

UKTAG River Assessment Method Benthic Invertebrate Fauna

Invertebrates (Anthropogenic Acidification): WFD Acid Water Indicator Community (WFD-AWIC)

by

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It is also the responsibility of the user if seeking to practise the method outlined here, to gain appropriate permissions for access to water courses and their biological sampling.

UKTAG Guide to Invertebrates in Rivers

Invertebrates (Anthropogenic Acidification): WFD-Acid Water Indicator Community (WFD-AWIC)

1 Introduction

This classification method enables the assessment of Invertebrates in rivers (in relation to anthropogenic acidification) according to the requirements of the Water Framework Directive (WFD). Mcfarland (2010) & Murphy et al (2013) give details of the index and its derivation.

WFD – AWICS generates EQRs via type specific reference conditions. The reference typology is based on a mixture of chemical (DOC) & geographical factors. Confidence of Class (CoC) is not yet available for WFD-AWIC.

The metric uses a weighted abundance approach and is simple to calculate. A calculator spreadsheet is available to ensure consistency.

1.1 Metrics

The classification comprises one metric (WFD-AWIC) that can be combined with other elements of classification.

1.2 Environmental pressures to which the method is sensitive

The method has been primarily designed to respond to anthropogenic acidification and has been calibrated against pH & ANC environmental gradients. It is thought that a large part of the invertebrate communities' response to anthropogenic acidification is mediated by the toxic effects of labile Aluminium (*IAI*) and Dissolved Organic Carbon. *IAI* analysis has not been routinely carried out by the agencies therefore the metric was assessed against pH & Cantrell ANC. Dissolved Organic Carbon (DOC) is thought to ameliorate the effects of *IAI*. Where naturally high concentrations of DOC are present specialised naturally acid tolerant invertebrate communities become evident. This is allowed for in WFD status assessment by including DOC in the reference typology (below).

1.3 Geographic application

This assessment method was originally developed using data from lotic waters in Scotland & Wales. It may be used elsewhere in the UK, however caution should be exercised as no specific reference conditions or boundaries have been developed outside the aforementioned areas. To be assessed sites **must** first pass the chemical screening criteria which consist of pH <7 & Ca <4 mg/l. At pH and Ca levels in excess of those stated, WFD-AWIC ceases to respond to the primary environmental gradient and will give erroneous results.

1.4 Intercalibration

WFD- AWIC has been intercalibrated. This is a process whereby all European Member States were required to compare WFD status classification boundary values for each biological quality element (e.g. phytoplankton, macrophytes) to ensure compatible levels are set across all countries. The process involved some adjustments of class boundary values for many of the classification tools in use and this process has influenced some of the calculations used in the WFD-AWIC method. Once a classification method has been intercalibrated, the method and boundaries must be adhered to by Member States for the purposes of WFD assessment and reporting.

Intercalibration focussed on the EQRs that define the boundaries between High and Good (H/G) and between Good and Moderate (G/M).

1.5 Sample frequency

For a site to be classified, one macroinvertebrate sample per year is required. The sample should be collected in the spring (1st March – 31st May) RICT sample season. Sites may be classified using data from as many individual years as data are available (see below).

1.6 Sample and associated data collection and analysis

The sampling methods used should be compliant with:

- BS EN 27828:1994, ISO 7828-1985 Water quality. Methods for biological testing. Methods of biological sampling: guidance on hand-net sampling of aquatic benthic macro-invertebrates; and/or
- BS EN ISO 9391:1995, BS 6068-5.15:1995 Water quality. Sampling in deep water for macro-invertebrates. Guidance on the use of colonization, qualitative and quantitative samplers.

Samples should be collected according to standard RIVPACS (River Prediction and Classification System) procedures, see EU-STAR (2004). Good practice suggests that it would be sensible to collect the associated RICT data when at the site. The guidance includes macroinvertebrate analysis methods. Macro invertebrate samples should be analysed to RIVPACS taxonomic-level TL5 (Davy-Bowker *et al.*, 2010) together with associated log abundances (Table 1), or analysed further, then aggregated to this level. For the purposes of screening and allocation to reference typology, data for pH, Ca & DOC should be available. This should ideally consist of at least four samples in the year previous to invertebrate sampling.

