THE DEVELOPMENT AND TESTING OF AN INTEGRATED ASSESSMENT SYSTEM FOR THE ECOLOGICAL QUALITY OF STREAMS AND RIVERS THROUGHOUT EUROPE USING BENTHIC MACROINVERTEBRATES.

MANUAL FOR THE APPLICATION OF THE AQEM SYSTEM

A COMPREHENSIVE METHOD TO ASSESS EUROPEAN STREAMS USING BENTHIC MACROINVERTEBRATES, DEVELOPED FOR THE PURPOSE OF THE WATER FRAMEWORK DIRECTIVE

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DEVELOPED AND WRITTEN BY THE AQEM CONSORTIUM

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[1] Full title of the project: The Development and Testing of an Integrated Assessment System for the Ecological Quality of Streams and Rivers throughout Europe using Benthic Macroinvertebrates

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ANNEXES

0 SHORT VERSION

Aims and scope

AQEM enables water managers in eight European countries to assess the Ecological Quality of streams with benthic macroinvertebrates using a system, which fulfils the demands of the Water Framework Directive. Presently AQEM covers 28 European stream types, future updates will further extend its applicability.
Aims of the AQEM system are:

- to classify a stream reach into an Ecological Quality Class from 5 (high) to 1 (bad) based on a macroinvertebrate taxa list, which has been obtained using a harmonised sampling method
- to give information about the cause of a possible degradation to help direct future management practices.

Different stream types are inhabited by very different macroinvertebrate communities. Therefore, AQEM applies an approach that is specifically designed for each stream type; different calculation methods are applied based on the comparison with type-specific reference conditions. However, the system always follows the same evaluation scheme and each stream-type specific method fits into the general assessment framework.
Version 1.0 of the AQEM system has not been subject of national or international standardisation so far. The methods described here have not been ultimately approved by the authorities responsible for the implementation of the Water Framework Directive at the national level.

Application

To apply AQEM you need the AQEM software and this manual. AQEM can be applied in new monitoring programmes, which are coherent with the Water Framework Directive and where the sampling method and determination level specified in the AQEM system is used. Furthermore, the AQEM evaluation system can also be used with existing data, taken within earlier stream monitoring programmes. In this case great care is recommended in checking whether or not the data are of sufficient quality. The checklist given in *Chapter 4* should be consulted by any user before applying the software to existing data. This short version is restricted to the use of AQEM in new monitoring programmes.

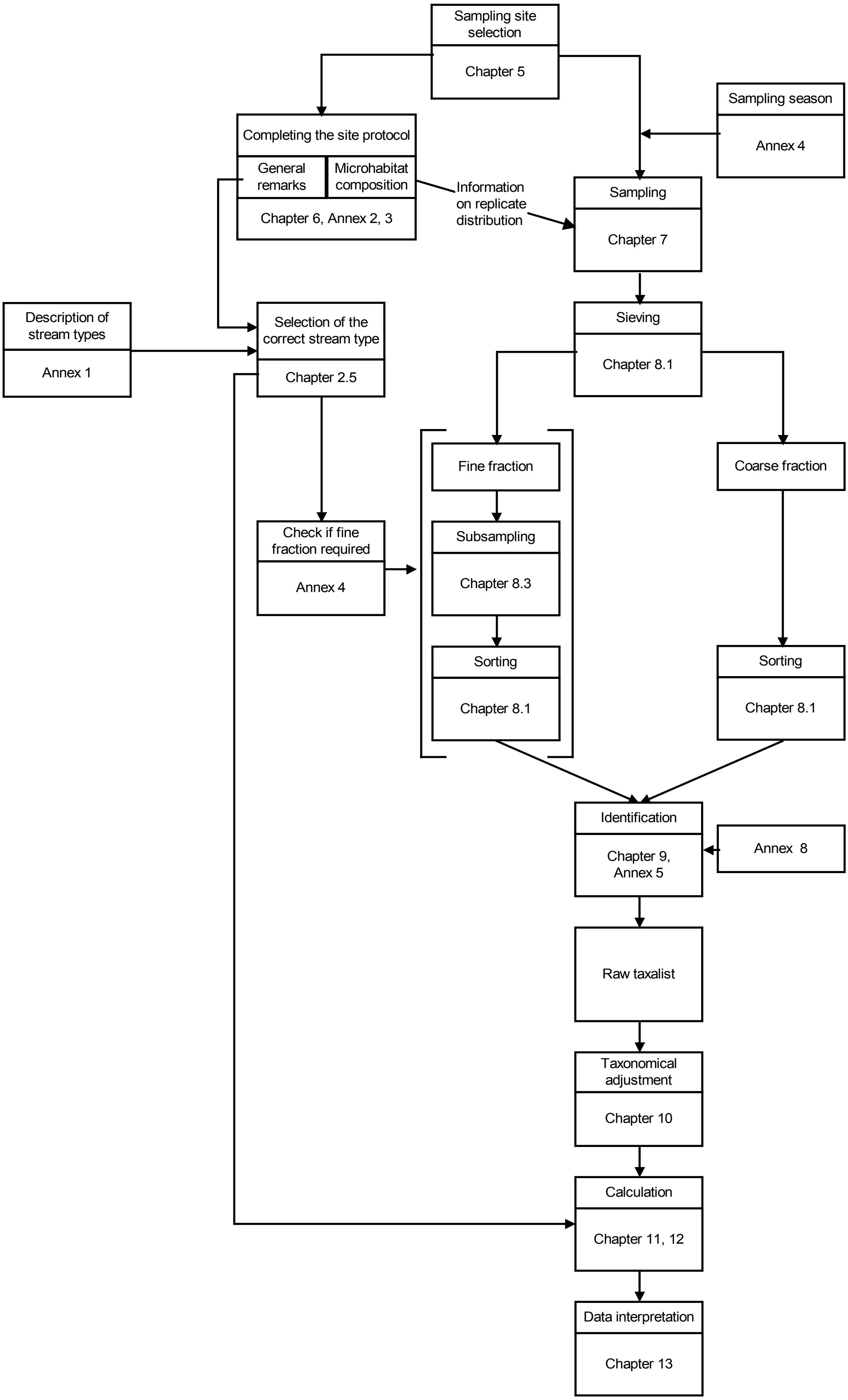

Figure 0.1: Steps of the AQEM procedure.

The AQEM system covers the complete assessment process from selecting the sampling site to data evaluation and gives some guidelines for interpreting the data and results (Figure 0.1). In the following, the most important steps for its practical use are briefly described. A more detailed description of the individual steps is given in Chapters 1-13 and the Annexes, which should be consulted in any case before applying the system.

General description of the AQEM procedure

After selecting suited sampling sites the general procedure of the AQEM system follows the same general field and lab steps shown in Figure 0.1. Depending on the stream type being assessed, some type-specific deviations must be undertaken. Some basic stream characteristics must be recorded according to the "site protocol", which help designate the site to the correct stream type. As a prerequisite for correct and successful biological sampling careful recording of the microhabitat composition is essential. The sampling itself must be done with the "multi-habitat method", by distributing 20 sampling replicates according to the distribution of microhabitats. For each stream type the best-suited sampling season(s) is(are) recommended. Sample processing includes defined sieving and sorting procedures. Identification levels differ somewhat between stream types, but generally macroinvertebrates are to be determined to the species level.

Field sampling and laboratory processing of biological samples result in a taxa list for each sampling site, which should be further harmonised performing a taxonomic adjustment. The harmonised taxa list is then imported into the AQEM software. After selecting the correct stream type the software calculates the Ecological Quality Class and gives a large number of additional information. Some interpretation guidelines are presented in this manual.

Sampling site selection (details: Chapter 4)

The "sampling site" is the spot where the biological sample is taken. This spot must be representative for the stream reach to be assessed. It is located in the "survey area", which might cover a section of several hundred meters stream length or the complete catchment area of a small stream. The length of the sampling site depends on stream width and the variability of the habitats. As a general rule, it should not be shorter than 20 meters in length and must cover the whole width of the stream; it must be representative for a minimum survey area of 500 meters stream length or 100 x average stream width, whichever is longer.

Sampling season (details: Chapter 7.1;Annex 4)

Most macroinvertebrate populations undergo distinct seasonal cycles. Since these patterns can differ greatly between stream types, different seasons are best suited for sampling. AQEM recommends sampling seasons for each stream type by defining broad time frames ("spring", "summer", "autumn", "winter", see Annex 4).

Selecting the correct stream type (details: Chapter 2.5)

The sampling site investigated must be assigned to the correct stream type before the AQEM system is applied. This can be done by comparing the sampling site with the type-specific reference conditions specified in Annex 1, by studying geological, morphological and landscape ecological maps or by studying stream-type maps.

The selection of the correct stream type is a fundamental requirement for sampling (different seasons are recommended for some stream types), lab procedures (in some cases slight deviations are recommended for certain stream types) and particularly for calculation (different metrics are best-suited for individual stream types).

Recording of basic data on stream characteristics ("site protocol"; details: Chapter 6)

In connection with the biological sampling a site protocol describing the sampling site must be completed. It contains both site and sample related information and gives an impression of stream and floodplain morphology, hydrology and vegetation. Furthermore, it ensures that the site can be precisely re-located in the field and documents the process of biological sampling. Most data relevant for the site protocol can be recorded from the stream banks. Those site protocol data, which require wading in the streambed, must be collected after the biological sampling in order to avoid disturbing the fauna. The only (!) exception is the estimation of microhabitat composition, which is a prerequisite for sampling.

Biological sampling (details: Chapter 7)

When sampling the investigator should closely follow the safety instructions given in Chapter 7.5.

The AQEM sampling method is based on a multi-habitat design, where major habitats are sampled according to their proportional distribution within a sampling reach. Macroinvertebrates are collected systematically from all available in-stream habitats. A total of 20 "replicates" is taken from all major habitat types in the reach (approx. 1.25 m^2 of habitat). For example, if the habitat in the sampling reach is 50% psammal (sand), then 50% or 10 sample units should be taken in that habitat. The microhabitats are to be categorised according to the site protocol.

Sampling starts at the downstream end of the reach and proceeds upstream. Each of the 20 "replicates" is to be taken by positioning the net and disturbing the substrate in an area that equals the square of the frame width upstream of the net (0.25 x 0.25 m). Therefore, either a hand-net/shovel sampler or a Surber sampler with a frame of 0.25 m width and at least 0.25 m height is to be used. Mesh size of the net must be 500 µm.

When kick-sampling, hold the net vertically with the frame at right angles to the current, downstream from your feet. Disturb the streambed vigorously by kicking or rotating the heel of your boot to dislodge the substratum and the fauna within a depth of at least 10-15 cm in the 0.25 x 0.25 m area upstream of the net. Hold the net close enough for the invertebrates to flow into the net with the current, but far close enough for the invertebrates to flow into the net with the current, but far enough away for most of the sand and gravel to drop before entering the net. Move cobbles and large stones by hand, sweep or brush the surfaces to dislodge clingers and sessile organisms. The surface of soft sediments (e.g. sand) should be sampled by pushing the hand-net gently through the uppermost 2-5 cm of the substrate.

Rinse the collected material by running clean stream water through the net two to three times after taking three replicates (or more frequently if necessary). Large debris can be removed after being rinsed and inspected for clinging or sessile organisms.

Transfer the sample from the net to a sample container and preserve with formalin (4% final concentration) or in enough 95% ethanol to cover the sample immediately after collection. Place a label (written in pencil, printed on a laser printer or photocopied) indicating the sample identification code, date, stream name, sampling location and collector name inside the sample container. The outside of the container should include the same information and the words "preservative: formalin 4%”, or “preservative: 95% ethanol”, respectively.

Samples that are transported alive must be kept in the minimal amount of liquid required, and they must be kept cool during transport, preferably between 4 and 8°C, in a cooler or mobile fridge. Live samples must be stored at 4 to 8°C immediately upon return to the laboratory.

Sieving (details: Chapter 8.1)

Before sorting the complete sample must be passed through a set of sieves in order to gently rinse the fine material from the sample under running water. For samples from soft-bottom streams (sand) use sieves with 1000 µm and 250 µm mesh size. For samples from gravel and hard-bottom streams use 2000 µm and 500 µm mesh size.

By sieving the sample is split up into two portions: the coarse and the fine fraction. The coarse fraction (>1000 and >2000 µm, respectively) must be sorted completely in the field or in the lab (all specimens should be removed). Only if more than 500 specimens of a taxon are present may this taxon be subsampled.

It is not necessary to analyse the fine fraction for all stream types (consult Annex 4 for details).

Subsampling (details: Chapter 8.3)

At least 500 specimens should be sorted out from the fine fraction. If it appears that more specimens are present, the fine fraction can be subsampled.

To subsample the fine fraction, first rinse the fine fraction over a 250 µm sieve. Afterwards spread the fine fraction evenly across a water-filled pan marked with grids approximately 6 cm x 6 cm. Using a random numbers table select four numbers corresponding to squares (grids) within the gridded pan. All material (organisms and debris) must be removed from the four grid squares and the material must be placed into a shallow white pan. If it appears (through a cursory count or observation) that there remain 500 organisms ± 20% (cumulative of four grids) in the selected subsample, then subsampling is complete. If many more than 500 organisms are presumed in the material from the 4 selected grids, transfer this material into another gridded pan. Once again, randomly select grids for this second level of sorting and sort grids until 500 organisms ± 20% are found.

Sorting (details: Chapter 8.1)

The organisms should be separated into systematic units when they are sorted in the lab (separate for the coarse and the fine fraction).

Identification (details: Chapter 9; determination level: Annex 5; determination literature: Annex 8)

The AQEM system is based on a specific set of calculation methods ("metrics") for each individual stream type. The AQEM metrics are mainly based on species level data in those countries, where taxonomic knowledge allows for a precise determination of aquatic stages. In the Southern European countries, genus and family level is sufficient in most cases for applying the AQEM metrics. Annex 5 lists the level of determination required for applying the system to each individual stream type.

Incorrect determination is the main source of errors in biological sample treatment. For state of the art determination use the determination literature specified in Annex 8. The identification process of the sorted specimens results in a preliminary taxa list for each sampling site.

Taxonomic adjustment (details: Chapter 10)

Further processing of the preliminary taxa list is recommended to obtain a consistent data set. There should be no taxa overlap, because taxonomic overlap results in a multiplication of the same information in one sample. For example, it should be avoided that "*Baetis* spec.", "*Baetis alpinus*-group" and "*Baetis alpinus*" are regarded as three different taxa. There are three methods for taxonomic data processing:

- aggregating species to a higher taxonomic level
- omitting a higher taxonomic level
- distributing individuals which are "only" determined to genus level according to the relative share of individuals determined to species level (e.g. 100 individuals determined as *Baetis sp.* could be divided among *Baetis fuscatus* (60 individuals determined) and *Baetis rhodani* (140 individuals determined) according to their relative occurrence 30:70).

All methods can be used within one data set. The choice of the best-suited method should be made depending on the taxonomic group at question, based on a combination of individuals occurring and their abundance and the ecological relevance of the species within the respective taxonomic group.

Calculation (details: Chapters 11, 12; Annex 6, Annex 7)

AQEM offers a user-friendly software package, which performs the calculation of the Ecological Quality Class and provides a lot of additional information. It is based on a so-called “multimetric calculation”, which is described in detail in Chapter 11. For each stream type a set of “metrics” (e.g. saprobic indices, number of occurring taxa, feeding-type composition) is used for assessing the ecological quality. In many cases the metrics are categorised according to their sensitivity in detecting the impact of certain stressors.

AQEM software (details: Chapter 12)

The AQEM software performs all calculations necessary for applying the AQEM system:

- calculation of the Ecological Quality Class of a sampling site, based on a macro-invertebrate taxa list, by performing the stream-type specific calculations specified in Chapter 11 and Annex 7;
- calculation of a large number of additional metrics, which are helpful for further data interpretation.

The AQEM software is only a calculation program and not designed for storing data. It is based on EXCEL as common and comparatively compatible computing system, to which most databases are able to export data sheets.

The AQEM software is capable of importing a taxa list in either EXCEL (*.xls) or ASCII file format and exporting results to either EXCEL or ASCII files. Preparing data sets for import into the AQEM software must be done using a different program, e.g. EXCEL or a text editor.

Data interpretation (details: Chapter 13)

If a stream is of “moderate”, “poor” or “bad” quality, restoration measures are necessary to improve stream quality. For this there are several options such as restoring natural stream morphology and decreasing acidification, pollution or eutrophication. The results of the individual metrics used to determine the Ecological Quality Class, also give information on which restoration methods may prove most useful.

1 INTRODUCTION

1.1 Aims of stream assessment with benthic invertebrates

General remarks

AQEM supports the implementation of the EU Water Framework Directive by providing a system for assessing ecological quality in European streams with benthic macroinvertebrates.

The EU Water Framework Directive (Directive 2000/60/EC - Establishing a Framework for Community Action in the Field of Water Policy) outlines a legal structure for the assessment of all types of water bodies in Europe. Thereby one main focus of future assessment systems lies in using biotic indicators (macrobenthic fauna, fish fauna and aquatic flora) for assessment measures – a novelty in many European countries. Furthermore the ecological status of a water body is to be defined by comparing the biological community composition of the investigated stream or lake with near-natural reference conditions. These newly established guidelines on water quality assessment, have given rise to a strong demand for “new” assessment systems, which fulfil these criteria and for adapting existing systems to meet them.

Benthic macroinvertebrates are ”...organisms that inhabit the bottom substrates (sediments, debris, logs, macrophytes, filamentous algae, etc.) of freshwater habitats” (definition after ROSENBERG & RESH 1993). They are usually considered to be large enough to be seen without magnification, i.e. retained in a net with a mesh size of 100 to 500 µm. These organisms, together with algae, serve as the most common biological water quality assessment indicators.

Generally, benthic macroinvertebrates are capable of reflecting different anthropogenic perturbations and, thus, enable a holistic assessment of streams. Besides organic pollution, which can be assessed using a large number of indices, benthic macroinvertebrates can also be used to detect acidification, habitat degeneration and overall stream degradation.

Aims of the AQEM system

AQEM enables water managers in eight European countries to assess the Ecological Quality of streams with benthic macroinvertebrates using a system, which fulfils the demands of the Water Framework Directive. Presently it covers 28 European stream types; future updates will further extend its applicability.

Aims of the AQEM system are:

- to classify a stream stretch into an Ecological Quality Class from 5 (high) to 1 (bad) based on a macroinvertebrate taxa list, which has been obtained from sampling the stretch using a harmonised method

- to give information about the possible causes of degradation in order to help direct future management practices.

As demanded by the Water Framework Directive AQEM applies a stream-type specific approach. Particularly at the European scale this is inevitable, since e.g. a highland river in Sweden and a lowland river in Italy are inhabited by very different macroinvertebrate communities. Thus each stream type is assessed using different calculation methods, which are applied based on the comparison with reference conditions for each particular stream type. However, the system always follows the same evaluation scheme and each stream-type specific method fits into the general assessment framework. This framework is based on:

- *Stressor-specific approach*: for each stream type the “main” degradation factor presently affecting the stream is assessed. This might be acidification (e.g. in Northern Sweden), degradation in stream morphology (e.g. in Central Europe) or organic pollution (e.g. in Southern Europe). In some cases more than one stressor are assessed individually. The results are then either combined to a final assessment result (see Chapter 3.3) or the assessment is considered to address “general degradation”, because stressors are always correlated.
- *Multimetric system*: for each stream type those calculation methods have been identified, which indicate a site’s state of degradation best. The results of the individual calculation methods are then combined in a “multimetric formula” (see Chapter 11).
- The multimetric result is converted into the final score ranging from 5 (high quality) to 1 (bad quality). The classes represent a gradient from degraded to reference or best-available conditions.

1.2 How the AQEM system was developed

The assessment system outlined here is the main result of the project AQEM (funded by the European Union), which was carried out from March 2000 to February 2002.
In contrast to many other comparable projects, the development of the AQEM system has been based on a new data set covering both the benthic macroinvertebrate fauna and general stream characteristics. The data were collected by all “scientific partners” within the project. Generally, the following steps were taken:

- Selection of 29 common European stream types[2].

[2] For one stream type the development process has not been completed. For this stream type only the field and lab procedures but not the calculation is described in this manual. Therefore, some parts of the manual refer to 29 stream types, some parts refer to 28 stream types.

- Selection of the most important stressor (e.g. organic pollution, degradation in stream morphology) affecting each individual stream type. In some cases, the impact of more than one stressor was investigated.
- Selection of 11 to 30 sampling sites per stream type covering differently degraded sections ranging from reference sites to heavily degraded sites in regard to the selected stressor only.
- Benthic macroinvertebrate sampling in at least two different seasons using a harmonised sampling method. Identification of the macroinvertebrates to the best obtainable level.
- Recording of a large number of parameters related to stream morphology, chemistry and catchment characteristics using a harmonised “site protocol”.
- Deriving a stream-type specific classification, which reflects the degradation of a site, based on the abiotic “site protocol” data. Alternatively: post-classification based on the biotic composition followed by setting of class boundaries.
- Test of a large variety of calculation methods (“metrics”) with the goal to identify metrics reflecting the degradation of the stream. In some cases, new metrics were developed.
- Selection of those metrics with the strongest correlation to the site’s state of degradation as derived from the abiotic classification.
- Exclusion of redundant metrics.
- Combination of the conclusive selection of metrics in a multimetric system.
- Testing and revision of the stream-type specific assessment systems with larger data sets.
- Defining class boundaries between “high”, “good”, “moderate”, “poor” and “bad” ecological status for the selected stream types.

1.3 Components necessary for applying the AQEM system

To apply AQEM you need the AQEM software and this manual, both of which can be downloaded free of charge from www.aqem.de. The AQEM software uses a taxa list containing large amounts of autecological information on the individual taxa. The list is part of the program.
The AQEM system is designed for use with either

- existing data of a sufficient quality (Chapter 4.2)
- or (preferably) data obtained in future monitoring programmes taken with a harmonised sampling method (Chapter 7).

Presently, the AQEM system is limited to the 28 stream types described in Chapter 2. More stream types will be added in the future, as results from various national and international projects. The process of adding more stream types to the system is described in Chapter 14.

Important note: version 1.0 of the AQEM system has not been subject of national or international standardisation so far. The methods described here have not been ultimately approved by the authorities responsible for the implementation of the Water Framework Directive at the national level.

1.4 "Help desk" and request for failure notice

Although the AQEM system has been developed with care and is based on an extensive data set, it certainly can and will be improved in future. For this purpose, we need your help!
If you notice any mistake or have suggestions for improvements we would be most grateful if you inform us via email (aqem@uni-essen.de).
Your failure or suggestion notice could e.g. cover:

- suggestions to improve the field and/or laboratory methods
- suggestions for applying alternative or additional metrics for a certain stream type, setting different class boundaries, altering scores for individual taxa
- suggestions to improve the software (e.g. more user-friendly application)
- suggestions to improve this manual.

In regular intervals an update of the software and the manual will be available at www.aqem.de. The first update (version 1.1) is planned for August 2002. All people and institutions contributing to the update with their suggestions will automatically be informed about the update.
We would like to thank you very much in advance for your effort and help!

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2 STREAM TYPOLOGIES

2.1 Introduction

History and application

The classification of water bodies has a long tradition in Europe, leading back to the classification of lakes at the end of the 19th century. The classification of streams generally follows one of two approaches: longitudinal zonation (e.g. by using "fish zones"), which was first developed in the 19th century and the regional classification, which is a comparatively new approach in aquatic sciences. The regional classification of streams (i.e. "stream typology") is an interdisciplinary and applied approach, which bases on a mix of hydrobiological, geological, geographical and hydrological sciences.

For developing such assessment systems as required by the EU Water Framework Directive, stream typologies based on near-natural reference conditions are essential. The comparison with undisturbed sites allows the definition and classification of different states of degradation. This comparison must be done specifically for each stream type. For example, it is not surprising that the abiotic conditions of slow-flowing lowland streams with finer substrates and higher temperature regimes support completely different biocoenoses compared to the fast flowing mountain streams with rough substrates and generally lower water temperature. Also the effects of deterioration are usually specific for each stream type. The effects of channel bed alteration (scouring, straightening, artificial bed fixation) lead to completely different results in lowland streams in comparison to mountain streams. Thus a stream-type specific assessment approach should be followed.

Furthermore, typologies allow an estimation of the ecological potential of streams in different landscapes or regions. The detailed description of regional stream types based on near-natural conditions may serve as an orientation in the processes of stream restoration.

What is a stream type?

A stream type is an artificially delineated but potentially ecologically meaningful entity with limited internal biotic and abiotic variation and a biotic and abiotic discontinuity toward other types.

Stream types might serve as "units", for which an assessment system can be applied. A stream type should always be defined on the basis of natural or near-natural reference sites, since the comparison with undisturbed sites of a certain stream type allows defining and classifying different states of degradation. Biological assessment requires sufficiently stable, integrated stream typologies, which consider both abiotic and biotic criteria. The most prominent abiotic factors are stream morphology, geochemistry, altitude, stream size and hydrology.

2.2 Outlines of a European stream typology

The Water Framework Directive requires stream-type specific assessment systems based on biotic parameters; however, a complete ”typology of European streams” appropriate for fulfilling the requirements of the Water Framework Directive is presently unavailable.

The approaches to stream typology in the EU member states are very diverse. Beside classification systems using single abiotic parameters (aquatic geochemistry in Greece) or based on abiotic factors and functional elements (e.g. France), some typologies are already founded on both abiotic and biological (mainly focusing on macroinvertebrates) factors (e.g. the Netherlands). Typologies based on several abiotic and biotic parameters are only available for small geographic regions in Europe.

Various countries are presently working out descriptions of “sub-ecoregions” or “aquatic landscape units”. This important step serves as a sound base for structuring the diverse landscape and in deducing different stream types (e.g. Austria, Germany).

Generally, stream typologies can be designed following either “top-down” or “bottom up” approaches or by a mixture of both. The major difference between a “top-down” and a “bottom-up” approach is the reliability of criteria (either environmental parameters or organism groups). In a “top-down” approach parameters are chosen on the basis of knowledge and human presumptions. For example dividing the large-scale unit of the ecoregion into “sub-ecoregions“ is a helpful, “top-down” method for further differentiating stream types based on a human perspective of landscape.

In a “bottom-up” approach the results of ecological analysis are used for grouping the streams. Only those parameters, which are actually ecologically relevant, are considered in this description. Research on the importance of scale and ecological relevance of parameters shows that even small-scale landscape units may only partially explain the distribution of species and communities.

Thus, for practical reasons one should begin with a “top-down” typological framework, which then must be verified through “bottom-up” directed ecological analysis in order to establish a sound typology.

2.3 Constructing stream typologies for the purposes of the EU Water Framework Directive

Rules

There may be thousands of streams in Europe and their natural conditions are quite different. In order to develop typologies, the following methodological rules are given by the Water Framework Directive (Annex II):

"Member States shall identify the location and boundaries of bodies of surface water and shall carry out an initial characterisation of all such bodies in accordance with the following methodology. Member States may group surface water bodies together for the purposes of this initial characterisation.

(i) The surface water bodies within the river basin district shall be identified as falling within either one of the following surface water categories - rivers, lakes, transitional waters or coastal waters - or as artificial surface water bodies or heavily modified surface water bodies.

(ii) For each surface water category, the relevant surface water bodies within the river basin district shall be differentiated according to type. These types are those defined using either "system A" or "system B" identified in section 1.2."

Which System should be used? System A or System B?

Annex II of the Water Framework Directive provides two optional approaches for the development of regional river typologies in the member states: System A and System B.

System A

"(iii) If system A is used, the surface water bodies within the river basin district shall first be differentiated by the relevant ecoregions in accordance with the geographical areas identified in section 1.2 and shown on the relevant map in Annex XI. The water bodies within each ecoregion shall then be differentiated by surface water body types according to the descriptors set out in the tables for system A."

For European rivers 25 ecoregions have been defined (acc. to ILLIES 1978; see map in Annex XI Water Framework Directive). For each ecoregion further differentiations are possible using several descriptors:

Fixed Typology	*Descriptors*
Ecoregion	Ecoregions shown on Map A in Annex XI
Type	Altitude typology high > 800 m mid-altitude 200 to 800 m lowland < 200 m Size typology based on catchment area small 10 – 100 km² medium > 100 to 1000 km² large > 1000 to 10000 km² very large > 10000 km² Geology calcareous siliceous organic

For states without any stream typology it has proven useful to apply System A of the EU Water Framework Directive for a preliminary classification. This system identifies the stream types based on general landscape conditions and serves as a first basis for comparisons by providing a common starting point .

System B

"(iv) If system B is used, Member States must achieve at least the same degree of differentiation as would be achieved using system A. Accordingly, the surface water bodies within the river basin district shall be differentiated into types using the values for the obligatory descriptors and such optional descriptors, or combinations of descriptors, as are required to ensure that type specific biological reference conditions can be reliably derived."

System B provides an alternative characterisation of the water bodies using five obligatory and 15 optional parameters. The obligatory parameters are partly coherent to system A (altitude, size, geology, supplemented by latitude and longitude). The 15 optional parameters comprise more detailed geomorphologic and hydrological features like shape of valley and streambed, water depth and width, substrates, discharge and some chemical parameters (see table below).

Alternative Characterisation	Physical and chemical factors that determine the characteristics of the river or part of the river and hence the biological population structure and composition
Obligatory factors	altitude latitude longitude geology size
Optional Factors	distance from river source energy of flow (function of flow and slope) mean water width mean water depth mean water slope form and shape of main river bed river discharge (flow) category valley shape transport of solids acid neutralising capacity mean substratum composition chloride air temperature range mean air temperature precipitation

System B allows for more flexibility and a more detailed and understandable description of the types. Following the state of the art in Europe, most of the EU member states use System B to define their stream types.
Within AQEM, fundamental elements of System B have been applied for describing the stream types.

2.4 Description of the AQEM stream types

Even within a large project like AQEM, it is impossible to cover all stream types occurring in Europe. Therefore 29 stream types were selected based on a general stream typology approach.
The lack of a generally accepted European stream typology led to a comparatively simple ”top down” method of defining the stream types investigated. In most cases, the criteria defined by the EU Water Framework Directive have been used for a first differentiation:

- ecoregions (according to ILLIES 1978)
- size classes (based on catchment area)
- geology of the catchment
- altitude classes

In regions, where stream types are better known or regional typologies exist, additional criteria were applied for the further definition and description of the types (e.g. in the Netherlands, Austria and Germany). Most criteria used are also considered in System B of the EU Water Framework Directive e.g. substrates, flow type and detailed geological categories. The more detailed descriptions of the stream types (Annex 1) also consider other parameters that proved useful in defining stream typologies (valley form, channel form, width of floodplain, natural entrenchment, average stream depth and width, substrates, natural vegetation, hydrology, flow velocity, discharge, water chemistry, macroinvertebrate community).
The AQEM system covers 28 common European stream types, which are representative for large parts of Europe (Table 2.1). Almost all of the stream types have a catchment area <1000 km^2 (”small” and ”mid-sized” streams).

TABLE 2.1: Overview of stream types investigated in AQEM. For details see Annex 1. Column “ecoregion”: number acc. to ILLIES (1978). Column “geology class”: cal = calcareous, sil = siliceous, org = organic, alluv = alluvial deposits. Column “major degradation factors”: M = degradation in stream morphology, O = Organic pollution, A = acidification, G = general degradation (not specified). Approximate distribution of the types: see Figure 2.1. Stream type I01: presently no assessment metrics are specified. For a detailed description of the stream types see Annex 1.

	Stream type	*Size class*	*Altitude class (m.a.s.l.)*	*Ecoregion*	*Geology class*	*Major degradation factors*
A01	Mid-sized streams in the Hungarian Plains	>100-1000 km^2	200-800	11	sil (moraines)	O
A02	Mid-sized calcareous pre-alpine streams	>100-1000 km^2	200-800	4	cal	M, O
A03	Small non-glaciated crystalline alpine streams	10-100 km^2	>800	4	sil	M, O
A04	Mid-sized streams in the Bohemian Massif	>100-1000 km^2	200-800	9	sil	M, O
C01	Mid-sized streams in the central sub-alpine mountains	>100-1000 km^2	200-500	9	sil	O
C02	Small streams in the Carpathian	10-100 km^2	200-500	10	flysch	O
C03	Mid-sized streams in the Carpathian	>100-1000 km^2	200-500	10	flysch	O
D01	Small sand bottom streams in the German lowlands	10-100 km^2	<200	14	sil	M, O
D02	Organic type brooks in the German lowlands	10-100 km^2	<200	14	org	M, O
D03	Mid-sized sand bottom streams in the German lowlands	>100-1000 km^2	<200	14	sil	M, O
D04	Small streams in lower mountainous areas of Central Europe	10-100 km^2	200-800	9	sil	M, O
D05	Mid-sized streams in lower mountainous areas of Central Europe	>100-1000 km^2	200-800	9	sil	M, O
H01	Mid-altitude mid-sized siliceous streams in North-Eastern Greece	>100-1000 km^2	200-800	6	sil	O

	Stream type	*Size class*	*Altitude class (m.a.s.l.)*	*Ecoregion*	*Geology class*	*Major degrada-tion fac-tors*
H02	Mid-altitude large siliceous streams in Central and Northern Greece	>1000-10000 km^2	200-800	6	sil	O
H03	Mid-altitude mid-sized calcareous streams in Western Greece	>100-1000 km^2	200-800	6	cal	O
I01	Small-sized streams in the south-ern silicate Alps	10-100 km^2	>800	4	sil	M
I02	Small-sized, calcareous streams in the Southern Apennines	10-100 km^2	200-800	3	cal	G
I03	Mid-sized calcareous streams in the Northern Apennines	>100-1000 km^2	200-800	3	cal	M
I04	Small lowland streams of the Po valley	10-100 km^2	<200	3	sil	G
N01	Small Dutch lowland streams	≤10-100 km^2	<200	13, 14	sil	G
N02	Small Dutch hill streams	≤10-100 km^2	<200	14	sil	G
P01	Small-sized siliceous streams in lower mountainous areas of Southern Portugal	10-100 km^2	200-800	1	sil	O
P02	Small-sized siliceous lowland streams of Southern Portugal	10-100 km^2	<200	1	sil	O
P03	Medium-sized siliceous lowland streams of Southern Portugal	>100-1000 km^2	<200	1	sil	O
S01	Small lowland streams in Northern Sweden	10-100 km^2	<200	22	sil	A
S02	Small mid-altitude streams in Northern Sweden	10-100 km^2	200-800	22	sil	A
S03	Small mid-altitude streams in the Boreal Highlands	10-100 km^2	200-800	20	sil	A
S04	Small high-altitude streams in the Boreal Highlands	10-100 km^2	>800	20	sil	A
S05	Medium-sized lowland streams in the South Swedish lowlands	100-1000 km^2	<200	14	sil	A, O

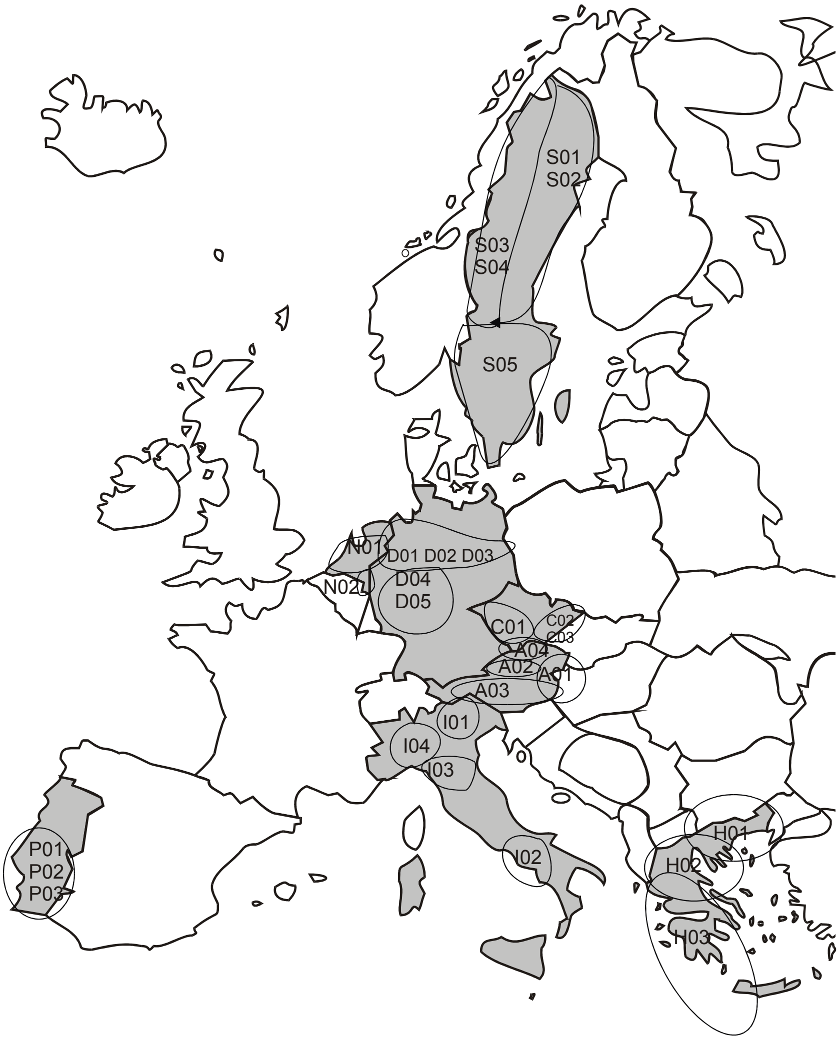


FIGURE 2.1: Approximate distribution of the AQEM stream types.

2.5 Selecting the correct stream type

General remarks

Even though the AQEM assessment system follows the same basic structure for assessing all of the individual stream types, different metrics are used to calculate the ecological quality. It is not possible to use the assessment formula developed for a certain type for another one, even if it belongs to the same system A-category. An example: Stream type D01 “small sand bottom stream (in the German) lowlands” is very common Northern Germany and adjacent areas. It is characterised by a sand dominated substratum, which is the main factor determining species composition under natural conditions (mainly psammal and xylal inhabitants, only a few rheophilous species). This type belongs to the following categories of system A of the Water Framework Directive:

Ecoregions: 13, 14
Altitude typology: lowland, < 200 m
Size typology: small, 10-100 km²
Geology: siliceous

In the same ecoregion, where this type is found, another type, the "small gravel-dominated stream" can occur. It has a comparably high thalweg slope and a relatively thick layer of gravel. The descriptors of the system A approach are the same, but the stream type has a completely different species composition, which is more related to that of small mountainous and hilly streams (more akal inhabitants, rheophilous species).
Therefore, the stream investigated (or the stream reach considered) has to be assigned to the correct stream type before the AQEM system is used. This can be done either in the field or with maps following the procedures given below:

- *Comparison with type-specific reference conditions*. This implies comparing the features of the stream investigated in its near-natural state with those features given in the descriptions in Annex 1. It is very important that the features compared reflect the reference conditions. This is especially difficult if streams are in a degraded state, which then have a more or less uniform character. Some indication of the near-natural condition of a stream can be provided by its general morphology (valley shape, channel form, cross section, substrates), geochemistry (alkalinity, pH value, conductivity) and hydrology. It should be made clear that, with the exception of valley shape, thalweg slope and alkalinity, most of the other parameters suitable for describing stream types are easily altered by human impacts and, therefore, should be used with caution and care. Sometimes hints may be provided by more natural streams in the vicinity, which (probably) belong to the same type.
- *Study of geological, morphological and landscape ecological maps*. The different stream types are usually defined and described with special emphasis on their geomorphologic and landscape ecological features. The distribution of many stream types is closely related to the occurrence of certain geological formations (e.g. Type D03 "Mid-sized sand bottom stream in the German lowlands" is common in the lowlands, in sand-dominated areas of the quaternary, especially sander and sandy parts of the moraines, but not in mountainous areas, or in terraces, loess areas, floodplain areas or gravel dominated parts of moraines).
- *Study of stream type maps*. In several countries maps showing the distribution of stream types, are in preparation or already finished (e.g. Austria). These maps make it easy to assign an investigation site to the correct stream type. Even if such a map is already available, one should be aware that they are quite new products. Therefore, they should always be validated using local features in the field.

3 REFERENCE CONDITIONS AND CLASSES OF DETERIORATION

The main goal of stream assessment according to the Water Framework Directive is to classify a stream stretch into an Ecological Quality Class ("high", "good", "moderate", "poor" or "bad"), which is defined by its deviation from a stream-type specific reference condition. This Chapter describes, how a "reference stream" is characterised and how the degradation classes might be defined.

3.1 Definitions of the Water Framework Directive

In general, the following criteria given by the Water Framework Directive must be met by the assessment system. In Annex II, 1.3 the Framework Directive defines the following under the headline "Establishment of type-specific reference conditions for surface water body types":

"(iii) [...] type-specific biological reference conditions may be either spatially based or based on modelling, or may be derived using a combination of these methods. Where it is not possible to use these methods, Member States may use expert judgement to establish such conditions. [...]

(iv) For spatially based type-specific biological reference conditions, Member States shall develop a reference network for each surface water body type. The network shall contain a sufficient number of sites of high status to provide a sufficient level of confidence about the values for the reference conditions, given the variability in the values of the quality elements corresponding to high ecological status for that surface water body type and the modelling techniques which are to be applied under paragraph (v).

(v) Type-specific biological reference conditions based on modelling may be derived using either predictive models or hind casting methods. The methods shall use historical, palaeological and other available data and shall provide a sufficient level of confidence about the values for the reference conditions to ensure that the conditions so derived are consistent and valid for each surface water body type.

(vi) Where it is not possible to establish reliable type-specific reference conditions for a quality element in a surface water body type due to high degrees of natural variability in that element, not just as a result of seasonal variations, then that element may be excluded from the assessment of ecological status for that surface water type. [...]"

Annex V outlines:

"General definitions [of high, good and moderate status] for streams, lakes, transitional waters and costal waters [...]

High status	There are **no, or only very minor**, anthropogenic alterations to the values of the physicochemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions. The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion. These are the type specific conditions and communities.
Good status	The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human impact activity, but deviate **only slightly** from those normally associated with the surface water body type under undisturbed conditions.
Moderate status	The values of the biological quality elements for the surface water body type deviate **moderately** from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status.

Waters achieving a status below moderate shall be classified as poor or bad.

Waters showing evidence of **major** alterations to the values of biological quality elements for the surface water body type and in which the relevant biological communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions, shall be classified as poor.

Waters showing evidence of **severe** alterations to the values of the biological quality elements for the surface water body type and in which large portions of the relevant biological communities normally associated with the surface water body type under undisturbed conditions are absent, shall be classified as bad."

More specifically, the high, good and moderate ecological status in streams concerning the benthic invertebrate fauna is defined as follows:

High status	The taxonomic composition and abundance correspond totally or nearly totally to undisturbed conditions. The ratio of disturbance sensitive taxa to insensitive taxa shows no sign of alteration from undisturbed levels. The level of diversity of invertebrate taxa shows no sign of alteration from undisturbed levels.
Good status	There are slight changes in the composition and abundances of invertebrate taxa from the type-specific communities. The ratio of disturbance sensitive taxa to insensitive taxa shows slight alteration from type specific levels. The level of diversity of invertebrate taxa shows slight signs of alteration from type specific levels.
Moderate status	The composition and abundance of invertebrate taxa differ moderately from the type-specific communities. Major taxonomic groups of the type-specific community are absent. The ratio of disturbance sensitive taxa to insensitive taxa, and the level of diversity, are substantially lower than the type specific level and significantly lower than for good status.

In conclusion, the assessment with benthic invertebrates should be performed using parameters, which describe

- taxonomic composition
- abundance
- ratio of sensitive to insensitive taxa
- species diversity.

