BS EN 14184:2014

BSI Standards Publication

Water quality — Guidance for the surveying of aquatic macrophytes in running waters

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EH/3/5, Biological Methods.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Water quality - Guidance for the surveying of aquatic macrophytes in running waters

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Wasserbeschaffenheit - Anleitung für die Untersuchung aquatischer Makrophyten in Fließgewässern

This European Standard was approved by CEN on 11 January 2014.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (EN 14184:2014) has been prepared by Technical Committee CEN/TC 230 “Water analysis”, the secretariat of which is held by DIN.

This document supersedes EN 14184:2003.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2014, and conflicting national standards shall be withdrawn at the latest by September 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document contains the following technical changes to the previous edition:

a) this document is applicable to all kinds of running surface waters (e. g. rivers, streams, artificial canals);

b) requirements for survey planning and documentation were revised concerning the requirements of the Water Framework Directive (WFD);

c) a further example for estimator scales widely used in Europe to assess aquatic macrophyte abundance was added in Table 1;

d) informative Annex A “Principles of interlaboratory comparison for macrophyte surveys in running waters – Occurrence and abundance of macrophyte species” was added.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Macrophytes are an important component of aquatic ecosystems and can be used to facilitate the monitoring of ecological status. The requirement to use macrophytes in monitoring is inherent in numerous European directives (e. g. the Water Framework Directive (2000/60/EC), Urban Waste Water Treatment Directive (91/271/EEC), Nitrates Directive (91/676/EEC), etc.).

In addition to their important ecological role, the use of macrophytes as indicators of ecological quality in running waters is based on the fact that certain species and species groups are indicators for specific running water types and are adversely affected by anthropogenic impact.

In certain types of running water habitats the lack of macrophytes is not an effect of anthropogenic impact but a characteristic feature. For example, in geological formations like the flysch, or in the central part of deeper rivers macrophytes may be absent due to the habitat limitations imposed by geology and substrate, water depth, current flow velocity, turbidity, etc.

A wide range of sampling and survey methodologies has been developed for specific applications including conservation, drainage impact, management, ecological habitat enhancement etc. The methodology of this guidance standard is recommended specifically for the surveying of macrophytes in running freshwaters, of natural, heavily modified and artificial character, and for the purpose of monitoring ecological status. It could be used as the basis for investigative monitoring of water quality or other applications, as well.

According to the precise usage to which this European Standard is to be put, it is essential for specifiers and users to mutually agree on any necessary variations or optional procedural details prior to use.

WARNING — Working in or around water is inherently dangerous. Persons using this European Standard should be familiar with usual field and laboratory practice. This European Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This European Standard specifies a method for surveying aquatic macrophytes in running waters for the purpose of assessing ecological status, using these organisms as elements of biological quality. The information provided by this method includes the composition and abundance of the aquatic macrophyte flora.

This European Standard is applicable to all kinds of surface running water bodies, like natural brooks, streams and rivers and their heavily modified equivalents, as well as to artificial water bodies like canals or run-of-river reservoirs.

The general principles of the approach described in this European Standard may also be applied when monitoring water bodies in the fluvial corridor of a river, such as side channels and oxbows.

It is recognized that for a complete assessment of ecological status, other elements of biological quality should also be assessed.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
aquatic macrophytes
larger plants of fresh water which are easily seen with the naked eye, or which usually form colonies, including all aquatic vascular plants, bryophytes, stoneworts (Characeae) and macro-algal growths

2.2
bank
permanent side of a river or island, which is above the normal water level and only submerged during periods of high river flow

Note 1 to entry: In the context of this standard, bank species include macrophytes that overhang the channel or overgrow the water surface but are rooted in the bank.

2.3
channel
course of a river or stream

Note 1 to entry: In the context of this standard, this includes only the in-stream part, i. e. that which is under water most of the time although it may be exposed temporarily under conditions of dry-weather flow or for longer periods under certain natural (climatic, geological) conditions.

2.4
belt transect
defined band across a river or stream at right angles to the bank

Note 1 to entry: This may be virtual or physically delineated within which the aquatic vegetation is analysed (species composition, abundance, cover).

2.5
ecological status
expression of the quality of the structure and functioning of aquatic ecosystems, expressed by comparing the prevailing conditions with reference conditions

Note 1 to entry: As classified in accordance with Annex V of the EC Water Framework Directive (2000/60/EC).

2.6
helophyte
plant usually rooted under water or in the wet part of the bank with emergent shoots, typically growing in marginal or marshy areas

2.7
hydrophyte
aquatic plant that is usually rooted under water with floating or submerged leaves, or totally free floating at the water surface

2.8
reference site
length of river representing the reference conditions for a given ecological type of river

2.9
reference conditions
biological conditions reflecting a totally undisturbed state, lacking human impact, or a near-natural with only minor evidence of distortion

Note 1 to entry: Biological reference conditions may be defined using field sites or, where necessary, using expert judgement or predictive modelling techniques.

2.10
representative site
length of river reach representative of the ecological quality that characterizes that reach

2.11
river reach
sub-division of a river, or surface water body with running water, defined by physical, hydrological and chemical characteristics that distinguishes it from other parts of the river upstream and downstream

2.12
survey stretch
survey unit
SU
short length of river for which community composition and abundance of aquatic species is determined

Note 1 to entry: Abundance can be assessed by quantitative or semiquantitative methods. This approach can be used for e. g. assessment of ecological status and/or for other purposes dealing with the description of the aquatic macropyhte vegetation.

3 Principle

This European Standard describes the methodological approach for determining the ecological status of river reaches using aquatic macrophytes. The status of a river reach, or surface water body with running water, is assessed by surveying short river stretches (‘representative sites’) which are representative for the ecological conditions in this water body. Thereafter its deviation from the conditions recorded in reference sites is determined. Reference sites are located in river reaches of similar ecological type which are still in natural or near-natural conditions. If natural conditions in river reaches no longer exist, it is necessary to reconstruct these conditions upon whatever existing records, or by modelling or expert knowledge. A published approach can be applied to situations where near-natural conditions are absent [5].

