

UKTAG RIVERS ASSESSMENT METHODS  
MACROPHYTES AND PHYTOBENTHOS

PHYTOBENTHOS - DIATOM ASSESSMENT for RIVER  
ECOLOGICAL STATUS (DARES<sup>1</sup>)

by  
Water Framework Directive - United Kingdom Advisory Group (WFD-  
UKTAG)

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<sup>1</sup> Referred to by the UK environmental agencies as River DARLEQ



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## **HEALTH AND SAFETY STATEMENT**

**WARNING**— working in or around water is inherently dangerous; persons using this standard should be familiar with normal laboratory and field practice. This published monitoring system does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and to ensure compliance with any national regulatory guidelines.

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

## UKTAG RIVERS ASSESSMENT METHODS

### PHYTOBENTHOS - DIATOM ASSESSMENT FOR RIVER ECOLOGICAL STATUS (DARES)

#### 1. Introduction

This method statement describes a monitoring system for monitoring, assessing and classifying rivers in accordance with the requirements of Article 8; Section 1.3 of Annex II; and Annex V of the Water Framework Directive (2000/60/EC).

##### 1.1 Geographic application of the method

The method can be applied to rivers in England, Northern Ireland, Scotland and Wales.

##### 1.2 Quality element assessed by the method

The method enables the assessment of the condition of the quality element, "macrophytes and phytobenthos", listed in Table 1.2.1 of Annex V to the Water Framework Directive

##### 1.3 Pressures to which the method is known to be sensitive

The method has been designed to detect the impact on the quality element of nutrient enrichment.

##### 1.4 Parameters used to assess the quality element

The method assesses the condition of the quality element using the parameter, "river trophic diatom index". This parameter is indicative of the impact of nutrient enrichment on the quality element. It is calculated using information on benthic diatom species and groups of such species.

#### 2. Sampling and analysis

To apply the method, samples of benthic diatom species should be collected by brushing or scraping the upper surface of cobbles or small boulders obtained from the stream bed in order to remove the biofilm.

Where there are no cobbles or small boulders present in the river at the sampling site,, samples should be collected from submerged portions of emergent macrophytes, such as *Phragmites australis*, *Sparganium erectum*, *Glyceria maxima* or *Typha* species, or submerged macrophytes such as *Ranunculus* species and *Potamogeton* species.

The sampling method used should conform to EN 13946 : 2003 Water quality – Guidance standard for the routine sampling and pre-treatment of benthic diatoms from rivers.

The samples should be analysed to identify the presence, and number of valves, of each of the diatom taxa listed in Column 1 of Table 1.

The analytical method used should conform to EN 14407 : 2004 Water quality – Guidance standard for the identification, enumeration and interpretation of benthic diatom samples from running waters.

### 3. Procedure for deriving the ecological quality ratio for the parameter

#### 3.1 Calculation of the observed value of the parameter

To calculate the observed value of the parameter, each taxon listed in Column 1 of Table 1 and identified as present in the river should be assigned the corresponding nutrient sensitivity score in Column 2 of Table 1.

The observed value of the parameter is then given by the equation:

$$\text{Observed value of river trophic diatom index} = (W \times 25) - 25$$

where:

"W" is given by the equation:

$$W = \frac{\sum_{j=1}^n a_j \times s_j}{\sum_{j=1}^n a_j}$$

"a<sub>j</sub>" is the number of valves of taxon j, where "j" represents a taxon listed in Column 1 of Table 1 and present in the sample. "j" has a value of 1 to "n" indicating which of the all the taxa (total number = "n") listed in Column 1 and present in the sample it represents; and

"s<sub>j</sub>" is the nutrient sensitivity score in column 2 of Table 1 corresponding to the taxon in column 1 of that Table represented by j.

#### 3.2 Calculation of the reference value for the parameter

Reference conditions were derived using absence of pressure and land use data.

The value for the parameter in the reference conditions applicable to the river should be calculated using the following equation:

Reference value  
for river trophic diatom index =  $-25.36 + [56.83 \times \log_{10} A] - [12.96 \times \log_{10} (A^2)] + [3.21 \times S]$

where:

"A" is the observed annual mean alkalinity of the river in mg/l CaCO<sub>3</sub> unless the observed annual mean alkalinity is:

- (i) < 6 mg L<sup>-1</sup> CaCO<sub>3</sub>, in which case the value of A should be set at "6"; or
- (ii) ≥150 mg L<sup>-1</sup> CaCO<sub>3</sub>, in which case the value of A should be set at "150";

"S" should have a value of "0" for samples collected in the period 1st January to 30th June and a value of "1" for samples collected at any other time.

