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Water quality — Biological classification of rivers —

Part 1: Guidance on the interpretation of biological quality data from surveys of benthic macroinvertebrates

Qualité de l'eau — Classification biologique des rivières —

Partie 1: Lignes directrices pour l'interprétation des données relatives à la qualité biologique à partir d'études des macro-invertébrés benthiques

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 8689 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 8689-1 was prepared by Technical Committee ISO/TC 147, *Water quality*, Subcommittee SC 5, *Biological methods*.

ISO 8689 consists of the following parts, under the general title *Water quality — Biological classification of rivers*:

— *Part 1: Guidance on the interpretation of biological quality data from surveys of benthic macroinvertebrates*

— *Part 2: Guidance on the presentation of biological quality data from surveys of benthic macroinvertebrates*

Annex A of this part of ISO 8689 is for information only.

Introduction

Many countries use benthic macroinvertebrates in surveillance and monitoring programmes to produce biological classifications of running waters that evaluate a variety of man-made stresses [1,2,3,4,5,6,7]. The list of benthic macroinvertebrate taxa found during a survey is normally used to calculate a biological index or score which is related to a particular stress [2,3,4,5,6,7]. A classification can be produced by comparison between a reference community, which represents unstressed conditions, and the observed community [6,8]. This type of classification takes into account the natural variability of biological communities.

As yet there is no single classification or index scheme that covers all geographical regions [1,2,3,5]. For rivers which cross national boundaries there is especially a need to have classifications which are the same or are at least comparable [9,10]. A comparison exercise allows conversion to be made between the differing classification schemes, without the need to sample and analyse data using the different methods each time a comparison is required.

According to the precise use to which this part of ISO 8689 is to be put, it is essential for specifiers and users mutually to agree any necessary variation or optional procedural details prior to use.

Water quality — Biological classification of rivers —

Part 1:
Guidance on the interpretation of biological quality data from surveys of benthic macroinvertebrates

1 Scope

This part of ISO 8689 gives guidance on the interpretation of biological quality data relating to running waters from surveys of benthic macroinvertebrates. It is recognized that for a complete assessment of ecological status, other elements of biological quality should be assessed.

NOTE Annex A gives guidance on how the comparison of the various classification systems can be made where classifications of the biological quality of running waters using benthic macroinvertebrates already exist.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8689. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 8689 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 5667-3, *Water quality — Sampling — Part 3: Guidance on the preservation and handling of samples*.

ISO 7828, *Water quality — Methods of biological sampling — Guidance on handnet sampling of aquatic benthic macro-invertebrates*.

ISO 8265, *Water quality — Design and use of quantitative samplers for benthic macro-invertebrates on stony substrata in shallow freshwaters*.

ISO 9391, *Water quality — Sampling in deep waters for macro-invertebrates — Guidance on the use of colonization, qualitative and quantitative samplers*.

3 Terms and definitions

For the purposes of this part of ISO 8689, the terms and definitions given in ISO 5667, ISO 7828, ISO 8265 and ISO 9391 and the following apply.

3.1
watercourse
body of surface water that has running water perennially or at some time during the annual hydrologic cycle

3.2
expected natural community
community present at a site when only natural stress (e.g. flooding) occurs and man-made stress is absent or not sufficient to alter the natural community significantly

4 Classification

4.1 Introduction

To evaluate stress using data from surveys of benthic macroinvertebrate communities in running waters, the data from the site (the observed data) should be compared with a set of reference data. The reference data represent the expected natural community that would be found at the site, when only natural stresses are present and man-made stresses are absent or considered to be insignificant. A classification of sites is based on the disparity between observed data and reference data.

4.2 Observed data

The observed data set should be based on collections of macroinvertebrates using standard sampling methods as described in ISO 7828, ISO 8265 and ISO 9391.

