



Background

The Environment Agency is responsible for water quality monitoring under the Water Resources Act 1991.

The quality of rivers and canals has been reported for many years. In 1978 a formal classification scheme was developed by the then National Water Council. Stretches of rivers and canals were classified as being of good quality (Classes 1A and 1B), through fair (Class 2), poor (Class 3) to bad (Class 4).

The basis of the scheme was the measurement of dissolved oxygen, biochemical oxygen demand (BOD) and ammonia. Other information - both chemical and biological - was used in various ways by the 10 regional Water Authorities. This led to regional inconsistencies and differences from one survey to another. Different statistical methods were also used.

A further problem was the need for the scheme to reflect uses of the river or canal water. This resulted in the need to incorporate other standards including those of the EC Directive on Surface Water Abstraction (75/440/EEC).

Introduction

To resolve these problems, the National Rivers Authority (NRA), one of the Environment Agency's predecessor bodies introduced a scheme to examine separate stretches of freshwater in terms of their chemical, biological, nutrient and aesthetic qualities. This is called the General Quality Assessment (GQA) scheme.

Assessments using the GQA (Chemical) scheme have been based on measurements taken since 1988. The assessment

Table 1. GQA Scheme for Biology

Grade	Outline Description
a - Very Good	Biology similar to (or better than) that expected for an average and unpolluted river of this size, type and location. High diversity of taxa, usually with several species in each. Rare to find dominance of any one taxon.
b - Good	Biology falls a little short of that expected for an unpolluted river. Small reduction in the number of taxa that are sensitive to pollution. Moderate increase in the number of individuals in the taxa that tolerate pollution.
c - Fairly Good	Biology worse than expected for an unpolluted river. Many sensitive taxa absent, or number of individuals reduced. Marked rise in numbers of individuals in taxa that tolerate pollution.
d - Fair	Sensitive taxa scarce and contain only small numbers of individuals. A range of pollution tolerant taxa present, some with high numbers of individuals.
e - Poor	Biology restricted to pollution tolerant species with some taxa dominant in terms of the numbers of individuals. Sensitive taxa rare or absent.
f - Bad	Biology limited to a small number of very tolerant taxa such as worms, midge larvae, leeches and water hoglouse, present in very high numbers. In the worst case, there may be no life present.

scheme for biology has taken longer to develop. Rivers were first assessed using this scheme in 1995. However, the methodology has been applied retrospectively to the 1990 biology survey. This fact sheet outlines how this assessment is carried out.

Biological assessment

The biological scheme is based on groups of macroinvertebrates (small animals including mayfly nymphs, snails, shrimps and worms) that are found on the river bed. Macroinvertebrates are used because they:

- do not move far;
- have reasonably long life cycles;
- respond to the physical and chemical characteristics of the river;
- are affected by pollutants which occur infrequently and which are not measured by spot-sampling used in the GQA (Chemical) scheme;
- provide a picture of quality integrated over time.

For biological assessment, macroinvertebrates are grouped into 83 taxa. As different taxa respond differently to pollution, they are given scores of 1 (pollution-tolerant taxa) to 10 (pollution-sensitive taxa). The presence of taxa sensitive to pollution suggests better water quality than for sites where only pollution-tolerant taxa are found.

By comparing taxa found in the sample with those expected if the river were unpolluted, rivers can be classified into one of six grades (Table 1).

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Sampling and analysis

Each stretch of river has representative biological and chemical sampling sites. Two biological samples are taken - 1 in Spring (March-May) and 1 in Autumn (September-November). To take account of seasonal variation, taxa found in the Spring sample are combined with any additional taxa found in the Autumn sample.

Samples are collected using a standard method of three minutes active sampling with a pond net. For deep sites, samples are collected by 3 to 5 trawls with a Medium Naturalist's Dredge or by using an air-lift sampler. Both deep water sampling methods are followed by a 1 minute sweep with a pond net. A 1 minute visual search for animals living on the water surface, or attached to rocks, logs or vegetation is carried out for all samples.

Methods used to wash and sort samples vary, depending on the amount of silt or weed present. In all laboratories, 10 percent of samples are re-inspected to ensure that on average no more than two taxa are missed. A second check, is also carried out, where at least 20 samples from each Agency laboratory and a minimum of 60 samples from each Agency Region are analysed by an independent auditor.

Other recorded information includes width and depth of the stream and the percentage cover on the river bed of boulders, gravel, sand and silt. These items are calculated as annual averages based on Spring, Summer and Autumn measurements. Information derived from maps includes grid reference, the slope of the river, its altitude above sea level and the distance of the site from the source of the river.