### 3.3 Calculation of the ecological quality ratio for the parameter

The ecological quality ratio (EQR<sub>DARES</sub>) for the parameter should be calculated using the following equation:

$$EQR_{DARES} = \left( 100 - \frac{\text{observed value of river trophic diatom index}}{\text{reference value for river trophic diatom index}} \right) \div \left( 100 - \frac{\text{reference value for river trophic diatom index}}{\text{reference value for river trophic diatom index}} \right)$$

Where the calculated EQR<sub>DARES</sub> is > 1, its value should be set to "1".

### 3.4 Application of the method for the purposes of classification

When using the method for the purposes of classifying the ecological status or potential of a water body, the annual mean value of the ecological quality ratio for the parameter should be used.

## 4 Glossary

"Biofilm" means a thin coating on submerged surfaces, composed of algae and other microorganisms in a polysaccharide matrix, along with trapped organic and inorganic particles.

"Boulder" means mineral substratum with a diameter > 256 mm.

"Cobble" means mineral substratum with a diameter > 64 mm and ≤ 256 mm.

"Valve" is one half of the silicate shell which surrounds the cell contents of each individual diatom. The valves usually separate during sample treatment.

Table 1: List of diatom taxa and associated nutrient sensitivity scores for the purposes of calculating the value of the parameter, river trophic diatom index	
Column 1	Column 2
Diatom taxa	Nutrient sensitivity score

**Table 1: List of diatom taxa and associated nutrient sensitivity scores for the purposes of calculating the value of the parameter, river trophic diatom index**

Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
<i>Achnanthes calcar</i> Cleve	3
<i>Achnanthes carissima</i> Lange-Bertalot	5
<i>Achnanthes coarctata</i> (Breb. in W. Sm.) Grun. in Cleve & Grun.	3
<i>Achnanthes conspicua</i> A. Mayer	4
<i>Achnanthes curtissima</i> J.R. Carter	3
<i>Achnanthes exigua</i> Grun. in Cleve & Grun.	4
<i>Achnanthes frigida</i> Hust. in A. Schmidt	3
<i>Achnanthes joursacense</i> Herib.	3
<i>Achnanthes kriegei</i> Krasske	3
<i>Achnanthes kryophila</i> J.B. Petersen	3
<i>Achnanthes laevis</i> Ostr.	2
<i>Achnanthes minuscula</i> Hust.	5
<i>Achnanthes oblongella</i> Ostr.	2
<i>Achnanthes oestrupii</i> (A. Cleve-Euler) Hust.	3
<i>Achnanthes pseudoswazi</i> J.R. Carter	1
<i>Achnanthes rricula</i> Hohn & Hellerman 1963	5
<i>Achnanthes rosenstockii</i> Lange-Bertalot 1989	5
<i>Achnanthes saccula</i> J.R. Carter in J.R. Carter & Watts	3
<i>Achnanthes silvahercynia</i> Lange-Bertalot 1989	2
<i>Achnanthes</i> sp. Bory	4
<i>Achnanthes straubiana</i> Lange-Bertalot	1
<i>Achnanthes suchlandtii</i> Hust.	4
<i>Achnanthes ventralis</i> (Krasske) Lange-Bertalot	1
<i>Achnanthes zieglerei</i> Lange-Bertalot 1991	2
<i>Achnanthidium biasolettiana</i> (Grunow) L. Bukhtiyarova	4
<i>Achnanthidium minutissimum</i> (Kütz.) Czarnecki 1994	2
<i>Amphipleura kriegei</i> (Krasske) Hust.	1
<i>Amphipleura pellucida</i> (Kütz.) Kütz.	1
<i>Amphipleura</i> sp. (Grunow) L. Bukhtiyarova	1
<i>Amphora delicatissima</i> Krasske ex Hust.	5
<i>Amphora dusenii</i> Brun	3
<i>Amphora fagediana</i> Krammer	4
<i>Amphora inariensis</i> Krammer	4
<i>Amphora libyca</i> Ehr.	4
<i>Amphora ovalis</i> (Kütz.) Kütz.	4
<i>Amphora pediculus</i> (Kütz.) Grun.	4
<i>Amphora</i> sp. Ehrenb. ex. Kütz.	5
<i>Amphora veneta</i> Kütz.	5
<i>Aneumastus tuscula</i> (Ehrenb.) Mann & Stickle	1
<i>Anomoeoneis follis</i> (Ehrenb.) Cleve	1
<i>Aulacoseira subarctica</i> (O.Mull.) Haworth	2
<i>Brachysira brebissonii</i> fo. <i>brebissonii</i> R. Ross in Hartley	1

**Table 1: List of diatom taxa and associated nutrient sensitivity scores for the purposes of calculating the value of the parameter, river trophic diatom index**

Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
Brachysira neoexilis Lange-Bertalot	1
Brachysira procera L-B & Moser	2
Brachysira serians (Breb. ex Kutz.) Round & Mann	1
Brachysira sp. Kutz.	1
Brachysira styriaca (Grun. in Van Heurck) R. Ross in Hartley	1
Brachysira vitrea (Grun.) R. Ross in Hartley	1
Caloneis bacillum (Grun.) Cleve	4
Caloneis silicula (Ehrenb.) Cleve	2
Caloneis sp. Cleve	2
Cavinula cocconeiformis (Greg. ex Greville) Mann & Stickle	3
Cavinula variostrata (Krasske) Mann	3
Cocconeis disculus (Schum.) Cleve	3
Cocconeis neothumensis Krammer	3
Cocconeis pediculus Ehrenb.	4
Cocconeis placentula Ehrenb.	3
Cocconeis pseudothumensis Reichardt 1982	3
Craticula accomoda (Hust) Mann	5
Craticula halophila (Grun. ex Heurck) Mann	4
Ctenophora pulchella (Ralfs ex Kutz.) Williams & Round	3
Cymbella aequalis W. Sm. ex Grev.	1
Cymbella affinis Kutz.	1
Cymbella aspera (Ehrenb.) H. Perag. in Pell.	1
Cymbella brehmii Hust.	3
Cymbella cesatii (Rabenh.) Grun. in A. Schmidt	1
Cymbella cistula (Ehrenb. in Hempr. & Ehrenb.) Kirchner	2
Cymbella cuspidata Kutz.	4
Cymbella cymbiformis Ag.	1
Cymbella delicatula Kutz.	1
Cymbella descripta (Hust.) Krammer & Lange-Bertalot	1
Cymbella gaeumannii Meister	2
Cymbella helvetica Kutz.	2
Cymbella hustedtii Krasske	4
Cymbella incerta Grun. in Cleve & Moller	2
Cymbella lacustris (Ag.) Cleve	3
Cymbella lanceolata (Ag.) Ag.	2
Cymbella lapponica Grun. ex Cleve	1
Cymbella leptoceras (Ehr.) Grun.	2
Cymbella leptoceros var. angusta Grun.	4
Cymbella microcephala fo. microcephala Grun. in Van Heurck	1
Cymbella naviculiformis Auersw. ex Heib.	2
Cymbella perpusilla A. Cleve	2
Cymbella pusilla Grun. ex A. Schmidt	1



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Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
Cymbella reinhardtii Grun. ex A. Schmidt	5
Cymbella sp. Ag.	2
Cymbella subaequalis Grun. in Van Heurck	4
Cymbella turgidula Grun.	3
Cymbellonitzschia diluviana Hust.	4
Denticula kuetzingii Grun.	4
Denticula tenuis Kutz.	1
Diadesmis contenta (Grun. ex Van Heurck) Mann	3
Diatoma mesodon (Ehrenber) Kutzing	1
Diatoma moniliformis Kutz	1
Diatoma tenue Ag.	2
Diatoma vulgare Bory	4
Diploneis elliptica (Kutz.) Cleve	3
Diploneis marginestriata Hust.	3
Diploneis oblongella (Naegeli ex Kutz.) R. Ross	3
Diploneis ovalis (Hilse) Cleve	3
Diploneis parma Cleve	4
Diploneis sp. Ehrenberg	1
Ellerbeckia arenaria (Moore) Crawford	5
Encyonema caespitosum Kutz.	3
Encyonema gracile Ehrenberg	2
Encyonema hebridicum Grun. ex Cleve	1
Encyonema minutum (Hilse in Rabenhorst) Mann	4
Encyonema reichardtii (Krammer) Mann	4
Encyonema silesiacum (Bleisch in Rabenhorst) Mann	3
Epithemia adnata (Kutz.) Rabenh.	2
Epithemia argus (Ehrenb.) Kutz.	1
Epithemia sorex Kütz.	3
Epithemia sp. Bréb.	3
Eucocconeis flexella Kütz.	2
Eunotia arculus (Grunow) Lange-Bert et Nörpel	1
Eunotia arcus Ehrenb.	1
Eunotia bidentula W. Sm.	1
Eunotia bilunaris (Ehrenb.) F.W. Mills	3
Eunotia diodon Ehrenb.	1
Eunotia elegans Ostr.	1
Eunotia exigua (Breb. ex Kutz.) Rabenh.	1
Eunotia faba (Ehrenb.) Grun. in Van Heurck	1
Eunotia fallax A. Cleve	1
Eunotia flexuosa Kutz.	1
Eunotia formica Ehrenb.	2
Eunotia glacialis Meister	1

