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Instruction Protocol for the ecological Assessment of Running Waters for Implementation of the EC Water Framework Directive: Macrophytes and Phytobenthos

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1 Preliminary remarks

The assessment procedures described in the following were developed and tested as part of a research program and are based on a limited number of sampling sites. For this purpose, organisms were assigned to different indication groups. The resulting species lists were completed by referring to literature. These species lists might be incomplete or faulty, but this can only be verified in the course of further application. **It is of high relevance that a potential adjustment of the classification is centralised and is exclusively carried out by those in charge of this project in cooperation with specialists. Ideally the project team in cooperation with the BAVARIAN ENVIRONMENT AGENCY should be consulted.**

Further information regarding this instruction protocol and how it was developed can be found in SCHAUMBURG et al. 2005.

2 Sampling and determination of the macrophyte & phytobenthos biocoenosis

Sampling is carried out once a year in summer, the main growing season of macrophytes. The ideal mapping time for each biocoenosis (usually mid June until early September) must be determined for each type of water according to the conditions in the field. The entire benthic vegetation aspect of a sampling section is investigated. Macrophyte vegetation is mapped in the field; diatoms are sampled and are stored for preparation. Phytobenthos without Diatoms is macroscopically determined and samples are taken for microscopic analysis. If an assessment procedure could not be developed for each module of a certain type of running water, for the time being, it will be assessed by using the other modules.

The exact location of the sampling site should be marked on topographical maps of the scale 1:25 000 or 1:50 000, so that later **easting** and **northing** of the sampling sites can be determined. Ideally, the coordinates can be read directly from a GPS. In this case the exact starting point and endpoint of a sampling section should be noted as precisely as possible.

The first step of sampling is the exact determination of the sampling section. For this purpose the running water is investigated from the shore. A decision which site to pick for macrophyte mapping is made based on the criteria described in chapter 2.1.2, page 4. The field report to assess structural quality is filled in. If a survey of structural quality is already at hand, this step can be omitted. Within the macrophyte mapping section an area for phytobenthos sampling is determined (chapter 2.3.1, page 14). The diatom sampling site is determined according to the criteria described in chapter 2.2.2, page 6.

In order to be able to take largely undisturbed diatom samples, sampling is carried out prior to entering the site for the purpose of macrophyte and phytobenthos mapping. Subsequently phytobenthos without diatoms is investigated and then the macrophyte vegetation. All investigations and sampling procedures have to be carried out as carefully as possible. It must be tried not to destroy other groups of organisms.

Documentation of the sampling procedure and mapping procedure is an important basis for evaluation and interpretation of the results. The field protocols presented in the instruction protocol contain all information relevant to the procedure. The reiteration of the information regarding abiotic characteristics on all field protocols serves to guarantee an unambiguous attribution of the original data collected in the field. If different specialists work on different components, the additional information regarding the sampling site is available to all. If sampling of the entire benthic flora is carried out by only one specialist, it is not necessary to note the abiotic characteristics on each sheet. A field protocol can be used that only once requires the documentation of abiotic factors (appendix C, figure 16, figure 17).

2.1 Macrophytes

2.1.1 Mapping equipment

Italics: optional

- Topographic maps of a scale 1:25 000 or 1: 50 000
- Field protocols
- Copy of the instruction protocol
- *Field protocol for mapping structural quality* (LÄNDER WORKING GROUP WATER 2000)
- *Instruction for mapping structural quality* (LÄNDER WORKING GROUP WATER 2000)
- Writing utensils
- Wading pants
- Extractable rake
- Under water viewer
- Camera and films
- Freezer bags and clips
- Cooler and cooling elements
- Envelopes or paper collecting packets for moss samples
- Determination literature (compare below)
- Magnifier
- (Portable) stereo microscope and accessories
- Herbarium press and accessories
- Safety equipment if necessary (e.g. life vest)

Determination literature (selection)

- CASPER & KRAUSCH (1980, 1981)
- KLAPP & OPITZ VON BOBERFELD (1990)
- KRAUSCH (1996)
- KRAUSE (1997)
- OBERDORFER (1994)
- ROTHMALER (1994a, 1994b)
- SCHMEIL (1993)

Special literature for moss determination (selection)

- BERTSCH (1959)
- BURCK (1947)
- DEMARET & CASTAGNE (1964)
- FRAHM & FREY (1992)
- FREY, FRAHM, FISCHER & LOBIN (1995)
- LANDWEHR (1984)
- MÜLLER (1957)
- NEBEL & PHILIPPI (2000)
- NEBEL & PHILIPPI (2001)
- NYHOLM (1986)
- NYHOLM (1993)
- PAUL, MÖNKEMEYER & SCHIFFNER (1931)
- SCHUSTER (1980)
- SMITH (1992)
- WELCH (1960)

2.1.2 Determination of the sampling section

Mapping of macrophyte vegetation is carried out in the **main growing season** (mid June until mid September) along river sections that from an ecologic point of view can be considered **homogenous**. Above all, the investigated section should be homogenous regarding **velocity of flow, shading** and **sediment conditions**. Adjacent to a sampling section there should not be drastic changes in **land use** (e.g. forest/pasture). Moreover, there must be **no inflows** (e.g. tributaries, drainages) into the sampling section of the running water system. If the **composition of macrophyte vegetation** abruptly changes, the investigated area must be reduced. For sampling sites close to **bridges or weirs** it has to be seen that mapping is carried out in upstream direction of these modifications, i.e. **outside** of the direct area of influence. The maximum length of a mapping section is approximately 100 m or longer, if necessary.

2.1.3 How to fill in the field protocol

On page 1 of the standardised **field protocol** (appendix C, figure 9) the structural characteristics at the sampling site are recorded. Fields marked in grey are optional, i.e. they only need to be filled in, if a detailed mapping procedure is carried out (see above). Apart from general information, characteristic structural parameters, e.g. mean depth, water level, mean width and optionally also turbidity are recorded. Shading of the entire section is estimated according to WÖRLEIN'S five degree scale (1992). Determination of the flow velocity is carried out according to the mapping and assessment procedure of structural quality of the BAVARIAN WATER MANAGEMENT AGENCY (1995). Unusual features regarding colouration and odour of the water can be noted verbally. The substratum conditions at the sampling site are classified in 5% steps according to an eight point scale (distribution of grain size according to SCHACHTSCHABEL et al. 1992). In addition, reinforcements of the river bank and foreign substrata are noted. If, in case of large running waters, it is impossible to investigate the entire cross section, it is noted whether the entire running water was investigated or only the area along the shore. For each sampling site at least two photographs (e.g. upstream and downstream) should be taken. In addition **unusual or striking features** at the sampling site are noted as well as the length of the mapping section.

The macrophytes occurring in the mapping section are investigated by **wading along the sampling section** and inspecting it, if possible, **in upstream direction**. To evaluate the entire width of the running water one should wade in a zigzag pattern. An **under water viewer** or a comparable viewing aid is absolutely recommended. If a river section is deep and wading is impossible using a boat is possible, but not obligatory.

Stoneworts, mosses and vascular plants are recorded, which at mean water levels grow submerged or at least are rooted under water. As far as possible, species determination is carried out on site. If necessary, samples are taken and determined later. Characeae and phanerogams are best transported in **labelled** freezer bags which contain little water and which are kept in a cooler.

Moss samples are stored in paper collecting packets, the so called "**moss capsules**" for which a DIN A4 paper is folded in the following fashion (Figure 1). The lower third of the sheet is folded upwards (1), then approx. 2 cm of the left and right side are folded inwards (2, 3) in order to seal the edges. In the end, the upper third of the sheet is folded downwards to function as a cover (4). The moss samples can be **dried** in these - ideally pencil labelled - paper packets. For later determination they can be remoistened.

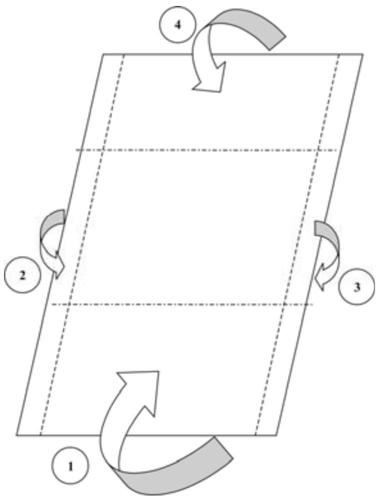

Figure 1: Folding a moss capsule

On the second page of the field protocol (appendix C, figure 10) the species and their **abundances** according to KOHLER (1978) are noted. In addition, it is noted whether plants **are submerged or emerged**. Optionally also vitality and sociability as well as details regarding the sediment of the macrophyte stand are noted and if herbarium samples were taken. If a species occurs in two growth forms, e.g. in a submerged and emerged form or on two very different substrata (e.g. stone or wood), the species is noted twice in the field report. In that case plant abundance is also noted twice. Furthermore, however, the **total abundance** of the taxon at a particular site is recorded. For general characterisation of a sampling site the dominant species growing along the shore should be briefly noted.

If a sampling section is very deep and/or very turbid, the plants are mapped by using an extractable rake (max. length = 3 m, width = 60 cm, spaces between tines approx. 2 cm). Deep and inaccessible running waters are investigated from the water's edge by wading into the river as far as possible and carefully raking the bottom. Mapping by boat with the help of divers is another option. The type of mapping procedure must be noted in the field protocol. If it is only possible to sample directly along the shore, this must also be noted in the field protocol (page 1).

The current version of the field protocol can be downloaded from the internet. (http://www.bayern.de/lfw/technik/gkd/lmn/fliessgewaesser_seen/pilot/fpmfg.pdf).

If a current assessment of structural quality is not already available, an exact morphological description of the sampling sites regarding riverbed, shoreline and surrounding area can be provided by filling in the "Field report for mapping structural quality in accordance with the recommendations of the LAWA 1998" (LÄNDER WORKING GROUP WATER 2000, appendix C, figure 11 and figure 12).

2.2 Diatoms

2.2.1 Sampling intervals

Sampling must be carried out at the end of the low water level period after hydrological conditions have been consistently stable for a while. In alpine drainage systems the most suitable time period is late winter. In the Central German Upland and the North German Lowland sampling should be carried out in August and September when generally plant communities are diverse and rich in species. Autumn and spring are not suitable sampling times in the Central German Upland and the North German Lowland as there is a maximum of biomass and plant communities are often dominated by one or a few species (e.g. *Navicula lanceolata*) in an extreme fashion making an assessment difficult or even impossible. If the ecological condition of the sampling site is temporarily altered due to cultivation of the adjacent land, an additional sampling procedure is strongly recommended.

For the running water systems of the Central German Uplands are prone to acidification, a special sampling routine must be carried out. In order to prove an acidification impact, sampling needs to be carried out 2 up to 4 weeks after thawing has set in. If the characterisation of acidification shall go beyond the assessment according to the WFD, a second sampling routine during times of low water levels is indispensable. Only then conclusions can be drawn regarding the status of acidification of the water system, i.e. whether it is acidic, periodically acidic or not acidic (see also CORING 1999).

2.2.2 Sampling methods

If there are no structural modifications within a sampling section, the natural soil substrates which are typical for the respective type of running water are sampled in representative proportions. In case of structural degradation of a sampling site, samples are taken of the available natural and/or anthropogenic substrates. Sampling is to be carried out in an area/ in depth zones consistently flooded with water in order to avoid the introduction of species adapted to periodic drying or aeric conditions. This is especially important for sampling along large streams.

Areas with an extremely strong current as well as still water areas close to the shore are to be avoided. Furthermore, strongly shaded sections of the water shall not be considered unless they are characteristic for the sampling section to be investigated. Moreover, there must be no inflows or drainage systems flowing into the sampling section. Mapping is carried out in upstream direction. The main characteristics (position, substrate, light conditions, etc.) of the investigated sampling section must be noted in a field protocol (appendix C, figure 13). For each sampling site at least two photographs (e.g. upstream and downstream) should be taken.

In running waters with a high to moderate flow velocity it is recommended to carry out sampling on hard substrata, especially on medium sized or large stones. For this purpose at least ten stones are carefully sampled in their original position. They should be evenly spaced along the entire cross section of the river and under normal hydrological conditions should not have been moved by the flow. The Aufwuchs/periphyton covering the stones' surface is scratched off with a toothbrush[1], tea spoon, spatula or similar device and is transferred into a labelled wide neck sampling container with a volume of at least 100 ml. Toothbrushes can only be used once in order to avoid potential contamination. In different types of water the percentage of colonisation with diatoms can vary considerably. In some locations the Aufwuchs cannot macroscopically be seen, but can be felt by touching the surface of the substrate. In any case a large amount should be sampled. After the sample has settled at least 5 ml of diatomaceous sediment should remain.

In order to assess different types of stress by using indices, KELLY et al. (1998) recommend the sampling of vertically exposed hard substrata, e.g. bridge piers or moorings, for slowly running waters. For investigations aiming to assess biocoenoses specific for certain types of water systems this procedure only rarely is the method of choice. The substratum naturally occurring in these water systems is to be preferred which in general consists of sand, gravel or fine sediment. In areas where wading is possible, the upper millimetres of the bottom substratum are carefully lifted off with a spoon. In areas with a higher velocity of flow this method might not work, as often the sample on the spoon is swept away by the flow. Due to a lack of experience, presently no standardised sampling procedure for such sampling sites is on hand. It still needs to be developed. In order to gain the upper levels of substratum sediment cores or sediment grabs can be useful. It should also be verified, if pipetting off the water is the method of choice. In waters of Lower Saxony shovels have turned out to be useful tools when lifting off the upper layers of sediment while standing on the shore.

The sampling of deep Low Land running waters sometimes turns out to be a problem for steep shores can make it difficult or impossible to enter the sampling site. When choosing sampling sites accessibility must be given priority, even if one has to select a less representative site.

The samples are preserved in the field or at the latest in the evening after sampling by adding formaldehyde of a final concentration of 1% to 4%. Until further processing the samples are to be kept in a storage room.

2.2.3 Sampling equipment for running waters

- Topographical maps of a scale 1:25.000 or 1:50.000
- GPS if available
- Field protocol
- Copy of the instruction protocol
- Writing utensils
- Wading pants
- Wide neck bottles or vials
- Water proof marker to label sampling containers
- Toothbrush[1], tea spoon, spatula or something similar
- Formaldehyde solution
- Camera equipment
- Safety equipment

1 *Disposable toothbrushes can be ordered via specialised dental trade, e.g. John-Dental- und Medizintechnik GmbH: Disposable toothbrush without toothpaste, Tel.: 033762/42977, E-Mail: info@john-dental.de.*

2.2.4 Preparation

2.2.4.1 Preparation equipment

Chemicals

- Acetic acid 25% p.a.
- Sulphuric acid 95-97% for analysis
- Potassium nitrate for analysis
- Formaldehyde

Additional equipment

- Hood
- Hot plate
- Safety clothing (lab coat, goggles, safety gloves, chemical proof lab gloves, if necessary)
- Beakers (100 ml or larger)
- Weighing glass with diameter corresponding to beakers
- Beaker tongs
- Magnetic stirrer
- Mortar and pistil to pulverize potassium nitrate, if necessary
- Spatula
- Small plastic sieve with diameter corresponding to diameter of beaker
- Universal indicator paper for pH determination
- Aqua dest.
- Wash bottle

2.2.4.2 Acid treatment

In order to determine diatoms to the species level, shape and structure of the siliceous valves must be focused on. Exact determination requires permanently mounted specimens. Especially species with small frustules can only safely be determined in a purified sample after removal of organic substance and other unwanted organic components. There are different procedures for preparation of the sampling material depending on the nature of the sample. A description of the most common preparation techniques is presented by KRAMMER & LANGE-BERTALOT (1986). For preparation of periphytic (Aufwuchs) substratum samples (stone, gravel, mud), which might contain a high percentage of organic material not containing diatoms, oxidation by strong acids (especially sulphuric acid) has turned out to be a useful method.

2.2.4.3 Treatment with acetic acid

If the material is from calcareous waters, the sample is initially boiled in acetic acid in order to prevent the formation of gypsum in the subsequent treatment with sulphuric acid. If the water content of the sample is high, the sample is allowed to sediment for 24 hours and then it is carefully decanted. Alternatively the sample can be heated until most of the water is evaporated. Prior to acid treatment a portion of the sampling material must be taken as a retain sample. The remaining sample is then mixed by shaking and approximately 20 ml of the sampling material are transferred into a 100 ml beaker to which 20–40 ml diluted acetic acid (25 %) are added. If the sample is strongly calcareous, prior to heating the acetic acid has to be added little by little to keep foam formation at a minimum. The sample is covered with a weighing glass and by boiling it for 30 minutes with a magnetic stirrer, the carbonates are dissolved and the protoplasm and protoplasmic threads are dissolved and frustules are separated from the substratum. If the sand content of the sample is high, it is likely that the beaker starts moving on the hotplate and that its position needs to be corrected. This can best be accomplished by using beaker tongs. When rinsing the beaker tongs in or with tap water, one must make sure not to accidentally transfer any sampling material from one sample to the next. Magnetic stirrers must also be cleaned between the different boiling routines.

After boiling the sample is allowed to cool off. If present, subsequently large remainders are sieved off with a small kitchen sieve and the beaker is filled with tap water. In order to largely remove sand, gravel or smaller stones, which might be present, the solution is vigorously stirred and allowed to sediment for a minute so that the diatom containing supernatant can be decanted. In the following, the sample is carefully decanted several times until approximately one third of the volume is left and is rinsed with tap water. A four fold washing and decanting routine has proven to be adequate. However, the sedimentation time between washings should not be less than 24 hours. Alternatively the sample can be centrifuged between washings in a table centrifuge for approximately 10 minutes at maximally 2 000 rpm and the supernatant (approximately two thirds) can be decanted or removed with a jet pump. This procedure allows a quick preparation, but is labour intensive and might cause long diatom frustules to break.

2.2.4.4 Treatment with sulphuric acid

The water content of the sample is reduced by decanting, then approximately 20 to 30 ml concentrated sulphuric acid are added and the sample is boiled. In 20 minute intervals a dash of potassium nitrate is added with a spatula until the sample loses its colour or gets a yellow tint. If the content of organic material is low, a few dashes of potassium nitrate are sufficient, but if the content is high, the boiling procedure can take up to eight hours. After changing colour, the sample needs to remain on the hot plate for another 20 minutes. After the sample has cooled off and the diatoms have settled they form a white to greyish sediment. Subsequently samples are washed until neutrality (indicator paper!) is reached. When adding water for the first time after boiling, one has to exercise extreme cautious as this can cause a strong reaction. Experience has shown that the washing routine should be carried out approximately eight times. The last washing of the sample should be carried out with distilled water. The purified sample is mixed by shaking the beaker and is transferred into a labelled vial (for labelling compare labelling of the microscope slide). The vials are to be stored in a storage room for documentation.

Carry out all boiling procedures described under an effective hood. Exercise caution and adhere to all work safety rules. Protective clothing and eye protection are mandatory.

2.2.5 Preparation of permanently mounted specimen

2.2.5.1 Materials

- Microscope slides
- Cover slip (recommended are round cover slips with18 mm diameter)
- Round tip tweezers or special tweezers to handle cover slips
- Vials (10 ml recommended)
- Naphrax[2]
- Storage system for mounted specimen
- Labels

Cover slips must be cleaned prior to adding the diatom suspension. A quick immersion into a highly concentrated solution with dishwashing detergent has proven suitable to remove fat and to reduce surface tension. Afterwards the suspension in the vial is mixed by shaking and immediately after a small amount is transferred with a clean pipette on to a cover slip. In order to reduce convection, the drop of sampling solution should be kept flat. If a suspension is highly concentrated, it often is necessary to dilute it in a weighing glass with distilled water. The degree of dilution depends on the density of valves desired for the preparation and on the presence of remaining organic components. Problems are often caused by a high content of mineralic components (loam and clay particles) which in a vial optically are impossible to differentiate from diatoms. For this reason it is useful to prepare different dilutions of the sample.

The ideal density of valves is reached, if after checking one or more complete transects under a 1000 fold magnification the required amount of 400 valves (compare below) is reached. The explanation is a partial demixing of diatom frustules caused by convection in the drop of sample solution on the cover slip. In case of strong convection flows, small frustules can be concentrated in the middle of the cover slip, whereas a high percentage of big and heavier frustules is concentrated along the edges. This phenomenon is compensated by counting complete transects.

In order to avoid contamination, one has to absolutely make sure to rinse used pipettes under running water prior to handling a new sample. After air drying the diatom sample overnight, a drop of Naphrax[2] is added to a labelled, fat free microscope slide and using tweezers the cover slip is carefully placed on top of the sample coated side facing down. In order to evaporate the solvent, the sample is heated over the small flame of a Bunsen burner until bubbles can be observed for about 5 seconds. Afterwards it is immediately placed on a vibration free, smooth surface until it has cooled off. Napharax[2] contains toluene that evaporates during heating and therefore must be handled with great care. Alternatively the evaporation of toluene can be carried out on a hot plate. Afterwards tweezers should be used to check if the cover slip strongly sticks to the microscope slide. If not, the procedure has to be repeated.

Immediately after completion of this procedure the sample can be evaluated under the light microscope and, if kept under appropriate conditions, it can be stored for decades. It is of essential importance to have a storage or archiving system and to precisely label microscope slides.

The information on the slides should contain the name of the sampling site or running water, position of the site (if available easting and northing). Furthermore, the sampled substratum, the date and, if available, any coded information which can be linked to other sources of data should be added.

After mounting of the permanent samples the diatom suspension remaining in the vial is preserved by adding two to three drops of a 30 percent formaldehyde solution. In order to keep the sample from drying out, five to ten drops of glycerine are added prior to placing the sample into storage.

2.2.6 Microscopic evaluation

In order to obtain a representative distribution, 400 diatom objects are determined to the species level with a 1000 fold up to 1200 fold magnification in microscopic slides prepared as described above. Partially the differentiation of varieties might be necessary (compare chapter 4.2.1). During counting the valve views as well as the girdle views are to be considered. When dealing with representatives of the *Naviculaceae* it is often impossible to tell from a valve view whether one is looking at single valves or entire frustules. Therefore during evaluation no difference is made between single or double valves, but one focuses on counting diatom objects. If valves of a frustule were not separated during preparation they are counted as a unit. Girdles which are impossible to determine must be characterized on the genus level and, if possible, must be grouped and categorized according to their size. After completion of microscopic analysis these diatom objects are attributed to the species they most likely represent according to the percentages with which these species occur. Fragments are only considered, if their size exceeds that of half a valve. Frequencies of species are presented as percentages. The results of diatom counting are to be documented along with data processing numbers according to MAUCH et al. (2003) in Excel or Access files or in specific databases.

When counting diatoms only benthic as well as benthic/planktonic taxa are considered. Taxa which are exclusively planktonic are not considered. For reliable literature regarding the life of centric taxa is not in all cases available and sometimes is even contradictory, with the exception of *Melosira varians,* Centrales are not considered during counting. The same is true for pennate taxa which are exclusively planktonic, e.g. *Asterionella formosa*, *Fragilaria crotonensis*, *Nitzschia acicularis*. Details regarding the different life forms can be found in KRAMMER & LANGE-BERTALOT (1986-1991).

The four volumes of KRAMMER & LANGE-BERTALOT (1986–1991) are the standard determination literature. In case of some genera or taxa it should be completed by the supplementary volumes and revisions of individual genera published since 1993 by the following authors: KRAMMER (2000), LANGE-BERTALOT (1993, 2001), LANGE-BERTALOT & MOSER (1994), LANGE-BERTALOT & METZELTIN (1996). In the water systems of the North German Lowland influenced by saline conditions additionally the work of WITKOWSKI & LANGE-BERTALOT (2000) must be taken into account. However, the revision of the genus *Cymbella* by KRAMMER (2000, 2002, 2003) can be neglected.

2.2.7 Criteria for a reliable assessment and evaluation

Samples are not suitable for assessment if the percentage of diatom objects that cannot be determined (sp., spp.) and/or cannot unambiguously be determined (cf., aff.) exceeds 5 %.

If, even after the best possible isolation of the sampling material there is still only a small amount of diatoms, this suggests that sampling was not carried out correctly or that the time of sampling was not suitable (Chapter 2.2.1). A minimum of 50 objects in a cover slip (18 mm diameter) transect at 1000 fold magnification are suggested as a criterion for evaluation. If one surmises that the sample cannot be evaluated, the density of diatoms must be tested by counting a transect. Experience has shown that despite careful operating, the portion of samples that cannot be evaluated can amount to 3 %.

Another exclusion criterion is a large number of aerophilic diatoms in the sample. This can occur if a recently flooded section is sampled in which the water level still rises. If the portion of aerophilic taxa (Table 1) exceeds 5%, most likely there is a strong aeric influence dominating or at least strongly influencing the assessment. Additional information regarding the aerophilic character of the taxa can be found in KRAMMER & LANGE-BERTALOT (1986–1991).

Table 1: Aerophilic taxa according to LANGE-BERTALOT (1996) and HILDEBRAND (1991)

DV-Nr.	Name	Author
6247	Achnanthes coarctata	(BREBISSON) GRUNOW
6286	Amphora montana	KRASSKE
6287	Amphora normannii	RABENHORST
16692	Denticula creticola	(OESTRUP) LANGE-BERTALOT & KRAMMER
6344	Diploneis minuta	PETERSEN
16264	Hantzschia abundans	LANGE-BERTALOT
6084	Hantzschia amphioxys	(EHRENBERG) GRUNOW
6802	Hantzschia elongata	(HANTZSCH) GRUNOW
16267	Hantzschia graciosa	LANGE-BERTALOT
16271	Hantzschia subrupestris	LANGE-BERTALOT
16276	Hantzschia vivacior	LANGE-BERTALOT
6805	Melosira dickiei	(THWAITES) KUETZING
6449	Navicula aerophila	KRASSKE
6458	Navicula brekkaensis	PETERSEN
6467	Navicula cohnii	(HILSE) LANGE-BERTALOT
6858	Navicula contenta	GRUNOW
16003	Navicula egregia	HUSTEDT
6489	Navicula gallica var. perpusilla	(GRUNOW) LANGE-BERTALOT
6492	Navicula gibbula	CLEVE
6504	Navicula insociabilis	KRASSKE
6028	Navicula mutica	KUETZING
16020	Navicula nivalis	EHRENBERG
16021	Navicula nivaloides	BOCK
16022	Navicula nolensoides	BOCK
16025	Navicula paramutica	BOCK
16026	Navicula parsura	HUSTEDT
6013	Navicula pelliculosa	(BREBISSON) HILSE
6528	Navicula pseudonivalis	BOCK
16360	Navicula pusilla var. incognita	(KRASSKE) LANGE-BERTALOT
16366	Navicula saxophila	BOCK
16036	Navicula subadnata	HUSTEDT
16375	Navicula suecorum var. dismutica	(HUSTEDT) LANGE-BERTALOT
6569	Neidium minutissimum	KRASSKE
6574	Nitzschia aerophila	HUSTEDT
16393	Nitzschia bacillariaeformis	HUSTEDT
6921	Nitzschia debilis	ARNOTT
16407	Nitzschia epithemoides var. disputata	(CARTER) LANGE-BERTALOT
16050	Nitzschia harderi	HUSTEDT
16053	Nitzschia modesta	HUSTEDT
6614	Nitzschia terrestris	(PETERSEN) HUSTEDT
16453	Nitzschia valdestriata	ALEEM & HUSTEDT
16460	Orthoseira dendroteres	(EHRENBERG) CRAWFORD
16060	Orthoseira roeseana	(RABENHORST) O'MEARA
6148	Pinnularia borealis	EHRENBERG
6635	Pinnularia frauenbergiana	REICHARDT
6645	Pinnularia krookii	(GRUNOW) CLEVE
16473	Pinnularia lagerstedtii	(CLEVE) CLEVE-EULER
6654	Pinnularia obscura	KRASSKE
6225	Simonsenia delognei	(GRUNOW) LANGE-BERTALOT
6679	Stauroneis agrestis	PETERSEN
16081	Stauroneis borrichii	(PETERSEN) LUND
16558	Stauroneis gracillima	HUSTEDT
16083	Stauroneis lundii	HUSTEDT
16084	Stauroneis muriella	LUND
6685	Stauroneis obtusa	LAGERSTEDT
16095	Surirella terricola	LANGE-BERTALOT & ALLES

2.3 Phytobenthos without Diatoms

In order to minimize the required input of time, in addition to the complete and detailed assessment procedure alternatively a simplified procedure was developed. The detailed procedure is based on a survey as complete as possible of all detectable phytobenthos algae including microscopic forms in all sampling sections to be assessed according to the biocomponent Macrophytes and Phytobenthos. The simplified procedure is limited to phytobenthos that can macroscopically be detected. In some type of sampling sites carrying out the simplified procedure results in a significantly reduced number of reliable assessments (SCHAUMBURG et al. 2005).

In the following, the simplified procedure is described. Differences to the detailed version are specifically pointed out so that the description at hand can be used to carry out both procedures. Partly directions were taken from the draft of the CEN standard for sampling of phytobenthos in shallow running waters (CEN/TC 230/WG 2/TG 3/N87).

2.3.1 Sampling

2.3.1.1 Phytobenthos sampling equipment

- Safety equipment
- Topographic maps of a scale 1:25 000 or 1:50 000 or GPS
- Camera
- Wading pants or waders
- Viewing aid
- Rubber gloves
- Magnifier
- Sometimes helpful: rake, pliers or similar grabbing instruments
- White plastic dish, if necessary, (2 to 3 l) for sorting material
- Spoon, tweezers, spatula
- Scalpel or knife (stainless steel)
- Pipettes
- Clean screw cap glasses, small (15-20 ml) and large
- Petri dishes (plastic)
- Freezer bags of different sizes
- Ready made water proof labels or duct tape and a water proof marker for labelling samples
- Cooler with cooling elements or ventilator
- Large bucket to transport larger samples of substratum
- Acidic Lugol's solution or neutralised formaldehyde
- Water proof lab book or field report and pencil
- Plastic containers for storage

The assessment procedure is based on a single sampling procedure per year. Sampling should be carried out when the water level is very low and after a phase of comparatively stable water level. After a period of flooding one should wait at least 4 weeks until sampling. For small rivers the sampling section to be investigated should have a length of 20 m, for larger streams approximately 50 m. In order to guarantee reproducibility of the investigation, the position of the sampling site should be noted exactly on a topographic map of a scale 1:25 000 or 1:50 000, so that later easting and northing of the sampling sites can be determined. Ideally coordinates can be read directly from a GPS. Photographs should be made in upstream and downstream direction of the sampling site for documentation. All data pertaining to the sampling section and the sub samples taken are noted in the field protocol (Appendix C, Figure 14).

For both simplified as well as detailed analysis sampling is carried out according to the procedure of Multi-Habitat-Sampling (MHS).

It is the goal of the sampling procedure to report as completely as possible covers of benthic algae and growth forms that can macroscopically be detected. For this purpose all habitats within a sampling section should be observed. They mainly differ in substrate, velocity of flow, depth and light conditions. During sampling one walks along the sampling section and then – as far as possible with waders - one walks through it. The river bed is examined with an underwater viewer. In sections which are impossible to wade through or can only partially be examined sampling is only representative to a certain degree. In such cases tools like a rake or a pair of pliers with long handles can be useful (chapter “Phytobenthos sampling equipment”, page 14). Several samples are taken in one sampling site reflecting the different aspects of the sampling site. These samples are called “sub samples”.

Note: Sampling is identical for the detailed and simplified procedure.

In a first step all growth forms and covers that can macroscopically be detected are noted as separate sub samples in the field protocol. Colour as well as growth form are described as exactly as possible and possibly photographs are taken for documentation. Some striking growth forms are listed in the following.

- Fine floating filaments or tufts (e.g. *Zygnema*, *Stigeoclonium*)
- Green filamentous tufts on stones or plants (e.g. *Cladophora*, *Oedogonium*, *Microspora*)
- Green patches (e.g. *Vaucheria*)
- Green or red filaments on stones in areas of wave action (e.g. *Ulothrix*, *Bangia*)
- Light green, mucilaginous floating filaments (e.g. *Spirogyra*, *Mougeotia*)
- Light green or yellowish netlike floating forms (e.g. *Hydrodictyon*)
- Green to brown coarse wiry filaments (e.g. *Lemanea*)
- Small ruby coloured, blue, violet or blackish tufts on stones (e.g. *Audouinella*, *Chantransia*)
- Black stains, pustules or wart like structures on stones (e.g. *Chamaesiphon*) Covers of different colour (blue-black, turquoise, dark blue, grey, black, greenish, golden) (e.g. *Phormidium, Phaeodermatium*)
- Widespread ruby coloured or blackish crusts (e.g. *Hildenbrandia*), also calcified (e.g. *Homoeothrix crustacea*)
- Gelatinous colonies or thalli (e.g. *Tetraspora*, *Hydrurus*, *Batrachospermum*, *Nostoc*)
- Leave shaped or tube shaped thalli (e.g. *Enteromorpha*)
- Leathery or felty mats (e.g. *Phormidium*)
- Attached spheroidal or hemispheric colonies, also calcified (e.g. *Rivularia*)
- Epiphytic algae (e.g. *Chamaesiphon*, *Coleochaete*)
- Metaphytic algae (growing in between aquatic plants) (e.g. *Closterium*, *Chroococcus*)
- Algae living on sand, mud or silt (e.g. *Euglena*, *Closterium*)

A small amount is sampled of **filamentous forms, of thalli or gelatinous colonies** and is transferred into an appropriate container (small glass vial). If **stones with a striking cover** are detected, it is advisable to take along the representative stones. They are sampled and packaged into suitable plastic bags (freezer bags). In this fashion later the different samples can individually be examined under the stereo microscope. If, in contrast, periphyton is scratched off the stones, a mixture of epilithic algae is the result which makes microscopic determination more difficult. **Covers on sand, mud and clay** or other substrata can be sampled with a spoon, tweezers or a pipette. In some cases it is possible to sample sediment by turning a petri dish upside down on the substrate and then pushing a spatula underneath.

These sub samples are enumerated starting with the number 2 (the number 1 is needed for the overall assessment, compare below) and are unambiguously labelled (number of sampling section, name of running water, position, date, number of sub sample). In the field protocol for each sub sample the percentage cover (percentage of the entire sampling section) is noted. Additionally the mean thickness of the periphyton cover in mm or cm can be noted.

The second step is to take samples of the substrata present at the site:

Immoveable substrata (boulder, bedrock, parts of trees, trees, roots) smaller pieces are broken off or cover is scratched off with a scalpel. These samples are packaged in plastic bags (freezer bags) and along with some water are transferred into small glass vials with a 15-20 ml volume.

Moveable hard substrata (stones of different sizes, smaller pieces of wood) are sampled and transferred into small plastic bags (freezer bags).

Plant substratum (mosses, macro algae, vascular plants, matting of roots) small tufts are taken and in a plastic bag with some river water are thoroughly squeezed. A portion containing a good amount of sampling material is transferred into a glass vial. A mixed sample consisting of different substrata from different locations of the sampling site.