Allocating a grade

Two indices are determined for each sample:

- the number of different scoring taxa present;
- the Average Score Per Taxon (ASPT).

The ASPT is calculated by dividing the Biological Monitoring Working Party (BMWP) score by the number of taxa. The BMWP score is calculated by totalling the pollution score for each taxon.

Having calculated these indices, they are compared to those which you would expect to find in an unpolluted river. As there is much natural variation due to geographical location, geology and habitat, a mathematical model - RIVPACS (River Invertebrate Prediction and Classification System) - is used to predict the fauna, using the physical data, measured at the site and from maps, together with alkalinity. From this, the

number of taxa and ASPT expected in the absence of pollution can be calculated.

The biological quality of a river is expressed as a ratio of the actual value from sampling compared with the predicted value. This ratio is known as the Ecological Quality Index (EQI) and is calculated for both the number of taxa and the ASPT. A sample with an EQI of 1 or more has a similar number of taxa or ASPT to that expected under conditions of natural water quality. Each EQI is then compared with those set for the biological grades (Table 2) and the site is assigned the lower of the two grades (if these differ for the two indices).

The divisions between grades are based on the need to detect changes in biological quality. The extremes (grades a and f) are set to reflect very good and bad quality with intermediate grades set pragmatically between these extremes.

The grading of waters through sampling is not precise. There is, on average, a risk of 22% that rivers will be graded incorrectly. It is unusual for this error to extend beyond the adjacent grade. There is a tendency for a pessimistic grade to be calculated as taxa are more likely to be missed, than added (due to mis-identification or a recording error), when samples are analysed.

Table 2. GQA (Biological) Grades

Grade	Ecological Quality Index	
	EQI for Taxa	EQI for ASPT
a	0.85	1.00
b	0.70	0.90
c	0.55	0.77
d	0.45	0.65
e	0.30	0.50
f	<0.30	<0.50

Improving water quality

Use of the GQA (Biological) scheme for classification will help the Agency fulfil its duties in describing the state of the environment and planning improvements in river quality.

Samplo a dadansoddi

Mae gan bob darn o afon fannau samplo cemegol a biolegol cynrychioladol. Cymerir dau sampl biolegol - un yn y Gwanwyn (Mawrth - Mai) ac un yn yr Hydref (Medi - Tachwedd). Er mwyn rhoi ystyriaeth i amrywiadau tymhorol, cyfunir tacsonau a geir yn sampl y Gwanwyn ag unrhyw dacsonau ychwanegol a geir yn sampl yr Hydref.

Cesglir y samplau gan ddefnyddio dull safonol o samplu gweithgar tri munud gyda rhwyd pwll. Mewn safleoedd dwfn, cesglir samplau mewn 3 i 5 treilliad gyda Threillrwyd Medium Naturalist neu trwy ddefnyddio sampludd awyrglud. Dilynir y ddau ddull samplu dŵr dwfn gyda llusgiad munud gyda rhwyd pwll. Cynhelir archwiliad llygad am anifeiliaid yn byw ar wyneb y dŵr, neu'n sownd wrth greigiau, boncyffion neu lystyfiant ar gyfer pob sampl.

Mae'r dulliau a ddefnyddir i olchi a didoli samplau'n amrywio, yn dibynnu ar faint o silt neu chwyn sy'n bresennol. Ym mhob labordy, ailarchwilir 10 y cant o samplau i sicrhau na fethir mwy na dau dacson ar gyfartaledd. Cynhelir ail archwiliad hefyd, lle mae o leiaf 20 sampl o bob un o labordai'r Asiantaeth ac o leiaf 60 sampl o bob un o Ranbarthau'r Asiantaeth yn cael eu dadansoddi gan archwilydd annibynnol.

Ymhlith y wybodaeth arall a gofnodir mae dyfnder a lled y ffrwd a chanran gorchudd clogfeini, graean, tywod a silt ar wely'r afon. Cyfrifir yr eitemau hyn yn gyfartaleddau blynyddol ar sail mesuriadau Gwanwyn, Haf a Hydref. Mae'r wybodaeth a geir o fapiau hefyd yn cynnwys cyfeirnod grid, gogwydd yr afon, uchder o lefel y môr a phellter y safle o darddle'r afon.

Dynodi gradd

Pennir dau fynegai ar gyfer pob sampl:

- nifer y tacsonau a sgorau gwahanol sy'n bresennol;
- Sgôr Cyfartalog Fesul Tacson (ASPT).