**Table 1: List of diatom taxa and associated nutrient sensitivity scores for the purposes of calculating the value of the parameter, river trophic diatom index**

Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
<i>Eunotia implicata</i> Norpel, Lange-Bertalot & Alles	1
<i>Eunotia incisa</i> W. Sm. ex Greg.	2
<i>Eunotia intermedia</i> (Hust) Norpel, Lange-Bertalot & Alles	1
<i>Eunotia meisteri</i> Hust.	1
<i>Eunotia microcephala</i> Krasske ex Hust.	1
<i>Eunotia minor</i> (Kutz) Grunow in Van Heurck	4
<i>Eunotia monodon</i> var. <i>bidens</i> (W. Sm.) Hust.	1
<i>Eunotia muscicola</i> Krasske	1
<i>Eunotia muscicola</i> var. <i>tridentula</i> Norpel & Lange-Bertalot 1991	2
<i>Eunotia naegelii</i> Migula	1
<i>Eunotia paludosa</i> Grun.	1
<i>Eunotia paludosa</i> var. <i>trinacria</i> (Krasske) Norpel 1991	4
<i>Eunotia pectinalis</i> (O.F. Mull.) Rabenh.	1
<i>Eunotia pirla</i> Carter et Flower	1
<i>Eunotia praerupta</i> Ehrenb.	2
<i>Eunotia rhomboidea</i> Hust.	1
<i>Eunotia rhyncocephela</i> Hustedt	1
<i>Eunotia serra</i> Ehrenb.	1
<i>Eunotia serra</i> var. <i>diadema</i> (Ehrenb.) Patr.	1
<i>Eunotia soleirolii</i> (Kutz) Rabenhorst	1
<i>Eunotia</i> sp. Ehrenb	2
<i>Eunotia subarcuatoides</i> Alles, Norpel, Lange-Bertalot	2
<i>Eunotia sudetica</i> O. Mull.	1
<i>Eunotia tenella</i> (Grun. in Van Heurck) A. Cleve	2
<i>Fragilaria bidens</i> Heib.	4
<i>Fragilaria capucina</i> Desm.	1
<i>Fragilaria capucina</i> var. <i>amphicephala</i> Grun) Lange-Bertalot	1
<i>Fragilaria capucina</i> var. <i>austriaca</i> (Grun) Lange-Bertalot	4
<i>Fragilaria capucina</i> var. <i>distans</i> (Grunow) Lange-Bertalot	3
<i>Fragilaria capucina</i> var. <i>mesolepta</i> (Rabenh.) Rabenh.	3
<i>Fragilaria capucina</i> var. <i>rumpens</i> (Kutz.) Lange-Bertalot	2
<i>Fragilaria construens</i> var. <i>exigua</i> (W. Sm.) Schulz	1
<i>Fragilaria construens</i> var. <i>pumila</i> Grun. in Van Heurck	2
<i>Fragilaria incognita</i> Reichardt 1988	1
<i>Fragilaria karelica</i> Molder	2
<i>Fragilaria lapponica</i> Grun. in Van Heurck	2
<i>Fragilaria nitzschioides</i> Grun. in Van Heurck	2
<i>Fragilaria perminuta</i> (Grunow) Lange-Bertalot	3
<i>Fragilaria pseudoconstruens</i> Marciniak	3
<i>Fragilaria</i> sp. H.C. Lyngb.	4
<i>Fragilaria vaucheriae</i> (Kutz.) J.B. Petersen	4
<i>Fragilaria vaucheriae</i> var. <i>capitellata</i> (Grun. in Van Heurck) R. Ross	2