4.3 Reference data

It is recommended that reference data be collated in one or a combination of the following ways.

a) Where historical records exist for the site in its natural condition these should be used (e.g. AMOEBA [11] system).

b) Where similar unstressed sites have been surveyed, the data from these should be used to predict the community for the sites under investigation. The prediction system can be a simple direct comparison with unstressed sites in the same catchment or a comparable region. More complex predictions can be based on national databases of sites where man-made stress is absent or considered to be insignificant and associated computer programmes (e.g. River Invertebrate Prediction and Classification System [12,13]).

c) Where a procedure has been devised and validated that calculates an index value relevant to the level of stress and this already takes into account a reference data set or the concept of reference conditions this should be used (e.g. Indice biologique global normalisé [14], Saprobien [15], Leitbild [6], Peeters *et al.* [16]).

Reference conditions may not be suitable as a management objective, in which case they are to be used in the classification for comparison purposes only.

4.4 Indices/scores

To measure the level of a particular stress, a biological index or score specifically designed to evaluate the stress should be used [17]. The most widely evaluated stress, using the benthic macroinvertebrate community, has been organic pollution and many scores and indices have been devised to evaluate this stress [2,3,5,18]. In many countries there is increasing use of macroinvertebrate based indices to evaluate other stresses e.g. current velocity, substratum alterations and eutrophication [16].

When a national index or score for a particular stress does not already exist, it is recommended that one be devised using the following method: a group of national experts gives each taxon a value reflecting its tolerance to the stress [12,13]; the value may also take into account the abundance of the taxon and its suitability as an indicator [6,15] (see Notes below). The site index is then derived using the tolerance for the taxa found at the site and can be expressed as a total score or as an average score per taxon [6,11,12,13,14,15]. It is recommended that in the first instance family level identification be used; if more discrimination is required, higher resolution at genus or species level is necessary.

NOTE 1 It is possible to directly compare the taxonomic lists of the observed data and the reference data, using Community Comparison Indices [19]. If there is no significant difference in the two sets of data, no man-made stress is indicated. Disparities in the two sets of data can indicate that stress is occurring. The types of stress can be investigated using specific indices (e.g. organic pollution index, acidity index etc.). Knowledge of the ecological requirements of the taxa missing may also indicate possible stressors. The number of taxa missing can indicate the severity of a stress.

NOTE 2 Moog [7] and Walley and Hawkes [20] have shown that when sufficient biological and environmental data are available tolerance values can be derived objectively. Peeters and Gardeniers [21] have shown that habitat requirements for macroinvertebrates can be derived from large databases with the help of logistic regression procedures.

4.5 Classification/banding

A classification should be produced by comparing the observed data with the reference data. When an index is used, separate indices or scores for the observed data and reference data should be calculated. The disparity between the observed and the reference indices or scores should then be calculated. The classification system should be based on the disparity between the observed and reference; this disparity is considered to represent the degree of stress and can be expressed as the ratio of the observed to reference.

Where a suitable national classification does not exist, it is recommended that a classification be produced with five bands which indicate increasing degrees of stress as shown in Table 1.

Table 1 — Five-band classification for benthic macroinvertebrate quality

Benthic macroinvertebrate quality classifications	Comments
High	The observed community corresponds totally or nearly totally to conditions where man-made stress is absent or considered insignificant (undisturbed)
Good	There are slight changes in the observed community compared with the reference community.
Moderate	The composition of the observed community differs moderately from the reference community. Major taxonomic groups of the reference community are absent.
Poor	The composition of the observed community differs significantly from the reference community. Many of the taxonomic groups of the reference community are absent.
Bad	The observed community is severely impaired compared with the reference community. Only taxonomic groups capable of living in extremely disturbed conditions are present.

A record should be made of those sites where no macroinvertebrates were found, for example due to extreme toxicity.

The top band of the classification, "high benthic macroinvertebrate biological quality", indicates the condition of a site when the significant natural and man-made stresses are absent or considered to be insignificant. The remaining classes are considered to indicate increasing levels of man-made stress. The top band should be wide enough to accommodate the natural variability of communities. Estimates of naturally occurring variability should be made by observation of reference sites and/or by predictive techniques. The remaining range of the classification should be divided into four parts indicating increasing man-made stress.

