<40,0	≥40,0

Table 7 Preliminary boundaries of the hydromorphological quality classes (SHMI, 2004)

Hydromorphological quality class		Limit values		Colour
1	High	1,0 – 1,7		
2	Good	1,8 – 2,5		
3	Moderate	2,6 – 3,4		
4	Poor	3,5 – 4,2		
5	Bad	4,3 – 5,0		

7.2 Ecological Status Classification Schemes for the Debed River basin

The scheme used classifies river water bodies based on: (i) macroinvertebrate status as a biological element, (ii) physico-chemical status and (iii) hydromorphological elements. To establish reference conditions, values and class boundary data from previous surveys in the Debed River basin (2012 – 2016) were used. Where possible, the estimated reference values and class boundaries are compared with those reported from other EU Member countries.

All together data from the following sampling stations were assessed in the Debed River basin with expected reference conditions:

- Alpine meadows rivers – The Pambak River at Khnkoyan and the Dzoraget River - upstream of Katnarat.
- Small gravel mountainous rivers – the Gargar River – upstream of Pushkino, the Garpi River at Tandzut, the Marziget River at Jukhtak and the Shnogh River upstream of Teghut.
- Middle gravel mountainous rivers – the Chqnagh River at Armanis and the Chichkhan River at Shirakamut.

In the case of the Debed River basin, H/G boundary was set to the 25th percentile of the type-specific reference value distribution and to illustrate the effect of the H/G-boundary value, also the 50th percentile (median) was used for comparison for the middle mountainous river type (for small mountainous river type the H/G boundary was set to the 25th percentile). The LA was set to the approximate theoretical minimum value (i.e. the lowest attainable value of the metric and quality classes were evenly spaced within the range LA – G/M class boundary. The results are presented in Tables 8-14.

Table 8 Classification scheme for the middle gravel mountainous river type in the Debed River basin

	Middle gravel mountainous type				
Class	**I**	**II**	**III**	**IV**	**V**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>120**	**>80**	**>53**	**>27**	**≤27**
EQR	>0,89	>0,6	>0,4	>0,2	≤0,2
BBI	**>8,5**	**>5,4**	**>3,7**	**>1,8**	**≤1,8**
EQR	>0,82	>0,6	>0,4	>0,2	≤0,2
IBE	**>8,2**	**>5,4**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,92	>0,6	>0,4	>0,2	≤0,2
EPT	**>12**	**>8**	**>5**	**>3**	**≤3**
EQR	>0,9	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>4,2**	**>2,8**	**>1,9**	**>1,0**	**≤1,0**
Multimetric Index EQR	**>0,88**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Table 9 Classification scheme for the small gravel mountainous river type in the Debed River basin

	Small gravel mountainous type				
Class	**I**	**II**	**III**	**IV**	**V**
EQR	>0,8	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>106**	**>79**	**>53**	**>25**	**≤25**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BBI	**>8**	**>5,4**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,82	>0,6	>0,4	>0,2	≤0,2
IBE	**>7,6**	**>4,6**	**>3,0**	**>1,5**	**≤1,5**
EQR	>0,83	>0,6	>0,4	>0,2	≤0,2
EPT	**>10**	**>7**	**>5**	**>2**	**≤2**
EQR	>0,87	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>3,5**	**>2,4**	**>1,6**	**>0,8**	**≤0,8**
Multimetric Index EQR	**>0,84**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Table 10 Classification scheme for the Alpine meadows river type in the Debed River basin

	Alpine meadows type				
Class	**I**	**II**	**III**	**IV**	**V**
EQR	>0,96	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>102**	**>64**	**>44**	**>22**	**≤22**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BBI	**>8**	**>5,4**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,86	>0,6	>0,4	>0,2	≤0,2
IBE	**>7,7**	**>4,6**	**>3,0**	**>1,5**	**≤1,5**
EQR	>0,9	>0,6	>0,4	>0,2	≤0,2
EPT	**>9**	**>6**	**>4**	**>2**	**≤2**
EQR	>0,82	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>3,5**	**>2,1**	**>1,4**	**>0,7**	**≤0,7**
Multimetris Index EQR	**>0,88**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Note: Multimetric Index EQR values were calculated as averages EQRs values for the selected metrics.

