UK Technical Advisory Group on the Water Framework Directive

Guidance on selection of risk assessment criteria in relation to biological classification schemes for rivers. (Working Draft)

This Guidance Paper is a working draft defined by the UKTAG. It documents the principles to be adopted by agencies responsible for implementing the Water Framework Directive (WFD) in the UK. This method will evolve as it is tested, with this working draft amended accordingly.

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			Updated for risk categories 13//03

1. Purpose of this Paper

1.1 The paper sets out UKTAG's guidance on the framework for the identification of, and assessments of 'type-specific' risk thresholds for deciding if a water body is likely to fail to achieve the 'good status' objectives in relation to existing biological classification schemes and monitoring data for rivers.

1.2 This approach will be adapted and applied by the environment and conservation agencies to achieve a consistent and effective approach to the use of existing environmental monitoring data and other relevant information in assessing the risk that river water bodies will fail to achieve the Directive's environmental objectives.

2.0 The Directive's requirements

2.1 As part of a review of the impact of human activity on the status of surface waters (the pressures and impacts analysis), Article 5 and Annex II of the Water Framework Directive require Member States to:

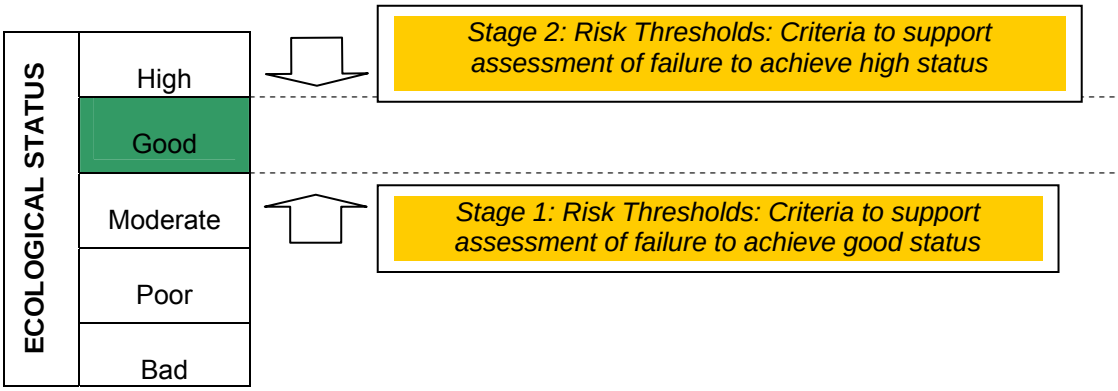
(a) collect and maintain information on the type and magnitude of the significant pressures to which surface water bodies in each River Basin District are liable to be subject; and

(b) carry out an assessment of the risk that surface water bodies will fail to meet the Directive's environmental objectives.

2.2 Member States must complete the first reviews of the impact of human activity by 22nd December 2004, and report the results to the Commission by 22 March 2005. The reviews are therefore urgent priority tasks in the implementation of the Directive.

2.3 The risk characterization process will define the boundaries around 'good status' recognizing the WFD's objective to *Protecting, enhancing and restoring all non-artificial surface water bodies with the aim of achieving good ecological status and good surface water chemical status by 22nd December 2015*.

2.3.1 The first stage (and this paper) is limited to the provision of thresholds which might be used to **assess the risk of failing to meet Good Status** (ie the lower boundary of the good status class.)



2.3.2 Stage 2 will continue to expand these threshold criteria to **encompass risk of failing to meet High Status** and, again, the relevant ecological criteria will be addressed in the classification tool development projects (refer Section 9 for further research requirements).

3. General approach & relationship with other UKTAG guidance

3.1 The UKTAG's Rivers Task Team (RTT) has assembled existing criteria from a variety of sources, including current river quality classification schemes, and described how these values might be used in the risk assessment process. These river quality systems include:

- Environment Agency's (EA) General Quality Assessment (RQA) River Classification applied in England and Wales
- Scottish Environment Protection Agency's (SEPA) River Classification for Scotland
- other national classification systems, including RIVPACs.

3.2 This revised version (version 9.P1) takes into account comments received at UKTAG Dublin on 5th June 2003 and subsequent discussions between UKTAG RTT members as well as UKTAG London discussions with respect to risk categories (25th November 2003).

3.3 This guidance is related to and should be read in association with, other guidance documents produced by UKTAG drafting groups. The principles identified with Task 7.a *Guidance on the general principles of pressures and impacts analyses* apply with regards to its use, consistency, risk management & local decision-making within agencies and has been applied to the method outlined in this guidance.

4. Content of this paper

The content of this paper includes:

- limitations of the approach (in terms of confidence of approach (Section 5)
- general approach to characterisation and risk categorisation (Section 6 & Section 8)
- alignment of risk categories with river classification schemes (Section 7.1)
- confidence in biological thresholds (Section 7.2)
- further research requirements (Section 9)

5. Limitations

The method outlined in this document is regarded as an iterative approach that will be improved over time as enhanced data and classification methods become available. The initial risk assessment processes allows for broader classification of risk using existing data where possible but improvements in methodology will be required as outlined in Section 9.0.