The presence of aquatic macrophyte taxa in the channels of representative river lengths is recorded. Macrophyte abundance, measured in terms of the spatial extension of taxa or macrophyte beds (coverage or macrophyte biovolume, see Table 1), is assessed by different methods adapted to the scale and purpose of the study.

Numerical derivatives (‘metrics’) of the macrophyte composition and abundance in a surveyed river length can be used to identify the divergence from type-specific “natural” conditions.

Methods for the sampling of macrophytes are given in EN ISO 10870.

4 Equipment

4.1 General

4.1.1 Maps, with scales compatible with the objectives of the survey.

4.1.2 Waterproof recording sheets, indelible pens/pencils and clipboard in a clear cover.

4.1.3 Plastic bags, small specimen tubes and waterproof labels.

4.1.4 Tape measure calibrated in metres, marking stakes and mallet.

4.1.5 Hand lens, magnification at least 10 x .

4.1.6 Identification keys and field guides.

4.1.7 Wading suit.

4.1.8 Polarizing sunglasses.

4.1.9 Camera with polarizing lens.

4.1.10 Global Positioning System (GPS)-instrument (for higher accuracy: differential GPS).

4.1.11 Rake with extendable handle and/or grapnel.

4.1.12 Underwater viewing aid/aqua-scope, bucket or box with clear Perspex base.

4.1.13 White plastic trays.

4.2 Deeper waters (optional)

4.2.1 Boat and necessary safety equipment.

4.2.2 Grapnel with depth markings in metres on the rope.

4.2.3 Underwater viewing aid/aqua-scope, viewing tube, bucket or box with clear Perspex base.

4.2.4 Wet-suit, diving equipment.

5 Survey planning

5.1 General

At the beginning of a survey the geographic region (or ‘ecoregion’), the river order, the river type and the respective reference conditions characteristic for the river reach under investigation should be defined.

5.2 Timing of initial and subsequent surveys

As far as possible, macrophyte surveys should be undertaken between late spring and early autumn, usually May to late September, but dependent on local climate and geographical region, when macrophyte growth will be at the optimum.

NOTE 1 This may not necessarily be the optimum growing period for macroscopic algae. Surveying may need to be later in Northern Europe.

Preferably, field survey should follow several days of lower flow where water clarity is maximised and water depths are reasonably low, thereby enhancing visibility and the possibility to detect submersed forms of macrophytes. Information regarding the timing of vegetation cutting is essential prior to surveying, where this is known to be usual management practice.

NOTE 2 When water depths are enhanced and water clarity is reduced following periods of high flow, the observation of smaller species is difficult and the recording of abundance may be inaccurate. This will in turn reduce the reliability of the data.

Macrophyte species grow and reach sexual maturity at different times over the summer period. Therefore, surveys at sites in the same river system should be undertaken in quite close chronological succession where comparative data are required.

When trying to assess the optimum development period of the macrophyte vegetation for the first time in unknown rivers or areas it is beneficial to survey on two separate occasions (e. g. May/June and August/September) to cover possible different vegetation development occurring during the vegetation period.

Once the optimum survey period for macrophyte assessment is known, practical experience all over Europe shows that a single survey per recording year is sufficient (running waters are not necessarily surveyed every year).

Comparative surveys in subsequent years shall be performed at the same period of vegetation development as the original survey. This will ensure that changes resulting from different seasonal development patterns are minimised. But knowledge on inter-annual natural changes in species number and abundance and in the dominance pattern in survey sites should be known to avoid misinterpretation regarding aspects of water quality and ecological status.

5.3 Survey protocols

There are many different survey protocols in use throughout Europe, therefore only general guidelines are given in this document. Macrophyte surveys can be undertaken at different levels of sophistication. In addition to the surveying of sites exhibiting reference conditions this can involve the surveying of the following.

— Approach 1: short lengths of river which are representative for a river stretch of water body. This requires relatively little time and is recommended for the routine survey of aquatic macrophytes, e. g. within the process of assessing the ecological status under Water Framework Directive rules. When only the short reach of a representative site needs to be described, it still can be used for spatial and temporal monitoring.

— Approach 2: longer river lengths in the process of defining the best location of representative sites; when defining representative sites a longer stretch of a river should be surveyed first using the second approach thereafter to prove “evenness” within this stretch of physical and biological variables.

— Approach 3: complete river length surveys to produce inventories of whole rivers. To fulfil more specialized needs. For example, as part of the procedure to provide statistical data for the numerical differentiation of reference sites in different ecological river types. It is a labour-intensive approach not to be applied for routine surveys. It is used in special cases, e. g. single-river long-term monitoring and for

detailed background information for ecological classification or monitoring of longer river reaches composed of several water bodies which are failing to meet a good ecological status.

The survey protocol may vary between these different approaches depending on the purpose of the survey, e. g. less intensive data collection during preliminary surveys designed to locate reference sites (high ecological status) or working at representative sites, which are indicative for the ecological status of certain river stretches or water bodies.

5.4 Selection of reference sites

Ecological reference conditions for each type of river need to be established before the ecological status of representative sites can be assessed. This can be achieved either by the surveying of still existing reference sites or, where such suitable river reaches cannot be found, by modelling or expert opinion. Reference sites should be as close as possible to natural conditions with respect to their species composition and the abundance of each species, physical and chemical variables and hydromorphological features. Usually the location of reference sites can be selected from regional or national surveys with data on species composition, distribution, and diversity of the aquatic vegetation. Appropriate statistical methods can be used to differentiate numerically reference sites in different river reaches or water bodies following the natural continuum from the source to the mouth of a running water system. The length of river surveyed for the reference sites should be of sufficient length to adequately reflect the diversity of plant species characteristic of this river type.