Table 11 Classification scheme for general physico-chemical parameters for Alpine meadows and Small gravel mountainous river types in the Debed River basin

Parameter		unit	I	II	III
Temperature	90%-tile	°C	<18	<21	≥21
Conductivity		µS/cm			
pH		-	(7,0; 8,5)	(6,0; 7,0> or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	Min	mg/l	>8,0	>6,0	≤6,0
BOD5	Mean	mg/l	<2,0	<4,0	≥4,0
COD-Cr	Mean	mg/l	<6,0	<15,0	≥15,0
N-NH4	Mean	mg/l	<0,2	<0,5	≥0,5
N-NO3	Mean	mg/l	<1,5	<3,0	≥3,0
P-PO4	Mean	mg/l	<0,03	<0,08	≥0,08

Table 12 Classification scheme for general physico-chemical parameters for Middle gravel mountainous river types in the Debed River basin

Parameter		unit	I	II	III
Temperature	Mean	°C	<20	<23	≥23
Conductivity		µS/cm			
pH		-	(7,0; 8,5)	(6,0; 7,0> or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	Min	mg/l	>7,0	>6,0	≤6,0
BOD5	Mean	mg/l	<3,0	<5,0	≥5,0
COD-Cr	Mean	mg/l	<7,0	<15,0	≥15,0
N-NH4	Mean	mg/l	<0,2	<0,5	≥0,5
N-NO3	Mean	mg/l	<2,0	<3,5	≥3,5
P-PO4	Mean	mg/l	<0,02	<0,06	≥0,06

Table 13 Classification scheme for heavy metals relevant for the Debed River basin

Parameter		unit	I	II	III
Cu	Mean	µg/l	<1,1	<5,0	≥5,0
Zn	Mean	µg/l	<5,9	<30,0	≥30,0

Table 14 Preliminary boundaries of the hydromorphological quality classes (SHMI, 2004)

Hydromorphological quality class		Limit values	Colour
1	High	1,0 – 1,7	
2	Good	1,8 – 2,5	
3	Moderate	2,6 – 3,4	
4	Poor	3,5 – 4,2	
5	Bad	4,3 – 5,0	

7.3 Ecological Status Classification Schemes for the Khrami River basin

The scheme used classifies river water bodies based on: (i) macroinvertebrate status as a biological element, (ii) physico-chemical status and (iii) hydromorphological elements. To establish reference conditions, values and class boundary data from previous surveys in the Khrami River basin (2012 – 2016) were used. Where possible, the estimated reference values and class boundaries are compared with those reported from other EU Member countries.

All together data from the following sampling stations were assessed in the Khrami River basin with expected reference conditions:

- Alpine meadows rivers – The Pambak River at Khnkoyan and the Dzoraget River - upstream of Katnarat;
- Middle gravel mountainous type - the Khrami River – Khramhesi, the Mashavera River – Dmanisi;
- Small gravel mountainous rivers - the Kldeisi River – Bediani.
  (Note: Due to lack of data from the Khrami River basin also one sampling location as representative for the small gravel mountainous type in the Debed River basin – Shnokh – upstream from Teghut (neighbouring river basin with similarities in habitat conditions was included into the analysis)).

In the case of the Khrami River basin, H/G boundary was set to the 25th percentile of the type-specific reference value distribution and to illustrate the effect of the H/G-boundary value, also the 50th percentile (median) was used for comparison for the middle mountainous river type (for small mountainous river type the H/G boundary was set to the 25th percentile). The LA was set to the approximate theoretical minimum value (i.e. the lowest attainable value of the metric and quality classes were evenly spaced within the range LA – G/M class boundary. The results are presented in Tables 15-21.