Cyfrifir yr ASPT trwy rannu sgôr y Gweithgor Monitro Biolegol (BMWP) â nifer y tacsonau. Cyfrifir y sgôr BMWP trwy gyfrif cyfanswm sgôr llygredd pob tacson.

Wedi cyfrif y mynegeion hyn, fe'u cymharir â'r rhai hynny y gallech ddisgwyl eu gweld mewn afon heb ei llygru. Gan fod llawer o amrywiadau naturiol oherwydd lleoliad daearyddol, daeareg a chynefin, defnyddir model mathemategol - RIVPACS (System Ddosbarthu a Rhagfynegi Infertebratau Afonydd) - i ragfynegi ffawna, gan ddefnyddio'r data ffisegol, a fesurir ar y safle ac o fapiau, ynghyd ag alcalinedd. Ar sail hyn, gellir cyfrif nifer y tacsonau a'r ASPT a ddisgwylir lle nad oes llygredd.

Mynegir ansawdd biolegol yr afon fel cymhareb o'r gwerth gwirioneddol o samplu o gymharu â'r gwerth a ragfynegwyd. Gelwir y gymhareb hon yn Fynegai Ansawdd Ecolegol (EQI) ac fe'i cyfrifir ar gyfer nifer y tacsonau a'r ASPT. Mae gan sampl sydd ag EQI o 1 neu fwy nifer gyffelyb o dacsonau neu ASPT â'r hyn a ddisgwylid mewn ansawdd dŵr naturiol. Cymharir pob EQI wedyn â'r rhai hynny a bennwyd ar gyfer graddau biolegol (Tabl 2) a dynodir yr isaf o'r ddwy radd ar gyfer y safle (os yw'r rhain yn wahanol ar gyfer y ddau fynegai).

Mae'r rhaniadau rhwng graddau'n seiliedig ar yr angen i nodi newidiadau mewn ansawdd biolegol. Pennir y pegynau (graddau a ac f) i adlewyrchu ansawdd da iawn a gwael iawn gyda graddau yn y canol yn cael eu pennu'n ymarferol rhwng y pegynau hyn.

Nid yw graddio dŵr trwy samplu'n union gywir. Ar gyfartaledd, mae perygl y gellid graddio 22% o afonydd yn anghywir. Mae'n anarferol i'r camgymeriad hwn ymestyn y tu hwnt i'r radd nesaf. Mae tuedd i radd besimistaidd gael ei chyfrif gan ei bod yn fwy tebygol i dacsonau gael eu methu na'u hychwanegu (oherwydd cam-adnabod neu gamgymeriad cofnodi), wrth ddadansoddi samplau.

Tabl 2. Graddau GQA (Biolegol)

Mynegai Ansawdd Ecolegol		
Gradd	EQI Tacsonau	EQI ASPT
a	0.85	1.00
b	0.70	0.90
c	0.55	0.77
d	0.45	0.65
e	0.30	0.50
f	<0.30	<0.50

Gwella ansawdd dŵr

Bydd defnyddio cynllun GQA (Biolegol) i ddsbarthu'n helpu'r Asiantaeth i gyflawni ei dyletswyddau o ran disgrifio cyflwr yr amgylchedd a chynllunio gwelliannau i ansawdd afonydd.



Cefndir

Asiantaeth yr Amgylchedd sy'n gyfrifol am fonitro ansawdd dŵr o dan Ddeddf Adnoddau Dŵr 1991.

Cafwyd adroddiadau ar ansawdd afonydd a chamlesi ers blynyddoedd lawer. Yn 1978 datblygwyd cynllun dosbarthu ffurfiol gan yr hen Gyngor Dŵr Cenedlaethol. Dosbarthwyd rhannau o afonydd a chamlesi'n rhai o ansawdd da (Dosbarthiadau 1A ac 1B), gweddol (Dosbarth 2), gwael (Dosbarth 3) i wael iawn (Dosbarth 4).

Yn sylfaen i'r cynllun roedd mesur ocsygen tawdd, galw am ocsygen biocemegol (BOD) ac amonia. Defnyddiwyd gwybodaeth arall gemegol a biolegol mewn amryw o ffyrdd gan y 10 Awdurdod Dŵr rhanbarthol. Arweiniodd hyn at anghysonderau rhanbarthol a gwahaniaethau rhwng un arolwg a'r llall. Roedd gwahanol dulliau ystadegol hefyd yn cael eu defnyddio.

Problem arall oedd bod yn rhaid i'r cynllun adlewyrchu'r ffordd y defnyddid dŵr yr afon neu'r gamlas. O ganlyniad bu'n rhaid cynnwys safonau eraill gan gynnwys Cyfarwyddeb y GE ar Dynnu Dŵr Arwyneb (75/440/EEC).