5.1 Status of Risk Thresholds

5.1.1 The risk thresholds presented here vary considerably in their derivation. While those criteria derived from current river classification schemes are well established and validated against very large datasets the thresholds have not been designed specifically for use in risk assessment in relation to WFD status boundaries. Some other biological thresholds are considered to be largely derived through expert judgement. **Most proposed criteria require testing and validation** and it is strongly recommended that this is carried out before final adoption as risk assessment thresholds in the characterisation process. Ecological criteria will be validated within the classification tool development projects.

5.1.2 Additional criteria could be developed from other existing datasets but require significant work to establish the relationship between the pressures and impacts. These **potential** criteria have been listed under each relevant biological quality element.

5.2 WFD Objectives: This paper is limited to the provision of thresholds which might be used to assess the risk of failure to meet Good Status. Work is continuing to expand these criteria to encompass risk of failing to meet High Status. Subject to acceptance of the principles outlined in section 4., it is already possible to apply SEPA and EA classification schemes to assess the risk of failing High Status if the current highest class boundaries are assumed to align with the WFD high/good boundary. In addition, it is likely that non-compliance with the guideline standards for the EC Fresh Water Fisheries Directive can be used to assess risk of failure to meet high status.

5.3 Type sensitivity: Available data does not support differentiation of criteria into any detailed type sensitivity thresholds and this would require comprehensive analysis of extensive datasets:

- A very broad type categorisation has been assigned where appropriate (eg. MTR, TDI and Phosphorus) which aligns with the UK river typology.
- RIVPACS quality ratios are derived from site-specific data and it is not appropriate to attempt to define type sensitivity in this case.
- The physio-chemical criteria associated with river classification schemes (BOD, DO and ammonia) have been extracted and tabulated separately since they relate to use of current schemes for risk assessment but are likely to have some degree of type-sensitivity which has not yet been determined.

5.4 Confidence of risk assessment thresholds: The thresholds derived are for use in risk assessment and are likely to be more precautionary, criteria than those eventually used for classification. However, the criteria derived from current river classification schemes utilize the approximate alignment of SEPA/EA GQA river quality class boundaries with the Directive High/Good and Good/Moderate boundaries (refer 5.1).

Two aspects of the confidence we have placed in the risk assessment thresholds are considered:

- Use of the existing river quality class information
- Confidence in biological impact thresholds derived from other sources

6. General risk categories and pressures

6.1 The purpose of initial screening is to characterise water bodies into one of three risk categories to decide if a water body **will fail to achieve the WFD's environmental objective of 'good status'**. Guidance 7a sets out the risk categories with respect to identifying water bodies at risk of failing to meet an environmental objective as per the table below:

WFD Risk Category	UKTAG Reporting Category
1. Water bodies at risk of failing to achieve an environmental objective	**(1.a) Water bodies at significant risk** *Note: Identifies water bodies for which consideration of appropriate measures can start as soon as practical*
	(1.b) Water bodies probably at significant risk but for which further information will be needed to make sure this view is correct *Note: Focus for more detailed risk assessments (including, where necessary, further characterisation) aimed at determining whether or not the water bodies in this category are at significant risk in time for the publication of the interim overview of significant water management issues in 2007*
2. Water bodies not at risk of failing to achieve an environmental objective	**(2.a & 2.b) Water bodies not at significant risk on the basis of available information** **(2.a) Water bodies for which confidence in the available information being comprehensive and reliable is low** *Note: Work on these water bodies will be focused on appropriately improving the quality of information on pressures and their likely environmental effects in time for the second pressures and impacts analysis due to be completed in 2013*
	(2.b) Water bodies for which confidence in the available information being comprehensive and reliable is high *Note: Review for the next pressures and impacts analysis report in 2013 to identify any significant changes in the situation*

6.2 The pressures that may impact on rivers will be assessed in first stage of this process include:

- Organic Pollution;
- Eutrophication;
- Acidification; and
- Multiple pressures (ie. affecting general ecological health with fish as bio-indicator species)

7.0 Classification schemes and associated levels of confidence

7.1 Use of existing River Classification information

7.1.1 **Current classification criteria:** (the EA GQA and SEPA River Classification) already provide well-established criteria for assigning quality classes. These criteria have been presented here to assist with risk assessment by aligning current class to risk categories (see Table 1) on the basis that the WFD good/moderate boundary has been assumed to be that between A2/B (SEPA) and b/c (EA GQA). A rationale for linking this class boundary with WFD normative definitions for the good/moderate boundary is presented in Annex 2.

Table 1: Alignment of current classification criteria with risk of failing Good Status

Risk category	SEPA Classification		EA GQA Classification	
	Class	**Descriptor**	**Class**	**Descriptor**
Not at risk	A1	Excellent	A	Very good
Not at risk	A2	Good	B	Good
At risk	B	Fair	C	Fairly good
At risk	CD	Poor, Seriously polluted	Def	Fair, Poor, Bad

7.1.2 **Confidence of risk assessment thresholds:** For the confidence associated with the first risk assessment that any riverine water body might fail the good status objective (based on

alignment of the A2/B or b/c class boundaries with the good/moderate boundary of the Directive) we can use the confidence of class information.

In assessing the confidence of risk assessment a distinction is drawn between the thresholds derived from the current river classification schemes and those from other sources.

7.1.3 SEPA/EA GQA River Classification Confidence levels: The river classification schemes used by SEPA and the EA have associated "confidence of class" statistics ie. a set of probabilities that a river stretch is in any particular class. Issues of class confidence have been dealt with more comprehensively by the UKTAG Classification Drafting Group (Water Framework Directive: avoiding mistakes in classifying water bodies. Warn et al., 10th March, 2003).