In case of **striking filamentous or floating forms** small parts are transferred into a glass container along with some water. It is useful to carefully, but thoroughly clean off accumulations of detritus and mud off the sampled algae.

Fine sediments (sand, mud, fine particulate organic material, loam) can be sampled with a spoon, tweezers or a pipette. In some cases it is possible to turn a petri dish upside down on the sediment and catch the sediment by slipping a spatula underneath the dish. Fine sediments are only sampled if an algal cover is macroscopically striking.

Overall at least 5 sub samples should be taken to obtain reliable results. Especially macroscopically striking covers and growth forms must be investigated. Moreover stony material should be sampled and a crushed sample of plant substrate should be created.

2.3.2 Transport, preservation, storage and shipment of samples

Materials

- Fixative: for recipe compare appendix B
- Transport: cooler and cooling elements
- Short term storage (2-3 days): refrigerator
- Long term storage of stones: freezer (ca. –20°C)

If analysis of the samples can be carried out immediately after sampling, the freshly taken samples are transported to the lab in a cooler for analysis. Liquid samples are kept in the refrigerator (5-8 C°) with lids slightly ajar in order to allow gas exchange. The samples should be exposed to light on a daily basis. Hard substrates can be kept in the refrigerator for 2 to 3 days.

If microscopic evaluation cannot be carried out within this time, the samples must be preserved and stored (fixative compare appendix B).

If possible, liquid samples are preserved immediately with a few drops of acidic Lugol's solution. Generally 5-10 drops are sufficient for a sample of 15-20 ml. Samples with a high content of organic matter (e.g. high density of algae, sand, mud, loam) need a higher concentration of Lugol's solution (visual inspection: colour similar to that of Cognac). Samples preserved in this fashion should be stored in a cool, dark and well aerated room for no longer than a year (if status of preservation is regularly controlled). Neutralised formaldehyde can also be used for preservation. Then samples can be stored for a longer period of time.

For hard substrates cryopreservation is the method of choice, i.e. until analysis they are kept in a freezer. Frequent freezing and thawing of the material, however, is to be avoided.

A combination of preservation and conservation procedures has turned out to be best for the samples. Lugol's solution alters the colours of the sampling material but preserves cell organelles. Cryopreservation preserves the colours, but does have an impact on cell organelles. For determination of taxa, however, all these characteristics are of importance.

If the samples are sent to an expert for microscopic evaluation, the preserved liquid samples must be packed in a shatter-proof fashion. Stones can be packaged in a thermo bag for transporting frozen goods (super market) along with cold cooling elements. The samples should reach their destination within a day.

2.3.3 Microscopic analysis and documentation

2.3.3.1 Materials

- White plastic dishes
- Petri dishes (diameter ca. 10 and 20 cm)
- Scalpel
- Tweezers in different sizes
- Brushes
- Preparation needles
- Pasteur pipettes
- Camera with macro mode (digital or conventional films)
- Stereo microscope (magnification 6,7 up to 40-fold) with external light source and camera equipment (digital conventional films)
- Compound light microscope with stage and 40- to 1000-fold magnification. An eyepiece micrometer for measuring cells is required. For documentation of the taxa found camera equipment is essential (digital or conventional films). For determination of organisms optical contrasting methods, e.g. interference contrast are very helpful
- Microscope slides and cover slips
- Cellulose wipes
- Tap water
- Lens paper and special lens cleaning paper and cleaning agent
- Glycerine and clear nail polish (for preparation of permanent specimen)
- Storage device with lid for permanently mounted specimen
- Dye to proof the existence of storage compounds etc. (compare determination literature)
- Clean, small glass bottles (15-20 ml) with screw cap for storage purposes
- Labels or duct tape and markers to label samples
- Acidic Lugol's solution or neutralised formaldehyde for preservation

2.3.3.2 Microscopy

The evaluation of samples is carried out with a stereo microscope (magnification 6,7 fold to 40 fold) as well as with a microscope (magnification 40 fold to 1000 fold). For documentation of the species detected (compare below) microscope camera equipment is essential. A camera for the stereo microscope is desirable.

It is the goal of microscopic analysis to determine, if possible, the taxa of the representative sub samples **to the species level**. According to our present knowledge we **cannot recommend** to limit the analysis to the indicator species mentioned. To be able to settle any taxonomic questions, each taxon should be photographed.

Preserved liquid samples usually can be analysed without any pre-treatment. If the sampling material turns out to be inhomogeneous, it is recommended to first observe the sampling material in a petri dish (if necessary add tap water) under the stereo microscope at low magnification. If different growth forms can be found, they should be documented and afterwards be examined under the microscope one by one. Please exercise caution when handling samples preserved with formalin.

Frozen stones must first be thawed. If different covers or kinds of growth are found (e.g. during inspection under the stereo microscope), they must be analysed separately.

Parts of coloured covers, stains, pustules, wart like structures or crusts are removed with a scalpel or a brush and then are applied to a microscope slide with a little water.

Filaments, tufts or patches are partly taken of the substratum with tweezers and are then applied to a microscope slide with a little water. It can be necessary for determination to include holdfasts or any other structures that serve to adhere to the substratum into the analysis. This is also true for leathery felty mats. In this way also epiphytic algae are documented.

For a more detailed analysis, gelatinous colonies (e.g. *Nostoc*) can be squeezed onto the microscope slide with the cover slip (squash preparation).

Rhodophytes with a thallus as well as other algae classes with leaf- or tube shaped thalli must be preserved for determination so that reproductive organs and other morphological characteristics can be recognized. For documentation we recommend glycerine based permanently mounted specimen.

Epipsamnic algae must be applied to the microscope slide with a small amount of water and as little sand, silt and mud as possible.

Liquid samples with metaphytic algae can directly be applied to the microscope slide with a pipette.

For each sub sample a microscopy protocol is filled in (example is given in appendix C, figure 15). All taxa which are microscopically common or massive are listed. The abundance of each taxon is recorded according to the descriptions in Table 2. In contrast to the complete analysis of phytobenthos, for the simplified analysis only those taxa are recorded which are microscopically massive (abundance 3). Species which are microscopically rare (abundance 1) are not considered.

Table 2: Estimating abundance

Abundance	Description
3	macroscopically rare, barely recognizable (note in field protocol: "solitary specimen" or 5 % coverage) or microscopically massive
2	microscopically common
1	microscopically rare

Note: If possible, for the **detailed procedure all** taxa present in a sample are determined to the species level and are also noted if their abundance is low. Microscopically rare corresponds to abundance 1.

Regarding labour intensity there are the following recommendations for the simplified analysis (Table 3):

3 to 5 cover slips should be prepared for samples taken off boulder, gravel, sand and mud as well as off floating material.

- For samples taken off boulders, gravel, sand and mud as well as floating material 3 to 5 cover slips should be prepared
- For samples of stones and plant material more than 5 cover slips might be necessary.

- 30 to 60 minutes should be spent on the microscopic analysis of stony substrata, approximately 30 minutes on plant substrata and approximately 15 minutes on all other types of substratum.

Table 3: Recommendations regarding the required input of time and labour to process sub samples

Substratum	Maximum amount of cover slips	Mean maximum input of time
Sand, mud	3 - 5	15 min.
Fine gravel	3 - 5	15 min.
Coarse gravel, stones	possibly more than 5	60 min.
Boulder	3 - 5	15 min.
Floating material	3 - 5	15 min.
Mosses and macrophytes squash preparation	possibly more than 5	30 min.

After investigation the samples should be preserved and kept in storage. If it turns out that during the simplified analysis not enough indicative taxa were found to obtain a reliable assessment, a detailed analysis can easily be carried out by examining further samples under the microscope. There is no need to carry out the sampling procedure again.

Note: Recommendations regarding the input of time for the **detailed procedure** (Table 4):

Table 4: Recommendations regarding the required input of time and labour to process sub samples

Substratum	Maximum number of cover slips	Maximum input of time
Sand, mud	max. 5	30 min.
Fine gravel	max. 5	30 min.
Coarse gravel, stones	Possibly more than 5	90 min.
Boulder	max. 5	30 min.
Floating material	max. 5	30 min.
Mosses and macrophytes squash preparation	Possibly more than 5	60 min.

Determination literature

Excluding diatoms and Charales, there is a considerable amount of phytobenthos determination literature wich is consistently being refined. At present we recommend the literature listed below for determination of benthic algae. The most important literature is marked in grey.

Comprehensive literature for different algal groups

- BOURRELLY, P. (1968)
- BOURRELLY, P. (1972)
- BOURRELLY, P. (1970)
- ENTWISLE,T.J., SONNEMANN, J.A., LEWIS, S.H. (1997)
- JOHN, D.M.; WHITTON, B.A.; BROOK, A.J. (Hrsg.; 2002)
- KANN, E. (1978)
- LINNE VON BERG, K.-H. & MELKONIAN, M. (2004)
- PANKOW, H. (1990):
- SIMONS, J.; LOKHORST, G.M.; VAN BEEM, A.P. (1999)
- WEHR, J.D. & SHEATH, R.G. (2003)

Nostocophyceae

- ANAGNOSTIDIS, K. & KOMÁREK, J. (1988a, b)

- GEITLER, L. (1932)
- KANN, E. & KOMÁREK, J. (1970)
- KOMÁREK, J. (1999)
- KOMÁREK, J. & ANAGNOSTIDIS, K. (1989)
- KOMÁREK J. & ANAGNOSTIDIS, K. (1998)
- KOMÁREK, J. ANAGNOSTIDES K. (2005)
- KOMÁREK, J. & KANN, E. (1973)
- KOMÁREK, J. & KOVÁCIK, L. (1987)
- MOLLENHAUER, D., BENGTSSON, R. & LINDSTRØM, E.-A. (1999)
- STARMACH, K. (1966)

Bangiophyceae / Florideophyceae / Fucophyceae

- COMPÈRE, P. (1991)
- ELORANTA, P. & KWANDRANS, J. (1996)
- FRIEDRICH, G. (1966)
- KUMANO, S. (2002)
- LEUKART, P. & KNAPPE, J. (1995)
- NECCHI, O.; SHEATH, R.G.; COLE K.M. (1993a)
- NECCHI, O.; SHEATH, R.G.; COLE K.M. (1993b)
- NECCHI, O. & ZUCCHI, M.R. (1993)
- RIETH, A. (1979)
- SHEATH, R.G.; WHITTICK, A.; COLE K.M. (1994)
- SHEATH, R.G. & VIS, M.L. (1995)
- STARMACH, K. (1977)
- VIS, M.L.; SHEATH, R.G.; ENTWISLE, T.J. (1995)
- WEHR, J.D. & STEIN, J.R. (1985)

Or comrehensive literature pertaining to different groups

Chrysophyceae/Synurophyceae

- KRISTIANSEN, J. & PREISIG, H.R. (2001)
- STARMACH, K. (1985)

Cryptophyceae / Dinophyceae

- FOTT, B. (1968)
- POPOVSKY, J. & PFIESTER, L.A. (1990)

Euglenophyceae

- HUBER-PESTALOZZI, G. (1955)
- KUSEL-FETZMANN, E. (2002)
- WOŁOWSKI, K. (1998)
- WOŁOWSKI, K. & HINDÁK, F. (2005)

Tribophyceae

- CHRISTENSEN, T.A. (1970)
- ETTL, H. (1978)
- RIETH, A. (1980)

Chlorophyceae / Trebouxiophyceae / Ulvophyceae / Tetrasporales/

- LOCKHORST, G.H. (1999)
- ETTL, H. (1983)
- ETTL, H. & GÄRTNER, G. (1988)
- FOTT, B. (1972)
- HUBER-PESTALOZZI, G. (1961)
- KOMÁREK, J. & FOTT, B. (1983)
- MROZINSKA, T. (1985)

- PRINTZ, H. (1964)
- STARMACH, K. (1972)
- HOEK, C. (1963)

Charales excl. Characeae

- COESEL, P.M. (1982)
- COESEL, P.M. (1983)
- COESEL, P.M. (1985)
- COESEL, P.M. (1991)
- COESEL, P.M. (1994)
- COESEL, P.M. (1997)
- CROASDALE, H. & FLINT, E.A. (1986)
- CROASDALE, H. & FLINT, E.A. (1988)
- CROASDALE, H.; FLINT, E.A.; RACINE, M.M. (1994)
- FÖRSTER, K. (1982)
- KADLUBOWSKA, J.Z. (1984)
- LENZENWEGER, R. (1996)
- LENZENWEGER, R. (1997)
- LENZENWEGER, R. (1999)
- LENZENWEGER, R. (2003)
- RŮŽIČKA, J. (1977)
- RŮŽIČKA, J. (1981)

2.3.3.3 Summarisation and processing of data

After microscopic analysis the taxa lists of the individual sub reports are **combined** in **one report**. It is referred to as sub report 1 and lists all taxa which during microscopic analysis were assigned an abundance of 3 (microscopically massive). Simultaneously for each sub sample the degrees of coverage of the different coatings noted in the field protocol need to be considered for a final determination of abundance. The final abundances of the taxa are attributed according to the description in Table 5.

Table 5: Estimating abundance – simplified procedure

Abundance	Description
5	Massive, covering more than 1/3 of the river bed (degree of coverage > 33%)
4	Frequent, but covering less than 1/3 of the river bed (degree of coverage 5-33%)
3	Macroscopically rare, barely noticeable (note in field protocol: „solitary finding“ or „5% coverage“) or microscopically massive

After microscopic analysis for each sampling procedure the results are available in form of a species list (including abundances for each species). Based on these species lists the sampling section can be evaluated for the time of sampling.

Note: For the **detailed** procedure for each taxon the highest abundance is noted which was attributed during microscopic analysis. If in at least three sub reports a taxon had the same abundance, for the overall assessment abundance is upgraded by one step. This means that a taxon which in four sub reports was microscopically rare (abundance 1) is attributed an abundance of 2 for the overall assessment. For those taxa which were microscopically massive for the final assessment of abundances the abundances or degrees of cover and the different growth forms noted in the field protocols must be considered. In this fashion the final abundances of the taxa can be determined according to Table 6.

Table 6: Estimating abundances – detailed procedure

Abundance	Description
5	massive, covering more than 1/3 of the river bed (degree of coverage > 33 %)
4	common, but covering less than 1/3 of the river bed degree of coverage 5–33 %)
3	macroscopically rare, barely recognizable (note in field protocol: „solitary specimen“ or „5 % degree of coverage or microscopically massive
2	microscopically common
1	microscopically rare

3 Determination of the type of running water

For application of the assessment procedure the sampled water system must correctly be assigned to the Macrophyte and Phytobenthos biocoenotic types. **The LAWA type map which is nationwide in effect can serve as an aid for type determination, but not as the sole basis. Any relevant additional information must be taken into consideration.** Additional simplifications for type attribution are presently being verified.

If the parameters relevant for determination of the macrophyte type and phytobenthos type are strongly influenced by anthropogenic factors, one should refer to values representing the sampling section in its original state (state of reference). This can pertain to parameters like depth, velocity of flow, width and also to acid capacity or water hardness. If modifications of this sort are noticed (e.g. backwaters, ramps) or known (e.g. potash mining in upper reaches, discharge of limed water from sewage treatment plants into siliceous areas), their impact (e.g. altered velocity of flow, increased hardness) must be ignored for type determination. In some cases helpful conclusion can be drawn from the attribution of the measuring point to the LAWA typology.

The LAWA typology according to SOMMERHÄUSER & POTTGIESSER (2004) describes different geochemical types (of low basicity and high basicity or siliceous and calcareous) in their state of reference. If a running water is attributed to the macrophyte and phytobenthos typology based on the LAWA typology of running waters this differentiation must be kept in mind.

If for the macrophytes the MRK type is determined and the acid capacity or total hardness measured are only slightly above the limit of 1,4 mmol/l, and if the sampling site can be characterised by a siliceous geology, for the macrophytes also the results of the siliceous type MRS (which is analogue to the calcareous type) must be calculated and the results must be discussed.

If no measurements of acid capacity and total hardness are available, in the case of MRS or MRK types, the result of calculation must thoroughly be checked for plausibility. If necessary, the analogous type must also be determined and both results must be discussed. Regarding the differentiation siliceous/calcareous or low basicity/high basicity, the same is true for type attribution of the subcomponent Phytobenthos without Diatoms.

If type attribution is unclear, always the analogous type must be determined and its ecological condition must be calculated. The situation can be unclear due to missing information, the location of the sampling site or if chemical, physical parameters are difficult to classify. Both results must be discussed.

To make attribution of macrophyte types easier their characteristics were summarised and can be looked up in the appendix pages 95 to 107.

Problems upon attributing the biocoenotic diatom type can occur in the transition zone of ecoregions and if the bedrock in the catchment area is heterogeneous. The latter is especially true for water systems with a catchment area showing siliceous as well as calcareous influence and which are differently assessed in the module “Trophic Index” (SCHAUMBURG et al. 2005). In this case typefication must be carried out based on the dominant geology of the catchment area (siliceous or calcareous) and must be discussed correspondingly. A total hardness or acid capacity of 1,4 mmol/l can be used as an auxiliary criterion. However, a heterogeneous geology does not affect the module „Species Composition and Abundance“ as in this case siliceous as well as calcareous reference species can be referred to (compare chapter 4.2.1)

Alps

As due to a lack of data for the Alps ecoregion no assessment procedure for the module „Phytobenthos without Diatoms“ could be developed, the assessment is carried out according to the WFD with the modules „Macrophytes“ and „Diatoms“. The biocoenotic water types of the Alps ecoregion are determined according to Tale 7 and Table 8.

Tale 7: Determination key for finding macrophyte types in the ecoregion Alps.

Macrophytes		
1a	Depth class = 1	→ **Type MRK**
1b	Depth class ≥ 2	→ 2
2a	Mean width ≥ 40m	→ 5
2b	Mean width < 40m	→ 3
3a	Velocity of flow > III	→ **Type MRK**
3b	Velocity of flow ≤ III	→ 4
4a	Influence of groundwater	→ **Type MPG**
4b	No influence of groundwater	→ **Type MP**
5a	Velocity of flow > III	→ **Type MRK**
5b	Velocity of flow ≤ III	→ 6
6a	Depth class = 3	→ **Type Mg**
6b	Depth class < 3	→ 4

Table 8: Determination key for finding diatom types in the ecoregion Alps. LAWA type according to SOMMERHÄUSER & POTTGIESSER (2004)

Diatoms	
LAWA-Type 1.1	→ **D 1.1**
LAWA-Type 1.2	→ **D 1.2**

Alpine Foreland

The running water of the tertiary hill region, river terraces and older moraines in the Alpine Foreland are considered slightly calcareous, but also siliceous. Those of the younger moraines are considered mostly calcareous (BRIEM 2003). This difference is reflected in the diatom assemblages. In the investigation at hand, however, no macrophyte societies with a siliceous character were found in the Alpine Foreland. This means that theoretically conditions typical for the MRS type of macrophytes can be found, but that this is very unlikely. If these conditions are the result of type determination, all parameters should be verified for correctness and the result should only be accepted under reservation. It is impossible that diatoms characterise a calcareous water system while macrophytes of the same sampling section characterise a siliceous water system.

Due to a lack of data for the running water systems of the Alpine Foreland, no assessment procedure could be developed for the module “Phytobenthos without Diatoms“. As a consequence the assessment according to the WFD is carried out with the module “Macrophytes“ and the module “Diatoms“.

The biocoenotic water types of the Alpine Foreland are determined according to Table 9 and Table 10.

Table 9: Key for type determination in the Alpine Foreland

Macrophytes		
1a	Depth class = 1	→ 2
1b	Depth class ≥ 2	→ 3
2a	Maximum value of total hardness or median of acid capacity 4,3 < 1,4 mmol/l	→ **Type MRS**
2b	Maximum value of total hardness and median of acid capacity 4,3 ≥ 1,4 mmol/l	→ **Type MRK**
3a	Mean width ≥ 40m	→ 6
3b	Mean width < 40m	→ 4
4a	Velocity of flow > III	→ 2
4b	Velocity of flow ≤ III	→ 5
5a	Influence of groundwater	→ **Type MPG**
5b	No influence of groundwater	→ **Type MP**
6a	Velocity of flow > III	→ 2
6b	Velocity of flow ≤ III	→ 7
7a	Depth class = 3	→ **Type Mg**
7b	Depth class < 3	→ 5

Table 10: Key for diatom type determination in the Alpine Foreland ecoregion**.** LAWA-Type according to SOMMERHÄUSER & POTTGIESSER (2004)

Diatoms		
LAWA-Type 1.1		→ **D 1.1**
LAWA-Type 1.2		→ **D 1.2**
LAWA-Type 2		→ **D 2**
LAWA-Type 3		→ **D 3**
LAWA-Type 11	**and** Alpine Foreland ecoregion	→ **D 3**
LAWA-Type 12	**and** Alpine Foreland ecoregion	→ **D 3**
LAWA-Type 19	**and** Alpine Foreland ecoregion	→ **D 3**
LAWA-Type 4		→ **D 4**

Central German Upland

Areas with variegated sandstone and volcanoes, which are very common in the Central German Upland as well as areas with gneiss, granite and slate have a siliceous character just like the waters running through them. However, calcareous water can enter a catchment area consisting of calcareous and siliceous areas so that the siliceous character is largely lost. For the diatom type is strongly linked to the dominating geochemical situation and the macrophyte type is linked to total hardness and acid capacity, the combination of a siliceous diatom type and a calcareous macrophyte or phytobenthos type is definitely possible. In such a case it needs to be thoroughly verified, if the increased values of hardness and acid capacity, which were the basis for attribution to the calcareous type, are not due to, for example, the inflow of industrial sewage or limed water. If this is the case, assessment must be based on the siliceous type.

Only in very rare cases combinations of siliceous macrophyte and phytobenthos types along with a calcareous diatom type can be observed. If this is the result of type determination, all relevant parameters must be checked again for correctness. If necessary, measurements must be taken again or another sampling site must be chosen.

The biocoenotic water types of the Central German Upland are determined according to, Table 11, Table 12 and Table 13.

Table 11: Key for macrophyte type determination in the Central German Upland

Macrophytes		
1a	Depth class = 1	→ 2
1b	Depth class ≥ 2	→ 3
2a	Maximum value of total hardness or median of acid capacity 4,3 < 1,4 mmol/l	→ **Type MRS**
2b	Maximum value of total hardness and median of acid capacity 4,3 ≥ 1,4 mmol/l	→ **Type MRK**
3a	Mean width ≥ 40m	→ 6
3b	Mean width < 40m	→ 4
4a	Velocity of flow > III	→ 2
4b	Velocity of flow ≤ III	→ 5
5a	Influence of groundwater	→ **Type MPG**
5b	No influence of groundwater	→ **Type MP**
6a	Velocity of flow > III	→ 2
6b	Velocity of flow ≤ III	→ 7
7a	Depth class = 3	→ **Type Mg**
7bc	Depth class < 3	→ 5

Table 12: Key for diatom type determination in the ecoregion Central German Upland. LAWA type according to SOMMERHÄUSER & POTTGIESSER (2004)

Diatoms		
LAWA-Type 5	**excl**. Subtype 5.2 (volcanic rock)	→ **D 5**
LAWA-Type 5.1		→ **D 5**
LAWA-Type 11	**and** Central German Upland ecoregion	→ **D 5**
LAWA-Type 5.2		→ **D 6**
LAWA-Type 9		→ **D 7**
LAWA-Type 6		→ **D 8.1**
LAWA-Type 19	**and** Central German Upland ecoregion	→ **D 8.1**
LAWA-Type 9.1	**and** loess-, keuper- and cretaceous regions **excl**. shell limestone, Jura-, Malm-,Lias-, Dogger-and other calcareous regions	→ **D 8.2**
LAWA-Type 7		→ **D 9.1**
LAWA-Type 9.1	**and** shell limestone-, Jura-, Malm-, Lias-, Dogger-and other calcareous regions **excl**. loess-, keuper- and cretaceous regions	→ **D 9.2**
LAWA-Type 9.2		→ **D 10.1**
LAWA-Type 10		→ **D 10.2**

Table 13: Key for phytobenthos type determination in the Central German Upland ecoregion. LAWA-Type according to SOMMERHÄUSER & POTTGIESSER (2004)

Phytobenthos without Diatoms		
LAWA-Type 5		→ **MG_sil**
LAWA-Type 5.1		→ **MG_sil**
LAWA-Type 5.2		→ **MG_sil**
LAWA-Type 9		→ **MG_sil**
LAWA-Type 6		→ **MG_carb**
LAWA-Type 7		→ **MG_carb**
LAWA-Type 9.1		→ **MG_carb**
LAWA-Type 9.2		→ **MG_carb**
LAWA-Type 10		→ **MG_carb**
LAWA-Type 19	**and** Central German Upland ecoregion	→ **MG_carb**

North German Lowland

The biocoenotic water types in the North German Lowland ecoregion are determined according to Table 14, Table 15and Table 16. The terms “type of low basicity” and “type of high basicity”, “low basicity” and “high basicity” or “siliceous” and “calcareous” type correspond to the terms siliceous and calcareous used in the summarised characteristics of the different types of running waters in Germany (POTTGIESSER und SOMMERHÄUSER 2004).

Table 14: Key for type determination in the North German Lowland ecoregion.

Macrophytes		
1a	Mean width > 30 m	→ **Type TN_g**
1b	Mean width < 30 m	→ 2
2a	Velocity of flow > III	→ **Type TR**
2b	Velocity of flow ≤ III	→ 3
3a	Velocity of flow = III	→ 4
3b	Velocity of flow < III	→ 5
4a	Depth class = 1	→ **Type TR**
4b	Depth class ≥ 2	→ 5
5a	Mean width ≥ 5 m	→ **TN**
5b	Mean width < 5 m	→ 6
6a	Depth class = lll	→ **TN**
6a	Depth class = ll	→ **TN_k**

Table 15: Key for diatom type determination in the North German Lowland ecoregion. LAWA-type according to SOMMERHÄUSER & POTTGIESSER (2004).

Diatoms		
LAWA-Type 11	**and** North German Lowland ecoregion, type of low basicity	**D 11.1**
LAWA-Type 14	**and** siliceous type	**D 11.1**
LAWA-Type 16	**and** siliceous type	**D 11.1**
LAWA-Type 12	**and** North German Lowland ecoregion, type of low basicity, catchment area < 1.000 km²	**D 11.2**
LAWA-Type 11	**and** North German Lowland, type of high basicity	**D 12.1**
LAWA-Type 14	**and** calcareous type	**D 12.1**
LAWA-Type 16	**and** calcareous type	**D 12.1**
LAWA-Type 19	**and** North German Lowland ecoregion	**D 12.1**
LAWA-Type 15	**and** catchment area < 1.000 km², excl. loess regions	**D 12.2**
LAWA-Type 17	**and** catchment area < 1.000 km²	**D 12.2**
LAWA-Type 12	**and** catchment area < 1.000 km², Ecoregion North German Lowland, type of high basicity	**D 12.2**
LAWA-Type 15	**and** catchment area > 1.000 km², loess regions excluded	**D 13.1**
LAWA-Type 17	**and** catchment area > 1.000 km²	**D 13.1**
LAWA-Type 12	**and** catchment area > 1.000 km², North German Lowland ecoregion, type of high basicity	**D 13.1**
LAWA-Type 20		**D 13.2**

Table 16: Key for phytobenthos type determination in the North German Lowland ecoregion. LAWA Type according to SOMMERHÄUSER & POTTGIESSER (2004)

Phytobenthos		
LAWA-Type 11	**and** North German Lowland ecoregion, type of low basicity	**NT_sil/org**
LAWA-Type 12	**and** North German Lowland ecoregion, type of low basicity	**NT_sil/org**
LAWA-Type 14	**and** siliceous type	**NT_sil/org**
LAWA-Type 16	**and** siliceous type	**NT_sil/org**
LAWA-Type 11	**and** North German Lowland ecoregion, type of high basicity	**NT_cal**
LAWA-Type 12	**and** North German Lowland ecoregion, type of high basicity	**NT_cal**
LAWA-Type 14	**and** calcareous type	**NT_ cal**
LAWA-Type 15	....	**NT_ cal**
LAWA-Type 16	**and** calcareous type	**NT_ cal**
LAWA-Type 17	....	**NT_ cal**
LAWA-Type 18	....	**NT_ cal**
LAWA-Type 19	....	**NT_ cal**
LAWA-Type 20	....	**NT_ cal**

4 Assessment

4.1 Macrophytes

4.1.1 Calculation of the Reference Index

The calculation of the Reference Index is **exclusively** carried out **based on the submerged species** of the sampling site. Amphiphytic taxa are considered if they grow completely submerged. Helophytically growing species will only be noted as an additional criterion termed “dominance of helophytes”.

4.1.1.1 Transformation of plant abundance into quantity

Prior to performing any calculations, the nominally scaled values of plant abundance are converted into metric quantities (Equation 1).

Equation 1: Transformation of plant abundance into quantity

$$Abundance^3 = Quantity$$

4.1.1.2 Incorporation of taxa into species groups

The taxa occurring at the sampling site are assigned to **type specific** species groups (compare Table 17)

Table 17: List of indicators

Taxon	MRK	MRS	MP(G)	TN	TR
Agrostis gigantea	B	B	B	B	B
Agrostis stolonifera	B	B	B	B	B
Amblystegium fluviatile	A	A	A	A	A
Amblystegium humile	B	B	B	B	B
Amblystegium serpens	B	B	B	B	B
Amblystegium tenax	B	B	A	A	A
Amblystegium varium	B	B	B	B	B
Aneura pinguis	B	B	B	B	B
Angelica sylvestris	B	B	B	B	B
Apium nodiflorum	B	B	B	B	B
Apium repens	B	B	B	B	B
Azolla caroliniana	C	C	C		
Azolla filiculoides	C	C	C	B	B
Berula erecta	B	B	B	A	A
Blindia acuta		A			
Brachythecium plumosum		A	A	A	A
Brachythecium rivulare	A	B	B	A	A
Bryum turbinatum	A	B		B	B
Butomus umbellatus	C	C	C	B	C

Taxon	MRK	MRS	MP(G)	TN	TR
Calliergon cordifolium	B	B	B	B	B
Calliergon giganteum	A	B	A	A	A
Callitriche cophocarpa	b	b	b	b	b
Callitriche hamulata	A	A	A	A	A
Callitriche hermaphroditica	b	b	b	b	b
Callitriche obtusangula	B	B	B	B	B
Callitriche platycarpa	B	B	B	A	A
Callitriche stagnalis	A		A	A	A
Cardamine amara	B	B	B	B	B
Ceratophyllum demersum	C	C	C	C	C
Ceratophyllum submersum				C	C
Chara aspera	A		A	A	A
Chara contraria	A		A	A	A
Chara delicatula	A		A	A	A
Chara globularis	A		A	A	A
Chara hispida	A		A	A	A
Chara intermedia	A		A	A	A
Chara tomentosa	A		A	A	A
Chara vulgaris	A		A	A	A
Chiloscyphus pallescens	A	A	A	A	A
Chiloscyphus polyanthos		A	A	A	A
Cinclidotus aquaticus	A	B	B		
Cinclidotus danubicus	A	B	A	A	A
Cinclidotus fontinaloides	A	B	A	A	A
Cinclidotus riparius	B		B		
Conocephalum conicum	A	B	B	B	A
Cratoneuron filicinum	A	A	A	A	A
Dichodontium pellucidum	A	A	A	A	A
Drepanocladus aduncus	A	B	B	A	A
Drepanocladus sendtneri	A	B	A	A	A
Eleocharis acicularis	A		A	A	A
Elodea canadensis	C	C	C	B	C
Elodea nuttallii	C	C	C	B	C
Equisetum fluviatile			B	A	A
Equisetum palustre			B		
Eucladium verticillatum	A	B			
Fissidens adianthoides	B	B	B	B	B
Fissidens arnoldii	A	A		A	A
Fissidens crassipes	B	B	B	A	A
Fissidens grandifrons	A	A			
Fissidens gymnandrus			B	B	B
Fissidens pusillus	B	B	B	B	B
Fissidens rivularis	A	A	A	A	A
Fissidens rufulus	A	A	A	A	A
Fontinalis antipyretica	B	B	B	B	B
Fontinalis hypnoides	A	A	A	A	A
Fontinalis squamosa		A	A		A
Galium palustre	B	B	B	B	B
Glyceria fluitans	B	B	B	B	B
Glyceria maxima	B	B	B	B	B
Groenlandia densa	B		A	A	B
Hippuris vulgaris	B	B	A	A	
Hottonia palustris	C		B	A	
Hydrocharis morsus-ranae	C		B	B	B
Hydrocotyle vulgaris			B	B	B
Hygrohypnum duriusculum		A			A
Hygrohypnum eugyrium	A	A			
Hygrohypnum luridum	A	B	A	A	A
Hygrohypnum ochraceum	A	V	A	A	A
Hymenostylium recurvirostre	A		A		
Hyocomium armoricum	A	V	A		
Isolepis fluitans				A	A
Juncus articulatus	B	B	A	B	B
Juncus bulbosus			A	A	A
Juncus subnodulosus	A		A		
Jungermannia atrovirens	A	A	A		

Taxon	MRK	MRS	MP(G)	TN	TR
Jungermannia exsertifolia	A	V			
Jungermannia sphaerocarpa	A	V			
Lagarosiphon major	C		C		C
Lemna gibba	C		C	C	C
Lemna minor	C	C	C	B	C
Lemna minutula				B	C
Lemna trisulca	C		B	B	C
Leptodictyum riparium	C	C	B	B	C
Leskea polycarpa	B	B		B	B
Lunularia cruciata			B	B	
Marchantia polymorpha	B	B	B	B	B
Marsupella emarginata	A	V	A	A	A
Marsupella emarginata var. aquatica	A	V	A	A	A
Mentha aquatica	B	B	B	B	B
Myosotis palustris	B		B	B	B
Myriophyllum alterniflorum	A	A	A	A	A
Myriophyllum spicatum	C	C	C	B	C
Myriophyllum verticillatum			B	B	
Najas marina	B		B		
Najas minor	C		C		
Nardia compressa	A	A		A	
Nasturtium microphyllum				B	B
Nasturtium officinale	B	B	B	A	B
Nitella flexilis	B	B	A	A	A
Nitella mucronata	A		A	A	A
Nitella opaca	A		A	A	A
Nitella tenuissima	A		A	A	A
Nitellopsis obtusa	A		A	A	A
Nuphar lutea	C	C	C	B	C
Nymphaea alba	C		B	B	C
Nymphoides peltata			B		
Octodiceras fontanum	B	B	B	B	B
Oenanthe aquatica	B		B		
Oenanthe fluviatilis			B		
Palustriella commutata	A	A	A	A	A
Palustriella decipiens					A
Pellia epiphylla		V			A
Phalaris arundinacea	B	B	B	B	B
Philonotis calcarea	A		A		
Plagiomnium undulatum		B			B
Plagiothecium succulentum		B	B	B	B
Pohlia wahlenbergii	B	B	B	B	B
Polygonum amphibium	B		B	B	B
Polygonum hydropiper	B	B		B	B
Porella cordeana		A	A		
Potamogeton acutifolius				A	
Potamogeton alpinus	A	A	A	A	A
Potamogeton berchtoldii	C	C	B	C	C
Potamogeton coloratus	A	A	A	A	A
Potamogeton compressus				B	
Potamogeton crispus	C	C	C	C	C
Potamogeton filiformis	B	B	B	A	B
Potamogeton friesii	B	C	B	C	C
Potamogeton gramineus			A	A	B
Potamogeton helveticus	C		C	A	
Potamogeton lucens	C	C	C	A	C
Potamogeton lucens x natans	C		B		C
Potamogeton lucens x perfoliatus	C		B		C
Potamogeton natans	C	C	B	B	B
Potamogeton natans x nodosus	C		B	B	
Potamogeton nodosus	C	C	C	B	C
Potamogeton obtusifolius	B	B	B	B	B
Potamogeton pectinatus	C	C	C	C	C
Potamogeton perfoliatus	C	C	B	A	C
Potamogeton polygonifolius		A	A	A	B
Potamogeton praelongus				A	

Taxon	MRK	MRS	MP(G)	TN	TR
Potamogeton pusillus	C	C	B	C	C
Potamogeton trichoides	C	C	C	C	C
Potamogeton x nitens	B		A		
Potamogeton x zizii				A	
Racomitrium aciculare	A	A		A	A
Racomitrium aquaticum		A			
Ranunculus aquatilis	C	B	B		
Ranunculus circinatus	B	B	B	B	C
Ranunculus circinatus x trichophyllus	B		B		
Ranunculus flammula		B		A	A
Ranunculus fluitans	B	B	B	B	A
Ranunculus fluitans x trichophyllus	B	B	B	B	A
Ranunculus hederaceus				A	
Ranunculus peltatus	B	B	B	B	A
Ranunculus penicillatus	B	B	B	B	A
Ranunculus trichophyllus	B	B	B	B	
Ranunculus x cookii	B		B		
Rhynchostegium alopecurioides		A		A	A
Rhynchostegium riparioides	B	B	B	B	B
Riccardia chamaedryfolia	A	A			A
Riccia fluitans	B	C	B	A	C
Riccia rhenana	B	C	B	A	C
Ricciocarpos natans	A	B		C	C
Sagittaria latifolia	C		C		C
Sagittaria sagittifolia	C		C	B	C
Scapania undulata		V	A	A	A
Schistidium rivulare		A		A	A
Schoenoplectus lacustris	B	B	B	B	B
Scorpidium scorpioides	A	B	A		A
Sparganium emersum	C	C	C	B	C
Sparganium erectum	C		C	B	C
Sparganium minimum				A	C
Sphagnum		V	A	A	A
Spirodela polyrhiza	C	C	C	C	C
Stratiotes aloides				A	
Thamnobryum alopecurum	A	B	A		A
Tolypella glomerata			A		
Tolypella prolifera			A		
Trapa natans	C			C	C
Utricularia australis	A		A		
Utricularia ochroleuca	A		A		
Utricularia vulgaris			A	A	
Veronica anagallis-aquatica	B	B	B	B	B
Warnstorfia exannulata		A			A
Warnstorfia fluitans	A	V	A	A	A
Zannichellia palustris	C	C	C	C	C

4.1.1.3 Calculation of total quantities

The quantities of the different species calculated from the plant abundances of a sampling site are summed up separately for each indicator group and for all submerged species of a sampling site.