Cyflwyniad

Er mwyn datrys y problemau hyn, cyflwynodd yr Awdurdod Afonydd Cenedlaethol (AAC), un o ragflaenwyr Asiantaeth yr Amgylchedd, gynllun i edrych ar wahanol hydoedd o ddŵr croyw o ran ansawdd cemegol, biolegol, maethyddol ac esthetig. Dyma'r hyn a elwir yn gynllun Asesu Ansawdd Cyffredinol (GQA).

Mae asesiadau'n defnyddio'r cynllun GQA (Cemegol) wedi eu seilio ar fesuriadau a gymerwyd ers 1988. Cymerwyd

mwy o amser i ddatblygu'r cynllun ar gyfer bioleg. Aseswyd afonydd am y tro cyntaf gan ddefnyddio'r cynllun hwn yn 1995. Fodd bynnag, cymhwyswyd y fethodoleg yn adolygol ar gyfer arolwg bioleg 1990. Mae'r ffeithlen hon yn amlinellu sut y cynhelir yr asesiad hwn.

Asesu biolegol

Mae'r cynllun biolegol yn seiliedig ar grwpiau o facroinfertebratau (anifeiliaid bach yn cynnwys nymffau gwybed Mai, malwod, berdys a mwydod) a geir ar wely'r afon. Defnyddir macroinfertebratau am:

- nad ydynt yn symud yn bell;
- bod ganddynt gylch bywyd eithaf hir;
- eu bod yn ymateb i nodweddion ffisegol a chemegol yr afon;
- bod llygryddion sy'n digwydd yn anaml ac nad ydynt yn cael eu mesur trwy hap-samplo'r cynllun GQA (Cemegol) yn effeithio arnynt;
- eu bod yn rhoi darlun o ansawdd wedi'i integreiddio dros amser.

Ar gyfer asesu biolegol, dosberthir macroinfertebratau'n 83 tacson. Gan fod gwahanol dacsonau'n ymateb yn wahanol i lygredd, rhoddir sgôr iddynt o 1 (tacsonau sy'n goddef llygredd) i 10 (tacsonau sy'n sensitif i lygredd). Mae presenoldeb tacsonau sy'n sensitif i lygredd yn awgrymu gwell ansawdd dŵr na mewn safleoedd lle ceir tacsonau sy'n goddef llygredd yn unig.

Trwy gymharu tacsonau a geir yn y sampl â'r rhai hynny y gellid eu disgwyl pe na bai'r afon wedi ei llygru, gellir dosbarthu afonydd yn un o chwe gradd (Tabl 1).

Tabl 1. Cynllun GQA Bioleg

Gradd	Disgrifiad Bras
a - Da iawn	Bioleg tebyg i'r hyn a ddisgwylid mewn afon gyffredin heb ei llygru o'r maint, y math a'r lleoliad hwn neu'n well na hynny. Tacsonau amrywiol iawn, fel rheol gyda sawl rhywogaeth ym mhob un. Anaml y ceir un tacson yn gryfach na'r lleill.
b - Da	Bioleg ddim cystal â'r hyn a ddisgwylid mewn afon heb ei llygru. Gostyngiad bach yn nifer y tacsonau sy'n sensitif i lygredd. Cynnydd bach yn nifer yr unigolion ymhlith y tacsonau a all oddef llygredd.
c - Eithaf Da	Bioleg yn waeth na'r hyn a ddisgwylid mewn afon heb ei llygru. Llawer o dacsonau sensitif yn absennol, neu nifer yr unigolion yn llai. Cynnydd amlwg yn nifer yr unigolion ymhlith y tacsonau a all oddef llygredd.
d - Gweddol	Prin yw'r tacsonau sensitif gyda nifer fach o unigolion yn eu plith. Ystod o dacsonau a all oddef llygredd yn bresennol, rhai gyda nifer fawr o unigolion.
e - Gwael	Bioleg wedi ei gyfyngu i rywogaethau a all oddef llygredd gyda rhai tacsonau'n gryfach o ran nifer yr unigolion. Tacsonau sensitif yn brin neu'n absennol.
f - Gwael iawn	Bioleg wedi ei gyfyngu i nifer fach o dacsonau goddefgar iawn megis mwydod, larfâu gwybed mân, gelod a llau dŵr, gyda nifer fawr yn bresennol. Yn yr achos gwaethaf, efallai na fydd dim byw yn yr afon.