Table 1. WFD-AWIC logarithmic abundance categories & sensitivity classes

Log Abundance counts	Highly Tolerant	Tolerant	Moderately Tolerant	Moderately Sensitive	Sensitive	Highly Sensitive
A or 1 (1-9)	3	5	7	8	10	12
B or 2 (10-99)	2	4	6	9	11	13
C+ or 3+ (100-999)	1	3	5	10	12	14

2 Procedures for calculating EQRs and generating site/water body classifications

The following sections outline how WFD- AWIC EQRs are calculated. Once the metric has been calculated the site is matched to a typology and the EQR is calculated in the normal WFD fashion (using Observed divided by Expected values). The procedure can either be done manually or via the calculator spreadsheet available on the UKTAG website. The spreadsheet automates the process of calculating WFD-AWICS and generates EQRs for each of the typologies (see 2.3). A summary flow chart of the process is provided in Appendix 1 and a worked example in Appendix 2.

2.1 Calculate observed WFD-AWIC

For each macroinvertebrate sample which passes the screening criteria (see 1.3) calculate WFD-AWICS using the following procedure.

Species / genera found in the sample are allocated abundance weighted sensitivity scores as per Tables 1 & 2, then overall WFD- AWIC is calculated using the equation:

$$\text{WFD- AWIC} = (\text{sum AS}) / n$$

Where **sum AS** is the sum of the WFD -AWIC sp taxon scores (**AS**) and **n** is the number of taxa used to calculate sum AS.

Table 2: Species scores and sensitivity classes

Taxon	AWIC Score	WFD-AWIC Sensitivity Group
<i>Agapetus Sp</i>	9	Highly Sensitive
<i>Caenis Sp</i>	9	
<i>Baetis muticus</i>	9	
<i>Glossosoma Sp</i>	9	
<i>Potamopyrgus jenkinsi</i>	9	
<i>Gammarus pulex</i>	9	
<i>Perla bipunctata</i>	9	
<i>Ancylus fluviatilis</i>	9	
<i>Philopotamus montanus</i>	8	Sensitive
<i>Silo pallipes</i>	8	
<i>Wormaldia Sp</i>	8	
<i>Hydropsyche instabilis</i>	8	
<i>Ecdyonurus Sp</i>	8	
<i>Rhithrogena Sp</i>	8	
<i>Hydraena gracilis</i>	8	
<i>Sercostoma personatum</i>	8	
<i>Heptagenia sulphurea</i>	8	
<i>Atherix Sp</i>	8	
<i>Esolus parallelepipedus</i>	8	
<i>Baetis rhodani</i>	8	
<i>Perlodes microcephala</i>	7	
<i>Lepidostoma hirtum</i>	7	
<i>Diplectrona felix</i>	7	
<i>Heptagenia lateralis</i>	7	
<i>Hydropsyche siltalai</i>	6	
<i>Hydropsyche pellucidula</i>	6	
<i>Baetis niger</i>	6	
<i>Elmis aenea</i>	6	
<i>Chloroperla tripunctata</i>	6	
<i>Limnius volckmari</i>	6	
<i>Crenobia alpina</i>	6	
<i>Cordulegaster boltonii</i>	5	
<i>Isoperla grammatica</i>	5	
<i>Brachyptera risi</i>	5	
<i>Rhyacophila dorsalis</i>	5	
<i>Phagocata vitta</i>	4	Tolerant
<i>Chloroperla torrentium</i>	4	
<i>Leuctra inermis</i>	4	
<i>Oulimnius Sp</i>	4	
<i>Amphinemura sulcicollis</i>	4	
<i>Protonemura Sp</i>	4	
<i>Leuctra nigra</i>	4	
<i>Leuctra hippopus</i>	3	
<i>Leptophlebia marginata</i>	3	
<i>Sialis Sp</i>	3	
<i>Nemoura Sp</i>	2	Highly Tolerant
<i>Nemurella picteti</i>	1	

2.2 Generating EQRs and classifying sites

Firstly allocate the site to a reference typology as per tables 3 & 4 below, then read off the associated reference (Expected) value. EQR calculation is then a matter of:

$$\text{EQR} = O/E$$

Where *O* = Observed, *E* = Expected (reference)

Table 3: DOC status bands

Humic Status	DOC Value
Clear	<10mg/l
Humic	>=10mg/l

Table 4: WFD – AWIC reference typology with expected (reference) values

Regional Typology	Humic Typology	WFD-AWIC Ref. Value
Scotland	Clear	8.61
UK	Humic	7.38
England and Wales	Clear	7.65

Once the EQR has been calculated, the appropriate (to the typology) boundaries can be applied (Table 5) to produce a classification.