For designating Quality Classes the following guidelines must be followed:

- high status: no, or only very minor, deviations from the reference
- good status: slight deviations from the reference
- moderate status: moderate deviations from the reference
- poor status: major deviations from the reference
- bad status: severe deviations from the reference

3.2 Criteria for reference conditions applied in AQEM

A reference stream should fulfil all requirements necessary to allow a completely undisturbed fauna to develop and establish itself. Therefore, "reference sites" should not only be characterised by clean water but also by undisturbed stream morphology and near-natural catchment characteristics. Though it is impossible for many stream types to find sites in such a pristine condition, AQEM has defined the following criteria, which should be met by "realistic" reference sites:

Basic statements

- The reference condition must be politically palatable and reasonable.
- A reference site, or process for determining it, must hold or consider important aspects of "natural" conditions.
- The reference conditions must reflect only minimal anthropogenic disturbance.

Land use practices in the catchment area

- In most countries there is anthropogenic influence within the catchment area. Therefore, the degree of urbanisation, agriculture and silviculture should be as low as possible for a site to serve as a reference site. No absolute minimum or maximum values have been set for the defining reference conditions (e.g. % arable land use, % native forest); instead the least-influenced sites with the most natural vegetation are to be chosen.

River channel and habitats

- The reference site floodplain should not be cultivated. If possible, it should be covered with natural climax vegetation and/or unmanaged forest.
- Coarse woody debris must not be removed (minimum demand: presence of coarse woody debris).
- Stream bottoms and stream margins must not be fixed.
- Preferably, there should be no migration barriers (effecting the bedload transport and/or the biota of the sampling site).
- Only moderate influence due to flood protection measures can be accepted.

Riparian vegetation and floodplain

- Natural riparian vegetation and floodplain conditions must still exist making lateral connectivity between the stream and its floodplain possible; depending on the stream type, the riparian buffer zone should be greater or equal to 3 x channel width.

Hydrologic conditions and regulation

- No alterations of the natural hydrograph and discharge regime should occur.

- There should be no or only minor upstream impoundments, reservoirs, weirs and reservoirs retaining sediment; no effect on the biota of the sampling site should be recognisable.
- There should be no effective hydrological alterations such as water diversion, abstraction or pulse releases.

Physical and chemical conditions

There should be

- no point sources of pollution or nutrient input affecting the site
- no point sources of eutrophication affecting the site
- no sign of diffuse inputs or factors which suggest that diffuse inputs are to be expected
- “normal“ background levels of nutrient and chemical base load, which reflect a specific catchment area
- no sign of acidification
- no liming activities
- no impairments due to physical conditions; especially thermal conditions must be close to natural
- no local impairments due to chemical conditions; especially no known point-sources of significant pollution, all the while considering near-natural pollution capacity of the water body
- no sign of salinity

Biological conditions

There must not be any

- significant impairment of the indigenous biota by introduction of fish, crustaceans, mussels or any other kind of plants and animals
- significant impairment of the indigenous biota by fish farming

In many cases, e.g. some lowland stream types or larger streams, no reference sites meeting the criteria above are available. For these stream types the “best available” existing sites, which meet most of the criteria should only be a starting point; the description of reference communities should be supplemented by evaluation of historical data and possibly the biotic composition of comparable stream types, e.g. streams of a similar size but located in different ecoregions.

FIGURE 3.1: Reference site stream type D01 (small sand-bottom streams in the German lowlands): diverse substrates, natural riparian and the floodplain vegetation (Furlbach, East-Westphalia).

FIGURE 3.2: Close to reference conditions: near-natural situation, but the stream is clearly scoured (Eltingmühlenbach, Westphalia).

FIGURE 3.3: No reference site: lack of natural riparian vegetation and agricultural land use in the floodplain (pasture) (Osterau, Schleswig-Holstein).

FIGURE 3.4: No reference site: no coarse woody debris due to the lack of riparian vegetation and intensive maintenance (Wehrau, Schleswig-Holstein).

FIGURE 3.5: Clearly no reference site: the stream is scoured and the banks are fixed with stones (Rotbach, Lower Rhine area).

FIGURE 3.6: No reference site: the migration of fish and invertebrates is obstructed by a weir (Dellbach, Lower Rhine area).

3.3 The "stressor specific approach" applied in AQEM

The assessment method must be capable of indicating a general degradation of the benthic macroinvertebrate fauna, regardless, which factor is causing the degradation. Most important is the discrimination between the "good" ecological status (slight deviation from the reference conditions) and the "moderate" ecological status (moderate deviation from the reference conditions), since all streams, which are not regarded as "heavily modified", should be transformed into a "good" or "high" status according to the Water Framework Directive. The border between "good" and "moderate" therefore indicates the necessity of applying management measures.

However, as soon as a stream is classified as being "moderate" in quality, the question arises, what the causes of degradation are. This information is necessary to direct the future management practices. Therefore, whenever possible the AQEM system uses several modules for assessment, which specifically reflect the impact of certain stressors.

The macroinvertebrate community of most streams in Europe is impacted by more than one stressor, such as organic pollution, eutrophication, acidification, toxic substances, habitat degradation and catchment use. In large parts of Europe, particularly in the Southern European countries, organic and inorganic pollution is still the main factor affecting the macroinvertebrate community, while in Central Europe the impact of habitat degradation is regarded as being more severe. Acidification is restricted to small areas in Europe, particularly the boreal highlands. The impact of eutrophication on the stream community is likely to be assessed more thoroughly using the aquatic flora.

If the data set available for assessing each individual stream type is sufficient a "stressor specific assessment approach" as outlined above is applied individually for all those stream types, which are often affected by more than one stressor:

- In ten of the AQEM stream types the system is capable of distinguishing the impact of more than one stressor (usually organic pollution and habitat degradation) with different calculation modules. The results of the single modules are finally combined to give the conclusive assessment result.
- In four stream types it proved impossible to distinguish the impact of certain stressors; therefore, the "general degradation" of the fauna is assessed with only one module.
- The remaining 14 stream types are mainly affected by a single stressor, either acidification (stream types in Northern Sweden) or organic pollution (most stream types in the Mediterranean). Other stressors might be present but are less important. Therefore, the assessment system is restricted to one module, which reflects the effect of only the main stressor.

This system allows for future extension through the simple addition of further modules for more stressors, as soon as these have been developed.

FIGURE 3.7: Organic pollution, an important stressor especially in Eastern and Southern European stream types.

FIGURE 3.8: Morphological degradation is a specific problem for most Central European streams.

FIGURE 3.9: *Sphagnum* mosses in the riparian area indicate acidification, which might be natural but is often man-made in parts of Northern and Eastern Europe.

FIGURE 3.10: Water abstraction for hydropower engineering is especially a problem in alpine and Mediterranean areas.

4 Application and Restrictions

Before using the AQEM software carefully check that all conditions necessary for the application of the system are fulfilled.

All assessment and calculation formulas ever developed, regardless whether metrics or multivariate methods are used, are specifically designed for certain circumstances. The user must be aware of this and adopt or adjust these circumstances if necessary. Incorrect use of assessment software can lead to almost any conceivable result. Obtaining valid and useful results is only possible, if the right functions are used under the right circumstances.

Concerning the application of the AQEM system two different situations should be distinguished: the use of the AQEM evaluation system

- in new monitoring programmes, which are coherent with the Water Framework Directive, and where the sampling method and determination level specified in the AQEM system is applied.
- with existing data, taken in earlier stream monitoring programmes.

Particularly in the latter case, great care is recommended in checking whether or not the AQEM system should be applied and, if yes, which module should be utilised. Any user should consult the following „checklist" before applying the software.

4.1 Applicability of the AQEM system in general

Is the stream type you are investigating covered by the AQEM system?

The AQEM system is stream-type specific in order to meet the Water Framework Directive requirements. The macroinvertebrate communities inhabiting certain stream types are very different (e.g. lowland versus mountain streams; Northern European streams vs. Southern European streams) and the AQEM system uses different sets of metrics to assess the individual stream types.

Please consult the stream type descriptions in Annex 1 and the procedure specified in Chapter 2.5 to make sure that the streams you plan to assess are covered by AQEM. Particularly for degraded stream stretches it is sometimes difficult to judge, to which stream types they belong. The selection of the correct stream type should, therefore, preferably be based on unalterable characteristics, such as geology, catchment size and altitude class, or on maps of stream types, bioregions or comparable sources, which are presently under development or already finished, e.g. in Germany and Austria (Chapter 2.5).

Is the sampling method, you have applied, comparable to the "multi-habitat sampling"?

Not surprisingly, the sampling, sorting and determination procedures greatly effect assessment results; e.g. the number of taxa or the number of indicator taxa for a certain metric recorded are directly affected by sampling and sample processing. The AQEM system has been specifically designed for calculating taxa lists obtained with the "multi-habitat sampling procedure" (see Chapter 7).

The AQEM software should only be used with taxa lists obtained with a comparable method. As a minimum requirement, all microhabitats should have been sampled concerning their share of the stream bottom and data on organism abundance should be available.

Have the sample replicates correctly been distributed between "riffles" and "pools"?

Particularly in some Southern European stream types (see Annex 1) the fauna of pool sections proved to discriminate best between the degradation classes. In such cases only taxa lists obtained from pool sections are to be used with the AQEM system (see Chapter 7.3).

Was the same mesh-size used?

The mesh-size used for the AQEM system is 500 µm; only in some cases (see Annex 4) a coarser mesh-size proved sufficient. The AQEM system should only be applied for samples taken with the equivalent mesh-size.

Has the sorting been done in the same way as described in Chapter 8.1?

Differences in sorting are among the most important sources of errors in biological sampling. Please make sure that the sorting has been done in a way comparable to the procedure described in Chapter 8.1.

Has the same determination level been applied?

Possibly the most important step in obtaining a valid result is checking the determination level applied in the taxa list to be assessed. While for the Northern and Central European stream types species level has to be applied in most cases, this is not possible for many Southern European stream types. Please compare your taxa list with the requirements specified in Annex 5.

Has a taxonomic adjustment been performed?

To avoid that "*Baetis* spec.", "*Baetis alpinus*-group" and "*Baetis alpinus*" are regarded as three different taxa, a taxonomic adjustment should be performed with each taxa list before applying the AQEM software. For details see Chapter 10.

4.2 Selection of the correct module

If all of the criteria specified above are fulfilled or adjusted, one should make sure that the correct software module for calculating indices and/or assessment results is chosen, particularly regarding the following questions:

Have you selected the correct stream type?
For the rationale see above. Please read Chapter 2, particularly Chapter 2.5, for details.

Is the stream “artificial” or “heavily modified”?
Certain watercourses in Europe will be regarded as “heavily modified water bodies” and different management goals are associated to these stretches. The AQEM system can be applied in these cases, but the results will possibly be interpreted differently.

Has the sample been taken in the correct season?
AQEM recommends the best-suited season for the assessment of each individual stream type (“spring”, “summer”, “autumn”, “winter”; compare Annex 4). In some cases a slightly different set of metrics is to be applied for samples from different seasons or the system should not be used for samples taken in a certain season. Please make sure that the correct season has been selected.

The AQEM software offers some “error checks” but the software itself cannot avoid improper use. Therefore, it is the responsibility of the individual user to check the factors listed in the Chapter above and make sure, that the AQEM system can be applied and which module(s) must be used.

5 SELECTION OF SAMPLING SITES

General remarks

The AQEM system is specifically designed for monitoring programmes, which are in coherence with the Water Framework Directive. The design of future national networks for biological monitoring must fulfil a large number of criteria, resulting from requirements set in the Water Framework Directive for sampling all the relevant biological groups.

This Chapter is solely concerned with those characteristics relevant for selecting suitable sampling sites for macroinvertebrates and for the application of the AQEM sampling method (Chapter 7).

In biological monitoring programmes first errors can already occur within the process selecting of sampling sites. To minimise the errors associated with sampling site selection, the following guidelines should always be considered:

- The main goal of a monitoring programme is not to assess local features of a stream but to gain understanding of the ecological quality of a larger stream stretch or a complete catchment. Therefore, the selected sampling site and any samples taken must reflect the nature of the entire stream or at least the stream reach, which is to be assessed.
- Biological samples usually require different sites than those used for chemical analyses. Usually it is not suitable to sample macroinvertebrates near a bridge, where water samples are most frequently taken. The site for the biological sampling should reflect the physical and ecological features of a larger reach.

How to select a representative sampling site for the survey area?

One must distinguish between the sampling site and survey area. The “sampling site” is the spot where the biological sample is taken and should be representative for the stream reach to be assessed. The “survey area” might cover a section of several hundred meters stream length up to a complete catchment area of a small stream; this is the area to be monitored, and for which the sampling site should be representative.

The length of the sampling site depends on the stream width and the variability of the habitats. As a general rule, it should not be shorter than 20 meters in length and must cover the whole width of the stream (Chapter 7.3); it must be representative for a minimum survey area of 500 meters stream length or 100 x average stream width, whichever is longer. The following characteristics must be met by the sampling site:

- *Stream morphology and habitat composition.* The site must reflect the habitat composition of the survey area. Examples: If the survey area is predominantly free of debris dams it should be avoided to sample the only accumulation of dead wood. If the stream channel is not channelised in most of its length the only channelised section is unsuitable for sampling.

- *Hydrology*. Short reaches of residual flow or affected by pulse releases should be avoided unless they are typical for the survey area.
- *Shoreline vegetation.* The site must accommodate the characteristic composition and density of shoreline vegetation and provide the typical shading within the survey area.
- *Riffle-pool sequences*. The sampling site must reflect the share of riffles and pools of the reach. If both pools and riffles are representative for the survey area, both must be sampled.
- *Artificial disturbances.* Places close upstream or downstream of bridges, fords or weirs should be avoided unless they are typical for the survey area.
- *Point source pollution.* If point source pollution, e.g. a sewage overflow, affects only a short stream section within the survey area, the sampling site must not be located close to the outlet of the sewer. Instead, the sampling should be performed at a distance from the outlet where the mixing process of river water and sewage overflow is complete.
- *Disturbance.* The macroinvertebrate community of sampling sites, which are sampled very frequently within other monitoring programmes, may be affected and should not be selected.

Marking the site

The sampling site and its length should be clearly defined and, if necessary, marked in the field by methods not affecting trees or private properties. In addition, the site must be marked on a map, and the Grid Reference of the centre of the sampling area needs to be recorded in the site protocol (Chapter 6).

Permissions

Different administrative permissions for biological sampling are required in the European countries. Permission to access private land must be obtained prior to sampling. If it cannot be obtained in advance, field workers should try to obtain permission by asking landowners or locals with knowledge on land ownership.

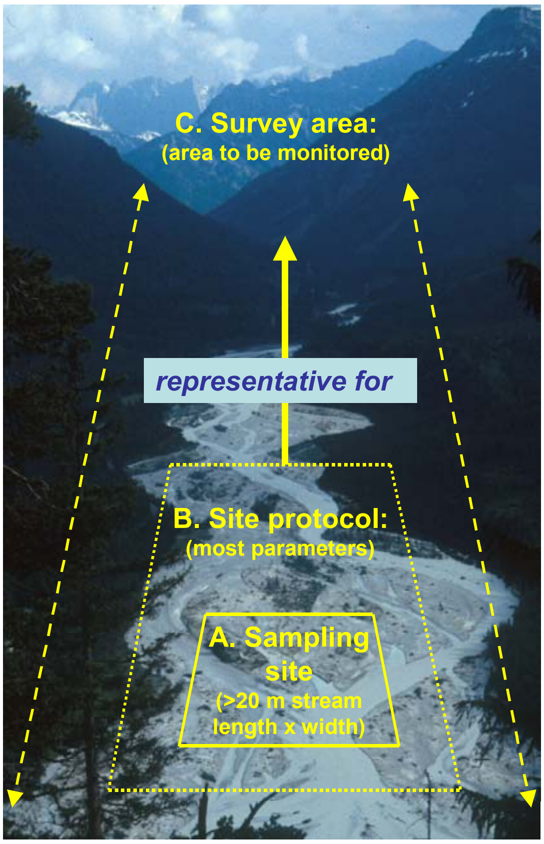


FIGURE 5.1: Sampling site (spot, where the sample is to be taken), area, to which most parameters of the site protocol apply and survey area (stream section to be monitored).

Safety (see Chapter 7.5)

Sites, which are unsafe to access, must be avoided. Sites should not require the field personnel to climb slippery or steep banks, to cross very deep waters or to cross deep mud or peat. Sites already inaccessible during smaller floods should not be selected.

6 SITE PROTOCOL

6.1 Aims and content of the site protocol

General remarks

A site protocol describes a sampling site. It contains both site and sample related information. It serves the following purposes:

- to give an impression of river and floodplain morphology, hydrology and vegetation
- to ensure that the site can be precisely re-located in the field
- to document the process of biological sampling (sample related information)

The site protocol specified here has been developed for practical fieldwork. It mainly serves the documentation of the biological sampling and provides some additional information, which can be easily quickly recorded in the field.

The site protocol is not designed to replace detailed morphological studies for other purposes. For more detailed investigations, e.g. scientific purposes, a more extensive site protocol has been developed, which can be downloaded from www.aqem.de.

Data sheets

The site protocol consists of four data sheets. The site name, sampling date, sample number and the name of the investigator must be recorded on the top of every page to avoid problems, in case individual sheets are separated or copied.

Basic and additional data

The site protocol contains 73 data fields, which should be recorded. 24 of these are basic and 49 are additional data. The basic data are essential for the documentation of the exact locality of the site and of the biological sampling (share of habitats and number of replicates taken from each habitat, compare Chapter 7.3). The additional parameters provide detailed and easy-to-note information on the physical and chemical features of the sampling site. Therefore, they may help in analysing the results of the biological assessment and provide valuable hints for water management action. They are named “additional” because they are not essential for the calculation process of the biological data. Data fields for documenting the results from water analyses are also offered.

Field and lab data

Most of the data must be recorded in the field. Only a few parameters on the first data sheet should be taken directly or indirectly from maps, usually topographic maps (no. 1 – 19). Preferably, a (digital) map of the stream reach investigated should be used with a 1:50,000 scale. If not available, 1:25,000 scale is also possible; in any case, the scale must be mentioned. Some data have to be measured, e.g. distance to source, stream order, size class based on catchment area, slope of the valley floor. To obtain these data, maps of the whole catchment upstream of the sampling site are necessary. Some data may sometimes require specific maps, e.g. geological maps (18) or maps on sub-ecoregions (12) and distribution of stream types (20), which are in preparation in several European states.

Equipment

Besides the sampling gear for the biological sampling (Chapter 7.2) the following equipment is necessary to complete the site protocol:

Obligatory:

- soft-leaded pencil and/or a waterproof pen
- clip board
- paper
- meter rule
- tape measure
- (digital) camera, films

Optional:

- stopwatch
- flow meter
- Polaroid glasses (sometimes helpful to assess the substrate types)
- binoculars (to observe features on the opposite river bank and in the floodplain)
- Global Positioning System (GPS)

Equipment necessary for recording physico-chemical parameters:

- conductivity meter
- oxymeter
- pH-meter

The latter devices must be calibrated before use in accordance with the manufacturer's instructions. Parameters 56 – 65 are to be measured in flowing sections of the site, usually in a riffle. Please consider that it is the policy of many laboratories not to measure these parameters in the field.

Please note that most data can be recorded from the riverbanks. Those site protocol data, which require wading in the streambed, must be collected after the biological sampling in order to avoid disturbing the fauna. The only exception is the estimation of microhabitat composition (parameters 23 and 24), which is a prerequisite for sampling. It is generally highly recommended not to wade in the stream before the biological sampling has been completed.

The site protocol form is given in Annex 2. A detailed description of all parameters to be recorded is given in Annex 3.

7 SAMPLING

This chapter describes the AQEM procedures for collecting and examining macroinvertebrate samples. The methods are based on the Rapid Bioassessment Protocols (BARBOUR et al. 1999), the procedures of the Environment Agency (ENVIRONMENT AGENCY 1999a), the Austrian Guidelines "Saprobiology" (MOOG et al. 1999) and ISO 7828. These guidelines have been tested and adapted by the AQEM partners to provide standardised procedures for collecting and analysing macroinvertebrate samples within the AQEM stream assessment procedures.
Chapters 7 and 8 do not aim at, nor are they able of competing with or replacing the references cited above. The information given here focuses on the application of the AQEM approach to guarantee a standardised procedure. This is necessary since the AQEM assessment system was specifically designed for calculating taxa lists obtained with the "multi-habitat sampling" and the AQEM sorting and determination procedures.

7.1 Sampling season

Most macroinvertebrate populations undergo distinct seasonal cycles. Therefore, in order to evaluate criteria like taxonomic composition, abundance and diversity adequately, sampling seasons and conditions must be clearly defined. AQEM generally recommends sampling in the best-suited season for the assessment of each individual river type ("spring", "summer", "autumn", "winter").
The designation of the best-suited sampling season(s) is based on the results of the AQEM project. Those seasons are recommended, in which the calculation methods described in Chapter 11 show the best discrimination between "stressed" and "unstressed" sites and when the highest number of indicator taxa can be collected in a determinable stage of life.
In some cases the system works independently of season, in other cases a slightly different set of metrics is to be applied for different seasons. In certain river types (e.g. in the I03) some periods may be unsuitable for collecting representative and reproducible samples from invertebrate communities due to high hydrological instability and resulting community changes. In these cases some seasons should specifically be avoided for sampling.
In general no samples should be taken

- during or shortly after floods
- during or shortly after droughts
- during any other man-induced or natural disturbances
- if unnatural turbidity prevents a proper sampling of the stream bottom.

The preferred sampling seasons for each individual stream type are given in Annex 4.

7.2 Sampling gear

Either a hand-net/shovel sampler or a Surber sampler must be used.

Hand-Net/Shovel Sampler

- Shape of the frame: D-Frame (shaped as a "D") or rectangular.
- Dimensions of the frame: 0.25 m width by >0.25 m height. The frame attaches to a long handle, similar to a broom stick.
- Shape of the net: cone or bag shaped for capturing organisms.
- Mesh size of the net: standard mesh size of 500 µm nytex screen.

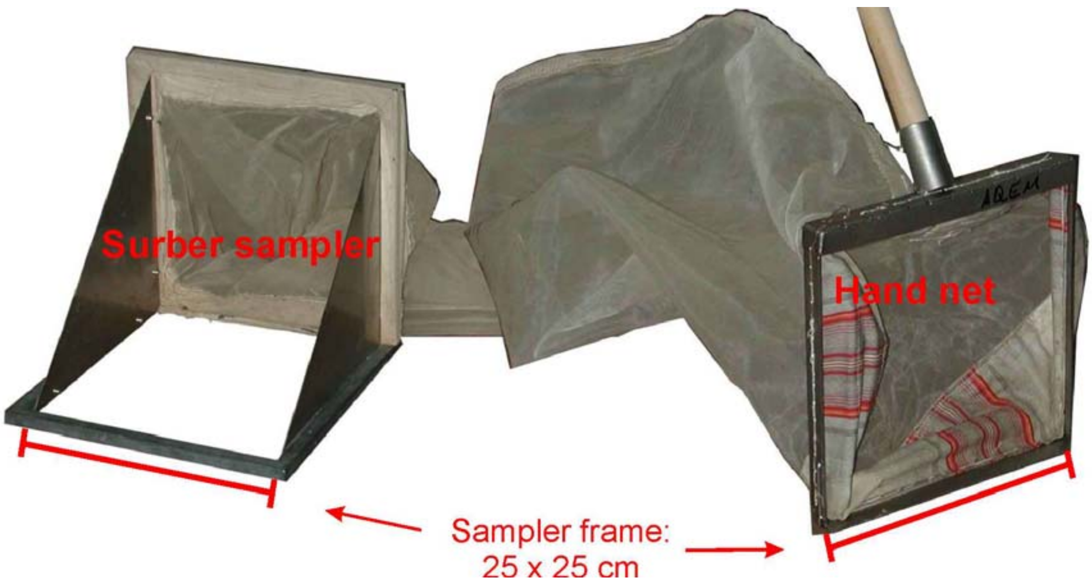


FIGURE 7.1: Surber sampler and hand-net.

Surber Sampler

For sampling stony substrates an open Surber Sampler, with lateral metal boundaries or no-box frame can be used in place of a hand-net. Dimensions of the sampler are 0.25 m x 0.25 m. The sampler is horizontally placed on the substrate to delineate a 0.0625 m^2 area. The net attaches to the vertical brace of the frame and captures the dislodged organisms from the sampling area. The sampling frame is also surrounded by a box frame with 500 µm meshes. The use of the open Surber sampler (without a net frame) is usually restricted to shallow, fast-flowing habitats; in standing or lentic zones a hand-net should be used instead .

7.3 Field sampling procedures

The AQEM method is based on BARBOUR et al. (1999) and focuses on a multi-habitat scheme designed for sampling major habitats proportionally according to their presence within a sampling reach.
A sample consists of 20 “replicates” taken from all microhabitat types at the sampling site with a share of at least 5% coverage. A “replicate” is a stationary sampling accomplished by positioning the net and disturbing the substrate for a distance that equals the square of the frame width upstream of the net (0.25 x 0.25 m). The 20 “replicates” must be distributed according to the share of microhabitats. For example, if the habitat in the sampling reach is 50% psammal (sand), then 10 “replicates” must be taken there. The categories of microhabitat composition are to be taken from the site protocol (parameters 23 and 24; Annex 5, 6; compare Figure 7.3). This procedure results in sampling of approximately 1.25 m^2 stream bottom area.

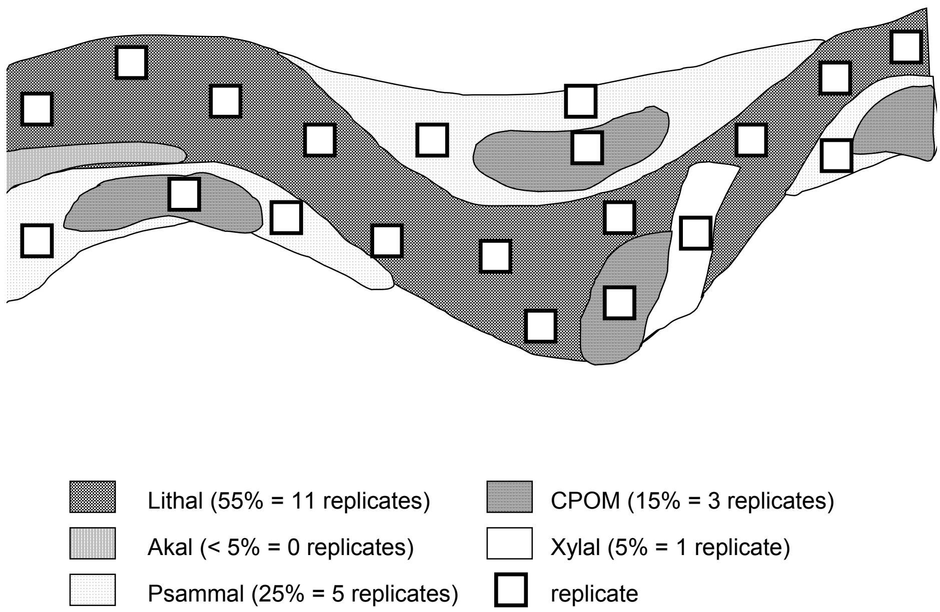


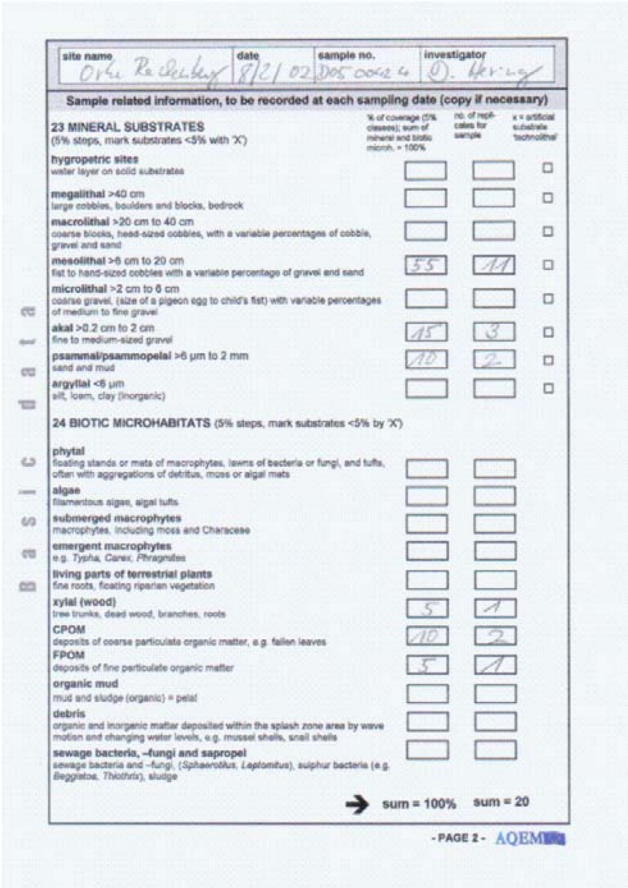
FIGURE 7.2: Example of replicate position in a theoretical sampling site according to the „multi habitat sampling“ method applied in AQEM.

More specifically, the “multi-habitat sampling“ procedure is performed in the following steps:

Preparation

1. **Select an appropriate sampling site** (compare Chapter 5).
2. Before sampling, the **site protocol** should be completed (compare Chapter 6). However, the sampling area should not be disturbed by physical contact, if at all possible. Therefore, after sampling, this information should be reviewed for accuracy and completeness (step 12).

3. Based on the microhabitat list given in the site protocol (parameters 23 and 24, 1st column) the **coverage of all microhabitats** with at least 5% cover is recorded to the nearest 5% interval, the presence of other microhabitats (<5% cover) is only indicated. Mineral and biotic microhabitats together are regarded as just one layer. The sum of the cover of all microhabitats (mineral and biotic) should be 100%.



site name	date	sample no.	investigator
[illegible]	8/2/02	D05 0042 4	D. Hering

Sample related information, to be recorded at each sampling date (copy if necessary)

23 MINERAL SUBSTRATES (5% steps, mark substrates <5% with 'X')	% of coverage (5% classes); sum of mineral and biotic microh. = 100%	no. of replicates for sample	x = artificial substrate 'technolithal'
hygropetric sites water layer on solid substrates			☐
megalithal >40 cm large cobbles, boulders and blocks, bedrock			☐
macrolithal >20 cm to 40 cm coarse blocks, head-sized cobbles, with a variable percentages of cobble, gravel and sand			☐
mesolithal >6 cm to 20 cm fist to hand-sized cobbles with a variable percentage of gravel and sand	55	11	☐
microlithal >2 cm to 6 cm coarse gravel, (size of a pigeon egg to child's fist) with variable percentages of medium to fine gravel			☐
akal >0.2 cm to 2 cm fine to medium-sized gravel	15	3	☐
psammal/psammopelal >6 µm to 2 mm sand and mud	10	2	☐
argyllal <6 µm silt, loam, clay (inorganic)			☐

24 BIOTIC MICROHABITATS (5% steps, mark substrates <5% by 'X')		
phytal floating stands or mats of macrophytes, lawns of bacteria or fungi, and tufts, often with aggregations of detritus, moss or algal mats		
algae filamentous algae, algal tufts		
submerged macrophytes macrophytes, including moss and Characeae		
emergent macrophytes e.g. *Typha*, *Carex*, *Phragmites*		
living parts of terrestrial plants fine roots, floating riparian vegetation		
xylal (wood) tree trunks, dead wood, branches, roots	5	1
CPOM deposits of coarse particulate organic matter, e.g. fallen leaves	10	2
FPOM deposits of fine particulate organic matter	5	1
organic mud mud and sludge (organic) = pelal		
debris organic and inorganic matter deposited within the splash zone area by wave motion and changing water levels, e.g. mussel shells, snail shells		
sewage bacteria, –fungi and sapropel sewage bacteria and –fungi, (*Sphaerotilus*, *Leptomitus*), sulphur bacteria (e.g. *Beggiatoa*, *Thiothrix*), sludge		
→	sum = 100%	sum = 20

- PAGE 2 - AQEM

FIGURE 7.3: Completed microhabitat list in the AQEM site protocol as a base for replicate positioning.

4. Based on estimation of microhabitat coverage (3.) the **number of replicates** in the individual habitats is determined and indicated in the site protocol (parameters 23 and 24, 2nd column). For example, if a sampling site consists of 50% mesolithal (pebbles and stones), 25% psammal (sand) and 25% CPOM, then 10 replicates should be taken in the mesolithal, 5 replicates in the psammal and 5 replicates in the CPOM.

Sampling

5. **Sampling** starts at the downstream end of the reach and proceeds upstream.
6. When **sampling the "replicates"** use the hand-net either as a kick net, or for "jabbing", "dipping" or "sweeping". When kick-sampling, hold the net vertically

with the frame at right angles to the current, downstream from your feet, and disturb the stream bed vigorously by kicking or rotating the heel of your boot to dislodge the substratum and the fauna within a depth of at least 10-15 cm. Disturb the substrate in the 0.25 x 0.25 m area upstream of the net. Hold the net close enough for the invertebrates to flow into the net with the current, but far enough away for most of the sand and gravel to drop before entering the net. Move cobbles and large stones by hand, sweep or brush the surfaces to dislodge clingers and sessile organisms. It is recommended to deposit wood and cobbles in a plastic bucket for a later inspection to remove adhering animals by hand-picking with forceps. To dislodge the animals from the interstices of the sediments, the substrate should be disturbed with a screwdriver or similar device. The surface of soft sediments and fine or organic microhabitats should be sampled by pushing the hand-net gently through the uppermost 2-5 cm of the substratum. In shallow waters with a strong current an open Surber sampler can be used instead of a hand-net. To sample with an open Surber sampler in slow-flowing areas the sediment within the Surber frame can be disturbed using the hands, in the normal fashion, and then a current created by pushing water through the net with the hands to trap the animals. It is possible to use different devices for different microhabitats, as long as the same area is sampled.

7. **Rinsing**: After every three replicates (or more frequently if necessary) rinse the collected material by running clean stream water through the net two to three times. If clogging occurs, which may interfere with obtaining an appropriate sample, discard the material in the net and redo the replicate in the same habitat type but at a different location.

8. If **riffle and pool areas** are clearly distinguishable in the investigated river stretch, the current and habitat conditions at the microhabitat scale and faunal assemblages are expected to show differences between the two areas. Accordingly, the replicates collected from the riffles can be stored and treated separately from pool replicates, if this additional information is needed in the study. Usually different numbers of replicates should be taken in riffles and pools (e.g. 13 replicates in riffles and 7 in pools) - depending on their relative importance. If the estimation of the relative proportion of areas covered by riffle and pool sections along the river stretch is difficult (e.g. for impervious banks, etc.), sampling 10 replicates in pools and ten in riffles is likely to be the best solution.

FIGURE 7.4: Using a hand-net for jabbing and sweeping.

FIGURE 7.5: Kick-sampling.

Follow-up treatment

9. **Removal of large material and sorting**: Large wood and stones can be removed after being rinsed and inspected for clinging or sessile organisms. Any organisms found have to be placed into the sample container. Generally, it is recommended not to spend time inspecting small debris in the field; however, larger and fragile organisms (e.g. Ephemeroptera) or species that cannot be preserved (e.g. Tricladida, Oligochaeta) should partly be sorted in the field. These organisms should be stored in a small separate container containing only organisms but no substrate.

   For South European stream types the samples can completely be sorted in the field, if time, weather and man-power constraints allow for.

10. **Removal of large organisms**: Large and rare organisms, which can easily be determined in the field (such as large mussels), should be removed from the sample and be placed back in the stream.

11. **Sieving**: The complete sample must be sieved through a coarse mesh (1000 µm for sand bottom streams; 2000 µm for stony bottom streams). The sieving can either be done in the field or in the lab – if the fine fraction is to be analysed for a specific stream type (compare Annex 4) it must be kept and stored separately.

12. **Storing**: Transfer the sample from the net to sample container(s) and preserve with formalin (4% final concentration) or in enough 95% ethanol to cover the sample immediately after collection. This form of fixation is important to prevent carnivores, particularly stoneflies (Setipalpia), beetles (Adephaga), caddis larvae (e.g. Rhyacophilidae), Sialidae and certain Gammaridae, from eating other organisms. The final ethanol concentration should be around 70%. When using ethanol, water in the sample should be decanted before adding the fixation liquid. Forceps may be needed to remove organisms from the dip net. The sample container should close tightly. The samples should be stored cool.

Alternatively, life sorting in the lab is possible. These samples must be kept in a minimum amount of liquid and transported immediately into the lab and must be kept cool during transport (see Chapter 7.4).

13. **Labelling**: Place a label (written in pencil, printed on a laser printer or photocopied) indicating the following information inside the sample container:
    - project (optional)
    - stream name
    - site name
    - site code (optional)
    - date of sampling
    - riffle or pool section
    - sieving fraction
    - investigators name (optional)

    The outside of the container should include the same information and the words "preservative: formalin 4%, or 95% ethanol, respectively". If more than one container is needed for a sample, each container should be labelled with all the information on the sample and should be numbered (e.g., 1 of 2, 2 of 2, etc.). If rare taxa (e.g. crayfish, large mussels) have been identified in the field and returned to the river (step 10), record their presence and abundance on the label placed in the sample containers as well as on the sample protocol. If possible, label and place the container with the rare and fragile organisms into the main sample container and note its existence in the site protocol.

14. **Refine the site protocol**, particularly the share of microhabitats, after sampling has been completed. Having sampled the various microhabitats and walked the reach helps ensure a more accurate assessment. Note the sampling gear used, and comment on conditions of the sampling, e.g. high flows, treacherous rocks, difficult access to stream, or anything that would indicate adverse sampling conditions.

For health and safety reasons, not all laboratories can use formalin although it is known to be the most effective fixative for freshwater macroinvertebrate samples (ENVIRONMENT AGENCY 1999a). If a laboratory cannot use formalin and the sample has been conserved with 95% ethanol instead, it should be re-preserved in the lab. The sample can then be kept for several months before analysis.

7.4 Transport

If the transport of fixed samples to be sorted in the lab is performed by the laboratory staff no special logistic advice is given. If samples are preserved with formalin

the proper techniques for rinsing the sample containers (bags, pots and/or buckets) and transportation in air-tight crates are recommended.
Samples that are transported alive must be kept in a minimal amount of liquid, and they must be kept cool during transport, preferably between 4 and 8°C, in a cool-box or mobile fridge. This will reduce carnivore activity and prevent the sample from deteriorating rapidly. If the sample occupies more than about 60% of the sample container, transfer some of it to another correctly labelled container. Live samples must be stored at 4 to 8°C immediately upon return to the laboratory.

7.5 Safety

Fieldwork always holds a potential for personal injury from equipment operation and exposure to environmental hazards. Every effort should be made to minimise risks in the field. Besides the scientific aspects, criteria for safe sampling should also be regarded when selecting a sampling site.

- Never take samples alone. When taking samples always be accompanied by at least one other person that can help you.
- The attending person should have clear sight of the sampling person at all times.
- Do not take samples when the conditions at a sampling site may be dangerous. In particular you should
    - avoid sampling rivers in flood conditions
    - avoid sampling during severely cold conditions
    - avoid steep or unstable banks
    - check depth and stability of the river bottom
    - watch out for hazards (broken glass, sharp metals etc.).
    - Wear a life jacket when sampling either in deep rivers, upstream from weirs or deep pools, in streams with strong current, or during extremely cold conditions with bottom ice. Have a bundled safety line stationed downstream that can be tossed out by the partner in the event the person sampling falls and is carried downstream by the current.
    - Wear appropriate clothing and use rubber gloves.

Precaution measures

- Do not forget a first-aid kit and learn how to use it before setting off.
- Prepare a list of telephone numbers of the nearest doctors and/or hospitals.
- If direct communication is not possible follow an agreed system of emergency action in case a field worker does not report in or sign-off at the end of the day.

Safety equipment

- Thigh or chest waders
- Elbow or shoulder length gloves preferably with elastic arm bands
- Life jackets (certified)
- Safety goggles - for use with kits
- Rope
- Spare set of clothes inclusive a towel (one set for each sampler)
- mobile phone

7.6 Quality control in the field

- Sample labels must be completed properly, including the sample identification code, date, stream name, sampling location, and collector's name, and placed inside the sample container. The outside of the container should be labelled with the same information. If chain-of-custody forms are required, they must include the same information as the sample container labels.
- After sampling has been completed at a site, all nets, pans, etc. that have come in contact with the sample should be rinsed thoroughly, examined carefully, and picked free of organisms or debris. Any additional organisms found should be placed into the sample containers. The equipment should be examined again prior to its use at the next sampling site.
- The equipment should also be sterilised before taking new samples, e.g. by dipping it in alcohol or letting it dry for a number of hours. This is particularly necessary in areas affected by cray-fish plagues.
- Field sampling quality control involves collecting replicate samples at various reaches to verify the reproducibility of the results obtained by a single set of field investigators. Each investigation team should conduct replicate sampling at 10% of the sampling reaches. Replicate sampling is conducted on an adjacent reach upstream of the initial sampling. The adjacent reach should be similar to the initial site in respect to habitat, stressors, point source pollution, etc. Replicate samples are preserved, subsampled, and organisms are identified; results are recorded in a sampling quality control book. The quality control data should be evaluated following the first year of replicate sampling in order to determine a level of acceptable variability and the appropriate replication frequency.

8 SAMPLE PROCESSING

8.1 Sieving, sorting, conservation

Macroinvertebrate samples are processed best in the laboratory under controlled conditions. Aspects of laboratory processing include sieving, sub sampling, sorting, and identification of organisms. All steps of sieving and sorting must be done in a fume cupboard or under a fume extractor.

Concerning the disposal of formalin and ethanol different instructions are to be applied in the individual countries.

Sieving

Before sorting, the complete sample must be passed through a set of sieves in order to gently rinse the fine material from the sample under running water. For samples from soft-bottom streams (sand) use sieves with 1000 µm and 250 µm mesh size. For samples from gravel and hard-bottom streams use 2000 µm and 500 µm mesh size. In addition, a coarse sieve may be used to retain stones and CPOM.

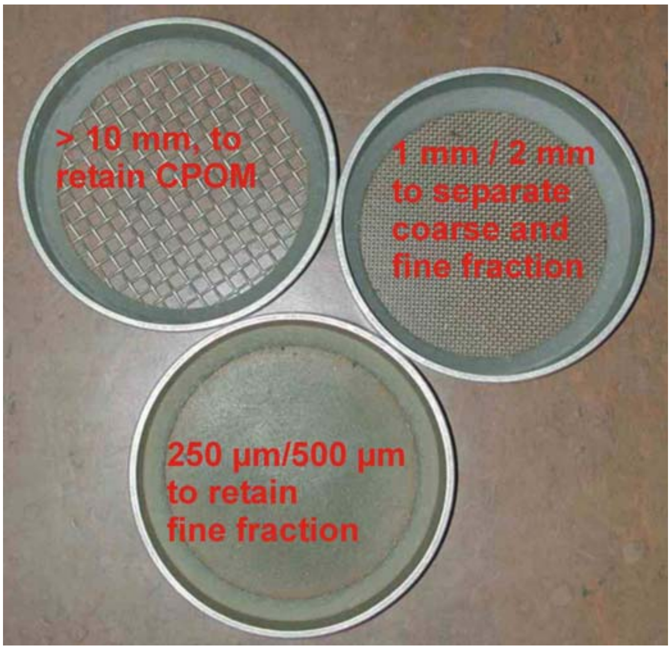


FIGURE 8.1: Set of sieves to be used for separating the coarse and the fine fraction.

By sieving the sample is split up into two portions: the coarse and the fine fraction.