The length of the surveyed stretch shall be adapted to river size and character. In running waters with narrow width and low water depth the whole bottom can serve as macrophyte habitat. In such cases survey length of 50 m to 100 m are used most frequently. If necessary, longer stretches may be needed, especially if macrophytes occur in a scattered pattern, to detect all species characteristic for this stretch. It is recommended to locate more than one survey unit (of e. g. 50 m) within such longer river stretch. In larger and deeper streams and rivers macrophytes only develop near the banks, and both near-bank parts shall be surveyed, if physically possible (e. g. rock faces on one river side may prohibit access). Deep and large rivers require much longer survey stretches to detect the characteristic species composition.

NOTE 1 In the Joint Danube Surveys of the International Commission for the Protection of the Danube River (ICPDR) an utmost minimum of 6 km (3 per river side) was found to be the shortest representative length for macrophyte survey in the navigable Danube course (single contiguous river kilometre surveys over the full length of the Danube served as background data for distinguishing this minimum length).

NOTE 2 When determining the adequate length of stretch to be surveyed some sources recommend the use of cumulative species curves. Yet, these are based on ‘homogenous’ habitats. These are rather found in smaller running waters, but macrophyte pattern turns more scattered in larger streams and rivers. In such cases placing several shorter survey stretches in contiguous order within the survey stretch has shown adequate results to cover species diversity.

NOTE 3 Regarding the assessment of reference conditions in absence of such river reaches in present anthropogenic landscapes a different approach is described by Birk et al.[5].

5.5 Selection of river reaches

Select the river reaches or water bodies to be surveyed. The selection should be dictated by factors including the objectives of the survey, degree of confidence required from the data, resources and expertise available etc. These decisions should be made before the initiation of fieldwork.

Ensure that sufficient reaches of river are surveyed to enable the changes in the macrophyte assemblage due to anthropogenic factors to be distinguished from changes due to natural factors, such as differences in geology, slope or stream order, or changes in land use.

EXAMPLE To monitor specifically the impact of a point discharge, the surveyed length should be as close upstream as practicable and yet in terms of geomorphological conditions as comparable as possible. The downstream location should be below the predicted effluent river-water mixing zone within the river or stream. The area of the mixing zone can be located by dye tracing or similar studies. Dye tracing should be undertaken under a range of flow conditions as these will influence the extent of the mixing zone in the receiving river reach.

To assist the process of site selection, gather relevant background information on the river(s) to be surveyed. Inspecting the area on foot, examination of detailed maps, aerial photographs and investigation of any other sources of relevant information such as water quality data sets is highly recommended. Identify potential point sources of pollution such as waste water treatment plants, fish farms, centres of high population density etc. Investigate land usage within the river catchment/sub-catchment to be surveyed. Establish where changes in catchment usage and potentially water quality in terms of nutrient loadings are likely to occur. Geomorphological criteria including solid and drift geology etc should be established. Locate any physical barriers such as reservoirs, weirs, navigation channels, ditches, drains and physical obstructions that may influence channel aquatic macrophyte communities.

Detailed analysis of water quality databases can be important in this context. If not available, chemical survey should be undertaken in the same reaches at the time of macrophyte survey, but more intensive data sets are also of great value.

It is recommended to map the collected background information in order to facilitate the ready identification of suitable survey sites. Reports on quality status monitoring require georeferencing and GIS background in many cases, especially with respect to national central organisations and/or at European Union level.

5.6 Selection of representative sites

Within river reaches or water bodies select sites which are representative for this stretch of running water. The ecological status of the representative site is measured in terms of the deviation from reference conditions. The number and location of sites should allow to record a representative composition of aquatic macrophytes be, reflecting the human impact within a river reach and including exposed and shaded stretches (within the resources available).

Structures such as bridges, gauging stations, weirs, locks, artificial channels etc. can affect substrate type, flow pattern and other physical parameters. In turn these can influence aquatic macrophyte colonisation and, therefore, give rise to man-induced patterns of plant communities. Areas of river with such structures often have a higher density of macrophytes due to the lack of shading on the banks upriver and downriver of these constructions. This effect needs to be considered when assessing the ecological status of these river stretches, as under close to natural reference conditions there may be less aquatic macrophyte species and/or lower abundance.

If shaded stretches are typical for ecological types of river reaches, the sparse growth or even the total lack of aquatic vegetation shall be mapped.

Representative sites should enable the assessment of as many biological and abiotic quality elements as possible. Yet, especially for macrophytes assessment relevant conditions may not be found at exactly the same location as for e. g. fish; then a fitting situation for surveying macrophytes should be selected as close by as possible, unless macrophytes cannot be included in the general assessment of ecological status for this river reach.

Where river branches and a less natural main channel are present within the river reach being surveyed, in some cases the first will usually be closer to reference conditions than the latter. Where the main channel is regulated or used for leisure boat traffic or commercial navigation, these conditions likely have adverse impact on the macrophyte community. In this case both branches and main channel should be surveyed and ecological status shall then be assessed separately. Combining the results of the parallel water courses would obscure the real situation. The selection of only branches or side channels with conditions of quality elements much closer to the natural, fails in reflecting the human impact on the main channel, and prevents a meaningful evaluation of the overall conditions. Such surveys may be acceptable, however, if the main channel is e. g. declared as artificial water body and evaluated with respect to its corresponding ecological potential.

The actual river length surveyed, the representative site, should be of sufficient length to reflect adequately the diversity of plant species characteristic for this ecological type of river reach.

The lengths of individual survey stretches may not be the same when mathematical scaling is used for comparison. Surveyors should be aware that the number of species recorded will increase when increasing the length of river surveyed beyond certain distances, of course individual to each river and water body type. It is therefore recommended that survey lengths are about the same as for the corresponding reference sites. Ideally the same length of river should be used for sites on the same river type or at least for each stream order of a river network. When using belt transects, belts of the same width should be used.

Any numerical derivatives of field data should be scaled either to unified length (e. g. metres or kilometres) or to the full actual length of the surveyed stretches (in metres).

It is strongly recommended that the survey stretches are studied prior to the first survey in order to ensure that they meet the preceding criteria. Preliminary studies can also provide information on seasonal variation of the aquatic vegetation.