For the confidence associated with the first risk assessment that any riverine water body might fail the good status objective (based on alignment of the A2/B or b/c class boundaries with the good/moderate boundary of the WFD) we can use the confidence of class information (refer Table 2)

Table 2 Confidence associated with risk category (applied to failure of good status objective)

Risk Category	Probability of true class being lower than A2 or b
At risk	> 95%
Probably at risk	> 50%
Not at risk	< 50%

Note: Lack of confidence may arise from:

- where UK river classifications (eg. SEPA) have components have no confidence of class information eg. biological class; or
- expert judgment might have to be used to take account of situations where multiple risk category stretch lengths need to be combined into a single water body risk assessment; or
- where recent known changes in quality are not yet showing as statistically significant change.

In such cases, a combined method also using stability of face value class as a rapid screen to target water risk assessments may also be considered. Table 3 provides a practical example describing an interim set of rules drafted by SEPA where there is lower certainty in the risk assessment.

Table 3 SEPA Use of Existing River Class Information in Risk Assessment

Issue: Lack of confidence on for any water body on the river classification network and for river class information for the years 2000, 2001 and 2002
Solution: Interim set of rules drafted by SEPA using distance from good/moderate boundary and class stability, which allows for reference back to more detailed confidence of class information where there is lower certainty in the risk assessment.

River class in 3 years:	Risk Category	Certainty	Note
Always A1 or A2	Not at risk		
At least one B	Probably at risk	M, L	1
Always B	At risk	H, M, L	2
At least one C or D	At risk	H	3

1. Confidence of class information should be used to assist in determining the level of certainty.
2. Where the confidence of class information shows a significant probability of C or A2 the certainty of being "at risk" is high or low respectively.
3. Exceptions may occur eg. class C as a result of an EQS failure due to the hardness of water and the level of certainty may be medium or low where it is likely that the classification scheme is not sensitive enough to distinguish natural effects.

7.2 Biological Metrics

7.2.1 The **annex tables (1.A. (i) - (ii), and 1.B (i) – (iii)) draw out the metrics used for biological elements** (RIVPACS metrics) and those chemical parameters considered to be directly related to the biological criteria. Confidence in these thresholds as indicators of the risk of failing good status varies in accordance with expert views on the reliability of the parameter for this purpose.

7.2.2 **Biological datasets and thresholds** used are:

(a) Calibrating Mean Trophic Rank (MTR) for setting thresholds for Eutoprhication pressures utilizing:

- JNCC Community types in their river types systems; or
- Utiling MTR manual fo screening process as per the MTR R&D Manual

(b) Using UK expert judgement for some biological quality elements (e.g. macro-invertebrates) and phyto-plankton where limited data sets are available to assess eutrophication pressures

(c) using fish as general indicator of health against Multiple pressures (eg…) using:

- chemical parameters defined by the European Commission Fresh Water Fish Directive;
- UK expert judgement to assess fish metrics thresholds and data (ie composition, age class & abundance)

Annex 1 tabulates risk assessment thresholds under each pressure for each biological quality

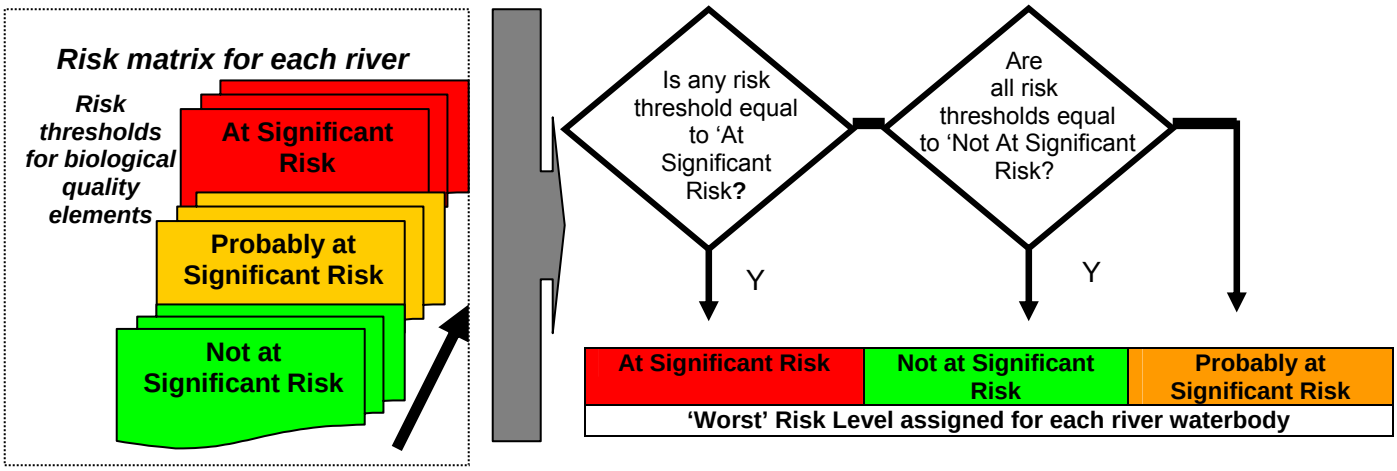
7.2.2 Confidence in biological impact thresholds not derived from river classification schemes:
For each of the parameters in Annex 1, a broad indication of confidence in the proposed risk threshold for a parameter has been given reflecting how well the relationship between a pressure and the impact has been demonstrated using good datasets:

- where possible, thresholds have been proposed for all three risk categories: High, Medium or Low.
- For some biological quality element metrics (eg. diatom TDI) this has not been considered appropriate because of the state of expert knowledge. In such cases a simple “at risk” and “not at risk” threshold has been given.