If the sample was stored in more than one container, the contents of all containers for a given sample should be combined at this time. The sample should be mixed gently by hand while rinsing to make it homogeneous. After rinsing and removing the fine sediments large organic material (whole leaves, twigs, algal or macrophyte mats, etc.) not removed in the field should be rinsed, visually inspected, and discarded.

Exception: samples taken in Sweden should not be sieved prior to sorting

For most AQEM stream types both the coarse and fine fraction resulting from the sieving process are to be investigated. There are, however, a few exceptions (see Annex 4).

Sorting

The preservative liquid must be washed from the samples thoroughly with tap water before the sample is treated.

The coarse fraction (>1000 and >2000 µm, respectively) must be sorted completely in the field or in the lab (all specimens should be removed). Only if more than 500 specimens of a taxon are present may this taxon be sub-sampled, preferably using an area based method (other threshold numbers for specimens can also be used, depending on local conditions and on the metrics included in the assessment system).

If threshold values for selected taxa are set and these taxa are easily identifiable in the field, only a small number of specimens for checking the identification are to be collected. For some abundance metrics included in the assessment systems (e.g. abundance of *Cordulegaster* and *Dinocras*, in stream type I02), specimens can easily be counted and returned to the river, after selecting a small subsample to take back to the lab for identification. More details on single metrics and sorting procedures will be presented in dedicated publications in each of the countries involved.

The fine fraction (<1000 and <2000 µm, respectively) should be sieved again in the lab using a 250 µm sieve to remove fine detritus. The fine fraction can be subsampled using an area based method (Chapter 8.2). However, at least 500 specimens should be sorted out of the fine fraction.

The animals sorted in the lab should be separated into systematic units.

All samples should be dated and recorded in a sample data form upon reception by laboratory personnel. All information from the sample container label should be included on the sample log sheet. If more than one container was used, the number of containers should be indicated as well. All samples should be sorted in a single laboratory to enhance quality control.

Sorting live samples

Live samples should be sorted and identified as soon as possible (absolute maximum of 48 hours) after being collected. This includes any re-analysis of live samples. A storage temperature between 4 and 8°C must be maintained during this period. Any live samples not processed within this time or not kept at this temperature must be discarded and new samples taken (ENVIRONMENT AGENCY 1999a).

Conservation

Samples should be transferred from fixative (e.g. formalin) to preservative (ethanol) if they are kept for more than a few months before sorting. Rare or fragile organisms that have been sorted in the field and stored separately have to be preserved in 70% ethanol after replacing the alcohol a number of times to ensure that there is an adequate concentration in the sample. Animals, which may be used for genetic analysis within other studies should be fixed in 96% ethanol.

Similarly, the animals sorted in the lab are stored in 70% (or higher) ethanol. Ideal is storing the organisms in glass vials, filled with ethanol and plugged with cotton swabs. Once any air bubbles inside the vials are removed, the vials are placed inside a larger glass container and covered with ethanol. The outside container should seal tightly.

Preserved samples must be stored at cool temperatures, away from any heat source and preferably in the dark to minimise the loss of colour.

If specimens are sent to outside taxonomists, posting has be done properly to prevent any damage and all sample information has to be recorded in a log book for dispatched samples.

8.2 Subsampling

Subsampling reduces the effort required for the sorting and identification of macroinvertebrate surveys and provides a more accurate estimate of time expenditure. AQEM foresees subsampling the sieved fine fraction using the following procedure (based on CATON 1991):

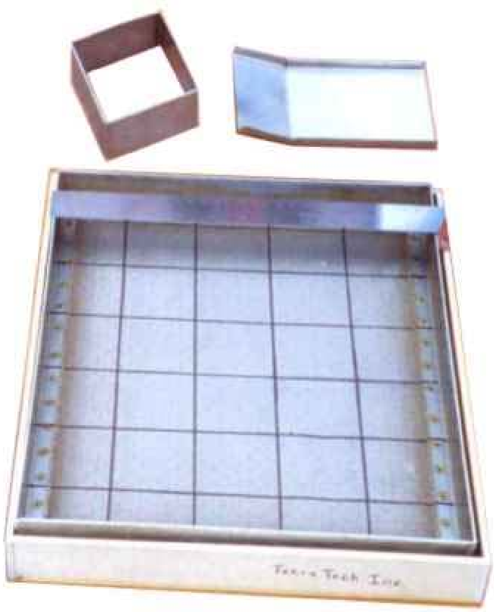


FIGURE 8.2: Subsampling gear: pan, grid and devices to remove debris from selected squares.

FIGURE 8.3: Subsampling procedure.

1. Thoroughly rinse the sample over a 250 µm sieve to remove preservative and fine sediment. Gently mix the sample by hand while rinsing to make it homogeneous.
2. After washing, spread the sample evenly across a pan (30 x 36 cm) marked with grids approximately 6 cm x 6 cm. Note the presence of large or obviously abundant organisms; do not remove them from the pan.
3. Use a random numbers table to select 4 numbers corresponding to squares (grids) within the gridded pan. Remove all material (organisms and debris) from the four grid squares, and place the material into a shallow white pan and add a small amount of water to facilitate sorting. If there appear (through a cursory count or observation) to be 500 organisms ± 20% (cumulative of 4 grids), then subsampling is complete.
4. Any organism that is lying over a line separating two grids is considered to be on the grid containing its head. In those instances where it may not be possible to determine the location of the head (worms for instance), the organism is considered to be in the grid containing most of its body.
5. If the density of organisms is high enough that many more than 500 organisms are contained in the 4 grids, transfer the contents of the 4 grids to a second gridded pan. Randomly select grids for this second level of sorting as was done for the first, sorting grids one at a time until 500 organisms ± 20% are found. If picking through the entire next grid is likely to result in a subsample of greater than 490 organisms, then that grid may be subsampled in the same manner as before to decrease the likelihood of exceeding 490 organisms. That is, spread the contents of the last grid into another gridded pan. Pick grids one at a time until the desired number is reached. The total number of grids for each subsorting level should be noted on the laboratory bench sheet.
6. Example: if the fine fraction is distributed in a dish, 1/16 of the dish's area is sampled. If the number of specimens sorted out is lower than 500, another 1/16 of the area is sampled. This is repeated until 500 specimens are found. The subsample which contains the 500th individual found, must be sorted completely.
7. The subsample must be preserved separately from the remaining sample for quality control checks.

8.3 Labelling and Sorting

After sorting, vials containing identified animals should be labelled in pencil on a slip of waterproof paper placed inside the vial. The following information should be included:

Projekt: AQEM | sampling date: 12.03.01
sampling site: Rur upstream of reservoir (TK 5404) | leg.: Rolauffs
taxonomic group: Trichoptera
sample number: D0400012
riffle – coarse fraction; 2 containers

8.4 Quality assurance and quality control in the lab

(partly based on: ENVIRONMENT AGENCY *1999a)*

The aims of quality assurance and control in the lab are to minimise errors in the treatment of biological samples and thus secure the validity of the biological assessment results. One must distinguish between the general improvement of the treatment of the samples in the laboratory (as a part of "quality assurance") and the quality control by an auditor. This chapter does not cover any aspects of auditing.

Important elements of quality assurance in the lab are:

Treatment of the samples during the process of sieving and sorting (compare Chapter 8.1).

In order to minimise damage to specimens in the process of sieving, e.g. loss of gills, legs and tails

- rinse very gently and never use a high-pressure spray when you separate specimens from substratum e.g. by means of a hose attached to the tap
- never swirl the sample violently in a bucket or sieve
- decant water very carefully.

When picking out the specimens from the sieved samples a soft pair of tweezers should be used in order to minimise damage to the animals.

Identification level and taxonomic nomenclature

To apply the assessment system correctly, the required minimal level of identification must be achieved for all specimens (for the different levels see Annex 5). The nomenclature and the taxa list to be used are provided by the digital version of the AQEM data base (available from www.aqem.de).

Identification

The correct identification of the specimens according to the level and nomenclature required is crucial for the correct application of the system. Use only state-of-the-art-determination literature as specified in Annex 8. All aquatic macroinvertebrates in the sample, including caddis and Dipteran pupae, have to be identified to the given taxonomic level. Terrestrial or aerial stages of aquatic animals, empty mollusc shells, exuviae, empty puparia, empty caddis cases and eggs are not part of the samples. Fragments of damaged specimens can cause errors particularly in the calculation of abundances. In case of fragments use only head *and* thorax or thorax *and* abdomen parts, not single heads, single abdomens, legs or other smaller parts.

Use suitable and regularly serviced binoculars and microscopes for identification (minimum magnification 100 x). The work area should be well illuminated; especially the lighting of the animals under the binoculars should be good. Cover the specimens with enough liquid to avoid reflections of light.

Sometimes it may be necessary to break mollusc shells and poke caddis cases to check for occupants.

Fitness of the lab personal staff

Sorting usually is a hard and very time-consuming work. Samples, which are easy to sort may be finished in two hours, laborious samples may consume more time. The work area should always be well lit and health implications should be considered during the whole process of sample treatment in the lab. A good physical condition during the process of treating the samples contributes to a good result in the process of biological evaluation. Short, regular breaks from the sorting every hour are highly recommended. If the tray is left for longer breaks, the sample should be covered completely in order to reduce evaporation.

Controlling methods

AQEM is not suggesting a detailed controlling or auditing system. However, particularly for larger monitoring programmes, a controlling and auditing system is highly recommended.

A very well-suited system for controlling sorting errors has been described by ENVIRONMENT AGENCY (1999b). Auditing needs to be undertaken for a set number of samples by a person or institution independent of those whose work is being audited.

9 IDENTIFICATION

The AQEM system is based on a specific set of metrics for each individual stream type. Some of these metrics require species level determination; others may do with coarser taxonomic levels. In general, species level data give the best information. Therefore, the AQEM metrics are often based on species level data in those countries, where taxonomic knowledge allows for a precise determination of aquatic stages. In the Southern European countries, genus and family level is sufficient in most cases for applying the AQEM metrics.

Annex 5 lists the level of determination necessary for applying the system to each individual stream type.

Incorrect determination is the main source of errors in biological sample treatment. For to the state-of-the-art-determination it is inevitable to use the determination literature specified in Annex 8.

All males, females, pupae, larvae, juveniles and nymphs are aggregated in the identification process, with the following exceptions: Coleoptera adults are separated from the larvae because they can differ in their ecological indicative value.

10 TAXONOMIC ADJUSTMENT

The identification process results in a raw taxa list, which should be processed further to obtain a consistent data set, which ensures unambiguous data processing. This means there should be no taxa overlap, because taxonomic overlap results in a multiplication of the same information in one sample. For example, it should be avoided that "*Baetis* spec.", "*Baetis alpinus*-group" and "*Baetis alpinus*" are regarded as three different taxa. There are three methods for taxonomic data processing:

- aggregating species to a higher taxonomic level
- omitting a higher taxonomic level
- distributing individuals which are "only" determined to genus level according to the relative share of individuals determined to species level (e.g. 100 individuals determined as *Baetis sp.* could be divided among *Baetis fuscatus* (60 individuals determined) and *Baetis rhodani* (140 individuals determined) according to their relative occurrence 30:70).

All methods can be used within one data set. The choice of the best-suited method should be made depending on the taxonomic group at question, based on a combination of individuals occurring and their abundance and the ecological relevance of the species within the respective taxonomic group.

If species either occur in many samples, the number of specimens is significant and species differ ecologically, they should be kept separated as individual taxa in the data set.
When applying any of the methods described above, the following criteria should be applied for taxonomic adjustment:

- Taxonomic adjustment always takes place at the lowest possible level, preferable at species level.
- When a genus is generally identified to species level, with the exception of only a few specimens, the genus level is omitted and specimens determined as *Genus sp.* are distributed among the species kept.
- In case the frequency of occurrence of a genus is more than 20% of the frequencies of occurrence of the underlying species together, all species are aggregated to genus level.
- The 20%-criteria is not a strict rule. In borderline situations a decision can be made based on the ecological indicative value of the genus or of the species in combination with their abundance.

- When species *and* groups/aggregates or genus *and* family are present, the same criteria are applied for taxonomic adjustment as at the genus and respective species level.

Most conveniently, the adjustment can be performed in an Excel table by adding an extra column, containing the “adjusted code”. After adding the adjusted code to each taxon, the table must be sorted by the “adjusted code” column. Then, all taxa with the same “adjusted code” are aggregated. Those taxa with the adjusted code “deleted” are skipped.
In the example below

- two higher taxonomic levels are deleted (Baetidae Gen. sp. and *Cloeon* sp.)
- two infrequently occurring taxa (*Baetis fuscatus* and *Baetis tracheatus*) are aggregated to *Baetis* sp.
- the remaining taxa are not changed

		short code	*adjusted code*	*number of samples*	*mean abundance*	*total abundance*
Baetidae	Gen. sp.	baetgen	delete	31	30.7	950.5
Baetis	fuscatus	baetfusc	baetissp	1	2.4	2.4
Baetis	sp.	baetissp	baetissp	24	59.7	1432.0
Baetis	tracheatus	baettrac	baetissp	2	2.0	4.0
Baetis	vernus	baetvern	baetvern	45	16.7	751.7
Centroptilum	luteolum	centlute	centlute	9	23.5	211.1
Cloeon	dipterum	cloedipt	cloedipt	41	26.9	1103.3
Cloeon	simile	cloesimi	cloesimi	6	7.5	44.8
Cloeon	sp.	cloesp	delete	3	9.3	28.0
Procloeon	bifidum	procbifi	procbifi	5	6.1	30.7

11 ASSESSING THE ECOLOGICAL STATUS OF A STREAM

11.1 What is a multimetric index?

The AQEM assessment method is based on a "multimetric" procedure[3]. A multimetric index combines several individual formulas (e.g. saprobic indices, feeding type composition), the results of which are finally combined into a multimetric result. Thus, multimetric indices integrate multiple attributes of stream communities ("metrics") to describe and evaluate a site's condition.

Metrics are defined as "Measurable parts or processes of a biological system empirically shown to change in value along a gradient of human influence" (KARR & CHU 1999). In other words, metrics should reflect specific and predictable responses of the macroinvertebrate community to human activities, not necessarily to one single impact factor but to the cumulative effects of all events and activities within a watershed. Minimally disturbed sites are used as reference sites, against which monitoring sites are compared.

TABLE 11.1: Examples of different metric categories and metrics types.

Category	*Metric*
Richness measures	Total number of taxa Number of EPT taxa
Composition measures	% Dominant taxon % Oligochaeta
Diversity measures	Shannon-Wiener Diversity index
Similarity/loss measures	Species deficit Missing taxa
Tolerance/intolerance measures	Saprobic index BMWP ASPT
Functional/trophic measures (Feeding measures)	% Filterers Index of trophic completeness RETI
Habitat/mode of existence measures	% of clinger Number of (semi)sessil taxa
Current preference measures	% limnophil % rheophil
Zonation measures	Zonation Index % littoral
Generation turnover measures	% bivoltin % univoltin
Individual condition measures	Contaminant levels % Diseased Individuals

[3] Multimetric Indices have not been "invented" by AQEM. Especially in North America multimetric procedures are an essential base of standard water monitoring. For a detailed and well-readable description of the multimetric approach see BARBOUR et al. (1999) and KARR & CHU (1999).

When creating a multimetric index, only those metrics should be combined that show a quantitative dose-response change across a gradient of human influence that is reliable, interpretable and not diffused or obscured by natural variation. Table 11.1 lists various categories and types of metrics.

A multimetric index comprising a number of such metrics thus integrates information from ecosystem, community, population and individual scales. It can be expressed in numbers and words. Rigorously done, multimetric biological assessment and monitoring offer a systematic approach that measures multiple dimensions of biological systems.

Although the multimetric calculation itself might be complex in some cases, it is easy to understand and is applied in a user-friendly way. In general, the advantages of a multimetric procedure lie in:

- providing detection capability over a broad range of stressors and giving a more complete picture of biological condition than single biological indicators - obtained from a single taxa list
- obtaining a more stable result than can be achieved with a single metric
- avoiding flawed, ambiguous, or difficult-to-use biological attributes
- covering different levels of the biological hierarchy
- cost effectiveness, since many results are extracted from a single taxalist.

11.2 General description of the AQEM assessment method

The general architecture of a multimetric approach as applied in the AQEM assessment system is outlined in Figure 11.1. It consists of the following steps (*general multimetric calculation*):

- Starting point is the taxa list obtained from the sampling site, which is to be assessed.
- With this taxa list a number of metrics is calculated.
- Generally, the metric results are individually converted into scores by comparing the results with a stream-type specific reference situation.
- The scores of all metrics are finally combined in a simple multimetric formula (usually the average of all scores) and result in an Ecological Quality Class for the survey stream reach.

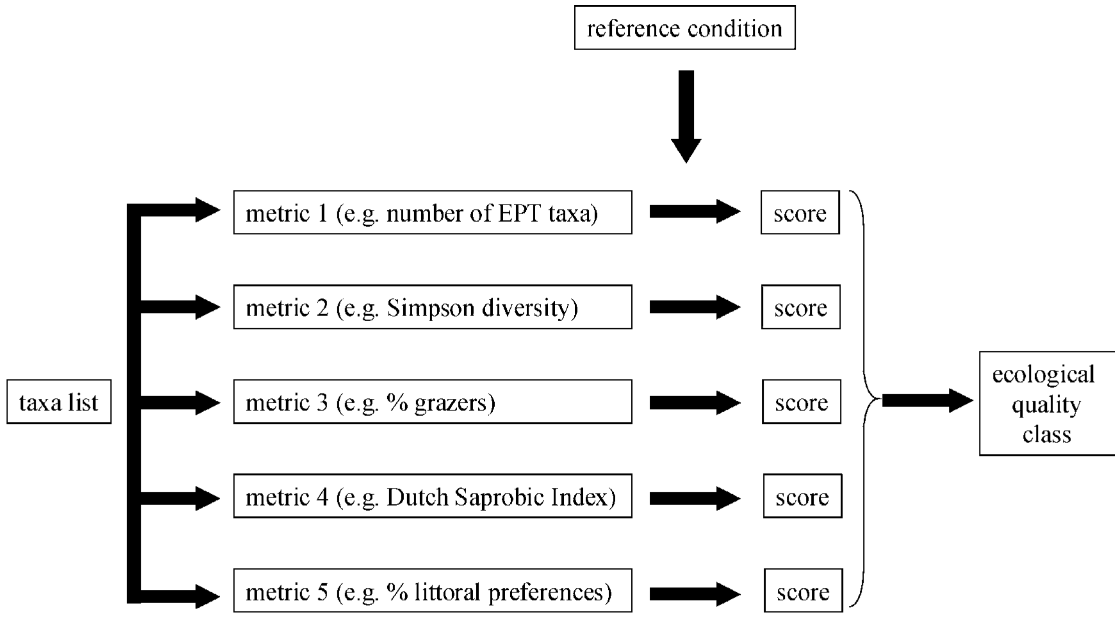


FIGURE 11.1: General scheme of a multimetric calculation.

This procedure enables the user to view both the final assessment result (Ecological Quality Class) *and* the individual metric results, allowing further interpretation of the data for future management procedures.

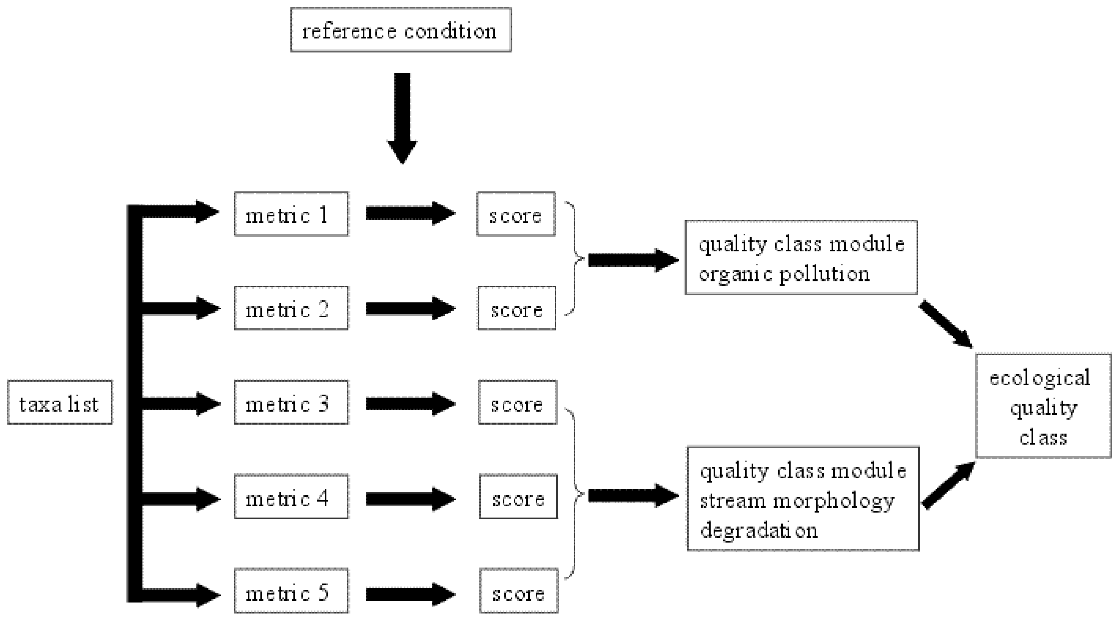


FIGURE 11.2: Scheme of a stressor-specific multimetric calculation.

Whenever possible, the metrics used for calculating the ecological quality of a stream type were categorised beforehand according to their ability for detecting the impact of certain stressors. This was possible for 11 out of 28 AQEM stream types. In these cases the multimetric procedure comprises one step more (Figure 11.2; *stressor-specific multimetric calculation*):

- Starting point is the taxa list obtained from the sampling site, which is to be assessed.
- With this taxa list a number of metrics is calculated; these metrics are categorised according to their sensitivity towards the impact of a certain stressor, e.g. for detecting "degradation of stream morphology" or "organic pollution"..
- In most cases, the metric results are individually converted into scores by comparing the results with a stream type specific reference situation.
- The scores or results of those metrics, which address the same specific stressor are transformed into stressor-specific Quality Classes and combined in a simple multimetric formula (usually the average of all scores) for a stressor-specific assessment module, e.g. a module for "organic pollution" or for "degradation in stream morphology."
- The stressor-specific Quality Classes are finally converted into the Ecological Quality Class using a worst-case scenario.

This procedure further eases data interpretation as results at three different scales are available: (1) the Ecological Quality Class, (2) the Quality Classes of the individual modules and (3) the results of the individual metrics.

11.3 Details on individual steps of the calculation

Which metrics are chosen for evaluating the Ecological Quality Class for a certain stream type and stressor?

Only metrics capable of discriminating between "stressed" and "unstressed" conditions are used. Metrics that clearly respond to specific pollutants or stressors are most useful as a diagnostic tool. Furthermore, the metrics used should cover diverse aspects of structure, composition, health and function of the aquatic biota (compare Table 11.1).

When considering these general guidelines, it becomes obvious that different metrics are required for assessing individual stream types. The details of the selection process are not part of this manual. The selection process resulted in up to 18 suited metrics for the individual AQEM stream types. In exceptional cases only one metric is used (usually if a single metric is extremely well correlated to s specific stressor). A complete list of metrics used for assessing the individual stream types and stressors is given in Annex 6.

How are the metrics calculated?

The formulas for all metrics are given in Annex 9.

How are the metrics scored?

Metrics vary in their scale: They result in integers, percentages, or dimensionless numbers. Prior to developing an integrated index for assessing the biological condition, it is necessary to standardise the metrics via transformation to unitless scores.
Therefore, each metric result is individually converted into a score; the same scoring system is applied for all metrics. Wherever possible the scoring system discerns the same classes that were used for scoring Ecological Quality Classes:

5 = high status
4 = good status
3 = moderate status
2 = poor status
1 = bad status

This procedure is applied for all stream types in Sweden, Germany, The Netherlands, The Czech Republic, Italy and Portugal.
A slightly different approach is used for the Austrian and Greek stream types: here, all metrics are scored between 0 and 1.
The decision, which metric result is converted to which score has been made individually for each metric and each stream type based on the AQEM data set.

How to calculate the Ecological Quality Classes (general multimetric calculation) or the stressor-specific Quality Classes (stressor-specific multimetric calculation)?

A multimetric index integrates information from several metrics by combining the individual scores in a simple multimetric formula, usually the average of all metric scores. In some exceptions there is a weighting factor for the score of a certain metric, which correlates best with stream degradation.

How is the Ecological Quality Class calculated from the stressor-specific Quality Class?

A worst-case scenario is used. Example: "Quality Class module organic pollution" = good; "Quality Class module stream morphology degradation" = moderate ⇒ Ecological Quality Class = moderate.

The metrics used for assessing the individual stream types are listed in Annex 6. A more detailed description of the assessment approaches for the individual stream types is given in Annex 7.

12 USE OF THE AQEM SOFTWARE (AQEM EUROPEAN STREAM ASSESSMENT PROGRAM)

Aims

The AQEM software performs all calculations necessary for applying the AQEM system:

- calculation of the Ecological Quality Class of a sampling site, based on a macroinvertebrate taxa list, by performing the stream-type specific calculations specified in Chapter 11 and Annex 7;
- calculation of a large number of additional metrics, which are helpful for further data interpretation.

The AQEM software is only a calculation program and not designed for storing data. The reason behind this limitation, lies in the multitude of databases, which are presently used by different European water authorities. It can be expected and it is reasonable that the authorities will continue to use those databases in the future. The AQEM software is based on EXCEL as common and comparatively compatible computing system, to which most databases are able to export data sheets.
The AQEM software is capable of importing a taxa list in either EXCEL (*.xls) or ASCII file format and exporting results to either EXCEL or ASCII files. Preparing data sets for import into the AQEM software must be done using a different program, e.g. EXCEL or a text editor.

12.1 Installation instructions

The AQEM software is available either on CD or from www.aqem.de. If the CD does not start automatically, start “Setup.exe” to install the program.

12.2 System requirements

- Microsoft operating system Windows 98, 2000 or NT4;
- Microsoft Office 97 or Microsoft Office 2000 for the reading and writing data input files (EXCEL) and establishing connections with the ACCESS databases.

The AQEM software is designed for English versions of Microsoft Windows and Microsoft Office. When running the AQEM software EXCEL must be closed.

Programming

The AQEM software has been programmed by:

Wageningen Software Labs
P.O. Box 47
6700 AA Wageningen
The Netherlands
http://www.wisl.nl

based on the calculation formulas developed by the AQEM consortium.

Start Window

The Start Window of the AQEM software is displayed in Figure 12.1.

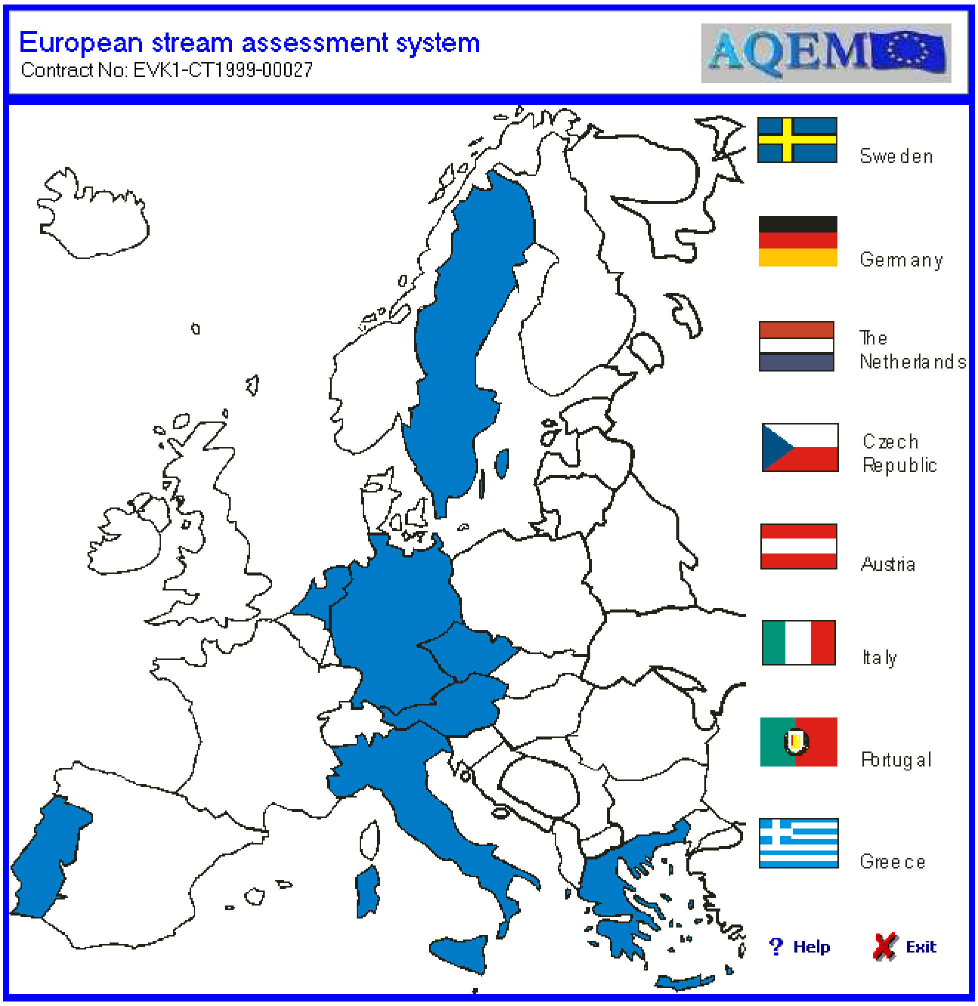


FIGURE 12.1: Start Window of the AQEM software.

By clicking on one of the flags corresponding information for the selected country is loaded into the program and the Main Program Window is opened. The country selection can be changed later in the Main Program Window or in the Sample Characterisation Window.

Main program Window

Figure 12.2 shows the Main Program Window of the AQEM software. The country selected for exemplary display is Sweden as shown in the drop-down box on the top left. In this drop-down list other countries can be selected.

There are three buttons in the upper right-hand frame of the window:

- The “Help” button opens the help function.
- The “Info” button opens a box displaying general information about the program, information about the consortium and the sources of autecological information.
- The “Exit” button closes the program.

To run the calculations a taxa list generated from the sampling site to be assessed must first be imported.

Note! Save the list before importing it into the AQEM software, as the AQEM software will alter the contents of the file. When importing a taxalist EXCEL must be closed.

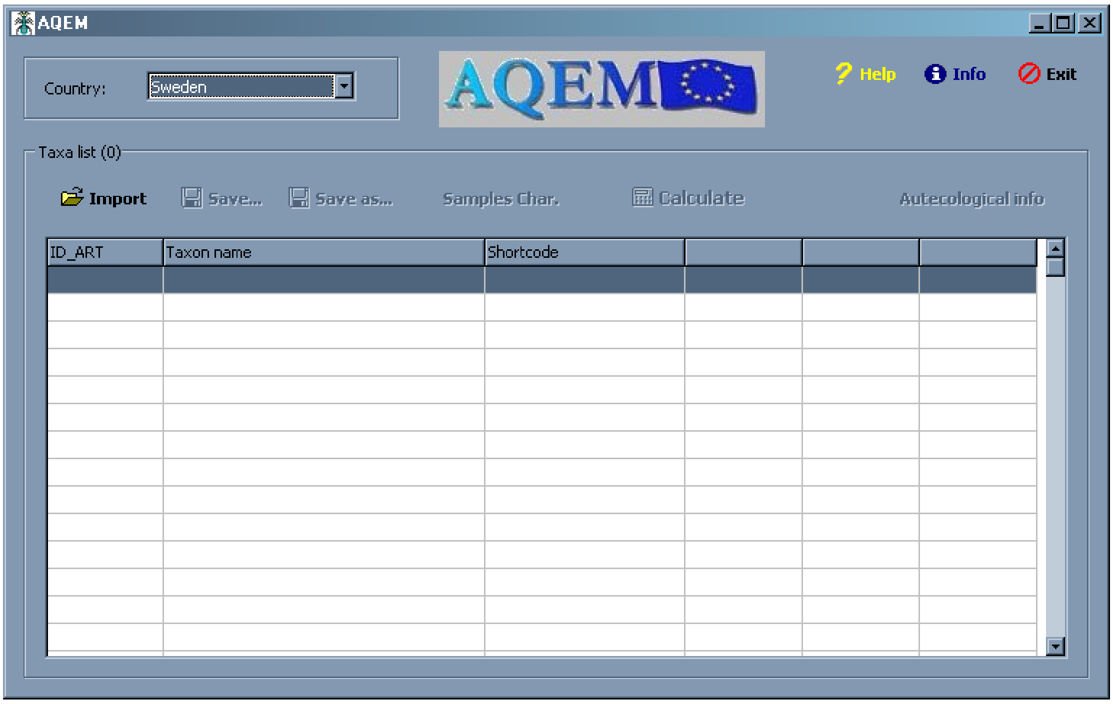


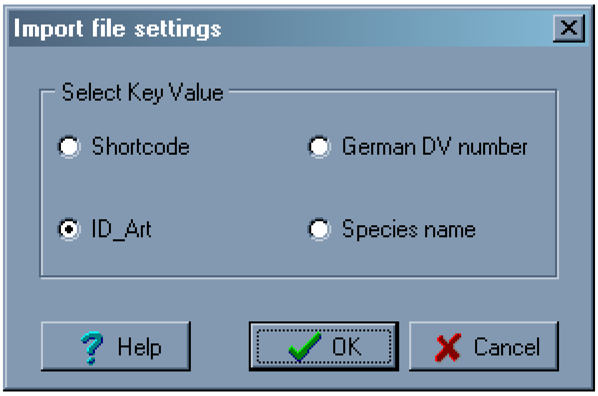
FIGURE 12.2: Main Program Window of the AQEM software.

Importing taxa lists

The “Import” button opens a standard windows dialog box, from which the taxa list to be imported can be selected.

The import file can either be an Excel or an ASCII table. Tables in either format must be layouted correctly (see section “File layout for importing taxa lists”). Otherwise the AQEM software is unable to import the data correctly.

After the import file is selected the following dialog box appears:



When importing taxa lists to computer programs one problem which often occurs is that taxa are incorrectly recognised and falsely imported into the program. Different use of nomenclature, different abbreviations (e.g. “spec.” or “sp.”) or simple spelling mistakes can lead to errors and confusion. Therefore, most systems use identification codes to clearly identify taxa.
Since the AQEM system is designed for application in several countries, the AQEM software offers five possibilities to specify taxa. One common identifier must be selected in the “Import file settings” dialog bow as the import “Key Value”.
Valid Key Values are:

Column heading in file	*Description*
Shortcode	Taxa shortcode for internal use in the AQEM project
ID_ART	Taxa identification number for internal use in the AQEM project; coherent to the Austrian standard taxa identification code, used in the Austrian software ECOPROF
German DV number	German DV-Code: the German standard taxa identification code
TAXON_NAME	Taxon name

The import file table should contain an extra column for one of the Key Value codes listed above. If the table does not contain any of the other codes it must be imported using “TAXON_NAME” as the Key Value.
Note! Headings in the Key Value columns in the import file table must be written in exactly the same way as they are written in the table above to ensure correct import of the data.
After selecting a Key Value from the “Import file setting” dialog box, press OK to import the selected file. Once the list is imported the program automatically links each

imported taxon with the relevant autecological information from the taxa database according to the Key Value.

Automatic replacement of taxa

The taxa list is imported by comparing the selected Key Value with the respective Key Values from the taxa database, which is part of the program. If the Key Value/taxon name combination in the imported taxa list differ from the Key Value/taxon name combination in the database, the taxon name will automatically be replaced.

If taxa have been replaced, a list of these taxa is displayed in the Replaced Taxa Names Window (Figure 12.3). It is possible to save this list as an EXCEL file.

Note! If a taxon name does not correspond the Key Value the program will automatically replace the taxon name by the taxon name belonging to the Key Value. Check the Replaced Taxa Names Window always carefully to avoid incorrect changes resulting from mistyped Key Values in the input file.

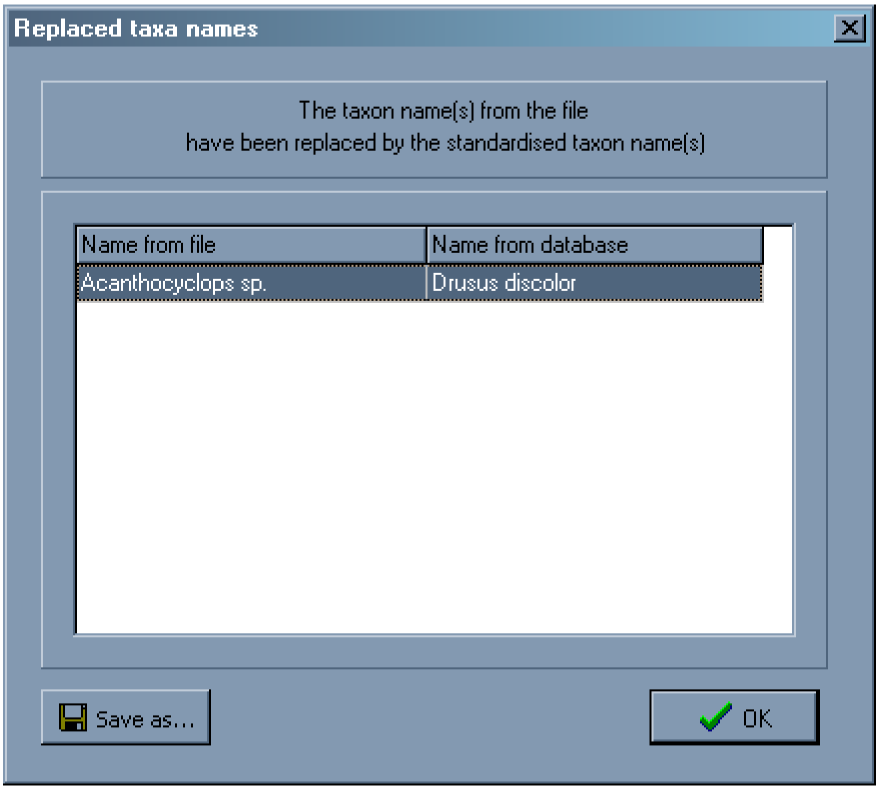


FIGURE 12.3: List of automatically replaced taxa

Replacement of unknown taxa

If a taxa cannot be found or correctly merged within the database, it can be altered manually. These “unknown” taxa are displayed in the Replace Unknown Taxa Window (Figure 12.4). In this window, these taxa can either be replaced by another taxon or deleted from the imported taxa list.

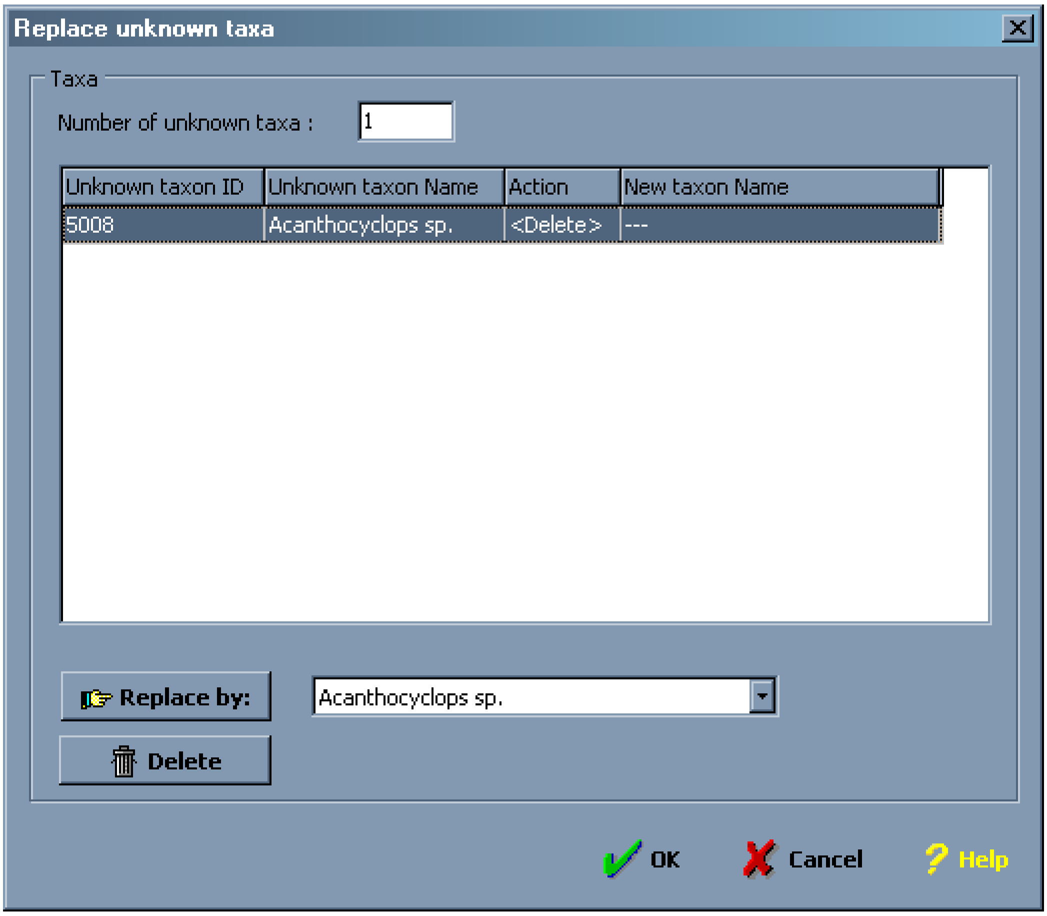


FIGURE 12.4: List of unknown taxa from an imported taxa list. The first column shows the unknown taxon ID (Key Value) from the import file; the second column shows the unknown taxon name from the import file; the third column shows the action to be taken (**Note!** The default setting is: removal of the taxon); the fourth column shows the new taxon name if the taxon is replaced.

The user can select the unknown taxon and search for an alternative name in the drop-down list. The taxon can be replaced by pressing the “Replace by” button. In this case the “Action” column will show “<Replace>”.

If the user wants to delete the taxon he can select the taxon and press the “Delete” button. In this case the “Action” column will show “<Delete>”. Note that default settings will delete the taxon; there is no need to specifically delete the taxon by selecting it and pressing the “Delete” button.

The “OK” button will confirm the actions selected for all taxa in the list, and will start performing the corresponding changes in the sample taxa lists. Unknown taxa marked as <Delete> in the ”Action” column, will be removed from the imported taxa list. Taxa marked as <Replace> in the “Action” column, will be replaced with the selected taxon name from column “New taxon name” and the corresponding Key Value from the database will be updated in the import taxa list. If the new taxon already exists in the sample list, the abundances will be added to the existing entry for the taxon.

The “Cancel” button cancels all the actions and returns to the Main Program Window without importing the taxa list into the program.

Note! Pressing the OK button causes all action to be undertaken simultaneously. Be sure that all the actions in the “Action“ column of Replace Unknown Taxa Window are set as you wish before pressing the OK button.

Sample Characterisation

Once all the taxa are successfully imported into the program the Sample Characterisation Window is automatically shown (Figure 12.5).