It is important to be able to locate the survey site as accurate as possible during subsequent surveys. The location can vary in subsequent surveys when natural impacts (e. g. bank scouring) alter river morphology, as long as the same general conditions apply to a shifted survey site within the same water body. Appropriate permanent landmarks should be recorded, but state-of-the-art procedures for marking survey stretches, reference and representative sites shall be geo-referenced (GPS). This facilitates easy processing in Geographic Information Systems (GIS), especially with respect to long term trend monitoring.

6 Survey procedure

6.1 Survey preparation

Prepare a data sheet for each reference site, and representative site surveyed, detailing the river name, individual site identification number, map location and any other relevant information. Where possible use a checklist of aquatic macrophyte species likely to be encountered to facilitate recording in the field. These checklists shall be based on national surveys, differing for each ecological type of river in the European countries.

With respect to conditions in the representative sites and reference sites, determine if a boat is required for the survey of deeper rivers. Consider alternative techniques such as the use of a grapnel, rake, underwater viewing aid, scuba diving equipment or direct observation from both river banks.

Assemble the necessary equipment.

6.2 Survey technique

Appropriate survey techniques meeting the objectives of establishing the ecological status of river reaches using the aquatic vegetation as a quality element are usually semiquantitative, descriptor scale based, with visual estimates of species composition and abundance. With respect to the efficient use of resources, this approach is especially recommended for short- and long-term monitoring of ecological status.

Surveys should take into account particular growth forms (submersed, emergent, floating leaf etc.). The growth form of the species present should be recorded irrespective of its growth form elsewhere. In the case of species that are distributed almost equally in the water and on the banks the use of the term amphiphyte can be appropriate. Absence or presence of species known to be reliable indicators of particular ecological conditions is useful additional information.

If this is a repeat of a survey undertaken in previous years, for example, part of a regular monitoring programme, ensure that the timings of the surveys are comparable. This limits seasonal variability between the surveys, which will influence subsequent temporal data comparisons.

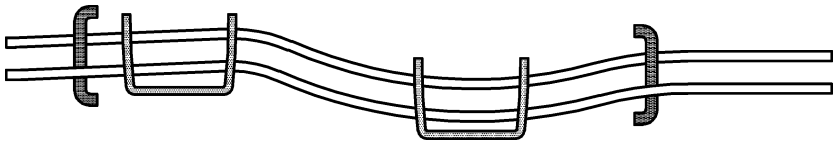
Methods suitable for monitoring regimes shall be efficient and cost effective. However, although time spent on collecting field data should be kept to a minimum, it is essential that sufficient time is allowed to record accurate, reproducible data with minimal inter-surveyor variation.

NOTE In river types where the macrophyte vegetation is rather sparse or shows scattered distribution in the reach sampling sites are often located where the best development of macrophytes is found. Regarding the whole length of the reach this may result in over-estimating the abundance of the aquatic vegetation.

6.3 Field survey

The aquatic vegetation of a river reach or water body can be assessed as follows:

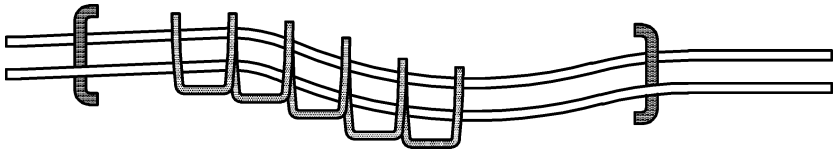
— by using several discrete survey stretches located wherever feasible within its limits (see Figure 1);



NOTE 1 In river types where the macrophyte vegetation is rather sparse or shows scattered distribution sampling sites are often located where the best development of macrophytes is found. Regarding the whole length of the reach this may result in over-estimating the abundance of the aquatic vegetation.

Figure 1 — Discrete survey stretches

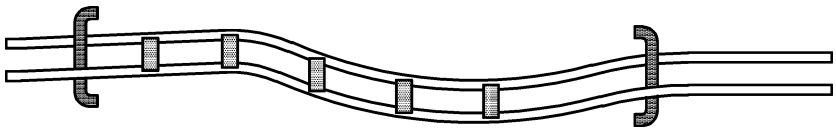
— by assessing a contiguous set of survey stretches throughout its whole length (see Figure 2);



NOTE 2 This arrangement of sampling sites covers a longer stretch of the reach in a contiguous way which avoids sparing river length where the aquatic vegetation is less dense or more scattered. This results in a more realistic description of macrophyte distribution in some river types (e. g. upper and middle reaches, and especially large rivers).

Figure 2 — Contiguous set of survey stretches

— by belt transects located within the reach (see Figure 3).



NOTE 3 This arrangement requires careful selection of the location of belt transects, otherwise effects equal to those described in Note 1 may influence the result.

Figure 3 — Belt transects

Individual discrete survey stretches and/or belt transects may be located within a river reach or water body, to prove representativeness of species composition and abundance for the full length of the reach. Contiguous survey stretches fulfil these conditions a priori, since they cover a considerable length of the reach, but in most cases only selected sites of limited length are used for assessing ecological status.

Upstream and downstream limits of the survey stretches, or the location of a belt transect shall be determined with a GPS instrument and recorded on the data sheet. If belt transects are used, physical features such as bridges, weirs, etc. should be absent from the section of river covered by the belt.

Record the date of the survey, the name or initials of the surveyor and any other relevant information that will assist the execution of future surveys.

Record any observations relevant to the survey stretch, such as river width (use range finder), depth, water turbidity, dominant sediment type, flow characteristics, bank structure, shading, surrounding land use etc. Where appropriate, contemporary sampling of water and sediments may be undertaken for subsequent chemical analysis, using CEN or ISO standards where these are available.

In shallow sites wade in a zigzag manner across the channel in order to observe the macrophyte species present. Wading upstream prevents suspended sediments to interfere with macrophyte observation and identification. Where it is not safe to wade (e. g. due to fast currents or the nature of the substratum) observations can be made from the bank instead when streams or rivers are narrow.