Table 15 Classification scheme for the middle gravel mountainous river type in the Khrami River basin

	Middle gravel mountainous type				
Class	**I**	**II**	**III**	**IV**	**V**
EQR	>0,83	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>120**	**>90**	**>62**	**>31**	**≤31**
EQR	>0,9	>0,6	>0,4	>0,2	≤0,2
BBI	**>9**	**>6**	**>4**	**>2**	**≤2**
EQR	>0,9	>0,6	>0,4	>0,2	≤0,2
IBE	**>10**	**>6,6**	**>4,4**	**>2,2**	**≤2,2**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
EPT	**>16**	**>11**	**>7**	**>4**	**≤4**
EQR	>0,78	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>3,68**	**>3,06**	**>2,04**	**>1,02**	**≤1,02**
Multimetrics Index EQR	**>0,86**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Table 16 Classification scheme for the small gravel mountainous river type in the Khrami River basin

	Small gravel mountainous type				
Class	**I**	**II**	**III**	**IV**	**V**

EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>108**	**>74**	**>49**	**>25**	**≤25**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BBI	**>8**	**>5,4**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,98	>0,6	>0,4	>0,2	≤0,2
IBE	**>8,9**	**>5,4**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,73	>0,6	>0,4	>0,2	≤0,2
EPT	**>11**	**>9**	**>6**	**>3**	**≤3**
EQR	>0,77	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>3,3**	**>2,58**	**>1,72**	**>0,86**	**≤0,86**
Multimetrics Index EQR	**>0,85**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Table 17 Classification scheme for the Alpine meadows river type in the Khrami River basin (based on data from the Debed River basin)

	Alpine meadows type				
Class	I	II	III	IV	V
EQR	>0,96	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>102**	**>64**	**>44**	**>22**	**≤22**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BBI	**>8**	**>5,4**	**>3,6**	**>1,8**	**≤1,8**
EQR	>0,86	>0,6	>0,4	>0,2	≤0,2
IBE	**>7,7**	**>4,6**	**>3,0**	**>1,5**	**≤1,5**
EQR	>0,9	>0,6	>0,4	>0,2	≤0,2
EPT	**>9**	**>6**	**>4**	**>2**	**≤2**
EQR	>0,82	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>3,5**	**>2,1**	**>1,4**	**>0,7**	**≤0,7**
Multimetris Index EQR	**>0,88**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Note: Multimetric Index EQR values were calculated as averages EQRs values for the selected metrics.

Table 18 Classification scheme for general physico-chemical parameters for Alpine meadows and Small gravel mountainous river types in the Khrami River basin

Parameter		unit	I	II	III
Temperature	90%-tile	°C	<18	<21	≥21
Conductivity		µS/cm			
pH		-	(7,0; 8,5)	(6,0; 7,0> or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	Min	mg/l	>8,0	>6,0	≤6,0
BOD5	Mean	mg/l	<2,0	<4,0	≥4,0
COD-Cr	Mean	mg/l	<6,0	<15,0	≥15,0
N-NH4	Mean	mg/l	<0,15	<0,5	≥0,5
N-NO3	Mean	mg/l	<1,5	<3,0	≥3,0
P-PO4	Mean	mg/l	<0,03	<0,08	≥0,08

Table 19 Classification scheme for general physico-chemical parameters for Middle gravel mountainous and braided river types in the Khrami River basin

Parameter		unit	I	II	III
Temperature	Mean	°C	<20	<23	≥23
Conductivity		µS/cm			
pH		-	(7,0; 8,5)	(6,0; 7,0> or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	Min	mg/l	>7,0	>6,0	≤6,0
BOD5	Mean	mg/l	<3,0	<5,0	≥5,0
COD-Cr	Mean	mg/l	<7,0	<15,0	≥15,0
N-NH4	Mean	mg/l	<0,2	<0,5	≥0,5
N-NO3	Mean	mg/l	<2,0	<3,0	≥3,0
P-PO4	Mean	mg/l	<0,04	<0,08	≥0,08

Table 20 Classification scheme for other specific pollutants relevant for the Khrami River basin

Parameter		unit	I	II	III
Cu	Mean	µg/l	<1,1	<5,0	≥5,0
Zn	Mean	µg/l	<5,9	<30,0	≥30,0

Table 21 Preliminary boundaries of the hydromorphological quality classes (SHMI, 2004)

Hydromorphological quality class		Limit values	Colour
1	High	1,0 – 1,7	
2	Good	1,8 – 2,5	
3	Moderate	2,6 – 3,4	
4	Poor	3,5 – 4,2	
5	Bad	4,3 – 5,0	

7.4 Ecological Status Classification Schemes for the Upper Prut River basin (Ukraine)

The classification schemes for the group of water body types, for the macroinvertebrate biological element and for physico-chemical and hydromorphological elements (supporting the biological one) were established. To establish reference conditions, values and class boundaries data from Joint Field Surveys (JFSs) in the Upper Prut River basin (2013 – 2016) were used. Where possible, the estimated reference values and class boundaries are compared with those reported from other EU Member countries.