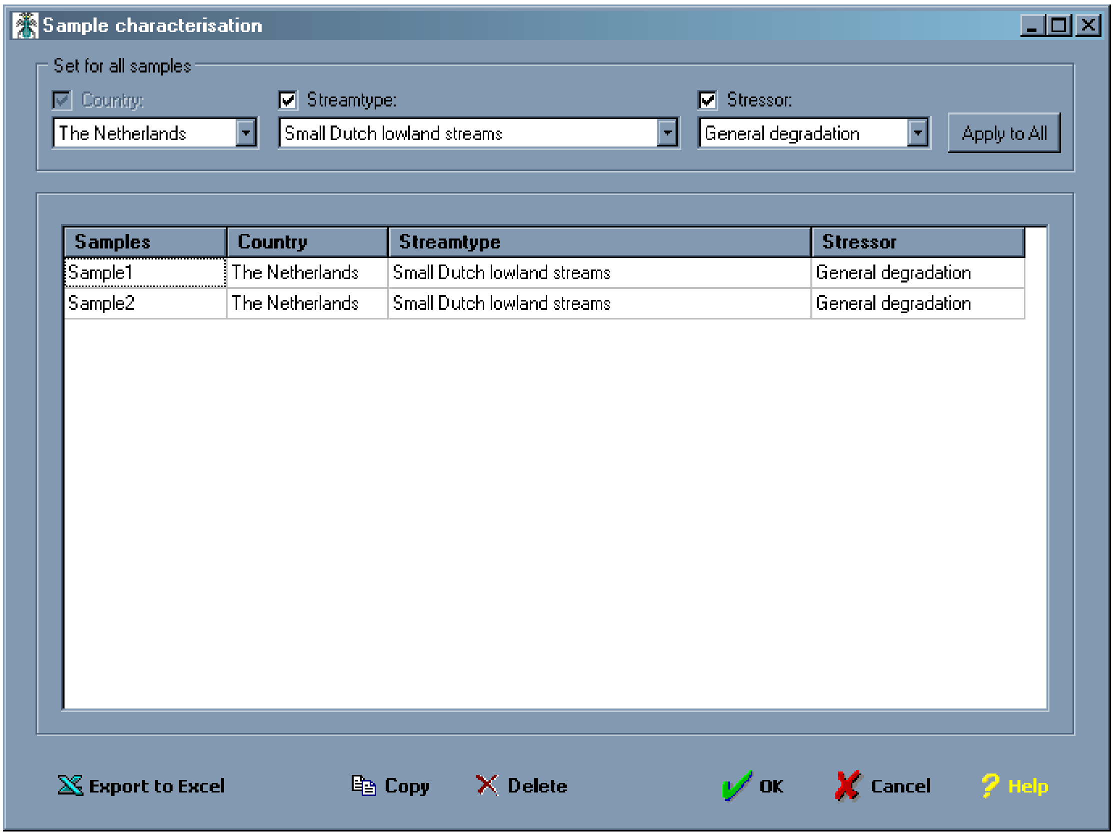


FIGURE 12.5: The Sample Characterisation Window.

In the example given in Figure 12.5, taxa lists from two sampling sites have been imported into sample file. For every list a country, a stream type and a stressor must be selected. See Section “Valid stream type/stressor combinations” for a detailed table of valid combinations.

The country is by default set to the country chosen when the program was started.

The default stream type and stressor are the first stream type/stressor combination in the list given in Table 12.1. Other stream types and stressors can be chosen in the drop-down list.

Country, stream type and/or stressor can be changed either for all samples at once to the same stream type and stressor or individually for each sample:

1. In the top frame of the window there are three drop-down boxes for selecting the appropriate characters. If the check-boxes above the drop-down boxes are checked then pressing the "Apply to all" button will apply the selected characters to **all** samples in the list.
2. By double-clicking on any given cell, which is to be changed, a drop-down list with the possible characters will appear. See also Figure 12.6 for an example, where the list with stream types is shown for an individual sample.

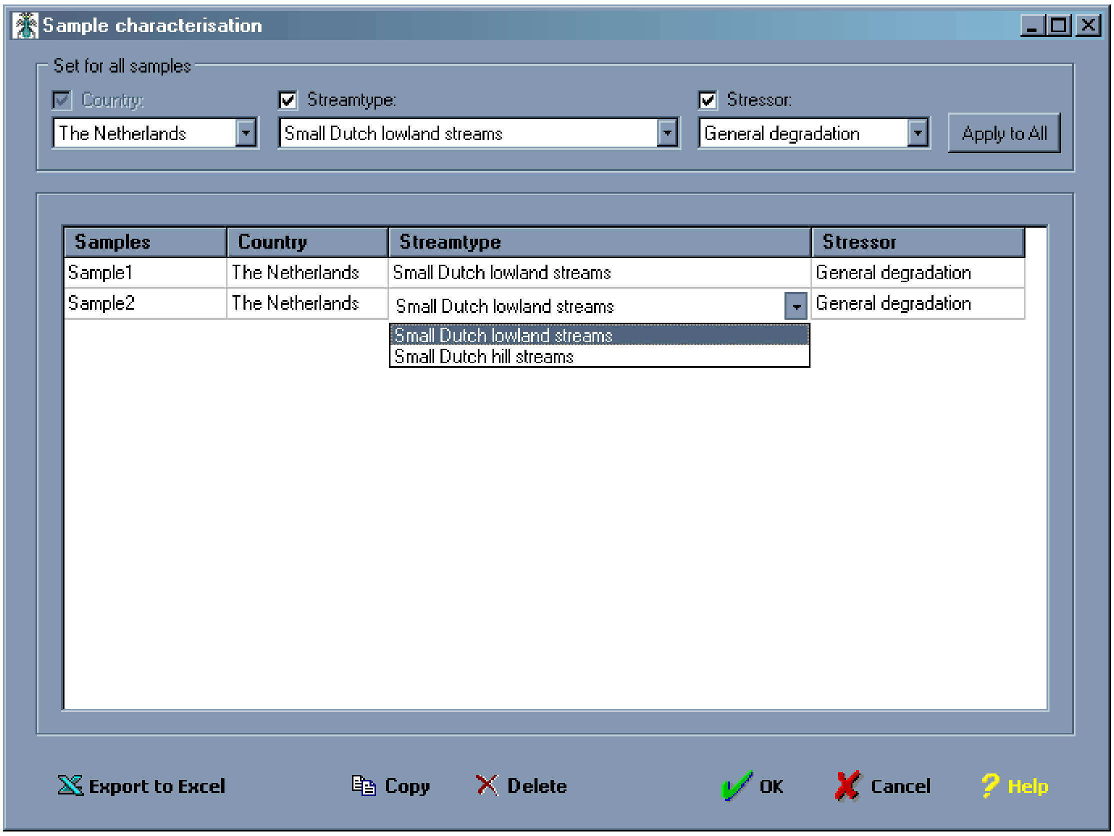


FIGURE 12.6: Drop-down list for selecting a stream type for an individual sample.

Any selected sample can also be copied, e.g. in case two stressors need to be calculated for the same sample. This should always be done if two stressors are "valid" for a certain stream type (see Table 12.1). If two stressors have been selected, the sample will be mentioned twice in the Summary Window (e.g. result 1 = Quality Class for "organic pollution"; result 2 = Quality Class for "degradation in stream morphology"). In the present version of the AQEM software the "final" Ecological Quality Class needs to be calculated "by hand" using the worst case out of the two stressor-specific results.
The name of a newly generated sample by copying can be edited by double clicking on the sample name. Any selected sample can also be deleted from the list.

- The “Export to Excel” button saves the Sample Characterisation table as an Excel file.
- The “Cancel” button discards all changes made and returns to the Main Program Window.
- The “OK” button confirms all the changes and returns to the Main Program Window.
- The “Help” button prompts this text.

Main program Window after a successful taxa list import

Once all imported taxa have been recognised and the stream type and stressor for the samples have been selected the Main Program Window appears as shown in Figure 12.7. Note that the buttons “Save”, “Save as”, “Samples Char.”, “Calculate” and “Autecological Info”, which were grey before the taxa list was imported are now functional.

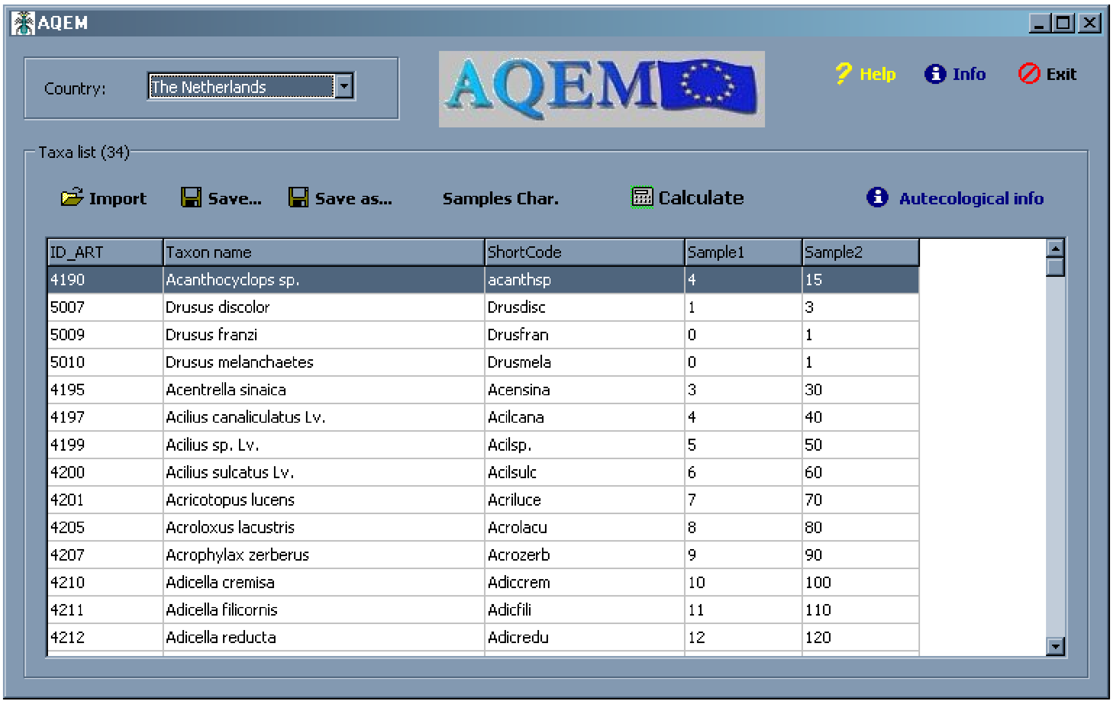


FIGURE 12.7: Main screen with an imported taxa list.

The first column displays the Key Value applied for importing the data. The second column contains the taxon name, the third column the shortcode. The following columns display the abundance of each taxon in the individual samples.

- The “Save” button saves the imported samples with the current file name.
- The “Save as” button saves the imported samples with a user-defined file name; also the file type can be chosen (EXCEL or plain ASCII).

- The “Sample char.” button opens the Sample Characterisation Window where the stream types and stressors can be selected. Note that only a limited combination of stream types and stressors are valid. See “Valid stream type/stressor combinations”.
- The “Autecological information” button opens a large data sheet, where all the scores are given for each taxon in the sample list, which are used for calculating the metrics. See section Autecological Information Window for detailed information.
- The “Calculate” button starts the calculation for the samples depending on the selected stream type and stressor. See section Calculation Results for more information.

Calculation Results

The calculation results are summarised in the Sample Score Window in two separate sheets: “Summary” and “Metrics”. The “Summary” sheet, which automatically appears, when the “Sample score” Window is opened only contains the determined Ecological Quality Class and the results of those metrics used to calculate it.
The “Metrics” table contains the results of all metrics calculated by the program.

It is possible to save both screens separately as EXCEL files.

Summary sheet

The “Summary” sheet displays the results of those metrics used to calculate the Ecological Quality Class for the selected stream type and stressor. The calculated Ecological Quality Class is also displayed.
Results are only displayed, if a valid stream type/stressor combination has been chosen in the “Sample Characterisation” Window. Otherwise the screen displays no values.

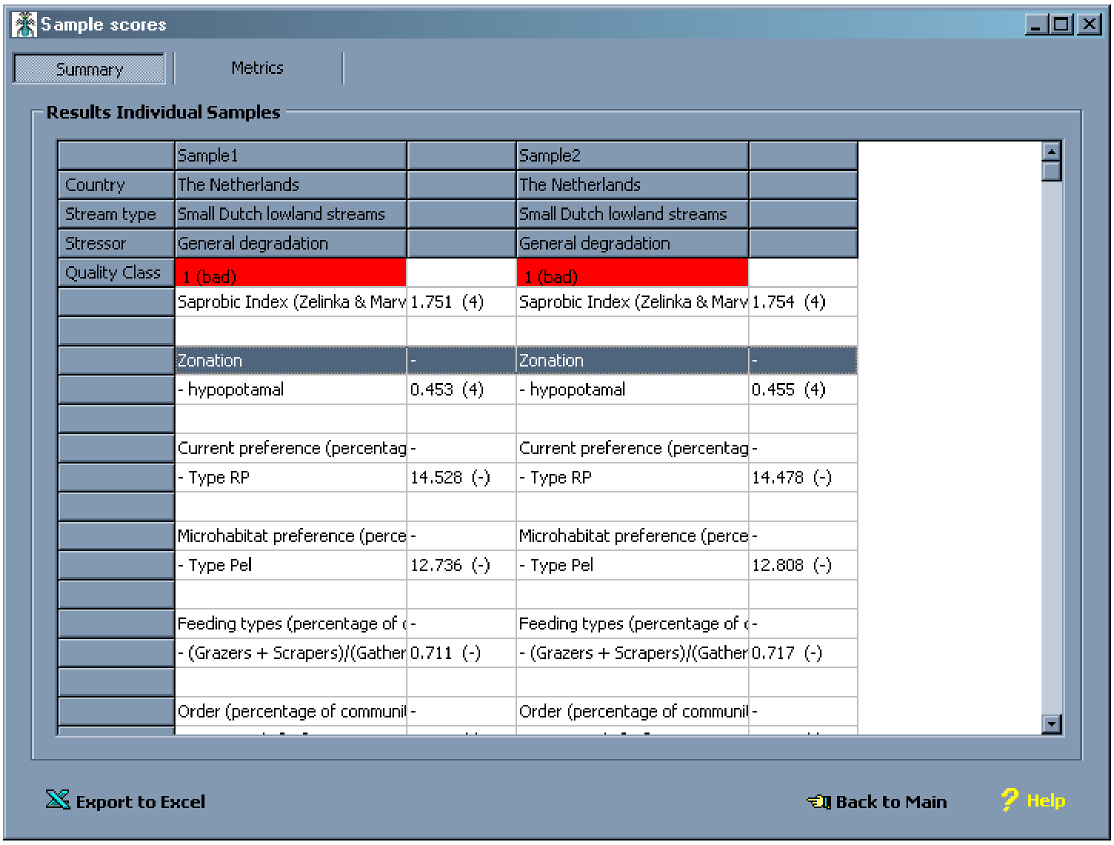


FIGURE 12.8: The Sample Score Window Summary sheet.

The Ecological Quality Class of the sample can be either:

5 (high) (indicated by a blue colour in the Quality-Class line)
4 (good) (indicated by a green colour)
3 (moderate) (indicated by a yellow colour)
2 (poor) (indicated by a orange colour)
1 (bad) (indicated by a red colour)

The results for all the calculated metrics are given for each sample. The value in brackets indicates the “Quality Class” of the metric ranging from 5 (high) to 1 (bad); “-“ is given in the brackets, if the metric does not qualify for calculating the Ecological Quality Class, because the value is out of range or certain organism groups have not been sampled, which are needed to calculate a certain metric.

Metrics sheet

The Metrics sheet shows the results of all metrics calculated by the program. Most of the metrics are not used to calculate the Ecological Quality Class but are helpful for data interpretation.
The metrics are explained in Annex 9 of this manual.

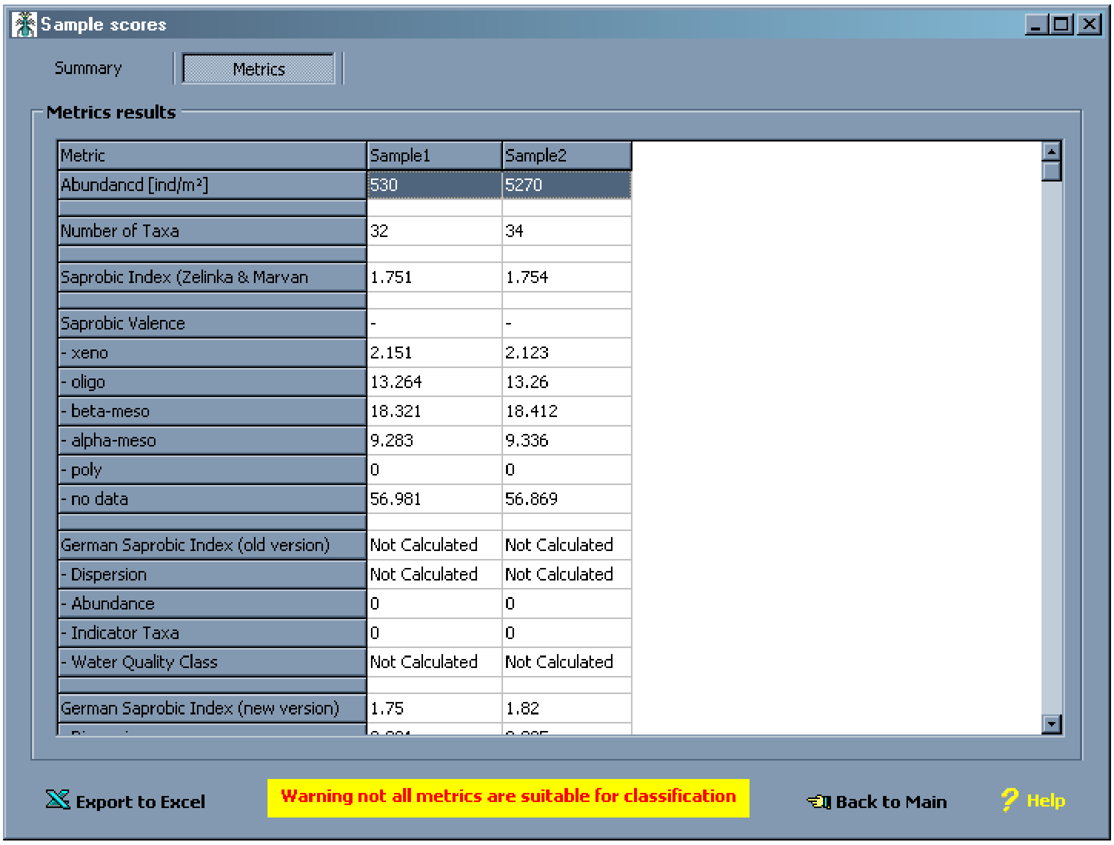
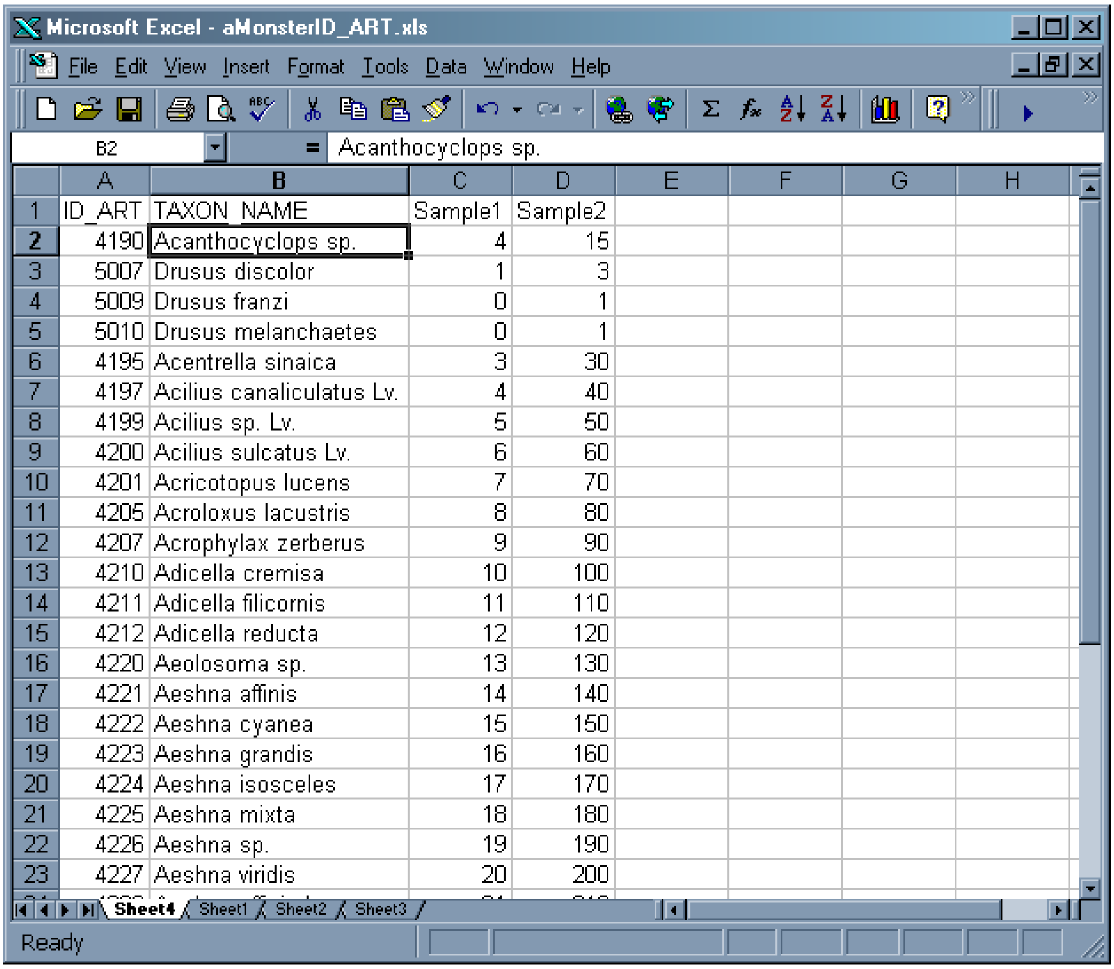


FIGURE 12.9: The Sample score Window Metrics sheet. “Not calculated” indicates that a certain metric has not been calculated since taxa relevant for the calculation have not been recorded.

File layout for importing a taxa list

EXCEL-file

Figure 12.10 shows an example how an EXCEL sheet must be formatted and layouted in order to be imported successfully.



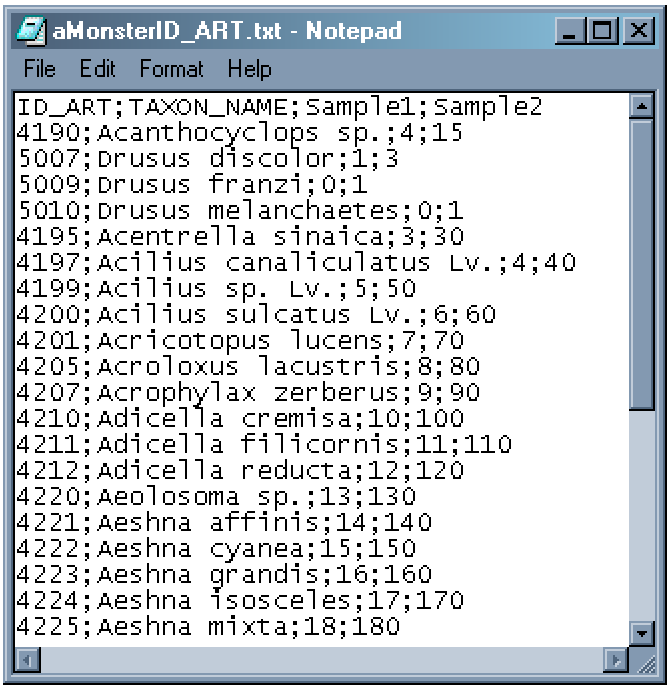
	A	B	C	D
1	ID_ART	TAXON_NAME	Sample1	Sample2
2	4190	Acanthocyclops sp.	4	15
3	5007	Drusus discolor	1	3
4	5009	Drusus franzi	0	1
5	5010	Drusus melanchaetes	0	1
6	4195	Acentrella sinaica	3	30
7	4197	Acilius canaliculatus Lv.	4	40
8	4199	Acilius sp. Lv.	5	50
9	4200	Acilius sulcatus Lv.	6	60
10	4201	Acricotopus lucens	7	70
11	4205	Acroloxus lacustris	8	80
12	4207	Acrophylax zerberus	9	90
13	4210	Adicella cremisa	10	100
14	4211	Adicella filicornis	11	110
15	4212	Adicella reducta	12	120
16	4220	Aeolosoma sp.	13	130
17	4221	Aeshna affinis	14	140
18	4222	Aeshna cyanea	15	150
19	4223	Aeshna grandis	16	160
20	4224	Aeshna isosceles	17	170
21	4225	Aeshna mixta	18	180
22	4226	Aeshna sp.	19	190
23	4227	Aeshna viridis	20	200

FIGURE 12.10: Example of an EXCEL input data sheet for import into the AQEM software.

The first column contains the Key Value. The second column contains the taxa names. The third and following columns contain the abundances of the species in each sample; a “0” indicates that this particular taxon is not present in the sample.
The abundances should be given in either “individuals/m^2” (Czech Republic, Germany), “individuals/1.25 m^2” (Austria, Greece, Portugal, The Netherlands, Sweden), “individuals/0.5 m^2” (Italian stream types I02 and I03) or “individuals/0.8 m^2” (Italian stream type I04).
Note that cells A1 and B1 and the text they contain must be formatted exactly the way given in Figure 12.10. Instead of “ID_ART”, cell A1 may also contain “German DV number”, “Shortcode”, “TAXON_NAME”, depending on which Key Value the user plans to use for importing the file.
When the imported sample file is saved it will have the same layout as given in Figure 12.10.

ASCII-file

The program is also capable of importing a plain ASCII file, which should be arranged as shown in Figure 12.11. Use “;” to separate the columns in the ASCII-file.




```
ID_ART;TAXON_NAME;Sample1;Sample2
4190;Acanthocyclops sp.;4;15
5007;Drusus discolor;1;3
5009;Drusus franzi;0;1
5010;Drusus melanchaetes;0;1
4195;Acentrella sinaica;3;30
4197;Acilius canaliculatus Lv.;4;40
4199;Acilius sp. Lv.;5;50
4200;Acilius sulcatus Lv.;6;60
4201;Acricotopus lucens;7;70
4205;Acroloxus lacustris;8;80
4207;Acrophylax zerberus;9;90
4210;Adicella cremisa;10;100
4211;Adicella filicornis;11;110
4212;Adicella reducta;12;120
4220;Aeolosoma sp.;13;130
4221;Aeshna affinis;14;140
4222;Aeshna cyanea;15;150
4223;Aeshna grandis;16;160
4224;Aeshna isosceles;17;170
4225;Aeshna mixta;18;180
```

FIGURE 12.11: Example of an ASCII input file.

The first column contains the Key Value, the second column contains the taxa names. The third and following columns contain the abundances (Ind/m²) of the species in each sample; a "0" indicates that this particular taxa is not present in the sample.

When the imported sample file is saved it will have the same layout as given in Figure 12.11.

Valid stream type/stressor combinations

Table 12.1 shows the valid combinations, which can be selected for characterising the sample in the Sample Characterisation Window.

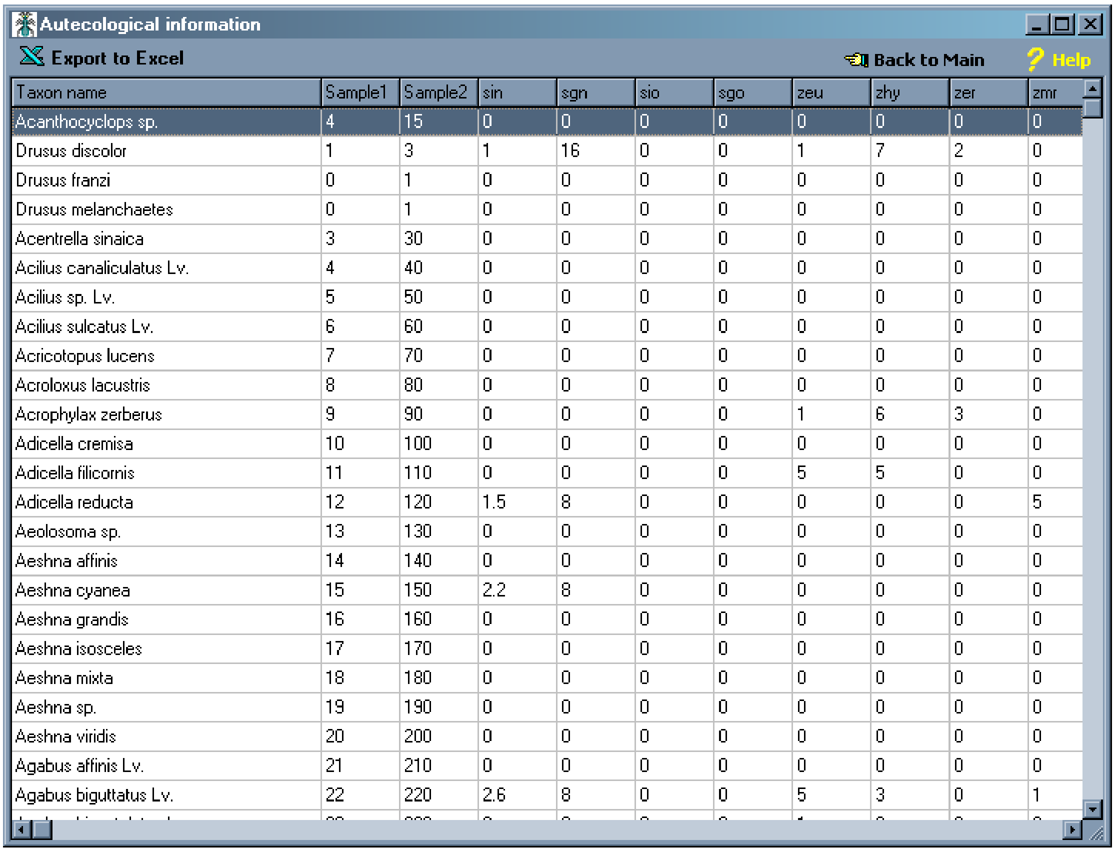
TABLE 12.1: Valid stream type/stressor combinations for the AQEM software. If two stressors are valid for a certain stream type, the sample must be copied and for each copy one of the stressors must be selected. the "final" Ecological Quality Class needs to be calculated "by hand" using the worst case out of the two stressor-specific results

Country	*Description*	*Stressors*
Sweden	Small lowland streams in Northern Sweden	Acidification
	Small mid-altitude streams in Northern Sweden	Acidification
	Small mid-altitude streams in Boreal highlands	Acidification
	Small high-altitude streams in Boreal highlands	Acidification
	Mid-sized lowland streams in South Swedish lowlands	Organic pollution, Acidification
Germany	Small sand bottom streams in the German lowlands	Organic pollution, Degradation in stream morphology
	Organic type brook in the German lowlands	Organic pollution, Degradation in stream morphology
	Mid sized sand bottom streams in the German lowlands	Organic pollution, Degradation in stream morphology
	(Spring) Small streams in lower mountainous areas of Central Europe	Organic pollution, Degradation in stream morphology
	Mid-sized streams in lower mountainous areas of Central Europe	Organic pollution, Degradation in stream morphology
The Netherlands	Small Dutch lowland streams	General degradation
	Small Dutch hill streams	General degradation
Czech Republic	Mid-sized streams in eastern lower mountainous areas of Central Europe	Organic pollution
	Small streams in lower mountainous areas of the Carpathian area	Organic pollution
	Mid-sized streams in lower mountainous areas of the Carpathian area	Organic pollution
Austria	Mid-sized streams in the Bohemian Massif	Organic pollution, Degradation in stream morphology
	Small non-glaciated crystalline alpine streams	Organic pollution, Degradation in stream morphology
	Mid-sized calcareous pre-alpine streams	Organic pollution, Degradation in stream morphology
	Mid-sized streams in Hungarian Plains	Organic pollution
Italy	Small streams in the southern silicate Alps	
	Small-sized, calcareous, 200-800m (South Apennines)	General degradation
	Mid-sized, calcareous, 200-800m (North Apennines)	Degradation in stream morphology
	Small streams in the lowlands of the Po valley	General degradation
Portugal	Small streams in lower mountainous areas of Southern Portugal	Organic pollution
	Small lowland streams of Southern Portugal	Organic pollution
	Medium sized lowland streams of Southern Portugal	Organic pollution

Country	*Description*	*Stressors*
Greece	(Summer) Mid-sized calcareous streams in Western Greece	Organic pollution
	(Summer) Mid-sized high-altitude streams in North-Eastern Greece	Organic pollution
	(Summer) Mid-sized high-altitude streams in Central and North Greece	Organic pollution
	(Winter) Mid-sized calcareous streams in Western Greece	Organic pollution
	(Winter) Mid-sized high-altitude streams in North-Eastern Greece	Organic pollution
	(Winter) Mid-sized high-altitude streams in Central and North Greece	Organic pollution
	(Summer) Small streams in lower mountainous areas of Central Europe	Organic pollution

Autecological Information Window

The data sheet shows all the information on ecological classification assigned to each imported species or taxon. This information is retrieved from the taxa database.



Taxon name	Sample1	Sample2	sin	sgn	sio	sgo	zeu	zhy	zer	zmr
Acanthocyclops sp.	4	15	0	0	0	0	0	0	0	0
Drusus discolor	1	3	1	16	0	0	1	7	2	0
Drusus franzi	0	1	0	0	0	0	0	0	0	0
Drusus melanchaetes	0	1	0	0	0	0	0	0	0	0
Acentrella sinaica	3	30	0	0	0	0	0	0	0	0
Acilius canaliculatus Lv.	4	40	0	0	0	0	0	0	0	0
Acilius sp. Lv.	5	50	0	0	0	0	0	0	0	0
Acilius sulcatus Lv.	6	60	0	0	0	0	0	0	0	0
Acricotopus lucens	7	70	0	0	0	0	0	0	0	0
Acroloxus lacustris	8	80	0	0	0	0	0	0	0	0
Acrophylax zerberus	9	90	0	0	0	0	1	6	3	0
Adicella cremisa	10	100	0	0	0	0	0	0	0	0
Adicella filicornis	11	110	0	0	0	0	5	5	0	0
Adicella reducta	12	120	1.5	8	0	0	0	0	0	5
Aeolosoma sp.	13	130	0	0	0	0	0	0	0	0
Aeshna affinis	14	140	0	0	0	0	0	0	0	0
Aeshna cyanea	15	150	2.2	8	0	0	0	0	0	0
Aeshna grandis	16	160	0	0	0	0	0	0	0	0
Aeshna isosceles	17	170	0	0	0	0	0	0	0	0
Aeshna mixta	18	180	0	0	0	0	0	0	0	0
Aeshna sp.	19	190	0	0	0	0	0	0	0	0
Aeshna viridis	20	200	0	0	0	0	0	0	0	0
Agabus affinis Lv.	21	210	0	0	0	0	0	0	0	0
Agabus biguttatus Lv.	22	220	2.6	8	0	0	5	3	0	1

FIGURE 12.12: The Autecological Information Window.

It is possible to save this data sheet as an EXCEL sheet by pressing the "Export to Excel" button in the top frame.

The first column on the screen shows the taxon name. The following columns with the header "Sample1" to "SampleN" show the abundance of each taxon in each particular sample. The following columns display the autecological information and ecological classification scores, which have been used to calculate the metrics.

TABLE 12.2: Explanation of abbreviated column headings in the Autecological information Window.

shortcode	*Explanation*
sin	German Saprobic Index (new version) saprobic score
sgn	German Saprobic Index (new version) weighting factor
sio	German Saprobic Index (old version) saprobic score
sgo	German Saprobic Index (old version) weighting factor
zeu	Preference for crenal (spring) (x out of 10 points)
zhy	Preference for hypocrenal (spring-brook) (x out of 10 points)
zer	Preference for epirhithral (upper-trout region) (x out of 10 points)
zmr	Preference for metarhithral (lower-trout region) (x out of 10 points)
zhr	Preference for hyporhithral (greyling region) (x out of 10 points)
zep	Preference for epipotamal (barbel region) (x out of 10 points)
zmp	Preference for metapotamal (brass region) (x out of 10 points)
zhp	Preference for hypopotamal (brackish water) (x out of 10 points)
zli	Preference for Littoral (x out of 10 points)
zpr	Preference for Profundal (x out of 10 points)
hpe	Preference for microhabitat Pelal (x out of 10 points)
har	Preference for microhabitat Argyllal (x out of 10 points)
hps	Preference for microhabitat Psammal (x out of 10 points)
hak	Preference for microhabitat Akal (x out of 10 points)
hli	Preference for microhabitat Lithal (x out of 10 points)
hph	Preference for microhabitat Phytal (x out of 10 points)
hpo	Preference for microhabitat POM (x out of 10 points)
hot	Preference for other microhabitats (x out of 10 points)
cup	Current preference (x out of 10 points); LB = limnobiont; LP = limnophil; LR = limno- to rheophil; RL = rheo- to limnophil; RP = rheophil; RB = rheobiont; IN = indifferent
fgr	Feeding type grazer and scrapers (x out of 10 points)
fmi	Feeding type miners (x out of 10 points)
fxy	Feeding type xylophagous taxa (x out of 10 points)
fsh	Feeding type shredders (x out of 10 points)
fga	Feeding type gatherers/collectors (x out of 10 points)
faf	Feeding type active filter feeders (x out of 10 points)
fpf	Feeding type passive filter feeders (x out of 10 points)
fpr	Feeding type predators (x out of 10 points)
fpa	Feeding type parasites (x out of 10 points)
fot	Other feeding types (x out of 10 points)
acidclass	Acid Class according to Braukmann
lss	Locomotion type: swimming/scating (x out of 10 points)
lsd	Locomotion type: swimming/diving (x out of 10 points)
lbb	Locomotion type: burrowing/boring (x out of 10 points)

shortcode	*Explanation*
lsw	Locomotion type: sprawling/waking (x out of 10 points)
lse	Locomotion type: (semi)sessil (x out of 10 points)
lot	Locomotion type: other (x out of 10 points)
szx	Saprobic valence ZELINKA&MARVAN: xenosaprob (x out of 10 points)
szo	Saprobic valence ZELINKA&MARVAN: oligosaprob (x out of 10 points)
szb	Saprobic valence ZELINKA&MARVAN: beta-mesosaprob (x out of 10 points)
sza	Saprobic valence ZELINKA&MARVAN: alpha-mesosaprob (x out of 10 points)
szp	Saprobic valence ZELINKA&MARVAN: polysaprob (x out of 10 points)
szs	Saprobic index ZELINKA&MARVAN: sabrobic score
szg	saprobic index ZELINKA&MARVAN weighting factor
masg	MAS Group
mass	MAS Score
masl	MAS Score (large river)
masgl	MAS Group (large river)
NSX	Netherland Saprobic valence xenosaprob (x out of 10 points)
NSO	Netherland Saprobic valence oligosaprob (x out of 10 points)
NSB	Netherland Saprobic valence beta-mesosaprob (x out of 10 points)
NSA	Netherland Saprobic valence alpha-mesosaprob (x out of 10 points)
NSP	Netherland Saprobic valence polysaprob (x out of 10 points)
IVD01	German Fauna Index indicator value D01
IVD02	German Fauna Index indicator value D02
IVD03	German Fauna Index indicator value D03
IVD04	German Fauna Index indicator value D04
IVD05	German Fauna Index indicator value D05
Mod1	Austrian Sensitive Taxa score
czx	Czech Saprobic Index valence xenosaprob
czo	Czech Saprobic Index valence oligosaprob
czb	Czech Saprobic Index valence beta-mesosaprob
cza	Czech Saprobic Index valence alpha-mesosaprob
czp	Czech Saprobic Index valence polysaprob
czsi	Czech Saprobic Index valence saprobic score
czv	Czech Saprobic Index weighting factor
AcidScore	Acid Score Hendrikson & Medin
dsfis	DSFI Family
dsfi1	DSFI Indicator group 1
dsfi2	DSFI Indicator group 2
dsfi3	DSFI Indicator group 3
dsfi4	DSFI Indicator group 4
dsfi5	DSFI Indicator group 5
dsfi6	DSFI Indicator group 6
ibef	IBE Family
ibeg	IBE Indicator Group
ibell	IBE Limit (low)
ibelh	IBE Limit (high)
bbif	BBI Family
bbig	BBI Indicator group
ID_FAM	ID of the family

shortcode	*Explanation*
Subfamily	Subfamily name
Port1	Score of the Portuguese Index
ID_GC	ID of the order
Family	Family name
TaxaGroup	Name of the taxonomic group
bmwp	BMWP Score
bmwpf	BMWP Family
bmwpe	BMWP Score Spain
bmwpef	BMWP Family Spain

Save file

To save the imported taxa list, press the “Save file” button. If a file with the same file name already exists the program prompts a warning, and gives the possibility to change the filename and/or file type.

The file can either be saved as an EXCEL datasheet or as an ASCII text file in the format described in section “File Layout for importing a taxa list”. The option to save the file as an EXCEL datasheet is only given, when EXCEL is installed on the computer where the AQEM program is being used.

Save file as

The “Save file as” button opens a standard windows dialog box, where it is possible to select the name and file type, to which the imported taxa list will be saved.

Two file types are possible, a plain-text type (ASCII) and an Excel datasheet. The option to save the file as an EXCEL datasheet is only given, when EXCEL is installed on the computer where the AQEM program is being used.

13 How to deal with a Degraded Stream?

13.1 How to interpret the output of the AQEM software?

The AQEM software delivers results at different levels, which can be used to specify management implications and procedures:

	specifications	interpretation
output sheet summary	Quality Class of a stream	"high", "good": no action needed "moderate", "poor", "bad": action needed
output sheet summary	Results of the individual metrics used to determine the Quality Class, usually sorted according to the stressor which they measure	• Which stressor is responsible for a "moderate", "poor", "bad" Quality Class? • Which metrics indicate a "moderate", "poor", "bad" Quality Class?
output sheet metrics	Results of all metrics, regardless whether or not they are used to determine the Quality Class	Identification of further deficits in the assessed stream stretch
output sheet autecological info	List of occurring taxa with their autecological specifications	Which are the missing or present taxa responsible for the result?

If a stream is of "moderate", "poor" or "bad" quality, restoration measures are needed to improve stream quality according to the Water Framework Directive. There are several options such as decreasing acidification, pollution or eutrophication, increasing habitat or current variability, establishing buffer strips or supporting riparian vegetation. The results of the individual metrics give a lot of information as to which restoration methods are most useful.

In all cases, in which stressors are assessed independently with different sets of metrics, some indication on which stressor is responsible for a "moderate", "poor" or "bad" quality class, is already given in output sheet "summary".

No manual can completely replace the investigators knowledge of the sampling sites. Basically, the result of each metric used to determine the Ecological Quality Class of a stream should be interpreted individually for each stretch, in consideration of the situation at the sampling site and in the catchment.

13.2 Examples for the interpretation of AQEM results

As mentioned above no general interpretation scheme for the AQEM metrics is given, since the results of individual metrics might be interpreted differently for different stream types. This section of the manual gives examples of how the output of the AQEM software might be interpreted.