NOTE 4 A variety of national provisions exists in Europe for assessing different parameters and features of habitat in and adjacent to running waters. Surveyors need to respect these regulations relevant for their object of survey.

Record all macrophyte species present in the channel within the survey stretch on the survey data sheet using an indelible pen. Collect samples of plant for later verification for especially *Bryophyta*, algae, *Ranunculus* species, *Callitriche* species, narrow leaved *Potamogeton* species, *Characeae* (Stoneworts) and any other species that cannot be instantly identified. Samples should be kept in voucher collections. Where necessary, specimens should be retained in national collections following verification of species which are rare or difficult to identify.

Where species are identified that are not present on the checklist, record these in an appropriate section of the recording sheet.

Bank species can be recorded separately for biotope or conservation purposes, but the data should be recorded independently of the channel species. The demarcation of the upper limit of the bank area is often unclear. Banks may be low or rather high, and delineating the extent of assessed area when wading in a river or working from a boat is often imprecise with respect to the extent of the real bank ‘ecotone’ and the adjacent terrestrial environment.

Where a boat is used, adopt the same strategy for observation and recording as for wading a shallow reach. In large rivers appropriate use of an engine driven boat and respecting legal requirements is necessary.

For belt transect evaluation, demarcate a strip of known width (e. g. 1 m) across the river. Since repetitive monitoring requires assessment of the aquatic vegetation at the same location, aside from visual reference to fixed points on both banks and/or physical delineation using marker posts locating the position by GPS is the regular procedure.

In shallow and slow flowing water bodies wade along the downstream edge of the belt transect and identify all macrophyte species within the demarcated area. At the same time or in a second run estimate the abundance of each species within the belt transect. Repeat the process for several other transects until a representative species list and abundance values have been produced for the river reach or water body.

When effects like flood or ice scouring prevent determining a highly exact position of a survey site or belt transect in subsequent surveys then the new survey site shall be located as close as possible to the location of former sites.

6.4 Recording and quantification scales for macrophytes

Either area/coverage/frequency or the three-dimensional development (synonym: infested volume, plant amount) of a species can be estimated for each survey stretch.

When using a descriptor scale or percentage-classes to record estimates of species-related parameters such as abundance, scales with about 5 levels are the most widely used, allowing adequate reproducibility and to discrimination between different macrophyte assemblages. Scales with a greater number of levels may appear to be more accurate but may be less reproducible under certain circumstances (e. g. long and wide survey stretches fitting large rivers). In any case intensive training of survey personnel is needed to accomplish reliable results.

Quality assurance measures are useful to organize comparisons between

a) individual surveyors or

b) laboratories (inter-laboratory comparison, see also Annex A).

Table 1 — Three examples of estimator scales widely used in Europe for assessing aquatic macrophyte abundance

Example A **Abundance**[a]		**Example B** **Percentage cover**[b]		**Example C** **Percentage cover**[c]	
Scale	Class	Scale	Class	Scale	Class
1	Very rare/ max. 5 individuals	1	< 0,1	1	0 to 10
2	Rare	2	0,1 to 1	2	10 to 20
3	Frequent	3	1 to 2,5	3	20 to 30
4	Abundant	4	2,5 to 5	4	30 to 40
5	Very abundant	5	5 to 10	5	40 to 50
		6	10 to 25	6	50 to 60
		7	25 to 50	7	60 to 70
		8	50 to 75	8	70 to 80
		9	> 75	9	80 to 90
				10	90 to 100

All estimator scales produce data in 'classes' (in contrast to e. g. biomass assessment of weight per area, which produces decimal data). Data of such 'categorical' character do not allow the use of the arithmetic mean in further calculation, e. g. statistical comparison. Rather, the median (the value in the centre of the data series) or in special cases the mode (the most frequent value) shall be used in statistical procedures.

NOTE As a general rule the more detailed estimator scales are the higher is the uncertainty of getting equal estimates from different surveyors. This applies to any method in practice at present. Intensive training of surveying personnel can reduce this quality aspect of macrophyte assessment to some extent.

[a] Abundance of Species X in relation to the total volume and length of the survey unit. Follows an exponential scale. Application: e. g. International Commission for the Protection of the Danube River[7].

[b] Percentage of channel area (survey unit) covered by Species X. Application: UK/Environment Agency Macrophyte Survey Methodology (LEAFPACS)[9].

[c] Percentage of channel area (survey unit) covered by Species X. Application: e. g. France[8].

6.5 Aquatic macrophyte identification

Suitably trained and experienced personnel is able to identify most macrophytes to species level and macroalgae to genus level in the field, using appropriate taxonomic keys and guides for specific member states when needed. Where the identity of a species cannot be established with confidence, samples should be returned to the laboratory for confirmation. Collect only so much material to allow positive identification. Transport samples in pre-labelled plastic bags or other appropriate sealed containers.

If necessary, confirmation by an independent national/regional expert should be sought particularly for difficult groups.

National and European legislation protects rare and endangered species of aquatic macrophytes. Surveyors should be fully conversant with the provisions of such legislation and the identification of these species.

Voucher collections should be maintained as either pressed or preserved specimens to allow quality assurance of plant identification. Photographic records of species detected in the survey stretches are recommended.

Annex A
(informative)

Principles of interlaboratory comparison for macrophyte surveys in running waters – Occurrence and abundance of macrophyte species

A.1 General

This instruction complies with EN 14996. General guidance on interlaboratory comparison studies for ecological assessment is provided in EN 16101. National regulations on quality assurance shall be respected when carrying out macrophyte surveys.

Macrophyte sampling (i.e. extraction of individual plants or small amounts of plant mass, using rakes or grapnels or other sampling instruments) shall be reduced to a minimum as to avoid longer-lasting changes in species occurrence or abundance. This is especially important for high temporal resolution sampling, e. g. successive surveys carried out in a single year.

In the following passages the term “river” comprises all running water body types.

A.2 General aspects of quality assurance in aquatic macrophyte survey

Quality assurance shall ensure an equal quality level for macrophyte survey results prepared by different surveyors, within an organization or between organisations. These activities are subsumed under Interlaboratory Comparison (IC) in the context of this standard.