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Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
Fragilariforma virescens (Ralfs) Williams & Round	3
Fragilariforma virescens var. exigua (Grunow) Poulin	3
Frustulia rhomboides (Ehrenb.) De Toni	1
Gomphonema acuminatum Ehrenb.	3
Gomphonema affine Kutz.	2
Gomphonema angustatum (Kutz.) Rabenh.	4
Gomphonema anoenum Lange-Bertalot	1
Gomphonema augur Ehr.	4
Gomphonema clavatum Ehr.	3
Gomphonema exiguum var. minutissimum Grun in Van Heurck	2
Gomphonema gracile Ehrenb.	2
Gomphonema hebridense Gregory	1
Gomphonema lateripunctatum Reichardt & Lange-Bertalot 1991	1
Gomphonema minutum (Ag.) Ag.	3
Gomphonema olivaceoides Hust.	2
Gomphonema olivaceum (Hornemann) Breb.	5
Gomphonema parvulum (Kutz.) Kutz.	4
Gomphonema parvulum var. exilissimum Grun. in Van Heurck	3
Gomphonema procerum Reichardt & Lange-Bertalot	1
Gomphonema pseudoaugur Lange-Bertalot	1
Gomphonema pseudotenellum Lange Bertalot	3
Gomphonema sp. Ehrenb.	3
Gomphonema subtile Ehrenb.	1
Gomphonema tergestinum (Grun. in Van Heurck) Fricke in A. Schmidt	3
Gomphonema truncatum Ehrenb.	4
Gomphonema vibrio Ehrenb.	1
Gyrosigma acuminatum (Kutz.) Rabenh.	4
Gyrosigma attenuatum (Kutz.) Rabenh.	4
Hannaea arcus (Ehrenb.) Patr. in Patr. & Reimer	1
Karayevia clevei (Grunow) Round et L. Bukhtiyarova	4
Karayevia laterostrata (Hust.) Round et L. Bukhtiyarova	4
Lemnicola hungarica (Grunow) Round et P.W. Basson	3
Luticola mutica (Kutz.) Mann	5
Mastogloia smithii Thwaites ex W. Sm.	2
Mastogloia smithii var. amphicephala Grun. in Van Heurck	1
Mastogloia sp. Thwaites ex W. Sm.	1
Melosira varians Ag.	5
Meridion circulare (Grev.) Ag.	1
Navicula [cf. seminulum] NJA+HB, Eutrophic sites	4
Navicula agrestis Hust.	5
Navicula angusta Grun.	5
Navicula aquaedurae Lange-Bertalot	1

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Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
Navicula arcus Ehrenb.	2
Navicula arvensis Hust.	1
Navicula atomus (Kutz.) Grun.	5
Navicula bryophila J.B. Petersen	3
Navicula capitata Ehrenb.	5
Navicula capitatoradiata Germain	4
Navicula cari Ehrenb.	4
Navicula caterva Hohn & Hellermann	2
Navicula cincta (Ehrenb.) Ralfs in Pritch.	3
Navicula cryptocephala Kutz.	4
Navicula cryptotenella Lange-Bertalot	5
Navicula cuspidata (Kutz.) Kutz.	4
Navicula decussis Ostr.	5
Navicula dicephala Ehrenb.	4
Navicula difficillima Hust.	3
Navicula digitoradiata var. digito-radiata (Greg.) Ralfs in Pritch.	4
Navicula gallica var. perpusilla (Grun) Lange-Bertalot	2
Navicula gastrum (Ehrenb.) Kutz.	3
Navicula graciloides A. Mayer	3
Navicula gregaria Donk.	5
Navicula hungarica Grun.	5
Navicula ignota var. acceptata (Hustedt) Lange-Bertalot	2
Navicula ignota var. palustris (Hust.) J.W.G. Lund	5
Navicula jaernefeltii Hust.	3
Navicula lanceolata (Agardh) Kutz.	4
Navicula leptostriata Jorgensen	2
Navicula libonensis Schoeman	4
Navicula mediocris Krasske	1
Navicula menisculus Schum.	5
<i>Navicula mimima</i> Grun. In Van Heurck	3
Navicula minuscula Grun. in Van Heurck	5
Navicula phyllepta Kutz.	2
Navicula placenta Ehrenb.	3
Navicula porifera var. opportuna (Hust.) Lange-Bertalot	2
Navicula pseudoanglica Lange-Bertalot	3
Navicula pseudolanceolata Lange-Bertalot	4
Navicula pseudoscutiformis Hust.	2
Navicula pseudotuscula Hust.	3
Navicula pygmaea Kutz.	3
Navicula radiosa Kutz.	2
Navicula radiosafallax Lange-Bertalot	3
Navicula reichardtiana Lange-Bertalot	5