Example 1: Stream type D03 (mid-sized sand bottom streams in the German lowlands): assessing the impact of organic pollution and degradation in stream morphology

The output of the AQEM software for three existing sampling sites (A, B, C) is:

		sample A	*sample B*	*sample C*
output sheet summary	Country	Germany	Germany	Germany
	Stream type	mid-sized...	mid-sized...	mid-sized...
	Stressor	organic pollution and degradation ...	organic pollution and degradation ...	organic pollution and degradation ...
	Quality Class (worst case out of Quality Class for pollution and Quality Class for degradation in stream morphology – to be “calculated” by hand)	5 (high)	3 (mod.)	1 (bad)
	Stressor-specific assessment results			
	Pollution	5 (high)	4 (good)	4 (good)
	German Saprobic Index (new version)	5 (high)	4 (good)	4 (good)
	Degradation in stream morphology – Multimetric Index	5 (high)	3 (mod.)	1 (bad)
	single results			
	German Fauna Index D03	5 (high)	3 (mod.)	1 (bad)
	[%] Trichoptera	4 (good)	4 (good)	2 (poor)
	[%] rheophilous preferences	5 (high)	3 (mod.)	1 (bad)
	[%] gatherers / collectors	5 (high)	2 (poor)	1 (bad)
	[%] littoral preferences	5 (high)	3 (mod.)	1 (bad)
	[%] pelal preferences	4 (good)	2 (poor)	1 (bad)
output sheet metrics		*sample A*	*sample B*	*sample C*
	(...)			
	e.g. [%] hyporhithral preferences	4 (good)	3 (mod.)	2 (poor)
	e.g. [%] shredders	5 (high)	5 (high)	3 (mod.)
	e.g. [%] Chironomidae	5 (high)	3 (mod.)	1 (bad)
output sheet autecological info	(+ = taxon occurring; - = taxon not occurring)	*sample A*	*sample B*	*sample C*
	(...)			
	e.g. *Lype* spp.	+	+	-
	e.g. *Lasiocephala basalis*	+	+	-
	e.g. *Heptagenia* spp.	+	-	-
	e.g. *Molanna angustata*	-	+	+
	e.g. *Tinodes waeneri*	-	-	+

Output sheet "Summary"

Quality Class: Sampling sites B and C are not scored with a "good" Quality Class. Improvement measures are necessary to meet the demands of the Water Framework Directive.

Stressor-specific assessment results:

Pollution: Apparently none of the sampling sites is severely polluted (the German Saprobic Index is resulting in a "high" or "good" Quality Class). Therefore, restoration measures at sampling sites B and C should not only focus on reducing organic pollution.

Degradation of stream morphology: The multimetric index for assessing the impact of stream morphological degradation shows a very different picture: each sampling site scores differently concerning its Quality Class. To achieve a "good" Quality Class at sampling sites B and C, measures to improve the stream morphology must be taken. More details on the scores and possible management procedures can be read from the results of the individual metrics:

- *German Fauna Index D03*: Low values of the German Fauna Index for this stream type indicate a lack of taxa dependent on diverse substrate and current conditions. Any measures to increase habitat variability might help improve sites B and C.
- *[%] Trichoptera*: A low proportion of Trichoptera indicates low substrate diversity and the absence of stable substrates such as coarse woody debris. Useful improvement might include insertion of wood and establishment or support of woody riparian vegetation.
- *[%] rheophilous preferences*: A low proportion of rheophilous taxa is characteristic for stagnant or scoured streams with a homogeneous current velocity of <0.15 m/s. Any measures to increase current diversity are useful.
- *[%] gatherers / collectors, [%] Littoral preferences, [%] Pelal preferences*: As a result of low and homogeneous current velocities solid substrates might be covered with mud, which is mainly colonised by gatherers/collectors and littoral preferring taxa. Thus the proportions of gatherers/collectors and littoral preferring taxa are low. Often, this functional composition is also a sign of lacking riparian vegetation in the catchment area, which in turn results in dense macrophyte populations. Measures for increasing current diversity and supporting riparian vegetation are useful.

Output sheet "Metrics"

Additional metrics for further data interpretation: The results of the "core metrics" mentioned above are supported by some additional metrics, which have not been used to calculate the multimetric index, e.g.:

- *[%] hyporhithral preferences*: A high value (e.g. at sampling sites A) is characteristic for near-natural streams of this type and size. A low value (e.g. at sampling site C) might be a sign for "potamalisation" resulting from habitat conditions similar to larger, very slowly flowing rivers.

- *[%] shredders*: Depends on the share of organic microhabitats such as CPOM and wood debris; the "good" result of this metric at sampling site B corresponds to the comparatively high proportion of Trichoptera (see above).
- *[%] Chironomidae*: An unusually high proportion is indicative of stagnant conditions at or upstream of the sampling site.

Output sheet "autecological information"

Taxa list with autecological background information: The interpretation of results can be refined by considering the occurrence of selected taxa:

- *Lype* spp. and *Lasiocephala basalis* indicate a high amount of wood in the stream (both taxa are xylophagous) and intact riparian vegetation, upon which the adult stages are dependent. The occurrence of both species at sampling site B underlines the potential for recovery.
- *Heptagenia* spp. is especially abundant on wood and prefers high current velocities. The lack of this taxon corresponds to apparently low current velocities at sampling sites B and C.
- *Molanna angustata* and *Tinodes waeneri* prefer stagnant waters and stones, like those used for bank fixation, respectively. Their occurrence is, therefore, a sign for altered habitat conditions.

Example 2: Stream type A04 (Mid-sized streams in the Bohemian Massif): assessing the impact of organic pollution and degradation in stream morphology.

The output of the AQEM software for three existing sampling sites (A, B, C) is as follows:

		sample A		*sample B*		*sample C*	
output sheet summary	Country	Austria		Austria		Austria	
	Stream type	mid sized ...		mid sized ...		mid sized ...	
	Stressor	organic pollution and degradation ...		organic pollution and degradation ...		organic pollution and degradation ...	
	Quality Class (worst case out of Quality Class for pollution and Quality Class for degradation in stream morphology – to be "calculated" by hand)	1 (bad)		3 (mod.)		5 (high)	
	Pollution	mod. (3)		good (4)		high (5)	
	Saprobic index (Marvan & Zelinka)	2.43		1.88		1.71	
	Degradation in stream morphology – Multimetric index	1 (bad)		3 (mod.)		5 (high)	
	metric results	value	score	value	score	value	score
	number of EPT taxa	0	0.00	32	0.68	39	0.83
	abundance Trichoptera	0	0.00	101	0.05	2177	1.00

	number of taxa	20	0.18	82	0.73	113	1.00
	total abundance	360	0.01	5776	0.19	31200	1.00
	Index of Biocoenotic Region	6.43	0.63	5.29	0.83	4.92	0.90
	[%] Oligochaeta & Diptera	80	0.36	45.12	1.00	46.90	0.97
	[%] Gatherers / collectors	70.60	0.38	46.10	0.70	32.60	0.87
	[%] Littoral preferences	2.37	0.78	1.06	0.91	0.62	0.95
output sheet metrics		*sample A*		*sample B*		*sample C*	
	(...)						
	Abundance Ephemeroptera	0		1310		5617	
	Active filterers	11.16		3.39		2.32	
	Passive filterers	0.00		11.53		9.09	
output sheet autecological info	(+ = taxon occurring; - = taxon not occurring)	*sample A*		*sample B*		*sample C*	
	(...)	-		-		-	
	Brachycentrus montanus	-		-		+	
	Micrasema longulum	-		-		+	
	Epeorus sylvicola	-		+		+	
	Elmis spp. (adult)	-		-		+	

Output sheet "Summary"

Quality Class: Sampling sites A and B must be improved to meet the requirements of the Water Framework Directive.

Stressor-specific assessment results:

Pollution: All sampling sites are apparently not severely polluted, except sampling site A. The saprobic Index (ZELINKA & MARVAN) results in a "high" or "good" Quality Class for Sample B and C and a "moderate" Quality Class for Sample A. Therefore, restoration measures have to focus on the reduction of organic pollution only at sampling site A.

Degradation in stream morphology: The multimetric index for assessing the impact of stream morphology degradation on the fauna results in different Ecological Quality Classes. To achieve a "good" Quality Class at sampling sites A and B, measures to improve the stream morphology are necessary. Details can be derived from individual metric results:

Taxa richness measures:

- *number of taxa, number of EPT-taxa*: The total number of taxa measures the overall variety of the macroinvertebrate assemblage; taxa richness represents the diversity within a sample. Decreasing diversity suggests that niches, habitat, and food sources are inadequate to support many species. The low values in samples A and B reflect decreased habitat variety, particularly concerning variable flow velocity and diverse structuring of the stream bed (e.g. increasing deposition of organic substrate, loss of coarse fractions). Ephemeroptera, Plecoptera and Trichoptera are known as sensitive taxa. They clearly respond to various stressors. The decrease of EPT-taxa at sites A and B compared to site C (reference) reflects a decrease in habitat diversity at site B. At site A, it seems that no suitable habitats for EPT-taxa remain at all. In particular, changes are caused by absence of coarse substrates, reduced flow velocity and limited decomposition processes, which cause oxygen depletion in the hyporheic interstices.

Abundance measures

- *total abundance and abundance of Trichoptera*: River-type specific Trichoptera are dramatically reduced by the loss of habitats to which they are adapted like e.g. stable substrates covered by mosses and woody debris. Within the fine sediment dwellers, which are supported by river damming, Trichoptera are underrepresented compared to other insects groups. The decrease in total abundance of all taxa generally indicates reduced productivity within the macrobenthic community, probably caused by high amounts of fine and instable sediments, which provide hostile conditions for most benthic invertebrates.

Species composition measures

- *[%] Oligochaeta & Diptera*: Tolerant colonisers of fine sediments are favoured by river damming. Especially small organisms with high turnover rates, like Oligochaeta and Diptera, are present in high percentages within the benthic assemblage. The high metric-value in site A reflects unfavourable habitat conditions for EPT taxa and a simultaneous increase of Oligochaeta and Diptera taxa.

Zonation measures

- *Index of Biocoenotic Region, Littoral preferences*: The Index of Biocoenotic Region is raised from the type-specific value (hyporhithral, 4.92; site C) up to 6.34 at site A, indicating a potamalisation effect. This shift is mainly caused by stagnation, which is also reflected by a high percentage of littoral preferences.

Feeding measures

- *[%] Gatherers / collectors:* Feeding measures comprise functional feeding groups and provide information on the balance of feeding strategies (food acquisition and morphology) in the benthic assemblage. Trophic metrics like feeding measures are surrogates of complex processes (e.g. trophic interaction, production, and food source availability). Generalists, like gatherers and collectors, have a broader range of acceptable food materials than specialists (scrapers, piercers, shredders), and thus are more tolerant to pollution, which might alter availability of certain food sources. The metric results of the impaired sites in the example above clearly show the effect of river impoundment on the distribution of functional feeding groups. The percentage of the gatherers and collectors representing generalists, are significantly increased in the impaired sites (A and B) Especially site A is overwhelmingly dominated by detritivores (70%), as a result of accumulating fine sediments; food resources for other feeding guilds are limited.

Output sheet "Metrics"

Additional metrics for further data interpretation: The results of the "core metrics" mentioned above are supported by some additional metrics, which have not been used to calculate the multimetric index, e.g.:

- *abundance of Ephemeroptera*: The density of Ephemeroptera is dramatically reduced in the impaired sites by the same effects as mentioned for the Trichoptera in the stream-type discussed above (loss of habitats, food resources etc.).
- *[%] active filterers, [%] passive filterers*: The proportion of filtering organisms indicate changes in the current velocity. The dose-response curves of the two functional feeding guilds show opposite reactions along a gradient of the specific stressor studied. While the percentage of passive filterers decreases under stagnant conditions, the proportion of active filter-feeders increases.

Output sheet "autecological information"

Taxalist with autecological background information: The interpretation of results can be refined by considering the occurrence of selected taxa:

- *Brachycentrus montanus*, a carnivorous filter-feeder, adapted to high water velocity and stable substratum like blocks, large woody debris and floating roots. These microhabitats occur exclusively under natural conditions and are substituted by instable fine fractions at degraded sites.
- *Epeorus sylvicola*: especially abundant on stable substrates in moderate to high water velocities. Last instar larvae preferably colonise woody substrates in lenthic areas, which indicates an intact transition zone between aquatic and terrestric habitats. Habitat degradation of sites A and B is underlined by the lack of *Epeorus sylvicola*.
- *Micrasema longulum* is mainly found in extensive stocks of mosses on which it feeds. This food resource is restricted to stable substrates like boulders and blocks in medium to high water current. The loss of this feeding habitat through modified current conditions and the domination of finer sediment fractions within impounded sections result in disappearance of this indicator species.
- *Elmis* spp. (adult): In this river type the genus *Elmis* is a characteristic representative of coarse lithal substrates and floating mosses, where it occurs in high numbers. The lack of these habitats in site A leads to a total absence of this species.

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ANNEX 1: Description of stream types

A01 Mid-sized streams in the Hungarian Plains

These low-gradient streams usually sinuate or meander within a broad floodplain. Due to the erosion power, prominent undercuts and slip slopes are frequent. The sediments are dominated by smaller grain fractions like sand and silt with gravel and cobbles limited to sections with higher currents. One further characteristic element is a high amount of Large Woody Debris, which provide habitats for filterers and grazers. Dense woody bank vegetation and a dynamic hydrological regime allow intact land-water transition zones. Oxbow lakes and other standing water bodies can still be found occasionally.

Average stream width reaches up to 15 m, mean current velocity is about 0.4 m/s, mean depth varies between 20 and 50 cm. Conductivity values range from 150 to 220 µS/cm, total hardness from 0.6 to 0.8 mmol/l.

The discharge regime shows either summer peaking with low values in winter or maxima between March and April with additional floods throughout the year.

The macroinvertebrate community consists of potamophilic species, some of which are endangered in Europe (e.g. *Heptagenia coerulans*, *H. flava, H. longicauda, Brachyptera braueri, Agnetina elegantula*). Besides filter-feeders (e.g. *Hydropsyche*-species, *Brachycentrus subnubilus* as well as freshwater mussels) and grazers (e.g. Ephemeroptera like Heptageniidae, *Ecdyonurus* spp*., Rhithrogena* spp. and the xylobiont beetle *Macronychus quadrituberculatus*), detritivorous taxa like Chironomidae and Oligochaeta are dominant.

In Austria this stream type is restricted to the Ecoregion "Hungarian Plains" and occurs exclusively in southern and eastern parts of the country.

This stream type is highly threatened by straightening, scouring damming and the removal of natural floodplain vegetation for the benefit of agricultural uses. Besides this, pollution from effluent as well as non-source eutrophication and input of toxic substances from agricultural land use result in devastated water channels, lacking sensitive taxa like those mentioned above.

A02 Mid-sized calcareous pre-alpine streams

These are high gradient streams, which flow in V- to U-shaped valleys. Substrate consists mainly of boulders, blocks, bedrock and cobbles. Near the shoreline and in current-reduced zones or pools, gravel and sand are deposited. Average stream width can reach up to 30 m, the mean current velocity is about 0.5 to 0.7 m/s, mean depth varies between 20 and 50 cm. Due to geology the conductivity is relatively high (from 250 up to 400 µS/cm), total hardness varies from 1.6 to 1.8 mmol/l. Total phosphorous base load does not exceed 10 µg/l.

Diatoms and mosses colonise the stony substrate depending on the degree of lighting, which is often limited by dense native deciduous/coniferous forest.

Extensive wetland areas are rare, although some spring fed tributaries occur frequently along the valley bottom and can contribute significantly to taxa richness.

The discharge regime is influenced by snow melting in spring (pluvio-nival) with highest discharges occurring between April and May.

A high proportion of rheophilic EPT-taxa within the macroinvertebrate community seems characteristic. In regard to functional feeding types, shredders and grazers (diverse representatives of Trichoptera like Limnephilidae, numerous Plecoptera like Taeniopterygidae, *Protonemura, Nemoura* and *Leuctra*, the Ephemeropteran genera *Rhithrogena, Ecdyonurus, Epeorus, Baetis* and Blephariceridae like *Hapalothrix* and *Liponeura*) are well represented.

In Austria this stream type is widely distributed within the alpine area. Human alterations are caused by stream regulation efforts like straightening, bank fixation, plastering, retention of bed load and impounding. Damming and water abstraction for power generation purposes cause severe ecological problems within vast stretches of residual flow and are often combined with pulse releases. Organic pollution, although evident in regions of tourism (skiing, mountaineering), presents a minor problem. Organic pollution, although evident especially in regions of tourism (skiing, mountaineering), causes minor problems.

A03 Small non-glaciated crystalline alpine streams

These are high gradient streams flowing in V- to U-shaped valleys. Extensive pool-riffle sequences mark the general appearance of these naturally constrained brooks. The substrate consists mainly of boulders, blocks, bedrock and cobbles. Near the shoreline and in current-reduced zones or pools, gravel and sand are deposited. Diatoms and mosses colonise the stony substrate depending on the degree of lighting, which is often limited by dense native deciduous/coniferous forest. Considerable numbers of debris dams are typical due to the high autumnal input of particulate organic matter. Extensive wetland areas are rare, although some spring fed tributaries occur frequently along the valley bottom and can contribute significantly to taxa richness.

Average stream width can reach up to 10 m, mean current velocity is about 0.3 to 0.5 m/s, mean depth varies between 10 and 30 cm. Conductivity is relatively low with values ranging between 30 to 200 µS/cm, total hardness varies from 0.3 to 0.8 mmol/l.

The discharge regime is characterised by spates in June (nival).

A high proportion of EPT-taxa within the macroinvertebrate community is characteristic. A dominance of shredders and grazers (diverse representatives of Trichoptera like Limnephilidae, numerous Plecoptera like Taeniopterygidae, *Protonemura, Nemoura* and *Leuctra*, the Ephemeropteran genera *Rhithrogena, Ecdyonurus, Epeorus, Baetis* and Blephariceridae like *Hapalothrix* and *Liponeura*) can be observed.

In Austria this stream type is widely distributed within the alpine area. Alterations are mainly caused by stream regulation efforts like straightening, bank fixation, plastering, retention of bed load and impounding. Damming and water abstraction for power generation purposes cause severe ecological problems within vast stretches of residual flow. Organic pollution, although evident in regions of tourism (skiing, mountaineering), presents a minor problem.

A04 Mid-sized streams in the Bohemian Massif

These are generally low to middle gradient streams flowing through U-shaped valleys. The channel form is variable, however mostly sinuate, except in low gradient sections, where it meanders. The composition of stream bed substrates is highly diverse and characterised by huge blocks and relatively high proportions of sand fractions, especially in low gradient zones and the leeward boulders. Bed load transport is very low in comparison to alpine streams. The share of organic microhabitats is high, typically with large numbers of debris dams and logs.

Stony substrates are colonised by diatoms and/or mosses depending on the degree of lighting, which is often limited by dense deciduous or mixed native forest (dominated by beech *Fagus sylvatica*). The high percentage of moss-covered boulders reflects stable substratum conditions. The average stream depth is about 0.5 m, average width between 10-15 m, mean discharge is about 2.500 – 3.500 l/s and temperature varies from 0 °C up to > 20 °C in summer. Connected standing water bodies in the floodplain are rare and primarily restricted to meandering stretches. The discharge regime is characterised by spates between April and May due to snow melting (pluvio-nival).

As far as Austria is concerned, the Bohemian Massif mainly consists of granites and gneisses, which are very poor in lime. This causes soft waters characterised by low total hardness (0,31 – 0,4 mmol/l) and low conductivity (100-130 µS/cm). The pH value comprises values between 6.88-7.90. Only floods - especially during snow melting periods – can temporarily lead to lower values.

A high number of different macrobenthic families is typical and reflects the heterogeneity of substrates and microhabitats, while the number of species is relatively low in relation to comparable streams in limestone areas. The number and abundance of Elmidae species, which prefer moss and living roots, and the share of EPT-taxa is high. In regard to functional feeding types, a high proportion of shredders and grazers (several representatives of Trichoptera like Limnephilidae, Plecoptera like Taeniopterygidae, *Protonemura, Nemoura* and *Leuctra*, the Ephemeroptera genera *Baetis*, *Rhithrogena, Ecdyonurus, Epeorus*, Ephemerellidae or Blephariceridae and *Gammarus*) is common.

Typical species of this region are e.g. *Hydropsyche silvfenii, Micrasema longulum*, *Anomalopterygella chauviniana*, *Canopsis schilleri*. *Ephemera danica* is found in high densities in sandy substrates, *Baetis sp*. and *Ephemerella* sp. occur frequently in moss and stony substrates compared to Heptageniidae. In Austria, the highly endangered mussel *Margaritifera margaritifera* (Unionidae) occurs only in the Bohemian Massif.

This stream type is restricted to the northern part of Upper and Lower Austria. Beside organic pollution and impairment of stream morphology, the most important degradation factor is the increasing amount of unstable sandy substrates mainly due to drainage measures in (unnatural) coniferous forests. Acidification is assumed for some higher reaches. Due to the low density of inhabitants in this part of Austria, several near-natural stretches can still be found.

C01 Mid-sized streams in the central sub-alpine mountains

This type of stream is characterised by a U-shaped valley and a meandering channel. Stream width varies between 7 and 30 m, stream depth averages 15 - 80 cm. Characteristic mineral substrates fractions are mesolithal or macrolithal. Algae (mainly diatoms) occur in spring, submerged macrophytes dominated by *Fontinalis* spp. CPOM mainly consists of fallen leaves. FPOM is present in pools and near the banks.

Potential natural vegetation are: Genisto-germanicae-Quercion and Luzulo-Fagion.

Streams are permanent with maximal discharges in spring; stream velocity ranges between 0.2 and 1.0 m/s, discharge varies from 1 to 10 m/s.

The water usually shows circum-neutral pH values, conductivity is usually below 300 µS/cm, mean alkalinity is relatively low (~ 1 mmol/l).

The macroinvertebrates community is characterised by high species diversity. *Baetis rhodani* and *Stylodrilus* spp. are euconstant and eudominant taxa, other typical species are *Rhithrogena semicolorata*, *Rhyacophila nubila* and *Hydropsyche siltalai*. The stream type is common in western and central parts of the Czech Republic. The most important degradation factors are changes in stream morphology, organic pollution and eutrophication. Natural stretches still remain.

C02 Small streams in the Carpathian

This type of stream is characterised by a U-shaped valley and a slightly meandering channel. Stream width varies between 1 and 6 m, mean stream depth ranges between 10 and 40 cm. Mineral substrate is dominated by mesolithal. Biotic substrates - comprising moss and diatoms in spring and CPOM in autumn - cover the bottom only partially.

Potential natural vegetation is: mainly Carpinion and Eu-Fagenion.

Streams are permanent with maximal discharges in spring, unstable discharge regime being typical for flysch areas. Average stream velocity is 0.2 – 0.6 m/s, average discharge is less then 1 m^3/s.

The water is usually slightly alkaline (pH>7.5), conductivity varies from 200 to 400 µS/cm, mean alkalinity is 2.5 mmol/l.

Gammarus fossarum and *Baetis rhodani* are constant and dominant species, other typical species is *Rhithrogena carpatoalpina*.

This stream type is common in the eastern parts of the Czech Republic near the Slovakian border.

The most important degradation factors are changes in stream morphology (transverse structures in higher altitudes and straightening of lower reaches, bed and bank fixation), organic pollution and eutrophication. Natural stretches still remain.


A01: Mid-sized streams in the Hungarian Plains


A02: Mid-sized calcareous streams in the Alps


A03: Small crystalline streams in the Alps


A04: Mid-sized streams in the Bohemian Massif


C01: Mid-sized streams in the central sub-alpine mountains


C02: Small streams in the Carpathian mountains


C03: Mid-sized streams in the Carpathian mountains

C03 Mid-sized streams in the Carpathian

This type of stream is characterised by a U-shaped valley and a braided channel (under natural conditions; nowadays most channels are meandering). Stream width varies between 7 and 30 m, stream depth ranges between 15 and 80 cm. Characteristic mineral substrates are macrolithal or mesolithal. Algae (mainly diatoms) occur in spring, submerged macrophytes are dominated by *Fontinalis* spp. CPOM is comprised mainly of fallen leaves. FPOM is present in pools and near the banks.

Potential natural vegetation is: Genisto-germanicae-Quercion and Luzulo-Fagion.

Streams are permanent with maximal discharges in spring. Range of stream velocity is between 0.2 and 1.0 m/s, with discharges varying from 1 to 10 m/s. The water is usually circum-neutral, with conductivity below 300 µS/cm and relatively low mean alkalinity (1 mmol/l).

The macroinvertebrate community is characterised by high species diversity. *Baetis rhodani* and *Stylodrilus spp*. are euconstant and eudominant taxa, other typical species are *Rhithrogena semicolorata*, *Rhyacophila nubila* and *Hydropsyche siltalai*. The stream type is common in western and central parts of the Czech Republic. The most important degradation factors are changes in stream morphology, organic pollution and eutrophication. Natural stretches still remain.

D01 Small sand bottom streams in the German lowlands

These streams are characterised by sand of fine to medium grain size and a meandering channel flowing in varying valley forms (trough valley to floodplain). Organic substrates range between 10% and 50%, and comprise considerable amounts of CWD (logs, debris dams). The water is characterised by low nutrient loads, a BOD_5 below 2 mg/l and a pH range between 6.5 and 7.5. The wide floodplain is dominated by deciduous woody vegetation.

The macroinvertebrate fauna is characterised by rheophilous and limnophilous taxa, the latter occurring in lentic zones near the shoreline or behind CWD accumulations. CWD is the only solid substrate available, and is therefore colonised by large quantities of filter feeders and scrapers. Typical taxa are *Leuctra nigra, Nemoura* spp. (Plecoptera), *Ephemera danica* (Ephemeroptera), *Hydropsyche* spp., *Lype* spp., *Halesus* spp., *Lasiocephala basalis* (Trichoptera) and *Elmis* spp. (Coleoptera).

Almost all stretches of this stream type have been degraded by scouring, straightening, impoundments, stagnation, removal of CWD, and devastation of floodplain vegetation. Smaller streams in forested areas sometimes remain in a good condition.

D02 Organic type brooks in the German lowlands

The organic type brook is characterised by a U-shaped valley and a braided channel. Entrenchment is minimal and the floodplain is completely inundated during minor floods. Biotic microhabitats cover most of the stream bottom, e.g. phytal (floating stands of *Potamogeton polygonifolius* and water mosses such as *Sphagnum* spp. and *Scapania undulata*), xylal (dead wood, roots) and coarse particulate organic matter (e.g. fallen leaves).

The water is usually acid and of brownish colour (humic substances), with pH-values ranging between 4.5 and 6.5. Conductivity is below 300 µS/cm. Most of the organic type brooks run dry in the summer months, mainly due to the hydro-geomorphological situation and evapotranspiration.

The benthic invertebrate community is characterised by species, which are highly adapted to the acid conditions and the dry period in summer. The macroinvertebrate community is dominated by Plecoptera (*Nemoura cinerea*, *Leuctra nigra*), Odonata (*Cordulegaster boltoni, Aeshna cyanea*), and Diptera (*Simulium vernum*).

This stream type was formerly wide-spread in the Northern German lowlands and can locally be found in the mountainous areas, as well. It has been nearly been completely destroyed by alterations of stream morphology (straightening, scouring, removal of floodplain vegetation) and eutrophication.

D03 Mid-sized sand bottom streams in the German lowlands

This stream type is characterised by sand of fine to coarse grain size, and a sinuate to meandering channel form in a meander valley or a plain floodplain. Organic substrates cover between 10% and 50% of the bottom and comprise considerable amounts of CWD (logs, debris dams). CWD causes high substrate and current diversity allowing both erosive and depositional zones. The water is characterised by low nutrient loads, a BOD_5 below 2 mg/l and pH values around 7,5. The wide floodplain is dominated by deciduous woody vegetation, and is flooded several times a year. Standing water bodies (side arms, backwaters) occur regularly.

The macroinvertebrate fauna is characterised by both rheophilous and limnophilous taxa, the latter occurring in lentic zones near shore or behind CWD accumulations. CWD is the only solid substrate available, and is therefore colonised by large quantities of filter feeders and scrapers. Typical taxa are *Taeniopteryx nebulosa, Nemoura* spp. (Plecoptera), *Brachycercus harrisella, Heptagenia* spp., *Caenis* spp. (Ephemeroptera), *Hydropsyche* spp., *Lype* spp., *Halesus* spp. (Trichoptera), *Gomphus* spp., *Ophiogomphus cecilia* (Odonata), *Macronychus quadrituberculatus*, *Limnius* spp. and *Elmis* spp. (Coleoptera). Standing water bodies in the floodplain are colonised by taxa capable of coping with dry periods in summer (e.g. the mayfly *Siphlonurus aestivalis*).

Almost all stretches of this stream type have been degraded by scouring, straightening, impoundments, stagnation, removal of CWD, and devastation of floodplain vegetation. Small near-natural fragments occur in north-eastern Germany and Poland.

D04 Small streams in lower mountainous areas of Central Europe

Usually characterised by U-shaped valleys or troughs and a sinuating channel with anabranched sections and temporarily connected side arms. The floodplain is completely covered with woody vegetation. The stream is characterised by frequent changes of riffles and pools and temporary side arms. Substrate diversity is high: mineral substrates range from large blocks to fine gravel, sand and mud (in the pools sections or in low current areas ashore); additional biotic substrates are floating riparian vegetation, fine roots of woody riparian vegetation and deposits of coarse and fine particulate organic matter.

The pH-value ranges between 6.5 and 8.0, conductivity is low (usually between 100 µS/cm and 300 µS/cm).

The macroinvertebrate community is characterised by species preferring the hypocrenal to metarhithral zones. Ephemeroptera, Plecoptera, Trichoptera and Diptera are the most abundant taxa. Some character species are *Epeorus sylvicola* (Ephemeroptera), *Dinocras cephalotes, Perla marginata* (Plecoptera), *Oreodytes sanmarki* (Coleoptera), *Philopotamus ludificatus, Micrasema longulum* (Trichoptera) and *Simulium argyreatum* (Diptera).

Due to improvements in water quality the most important degradation factors today are removal of woody vegetation, straightening, bank fixation and removal of Coarse Woody Debris.

D01: Small sand bottom streams in the German lowlands

D02: Organic type brooks in the German lowlands

D03: Mid-sized sand bottom streams in the German lowlands

D04: Small streams in lower mountainous areas of Central Europe

D05: Mid-sized streams in lower mountainous areas of Central Europe

H01: Mid-altitude mid-sized siliceous streams in North-Eastern Greece

H02: Mid-altitude large siliceous streams in Central and North Greece

H03: Mid-altitude mid-sized calcareous streams in Western Greece

D05 Mid-sized streams in lower mountainous areas of Central Europe

These streams are distributed from Belgium to the western parts of the Czech Republic. The geology is fairly homogenous in the whole range and consists of schist, greywacke, mudstone and sandstone. The streams have gravel beds (micro- to megalithal) with insertions of bedrock; sand is restricted to lentic stretches. Entrenchment is minimal.

Depending on its width the valley form can vary between U-shaped and meander valleys. Braided channel forms are primarily found in meander valleys. In general, the channel is shallow and wide. Floating plants, mosses and debris dams, which can block entire channels but are mainly found along the banks, are present. The banks and the floodplain are covered by deciduous forest and there are different succession stages of backwaters.

Due to the siliceous geology conductivity is moderate (~ 300 µS/cm) and pH-values range between 6.5 and 8.

The macroinvertebrate fauna is characterised by species inhabiting lithal microhabitats, e.g. *Epeorus sylvicola* (Ephemeroptera), *Perla burmeisteriana* (Plecoptera) and *Hydropsyche incognita* (Trichoptera) and species, which inhabit lentic sandy reaches or areas in lee of woody debris e.g. *Ephemera danica* (Ephemeroptera) and *Stenelmis canaliculata* (Coleoptera).

Nowadays most streams are altered morphologically (straightened, deep cut, dammed) and Coarse Woody Debris is generally removed.

H01 Mid-altitude mid-sized siliceous streams in North-Eastern Greece

These streams generally sinuate in trough and V-shaped valleys of medium-sized catchments dominated by silicate rocks. As a result the floodplain of these sites is rather small. Aquatic vegetation is rare, but there are still many biotic microhabitats such as fine roots, fallen leaves, moss and filamentous algae. As a result of the geochemical background the streams show low values of conductivity (average 273 µS/cm) and alkalinity (average 2.2 mval/l) with moderate silicate concentrations, relative high sulphate concentrations and very high sodium and potassium levels (in average 15 and 3.5 mg/l respectively). The streams are sometimes degraded by organic pollution and agricultural land use. Further sources of degradation include eco-tourism, cattle grazing, clear-cutting and fire in the catchment; however, completely undisturbed sections still remain.

H02 Mid-altitude large siliceous streams in Central and North Greece

These mid-altitude streams (average catchment elevation: 700 m) generally sinuate in trough and V-shaped valleys with narrow floodplains. Catchment geology is dominated by silicate rocks (average 60%; 10% being mafic rocks); carbonate rocks are the second major rock type (average 24%). Aquatic vegetation is rare, but fine roots, fallen leaves and mosses are well established. The biocoenosis is characterised by species, which are strongly related with the geomorphology, altitude and other biotic characteristics of the habitat such as plants etc. Hydrochemically, these streams show relatively low conductivities (average 297 µS/cm), minimal total hardness (average 172 mg/l $CaCO_3$), very low calcium (average 22 mg/l), magnesium (7 mg/l), and sulphate levels (average 15 mg/l). Sodium and potassium concentrations are high. Due to the abundance of mafic silicates the Mg/Ca ratio is high (0.54). This stream type is effected by a combination of organic pollution and agricultural activities. Further sources of degradation include eco-tourism, cattle grazing, clear-cutting and fire in the catchment; however, completely undisturbed sections still exist in remote areas.

H03 Mid-altitude mid-sized calcareous streams in Western Greece

These streams are characterised by sinuate channels, with variable valley forms. Catchments are dominated by carbonate rocks (average 60%) and mainly calcareous flysch and molasse deposits (average 24%). Lacustrine sediments are also present (average 8%). In the highlands, where bedrock outcrops dominate, the floodplain is rather small. Further downstream the floodplain becomes larger. Aquatic vegetation is only present at low altitudes and is dominated by *Typha latifolia, Lemna polyrhizza* and *Carex* spp. Biotic microhabitats usually only cover marginal areas. Fallen leaves and fine roots are present at almost all sites, while filamentous algae dominate at the degraded sites. Macroinvertebrate abundance at the reference sites is extremely high. Hydrochemically streams of this type reflect the carbonate and lacustrine deposits and are characterised by high levels of conductivity (average 428 µS/cm), total hardness (average 367 mg/l $CaCO_3$), alkalinity (average 3.41 mval/l), earth alkali (average Ca 53 mg/l, Mg 12 mg/l) sulphate (average 41 mg/l) and chloride (average 12 mg/l). The Mg/Ca ratio (0.38) is minimal, due to the absence of mafic silicate rocks. This stream type is effected by organic pollution and agricultural activities. Completely unpolluted reference sites still remain.

I01 Small-sized streams in the southern silicate Alps

The small-sized streams in the southern silicate Alps are characterised by a trough valley and a sinuate channel with a relatively high slope. The width of the floodplain is small, usually less than 10 m;.the average stream depth is less than 0.5 m and average width about 6 m. Mineral microhabitats cover most of the stream bottom, dominated by mega- and macrolithal (66%), followed by meso- and microlithal (26%). Hygropetric sites, akal and psammal/psammopelal represent the remaining substrates of the stream bottom. Presence of biotic microhabitats is marginal; it consists of xylal (dead wood, branches, roots), coarse particulate organic matter (e.g. fallen leaves), fine particulate organic matter and algae (filamentous algae, diatoms). The natural vegetation in the floodplain is coniferous and deciduous forest. The annual hydrologic regime is permanent and current velocities and discharges are low (less than 1 m/s and <1500 l/s).

The water shows a very low hardness and a low alkalinity. pH-values range between 7.1 and 8.5; mean conductivity is below 130 µS/cm.

The macroinvertebrate community is dominated by Ephemeroptera (*Baetis alpinus, Rhithrogena hybrida*-Gr., *Epeorus alpicola*), Diptera (*Hapalothrix lugubris, Dicranota* sp., *Micropsectra* sp., *Liponeura cinerascens, Simulium variegatum, Prosimulium rufipes, Orthocladius rivulorum, Orthocladius rivicola*-Gr.), Plecoptera (*Leuctra* sp., *Protonemura* sp., *Isoperla* sp., *Nemoura mortoni*) and Trichoptera (*Drusus biguttatus, Allogamus auricollis, Metanoea rhaetica*).

This stream type is distributed in the Italian silicate Alps. The most important degradation factors are alteration of stream morphology (torrent modification, transverse structures, bank and bed fixation, straightening, removal of CWD), and hydrological changes. Most of the streams belonging to this type have a degraded morphology.

I02 Small-sized, calcareous mountain streams in the Southern Apennines

These small streams (channel widths 5 – 15 m) pass through mountain valleys and generally have narrow floodplains (10 - 250 m), relatively high slopes (0.6 – 4.5%) and coarse substrates. Annual hydrology is usually permanent. Under extreme conditions some sites can run dry in summer. Both mineral (from megalithal to sand) and biotic substrates (phytal, submerged macrophytes, living parts of terrestrial plants and POM) are well represented. The water has medium pH values (>7.5), conductivity values between 350 and 500 µS/cm and hardness between 1.4 and 2.5 mmol/l. Benthic invertebrate communities are rich, diverse and are dominated by Ephemeroptera (*Alainites muticus*, *Baetis fuscatus*, *B. vernus*, *B. alpinus*, *Ecdyonurus aurantiacus*, *Electrogena calabra*, *Rhithrogena fiorii*, *Habrophlebia eldae*, *Caenis luctuosa, Siphlonurus spp.*), Plecoptera, Trichoptera, Odonata (*Gomphus vulgatissimus*, *Lestes viridis*, *Anax imperator, Cordulegaster bidentata, Ischnura elegans*) and Diptera. This stream type is well distributed in lower mountain areas of Southern Italy. Water quality ranges from very good to heavily polluted by sewage and other factors. Anthropogenic impact on stream morphology can be also present (bank reinforcement, weirs).

I03 Mid-sized calcareous streams in the Northern Apennines

Mid-sized streams in lower mountain areas of the Northern Apennines are coarse sediment streams in mountain valleys (slopes range from 0.3 - 1.6%). Their floodplains are narrow compared to channel and water width (channel widths 25 - 150 m; estimated floodplain widths [left + right bank floodplain + channel width] from 30 - 500 m). Anabranching channels and braided stretches are common. They have a permanent but highly dynamic hydrological regime. Both mineral (from megalithal to sand) and biotic substrates (phytal, submerged macrophytes, living parts of terrestrial plants and POM) are frequent.

The water has quite high pH values (>8), conductivity values between 200 and 400 µS/cm and hardness between 1.2 and 2.1 mmol/l. The benthic community is diverse, common taxa include Ephemeroptera (*Acentrella sinaica*, *B. lutheri*, *B. vardarensis*, *Procloeon spp.*, *Ecdyonurus gr. aurantiacus*, *Electrogena lunaris*, *Potamanthus luteus*, *Habroleptoides pauliana*, *Torleya major, Caenis belfiorei*), Plecoptera, Trichoptera, Odonata (*Gomphus spp.*, *Onycogomphs forcipatus*, *Platycnemis pennipes, Calopteryx splendens*) and Diptera.

This stream type is very common in the Northern Apennines. Anthropogenic impact on stream morphology (concrete/stone weirs, dams, bank reinforcement) can be severe; in general these streams are characterised by high water quality. Alterations of the natural hydrological regime are common.

I04 Small streams in the lowlands of the Po valley

These small, spring-fed streams are common in the floodplain of the Po valley and are characterised by their low slope (0.1-0.5%) and very constant discharge. They do not flood because they are fed by springs and receive very little run-off, their catchments being small (0.5-20 km^2) and flat. Some sites may be inundated by floodwater from the nearby, large streams (e.g. river Ticino), under extreme flow conditions. Width usually ranges between 1 and 6 m. Water depth is generally < 40 cm although including an unconsolidated, wet silt layer, depth can increase to > 1 m. Flow is generally sluggish, with the fastest measured velocity being < 0.5 m/s. Channel substrates are predominantly silt and fine gravel, with some sand. Submerged and emergent macrophytes are very common, as is leaf-litter. pH-values range between 7.2 and 8.3, conductivity levels from 150 - 400 µS/cm.

Streams have a characteristic invertebrate fauna, in part as a consequence of the dominance of groundwater inputs with a relatively constant temperature. Ephemeroptera (*Baetis liebenauae*, *B. buceratus*, *Nigrobaetis niger*, *Ecdyonurus venosus*, *Paraleptophlebia submarginata*), Coleoptera and Trichoptera are common. The few taxa of Plecoptera occur only infrequently.

These streams are often located in an intensively farmed area and lack buffer strips and bank-side trees. Sources of pollution include industrial and organic effluent and field run-off, which includes fertilisers and pesticides. Almost all these streams are heavily canalised, for land drainage purposes. If left to their own devices these streams would presumably fill up with plants and sediment and become wetland areas.

I02: Small-sized, calcareous streams in the Southern Apennines

I01: Small-sized streams in the southern silicate Alps

I03: Mid-sized calcareous streams in the Northern Apennines

I04: Small lowland streams of the Po valley

N01: Small Dutch lowland streams

N02: Small Dutch hill streams

N01 Small Dutch lowland streams

The lowland stream is characterised by a plain floodplain and a meandering channel. The stream is hardly incised and the floodplain is severely flooded even by minor floods. Biotic microhabitats cover about 25-50% of the stream bottom, e.g. fine and coarse particulate organic matter (e.g. fallen and partly leaves), local stands of phytal (like *Berula erecta*, *Potamogeton polygonifolius, Callitriche hamulata* and water moss), and xylal (dead wood, branches and roots).

The water is soft to moderately hard, usually slightly acid to neutral and clear. pH-value ranges between 5.5 and 7.0; conductivity is below 300 µS/cm. Most of the lowland streams are permanent although some may dry up periodically in summer. The discharge pattern is rather dynamic due to the hydro-geomorphological conditions of the catchment (rain- and groundwater dependent).

The biocoenosis is characterised by species adapted to lotic, well oxygenated conditions. Most of the macroinvertebrate community belongs to the orders of Diptera (Chironomidae), Trichoptera (*Chaetopteryx villosa, Rhyacophila fasciata*), Coleoptera (*Platambus maculatus, Dytiscus marginalis)*, and Odonata (*Cordulegaster boltoni, Calopteryx virgo*).

This stream type was distributed widely in the pleistocene parts of the Netherlands and can be found locally in the dune areas. It has been almost completely been destroyed by alteration of stream morphology (straightening, scouring, removal of floodplain vegetation) and eutrophication.

N02 Small Dutch hill streams

The hill stream is characterised by a U-shaped valley, a quite straight upper course and more meandering lower reaches. The stream is hardly incised and the riparian zone is widely flooded by minor floods. Biotic microhabitats cover about 25% of the stream bottom, e.g. fine and coarse particulate organic matter (e.g. fallen and partly leaves), local stands of phytal (like *Ranunculus fluitans, Ranunculus peltatus, Callitriche hamulata* and water mosses like *Fontinalis antipyretica*), and xylal (dead wood, branches and roots). Mineral microhabitats dominate (stones and gravel).

The water is of a moderate to higher hardness, usually neutral and clear. pH-value ranges from 6.5 to 8.0, conductivity between 250-500 µS/cm. Hill streams are permanent and their discharge pattern is rather constant due to the hydro-geomorphological conditions of the catchment (rather groundwater dependent).

The biocoenosis is characterised by species adopted to high flow velocities and well oxygenated conditions. The macroinvertebrate community is dominated by Diptera (Simuliidae, Chironomidae), Crustacea (*Gammarus fossarum*), Trichoptera (*Silo nigricornis, Lasiocephala basalis*) Coleoptera (*Limnius volckmari, Elodes minuta)*, and Plecoptera (*Leuctra fusca*).

This stream type was formerly widely distributed in the southern parts of the Netherlands. It has been strongly degraded by alteration of stream morphology (straightening, scouring, removal of floodplain vegetation) and eutrophication.