The Prut River basin as defined by the EU WFD, the pilot river basin was subdivided into these groups of water bodies: Small&Middle mid-altitude rivers, Large mid-altitude rivers and High altitude rivers:

- Mountain “stone” type of river in coniferous forest area
- Flood-plain eroded small river with fine substrata (sand, clay)
- Small plain meandering river with fine substrata (mud, silt, clay)

For those groups the reference conditions locations were selected and analysis of the data from JFS was done to develop the ecological status classification schemes (ESCS).

The waterbodies of the region belong to this three categories:

- 10: Carpathians
- 16: Eastern plains
- 12: Pontic province

Based on the previous analysis of the macroinvertebrates data from JFSs in the Prut River basin (2013–2013), classifications schemes were developed for the high-middle mountainous river type and the small mountainous river type. Combined data sets were used in this process. The results are presented in the following tables: 22-24

Note: The classification scheme for the high-middle river type will be further developed when results from the 2015 JFS become available for the middle lowland river type modelling or expert judgement will be used.

Table 22 Classification scheme for the high-middle mountainous of water body type in the Prut River basin

	High-middle mountainous type; Altitude 400–800 m a.s.l.				
Class	**I**	**II**	**III**	**IV**	**V**
EQR	**>0,84**	**>0,60**	**>0,40**	**>0,20**	**≤0,20**
BMWP Score	>121,50	>87	>58	>29	≤29
EQR	**>1**	**>0,60**	**>0,40**	**>0,20**	**≤0,20**
BBI	>9,0	>5,4	>3,6	>1,8	≤1,8
EQR	**>0,83**	**>0,60**	**>0,40**	**>0,20**	**≤0,20**
IBE	>8	>5,78	>3,86	>1,93	≤1,93
EQR	**>0,87**	**>0,60**	**>0,40**	**>0,20**	**≤0,20**
EPT	>15,5	>10,68	>7,12	>3,56	≤3,56
EQR	**>0,95**	**>0,60**	**>0,40**	**>0,20**	**≤0,20**
Margalef's Diversity Index	>4,36	>2,75	>1,83	>0,92	≤0,92
Multimetric Index EQR	**>0,90**	**>0,60**	**>0,40**	**>0,20**	**≤0,20**

Note: Multimetric Index EQR values were calculated as averages EQRs values for the selected metrics.

Table 23 Classification scheme for general physico-chemical parameters

Parameter	unit	I	II	III
Temperature	°C	<23	23-26	≥26
Conductivity	µS/cm	<250	250-500	≥500
pH	-	(7,0; 8,5) or (6,5-8,4)	(6,0; 7,0> or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	mg/l	>9	>8	≤8
BOD$_5$	mg/l	<3	<5	≥5
COD-Cr	mg/l	<10	<20	≥20
N-NH_4	mg/l	<0,25	<1	≥1
N-NO_3	mg/l	<4	<10	≥10
N-PO_4	mg/l	<0,1	<0,3	≥0,3

Table 24 Preliminary boundaries of the hydromorphological quality classes (SHMI, 2004)

Hydromorphological quality class		Limit values	Colour
1	High	1,0 – 1,7	
2	Good	1,8 – 2,5	
3	Moderate	2,6 – 3,4	
4	Poor	3,5 – 4,2	
5	Bad	4,3 – 5,0	

7.5 Ecological Status Classification Schemes for the Upper Dnieper in Belarus and Ukraine River basin

The Dnieper River is 2201 km long, Of its entire length, 485 km (22%) are within Russia, 516 km (23%) within Belarus and 1200 km (55%) within Ukraine,

Dnieper River ranks top in size and water content in the territory of the pilot basin, Main tributaries of the Dnieper in Belarus are: on the left – **Sozh** (648 km long, basin area 21700 km^2); on the right – **Drut** (long, basin area 5020 km^2), **Berezina** (561 km long, basin area 24500 km^2), and **Iput** (437 km long, basin area 10900 km^2),