If in the course of new surveys **species** are found, which are ***not* mentioned in the above species list,** these species should not be considered for calculation of the index. If the number of unlisted (=non indicative) species is high, this most likely will falsify the calculated index. Consequently, if the percentage of non indicative species is ≥ 25 % of the total quantity, the index value cannot be considered reliable.

4.1.1.4 Criteria for a reliable assessment

Prerequisites for a **reliable assessment**

- the total quantity of all submerged indicator species in a sampling site must add up to a minimum of 26 and at the same time
- plant quantity of indicator species must exceed 75 %.

If the portion of listed macrophytes (indicator species) is below 75 %, the ecological status class determined on the basis of the index value cannot be considered reliable. In the overall assessment it can only serve to describe tendencies. If for a particular sampling site the minimum quantity is not reached, it must be verified whether this is the result of natural causes or macrophyte depopulation due to eutrophication. If the latter is the case, the respective sites must be assigned the ecological status class 5 (unreliable). Macrophyte degeneration must always be proven and must be backed up by structural, physical, chemical and biological investigations. Depopulation can be the result of trophic or saprobic stress, influence of herbicides, severe acidification, clearing or mowing of the site or introduction of herbivorous fish.

4.1.1.5 Calculation of the Reference Index

For the **types MRK, MP(G), TR, TN_k, TN as well as TN_g** the Reference Index is calculated according to the following formula (Equation 2):

Equation 2: Calculation of the Reference Index

$$RI = \frac{\sum_{i=1}^{n_A} Q_{Ai} - \sum_{i=1}^{n_C} Q_{Ci}}{\sum_{i=1}^{n_g} Q_{gi}} * 100$$

RI = Reference Index
QAi = Quantity of the i-th taxon of group A
QCi = Quantity of the i-th taxon of group C
Qgi = Quantity of the i-th taxon of all groups
nA = Total number of taxa in group A
nC = Total number of taxa in group C
ng = Total number of taxa in all groups

For the MRS type the index calculation is carried out according to the following modified equation (Equation 3):

Equation 3: Calculation of the Reference Index for the MRS type

$$RI = \frac{\sum_{i=1}^{n_A} Q_{Ai} + \sum_{i=1}^{n_V} Q_{Vi} - \sum_{i=1}^{n_C} Q_{Ci}}{\sum_{i=1}^{n_g} Q_{gi}} * 100$$

RI = Reference Index
Q_{Ai} = Quantity of the i-th taxon of group A
Q_{Ci} = Quantity of the i-th taxon of group C
Q_{Vi} = Quantity of the i-th taxon of group V
Q_{gi} = Quantity of the i-th taxon of all groups
n_A = Total number of taxa in group A
n_C = Total number of taxa in group C
n_V = Total number of taxa in group V
n_g = Total number of taxa in all groups

4.1.2 Type specific characteristics of the assessment procedure

Upon determination of the Reference Index the following type specific characteristics and prerequisites must be considered.

4.1.2.1 MRK type

No specific characteristics must be considered for the assessment of the macrophyte MRK type.

The Reference Index is calculated according to equation 2.

No additional criteria are calculated.

4.1.2.2 MRS type

The Reference Index is calculated according to equation 3.

In addition to macrophyte depopulation a depopulation of mosses must be verified.

The relevant additional criterion for the MRS type is acidification. If **100% of the mosses** mapped in a certain section **belong to the species group V**, one is dealing with acidification. In such a case action needs to be taken at this sampling site.

4.1.2.3 MP(G) type

Type MPG is characterised by an increased influence of groundwater. In contrast to waters without groundwater influence, running waters **fed by** large amounts of **groundwater** have a smaller temperature amplitude, i.e. they are warmer in winter and cooler during the summer (POTT & REMY 2000). Generally, CO_2-contents are relatively high (SCHWOERBEL 1994) and in their natural state they are oligotrophic.

The reference index for the MP type and the MPG type is calculated according to equation 2.

For the subtypes MP and MPG the additional criterion “minimum number of species”, must be considered along with the RI-value.

If the value of the RI exceeds –70 and if there are less than 4 submerged taxa the RI value is reduced by 30.

4.1.2.4 TR type

The reference index for the TR type is calculated according to equation 2.

The additional criterion „dominance of helophytes“ is considered valid, if the river bed of a section is covered throughout with dense populations of one or several of the following **emerged** species:

- *Glyceria maxima*
- *Phalaris arundinacea*
- *Phragmites australis*
- *Sagittaria sagittifolia*
- *Sparganium emersum*
- *Sparganium erectum*
- *Urtica dioica*

Additional criteria for the TR type are:

- if RI ≥ 0 and dominance of helophytes, RI is reduced by 80

4.1.2.5 TN_k type

The reference index for the TN_k type is calculated according to equation 2.

For assessment of the additional criteria, the minimum number of species, the total quantity of the taxa *Myriophyllum spicatum* und *Ranunculus ssp.*, dominance of helophytes and evenness must be considered.

The additional criterion „dominance of helophytes“ is considered valid, if the river bed of a section is covered throughout with dense populations of one or several of the following **emerged** species:

- *Glyceria maxima*
- *Phalaris arundinacea*
- *Phragmites australis*
- *Sagittaria sagittifolia*
- *Sparganium emersum*
- *Sparganium erectum*
- *Urtica dioica*

The criterion „evenness“ (equation 5) is calculated based on the SHANNON & WEAVER(1949) diversity index (Equation 4).

Equation 4: Calculation of the Diversity Index

$$H_s = -\sum_{i=1}^{s} N_i \cdot \ln N_i$$

H_s = *Diversity Indey*
N_i = *Quantity of the species i/Total quantity of all species*
s = *Total number of taxa of the biocoenosis*

Equation 5: Calculation of Evenness

$$E = \frac{H_s}{\ln s}$$

E = *Evenness*
H_s = *SHANNON-WEAVER Diversity-Index*
s = *Total number of species*

Additional criteria for the TN_k type:

- if RI ≥ 0 and if there are less than five submerged taxa, the RI is reduced by 20
- if RI ≥ 0 and if evenness < 0,75, the RI is reduced by 30
- if RI ≥ 0 and if the total quantity of the taxa *Myriophyllum spicatum* and *Ranunculus spp*. > 60 % , the RI is reduced by 80
- if RI ≥ 0 and if there is a dominance of helophytes, the RI is reduced by 80
- if due to application of several criteria the RI falls < -100, a value of -100 will be stipulated

4.1.2.6 TN type

The Reference Index for the TN type is calculated according to equation 2.

For assessment of the additional criteria, the minimum number of species, the total quantity of the taxa *Myriophyllum spicatum* und *Ranunculus ssp*., dominance of helophytes and evenness must be considered.

The additional criterion „dominance of helophytes" is considered valid, if the river bed of a section is completely covered with dense populations of one or several of the following **emerged** species:

- *Glyceria maxima*
- *Phalaris arundinacea*
- *Phragmites australis*
- *Sagittaria sagittifolia*
- *Sparganium emersum*
- *Sparganium erectum*
- *Urtica dioica*

The criterion „evenness" (equation 5) is calculated based on the SHANNON & WEAVER(1949) diversity index (Equation 4).

Additional criteria for the TN type:

- if RI ≥ 0 and if there are less than five submerged taxa, the RI is reduced by 20
- if RI ≥ 0 and if evenness < 0,75, the RI is reduced by 30
- if RI ≥ 0 and if the total quantity of the taxa *Myriophyllum spicatum* and *Ranunculus spp*. > 60 % , the RI is reduced by 80
- if RI ≥ 0 and if there is a dominance of helophytes, the RI is reduced by 80
- if due to application of several criteria the IR falls < -100, a value of -100 will be stipulated

4.1.2.7 TN_g type

The Reference Index for the TN_g type is calculated according to equation 2.

For assessment of the additional criteria, a minimum number of species, the total quantity of the taxa *Myriophyllum spicatum* und *Ranunculus ssp*. and evenness must be considered.

The criterion „evenness" (equation 5) is calculated based on the SHANNON & WEAVER(1949) diversity index (Equation 4).

Additional criteria for the TN_g type:

- if RI ≥ -40 and if there are less than 5 submerged taxa, the RI is reduced by 20
- if RI ≥ -40 and if evenness < 0,75 the RI is reduced by 30
- if RI ≥ -40 and if the total quantity of the taxa *Myriophyllum spicatum* and *Ranunculus spp*. > 60 % , the RI is reduced by 80
- if due to application of several criteria the IR falls < -100, a value of -100 will be stipulated

4.2 Diatoms

4.2.1 Assessment module „Species Composition and Abundance“

Assessment is carried out using the percentage of cumulated frequencies of the general reference species present at the sampling site. A distinction is made between general reference species and type specific reference species. General reference species are mostly oligotraphent and oligo-mesotraphent diatoms, but few euryoecious species are included. The majority of species has a clear geochemical preference and is either characteristic for siliceous or calcareous waters. A small number of species is indifferent towards basicity and can be found in both geochemical types of water. The total of 442 general reference species and their geochemical preference can be found in Table 24. The attribution of the siliceous and calcareous reference species to the different diatom types is summarised in Table 18.

The list of general reference species does not for all biocoenotic types reflect the actual species composition in high condition. Instead it provides an open “pool of species” with room for future additions to the reference species list of the different diatom types (also see Schaumburg et al. 2005) which in the course of increasing number of investigated waters in high ecological condition and increasing knowledge can be expected. In case of most species, the geochemical preferences are known and can be backed up by sufficient literature data. If presently the geochemical preference cannot accurately be specified, it can be looked up in Table 24. This is especially true for rare and/or taxa generally represented only by a few individuals.

Table 18: Attribution of siliceous and calcareous reference species lists to the different diatom types. In this table subtypes are included in types of higher order.

Diatom type	Siliceous reference species	Calcareous reference species
1		x
2	x	x
3		x
4	x	x
5	x	
6	x	
7	x	x
8		x
9		x
10	x	x
11	x	x
12	x	x
13	x	x

The so called type specific reference species (Table 23) are neither limited to the respective type, nor can they be considered to be reference species sensu strictu. These taxa are wide spread and in certain types of water even in good or high ecological condition can occur in great numbers.

Evaluation is carried out with the cumulated frequencies of the general and type specific reference species present at the sampling site. Cumulated frequencies between 76% and 100% characterise the high ecological condition, values between 51% and 75% represent a good ecological condition. Cumulated frequencies between 26% and 50% reflect a moderate ecological condition.

Additionally diversity is considered for evaluation of communities (SCHAUMBURG et al. 2005) for the water types of the Central German Upland and the North German Lowland (Type D 5 to D 13, including subtypes). If in a sampling site of this type the percentage of a type specific reference species exceeds a value of 40% (massive occurrence), the value 25 is subtracted from the sum of all reference species representing the sample. If in the diatom types of the Central German Upland and North German Lowland there is a massive occurrence of a general reference species it is advisable to verify the assessment by carrying out an additional sampling procedure.

4.2.2 Assessment module „Trophic Index and Saprobic Index“

The biocoenotic types of running waters 1 to 12 are assessed based on the Trophic Index according to ROTT et al. (1999) (Equation 6). The species specific parameters are listed in Table 25.

The Saprobic Index is the basis for the assessment of diatom type 13 (large rivers and streams of the North German Lowland) (Equation 7, Table 25).

The importance of the trophic or saprobic situation in the respective water types is explained in detail in SCHAUMBURG et al. 2005.

Equation 6: Calculation of the Trophic Index according to ROTT et al. (1999)

$$TI = \frac{\sum_{i=1}^{n} TW_i * G_i * H_i}{\sum_{i=1}^{n} G_i * H_i}$$

TI : Trophic-Index
TW_i : Trophic value of the i-th species
G_i : Weighting of species i
H_i : Abundance of species i in percent

Equation 7: Calculation of the Saprobic Index according to ROTT et al. (1997)

$$SI = \frac{\sum_{i=1}^{n} SW_i * G_i * H_i}{\sum_{i=1}^{n} G_i * H_i}$$

SI : Saprobic Index
SWi : Saprobic value of species i
Gi : Weighting of species i
Hi : Abundance of species i in percent

4.2.3 Assessment module „Acidification Indicator“

For the rivers of the siliceous Central German Upland, especially for the waters of the variegated sandstone and the bedrock, the verification of acidification characteristics is indispensable and is carried out based on the occurrence of the quantitatively most important indicators of anthropogenic acidification (Table 19). These species are the typical components of undisturbed coenoses and therefore are listed as general reference species. However, if the ecological condition is high, there only is a small to moderate amount of these individuals. Only if acidification sets in, their portion rises and an extremely large number of individuals becomes a characteristic of permanently acidic plant communities.

Depending on the abundance of the acidification indicators the ecological status class determined based on the entire biocomponent Macrophytes & Phytobenthos is degraded according to Table 20 (compare chapter Combination of results with additional criteria, page 89). This simple way of incorporating degradation due to acidification is suitable for assessment according to the guidelines of the EC-WFD, but must not be regarded as a substitute of the existing procedures which exclusively serve to indicate acidification (e.g. CORING 1999). Application of this module is restricted to the siliceous waters of the Central German Upland.

Table 19: Indicators of anthropogenic acidification

DV-Nr	Name	Author
6253	Achnanthes helvetica	(HUSTEDT) LANGE-BERTALOT
6975	Eunotia exigua	(BREBISSON) RABENHORST
6214	Eunotia incisa	GREGORY
6375	Eunotia rhomboidea	HUSTEDT
6383	Eunotia tenella	(GRUNOW) HUSTEDT
6513	Navicula mediocris	KRASSKE
6543	Navicula soehrensis	KRASSKE
16074	Pinnularia silvatica	PETERSEN
6126	Pinnularia subcapitata var. subcapitata	GREGORY
6665	Pinnularia subcapitata var. hilseana	(JANISCH) O.MUELLER

Table 20: Assessment module „Acidification Indicator"

Cumulated frequency of acidification indicators	Degradation by
10% to 25%	one ecological status class
26% to 50%	two ecological status classes
51% to 99%	three ecological status classes
100%	four ecological status classes

4.2.4 Assessment module „Halobic Index"

In order to prove different degrees of salinisation in limnic water systems, the Halobic Index has proven its value. It is based on classifying species according to their occurrence in different zones of salinity (ZIEMANN 1971, 1999). Haloxenic or halophobic and halophilic taxa are differentiated. The group of halophilic taxa consists of halophilic, mesohalobic and polyhalobic forms, which altogether, without weighting, are considered for index calculation (Equation 8). The list of species is summarised in Table 26. Limnic (without oligohalobic preferences) taxa are not included in this list, but they are part of the sum in the denominator and thus are considered during calculation.

Halobic indices close to 0 are characteristic for typical soft waters, negative indices are characteristic for waters with low salinity which often are poor in electrolytes and/or are acidic. Values between +10 and +30 indicate and increased salt content. At a value of +30 one speaks of moderate salinisation and at values of +50 of severe salinisation. As summarised in Table 22, this is incorporated into an assessment module and follows the definition of ZIEMANN (1999). If the Halobic Index exceeds a value of 15 and if the assessment module Diatoms is applied exclusively and independent of an assessment according to the WFD, the ecological status class is degraded by one. For assessment according to the EU-Water Framework Directive by the means of the biocomponent Macrophytes & Phytobenthos, the metric „Salinisation" only has an informative character and can, if necessary, be employed to plan restoration measures.

In waters affected by salinisation often mass occurrences of halophilic and/or mesohalobic species can be observed. If the halobic index is calculated based on percentages, indicative species of which only a small number of individuals were found are underrepresented. Therefore, abundances are used to calculate the Halobic Index (ZIEMANN et al. 1999). For this purpose percentage values must be transformed into abundance values according to Table 21.

For waters of type 14 and type 15 with a natural saline influence the Halobic Index is not valid. The same is true for naturally saline running waters, e.g. those influenced by a brine source. The Halobic Index cannot be used for assessment.

The „Salinisation" module only serves as an addition in assessing degraded waters with a moderate to poor condition. For type specificity is not considered this criterion has relatively little differentiating power.

Equation 8: Calculation of the Halobic Index

$$H = \frac{\sum h_H - \sum h_x}{\sum h} * 100$$

Σ h_H = Sum of abundances of the halophil, mesohalobic and polyhalobic taxa
Σ h_{hx} = Sum of abundances of haloxenic taxa
Σ h = Sum of abundances of all taxa present in the sample

Table 21: Transformation of percentages into abundance values

Percentage	Abundance
≤ 1,0 %	2
> 1,0 % and ≤ 2,5 %	3
> 2,5 % and ≤ 10,0 %	5
> 10,0 % and ≤ 25,0 %	7
> 25,0 %	9

Table 22: Assessment module „Salinisation“

Halobic Index	Degradation by
> 15	one ecological status class

4.2.5 Determination of ecological quality by combination of modules

4.2.6 Module Diatoms

The overall assessment of the sub module Diatoms is carried out by combining the modules „Species Composition and Abundance“ and „Trophic Index and Saprobic Index“ to obtain the DIÖZ$_{\text{Fließgewässer}}$ (Diatom Indicted Ecological Status$_{\text{running waters}}$). For this combination the calculated values of both components (Equation 9, Equation 10, Equation 11) are transformed and the arithmetic mean of all results is determined (Equation 12, Equation 13). This mean value called Diatom Index$_{\text{Fließgewässer}}$ (DI$_{FG}$ or Diatom Index$_{\text{running waters}}$) is considered when calculating the ecological status class for Macrophytes & Phytobenthos.

If sampling was carried out twice, the diatom index with the higher value or the lower ecological status class is used as a basis.

Equation 9: Transformation of the sum of reference species

$$M_{ASR} = \frac{\sum_{i=1}^{n} RA_i}{100}$$

M_{ASR} :Module Cumulated Abundances of Reference Species
RA_i :Abundance of reference species i
n :Total number of all general and type specific reference species present in a sample

Equation 10: Transformation of the Trophic Index (diatom types 1 to 12)

$$M_{TI} = 1 - ((TI - 0{,}3) / 3{,}6)$$

M_{TI} :Module Trophic Index
TI :calculated Trophic Index

Equation 11: Transformation of the Saprobic Index (diatom type 13)

$$M_{SI} = 1 - ((SI - 1) / 2,8)$$

M_{SI} :Module Saprobic Index
SI :calculated Saprobic Index

Equation 12: Calculation of the DI_{FG} for the diatom types 1 to12

$$DI_{FG} = \frac{M_{ASR} + M_{TI}}{2}$$

M_{ASR} :Module Cumulated Abundances of Reference Species
TI :calculated Trophic Index

Equation 13: Calculation of the DI_{FG} for the diatom type 13

$$DI_{FG} = \frac{M_{ASR} + M_{SI}}{2}$$

M_{ASR} :Module Cumulated Abundances of Reference Species
SI :calculated Saprobic Index

4.2.7 Further Metrics

In addition to the tree modules relevant for assessment further evaluation of structural community aspects can provide additional information regarding the ecological quality of the sampling section as well as helpful hints for interpretation. This is especially true for the abundance of planktonic taxa, the occurrence of Red List taxa and the heterogeneity of a community in view of autecological aspects. For there is still insufficient data, the aspects mentioned cannot yet be incorporated into the assessment procedure.

4.2.7.1 Frequency of planktonic taxa in rivers and small streams

The occurrence of planktonic taxa in rivers (catchment area < 100 km^2) is the direct consequence of structural degradation due to dams and weirs. In extreme cases, the diatomaceous plancton exerts a considerable influence on the benthic communities (e.g. by shading, nutrient competition or release of nutrients).With its seasonal dynamic, it also essentially influences the natural environmental conditions of the benthic communities. No sufficient data is available to answer the question of how likely it is that diatomaceous plancton naturally develops in small streams (catchment area> 100 km^2 and < 1.000 km^2). According to MISCHKE (2005) small streams which are characterised by chlorophyll a contents of more than 20 µg/l do not typically have a lot of plancton. The frequency of planktonic species can be estimated in classes or by counting 100 objects to determine the portion of plancton. Information regarding life forms can be found in KRAMMER & LANGE-BERTALOT (1986-1991). In principle the determination of planktonic forms is not required, but can turn out to be helpful additional information.

4.2.7.2 Occurrence Red List species

A Red List Index was developed for the purpose of comparing the inventory and frequency of endangered taxa (RLI, SCHAUMBURG et al. 2004a) which calculatively corresponds to the Rheo-Index of BANNING (1990). It is based on LANGE-BERTALOT'S (1996) endangered species list (Red List) of German diatoms consisting of 535 taxa. This corresponds to 37% of all species listed in

Germany. Almost all of the species listed as endangered are restricted to oligotrophic or dystrophic habitats which are extremely endangered habitats. Due to eutrophication, punctual introduction of nutrients or acidification due to atmospheric depositions of sulphur dioxide, the number of these habitats has drastically declined in the past decades. The Red List species are endangered to different degrees. This is accounted for by a special weighting of species (Equation 14).

Equation 14: Red List-Index (RLI)

$$RLI = \frac{6*(\sum Ai; RL1) + 5*(\sum Ai; RL2) + 4*(\sum Ai; RL3) + 3*(\sum Ai; RL4) + 2*(\sum Ai; RL5)}{6*(\sum Ai; RL1) + 5*(\sum Ai; RL2) + 4*(\sum Ai; RL3) + 3*(\sum Ai; RL4) + 2*(\sum Ai; RL5) + 1*(\sum Ai; RL6)}$$

RLI = *Red List-Index*
Ai = *relative abundances of the species i in percent*
RLx = *Category of endangerment according to* LANGE-BERTALOT *(1996)*
RL1 = *„threatened with extinction“*
RL2 = *„extremely endangered or near threatened“*
RL3 = *„endangered“*
RL4 = *„endangerment assumed“*
RL5 = *„extremely rare“*
RL6 = *species not categorised or not endangered*

Regarding the aptitude of the RLI, data is only available from the project „Development of an ecological assessment procedure for running waters and lakes pertaining to macrophytes and phytobenthos for implementation of the EC-Water Framework Directive” and the “Nationwide test: Assessment procedure for macrophytes and phytobenthos in running waters for implementation of the EC-Water Framework Directive”. In contrast to lakes high values are only rarely reached in running waters. The highest possible index value is 1,0. Only in 2,7% of a total of 1215 evaluated samples values exceeding 0,30 were noted. For 1% of all samples a value of 0,50 was exceeded and the highest index value was 0,96. Type specific concentrations of values were observed. The highest indices were noted for the diatom types 1 and 5 as well as for marshes and outflows of lakes.

4.2.7.3 Autoecological heterogeneity

If there is a great variance of the autecological characteristics of the species present one has to suspect disturbances of the community limited in space and time. Fluctuating conditions can be the result of punctual or short term saprobic and trophic stress or as a result of recurring acidification processes. In such cases a second sampling routine is strongly recommended. Marshes (diatom type 14) are an exception, as a characteristic of these communities is the coexistence of marine taxa and reference species of siliceous waters or of waters with a strong organic influence.

Table 23: Type specific reference species
If no varieties are mentioned the type variety is meant, i.e. variety name corresponds to species name

DV-Nr.	Taxon	Diatom type												
		1	2	3	4	5	6	7	8	9	10	11	12	13
6180	Achnanthes clevei										x		x	x
6855	Achnanthes conspicua									x	x		x	x
6703	Achnanthes kolbei												x	
6260	Achnanthes lanceolata ssp. frequentissima					x	x					x		
16127	Achnanthes lanceolata ssp. lanceolata					x	x	x				x		
6263	Achnanthes lauenburgiana								x				x	
6984	Achnanthes ploenensis										x		x	x
6983	Amphora pediculus		x	x	x				x	x	x		x	x
6306	Cocconeis neothumensis										x		x	x
6020	Cocconeis pediculus													x
6726	Cocconeis placentula var. euglypta		x	x	x	x	x	x	x	x	x		x	x
6728	Cocconeis placentula var. lineata		x	x	x	x	x	x	x	x	x		x	x
6021	Cocconeis placentula var. placentula		x	x	x	x	x	x	x	x	x		x	x
6307	Cocconeis pseudothumensis												x	
6891	Cymbella caespitosa													x
6059	Cymbella cistula													x
6323	Cymbella helvetica var. compacta													x
6334	Cymbella reichardtii												x	
6898	Cymbella silesiaca			x	x		x	x		x	x		x	
6065	Cymbella sinuata		x	x	x	x	x	x	x	x	x	x	x	x
6006	Diatoma vulgaris													x
6385	Fragilaria bicapitata					x						x	x	
6388	Fragilaria brevistriata										x		x	x
6390	Fragilaria capucina var. capucina					x	x	x		x	x	x	x	x
16571	Fragilaria capucina distans-Sippen												x	x
6393	Fragilaria capucina var. mesolepta						x						x	x
6034	Fragilaria construens f. construens										x	x	x	x
6397	Fragilaria construens f. binodis										x	x	x	x
6828	Fragilaria construens f. venter					x	x	x		x	x	x	x	x
6915	Fragilaria famelica											x	x	
167888	Fragilaria sp. (Krammer & Lange-Bertalot, 1991, 3. Teil, Tafel 112: 10, 11)					x						x		
6774	Fragilaria leptostauron var. dubia												x	x
6076	Fragilaria leptostauron var. leptostauron												x	x
6078	Fragilaria pinnata					x	x	x		x	x	x	x	x
6079	Frustulia vulgaris					x						x	x	
16594	Gomphonema grovei var. lingulatum													x
6912	Gomphonema minutum													x
6867	Gomphonema olivaceum			x	x				x	x	x		x	x
6158	Gomphonema parvulum (excl. f. saprophilum)					x	x	x				x		
6437	Gomphonema pumilum	x	x	x	x		x		x	x	x		x	x
6897	Gomphonema tergestinum	x		x	x					x	x		x	x
6910	Navicula capitatoradiata													x
6010	Navicula cryptocephala					x								
6889	Navicula cryptotenella		x	x	x				x	x	x		x	x
6473	Navicula decussis													x
6507	Navicula joubaudii													x
6221	Navicula reichardtiana													x
6022	Navicula rhynchocephala					x		x				x	x	x
6106	Navicula subhamulata													x
6831	Navicula tripunctata													x
6008	Nitzschia dissipata													x
6025	Nitzschia fonticola			x	x						x			x
6603	Nitzschia palea var. debilis					x	x	x						
6918	Nitzschia pura			x	x									
6029	Nitzschia recta													x
6224	Rhoicosphenia abbreviata													x

Table 24: General reference species

Geochemistry: marked blue: = Reference species of siliceous waters, marked yellow: = Reference species of calcareous waters; marked grey = to be considered as a reference species due to their trophic sensitivity (data regarding geochemical preferences still insufficient).

If no varieties are mentioned the type variety is meant, i.e. variety name corresponds to species name.