P01 Small-sized siliceous streams in lower mountainous areas of Southern Portugal

The stream type “small streams of the lower mountainous areas” is present in two forms in the siliceous areas of southern Portugal: permanent streams present in the humid regions of Monchique and S. Mamede, and summer-dry ones typical of the Guadiana-basin. The first form shows similarities to some small streams in the low mountainous regions of northern Portugal.

The humid form sinuates through a V-shaped valley while the summer-dry streams meander in U-shaped valleys with a braided channel. Due to the climatic and relief conditions both forms can vary strongly in discharge, usually showing high peaks in winter. The mean water depth lies around 20 cm and mean stream width is below 5 m. Disconnected, temporary side arms can be found in both forms.

The streambed is covered with stones (macro-microlithal) and bedrock. Alders (*Alnus glutinosa*) dominate the riparian vegetation of the humid form, where moss and tree roots form important biotic habitats. Diatoms and macrophytes occur in the less shaded bottom of the dryer forms, where tamarisks (*Tamarix africana*) and oleanders (*Nerium oleander*) form looser side bands that often invade the streambed and separate several channels.

Water conductivity normally lies below 200µS/cm, pH measures around 7.0.

The macroinvertebrate community is dominated by Plecoptera (*Perla madritensis, Leuctra geniculata*), Ephemeroptera (*Serratella ignita*), Trichoptera (*Agapetus* sp.), Odonata (*Boyeria irene*) and Diptera (Blephariceridae, Athericidae).

Many streams belonging to this type still show good ecological status. However, fully unimpacted sites/stretches are very seldom due to the traditional use of the narrow floodplain strip for agriculture, removal or substitution of bank vegetation (by *Rubus ulmifolio, Phragmites australis*) and multiple low-step damming.

P02 Small-sized siliceous lowland streams of Southern Portugal

The small lowland stream type is widely spread in the Schist-areas of southern Portugal. The sloped valley can range in its form from a trough to a U-shaped valley to a plain floodplain. The channel generally meanders and is incised to 80 cm below the valley floor. Mean water depth lies at 20-30 cm, mean width under < 5 m. Disconnected temporary side arms can be found in the infrequently inundated floodplains.

Small flat stones (meso-microlithal) cover most of the streambed; leaves and small branches can form small dams into wide spread mats. The continuous strip of riparian vegetation is dominated by alder (*Alnus glutinosa*) and willow (*Salix salvifolia*) in the more humid areas, whereas willow alone is found in the dryer ones.

Conductivity levels normally lie under 200µS/cm and the pH around 7.0; clay-rich areas may have higher conductivity values (up to 600 µS/cm).

Due to the climatic conditions these streams undergo high discharge peaks in winter and run dry in summer.

The macroinvertebrate community includes Plecoptera, Ephemeroptera (*Ecdyonurus* sp., *Epeorus sylvicola*), Trichoptera and Odonata (*Onychgomphus* sp.).

As the catchment areas of these streams are extensively used for farming, diffuse organic pollution and nutrient enrichment are the major degradation factors. To a lesser extent, this land use also leads to morphological alterations; extensive removal/substitution of the natural bank vegetation (by *Rubus ulmifolio, Phragmites australis*) and multiple low-step damming. Water abstraction and removal of streambed material can also cause local impacts. Unimpacted streams are not longer found in Southern Portugal; most streams show signs of moderate to severe degradation.

P03 Medium-sized siliceous lowland streams of Southern Portugal

The medium-sized lowland stream type is widely spread in the Schist areas of southern Portugal.

This very low-gradient stream type, flows through valleys varying between a plain floodplain with a meandering channel in flat areas (e.g. Sado-basin) and a meander valley with a braided channel downstream from mountain regions (e.g. Guadiana-basin). Entrenchment can be up to 1 m, with the mean water depth being around 50 cm. Due to the climatic conditions, these very slow running streams are subject to high discharge peaks in winter, with infrequent flooding events, but run dry in the summer.

Small flat stones (microlithal) dominate the streambed. Leaf-mats, debris dams and logs can be present in the wetter plain areas, where riparian vegetation is dominated by alder (*Alnus glutinosa)*. In the dryer regions willows (*Salix salvifolia*) are found, which do not fully shade the streambed, allowing diatoms and macrophytes to occur.

The water conductivity normally lies below 200µS/cm, pH around 7.0.

The macroinvertebrate community mainly consists of Plecoptera, Ephemeroptera (*Ecdyonurus* sp., *Epeorus sylvicola*), Trichoptera, Odonata (*Onychgomphus* sp.) and Gastropoda (*Ancylus fluviatilis*).

As the catchment areas of these streams is intensely used for farming, diffuse organic pollution and nutrient enrichment are the major degradation factors. To a lesser extent, this land use also leads to morphological alterations; extensive removal/substitution of the natural bank vegetation (by *Rubus ulmifolio, Phragmites australis*) and multiple low-step damming. Water abstraction and removal of streambed material can also cause major local impacts.

Unimpacted streams are not longer found in Southern Portugal; most streams show signs of moderate to severe degradation.

S01 Small lowland streams in Northern Sweden

Small lowland streams in Northern Sweden are usually permanent streams with no distinctive valley or channel form features. These streams flow both slow and fast, depending on season. The water is usually colourless with conductivity values below 200 µS/cm and pH-values ranging between 5.3 and 7.6. Total phosphate values are usually below 100 µg/l. The dominating primary producers are benthic diatoms and algae, while vascular hydrophytes are important in the lower reaches. The macroinvertebrate community is dominated by the orders Diptera, Ephemeroptera, Trichoptera and Plecoptera. This stream type is usually found in the eastern parts of northern Sweden. The most important degradation factor for this stream type is acidification. Many of the streams belonging to this type remain in near-natural condition.

S02 Small mid-altitude streams in Northern Sweden

The small mid-altitude streams in Northern Sweden are usually permanent streams characterised by a plain floodplain, but without distinctive channel form features. These streams flow both slow and fast, depending on season. The water is usually colourless with conductivity values below 150 µS/cm and pH-values ranging between 5.5 and 7.9. Total phosphate values are usually below 70 µg/l. The dominating primary producers are benthic diatoms and algae, while vascular hydrophytes are important in the lower reaches. The macroinvertebrate community is dominated by Ephemeroptera, Diptera, Plecoptera and Trichoptera. This stream type is usually found in the eastern parts of northern Sweden. The most important degradation factor for this stream type is acidification. Many of the streams belonging to this type remain in near-natural condition.

S03 Small mid-altitude streams in the Boreal Highlands

Small mid-altitude streams in the Boreal Highlands are usually fast-flowing permanent streams with no distinctive valley or channel form features. The water is usually colourless with conductivity values below 100 µS/cm and pH-values ranging between 6.1 and 7.8. Total phosphate values are usually below 30 µg/l. The dominating primary producers are benthic diatoms and algae, while vascular hydrophytes are important in the lower reaches. The macroinvertebrate community is dominated by Diptera, Ephemeroptera and Plecoptera. This stream type is usually found in the western parts of northern Sweden near or in the mountainous areas along the border between Sweden and Norway. The most important degradation factor for this stream type is acidification. Most of the streams belonging to this type remain in near-natural condition.

S04 Small high-altitude streams in the Boreal Highlands

The small high-altitude streams in the Boreal Highlands are usually fast-flowing permanent streams characterised by a U-shaped valley, but without distinctive channel form features. The water is usually colourless with conductivity values below 80 µS/cm and pH-values ranging between 6.1 and 7.8. Total phosphate values are usually below 30 µg/l. The dominating primary producers are benthic diatoms and algae. The macroinvertebrate community is dominated by Ephemeroptera, Diptera and Plecoptera. This stream type is usually found in the western parts of northern Sweden in the mountainous areas along the border between Sweden and Norway. The most important degradation factor for this stream type is acidification. Most of the streams belonging to this type remain in near-natural condition.

S05 Medium-sized lowland streams in the South Swedish lowlands

Medium-sized lowland streams in the South Swedish Lowlands are usually slow-flowing permanent streams with no distinctive valley or channel form features. The water is usually of brownish colour or colourless with conductivity values below 1000 µS/cm and pH-values ranging between 5.2 and 8.2. Total phosphate values are usually below 500 µg/l. For most streams within this stream type a transition from shaded, shallow, fast and clear headwater reaches where benthic diatoms dominate the primary production, to unshaded, deep, slow downstream reaches where macrophytes and epiphytic algae are the primary producers can be discerned. The macroinvertebrate community is dominated by Diptera, Crustacea, Ephemeroptera and Trichoptera. The most important degradation factor for this stream type is organic pollution, with acidification being very important locally. Streams belonging to this type are, compared to other Swedish streams, strongly affected by human activities, which does not necessarily mean that they are of low ecological quality.

P01: Small siliceous streams in lower mountainous areas of Southern Portugal

P02: Small siliceous streams in the lowlands of Southern Portugal

P03: Mid-sized siliceous streams in the lowlands of Southern Portugal

S01: Small streams in the lowlands of Northern Sweden

S02: Small mid-altitude streams in Northern Sweden

S03: Small mid-altitude streams in the Boreal Highlands

S04: Small high-altitude streams in the Boreal Highlands

S05: Small streams in the South Swedish lowlands

Next pages:

ANNEX 2: Site protocol

site name	date	sample no.	investigator

Site related information: Site description

1 map (No., scale)	**2 stream name**
	3 stream system (river flowing into the sea)
	4 country
	5 federal state
	6 map no.
	7 longitude (degree, min, sec)
	8 latitude (degree, min, sec)
	9 distance to source [km]
10 stream order (Strahler system)	**11 slope of the valley floor** [%]
12 subregion (if applicable)	**13 ecoregion and ecoregion no.**
14 altitude of sampling site [m a. s. l.]	**15 altitude class**
16 catchment area [km²] at sampling site	**17 size class based on catchment area**
18 Geology (dominant type)	**19 geology class**

WFD Categories

20 stream type (mark system and fill in name)
☐ System A ☐ System B

21 photographs (a. downstream) (b. upstream)

22 short description

Basic data

site name	date	sample no.	investigator

Sample related information, to be recorded at each sampling date (copy if necessary)

23 MINERAL SUBSTRATES (5% steps, mark substrates <5% with 'X')	% of coverage (5% classes); sum of mineral and biotic microh. = 100%	no. of replicates for sample	x = artificial substrate 'technolithal'
hygropetric sites water layer on solid substrates			☐
megalithal >40 cm large cobbles, boulders and blocks, bedrock			☐
macrolithal >20 cm to 40 cm coarse blocks, head-sized cobbles, with a variable percentages of cobble, gravel and sand			☐
mesolithal >6 cm to 20 cm fist to hand-sized cobbles with a variable percentage of gravel and sand			☐
microlithal >2 cm to 6 cm coarse gravel, (size of a pigeon egg to child's fist) with variable percentages of medium to fine gravel			☐
akal >0.2 cm to 2 cm fine to medium-sized gravel			
sand and mud			
silt, loam, clay (inorganic)			
phytal floating stands or mats of macrophytes, lawns of bacteria or fungi, and tufts, often with aggregations of detritus, moss or algal mats			
algae filamentous algae, algal tufts			
submerged macrophytes macrophytes, including moss and Characeae			
emergent macrophytes e.g. *Typha, Carex, Phragmites*			
living parts of terrestrial plants fine roots, floating riparian vegetation			
xylal (wood) tree trunks, dead wood, branches, roots			
CPOM deposits of coarse particulate organic matter, e.g. fallen leaves			
FPOM deposits of fine particulate organic matter			
organic mud mud and sludge (organic) = pelal			
debris organic and inorganic matter deposited within the splash zone area by wave motion and changing water levels, e.g. mussel shells, snail shells			
sewage bacteria, –fungi and sapropel sewage bacteria and –fungi, (*Sphaerotilus, Leptomitus*), sulphur bacteria (e.g. *Beggiatoa, Thiothrix*), sludge			
➔	**sum = 100%**	**sum = 20**	

Basic data

site name	date	sample no.	investigator

Sample related information, to be recorded just once

Stream morphology and hydrology at sampling site (☝ = one mark, ✋ = more than one mark possible)

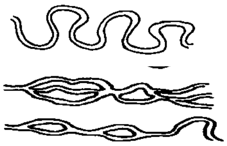
25 valley form ☝

☐ canyon
☐ V-shaped valley
☐ trough

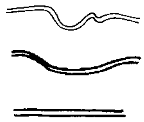
☐ meander valley
☐ U-shaped valley
☐ plain floodplain

26 channel form ☝

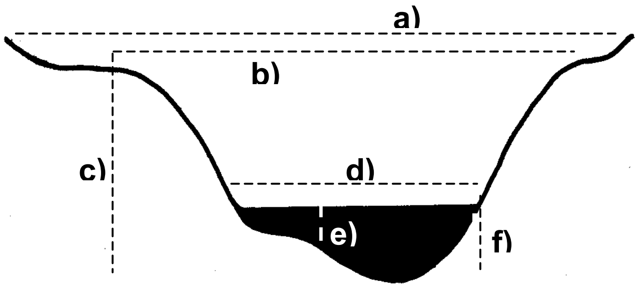
☐ meandering
☐ braided
☐ anabranching



☐ sinuate
☐ constrained (natural)
☐ constrained (artificial)



27 cross section



a) width of floodplain [m] _______
b) flood prone area width [m] _______
c) entrenchment depth [m] _______
d) average stream width [m] _______
e) mean depth water body [m] _______
f) maximum depth water body [m] _______

28 relation riffles/pools [share of pools%] estimated for a stretch 20 x av. stream width or 100 m, whichever is longer

29 debris dams ☝ (POM accumul. >0.3 m³) at sampling site
☐ none ☐ few ☐ several ☐ many

30 logs ☝ (>10 cm Ø) at sampling site
☐ none ☐ few ☐ several ☐ many

31 bank and bed fixation ✋

	left shoreline	bed	right shoreline
concrete without seams	☐	☐	☐
concrete with seams	☐	☐	☐
stones	☐	☐	☐
wood	☐	☐	☐
trees	☐	☐	☐
stone plastering with interstices	☐	☐	☐
stone plastering without interstices	☐	☐	☐
other materials __________________	☐	☐	☐
no bank fixation	☐	☐	☐

32 dams ☐ yes ☐ no ☐ ?	**33 oth. transv. structures** ☐ yes ☐ no ☐ ?	**34 pulse releases** ☐ yes ☐ no ☐ ?	**35 water abstract.** ☐ yes ☐ no ☐ ?
36 stagnation ☐ yes ☐ no ☐ ?	**37 torrent modification** ☐ yes ☐ no ☐ ?	**38 channelg. for navigation** ☐ yes ☐ no ☐ ?	**39 straightening** ☐ yes ☐ no ☐ ?
40 removal of CWD ☐ yes ☐ no ☐ ?	**41 cut-off meanders** ☐ yes ☐ no ☐ ?	**42 scouring** [m bel. surface] ☐ yes ☐ no [m] ☐ ?	**43 culverting** ☐ yes ☐ no ☐ ?
44 fire incident ☐ yes ☐ no ☐ ?	**45 waste** ☐ yes ☐ no	**46 others**	

A d d i t i o n a l d a t a

Additional data

site name	date	sample no.	investigator

Sample related information, to be recorded just once

Hydrology and water chemistry at sampling site

47 hydrologic stream type
☐ permanent ☐ periodic (regularly) ☐ summer-dry ☐ winter-dry ☐ episodic (non predictable)

48 velocity (dominant) [m/s]
mean ☐ <0.2 m/s ☐ 0.2-0.4 m/s ☐ 0.4-0.8 m/s ☐ >0.8 m/s
maximum ☐ <0.2 m/s ☐ 0.2-0.4 m/s ☐ 0.4-0.8 m/s ☐ >0.8 m/s

49 discharge (actual, estimated) [l/s]
☐ <10 l/s ☐ 10-300 l/s ☐ 300-1,000 l/s ☐ 1,000-10,000 l/s ☐ >10,000 l/s

50 colour	**51 odours**	**52 turbidity**
☐ blue ☐ grey ☐ red ☐ green ☐ yellow ☐ brown ☐ black ☐ colourless	☐ yes ☐ no	☐ yes ☐ no

53 foam	**54 reduction phenomena** (ferrosulfides below stones)	**55 sewage**
☐ yes ☐ no	☐ partly ☐ frequently ☐ no ☐ ?	☐ yes ☐ no

56 water temperature [°C]	**57 pH-value**	**58 conductivity** [µS/cm]	**59 dissolved oxygen content** [mg/l]	**60 oxygen saturation** [%]
61	**62**	**63**	**64**	**65**

Shoreline and floodplain morphology

66 shading at zenit (foliage cover)
☐ 0% ☐ 20% ☐ 40% ☐ 60% ☐ 80% ☐ 100%

67 woody riparian vegetation at sampling site (mark left ☐ and ☐ right shoreline separately)
☐ 0-25% ☐ ☐ 25-50% ☐ ☐ 50-75% ☐ ☐ 75-100% ☐

68 average width of woody riparian vegetation (mark left ☐ and ☐ right shoreline separately)
☐ 0-1 m ☐ ☐ 1-5 m ☐ ☐ 5-10 m ☐ ☐ 10-20 m ☐ ☐ 20-50 m ☐ ☐ >50 m ☐

69 land use in the floodplain (1 km length) (1 = sparse, 2 = moderate, 3 = dominant)

left	right	left	right	left	right
☐ deciduous native forest	☐	☐ reeds	☐	☐ crop land	☐
☐ coniferous native forest	☐	☐ alpine heath	☐	☐ pasture	☐
☐ mixed native forest	☐	☐ naturally unvegetated	☐	☐ clear-cutting	☐
☐ evergreen non conifer. forest	☐	☐ standing waters	☐	☐ urban sites (resid.)	☐
☐ wetland (mire)	☐	☐ non-native forests	☐	☐ urban sites (industrial)	☐
☐ open grass-/bushland	☐	☐ macchie	☐	☐ others: _____________	☐
☐ meadow	☐				

70 impoundments at sampling site	**71 removal/lack of natural floodplain vegetation**	**72 non-native woody riparian vegetation**
☐ yes ☐ no	☐ yes ☐ no ☐ ?	☐ yes ☐ no ☐ ?

73 number of standing water bodies in the floodplain

☐ no standing water bodies present

_ side arms connected to the river/stream
_ temporary side arms recently disconnected from the river/stream
_ permanent side arms recently disconnected from the river/stream
_ side arms abandoned years/decades ago in the process of silting up
_ standing water bodies located in the floodplain and fed by tributaries
_ other types (please specify)

ANNEX 3: Site protocol manual

DATA SHEET HEADLINE

site name
e.g. "Orke near Reckenberg" or "Isar at km 247.2"

date
date of the sampling

sample no.
Every sample is to be identified by a number. The composition of the number may vary between countries, federal states or water authorities. We give an example for the composition used in AQEM:
The number is composed of 8 digits:

- digit 1: country abbreviation (may be replaced by a federal state code, a watershed code etc.)
  A = Austria
  C = Czech Republic
  D = Germany
  H = Greece
  I = Italy
  N = The Netherlands
  P = Portugal
  S = Sweden
- digit 2 and 3: stream type number in the country (e.g. 01 for „small sand bottom stream in the lowlands of Northern Germany, ecoregion 14").
- digit 4-7: sampling site number (e.g. 0001 for the first sampling site).
- digit 8: sampling season (can be replaced)
  1 = spring
  2 = summer
  3 = autumn
  4 = winter

Example: a spring sample taken in Germany at stream type no 01 ("Small sand bottom stream in the lowlands of Northern Germany, ecoregion 14") at sampling site no 0001 will be identified by: D 01 0001 1

investigator

- person: family name, pre-name
- agency

- PAGE 1- BASIC DATA

SITE RELATED INFORMATION

1 to 22: Site description

Parameters 1 to 19

Parameters 1 to 19 should predominantly be recorded from maps and/or GIS information. They are only related to the catchment, the upstream and the downstream reach of the site. To answer these questions, field investigations are not required.

1 map (No., scale)
Preferably use a digital/scanned map of the stream section investigated. Scale: preferably 1:50 000; if not available, 1:25 000 is also possible. If it is not possible to obtain a digital map, please use a copy of the map and mention the scale.

2 stream name
Name of the stream, preferably taken from map used for 1.

3 stream system (river(s) flowing into the sea)
Example: Felderbach, Deilbach, Ruhr, Rhein (Rhine)

4 country
EU member state where the site is located.

5 federal state
Province or federal state where the site is located.

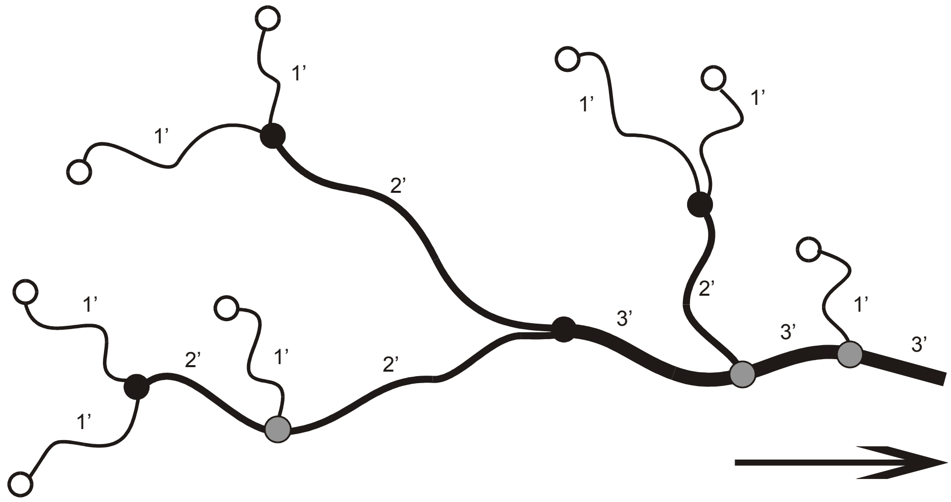
6 map no.
Registration number of the map used for 1.

7 longitude (degree, minutes, seconds)

8 latitude (degree, minutes, seconds)

9 distance to source [km]
Preferably taken from a map 1:50,000 or from Geographical Information Systems (GIS). If a map is used: the stream starts at the point where it is shown as a blue line in the map.

10 stream order (Strahler system)
Preferably based on map 1:50,000; please indicate, if you have used another map.
Stream order is based on confluence points (see figure). The so-called “blue line method” is to be used: all streams shown on a map 1:50 000 as a blue continuous line upstream of the first confluence are regarded as 1st order streams; two 1st order streams together form a 2nd order stream, two second order streams a 3rd order stream etc. Stream sections upstream of this first visible point on the 1:50,000 map are neglected.



11 slope of the valley floor [%]
Must be calculated for a stream reach of at least 500 meters (scale 1:25,000) or 1,000 meters (scale 1:50,000) using direct line of the valley floor and the difference between altitude line at the beginning and at the end of the reach.

12 subregion, sub-ecoregion (if applicable)
For those countries, which have generally accepted subunits (“sub-ecoregions“, “aquatic landscape units“).

13 ecoregion and ecoregion no
According to Illies and the Water Framework Directive (Annex XI, map A).

14 altitude of sampling site [m above sea level]
Preferably taken from a map 1:50,000 or from Geographical Information Systems.

15 altitude class
According to the Water Framework Directive (Annex II, 1.2.1, system A).
>800 m
200-800 m
<200 m

16 catchment area [km^2] of the stream at the sampling site
Using a GIS or hydrologic atlas if available; indicate the catchment area at the sampling site, not the total catchment area of the stream.

17 size class based on catchment area
(according to the Water Framework Directive, Annex II, 1.2.1, system A)

small:	10-100 km^2 catchment area
medium sized:	>100-1,000 km^2 catchment area
large:	>1,000-10,000 km^2 catchment area
very large:	>10,000 km^2 catchment area

18 geology (dominant type)
If available, the dominant geological unit has to be noted (e.g. granite, gneiss, loess, sander)

19 geology class
(according the Water Framework Directive, Annex II, 1.2.1, system A)
Indicate the most abundant catchment geology.
- calcareous
  - carbonate rocks
  - flysch and molasse (in parts)

  - alluvial deposits (in parts)
  - terrestrial deposits (in parts)
  - marine deposits (in parts)
  - loess
- siliceous
  - acid silicate rocks
  - mafic silicate rocks
  - flysch and molasse (in parts)
  - alluvial deposits (in parts)
  - terrestrial deposits (in parts)
  - marine deposits (in parts)
- organic
  - organic formations

20 stream type
According to the national stream typology. The correct type can either be taken from GIS maps on stream type distributions (in preparation in several countries) or determined by the investigator based on geology, soils, valley shape etc.

21 photographs
At least one photograph of the sampling site must be taken which clearly shows the habitat conditions and morphological situation of the site (channel form, shoreline vegetation, if possible substratum and transition into the floodplain). It should be noted whether the photograph is taken in upstream or downstream direction. Two photographs are recommended.

22 short description
A short description dealing with the most important physical features of the site must be given (not exceeding 200 words). The description should cover the following points: valley form, channel form, width of floodplain, degree of bed and bank fixation, average stream depth and width, dominant substratum, vegetation, standing water bodies in the floodplain, hydrology, water colour, anthropogenic influences (scouring, straightening, hazards, sewage pipes, visible pollutions).

- PAGE 2 - BASIC DATA

SAMPLE RELATED INFORMATION, TO BE RECORDED AT EACH SAMPLING DATE

23 (mineral substrates) and 24 (biotic microhabitats): microhabitat composition

The data recorded in 23 and 24 are crucial for the sampling procedure and describe the microhabitat composition, on which the sampling is based.

The microhabitat composition in the channel must be estimated according to the microhabitat list given in 23 and 24. The coverage of all microhabitats with more than 5% cover is estimated to 5%, the presence of other microhabitats (<5% cover) is indicated by a cross ("X"). The stretch, for which the microhabitat composition is estimated, must be representative for the stream reach and should cover at least a riffle-pool sequence or >20 meters (whichever is longer). Mineral substrates and biotic microhabitats together must be 100%.

The estimation of microhabitat composition comprises the following steps:

- Estimation of the cover of mineral substrates (1st column, upper part).
- Estimation of the cover of biotic microhabitats (1st column, lower part). The sum of the cover of *all* microhabitats (mineral and biotic) must be 100%.
- For the mineral substrates it must be indicated, whether they are artificial (e.g. "technolithal" = riprap) (3rd column).

Distribution of the sample replicates according to the share of habitats using the data in the 1st column. E.g.: 50% mesolithal, 25% psammal, 25% CPOM means 10 replicates mesolithal, 5 replicates psammal, 5 replicates CPOM. When only the pool or riffle area is to be sampled for a certain stream type, a total of 10 sample replicates are positioned and collected, each of them representing 10% of total coverage. The number of replicates sampled in the individual microhabitats must be indicated in the 2nd column. See Chapter 7.

23 Mineral Substrates (5% steps)

hygropetric sites	**water film or thin layer covering solid substrates**
megalithal [1)] >40 cm	large cobbles, boulders and blocks, bedrock; the upper side is sampled
macrolithal [1)] >20 cm to 40 cm	coarse blocks, head-sized cobbles, with a variable percentages of cobble, gravel and sand
mesolithal [1)] >6 cm to 20 cm	fist to hand-sized cobbles with a variable percentage of gravel and sand
microlithal [1)] >2 cm to 6 cm	coarse gravel (size of a pigeon egg to child's fist), with variable percentages of medium to fine gravel
akal >0.2 cm to 2 cm	fine to medium-sized gravel
psammal/ psammopelal >6 µm to 2 mm	sand and mud
argyllal <6 µm	silt, loam, clay (inorganic); a solid structure composed of very fine adhesive grains forming a solid surface

[1)] "lithal" categories: usually finer substrate is present between the coarser stones. The category is, therefore, dependent on the coarsest frequently occurring fraction.

24 Biotic microhabitats (5% steps)

phytal	floating stands or mats of macrophytes, lawns of bacteria or fungi, and tufts, often with aggregations of detritus, moss or algal mats (interphytal: habitat within a vegetation stand, plant mats or clumps)
algae	filamentous algae, algal tufts, diatoms
submerged macrophytes	macrophytes, including moss and Characeae
emergent macrophytes	e.g. *Typha, Carex, Phragmites*
living parts of terrestrial plants	fine roots, floating riparian vegetation
xylal (wood)	tree trunks, dead wood, branches, roots
CPOM	deposits of coarse particulate organic matter, e.g. fallen leaves
FPOM	deposits of fine particulate organic matter
organic mud	mud and sludge (organic) = pelal; predominantly occurring in lowland streams and stagnant zones. To be considered as “organic mud” the organic fraction is apparently larger than the mineral fraction. Otherwise, the site should be considered as “psammopelal”.
debris	mainly inorganic and partly organic matter deposited within the splash zone area affected by wave motion and changing water levels, e.g. mussel and snail shells
sewage bacteria and –fungi and sapropel	sewage bacteria and –fungi (*Sphaerotilus, Leptomitus*), sulphur bacteria (e.g. *Beggiatoa, Thiothrix*), sludge

Figure A1: Phytal - floating stands of *Ranunculus fluitans*.

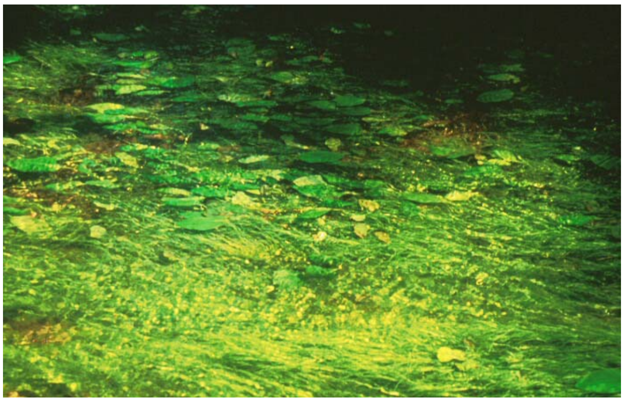


Figure A2: Submerged (and partly emerged) stands of aquatic macrophytes (*Potamogeton spp.).*

Figure A3: Fine particulate organic matter (FPOM) between the roots of aquatic macrophytes near the shoreline.

Figure A4: Deposits of coarse particulate organic matter (CPOM): fallen leaves.

Figure A5: Organic mud and sludge in a summer-dry lowland stream.

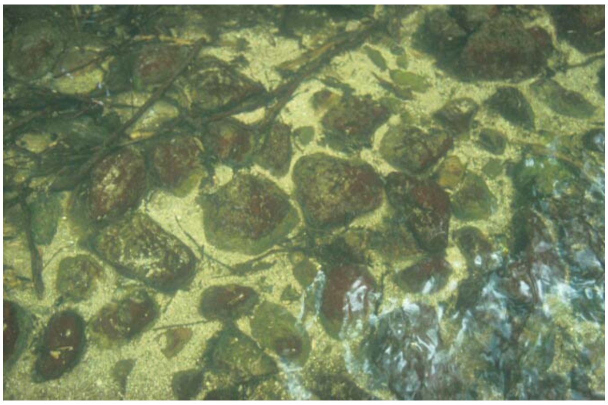


Figure A6: Debris: Grinded whitish mussel shells between pebbles in a lowland river.

- PAGE 3 - ADDITIONAL DATA

Parameters 25 to 73

Parameters 25 to 73: = “one mark” ; = ”more than one mark possible”. A mark in the field “?” stands for “situation is unclear”.

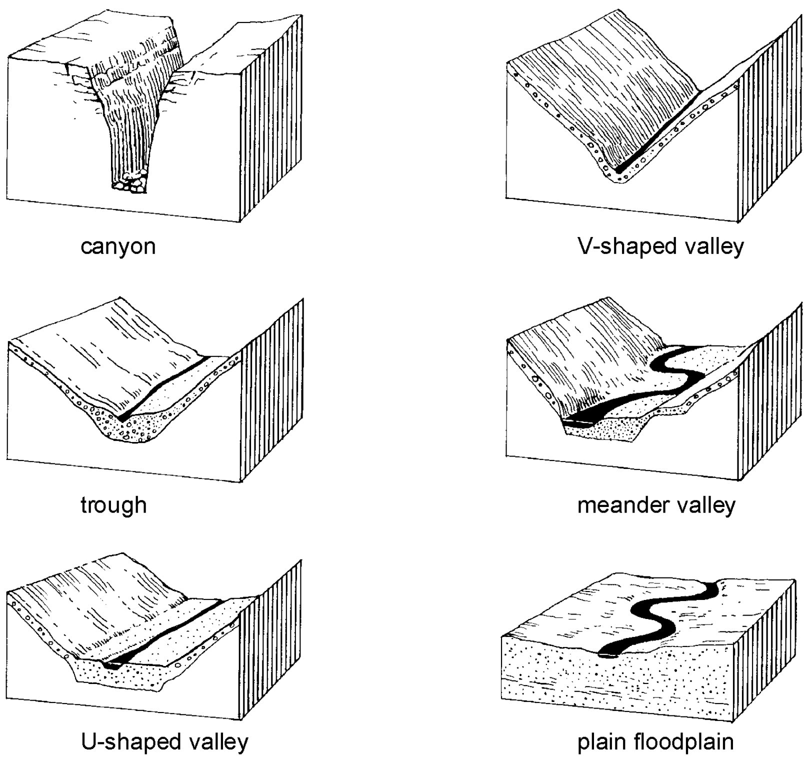
SAMPLE RELATED INFORMATION
25 to 46: Stream morphology and hydrology at sampling site

25 valley form

Valley form can sometimes be obtained from maps; if not, field data should be used.

- canyon: the stream is deep-cutting; hill slopes are almost vertical
- V-shaped valley: no floodplain existing; sediment arising from the hill slopes is not completely transported by the stream (small streams only)
- trough: sediment arising from the hill slopes is only partially transported by the stream
- meander valley: a distinct floodplain is present; edges at the hill slope are figured out by the meandering stream
- U-shaped valley: a distinct floodplain is present accompanied by hill slopes
- plain floodplain: (partly) in lowlands; no valley present

Peri- and post-glacial valley shapes



from: Patt et al. (1998)

26 channel form

The channel form has to be marked according to the sketches given in the form.

27 cross section
The different measurements have to be done by means of a meter rule and a tape measure (one decimal, e.g. “0.4” meters or “1.8” meters).

28 relation riffles : pools [share of pools%], estimated for a stretch 20 times length of the average stream width or a length of at least 100 meters, whichever is longer. The share of pools in this stretch has to be noted, e.g. “40%”.

29 debris dams (POM accumulations >0.3 m^3) at sampling site
Frequency of debris dams/accumulations has to be recorded roughly according to the categories given in the protocol form.

30 logs (>10 cm diameter) at sampling site
Frequency of at least partly isolated single logs >10 cm maximum diameter in the stream bed has to be recorded roughly according to the categories given in the protocol.

31 bank and bed fixation
Mark, whether fixations on the banks (left shoreline, right shoreline and stream bed separately) are present. More than one mark possible. Categories:

- concrete without seams: a solid concrete structure without interstices
- concrete with seams: concrete plates with interstices
- stones: e.g. riprap
- stone plastering with interstices
- stone plastering without interstices
- wood: dead wood
- trees: if trees (e.g. alders) have apparently been planted to prevent stream shifting
- other materials
- no bed fixation

32 dams
Indicate, whether there are dams upstream or downstream of the sampling site.

33 other transverse structures
Indicate, whether there are other transverse structures upstream or downstream the sampling site.

34 pulse releases
Indicate, if the sampling site is affected by pulse releases of upstream weirs or outlets.

35 water abstraction
Indicate, whether water is abstracted for purposes of hydropower engineering.

36 stagnation
Indicate, if the stream at the study site is artificially stagnant (usually, if a dam or weir is present downstream).

37 torrent modification
Only applicable for alpine and mountainous areas.

38 channelling for navigation
Only applicable for large rivers, which are (or have been historically) used for navigation.

39 straightening
Indicated by cut-off meanders, channel form or known from local/historical sources.

40 removal of CWD
May be indicated by a low number of logs inside the channel, existing data or be directly observed.

41 cut-off meanders
Presence of cut-off meanders (either intact of filled) in the floodplain.

42 scouring [m below surface]
Indicate, if the channel is significantly deep cut below the floodplain level (depth should be given as the average over the stretch). Natural incision is not to be considered. Note only if characteristic for the whole site, not an exceptional short and scoured reach e.g. after a bridge.

43 culverting
Indicate, if the channel is partly culverted in the survey area.

44 fire incident (only Mediterranean streams)
Indicate, whether the sampling site and/or its surrounding has been affected by fire incidents.

45 waste
Indicate, if waste is affecting the sampling site.

46 others
Note other human impacts on the stream morphology and hydrology, which have not been listed here.

- PAGE 4 - ADDITIONAL DATA

SAMPLE RELATED INFORMATION

47 to 65: Hydrology and water chemistry at the sampling site

47 hydrologic stream type
If possible, give a mark for one of the categories given in the protocol. Usually more than one visit of the sampling site is necessary to judge about the hydrologic stream type.

- permanent = not drying out or only in extreme years
- periodic = dries out regularly; if possible mark period when stream is dry
- summer-dry = dries out in a climatically "normal" summer (between May and October); beginning, end and duration of the dry period may vary within this period of time
- winter dry = dries out in climatically „normal" winters (between November and April); beginning, end and duration of the dry period may vary within this period of time
- episodic (not predictable) = dries out in unpredictable intervals

48 velocity [m/s] (a. medium and b. maximum)
Mark the categories of the medium and of the maximum flow velocity. Flow velocity may either be estimated or measured.

49 discharge [l/s] (actual, estimated)
The discharge at the sampling date has to be estimated (roughly) according to the categories given in the protocol (one mark).

50 colour
Indicate natural occurring colours, e.g. brownish water by humid acids as well as artificial altered colours e.g. whitish films by organic pollution.

51 odours
Odours indicating pollution, e.g. H_2S, sewage, phenolic substances.

52 turbidity
Note if turbidity can be seen within the water body.

53 foam
Only foam indicating pollution must be mentioned, not foam resulting from humid acids or other natural sources like pollen, rotten exuviae.

54 reduction phenomena (ferrosulfides below stones)
Indicate, if a black layer indicating reduction phenomena can partly or frequently be observed underneath or on the bottom side of stones or other coarse matter in the stream bed.

55 sewage
Note if there is a clear hint for a point source pollution, e.g. by a combined sewer overflow or a sewage plant.

56 water temperature [°C]
To be measured in the field with a temperature meter within a pH-, conductivity- or oxy-meter.

57 pH-value
To be measured in the field with a pH meter.

58 conductivity [µS/cm]
To be measured in the field with a conductivity meter.

59 dissolved oxygen content [mg/l]
To be measured in the field with an oxy-meter.

60 oxygen saturation [%]
To be measured in the field with an oxy-meter.

61 – 65 fields for other parameters to be measured (your choice)

66 to 73: Shoreline and floodplain morphology

66 shading at zenith (foliage cover)
Seen as a projection from the mid of the stream bed at times of full foliage cover (mark in 20% steps).

67 woody riparian vegetation at sampling site (left and right shoreline)
Indicate, to which degree the shorelines are accompanied by woody riparian vegetation (mark in 25% steps; left and right shoreline separately). Any vegetation that shades the stream and possibly protects it (at least in parts) from non-source pollution and/or erosion should be regarded as “woody riparian vegetation“.

68 average width of woody riparian vegetation (left and right shoreline)
Indicate the width by marking; left and right shoreline separately.

69 land use in the floodplain (1 km length)
Can be recorded in the field, if possible, or taken from maps. GIS (e.g. “Corine land cover“ can be used especially for large streams). The sampling site must be located in the centre of the floodplain stretch considered. Lowland streams: “floodplain“ = 10 x stream width.

70 impoundments at sampling site
Indicate, whether there are longitudinal dams or impoundments present.

71 removal/lack of natural floodplain vegetation
Indicate, whether the natural floodplain vegetation is (at least partly) removed or not (>20%).

72 non-native woody riparian vegetation
Indicate, whether the woody riparian vegetation is (at least partly) replaced by non-native species or not (>20%).

73 number of standing water bodies in the floodplain
Mark whether there are
- side arms connected to the river/stream
- temporary side arms recently disconnected from the river/stream
- permanent side arms recently disconnected from the river/stream
- side arms abandoned years/decades ago in the process of silting up
- standing water bodies located in the floodplain and fed by tributaries
- other types (please specify)
- no standing water bodies present

Side arms, which are connected with the stream only during floods and isolated or dry most of the year belong to the type ”side arms connected to the river system“.

ANNEX 4: Sampling seasons, fractions required, sampling devices and riffle / pool areas to be sampled in the individual stream types.

Stream type		Sampling season: Spring (March-May)	Sampling season: Summer (June-Aug)	Sampling season: Autumn (Sep – Nov)	Sampling season: Winter (Dec – Feb)	Fraction	Preferred sampling device	Riffles/ pools to be sampled
A01	Mid-sized streams in the Hungarian Plains	■	■			>500 µm	hand-net	r and p
A02	Mid-sized calcareous pre-alpine streams	■	■			>500 µm	hand-net	r and p
A03	Small non-glaciated crystalline alpine streams	■	■			>500 µm	hand-net	r and p
A04	Mid-sized streams in the Bohemian Massif	■	■			>500 µm	hand-net	r and p
C01	Mid-sized streams in the central sub-alpine mountains	■	■			>500 µm	hand-net	r and p
C02	Small streams in the Carpathian	■	■			>500 µm	hand-net	r and p
C03	Mid-sized streams in the Carpathian	■	■			>500 µm	hand-net	r and p
D01	Small sand bottom streams in the German lowlands	■	■			>1000 µm	hand-net	r and p
D02	Organic type brooks in the German lowlands	■				>1000 µm	hand-net	r and p
D03	Mid-sized sand bottom streams in the German lowlands	■	■			>1000 µm	hand-net	r and p
D04	Small streams in lower mountainous areas of Central Europe	■	■			>2000 µm	hand-net	r and p
D05	Mid-sized streams in lower mountainous areas of Central Europe	■	■			>2000 µm	hand-net	r and p
H01	Mid-altitude mid-sized siliceous streams in North-Eastern Greece		■		■	>500 µm	hand-net	r and p
H02	Mid-altitude large siliceous streams in Central and Northern Greece		■		■	>500 µm	hand-net	r and p
H03	Mid-altitude mid-sized calcareous streams in Western Greece		■		■	>500 µm	hand-net	r and p
I02	Small-sized, calcareous streams in the Southern Apennines	■		■	■	>500 µm	Surber	10 repl. pools

Stream type		Sampling season				Fraction	Preferred sampling device	Riffles/ pools to be sampled
		Spring (March-May)	Summer (June-Aug)	Autumn (Sep – Nov)	Winter (Dec – Feb)			
I03	Mid-sized calcareous streams in the Northern Apennines			■		>500 µm	Surber	10 repl. pools
I04	Small lowland streams of the Po valley	■		■	■	>500 µm	Surber	r and p
N01	Small Dutch lowland streams	■		■		>500 µm	hand-net	r and p
N02	Small Dutch hill streams	■		■		>500 µm	hand-net	r and p
P01	Small-sized siliceous streams in lower mountainous areas of Southern Portugal	■				>500 µm	hand-net	r and p
P02	Small-sized siliceous lowland streams of Southern Portugal	■				>500 µm	hand-net	r and p
P03	Medium-sized siliceous lowland streams of Southern Portugal	■				>500 µm	hand-net	r and p
S01	Small lowland streams in Northern Sweden			■		>500 µm	hand-net	riffles
S02	Small mid-altitude streams in Northern Sweden			■		>500 µm	hand-net	riffles
S03	Small mid-altitude streams in the Boreal Highlands			■		>500 µm	hand-net	riffles
S04	Small high-altitude streams in the Boreal Highlands			■		>500 µm	hand-net	riffles
S05	Medium-sized lowland streams in the South Swedish lowlands			■		>500 µm	hand-net	riffles

ANNEX 5: Level of determination for the application of the AQEM system. s = species; (s) = usually species; g = genus; (g) = usually genus; t = tribus; f = family; c = class; - = not necessary for the assessment; * = reference to the MAS Operational Units (usually genus; morphological groups for *Caenis*, *Rhithrogena* and selected Baetidae). ** *Ecdyonurus* to be identified to the group level (*venosus* vs. *helveticus* Gr.). *Alainites* and *Nigrobaetis* have to be separated from *Baetis*.