In Ukraine, the Dnieper River basin is abundant in rivers: the river density is 0,39 km/km2, Main tributaries of the Dnieper in Ukraine are: **Desna** (575 km long in Ukraine, total basin area 88900 km^2); **Teterev** (365 km long, basin area 15100 km^2) and **Uzh** (256 km long, basin area 8080 km^2),

The Upper Dnieper River basin as defined by the EU WFD, the pilot river basin is composed by these groups of water bodies:

- Large plain river with fine substrata (sand/clay/silt),
- Small and medium-size plain rivers (fine substrata, macrophytes, organic - peaty),

Table 25 Classification scheme for the Lowland rivers in Dnieper in Belarus and in Ukraine

	Large and small lowland rivers type; Altitude 80–200 m a,s,l,				
Class	**I**	**II**	**III**	**IV**	**V**
EQR	>0,78	>0,60	>0,40	>0,20	≤0,20
BMWP Score	>128,00	>98,16	>65,44	>32,72	≤32,72
EQR	>0,79	>0,60	>0,40	>0,20	≤0,20
BBI	>7,00	>5,34	>3,56	>1,78	≤1,78
EQR	>0,79	>0,60	>0,40	>0,20	≤0,20
IBE	>7,40	>4,80	>3,20	>1,60	≤1,60
EQR	>0,64	>0,60	>0,40	>0,20	≤0,20
EPT	>7	>6,54	>4,36	>2,18	≤2,18
EQR	>0,80	>0,60	>0,40	>0,20	≤0,20
Margalef's Diversity Index	>4,63	>3,45	>2,30	>1,15	≤1,15
Multimetric Index EQR	**>0,79**	**>0,60**	**>0,40**	**>0,20**	**≤0,20**

Table 26 Classification scheme for general physico-chemical parameters:

Parameter	unit	I	II	III
Temperature	**°C**	<20	<27	≥27
Conductivity	**µS/cm**	<300	<500	≥500
pH	**--**	(7,0; 8,5) or 8,5-7,0	(6,0; 7,0) or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	**mg/l**	>9	>7,5	≤7,5
BOD5	**mg/l**	<3	<6	≥6
COD-Cr	**mg/l**	<10,0	<25	≥25
$N\text{-}NH_4$	**mg/l**	<0,4	<0,9	≥0,9
$N\text{-}NO_3$	**mg/l**	<3,5	<8	≥8
$N\text{-}PO_4$	**mg/l**	<0,2	<0,5	≥0,5

Mean annual concentrations of the physico-chemical parameters (general conditions and other specific pollutants) are recommended to be used to classify ecological status.

Table 27 Preliminary boundaries of the hydromorphological quality classes (SHMI, 2004)

Hydromorphological quality class		Limit values	Colour
1	High	1,0 – 1,7	
2	Good	1,8 – 2,5	
3	Moderate	2,6 – 3,4	
4	Poor	3,5 – 4,2	
5	Bad	4,3 – 5,0	

7.6 Ecological Status Classification Schemes for the Lower Prut River basin with small tributaries (Moldova)

In the JFSs it was decided to use a method combining elements of the first and third of these options. Selection of the potential locations to represent reference conditions involved the following main steps:

- An initial scoping study using maps and historical literature for preliminary identification.
- Pressure – impact analysis results.
- Reconnaissance mission by experts (hydrology, hydrobiology, chemistry).
- Sampling for macro-invertebrates, hydro-morphological quality elements and physicochemical parameters.
- Reassessment of the selected locations based on the data from the first JFSs rounds.
- A second reconnaissance mission to confirm (or otherwise) the locations for reference conditions.

The above steps allowed for more or less adequate selection of sampling locations representative of the specific reference conditions.