Where thresholds have been proposed for the “probably at risk” category these have often been derived through an expert judgment of the range of metric values indicative of the pressure and might have a lower confidence than the thresholds for “at risk” and “not at risk” since they represent more extreme ends of the range.

8. Using Multiple Risk Thresholds for Risk Assessment.

8.1 In assessing the risk of failure for any riverine water body all of these pressure-impact risk thresholds should be applied where appropriate. A water body then defaults to the worst risk categorisation derived from any appropriate threshold applied (see figure below)



8.2 It is important, however, to take into account the confidence placed in the relevant threshold. "Medium" and especially "Low" confidence criteria should not be used alone to finalise the risk categorisation but rather in combination with other information.

8.3 Risk Threshold Template

Annex 1 tabulates suggested risk assessment thresholds based on identical format for each biological quality element metric (IMPACT criteria) and for relevant associated physico-chemical or hydromorphological criteria (EXPOSURE pressure). Each table identifies the relevant:

- Biological quality element
- Biological quality element metric threshold (IMPACT)
- Physico-chemical/hydromorphological threshold (EXPOSURE pressure)
- Other potential pressures/ metrics under development.

A summary of available threshold criteria is provided in Table 4 with a reference to the relevant tables in Annex 1.

Table 4. Summary of Threshold Criteria Tables for Assessing Risk of Failing Good Status

Pressure	Biological Quality element	Metric or associated Pc/hm element	IMPACT/ PRESSURE	Annex 1 Table ref.
Organic pollution	Macroinvertebrates	RIVPACS ASPT	IMPACT	1.A.i
		RIVPACS NTAXA	IMPACT	1.A.ii
		Biochemical Oxygen Demand (BOD)	PRESSURE	1.B.i
		Dissolved Oxygen (DO)	PRESSURE	1.B.ii
		Ammonia	PRESSURE	1.B.iii
Eutrophication	Macrophytes	Mean Trophic Rank (MTR)	IMPACT	2.A.i (1) & (2)
		Sol. Reactive Phosphorous	PRESSURE	2.B.i
	Diatoms	Trophic Diatom Index	IMPACT	3.A.i
	Phytoplankton	Chlorophyll	IMPACT	4.A.i
Acidification	Diatoms	Species Composition	IMPACT	5.A.i
		PH	PRESSURE	5.B.i
Multiple/ Pressures on General Ecological Health	Fish	Species absence	IMPACT	6.A.i
		Abundance	IMPACT	6.A.ii
		Age class	IMPACT	6.A.iii
		Physio-chemical elements	PRESSURE	6.B.i

9.0 Further research requirements

9.1 **Validating Criteria and thresholds in Annex 1**: Recognizing the iterative approach characterisation and classification when implementing the WFD, most:

- It is strongly recommended that proposed criteria in Annex 1 are tested and validated before final adoption as risk assessment thresholds in the characterisation process.
- Ecological criteria will be validated within the classification tool development projects

9.2 Expanding types of threshold criteria for assessing risk of failing to meet good status:

Additional criteria could be developed from other existing datasets (such as using macro-invertebrates to assess acidification pressures) but require significant work to establish the relationship between the pressures and impacts. These potential criteria have been listed under each relevant biological quality element in Annex 1.

9.3 **Type sensitivity:** Available data does not support differentiation of criteria into any detailed type sensitivity thresholds and this would require comprehensive analysis of extensive datasets

9.4 **Expanding threshold criteria to encompass risk of failing to meet High Status,** noting:

- classification tool development projects identify and improve the relevant ecological criteria
- subject to acceptance of the limitations outlined in section 4.0 and the principles outlined in section 7.0. it is already possible to apply SEPA and EA classification schemes to assess the risk of failing High Status if the current highest class boundaries are assumed to align with the WFD high/good boundary.

It is likely that non-compliance with the guideline standards for the EC Fresh Water Fisheries Directive can be used to assess risk of failure to meet high status.

Annex 1

Risk Thresholds for failing Good Status

Approach:

Outlined below under each of the PRESURES are:

(a) Summary identifying the pressure:
   a. Biological quality element;
   b. cross-referencing to risk assessment threshold tables:
      - Biological quality element metric threshold (IMPACT); and
      - Physico-chemical/hydromorphological threshold (EXPOSURE pressure);
      - Other potential pressures/ metrics under development (if any).

(b) Risk assessment threshold tables providing suggested thresholds based on identical format for each biological quality element metric (IMPACT criteria) and for relevant associated physico-chemical or hydromorphological criteria (EXPOSURE pressure).