DV-Nr.	Taxa	Author	Geochemistry	
6699	Achnanthes altaica	(PORETZKY) CLEVE-EULER	S	
6139	Achnanthes biasolettiana	GRUNOW	S	K
16106	Achnanthes biasolettiana var. subatomus	LANGE-BERTALOT	S	K
6835	Achnanthes bioretii	GERMAIN	S	K
6246	Achnanthes calcar	CLEVE	S	K
16108	Achnanthes carissima	LANGE-BERTALOT	S	
6700	Achnanthes chlidanos	HOHN & HELLERMANN	S	
16111	Achnanthes daonensis	LANGE-BERTALOT	S	
6701	Achnanthes daui	FOGED	S	
16113	Achnanthes delicatula ssp. hauckiana	LANGE-BERTALOT		K
16114	Achnanthes didyma	HUSTEDT	S	
16116	Achnanthes distincta	MESSIKOMMER	S	
6249	Achnanthes exilis	KUETZING		K
6250	Achnanthes flexella	(KUETZING) BRUN	S	K
6251	Achnanthes flexella var. alpestris	BRUN	S	K
6252	Achnanthes grischuna	WUTHRICH	S	K
6253	Achnanthes helvetica	(HUSTEDT) LANGE-BERTALOT	S	
16118	Achnanthes impexiformis	LANGE-BERTALOT	S	
6255	Achnanthes joursacense	HERIBAUD	S	K
6256	Achnanthes kranzii	LANGE-BERTALOT	S	
6257	Achnanthes kryophila	PETERSEN	S	K
16119	Achnanthes kuelbsii	LANGE-BERTALOT	S	
16121	Achnanthes lacus-vulcani	LANGE-BERTALOT & KRAMMER	S	
6258	Achnanthes laevis	OESTRUP	S	K
16122	Achnanthes laevis var. austriaca	(HUSTEDT) LANGE-BERTALOT	S	K
6259	Achnanthes laevis var. quadratarea	(OESTRUP) LANGE-BERTALOT	S	K
6262	Achnanthes lapidosa	KRASSKE	S	
6705	Achnanthes laterostrata	HUSTEDT	S	K
6264	Achnanthes levanderi	HUSTEDT	S	
16683	Achnanthes linearioides	LANGE-BERTALOT	S	
6706	Achnanthes lutheri	HUSTEDT	S	K
6265	Achnanthes marginulata	GRUNOW	S	
16529	Achnanthes microscopica	(CHOLNOKY) LANGE-B. & KRAMMER	S	
6014	Achnanthes minutissima	KUETZING	S	K
6240	Achnanthes minutissima var. gracillima	(MEISTER) LANGE-BERTALOT		K
6267	Achnanthes minutissima var. scotica	(CARTER) LANGE-BERTALOT	S	K
6709	Achnanthes nodosa	CLEVE	S	
6268	Achnanthes oblongella	OESTRUP	S	
6270	Achnanthes peragalli	BRUN & HERIBAUD	S	
6271	Achnanthes petersenii	HUSTEDT	S	K
16140	Achnanthes pseudoswazi	CARTER	S	
6272	Achnanthes pusilla	(GRUNOW) DE TONI	S	
6711	Achnanthes rechtensis	LECLERCQ	S	
6273	Achnanthes rosenstockii	LANGE-BERTALOT		K
16143	Achnanthes rossii	HUSTEDT	S	
6275	Achnanthes silvahercynia	LANGE-BERTALOT	S	
6276	Achnanthes subatomoides	(HUSTEDT) LANGE-B. & ARCHIBALD	S	
16146	Achnanthes subexigua	HUSTEDT	S	
6277	Achnanthes suchlandtii	HUSTEDT	S	
6279	Achnanthes trinodis	(W.SMITH) GRUNOW		K
6713	Achnanthes ventralis	(KRASSKE) LANGE-BERTALOT	S	
6283	Amphora fogediana	KRAMMER	S	K
6171	Amphora inariensis	KRAMMER	S	K
6288	Amphora thumensis	(A.MAYER) CLEVE-EULER		K
6289	Amphora veneta var. capitata	HAWORTH		K
6172	Asterionella ralfsii	W.SMITH	S	
6291	Brachysira brebissonii	ROSS	S	
6292	Brachysira calcicola	LANGE-BERTALOT		K
16165	Brachysira follis	(EHRENBERG) ROSS	S	
16166	Brachysira garrensis	(LANGE-B. & KRAMMER) LANGE-B.	S	
6293	Brachysira hofmanniae	LANGE-BERTALOT		K
6294	Brachysira liliana	LANGE-BERTALOT		K
6295	Brachysira neoexilis	LANGE-BERTALOT	S	K
16167	Brachysira procera	LANGE-BERTALOT & MOSER	S	K

DV-Nr.	Taxa	Author	Geochemistry	
6296	Brachysira serians	(BREBISSON) ROUND & MANN	S	
6297	Brachysira styriaca	(GRUNOW) ROSS	S	K
6298	Brachysira vitrea	(GRUNOW) ROSS		K
16168	Brachysira wygaschii	LANGE-BERTALOT	S	
6299	Brachysira zellensis	(GRUNOW) ROUND & MANN	S	K
6300	Caloneis aerophila	BOCK	S	
6166	Caloneis alpestris	(GRUNOW) CLEVE		K
16690	Caloneis bottnica	CLEVE		K
6301	Caloneis latiuscula	(KUETZING) CLEVE	S	K
6721	Caloneis lauta	CARTER & BAILEY-WATTS	S	
16169	Caloneis lepidula	(GRUNOW) CLEVE	S	
6174	Caloneis leptosoma	(GRUNOW) KRAMMER	S	
6302	Caloneis obtusa	(W.SMITH) CLEVE	S	K
6304	Caloneis schumanniana	(GRUNOW) CLEVE		K
6810	Caloneis tenuis	(GREGORY) KRAMMER		K
6175	Caloneis undulata	(GREGORY) KRAMMER	S	
6058	Cymbella affinis	KUETZING		K
6310	Cymbella alpina	GRUNOW		K
6311	Cymbella amphicephala	NAEGELI	S	K
6739	Cymbella amphicephala var. hercynica	(SCHMIDT) CLEVE	S	K
6740	Cymbella amphioxys	(KUETZING) CLEVE	S	
6312	Cymbella ancyli	CLEVE		K
6741	Cymbella angustata	(W.SMITH) CLEVE	S	
6313	Cymbella austriaca	GRUNOW		K
16195	Cymbella austriaca var. erdobenyiana	(PANTOCSEK) KRAMMER		K
6314	Cymbella brehmii	HUSTEDT	S	K
6183	Cymbella cesatii	(RABENHORST) GRUNOW	S	K
6979	Cymbella cymbiformis	J.G.AGARDH	S	K
6315	Cymbella delicatula	KUETZING		K
6316	Cymbella descripta	(HUSTEDT) KRAMMER & LANGE-B.	S	K
6317	Cymbella elginensis	KRAMMER	S	
6318	Cymbella falaisensis	(GRUNOW) KRAMMER & LANGE-B.	S	K
6319	Cymbella gaeumannii	MEISTER	S	
6320	Cymbella gracilis	(EHRENBERG) KUETZING	S	
6321	Cymbella hebridica	(GRUNOW) CLEVE	S	
6184	Cymbella helvetica	KUETZING		K
6978	Cymbella hustedtii	KRASSKE		K
6324	Cymbella hybrida	GRUNOW		K
16581	Cymbella hybrida var. lanceolata	KRAMMER		K
6325	Cymbella incerta	(GRUNOW) CLEVE	S	K
6327	Cymbella laevis	NAEGELI		K
6328	Cymbella lapponica	GRUNOW	S	K
6331	Cymbella mesiana	CHOLNOKY	S	
6895	Cymbella microcephala	GRUNOW	S	K
6909	Cymbella minuta	HILSE	S	K
16196	Cymbella naviculacea	GRUNOW	S	K
6063	Cymbella naviculiformis	AUERSWALD	S	
6747	Cymbella norvegica	GRUNOW	S	
6332	Cymbella obscura	KRASSKE	S	K
16197	Cymbella paucistriata	CLEVE-EULER	S	K
6977	Cymbella perpusilla	CLEVE-EULER	S	
6333	Cymbella proxima	REIMER		K
6749	Cymbella reinhardtii	GRUNOW	S	K
6335	Cymbella rupicola	GRUNOW	S	
16199	Cymbella schimanskii	KRAMMER		K
6337	Cymbella similis	KRASSKE		K
6336	Cymbella simonsenii	KRAMMER		K
6338	Cymbella stauroneiformis	LAGERSTEDT	S	K
6150	Cymbella subaequalis	GRUNOW	S	K
6067	Cymbella tumidula	GRUNOW		K
6339	Cymbella tumidula var. lancettula	KRAMMER		K
6340	Denticula kuetzingii	GRUNOW		K
6068	Denticula tenuis	KUETZING		K
6185	Diatoma anceps	(EHRENBERG) KIRCHNER	S	
6208	Diatoma ehrenbergii	KUETZING		K
6167	Diatoma hyemalis	(ROTH) HEIBERG	S	
6949	Diatoma mesodon	(EHRENBERG) KUETZING	S	K
16208	Diatomella balfouriana	GREVILLE	S	
16209	Didymosphenia geminata	(LYNGBYE) M.SCHMIDT		K
6341	Diploneis alpina	MEISTER	S	K

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6807	Diploneis elliptica	(KUETZING) CLEVE		K
6345	Diploneis modica	HUSTEDT		K
6346	Diploneis oblongella	(NAEGELI) CLEVE-EULER		K
6070	Diploneis ovalis	(HILSE) CLEVE		K
6348	Diploneis parma	CLEVE	S	
6349	Diploneis petersenii	HUSTEDT	S	
6754	Entomoneis ornata	(BAILEY) REIMER	S	K
6351	Epithemia goeppertiana	HILSE		K
6352	Epithemia smithii	CARRUTHERS		K
16666	Eunotia angusta	(GRUNOW) BERG	S	
6354	Eunotia arcubus	NOERPEL & LANGE-BERTALOT		K
16221	Eunotia arculus	(GRUNOW) LANGE-B. & NOERPEL	S	
6886	Eunotia arcus	EHRENBERG	S	
6213	Eunotia bilunaris	(EHRENBERG) MILLS	S	K
16222	Eunotia bilunaris var. linearis	(OKUNO) LANGE-B. & NOERPEL	S	
6355	Eunotia bilunaris var. mucophila	LANGE-BERTALOT & NOERPEL	S	
6761	Eunotia botuliformis	WILD et al.	S	
16223	Eunotia circumborealis	LANGE-BERTALOT & NOERPEL	S	
6356	Eunotia denticulata	(BREBISSON) RABENHORST	S	
6357	Eunotia diodon	EHRENBERG	S	
16224	Eunotia elegans	OESTRUP	S	
6975	Eunotia exigua	(BREBISSON) RABENHORST	S	
16225	Eunotia exigua var. undulata	MAGDEBURG	S	
6358	Eunotia faba	EHRENBERG	S	
6359	Eunotia fallax	A.CLEVE	S	
6360	Eunotia flexuosa	(BREBISSON) KUETZING	S	
6362	Eunotia glacialis	MEISTER	S	
6363	Eunotia hexaglyphis	EHRENBERG	S	
6364	Eunotia implicata	NOERPEL et al.	S	
6214	Eunotia incisa	GREGORY	S	
6365	Eunotia intermedia	(KRASSKE) NOERPEL & LANGE-B.	S	
16226	Eunotia islandica	OESTRUP	S	
16104	Eunotia jemtlandica	(FONTELL) BERG	S	
16228	Eunotia major	(W.SMITH) RABENHORST	S	
6367	Eunotia meisteri	HUSTEDT	S	
6368	Eunotia microcephala	KRASSKE	S	
6369	Eunotia minor	(KUETZING) GRUNOW	S	K
6885	Eunotia monodon	EHRENBERG	S	
6370	Eunotia muscicola var. tridentula	NOERPEL & LANGE-BERTALOT	S	
6371	Eunotia naegelii	MIGULA	S	
16695	Eunotia neofallax	NOERPEL	S	
6372	Eunotia nymanniana	GRUNOW	S	
6373	Eunotia paludosa	GRUNOW	S	
6884	Eunotia paludosa var. trinacria	(KRASSKE) NOERPEL	S	
6168	Eunotia pectinalis	(DILLWYN) RABENHORST	S	
6766	Eunotia pectinalis var. undulata	(RALFS) RABENHORST	S	
6851	Eunotia praerupta	EHRENBERG	S	
6374	Eunotia praerupta var. bigibba	(KUETZING) GRUNOW	S	
6768	Eunotia praerupta var. curta	GRUNOW	S	
6769	Eunotia praerupta var. inflata	GRUNOW	S	
16229	Eunotia pseudopectinalis	HUSTEDT	S	
6375	Eunotia rhomboidea	HUSTEDT	S	
16230	Eunotia rhynchocephala	HUSTEDT	S	
6376	Eunotia septentrionalis	OESTRUP	S	
6850	Eunotia serra	EHRENBERG	S	
6770	Eunotia serra var. diadema	(EHRENBERG) PATRICK	S	
6377	Eunotia serra var. tetraodon	(EHRENBERG) NOERPEL	S	
6378	Eunotia silvahercynia	NOERPEL et al.	S	
6379	Eunotia soleirolii	(KUETZING) RABENHORST	S	
6380	Eunotia steineckei	PETERSEN	S	
6381	Eunotia subarcuatoides	ALLES et al.	S	
6382	Eunotia sudetica	O.MUELLER	S	
6383	Eunotia tenella	(GRUNOW) HUSTEDT	S	
6771	Eunotia triodon	EHRENBERG	S	
16233	Fragilaria acidoclinata	LANGE-BERTALOT & HOFMANN	S	
6077	Fragilaria arcus	(EHRENBERG) CLEVE	S	K
6908	Fragilaria capucina var. amphicephala	(GRUNOW) LANGE-BERTALOT		K
6389	Fragilaria capucina var. austriaca	(GRUNOW) LANGE-BERTALOT		K
6392	Fragilaria capucina var. gracilis	(OESTRUP) HUSTEDT	S	K
6396	Fragilaria capucina var. rumpens	(KUETZING) LANGE-BERTALOT	S	K

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16234	Fragilaria constricta	EHRENBERG	S	
6399	Fragilaria delicatissima	(W.SMITH) LANGE-BERTALOT		K
6401	Fragilaria exigua	GRUNOW	S	
6405	Fragilaria nanana	LANGE-BERTALOT	S	K
6407	Fragilaria pseudoconstruens	MARCINIAK	S	
6409	Fragilaria tenera	(W.SMITH) LANGE-BERTALOT	S	K
6169	Fragilaria virescens	RALFS	S	
6187	Frustulia rhomboides	(EHRENBERG) DE TONI	S	
6412	Frustulia rhomboides var. crassinervia	(BREBISSON) ROSS	S	
6413	Frustulia rhomboides var. saxonica	(RABENHORST) DE TONI	S	
6414	Frustulia rhomboides var. viridula	(BREBISSON) CLEVE	S	
6417	Gomphonema acutiusculum	(O.MUELLER) CLEVE-EULER	S	K
16246	Gomphonema amoenum	LANGE-BERTALOT	S	
6819	Gomphonema angustum	J.G.AGARDH		K
6419	Gomphonema auritum	A.BRAUN	S	K
6420	Gomphonema bavaricum	REICHARDT & LANGE-BERTALOT		K
6421	Gomphonema bohemicum	REICHELT & FRICKE	S	
6423	Gomphonema dichotomum	KUETZING	S	K
6424	Gomphonema hebridense	GREGORY	S	
6425	Gomphonema helveticum	BRUN		K
16661	Gomphonema lacus-vulcani	REICHARDT & LANGE-BERTALOT	S	
6426	Gomphonema lagerheimii	A.CLEVE	S	
6427	Gomphonema lateripunctatum	REICHARDT & LANGE-BERTALOT		K
6429	Gomphonema occultum	REICHARDT & LANGE-BERTALOT		K
6430	Gomphonema olivaceum v. minutissimum	HUSTEDT	S	
6431	Gomphonema olivaceum v. olivaceoides	(HUSTEDT) LANGE-B. & REICHARDT	S	K
6433	Gomphonema parvulum var. exilissimum	GRUNOW	S	K
16258	Gomphonema parvulum var. parvulius	LANGE-BERTALOT & REICHARDT	S	K
6434	Gomphonema procerum	REICHARDT & LANGE-BERTALOT		K
6435	Gomphonema productum	(GRUNOW) LANGE-B. & REICHARDT	S	
16586	Gomphonema rhombicum	FRICKE	S	
6440	Gomphonema subtile	EHRENBERG	S	K
6441	Gomphonema tenue	FRICKE		K
6999	Gomphonema ventricosum	GREGORY	S	K
6442	Gomphonema vibrio	EHRENBERG		K
6804	Mastogloia grevillei	W.SMITH		K
6445	Mastogloia smithii var. lacustris	GRUNOW		K
6446	Meridion circulare var. constrictum	(RALFS) VAN HEURCK	S	K
6448	Navicula absoluta	HUSTEDT	S	K
16717	Navicula adversa	KRASSKE	S	
6809	Navicula angusta	GRUNOW	S	
16289	Navicula aquaedurae	LANGE-BERTALOT		K
6460	Navicula brockmannii	HUSTEDT	S	
6461	Navicula bryophila	PETERSEN	S	K
6464	Navicula catalanogermanica	LANGE-BERTALOT & HOFMANN	S	K
16300	Navicula cataractarheni	LANGE-BERTALOT		K
6969	Navicula cocconeiformis	GREGORY	S	K
6468	Navicula concentrica	CARTER	S	K
6472	Navicula dealpina	LANGE-BERTALOT		K
16308	Navicula declivis	HUSTEDT	S	
6474	Navicula densilineolata	(LANGE-B.) LANGE-BERTALOT		K
6475	Navicula detenta	HUSTEDT	S	
16000	Navicula digitulus	HUSTEDT	S	
6478	Navicula diluviana	KRASSKE		K
16001	Navicula disjuncta	HUSTEDT	S	
6482	Navicula evanida	HUSTEDT	S	
6917	Navicula exilis	KUETZING	S	
6485	Navicula festiva	KRASSKE	S	
6489	Navicula gallica var. perpusilla	(GRUNOW) LANGE-BERTALOT	S	
6493	Navicula gotlandica	GRUNOW		K
6496	Navicula heimansioides	LANGE-BERTALOT	S	
16324	Navicula hoefleri	CHOLNOKY	S	
6501	Navicula ignota var. acceptata	(HUSTEDT) LANGE-BERTALOT	S	K
6502	Navicula ignota var. palustris	(HUSTEDT) LUND	S	
6505	Navicula jaagii	MEISTER	S	K
6506	Navicula jaernefeltii	HUSTEDT		K
6509	Navicula krasskei	HUSTEDT	S	
6882	Navicula laevissima	KUETZING	S	K
16010	Navicula lapidosa	KRASSKE	S	
16334	Navicula laticeps	HUSTEDT		K

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16335	Navicula leistikowii	LANGE-BERTALOT		K
6923	Navicula lenzii	HUSTEDT		K
16011	Navicula leptostriata	JOERGENSEN	S	
16337	Navicula levanderii	HUSTEDT	S	
6511	Navicula lundii	REICHARDT	S	K
16012	Navicula maceria	SCHIMANSKI	S	
16342	Navicula mediocostata	REICHARDT		K
6513	Navicula mediocris	KRASSKE	S	
6515	Navicula minuscula	GRUNOW	S	
16349	Navicula notha	WALLACE	S	
6521	Navicula oligotraphenta	LANGE-BERTALOT & HOFMANN		K
16356	Navicula porifera var. opportuna	(HUSTEDT) LANGE-BERTALOT	S	
6524	Navicula praeterita	HUSTEDT		K
6527	Navicula pseudobryophila	(HUSTEDT) HUSTEDT	S	
6529	Navicula pseudoscutiformis	HUSTEDT	S	K
16028	Navicula pseudosilicula	HUSTEDT	S	
6530	Navicula pseudotuscula	HUSTEDT		K
6533	Navicula pusio	CLEVE	S	
6536	Navicula rotunda	HUSTEDT	S	
6538	Navicula schadei	KRASSKE		K
6539	Navicula schmassmannii	HUSTEDT	S	
6926	Navicula schoenfeldii	HUSTEDT		K
6543	Navicula soehrensis	KRASSKE	S	
16034	Navicula soehrensis var. hassiaca	(KRASSKE) LANGE-BERTALOT	S	
6544	Navicula soehrensis var. muscicola	(PETERSEN) KRASSKE	S	
16035	Navicula stankovicii	HUSTEDT		K
6546	Navicula stroemii	HUSTEDT		K
6547	Navicula subalpina	REICHARDT		K
6549	Navicula submolesta	HUSTEDT	S	
6878	Navicula subtilissima	CLEVE	S	
6551	Navicula suchlandtii	HUSTEDT	S	
6554	Navicula tridentula	KRASSKE	S	
6989	Navicula tuscula	(EHRENBERG) GRUNOW		K
6556	Navicula utermoehlii	HUSTEDT		K
16037	Navicula variostriata	KRASSKE	S	
16736	Navicula ventraloconfusa	LANGE-BERTALOT	S	
6560	Navicula vulpina	KUETZING		K
6561	Navicula wildii	LANGE-BERTALOT		K
6820	Neidium affine	(EHRENBERG) PFITZER	S	K
6562	Neidium affine var. longiceps	(GREGORY) CLEVE	S	K
6563	Neidium alpinum	HUSTEDT	S	
6564	Neidium ampliatum	(EHRENBERG) KRAMMER	S	K
6566	Neidium bisulcatum	(LAGERSTEDT) CLEVE	S	
6567	Neidium carterii	KRAMMER	S	
16383	Neidium densestriatum	(OESTRUP) KRAMMER	S	
6568	Neidium hercynicum	A.MAYER	S	
6109	Neidium iridis	(EHRENBERG) CLEVE	S	
16386	Neidium ladogensis	(CLEVE) FOGED	S	
6110	Neidium productum	(W.SMITH) CLEVE	S	
6571	Neidium septentrionale	CLEVE-EULER	S	
6573	Nitzschia acidoclinata	LANGE-BERTALOT	S	K
6575	Nitzschia alpina	HUSTEDT	S	
16100	Nitzschia alpinobacillum	LANGE-BERTALOT	S	K
6577	Nitzschia bacilliformis	HUSTEDT		K
16396	Nitzschia bryophila	(HUSTEDT) HUSTEDT	S	
16579	Nitzschia dissipata ssp. oligotraphenta	LANGE-BERTALOT	S	K
6586	Nitzschia dissipata var. media	(HANTZSCH) GRUNOW	S	K
6587	Nitzschia diversa	HUSTEDT		K
6589	Nitzschia fibulafissa	LANGE-BERTALOT		K
16749	Nitzschia garrensis	HUSTEDT	S	
6592	Nitzschia gessneri	HUSTEDT		K
6593	Nitzschia gisela	LANGE-BERTALOT		K
6931	Nitzschia hantzschiana	RABENHORST	S	K
16051	Nitzschia homburgiensis	LANGE-BERTALOT	S	
6597	Nitzschia lacuum	LANGE-BERTALOT	S	K
16433	Nitzschia paleaeformis	HUSTEDT	S	
6605	Nitzschia perminuta	(GRUNOW) M.PERAGALLO	S	K
6607	Nitzschia radicula	HUSTEDT		K
6608	Nitzschia regula	HUSTEDT		K
16455	Nupela rhetica	(WUETHRICH) LANGE-BERTALOT	S	K

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16456	Nupela tenuicephala	(HUSTEDT) LANGE-BERTALOT	S	
6619	Peronia fibula	(BREBISSON) ROSS	S	
6620	Pinnularia acoricola	HUSTEDT	S	
6877	Pinnularia acuminata	W.SMITH	S	
6621	Pinnularia anglica	KRAMMER	S	
6622	Pinnularia angusta	(CLEVE) KRAMMER	S	
16543	Pinnularia bacilliformis	KRAMMER	S	
16461	Pinnularia balfouriana	GRUNOW	S	K
6624	Pinnularia brandeliformis	KRAMMER	S	
6625	Pinnularia brandelii	CLEVE	S	
16463	Pinnularia brauniana	(GRUNOW) MILLS	S	
6881	Pinnularia braunii	(GRUNOW) CLEVE	S	
6627	Pinnularia brevicostata	CLEVE	S	
16062	Pinnularia cardinalis	(EHRENBERG) W.SMITH	S	
16544	Pinnularia carminata	BARBER & CARTER	S	
6629	Pinnularia cleveiformis	KRAMMER	S	
6632	Pinnularia divergens	W.SMITH	S	
16466	Pinnularia divergens var. decrescens	(GRUNOW) KRAMMER	S	
6633	Pinnularia divergentissima	(GRUNOW) CLEVE	S	
6845	Pinnularia episcopalis	CLEVE	S	
16063	Pinnularia esox	EHRENBERG	S	
16546	Pinnularia esoxiformis	FUSEY	S	
16547	Pinnularia esoxiformis var. eifeliana	KRAMMER	S	
6636	Pinnularia gentilis	(DONKIN) CLEVE	S	
6121	Pinnularia gibba	EHRENBERG	S	K
6638	Pinnularia gibbiformis	KRAMMER	S	K
16065	Pinnularia gigas	EHRENBERG	S	
6223	Pinnularia hemiptera	(KUETZING) RABENHORST	S	K
6642	Pinnularia infirma	KRAMMER	S	K
6643	Pinnularia intermedia	(LAGERSTEDT) CLEVE	S	
6844	Pinnularia interrupta	W.SMITH	S	
6853	Pinnularia lata	(BREBISSON) RABENHORST	S	
6958	Pinnularia legumen	EHRENBERG	S	K
6648	Pinnularia macilenta	(EHRENBERG) EHRENBERG	S	K
6123	Pinnularia maior	(KUETZING) RABENHORST	S	
6124	Pinnularia mesolepta	(EHRENBERG) W.SMITH	S	K
16475	Pinnularia mesolepta var. gibberula	(HUSTEDT) KRAMMER	S	K
6125	Pinnularia microstauron	(EHRENBERG) CLEVE	S	
6651	Pinnularia neomajor	KRAMMER	S	
6111	Pinnularia nobilis	(EHRENBERG) EHRENBERG	S	
6652	Pinnularia nodosa	(EHRENBERG) W.SMITH	S	
6653	Pinnularia notabilis	KRAMMER	S	
6654	Pinnularia obscura	KRASSKE	S	K
6655	Pinnularia oriunda	KRAMMER	S	K
6656	Pinnularia parallela	BRUN	S	K
16070	Pinnularia platycephala	(EHRENBERG) CLEVE	S	
6842	Pinnularia polyonca	(BREBISSON) W.SMITH	S	
6658	Pinnularia pseudogibba	KRAMMER	S	
16552	Pinnularia renata	KRAMMER	S	
6659	Pinnularia rupestris	HANTZSCH	S	
6660	Pinnularia schoenfelderi	KRAMMER	S	
16074	Pinnularia silvatica	PETERSEN	S	
16075	Pinnularia similiformis	KRAMMER	S	
6662	Pinnularia sinistra	KRAMMER	S	
6663	Pinnularia stomatophora	(GRUNOW) CLEVE	S	
16479	Pinnularia stomatophora var. triundulata	(FONTELL) HUSTEDT	S	
6664	Pinnularia streptoraphe	CLEVE	S	
16480	Pinnularia streptoraphe var. parva	KRAMMER	S	
6126	Pinnularia subcapitata	GREGORY	S	
16481	Pinnularia subcapitata var. elongata	KRAMMER	S	
6665	Pinnularia subcapitata var. hilseana	(JANISCH) O.MUELLER	S	
6667	Pinnularia subgibba	KRAMMER	S	K
16482	Pinnularia subgibba var. hustedtii	KRAMMER	S	K
16483	Pinnularia subgibba var. undulata	KRAMMER	S	K
6670	Pinnularia subrupestris	KRAMMER	S	
16557	Pinnularia subrupestris var. parva	KRAMMER	S	
6671	Pinnularia suchlandtii	HUSTEDT	S	
6673	Pinnularia transversa	(A.SCHMIDT) MAYER	S	
6674	Pinnularia viridiformis	KRAMMER	S	
6128	Pinnularia viridis	(NITZSCH) EHRENBERG	S	K

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6676	Pinnularia woerthensis	(MAYER) KRAMMER	S	
6678	Rhopalodia gibba var. parallela	(GRUNOW) H.ET M.PERAGALLO		K
16495	Rhopalodia rupestris	(W.SMITH) KRAMMER	S	
6129	Stauroneis anceps	EHRENBERG	S	
6680	Stauroneis anceps var. gracilis	(EHRENBERG) BRUN	S	
6681	Stauroneis kriegerii	PATRICK	S	K
6840	Stauroneis nobilis	SCHUMANN	S	
6688	Stauroneis thermicola	(PETERSEN) LUND	S	K
6689	Stauroneis undata	HUSTEDT	S	
16087	Stenopterobia curvula	(W.SMITH) KRAMMER	S	
6690	Stenopterobia delicatissima	(LEWIS) BREBISSON	S	
16503	Stenopterobia densestriata	(HUSTEDT) KRAMMER	S	
16507	Surirella barrowcliffia	DONKIN	S	
6691	Surirella bifrons	EHRENBERG	S	K
6135	Surirella linearis	W.SMITH	S	K
16091	Surirella linearis var. helvetica	(BRUN) MEISTER	S	K
6694	Surirella roba	LECLERCQ	S	
6137	Surirella robusta	EHRENBERG	S	
6097	Surirella spiralis	KUETZING	S	K
16092	Surirella tenera	GREGORY	S	K
16518	Surirella turgida	W.SMITH	S	K
16519	Tabellaria binalis	(EHRENBERG) GRUNOW	S	
6091	Tabellaria flocculosa	(ROTH) KUETZING	S	K
16096	Tabellaria quadriseptata	KNUDSON	S	
6698	Tabellaria ventricosa	KUETZING	S	
16521	Tetracyclus emarginatus	(EHRENBERG) W.SMITH	S	
16522	Tetracyclus glans	(EHRENBERG) MILLS	S	
16097	Tetracyclus rupestris	(BRAUN) GRUNOW	S	

Table 25: Species specific parameters for calculation of the Trophic Index and the Saprobic Index according to ROTT et al. (1997, 1999).
TW = Trophic value; SW = Saprobic value; G = Weighting. If no varieties are mentioned the type varieties are meant.

DV-Nr.	Taxa	Author	TW	G	SW	G
6699	Achnanthes altaica	(PORETZKY) CLEVE-EULER	1,7	2	1,0	5
6139	Achnanthes biasolettiana	GRUNOW	1,3	1	1,4	3
6835	Achnanthes bioretii	GERMAIN			1,2	4
6180	Achnanthes clevei	GRUNOW			1,6	3
6247	Achnanthes coarctata	(BREBISSON) GRUNOW	0,9	2		
6855	Achnanthes conspicua	A.MAYER			1,5	2
16110	Achnanthes curtissima	CARTER	0,6	2		
16111	Achnanthes daonensis	LANGE-BERTALOT			1,1	4
6248	Achnanthes delicatula	(KUETZING) GRUNOW	2,9	3	2,6	3
16112	Achnanthes delicatula ssp. engelbrechtii	(CHOLNOKY) LANGE-BERTALOT			2,0	3
6249	Achnanthes exilis	KUETZING	1,2	3	1,3	4
6250	Achnanthes flexella	(KUETZING) BRUN	0,3	3	1,0	5
6251	Achnanthes flexella var. alpestris	BRUN			1,0	5
6253	Achnanthes helvetica	(HUSTEDT) LANGE-BERTALOT	0,6	3	1,0	5
6047	Achnanthes hungarica	(GRUNOW) GRUNOW	3,4	2	2,7	3
6703	Achnanthes kolbei	HUSTEDT	3,9	2		
6258	Achnanthes laevis	OESTRUP	1,2	2	1,3	3
6260	Achnanthes lanceolata ssp. frequentissima	LANGE-BERTALOT	2,8	3		
16127	Achnanthes lanceolata ssp. lanceolata	(BREBISSON) GRUNOW	3,3	3		
6262	Achnanthes lapidosa	KRASSKE	0,7	3	1,0	5
6705	Achnanthes laterostrata	HUSTEDT	1,2	2	1,0	5
6263	Achnanthes lauenburgiana	HUSTEDT	1,8	3	1,9	4
6264	Achnanthes levanderi	HUSTEDT	0,6	3	1,0	5
6045	Achnanthes linearis	(W.SMITH) GRUNOW	1,8	1		
6265	Achnanthes marginulata	GRUNOW	0,6	2	1,0	5
6266	Achnanthes minuscula	HUSTEDT	2,3	2	1,9	4
6014	Achnanthes minutissima	KUETZING	1,2	1	1,7	1
6173	Achnanthes minutissima var. affinis	(GRUNOW) LANGE-BERTALOT	2,3	2	1,3	3
6240	Achnanthes minutissima var. gracillima	(MEISTER) LANGE-BERTALOT	0,6	3	1,0	5
6707	Achnanthes minutissima var. jackii	(RABENHORST) LANGE-BERTALOT	1,2	3		
16135	Achnanthes minutissima var. saprophila	KOBAYASI et MAYAMA	2,7	4	3,1	3
6267	Achnanthes minutissima var. scotica	(CARTER) LANGE-BERTALOT	1,0	2	1,0	5
6708	Achnanthes montana	KRASSKE	0,6	2	1,0	5
6709	Achnanthes nodosa	CLEVE	0,6	2	1,0	5

DV-Nr.	Taxa	Author	TW	G	SW	G
6268	Achnanthes oblongella	OESTRUP	1,0	2	1,0	5
6269	Achnanthes oestrupii	(CLEVE-EULER) HUSTEDT	1,2	2	1,3	4
6270	Achnanthes peragalli	BRUN et HERIBAUD	0,6	3	1,1	4
6271	Achnanthes petersenii	HUSTEDT	0,6	1	1,0	5
6984	Achnanthes ploenensis	HUSTEDT	2,6	3	1,9	4
6272	Achnanthes pusilla	(GRUNOW) DE TONI	0,6	3	1,0	5
6711	Achnanthes rechtensis	LECLERCQ	0,6	2	1,0	5
6712	Achnanthes rupestoides	HOHN	1,2	3		
16144	Achnanthes rupestris	KRASSKE	0,6	2		
6276	Achnanthes subatomoides	(HUST.) LANGE-B. et ARCHIBALD	2,1	2	1,1	4
16148	Achnanthes subsalsa	PETERSEN	0,6	2		
6277	Achnanthes suchlandtii	HUSTEDT	0,6	2	1,0	5
6279	Achnanthes trinodis	(W.SMITH) GRUNOW	0,6	2	1,0	5
6048	Amphipleura pellucida	(KUETZING) KUETZING	2,1	2	1,3	3
6281	Amphipleura rutilans	(TRENTEPOHL) CLEVE	2,9	3		
6171	Amphora inariensis	KRAMMER	2,1	1	1,2	4
6860	Amphora libyca	EHRENBERG	3,5	5	1,6	2
6286	Amphora montana	KRASSKE	2,9	2		
6044	Amphora ovalis	(KUETZING) KUETZING	3,3	2	1,5	2
6983	Amphora pediculus	(KUETZING) GRUNOW	2,8	2	2,1	2
6288	Amphora thumensis	(A.MAYER) CLEVE-EULER	1,4	3	1,1	4
6181	Amphora veneta	KUETZING	3,8	2	3,6	3
6049	Anomoeoneis sphaerophora	(EHRENBERG) PFITZER	3,4	3	2,7	3
6050	Asterionella formosa	HASSALL	1,8	2	1,5	3
6799	Aulacoseira distans	(EHRENBERG) SIMONSEN	1,0	4		
6787	Aulacoseira italica	(EHRENBERG) SIMONSEN	1,4	2		
6716	Aulacoseira lirata	(EHRENBERG) ROSS	1,8	2		
6143	Bacillaria paradoxa	GMELIN	2,9	3	2,3	3
6291	Brachysira brebissonii	ROSS	1,1	2	1,0	5
6295	Brachysira neoexilis	LANGE-BERTALOT	1,2	2	1,1	5
6296	Brachysira serians	(BREBISSON) ROUND et MANN	0,6	1	1,0	5
6298	Brachysira vitrea	(GRUNOW) ROSS	0,7	2	1,0	5
6300	Caloneis aerophila	BOCK			1,0	5
6166	Caloneis alpestris	(GRUNOW) CLEVE	1,3	2	1,0	5
6043	Caloneis amphisbaena	(BORY DE SAINT VINCENT) CLEVE	3,9	2	2,3	3
6051	Caloneis bacillum	(GRUNOW) CLEVE	2,5	1	2,0	4
6301	Caloneis latiuscula	(KUETZING) CLEVE			1,0	5
6302	Caloneis obtusa	(W.SMITH) CLEVE	0,6	2	1,0	5
6303	Caloneis pulchra	MESSIKOMMER	1,2	1	1,0	5
6304	Caloneis schumanniana	(GRUNOW) CLEVE			1,2	4
6052	Caloneis silicula	(EHRENBERG) CLEVE			1,2	4
6723	Caloneis sublinearis	(GRUNOW) KRAMMER			1,0	5
6810	Caloneis tenuis	(GREGORY) KRAMMER	1,1	2		
6175	Caloneis undulata	(GREGORY) KRAMMER	0,6	2		
6053	Campylodiscus noricus	EHRENBERG	2,3	1		
6981	Cocconeis disculus	(SCHUMANN) CLEVE	2,2	3		
6306	Cocconeis neothumensis	KRAMMER	2,0	2	1,5	3
6020	Cocconeis pediculus	EHRENBERG	2,6	2	2,0	3
6021	Cocconeis placentula	EHRENBERG	2,6	2	1,8	2
6726	Cocconeis placentula var. euglypta	EHRENBERG	2,3	2		
6727	Cocconeis placentula var. klinoraphis	GEITLER	2,3	2		
6728	Cocconeis placentula var. lineata	(EHRENBERG) VAN HEURCK	2,3	2		
6307	Cocconeis pseudothumensis	REICHARDT			1,0	5
6943	Cyclostephanos dubius	(FRICKE) ROUND	2,9	3		
6002	Cyclotella meneghiniana	KUETZING	2,8	5		
6936	Cyclotella ocellata	PANTOCSEK	1,5	1		
6057	Cymatopleura elliptica	(BREBISSON) W.SMITH	2,9	3	1,4	3
6031	Cymatopleura solea	(BREBISSON) W.SMITH	3,1	3	2,1	3
6738	Cymbella aequalis	W.SMITH	0,6	2		
6058	Cymbella affinis	KUETZING	0,7	4	1,2	4
6310	Cymbella alpina	GRUNOW	0,6	3	1,0	5
6311	Cymbella amphicephala	NAEGELI	1,1	3	1,1	4
6739	Cymbella amphicephala var. hercynica	(SCHMIDT) CLEVE	0,9	2		
6740	Cymbella amphioxys	(KUETZING) CLEVE	0,6	2		
6312	Cymbella ancyli	CLEVE	0,9	2		
6741	Cymbella angustata	(W.SMITH) CLEVE	0,9	2	1,0	5
6092	Cymbella aspera	(EHRENBERG) CLEVE	1,7	1		
6313	Cymbella austriaca	GRUNOW	0,6	1	1,0	5
6891	Cymbella caespitosa	(KUETZING) BRUN			1,6	2