Table 5: Classification Boundaries by WFD-AWIC typology

Boundary	UK (Humic)	Scotland (Clear)	England & Wales (Clear)
H-G	0.93	0.91	1
G-M	0.83	0.83	0.89
M-P	0.77	0.72	0.78
P-B	0.73	0.66	0.67

2.3 Using the Spreadsheet

An MS Excel spreadsheet has been produced with a series of worksheets for data input and calculation of components of the classification. The most recent version of the spreadsheet calculator can be found on the UKTAG website.

NB: As revisions are likely to be made and the calculator updated over time, it is important to check that the most recent version is being used.

Clear any existing abundances from the grey cells. Do NOT delete or reformat any of the cells on the spreadsheet. Enter the abundances obtained from the sample next to the appropriate taxon names, then read off the appropriate EQR.

2.4 Combining classifications

Temporal and spatial classifications may be combined in one of two ways, namely:

- A “worst of” approach
- A mean EQR over available samples (temporal/spatial) to which the classification boundaries are applied.

Other statistical combination methods (for instance “VISCOUS”) can also be used.

3 References

Davy-Bowker, J., Arnott, S., Close, R., Dobson, M., Dunbar, M., Jofre, G., Morton, D., Murphy, J., Wareham, W., Smith, S. & Gordon V. (2010) *Further Development of River Classification Tool*. Final Report, SNIFFER project WFD100.

McFarland, B. (2010) *Developing typology and class boundaries for WFD-AWICsp to assess acidification in UK rivers using macroinvertebrates*. Report to Freshwater Task team FTT003a.

Murphy, J.F., Davy-Bowker, J., McFarland, B., Ormerod, S.J. (2013) *A diagnostic biotic index for assessing acidity in sensitive streams in Britain*. *Ecological Indicators* **24** pp 562-572

UK Invertebrate sampling and analysis procedure for STAR project (2004)
<http://www.eu-star.at/pdf/RivpacsMacroinvertebrateSamplingProtocol.pdf>

WFD-AWIC calculation sheet – Excel standalone workbook that can be used to calculate WFD-AWIC & allocate EQR to appropriate class.
<http://www.wfduk.org/resources/rivers-invertebrates-acidification>

Appendix 2: Worked Example

The site in question (Table 6) is located in Scotland. pH is 5.9, Ca 2.7 mg/l & DOC 12.5 mg/l. The chemical parameters suggest that a) WFD-AWIC is a suitable analysis and b) the humic reference is applicable.

Table 6: Worked example data and calculations

Taxon	Abundance	Score
Highly Sensitive Taxa		
<i>Agapetus</i> sp.	18	13
<i>Caenis</i> sp.	15	13
<i>Alainites muticus</i>	15	13
Sensitive Taxa		
<i>Philopotamus montanus</i>	1	10
Moderately Sensitive Taxa		
<i>Lepidostoma hirtum</i>	45	9
<i>Limnius volckmari</i>	3	8
Moderately Tolerant Taxa		
<i>Rhyacophila dorsalis</i>	2	7
Tolerant Taxa		
<i>Chloroperla torrentium</i>	1	5
<i>Oulimnius</i> sp.	1	5
<i>Amphinemura sulcicollis</i>	18	4
<i>Protonemura</i> sp.	3	5
∑	92	
Number of Scoring Taxa	11	
WFD-AWICsp	8.363636364	

Therefore the observed WFD –AWIC is 8.36. Reading from Table 4 the expected score for the Humic UK typology is 7.38.

Therefore the EQR is calculated by $8.36 \text{ (Observed)} / 7.38 \text{ (expected)} = 1.13$.

WFD status for this sample would be **High** (using Table 5).