1. Pressure: Organic pollution

1.1 Biological quality element Macroinvertebrates

Thresholds	Table Reference
Biological quality element metric threshold (IMPACT)	**Table 1.A.i** RIVPACS Average Score per Taxon **Table1.A.ii** RIVPACS Number of Taxa
Physico-chemical threshold (EXPOSURE pressure)	**Table 1.B.i** Biochemical Oxygen Demand (mg/l)(90%ile) **Table 1.B.ii** Dissolved Oxygen (%sat)(10%ile) **Table 1.B.iii** Ammonia (mg/l)(90%ile)
Other potential pressures/ metrics under development	**Toxic effects of pesticides:** o An index of macroinvertebrate response to the toxic effects of pesticides has been developed by the EA but not yet sufficiently validated for use as reliable risk assessment criteria. **Acidification** o Macroinvertebrates in rivers are known to respond to acidification but there is no accepted classification scheme for identifying ecological status. o Indices of acidification have been developed by EA and SEPA but have not been tested or validated and are not included yet as risk criteria for good status. o Refer Annex 2 for a description of how WFD normative definitions can be used to infer the degree of impact on Macroinvertebrates at the good/moderate boundary. **Flow modification** o Macroinvertebrates are believed to respond to flow modification but there is no validated classification method available. LIFE (an index being developed in the EA) scores require to be further tested before use as reliable risk assessment criteria.

Risk Threshold Assessment Tables

Table 1.A.i RIVPACS Average Score per Taxon

Risk Category	Threshold values for parameter	Threshold Confidence	Source data
Not at risk	≥ 1.00	H	GQA/SEPA Class a/A1
Not at risk	0.90 – 0.99	H	GQA/SEPA Class b/A2
At risk	0.77 – 0.89	H	GQA/SEPA Class c/B
At risk	< 0.77	H	GQA/SEPA Class def/CD
Note: See 4.1 for application of class confidence to risk categories			

Table 1.A.ii RIVPACS Number of Taxa

Risk Category	Threshold values for parameter	Threshold Confidence	Source data
Not at risk	≥ 0.85	H	GQA/SEPA Class a/A1
Not at risk	0.70 – 0.84	H	GQA/SEPA Class b/A2
At risk	0.55 – 0.69	H	GQA/SEPA Class c/B
At risk	< 0.55	H	GQA/SEPA Class def/CD
Note: 1. See 4.1 for application of class confidence to risk categories *2. The lowest of both 1.A.i and 1.A.ii thresholds should be used to assess risk.*			

Table 1.B.i Biochemical Oxygen Demand (mg/l)(90%ile)

Risk Category	Threshold values for parameter	Threshold Confidence	Source data
Not at risk	≤ 2.5	H	GQA/SEPA Class a/A1
Not at risk	2.6 – 3.9	H	GQA/SEPA Class b/A2
At risk	4.0 – 5.9	H	GQA/SEPA Class c/B
At risk	> 6.0	H	GQA/SEPA Class def/CD
Note: See 4.1 for application of class confidence to risk categories			

Table 1.B.ii Dissolved Oxygen (%sat)(10%ile)

	Threshold values for parameter	Threshold Confidence	Source data
Not at risk	≥ 80	L	GQA/SEPA Class a/A1
Not at risk	70 – 79	L	GQA/SEPA Class b/A2
At risk	60 – 69	L	GQA/SEPA Class c/B
At risk	<60	L	GQA/SEPA Class def/CD
Note: *1. Note: See 4.1 for application of class confidence to risk categories* *2.Spot measurements of DO can be unreliable for classification, especially in relation to downstream nutrient enrichment, unless diurnal variability has been taken into account.*			

Table 1.B.iii Ammonia (mg/l)(90%ile)

	Threshold values for parameter	Threshold Confidence	Source data
Not at risk	≤ 0.25	H	GQA/SEPA Class a/A1
Not at risk	0.26 – 0.60	M	GQA/SEPA Class b/A2
At risk	0.61 – 1.29	M	GQA/SEPA Class c/B
At risk	>1.30	H	GQA/SEPA Class def/CD
Note: See 4.1 for application of class confidence to risk categories			

2.Pressure: Eutrophication

2.1 Biological quality element	Macroinvertebrates
Thresholds	**Table Reference**
Biological quality element metric threshold (IMPACT)	**Table2.A.i (1&2)** Mean Trophic Rank (MTR) Scores o Option 1: applied where JNCC community type unknown or not applicable. o Option 2: Risk in relation to JNCC community type.
Physico-chemical threshold (EXPOSURE pressure)	**Table 2.B.i** Phosphorus threshold values (mg/l Soluble Reactive Phosphorus)
Other potential pressures/ metrics under development	**Flow modification** A module in CAMs holds data on flow sensitive macrophyte species.

Risk Threshold Assessment Tables

Table 2.A.i(1) Mean Trophic Rank (MTR) Scores - Option 1: Applied where JNCC community type unknown or not applicable.

Risk category	Low productivity-Organic/ Siliceous	Moderate/High productivity-Calcareous.	Threshold Confidence	Source data
Not at risk	>75	>55	M	MTR R&D Manual Dawson et al. 1999
Probably at risk	55 - 75	35 - 55	L	MTR R&D Manual Dawson et al. 1999
At risk	<55	<35	M	MTR R&D Manual Dawson et al. 1999
Note: MTR works best as a tool for comparison of sites upstream and downstream of a nutrient source. It is recommended: (i) that the thresholds in Table 2.A.i should be applied to any appropriate site as a screening method to assess absolute risk of failure; and (ii) where u/s and d/s site data is available of a nutrient source use a comparison method to assess impact. (see MTR manual).				

Table2.A.i(2) Mean Trophic Rank (MTR) Scores -Option 2: Risk in relation to JNCC community type.
(ie Relationship between MTR Scores and JNCC River Types. After Dawson et al. 1999.)