DV-Nr.	Taxa	Author	TW	G	SW	G
6183	Cymbella cesatii	(RABENHORST) GRUNOW	0,6	4	1,0	5
6059	Cymbella cistula	(EHRENBERG) KIRCHNER	2,3	1	1,4	3
6060	Cymbella cuspidata	KUETZING			1,1	4
6979	Cymbella cymbiformis	J.G.AGARDH	1,8	3	1,0	5
6315	Cymbella delicatula	KUETZING	0,3	4	1,0	5
6316	Cymbella descripta	(HUSTEDT) KRAMMER et LANGE-B.	0,6	2	1,0	5
6061	Cymbella ehrenbergii	KUETZING	2,2	3	1,1	4
6317	Cymbella elginensis	KRAMMER	0,6	2		
6318	Cymbella falaisensis	(GRUNOW) KRAMMER et LANGE-B.	0,4	3	1,0	5
6319	Cymbella gaeumannii	MEISTER	0,6	2	1,0	5
6320	Cymbella gracilis	(EHRENBERG) KUETZING	0,6	4	1,0	5
6321	Cymbella hebridica	(GRUNOW) CLEVE	0,6	2	1,0	5
6184	Cymbella helvetica	KUETZING	1,4	2	1,1	4
6323	Cymbella helvetica var. compacta	(OESTRUP) HUSTEDT	2,6	3	1,8	3
6978	Cymbella hustedtii	KRASSKE	1,2	2		
6324	Cymbella hybrida	GRUNOW	0,6	2	1,0	5
6325	Cymbella incerta	(GRUNOW) CLEVE	0,6	2	1,0	5
6327	Cymbella laevis	NAEGELI	0,9	2	1,0	5
6062	Cymbella lanceolata	(EHRENBERG) KIRCHNER			1,6	4
6330	Cymbella leptoceros	(EHRENBERG) KUETZING			1,3	4
6331	Cymbella mesiana	CHOLNOKY			1,0	5
6895	Cymbella microcephala	GRUNOW	1,2	1	1,2	4
6909	Cymbella minuta	HILSE	2,0	1	1,6	2
6063	Cymbella naviculiformis	AUERSWALD	1,8	1	1,3	3
6747	Cymbella norvegica	GRUNOW	0,6	2	1,0	5
6977	Cymbella perpusilla	CLEVE-EULER	0,5	2	1,0	5
6040	Cymbella prostrata	(BERKELEY) CLEVE	2,3	1	1,8	3
6333	Cymbella proxima	REIMER	1,2	2	1,1	5
6748	Cymbella pusilla	GRUNOW	1,2	2		
6334	Cymbella reichardtii	KRAMMER	2,7	3	1,5	4
6335	Cymbella rupicola	GRUNOW			1,0	5
6337	Cymbella similis	KRASSKE	0,6	2	1,0	5
6336	Cymbella simonsenii	KRAMMER	0,6	2	1,0	5
6065	Cymbella sinuata	GREGORY	2,1	1	2,0	2
6150	Cymbella subaequalis	GRUNOW	1,0	2	1,0	5
6066	Cymbella tumida	(BREBISSON) VAN HEURCK	2,5	2	1,6	4
6067	Cymbella tumidula	GRUNOW	0,6	2	1,0	5
6339	Cymbella tumidula var. lancettula	KRAMMER	0,3	2	1,0	5
6752	Denticula elegans	KUETZING	1,8	2		
6340	Denticula kuetzingii	GRUNOW	1,0	2	1,0	5
6068	Denticula tenuis	KUETZING	1,4	3	1,3	4
6185	Diatoma anceps	(EHRENBERG) KIRCHNER	0,3	2	1,0	5
6208	Diatoma ehrenbergii	KUETZING	1,6	2	1,3	3
6167	Diatoma hyemalis	(ROTH) HEIBERG	1,0	4	1,0	5
6949	Diatoma mesodon	(EHRENBERG) KUETZING	0,7	4	1,3	4
6209	Diatoma moniliformis	KUETZING	2,0	3	2,2	4
6210	Diatoma tenuis	J.G.AGARDH			1,3	4
6006	Diatoma vulgaris	BORY DE SAINT VINCENT			2,1	4
16208	Diatomella balfouriana	GREVILLE	0,6	2	1,0	5
16209	Didymosphenia geminata	(LYNGBYE) M.SCHMIDT	0,6	1		
6807	Diploneis elliptica	(KUETZING) CLEVE	1,7	2	1,1	4
6346	Diploneis oblongella	(NAEGELI) CLEVE-EULER	1,0	2	1,0	5
6347	Diploneis oculata	(BREBISSON) CLEVE			1,2	4
6070	Diploneis ovalis	(HILSE) CLEVE	1,0	2	1,0	5
6349	Diploneis petersenii	HUSTEDT	1,3	2	1,1	4
6754	Entomoneis ornata	(BAILEY) REIMER	1,2	2		
6212	Epithemia adnata	(KUETZING) BREBISSON	2,2	2	1,2	4
6350	Epithemia argus	(EHRENBERG) KUETZING	1,1	2		
6887	Epithemia sorex	KUETZING	2,7	2	1,4	3
6353	Epithemia turgida	(EHRENBERG) KUETZING	2,3	2		
6354	Eunotia arcubus	NOERPEL et LANGE-BERTALOT	0,6	2	1,0	5
16221	Eunotia arculus	(GRUNOW) LANGE-B. et NOERPEL	1,1	2		
6886	Eunotia arcus	EHRENBERG			1,0	5
6213	Eunotia bilunaris	(EHRENBERG) MILLS			1,7	2
6357	Eunotia diodon	EHRENBERG	0,6	2	1,0	5
6975	Eunotia exigua	(BREBISSON) RABENHORST	0,5	3	1,1	4
6359	Eunotia fallax	A.CLEVE	0,6	2	1,0	5
6360	Eunotia flexuosa	(BREBISSON) KUETZING	0,7	2	1,0	5
6362	Eunotia glacialis	MEISTER	0,7	2	1,0	5

DV-Nr.	Taxa	Author	TW	G	SW	G
6363	Eunotia hexaglyphis	EHRENBERG	0,6	2		
6364	Eunotia implicata	NOERPEL et al.	0,6	2	1,0	5
6214	Eunotia incisa	GREGORY	0,6	2	1,0	5
6365	Eunotia intermedia	(KRASSKE) NOERPEL et LANGE-B.	0,6	2		
6368	Eunotia microcephala	KRASSKE	0,6	2	1,0	5
6369	Eunotia minor	(KUETZING) GRUNOW			1,5	2
6885	Eunotia monodon	EHRENBERG	0,6	2		
6370	Eunotia muscicola var. tridentula	NOERPEL et LANGE-BERTALOT	0,6	2	1,0	5
6371	Eunotia naegelii	MIGULA	0,6	2		
6372	Eunotia nymanniana	GRUNOW	0,6	2	1,0	5
6765	Eunotia parallela	EHRENBERG	0,6	2		
6168	Eunotia pectinalis	(DILLWYN) RABENHORST			1,0	5
6851	Eunotia praerupta	EHRENBERG	0,9	2	1,0	5
6767	Eunotia praerupta var. bidens	(EHRENBERG) GRUNOW	1,1	2		
6374	Eunotia praerupta var. bigibba	(KUETZING) GRUNOW	0,9	2		
6375	Eunotia rhomboidea	HUSTEDT	0,6	2	1,0	5
6850	Eunotia serra	EHRENBERG	0,6	2	1,0	5
6377	Eunotia serra var. tetraodon	(EHRENBERG) NOERPEL	0,6	2	1,0	5
6382	Eunotia sudetica	O.MUELLER	0,6	2	1,0	5
6383	Eunotia tenella	(GRUNOW) HUSTEDT			1,0	5
6771	Eunotia triodon	EHRENBERG	0,6	2	1,0	5
6384	Fragilaria alpestris	KRASSKE	0,6	2		
6077	Fragilaria arcus	(EHRENBERG) CLEVE	1,0	3	1,5	2
6385	Fragilaria bicapitata	A.MAYER	1,1	1	1,6	3
6388	Fragilaria brevistriata	GRUNOW	3,0	1	1,3	4
6033	Fragilaria capucina	DESMAZIERES	1,8	2		
6394	Fragilaria capucina perminuta - Sippen	KRAMMER et LANGE-BERTALOT	2,1	4	1,5	3
6395	Fragilaria capucina radians - Sippen	KRAMMER et LANGE-BERTALOT	2,0	2		
6908	Fragilaria capucina var. amphicephala	(GRUNOW) LANGE-BERTALOT	0,9	2	1,0	5
6389	Fragilaria capucina var. austriaca	(GRUNOW) LANGE-BERTALOT	0,5	4	1,0	5
6392	Fragilaria capucina var. gracilis	(OESTRUP) HUSTEDT	1,1	2	1,3	4
6393	Fragilaria capucina var. mesolepta	(RABENHORST) RABENHORST	2,5	1	1,5	3
6396	Fragilaria capucina var. rumpens	(KUETZING) LANGE-BERTALOT	1,0	2	1,6	3
6186	Fragilaria capucina var. vaucheriae	(KUETZING) LANGE-BERTALOT	1,8	1	2,5	2
16234	Fragilaria constricta	EHRENBERG	0,6	3	1,0	5
6034	Fragilaria construens	(EHRENBERG) GRUNOW	2,3	2	1,4	3
6397	Fragilaria construens f. binodis	(EHRENBERG) HUSTEDT	2,3	2		
6828	Fragilaria construens f. venter	(EHRENBERG) HUSTEDT	2,3	2		
6075	Fragilaria crotonensis	KITTON			1,4	3
6399	Fragilaria delicatissima	(W.SMITH) LANGE-BERTALOT	1,4	2	1,0	5
6401	Fragilaria exigua	GRUNOW	0,6	2	1,0	5
6915	Fragilaria famelica	(KUETZING) LANGE-BERTALOT	0,7	4		
6234	Fragilaria fasciculata	(J.G.AGARDH) LANGE-BERTALOT	3,5	3	2,5	3
6402	Fragilaria incognita	REICHARDT	2,2	1	1,1	4
6076	Fragilaria leptostauron	(EHRENBERG) HUSTEDT	2,0	1		
6405	Fragilaria nanana	LANGE-BERTALOT	1,2	2	1,1	4
6237	Fragilaria parasitica	(W.SMITH) GRUNOW	2,3	3	2,2	3
6078	Fragilaria pinnata	EHRENBERG	2,2	1	1,4	3
6238	Fragilaria pulchella	(RALFS) LANGE-BERTALOT	3,5	2	2,8	4
6408	Fragilaria robusta	(FUSEY) MANGUIN			1,0	5
6409	Fragilaria tenera	(W.SMITH) LANGE-BERTALOT	1,0	2	1,0	5
6239	Fragilaria ulna	(NITZSCH) LANGE-BERTALOT	3,5	4		
16575	Fragilaria ulna acus - Sippen	KRAMMER et LANGE-BERTALOT	1,8	2		
6410	Fragilaria ulna angustissima - Sippen	KRAMMER et LANGE-BERTALOT	1,8	2		
6780	Fragilaria ulna oxyrhynchus - Sippen	KRAMMER et LANGE-BERTALOT	2,9	2		
6169	Fragilaria virescens	RALFS	1,4	1	1,2	4
6187	Frustulia rhomboides	(EHRENBERG) DE TONI	0,5	3	1,0	5
6411	Frustulia rhomboides var. amphipleuroides	(GRUNOW) DE TONI	0,6	2	1,2	4
6412	Frustulia rhomboides var. crassinervia	(BREBISSON) ROSS	0,4	2	1,0	5
6413	Frustulia rhomboides var. saxonica	(RABENHORST) DE TONI	0,4	2	1,0	5
6079	Frustulia vulgaris	(THWAITES) DE TONI	2,0	2	2,0	3
6080	Gomphonema acuminatum	EHRENBERG	2,5	2	1,5	2
6418	Gomphonema affine	KUETZING	1,8	3		
16246	Gomphonema amoenum	LANGE-BERTALOT	0,4	1		
6819	Gomphonema angustum	J.G.AGARDH	1,0	3	1,6	3
6081	Gomphonema augur	EHRENBERG	3,1	1	2,1	3
6419	Gomphonema auritum	A.BRAUN	0,6	1	1,1	4
6420	Gomphonema bavaricum	REICHARDT et LANGE-BERTALOT	0,6	2	1,1	5
6421	Gomphonema bohemicum	REICHELT et FRICKE	0,6	1	1,0	5

DV-Nr.	Taxa	Author	TW	G	SW	G
6217	Gomphonema clavatum	EHRENBERG			1,2	4
6422	Gomphonema clevei	FRICKE	1,2	2		
6423	Gomphonema dichotomum	KUETZING	1,3	2		
6883	Gomphonema gracile	EHRENBERG			1,2	4
6424	Gomphonema hebridense	GREGORY	0,9	2	1,1	4
6427	Gomphonema lateripunctatum	REICHARDT et LANGE-BERTALOT	0,7	2	1,0	5
6428	Gomphonema micropus	KUETZING			1,9	4
6912	Gomphonema minutum	(J.G.AGARDH) J.G.AGARDH	2,2	1	2,0	5
6429	Gomphonema occultum	REICHARDT et LANGE-BERTALOT	0,6	2	1,0	5
6867	Gomphonema olivaceum	(HORNEMANN) BREBISSON	2,9	1	2,1	4
16255	Gomphonema olivaceum var. calcareum	(CLEVE) CLEVE	1,8	3		
6430	Gomphonema olivaceum var. minutissimum	HUSTEDT	1,2	2	1,5	3
6431	Gomphonema olivaceum var. olivaceoides	(HUST.) LANGE-B. et REICHARDT	1,5	2	1,5	3
6432	Gomphonema olivaceum v. olivaceolacuum	LANGE-BERTALOT et REICHARDT	1,9	3	1,9	4
6158	Gomphonema parvulum	(KUETZING) KUETZING	3,6	2		
6433	Gomphonema parvulum var. exilissimum	GRUNOW	0,7	2		
16258	Gomphonema parvulum var. parvulius	LANGE-BERTALOT et REICHARDT	0,6	2		
6434	Gomphonema procerum	REICHARDT et LANGE-BERTALOT	1,2	2	1,0	5
6435	Gomphonema productum	(GRUN.) LANGE-B. et REICHARDT	1,3	2	1,2	4
6436	Gomphonema pseudoaugur	LANGE-BERTALOT	3,7	3	2,5	3
6437	Gomphonema pumilum	(GRUNOW) LANGE-B. et REICH.	1,1	1	1,6	3
16586	Gomphonema rhombicum	FRICKE	0,6	1		
6438	Gomphonema sarcophagus	GREGORY	1,3	2		
6439	Gomphonema stauroneiforme	GRUNOW	0,3	3		
6897	Gomphonema tergestinum	FRICKE	1,4	1	1,9	4
6188	Gomphonema truncatum	EHRENBERG	1,9	1	1,5	2
6999	Gomphonema ventricosum	GREGORY	0,5	5	1,0	5
6036	Gyrosigma acuminatum	(KUETZING) RABENHORST	3,7	3	1,9	3
6041	Gyrosigma attenuatum	(KUETZING) RABENHORST	2,6	3		
6443	Gyrosigma nodiferum	(GRUNOW) REIMER	2,7	2	2,0	4
6974	Gyrosigma scalproides	(RABENHORST) CLEVE	2,3	1		
6084	Hantzschia amphioxys	(EHRENBERG) GRUNOW	3,6	3	1,8	1
6005	Melosira varians	J.G.AGARDH	2,9	4	2,3	2
6026	Meridion circulare	(GREVILLE) J.G.AGARDH	2,5	2	1,9	3
6446	Meridion circulare var. constrictum	(RALFS) VAN HEURCK	1,2	2	1,2	4
6448	Navicula absoluta	HUSTEDT	1,4	3	1,1	4
6809	Navicula angusta	GRUNOW	0,6	2	1,0	5
16292	Navicula arvensis var. major	LANGE-BERTALOT	3,9	2	3,5	2
6117	Navicula atomus	(KUETZING) GRUNOW	2,8	3	3,4	2
6241	Navicula atomus var. permitis	(HUSTEDT) LANGE-BERTALOT	3,1	4	3,4	2
6087	Navicula bacillum	EHRENBERG	2,3	3	1,6	4
6461	Navicula bryophila	PETERSEN	1,3	2	1,1	4
6462	Navicula canoris	HOHN et HELLERMANN	2,9	1	2,0	5
6868	Navicula capitata	EHRENBERG	3,4	3	2,7	3
6966	Navicula capitata var. hungarica	(GRUNOW) ROSS	2,7	2		
6910	Navicula capitatoradiata	GERMAIN	3,3	4	2,3	3
6088	Navicula cari	EHRENBERG	2,6	1	1,5	3
6089	Navicula cincta	(EHRENBERG) RALFS	3,4	2	2,6	2
6968	Navicula citrus	KRASSKE	2,9	1	2,3	3
6466	Navicula clementis	GRUNOW	2,5	2	1,7	4
6969	Navicula cocconeiformis	GREGORY	1,2	2	1,0	5
6467	Navicula cohnii	(HILSE) LANGE-BERTALOT	3,5	2		
6469	Navicula constans	HUSTEDT	2,9	1	1,4	4
6858	Navicula contenta	GRUNOW			1,4	3
6470	Navicula costulata	GRUNOW	2,9	2	1,5	3
6010	Navicula cryptocephala	KUETZING	3,5	4	2,5	2
6471	Navicula cryptofallax	LANGE-BERTALOT et HOFMANN	2,1	2	1,9	4
6889	Navicula cryptotenella	LANGE-BERTALOT	2,3	1	1,5	2
6038	Navicula cuspidata	(KUETZING) KUETZING	3,8	3	2,7	3
6473	Navicula decussis	OESTRUP	1,2	1	1,7	3
6475	Navicula detenta	HUSTEDT	0,6	2	1,0	5
6826	Navicula elginensis	(GREGORY) RALFS	2,1	2	1,5	3
6481	Navicula erifuga	LANGE-BERTALOT	2,9	2	2,3	3
6482	Navicula evanida	HUSTEDT	1,8	1	1,0	5
6808	Navicula exigua	(GREGORY) GRUNOW	2,9	3	1,5	3
6917	Navicula exilis	KUETZING	2,0	1	1,1	4
6485	Navicula festiva	KRASSKE	0,6	2	1,0	5
6489	Navicula gallica var. perpusilla	(GRUNOW) LANGE-BERTALOT	1,2	1	1,2	4
6967	Navicula gastrum	(EHRENBERG) KUETZING	2,9	3	1,5	5

DV-Nr.	Taxa	Author	TW	G	SW	G
6916	Navicula goeppertiana	(BLEISCH) H.L.SMITH	3,6	5	3,3	2
6493	Navicula gottlandica	GRUNOW	1,5	2	1,0	5
6015	Navicula gregaria	DONKIN	3,5	4	2,5	2
6833	Navicula halophila	(GRUNOW) CLEVE	3,4	5	3,0	3
6500	Navicula hustedtii	KRASSKE	1,8	2		
6501	Navicula ignota var. acceptata	(HUSTEDT) LANGE-BERTALOT	1,8	2		
6812	Navicula integra	(W.SMITH) RALFS	2,9	2	2,4	2
6505	Navicula jaagii	MEISTER	0,9	2	1,0	5
6506	Navicula jaernefeltii	HUSTEDT	1,3	2	1,1	4
6507	Navicula joubaudii	GERMAIN	3,6	5	1,8	3
16330	Navicula lacunolaciniata	LANGE-BERTALOT et BONIK	3,9	3		
6882	Navicula laevissima	KUETZING	1,1	2	1,1	4
6864	Navicula lanceolata	(J.G.AGARDH) EHRENBERG	3,5	4	2,3	3
6156	Navicula laterostrata	HUSTEDT	1,4	2	1,0	5
6923	Navicula lenzii	HUSTEDT	1,2	2	1,1	4
16337	Navicula levanderi	HUSTEDT			1,0	5
6513	Navicula mediocris	KRASSKE	0,6	2	1,0	5
6094	Navicula menisculus	SCHUMANN	2,7	2	1,1	5
6514	Navicula menisculus var. grunowii	LANGE-BERTALOT	2,1	2	2,2	2
16343	Navicula menisculus var. upsaliensis	GRUNOW	2,9	2		
6095	Navicula minima	GRUNOW	2,9	2		
6872	Navicula minuscula var. muralis	(GRUNOW) LANGE-BERTALOT	2,9	3	3,1	3
6516	Navicula minusculoides	HUSTEDT	2,9	2	3,0	2
6219	Navicula molestiformis	HUSTEDT	2,9	2	3,1	2
6861	Navicula monoculata	HUSTEDT	2,9	2	2,2	4
6028	Navicula mutica	KUETZING	2,9	1	2,0	3
6519	Navicula mutica var. ventricosa	(KUETZING) CLEVE et GRUNOW	3,1	2		
16020	Navicula nivalis	EHRENBERG	2,9	1		
6073	Navicula oblonga	KUETZING	2,7	1	1,4	3
6013	Navicula pelliculosa	(BREBISSON) HILSE	2,5	3		
16353	Navicula perminuta	GRUNOW	3,4	3	2,3	3
6866	Navicula phyllepta	KUETZING	2,9	3	2,3	3
6099	Navicula placentula	(EHRENBERG) GRUNOW	2,7	3	1,6	4
6524	Navicula praeterita	HUSTEDT	0,9	2	1,0	5
6100	Navicula protracta	(GRUNOW) CLEVE	2,9	2	2,1	4
6527	Navicula pseudobryophila	(HUSTEDT) HUSTEDT	0,6	2	1,0	5
6865	Navicula pseudolanceolata	LANGE-BERTALOT	2,5	2		
6529	Navicula pseudoscutiformis	HUSTEDT	1,4	2	1,0	5
6530	Navicula pseudotuscula	HUSTEDT	1,8	2	1,3	4
6101	Navicula pupula	KUETZING	3,7	5	2,4	2
6532	Navicula pupula var. mutata	(KRASSKE) HUSTEDT	1,2	2		
6102	Navicula pygmaea	KUETZING	3,7	5	2,6	3
6103	Navicula radiosa	KUETZING	0,6	3	1,3	4
6534	Navicula recens	(LANGE-BERTALOT) LANGE-B.	2,9	2	2,4	3
6221	Navicula reichardtiana	LANGE-BERTALOT	2,3	1	2,1	4
6535	Navicula reichardtiana var. crassa	LANGE-BERTALOT et HOFMANN	2,3	1		
6104	Navicula reinhardtii	GRUNOW	2,8	1	1,9	4
6022	Navicula rhynchocephala	KUETZING	2,3	1	1,7	2
6105	Navicula salinarum	GRUNOW	2,3	2		
6537	Navicula saprophila	LANGE-BERTALOT	2,6	1	3,5	2
6539	Navicula schmassmannii	HUSTEDT	0,6	2	1,0	5
6926	Navicula schoenfeldii	HUSTEDT	1,9	1	1,6	4
6541	Navicula scutelloides	W.SMITH	2,7	3	1,6	4
16368	Navicula seibigiana	LANGE-BERTALOT	2,3	2		
16032	Navicula semen	EHRENBERG	0,6	3		
6192	Navicula seminulum	GRUNOW	3,2	2	3,2	2
6873	Navicula slesvicensis	GRUNOW	3,0	2	2,0	5
6543	Navicula soehrensis	KRASSKE	0,6	2	1,0	5
16034	Navicula soehrensis var. hassiaca	(KRASSKE) LANGE-BERTALOT	0,6	2	1,0	5
6813	Navicula splendicula	VAN LANDINGHAM	1,5	2		
6546	Navicula stroemii	HUSTEDT	1,2	2	1,0	5
6547	Navicula subalpina	REICHARDT	1,4	2	1,0	5
6106	Navicula subhamulata	GRUNOW	2,5	1	1,9	3
6548	Navicula sublucidula	HUSTEDT	2,9	1	1,9	4
6896	Navicula subminuscula	MANGUIN	3,5	4	3,4	2
16373	Navicula submuralis	HUSTEDT	0,6	2		
6550	Navicula subrotundata	HUSTEDT	1,8	2	1,4	4
6878	Navicula subtilissima	CLEVE	0,5	2	1,0	5
6551	Navicula suchlandtii	HUSTEDT	0,6	2	1,0	5

DV-Nr.	Taxa	Author	TW	G	SW	G
6553	Navicula tenelloides	HUSTEDT	2,9	2		
6554	Navicula tridentula	KRASSKE	0,6	2		
6831	Navicula tripunctata	(O.F.MUELLER) BORY DE ST. VINC.	3,1	3	2,0	3
6870	Navicula trivialis	LANGE-BERTALOT	3,3	1	2,7	3
6989	Navicula tuscula	(EHRENBERG) GRUNOW	1,8	1	1,1	4
6556	Navicula utermoehlii	HUSTEDT	1,8	2	1,4	4
16037	Navicula variostriata	KRASSKE	0,5	2	1,0	5
6890	Navicula veneta	KUETZING	3,5	5	3,3	2
6557	Navicula ventralis	KRASSKE	0,5	3		
6037	Navicula viridula	(KUETZING) EHRENBERG	3,5	4	2,2	4
6558	Navicula viridula var. rostellata	(KUETZING) CLEVE	3,5	4	2,2	4
6559	Navicula vitabunda	HUSTEDT	1,3	2	1,2	4
6560	Navicula vulpina	KUETZING	1,8	2	1,0	5
6561	Navicula wildii	LANGE-BERTALOT	0,3	2	1,0	5
6820	Neidium affine	(EHRENBERG) PFITZER	0,6	2	1,0	5
6562	Neidium affine var. longiceps	(GREGORY) CLEVE	0,6	2		
6563	Neidium alpinum	HUSTEDT	0,6	2	1,0	5
6564	Neidium ampliatum	(EHRENBERG) KRAMMER	1,5	2	1,0	5
6856	Neidium binodis	(EHRENBERG) HUSTEDT	1,8	1	1,3	3
6566	Neidium bisulcatum	(LAGERSTEDT) CLEVE	0,6	3	1,0	5
6108	Neidium dubium	(EHRENBERG) CLEVE	2,3	2	1,3	3
6568	Neidium hercynicum	A.MAYER	0,5	2	1,0	5
6109	Neidium iridis	(EHRENBERG) CLEVE	1,3	2	1,0	5
16386	Neidium ladogensis	(CLEVE) FOGED	0,8	1		
6110	Neidium productum	(W.SMITH) CLEVE	1,4	2	1,0	5
6023	Nitzschia acicularis	(KUETZING) W.SMITH	3,6	5	2,5	2
6573	Nitzschia acidoclinata	LANGE-BERTALOT	2,3	2	1,3	3
6965	Nitzschia acula	HANTZSCH	2,7	2	2,0	3
6575	Nitzschia alpina	HUSTEDT	0,6	3	1,0	5
6039	Nitzschia amphibia	GRUNOW	3,8	5	2,5	2
6991	Nitzschia angustata	(W.SMITH) GRUNOW	1,9	1	1,3	4
6576	Nitzschia angustatula	LANGE-BERTALOT	2,6	2	1,9	4
16045	Nitzschia angustiforaminata	LANGE-BERTALOT	3,9	2		
6922	Nitzschia archibaldii	LANGE-BERTALOT	2,0	2	1,9	3
6578	Nitzschia bacillum	HUSTEDT	1,9	2	1,1	4
6580	Nitzschia brevissima	GRUNOW	2,9	2		
16048	Nitzschia calida	GRUNOW	3,0	2	2,9	4
6964	Nitzschia capitellata	HUSTEDT	3,8	5	3,4	2
6193	Nitzschia clausii	HANTZSCH	3,9	2	2,9	4
6194	Nitzschia communis	RABENHORST	3,9	2	3,3	3
6581	Nitzschia commutata	GRUNOW	3,5	2		
6242	Nitzschia constricta	(KUETZING) RALFS	3,9	5	2,8	4
6584	Nitzschia dealpina	LANGE-BERTALOT et HOFMANN	2,3	2	1,1	4
6921	Nitzschia debilis	ARNOTT	2,9	2		
6008	Nitzschia dissipata	(KUETZING) GRUNOW	2,4	2	2,0	3
6586	Nitzschia dissipata var. media	(HANTZSCH) GRUNOW	2,6	1	1,3	3
6113	Nitzschia dubia	W.SMITH	2,9	2		
6195	Nitzschia filiformis	(W.SMITH) VAN HEURCK	3,7	2	2,9	4
6025	Nitzschia fonticola	GRUNOW			2,1	4
6196	Nitzschia frustulum	(KUETZING) GRUNOW	3,3	4	2,2	4
6806	Nitzschia fruticosa	HUSTEDT	2,9	2		
6594	Nitzschia graciliformis	LANGE-BERTALOT et SIMONSEN	3,4	1	1,6	2
6197	Nitzschia gracilis	HANTZSCH	2,5	2	1,3	4
6931	Nitzschia hantzschiana	RABENHORST	2,0	3	1,6	2
6963	Nitzschia heufleriana	GRUNOW	3,3	4	2,0	5
16051	Nitzschia homburgiensis	LANGE-BERTALOT	1,4	3	1,3	3
6114	Nitzschia hungarica	GRUNOW	3,9	3	2,9	4
6595	Nitzschia inconspicua	GRUNOW	3,1	1	2,2	4
6857	Nitzschia intermedia	HANTZSCH	2,9	2		
6597	Nitzschia lacuum	LANGE-BERTALOT	1,2	1	1,2	4
6888	Nitzschia levidensis	(W.SMITH) GRUNOW	3,7	2	2,9	4
6024	Nitzschia linearis	(J.G.AGARDH) W.SMITH	3,4	4	1,9	2
6599	Nitzschia linearis var. subtilis	(GRUNOW) HUSTEDT	3,9	3		
6198	Nitzschia microcephala	GRUNOW	3,9	3	2,5	2
6198	Nitzschia microcephala	GRUNOW	3,9	3	2,5	2
6011	Nitzschia palea	(KUETZING) W.SMITH	3,3	3		
6603	Nitzschia palea var. debilis	(KUETZING) GRUNOW	2,3	1		
6199	Nitzschia paleacea	GRUNOW	2,3	2	2,7	3
6605	Nitzschia perminuta	(GRUNOW) M.PERAGALLO	2,3	1	1,3	3

DV-Nr.	Taxa	Author	TW	G	SW	G
6918	Nitzschia pura	HUSTEDT	1,9	3	1,8	2
6925	Nitzschia pusilla	GRUNOW	2,7	2	2,4	3
6029	Nitzschia recta	HANTZSCH	3,0	3	1,5	2
16445	Nitzschia reversa	W.SMITH	2,9	2		
6201	Nitzschia sigma	(KUETZING) W.SMITH	2,9	2	2,9	4
6027	Nitzschia sigmoidea	(NITZSCH) W.SMITH	3,8	4	2,1	4
6610	Nitzschia sinuata var. delognei	(GRUNOW) LANGE-BERTALOT	2,3	2	1,8	2
6611	Nitzschia sinuata var. tabellaria	(GRUNOW) GRUNOW	1,2	1		
6961	Nitzschia sociabilis	HUSTEDT	2,8	1	2,1	4
6612	Nitzschia solita	HUSTEDT	3,4	2		
6613	Nitzschia subacicularis	HUSTEDT			2,0	3
6960	Nitzschia sublinearis	HUSTEDT	2,7	4	1,6	2
6924	Nitzschia supralitorea	LANGE-BERTALOT	2,9	4	2,7	3
6119	Nitzschia tryblionella	HANTZSCH	3,8	4	2,4	4
6615	Nitzschia tubicola	GRUNOW	3,4	2	2,1	4
6615	Nitzschia tubicola	GRUNOW	3,4	2	2,1	4
6118	Nitzschia umbonata	(EHRENBERG) LANGE-BERTALOT	3,8	3	3,8	4
6120	Nitzschia vermicularis	(KUETZING) HANTZSCH			2,0	3
6616	Nitzschia wuellerstorffii	LANGE-BERTALOT			2,1	4
6846	Pinnularia alpina	W.SMITH	0,6	2		
16461	Pinnularia balfouriana	GRUNOW	0,6	2		
6148	Pinnularia borealis	EHRENBERG	1,9	1	1,4	3
6881	Pinnularia braunii	(GRUNOW) CLEVE	0,7	2		
6627	Pinnularia brevicostata	CLEVE	0,3	2		
16062	Pinnularia cardinalis	(EHRENBERG) W.SMITH	0,4	2		
6631	Pinnularia dactylus	EHRENBERG	0,6	2		
6632	Pinnularia divergens	W.SMITH	0,6	2		
6633	Pinnularia divergentissima	(GRUNOW) CLEVE	0,6	2		
6845	Pinnularia episcopalis	CLEVE	0,6	2		
6636	Pinnularia gentilis	(DONKIN) CLEVE	1,5	2		
6121	Pinnularia gibba	EHRENBERG			2,5	1
6637	Pinnularia gibba var. linearis	HUSTEDT	0,3	2	1,0	5
6639	Pinnularia globiceps	GREGORY	1,8	2		
6223	Pinnularia hemiptera	(KUETZING) RABENHORST	0,6	2		
6844	Pinnularia interrupta	W.SMITH	0,7	2	1,2	4
16473	Pinnularia lagerstedtii	(CLEVE) CLEVE-EULER	0,6	2		
6853	Pinnularia lata	(BREBISSON) RABENHORST	0,6	2		
6958	Pinnularia legumen	EHRENBERG	0,6	2		
6123	Pinnularia maior	(KUETZING) RABENHORST	1,4	3	1,0	5
6650	Pinnularia microstauron var. brebissonii	(KUETZING) MAYER			2,1	2
6111	Pinnularia nobilis	(EHRENBERG) EHRENBERG	0,5	2		
6652	Pinnularia nodosa	(EHRENBERG) W.SMITH	0,3	2		
16071	Pinnularia pulchra	OESTRUP	0,6	2		
6659	Pinnularia rupestris	HANTZSCH	0,6	2		
6663	Pinnularia stomatophora	(GRUNOW) CLEVE	0,6	2		
6126	Pinnularia subcapitata	GREGORY	0,9	2	1,0	5
6665	Pinnularia subcapitata var. hilseana	(JANISCH) O.MUELLER	0,3	2	1,0	5
6669	Pinnularia subrostrata	(A.CLEVE) CLEVE-EULER	0,3	2		
6672	Pinnularia sudetica	(HILSE) HILSE	1,3	2		
6128	Pinnularia viridis	(NITZSCH) EHRENBERG	1,3	2	1,2	4
16485	Pleurosigma angulatum	QUEKETT	2,9	2		
6224	Rhoicosphenia abbreviata	(J.G.AGARDH) LANGE-BERTALOT	2,9	2	2,1	4
6677	Rhopalodia gibba	(EHRENBERG) O.MUELLER	2,7	2	1,5	3
6678	Rhopalodia gibba var. parallela	(GRUNOW) H.et M.PERAGALLO	0,6	3	1,0	5
6225	Simonsenia delognei	(GRUNOW) LANGE-BERTALOT	2,9	2	2,2	4
6841	Stauroneis acuta	W.SMITH	1,8	1		
6679	Stauroneis agrestis	PETERSEN			1,0	5
6129	Stauroneis anceps	EHRENBERG			1,2	4
16558	Stauroneis gracillima	HUSTEDT	1,1	1		
6681	Stauroneis kriegerii	PATRICK	3,3	2	1,6	2
6683	Stauroneis legumen	EHRENBERG	1,9	2		
6685	Stauroneis obtusa	LAGERSTEDT	0,6	2	1,0	5
6130	Stauroneis phoenicenteron	(NITZSCH) EHRENBERG	2,9	1	1,5	2
6131	Stauroneis smithii	GRUNOW	3,3	2	1,5	2
6688	Stauroneis thermicola	(PETERSEN) LUND			1,4	3
16087	Stenopterobia curvula	(W.SMITH) KRAMMER	0,4	2	1,0	5
6690	Stenopterobia delicatissima	(LEWIS) BREBISSON	0,5	2	1,0	5
6227	Surirella amphioxys	W.SMITH	2,9	2		
6133	Surirella angusta	KUETZING	3,7	3	2,2	2