NOTE Where the natural variability results in a top band that is a large part of the range of the classification the subdivision into the remaining bands is not justified, as this subdivision is not considered to reflect man-made stress.

Annex A
(informative)

Methodology for comparison of classifications

A.1 General considerations

A comparison exercise allows the conversion to be made between classifications without the need for sampling and analysis of the data from each classification each time a comparison is required. Comparison should be made between indices and/or scores rather than classifications. The comparison of indices/scores is only valid where the data have been validated at sufficient sampling sites. If a relationship between indices is established using regression techniques[22] inter-conversion of classifications is possible.

NOTE Indices may work in the same way but existing classifications may have been produced using different philosophies. The different ways of defining bands may introduce anomalies if classifications are compared at the band level rather than the index level. Similarly problems in comparison may arise when classifications which use different reference conditions are compared.

Only indices which attempt to evaluate the same aspect of man-made stress should be compared one with another. For example, Saprobien[15], BMWP — Average Score Per Taxon (ASPT)[13] and IBGN[14] can highlight organic pollution and therefore are suitable for comparison.

Comparisons of indices should be made using data compiled over the entire range of each of the classifications under consideration and from which the classification bands have been defined. Wherever possible data from all classes/qualities, of all the systems being compared, should be used in the comparison.

When comparing more than two indices or scores it is recommended that each should be compared with a single index or score (baseline index/score): producing a matrix of all possible comparisons is not recommended. It is further recommended that the baseline score should be the one requiring the least sampling and analytical error.

Comparisons should be made by sampling each site using all sampling methods relevant to the indices being compared. It is important that samples are taken at the same time of the year and from the same type of habitats, otherwise seasonal variations or microhabitat variations will increase the degree of variation between data sets. Stratification of sampling, in time (by season) and by habitat (riffles, pools, etc.), decreases the variability and hence increases the statistical power [22].

A.2 Statistical considerations

When no difference is found for an index or score between sites (observed and expected values) or years (time series for same site), it is important to determine the probability of a type II (beta) error [22]. Simply put, is the statistical power (I-beta error) of the test great enough to find a difference if a difference exists?

Caution should be used when selecting and using many biotic indices in biomonitoring studies. Pollution-specific indicators may be very useful for detecting improvement of habitat quality, as the index or score will change when a single taxon of the family (e.g. BMWP[13]) or pH interval (e.g. acidification score[18]) is recorded as present. However, inherent in this simplified approach is the possibility for change to occur undetected (beta error). For example, if categorical score approaches are used to monitor habitat degradation, a substantial change in macroinvertebrate species biodiversity may occur before the site-specific score shifts, signalling impact[24]. Work using RIVPACS[12] and BMWP scores[13] to calculate observed to reference ratios has shown that tests of statistical significance can be made demonstrating differences between sites or at a given site over time[23].

Regarding statistical tests: care should be taken when applying parametric tests to many biotic indices. One alternative approach is to perform tests using randomization procedures that are becoming increasingly more common.

Bibliography

[1] NEWMAN P.J. *Classification of surface water quality. Review of the schemes used in EC Member States*. Heinemann, Oxford, 1988.

[2] ROSENBERG D.M. and RESH V.H. *Freshwater biomonitoring and benthic macroinvertebrates*. Chapman and Hall, London, 1993.

[3] METCALFE J.L. Biological water quality assessment of running waters based on macroinvertebrate communities: history and present status in Europe. *Environment Pollution,* **60**, pp. 101-139, 1989.

[4] BRITTAIN J.E. and SAITVEIT S.J. *The use of macroinvertebrates in watercourse monitoring*. Vann 1-84, pp. 116-122, 1984 (In Norwegian).

[5] DE PAUW N., GHETTI P.F., MANZINI P. and SPAGGIARI R. Biological assessment methods for running waters. In: *River Water Quality, Ecological Assessment and Control*, 1992.