River Community Type	Description	Mean MTR	Top 10% ile MTR boundary[1]
I	Lowland rivers with minimal gradients. Predominantly in S and SE England. Generally eutrophic, base-rich, stable flows	34.0	Tba
II	Clay dominated rivers. Eutrophic, often species-poor	32.9	Tba
III	Chalk and soft limestone rivers	40.2	Tba
IV	Rivers with impoverished floras, usually impacted. **SHOULD USUALLY BE NO HIGHER THAN MODERATE STATUS OR HMWB**	39.5	Tba
V	Rivers of hard limestone or sandstone, usually in SW England and Wales. Substrates usually mixed coarse gravels, sands and silts interspersed with cobbles and boulders.	47.6	Tba

River Community Type	Description	Mean MTR	Top 10% ile MTR boundary[1]
VI	Rivers of hard limestone or sandstone, usually in Scotland or N England. Substrates usually mixed coarse gravels, sands and silts interspersed with cobbles and boulders.	46.2	Tba
VII	Mesotrophic rivers where fine sediments occur in between boulders and cobbles, so a mix of bryophytes and higher plants is typical.	52.9	Tba
VIII	Oligo-mesotrophic, fast-flowing rivers where boulders are common and bryophytes typify the plant assemblages.	68.1	Tba
IX	Oligotrophic Rivers of mountains and moorlands where nutrient and base levels are usually low; gradient not necessarily high	68.8	Tba
X	Ultra-oligotrophic rivers in mountains, or streams flowing off acid sands; usually bedrock and boulders	83.0	Tba

Note: 1. Top 10%ile boundary figures available from CEH (not yet available at this issue date)

Notes on interpreting MTR Data in Option 2.

- Low MTR scores indicate eutrophication. In general, the top 10% of sites for each type will represent examples that are **not at risk** from eutrophication
- Sites with a below average MTR for their type are **at risk** of failing good ecological status.
- Sites with an MTR score between the community type mean and the 10%le boundary are **probably at risk** from eutrophication.
- Type IV are mostly rivers impacted by canalisation etc and have impoverished floras. MTR scores are likely to have low confidence.
- In base-poor types (especially VIII and X), high MTR values (>85) may be indicative of acidification.
- Significant eutrophication may lead to apparent shifts in River Community Type as well as declines in MTR score. The following are particularly likely

Original Type	*Impact*	*New Type*
III	Eutrophication	I
II	Canalisation / Eutrophication	IV
IX	Eutrophication	VII
VIII	Acidification	X
I	Eutrophication	II

Note: Method adopted in Northern Ireland

Due to the geographical isolation of the island of Ireland, the number of species of aquatic macrophytes is limited compared to mainland Britain. Therefore the criteria in UK TAG paper are not relevant to the ecoregion. Therefore alternative thresholds will be applied to NI water-bodies which are: • NVZ consistent • Used routinely in NI for trophic status studies Assessments for nutrients will be made according to UKTAG guidance 7f. The thresholds have not been reviewed to take account of typology.	MTR > 65 MTR 25-65 MTR< 25	Not at risk Probably at risk At risk.

Table 2.B.i Phosphorus threshold values (mg/l Soluble Reactive Phosphorus)

Risk Category	Low Productivity (Organic/Siliceous)	Threshold Confidence	Moderate/High Productivity (Calcareous)	Threshold Confidence	Source data
Not at risk	< 0.02	H	< 0.06	M	Phillips et al (modified)
Probably at risk	0.02 – 0.04	M	0.06 – 0.10	M	Phillips et al (modified)
At risk	> 0.04	H	> 0.10	M	Phillips et al (modified)

Notes
1. The above values are arithmetic means calculated over a three-year period.
2. Division into geological types is based on maps supplied by BGS.
3. Type sensitivities as defined in Philips et al.
4. Total P may be a more relevant parameter in slow flowing rivers.
5. Given the precautionary nature of these Phosphorus thresholds agencies may need to consider local factors such as nutrient spiraling when applying them to lower sections of large rivers

2.Pressure: Eutrophication

2.2 Biological quality element	Diatoms
Thresholds	**Table Reference**
Biological quality element metric threshold (IMPACT)	**Table 3. A.i** Trophic Diatom Index (TDI) Scores
Physico-chemical threshold (EXPOSURE pressure)	**3.B.i** Phosphorus threshold values (mg/l Soluble Reactive Phosphorus) (same as Table 2.B.i, cross-reference)
Other potential pressures/ metrics under development	N/A

Table 3. A.i Trophic Diatom Index (TDI) Scores

Risk Category	Low Productivity (Organic/Siliceous)	Moderate/High Productivity (Calcareous)	Threshold Confidence	Source Data
At Risk	>50	>70	M	J.Jamieson/C.R. Doughty
Probably at risk	41-49	61-69	M (Mod/High Prod.) L (Low Prod.)	J.Jamieson/C.R. Doughty
Not at risk	≤40	≤60	M	J.Jamieson/C.R. Doughty

Notes
1. For low productivity rivers: TDI >40 and the presence of Cladophora or Vaucheria is a better indication of failure of good status than TDI alone. TDI ≤40 and presence of Lemanea or Batrachospermum or Hildenbrandia is a better indication of good ecological status than TDI alone.
2. For mod/high productivity rivers: TDI ≤60 and absence or low abundance of Cladophora or Vaucheria is a better indication of good status than TDI alone. TDI >60 and absence of red algae is a better indication of failure of good status than TDI alone.