DV-Nr.	Taxa	Author	TW	G	SW	G
6691	Surirella bifrons	EHRENBERG	2,3	2		
6134	Surirella biseriata	BREBISSON	2,1	2		
6693	Surirella brebissonii	KRAMMER et LANGE-BERTALOT	3,6	5	2,5	2
6994	Surirella capronii	BREBISSON	2,5	2		
16513	Surirella crumena	BREBISSON	2,9	2		
6880	Surirella elegans	EHRENBERG	2,7	3		
6135	Surirella linearis	W.SMITH	1,0	2	1,1	4
16091	Surirella linearis var. helvetica	(BRUN) MEISTER	0,6	2	1,0	5
6229	Surirella minuta	BREBISSON	3,8	3	2,4	3
6136	Surirella ovalis	BREBISSON			2,9	4
6694	Surirella roba	LECLERCQ	0,6	2	1,0	5
6097	Surirella spiralis	KUETZING	0,6	2		
16518	Surirella turgida	W.SMITH	0,6	2		
6074	Tabellaria fenestrata	(LYNGBYE) KUETZING	1,4	3		
6091	Tabellaria flocculosa	(ROTH) KUETZING	0,8	2	1,1	4
6698	Tabellaria ventricosa	KUETZING	0,9	2	1,0	5
16522	Tetracyclus glans	(EHRENBERG) MILLS	0,6	3	1,0	5
16097	Tetracyclus rupestris	(BRAUN) GRUNOW	0,5	2	1,0	5

Table 26: Indicator species for für den salinity of inland waters (modified and continued according to ZIEMANN et al. 1999)
HG = Halobic group: hx = haloxenic taxa, hmp = halophilic, mesohalobic and polyhalobic taxa

DV-Nr.	Taxa	Author	HG
6699	Achnanthes altaica	(PORETZKY) CLEVE-EULER	hx
16105	Achnanthes bahusiensis	(GRUNOW) LANGE-BERTALOT	hmp
16106	Achnanthes biasolettiana var. subatomus	LANGE-BERTALOT	hx
16107	Achnanthes brevipes	J.G.AGARDH	hmp
16528	Achnanthes brevipes var. intermedia	(KUETZING) CLEVE	hmp
16111	Achnanthes daonensis	LANGE-BERTALOT	hx
6248	Achnanthes delicatula	(KUETZING) GRUNOW	hmp
16114	Achnanthes didyma	HUSTEDT	hx
6253	Achnanthes helvetica	(HUSTEDT) LANGE-BERTALOT	hx
6256	Achnanthes kranzii	LANGE-BERTALOT	hx
16119	Achnanthes kuelbsii	LANGE-BERTALOT	hx
6262	Achnanthes lapidosa	KRASSKE	hx
6705	Achnanthes laterostrata	HUSTEDT	hx
6264	Achnanthes levanderi	HUSTEDT	hx
6045	Achnanthes linearis	(W.SMITH) GRUNOW sensu auct. nonnull	hx
6265	Achnanthes marginulata	GRUNOW	hx
6268	Achnanthes oblongella	OESTRUP	hx
16138	Achnanthes parvula	KUETZING	hmp
6270	Achnanthes peragalli	BRUN & HERIBAUD	hx
16139	Achnanthes pseudopunctulata	SIMONSEN	hmp
16141	Achnanthes punctulata	SIMONSEN	hmp
6711	Achnanthes rechtensis	LECLERCQ	hx
16143	Achnanthes rossii	HUSTEDT	hx
6275	Achnanthes silvahercynia	LANGE-BERTALOT	hx
6276	Achnanthes subatomoides	(HUSTEDT) LANGE-B. & ARCHIBALD	hx
6277	Achnanthes suchlandtii	HUSTEDT	hx
6713	Achnanthes ventralis	(KRASSKE) LANGE-BERTALOT	hx
6281	Amphipleura rutilans	(TRENTEPOHL) CLEVE	hmp
16152	Amphora coffeaeformis	(J.G.AGARDH) KUETZING	hmp
16153	Amphora coffeaeformis var. acutiuscula	(KUETZING) RABENHORST	hmp
16154	Amphora commutata	GRUNOW	hmp
16155	Amphora delicatissima	KRASSKE	hmp
6285	Amphora holsatica	HUSTEDT	hmp
16156	Amphora lineolata	EHRENBERG	hmp
16157	Amphora subcapitata	(KISSELEV) HUSTEDT	hmp
6049	Anomoeoneis sphaerophora	(EHRENBERG) PFITZER	hmp
6143	Bacillaria paradoxa	GMELIN	hmp
6291	Brachysira brebissonii	ROSS	hx
16165	Brachysira follis	(EHRENBERG) ROSS	hx
16166	Brachysira garrensis	(LANGE-B. & KRAMMER) LANGE-B.	hx
16167	Brachysira procera	LANGE-BERTALOT & MOSER	hx
6296	Brachysira serians	(BREBISSON) ROUND & MANN	hx
16168	Brachysira wygaschii	LANGE-BERTALOT	hx

DV-Nr.	Taxa	Author	HG
6300	Caloneis aerophila	BOCK	hx
6043	Caloneis amphisbaena	(BORY DE SAINT VINCENT) CLEVE	hmp
16171	Caloneis permagna	(BAILEY) CLEVE	hmp
16172	Caloneis westii	(W.SMITH) HENDEY	hmp
16174	Campylodiscus clypeus	EHRENBERG	hmp
16175	Campylodiscus echeneis	EHRENBERG	hmp
16180	Cocconeis scutellum	EHRENBERG	hmp
6309	Cylindrotheca gracilis	(BREBISSON) GRUNOW	hmp
6316	Cymbella descripta	(HUSTEDT) KRAMMER & LANGE-B.	hx
6317	Cymbella elginensis	KRAMMER	hx
6319	Cymbella gaeumannii	MEISTER	hx
6320	Cymbella gracilis	(EHRENBERG) KUETZING	hx
6321	Cymbella hebridica	(GRUNOW) CLEVE	hx
6331	Cymbella mesiana	CHOLNOKY	hx
6747	Cymbella norvegica	GRUNOW	hx
6977	Cymbella perpusilla	CLEVE-EULER	hx
6748	Cymbella pusilla	GRUNOW	hmp
6338	Cymbella stauroneiformis	LAGERSTEDT	hx
16202	Denticula subtilis	GRUNOW	hmp
6185	Diatoma anceps	(EHRENBERG) KIRCHNER	hx
6167	Diatoma hyemalis	(ROTH) HEIBERG	hx
6949	Diatoma mesodon	(EHRENBERG) KUETZING	hx
16206	Diatoma moniliformis ssp. ovalis	(FRICKE) LANGE-BERTALOT	hmp
16207	Diatoma problematica	LANGE-BERTALOT	hmp
16210	Diploneis didyma	(EHRENBERG) EHRENBERG	hmp
16211	Diploneis interrupta	(KUETZING) CLEVE	hmp
16213	Diploneis smithii	(BREBISSON) CLEVE	hmp
16214	Diploneis smithii var. dilatata	(PERAGALLO) TERRY	hmp
16215	Diploneis smithii var. pumila	(GRUNOW) HUSTEDT	hmp
16216	Diploneis smithii var. rhombica	MERESCHKOWSKY	hmp
16217	Entomoneis alata	(EHRENBERG) EHRENBERG	hmp
16218	Entomoneis costata	(HUSTEDT) REIMER	hmp
16219	Entomoneis paludosa	(W.SMITH) REIMER	hmp
16220	Entomoneis paludosa var. subsalina	CLEVE	hmp
16221	Eunotia arculus	(GRUNOW) LANGE-B. & NOERPEL	hx
6886	Eunotia arcus	EHRENBERG	hx
6213	Eunotia bilunaris	(EHRENBERG) MILLS	hx
16222	Eunotia bilunaris var. linearis	(OKUNO) LANGE-BERTALOT & NOERPEL	hx
6355	Eunotia bilunaris var. mucophila	LANGE-BERTALOT & NOERPEL	hx
6761	Eunotia botuliformis	WILD et al.	hx
16223	Eunotia circumborealis	LANGE-BERTALOT & NOERPEL	hx
6356	Eunotia denticulata	(BREBISSON) RABENHORST	hx
6357	Eunotia diodon	EHRENBERG	hx
16224	Eunotia elegans	OESTRUP	hx
6975	Eunotia exigua	(BREBISSON) RABENHORST	hx
16225	Eunotia exigua var. undulata	MAGDEBURG	hx
6358	Eunotia faba	EHRENBERG	hx
6359	Eunotia fallax	A.CLEVE	hx
6762	Eunotia fallax var. groenlandica	(GRUNOW) LANGE-B. & NOERPEL	hx
6360	Eunotia flexuosa	(BREBISSON) KUETZING	hx
6362	Eunotia glacialis	MEISTER	hx
6363	Eunotia hexaglyphis	EHRENBERG	hx
6364	Eunotia implicata	NOERPEL et al.	hx
6214	Eunotia incisa	GREGORY	hx
6365	Eunotia intermedia	(KRASSKE) NOERPEL & LANGE-B.	hx
16226	Eunotia islandica	OESTRUP	hx
16104	Eunotia jemtlandica	(FONTELL) BERG	hx
16228	Eunotia major	(W.SMITH) RABENHORST	hx
6367	Eunotia meisteri	HUSTEDT	hx
6368	Eunotia microcephala	KRASSKE	hx
6885	Eunotia monodon	EHRENBERG	hx
6370	Eunotia muscicola var. tridentula	NOERPEL & LANGE-BERTALOT	hx
6371	Eunotia naegelii	MIGULA	hx
16695	Eunotia neofallax	NOERPEL	hx
6372	Eunotia nymanniana	GRUNOW	hx
6373	Eunotia paludosa	GRUNOW	hx
6884	Eunotia paludosa var. trinacria	(KRASSKE) NOERPEL	hx
6168	Eunotia pectinalis	(DILLWYN) RABENHORST	hx
6766	Eunotia pectinalis var. undulata	(RALFS) RABENHORST	hx
6851	Eunotia praerupta	EHRENBERG	hx

DV-Nr.	Taxa	Author	HG
6767	Eunotia praerupta var. bidens	(EHRENBERG) GRUNOW	hx
6374	Eunotia praerupta var. bigibba	(KUETZING) GRUNOW	hx
6768	Eunotia praerupta var. curta	GRUNOW	hx
6769	Eunotia praerupta var. inflata	GRUNOW	hx
16229	Eunotia pseudopectinalis	HUSTEDT	hx
6375	Eunotia rhomboidea	HUSTEDT	hx
16230	Eunotia rhynchocephala	HUSTEDT	hx
6376	Eunotia septentrionalis	OESTRUP	hx
6850	Eunotia serra	EHRENBERG	hx
6770	Eunotia serra var. diadema	(EHRENBERG) PATRICK	hx
6377	Eunotia serra var. tetraodon	(EHRENBERG) NOERPEL	hx
6378	Eunotia silvahercynia	NOERPEL et al.	hx
6379	Eunotia soleirolii	(KUETZING) RABENHORST	hx
6380	Eunotia steineckei	PETERSEN	hx
6381	Eunotia subarcuatoides	ALLES et al.	hx
6382	Eunotia sudetica	O.MUELLER	hx
6383	Eunotia tenella	(GRUNOW) HUSTEDT	hx
16668	Eunotia tetraodon	EHRENBERG	hx
6771	Eunotia triodon	EHRENBERG	hx
16233	Fragilaria acidoclinata	LANGE-BERTALOT & HOFMANN	hx
16234	Fragilaria constricta	EHRENBERG	hx
6401	Fragilaria exigua	GRUNOW	hx
6234	Fragilaria fasciculata	(J.G.AGARDH) LANGE-BERTALOT	hmp
6238	Fragilaria pulchella	(RALFS) LANGE-BERTALOT	hmp
6169	Fragilaria virescens	RALFS	hx
16245	Frustulia creuzburgensis	(KRASSKE) HUSTEDT	hmp
6187	Frustulia rhomboides	(EHRENBERG) DE TONI	hx
6412	Frustulia rhomboides var. crassinervia	(BREBISSON) ROSS	hx
6413	Frustulia rhomboides var. saxonica	(RABENHORST) DE TONI	hx
6414	Frustulia rhomboides var. viridula	(BREBISSON) CLEVE	hx
6421	Gomphonema bohemicum	REICHELT & FRICKE	hx
6424	Gomphonema hebridense	GREGORY	hx
6426	Gomphonema lagerheimii	A.CLEVE	hx
6430	Gomphonema olivaceum var. minutissimum	HUSTEDT	hx
6435	Gomphonema productum	(GRUNOW) LANGE-B. & REICHARDT	hx
6999	Gomphonema ventricosum	GREGORY	hx
16227	Gyrosigma balticum	(EHRENBERG) RABENHORST	hmp
16262	Gyrosigma parkeri	(HARRISON) ELMORE	hmp
6996	Gyrosigma peisonis	(GRUNOW) HUSTEDT	hmp
6042	Gyrosigma spenceri	(W.SMITH) CLEVE	hmp
16263	Gyrosigma strigilis	W.SMITH	hmp
16270	Hantzschia spectabilis	(EHRENBERG) HUSTEDT	hmp
16272	Hantzschia virgata	(ROPER) GRUNOW	hmp
16277	Hantzschia vivax	(W.SMITH) M.PERAGALLO	hmp
16279	Mastogloia baltica	GRUNOW	hmp
16280	Mastogloia braunii	GRUNOW	hmp
16281	Mastogloia elliptica	J.G.AGARDH	hmp
6803	Mastogloia elliptica var. dansei	(THWAITES) CLEVE	hmp
6444	Mastogloia smithii	THWAITES	hmp
16287	Melosira nummuloides	(DILLWYN) J.G.AGARDH	hmp
6446	Meridion circulare var. constrictum	(RALFS) VAN HEURCK	hx
16717	Navicula adversa	KRASSKE	hx
6809	Navicula angusta	GRUNOW	hx
16290	Navicula arenaria	DONKIN	hmp
16297	Navicula bulnheimii	GRUNOW	hmp
6089	Navicula cincta	(EHRENBERG) RALFS	hmp
6969	Navicula cocconeiformis	GREGORY	hx
6901	Navicula crucicula	(W.SMITH) DONKIN	hmp
16304	Navicula crucigera	(W.SMITH) CLEVE	hmp
16306	Navicula cryptolyra	BROCKMANN	hmp
6038	Navicula cuspidata	(KUETZING) KUETZING	hmp
6475	Navicula detenta	HUSTEDT	hx
6477	Navicula digitoradiata	(GREGORY) RALFS	hmp
16000	Navicula digitulus	HUSTEDT	hx
6479	Navicula duerrenbergiana	HUSTEDT	hmp
16314	Navicula elegans	W.SMITH	hmp
6482	Navicula evanida	HUSTEDT	hx
6917	Navicula exilis	KUETZING	hx
16316	Navicula flanatica	GRUNOW	hmp
6489	Navicula gallica var. perpusilla	(GRUNOW) LANGE-BERTALOT	hx

DV-Nr.	Taxa	Author	HG
6833	Navicula halophila	(GRUNOW) CLEVE	hmp
16321	Navicula halophiloides	HUSTEDT	hmp
6496	Navicula heimansioides	LANGE-BERTALOT	hx
16325	Navicula humerosa	BREBISSON	hmp
6812	Navicula integra	(W.SMITH) RALFS	hmp
6509	Navicula krasskei	HUSTEDT	hx
16010	Navicula lapidosa	KRASSKE	hx
16011	Navicula leptostriata	JOERGENSEN	hx
16337	Navicula levanderii	HUSTEDT	hx
6513	Navicula mediocris	KRASSKE	hx
16346	Navicula microdigitoradiata	LANGE-BERTALOT	hmp
16349	Navicula notha	WALLACE	hx
6098	Navicula peregrina	(EHRENBERG) KUETZING	hmp
16353	Navicula perminuta	GRUNOW	hmp
6866	Navicula phyllepta	KUETZING	hmp
16355	Navicula plicata	DONKIN	hmp
6100	Navicula protracta	(GRUNOW) CLEVE	hmp
6527	Navicula pseudobryophila	(HUSTEDT) HUSTEDT	hx
6102	Navicula pygmaea	KUETZING	hmp
6534	Navicula recens	(LANGE-BERTALOT) LANGE-BERTALOT	hmp
16362	Navicula rhynchotella	LANGE-BERTALOT	hmp
6105	Navicula salinarum	GRUNOW	hmp
16365	Navicula salinicola	HUSTEDT	hmp
6539	Navicula schmassmannii	HUSTEDT	hx
6540	Navicula schroeterii	MEISTER	hmp
6543	Navicula soehrensis	KRASSKE	hx
16034	Navicula soehrensis var. hassiaca	(KRASSKE) LANGE-BERTALOT	hx
6544	Navicula soehrensis var. muscicola	(PETERSEN) KRASSKE	hx
16370	Navicula soodensis	KRASSKE	hmp
16371	Navicula spicula	(HICKIE) CLEVE	hmp
6549	Navicula submolesta	HUSTEDT	hx
6878	Navicula subtilissima	CLEVE	hx
6551	Navicula suchlandtii	HUSTEDT	hx
16376	Navicula tenera	HUSTEDT	hmp
16037	Navicula variostriata	KRASSKE	hx
6563	Neidium alpinum	HUSTEDT	hx
6566	Neidium bisulcatum	(LAGERSTEDT) CLEVE	hx
6110	Neidium productum	(W.SMITH) CLEVE	hx
6573	Nitzschia acidoclinata	LANGE-BERTALOT	hx
16390	Nitzschia agnita	HUSTEDT	hmp
6575	Nitzschia alpina	HUSTEDT	hx
16391	Nitzschia amplectens	HUSTEDT	hmp
6580	Nitzschia brevissima	GRUNOW	hmp
16048	Nitzschia calida	GRUNOW	hmp
16397	Nitzschia circumsuta	(BAILEY) GRUNOW	hmp
6193	Nitzschia clausii	HANTZSCH	hmp
6581	Nitzschia commutata	GRUNOW	hmp
6583	Nitzschia compressa var. balatonis	(GRUNOW) LANGE-BERTALOT	hmp
16049	Nitzschia compressa var. vexans	(GRUNOW) LANGE-BERTALOT	hmp
6242	Nitzschia constricta	(KUETZING) RALFS	hmp
16402	Nitzschia dippelii	GRUNOW	hmp
6113	Nitzschia dubia	W.SMITH	hmp
16405	Nitzschia elegantula	GRUNOW	hmp
16406	Nitzschia epithemoides	GRUNOW	hmp
16408	Nitzschia fasciculata	GRUNOW	hmp
6195	Nitzschia filiformis	(W.SMITH) VAN HEURCK	hmp
6196	Nitzschia frustulum	(KUETZING) GRUNOW	hmp
6591	Nitzschia frustulum var. bulnheimiana	(RABENHORST) GRUNOW	hmp
6931	Nitzschia hantzschiana	RABENHORST	hx
16051	Nitzschia homburgiensis	LANGE-BERTALOT	hx
6114	Nitzschia hungarica	GRUNOW	hmp
16414	Nitzschia hybrida	GRUNOW	hmp
6595	Nitzschia inconspicua	GRUNOW	hmp
6888	Nitzschia levidensis	(W.SMITH) GRUNOW	hmp
16102	Nitzschia levidensis var. salinarum	GRUNOW	hmp
16052	Nitzschia levidensis var. victoriae	GRUNOW	hmp
16423	Nitzschia liebetruthii	RABENHORST	hmp
6601	Nitzschia littoralis	GRUNOW	hmp
16427	Nitzschia lorenziana	GRUNOW	hmp
6198	Nitzschia microcephala	GRUNOW	hmp

DV-Nr.	Taxa	Author	HG
16055	Nitzschia obtusa	W.SMITH	hmp
6602	Nitzschia ovalis	ARNOTT	hmp
16437	Nitzschia perspicua	CHOLNOKY	hmp
16446	Nitzschia rosenstockii	LANGE-BERTALOT	hmp
16447	Nitzschia scalaris	(EHRENBERG) W.SMITH	hmp
16057	Nitzschia scalpelliformis	(GRUNOW) GRUNOW	hmp
6201	Nitzschia sigma	(KUETZING) W.SMITH	hmp
6119	Nitzschia tryblionella	HANTZSCH	hmp
16058	Nitzschia vitrea	NORMAN	hmp
6619	Peronia fibula	(BREBISSON) ROSS	hx
6621	Pinnularia anglica	KRAMMER	hx
6622	Pinnularia angusta	(CLEVE) KRAMMER	hx
6623	Pinnularia appendiculata	(J.G.AGARDH) CLEVE	hmp
16543	Pinnularia bacilliformis	KRAMMER	hx
6625	Pinnularia brandelii	CLEVE	hx
16463	Pinnularia brauniana	(GRUNOW) MILLS	hx
6627	Pinnularia brevicostata	CLEVE	hx
16062	Pinnularia cardinalis	(EHRENBERG) W.SMITH	hx
6629	Pinnularia cleveiformis	KRAMMER	hx
6845	Pinnularia episcopalis	CLEVE	hx
6636	Pinnularia gentilis	(DONKIN) CLEVE	hx
16065	Pinnularia gigas	EHRENBERG	hx
6125	Pinnularia microstauron	(EHRENBERG) CLEVE	hx
6651	Pinnularia neomajor	KRAMMER	hx
6658	Pinnularia pseudogibba	KRAMMER	hx
6659	Pinnularia rupestris	HANTZSCH	hx
6660	Pinnularia schoenfelderi	KRAMMER	hx
16074	Pinnularia silvatica	PETERSEN	hx
6663	Pinnularia stomatophora	(GRUNOW) CLEVE	hx
16479	Pinnularia stomatophora var. triundulata	(FONTELL) HUSTEDT	hx
6664	Pinnularia streptoraphe	CLEVE	hx
16480	Pinnularia streptoraphe var. parva	KRAMMER	hx
6126	Pinnularia subcapitata	GREGORY	hx
16481	Pinnularia subcapitata var. elongata	KRAMMER	hx
6665	Pinnularia subcapitata var. hilseana	(JANISCH) O.MUELLER	hx
6670	Pinnularia subrupestris	KRAMMER	hx
16485	Pleurosigma angulatum	QUEKETT	hmp
16486	Pleurosigma elongatum	W.SMITH	hmp
16078	Pleurosigma salinarum	GRUNOW	hmp
16487	Pleurosira laevis	(EHRENBERG) COMPERE	hmp
16492	Rhopalodia constricta	(W.SMITH) KRAMMER	hmp
6677	Rhopalodia gibba	(EHRENBERG) O.MUELLER	hmp
16493	Rhopalodia musculus	(KUETZING) O.MUELLER	hmp
6840	Stauroneis nobilis	SCHUMANN	hx
16501	Stauroneis salina	W.SMITH	hmp
-	Stauroneis simulans	(DONKIN) ROSS	hmp
16087	Stenopterobia curvula	(W.SMITH) KRAMMER	hx
6690	Stenopterobia delicatissima	(LEWIS) BREBISSON	hx
16503	Stenopterobia densestriata	(HUSTEDT) KRAMMER	hx
16510	Surirella brightwellii	W.SMITH	hmp
16511	Surirella brightwellii var. baltica	(SCHUMANN) KRAMMER	hmp
16513	Surirella crumena	BREBISSON	hmp
6136	Surirella ovalis	BREBISSON	hmp
6694	Surirella roba	LECLERCQ	hx
16517	Surirella striatula	TURPIN	hmp
16519	Tabellaria binalis	(EHRENBERG) GRUNOW	hx
16520	Tabellaria binalis var. elliptica	FLOWER	hx
16096	Tabellaria quadriseptata	KNUDSON	hx
6698	Tabellaria ventricosa	KUETZING	hx

4.3 Phytobenthos without diatoms

For phytobenthos evaluation indicative species of comparable ecological conditions are summed up in the classification categories A, B, C and D (Table 27). This category must be noted for each taxon of a sampling site. It must be kept in mind that classification of taxa into different categories can vary between the different groups of running waters.

For calculation of the Assessment Index quantities must be squared. The Assessment index is calculated according to equation 15. Theoretically the calculated value can lie between +100 and –100.

Calculation of the Assessment Index can be considered reliable, if at least five indicative taxa were found or if (in case of less than 5 taxa) the sum of the squared degrees of cover adds up to **more than** 16. If an assessment is not reliable this must be noted. For running water sampling sites of the Alps and the Alpine Foreland presently no assessment procedure is available

Equation 15: Calculation of the Assessment Index

$$BI = \frac{\sum_{i=1}^{n_A} Q_{Ai} + \frac{1}{2}\sum_{i=1}^{n_B} Q_{Bi} - \frac{1}{2}\sum_{i=1}^{n_C} Q_{Ci} - \sum_{i=1}^{n_D} Q_{Di}}{\sum_{i=1}^{n_A} Q_{Ai} + \sum_{i=1}^{n_B} Q_{Bi} + \sum_{i=1}^{n_C} Q_{Ci} + \sum_{i=1}^{n_D} Q_{Di}} * 100$$

BI =Assessment Iindex
Q_A = *squared quantity of a taxon from assessment category A*
Q_B = *suared quantity of a taxon from assessment category B*
Q_C = *squared quantity of a taxon from assessment category C*
Q_D = *suared quantity of a taxon from assessment category D*
i = 1 to nA, nB, nC, nD

Table 27: List of indicators in the submodule Phytobenthos without Diatoms
MG_sil = running waters of the Central German Uplands with siliceous influence, MG_karb = running waters of the Central German Uplands with calcareous influence, NT_karb =running waters of the North German Lowland with calcareous influence, NT_sil/org = running waters of the North German Lowland with siliceous and organic influence.

System	Name	MG_sil	MG_cal	NT_cal	NT_sil/org
Nostocophyceae	Aphanocapsa fonticola	A	B		
Nostocophyceae	Aphanocapsa rivularis		A		
Nostocophyceae	Aphanothece stagnina	C		B	C
Nostocophyceae	Chamaesiphon confervicolus	B			B
Nostocophyceae	Chamaesiphon fuscus	A			
Nostocophyceae	Chamaesiphon incrustans	B	B	B	B
Nostocophyceae	Chamaesiphon polonicus	B			
Nostocophyceae	Chamaesiphon polymorphus	C	C		
Nostocophyceae	Chamaesiphon starmachii	A			
Nostocophyceae	Chamaesiphon subglobosus	B	A	A	
Nostocophyceae	Chroococcopsis gigantea	B	B	B	
Nostocophyceae	Heteroleibleinia kuetzingii	B	B		
Nostocophyceae	Homoeothrix crustacea		A		
Nostocophyceae	Homoeothrix janthina	A		C	A
Nostocophyceae	Homoeothrix varians	B	B	B	B
Nostocophyceae	Hydrococcus cesatii	B	A		
Nostocophyceae	Hydrococcus rivularis	B	A		
Nostocophyceae	Hyella fontana		A		
Nostocophyceae	Komvophoron constrictum	C		C	C
Nostocophyceae	Leptolyngbya foveolarum	D	D	D	
Nostocophyceae	Merismopedia glauca		A	A	
Nostocophyceae	Microcoleus vaginatus			C	
Nostocophyceae	Nostoc parmelioides	A			
Nostocophyceae	Oscillatoria limosa	C	C	C	C
Nostocophyceae	Oscillatoria princeps			C	

System	Name	MG_sil	MG_cal	NT_cal	NT_sil/org
Nostocophyceae	Phormidium ambiguum			C	
Nostocophyceae	Phormidium corium	B	A	A	
Nostocophyceae	Phormidium incrustatum	C	A	A	
Nostocophyceae	Phormidium retzii	C	C	C	C
Nostocophyceae	Phormidium subfuscum	B	C	C	
Nostocophyceae	Plectonema tomasinianum	B			
Nostocophyceae	Pleurocapsa minor	C	C		
Nostocophyceae	Porphyrosiphon martensianus	B			
Nostocophyceae	Pseudanabaena catenata			D	
Nostocophyceae	Schizothrix tinctoria	B			
Nostocophyceae	Xenotholos kerneri	A			
Bangiophyceae	Bangia atropurpurea	B	B	B	
Florideophyceae	Audouinella	B	A	A	B
Florideophyceae	Audouinella chalybaea	B	A	A	B
Florideophyceae	Audouinella hermannii	B	A	A	B
Florideophyceae	Audouinella pygmaea	B	A	A	B
Florideophyceae	Batrachospermum	B	B	B	B
Florideophyceae	Batrachospermum gelatinosum	B	B	B	
Florideophyceae	Batrachospermum helminthosum				A
Florideophyceae	Chantransia - Stadien	B	B	B	B
Florideophyceae	Hildenbrandia rivularis	B	B	B	
Florideophyceae	Lemanea	B			
Florideophyceae	Lemanea fluviatilis	A	B		
Florideophyceae	Paralemanea	B			
Florideophyceae	Thorea sp.			A	
Fucophyceae	Heribaudiella fluviatilis		B	B	
Chrysophyceae	Hydrurus foetidus		B		
Chrysophyceae	Phaeodermatium rivulare	B	B		
Euglenophyceae	Lepocinclis texta			B	
Euglenophyceae	Phacus acuminatus			B	
Euglenophyceae	Phacus orbicularis			B	
Tribophyceae	Tribonema viride	C	B		C
Tribophyceae	Tribonema vulgare	B	B		
Tribophyceae	Vaucheria	C	C	B	C
Tribophyceae	Vaucheria mit Häufigkeit 5			C	
Chlorophyceae	Bulbochaete	B			
Chlorophyceae	Draparnaldia mutabilis	B			
Chlorophyceae	Gongrosira debaryana	B	B	B	
Chlorophyceae	Gongrosira fluminensis	B			
Chlorophyceae	Gongrosira incrustans		A	A	
Chlorophyceae	Microspora	B		B	B
Chlorophyceae	Microspora amoena	B	B	B	B
Chlorophyceae	Microspora floccosa	B	B	B	B
Chlorophyceae	Microspora stagnorum			B	B
Chlorophyceae	Microspora tumidulum			B	B
Chlorophyceae	Microspora wittrockii		B	B	B
Chlorophyceae	Oedogonium	B	C	C	B
Chlorophyceae	Oedogonium mit Häufigkeit 5	C			C
Chlorophyceae	Stigeoclonium	D	D	D	D
Chlorophyceae	Stigeoclonium farctum			D	
Chlorophyceae	Tetraspora gelatinosa	A	A	A	A
Trebouxiophyceae	Microthamnion curvatum	B		C	
Trebouxiophyceae	Microthamnion kuetzingianum	B		C	
Trebouxiophyceae	Microthamnion strictissimum	B		C	
Ulvophyceae	Cladophora glomerata	C	B	B	C
Ulvophyceae	Cladophora glomerata mit Häufigkeit 5		C	C	
Ulvophyceae	Cladophora rivularis		B	B	C
Ulvophyceae	Cladophora rivularis mit Häufigkeit 5		C	C	
Ulvophyceae	Enteromorpha		C	C	
Ulvophyceae	Enteromorpha prolifera		D	D	
Ulvophyceae	Rhizoclonium hieroglyphicum	C	C	C	C
Ulvophyceae	Ulothrix tenerrima	C	C	C	
Ulvophyceae	Ulothrix tenuissima	B	B	B	

System	Name	MG_sil	MG_cal	NT_cal	NT_sil/org
Ulvophyceae	Ulothrix zonata	B	B	B	
Charophyceae	Actinotaenium cruciferum	A			
Charophyceae	Closterium acerosum	C	C	C	C
Charophyceae	Closterium cornu	A			
Charophyceae	Closterium dianae	A			
Charophyceae	Closterium eboracense	-		B	
Charophyceae	Closterium ehrenbergii	C	B	B	C
Charophyceae	Closterium ehrenbergii var. malinverianum	C			
Charophyceae	Closterium incurvum	B			B
Charophyceae	Closterium intermedium	A			
Charophyceae	Closterium kuetzingii			B	C
Charophyceae	Closterium leibleinii var. boergensenii	C	B	B	C
Charophyceae	Closterium littorale		B	B	
Charophyceae	Closterium littorale var. crassum	C	B	B	
Charophyceae	Closterium moniliferum	C	B	B	C
Charophyceae	Closterium moniliferum var. concavum	C	B	B	
Charophyceae	Closterium nilssonii	A			
Charophyceae	Closterium praelongum				
Charophyceae	Closterium praelongum var. brevius	B	B	B	B
Charophyceae	Closterium rostratum	A	C	C	A
Charophyceae	Closterium strigosum	B	B	B	B
Charophyceae	Closterium strigosum var. elegans	B	B	B	B
Charophyceae	Closterium striolatum	A			A
Charophyceae	Closterium sublaterale	C	B	B	C
Charophyceae	Closterium tumidulum	B	B	B	B
Charophyceae	Closterium tumidum	A			
Charophyceae	Cosmarium laeve	C	C	C	
Charophyceae	Cosmarium pachydermum var. aetiopicum	A			
Charophyceae	Klebsormidium rivulare	A			
Charophyceae	Mougeotia	B	B	B	B
Charophyceae	Penium margaritaceum	A			
Charophyceae	Pleurotaenium crenulatum				A
Charophyceae	Spirogyra	B	B	B	B
Charophyceae	Staurastrum punctulatum	B			
Charophyceae	Xanthidium antilopaeum	A			
Charophyceae	Zygnema	B			

4.4 Overall assessment of running waters with Macrophytes & Phytobenthos

According to the WFD the **entire group of organisms** consisting of the benthic flora, Macrophytes & Phytobenthos is considered to be **one of the four biological components** to assess the status of a water system. Therefore, the three subcomponents must be considered as modules or metrics for assessment in terms of the WFD.