[6] ON M 6232, *Richtlinien für die ökologische Untersuchung und Bewertung von Fließgewässern*, 2sprachige Fassung. (*Guidelines for the ecological study and assessments of waters*, bilingual edition).

[7] Bundesministerium für Land- und Forstwirtschaft, *Fauna aquatica austriaca, Katalog zur autökologischen Einstufung aquatischer Organismen Österreichs*; Moog O. (ed). Univ. für Bodenkultur, Abt. Hydrobiol., Fischereiwirtschaft und Aquakultur, 1995.

[8] Environment Agency *Assessing Water Quality — General Quality Assessment (GQA) scheme for Biology*. Environment Agency, Bristol, UK, 1997.

[9] KNOBEN R.A.E., ROOS C. and VAN OIRSCHOT M.C.M. *Biological assessment methods for watercourses*. Vol. 3, UN/ECE Task Force on Monitoring and Assessment Vol. 3, RIZA, Lelystad, 1995.

[10] UN/ECE Task Force on monitoring and assessment *Guidelines on water quality monitoring and assessment of transboundary rivers*. RIZA, Lelystad, 1996.

[11] REIJNEN R., HARMS W.B., FOPPEN R.P.B., DE VISSER R. and WOLFERT H.P. Ecological networks in river rehabilitation scenarios: A case study for the Lower Rhine, *Rhine-Econet Report* No. 58, RIZA, Lelystad, 1995.

[12] WRIGHT J.F., FURSE M.T. and ARMITAGE P.D. Use of macroinvertebrate communities to detect environmental stress in running waters. In: *Water quality and stress indicators in marine and freshwater systems: linking levels of organisation*, Sutcliffe D.W. (ed). Freshwater Biological Association, pp. 15-34, 1994.

[13] *River Water Quality: the 1980 survey and future outlook.* National Water Council, London, 1981.

[14] Agences de l'eau, Ministère de l'Environnement, Conseil Supérieur de la Pêche, *Indice biologique global normalisé (IBGN) – NF T 90-350 – Cahier technique.* Gay Environnement, 1995.

[15] DIN 38410 Teil 2, *Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung: Biologisch-ökologische Gewässeruntersuchung, Bestimmung des Saprobienindex (M2)*, 1991.

[16] PEETERS E.T.H.M., GARDENIERS J.J.P. and TOLKAMP H.H. New method to assess the ecological status of surface waters in The Netherlands. Part 1: Running waters. *Verh. Internat. Verein. Limnol.*, **25**, pp. 1914-1916, 1994.

[17] JOHNSON R.K. The indicator concept in freshwater biomonitoring. In: *Chironomids (from genes to ecosystems).* Cranston P. (ed). CSIRO, Canberra, pp. 11-26, 1995.

[18] HELLAWELL J.M. *Biological indicators of freshwater pollution and environmental management*. Elsevier, London and New York, 1988.

[19] METCALFE-SMITH J.L. Biological water-quality assessment of rivers: Use of macroinvertebrate communities. In: *The Rivers Handbook: hydrological and ecological principles* Vol. 2, Calow P. and Petts G E. (eds), Blackwell, Oxford, 1994.

[20] WALLEY W.J. and HAWKES H.A. A computer-based reappraisal of Biological Monitoring Working Party scores using data from the 1990 River Quality Survey of England and Wales. *Water Research,* **30**, pp. 2086-2094, 1996.

[21] PEETERS E.T.H.M. and GARDENIERS J.J.P. Logistic regression as a tool for defining habitat requirements of two common gammarids. *Freshwater Biology,* **39**, pp. 605-615, 1998.

[22] SOKAL R.R. and ROHLF F.J. *Biometry, the principles and practise of statistics in biological research.* 3rd edn., W.H. Freeman, New York, 1995.

[23] National Rivers Authority *Biological assessment methods: Controlling the quality of biological data.* National Rivers Authority, Bristol, UK, 1995.

[24] JOHNSON R. Personal communication.

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