2.Pressure: Eutrophication

2.3 Biological quality element	Phytoplankton
Thresholds	**Table Reference**
Biological quality element metric threshold (IMPACT)	**Table 4.A.i** Chlorophyll 'a'
Physico-chemical threshold (EXPOSURE pressure)	**4.B.i** Phosphorus threshold values (mg/l Soluble Reactive Phosphorus) (same as Table 2.B.i, cross-reference)
Other potential pressures/ metrics under development	N/A

Table 4.A.i Chlorophyll 'a'

	Threshold values for parameter (ug/l)	Threshold Confidence	Source data
	Lowland slow-flowing rivers		
Not at Risk	<25	M	UK UWWTD guidance
At risk	≥25	M	UK UWWTD guidance
Notes: 1. Arithmetic mean values. 2. For lowland, slow flowing rivers, chlorophyll 'a' value may be a better measure of biological response than MTR or TDI.4. B.i Phosphorus threshold values (mg/l Soluble Reactive Phosphorus)			

3.Pressure: Acidification

3.1 Biological quality element	Diatoms
Thresholds	**Table Reference**
Biological quality element metric threshold (IMPACT)	**Table 4.A.i** Diatom Species Composition
Physico-chemical threshold (EXPOSURE pressure)	**Table 4.B.i** pH
Other potential pressures/ metrics under development	N/A

Table 4.A.i Diatom Species Composition

Risk Category	Threshold values for parameter	Threshold Confidence	Source data
Not at risk	0 - 10% acid tolerant species present.	M	J.Jamieson
Probably at risk	10 – 20% acid tolerant species present.	L	J.Jamieson
At risk	>20% acid tolerant species present.	M	J.Jamieson
Notes 1. Thresholds derived from expert judgement			

Table 4.B.i pH

Risk Category	Threshold values for parameter	Threshold Confidence	Source data
Not at risk	10%ile ≥5.2	M	SEPA Classification, 1997
At risk	10%ile <5.2	M	SEPA Classification, 1997

3.Pressure: Multiple- or General Ecological Health

3.1 Biological quality element	Fish
Thresholds	**Table Reference**
Biological quality element metric threshold (IMPACT)	**Table5.A.i** Species composition **Table5.A.ii** Expected Age Class **Table5.A.iii** Abundance
Physico-chemical threshold (EXPOSURE pressure)	**Table 5.B.i** Physico-chemical parameters of the Fresh Water Fish Directive
Other potential pressures/ metrics under development	N/A

Table5.A.i Species composition

Risk Category	Threshold values for parameter				Threshold Confidence	Source data
	Salmonid waters[1] (salmon and trout expected))	Salmonid waters[2] (trout only expected)	Cyprinid waters			
			Gradient <0.5‰	Gradient 0.5-8.0‰		
Not at risk	Both species present	Trout present	Roach & Bream Present	Chub & Dace Present	H	W.Duncan, M.Beveridge Alan Starkie
Probably at risk	One species missing	-	-	-	H	W.Duncan, M.Beveridge Alan Starkie
At risk	Both species missing	Trout absent	Either Roach or Bream missing	Either Chub or Dace missing	H	W.Duncan, M.Beveridge Alan Starkie

Notes:
1. Salmonid Waters: Salmon and Trout Expected. These criteria should be applied in rivers designated as Salmonid Waters under the Freshwater Fish Directive downstream of impassible natural barriers, or where the gradient > 8.0‰.
2. Salmonid Waters: Trout Only Expected. These criteria should be applied in rivers designated as Salmonid Waters under the Freshwater Fish Directive upstream of impassible natural barriers, or where the gradient > 8.0‰.

Table5.A.ii Expected Age Class

Risk Category	Threshold values for parameter		Threshold Confidence	Source data
	Salmonid waters[1]	Cyprinid waters[2]		
Not at risk	All age classes represented	All age classes represented.	M	W.Duncan, M.Beveridge Alan Starkie
Probably at risk	One age class missing.	One or two missing age-classes.	M	W.Duncan, M.Beveridge Alan Starkie
At risk	Two or more age classes missing	More than two age-classes missing.	M	W.Duncan, M.Beveridge Alan Starkie

Notes:
1. In upland waters (>200m altitude) missing year classes can be due to washout by spates.
2. In waters with longer lived cyprinids only apply criteria to age classes 0-5+.

Table5.A.iii Abundance

Risk Category	Threshold values for parameter		Threshold Confidence	Source data
	Salmonid waters[1]	Cyprinid waters[1]		
Not at risk	Total density >0.5/m^2	Biomass >20g/m^2	M	W.Duncan, M.Beveridge Alan Starkie
At risk	Total density $\leq$0.5/m^2	Biomass $\leq$20g/m^2	M	W.Duncan, M.Beveridge Alan Starkie
Note: 1. The expected density and biomass figures are likely to decline towards the northern limit of typed waters				