4.4.1 Combination of the metrics Macrophytes, Diatoms and Phytobenthos without Diatoms

For the overall assessment of running waters with the biocomponent Macrophytes & Phytobenthos it is absolutely necessary to carry out an assessment of the three subcomponents Macrophytes, Diatoms and Phytobenthos without Diatoms exactly following the method described for these modules. A prerequisite is the collection of data according to the guidelines and exact determination of the biocoenotic type depending on different groups of organisms. In particular cases there are contradictory results for the different sub-groups of organisms. A sampling site can be attributed to the siliceous type of running water according to LAWA, but can be influenced by calcareous water from the catchment area. It is possible to have an attribution to a siliceous diatom type and a calcareous macrophyte type or phytobenthos type. In such cases it must be verified, if the increased values for hardness or acid capacity are the result of anthropogenic influences as for example the discharge of industrial waste. The values are then considered the result of degradation and the type must be corrected correspondingly. This situation can often be observed for strongly degraded waters as well as for waters with a large catchment area. If a sampling section is located in an area of alternating geological conditions, if possible, a geologically more homogenous site should be chosen.

The combination of calcareous geology and low hardness is impossible.

The differentiation between rhitral or potamal running waters according to the macrophyte typology is important for the chances of higher water plants to colonise this type of water. Mechanical stress exerted on the plants due to the continuous flow and the resistance of the individual species towards this kind of stress plays an important role. In contrast to certain types of small, narrow leafed species of Potamogeton for example, a large leafed species will hardly be expected in turbulently running waters. In its natural state, a running water with a large catchment area can for certain stretches show water levels and velocities of flow that are only suitable for species resistant to the current.

The LAWA typology or type map, which nationwide is in effect, cannot yet exclusively be used as the sole basis for type determination. Typology of the macrophyte and phytobenthos assessment procedure can easily be harmonised with this system (SCHAUMBURG et al. 2005, as well as chapter 3), but as the nationwide type map is still being worked upon and as after completion of other biological projects there might still be changes, typification of the sampling sites according to the described criteria is necessary. Furthermore, the changes in type attribution show that nationwide type attribution cannot be considered completed.

In order to create a basis for comparison for the three metrics Macrophytes, Diatoms and Phytobenthos without Diatoms, all index values must be transformed to match a unified scale from “0“ to “1“. The value „1“ reflects the best possible ecological status in terms of the WFD, i.e. ecological status class 1. A value of “0” stands for the highest degree of degradation of a water system, i.e. ecological status class 5. Transformation of the module “Macrophytes” (Reference Index, RI) and the module “Phytobenthos without Diatoms” (Assessment Index, BI) is carried out following Equation 16 and Equation 17. The result of the module “Diatoms” (Diatom $\text{Index}_{\text{Fließgewässer}} = DI_{FG}$) already is on this scale and therefore does not need to be transformed.

Equation 16: Equation for transformation of the module RI_{FG} (Reference $\text{Index}_{\text{Fließgewässer}}$ macrophytes) on a scale from 0 to 1.

$$M_{MP} = \frac{(RI_{FG} + 100) * 0,5}{100}$$

M_{MP} = Module Macrophyte Assessment
RI_{FG} = type specifically calculated reference index

Equation 17: Equation for transformation of the module BI (Assessment Index Phytobenthos without Diatoms) on a scale from 0 to 1

$$M_{PB} = \frac{(BI + 100) * 0,5}{100}$$

M_{PB} = Module Phytobenthos
BI = type specific assessment index

Calculation of the common Macrophyte-Phytobenthos Index of running waters ($M\&P_{FG}$) from the three components is carried out according to Equation 18. If individual modules cannot be considered reliable, the Macrophyte Phytobenthos Index for running waters $M\&P_{FG}$ can be calculated in addition. If the module “Macrophytes” is not reliable, Equation 19 is used and if the module “Phytobenthos without Diatoms” is not reliable Equation 20. If, in exceptional cases the module “Diatoms” cannot reliably be evaluated, Equation 21 can be referred to. If two modules are inconclusive, assessment is done according to the one reliable module. Nevertheless, the final result must be critically verified and doesn’t have the same significance as an assessment with two or three modules!

Equation 18: Calculation of the index value $M\&P_{FG}$ for determination of the ecological status class of a running water system in case of three reliable modules.

$$M\&P_{FG} = \frac{M_{MP} + M_D + M_{PB}}{3}$$

$M\&P_{FG}$ = Macrophyte & Phytobenthos-Index for running waters
M_{MP} = Module Macrophytes
M_D = Module Diatoms
M_{PB} = Module Phytobenthos without Diatoms

Equation 19: Calculation of the index value $M\&P_{FG}$ for determination of the ecological status class of a running water if the modules Diatoms and Phytobenthos without Diatoms are reliable.

$$M\&P_{FG} = \frac{M_D + M_{PB}}{2}$$

$M\&P_{FG}$ = Macrophytes & Phytobenthos-Index for running waters
M_D = Module Diatoms
M_{PB} = Module Phytobenthos without Diatoms

Equation 20: Calculation of the index value $M\&P_{FG}$ for determination of the ecological status class of a running water, if the modules Macrophytes and Diatoms are reliable.

$$M\&P_{FG} = \frac{M_{MP} + M_{D}}{2}$$

$M\&P_{FG}$ = Macrophytes & Phytobenthos-Index for running waters
M_{MP} = Module Macrophytes
M_{D} = Module Diatoms

Equation 21: Calculation of the index value $M\&P_{FG}$ for determination of the ecological status class in case the module Macrophytes and the module Phytobenthos without Diatoms are reliable.

$$M\&P_{FG} = \frac{M_{MP} + M_{PB}}{2}$$

$M\&P_{FG}$ = Macrophytes & Phytobenthos-Index for running waters
M_{PB} = Module Phytobenthos without Diatoms
M_{MP} = Module Macrophytes

4.4.2 Determination of the ecological status class

Separated according to ecoregions Table 28to Table 71show the limits for attribution of the calculated index $M\&P_{FG}$ to the ecological status classes according to the WFD. If one or two modules must be considered inconclusive, the results will still be used as a aid for interpretation of the total result, but will not be used for classification of the ecological status according to the WFD. An exception is the designation of an unreliable status class 5 in the sub module Macrophytes, which in case of a **proven macrophyte depopulation** (e.g. due to mowing, clearing, high input of nutrients, introduction of herbivorous fish) is assigned. In this case, if the ecological status “good” or “high” is determined with the module Diatoms and Phytobenthos, the ecological status class “moderate” (3) is assigned.

For unreliable individual assessments the index limits are also listed in the tables mentioned above.

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4.4.2.1 Alps

As due to a lack of data for the ecoregion Alps no assessment procedure for the module "Phytobenthos without Diatoms" could be developed, assessment of these sampling sites is carried out pursuant to the WFD with the modules "Macrophytes" and "Diatoms".

Assessment with the modules Macrophytes and Diatoms

Table 28: Index limits for attribution of the ecological status class:
Running waters of the calcareous alps with a catchment area of 1000 km²

Diatoms	D 1.1 Running waters of the calcareous alps with a catchment area < 1000 km²		
Macrophytes	**MRK**	**MP**	**MPG**
1	1,00 – 0,67	1,00 – 0,75	1,00 – 0,80
2	0,66 – 0,52	0,74 – 0,45	0,79 – 0,52
3	0,51 – 0,26	0,44 – 0,21	0,51 – 0,28
4	0,25 – 0,00	0,20 – 0,00	0,27 – 0,00
5	–	–	–

Table 29: Index limits for attribution of the ecological status class:
Running waters of the calcareous alps with a catchment area larger than1000 km²

Diatoms	D 1.2 Running waters of the calcareous alps with a catchment area > 1000 km²		
Macrophytes	**MRK**	**MP**	**MPG**
1	1,00 – 0,65	1,00 – 0,73	1,00 – 0,78
2	0,64 – 0,50	0,72 – 0,42	0,77 – 0,50
3	0,49 – 0,26	0,41 – 0,21	0,49 – 0,28
4	0,25 – 0,00	0,20 – 0,00	0,27 – 0,00
5	–	–	–

Assessment with the module Diatoms
to be applied, if the module Macrophytes is not reliable

Table 30: Index limits for attribution of the ecological status class if the module Macrophytes is not reliable: Running waters of the calcareous alps

Diatoms	D 1.1 Running waters of the calcareous alps with a catchment area < 1000 km²	D 1.2 Running waters of the calcareous alps with a catchment area > 1000 km²
1	1,00 – 0,74	1,00 – 0,71
2	0,73 – 0,54	0,70 – 0,49
3	0,53 – 0,31	0,48 – 0,31
4	0,30 – 0,08	0,30 – 0,08
5	0,07 – 0,00	0,07 – 0,00

Assessment with the module Macrophytes
to be applied, if the module Diatoms is not reliable

Table 31: Index limits for attribution of the ecological status class, if the module Diatoms is not reliable: Running waters of the calcareous alps

Macrophytes	MRK	MP	MPG
1	1,00 – 0,59	1,00 – 0,75	1,00 – 0,85
2	0,58 – 0,50	0,74 – 0,35	0,84 – 0,50
3	0,49 – 0,20	0,34 – 0,10	0,49 – 0,25
4	0,19 – 0,00	0,09 – 0,00	0,24 – 0,00
5	–	–	–

4.4.2.2 Alpine Foreland

Due to a lack of data for the running water systems of the Alpine Foreland no assessment procedure could be developed for the module “Phytobenthos without Diatoms“. As a consequence the assessment according to the WFD is carried out with the module “Macrophytes“ and the module “Diatoms“.

Assessment with the modules Macrophytes and Diatoms

Table 32: Index limits for attribution of the ecological status class:
Siliceous running waters of the Alpine Foreland with a catchment area smaller than 1000 km²

Diatoms	D 2 Siliceous running waters with a catchment area < 1000 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,63	1,00 – 0,71	1,00 – 0,76	1,00 – 0,71
2	0,62 – 0,47	0,70 – 0,39	0,75 – 0,47	0,70 – 0,47
3	0,46 – 0,22	0,38 – 0,17	0,46 – 0,25	0,46 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Table 33: Index limits for attribution of the ecological status class:
Calcareous running waters of the Alpine Foreland with a catchment area smaller than 1000 km²

Diatoms	D 3 Calcareous running waters with a catchment area < 1000 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,63	1,00 – 0,71	1,00 – 0,76	1,00 – 0,71
2	0,62 – 0,47	0,70 – 0,39	0,75 – 0,47	0,70 – 0,47
3	0,46 – 0,22	0,38 – 0,17	0,46 – 0,25	0,46 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Table 34: Index limits for attribution of the ecological status class:
Running waters of the Alpine Foreland with a catchment area larger than 1000 km²

Diatoms	D 4 Running waters with a catchment area > 1000 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,60	1,00 – 0,68	1,00 – 0,73	1,00 – 0,68
2	0,59 – 0,47	0,67 – 0,39	0,72 – 0,47	0,67 – 0,47
3	0,46 – 0,22	0,38 – 0,17	0,46 – 0,25	0,46 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Assessment with the module Diatoms
to be applied, if the module Macrophytes is not reliable

Table 35: Index limits for attribution of the ecological status class to be applied, if the module Macrophytes is not reliable:
Running waters of the Alpine Foreland

Diatoms	D 2 Siliceous running waters with a catchment area < 1000 km²	D 3 Calcareous running waters with a catchment area < 1000 km²	D 4 Running waters with a catchment area > 1000 km²
1	1,00 – 0,67	1,00 – 0,67	1,00 – 0,61
2	0,66 – 0,43	0,66 – 0,43	0,60 – 0,43
3	0,42 – 0,24	0,42 – 0,24	0,42 – 0,24
4	0,23 – 0,08	0,23 – 0,08	0,23 – 0,08
5	0,07 – 0,00	0,07 – 0,00	0,07 – 0,00

Assessment with the module Macrophytes
to be applied, if the module Diatoms is not reliable

Table 36: Index limits for attribution of the ecological status class to be applied, if the module Diatoms is not reliable:
Running waters of the Alpine Foreland

Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,59	1,00 – 0,75	1,00 – 0,85	1,00 – 0,75
2	0,58 – 0,50	0,74 – 0,35	0,84 – 0,50	0,74 – 0,51
3	0,49 – 0,20	0,34 – 0,10	0,49 – 0,25	0,50 – 0,25
4	0,19 – 0,00	0,09 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

4.4.2.3 Central German Upland

Assessment with the modules Macrophytes, Diatoms and Phytobenthos without Diatoms

Table 37: Index limits for attribution of the ecological status class:
Siliceous running waters of the variegated sandstone and the bedrock of the Central German Uplands with a catchment area smaller than 100 km²

Phytobenthos	MG_sil			
Diatoms	D 5 Running waters of the variegated sandstone and the bedrock with a catchment area < 100 km²			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,67	1,00 – 0,72	1,00 – 0,76	1,00 – 0,72
2	0,66 – 0,51	0,71 – 0,46	0,75 – 0,51	0,72 – 0,51
3	0,50 – 0,28	0,45 – 0,25	0,50 – 0,30	0,51 – 0,30
4	0,27 – 0,00	0,24 – 0,00	0,29 – 0,00	0,29 – 0,00
5	–	–	–	–

Table 38: Index limits for attribution of the ecological status class:
Siliceous running waters of volcanic areas in the Central German Uplands with a catchment area smaller than 100 km²

Phytobenthos	MG_sil			
Diatoms	D 6 Running waters of volcanic areas with a catchment area < 100 km²			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,65	1,00 – 0,70	1,00 – 0,74	1,00 – 0,70
2	0,64 – 0,50	0,69 – 0,45	0,73 – 0,50	0,69 – 0,50
3	0,49 – 0,28	0,44 – 0,25	0,49 – 0,30	0,49 – 0,30
4	0,27 – 0,00	0,24 – 0,00	0,29 – 0,00	0,29 – 0,00
5	–	–	–	–

Table 39: Index limits for attribution of the ecological status class:
Siliceous running waters of the variegated sandstone and bedrock of the Central German Uplands with a catchment area larger than 100 km² and smaller than 1000 km²

Phytobenthos	MG_sil			
Diatoms	D 7 Running waters of the variegated sandstone and bedrock with a catchment area > 100 km² and < 1000 km²			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,65	1,00 – 0,70	1,00 – 0,74	1,00 – 0,70
2	0,64 – 0,50	0,69 – 0,45	0,73 – 0,50	0,69 – 0,50
3	0,49 – 0,28	0,44 – 0,25	0,49 – 0,30	0,49 – 0,30
4	0,27 – 0,00	0,24 – 0,00	0,29 – 0,00	0,29 – 0,00
5	–	–	–	–

Table 40: Index limits for attribution of the ecological status class:
Calcareous running waters of the loess- and keuper regions of the Central German Uplands with a catchment area smaller than 1000 km²

Phytobenthos	MG_calc			
Diatoms	D 8 Running waters of the loess and keuper regions with a catchment area ≤ 1000 km²			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,63	1,00 – 0,69	1,00 – 0,72	1,00 – 0,69
2	0,62 – 0,50	0,68 – 0,45	0,71 – 0,50	0,68 – 0,50
3	0,49 – 0,28	0,44 – 0,25	0,49 – 0,30	0,49 – 0,30
4	0,27 – 0,00	0,24 – 0,00	0,29 – 0,00	0,29 – 0,00
5	–	–	–	–

Table 41: Index limits for attribution of the ecological status class:
Calcareous running water of calcareous regions in the Central German Uplands with a catchment area smaller than 100 km²

Phytobenthos	MG_calc			
Diatoms	D 9.1 Running waters of calcareous regions with a catchment area ≤ 100 km²			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,65	1,00 – 0,70	1,00 – 0,74	1,00 – 0,70
2	0,64 – 0,51	0,69 – 0,46	0,73 – 0,51	0,69 – 0,51
3	0,50 – 0,28	0,45 – 0,25	0,50 – 0,30	0,50 – 0,30
4	0,27 – 0,00	0,24 – 0,00	0,29 – 0,00	0,29 – 0,00
5	–	–	–	–

Table 42: Index limits for attribution of the ecological status class:
Calcareous running waters of the calcareous regions of the Central German Uplands with a catchment area larger than 100 km² and smaller than 1000 km²

Phytobenthos	MG_calc			
Diatoms	D 9.2 Running waters of calcareous areas with a catchment area > 100 km² und ≤ 1000 km²			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,64	1,00 – 0,69	1,00 – 0,72	1,00 – 0,69
2	0,63 – 0,50	0,68 – 0,45	0,71 – 0,50	0,68 – 0,50
3	0,49 – 0,28	0,44 – 0,25	0,49 – 0,30	0,49 – 0,30
4	0,27 – 0,00	0,24 – 0,00	0,29 – 0,00	0,29 – 0,00
5	–	–	–	–

Table 43: Index limits for attribution of the ecological status class:
Calcareous running waters of the Central German Uplands with a catchment area larger than 1000 km²

Phytobenthos	MG_calc			
Diatoms	D 10 Running waters with a catchment area > 1000 km²			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,65	1,00 – 0,70	1,00 – 0,73	1,00 – 0,70
2	0,64 – 0,50	0,69 – 0,45	0,72 – 0,50	0,69 – 0,50
3	0,49 – 0,28	0,44 – 0,25	0,49 – 0,30	0,49 – 0,30
4	0,27 – 0,00	0,24 – 0,00	0,29 – 0,00	0,29 – 0,00
5	–	–	–	–

Assessment with the modules Macrophytes and Diatoms to be applied, if the module Phytobenthos without Diatoms is not reliable

Table 44: Index limits for the attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
Siliceous running waters of the variegated sandstone and bedrock of the Central German Uplands with a catchment area smaller than 100 km²

Diatoms	D 5 Running waters of variegated sandstone and bedrock with a catchment area < 100 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,63	1,00 – 0,71	1,00 – 0,76	1,00 – 0,71
2	0,62 – 0,47	0,70 – 0,39	0,75 – 0,47	0,70 – 0,47
3	0,46 – 0,22	0,38 – 0,17	0,46 – 0,25	0,46 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Table 45: Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
Running waters of the volcanic areas of the Central German Uplands with a catchment area smaller than 100 km²

Diatoms	D 6 Running waters of volcanic areas with a catchment area < 100 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,60	1,00 – 0,68	1,00 – 0,73	1,00 – 0,68
2	0,59 – 0,45	0,67 – 0,38	0,72 – 0,45	0,67 – 0,45
3	0,44 – 0,22	0,37 – 0,17	0,44 – 0,25	0,44 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Table 46: Index limits for attribution of the ecological status class:
Running waters of the variegated sandstone and bedrock of the Central German Uplands with a catchment area larger than 100 km² and smaller than 1000 km²

Diatoms	D 7 Running waters of the variegated sandstone and bedrock with a catchment area > 100 km² and < 1000 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,60	1,00 – 0,68	1,00 – 0,73	1,00 – 0,68
2	0,59 – 0,45	0,67 – 0,38	0,72 – 0,45	0,67 – 0,45
3	0,44 – 0,22	0,37 – 0,17	0,44 – 0,25	0,44 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Table 47: Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
Running waters of the loess and keuper regions in the Central German Upland with a catchment area smaller than 1000 km²

Diatoms	D 8 Running waters of the loess and keuper regions with a catchment area ≤ 1000 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,58	1,00 – 0,66	1,00 – 0,71	1,00 – 0,66
2	0,57 – 0,45	0,65 – 0,37	0,70 – 0,45	0,65 – 0,45
3	0,44 – 0,22	0,36 – 0,17	0,44 – 0,25	0,44 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Table 48: Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
Running waters of the calcareous region of the Central German Upland with a catchment area smaller than 100 km²

Diatoms	D 9.1 Running waters of the calcareous regions with a catchment area ≤ 100 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,60	1,00 – 0,68	1,00 – 0,73	1,00 – 0,68
2	0,59 – 0,47	0,67 – 0,39	0,72 – 0,47	0,67 – 0,47
3	0,46 – 0,22	0,38 – 0,17	0,46 – 0,25	0,46 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Table 49: Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
Running waters of the calcareous regions in the Central German Uplands with a catchment area larger than 100 km² and smaller than 1000 km²

Diatoms	D 9.2 Running waters of the calcareous region with a catchment area > 100 km² and ≤ 1000 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,58	1,00 – 0,66	1,00 – 0,71	1,00 – 0,66
2	0,57 – 0,45	0,65 – 0,38	0,70 – 0,45	0,65 – 0,45
3	0,44 – 0,22	0,37 – 0,17	0,44 – 0,25	0,44 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Table 50: Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
Running waters of the Central German Upland with a catchment area larger than 1000 km²

Diatoms	D 10 Running waters with a catchment area > 1000 km²			
Macrophytes	**MRK**	**MP**	**MPG**	**MRS**
1	1,00 – 0,60	1,00 – 0,68	1,00 – 0,73	1,00 – 0,68
2	0,59 – 0,45	0,67 – 0,38	0,72 – 0,45	0,67 – 0,45
3	0,44 – 0,22	0,37 – 0,17	0,44 – 0,25	0,44 – 0,25
4	0,21 – 0,00	0,16 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Assessment with the modules Macrophytes and Phytobenthos without Diatoms to be applied, if the module Diatoms is not reliable

Table 51: Index limits for attribution of the ecological status class to be applied, if the module Diatoms is not reliable: siliceous running waters of the Central German Upland

Phytobenthos	MG_sil			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,67	1,00 – 0,75	1,00 – 0,80	1,00 – 0,75
2	0,66 – 0,55	0,74 – 0,48	0,79 – 0,55	0,74 – 0,55
3	0,54 – 0,30	0,47 – 0,25	0,54 – 0,33	0,54 – 0,33
4	0,29 – 0,00	0,24 – 0,00	0,32 – 0,00	0,32 – 0,00
5	–	–	–	–

Table 52: Index limits for attribution of the ecological status class to be applied, if the module Diatoms is not reliable: calcareous running waters of the Central German Upland

Phytobenthos	MG_calc			
Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,67	1,00 – 0,75	1,00 – 0,80	1,00 – 0,75
2	0,66 – 0,55	0,74 – 0,48	0,79 – 0,55	0,74 – 0,55
3	0,54 – 0,30	0,47 – 0,25	0,54 – 0,33	0,54 – 0,33
4	0,29 – 0,00	0,24 – 0,00	0,32 – 0,00	0,32 – 0,00
5	–	–	–	–

Assessment with the modules Diatoms and Phytobenthos without Diatoms to be applied, if the module Macrophytes is not reliable

Table 53: Index limits for attribution of the ecological status class to be applied, if the module Macrophytes is not reliable:
siliceous running waters of the Central German Upland

Phytobenthos	MG_sil		
Diatoms	D 5 Running waters of variegated sandstone and bedrock with a catchment area < 100 km²	D 6 Running waters of volcanic regions with a catchment area < 100 km²	D 7 Running waters of variegated sandstone and bedrock with a catchment area > 100 km² and < 1000 km²
1	1,00 – 0,71	1,00 – 0,68	1,00 – 0,68
2	0,70 – 0,52	0,67 – 0,50	0,67 – 0,50
3	0,51 – 0,32	0,49 – 0,32	0,49 – 0,32
4	0,31 – 0,17	0,31 – 0,17	0,31 – 0,17
5	0,16 – 0,00	0,16 – 0,00	0,16 – 0,00

Table 54: Index limits for attribution of the ecological status class to be applied, if the module Macrophytes is not reliable:
calcareous running waters of the Central German Upland

Phytobenthos	MG_calc			
Diatoms	D 8 Running waters of the loess and keuper regions with a catchment area ≤ 1000 km²	D 9.1 Running waters of the calcareous regions with a catchment area ≤ 100 km²	D 9.2 Running waters of the calcareous regions with a catchment area > 100 km² and ≤ 1000 km²	D 10 Running waters with a catchment area > 1000 km²
1	1,00 – 0,66	1,00 – 0,68	1,00 – 0,66	1,00 – 0,68
2	0,65 – 0,50	0,67 – 0,52	0,65 – 0,50	0,67 – 0,50
3	0,49 – 0,32	0,51 – 0,32	0,49 – 0,32	0,49 – 0,32
4	0,31 – 0,17	0,31 – 0,17	0,31 – 0,17	0,31 – 0,17
5	0,16 – 0,00	0,16 – 0,00	0,16 – 0,00	0,16 – 0,00

Assessment with the module Macrophytes to be applied, if the module Diatoms and the module Phytobenthos are not reliable

Table 55 Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
running waters of the Central German Upland

Macrophytes	MRK	MP	MPG	MRS
1	1,00 – 0,59	1,00 – 0,75	1,00 – 0,85	1,00 – 0,75
2	0,58 – 0,50	0,74 – 0,35	0,84 – 0,50	0,74 – 0,51
3	0,49 – 0,20	0,34 – 0,10	0,49 – 0,25	0,50 – 0,25
4	0,19 – 0,00	0,09 – 0,00	0,24 – 0,00	0,24 – 0,00
5	–	–	–	–

Assessment with the module Diatoms to be applied, if the module Macrophytes and the module Phytobenthos without Diatoms are not reliable

Table 56: Index limits for attribution of the ecological status class to be applied, if the module Macrophytes and the module Phytobenthos without Diatoms are not reliable:
siliceous running waters of the Central German Upland

Diatoms	D 5 Running waters of the variegated sandstone and bedrock with a catchment area < 100 km²	D 6 Running waters of volcanic regions with a catchment area < 100 km²	D 7 Running waters of the variegated sandstone and bedrock with a catchment area > 100 km² and < 1000 km²
1	1,00 – 0,67	1,00 – 0,61	1,00 – 0,61
2	0,66 – 0,43	0,60 – 0,40	0,60 – 0,40
3	0,42 – 0,24	0,39 – 0,24	0,39 – 0,24
4	0,23 – 0,08	0,23 – 0,08	0,23 – 0,08
5	0,07 – 0,00	0,07 – 0,00	0,07 – 0,00

Table 57: Index limits for attribution of the ecological status class to be applied, if the module Macrophytes and the module Phytobenthos without Diatoms is not reliable:
Calcareous running waters of the Central German Upland

Diatoms	D 8 Running waters of the loess and keuper regions with a catchment area ≤ 1000 km²	D 9.1 Running waters of calcareous regions with a catchment area ≤ 100 km²	D 9.2 Running waters of calcareous regions with a catchment area > 100 km² and ≤ 1000 km²	D 10 Running waters with a catchment area > 1000 km²
1	1,00 – 0,56	1,00 – 0,61	1,00 – 0,57	1,00 – 0,60
2	0,55 – 0,39	0,60 – 0,43	0,56 – 0,40	0,59 – 0,40
3	0,38 – 0,24	0,42 – 0,24	0,39 – 0,24	0,39 – 0,24
4	0,23 – 0,08	0,23 – 0,08	0,23 – 0,08	0,23 – 0,08
5	0,07 – 0,00	0,07 – 0,00	0,07 – 0,00	0,07 – 0,00

Assessment with the module Phytobenthos without Diatoms
to be applied, if the module Macrophytes and the module Diatoms are not reliable

Table 58: Index limits for attribution of the ecological status class to be applied, if the module Macrophytes and the module Diatoms are not reliable:
Siliceous and calcareous running waters of the Central German Upland

Phytobenthos	MG_sil	MG_calc
1	1,00 – 0,75	1,00 – 0,75
2	0,74 – 0,60	0,74 – 0,60
3	0,59 – 0,40	0,59 – 0,40
4	0,39 – 0,25	0,39 – 0,25
5	0,24 – 0,00	0,24 – 0,00

4.4.2.4 North German Lowland

Assessment with the modules Macrophytes, Diatoms and Phytobenthos without Diatoms

Table 59: Index limits for attribution of the ecological status class:
siliceous or organic running waters of the North German Lowland with a catchment area smaller than 1000 km²

Phytobenthos	NT_org/sil			
Diatoms	D 11 Siliceous running waters with a catchment area ≤ 1000 km²			
Macrophytes	TR	TNk	TN	TNg
1	1,00 – 0,72	1,00 – 0,68	1,00 – 0,67	1,00 – 0,64
2	0,71 – 0,51	0,67 – 0,51	0,66 – 0,48	0,63 – 0,44
3	0,50 – 0,28	0,50 – 0,30	0,47 – 0,28	0,43 – 0,26
4	0,27 – 0,00	0,29 – 0,00	0,27 – 0,00	0,25 – 0,00
5	–	–	–	–

Table 60: Index limits for attribution of the ecological status class:
calcareous running waters of the North German Lowland with a catchment area smaller than 1000 km²

Phytobenthos	NT_calc			
Diatoms	D 12 Calcareous running waters with a catchment area ≤ 1000 km²			
Macrophytes	TR	TNk	TN	TNg
1	1,00 – 0,70	1,00 – 0,66	1,00 – 0,65	1,00 – 0,62
2	0,69 – 0,51	0,65 – 0,51	0,64 – 0,48	0,61 – 0,44
3	0,50 – 0,28	0,50 – 0,30	0,47 – 0,28	0,43 – 0,26
4	0,27 – 0,00	0,29 – 0,00	0,27 – 0,00	0,25 – 0,00
5	–	–	–	–

Table 61: Index limits for attribution of the ecological status class:
calcareous running waters of the North German Lowland with a catchment area larger than 1000 km²

Phytobenthos	NT_calc			
Diatoms	D 13 Running waters with a catchment area > 1000 km²			
Macrophytes	TR	TNk	TN	TNg
1	1,00 – 0,74	1,00 – 0,70	1,00 – 0,69	1,00 – 0,66
2	0,73 – 0,55	0,69 – 0,55	0,68 – 0,52	0,65 – 0,48
3	0,54 – 0,32	0,54 – 0,34	0,51 – 0,32	0,47 – 0,30
4	0,31 – 0,00	0,33 – 0,00	0,31 – 0,00	0,29 – 0,00
5	–	–	–	–

Assessment with the modules Macrophytes and Diatoms to be applied, if the module Phytobenthos without Diatoms is not reliable

Table 62: Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
siliceous or organic running waters of the North German Lowland with a catchment area smaller than 100 km²

Diatoms	D 11 Siliceous running waters with a catchment area ≤ 1000 km²			
Macrophytes	**TR**	**TNk**	**TN**	**TNg**
1	1,00 – 0,71	1,00 – 0,65	1,00 – 0,62	1,00 – 0,59
2	0,70 – 0,47	0,64 – 0,47	0,61 – 0,42	0,58 – 0,37
3	0,46 – 0,22	0,46 – 0,25	0,41 – 0,22	0,36 – 0,20
4	0,21 – 0,00	0,24 – 0,00	0,21 – 0,00	0,19 – 0,00
5	–	–	–	–

Table 63: Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
calcareous running waters of the North German Lowland with a catchment area smaller than 1000 km²

Diatoms	D 12 Calcareous running waters with a catchment area ≤ 1000 km²			
Macrophytes	**TR**	**TNk**	**TN**	**TNg**
1	1,00 – 0,68	1,00 – 0,62	1,00 – 0,59	1,00 – 0,56
2	0,67 – 0,47	0,61 – 0,47	0,58 – 0,42	0,55 – 0,37
3	0,46 – 0,22	0,46 – 0,25	0,41 – 0,22	0,36 – 0,20
4	0,21 – 0,00	0,24 – 0,00	0,21 – 0,00	0,19 – 0,00
5	–	–	–	–

Table 64: Index limits for attribution of the ecological status class to be applied, if the module Phytobenthos without Diatoms is not reliable:
Running waters of the North German Lowland with a catchment area larger than 1000 km²

Diatoms	D 13 Running waters with a catchment area > 1000 km²			
Macrophytes	**TR**	**TNk**	**TN**	**TNg**
1	1,00 – 0,74	1,00 – 0,68	1,00 – 0,65	1,00 – 0,62
2	0,73 – 0,53	0,67 – 0,53	0,64 – 0,48	0,61 – 0,43
3	0,52 – 0,28	0,52 – 0,31	0,47 – 0,28	0,42 – 0,26
4	0,27 – 0,00	0,30 – 0,00	0,27 – 0,00	0,25 – 0,00
5	–	–	–	–

Assessment with the module Macrophytes and the module Phytobenthos without Diatoms

Table 65: Index values for attribution of the ecological status class to be applied, if the module Diatoms is not reliable: siliceous or organic running waters of the North German Lowland

Phytobenthos	NT_org/sil			
Macrophytes	**TR**	**TNk**	**TN**	**TNg**
1	1,00 – 0,75	1,00 – 0,69	1,00 – 0,66	1,00 – 0,63
2	0,74 – 0,55	0,68 – 0,55	0,65 – 0,50	0,62 – 0,45
3	0,54 – 0,30	0,54 – 0,33	0,49 – 0,30	0,44 – 0,28
4	0,29 – 0,13	0,32 – 0,13	0,29 – 0,13	0,27 – 0,13
5	-	-	-	-

Table 66: Index limits for attribution of the ecological status class to be applied, if the module Diatoms is not reliable: calcareous running waters of the North German Lowland

Phytobenthos	NT_calc			
Macrophytes	**TR**	**TNk**	**TN**	**TNg**
1	1,00 – 0,75	1,00 – 0,69	1,00 – 0,66	1,00 – 0,63
2	0,74 – 0,55	0,68 – 0,55	0,65 – 0,50	0,62 – 0,45
3	0,54 – 0,30	0,54 – 0,33	0,49 – 0,30	0,44 – 0,28
4	0,29 – 0,13	0,32 – 0,13	0,29 – 0,13	0,27 – 0,13
5	-	-	-	-

Assessment with the module Diatoms and Phytobenthos without Diatoms to be applied, if the module Macrophytes is not reliable

Table 67: Index limits for attribution of the ecological status class to be applied, if the module Macrophytes is not reliable:
siliceous or organic running waters of the North German Lowland with a catchment area smaller than 100 km²

Phytobenthos	**NT_org/sil**
Diatoms	**D 11 Siliceous running waters with a catchment area ≤ 1000 km²**
1	1,00 – 0,71
2	0,70 – 0,52
3	0,51 – 0,32
4	0,31 – 0,17
5	0,16 – 0,00

Table 68: Index values for attribution of the ecological status class to be applied, if the module Macrophytes is not reliable:
calcareous running waters of the North German Lowland

Phytobenthos	**NT_calc**	
Diatoms	**D 12 Calcareous running waters with a catchment area ≤ 1000 km²**	**D 13 Running waters with a catchment area > 1000 km²**
1	1,00 – 0,68	1,00 – 0,74
2	0,67 – 0,52	0,73 – 0,58
3	0,51 – 0,32	0,57 – 0,38
4	0,31 – 0,17	0,37 – 0,20
5	0,16 – 0,00	0,19 – 0,00

Assessment with the module Macrophytes
to be applied, if the module Diatoms and the module Phytobenthos without Diatoms is not reliable

Table 69: Index limits for attribution of the ecological status class to be applied, if the module Diatoms and the module Phytobenthos without Diatoms are unreliable:
running waters of the North German Lowland

Macrophytes	TR	TNk	TN	TNg
1	1,00 – 0,75	1,00 – 0,63	1,00 – 0,58	1,00 – 0,50
2	0,75 – 0,50	0,62 – 0,50	0,57 – 0,40	0,50 – 0,30
3	0,50 – 0,20	0,50 – 0,25	0,40 – 0,20	0,30 – 0,15
4	0,20 – 0,00	0,25 – 0,00	0,20 – 0,00	0,15 – 0,00
5	–	–	–	–

Assessment with the module Diatoms
to be applied, if the module Macrophytes and the module Phytobenthos without Diatoms are unreliable

Table 70: Index limits for the attribution of the ecological status class to be applied, if the module Macrophytes and the module Phytobenthos without Diatoms are unreliable:
siliceous or organic and calcareous running waters of the North German Lowland

Diatoms	D 11 Siliceous running waters with a catchment area ≤ 1000 km²	D 12 Calcareous running waters with a catchment area ≤ 1000 km²	D 13 Running waters with a catchment area > 1000 km²
1	1,00 – 0,67	1,00 – 0,61	1,00 – 0,73
2	0,66 – 0,43	0,60 – 0,43	0,72 – 0,55
3	0,42 – 0,24	0,42 – 0,24	0,54 – 0,36
4	0,23 – 0,08	0,23 – 0,08	0,35 – 0,14
5	0,07 – 0,00	0,07 – 0,00	0,13 – 0,00

Assessment with the module Phytobenthos without Diatoms
to be applied, if the modules Macrophytes and Diatoms are not reliable

Table 71: Index limits for attribution of the ecological status class to be applied, if the modules Macrophytes and Diatoms are not reliable:
siliceous or organic and calcareous running waters of the North German Lowland

Phytobenthos	NT_org/sil	NT_calc
1	1,00 – 0,75	1,00 – 0,75
2	0,74 – 0,60	0,74 – 0,60
3	0,59 – 0,40	0,59 – 0,40
4	0,39 – 0,25	0,39 – 0,25
5	0,24 – 0,00	0,24 – 0,00

4.4.2.5 Combination of the results with additional criteria

After determination of the ecological status by calculating the respective index values, the individual assessment procedures for the modules Macrophytes and Diatoms call for a verification of different metrics indicating different kinds of stress. These additional criteria are also considered for determination of the biocomponent Macrophytes & Phytobenthos. For the different kinds of stress cannot equally well be indicated by all groups of organisms, in the end they are considered for the overall assessment.