IC in macrophyte surveying includes aspects like

— selection of the water bodies or survey reaches or survey sites suitable for assessment of ecological status (in practise these are often preselected by legislative regulation);

— field assessment of species and their abundance (survey methodology described in this standard);

— taxonomic correctness (respecting geographical differences as well as the possibility of synonyms and the use of different taxonomic keys);

— data processing procedures which shall respect the ‘categorical’ character of data resulting from the recording of species abundance in classes, where counting of individuals or weighing biomass is impractical.

This annex deals exclusively with the field assessment of macrophyte species and their abundance as performed for quality assurance in IC. It is not focused on e. g. determination of species with complicated taxonomic status.

A.3 Site selection

A.3.1 General

Success of any IC activity starts with selecting most suitable conditions. This refers to laboratory and instrument-based methods as well as to field methods.

Prior to starting an IC activity a suitable river reach shall be selected for the test. Properties of the site need to be selected carefully and specifically with the purpose of the IC activity in mind, to ensure equa, and strictly controlled conditions for each surveyor, or laboratory, engaged.

Not every river reach is suitable for IC activities. ‘Real life’ conditions can vary over a very large scale, but for IC sites shall be selected,

— which represent specifics of the geographic region, but

— shall conform with specific conditions needed for running the test.

Site selection and all further activities encompassed by the IC activity shall be carried out under the supervision of an independent expert, or expert panel.

A.3.2 Site parameters

A.3.2.1 Flow

Water flow, especially in deeper rivers, should not be too fast as enhanced turbulence obscures the view into the water body.

High flow velocities increase the danger of accidents in running waters. Such conditions given wading the survey site implicates enhanced accident risk.

The substrate type close to the macrophyte stands should be noted as a general environmental parameter determined by flow conditions

A.3.2.2 Depth

Deep and large rivers usually are free of aquatic macrophyte growth in their central part, and aquatic plant growth is found only in the upper littoral strip (macrophyte growth is restricted to 1,5 m depth, or less, in most large rivers).

If the river bed is narrow, the water transparency is high and depth does not exceed about 1 m, macrophyte stands can often be determined from the river bank.

If wading the river, deep areas shall be avoided unless sufficient additional safety precaution is taken.

For sampling deeper water the application of grapnels or rakes with extendable bars, and in even deeper conditions snorkelling or SCUBA equipment is needed to provide reliable results.

When performing IC in deeper and/or swift water courses a boat of appropriate size and propulsion shall be used for safety reasons. Appropriate equipment is equivalent to the listing in the former paragraph.

A.3.2.3 Width

IC sites with a focus on species detection and abundance estimation – as described here - are ideally located on narrower river reaches as the macrophyte vegetation can be easily assessed, either from the bank or by wading.

In large rivers both littoral areas shall be probed by boat. For large rivers longer experience with the possible scarceness of macrophytes in such water bodies should be a prerequisite for participants in IC. Examples like the Joint Danube Surveys carried out and published by the International Commission for the Protection of the Danube River (ICPDR) provide guidance.

A.3.2.4 Transparency

IC test sites shall be located in river reaches with clear water, ideally. When suspended solids obscure water transparency usually macrophyte growth is limited or absent. Unless low water transparency is a specific feature to which participants should be subjected, such conditions shall be avoided.

A.3.3 Survey unit number, length and demarcation

Descriptive, as well as analytical statistical analysis of the survey results should be a main aim in IC. Therefore, a reasonable number of survey units should be allowed for. In most cases, 6 to 8 survey units provide a sufficiently large data set. If possible under given conditions situating the survey units in a contiguous order within the limits of the selected river reach saves time and eases organisational effort.

Survey unit length shall be adequate with respect to the character of water bodies encountered by surveyors in their geographic region and river types. In regions with very densely vegetated rivers survey units can be shorter, for sparsely vegetated rivers units should be longer.

For IC activities, survey unit limits shall be clearly demarcated to provide all participants with clear information on where the limits of each unit are located and to have participants focus exclusively on species detection and abundance assessment.

When focusing on species detection and abundance assessment taxonomic difficulties should not distract participants from the main aim, as they should already be competent in macrophyte taxonomy. In case of participants not yet fully competent of species determination introducing them to correct species composition in another part of the water body can be beneficial. Taxonomic expertise can be examined in a different test setting, and not necessarily simultaneously (i.e. same date, time, location). Taxonomic IC activity shall encompass a much higher number and diversity of aquatic macrophyte species as usually found in a single water body or test reach. Taxonomic IC shall also provide for laboratory facilities with optical equipment (stereo and regular microscopes).

A.3.4 Aquatic vegetation characteristics suitable for IC

The number of species should not be extremely less, or extremely higher than participants would usually encounter when surveying river types in their respective geographical region.

Species composition and abundance of species should conform with regular situations, but a mix of species, even with overlapping of plant stands, and a mix of abundances, even including some very rare and some highly abundant species is preferable for sufficient differentiation of the participants' skills.

Depending on preselected conditions, bank species can either be included in, or omitted from the test. In case of including bank species in the IC exercise a clear delineation shall be found where the survey should be limited on the banks, unless confusion in this point will spoil the results. As running waters often have a narrow upper littoral, where bank species would grow, this demarcation should be easily defined. If the bank vegetation is very rich in semi-terrestrial species, this type of survey should be limited to the clearly aquatic vegetation. If semi-terrestrial vegetation is in the prime focus of a survey other survey methods may be required (e. g. transect method with frequency recording or remote sensing approaches).

A.4 Independence of participant's results

IC needs independent results, i.e. free from, even un-deliberate, interaction between participants (e. g. some are used to verbalise their abundance estimates while making notes in the protocol). Either sequential start times or alternately starting from the two ends of the stretch of survey units assists in securing independent results.

The whole field survey shall be supervised permanently by an independent expert, or expert panel.