Table 5.B.i Physico-chemical parameters of the Fresh Water Fish Directive

Risk category	Threshold values for parameter		Threshold Confidence	Source data
	Salmonid waters	Cyprinid waters		
Not at risk	Compliance with FWFD guideline parameters	Compliance with FWFD guideline parameters	H	EC FWFD
Not at risk	Compliance with FWFD mandatory parameters	Compliance with FWFD mandatory parameters	M	EC FWFD
At risk	Failure of FWFD guideline parameters	Failure of FWFD guideline parameters	M	EC FWFD
At risk	Failure of FWFD mandatory parameters	Failure of FWFD mandatory parameters	H	EC FWFD

Annex 2 Linkage of Normative Definitions to Risk Thresholds in Current River Classification S

Biological element: Invertebrate **Pressures:** Organic Pollution

Good/Moderate boundary Normative definition	Interpretation	Justification of interpretation - structural and functional relevance	Comparability
There are slight to moderate changes in the composition and abundance of invertebrate taxa from type specific reference communities.	For many types of UK rivers the boundary represents the point below which it is likely that taxonomic groups at the level of order (e.g. Plecoptera, Ephemeroptera) will be absent or represented only by their most pressure tolerant families. For example, all except one Plecoptera (stoneflies) family found in the UK are highly sensitive to organic pollution. Consequently for low to medium productivity UK rivers all the expected sensitive Plecoptera families are likely to be absent or poorly represented at the boundary. This is expressed in existing classification systems by Taxa (mostly families) with an organic pressure sensitivity having higher scores than those that are insensitive. From an understanding of the pressure impact relationship in the UK it is estimated that conditions consistent with the good/moderate boundary occur when: i. many of the sensitive families are absent, reducing the Average Score per Taxon (ASPT) by >10% of its expected value for any type at reference conditions, and, ii. when there are >30% of the expected families missing (low confidence in this threshold – requires review)	Plecoptera and Ephemeroptera are ubiquitous and abundant within type specific reference communities and their absence from a water body would arise from anthropogenically-induced stress. Their sensitivity to organic pressure has been described in both field and laboratory based investigations, with the relationship being the basis of most invertebrate based water quality assessment methods throughout the world. These taxonomic groups contain species with a diversity of functional attributes, indicating an ecosystem with broad ecological niche utilisation appropriate for an unimpacted river of the relevant type. Loss of these groups indicates a change towards a more functionally restricted ecosystem in which stress adapted taxa predominate e.g. Hirudinea, Oligochaetes & Chironomids. The loss of sensitive taxa is due to reduced DO levels, elevated ammonia concentrations, and in extreme circumstances the loss interstitial river bed habitat that are consistent with organic loading. Their loss will indicate stress on other biological quality elements and the likelihood of decreased amenity, aesthetic and utility value of the water resource. The level of change regarded as moderate indicates a clearly impacted ecosystem but allows sufficient room for the classification of poor and bad quality rivers. The general descriptions used for the biological quality of these lower status water bodies would be compatible to an appropriate division of the remaining status below the definition given for moderate in the normative definitions.	The broad principles associated with UK methods will be directly transferable to other member states, although the differing faunal assemblages will compromise inter-state transferability to some degree. Diversity measured by taxon richness at the family level is a readily transferable measure between member states. However, its suitability as a measure of diversity is likely to be questioned.

Biological element: **Invertebrate** Pressures: Acidification

Good/Moderate boundary Normative definition	Interpretation	Justification of interpretation - structural and functional relevance	Comparability
There are slight to moderate changes in the composition and abundance of invertebrate taxa from type specific reference communities.	In acid sensitive UK river types the boundary represents the point below which it is likely that taxonomic groups at the level of Order e.g., Coleoptera (beetles) or Ephemeroptera (mayflies) will be absent or represented only by their most acid pressure tolerant families/species. Additionally the loss of Gammarus sp. Ancylus fluviatilus and net spinning Hydropsychids has been reported in acidified waters. However, relationships between acidification and invertebrate population biomass and density are weak.	These taxonomic groups contain species with a diversity of functional attributes, indicating an ecosystem with broad ecological niche utilisation appropriate for an unimpacted river of the relevant type. Loss of these groups indicates a change towards a more functionally restricted ecosystem in which stress adapted taxa predominate, and in which predator prey relationships can be modified. The loss of sensitive species can be attributed to physiological disruption arising from increasing hydrogen ion concentration, metal toxicity (particularly aluminum), and the loss of base ions that are important for exoskeleton construction, although the relative importance of each is poorly understood. The taxa that are likely to be lost as the consequence of increasing acidification stress have well documented sensitivities to the effects of acidification. Their loss will indicate stress on other biological quality elements and the likelihood of decreased amenity, aesthetic and utility value of the water resource. The level of change regarded as moderate indicates a clearly impacted ecosystem but allows sufficient room for the classification of poor and bad quality rivers. The general descriptions used for the biological quality of these lower status water bodies would be compatible to an appropriate division of the remaining status below the definition given for moderate in the normative definitions. The level of change regarded as moderate indicates a clearly impacted ecosystem but allows sufficient room for the classification of poor and bad quality rivers. The general descriptions used for the biological quality of these lower status water bodies would be compatible to an appropriate division of the remaining status below the definition given for moderate in the normative definitions.	The broad principles associated with UK methods will be directly transferable to other member states, although the differing faunal assemblages will compromise inter-state transferability to some degree. It is likely that all other member states will have taxonomic groups which are ubiquitous and abundant within their relevant river type and which are also highly sensitive to pressures. Other member states use invertebrate monitoring tools, which rely on the differential sensitivity of invertebrate taxonomic groups to pressures.