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Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
<i>Navicula reinhardtii</i> Grun. in Van Heurck	5
<i>Navicula rhynchocephala</i> Kutz.	4
<i>Navicula rotunda</i> Hust.	5
<i>Navicula salinarum</i> Grun. in Cleve & Grun.	5
<i>Navicula saprophila</i> Lange-Bertalot & Bonik	4
<i>Navicula saxophila</i> Brock ex Hust	5
<i>Navicula schoenfeldii</i> Hust.	2
<i>Navicula scutelloides</i> W. Sm. ex Greg.	4
<i>Navicula seminuloides</i> Hust.	5
<i>Navicula slesvicensis</i> Grun. in Van Heurck	5
<i>Navicula soehrensensis</i> Krasske	1
<i>Navicula soehrensensis</i> var. <i>hassiac</i> (Krasske)Lange-Bertalot	1
<i>Navicula</i> sp. Bory	4
<i>Navicula stroemii</i> Hust.	4
<i>Navicula subatomoides</i> Hust. ex Patr.	5
<i>Navicula subminuscula</i> Manguin	5
<i>Navicula submuralis</i> Hust.	5
<i>Navicula subrotundata</i> Hust.	4
<i>Navicula subtilissima</i> Cleve	1
<i>Navicula tenelloides</i> Hust.	5
<i>Navicula tenuicephala</i> Hust.	1
<i>Navicula tripunctata</i> (O.F. Mull.) Bory	5
<i>Navicula trivialis</i> Lange-Bertalot	3
<i>Navicula veneta</i> Kutz.	5
<i>Navicula vixvisibilis</i> Hust.	3
<i>Neidium affine</i> (Ehrenb.) Pfitz.	1
<i>Neidium ampliatum</i> (Ehren) Krammer	1
<i>Neidium bisulcatum</i> (Lagerst.) Cleve	1
<i>Neidium hercynicum</i> A. Mayer	1
<i>Neidium</i> sp. Pfitzer	2
<i>Nitzschia acicularis</i> (Kutz.) W. Sm.	3
<i>Nitzschia acidoclinata</i> Lange Bertalot	2
<i>Nitzschia amphibia</i> Grun.	5
<i>Nitzschia angustatula</i> Lange-Bertalot	4
<i>Nitzschia angustiforaminata</i> Lange-Bertalot	5
<i>Nitzschia archibaldii</i> Lange-Bertalot	1
<i>Nitzschia bacillum</i> Hustedt in A.Schmidt et al	2
<i>Nitzschia capitellata</i> Hust.	5
<i>Nitzschia commutata</i> Grun. in Cleve & Grun.	4
<i>Nitzschia dissipata</i> (Kutz.) Grun.	5
<i>Nitzschia flexa</i> Schum.	1
<i>Nitzschia fonticola</i> Grun. in Van Heurck	4

**Table 1: List of diatom taxa and associated nutrient sensitivity scores for the purposes of calculating the value of the parameter, river trophic diatom index**

Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
Nitzschia frustulum (Kutz.) Grun. in Cleve & Grun.	5
Nitzschia gracilis Hantzsch	3
Nitzschia hantzschiana Rabenh.	3
Nitzschia heufleriana Grun.	2
Nitzschia incognita Legler & Krasske	1
Nitzschia inconspicua Grun.	5
Nitzschia intermedia Hantzsch ex Cleve & Grun.	1
Nitzschia lacuum Lange-Bertalot	3
Nitzschia linearis W. Sm.	3
Nitzschia microcephala Grun. in Cleve & Grun.	3
Nitzschia obtusa var. scalpelliformis Grun. in Van Heurck	3
Nitzschia palea (Kutz.) W. Sm.	4
Nitzschia paleacea (Grun. in Cleve & Grun.) Grun. in Van Heurck	4
Nitzschia paleaeformis Hust.	1
Nitzschia pumila Hust.	3
Nitzschia pura Hustedt	4
Nitzschia pusilla Grun.	4
Nitzschia recta Hantzsch ex Rabenh.	3
Nitzschia sigma (Kutz.) W. Sm.	1
Nitzschia sigmoidea (Nitzsch) W. Sm.	1
Nitzschia sinuata var. delognei (Grun. in Van Heurck) Lange-Bertalot	5
Nitzschia sinuata var. tabellaria (Grun.) Grun. ex Van Heurck	1
Nitzschia sociabilis Hust.	5
Nitzschia solita Hustedt	5
Nitzschia sp. Hassall	4
Nitzschia sublinearis Hust.	2
Nitzschia supralitorea Lange-Bertalot	5
Nitzschia valdestriata Aleem & Hust.	1
Nitzschia vermicularis (Kutz.) Hantzsch. in Rabenh.	2
Opephora sp. Petit	2
Pennate undif.	2
Peronia fibula (Breb. ex Kutz.) R. Ross	2
Pinnularia appendiculata (Ag.) Cleve	1
Pinnularia borealis Ehrenb.	4
Pinnularia brebissonii (Kutz.) Rabenh.	2
Pinnularia gibba (Ehrenb.) Ehrenb.	1
Pinnularia intermedia (Lagerst.) Cleve	2
Pinnularia interrupta W. Smith	1
Pinnularia major (Kutz.) W. Sm.	3
Pinnularia microstauron (Ehrenb.) Cleve	2
Pinnularia rupestris Hantzsch in Rabenh.	2
Pinnularia sp. Ehrenb.	3

**Table 1: List of diatom taxa and associated nutrient sensitivity scores for the purposes of calculating the value of the parameter, river trophic diatom index**

Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
<i>Pinnularia subcapitata</i> Greg.	2
<i>Pinnularia viridis</i> (Nitzsch) Ehrenb.	1
<i>Placoneis clementis</i> (Grunow) E.J. Cox	4
<i>Placoneis elginensis</i> (Greg.) E.J. Cox	5
<i>Placoneis placentula</i> (Ehrenb.) Heinzerl.	4
<i>Planothidium dau</i> i (Foged) Lange-Bert.	2
<i>Planothidium delicatulum</i> (Kütz.) Round et L. Bukhtiyarova	5
<i>Planothidium granum</i> (Hohn et Hellerman) Lange-Bert.	5
<i>Planothidium haukianum</i> (Grunow) Round et L. Bukhtiyarova	5
<i>Planothidium lanceolatum</i> (Bréb.) Round et L. Bukhtiyarova	4
<i>Planothidium peragalli</i> (Brun et Hérib.) Round et L. Bukhtiyarova	3
<i>Psammothidium bioretii</i> (Germain) L. Bukhtiyarova et Round	2
<i>Psammothidium chlidanos</i> (Hohn et Hellerman) Lange-Bert.	2
<i>Psammothidium didymum</i> (Hust.) L. Bukhtiyarova et Round	5
<i>Psammothidium grishun</i> un fo. <i>daonensis</i> (Lange-Bert.) L. Bukhtiyarova et Round	2
<i>Psammothidium lauenburgianum</i> (Hust.) L. Bukhtiyarova et Round	5
<i>Psammothidium levanderi</i> (Hust.) L. Bukhtiyarova et Round	2
<i>Psammothidium marginulatum</i> (Grunow) L. Bukhtiyarova et Round	3
<i>Psammothidium rossii</i> (Hust.) L. Bukhtiyarova et Round	3
<i>Pseudostaurosira brevistriata</i> (Grun. in Van Heurck) Williams & Round	4
<i>Pseudostaurosira robusta</i> (Fusey) Williams & Round	3
<i>Rhopalodia brebissonii</i> Krammer	2
<i>Rhopalodia gibba</i> (Ehrenb.) O. Mull.	2
<i>Rhopalodia gibberula</i> var. <i>rupestris</i> (W. Sm.) O. Mull.	1
<i>Rossithidium linearis</i> (W. Sm.) Round et L. Bukhtiyarova	2
<i>Rossithidium petersenii</i> (Hust.) Round et L. Bukhtiyarova	1
<i>Rossithidium pusillum</i> (Grunow) Round et L. Bukhtiyarova	2
<i>Sellaphora bacillum</i> (Ehenb.) Mann	4
<i>Sellaphora pupula</i> (Kutz.) Mereschkowsky	3
<i>Sellaphora seminulum</i> (Grun.) Mann	4
<i>Simonsenia delognei</i> (Grun. in Van Heurck) Lange-Bertalot	5
<i>Skeletonema</i> sp. Grev.	4
<i>Stauroneis kriegeri</i> Patr.	4
<i>Stauroneis palustris</i> Hust.	2
<i>Stauroneis</i> sp. Ehrenb.	4
<i>Staurosira construens</i> Ehrenb.	4
<i>Staurosira elliptica</i> (Schumann) Williams & Round	4
<i>Staurosirella pinnata</i> (Ehrenb.) Williams & Round	4
<i>Stenopterobia curvula</i> (W Smith) Krammer	1
<i>Surirella angusta</i> Kutz.	4
<i>Surirella brebissonii</i> Krammer & Lange-Bertalot	5

**Table 1: List of diatom taxa and associated nutrient sensitivity scores for the purposes of calculating the value of the parameter, river trophic diatom index**

Column 1	Column 2
Diatom taxa	Nutrient sensitivity score
<i>Surirella elegans</i> Ehrenb.	5
<i>Surirella minuta</i> Breb. ex Kutz.	5
<i>Surirella roba</i> Leclercq	1
<i>Surirella</i> sp. Turpin	1
<i>Synedra acus</i> Kutz.	3
<i>Synedra acus</i> var. <i>delicatissima</i> (W. Sm.) Grun.	1
<i>Synedra delicatissima</i> W. Sm.	2
<i>Synedra fasciculata</i> (Ag.) Kutz.	5
<i>Synedra parasitica</i> (W. Sm.) Hust.	3
<i>Synedra parasitica</i> var. <i>subconstricta</i> (Grun. in Van Heurck) Hust.	4
<i>Synedra</i> sp. Ehrenb.	2
<i>Synedra tenera</i> W. Sm.	1
<i>Tabellaria binalis</i> (Ehrenb.) Grun. in Van Heurck	1
<i>Tabellaria fenestrata</i> (Lyngb.) Kutz.	1
<i>Tabellaria flocculosa</i> (Roth) Kutz.	2
<i>Tabellaria quadriseptata</i> Knudson	1
<i>Tabellaria ventricosa</i> Kütz.	1
<i>Tabularia fasciculata</i> (Ag.) Williams & Round	4
<i>Tetracyclus lacustris</i> Ralfs	1
<i>Thalassiosira pseudonana</i> (Hust.) Hasle & Heimdal	5
<i>Tryblionella acuminata</i> W. Sm.	4
<i>Tryblionella hungarica</i> (Grun) Mann	5
<i>Tryblionella levidensis</i> W. Sm.	4



## Annex 1: Worked example

The following taxon list was obtained from an analysis of a sample collected from a site in the English midlands:

The first column has the taxon name, the second column shows the abundance (= number of valves) of that taxon in the sample; the third column has the nutrient sensitivity score for that taxon and the final column shows the product of  $a \times s$ .