A.5 Field protocol and time limit

A.5.1 General aspects

Field protocols shall be prepared, which have fixed positions for each survey unit, e. g. numbered poles for each of the survey unit limits pre-selected by the independent supervising expert/expert panel.

For testing species detection and recognition ability the field protocol should allow for as many macrophyte species as found by the individual participant. For IC no species list shall be provided in the protocol.

This is in contrast to field protocols widely used for regular surveys, as these often incorporate fixed species lists, in which the species occurring in each survey unit can be marked, and additional species shall be added separately.

A.5.2 Time limit for the field survey

A reasonable time limit shall be given to simulate a real-life advance in the field survey. A too extended time span can affect the detection of important differences between participants.

Based on the fastest participant's time the relation of participants finishing later can be documented. Yet, as a good measure of a justified time for survey under conditions of the selected IC site a finishing time of 50 % of the participants can be taken as a reference for "good practice".

Later statistical investigation can focus on efficiency, as a relation between time spent and results for species detection and accurateness of assessment of abundance.

A.6 Data collection for the whole group of participants

The assemblage of the data files of individual participants shall also follow quality assurance rules. It is necessary to follow the four-eye-principle when transferring data into a common database for the whole group. This can be done by two independent persons, but in many cases one independent person and the participant who has produced the data serve the same purpose (e. g. typing errors can corrected instantly)

Assembled data files shall be stored by the supervising independent expert, or expert panel, on an independent computer. Data files shall be saved on an additional independent electronic device.

A.7 Reference values for the survey

A.7.1 General

Reference values shall be worked out for

— the number, and taxonomic correctness, of the macrophyte species present in the survey units of the stretch of water body selected for the IC

— the values for species abundance in each survey unit.

A.7.2 Reference values for species number, taxonomic correctness and abundance of species

The value to which to refer when determining the correctness of survey results can be derived by a detailed survey of the IC site by an independent expert/expert panel.

In case of a group of experienced participants it may be feasible to use the median or the mode value for comparison with the data produced by the independent expert /expert panel.

A taxonomical reference should be provided by the supervising independent expert/expert panel.

In case of the second approach it can happen that only very few participants recognize e. g. a rare species. In this case the mode value, i.e. the value for that species found by the majority of participants would be zero (i. e. it was missed by the majority). This would be an incorrect reference. Therefore, the detailed survey by independent expert/expert panel shall be used as reference wherever possible.

A.8 Description of results concerning species detection

Description of results is worked out by the supervising independent expert/expert panel.

The pre-condition for passing the test requires a complete species list, covering all survey units, which can be compared with the survey results of the independent expert's /expert. Taxonomic clarity regarding genus and species names should be provided by adding the authorities, and a species name code, if available, e. g. according to Table A.1.

Table A.1 — Examples for complete genus and species names

Genus	**species**	**Authority**	**Family**	**Code**	**Remark**
Callitriche	*palustris*	L.	*Callitrichaceae*	Cal pal	
Groenlandia	*densa*	(L.) Fourr.	*Potamogetonaceae*	Gro den	

Species occurrence in the IC site (as according to reference by independent expert/expert panel) can be provided by a table with presence/absence graphically marked for each species in alphabetic order and for each survey unit. See Table A.2 for a schematic example.

Table A.2 — Schematic example for presence/absence of species in the survey units

	SU 1	SU 2	SU 3	SU 4	SU 5	SU 6
Sp a						
Sp b						
Sp c						
Sp d						
Key SU survey unit Sp species						

This type of table allows for differentiation of participant's ability of detecting individual macrophyte species in the survey units, as compared to the "full" list of species detected by the independent expert/expert panel. Survey quality is easily assessed by counting the species number detected in each survey unit, and accumulating these results (e. g. total percentage of missed species).

In case of incorrect taxonomic assessment the supervising independent expert/expert panel shall refer to the taxonomic list valid for that geographic region or locality. To avoid such confusion prior training on macrophyte taxonomy is substantial.

National regulation for detecting and describing participant's test results may differ and shall be respected where applicable.

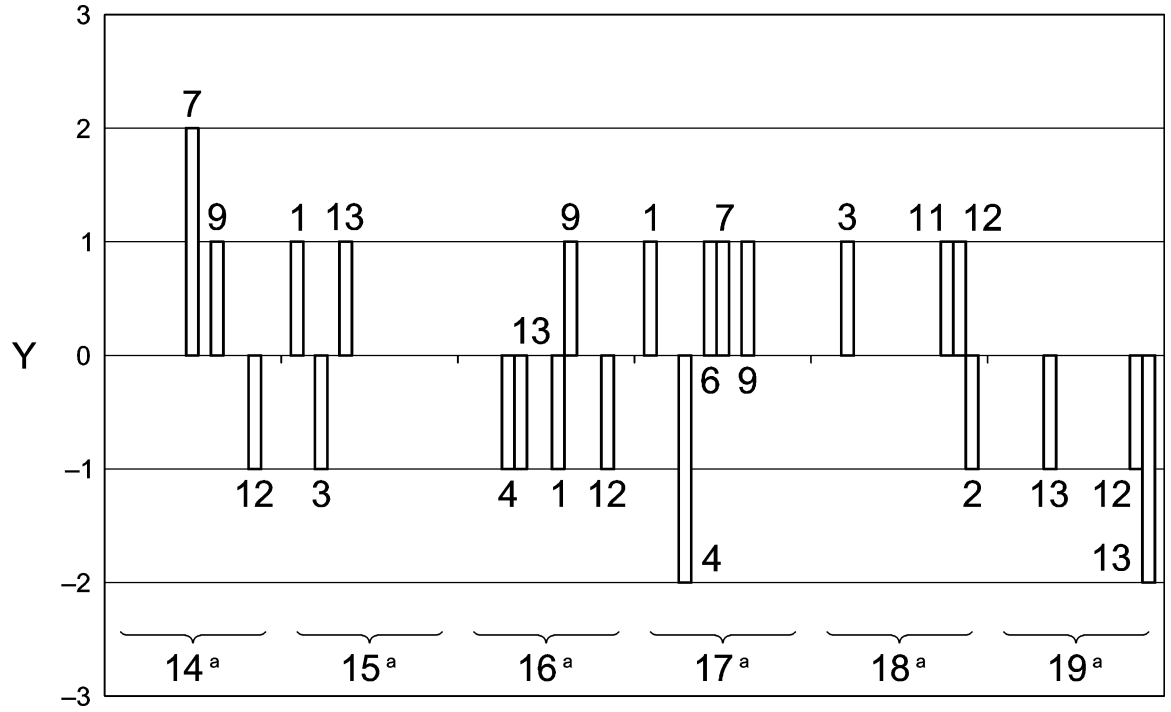
A.9 Description of results concerning species abundance

Results are worked out by the supervising independent expert/expert panel.