Because no typology was originally undertaken for the Lowland Prut River basin and because the quality and the areas of the waterbodies in the lowland part of the River Basin were very similar the river network was analyzed in one water body into two groups:

- Lowland part of Prut river
- Small lowland tributaries of Prut river basin

Table 28 Classification scheme for the Lowland rivers in Lower Prut and small tributaries in Moldova

Lowland rivers (Prut river and small tributaries) in Moldova					
Class	**I**	**II**	**III**	**IV**	**V**
EQR	>0,88	>0,6	>0,4	>0,2	≤0,2
BMWP Score	**>62**	**>42,5**	**>28,3**	**>14,16**	**≤14,16**
EQR	>0,94	>0,6	>0,4	>0,2	≤0,2
BBI	**>7**	**>4,4**	**>3,0**	**>1,5**	**≤1,5**
EQR	>1	>0,6	>0,4	>0,2	≤0,2
IBE	**>7**	**>4,2**	**>2,8**	**>1,4**	**≤1,4**
EQR	>0,75	>0,6	>0,4	>0,2	≤0,2
EPT	**>3**	**>1,2**	**>0,8**	**>,4**	**≤0,4**
EQR	>0,90	>0,6	>0,4	>0,2	≤0,2
Margalef's Diversity Index	**>1,8**	**>1,2**	**>0,8**	**>0,4**	**≤0,4**
Multimetrics Index EQR	**>0,89**	**>0,6**	**>0,4**	**>0,2**	**≤0,2**

Table 29 Classification scheme for general physico-chemical parameters:

Parameter	unit	I	II	III
Temperature	°C	<26	26-28	≥28
Conductivity*	µS/cm	<500	<700	≥700
pH	-	(7,0; 8,5)	(6,0; 7,0> or <8,5; 9)	≤ 6,0 or ≥ 9,0
Dissolved oxygen	mg/l	>8	>7	≤7
BOD_5	mg/l	<3	<5	≥5
COD-Cr	mg/l	<10	<25	≥25
$N\text{-}NH_4$	mg/l	<0,2	<0,5	≥0,5
$N\text{-}NO_3$	mg/l	<3,5	<6	≥6
$P\text{-}PO_4$	mg/l	<0,15	<0,3	≥0,3

Mean annual concentrations of the physico-chemical parameters (general conditions and other specific pollutants) are recommended to be used to classify ecological status.

Table 30 Preliminary boundaries of the hydromorphological quality classes (SHMI, 2004)

Hydromorphological quality class		Limit values	Colour
1	High	1,0 – 1,7	
2	Good	1,8 – 2,5	
3	Moderate	2,6 – 3,4	
4	Poor	3,5 – 4,2	
5	Bad	4,3 – 5,0	

8. CONCLUSIONS AND RECOMMEDATIONS

The document presented provides specific guidance on the role of the classification of the ecological status using biological elements, general physico-chemical quality and hidromorphological parameters.

During the EPIRB Project 2012-2016 many data have been collected in the field and that information was used to develop this new approach of Ecological Status Classification for the River Basins of the EPIRB project.

The recommendation of the EU for Ecological Classification for rivers includes:

- Composition and abundance of aquatic flora
- Composition and abundance of benthic invertebrate fauna
- Composition, abundance and age structure of fish fauna

The authors of this document decided to include only in this exercise for ESCS the group of macroinvertebrates for the biological evaluation. The EU members must monitor parameters indicative of the condition of biological quality, using the combination of different biological elements in order to create the strongest and reliable system as possible. Combining parameters can help reduce the risk of misclassification by improving confidence in the assessment. 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.[2]

Related with this needs, during 2015 and 2016 some macrophytes were sampling and including into the routine for collecting and analysing the data, that was included into the JFS. However, the teams and the results achieved were not ready and enought for including these results into this Classification Scheme.

It is necessary to reinforce the idea of including more biological elements as macrophytes and phytobethos in the future in the monitoring programs and to increase the frequency in twice per year (spring/autumn) to cover the whole vegetative cycle.

Also, this is a first approach for the category of rivers but it is necessary to develop the scheme for lakes, artificial waters and heavily modified water bodies.

With this document, the authorities have achieved an acceptable level of confidence and precision for assigning water bodies to an appropriate class. In the future, the estimates of the level of confidence and precision of the results will be updated into the Plan and the future Plans.

[2] COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE (2000/60/EC) Guidance Document No 13 Overall Approach to the Classification of Ecological Status and Ecological Potential Produced by Working Group 2A