<b>Taxon</b>	<b>a</b>	<b>s</b>	<b>as</b>
<i>Achnanthydium minutissimum</i> type	12	2	24
<i>Amphora montana</i>	1	5	5
<i>Amphora pediculus</i>	1	5	5
<i>Cocconeis pediculus</i>	5	4	20
<i>Cocconeis placentula</i>	5	2	10
<i>Cocconeis placentula</i> var. <i>euglypta</i>	54	4	216
<i>Cocconeis placentula</i> var. <i>lineata</i>	2	3	6
<i>Cyclotella atomus</i>	1	0	0
<i>Cyclotella meneghiniana</i>	3	0	0
<i>Diatoma vulgare</i>	1	5	5
<i>Encyonema minutum</i>	1	2	2
<i>Encyonema silesiacum</i>	14	3	42
<i>Fragilaria vaucheriae</i>	1	2	2
<i>Gomphonema angustum/pumilum</i> type	1	3	3
<i>Gomphonema clavatum</i>	1	2	2
<i>Gomphonema minutum</i>	2	4	8
<i>Gomphonema parvulum</i>	3	3	9
<i>Melosira varians</i>	3	4	12
<i>Navicula</i> [small species]	1	4	4
<i>Navicula capitatoradiata</i>	54	4	216
<i>Navicula cryptotenella</i>	107	4	428
<i>Navicula gregaria</i>	2	4	8
<i>Navicula lanceolata</i>	1	4	4
<i>Navicula menisculus</i>	1	4	4
<i>Navicula minima</i>	1	3	3
<i>Navicula reichardtiana</i>	1	4	4
<i>Navicula tripunctata</i>	2	5	10
<i>Nitzschia fonticola</i>	2	4	8
<i>Nitzschia gracilis</i>	1	3	3
<i>Nitzschia palea</i>	7	4	28
<i>Nitzschia paleacea</i>	3	3	9
<i>Nitzschia</i> sp.	1	3	3
<i>Planothidium frequentissimum</i>	2	3	6
<i>Reimeria sinuata</i>	6	3	18

<b>Taxon</b>	<b>a</b>	<b>s</b>	<b>as</b>
<i>Reimeria uniseriata</i>	4	4	16
<i>Rhoicosphenia abbreviata</i>	7	4	28
Unidentified pennate diatom	1	3	3
$\Sigma a =$	314	$\Sigma as =$	1174

The observed value for the river trophic diatom index for this sample is calculated as follows:

1. sum as for all taxa in sample = 1174
2. sum a for all taxa in sample = 314
3. Calculate  $W = \text{sum as} / \text{sum a} = 3.74$
4. Calculate the observed value of river trophic diatom index using the equation in Section 3.1:

$$(W \times 25) - 25 = (3.74 \times 25) - 25 = 68.5$$

The mean total alkalinity (A) for this sample in 2003 was 88.5 mg/l CaCO<sub>3</sub>. As the sample was collected in July, "S" = 1

Using the equation in Section 3.2, the reference value for river trophic diatom index for the sample is:

$$-25.36 + [56.83 \times \log_{10}88.5] - [12.96 \times \log_{10}(88.5)^2] + [3.21 \times 1] = 38.03$$

Applying the equation in Section 3.3, the ecological quality ratio for the sample is:

$$(100 - 68.5) / (100 - 38.0) = 31.5 / 62.0 = 0.51$$

## Annex 2: Further Reading

Kelly, M.G., Juggins, S., Bennion, H., Burgess, A., Yallop, M., Hirst, H., King, L., Jamieson, J., Guthrie, R., and Rippey, B. (2007) *Use of Diatoms for Evaluating Ecological Status in UK Freshwaters*. Environment Agency Science Report SCO301030.

Kelly, M.G., Juggins, S., Guthrie, R., Pritchard, S., Jamieson, B.J., Rippey, B., Hirst, H., Yallop, M.L., 2008. Assessment of ecological status in U.K. rivers using diatoms. *Freshwater Biology* 53, 403-422.