If the module „Acidification“ is relevant, the ecological status class is downgraded correspondingly. Due to the particular ecological relevance of this stress factor, downgrading is only carried out in the process of overall assessment after combination of the three sub modules Macrophytes, Diatoms and Phytobenthos without Diatoms to determine the ecological status class Macrophytes & Phytobenthos. This procedure corresponds to the guidelines of ECOSTAT (2003).

(**If not noted otherwise) all prerequisites for the application of additional criteria as well as for modifications of the results refer to the overall assessment, i.e. the ecological status class of the entire biocomponent Macrophytes & Phytobenthos!**

Macrophyte depopulation

For all ecoregions and for all biocoenotic types of macrophytes the reason for a lack of macrophytes is to be determined. If it can be proven that **macrophyte depopulation is the consequence of degradation**, for example due to chemical physical parameters, structural modifications (embankments), mowing, clearing or introduction of herbivorous fish or other anthropogenic influences, a “high” or “good” overall assessment must be downgraded to be ecological status class 3.

Acidification

Macrophytes

Type MRS	if 100% of the mosses = V **and** the ecological status class is 1 or 2 → downgrade to status class 3 unless the module Acidification Diatoms indicates a more severe acidification

Diatoms

Types D 5, D 6, D7	Relevance module Acidification → downgrade according to Table 20, page 42

4.5 Expenditure of time

4.5.1 Macrophytes

Duration of macrophyte mapping in the field (compare instruction protocol) amounts to approx. 30 minutes to 1 (maximal 2) hour(s) per sampling site. Time required for travelling to the sampling site can vary considerably and must also be considered. Determination of critical species (e.g. mosses) can require additional time.

Depending on the local conditions and time required to ensure personal safety, mapping can be carried out by one to two people. A detailed mapping procedure during which also the optional fields of the field protocol are filled in maximally takes ten minutes longer than mapping without filling in the optional fields. For an experienced field worker filling in the field report for mapping structural quality according to LAWA (LÄNDER WORKING GROUP WATER 2000) takes 10 to 15 minutes.

4.5.2 Diatoms

Determination of the ecological status of a river section consists of sampling, preparation of the diatom sampling material, determination of species composition and species abundance by counting 400 valves under the light microscope, entering the data regarding the diatom assemblages and calculating the required metrics and the resulting ecological status class. For sampling (planning and travelling excluded) approximately 20 minutes are estimated. The mean processing time of the diatom sample depends on the preparation method and the respective number of samples or the size of the available hot plate. For a preparation by oxidation in salt and sulphuric acid with subsequent preservation of the samples and mounting of permanent samples the estimated time frame is two to three days – up to 50 samples the additional effort required for an increasing number of samples can be neglected. Depending on the density of valves in the sample and the diversity of the assemblages, the microscopic evaluation by an expert amounts to approximately one to three hours. For entering the data into a database on average 20 minutes are estimated. The effort required for evaluating the entered data and carrying out the assessment depends on the availability of a special software.

4.5.3 Phytobenthos without Diatoms, simplified procedure

Sampling (including filling in the field protocol) takes between 30 minutes and 1 h depending on the structural diversity of the sampling site. In addition, the time required for travelling to and finding the sampling site must be considered, which depends on the local conditions. If the samples cannot be evaluated immediately after sampling, they must be preserved in the lab, labelled exactly and stored adequately. For each sampling site these steps take 20 to 30 minutes.

Depending on the substratum of the sub samples for the simplified procedure on average microscopic analysis should not take longer than three to four hours per sampling site.

If a database is already available, entering the sampling data does not require much time. In such cases calculation of the Assessment Index can be carried out in a fast and convenient fashion. However, the time required for creating and maintaining a database must be kept in mind.

4.5.4 Overall procedure

An overview of the time required is given in Table 72. The time required for travelling to and finding the respective sampling sites is not considered. For preparation of up to 50 diatom samples the processing time required is two to three days. For this reason the preparation is not listed in the table.

Table 72: Overview of the average time required for assessment of the component Macrophytes & Phytobenthos according to the WFD for each sampling site and sampling procedure

	Mean expenditure of time
Macrophytes	2,5 h
Diatoms	3 h
Phytobenthos without Diatoms	5 h
Overall	**10,5 h**

Appendix A
Characteristics of the biocoenotic macrophyte types

Siliceous-rhithral running waters of the Central German Upland and the Alps and Alpine Foreland (MRS)

Figure 2: Type MRS: Schwarzbach near Jagdschlösschen (sampling site Nr. 33, Bavaria)

The siliceous rhithral running waters of the Central German Uplands, Alps and Alpine Foreland (MRS, Figure 2) due to their geochemistry have lower values of total hardness and acid capacity. In an almost natural state without anthropogenic influences the mean value does not exceed 1,4 mmol/l. Generally MRS type running waters only have a width of approximately three meters, in rare cases of ten meters. Their water level is low, i.e. they are only 30 cm deep. In their pristine state these running waters are usually surrounded by woods and therefore are (strongly) shaded. According to the scale of the BAVARIAN WATER MANAGEMENT AGENCY (1995) the velocity of flow is almost always IV (rapidly running, current with moderate turbulences) or higher (rapid, torrential). These conditions are reflected in the substratum which is dominated by coarse gravel, stones and boulders. Due to these site characteristics the main growth form of aquatic macrophytes is represented especially by aquatic mosses haptophytes, especially mosses. Vascular hydrophytes are rare (modified according to MEILINGER 2003).

Calcareous rhitrhal running waters of the Central German Upland, the Alpine Foreland and the Alps (MRK)

Figure 3: Type MRK: River Würm close to Mühltal (sampling site Nr. 223, Bavaria)

The calcareous rhithral type of running water of the Central German Upland, the Alpine Foreland and the Alps shows similarities to the siliceous type. However, due to their geochemistry MRK types have higher values of total hardness and acid capacity than MRS types. In an almost natural state without anthropogenic influences the mean value exceeds 1,4 mmol/l. Although larger rivers with a width of more than 30 m and a depth of one meter represent this type, high velocities of flow, i.e. class IV (rapidly running, current with moderate turbulences) and higher (rapid, torrential) (BAVARIAN WATER MANAGEMENT AGENCY 1995) are characteristic for rhitral waters. Shading can also reach high values. Large grain sizes are mostly characteristic for the sediment of rhithral waters of the Central German Uplands. In contrast to the MRS type, for the calcareous rhithral type of the Central German Uplands the portion of stones and boulders is somewhat reduced. Mosses make up most of the macrophyte vegetation. Due to the greater flow of water also hydrophytes can be found, especially in eutrophicated waters (modified according to MEILINGER 2003).

Potamal running waters of the Central German Upland, the Alpine Foreland and Alps (MP) including subtype MPG (influenced by groundwater)

Figure 4: Type MPG: Inner Rhine River, Niederhausen (sampling site Nr. 881, Baden-Wuerttemberg)

Potamal running waters of the Central German Upland in terms of their habitat conditions for macrophytes are similar to the potamal running waters of the North German Lowland. The waters of type MP(G) often are about 10 meters wide and have a depth of 30 cm. The degree of shading is usually low and the velocity of flow is characterised by class III (slowly running, current visible, water surface almost smooth, BAVARIAN WATER MANAGEMENT AGENCY 1995). Therefore the portion of fine sediments like mud, sand and fine gravel is high. However, coarse substrata like coarse gravel, stones and boulders also make up a considerable portion of the sediment. These suitable conditions for water plants result in a macrophyte vegetation with a high percentage of hydrophytes (modified according to MEILINGER 2003).

The subtype MPG (influenced by groundwater) is noticeably fed by groundwater. It is characteristic of this type that water temperatures are low in summer (“summer cold”) and high in winter (“winter warm”).

TR – rhithral running waters of the North German Lowland

Figure 5: Type TR: Outflow of River Schwärze into Lake Schwärzensee (Sampling site Nr .018; Brandenburg)

The rhithral running waters of the North German Lowland (TR, Figure 5) are often only about two to three meters wide and rarely reach a width of more than ten meters. Water flow is low and generally depth does not exceed 30 cm. Almost natural sites of this type are surrounded by woods and therefore are more or less shaded. The velocity of flow is higher higher than for potamal running waters of the North German Lowland (TN), and is characterised by classes III (slowly running, current visible, water surface almost smooth) and class IV (rapidly running, current with moderate turbulences) according to the BAVARIAN WATER MANAGEMENT AGENCY (1995). The current appears rather turbulent. Substrata consist of sand and/or gravel. The running waters of type TR are characterised by a low flow of water which does not allow e.g. for large pondweeds to grow. Due to these particular local conditions sites with little or no anthropogenic influence are generally colonised by mosses or *Berula erecta* (submerged and emerged), *Ranunculus*- und *Callitriche*-species.

TN_k – small running waters of the North German Lowlands

Figure 6: Type TN_k: River Grove close to Wehdel (Sampling site 10026; Lower Saxony)

The small running waters of the North German Lowland (TN_k, Figure 13) are approximately three to five meters wide, have a depth of about one meter and a low degree of shading. The velocity of flow is less than for the rhithral running waters of the North German Lowland and is characterised by class II (current barely visible) and class III (slowly running) according to the BLfW 1995. This potamal current influences substratum composition. It consists of fine sediments like mud and sand. The habitats typical for running waters of the type TN_k are well suitable for a colonisation with macrophytes.

(Medium sized) running waters of the North German Lowland (TN)

Figure 7: Type TN: River Pfefferfließ west of Stangenhagen (sampling site Nr. 25, Brandenburg)

The medium sized potamal running waters of the North German Lowland (TN, Figure 7) are about three to 20 meters wide, have a depth of more than 30 cm up to one meter and have a small degree of shading. The velocity of flow is low, i.e. class II (very slowly running, current very weak, but visible) and class III (slowly running, current visible, water surface almost smooth) according to the BAVARIAN WATER MANAGEMENT AGENCY 1995. This potamal current also influences substratum composition. It consists above all of fine sediments like mud and sand. The typical habitat of type TN is well suitable for a colonisation with macrophytes, which is reflected in a great variety of growth forms. Typical water plant communities of this type are composed of large pond weeds. (Modified according to MEILINGER 2003).

TN_g – large running waters of the North German Lowland

Figure 8: Type TN_g: River Weser close to Dörverdev (sampling site 10084; Lower Saxony)

The large potamal running waters of the North German Lowland (TN_g, Figure 15) have a width of at least 30 meters. In their pristine state they have a wide and shallow profile with frequent formation of furts. Wide spaced changes in the water course, formation of deltas (Figure 8) as well as a high amount of coarse woody debris are characteristic. Due to hydraulic engeneering these running waters today are relatively deep, which does not provide the original basis for colonisation with macrophytes, but limits their occurrence to the border areas. For this reason, in many cases, an assessment with macrophytes is not possible.

Appendix B
Fixatives for the phytobenthos sampling procedure

acidic Lugol's solution

20 g potassium iodide (IK)

200 ml distilled water

10 g resublimated iodine (J2)

19 ml glacial acetic acid (96-100% CH3COOH)

Dissolve potassium iodide in a little water, then add iodine and the remaining water. Afterwards add glacial acetic acid. Keep the solution in small brown bottles. It is recommended to fill the bottles well as iodide is oxidised in half empty bottles.

neutralised formaldehyde

500 ml formaldehyde (40%)

500 ml aqua dest.

100 g Hexamethylentetramine

Dilute formaldehyde in aqua dest. and then add hexamethylentetramine. Filter after one week (pH 7,3-7,9).

For preservation of the samples a final concentration of 3-4% should be reached.

Appendix C

Field protocol for mapping running water macrophytes

(Macrophyte- & Phytobenthos-evaluation according to EC-WFD 2005; gray fields are optional)

Name of water body

Sampling site

Location of sampling site

Nearby town/village | Editor

Sampling Site No. | Reprot No.

Easting | Northing

Topo. Map No. | Recording date

Length of section ___ m | Mean width ___ m

Mean depth
- ☐ I 0-30 cm
- ☐ II 30-100 cm
- ☐ III >100 cm

Water level
- ☐ dry
- ☐ low
- ☐ medium
- ☐ high

Can sampling be carried out over the entire width of the running water? yes ☐ no ☐

Turbidity
- ☐ no turbidity, clear
- ☐ Medium turbidity
- ☐ Strong turbidity

Bottom visible?
- ☐ yes
- ☐ no

Film-/Photo-No.

Velocity of flow according to BLfW (1995)

☐	I	not visible	almost still, eddy
☐	II	barely visible	current very weak, but visible
☐	III	slowly running	current visible, water surface smooth
☐	IV	rapidly running	current with moderate turbulence
☐	V	rapid	turbulently running
☐	VI	torrential	very turbulent, loud brawl

Shading according to Wörlein (1992)

☐	1 completely sunny	sunny from sunrise to sunset
☐	2 sunny	in full sun most of the time between sunrise and sunset, but always during the warmest hours of the day
☐	3 partly overcast	mostly in the sun, but in the shade during the warmest hours of the day
☐	4 half shaded	in the shade for more than half of the day and always at noon
☐	5 completely shaded	completely shaded by trees

Plant cover
Covering large areas ☐ mosaic ☐

Water
Colouration ___ Odour ___

Substratum

Percentage			Substratum Cover
%	Mud		☐
%	Clay/loam	(<0,063 mm)	☐
%	Sand	(0,063-2,0 mm)	☐
%	Fine/med. gravel	(2,0-6,3/6,3-20mm)	☐
%	Coarse gravel	(20-63 mm)	☐
%	Stones	(63-200 mm)	☐
%	Boulders	(> 200 mm)	☐
%	organic/peat		☐

Embankment/Foreign substrata

Distance		near natural
m	Enforcement of river bed	☐
m	Modific. In transverse dir.	☐
m	Embankment	☐
m	Outlets	☐
m	Pipes	☐
m	Waste/(construction)debris	☐
m		☐
m		☐

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Figure 9: Field protocol running water macrophytes (page1)

Macrophytes

Species name	Plant-abundance*	Total plant abundance*	sub-/emerged	Vitality**	Sociability***	Sediment/Substratum-type	Herb.

* Plant abundance according to KOHLER (1978)
1 = very rare
2 = rare
3 = common
4 = frequent
5 = very frequent, predominant

** Vitality, modified according to BRAUN-BLANQUET (1964)
● = very well developed
ß = well developed
O = moderately developed
oo = poorly developed

*** Sociability modified according to BRAUN-BLANQUET (1964)
I = scattered
II = tufts, caespitose
III = small patches
IV = larger patches
V = forming large mats

☐ **Dominance of helophytes** Species

Dominant plants of the riparian zone
- ☐ Meadows & grassland
- ☐ Reeds & sedge fen
- ☐ Herb. veg. & tall herb community
- ☐ Riparian forest
- ☐ Plants of the forest floor
- ☐ Forest, silviculture
- ☐ Cultivated species & neophytes

Other/Special characteristics

Algae-aspect

Remarks

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Figure 10: Field protocol running water macrophytes (page2)

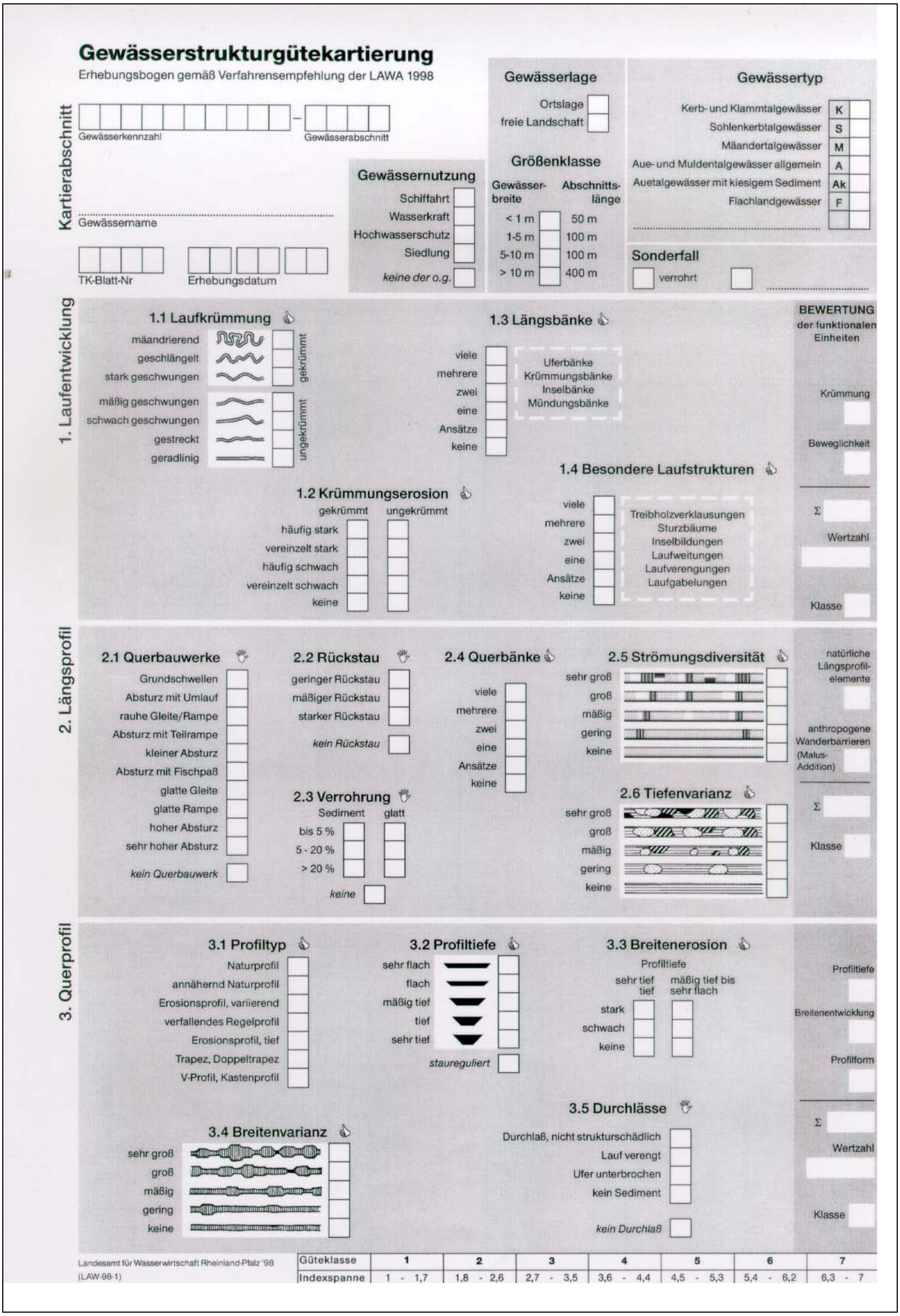
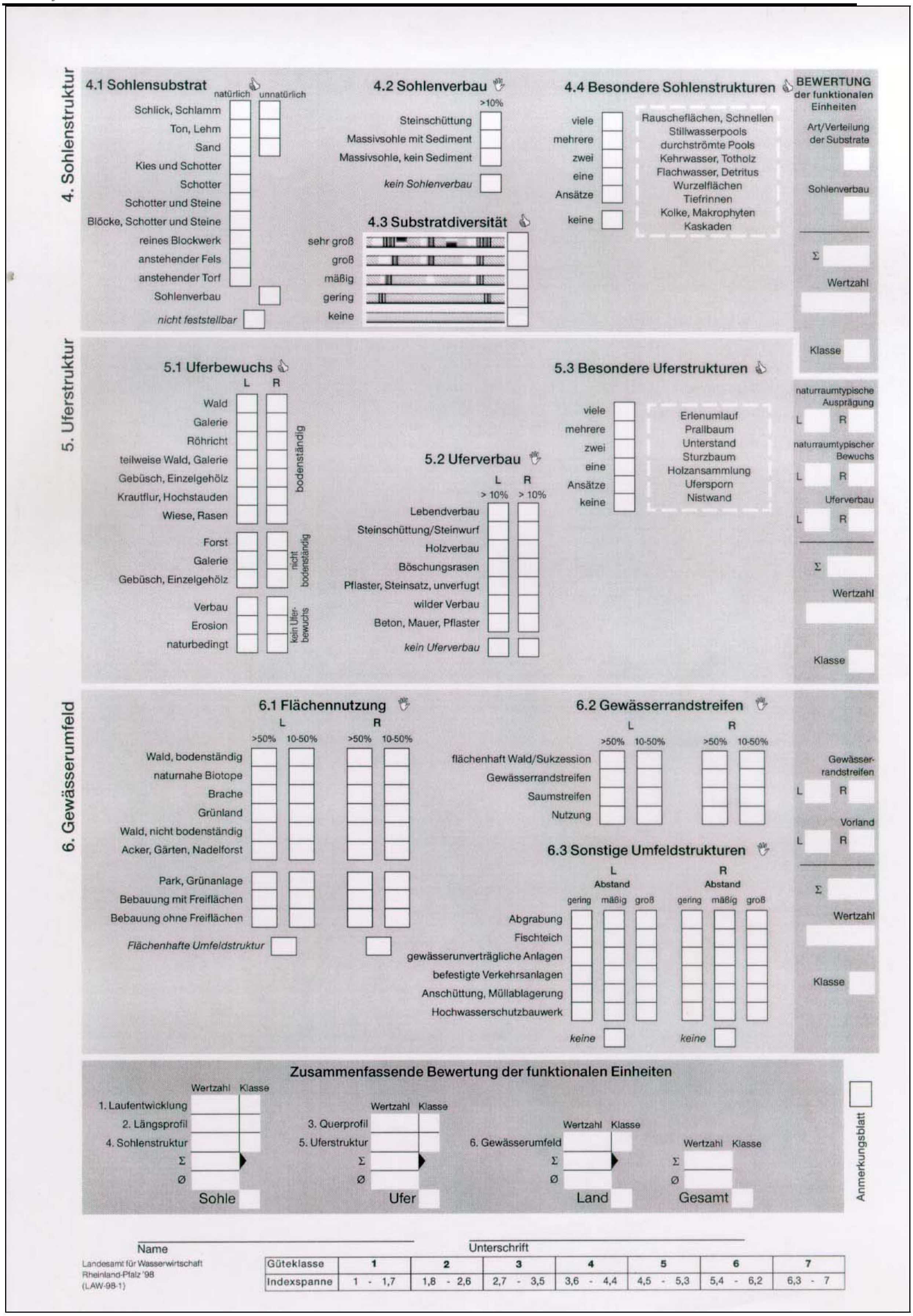


Figure 11: Field protocol for mapping structural quality according to LAWA (2000) (page1)



4. Sohlenstruktur

4.1 Sohlensubstrat — natürlich / unnatürlich
Schlick, Schlamm
Ton, Lehm
Sand
Kies und Schotter
Schotter
Schotter und Steine
Blöcke, Schotter und Steine
reines Blockwerk
anstehender Fels
anstehender Torf
Sohlenverbau
nicht feststellbar

4.2 Sohlenverbau — >10%
Steinschüttung
Massivsohle mit Sediment
Massivsohle, kein Sediment
kein Sohlenverbau

4.3 Substratdiversität
sehr groß
groß
mäßig
gering
keine

4.4 Besondere Sohlenstrukturen
viele
mehrere
zwei
eine
Ansätze
keine
Rauscheflächen, Schnellen
Stillwasserpools
durchströmte Pools
Kehrwasser, Totholz
Flachwasser, Detritus
Wurzelflächen
Tiefrinnen
Kolke, Makrophyten
Kaskaden

BEWERTUNG der funktionalen Einheiten
Art/Verteilung der Substrate
Sohlenverbau
Σ
Wertzahl
Klasse

5. Uferstruktur

5.1 Uferbewuchs — L R
bodenständig: Wald; Galerie; Röhricht; teilweise Wald, Galerie; Gebüsch, Einzelgehölz; Krautflur, Hochstauden; Wiese, Rasen
nicht bodenständig: Forst; Galerie; Gebüsch, Einzelgehölz
kein Uferbewuchs: Verbau; Erosion; naturbedingt

5.2 Uferverbau — L > 10%, R > 10%
Lebendverbau
Steinschüttung/Steinwurf
Holzverbau
Böschungsrasen
Pflaster, Steinsatz, unverfugt
wilder Verbau
Beton, Mauer, Pflaster
kein Uferverbau

5.3 Besondere Uferstrukturen
viele
mehrere
zwei
eine
Ansätze
keine
Erlenumlauf
Prallbaum
Unterstand
Sturzbaum
Holzansammlung
Ufersporn
Nistwand

naturraumtypische Ausprägung L R
naturraumtypischer Bewuchs L R
Uferverbau L R
Σ
Wertzahl
Klasse

6. Gewässerumfeld

6.1 Flächennutzung — L: >50%, 10-50%; R: >50%, 10-50%
Wald, bodenständig
naturnahe Biotope
Brache
Grünland
Wald, nicht bodenständig
Acker, Gärten, Nadelforst
Park, Grünanlage
Bebauung mit Freiflächen
Bebauung ohne Freiflächen
Flächenhafte Umfeldstruktur

6.2 Gewässerrandstreifen — L: >50%, 10-50%; R: >50%, 10-50%
flächenhaft Wald/Sukzession
Gewässerrandstreifen
Saumstreifen
Nutzung

6.3 Sonstige Umfeldstrukturen — L Abstand: gering, mäßig, groß; R Abstand: gering, mäßig, groß
Abgrabung
Fischteich
gewässerunverträgliche Anlagen
befestigte Verkehrsanlagen
Anschüttung, Müllablagerung
Hochwasserschutzbauwerk
keine *keine*

Gewässerrandstreifen L R
Vorland L R
Σ
Wertzahl
Klasse

Zusammenfassende Bewertung der funktionalen Einheiten
Wertzahl Klasse
1. Laufentwicklung
2. Längsprofil
4. Sohlenstruktur
Σ
Ø
Sohle
Wertzahl Klasse
3. Querprofil
5. Uferstruktur
Σ
Ø
Ufer
Wertzahl Klasse
6. Gewässerumfeld
Σ
Ø
Land
Wertzahl Klasse
Σ
Ø
Gesamt
Anmerkungsblatt

Name
Unterschrift
Landesamt für Wasserwirtschaft Rheinland-Pfalz '98 (LAW-98-1)

Güteklasse	1	2	3	4	5	6	7
Indexspanne	1 - 1,7	1,8 - 2,6	2,7 - 3,5	3,6 - 4,4	4,5 - 5,3	5,4 - 6,2	6,3 - 7

Figure 12: Field protocol for mapping structural quality according to LAWA (2000) (page2)

Field protocol for diatom sampling in running waters

(Macrophyte- & Phytobenthos-evaluation according to EC-WFD 2005; gray fields are optional)

Name of water body

Sampling site

Location of sampling site

Nearby town/village **Editor**

Sampling Site No. **Report No.**

Easting **Northing**

Topo. Map No. **Date**

Length of section m

Mean width m

Mean depth

- ☐ I 0-30 cm
- ☐ II 30-100 cm
- ☐ III >100 cm

Water level

- ☐ dry
- ☐ low
- ☐ medium
- ☐ high

Can sampling be carried out over the entire width of the running water? yes ☐ no ☐

Turbidity

- ☐ no turbidity, clear
- ☐ Medium turbidity
- ☐ Strong turbidity

Bottom visible?

- ☐ yes
- ☐ no

Film-/Photo-No.

Velocity of flow according to BLfW (1995)

☐	I	not visible	almost still, eddy
☐	II	barely visible	current very weak, but visible
☐	III	slowly running	current visible, water surface smooth
☐	IV	rapidly running	current with moderate turbulence
☐	V	rapid	turbulently running
☐	VI	torrential	very turbulent, loud brawl

Shading according to Wörlein (1992)

☐	1 completely sunny	sunny from sunrise to sunset
☐	2 sunny	in full sun most of the time between sunrise and sunset, but always during the warmest hours of the day
☐	3 partly overcast	mostly in the sun, but in the shade during the warmest hours of the day
☐	4 half shaded	in the shade for more than half of the day and always at noon
☐	5 completely shaded	completely shaded by trees

Substratum diatom sample

Substratum

Percentage

%	Mud	
%	Clay/loam	(<0,063 mm)
%	Sand	(0,063-2,0 mm)
%	Fine/med. gravel	(2,0-6,3/6,3-20 mm)
%	Coarse gravel	(20-63 mm)
%	Stones	(63-200 mm)
%	Boulders	(> 200 mm)
%	organic/peat	

Macrophyte aspect

Aspect of remaining phytobenthos

Remarks

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Figure 13: Field protocol running water diatoms

Field protocol running water phytobenthos

(Macrophyte- & phytobenthos-evaluation according to-WFD 2005; grey fields are optional)

Name of water body

Sampling site

Location of sampling site

Nearby town or village | Editor

Sampling site No. | Report-No.

Easting | Northing

Topo. Map No. | Date

Length of section ___ m | Mean width ___ m

mean depth
- ☐ I 0-30 cm
- ☐ II 30-100 cm
- ☐ III >100 cm

water level
- ☐ dry
- ☐ low
- ☐ medium
- ☐ high

Can sampling be carried out over the entire width of the running water? yes ☐ no ☐

Turbidity
- ☐ no turbidity, clear
- ☐ medium turbidity
- ☐ strong turbidity

Bottom visible?
- ☐ yes
- ☐ no

Film-/photo-No.

Phytobenthos samples

Nr.	Description of sample	Type of substratum	Degree of cover or estimated abundance
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

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Figure 14: Field protocol running water phytobenthos without diatoms

Microscopy Protocol Phytobenthos

Remarks

NoSamSite

NoSubRep

Date of sampling

NoSamSite

			Cover slip									
Photo	Taxon	Abundance	1	2	3	4	5	6	7	8	9	10

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Figure 15: Microscopy protocol running water phytobenthos without diatoms

Field Protocol Macrophytes & Phytobenthos of running waters

(Macrophytes- & Phytobenthos evaluation according to EC-WFD 2005; grey fields are optional)

name of water body

Sampling site

Location of sampling site

Nearby town/village   Editor

Sampling Site-No.   Report-No.

Easting   Northing

Top. Map No.   Recording date

Length of section ___ m   Mean width ___ m

Mean depth
- I 0-30 cm
- II 30-100 cm
- III >100 cm

Water level
- dry
- low
- medium
- high

Can sampling be carried out over the entire width of the running water? yes ☐ no ☐

Turbidity
- No turbidity, clear
- Medium turbidity
- Strong turbidity

Bottom visible
- yes
- no

Film-/Photo-No.

Velocity of flow according to BLfW (1995)

I	not visible	almost still, eddy
II	barely visible	current very weak, but visible
III	slowly running	current visible, water surface smooth
IV	rapidly running	current with moderate turbulences
V	rapidly running	turbulently running
VI	torrential	very turbulent, loud brawl

Diatom sample   Yes/no

Substrate

Shading according to Wörlein (1992)

1	completely sunny	sunny from sunrise to sunset
2	sunny	in full sun most of the time between sunrise andsunset, but always during the warmest hours of the day
3	partly overcast	mostly in the sun, but in shade during the warmest hours of day
4	half shaded	in the shade for more than half of the day and always at noon
5	compl. Shaded	completely shaded by trees

Macrophyte stands

covering large areas ☐   mosaic ☐

Water
- Colouration
- Odour

☐ **Dominance of helophytes**   **Species**

Algae aspect

Dominant plants of the riparian zone
- Meadows & grassland
- Reeds & sedge fen
- Herb veg. & tall herb community
- Riparian forest
- Plants of the forest floor
- Forest, silviculture
- Cultivated species & neophytes

Remarks

Substrate

Percentage			Substrate Cover
%	Mud		☐
%	Clay/oam	(<0,063 mm)	☐
%	sand	(0,063-2,0 mm)	☐
%	Fine/med. gravel	(2,0-6,3/6,3-20mm)	☐
%	Coarse gravel	(20-63 mm)	☐
%	Stones	(63-200 mm)	☐
%	Boulders	(> 200 mm)	☐
%	organic/peat		☐

Embankments/Foreign substrata

Distance		near natural
m	Enforcement of river bed	☐
m	Modific in transverse dir.	☐
m	Embankm./Modific. of shore	☐
m	Outlets	☐
m	Pipes	
m	Waste/(construction) debris	
m		☐
m		☐

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Figure 16: Field protocol running water macrophytes and phytobenthos (page 1)

Macrophytes

Species name	Plant-abundance	Total plant abundance	sub-/ emerge	Vitali-ty**	Sozia-bility**	Sediment/ Substrate-	Herb

* Plant abundace according to KOHLER (1978)
1 = vera rare
2 = rare
3 = common
4 = frequent
5 = very frequent, predominant

** Vitalität, verändert nach BRAUN-BLANQUET (1964)
● = very well developed
ß = well developed
O = moderately developed
oo = poorly developed

*** Sociability modified according to BRAUN-BLANQUET (1964)
I = scattered
II = tuts, caespitose
III = small patches
IV = larger patches
V = forming large mats

Phytobenthos samples

No	Description of sample	Type of substratum	Degree of cover or estimated abundance
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			

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Figure 17: Field protocol running water macrophytes and phytobenthos (page 2)