Participator's performance of assessing abundance is based on comparing its deviation from expert values in each survey unit and for each species. When participants are very experienced with a method the median, or the mode value, depending on data quality, of their collective data per species and survey unit can be used as an additional source of reference.

Macrophyte abundance assessment is based on estimator scales, which are responsible for the categorical character of the data. This excludes statistical methods, which are appropriate for decimal data and normal distribution only. Due that fact it is not allowed to apply e. g. the z-score to categorical data.

As different estimator scales in use across Europe contain more or fewer levels, an appropriate assessment of quality can be produced by graphics, which show the deviation, and its number of levels, for each survey unit and species, for a single participant (see Figure A.1, "0"-line = mode value).



Key

Y difference from mode value

1 species 1, Azo sp

2 species 2, But umb

3 species 3, Cer dem

4 species 4, Cyp sp

6 species 6, Myr spi

7 species 7, Naj min

8 species 8, Nym pel

9 species 9, Pot cri

10 species 10, Pot sp

11 species 11, Phr aus

12 species 12, Tra nat

13 species 13, Typ ang

14 to 19 survey units (SU)

a species with no deviation from mode value are not shown in the survey units (i.e. for species 5, Hyd mor, no deviation was found)

Figure A.1 - Example of interpreting deviation of participant results for abundance of 13 species in six survey units from mode value provided by expert panel

This type of graph allows for differentiation of participant's ability of detecting individual macrophyte species in the survey units, as compared to the 'full' list of species detected by the independent expert/expert panel. Survey quality is easily assessed by counting the species number detected in each survey unit and accumulating these results (e. g. the total percentage of missed species), and trends in under- or over-estimating are instantly detected.

In the example in Figure A.1 a participant surveyed 13 species in six survey units. The species where the mode value was missed, are indicated by the species bars. Species with abundance not deviating from the mode value are not shown. In the first survey unit, SU 14, the participant missed the mode with 3 estimates (three species bars shown). In SU 15 again, but different species show deviating estimates; and so on until SU 19 (deviating species numbers according to the bars are: 3, 3, 5, 5, 4 and 3 for the 6 survey units). The performance can be easily calculated: e. g. in 3 out of 6 [SU] * 13[species] = 78 total estimates the participant mis-estimated by two levels (= 3,8 %), which can be considered a strong deviation. 20 estimates showed a mild deviation of a single level (= 25,6 %), which can be rather considered a fluctuation around the "true" values, as remaining 70,5 % were in full accordance with the mode value (these species indicator bars do not show as they are equal in estimator value to the mode represented by the zero line). The number of over- and under-estimates is about the same (12 over, 11 under). Such results can be introduced to enhance the quality of future surveyor training, and can be used in validating the method. This is especially important for balancing the assessment performance of different working groups in the same country and with activities on different river types.

In a similar graphic way the estimating ability of participants can be shown for single species. This allows for detection of weaknesses in abundance assessment, which relate to specific species or growth forms.

Provided there are enough survey units (≥6), species (≥5), and participants (≥15) in an IC activity, confidence limits can be defined for the dispersion of abundance data, with the mode value, or the median (with respect to data quality), used as the value defining the centre of the distribution.

Participants failing to meet confidence limits or minimum levels of divergence of estimates defined by experts/expert panel shall undergo additional instruction and field training.

A.10 Reporting

Reports shall be worked out by the supervising independent expert/expert panel.

Reports shall contain, when requested by the contracting body:

— information on the performance of the whole group of participants;

— information on the performance of individual participants;

— information on e. g. species or species types with very bad detection results;

— information on e. g. species with a high dispersal of abundance values and/or a large proportion of over- or under-estimation;

— information on participants with lower performance, including an analysis of their weaknesses and a specific recommendation for additional instruction and re-training in the field.

Bibliography

[1] EN 14996, *Water quality - Guidance on assuring the quality of biological and ecological assessments in the aquatic environment*

[2] EN 15460, *Water quality - Guidance standard for the surveying of macrophytes in lakes*

[3] EN 16101, *Water quality - Guidance standard on interlaboratory comparison studies for ecological assessment*

[4] EN ISO 10870, *Water quality - Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters (ISO 10870)*

[5] BIRK A., KOUWEN L.V., WILLBY N. Harmonising the bioassessment of large rivers in the absence of near-natural reference conditions – a case study of the Danube River. *Freshw. Biol.* 2012, **57** pp. 1718–1732

[6] HOLMES N.T.H., WHITTON B.A. Macrophytes of the River Tweed. *Transactions Botanical Society Edinburgh*. 1975, **42** pp. 369–381

[7] KOHLER A., JANAUER G.A. 1995. *Zur Methodik der Untersuchung von Fließgewässern*. In: Steinberg, C.B.H., Klapper, H. (Eds.). Handbuch Angewandte Limnologie [Handbook of Applied Limnology], VIII-1.1.3. Ecomed, Landsberg /Lech. 1-22

[8] LONDO G. The decimal scale for relevés of permanent quadrats. *Vegetatio*. 1976, **33** pp. 61–64

[9] Willby, N.J., Pitt, J.A., Phillips, G. 2009. Development of a system for the classification of lakes and rivers in the UK using aquatic macrophytes. Part II. Rivers. Environment Agency Science Report

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