AQEM code	Stream type	Turbellaria	Gastropoda	Bivalvia	Oligochaeta	Hirudinea	Crustacea	Ephemeroptera	Plecoptera	Odonata	Heteroptera	Coleoptera	Planipennia/Megaloptera	Trichoptera	Tipulidae/Limoniidae	Psychodidae	Simuliidae	Chironomidae	Ceratopogonidae	other Nematocera	Brachycera
A01	Mid-sized streams in the Hungarian Plains	c	s	s	s	s	s	s	s	s	s	s	s	s	g	g	s	s	g	f	g
A02	Mid-sized calcareous pre-alpine streams	c	s	s	s	s	s	s	s	s	s	s	s	s	g	g	s	s	g	f	g
A03	Small non-glaciated crystalline alpine streams	c	s	s	s	s	s	s	s	s	s	s	s	s	g	g	s	s	g	f	g
A04	Mid-sized streams in the Bohemian Massif	c	s	s	s	s	s	s	s	s	s	s	s	s	g	g	s	s	g	f	g
C01	Mid-sized streams in the central sub-alpine mountains	s	s	s	(s)	s	s	s	s	s	s	(s)	-	s	s/g	g/f	s	s/g	g	g	g
C02	Small streams in the Carpathian	s	s	s	(s)	s	s	s	s	s	s	(s)	-	s	s/g	g/f	s	s/g	g	g	g
C03	Mid-sized streams in the Carpathian	s	s	s	(s)	s	s	s	s	s	s	(s)	-	s	s/g	g/f	s	s/g	g	g	g
D01	Small sand bottom streams in the German lowlands	s	s	(s)	g	s	s	s	s	s	s	s	s	s	g	g	g/s	sf	f	f	f
D02	Organic type brooks in the German lowlands	s	s	(s)	g	s	s	s	s	s	s	s	s	s	g	g	g/s	sf	f	f	f
D03	Mid-sized sand bottom streams in the German lowlands	s	s	(s)	g	s	s	s	s	s	s	s	s	s	g	g	g/s	sf	f	f	f
D04	Small streams in lower mountainous areas of Central Europe	s	s	(s)	g	s	s	s	s	s	s	s	s	s	g	g	g/s	sf	f	f	f
D05	Mid-sized streams in lower mountainous areas of Central Europe	s	s	(s)	g	s	s	s	s	s	s	s	s	s	g	g	g/s	sf	f	f	f

AQEM code	Stream type	Turbellaria	Gastropoda	Bivalvia	Oligochaeta	Hirudinea	Crustacea	Ephemeroptera	Plecoptera	Odonata	Heteroptera	Coleoptera	Planipennia/Megaloptera	Trichoptera	Tipulidae/Limoniidae	Psychodidae	Simuliidae	Chironomidae	Ceratopogonidae	other Nematocera	Brachycera
H01	Mid-altitude mid-sized siliceous streams in North-Eastern Greece	g/s	g/s	g/s	g	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	f/g	f/g	f/g	f/g	f/g	f/g	f/g
H02	Mid-altitude large siliceous streams in Central and North. Greece	g/s	g/s	g/s	g	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	f/g	f/g	f/g	f/g	f/g	f/g	f/g
H03	Mid-altitude mid-sized calcareous streams in Western Greece	g/s	g/s	g/s	g	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	f/g	f/g	f/g	f/g	f/g	f/g	f/g
I02	Small-sized, calcareous streams in the Southern Apennines	g	g	f	f	g	f	(g) * **	g	g	g	f	g	f	f	f	f	f	f	f	f
I03	Mid-sized calcareous streams in the Northern Apennines	g	g	f	f	g	f	(g) *	g	g	g	f	g	f	f	f	f	f	f	f	f
I04	Small lowland streams of the Po valley	g	g	f	f	g	f	(g) *	g	g	g	f	g	f	f	f	f	f	f	f	f
N01	Small Dutch lowland streams	s	s	s	s	s	s	s	s	s	s	s	s	s	g	g	s	s	f	f	f
N02	Small Dutch hill streams	s	s	s	s	s	s	s	s	s	s	s	s	s	g	g	s	s	f	f	f
P01	Small-sized siliceous streams in lower mountainous areas in Southern Portugal	-	f	-	f	-	-	f	-	f	f	f	-	-	f	-	f	t	f	f	f
P02	Small-sized siliceous lowland streams in Southern Portugal	-	f	-	f	-	-	f	-	f	f	f	-	-	f	-	f	t	f	f	f
P03	Medium-sized siliceous lowland streams in Southern Portugal	-	f	-	f	-	-	f	-	f	f	f	-	-	f	-	f	t	f	f	f
S01	Small lowland streams in Northern Sweden	o	s	g	f	s	s	s	s	s	g	g/s	g	g	s	f	f	f	f	f	f
S02	Small mid-altitude streams in Northern Sweden	o	s	g	f	s	s	s	s	s	g	g/s	g	g	s	f	f	f	f	f	f
S03	Small mid-altitude streams in the Boreal Highlands	o	s	g	f	s	s	s	s	s	g	g/s	g	g	s	f	f	f	f	f	f
S04	Small high-altitude streams in the Boreal Highlands	o	s	g	f	s	s	s	s	s	g	g/s	g	g	s	f	f	f	f	f	f
S05	Medium-sized lowland streams in the South Swedish lowlands	o	s	g	f	s	s	s	s	s	g	g/s	g	g	s	f	f	f	f	f	f

ANNEX 6: Metrics used for calculating the ecological quality of individual stream types.

AQEM code	*Stream type*	*Metrics used to assess the ecological quality*	*Predicted response to increasing perturbation*
A01	Mid-sized streams in the Hungarian Plains	organic pollution	
		• Saprobic Index ZELINKA & MARVAN	increase
		• number of Ephemeroptera+Plecoptera-taxa	decrease
		• [%] Ephemeroptera+Plecoptera-taxa / total taxa (sp)	decrease
		• [%] Ephemeroptera+Plecoptera individuals / total individuals	decrease
		• total number of families	decrease
		• number of sensitive taxa	decrease
		• [%] littoral+profundal	increase
		• abundance of Plecoptera	decrease
		• [%] shredder	decrease
		• diversity (Margalef)	decrease
A02	Mid-sized calcareous pre-alpine streams	organic pollution	
		• Saprobic Index ZELINKA & MARVAN	increase
		degradation in stream morphology	
		• number of EPT-taxa	decrease
		• total number of taxa	decrease
		• [%] EPT-taxa / total taxa	decrease
		• number of sensitive taxa	decrease
		• abundance of Plecoptera	decrease
		• abundance of Trichoptera	decrease
		• Diversity (Margalef)	decrease
A03	Small non-glaciated crystalline alpine streams	organic pollution	
		• Saprobic Index ZELINKA & MARVAN	increase
		degradation in stream morphology	
		• number of EPT-taxa	decrease
		• total number of taxa	decrease
		• number of sensitive taxa	decrease
		• abundance of Plecoptera	decrease
		• ratio Oligochaeta and Diptera/total-taxa	increase
		• abundance of Oligochaeta	increase
		• RETI	decrease
		• diversity (Margalef)	decrease
		• [%] littoral and Profundal preferences	increase

AQEM code	*Stream type*	*Metrics used to assess the ecological quality*	*Predicted response to increasing perturbation*
A04	Mid-sized streams in the Bohemian Massif	organic pollution	
		• Saprobic Index ZELINKA & MARVAN	increase
		degradation in stream morphology	
		• number of EPT-taxa	decrease
		• abundance of all taxa	variable
		• Index of Biocoenotic Region	variable
		• [%] of Oligochaeta and Diptera taxa	increase
		• [%] littoral preferences	increase
		• [%] gatherers/collectors	increase
		• total number of taxa	decrease
		• abundance of Trichoptera	decrease
C01	Mid-sized streams central sub-alpine mountains	organic pollution	
		• Czech saprobic index	increase
		• ASPT	decrease
		• RETI	decrease
C02	Small streams in the Carpathian	organic pollution	
		• Czech saprobic index	increase
		• number of Plecoptera taxa	decrease
		• number of Ephemeroptera taxa	decrease
C03	Mid-sized streams in the Carpathian	organic pollution	
		• Czech saprobic index	increase
		• number of EPT taxa	decrease
D01	small sand bottom stream in the German lowlands	organic pollution	
		• German saprobic index (new version)	increase
		degradation in stream morphology	
		• German Faunaindex D01	decrease
		• [%] Plecoptera	decrease
		• [%] rheophilous preferences	decrease
		• [%] gatherers/collectors (ind.)	increase
		• [%] littoral preferences	increase
		• [%] pelal preferences	increase
D02	Organic type brook in the German lowlands	organic pollution	
		• German saprobic index (new version)	increase
		degradation in stream morphology	
		• German Faunaindex D02	decrease
D03	Mid-sized sand bottom stream in the German lowlands	organic pollution	
		• German saprobic index (new version)	increase
		degradation in stream morphology	
		• German Faunaindex D03	decrease
		• [%] Trichoptera	decrease
		• [%] rheophilous preferences	decrease

AQEM code	Stream type	Metrics used to assess the ecological quality	Predicted response to increasing perturbation
		• [%] gatherers/collectors	increase
		• [%] littoral preferences	increase
		• [%] pelal preferences	increase
D04	Small streams in lower mountainous areas of Central Europe	organic pollution	
		• German saprobic index (new version)	increase
		degradation in stream morphology	
		• German Faunaindex D04	decrease
		• BMWP	decrease
		• Shannon-Wiener Diversity	decrease
		• [%] hyporhithral preferences	increase
		• [%] hypocrenal preferences	decrease
		• [%] akal preferences	decrease
		• [%] phytal preferences	increase
D05	Mid-sized streams in lower mountainous areas of Central Europe	organic pollution	
		• German saprobic index (new version)	increase
		degradation in stream morphology	
		• German Faunaindex D05	decrease
		• number of EPTCBO taxa	decrease
		• [%] xylophagous taxa + [%] shredder + [%] active filter feeders + [%] passive filter feeders	decrease
		• [%] akal + [%] lithal + [%] psammal	decrease
		• Shannon-Wiener-Diversity	decrease
H01	Mid-altitude mid-sized siliceous streams in North-Eastern Greece	organic pollution	
		• Type LR	increase
		• Type RP	decrease
		• [%] EPT-taxa	decrease
		• BMWP	decrease
H02	Mid-altitude large siliceous streams in Central and Northern Greece	organic pollution	
		• ASPT	decrease
		• BMWP	decrease
		• DSFI	decrease
		• Diversity Groups	decrease
		• IBE	decrease
		• Simpson Diversity	decrease
		• [%] Littoral preferences	decrease
		• [%] Predators	decrease
		• number of EPT - taxa	decrease
		• Type RP	decrease
		• [%] metapotamal preferences	decrease
		• [%] EPT - taxa	decrease

AQEM code	*Stream type*	*Metrics used to assess the ecological quality*	*Predicted response to increasing perturbation*
H03	Mid-altitude mid-sized calcareous streams in Western Greece	organic pollution	
		• German Saprobic Index (old version)	increase
		• [%] Hypopotamal preferences	increase
		• [%] Parasites%	increase
		• [%] Profundal	increase
		• [%] Passive filter feeders	increase
I02	Small-sized, calcareous streams in the Southern Apennines	general degradation	
		• ASPT	decrease
		• BMWP	decrease
		• MTS (Mayfly total score)	decrease
		• number of Plecoptera taxa	decrease
		• number of Trichoptera taxa	decrease
		• number of MAS Operational Units	decrease
		• TROPHIC_Sel_Grazers	decrease
		• abundance of *A. muticus* + *N. digitatus*	decrease
		• abundance of Leptophlebiidae	decrease
		• Sel_Ephemeroptera_GS	decrease
		• abundance of *Cordulegaster* and *Dinocras*	decrease
		• abundance of *Amphinemura* and *Protonemura*	decrease
		• Sel_Trichoptera_GS	decrease
		• DIPTERA_Good_G	decrease
		• DIPTERA_Bad_SIPH_G	increase
I03	Mid-sized calcareous streams in the Northern Appennines	degradation in stream morphology	
		• BMWP	decrease
		• MTS (Mayfly Total Score)	decrease
		• number of Plecoptera and Trichoptera taxa	decrease
		• number of MAS Operational Units	decrease
		• [%] Argillal preferences	decrease
		• [%] Filter feeders	increase
		• [%] Borrowing locomotion types	decrease
		• abundance of Sel_Ephemeroptera_M	decrease
		• abundance of Sel_Plecoptera_M	decrease
		• abundance of Sel_nonEPtaxa_M	decrease
		• abundance of *Dugesia* and *Lymnaea*	increase
		• abundance of all taxa / abundance of Diptera taxa	decrease
I04	Small streams in the lowlands of the Po valley	general degradation	
		• ASPT	decrease
		• BMWP	decrease
		• MTS (Mayfly Total Score)	decrease
		• number of Plecoptera and Trichoptera taxa	decrease

AQEM code	*Stream type*	*Metrics used to assess the ecological quality*	*Predicted response to increasing perturbation*
		• Diversity Groups (DSFI)	decrease
		• number of MAS Operational Units	decrease
		• abundance of Sel_Ephemeroptera_GN	decrease
		• abundance of Sel_Trichoptera_GN	decrease
		• abundance of *Leuctra* and *Calopteryx*	decrease
		• abundance of Elmidae	decrease
		• abundance of Lumbricidae	decrease
		• abundance of Tubificidae	increase
N01	Small Dutch lowland streams	general degradation	
		• Saprobic Index ZELINKA & MARVAN	Combination of metrics results in the Quality Class. Most individual metrics do not respond in a linear way to pertubation.
		• [%] hypopotamal preferences	
		• [%] type PEL	
		• [%] type RP	
		• [%] hypopotamal-[%] EPT/[%] Oligochaeta	
		• [%] Gastropoda-[%] EPT/[%] Oligochaeta	
		• [%] EPT/[%]Oligochaeta	
		• number of EPT taxa/number of Oligochaeta taxa	
		• [%] (grazers+scrapers)/ [%] (gatherers/collecters+filter feeders)	
		• [%] Gastropoda	
N02	Small Dutch hill streams	general degradation	
		• Saprobic Index (Zelinka en Marvan)	Combination of metrics results in the Quality Class. Most individual metrics do not respond in a linear way to pertubation.
		• [%] hypopotamal preferences	
		• total number of taxa	
		• [%] of passive filter feeders	
		• [%] EPT/[%] Oligochaeta	
		• number of EPT taxa/number of Oligochaeta taxa	
		• [%] of Trichoptera	
		• [%] EPT/[%] Oligochaeta - [%] Gastropoda	
		• [%] EPT/[%] Oligochaeta - [%] type RP	
		• [%] EPT/[%] Oligochaeta - [%] type PEL	
P01	Small-sized siliceous streams in lower mountainous areas of Portugal	organic pollution	
		• Portuguese Index	decrease
P02	Small-sized siliceous lowland streams of Portugal	organic pollution	
		• Portuguese Index	decrease
P03	Medium-sized siliceous lowland streams of Portugal	organic pollution	
		• Portuguese Index	decrease

AQEM code	Stream type	Metrics used to assess the ecological quality	Predicted response to increasing perturbation
S01	Small lowland streams in Northern Sweden	acidification	
		• Acid index (Henrikson & Medin)	decrease
		• number of EPT taxa	decrease
		• [%] Swimming/diving taxa	decrease
S02	Small mid-altitude streams in Northern Sweden		
		• Acid index (Henrikson & Medin)	decrease
		• number of EPT taxa	decrease
		• [%] Grazers/scrapers	decrease
S03	Small mid-altitude streams in the Boreal Highlands	acidification	
		• Acid index (Henrikson & Medin)	decrease
		• number of EPT taxa	decrease
S04	Small high-altitude streams in the Boreal Highlands	acidification	
		• Acid index (Henrikson & Medin)	decrease
		• number of EPT taxa	decrease
S05	Medium-sized lowland streams in the South Swedish lowlands	organic pollution	
		• ASPT	decrease
		• DSFI	decrease
		acidification	
		• Acid index (Henrikson & Medin)	decrease

ANNEX 7: Description of the assessment approach of each individual stream type

A01 Mid-sized streams in the Hungarian Plains

Organic pollution, mainly due to discharge of waste water from sewage treatment plants, untreated sewage or non-source pollution presents the main factor of degradation. It leads to high loads of organic matter (nutrients) and high decomposition rates, which in turn cause oxygen depletion. High amounts of organic matter can cover inorganic substrates and lead to uniform surface bed sediments. This impact is assessed (beside saprobic index) by using the following metrics: [%] Ephemeroptera and Plecoptera individuals / total individuals, total number of families, number of sensitive taxa, [%] littoral and profundal preferences, abundance of Plecoptera, [%] shredder, diversity (Margalef).

A02 Mid-sized calcareous pre-alpine streams

Flood protection measures like straightening, bank fixation and plastering of the stream bed present the main factors of morphological degradation, causing more uniform stream bed structures and decreasing microhabitat diversity (e.g. loss of dead wood and fine inorganic and organic substrate). For assessing this impact the following metrics are used number of EPT-taxa, total number of taxa, [%] EPT-taxa / total taxa, number of sensitive taxa, abundance of Plecoptera, abundance of Trichoptera, diversity (Margalef).

A03 Small non-glaciated crystalline alpine streams

Flood protection measures like straightening, bank fixation and plastering of the stream bed present the main factors of morphological degradation, causing more uniform stream bed structures and decreasing microhabitat diversity (e.g. loss of dead wood and fine inorganic and organic substratum). For assessing this impact the following metrics showed a high discriminatory power: number of EPT-taxa, total number of taxa, number of sensitive taxa, abundance of Plecoptera, ratio Oligochaeta and Diptera/total-taxa, abundance of Oligochaeta, RETI, diversity (Margalef), [%] littoral and profundal preferences.

A04 Mid-sized streams in the Bohemian Massif

Impoundment measures are the main source of degradation and lead to decreasing flow velocity and more uniform flow characteristics as well as less diverse stream bed structures (e.g. increasing deposition of organic substrate, loss of coarse fractions). This impact is assessed with the following metrics: number of EPT-taxa, abundance of all taxa, Index of Biocoenotic Region, [%] Oligochaeta and Diptera taxa, [%] littoral preferences, [%] gatherers/collectors, total number of taxa, abundance of Trichoptera.

C01 Mid-sized streams in the central sub-alpine mountains
C02 Small streams in the Carpathian
C03 Mid-sized streams in the Carpathian

Saprobic index (calculated according to the Czech standard 757716) is the main component of assessment used for detecting organic pollution in stream types C01, C02 and C03. The following auxiliary metrics are also applied: ASPT and RETI (C01), number of stonefly taxa, number of mayfly taxa (C02), number of EPT taxa (C03). Class boundaries for each metric were based on hierarchical classification using only taxa significantly related to those abiotic parameters, which indicate organic pollution. Reference conditions were defined using data collected in the PERLA project.

D01 Small sand bottom streams in the German lowlands

The impact of organic pollution is assessed with the German Saprobic System (new version), where scores are compared to a stream-type specific saprobic base condition.

The impact of morphological degradation on the macroinvertebrate fauna is assessed with six metrics. A stream type-specific “Fauna Index”, based on taxa predominantly occurring in microhabitats typical for reference conditions or degraded sections, respectively, contributes to 50% of the multimetric results. Beyond this, the following metrics are used: [%] Plecoptera, [%] rheophilous preferences, [%] gathering collectors, [%] littoral preferences, [%] pelal preferences. These are predominantly related to lack of shoreline vegetation and lower diversity of organic substrates.

D02 Organic type brooks in the German lowlands

The impact of organic pollution is assessed with the German Saprobic System (new version), where scores are compared to a stream-type specific saprobic base condition.

This formerly widely distributed stream type in the northern German lowlands has been nearly completely destroyed by alteration of stream morphology (straightening, scouring, removal of floodplain vegetation) and eutrophication (eutrophication is also caused -by scouring which leads to quicker mineralisation processes in the floodplain and therefore higher nutrient loading in the stream).

The impact of morphological degradation on the macroinvertebrate fauna is exclusively assessed with the metric “German Fauna Index D02”. Especially the number and share of highly specialised taxa, which are adapted to the naturally acidic water quality and temporary stream flow, are used to differentiate between reference or good conditions and the other quality classes. Common inhabitants of degraded streams (numerous mayflies, most snails, leeches and flatworms) signalise altered water quality (higher pH-values and more nutrients).

D03 Mid-sized sand bottom streams in the German lowlands

The impact of organic pollution is assessed with the German Saprobic System (new version), where scores are compared to a stream-type specific saprobic base condition.

The prevailing morphological degradation of this stream type is caused by straightening, scouring and bank fixation, which often occur simultaneously with damming and stagnation. Furthermore, the riparian corridor is often heavily degraded by intensive agricultural land use. The alteration of hydrological (current diversity, flood events) and morphological diversity (loss of substrates e.g. woody debris, CPOM), lead to decreasing species richness and a shift from lotic to lentic communities. The impact of morphological degradation on the macroinvertebrate fauna is assessed with five metrics. A stream-type specific “Fauna Index”, based on taxa predominantly occurring in microhabitats typical for reference conditions or degraded sections, respectively, contributes to 50% of the multimetric result. In addition, the following metrics are used: [%] Trichoptera, [%] rheophilous preferences, [%] gathering collectors, [%] littoral preferences, [%] pelal preferences. Although a similar set of metrics is used as for D01, class boundaries differ.

D04 Small streams in lower mountainous areas of Central Europe

The impact of organic pollution is assessed with the German Saprobic System (new version), where scores are compared to a stream-type specific saprobic base condition.

The impact of morphological degradation on the macroinvertebrate fauna is assessed with five metrics. A stream-type specific “Fauna Index”, based on taxa predominantly occurring in microhabitats typical for reference conditions or degraded sections, respectively, contributes to 50% of the multimetric result. In addition the following metrics are used to assess the impact of degradation in stream morphology: BMWP-score, Shannon-Wiener-diversity, hypocrenal preferences [%] and akal preferences [%]; a low value of these metrics indicates degradation. A second set of metrics indicates degradation through high values: hyporhithral preferences [%] and phytal preferences [%].

D05 Mid-sized streams in lower mountainous areas of Central Europe

The impact of organic pollution is assessed with the German Saprobic System (new version), where scores are compared to a stream-type specific saprobic base condition.

The impact of morphological degradation on the macroinvertebrate fauna is assessed with five metrics, which consider natural substrate assemblages with gravel, accumulations of woody debris and lentic stretches with sandy patches.

A stream-type specific “Fauna Index”, based on taxa predominantly occurring in microhabitats typical for reference conditions or degraded sections, respectively, contributes to 50% of the multimetric result.

The percentages of taxa inhabiting lithal (stones), akal (gravel) and psammal (sand) is high under reference conditions. The same is true for the percentage of shredding, filtering (passive and active) and xylophagous taxa. Low percentages of these taxa indicate degradation. The following metrics are used to assess loss of natural substrate assemblages: [%] lithal, akal and psammal preferring taxa and [%] shredding, filtering and xylophagous taxa. The number of Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, Bivalvia and Odonata taxa is strongly affected by habitat degradation, due to the loss of certain microhabitats. This is also reflected by the diversity of the fauna and assessed with the Shannon-Wiener diversity index.

H01 Mid-altitude mid-sized siliceous streams in North-Eastern Greece

In order to assess the impact of both organic pollution and agriculture disturbance, correlations between an Inorganic Pollution Index and a large number of metrics have been carried out. The results show high correlation coefficients (> 0.5) between the Pollution Index and a number of metrics. Different multimetric indices are used for each sampling season. For summer samples, the best results are obtained by combining "Type LR" ([%] limno- to rheophile preferences) and [%] EPT-taxa. With this combination it is possible to distinguish three quality classes: 1) high-good, 2) moderate-poor and 3) bad. For winter samples the following metrics are used: Spanish BMWP and "Type RP" ([%] rheo- to limnophil preferences). With this combined index, it is possible to distinguish three quality classes: 1) high, 2) good-moderate-poor and 3) bad.

H02 Mid-altitude large siliceous streams in Central and Northern Greece

The same procedure as described for H01 is used for selecting and calculating multimetric indices for indicating organic and agricultural pollution. Different multimetric indices proved suitable for each sampling season. For summer samples the best result was given by combining ASTP, DSFI, DSFI diversity groups, IBE, diversity (Simpson), [%] littoral preferences, [%] predators and number of EPT-taxa. This multimetric index discriminates five quality classes. For winter samples the following metrics are combined: ASPT, DSFI, BMWP (Spain), IBE, "Type RP" ([%] rheo- to limnophil preferences), [%] metapotamal preferences and number of EPT-taxa. With this index four quality categories can be distinguished: 1) high, 2) good, 3) moderate and 4) poor-bad.

H03 Mid-altitude mid-sized calcareous streams in Western Greece

For this river type the impact of organic and agricultural pollution are assessed. Different multimetric indices proved suitable for each sampling season. Only 4 metrics proved suitable for the multimetric approach: for summer samples, a combination of the German Saprobic Index (old version), [%] hypopotamal preferences, [%] parasites and [%] profundal preferences are selected. It is possible to distinguish four quality classes: 1) high-good, 2) moderate, 3) poor and 4) bad. For winter samples, combining the metrics [%] hypopotamal preferences and [%] passive filter feeders, allowed the distinction of three quality classes: 1) high-good, 2) moderate-poor and 3) bad.

I02 Small-sized, calcareous streams in the Southern Apennines

A multimetric approach for assessing general degradation is used. Organic pollution, together with habitat modification, are the major stress factors affecting the invertebrate communities. Four different types of metrics are applied: metrics related to taxa richness (no. of Plecoptera genera, Trichoptera families, Operational Units of Ephemeroptera), abundance metrics, which consider the presence of selected taxa (selected Ephemeroptera, *Dinocras_Cordulegaster, Amphinemura_Protonemura*, etc.), habitat/trophic composition/state indicators (selected grazers only) and tolerance metrics (ASPT, BMWP, MTS). The selected metrics show a high correlation with the degradation of the sites, which was measured as the PCA axis representing the degradation factors in the development process. While selecting the final set of metrics, attention was also paid to suitability and ease of application (e.g. the identification levels for taxa were the same as the Italian standard monitoring method, wherever possible). On the basis of its observed value, each metric is scored as1 (bad), 3 (moderate), or 5 (good). The multimetric index is calculated from the sum of the scores given to each metric (for a total of 15 metrics). The assessment is derived from data of three sampling seasons (spring, late summer and winter) and requires samples from pool areas of the stream.

I03 Mid-sized calcareous streams in the Northern Apennines

Metrics belonging to the same groups as indicated above are used: richness measures (number of Plecoptera genera+Trichoptera families, Operational Units of Ephemeroptera), abundance measures (selected Ephemeroptera: *B. rhodani, Ecdyonurus, Habrophlebia, Torleya, C. beskidensis, C. belfiorei*; selected non EPtaxa: *Ancylus*, Lumbriculidae, *Micronecta*, Gyrinidae Ad., Limnephilidae, Odontoceridae; *Dugesia_Lymnaea*; all taxa/Diptera, etc.), habitat/trophic composition/state indicators (3 metrics selected) and tolerance metrics (BMWP, MTS). On the basis of its observed value, each metric is scored as 1 (bad), 3 (moderate), or 5 (good). The multimetric index is calculated from the sum of the scores given to each metric (for a total of 15 metrics). The assessment method is based on a single sampling season (late summer) and is applied for pool areas only. Because its development is based on a limited dataset, further validation of the multimetric method for this area is needed.

I04 Small streams in the lowlands of the Po valley

The multimetric approach is used to assess the impact of organic pollution, habitat degradation and chemical contamination. Metrics belong to for the following three groups: richness measures (e.g. number of Plecoptera genera+Trichoptera families, Diversity Groups, etc.), abundance measures (e.g. selected Ephemeroptera, *Leuctra_Calopteryx*, Elmidae, Lumbricidae and Tubificidae) and Tolerance metrics (ASPT, BMWP, MTS). On the basis of its observed value, each metric is scored as 1 (bad), 3 (moderate), or 5 (good). The multimetric index is calculated from the sum of the scores given to each metric (for a total of 15 metrics). The assessment system is usable all over the year and requires that samples are collected in the pool and riffle sections of the stream.

N01 Small Dutch lowland streams

Small Dutch lowland streams were frequent in the eastern, middle and southern parts of the Netherlands. Human interference has nearly been completely destroyed the natural slow running lowland streams by organic pollution and eutrophication (eutrophication is caused by intensive agricultural farming) and alteration of stream morphology (straightening, scouring, removal of floodplain vegetation). Therefore, metrics were selected that, where possible, cover this entangled combination of stressors: Saprobic Index ZELINKA & MARVAN, [%] hypopotamal preferences, [%] type PEL, [%] type RP, [%] hypopotamal-[%] EPT/[%] Oligochaeta, [%] Gastropoda-[%] EPT/[%] Oligochaeta, [%] EPT/[%]Oligochaeta, number of EPT taxa/number of Oligochaeta taxa, [%] (grazers+scrapers)/ [%] (gatherers/collecters+filterfeeders), [%] Gastropoda. It must be noted that each of these metrics individually do not cover a linear gradient in a certain stressor.

N02 Small Dutch hill streams

At present small Dutch hill streams are most often always affected by both, organic pollution and eutrophication, and stream morphology degradation. Therefore, metrics were selected that, where possible, cover this entangled combination of stressors: Saprobic Index (ZELINKA & MARVAN), [%] hypopotamal preferences, total number of taxa, [%] of passive filter feeders, [%] EPT/[%] Oligochaeta, number of EPT taxa/number of Oligochaeta taxa, [%] of Trichoptera, [%] EPT/[%] Oligochaeta - [%] Gastropoda, [%] EPT/[%] Oligochaeta - [%] type RP, [%] EPT/[%] Oligochaeta - [%] type PEL. It must be noted that each of these metrics individually do not cover a linear gradient in a certain stressor.

P01 Small-sized siliceous streams in lower mountainous areas of Southern Portugal
P02 Small-sized siliceous lowland streams of Southern Portugal
P03 Medium-sized siliceous lowland streams of Southern Portugal

Although the steep relief of this area limits agricultural activity to narrow strips within the floodplain and extensive cattle grazing to the slopes, an increase in the nutrient loading and organic pollution present the main degradation factors: saprobic degradation is complemented by different levels of erosion. Local effects of from inefficient sewage treatment plants augment degradation. Habitat degradation is caused through removal or replacement of native riparian vegetation with exotic species, multiple small-step damming and water abstraction. Straightening, bank and streambed fixation are rare.

Being the major impact factor, only organic pollution is assessed for this stream type through the newly developed Portuguese Index, which combines stress tolerance (scores) and community composition (relative abundance). A list of indicator taxa (family level) was established to this purpose, based on autecology and distribution along the impact gradient. Samples must be taken in riffle and pool sections.

The new Portuguese Index is the best-suited assessment metric for all three Portuguese stream types.

S01 Small lowland streams in Northern Sweden

To assess acidification in Northern Sweden three indices were combined. First, the acid index by Henrikson & Medin was chosen. This index combines a number of metrics (e.g., number of taxa, presence of groups sensitive to acidification, and the ratio between number of individuals of *Baetis* and Plecoptera) into a single value. Second, the number of Ephemeroptera, Plecoptera, and Trichoptera taxa, proved sensitive to acidic conditions. The third index was composed of the percentage of swimming/diving taxa where a higher percentage of these taxa were correlated with a higher pH / alkalinity. These taxa include certain Ephemeroptera, Coleoptera, Gammaridae, and Heteroptera, which are generally considered sensitive toward acidity.

S02 Small mid-altitude streams in Northern Sweden

To assess acidification in Northern Sweden three indices were combined. First, the acid index by Henrikson & Medin was chosen. This index combines a number of metrics (e.g., number of taxa, presence of groups sensitive to acidification, and the ratio between number of individuals of *Baetis* and Plecoptera) into a single value. Second, the number of Ephemeroptera, Plecoptera, and Trichoptera taxa, showed to be sensitive to acid conditions. The third index was composed of the percentage of grazers/scrapers where a higher percentage of these taxa were correlated with a higher pH / alkalinity. Grazing/scraping taxa are e.g., certain Gastropoda, Ephemeroptera, Trichoptera and Coleoptera, which are generally considered as being sensitive to acidity.

S03 Small mid-altitude streams in the Boreal Highlands

To assess acidification in Northern Sweden three indices were combined. First, the acid index by Henrikson & Medin was chosen. This index combines a number of metrics (e.g., number of taxa, presence of groups sensitive to acidification, and the ratio between number of individuals of *Baetis* and Plecoptera) into a single value. Second, the number of Ephemeroptera, Plecoptera, and Trichoptera taxa, proved sensitive to acid conditions.

S04 Small high-altitude streams in the Boreal Highlands

To assess acidification in Northern Sweden two indices were combined. First, the acid index by Henrikson & Medin was chosen. This index combines a number of metrics (e.g., number of taxa, presence of groups sensitive to acidification, and the ratio between number of individuals of *Baetis* and Plecoptera) into a single value. Second, the number of Ephemeroptera, Plecoptera, and Trichoptera taxa, proved sensitive to acid conditions.

S05 Medium-sized lowland streams in the South Swedish lowlands

The assessment of organic pollution in the Central Lowlands (southern Sweden) combines two indices indicating organic pollution – Danish Stream Fauna Index (DSFI) and general ecological degradation (Average Score Per Taxon – ASPT). In both cases taxa (mainly family level) are given scores based on their tolerance toward organic pollution. Both these indices show a strong (negative) correlation with the total phosphorous content of the streams. For the assessment of acidity, the acid index by Henrikson & Medin was chosen, since it has consistently been shown to clearly indicate when sites are affected by acidity in the southern parts of Sweden. This index combines a number of metrics (e.g., number of taxa, presence of groups sensitive to acidification, and the ratio between number of individuals of *Baetis* and Plecoptera) into a single value.

ANNEX 8: Determination literature

For the application of AQEM the use of the following determination literature is inevitable. The following compilation is sorted by country.

For a more precise level of determination than necessary to apply AQEM additional references should be used. A more extensive list of determination literature is available from www.aqem.de.

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GLÖER, P., C. MEIER-BROOK 1998. Süßwassermollusken. Deutscher Jugendbund für Naturbeobachtung (DJN), 136 pp.

NESEMANN, H. 1996a. Abbildungen von Gehäuse und Bestimmungsmerkmalen der Taxa der Großmuscheln (Unionacea) Österreichs. Kursunterlagen zu „Taxonomie und Ökologie aquatischer wirbelloser Organismen". Abt. Hydrobiologie Univ. f. Bodenkultur & Sektion IV, BM f. Land- und Forstwirtschaft, Wien, 13 pp.

NESEMANN, H. 1996b. Zusammenstellung der Merkmale der Kleinmuscheln (Sphaeriacea) Österreichs. Kursunterlagen zu „Taxonomie und Ökologie aquatischer wirbelloser Organismen". Abt. Hydrobiologie Univ. f. Bodenkultur & Sektion IV, BM f. Land- und Forstwirtschaft, Wien, 12 pp.

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NIELSEN, C.O. & B. CHRISTENSEN 1959. The Enchytraeidae: Critical revision and taxonomy of European species. (Studies on Enchytraedae). Natura jutlandica 8-9: 167 pp.

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NIELSEN, C.O. & B. CHRISTENSEN 1963. The Enchytraeidae: Critical revision and taxonomy of European species. Suppl.2. Natura jutlandica 10: 19 pp.

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Hirudinea / Branchiobdellida

NESEMANN, H. 1996a. Abbildung von Habitus und Bestimmungsmerkmalen der Egel (Hirudinea) und Krebsegel (Branchiobdellida) Österreichs. Kursunterlagen zu „Taxonomie und Ökologie aquatischer wirbelloser Organismen“. Abt. Hydrobiologie, Univ. f. Bodenkultur & Sektion IV, BM f. Land- und Forstwirtschaft, Wien, 32 pp.

NESEMANN, H.1996b. Kurzcharakteristik der Egel (Hirudinea) und Krebsegel (Branchiobdellida) Österreichs. Kursunterlagen zu „Taxonomie und Ökologie aquatischer wirbelloser Organismen“. Abt. Hydrobiologie, Univ. f. Bodenkultur & Sektion IV, BM f. Land- und Forstwirtschaft, Wien, 53 pp.

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ANNEX 9: Description of the metrics covered by the AQEM program

The AQEM software calculates a large number of biological indices (“metrics”). For the assessment of each stream type the best suited subset of metrics is used. However, the results of *all* metrics are always displayed, to ease the interpretation of the data.

In the Chapter, it is explained how the individual metrics are calculated, which stressor they are addressing and how they relate to the criteria specified in the Water Framework Directive. The metrics are given in the same order than in the output of the AQEM software. Further interpretation guidelines are given in Chapter 11.

Abundance [Ind./m²]				
Formula: $A = \sum_i n_i$ n_i number of individuals of the i^{th} taxon				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
The metric contributes to the assessment of the following stream types: A04				

Number of taxa				
Formula: Counts the number of different taxa in the input list.				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity	
organic pollution	degradation in stream	acidification	general	others
Further comments:				
The metric contributes to the assessment of the following stream types: A02; A03; A04; N02				

Saprobic Index (ZELINKA & MARVAN)
Saprobic Valence

oligo [%]
beta-meso [%]
alpha-meso [%]
poly [%]
no data available [%]

Formula:
Five different saprobic valences have been defined:
1. xeno saprobic (szx) $s_{Z\&M}x$
2. oligo saprobic (szo) $s_{Z\&M}o$
3. beta-meso saprobic (szb) $s_{Z\&M}b$
4. alpha-meso saprobic (sza) $s_{Z\&M}a$
5. poly saprobic (szp) $s_{Z\&M}p$

If information on the saprobic valences of a taxon is available, 10 points are distributed among the individual valences: if a species is preferring to 40% xeno saprobic zones (type 1.) and to 60% preferring the oligo saprobic zones (type 2.), the parameters for type 1. and type 2. will be 4 and 6, respectively. Any other parameter will be 0.

The percentage of the community representing a certain saprobic valence is:

$$SV_{Z\&M}v = \frac{\sum_i s_{Z\&M}v_i \cdot n_i}{\sum_i n_i} \cdot \frac{100}{10}$$

v: xeno saprobic, oligo saprobic, beta-meso saprobic, alpha-meso saprobic, p.

The saprobic score (szs) $s_{Z\&M}s$ is calculated as:

$$s_{Z\&M}s = \frac{0 \cdot s_{Z\&M}x + 1 \cdot s_{Z\&M}o + 2 \cdot s_{Z\&M}a + 3 \cdot s_{Z\&M}b + 4 \cdot s_{Z\&M}p}{10}.$$

The saprobic index after ZELINKA & MARVAN is calculated as:

$$SI_{Z\&M} = \frac{\sum_i s_{Z\&M}s_i \cdot s_{Z\&M}g_i \cdot n_i}{\sum_i s_{Z\&M}g_i \cdot n_i}$$

$s_{Z\&M}g$: weighting factor (szg)
i: each species that is specified by this index $\{s_{Z\&M}g \neq 0\}$

Column headings in the Autecological database:

szx	Saprobic valence ZELINKA&MARVAN: xenosaprob (x out of 10 points)
szo	Saprobic valence ZELINKA&MARVAN: oligosaprob (x out of 10 points)
szb	Saprobic valence ZELINKA&MARVAN: beta-mesosaprob (x out of 10 points)
sza	Saprobic valence ZELINKA&MARVAN: alpha-mesosaprob (x out of 10 points)
szp	Saprobic valence ZELINKA&MARVAN: polysaprob (x out of 10 points)
szs	Saprobic index ZELINKA&MARVAN: sabrobic score
szg	saprobic index ZELINKA&MARVAN weighting factor

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio taxa	diversity

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
A01; A02; A03; A04; N01; N02

German Saprobic Index (DIN 38 410) (old version)
Measure of dispersion (Streuungsmaß)
Measure of abundance (Abundanzziffer)

Water Quality Class

Formula:
The calculation of the German saprobic index performed similarly to the calculation for the Saprobic Index (PANTLE & BUCK, modif. by Marvan). Instead of the number of individuals, a statistical distribution is used:

$$f(n) = \begin{cases} 0 & \text{for } n = 0 \\ 1 & \text{for } 0 < n \le 7 \\ 2 & \text{for } 7 < n \le 35 \\ 3 & \text{for } 35 < n \le 150 \\ 4 & \text{for } 150 < n \le 300 \\ 5 & \text{for } 300 < n \le 1000 \\ 6 & \text{for } 1000 < n \le 3000 \\ 7 & \text{for } 3000 < n \end{cases}$$

The saprobic index is calculated by

$$SI_G = \frac{\sum_i s_G s_i \cdot s_G g_i \cdot f(n_i)}{\sum_i s_G g_i \cdot f(n_i)},$$

$s_G s$: saprobic score
$s_G g$: weighting factor
i: each species specified by the sabrobic index $\{s_G g \neq 0\}$

There are some values related to the saprobic index:

Measure of dispersion („Streuungsmaß“)

$$SM = \sqrt{\frac{\sum_i (s_G s_i - SI_G)^2 \cdot s_G g_i \cdot f(n_i)}{(t-1) \cdot \sum_i s_G g_i \cdot f(n_i)}}$$

t: number of indicator taxa

Measure of abundance („Abundanzziffer“)

$$AZ = \sum_i f(n_i)$$

i: each species that is specified by the SI

Number of indicator taxa
Number of taxa, which are classified by the SI

Water quality class

$$QC = \begin{cases} \text{I} & \text{for SI} < 1.5 \\ \text{I - II} & \text{for } 1.5 \leq \text{SI} < 1.8 \\ \text{II} & \text{for } 1.8 \leq \text{SI} < 2.3 \\ \text{II - III} & \text{for } 2.3 \leq \text{SI} < 2.7 \\ \text{III} & \text{for } 2.7 \leq \text{SI} < 3.2 \\ \text{III - IV} & \text{for } 3.2 \leq \text{SI} < 3.5 \\ \text{IV} & \text{for } 3.5 \leq \text{SI} \end{cases}$$

Column headings in the Autecological database:

sio	German Saprobic Index (old version) saprobic score
sgo	German Saprobic Index (old version) weighting factor

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
H03

Reference:
DEV (Deutsches Institut für Normung e.V.) 1992. Biologisch-ökologische Gewässergüteuntersuchung: Bestimmung des Saprobienindex (M2). In: Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung. VCH Verlagsgesellschaft mbH, Weinheim, 1-13.

German Saprobic Index (new version)
Measure of dispersion (Streuungsmaß)
Measure of abundance (Abundanzziffer)
Number of indicator taxa
Water Quality Class

Formula:
Calculated exactly the same way as the German Saprobic Index (old version) but with an extended list of indicator species. The list was generated by the committee DIN-NAW I 3 UA 5 AK 6 “Biologisch-ökologische Gewässeruntersuchungen“. It is a draft and has not been subject of standardisation so far; however standardisation is planned for 2002.

Column headings in the Autecological database:

sin	German Saprobic Index (new version) saprobic score
sgn	German Saprobic Index (new version) weighting factor

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
D01; D02; D03; D04; D05

Reference:
Unpublished; standardisation planned for 2002.

Dutch Saprobic Index				
Formula: Calculated exactly the same way as the Saprobic index (ZELINKA & MARVAN), but without any weighting factor.				
Column headings in the Autecological database:				
NSX	Netherland saprobic valence xenosaprob (x out of 10 points)			
NSO	Netherland saprobic valence oligosaprob (x out of 10 points)			
NSB	Netherland saprobic valence beta-mesosaprob (x out of 10 points)			
NSA	Netherland saprobic valence alpha-mesosaprob (x out of 10 points)			
NSP	Netherland saprobic valence polysaprob (x out of 10 points)			
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: None				

Czech Saprobic Index				
Formula: Calculated exactly the same way as the Saprobic index (ZELINKA & MARVAN) including the weighting factors but with a slightly different taxa list.				
Column headings in the Autecological database:				
szx	Saprobic valence ZELINKA&MARVAN: xenosaprob (x out of 10 points)			
szo	Saprobic valence ZELINKA&MARVAN: oligosaprob (x out of 10 points)			
szb	Saprobic valence ZELINKA&MARVAN: beta-mesosaprob (x out of 10 points)			
sza	Saprobic valence ZELINKA&MARVAN: alpha-mesosaprob (x out of 10 points)			
szp	Saprobic valence ZELINKA&MARVAN: polysaprob (x out of 10 points)			
szs	Saprobic index ZELINKA&MARVAN: sabrobic score			
szg	saprobic index ZELINKA&MARVAN weighting factor			
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: C01; C02; C03				
Reference: Czech Standard No. 757716 (Water quality-Biological analysis-Determination of Saprobic index).				

BMWP (Biological Monitoring Working Party)				
Formula: Certain macroinvertebrate families are scored according to their sensitivity to organic pollution. The BMWP is the total of the scores of all families present in a taxa list. Each family in the sample is counted only one time, regardless of the number of species.				
Column headings in the Autecological database:				
bmwp	BMWP Score			
bmwpf	BMWP Family			
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: D04; I02; I03; I04				
Reference: ARMITAGE, P.D., D. MOSS, J.F. WRIGHT & M.T. FURSE 1983. The performance of a new biological water quality score system based on macroinvertebrates over a wide range of unpolluted running-water sites. Water Res. 17, 333-347.				

ASPT (Average Score per Taxon)				
Formula: The ASPT is the BMWP divided by the number of BMWP families present in the taxa list. Each family with more than 2 individuals in the sample is counted.				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: C01; H02; I02; I04; S05				
Reference: ARMITAGE, P.D., D. MOSS, J.F. WRIGHT & M.T. FURSE 1983. The performance of a new biological water quality score system based on macroinvertebrates over a wide range of unpolluted running-water sites.- Water Res. 17, 333-347.				

BMWP (Biological Monitoring Working Party) (Spanish Version)

Formula:
Calculated exactly the same way like the BMWP, but with a slightly different list of families and scores.

Column headings in the Autecological database:

bmwpe	BMWP Score Spain
bmwpef	BMWP Family Spain

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
None

Reference:
ALBA-TERCEDOR, J. & A. SANCHEZ-ORTEGA 1988. Un metodo rapido y simple para evaluar la calidad biologica de las aguas corrientes basado en el de Hellawell (1978). Limnetica 4, 51-56.

DSFI (Danish Stream Fauna Index)
Diversity Groups

Formula:
The DSFI is based on the occurrence of certain “Diversity groups” and “Indicator groups”.

Diversity groups:

The following taxa have the score +1:
Tricladida (each? genus)
Gammarus (genus)
each genus of Plecoptera
each family of Ephemeroptera
Elmis (genus)
Limnius (genus)
Elodes (genus)
Rhyacophilidae (each? genus)
Ancylus (genus)
each family of case-bearing Trichoptera

The following elements have the score –1:
Oligochaeta (group), if equal or more than 100 individuals are present in the sample
Helobdella (genus)
Erpobdella (genus)
Asellus (genus)
Sialis (genus)
Psychodidae (each? genus)
Chironomus (genus)
Eristalinae (genus)
Sphaerium (genus)
Lymnaea (genus)

The number of diversity groups (DG) is the total of scores from the list above; each taxon present in the sample is counted only once.

Indicator groups (IG):
IG 1:

Taxa	Level	Individuals necessary
Brachyptera	Genus	2
Capnia	Genus	2
Leuctra	Genus	2

Isogenus	Genus	2
Isoperla	Genus	2
Isoptena	Genus	2
Perlodes	Genus	2
Protonemura	Genus	2
Siphonoperla	Genus	2
Ephemeridae	Family	2
Limnius	Genus	2
Glossosomatidae	Family	2
Sericostomatidae	Family	2

IG 2:

	Level	Individuals necessary
Asellus	Genus	5
Chironomus	Genus	5
Amphinemura	Genus	2
Taeniopteryx	Genus	2
Ametropodidae	Family	2
Ephemerellidae	Family	2
Heptageniidae	Family	2
Leptophlebiidae	Family	2
Siphlonuridae	Family	2
Elmis	Genus	2
Elodes	Genus	2
Rhyacophilidae	Family	2
Goeridae	Family	2
Ancylus	Genus	2

IG 3:

	Level	Individuals necessary
Chironomus		5
Gammarus	Genus	10
Caenidae	Family	2
Any other Trichoptera		5

IG 4:

	Level	Individuals necessary
Gammarus	Genus	10
Asellus	Genus	2
Caenidae	Family	2
Sialis	Genus	2
Any other Trichoptera		2

IG 5:

	Level	Individuals necessary
Oligochaeta		100
Eristalinae		2
Gammarus	Genus	< 10
Baetidae	Family	2
Simuliidae	Family	25

IG 6:

	Level	Individuals necessary
Tubificidae	Family	2
Psychodidae	Family	2

Chironomidae	Family	2
Eristalinae		2

From these two lists, DG and IG, the DSFI is calculated by using the following rules:

					DSFI
IG 1 groups	≥ 2	AND	The number of DG	≤ -2	-
				-1 ≤ DG ≤ 3	5
				4 ≤ DG ≤ 9	6
				≥ 10	7
IG 1 groups	= 1	AND	The number of DG	≤ -2	-
					4
				4 ≤ DG ≤ 9	5
				≥ 10	6
IG 1 groups	= 0	AND	The number of *Asellus* sp.	≥ 5	Go to IG 3
		OR	The number of *Chironomus* sp.	≥ 5	Go to IG 4
		ELSE	Go to IG 2		
IG 2 groups	> 0	AND	The number of DG	≤ -2	4
				-1 ≤ DG ≤ 3	4
				4 ≤ DG ≤ 9	5
				≥ 10	5
IG 2 groups	= 0	AND	The number of *Chironomus* sp.	≥ 5	Go to IG 4
IG 3 groups	> 0	AND	The number of DG	≤ -2	3
				-1 ≤ DG ≤ 3	
					4
				≥ 10	4
IG 4 groups	≥2	AND	The number of DG	≤ -2	3
				-1 ≤ DG ≤ 3	3
				4 ≤ DG ≤ 9	4
				≥ 10	-
IG 4 groups	=1	AND	The number of DG	≤ -2	2
				-1 ≤ DG ≤ 3	3
				4 ≤ DG ≤ 9	3
				≥ 10	
Oligochaeta	≥ 100		Go to IG 5 equals 1 group		
Eristalinae	≥ 2		Go to IG 6		
IG 5 groups	≥2	AND	The number of DG	≤ -2	2
				-1 ≤ DG ≤ 3	3
				4 ≤ DG ≤ 9	3
				≥ 10	-
IG 5 groups	=1		The number of Oligochaeta	≥ 100	
		AND		≤ -2	
				-1 ≤ DG ≤ 3	2
					3
				≥ 10	
IG 6 groups	> 0	AND	The number of DG	≤ -2	1
				-1 ≤ DG ≤ 3	1
				4 ≤ DG ≤ 9	-
				≥ 10	-

Column headings in the Autecological database:	
dsfis	DSFI Family
dsfi1	DSFI Indicator group 1
dsfi2	DSFI Indicator group 2

<table>
<tr><td>dsfi3</td><td colspan="4">DSFI Indicator group 3</td></tr>
<tr><td>dsfi4</td><td colspan="4">DSFI Indicator group 4</td></tr>
<tr><td>dsfi5</td><td colspan="4">DSFI Indicator group 5</td></tr>
<tr><td>dsfi6</td><td colspan="4">DSFI Indicator group 6</td></tr>
<tr><td colspan="5">Criteria of the Water Framework Directive met:</td></tr>
<tr><td>taxonomic composition</td><td>abundance</td><td colspan="2">tive/insensitive taxa</td><td>diversity</td></tr>
<tr><td colspan="5">Most suited for assessing the impact of:</td></tr>
<tr><td>organic pollution</td><td>degradation in stream morphology</td><td>acidification</td><td>general degradation</td><td>others</td></tr>
<tr><td colspan="5">Further comments:</td></tr>
<tr><td colspan="5">The metric contributes to the assessment of the following stream types:
H02; I04; S05</td></tr>
<tr><td colspan="5">Reference:
SKRIVER, J., N. FRIBERG & J. KIRKEGAARD, 2001. Biological assessment of running waters in Denmark: introduction of the Danish Stream Fauna Index (DSFI). Verhandlungen der Internationale Vereinigung für Theoretische und Angewandte Limnologie, 27(4), 1822-1830.</td></tr>
</table>

BBI (Belgian Biotic Index)

Formula:
The BBI is based on a list of scores and a matrix for the calculation.

Score	Group	Level
1	Plecoptera	genus
	Heptageniidae	
2	Trichoptera (cased)	family
3	Ancylidae	genus
	Ephemeroptera (except Heptageniidae)	genus
4	*Aphelocheirus*	genus
	Odonata	genus
	Gammaridae	genus
	Mollusca (except Spaeriidae)	genus
5	Asellidae	genus
	Hirudinea	genus
	Sphaeriidae	genus
	Hemiptera (except *Aphelocheirus*)	
6	Tubificidae	
	Chironomus thummi + plumosus	species
7	Syrphidae + Eristalinae	family

The taxa with at least two individuals are counted, using the taxonomic level from the list above (e.g. each genus of Plecoptera with 2 or more individuals). For calculation the number of taxa with the lowest score present in the sample is needed, and the total number of taxa. These numbers are used in the following matrix:

lowest Score	taxa in this score	total number of taxa				
		0-1	2-5	6-10	11-15	>15
1	≥ 2	-	7	8	9	10
1	= 1	5	6	7	8	9
2	≥ 2	-	6	7	8	9
2	= 1	5	5	6	7	8
3	> 2	-	5	6	7	8
3	1-2	3	4	5	6	7
4	≥ 1	3	4	5	6	7
5	≥ 1	2	3	4	5	-
6	≥ 1	1	2	3	-	-
7	≥ 1	0	1	1	-	-

(e.g. the lowest score is 3, number of taxa with score 3 and at least two individuals are 2, and the total number of taxa is 12, then the BBI is 6.)

Column headings in the Autecological database:

bbif	BBI Family
bbig	BBI Indicator group

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

References:
DE PAUW, N. & G. VANHOOREN 1983. Method of biological quality assessment of watercourses in Belgium. Hydrobiologia 100, 153-168.
DE PAUW, N., P.F. GHETTI, D.P. MANZINI & D.R. SPAGGIARI 1992. Biological assessment methods for running water. In: River Water Quality. Ecological Assessment and Control. (eds. P.J. Newman, M.A. Piavaux & R.A. Sweeting), Commission of the European Communities, EUR 14606 En-Fr, 217-248.

IBE (Indice Biotico Esteso)
Quality Class
Systematic Units

Formula:
The calculation of the IBE is similar to the BBI.

It is based on the following list of systematic units (SU):

faunistic group	level of a SU
Plecoptera	genus
Trichoptera	family
Ephemeroptera	genus
Coleoptera	family
Odonata	genus
Diptera	family
Heteroptera	family
Crustacea	family
Gastropoda	family
Bivalvia	family
Tricladida	genus
Hirudinea	genus
Oligochaeta	family
Megaloptera	group
Planipennia	group
Nematoda	group
Nematomorpha	group

A minimum number of individuals is necessary for each SU to be counted. For all Plecoptera and Heptageniidae and Leptophlebiidae Ephemeroptera, there are two different limits, a low one and a high one. In those cases in which "1 SU" and ">1 SU" are distinguished (see above table) different abundance limits are used for these taxa. In the case of "1 SU" collected, the higher limit has to be used, otherwise the lower limit has to be used.
The IBE is calculated by the following matrix

	number of SU in this group	number of SU								
		0-1	2-5	6-10	11-15	16-20	21-25	26-30	31-35	36-…
Plecoptera (Leuctra°)	> 1	-	-	8	9	10	11	12	13*	14*
	= 1	-	-	7	8	9	10	11	12	13*
Ephemeroptera (excluding Baetidae, Caenidae°°)	> 1	-	-	7	8	9	10	11	12	-
	= 1	-	-	6	7	8	9	10	11	-
Trichoptera and Baetidae, Caenidae	> 1	-	5	6	7	8	9	10	11	-
	= 1	-	4	5	6	7	8	9	10	-
Gammaridae and/or Atyidae and/or Palaemonidae	All the above are absent	-	4	5	6	7	8	9	10	-
Asellidae and/or Niphargidae	All the above are absent	-	3	4	5	6	7	8	9	-
Oligochaeta or Chironomidae	All the above are absent	1	2	3	4	5	-	-	-	-

Other organisms	All the above are absent	-	-	-	-	-	-	-	-	-

° If *Leuctra* is the only Plecoptera taxon and no Ephemeroptera (excluding Baetidae and Caenidae) are found, *Leuctra* must be included at the Trichoptera level for the horizontal entry in the table.
°° For the horizontal entry in the table, Baetidae and Caenidae enter at the Trichoptera level
- Doubtful judgement, because of: inappropriate sampling, "drift" organisms included, unstably colonised environment, river types, where IBE should not be applied
* These values are infrequently recorded in Italian watercourses.

In those cases in which “1 SU” and “>1 SU” are distinguished (see above table) different limits are used. In the case of “1 SU” the higher limit has to be used, otherwise the lower limit has to be used.

The Quality Class is related to the IBE:

IBE	> 9	8-9	6-7	4-5	1-3
Class	I	II	III	IV	V

Column headings in the Autecological database:

ibef	IBE Family
ibeg	IBE Indicator Group
ibell	IBE Limit (low)
ibelh	IBE Limit (high)

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
H02

Reference:

GHETTI, P.F. 1997. Manuale di applicazione Indice Biotico Esteso (I.B.E.). I macroinvertebrati nel controllo della qualità degli ambienti di acque correnti. Provincia Autonoma di Trento, Agenzia provinciale per la protezione dell’ambiente.

MAS (Mayfly Average Score)
Integrity Class
Operational Units
MTS

Formula:
For the calculation of the MAS only the Ephemeroptera are used. The different taxa are scoring as follows:

score	Operational Unit (OU)		
1	*Baetis rhodani/Baetis buceratus*		exploiter taxa
	Caenis gr. *macrura*	*Siphlonurus*	
3	*Brachycercus*	*Ecdyonurus*	ancillary taxa
	Caenis gr. 3	*Choroterpes*	
	Ephemerella/Serratella	*Acentrella*	
	Habroleptoides	Baetidae gr. A	
	Paraleptophlebia	Baetidae gr. B	
	Ephoron	*Centroptilum*	
	Potamanthus	*Cloeon*	
	Oligoneuriella	*Procloeon (simple gills)*	
	Thraulus	*Pseudocentroptilum/Procloeon (double gills)*	
	Torleya		
5	*Caenis* gr. 5	*Rhithrogena* gr. C	indicator taxa
	Ephemera	*Rhithrogena* gr. D	
	Epeorus	*Rhithrogena* gr. E	
	Heptagenia	*Rhithrogena* gr. F	
	Electrogena	*Habrophlebia*	
	Rhithrogena gr. A	*Siphlonurus (if at least 2 other score_5 OUs are present)*	
	Rhithrogena gr. B		

gr. 3, 5, and A-F are groups of certain species

The Mayfly Total Score (MTS) is the total of all scores of the Operational Units in the sample. Each Operational Unit is counted only once. The Operational Units of score 5 are only counted if at least two individuals are present. If there are less than two other score 5 Operational Units, *Siphlonurus* is be counted as a score 1 OU.
The MTS is calculated as:

$$MAS = \frac{MTS}{number\ of\ OUs}$$

The number of Operational Units is also needed to determine the Integrity Class:

		Number of Operational Units (OU) of Mayflies						
Mayfly Average Score (MAS)		No Mayfly	1-2	3	4	5	6-7	8-9	10
	> 3,5		-	-	II	I	I	I	I+
	3 < s < 3,5		-	-	III	II	II	I	I
	2,5 < s 3		-	-	III	III	III	II	I
	< 2,5		-	-	IV	IV	III	III	-
			V	IV					

There are two different lists, one standard list and one for large rivers.

Column headings in the Autecological database:

masg	MAS Group
mass	MAS Score

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	tive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream	acidification	general	others

Further comments: A detailed Manual is going to be published concerning the method (BUFFAGNI et al., 2002 in preparation).

The metric contributes to the assessment of the following stream types:
I02 (MTS + number of Operational Units); I03 (MTS + number of Operational Units); I04 (MTS + number of Operational Units)

References:

BUFFAGNI, A. 1997. Mayfly community composition and the biological quality of streams. In: Landolt P. & M. Sartori (ed.). Ephemeroptera & Plecoptera: Biology-Ecology-Systematics, MTL, Fribourg, 235-246.

BUFFAGNI, A. 1999. Pregio naturalistico, qualità ecologica e integrità della comunità degli Efemerotteri. Un indice per la classificazione dei fiumi italiani. Acqua & Aria 8, 99-107.

BUFFAGNI, A. et al. 2002. Gli Efemerotteri e la qualità ecologica dei corsi d'acqua. Quad. Ist. Ric. Acque (In preparation).

MAS (Mayfly Average Score) (Large Rivers)
Integrity Class
Operational Units
MTS

Calculated exactly the same way like the MAS but with different species scores.

Column headings in the Autecological database:

masl	MAS Score (large river)
masgl	MAS Group (large river)

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
None

Diversity (Simpson-Index)				
Formula: $$D_{Simpson} = 1 - \sum_i \frac{n_i \cdot (n_i - 1)}{A \cdot (A-1)}$$ A: Abundance n_i: number of individuals of the i[th] species				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further Comments:				
The metric contributes to the assessment of the following stream types: None				
Reference: SIMPSON, E. H. 1949. Measurement of diversity. Nature 163, 688.				

Diversity (Shannon-Wiener-Index)				
Formula: $$D_{S-W} = -\sum_{i=1}^{s} \left(\frac{n_i}{A}\right) \cdot \ln\left(\frac{n_i}{A}\right)$$				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: D04; D05; H02				
Reference: SHANNON, C. E. & W. WEAVER 1949. The Mathematical Theory of Communication. The University of Illinois Press, Urbana, IL.				

Diversity (Margalef-Index)

Formula:

$$D_M = (i-1) / \ln(A)$$

i = total number of taxa
A = total individuals/m²

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
A01; A02; A03

Reference:

MARGALEF, R. 1984. The Science and Praxis of Complexity. Ecosystems: Diversity and Connectivity as measurable components of their complication. In Aida,et al. (Ed.). United Nations University, Tokyo, 228-244.

Evenness

Formula:

$$evenness = \frac{D_{S-W}}{\ln(t)}$$

t: number of taxa
Ds-w = Shannon-Wiener-Index

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
None

Acid class (according to BRAUKMANN) **Share acid class 1 (no acidification)** **Share acid class 2 (periodical slight acidification)** **Share acid class 2 (periodical serious acidification)** **Share acid class 1 (permanent acidification)**

Formula:

An acid class (1-4) is assigned to certain taxa. The percentage of individuals of an acid class x is calculated as:

$$ac_x = \frac{\sum_i n_i(y)}{\sum_{i,y} n_i(y)}$$

$$n_i(x) = \begin{cases} n_i & \text{for x = y} \\ 0 & \text{for x} \neq \text{y} \end{cases}$$

y: acid class 1, 2, 3, 4

Starting with the most sensitive class (acid class 1) the first class contributing to more than 10% of the individuals (scored taxa only) is chosen.

Column headings in the Autecological database:

acidclass	Acid Class according to Braukmann

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
None

Reference:

BRAUKMANN, U. 2000. Hydrochemische und biologische Merkmale regionaler Bachtypen in Baden-Württemberg. Landesanstalt für Umweltschutz Baden-Württemberg, Oberirdische Gewässer, Gewässerökologie 56, 501pp.

Acid Index (Hendrikson & Medin)

Formula:
The index is calculated as the sum of the highest scores of each of the criteria I – V below.

I. Presence of mayflies, stoneflies, and caddis-flies with differing pH tolerance
Taxa having an indicator value of 3 score 3 points
Taxa having an indicator value of 2 score 2 points
Taxa having an indicator value of 1 score 1 points
Taxa having an indicator value of 0 score 0 points

Maximum score 3 points, the indicator value is found in table 1.

II. Presence of amphipods
The presence of amphipods score 3 points

Maximum score 3 points

III. Presence of groups sensitive to acidification, Hirudinea, Elmidae, Gastropoda and Bivalvia each score 1 point.
Maximum score 4 points.

IV. Ratio between the number of individuals of mayflies of the *Baetis* and *Nigrobaetis* genus and stoneflies (Plecoptera)
Ratio > 1 scores 2 points
Ratio 0.75 – 1 scores 1 point
Ratio < 0.75 score 0 points

Maximum score 2 points

V. Number of taxa present.
> = 32 taxa scores 2 points
17 – 31 taxa scores 1 point
< = 16 taxa scores 0 points

Maximum score 2 points

Total maximum score is 14 points.

Column headings in the Autecological database:

AcidScore	Acid Score Hendrikson & Medin

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
S01; S02; S03; S04; S05

Reference:
HENRIKSON, L. & M. MEDIN 1986. Biologisk bedömning av försurningspåverkan på Lelångens tillflöden och grundområden 1986. Aquaekologerna, Rapport till länsstyrelsen i Älvsborgs län.

German Fauna Index D01
German Fauna Index D02
German Fauna Index D03
German Fauna Index D04
German Fauna Index D05

Formula:

The „German Fauna Index“ is based on species-specific scores (different values for each stream type) and it is calculated by:

$$total\ score = \frac{\sum_{i}^{N} sc_i \cdot a_i}{\sum_{i}^{N} a_i}$$

i = number of indicator taxa
N = total number of indicator taxa
sc_i = score of the i^{th} taxon
a_i = abundance-class of the i^{th} taxon

The scores range from –2 (taxa preferably occurring in rivers with a degraded morphology) to +2 (taxa preferably occurring in rivers with a near to natural morphology, e.g. xylophagous taxa).

Class boundaries for abundance classes

max. taxa abundance	
0	0
3	1
10	2
30	3
100	4
300	5
1000	6
> 1000	7

Column headings in the Autecological database:

IVD01	German Fauna Index indicator value D01
IVD02	German Fauna Index indicator value D02
IVD03	German Fauna Index indicator value D03
IVD04	German Fauna Index indicator value D04
IVD05	German Fauna Index indicator value D05

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
D01; D02; D03; D04; D05

Reference:

LORENZ, A., P. ROLAUFFS & D. HERING (in print). Bewertung von Bächen und Flüssen mit silikatisch geprägtem Einzugsgebiet - wirkt sich gewässermorphologische Degradation auf das Makrozoobenthos aus?- DGL, Erweiterte Zusammenfassung der Jahrestagung Kiel 2001.

Portuguese Index				
Formula: PI = Sum (relative abundance of the family x points of the family according the list)/sum (relative abundance of the families, which are in the pointlist). Maximum value = 7; minimum value = 1.				
Column headings in the Autecological database:				
Port1	Score of the Portuguese Index			
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: P01; P02; P03				
Reference: New metric developed in AQEM.				

Number of sensitive taxa (Austria)				
Formula: Counts the number of sensitive taxa, which can be determined in the field according to an Austrian list				
Column headings in the Autecological database:				
Mod1	Austrian Sensitive Taxa score			
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: A01; A02; A03				
Reference: MOOG, O., A. CHOVANEC, J. HINTEREGGER & A. RÖMER 1999. Richtlinie zur Bestimmung der saprobiologischen Gewässergüte von Fließgewässern. Bundesministerium für Land- und Forstwirtschaft, Wien.				

Zonation (percentage of community preferring a certain zone)

- **crenal (spring) [%]**
- **hypocrenal (spring-brook) [%]**
- **epirhithral (upper-trout region) [%]**
- **metarhithral (lower-trout region) [%]**
- **hyporhithral (greyling region) [%]**
- **epipotamal (barbel region) [%]**
- **metapotamal (brass region) [%]**
- **hypopotamal (brackish water) [%]**
- **Littoral [%]**
- **Profundal [%]**
- **no data available [%]**

Formula:

If information on the zonation preference of a taxon is available, 10 points are distributed among the individual zones: if a species is to 40% preferring the epirhithral (type 1.) and to 60% preferring the hyporhithral (type 2.), the parameters for type 1. and type 2. are 4 and 6, respectively. Any other parameter is 0.

If no information about the zonation preferences are available, all parameters are 0.

The total of the parameters has always to be 10 or 0.

The percentage of the individual preferences is calculated regarding the above mentioned score distributions and the abundance of all taxa (including those taxa, which are not scored). The result "no data available" is the percentage of those taxa, for which all parameters are 0.

Column headings in the Autecological database:

zeu	Preference for crenal (spring) (x out of 10 points)
zhy	Preference for hypocrenal (spring-brook) (x out of 10 points)
zer	Preference for epirhithral (upper-trout region) (x out of 10 points)
zmr	Preference for metarhithral (lower-trout region) (x out of 10 points)
zhr	Preference for hyporhithral (greyling region) (x out of 10 points)
zep	Preference for epipotamal (barbel region) (x out of 10 points)
zmp	Preference for metapotamal (brass region) (x out of 10 points)
zhp	Preference for hypopotamal (brackish water) (x out of 10 points)
zli	Preference for Littoral (x out of 10 points)
zpr	Preference for Profundal (x out of 10 points)

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:

A01 (Littoral [%] + Profundal [%]; scored taxa only);A03 (Littoral [%] + Profundal [%]; scored taxa only);A04 (Littoral [%]; scored taxa only); D01 (Littoral [%]); D03 (Littoral [%]); D04 (Hyporhithral [%]; Hypocrenal [%]); H02 (Littoral [%]); H03 (Hypopotamal [%] + Profundal [%]); N01 (Hypopotamal [%]); N02 (Hypopotamal [%])

Reference:

The information on the zonation preferences have been taken from:

(First priority): MOOG, O. (Ed.) 1995. Fauna Aquatica Austriaca – a comprehensive species inventory of Austrian aquatic organisms with ecological data. First edition, Wasserwirtschaftskataster, Bundesministerium für Land- und Forstwirtschaft, Wien.

(Second priority): SCHMEDTJE, U. & M. COLLING 1996. Ökologische Typisierung der aquatischen Makrofauna. Informationsberichte des Bayerischen Landesamtes für Wasserwirtschaft 4/96.

(Third priority): Information sampled by the AQEM consortium.

Index of Biocoenotic Region	
Formula: REG_i = Zonation Index of species i $REG_i = \Sigma$ (euc_i + hyc_i + …$prof_i$)/10 euc_i = eucrenal valency of species i hyc_i = hypocrenal valency of species i …etc. A_i = Abundance of species I	
Column headings in the Autecological database:	
zeu	Preference for crenal (spring) (x out of 10 points)
zhy	Preference for hypocrenal (spring-brook) (x out of 10 points)
zer	Preference for epirhithral (upper-trout region) (x out of 10 points)
zmr	Preference for metarhithral (lower-trout region) (x out of 10 points)
zhr	Preference for hyporhithral (greyling region) (x out of 10 points)
zep	Preference for epipotamal (barbel region) (x out of 10 points)
zmp	Preference for metapotamal (brass region) (x out of 10 points)
zhp	Preference for hypopotamal (brackish water) (x out of 10 points)
zli	Preference for Littoral (x out of 10 points)
zpr	Preference for Profundal (x out of 10 points)

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
A01

Current preference (percentage of community preferring a certain current velocity)

- **Type LB (limnobiont, occurring only in standing waters) [%]**
- **Type LP (limnophil, preferably occurring in standing waters; avoids current; rarely found in slowly flowing streams) [%]**
- **Type LR (limno- to rheophil, preferably occurring in standing waters but regularly occurring in slowly flowing streams) [%]**
- **Type RL (rheo- to limnophil, usually found in streams; prefers slowly flowing streams and lentic zones; also found in standing waters) [%]**
- **Type RP (rheophil, occurring in streams; prefers zones with moderate to high current) [%]**
- **Type RB (rheobiont, occurring in streams; bound to zones with high current) [%]**
- **Type IN (indifferent, no preference for a certain current velocity) [%]**
- **no data available [%]**

Formula:

A current preference has been assigned to certain taxa. This preference can be LB, LP, LR, RL, RP, RB or IN. Each species has only one preference.

The current preference of the community is calculated using the above mentioned categories and the abundance of all taxa (including those taxa, which are not scored).The result “no data available” is the percentage of those taxa, for which no data on current preference is available.

Column headings in the Autecological database:

cup	Preference for a certain current (x out of 10 points); LB = limnobiont; LP = limnophil; LR = limno- to rheophil; RL = rheo- to limnophil; RP = rheophil; RB = rheobiont; IN = indifferent)

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:

D01 (rheophilous preferences); D03 (rheophilous preferences); H01 (Type LR); H02 (Type RP); N01 (Type RP)

Reference:

The information on the current preferences have been taken from:

SCHMEDTJE, U. & M. Colling 1996. Ökologische Typisierung der aquatischen Makrofauna. Informationsberichte des Bayerischen Landesamtes für Wasserwirtschaft 4/96.

Microhabitat preference (percentage of community preferring a certain microhabitat)

- **Type Pel (Pelal: mud; grain size < 0.063 mm) [%]**
- **Type Arg (Argyllal: silt, loam, clay; grain size < 0.063 mm) [%]**
- **Type Psa (Psammal: sand; grain size 0.063-2 mm) [%]**
- **Type Aka (Akal: fine to medium-sized gravel; grain size 0.2-2 cm) [%]**
- **Type Lit (Lithal: coarse gravel, stones, boulders; grain size > 2 cm) [%]**
- **Type Phy (Phytal: algae, mosses and macrophytes including living parts of terrestrial plants) [%]**
- **Type POM (particulate organic matter, such as woody debris, CPOM, FPOM) [%]**
- **Type Oth (other habitats) [%]**
- **no data available [%]**

Formula:
The microhabitat preferences are calculated the same way as the zonation preferences (see above).

Column headings in the Autecological database:

hpe	Preference for microhabitat Pelal (x out of 10 points)
har	Preference for microhabitat Argyllal (x out of 10 points)
hps	Preference for microhabitat Psammal (x out of 10 points)
hak	Preference for microhabitat Akal (x out of 10 points)
hli	Preference for microhabitat Lithal (x out of 10 points)
hph	Preference for microhabitat Phytal (x out of 10 points)
hpo	Preference for microhabitat POM (x out of 10 points)
hot	Preference for other microhabitats (x out of 10 points)

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:
The metric contributes to the assessment of the following stream types:
D01 (Type Pel); D03 (Type Pel) ; D04 (Type Aka; Type Phy); D05 (Type Aka + Type Lit + Type Psa); I03 (Type Arg) ; N01 (Type Pel)

Reference:
The information on microhabitat preferences have been taken from:
(First priority): SCHMEDTJE, U. & M. COLLING 1996. Ökologische Typisierung der aquatischen Makrofauna. Informationsberichte des Bayerischen Landesamtes für Wasserwirtschaft 4/96.
(Second priority): Information sampled by the AQEM consortium.

Feeding types (percentage of community)

- **Grazer and scrapers [%]**
- **Miners [%]**
- **Xylophagous taxa [%]**
- **Shredders [%]**
- **Gatherers/Collectors [%]**
- **Active filter feeders [%]**
- **Passive filter feeders [%]**
- **Predators [%]**
- **Parasites [%]**
- **Other Feeding Types [%]**
- **no data available [%]**

Formula:
The feeding type composition is calculated the same way as the zonation preferences (see above).

Column headings in the Autecological database:

fgr	Feeding type Grazer and scrapers (x out of 10 points)
fmi	Feeding type Miners (x out of 10 points)
fxy	Feeding type Xylophagous taxa (x out of 10 points)
fsh	Feeding type Shredders (x out of 10 points)
fga	Feeding type Gatherers/Collectors (x out of 10 points)
faf	Feeding type Active filter feeders (x out of 10 points)
fpf	Feeding type Passive filter feeders (x out of 10 points)
fpr	Feeding type Predators (x out of 10 points)
fpa	Feeding type Parasites (x out of 10 points)
fot	Other Feeding Types (x out of 10 points)

Criteria of the Water Framework Directive met:

taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
A01 ([%] Shredders; scored taxa only); A04 ([%] Gatherers/Collectors; scored taxa only); D01 ([%] Gatherers/Collectors); D03 ([%] Gatherers/Collectors); D05 ([%] xylophagous taxa + [%] shredder + [%] active filter feeders + [%] passive filter feeders); H02 ([%] Predators); H03 ([%] Parasites); I03 ([%] filter feeders); N02 ([%] passive filter feeders); S02 ([%] Grazers and scrapers); I02 ([%] Grazers)

Reference:
The information on feeding types have been taken from:
(First priority): MOOG, O. (Ed.) 1995. Fauna Aquatica Austriaca – a comprehensive species inventory of Austrian aquatic organisms with ecological data. First edition, Wasserwirtschaftskataster, Bundesministerium für Land- und Forstwirtschaft, Wien.
(Second priority): SCHMEDTJE, U. & M. COLLING 1996. Ökologische Typisierung der aquatischen Makrofauna. Informationsberichte des Bayerischen Landesamtes für Wasserwirtschaft 4/96.
(Third priority): Information sampled by the AQEM consortium.

RETI (Rhithron Feeding Type Index)

Formula:
The RETI is calculated as:

$$RETI = \frac{\sum n_{gs} + \sum n_{xy} + \sum n_{sh}}{\sum n_{gs} + \sum n_{xy} + \sum n_{sh} + \sum n_{mi} + \sum n_{gc} + \sum n_{af} + \sum n_{pf} + \sum n_{ot}}$$

n_a: individuals of the feeding type a:
- gs: grazers and scrapers
- xy: xylophagous taxa
- sh: shredders
- mi: miners
- gc: gatherers/collectors
- af: active filter
- pf: passive filter
- ot: other feeding types

Criteria of the Water Framework Directive met:

taxonomic	abundance	ratio sensitive/insensitive taxa	diversity

Most suited for assessing the impact of:

organic pollution	degradation in stream morphology	acidification	general degradation	others

Further comments:

The metric contributes to the assessment of the following stream types:
A03; C01

Reference:

SCHWEDER, H 1992. Neue indices für die Bewertung des ökologischen Zustandes von Fließgewässern, abgeleitet aus der Makroinvertebraten-Ernährungstypologie. Limnologie Aktuell 3, 353-377.

Locomotion type (percentage of community) • **Swimming/skating [%]** • **Swimming/diving [%]** • **Burrowing/boring [%]** • **Sprawling/walking [%]** • **(Semi)sessil [%]** • **Others (e.g. climbing) [%]** • **no data available [%]**				
Formula: The share of certain locomotion types is calculated the same way as the zonation preferences (see above).				
Column headings in the Autecological database:				
lss	Locomotion type: swimming/scating (x out of 10 points)			
lsd	Locomotion type: swimming/diving (x out of 10 points)			
lbb	Locomotion type: burrowing/boring (x out of 10 points)			
lsw	Locomotion type: sprawling/waking (x out of 10 points)			
lse	Locomotion type: (semi)sessil (x out of 10 points)			
lot	Locomotion type: other (x out of 10 points)			
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: I03 ([%] Burrowing/boring); (S01 ([%] swimming/diving)				
Reference: The information on feeding types have been taken from: (First priority): SCHMEDTJE, U. & M. COLLING 1996. Ökologische Typisierung der aquatischen Makrofauna. Informationsberichte des Bayerischen Landesamtes für Wasserwirtschaft 4/96. (Second priority): Information sampled by the AQEM consortium.				

Taxonomic group (percentage of community)				
Formula: Percentage of individuals of certain taxonomic groups.				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensitive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: A01; A02; A03; A04; D01; D03; I02; I03; I04; N02				

Taxonomic group (number of taxa)				
Formula: Counts the number of taxa in the individual taxonomic groups.				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: A01; C02; D05; I02; I03; I04				

Number of EPT taxa				
Formula: Counts the number of Ephemeroptera, Plecoptera and Trichoptera taxa.				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: A02; A03; A04; C03; H01; H02; S01; S02; S03; S04				

Taxonomic group (abundance)				
$A = \sum_i n_i$ n_i number of individuals of the i^{th} taxon				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: None				

Number of Families				
Formula: Counts the number of families				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: A01				

<table>
<tr><th colspan="5">Number of Genera</th></tr>
<tr><td colspan="5">Formula:
Counts the number of genera</td></tr>
<tr><td colspan="5">Criteria of the Water Framework Directive met:</td></tr>
<tr><td>taxonomic composition</td><td>abundance</td><td>ratio sensitive/insensitive taxa</td><td colspan="2">diversity</td></tr>
<tr><td colspan="5">Most suited for assessing the impact of:</td></tr>
<tr><td>organic pollution</td><td>degradation in stream morphology</td><td>acidification</td><td>general degradation</td><td>others</td></tr>
<tr><td colspan="5">Further comments:</td></tr>
<tr><td colspan="5">The metric contributes to the assessment of the following stream types:
None</td></tr>
</table>

<table>
<tr><th colspan="5">TROPHIC_Sel_Grazers</th></tr>
<tr><td colspan="5">Formula:
sum of abundance of Rhithrogena + Epeorus + Centroptilum + Goeridae + Hydraenidae + Elmidae + Ancylus</td></tr>
<tr><td colspan="5">Criteria of the Water Framework Directive met:</td></tr>
<tr><td>taxonomic composition</td><td>abundance</td><td>ratio sensitive/insensitive taxa</td><td colspan="2">diversity</td></tr>
<tr><td colspan="5">Most suited for assessing the impact of:</td></tr>
<tr><td>organic pollution</td><td>degradation in stream morphology</td><td>acidification</td><td>general degradation</td><td>others</td></tr>
<tr><td colspan="5">Further comments:</td></tr>
<tr><td colspan="5">The metric contributes to the assessment of the following stream types:
I02</td></tr>
</table>

<table>
<tr><th colspan="5">Abundance of Sel_Ephemeroptera_GS</th></tr>
<tr><td colspan="5">Formula:
sum of abundance of Rhithrogena + Ecdyonurus gr. venosus + Ephemera</td></tr>
<tr><td colspan="5">Criteria of the Water Framework Directive met:</td></tr>
<tr><td>taxonomic composition</td><td>abundance</td><td>ratio sensitive/insensitive taxa</td><td colspan="2">diversity</td></tr>
<tr><td colspan="5">Most suited for assessing the impact of:</td></tr>
<tr><td>organic pollution</td><td>degradation in stream morphology</td><td>acidification</td><td>general degradation</td><td>habitat quality</td></tr>
<tr><td colspan="5">Further comments:</td></tr>
<tr><td colspan="5">The metric contributes to the assessment of the following stream types:
I02</td></tr>
</table>

<table>
<tr><th colspan="5">Sel_Trichoptera_GS</th></tr>
<tr><td colspan="5">Formula:
sum of abundance of Brachycentridae + Goeridae + Sericostomatidae + Odontoceridae</td></tr>
<tr><td colspan="5">Criteria of the Water Framework Directive met:</td></tr>
<tr><td>taxonomic composition</td><td>abundance</td><td>ratio sensitive/insensitive taxa</td><td colspan="2">diversity</td></tr>
<tr><td colspan="5">Most suited for assessing the impact of:</td></tr>
<tr><td>organic pollution</td><td>degradation in stream morphology</td><td>acidification</td><td>general degradation</td><td>others</td></tr>
<tr><td colspan="5">Further comments:</td></tr>
<tr><td colspan="5">The metric contributes to the assessment of the following stream types:
I02</td></tr>
</table>

DIPTERA_Good_G				
Formula: sum of abundance of Dixidae + Empididae + Stratiomyidae + Dolichopodidae + Athericidae				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	habitat quality and number
Further comments:				
The metric contributes to the assessment of the following stream types: I02				

DIPTERA_Bad_SIPH_G				
Formula: sum of abundance of Syrphidae + Culicidae + Ceratopogonidae + *Siphlonurus** (*EXCLUDE *Siphlonu-rus* from calculation, if 2 other score_5 OU (see MAS application) are present)				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments: Only tested in rivers with good water quality.				
The metric contributes to the assessment of the following stream types: I02				

[%] Argyllal preferences				
Formula: [%] Type Arg / ([%] Type Phy + [%] Type Pel)				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	habitat quality
Further comments: Only tested in rivers with good water quality.				
The metric contributes to the assessment of the following stream types: I03				

[%] Filter feeders				
Formula: abundance of Active filter feeders / (Grazer_scrapers+Shredders+Gatherers_Collectors+Passive filter feeders)				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	habitat quality
Further comments: Only tested in rivers with good water quality.				
The metric contributes to the assessment of the following stream types: I03				

[%] Borrowing locomotion types				
Formula: abundance of Burrowing_boring / (Semi)sessil				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	habitat quality and number
Further comments: Only tested in rivers with good water quality.				
The metric contributes to the assessment of the following stream types: None				

Abundance of Sel_Ephemeroptera_M				
Formula: sum of abundance of *Baetis rhodani* +*Ecdyonurus* +*Habrophlebia* +*Torleya* +*Caenis beskidensis_belfiorei* + *Caenis beskidensis* + *Caenis belfiorei*				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	habitat quality and number
Further comments: Only tested in rivers with good water quality.				
The metric contributes to the assessment of the following stream types: I03				

Abundance of Sel_Plecoptera_M				
Formula: sum of abundance of *Amphinemura* +*Protonemura* +*Nemoura* +*Leuctra* +*Perla*				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments: Only tested in rivers with good water quality.				
The metric contributes to the assessment of the following stream types: I03				

Abundance of Sel_nonEPtaxa_M				
Formula: Sum of abundance of *Ancylus* +Lumbriculidae +*Micronecta* +GyrinidaeAd +Limnephilidae +Odontoceridae				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	habitat quality and number
Further comments: Only tested in rivers with good water quality.				
The metric contributes to the assessment of the following stream types: I03				

Abundance of all taxa / abundance of Diptera taxa				
Formula: Sum of abundance of (Ephemeroptera +Odonata +Plecoptera +Heteroptera +Trichoptera) / abundance of Diptera				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments: Only tested in rivers with good water quality.				
The metric contributes to the assessment of the following stream types: I03				

Abundance of Sel_Ephemeroptera_GN				
Formula: sum of abundance of *Procloeon* + *Centroptilum* + *Ecdyonurus* + *Paraleptophlebia* + *Ephemera* + *Rhithrogena*				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	others
Further comments:				
The metric contributes to the assessment of the following stream types: I04				

Abundance of Sel_Trichoptera_GN				
Formula: sum of abundance of Odontoceridae + Limnephilidae + Polycentropodidae				
Criteria of the Water Framework Directive met:				
taxonomic composition	abundance	ratio sensi-tive/insensitive taxa	diversity	
Most suited for assessing the impact of:				
organic pollution	degradation in stream morphology	acidification	general degradation	habitat quality
Further comments:				
The metric contributes to the assessment of the following stream types: I04				